CENTRAL INTERCEPTOR PROJECT

Environmental Investigations Programme – Noise Impact Assessment

23 July 2012

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1.0 INTRODUCTION

Marshall Day Acoustics Limited (MDA) has been engaged by Watercare Services Limited (Watercare) to undertake an assessment of the potential construction and operational noise impacts for the Central Interceptor Project.

Watercare is planning to construct a new wastewater tunnel to collect wastewater flows from the Auckland isthmus area and transfer them across the Manukau Harbour to the Mangere Wastewater Treatment Plant (Mangere WWTP). The Central Interceptor Project (the Project) arose out of the Three Waters Plan (2008) which identified the need to provide trunk sewer capacity to central Auckland to reduce wet weather wastewater overflows and provide capacity for growth.

The project extends across the Auckland isthmus from Western Springs in the north to the Mangere WWTP in the south.

This report predicts the noise impact from construction and operation noise based on the current concept design and site layouts. The work undertaken by MDA has involved the specification of appropriate noise performance standards, prediction of potential construction and operation noise levels and noise mitigation measures including Construction Noise Management Plans to achieve compliance with the noise performance standards.

A glossary of technical acoustical terms is contained in Appendix 1.

2.0 PROJECT DESCRIPTION

The overall concept proposed for the Central Interceptor is a gravity tunnel from the Western Springs area to the Mangere WWTP with various link sewers and connecting pipelines connecting the existing network to the main tunnel at key locations along this route.

The key elements of the project include:

- An approximately 13 kilometres long - 4.5 metres diameter main tunnel from Western Springs to Mangere WWTP, up to 110 metres below ground;
- Four link sewers connecting the main tunnel to the existing sewerage network;
- Associated connections to existing sewers;
- Associated structures at key sites along the route and at connections. At each site facilities include access shafts, drop shafts, and flow control structures. Grit traps, air intake stacks, air vent stacks, or air treatment facilities are proposed at some sites;
- A limited number of overflow structures in nearby watercourses to enable the safe discharge of occasional overflows from the tunnel;

- A pump station located at the Mangere WWTP;
- Other associated works at and in the vicinity of the Mangere WWTP, including a rising main to connect to the WWTP and an emergency overflow structure to enable the safe discharge of flows in the event of pump station failure.

The main tunnel, link sewers, connection pipes and many of the associated structures will be underground. The tunnel and link sewers will be constructed by tunnelling methods, with access provided from around 20 surface construction sites. These surface construction sites include:

- Three primary construction sites (at Western Springs, May Road and Mangere WWTP);
- 16 secondary construction sites to provide connections to the main tunnel and link sewers;

The primary construction sites will be used for launching or retrieving the tunnel boring machine (TBM) and materials for tunnel construction would be delivered and stored, tunnel spoil removed, and permanent facilities constructed. Activities at the secondary sites on the main tunnel include shaft sinking and the construction of surface facilities and at the link sewer sites will also include launching or retrieving the microtunnel boring machine (MTBM).

Other construction activities include removal of vegetation, service relocations, establish construction yards, lay down areas and site access-ways, traffic management, earthworks and site reinstatement.

The duration of construction will range from generally around 5 to 6 years at the primary sites and 6 to 18 months at the secondary sites. Due to the nature of construction at the secondary sites the total period of occupation will be longer than this (ranging between 2 and 5 years) with some periods of time where no active construction works will occur at the sites.

The project has been developed to a concept design stage. It is likely that some details may change as the project moves through the detailed design process. Detailed construction methodology will be determined following appointment of a construction contractor.

2.1 List of Sites

2.1.1 Main Tunnel

Western Springs (WS1)
Mt Albert War Memorial Reserve (AS1/L2S3)
Lyon Avenue (AS2)
Haverstock Road (AS3)
Walmsley Park (AS4)
May Road (WS2)
Keith Hay Park (AS5)

PS23 (AS6)
Kiwi Esplanade (AS7) – alternative site
Ambury Place (AS7) – alternative site
Mangere Pump Station (WS3)

2.1.2 Link Sewers

Motions Road (L1S1)
Western Springs Depot (L1S2)
Rawalpindi Reserve (L2S1)
Norgrove Avenue (L2S2)
PS25 (L3S1)
Miranda Reserve (L3S2)
Whitney Street (L3S3)
Dundale Avenue (L3S4)
Haycock Avenue (L3S5)

3.0 NOISE PERFORMANCE STANDARDS

The full extent of the project is within the area under the jurisdiction of the Auckland Council. The relevant District Plans are those of the Auckland City District Plan – Isthmus Section, applying to the majority of locations north of the Manukau Harbour and the Manukau District Plan applying to locations south of the Manukau Harbour. In addition, the Auckland Regional Plan: Coastal applies to the sites PS23 and Mangere Pump Station as they are located within the coastal marine area.

3.1 Manukau District Plan

There are two sites in Manukau, these are:

- The pump station adjacent to the MWWTP, accessed from Greenwood Road in Mangere. This site is currently designated in the Manukau District Plan for wastewater treatment purposes.
- The second site is located on land zoned Public Open Space Activity Zone 2, on the northern side of Kiwi Esplanade, Mangere Bridge. It is noted that a second alternative site at Ambury Place is located on land designated for Wastewater Purposes and Ambury Regional Park

3.1.1 Noise Limits

(a) For activity on the MWWTP site Rule 7.5.9 (Chapter 5) of the Manukau District Plan applies and specifies noise limits not to be exceeded by any additions to the MWWTP within residential and business sites and within notional boundaries of dwellings in rural zones.

In summary, the limits are:

(i) Residential and Rural

Monday to Saturday	0700 – 2200hrs	50 dB L_{A10}
At all other times		45 dB L_{A10}

(ii) Business

At all times	60 dB L_{A10}

- Noise levels to be measured and assessed in accordance with NZ Standards 6801 and 6802 1991.
- Certification of compliance with noise standards required for new activities.
- Construction noise to comply with Construction Noise Standard NZS 6803P: 1984.

Rule 7.5.9 is set out in full in Appendix 2, Noise Rules.

3.1.2 Open Space Activity Zone

(iii) For the Public Open Space 2 zoned Kiwi Esplanade Reserve, Rule 15.11.1.7 is relevant in that it provides a guideline as to what noise criteria the Manukau District Plan anticipates being met for activities in this zone.

In summary, the specified limits for operation noise are:

Monday to Sunday	0700 – 1800hrs	45 dB L_{A10}
Monday to Sunday	1800 – 0700hrs	40 dB L_{A10} 65 dB L_{Amax}

Rule 15.11.1.7 is set out in full in Appendix 2.

Furthermore, Rule 5.18.3.6 that construction noise is to comply with Construction Noise Standard NZS 6803: 1999.

3.2 Auckland City District Plan – Isthmus Section

Most of the sites in the area of the former Auckland City Council are located in Open Space Activity Zones, with a small number (2 – 3) in residential zones, and the May Road site situated in a Business 4 Zone.

3.2.1 Open Space Activity Zone and Recreation Activity Zone

Rule 9.8.1.5 specifies noise limits for activities in Open Space Activity Zone zones 1 – 4 not to be exceeded in Residential sites. In summary the relevant limits are:

Monday to Saturday, Sundays and Public Holidays	0700 – 2000 hrs	55 dB L_{A10}

At all other times	40 dB L_{A10} 75 dB L_{Amax}

Noise levels to be measured and assessed in accordance with the relevant New Zealand Standards NZS 6801 and 6802 1991.

The full rule is set out in Appendix 2.

3.2.2 Residential Zones

Rule 7.8.1.10 specifies noise limits for activities in Residential Zones 2, 3, 4, 5, 6 and 7. In summary the limits are:

Monday to Saturday	0700 – 2000hrs	50 dB L_{A10}
Sunday and Public Holidays	0900 – 1800 hrs	50 dB L_{A10}
At all other times		40 dB L_{A10} 75 dB L_{Amax}

Noise levels to be measured and assessed in accordance with the relevant New Zealand Standards NZS 6801 and 6802 1991.

The full rule is contained in Appendix 2.

3.2.3 Business Zones

Rule 8.8.1.4 specifies noise limits for activities in Business Zones as received in other Business and Residential zone sites. In summary the relevant limits are:

Noise received in Residential Zones from Business Zone 4 (May Road site)

Monday to Saturday, Sundays and Public Holidays	55 dB L_{A10}
At all other times	45 dB L_{A10} 75 dB L_{Amax}

Noise received in Business Zone 4:

At all times	60 dB L_{A10}

The full text of Rule 8.8.1.4 is contained in Appendix 2.

3.2.4 Construction Noise

Part 4A - General Rules of the Auckland District Plan requires compliance with the Construction Noise Standard NZS 6803P:1984.

With respect to the use of explosives on a construction site, Part 4A.1 Section D of the Auckland District Plan states that noise created shall not exceed a peak overall sound pressure level of 128dB (L_{peak}) or 122dBC.

It is noted that Section 8.1.4 of New Zealand Standard NZS 6803:1999 *Acoustics – Construction Noise* recommends that airblast noise from the use of explosives on construction sites shall not exceed a peak sound pressure level of 120dBC.

MDA recommends that the lower limit contained in Section 8.1.4 of NZS6803: 1999 apply to the use of explosives on any construction site relating to the Project.

3.3 Auckland Regional Plan: Coastal

The Operative Auckland Regional Plan: Coastal (ARPC) applies to part of site PS23 and Mangere Pump Station (WS3).

3.3.1 Residential

Rule 35.5.1 (a) from the ARPC specifies noise limits for activities within the coastal marine environment at the boundary of land where residential activity is the preferred activity. In summary the relevant limits are:

0700 – 2200hrs	55 dB L_{A10}
2200 – 0700 hrs	45 dB L_{A10} or 75 dB L_{Amax}

The full text of rule 35.5.1 (a) is contained in Appendix 2.

3.3.2 Construction Noise

Rule 35.5.5 (b) specifies noise limits for construction noise of 15 days or more in duration. In summary the relevant limits are:

Monday to Friday 0630 – 2230	75 dB L_{A10} or 90 dB L_{Amax}
Saturday 0700 – 2300	80 dB L_{A10} or 90 dB L_{Amax}
Sunday 0900 – 1900	65dB L_{A10} or 85 dB L_{Amax}
At all other times (night-time)	55 dB L_{A10} or 75 dB L_{Amax}

The full text of rule 35.5.5 (b) is contained in Appendix 2.

3.4 Discussion

As can be seen from the above summary of noise rules related to the various sites included in this project, there are a range of noise limits and time frames potentially applicable.

It is considered that it is desirable for the noise criteria which would be applicable to this project as a result of the designation process, to be formulated so as to be consistent throughout the full extent of the project, as far as is practicable. This is considered to be appropriate as all sites are now located in the area under the jurisdiction of one local authority (the Auckland Council), including any parts which might lie within the Coastal Marine Area.

The recommended noise criteria which are set out below have been specified taking into consideration the following factors:

(i) the existing noise controls for the sites under consideration;

(ii) the necessity to provide adequate protection for residential and business properties in the vicinity of the project sites against unacceptable noise levels generated by both construction and operation activity;

(iii) the use of the most recent New Zealand Acoustical Standards for both construction and operation noise. This would facilitate alignment of the recommended noise controls with the future Auckland Council district plan;

(iv) the advantage of using the L_{eq} (energy average) noise descriptor for recommended noise limits (and L_{max}) to align with the most recent versions of the relevant New Zealand acoustic standards, which are: New Zealand Standard NZS 6801:2008 "*Acoustics – Measurement of environmental sound*" and New Zealand Standard NZS 6802:2008 *"Acoustics - Environmental Noise", and New Zealand Standard NZS 6803: 1999 "Acoustics - Construction Noise";*

(v) Consistency of criteria throughout the project insofar as is practicable.

3.5 Recommended Project Noise Criteria

The following noise criteria are recommended to be applied for all construction and operation noise emissions from the project sites.

3.5.1 Resource Management Act

Under the provisions of the Resource Management Act (RMA) there is a duty to adopt the best practicable option to ensure that the noise from any development does not exceed a reasonable level. Specifically, Sections 16 and 17 reference noise effects as follows.

Section 16 states that *"every occupier of land (including any coastal marine area), and every person carrying out an activity, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level"*.

Section 17 states that *"every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity, whether or not the activity is in accordance with a rule in a plan, a resource consent or relevant sections of the RMA"*.

3.5.2 Operation Noise

Mangere Pump Station

The following criteria are those applying to the existing MWWTP designation as specified in the Manukau District Plan. It is not proposed to alter these because the site is currently designated for existing and intended purposes.

"Rule 7.5.9 Noise

(a) Any additions to the MWWTP shall be so designed and the use of the buildings and site shall be so conducted, that the noise levels does not exceed the limits set out below:

(b) When measured at, or within, the boundary of any site zoned Residential or the notional boundary of any site zoned Mangere Puhinui Rural, (as at the date the district plan became operative) which is located beyond the boundary shown on Figure 5.6 attached to this designation. (The notional boundary is a line 20 metres from the façade of any rural dwelling or the legal boundary where this closer to the dwelling).

DAY/TIME	*NOISE LEVEL (L_{10} dBA)*
Monday to Saturday 0700 – 2200	*50*
At all other times including Sundays and Public Holidays	*45*

(i) When measured at or within the boundary of any site zoned Business:

DAY/TIME	*NOISE LEVEL (L_{10} dBA)*
At all times	*60*

L_{max} 65 dBA (or background plus 30 dBA, whichever is lower) shall apply between the hours of 2200 – 0700, seven days a week.

(c) The noise levels shall be measured and assessed in accordance with NZS 6801:1991 "Measurement of Sound" and NZS 6802:1991 "Assessment of Environmental Sound".

(d) Any construction noise (as defined in Section 2 of the Construction Act 1959) emanating from the site shall comply with the requirements of NZS 6803P:1984 "The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work".

(e) Prior to the commencement of any new activities, the applicant shall provide Council with a certificate from a qualified Acoustic Engineer demonstrating that the above performance standards will be met.

(f) Notwithstanding the noise standards above, the Council reserves the power conferred on it under the relevant sections of the Resource Management Act 1991, to control any noise which contravenes the provisions of the abovementioned Act."

All Sites Other than Mangere Waste Water Treatment Plant

(i) The noise level from activities within the site shall not exceed the following noise limits when measured within the boundary of any site zoned:

Residential

Time		Noise Limit
Any day	0700 – 2200hrs	50 dB L_{Aeq}
	2200 – 0700hrs	40 dB L_{Aeq} 75 dB L_{Amax}

Business

Time	Noise Limit
Any day at all times	60 dB L_{Aeq}

(ii) Noise levels shall be measured and assessed in accordance with the requirements of New Zealand Standard NZS 6801:2008 *"Acoustics – Measurement of Environmental Sound"* and New Zealand Standard NZS 6802:2008 *"Acoustics - Environmental Noise.*

3.5.3 Construction Noise

(iii) Noise generated by construction activity shall not exceed the limits recommended in, and shall be measured and assessed in accordance with, New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"* (the Construction Noise Standard).

The construction noise limits from NZS 6803: 1999 are set out in Appendix 3.

(iv) Noise generated by blasting during the construction phase shall not exceed a peak sound pressure level of 120dBC.

For this project, construction noise levels are proposed to be managed based on the NZS6803:1999 noise criteria where practicable.

The Construction Noise Standard provides for construction noise criteria that are higher than criteria for ongoing operational noise levels. This is because it is commonly accepted that for any construction to occur, noise criteria must be less stringent, with the understanding that construction is a temporary activity with a finite duration. The Standard states in the Foreword:

> *The generally acceptable level of intrusive noise in the community is assessed under the provisions of NZS6802:1999. However, construction noise is outside the scope of NZS6802:1999 because it usually cannot be kept within the specified limits. Although this may mean that the noise is undesirable, it is not necessarily unreasonable when all the relevant factors are taken into consideration. Construction noise is an inherent part of the progress of society.*

As noise from construction projects is generally of limited duration, people and communities will usually tolerate a higher noise level provided it is no louder than necessary, and occurs within appropriate hours of the day.

It is considered that the Central Interceptor can be constructed within reasonable noise criteria, provided that the best practicable option of mitigation is implemented throughout and contractors are committed to managing construction noise on an ongoing basis. It is noted that ambient noise levels in the areas under consideration range from 41 – 65dB L_{Aeq} during the daytime and 44-55dB L_{Aeq} at night-time (primary sites only). Therefore, even when achieving compliance with the daytime construction noise criteria, there will be appreciable increases in overall noise level during the construction phase at some locations. This is, as recognised by the Construction Noise Standard, an expected and inevitable result of large construction projects in the vicinity of receivers.

Construction would occur in close proximity to some receivers and in some instances, noise emissions have the potential to exceed the Construction Noise Standard. It is generally noted that for most large scale construction projects, exceedances of construction noise limits occur from time-to-time. Provided all reasonable mitigation steps are taken, the exceedance is of limited duration, and the community is consulted prior to commencement, noise may not be unreasonable.

The reasonableness or otherwise of noise from a construction activity exceeding the criteria may vary from site-to-site and activity-to-activity. The impact of any exceedance will be dependent upon the circumstances in which it occurs. For instance, where the daytime noise criterion is exceeded for several days, but neighbouring residents are not at home, no one would be affected and therefore mitigation may not be required beyond communication with residents.

In the event that night-time works occur for one or two nights, this may be acceptable provided that residents have been informed and a clear time frame provided. However, should night-time works be ongoing for several consecutive nights, and at a noise level that affects residents' ability to sleep, then alternatives should be found, such as temporary relocation. This would be determined on a case-by-case basis throughout the construction process when construction equipment, methodologies and timing have been ascertained.

Any such measures would be found in the CNMP that provides detail as to the methodology for pro-actively avoiding, or responding to noise issues.

4.0 CONSTRUCTION AND OPERATION NOISE ASSESSMENT

4.1 Background

The following sub-sections discuss the existing noise environment, predict construction and operation noise and assess compliance for each of the primary and secondary sites that form the basis of potential noise generating activities for the project.

For all primary and secondary sites, operational arrangements are anticipated to occur on the following general basis:

- Tunnelling activities – 24 hours a day 7 days a week operations will occur for all tunnelling activities related to the main tunnel works;
- Microtunnelling activities – this work would normally occur during normal working hours, 7 am to 6 pm, Monday to Friday and 8 am to 6 pm Saturday. However, in special circumstances, Watercare may need to undertake works 24 hours a day 7 days a week (or alternative extended hours) to meet construction demands, provided that construction work can be managed to meet construction traffic, noise, and vibration requirements
- Truck movements – 0700 – 1800hrs Monday to Friday, 0800 – 1800hrs Saturday;
- Special deliveries – as required to address traffic management issues;
- General site activities – 0700 – 1800hrs Monday to Friday, 0800 – 1800hrs Saturday with provision to extend hours during summer daylight savings periods as required.

General site activities encompasses initial site establishment, shaft excavation and also includes pipeline trenching and chamber construction which it is assumed will take place during normal construction hours. However, flexibility is required to enable these sites to also operate in the night-time period where circumstances dictate e.g. where critical work tasks need to be completed; support of tunnelling operations; where connections need to be made to the existing sewers etc. As such, the resource consent application will seek to operate each site at any time during the 24 hour period.

However, it is emphasised that critical above ground night-time works would be of short-term duration and would be restricted to activities which comply with the Construction Noise Standard.

It is noted that standard site hours span two time periods in the Construction Noise Standard, namely 0630 – 0730 and 0730 – 1800hrs.

It is important to note that the 0630 – 0730 period, often termed the morning shoulder, has a significantly lower noise limit than the daytime period. And it is recognised that there is potential risk that construction works operating in the morning shoulder period may exceed the lower noise limit by a significant margin, unless early morning site activities are managed appropriately. Two examples would be where trucks queue up outside site gates prior to site opening and also crane lift of heavy items delivered by truck during this period.

Noise issues at Watercare Project Hobson

Watercare has previous experience with similar tunnelling projects, particularly Project Hobson, which involved the construction of a tunnel in Hobson Bay, linking the Orakei main sewer to a new Orakei pump station.

The following list provides a summary of noise issues encountered at Watercare's Project Hobson and the proposed resolutions if encountered on the Central Interceptor Project. As the Project will utilise similar construction methods and therefore noise generating equipment, a corollary can be drawn between actual noise issues encountered for Project Hobson and issues likely to be encountered for this project.

Table 1: Noise issues encountered at Project Hobson

Complaint	Complaints resolution if encountered on the Central Interceptor Project
• Noise from construction work prior to/after consented hours	• Carry out noise intensive works 0730 – 1800 only. Unless managed through Construction Noise Management Plan (CNMP) for critical work
• Connection to existing sewer at night-time	• Management through CNMP. A 24-hour project hotline is recommended.
• Tunnel ventilation fan noise	• Vent fan to outside through attenuator or plenum/louvre arrangement
• Noise during night-time e.g. pump noise, noise breakout through open enclosure doors.	• Ensure all continuously operating plant such as generators, pumps etc provided with acoustic enclosures or noise barriers. Keep doors closed.
• Sheet piling noise	• Consideration should be given to an alternative method of driving sheet piles such as hydraulic pressed in method. Where not practicable to do so, management through CNMP will be required.
• Drop hammer piling of trestle way – specifically noise of ropes/shackles clanging	• On-site assessment and measurement at start of noise intensive activities/activities likely to cause noise sensitivity can identify issues before they cause problems.
• Site establishment works e.g. excavators and rollers	• Site noise barriers, where proposed, should be installed prior to use of machinery on site, where practicable.
• Muck-out noise during tunnelling activities e.g. crane, excavator lift of debris, impact noise	• Fit additional silencer to diesel engine; prevent bucket from hitting ground or muck storage bin.

4.2 Construction Methodology Overview

As the project is still in the concept design stage, a detailed construction methodology for each site has not yet been developed. It is expected a detailed construction management plan will be prepared, which will directly feed into the Construction Noise Management Plan (CNMP).

