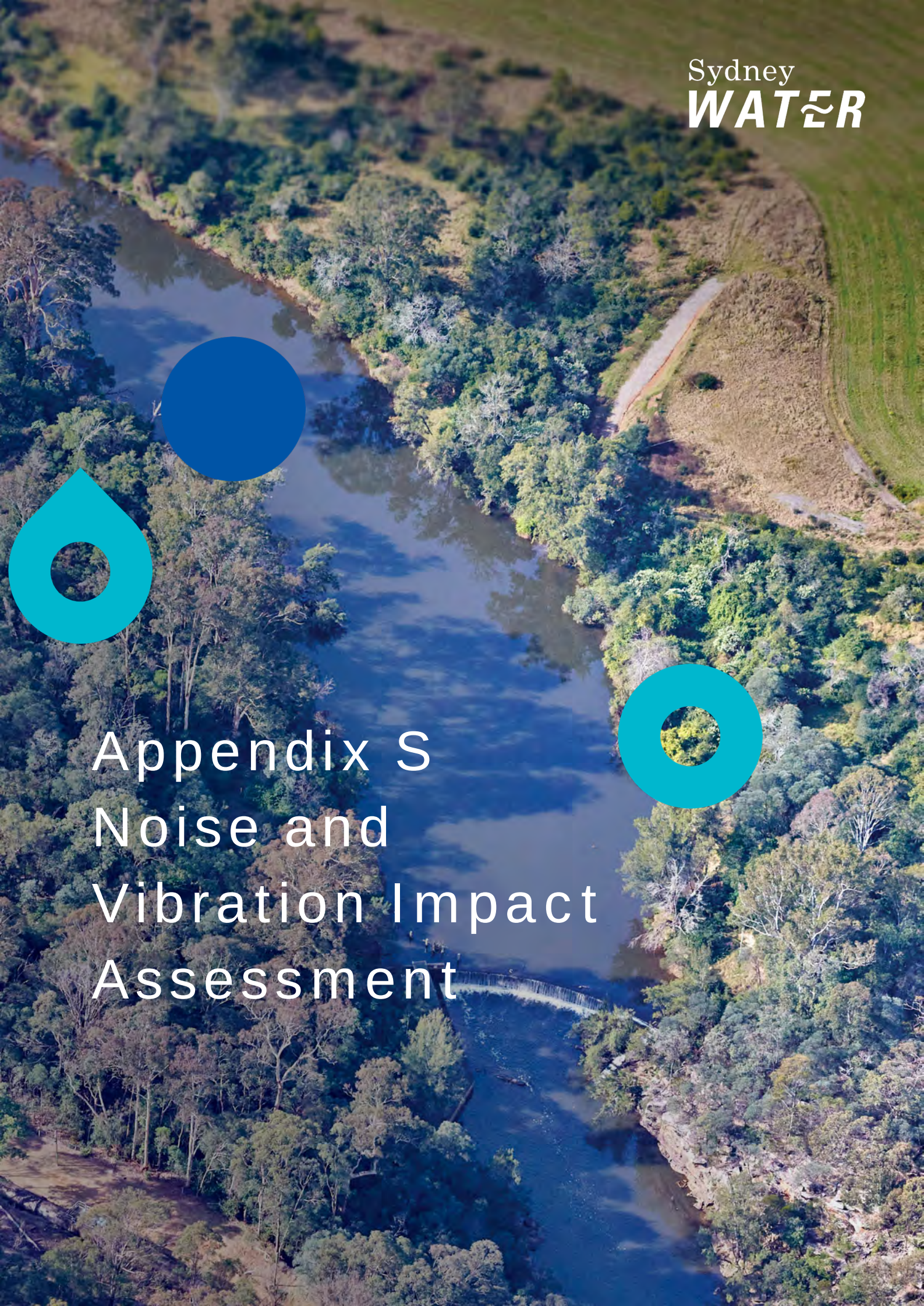

Sydney WATER

Appendix S Noise and Vibration Impact Assessment

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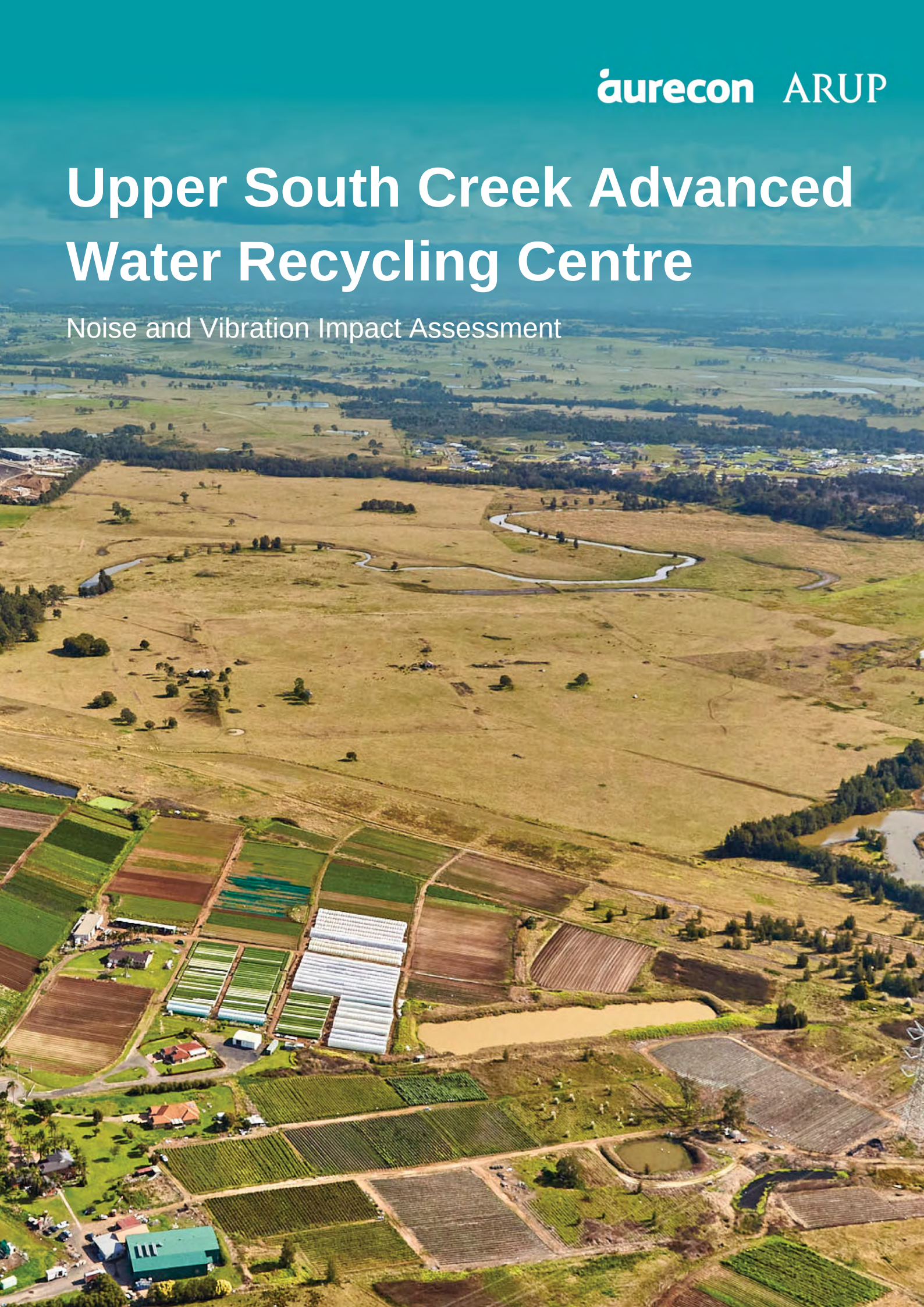
Upper South Creek Advanced Water Recycling Centre

Noise and Vibration Impact Assessment



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Document title	Technical Report I Noise and Vibration Impact Assessment	**File reference:** AC04	
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			Prepared by	**Checked by**	**Approved by**
		Name	Clemence Terraz	Glenn Wheatley	Glenn Wheatley
		Signature			

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Table of Contents

Content and chapter structure

The chapter structure and the associated content are outlined in Table 1.

Table 1: Content and chapter structure

Chapter	Content
1. Introduction	Introduces the purpose of this report. The introduction includes a high-level description of the Project including a map showing the location of the Project: The Upper South Creek Advanced Water Recycling Centre (AWRC), associated pipelines and release structures.
2. Assessment requirements	Presents the Secretary's Environmental Assessment Requirements (SEARs) and agency requests and where they have been addressed within the report. Following, and in accordance with the SEARs, all relevant Standards, policies, and guidelines used for the assessment of the noise and vibration impacts of the construction and operation of the Project are outlined.
3. Assessment methodology	Sets out the methodology used to assess the noise and vibration impacts of the operation and construction of the Project.
4. Assessment locations	Presents the assessment locations used for the assessment of the noise and vibration impacts of the construction and operation of the Project, considering both existing and future receivers.
5. Receivers acoustic environment	Provides the existing acoustic environment for the both existing and future receivers based on measured data, estimated background based on typical background levels and anticipated increase in background levels due to new developments in the area.
6. Operational noise and vibration assessment (including mitigation measures)	This chapter sets out the criteria for the noise and vibration assessment of the operation of the Project, identifies the main sources of noise and vibration, establishes the noise and vibration impacts on existing and future receivers and analyses the mitigation measures required.
7. Construction noise and vibration assessment (including mitigation measures)	This chapter sets out the criteria for the noise and vibration assessment of the construction of the Project, identifies the main sources of noise and vibration, establishes the noise and vibration impacts on existing and future receivers and analyses the mitigation measures required.

1 Introduction

Sydney Water is seeking approval for construction and operation of a wastewater treatment plant, and associated pipelines, in Western Sydney (the Project).

This report has been prepared to support the Environmental Impact Statement (EIS) for the Project. This report provides a noise and vibration impact assessment (NVIA) of the construction and operation of the Project and addresses the Secretary's Environmental Assessment Requirements (SEARs) relating to noise and vibration for the Project (SSI-8609189).

1.1 Project description

Sydney Water is planning to build and operate new wastewater infrastructure to service the South West and Western Sydney Aerotropolis Growth Areas (WSAGA). The proposed development will include a wastewater treatment plant in Western Sydney, known as the Upper South Creek Advanced Water Recycling Centre. Together, the Advanced Water Recycling Centre (AWRC) and the associated treated water and brine pipelines, will be known as the 'Project'. An overview of the location of the proposed infrastructure is provided in Figure 1. Further details of each component of the Project are provided below.

Advanced Water Recycling Centre

- a wastewater treatment plant with the capacity to treat up to 50 ML of wastewater per day, with ultimate capacity of up to 100ML per day
- the AWRC will produce:
  - high-quality treated water suitable for a range of uses including recycling and environmental flows
  - renewable energy, including through the capturing of heat for cogeneration
  - biosolids suitable for beneficial reuse
  - brine, as a by-product of reverse osmosis treatment.

Treated water pipelines

- a pipeline about 17 km long from the AWRC to the Nepean River at Wallacia Weir, for the release of treated water
- infrastructure from the AWRC to South Creek to release excess treated water and wet weather flows
- a pipeline about five kilometres long from the main treated water pipeline at Wallacia to a location between the Warragamba Dam and Warragamba Weir, to release high-quality treated water to the Warragamba River as environmental flows.

Brine pipeline

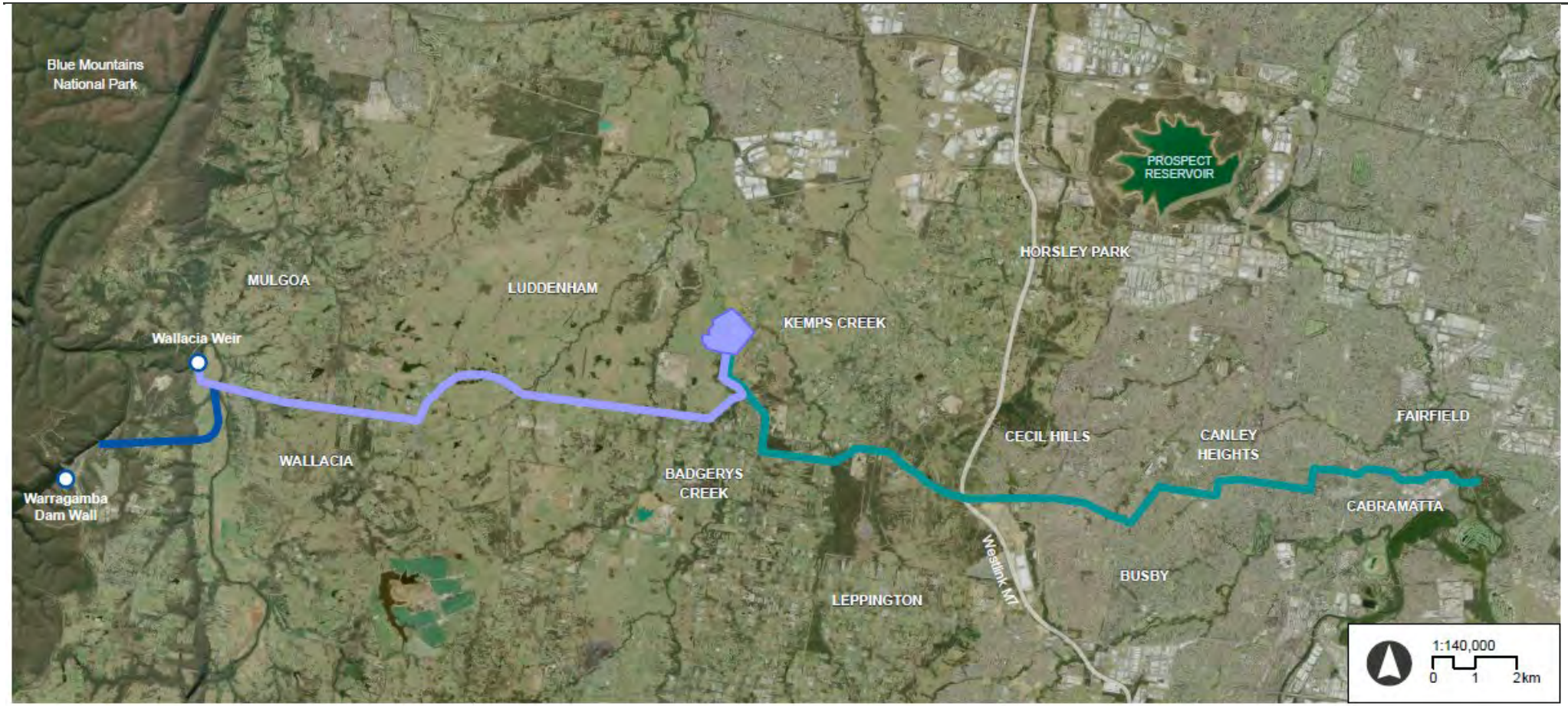
- a pipeline about 24 km long that transfers brine from the AWRC to Lansdowne, in south-west Sydney, where it connects to Sydney Water's existing Malabar wastewater network

Sydney Water is planning to deliver the Project in stages. This EIS seeks approval of Stage 1 operation only. Stage 1 comprises:

- building and operating the AWRC to treat an average dry weather flow of up to 50ML per day

- building all pipelines to their ultimate capacity, but only operating them to transport and release volumes produced by the Stage 1 AWRC.

The timing and scale of future stages will be phased to respond to drivers including population growth rate and the most efficient way for Sydney Water to optimise its wastewater systems.



Projection: GDA 1994 MGA Zone 56
Project infrastructure locations are indicative and will be refined during design

Figure 1: Project Overview

2 Assessment requirements

The SEARs for SSI-8609189, along with relevant agency requests have been reviewed and are listed in Table 2 and Table 3 respectively.

Table 2: SEARs relevant to the acoustic assessment

SEARs	Requirements	Where addressed
The level of assessment of likely impacts should be commensurate with the significance, degree or extent of impact within the context of the proposed location and surrounding environment. The assessment must have regard to applicable NSW and Commonwealth Government policies and guidelines. In particular, the EIS must address the following:		
Noise and Vibration – including:	38. An assessment of construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers, infrastructure, heritage and include, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	Sensitive receivers have been identified in Section 4 and Appendix B. Relevant standard, policies and guidelines are identified in Section 2. Operational assessment has been conducted in Section 6. Construction assessment has been conducted in Section 7.
	39. Details and justification of proposed noise mitigation and monitoring measures.	Operational mitigation measures have been addressed in Section 6.6. Construction mitigation measures have been addressed in Section 7.6.

Table 3: Agencies requests relevant to the acoustic assessment

Agencies	Requests	Where addressed
WaterNSW[1]	The EIS should include: an assessment of the construction and operation vibration impacts of the project on WaterNSW infrastructure, and the proposed measures to mitigate those risks and impacts, including monitoring requirements.	Refer to Sections 7.2.3.3, 7.4.4.2

Agencies	Requests	Where addressed
Penrith City Council	Acoustic impact - An acoustic assessment must be prepared as part of a proposal to demonstrate the impact of the project on nearby receivers. This report is to be prepared by a suitably qualified and experienced acoustic consultant, and is to consider noise impacts including, but not limited to: • Construction • Operation • Mechanical plant • Vehicular movements • Road traffic noise Should mitigation measures be necessary, recommendations should be included to this effect. Recommendations and mitigation measures must be shown on all architectural plans.	Operational assessment has been conducted in Section 6 Construction assessment has been conducted in Section 7. Operational mitigation measures have been addressed in Section 6.6. Construction mitigation measures have been addressed in Section 7.6. Note that with regards to mitigation measures for the operation of the AWRC, no mitigation measures have been shown graphically. Preferred mitigation measures such as mitigation at the source with selection of plant and equipment with low noise levels should be prioritise and will be conducted at detailed design. Note that with regards to mitigation measures for the construction of the Project, no mitigation measures have been shown graphically. Mitigation measures in the form of site hoarding have been discussed in the report but should be reviewed during detailed design.
Notes: 1. WaterNSW guidelines for assessment of noise and vibration • German Standard DIN 4150-3: Structural Vibration - effects of vibration on structures.		

2.1 Standards, policies and guidelines relevant to the assessment

In accordance with the SEARs, the relevant guidelines, specifications and policy documents relevant to this NVIA are listed in Table 4 together with the areas where those documents apply. It is noted that several documents referred to in the SEARs have been superseded, and the following outlines the current reference documents.

Table 4: Documents relevant to the assessment

Assessment	Legislation/Policy/Guidelines	Used for:
Operation noise assessment	NSW Noise Policy for Industry (NPfI) (2017), Environment Protection Authority (EPA) [1]	The NPfI provides guidelines for the assessment of noise impacts from the operation of an industrial development onto nearby receivers. The NPfI has superseded the NSW Industrial Noise Policy [2] referred to in the SEARs.
Operation road traffic noise assessment	NSW Road Noise Policy, Dept. of Environment, Climate Change and Water 2011 (RNP) [3]	The RNP is used for assessing noise of operation traffic when travelling on the road network from/to a development site.
Construction noise assessment	NSW Interim Construction Noise Guideline (ICNG), EPA 2009 [4]	The ICNG provides guidelines for the assessment and management of construction noise. The ICNG provides a range of work practices to minimise construction noise impacts

Assessment	Legislation/Policy/Guidelines	Used for:
	Transport for NSW's Construction Noise and Vibration Strategy (2018) (CNVS) [5]	The CNVS supersedes the TfNSW Construction Noise Strategy outlined in the SEARS. The CNVS provides practical guidance on how to mitigate the impacts on construction noise and vibration through the application of all feasible and reasonable mitigation measures. The CNVS addresses the assessment requirements of the ICNG. The CNVS was also used to source Sound power levels for construction equipment
	Australian Standard AS2436-2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites [6]	Used to source Sound power levels for construction equipment
	BS 5228-1 -2009 Code of Practice for noise and vibration control on construction and open sites [7]	Used to source Sound power levels for construction equipment
Construction road traffic noise assessment	NSW Road Noise Policy, EPA 2011 (RNP) [3]	The RNP is used for assessing noise of construction traffic when travelling on the road network from/to a construction site.
	Construction Noise Estimator and Application Notes	The Construction Noise Estimator and Application Notes are used for assessing noise from construction traffic and assessing noise from rerouting existing traffic.
Operation and Construction vibration assessment	NSW Assessing Vibration – a technical guideline (AVTG), EPA 2006 [8] (based on BS 6472 [9])	Used for assessing potential vibration disturbance to human occupants of buildings and building contents
	British Standard BS 6472-1992, 'Evaluation of human exposure to vibration in buildings (1-80Hz)' [9]	Used for assessing potential vibration disturbance to human occupants of buildings and building contents
	British Standard BS 7385: Part 2-1993 'Evaluation and measurement of vibration in buildings Part 2' [10]	Used for assessing potential structural or cosmetic damage to buildings/structures as a result of vibration
	DIN 4150-3 (2016) Vibrations in buildings - Part 3: Effects on structures, English translation [11]	Used to set guideline values for vibration effects on buildings/structures (including buried pipework)

The following guidelines referred to in the SEARs are not relevant to the Project:

Table 5: SEARs guidelines not relevant to Project NVIA

Document	Reason for exclusion
Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZECC, 1990)	No blasting is proposed for the Project.
Rail Infrastructure Noise Guideline (EPA, 2013)	Guideline relates to the assessment of rail infrastructure.
Environmental Noise Management Manual (RMS 2001)	Guideline relates to the assessment of new or redeveloped roads.
Development Near Rail Corridors and Busy Roads – Interim guideline (DoP, 2008)	Guideline relates to the development of sensitive land uses near rail corridors or busy roads
Noise Mitigation Guideline (RMS, 2015)	Guideline relates to the assessment of new or redeveloped roads.
Noise Criteria Guideline (RMS, 2015)	Guideline relates to the assessment of new or redeveloped roads.
NSW Sustainable Design Guidelines Version 3.0 (TfNSW, 2013)	Does not include noise and vibration assessment criteria.

