MARSHALL DAY Acoustics

HUIA REPLACEMENT WTP PROJECT
ACOUSTIC ASSESSMENT

Rp 001 20170761 | 20 May 2019

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Project: **HUIA REPLACEMENT WATER TREATMENT PLANT PROJECT**
Acoustic Assessment

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EXECUTIVE SUMMARY

This report provides an assessment of acoustical effects from the construction and operation of the proposed Huia Replacement Water Treatment Plant Project and associated reservoirs ("the project"). Works are programmed to take up to 8 years to complete.

Daytime construction noise emissions and night-time operational noise are the primary issues of note.

Long-term unattended noise logging, attended measurements and noise modelling has been used to predict the existing noise baseline from the Huia WTP. Proposed noise emission from the replacement WTP has been compared to this baseline.

The assessment discusses the guideline noise and vibration ("acoustic") criteria from the Auckland Unitary Plan (AUP) (in lieu of any acoustic performance criteria contained in the designation); outlines the acoustic effects assessment methodology; predicts noise and vibration levels and assesses the potential impacts from the construction and operation of the project.

It is recommended that the project adopts the guideline criteria contained in the AUP. The aim is to achieve compliance with these criteria where practicable. In accordance with Section 16 of the Resource Management Act the best practicable option should be adopted to ensure that project noise and vibration emissions do not exceed a reasonable level.

The predictions contained in this assessment cover the anticipated envelope of potential noise and vibration effects based on current construction methodologies. However, the assessment is considered broad enough to cover the anticipated effects envelope should alternative construction techniques be used.

Construction noise has been predicted using equivalent noise source data from other similar projects and from information contained in NZS 6803: 1999 and BS 5228-1: 2009. Tables are provided that show potential worst-case noise levels from the construction activities proposed. The predictions are based on assumptions and estimates detailed in the indicative construction methodology provided by Alta. There may be some variation in the actual methodology or equipment used to carry out the work as the final decision would be made by the lead Contractor. However, the project Construction Noise and Vibration Management Plan ("CNVMP") will contain the procedures necessary for identifying and mitigating/managing any potential noise issues through an adaptive management approach, as has historically occurred on various large infrastructure projects in Auckland.

Activities such as vegetation removal using chainsaws and a wood chipper may require activity-specific management and mitigation where they occur close to neighbouring receivers. This will be addressed via Activity Specific Noise and Vibration Management Plans ("ASCNVMPs").

General acoustic management and mitigation measures are recommended to be implemented throughout the course of the project as a best practice provision e.g. maintenance of equipment and site haul roads to a high level and the avoidance of unnecessary noise and vibration such as the use of horns, tonal reverse alarms or clearing excavator buckets by hitting the ground.

Overall, the construction of the project is predicted to result in noise and vibration levels that are generally within the project construction acoustic performance criteria, with some exceptions. Whilst construction noise and vibration levels are higher than ongoing operational levels, it is commonly accepted that for any construction to occur, acoustic criteria must be less stringent, with the understanding that construction is a temporary activity with a finite duration.

Operation noise from the replacement WTP has been predicted using SoundPLAN noise modelling software. Comparing prediction results against existing emissions from the Huia WTP shows that noise levels will increase for some receivers and decrease for others, given that the treatment plant would be moving closer / further away from any given receiver.

Importantly, site noise emissions would remain compliant with the guideline AUP night-time limit of 40dB L_{Aeq} and would be generally comparable to the level of noise currently received by a number of dwellings on Manuka and Taraire Roads that are close to the existing Huia WTP.

The cumulative noise increases from the temporary operation of the existing WTP and replacement WTP would be no more than 3 decibels, which is barely noticeable.

Based on the above, it is concluded that the operational noise effects from the replacement WTP project would be noticeable for a limited number of receivers but considered acceptable.

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1.0 INTRODUCTION

Watercare Services Limited (Watercare) is responsible for the treatment and supply of potable water and for the collection, treatment and disposal of wastewater to around 1.5 million people in Auckland. Watercare is a Council Controlled Organisation (CCO), wholly owned by the Auckland Council.

Watercare operates five dams within the Waitākere Ranges, including the Upper and Lower Huia Dams and the Upper and Lower Nihotupu Dams. Water from these western water supply dams is treated at the Huia and Waitākere Water Treatment Plants before being distributed via the water transmission network, primarily to west and north Auckland. The Huia Water Treatment Plant (Huia WTP) is the third largest water treatment plant in Auckland and is a crucial component of Auckland's water supply network, treating approximately 20% of Auckland's water.

The Huia WTP was constructed in 1929 and is now nearing the end of its operational life (90 years old). Watercare therefore proposes to construct a new WTP (termed the Huia Replacement Water Treatment Plant Project or 'the project') to replace the aging Huia WTP. As part of this project Watercare is also proposing to construct two treated water reservoirs (50ML total capacity) to increase treated water storage within the western supply zone.

This report has been prepared to assess the potential noise and vibration effects of the proposed works and to accompany the regional resource consent application and/or Outline Plan of Works in relation to the construction and operation of the WTP and reservoirs.

A glossary of acoustic terminology used in this report can be found in Appendix A.

2.0 PROJECT AND SITE DESCRIPTION

2.1 Project Description

The replacement WTP will be constructed on the corner of Manuka Road and Woodlands Park Road directly across from the existing Huia WTP site. The replacement WTP will have a treatment capacity of 140 mega-litres per day (MLD). A new 25ML treated water reservoir will be located on the northern side of Woodlands Park Road (Reservoir 1), with another 25ML reservoir (Reservoir 2) subsequently constructed on the existing Huia WTP site once the existing plant has been decommissioned. The proposed works also includes construction of the North Harbour 2 watermain (NH2) valve chamber and tunnelling reception shaft within the Reservoir 1 site.

In summary, the key construction activities considered within this report and described in more detail in later sections are: vegetation removal and site establishment (for the proposed NH2 valves and receiving chamber, reservoirs and replacement WTP building platforms), soil retention (by construction of retaining walls and/or soil stabilisation), importation and placement of fill, bulk earthworks, demolition of existing structures and the construction of the WTP and two reservoirs.

Construction of the project is programmed to take up to 8 years to complete.

Refer to Appendix B for figures showing the indicative layouts for the replacement WTP and reservoirs.

2.2 Site Description

The project is located on land owned by Watercare and is designated in the Auckland Unitary Plan (AUP) for 'Water supply purposes – water treatment plants and associated structures'[1]. The project spans three sites owned by Watercare which have a total site area of approximately 145,700 m^2. The site on which the proposed replacement Huia WTP is located has an area of approximately 42,000 m^2, the proposed Reservoir 1 site has an area of approximately 63,600 m^2, and the existing WTP site (on which Reservoir 2 is proposed) has an area of approximately 40,100 m^2.

The replacement Huia WTP, Reservoir 1 and Reservoir 2 sites are all accessed from Woodlands Park Road and are collectively referred to as "the project site".

The project site is located approximately 1 km from Titirangi Village and approximately 1.5 km north of the closest reach of the Manukau Harbour. The project site is predominately surrounded by residential (large lot) zones in all directions other than to the south-east of the proposed WTP site which adjoins land zoned Open Space – Conservation and designated by Auckland Council for Regional Park purposes.

The replacement WTP site slopes gently from the Woodlands Park Road to the south with gullies located at the southern boundary running north to south. The eastern extent of this site features steep slopes which rise up towards Scenic Drive. A section of the Yorke Gully Stream traverses the south eastern part of the replacement WTP site and a small tributary of the Armstrong Gully Stream is located in the north-western corner of the site.

The Reservoir 1 site comprises an elevated tract of land with a knoll located in the middle of the site near the southern boundary, and a small gully feature (Armstrong Gully) runs through the site. Extremely steep slopes are present along the northern boundary beneath and above Exhibition Drive. A permanent section of Armstrong Gully stream is located to the west of Reservoir 1.

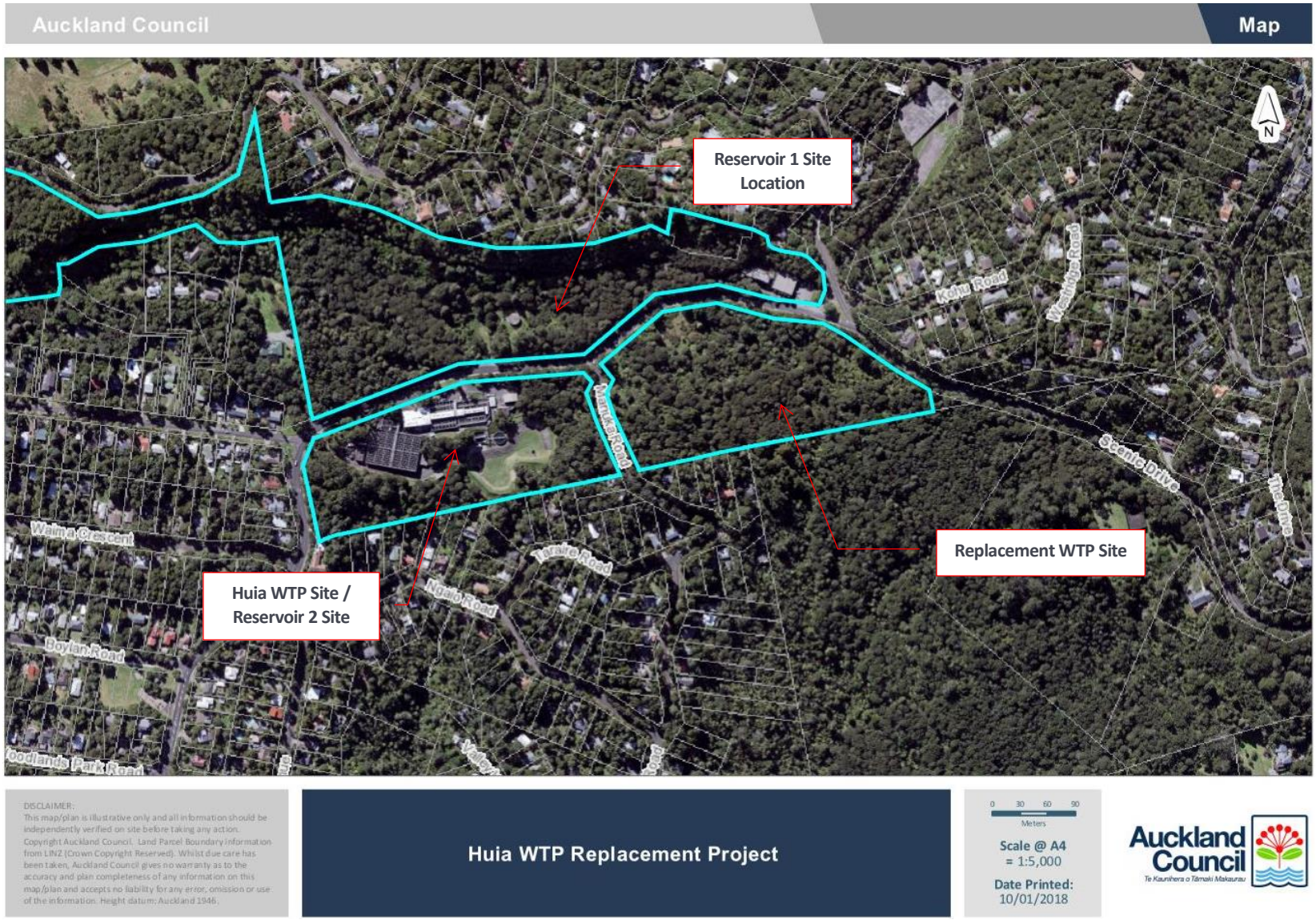
The existing WTP site where Reservoir 2 will be located has been developed as a WTP for the last 90 years. The site has a generally moderate to steep slope towards the south, with very steep slopes along the eastern and southern site boundaries. The Armstrong Gully watercourses are piped beneath the centre of the site, discharging into an open channel near the southern boundary. A small tributary of the Armstrong Gully Stream extends from the replacement WTP site into the north-eastern corner of the existing Huia WTP site.

