REPORT

Tonkin+Taylor

Extension to the Central Interceptor - Point Erin Tunnel

Assessment of Noise and Vibration Effects

Prepared for
Watercare Services Limited
Prepared by
Tonkin & Taylor Ltd
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1 Introduction

This report has been prepared by Tonkin & Taylor Ltd (T+T) to inform a resource consent application by Watercare Services Ltd (Watercare) for the proposed extension of the Central Interceptor (CI) wastewater interceptor. The proposed Point Erin Tunnel will run from the current termination point of the CI Grey Lynn Tunnel at Tawariki Street through to Point Erin in Herne Bay (Point Erin Tunnel / the Project).

This report provides an assessment of the noise and vibration effects associated with the construction and operation of the Project. In particular, this report:

- Establishes the relevant noise and vibration limits for the site set out in the Auckland Unitary Plan (AUP), as well as in the existing CI and Grey Lynn Tunnel designations and suite of resource consents which Watercare is currently operating under for those respective projects;
- Identifies the construction activities that will generate noise and vibration;
- Identifies nearby receivers;
- Predicts the construction noise and vibration levels at identified receivers and determines compliance with relevant noise and vibration limits;
- Discusses potential noise and vibration effects;
- Discusses the reasonableness of these effects; and
- Provides recommendations to avoid, remedy or mitigate these effects.

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

This report has been prepared in accordance with T+T's proposal dated 16 November 2022.

2 Project details

2.1 Project purpose and overview

Watercare is proposing to extend the Central Interceptor wastewater conveyance and storage tunnel from Tawariki Street in Grey Lynn to a new terminal shaft in Point Erin. The tunnel extension will ensure combined overflows are picked up and conveyed to Māngere Wastewater Treatment Plant for safe treatment, reducing overflows to the environment and improving the quality of waterways and swimmable beaches by 2028.

The Project involves the construction, commissioning, operation and maintenance of a wastewater interceptor and associated activities at Point Erin Park in Herne Bay. The Project can be broken into two distinct parts:

- The wastewater interceptor tunnel which runs from Tawariki Street in Grey Lynn to Point Erin Park in Herne Bay; and
- The Point Erin Park shaft site.

These are described in further detail below (as relevant to this assessment).

2.2 The Point Erin tunnel

The Point Erin tunnel runs from Tawariki Street in Grey Lynn to Point Erin Park in Herne Bay over a length of up to approximately 1.6 km. The tunnel is located entirely below ground at depths typically between 20 m – 60 m and will reach its shallowest point of 17 m as it enters the Point Erin Park where the proposed terminal shaft is located[1]. There are no surface works required for the tunnel.

Excavation of the tunnel will continue using the existing CI Tunnel Boring Machine ("**TBM**"). As well as currently being used to construct the CI tunnel, this type of machine has been successfully used in Auckland in similar ground conditions on Project Hobson, the replacement of the Rosedale Wastewater Treatment Plant Outfall and the Waterview Connection. Construction spoil from the tunnel will be taken back down the CI tunnel and removed at the existing consented/designated CI May Road construction site and does not form part of this assessment.

The general alignment of the tunnel is shown in Figure 2.1.

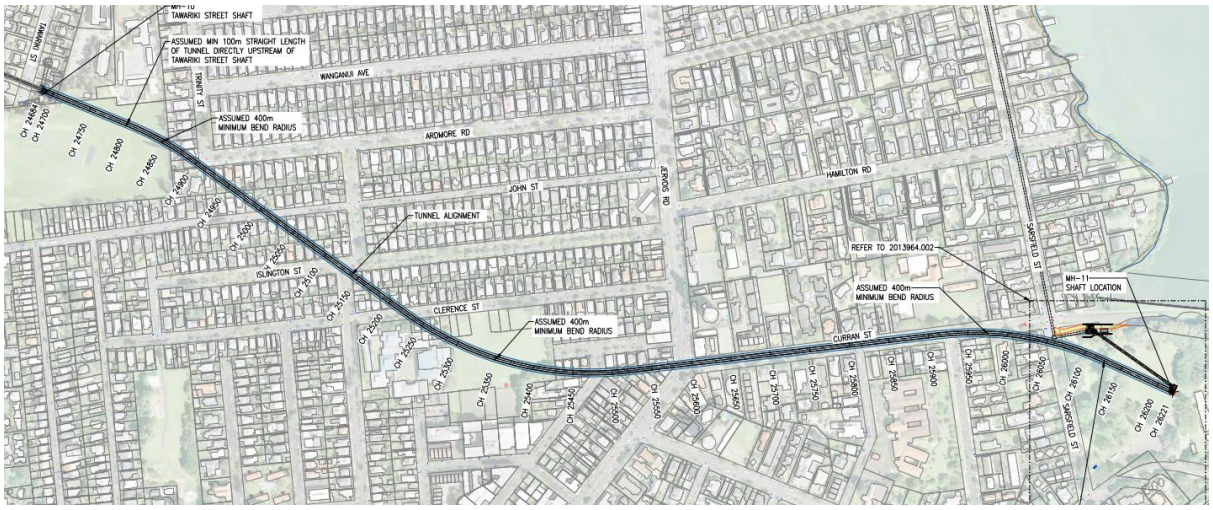

Figure 2.1: Point Erin Tunnel general alignment

[1] Depth to invert which is the depth to the bottom inside of the pipe.

2.3 The Point Erin Park Shaft Site

The works at the Point Erin Shaft Site are proposed to occur in two discrete locations within the park:

- The terminal shaft and associated construction area is proposed to be located in the grassed area immediately to the south of the Point Erin Pools (referred to as the main construction area); and
- The control chamber, plant room and associated construction area is proposed to be located towards the southwest corner of Point Erin Park near the intersection of Curran and Sarsfield Streets (referred to as the southwestern construction area).

The proposed general layout for these activities is shown in the below image:

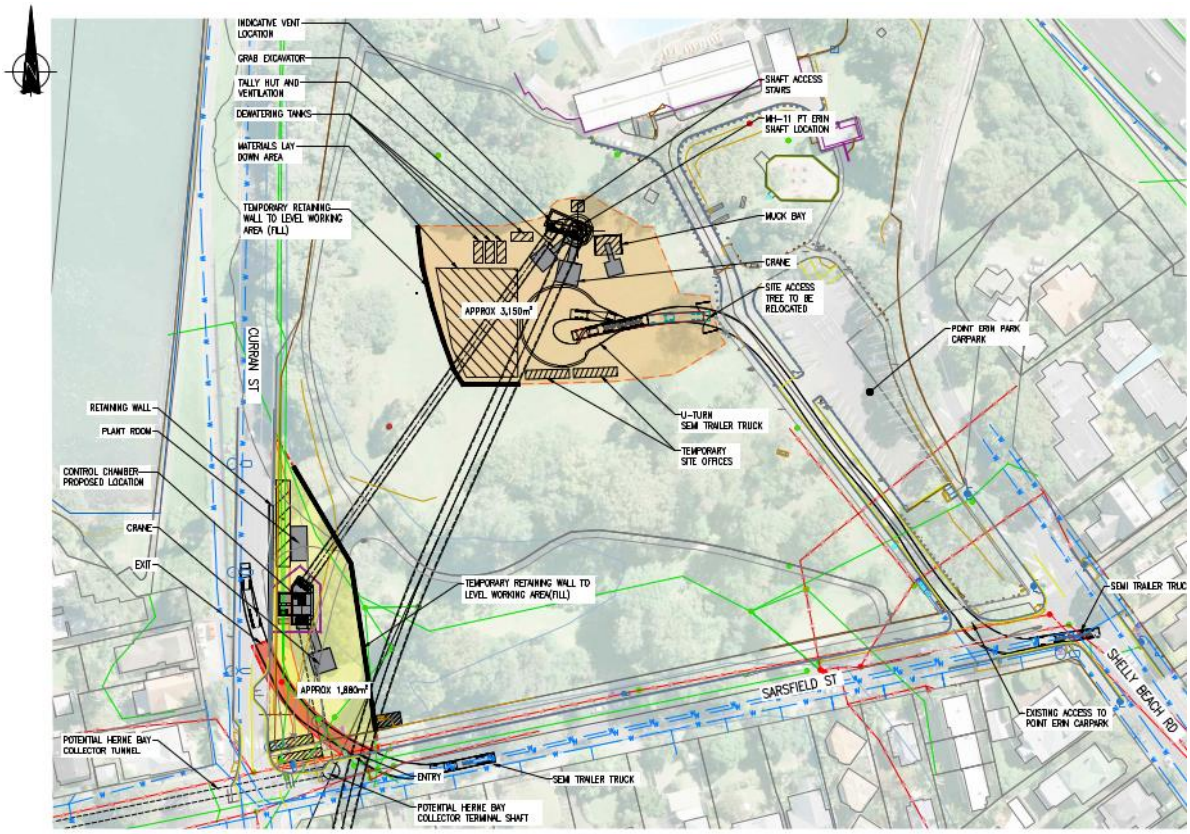

Figure 2.2: Point Erin Park general layout (main construction area shown in orange and south western construction area in yellow)

The Project works within the above mentioned locations in Point Erin Park broadly comprise:

- The construction of infrastructure including a control chamber and plant room, and a terminal shaft for removal of the CI TBM;
- Earthworks of approximately 5,000 m^2 in total across the two construction areas (approx. 3,150 m^2 in the grassed area to the south of the Point Erin Pools and approx. 1,880 m^2 in the south-western corner of the park);
- Tree works (pruning, works in the root zone, removal, relocation);
- Temporary works including retaining walls to create level working areas, site access and internal circulation, and Contractor's site compound;

- Transport movements including delivery of plant and construction materials, removal of material excavated during the construction of the shaft and control chamber, and removal of the TBM; and
- Park reinstatement and landscaping following completion of construction works.

The Project has been developed to a concept design stage. As it moves through the detailed design process and as construction methodology is confirmed, it is likely that some details will change but remain within the envelope of effects assessed in this assessment. All figures and dimensions provided are approximate and will be confirmed during the detailed design stage.

2.4 Construction Timeframe

2.4.1 Indicative construction programme

The TBM is expected to arrive at Tawariki Street in February 2025 and at Point Erin in May 2025 (noting timeframes may change as the TBM progresses along the CI alignment). Ideally, construction works at Point Erin will commence at least 12 months prior to the expected arrival of the TBM at Point Erin, i.e. site establishment in the first half of 2024.

The CI terminal shaft construction is expected to occur over a 6 month period from around September 2024 to February 2025 potentially followed by a hiatus of a few months due to the time taken for the TBM to arrive at the shaft site. This will be followed by approximately 9 months of activity from May 2025 to February 2026 to remove the TBM and complete the internal structure of the main shaft.

The chamber construction is anticipated to take appropriately 9 months (indicatively from around January 2025 to October 2025).

The shaft and chamber are likely to be constructed separately; although, there is the potential there may be some cross over in the construction programme with the programming of works determined by the Contractor.

Overall construction works at Point Erin are expected to take approximately two years (i.e. around 2024 to mid-late 2026), although it may take longer depending on the TBM's progress and other factors such as supply chains and resourcing (e.g. up to three years). It is relevant to note that construction will not be continuous over this full duration, rather there is likely to be periods of more intensive or less intensive construction and then 'quieter' periods, for example when waiting for the arrival of the TBM.

The Point Erin Extension project is expected to be completed mid to late 2026, with the northern section of CI including the Point Erin Extension expected to be commissioned in 2026/2027.

2.4.2 Working hours

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

- Monday to Friday: 7 am to 6 pm;
- Saturdays: 8 am to 6 pm; and
- Tunnelling activities will occur 24 hours a day, 7 days a week.

Due to the nature of construction and the Project's timeline, it is likely that some activities will be undertaken outside these usual hours, for example during summer daylight savings periods and under certain circumstances as detailed below.

2.4.3 Works outside of standard construction hours

Works outside of standard hours will be limited as far as is practicable but activities outside of standard hours may be required on occasions, similar to existing CI sites. The consent conditions for CI specifically provide for works to occur outside of standard hours for the following activities and scenarios[2]:

- Where, due to unforeseen circumstances, it is necessary to complete an activity that has commenced;
- Where work is specifically required to be planned to be carried out at certain times e.g. to tie into the existing network during periods of low flow, or to tie into tidal cycles for works in the CMA;
- For delivery of large equipment or special deliveries required outside of normal hours due to traffic management requirements;
- In cases of emergency;
- For the securing of the site or the removal of a traffic hazard; and/or
- For any other reason specified in the Construction Management Plan or Traffic Management Plan.

