Project Number: W-SL001.03

Queen Street Wastewater Diversion: Part 3 Works

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PUBLIC

Construction Noise and Vibration Assessment

wsp

150 YEARS IN AOTEAROA

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Revision Details

Revision	Details
0	Issue to Client
1	Updated construction methodology
2	Updated basalt removal methodology and Greys Ave Support
3	Updated for shaft and construction site area layout changes, change in construction methodology, and updates to construction programme
4	Revision from Client feedback

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Abbreviation and Definitions

AC	Auckland Council
AT	Auckland Transport
AUP	Auckland Unitary Plan
CNVMP	Construction Noise and Vibration Management Plan
CNVA	Construction Noise and Vibration Assessment
CRLL	City Rail Link Limited
CSA	Construction Support Area
DCS	Design and Construction Statement
mTBM	Micro Tunnel Boring Machine
NSR	Noise Sensitive Receptor(s)
TMPs	Traffic Management Plans
Watercare	Watercare Services Limited
WSP	WSP New Zealand Limited

Glossary

Glossary	
Term	Description
A-weighting, dBA	The unit of sound level, weighted according to the A-scale, which considers the increased sensitivity of the human ear at some frequencies at low levels.
Ambient noise	The all-encompassing sound, at a given place at a certain time, is usually a composite of sounds from many sources near and far.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10} (s_1 / s_2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
Façade Level	A noise level measured/assessed at 1 metre in front of a sound reflecting object such as a building façade and including the contribution of the sound reflection.
Free-Field Level	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5 metres.
Equivalent Continuous Sound Pressure Level, $L_{eq,T}$	A noise level index called the equivalent continuous noise level over time T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
Maximum Sound Pressure Level, L_{max}	A noise level index is defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
Octave Band	A range of frequencies whose upper limit is twice the frequency of the lower limit.
Peak Particle Velocity, PPV	Peak Particle Velocity: Measure of the greatest instantaneous velocity change in a specific spot during a measurement period.
Sound Power Level (L_W or SWL)	The logarithmic measure in decibels of the sound power (P) generated by a source.
Sound Pressure Level (L_p or SPL)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa (20×10^{-6} Pascals) on a decibel scale.

Executive Summary

WSP has been engaged by Watercare Services Limited to assess the noise and vibration impacts from Part 3 of the Queen Street Wastewater Diversion Project, in Auckland.

Noise and vibration criteria have been developed based on the Auckland Unitary Plan. Noise from construction works within the roading corridor is exempt from the construction noise limits, provided that a Construction Noise and Vibration Management Plan (CNVMP) is developed with the measures being implemented. While a CNVMP will be adopted by the contractor (and a framework CNVMP has been provided with the Resource Consent), we have assessed noise from within the roading corridor for completeness.

The construction methodology for the installation of the wastewater pipework has been provided by Fulton Hogan (proposed main contractor), McConnell Dowell (the proposed tunnelling contractor) and the WSP design team. This methodology has been used to develop the phases of construction and equipment used as part of the construction.

Physical mitigation is proposed by the contractor by using solid site hoardings around each construction area, apart from access gates. However, as many of the surrounding buildings are multi-story, the screens are unlikely to be effective at screening noise to receptors above ground level.

Managerial mitigation measures such as controlling high-vibration equipment from operating near buildings within the Historic Heritage Overlay and using low-vibration rock fracking procedures will minimise the vibration generated during construction.

Based on the construction methodology, and managerial and physical mitigation measures, it is predicted that noise and vibration levels will be below the AUP construction noise and vibration standards.

Therefore, to ensure that the mitigation measures incorporated in this assessment are undertaken, a CNVMP shall be adopted. This will require noise and vibration to be reduced as far as reasonably practicable by the use of physical and managerial mitigation measures to control the effects.

The implementation of a CNVMP is expected to manage noise and vibration levels related to the construction of the Stage 3 works associated with the Queen Street Wastewater Diversion Programme effectively.

1 Introduction

Watercare Services Limited ("Watercare") is a lifeline utility providing water and wastewater services to a population of 1.7 million people in Auckland. Its services are vital for life, keep people safe and help communities to flourish. More specifically, Watercare is the council-controlled organisation of Auckland Council responsible for municipal water supply and wastewater treatment within Auckland, and the provider of bulk water and wastewater services to Pokeno and Tuakau in the Waikato District.

Watercare is proposing to upgrade the wastewater network within the upper catchment (southern) of Auckland City Centre. It has been established by Watercare that the existing network does not have sufficient capacity to meet future demands. WSP New Zealand Limited (WSP) has been engaged by Watercare to design and consent a new wastewater mainline through Auckland city centre (the Project).

This report provides an assessment of construction noise and vibration for Part 3 of the Queen Street Wastewater Diversion Programme. Resource Consent for the separate parts of the wider programme of works will be sought separately from these works, and therefore is excluded from this assessment.

Figure 1 Aerial view of the Part 3 alignment along Queen Street

This project involves a new wastewater pipe being positioned under Queen Street, between the intersection at Mayoral Drive and the intersection at Victoria Street as shown in Figure 1. Manholes for the new wastewater pipe will be provided at the Mayoral Drive intersection, Wellesley Street intersection and Victoria Street intersection of Queen Street. During construction, the manhole locations will be temporarily used as construction shafts.

This report is based on discussions with the design team along with the following information:

- Construction methodology titled *Queen St WW Diversion – Part 3 Construction Methodology*, revision 03, prepared by Fulton hogan, and dated 5 June 2024.
- Wastewater pipe alignment drawings titled *Queen Street Wastewater Diversion Part 3 main Works and Cross Connections*, issue 3, prepared by WSP and dated 30 May 2024.
- Design changes memo subject *Part 3 Queen Street Wastewater Diversion: Design Changes*, reference W-SL001.03/I3PTL, prepared by WSP, and dated 30 May 2024.
- Greys Ave Carpark layout titled *Queen Street Sewer Diversion; Site Compound & Welfare Layout*, drawing number QSSD_FH_001, revision I, prepared by Fulton Hogan, and dated 21 March 2024.

2 Description of Existing Environment

2.1 Location

The project is located within Auckland City Centre, a dense urban environment with a mixture of commercial, civic and residential activities and uses. The built form is predominately made up of multi-level buildings that generally align with the street. The majority of buildings are provided with verandas, overhanging the footpath area of the roads. The built form along Queen Street is a mix of modern buildings as well as important heritage structures. At street levels, the majority of buildings provide retail stores/units.

The project area is linear along Queen Street, between Victoria Street and Mayoral Drive. During construction, the area subject to project works will extend onto sections of Victoria Street, Wellesley Street and the surface carpark at 329 Queen Street and 38 Greys Avenue.

Figure 2 shows the approximate geographic area for the project in yellow, however, construction activity at surface level will be focused on the Queen Street intersections of Mayoral Drive, Wellesley Street and Victoria Street as approximately shown in red.

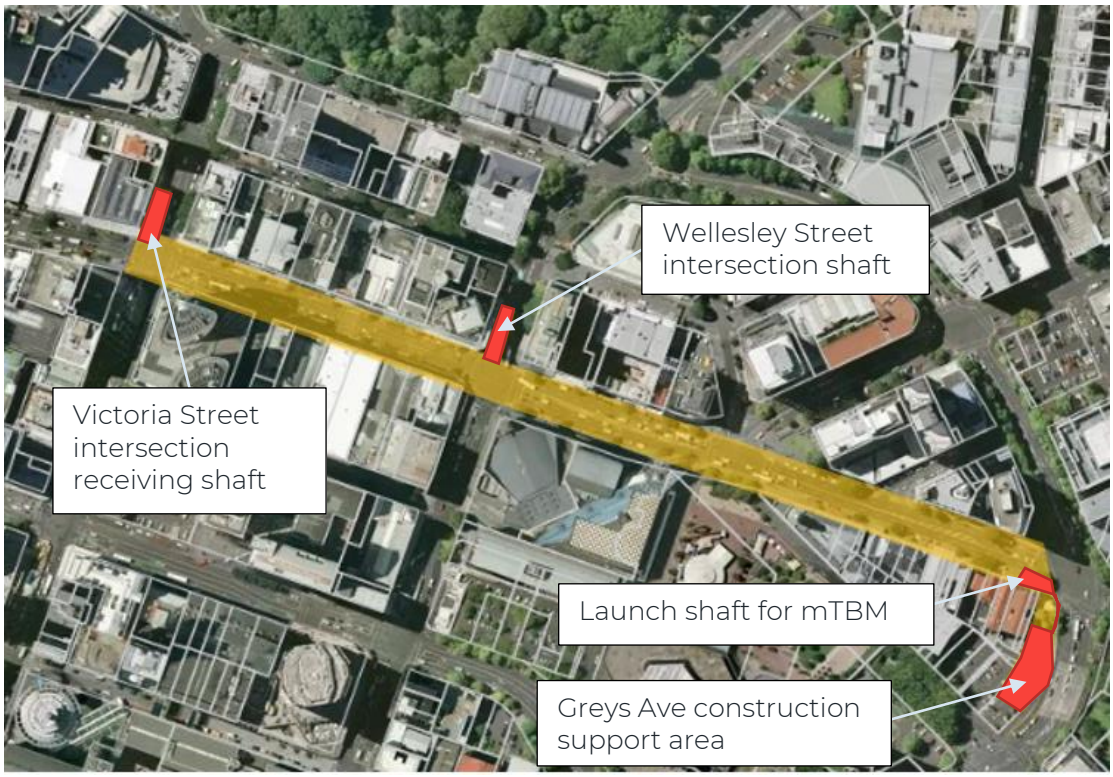


Figure 2 Project area and surface level areas used

2.2 Zoning and Overlays

All construction works occur within the road corridor, apart from the location of the Greys Ave construction support area (CSA), which is located within a Business – City Centre Zone, as outlined in the Auckland Unitary Plan (AUP).

Many sites directly adjacent to the works are located within a Business – City Centre Zone. The exception is Myers Park (Open Space – Community Zone) and Aotea Square (Open Space – Civic Spaces Zone). Some adjacent buildings are also protected by a Historic Heritage and Special Character overlay under the AUP.

The zoning of the three sites and surrounding areas are shown in Figure 3.

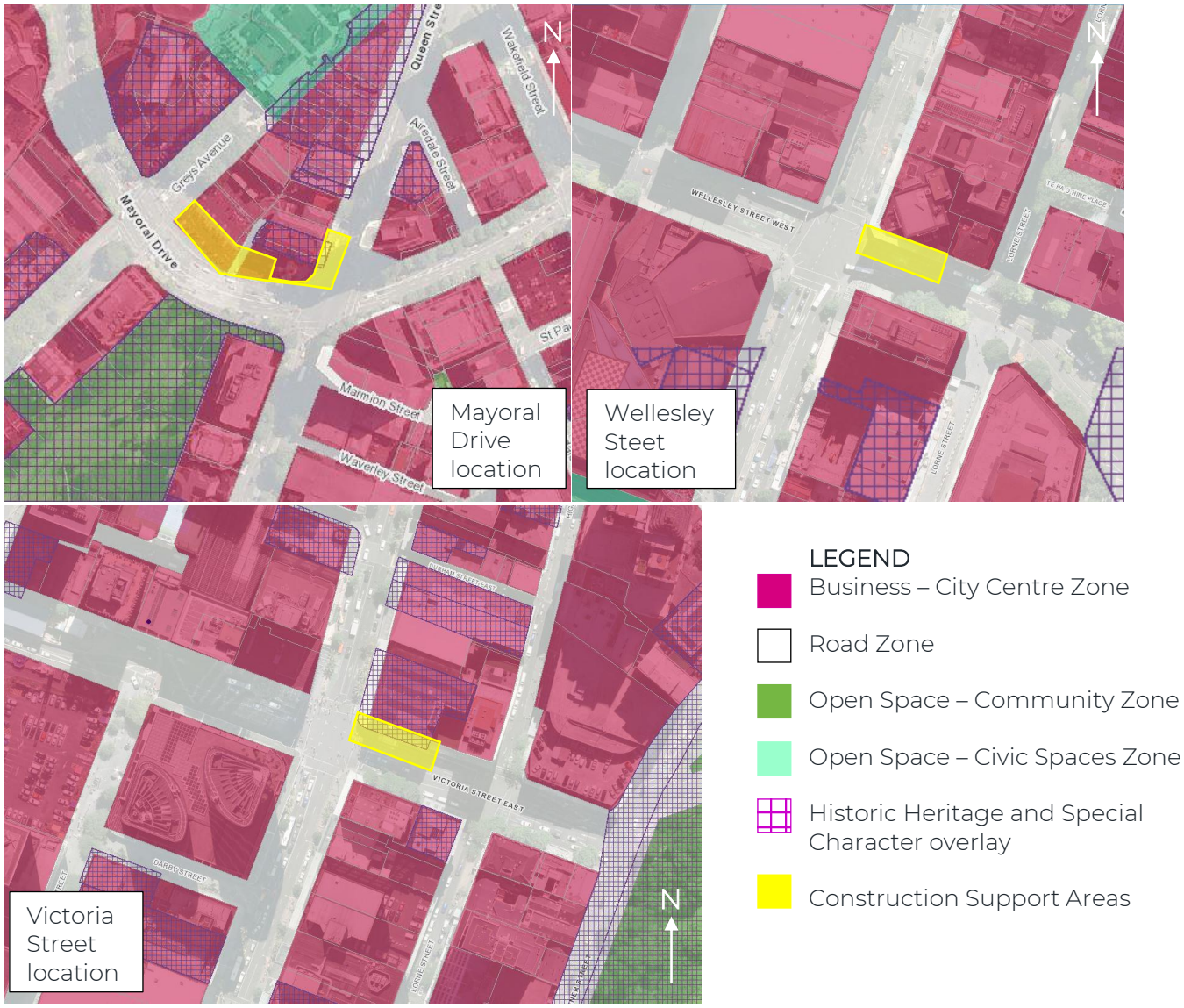


Figure 3 Sites (yellow) and surrounding zoning

2.3 Noise and Vibration Sensitive Receptors

Most buildings around the construction areas are commercial. There are also hotels and apartments near the sites. Commercial properties (yellow), hotels (blue), and apartments (pink) near each of the construction sites (red) are provided in Figure 3.

