Noise and Vibration Impact Assessment

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Sydney Water
IN.P0001436

Quakers Hill WRRF Advanced Treatment Upgrade
5 September 2025

Noise and Vibration Impact Assessment

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Executive summary

Jacobs has completed an assessment of the predicted noise and vibration impacts of the Quakers Hill Water Resource Recovery Facility (WRRF) Advanced Treatment Upgrade project (the project). The assessment identifies potential noise impacts during the construction and operation of the project and provides measures to address these impacts.

Background

This noise and vibration impact assessment informs the review of environmental factors that Sydney Water is preparing for the project. The project involves the development of an advanced water treatment plant (AWTP) at Quakers Hill WRRF, an upgrade of the site's existing secondary treatment infrastructure, and a pipeline to transfer brine from Quakers Hill WRRF to the existing Northern Suburbs Ocean Outfall Sewer at Seven Hills.

This report assesses the potential noise, and vibration impacts during construction and operation and provides measures and recommendations to minimise these impacts.

Existing environment

Noise-sensitive receivers were classified into noise catchment areas (NCAs) based on land usage and local noise sources. The Quakers Hill WRRF is mainly in a residential area, with land zoned for low-density residential, public recreation, and educational establishments. The brine pipeline and compounds are in similar areas.

Between 18th March and 7th April 2025, noise monitoring was undertaken at five locations in the residential areas surrounding the Quakers Hill WRRF and the brine pipeline. The background noise levels measured were used in the development of the construction and operation noise targets for the NCAs.

No precision industry was identified within 200 metres of the project. If additional sensitive receivers are identified later, they will need further assessment according to relevant guidelines.

Construction

Construction noise

Construction noise impacts from the upgrades at the Quakers Hill WRRF site, the brine pipeline and the compound sites supporting the pipeline works were assessed using appropriate noise modelling methods. SoundPLAN 9.1 was used for the Quakers Hill WRRF site due to the varying stages and locations of work, while AS2436 methodology was applied for the pipeline and compound works. Following the contractor's appointment and the availability of the detailed construction methodology, the builder must review and confirm the assumptions related to the construction inventory and staging outlined in this report.

At the Quakers Hill WRRF site, both minimum and maximum noise levels during most construction activities are expected to exceed the standard hours Noise Management Levels (NML), but not the Highly Noise Affected level (75dB). Noise levels are generally highest during the early stages of construction, when heavy equipment such as compactors, dump trucks, and concrete trucks are in frequent use. As construction progresses and the use of this machinery decreases or ceases, both the intensity and duration of elevated noise levels are expected to reduce.

For the pipeline works, receivers close to the boundary are predicted to experience noise impacts higher than both the NMLs and Highly Noise Affected levels due to both the proximity of the nearest receivers to the pipeline works and the use of equipment such as excavator mounted hammers (117 dB(A)) and rock breakers (117 dB(A)). However, these impacts are expected to be limited in duration as the pipeline progresses. Similar temporary noise impacts are anticipated at the compound sites.

The compound activities, similarly to the pipeline works, have been predicted to result in noise impacts significantly higher than both the NMLs and Highly Noise Affected levels at the nearest residential receivers, due to the close proximity to the nearest receivers and the use of equipment such as the following:

- Loaders (107 dB(A)) and bulldozers (105 dB(A)) in the support and pipe-stringing compounds
- Excavator mounted hammers (117 dB(A)), rock breakers (117 dB(A)) and horizontal directional drilling (HDD) rigs (106 dB(A)) in the tunnelling compounds

While noise impacts from construction compounds are generally limited in duration, it is acknowledged that some compounds will remain in place for extended periods, potentially several months. As such, these locations may experience longer-term impacts compared to individual pipeline sections, which are typically subject to shorter construction durations as the location of the construction works move. To address this, more permanent mitigation measures, such as the installation of site hoarding, are proposed at compound sites to provide localized noise attenuation for nearby sensitive receivers.

Construction vibration

The minimum working distances developed within the Transport for NSW - *Construction Noise and Vibration Guideline (Roads)* have been used to provide an indication of the distance from the vibration intensive equipment at which nearby receivers may experience vibration impacts. Where a receiver is located within the minimum working distance, vibration monitoring is recommended to inform whether the equipment selection and/or construction methodology be reviewed.

While noise impacts from construction compounds are generally limited in duration, it is acknowledged that some compounds will remain in place for extended periods, potentially several months. As such, these locations may experience longer-term impacts compared to individual pipeline sections, which are typically subject to shorter construction durations as the location of the construction works move. To address this, more permanent mitigation measures, such as the installation of site hoarding, are proposed at compound sites to provide localized noise attenuation for nearby sensitive receivers

Construction traffic noise

Construction traffic for the project will mainly involve light and heavy vehicles. For the majority of the roads used to access the site, such as the M7 Motorway, Quakers Hill Parkway, Sunnyholt Road and Vardys Road, the significant existing traffic volumes meant the proposed construction traffic was highly unlikely to increase traffic noise by more than 2 dB. For Quakers Road (between Quakers Hill Parkway and the Quakers Hill WRRF access), hourly peak construction traffic noise was assessed using *EMF-NV-TT-0067 Construction and Maintenance Noise Estimator (Roads)* (Transport for NSW, 2024) (CMNE(R)) and found to not increase traffic noise by 2dB.

Quakers Road (south of the Quakers Hill WRRF access) and Vardys Road however are both anticipated to carry lower traffic. An initial test with the CMNE(R) identified that 50 light vehicle movements and one heavy vehicle movement would be capable of reaching but not exceeding the 55 dB(A) hourly daytime noise criteria. As such, further investigation of whether the existing traffic noise on these roads to determine if construction traffic would increase the overall noise levels by 2dB or more should be undertaken prior to the commencement of construction.

Ground-borne noise

Ground-borne noise (GBN) is mainly a concern for underground construction like tunnelling and HDD, especially during evening and night-time in residential areas. It is generally not an issue for surface construction or commercial properties. GBN is only relevant when it is audible and exceeds airborne noise levels inside habitable rooms.

To stay below the night-time GBN threshold of 35 dB $_{LAeq(15min)}$, a minimum 50 metre separation from buildings is typically needed. For slant distances under 50 metres, site-specific monitoring is recommended.

HDD activities planned at night may pose a sleep disturbance risk to residents within 50 metres of drilling but more than 100 metres from compound sites. Near compound sites, airborne noise is expected to dominate.

Cumulative noise

The potential for cumulative construction noise impacts was assessed in accordance with the *Cumulative Impact Assessment Guidelines for State Significant Projects* (Department of Planning, Industry and Environment, 2022). The only nearby project identified as potentially relevant is the Quakers Hill to Prospect project, for which cumulative impacts were assessed. The cumulative noise impact at the nearest receivers associated with the Quakers Hill WRRF project is expected to be negligible.

Operation

Operational noise impacts

Noise levels from the retained existing Quakers Hill WRRF, along with the proposed AWTP and secondary treatment upgrades, have been predicted at the surrounding potential noise sensitive receivers. Following construction, the operation of the brine pipeline is expected to generate negligible noise emissions. As such, operational noise from the brine pipeline is not further assessed in this report. Construction noise impacts associated with the proposed advanced treatment upgrade and secondary treatment expansion were assessed using SoundPLAN 9.1 due to the complexity of the noise sources and the software's detailed modelling capabilities.

The assessment found that at the most noise-affected receiver, the highest predicted noise levels under noise-enhancing conditions are up to 12-17 dB(A) higher than the nominal day project noise trigger levels (PNTLs) at NCA01, NCA02 and NCA03. Within NCA01, the loudest noise is predicted to come from the AWTP area, the new blower room, and some existing equipment, notably the odour control stack and backwash pumps. The AWTP and blower room also contribute the most noise at NCA02, while at NCA03, the largest noise source is the brine transfer pumps located in the far south of the Quakers Hill WRRF site.

Cumulative noise

The operational noise assessment follows the *Noise Policy for Industry* (NSW Environment Protection Authority, 2017), which already accounts for cumulative impacts from nearby industrial sources when setting project-specific noise criteria. Therefore, no additional cumulative assessment of nearby operations is required in this report.

Mitigation of noise impact

Mitigation of construction impacts

Based on the construction noise and vibration predictions and assessments, feasible and reasonable mitigation measures must be implemented to reduce or eliminate impacts. Once the contractor finalises the construction methodology, stages, and equipment, a detailed Construction Noise and Vibration Management Plan must be prepared.

Sydney Water's safeguard measures for noise and vibration measures have been adopted to address construction noise and vibration impacts. Sydney Waters' standard noise mitigation measures have also been provided to be applied where reasonable and feasible. These measures have been further supplemented with measures to address other identified impacts including construction traffic noise and impacts associated with HDD works.

Mitigation of operational noise

The assessment of operational noise found that noise from the project is likely to exceed the PNTLs at NCA01, NCA02 and NCA03 during all time periods. Therefore, it was necessary to explore mitigation options to achieve the PNTLs. The minimum required attenuation can be achieved by selecting quieter equipment or providing additional mitigation measures like a steel acoustic enclosure.

For this assessment, the application of a 3-millimetre steel acoustic enclosure is assumed as an indicative mitigation measure and proof of concept.

For this assessment a number of indicative mitigation measures were applied to determine the minimum required attenuation required to reduce noise to below the PNTLs. These measures included the application of acoustic enclosures to proposed pumps and blowers, the addition of acoustic lining on the proposed odour control unit stack, and the use of acoustic louvres in the proposed blower room. It is noted that the mitigation measures assumed in this study are indicative only to demonstrate proof of concept.

With the application of the above measures, the highest predicted noise levels under standard meteorological conditions remain at or below the nominal PNTLs at all times of day in NCA 02 and NCA 03. Within NCA 01, noise impacts are greater than the day and evening PNTLs at a single receiver on Riley Place during noise enhancing conditions. This increases to four receivers experiencing noise greater than the night PNTLs. It is noted that these receivers are all on the southern extent of Riley Place and Elwood Crescent.

When considering these noise impacts, it is noted that these receivers were identified as experiencing noise greater than the PNTLs primarily due to the contribution of the retained equipment. Additionally, due to the proximity of these receivers to the M7 Motorway, it is highly likely that the background noise at these receivers is greater than the rating background levels measured within the NCA (which were measured further back from the motorway). This would have a masking effect on the noise from the Quakers Hill WRRF site and would limit the actual impact from the works on these receivers.

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Acronyms and abbreviations

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<tr><th>Term/ Abbreviation</th><th>Definition</th></tr>
<tr><td>Ambient noise level</td><td>The prevailing noise level at a location due to all noise sources but excluding the noise from the specific noise source under consideration. Generally measured as a dB(A) noise level.</td></tr>
<tr><td>Acoustic spectrum</td><td>The sound pressure level (or sound power level) as a function of frequency (e.g. octave band, ⅓ octave or narrow band). Generally used to identify noise sources or items contributing disproportionately to an overall noise level.</td></tr>
<tr><td>AGL</td><td>Above ground level</td></tr>
<tr><td>Approved Methods</td><td>Approved Methods for the Measurement and Analysis of Environmental Noise in NSW (EPA, 2022)</td></tr>
<tr><td>AWTP</td><td>Advanced water treatment plant</td></tr>
<tr><td>Background noise level</td><td>The lower ambient noise level, usually defined as the value of the time varying ambient noise level exceeded for 90% of the measurement time. Usually defined in the dB(A) scale - LA90.</td></tr>
<tr><td>BTF</td><td>Biotrickling filter</td></tr>
<tr><td>CIP</td><td>Clean in place</td></tr>
<tr><td>CMNE(R)</td><td>EMF-NV-TT-0067 Construction and Maintenance Noise Estimator (Roads) (TfNSW, 2024)</td></tr>
<tr><td>CNVG(R)</td><td>Construction Noise and Vibration Guideline (Roads) (TfNSW, 2024)</td></tr>
<tr><td>CNVMP</td><td>Construction Noise and Vibration Management Plan</td></tr>
<tr><td>Day period</td><td>The period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays as defined in the Noise Policy for Industry 2017 (NSW EPA, 2017).</td></tr>
<tr><td>dB</td><td>Sound pressure levels are expressed in decibels as a ratio between the measured sound pressure squared and the reference pressure squared $[10\times\log_{10}(p^2/p_{ref}^2)]$. The reference pressure p_{ref} is 20 micro-Pascals (20×10^{-6} Pascal or 20 mPa). Some typical noise levels are presented below:
<table>
<tr><th>Sound Pressure Level, dB(A)</th><th>Example</th></tr>
<tr><td>130</td><td>Threshold of pain</td></tr>
<tr><td>120</td><td>Jet aircraft take-off at 100 m</td></tr>
<tr><td>110</td><td>Power tool at 1 m</td></tr>
<tr><td>100</td><td>Nightclub</td></tr>
<tr><td>90</td><td>Heavy trucks at 5 m</td></tr>
<tr><td>80</td><td>Kerbside of busy street</td></tr>
<tr><td>70</td><td>Loud radio (in typical domestic room)</td></tr>
<tr><td>60</td><td>Office</td></tr>
<tr><td>50</td><td>Domestic fan heater at 1m</td></tr>
<tr><td>40</td><td>Living room</td></tr>
</table>
</td></tr>
</table>

Term/ Abbreviation	Definition
	30 — Theatre 20 — Rural environment on still night 10 — Sound insulated test chamber 0 — Threshold of hearing
dB(A)	The A-weighted sound pressure level in decibels, denoted dB(A) is the unit generally used for the measurement of environmental, transportation or industrial noise. The A-weighting scale approximates the sensitivity of the human ear when it is exposed to normal levels and correlates well with subjective perception over a number of different types of sounds. An increase or decrease in sound level of approximately 10 dB(A) corresponds to a subjective doubling or halving in loudness. A change in environmental noise level of 2 dB(A) is considered to be just noticeable.
dB(C)	The unit used for measuring occupational health and safety maximum industrial noise levels in Australia is the C-weighted sound pressure level in decibels, denoted dB(C). C-weighting has a relatively flat response when compared to an A-weighting network.
dB(Z)	Z-Weighted Decibel, Un-weighted Decibel or Linear Decibel
DEC	NSW Department of Environment and Conservation (former)
DECC	NSW Department of Environment and Climate Change (former)
EPA	NSW Environment Protection Authority
Evening period	The period from 6 pm to 10 pm Monday to Sunday and public holidays as defined in the *Noise Policy for Industry 2017* (NSW EPA, 2017).
Frequency	The rate of repetition of a sound wave. The unit of frequency is the Hertz (Hz), defined as one cycle per second. Human hearing ranges approximately from 20 Hz to 20,000 Hz. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. The most commonly used frequency bands are octave bands. For more detailed analysis each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.
FTA	Federal Transit Administration
GBN	Ground-borne noise
HDD	Horizontal directional drilling
ICNG	Interim Construction Noise Guideline (DECC, 2009)
km	Kilometres
L_{A90}	The A weighted sound pressure level that is exceeded for 90% of the measurement period. Usually used to represent the background noise level.
L_{eq}, L_{Aeq}	The equivalent continuous sound level. The steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level. The A weighted equivalent continuous sound level is denoted L_{Aeq}.

Term/ Abbreviation	Definition
L_{Max}, L_{AMax}	The maximum measured sound pressure level. The A-weighted maximum measured sound pressure level is denoted L_{AMax}.
m	Metres
MBR	Membrane bioreactor
ML/day	Megalitres per day
mm	Millimetres
m/s	Metres per second
mm/s	Millimetres per second
MRAS	Membrane Return Activated Sludge
NATA	National Association of Testing Authorities
NCA	Noise catchment area
Night period	The period from 10 pm to 7 am Monday to Saturday or 10 pm to 8 am on Sundays and public holidays as defined in the *Noise Policy for Industry 2017* (EPA, 2017).
NPfI	*Noise Policy for Industry* (EPA, 2017)
NSOOS	Northern Suburbs Ocean Outfall Sewer
NSW	New South Wales
OOHW	Out of hours works
PANL	Project amenity noise level
PINL	Project intrusiveness noise level
PNTL	Project noise trigger level
PPV	Peak particle velocity
PRW	Purified recycled water
RBL	Rating background level
RE	Reclaimed effluent
REF	Review of environmental factors
RNP	NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011)
RO	Reverse osmosis
SH	Standard hours
Sound level meter	An instrument consisting of a microphone, amplifier and data analysis package for measuring and quantifying noise.
SPL	Sound pressure level (dB)
Suitably qualified acoustic consultant	An acoustic consultant who is a full member of the Australian Acoustical Society (or equivalent)
SWL	Sound power level
TfNSW	Transport for NSW
The project	Quakers Hill WRRF Advanced Treatment Upgrade project

Term/ Abbreviation	Definition
UF	Ultrafiltration
VDV	Vibration dose value
WAS	Waste activated sludge
WRRF	Water resource recovery facility

1. Introduction

1.1 Background

This noise and vibration impact assessment report has been prepared to inform the review of environmental factors for the Quakers Hill Water Resource Recovery Facility (WRRF) Advanced Treatment Upgrade project (the project). The project involves the development of an advanced water treatment plant (AWTP) at Quakers Hill WRRF, an upgrade of the site's existing secondary treatment infrastructure, and a pipeline to transfer brine from Quakers Hill WRRF to the existing Northern Suburbs Ocean Outfall Sewer (NSOOS) at Seven Hills. The location of the project is shown in Figure 1.1. Sydney Water is the proponent of the project.

This report provides an assessment of the potential noise and vibration impacts associated with the construction and operation of the project and identifies measures and recommendations for avoiding or minimising these impacts.

1.2 Project overview

Upgrades to Sydney Water's Quakers Hill WRRF are required by 2028 to:

- Service industry growth and housing policies as the current treatment capacity at the plant of 28 megalitres per day (ML/day) is expected to be exceeded in late 2028
- Meet environment protection licence (EPL) limits that require reduced nutrient loads to the Hawkesbury-Nepean River (Sackville 2 zone)
- Provide high quality water treatment that enables a future purified recycled water (PRW) scheme and its introduction into Prospect Reservoir.

The project is in the Blacktown local government area, in largely urbanised areas with a mix of residential, industrial, and recreational land uses.

The key features of the project include:

- A secondary treatment process upgrade from the current 28 ML/day to 48 ML/day
- A new AWTP, including reverse osmosis (RO), ultrafiltration (UF) and stabilisation
- A range of ancillary infrastructure such as new buildings, tanks, pipes, services and chemical storage
- Demolition and restoration of previously decommissioned structures
- A new brine pipeline to transfer the brine generated as a by-product of the reverse osmosis process into the existing wastewater network. The pipeline would:
  - Have a flow capacity of up to 12.5 ML/day
  - Be about 8 kilometres (km) long and about 500 millimetres (mm) diameter
  - Be installed largely along shared paths, public parkland, and road corridors
  - Be mostly underground and built using open trench and trenchless methods
  - Be connected into Sydney Water's existing NSOOS.

The AWTP is required to treat wastewater to meet more stringent nutrient limits. However, it would also produce high quality water that could be further treated to produce PRW.