Consistent with the existing CI consents, these are reflected in the proposed conditions of consent for the Point Erin Tunnel contained in Appendix A of the AEE.

Works and activities outside of standard construction hours typically occur intermittently and for a limited period of time. Recent examples at other CI sites include:

- Overpumping and/or dewatering activities at the Miranda Reserve[3], Pump Station 25[4] and Haycock Avenue[5] CI sites in order to provide temporary sewer diversions and removal of water from shafts. Overpumping and dewatering occurred for 24 hours a day, 7 days a week for durations between 1 and 4 months (depending on the location). Based on receiver locations and equipment positioning for each site, predictions were undertaken to identify mitigation required to meet the night time limit of 45 dB L_{Aeq}. Trial noise monitoring was carried out to check compliance with night time noise limits and ensure these could be achieved prior to seeking Auckland Council approval. Mitigation such as barriers and enclosures were employed to reduce noise levels and achieve compliance with the night time noise limits, alongside stakeholder notification.
- Concrete pours typically last 1 night (e.g. at May Road[6]) with continuous pours required into standard hours or vice versa depending on the size of pour required and traffic considerations. Monitored noise levels were no more than 50 dB L_{Aeq}. Consultation with surrounding dwellings was a key mitigation measure and ensured disruption to neighbouring properties could be minimised. On occasions, longer durations were required as below:
  - Concrete pours for secant pile were expected to be required after 6pm, over a period of 1.5 months, due to possible unforeseen circumstances and the need to continue the activity after a pour has started (Haycock Avenue[7]). Mitigation included restrictions of no new piles after 3:30 pm to minimise the chance of works extending beyond 6pm and no other noisy activities after 6 pm. Every effort was made to finish works before 6pm and advance notification was provided to stakeholders.

[2] Subject to five working days' notice to council for authorisation prior to work commencing.
[3] Permit number 900-046 – Pumping for shaft water discharge.
[4] Permit number 900-047 – Over pump of sewer line.
[5] Permit number 900-015 – Removal of water from shaft (dewatering).
[6] Permit number 900-080 – Night time concrete pour.
[7] Permit number 900-002 – Secant pile concrete pours.

  - Continuous concrete pours were required for the shaft at Mount Albert War Memorial[8]. To enable completion of these works during daytime hours (before 6pm), two permits were required: one for preparation of concrete pours which started one hour before the standard shift and one permit to enable continuous operation on site outside of site restrictions[9] for a period of 4 days.

- Large machinery or material delivery requires road closure due to oversized equipment and parts. At Greenwood Road[10] the use of an oversized load truck and escort were required for TBM delivery which generated minimal noise and was below ambient sound levels for 3 nights. At Walmsley Park, delivery of liners arrived before 7am but unloading was carried out after 7:30 am to reduce noise disturbance and ensure compliance with the relevant permitted noise limits.
- CCTV inspections (Closed Circuit Television Video) have to be carried out during periods of lower flows. CCTV inspections have been required across Haycock Avenue, Pumpstations 23 and 25[11] for 1 night involving the use of a CCTV van. Little to no noise was generated but communication with stakeholders (notice to inform them of the works) was provided prior to works being undertaken.

Experience on existing CI sites shows that it is likely that overpumping, concrete pours and dewatering of the shaft and chamber may be required outside of standard hours. These activities have therefore also been provided for in the proposed draft conditions of consent attached to the AEE. An assessment of undertaking these additional activities (concrete pours, over-pumping, and dewatering) outside of standard working hours is included in Section 5.3.3.2 below. Activities for delivery of machinery/equipment and CCTV inspections have not been assessed as they are low risk and likely to be within permitted noise levels.

Works outside standard construction hours will be detailed in the Project's Construction Noise and Vibration Management Plan (CNVMP) and/or an Activity Specific Construction Noise and Vibration Management Plan (ASCNVP). Where exceedances are predicted as set out in this report, activity specific sections in the CNVMP will identify appropriate management and mitigation measures (i.e. adopting the best practicable option (BPO) to minimise potential adverse effects). More broadly this process will also involve seeking Auckland Council certification prior to the works and adoption of appropriate mitigation, such as communication with surrounding properties, the use of acoustic barriers and other practicable controls such as locating the works away from dwellings to achieve appropriate noise levels. Experience on CI to date has shown that this approach appropriately ensures a BPO approach is taken to the management of these activities.

2.5 Operation of infrastructure

The plant room will be operational 24 hours a day, 7 days a week.

An air vent located by the shaft will also be required for continuous air entry into the tunnel for ventilation purposes. The operation of the air vent is addressed in the Air Quality Assessment contained in the appendices to the AEE. However the air exhaust will be passive and any ventilation is only expected during periods of severe wet weather.

[8] Permit numbers 900-068, 900-069 – Concrete pours outside standard hours and restricted hours.
[9] Permit number 900-010 – TBM delivery.
[10] Permit number 900-035 – CCTV.

3 Performance standards

3.1 Introduction

The Auckland Unitary Plan Operative in Part (AUP)[12] sets out noise standards for permitted activities. If noise above those limits is generated, then a resource consent is required.

In addition to this, there is a general duty under section 16 of the RMA to avoid unreasonable noise.

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

This section identifies the relevant performance standards applicable for the Project.

3.2 Auckland Unitary Plan zoning

The Project site at Point Erin Park is located within the Open Space Zone as defined in the AUP. Neighbouring land is zoned for residential uses and subject to the residential zone noise limits as set out in the AUP, and the Strategic Transport Corridor Zone which applies to the State Highway network, as shown in Figure 3.1.

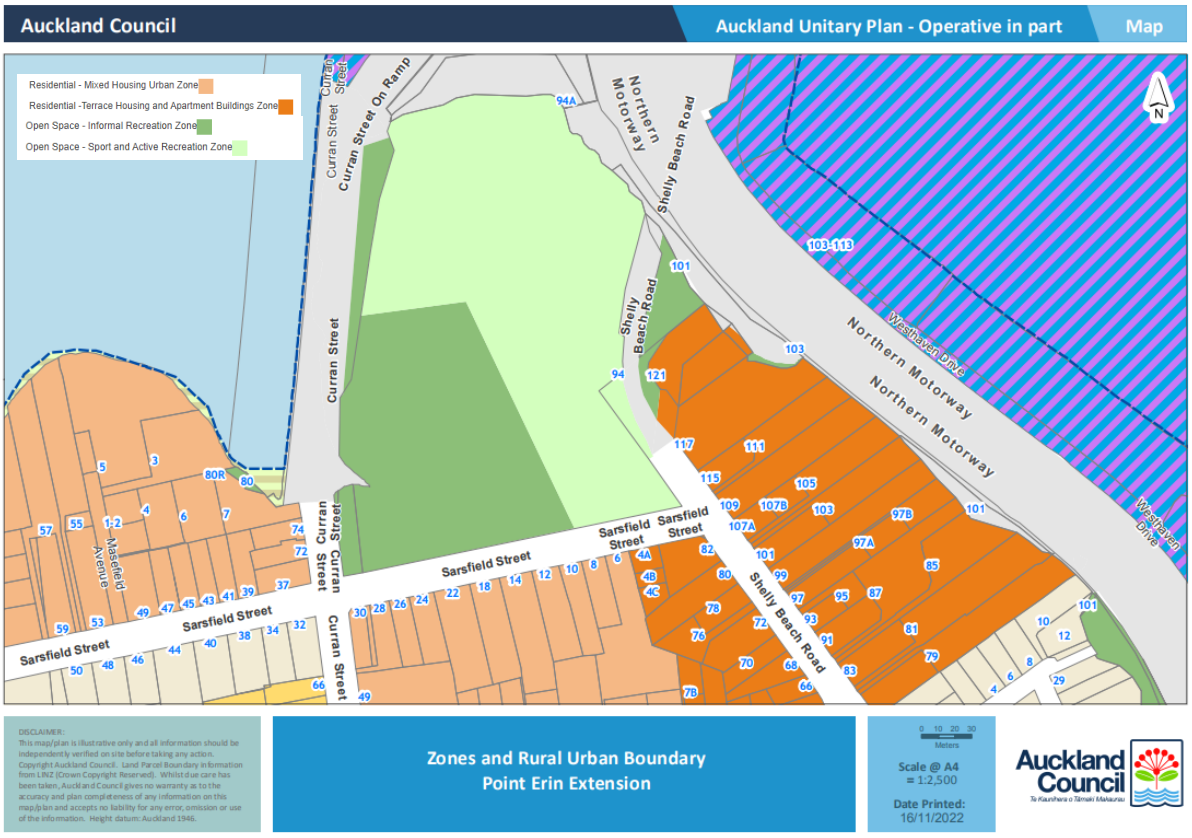

Figure 3.1: Auckland Unitary Plan Zoning map Source: https://unitaryplanmaps.aucklandcouncil.govt.nz/upviewer/

[12] AUP, Chapter E Auckland-Wide Built Environment - E25 Noise and Vibration

The interceptor tunnel alignment will traverse underneath residential, special purpose, business, road and open space zones from Tawariki Street to the Point Erin Park site (refer main AEE for detailed zoning description).

3.3 Construction noise

Rule E25.6.1(3) of the AUP states that "*The noise from any construction activity must be measured and assessed in accordance with the requirements of New Zealand Standard NZS6803:1999 Acoustics – Construction noise*".

Rules E25.6.27(1) and E25.6.27(2) respectively contain construction noise limits for activities sensitive to noise (residential receivers) and for any other activity (commercial receivers).

In accordance with E25.6.27(4), projects with a construction duration of more than 20 weeks are to include a 5 dB reduction to the noise limits in E25.6.27(1). The applicable construction noise limits with the required 5 dB reduction applied (in accordance with NZS6803) are detailed in Table 3-1 for residential receivers and Table 3-2 for non-residential receivers.

Table 3-1: Construction noise limits for residential dwellings

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

Table 3-2: Construction noise limits for any other activities

Time Period	Maximum noise levels (L_{Aeq} dB)
7:30 am – 6:00 pm	70
6:00 pm – 7:30am	75

3.4 Operational noise

Standard E25.6.2(1) of the AUP states noise from any activity within the residential zone adjacent to Point Erin Park must not exceed the limits in Table E25.6.2.1 as reproduced in Table 3-3 below[13].

Table 3-3: AUP Table E25.6.2.1 Noise levels in residential zones

Time	Noise level
Monday to Saturday 7am – 10pm	50 dB L_{Aeq}
Sunday 9am – 6pm	
All other times	40 dB L_{Aeq} 75 dB L_{Afmax}

3.5 Vibration from construction activities

The AUP contains rules relating to construction vibration that cover both building damage and amenity limits[14]. Rule E25.6.30 states that construction activities must be controlled to ensure any resulting vibration does not exceed:

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

b The limits set out in Table E25.6.30.1 [see Table 3-5] in buildings in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500 mm of ground level at the foundation of a single storey building.

3.5.1 Structural vibration

3.5.1.1 DIN 4150-3:1999

The German Standard DIN 4150:1999[15] '*Structural Vibration – Part 3: Effects of Vibration on Structures*' is an internationally recognised standard used to assess the effects of vibration on structures. The Standard is commonly used across New Zealand and, as set out above, is adopted by the AUP. The DIN 4150-3:1999 criteria to evaluate the effects of short-term vibration on structures are shown in Table 3-4 and summarised in Figure 3.2. Short-term vibration is vibration that does not induce resonance in a building structure.

The table and figure show the recommended vibration limits in terms of Peak Particle Velocity (PPV) for potential for damage to structures. They are lowest in the frequency range of 1-10 Hz, which is the normal range of natural frequency of most structures. The limits increase at higher frequencies where the potential harmonic effects are reduced. The guideline values for PPV are at the foundation and in the plane of the highest floor of various types of building.