Many properties directly adjacent to the construction works are also located within the Historic Heritage overlay as outlined in the AUP. These properties are likely more sensitive to vibration and therefore specific management procedures will need to be adopted by the contractor to minimise the impact of vibration. These management procedures will be captured in a Construction Noise and Vibration Management Plan (CNVMP).

Figure 4 Adjacent noise sensitive receptor building types – commercial (yellow), hotels (blue), apartments (pink)

3 Project Works

The Project works will see the construction of a new wastewater pipeline under Queen Street, running between Mayoral Drive and Victoria Street. Connections to the existing wastewater network will be provided at Mayoral Drive, Wellesley Street and Victoria Street.

To provide for the new pipe, three temporary shafts will be provided along Queen Street (located at Mayoral Drive, Wellesley Street and Victoria Street). Once the shafts are constructed, tunnelling works will commence from Mayoral Drive, heading north along Queen Street towards Victoria Street. The Micro-Tunnel Boring Machine (mTBM) will be extracted at Victoria Street. Once tunnelling works are completed, the three shafts will be backfilled and converted to manholes.

The following is a summary of the project works, with a more detailed description provided within the Design and Construction Statement (appended to the Resource Consent application).

3.1 Construction Hours and Duration

The anticipated construction hours are noted in Table 1.

Table 1 Construction hours

Construction Hours	
Activity	Hours
Shaft construction	Monday to Saturday – 0700hrs to 1800hrs Sunday, Public Holiday and night works are not proposed (except for dewatering). These will only be carried out if required by traffic management restrictions or Watercare operational requirements for tie-in connections to existing network.
Tunnelling works	Monday to Saturday – 0700hrs to 1900hrs Sunday and Public Holidays – No construction works
Greys Avenue CSA	Monday to Saturday – 0700hrs to 2000hrs Sunday and Public Holidays – No construction works

In some exceptional circumstances, works may be required outside the hours noted above due to operational requirements. Any works outside of these hours will be approved by Auckland Transport and Auckland Council and be outlined within the CNVMP prior to being undertaken.

The duration of construction works is yet to be confirmed; however, it is anticipated that physical works will commence in Q3 2024 and would finish around Q3 2025. Table 2 notes the estimated construction duration.

Table 2 Construction duration

Construction Duration	
Site	Duration
Queen Street / Mayoral Drive Shaft	2 – 3 months to construct the shaft (Q3 2024 to Q1 2025)
Queen Street/ Wellesley Street Shaft	2 – 3 months to construct the shaft (Q4 2024 to Q2 2025)
Queen Street/ Victoria Street Shaft	3 – 4 months to construct the shaft (Q3 2024 to Q1 2025)
Tunnelling Activity (including site establishment)	Approx March 2025 to June 2025
Trenched tie-in works	Queen Street pipe work connections (x3) – 1 month (Q4 2024)

3.2 Temporary Construction Shafts

Three temporary shafts for trenchless construction are to be provided along the alignment. These will be constructed into manholes once the trenchless construction works have finished.

Queen Street/ Mayoral Drive Shaft

This shaft will be located on Queen Street, outside 323 Queen Street and once constructed will be approximately 14 metres deep, 4.5 metres wide, and 11 metres long. This shaft will be used as a launch shaft for tunnelling works. Secant piling methodology will be used to construct the extent of the shaft, which will require dewatering when open, depending on final groundwater level.

Figure 5 shows the position of the shaft (red/yellow) and the surrounding construction area (pink).

Figure 5 Mayoral Drive Shaft position and compound

Queen Street/ Wellesley Street Shaft

This shaft will be located on Wellesley Street, adjacent to 290 Queen Street and will be approximately 7.2 metres deep with an internal diameter of 3.5 metres. This shaft will be used for service connections as well as support for tunnelling works.

The shaft will be constructed using secant piling, and will be sealed once constructed. Dewatering is not required for this shaft.

Figure 6 shows the position of the shaft (light blue) and the surrounding construction area on Wellesley Street (dark blue).

Figure 6 Wellesley Street Shaft position and compound

Queen Street/ Victoria Street Shaft

This shaft will be located on Victoria Street, adjacent to 210 Queen Street and will be approximately 7 metres deep, 5 metres wide and 7.8 metres long, in an irregular polygon shape. This shaft will be used to provide a connection to the Ōrākei Main Sewer (OMS) as well as for the recovery of the mTBM. The shaft will be of post and panel construction and as such will require continued dewatering whilst the shaft is in use.

Figure 7 shows the position of the shaft (red) and the surrounding construction compound on Victoria Street (pink).

Figure 7 Victoria Street Shaft position and compound

3.3 Tunnelling Works

Tunnelling works will commence from the shaft at Mayoral Drive and end at the shaft at Victoria Street using a mTBM.

To support tunnelling works, a CSA will be established on part of the public car park at 38 Greys Avenue that will contain ancillary equipment and functions for tunnelling. A construction area around the shaft will include equipment used for the operation of the mTBM. Figure 8 shows the proposed layout for the Greys Avenue CSA and how it relates to the construction shaft on Queen Street.

Approximately 595 metres of 1.2 metre diameter pipe will be installed between the Mayoral Drive site and Victoria Street site.

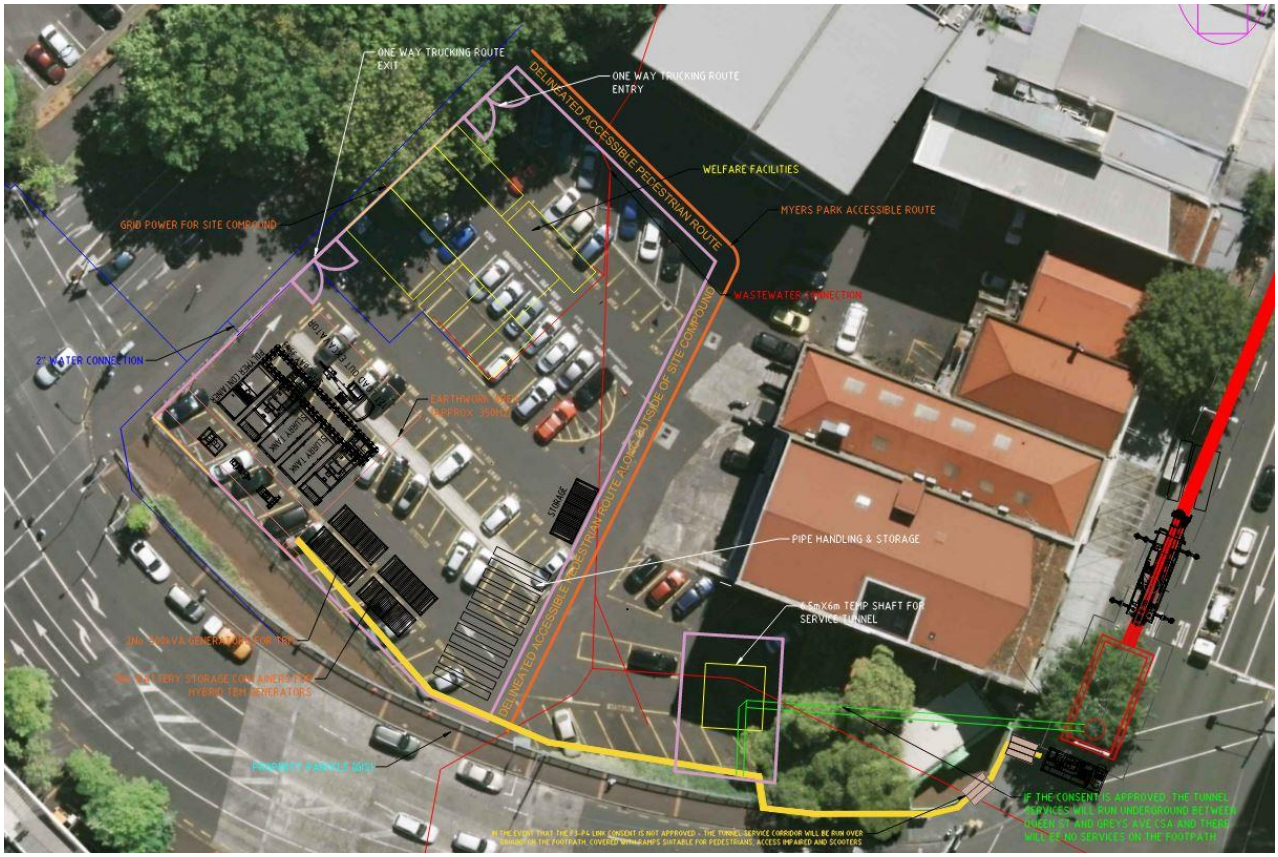


Figure 8 Greys Avenue CSA during tunnelling works

The equipment to be provided within the Greys Avenue CSA and the Mayoral Drive construction compound during tunnelling is given in Table 3.

Table 3 Equipment located at Greys Avenue CSA and Mayoral Drive site

Construction Support Areas Equipment during Tunnelling works	
Greys Avenue CSA	Mayoral Drive compound
• Project site office • Staff welfare facilities • 12t excavator • Separation plant • Slurry tanks • Electrical container • 800kW diesel generator (only required where mains connection cannot be established) • Pumps • Site laydown area/ material storage area • Pipe fit-out area	• Tunnelling control cabin • In-shaft jacking equipment • 50t mobile crane • Pipe laydown area

Once tunnelling commences, extracted material will be transported in a slurry medium to the separation plant at Greys Avenue CSA via a connection pipe between a temporary shaft in the Greys Avenue CSA and Mayoral Drive Shaft (consented separately under the Part 3-Part 4

Connector Tunnel consent). Once the solids have been removed from the slurry, it will be loaded onto trucks and disposed of off-site, with the liquid returning to the closed-loop system.

As the mTBM progresses from the Mayoral Drive shaft, 6m long sections of pipe will be installed. As the jacking rig is retracted, the next pipe section is lowered by a crane from the surface of the Mayoral Drive CSA and placed into position. The cycle continues until the drive is complete.

Once tunnelling is completed, the mTBM will be recovered at the Victoria Street Shaft.

Further detail on the construction methodology and staging is provided in Section 5.1 below. This includes a breakdown of the equipment, expected durations, and processes undertaken.

3.4 Vehicle Movements

Vehicle movements will be occurring to and from each CSA during the project works. Table 4 outlines the likely vehicle movements expected to occur.

Table 4 Vehicle movements

Proposed Vehicle Movements at Each Site		
Stage of Works	Likely vehicle movements (daily – average)	
Shaft Construction	Mayoral Drive site	• Light vehicles: 10 per day • Flatbed delivery trucks: 2 per day • Spoil/ aggregate trucks: 8 per day (peak)
	Wellesley Street site	• Light vehicles: 10 per day • Flatbed delivery trucks: 2 per day • Spoil/ aggregate trucks: 8 per day (peak)
	Victoria Street site	• Light vehicles: 10 per day • Flatbed delivery trucks: 2 per day • Spoil/ aggregate trucks: 8 per day (peak)
Tunnelling works	Light vehicles: 10 per day	
	Flatbed delivery trucks: 2 per day	

Please note that other vehicle movements will occur during site establishment and disestablishment activities. However, the movements are expected to result in noise levels significantly lower than those predicted, and therefore are not expected to make a material difference to the assessment.

4 Performance Standards

Section 16 of the Resource Management Act (RMA) requires occupiers of land to avoid unreasonable noise:

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

Guidance as to what a reasonable level of noise and vibration when assessed at adjacent noise sensitive receptors is taken from Chapter E25 – Noise and Vibration of the AUP. This chapter sets out noise and vibration standards for permitted activities. Where the AUP noise and/or vibration standards are exceeded, then a resource consent is required as a restricted discretionary activity.

4.1 Construction Noise Criteria

This section outlines guidance as to what constitutes a reasonable level of noise.

4.1.1 Auckland Unitary Plan

The majority of the construction works occur within the road corridor and therefore section E25.6.29 of Chapter E25 (AUP) applies. The relevant sections of these noise standards are reproduced below. Where construction works occur outside of the road corridor, the noise standards outlined in section E25.6.27 apply.