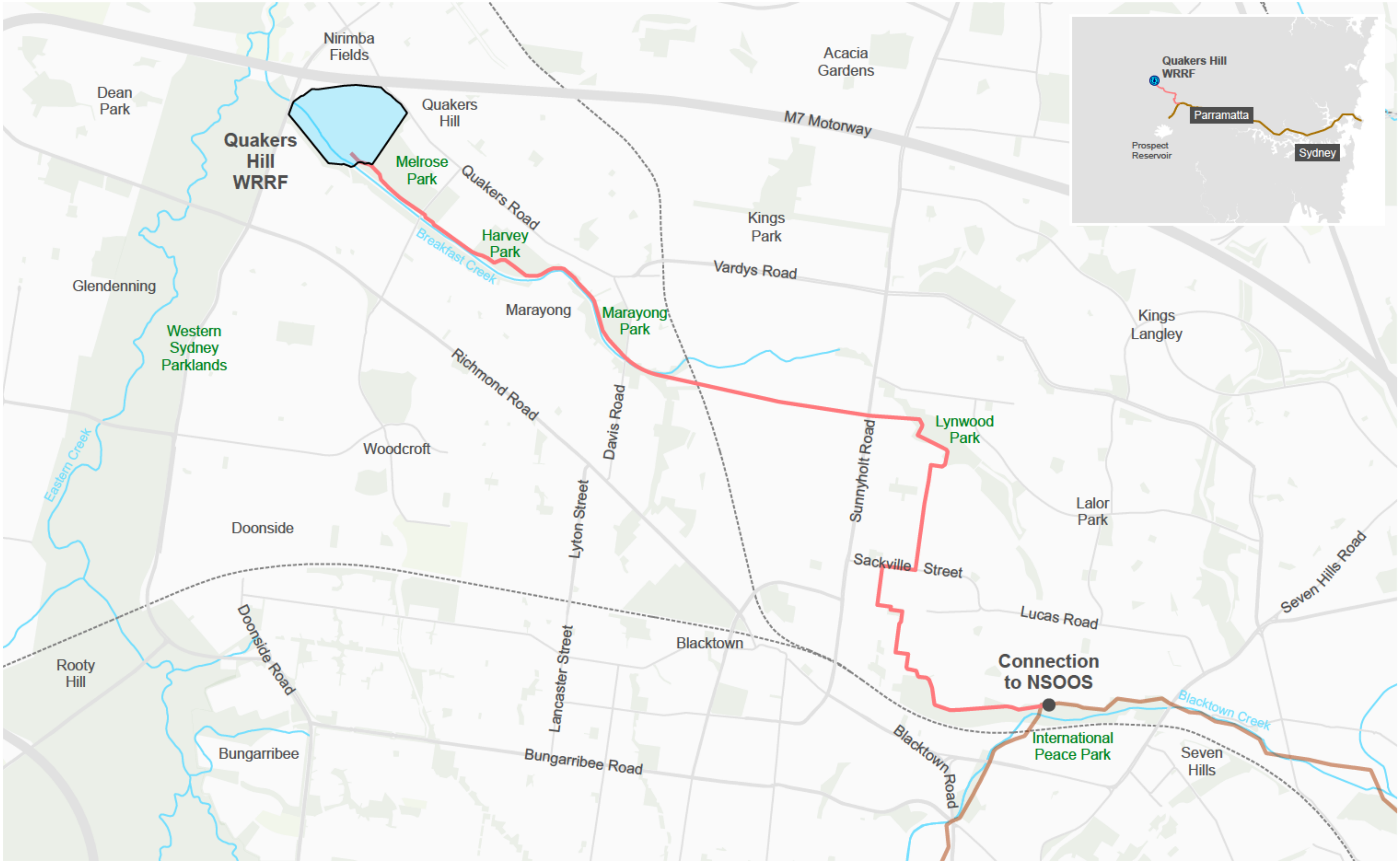
Sydney Water is preparing an REF for the project. This report has been prepared to support that REF. PRW is not part of the scope of this assessment. Sydney Water is separately assessing the potential introduction of PRW in an environmental impact statement.

1.3 Purpose

The purpose of this noise and vibration impact assessment is to assess and address potential noise and vibration impacts associated with the construction and operation of the project. It also aims to provide guidance on ways of managing the potential noise and vibration impacts to avoid any environmental degradation.

1.4 Assessment area

The desktop assessment is of an impact assessment area that includes the Quakers Hill WRRF site as well as land on either side of the brine pipeline.



Quakers Hill Water Resource Recovery Facility (WRRF)

Brine pipeline

NSOOS pipeline

Parks and open space

Figure 1-1 Overview of the proposed scheme

0 1 km

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:35,000 @ A4
GDA2020 MGA Zone 56

1.5 Report structure

The report is structured as described in Table 1.1 below.

Table 1.1 Structure of the noise and vibration impact assessment report

Chapter	Contents
Chapter 1 Introduction	Outlines details of the project in addition to the purpose of this report (this Chapter).
Chapter 2 Existing environment	Provides a description of the existing land usage and noise-sensitive receivers around the proposed alignment, in addition details of the noise monitoring undertaken.
Chapter 3 Legislation and policy context	Provides a description of the applicable policy and guidelines for the assessment of construction noise and vibration, as well as operational traffic noise, in addition to determining the appropriate criteria for the assessment.
Chapter 4 Method	Details the approach and methodology to the assessment, in addition to the modelling parameters and inputs into the assessment.
Chapter 5 Impact assessment	Presents the results and outcomes of the assessment, and details whether measures to mitigate and/or manage noise impacts are required.
Chapter 6 Mitigation and management	Summarises appropriate mitigation measures to be applied to manage the predicted impacts.
Chapter 7 Conclusion	Summarises the findings of this report.

2. Existing environment

This section provides an overview of the current noise environment related to the project, including relevant noise information. The surrounding areas have been categorised into several 'noise catchment areas' (NCAs), based on anticipated predominant background noise and the proximity to major noise sources (e.g. highways, rail, etc.). The following subsections detail the existing acoustic environments and the defined NCAs.

2.1 Land usage and sensitive receivers

2.1.1 Quakers Hill WRRF

A portion of the project is located within the Quakers Hill WRRF site in Quakers Hill, NSW. Quakers Hill WRRF is bordered to the south and southeast by land zoned in the *Blacktown Local Environmental Plan 2015* as RE1 – Public Recreation, to the west by the Western Sydney Parklands area under Chapter 7 of the State Environmental Planning Policy (Precincts—Western Parkland City) 2021 (which currently consists mainly of undeveloped farmland and bushland) and the M7 Motorway to the north. The land usage beyond these areas is residential, with the majority of land zoned as R2 – Low Density Residential, with pockets of land zoned as B1 – Neighbourhood Centre, B2 – Local Centre and SP2 – Educational Establishment. The nearest noise sensitive receivers are located approximately 140m from noise sources within the WRRF, with residential receivers to the north and southwest being the nearest.

2.1.2 Brine pipeline

The brine pipeline extends from the Quakers Hill WRRF to International Peace Park in Seven Hills, passing through the suburbs of Marayong, Blacktown and Lalor Park. The land surrounding the pipeline is predominantly zoned as R2 – Low Density Residential, with a number of parks zoned as RE1 – Public Recreation and smaller pockets of land zoned as SP2 – Educational Establishment. Distances to the nearest sensitive receivers vary depending on the section of the pipeline. However, at a number of locations the pipeline works would extend to the property boundary of residential receivers. The pipeline crosses a section of land zoned as B7 – Business Park. However, this part of the pipeline would be tunnelled using horizontal directional drilling (HDD), supported by two compounds at each end of the tunnel. During the tunnelling works, airborne noise is expected only to be generated at the supporting compound sites.

2.2 Noise catchment areas

For the purpose of assessing noise impacts, areas with similar existing noise conditions are typically grouped into NCAs, based on anticipated predominant background noise and proximity to major noise sources (e.g. highways, rail, etc.). These NCAs are not necessarily the same as the assessment areas; rather, they serve to characterise the baseline noise environment prior to the commencement of the proposed construction works.

Based on the land usage, background noise influences and sensitive receivers, the land surrounding the project was divided into NCAs. The NCAs have been described in Table 2.1 and the maps showing the NCAs have been provided in Figure 2.1.

Table 2.1 Noise catchment areas

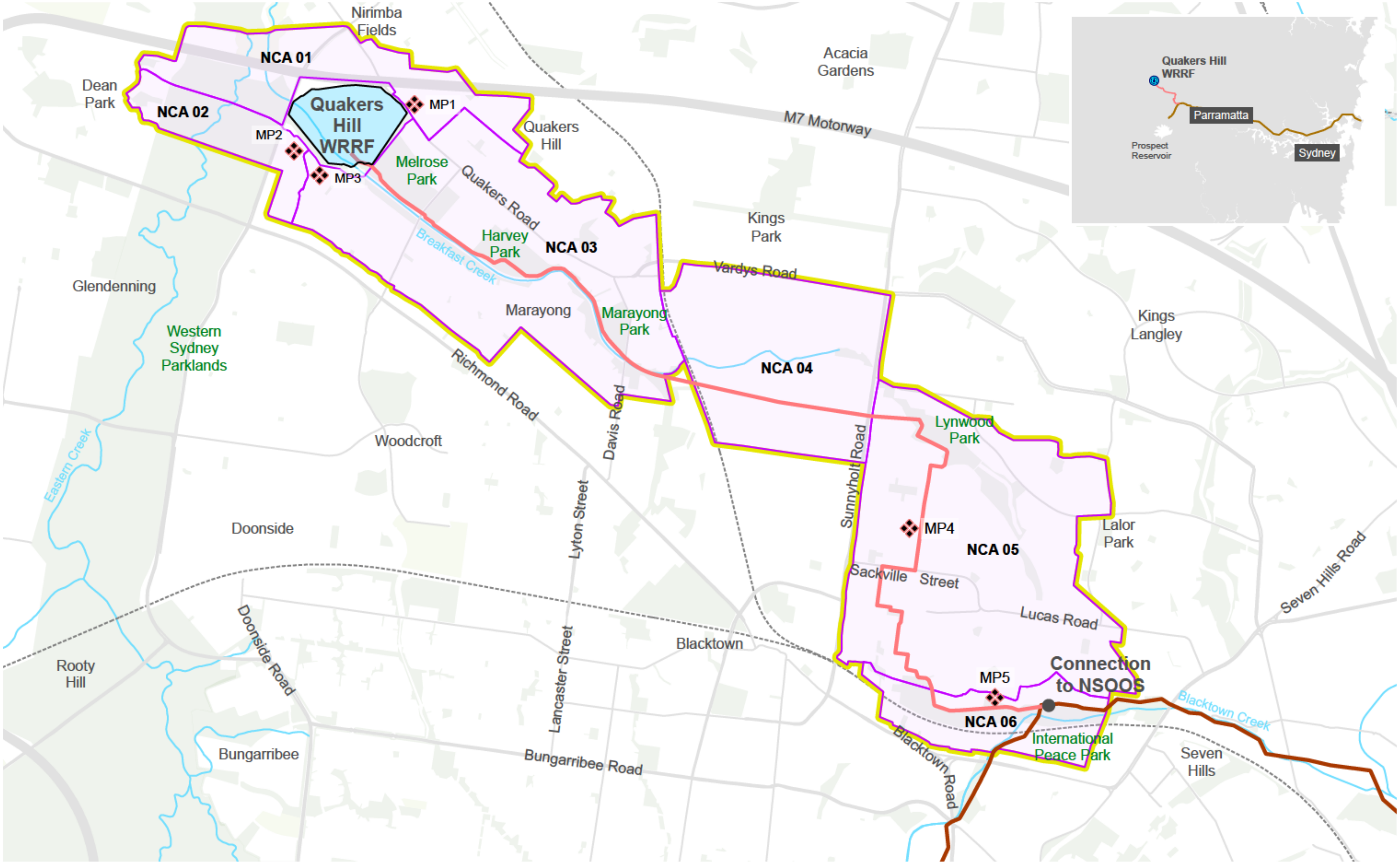
NCA	Suburbs	Background noise sources	Land usage
NCA 01	▪ Quakers Hill ▪ Dean Park	▪ M7 Motorway ▪ Local traffic	▪ Residential ▪ Passive recreation
NCA 02	▪ Quakers Hill ▪ Dean Park	▪ Local traffic	▪ Residential ▪ Passive recreation
NCA 03	▪ Quakers Hill ▪ Marayong	▪ M7 Motorway ▪ Local traffic	▪ Residential ▪ Passive recreation ▪ Educational
NCA 04	▪ Blacktown ▪ Kings Park	▪ North Shore & Western Line ▪ Cumberland Line ▪ Local traffic ▪ Local industry	▪ Industry ▪ Commercial
NCA 05	▪ Blacktown ▪ Lalor Park ▪ Seven Hills	▪ Local traffic	▪ Residential ▪ Passive recreation ▪ Educational
NCA 06	▪ Blacktown ▪ Seven Hills	▪ North Shore & Western Line ▪ Cumberland Line ▪ Local traffic	▪ Residential ▪ Passive recreation ▪ Educational

In order to provide an indication of the non-residential receivers which may be impacted within each NCA, identified key non-residential noise-sensitive receivers have been detailed in Table 2.2.

Table 2.2 Key non-residential noise sensitive receivers in NCAs

NCA	Non-residential receivers	
NCA 01	▪ Childcare	▪ Quakers Road Family Daycare
NCA 02	▪ Recreation	▪ Western Sydney Parklands Richmond Road
NCA 03	▪ Education	▪ Quakers Hill Public School ▪ St Andrews College Junior Campus ▪ St Andrews Primary School ▪ St Andrews College Marayong
	▪ Childcare	▪ Marayong Preschool ▪ Playbright Marayong ▪ Oz Kindy Early Learning Centre ▪ Holy Family Childrens Centre ▪ Quakers Road Family Daycare
	▪ Place of Worship	▪ Our Lady of Czestochowa Queen of Poland, Marayong ▪ Polish War Memorial Chapel ▪ St Andrew The Apostle Catholic Church, Marayong
	▪ Medical	▪ Quakers Court Medical Centre ▪ Marayong Medical Centre

NCA	Non-residential receivers	
	▪ Recreation	▪ Melrose Park ▪ Harvey Park ▪ Marayong Park and Sports Field
	▪ Aged Care	▪ Noble Care Australia
NCA 04	Nil	
NCA 05	▪ Education	▪ Seven Hills West Public School ▪ St Bernadette's Primary School ▪ Lalor Park Public School
	▪ Childcare	▪ Kids Academy Early Learning Blacktown ▪ Rose of Sharon Child Care and Preschool ▪ Kermi's Kindy ▪ The Hills Little Learners ▪ Our Little Angels - Family Day Care
	▪ Place of Worship	▪ Blacktown Baptist Church ▪ Victory Life Christian Church ▪ C3 Church Blacktown ▪ St Bernadette's Catholic Church
	▪ Medical	▪ Barbara Boulevard Medical Centre
	▪ Recreation	▪ Lynwood Park ▪ Cavanagh Reserve ▪ Stuart Mould Park ▪ Bill Swift Reserve ▪ Bruce Street Reserve ▪ Vera Street Reserve
	▪ Aged Care	▪ Euroka Homes Retirement Village ▪ Hardi Aged Care
NCA 06	▪ Recreation	▪ Blacktown Aquatic Centre ▪ International Peace Park ▪ Cumberland Nepean Softball Grounds



Quakers Hill Water Resource Recovery Facility (WRRF)
Brine pipeline
NSOOS pipeline
Parks and open space
Logger locations
Noise catchment areas
Noise study area

Figure 2-1 NCAs and noise measurement

0 1 km

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024
Scale: 1:35,000 @ A4
GDA2020 MGA Zone 56

2.3 Background noise monitoring

Background and traffic noise monitoring was performed from 18 March to 7 April 2025. Meteorological data was obtained at the monitoring stations set up at 6 Chaplin Crescent, Quakers Hill and 32A Janice St, Seven Hills. Since all noise monitoring locations were within 30 km of each other the measured meteorological data was assumed to be applicable at the other noise monitors. Details of the noise monitoring equipment used are provided in Table 2.3. The noise monitoring locations are shown in Figure 2.1.

Table 2.3 Noise monitoring equipment details

Equipment class	Measurement location	Equipment model	Serial number	Calibration date
Noise logger	6 Chaplin Crescent, Quakers Hill	SV 307A S/N	131818	26th Nov 2024
	12 Ebony Crescent, Quakers Hill	SV 307A S/N	131814	30th Jan 2025
	21 Jasmine Ave, Quakers Hill	SVAN 977 S/N	98091	10th Jul 2024
	32A Janice St, Seven Hills	SV 307A S/N	131817	6th Nov 2024
Weather station	6 Chaplin Crescent, Quakers Hill	SVAN WS1	22480106	-
Calibrator	32A Janice St, Seven Hills	SVAN WS2	22480104	-
	Every location	B&K Cal	125708	27th Feb 2025

Monitored background noise levels have been summarised in Table 2.4. The table shows the equivalent noise level (L_{Aeq}) and 'rating background level' (RBL). In this context, the L_{Aeq} represents the continuous A-weighted sound pressure level over 15 minutes, while the RBL represents the lowest 10th percentile of L_{A90} noise (the A-weighted noise level that is exceeded for 90% of the time).

Graphs of the monitored noise levels are provided in Appendix A. These graphs show the filtering of extraneous effects in accordance with the background noise monitoring guidance within Fact Sheet B of the *Noise Policy for Industry* (NSW Environment Protection Authority (EPA), 2017) (NPfI), including removing data where detectable rainfall occurred and/or wind speed over 5 metres per second (m/s) occurred.

Table 2.4 Background noise levels

Monitor ID	NCA	Monitoring location	Monitoring duration	Measurement	Primary noise source	Measured Noise Level – $L_{Aeq,15min}$ dB(A)[1]		
						Day	Evening	Night
MP1	NCA01	6 Chaplin Crescent, Quakers Hill	18th Mar – 1st Apr	L_{Aeq}	Nature & Traffic	48	48	49
				RBL		40	42	41
MP2	NCA02	12 Ebony Crescent, Quakers Hill	18th Mar – 1st Apr	L_{Aeq}	Nature & Traffic	52	50	58
				RBL		39	43	45
MP3	NCA03	21 Jasmine Ave, Quakers Hill	19th Mar – 1st Apr	L_{Aeq}	Traffic	56	50	45
				RBL		37	40	38

Monitor ID	NCA	Monitoring location	Monitoring duration	Measurement	Primary noise source	Measured Noise Level – $L_{Aeq,15min}$ dB(A)[1]		
						Day	Evening	Night
MP4	NCA05	83 Harold St, Blacktown	26th Mar – 7th Apr	L_{Aeq}	Traffic	50	47	43
				RBL		38	38	35
MP5	NCA06	32A Janice St, Seven Hills	18th Mar – 1st Apr	L_{Aeq}	Traffic (Train)	51	55	57
				RBL		38	40	44

Note 1: Time periods are based on guidance within the Noise Policy for Industry 2017:

- Day: the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays
- Evening: the period from 6 pm to 10 pm
- Night: the remaining periods (10 pm to 7 am Monday to Saturday or 10 pm to 8 am on Sundays and public holidays)

2.4 Existing noise sources

A number of noise sources within the Quakers Hill WRRF had been identified based on the sources listed in the *Quakers Hill WRP – Construction and Operational Noise Impact Assessment Report* (AAJV, 2017) and guidance provided by Sydney Water. Noting that a number of operational changes have occurred at Quakers Hill WRRF since that assessment was undertaken, it was considered appropriate to undertake noise monitoring on site to confirm noise sources and source noise levels. The review and site measurements focused solely on the currently operational equipment that will be retained as part of the project.

On 7th May 2025 a site visit was conducted to observe and measure the noise sources on site. The identified sources, quantities, measured noise levels and additional observations have been detailed in Table 2.5.

Table 2.5 Summary of noise monitoring undertaken at Quakers Hill WRRF

Noise source	Quantity	Measured sound pressure level (SPL) @ 1 m	Notes
Gallery vent fan	1	72	The fan was located at a height of 1.4 m above ground level (AGL).
Filter building pumps	6	82	Two pumps were submerged and were hence inaudible. The remaining four pumps were located at a height of 2.2 m AGL.
Sodium bisulphate tank pumps	3	-	One pump was operating at the time of measurement. Pump was inaudible over other noise sources.
Concentrate transfer pumps	4	N/A	The pumps were not operating on day of monitoring; however, it was noted that two of the four pumps typically operate at any one time. Pumps were located in a 3 m deep pit, at a height of 0.5 m AGL.
Primary sludge treatment pumps	2	88	One pump was operating on the day of monitoring; however, both typically operate. Pumps were located in a 2 m deep pit, at a height of 0.5 m AGL.
Odour control unit fans	3	Eastern – 84 Centre – N/A Western – 77	The centre fan was not in operation on the day of monitoring. The eastern fan was identified as being older than the western fan. Fans are located at a height of 0.5 m AGL.

Noise source	Quantity	Measured sound pressure level (SPL) @ 1 m	Notes
Odour control unit stack	1	85	Stack was measured at ground level, 23 m west of the stack. Noise at 1 m was calculated based on this measurement.
St Marys Transfer pumps	4	75	One pump was operating on the day of monitoring. Pumps were located in a 2.5 m deep pit, at a height of 2 m AGL.
Backwash pumps	2	72	One pump was operating on the day of monitoring. Typically pumps only operate once every 12 hours for a duration of 10 minutes. Pumps were located at a height of 2.6 m AGL.
Blower room	1	Front louvres – 68 Rear louvres – 76	Two louvres (0.5 m W x 0.9 m H) were located on the front (western) façade of the building, while four louvres (1.8 m W x 1.9 m H) were located on the rear (eastern) façade of the building. The loudest louvre on each façade has been displayed, however the measured noise levels from the louvres on each façade of the building were generally consistent with one another.

The noise measurements, including the recorded one third octave noise levels were used in site noise modelling. The one third octave noise data have been displayed in Appendix A.

2.5 Particularly vibration sensitive items

Specific buildings and structures, such as precision industry, medical centres and heritage items can be particularly vibration sensitive due to their nature of operations or structural conditions.

A review of land use surrounding the project area found no precision industry within 200 m of the project. A single medical centre located within 200m of the Project was identified and has been provided in Table 2.6.

Table 2.6 Medical centres identified within 200 metres of the Project

Medical centre	Address	Distance from works (m)[1]
Barbara Boulevard Medical Centre	6/78 Barbara Blvd, Seven Hills	146

Note 1: Distance measured from construction impact area to base of the structure.