Both the WTP and Reservoir 1 sites are almost completely vegetated in native bush, while the existing WTP site is approximately half vegetated in native bush with the remainder developed as part of the existing Huia WTP. The sites are identified as part of an extensive Significant Ecological Area (SEA_T_5539) in the AUP that essentially extends throughout the entire Waitakere Ranges area.

The project's location and the surrounding receiver environment are shown in Figure 1.

[1] Designation reference 9324 – Huia and Nihotupu Water Treatment Plants

Figure 1: Site and Surrounding Environment



Source: https://unitaryplanmaps.aucklandcouncil.govt.nz/upviewer/

2.3 Closest Potentially Sensitive Receivers

There are five residential sites adjoining the replacement WTP site southern boundary[2]; one dwelling to the east on Kohu Road is elevated above the site; 11 properties located on the ridge above the Reservoir 1 site; and 12 immediately neighbouring properties directly to the south of the existing WTP site. These receivers are the closest potentially affected receivers surrounding the project site.

Table 1 identifies these receivers, zoning / primary use and distance to project works.

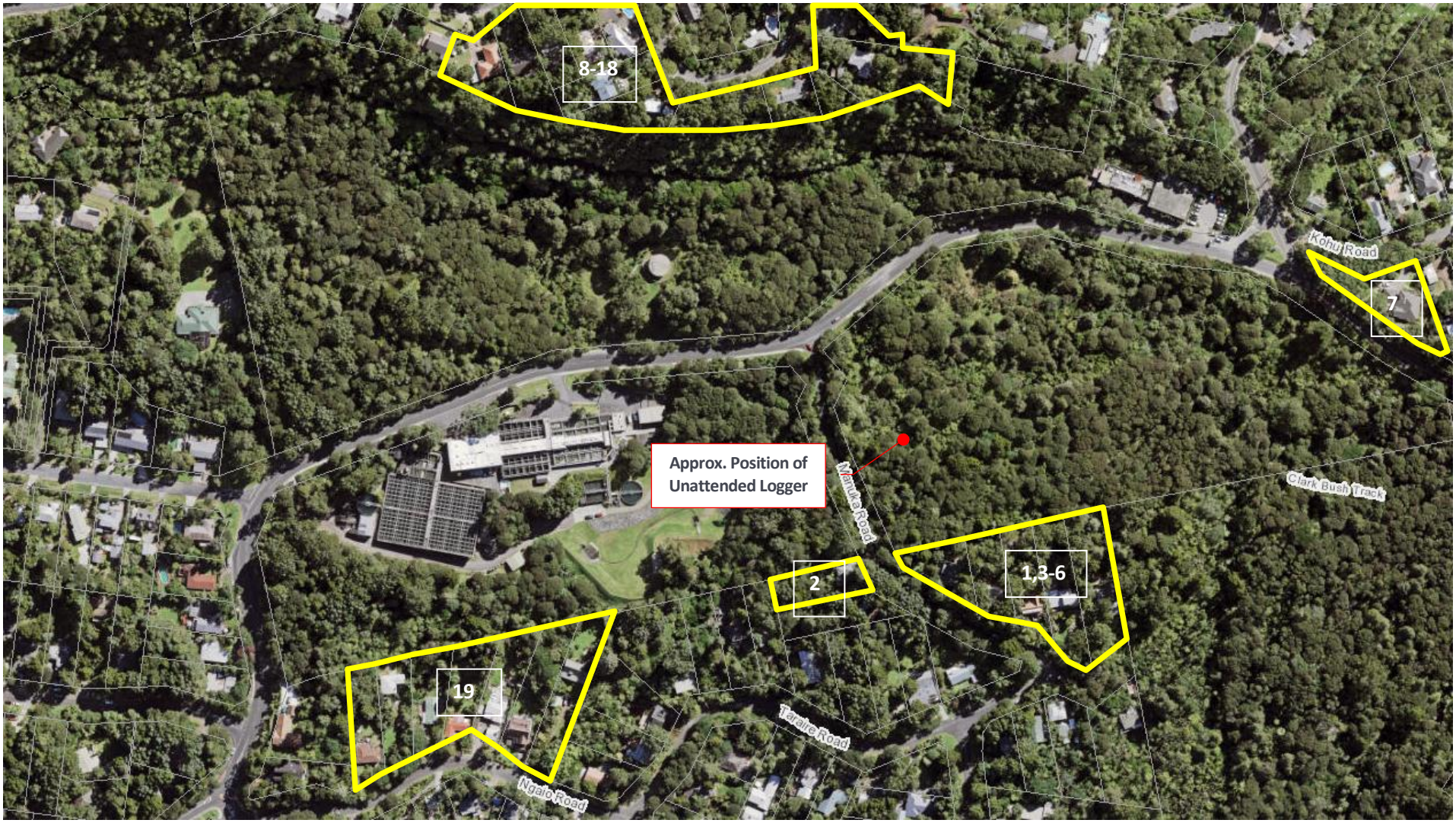
Table 1: Site Activity to Receiver Boundary Distances

Loc. No.	Address	Zoning / Usage	Distance to Closest Project Works (m)
Replacement WTP Site:			
1	12 Manuka Road	Residential / dwelling	60
2	13 Manuka Road	Residential / dwelling	80
3	14 Manuka Road	Residential / dwelling	55
4	16 Manuka Road	Residential / dwelling	55
5	18 Manuka Road	Residential / dwelling	55
6	20 Manuka Road	Residential / dwelling	55
7	78 Kohu Road	Residential / dwelling	85
Reservoir 1 Site:			
8	92 Scenic Drive	Residential / dwelling	100
9	94 Scenic Drive	Residential / dwelling	70
10	96 Scenic Drive	Residential / dwelling	65
11	98 Scenic Drive	Residential / dwelling	65
12	100 Scenic Drive	Residential / dwelling	65
13	102 Scenic Drive	Residential / dwelling	80
14	104 Scenic Drive	Residential / dwelling	100
15	106 Scenic Drive	Residential / dwelling	100
16	108 Scenic Drive	Residential / dwelling	100
17	110 Scenic Drive	Residential / dwelling	105
18	112 Scenic Drive	Residential / dwelling	110
Reservoir 2 Site:			
19	4, 6, 8, 10, 12, 14, 16 Ngaio Road	Residential / dwellings	95-175

Figure 2 overleaf identifies the general location of the receivers listed in Table 1.

[2] 13 Manuka Road has also been included given the proximity of the dwelling relative to the WTP site southern boundary

Figure 2: Location Numbers of Closest Potentially Affected Receivers



3.0 EXISTING ACOUSTIC BASELINE

3.1 Long-term Noise Logging

A noise logger was deployed to quantify the existing ambient noise environment in and around the project area. The logger was deployed between 21 and 28 March 2018 at the location indicated in Figure 2. The logger's position[3] is considered to be representative of the existing acoustic environment experienced by dwellings located at a similar distance from the Huia WTP as the logger.

The logger automatically measured noise levels over 1-second intervals[4] for a period of 7 days. Any noise measurement intervals where the weather was shown to be outside the allowable meteorological window prescribed in NZS6801:2008 were removed from the dataset.

Table 2 summarises the processed noise logger results and shows the average noise level per period and overall average.

Table 2: Measured and Derived Ambient Noise Levels

Period	Measured Levels (dB)	
	L_{Aeq}	L_{A90}
Daytime (7.00am-10.00pm)	45-49	37-43
Daytime Average	46	40
Night-time (10.00pm-7.00am)	39-41	32-35
Night-time Average	40	34

Notes to Table:

(1) An explanation of technical terms is provided in Appendix A
(2) Refer Figure 2 for approximate location of logger

Refer to Appendix C for the full summary of noise logging results and level versus time histogram.

3.2 Attended Noise Level Survey

Attended noise measurements were carried out on 4 October 2018 between 9:00pm and 10:00pm, during which ambient noise levels were measured, in accordance with the relevant standards, at the positions marked MP1 and MP2 (refer to Figure 3). The positions were considered representative of dwellings close to the Huia WTP site.

The weather at the time of the survey was fine with little breeze apparent and therefore within the allowable meteorological window prescribed in NZS6801:2008.

Watercare has confirmed that the Huia WTP site was operating normally during the survey period.

The measured noise levels are shown in Table 3.

[3] NZTM coordinates: 1746243.15 easting, 5910712.03 northing

[4] Post-processing of data was used to derive 15-minute intervals prescribed in NZS6801:2008

Table 3: Measured Ambient Noise Levels

Measurement Position	Measurement		Measured Level (dB) (1)			Noise Source (2)
	Start Finish Times	Duration min:sec	L_{Aeq}	L_{A90}	L_{AFmax}	
MP1 (adj. 17 Taraire Rd)	9:11 pm 9:28pm	15:00	32	28	-	Vehicles on Woodlands Park Rd, WTP site (~28dB L_{AF})
MP2 (adj. 13 Manuka Rd)	8:39 pm 8:55 pm	15:00	44	37	57	Vehicles on Woodlands Park Rd (50-56dB L_{AF}), WTP site (~37dB L_{AF}) Note: Vehicles on Manuka Rd paused out

Notes to Table:

(1) An explanation of technical terms is provided in Appendix A
(2) The controlling noise source is underlined

Figure 3: Attended Measurement Positions

The result at MP1 indicated that the Taraire and Ngaio Roads area is quiet and receives relatively little traffic noise from vehicles on Woodlands Park Road. The result also indicated that a level of approximately 28dB was received in this area from the WTP site.

Observations and analysis of the result at MP2 indicated that traffic noise was controlling the ambient environment at this measurement location. The WTP site was inaudible during vehicular pass-bys. During periods of little traffic flow on Woodlands Park Road steady-state audible noise from the WTP site of 37dB was measured. This is consistent with the long-term measurements undertaken.

Both measurement results indicated that the WTP site was operating within the guideline noise limits of the AUP (refer to section 4.3.1) during the period of the survey.

4.0 ACOUSTIC PERFORMANCE STANDARDS AND LEGISLATION

4.1 Resource Management Act 1991 (RMA)

Under the provisions of the RMA there is a duty to adopt the best practicable option to ensure that noise (including vibration[5]) from any development does not exceed a reasonable level. Specifically, Sections 16 and 17 reference noise effects as follows.