E25.6.29. Construction noise and vibration levels for work within the road

(3) The noise levels specified in Standard E25.6.29(1) above do not apply to unplanned repair or maintenance works or planned works in the road corridor between the hours of 7am and 10pm where:

(b) because of the nature of the works and the proximity of receivers the noise generated cannot be practicably made to comply with the relevant noise levels of the following tables:

(i) Table E26.6.27.1 Construction noise limits for activities sensitive to noise in all zones except the Business - City Centre Zone and the Business – Metropolitan Centre Zone;

(ii) Table E25.6.27.2 Construction noise levels for noise affecting any other activity; or

(iii) Table E25.6.28.1 Construction noise levels for construction less than 15 consecutive calendar days duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone; or

(iv) Table E25.6.28.2 Construction Noise levels for construction of 15 consecutive calendar days or more duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone; or

(c) for planned works, a copy of the works access permit issued by Auckland Transport or approval from the New Zealand Transport Agency is provided to the Council five days prior to work commencing; or

(d) for planned works where the works will take more than 8 hours to complete a construction noise and vibration management plan is provided to the Council no less than five days prior to the works commencing in accordance with the applicable provisions of Standard E25.6.29(5) below

(4A) The vibration levels specified in E25.6.29(1A)(b) do not apply to works within the road where:

(b) a construction noise and vibration management plan is provided to the Council no less than five days prior to the works commencing in accordance with the applicable provisions of Standard E25.6.29.(5) below.

(5) construction noise and vibration management plan must be prepared by a suitably qualified and experienced person and include the following:

(a) details of the community consultation to be undertaken to advise the occupiers of properties located within 100m of the proposed works of all of the following:

(i) the area affected by the work;

(ii) why the work is required to be undertaken at night (where relevant);

(iii) the times and days when the noise and vibration is likely to be generated;

(iv) a contact name and number of the works supervisor who can be contacted if any issues arise and

(v) how noise and vibration complaints will be managed and responded to;

(b) a description of the works and its duration, anticipated equipment to be used, the processes to be undertaken, and the predicted noise and vibration levels; and

(c) identification of the best practicable options that will be undertaken to mitigate and minimise any noise and vibration being produced that is likely to exceed the relevant levels of the following tables:

(i) Table E26.6.27.1 Construction noise limits for activities sensitive to noise in all zones except the Business - City Centre Zone and the Business – Metropolitan Centre Zone;

(6) For the purpose of Standards E25.6.29(1) to E25.6.29(4A) above:

(a) planned work means work that has been planned to take place at least seven days before the work commences;

(b) the measurement and assessment of all construction noise must be in accordance with New Zealand Standard NZS 6803:1999 Acoustics – Construction noise; and

(c) the measurement of all vibration must be in accordance with E25.6.30 Vibration.

The ability to exceed noise limits for works in the road corridor, as per item 3(d), allows for road corridor works to be completed efficiently to minimise road closures and subsequent disruptions.

However, under Section 16 of the RMA, there is still a requirement for construction noise (and vibration) to not exceed a reasonable level. There is also a requirement for the CNVMP to indicate the area impacted by the works. Therefore, we have predicted noise generated by the construction activities regardless of where the works occur.

E25.6.28. Construction noise levels in the Business – City Centre Zone and the Business – Metropolitan Centre Zone

(1) Construction activities in the Business – City Centre Zone and the Business –Metropolitan Centre Zone must comply with Standard E25.6.27(1) above for any receiver not in a Business – City Centre Zone or a Business –Metropolitan Centre Zone and must not exceed the levels in Table E25.6.28.1 Construction noise levels for construction less than 15

consecutive calendar days duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone and Table E25.6.28.2 Construction noise levels for construction of 15 consecutive calendar days or more duration in the Business – City Centre Zone and the Business – Metropolitan Centre Zone when measured for any 30 minute period 1m from the façade of any building in the Business – City Centre Zone or the Business – Metropolitan Centre Zone that is occupied during the work.

Where external measurement of construction noise is impractical or inappropriate, the upper limits for the noise measured inside the building will be 20dB less than the relevant levels.

Whilst construction works are only proposed on Monday to Saturday, and therefore will always be less than 15 consecutive calendar days in duration, we have conservatively applied the noise limits in Table E25.6.28.2 (for works that occur for more than 15 consecutive days), which are reproduced below.

Table 5 AUP Construction noise limits in the Business – City Centre Zone

Construction Noise Assessment Criteria AUP Construction noise limits in the Business – Metropolitan Centre Zone, assessed 1m from the facade		
Time	$L_{Aeq,30\ min}$ (dB)	L_{AFmax} (dB)
Monday to Friday 6.30am – 10.30pm	75	90
Saturday 7am-11pm	80	90

The most stringent noise limit during this time is 75 dB $L_{Aeq(30min)}$ / 90 dB L_{AFmax} from construction activities. We have therefore assessed noise against these criteria.

E25.6.27. Construction noise levels in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone

(1) Noise from construction activities in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone must not exceed the levels in Table E25.6.27.1 Construction noise levels for activities sensitive to noise in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone when measured 1 m from the façade of any building that contains an activity sensitive to noise that is occupied during the works.

(4) For a project involving a total duration of construction work that is more than 20 weeks the noise limits in Table E25.6.27.1 Construction noise levels for activities sensitive to noise in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone and Table E25.6.27.2 Construction noise levels for noise affecting any other activity above shall be decreased by 5 dB in all cases.

Based on the proposed construction methodology, the construction works will occur for 6 – 8 months, as outlined in Table 2 .

This rule applies to all properties that are not zoned City Centre. Specifically for this project, the buildings within Aotea Square are outside of the City Centre zone, and therefore the construction noise limits in Rule E25.6.27 of the AUP apply. These levels (including the adjustment for works greater than 20 weeks) are provided in Table 6.

Table 6 Construction noise limits outside the city centre

Construction Noise Assessment Criteria AUP Construction noise limits for sites outside of the Business – Metropolitan Centre Zone or Business – Metropolitan Centre Zone, assessed 1m from the facade			
Day	Time	$L_{Aeq,30min}$ (dB)	L_{AFmax} (dB)
Monday to Friday	6:30am – 7:30am	55	70
	7:30am – 6pm	70	85
	6pm – 8pm	65	80
Saturdays	6:30am – 7:30am	40	70
	7:30am – 6pm	70	85
	6pm – 8pm	40	70
Sundays and public holidays	6:30am – 7:30am	40	70
	7:30am – 6pm	50	80
	6pm – 8pm	40	70
Night-time	8pm – 6:30am	40	70

Source: Auckland Unitary Plan – Table E25.6.27.1

The construction noise limits under the AUP apply 1 metre away from the façade of a residentially occupied building.

In line with other noise standards within the AUP, construction noise in this assessment has been undertaken over 30 minutes.

4.1.2 New Zealand Standard NZS 6803:1999

New Zealand Standard NZS 6803:1999 provides guidance for the prediction and measurement of noise from construction sites. Table 2 and Table 3 of NZS 6803:1999 outlines the recommended upper limits for construction noise for noise received at residential receptors and commercial or industrial receptors.

The long-term duration construction noise limits (defined as *construction work at any one location with a duration exceeding 20* weeks) from NZS 6803:1999 are reproduced in Table 7, based on the timeframes where construction will occur.

Table 7 NZS 6803 Recommended upper limits for construction noise

Construction Noise Assessment Criteria New Zealand Standard NZS 6803:1999 recommended noise limits			
Day	Time	$L_{Aeq,30min}$ (dB)	L_{AFmax} (dB)
Residential receptors			
Weekdays	0630-0730	55	75
	0730-1800	70	85
	1800-2000	65	80
	2000-0630	45	75
Saturday	0630-0730	45	75
	0730-1800	70	85
	1800-2000	45	75
	2000-0630	45	75
Sundays and public holidays	0630-0730	45	75
	0730-1800	55	85
	1800-2000	45	75
	2000-0630	45	75
Commercial and Industrial receptors			
All days	0730-1800	70	-
	1800-0730	75	-

These noise limits apply 1 m from the wall most exposed to construction activity and 1.2 to 1.5 m above the relevant floor level.

NZS 6803:1999 notes that a measurement sample time should not exceed one hour, and 15 minutes will often be adequate.

4.2 Construction Vibration Criteria

This section outlines guidance as to what constitutes a reasonable level of vibration.

4.2.1 Auckland Unitary Plan

Section E25.6.30 of the AUP outlines the relevant vibration limits, which are reproduced below.

E25.6.30. Vibration

(1) Construction and demolition activities must be controlled to ensure any resulting vibration does not exceed:

a. the limits set out in German Industrial Standard DIN 4150-3 (1999): Structural vibration – Part 3 Effects of vibration on structures when measured in accordance with that Standard on any structure not on the same site; and

b. the limits in Table E25.6.30.1 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.

4.2.2 German Standard DIN 4150-3:1999

The German Standard DIN 4150:1999 'Structural Vibration – Part 3: Effects of Vibration on Structures' is an internationally recognised standard used to assess the effects of vibration on

structures. The Standard is widely used throughout New Zealand and is referenced by many District Plans (or similar) including the AUP.

DIN 4150-3:1999 criteria to evaluate the effects of short-term vibration on structures (such as impact piling or blasting which occurs instantaneously) that does not induce resonance in a building structure, or long-term vibration (such as from vibratory piling or traffic).

The vibration limits in DIN 4150-3 relate to avoiding cosmetic damage to buildings (such as cracking in paint). This is framed as 'minor damage' in DIN 4150, meaning it can easily be repaired. DIN 4150 states:

> *'Experience has shown that if these values are complied with, damage will not occur. Exceeding the values in table 3 slightly does not necessarily lead to damage.'*

The vibration limits outlined in DIN 4150-3 are set such that there is a low probability of cosmetic damage. These apply at the plane of the highest floor of various types of building. Structural damage is unlikely to occur in both residential and commercial structures at less than 50 mm/s, and for in-ground structures and infrastructure services at less than 100 mm/s.

The long-term vibration limits outlined in Table 3 of DIN 4150-3:1999 are outlined in Table 8.

Table 8 DIN 4150-3 long-term guideline vibration limits

Construction Vibration Criteria DIN 4150-3 Guideline vibration limits used to assess the effects of long term-vibration on structures		
Line	Type of Structure	Guideline values for velocity, i_i, in mm/s, of vibration in the horizontal plane of the highest floor, at all frequencies.
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	10
2	Dwellings and buildings of similar design and/or use.	5
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic values (e.g., buildings under a preservation order).	2.5

4.2.3 Auckland Unitary Plan Vibration Amenity Limits

The vibration amenity limits outlined in Table E25.6.30.1 of the AUP are reproduced below.

Table 9 AUP Amenity vibration limits

Construction Vibration Criteria Vibration limits in buildings from construction (E25.6.30.1)		
Receiver	Period	Maximum Peak Particle Velocity (PPV) Limit, mm/s
Occupied activity sensitive to noise	Night-time 10pm to 7am	0.3
	Daytime 7am to 10pm	2.0
Other occupied buildings	At all times	2.0

The vibration limits in Table 8 apply to any axis when measured in the corner of the floor of the storey of interest for a multi-storey building, or within 500mm of ground level at the foundation of a single storey building. An allowance for properties to receive up to 5 mm/s is provided for, only if prior notification was given, at least three days in advance, within 50m of the works.

The vibration limits in Table 9 are useful in considering whether an adjacent resident or occupant is likely to have their amenity reasonably affected by vibration, however they should not generally be used as an absolute threshold. Exceeding these limits is a call to action, that requires certain management measures to be set in place i.e., through a CNVMP.

4.2.4 British Standard BS 5228-2:2014

British Standard BS 5228-2:2014 *Code of Practice for noise and vibration control on construction and open sites – Part 2: Vibration* provides guidance on human perception of vibration. However, we note that 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.

Humans perceive vibration at much lower magnitudes than the levels of vibration that are likely to cause building damage. Occupants of buildings are therefore likely to complain about vibration significantly below the levels likely to result in cosmetic damage to buildings.

The guidance values in BS 5228-2 are provided in Table 10. These levels are provided as a means of acknowledging that humans perceive vibration well before vibration venerated from construction activities would impact the building structure. However, these levels can be used to provide guidance as to at what level certain management measures should be adopted.

Table 10 BS5228 vibration subjective impacts

Construction Perception Criteria BS 5228-2:2014 guidance on human perception of vibration	
Vibration Level (PPV)	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.

4.3 Noise Impact Terminology

We have used the following terminology when considering the impacts on adjacent properties

Table 11 Noise impact terminology

Noise Impact Terminology	
Noise impact wording	Description
Acceptable	The predicted noise or vibration level is at or below the AUP criteria
Reasonable	The predicted noise or vibration level is above the AUP criteria, but due to timing, assessment location, hours of operation, receiver, or other factor the level of noise or vibration impact on the receiver is low.
Obvious	The predicted noise or vibration level is above the AUP criteria and is likely to have a low or medium impact on adjacent receptors. Noise-sensitive activities are likely to be disturbing.
Unreasonable	The noise or vibration level is likely to have a high impact on adjacent receptors. All but least lest sensitive activities are likely to be disturbed.

5 Assessment Methodology

This section details the assessment methodology, the assumptions and limitations used within this assessment.

5.1 Construction Staging and Equipment

5.1.1 Construction Equipment

Appendix A provides a list of the expected equipment to be used during construction, the associated sound power of that equipment, and the percentage of time in use over a worst-case 30-minute period.

The equipment selection and associated sound power levels are based on BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites*, NZS 6803:1999 *Acoustics – Construction noise*, or previous measurements of similar equipment.

Appendix A also presents the vibration levels for specific high-vibration equipment taken from the NZTA *State highway construction and maintenance noise and vibration guide,* BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites*, or previous measurements of similar equipment.