3 Assessment methodology

This NVIA has been prepared to address the SEARs and other agency requests for the Project. The purpose of this report is to identify and assess the potential noise and vibration impacts of the construction and operation of the Project onto nearby receivers.

The NVIA includes:

- A noise and vibration impact assessment for the operational phase of the Project. While this EIS seeks approval of Stage 1 operation only, a preliminary assessment of the future stages has been included to assess potential cumulative impacts an enable consideration of additional mitigation measures for Stage 1 and minimise constraints on the design of future stages.

  Separate planning approval will be sought for any future expansions beyond Stage 1, in accordance with the staged approval.

- A combination of quantitative and qualitative noise and vibration assessment for the construction of the AWRC and associated pipelines onto nearby receivers and structures, including the use of temporary ancillary sites and construction routes.

3.1 Operational assessment

The following outlines the operational noise and vibration assessment methodology:

- Identify the potentially most-affected receivers (current and future) (Refer to Section 4 and Appendix B)
- Categorise each receiver (e.g. residential, educational, commercial etc) in accordance with relevant policy (Refer to Section 4 and Appendix B)
- For residential receivers, establish the existing and future acoustic environment at relevant surrounding receiver locations to set project targets in accordance with relevant policy. Fixed criteria apply to other receiver types (Refer to Section 5).
- Examine the proposed Project plans to identify acoustic aspects of the operation of the Project (Refer to Section 6.2).
- Carry out a quantitative acoustic assessment of potential noise and vibration impacts and compare against the relevant noise and vibration targets (Refer to Section 6.2, Section 6.3, Section 6.4 and Section 6.5).
- Identify where further design development is required and identify in-principle mitigation or management methods for the control of noise and vibration where required (Refer to Section 6.6).
- Outline the processes to be adopted for the continued design development of acoustic aspects for the Project (Refer to Section 6.2.5, Section 6.5 and Section 6.6).

3.2 Construction assessment

The following outlines the construction noise and vibration assessment methodology:

- Identify the potentially most-affected receivers to the construction sites. Like assessments for other large project sites, receiver locations are grouped into areas having a similar relationship to construction works. (Refer to Section 4 and Appendix B).

- Categorise each receiver (e.g. residential, educational, commercial etc) in accordance with relevant policy (Refer to Section 4 and Appendix B).
- For residential receivers, establish the existing and/or future acoustic environment to set project targets in accordance with relevant policy. Fixed criteria apply to other receiver types (Refer to Section 5 and Section 7.2).
- Identify anticipated construction activities (including plant and equipment used), hours of construction and duration of construction activities (Refer to Section 7.1)
- Conduct a qualitative or quantitative assessment of construction noise and vibration impacts depending on anticipated duration of activities at any one location and available construction information (Refer to Section 7.3 to Section 7.4)
- Identify mitigation and management measures to be adopted during construction (Refer to Section 7.6)
- Outline the processes to be adopted for the continued development of detailed mitigation and management measures for the Project (Refer to Section 7.6).

4 Assessment locations

The assessment locations differ for the operational and construction assessment of the Project. Assessment locations have been identified at the reasonable most- or potentially most-affected receivers to the main sources of noise and vibration.

Assessment locations for the operational phase include receivers near the AWRC site (for assessment of plant, equipment and road traffic), near the pipeline release sites and air valves associated with the underground pipelines. Further detail regarding the operational assessment is included in Section 6.

Assessment locations for the construction phase includes receivers near the AWRC site, the pipeline release sites, along the pipeline alignments and in proximity of ancillary sites, such as compounds and laydown areas. Further detail regarding the construction assessment is included in Section 7.

Receivers potentially impacted by the Project are defined based on the type of occupancy and their sensitivity to cosmetic or structural damage. The categorisation of receivers differs across the various policies and Standards, however generally includes the following receiver types:

- Residential
- Commercial
- Industrial
- Educational
- Place of worship
- Medical
- Recreation areas (passive or active)
- Childcare centres
- Hotels
- other structures (such as the WaterNSW assets).

Buildings or structures that are Heritage listed, are also noted, as they may be more sensitive to vibration impact.

For residential receivers, to simplify the derivation of noise targets where criteria are related to the baseline noise environment, noise catchment areas (NCAs) have been established based on their likely similar noise environment.

The noise and vibration sensitive receivers (including Heritage structures) and NCAs are shown in Appendix B.

4.1 Advanced Water Recycling Centre assessment locations

The area surrounding the AWRC will be subject to significant change associated with the NSW Government's planned growth in Western Sydney, including construction of the M12, the Western Sydney Airport and the East West Rail link stabling facility, rezoning within the Mamre Road, Kemps Creek and Badgerys Creek precincts, and redevelopment of the Wianamatta South Creek.

The nature and timing of these developments can influence the noise and vibration assessment, by potentially changing the type of development and receivers surrounding the site and the baseline acoustic environment.

While exact timing for construction of the developments listed above and anticipated type of receivers within the precincts are not yet known, guidance has been taken from public information to derive assessment scenarios considered to be representative of the existing and future environment. The documents that have informed the assessment are listed in Table 6.

Table 6: Public documents used to inform the assessment

Document ID	Document name	Date
1	Western Sydney Aerotropolis Plan (WSAP) [12]	September 2020
2	M12 Motorway Environmental Impact Statement, Appendix K Noise and Vibration Assessment report [13]	October 2019
3	Western Sydney Airport, Appendix E1 Aircraft overflight noise	August 2016
4	Western Sydney Airport, Appendix E2 Airport ground-based noise and vibration	August 2016
5	Western Sydney Airport EIS, volume 2a, Stage 1 Development, Chapter 10: Noise (Aircraft)	2016
6	Western Sydney Airport EIS, volume 2a, Stage 1 Development, Chapter 11: Airport construction and ground operation noise	2016

Based on the information contained within documents listed above and anticipated date of operation of the AWRC (approximately 2025), it is anticipated that existing receivers will be the most sensitive for the construction phase, while both the existing and future receivers will need to be considered for the operational phase of the AWRC. For the operational phase of the AWRC, the following has been assumed:

- Scenario 1 (Stage 1, Existing Receivers) which assumes that the existing receivers all remain and are operational and that Stage 1 is operational.
- Scenario 2 (Stage 1 + Future Stages, Existing + Future Receivers) which assumes that precincts have been redeveloped (as per WSAP) and that the AWRC plant is fully built and operational (Stage 1 + Future Stages).

Note that while the WSAP indicates the preferred type of receivers to be located within the precincts, it is unclear if the existing receivers will remain when the precincts are redeveloped. As a conservative approach, the assessment includes both the future receivers (as per WSAP preferred type of receivers) and the existing receivers.

Sensitive receivers for assessment Scenario 1 and Scenario 2 are shown below in Figure 2 and Figure 3 respectively and described in Table 7 and Table 8.

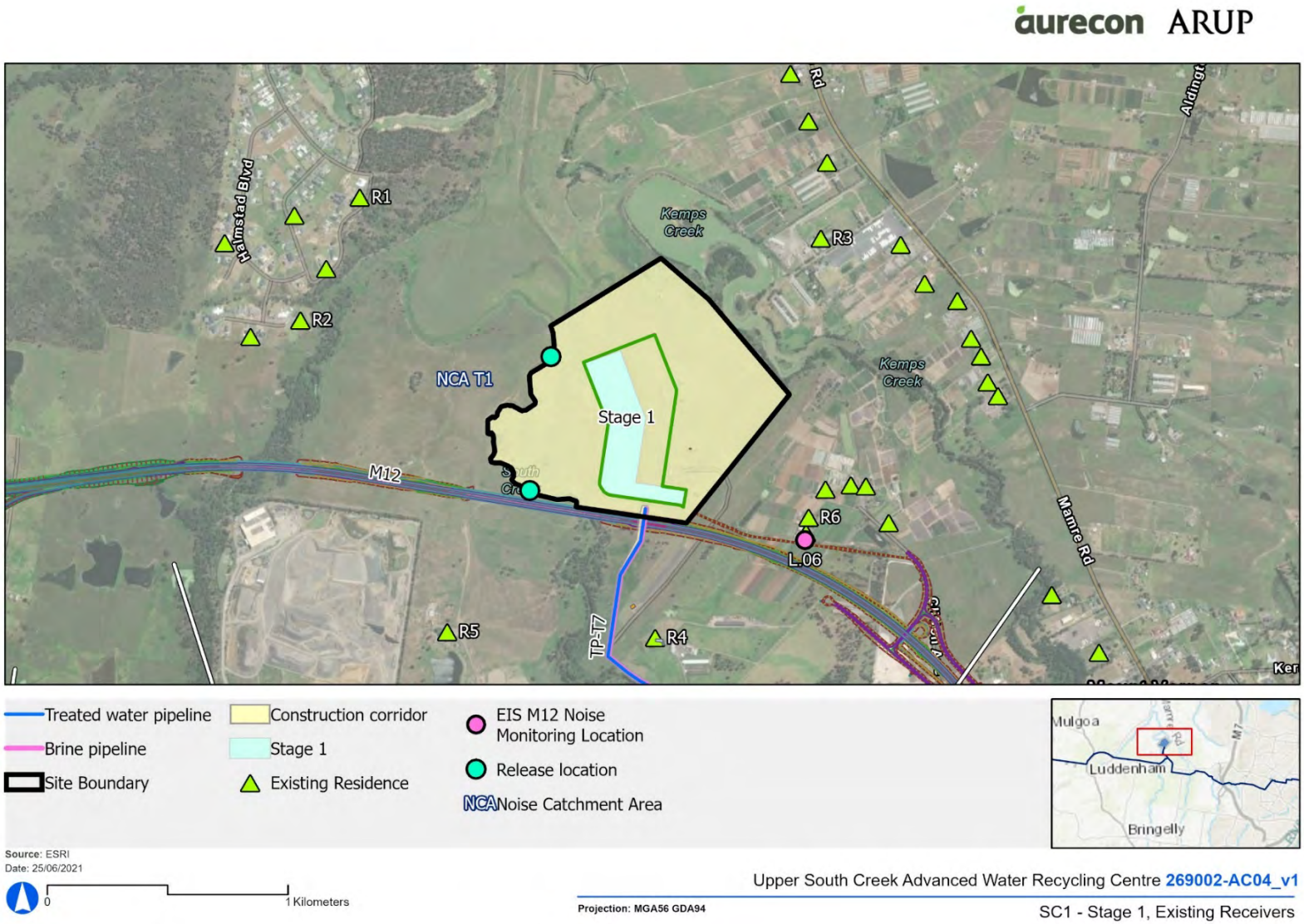


Figure 2: Scenario 1 – Stage 1, Existing receivers

Table 7: Receiver and noise logger locations – SCENARIO 1 – Stage 1, Existing Receivers

Receiver	ID	Representative of	Address	Approximate Distance to AWRC site boundary (m)
Residential	R1	Twin Creeks receivers	4 Ganton Way, Luddenham, NSW	925
	R2	Twin Creeks receivers	9 Farmingdale Ct, Luddenham, New South Wales, 2745	835
	R3	Mamre Road receivers	901 Mamre Rd, Kemps Creek, NSW	490
	R4	Kemps Creek receivers	Kemps Creek, NSW	475
	R5	Badgerys Creek receivers	1669 Elizabeth Dr, Badgerys Creek, NSW	650
	R6	Kemps Creek receivers	203-229 Clifton Av, Kemps Creek, New South Wales, 2178	390
Noise Logger	L06	-	Logger L06 from M12 EIS	410

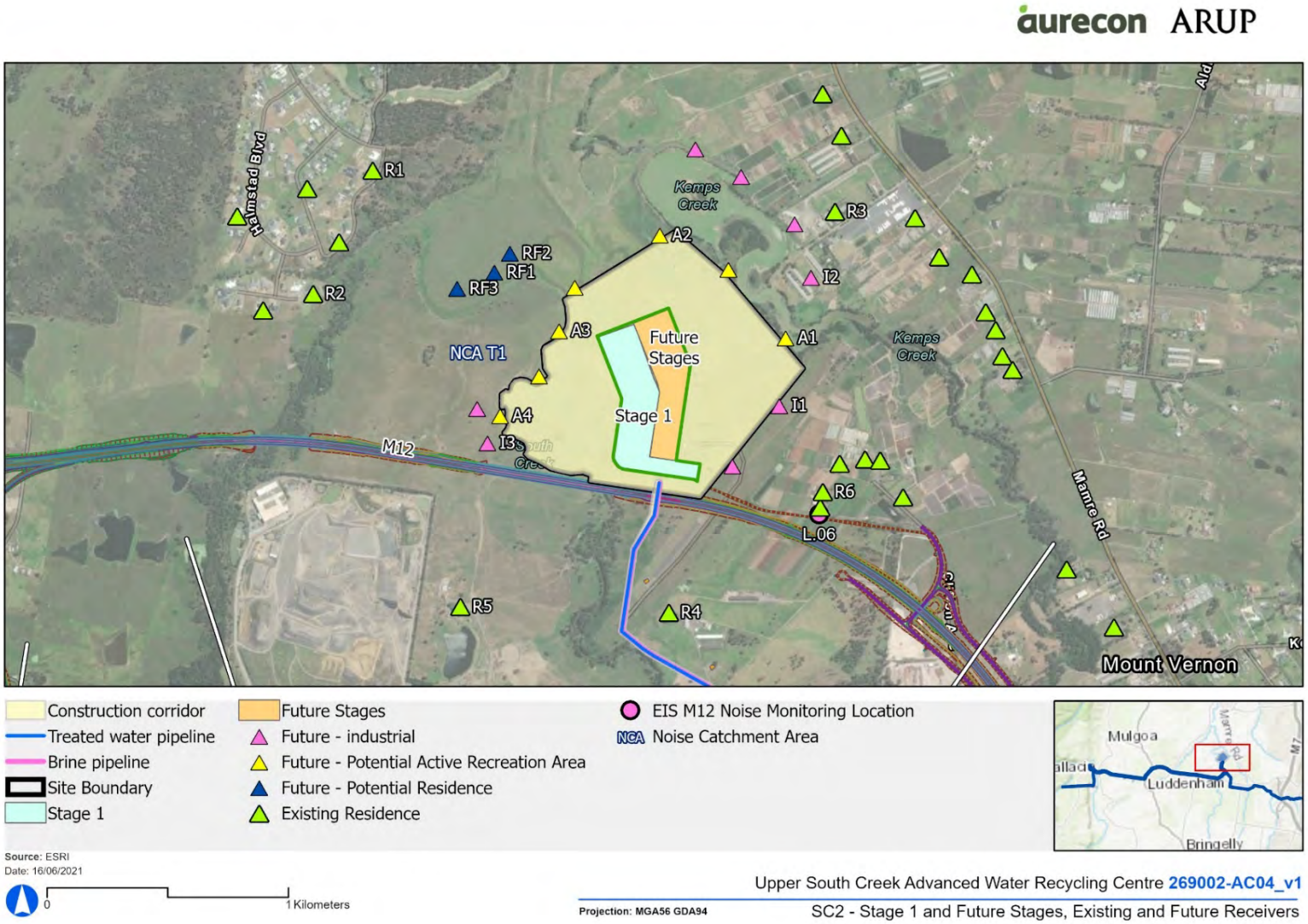


Figure 3: Scenario 2 – Stage 1 + Future Stages, Existing receivers and Future receivers

Table 8: Receiver and noise logger locations – SCENARIO 2 – Stage 1 + Future Stages, Existing + Future Receivers

Receiver type	ID	Representative receiver area	Address	Approximate Distance to AWRC site boundary (m)
Residential (existing)	R1	Twin Creeks Receivers	4 Ganton Way, Luddenham, NSW	925
	R2	Twin Creeks receivers	9 Farmingdale Ct, Luddenham, New South Wales, 2745	835
	R3	Mamre Road receivers	901 Mamre Rd, Kemps Creek, NSW	490
	R4	Kemps Creek receivers	Kemps Creek, NSW	475
	R5	Badgerys Creek receivers	1669 Elizabeth Dr, Badgerys Creek, NSW	650
	R6	Kemps Creek receivers	203-229 Clifton Av, Kemps Creek, New South Wales, 2178	390
Residential (Future)	RF1	Twin Creeks potential future Receivers	1 Ganton Way, Luddenham, NSW	315
	RF2	Twin Creeks potential future Receivers	1 Ganton Way, Luddenham, NSW	295
	RF3	Twin Creeks potential future Receivers	1 Ganton Way, Luddenham, NSW	440
Industrial (future)	I1	Kemps Creeks Receivers	Kemps Creek, NSW	390
	I2	Mamre Road Receivers	Kemps Creek, NSW	230
	I3	Badgerys Creek Receivers	Badgerys Creek, NSW	70
Active recreation	A1	Potential bushwalker trail around the AWRC site boundary	Kemps Creek, NSW	0
	A2		Kemps Creek, NSW	0
	A3		Badgerys Creek, NSW	0
	A4		Badgerys Creek, NSW	0

4.2 Pipeline release site assessment locations

The treated water and environmental flow pipelines will be released at the two locations shown on Figure 4 and Figure 5.

Figure 4 and Figure 5. Potential noise from the water release will be limited, as the treated and environmental flow pipelines will release into a weir structure which is elevated and situated back from the river edge, such that water will flow down the river edge, rather than cascade directly into the river like a waterfall. Sensitive receivers near the release locations are shown in Figure 4 and Figure 5 and described in Table 9.

There will be 2 release sites at the AWRC site, which are shown and assessed in Section 6.2.