At primary sites the construction sequence will typically involve the following:

- Site establishment
- Access and drop shaft excavations and spoil removal
- TBM assembly and launch or retrieval
- Shaft permanent works construction

Other permanent works will include grit, control and connection chambers, connecting pipelines, permanent access roads, stormwater drainage.

At the Mangere WWTP (WS3) a pump station wet well, building and fit out will occur in addition to an Air Treatment Facility (ATF). ATF's may also be constructed at May Road (WS2), PS25 (Miranda Reserve) and Western Springs (WS1).

At the completion of site works, site reinstatement will involve activities such as removal of plant and equipment, any temporary structures, landscaping and planting.

Construction works at secondary sites associated with the main tunnel alignment will typically involve the following:

- Site establishment – excavators, loaders, trucks etc
- Access and drop shaft excavations – excavators, cranes, trucks etc
- Construction of connection chambers and other permanent works

It is noted that spoil removal will occur at secondary sites used as a micro-tunnelling jacking shaft location. Similar site reinstatement works are anticipated.

Throughout this report, 'Stage 1' refers to shaft excavation and 'Stage 2' refers to tunnelling and related work.

Table 2 provides an overview of ground retention methods and the most noise-intensive equipment likely to be utilised for shaft construction at the shaft sites shown. Similar methods will occur at the remaining link sewer sites. It is important to note that these methods are indicative only and the contractor may utilise different methods. As the ground conditions for each site are unique, different combinations of methods will be used, resulting in different noise emissions.

It is recognised that as shafts are worked deeper into the ground, they will inherently provide additional noise screening to the nearest receivers, and will result in a more directional i.e. vertical noise emission.

Table 2: Indicative shaft construction methods and timings

Shaft	Diam (m)	Ground Level (m RL)	Invert Level (m RL)	Geological Profile	Retention Method	Temporary Shaft Construction Time (conservative estimates)
WS1	15x25	13.0	-14.0	MD sand Basalt ECBF	Battered dig Grout cut-off, bolts, mesh Soil nails, mesh, shotcrete	• 0.5-1 month for treatment/support of sand & silt, if required • 1-2 months to install soil nails and mesh. • 1 month to construct base slab, headwalls etc • Total: 3 - 4 months
WS3	34.0	3.0	-28.1	D sands, gravel M-D sand D sand W ECBF ECBF	Diaphragm wall Diaphragm wall Diaphragm wall Diaphragm wall Diaphragm wall	• 4 months for treatment/support of sand & silt, if required • 2 months to construct base slab, headwalls etc • Total: 6 months
WS2	15x25	49.0	-20.6	Alluvium Basalt ECBF Soil ECBF	Secant Piles Secant Piles Soil nails with mesh, shotcrete	• 2 months to install secant piles and excavate to ECBF 'rockhead'. • 2-3 months to install soil nails and mesh. • 1 month to construct base slab, headwalls etc. • Total: 5 - 6 months
AS1	13.5 & 8.5	21.0	-15.9	Basalt M-D Sand, stiff silt ECBF	Grout cut-off, + bolts, mesh Overlapping jet grout columns Soil nails with mesh, shotcrete	• 0.5-1 month for grouting basalt • 1 month for excavating and supporting basalt • 0.5-1 month for treatment/support of sand & silt, if required • 1-2 months to install soil nails and mesh. • 0.5 month to construct base slab, headwalls etc. • Total: 3.5 – 5 months
AS2	9.0	28.0	-17.0	Basalt Alluvium ECBF	Grout cut-off + bolts, mesh Secant piles Soil nails with mesh, shotcrete	• 0.5-1 month for grouting basalt • 1 month for excavating and supporting basalt • 1-1.5 month to install secant piles and excavate to ECBF 'rockhead'. • 1-2 months to install soil nails and mesh. • 0.5 month to construct base slab, headwalls etc. • Total: 4 – 6 months
AS3	9.0	31.0	-17.8	Fill Basalt Alluvium ECBF	Battered dig Grout cut-off + bolts, mesh Secant piles Soil nails with mesh, shotcrete	• 1-2 weeks for battered excavation • 0.5 month for grouting basalt • 0.5 month for excavating and supporting basalt • 0.5-1 month to install secant piles and excavate to ECBF 'rockhead'. • 2 months to install soil nails and mesh. • 0.5 month to construct base slab, headwalls etc. • Total: 4 – 5 months

	AS4	7.0	47.0	-19.2	Alluvium Basalt ECBF	Steel sheet piles / battered dig Grout cut-off + bolts, mesh Soil nails with mesh, shotcrete	• 0.5 month to pitch and drive sheet piles, and excavate soil • 0.5-1 months for grouting basalt • 1-1.5 months for excavating and supporting basalt • 1-1.5 months to install soil nails and mesh. • 0.5 month to construct base slab, headwalls etc. • Total: 3.5 – 5 months
	AS5	9.0	56.0	-22.5	Alluvium ECBF	Secant piles Soil nails with mesh, shotcrete	• 1-1.5 months to install secant piles and excavate to ECBF 'rockhead'. (note – sheetpiles could possibly be used in this location as well) • 2.5-3 months to install soil nails and mesh. • 0.5 month to construct base slab, headwalls etc. • Total: 4 – 5 months
	AS6	9.0	3.0	-24.0	Fill ECBF	Secant piles Soil nails with mesh, shotcrete	• Reclamation not included • 1-1.5 months to install secant piles and excavate to ECBF 'rockhead'. (note – sheet piles could possibly be used in this location as well) • 1.5-2 months to install soil nails and mesh. • 0.5 month to construct base slab, headwalls etc. • Total: 3 – 4 months
	AS7	9.0	3.0	-25.6	Marine mud Basalt L-D Sand ECBF	Steel sheet piles / battered dig Grout cut-off + bolts, mesh Secant piles Secant piles	• 1 month to pitch and drive sheet piles, and excavate soil • 0.5 month for grouting basalt • 1-1.5 months for excavating and supporting basalt • 1-2 months to install secant piles to tunnel invert • 0.5 month to construct base slab, headwalls etc. • Total: 4 – 5.5 months
	L2S2	6.5	15.0	-12.0	MD Sand ECBF	Secant piles Soil nails with mesh, shotcrete	• 1-1.5 months to install secant piles and excavate to ECBF 'rockhead'. (note – sheet piles could possibly be used in this location as well, and could shorten time by 0.5 month) • 1 month to install soil nails and mesh. • 0.5 month to construct base slab, headwalls etc. • Total: 2.5 – 3 months
	L3S3	6.5	26.0	-15.8	Soft Clay, Silt ECBF	Secant piles Soil nails with mesh, shotcrete	• 1-1.5 months to install secant piles and excavate to ECBF 'rockhead'. (note – sheet piles could possibly be used in this location as well, and could shorten time by 0.5 month) • 1-1.5 month to install soil nails and mesh. • 0.5 month to construct base slab, headwalls etc. • Total: 2.5 – 3.5 months

Table 2 notes:

Battered Dig Excavation (Fill or other soil, where space permits)

- Standard tracked excavators, loading directly to dump trucks
- Drainage by sumps or well pointing may be used, with sporadic pump noise

Excavation and Support in Basalt

- Grouting requires rock drilling (hammer drills with compressed air) pumps and generators
- Rockbolts in basalt require hammer drills.
- Excavation in basalt by mechanical breaking, or blasting (only if required).
- Mucking out typically by loading buckets/skips by small excavators, hoisting via crane, and tipping to muck pile. Front end loader or excavator used to load dump trucks from muck pile.

[Note: at this stage, on site crushing and re-use of suitable basalt has not been considered]

Sheet piling (Alluvium, residual soil of ECBF)

- Sheet pile pitching by crawler crane, using hydraulic or vibrating hammer. In extreme case, may need drop hammer, but unlikely.
- Waler beams & bracing may be steel, precast or cast in place reinforced concrete.
- Excavation in soil within shaft by digging with small tracked excavators, or by longreach/telescoping excavators.
- Mucking out typically by loading buckets/skips by small excavators, hoisting via crane, and tipping to muck pile. Longreach/telescoping excavators muck directly to surface spoil pile, or dump truck in some cases. Front end loader used to load dump trucks from muck pile.

Secant Piles (Alluvium, residual soil of ECBF)

- Piling - typical pile boring noise from piling rig (rattling and impact noise when emptying buckets/augers), cranes to lift cages, concrete pours. Piling may be by continuous flight augers, or standard auger and rock bucket attachments
- Capping beams and ring beam walers typically by cast in place reinforced concrete.
- Excavation in soil within shaft by digging with small tracked excavators, or by longreach/telescoping excavators where within plant reach.
- Mucking out typically by loading buckets/skips by small excavators, hoisting via crane, and tipping to muck pile. Longreach/telescoping excavators muck directly to surface spoil pile, or dump truck in some cases. Front end loader used to load dump trucks from muck pile.

Jet Grouting Ground Improvement (Alluvium, soft soils)

- Jet grouting is unlikely to be required except as method of last resort.
- If jet grouting required in soft soils, then method requires modified tracked drilling rigs with high pressure grout pumps required (there is a hissing sound when pulling out of the ground).
- Excavator and dump trucks required to clean up excess surface soil-cement spoil.

Soil Nailing / Rock Bolting in ECBF

- Soil nailing requires drilling rigs (mainly noise from motors and pumps). Facing may comprise reinforced shotcrete or reinforcing/rockfall mesh
- Excavation by ripping and digging.
- Mucking out typically by loading buckets/skips by small excavators, hoisting via crane, and tipping to muck pile. Front end loader used to load dump trucks from muck pile.

[Note: an alternative means of ground support in ECBF materials may comprise extending alternate secant piles down to full depth, with shotcrete infill. Noise generated from this type of support construction is anticipated to be similar to or less than soil nailing/rockbolting]

Base Slab & Headwalls

- Base slab & headwalls present routine construction noise associated with cast in place reinforced concrete work.

4.3 Construction Noise Prediction Methodology

Construction noise emissions have been predicted for all primary and secondary sites based on the concept design drawings detailed in the Central Interceptor Main Project Works Assessment of Effects on the Environment Report, Part C.

Predictions of construction noise have been modelled using the algorithm detailed in ISO9613-2: 1996- *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO9613) as implemented in SoundPLAN® environmental noise modelling software. The ISO9613 standard considers a range of input factors, including frequency dependent atmospheric attenuation (using humidity, air temperature and pressure), ground effect and topographic screening, amongst others. No duration correction has been applied to predicted noise levels.

Equipment sound power levels listed in Appendix 4 are based on data contained in Annex D of British Standard BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites* in addition to being sourced from measurements made by MDA of equipment and processes of comparable size and sound power level to those likely to be used on this project.

Furthermore, noise level predictions take into consideration the screening loss provided by noise barriers applied to the boundary of each construction site where it is practicable to do so and where line-of-sight is interrupted between significant noise sources and receiver locations. It is noted for the entirety of some sites or along certain boundaries, the use of noise barriers would be ineffectual, due to elevated receiver topography or overlooking multi-storey dwellings. In these instances, predicted noise levels for some activities are close to or exceed the noise limit and would trigger management through the CNMP or consideration of quieter construction methods where available and practicable.

Where noise barriers have been recommended, the primary beneficiary of noise level reduction would be dwellings immediately adjacent to construction sites. Other dwellings located further from the site would generally comply based on noise reduction through distance loss and/or building screening. It is noted that where trenching occurs outside the construction site boundary, no screening will be afforded to dwellings from site noise barriers, therefore where it is practicable to do so, recommendations have been made to utilise mobile screening and/or noise management via the CNMP.

It is advisable and beneficial to the project to construct noise barriers as early as possible and prior to site establishment works where practicable to do so.

It is acknowledged that as shafts are worked deeper into the ground, noise sources associated with ground removal and support, such as in-shaft excavation, rock-breakers and drills will be afforded noise screening by the shaft itself, reducing noise levels at receivers.

Trenching & underground structures

The excavation of trenches for connection pipelines may involve the use of sheet piling and excavation outside the site boundary of some sites. Some sections of pipeline follow the road designation with houses as close as 15-20 metres from proposed works.

While mobile trench shields will be used where possible for pipe-laying operations, sheet piling may be unavoidable in some locations, particularly at connections.

Where sheet piles are driven into the ground using a vibrating head, this form of piling will be problematic in that for a considerable period of the drive the vibro-head and vibrating sheet pile will be located many metres above ground and consequently above any ground-based mitigation such as noise barriers.

The measurement of noise from vibratory sheet piling indicates that compliance with the daytime construction noise limit of 70dB L_{Aeq} can only be achieved at approximately 65 metres distance. It is noted that some trench routes are located significantly closer to noise sensitive receivers, with predictions indicating short-term noise levels of 80 – 85dB L_{Aeq} may be encountered. A consequence of this is that compliance with the Construction Noise Standard cannot practicably be achieved using this method of piling. It is recognised that for some ground conditions, hydraulic press installation of sheet piles may be possible, resulting in considerably lower levels of generated noise (no impact noise or vibration). Where alternative (quieter) methods are not practicable or available, the potential short-term effects from sheet pile trenching would require management through the CNMP.

Truck movements

In regard to secondary site heavy vehicle traffic noise on local roads, the trip generation data for Lyon Avenue (AS2) has been used to assess traffic noise impacts at these sites as it is anticipated that vehicular movements at AS2 will be the highest and therefore representative of the worst case scenario[1].

4.4 Operation Noise

Noise predictions have been carried out for the operational aspect of each of the primary and secondary sites. Permanent structures which may cause noise include flow control structures and air intake vents (low-level) and air treatment facilities (high-level noise).

It is noted that the perceptibility of noise will be largely dependent on the background noise level at each site. It is anticipated that the point of greatest impact from operation noise will the morning shoulder period, 0600-0700, where demand on the system increases yet the background noise level remains low. For each of the primary and secondary sites where air treatment facilities are proposed, additional long-term background noise level logging has been recommended in order to establish whether the proposed operation noise limits sufficiently protect the amenity of receivers, or conversely, are too stringent.

[1] Section 4.2.9 Traffic Generation, Traffic Design Group report dated November 2011

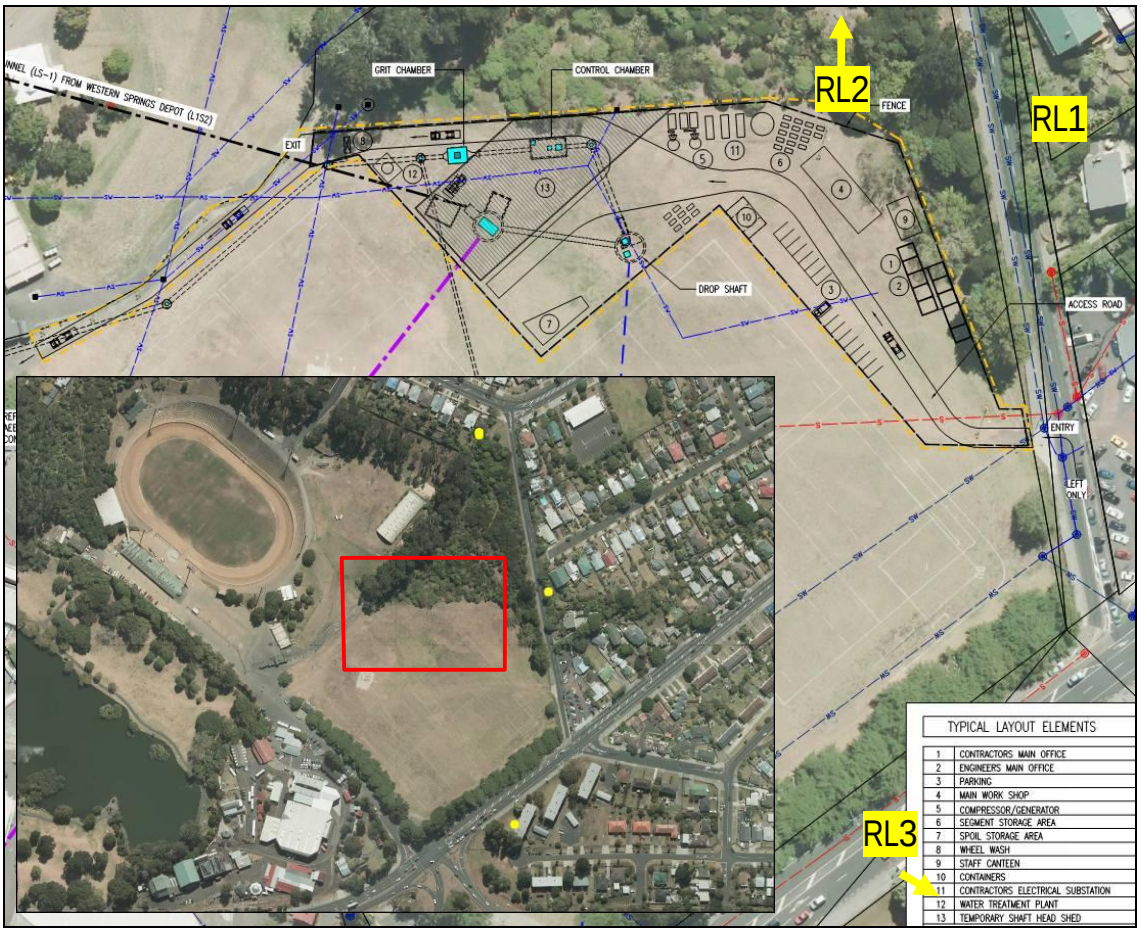
4.5 Individual Site Assessment

4.5.1 Western Springs (WS1)

Details of Proposed Site

The proposed site is situated on the north-east corner of Western Springs Playing Field, Open Space Activity Zone 3 land adjacent to Great North Road, the Bullock Track and MOTAT. The nearest dwellings are located approximately 60 metres distance to the east of the site with further dwellings located to the north, on Old Mill Road, and to the south on Great North Road. Figure 1 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 1: Site overview



Currently, the predominant noise source is traffic from surrounding roads. An ambient noise level of 65 dB L_{Aeq} was measured on 12 May 2011 during the day-time, while an ambient noise level of 55 dB L_{Aeq} was measured on 19 July 2011 during the night-time.

Further long-term noise logging is to be undertaken to assess the appropriateness of Project noise limits.

The proposed site is the northern extent of the main tunnel and will be a primary construction and permanent operational site. A large temporary construction shaft is necessary to serve as a TBM launch or retrieval site. Permanent constructions will contain an access shaft, a drop shaft, flow control structure, grit chamber, air treatment facility and connections to existing sewers and CSO Collector Pipe CC-2.

In addition, a secondary, smaller site is proposed to be located on the southern side of Great North Road, immediately east of the Caltex Service Station. The site would consist of a drop shaft and flow control structure. The existing pump station PSW25 located nearby would be demolished.

Construction Noise

Construction is estimated to be of five years duration if the site is used as a TBM launch site. Construction would extend throughout the day and night-time and is of long-term duration according to the provisions of the Construction Noise Standard.

Significant temporary construction activities at the site include the excavation and support of a 27 metre deep access shaft and drop shaft in addition to deep excavations for other underground permanent works and a 24-hour tunnelling operation.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as mobile and gantry cranes, excavators, concrete pumping, rock breaking, drilling and spoil removal by truck.

Where the site is used as a TBM launch shaft, tunnelling operations noise would include truck noise, heavy lifts of precast tunnel segments by crane, tunnel ventilation by axial fan, water treatment plant, generators, electrical substation, gantry or tower cranes, crawler crane and debris storage and removal by truck to landfill.

It is noted that the site would be scaled down where it is used as a reception shaft for the TBM.

It is estimated that approximately 64 and 104 heavy vehicle movements per day will occur during Stage 1 and Stage 2 construction respectively. The impact of site heavy vehicle traffic on traffic noise levels has been considered for WS1. It is noted that the site is situated next to Great North Road and the 6-lane North Western Motorway and it is assumed that these will be used as haulage routes. MDA predicts that traffic noise levels will increase by less than 1 decibel during the daytime and evening periods due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Several construction noise mitigation measures are proposed and have been incorporated into preliminary construction plans:

- A shed enclosure constructed over the temporary tunnelling shaft site with a weighted sound reduction index (R_w) of at least 40. Openings designed to face away from the nearest noise sensitive receivers.

- Truck movements restricted to Monday-Saturday day-time and weekday evening periods so as to limit noise impact during the night-time.
- Enclosure doors closed at night-time to ensure maximum noise reduction.
- Noise intensive construction work limited to within the enclosure at all times excluding Monday to Saturday daytime (0730 – 1800hrs) and weekday evening (1800 – 2000hrs) periods. It should be noted that night-time works outside the enclosure would be acceptable where they are of a less noise –intensive nature. Activities such as piling, trenching, concrete pumping and heavy lifts would not be permissible during the night-time outside of the enclosure.
- All outside plant such as generators, compressors, electrical substation, water and slurry treatment plant will require enclosures or noise barriers for night-time operation.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 3 presents the results of predictions during the Monday-Saturday daytime and weekday evening periods, whilst Table 4 presents the results of predictions for all other times. Noise levels are predicted assuming the mitigation measures outlined above.

Table 3: Monday-Saturday day-time and weekday evening construction noise level predictions

Receiver Location		Stage 1 Excavation	Stage 2 Tunnelling
		dB L_{Aeq}	dB L_{Aeq}
1	42 Sefton Avenue	64	58
2	6 Old Mill Road	52	50
3	744 Great North Road	59	52

The above construction noise levels are compliant with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) and weekday evening (1800 – 2000hrs) periods.

Although compliance is predicted during the evening period without additional mitigation required compared to the daytime period, it is recommended that outside construction activities such as piling, trenching, concrete pumping and heavy lifts be confined to the daytime period in as far as it is practicable to do so.

Table 4: All other times construction noise level predictions

Receiver Location		Stage 1 Excavation	Stage 2 Tunnelling
		dB L_{Aeq}	dB L_{Aeq}
1	42 Sefton Avenue	-	45
2	6 Old Mill Road	-	40
3	744 Great North Road	-	40

The construction noise levels are compliant with the Construction Noise Standard for all other time periods. However, in order for compliance to be achieved no outside construction activities of a significant noise generating nature can occur. It is recommended that static equipment located externally which is anticipated to operate 24-hours per day be designed to a level of 65 dB L_{Aeq} or less at 1 metre.