The identified non-Aboriginal heritage items have been provided in Table 2.7.

Table 2.7 Non-Aboriginal heritage items identified within 200 m of the project

Jurisdiction	Heritage register	Item No.	Listing	Address	Distance from works (m)[1]
State	Section 170 Heritage and Conservation Register (Sydney Water)	4570286	NSOOS	-	0 (Project connects to item)
Local	Blacktown Local Environmental Plan 2015	I17	House	5 Sarsfield Street, Blacktown	45
		I12	House	11 Harold Street, Blacktown	80
		I16	House	2 Sarsfield Street, Blacktown	104
		I34	Church	116 Quakers Road, Marayong	180

Note 1: Distance measured from vibration intensive construction impact area to base of the structure.

A review of Aboriginal Heritage Information Management System (AHIMS) and Aboriginal Heritage Impact Permit (AHIP) sites in the vicinity of the works identified a number of sites within 200 m. These are displayed in Table 2.8.

Table 2.8 Aboriginal heritage items identified within 200 m of the project

Item ID	Item classification	Distance from Project impact area (m)[1]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Note 1: Distance measured from vibration intensive construction impact area to the location.

Aboriginal heritage structures such as artefacts, scatters and scar trees do not typically have the same level of susceptibility to vibration as larger heritage structures. The Aboriginal Cultural Heritage Assessment Report should be reviewed to identify further information on the sites; the type of artefacts found on the sites and the status of the sites.

3. Legislation and policy context

3.1 Legislation, policy and guidelines

The following sections summarise the current legislative requirements and guidelines relevant to noise and vibration considerations for the project. Table 3.1 outlines the legislation and policy context with regard to noise and vibration, including guidance documents.

Table 3.1 Legislation, policy and guidelines applicable to the project

Legislation, policy or guideline	Brief description and intent	Relevance to the project
Protection of the Environment Operations Act 1997 (POEO Act)	The POEO Act is the principal environmental legislation in NSW, designed to protect, restore, and enhance the quality of the environment while promoting ecologically sustainable development. It consolidates laws related to air, water, noise, and waste pollution into a single, streamlined framework. The Act empowers the NSW Environment Protection Authority (EPA) and local councils to regulate pollution through licensing, monitoring, and enforcement.	The POEO Act is directly relevant to managing noise impacts during both the construction and operational phases of the project. It provides the legal framework and regulatory tools for controlling noise pollution from the project. The Act supports proactive noise management through planning approvals and licensing, and it is often implemented in conjunction with guidelines like the ICNG to assess and mitigate noise impacts effectively.
Environmental Planning and Assessment Act 1979 (EP&A Act)	The EP&A Act is the cornerstone of the planning system in NSW. Its primary intent is to establish a structured and transparent framework for land use planning and development assessment across the state. The Act governs how development applications are assessed, how planning instruments are created, and how strategic planning is conducted. It aims to balance environmental protection, economic development, and community well-being by ensuring that planning decisions are made in a fair, efficient, and consultative manner. The Act also mandates community participation and integrates environmental considerations into the planning process to support sustainable development.	The EP&A Act is relevant to managing noise impacts during both the construction and operational phases of the project. It provides the legal and procedural framework for assessing development proposals, including their potential environmental impacts such as noise.
Interim Construction Noise Guideline (Department of Environment and Climate Change (DECC), 2009) (ICNG)	The ICNG provides a framework for the assessment and management of noise impacts from construction and maintenance activities. The ICNG's primary purpose is to ensure that feasible and reasonable mitigation measures are implemented to manage construction noise, in order to minimise the impact on surrounding communities.	The ICNG defines the methodology for the assessment of construction noise impacts. It also defines 'Noise Management Levels' (NMLs), which are used to determine the impact of construction noise on receivers.

Legislation, policy or guideline	Brief description and intent	Relevance to the project
Noise Policy for Industry (EPA, 2017) (NPfI)	The NPfI aims to ensure that noise impacts from industrial activities are managed effectively and consistently. The NPfI provides a framework for assessing and mitigating operational noise impacts to protect community wellbeing and amenity while supporting industrial growth and investment. It establishes 'Project Noise Trigger Levels' to evaluate potential impacts and provides guidance on feasible and reasonable noise mitigation measures.	The NPfI defines the assessment methodology for the assessment of noise from the operation of the project. It also defines 'Project Noise Trigger Levels', which are used to determine the impact of construction noise on receivers.
NSW Road Noise Policy (Department of Environment, Climate Change and Water, 2011) (RNP)	The RNP aims to manage and mitigate the impact of road traffic. The RNP provides a comprehensive framework for the assessment and management of road noise. It sets out the noise assessment criteria for different types of sensitive use receivers and road categories and emphasises the importance of feasible and reasonable noise mitigation measures.	The RNP provides guidance on the assessment of construction traffic noise impacts.
Assessing Vibration: a technical guideline (Department of Environment and Conservation (DEC), 2006)	*Assessing Vibration: a technical guideline* (DEC, 2006) provides a framework for evaluating human exposure to vibration. Its primary intent is to provide guidance on assessing vibration impacts and recommending effective management measures to address identified impacts.	Assessing Vibration provides the vibration criteria which drives the setback distances for human comfort impacts.
Construction Noise and Vibration Guideline (Roads) (Transport for NSW (TfNSW), 2024) (CNVG(R))	The CNVG(R) provides a detailed framework for assessing and mitigating noise and vibration impacts from road construction activities. Its primary intent is to ensure that feasible and reasonable measures are implemented to minimise the impact of construction noise and vibration on surrounding sensitive receivers. It applies to all road construction and maintenance projects under TfNSW's control; however the guidance provided in the CNVG(R) remains applicable and useful for non-TfNSW projects.	The CNVG(R) provides minimum working distances for vibration impacts which have been adopted to assess the potential vibration impacts from the construction of the project.
Approved Methods for the Measurement and Analysis of Environmental Noise in NSW (EPA, 2022) (Approved Methods)	The Approved Methods establishes the minimum requirements and good-practice procedures for the measurement of environmental noise. The guidance in the document supplements the noise measurement guidance in documents such as the ICNG and NPfI.	The Approved Methods provided additional guidance on the background and site noise monitoring undertaken.

3.2 Construction noise targets

The establishment and selection of the appropriate target noise levels for construction activities and traffic are detailed in the following subsections.

3.2.1 Construction noise

Target noise levels for construction activities are developed through guidance from the ICNG. Particularly, it provides guidance for the development of noise management levels (NMLs), as well as targets for sleep disturbance impacts.

3.2.1.1 Noise Management Levels

The ICNG provides guidance for assessing noise from construction activities in NSW. It establishes NMLs for recommended standard construction hours and for hours outside of the recommended standard hours.

Construction is considered to have the potential to cause a noise impact if the predicted noise exceeds the applicable noise management level. Table 3.2 lists ICNG guidance for establishing construction NMLs at residential receivers.

Table 3.2 ICNG guidance for establishing construction NMLs at residential receivers

Time of day	Noise management level ($L_{Aeq\,(15\,min)}$)	How to apply
Recommended standard hours (SH): Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected: RBL + 10 dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15\,min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of work to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected: 75 dB(A)	The highly noise affected level represents the point above which there may be a strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for work near schools, or mid-morning or mid-afternoon for work near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours – All other times including public holidays	Noise affected: RBL + 5 dB(A)	A strong justification would typically be required for work outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see Section 7.2.2 of the ICNG.

Construction activities would be undertaken during the recommended standard hours. However, there may be some situations where construction may need to be carried out outside of the recommended standard construction hours. Since the exact timing of the required work outside the recommended hours is not known at this stage, three additional Out-of-Hours Works (OOHW) periods are assumed:

- Day (outside of standard hours) 7:00 am – 6:00 pm Outside of Standard Hours
- OHHW-1 (Evening) 6:00 pm – 10:00 pm
- OOHW-2 (Night) 10:00 pm – 7:00 am.

Considering the RBLs presented in Table 2.4, the NMLs for the identified surrounding residential receivers are presented in Table 3.3.

Table 3.3 Construction noise management levels (residential receivers)

Receiver	NML $L_{eq\ 15min}$ dB(A)			
	Day (during standard hours) 7 am – 6 pm Weekdays, 8 am – 1 pm Saturdays	Day (outside standard hours) 7am – 6 pm	OOHW-1 (Evening) 6 pm – 10 pm	OOHW-2 (Night) 10 pm – 7 am
NCA 01	50	45	45[1]	45[1]
NCA 02	49	44	44[1]	44[1]
NCA 03	47	42	42[1]	42[1]
NCA 04[2]	-	-	-	-
NCA 05	48	43	41	40
NCA 06	48	43	43[1]	43[1]

Note 1: RBL decreased to not be louder then preceding period.

Note 2: No residential receivers are in this NCA.

The ICNG also provides construction NMLs for non-residential land uses. These are presented in Table 3.4.

Table 3.4 ICNG NMLs for non-residential receivers

Non-residential receiver type	Noise management level, $L_{Aeq(15min)}$ (applies when properties are occupied and are in use)
Commercial	External Noise Level – 70 dB(A)
Industrial	External Noise Level – 75 dB(A)
Educational facilities	Internal Noise Level – 45 dB(A)
Hospital / Medical	Internal Noise Level – 45 dB(A)
Place of Worship	Internal Noise Level – 45 dB(A)
Passive Recreation	External Noise Level – 60 dB(A)
Active Recreation	External Noise Level – 65 dB(A)

It should be noted that the EPA is developing a new construction noise guideline, the Construction Noise Guideline, which is currently in draft form. When released, the Construction Noise Guideline will replace the ICNG. As of the timing of this report, the draft version of the Construction Noise Guideline remains largely the same as the ICNG.

3.2.1.2 'Particularly annoying' noise characteristics

Section 4.5 of the ICNG identifies a number of activities that are proven to be particularly annoying to nearby residents, including:

- Use of 'beeper' style reversing or movement alarms, particularly at night-time
- Use of power saws, such as those used for cutting timber, rail lines, masonry, road pavement or steel work
- Grinding metal, concrete or masonry
- Rock drilling
- Line drilling
- Vibratory rolling
- Rail tamping and regulating
- Bitumen milling or profiling
- Jackhammering, rock hammering or rock breaking
- Impact piling.

As per the recommendations of the ICNG, a +5 dB(A) penalty is applied to the assumed Sound Power Level (SWL) of the equipment when the above-mentioned equipment is proposed for use, refer to Appendix B for assumed SWLs.

3.2.1.3 Sleep disturbance

For premises where night construction occurs, the potential for noise levels to lead to sleep disturbance should be considered. Section 4.3 of the ICNG discusses the method for assessing and managing sleep disturbance. This guidance references further information in the RNP that discusses the assessment of sleep disturbance. Based on the advice on sleep disturbance impacts contained within the RNP, a sleep disturbance screening criterion of RBL +15 dB(A) is advised. As additional guidance, Appendix E of CNVG(R) provides an external noise level of L_{AMax} 65 dB(A) as a benchmark for an 'awakening reaction' related to night-time construction activities.

Based on the above guidance, a night-time sleep disturbance 'screening criterion' noise goal of RBL +15 dB(A) has been used to identify the receivers where there is potential for sleep disturbance. Where the sleep disturbance screening criterion is exceeded, further assessment is conducted to determine whether the 'awakening reaction' level of L_{Amax} 65 dB(A) would be exceeded and the likely number of these events. The awakening reaction level is the level above which sleep disturbance is considered likely to occur.

Based on the approach above, Table 3.5 presents the sleep disturbance screening and awakening reaction levels for the residential receivers surrounding the project.

Table 3.5 Sleep disturbance screening levels

Receiver	L_{AMax} Sleep disturbance screening level	L_{AMax} Awakening reaction screening level
NCA 01	55[1]	65
NCA 02	54[1]	65
NCA 03	52[1]	65
NCA 04[2]	-	-
NCA 05	52	65
NCA 06	53[1]	65

Note 1: RBL decreased to not be louder then preceding period.

Note 2: No residential receivers are in this NCA.

3.2.2 Construction traffic noise

The ICNG advises that road traffic noise impacts due to construction traffic are assessed against the RNP. The project has been assessed against the following guidance from the application notes of the RNP:

> *'…for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion.'*

In reference to the day or night assessment criterion above, the assessment refers to the criterion provided in the RNP, displayed in Table 3.6 below.

Table 3.6 Relevant road noise policy assessment criteria

Road category	Type of project/land use	Assessment criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq, (15\ hour)}$ 60 dB(A)	$L_{Aeq, (9\ hour)}$ 55 dB(A)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq, (1\ hour)}$ 55 dB(A)	$L_{Aeq, (1\ hour)}$ 50 dB(A)

3.3 Ground-borne noise

Vibrations from construction can travel into nearby buildings, causing parts of the structure, such as floors, walls, and ceilings, to vibrate. These vibrations can then be converted into sound within the building, a phenomenon known as structure-borne noise. This type of noise is acoustically distinct from typical airborne construction noise and is therefore assessed separately.

The ICNG provides recommended ground-borne noise levels, outlined in Table 3.7. These guidelines are intended to help determine when management measures should be taken. They apply only to residential areas during the evening and night-time, aiming to protect residents' comfort and sleep. Moreover, these target noise levels are considered for the temporary nature of construction and are only applicable when ground-borne noise levels exceed airborne noise levels. The specified noise limits do not require adjustments for subjective sound characteristics such as tonality, impulsiveness, or low-frequency content.

Table 3.7 Ground-borne noise assessment levels

Receiver type	Time period	Ground-borne noise level $L_{Aeq(15\ minutes)}$
Residential only (Internal; within the most affected habitable room)	Evening (6pm to 10 pm)	40 dB(A)
	Night (10 pm to 7 am)	35 dB(A)

3.4 Construction vibration targets

The potential vibration impacts associated with the project's construction have been assessed. The following subsections detail the vibration goals used in the assessment of the vibration impacts.

3.4.1 Overview

Vibration arising from construction activities can result in impacts on human comfort or the damage of physical structures. These two outcomes have different criteria, with the effects of vibration on human comfort having a lower threshold.

3.4.2 Human comfort

With respect to human comfort, vibration arising from construction activities must comply with criteria presented in "Assessing Vibration: a technical guideline", (Department of Environment and Conservation (DEC), 2006) and British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting [BS 6472-1: 2008]. Assessing Vibration: a technical guideline (DEC, 2006) identifies three different forms of vibration associated with construction activities:

- Continuous: uninterrupted vibration occurring over a defined period
- Impulsive: short-term (typically less than two seconds) bursts of vibration which occurs up to three times over an assessment period
- Intermittent: interrupted periods of continuous or repeated impulsive vibration, or continuous vibration that varies significantly in magnitude.

Continuous vibration may result from steady road traffic or steady use of construction equipment (i.e. generator). Impulsive vibration may arise during the loading or unloading of heavy equipment or materials or infrequent use of hammering equipment. Intermittent vibration may arise from the varied use of construction equipment (i.e. a dump truck moving around a site, idling while being loaded with materials, and then dumping the materials) or repeated high-noise activities such as hammering, piling or cutting.

Preferred and maximum values of human exposure for continuous and impulsive vibrations are listed in Table 3.8, for relevant receivers to this project. As detailed in Assessing Vibration: a technical guideline, daytime is between 7:00 am and 10:00 pm, and night is between 10:00 pm and 7:00 am.

Table 3.8 Preferred and maximum weighted Root Mean Square values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz (from Assessing Vibration: a technical guideline (DEC, 2006))

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis[2]	X and y axis[2]	z-axis	x and y axis
Continuous vibration					
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Impulsive vibration					
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14

[1] Daytime is 7:00 am to 10:00 pm. Night-time is 10:00 pm to 7:00 am

[2] z-axis refers to vertical vibration, while the x and y axes refer to horizontal vibration.

Intermittent vibration is assessed differently using vibration dose values (VDV). Preferred and maximum VDVs for different types of receivers have been reproduced in Table 3.9 for relative receivers in this assessment.

Table 3.9 Preferred and maximum VDVs for intermittent vibration (m/s1.75), (DEC, 2006)

Location	Daytime (7:00 am to 10:00 pm)		Nighttime (10:00 pm to 7:00 am)	
	Preferred VDV	Maximum VDV	Preferred VDV	Maximum VDV
Residences	0.20	0.40	0.13	0.26
Critical areas[1]	0.10	0.2	0.1	0.2
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8
Workshops	0.8	1.6	0.8	1.6

Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

3.4.3 Buildings and structures

Section J4.4.3 of Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives provides frequency-dependent guide levels for cosmetic damage to structures arising from vibration. These levels are adopted from British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground-borne vibration [BS7385-2:1993] and are presented in Table 3.10.

Table 3.10 Transient vibration guideline values for cosmetic damage

Type of building	Peak particle velocity (PPV) mm/s		
	4 to 15 Hz	15 to 40 Hz	40 Hz and above
Reinforced or framed structures in industrial and heavy commercial buildings	50		
Un-reinforced or light-framed structures residential or light commercial type buildings	15 to 20	20 to 50	50

Guidance for more sensitive structures is presented in the German standard, DIN 4150-3 Vibrations in buildings – Part 3: Effects on structures (DIN 4150-3: 2016). As shown in Table 3.11, Vibration velocities not exceeding 3 mm/s at 1 to 10 Hz are recommended in this standard.

Table 3.11 DIN 4150-3:2016 guideline values for short term vibration velocity

Type of building	Guideline values for velocity (mm/s)[1]		
	Vibration at the foundation at a frequency of:		
	1 to 10 Hz[2]	10 to 50 Hz	50 to 100 Hz[3]
Offices and industrial premises	20	20 – 40	40 – 50
Domestic houses and similar construction	5	5 – 15	15 – 20
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g., listed buildings under preservation order)	3	3 – 8	8 – 10

Note 1: Values referred to are at the base of the building.

Note 2: At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

Note 3: At frequencies above 100 Hz the values given in this column may be used as minimum values.

3.4.4 Minimum working distances

Section 6 of the CNVG(R) provides guidance on minimum working distances to achieve human comfort (Assessing Vibration: a technical guideline, (DEC, 2006)) and cosmetic building damage (BS7385-2:1993) criteria for a range of different plant and equipment. These safe working distances are relevant for some plant and equipment that may be used during construction of the project, and so this guidance (presented below in Table 3.12) is recommended for vibration management during construction of the project. Supplementary distances have been adopted from TfNSW's EMF-NV-TT-0067 Construction and Maintenance Noise Estimator (Roads) (CMNE(R)) (TfNSW, 2024), which provides setback distances for vibration impacts to heritage items based on DIN 4150. Working distances from Jacobs' vibration database has been adopted for equipment not provided in the TfNSW documents.

Table 3.12 Recommended minimum setback distances

Plant	Rating / description	Safe working distance (m)		
		Cosmetic damage		Human response (Ref: *Assessing Vibration: a technical guideline*)
		Residential and light commercial (Ref: BS7385-2: 1993)	Heritage items (Ref: DIN 4150, Group 3)	
Vibratory roller	<50 kN (typically 1-2 tonne)	5 m	14 m	15 m to 20 m
	<100 kN (typically 2-4 tonne)	6 m	16 m	20 m
	<200 kN (typically 4-6 tonne)	12 m	33 m	40 m
	<300 kN (typically 7-13 tonne)	15 m	41 m	100 m
	>300 kN (typically 13-18 tonne)	20 m	54 m	100 m
	>300 kN (> 18 tonne)	25 m	68 m	100 m
Small hydraulic hammer	300 kg – 5 to 12 tonne excavator	2 m	5 m	7 m
Medium hydraulic hammer	900 kg – 12 to 18 tonne excavator	7 m	19 m	23 m
Large hydraulic hammer	1600 kg – 18 to 34 tonne excavator	22 m	60 m	73 m
Vibratory pile driver	Sheet piles	20 m	50 m	20 m
Pile boring	≤800 mm	2 m (nominal)	5 m	7 m
Jackhammer	Handheld	1 m (nominal)	2 m	3 m
Asphalt paver	Vogele Super 1800-3	1 m	Avoid contact with structure	Avoid contact with structure
Horizontal directional drilling		2 m (nominal)	5 m	7 m
Large excavator with bucket		5 m	5 m	10 m

3.5 Operational noise targets

Following construction, the operation of the brine pipeline is expected to generate negligible noise emissions. As such, operational noise from the brine pipeline is not further assessed in this report. Operational noise from all other project noise sources has been assessed, including both to be retained and proposed noise sources at the Quakers Hill WRRF site. Operational noise has been assessed in accordance with the NPfI.

3.5.1 Project noise trigger levels

The NPfI seeks to regulate noise impact from 'industrial activity' pertaining to noise from fixed industry and mechanical plant. To achieve this, the NPfI applies two separate assessment noise levels:

- Project intrusiveness noise levels (PINLs) constituting assessment noise levels aimed at limiting the intrusiveness of the project's noise against the prevailing background noise
- Project amenity noise level (PANL) constitutes an assessment of noise levels aimed at maintaining suitable acoustic amenity for the surrounding land uses from industry.