[13] There is no operational noise associated with underground infrastructure such as the Point Erin Tunnel.
[14] There are no sources of potential vibration post-construction.
[15] Superseded by latest version DIN 4150-3:2016

Table 3-4: DIN 4150-3 :1999 guidelines for evaluating the effects of short-term vibration on structures

Line	Type of structure	Vibration at the foundation at a frequency of			Vibration at horizontal plane of the highest floor
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20 mm/s	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or occupancy	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

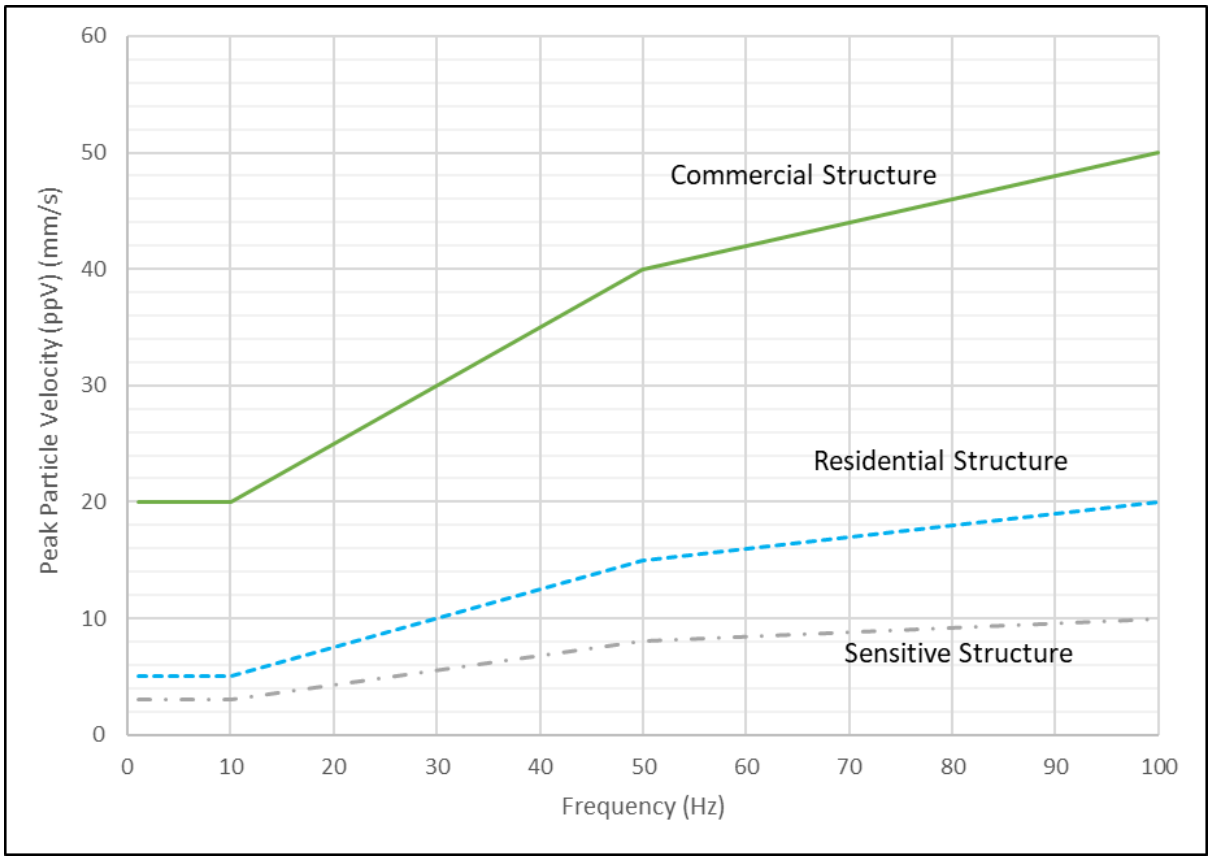

Figure 3.2: DIN 4150-3 Short-term standard baseline curves.

DIN:4150-3 gives further context to the guideline values:

> *"Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible. Exceeding the values in table 1 does not necessarily lead to damage; should they be significantly exceeded; however, further investigations are necessary."*

For the structures listed in lines 2 and 3 of Table 3-4, the serviceability is considered to have been reduced if:

- Cracks form in plastered surfaces of walls;
- Existing cracks in the building are enlarged; and
- Partitions become detached from loadbearing walls or floors.

These effects are deemed 'minor damage'.

The limits recommended in DIN 4150-3 provides a low probability of cosmetic damage. In reality, structural damage (i.e. not cosmetic damage) is unlikely to occur in both residential and commercial structures at less than 50 mm/s, and for in-ground structures and infrastructure services at less than 100 mm/s.

It is also relevant to note that vibration is not the only potential cause of cosmetic damage to buildings. As set out in the Groundwater Report attached to the AEE, natural seasonal fluctuations in groundwater and associated ground settlement may also contribute to minor damage.

3.5.2 AUP amenity vibration limits

The relevant AUP amenity limits are set out in Table 3-5 below.

Table 3-5: AUP Table E25.6.30.1 Vibration limits in buildings (amenity values)

Receiver	Period	Peak Particle Velocity (PPV) mm/s
Occupied activity sensitive to noise	Night-time 10 pm to 7 am	0.3
	Daytime 7 am to 10 pm	2.0
Other occupied buildings	At all times	2.0

AUP Rule E25.6.30 includes an allowance for up to 5 mm/s PPV being received between 7 am and 6 pm for no more than three days provided that occupants within 50 m are advised at least three days prior to works commencing.

3.5.3 Human vibration perception within buildings

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

Low levels of vibration can cause fixtures and fittings, such as door and windows, to rattle and the noise that is sometimes generated by the 'rattling' can draw an individual's attention to the original source of the vibration. Humans perceive vibration at much lower magnitudes than the levels of vibration that are likely to cause building damage and as such homeowners are likely to complain about vibration significantly below the levels likely to result in cosmetic damage of buildings.

Within New Zealand there are no national vibration standards for the effects on human exposure within buildings, however, it is accepted practice to apply the guidance from British Standard BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* (BS 5228-2)[16].

3.5.3.1 BS 5228-2

British Standard BS 5228-2[17] discusses vibration levels at which adverse comment is likely from building occupants. The guidance values of Table B.1 of BS 5228-2 are provided in Table 3-6.

Table 3-6: Guidance on effects of vibration levels (after Table B.1 of BS 5228-2:2009)

Vibration level (PPV)	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction[18]. At lower frequencies[19], people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.

3.6 Night time regenerated noise - AS/NZS 2107:2016

The TBM operates 24 hours, 7 days a week and will be operating beneath dwellings during the night time period (albeit at significant depths, ranging from a minimum of 20 m and up to 60 m deep). For internally regenerated ground-borne noise, the noise limits as specified in NZS 6803 are not applicable as construction noise levels are determined at a distance of 1 m from an external facade. Australian/New Zealand Standard 2107:2016[20] provides recommended design criteria for conditions affecting the acoustic environment within occupied spaces. For dwellings near major roads (State Highway 1) an internal level of 35 to 40 dB L_{Aeq} is recommended[21] for sleeping areas at night. For dwellings in suburban areas or near minor roads (Sarsfield Street), an night time internal level of 30 to 35 dB L_{Aeq} is recommended.

As the proposed tunnel is expected to be within the same parameters and utilise the same equipment as existing CI works, a regenerated noise criterion of 35 dB $L_{Aeq(15min)}$, as adopted for other stages of CI works[22] and as recommended in AS/NZS 2107, is appropriate for this Project.

[16] The previous version of this standard is referenced extensively throughout NZS 6803 as a method for predicting the noise levels from specific construction activities. The current version is considered appropriate.
[17] BS 5228-2:2009+A1:2014, Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration
[18] Generally below 100 Hz
[19] Generally below 10 Hz
[20] AS/NZS 2107:2016 – Acoustics – Recommended design sound levels and reverberation times for building interiors
[21] AS/NZS 2107:2016, Table 1 Item 7
[22] Appendix L, Grey Lynn Tunnel Assessment of noise effects, Marshall Day Acoustics, Rp 002 20180726, 13 Feb 2019

3.7 Existing CI consent limits

The CI project was granted consent in 2013 and construction commenced in 2019. The Grey Lynn Tunnel section was consented in 2019.

The requirements relating to construction noise and vibration are set out in the CI Grey Lynn Tunnel Designation 9468 (conditions 3.1 to 3.9) and CI Designation 9466 (conditions 3.2 to 3.11) and Resource Consents (conditions 1.11 to 1.21) and reproduced in Table 3-7 below.

These construction noise limits are more stringent than the permitted activity levels for construction noise in the AUP outside of daytime working, i.e. the night time limit of 45 dB L_{Aeq} applies at all times rather than the relevant early morning or evening shoulder-period noise limits of the AUP. More recent consents issued for projects associated with CI, including the CC9 project, set noise limits which align with the permitted activity standards for construction noise in the Auckland Unitary Plan. Requiring compliance with the AUP permitted activity standards and the limits set out in *New Zealand Standard NZS6803:1999 Acoustics – Construction noise* is considered to be appropriate for this Project.

Table 3-7: Existing CI construction noise limits

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

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

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

Watercare is currently seeking to amend Condition 3.8 of the Grey Lynn Tunnel designation (ID 9468). Whilst some vibrations may be just above the vibration limits set out in the AUP, low-level vibrations are generally considered acceptable and can be tolerated provided that prior warning and explanation of the operation are provided to the residents. As such, requiring written approval for exceedances of a permitted activity standard is not considered to be appropriate. Instead, Watercare proposes to consult with adjacent properties and offer building condition surveys to property owners where limits are expected to be exceeded.

4 Exisiting environment

4.1 Point Erin Tunnel alignment

The Project alignment passes through the urban environment of the Auckland Isthmus, beneath a range of urban land uses in Grey Lynn and Herne Bay[23].

Land uses along the southern half of the tunnel alignment include residential dwellings, local businesses and a commercial area focused along the Jervois Road ridge line, a number of schools and the road network.

The northern half of the alignment is largely contained within the Curran Street road corridor which is bordered by adjacent residential and business land uses.

The Herne Bay end of the tunnel is located in Point Erin Park which is located on a coastal headland looking out towards the Waitematā Harbour with the Auckland Harbour Bridge located immediately to the north of the park.

4.2 Point Erin Park

4.2.1 Site description

Point Erin Park is owned by Auckland Council and covers an area of approximately five hectares. The park comprises a large area of grassed open space which is used for a variety of passive and active recreation uses and also contains a number of mature trees. A key feature of Point Erin Park is the Point Erin Pools, which dominate the northern portion of the park. There are a number of other amenities inside the park including a children's playground, car parking, a toilet block, basketball half-court, paved walking/cycling paths and picnic tables and seating. A dense and mature area of predominantly native trees which is identified as a Significant Ecological Area (SEA) in the AUP is located along the northern bank / cliff face of the headland. The SEA and the northern part of the Point Erin Pools are also identified as a Site and Place of Significance to Mana Whenua.

Vehicle access to the park is from Sarsfield Street which forms the southern boundary of the park. The park is bounded by Curran Street and the SH1 onramp to the Auckland Harbour Bridge on its western boundary, and the SH1 Shelly Beach Road offramp on its eastern side.

Masefield Beach and Reserve is located immediately to the west of Curran Street. The surrounding areas of Herne Bay and St Mary's Bay comprise predominantly residential dwellings of varying scale, typically between one to three storeys in height. Ponsonby Primary School is also located on Curran Street approximately 80 m south of the Project site at is closest point.

4.2.2 Existing noise environment

To gain an understanding of the existing environmental noise for dwellings in close proximity to the Point Erin construction site, attended noise measurements were carried out on 2 November 2022 between 1 pm and 3 pm during off peak traffic hours. This period is considered to be representative of the off peak noise environment and provides a more conservative basis for the assessment below (noting that road noise is the main contributor to the existing noise environment and this will be higher during the peak morning and evening period).

Monitoring was undertaken using a 01dB Fusion (Serial 12113) sound level meter (SLM), mounted on a tripod at a height of 1.5 m above ground level, at five locations around Point Erin Park. Monitoring locations were considered representative for receivers overlooking the Point Erin Park Shaft site.

[23] Refer to Appendix C of the AEE which shows properties overlying the tunnel alignment.

The weather conditions at the time of survey were clear skies with a light breeze within allowable weather parameters as prescribed in NZS 6801:2008. The SLM was calibrated before and after the measurements with no significant drift recorded.

Figure 4.1: Monitoring locations

It was observed that the noise environment around Point Erin Park is dominated by traffic noise from the local roads - Curran Street, Sarsfield Street and Shelly Beach Road and the State Highway was clearly audible from all monitoring locations.