Section 16 states that *"every occupier of land (including any 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"*.

Section 17 states that "every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried on by or on behalf of the person, whether or not the activity is in accordance with –

(a) Any of sections 10, 10A, 10B and 20A; or

(b) A national environmental standard, a rule, a resource consent, or a designation

This report uses the guiding principles of Section 16 and 17 of the RMA as noted above in assessing effects and recommending mitigation measures.

4.2 Designation 9324 Conditions

The Project site has an existing designation[6] in place although there are no acoustic conditions contained in it. Although strictly not applicable to Watercare's activities on the site we have referenced the relevant rules contained in the AUP for guidance on what levels of Project noise and vibration could be considered 'reasonable' with respect to s16 of the RMA.

4.3 Auckland Unitary Plan (AUP)

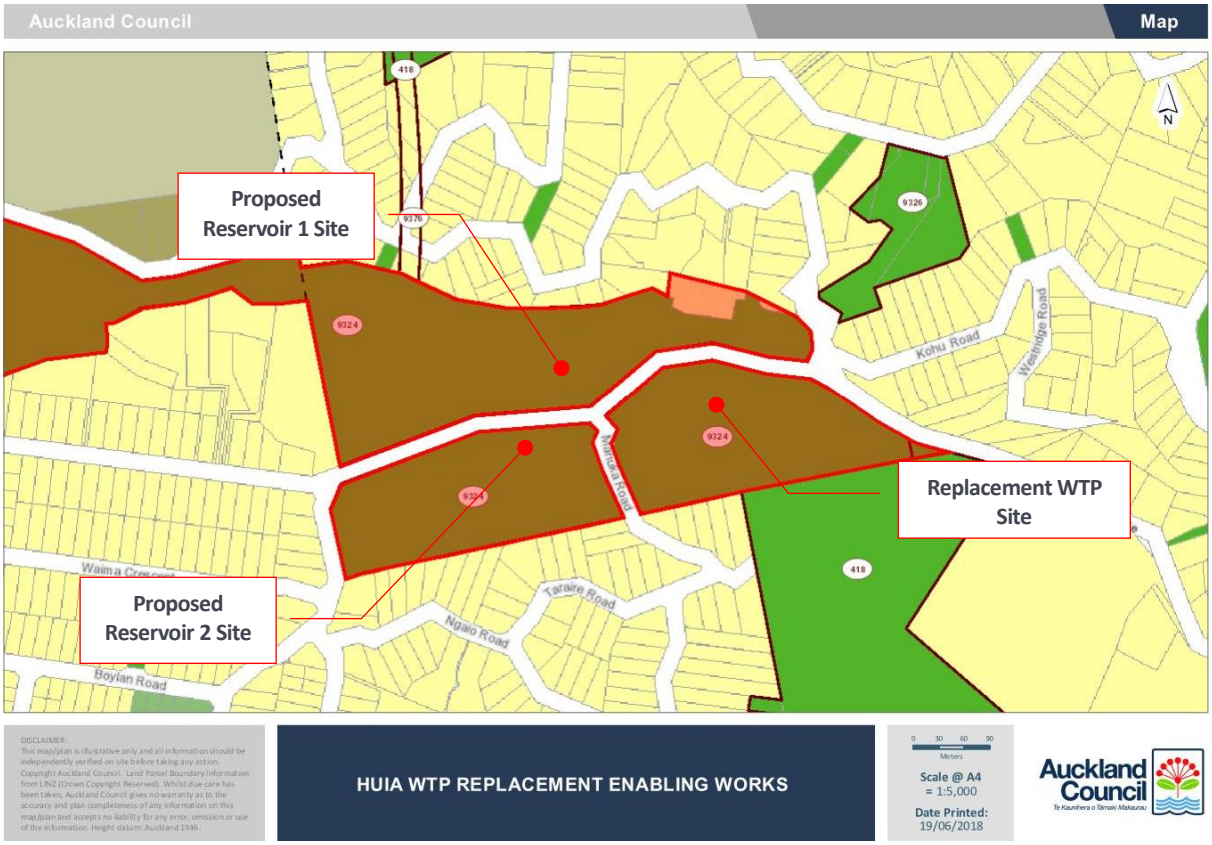
The underlying zoning of the project site is *Open Space – Conservation* in the AUP. All surrounding properties with dwellings on them are zoned *Residential – Large Lot Zone*.

The AUP zone map is shown in Figure 4, followed by a discussion in relation to the applicable noise and vibration performance standards.

[5] RMA 1991 Part 1 Section 2 Interpretation: Noise includes vibration

[6] Designation 9324 - Water supply purposes: water treatment plants and associated structures

Figure 4: AUP Zone Map



Source: https://unitaryplanmaps.aucklandcouncil.govt.nz/upviewer/

4.3.1 Operation Noise

Noise received by dwellings in residential zones from replacement WTP operation

Standard E25.6.18 (1) of the AUP states that noise from any activity in the Open Space – Conservation Zone, when measured on a site in a residential zone must not exceed the limits in Table E25.6.18.1, reproduced as follows:

Table E25.6.18.1 Noise limits at the Open Space – Conservation Zone, Open Space – Informal Recreation Zone, Open Space – Civic Spaces Zone or Open Space – Community Zone interface

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

4.3.2 Construction Noise

Standard E25.6.1 (3) of the AUP states that noise from any construction work activity must be measured and assessed in accordance with the requirements of NZS 6803: 1999 *"Acoustics - Construction Noise"*.

Standard E25.6.27(1) sets noise limits for typical[7] duration construction. As the anticipated length of the construction period would exceed 20 weeks, Standard E25.6.27 (4) would apply to the project.

[7] Typical duration construction is defined in Clause 7.2.1(b) of NZS6803:1999 as "continuous construction lasting more than 14 days but less than 20 weeks"

Subsequently, the construction noise limits set out in Table E25.6.27.1 would be decreased by 5 decibels.

In summary, the noise limits applying to typical construction hours (7:30am to 6:00pm) would be 70 dB L_{Aeq} and 85 dB L_{Amax} assessed at 1m from the façade of occupied buildings. Refer to Appendix D for the full construction noise limits found in the AUP.

4.3.3 Operation Vibration

Standard E25.6.30 (2) stipulates vibration levels for stationary vibrating, reciprocating and rotating machinery, including piping and ducting, to not exceed the limits of Table E25.6.30.2 when measured in any occupied room of any building on another site.

Table 4: Vibration Levels for Stationary Machinery

Affected Occupied Building or Area	Time of Day	Maximum Vibration Level between 8 and 80Hz (mm/s)
Noise sensitive spaces	7am-10pm	0.20
Bedrooms and sleeping areas only within activities sensitive to noise	10pm-7am	0.14

Vibration must be measured in accordance with ISO 2631-2:2003 *Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 2: Vibration in buildings (1Hz to 80Hz).*

4.3.4 Construction Vibration

The control of construction vibration for this project falls under two categories: human response to vibration and the prevention of cosmetic building damage. Standard E25.6.30.1 of the AUP specifies the following vibration criteria for residential receiver types.

Human Response – Vibration Amenity

For occupied buildings within 50 metres of construction works generating vibration for greater than three days, and where occupants are advised details of construction work in advance, the following vibration levels are deemed acceptable.

Table 5: Human Response Vibration Criteria (during construction lasting more than 3 days)

Receiver	Period	PPV Limit
Occupied Activity sensitive to vibration	Night-time 10pm to 7am	0.3 mm/s
	Daytime 7am to 10pm	2 mm/s
Other occupied buildings	At all times	2 mm/s

Cosmetic Building Damage[8]

For occupied buildings within 50 metres of construction works generating vibration for three days or less, and where occupants are advised details of construction work in advance, vibration must not exceed the levels in DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"* as summarised below.

[8] Vibration levels much higher (in the order of 5 – 10 times) than those listed in Table 6 would be needed to cause structural damage to buildings

Table 6: Prevention of Cosmetic Damage to Buildings DIN4150-3: 1999 Vibration Criteria (mm/s PPV)

Type of Structure	Short-term vibration				Long-term vibration
	Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies	Vibration at horizontal plane of highest floor at all frequencies
	1-10Hz	10-50Hz	50-100Hz		
Commercial, Industrial	20	20 to 40	40 to 50	40	10
Residential, School	5	5 to15	15 to 20	15	5
Historic, Sensitive	3	3 to 8	8 to 10	8	2.5

5.0 NOISE ASSESSMENT

5.1 Replacement WTP Operational Noise

5.1.1 Operational Noise Prediction Methodology

Operational noise has been predicted in general accordance with the algorithm detailed in ISO 9613-2: 1996[9] as implemented in SoundPLAN® environmental noise modelling software. ISO 9613 considers a range of frequency-dependent attenuation factors, including spherical spreading, atmospheric absorption, ground effect and barrier effect.

5.1.2 Operational Noise Predictions

The model considers the noise emission from all significant noise sources and their associated sound power levels as detailed in Appendix E.

The following summarises the conceptual mitigation measures that will be incorporated into the design of the replacement WTP to ensure that noise emission complies with the guideline AUP limits and remains 'reasonable' with respect to s16 of the RMA. These measures would be confirmed during the detailed design stage of the project.

- External above-ground walls and roofs constructed from precast or cast in-situ concrete panels
- The masonry construction requirement would apply to the following buildings:
  - Sludge dewatering, raw water pump station, blower, DAF, CCT pump station
- All external doors to high-noise areas would need to be acoustic with a minimum performance of R_w40dB
- All louvres and vent attenuators servicing high-noise areas would need to be acoustically rated with a minimum performance of R_w25dB or greater in some cases
- No truck movements on site during the night-time period
- No operation of the lime silo cyclone during the night-time period

Table 7 sets out the predicted operational noise levels for the replacement WTP during the most stringent period of the day in terms of the guideline AUP noise limit i.e. the night-time. Compliance with this limit would result in automatic compliance with the higher daytime limit. A comparison is also made to the Huia WTP site's existing predicted environmental noise baseline.

