Project Number: W-SL001.03

Queen Street Wastewater Diversion: Part 3 Works

20 July 2023

Framework Construction Noise and Vibration Management Plan

Contact Details

WSP
100 Beaumont Street
Auckland 1010
New Zealand
+64 9 355 9500
wsp.com/nz

Document Details:

Date: 24 July 2023
Reference: 230720-WSL001.03-GvH-R6-Rev2-Queen St S3 CNVMP
Status: Final

Prepared by
George van Hout

Reviewed by
Kezia Lloyd

Approved for release by
Kezia Lloyd

Document History and Status

Revision	Date	Author	Reviewed by	Approved by	Status
0	15 May .23	G. van Hout	K. Lloyd	K. Lloyd	Final
1	8 June .23	G. van Hout	K. Lloyd	K. Lloyd	Final
2	20 July .23	G. van Hout	K. Lloyd	K. Lloyd	Final

Revision Details

Revision	Details
0	Issue to Client
1	Updated construction methodology
2	Updated basalt removal methodology and Greys Ave Support

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Abbreviation and Definitions

AC	Auckland Council
AEE	Assessment of Environmental Effects
AT	Auckland Transport
AUP	Auckland Unitary Plan
CNVMP	Construction Noise and Vibration Management Plan
CNVIA	Construction Noise and Vibration Impact Assessment
CRLL	City Rail Link Limited
DCS	Design and Construction Statement
mTBM	Micro Tunnel Boring Machine
NES	National Environmental Standard
NPS	National Policy Statement
NSR	Noise Sensitive Receptor(s)
TMPs	Traffic Management Plans
Watercare	Watercare Services Limited
WSP	WSP New Zealand Limited

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.

The Queen Street Wastewater Diversion Project 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.

This Construction Noise and Vibration Management Plan (CNVMP) covers Part 3 (the Project) of the works. Specific CNVMP's will be provided for the other Parts of the wider Diversion works.

The objective of this CNVMP is to provide a framework for construction noise and vibration management to assist the contractor in the management of noise and vibration levels at neighbouring buildings to achieve the relevant limits, where practicable.

This plan achieves the requirements outlined in the Auckland Unitary Plan (AUP). It also follows the guidance set out in NZS 6803:1999 *Acoustics – Construction noise*.

This CNVMP outlines the predicted noise emissions and provides the best practicable options for physical and managerial mitigation measures to be considered where noise and/or vibration levels exceed the associated limits.

A glossary of acoustic terminology is provided in Appendix A.

General details of the Project are presented in Table 1.

Table 1 Project details

General Project Details	
Property	Description
Location	Part 3 of the Queen Street Diversion Project: The works include the installation of a new wastewater gravity pipeline along Queen Street between Mayoral Drive and Victoria Street,
Contractor	*TBC*
Construction Period	An 8-month period commencing April 2024
Construction Hours	<u>Shaft Construction:</u> Monday to Saturday: 0700 – 1800 hours Sunday, Public Holiday and night work are not currently proposed. These will only be carried out if required by traffic management restrictions or Watercare operational requirements for tie ins/ connections to the existing network.
	<u>Tunnelling Works:</u> Monday to Saturday – 0700hrs to 1900hrs Sunday and Public Holidays – No construction works
	<u>Greys Avenue Construction Support Area:</u> Monday to Saturday – 0700hrs to 2000hrs Sunday and Public Holidays – No construction works
Contractor Contact	*TBC*
Noise and Vibration Contact	*TBC*

Night works will only be undertaken for de-watering works (a water pump and generator operating only), depending on the site's groundwater conditions.

The general construction staging for the overall construction works is provided in Table 2.

Table 2 Overall construction works staging

Overall Construction Staging		
Activity	Starting	Duration
Queen Street / Mayoral Drive shaft	Q2 2024	2 – 3 months to construct the shaft (Q2 to Q3 2024)
Queen Street/ Wellesley Street Shaft	Q2 2024	2 – 3 months to construct the shaft (Q2 to Q3 2024)
Queen Street/ Victoria Street Shaft	Q2 2024	3 – 4 months to construct the shaft (Q2 to Q3 2024)
Construction Support Area setup	Q2 2024	7 months including site establishment operation and take-down Q2 to Q4 2024).
Trenchless pipe installation	Q3 2024	Queen Street pipe work connections (x3) – 1 month (Q4 2024)
Trenched tie-in works	Q3 2024	2 – 3 months to construct the shaft (Q2 to Q3 2024)

Items in *red italics* are important specific areas of the plan that need to be reviewed and updated as works progress.

This is a live document and will be continually updated if the construction methodology changes, when measurements have been undertaken on the specific machinery, and for specific management of impacted properties.

1.1 Contact Details

The contractor nominated Noise Liaison Officer will be responsible for ensuring that this CNVMP is correctly implemented. They will review all documentation relating to construction noise before it is issued.

As part of site induction, all personnel will be made aware of the noise sensitivity of the surrounding environment, along with the acoustic mitigation strategies outlined in this plan.

The respective authority for these works is Auckland Council.

Table 3 should be completed by the relevant person before the commencement of any construction works, this table outlines key contacts associated with the project.

Table 3 Key Contacts

Key Contract People for The Project				
Role	Name	Organisation	Phone	Email
24 – Hour Public Contact	*TBC*			
Environmental Manager	*TBC*			
Project Manager	*TBC*			
Construction Manager	*TBC*			
Community Relations Manager	*TBC*			
Noise Liaison Officer	*TBC*			
Noise and Vibration Monitoring Manager	*TBC*			
Council – Noise Officer	*TBC*			
Compliance Monitoring Officers	*TBC*			

2 Project Overview

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.

Figure 1 shows the 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 shown in red.

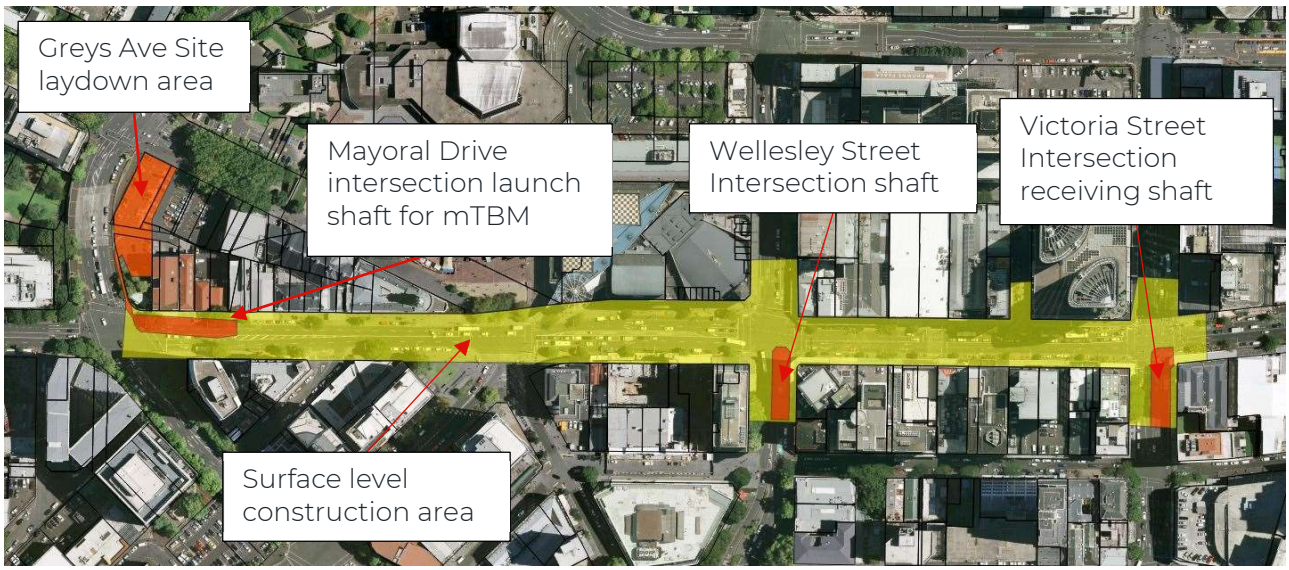


Figure 1 Project area and surface level areas used

2.1 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 have a depth of around 13.79m and be 4.5 metres wide by 10 metres long. This shaft will be used as a launch shaft for tunnelling works. The shaft will be of post and panel construction and as such will require continuous dewatering whilst the shaft is in use.

Excavation of the shaft will result in a total of approximately 968 m^3 of spoil being removed.

Figure 2 shows the position of the shaft (red) and the surrounding construction area (yellow).

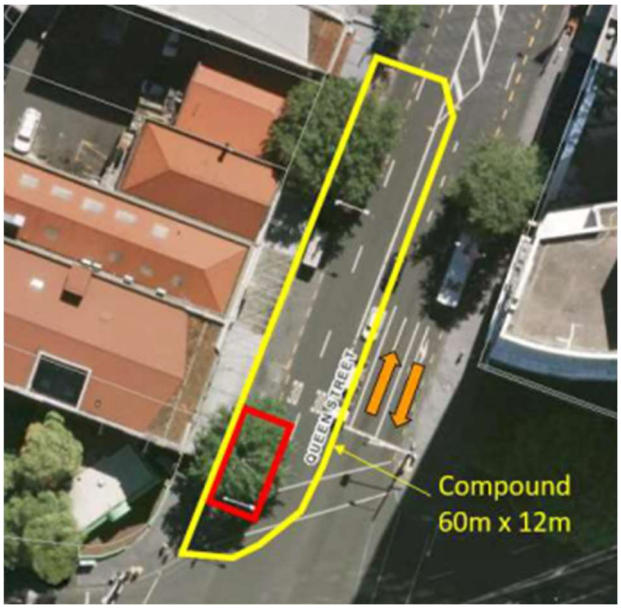


Figure 2 Mayoral Drive Shaft position and construction support area

Queen Street/ Wellesley Street Shaft

This shaft will be located on Wellesley Street, adjacent to 290 Queen Street and will have a total depth of around 7.21m. This shaft will be used for service connections as well as support for tunnelling works. This shaft will be sealed once constructed and as such ongoing dewatering will not be required.