Table 4-1: Monitoring results

Monitoring location	Time start	Duration	L_{Aeq}, dB	L_{max}, dB	L_{A90}, dB	Observations
Loc 1	13:26	15 mins	68	87	56	Motorway was audible and the dominant noise source. 50 cars were observed during the monitoring period.
Loc 2	13:46	15 mins	65	89	55	Constant car noise dominant along Curran Street & Sarsfield Street. Birds were audible in-between car movements.

Monitoring location	Time start	Duration	L_{Aeq}, dB	L_{max}, dB	L_{A90}, dB	Observations
Loc 3	14:03	15 mins	61	75	53	Motorway audible – dominant source. Constant car movements along Sarsfield Street.
Loc 4	14:20	15 mins	64	77	54	Car noise dominant – around 150 cars observed during monitoring period.
Loc 5	14:37	15 mins	63	76	52	Car noise dominant – around 130 cars observed during monitoring period.

The noise levels recorded ranged between 61 – 68 dB L_{Aeq} and are well above the AUP residential noise limit of 50 dB L_{Aeq} by more than 10 dB. However, the recorded ambient noise levels are typical for areas near a State Highway slip road and with passing traffic on local roads.

It is anticipated that night time noise levels in this area will also be elevated above the relevant AUP noise standards (40/45 dB L_{Aeq}), especially during the early morning period before 7 am and after 10 pm due to commuter traffic. Whilst night time monitoring has not been carried out for this Project, elevated noise levels above 40/45 dB L_{Aeq} for the area are supported by previous monitoring carried out on a similar Watercare project at St Mary's Bay[24]. The monitoring at St Mary's Bay was carried out over a one week period in 2017 which showed traffic noise from SH1 was the dominant source and background levels during the night ranged between 42 – 47 dB L_{A90}. Since traffic volumes along SH1 would have likely increased since this monitoring took place, the noise levels would also be slightly higher in 2022.

4.2.3 Sensitive receivers

Residential receivers that may potentially be adversely affected by noise from construction at the Point Erin Shaft site have been identified in Table 4-2 and Appendix A to this report. The distance to the nearest surface works at Point Erin Park and the type of works have also been provided. Receivers over 100 m from any surface works have not been included due to no predicted exceedances at these distances.

As noted above, for tunnelling works all receivers are more than 18 m from the proposed TBM alignment and no potential noise or vibration exceedances are predicted. A list of property addresses where the TBM alignment is proposed to pass directly beneath buildings is provided in Appendix B the AEE.

Table 4-2: Potential sensitive receivers

Nearest construction activity	Address	Distance to nearest surface works (m)
Chamber construction	1-3/7 Masefield Avenue	54
	3/3 Masefield Avenue	96
	70 Curran Street	31
	72 Curran Street	23

[24] St Marys Bay Masefield Beach Water Quality Improvement Project, Noise and Vibration Assessment of Effects, Aurecon, Ref 255303 Rev 8, April 2018

Nearest construction activity	Address	Distance to nearest surface works (m)
	74 Curran Street	21
	30 Sarsfield Street	53
	34C Sarsfield Street	68
	32 Sarsfield Street*	59
	28 Sarsfield Street*	53
	26 Sarsfield Street	56
	24 Sarsfield Street	62
	22 Sarsfield Street	77
	18 Sarsfield Street	91
Shaft Construction	94 Shelly Beach Road (Pool Building)	20

* Identified as Special Character Areas Overlay within AUP but not listed as Heritage building

5 Noise and vibration assessment

5.1 Existing experience and approach to assessment

The Central Interceptor project was granted consent in 2013 and construction commenced in 2019. Since this time, the CI project team has established all of the major CI construction sites along the main CI tunnel and link sewer alignments. Over half of the main CI tunnel has been completed (southern section), Link Sewer C is almost complete and most of the 17 shafts along the CI alignment have been built. These works-to-date includes a number of sites located within public parks and reserves (e.g. Keith Hay Park, Western Springs, Miranda Reserve, Rawalpindi Reserve, Mt Albert War Memorial Reserve) and in close proximity to houses.

Given the significant progress already made towards constructing the CI tunnel in Auckland, the activities and effects of construction are well understood. The CI project team's experience over the past three years has demonstrated that the effects associated with the construction of the CI tunnel, including noise and vibration effects, can be successfully managed through conditions and the suite of management plans approved by Council for the current construction sites which ensure a BPO approach.

A preliminary assessment of construction noise and vibration has been based on an indicative construction methodology informed by the CI Shaft and Chamber construction works for the Grey Lynn Tunnel and Tawariki Street Shaft Site[25] and other existing CI sites for a worst-case scenario. A detailed construction programme and methodology will be finalised prior to the commencement of construction activities at Point Erin. It is anticipated this will be prepared by the Contractor and incorporated into the Project's CMP consistent with ongoing CI works. However, this noise and vibration assessment is heavily informed by practical on-the-ground experience gained through the CI project to date, including directly comparable experience in relation to the type of works (tunnel and shaft) and location of works (in a park in proximity to houses). This provides a solid 'real-world' basis for understanding the nature of activities at Point Erin, the actual and potential noise and vibration effects of those activities, and how the effects are best managed and mitigated to cause the least disruption to surrounding residents and to minimise environmental effects. A conservative approach based on existing data has been adopted for this assessment, such that the finalised methodology will likely result in lower effects than presented in this report.

5.2 Point Erin Tunnel

5.2.1 Source information

There are no surface works required for the tunnel alignment, as such only regenerated noise and vibrations levels have been assessed.

Equipment information for the CI TBM have been sourced from previously approved CI vibration reports[26]. The CI TBM is expected to operate at a rate of around 10 – 20 m per day.

5.2.2 Predicted vibration levels

The tunnel alignment is proposed at a depth where East Coast Bays Formation (ECBF) rock[27] is continuously present, i.e. similar to the main CI alignment. Vibration assessment and testing of

[25] Grey Lynn Tunnel, Notice of Requirement, Resource Consent Application and Assessment of Environmental Effects, Jacobs, IZ027500-709-NP-RPT-001, Feb 2019

[26] Central Interceptor, Vibration Assessment for Main tunnels and link sewers, Tonkin & Taylor Ltd, July 2012; Grey Lynn Tunnel, Vibration assessment of Grey Lynn Tunnel and Tawariki Street Shafts, Jacobs, Rev No3, April 2019

[27] Tawariki St to Point Erin CI Project. Stage 1: Screening-level Assessment of Effects, Tonkin + Taylor Ltd, Dec 2022, Ref 30552.9081

ground conditions carried out by T+T[28] for the original CI locations identified a best fit ground attenuation for vibration along the Auckland alignment in the form of $PPV = 9.26(d)^{-1.44}$ where d is distance from the source to the receiver.

Based on this relationship, a vibration level of 0.2 mm/s PPV is predicted at 17 m.

This finding is supported by vibration monitoring[29] carried out in St Marys Bay for a similar Healthy Waters project when the TBM was passing directly underneath a dwelling between 12 – 17 m below ground surface level. Vibration was not perceptible at the time of measurements and recorded levels were less than 0.1 mm/s PPV. As measurements show lower levels than predicted, the above equation is therefore still considered appropriate for this Project to predict reasonable vibration risks levels. It should be noted that other large infrastructure projects in Auckland such as City Rail Link using a larger TBM at shallower depths have not resulted in any significant vibration issues with management practices in place. This provides assurance that vibration from operation of the TBM will likely be imperceptible (see Table 3-6) at a depth of 17 m.

The tunnel is located entirely below ground at depths typically between 20 m – 60 m and will reach its shallowest point of 17 m as it enters the Point Erin Park where the proposed terminal shaft is located. The closest receiver (30 Sarsfield Road) is located approximately 23 m above the tunnel near Point Erin Park[30]. Other receivers along the tunnelling alignment are generally between 35 – 60 m above the tunnelling works.

Potential residential and commercial receivers along the alignments, with the distance (to the top of the pipe) and predicted vibration levels are provided in Table 5-1.

Table 5-1: Predicted vibration levels at receivers - Tunnelling

Type	Receiver	Depth to invert	Approx vertical distance to top of pipe	Predicted PPV
Residential	30 Sarsfield Street	23 m	18.5 m	0.13 mm/s
Residential (Heritage Area)	32 Sarsfield Street	24 m	19.5 m	0.12 mm/s
Residential	31 Emmett Street	35 m	30.5 m	0.07 mm/s
School	Ponsonby Primary School, 44 Curran Street, Herne Bay	41 m	36.5 m	0.05 mm/s
School	Ponsonby Intermediate School, 50 Clarence Street, Ponsonby	40 m	35.5 m	0.05 mm/s
School	Marist School Herne Bay, 82 Kelmarna Avenue, Grey Lynn	35 m	30.5 m	0.07 mm/s
Recording Studio	Stebbing Recording Centre, 108/114 Jervois Road, Herne Bay	60 m	55.5 m	0.03 mm/s

It is predicted that vibration from tunnelling will be negligible and unlikely to exceed the 0.3 mm/s most stringent night time project criterion for all receivers along the alignment. All receivers will experience vibration levels less than 0.15 mm/s PPV, i.e. an imperceptible level of vibration.

[28] Central Interceptor – Vibration Assessment for Main Tunnels and Link Sewers, Tonkin + Taylor Ltd, July 2012, Ref 27993
[29] St Mary's Bay Pipeline, Memo Tunnel Boring Machine (TBM) vibration measurements – 105 Shelly Beach Road, Marshall Day Acoustics, 31 Aug 2022
[30] Depth to invert i.e. to the bottom of the 4.5 m diameter pipe. The top of the pipe will therefore be over 12 m below ground as it enters Point Erin Park, and over 18 m below ground at the closest receiver (30 Sarsfield Road).

A recording studio, Stebbing Recording Centre, has been specifically identified as a potentially sensitive receiver due to the nature of activities within. At the vertical distance of over 55 m from the tunnelling works, a vibration level of 0.03 mm/s is predicted which is well below a 0.06 mm/s PPV construction vibration limit as adopted by other major projects[31] for sensitive recording studios. Vibration levels from operation of the TBM are therefore considered negligible for the recording studio.

5.2.3 Tunnelling regenerated noise

Based on experience from the main CI tunnelling works, a minimum slant distance[32] of 18 m from buildings with bedrooms on the ground floor to the TBM will achieve compliance with a regenerated noise criterion of 35 dB L_{Aeq}.

The vertical tunnel depth between Tawariki Street and Point Erin Park generally ranges between 20 m – 60 m below surface level with the exception of an area in Point Erin Park dipping to 17 m at the shallowest depth of the whole alignment[33]. However, all properties are calculated to have a slant distance of 18 m or greater depth to the top of the pipe and therefore would comply with the 35 dB L_{Aeq} night time criterion for regenerated noise.

At the vertical distance of over 55 m from the tunnelling works, regenerated noise within Stebbing Recording Centre will also be negligible due to the spatial separation between the TBM and building.

5.3 Point Erin Park

5.3.1 Source information

Sound power levels are provided in Table 5-2 below for the likely significant noise sources on site. Façade sound pressure levels at different set back distances, calculated using NZS 6803 principles, are also provided to give an indication of likely noise levels for short term activities.

Equipment data have been sourced from approved CNVMPs[34,35] for CI works similar to this Project. No form of mitigation, such as acoustic barriers or enclosures, has been included within these noise levels and they therefore represent a 'worst-case' scenario. Not all items of construction plant associated with Project will operate simultaneously or within the same area.