With the outlined noise mitigation measures implemented, MDA predicts that construction noise levels will be compliant at all times. A CNMP is included in Appendix 5.

Operation Noise

Permanent constructions will contain an access shaft, a drop shaft, flow control structure, grit chamber, air treatment facility and connections to existing sewers and CSO Collector Pipe CC-2.

The long-term noise emission sources at this location would be in the form of an air treatment facility and ancillary equipment as well as a drop shaft air intake.

Predicted noise levels from the air intake are readily compliant with the noise limit at adjacent sites.

Operation noise levels due to the air treatment facility have been predicted for representative dwelling sites, with the results presented in Table 5. It should be noted that noise levels are predicted assuming the mitigation measures detailed later in this section.

Table 5: Operation noise level predictions

Receiver Location		Predicted Noise Level
		dB L_{Aeq}
1	42 Sefton Avenue	40
2	6 Old Mill Road	35
3	744 Great North Road	34

The results in the preceding table indicate that operation noise levels are fully compliant with the proposed noise limit for all periods of the day based on the recommended noise mitigation measures.

Recommended Noise Mitigation Measures - Operation

Based on the indicative equipment selections and building concept design MDA recommends that the air treatment facility be constructed with an enclosure giving a weighted sound reduction index (R_w) of at least 30. Internal absorption will be required to some surfaces in order to control the reverberant level within the enclosure. All venting of air to atmosphere will require louvres treated to 65dBA at 1 metre, while an attenuator is necessary for the air intake. Any openings should face away from the closest noise sensitive receivers.

It should be noted that these recommendations are indicative only and subject to change once equipment selection is finalised during the detailed design phase of the project.

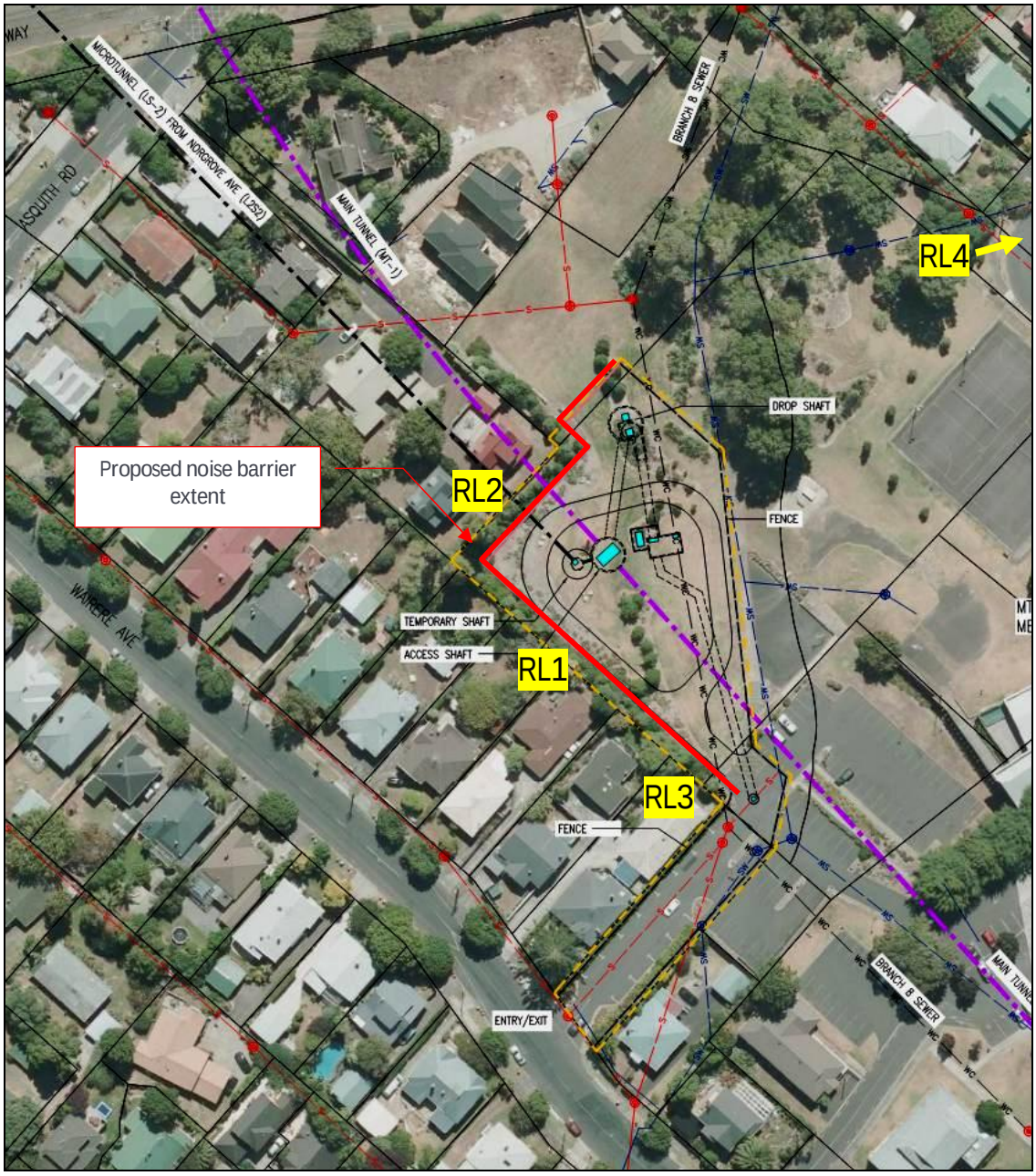
Based on the above recommendations, operation noise levels are predicted to be within the recommended noise limits at adjacent sites.

4.5.2 Mt Albert War Memorial Reserve (AS1)

Details of Proposed Site

The proposed site is situated on Mt Albert War Memorial Reserve on Open Space Activity Zone 4 land adjacent to Wairere Avenue. The nearest dwelling is located approximately 15 metres distance to the north-west of the construction site centre. Figure 2 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 2: Site overview



Currently, the predominant noise source is traffic from surrounding roads. An ambient noise level of 47 dB L_{Aeq} was measured on 12 May 2011 during the day-time, excluding traffic noise when practicable.

The proposed site will connect to the existing sewer and contain access shafts, a drop shaft, flow control structure and inlet overflow structure improvements.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard. Significant temporary construction activities at the site include the excavation and support of a 38 metre deep access shaft and drop shaft in addition to deep excavations for other underground permanent works.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck.

This site has been identified as potentially requiring blasting where basalt is found in the shaft excavation. Refer to Section 4.50 for further discussion in relation to the prediction and management of blasting effects. It is noted that blasting would be avoided where at all possible.

It is estimated that approximately between 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Wairere Avenue has been considered. MDA predicts that noise levels will increase by less than 3 decibels during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be no more than minor.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 6 presents the results of predictions for a range of construction equipment. Noise levels are predicted assuming a 2 metre high noise barrier as detailed in Figure 2.

Table 6: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	13A Wairere Ave	44 - 67
2	65 Asquith Ave (ground floor)	36 - 68
-	65 Asquith Ave (first floor)	41 - 73
3	9 Wairere Ave	44 - 68
4	22 Selcourt Road	33 - 58

The construction noise levels are predicted to generally comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for the receivers assessed with the exception of RL2, where piling operations are predicted to be non-compliant.

It is noted that RL2 is a 2-storey building and as such, screening afforded by the recommended noise barrier will be ineffectual due to the elevated nature of the second storey, likely to consist of a bedroom. It is therefore recommended that piling operations should be confined to the daytime period only and as it is likely that the second storey will only be occupied during the night-time period, it is considered that noise impacts would be acceptable. It is recommended that a quieter form of piling such as the hydraulic 'pressed-in' method be considered in as far as it is practicable to do so.

With regards to RL3, it is noted that trenching and sheet piling will occur in close proximity to this dwelling (connection to MH18 overflow) and that site access is immediately adjacent the southern property boundary. It is envisaged that noise management will be required where noise intensive works occur in close proximity to this property. In addition, trucks should not sit idling for long periods on the access-way adjacent to the southern boundary.

Operational Noise

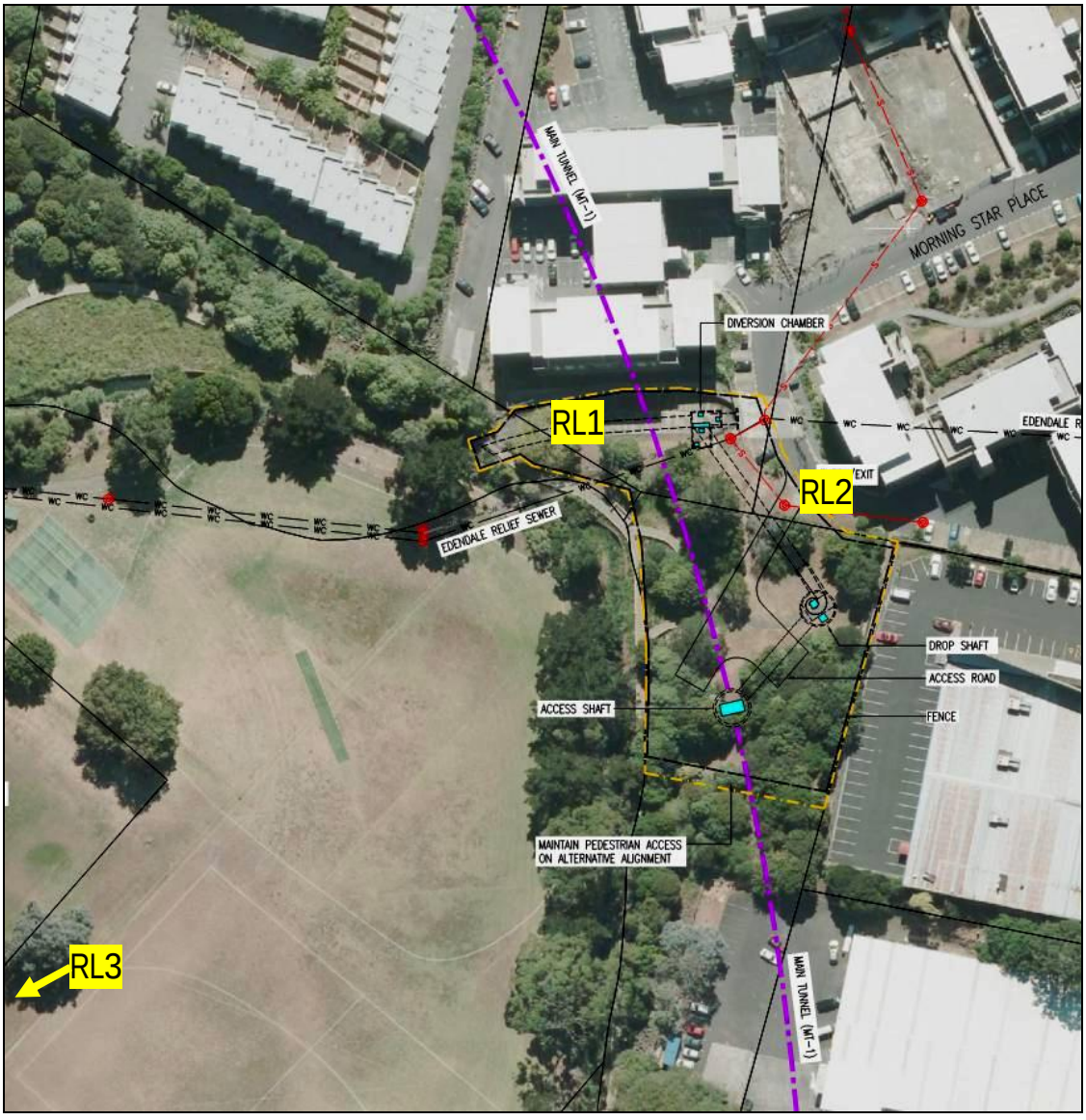
Permanent constructions will contain a 7 metre and 2.4 metres diameter access shaft, a drop shaft, flow control structure and inlet overflow structure improvements. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.3 Lyon Avenue (AS2)

Details of Proposed Site

The proposed site is situated on Lyon Avenue, adjacent to Mt. Albert Grammar School. The land has designation for Mt. Albert Grammar School and wastewater purposes. The nearest dwellings are five-storey apartment blocks located between 40 - 50 metres distance to the north and north-east of the construction site centre however it is noted that construction of the diversion chamber will occur at smaller distances. Figure 3 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 3: Site Overview



Currently, the predominant noise source is traffic from surrounding roads. An ambient noise level of 46 dB L_{Aeq} was measured on 12 May 2011 during the day-time.

The proposed site will connect to the existing sewer and contain an access shaft, a drop shaft, flow control structure and overflow structure improvements.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard. Significant temporary construction activities at the site include the excavation and support of a 45 metre deep access shaft and drop shaft in addition to deep excavations for other underground permanent works.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck.

This site has been identified as potentially requiring blasting where basalt is found in the shaft excavation. Refer to Section 4.50 for further discussion in relation to the prediction and management of blasting effects.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on St. Lukes Road has been considered. MDA predicts that noise levels will increase by less than 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 7 presents the results of predictions for a range of construction equipment. Noise levels are predicted assuming no noise barrier surrounding the construction site due to the elevated nature of adjacent receivers.

Table 7: Day-time Construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	11-27 Morning Star Place	43 – 74
2	12-28 Morning Star Place	44 – 72
3	Mount Albert Grammar School (classrooms)	24 - 45

The construction noise levels are predicted to comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for the majority of works on site with the exception of piling and excavation in close proximity to RL1 and site establishment works in close proximity to RL2.

With respect to piling and other noise intensive operations in close proximity to RL1 during construction of the diversion chamber and associated works, it is recommended that a

quieter form of piling such as the hydraulic 'pressed-in' method be utilised in as far as it is practicable to do so in order to mitigate noise levels to acceptable levels.

Where excavators are used to break up basalt, noise effects from this process will require noise management through the CNMP.

Frequent and effective communication with affected parties via the CNMP will also be required. It is recommended that no night-time works be carried out on the diversion chamber due to dwellings overlooking the chamber.

It is further recommended where deliveries are made between 0700 – 0730hrs, that trucks do not sit idling at the entrance for long periods.

Operational Noise

Permanent features include an access shaft, drop shaft, flow control structure and overflow structure improvements.

The long-term noise emission source at this location would be in the form of an air intake. Predicted noise levels from the air intake are readily compliant with the noise limit at adjacent sites.

4.5.4 Haverstock Road (AS3)

Details of Proposed Site

The proposed site is situated on Special Purpose Activity Zone 2 land 50 metres directly south of 98-102 Haverstock Road. The Plant and Food Research Facility is located to the south-west of the site. Figure 4 details the proposed site and surrounding environment, with labelled receiver locations (RL). It is noted that Housing New Zealand has plans to redevelop land adjacent to the site (RL2) although construction has yet to commence.

Figure 4:Site Overview

Currently, the predominant noise source is traffic from Haverstock Road. An ambient noise level of 44 dB L_{Aeq} was measured on 12 May 2011 during the day-time, excluding traffic noise when practicable.

The proposed site will connect to the existing overflow and contain an access shaft, a drop shaft, manhole, flow control structure, access road, emergency overflow structure system and connection to existing overflows and CSO Collector Pipe CC-4.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard. Significant temporary construction activities at the site include the excavation and support of a 50 metre deep access shaft and drop shaft in addition to deep excavations for other underground permanent works.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck.

This site has been identified as potentially requiring blasting where basalt is found in the shaft excavation. Refer to Section 4.50 for further discussion in relation to the prediction and management of blasting effects.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Haverstock Road has been considered. MDA predicts that noise levels will increase by less than 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 8 presents the results of predictions for a range of construction equipment. Noise levels are predicted assuming a 2 metre high noise barrier as detailed in Figure 4.

Table 8: Day-time construction noise level predictions

Receiver Location		Construction Noise Level
		dB L_{Aeq}
1	7 Camden Rd	46 – 64
2	96 Haverstock Rd	47 - 67
3	98 Haverstock Rd (ground floor)	48 – 68
-	98 Haverstock Rd (first floor)	52 - 70

The above construction noise levels are compliant with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for the receivers assessed.

With regard to predicted noise levels at RL3, it is noted that this dwelling is a 2-storey building and as such, screening afforded by the recommended noise barrier will be ineffectual due to the elevated nature of the second storey.

Although predictions indicate compliance with the Construction Noise Standard, albeit marginally, it is recommended that a quieter form of piling such as the hydraulic 'pressed in' sheet piling method be utilised in as far as it is practicable to do so in order to ensure compliance.

Operational Noise

Activities which are likely to be sources of noise during the operational phase will include a drop shaft and emergency overflow structure, which will occur on an infrequent basis. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.5 Walmsley Park (AS4)

Details of Proposed Site

The proposed site is situated at the south-eastern end of Walmsley Park, Open Space Activity Zone 2 land adjacent to Sandringham Road Extension. The nearest dwellings are located on O'Donnell Avenue over 25 metres distance to the west of the construction site centre. Figure 5 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 5: Site overview

Currently, the predominant noise source is traffic from Sandringham Road. An ambient noise level of 55 dB L_{Aeq} was measured on 12 May 2011 during the day-time.

The proposed site will connect to an existing sewer and contain an access shaft, 5 metre diameter drop shaft and connection to existing sewer.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard. Significant temporary construction activities at the site include the excavation and support of a 67 metre deep access shaft and drop shaft in addition to deep excavations for other underground permanent works as well as a temporary bridge installation across Oakley Creek.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, vibratory sheet piling, concrete pumping, rock breaking, drilling and spoil removal by truck.

This site has been identified as potentially requiring blasting where basalt is found in the shaft excavation. Refer to Section 4.50 for further discussion in relation to the prediction and management of blasting effects.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Sandringham Road Extension has been considered. MDA predicts that noise levels will increase by less than 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 9 presents the results of predictions for a range of construction equipment. Noise levels are predicted assuming a 2 metre high noise barrier as detailed in Figure 5.

Table 9: Day-time Construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	734 Sandringham Road Extension (first floor)	50 - 69
2	725 Sandringham Road Extension	51 - 70
3	7 O'Donnell Ave	43 – 74
4	3 O'Donnell Ave	44 – 78

The construction noise levels are predicted to comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for the majority of works on site with the exception of vibratory steel sheet piling.

As noise reduction from screening will be ineffective for this method of piling, a quieter form of piling such as the hydraulic 'pressed in' sheet piling method could be considered in as far as it is practicable to do so. It is noted that sheet piling and excavation could conservatively occur for up to two weeks.

Therefore, where vibratory sheet piling is used, noise management and communication with affected parties will be necessary to ensure an acceptable outcome.

Operational Noise

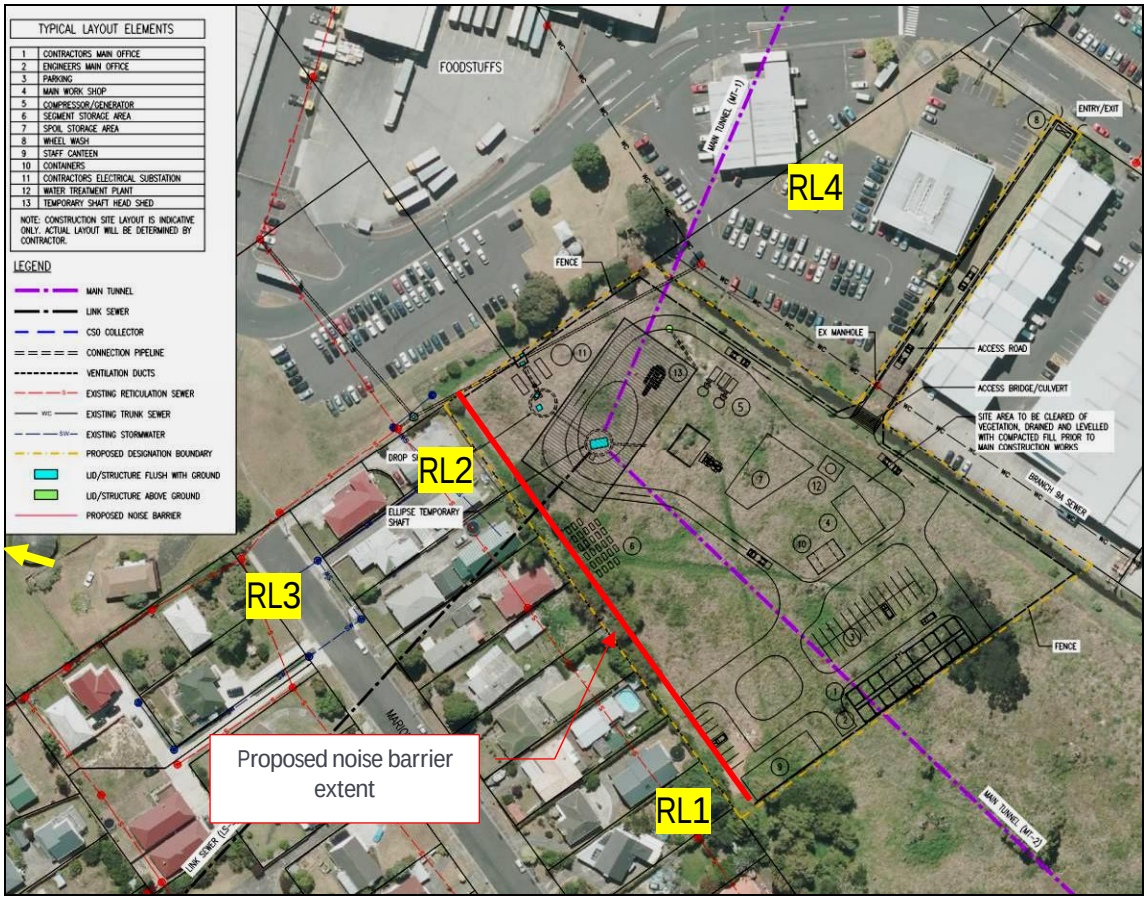
The proposed site will connect to an existing sewer and contain an access shaft, drop shaft and connection to existing sewer. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.6 May Road (WS2)

Details of Proposed Site

The proposed site is situated on May Road and is privately owned land zoned Business Activity 4. The nearest dwellings are located approximately 50 metres distance to the west of the construction site centre. Figure 6 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 6: Site Overview



An ambient noise level of 43 dB L_{Aeq} was measured in the surrounding residential area on 12 May 2011 during the day-time, excluding traffic noise when possible. An additional ambient noise level of 44 dB L_{Aeq} was measured on 19 July 2011 during the night-time.