The shaft is to have an internal diameter of 3.5 metres and results in 126 m^3 of spoil being removed due to excavation.

Figure 3 shows the position of the shaft (red) and the surrounding construction area on Wellesley Street (yellow).

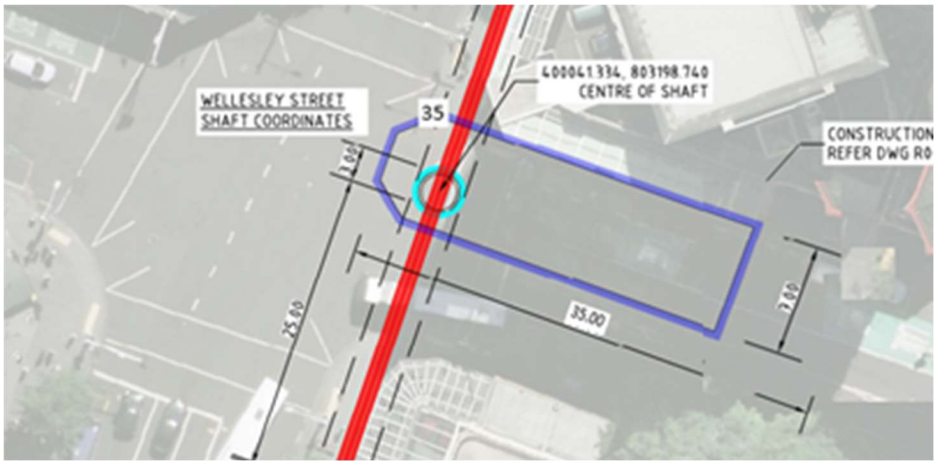


Figure 3 Wellesley Street Shaft position and construction support area

Queen Street/ Victoria Street Shaft

This shaft will be located on Victoria Street, adjacent to 210 Queen Street and will have a total depth of around 6.87m. 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.

The shaft is to be 3 metres wide by 7 metres long and will result in 240 m^3 of spoil being removed due to excavation.

Figure 4 shows the position of the shaft (red) and the surrounding construction support area on Victoria Street (yellow).

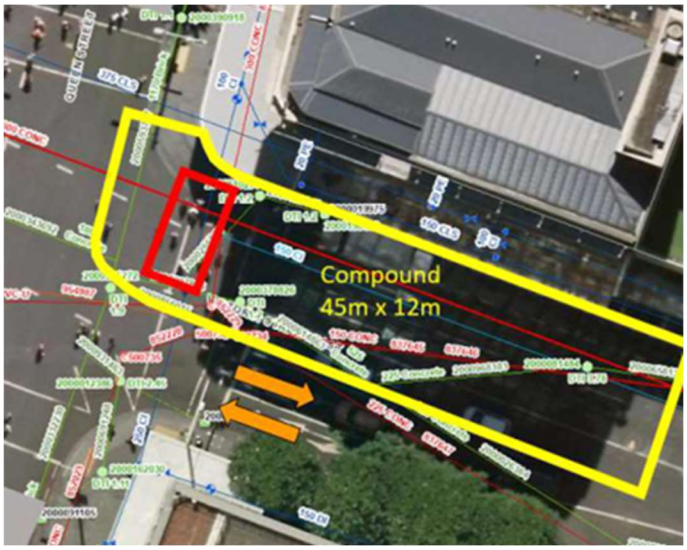


Figure 4 Victoria Street Shaft position and construction support area

2.2 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 Construction Support Area (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 5 shows the proposed layout for the Greys Avenue CSA and how it relates to the construction shaft on Queen Street.

Approximately 576 metres of 1.2 metre diameter pipe will be installed between the Mayoral Drive site and Victoria Street site. A total of 970 m^3 of spoil is to be excavated during tunnelling activities.

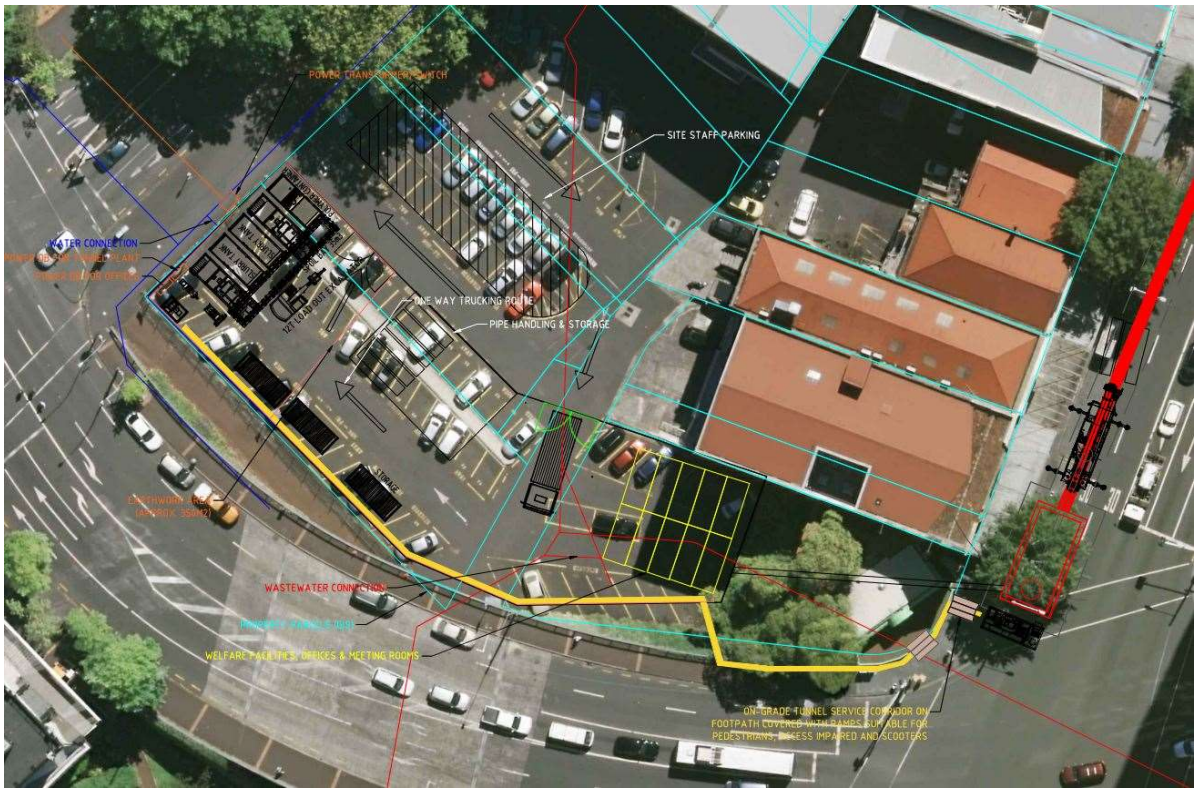


Figure 5 Greys Avenue CSA during tunnelling works

The equipment to be provided within the Greys Avenue CSA and the Mayoral Drive construction area during tunnelling is given in Table 4.

Table 4 Equipment located at Greys Avenue CSA and Mayoral Drive site

Construction Support Areas Equipment during Tunnelling works	
Greys Avenue CSA	Mayoral Drive
• Project site office • Staff welfare facilities • 12t excavator (for removing spoil from the site and loading onto trucks) • Separation plant • Slurry tanks • Electrical container • 800kW diesel generator (only required if connection to electrical mains 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

A 2m wide service corridor will connect the Greys Avenue CSA and Mayoral Drive construction area. The services will be laid on the ground and covered with a walkway to maintain pedestrian access between Queen Street and Mayoral Drive.

Once tunnelling commences, extracted material will be transported in a slurry medium to the separation plant at Greys Avenue CSA. The solids are removed from the slurry, and disposed of off-site, with the liquid returning to the closed-loop system.

As the mTBM progresses, 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 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.

2.3 Vehicle Movements

Vehicle movements will be occurring to and from CSAs during the project works. The following outlines the likely vehicle movements expected to occur.

Table 5 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.

2.4 Noise and Vibration Sensitive Receptors

Most buildings around the construction areas are commercial in nature. Figure 6 shows the commercial properties (yellow) hotels (blue) and apartments (pink) near each of the construction sites (red).

Many of the properties directly adjacent to the construction support areas are also located within the historic heritage overlay as outlined in the AUP. These properties are likely more sensitive to vibration and therefore should be considered in further detail.

Figure 6 Adjacent noise sensitive receptor building types – commercial (yellow), hotels (blue), apartments (pink)

3 Construction Noise and Vibration Criteria

The construction noise and vibration criteria for the Project have been developed based on the following documents:

- Auckland Unitary Plan: Section E25.6.28 – Construction noise levels in the Business – City Centre Zone and the Business – Metropolitan Centre Zone.
- Auckland Unitary Plan: Section E25.6.29 – Construction noise and vibration levels for work within the road.
- Auckland Unitary Plan: Section E25.6.30 – Vibration.
- NZS 6803:1999 Acoustics – Construction Noise.
- DIN 4150-3:1999 Vibrations in buildings – Part 3: Effects on structures.
- BS 5228-2:2014: Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration.

3.1 Construction Noise Criteria

Table 6 outlines the trigger levels for construction noise. Where predicted or measured noise levels are above the noise criteria in Table 6, the Best Practicable Option (BPO) of mitigation will need to be implemented.

Table 6 Construction noise criteria 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			
Day	Time	$L_{Aeq,30min}$ (dB)	L_{AFmax} (dB)
Monday to Friday	6.30am – 10.30pm	75	90
Saturday	7am-11pm	80	90

These noise levels apply at 1m from the façade of any building sensitive to noise.

3.2 Construction Vibration Criteria

Construction vibration criteria are provided in Table 7. Where predicted or measured vibration levels are at or above the vibration criteria in Table 7, the BPO of mitigation will be implemented.

Table 7 DIN 4150-3 long-term guideline vibration criteria

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 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

The vibration criteria in Table 7 apply in any horizontal 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.