Table 5-2: Equipment list – Source data and indicative construction noise levels at different distances (without mitigation)

Activity	Equipment	Sound Power Level (dB L_{WA})	Noise Level (dB L_{Aeq}) at set back distances				Set back distance to achieve 70 dB L_{Aeq}
			10 m	20 m	30 m	50 m	
Shaft / chamber excavation	**Auger Pile rig (Secant pile)**	**114**	89	83	79	74	69
	30t Excavator with vibratory attachment	**116**	91	85	81	76	83

[31] CRL, Mediaworks construction vibration limit in Studio 1 is 0.06 mm/s PPV
[32] The straight line distance between the top of the tunnelling source (below ground) and receiver (building's foundation)
[33] 17 m depth to invert / 12.5 m depth to top of the pipe.
[34] Construction Noise and Vibration Management Plan, Walmsley Park shaft site, CI, Doc No: GAJV-PLN-00038 v0.4
[35] Construction Noise and Vibration Management Plan, Haycock Avenue Shaft, CI, Doc No: GAJV-PLN-00039 v0.4

Activity	Equipment	Sound Power Level (dB L_{WA})	Noise Level (dB L_{Aeq}) at set back distances				Set back distance to achieve 70 dB L_{Aeq}
			10 m	20 m	30 m	50 m	
and construction	**(Sheet Piles – chamber only)**						
	30t Excavator	103	78	72	68	63	25
	15t Excavator	96	71	65	61	56	11
	Concrete truck/pump	103	78	72	68	63	25
	100t Mobile Crane	101	76	70	66	61	20
	250t Mobile Crane (for TBM extraction)	104	79	73	69	64	28
	25t Mobile crane	98	73	67	63	58	14
	50t Crawler crane	100	75	69	65	60	18
	Concrete Saw	115	90	84	80	75	76
	Plate compactor	106	81	75	71	66	33
	Roller	103	78	72	68	63	25
	Franna	103	78	72	68	63	25
	Shaft ventilation	102	77	71	67	62	22
Tree removal	Chainsaw	114	89	83	79	74	69
	Wood chipper	124	99	93	89	84	174
Support	Grout Pump	107	82	76	72	67	36
	3 axle- Trucks	105	80	74	70	65	30
	Dewatering pump	97	72	66	62	57	13
	Generator	103	78	72	68	63	25

Hand tools have the potential to produce relatively high noise levels, however, these are typically used for short durations and are normally straightforward to screen effectively.

The following table shows key equipment likely to generate vibration for the Point Erin site. Vibration data has been sourced from approved CI CNVMPs for similar works.

Table 5-3: Construction equipment generating vibration

Equipment	PPV at 10 m
Large Excavator	3 - 4 mm/s
Vibratory roller	5 – 6 mm/s
Vibratory sheet piles	5 – 6 mm/s
Auger bore piles	1 – 2 mm/s

5.3.2 Assessment methodology

Due to the nature and extent of the proposed works there will be a variety of construction plant used. Table 5-2 lists the expected significant items of plant. It is not feasible to provide an assessment of noise effects from all construction plant that will operate across these works.

In order to provide a reasonable assessment of noise exposure for individual receivers, this assessment has taken the approach of assessing the impact from the main significant noise generating item of construction plant to be used in each activity.

A combination of computer noise modelling and realistic assessments based on CI experience and monitored data are used to predict noise levels, required set back distances and minimum mitigation measures.

5.3.2.1 Noise model

A SoundPLAN computer model (version 8.2) implementing ISO 9613-2:1996 *"Acoustics – Attenuation of sound outdoors – Part 2: general method of calculation"* prediction algorithm has been used to predict noise levels from activities associated with the construction of the Point Erin Shaft and Chamber and operation of the plant room. The noise model takes into account ground contours, ground absorption, terrain, buildings and the location of works. The building footprints have been obtained from the LINZ database and adjusted for the number of floors (assuming 2.8 m height per floor with an average height of 8 m for double storey buildings).

For each receiver, the worst-case noise level has been calculated, which is typically when equipment is operating at the closest location.

The following scenarios have been modelled for the activities closest to receivers, with the construction plant operating 100% on time at the edge of the construction location (i.e. worst case assessment):

- Shaft construction: auger piles – source height of 1.8 m; and
- Chamber construction: sheet piles – source height of 5 m.

It is also recognised that there will be times during the day when there will be no noisy works or minimal noise generating activities. As such, predictions present a worst case to account for any uncertainties in methodology and provide an envelope of effects.

5.3.3 Predicted construction noise levels

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

Grid noise maps are modelled at 1.5 m above ground level in line with noise survey measurements undertaken in accordance with NZS 6801:2008 to enable comparison. As buildings around Point Erin are typically more than one storey high, predicted façade levels may be greater than those shown on the grid noise contours.

Table 5-4 summarises the predicted worst-case noise levels for receivers without screening. Exceedances of the 70 dB $L_{Aeq(15min)}$ project criterion are identified in bold.

Due to the height of the sheet piling rig, effective screening is often difficult to provide for surrounding receivers[36]. For this reason this assessment assumes no screening is effective for the

[36] A 6 m high acoustic barrier would be required to effectively screen sheet piling activities which is considered to be impracticable for this site and potentially cause undesirable visual and shading effects for an extended period of time (relative to the effects of sheet piling which is an intermittent activity). It also has the potential to constrain construction activities such that there are efficiency and safety impacts, which in turn means the period of sheet piling is extended.

majority of receivers near the sheet piling rig (chamber construction), except where other buildings are between the proposed works.

Table 5-4: Maximum predicted noise levels at nearest receivers (1 m from building façade)

Address	Chamber - Sheet pile, dB L_{Aeq}	Shaft - Auger Piles, dB L_{Aeq}
1-3/7 Masefield Avenue	**73**	61
3/3 Masefield Avenue	65	59
70 Curran Street	**74**	57
72 Curran Street	**78***	60
74 Curran Street	**78***	61
30 Sarsfield Street	**71**	59
34C Sarsfield Street	68	56
32 Sarsfield Street	70	58
28 Sarsfield Street	**71**	58
26 Sarsfield Street	70	58
24 Sarsfield Street	69	59
22 Sarsfield Street	67	59
18 Sarsfield Street	68	60
94 Shelly Beach Road (Swimming Pool)	59	**74** (69)[37]

**Denotes that these two receivers may also experience noise levels up to 72 dB $L_{Aeq(15min)}$ for the construction of the retaining wall on the boundary of the park.*

Noisy activities associated with construction of the terminal shaft can be effectively screened using an acoustic barrier around the shaft construction site as indicated in Appendix D. However, it is also noted that the setback of the shaft site from surrounding dwellings (i.e. 100 m to 150 m or greater) effectively mitigates noise associated with activities at the shaft site.

5.3.3.1 Other works

Supporting works and other general construction activities such as the use of excavators, mobile cranes and shaft ventilation is highly unlikely to have a combined sound power level greater than any piling activities assessed above. Without screening, and machinery assumed to operate 100% of the 15-minute assessment period, a minimum set back distance of 40 m is recommended. It is recognised, that realistically, machinery will not be operational 100% of the time within the 15-minute assessment period. With acoustic barriers around both construction sites, placed along the boundary closest to receivers, noise levels can be effectively mitigated to comply with the daytime noise criterion of 70 dB $L_{Aeq(15min)}$.

It is understood a total of 17 trees will be removed as part of the Project across Point Erin Park. Wood chipping will be the dominant noise source for the tree removal activity and receivers located within 80 m of the un-mitigated woodchipper source will likely exceed the noise criterion of 70 dB $L_{Aeq(15min)}$. Common with current CI practice, scheduling of works and noise barriers around the equipment will be employed to mitigate excessive noise levels and work will be undertaken according to best practice. Tree removal activities are likely to be short in duration and consistent with activities in the urban environment (no different to gardening/woodchipping activities undertaken by homeowners). Overall, it is considered noise effects from the tree removal activities

[37] Mitigated (1.8-2 m acoustic barrier) noise level is provided in brackets.

can be effectively managed using practicable measures, such as orientation of equipment and use of temporary barriers. These measures will be set out as an activity specific section within the CNVMP, such that the temporary effects will be less than minor.

Based on experience at other CI sites, retaining wall construction is typically carried out using a 15 t to 20 t excavator with a driven pile attachment. To mitigate potentially elevated noise levels, the pile locations can be pre-drilled before being driven in. For the majority of the proposed retaining wall construction, the closest receiver is located more than 30 m away and is well outside the required set back distance of 11 – 25 m to achieve the noise criterion.

For the proposed retaining wall on the boundary of the park, adjacent to Curran Street, the distance to the nearest receivers is just over 20 m. Assuming a methodology of driven piles, without mitigation these two receivers may experience noise levels of up to 72 dB $L_{Aeq(15min)}$. There may be opportunities to implement mitigation (noise barriers) or to adopt a different construction methodology to reduce the noise level to comply with the daytime noise criterion of 70 dB $L_{Aeq(15min)}$. In any case this is a marginal exceedance of the permitted activity noise limits and can be managed through the CNVMP.

5.3.3.2 Works outside of standard construction hours

Concrete pours for the shaft and chamber construction are a common element to all CI sites and may need to be undertaken outside of standard construction hours (i.e. after 6 pm). As mentioned in Section 2.4.3, the existing CI conditions provide for activities to occur outside of hours, subject to approval by Auckland Council.

Based on previously required concrete pouring at other CI sites, Auckland Council has previously granted 'out of standard hour requests'[38] for concrete pouring on the basis that the activity generates a noise level of less than 50 dB L_{Aeq} when monitored at nearby residential dwellings. This noise level is realistically achievable as demonstrated by CI noise monitoring[39] for this activity. If working outside of standard hours is required for the Point Erin site, a similar process will be adopted for this Project.

This process will involve seeking Auckland Council approval prior to the works and adoption of appropriate mitigation, such as acoustic barriers and other practicable controls such as locating the high speed mixing away from dwellings to achieve a maximum noise level of 50 dB L_{Aeq}.

For Point Erin site, the noise level of 50 dB L_{Aeq} can be achieved with a minimum set back distance of 80 m from any dwelling[40]. Where possible, concrete pouring completed before 8 pm can comply with the daytime limit of 65 dB L_{Aeq}. As the shaft construction site is over 100 m from nearest residential dwelling, noise will be mitigated to less than 50 dB by distance alone[41].

Ambient noise monitoring around Point Erin indicated that noise levels are elevated due to the nearby State Highway when compared to a residential area which does not experience increased traffic noise. Ambient noise environment outside of standard hours will also be elevated and concrete pours are expected to be masked in part by the existing noise environment. Additionally, noise for concrete pours outside of standard construction hours can be effectively managed via activity specific controls and limits in the Project's CNVMP such as those provided in Section 7.1.5.

Dewatering and overpumping of the shaft may also be required outside of standard construction hours and may operate 24/7 to pump out groundwater. Pumping may also be required when tying in the connection to the existing network and when needing to divert the flows around the tie-in.

[38] Outside of 7 am – 6 pm Monday to Friday and 8 am – 6 pm Saturdays – PWOH900-069 May Road Shaft B

[39] Monitoring undertaking during night time concrete pours at May Road, Nov 2022.

[40] The setback distance of the terminal shaft site from surrounding dwellings exceeds this required setback distance.

[41] A sound level of 78 dB at 10 m (source level taken from Table 5-2) will reduce to below 50 dB when assessed at 100 m and allowing for an orientation correction of 3 dB.

Dewatering pumps and shaft ventilation will be located over 100 m from the nearest residential dwelling, which will provide the required mitigation[42]. With barriers in place, noise can be further mitigated for night time works.

5.3.3.3 Construction traffic movements

Although the AUP does not require noise from construction truck movements to be assessed[43], noise impacts have been considered due to the close proximity (less than 30 m) of the south-western construction area to nearby receivers.

The main access to the control chamber site is to be established off Sarsfield Street, with traffic exiting on to Curran Street to enable the efficient movement of excavated material off site. Access to the shaft construction site will be through the existing Point Erin Pool's carpark.

Vehicle movements to the two work sites will be less than 100 vehicles per day.. Existing traffic count[44] data along Sarsfield Street is estimated to be 4,168 vehicles per day with 3.7% heavy vehicle and 8,179 vehicles per day with 8% heavy vehicle along Curran Street. The additional construction truck movements will contribute less than 2% of total traffic movements within the local area.

A change in traffic volume data by +25% or – 20% volume only results in 1 dB change in predicted noise level, which would be imperceptible. As such, additional traffic movements for the Project at less than 2% increase will result in a negligible noise increase.

Spot measurements of the existing environment identified the local environment is already dominated by traffic noise. Construction truck movements will generally by inseparable from general traffic on the existing roads during the day.

As set out in the Construction Traffic Effects Assessment, there may be some circumstances where out of hours traffic movements will be required, including for removal of the TBM. These movements will generally be low speed and will not be a regular occurrence. Again the noise generated by construction vehicles will generally be inseparable from other vehicle movements that may occur in the local area. The noise of these movements will be managed by the CNVMP.

5.3.4 Predicted construction vibration levels

The generation of vibration is dependent on the local site geology, the equipment being used, the nature of the works, and even the operator. To account for this, the likely worst-case vibration has been calculated based on the equipment from Table 5-3 and hard ground geology[45] to provide predicted vibration levels at the closest receivers.