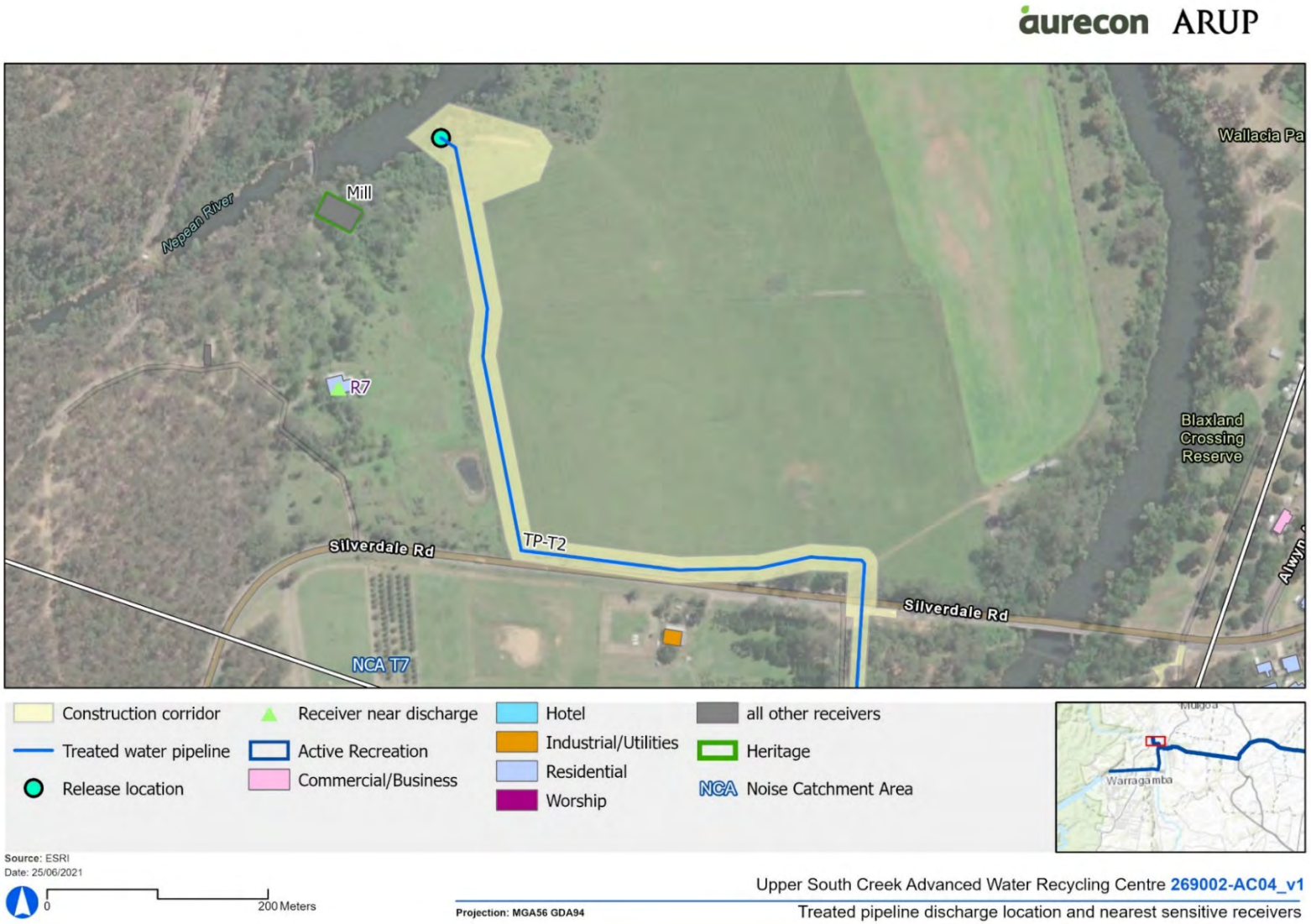


Figure 4: Treated pipeline release location and nearest sensitive receivers

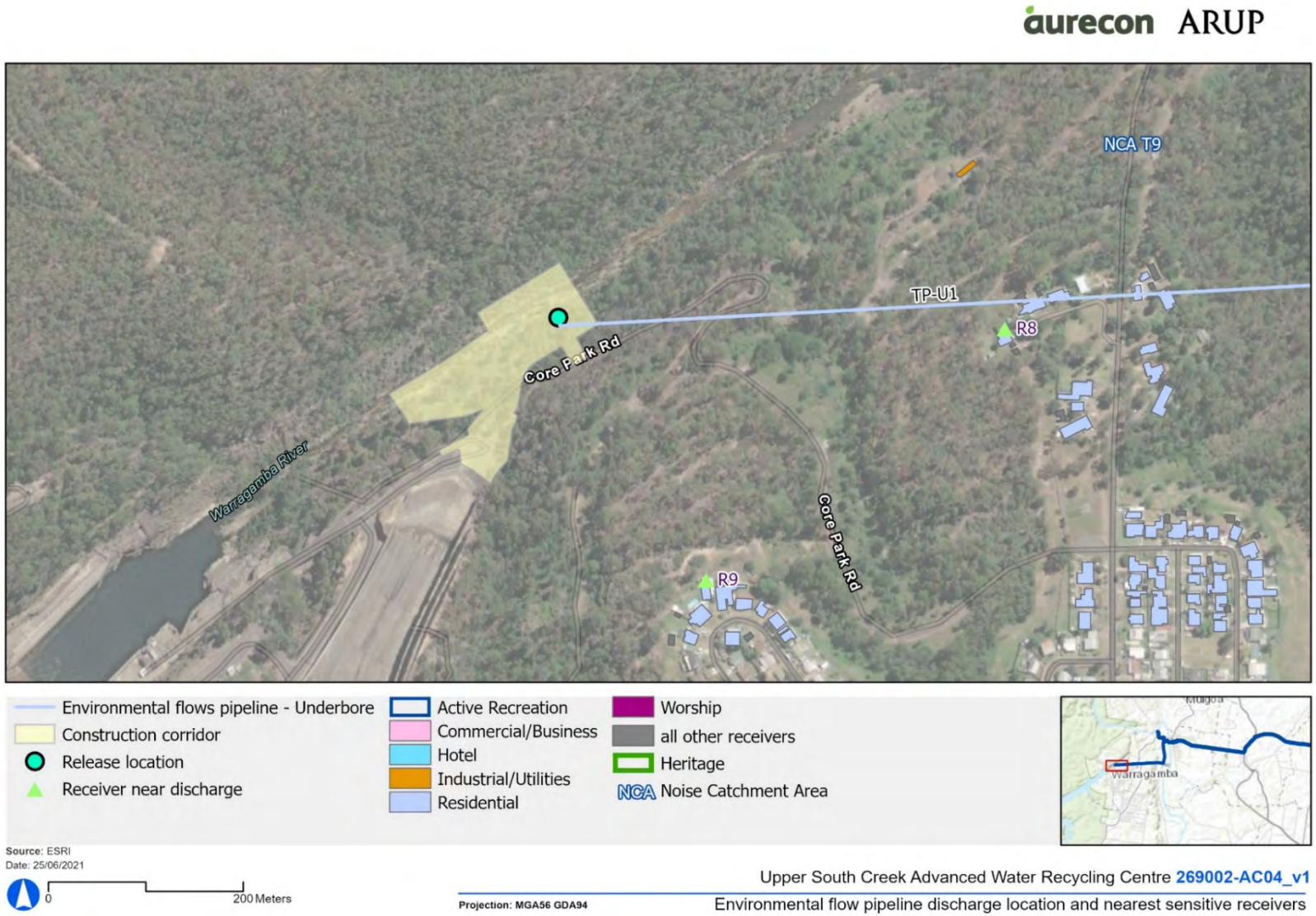


Figure 5: Environmental flow pipeline release location and nearest sensitive receivers

Table 9: Nearest receivers to the release locations

Receiver type	ID	Representative of	Address	Approximate Distance to release site (m)
Residential	R7	NCA T7	2592 Silverdale Road Wallacia NSW 2745	250
	R8	NCA T9	4 Kipara Crescent Warragamba NSW 2752	450
	R9	NCA T9	28 Twelfth Street Warragamba NSW 2752	240

4.3 Pipeline valves assessment locations

Air valves will be installed along the pipelines' alignments. Indicative valve locations and the corresponding nearest receivers are shown in Appendix B. It is understood that the valve locations may require amendment during detailed design.

4.4 Pipeline construction assessment locations

A preliminary desktop survey covering approximatively 100 m each side of the proposed pipeline centreline has been carried out. This area is considered sufficient for the assessment of vibration impact, particularly structural damage. While noise impacts could occur at greater distances than 100 m, especially in non-built-up areas, the current survey is considered to have identified the nearest sensitive receivers.

The survey has identified and categorised relevant receivers, structures and utilities according to the applied noise and vibration policies, standards and guidelines. The survey is provided in Appendix B. The study area and receiver categorisation should however be progressively reviewed following:

- Community consultation and stakeholder engagement
- Ground truthing by the contractor(s) during construction planning
- Advice from authorities regarding any future development.
- Advice received regarding medical facilities and any vibration sensitive equipment or activities.
- Heritage structures and /or sensitive structures based on available information and communication with the heritage consultant and relevant stakeholders. Before start of construction, an assessment of the integrity of the structures should be conducted.

5 Receiver acoustic environment

Criteria for the assessment of operational and construction noise for residential receivers are, in part, derived from the existing noise environment of an area, excluding noise from the subject development. All other receivers have fixed criteria based on land use type.

For this Project, noting the anticipated changes in the acoustic environment due to the operation of the new developments listed in Section 4, residential criteria for the operational assessment has included consideration of the anticipated future acoustic environment.

5.1 Existing acoustic environment

For locations in proximity to the AWRC, unattended background noise monitoring was conducted as part of the EIS for the M12 [13], in June and July 2017, and has been relied upon. Monitoring also included several locations along Elizabeth Drive near the proposed pipeline alignment. The M12 EIS identified that the existing environment near the AWRC was dominated by natural sounds and traffic noise from Elizabeth Drive. The background measurements conducted for the M12 EIS are deemed appropriate for this assessment, as no significant change to the environment is expected to have occurred since the data was acquired.

Relevant monitoring locations for this assessment and monitoring results are shown on Appendix B and Appendix C respectively.

The existing noise environment for the remainder of the alignment was not quantified by long-term noise measurements, as a largely qualitative assessment has been carried out for the construction activities. Where a quantitative assessment has been carried out, criteria has been conservatively established based on AS1055 [14] typical background noise levels and guidance in the NPfI (refer to Appendix C).

Table 10 summarises the existing background levels (measured and estimated) for the various Noise Catchment Areas (NCAs) and receiver locations.

Table 10: Existing Background noise levels – measured and estimated

Receivers	Description	Basis of background level	Rating Background Level (RBL)		
			Day[4]	Evening[4]	Night[4]
NCA T1	Residential Receiver near the AWRC Centre	L06[2]	35[1]	35	31
NCA T2	Residential receiver along Elizabeth Drive (East)	L12[2]	40	37	30
NCA T3	Residential receiver along Elizabeth Drive (West)	L14[2]	42	39	33
NCA T4	Residential receiver along the Northern Road	Urban[3]	50	45	40
NCA T5	Residential receiver along Park Road	Suburban/ Urban[3]	45	40	35
NCA T6	Residential receiver Wallacia Town Centre	Suburban/ Urban[3]	45	40	35

Receivers	Description	Basis of background level	Rating Background Level (RBL)		
			Day[4]	Evening[4]	Night[4]
NCA T7	Residential receivers along Silverdale Road	Rural[3]	40	35	30
NCA T8	Residential receivers along Bents Basin Road	Rural[3]	40	35	30
NCA T9	Residential receivers near North Warragamba	Rural[3]	40	35	30
NCA B1	Residential receivers along Western Road	L05[2]	39	42	35
NCA B2	Residential receivers along Cross Street	L05[2]	39	42	35
NCA B3	Residential receivers near Cecil Park	L03[2]	54	48	37
NCA B4	Residential receivers along Kensington Place	L01[2]	45	44	40
NCA B5	Residential receivers along Stirling Street, Feodore Drive, Frederick Road	L01[2]	45	44	40
NCA B6	Residential Receivers along North Liverpool Road	Urban[3]	50	45	40
NCA B7	Residential Receivers along Montgomery Road	Urban[3]	50	45	40
NCA B8	Residential Receivers along Monash Place and Hebblewhite Place	Suburban/ Urban[3]	45	40	35
NCA B9	Residential Receivers along West Cabramatta Road	Urban[3]	50	45	40
NCA B10	Residential Receivers along Meadows Road	Urban[3]	50	45	40
NCA B11	Residential Receivers along Edensor Road, Harrington Street, John Street	Suburban/ Urban[3]	45	40	35
NCA B12	Residential Receivers on John Street (East of Joseph Street)	Suburban/ Urban[3]	45	40	35
NCA B13	Residential receivers along Gladstone Street, St John Road, Barley Street	Urban[3]	50	45	40
NCA B14	Receivers along Curtin Street and Fairview Road	Suburban/ Urban[3]	45	40	35
NCA B15	Residential receiver along Bareena Street, Vale Street, Chancery Street	Urban[3]	50	45	40
NCA B16	Residential receiver along Bromley Street, Beckenham street and Willowbank Crescent	Suburban/ Urban[3]	45	40	35
NCA B17	Residential receivers along the Hume Highway	Urban industrial[3]	55	50	45

Receivers	Description	Basis of background level	Rating Background Level (RBL)		
			Day[4]	Evening[4]	Night[4]
NCA B18	Residential receivers along Knight St	Urban[3]	50	45	40

Notes:

1. As per NPfI, minimum daytime background assumed to be 35 dBA
2. Measured background – as per monitoring conducted for the M12 EIS **[13]** – Refer to **Appendix C**
3. Estimated background – Based on AS1055 **[14]** typical background noise levels and guidance in the NPfI – Refer to **Appendix C**
4. As per NPfI – day is the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays, evening is the period from 6 pm to 10 pm, night is the remaining periods.

5.2 Future acoustic environment

The noise environment near the AWRC is expected to increase in level as a result of the developments listed in Section 4, most notably the operation of the M12. While the operation of the Western Sydney Airport is likely to increase overall L_{Aeq} noise levels (average noise levels), the background noise level is anticipated to not be affected due to the intermittent nature of aircraft movements. The anticipated increase in noise levels for receivers near the AWRC is approximately 5 dB or more based of the predicted traffic noise levels, and accordingly, the following assumptions have been made:

- Estimating that the background will increase by at least 5 dB due to the operation of the M12, the RBL at the receivers near the AWRC (currently classified as rural, refer to Appendix C) would be 40 dBA during daytime, 40 dBA during evening and 36 dBA during night-time.
- Receivers experiencing those noise levels during the evening and night-time periods are categorised as Urban residential in the NPfI. While the daytime RBL does not fit into the typical existing background noise levels for Urban residential category (as defined in the NPfI), as the AWRC will operate 24-hours with relatively consistent operating conditions, the evening/night-time periods will determine the project assessment. The Urban residential category is therefore considered appropriate as an estimation of future background noise at the receivers near the AWRC when the M12 is operational.

5.3 Background noise levels adopted for the Project

5.3.1 Operation assessment

For the operation of the AWRC, the following scenarios have been assessed (as per Section 4 and Section 5.2):

- **Scenario 1 (Stage 1, Existing Receivers + Future background)**: In this scenario it is assumed that the AWRC Stage 1 is operational and that the M12 is also operational while other developments have not yet been completed. Anticipated background noise levels at receivers near the AWRC are estimated to increase by 5 dB or more (due to the operation of the M12). The resulting background noise levels are estimated to fall into the Urban residential category as defined in the NPfI.

While there is potential for the Project to be in operation one year before the opening of the M12, designing to the existing situation (when the M12 is not operational) is considered to be unduly stringent. In addition, during the initial operation of Stage 1, the plant will not be operating at 100% capacity and therefore expected to emit lower noise levels than predicted in this assessment.

- **Scenario 2 (Stage 1 + Future Stages, Existing and Future Receivers):** This scenario is based on Stage 1 and Future stages of the AWRC being fully operational and with surrounding developments listed in Section 4.1 completed. As per Section 4.1, while the WSAP indicates the preferred type of receivers to be located within the precincts, it is unclear if the existing receivers will remain. Therefore, both the existing and future receivers have been included in the assessment. The background noise level at all residential receivers is assumed to be the same as assessed in Scenario 1.

For the operation of the release structures and the valves, the existing environment as per Section 5.1 is adopted as the pipelines will be built for ultimate capacity.

5.3.2 Construction assessment

For the construction assessment, the existing environment as per Section 5.1 has been adopted.

6 Operational noise and vibration assessment

As described in Section 4, the main sources of noise and vibration from the operation of the Project have been identified as the following:

- Fixed facilities including:
  - plant and equipment operating on the AWRC site,
  - the release sites and
  - the intermittent operation of the air valves located along the underground pipelines.
- AWRC traffic travelling onto the road network

For the fixed facilities, Section 6.1.1 determines relevant noise criteria. Section 6.2 contains a description of the noise sources operating on the AWRC site as well as the noise assessment of the operation of the AWRC. Section 6.4 and 6.5 contain a description and assessment of noise from the release sites and the air valves respectively.

For the operational traffic travelling onto the road network, Section 6.1.2 determine relevant criteria. Section 6.2.3 contains a description of the traffic generated by the operation of the AWRC and Section 6.3 contains the traffic noise assessment.

The vibration criteria and assessment are in Section 6.1.3.

Mitigation measures for the operation of the Project are summarised in Section 6.6.

6.1 Operational criteria

6.1.1 Fixed operational facilities

Operational noise emissions from fixed facilities associated with the Project, including noise emissions from the AWRC site, the pipeline release locations and the valves, have been assessed in accordance with the NPfI [1], which is primarily concerned with controlling intrusive noise impacts in the short-term for residences and maintaining long-term noise level amenity for residences and other land uses. Potential for sleep disturbance is also assessed for residential locations for operation during the night period.

The NPfI [1] sets out the procedure to determine the Project Specific Noise Trigger Levels (PSNTLs) relevant to an industrial development. The PSNTL is a level that, if exceeded would indicate a potential noise impact on the community and so ‘trigger’ a management response.

6.1.1.1 Intrusive noise trigger level

The intrusiveness noise trigger level is applicable to residential premises only and is established relative to the existing background noise level, as follows:

- $L_{Aeq,15minute}$ ≤ RBL plus 5 dB

6.1.1.2 Recommended and project amenity noise levels

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from **all** industrial noise sources combined should remain below the Recommended Amenity Noise Levels (RANL) specified in Table 2.2 of the NPfI where feasible and reasonable. To account for the potential cumulative impact of multiple industrial sites, the Project Amenity Noise Level (PANL), being the objective for a single industrial development at a receiver location, is established as follows:

- Project Amenity Noise Level (PANL) = Recommended Amenity Noise Level (RANL) minus 5 dB(A)

The NPfI also provides the following exceptions to the above method for deriving the PANL:

- In areas with high traffic noise levels.
- In proposed developments in major industrial clusters.
- Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
- Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development.

6.1.1.3 Sleep disturbance

Sleep disturbance relates to both awakenings and disturbance to sleep stages. The NPfI outlines the following noise trigger levels for assessment of night-time noise levels at residential locations:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

Where these trigger levels are exceeded, a detailed maximum noise level (L_{Amax}) event assessment should be undertaken.

Advanced Water Recycling Centre and release locations

The noise from the operation of the AWRC is expected to be relatively continuous during night-time, without the movement of trucks or other variable noise sources, therefore the night-time project-specific noise level is sufficient (equivalent to the first dot point) for assessing sleep disturbance.

Valves

Air valves are required to release air or admit air into the water system during pipeline filling and draining/rupture.

Criteria for the operation of the valves has been derived from the NPfI [1] and is as follows:

- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,
- The night-time project specific noise level ($L_{Aeq15minute}$) for the area in which the valves are located corrected for the duration of the event as per Table C3 of the NPfI

6.1.1.4 Modifying factors

Table C1 of the NPfI sets modifying factor corrections for annoying noise characteristics such as tonality, dominant low frequency, intermittency or irregularity.

When assessing low frequency impacts, an initial screening test is first undertaken by evaluating whether the difference in noise levels in C-weighted and in A-weighted are 15 dB or more at the receivers, which identifies the potential for an unbalanced spectrum in which case further assessment is required.

6.1.1.5 Project specific noise trigger levels (PSNTLs)

The PSNTLs are summarised in Table 11. The PSNTLs are the lower (or more stringent) of the intrusive and amenity noise levels. Because the intrusive noise levels ($L_{Aeq(15minute)}$) is determined over a 15-minute period and the amenity noise levels $L_{Aeq(period)}$ is determined over an assessment period (day, evening and night-time period), the NPfI assumes that $L_{Aeq(15minute)} = L_{Aeq(period)} + 3$ dB to standardise the time periods for the intrusiveness and amenity noise levels.

Table 11: NPfI Project specific noise levels for residential receivers

Receiver type	Receiver ID	Time period	Background noise levels (RBL)	Intrusive Noise Trigger Levels $dBL_{Aeq, 15min}$	Project Amenity Noise Level (PANL) $dBL_{Aeq(period)}$	Project Amenity Noise Level (PANL) $dBL_{Aeq(15min)}$	Project-specific noise trigger level (PSNTL) $dBL_{Aeq, 15min}$	Sleep Disturbance
Advanced Water Recycling Centre – SCENARIO 1 (Sc1 – Stage 1, Existing Receivers)								
Residential	R1 – R6	Day	40[1]	45	55[2]	58[3]	**45**	**N/A**
		Evening	40[1]	45	45[2]	48[3]	**45**	**N/A**
		Night	36[1]	41	40[2]	43[3]	**41**	**52**
Advanced Water Recycling Centre – SCENARIO 2 (Sc2 – Stage 1+Future Stages, Future Receivers)								
Residential	R1 – R6 RF1 – RF3	Day	40	45[1]	55[2]	58[3]	**45**	**N/A**
		Evening	40	45[1]	45[2]	48[3]	**45**	**N/A**
		Night	36	41[1]	40[2]	43[3]	**41**	**52**
Industrial	I1, I2, I3	When in use	-	N/A	65	68[3]	**68[3]**	**N/A**
Active recreation	A1, A2, A3, A4	When in use	-	N/A	50	53[3]	**53[3]**	**N/A**
Pipeline release Assessment								
Residential	R7	Day	40	45	45	48[3]	**45**	**N/A**
		Evening	35	40	40	43[3]	**40**	**N/A**
		Night	30	35	35	38[3]	**35**	**52**
	R8 – R9	Day	40	45	45	48[3]	**45**	**N/A**
		Evening	35	40	40	43[3]	**40**	**N/A**

Receiver type	Receiver ID	Time period	Background noise levels (RBL)	Intrusive Noise Trigger Levels $dBL_{Aeq, 15min}$	Project Amenity Noise Level (PANL) $dBL_{Aeq(period)}$	Project Amenity Noise Level (PANL) $dBL_{Aeq(15min)}$	Project-specific noise trigger level (PSNTL) $dBL_{Aeq, 15min}$	Sleep Disturbance
		Night	30	35	35	38[3]	**35**	**52**
Pipeline Valve Assessment								
Residential	Within NCA B6	Night	40	-	-	**-**	**40 + C[4]**	**55**
	Within NCA B7	Night	40	-	-	**-**	**40 + C[4]**	**55**
	Within NCA B9	Night	40	-	-	**-**	**40 + C[4]**	**55**
	Within NCA B11	Night	35	-	-	**-**	**35 + C[4]**	**52**
	Within NCA B12	Night	35	-	-	**-**	**35 + C[4]**	**52**

Notes:

1. Refer to Section 5.3.1. A 5 dB increase in RBL has been assumed due to M12 operation.
2. Based on Urban residential typical criteria as per Table 2.3 of the NPfI, Section 5.2 and Section 5.3
3. Includes a conversion factor of 3 dB to convert the $L_{Aeq(period)}$ to an $L_{Aeq(15minutes)}$
4. C: correction for the duration of the event as per Table C3 of the NPfI

6.1.2 Road traffic noise

Increased traffic generated on the public road network is assessed in accordance with the NSW *Road Noise Policy* (RNP) [3]. Traffic accessing the AWRC site is anticipated to travel on Elizabeth Drive, Clifton Avenue and a new access road (as there is currently no road connecting the AWRC site to Clifton Avenue). Works related to the AWRC access road are not included in the Project and do not form part of this assessment.

When assessing noise impact using the existing road network, an initial screening test is applied to evaluate whether noise levels are expected to increase by more than 2 dBA due to the additional traffic generated by the Project.

Where noise levels are predicted to increase by more than 2 dBA (i.e. 2.1 dBA or greater) further assessment is required against the criteria in Table 3 of the RNP, as summarised in Table 12 below.