4 Assessment Methodology

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

4.1 Construction Activities

The construction staging for the proposed works, along with a description of the works for each phase and proposed equipment are outlined in Table 8 to Table 14.

Table 8 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 an 8t to 14t excavator used to remove pavement layers and other shallow level obstructions.	• Concreate cutter • Excavator
2	A GEAZ EX40/60 piling rig will be used to bore 400 to 600mm diameter holes to a depth of 2m below shaft base.	• Piling rig (GEAZ EX40/ 60)
3	Steel UC posts will be lowered into each bore using a 14t excavator and the bores backfilled with sand or pea gravel.	• Excavator
4	Shaft extent will be excavated using a 5 to 20t excavator and workers with compressor powered handheld air tools. A 25t crane and skip will be used to remove hand excavated materials when the excavator runs out of reach. Shaft spoil will be removed from site using a 6 or 8-wheeler truck with sealed bins.	• Excavator • Handheld power tools • Crane • Skip • 6 or 8-wheeler truck
5	Timber lagging will be cut to fit and installed between UC posts as the excavation progresses to retaining surrounding ground. 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.*
6	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, connection to 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.	*This activity will occur concurrently with Phase 4. Therefore, noise generated in this phase has been assessed concurrently with Phase 4.* • Submersible pump • Diesel generator • Ventilation fan
6	Following completion of tunnelling works, an in situ concrete manhole will be formed and poured within the shaft using a concrete skip and 25t crane at road level or with concrete pump. Precast concrete riser manhole sections will be installed using a 25t crane at road level. Shaft will be backfilled with compacted GAP65 or low strength concrete.	• Crane • Concrete skip • Concrete pump
7	Temporary works will be progressively removed using a 5t to 20t excavator as the shaft is backfilled.	• Excavator
8	Road pavement (GAP65 and AC) will be reinstated using a 5 to 20t excavator and vibratory roller.	• Excavator • Plate compactor

For this phase, dewatering will be required for up to 12 months, all day and night. This is expected to be the only activity requiring night works.

Table 9 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 5t to 20t excavator used to remove pavement layers and other shallow-level obstructions.	• Concrete cutter • Excavator
2	A concrete ring beam will be formed. If required by temporary work design, hydraulic jacks will be fixed to the top of the ring beam.	• Hydraulic jack • Concrete truck • Concrete pump
3	A combination of 8t excavator digging and jacks will be used to sink the precast shaft rings. As the depth increases workers will access the shaft and hand excavate the shaft into a skip lifted by 25t crane. Shaft spoil will be removed from the site using 6 or 8-wheeler trucks with sealed bins.	• Excavator • Hydraulic jacks • Handheld power tools • Skip • Crane • 6 or 8-wheeler trucks • Submersible pump • Diesel generator • Ventilation fan
4	In situ concrete foundation plug will be poured using a concrete boom pump or skip.	• Concrete pump (or skip) • Concrete truck
5	Following completion of tunnelling works, an in situ concrete manhole will be formed and poured within the shaft using a concrete skip and 25t crane at road level or with concrete pump. Precast concrete riser manhole sections will be installed using a 25t crane at road level. Shaft will be backfilled with compacted GAP65 or low strength concrete.	• Crane • Concrete skip • Concrete pump
6	Temporary works will be progressively removed using a 5t to 20t excavator as the shaft is backfilled.	• Excavator
7	Road pavement (GAP65 and AC) will be reinstated using a 5 to 20t excavator and vibratory roller.	• Excavator • Plate compactor

For this phase, dewatering will be required for up to 12 months, all day and night. This is expected to be the only activity requiring night works.

Table 10 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.	• Concreate cutter • Excavator
2	GEAZ EX 40/60 piling rig will be used to bore 400 to 600mm diameter holes to the top of basalt level.	• Piling rig (GEAZ EX40/ 60)
3	Steel UC posts will be lowered into each bore using a 5 to 20t excavator and the bores backfilled with sand or pea gravel.	• Excavator • 6 or 8-wheeler truck
4	The shaft extents will be excavated using an 8 to 14t excavator and workers with compressor powered handheld air tools. A 25t crane and skip will be used to remove handheld excavated materials when the excavator runs out of reach. Shaft spoil will be removed from site using a 6 to 8-wheeler trucks with sealed bins.	• Excavator • Handheld power tools • Crane • Skip • 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.* • Timber lagging • Steel waler beams
6	Solid basalt will be found within this shaft at approximately 5.5m below road level. The basalt layer will be fractured using a stitch core line of holes to nominated lift depth in the basalt, adjacent and parallel to the main sewer to provide a relief gap. Rows of holes will be drilled adjacent and parallel to the stitch cored row. Plug and feather wedges or expanding mortar methods will be used to fracture the basalt until the final excavation depth is achieved.	• Excavator • Rock diamond drill • Crane
7	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, connection to 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.	*This activity will occur concurrently with Phase 4 and 6. Therefore, noise generated in this phase has been assessed concurrently with Phase 4 and 6.* • Submersible pump • Diesel generator • Ventilation fan
8	After mTBM extraction, an in situ concrete manhole will be formed and poured within the shaft using a concrete skip and 25t crane at road level or with concrete pump. Precast concrete riser manhole sections will be installed using a 25t crane at road level. Shaft will be backfilled with compacted GAP65 or low strength concrete.	• Concrete skip • Crane • Concrete pump • Concrete truck • Trucks • Excavator • Submersible pump • Diesel generator • Ventilation fan
9	Temporary works will be progressively removed using a 5t to 20t excavator as the shaft is backfilled.	• Excavator
10	Road pavement (GAP65 and AC) will be reinstated using a 5t to 20t excavator and vibratory roller.	• Excavator • Plate compactor

Table 11 Open 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.*
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 cut to waste as clean, managed or contaminated fill subject on 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.*
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.*
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 300kg 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.	• Excavator • Drum roller

The location of the open-trench construction works are shown in Table 12.

Table 12 Location and Length of Three Wastewater Connections

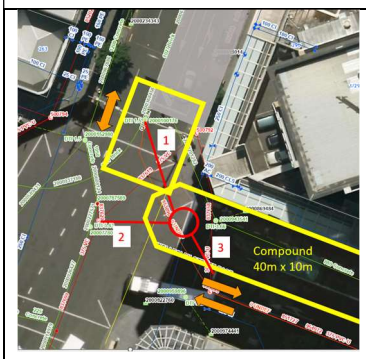
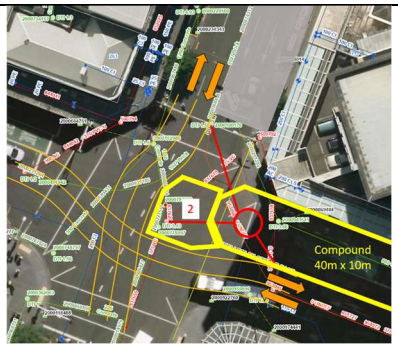
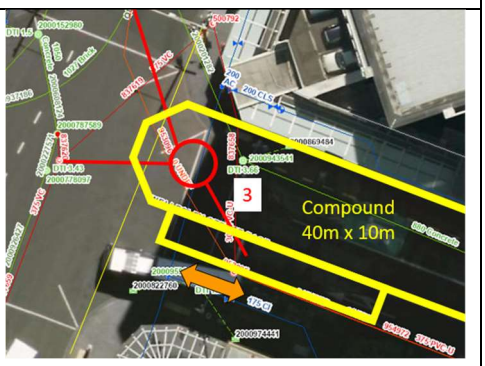
Connection 1	Connection 2	Connection 3
14.76m in length	10m in length	11.4m in length
Adjacent to the north approach on Queen Street	In the middle of the intersection	Adjacent to the east approach on Wellesley Street
		

Table 13 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 different 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 to the o 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 • Submersible pump • Diesel generator • Ventilation fan • 6-inch pumps
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 14 Noise from Construction Compound Area and haul road

Greys Avenue Construction Support Compound		
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 including cranes and excavators. Temporary traffic management and site hoardings will enclose the site and haul the road.	• 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 onto 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 • Slurry Tanks • Generator • Pumps • Excavator • Trucks

Appendix B 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 B 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 *Code of practice for noise and vibration control on construction and open sites*, or previous measurements of similar equipment.

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 B. 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.

4.2 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 in conjunction with the calculations and are presented to support the acoustic assessment.

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

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

Table 15 presents the noise modelling parameters adopted for this assessment.

Table 15 Noise modelling parameters

Parameters for computational noise modelling		
Property	Value	Source
Calculation method	ISO 9613	-
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	-

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.

4.3 Vibration Prediction Methodology

Appendix B 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 Predicted Noise Levels

This section outlines the predicted noise and vibration levels.

5.1 Predicted Noise Levels

5.1.1 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 C.

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 the council. Furthermore, properties marked with a hash (#) indicate those affected by noise levels generated from activities 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 are exempt from the wider Auckland Unitary Plan (AUP) construction noise limits. This exemption is based on the understanding that construction activities within the road reserve are subject to separate noise regulations and considerations.

Greys Avenue Construction Support Area 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 a Resource Consent is granted.

The construction works at Mayoral Drive/Queen Street intersection and at Greys Avenue Construction Support Area 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 Construction Support Area 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 75 dB $L_{Aeq,30\ min}$ noise criteria irrespective of the noise source being within the road corridor within any other zoned land.