Further long-term noise logging is to be undertaken to assess the appropriateness of Project noise limits.

The proposed site is a key site of the main tunnel and primary construction site. A large construction shaft is necessary to serve as a TBM launch or retrieval site. Permanent works will contain connections to existing sewers and CSO Collector Pipe CC-5, flow control structure, access road, an access shaft, a drop shaft and an air treatment facility.

Construction Noise

Construction is estimated to be of 3 - 5 years duration if the site is used as a TBM launch site. Construction would extend throughout the day and night-time and is defined as long-term duration according to the Construction Noise Standard.

Significant temporary construction activities at the site include the excavation and support of a 70 metre deep access shaft and drop shaft in addition to deep excavations for other underground permanent works.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as mobile and gantry cranes, bored piling rig, excavators, concrete pumping, rock breaking, drilling and spoil removal by truck.

Where the site is used as a TBM launch shaft, tunnelling operations noise would include truck noise, heavy lifts of precast tunnel segments by crane, tunnel ventilation by axial fan, water treatment plant, generators, electrical substation, gantry or tower cranes, crawler crane and debris storage and removal by truck to landfill.

It is estimated that approximately 12 and 64 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on May Road has been considered for this site. It is noted that the site is situated next to May Road and approximately 240 metres from the south-western motorway (SH20), both with existing high traffic volumes. On the proviso that site heavy vehicle traffic is confined to the daytime and evening periods as detailed below, MDA predicts that noise levels will increase by less than 1 decibel and therefore considers the impact to be minimal.

Several construction noise mitigation measures are proposed and have been incorporated into preliminary construction plans:

- A 3 metre high noise barrier as detailed in Figure 6.
- A shed enclosure constructed over the temporary tunnelling shaft site with a weighted sound reduction index (R_w) of at least 40dB. Openings designed to face away from sensitive noise receivers.
- Truck traffic and other heavy vehicles concentrated in the Monday-Saturday day-time and weekday evening periods to limit noise impact during the night-time.
- Enclosure doors closed at night-time to ensure maximum noise reduction.
- Noise intensive construction work limited to within the enclosure at all times excluding Monday to Saturday daytime (0730 – 1800hrs) and weekday evening (1800 – 2000hrs) periods. It should be noted that night-time works outside the enclosure would be acceptable where they are of a less noise –intensive nature.

  Activities such as piling, trenching, concrete pumping and heavy lifts etc would not be permissible during the night-time outside of the enclosure.

- All outside plant such as generators, compressors, electrical substation, water and slurry treatment plants will require enclosures or noise barriers.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 10 presents the results of predictions during the Monday-Saturday day-time and weekday evening periods, whilst Table 11 presents the results of predictions at all other times. Noise levels are predicted assuming the mitigation measures outlined above

Table 10: Day-time and weekday evening construction noise level predictions

Receiver Location		Stage 1 Excavation	Stage 2 Tunnelling
		dB L_{Aeq}	dB L_{Aeq}
1	41A Marion Ave	54	58
2	53A Marion Ave	70	51
3	48 Marion Ave (first floor)	61	49
4	Commercial receiver – Roma Road	62	63

The above construction noise levels are compliant with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) and weekday evening (1800 – 2000hrs) periods for the receivers assessed with the exception of RL2, where piling and trenching activities are predicted to be non-compliant in the evening period. It is recommended that external construction activities such as piling, trenching, concrete pumping and heavy lifts et al be confined to the daytime period in as far as it is practicable to do so.

An example of management technique would be to arrange a suitable time with affected residences to carry out close proximity trenching activities when dwellings are unoccupied. Frequent and effective communication with affected parties will also be required. As part of the CNMP process, it is recommended that non-complying activities be restricted to Monday to Friday and do not occur on Saturdays.

Table 11: Night-time construction noise level predictions

Receiver Location		Stage 1 Excavation	Stage 2 Tunnelling
		dB L_{Aeq}	dB L_{Aeq}
1	41A Marion Ave	40	43
2	53A Marion Ave	39	43
3	48 Marion Ave	34	39
4	Commercial receiver – Roma Road	-	-

The construction noise levels are compliant with the Construction Noise Standard for all other time periods. However, in order for compliance to be achieved at night no external construction activities of a significant noise generating nature can occur. It is recommended that static equipment located externally which is anticipated to operate 24-hours per day be designed to a level of 65 dB L_{Aeq} or less at 1 metre.

With the implementation of the recommend noise mitigation measures, MDA predicts that construction noise levels will be compliant with the Construction Noise Standard at all times. A CNMP is included in Appendix 5.

Operational Noise

Permanent works will contain connections to existing sewers and CSO Collector Pipe CC-5, flow control structure, access road, an access shaft, a drop shaft and an air treatment facility.

The long-term noise emission source at this location would be the air intake. Predicted noise levels from air intake operation are readily compliant with the noise limit at adjacent sites.

Operation noise levels due to the air treatment facility have been predicted for representative dwellings, with the results presented in Table 12. It should be noted that noise levels are predicted assuming the mitigation measures detailed later in this section.

Table 12: Operation noise level predictions

Receiver Location		Predicted Noise Level
		dB L_{Aeq}
1	41A Marion Ave	30
2	53A Marion Ave	39
3	48 Marion Ave	32
4	Commercial receiver – Roma Road	42

The results in the preceding table indicate that operation noise levels are fully compliant for all periods of the day based on the recommended noise mitigation measures.

Recommended Noise Mitigation Measures - Operation

Based on the indicative equipment selections and building concept design MDA recommends that the facility be constructed with an enclosure giving a weighted sound reduction index (R_w) of at least 30dB. Internal absorption will be required to some surfaces in order to control the reverberant level within the enclosure. All venting of air to atmosphere will require louvres treated to 65dBA at 1 metre, while an attenuator is necessary for the air intake. Any openings should face away from the closest noise sensitive receivers.

It should be noted that these recommendations are indicative only and subject to change once equipment selection is finalised during the detailed design phase of the project.

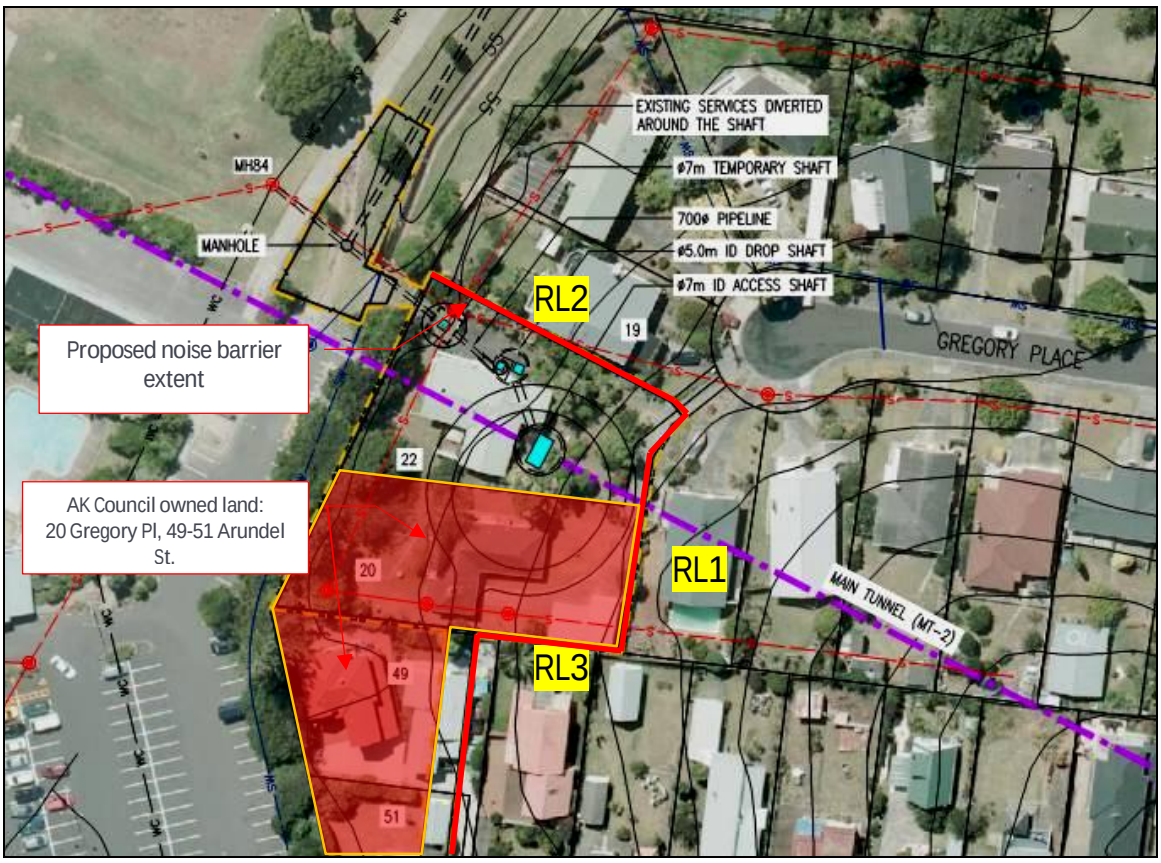
Based on the above recommendations, Operation noise levels are predicted to be within the recommended noise limits at adjacent sites.

4.5.7 Keith Hay Park (AS5)

Details of Proposed Site

The proposed site is situated adjacent to the eastern boundary of Keith Hay Park, currently residentially zoned private properties. The nearest dwellings are located adjacent to the site, on Gregory Place and Arundel Street. It is understood that the properties located at 20 Gregory Place and 49-51 Arundel Street are owned by Auckland Council and have been removed. The property located at 22 Gregory Place will be acquired by the Project and subsequently demolished. Figure 7 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 7: Site Overview



Currently, the predominant noise source is traffic from surrounding roads. An ambient noise level of 47 dB L_{Aeq} was measured on 27 July 2011 during the day-time, excluding traffic noise when practicable.

The proposed site will connect to an existing sewer and contain an access shaft, and a drop shaft.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Significant temporary construction activities at the site include the excavation and support of a 78 metre access shaft and a drop shaft in addition to deep excavations for other underground permanent works. Site establishment will likely involve the demolition of existing site structures.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, possibly sheet piling, concrete pumping, rock breaking, drilling and spoil removal by truck.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Stamford Park Road has been considered. MDA predicts that noise levels will increase by less than 3 decibels during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be no more than minor.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 13 presents the results of predictions for a range of construction equipment. Noise levels are predicted assuming a 3 metre noise barrier along the boundaries of the construction site as indicated.

Table 13: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	18 Gregory Place (ground floor)	38 - 64
	18 Gregory Place (first floor)	52 - 79
2	19 Gregory Place (ground floor)	47 – 72
	19 Gregory Place (first floor)	60 - 85
3	47 Arundel Street (ground floor)	37 – 70
	47 Arundel Street (first floor)	51 - 80

The construction noise levels are predicted to comply or marginally non-comply with the Construction Noise Standard for all ground floor receivers.

It is noted that all adjacent receiver dwellings are of 2-storey construction and as such, screening afforded by the recommended noise barrier will be ineffectual due to the elevated nature of the second storey.

It is predicted that construction noise levels to the second storey will be elevated for extended periods of time and will not comply with the Construction Noise Standard where demolition, bored piling rigs and other noise intensive equipment is used. It is further noted that sheet piling may be used as an alternative to secant piling. Where the sheets are driven into the ground using the vibratory method, noise levels are predicted to be up to 5 decibels higher from this source than for bored piling.

It is recommended that noise barriers be constructed as early in the process as is practicable in order to mitigate noise from site establishment works to ground floor based receivers.

This site is considered to be noise sensitive, due to the elevated second storey receivers. Frequent and effective communication with affected parties via the CNMP will also be required.

An example of management technique would be to arrange a suitable time with affected residences to carry out demolition (and other short-term noise intensive works) when dwellings are unoccupied. As part of the CNMP process, it is recommended that activities not complying with the Construction Noise Standard be restricted to Monday to Friday and do not occur on Saturdays.

Operational Noise

The proposed site will connect to an existing sewer and contain an access shaft, and a drop shaft. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.8 PS23 (AS6)

Details of Proposed Site

The proposed site is located within the coastal marine environment on the northern shoreline of Manukau Harbour, on land currently designated for pump station use. The nearest dwellings are located immediately to the east of the site. Figure 8 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 8: Site overview

Currently, the predominant noise source is traffic from surrounding roads. An ambient noise level of 47 dB L_{Aeq} was measured on 27 July 2011 during the day-time, excluding traffic noise when practicable.

Further long-term noise logging is to be undertaken to assess the appropriateness of Project noise limits.

The proposed site will connect to the existing Onehunga link sewer and contain an access shaft, a drop shaft, flow control structure, access road, connection to existing sewer and air treatment facility.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur only during day-time hours (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard. Significant temporary construction activities at the site include the excavation and support of a 28 metre deep access shaft and drop shaft in addition to deep excavations for other underground permanent works. A temporary platform is required to be constructed on the foreshore to support construction works.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; machinery for the construction of the temporary platform such as excavators, bulldozers and trucks dumping rock and aggregate; shaft excavation and retention machinery such as excavators, bored piling rig, possibly sheet piling, concrete pumping, rock breaking, drilling and spoil removal by truck. Demolition of the existing pump station will also occur and involve the use of excavators, loaders and trucks.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Frederick Street has been considered. MDA predicts that noise levels will increase by approximately 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 14 presents the results of predictions for a range of construction equipment. Noise levels are predicted assuming no noise barrier, due to the elevated nature of dwellings surrounding the site.

Table 14: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	33A Frederick St (first floor)	50 – 76
2	6/41 Frederick St (first floor)	57 – 78
3	25 Frederick St (first floor)	42 - 71

From the range of noise levels predicted in the table, it is evident that certain activities will not comply with the Construction Noise Standard for Monday to Saturday day-time (0730 - 1800hrs) for the receivers assessed. Activities which will not comply include the demolition of the existing pump station, piling, truck movements traversing the access road to Frederick Street and construction of the temporary platform.

Without exception, mitigation of these activities will prove problematic due to their non-static nature and the fact that receivers are elevated above the site, meaning that noise barriers will be ineffectual, whether constructed at site ground level or receiver ground level.

It noted that sheet piling may be used as an alternative to secant piling. Where the sheets are driven into the ground using the vibratory method, noise levels are predicted to be up to 5 decibels higher from this source than for bored piling.

It is recommended that noise effects from the activities outlined be managed through the CNMP. An example of management technique would be to carry out particularly noise intensive activities such as demolition during the middle of the day (Monday to Friday), whilst the majority of people are away from home. Frequent and effective communication with affected parties will also be required. As part of the CNMP process, it is recommended that non-complying activities be restricted to Monday to Friday and do not occur on Saturdays.

Operational Noise

The long-term noise emission source at this location would be the air intake stack and air treatment facility. Predicted noise levels from the air intake are readily compliant with the noise limit at adjacent sites. It is noted that the air treatment facility would only operate occasionally, during extreme rainfall events.

Operation noise levels due to the air treatment facility have been predicted for representative dwellings, with the results presented in Table 15. It should be noted that noise levels are predicted assuming the mitigation measures detailed later in this section.

Table 15: Operation noise level predictions

Receiver Location		Predicted Noise Level (dB L_{A10})
1	33A Frederick St	37
2	6/41 Frederick St	40
3	25 Frederick St	32

The results in the preceding table indicate that operation noise levels are fully compliant with the proposed noise limits as well as the ARPC noise limits for all periods of the day based on the recommended noise mitigation measures.

Recommended Noise Mitigation Measures

Based on the indicative equipment selections and building concept design MDA recommends that the air treatment facility be constructed with an enclosure giving a weighted sound reduction index (R_w) of at least 30 (R_w 40 on eastern façade). Internal absorption will be required to some surfaces in order to control the reverberant level within the enclosure.

All venting of air to atmosphere will require louvres treated to 65dBA at 1 metre, while an attenuator is necessary for the stack. Any openings should face away from the closest noise sensitive receivers to the east.

It should be noted that these recommendations are indicative only and subject to change once equipment selection is finalised during the detailed design phase of the project.

Based on the above recommendations, operation noise levels are predicted to be within the recommended noise limits at adjacent sites.

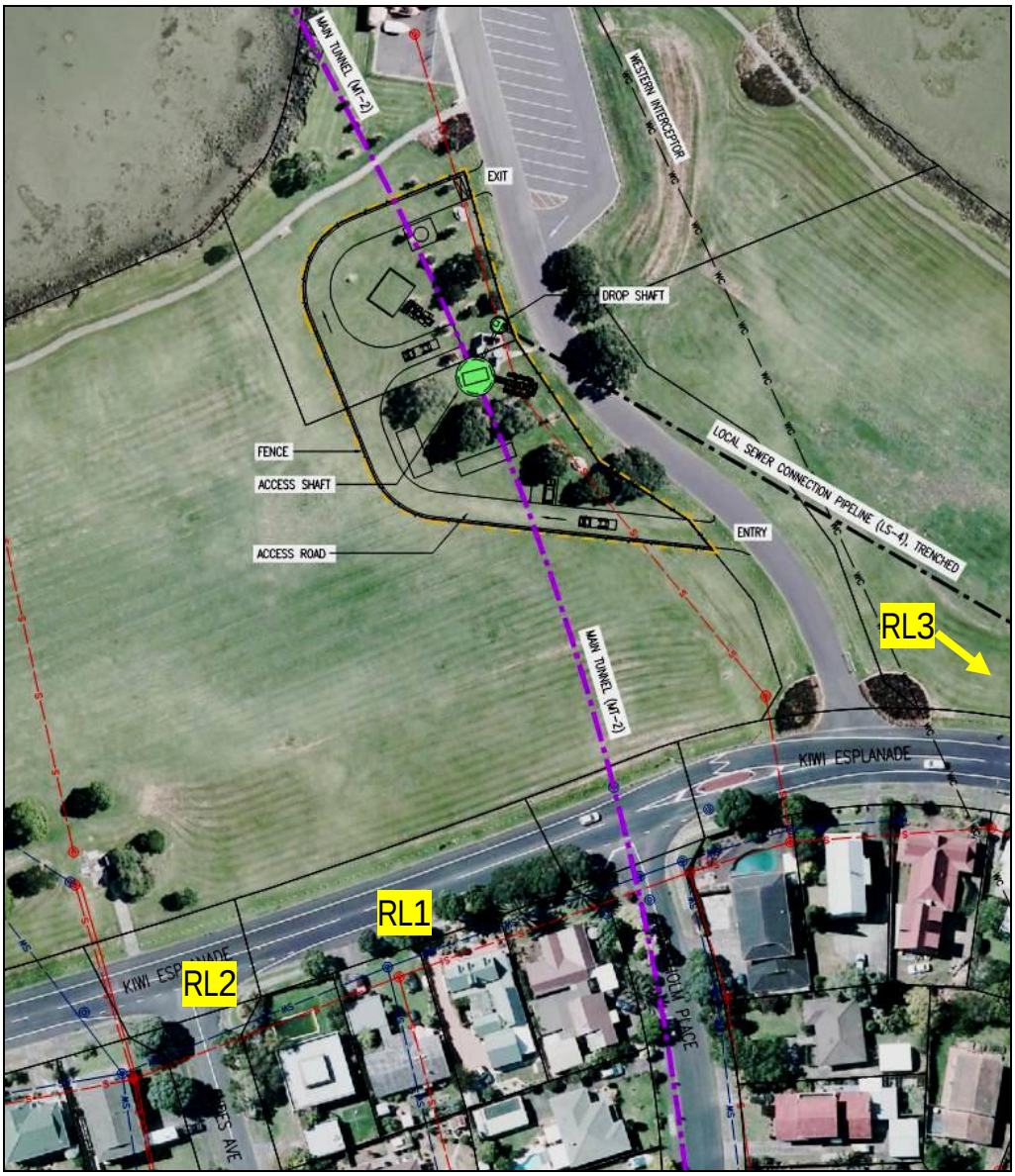
4.5.9 Kiwi Esplanade (AS7)

Details of Proposed Site

The Kiwi Esplanade site is an alternative to the Ambury Park site. At the time of completing this assessment a decision has yet to be made on which site is to be constructed. Therefore both sites have been assessed, although only one will ultimately be used for construction.

The proposed site is situated on Public Open Space Zone 2 and Zone 5 land bordering Manukau Harbour. The nearest dwellings, on the corner of Kiwi Esplanade and Andes Avenue, are located over 100 metres distance to the south of the construction site centre, although properties will be substantially closer where pipeline trenching occurs. Figure 9 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 9: Site overview



An ambient noise level of 40 dB L_{Aeq} was measured on 12 May 2011 day-time, excluding traffic noise when practicable.

The proposed site will connect to the existing wastewater system and contain an access shaft, 3 metre diameter drop shaft and air vent.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur only during day-time hours (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard. Significant temporary construction activities at the site include the excavation and support of a 29 metre deep access shaft and drop shaft in addition to deep excavations for other underground permanent works.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, possibly steel sheet piling, concrete pumping, rock breaking, drilling and spoil removal by truck. In addition, connection to the existing wastewater system (Link Sewer 4) will require an open trench excavation in basalt outside the construction site boundaries and will involve sheet piling.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Kiwi Esplanade has been considered. MDA predicts that noise levels will increase by approximately 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 16 presents the results of predictions at the nearest dwellings. Noise levels are predicted assuming no noise barrier surrounding the construction site.