Vibration measurements of pipejacking operations have been undertaken by the contractor on other projects. These have resulted in vibration levels of 0.3 mm/s PPV or less at adjacent buildings. However, without the specific ground conditions known, distance, or foundation type, we have used a conservative vibration generating assumption in our calculations.

WSP undertook vibration measurements of a plate compactor at the proposed Victoria Street / Queen Street shaft location. The plate compactor operated on a single spot, with the vibration measurements made at various distances away from the plate compactor including on the foundation (on ground level) and within the basement of 210 Queen Street. The measurements of the plate compactor operating and the specific foundation reduction for 210 Queen Street have been used in our analysis.

The evaluation and assessment have been conducted under the assumption that the equipment or plant will not exceed the levels outlined in Appendix A. It is the contractor's responsibility to ensure that all equipment and/or plant on site is equivalent to or less than the assumed sound power levels.

Light construction works (such as light handheld tools, manual digging, line painting etc.) are also expected to occur on site. These activities are not expected to produce excessive noise or vibration levels and have therefore not been included unless otherwise specified.

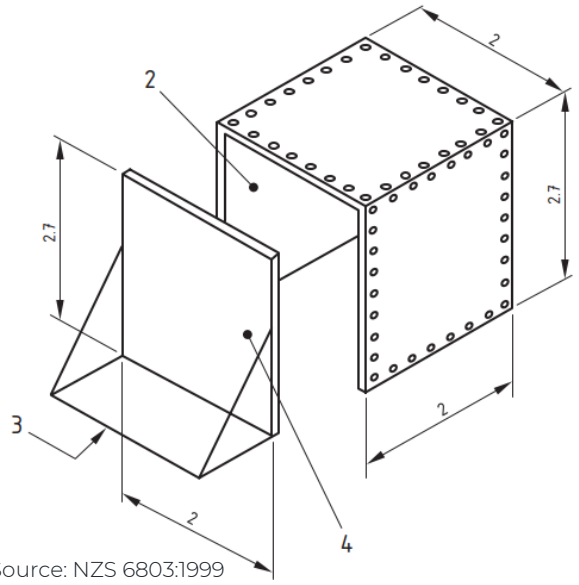
5.1.2 Physical Site Mitigation

The contractor is proposing to use temporary steel barriers with solid/temporary fence hoardings around the perimeter of each of the construction compounds, except where a gate is required for access. These include the launch and receiving shafts for the trenchless construction. The locations of the proposed site hoardings are shown in Figure 9.

Figure 9 Proposed locations of site hoardings (pink)

The site hoardings are to be constructed to a height of no less than 2.0 metres with a surface mass of 10 kg/m^2 (such as 18 mm plywood) and have no gaps or cracks.

Temporary localised barriers or enclosures should be used over the opening of the shaft during any drilling of the basalt, and around generators and/or pumps used for dewatering during the night-time. An example of temporary enclosures that could be constructed over the shaft opening during rock breaking or compaction is shown in Figure 10.



Source: NZS 6803:1999

Source: https://blog.echobarrier.com/

Figure 10 Example of temporary acoustic enclosure

5.1.3 Managerial Mitigation

Managerial mitigation measures will be adopted by the contractor to further help reduce the noise and vibration and the impacts of any exceedances.

Further information on managerial mitigation measures is provided in Section 9.3.

A CNVMP is recommended as a condition of consent, and a Framework CNVMP is appended to this assessment. This is to ensure that the best practicable option of mitigation is adopted by the contractor.

5.1.4 Construction Staging

The general construction staging for the overall construction works is provided in Table 12. It is unknown whether the shafts will be constructed concurrently or consecutively.

Table 12 Overall construction works staging

Overall Construction Staging		
Activity	Starting	Duration
Queen Street / Mayoral Drive shaft	Q3 2024	2 – 3 months to construct the shaft
Queen Street/ Wellesley Street Shaft	Q3 2024	2 – 3 months to construct the shaft
Queen Street/ Victoria Street Shaft	Q3 2024	3 – 4 months to construct the shaft
CSA to support tunnelling operations	Q3 2024	7 months including site establishment operation and take-down
Trenchless pipe installation	Q1 2025	Queen Street pipe work connections (x3) – 1 month
Trenched tie-in works	Q1 2025	2 – 3 months to construct the shaft

The construction staging for all stages of the works are outlined in Table 13 to Table 19 separately. Some phases do not include significant noise-generating activities. These phases have not been assessed as they will generate noise levels lower than the remainder of the phases assessed.

Table 13 Shaft Construction - Queen Street / Mayoral Drive

Shaft Construction Queen Street/ Mayoral Drive		
Phase	Activity	Equipment/Materials assessed for noise and/or vibration impact.
1	Shaft extent will be saw cut and a 14t – 20t excavator used to remove pavement layers and other shallow level obstructions.	• Concrete cutter • Excavator • 6 or 8 wheeler truck
2	A SR-45 SFA drill rig will auger 600mm dia holes to 18m deep. The auger will be replaced with concrete as it extracts to surface level to prevent collapse. Hard piles will be reinforced with UC posts or helical reinforcing cages.	• SR-45 drill rig • 6 or 8 wheeler truck • Concrete truck and pump
3	Shaft extent will be excavated using a combination of a 3t excavator and 20 – 35t excavator (with a telescopic boom arm) and workers with compressor powered hand held air tools, and welder. Shaft spoil will be removed from site using a 6 or 8 wheeler truck with sealed bins. Shaft will require 24/7 dewatering and a submersible pump will be used to pump water into clarifying tank(s) for treatment, before discharging into the local wastewater network. The pump will be powered by a diesel generator (running 24/7) or local power network. Forced air ventilation will be required using a fan at surface level with ventilation ducting into the shaft.	• Excavators • Hand held power tools • 6 or 8 wheeler truck • Ventilation fan • Submersible pump • Diesel generator
4	Steel waler beams will be installed and welded together within the shaft to support the UC posts.	*This activity will occur concurrently with Phase 3. Therefore, noise generated in this phase has been assessed concurrently with Phase 3.* *The same equipment used in Phase 3 will occur within this Phase.*
5	Following tunnelling works, an in situ concrete manhole will be formed and poured within the shaft using a concrete skip and 90t crane at road level or with a concrete pump. Precast concrete riser manhole sections will be installed using a 90t crane at road level. The temporary works will be progressively removed using a gas axe and 90t crane The shaft will be backfill with compacted GAP65 or low strength concrete using the 90t crane and skip.	• Crane • Concrete truck pump and skip • Trucks • Excavator • Submersible pump • Diesel generator • Ventilation fan
6	Road pavements (GAP65 and AC) will be reinstated using a 14 – 20t excavator, 400kg plate compactor and static drum roller.	• Excavator • Static drum roller • 400 kg plate compactor

Table 14 Shaft Construction - Queen Street / Wellesley Street

Shaft Construction Queen Street/ Wellesley Street		
Phase	Activity	Equipment/Materials assessed for noise and/or vibration impact.
1	Shaft extent will be saw cut and a 20t excavator used to remove pavement layers and other shallow-level obstructions including existing redundant overflow pipe. A trench will be dug to remove the 4m deep redundant overflow pipe that runs across the shaft..	• Concrete cutter • Excavator • 6 or 8 wheeler truck
2	A concrete guide beam will be formed a poured to assist with managing pile placement and verticality. A SR-45 drill rig will be used to undertake secant piling of the shaft perimeter to a depth of approximately 14 metres.	• SR-45 drill rig • 6 or 8 wheeler truck • Concrete truck and pump
3	Shaft extent will be excavated using a combination of a 3t excavator and 20 – 35t excavator (with a telescopic boom arm) and workers with compressor powered hand held air tools. Shaft spoil will be removed from site using a 6 or 8 wheeler truck with sealed bins.	• Excavators • Hand held power tools • 6 or 8 wheeler truck • Submersible pump • Diesel generator • Ventilation fan
4	Following tunnelling works, an in situ concrete manhole will be formed and poured within the shaft using a concrete skip and 90t crane at road level or with concrete pump. Precast concrete riser manhole sections will be installed using a 90t crane at road level. The temporary works will be progressively removed using a gas axe and 90t crane The shaft will be backfill with compacted GAP65 or low strength concrete using the 90t crane and skip.	• Crane • Concrete truck pump and skip • Trucks • Excavator • Submersible pump • Diesel generator • Ventilation fan
5	Road pavements (GAP65 and AC) will be reinstated using a 14 – 20t excavator, 400kg plate compactor and static drum roller.	• Excavator • Static drum roller • 400kg plate compactor

As the shaft will be sealed, no dewatering is required for the Queen Street / Wellesley Street shaft.

Table 15 Shaft Construction - Queen Street / Victoria Street

Shaft Construction Queen Street/ Victoria Street		
Phase	Activity	Equipment/Materials assessed for noise and/or vibration impact.
1	Shaft extent will be saw cut and a 5 to 20t excavator used to remove pavement layers and other shallow-level obstructions.	• Concrete cutter • Excavator • 6 or 8 wheeler truck
2	SR-45 drill rig will be used to bore 400 to 600mm diameter holes to 10 metres depth and backfilled with concrete	• SR-45 drill rig • 6 or 8 wheeler truck • Concrete truck and pump
3	Steel UC posts will be lowered into each bore using a 14 to 20t excavator and the bores backfilled with sand.	• Excavator • 6 or 8 wheeler truck
4	The shaft extents will be excavated using an 5 and 35t excavator and workers with compressor powered hand held air tools. A 25t crane and skip will be used to remove hand held excavated materials when the excavator runs out of reach. Shaft spoil will be removed from site using a6 to 8 wheeler trucks. Shaft will require 24/7 dewatering and a submersible pump will be used to pump water into clarifying tank(s) for treatment, before discharging into the local wastewater network. The pump will be powered by a diesel generator (running 24/7) or local power network. Forced air ventilation will be required using a fan at surface level with ventilation ducting into the shaft.	• Excavators • Hand held power tools • Crane • Welder • Submersible pump • Ventilation fan • Diesel generator • 6 or 8 wheeler truck
5	Timber lagging will be cut to fit and installed between UC posts as the excavation progresses to retaining the surrounding ground. At least two steel waler beams will be installed and welded together within the shaft to support the UC posts.	*This activity will occur concurrently with Phase 4. Therefore, noise generated in this phase has been assessed concurrently with Phase 4.* *The same equipment used in Phase 4 will occur within this Phase.*
6	Solid basalt will be found within this shaft at approximately 5.5m below road level. The basalt layer will be broken out using coring, cutting and rock splitting techniques. Shaft will require 24/7 dewatering and a submersible pump will be used to pump water into clarifying tank(s) for treatment, before discharging into the local wastewater network. The pump will be powered by a diesel generator (running 24/7) or local power network. Forced air ventilation will be required using a fan at surface level with ventilation ducting into the shaft. Concrete piles installed at tunnel entry for breakthrough of mTBM	• Excavator • Rock diamond drill • Crane • Submersible pump • Ventilation fan • Diesel generator • Concrete truck and pump
7	After mTBM extraction, an in situ concrete manhole will be formed and poured within the shaft using a concrete skip and 90t crane at road level or with concrete pump. Precast concrete riser manhole sections will be installed using a 90t crane at road level. The temporary works will be progressively removed using a gas axe and 90t crane The shaft will be backfill with compacted GAP65 or low strength concrete using the 90t crane and skip.	• Crane • Concrete truck pump and skip • Trucks • Excavator • Submersible pump • Diesel generator • Ventilation fan
8	Road pavements (GAP65 and AC) will be reinstated using a 14 – 20t excavator, 400kg plate compactor and static drum roller.	• Excavator • Static drum roller • 400kg plate compactor

Table 16 Open Cut Trench Pipe Installation

Open Cut Pipe Laying Queen Street/ Wellesley Street		
Phase	Activity	Equipment/Materials assessed for noise and/or vibration impact.
1*	Temporary traffic management set up in accordance with approved Traffic Management Plans (TMPs). TMPs will be staged, allowing only short sections of pipeline to be constructed at any one time.	• Traffic management equipment
2	Approximately 20 to 30m of trenching will be open at any one time. Open earthworks would be up to 300m^3. Depth of trenches are not known, however for any trench deeper than 1.5m, a trench shield will be used.	• Trench shield • Flatbed truck • Excavator • Submersible pump • Diesel generator
3	Pipe lengths and precast manholes will be delivered to site on flatbed trucks and unloaded within the site using HIAB or excavators.	*This activity will occur concurrently with Phases 2 - 5. Therefore, noise generated in this phase has been assessed concurrently with Phases 2 – 5.* *The same equipment used in Phase 2 will occur within this Phase.*
4	Excavator will be used to trench to the required depth and install trench shields as the excavations advance. Wider trench boxes will be provided at manhole locations. Excavated material will be removed from site as clean, managed or contaminated fill subject to contamination testing results.	*This activity will occur concurrently with Phases 2 - 5. Therefore, noise generated in this phase has been assessed concurrently with Phases 2 – 5.* *The same equipment used in Phase 2 will occur within this Phase.*
5	If dewatering is required (subject to ground investigation outcome), a two-inch submersible pump and hole will be used to remove water from excavations. Water will be pumped into clarifying tanks/ containers for treatment before discharge. The pumps will be powered by a diesel generator which will run continuously while the trench is open, dependent on water ingress rates. Dewater is not anticipated to be required in a single location for more than three weeks.	*This activity will occur concurrently with Phases 2 - 5. Therefore, noise generated in this phase has been assessed concurrently with Phases 2 – 5.* *The same equipment used in Phase 2 will occur within this Phase.*
6	Pipe bedding material will be carted to the worksite directly from source in 6 or 8 wheeler trucks, spread into the trench using an excavator and compacted using 400kg plate compactors. Excavators will be used to lift 2.4m pipe lengths into the trench.	• 6 to 8 wheeler truck • Excavator • Plate compactor
7	Side haunch, overlay bedding and hard fill to pavement level will be constructed as per pipe bedding material (refer above). Pavement layer will be stepped out from trench excavation to provide key into the existing pavement layers. Pavement aggregates will be spread using excavators and compacted using drum rollers, apart from where within 15m of a heritage structure.	• Excavator • Static drum roller • Plate compactor

The location of the open-trench construction works are shown in Table 17.