[9] ISO 9613-2: 1996 "Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation"

Table 7: Replacement WTP Noise Levels

Loc. No.	Receiver Location	Zone/AUP Night-time Limit [dB L_{Aeq}]	Huia WTP Baseline (dB L_{Aeq})	Replacement WTP (dB L_{Aeq})	Change in Received Site Noise (dB)
1	12 Manuka Road	Residential [40]	29	36	+7[2]
2	13 Manuka Road	Residential [40]	37	33	-4[1]
3	14 Manuka Road	Residential [40]	28	36	+8[2]
4	16 Manuka Road	Residential [40]	27	38	+11[3]
5	18 Manuka Road	Residential [40]	25	37	+12[3]
6	20 Manuka Road	Residential [40]	23	40	+17[3]
7	78 Kohu Road	Residential [40]	25	40	+15[3]
8	92 Scenic Drive	Residential [40]	20	26	+6[1]
9	94 Scenic Drive	Residential [40]	30	38	+8[2]
10	96 Scenic Drive	Residential [40]	32	37	+5[2]
11	98 Scenic Drive	Residential [40]	33	36	+3[1]
12	100 Scenic Drive	Residential [40]	34	34	No change[1]
13	102 Scenic Drive	Residential [40]	15	24	+9[1]
14	104 Scenic Drive	Residential [40]	16	22	+6[1]
15	106 Scenic Drive	Residential [40]	24	26	+2[1]
16	108 Scenic Drive	Residential [40]	33	27	-6[1]
17	110 Scenic Drive	Residential [40]	34	32	-2[1]
18	112 Scenic Drive	Residential [40]	33	31	-2[1]
19	4, 6, 8, 10, 12, 14, 16 Ngaio Road	Residential [40]	34-37	21-27	-7 to -15

Notes to Table:

(1) Change in noise level would be positive i.e. a reduction or a barely noticeable increase compared to existing background level (green highlight)
(2) Increase in noise level would be appreciable (yellow highlight)
(3) Increase in noise level would be very noticeable (orange highlight)

Based on the noise levels in the table, the operation of the replacement WTP is predicted to comply with the guideline AUP night-time noise limit of 40dB L_{Aeq} at the closest receiver boundaries.

5.1.3 Effects Conclusion on Operational Noise of Replacement WTP

Comparing operational noise from the existing WTP and the replacement WTP shows that noise would naturally increase for some receivers and decrease for others and is a function of the relative distance change. Although this may be the case, the new plant will be inherently quieter than the existing (at the same distance) due to its modern design and adoption of noise control features.

For 17 receivers, the change in received site noise would be positive (a reduction) or a barely noticeable increase compared to the existing acoustic environment (32-35dB L_{A90} and 39-41dB L_{Aeq}). In addition, for four receivers the increase in received site noise would be noticeable (5 to 9dB) although still not intrusive. For the final four receivers the increase in received site noise would be

very noticeable (11 to 17dB), however, importantly the noise emission would remain compliant with the guideline AUP limit permitted in residential zones of 40dB L_{Aeq}.

Based on the above, it is concluded that the operational noise effects from the replacement WTP project would be noticeable for a limited number of receivers but considered acceptable.

Refer to Appendix F for night-time noise contour predictions of the Huia WTP (existing baseline) as well as the replacement WTP.

5.1.4 Cumulative Operational Noise

As is dictated by operational requirements there is likely to be some temporary cross-over in operation between the Huia WTP and replacement WTP. Given this, MDA has predicted cumulative noise levels from the simultaneous operation of both sites. The results are presented in Table 8.

Table 8: Cumulative Noise Levels

Loc. No.	Receiver Location	Zone/AUP Night-time Limit [dB L_{Aeq}]	Huia WTP (dB L_{Aeq})	Replacement WTP (dB L_{Aeq})	Cumulative Level (dB L_{Aeq}, increase in brackets)
1	12 Manuka Road	Residential [40]	29	36	37 (+1)
2	13 Manuka Road	Residential [40]	37	33	38 (+1)
3	14 Manuka Road	Residential [40]	28	36	37 (+1)
4	16 Manuka Road	Residential [40]	27	38	38 (No change)
5	18 Manuka Road	Residential [40]	25	37	37 (No change)
6	20 Manuka Road	Residential [40]	23	40	40 (No change)
7	78 Kohu Road	Residential [40]	25	40	40 (No change)
8	92 Scenic Drive	Residential [40]	20	26	27 (+1)
9	94 Scenic Drive	Residential [40]	30	38	39 (+1)
10	96 Scenic Drive	Residential [40]	32	37	38 (+1)
11	98 Scenic Drive	Residential [40]	33	36	38 (+2)
12	100 Scenic Drive	Residential [40]	34	34	37 (+3)
13	102 Scenic Drive	Residential [40]	15	24	25 (+1)
14	104 Scenic Drive	Residential [40]	16	22	23 (+1)
15	106 Scenic Drive	Residential [40]	24	26	28 (+2)
16	108 Scenic Drive	Residential [40]	33	27	34 (+1)
17	110 Scenic Drive	Residential [40]	34	32	36 (+2)
18	112 Scenic Drive	Residential [40]	33	31	35 (+2)
19	4, 6, 8, 10, 12, 14, 16 Ngaio Road	Residential [40]	34-37	21-27	35-37 (0 to +1)

Based on the results in the table, it is predicted that cumulative noise increases from the temporary operation of both sites would be no more than 3 decibels which is barely noticeable albeit still compliant with the guideline limits of the AUP.

5.2 Construction Noise

As typically occurs on large infrastructure projects such as this, a detailed construction programme would be developed prior to the commencement of construction activities. It is anticipated that this would be prepared by the lead contractor and incorporated into the project's Construction Management Plan. As such, the following preliminary assessment of construction noise (and vibration) has been based on an indicative construction methodology prepared by Alta[10].

It should be noted that the indicative construction methodology is based on a worst-case scenario in that it assumes all cut material from Reservoir 1 excavation cannot be used as fill on the replacement WTP site, which obviously significantly influences the overall number of 6-wheeler truck and trailer movements.

5.2.1 Noise Prediction Methodology

Construction noise has been predicted in general accordance with the method detailed in Annex D[11] of NZS6803:1999. The method considers the sound power level, periods of operation, distance from source to receiver and screening of each source, as well as façade reflection and the degree of soft ground attenuation.

5.2.2 Construction Activity Noise Levels

The following tables set out the plant and activities anticipated to be used during construction works firstly for the replacement WTP site and secondly for the reservoir sites. The tables include the per unit sound power level and the minimum distance required to comply with AUP Rule E25.6.27(4).

Noise from works carried at the replacement WTP site (refer to Table 9) is predicted to comply with the relevant noise limits apart from where vegetation removal (chainsaw/chipper) occurs at 55m from Manuka Road receivers. The occasional exceedance is not uncommon for large infrastructure projects undertaken in proximity to sensitive receivers. The predicted exceedances therefore trigger the requirement for noise mitigation and effects management via a Construction Noise and Vibration Management Plan (CNVMP).

Table 9: Predicted Construction Noise Levels Generated by Replacement WTP Site (Unmitigated)

Activity	Equipment	Sound Power	Façade Noise Level[1] (dB L_{Aeq})			Limit Setback (m)[2]
		(dB L_{WA})	55m	150m	350m	70dB L_{Aeq}
Vegetation Removal	20T excavator	103	61	51	41	25
	Chainsaws / tree chippers	116	***74***	64	54	83
	4-axle bin truck	105	63	53	43	30
Site Establishment	5T excavator	102	60	50	40	22
	20-30T excavator	103	61	51	41	25
	25T crane	98	56	46	36	14
	6-wheel truck	105	63	53	43	30
	Flat deck truck	103	61	51	41	25
	Hiab truck	103	61	51	41	25

[10] ALTA *Indicative Construction Methodology* dated May 2019

[11] Annex D refers to BS5228-1: 1997 (now superceded by BS 5228-1:2009)

Activity	Equipment	Sound Power	Façade Noise Level[1] (dB L_{Aeq})			Limit Setback (m)[2]
		(dB L_{WA})	55m	150m	350m	70dB L_{Aeq}
Bulk earthworks	14-30T excavator	103	61	51	41	25
	Dump truck	106	64	54	44	33
	Bulldozer	110	68	58	48	48
	Sheep's foot roller	103	61	51	41	25
	6-wheel truck & trailer	105	63	53	43	30
Retaining wall construction	Piling (bored and cast in situ	111	69	59	49	52
	25-35T mobile crane	98	56	46	36	14
	5T excavator	102	60	50	40	22
	20-30T excavator	103	61	51	41	25
	Vibrating roller	103	61	51	41	25
	6-wheel truck	105	63	53	43	30
	Flat deck truck & trailer	103	61	51	41	25
	Concrete truck and pump	103	61	51	41	25
Place imported fill up to platform level	14-30T excavator	103	61	51	41	25
	Bulldozer	110	68	58	48	48
	Vibrating roller	103	61	51	41	25
	6-wheel truck & trailer	105	63	53	43	30
WTP Structures	Concrete truck and pump	103	60	51	41	25
	Concrete vibrator	97	61	45	35	13
	50T mobile crane	99	56	47	37	16
	12T excavator	102	63	50	40	22
	8T roller	103	61	51	41	25
	Watercart	97	61	45	35	13
	Elevated work platform	98	61	46	36	14

Notes to Table:

(1) The level as assessed at 1m from a wall most exposed to sound as per Clause 6.2.1 of NZS6803:1999

(2) Limit setback is the distance required for noise from an activity to comply with the limit (70dB L_{Aeq})

As set out in Table 10 overleaf, noise from construction works carried out at the reservoir sites is predicted to comply with the relevant noise limit apart from when vegetation removal (chainsaw/chipper) occurs at 65m from Scenic Drive receivers. The exceedances are minor (3dB) and would be intermittent. Given this work would be carried out during normal construction hours, no adverse effects are anticipated.

Table 10: Predicted Construction Noise Levels Generated during Reservoir Construction (Unmitigated)

Activity	Equipment	Sound Power	Façade Noise Level[1] (dB L_{Aeq})			Limit Setback (m)[2]
		(dB L_{WA})	65m	150m	255m	70dB L_{Aeq}
Vegetation Removal	20T excavator	103	60	51	45	25
	Chainsaws / tree chippers	116	***73***	64	58	83
	4-axle bin truck	105	62	53	47	30
Site Establishment	5T excavator	102	59	50	44	22
	20-30T excavator	103	60	51	45	25
	25T crane	98	55	46	40	14
	6-wheel truck	105	62	53	47	30
	Flat deck truck	103	60	51	45	25
	Hiab truck	103	60	51	45	25
Retaining wall construction	Bored piling rig	111	68	59	53	52
	25-50T mobile crane/crawler crane	105	62	53	47	30
	12T excavator	102	59	50	44	22
	6-wheel truck	105	62	53	47	30
	Flat deck truck & trailer	103	60	51	45	25
	Concrete truck and pump	103	60	51	45	25
Bulk earthworks	14-35T excavator	103	60	51	45	25
	Dump truck	106	63	54	48	33
	Loader	104	61	52	46	28
	6-wheel truck & trailer	105	62	53	47	30
Reservoirs Structures	Concrete truck and pump	103	60	51	45	25
	Concrete vibrator	97	54	45	39	13
	50T mobile crane	99	56	47	41	16
	12T excavator	102	59	50	44	22
	8T roller	103	60	51	45	25
	Watercart	97	54	45	39	13
	Elevated work platform	98	55	46	40	14
Demolition of WTP	14-35T excavator	103	60	51	45	25
	Dump truck	106	63	54	48	33
	Loader	104	61	52	46	28
	6-wheel truck & trailer	105	62	53	47	30

Notes to Table:

(1) The level as assessed at 1m from a wall most exposed to sound as per Clause 6.2.1 of NZS6803:1999
(2) Limit setback is the distanced required for noise from an activity to comply with the limit (70dB L_{Aeq})

Noisy construction should generally be programmed to occur between 7:30 am and 6:00 pm, with no significant construction occurring outside these hours Monday to Saturday and no construction on Sundays, unless supported by an Activity Specific Construction Noise Management Plan (ASCNVMP). An example where an ASCNVMP may be required is for early morning concrete pours.