Table 16 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	Phase 9	Phase 10
Shaft Construction: Queen Street/Mayoral Drive [#]	313 Queen St 317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St 380 Queen St 396 Queen St	313 Queen St 317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St	313 Queen St 317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St	313 Queen St 317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St 380 Queen St 396 Queen St			313 Queen St 317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St	313 Queen St 317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St 380 Queen St 396 Queen St	n/a	n/a
Shaft Construction: Queen Street/Wellesley Street [#]	290 Queen St 300 Queen St 10 Wellesley St	290 Queen St 300 Queen St 10 Wellesley St	290 Queen St 300 Queen St 10 Wellesley St	290 Queen St 10 Wellesley St	290 Queen St 300 Queen St 10 Wellesley St	290 Queen St 300 Queen St 10 Wellesley 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 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 214 Queen St 9 Victoria St E	Phase undertaken concurrently with Phase 4	59-67 High St 2 Lorne St 186 Queen Street 203 Queen St 205-225 Queen St 214 Queen St 238 Queen St 9 Victoria St E	Phase undertaken concurrently with Phase 4 or Phase 6	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 214 Queen St 9 Victoria St E
Open Trench Construction: Queen Street/Wellesley Street [#]	-	290 Queen St				290 Queen St 300 Queen St	290 Queen St 300 Queen St	n/a	n/a	n/a
Trenchless construction: Shaft locations only[#]	313 Queen St 317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St	313 Queen St 317 Queen St 319 Queen St 321 Queen St 323 Queen St 329 Queen St 396 Queen St	59-67 High St 214 High St 9 Victoria St E	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Greys Ave CSA operating only.	-	-	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Greys Avenue CSA and Mayoral Drive operating concurrently.	313 Queen St[#] 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	n/a	n/a	n/a	n/a

[#]Noise generated within the roading corridor impacting properties only.

5.1.2 Maximum Noise Levels (L_{AFmax})

The predicted maximum noise levels have been undertaken for the loudest construction activities; including piling, excavation, rock drilling, and vibratory roller. All of 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 C.

The following properties are predicted to exceed the 80 dB L_{AFmax} maximum noise limit outlined in the AUP, with the exceedance decibel level provided in brackets:

- 301 Queen Street (4 dB)
- 313 Queen Street (10 dB)
- 317 Queen Street (18 dB)
- 319 Queen Street (18 dB)
- 321 Queen Street (18 dB)
- 323 Queen Street(20 dB)
- 329 Queen Street (19 dB)
- 380 Queen Street (7 dB)
- 396 Queen Street (9 dB)

Maximum noise levels from construction activities outside of the road corridor are predicted to comply with the maximum noise limits of the AUP.

5.2 Predicted Vibration Levels

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

Table 17 outlines the stand-off distance of each piece of high vibration equipment likely 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.

Other equipment will also be used on site but generate lower levels of vibration or installed on manufacturer's vibration isolation (such as the separation unit). Therefore, vibration levels will be lower than the equipment provided below.

Table 17 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	1.5	1.5	3	6	8
2	CFA piling, auguring or similar	0.5	1	2	3	4
3	Tunnel Boring	2.0	2	4	8	10
4	Vibratory Roller	3.6	4	8	15	18
5	Plate Compactor**	1	1	2	4	5

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

The 10 mm/s criteria apply at any commercial building, or structure commercial in nature (high-rise concrete or steel residential buildings for instance). The 5 mm/s applies to single or two-storey 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 heritage building overlay under the AUP.

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

- Not operating vibratory rollers within 15 metres of any building within the Historic Heritage Overlay in the AUP. This requires that only plate compactors are used at the Mayoral Drive and Victoria Street CSA's.
- Using low/no vibration rock fracturing methods to remove basalt from the Victoria Street CSA.
- 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.

6 Mitigation and Management

This section describes the managerial and physical mitigation measures which should be implemented as far as reasonably practicable. This is to protect against unreasonable noise and reduce the effects of noise and vibration at receptors in line with the Resource Management Act (RMA). *This section shall be kept up to date by the contractor throughout the construction process.*

6.1 Principles of Mitigation

Proactive noise mitigation is the most effective method to control construction noise and vibration. Noise and vibration events that the community deem to be unnecessary are more likely to generate complaints.

Guiding Principles:

- The BPO shall be identified and implemented to manage and mitigate potential adverse effects of noise and vibration. The BPO of mitigation will need to be constantly reviewed during construction.
- Construction noise and vibration effects need to be managed, even when levels are within the limits, and management needs to be intensified if the limits are approached.
- Ongoing assessment of all construction activities and continual consideration of potential noise and vibration effects and appropriate mitigation shall be undertaken.
- Ongoing effective stakeholder engagement shall be provided, making available information on what, when and why construction works are happening.

6.1.1 Development of Best Practicable Options for Mitigation

A general hierarchy of mitigation measures to reduce the impact of noise and vibration is:

1 Scheduling construction activities to avoid sensitive times, particularly in the case of night works.
2 Use equipment and construction methods that minimise noise and vibration at the source, including the use of quieter machinery and tools.
3 Including physical mitigation measures to reduce the noise and vibration levels at receivers, such as noise barriers at the boundary of the Site and for specific items of plant.
4 Maintain open communication with the community and inform them about the schedule, duration, and potential noise impacts of the construction work. Respond promptly to any complaints and adjust the work plan as needed.
5 Deploying trained workers in noise management practices and encourage them to minimise noise by following best practices, such as avoiding unnecessary idling of equipment and using proper tools for the job. Hold regular toolbox talks and site inductions which discuss potential noise and vibration impacts.
6 Temporary relocation of potentially affected parties during high noise/vibration night works.

6.2 Physical Mitigation

Where practicable, physical mitigation shall be used to reduce the noise emissions from the construction works. In some instances, the use of physical mitigation may not be practicable (due to space requirements, or machinery utilised).

For this site, the key physical mitigation measures for noise and vibration are:

- Equipment selection, operation, and siting of equipment.
- Adoption of equipment specific enclosures, or other physical barriers.

Where new or improved physical mitigation measures are available, these will be considered by the team and added as a best practicable option to this section, if they can be utilised for this project.

6.2.1 Equipment Selection and Siting

Equipment and plant for the Project will, as far as reasonably practicable:

- Prioritise quieter and newer technologies/models over noisier and older equipment/plant.
- Will have periodic inspections of equipment to ensure that they have been maintained correctly and are not generating excessive noise and/or vibration.
- Be well-maintained, so noise and vibration emissions are within expectations for that equipment or plant.
- Be the appropriate power, size, or type for the proposed task/activity.
- Be fitted with the appropriate exhaust attenuators and broadband reversing alarms.
- Equipment that is used intermittently to be shut off when not in use.
- Limit and/or not use any compression/engine breaking on site as far as practicable; and
- Plan traffic flow, parking, and loading/unloading area to reduce reversing movements of trucks and equipment. Forward-in/forward-out movements are preferred.

6.2.2 Specific Physical Mitigation Measures

To reduce noise from that predicted from the equipment and plant to adjacent receptors, the following physical noise reduction measures are to be incorporated as far as reasonably practicable:

- The contractor is proposing to use temporary concrete barriers with plywood hoardings around most of the perimeter of each of the construction areas, except where a gate is required for access at one end. The proposed site hoardings are shown in Figure 7.

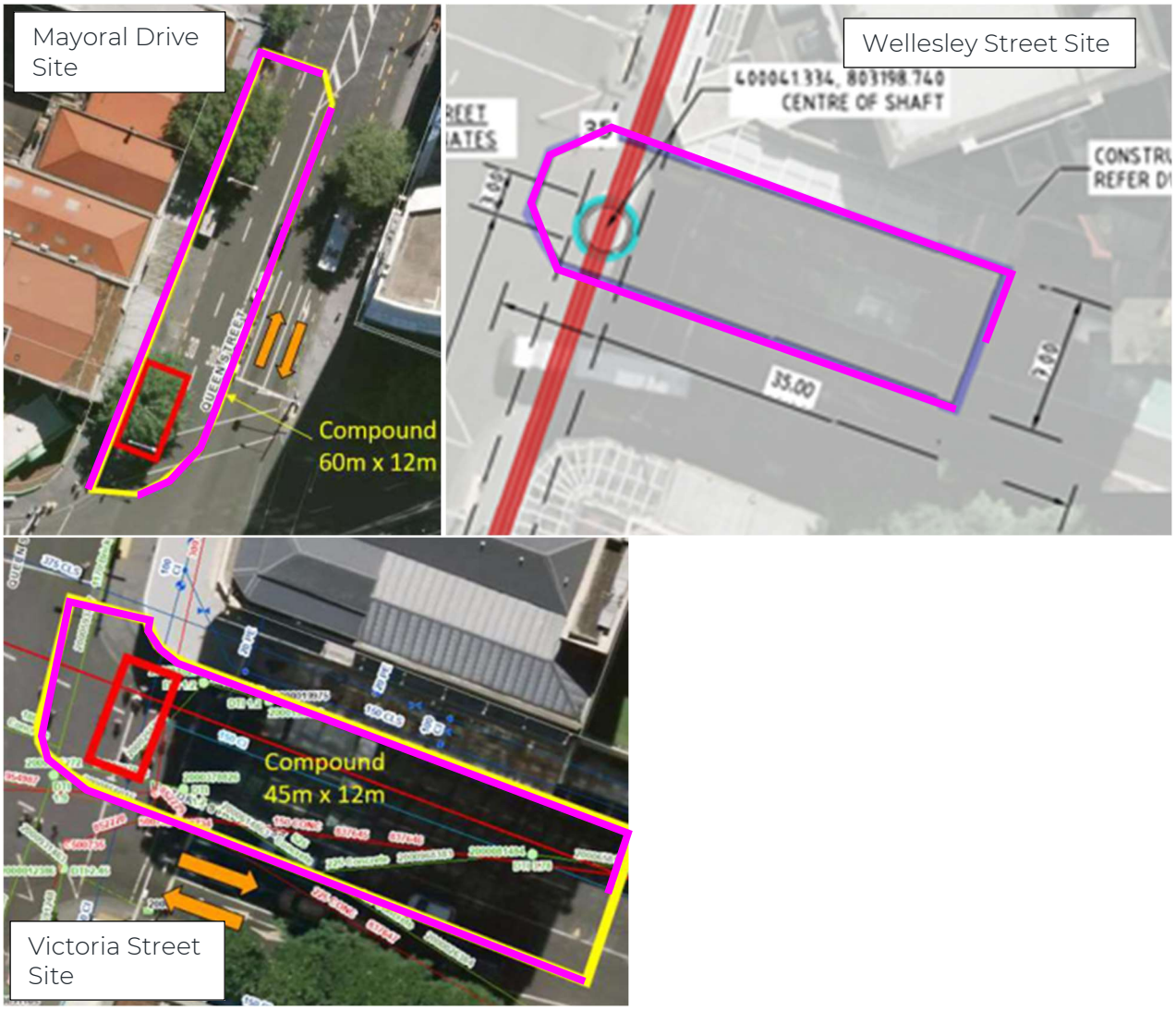
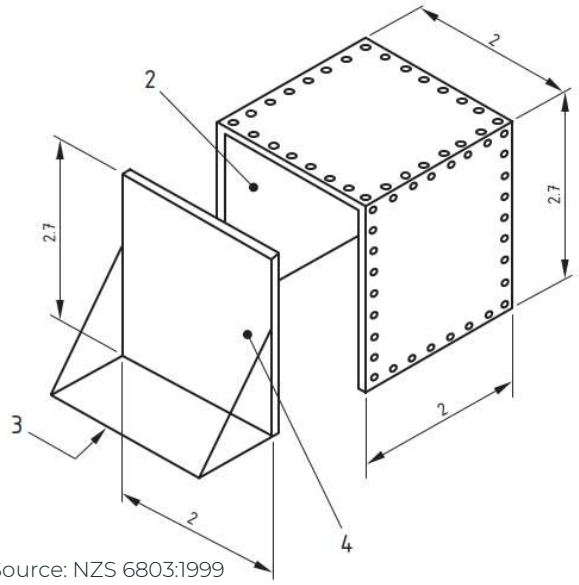