Table 16: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	87 Kiwi Esplanade	38 - 61
2	85 Kiwi Esplanade (ground floor)	38 - 60
	85 Kiwi Esplanade (first floor)	39 - 62
3	3 Yorkton Rise (trenching)	28- 67

The construction noise levels are predicted to comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for all receivers assessed.

However, it is noted that trenching works will occur inside the road reserve for a considerable length of Kiwi Esplanade, Yorkton Rise, Muir Avenue and Witla Crescent, therefore exposing dwellings to noise levels at the upper end of the acceptable range for extended periods. It is recommended that screening is placed around trenching works that occur on the road as a best practicable option to reduce noise levels. At the very least, noise management and communication with affected parties will be necessary to ensure an acceptable outcome.

Operational Noise

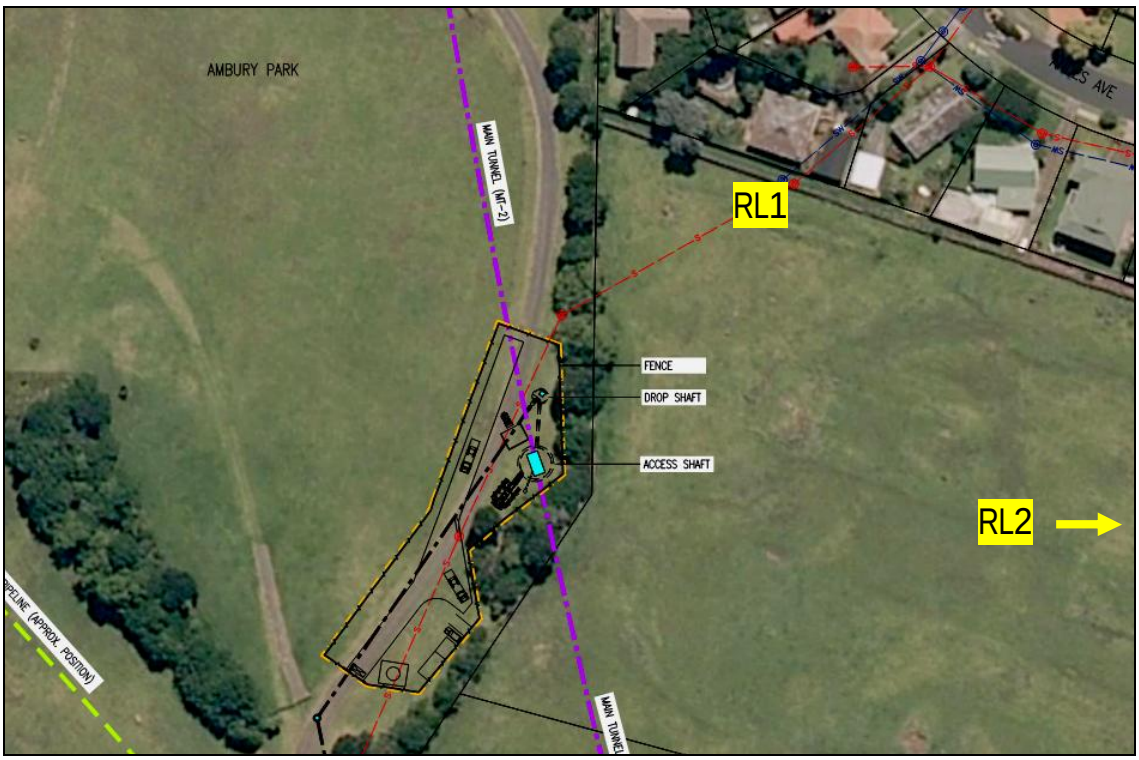
The only permanent structure will be a drop shaft and associated air vent. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.10 Ambury Park (AS7)

Details of Proposed Site

The Ambury Park site is proposed as an alternative to Kiwi Esplanade. At the time of completing this assessment a decision has yet to be made on which site is to be constructed. Therefore both sites have been assessed, although only one will ultimately be used for construction. The site is situated on land designated for Wastewater Purposes and Ambury Regional Park. The nearest dwellings, on Andes Avenue and Muir Avenue, are located over 65 and 180 metres distance to the north and east of the site. Figure 10 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 10: Site overview



An ambient noise level of 40 dB L_{Aeq} was measured in the vicinity of the site on 12 May 2011 during the day-time, excluding traffic noise when practicable.

The only permanent works will be an access shaft for main tunnel MT-2.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur only during day-time hours (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard. Significant temporary construction activities at the site include the excavation and support of an access shaft and a drop shaft in addition to deep excavations for other underground permanent works.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Kiwi Esplanade has been considered. MDA predicts that noise levels will increase by approximately 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 17 presents the results of predictions at the nearest dwellings. Noise levels are predicted assuming no noise barrier surrounding the construction site.

Table 17: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	20 Andes Avenue	36 – 64
2	117 Muir Avenue	35 - 56

The construction noise levels are predicted to comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for the receivers assessed.

It is noted that noise –intensive activities such as vibratory sheet piling can be carried out at this site and comply with the daytime construction noise limit.

Operational Noise

The only permanent structure will be a drop shaft and associated air vent. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.11 Mangere Pump Station (WS3)

Details of Proposed Site

The proposed site is situated on Watercare land adjacent to the existing Mangere Wastewater Treatment Plant. The land is designated for wastewater purposes. The nearest dwellings are located over 500 metres distance to the east of the site. Any specific noise mitigation provisions required for works at this site would be addressed during the detailed design phase and through the Outline Plan of Works.

Construction Noise

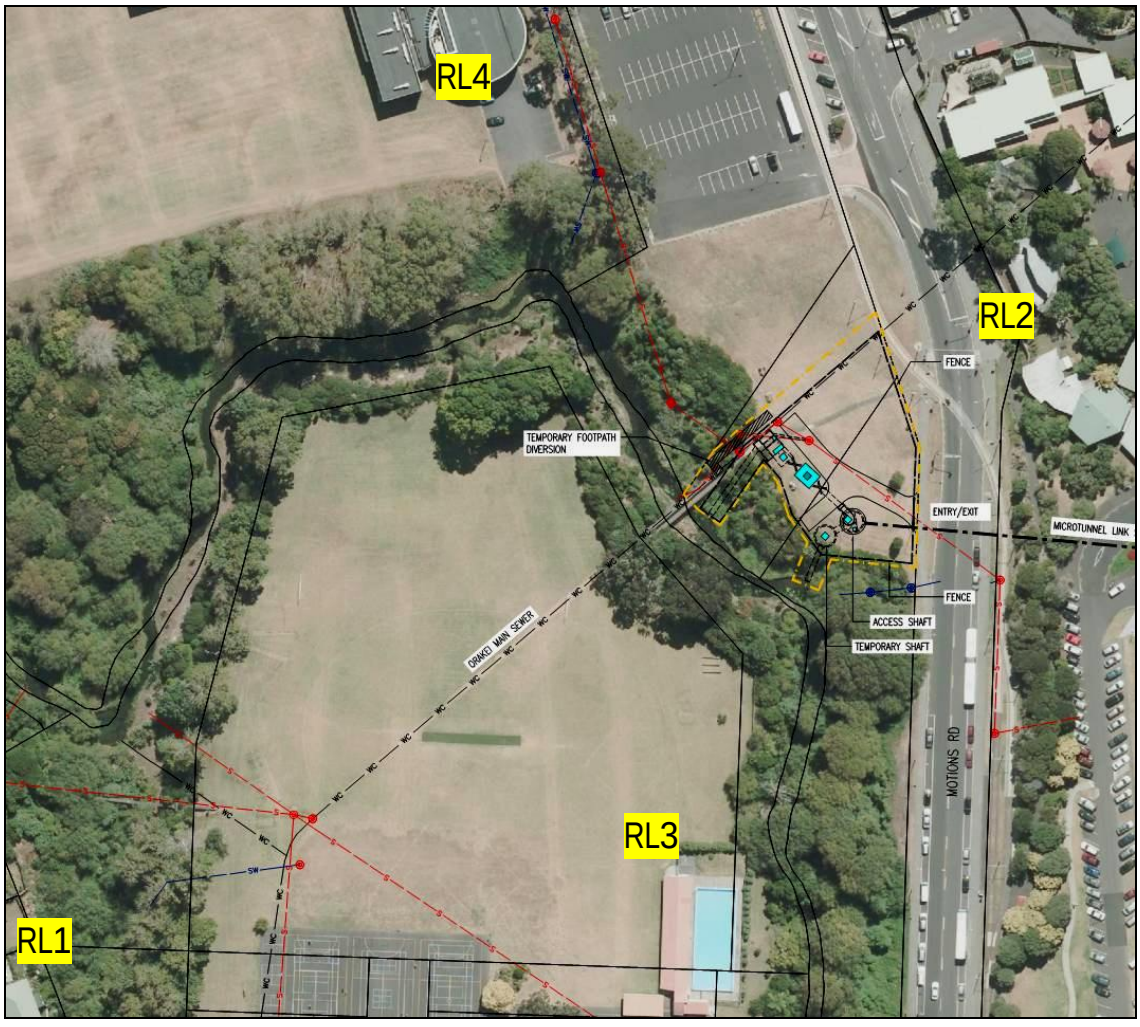
Construction activities will include works within the coastal marine area for the construction of the emergency pressure relief structure. The construction noise levels are predicted to comply with the ARPC noise limits for all periods of the day without further mitigation necessary. A draft CNMP is included in Appendix 5.

4.5.12 Motions Road (L1S1)

Details of Proposed Site

The proposed site is situated on Open Space Activity Zone 2 and 4 land to the west of Auckland Zoo, south-east of Western Springs College and north-east of Pasadena Intermediate School. The nearest dwellings, on Premier Avenue, are located over 220 metres distance to the south-west of the construction site centre. Figure 11 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 11: Site overview



Currently, the predominant noise source is traffic from Motions Road. An ambient noise level of 41 dB L_{Aeq} was measured on 12 May 2011 during the daytime.

The proposed site will connect to the existing Orakei Main Sewer and CSO Collector Pipeline CC-1. It will contain a 5 metre diameter drop shaft, grit trap, flow control structure and inlet overflow structure.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck. The site is a likely micro-tunnelling launch/retrieval shaft location and associated noise sources may include a slurry separation plant, mobile crane, generator and debris removal by crane and truck.

This site has been identified as potentially requiring blasting where basalt is found in the shaft excavation. Refer to Section 4.50 for further discussion in relation to the prediction and management of blasting effects.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Motions Road has been considered. MDA predicts that noise levels will increase by less than 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 18 presents the results of predictions at the nearest dwellings. Noise levels are predicted assuming no noise barrier surrounding the construction site.

Table 18: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	47A Premier Ave	30 – 48
2	Auckland Zoo	46 – 65
3	99 Motions Road	44 – 60
4	Western Springs College	40 – 58

The construction noise levels are predicted to comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for all receivers assessed.

Noise impact on animals

The effect of noise on wild animals housed at Auckland Zoo has been considered with respect to construction noise emissions from Motions Road. Most researchers agree[2] that "noise can affect an animal's physiology and behaviour" however, based on MDA's experience and on research by Munci et al[3] it is suggested that the only possible causes of disturbance to animals would be impulsive noises such as blasting and pile driving. To ensure that any such effects are minimised, we recommend that noise levels received at Auckland Zoo should be no greater than the criteria suggested for human exposure, specifically the Construction Noise Standard.

Operational Noise

Activities which are likely to be sources of noise during the operational phase will include inlet overflow structure and removal of debris from the grit trap. We note that these activities will occur on an infrequent basis. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

[2] The Effect of Noise on Wildlife: A Literature Review by A.L. Radle (1998)

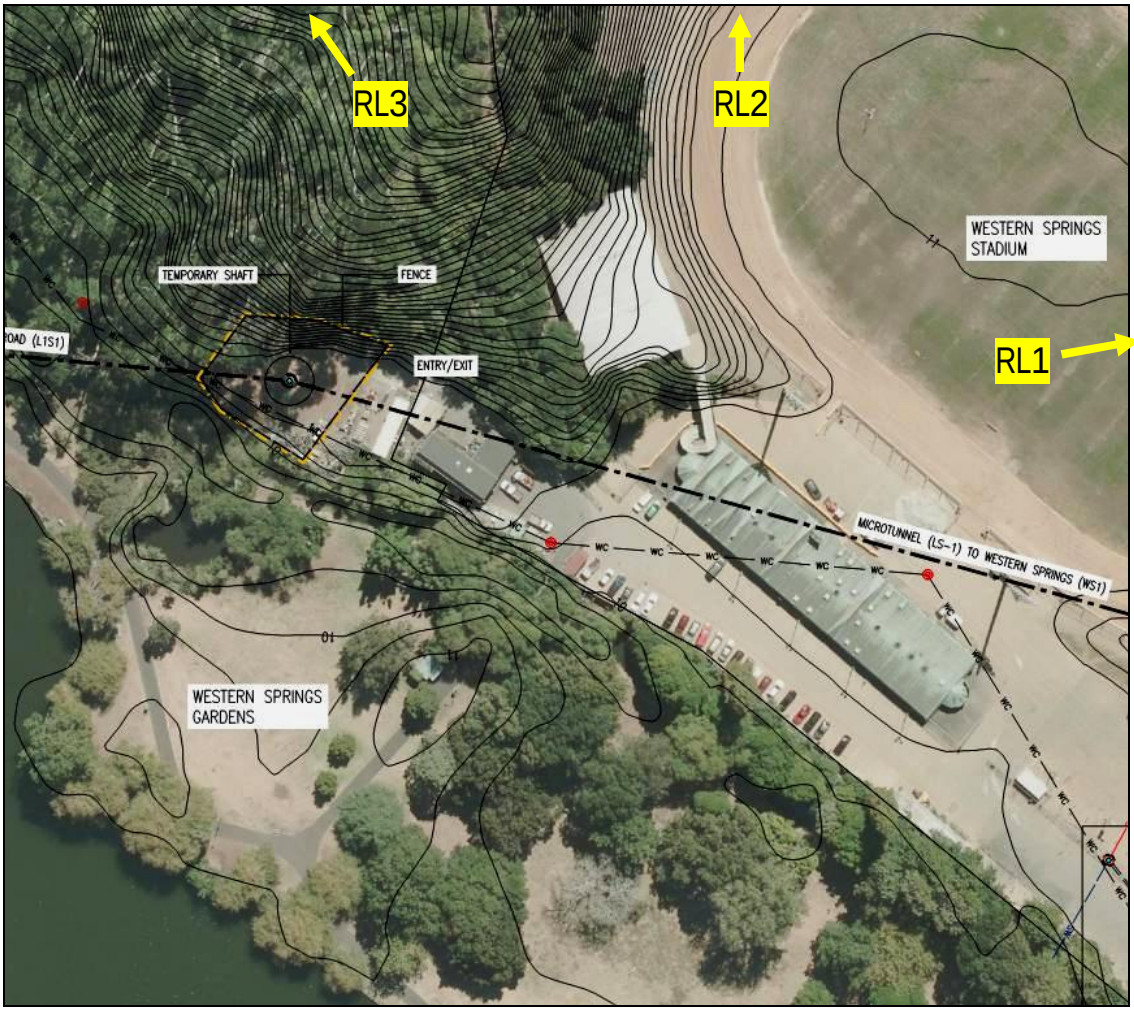
[3] Manci et al. 1988. "Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis". U.S. Fish and Wildlife Service National Ecology Research Centre.

4.5.13 Western Springs Depot (L1S2)

Details of Proposed Site

The proposed site is situated on Open Space Activity Zone 5 land next to the parking area of the Western Springs depot. The nearest dwellings, on West View Road, are located over 160 metres distance to the north-west of the construction site centre. Figure 12 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 12: Site overview



Currently, urban hum characterises the surrounding ambient noise environment, contributed to by distant traffic noise from the North-western motorway located approximately 400 metres to the south and noise from nearby Auckland Zoo. An ambient noise level of 44 dB L_{Aeq} was measured on 12 May 2011 during the day-time, excluding traffic noise when practicable.

The only permanent works will be an access shaft for micro-tunnel LS1.

Construction Noise

General site construction activities are estimated to be of 6 - 8 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck. The site is a likely micro-tunnelling launch/reception shaft location and associated noise sources may include a mobile or crawler crane, generator and trucks.

This site has been identified as potentially requiring blasting where basalt is found in the shaft excavation. Refer to Section 4.50 for further discussion in relation to the prediction and management of blasting effects.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site, with the results presented in Table 19. Noise levels are predicted assuming no noise barrier surrounding the construction site

Table 19: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	Old Mill Rd East	28 – 42
2	Old Mill Rd North	16 – 37
3	Westview Rd	26 - 42

The construction noise levels are predicted to readily comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for all receivers assessed.

Operational Noise

The only permanent structure will be a drop and access shaft, with maintenance occurring on an infrequent basis. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.14 Rawalpindi Reserve (L2S1)

Details of Proposed Site

The proposed site is situated on Rawalpindi Reserve, Open Space Activity Zone 2 land adjacent to Chamberlain Park Golf Course. The nearest dwellings, on Rawalpindi Street, are located less than 20 metres distance to the west of the site boundary. Figure 13 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 13: Site overview

Currently, the predominant noise source is traffic from Rawalpindi Road. An ambient noise level of 47 dB L_{Aeq} was measured on 12 May 2011 during the day-time.

The proposed site will connect to the existing Orakei Main Sewer and contain a drop shaft, flow control chamber, connections to existing sewers and overflow structures.

Construction Noise

General site construction activities are estimated to be of 12 -18 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck. Outside the construction site boundary, short-term trenching will take place to create connection pipelines to existing sewers. The site is a likely micro-tunnelling launch/retrieval shaft location and associated noise sources may include a slurry separation plant, mobile crane, generator and debris removal by crane and truck.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Rawalpindi Street has been considered. MDA predicts that noise levels will increase by less than 3 decibels during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be no more than minor.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 20 presents the results of predictions for a range of construction equipment. Noise levels are predicted assuming a 2 metre high noise barrier as detailed in Figure 13.

Table 20: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	29 Rawalpindi St	26 - 58
2	11 Rawalpindi St (ground floor)	38 - 66
	11 Rawalpindi St (first floor)	41 - 67
3	46 Parkdale Road	47 - 67
4	19 Rawalpindi St	43 - 69

The above construction noise levels are compliant with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for the receivers assessed.

Operational Noise

Activities which are likely to be sources of noise during the operational phase will include overflow structures and periodic cleaning of the grit trap, neither of which is expected to occur frequently. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.15 Norgrove Avenue (L2S2)

Details of Proposed Site

The proposed site is situated at the end of Norgrove Avenue, on land with road designation. The nearest dwelling is located approximately 14m distance to the north-west of the construction site centre. Figure 14 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 14: Site overview

Currently, the predominant noise source is traffic from the North-western motorway, located approximately 440 metres to the north. An ambient noise level of 47 dB L_{Aeq} was measured on 12 May 2011 during the day-time.

The proposed site will connect to CSO Collector Pipe CC-3 and contain an 8m diameter drop shaft.

Construction Noise

General site construction activities are estimated to be of 6 -8 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, possibly sheet piling, trenching, concrete pumping, rock breaking, drilling and spoil removal by truck. The site is a likely micro-tunnelling launch/reception shaft location and associated noise sources may include a mobile or crawler crane, generator and trucks.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Norgrove Avenue has been considered. MDA predicts that noise levels will increase by up to 10 decibels during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be appreciable. It is noted that predictions are based on anticipated traffic numbers from Lyon Avenue (AS2) and are therefore considered to be a worst case scenario.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site, with the results presented in Table 21. Noise levels are predicted assuming a 2.5 metre high noise barrier surrounding the construction site as detailed in Figure 14.

Table 21: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	16 Norgrove Ave	43 – 63
2	20 Burnside Ave	25 – 69
3	23 Verona Ave	34 – 65
4	27 Verona Ave (ground floor)	39 – 61
	27 Verona Ave (first floor)	45 - 64

The above construction noise levels are compliant with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for all receivers assessed.

It is noted that sheet piling may be used as an alternative to secant piling at this site. Where the sheets are driven into the ground using the vibratory method, noise levels are predicted to be up to 5 decibels higher from this source than for bored piling, necessitating management through the CNMP process.

An example of management technique would be to arrange a suitable time with affected residences to carry out trenching and control chamber piling when dwellings are unoccupied.

Frequent and effective communication with affected parties will also be required. As part of the CNMP process, it is recommended that non-complying activities be restricted to Monday to Friday and do not occur on Saturdays.