Table 12: Road traffic noise criteria for residential land uses

Road (RNP category)	Type of project/land use	Assessment criteria – dBA	
		Day 7 am-10 pm	Night 10 pm-7 am
Elizabeth Drive (Freeway/arterial/ sub-arterial roads)	Existing residences affected by additional traffic on existing freeways/arteria/sub-arterial roads generated by land use developments	60 $L_{Aeq(15hour)}$ (external)	55 $L_{Aeq(9hour)}$ (external)
Clifton Avenue (Local roads)	Existing residences affected by additional traffic on existing local roads generated by land use developments	55 $L_{Aeq(1hour)}$ (external)	50 $L_{Aeq(1hour)}$ (external)
Notes: These criteria are for assessment against façade corrected noise levels when measured in front of a building façade.			

6.1.3 Vibration

Vibration impacts are generally assessed in accordance with NSW *Assessing Vibration: a technical guideline* [15], AS 2187:Part 2 [16], BS 7385 Part 2 [10] and DIN 4150 [11].

While vibration generating equipment has been identified for the site (such as the centrifuge, effluent transfer pumps and brine transfer pumps), standard mounting and installation practices can readily mitigate vibration transmission to external receivers. Furthermore, there are no highly sensitive structures located in the vicinity of the site and therefore operational vibration impacts at surrounding receivers are not expected.

6.2 Advanced Water Recycling Centre site operational assessment

6.2.1 Indicative site layout

An indicative site layout is shown in Figure 6. Identified noise sources are shown in Figure 6 and are described in Section 6.2.2. It is acknowledged that site layout might change during detail design.

The AWRC will be developed in stages (refer to Section 1 and Section 3). Future stages will likely include similar plant and equipment as equipment in Stage 1.

While the subject application relates only to Stage 1, Future stages have been included in the assessment to evaluate potential cumulative emissions of the Project to inform noise mitigation and management strategies. Subsequent stages will nonetheless be subject to assessment in the future, at which time current site operations can be confirmed, along with the prevailing acoustic environment.

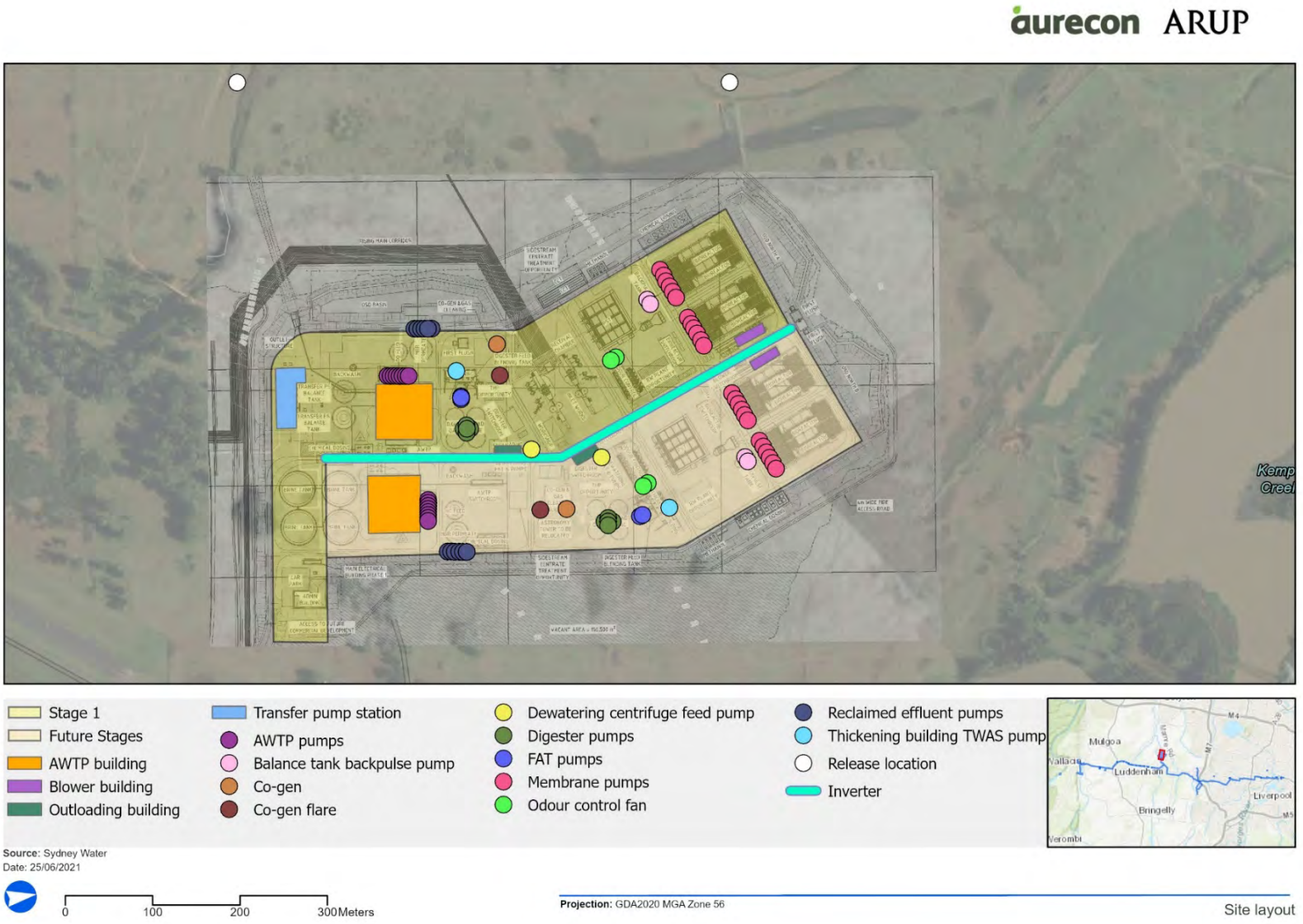


Figure 6: Indicative Site layout identifying main noise generating plant and equipment

6.2.2 Site equipment, activities and building design

The primary operational noise sources associated with the AWRC with the potential to impact on surrounding receivers are:

- Plant and equipment:
  - Blower building
  - Outloading building
  - Advanced water treatment plant (AWTP) building
  - Transfer Pump Station
  - Various pumps
  - Co-gen and associated equipment
  - Odour control fans
  - Inverters for the solar panels
- Vehicular traffic:
  - Heavy vehicles (trucks) travelling to and from site
    - to deliver chemicals
    - to pick up biosolids
  - Light vehicles travelling to/from the site

A summary of the noise level data used in the prediction model is given in Table 13 and Table 14. Noise levels used in this assessment were sourced from existing water facilities, empirical data and Aurecon Arup's noise levels database. Note that detailed information regarding plant and equipment is yet to be finalised, and all plant and equipment and building design will be subject to further detailed design to ensure that criteria are met. Detailed inputs used in the noise model for this assessment is given in Appendix B.

Table 13: Noise modelling source level data

Equipment	Metric	Broadband sound level – dBA	Data Reference
Moving sources			
Truck (20t semi-trailer truck and B double) – 10 km/h	$L_{eq(15minute)}$/m – L_w	70	Arup database (based on measurements)
Trucks braking	$L_{eq(15\ minute)}$ – L_w	71	
	L_{max} – L_w	120	
Trucks idling	$L_{eq(15\ minute)}$ – L_w	95	
Light vehicle 10 km/h	$L_{eq(15minute)}$/m – L_w	48	
Stationary sources			
Membrane Permeate Pump	$L_{eq(15minute)}$ – L_w	95 (per unit)	Empirical calculation [17]

Equipment	Metric	Broadband sound level – dBA	Data Reference
Balance Tank Backpulse Pump	$L_{eq(15minute)} – L_w$	86 (per unit)	RPM & power for each pump provided by design team.
FAT Dewatering / Centrifuge Feed Pump	$L_{eq(15minute)} – L_w$	86 (per unit)	
FAT Mixing Centrifugal Pump	$L_{eq(15minute)} – L_w$	87 (per unit)	
FAT Digester Feed Pump	$L_{eq(15minute)} – L_w$	85 (per unit)	
Thickening and Poly TWAS Pump	$L_{eq(15minute)} – L_w$	86 (per unit)	
Digester Sludge Transfer Pump	$L_{eq(15minute)} – L_w$	84 (per unit)	
Digester Mixing Pump	$L_{eq(15minute)} – L_w$	95 (per unit)	
Digester Heating Pump	$L_{eq(15minute)} – L_w$	89 (per unit)	
Digester Fill and Spill Transfer Pump	$L_{eq(15minute)} – L_w$	87 (per unit)	
Digester Recuperative Thickening Feed Pump	$L_{eq(15minute)} – L_w$	86 (per unit)	
RO Feed Pump	$L_{eq(15minute)} – L_w$	99 (per unit)	
UF Pump	$L_{eq(15minute)} – L_w$	96 (per unit)	
Reclaimed Effluent Pump (37 kW)	$L_{eq(15minute)} – L_w$	91 (per unit)	
Reclaimed Effluent Pump (55 kW)	$L_{eq(15minute)} – L_w$	93 (per unit)	
Odour Control Extraction Fan	$L_{eq(15minute)} – L_w$	92 (per unit)	Empirical calculation [18] [19] Pressure and flow rate data provided by design team.
Inverter	$L_{eq(15minute)} – L_w$	84 (per unit)	Based on a maximum 70 dBA Lp at 1 m (provided by design team)
Weir	$L_{eq(15minute)} – L_w$	76 (per unit)	Based on [20] and Arup database
Co-Gen Exhaust (with silencer)[1]	$L_{eq(15minute)} – L_w$	96 (per unit)	Manufacturer data (Jenbacher)
Co-Gen Engine (within enclosure)[1]	$L_{eq(15minute)} – L_w$	96 (per unit)	
Co-Gen Flare	$L_{eq(15minute)} – L_w$	95 (per unit)	Empirical formula [21]
Buildings			
Blower Building	$L_{eq(15minute)}$ – Internal L_p[2]	85	Refer to Table 14
Outloading Building	$L_{eq(15minute)}$ – Internal L_p[2]	84	
AWTP Building	$L_{eq(15minute)}$ – Internal L_p[2]	79	

Equipment	Metric	Broadband sound level – dBA	Data Reference
Transfer Pump Station: • Pump Room • Fan Room	$L_{eq(15minute)}$ – Internal L_p[2] $L_{eq(15minute)}$ – Internal L_p[2]	87 93	
Notes: 1. Co-gen noise levels assume that the co-gen, when enclosed and fitted with an exhaust silencer, will achieve a sound pressure level of 65 dB(A) or less at a distance of 10 m. 2. Refer to Table 14 for equipment noise levels used to calculate internal Lp			

Table 14: Noise modelling source level data – equipment inside buildings

Equipment	Quantity	Metric	Broadband sound level – dBA	Data reference
Blower Building				
Blower	7	$L_{eq(15minute)}$ – L_w	92 (per unit)	Sydney Water [22] [23]
Outloading Building				
Decantering centrifuge	2	$L_{eq(15minute)}$ – L_w	99 (per unit)	Measured data [24]
Transfer Pump Station				
Brine Transfer Pump – Pump Room	2	$L_{eq(15minute)}$ – L_w	99 (per unit)	Empirical calculation [17] RPM & power for each pump provided by design team.
Effluent Transfer Pump – Pump Room	3	$L_{eq(15minute)}$ – L_w	101 (per unit)	
Exhaust Fan – Pump Room	2	$L_{eq(15minute)}$ – L_w	96 (per unit)	Empirical calculation [18] [19] Pressure and flow rate data provided by design team.
Inlet fans – Fan Room	3	$L_{eq(15minute)}$ – L_w	95 (per unit)	
AWTP Building				
Blower	2	$L_{eq(15minute)}$ – L_w	92 (per unit)	Sydney Water [22] [23]
RO Pumps (22 kW)	8	$L_{eq(15minute)}$ – L_w	89 (per unit)	Empirical calculation [17] RPM & power for each pump provided by design team.
RO Pumps (15 kW)	8	$L_{eq(15minute)}$ – L_w	87 (per unit)	
RO Backwash Pumps	2	$L_{eq(15minute)}$ – L_w	97 (per unit)	

For the purpose of the assessment, the following assumptions have been made:

- facades of the blower building, the AWTP building and the Outloading building have been conservatively modelled as constructed from metal cladding.
- The transfer pump station is as listed below and was modelled as 200 mm blockwork with acoustic louvres and hollow metal doors in accordance with information provided by the design team:
  - 1x door for truck arrival and departure

  - 7x doors for pedestrian access
  - 7x air inlet louvres
  - 8x air outlet louvres
  - 1x exhaust fan outlet louvre
  - 1x fan room inlet louvre
- Outloading Building:
  - 2x doors for truck arrival and departure
- The truck doors to/from for the outloading building have been conservatively modelled as open.
- Blower Building:
  - 8x louvres along one façade
  - 8x duct outlets along opposite façade
- The blower building louvres have been conservatively modelled as weather louvres with no acoustic rating.

The assumed sound transmission loss for the construction materials used in this assessment are given in Table 15.

Table 15: Transmission Loss of building envelope materials

Material	R_w	Octave Band Centre Frequency – Transmission Loss, dB							
		63	125	250	500	1 k	2 k	4 k	8 k
Metal cladding (roofs)	18	-9	-12	-15	-15	-16	-20	-23	-23
Metal facade cladding	29	-15	-20	-20	-28	-30	-30	-30	-30
Hollow Metal door	30	-12	-22	-28	-30	-33	-27	-36	-36
Blockwork	51	-39	-35	-40	-48	-56	-63	-70	-76
Acoustic louvre	24	-6	-12	-15	-21	-24	-27	-25	-20

6.2.3 Traffic

Traffic generated by the operation of the AWRC has been sourced from the Traffic and Transport Impact Assessment and is reproduced below in Table 16.

The AWRC will be operational 24/7 with vehicle movements consisting of staff, biosolids, screening and grit removal, and other deliveries. It is expected that the AWRC will require up to 15 staff on site during the operation of Stage 1. The majority of staff movements are expected to occur between standard hours of operation, Monday to Friday 7 am to 5 pm. A small number of staff will be present outside work hours in order to run the AWRC.

The majority of staff are expected to arrive between 6 am and 9 am and depart between 4 pm and 7 pm aligning with the standard hours of operation. Servicing vehicles may arrive at any time throughout the workday but could arrive as early as 6 am.

Table 16: Total daily movements during operation – Stage 1

Activity	Vehicle type	Number of vehicles (Peak) per day
Biosolids outload (50ML)	Heavy vehicle	2
Screening removal	Heavy vehicle	1
Grit removal	Heavy vehicle	1
Other deliveries (50ML)	Heavy vehicle	7
Staff	Light vehicle	15

Accordingly, for the daytime, evening and night-time periods, two trucks travelling in and out of the site (in Stage 1) (equivalent to 4 truck movements within a 15 minute period) and fifteen cars travelling in or out of the site have been modelled for the typical worst-case 15-minute assessment period (equivalent to 15 car movements within a 15 minute period).

Future stages will likely include similar traffic as Stage 1 traffic.

6.2.4 Operational scenarios

Table 17 presents the number of equipment and activities included for each operational scenario.

Table 17: Modelling scenarios

Noise Sources	Number of sources/equipment per period			
	Sc1 – Stage 1, Existing Receivers		Sc2 – Stage 1+Future Stages, Existing + Future Receivers	
	Day/Evening	Night	Day/Evening	Night
Vehicle movements				
Trucks (assumes in and out during period)	4	4	8	8
Light vehicles	15	15	30	30
Plant, equipment and internal activities				
Membrane Permeate Pump	12	12	24	24
Balance Tank Backpulse Pump	2	2	4	4
Odour Control Extraction Fan	2	2	4	4
FAT Dewatering / Centrifuge Feed Pump	2	2	4	4
FAT Mixing Centrifugal Pump	1	1	2	2
FAT Digester Feed Pump	2	2	4	4
Thickening and Poly TWAS Pump	1	1	2	2
Digester Sludge Transfer Pump	2	2	4	4
Digester Mixing Pump	4	4	8	8
Digester Heating Pump	4	4	8	8
Digester Fill and Spill Transfer Pump	2	2	4	4

Noise Sources	Number of sources/equipment per period			
	Sc1 – Stage 1, Existing Receivers		Sc2 – Stage 1+Future Stages, Existing + Future Receivers	
	Day/Evening	Night	Day/Evening	Night
Digester Recuperative Thickening Feed Pump	2	2	4	4
Co-Gen Exhaust (with silencer)[1]	1	1	2	2
Co-Gen Engine (within enclosure)[1]	1	1	2	2
Co-Gen Flare	1	1	2	2
RO Feed Pump	8	8	16	16
UF Pump	8	8	16	16
Reclaimed Effluent Pump (37 kW)	2	2	4	4
Reclaimed Effluent Pump (55 kW)	4	4	8	8
Inverter	50	-	100	-
Weir	2	2	2	2
Buildings				
Blower Building	1	1	2	2
Outloading Building	1	1	2	2
AWTP Building	1	1	2	2
Transfer Pump Station	1	1	1	1

6.2.5 Advanced Water Recycling Centre operational noise predictions

Noise modelling was undertaken using SoundPlan v8.1 adopting the CONCAWE algorithms in line with NPfI recommendations. The model includes:

- Noise sources and associated sound power levels in Section 6.2.2
- Receivers as listed in Section 4.1
- Ground terrain and absorption
- A + 2dB engineering margin on all predicted levels
- Weather conditions: both standard (Category D, no wind) and noise enhancing (per Fact Sheet D), as follows:
  - Meteorological Condition 1: Stability A-D class with wind up to 3 m/s at 10 m above ground level
  - Or Meteorological Condition 2: Stability F class with wind up to 2 m/s at 10 m above ground level. – Note that stability F class represents temperature inversion
  - with a conservative approach that considers source to receiver wind vectors for all receivers.

As there was no material difference between the two noise enhancing meteorological conditions, only noise enhancing meteorological condition 1 has been presented.

Predicted noise levels are shown in Table 18 and Table 19, for Scenario 1 and 2 respectively. The results are presented as dB(A) only, however a review of low frequency noise has been conducted. Receivers potentially subject to excess low frequency noise are indicated and include a 5 dB penalty as per Section 6.1.1.4. This assessment is conservative, as it has compared the A-weighted and C-weighted site contribution only and not the background noise contribution.

Additional assessment regarding low frequency and tonality is however warranted during the detailed design stage once more detailed data spectral data for equipment is available. Notwithstanding, additional mitigation measures can be implemented, as outlined in Section 6.2.6.

Table 18: Predicted operational noise levels dBL$_{Aeq(15minute)}$ – Scenario 1 (Sc1 – Stage 1, Existing Receivers)

Receiver ID	Standard meteorological conditions (Stability Category D, no wind)						Enhanced meteorological conditions (Stability Category D, 3 m/s wind)					
	Day/Evening			Night			Day/Evening			Night		
	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance
R1	33[1]	*45*	YES	32[1]	*41*	YES	33	*45*	YES	32	*41*	YES
R2	29	*45*	YES	29	*41*	YES	34	*45*	YES	34	*41*	YES
R3	33	*45*	YES	32	*41*	YES	37	*45*	YES	37	*41*	YES
R4	36	*45*	YES	35	*41*	YES	40	*45*	YES	40	*41*	YES
R5	37	*45*	YES	37	*41*	YES	42	*45*	YES	42	*41*	NO (+1)
R6	37	*45*	YES	36	*41*	YES	41	*45*	YES	40	*41*	YES

Notes:

1. Site contribution dB(C) exceeds dB(A) by more than 15 dB. Results include a 5 dB modifying factor as per Section 6.1.1.4

Table 19: Predicted operational noise levels dB(A) – Scenario 2 (Sc2 – Stage 1+Future Stages, Existing + Future Receivers)

Receiver ID	Standard meteorological conditions (Stability Category D, no wind)						Enhanced meteorological conditions (Stability Category D, 3 m/s wind)					
	Day/Evening			Night			Day/Evening			Night		
	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance
R1	35[1]	*45*	YES	34[1]	*41*	YES	35	*45*	YES	34	*41*	YES
R2	32	*45*	YES	32	*41*	YES	37	*45*	YES	37	*41*	YES
R3	36	*45*	YES	35	*41*	YES	40	*45*	YES	40	*41*	YES
R4	38	*45*	YES	38	*41*	YES	43	*45*	YES	43	*41*	NO (+2)
R5	38	*45*	YES	37	*41*	YES	43	*45*	YES	42	*41*	NO (+1)

Receiver ID	Standard meteorological conditions (Stability Category D, no wind)						Enhanced meteorological conditions (Stability Category D, 3 m/s wind)					
	Day/Evening			Night			Day/Evening			Night		
	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance
R6	41	*45*	YES	41	*41*	YES	46	*45*	NO (+1)	45	*41*	NO (+4)
RF1	43[1]	*45*	YES	42[1]	*41*	NO (+1)	42	*45*	YES	42	*41*	NO (+1)
RF2	44[1]	*45*	YES	43[1]	*41*	NO (+2)	43	*45*	YES	43	*41*	NO (+2)
RF3	42[1]	*45*	YES	41[1]	*41*	YES	41	*45*	YES	41	*41*	YES
I1	47	68 (When in use)	YES	N/A	68 (When in use)	N/A	52	68 (When in use)	YES	N/A	68 (When in use)	N/A
I2	39	68 (When in use)	YES	N/A	68 (When in use)	N/A	44	68 (When in use)	YES	N/A	68 (When in use)	N/A
I3	43	68 (When in use)	YES	N/A	68 (When in use)	N/A	48	68 (When in use)	YES	N/A	68 (When in use)	N/A
A1	44	53 (When in use)	YES	N/A	53 (When in use)	N/A	48	53 (When in use)	YES	N/A	53 (When in use)	N/A
A2	47[1]	53 (When in use)	YES	N/A	53 (When in use)	N/A	47	53 (When in use)	YES	N/A	53 (When in use)	N/A
A3	47	53 (When in use)	YES	N/A	53 (When in use)	N/A	51	53 (When in use)	YES	N/A	53 (When in use)	N/A
A4	44	53 (When in use)	YES	N/A	53 (When in use)	N/A	48	53 (When in use)	YES	N/A	53 (When in use)	N/A

Notes:

1. Site contribution dB(C) exceeds dB(A) by more than 15 dB. Results include a 5 dB modifying factor as per Section 6.1.1.4

The assessment summarised in Table 18 indicates the current Stage 1 site layout, operations, equipment information and building design, can comply with PSNTLs, except during the night period under enhanced meteorological conditions at R5 (+1 dB).