The more stringent of these is used to define the operational project noise trigger levels (PNTLs) for a project. The following sections detail the derivation of these PNTLs.

3.5.1.1 Project intrusiveness noise levels

A noise source would be deemed non-intrusive if the monitored $L_{Aeq\,(15\,minute)}$ noise level of the development does not exceed the RBL by more than 5 dB(A). Table 3.13 presents the PINLs for the surrounding receivers, based on the measured and assumed RBLs (see Table 2.4).

Table 3.13 NPfI project intrusiveness noise levels

Receiver	Time of day	L_{90} (RBL) dB(A)	Allowance	Project intrusiveness noise level, $L_{eq\,15\text{-}minute}$ dB(A)
NCA 01	Day[1]	40	+5 dB(A)	45
	Evening[1]	40[2]		45[2]
	Night[1]	40[2]		45[2]
NCA 02	Day[1]	39	+5 dB(A)	44
	Evening[1]	39[2]		44[2]
	Night[1]	39[2]		44[2]
NCA 03	Day[1]	37	+5 dB(A)	42
	Evening[1]	37[2]		42[2]
	Night[1]	37[2]		42[2]

Note 1: Time periods as per the NPfI:

- Day: 7:00am – 6:00pm
- Evening: 6:00pm – 10:00pm
- Night: 10:00pm – 7:00am

Note 2: RBL decreased to not be louder then preceding period.

PINLs are not used directly as regulatory criteria. They are used in combination with the project amenity noise levels to assess the potential impact of noise, assess reasonable and feasible mitigation options and subsequently determine achievable noise requirements.

3.5.1.2 Project amenity noise levels

As per the NPfI, the recommended amenity noise levels represent the objective for total industrial noise at a receiver location, whereas the PANL represents the objective for noise from a single industrial development at a receiver location. PANLs seek to ensure that industrial noise levels from all existing and future developments combined remain within the recommended amenity noise levels for an area.

Similar to PINLs, PANLs are not directly used as regulatory criteria. Instead, they are combined with PINLs to evaluate the potential noise impact, assess reasonable and feasible mitigation options, and determine achievable noise requirements.

Table 3.14 presents the recommended amenity noise levels for residential receivers as per the NPfI. The PANL for a project is equal to the recommended amenity level – 5 dB. However, at this location the cumulative industrial noise is not a necessary consideration as no other industries are present or likely to be introduced. Hence the relevant recommended amenity noise level from Table 3.14 has been assigned as the PANL. A correction of +3 dB has also been applied to convert from a period level to a 15-minute noise level. Table 3.14 also presents the amenity noise levels for non-residential land usage.

Based on the existing environment surrounding the project area, being heavily built up with significant local noise sources such as the M7 Motorway, the 'Urban' residential receiver classification for PANLs has been adopted for all receivers surrounding the project area.

Table 3.14 NPfI project amenity noise levels

Receiver	Time of day	Recommended amenity noise level, $L_{Aeq\ (time\ period)}$ dB(A)	Project amenity noise level, $L_{eq\ 15\text{-}minute}$ dB(A)
Residential receivers (rural)	Day (7 am to 6 pm)	50	53
	Evening (6 pm to 10 pm)	45	48
	Night (10 pm to 7 am)	40	43
Residential receivers (suburban)	Day (7 am to 6 pm)	55	58
	Evening (6 pm to 10 pm)	45	48
	Night (10 pm to 7 am)	40	43
Residential receivers (urban)	Day (7 am to 6 pm)	60	63
	Evening (6 pm to 10 pm)	50	53
	Night (10 pm to 7 am)	45	48
Commercial	When in use	65	68
Industrial	When in use	70	73
Educational / childcare	Noisiest 1-hour period when in use	35 (internal), 45 (external)	38 (internal), 48 (external)
Hospital / medical	Noisiest 1-hour period	35 (internal), 50 (external)	38 (internal), 53 (external)
Place of worship	When in use	40 (internal), 50 (external)	43 (internal), 53 (external)
Passive recreation	When in use	50	53
Active recreation	When in use	55	58

3.5.1.3 Project noise Trigger Levels

The NPfI recommends that the more stringent values between PINLs and PANLs be applied for an operational noise assessment. Table 3.15 presents the PNTLs adopted for the project and this assessment, with consideration of the PINLs and PANLs outlined in Section 3.5.1.1 and Section 3.5.1.2.

The areas immediately surrounding the Quakers Hill WRRF site currently do not have industrial noise sources that could contribute to cumulative noise impacts. As a result, the PNTLs are driven by PINLs.

Table 3.15 NPfI project noise trigger levels

Receiver	Time of day	Project intrusiveness noise level, $L_{eq\ 15\ minute}$ dB(A)	Project amenity noise level, $L_{eq\ 15\text{-}minute}$ dB(A)	Project noise trigger level, $L_{Aeq,\ 15\ minute}$ dB(A)
NCA 01	Day (7:00 am to 6:00 pm)	45	58	45
	Evening (6:00 to 10:00 pm)	45	48	45
	Night (10:00 pm to 7:00 am)	45	43	43
NCA 02	Day (7:00 am to 6:00 pm)	44	58	44
	Evening (6:00 to 10:00 pm)	44	48	44
	Night (10:00 pm to 7:00 am)	44	43	43
NCA 03	Day (7:00 am to 6:00 pm)	42	58	42
	Evening (6:00 to 10:00 pm)	42	48	42
	Night (10:00 pm to 7:00 am)	42	43	42

3.5.2 Sleep disturbance

Section 2.5 of the NPfI provides the following guidance on sleep disturbance impacts from operational noise:

> *Where the subject development/premises night-time noise levels at a residential location exceed: L_{Aeq}, 15min 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or L_{Amax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater, a detailed maximum noise level event assessment should be undertaken.*

Based on the approach above, Table 3.16 presents the sleep disturbance screening levels for the residential receivers surrounding the project.

Table 3.16 Sleep disturbance screening levels

Receiver	$L_{Aeq,\ 15min}$ Sleep disturbance level	L_{AMax} Sleep disturbance level
NCA 01	45[1]	55[1]
NCA 02	44[1]	54[1]
NCA 03	42[1]	52

Note 1: RBL decreased to not be louder then preceding period.

Note 2: No residential receivers are in this NCA.

3.5.3 'Annoying' noise characteristics

'Annoying' noise characteristics associated with the operation of industrial facilities are addressed in Fact Sheet C of the NPfI. Where an 'annoying' noise characteristic is identified, a positive correction will be applied to the noise levels to account for it. For this assessment, the two most likely 'annoying' noise characteristics are tonality and low frequency noise.

Where a tonal noise is predicted to be generated from a noise source, a one-third octave analysis should be performed using the methodology detailed in ISO 1996-2:2007 Annex D: Objective Method for Assessing the Audibility of Tones in Noise. Where the level of one-third octave band exceeds the level of the adjacent bands on both sides by:

- 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz;
- 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz; or
- 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.

Then a correction of 5 dB should be applied to the noise source.

Low frequency noise is accounted for using a two-step assessment of the A-weighted and C-weighted noise levels. A correction for low frequency noise would be applied where:

1. The C-weighted noise contribution is 15 dB greater than the A-weighted noise source contribution at a noise sensitive receiver
2. Any of the third octave noise levels presented in Table C2 of Fact Sheet C are exceeded at the noise sensitive receiver (replicated in Table 3.17).

Where the exceedance of the third octave noise levels is less than or equal to 5 dB, a correction of 2 dB would be applied during the Evening and Night periods, and where the exceedance of the third octave noise levels is greater than 5 dB, a correction of 5 dB would be applied during the Evening and Night periods.

Table 3.17 One-third octave low-frequency noise thresholds (replicated from Table C2 of the NPfI)

Hz/dB(Z)	One-third octave $L_{Zeq,15min}$ threshold level												
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

4. Method

This section of the report describes the method that was used to assess the potential impacts during the construction and operation of the project. Further details of the approaches applied for each step in the assessment are provided in the following sub-sections.

4.1 Study area

4.1.1 Construction area

The study area for the construction impact assessment comprises the NCAs adopted, which generally span 500 m – 1 km from the WRRF and the brine pipeline. The NCAs are shown in Figure 2.1.

4.1.2 Operation area

The study area for assessing noise emissions from Quakers Hill WRRF during operations was extended approximately 500 m to the north, east and south of the site and 1 km to the nearest receivers to the west. This is captured in NCA 01, NCA 02 and NCA 03 of Figure 2.1.

4.2 Construction Impact assessment methodology

4.2.1 Project construction hours

Construction activities would be undertaken during the recommended standard hours in accordance with relevant noise guidelines:

- Monday to Friday – 7 am to 6 pm
- Saturday – 8 am to 1 pm
- Sunday and Public Holidays – no work.

The ICNG recognises there are some situations where construction may need to be carried out outside of the recommended standard construction hours. For the project, these activities may include:

- Pipe trenching/ installation in/across busy roads
- HDD pipeline construction
- Large concrete pours
- The delivery of materials as required by the authorities for safety reasons
- Emergency situations to prevent the loss of lives and properties and/or to prevent environmental harm
- Work determined to comply with the relevant noise management levels
- Situations where agreement is reached with affected receivers.

OOHW are expected to require approval on a case-by-case basis through a dedicated OOHW Protocol. The approval process should follow a risk-based approach to ensure that the appropriate authority or delegate grants approval, while avoiding unnecessary regulatory delays that could hinder project progress. Given that 24-hour HDD operations help reduce overall construction duration and mitigate the risk of tunnelling failure, continuous operation over a 24-hour period is likely to be necessary for this activity.

Based on the possibility for works to occur outside of standard construction hours and to provide a robust understanding of construction noise impacts, construction noise predictions have been assessed against the relevant NMLs during the recommended standard hours and OOHW as presented in Section 3.2.1.

4.2.2 Construction noise inventory

SWLs were estimated for the significant noise-generating activity of project construction. SWLs for each construction stage were determined by developing an inventory of noise generating equipment and the estimated numbers of equipment based on the work taking place. The sound emissions of each piece of equipment were estimated based on SWLs presented in national and international standards (particularly Australian Standard AS 2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites [AS2436-2010] and British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise [BS5228-1:2009]), as well as from other relevant guidelines and databases where necessary.

Activities relating to the brine pipeline have been divided into works to install the pipeline, as well as activities at construction compounds to support the pipeline installation. These compounds have been subdivided into support compounds, which will be used for laydown and supporting activities, tunnelling compounds, which will be used as launch and retrieval points for HDD, and pipe-stringing compounds, where pipe-stringing will occur. A summary of all construction activities is shown in Table 4.1. The full construction noise inventory, including the locations, equipment and overall sound power level associated with each activity is shown in Appendix B.

It is noted that the HDD compounds have been set up in pairs so that one compound will be a launch compound while the other will be a receival compound (which is associated with comparatively lower noise). There is the opportunity to choose which compound will be launch and receival, and so to maintain flexibility in the selection of each, each HDD compound has been modelled conservatively (i.e. as a launch compound).

Following the appointment of the contractor and the availability of the detailed construction methodology, the builder must review and validate the assumptions underlying the construction inventory.

Note that the acoustic emission from pipe-stringing compound activities are assumed to be identical to those from the support compounds.

Table 4.1 Construction inventory summary

Works location	Stage ID and description	Overall stage SWL – $L_{Aeq,15min}$ dB(A)
Quakers Hill WRRF	WRRF_S1 – AWTP site establishment	115
	WRRF_S2 – Secondary treatment upgrade site establishment	115
	WRRF_S3 – Civil works	116
	WRRF_S4 – Structure construction	114
	WRRF_S5 – Mechanical and electrical installation	105
	WRRF_S6 – Commissioning	100
Brine pipeline	OT_S1 – Earthworks and civil works	121
	OT_S2 – Pipe installation	114
	OT_S3 – Commissioning	102
	OT_S4 – Landscaping and restoration	112
Support compounds	Sup_S1 – Pipeline Support activities ▪ Spoil and equipment storage site ▪ Material laydown ▪ Welding of pipes prior to installation ▪ Preparation of pipes for installation	113

Works location	Stage ID and description	Overall stage SWL – $L_{Aeq,15min}$ dB(A)
Tunnelling compounds	HDD_S1 – Site establishment	122
	HDD_S2 – Earthworks and civil works	121
	HDD_S3 – Pipe path creation and pipe installation	115
	HDD_S4 – Commissioning	102
	HDD_S5 – Landscaping and restoration	112
Pipe-stringing compounds	Sup_S1 – Pipe-stringing activities	121

The locations of the construction activities within the Quakers Hill WRRF site are detailed in Figure 4.1 to Figure 4.4 Locations of the brine pipeline, compound and reservoir works, have been displayed in Appendix D.1 alongside the noise contours.

Quakers Hill Water Resource Recovery Facility (WRRF)
Plant access
Plant hardstand
Impact area

Brine pipeline construction method
Open trench
Proposed construction noise sources

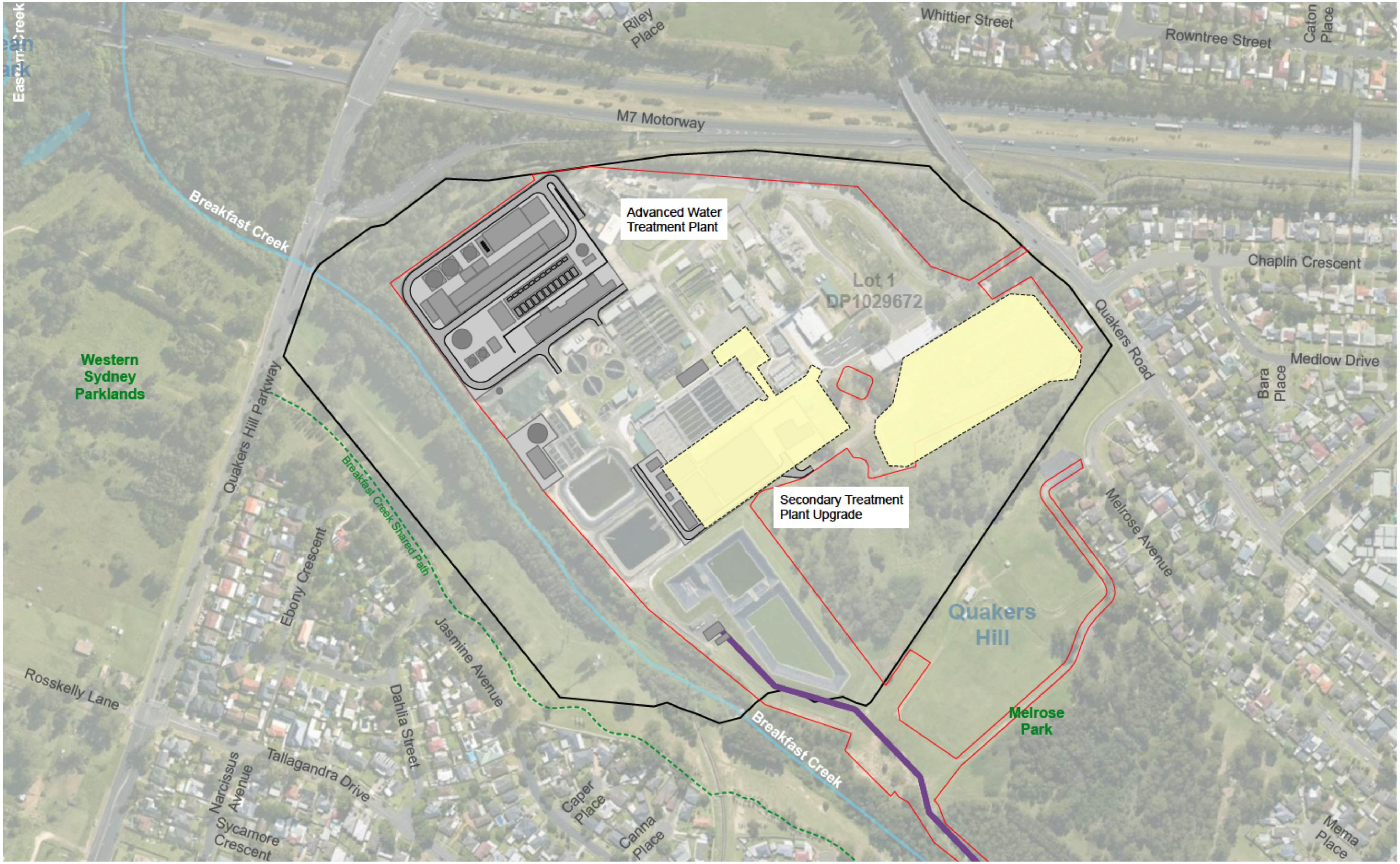
Figure 4-1 Proposed construction noise sources (Stage 1)

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56

N



Quakers Hill Water Resource Recovery Facility (WRRF)
Plant access
Plant hardstand
Impact area

Brine pipeline construction method
Open trench
Proposed construction noise sources

Figure 4-2 Proposed construction noise sources (Stage 2)