Operational Noise

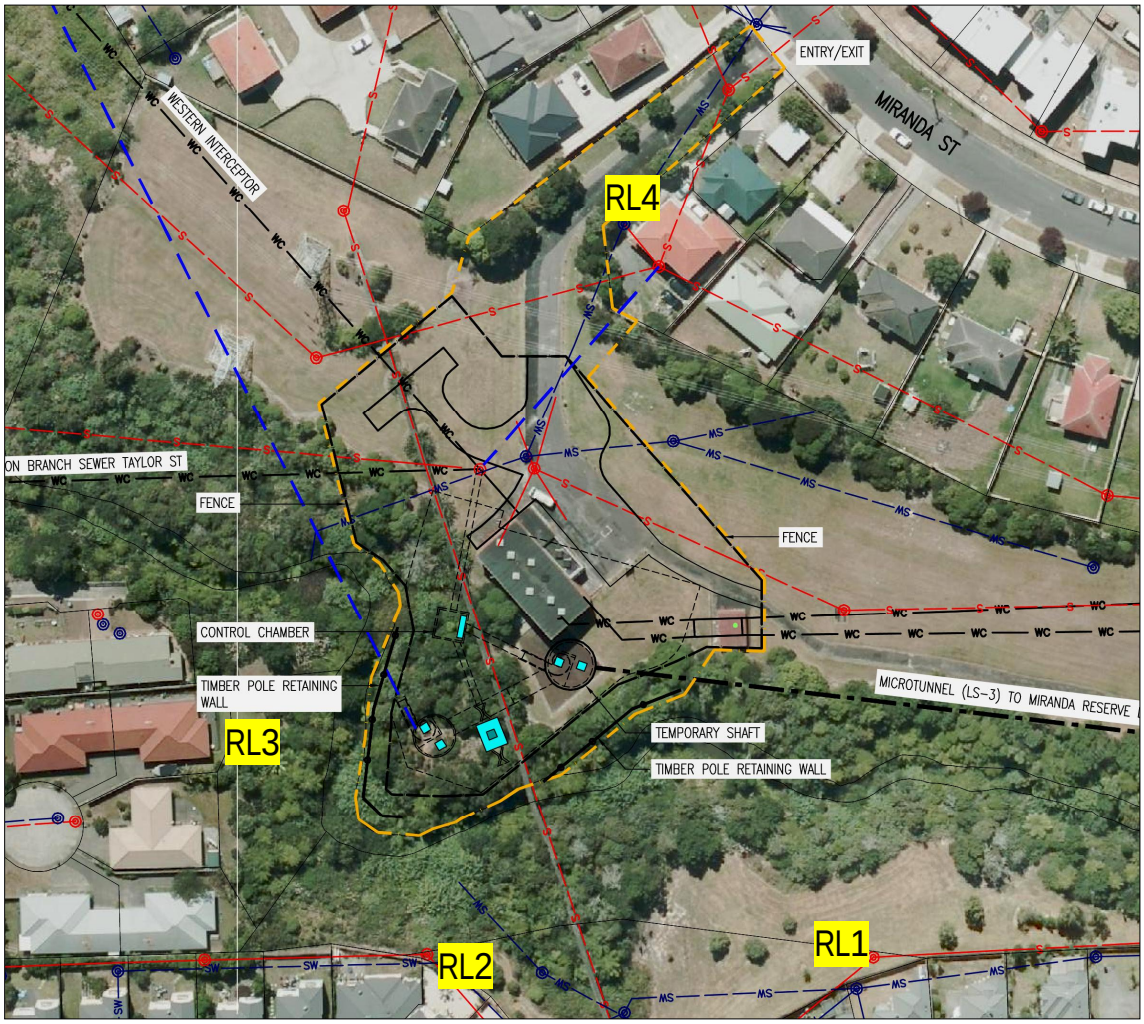
The only permanent structure will be a drop and access shaft, with maintenance occurring on an infrequent basis. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.16 PS25 (L3S1)

Details of Proposed Site

The proposed site is on Open Space Activity Zone 2 land where Watercare Pump Station 25 is currently situated. The nearest dwellings on Miranda Street are located over 40 metres distance to the north-east of the site. Figure 15 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 15: Site overview



Currently, the predominant noise source is traffic from Miranda Street. An ambient noise level of 49 dB L_{Aeq} was measured on 17 May, 2011 during the day-time, excluding traffic noise when practicable.

Further long-term noise logging is to be undertaken to assess the appropriateness of Project noise limits.

The proposed site will connect to the existing sewers and CSO Collector CC-6. It will contain an 8m diameter access shaft, flow control structure, air treatment facility, grit trap and an access road.

Construction Noise

General site construction activities are estimated to be of 12-18 months duration and occur during day-time hours (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment and demolition machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck. Short-term trenching by sheet pile outside the construction site will be required. The site is a likely micro-tunnelling launch/reception shaft location and associated noise sources may include a mobile or crawler crane, generator and trucks.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Miranda Street has been considered. MDA predicts that noise levels will increase by less than 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 22 presents the results of predictions at the nearest dwellings. Noise levels are predicted assuming no noise barriers.

Table 22: Day-time construction noise level measurements

Receiver Location		Construction Noise Level dB L_{Aeq}
1	16 Pitfire Place (ground floor)	43 – 66
	16 Pitfire Place (first floor)	44 - 67
2	29 Temuka Gardens (ground floor)	45 – 68
	29 Temuka Gardens (first floor)	45 - 69
3	Taylor Close	46 – 71
4	32A Miranda St	45 – 79

The construction noise levels are predicted to comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for the majority of works on site with the exception of trenching in close proximity to RL4 in addition to a minor non-compliance during pump station demolition for RL3.

It is therefore recommended that mobile screening is implemented where trenching occurs close to dwellings, reducing noise levels from this source by 5 - 10 decibels. At the very least, noise management and communication with neighbours will be necessary to ensure acceptable noise levels.

An example of management technique would be to arrange a suitable time with affected residences to carry out trenching when dwellings are unoccupied. Refer to Appendix 7 for recommended design detail of the mobile screen.

Demolition has been predicted assuming use of a pneumatic hammer. Different demolition methods would result in varying noise levels. As for trenching, noise management and communication with neighbours will be necessary to ensure acceptable noise levels.

Operational Noise

The long-term noise emission source at this location would be in the form of a drop shaft air intake and air treatment facility. Predicted noise levels from the air intake are readily compliant with the noise limit at adjacent sites.

Operation noise levels due to the air treatment facility have been predicted for representative dwellings, with the results presented in Table 23. It should be noted that noise levels are predicted assuming the mitigation measures detailed later in this section.

Table 23: Operation noise level predictions

Receiver Location		Predicted Noise Level dB L_{Aeq}
1	16 Pitfire Place	33
2	29 Temuka Gardens	34
3	Taylor Close	37
4	32A Miranda St	35

The results in the preceding table indicate that operation noise levels are fully compliant for all periods of the day based on the recommended noise mitigation measures.

Recommended Noise Mitigation Measures

Based on the indicative equipment selections and building concept design MDA recommends that the air treatment facility be constructed with an enclosure giving a weighted sound reduction index (R_w) of at least 30. Internal absorption will be required to some surfaces in order to control the reverberant level within the enclosure. All venting of air to atmosphere will require louvres treated to 65dBA at 1 metre, while an attenuator is necessary for the air intake. Any openings should face away from the closest noise sensitive receivers.

It should be noted that these recommendations are indicative only and subject to change once equipment selection is finalised during the detailed design phase of the project.

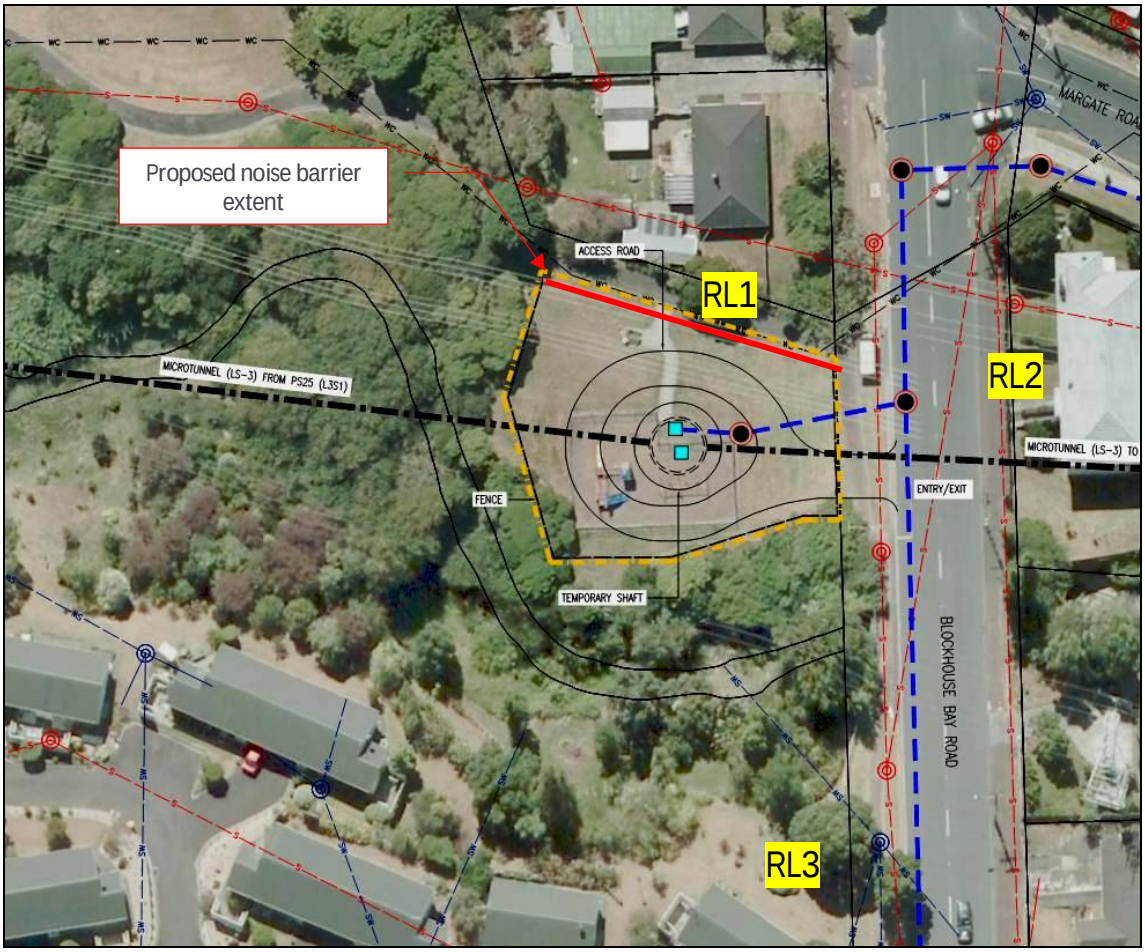
Based on the above recommendations, Operation noise levels are predicted to be within the recommended noise limits at adjacent sites.

4.5.17 Miranda Reserve (L3S2)

Details of Proposed Site

The proposed site is situated on Miranda Reserve, an Open Space Activity Zone 2 land on Blockhouse Bay Road. The nearest dwellings are located over 20 metres distance to the north of the construction site centre. Figure 16 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 16: Site overview



Currently, the predominant noise source is traffic from Blockhouse Bay Road. An ambient noise level of 51dB L_{Aeq} was measured on 12 May 2011 during the day-time.

The proposed site will be used for micro-tunnelling equipment launch and retrieval via a 10 metres diameter temporary shaft. The only permanent structures will be a 6m diameter drop shaft and connections to CSO Collector CC-7.

Construction Noise

General site construction activities are estimated to be of 6-8 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck. The site is a micro-tunnelling launch/reception shaft location and associated noise sources may include a slurry separation plant, mobile crane, generator and debris removal by crane and truck.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Blockhouse Bay Road has been considered. MDA predicts that noise levels will increase by less than 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site, with the results presented in Table 24. Noise levels are predicted assuming a 2 metre high noise barrier as detailed in Figure 16.

Table 24: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	337 Blockhouse Bay Road	50 – 67
2	356 Blockhouse Bay Road	46 – 65
3	Fran Andrews Drive	49 - 68

The construction noise levels are predicted to comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for all receivers assessed.

Operational Noise

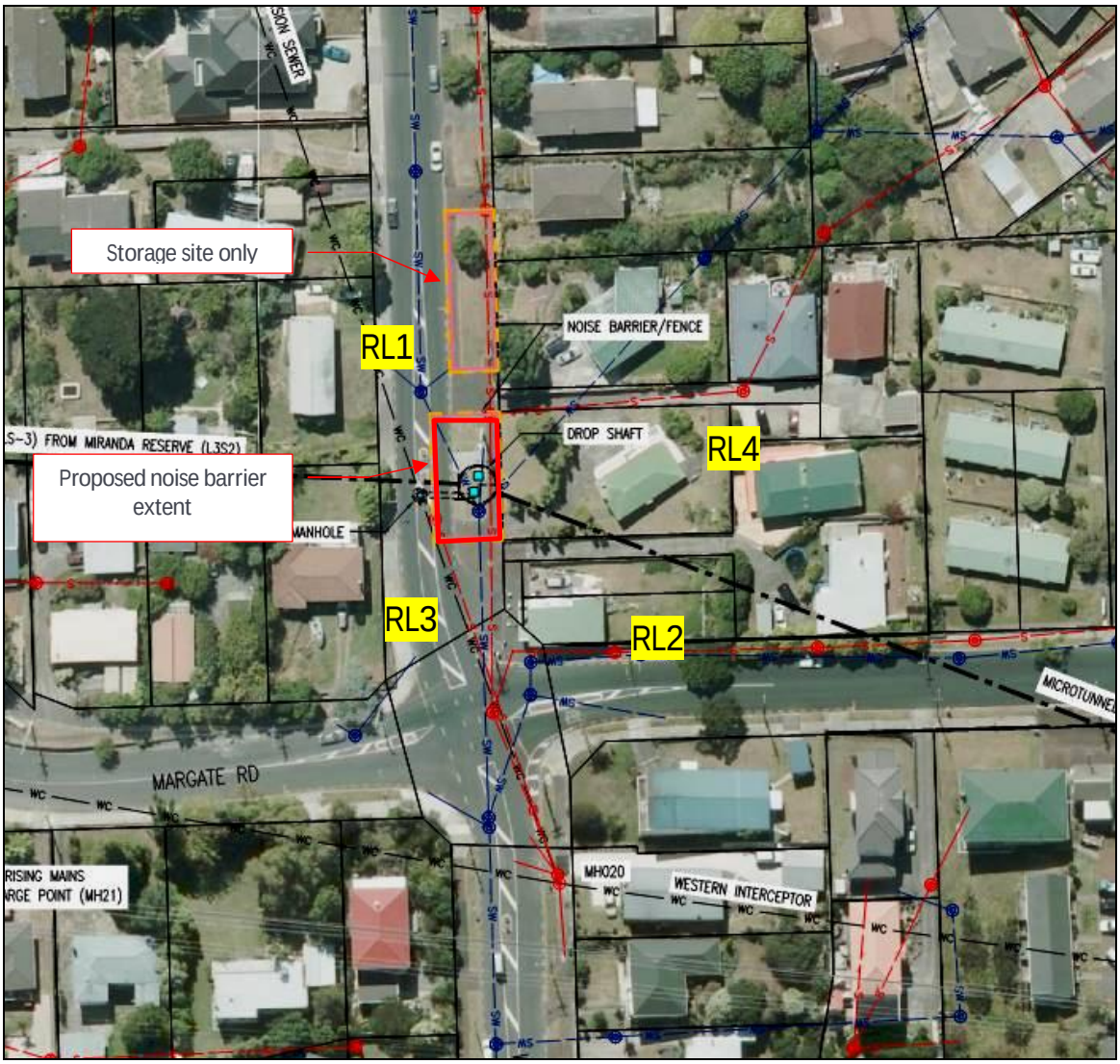
The only permanent construction will be a 6m diameter drop shaft. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.18 Whitney Street (L3S3)

Details of Proposed Site

The proposed site is situated on Whitney Street, within the road reserve. The construction site is on Road Reserve land. Several dwellings are in close proximity to the site, with the residence at 124 Whitney Street being approximately 20 metres distance from the construction site centre. Figure 17 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 17: Site overview



Currently, the predominant noise source is traffic from Whitney Street. An ambient noise level of 51dB L_{Aeq} was measured on 12 May 2011 during the day-time.

The proposed site will connect to the Avondale Diversion Sewer and contain a 6 metre diameter drop and access shaft.

Construction Noise

General site construction activities are estimated to be of 6-8 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, possibly sheet piling, concrete pumping, rock breaking, drilling and spoil removal by truck. Outside the construction site boundary, short-term trenching will take place to create connection pipelines to the Avondale Branch Diversion Sewer. The site is a likely micro-tunnelling reception shaft location and associated noise sources may include a mobile or crawler crane, generator and trucks.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Whitney and Margate Streets has been considered. MDA predicts that noise levels will increase by less than 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 25 presents the results of predictions at the nearest dwellings. Noise levels are predicted assuming a 2 metre high noise barrier as detailed in Figure 17.

Table 25: Daytime construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	115 Whitney St (ground floor)	52 – 68
	115 Whitney St (first floor)	56 - 71
2	130 Whitney St (ground floor)	50 – 68
	130 Whitney St (first floor)	55 – 73
3	56 Margate Rd (ground floor)	49 – 71
	56 Margate St (first floor)	52 – 72
4	124 Whitney St (ground floor)	51 – 69
	124 Whitney St (first floor)	55 - 73

The construction noise levels are predicted to comply or marginally non-comply with the Construction Noise Standard for all ground-floor based receivers. It is noted that trenching will occur partially outside the site confines and consequently, noise from this source is predicted to be non-compliant for RL3.

It is therefore recommended that mobile screening is implemented if practicable to do so, reducing noise levels from this source by 5 - 10 decibels. At the very least, noise management and communication with neighbours will be necessary to ensure acceptable noise levels. Refer to Appendix 7 for recommended design detail of the mobile screen

It is noted that all adjacent receiver dwellings are of 2-storey construction and as such, screening afforded by the recommended noise barrier to the second storey will be ineffectual. A consequence of this is that noise levels from activities such as piling will be higher than for ground-floor based receivers and will require management through the CNMP process.

It is further noted that sheet piling may be used as an alternative to secant piling at this site. Where the sheets are driven into the ground using the vibratory method, noise levels are predicted to be up to 5 decibels higher from this source than for bored piling, necessitating management through the CNMP process. It is recommended that a quieter form of piling such as the hydraulic 'pressed-in' method be considered in as far as it is practicable to do so.

Operational Noise

The only permanent structure will be a drop and access shaft for maintenance work, which will occur on an infrequent basis. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.19 Dundale Avenue (L3S4)

Details of Proposed Site

The proposed site is situated on a road reserve near Dundale Avenue. The nearest dwellings are located over 25 metres distance to the north of the site, a kindergarten is also situated approximately 35 metres north-east of the site. Figure 18 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 18: Site overview

Currently, the predominant noise source is traffic from Dundale Avenue. An ambient noise level of 44dB L_{Aeq} was measured on 12 May 2011 at during the day-time.

The proposed site will be used for micro-tunnelling equipment launch and retrieval via a 10 metre diameter temporary shaft. The only permanent structure will be a 2.4 metre diameter access shaft to Link Sewer 3.

Construction Noise

General site construction activities are estimated to be of 6-8 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck. The site is a likely two-way micro-tunnelling jacking shaft location and associated noise sources may include a slurry separation plant, mobile crane, generator and debris removal by crane and truck.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Dundale Avenue has been considered. MDA predicts that noise levels will increase by less than 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction site. Table 26 presents the results of predictions at the nearest dwellings. Noise levels are predicted assuming a 2 metre high noise barrier as detailed in Figure 18.

Table 26: Day-time construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	73 Dundale Ave (first floor)	44 – 65
2	66D Dundale Ave	43 – 68

The construction noise levels are predicted to comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800 hours) for the receivers assessed.

Operational Noise

The only permanent structure will be a drop and access shaft, with maintenance occurring on an infrequent basis. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.5.20 Haycock Avenue (L3S5)

Details of Proposed Site

The proposed site is situated at 2 & 4 Haycock Road, currently residentially zoned private properties. The nearest dwellings are within a 20 metre radius of the site centre. Figure 19 details the proposed site and surrounding environment, with labelled receiver locations (RL).

Figure 19: Site overview

Currently, the predominant noise source is traffic from surrounding roads. An ambient noise level of 48 dB L_{Aeq} was measured on 12 May 2011 during the day-time.

The proposed site will be used for micro-tunnelling equipment retrieval via an 8.5 metre diameter temporary shaft. Additionally, it is expected that a TBM (installing segmental lining) driving from WS2 will be retrieved or permanently abandoned underground at this site. The only permanent constructions will be a 8 metre diameter drop shaft and connections to existing sewer and CSO Collector Pipeline CC-8.

Construction Noise

General site construction activities are estimated to be of 6 - 8 months duration and occur during day-time hours only (0700 – 1800hrs). This is classified as long-term duration according to the Construction Noise Standard.

Construction noise sources will include site establishment machinery such as excavators, loaders and trucks; shaft excavation and retention machinery such as excavators, bored piling rig, concrete pumping, rock breaking, drilling and spoil removal by truck. Outside the construction site boundary, short-term trenching may take place to allow connections to be made with the Western Interceptor, Lynfield Branch Sewer, and CSO Collector CC-8.

The site is a likely micro-tunnelling reception shaft location, receiving the TBMs from May Road and the MTBM from Dundale Avenue. Associated noise sources may include a mobile crane and delivery trucks.

It is estimated that between approximately 34 and 56 heavy vehicle movements per day will occur during Stage 1 and Stage 2 respectively. The impact of site heavy vehicle traffic on traffic noise levels on Haycock Avenue has been considered. MDA predicts that noise levels will increase by approximately 1 decibel during the daytime period due to the additional heavy vehicle volumes and therefore considers the impact to be of no appreciable significance.

Construction noise levels have been predicted for the closest noise sensitive receivers surrounding the construction, with the results presented in Table 27. Noise levels are predicted assuming a 2.5 metre high noise barrier as detailed in Figure 19.

Table 27: Day-time Construction noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
1	1 Haycock Ave (ground floor)	47 – 70
	1 Haycock Ave (first floor)	50 – 73
2	2 Haycock Ave (ground floor)	50 - 75
3	83B White Swan Road (ground floor)	42 – 73
	83B White Swan Road (first floor)	47 – 73
4	6 Haycock Ave	47 – 76

From the range of noise levels predicted in the table, it is evident that certain activities will not comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for the receivers assessed. Activities which will non-comply include the demolition of existing structures on the site, trenching where it occurs outside the site boundary and use of a large crawler crane if it is decided to extract the TBM from the reception shaft.

With regard to trenching it is recommended that mobile screening is implemented if practicable to do so, reducing noise levels from this source by 5 - 10 decibels. At the very least, noise management and communication with neighbours will be necessary to achieve acceptable noise levels. Refer to Appendix 7 for recommended design detail of the mobile screen.

Further mitigation of demolition noise cannot be made without a significant increase in noise barrier height, which is considered to be impractical for this site, vis-à-vis adjacent dwellings. It is therefore recommended that noise effects from demolition and other activities outlined be managed through the CNMP.

An example of management technique would be to arrange a suitable time with affected residences to carry out demolition and trenching when dwellings are unoccupied.