The assessment summarised in Table 19 indicates that the current Future stages site layout, operations, equipment information and building design, can comply with the PSNTLs, except during the daytime under enhanced meteorological conditions at R6 (+1 dB), during the night period under standard meteorological conditions at RF1 (+1 dB) and RF2 (+2 dB) and under enhanced meteorological conditions at R4 (+2 dB), R5 (+1 dB), R6 (+4 dB), RF1 (+1 dB) and RF2 (+2 dB).

For both assessment scenarios, exceedances are limited to locations that are potentially subject to future redevelopment (R4, R5 and R6) and residential receivers that may not be built (RF1 and RF2).

To inform potential mitigation strategies, individual noise contributions are presented in Table 20 and Table 21 for Scenario 1 and 2 respectively.

Table 20: Noise contributions – Scenario 1 (Stage 1, Existing Receivers), Night, Adverse meteorological conditions

Noise source	$L_{Aeq(15minute)}$ dB contribution					
	R1	R2	R3	R4	R5	R6
FAT Pumps S1	16	17	17	9	7	21
Tx Pump Station S1	22	23	25	29	26	26
AWTP Bld Stage 1	16	15	17	26	21	25
Balance Tank Pumps S1	14	14	16	17	15	17
Blower Bld – Stage 1	23	22	23	25	22	23
Co-Gen Stage 1	22	23	25	25	26	18
Digester Pumps Stage 1	8	25	12	16	10	27
Membrane Pumps Stage 1	25	28	34	33	31	35
Fans S1	21	21	23	16	22	25
Outloading Bld Stage 1	20	20	24	22	16	28
Reclaimed Effluent Pump S1	24	25	26	23	29	10
AWTP Pumps S1	23	26	16	22	40	21
Inverters Stage1	-	-	-	-	-	-
Thickening Pumps S1	9	10	12	3	2	8
Weir	5	5	2	7	6	2
Traffic - cars	2	2	6	17	9	16
Traffic - truck	19	20	29	37	30	37
TOTAL unmitigated	**32**	**34**	**37**	**40**	**42**	**40**
Criteria	**41**	**41**	**41**	**41**	**41**	**41**
Note: Highlighted in red: noise sources within 10 dB of criteria which contribute to exceedance of the criteria						

Table 21: Noise contribution – Scenario 2 (Stage 1+Future Stages, Existing + Future Receivers), Night, Adverse met conditions

Noise source	$L_{Aeq(15minute)}$ dB contributions															
	R1	R2	R3	R4	R5	R6	RF1 (Potential)	RF2 (Potential)	RF3 (Potential)	I1	I2	I3	A1	A2	A3	A4
FAT Pumps S1	16	17	9	8	7	21	24	23	22	26	8	27	17	28	30	28
Tx Pump Station S1	22	23	23	29	26	26	28	28	28	27	26	34	29	25	33	33
AWTP Bld Future Stages	13	16	17	15	19	27	17	15	20	30	20	26	26	20	21	24
AWTP Bld Stage 1	16	15	17	24	21	25	23	23	21	26	21	26	25	22	29	25
Balance Tank Pumps S1	14	14	16	17	15	5	23	23	21	9	19	23	22	25	32	25
Balance Tank Pumps Future Stages	13	12	19	16	13	13	20	21	19	25	23	19	26	27	27	21
Blower Bld – Stage 1	23	22	22	25	22	23	31	31	28	27	24	28	27	32	37	30
Blower Bld – Future Stages	20	18	26	21	19	26	27	28	25	30	28	24	31	35	33	26
Co-Gen Stage 1	22	23	25	24	26	17	30	30	29	19	17	34	26	31	38	35
Co-Gen Future Stages	17	21	23	17	19	31	24	16	23	38	31	28	35	28	30	31
FAT Pumps Future Stages	16	16	22	4	3	26	24	24	22	29	27	21	31	25	30	23
Digester Pumps Stage 1	8	25	12	16	10	21	15	14	17	27	15	29	19	29	21	29
Digester Pumps Future Stages	6	24	16	16	8	19	13	14	20	40	17	15	23	18	26	15
Membrane Pumps Stage 1	25	28	34	33	31	29	33	32	35	39	37	39	39	36	46	41

Noise source	$L_{Aeq(15minute)}$ dB contributions															
	R1	R2	R3	R4	R5	R6	RF1 (Potential)	RF2 (Potential)	RF3 (Potential)	I1	I2	I3	A1	A2	A3	A4
Membrane Pumps Future Stages	25	27	36	30	30	36	32	30	31	42	39	37	42	36	39	38
Fans S1	21	21	23	16	22	19	28	28	27	26	26	29	29	30	35	30
Fans Future Stages	20	19	25	18	10	14	26	27	25	33	28	27	32	30	32	28
Outloading Bld Stage 1	20	20	18	21	16	28	26	26	25	33	22	24	30	28	32	30
Outloading Bld Future Stages	20	20	25	23	21	27	27	27	26	33	28	29	28	30	33	29
Reclaimed Effluent Pump S1	24	25	14	23	29	10	31	31	30	14	23	36	19	31	38	37
Reclaimed Effluent Pump Future Stages	6	3	27	32	11	36	12	9	8	40	31	11	37	15	14	12
AWTP Pumps S1	23	26	16	22	40	21	33	36	24	22	19	44	22	40	42	44
AWTP Pumps Future Stages	19	30	24	22	17	41	25	34	23	49	31	26	41	40	27	27
Inverters Stage 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inverters Future Stages	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thickening Pumps S1	9	10	2	2	2	8	17	17	16	6	4	21	5	18	24	22
Thickening Pumps Future Stages	9	9	16	2	2	20	17	17	15	26	20	17	24	8	23	18
Weir	5	5	2	7	6	2	16	15	12	4	2	21	2	11	40	20
Traffic – cars – Stage 1	2	2	6	17	9	16	2	2	2	18	9	7	13	6	2	2

Noise source	$L_{Aeq(15minute)}$ dB contributions															
	R1	R2	R3	R4	R5	R6	RF1 (Potential)	RF2 (Potential)	RF3 (Potential)	I1	I2	I3	A1	A2	A3	A4
Traffic - cars – Future Stages	2	2	6	17	9	16	2	2	2	18	9	7	13	6	2	2
Traffic – truck – Stage 1	18	20	26	37	30	36	23	24	24	37	30	34	34	25	27	31
Traffic - truck – Future Stages	22	23	27	37	30	37	29	30	28	39	30	35	35	26	34	33
TOTAL unmitigated	**34**	**37**	**40**	**42**	**42**	**45**	**42**	**43**	**41**	**52**	**44**	**48**	**48**	**46**	**50**	**48**
Criteria	**41**	**41**	**41**	**41**	**41**	**41**	**41**	**41**	**41**	**68**	**68**	**68**	**53**	**53**	**53**	**53**
Note: Highlighted in red: noise sources within 10 dB of criteria which contribute to exceedance of the criteria																

Table 20 and Table 21 indicate that the main noise contributors are the various pumps, in particular the AWTP, membrane pumps and reclaimed effluent pumps. Mitigation measures to be implemented are described in the following section and the trucks.

6.2.6 Advanced Water Recycling Centre operational noise mitigation measures

As outlined in Section 6.2.2, a review of the design of the building envelope and plant and equipment will be conducted during detail design to address predicted non-compliances, and should include:

- Reselection of pumps with lower noise level alternatives and/or installation of barriers and / or enclosures around the noisiest pumps. Mitigation measures will be required for several pumps (such as but not limited to the AWTP RO Feed and UF pumps, reclaimed effluent pumps and the membrane pumps).
- Potentially upgrade to the construction of the building envelopes.
- Limit the number of trucks movements within the site during the night-time period

Table 22 and Table 23 shows predicted levels for Stage 1 and Stage 1 + Future stages including the mitigation measures listed above. The following reductions in noise levels have been assumed:

- 3 dB reduction has been included to account for 2 truck movements instead of 4
- 5 dB reduction has been included to the Stage 1 AWTP pumps
- 10 dB reduction has been included to the Future Stages membrane pumps, the Future Stages reclaimed effluent pumps and the Future Stages AWTP pumps noise contribution as a result of the mitigations listed above. To provide a 10 dB reduction in noise level, the enclosures should be fully sealed, made of material with a surface density above 10 kg/m^2 and internally lined with 25 mm to 50 mm absorbent material in accordance with AS 2436-2010 [6].

With mitigation measures listed above, criteria are predicted to be achievable at all receivers for the operation of Stage 1 and Future Stages.

Table 22: Predicted operational noise levels including mitigation dB(A) – Scenario 1 (Sc1 – Stage 1, Existing Receivers)

Receiver ID	Standard meteorological conditions (Stability Category D, no wind)						Enhanced meteorological conditions (Stability Category D, 3 m/s wind)					
	Day/Evening			Night			Day/Evening			Night		
	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance
R1	32[1]	*45*	YES	32[1]	*41*	YES	32	*45*	YES	32	*41*	YES
R2	29	*45*	YES	29	*41*	YES	34	*45*	YES	34	*41*	YES
R3	32	*45*	YES	32	*41*	YES	37	*45*	YES	36	*41*	YES
R4	34	*45*	YES	34	*41*	YES	39	*45*	YES	38	*41*	YES
R5	34	*45*	YES	34	*41*	YES	39	*45*	YES	39	*41*	YES
R6	36	*45*	YES	35	*41*	YES	40	*45*	YES	39	*41*	YES

Table 23: Predicted operational noise levels including mitigation dB(A) – Scenario 2 (Sc2 – Stage 1+Future Stages, Existing + Future Receivers)

Receiver ID	Standard meteorological conditions (Stability Category D, no wind)						Enhanced meteorological conditions (Stability Category D, 3 m/s wind)					
	Day/Evening			Night			Day/Evening			Night		
	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance
R1	34[1]	*45*	YES	33[1]	*41*	YES	34	*45*	YES	33	*41*	YES
R2	31	*45*	YES	30	*41*	YES	35	*45*	YES	35	*41*	YES
R3	33	*45*	YES	33	*41*	YES	38	*45*	YES	38	*41*	YES
R4	36	*45*	YES	36	*41*	YES	40	*45*	YES	40	*41*	YES
R5	35	*45*	YES	34	*41*	YES	39	*45*	YES	39	*41*	YES
R6	37	*45*	YES	37	*41*	YES	41	*45*	YES	41	*41*	YES
RF1	42[1]	*45*	YES	41[1]	*41*	YES	41	*45*	YES	41	*41*	YES

Receiver ID	Standard meteorological conditions (Stability Category D, no wind)						Enhanced meteorological conditions (Stability Category D, 3 m/s wind)					
	Day/Evening			Night			Day/Evening			Night		
	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance	Predicted Level	*Criteria*	Compliance
RF2	42[1]	*45*	YES	41[1]	*41*	YES	41	*45*	YES	41	*41*	YES
RF3	41[1]	*45*	YES	40[1]	*41*	YES	40	*45*	YES	40	*41*	YES
I1	44	68 (When in use)	YES	N/A	68 (When in use)	N/A	48	68 (When in use)	YES	N/A	68 (When in use)	N/A
I2	37	68 (When in use)	YES	N/A	68 (When in use)	N/A	41	68 (When in use)	YES	N/A	68 (When in use)	N/A
I3	41	68 (When in use)	YES	N/A	68 (When in use)	N/A	46	68 (When in use)	YES	N/A	68 (When in use)	N/A
A1	41	53 (When in use)	YES	N/A	53 (When in use)	N/A	45	53 (When in use)	YES	N/A	53 (When in use)	N/A
A2	46[1]	53 (When in use)	YES	N/A	53 (When in use)	N/A	45	53 (When in use)	YES	N/A	53 (When in use)	N/A
A3	47	53 (When in use)	YES	N/A	53 (When in use)	N/A	50	53 (When in use)	YES	N/A	53 (When in use)	N/A
A4	42	53 (When in use)	YES	N/A	53 (When in use)	N/A	47	53 (When in use)	YES	N/A	53 (When in use)	N/A

6.3 Advanced Water Recycling Centre road traffic noise assessment

Noise from additional road traffic on Elizabeth Drive and Clifton Avenue is assessed in Table 24 and Table 25 respectively. Existing and forecast traffic have been taken from the Traffic and Transport Impact Assessment (Refer to Section 6.2.3).

For Elizabeth Drive, the predicted noise increase is below the RNP screening criterion and therefore no further assessment is warranted. The predicted increase would not be perceived as a noticeable increase in noise.

For Clifton Avenue, it is noted that the AM and PM peak traffic periods do not correspond to the predicted peak hour traffic generated by the AWRC, however has been adopted in the absence of other data. As presented, the predicted increase in noise levels is below the RNP screening criterion and therefore no further assessment is considered to be warranted.

Table 24: Forecast traffic generated by the operation of the proposed Project – Elizabeth Drive

Road	Road Category	Average daily	Additional traffic generated by the development	% increase of total traffic	dB increase
Elizabeth Drive (West of Devonshire Road)	Sub-arterial Road	14,337	34[1]	0.4%	0.02

Note 1: Based on 11 trucks (22 trucks movements) + 15 light vehicles (30 movements) as per Section 6.2.3.

Table 25: Forecast traffic generated by the operation of the proposed Project – Clifton Ave

Road	Existing traffic		Additional		% increase of total traffic		dB increase	
	AM Peak [1]	PM Peak [1]	AM Peak [2]	PM Peak [2]	AM Peak	PM Peak	AM Peak	PM Peak
Clifton Avenue	52	55	19	19	37.3%	32.8%	1.38	1.23

Note 1: Based on 2020 traffic survey – AM peak is 7 – 8 and PM peak is 16 – 17

Note 2: Based on 2 trucks (4 trucks movements) + 15 light vehicles (coming in or out) as per Section 6.2.3

6.4 Pipeline release assessment

An assessment of the pipeline release locations has been carried out based on the following:

- Sound power levels (L_w) from '*Acoustics of weirs*' [20]. Appendix D shows the L_w and noise level spectrum.
- Distance and topography between release locations and nearest receivers. Refer to Section 4.2 for the location of the receivers and the release locations used in the assessment.

The assessment indicates that noise from the release locations will be less than the 35 $dBL_{Aeq(15minute)}$ criteria (being the NPfI minimum criteria). It is also noted that noise from the release locations will be water noise which is likely to be less intrusive than industrial type noise sources.

6.5 Pipeline valves assessment

With appropriate sizing of the pipeline valve outlet orifice, noise emission from the normal operation of valves for this Project will be minimal. The sizing of valve outlet orifices is standard practice and will be determined during the detailed design phase. Noise emission will be further contained by the pits in which the valves are located. Additional noise mitigation, such as adding a muffler/attenuator to the valves, can be incorporated if required.

It is noted that higher noise levels may be exhibited in the case of a surge event, which may occur as a result of unexpected power trip or mechanical failure at the pumping station. During such an event, the valve orifice automatically reduces to prevent surge and water-hammer that could otherwise cause stress and damage to the pipeline. While higher noise events may result, the likelihood of a surge event is low (anticipated to occur no more than twice a year) and would generally last approximately 4-5 seconds. While noise levels will be minimised where practicable, it is considered that the standard noise criteria should not apply under surge events.

6.6 Operational mitigation measures

Measures to mitigate noise impacts from the operation of the AWRC, releases and valves have been described in the Section 6.2 to Section 6.5 and are summarised in Table 26.

Table 26: Operational mitigation measures

Item	Impact	Mitigation measures
Advanced Water Recycling Centre operation	Predicted exceedances of the adopted noise criteria for Stage 1 operation and Stage 1 + Future Stages Vibration impacts at nearest receivers not predicted	Noise emissions of the AWRC will be reviewed at detailed design and measures to reduce noise impacts will be assessed and implemented to ensure that operational noise criteria are met, including consideration of the following measures: • Scheduling heavy vehicles to access site during daytime hours. • Reselection of pumps with lower noise level alternatives and/or installation of barriers and / or enclosures around the noisiest pumps. • Upgrade to building envelopes No mitigation measures have been recommended to reduce noise emissions from traffic generated by the operation of the AWRC. Refer to Section 6.1.1.5, Section 6.2 and Section 6.3
Release locations	No noise or vibration impacts predicted	Refer to Section 6.4

Item	Impact	Mitigation measures
Valves	Potential noise impacts predicted	Minimise noise by appropriate sizing of the valve outlet orifice. Additional mitigation such as adding a muffler/attenuator to the valves can be incorporated if required. Refer to Section 6.5

7 Construction noise and vibration assessment

As described in Section 4, the main sources of noise and vibration from the construction of the Project have been identified as the following:

- the construction plant and equipment operating on the AWRC site,
- the construction plant and equipment operating at the release sites,
- the construction plant and equipment operating along the pipeline alignments within and outside the construction corridor
- the construction traffic travelling onto the road network.

This construction noise and vibration assessment has been conducted to identify works that have the potential to impact sensitive receivers in proximity to the Project, to inform mitigation and management strategies. The assessment includes the following:

- A preliminary quantitative assessment of the impacts from:
  - the construction of the AWRC
  - the operation of the long-term main compounds (including drilling sites) operating during night period
- A qualitative assessment of the impacts from:
  - the construction of the pipelines
  - the construction traffic travelling onto local roads

A detailed Construction Noise and Vibration Management Plan (CNVMP) will be prepared prior to commencement of works, supported, as required, by more detailed quantitative assessment.

Section 7.1 provides a description of the overall construction works for the Project. Section 7.2 contains the noise and vibration criteria. Section 7.3 contains a description and noise and vibration assessment of the construction works for the AWRC site. Section 7.4 contains a description and noise and vibration assessment of the construction works along the pipelines (including construction sites located within and outside the construction corridor. Section 7.5 contains the traffic noise assessment.

Mitigation measures for the construction of the Project are summarised in Section 7.6.

7.1 Construction works description

7.1.1 General

Construction works includes construction of the AWRC site, construction of the release structures and installation of the pipelines.

For the construction of the pipelines, construction will generally be carried out progressively along the alignment with approximately 70 m – 150 m of active construction at any one pipeline location, however several areas may be in progress at any one time.

Construction of the pipelines will include both open trenching and trenchless methodologies. Open trenching is expected to be the primary approach for the pipelines and the trenching depth will range from 1.5 m to 7 m. Where trenching is required, the construction corridor will vary from 15 m to 25 m.

Trenchless construction techniques will be used at specific locations to minimise disruptions such as:

- To avoid environmentally sensitive areas
- Under flowing rivers, creeks (dry creeks may be open trenched) and canals
- Crossing TfNSW roads
- Crossing rail corridors
- In steep topography, or where other safety/access issues dictate.

Drilling (Trenchless technique) is anticipated to progress in three stages:

- 12-1/4" pilot hole – 70 to 100 m per day
- 26 or 28" forward reaming pass - 65 to 85 m per day
- 36" forward reaming pass – 50 to 70 m per day

Trenchless pipelines may be deeper than open trench pipelines depending on ground conditions and topography.

While detailed construction techniques have not been finalised, the works have been broadly broken down into phases based on anticipated construction activities. , Table 27, Table 28, Table 29 and

Table 30 below summarise the construction phases for the construction of the AWRC, the release structures and the construction of the pipelines. The tables include a list of the associated equipment likely to be used. The overall construction timeframe is expected to be approximately 36 months.