[42] A sound level of 72 dB at 10 m (source level taken from Table 5-2) will reduce to below 50 dB when assessed at 100 m.
[43] The AUP excludes traffic noise – see AUP E25.1. Background.
[44] Estimated traffic counts from Table 3.1, Construction Traffic Effects Assessment, T+T, Nov 2022
[45] Geotechnical report '*Tawariki St to Point Erin CI Project. Stage 1: Screening-level Assessment of Effects, Tonkin + Taylor Ltd, Dec 2022, Ref 30552.9081*' identified ground conditions at piling and excavation depths are a mixture of residual and weathered ECBF (silt and clay (stiff), sand (dense), weathered mudstone and muddy sandstone) – the assumed hard geology is therefore worst case.

Table 5-5: Predicted vibration levels at nearest receivers – surface construction

Address	Sheet Piling		Excavation		Bore Piling	
	Distance to works	Predicted PPV	Distance to works	Predicted PPV	Distance to works	Predicted PPV
70 Curran Street	31 m	3 mm/s	21 m	2 mm/s	> 150 m	< 1 mm/s
72 Curran Street	23 m	3 mm/s	20 m	2 mm/s	150 m	< 1 mm/s
74 Curran Street	21 m	3 - 4 mm/s	21 m	2 mm/s	145 m	< 1 mm/s
94 Shelly Beach Road (Pool Building)	148 m	< 1 mm/s	17 m	2 mm/s	20 m	1 mm/s

The receivers at 72 and 74 Curran Street are located less than 25 m from potential sheet piling works. At these distances, vibration levels are likely to be around 3 – 4 mm/s PPV or less, but are expected to be well below the DIN 4150-3 limit for cosmetic building damage of 5 mm/s PPV for residential buildings. Properties located further away (> 50m) are predicted to experience vibration levels of less than 2 mm/s.

The swimming pool is located over 40 m from the nearest works. For the pool, it is considered that the structural integrity of a commercial pool will be similar to a commercial building[46] and subjected to a higher DIN 4150-3 vibration threshold of 20 mm/s PPV. In any case vibration levels are likely to be negligible (e.g. 1 – 2 mm/s) and well within both the limit for a commercial building and the lower limit of 5 mm/s PPV for a residential building. As such, there will be no adverse effects on the structural integrity of the pool.

5.4 Operational noise levels

A single storey plant room will house the power supply and controls for the chamber and is located on the south-western side of Point Erin Park by Curran Street and is expected to operate 24-hours per day, 7-days per week.

Consistent with the main CI projects, the plant room will be designed to include the following mitigation measures to ensure that operational noise complies with the relevant AUP limits:

- Walls facing dwellings assumed to be constructed from precast concrete or an alternative material / design giving equivalent sound insulation performance;
- Ceiling lined with an absorptive product;
- Roof constructed from an insulated roofing product with a minimum performance of Rw 24 dB;
- Solid core access doors facing dwellings; and
- Roller door (where it faces a dwelling) to be acoustic with a minimum performance of Rw 24 dB.

Based on plant room source power level of 83 dB L_{WA}[47] the operations are expected to be less than 40 dB L_{Aeq} at the nearest receiver of 74 Curran Street (> 40 m) and will comply with the most

[46] Commercial building thresholds are based on either concrete or steel framed constructions. A reinforced concrete pool will respond to vibration in a similar manner to a concrete ground slab of a commercial building.
[47] Grey Lynn Tunnel, Notice of Requirement, Resource Consent Application and Assessment of Environmental Effects, Jacobs, IZ027500-709-NP-RPT-001, Feb 2019

stringent AUP night-time noise criterion of 45 dB $L_{Aeq.}$ Grid Contour maps are presented in Appendix C.

The above measures will be confirmed during the detailed design stage. However, the plant room will be designed to ensure compliance with the AUP's night time noise limit for residential zones.

6 Assessment of effects

6.1 Point Erin Tunnel

6.1.1 Potential vibration effects

Vibration from tunnelling along the alignment is predicted to be significantly less than vibration that would be generated by surface works.

The closest receiver to any TBM tunnelling works is calculated to be 18.5 m at 30 Sarsfield Street[48], when tunnelling occurs directly beneath the property as it approaches Point Erin Park. All other properties are situated at greater vertical distances from the TBM.

At 18.5 m, predicted vibration levels[49] are expected to meet the most stringent night time AUP amenity criteria of 0.3 mm/s at all receivers. At 0.3 mm/s PPV, vibrations may be just perceivable within residential environments but will likely be acceptable for limited durations. Based on previous CI monitoring, maximum vibration levels of 0.1 mm/s PPV are anticipated at the shallowest depth of the TBM (vertical distance of 17 m). Vibration levels at 0.1 mm/s are likely to be imperceptible within a residential building.

A vibration level of 0.03 mm/s is predicted at the Stebbing Recording Centre located along the Jervois Road ridgeline at a vertical distance of approximately 55 m from the tunnelling works. This level of vibration will not be perceptible and is highly unlikely to interfere with recording studio activities.

The majority of all other receivers along the tunnelling alignment between Tawariki Street and Point Erin are within 35 – 60 m from the TBM tunnel invert depth (30 – 55 m from the top of the pipe). Even with potential basements and pool depths taken into consideration, vibration from tunnelling is unlikely to be perceptible at any residential receiver.

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

Overall the effects of vibration on receivers along the tunnel alignment from the TBM are expected to be **negligible.**

6.1.2 Regenerated tunnelling noise

Regenerated noise levels due to tunnelling is predicted to comply with the 35 dB L_{Aeq} night time criterion at all receivers along the tunnel alignment.

Indoor noise at 35dB L_{Aeq} is unlikely to be noticeable from normal indoor activities and should not result in any sleep disturbance effects. With the TBM moving at a rate of 10 - 20 m a day, the potential for regenerated noise while the TBM passes underneath individual properties will only occur for 1-2 days. The effects from regenerated noise due to tunnelling is therefore likely to be negligible. Advance communication and consultation when the TBM approaches within 50 m of receivers is recommended to ensure receivers are informed in advance of any potential for regenerated noise.

Stebbing Recording Centre is situated approximately 56 m above the tunnelling works and regenerated noise levels is predicted to be below 30 dB L_{Aeq}[50]. Whilst the effects of tunnelling works are likely to be negligible at the current proposed distances, noise may still be audible within the

[48] 23 m depth to invert level.
[49] Based on previously monitored levels of a similar project and detailed ground investigations across CI sites as described in Section 5.3.3
[50] CRL, Mediaworks construction noise limit for inside Studio 1.

studios with sensitive audio equipment. Consultation with the studio should be undertaken prior to the TBM approaching the receiver location to enable scheduling of sensitive recording times around TBM operations.

Overall, noise effects on receivers along the tunnel alignment from the TBM are predicted to be **negligible.**

6.2 Point Erin Park

6.2.1 Potential noise effects

The degree of the noise effects from the works proposed in Point Erin Park will depend upon the magnitude, frequency of occurrence and duration of the noise exposure. Residents will experience noise inside and outside their dwellings if they are at home. An indication of the potential effects is provided in Table 6-1. Depending on the construction of the house, facades may provide a 25 - 30 dB reduction, therefore assumptions and effects provided below are based on a conservative approach.

Table 6-1: Subjective response to environmental noise (daytime) - residential building occupiers

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

Note: The adjustment factor between the external noise level and the internal noise level is based on a 20-decibel reduction as allowed for in NZS 6803.

This table relates to noise experienced during non-sleeping hours.

6.2.2 Construction noise effects

Overall construction works will generally comply with the daytime noise criterion of 70dB L_{Aeq} and effects can be minimised and managed within a CNVMP. Where specific activities are predicted to exceed the noise criterion, these have been discussed further in this section.

6.2.2.1 Sheet Piling

External noise levels without any mitigation in place may exceed the construction noise criterion of 70 dB L_{Aeq} at six properties of 7 Masefield Avenue, 70, 72 and 74 Curran Street, 28 and 30 Sarsfield Street due to sheet piling works to construct the chamber. A maximum noise level of 78 dB L_{Aeq} is predicted at 72 and 74 Curran Street located less than 25 m from the piling works.

Noise levels will vary during the construction of the chamber. The maximum noise levels presented in Table 5-4 are only likely to occur when the sheet pile works is nearest to the receivers. In reality, maximum noise levels may only occur for a relatively short period and intermittently within the total duration of the works. If sheet piling is required, it will be undertaken for an estimated total of 30 days and up to a maximum of 60 days intermittently within the Project duration. As works move further from particular properties, noise levels will decrease.

Noise from sheet piling cannot be effectively mitigated as 6 m high noise barriers would be required to achieve the Project's noise criterion. Temporary barriers this high would be impracticable to construct and are likely to cause other negative environmental effects such a visual blocking/ eyesore for receivers for extended periods of time.

A predicted sheet piling noise level of 78 dB L_{Aeq} would usually equate to an internal noise level 20-25 dB lower, i.e. 53-58 dB L_{Aeq} depending on the glazing and façade construction. An internal noise level less than 60 dB L_{Aeq} is unlikely to interfere with normal residential activities for short durations. High external noise levels for sheet piling are not uncommon for this type of works close to residential receivers and have been successfully managed on existing CI sites through an ASCNMP, which includes industry standard practice for sheet piling mitigation and consultation with receivers around timing and duration. Overall, due to the relatively limited duration and intermittent nature of sheet piling, along with the implementation of the CNVMP with an activity specific section to appropriately manage sheet piling activities, it is considered that noise effects from sheet piling on surrounding residents will be reasonable, i.e. within an acceptable range of construction noise levels (75 – 80 dB L_{Aeq}).

6.2.2.2 Works outside of standard construction hours

Predicted unmitigated noise levels indicate that concrete pours outside of standard construction hours are likely to exceed the most stringent night time criterion of 45 dB L_{Aeq} at nearby receivers.

With the adoption of the best practicable option, such as (but not limited to) a minimum set back distance of 80 m from all receivers (i.e. for the terminal shaft), completing works before 8 pm and other practicable mitigation controls as conducted on other CI sites (such as temporary screens), noise levels of less than 50 dB L_{Aeq} can likely be achieved.

At 50 dB L_{Aeq}, internal noise levels are likely to be around 25-30 dB L_{Aeq} with windows closed. This is below the recommended internal noise level criterion for sleeping areas[51]. It is therefore considered that external noise levels of 50 dB L_{Aeq} will be acceptable for the infrequent and limited duration of the activity. Prior communication and consultation with potentially affected receivers will be undertaken to inform them of potential noise; this approach is consistent with other CI sites.

[51] AS/NZS 2107:2016 - 35 to 40 for residential buildings near major road and 30-35 dB for houses in suburban areas or near minor roads

The above control measures can be implemented through a section in the CNVMP for concrete pours, such that the effects of occasional out of hours activities are considered to be acceptable.

Dewatering and overpumping for temporary diversions or connections into the existing network will require the use of pumps that may operate 24/7. Similarly shaft ventilation is likely to operate outside of standard hours. All of these noise sources are likely to be located over 100 m from the nearest residential dwelling, and with localised noise screening, the resulting noise effects will be less than minor.

Furthermore, the noise effects of working at 50 dB L_{Aeq} or less outside standard construction hours will likely be masked by the existing noise environment, i.e. further reducing the potential adverse effects of the above works.

6.2.3 Potential vibration effects

Construction activities may generate vibration. The assessment has shown that with the exception of three receivers, all vibration levels are predicted to be 2 mm/s or less at the closest receivers identified in Table 5-5.

For sheet piling and subsequent excavations, three receivers at 70, 72 and 74 Curran Street are predicted to experience vibration levels above the 2 mm/s amenity level but under the 5 mm/s DIN 4150-3 threshold for cosmetic damage. Vibration levels of 2 mm/s may be perceivable by occupants and they may be disturbed by such occurrences, but based on experience with other construction projects vibrations at this level will generally be acceptable to receivers provided they have received prior warning (this is so that the receivers are not surprised or startled when the vibrations occur). Effects will be managed through vibration monitoring and consultation with the occupants prior to construction works starting.

Vibration effects are considered to be less than minor for the three identified receivers above and negligible for all other receivers.