Frequent and effective communication with affected parties will also be required. As part of the CNMP process, it is recommended that non-complying activities be restricted to Monday to Friday and do not occur on Saturdays.

It is recommended that noise barriers be constructed as early in the project as is practicable in order to mitigate noise from site establishment works to ground floor based receivers.

Operational Noise

The only permanent structure will be a drop and access shaft, with maintenance occurring on an infrequent basis. Operation noise levels are predicted to be within noise limits at adjacent sites. No mitigation measures are necessary.

4.6 Blasting Noise Effects – All Sites

Generally, blasting will not take place during shaft excavation. However, where no reasonable alternative exists controlled blasting techniques may be needed for sites where basalt is present. The following sites have been identified as potentially requiring blasting in basalt:

- Western Springs
- Mt Albert War Memorial Park
- Lyon Avenue
- Haverstock Rd
- Walmsley Park
- May Road
- Kiwi Esplanade
- Motions Road
- Western Springs Depot

All blasts would be designed and managed by suitably qualified personnel and would take into account site specific variables such as direction of initiation, cavities, maximum instantaneous charge, weather conditions, underlying geology of the site and surrounding area, distance to dwellings, correct stemming and adequate burden. The noise and vibration effects from blasting would be mitigated to no more than 120 dB L_{Cpeak} in compliance with the Construction Noise Standard.

An alternative to explosive rock-breaking is chemical rock splitting or non-explosive rock breaking, whereby a chemical is used that reacts with the rock, splitting it apart. It is understood that this method is expensive and not commonly used in New Zealand. It should be noted that this method would be used as a last resort.

It is recognised that the process of setting blast charges may involve the use of a rock drill to make firing holes and a rock breaker to tidy up uneven faces. Based on sound power levels of 116 dB and 120 dB L_{Aeq} for these respective noise sources, the following table predicts noise levels at the most potentially impacted receiver for each site. It is noted that predictions of noise are for the shaft opening i.e. at ground level and are therefore considered to be conservative. It is recognised that as shafts are worked deeper into the ground, they will inherently provide additional noise screening to the nearest receivers, and will result in a more directional i.e. vertical noise emission.

Table 28: Blasting preparation noise level predictions

Receiver Location		Construction Noise Level dB L_{Aeq}
WS1-1	42 Sefton Avenue	62 - 65
AS1-1	13A Wairere Avenue	77 - 79
AS2-2	28 Morning Star Place	78 - 80
AS3-3	98 Haverstock Road	72 - 76
AS4-4	3 O'Donnell Avenue	79 – 82
WS2-2	55A Marion Avenue	77 – 80
AS7-2	85 Kiwi Esplanade	63 – 66
L1S1-2	Auckland Zoo	67 – 70
L1S2-1	Old Mill Road East	49 - 51

From the range of predicted noise levels in the table, it is evident that blasting hole preparation will not comply with the Construction Noise Standard for Monday to Saturday day-time (0730 – 1800hrs) for some of the receivers assessed.

Where it is determined that effects from preparatory work may potentially be an issue, for example basalt located near ground surface or dwellings overlook shaft, the process would be managed through the CNMP. An example of management technique would be to arrange a suitable time with affected residences to carry out blast hole preparation (and blasting) when dwellings are unoccupied. Frequent and effective communication with affected parties will also be required. As part of the CNMP process, it is recommended that non-complying activities be restricted to Monday to Friday and do not occur on Saturdays.

It is recommended that the CNMP include the facility to incorporate a site-specific Blasting Noise and Vibration Management Plan (BNVMP), where deemed necessary.

4.7 Tunnelling Noise Effects

Reradiated noise from tunnelling – i.e. vibration energy in building structures, manifests itself as a 'rattle or hum' and is heard rather than felt. It is often difficult for a listener to distinguish this effect from felt vibration, and complaints of vibration can be made when in fact the cause of disturbance is reradiated noise. This effect varies considerably from structure to structure due to the complexity of building junctions and variance in building materials, ground type etc.

In the rock expected to be encountered during tunnelling, the TBM will generally produce low level vibrations that would be expected to attenuate quickly and be below the perception threshold at the ground surface[4].

[4] Refer T&T, 2012 Vibration Assessment for Main Tunnels and Link Sewers

MDA understands that the rate of tunnel excavation is anticipated to be in the order of 12 m per day and that the proximity of the tunnel drive to dwellings or other sensitive buildings would not be less than 20 metres. Based on the rate of extraction, duration in one location and minimum separation distance, MDA considers that any effects from tunnelling, including reradiated noise, would be no more than minor.

It is anticipated that any reradiated noise effects, if experienced, would be handled on a case-by-case basis through the complaint management procedures in the CNMP.

5.0 CONSTRUCTION NOISE MANAGEMENT PLAN

A draft CNMP has been prepared and is contained in Appendix 5. The purpose of a CNMP is to provide recommendations and processes which mitigate noise levels from construction activities to acceptable levels. It is recognised that in some cases, acceptable noise levels will be in excess of the Construction Noise Standard where affected parties are pre-emptively informed and consulted on a regular basis.

The CNMP is a living document and as such can be updated to account for site-specific variables which may arise on an individual site basis, such as the use of different constructions methods not covered in this noise impact assessment.

6.0 OVERALL SUMMARY AND CONCLUSIONS

Marshall Day Acoustics has been engaged to undertake a noise impact assessment for both construction and operational phases for 3 primary and 17 secondary shaft sites and associated tunnels that form the basis of the Central Interceptor Project.

The work undertaken by MDA has involved the specification of appropriate noise performance standards, measurement of existing ambient noise levels as appropriate, prediction of potential construction and operation noise levels, and the outlining of noise mitigation options.

Operation noise compliance for the proposed pumping station and air treatment facility to be located at the Mangere WWTP has been assessed against the designation noise condition from the Manukau District Plan.

Operation noise compliance for the remainder of the sites has been assessed based on criteria derived from the Auckland City District Plan and relevant, current New Zealand acoustical Standards.

Construction noise for all of sites has been assessed in accordance with New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*.

Prediction of construction noise has been undertaken assuming 2-3 metre high noise barriers as indicated.

Operation noise is predicted to comply at all secondary sites without air treatment facilities. The remainder of the sites, including primary sites, will require further noise mitigation in various forms, as summarised below.

Buildings enclosing primary sites and facilities including the pump station and air treatment facilities will require acoustic treatment to the walls, roofs and vents. All openings should face away from the nearest noise sensitive receivers insofar as is practicable.

General construction noise is predicted to comply at most sites, except where noise intensive works such as vibratory sheet piling, demolition, trenching and rock breaking etc occur in close proximity with receivers. Management via the CNMP will be required.

Careful management of construction activities during the 0700-0730 period will be required due to the more stringent noise limit in this period. It is recommended that noise intensive activities do not occur in this period.

Management of construction noise will require communication with affected residents, including notification to residents of proposed night works in close proximity to dwellings. Timing of particularly noisy works should be restricted to the day-time period insofar as possible in order to minimise noise impact to nearby noise sensitive receivers.

Mitigation measures should include the selection of low noise equipment where this is possible, and the installation of temporary on-site noise barriers or enclosures between dwellings and the construction site on a progressive basis, such that acoustic line-of-sight is interrupted and maximum noise mitigation achieved.

A Construction Noise Management Plan has been prepared for all sites where night-time construction activity is anticipated, in order to ensure acceptable outcomes for potentially affected residents.

APPENDIX 1: GLOSSARY OF TECHNICAL ACOUSTICAL TERMS

Sound Pressure Level (L_P)	A logarithmic ratio of a sound pressure measured at distance, relative to the threshold of hearing (20 μPa RMS) and expressed in decibels.
Sound Power Level (L_W)	A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels.
dB	Decibel – A measurement of sound level expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa i.e. dB = 20 x log(P/Pr)
dBA	A measurement of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear. All noise levels are quoted relative to a sound pressure of $2x10^{-5}$Pa
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates
$L_{A95\ (t)}$	The A-weighted noise level equalled or exceeded for 95% of the measurement period. This is commonly referred to as the background noise level. The suffix "t" represents the time period to which the noise level relates.
$L_{A10\ (t)}$	The A-weighted noise level equalled or exceeded for 10% of the measurement period. This is commonly referred to as the average maximum noise level. The suffix "t" represents the time period to which the noise level relates.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.

APPENDIX 2: NOISE RULES

Manukau District Plan Rule 7.5.9

Explanation

Large quantities of biosolids are to be removed from the MWTP each day. In addition, other materials which could contribute to dust nuisance will be delivered and removed from the site. The above rule is designed to avoid any adverse effects from particulate materials being lost from vehicles.

Rule 7.5.9 Noise

(a) Any additions to the MWTP shall be so designed and the use of the buildings and site shall be so conducted, that the noise level does not exceed the limits set out below:

(i) When measured at, or within, the boundary of any site zoned Residential or the notional boundary of any site zoned Mangere Puhinui Rural , (as at the date the district plan became operative) which is located beyond the boundary shown on Figure 5.6 attached to this designation. (The notional boundary is a line 20m from the facade of any rural dwelling or the legal boundary where this is closer to the dwelling.)

DAY/TIME	NOISE LEVEL (L_{10}dBA)
Monday to Saturday 0700–2200	50
At all other times including Sundays and public holidays	45

(ii) When measured at or within the boundary of any site zoned Business.

DAY/TIME	NOISE LEVEL (L_{10}dBA)
At all times	60

L_{max} 65 dBA (or background plus 30 dBA, whichever is lower) shall apply between the houses of 2200–0700, seven days a week.

(b) The noise levels shall be measured and assessed in accordance with NZS 6801: 1991 "Measurement of Sound" and NZ 6802: 1991 "Assessment of Environmental Sound".

(c) Any construction noise (as defined in Section 2 of the Construction Act 1959) emanating from the site shall comply with the requirements of NZS 6803P:1984 "The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work".

(d) Prior to the commencement of any new activities, the applicant shall provide Council with a certificate from a qualified Acoustic Engineer demonstrating that the above performance standards will be met.

(e) Notwithstanding the noise standards above, the Council reserves the power conferred on it under the relevant sections of the Resource Management Act 1991, to control any noise which contravenes the provisions of the abovementioned Act.

Explanation

The noise standards above are similar to those that apply to activities in the Business zones. During the construction period from 1997–2003 noise levels will exceed those specified in clause (a) above, but will be below the daytime construction noise limit of 75dBA set out in NZS 6803P: 1984 "The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work".

Manukau District Plan Rule 15.11.1.7

Rule
15.11.1.7 Noise

The following noise performance standards shall not be exceeded at or within the boundary of any site zoned Residential, Papakainga, or Maori Purpose Zone:

ZONE	AVERAGE MAXIMUM NOISE LEVEL			MAXIMUM
	L_{10} dBA MONDAY TO SUNDAY			L_{MAX} dBA
	7.00AM–6.00PM (0700–1800)	6.00PM–10.00PM (1800–2200)	10.00PM–7.00AM (2200–0700)	10.00PM–7.00AM (2200–0700)
Public Open Space 1, 2 and 5	45	40	40	65
Public Open Space 3 and 4	55	45	40	70 (or background plus 30, whichever is the lower)

Rule
15.11.1.7.1 The noise limits specified for Public Open Space zone 3 may be exceeded by a maximum of 10 dBA during the day time period only, provided that such activity does not occur more than 6 times in any 12 month period and for a period of not more than 3 hours on any single occasion. (The day time period is defined as 7.00 am to 10.00 pm).

Provided that all Community Buildings, Indoor Recreation Facilities and Sports Clubrooms located within 50m of any site zoned residential shall submit a noise management plan detailing the control measures which will be put into practice and shall include the following details:

- hours of operation
- types of activity to be carried out
- access routes and parking provisions, and the location of carparking
- numbers of persons permitted on the site
- ventilation of buildings and control of building
- power and type of sound amplification systems
- the hours within which service vehicles should operate
- an acoustic design certificate from a professional Acoustic Engineer demonstrating that the standards of noise under 15.11.1.7 and 15.11.1.7.1 will not be exceeded.

CITY OF AUCKLAND - DISTRICT PLAN
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PART 9 - OPEN SPACE AND RECREATION ACTIVITY

9.8.1.5 NOISE

The following rules apply to all Open Space 1-4 zones except the land at Rosebank Road, Domain. Refer to Clause 9.8.1.8 USE OF ROSEBANK ROAD DOMAIN for the development controls for Rosebank Road.

No activity shall be permitted to create any noise which results in the following standards being exceeded -

i) Recreational activities in the Open Space 1 zone shall not produce noise levels above the background noise levels.

ii) The L10 noise level and maximum level (Lmax) arising from any activity measured at or within the boundary of any residentially zoned property shall not exceed the following limits:

Monday to Saturday	7.00am - 10.00pm	L10 55dBA
Sunday & Public Holidays	9.00am - 6.00pm	
At all other times	L10 40 dBA Lmax 75 dBA, or background (L95) plus 30 dBA, whichever is the lower	

The Council may, subject to such conditions as are considered appropriate, permit the noise levels or particular activities occurring occasionally to exceed the levels set for a reasonable proportion of the time.

Crowd noise shall not be included in any assessment of noise levels.

The above noise levels shall be measured and assessed in accordance with the requirements of the NZS 6801: 1991 "Measurement of Sound" and NZS 6802:1991 "Assessment of Environmental Sound".

The noise shall be measured with a sound level meter complying at least with the International Standard IEC 651 (1979): Sound Level Meters, Type 1.

iii) Where a recreational activity is to be undertaken on any open space zoned land and/or where buildings are to be constructed, altered or used in relation to the recreational activity, the Council may require certification from an acoustic engineer to confirm that the activity and the use of the building will not exceed the noise levels set out in (ii).

7.8.1.10 NOISE

The L10 noise level and maximum level (Lmax) arising from any activity measured at or within the boundary of any residential zoned property shall not exceed the following limits:

Monday to Saturday	7.00am - 10.00pm	L10 50dBA
Sunday & Public Holidays	9.00am - 6.00pm	
At all other times	L10 40dBA Lmax 75 dBA, or background (L95) plus 30 dBA, whichever is the lower	

Except that the noise levels may be exceeded by intermittent noise associated with normal household activity eg lawn mowing undertaken at reasonable times during the day.

The above noise levels shall be the L10 noise level as measured on residentially zoned land. Measurement and assessment shall be in accordance with the requirements of the NZS 6801:1991 "Measurement of Sound" and NZS 6802:1991 "Assessment of Environmental Sound".

The noise shall be measured with a sound level meter complying at least with the International Standard IEC 651 (1979): Sound Level Meter, Type 1.

Part 8 – Business Activity

8.8.1.4 NOISE

A. Noise Control at the Residential Zone Interface

The L10 noise level and maximum level (Lmax) arising from any activity measured at or within the boundary of any residential zoned property shall not exceed the following limits:

i) for Business zones 1, 2 and 3

Monday to Saturday	7.00 am - 10.00 pm	L 10 50dBA
Sunday & Public Holidays	9.00 am - 6.00 pm	
At all other times	L10 40dBA Lmax 75 dBA, or background (L95) plus 30 dBA, whichever is the lower	

ii) for Business zones 4, 5 and 6

Monday to Saturday	7.00 am - 10.00 pm	L 10 55dBA
Sunday & Public Holidays	9.00 am - 6.00 pm	
At all other times	L10 45dBA Lmax 75 dBA, or background (L95) plus 30 dBA, whichever is the lower	

Where an applicant can prove that background noise levels (L95) significantly exceed these limits then the Council may set noise levels higher than these subject to such conditions as are considered appropriate.

B. Noise Control within the Business Zones

To provide some acoustic privacy between sites within the business zones, the following noise levels are imposed at the site boundary of every site (not held in common ownership) within the relevant business zones. (This control is addition to, and not in substitution for Clause 8.8.1.4A NOISE CONTROL).

The L10 noise levels measured at or within the boundary of any adjacent site (not held in common ownership) with the same business zoning shall not exceed:

	BUSINESS ZONES						
	1	2	3	4	5	5a	6
7.00 am to 10.00 pm	55	55	60	60	70	70	70
10.00 pm to 7.00 am	45	45	60	60	70	70	70

The above noise levels in A and B shall be measured and assessed in accordance with the requirements of the NZS 6801:1991 "Measurement of Sound" and NZS 6802:1991 "Assessment of Environmental Sound" or their replacement.

The noise shall be measured with a sound level meter complying at least with the International Standard IEC 651 (1979): Sound Level Meters, Type 1.

Operative Auckland Regional Plan: Coastal

Rule 35.5.1 (a)

Permitted Activities

35.5.1 The following noise standards shall apply to all activities undertaken in the coastal marine area other than those listed in Rules 35.5.2, 35.5.3, 35.5.5 or 35.5.6, or exempted by Rule 35.5.7:

a The noise level as measured within the boundary of any land in respect of which an operative District Plan provides for residential activity to be the principal activity, shall not exceed the following limits:

i	7.00 am to 10.00 pm	55 dBA L_{10}
ii	10.00 pm to 7.00 am	45 dBA L_{10}
		75 L_{max}

Rule 35.5.5 (b)

b Construction noise of 15 days or more in duration shall not exceed the following levels when measured 1 metre from the façade of any occupied or inhabited adjacent building, for any 30 minute period in accordance with Section 3.2.1 of NZS 6803P: 1984:

	L_{10}	L_{max}
Monday to Friday 6.30am to 10.30pm	75 dBA	90 dBA
Saturday 7.00am to 11.00pm	80 dBA	90 dBA
Sunday 9.00am to 7.00pm	65 dBA	85 dBA
At all other times (night times)	60 dBA	75 dBA
At all other times (night time in any area where an operative District Plan provides for residential activity as the principal activity)	55 dBA	75 dBA

APPENDIX 3: CONSTRUCTION NOISE LIMITS

NZS 6803: 1999

Table 2 – Recommended upper limits for construction noise received in residential zones and dwellings in rural areas

Time of week	Time period	Duration of work					
		Typical duration (dBA)		Short-term duration (dBA)		Long-term duration (dBA)	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	0630-0730	60	75	65	75	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75
Sundays and public holidays	0630-0730	45	75	45	75	45	75
	0730-1800	55	85	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75

Table 3 – Recommended upper limits for construction noise received in industrial or commercial areas for all days of the year

Time period	Duration of work		
	Typical duration	Short-term duration	Long-term duration
	L_{eq} (dBA)	L_{eq} (dBA)	L_{eq} (dBA)
0730 – 1800	75	80	70
1800 – 0730	80	85	75

APPENDIX 4: CONSTRUCTION & OPERATION EQUIPMENT NOISE DATA

Table 4.1: Octave band sound power level data - Construction

	Octave Band Centre Frequency (Hz)							
Source	63	125	250	500	1000	2000	4000	dBA
Mobile Crane	96	99	96	90	94	94	83	99
Vibratory sheet Piling	119	115	114	113	111	106	98	115
Rock breaker	115	121	117	113	114	114	111	120
Rock drill	132	117	111	109	110	110	108	116
Hydraulic Sheet Piling Rig	99	96	91	88	84	82	78	91
Bored Piling Rig	112	120	109	108	106	104	96	111
Truck	98	103	100	101	100	100	93	105
Generator	103	100	104	98	97	93	84	102
Slurry Separation Plant	83	85	92	91	90	88	84	95
Frontend Loader	106	105	99	96	92	94	89	99
Demolition	116	116	114	117	111	111	108	118
Trenching	105	114	103	103	99	97	92	105
Bull Dozer	102	111	100	100	107	105	98	110
Tunnel Ventilation	94	96	100	99	98	94	90	102
Pumping Grout	97	112	110	104	100	98	96	108
Water treatment plant	83	85	92	91	90	88	84	95
Compressor	94	94	94	97	100	100	100	106
Dredging	111	119	108	106	106	101	94	110
Diaphragm Wall Construction	119	112	111	111	107	105	102	113
Transformer (5mVA)	70	75	81	85	83	85	82	85

Table 4.2: Octave band sound power level data - Operation

	Octave Band Centre Frequency (Hz)							
Source	63	125	250	500	1000	2000	4000	dBA
Air Treatment fan outlet (6600 L/s)	86	88	84	86	85	82	79	90
Air Treatment fan outlet (18000 L/s)	101	95	97	94	94	93	89	99
1MW Pump (1 metre^3/s)	83	91	87	89	90	87	80	94
Transformer (300kVA)	51	56	62	66	64	67	63	72
Transformer (600kVA)	56	61	67	71	69	71	68	76
Transformer (1MVA)	59	64	70	74	72	74	71	79
Exhaust Fan (5 metres^3/s)	104	105	102	98	96	94	94	102
Exhaust Fan (10 metres^3/s)	115	107	104	100	98	96	95	104
Plantroom AHU (estimated)	100	97	96	93	90	89	84	96

APPENDIX 5: CONSTRUCTION NOISE MANAGEMENT PLAN

The following section outlines the recommended Noise Management Measures to reduce the effects of construction noise on neighbouring properties. The measures aim to achieve compliance with NZS6803:1999 (Construction Noise Standard) where practicable.

Community Liaison with Noise Sensitive Receivers

The most important management tool for construction noise is consultation and communication with noise sensitive receivers. Communication and consultation should:

- Ensure widespread awareness of the outcome and long term benefits of the project;
- Explain the likely environmental impacts of construction and options to mitigate these effects;
- Establish regular channels of communication to ensure the community and the Council is kept informed of project progress and has the opportunity to express their concerns.

Community liaison should continue throughout the project and should include:

- No less than two weeks prior to commencement of construction at each site, a project notification letter drop should be carried out. The notification letter should give details of expected work timing and duration (to give a realistic expectation of noise effects and traffic effects) along with contact information to which complaints and enquiries can be directed.
- No less than one week prior to commencement of construction, a project representative should visit all affected properties immediately adjacent to the surface construction sites. The representative should discuss proposed construction works with residents, and incorporate any feedback where possible.
- A 24 hour hotline, project website and e-mail address for those wishing to find out more about the project or express concerns about construction activities;
- Regular written updates delivered to the affected communities to ensure general awareness of project progress and to promote contact details;
- Written notification to businesses/occupiers in localised areas within a minimum of 20 metres of the proposed works to give advance warning of specific construction activities that may create a disturbance, and provide contact details.