Figure 7 Proposed locations of site hoardings (pink)

- 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.
    - Alternatively, “noise mats” such as Duraflex Hushtec construction noise barriers can be used, ensuring that there are no gaps between panels, and between the panel and ground.
    - Temporary localised barriers will be used where practicable over the shaft during rock 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 fracturing or compaction is shown in Figure 8.



Source: NZS 6803:1999

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

Figure 8 Example of temporary acoustic enclosure

- 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.
- All vehicles that are fitted with audible reversing warning sirens will be fitted with broadband reversing beepers.
- Where practicable, vibratory piling attachments to excavators and sheet piling rigs shall have an acoustic piling cover (such as Hushtec or Duraflex Piling attachment or rock fracturing attachment). These are likely to reduce noise up to 8 dB.
- Where practicable, power shall be provided from mains power rather than generators.
- 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 away 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.

The above provides the best practicable option for physical mitigation measures to control noise and/or vibration from the proposed construction works.

6.3 Managerial Mitigation Measures

This section describes the best practicable option for managerial mitigation measures which can be implemented to reduce the effects of noise and vibration at adjacent properties.

For this site, the key managerial mitigation for noise and vibration are:

- Noise and vibration monitoring and validation
- Training of staff

- Site conduct of staff on site

This section shall be kept up to date by the contractor throughout the construction process.

6.3.1 Validation and Monitoring

Acoustic validation measurements for specific parts of the works shall be undertaken to ensure acoustic predictions are accurate and in line with site noise levels.

In particular:

- Noise and vibration monitoring of piling activities are to be measured on-site during the first activity to confirm noise and vibration levels emitted.
- Noise and vibration monitoring of tunnel boring activity including the separation plant are to be measured on-site during the first activity to confirm noise and vibration levels emitted.

6.3.2 Training

Site-specific training shall be given to site personnel including management and workers involved in construction activities that have the potential to generate noise and vibration effects. Site inductions for these personnel will include a briefing on relevant aspects of the CNVMP, including:

- The roles and responsibilities of all site personnel in the management of noise and vibration effects.
- Identification of the sensitive receivers and activities that have the potential to cause noise and vibration effects.
- Procedures and operational considerations associated with those sensitive receivers and activities, to manage the noise and vibration effects. This may include the understanding of minimum set-back distances, physical mitigation requirements, the understanding of allowable hours of operation and appropriate use of equipment.
- Contacts for site personnel to gain information related to noise and vibration including the limits, equipment on site, mitigation measures, and management procedures.
- How plant equipment and methodologies may impact noise and vibration effects, and the relevant procedures to follow for the selection of appropriate plant and methodologies.
- How site behaviours and conduct may affect noise and vibration effects, and procedures to follow for appropriate site behaviours and conduct.
- Maintaining goodwill amongst the community.

Toolbox/tailgate meetings throughout the construction will also include consideration of noise and vibration effects, refreshing the training information given in the site induction and/or updating training information.
Site specific training will be given to all excavator operators such that they understand how operation of the plant may impact vibration generated. This training will include minimising ground impacts with the bucket, minimising scraping of the bucket over rock, placement of the excavator away from any vibration sensitive buildings.

Site specific training must be provided to site personnel involved in monitoring noise and vibration and development of procedures for management and mitigation of noise and vibration effects, where required.

This includes where noise and/or vibration monitoring is required to investigate any complaint. Site induction for these personnel will include a briefing on relevant aspects of the CNVMP as

above, plus procedures for recording monitoring results and where noise and vibration effects are identified to comply or not comply with the limits.

6.3.3 Scheduling of Works

The final scheduling of particularly loud activities shall be decided once consultation with the community has been undertaken.

Occupied buildings are sensitive to the timing of construction works.

Currently no night-time works are proposed under the construction methodology. As such there is a low risk of sleep disturbance to residential or hotel receptors.

While construction activities should be prioritised when buildings are not occupied (and less sensitive to noise), with residential and commercial properties nearby, there will unlikely be a period where all buildings are unoccupied.

Cumulative noise emissions should always be considered by the contractor when scheduling the works, noise emitting from multiple items of the plant will summate and cause a greater overall noise level. Only one item of particularly loud plant should be used at any one time on site, to reduce the cumulative noise and vibration from multiple items of equipment operating concurrently.

6.3.4 Behaviour and Conduct

Site personnel shall understand that their behaviours and conduct can affect noise and vibration effects. Conduct that is perceived as unnecessarily noisy can influence the community's perception of the overall noise generated by the project.

During the site induction for contractor staff, the following management mitigation measures will be acknowledged and addressed where practicable and safe to do so:

- When arriving at work, please drive slowly on site and keep revs to a minimum. Keep stereos at a low volume (or off) and do not slam doors.
- No shouting on site. Either walk over and talk to somebody or use a radio/phone.
- Be careful with tools and equipment. Place them down and do not drop them.
- Do not drag materials on the ground. Place them down when you arrive at the work area.
- Equipment and vehicles shall be switched off when not in use.
- When loading trucks do not drop material from a height.
- Noise enclosures should also have doors/hatches closed when the equipment is in use.
- All equipment is to be well maintained.
- If staff, see anything/anyone making unnecessary noise then stop it/them. If the source cannot be stopped, then report it to the Noise Liaison Officer.

It is essential that good relationships are maintained with the local community. Any queries from members of the public shall be responded to politely and referred to the Noise Liaison Officer / Stakeholder and Engagement Manager. Staff shall assist the public to contact this person. Staff shall not enter a debate or argue with members of the public.

6.3.5 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 following vibration

managerial mitigation measures are to be followed to reduce the likelihood of high vibration levels impacting heritage buildings:

- Not operating vibratory rollers within 15 metres of any building within the Historic Heritage Overlay in the AUP. This requires only plate compactors to be used at the Mayoral Drive and Victoria Street CSA's
- Using low/no vibration rock fracturing methods to remove basalt from the Victoria Street CSA.
- 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.

6.3.6 Temporary Relocation

Temporary relocation is only required for construction works during the night where, even with the BPO physical and managerial mitigation measures incorporated, noise levels may impact sleep to a level where there will be health impacts.

The following procedure will need to be undertaken to action temporary relocation:

- Where noise levels are above the AUP noise standards, undertake community consultation to determine the level of impact this may have (i.e., are bedrooms facing away from construction areas and therefore will receive lower noise levels when assessed within bedroom spaces, or will people be home during this period).
- Analyse the noise level within bedrooms to determine whether noise from night works may cause sleep disturbance.
- If the above analysis shows that noise levels within bedrooms may disrupt sleep, then consultation will be required with the impacted property to determine when and where temporary relocation of the occupiers can be undertaken.
- Once night works associated with the temporary relocation are complete, follow up with the occupants who were temporarily relocated to determine what impacts that may have caused and to revise the methodology for any future relocation.

6.4 Receptor Specific Measures

Additional receptor specific noise and/or vibration mitigation measures may be required due to changes in the use of adjacent buildings, or complaints received. This section will be updated with a list of properties which specific management schedules are developed. All Receptor Specific Measures will be included as appendices to this CNVMP.

6.4.1 Specific Management Schedules

A specific management schedule is likely needed for vibration activities that are predicted to exceed the 2.5 mm/s PPV vibration criteria at buildings within the historic heritage overlay in the AUP. The best practicable option of mitigation shall be considered in the specific management schedule and may include specific measures for mitigation and management of the effects.

A specific management schedule should include:

- Identification of potentially affected neighbours and confirms the proposed methodology and equipment to be used;

- Details specific physical mitigation measures to be adopted based on the predicted noise and vibration levels; and
- Details any specific monitoring or communication requirements.

Heritage listed buildings may be considered particularly noise and/or vibration sensitive and therefore a specific management schedule should be undertaken for these sensitive receptors. Details around specific pre and post-construction survey required and/or monitoring requirements throughout construction.

7 Community Engagement

A key component in minimising the impact of noise and vibration effects is early community engagement. Prior to the start of construction, a Community Relations Manager role (or equivalent) will be established. This representative for the Project will advise (in person or by writing) all properties within 100 metres of any construction site. This advice will include:

- Description of the wider construction works
- The activity that the occupants/landowners may be impacted by.
- Why the works are required to occur.
- Duration of these specific activities.
- Timing of when they will occur.
- Contact details (including telephone number and email) for the Noise Liaison Officer which the public can contact to find out information or lodge a complaint.
- How any noise and vibration complaints will be handled by the contractor.

Regular direct communication (in person or by writing) will be undertaken with the properties that potentially could receive noise levels greater than the noise limits outlined in this report at any point during the construction.