7 Noise and vibration management

7.1 Construction Noise and Vibration Management Plan (CNVMP)

It is common practice for infrastructure projects to implement a CNVMP as part of the construction management plan. Implementing noise management and mitigation measures via a CNVMP is the most effective (and best practice) way to control construction noise and vibration impacts. The objective of the CNVMP should be to provide a framework for the development and implementation of best practicable options to avoid, remedy or mitigate the adverse effects on receivers of noise and vibration resulting from construction. A CNVMP identifying the minimum level of information as set out in AUP E25.6.29(5) for the Point Erin Tunnel and shaft works will be prepared by the Contractor.

A CNVMP will be implemented for the work site with specific sections on activities that are predicted to exceed adopted project limits. The CNVMP will be kept up to date regarding actual timing/equipment used and methodologies.

The CNVMP should include, but not be limited to, the following recommended mitigation and management measures. As there are negligible effects associated with the construction of the tunnel, unless otherwise stated these control measures focus on works within Point Erin Park.

7.1.1 General noise mitigation

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

7.1.2 Communication and Consultation

The key element of noise and vibration management is ensuring that appropriate communication occurs with affected neighbours. Such measures include:

- Prior notification of the works via a letterbox drops or supplemented by other means (news article, website etc) to affected neighbours and properties along the tunnel alignment. The letterbox drop will provide contact details and will detail the overall nature and expected duration of the works;
- Prior to any particularly noisy process being identified, the most affected neighbours as identified in Table 5-4 and Table 5-5 will be contacted individually. Neighbours will be informed of the proposed timing of the specific works. Ongoing consultation and communication with neighbours less than 50 m from any construction works or tunnelling works should be undertaken; and
- Consultation with Stebbing Recording Centre prior to the TBM approaching the studio to enable scheduling of sensitive recording times around TBM operations.

7.1.3 Noise Barriers

Where practicable, panels should be positioned as close as possible to the construction activity to block line-of-sight between the activity and noise sensitive receivers. Additional local barriers may

be necessary near the activity to ensure effective mitigation for sensitive receivers on upper floor levels. The panels should be a minimum height of 2 m, and higher if practicable to block line-of-sight[52]. The panels must be abutted or overlapped to provide a continuous screen without gaps at the bottom or sides of the panels.

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

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

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

1.8 m to 2 m high barriers are recommended around the shaft construction site as indicated in Appendix D.

7.1.4 Timings

It is recommended that driven and vibratory piling associated with works within Point Erin Park should be restricted to the period of 7 am to 6 pm, with noisy works restricted between 7:30 am and 6 pm.

7.1.5 Works outside of standard construction hours

Where practicable all works within Point Erin Park should be undertaken during the standard construction hours (see Section 2.4.2).

Depending upon the nature of the activities, Auckland Council has previously approved CI situations when works (and their scale) are not inconsistent with activities undertaken by homeowners, e.g. vegetation clearance. In these situations, and where it is unavoidable for them to take place during standard hours, works must take be scheduled to avoid sensitive times (i.e. as close to standard construction hours as possible). Furthermore, Auckland Council has approved additional activities such as:

- Where, due to unforeseen circumstances, it is necessary to complete an activity that has commenced;
- Where works is specifically required to be planned to be carried out at certain times;
- For delivery of large equipment or special deliveries outside of normal hours due to traffic management requirements;
- In cases of emergency;
- For the securing of the site; and
- For any other reasons specified in the CNVMP – eg dewatering, shaft ventilation etc.

For each situation, the best practicable option should be implemented to minimise adverse noise effects. For concrete pours appropriate controls would include a minimum set back distance of 80 m from the nearest receiver, completing works before 8 pm and other practicable mitigation controls such as use of temporary screens.

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

Where there are no practicable alternative options to complete works prior to 8 pm and noise level exceedances are anticipated, it may be necessary to implement enhanced noise and vibration management measures. For example:

- increase the frequency of communications with stakeholders;
- carry out regular noise and vibration monitoring to confirm noise and vibration levels; or
- offer temporary relocation to neighbours if unreasonable noise and/or vibration levels cannot be avoided.

7.1.6 Vibration mitigation

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

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

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

8 Conclusion

An assessment of noise and vibration has been carried out for the construction and operation of the proposed CI Point Erin Tunnel comprising a shaft and chamber at Point Erin Park and tunnelling between Tawariki Street and Point Erin Park. The works described in this report are typical for construction works carried out at other large scale infrastructure works across Auckland and at previously consented CI sites.

Predicted noise and vibration levels have been assessed against relevant AUP performance standards. The assessment is based on an indicative construction methodology for a worst case scenario. It is also informed by practical on-the-ground experience gained through the CI project to date which provides a solid 'real-world' basis for understanding the nature of activities at Point Erin and tunnelling works, the actual and potential noise and vibration effects of those activities, and how the effects are best managed and mitigated to cause the least disruption to surrounding residents and to minimise environmental effects.

The assessment has been split between ground tunnelling works between Tawariki Street and Point Erin Park, and the surface construction works at Point Erin Park.

Point Erin Tunnel

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

Vibrations due to tunnelling are unlikely to be perceptible at all receivers and within the most stringent night time AUP amenity limit. Overall the effects of vibration from the TBM are expected to be negligible.

Regenerated noise due to tunnelling is also unlikely to be perceptible and is predicted to comply with the 35 dB L_{Aeq} night time criterion at all receivers.

Overall, regenerated noise and vibration due to tunnelling are predicted to comply with the relevant internal and night time criteria at all times and any effects are considered to be negligible.

Point Erin Park

Noise levels have been predicted at sensitive receivers within the vicinity of the Point Erin Park construction areas. Predictions indicate worst-case noise levels at six properties (1-3/7 Masefield Avenue, 70, 72 and 74 Curran Street, and 28 and 30 Sarsfield Street) may exceed the long term construction noise limit of 70 dB L_{Aeq} on a temporary basis during sheet piling of the chamber (71 – 78 dB L_{Aeq}). The maximum noise levels at façades are not expected to be continuous (it will be intermittent in nature and temporary) and are only likely to occur as a worst case scenario when vibro sheet piling is occurring immediately adjacent to the site boundaries. Noise effects from sheet piling works are likely to be minor for 1-3/7 Masefield Avenue, 70 Curran Street and 28 and 30 Sarsfield Street.

For 72 and 74 Curran Street, an external façade noise level of 78 dB L_{Aeq} is predicted. Internal sound levels at these properties will be noticeable but unlikely to interfere with normal residential activities. High external noise levels for sheet piling are not uncommon for this type of works close to residential receivers and this has been successfully managed on existing CI sites through an ASCNVMP which includes standard practice for sheet piling mitigation and consultation with receivers around timing and duration. As required by the proposed conditions of consent, the Project will address this through the CNVMP (an activity specific section or addendum) which details the level of mitigation, management and consultation that is required to manage disruption.

The construction of the retaining wall in the south west corner of Point Erin Park may also result in a small exceedance of the construction noise limit for 72 and 74 Curran Street. These two receivers

may experience noise levels of up to 72 dB $L_{Aeq(15min)}$. There may be opportunities to implement mitigation (noise barriers) or to adopt a different construction methodology to reduce the noise level to comply with the daytime noise criterion of 70 dB $L_{Aeq(15min)}$. In any case this is a short term and marginal exceedance of the permitted activity noise limits and can be managed through the CNVMP.

Noise mitigation measures and consultation will be required to manage noise. With mitigation in place, overall effects can be appropriately managed and reduced to ensure construction noise effects are acceptable and no more than minor.

Predicted vibration levels indicate that construction vibration is not likely to exceed 5 mm/s DIN 4150-3 limits for residential cosmetic building damage at any receiver. Three properties (70, 72 and 74 Curran Street) may experience vibration levels above the AUP 2 mm/s amenity criterion but below 5mm/s during sheet piling for more than 3 days[53]. Vibration at these three properties will be managed via consultation addressed in the CNVMP and the effects will be less than minor.

The operation of the plant room is predicted to comply with relevant noise criteria at all times with the recommended conceptual acoustic measures in place. Any residual noise effects from its operation will be less than minor.

[53] AUP Rule E25.6.30

9 Applicability

This report has been prepared for the exclusive use of our client Watercare Services Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Auckland Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

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Appendix A Glossary

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

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

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

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

Appendix B Receiver Locations

Appendix C Façade Noise Maps

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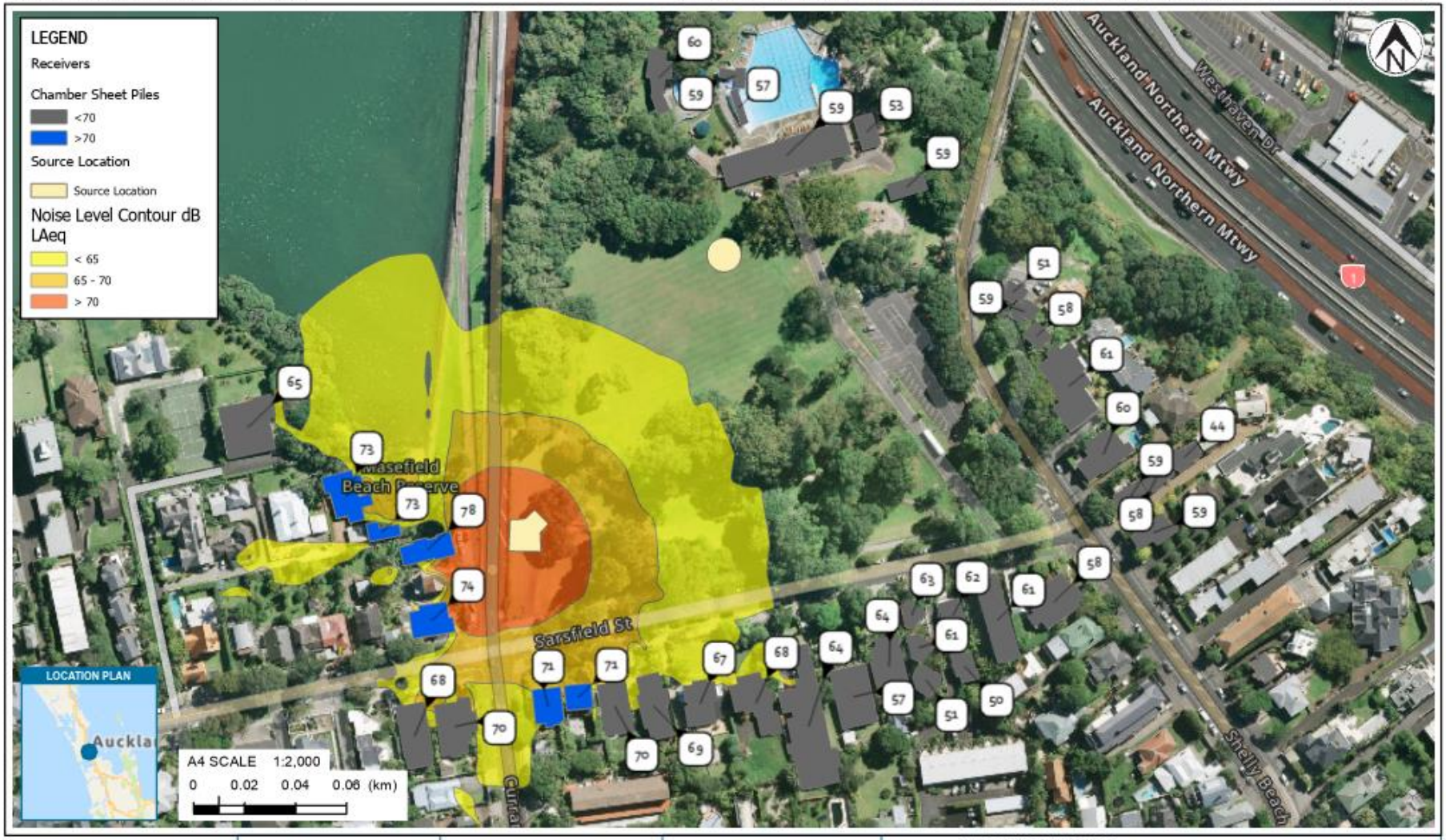

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APPROVED	DATE	

CLIENT **WATERCARE LTD**
PROJECT **CENTRAL INTERCEPTOR POINT ERIN EXTENSION**
TITLE CHAMBER SHEET PILE - PREDICTED NOISE LEVEL
SCALE (A4) 1:2,000 FIG No. FIGURE 1. REV 0