Table 27: Construction activities for the Advanced Water Recycling Centre

Phase (Duration)	Typical Construction Activities	Anticipated significant noise and vibration emitting equipment
Phase 1: Site Establishment **(Duration 2 months)**	• Install environmental controls and delineate site • Ancillary construction works such as roads and fencing • Traffic control • Plant and equipment delivery • Grubbing and removal of surface vegetation • Demolish existing buildings • Contamination management	Backhoe loaders Chainsaws Cranes Dozers Dump trucks Excavators Front End Loaders Hand tools Trucks Water trucks

Phase (Duration)	Typical Construction Activities	Anticipated significant noise and vibration emitting equipment
Phase 2: Earthworks **(Duration 12 months)**	• Cut and fill to prepare site (including importing fill) • Temporary establish site drainage and soil and water management controls • Excavate for detention basins, underground infrastructure etc • Excavation dewatering • Waste disposal	Backhoe loaders Compactors Concrete saws Cranes Dozers Dump trucks Excavators Excavators hammer Front End Loaders Grader Hand tools Pumps Roller Paver Profiler Trucks Water trucks
Phase 3: Civil works **(Duration 12 months)**	• Construction of roads and stormwater infrastructure • Landscaping • Permanent OSD Construction	Compactors Concrete pumps Concrete trucks Cranes Dozers Excavators Front End Loaders Grader Hand tools Piling rig Road Paving machinery Roller Trucks Water trucks
Phase 4: Structure construction **(Duration 18 months)**	• Construction of buildings, treatment infrastructure, erect storage tanks and other treatment process units • Treatment equipment installation	Concrete pumps Concrete trucks Cranes Dozers Front End Loaders Grader Hand tools Roller Trucks Water trucks

Phase (Duration)	Typical Construction Activities	Anticipated significant noise and vibration emitting equipment
Phase 5: Mechanical and electrical installation **(Duration 18 months)**	• Utility connections • Operations equipment installation and testing	Hand tools Light vehicles Trucks Cranes Delivery Trucks
Phase 6: Commissioning **(Duration 6 months or more depending on procurement model)**	• Equipment testing • Process proving • Discharging commissioning wastewater	Light vehicles Trucks

Table 28: Typical Construction activities – Open Trenching technique

Phase	Typical Construction Activities	Anticipated significant noise and vibration emitting equipment
Phase 1: Site Establishment	• Install environmental controls and delineate site • Traffic control • Ancillary construction works such as roads, site compounds and fencing • Plant and equipment delivery • Clearing and grubbing	Chainsaws Delivery trucks Dump trucks Excavators Excavators breaker Graders Light vehicles Loaders Rock breakers Rock screens Scrapers Survey equipment (drones) Water carts
Phase 2a: Earthworks and civil works	• Excavate trenches and install shoring • Dewater excavation • Waste disposal	Concrete trucks Concrete pumps Dozers Loaders Excavators Excavators breaker Rock breakers Rock screens Delivery trucks Pumps and other dewatering equipment Trenching machines Waste trucks

Phase	Typical Construction Activities	Anticipated significant noise and vibration emitting equipment
Phase 2b: Earthworks and civil works - Pipe installation	• Pipe delivery and placement of the section of the pipes near the trench in a line (pipe stringing) • Field bending of pipe • Welding of each section of pipe together into one continuous length • Pipe lowering into trench • Backfilling • Inspection and test of pipes	Bending machines Compactors Cranes Delivery trucks Excavators Light vehicles Side booms or pipe layers Powered hand tools Semi-trailers Truck and dog Shoring equipment Welding equipment
Phase 3: Commissioning	• Pipe pressure testing and disinfection • Discharging commissioning wastewater	Light vehicles Trucks
Phase 4: Landscaping and restoration	• Topsoil placement and restoration	Compactors Excavators Graders Road Paving machinery Rollers

Table 29: Typical Construction activities – Trenchless technique (or horizontal directional drilling HDD)

Phase	Typical Construction Activities	Anticipated significant noise and vibration emitting equipment
Phase 1: Entry site and exit and stringing site establishment	• Install environmental controls and delineate site • Traffic control • Ancillary construction works such as roads, site compounds and fencing • Plant and equipment delivery • grubbing	Chainsaws Delivery trucks Dump trucks Excavators Excavators breaker Graders Light vehicles Loaders Rock breakers Rock screens Scrapers Survey equipment (drones) Water carts

Phase	Typical Construction Activities	Anticipated significant noise and vibration emitting equipment
Phase 2a/2b: Earthworks and civil works	• Site entry pit excavation • Dewater excavation • Waste disposal	Concrete trucks Concrete pumps Dozers Excavators Excavators breaker Rock breakers Rock screens Delivery trucks Pumps and other dewatering equipment Waste trucks
Phase 2c/2d: Earthworks and civil works pipe path creation and pipe installation	• Drilling operations • Pipe delivery and placement of the section of the pipes (pipe stringing) at the allocated stringing site location • Welding of each section of pipe together into one continuous length • Pipe installation • Backfilling using pad fill and overburden (using excavators)	Compactors Cranes Delivery trucks Excavators Generators Light vehicles Pipe rollers Powered hand tools Pumping equipment Pumps and other dewatering equipment Micro-tunnelling/directional drilling rigs/Tunnel Boring machine (TBM) Pumping equipment Semi-trailers Slurry management equipment Truck and dog Welding equipment
Phase 3: Commissioning	• Pipe pressure testing and disinfection • Discharging commissioning wastewater	Light vehicles Trucks
Phase 4: Landscaping and restoration	• Topsoil placement and restoration	Compactors Excavators Graders Road Paving machinery Rollers

Table 30: Typical Construction activities – Release structures construction

Phase	Typical Construction Activities	Anticipated significant noise and vibration emitting equipment
Earthworks and civil works	• Structure construction	Concrete trucks Concrete pumps Excavators Hand tools

Prior to commencement of the pipeline construction proper, other activities may need to be undertaken to optimise and finalise alignments, and to confirm design and constructability such as:

- Survey work (including dilapidation surveys)
- Potholing for existing underground services
- Condition surveys
- Installing environmental controls
- Utility/service provision to facilitate construction activities
- Establishing and operating ancillary facilities (e.g. delineation of site boundaries, install environmental controls, equipment delivery, site access, compounds and offices
- Minor vegetation clearing
- Heritage salvage/preservation works

7.1.2 Temporary ancillary facilities

During construction, several temporary ancillary facilities will be required such as:

- Construction compounds and laydown areas:
  - Main compounds are needed for the duration of construction, for centralised plant and equipment storage, large stockpiles.
  - Smaller satellite compounds will be stationed along the pipeline alignments. More of these may be needed if the main compound sites are space constrained. The number of compounds will depend on the procurement strategy and staging.
  - Temporary equipment lay-down areas within the construction corridor will also be needed. These will move along the pipeline alignments as work progresses. This also includes temporary compounds within the construction corridor associated with trenchless techniques.
- Access roads
- Site offices and amenities
- Worker parking

Major fixed sites with active construction (such as drilling sites, release structure construction sites and AWRC sites) and ancillary facilities providing support for the construction of the Project are outlined in Table 31 and in Appendix B.

Table 31: Indicative activities required at construction compounds

Compounds	Drilling site	Release structure construction site	Site Office	AWRC construction	Support sites	
					Spoil and equipment storage site, material laydown	Pipe welding
C1	x	x	x		x	
C2	x		x		x	
C3		x			x	
C4	x					
C5			x			
C6			x		x	
C7	x		x		x	
C8			x	x	x	x
C9	x				x	
C10			x		x	
C11			x		x	
C12			x		x	
C13	x				x	
C14	x				x	
C15	x				x	

Anticipated significant noise and vibration emitting equipment for the construction compounds are outlined in Table 32.

Table 32: Construction compounds noise and vibration plant and equipment

Compound	Anticipated significant noise and vibration emitting equipment
Drilling sites	As per Table 29
Release structure construction sites	As per Table 30
Site office	-
AWRC construction site	As per Table 27
Support site **Spoil and equipment storage site, material laydown**	Cranes Dozers Excavators Front End Loaders Trucks Light vehicles

Compound	Anticipated significant noise and vibration emitting equipment
Support site **Pipe welding**	Welding equipment

7.1.3 Hours of work

Wherever possible, construction of the Project would be carried out during standard hours (as defined in Section 7.2.1). However, some activities may be required to be conducted outside standard hours (refer to as Out of Hour Works (OOHW)) such as for the following:

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads;
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm;
- public infrastructure works that shorten the length of the Project construction and are supported by the affected community (Duration reduction assessment)
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours.
- Works that cannot be completed within the standard respite periods for engineering justifications

It is expected that OOHW would be subject to approval, via a dedicated OOHW Protocol, on a case-by case basis.

The approval pathway for the OOHW should be determined on a risk-based approach to ensure that OOHW are approved by the appropriate authority or delegate, while minimising unnecessary regulatory procedures that could unreasonably delay works.

The following sites seeks permission to conduct construction works over a 24 hour period:

- Drilling operation between Bent Basins Road and the Warragamba river (Refer to TP-U1, C1 and C2)
- Drilling operation in Lansvale Reserve (Refer to BP-U14, C14 and C15)

The 24 hour HDD drilling operation will minimise duration impacts and risk of tunnelling failure.

Hours of operation for the construction of the AWRC, the release structures and the pipelines as well as hours of operation for the main construction temporary ancillary facilities are listed in Table 33.

Table 33: Project hours of operations

Ref ID	Location	Indicative Duration	Hours of Work			
			Standard – Day	OOHW – Day	OOHW – Evening	OOHW – Night
C1	Warragamba River via Core Park Road	6 months	✓	✓	✓	✓
C2	Bent Basins Road	6 months	✓	✓	✓	✓

Ref ID	Location	Indicative Duration	Hours of Work			
			Standard – Day	OOHW – Day	OOHW – Evening	OOHW – Night
C3	Treated Effluent release location near Wallacia Weir at Nepean River	6 months	✓			
C4	West of Wallacia drilling site (Fowler Reserve)	3 months	✓			
C5	1 Park Rd, Wallacia	36 months	✓			
C6	344 Park Rd, Wallacia	30 months (include up to 6 months of Night-time works)	✓	✓	✓	✓
C7	Elizabeth Drive between The Northern Road and Luddenham Rd	24 months	✓	✓	✓	✓
C8	AWRC site	36 months	✓			
C9	Western Sydney Parklands, near Liverpool Offtake Reservoir	36 months	✓	✓	✓	✓
C10	Liverpool reservoir, Cecil Hills – Brine Satellite Compound	36 months	✓	✓	✓	✓
C11	Plan DP262454 Lot 419, Bonnyrigg - Brine Satellite Compound	36 months	✓	✓	✓	✓

Ref ID	Location	Indicative Duration	Hours of Work			
			Standard – Day	OOHW – Day	OOHW – Evening	OOHW – Night
C12	East Parade, Fairfield – Brine pipeline satellite compound	36 months	✓	✓	✓	✓
C13	Cabravale Park - Cabramatta Rail underbore crossing	3 months	✓	✓	✓	✓
C14	Lansvale Park, Lansdowne - west of Henry Lawson Drive and Prospect Creek	3 months	✓	✓	✓	✓
C15	Lansdowne east of Henry Lawson Drive – NGRS connection location	3 months	✓	✓	✓	✓
TP – U1	From C6 to C1 (between Bents Basin Road and the release location)	6 months	✓	✓	✓	✓
TP – U2	From C3 to Fowler Reserve	8 weeks	✓			
TP – U3	Under Crossman Reserve	8 weeks	✓			
TP – U4	Across the Northern Road to Elisabeth Drive	8 weeks	✓			
TP – U5	Across Elizabeth Drive	8 weeks	✓			

Ref ID	Location	Indicative Duration	Hours of Work			
			Standard – Day	OOHW – Day	OOHW – Evening	OOHW – Night
TP – U6	Along Elizabeth Drive (3 underbore locations)	8 weeks	✓			
BP – U1	Across Elizabeth Drive	3 months	✓			
BP – U2	Near the Liverpool Reservoir (2 sections)	3 months	✓			
BP – U3	Across the Upper Canal	3 months	✓			
BP – U4	Across the M7	3 months	✓			
BP – U5	Across Cowpasture Road	3 months	✓			
BP – U6	Small section on North Liverpool Road near Maria Locke Park	3 months	✓			
BP – U7	Small section on Montgomery Avenue near Beltana Avenue	3 months	✓			
BP – U8	Across Elizabeth Drive	3 months	✓			
BP – U9	Along Cabramatta road, across the creek, west of Meadow Road	3 months	✓			
BP – U10	Across Joseph Street	3 months	✓			

Ref ID	Location	Indicative Duration	Hours of Work			
			Standard – Day	OOHW – Day	OOHW – Evening	OOHW – Night
BP – U11	Across the T2, T3 and T5 train lines	3 months	✓			
BP – U12	A small area along Beckenham street	3 months	✓			
BP – U13	Across the Hume Hwy	3 months	✓			
BP – U14	Across Lansvale Reserve and Henry Lawson Drive	3 months	✓	✓	✓	✓
TP – T1	On Bents Basin Road – from C3 to C6	-	✓			
TP – T2	From C3 to C4 Along Silverdale Road	-	✓			
TP – T3	From Fowler Reserve to Crossman Reserve	-	✓			
TP – T4	From Crossman reserve, along Park Road	-	✓	✓	✓	✓
TP – T5	Along the Northern Road	-	✓	✓	✓	✓
TP – T6	Between the Northern Road and Elizabeth Drive	-	✓			
TP – T7	Along Elizabeth Drive (4 Segments) to the AWRC	-	✓			

Ref ID	Location	Indicative Duration	Hours of Work			
			Standard – Day	OOHW – Day	OOHW – Evening	OOHW – Night
BP – T1	From the AWRC to Elizabeth Drive	-	✓			
BP – T2	From Elizabeth Drive, along Western Street, Cross Street,	-	✓	✓	✓	✓
BP – T3	Through Cecil park to Liverpool Off lake Reservoir (3 segments)	-	✓	✓	✓	✓
BP – T4	From the Liverpool Off lake Reservoir to the M7	-	✓			
BP – T5	From the M7 to Cowpasture Road	-	✓	✓	✓	✓
BP – T6	From Cowpasture Road to Maria Locke Park along North Liverpool Road	-	✓	✓	✓	✓
BP – T7	From Maria Locke Park along North Liverpool Road, along Montgomery Road to the intersection with Beltana Avenue	-	✓	✓	✓	✓

Ref ID	Location	Indicative Duration	Hours of Work			
			Standard – Day	OOHW – Day	OOHW – Evening	OOHW – Night
BP – T8	Along Montgomery Avenue from Beltana avenue to Elizabeth Drive	-	✓	✓	✓	✓
BP – T9	From Elizabeth Drive, along Cabramatta Road West to the creek west of Meadow Road	-	✓	✓	✓	✓
BP – T10	From the Creek west of Meadow Road, along Meadow Road, Edensor Road, John Street to Joseph Street	-	✓	✓	✓	✓
BP – T11	From Joseph Street, along John street, Gladstone Street, Bartley Street to the T2, T3 and T5 train lines	-	✓	✓	✓	✓
BP – T12	From the T2, T3 and T5 train lines, along Curtin Street, Bareena Street, Chancery Street, Bromley Street and Beckenham street	-	✓	✓	✓	✓

Ref ID	Location	Indicative Duration	Hours of Work			
			Standard – Day	OOHW – Day	OOHW – Evening	OOHW – Night
BP – T13	From Beckenham street to Lennox Reserve	-	✓	✓	✓	✓
BP – T14	In Lansvale Reserve	-	✓	✓	✓	✓
BP – T15	In Lansvale Reserve, east of Henry Lawson Drive	-	✓			

Justification for conducting OOHW work is given in Table 34.

Table 34: Justification for OOHW

Ref ID	Justification for OOHW works
C1, C2, TP – U1 **C14, C15, BP – U14**	The 24 hour HDD drilling operation will minimise duration impacts and risk of tunnelling failure
TP – T4, TP – T5, C6, C7	Possible night-time works depending on Road Occupancy Licences (ROLs) for works on the treated pipeline along Parks Road and the Northern Road
BP – T2, BP- T3, BP – T5 to BP - T14 **C9, C10, C11, C12, C13**	Possible night-time works depending on ROLs for works along the Brine pipeline

7.1.4 Construction traffic

The construction of the Project will generate an increase in vehicle movements on the surrounding road network. Additional vehicle movements will be generated by:

- The arrival and departure of construction plant, equipment and vehicles.
- The haulage and delivery of road work materials, and removal of waste to and from the construction zones
- The arrival and departure of construction workers at the start and end of each workday and night shift, which will result in an increased traffic demand and turning manoeuvres to and from the construction site access.
- Potential traffic diversion due to lane closures because of construction works

The construction of the pipelines is expected to occur concurrently with the construction of the AWRC.

The number of construction staff will depend on how the delivery contractor schedules the works. It is likely that multiple crews will be working at various places along the pipeline at the same time. Anticipated number of vehicles travelling on public road generated by the construction of the Project has been sourced from the Traffic and Transport Impact Assessment and is reproduced in Figure 7 and Figure 8.

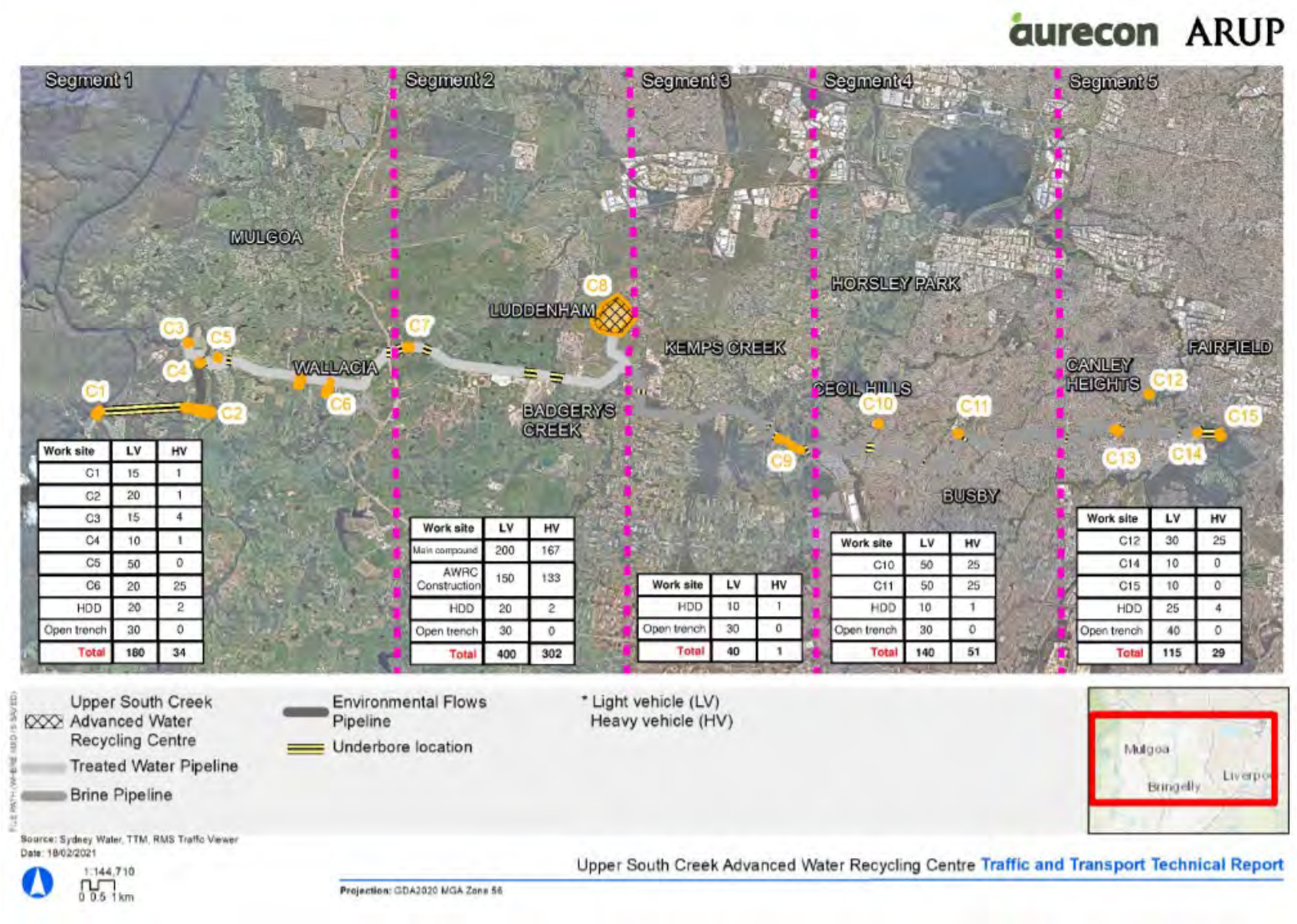


Figure 7: Light and heavy vehicles daytime peak (7am to 6pm)

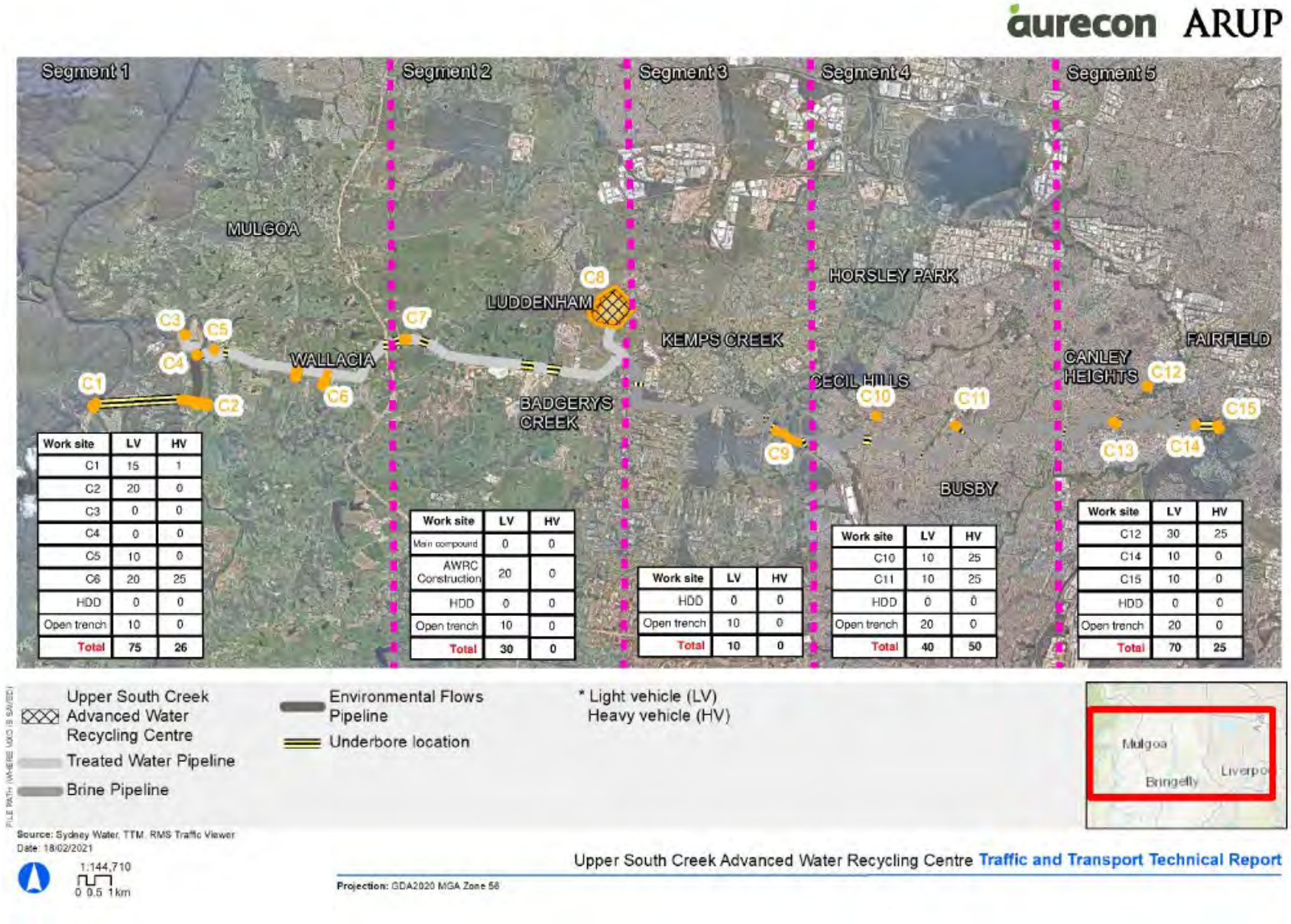


Figure 8: Light and heavy vehicles night-time peak (10pm to 7am)

7.2 Construction noise and vibration criteria

The primary objectives concerning the management of construction noise and vibration are:

- Works and activities to be undertaken in a manner that will minimise noise and vibration impacts on sensitive receivers.
- Minimise unreasonable noise and vibration impacts on residents and businesses.
- Avoid cosmetic and structural damage to buildings, structures and/or heritage items.
- Avoid damage to sensitive equipment or additional time spent reconducting measurements
- Undertake active community consultation.
- Maintain positive, cooperative relationships with schools, childcare centres, local residents and building owners

Regarding quantitative criteria, there is no single NSW Department of Planning, Industry and Environment (DPIE) or EPA policy document that summarises all relevant noise and vibration criteria and objectives for construction activities. TfNSW CNVS, however provides a useful summary in its Appendix A [25]. Relevant standards and policies have been summarised in Section 2.