General Noise Mitigation Measures

It is the responsibility of the contractor to implement the following noise mitigation measures prior to and during construction:

- Maintain a tight timeframe and keep the construction time to a minimum. The use of equipment considered likely to generate complaints should be restricted wherever practicable to daytime hours in order to reduce the noise impact on residents during evening and night-time periods.

- At all times use the construction methodologies and equipment which result in the lowest practicable noise level. Construction equipment should be well maintained in order to reduce noise resulting from the deterioration of equipment.
- At many construction sites it can be observed that some construction practices unnecessarily increase noise levels. These include the sounding of horns when a truck is fully laden, the air brake release noise of trucks, and the utilisation of audible reversing alarms. These issues must be avoided or noise levels reduced by means of changed construction site management, fitting of mufflers to trucks, and the replacement of audible reversing alarms with visual or low-noise broadband audible reversing alarms (not 'beepers').
- Temporary noise barriers should be erected where beneficial and practicable.

Specific Noise Mitigation Measures – WS1 & WS2

- For WS2, a 3 metre high noise barrier should extend along the south-west boundary as indicated.
- An enclosure should be constructed over the temporary tunnelling shaft site with a weighted sound reduction index (Rw) of at least 40. Openings shall be designed to face away from sensitive noise receivers.
- Truck traffic should be concentrated in the Monday-Saturday day-time and weekday evening periods to limit noise impact during the night-time.
- Enclosure doors should be closed as much as practicable at night-time to ensure maximum noise reduction.
- Noise intensive construction work should be limited to within the enclosure at all times excluding Monday to Saturday daytime (0730 – 1800hrs) and weekday evening (1800 – 2000hrs) periods. It should be noted that night-time works outside the enclosure are acceptable where they are of a less noise –intensive nature.
- The generator, compressor, electrical substation and water treatment plant should be located within suitable noise barriers or enclosures.
- Temporary noise barriers around specific items of equipment such as the piling rig should be used where practicable to reduce noise propagation to neighbouring properties.

Specific Noise Mitigation Measures – All other sites

- Implementation of all site specific mitigation measures outlined in the Marshall Day Acoustics report.
- Temporary noise barriers around specific items of equipment such as the piling rig should be used where practicable to reduce noise propagation to neighbouring properties.
- Night-time works are acceptable where they are of a less noise-intensive nature.

Additional Noise Mitigation Measures

Where measured noise levels consistently exceed the noise limits, or where noise levels are predicted to be disruptive to noise sensitive activities or to cause sleep disturbance, the following measures should be implemented where practicable, in order to satisfy Section 16 of the Resource Management Act:

- On-going consultation with affected occupiers,
- Written notification to occupiers explaining the need for the work during specific periods, the likelihood of it exceeding noise limits, and provision of contact details.
- Individual contact and liaison with residents within 50 metres of night-time general construction works,
- Where practicable, the construction of additional temporary acoustic screens specifically targeted for an individual or group of dwellings (barriers could be erected on a particular resident's property) as required.
- Consideration of other measures requested by the affected residents and occupiers where they can be reasonably met.

Noise Monitoring

Construction noise levels and the achievement of compliance with New Zealand Standard NZS 6803:1999 "Acoustics – Construction Noise" will be monitored throughout the construction process. Attended monitoring will be conducted by a suitably qualified and experienced person in accordance with the relevant standards including New Zealand Standard NZS 6801:2008 "Measurement of environmental sound".

Measurement of construction noise levels should be conducted during critical phases of construction, e.g. during the use of heavy earth moving machinery, rock breaking and other known noise intensive construction activities within 20 metres of residential or other noise sensitive premises.

After each noise survey, a report would be made available detailing the the site plan and commentary discussing any significant issues and summarising the findings and recommendations If measured levels significantly exceed predictions and are non-compliant the response to this circumstance could involve the following steps:

- Determine the source of excessive noise and halt that activity;
- Determine best practicable mitigation option in conjunction with Project Manager (e.g. screening of specific activity, alternative methodology);
- Further monitoring of noise following the implementation of mitigation actions.

Noise monitoring locations will be selected to be representative of the nearest affected properties.

Contingency Measures

In situations where measured incident noise levels prove to be non-compliant or problematic, Watercare may where appropriate undertake an assessment of internal noise levels in spaces containing noise sensitive activities to determine if such activities are unreasonably or detrimentally affected. Following this, Watercare should communicate and consult with affected occupants advising of the findings.

In the event that there is an incidence of non-compliance which has not been predicted and previously addressed, the procedures to be employed to rectify the situation within a 24-hour response time frame should involve:

- Utilisation of alternative construction methods if available
- Implementation of additional temporary noise mitigation measures, i.e. additional or higher temporary barriers
- Additional noise surveys in order to identify the non-compliant activity and subsequently show the effectiveness of noise mitigation measures
- Liaison with affected residents

Procedures for Handling Noise Complaints

As part of the liaison process residents and businesses will be informed to direct complaints to the Watercare call centre. The following complaint procedures should be followed:

- The caller's name, contact details and the nature of their complaint are noted and immediately forwarded to a designated complaints handler by text message and email.
- The designated complaints handler should ring the complainant back within one hour, or as soon as possible, during the day and 30 minutes, or as soon as possible, at night (2200 to 0700) to obtain further information about the nature of the complaint and give an explanation of the activity.
- The designated complaints handler should have contact details of relevant project and construction managers and site supervisors and if further action is needed, should telephone to discuss the complaint. If practicable and appropriate, instructions should be issued to construction workers to modify activity to address the concerns of the complainant.
- The designated complaints handler should phone back the complainant to inform them of any steps taken to address their concerns.
- The designated complaints handler should notify the Auckland Council of any noise complaints that require further action from Watercare.

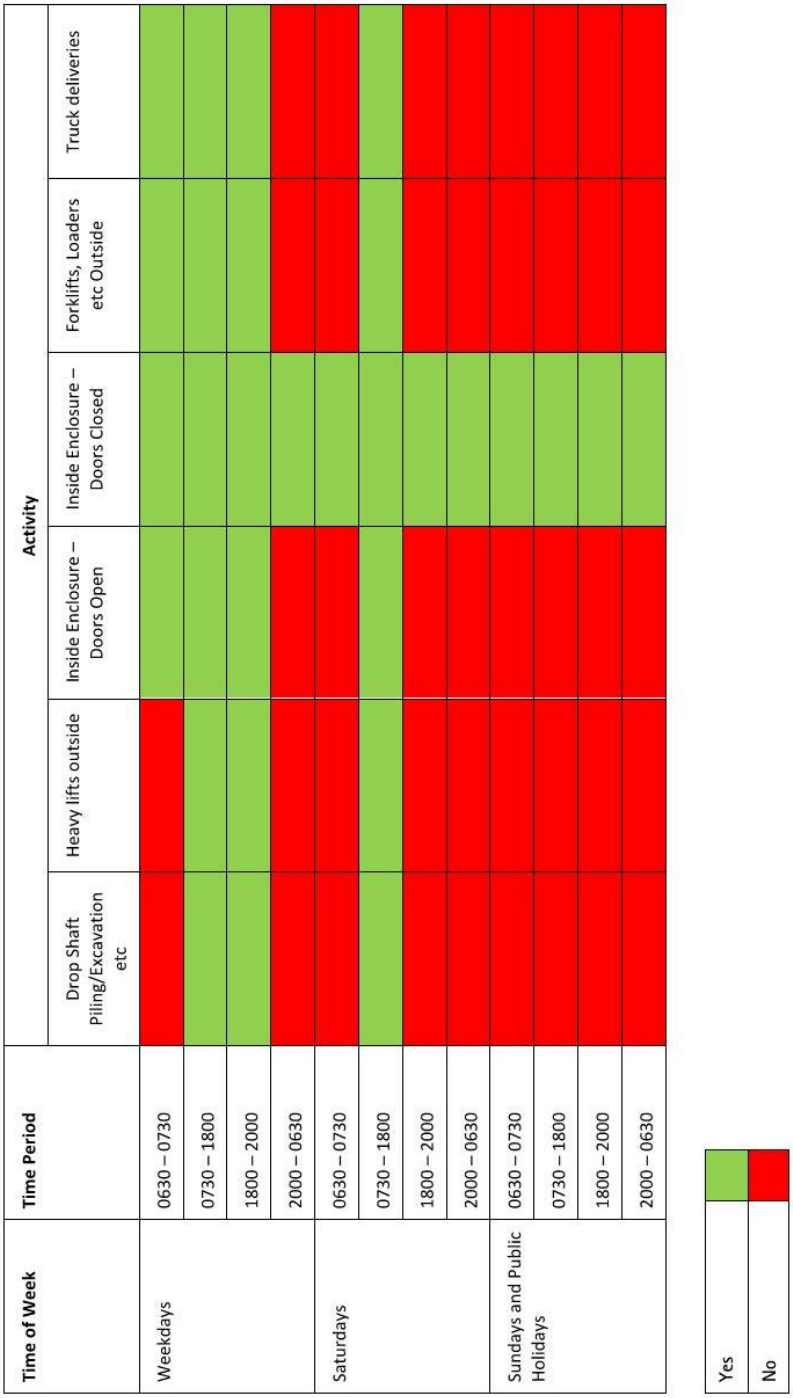
For on-going complaints or issues, the Project Manager may request additional acoustic measurements targeting the specific noise source and time of day. As appropriate for the situation, a noise complaint investigation may include the following:

- Determine noise sources at time of complaint and measurement and assessment of noise levels from this activity;
- Determine best practicable mitigation options in conjunction with Project Manager;
- Measure noise level following mitigation actions;
- Communicate with complainant;
- Report on findings and actions to Project Manager and Auckland Council.

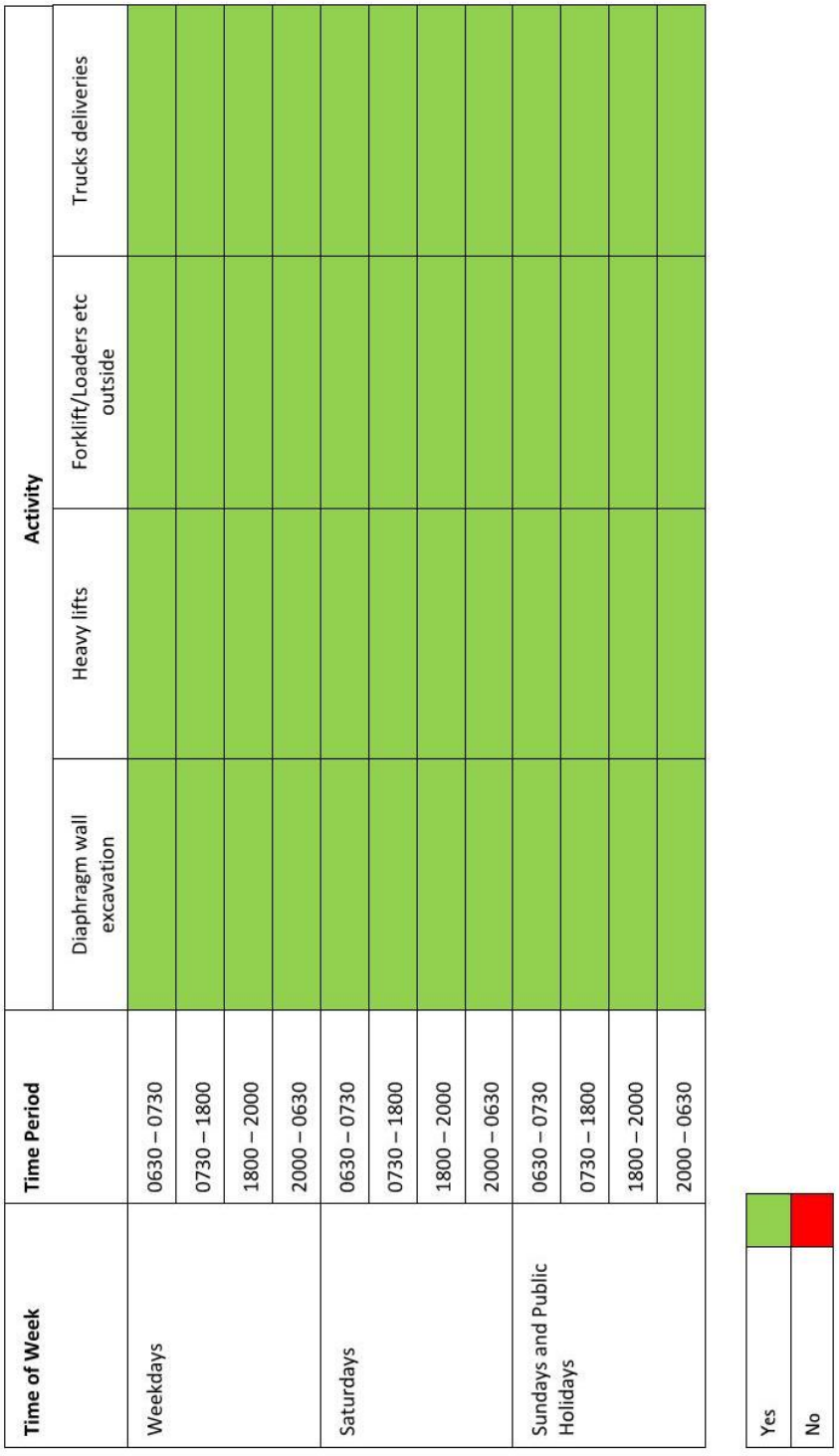
In addition, a complaints file will be maintained which will be available for inspection by affected parties and Auckland Council Regulatory Officers during normal office hours.

APPENDIX 6: EQUIPMENT USAGE SCHEDULES

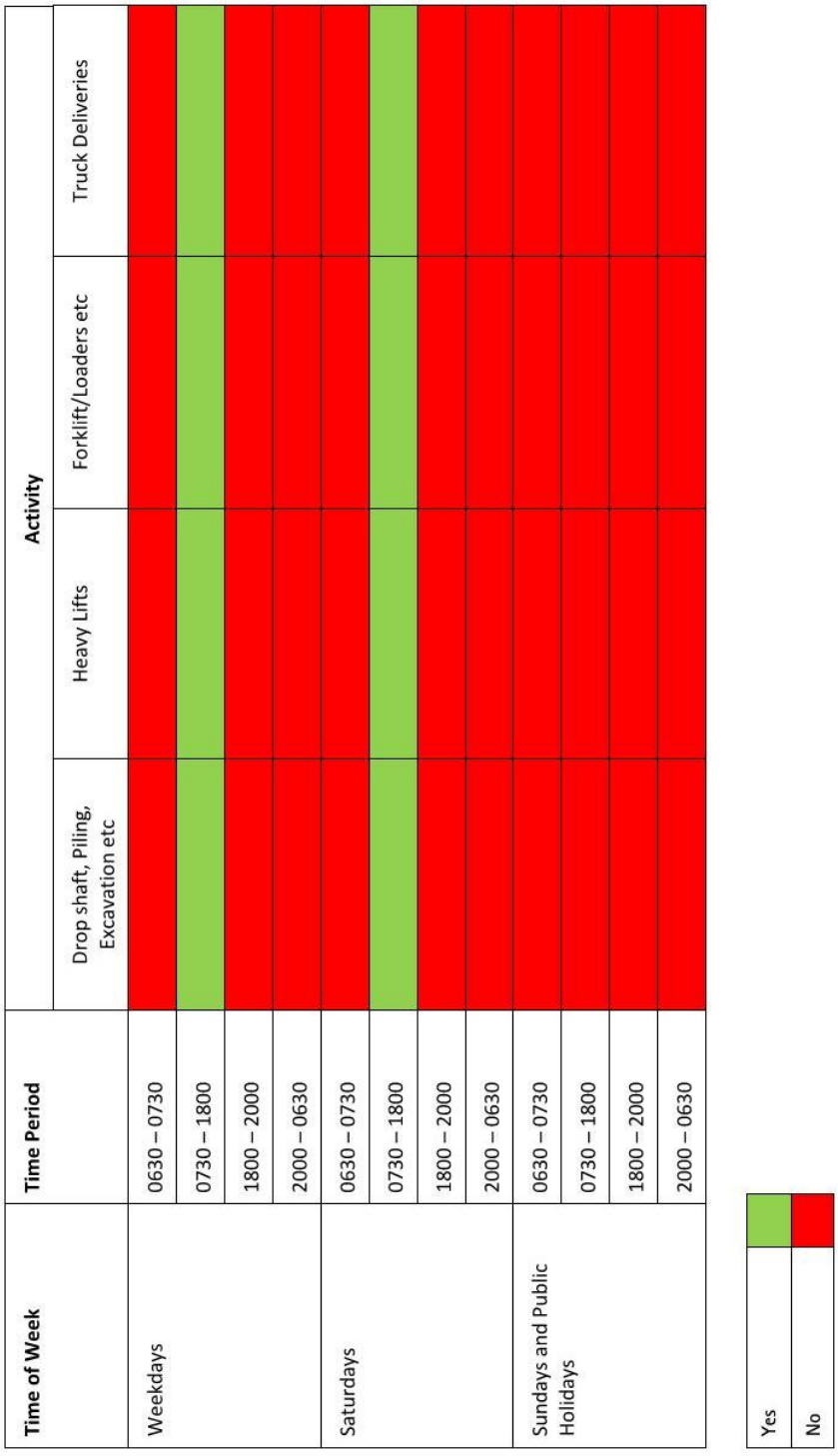
WESTERN SPRINGS (WS1) & MAY ROAD (WS2)



MANGERE WWTP (WS3)



All secondary sites



APPENDIX 7: MOBILE NOISE SCREENING/ENCLOSURE DESIGN

Table B.4 Measured sound reduction given by types of partial enclosure

Type of enclosure (see figure B.3)	Reduction dB(A)		
	Facing the opening(s)	Sideways	Facing rear of shed
Open-sided shed lined with absorbent material; no screen	1	9	14
Open-sided shed lined with absorbent material; with reflecting screen in front	10	6	8
Open-sided shed lined with absorbent material; with absorbent screen in front	10	10	10

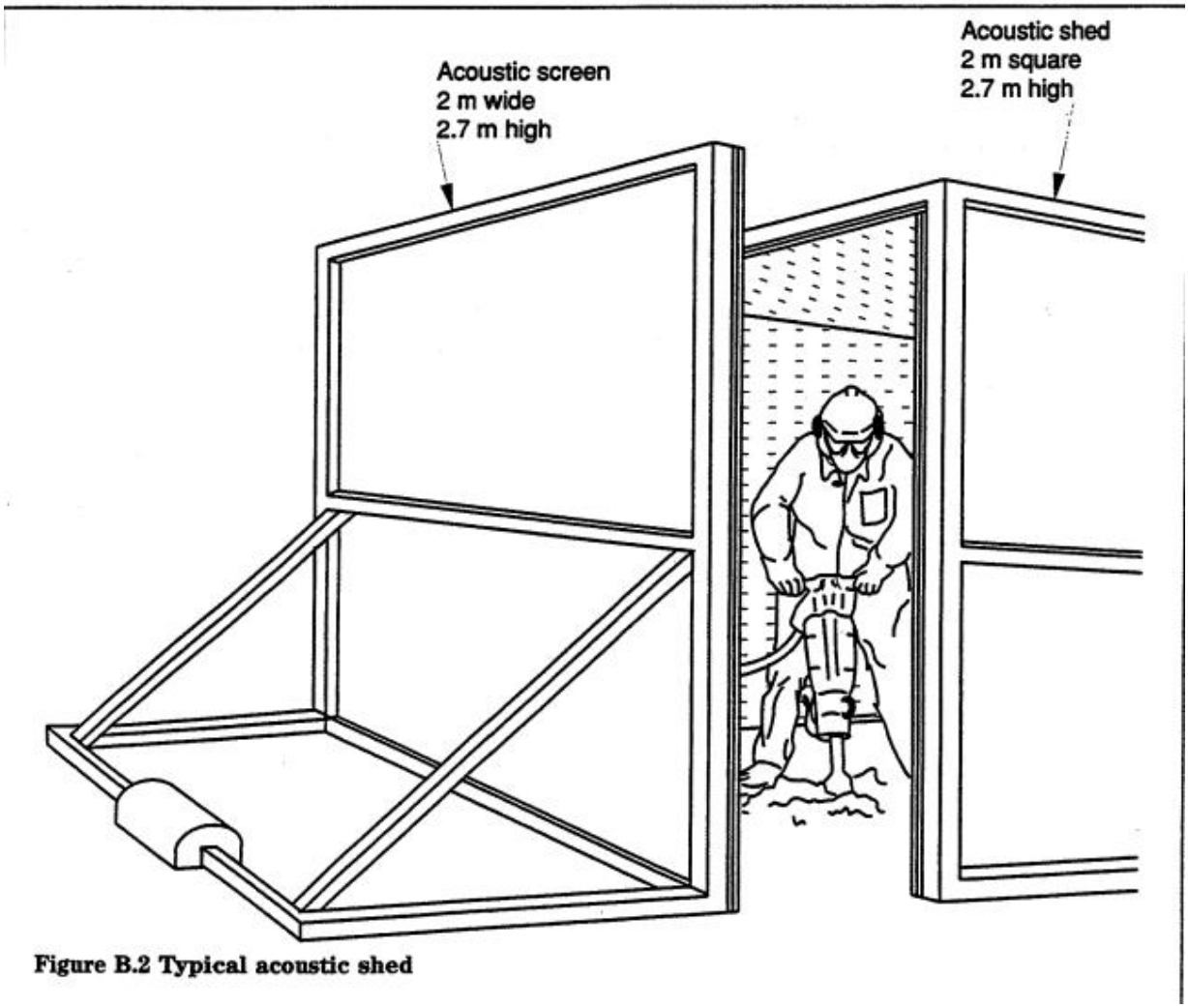


Figure B.2 Typical acoustic shed

Source: BS 5228:1 1997