In the opinion of MDA, if general compliance with the construction noise limits is achieved and a CNVMP/ASCNVMP implemented, particularly for those activities predicted to exceed the relevant limit, then construction noise would be adequately controlled.

5.2.3 Cumulative Activity Noise Levels

Noise predictions have been carried out at four stages of the project's construction for the replacement WTP site as well as one stage for the Reservoir 1 site. These are intended to provide a noise 'snapshot' of cumulative construction noise emission based on all plant operating at critical times for the activities listed in the preceding tables. The following describes each stage:

- Stage 1: Bulk Earthworks and retaining wall construction)
- Stage 2: Concrete Pour Bulk Earthworks in Southern area
- Stage 3: Partial Construction of Buildings
- Stage 4: Construction of Buildings and Storage Tanks
- Reservoir 1 site retaining wall construction and slope stabilisation

Refer to Appendix G for noise contour predictions.

5.2.4 Cumulative Noise Impacts from Parallel Construction Programmes

MDA has considered the potential for cumulative noise impacts during the overlapping periods of work on the replacement WTP and the Reservoir 1 site. Given the sites' separation distances as well as the distances to the nearest common receivers, MDA predicts that the cumulative impact of sustained parallel construction programmes would be +3dB at the most. Given the inherent variability in construction noise and the predicted increase, it is considered that if this scenario were to eventuate it would not result in an increase in adverse effects and would in fact reduce the duration of exposure (due to both sites being worked on in parallel rather than in series) to construction noise, which is a positive effect.

5.2.5 Construction Traffic Noise on Public Roads

Although not explicitly required by AUP provisions, due the size of the project MDA has considered the potential noise impact of increased truck movements on the road network resulting from project's construction.

The indicative construction programme indicates that there will be some overlap between the construction of the replacement WTP and Reservoir 1. The Beca Transportation Assessment states that the highest number of truck movements will be generated during months 29 to 35 (the project has a 93-month programme) with an anticipated 119 to 176 truck movements per day (60 to 88 vehicles) for the combined sites[12].

The following scenarios have been modelled to ascertain the effect on traffic noise levels on the road network based on the Option 2 'one-way loop' option discussed in the Beca report:

[12] Beca Transportation Assessment Figure 3-2

- Existing Baseline: Based on traffic count data and heavy vehicle percentages supplied by Beca. This is considered to be the baseline
- Scenario 1: Average of 33 heavy vehicle movements and 130 staff light vehicle movements per day over a 52-month construction period
- Scenario 2: Maximum of 176 heavy vehicle movements and 130 staff light vehicle movements per day during months 29 to 35

Using traffic count data and trip generation estimates provided by Beca, MDA has predicted traffic noise levels for each scenario using the CoRTN algorithm[13]. The resulting change in traffic noise level for a receiver nominally located at 15m from road's edge is set out in Table 11. Comparison to the Existing Baseline scenario indicates the change in noise level.

The results in the table indicate that the increased truck movements and ratio of heavy vehicles on the identified roads would result in no more than a 1 decibel increase in noise when assessed over the daytime.

MDA concludes that given the relatively moderate number of trips generated during construction works when considering the already comparatively high number of non-project related vehicle movements on the identified roads, the predicted increase in traffic noise level due to project heavy vehicle traffic would be generally imperceptible.

Table 11: Predicted Change in Traffic Noise on Road Network

	AADT / HCV % / Predicted Road Traffic Noise Level (dB $L_{Aeq\ 1\text{-}hour}$)[1, 2,3]			Change in Level to Existing
Road	**Existing Baseline**	**Scenario 1**	**Scenario 2**	
Glendale Rd	12,265 / 3% / 66	12,428 / 3.2% / 66	12,571 / 4.3% / 66	No change
Kaurilands Rd	7,531 / 2.4% / 64	7,694 / 2.8% / 64	7,837 / 4.5% / 64	No change
Atkinson Rd	7,954 / 5% / 64	8,117 / 5.3% / 65	8,260 / 6.9% / 65	(↑1dB)
Scenic Drive	7,325 / 4% / 64	7,488 / 4.5% / 64	7,631 / 6.3% / 64	No change
Woodlands Park Rd	5,135 / 3% / 62	5,298 / 3.7% / 63	5,441 / 6.3% / 63	(↑1dB)
Titirangi Road	18,415 / 5% / 68	18,754 / 4.5% / 68	18,840 / 5.3% / 68	No change

Notes to Table:

(1) Predictions are based on a nominal receiver distance from the road of 15 metres and a speed of 50km/h

(2) AADT = Annual Average Daily Traffic; HCV % = Heavy Commercial Vehicle (expressed as a percentage of total daily flow)

(3) Data supplied by Beca

[13] An adjustment has been applied to the output to convert from L_{10} to L_{eq} descriptor

6.0 VIBRATION ASSESSMENT

6.1 Operational Vibration Assessment

With appropriate design, vibration generation from the operation of the replacement WTP, reservoirs and ancillary equipment is expected to be negligible (i.e. very unlikely to cause annoyance) based on the site's location below and separation distances from the nearest potentially affected receivers.

Based on the above, the vibration effects from the operational phase of the project would be negligible and generally unnoticeable. MDA recommends that the control of vibration is considered during the detailed design process and that all plant is designed to comply with AUP Table E25.6.30.2.

6.2 Construction Vibration

Given the location of reservoir works and setback distances to nearest receivers (refer to Table 1), MDA considers there to be negligible potential for adverse vibration effects from construction of both reservoirs. Therefore, no further consideration is given to vibration generation during reservoir construction in this section.

Referring to the replacement WTP earthworks plan in Appendix B as well as Figure 1 (section 2.2), the drawings indicate that works would occur at a minimum setback distance of 50 metres from building foundations of the closest Manuka Road receivers (18 and 20 Manuka Road), 150m from the Huia Filter Station on the existing Huia WTP site and 45m from the Nihotupu Filter Station located on the northern side of Woodlands Park Road. These setback distances and the potential for vibration effects are considered further in the following sections.

6.2.1 Predicted Construction Vibration Levels

The following plant and activities have been identified as high-vibration sources:

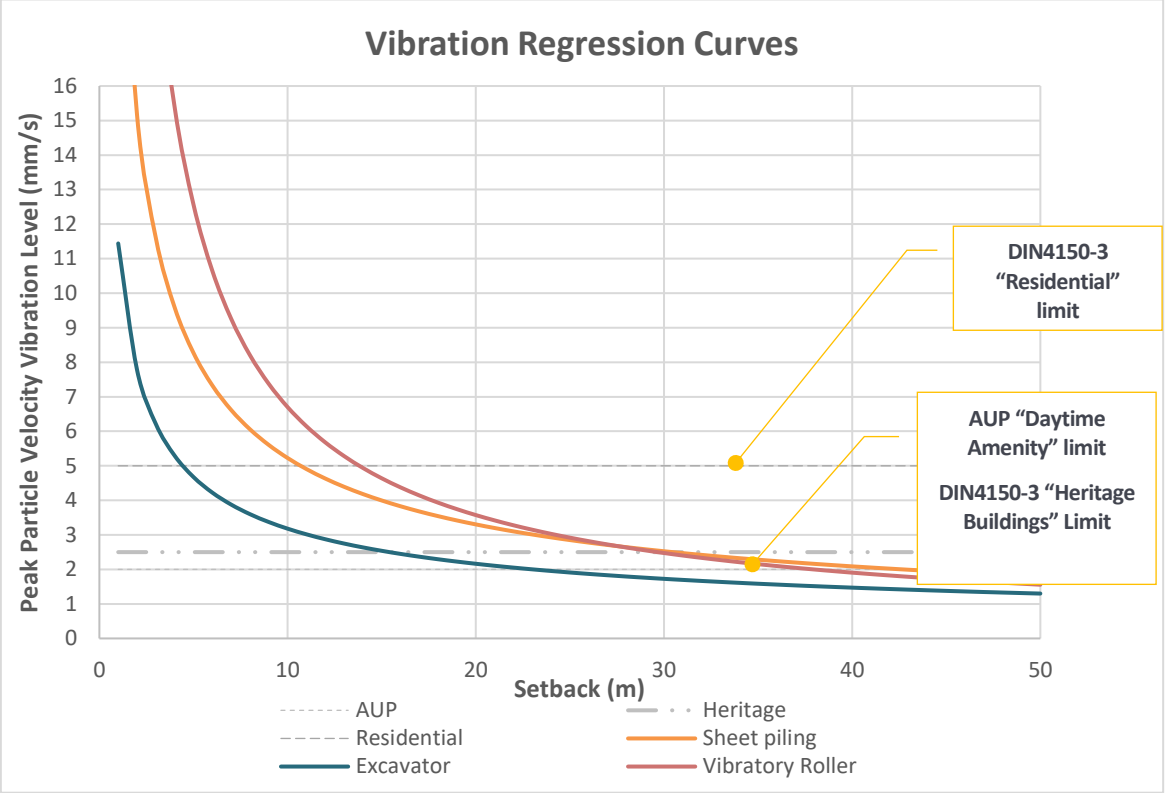
- Excavator
- Sheet piling (replacement WTP site only)
- 7t vibratory roller (road surface reinstatement, formation of foundation base pads)

Vibration source data has been obtained from BS 5228-2:2009[14], measurements made by MDA, and other relevant projects where equivalent plant has been used.

Figure 5 shows the regression curves (PPV vs. distance) for each high-vibration source identified.

[14] BS 5228-2:2009 references Hiller, D.M and Crabb, G.I., *"Groundborne vibration caused by mechanised construction works",* Transport Research Laboratory Report 429, England, 2000

Figure 5: Construction Vibration Propagation



The intersection of the relevant vibration limit and the regression curves in Figure 5 gives an indication of the emission radius of each vibration source. This is the distance inside of which exceedance of the criteria may occur at the foundation of receiving buildings.

The emission radii are summarised in Table 12.

Table 12: Vibration emission radii to comply with cosmetic building damage and AUP amenity criteria

Vibration Source	Emission radius (m)[15]		
	DIN4150 Residential	DIN4150 Heritage	AUP Amenity
Excavator	4	15	23
Sheet piling	11	30	43
7t vibratory roller	14	30	38

6.2.2 Discussion Regarding Construction Vibration

The identified activities can generate high vibration levels at and near the source although, it is noted that vibration would attenuate through the ground during propagation in a relatively short distance to compliant levels at the nearest receiver locations.

Comparing the minimum setback distances noted in the last column of Table 1 to the vibration emission radii given in Table 12 indicates that all activities are predicted to readily comply with the vibration limits in DIN4150-3 and any potential risks of cosmetic damage to these buildings would

[15] MDA recommends that these distances be checked through on-site measurements at the commencement of construction, with the results fed back into the CNVMP.

therefore be low. There would also be a low risk of cosmetic damage to the Nihotupu and Huia Filter Stations; both heritage-listed buildings.

The AUP amenity limits would be complied with at 43 metres distance or greater.