7.1 Consultation

The objective of consultation with neighbouring properties is to foster positive communication and relationships between the contractors, clients, and potentially affected parties. It also provides a platform for residents to learn about the Project.

Consultation will be undertaken with all properties that are potentially impacted by construction noise and/or vibration to determine:

- Hours that higher noise and/or vibration activities would have the lowest impact (such as times when all residential occupants are at work).
- Days/times when occupants are the most sensitive (during key religious events, at night if small children are going to bed, etc.).
- If there are any special needs relating to noise and/or vibration within the construction window (i.e., children birthday parties), that may require key management of construction noise and/or vibration.

Where practicable, high noise and/or vibration construction activities will occur at times when the adjacent occupants are least noise sensitive.

7.2 Notification Procedures

For buildings that are to receive noise or vibration levels greater than the required criteria, the following procedure to notify these properties is to be undertaken:

- Identification of properties that would receive levels greater than the AUP noise and vibration criteria for the specific equipment being used.
- A minimum of 10 working days prior to any noise or vibration equipment being used that would lead to potential exceedances, communication will be undertaken to adjacent receptor buildings to notify them of upcoming high noise and/or vibration works. This communication is to include:

- Description of the specific activity being undertaken
- Why the works are required to occur.
- Duration of these specific activities.
- Timing of when they will occur.
- Contact details (including telephone number and email) for the Noise Liaison Officer which the public can contact to find out information or lodge a complaint.
- How any noise and vibration complaints will be handled by the contractor.
- If pre and post construction inspections will be undertaken (if not already) and when likely times these will occur.

- Any noise and/or vibration monitoring is to be undertaken during activities where practicable to confirm the received levels and to determine future mitigation for the equipment.

8 Complaints Handling Protocol

The Contractor will adopt the following protocol for handling complaints. This protocol is intended to ensure that the issues are addressed, and that appropriate corrective actions are identified and implemented as necessary.

The Noise Liaison Officer will record all verbal and telephone complaints in writing within a Noise Complaint Register. Details to be recorded should include:

- Full details of the complaint (complainant's name and address)
- Time and date of the event.
- Location of the event.
- What was felt/heard (can they identify the plant or process).
- If it was felt/heard outside or inside.
- If inside, were windows/doors open.
- Impact of the event (e.g., woken from sleep, couldn't hear the TV, disturbed whilst reading etc.).
- Weather conditions at the time (if known) including cloud cover, temperature, wind strength and direction.
- Any specific requests.
- What activities were occurring at the time of the complaint, including the items of equipment operating and where they were operating.
- Any additional acoustic data, including any noise or vibration measurements that are relevant to the complaint.

An initial response will be made and recorded. Depending on the nature of the complaint, the initial response could be to immediately cease the activity pending investigation, to replace an item of equipment, or screen the activity. However, it might not be practicable to provide immediate relief in some cases. The complainant and Council will be informed of actions taken. Contact details for the Council are recorded above.

Where the initial response does not address the complaint, further investigation, corrective action, and follow-up monitoring shall be undertaken as appropriate within 5 working days. The complainant [and Council] will be informed of actions taken.

Complainants will be informed of the implementation of the corrective action that has been taken to mitigate the adverse effects.

All actions will be recorded on a Noise Complaint Register, and the complaint will then be closed. The Contractors' complaint response line will be always attended to during out of hours works. It will be kept up to date and made available to the Environmental Health Officer (or equivalent) of Auckland Council if requested.

9 Monitoring

It is recommended that acoustic monitoring is undertaken at key milestones to confirm that the actual noise emissions are no greater than those predicted, or to investigate any noise and/or vibration complaints.

9.1 Noise

Noise monitoring shall be conducted by one of the following staff in accordance with NZS 6801:2008 and NZS 6803:1999.

- George van Hout, Chris Bradley, Leonard Terry, William Zhu, Sandeep Manilal, Raj Prasad; WSP
- *Contractor to include appropriately qualified staff*

Noise monitoring will be undertaken by a suitably qualified person using a Class 1 or 2 Sound Level Meter (SLM) and associated kit. The calibrator will be verified by an accredited laboratory annually, and the sound level meter and microphone biannually (every two years) during the construction programme.

The contractors may undertake noise monitoring with an SLM that does not have any class classification; however, it must be noted that this approach would not be in accordance with noise measurement guidance and standards. If this approach is adopted and measured noise levels exceed the predicted noise levels, noise monitoring by a suitably qualified person using a Class 1 or 2 SLM shall be undertaken.

Noise monitoring is recommended to be conducted:

- During Part 2 of the construction works for piling construction activities at nearby sensitive receptors. Measurements are recommended to be taken for noise producing activities at manholes MH-9, MH-10 and MH-11.
- Measurement sample time should not exceed one-hour and 15-minutes is likely to be adequate. Measurements will be used to validate or refine the noise level predictions and determine which receivers may be at risk of noise levels exceeding the criteria.

Following each noise survey, the results will be evaluated and reported on a noise survey report template. If noise monitoring indicates an exceedance of the noise criteria, then the noise management of the works will be reviewed and updated.

All noise survey reports will be kept on file and available to the territorial authority on request.

9.2 Vibration

Monitoring of building vibration will be performed in accordance with *DIN 4150-3 Structural Vibration – Effects of vibration on structures* by the following trained staff:

- George van Hout, Chris Bradley, Leonard Terry, William Zhu, Sandeep Manilal, Raj Prasad; WSP
- *Contractor to include appropriately qualified staff*

Vibration monitoring will be conducted at the following occasions:

- At the start of piling or other high vibration generating activities outlined in Table 17 to validate predictions and confirm vibration levels near heritage buildings are acceptable.
- During the first pipe jacking operation to determine the vibration level from this activity and reassess any mitigation measures required to control vibration.

- When equipment is located at the closest point to 232-327 Queen Street and 210 Queen Street to confirm vibration levels within the foundations of the building and consider whether cosmetic damage may occur,
- To address reasonable complaints relative to construction vibration.

If vibration monitoring indicates that criteria are being exceeded and that was not anticipated, then the management of the works will be reviewed.

All vibration survey reports will be kept on file and available to the territorial authority upon request.

It is also recommended that because high-risk vibratory construction methods (such as piling) will be implemented within this project, chosen the best practicable mitigation means should be taken into consideration, such as using smaller items of plant to reduce ground-borne vibration.

9.3 Building Condition Survey

Currently, no buildings are predicted to exceed the vibration criteria, and therefore no requirement to undertake building condition surveys. Where vibration meausrements are undertaken and are shown to be above the vibration criteria, all works on site will cease, and a building condition survey will be undertaken.

Qualified building surveyor staff who will conduct building condition surveys are:

- *TBC*
- *TBC*

A report will be prepared for each building surveyed including:

- A description of the building condition including construction materials and the present condition;
- Any existing cosmetic or structural damage, or other building-related defects;
- Sketched and photographs showing the location and extent of any existing damage such as cracks; and
- Verification of the report by the surveyor and building owner.
- Following the works all building condition surveys will be repeated. The post-completion report will be prepared including:
- Sketches and new photographs of any new damage, and
- Verification of the report by the surveyor and building owner.

Pre- and post-construction building condition surveys will be held on record and provided to the building owner, Heritage New Zealand Pouhere Taonga, and/or relevant territorial authority if requested.

Appendix A
Glossary

TERM	DESCRIPTION
A-weighting, dBA	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear.
Ambient noise	The all-encompassing sound, at a given place at a certain time, being usually a composite of sounds from 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 log10 (s_1 / s_2). The decibel is 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.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, fluctuating, sound that was recorded.
$L_{10,T}$	A statistical analysis noise descriptor being a sound pressure level exceeded for 10% of the measurement period.
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 a negligible effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, the sound level meter is set to a 'fast' response.
L_{eak}	The instantons peak pressure level was recorded during the measurement period.
Octave Band	A range of frequencies whose upper limit is twice the frequency of the lower limit.
PPV	Peak Particle Velocity: Measure of the greatest instantaneous velocity change in a specific spot during a measurement period.
Sound Power Level (SWL)	The logarithmic measure in decibels of the sound power (P) generated by a source.
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (SPL)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa ($20x10^{-6}$ Pascals) on a decibel scale.

Appendix B
Construction Equipment Schedule

Equipment List						
Site	Stage	Activity	Equipment	SWL (dB L_{Aeq})	SWL (dB L_{Amax})	% 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	Boring holes	Piling Rig (GEAZ EX40/60)	105	-	100
	3	Installing UC beams into holes	20T Excavator	105	120	100
			Truck	107	120	50
	4	Excavation of shaft	20T excavator	105	120	100
			Hand-held power tools	100	-	100
			50T crane	98	-	100
			Truck	107	120	50
			Welder and generator	101	-	50
			Submersible pump	96	-	100
			Diesel Generator	94	-	100
			Ventilation fan	100	-	100
	5	Installation of manhole and backfilling	50T crane	98	-	100
			Concrete truck and pump	103	-	100
			Truck	107	120	50
			Ventilation fan	100	-	100
			20T excavator	105	120	100
	6	Reinstatement	20T Excavator	105	120	100
			Vibratory Roller	107	-	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	Construction of concrete beam	Concrete truck and pump	103	-	100
			Trucks	107	120	50
			Hydraulic jack	85	-	100
	3	Excavation of shaft	20T excavator	105	120	100
			Hydraulic jack	85	-	100
			Hand-held power tools	100	-	100
			50T crane	98	-	100
			Trucks	107	120	50
	4	Construction of concrete foundation plug	Concrete truck and pump	103	-	100
			Plate compactor	108	-	100
	5		50T crane	98	-	100