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56

N

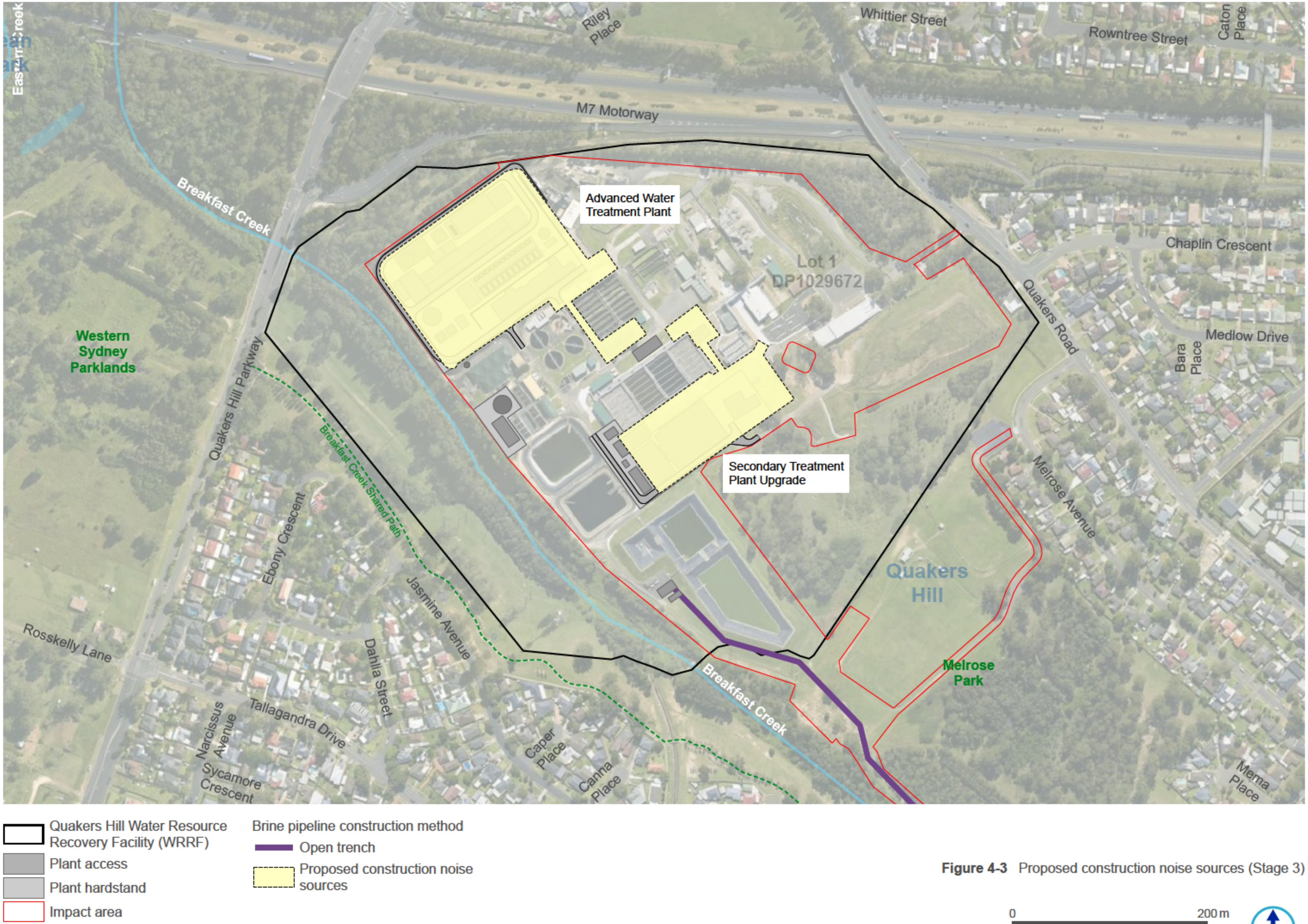
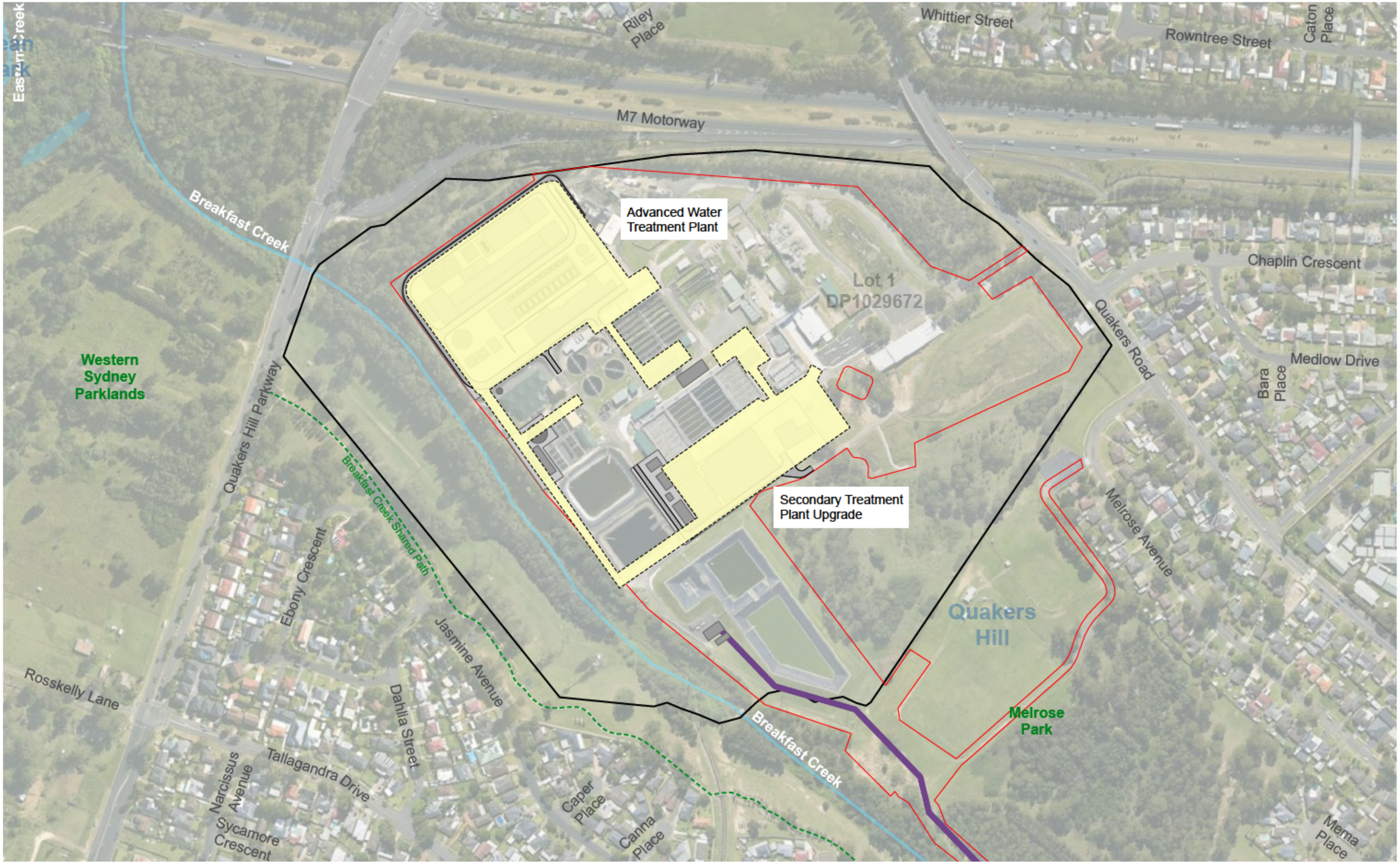


Figure 4-3 Proposed construction noise sources (Stage 3)

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56



Quakers Hill Water Resource Recovery Facility (WRRF)

Plant access

Plant hardstand

Impact area

Brine pipeline construction method

Open trench

Proposed construction noise sources

Figure 4-4 Proposed construction noise sources (Stage 4 - 6)

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56

4.2.3 Construction traffic noise

Traffic generated by the project will primarily occur during the construction stage, involving the movement of material and equipment in and out of the project area.

The Traffic and Transport Impact Assessment identified the vehicle movements required to facilitate the construction of all elements of the project. Daily trips anticipated from the construction works during peak construction are detailed in Table 4.2.

Table 4.2 Daily construction traffic generated by the project

Works location	Primary routes	Estimated peak daily trips		
		Direction	Light vehicles	Heavy vehicles
AWTP works at the Quakers Hill WRRF	Quakers Road	In	100	78
		Out	100	78
Brine pipeline - Northern	M7 Motorway	In	50	8
		Out	50	8
	Quakers Hill Parkway	In	50	8
		Out	50	8
	Quakers Road	In	50	8
		Out	50	8
Brine pipeline - Central	M7 Motorway	In	50	8
		Out	50	8
	Sunnyholt Road	In	50	8
		Out	50	8
	Vardys Road	In	50	8
		Out	50	8
Brine pipeline - Southern	M7 Motorway	In	50	8
		Out	50	8
	Sunnyholt Road	In	50	8
		Out	50	8

Hourly peak traffic volumes were also provided and have been displayed in Table 4.3.

Table 4.3 Hourly construction traffic generated by the Project

Works location	Period	Trips per hour			
		Light vehicles		Heavy vehicles	
		In	Out	In	Out
AWTP works at the Quakers Hill WRRF	Weekday AM peak	100	0	8	8
Brine pipeline		50	0	1	1
AWTP works at the Quakers Hill WRRF	Weekday PM peak	0	100	8	8
Brine pipeline		0	50	1	1

The Traffic and Transport Impact Assessment also undertook intersection counts at the Quakers Road – Quakers Hill WRRF access intersection. The volumes of which can be used in the assessment of construction traffic noise. These are provided in Table 4.4.

Table 4.4 Intersection count traffic volumes

Works location	Period	Direction	Trips per hour	
			Light vehicles	Heavy vehicles
Quakers Road – at WRRF	Weekday AM peak	Northbound	423	14
		Southbound	666	15
	Weekday PM peak	Northbound	575	13
		Southbound	402	20

Based on a review of the full extent of Quakers Road, it is assumed that the traffic on the road would reduce as it extends further into the residential areas to the south and east. As such, while these traffic volumes would be suitable for the construction traffic noise assessment for the Quakers Hill WRRF site works, it would not be suitable for the assessment of construction traffic noise from the brine pipeline construction.

4.2.4 Construction vibration inventory

Based on the construction noise inventory in Appendix B, several construction plant and equipment items have been identified as vibration-intensive equipment that generate vibration levels to cause potential impacts. The stages in which vibration-intensive construction work would take place, and the associated vibration inducing equipment are given in Table 4.5.

Table 4.5 Vibration intensive equipment inventory

Work activity location	Construction stage	Equipment
Quakers Hill WRRF	WRRF_S1 – AWTP site establishment	Vibratory roller (13-18t)
		Large excavator
	WRRF_S2 – Secondary treatment upgrade site establishment	Vibratory roller (13-18t)
		Large excavator
	WRRF_S3 – Civil works	Vibratory roller (13-18t)
		Asphalt paver
		Large excavator
	WRRF_S4 – Structure construction	Vibratory roller (13-18t)
Pipeline works	OT_S1 – Earthworks and civil works	Excavator with medium hammer
	OT_S4 – Landscaping and restoration	Asphalt paver
		Vibratory roller (13-18t)
Tunnelling compounds	HDD_S1 – Site establishment	Excavator with medium hammer
	HDD_S2 – Earthworks and civil works	Excavator with medium hammer
	HDD_S3 – Pipe path creation and pipe installation	HDD rig
	HDD_S5 – Landscaping and restoration	Asphalt paver
		Vibratory roller (13-18t)
HDD alignments	-	HDD rig

4.2.5 Modelling assumptions

A number of assumptions were made throughout the noise and vibration assessment to facilitate the construction noise modelling process. These assumptions have been detailed in Table 4.6.

Table 4.6 Construction noise modelling assumptions

Modelling Component	Assumption
SWLs for each stage	The assessment assumed that all plant and equipment for each activity were operated simultaneously. This conservative approach to noise modelling aimed to determine the upper range of potential noise levels. However, actual construction noise levels are expected to be lower than those predicted in this assessment.
Quakers Hill WRRF	Noise from the construction activities at Quakers Hill WRRF was modelled using SoundPLAN 9.1. This method is considered more suitable due to the various stages of work proposed at different locations within the site. The localisation of equipment relative to the nearest receivers can vary significantly. Therefore, a more detailed noise modelling approach is implemented for the construction works at Quakers Hill WRRF. As a result of this method, detailed construction noise level predictions for all receivers within the study area are calculated.
Construction of the brine pipeline and compounds	Construction noise levels from the brine pipeline and compound works were modelled using the prediction methodology provided in AS2436[1]. This method is particularly useful for estimating and evaluating the risk of noise impacts over longer construction areas (e.g. trenching) where the stages and number of equipment are limited and less variable. It is especially effective when the nearest receivers are relatively close to the boundary of the work. As a result of this method: 1. Maximum noise levels during various stages of construction within different NCAs at the nearest typical receivers are calculated. 2. The distance from the proposal at which there is a risk that noise may exceed the relevant NML is determined. 3. These distances can be used to visually represent the extent of likely construction noise impacts at each NCA.

4.2.6 Noise model setup

As mentioned in Section 4.2.5, noise impacts from construction activities at the Quakers Hill WRRF were predicted using SoundPLAN 9.1 acoustic modelling software. For construction along the brine pipeline and at associated compound sites, an Excel-based noise estimator was used, applying the prediction methodology outlined in AS2436.

Within the noise modelling software (SoundPLAN), project noise was predicted using the CONCAWE noise propagation algorithm. This algorithm was selected based on Jacobs' understanding of the different prediction methods being more suited to the calculation of noise propagation for the different types of noise sources. CONCAWE considers noise propagation and attenuation by:

- Geometrical spreading
- Atmospheric absorption
- Ground effects

[1] AS2436:2010 – *Guide to noise and vibration control on construction, demolition and maintenance sites*

- Meteorological conditions conducive of the propagation of noise
- Barriers
- Topography and distance between the source and receiver.

A number of inputs and assumptions have been adopted in order to model construction noise from the project. These are provided in Table 4.7.

Table 4.7 Construction noise model inputs and assumptions

Model input	Details
Topography	Terrain data was derived from the NSW Government's Spatial Services Penrith 1 m Digital Elevation Model.
Receivers	Buildings data was purchased from Geoscape Australia by Jacobs in January 2025. Building footprints and heights were derived from LiDAR data, while addresses and floors were added by Geoscape post extraction. Model measurement heights: ▪ Ground floor: 1.5 m ▪ First floor: 4.5 m ▪ Second floor: 7.5 m
Ground absorption	Hard ground and water: (Absorption coefficient = 0.00) Farmland and residential: (Absorption coefficient = 0.50) Bushland: (Absorption coefficient = 0.75)
Noise sources	Construction noise sources are discussed in Section 4.2.2 and modelled as point sources. Point sources are distributed along the boundary of the construction work area. For each receiver, a range of predicted noise levels is determined by identifying the lowest level, from the furthest point source, and the highest potential level the closest point source to a receiver. SWLs are displayed in Appendix B.
Site Layout	Construction noise source locations are displayed in Figure 4.1, Figure 4.2, Figure 4.3 and Figure 4.4.
Meteorological conditions	**Construction noise within Quakers Hill WRRF** 'Standard' Meteorological conditions, as defined by the NPfI: ▪ Air Temperature: 10°C ▪ Humidity: 70% ▪ Air Pressure: 1013.3 mbar ▪ Wind Speed: 0.5 m/s ▪ Wind Direction: N/A ▪ Pasquill Stability Class: D

4.2.7 Cumulative impacts

A cumulative impact assessment considers the impacts of a project together with the impacts of other relevant projects that may interact spatially and temporally to change the level of impact. Cumulative noise impacts may arise from the interaction of construction activities of the project, and other developments in the area, both current and future. When considered in isolation, specific project impacts may be considered minor. These minor impacts may, however, be more substantial, when the impact of multiple projects on the same receptors are considered.

Projects with the potential to result in cumulative construction noise impacts along with the project were identified and evaluated. This aspect of the assessment is presented below in Section 5.1 for construction and Section 5.2 for operation.

4.2.8 Ground-borne noise

The pipeline would be about 12 km long and 500 mm in diameter. Two adjacent pipes may be installed in some locations.

Structure-borne or ground-borne noise (GBN) is typically only a concern for underground construction activities, such as HDD. In contrast, vibrations from surface construction rarely result in perceptible structure-borne noise within buildings, as they are generally masked by higher levels of airborne noise from the same activities. Accordingly, the prediction and assessment of 4-8 GBN in this study focuses on potential noise generated by underground drilling operations.

GBN should be assessed for works conducted during the evening and the night-time period as per Section 3.3. GBN works for this project may be conducted during outside standard hours.

As part of a risk assessment, this section outlines indicative minimum operational distances at which the noise targets specified in Section 3.3 are unlikely to be exceeded. These distances are intended as a guide for managing potential GBN impacts. They are derived from international standards, field measurements across various tunnelling methods, and are highly dependent on site-specific geotechnical conditions.

In the absence of detailed tunnelling methodologies, the nominated rotational speed of the platters, and detailed site-specific geotechnical conditions, only a range of indicative safe working distances can be provided based on general assumptions. Actual minimum distances should be confirmed once the specific equipment and site conditions are known. Additionally, the duration of equipment operation at any given location should be considered, as tunnelling machinery typically does not remain stationary for extended periods. Following the contractor's appointment and the development of a detailed construction methodology, the assumptions in this section must be reviewed and updated with a more site-specific assessment. Table 4.8 shows the assumptions made in this study to estimate a range of safe slant distances.

Table 4.8 GBN model inputs and assumptions

Model input	Details
Vibration sources	HDD
Vibration Level range (PPV at 10 m slant distance to the surface)	450 mm bore diameter HDD*: <1 mm/s 1.2 m diameter micro tunnelling in clay#: 0.052 mm/s Full face TBM tunnelling in rock#: 0.5 to 2 mm/s (depending on the operation conditions)
Geotechnical conditions	Clay/ sandstone/ rock
Dominant frequency^	< 30Hz
Building type	1-2 story masonry
Estimation methodology	Federal Transit Administration (FTA) predictive methodology[2]

* Based on study by Reilly, Ciaran et al. (2020)[3]

Based on study by C. H. D and G. I. Miller. (2000)[4]

^ Depends on the rotational speed of the platters and natural frequencies of the system. HDD without vibration-assist generally generate low-frequency vibrations.

[2] The US Department of Transportation FTA document, *Transit Noise and Vibration Impact Assessment FTA-VA-90-1003-06, FTA 2006*

[3] Reilly, Ciaran & Meehan, Niall & Quirke, Paraic & McCarron, Robert. (2020). *Vibrations due to horizontal directional drilling in Lucan Formation rock and Dublin Boulder Clay*.

[4] C. H. D and G. I. Miller. (2000). *Transport Reseach Laboratory (TRL), GroundBorne vibration caused by mechanised construction works.*

Table 4.9 outlines indicative distances from the tunnel to nearby receivers where ground-borne noise criteria may be exceeded, based on the assumptions described above. The lower range typically reflects conditions associated with low-speed, medium-sized tunnelling operations in softer ground. In contrast, the upper range corresponds to medium-speed, medium-sized operations in harder ground. These indicative distances apply to both evening and night-time noise targets, as defined in Section 3.3.

Table 4.9 Indicative minimum slant distances from tunnel for compliance with GBN criteria

Plant Item	Slant distance from tunnel, m	
	Evening, 40 dB $L_{Aeq(15min)}$	Night, 35 dB $L_{Aeq(15min)}$
Tunnelling equipment	5 to 30	5 to 50

It is important to note that the minimum working distances provided are indicative only and may vary depending on the specific plant used, local geotechnical conditions, and the proposed equipment and operational scenarios. In extreme cases, particularly where the dominant frequency of tunnelling operations in rock exceeds the assumptions outlined in Table 4.8, the actual minimum safe working distances may be significantly greater than those shown in Table 4.9.

4.3 Operation impact assessment methodology

4.3.1 Operational noise inventory

The noise sources for the project are typical of a WRRF. The primary noise sources include:

- Pumps
- Blowers
- Ventilation fans
- Valves
- Odour control unit stacks.

As part of the project, several existing operations and equipment on-site will remain in use, alongside the installation of new equipment associated with the Project. While evaluating the current operations of the site in isolation is beyond the scope of this report, the assessment considers a future operational scenario that includes both the retained operations and the proposed upgrades. Therefore, the operational impact assessment accounts for the cumulative noise generated by the entire site once the upgrades are completed as part of the REF.

Where possible, the modelled noise source levels for each piece of equipment were based on supplier information. Where supplier information was not available, indicative noise source emissions were estimated based on either:

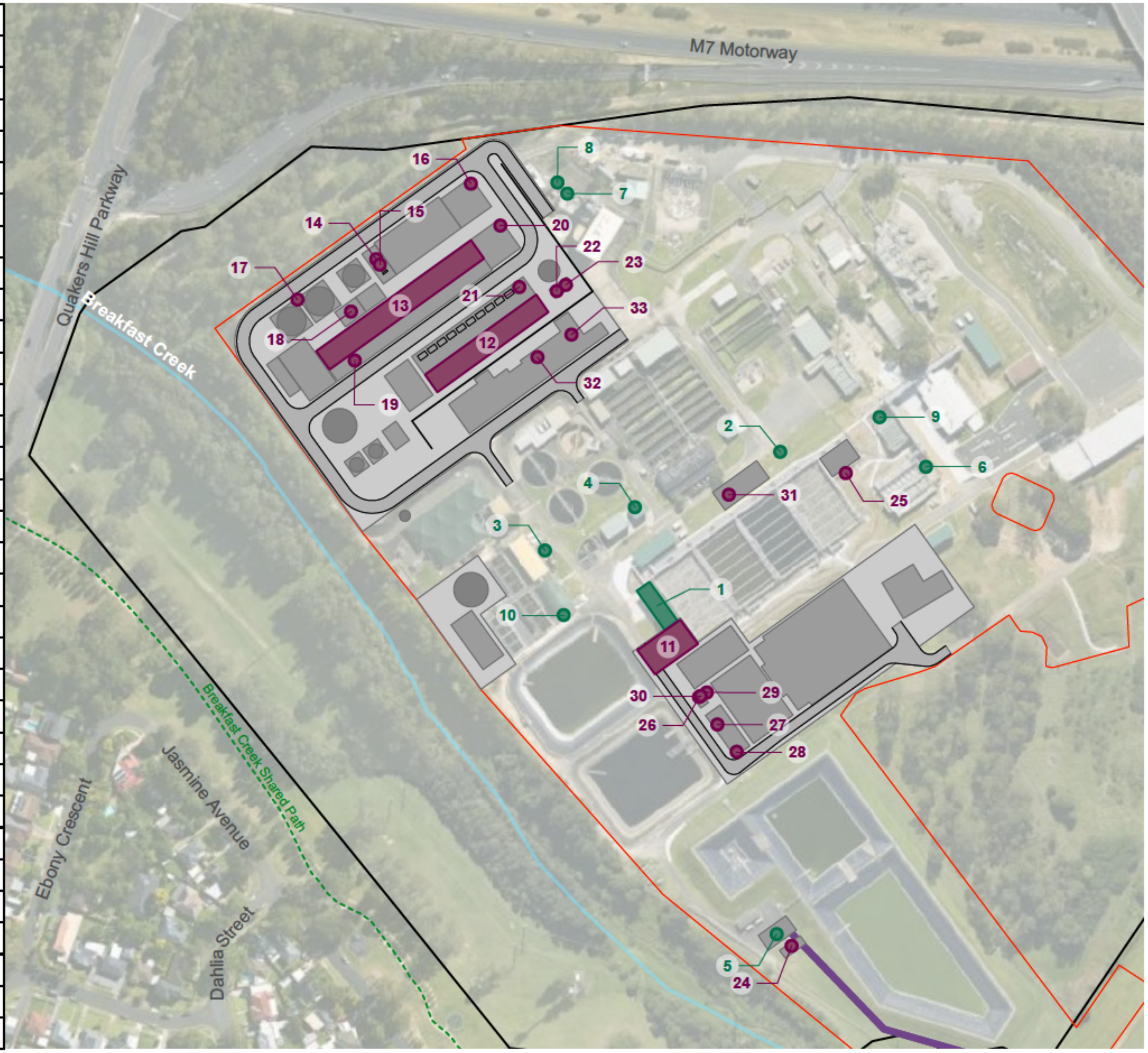
- Measured sound pressure levels (for existing equipment to be retained),
- SWLs provided by the design team,
- SWLs of similar equipment sourced from Jacobs' library and noise database, or
- Empirical calculation methods provided in *Engineering Noise Control 5th Edition* (Bies & Hansen, 2017).