Table 17 Location and Length of Three Wastewater Connections

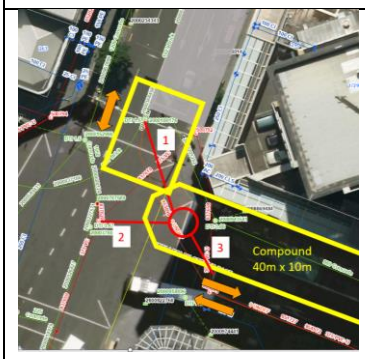
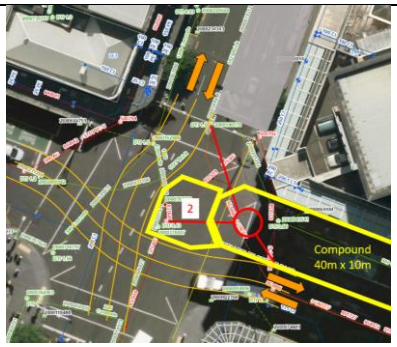
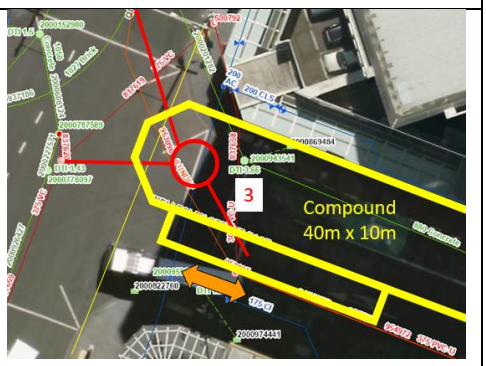
Connection 1	Connection 2	Connection 3
14.76m in length	10m in length	11.4m in length
Adjacent to the north approach on Queen Street	In the middle of the intersection	Adjacent to the east approach on Wellesley Street
		

Table 18 Trenchless Pipe Installation – shaft areas

Queen Street/Victoria Street and Queen Street/Mayoral Drive Trenchless Construction		
Stage	Activity	Equipment/Materials
1*	Insertion of mTBM into the shaft in multiple stages. A 25t crane at surface level will be used to drop mTBM into the shaft. Handheld power tools will be used to connect all parts and move to the required position. The shaft will require 24/7 dewatering and a submersible pump will be used to pump water into clarifying tank(s) for treatment, before discharging into the local wastewater network. The pump will be powered by a diesel generator which will run continuously while the shaft is open (subject to water ingress rates). Please note that, if possible, a connection the local power network would be used over a generator. Forced air ventilation will be required using a fan at surface level with ventilation ducting into the shaft.	• Submersible pump • Diesel generator • Ventilation fan • Crane • Handheld power tools
2*	Operation of the mTBM including noise from the operation, control cabin and 50t crane to insert new 6m lengths of pipe. It is predicted that up to 12 metres of pipe installation will occur each day requiring the use of the crane twice for insertion of new pipework. Pumps will be required at the surface level to remove the slurry from the bore face and bring water back, along with the pumping bentonite slurry around the drill head for lubrication for the pipes. Forced air ventilation will be required using a fan at surface level with ventilation ducting into the shaft. Dewatering of the shaft will be required 24/7 with a submersible pump with a clarifying tank, powered by a diesel generator.	• mTBM machine • Control cabin • Crane • Diesel generator • Ventilation fan • 6-inch mTBM pump • Submersible pump
3^	Victoria Street intersection will receive the mTBM. Hand power tools will be used to dismantle the drill head to allow extraction from the shaft. A 30t mobile crane will be used to lift the mTBM parts from the shaft onto a truck and trailer unit. Each shaft will then be backfilled as per the tables above.	• Submersible pump • Diesel generator • Ventilation fan • Crane • Handheld power tools • Truck and trailer

*Noise generated at Wellesley Street shaft only
^Noise Generated at Victoria Street shaft only

Table 19 Noise from the Construction Support Area at Greys Avenue

Greys Avenue Construction Support Area		
Stage	Activity	Equipment/Materials
1	The Greys Avenue Construction Support Area will be established around June 2024. This will require multiple hiabs delivering site office, staff welfare facilities, separation plant and slurry tanks, and generators. Trucks will deliver large machinery. Temporary traffic management and site hoardings will enclose the site.	• Hiabs, • Trucks • Excavator • Crane
2*	During the mTBM operation, the separation plant and slurry tank will be operational. An excavator will be used to remove slurry from the tank into arriving and departing 6 wheeled trucks. Excavators will be used to move pipes from the compound to the Mayoral Drive shaft location via the service corridor (twice daily).	• Separation plant • Generator • Pumps • Excavator • Trucks
3^	Operation of the Greys Ave CSA and mayoral Drive shaft during concurrently during trenchless construction.	• Stage 2 in Table 18 and Stage 2 in Table 19

* Noise generated in the Greys Ave CSA only
^ Cumulative noise from Greys Ave CSA and Mayoral Drive Shaft operating concurrently

5.2 Noise Prediction Methodology

A noise prediction model has been prepared using SoundPLAN Version 8.2 3D computational noise modelling software. A series of scenarios have been analysed with supporting spreadsheet calculations.

Noise predictions between the source equipment and one metre from the façade of all adjacent buildings has been undertaken in accordance with the method provided in NZS 6803 and *ISO 9613-2:1996 Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation* (ISO 9613-2).

The model prediction considers attenuation due to distance, terrain, absorption by the atmosphere and ground, and reflections from building facades (including the receiver façade).

The noise modelling assumes worst-case theoretical downwind conditions in all directions from all sources, which provides a conservative approach for assessment.

Table 20 presents the noise modelling parameters adopted for this assessment.

Table 20 Noise modelling parameters

Parameters for computational noise modelling		
Property	Value	Source
Calculation method	NZS 6803 for construction noise ISO 9613-2 for propagation	-
Terrain contours	0.25 m vertical heights	Auckland Council GeoMaps
Buildings	Outlines of Building footprints Heights set to 3.m for each story	Auckland Council GeoMaps, Heights via Google Street View.
Land parcels	Property land and road extent	Auckland Council GeoMaps
Ground Absorption Coefficient	0.1 – acoustically hard ground	Street View
Number of Reflections	3	-
Assessment location	1.0 metres from any façade	NZS 6803

All equipment is assumed to operate at the closest point to any adjacent site for our analysis.

The L_{AFmax} was calculated using the maximum noise level generated by any piece during any phase when undertaken at the closest point from the site to the receptor building. This approach provides a worst-case assessment of noise levels.

5.3 Vibration Prediction Methodology

Appendix A presents the vibration levels for specific high-vibration equipment. Vibration propagation between the source equipment and receiving locations has been predicted based on the methodology outlined in the Waka Kotahi NZ Transport Agency's *State Highway Construction and Maintenance Noise Vibration Guide* (version 1.1, dated August 2019). This method assumes hard soil conditions (compacted clay, exposed rock), and slab-on-grade foundations type of all adjacent properties. This is a conservative assessment of the ground conditions and foundation types. Actual vibration levels are likely to be lower.

5.4 Assumptions and Limitations

The following assumptions and limitations apply to this construction noise and vibration assessment:

- Construction activity locations are based on the contractor's documentation, including proposed methodology, construction plant and master schedule.
- An assessment period of 30-minutes has been applied.
- It is conservatively assumed that all equipment will operate within a worst-case 30-minute period for each construction stage.
- There is always a level of uncertainty in predicting noise from construction activities. Numerous variables including variations in the specific models of equipment, the exact location of each item on site, and how the operator uses the equipment, will affect the accuracy of the noise predicted.

6 Predicted Levels

This section outlines the predicted noise and vibration levels associated with the construction works.

6.1 Predicted Noise Levels

6.1.1 Average Noise Levels ($L_{Aeq,30min}$)

The predicted noise levels at each noise-sensitive receptor for each construction phase and stage are presented in Appendix B, assuming the physical mitigation measures described in Section 5.1.2 are provided, unless otherwise specified.

In Appendix B, properties that receive noise levels exceeding the 75 dB $L_{Aeq,30\ min}$ noise limit are highlighted in red, indicating a potential non-compliance with the noise limits set by Auckland Council. Sites marked with a hash (#) indicate those affected by noise levels generated from within the road corridor designation only.

It is important to note that works associated with the shaft construction, open trenching, and trenchless construction are located within road reserve, and so, the wider Auckland Unitary Plan (AUP) construction noise limits do not apply. This is based on the understanding that construction activities within the road reserve are subject to separate noise regulations and considerations.

Greys Avenue CSA is the only area of the construction works which is located outside of the road reserve. Therefore, noise generated in this area must adhere to the broader AUP construction noise limits unless Resource Consent is granted.

The construction works at Mayoral Drive/Queen Street intersection and at Greys Avenue CSA has been assessed when operating independently and concurrently. All other work has been assessed independently.

Assessing all stages independently and assessing the Mayoral Drive/Queen Street Intersection stage and Greys Avenue CSA stage concurrently, allows specific assessment of compliance at all construction operating scenarios. This is then compared to the compliance requirements related to the road reserve and non-road reserve areas, ensuring alignment with the Auckland Council's regulations and guidelines.

Through this assessment with consideration to the exemptions and applicable regulations, this allows the predicted construction noise levels to be compared against the applicable AUP noise standards and maintain a responsible approach to construction noise management.

The table below outlines the properties which exceed the AUP 75 dB $L_{Aeq,30\ min}$ noise limit irrespective of the noise source being within the road corridor or within any other zoned land.

Table 21 Properties predicted to exceed the construction noise limits

Properties Predicted to Exceed the AUP Construction Noise Limits								
Stage of Works	Properties exceeded at each phase							
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
Shaft Construction: Queen Street/Mayoral Drive #	313 Queen St 317 Queen Street 319 Queen Street 321 Queen Street 323 Queen Street 329 Queen Street 380 Queen Street 396 Queen Street 430 Queen Street	313 Queen St 317 Queen Street 319 Queen Street 321 Queen Street 323 Queen Street 329 Queen Street 380 Queen Street 396 Queen Street	313 Queen St 317 Queen Street 319 Queen Street 321 Queen Street 323 Queen Street 329 Queen Street 380 Queen Street 396 Queen Street		313 Queen St 317 Queen Street 319 Queen Street 321 Queen Street 323 Queen Street 329 Queen Street 380 Queen Street 396 Queen Street	313 Queen St 317 Queen Street 319 Queen Street 321 Queen Street 323 Queen Street 329 Queen Street 380 Queen Street 396 Queen Street	n/a	n/a
Shaft Construction: Queen Street/Wellesley Street #	253-261 Queen St 263 Queen St 269-297 Queen St 280 Queen St 290 Queen St 300 Queen St 10 Wellesley St	263 Queen St 290 Queen St 300 Queen St 10 Wellesley St	253-261 Queen St 263 Queen St 269-297 Queen St 280 Queen St 290 Queen St 300 Queen St 10 Wellesley St 18-26 Wellesley St East	253-261 Queen St 263 Queen St 290 Queen St 300 Queen St 10 Wellesley St	253-261 Queen St 263 Queen St 290 Queen St 300 Queen St 10 Wellesley St	n/a	n/a	n/a
Shaft Construction: Queen Street/Victoria Street #	59-67 High St 203 Queen St 205-225 Queen St 214 Queen St 9 Victoria St E	59-67 High St 214 Queen St 9 Victoria St E	59-67 High St 214 Queen St 9 Victoria St E	59-67 High St 203 Queen St 214 Queen St 9 Victoria St E		59-67 High St 2 Lorne St 186 Queen St 191 Queen St 203 Queen St 205-225 Queen St 214 Queen St 222 Queen St 238 Queen St 9 Victoria St E	59-67 High St 203 Queen St 214 Queen St	59-67 High St 203 Queen St 205-225 Queen St 214 Queen St 9 Victoria St E
Open Trench Construction: Queen Street/Wellesley Street #	290 Queen St 300 Queen St	253-261 Queen St 263 Queen St 290 Queen St 300 Queen St				253-261 Queen St 263 Queen St 290 Queen St 300 Queen St 10 Wellesley St	253-261 Queen St 263 Queen St 290 Queen St 300 Queen St	n/a
Trenchless construction: Shaft locations only#	317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St	317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St	59-67 High St 214 Queen St 9 Victoria St E	n/a	n/a	n/a	n/a	n/a
Greys Ave CSA.	-	-	48 Greys Ave^ 100 Mayoral Dr^ 317 Queen St^ 319 Queen St^ 321 Queen St^ 323 Queen St^ 329 Queen St^	n/a	n/a	n/a	n/a	n/a

#Noise generated within the roading corridor impacting properties only.
^Noise generated by Greys Avenue CSA and Mayoral Drive operating concurrently.