Notwithstanding the above, there will be instances where vibration may be felt by some receivers therefore advance communication with some stakeholders located on Manuka Road is recommended to address any concerns about potential building damage. While vibration limits are comfortably met, pre and post-construction building condition surveys could also be undertaken at the nearest sensitive receptors to alleviate concerns.

7.0 MITIGATION AND MANAGEMENT OF CONSTRUCTION NOISE AND VIBRATION

Potential management and mitigation measures are discussed below.

7.1 Consultation and Communication

The most important tool for managing construction noise and vibration is consultation and communication. For this project, the daytime noise criterion is predicted to generally be achieved at all dwellings although, the limits may be exceeded on occasion, due to various short-term activities.

Communication should occur with stakeholders prior to works being carried out, by means of letter drop or face-to-face contact.

7.2 Timing of Activities

It is noted that general construction hours span two periods in the project construction noise criterion, namely 0630 – 0730 hrs and 0730 – 1800 hrs. Of these periods, the 0630 - 0730 period, often termed the 'morning shoulder', has a significantly lower noise limit than the daytime period. Therefore, a potential risk exists for construction activities to exceed the morning shoulder criterion, unless early morning site activities are appropriately managed. Two examples of early morning site activities include the queueing up of trucks with engines running outside the site gates prior to site opening; the operation of the crane to lift off heavy items delivered by truck during this period.

The management of these issues could include preventing trucks from queuing/idling adjacent to occupied buildings, prohibiting the use of tonal reverse beepers, and scheduling heavy deliveries to occur after 0730 hrs. These management measures and others would be addressed via the CNVMP.

7.3 Avoidance of Unnecessary Noise

At many construction sites it can be observed that some construction practices unnecessarily increase noise levels. Those include the sounding of horns when a truck is fully laden, truck air-brake release and the use of audible, often tonal, reversing alarms.

Those issues can be avoided, or noise levels reduced by means of changed construction site management; fitting of mufflers to trucks; maintenance of equipment to a high standard and the replacement of audible reversing alarms with visual or lower noise broadband audible reversing alarms. Where these measures are implemented they would form a part of best practice management and mitigation of construction noise.

Other unnecessary noise may include shouting, loose tail gates and music/radios played loudly. These can be avoided with good site management and are generally addressed in a management plan.

7.4 Construction Noise and Vibration Management Plan

It is common practice for infrastructure projects of a significant size to include a CNVMP as part of the construction management plan. These contain information on site management, mitigation, communication, complaints procedures and similar issues.

The objective of such a plan is to reduce construction noise and vibration effects through for example, selecting the best practicable option in terms of timing of activities, equipment selection and mitigation measures (or a combination thereof).

The project's noise and vibration management requirements should be identified at an early stage and integrated into all phases of project planning and development and incorporated into tender documents and contracts[16].

The minimum requirements of a CNVMP are set out in NZS6803:1999 Section 8 and Annex E.

The CNVMP should contain, but not be limited to:

- A summary of the project noise criteria
- A summary of construction noise assessments/predictions
- General construction practices, management and mitigation
- Noise management and mitigation measures specific to activities and/or receiving environments
- The requirement for pre and post-construction building condition surveys
- Monitoring and reporting requirements
- Procedures for handling complaints
- Procedures for review of the CNVMP throughout the project

A CNVMP would be implemented on site for each specific area of work and some specific activities where exceedance of the guideline AUP noise limits is likely and will be kept up-to-date regarding actual timing/equipment use and methodologies, should these change at any point during the construction process.

8.0 RECOMMENDED CONDITIONS OF CONSENT

The following conditions are recommended, should consent be granted:

(i) Noise from construction work activity shall be measured and assessed in accordance with the requirements of New Zealand Standard NZS 6803:1999 Acoustics – Construction noise.

(ii) Noise from construction work activities shall where practicable comply with the limits contained in Table E25.6.27.1 of the Auckland Unitary Plan Operative in Part as modified by Standard E25.6.27(4).

(iii) Vibration levels arising from construction work activity of more than three days in a given location shall comply with Standard E25.6.30(1)(b) Table E25.6.30.1 of the Auckland Unitary Plan Operative in Part or limits approved by an Activity Specific Construction Noise and Vibration Management Plan (ASCNVMP).

(iv) Vibration levels arising from construction work activity of three days or less in a given location shall comply with the limits stipulated in Standard E25.6.30(1)(a) of the Auckland Unitary Plan Operative in Part, as set out in German Industrial Standard DIN 4150-3 (1999) Structural

[16] Annex E Clause E2 NZS6803:1999

Vibration – Part 3 Effects of Vibration on Structures, when measured in accordance with that standard.

(v) A Construction Noise and Vibration management Plan (CNVMP) shall be prepared for the works as part of the Construction Management Plan and submitted to Council no less than five days prior to works commencing.

(vi) An ASCNVMP shall be prepared for any night-time works or works predicted to exceed the project construction noise limits and be appended to the main CNVMP.

(vii) The consent holder shall engage a suitably qualified acoustic specialist to prepare the CNVMP and all ASCNVMPs to identify how conditions (ii), (iii) and (iv) will be met. The CNVMP / ASCNVMP shall identify the best practicable option for management and mitigation of all construction noise and vibration, including where full compliance with the levels in Conditions (ii), (iii) and (iv) cannot be achieved at all times. The CNVMP / ASCNVMP shall as a minimum include but not be limited to the following information:

(a) Construction noise/vibration criteria;

(b) Identification of the most affected premises where there exists the potential for noise/vibration effects;

(c) Description and duration of the works, anticipated equipment and the processes to be undertaken;

(d) Hours of operation, including specific times and days when construction activities causing noise/vibration would occur;

(e) Mitigation options where noise/vibration levels are predicted or demonstrated to approach or exceed the relevant limits. Specific noise/vibration mitigation measures must be implemented which may include, but not limited to, acoustic screening, time management procedures and alternative excavation/construction/piling method technologies;

(f) The erection of temporary construction noise barriers where appropriate;

(g) Schedule and methods for monitoring and reporting on construction noise/vibration;

(h) Details of noise/vibration monitoring to be undertaken in the event of any complaints received. The results of such monitoring shall be submitted to council within one week of receiving the complaint;

(i) Implementation of a complaint management system with contact numbers for key construction staff responsible for the implementation of the CNVMP and complaint investigation. This system should include procedures for maintaining contact with stakeholders, notifying of proposed construction activities and handling of noise/vibration complaints;

(j) Notification shall be provided to the owners and occupiers of adjacent buildings prior to construction activities commencing on the site; and

(k) Training procedures for construction personnel.

9.0 SUMMARY AND CONCLUSIONS

Marshall Day Acoustics has carried out an assessment of noise and vibration from the construction and operation of the replacement Huia WTP project. The project includes the construction of two reservoirs on Watercare owned and designated land.

In lieu of any construction noise and vibration conditions in Designation 9324, the relevant rules contained in the AUP have been referenced for guidance on what levels of project noise and vibration could be considered 'reasonable' with respect to s16 of the RMA.

The infrastructure works described in this report are typically carried out almost daily within the Auckland region. Construction noise is the principal acoustic issue that may result in potential effects from this project. This effect has been successfully mitigated and managed on many other comparable construction projects and this project would adopt similar management and mitigation measures to ensure a similar outcome.

The predicted noise and vibration from the proposed construction works represents an outer envelope of effects within which the project is anticipated to operate. This assessment generally predicts compliance with the relevant limits from the AUP except where noted. The predicted exceedances would trigger mitigation and management measures and would be addressed in the CNVMP.

The best practicable option for this project is to ensure that construction noise and vibration effects are managed with the aim of meeting the limits in the AUP and any potential exceedances are identified and addressed through management and mitigation.

A project Construction Noise and Vibration Management Plan is recommended which would be formulated and submitted to Council prior to construction starting. Activity specific management plans would be formulated for any activity predicted to exceed the relevant limits and appended to the main CNVMP.

The noise impact of heavy vehicle movements on the road network has been assessed. The assessment concludes that given moderate number of trips generated during works and when considering the already comparatively high number of vehicle movements on the identified roads, the predicted increase in traffic noise level would be negligible.

Acoustic mitigation measures will need to be included in the design so as to ensure that operational noise complies with the guideline AUP limits. These measures are common-place and would consist of masonry construction for some buildings, specification of acoustic louvres and attenuators to some openings and vents, acoustically rated doors, and avoiding night-time operation for activities such as truck movements and the lime silo cyclone.

Comparing operational noise from the existing WTP and the replacement WTP shows that noise would naturally increase for some receivers and decrease for others and is a function of the relative distance change. Although this may be the case, the new plant will be inherently quieter than the existing (at the same distance) due to its modern design and adoption of the aforementioned noise control features.

Night-time noise is predicted to remain compliant with the guideline AUP limit of 40dB L_{Aeq} for all assessed receivers and would be generally comparable to or less than the level of noise currently received by a number of dwellings on Manuka and Taraire Roads that are close to the existing Huia WTP.

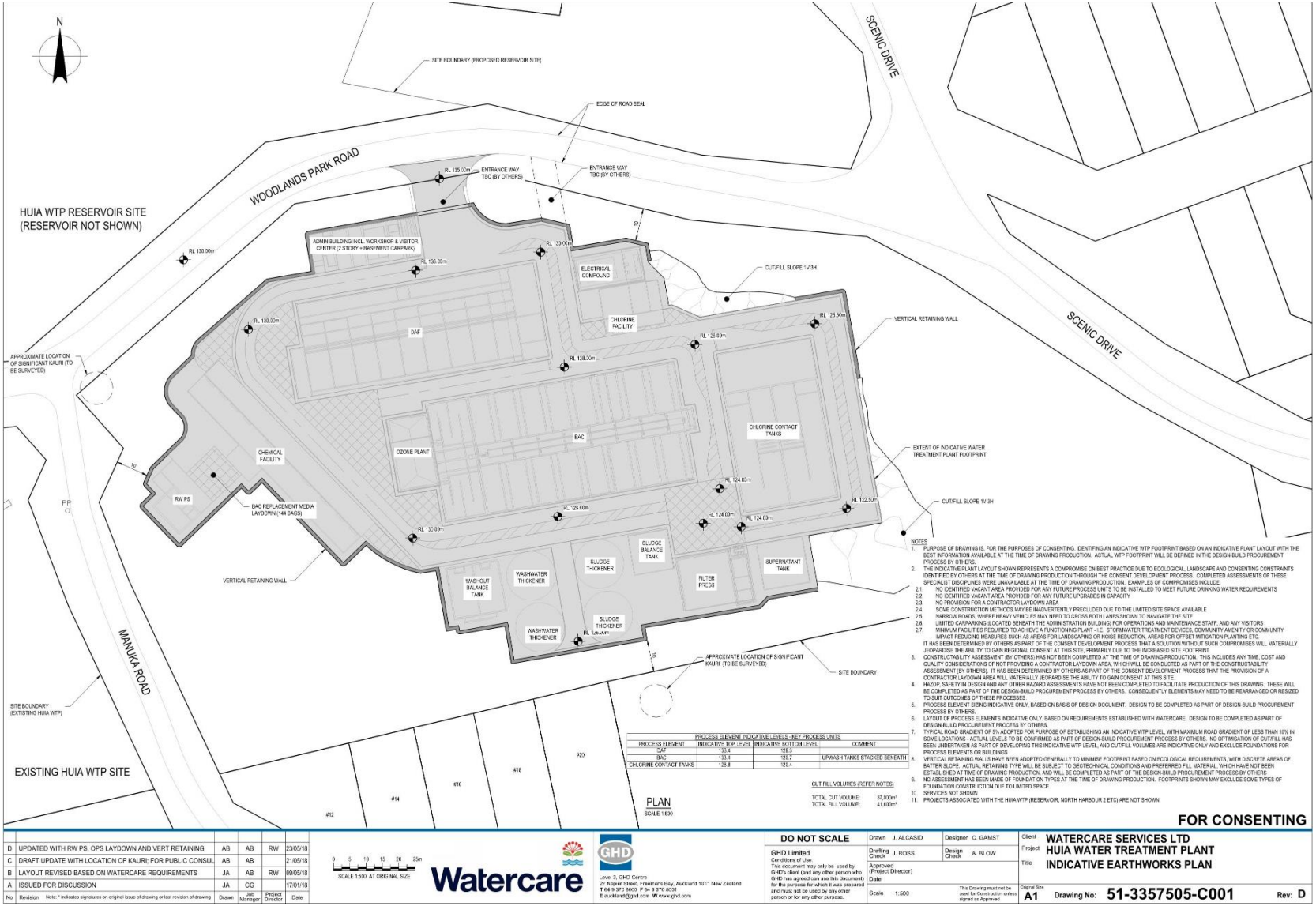
The cumulative noise increase from the temporary operation of both sites would be no more than 3 decibels.