7.2.1 Construction assessment time periods

Criteria applied to construction activity often varies by time of day, with both the quantitative criteria and management objectives adjusted to reflect people's response to noise and vibration and provide reasonable respite to impacts. The ICNG [26] outlines recommended 'standard hours' for construction, while the CNVS [25] provides additional guidance in the defining of periods out of the standard hours (out of hours work – OOHW) that account for times when people are more sensitive to noise and vibration.

The recommended construction hours derived from the INCG and CNVS are summarised in **Table 35** and**Table 36.**

Table 35: Construction assessment time periods

Period	Days and hours	
Standard hours	Day	Monday to Friday – 7 am to 6 pm Saturdays – 8 am to 1 pm
OOHW Period 1	Day	Sundays and public holidays – 8 am to 6 pm Saturday 7 am to 8 am and 1 pm to 6 pm
	Evening	Monday to Saturday – 6 pm to 10 pm
OOHW Period 2	Evening	Sunday and public holidays – 6 pm to 10 pm
	Night	Monday to Saturday – 12 am to 7 am and 10 pm to 12 am Sundays and public holidays – 12 am to 8 am and 10 pm to 12 am

Table 36: Construction periods (as per CNVS)

Hour Commencing	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Monday																								
Tuesday																								
Wednesday	OOHW							Standard											OOHW					
Thursday	Period 2							Hours											Period 1					
Friday																			Evening					
Saturday																								
Sunday								OOHW Period 1											OOHW					
Public Holiday								Day											Period 2					

It is noted that more restrictive hours can be applied to specific activities, such as blasting (which is not proposed for this Project) and use of equipment with special audible characteristics (as defined in Appendix A). Such restrictions are outlined in Section 7.6 as they are considered specific management measures applicable to certain equipment and activities.

7.2.2 Construction noise objectives

7.2.2.1 Airborne noise management levels (NMLs)

Construction airborne noise objectives (or noise management levels NMLs) are based on the ICNG [26]. The NMLs are noise levels that guide the need to apply work practices to minimise noise impacts.

Construction NMLs relevant to the Project are presented in Table 37 for Standard and Outside Standard Hour periods. Appendix C presents further details on how the NMLs have been established.

Table 37: Construction NMLs – external noise levels

Receiver	Description	Basis of background[6]	Standard hours $L_{Aeq(15\ min)}$[1]		Outside standard hours (OOHW)
			Noise affected	Highly noise affected[2]	
RESIDENTIAL RECEIVERS					
NCA T1	Residential Receiver near the AWRC	L06[6a]	45[8]	75	40[8] (Day) / 40 (Evening) / 36 (Night)
NCA T2	Residential receiver along Elizabeth Drive (East)	L12[6a]	50	75	45 (Day) / 42 (Evening) / 35 (Night)
NCA T3	Residential receiver along Elizabeth Drive (West)	L14[6a]	52	75	47 (Day) / 44 (Evening) / 38 (Night)
NCA T4	Residential receiver along the Northern Road	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NCA T5	Residential receiver along Park Road	Suburban/ Urban[6b]	55	75	50 (Day) / 45 (Evening) / 40 (Night)
NCA T6	Residential receiver Wallacia Town Centre	Suburban/ Urban[6b]	55	75	50 (Day) / 45 (Evening) / 40 (Night)
NCA T7	Residential receivers along Silverdale Road	Rural[6b]	50	75	45 (Day) / 40 (Evening) / 35 (Night)
NCA T8	Residential receivers along Bents Basin Road	Rural[6b]	50	75	45 (Day) / 40 (Evening) / 35 (Night)

Receiver	Description	Basis of background[6]	Standard hours $L_{Aeq(15\ min)}$[1]		Outside standard hours (OOHW)
			Noise affected	Highly noise affected[2]	
NCA T9	Residential receivers near North Warragamba	Rural[6b]	50	75	45 (Day) / 40 (Evening) / 35 (Night)
NCA B1	Residential receivers along Western Road	L05[6a]	58	75	53 (Day) / 51 (Evening) / 42 (Night)
NCA B2	Residential receivers along Cross Street	L05[6a]	58	75	53 (Day) / 51 (Evening) / 42 (Night)
NCA B3	Residential receivers near Cecil Park	L03[6a]	64	75	59 (Day) / 53 (Evening) / 42 (Night)
NCA B4	Residential receivers along Kensington Place	L01[6a]	55	75	50 (Day) / 50[9] (Evening) / 45 (Night)
NCA B5	Residential receivers along Stirling Street, Feodore Drive, Frederick Road	L01[6a]	55	75	50 (Day) / 50[9] (Evening) / 45 (Night)
NCA B6	Residential Receivers along North Liverpool Road	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NCA B7	Residential Receivers along Montgomery Road	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NCA B8	Residential Receivers along Monash Place and Hebblewhite Place	Suburban/ Urban[6b]	55	75	50 (Day) / 45 (Evening) / 40 (Night)
NCA B9	Residential Receivers along West Cabramatta Road	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NCA B10	Residential Receivers along Meadows Road	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NCA B11	Residential Receivers along Edensor Road, Harrington Street, John Street	Suburban/ Urban[6b]	55	75	50 (Day) / 45 (Evening) / 40 (Night)

Receiver	Description	Basis of background[6]	Standard hours $L_{Aeq(15\ min)}$[1]		Outside standard hours (OOHW)
			Noise affected	Highly noise affected[2]	
NCA B12	Residential Receivers on John Street (East of Joseph Street)	Suburban/ Urban[6b]	55	75	50 (Day) / 45 (Evening) / 40 (Night)
NCA B13	Residential receivers along Gladstone Street, St John Road, Barley Street	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NCA B14	Receivers along Curtin Street and Fairview Road	Suburban/ Urban[6b]	55	75	50 (Day) / 45 (Evening) / 40 (Night)
NCA B15	Residential receiver along Bareena Street, Vale Street, Chancery Street	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NCA B16	Residential receiver along Bromley Street, Beckenham street and Willowbank Crescent	Suburban/ Urban[6b]	55	75	50 (Day) / 45 (Evening) / 40 (Night)
NCA B17	Residential receivers along the Hume Highway	Urban industrial[6b]	65	75	60 (Day) / 60[9] (Evening) / 50 (Night)
NCA B18	Residential receivers along Knight St	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NCA B19	Along East Parade	Urban[6b]	60	75	55 (Day) / 50 (Evening) / 45 (Night)
NON-RESIDENTIAL RECEIVERS					
Commercial	N/A	N/A	70	75	70 (when in use)
Industrial	N/A	N/A	75	75	75 (when in use)
Place of workship[5]	N/A	N/A	55	75	55 (when in use)
School[5]	N/A	N/A	55	75	55 (when in use)
Child Care Centre[5]	N/A	N/A	55	75	55 (when in use)

Receiver	Description	Basis of background[6]	Standard hours $L_{Aeq(15\ min)}$[1]		Outside standard hours (OOHW)
			Noise affected	Highly noise affected[2]	
Active Recreation area[3]	N/A	N/A	65	75	65 (when in use)
Passive recreation area[4]	N/A	N/A	60	75	60 (when in use)

Notes:

1. 7 am to 6 pm Monday to Friday, 8 am to 1 pm Saturday, no work on Sunday or public holidays Refer to Section 5.1
2. Applies to residential receivers per the ICNG. However, for this assessment the highly noise affected has been applied to all receivers.
3. Characterised by sporting activities and activities which generate their own noise or focus for participant, making them less sensitive to external noise intrusion
4. Characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation
5. For predictive assessment and where noise monitoring is required, it is often more practical to assess at external locations. External management levels have been established assuming premises have open windows with a nominal noise reduction of 10 dB(A). This noise reduction can be amended with appropriate justification, such as site inspection and consultation with affected receivers.
6. Refer to Section 5.1,
   a. Measured background – as per monitoring conducted for the M12 EIS [13] - Refer to Section 5 and Appendix C
   b. Estimated background – Based on AS1055 [14] typical background noise levels and guidance in the NPfI – Refer to Appendix C
7. N/A not applicable
8. Background has been adjusted to minimum background as per Table 2.1 of the NPfI [1]
9. Per the NPfI, the community generally expects greater control of noise during the more sensitive evening and night-time periods than during the less sensitive daytime period. Therefore, it is appropriate to adjust the evening criteria to no more than the daytime criteria.

7.2.2.2 Ground-borne noise management levels (GNMLs)

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne construction noise is usually present on tunnelling projects when equipment such as tunnel boring machines, road headers, rock hammers and drilling rigs are operated underground. The ground-borne noise inside buildings initially propagates as ground-borne vibration, before entering the building, which causes floors, walls and ceilings to gently vibrate and hence radiate noise. Ground-borne noise is usually not a significant disturbance to building occupants during daytime periods due to higher ambient levels which mask the audibility of ground-borne noise emissions. During night-time periods however, when ambient noise levels are often much lower, ground-borne noise is more prominent and may result in adverse comment from building occupants.

The following ground-borne noise levels from the ICNG for residences indicate when management actions should be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels. The ground-borne noise levels are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

The ICNG does not provide guidance levels for receivers that are not residential receivers. To derive ground-borne noise objectives for those non-residential receivers, guidance has been taken from '*AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors*' and the ICNG NML assuming 10 dB reduction from outside to inside with windows open.

Table 38: Ground-Borne noise objectives – internal noise levels

Land use	Period	Ground-Borne Noise objectives $L_{Aeq(15min)}$
Residential	Daytime (7am to 6pm)	Not applicable. Human comfort vibration objectives only (As a guide 45 dBA – internal)
	Evening (6pm to 10pm)	40 dBA
	Night (10pm to 7am)	35 dBA
	Trigger for alternative accommodation (8pm to 7am)[1]	*45 dBA*
Commercial (offices)	When in use	50 dBA
Commercial (retail outlet)	When in use	60 dBA
Industrial	When in use	65 dBA
Places of worship	When in use	45 dBA
Schools	When in use	45 dBA
Childcare centres	When in use	45 dBA
Notes: 1. Per Sydney Metro Chatswood to Sydenham project approval.		

7.2.2.3 Traffic noise criteria

When trucks and other vehicles are operating within the boundaries of the various construction sites, vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ construction site noise emissions. When construction related traffic moves onto the public road network, traffic generated noise is assessed in accordance with the NSW *Road Noise Policy* (RNP) [3].

When assessing traffic noise generated on an existing road network, an initial screening test is adopted that evaluates whether existing noise levels are expected to increase by more than 2 dBA due to the additional traffic generated by the Project.

Where noise levels are predicted to increase by more than 2 dBA (i.e. 2.1 dBA or greater) more detailed assessment is required in accordance with the RNP and against the criteria outlined in Table 39 (Table 3 of the RNP).

Table 39: Road traffic noise criteria for residential land uses

Road category	Type of project/land use	Assessment criteria – dBA	
		Day 7 am-10 pm	Night 10 pm-7 am
Freeway/arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arteria/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)
Note: Criteria are for assessment against façade corrected noise levels when measured in front of a building façade.			

The RMS CNVG [27] also adds that consideration should be given to the RMS *Noise Criteria Guideline* [28] (which documents RMS' approach to implementing the Road Noise Policy) as to whether the construction traffic or temporary reroute triggers new road criteria due to changes in road category.

7.2.2.4 Sleep disturbance

The ICNG recommends that where construction works are planned to extend over two or more consecutive nights, maximum levels and extent and frequency of maximum noise levels events exceeding the RBL should be assessed.

The NPfI criteria, being the most recent criteria to assess sleep disturbance, are considered relevant for this assessment and are as follows:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

Where these are exceeded, a detailed maximum level (L_{Amax}) event assessment should be undertaken.

7.2.3 Vibration criteria

The effect of vibration in buildings can be divided into three main categories:

1. **Human perception of vibration**: when the occupants or users of the building are potentially disturbed by vibration**.** Relevant guidance is provided in NSW *Assessing Vibration: a technical guideline* [8]. This document is based on BS 6472:1992 [9].
2. **Effects on building contents**: People can perceive floor vibration at levels well below those likely to cause damage to typical building contents. However, some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives [29, 30, 31, 32].
3. **Effects of vibration on structures:** A level of vibration where the integrity of the building or the structure itself may be affected, ranging from cosmetic to major structural damage. The relevant criteria is typical well above the level of vibration which people may consider intrusive. Guidance may be found in AS 2187:Part 2 [16], BS 7385 Part 2 [10] and DIN 4150 [11] which also has criteria of particular reference for heritage structures and buried pipework.

7.2.3.1 Disturbance to buildings occupants

Potential vibration disturbance to human occupants of buildings is made in accordance with the NSW DEC *'Assessing Vibration; a technical guideline'* [8]. The criteria outlined in the guideline is based on the British Standard BS 6472-1992 [9]. Sources of vibration are defined as either 'Continuous', 'Impulsive' or 'Intermittent', as described in Table 40.

Table 40: Types of vibration – Definition

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

Table 41 reproduces the 'Preferred' and 'Maximum' values for continuous and impulsive vibration and Table 42 reproduces the 'Preferred' and 'Maximum' values for intermittent vibration (Table 2.2 and 2.4 of the Guideline respectively [8]).

Table 41: Preferred and maximum vibration acceleration levels for human comfort, m/s^2

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration (weighted root-mean-square (RMS) acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshop	Day- or night-time	0.040	0.029	0.080	0.058
Impulsive vibration (weighted[2] RMS acceleration, m/s^2, 1-80Hz)					
Residences	Daytime	0.30	0.21	0.60	0.42

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshop	Day- or night-time	0.64	0.46	1.28	0.92

Notes:
1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am
2. Wg for z axis and Wd for x and y axes

Table 42: Acceptable vibration dose values (VDV) for intermittent vibration (m/s$^{1.75}$)

Location	Daytime[1]		Night-time	
	Preferred value	**Maximum value**	**Preferred value**	**Maximum value**
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:
1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am
2. Note that the VDV is dependent upon the level and duration of the vibration event and the number of vibration events occurring during the assessment period; a higher vibration level is permitted if the total duration of the vibration event(s) is small.

7.2.3.2 Impact on building contents – Sensitive equipment

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort.

Where vibration sensitive scientific and/or medical instruments are in use within an identified vibration sensitive receiver, objectives for the satisfactory operation of the instrument should be sourced from manufacturer's data. Where manufacturer's data is not available, generic vibration criterion (VC) curves as published by the Society of Photo-Optical Instrumentation Engineers [30] or the ASHRAE Chapter 49 [31] may be adopted, as presented in Table 43. Baseline vibration levels could also be measured to inform the establishment of appropriate criteria.

Table 43: Application and interpretation of the generic Vibration Criterion (VC) curves (as defined in the CNVS)

Criterion Curve	Max Level (μm/sec, rms)[1]	Detail size (micron)[2]	Description of use
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.

Criterion Curve	Max Level (μm/sec, rms)[1]	Detail size (micron)[2]	Description of use
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3 micron line widths.
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1 micron detail size.
VC-D	6	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability.
VC-E	3	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability.
Note 1: As measured in one-third octave bands of frequency over the frequency range 8 to 100 Hz Note 2: The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given consider the observation that the vibration requirements of many items depend upon the detail size of the process.			

7.2.3.3 Impact on structures and services

Potential structural or cosmetic damage to buildings as a result of vibration is typically assessed in accordance with British Standard 7385 Part 2 [33] and/or German Standard DIN4150-3 [11]. Additional information is also provided in the CNVS.

Standard structures

British Standard 7385 Part 1:1990 [34], defines different levels of structural damage as:

- *Cosmetic – The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.*
- *Minor – The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major – Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

BS7385-2 (Table 1 and Section 7.4.2) sets limits for the protection against the different levels of structural damage and those levels are reproduced in Table 44. The criteria relate predominantly to transient vibration that does not give rise to resonant responses in structures, and to low rise buildings.

Table 44: BS 7385-2 Structural damage criteria

Line	Type of structure	Damage level	Peak component particle velocity (PCPV), mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
1		Cosmetic	50		
		Minor[2]	100		

Line	Type of structure	Damage level	Peak component particle velocity (PCPV), mm/s[1]		
			4 Hz to 15 Hz	15 Hz to 40 Hz	40 Hz and above
	Reinforced or framed structures Industrial and heavy commercial buildings	Major[2]	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor[2]	30 to 40	40 to 100	100
		Major[2]	60 to 80	80 to 200	200

Notes:

1. Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.
2. Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2
3. All levels relate to transient vibrations in low-rise buildings. Continuous vibration can give rise to dynamic magnifications that may require levels to be reduced by up to 50%.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, the values in Table 44 may need to be reduced by up to 50%. Activities considered to have the potential to cause dynamic loading in some structures (e.g. residences) include rock breaking/hammering and sheet piling activities. On the basis that the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range) a conservative vibration damage screening level per receiver type is given below:

- Reinforced or framed structures: 25.0 mm/s PCPV
- Unreinforced or light framed structures: 7.5 mm/s PCPV

At locations where the predicted and/or measured vibration levels are greater than above, a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

Sensitive structures (including WaterNSW assets)

German Standard *DIN 4150 – Part 3 'Structural vibration in buildings – Effects on Structure'* [11] is generally recognised to be conservative and is often referred to for the purpose of assessing structurally sensitive buildings.

Heritage buildings and structures should not be assumed to be more sensitive to vibration unless they are found to be structurally unsound and should otherwise be assessed in accordance with BS7385-2. If a heritage building or structure is found to be structurally unsound (following inspection) DIN 4150-3, line 3 as outlined in Table 45, provides a conservative cosmetic damage objective that should be adopted unless alternative limits are justified by a dilapidation or structural survey. The sensitivity of heritage buildings and other potentially at-risk structures are subject to confirmation by the contractor prior to start of any works.

WaterNSW '*Guidelines for Development Adjacent to the Upper Canal and Warragamba Pipelines*' [35], outlines that the Upper Canal is structurally fragile due to its age and that the Warragamba pipelines are fragile due to their inner concrete lining, footings and expansion joints. In the absence of an Australian Standard, WaterNSW accepts Line 3 of Table 1 from DIN4150-3 2016 [11] as the maximum allowable limit of vibration acceptable at WaterNSW assets.