Noise levels from the retained existing equipment were measured during monitoring conducted at the Quakers Hill WRRF site. These measurements were then modelled using frequency spectra in 1/3 octave bands. For all other sources, wherever spectral noise emission data was available, the noise sources were modelled with SWL frequency spectra in 1/1 octave bands. Otherwise, the noise sources were defined with all noise emission energy contained within a single frequency band, usually 500 Hz depending on the typical noise emission spectrum for the specific type of equipment.

A full breakdown of noise sources and the noise levels associated with each of the plant items is provided in Appendix B. The overall SWLs, frequency spectra (if available) and origins of the noise data are detailed in the appendix.

The locations of noise generating equipment within the Quakers Hill WRRF site, including existing equipment to be retained and new equipment proposed as part of the project are displayed in Figure 4.5.

1	Blower Room	Existing
2	1x Duty Gallery Vent Fan	Existing
3	Filter Building Pumps: 4x Duty, 2x Submerged	Existing
4	Sodium Bisulphate Pumps, 1x Duty	Existing
5	Concentrate Transfer Pumps, 2x Duty	Existing
6	Primary Sludge Transfer Pumps, 2x Duty	Existing
7	Odour Control Unit Fans, 2x Duty	Existing
8	Odour Control Unit Stack, 1x Duty	Existing
9	St Marys Transfer Pumps, 1x Duty	Existing
10	Backwash Pumps, 1x Duty	Existing
11	Blower Room: Bioreactor Blowers, 5x Duty + MBR Blowers, 4x Duty	REF
12	Enhanced Treatment Building: Enhanced Treatment Units, 1x Duty	REF
13	RO Building: RO Units, 4x Duty	REF
14	UF Feed Pump, 2x Duty	REF
15	UF Backwash Pump, 1x Duty	REF
16	UF CIP Pumps, 1x Duty	REF
17	RO Feed Tank Fan, 1x Duty	REF
18	RO LP Pumps, 3x Duty	REF
19	RO HP Pumps, 4x Duty	REF
20	RO CIP Pumps, 2x Duty	REF
21	Enhanced Treatment Feed Pumps, 1x Duty	REF
22	ROP Service Water Pumps, 2x Duty	REF
23	RO Flush Pumps, 1x Duty	REF
24	Brine Transfer Pumps, 2x Duty	REF
25	Sludge Transfer Pump, 1x Duty	REF
26	MBR WAS Pumps, 1x Duty	REF
27	MBR Filtrate Pumps, 6x Duty	REF
28	MBR Backpulse Pumps, 1x Duty	REF
29	RE Pumps, 2x Duty	REF
30	Bioreactor WAS Pumps, 2x Duty	REF
31	Foul Air Fan, 1x Duty	REF
32	Pre RO Chemical Dosing Mixing Pump, 1x Duty	REF
33	RO Permeate Chemical Dosing Mixing Pump, 1x Duty	REF



Quakers Hill Water Resource Recovery Facility (WRRF)
Impact area
Plant access
Plant hardstand

Brine pipeline construction method
Open trench

Existing operational noise sources
REF operational noise sources

Figure 4-5 Proposed operational noise sources

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:3,500 @ A4
GDA2020 MGA Zone 56

4.3.2 Modelling assumptions

A number of assumptions were made throughout the noise and vibration assessment to facilitate the operational noise modelling process. These assumptions have been detailed in Table 4.10.

Table 4.10 Operational noise modelling assumptions

Modelling stage	Component	Assumption
Operation	Equipment noise spectra	For the majority of equipment provided, only sound power level data was provided. For this equipment, the spectra were empirically calculated using Bies & Hansen's *Engineering Noise Control*.
	Retained equipment	Existing noise generating sources were modelled based on the sources identified in the *Quakers Hill WRP – Construction and Operational Noise Impact Assessment Report* (AAJV, 2017), guidance from Sydney Water and on-site observations. The equipment, quantities and noise levels have been provided in Table 2.5.
	Retained equipment noise levels	While the Quakers Hill WRRF site measurements provided noise levels for the majority of equipment, the concentrate transfer pumps were not in operation on the day of monitoring or was not accessible for monitoring on the day. The sound power levels for these pumps were adopted from the *Quakers Hill WRP – Construction and Operational Noise Impact Assessment Report* (AAJV, 2017), while the spectra was adopted from similar proposed equipment.
	Retained equipment operation	The number of each piece of equipment currently on site was identified as part of the site investigation, and it was also identified that not all of the units would operate at the same time. Equipment where this was identified are detailed below: ▪ Sodium bisulphite pumps: Three units identified, one observed operating ▪ Concentrate transfer pumps: Four units identified, noted that two units operate at any one time ▪ Odour control fans: Three units identified, two observed operating. ▪ St Marys transfer pumps: Four units identified, one observed operating. ▪ Backwash pumps: Two units identified, one observed operating. The above noise sources have been modelled based on the observed number of operating units.
	Submerged noise sources	Noise sources immersed in water typically have their airborne noise levels significantly dampened. As such, submerged noise sources were not included in the noise assessment. These sources are: ▪ Retained equipment: - Filter building pumps (two of the six identified on site)

Modelling stage	Component	Assumption
		▪ Proposed equipment - Fine screen feed pumps - Membrane bioreactor (MBR) feed pumps - Membrane Return Activated Sludge (MRAS) tank mixers - Bioreactor anaerobic zone mixers - Bioreactor swing zone mixers - Anaerobic zone mixers - Biotrickling filter (BTF) recirculation pumps - Foul water pumps.
	Sound power data limitations	In addition to the measured existing equipment, some proposed equipment noise data was presented as an SPL. Based on an assumed SPL distance of 1m, sound power data was calculated based on the SPL and the assumed size of the equipment. This was performed for the following: ▪ Enhanced treatment plant ▪ Enhanced treatment feed pumps ▪ MBR waste activated sludge (WAS) pumps ▪ Reclaimed effluent (RE) pumps ▪ Bioreactor WAS pumps. Furthermore, details of the enhanced treatment plant are limited, and it has been modelled without a spectra.
	Existing blower room	Noise sources from the blower room were modelled based on the monitored data. As such, the noise sources were modelled exclusively as the louvres on the facades of the building.
	Foul air fan	Details of whether the supplier's noise level was in the duct or at the vent opening were not available. Instead, noise levels for the foul air fan were modelled at the vent opening using noise data previously utilised for foul air fans at similar wastewater treatment facilities.
	Reverse Osmosis (RO) building	The site model for the assessed design did not include openings (doors, roller doors, louvres, roof vents etc). Hence, these were not included in the model.
	WRRF terrain	A stockpiling site is currently located on the eastern side of the Quakers Hill WRRF. This stockpile provides some noise screening to the receivers directly behind it. However, it is understood that material from the stockpile will be moved to the IDAL as part of the project. As such, for a conservative assessment, it is assumed the stockpile will not be present by time the project commences operations and has not been adopted in the modelling. A review of the 2017 terrain data for the WRRF and its immediate surroundings, sourced from the NSW Government's Spatial Services in Penrith, revealed lower elevation levels compared to the more recent 2019 dataset. A 1-metre Digital Elevation Model was applied in the 3D model.

4.3.3 Noise model setup

The noise impacts from the operation of the project and the construction activities at the Quakers Hill WRRF were predicted using the SoundPLAN 9.1 acoustic modelling software. Within the noise modelling software, project noise was predicted using the CONCAWE noise propagation algorithm. This algorithm was selected based on Jacobs' understanding of the different prediction methods being more suited to the calculation of noise propagation for the different types of noise sources. CONCAWE considers noise propagation and attenuation by:

- Geometrical spreading
- Atmospheric absorption
- Ground effects
- Meteorological conditions conducive to the propagation of noise
- Barriers
- Topography and distance between the source and receiver.

A number of inputs and assumptions have been adopted in order to model noise from the project. These are provided in Table 4.11.

Table 4.11 Operational noise model inputs and assumptions

Model input	Details
Topography	Terrain data was derived from the NSW Government's Spatial Services Penrith 1 m Digital Elevation Model.
Receivers	Buildings data representing the receivers around Quakers Hill WRRF was purchased from Geoscape Australia by Jacobs in January 2025. Building footprints and heights were derived from LiDAR data, while addresses and floors were added by Geoscape post extraction. Model measurement heights: ▪ Ground floor: 1.5 m ▪ First floor: 4.5 m ▪ Second floor: 7.5 m.
Ground absorption	Hard ground and water: (Absorption coefficient = 0.00) Farmland and residential: (Absorption coefficient = 0.50) Bushland: (Absorption coefficient = 0.75)
Noise sources	Operational noise sources are discussed in Section 4.3.1. SWLs are displayed in Appendix B. When individual noise sources, such as pumps, are proposed to be located outdoors in open environments, they are modelled as point sources. However, when these sources are housed within plant rooms, they are modelled as area sources to represent acoustic openings (e.g., louvers) or acoustically weak elements (e.g., metal roofs).
Site layout	Operational noise source locations are displayed in Figure 4.1 and Figure 4.2.
Meteorological conditions	'Noise-Enhancing' Meteorological conditions, as defined by the NPfI: ▪ Air Temperature: 10°C ▪ Humidity: 70% ▪ Air Pressure: 1013.3 mbar ▪ Wind Speed: 3 m/s ▪ Wind Direction: Source to Receiver ▪ Pasquill Stability Class: F.

4.3.4 Cumulative impacts

The operational noise impact assessment has been undertaken in accordance with the NPfI, Section 3.5.1, which requires that cumulative noise from nearby existing or approved industrial sources be considered when establishing project-specific trigger levels. This ensures that the total noise environment remains within acceptable limits and that the contribution of the proposed development is appropriately considered. As this policy inherently accounts for cumulative impacts in the derivation of noise criteria, no further detailed cumulative assessment of the operation of nearby industrial operations has been included in this report.

5. Impact assessment

5.1 Construction

5.1.1 Noise impacts

5.1.1.1 Quakers Hill WRRF

Estimated noise levels at the nearest receivers surrounding the Quakers Hill WRRF works were predicted using SoundPLAN 9.1 with the anticipated sound power levels generated for each construction works activity listed in Appendix B. A range of noise levels was predicted based on the potential location of construction works across the respective construction areas. A summary of the construction noise results at residential receivers is given in Table 5.1.

Table 5.1 Construction noise predictions at residential receivers

Construction stage	NCA	NML				Highly Noise Affected	Predicted noise level at most affected receiver during works, $L_{Aeq,15min}$ dB(A)	
		SH	OOHW Day	OOHW Eve	OOHW Night		Minimum	Maximum
WRRF_S1 – AWTP site establishment	NCA 01	50	45	45	45	75	42	70
	NCA 02	49	44	44	44		46	59
	NCA 03	47	42	42	42		44	69
WRRF_S2 – Secondary treatment upgrade site establishment	NCA 01	50	45	45	45		45	70
	NCA 02	49	44	44	44		49	55
	NCA 03	47	42	42	42		49	69
WRRF_S3 – Civil works	NCA 01	50	45	45	45		42	63
	NCA 02	49	44	44	44		43	59
	NCA 03	47	42	42	42		43	59
WRRF_S4 – Structure construction	NCA 01	50	45	45	45		38	61
	NCA 02	49	44	44	44		39	58
	NCA 03	47	42	42	42		42	61
WRRF_S5 – Mechanical and electrical installation	NCA 01	50	45	45	45		29	52
	NCA 02	49	44	44	44		30	49
	NCA 03	47	42	42	42		33	52
WRRF_S6 – Commissioning	NCA 01	50	45	45	45		24	47
	NCA 02	49	44	44	44		25	44
	NCA 03	47	42	42	42		28	47

Due to the proximity of Quakers Hill WRRF to the nearest receivers, both the minimum and maximum noise levels during most construction stages would exceed the standard hours NML. However, during all stages it has been predicted that noise levels would remain below the Highly Noise Affected recommended level (75 dB).

Noise levels are typically highest in the earlier construction stages when equipment such as compactors (110 dB(A)), dump trucks (107 dB(A)) and concrete trucks (109 dB(A)) are in operation. During later stages when the use of this equipment decreases or is no longer required, it is anticipated that the overall noise levels from these stages would reduce.

For additional context, figures for all stages have been provided in Appendix D.1 to illustrate the potential areas where residential receivers may be exposed to noise levels exceeding the recommended NMLs.

Noise impacts at potential non-residential receivers in the vicinity of the site are displayed in Table 5.2.

Table 5.2 Construction noise predictions at non-residential receivers

Construction stage	Receiver type	NML	Predicted noise level at most affected receiver during works, $L_{Aeq,15min}$ dB(A)	
			Minimum	Maximum
WRRF_S1	Commercial	70	38	81
	Industrial	75	28	46
	Passive recreational	60	47	62
	Childcare	45	35	70
WRRF_S2	Commercial	70	40	81
	Industrial	75	29	43
	Passive recreational	60	50	62
	Childcare	45	39	70
WRRF_S3	Commercial	70	40	59
	Industrial	75	26	47
	Passive recreational	60	42	61
	Childcare	45	35	58
WRRF_S4	Commercial	70	38	57
	Industrial	75	24	45
	Passive recreational	60	41	62
	Childcare	45	33	56
WRRF_S5	Commercial	70	29	48
	Industrial	75	15	36
	Passive recreational	60	32	53
	Childcare	45	24	47
WRRF_S6	Commercial	70	24	43
	Industrial	75	10	31
	Passive recreational	60	27	48
	Childcare	45	19	42

Due to the non-residential receivers generally being located near the work locations within Quakers Hill WRRF, noise impacts are higher than the associated NMLs during some work stages. During WRRF_S1 and WRRF_S2, noise levels may be up to 11 dB(A) over the NML at the nearest commercial receivers located in

NCA 03, 2 dB(A) over the passive recreation NML at Melrose Park in NCA 03, and 25 dB(A) over the NML at the childcare centre located along Quakers Road within NCA 01. These impacts are greatest in the earliest stages however, and as work progresses, noise impacts are expected to reduce.

5.1.1.2 Pipeline alignment

Noise predictions during construction activities along the pipeline and at the associated compound sites, were undertaken by utilising an Excel-based noise estimator using the prediction methodology provided in AS2436.

Based on a desktop inspection of the area surrounding the proposed pipeline, it appears there are no significant screens (such as walls or structures) between the pipeline and the nearest receivers. Therefore, no correction for barrier shielding was applied to the noise level calculations. A summary of the construction noise results at residential receivers is given Table 5.3.

Table 5.3 Predicted noise level at the nearest residential receivers

NCA	NML				Highly noise affected	Predicted noise level at the nearest receiver, $L_{Aeq,15min}$ dB(A)			
	SH	OOHW day	OOHW eve	OOHW night		OT_S1 – Earthworks and civil works	OT_S2 – Pipe installation	OT_S3 - Commissioning	OT_S4 – Landscaping and restoration
NCA 03	47	42	42	42	75	107	100	88	98
NCA 04[1]	-	-	-	-		-	-	-	-
NCA 05	48	43	41	40		113	106	94	104
NCA 06	48	43	43	43		113	106	94	104

Note 1: The pipeline in this NCA is proposed to be entirely constructed by horizontal direction drilling.

Due to the proximity of the nearest receivers to the pipeline works and the use of equipment such as excavator mounted hammers (117 dB(A)) and rock breakers (117 dB(A)), these receivers have been predicted to experience noise impacts significantly higher than both the NMLs and Highly Noise Affected levels. However, as the pipeline works progress along the alignment, it is anticipated that the duration during which an individual receiver will experience the noise levels shown in the table above will be limited. Additionally, some properties immediately adjacent to the works, particularly those near the stormwater channel and electrical easements, have wooden or metal fences that may offer partial noise screening. However, due to the unverified condition of these fences and the predicted noise levels at the nearest receivers, it is not expected that they would significantly reduce noise impacts.

To estimate the potential impact of noise exceeding the recommended standard hours NML, the distance from the works where noise levels meet or exceed the NMLs was calculated. These are displayed in Table 5.4. This estimation considers a 15dB noise reduction due to the presence of first-row houses and substantial screens. In practice, further noise attenuation is expected beyond the second row of houses.

Figures for all stages have been provided in Appendix D.1 to illustrate the distance to which residential receivers may be exposed to noise levels exceeding the recommended NMLs.

Table 5.4 Distance from work where noise impacts above standard hours NML is anticipated - pipe works

NCA	Standard hours NML	Predicted distance from work where construction noise may be greater than NML (m)			
		OT_S1 – Earthworks and civil works	OT_S2 – Pipe installation	OT_S3 – Commissioning	OT_S4 – Landscaping and restoration
NCA 03	47	357	153	39	130
NCA 04[1]	-	-	-	-	-
NCA 05	48	318	136	35	116
NCA 06	48	318	136	35	116

Note 1: The pipeline in this NCA is proposed to be entirely constructed by horizontal direction drilling.

5.1.1.3 Pipeline compounds

Noise from construction activities within the site compounds along the pipeline alignment was predicted using the Excel-based noise estimator, using the prediction methodology provided in AS2436. The compound result tables have been divided into the three compound usages which may produce noise impacts:

- Support compounds
- Tunnelling compounds
- Pipe-stringing compounds (noise levels are identical to those in the support compounds).

The potential noise levels during activities within the support, tunnelling, and pipe-stringing compounds are provided in Table 5.5, Table 5.6 and Table 5.7, respectively.

Table 5.5 Predicted noise level at the nearest receiver to a support compound

Compound	NCA	NML				Highly noise affected	Predicted noise level at the nearest receiver, $L_{Aeq,15min}$ dB(A) – Sup_S1 – Pipeline support activities
		SH	OOHW day	OOHW eve	OOHW night		
Compound 1	NCA 03	47	42	42	42	75	67
Compound 2	NCA 03	47	42	42	42		67
Compound 3	NCA 03	47	42	42	42		68
Compound 4	NCA 03	47	42	42	42		85
Compound 5	NCA 03	47	42	42	42		65
Compound 6	NCA 03	47	42	42	42		77
Compound 7	NCA 03	47	42	42	42		99
Compound 8	NCA 03	47	42	42	42		87
Compound 16	NCA 05	48	43	41	40		105
Compound 17	NCA 05	48	43	41	40		105
Compound 18	NCA 05	48	43	41	40		99
Compound 19	NCA 05	48	43	41	40		87
Compound 20	NCA 06	48	43	41	40		96

Table 5.6 Predicted noise level at the nearest receiver to a tunnelling compound

Compound	NCA	NML				Highly noise affected	Predicted noise level at the nearest receiver, $L_{Aeq,15min}$ dB(A)				
		SH	OOHW Day	OOHW Eve	OOHW Night		HDD_S1 – Site establishment	HDD_S2 – Earthworks and civil works	HDD_S3 – Pipe path creation and pipe installation	HDD_S4 – Commissioning	HDD_S5 – Landscaping and restoration
Compound 9	NCA03	47	42	42	42	75	85	84	77	65	75
Compound 10[1]	NCA04	-	-	-	-		47	46	40	27	47
Compound 11[1]	NCA04	-	-	-	-		46	44	38	25	46
Compound 13	NCA05	48	43	41	40		89	87	81	68	78

Note 1: No residential receivers are located in this NCA.

Table 5.7 Predicted noise level that the nearest receiver to a pipe-stringing compound

Compound	NCA	NML				Highly noise affected	Predicted noise level at the nearest receiver, $L_{Aeq,15min}$ dB(A) – PS_S1 – Pipe-stringing activities
		SH	OOHW Day	OOHW Eve	OOHW Night		
Compound 14	NCA 05	48	43	41	40	75	73
Compound 15	NCA 05	48	43	41	40		77

Similarly to the pipeline works, the proximity of the nearest receivers and the use of equipment such as the following means they have been predicted to experience noise impacts significantly higher than both the NMLs and Highly Noise Affected levels:

- Loaders (107 dB(A)) and bulldozers (105 dB(A)) in the support and pipe-stringing compounds
- Excavator mounted hammers (117 dB(A)), rock breakers (117 dB(A)) and HDD rigs (106 dB(A)) in the tunnelling compounds

While noise impacts from construction compounds are generally limited in duration, it is acknowledged that some compounds will remain in place for extended periods, potentially several months. As such, these locations may experience longer-term impacts compared to individual pipeline sections, which are typically subject to shorter construction durations as the location of the construction works move. To address this, more permanent mitigation measures, such as the installation of site hoarding, are proposed at compound sites to provide localized noise attenuation for nearby sensitive receivers. This is further detailed in Section 6.1.