		Installation of manhole and backfilling	Concrete truck and pump	103	-	100
			Truck	107	120	50
			Ventilation fan	100	-	100
			20T excavator	105	120	100
	6	Reinstatement	20T Excavator	105	120	100
			Vibratory Roller	107	-	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	Piling Rig (GEAZ EX40/60)	105	-	100
	3	Installing UC beams into holes	20T Excavator	105	120	100
			Truck	107	120	50
	4	Excavation of shaft	20T excavator	105	120	100
			Hand-held power tools	100	-	100
			50T crane	98	-	100
			Truck	107	120	50
			Welder and generator	101	-	50
			Submersible pump	96	-	100
			Diesel Generator	94	-	100
			Ventilation fan	100	-	100
	5	Excavation of Basalt	20T excavator	105	120	100
			Rock drill (attachment or handheld)	114	120	100
			50T crane	98	-	100
			Submersible pump	96	-	100
			Diesel Generator	94	-	100
			Ventilation fan	100	-	100
	5	Installation of manhole and backfilling	50T crane	98	-	100
			Concrete truck and pump	103	-	100
			Truck	107	120	50
			Ventilation fan	100	-	100
			20T excavator	105	120	100
	6	Reinstatement	20T Excavator	105	120	100
			Vibratory Roller	107	-	100
Open cut pipe installation	1	Temporary traffic management setup	Truck	107	120	50
	2	Excavation of trench	Truck	107	120	50
			20T excavator	105	120	100
			Submersible pump	96	-	100
			Diesel Generator	94	-	100

	3	Installation of pipe	Truck	107	120	50
			20T excavator	105	120	100
			Plate compactor	108	-	100
	4	Backfilling and reinstatement	20T excavator	105	120	100
			Drum Roller			
			Truck	107	120	50
Trenchless pipe installation	1*	Insertion of mTBM into the shaft	50T crane	98	-	100
			Ventilation fan	100	-	100
			Hand-held power tools	100	-	100
			Diesel Generator	94	-	100
	2*	Operation of mTBM at Mayoral Drive Site	mTBM machine	103	-	100
			Control Cabin	86	-	100
			50T Crane	98	-	100
			Diesel Generator	94	-	100
			Ventilation Fan	100	-	100
	3^	Extraction of mTBM at Victoria Street site	50T Crane	98	-	100
			Diesel Generator	94	-	100
			Ventilation Fan	100	-	100
			Truck	107	120	50
			Hand-held power tools	100	-	100
Greys Avenue Construction Support Compound	1	Set-up	Hiab trucks	107	120	50
			20T excavator	105	120	100
			Truck	107	120	50
			50T crane	98	-	100
	2	Operation of mTBM	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	1.5
2	CFA piling, auguring, drilling of holes, or similar	0.5
3	Tunnel Boring	2.0
4	Vibratory Roller	3.6
5	Plate compactor	1.0

Appendix C
Predicted Noise Levels

Queen Street/Mayoral Drive Shaft Construction						
Property	Phases					
	1	2	3	4, 5, 6	7	8
16 Wakefield Street	57	51	54	58	54	55
36 Wakefield Street	58	52	55	59	55	56
3 Airedale Street	69	63	66	70	66	67
8 Airedale Street	67	61	64	68	64	65
35 Airedale Street	54	48	51	55	51	52
3 Greys Avenue	55	49	52	56	52	53
48 Greys Avenue	64	58	61	65	61	62
68 Greys Avenue	61	55	58	62	58	59
78 Greys Avenue	57	51	54	58	54	55
80 Greys Avenue	55	49	52	56	52	53
95 Greys Avenue	59	53	56	60	56	57
100 Mayoral Drive	61	55	58	62	58	59
120 Mayoral Drive	69	63	66	70	66	67
269-297 Queen Street	57	51	54	58	54	55
280 Queen Street	50	44	47	51	47	48
290 Queen Street	51	45	48	52	48	49
299 Queen Street	56	50	53	57	53	54
300 Queen Street	52	46	49	53	49	50
301 Queen Street	74	68	71	75	71	72
304-308 Queen Street	55	49	52	56	52	53
313 Queen Street	81	75	78	82	78	79
317 Queen Street	89	83	86	90	86	87
319 Queen Street	89	83	86	90	86	87
321 Queen Street	89	83	86	90	86	87
323 Queen Street	91	85	88	92	88	89
329 Queen Street	87	81	84	88	84	85
330 Queen Street	57	51	54	58	54	55
350 Queen Street	60	54	57	61	57	58
360 Queen Street	58	52	55	59	55	56
361 Queen Street	69	63	66	70	66	67
363 Queen Street	62	56	59	63	59	60
368 Queen Street	68	62	65	69	65	66
369 Queen Street	56	50	53	57	53	54
371 Queen Street	60	54	57	61	57	58
380 Queen Street	78	72	75	79	75	76
396 Queen Street	78	72	75	79	75	76
438 Queen Street	68	62	65	69	65	66
450 Queen Street	62	56	59	63	59	60
456 Queen Street	58	52	55	59	55	56

Queen Street/Wellesley Street Shaft Construction							
Property	Phases						
	1	2	3	4	5	6	7
16 Wakefield Street	54	50	52	46	52	52	52
36 Wakefield Street	52	48	50	44	50	50	50
3 Airedale Street	36	32	34	28	34	34	34
8 Airedale Street	55	51	53	47	53	53	53
35 Airedale Street	36	32	34	28	34	34	34
98-102 Albert Street	45	41	43	37	43	43	43
99 Albert Street	45	41	43	37	43	43	43
135 Albert Street	58	54	56	50	56	56	56
1 Kitchener Street	66	62	64	58	64	64	64
44-48 Lorne Street	70	66	68	62	68	68	68
187-189 Queen Street	54	50	52	46	52	52	52
191 Queen Street	56	52	54	48	54	54	54
203 Queen Street	57	53	55	49	55	55	55
205-225 Queen Street	62	58	60	54	60	60	60
214 Queen Street	60	56	58	52	58	58	58
222 Queen Street	61	57	59	53	59	59	59
229 Queen Street	64	60	62	56	62	62	62
233-237 Queen Street	65	61	63	57	63	63	63
238 Queen Street	64	60	62	56	62	62	62
239 Queen Street	69	65	67	61	67	67	67
246 Queen Street	65	61	63	57	63	63	63
253-261 Queen Street	74	70	72	66	72	72	72
256 Queen Street	66	62	64	58	64	64	64
262 Queen Street	68	64	66	60	66	66	66
263 Queen Street	75	71	73	67	73	73	73
269-297 Queen Street	72	68	70	64	70	70	70
280 Queen Street	72	68	70	64	70	70	70
290 Queen Street	92	88	90	84	90	90	90
299 Queen Street	49	45	47	41	47	47	47
300 Queen Street	80	76	78	72	78	78	78
301 Queen Street	58	54	56	50	56	56	56
304-308 Queen Street	72	68	70	64	70	70	70
313 Queen Street	53	49	51	45	51	51	51
330 Queen Street	64	60	62	56	62	62	62
350 Queen Street	63	59	61	55	61	61	61
360 Queen Street	57	53	55	49	55	55	55
361 Queen Street	49	45	47	41	47	47	47
363 Queen Street	48	44	46	40	46	46	46
368 Queen Street	58	54	56	50	56	56	56
10 Wellesley Street	90	86	88	82	88	88	88
15-23 Wellesley Street	65	61	63	57	63	63	63
24 Wellesley Street	65	61	63	57	63	63	63

32-42 Wellesley Street	62	58	60	54	60	60	60
37 Wellesley Street	61	57	59	53	59	59	59
44-52 Wellesley Street	60	56	58	52	58	58	58
54-56 Wellesley Street	58	54	56	50	56	56	56
18-26 Wellesley Street East	73	69	71	65	71	71	71
28-36 Wellesley Street East	67	63	65	59	65	65	65
37-69 Wellesley Street East	56	52	54	48	54	54	54

Queen Street/Victoria Street

Shaft Construction

Property	Phases							
	1	2	3	4	5	6	7	8
98-102 Albert Street	60	54	57	59	67	58	54	58
99 Albert Street	60	54	57	59	67	58	54	58
135 Albert Street	44	38	41	43	51	42	38	42
22 Durham Street West	65	59	62	64	72	63	59	63
59-67 High Street	89	83	86	88	96	87	83	87
2 Lorne Street	73	67	70	72	80	71	67	71
4 Lorne Street	68	62	65	67	75	66	62	66
44-48 Lorne Street	44	38	41	43	51	42	38	42
152 Queen Street	61	55	58	60	68	59	55	59
154 Queen Street	61	55	58	60	68	59	55	59
155 Queen Street	60	54	57	59	67	58	54	58
158 Queen Street	62	56	59	61	69	60	56	60
162 Queen Street	63	57	60	62	70	61	57	61
163 Queen Street	61	55	58	60	68	59	55	59
164 Queen Street	63	57	60	62	70	61	57	61
166-174 Queen Street	65	59	62	64	72	63	59	63
167 Queen Street	64	58	61	63	71	62	58	62
175 Queen Street	66	60	63	65	73	64	60	64
176 Queen Street	66	60	63	65	73	64	60	64
182-184 Queen Street	67	61	64	66	74	65	61	65
186 Queen Street	72	66	69	71	79	70	66	70
187-189 Queen Street	68	62	65	67	75	66	62	66
191 Queen Street	73	67	70	72	80	71	67	71
203 Queen Street	76	70	73	75	83	74	70	74
205-225 Queen Street	73	67	70	72	80	71	67	71
214 Queen Street	82	76	79	81	89	80	76	80
222 Queen Street	74	68	71	73	81	72	68	72
229 Queen Street	66	60	63	65	73	64	60	64
233-237 Queen Street	64	58	61	63	71	62	58	62
238 Queen Street	71	65	68	70	78	69	65	69
239 Queen Street	63	57	60	62	70	61	57	61
246 Queen Street	67	61	64	66	74	65	61	65
253-261 Queen Street	61	55	58	60	68	59	55	59
256 Queen Street	64	58	61	63	71	62	58	62