6.1.2 Maximum Noise Levels (L_{AFmax})

The predicted maximum noise levels have been undertaken for the loudest construction activities; including piling, excavation, and rock drilling. All these activities are located within the road corridor.

The predicted maximum noise levels at each receptor based on the worst-case equipment without any noise mitigation are presented in Appendix B.

The following properties are predicted to exceed the maximum noise limit outlined in the AUP, with the exceedance decibel level provided in brackets:

- 59-67 High Street (13 dB)
- 2 Lorne Street (2 dB)
- 186 Queen Street (2 dB)
- 191 Queen Street (2 dB)
- 203 Queen Street (5 dB)
- 205-225 Queen Street (4 dB)
- 214 Queen Street (11 dB)
- 222 Queen Street (3 dB)
- 239 Queen Street (1 dB)
- 253-261 Queen Street (6 dB)
- 263 Queen Street (8 dB)
- 269-297 Queen Street (3 dB)
- 280 Queen Street (4 dB)
- 290 Queen Street (17 dB)
- 300 Queen Street (10 dB)
- 313 Queen Street (9 dB)
- 317 Queen Street (12 dB)
- 319 Queen Street (17 dB)
- 321 Queen Street (14 dB)
- 323 Queen Street (13 dB)
- 329 Queen Street (12 dB)
- 380 Queen Street (3 dB)
- 396 Queen Street (9 dB)
- 430 Queen Street (4 dB)
- 9 Victoria Street East (8 dB)

Maximum noise levels from construction activities outside of the road corridor (generated within the Greys Ave CSA) are predicted to comply with the maximum noise limits of the AUP.

6.2 Predicted Vibration Levels

The key vibration activities are from excavators breaking ground, piling or drilling of holes, operation of the mTBM, and compaction.

Table 22 outlines the stand-off distance of each piece of high vibration equipment used to achieve the various vibration limit. The stand-off distance is the distance from any vibration generating equipment at which the vibration limits are reached. Any building within the stand-off distance is predicted to exceed the vibration criteria.

All other equipment is expected to generate lower levels of vibration or be installed on the manufacturer's vibration isolation (such as the separation unit). Therefore, vibration levels will be lower than the equipment provided below.

Table 22 Vibration stand-off distances

Predicted vibration stand-off distances to achieve the relevant vibration criteria						
No.	Equipment	The vibration level of equipment (mm/s PPV @10m)	Stand-off distance to achieve vibration criteria (metres)			
			10 mm/s	5 mm/s	2.5 mm/s	2 mm/s*
1	Excavator breaking ground	1.9	0.5	1.8	6.5	10
2	Secant piling 600mm diameter piles.	0.5	0.1	0.2	0.5	1
3	mTBM Tunnel Boring	2.0	2	4	8	10
4	Plate Compactor**	1	0.1	0.2	0.7	1

*AUP vibration amenity limit
**From WSP measurements at Victoria St site

The 10 mm/s criteria apply at any commercial building, or structure that are commercial in nature (high-rise concrete or steel residential buildings for instance). The 5 mm/s applies to single, or two-storey detached or semi-detached residential dwellings.

Heritage properties are subject to more onerous vibration limits because of their structural sensitivity to vibration and their intrinsic value. We have considered that the 2.5 mm/s PPV limit applies to all buildings within the Historic Heritage overlay under the AUP.

Managerial mitigation measures have been adopted by the contractor to minimise the impacts of vibration. These include:

- Only static rollers or plate compactors to be used at the Mayoral Drive and Victoria Street compounds.
- Using low/no vibration rock fracturing methods to remove basalt from the Victoria Street shaft.
- Providing excavator operator training on specific measures to reduce vibration (such as slowly lowering the bucket onto the ground).
- Undertaking vibration measurements during the first operation of each piece of high-vibration equipment to quantify the level of vibration generated on site.

Based on the setback distances and mitigation measures adopted above, there are no properties predicted to exceed the DIN 4150-3 vibration criteria.

There are also no properties within the 2 mm/s AUP amenity limit setback distance from vibration generated outside of the road corridor.

7 Proposed Activity/s and Triggered Rules

The following section provides an indication of the AUP Chapter E25 rules which are predicted to be exceeded.

7.1 Noise

Noise generated from construction activity within the road corridor is exempt from achieving the AUP construction noise limits if a CNVMP is adopted, as outlined in Section E25.6.29 of the AUP.

A framework CNVMP has been provided as part of this resource consent application. The CNVMP will be reviewed and finalised by the contractor (including any changes to the methodology etc.) prior to the works commencing and provided to Auckland Council for certification before works start on site. The adoption of a CNVMP by the contractor allows for specific exemptions or deviations from the standard AUP construction limits for works within the road corridor. These exemptions are based on the mitigation strategies outlined in the CNVMP, which are designed such that noise and vibration levels are managed within acceptable levels.

There are no properties which are predicted to receive noise levels higher than the AUP construction noise standards from works outside of the road corridor.

7.2 Vibration

Vibration generated within the roading corridor is exempt from achieving the vibration limits outlined in Section E25.6.30(1)(b) where a CNVMP is adopted. A CNVMP is provided as part of this application.

A framework CNVMP has been provided as part of this resource consent application. The CNVMP will be reviewed and finalised by the contractor (including any changes to the methodology etc.) prior to the works commencing and provided to Auckland Council for certification before works start on site. The adoption of a CNVMP by the contractor allows for specific exemptions or deviations from Section E25.6.30(1)(b) vibration limits for works within the road corridor. These exemptions are based on the mitigation strategies outlined in the CNVMP, which are designed such that noise and vibration levels are managed within acceptable levels.

The vibration limits outlined in Section E25.6.30(1)(a) are required to be achieved regardless of location and if a CNVMP is adopted.

Based on the setback distances and specific managerial mitigation measures outlined in Section 6.2, **no properties are predicted to exceed the AUP Section E25.6.30(1)(a) vibration limits**.

Vibration generated outside of the road corridor is also predicted to comply with the AUP Section E25.6.30(1)(b) vibration limits.

8 Effects Assessment

The following sections provide an assessment of the construction noise and vibration generated by the proposed activities.

8.1 Construction Noise Effects

Noise from construction works will likely dominate the surrounding areas at times. In addition, most adjacent buildings are multi-storey or elevated compared to the work sites. Whilst physical barriers will mitigate noise effects at street level, barriers will not reduce noise for receptors above ground level due to the unobstructed line of sight.

We have the following comments regarding the noise impacts from the proposal:

- All noise exceedances are within the roading corridor. A CNVMP will be implemented by the contractor to outline the procedures for the best practicable option (BPO) of mitigation to control the noise and vibration effects.
- Noise from outside of the road corridor can exceed the AUP construction noise standards and still be a permitted activity, so long as other assessment parameters are achieved.
- While the worst-case noise levels have been predicted, we have considered the dynamic nature of the construction activities and the varying equipment used. We anticipate fluctuations in noise levels at different stages of the project. We have taken this into account during the noise impact assessment and have adjusted our recommended mitigation measures accordingly.
- The predicted noise levels provided in Appendix B are for all equipment within each phase operating concurrently at surface level at the closest relevant location where the equipment could occur on site. This is unlikely to occur at all times on all days. Therefore, actual noise received at adjacent buildings is likely lower than that predicted for most of the time.
- The assessment assumes that all equipment within each phase operates within a worst-case 30-minute period. This is unlikely to occur for most of the construction period where equipment is not used or is used less than assumed. Therefore, it is likely that for much of the construction period, noise levels received at adjacent properties will be lower than those predicted.
- The above analysis assumes that all equipment is located at the surface. Where machinery is located below ground level, the equipment will benefit from acoustic screening from the pit itself (this could include a plate compactor working at the bottom of trenches, or hydraulic breakers breaking rock in shafts).
- During high noise activities within the shaft (such as when drilling the basalt), an acoustic enclosure shall be installed over the shaft opening, where practicable. This will further reduce noise from this activity (by approximately 8 – 10 dB).
- The predicted noise levels are assessed at 1 metre from the façade of the building at 1.5 metres above any floor level in the building. At levels above the ground that wouldn't be screened by the proposed site hoardings, a noise level 1 metre from the façade is not an appropriate location to assess the noise effects from construction works. Inside a building at levels above the ground is a more relevant location to assess the impacts of construction noise. Table 23 has been developed based on current guidance and our professional experience. This assumes a 25 dB reduction as either there are no windows in the façade or the windows in the adjacent buildings are likely to be closed.

Table 23 Construction noise subjective effects

Subjective Construction Noise Effects in Adjacent Buildings	
External noise level, 1m from the facade	Effects with windows closed
80 dB $L_{Aeq, T}$	Disruption is likely for quiet activities. Likely to require volume the on TV or radio to be turned up to be intelligible over background noise.
75 dB $L_{Aeq, T}$	Noise from construction is likely perceptible over background noise. May be disruptive for quiet activities such as reading. Not likely to disrupt fewer sensitive activities such as watching TV; however, these may require more concentration.
70 dB $L_{Aeq, T}$	Little disruption. Noise is likely to be perceptible over background noise during quiet activities (such as reading). Unlikely to disrupt less sensitive activities such as watching TV.
65 dB $L_{Aeq, T}$	Unlikely to disrupt activity. May be audible within the building if quiet activities are occurring

The sites which are directly impacted by noise are within the Business – City Centre Zone. More recent buildings (generally either constructed under the previous Auckland City Council's District Plan or the current AUP) are likely to have specific façade constructions to minimise reverse sensitivity issues. For these buildings, the façade is likely to reduce external noise by 30 – 35 dB. However, we assumed all facades reduce noise by 25 dB.

- Noise from outside of the road corridor is predicted to be 75 dB $L_{Aeq,T}$ or lower, and therefore while construction noise is likely perceptible, it is unlikely to disrupt typical daytime activities.
- No night works are required (unless specifically required due to non-acoustic requirements, such as the traffic management plan). Therefore, there is no concern that noise from these construction works would cause sleep disturbance.
- During dewatering works, a low-noise generator and pump will run 24 hours a day to keep water out of the shafts. The Victoria Street shaft will require constant dewatering until reconstructed as a manhole. The Wellesley Street and Mayoral Drive shafts will only require dewatering during earthworks until the shaft base slab is constructed. To provide a worst-case estimate of effects, a sound power level of 97 dB L_{wA} has been assumed, operating at ground level without any additional hoardings or enclosures. Noise from this equipment operating at night is predicted to be no greater than 35 dB $L_{Aeq,30min}$ within any adjacent residential apartment, and therefore unlikely to cause sleep disturbance.
- Where practicable, all available physical mitigation measures shall be provided by the contractor to reduce the actual noise levels received by adjacent residents. Managerial mitigation measures shall also be adopted as part of a CNVMP to advise residents of the construction activities.

With the adoption of all practicable physical mitigation measures, the assessment of noise described above, and the implementation of a CNVMP, noise effects from construction are predicted to be **acceptable**.

8.2 Construction Vibration Effects

Vibration from the proposed construction activities are predicted to be below the vibration criteria outlined in Section E25.6.30 of the AUP both for works within the road corridor and outside of the road corridor.

Vibration at all other properties is predicted to be **acceptable**, as the levels are lower than that recommended under DIN 4150-3 and are allowed under the AUP as a permitted activity.

It should be noted that properties that are predicted to be within the 2 mm/s PPV setback distance may still experience vibration. Therefore, it is recommended that regardless of the location of the works as part of the CNVMP, these properties are notified a minimum of 10 working days prior to the commencement of the vibration activities outlined in Table 22.

9 Mitigation Measures

The construction noise and vibration assessment indicates that mitigation measures are required to reduce the noise and/or vibration impacts on adjacent properties.

This section provides details of the specific mitigation measures that shall be applied to the construction works.

Additionally, as noted in the Resource Management Act, mitigation measures should be adopted in any case to protect against unreasonable levels of noise and vibration where practically possible.

9.1 General Mitigation Measures

A CNVMP is recommended to be adopted as a condition of consent. This document shall be followed and updated by the contractor for the duration of the project. The CNVMP shall be developed in accordance with E25.6.29(5) of the AUP and Annex E2 of NZS 6803:1999, and be consistent with the framework CNVMP is provided as part of this Resource Consent application.

Chiefly, the CNVMP shall include an outline of how communications will be undertaken between the consent holder (and its contractors) and the neighbouring properties, particularly those that are predicted to exceed the recommended noise and/or vibration limits. The CNVMP shall include:

- How communication by the consent holder will occur about certain construction works expected to exceed the noise levels in NZS 6803:1999, including scheduling/timing of works and the identification of potential temporary nuisance effects.
- How residents may communicate any enquiries or complaints about construction noise.
- Procedures for directly notifying neighbouring properties at least 10 working days in advance of programmed noise events which are predicted to exceed the noise limit for each property such as piling, including the duration that they will occur for, and times they will occur between.
- Procedures for notifying neighbouring properties within the 2 mm/s PPV setback distance at least 10 working days in advance of the equipment outlined in Table 22 operating. This includes the duration that the equipment will operate and the times that it will operate between. Noting that vibration is unlikely to be at this level for the entire period.
- The contact details of the lead contractor/project manager and a representative of the consent holder.