Figures for all stages have been provided in Appendix D.1 to illustrate the distance to which residential receivers may be exposed to noise levels exceeding the recommended NMLs.

Table 5.8 Distance from works where noise impacts above the standard hours NML is anticipated – support compound works

Compound ID	NCA	Standard hours NML	Predicted distance from work where construction noise may be greater than NML (m) – Sup_S1 – Pipeline support activities
Compound 1	NCA 03	47	148
Compound 2	NCA 03	47	148
Compound 3	NCA 03	47	148
Compound 4	NCA 03	47	148
Compound 5	NCA 03	47	148
Compound 6	NCA 03	47	148
Compound 7	NCA 03	47	148
Compound 8	NCA 03	47	148
Compound 16	NCA 05	48	132
Compound 17	NCA 05	48	132
Compound 18	NCA 05	48	132

Table 5.9 Distance from works where noise impacts above the standard hours NML is anticipated – tunnelling compound works

Compound ID	NCA	Standard hours NML	Predicted distance from work where construction noise may be greater than NML (m)				
			HDD_S1 – Site establishment	HDD_S2 – Earthworks and civil works	HDD_S3 – Pipe path creation and pipe installation	HDD_S4 – Commissioning	HDD_S5 – Landscaping and restoration
Compound 9	NCA 03	47	409	348	171	39	124
Compound 10[1]	NCA 04	-	-	-	-	-	-
Compound 11[1]	NCA 04	-	-	-	-	-	-
Compound 13	NCA 05	48	364	310	152	35	110

Note 1: No residential receivers are located in this NCA.

Table 5.10 Distance from works where noise impacts above the standard hours NML is anticipated – pipe-stringing compound works

Compound ID	NCA	Standard hours NML	Predicted distance from work where construction noise may be greater than NML (m) – PS_S1 – Pipe-stringing activities
Compound 14	NCA 05	48	127
Compound 15	NCA 05	48	127

5.1.2 Sleep disturbance impacts

As mentioned in Section 4.2.1, construction activities for the Project have been expected to primarily take place within Standard construction hours. However, the horizontal directional drilling has been expected to potentially occur at any time of day. In order to consider the sleep disturbance risk of the Project, activity HDD_S3 of the tunnelling compound activities (where tunnelling will take place) has been compared against the sleep disturbance screening and awakening levels for the Project. This has been displayed in Table 5.11.

Table 5.11 Predicted sleep disturbance risk at the nearest receiver to a tunnelling compound

Compound	NCA	Sleep disturbance levels, $L_{AMax,15min}$ dB(A)		Predicted noise level at the nearest receiver, $L_{AMax,15min}$ dB(A) – HDD_S3 – Pipe path creation and pipe installation	Likelihood of sleep risk?	
		Screening level	Awakening level		Sleep disturbance	Awakening disturbance
Compound 9	NCA 03	52	65	82	Likely	Likely
Compound 10	NCA 04	-		45	-	-
Compound 11	NCA 04	-		43	-	-
Compound 13	NCA 05	52		86	Likely	Likely

As displayed in the table, sleep disturbance impacts are likely at the nearest receivers to the tunnelling compounds, should the tunnelling activities be undertaken at night. In order to mitigate risks to sleep disturbance, mitigation measures in Table 6.1 should be applied. In particular, a measure to manage noise could be to set the launch point for the tunnelling (where noise impacts are expected to be greatest) in the compound furthest from the nearest noise sensitive receivers. This could include:

- Launching from Compound 10 to Compound 9
- Launching from Compound 11 to Compound 13.

Even after the mitigation measures to reduce noise levels from the OOHW tunnelling activities, residual sleep disturbance impacts are likely. As such, other mitigation measures listed in Table 6.1 regarding alternative accommodation and respite periods should be considered.

5.1.3 Vibration impacts

As described in Section 3.4.4, the minimum working distances developed within the CNVG(R) provide an indication of the distance from the vibration intensive equipment at which nearby receivers may experience vibration impacts. Where a receiver is located within the minimum working distance, vibration monitoring is recommended to inform whether the equipment selection and/or construction methodology should be reviewed. The minimum working distances of the relevant equipment and stages have been displayed in Table 5.12.

Table 5.12 Vibration safe working distances

Work activity location	Construction stage	Equipment	Setback distance		Heritage (m)
			Human Comfort	Cosmetic Damage	
Quakers Hill WRRF	WRRF_S1 – AWTP site establishment	Vibratory roller (13-18t)	100 m	20 m	54 m
		Large excavator with bucket	10 m	5 m	5 m
	WRRF_S2 – Secondary treatment upgrade site establishment	Vibratory roller (13-18t)	100 m	20 m	54 m
		Large excavator with bucket	10 m	5 m	5 m
	WRRF_S3 – Civil works	Vibratory roller (13-18t)	100 m	20 m	54 m
		Large excavator with bucket	10 m	5 m	5 m
		Asphalt paver	Avoid contact with structure	1 m	Avoid contact with structure
	WRRF_S4 – Structure construction	Vibratory roller (13-18t)	100 m	20 m	54 m
Brine pipeline works	OT_S1 – Earthworks and civil works	Excavator with medium hammer	23 m	7 m	19 m
	OT_S4 – Landscaping and restoration	Asphalt paver	Avoid contact with structure	1 m	Avoid contact with structure
		Vibratory roller (13-18t)	100 m	20 m	54 m
Tunnelling compounds	HDD_S1 – Site establishment	Excavator with medium hammer	23 m	7 m	19 m
	HDD_S2 – Earthworks and civil works	Excavator with medium hammer	23 m	7 m	19 m
	HDD_S3 – Pipe path creation and pipe installation	Horizontal drilling rig	7 m	2 m	5 m
	HDD_S5 – Landscaping and restoration	Asphalt paver	Avoid contact with structure	1 m	Avoid contact with structure
		Vibratory roller (13-18t)	100 m	20 m	54 m
Horizontal directional drilling alignments	-	HDD rig	7 m	2 m	5 m

Based on the locations of the activities and the setback distances above, vibration setback maps have been developed and are displayed in Appendix E. Vibration from works at the Quakers Hill WRRF were assessed to not pose a risk to the nearest receivers. Vibration from the pipeline and the compounds were found to generally extend to the first two rows of properties away from the works, where properties were immediately adjacent to the works.

5.1.3.1 Vibration impacts at heritage items

A number of heritage items have been identified within 200m of the Project impact areas. Of these items, only the Northern Suburbs Ocean Outfall Sewer (NSOOS) and 5 Sarsfield Street fall within the setback distance for the vibration impacts on heritage items.

The Statement of Heritage Impact (SoHI) for the *Quakers Hill Water Resource Recovery Facility Advanced Water Treatment Upgrade* (EMM, 2025) concluded that no heritage structures within the works impact area would be affected. This is primarily because the connection to the NSOOS involves infrastructure installed in 1963, which is not considered to have heritage significance. Nevertheless, due to the proximity of the NSOOS and 5 Sarsfield Street to works, the SoHI recommended precautionary measures, including condition surveys at both the structures, and maintaining vibration levels below the DIN4150 threshold, which underpins the setback distances for heritage items.

5.1.4 Traffic noise impacts

Construction traffic noise from the project was assessed in accordance with the CMNE(R). Road traffic noise predictions were made at the nearest noise sensitive receivers to each of the roads in the primary route (see Section 4.2.3).

5.1.4.1 Construction traffic to AWTP Works

The majority of the expected traffic generated by the project is expected to be associated with the AWTP works at Quakers Hill WRRF. Traffic accessing the WRRF will primarily access the site from Quakers Hill Parkway via the northern portion of Quakers Road. As Quakers Road acts as a local road providing access to the nearby residences rather than an arterial road, the local road criteria has been adopted for the assessment. A calculation of construction traffic noise from Quakers Road has been undertaken using the CMNE(R) and is displayed in Table 5.13.

Table 5.13 Construction traffic noise assessment of Quakers Road

Road	Time Period	Noise criteria (1-hour)	Existing traffic noise level (1-hour)	Existing + construction traffic noise level (1-hour)	Increase in traffic noise due to construction
Quakers Road – between Quakers Hill Parkway and Quakers Hill WRRF	AM Peak	55 dB(A)	67.8	68.3	0.5
	PM Peak		66.9	67.5	0.6

As displayed in the table, while the overall traffic noise may be greater than the noise criteria for a local road, the contribution of the construction traffic to these noise levels remains below the 2 dB threshold. Hence construction traffic noise impacts have not been anticipated.

5.1.4.2 Construction traffic to the Brine pipeline

Construction traffic to facilitate the installation of the Brine pipeline has been anticipated to primarily utilise the M7 Motorway, Quakers Hill Parkway, Sunnyholt Road, Vardys Road and Quakers Road to access the site.

Of these roads, the M7 Motorway, Quakers Hill Parkway and Sunnyholt Road all carry significant traffic. With the anticipated daily construction traffic anticipated from the Project, it is highly unlikely that the overall traffic noise to be increased by 2 dB and hence construction traffic noise at this location has not been considered any further.

As the brine pipeline construction is anticipated to require less traffic than the WRRF construction, the traffic noise assessment in Table 5.13 indicates that traffic noise impacts along the northern portion of Quakers Road around the WRRF access would not increase traffic by 2 dB.

The southern portion of Quakers Road is anticipated to carry less traffic than the northern portion as it extends further into residential areas. Likewise, with the exception of the section traversing Kings Park, Vardys Road also mainly services the nearby residential areas and is also anticipated to carry less traffic than the other roads used as construction access.

However, preliminary testing using the CMNE(R) model indicated that up to 50 light vehicle movements and one heavy vehicle movement per hour could occur without exceeding the 55 dB(A) daytime noise criterion. As a precautionary measure, it is considered likely that these roads may experience construction traffic noise impacts. This assumption also applies to the local roads that will be used to access the pipeline via these main access routes. Based on this assumption, the traffic noise mitigation measures outlined in Table 6.1 must be considered to reduce potential noise impacts while these roads are being utilised.

5.1.5 Ground-borne noise

GBN is primarily a concern for underground construction activities such as HDD. In contrast, surface construction rarely generates perceptible structure-borne noise within buildings, as it is typically masked by higher levels of airborne noise from the same activities.

GBN considerations apply only to residential areas during evening and night-time hours. Trigger levels for GBN are not applicable to commercial properties. GBN levels are only relevant when they are both audible and exceed airborne noise levels from the construction, particularly within habitable rooms. As such, GBN is typically not a concern for sensitive receivers located near compound sites where drilling machines are located. In these areas, airborne noise from above-ground equipment is expected to dominate, making GBN impacts negligible by comparison. For receivers away from compound sites, generally directly above the HDD underground drilling, to remain below the recommended night-time GBN threshold of 35 dB $_{LAeq(15min)}$, a minimum separation distance of 50 m from buildings is generally required. For slant distances to a building under 50 m, site-specific monitoring and review of the assumptions provided in Section 4.2.8 is advised to confirm actual noise and vibration levels.

HDD activities are planned at several compound sites. If HDD occurs at night, residential receivers located within 50 m slant distance from the drilling and more than approximately 100 m from the compound sites may be at risk of sleep disturbance due to GBN. However, this risk does not apply to receivers near compound sites, where airborne noise from HDD rigs and associated machinery is expected to dominate over GBN from underground operations. Details regarding the recommended noise mitigation strategies are outlined in Section 6.1.

5.1.6 Cumulative impacts

Potential cumulative noise impacts were evaluated with reference to the guidance presented in Cumulative Impact Assessment Guidelines for State Significant Projects (Department of Planning, Industry and Environment, 2022). Using this approach, the following projects were identified as being potentially relevant to noise on the basis of:

1. their general proximity to the project and thus their potential to cause cumulative noise impacts at the same receptors (if both are not effectively managed);
2. their projected timings such that they may overlap with the project; and
3. the nature of their key emissions being similar to the project which could lead to cumulative effects.

The potential for the Quakers Hill to Prospect project to contribute to cumulative operational noise impacts, in conjunction with the Quakers Hill WRRF project, has been assessed in Table 5.14.

Table 5.14 Relevant future projects with the potential for cumulative noise and vibration impacts

Project	Details and cumulative impacts review
Securing our water supply – Quakers Hill to Prospect project	**Details:** The project includes developing a PRW treatment plant at Quakers Hill WRRF, a pipeline to transfer PRW to Prospect Reservoir, and infrastructure within Prospect Reservoir. **Impact review:** A Noise and Vibration Impact Assessment (Jacobs, 2025) was prepared to support the environmental impact statement (EIS). The two projects are sequential, with the ATU project ending prior to the commencement of the EIS project. While there is some overlap in the pipeline works, construction of the brine pipeline begins approximately one year before the PRW pipeline and is planned to be completed approximately two years before the completion of the PRW pipeline construction. This sequencing provides Sydney Water with considerable flexibility to schedule the works in a way that avoids cumulative impacts, particularly as the pipelines diverge in different directions from the Quakers Hill WRRF site. At locations further from the Quakers Hill WRRF, cumulative impacts are expected to be negligible. However, in the event that construction activities for both the PRW and brine pipelines near the Quakers Hill WRRF cannot be sequential, a cumulative noise impact of up to 3 dBA may be experienced at some of the nearest receivers within the NCA 03. The predicted noise levels at the closest receivers in NCA03 are between 94 dBA to 113 dBA. As such, maximum cumulative construction noise levels of 96 to 116 dBA may occur at a few receiver locations. However, this increase does not alter the outcome of the assessment, as both the recommended standard hours Noise Management Level (NML) and the threshold for highly affected noise levels are already predicted to be exceeded, even without accounting for cumulative impacts.

5.1.7 Residual construction noise and vibration impact

Following the implementation of the recommended noise mitigation strategies outlined in Section 6.1, and the adoption of a site-specific Construction Noise and Vibration Management Plan (CNVMP) for this project, significant reductions in construction noise levels at nearby receivers are anticipated in most cases. In some instances, noise reductions of up to 15 dB are expected.

While only minimal residual construction noise impacts are anticipated around Quakers Hill WRRF, during the construction of the brine pipeline and at compound sites designated for HDD operations, there may be circumstances where the application of all feasible and reasonable mitigation measures is insufficient to reduce noise levels to the recommended NMLs. In such cases, residual noise impacts should be managed in accordance with the recommendations provided in Table 6.1.

5.2 Operational noise impacts

5.2.1 Quakers Hill WRRF site noise levels

Noise levels from the retained Quakers Hill WRRF in addition to the project related upgrades have been predicted and summarised in Table 5.15.

Table 5.15 Predicted operational noise impacts at residential receivers

NCA	Highest predicted noise level within NCA, $L_{Aeq,15min}$ dB(A)		Project noise trigger levels, $L_{Aeq,15min}$ dB(A)			Number of receivers over PNTL					
						Day		Evening		Night	
	Standard met. conditions	Noise-enhancing met. conditions	Day	Evening	Night	Standard met. conditions	Noise-enhancing met. conditions	Standard met. conditions	Noise-enhancing met. conditions	Standard met. conditions	Noise-enhancing met. conditions
NCA 01	54	57	45	45	43	62	119	62	119	102	152
NCA 02	55	57	44	44	43	54	62	54	62	58	65
NCA 03	56	59	42	42	42	118	167	118	167	118	167

As shown in the table, the highest predicted noise levels under noise-enhancing meteorological conditions are up to 12-17 dB(A) higher than the nominal day PNTLs at the NCAs immediately near the Quakers Hill WRRF. Within NCA01, the loudest noise is predicted to be the equipment within the AWTP area as well as the new blower room. At NCA02, the AWTP and blower room are the primary contributors to noise levels, while at NCA03, the dominant source is the brine transfer pumps located at the southern end of the Quakers Hill WRRF site.

The extent of noise impacts at non-residential receivers are expected to be less than those at residential locations. Construction noise levels at Quakers Road Family Daycare are anticipated to exceed the education PNTL under noise-enhancing conditions, while Melrose Park, located west of the Quakers Hill WRRF, is expected to exceed the passive recreation PNTL under both meteorological scenarios.

Table 5.16 Predicted operational noise impacts at non-residential receivers

NCA	Number of receivers over PNTL									
	Commercial $L_{Aeq,15min}$ 63 dB(A)		Industrial $L_{Aeq,15min}$ 68 dB(A)		Medical $L_{Aeq,15min}$ 53 dB(A)		Childcare $L_{Aeq,15min}$ 48 dB(A)		Passive Recreation $L_{Aeq,15min}$ 53 dB(A)	
	Standard met. conditions	Noise-enhancing met. conditions	Standard met. conditions	Noise-enhancing met. conditions	Standard met. conditions	Noise-enhancing met. conditions	Standard met. conditions	Noise-enhancing met. conditions	Standard met. conditions	Noise-enhancing met. conditions
NCA 01	0	0	0	0	0	0	0	1	0	0
NCA 02	0	0	0	0	0	0	0	0	0	0
NCA 03	0	0	0	0	0	0	0	0	1	1

Due to the anticipated operational noise exceedances, additional mitigation measures are required. Details regarding the proposed noise mitigation strategies are outlined in Section 6.2.

5.2.2 Sleep disturbance impacts

Noise levels have also been compared against the sleep disturbance screening criteria, which has been detailed in Table 5.17.

Table 5.17 Predicted operational sleep disturbance impacts

NCA	Highest predicted noise level within NCA, $L_{Aeq,15min}$ dB(A)		Sleep disturbance screening level, $L_{Aeq,15min}$ dB(A)	Number of receivers over sleep disturbance screening level	
	Standard met. conditions	Noise-enhancing met. conditions		Standard met. conditions	Noise-enhancing met. conditions
NCA 01	54	57	45	62	119
NCA 02	55	57	44	54	62
NCA 03	56	59	42	118	167

As displayed in the table, noise levels under noise-enhancing conditions are up to 12-17 dB(A) higher than the sleep disturbance screening levels.

As the sleep disturbance screening level canto potentially be greater than the night PNTLs at all three NCAs adjacent to the Quakers Hill WRRF, the proposed noise mitigation strategies are outlined in Section 6.1 would also be suitable in addressing sleep disturbance impacts during operation.

5.2.3 Traffic noise impacts

The Traffic and Transport Impact Assessment identified that the project would result in negligible increase in permanent daily traffic, equivalent to four light vehicle and two heavy vehicle movements a day. Given the existing traffic volumes on Quakers Road, alongside the traffic noise from the nearby M7, it is highly unlikely that these additional vehicles would increase traffic noise at nearby receivers by 2 dB.

6. Mitigation and management

6.1 Construction noise mitigation

Based on the construction noise and vibration predictions and assessments presented in Section 5.1, feasible and reasonable mitigation measures must be implemented to reduce or eliminate impacts. Once the appointed contractor finalises the details of the construction methodology, stages, and equipment, a detailed Construction Noise and Vibration Management Plan (CNVMP) would be prepared. The CNVMP must identify and assess any construction noise impacts that differ from those evaluated in this NVIA, and outline measures to manage potential impacts. It aims to minimise disruption to nearby communities and sensitive areas by detailing mitigation measures, ensuring compliance with regulatory requirements, and establishing a framework for ongoing monitoring and response throughout the construction phase.

However, this section provides general mitigation measures based on the likely noise impact as presented in this report, which may be adopted when the detailed CNVMP is being developed by the contractor at a later stage. outlines the recommended general mitigation measures aligned with Sydney Water's safeguard guidelines, along with additional mitigation and management strategies tailored to the Project.

Table 6.1 Environmental safeguards and mitigation measures for noise and vibration impacts

ID	Mitigation description
NV01	Prior to the commencement of construction, a CNVMP should be developed. This CNVMP will be updated as the Project develops and followed during construction. The CNVMP will include: ▪ Roles and responsibilities ▪ Noise sensitive receiver locations ▪ Construction phase noise and vibration management measures from this table ▪ Monitoring methodology ▪ Community engagement.
NV02	Works must comply with the ICNG, including scheduling work and deliveries during standard daytime working hours of 7am to 6pm Monday to Friday and 8am to 1pm Saturday. No work to be scheduled on Sunday nights or public holidays. Any proposed work outside of these hours must be justified. The project will also be carried out in accordance with: ▪ Sydney Water's Noise Management Procedure SWEMS0056 All reasonable and feasible noise mitigation measures should be justified, documented and implemented on-site to mitigate noise impacts.
NV03	Incorporate **standard daytime hours noise management safeguards** into the CNVMP, including: ▪ Identify and consult with potentially affected residents prior to commencement of works. This should: - describe the nature of works, the expected noise impacts, approved hours of work, duration, complaints handling and contact details - determine need for, and appropriate timing of respite periods (e.g. times identified by the community that are less sensitive to noise such as mid-morning or mid-afternoon for works near residences) ▪ Implement complaints handling procedure for noise ▪ Implement the mitigation measures where reasonable and feasible.