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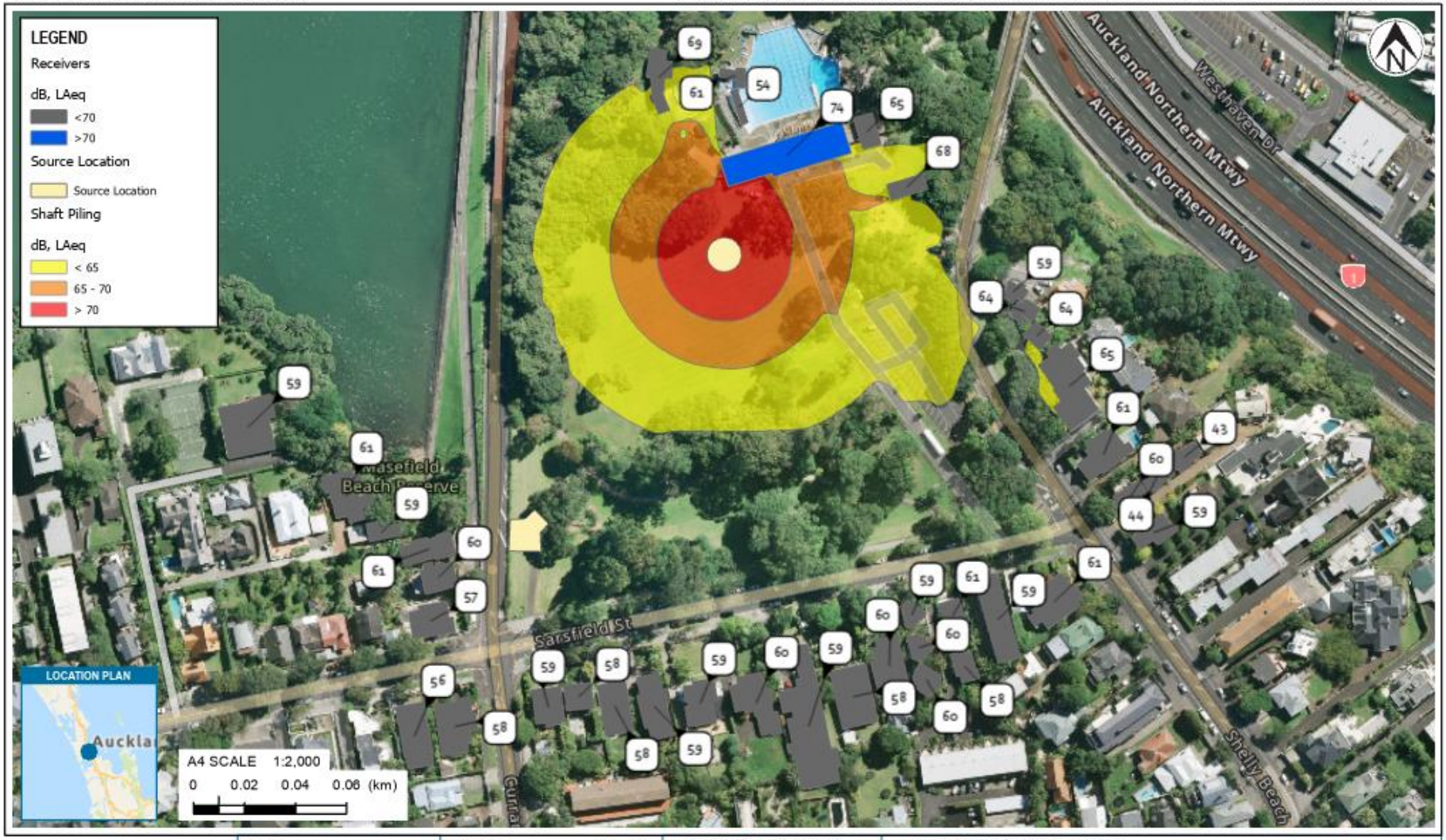

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CLIENT **WATERCARE LTD**

PROJECT **CENTRAL INTERCEPTOR POINT ERIN EXTENSION**

TITLE **SHAFT AUGER PILES - PREDICTED NOISE LEVEL**

SCALE (A4) 1:2,000 FIG No. FIGURE 2 REV 0

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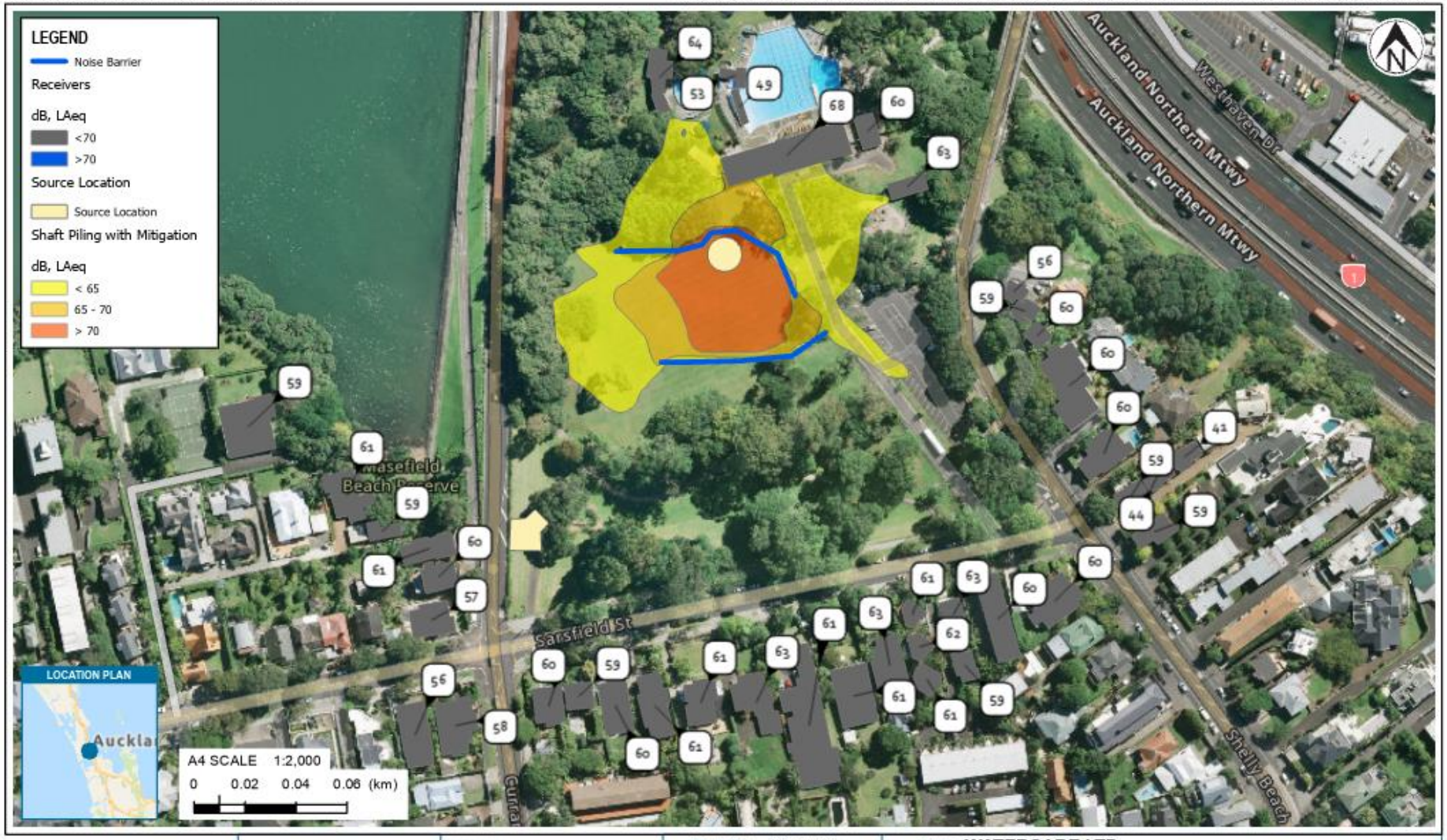

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CLIENT **WATERCARE LTD**

PROJECT **CENTRAL INTERCEPTOR POINT ERIN EXTENSION**

TITLE SHAFT AUGER PILES WITH MITIGATION - PREDICTED NOISE LEVEL

SCALE (A4) 1:2,000 FIG No. FIGURE 3 REV 0

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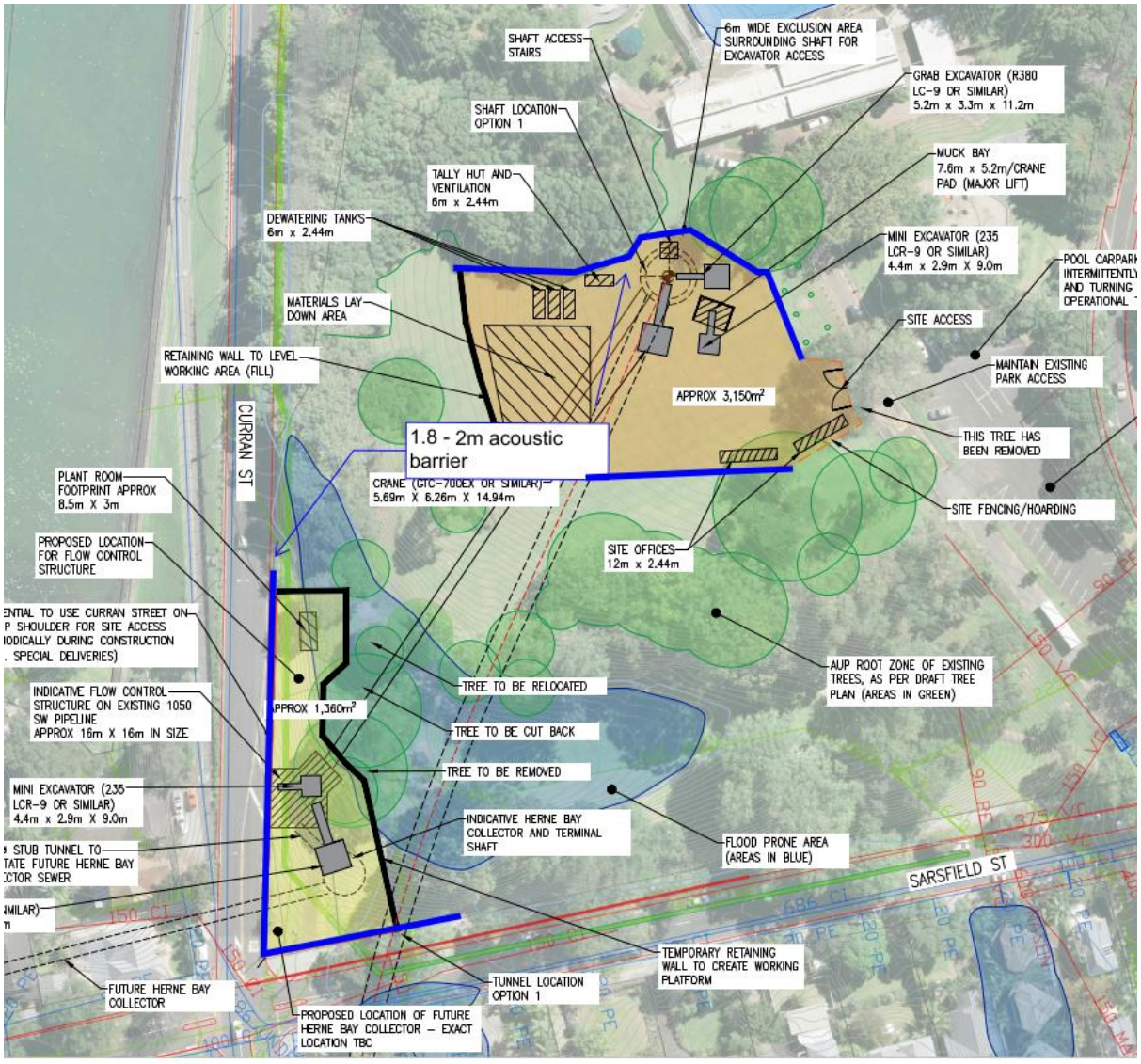
PROJECT **CENTRAL INTERCEPTOR POINT ERIN EXTENSION**

TITLE PLANTROOM OPERATIONAL - PREDICTED NOISE LEVEL

SCALE (A4) 1:2,000 FIG No. FIGURE 4 REV 0

Appendix D Indicative construction acoustic barrier location

Note: These locations are indicative and will be confirmed through detailed design taking into account the need for barriers and subject to access requirements/constraints, particularly to the south western construction area.



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