9.2 Physical Mitigation Measures

9.2.1 Acoustic Site Hoardings

Physical mitigation measures are only effective where they block the line of sight from the plant to the receptor. In many cases, the surrounding buildings are multi-story and therefore when assessing noise at 1 metre from the façade of the building, therefore physical mitigation will have a limited impact.

However, physical mitigation measures are recommended as they can effectively reduce the impact in receptors who traverse along the footpath adjacent to the construction sites.

Site hoardings are proposed to be installed around the construction sites, as outlined in Section 5.1.2. The acoustic site hoardings shall achieve the following minimum specification:

- Height: >2.0metres
- Surface mass: >10 kg/m^2

- The hoardings shall be constructed and maintained such that there are no gaps or cracks in the fence.
- Where timber is used, the paling shall be overlapped by a minimum of 25 mm, or a board and batten system implemented. A sleeper rail will be required to seal the bottom of the fence to the ground. If timber is used, this would be constructed of 25 mm pine (or equivalent) to resist warping.

Where practicable, localised movable acoustic screens/barriers/hoardings shall be used around high noise-generating equipment when in use, such as a concrete saw. The movable site hoardings shall achieve the minimum specifications listed above.

9.2.2 Selection of Equipment

Equipment is to be selected with the generated noise level in mind. This includes:

- Vehicles with audible reversing warning sirens will be fitted with broadband reversing beepers.
- Generators and/or water pumps are to be selected that have acoustic enclosures to reduce the noise radiated by these units. The reduction the acoustic enclosures provide over standard units depends on the manufacturer. Where generators are required, these shall be installed on site as far as practicable from sensitive receptors. Where possible, dedicated localised acoustic barriers will be constructed around any generators and water pumps.
- Use of electric equipment over petrol/diesel alternatives including saws, hand power tools, chainsaws, and the like.
- Selection of equipment that is an appropriate power for the use (i.e., not using more powerful equipment than needed.

9.3 Managerial Mitigation Measures

9.3.1 General

The following managerial mitigation measures are to be adopted by the contractor as far as reasonably practicable:

- Site-specific training shall be given to site personnel including management and workers involved in construction activities or equipment operators that have the potential to generate noise and vibration effects. This also includes training for personnel involved in monitoring noise and vibration.
- Equipment outlined in Appendix A (or other high noise generating equipment) is to be operated only between 0730 and 1800 hours Monday to Saturday, with no works occurring on Sundays or Public Holidays.
- All machinery to be used on site will be acoustically tested to determine the sound power level of the machinery and compared to the sound power levels in Appendix B of this Assessment. Where the tested sound power level is greater, either this machinery shall be fitted with acoustic noise reduction measures (mufflers), or additional noise modelling was undertaken to determine whether further mitigation is required to attenuate noise to adjacent properties to achieve desired noise levels.
- Preferential selection of sub-contractors that use a lower noise-generating demolition, piling, compaction, and construction methodologies.
- No unnecessary idling of equipment on site (such as trucks and excavators) when not in use.

9.3.2 Vibration Management

Specific vibration management will be required to control vibration generating plant, particularly near buildings within the Historic Heritage Overlay in the AUP. The vibration managerial mitigation measures outlined in Section 6.2 are to be adopted as part of the CNVMP to reduce the likelihood of high vibration levels impacting heritage buildings.

9.3.3 Monitoring

While managerial mitigation measures are adopted by the contractor to reduce the level of vibration received at buildings, it is recommended that vibration monitoring is undertaken during the first high-vibration equipment operating to confirm the setback distances.

Vibration monitoring will be undertaken during the first high-vibration equipment outlined in Table 22 at the following properties:

- 323-327 Queen Street
- 210 Queen Street

Where vibration levels are measured to be above 2.5mm/s, works on site will stop until the vibration source is identified and any/all mitigation measures are implemented to reduce the received vibration level within the buildings.

Vibration monitoring will also be undertaken during the first operation of pipe installation using trenchless construction. Vibration measurements are to be undertaken to confirm the vibration levels meet the required acoustic criteria. Where levels are measured to be above 2.5mm/s from the mTBM, continuous vibration monitoring will be undertaken.

10 Identification of Affected Parties

This section outlines the potentially affected parties.

10.1 Noise

There are no properties which exceed the construction noise limits when noise is generated outside of the road corridor. Therefore, there are no parties that have been identified as affected by construction noise from these works.

10.2 Vibration

With the managerial mitigation measures outlined in Section 6.2, there are no properties that are predicted to exceed the vibration limits outlined in the AUP, and therefore, there are no parties that have been identified as affected by construction vibration from these works .

11 RMA s104 Assessment

Section 104 of the RMA sets out the matters that the consent authority are to consider when assessing an application for resource consent.

Based on the assessment provided within this report, construction noise and vibration has been is a permitted activity under the provision of the AUP. As such, in accordance with s.104(2), a consent authority may disregard any adverse effects in relation to noise and vibration as they are provided for by the AUP.

Mitigation and management measures have been detailed within this report, with a framework CNVMP provided to meet the permitted activity provisions of the AUP.

12 Conclusion and Recommendations

WSP has been engaged by Watercare to assess the noise and vibration impacts from the construction of a new wastewater mainline through Auckland city centre for the Queen Street Wastewater Diversion Project. This report provides an assessment of the construction noise and vibration in relation to Part 3 of the Project.

Noise and vibration criteria have been developed based on the AUP. Noise from construction works within the roading corridor is exempt from the construction noise limits, provided that a CNVMP is developed. However, for completeness, noise generated in the road corridor specifically associated with this Project has been predicted.

The construction methodology for Part 3 of the Project has been provided by Fulton Hogan, the proposed contractor. This methodology has been used to develop the phases of construction and equipment used.

Based on the construction methodology and proposed mitigation, there are no properties that are predicted to exceed the noise and vibration levels within the AUP. It is recommended that as a conditions of consent a CNVMP is adopted to ensure that noise and vibration impacts are mitigated as far as reasonably practicable.

With the adoption of the conditions of consent as per the approved Part 3 consent, the effects associated with the construction of the shafts and installation of the wastewater pipes are predicted to be acceptable.

Appendix A
Construction Equipment Schedule

Equipment List						
Site	Stage	Activity	Equipment	SWL L_{Aeq}	SWL L_{AFmax}	% on time
Queen Street/Mayoral Drive Shaft Construction	1	Road surface breakout	Concrete saw	113	-	50
			20T Excavator	105	120	100
			Truck	107	120	50
	2	Secant piling	SR-45 drill rig	107	-	100
			Truck	107	120	50
			Concrete truck and pump	103	-	100
	3,4	Excavation of shaft	35T Excavator	107	120	100
			3T Excavator	102	120	100
			Hand-held power tools	100	-	100
			Truck	107	120	50
			Ventilation fan	100	-	100
			Submersible pump	96	-	100
			Diesel generator	94	-	100
	5	Installation of manhole and backfilling	90T Crane	105	-	75
			Concrete truck and pump	103	-	100
			Truck	107	120	50
			20T Excavator	105	120	100
			Submersible pump	96	-	100
			Diesel generator	94	-	100
			Ventilation fan	100	-	100
	6	Reinstatement	20T Excavator	105	120	100
			Static drum roller	107	-	100
			Plate compactor	108	-	100
Queen Street/Wellesley Street Shaft Construction	1	Road surface breakout	Concrete saw	113	-	50
			20T Excavator	105	120	100
			Truck	107	120	50
	2	Secant Piling	SR-45 drill rig	107	-	100
			Trucks	107	120	50
			Concrete truck and pump	103	-	100
	3	Excavation of shaft	35T Excavator	107	120	100
			3T Excavator	102		100
			Hand-held power tools	100	-	100
			Trucks	107	120	50
			Submersible pump	96	-	100
			Diesel Generator	94	-	100
			Ventilation fan	100	-	100
	4	Installation of manhole and backfilling	90T Crane	105	-	75
			Concrete truck and pump	103	-	100
			Truck	107	120	50
			20T Excavator	105	120	100
			Submersible pump	96	-	100
			Diesel generator	94	-	100
			Ventilation fan	100	-	100
	5	Reinstatement	20T Excavator	105	120	100
			Static drum roller	107	-	100
			Plate compactor	108	-	100
Queen Street/Victoria Street Shaft Construction	1	Road surface breakout	Concrete saw	113	-	50
			20T Excavator	105	120	100
			Truck	107	120	50
	2	Boring holes	SR-45 drill rig	107	-	100
			Trucks	107	120	50
			Concrete truck and pump	103	-	100
	3		20T Excavator	105	120	100

		Installing UC beams into holes	Truck	107	120	50
	4,5	Excavation of shaft	35T Excavator	107	120	100
			5T Excavator	102		100
			Hand-held power tools	100	-	100
			90T Crane	102	-	100
			Welder and generator	101	-	50
			Submersible pump	96	-	100
			Ventilation fan	100	-	100
			Diesel generator	94	-	100
			Truck	107	120	50
	6	Excavation of Bassalt	35T Excavator	107	120	100
			Rock diamond drill	115	125	100
			90T Crane	105	-	75
			Submersible pump	96	-	100
			Ventilation fan	100	-	100
			Diesel generator	94	-	100
			Concrete truck and pump	103	-	100
	7	Installation of manhole and backfilling	90T Crane	105	-	75
			Concrete truck and pump	103	-	100
			Truck	107	120	50
			35T Excavator	107	120	100
			Submersible pump	96	-	100
			Diesel generator	94	-	100
			Ventilation fan	100	-	100
	8	Reinstatement	20T Excavator	105	120	100
			Static drum roller	107	-	100
			Plate compactor	108	-	100
Open cut pipe installation	1	Temporary traffic management setup	Truck	107	120	50
	2,3,4,5	Excavation of trench	Truck	107	120	50
			20T Excavator	105	120	100
			Submersible pump	96	-	100
			Diesel generator	94	-	100
	6	Installation of pipe	Truck	107	120	50
			20T Excavator	105	120	100
			Plate compactor	108	-	100
	7	Backfilling and reinstatement	20T Excavator	105	120	100
			Static drum roller	103	-	100
			Plate compactor	107	120	50
Trenchless pipe installation	1*	Insertion of mTMB into shaft	90T Crane	105	-	75
			Ventilation fan	100	-	100
			Hand-held power tools	100	-	100
			Submersible pump	96	-	100
			Diesel generator	94	-	100
	2*	Operation of mTMB at Mayoral Drive Site	mTMB machine	103	-	100
			Control cabin	86	-	100
			90T Crane	105	-	75
			Diesel generator	94	-	100
			Ventilation fan	100	-	100
			Submersible pump	96	-	100
			mTBM Pump	96	-	100
	3^	Extraction of mTMB at Victoria Street site	Submersible pump	96	-	100
			Diesel generator	94	-	100
			Ventilation fan	100	-	100
			90T Crane	105	-	75

			Hand-held power tools	100	-	100
			Truck	107	120	50
Greys Avenue Construction Support Compound	1	Set-up	Hiab trucks	107	120	50
			20T excavator	105	120	100
			Truck	107	120	50
			90T Crane	105	-	75
	2	Operation of mTMB	20T Excavator	105	120	100
			Separating tanks, slurry tanks with generator	117	120	100
			Truck	107	120	50

Vibration Equipment List		
No.	Equipment	PPV (mm/s) @10m
1	Excavator breaking ground	1.9
2	CFA piling, auguring, drilling of holes, or similar	0.5
3	Tunnel Boring	2.0
4	Plate compactor	1.0

Appendix B
Predicted Noise Levels

Queen Street/Mayoral Drive Shaft Construction					
Property	Predicted Façade Noise Level (dB $L_{Aeq,30min}$) During Phase				
	1	2	3,4	5	6
3 Airedale Street	71	69	70	69	71
22 Durham Street West	45	43	43	43	45
3 Greys Avenue	58	56	57	56	58
48 Greys Avenue	67	65	65	65	67
95 Greys Avenue	62	60	60	60	62
59-67 High Street	46	44	45	44	46
2 Lorne Street	44	42	42	42	43
4 Lorne Street	44	42	42	42	44
44-48 Lorne Street	51	48	49	49	50
100 Mayoral Drive	62	60	60	60	62
175 Queen Street	48	46	46	46	48
182-184 Queen Street	51	49	49	49	50
186 Queen Street	51	49	49	49	51
187-189 Queen Street	44	42	42	42	44
191 Queen Street	45	43	44	44	45
203 Queen Street	47	44	45	45	46
205-225 Queen Street	51	49	49	49	50
214 Queen Street	49	47	48	47	49
222 Queen Street	49	47	48	47	49
229 Queen Street	52	49	50	50	51
233-237 Queen Street	52	50	50	50	52
238 Queen Street	55	53	53	53	54
239 Queen Street	53	50	51	51	52
253-261 Queen Street	53	51	52	51	53
262 Queen Street	54	52	52	52	54
263 Queen Street	56	53	54	54	55
269-297 Queen Street	58	56	57	56	58
280 Queen Street	54	51	52	52	53
290 Queen Street	53	51	52	51	53
300 Queen Street	56	54	54	54	55
301 Queen Street	71	69	70	69	71
304-308 Queen Street	58	56	56	56	58
313 Queen Street	81	79	79	79	81
317 Queen Street	84	81	82	82	83
319 Queen Street	89	87	88	88	89
321 Queen Street	86	84	84	84	86
323 Queen Street	85	83	84	83	85
329 Queen Street	84	81	82	82	83
361 Queen Street	71	69	69	69	70
380 Queen Street	75	73	74	73	75
396 Queen Street	81	78	79	79	80
430 Queen Street	76	74	74	74	75
3 Victoria Street East	37	34	35	35	36
9 Victoria Street East	45	42	43	43	44
27-31 Victoria Street East	41	39	39	39	40
19 Victoria Street West	44	41	42	42	43
10 Wellesley Street	51	49	49	49	51
18-26 Wellesley St East	44	41	42	42	43