ID	Mitigation description
NV04	If works **beyond standard daytime hours are needed (beyond those identified in this REF)**, the Delivery Contractor would: ▪ Justify the need for OOHW and why it is not possible to carry out the works during standard daytime hours ▪ Consider potential noise impacts and implement the relevant standard daytime hours safeguards, follow Sydney Water's Noise Management Code of Behaviour (SWEMS0056.01) and document all reasonable and feasible management measures to be implemented ▪ Identify additional community notification requirements and outcomes of targeted community consultation ▪ Consult with residents that will be impacted by OOHW about measures to manage impacts in accordance with the ICNG, including considering alternative accommodation ▪ Seek approval from the Sydney Water Project Manager in consultation with the environment and communications representatives.
NV05	**If night works are needed (beyond those identified in this REF),** the Delivery Contractor would: ▪ Justify the need for night works ▪ Consider potential noise impacts and implement the relevant standard daytime and out of hours safeguards and document consideration of all reasonable and feasible management measures ▪ Identify community notification requirements (i.e. for scheduled night work, not emergency works) ▪ Notify all potentially impacted residents and noise sensitive receivers not less than one week prior to commencing night work ▪ Consult with residents that will be impacted by night works about measures to manage sleep disturbance impacts in accordance with the ICNG, including considering alternative accommodation ▪ Seek approval from the Sydney Water Project Manager in consultation with the environment and communications representatives.
NV06	If works on **Sundays or public holidays are required**, the Delivery Contractor would: ▪ Justify why all other times are not feasible ▪ Consider potential noise impacts and implement relevant standard daytime, out of hours and night-time safeguards and other reasonable and feasible management measures ▪ Identify community notification requirements ▪ Seek approval from the Sydney Water Project Manager in consultation with the environment and communications representatives.
NV07	Select equipment to minimise noise emissions. For example: ▪ Select equipment with lower noise emissions than alternative equipment ▪ Ensure equipment mufflers operate in a proper and efficient manner ▪ Use electric/ hydraulic equipment where possible ▪ Use the minimum size and power requirement to complete a task.
NV08	Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise, including: ▪ Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied ▪ Avoid the use of radios or stereos outdoors

ID	Mitigation description
	▪ Avoid the overuse of public address systems ▪ Avoid shouting and minimise talking loudly and slamming vehicle doors ▪ Turn off all plant and equipment when not in use ▪ Maintain and monitor equipment to ensure proper and efficient operation ▪ Scheduling noisy activities around times of surrounding high background noise (local road traffic or when other noise sources are active).
NV09	Manage noise from reversing vehicles, including: ▪ Implement and use non-tonal reversing beepers (or an equivalent mechanism) on all construction vehicles and mobile plant, where possible. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level ▪ Plan traffic flow, parking and loading/unloading areas to minimise reversing movements.
NV10	Site works to reduce noise impacts through measures including: ▪ Develop and implement construction site layout plans as part of the project's construction environmental management plan. Development of the plans should maximise the offset distance between noisy plant and adjacent sensitive receivers, including directing noise-emitting plant away from sensitive receivers ▪ Where possible, concentrate noisy activities at one location and move to another as quickly as possible ▪ Maximise the offset distance between the noisy plant and sensitive receivers ▪ Where possible, avoid the simultaneous operation of two or more noisy plants close to receivers ▪ Do not warm-up plant or machinery near residential dwellings before the nominated working hours.
NV11	Implement physical noise mitigation for construction activities near sensitive receivers, including: ▪ Construct temporary barriers or hoarding between noise-intensive works and receivers to decrease line-of-sight noise impacts ▪ Where practicable, install enclosures around noisy mobile and stationary equipment as necessary.
NV12	Undertake measures to manage vibration from construction activities, including: ▪ Investigating opportunities for using alternatives to vibration generating equipment where vibration impacts have the potential to occur ▪ Using electric/ hydraulic equipment where possible ▪ Using the minimum size and power requirement to complete a task ▪ Maximising the offset distance between the vibration-intensive plant and sensitive receivers ▪ Considering less vibration intensive methodologies where practicable and use only the necessary sized and powered equipment.
NV13	Implement measures to address construction traffic noise, including: ▪ Scheduling construction traffic movements to avoid night periods and other sensitive times ▪ Revising vehicle routes and scheduling to reduce heavy vehicle traffic along roads predicted to experience construction traffic noise impacts ▪ Avoiding the use of compression brakes ▪ Ensuring vehicles are adequately silenced before leaving or accessing the project area.

ID	Mitigation description
NV14	Undertake monitoring to verify construction noise and vibration: ▪ Complete routine monitoring to evaluate construction noise levels and evaluate whether the mitigation measures in place are adequate or require revision ▪ Undertake in-situ vibration monitoring to confirm vibration levels and assess potential impacts where minimum vibration impact distances cannot be achieved. Where the monitoring identifies exceedances in the relevant criteria, or where impacts are identified, additional management measures will be identified and implemented to appropriately manage impacts ▪ Monitor compliance with the recommended vibration levels in DIN 4150-3 1999: Structural Vibration – Part 3; Effects of vibration on structures.
NV15	Implement where feasible the following actions to manage noise from the HDD activities: ▪ Select HDD equipment with the lowest possible noise emissions, and where available, use noise reduction features such as exhaust silencers and treated engine enclosures. ▪ Identify and address any intrusive noise characteristics that may lead to complaints or penalties, with particular focus on the frequency and tonal qualities of HDD drive systems (e.g., low-frequency noise and diesel engine tonality). ▪ Install localised noise barriers around specific machinery, separate from broader noise control structures, where they can effectively reduce noise and are feasible given site conditions. ▪ Implement efficient work practices to reduce the overall duration of HDD operations. ▪ Provide advance notice to all potentially affected residents, informing them of planned works. Where possible, offer flexible scheduling options to minimise disruption to the local community. ▪ Prior to the commencement of HDD activities, revise noise modelling for the activities, including developing a more specific out of hours tunnelling scenario, in order to develop a more accurate understanding of OOHW noise impacts. ▪ Lower the rotational speed to control GBN levels where possible. ▪ Where possible, microtunnelling and HDD without vibration-assist should be adopted. ▪ Prior to the commencement of tunnelling activities, where possible prepare the tunnelling compounds so the launch points are in the compound furthest from noise and vibration sensitive receivers.
NV16	Complete dilapidation and condition surveys on infrastructure and structures at risk from being damaged by vibration during construction, including heritage items.
NV17	Continue to consult and coordinate with other major projects and utility providers that may be impacted during construction, or where cumulative impacts may occur.
NV18	Address impacts from residual and long-term noise where possible, including the implementation of: ▪ Appropriate notification to the community on the nature and duration of the works ▪ Negotiation for a community agreement for work scheduled outside the recommended standard hours ▪ For works to be conducted during night-time, implement the requirement for alternative accommodation should be evaluated in accordance with the number of nights where sleep disturbance is generated in any particular location ▪ If alternative accommodation is offered to provide respite from potential sleep disturbance, following consultation with affected individuals, but is declined, other feasible and reasonable mitigation measures must be explored. In such cases, some residual noise impacts may still occur despite all reasonable efforts to reduce them.

6.2 Operational noise mitigation

The assessment of operational noise found that noise from the project is likely to be greater than the PNTLs at NCA01, NCA02 and NCA03 during all time periods. As such, it was deemed necessary to explore mitigation options and determine potential measures to aid in achieving the PNTLs.

A study of noise contributions revealed that, based on assumptions for existing noise sources, some of these sources are contributing to the predicted future noise levels along with various proposed noise sources. After considering options, the following combination of mitigation measures was adopted to demonstrate the viability of achieving the PNTLs at all nearby receivers. These noise reduction measures include:

- **Major proposed pumps –** The minimum required attenuation can be achieved by selecting quieter equipment or providing a steel acoustic enclosure. For this assessment, the application of a 3 mm steel acoustic enclosure is assumed as an indicative mitigation measure and proof of concept.
- **New Odour Control Unit stack –** The minimum required attenuation can be achieved by selecting quieter equipment or providing acoustic lining inside the stack. For this assessment, the application of 25 mm acoustic lining on the new Odour Control Unit stack is assumed as an indicative mitigation measure and proof of concept.
- **Blower building –** The minimum required attenuation can be achieved by selecting quieter equipment or providing acoustic louvres. For this assessment, the application of acoustic louvres is assumed as an indicative mitigation measure and proof of concept.

Based on the above, the proposed mitigation was applied to the following equipment:

- Ultrafiltration (UF) Feed Pumps
- UF Backwash Pumps
- UF CIP Pumps
- RO LP Pumps
- RO HP Pumps
- RO CIP Pumps
- RO Units
- Enhanced Treatment Feed Pumps
- Enhanced Treatment Units
- ROP Service Water Pumps
- RO Flush Pumps
- Brine Transfer Pumps
- Sludge Transfer Pumps
- MBR WAS Pumps
- MBR Filtrate Pumps
- MBR Backpulse Pump
- MBR Blowers
- RE Pumps
- Bioreactor WAS Pumps
- Bioreactor Blowers
- Foul Air Fan
- Pre RO Chemical Dosing Mixing Pump
- RO Permeate Chemical Dosing Mixing Pump.

The above measures were adopted into the noise modelling to develop a mitigated project scenario. It is important to note that other mitigation options could be considered to achieve the minimum required attenuations. Other recommended activities to manage noise from the project include:

- Considering noise levels during equipment selection
- The exploration of other mitigation measures such as noise mats.

6.2.1 Mitigated site noise levels

Noise levels from the Quakers Hill WRRF in addition to the mitigation applied to the project have been predicted at the nearest residential receivers. These predictions are presented in Table 6.2.

Table 6.2 Predicted mitigated noise impacts at residential receivers

NCA	Highest predicted noise level within NCA, $L_{Aeq,15min}$ dB(A)		Project noise trigger levels, $L_{Aeq,15min}$ dB(A)			Number of receivers over PNTL					
						Day		Evening		Night	
	Standard met. conditions	Noise-enhancing met conditions	Day	Evening	Night	Standard met. conditions	Noise-enhancing met. Conditions	Standard met. conditions	Noise-enhancing met. conditions	Standard met. conditions	Noise-enhancing met. conditions
NCA 01	44	46	45	45	43	0	1	0	1	1	4
NCA 02	35	37	44	44	43	0	0	0	0	0	0
NCA 03	37	40	42	42	42	0	0	0	0	0	0

As shown in the table, with the adoption of the mitigation to the proposed equipment described in Section 6.2, noise levels will reduce to below the PNTLs in NCA 02 and NCA 03 during all times of day under both standard and meteorological conditions. Within NCA 01, noise impacts are greater than the day and evening PNTLs at a single receiver on Riley Place during noise enhancing meteorological conditions. This increases to four receivers experiencing noise greater than the night PNTLs. Under standard meteorological conditions, impacts reduce to a single receiver in NCA 01. It is noted that these receivers are all on the southern extent of Riley Place and Elwood Crescent. When assessing sleep disturbance impacts from the mitigated site, this receiver is also the only location expected to experience noise levels exceeding the operational sleep disturbance screening threshold, as detailed in Table 6.3.

Table 6.3 Predicted operational sleep disturbance impacts

NCA	Highest predicted noise level within NCA, $L_{Aeq,15min}$ dB(A)		Sleep disturbance screening level, $L_{Aeq,15min}$ dB(A)	Number of receivers over sleep disturbance screening level	
	Standard met. conditions	Noise-enhancing met. conditions		Standard met. conditions	Noise-enhancing met. conditions
NCA 01	44	46	45	0	1
NCA 02	35	37	44	0	0
NCA 03	37	40	42	0	0

When considering these noise impacts, it is noted that these receivers were identified as experiencing noise greater than the PNTLs from the retained equipment alone. Additionally, due to the proximity of these receivers to the M7 Motorway, it is highly likely that the background noise at these receivers is greater than the RBLs measured within the NCA (which were measured further back from the motorway). This would have a masking effect on the noise from Quakers Hill WRRF and would limit the actual impact from the works on these receivers. Given the relatively high ambient noise levels at this receiver, the potential for operational sleep disturbance impacts is considered to be very low.

7. Conclusion

Jacobs has undertaken an assessment of the Quakers Hill WRRF Advanced Treatment Upgrade project. The assessment identified noise impacts during the construction and operation of the project and provided measures to address these impacts.

7.1 Construction

7.1.1 Construction noise

The assessment of construction noise impacts from the upgrades at Quakers Hill WRRF, the brine pipeline, and associated compound sites has been carried out using appropriate modelling techniques tailored to each component of the project. The complex and staged nature of works at Quakers Hill WRRF required detailed modelling using SoundPLAN, while the more linear and mobile nature of the brine pipeline and compound activities was assessed using established methodologies from AS2436.

At the Quakers Hill WRRF site, construction activities are expected to generate noticeable noise impacts, particularly during the early stages when heavy machinery is most active. These impacts are likely to exceed the standard noise management thresholds at times, though they are not expected to reach levels considered highly disruptive. As the project progresses and the use of high-impact equipment decreases, noise levels are anticipated to reduce accordingly.

For the brine pipeline works, the proximity of construction to residential areas means that some receivers may experience elevated noise levels, especially during activities involving rock breaking or excavation. However, these impacts are expected to be short-lived at any one location, as the pipeline construction moves along the alignment. Similarly, compound sites used to support trenching, HDD, pipe stringing, and general logistics may also generate temporary noise impacts, particularly when located near sensitive receivers.

While noise impacts from construction compounds are generally limited in duration, it is acknowledged that some compounds will remain in place for extended periods, potentially several months. As such, these locations may experience longer-term impacts compared to individual pipeline sections, which are typically subject to shorter construction durations as the location of the construction works move. To address this, more permanent mitigation measures, such as the installation of site hoarding, are proposed at compound sites to provide localized noise attenuation for nearby sensitive receivers.

Overall, while some construction noise impacts are unavoidable, they are expected to be manageable with the implementation of feasible and reasonable mitigation measures. Once the contractor finalises the construction methodology, staging, and equipment selection, a detailed CNVMP will be developed to guide the application of these measures and ensure compliance with relevant guidelines.

7.1.2 Construction traffic noise

Construction traffic for the project will mainly involve light and heavy vehicles. For the majority of the roads used to access the site, such as the M7 Motorway, Quakers Hill Parkway, Sunnyholt Road and Vardys Road, the significant existing traffic volumes meant the proposed construction traffic was highly unlikely to increase traffic noise by more than 2 dB. For Quakers Road (between Quakers Hill Parkway and the Quakers Hill WRRF access), hourly peak construction traffic noise was assessed using the CMNE(R) and found to not increase traffic noise by 2dB.

Quakers Road (south of the Quakers Hill WRRF access), Vardys Road and the local roads used to access the pipeline from these roads anticipated to carry lower traffic. An initial test with the CMNE(R) identified that 50 light vehicle movements and one heavy vehicle movement would be capable of reaching but not exceeding the 55 dB(A) hourly daytime noise criteria. As a result, it can be conservatively assumed that properties along these roads would be at risk of traffic noise impacts and hence mitigation measures should be applied where reasonable and feasible.

7.1.3 Construction ground-borne noise

GBN is mainly a concern for underground construction like HDD, especially during evening and night-time in residential areas. It is generally not an issue for surface construction or commercial properties. GBN is only relevant when it is audible and exceeds airborne noise levels inside habitable rooms.

To stay below the night-time GBN threshold of 35 $dB_{LAeq(15min)}$, a minimum 50 m separation from buildings is typically needed. For slant distances under 50 m, site-specific monitoring is recommended.

HDD activities planned at night may pose a sleep disturbance risk to residents within 50 m of drilling but more than 100 m from compound sites. Near compound sites, airborne noise is expected to dominate.

It is important to note that the minimum working distances provided in this report are indicative only and may vary depending on the specific plant used, local geotechnical conditions, and the proposed equipment and operational scenarios. In extreme cases, the actual minimum safe working distances may be significantly greater than slant distances under 50 m.

7.1.4 Construction vibration

The minimum working distances developed within the CNVG(R) have been used to provide an indication of the distance from the vibration intensive equipment at which nearby receivers may experience vibration impacts. Where a receiver is located within the minimum working distance, vibration monitoring is recommended to inform whether the equipment selection and/or construction methodology be reviewed.

With the risk of cosmetic damage assessed as low and the risk of human response to vibration considered moderate, vibration from works at the Quakers Hill WRRF is not expected to pose a significant risk to the nearest receivers. Vibration associated with the pipeline and compounds is generally expected to extend only to the first two rows of residential properties adjacent to the works, where proximity is closest.

7.1.5 Construction noise and vibration mitigation

Based on the construction noise and vibration predictions and assessments, feasible and reasonable mitigation measures must be implemented to reduce or eliminate impacts. Once the contractor finalises the construction methodology, stages, and equipment, a detailed CNVMP must be prepared.

Mitigation measures have been developed based on the noise and vibration impacts presented in the report. These measures have been based on both Sydney Water’s safeguard measures and standard mitigation measures for noise and vibration impacts, alongside additional mitigation and management strategies tailored to the Project.

7.2 Operation

7.2.1 Operational noise

Noise levels from the retained existing Quakers Hill WRRF, along with the proposed AWTP and secondary treatment upgrades, have been predicted at the surrounding potential noise sensitive receivers. Following construction, the operation of the brine pipeline is expected to generate negligible noise emissions and as such it has not been further assessed in this report. Construction noise impacts associated with the proposed AWTP and secondary treatment expansion were assessed using SoundPLAN9.1 due to the complexity of the noise sources and the software's detailed modelling capabilities.

The assessment found that at the most noise-affected receiver, the highest predicted noise levels under noise-enhancing conditions are up to 12-17 dB(A) higher than the nominal day PNTLs at NCA 01, NCA 02 and NCA 03. Within NCA 01, the loudest noise is predicted to come from the AWTP area, the new blower room, and some existing equipment, notably the odour control stack and backwash pumps. The AWTP and blower room also contribute the most noise at NCA 02, while at NCA 03, the largest noise source is the brine transfer pumps located in the far south of the Quakers Hill WRRF site.

Following construction, the operation of the brine pipeline is expected to generate negligible noise emissions.

7.2.2 Operational traffic noise

The Traffic and Transport Impact Assessment identified that the project would result in negligible increase in permanent daily traffic, equivalent to four light vehicle and two heavy vehicle movements a day. Given the existing traffic volumes on Quakers Road, alongside the traffic noise from the nearby M7 Motorway, it is highly unlikely that these additional vehicles would increase traffic noise at nearby receivers by 2 dB.

7.2.3 Operational noise mitigation

The assessment of operational noise found that noise from the project is likely to exceed the PNTLs at NCA 01, NCA 02 and NCA03 during all time periods. Therefore, it was necessary to explore mitigation options to achieve the PNTLs. The minimum required attenuation can be achieved by selecting quieter equipment or providing additional mitigation measures like steel acoustic enclosure. For this assessment, the application of a 3 mm steel acoustic enclosure is assumed as an indicative mitigation measure and proof of concept.

For this assessment a number of indicative mitigation measures were applied to determine the minimum required attenuation required to reduce noise to below the PNTLs. These measures included the application of acoustic enclosures to proposed pumps and blowers, the addition of acoustic lining on the proposed odour control unit stack, and the use of acoustic louvres in the proposed blower room. It is noted that the mitigation measures assumed in this study are indicative only to demonstrate proof of concept.

With the application of the above measures, the highest predicted noise levels under standard meteorological conditions remain at or below the nominal PNTLs at all times of day in NCA 02 and NCA 03. Within NCA 01, noise impacts are greater than the day and evening PNTLs at a single receiver on Riley Place during noise enhancing meteorological conditions. This increases to four receivers experiencing noise greater than the night PNTLs. It is noted that these receivers are all on the southern extent of Riley Place and Elwood Crescent.

When considering these noise impacts, it is noted that these receivers were identified as experiencing noise greater than the PNTLs primarily due to the contribution of the retained equipment. Additionally, due to the proximity of these receivers to the M7 Motorway, it is highly likely that the background noise at these receivers is greater than the RBLs measured within the NCA (which were measured further back from the motorway). This would have a masking effect on the noise from the WRRF and would limit the actual impact from the works on these receivers.

7.3 Cumulative noise

The potential for cumulative construction noise impacts was assessed in accordance with the *Cumulative Impact Assessment Guidelines for State Significant Projects* (Department of Planning, Industry and Environment, 2022). The only nearby project identified as potentially relevant is the Quakers Hill to Prospect project, for which cumulative impacts were assessed. The cumulative noise impact at the nearest receivers associated with the Quakers Hill WRRF project is expected to be negligible.

The operational noise assessment follows NPfI, which already accounts for cumulative impacts from nearby industrial sources when setting project-specific noise criteria. Therefore, no additional cumulative assessment of nearby operations is required.

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