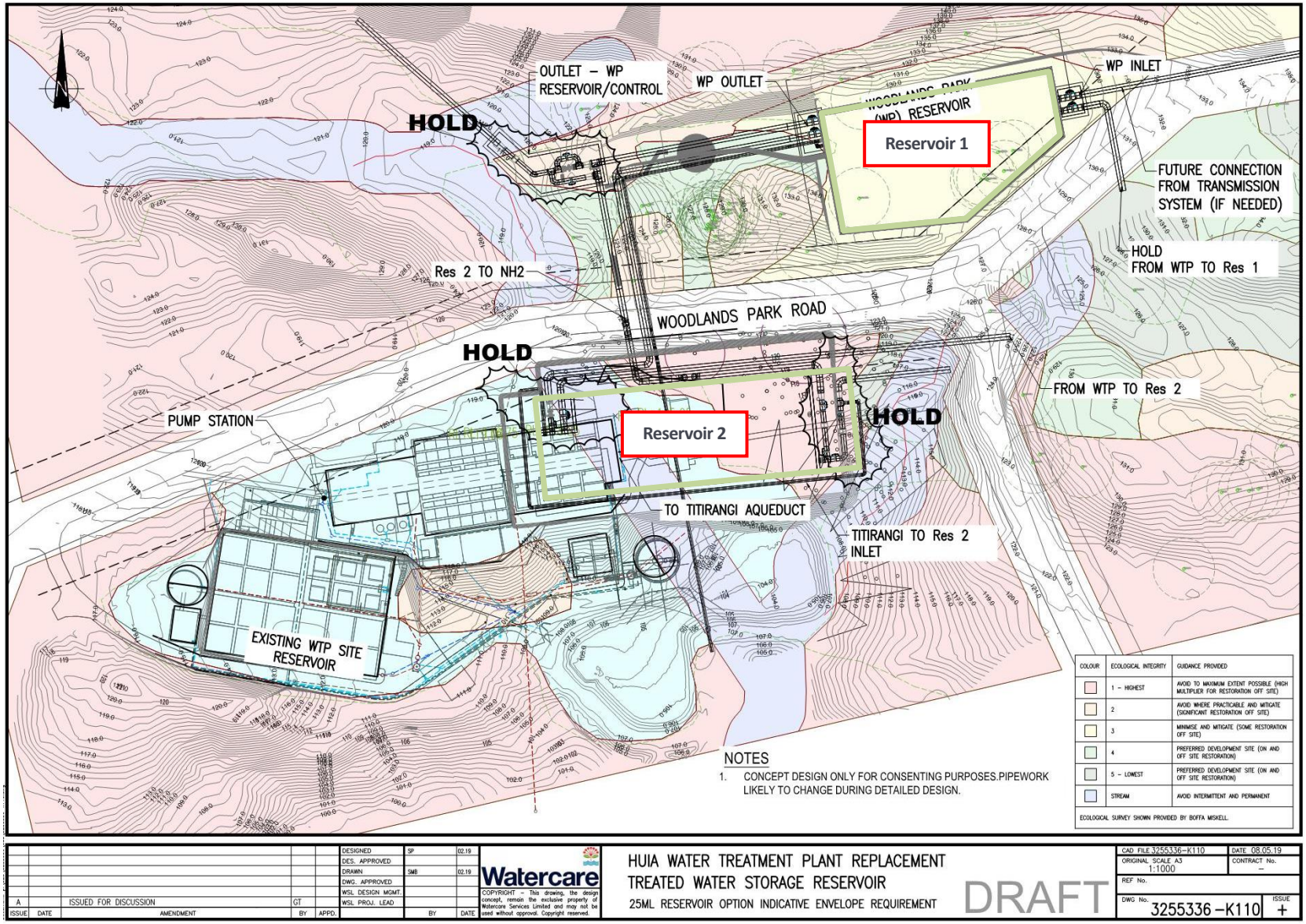
Based on the above, MDA considers that the residual noise and vibration effects associated with the replacement Huia WTP project would be noticeable for a limited number of receivers but considered acceptable.

APPENDIX A GLOSSARY OF TERMINOLOGY

A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear. All noise levels are quoted relative to a sound pressure of $2x10^{-5}$Pa
dB	Decibel. The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of Pr=20 μPa i.e. dB = 20 x log(P/Pr)
dBA	The unit of sound level, which has its frequency characteristics modified by a filter (A-weighted) to approximate the frequency bias of the human ear.
DIN 4150	DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"*
$L_{Aeq\,(t)}$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the measurement time interval to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{AFmax}	The A-weighted maximum noise level. The highest noise level that occurs during the measurement period.
NZS 6801:2008	New Zealand Standard NZS 6801:2008 "Acoustics – Measurement of environmental sound"
NZS 6802:2008	New Zealand Standard NZS 6802:2008 *"Acoustics - Environmental Noise"*
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*
PPV	Peak Particle Velocity For Peak Particle Velocity (PPV) is the measure of the vibration aptitude, zero to maximum. Used for building structural damage assessment.
RMA	Resource Management Act (1991)
SWL or L_W	Sound Power Level A logarithmic ratio of the acoustic power output of a source relative to 10^{-12} watts and expressed in decibels. Sound power level is calculated from measured sound pressure levels and represents the level of total sound power radiated by a sound source.
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into the vertical direction (up and down vibration), the horizontal transverse direction (side to side) and the horizontal longitudinal direction (front to back).

APPENDIX B INDICATIVE WTP AND RESERVOIR SITE LAYOUTS



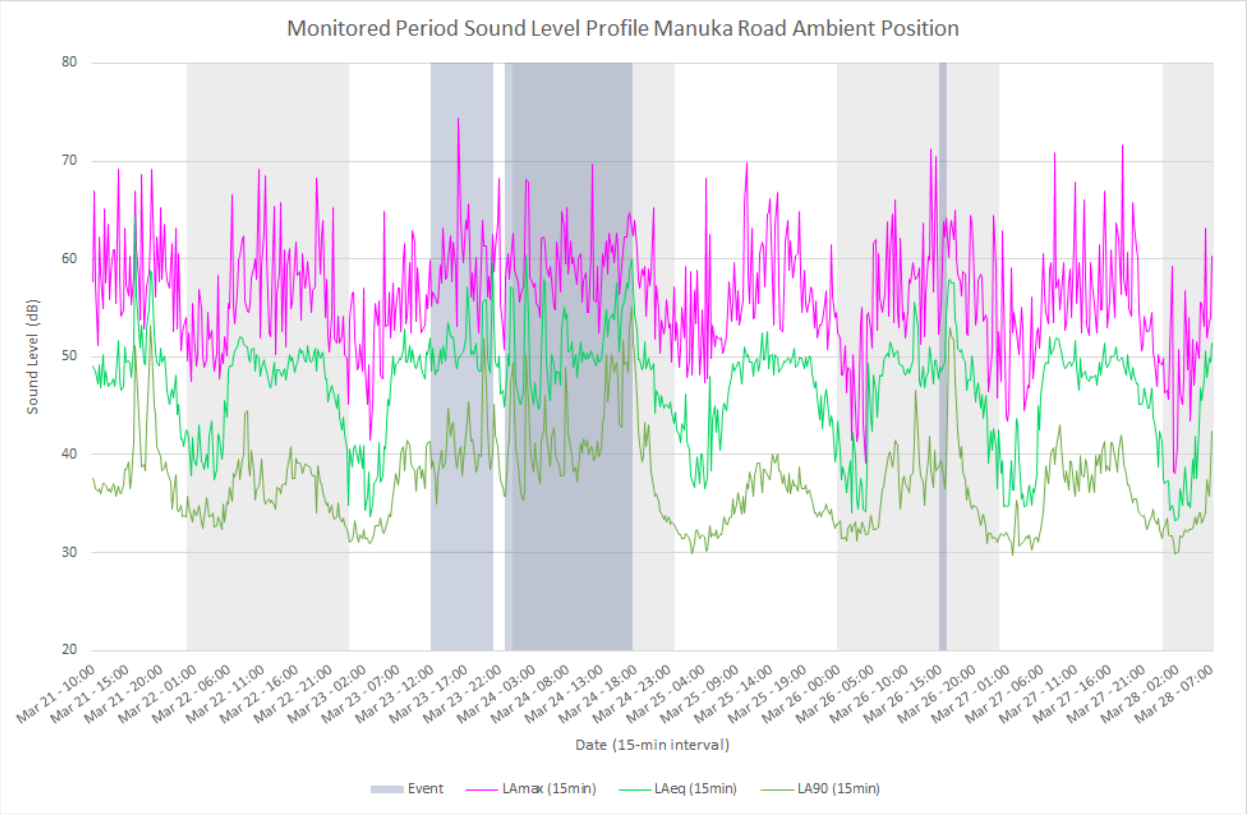


APPENDIX C NOISE LOGGER SUMMARY

Table C1: Results Overview

	LAmax (dB)			LA10 (dB)			LAeq (dB)			LA90 (dB)		
	Ldn	*Ld*	*Ln*	*Ldn*	*Ld*	*Ln*	*Ldn*	*Ld*	*Ln*	*Ldn*	*Ld*	*Ln*
	24-hour	*07 - 22*	*22 - 07*	*24-hour*	*07 - 22*	*22 - 07*	*24-hour*	*07 - 22*	*22 - 07*	*24-hour*	*07 - 22*	*22 - 07*
21 Mar '18	61	62	57	51	52	43	48	49	41	42	43	35
22 Mar '18	65	65	61	47	48	42	44	46	40	37	38	34
23 Mar '18	63	60	63	46	49	42	43	46	40	37	39	34
24 Mar '18	61	61	54	47	48	44	45	46	40	41	42	33
25 Mar '18	66	66	63	46	48	41	44	45	39	36	37	32
26 Mar '18	66	66	60	47	49	42	45	47	39	39	41	33
27 Mar '18	66	66	58	47	48	41	44	46	39	37	39	33
28 Mar '18	58	56	58	43	48	42	41	46	39	35	40	33
AVERAGE	64	64	60	47	49	42	45	46	40	39	40	34
Maximum	66	66	63	51	52	44	48	49	41	42	43	35
Minimum	58	56	54	43	48	41	41	45	39	35	37	32