262 Queen Street	64	58	61	63	71	62	58	62
263 Queen Street	58	52	55	57	65	56	52	56
269-297 Queen Street	54	48	51	53	61	52	48	52
280 Queen Street	61	55	58	60	68	59	55	59
290 Queen Street	59	53	56	58	66	57	53	57
3 Victoria Street East	67	61	64	66	74	65	61	65
9 Victoria Street East	82	76	79	81	89	80	76	80
27-31 Victoria Street East	68	62	65	67	75	66	62	66
19 Victoria Street West	67	61	64	66	74	65	61	65
27-35 Victoria Street West	64	58	61	63	71	62	58	62
37-39 Victoria Street West	63	57	60	62	70	61	57	61
43 Victoria Street West	61	55	58	60	68	59	55	59
55-59 Victoria Street West	58	52	55	57	65	56	52	56

Queen Street/Wellesley Street

Open Trench Construction

Property	Phases			
	1	2	3	4
135 Albert Street	51	55	57	56
1 Kitchener Street	56	60	62	61
44-48 Lorne Street	58	62	64	63
191 Queen Street	47	51	53	52
203 Queen Street	47	51	53	52
205-225 Queen Street	53	57	59	58
214 Queen Street	51	55	57	56
222 Queen Street	53	57	59	58
229 Queen Street	55	59	61	60
233-237 Queen Street	57	61	63	62
238 Queen Street	55	59	61	60
239 Queen Street	61	65	67	66
246 Queen Street	56	60	62	61
253-261 Queen Street	67	71	73	72
256 Queen Street	57	61	63	62
262 Queen Street	60	64	66	65
263 Queen Street	69	73	75	74
269-297 Queen Street	65	69	71	70
280 Queen Street	64	68	70	69
290 Queen Street	74	78	80	79
300 Queen Street	71	75	77	76
301 Queen Street	50	54	56	55
304-308 Queen Street	63	67	69	68
330 Queen Street	56	60	62	61
350 Queen Street	55	59	61	60
360 Queen Street	49	53	55	54
10 Wellesley Street	65	69	71	70
15-23 Wellesley Street	58	62	64	63

24 Wellesley Street	57	61	63	62
32-42 Wellesley Street	54	58	60	59
37 Wellesley Street	54	58	60	59
44-52 Wellesley Street	52	56	58	57
54-56 Wellesley Street	49	53	55	54
18-26 Wellesley Street East	60	64	66	65
28-36 Wellesley Street East	56	60	62	61

Queen Street/Victoria Street and Queen Street/Mayoral Drive Trenchless Construction			
Property	Phases		
	1*	2*	3^
16 Wakefield Street	51	54	39
36 Wakefield Street	52	55	39
3 Airedale Street	63	66	35
8 Airedale Street	61	64	37
35 Airedale Street	48	51	30
3 Greys Avenue	49	52	35
48 Greys Avenue	58	61	38
68 Greys Avenue	54	57	38
78 Greys Avenue	51	54	38
80 Greys Avenue	48	51	36
95 Greys Avenue	53	56	39
59-67 High Street	34	37	86
2 Lorne Street	35	38	70
4 Lorne Street	35	38	66
44-48 Lorne Street	46	49	41
100 Mayoral Drive	55	58	41
120 Mayoral Drive	63	66	38
152 Queen Street	38	41	58
154 Queen Street	39	42	58
155 Queen Street	35	38	57
158 Queen Street	39	42	59
162 Queen Street	39	42	60
163 Queen Street	33	36	58
164 Queen Street	38	41	60
166-174 Queen Street	39	42	62
167 Queen Street	35	38	61
175 Queen Street	35	38	63
176 Queen Street	39	42	63
182-184 Queen Street	39	42	64
186 Queen Street	40	43	69
187-189 Queen Street	34	37	65
191 Queen Street	36	39	70
203 Queen Street	36	39	73
205-225 Queen Street	42	45	71

214 Queen Street	41	44	80
222 Queen Street	41	44	71
229 Queen Street	43	46	63
233-237 Queen Street	43	46	61
238 Queen Street	43	46	68
239 Queen Street	44	47	60
246 Queen Street	43	46	64
253-261 Queen Street	45	48	58
256 Queen Street	43	46	61
262 Queen Street	44	47	61
263 Queen Street	44	47	55
269-297 Queen Street	51	54	51
280 Queen Street	44	47	58
290 Queen Street	44	47	56
299 Queen Street	49	52	37
300 Queen Street	45	48	54
301 Queen Street	69	72	49
304-308 Queen Street	49	52	53
313 Queen Street	75	78	47
317 Queen Street	83	86	46
319 Queen Street	83	86	45
321 Queen Street	83	86	45
323 Queen Street	85	88	45
329 Queen Street	81	84	38
330 Queen Street	50	53	50
350 Queen Street	53	56	50
360 Queen Street	52	55	45
361 Queen Street	63	66	45
363 Queen Street	56	59	44
368 Queen Street	62	65	47
369 Queen Street	50	53	39
371 Queen Street	54	57	43
380 Queen Street	72	75	47
396 Queen Street	74	77	45
438 Queen Street	62	65	44
450 Queen Street	56	59	43
456 Queen Street	52	55	43
3 Victoria Street East	31	34	64
9 Victoria Street East	34	37	79
27-31 Victoria Street East	33	36	65
19 Victoria Street West	35	38	65
27-35 Victoria Street West	32	35	61
37-39 Victoria Street West	31	34	60
43 Victoria Street West	32	35	58
55-59 Victoria Street West	34	37	55

Greys Avenue Construction Support Compound		
Property	Phases	
	1	2
3 Airedale Street	52	60
8 Airedale Street	42	50
35 Airedale Street	38	46
3 Greys Avenue	61	69
48 Greys Avenue	66	74
68 Greys Avenue	58	66
78 Greys Avenue	49	57
80 Greys Avenue	50	58
95 Greys Avenue	61	69
100 Mayoral Drive	65	73
120 Mayoral Drive	47	55
269-297 Queen Street	43	51
299 Queen Street	52	60
301 Queen Street	53	61
313 Queen Street	55	63
317 Queen Street	54	62
319 Queen Street	55	63
321 Queen Street	62	70
323 Queen Street	67	75
329 Queen Street	61	69
350 Queen Street	37	45
361 Queen Street	64	72
363 Queen Street	61	69
368 Queen Street	43	51
369 Queen Street	57	65
371 Queen Street	48	56
380 Queen Street	52	60
396 Queen Street	52	60
438 Queen Street	53	61
450 Queen Street	42	50
456 Queen Street	41	49
3 Victoria Street East	25	33

Greys Avenue, Mayoral Street/Queen Street Intersection	
All Trenchless Construction Concurrently	
Property	Operation
16 Wakefield Street	51
36 Wakefield Street	52
3 Airedale Street	63
8 Airedale Street	61
35 Airedale Street	50
3 Greys Avenue	67
48 Greys Avenue	72
68 Greys Avenue	66
78 Greys Avenue	63
80 Greys Avenue	60
95 Greys Avenue	68
100 Mayoral Drive	71
120 Mayoral Drive	63
269-297 Queen Street	56
299 Queen Street	66
301 Queen Street	69
313 Queen Street	75
317 Queen Street	83
319 Queen Street	83
321 Queen Street	83
323 Queen Street	85
329 Queen Street	81
330 Queen Street	50
350 Queen Street	53
360 Queen Street	52
361 Queen Street	75
363 Queen Street	67
368 Queen Street	62
369 Queen Street	65
371 Queen Street	54
380 Queen Street	72
396 Queen Street	74
438 Queen Street	71
450 Queen Street	65
456 Queen Street	52

Maximum Noise Levels from Any Construction Equipment	
Property	Maximum Noise Level L_{AFmax} (dB)
16 Wakefield Street	66
36 Wakefield Street	67
3 Airedale Street	78

8 Airedale Street	76
35 Airedale Street	63
98-102 Albert Street	47
99 Albert Street	50
135 Albert Street	55
22 Durham Street West	49
3 Greys Avenue	64
48 Greys Avenue	73
68 Greys Avenue	70
78 Greys Avenue	66
80 Greys Avenue	64
95 Greys Avenue	68
59-67 High Street	49
1 Kitchener Street	50
2 Lorne Street	50
4 Lorne Street	51
44-48 Lorne Street	61
100 Mayoral Drive	70
120 Mayoral Drive	78
152 Queen Street	54
154 Queen Street	54
155 Queen Street	50
158 Queen Street	54
162 Queen Street	54
163 Queen Street	48
164 Queen Street	54
166-174 Queen Street	54
167 Queen Street	50
175 Queen Street	50
176 Queen Street	54
182-184 Queen Street	54
186 Queen Street	55
187-189 Queen Street	49
191 Queen Street	51
203 Queen Street	51
205-225 Queen Street	57
214 Queen Street	56
222 Queen Street	57
229 Queen Street	58
233-237 Queen Street	58
238 Queen Street	58
239 Queen Street	59
246 Queen Street	58
253-261 Queen Street	60
256 Queen Street	58
262 Queen Street	59

263 Queen Street	60
269-297 Queen Street	66
280 Queen Street	59
290 Queen Street	60
299 Queen Street	65
300 Queen Street	61
301 Queen Street	84
304-308 Queen Street	64
313 Queen Street	90
317 Queen Street	98
319 Queen Street	98
321 Queen Street	98
323 Queen Street	100
329 Queen Street	96
330 Queen Street	66
350 Queen Street	69
360 Queen Street	67
361 Queen Street	78
363 Queen Street	71
368 Queen Street	77
369 Queen Street	65
371 Queen Street	69
380 Queen Street	87
396 Queen Street	89
438 Queen Street	77
450 Queen Street	71
456 Queen Street	67
3 Victoria Street East	46
9 Victoria Street East	49
27-31 Victoria Street East	49
19 Victoria Street West	50
27-35 Victoria Street West	48
37-39 Victoria Street West	46
43 Victoria Street West	47
55-59 Victoria Street West	49
10 Wellesley Street	56
15-23 Wellesley Street	51
24 Wellesley Street	56
32-42 Wellesley Street	54
37 Wellesley Street	54
44-52 Wellesley Street	55
54-56 Wellesley Street	55
18-26 Wellesley Street East	53
28-36 Wellesley Street East	51
37-69 Wellesley Street East	47

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