Queen Street/Wellesley Street Shaft Construction					
Property	Predicted Façade Noise Level (dB $L_{Aeq,30min}$) During Phase				
	1	2	3	4	5
3 Airedale Street	40	37	41	38	39
22 Durham Street West	51	48	52	49	51
3 Greys Avenue	42	39	43	40	42
48 Greys Avenue	49	45	50	47	48
95 Greys Avenue	48	45	49	46	47
59-67 High Street	48	44	48	45	47
2 Lorne Street	49	45	50	47	48
4 Lorne Street	50	46	50	47	49
44-48 Lorne Street	73	69	73	71	72
100 Mayoral Drive	50	46	50	48	49
175 Queen Street	52	48	52	49	51
182-184 Queen Street	54	51	55	52	53
186 Queen Street	55	51	55	52	54
187-189 Queen Street	53	49	54	51	52
191 Queen Street	57	54	58	55	56
203 Queen Street	57	54	58	55	57
205-225 Queen Street	63	60	64	61	62
214 Queen Street	60	57	61	58	59
222 Queen Street	62	58	62	59	61
229 Queen Street	67	63	67	65	66
233-237 Queen Street	69	65	69	66	68
238 Queen Street	66	63	67	64	66
239 Queen Street	73	69	74	71	72
253-261 Queen Street	79	75	79	77	78
262 Queen Street	72	68	72	69	71
263 Queen Street	80	77	81	78	79
269-297 Queen Street	76	72	76	74	75
280 Queen Street	76	73	77	74	75
290 Queen Street	89	86	90	87	88
300 Queen Street	82	79	83	80	82
301 Queen Street	60	56	60	57	59
304-308 Queen Street	74	71	75	72	73
313 Queen Street	51	48	52	49	51
317 Queen Street	51	48	52	49	50
319 Queen Street	51	47	51	48	50
321 Queen Street	51	47	51	48	50
323 Queen Street	51	47	51	48	50
329 Queen Street	41	38	42	39	40
361 Queen Street	51	47	52	49	50
380 Queen Street	54	51	55	52	54
396 Queen Street	50	47	51	48	50
430 Queen Street	51	48	52	49	50
3 Victoria Street East	44	40	44	42	43
9 Victoria Street East	47	44	48	45	47
27-31 Victoria Street East	48	44	49	46	47
19 Victoria Street West	49	46	50	47	48
10 Wellesley Street	85	81	85	82	84
18-26 Wellesley St East	75	71	76	73	74

Queen Street/Victoria Street Shaft Construction							
Property	Predicted Façade Noise Level (dB $L_{Aeq,30min}$) During Phase						
	1	2	3	4,5	6	7	8
3 Airedale Street	43	40	38	41	47	42	42
22 Durham Street West	67	64	62	66	71	66	66
3 Greys Avenue	40	37	35	38	44	39	39
48 Greys Avenue	44	41	39	43	48	43	43
95 Greys Avenue	45	43	40	44	50	44	45
59-67 High Street	86	83	81	84	90	84	85
2 Lorne Street	74	72	69	73	78	73	73
4 Lorne Street	69	67	65	68	74	68	69
44-48 Lorne Street	47	45	42	46	51	46	46
100 Mayoral Drive	46	43	41	44	50	44	45
175 Queen Street	67	64	62	66	71	66	66
182-184 Queen Street	68	66	63	67	73	67	68
186 Queen Street	74	72	70	73	79	73	74
187-189 Queen Street	70	67	65	68	74	69	69
191 Queen Street	74	71	69	73	78	73	73
203 Queen Street	77	74	72	76	81	76	76
205-225 Queen Street	76	74	71	75	81	75	76
214 Queen Street	83	81	78	82	87	82	82
222 Queen Street	75	72	70	74	79	74	74
229 Queen Street	68	66	63	67	72	67	67
233-237 Queen Street	67	64	62	65	71	66	66
238 Queen Street	72	69	67	70	76	71	71
239 Queen Street	65	62	60	63	69	63	64
253-261 Queen Street	62	59	57	61	66	61	61
262 Queen Street	64	61	59	62	68	62	63
263 Queen Street	60	57	55	58	64	58	59
269-297 Queen Street	55	52	50	53	59	54	54
280 Queen Street	62	60	57	61	67	61	62
290 Queen Street	58	56	54	57	63	57	58
300 Queen Street	56	54	51	55	60	55	55
301 Queen Street	52	49	47	50	56	51	51
304-308 Queen Street	56	53	51	54	60	54	55
313 Queen Street	47	45	42	46	52	46	47
317 Queen Street	47	45	42	46	51	46	46
319 Queen Street	47	44	42	45	51	46	46
321 Queen Street	47	44	42	45	51	46	46
323 Queen Street	47	44	42	45	51	45	46
329 Queen Street	39	36	34	37	43	38	38
361 Queen Street	48	45	43	46	52	47	47
380 Queen Street	50	47	45	48	54	48	49
396 Queen Street	47	44	42	45	51	46	46
430 Queen Street	46	43	41	44	50	45	45
3 Victoria Street East	70	67	65	68	74	68	69
9 Victoria Street East	80	78	75	79	85	79	80
27-31 Victoria Street East	70	67	65	68	74	68	69
19 Victoria Street West	70	67	65	68	74	68	69
10 Wellesley Street	46	43	41	45	50	45	45
18-26 Wellesley St East	52	49	47	50	56	51	51

Queen Street/Wellesley Street Open Trench Construction				
Property	Predicted Façade Noise Level (dB $L_{Aeq,30min}$) During Phase			
	1	2,3,4,5	6	7
3 Airedale Street	33	37	40	38
22 Durham Street West	43	47	50	48
3 Greys Avenue	31	35	38	36
48 Greys Avenue	41	45	48	46
95 Greys Avenue	40	44	46	45
59-67 High Street	39	43	45	44
2 Lorne Street	39	43	45	44
4 Lorne Street	41	45	47	46
44-48 Lorne Street	61	65	67	66
100 Mayoral Drive	39	43	46	44
175 Queen Street	43	47	50	48
182-184 Queen Street	46	50	53	51
186 Queen Street	49	53	55	54
187-189 Queen Street	46	50	53	51
191 Queen Street	50	54	57	55
203 Queen Street	51	55	57	56
205-225 Queen Street	57	61	64	62
214 Queen Street	53	57	60	58
222 Queen Street	55	59	62	60
229 Queen Street	59	63	66	64
233-237 Queen Street	61	65	68	66
238 Queen Street	59	63	66	64
239 Queen Street	65	69	72	70
253-261 Queen Street	74	78	80	79
262 Queen Street	64	68	70	69
263 Queen Street	75	79	82	80
269-297 Queen Street	69	73	75	74
280 Queen Street	68	72	75	73
290 Queen Street	77	81	84	82
300 Queen Street	77	81	84	82
301 Queen Street	53	57	60	58
304-308 Queen Street	66	70	72	71
313 Queen Street	43	47	50	48
317 Queen Street	43	47	50	48
319 Queen Street	42	46	49	47
321 Queen Street	42	46	49	47
323 Queen Street	42	46	48	47
329 Queen Street	37	41	43	42
361 Queen Street	45	49	51	50
380 Queen Street	47	51	54	52
396 Queen Street	44	48	51	49
430 Queen Street	43	47	50	48
3 Victoria Street East	34	38	41	40
9 Victoria Street East	39	43	45	44
27-31 Victoria Street East	40	44	46	45
19 Victoria Street West	39	43	46	44
10 Wellesley Street	69	73	76	75
18-26 Wellesley St East	64	68	70	69

Queen Street/Victoria Street and Queen Street/Mayoral Drive Trenchless Construction			
Property	Predicted Façade Noise Level (dB $L_{Aeq,30min}$) During Phase		
	1*	2*	3^
3 Airedale Street	65	65	38
22 Durham Street West	37	37	62
3 Greys Avenue	50	49	35
48 Greys Avenue	59	59	39
95 Greys Avenue	54	53	41
59-67 High Street	39	38	82
2 Lorne Street	36	36	70
4 Lorne Street	37	36	65
44-48 Lorne Street	44	43	43
100 Mayoral Drive	54	54	41
175 Queen Street	41	36	62
182-184 Queen Street	44	43	64
186 Queen Street	44	43	70
187-189 Queen Street	36	35	66
191 Queen Street	38	37	70
203 Queen Street	39	38	73
205-225 Queen Street	44	43	72
214 Queen Street	42	41	79
222 Queen Street	42	41	71
229 Queen Street	44	44	64
233-237 Queen Street	45	44	63
238 Queen Street	46	46	67
239 Queen Street	46	45	60
253-261 Queen Street	46	46	57
262 Queen Street	45	45	59
263 Queen Street	48	48	55
269-297 Queen Street	51	51	50
280 Queen Street	45	44	57
290 Queen Street	45	45	54
300 Queen Street	48	47	51
301 Queen Street	64	64	47
304-308 Queen Street	51	50	51
313 Queen Street	74	75	42
317 Queen Street	77	76	42
319 Queen Street	83	83	42
321 Queen Street	80	79	42
323 Queen Street	79	78	42
329 Queen Street	76	76	34
361 Queen Street	64	63	43
380 Queen Street	68	68	45
396 Queen Street	73	73	42
430 Queen Street	69	68	41
3 Victoria Street East	29	28	65
9 Victoria Street East	37	36	76
27-31 Victoria Street East	34	33	65
19 Victoria Street West	36	36	65
10 Wellesley Street	44	43	41
18-26 Wellesley St East	36	36	47

Greys Avenue Construction Support Compound			
Property	Predicted Façade Noise Level (dB $L_{Aeq,30min}$) During Phase		
	1	2	3
3 Airedale Street	60	68	68
22 Durham Street West	45	53	53
3 Greys Avenue	65	73	73
48 Greys Avenue	69	75	77
95 Greys Avenue	64	72	72
59-67 High Street	39	47	47
2 Lorne Street	39	47	47
4 Lorne Street	39	47	47
44-48 Lorne Street	41	49	49
100 Mayoral Drive	68	75	76
175 Queen Street	34	44	44
182-184 Queen Street	39	47	47
186 Queen Street	39	47	47
187-189 Queen Street	33	41	41
191 Queen Street	31	39	39
203 Queen Street	39	47	47
205-225 Queen Street	42	50	50
214 Queen Street	40	48	48
222 Queen Street	40	48	48
229 Queen Street	36	44	44
233-237 Queen Street	42	50	50
238 Queen Street	42	50	50
239 Queen Street	41	49	49
253-261 Queen Street	41	49	49
262 Queen Street	43	51	51
263 Queen Street	43	51	51
269-297 Queen Street	57	65	65
280 Queen Street	45	53	53
290 Queen Street	44	52	52
300 Queen Street	44	52	52
301 Queen Street	61	69	69
304-308 Queen Street	44	52	52
313 Queen Street	67	75	75
317 Queen Street	67	75	77
319 Queen Street	66	74	83
321 Queen Street	69	75	80
323 Queen Street	70	75	79
329 Queen Street	67	75	76
361 Queen Street	65	73	73
380 Queen Street	59	67	68
396 Queen Street	62	70	73
430 Queen Street	62	70	70
3 Victoria Street East	36	44	44
9 Victoria Street East	39	47	47
27-31 Victoria Street East	36	44	44
19 Victoria Street West	42	50	50
10 Wellesley Street	42	50	50
18-26 Wellesley St East	39	47	47

Maximum Noise Levels from Any Construction Equipment	
Property	Predicted Façade Maximum Noise Level (dB L_{AFmax})
3 Airedale Street	84
22 Durham Street West	80
3 Greys Avenue	71
48 Greys Avenue	80
95 Greys Avenue	75
59-67 High Street	98
2 Lorne Street	87
4 Lorne Street	82
44-48 Lorne Street	85
100 Mayoral Drive	75
175 Queen Street	81
182-184 Queen Street	81
186 Queen Street	87
187-189 Queen Street	82
191 Queen Street	87
203 Queen Street	90
205-225 Queen Street	89
214 Queen Street	96
222 Queen Street	88
229 Queen Street	81
233-237 Queen Street	79
238 Queen Street	84
239 Queen Street	86
253-261 Queen Street	91
262 Queen Street	84
263 Queen Street	93
269-297 Queen Street	88
280 Queen Street	89
290 Queen Street	102
300 Queen Street	95
301 Queen Street	84
304-308 Queen Street	71
313 Queen Street	94
317 Queen Street	97
319 Queen Street	102
321 Queen Street	99
323 Queen Street	98
329 Queen Street	97
361 Queen Street	84
380 Queen Street	88
396 Queen Street	94
430 Queen Street	89
3 Victoria Street East	82
9 Victoria Street East	93
27-31 Victoria Street East	82
19 Victoria Street West	82
10 Wellesley Street	59
18-26 Wellesley Street East	65

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