Figure C1: Noise Logger Level vs Time Histogram



APPENDIX D AUP CONSTRUCTION NOISE LIMITS[17]

Table E25.6.27.1 Construction noise levels for activities sensitive to noise in all zones except the Business – City Centre Zone and the Business – Metropolitan Centre Zone

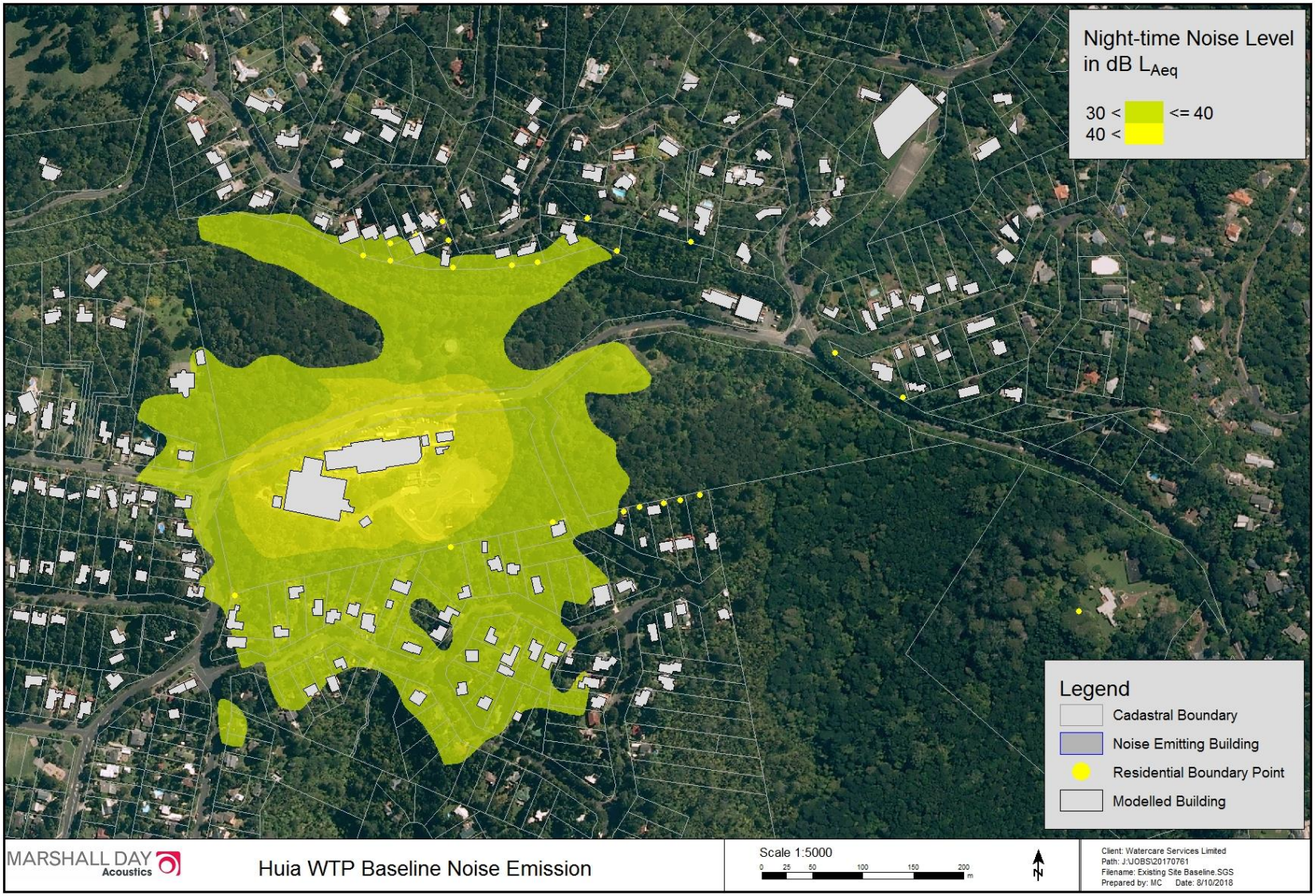
Time of week	Time Period	Maximum noise level (dBA)	
		L_{eq}	L_{max}
Weekdays	6:30am - 7:30am	60	75
	7:30am - 6:00pm	75	90
	6:00pm - 8:00pm	70	85
	8:00pm - 6:30am	45	75
Saturdays	6:30am - 7:30am	45	75
	7:30am - 6:00pm	75	90
	6:00pm - 8:00pm	45	75
	8:00pm - 6:30am	45	75
Sundays and public holidays	6:30am - 7:30am	45	75
	7:30am - 6:00pm	55	85
	6:00pm - 8:00pm	45	75
	8:00pm - 6:30am	45	75

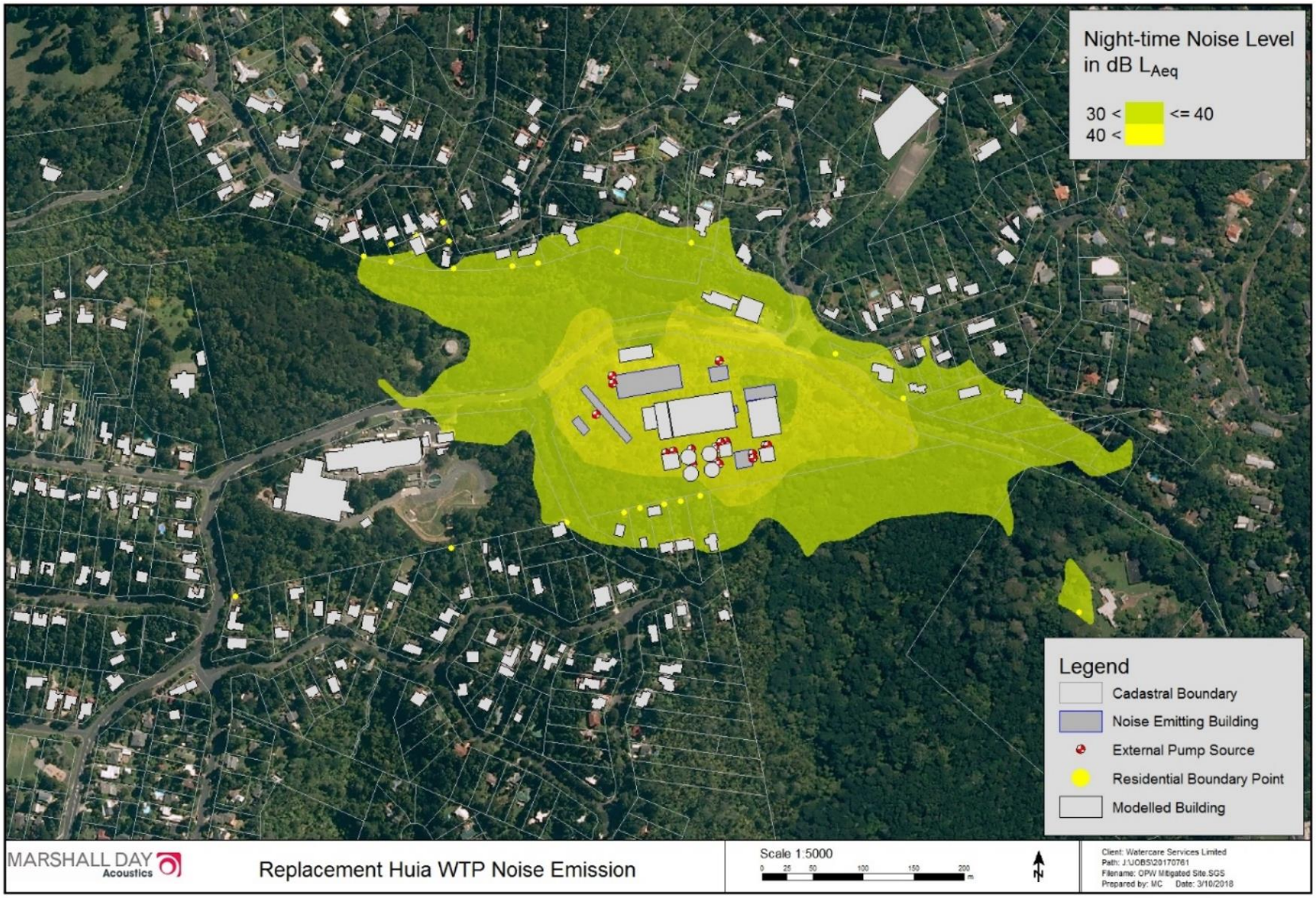
[17] As the anticipated length of the construction period exceeds 20 weeks, Standard E25.6.7 (4) would apply to the project, resulting in the construction noise limits set out in Table E25.6.27.1 decreasing by 5 decibels.

APPENDIX E OPERATIONAL NOISE SOURCE SOUND POWER LEVEL ESTIMATES

	Octave Band Centre Frequency (Hz)							
Source	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**dBA**
5MVA Transformer	81	89	78	64	63	60	58	75
Washwater Thickener Feed Pumps	71	76	71	77	72	73	75	81
Sludge Thickener Feed Pumps	71	76	71	77	72	73	75	81
Supernatant Return Pumps	81	86	81	87	82	83	85	91
Sludge Dewatering Building (L_{prev})	92	96	90	97	103	97	92	105
Sludge Filter Press Pumps	71	76	71	77	72	73	75	81
CCT Pump Station (L_{prev})	71	77	80	79	78	90	75	92
DAF Building (L_{prev})	97	78	83	80	73	67	63	81
DAF Feed Pump	69	70	67	76	71	67	69	77
DAF Tanks	113	93	96	92	86	81	74	94
DAF Mixer	86	80	87	85	79	75	71	86
De-aeration Tank Pumps	71	76	71	77	72	73	75	81
Chemical Storage Building Ventilation Fans	86	88	84	86	85	82	79	90
Blower Building (L_{prev})	105	100	98	102	101	92	85	104
Lime Silo Cyclone	111	110	105	101	95	96	100	106
Semi-trailer Truck	99	103	100	101	100	100	93	105

APPENDIX F HUIA WTP AND REPLACEMENT WTP OPERATION NOISE CONTOUR PREDICTIONS





APPENDIX G CONSTRUCTION NOISE CONTOUR PREDICTION SNAPSHOTS