Table 45: DIN 4150-3 structural damage guideline values

Line	Type of structure	Peak component particle velocity (PCPV), mm/s				
		Vibration at the foundation at a frequency of			At horizontal plane of highest floor	In the vertical direction, at floor slabs
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[1]	All frequencies	All frequencies
3	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 a preservation order)[3]	3	3 to 8	8 to 10	8	20[2]

Notes

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values.
2. Guideline value might have to be lowered to prevent minor damage
3. Line 1 refer to buildings used for commercial purposes, industrial buildings and buildings of similar design, while Line 2 refers to residential buildings and buildings of similar design and/or occupancy

Buried services

DIN 4150-2:2016 sets out guideline values for vibration effects on buried pipework (see Table 46).

Table 46: Guideline values for short-term vibration impacts on buried pipework

Line	Pipe material	Peak component particle velocity (PCPV) measured on pipe, mm/s
1	Steel, welded	100
2	Vitrified clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50
-	High pressure gas pipelines*	75 Monitoring required if predicted above 50. No piling within 15 m of pipeline without detailed assessment.

Note:

For gas and water supply pipes within 2 m of buildings, the levels given in DIN4150-3 **[11]** should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.

For Rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient values by 50%.

* Based on UK National Grid's specification **[36]**

Other services that maybe encountered include electrical cables and telecommunication services such as fibre optic cables. While these may sustain vibration velocity levels from between 50 mm/s and 100 mm/s, the connected services such as transformers and switchgear, may not. Where encountered, site specific vibration assessment in consultation with the utility provider should be carried out.

7.3 Advanced Water Recycling Centre construction assessment

The following noise assessment aim to provide a 'realistic worst-case' noise impact assessment based on construction works in a 15-minute period. The scenarios assessed are considered representative of the noisiest construction activities likely to occur across the Project. It is noted that there would be frequently periods when construction noise levels are lower than the predicted noise levels and that in general, construction works are temporary in nature and therefore any potential noise impact on the community and the surrounding environment will not be permanent.

The predictions assume that all equipment in Table 47 are located at the closest point of the works zone to the nearest sensitive receivers. In practice, the potential construction noise impacts at any location will vary depending on factors including:

- The type of construction activities conducted, and plant and equipment operated
- The position of the works within the site and distance to the nearest sensitive receiver
- The overall duration of the works
- The cumulative operation of works

Sound power data provided include an estimated time correction of the plant and equipment use in 15-minutes (Refer to Appendix E). A 5 dB penalty has also been included to the sound power levels of equipment identified as particularly annoying to nearby residents in accordance with the ICNG [37], such as chain saws, excavator hammers where applicable (Refer to Equipment with special audible characteristics definition in Appendix A).

No barriers have been considered in the noise assessment in Table 49. Temporary barriers and screens may provide up to 7 to 10 dB reduction to the predicted levels at the sensitive receivers (As per AS 2436) when located in close proximity to the noise source or to a receiver.

Cumulative impacts conducted concurrently as part of the AWRC project construction have not been included as it is unknown at the time of this assessment. As the predictions are based on worst-case nearest distances, the influence of cumulative works is not expected to be significantly higher than the levels predicted and alter the mitigation and management response.

An analysis of potential cumulative impacts due to concurrent construction of other nearby developments has not been included. Should concurrent activities occur (such as but not limited to the construction of the M12 and redevelopment of Elizabeth Drive), there is a potential that receivers may be exposed to higher construction noise levels. In these instances, consultation with relevant development should be conducted as per Section 7.6.

Predicted noise levels have been compared to the receiver's NMLs and exceedances have been highlighted. Where the predicted $L_{Aeq(15min)}$ noise level is greater than the noise management levels all feasible and reasonable work practices should be applied to minimise noise.

7.3.1 Advanced Water Recycling Centre construction technique

The assessment scenarios are presented in Table 47. They have been developed based on indicative construction techniques and activities conducted at the AWRC site (C8) presented in Section 7.1.

7.3.2 Advanced Water Recycling Centre noise assessment

Predicted construction noise levels for the construction of the AWRC are tabulated in Table 48 based on Table 47, Section 7.1 and Appendix E.

Table 47: Advanced Water Recycling Centre Construction and support site sound power levels (L_w) - dBA

Equipment	Lw of equipment	% of used within 15 min	Resulting Lw $L_{Aeq(15min)}$	AWRC [1] – number of items							AWRC C8 – number of items
				Phase 1	Phase 2a	Phase 2b	Phase 3	Phase 4	Phase 5	Phase 6	Support Site
Backhoe loader	108	100	108	2	2	2					
Bulldozer	114	100	114	2	2	2	2	2			2
Chainsaw	119[2]	25	113	2							
Compactor	120[2]	100	120		1	1	2				
Concrete saw	127[2]	25	121		2	2					
Concrete agitator truck	111	100	111				2	2			
Concrete pump truck	106	100	106				2	2			
Crane (Truck mounted)	108	100	108	2	2	2	2	2	2		2
Excavator (15t)	100	100	100	2							2
Excavator (30t)	102	100	102			2					
Excavator (30t) + hydraulic hammer	127[2]	50	124		2						
Grader	115	100	115		2	2	2	2			
Hand tools (electric)	110	100	110	2	2	2	2	2	2		

Equipment	Lw of equipment	% of used within 15 min	Resulting Lw $L_{Aeq(15min)}$	AWRC [1] – number of items							AWRC C8 – number of items
				Phase 1	Phase 2a	Phase 2b	Phase 3	Phase 4	Phase 5	Phase 6	Support Site
Loader (FEL) 23t	112	100	112	2	2	2	2	2			2
Pavement laying machine	114	100	114		2	2	2				
Pavement profiler	117	100	117		2	2	2				
Piling rig (bore)	112	100	112				1				
Roller (smooth drum)	107	100	107		2	2	2	2			
Truck	107	100	107	2	2	2	2		2	2	
Truck (Dump)	117	100	117	2	6	6					
Truck (Road truck/truck & dog)	108	25	102						2		8
Truck (Water cart)	108	25	102	2	2	2	2	2			
Water pump (electric)	96	100	96		2	2		2			
Vehicle (Light Commercial (4WD)	111	25	105						2	2	2

Equipment	Lw of equipment	% of used within 15 min	Resulting Lw $L_{Aeq(15min)}$	AWRC [1] – number of items							AWRC C8 – number of items
				Phase 1	Phase 2a	Phase 2b	Phase 3	Phase 4	Phase 5	Phase 6	Support Site
Welding equipment	110	100	110								2
Total Lw				**125**	**132**	**130**	**129**	**125**	**117**	**111**	**120**

Notes:

1. Phase 1: Site establishment, Phase 2a: earthworks with breaker, Phase 2b: earthworks, Phase 3: Civil works, Phase 4: Structure construction, Phase 5: Mechanical and electrical installation, Phase 6: Commissioning
2. Includes a 5dB penalty for special characteristics

Table 48: Predicted construction noise levels at sensitive receivers - dBA

Rec ID	Receiver Type	Predicted Noise Level, $L_{Aeq,15min}$ Construction Phases								Construction NMLs - $L_{Aeq(15\ min)}$ Standard hours		OOHW			Sleep disturbance criteria L_{Amax}
		Phase 1[4]	Phase 2a[4]	Phase 2b[4]	Phase 3[4]	Phase 4[4]	Phase 5[4]	Phase 6[4]	Support site	Noise Affected NMLs	Highly noise affected NMLs	Day	Evening	Night	
R1	Residential	50	57	55	54	50	42	36	45	45	75	40	40	36	52
R2	Residential	48	57	55	53	49	42	36	45	45	75	40	40	36	52
R3	Residential	53	60	59	57	53	45	40	48	45	75	40	40	36	52
R4	Residential	56	63	62	60	56	48	43	51	45	75	40	40	36	52
R5	Residential	53	60	59	57	53	45	40	48	45	75	40	40	36	52
R6	Residential	55	63	61	59	55	48	42	51	45	75	40	40	36	52

Notes:

1. Greyed text - Work not anticipated to be conducted during OOHW as per Section 7.1.3.
2. Yellow: <10 above NML (Standard hours)
3. Orange: >10 to 20 above NML (Standard hours)
4. Phase 1: Site establishment, Phase 2a: earthworks with breaker, Phase 2b: earthworks, Phase 3: Civil works, Phase 4: Structure construction, Phase 5: Mechanical and electrical installation, Phase 6: Commissioning

Table 48 indicates that construction noise impacts are likely to be above the NMLs during the construction of Stage 1, however do not exceed the Highly Noise Affected NMLs.

Mitigation measures to be applied during the construction are provided in Section 7.6.

7.3.3 Advanced Water Recycling Centre vibration assessment

As a guide, the recommended minimum working distances for vibration intensive plant in Table 60 provide an indication of the possibility of impact due to vibration generating plant and equipment onto nearby receivers. While the minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions, if a receiver is located within the minimum working distance, vibration monitoring might be required, and equipment selection and/or method of construction might have to be reviewed.

All receivers are located outside the minimum working distance in Table 60 and therefore no further assessment is required.

7.4 Pipeline and ancillary facilities construction assessment

As per Section 7, a qualitative assessment has been carried out for the construction of the pipelines given the relative short-duration of continuous works in any one location.

A quantitative noise assessment has been conducted for the following:

- operation of the two main drilling locations where 24 hour drilling is required:
  - Drilling operation between Bent Basins Road and the Warragamba river (Refer to TP-U1, C1 and C2)
  - Drilling operation in Lansvale Reserve (Refer to BP-U14, C14 and C15)
- Long-term support sites where the sites will be used for 24 months or more (C5, C6, C7, C8, C9, C10, C11, C12).

Locations of the works described above are shown in Appendix B.

7.4.1 Pipeline construction noise and vibration assessment - General

Appendix B shows where open trenched/trenchless techniques are proposed. Note that this may change as design progresses.

Typical construction activities for open trenching and trenchless methodologies are described in Section 7.1 with anticipated plant and equipment likely to be used during each phases.

Predicted construction noise levels are provided in Table 49which identify the predicted noise levels at varying distances from relevant plant and equipment as provided in Section 7.1 and Appendix E. Plant is conservatively assumed to operate continuously for the 15-minute period.

Table 49: Sound pressure levels of individual plant items at various distances

Equipment	Equipment Lw	Distance from equipment – Predicted sound pressure levels – $L_{Aeq(15min)}$ - dB												
		10 m	30 m	50 m	75 m	100 m	150 m	200 m	300 m	500 m	700 m	1 km	2 km	3 km
Pump and dewatering equipment	96	68	58	54	51	48	44	42	38	34	31	28	22	18
Trenching machine/ excavator (20t)	105	77	67	63	60	57	53	51	47	43	40	37	31	27
Sideboom/crane	108	80	70	66	63	60	56	54	50	46	43	40	34	30
Roller (non vibratory)	109	81	71	67	64	61	57	55	51	47	44	41	35	31
Welding equipment	110	82	72	68	65	62	58	56	52	48	45	42	36	32
Micro-tunnelling/ directional drilling	112	84	74	70	67	64	60	58	54	50	47	44	38	34
Vibratory roller	114[2]	86	76	72	69	66	62	60	56	52	49	46	40	36
Dozer D9	116	88	78	74	71	68	64	62	58	54	51	48	42	38
Chainsaw	119[2]	91	81	77	74	71	67	65	61	57	54	51	45	41
Concrete saw/ Excavator breaker (10 tonnes)	123[2]	95	85	81	78	75	71	69	65	61	58	55	49	45
Excavator Breaker (30 tonnes)	127[2]	99	89	85	82	79	75	73	69	65	62	59	53	49

Notes:

1. In Red – Noise levels above the 75 dBA Highly Noise Affected NMLs – Receivers experiencing noise levels higher than 75 dBA fall into the Highly noise affected category as defined in Section 7.2.
2. Sound power levels include a 5 dBA penalty because these plant and equipment are identified as containing special audible characteristics (refer to Appendix A and Appendix E).

Predicted noise levels in Table 49 indicate that construction works are likely to be above NMLs for receivers located near to the construction pipelines and that some receivers might experience noise levels above the 75 dBA Highly Noise Affected NMLs.

Mitigation and management measures to reduce noise and vibration impacts at nearby sensitive receivers are to be applied for the construction of the pipelines. The extent of the mitigation will depend on the level of impacts on the receivers (Refer to Section 7.6 for the mitigation and management measures).

7.4.2 Pipeline construction noise and vibration assessment – Site specific

The noise assessment aims to provide a 'realistic worst-case' noise impact assessment based on construction works within any 15-minute period. The predictions assume all equipment is located at the closest point of the works zone to the nearest sensitive receivers.

Cumulative impacts as a result of concurrent works has not been included as the detail of any such requirements is not currently known. As the predictions are based on worst-case nearest distances, the influence of cumulative works is not expected to be significant nor expected to alter the mitigation and management response.

An analysis of potential cumulative impacts due to concurrent construction of other nearby developments has not been included. Should other construction activities be occurring in proximity to nearby receivers, consultation with the relevant works shall be carried out as outlined in Section 7.6.

No barriers have been considered in the noise assessment. Temporary barriers and screens may provide up to 7 to 10 dB reduction to the predicted levels at the sensitive receivers (As per AS 2436 [6]) when located in close proximity to the noise source or to a receiver.

7.4.2.1 Drilling operation between Bent Basins Road and the Warragamba river (Refer to TP-U1, C1 and C2)

Airborne noise

Assessment scenarios have been developed based on Section 7.1 and Appendix E and are shown in Table 50 and

Table 51.

Predicted construction noise levels for the operation of C1 and C2 associated with TP-U1 are tabulated in

Table 52.

Table 50: C1 Construction activities sound power levels (L_w) - dBA

Equipment	Lw of equipment	% of used within 15 min	Resulting Lw $L_{Aeq(15min)}$	C1[1] – number of items per phase					
				Phase 1	Phase 2a	Phase 2b	Phase 2c	Phase 3	Phase 4
Chainsaw - petrol	119[2]	25	113	1					
Concrete pump truck	106	100	106				1		
Concrete pump truck	113	100	113				1		
Excavator (15t)	100	100	100	1					1
Excavator (30t)	102	100	102			1			
Excavator (30t) + hydraulic hammer	127[2]	50	124		1				

Equipment	Lw of equipment	% of used within 15 min	Resulting Lw $L_{Aeq(15min)}$	C1[1] – number of items per phase					
				Phase 1	Phase 2a	Phase 2b	Phase 2c	Phase 3	Phase 4
Pavement laying machine	114	100	114				1		
Truck	107	100	107	1	1	1		1	1
Truck (Water Cart)	108	25	102	1					
Vehicle (Light Commercial (4WD)	111	25	105					1	1
Water pump - Diesel	106	100	106			1			
Total Lw				**114**	**124**	**110**	**117**	**109**	**110**

Notes:

1. Phase 1: Site establishment (Roads construction), Phase 2a: earthworks with breaker, Phase 2b: earthworks, Phase 2c: Civil works (Construction of release structure and maintenance access), Phase 3: Commissioning, Phase 4: Landscaping and restoration
2. Includes a 5dB penalty for special characteristics

Table 51: C2 Construction activities sound power levels (L_w) - dBA

Equipment	Lw of equipment	% of used within 15 min	Resulting Lw $L_{Aeq(15min)}$	C6[1] – number of items per phase						
				Phase 1	Phase 2a	Phase 2b	Phase 2c	Phase 2d	Phase 3	Phase 4
Excavator (15t)	100	100	100	1						1
Excavator (30t)	102	100	102			1				
Excavator (30t) + hydraulic hammer	127[2]	50	124		1					
Micro tunnelling/directional drilling	112	100	112				1			
Sideboom/pipe layers	108	100	108					1		
Slurry management	96	100	96				1			
Truck	107	100	107	1	1	1			1	1
Vehicle (Light Commercial (4WD)	111	25	105						1	1
Water pump - Diesel	106	100	106			1	1			

Equipment	Lw of equipment	% of used within 15 min	Resulting Lw $L_{Aeq(15min)}$	C6[1] – number of items per phase						
				Phase 1	Phase 2a	Phase 2b	Phase 2c	Phase 2d	Phase 3	Phase 4
Welder	110	100	110					1		
Total Lw				**108**	**124**	**110**	**113**	**112**	**109**	**110**

Notes:

1. Phase 1: Site establishment, Phase 2a: earthworks with breaker, Phase 2b: earthworks, Phase 2c: Drilling, Phase 2d: pipe welding, Phase 3: Commissioning, Phase 4: Landscaping and restoration
2. Includes a 5dB penalty for special characteristics

Table 52: Predicted construction noise levels at sensitive receivers C1 and C2 – dBA

Compound	Distance to nearest receiver	NCA	Phase	Lw	Predicted Noise Level, $L_{Aeq,15min}$	Noise Management Levels - NMLs					
						Standard hours, $L_{Aeq,15min}$		OOHW, $L_{Aeq,15min}$			Sleep disturbance
						Noise Affected	Highly noise affected	Day	Evening	Night	
C1	225 m (Residential)	NCA T9	Phase 1 - Site establishment (Roads construction)	114	59	50	75	45	40	35	52
	225 m (Residential)		Phase 2a - earthworks - with breaker	124	69	50	75	45	40	35	52
	225 m (Residential)		Phase 2b - earthworks	110	55	50	75	45	40	35	52
	225m (Residential)		Phase 2c - civil works (construction of release structure and maintenance access)	117	62	50	75	45	40	35	52
	225 m (Residential)		Phase 3 - Commissioning	109	54	50	75	45	40	35	52
	225 m (Residential)		Phase 4 - Landscaping and restoration	110	55	50	75	45	40	35	52
C2	17 m (Residential)	NCA T8	Phase 1 - Site establishment	108	75	50	75	45	40	35	52
	17 m (Residential)		Phase 2a - earthworks - with breaker	124	91	50	75	45	40	35	52
	17 m (Residential)		Phase 2b - earthworks	110	78	50	75	45	40	35	52
	17 m (Residential)		Phase 2c - drilling	113	80	50	75	45	40	35	52
	17 m (Residential)		Phase 2d - Pipe welding	112	80	50	75	45	40	35	52
	17 m (Residential)		Phase 3 - Commissioning	109	77	50	75	45	40	35	52

Compound	Distance to nearest receiver	NCA	Phase	Lw	Predicted Noise Level, $L_{Aeq,15min}$	Noise Management Levels - NMLs					
						Standard hours, $L_{Aeq,15min}$		OOHW, $L_{Aeq,15min}$			Sleep disturbance
						Noise Affected	Highly noise affected	Day	Evening	Night	
	17 m (Residential)		Phase 4 - Landscaping and restoration	110	77	50	75	45	40	35	52
Notes: In red, predicted noise levels exceeding the 75 dBA highly noise affected											

Table 52 shows that NMLs will be exceeded at the receivers near the 24 drilling locations. Mitigation and management measures to be applied during the construction are provided in Section 7.6.

For C1, exceedance of the NMLs are predicted. Mitigation and management measures to reduce noise impacts to nearest receivers should be implemented. Physical mitigation measures such as implementing noise screening in the form of site hoarding between the sites and nearby noise sensitive receiver and/or an enclosure around the site or noisy piece of equipment should be implemented.

For C2, noise levels have been predicted to exceed the 75 dBA highly noise affected criteria at the receivers located near C2. Mitigation and management measures to reduce noise impacts to nearest receivers should be implemented. Physical mitigation measures such as implementing noise screening in the form of site hoarding between the site and nearby noise sensitive receiver and/or an enclosure around the sites or noisy piece of equipment should be implemented.

These recommendations should be reviewed prior to commencement of works.

Ground-borne noise (GBN)

GBN should be assessed for works conducted during the evening and the night-time period as per Section 7.2.2.

Tunnelling works will be mostly conducted during standard hours except at TP-U1 where tunnelling works will be conducted continuously for 6. Table 53 presents indicative distances, from tunnel to receiver, within which ground-borne noise criteria may be exceeded. The predictions have been based on international standards and guidance, however based on propagation under typical geotechnical conditions that should be verified based on the actual plant to be used and site-specific ground conditions. It is also noted that the duration of exposure should be factored into any assessment as tunnelling equipment will not be in any one place for an extended period.

Table 53: Indicative slant distances from tunnel to receiver for compliance with GBN criteria

Plant Item	Slant distance from tunnel to receiver	
	GBN 40 $dBL_{Aeq(15min)}$	GBN 35 $dBL_{Aeq(15min)}$
Mechanised bored tunnelling works (Tunnel Boring Machine, Horizontal Directional Drilling, Micro-tunnelling)	40 m	50 m
Note: calculation based on TRL document **[38]** using equation 25		

There are approximately 14 residences located within 50 m of the pipeline that are potentially impacted by tunnelling works. Based on the drilling process outlined in Section 7.1, each dwelling will be impacted on three separate occasions for approximately up to three consecutive days.

With regard to the trigger level for alternative accommodation (45 $dBL_{Aeq(15min)}$, per Section 7.2.2.2), the corresponding slant distance is approximately 35 m and the number of potentially impacted residences reduces to 11.

Vibration

The minimum working distances in Table 60 provide an indication of the possibility of impact due to vibration generating plant and equipment onto nearby receivers. While the minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions, if a receiver is located within the minimum working distance, vibration monitoring may be required, and alternative equipment selection and/or method of construction may be required.

Regarding the HDD drilling, the closest distance between the HDD drilling and receivers is approximately 36 m as per Figure 9, which is outside the cosmetic damage minimum working distance. Predictions using *Rahman and Orr prediction* [39] method (which is a more detailed method than the TRL method [38]) also indicates that the predicted PPV is likely to be below the cosmetic damage criteria (BS 7385) during HDD drilling.

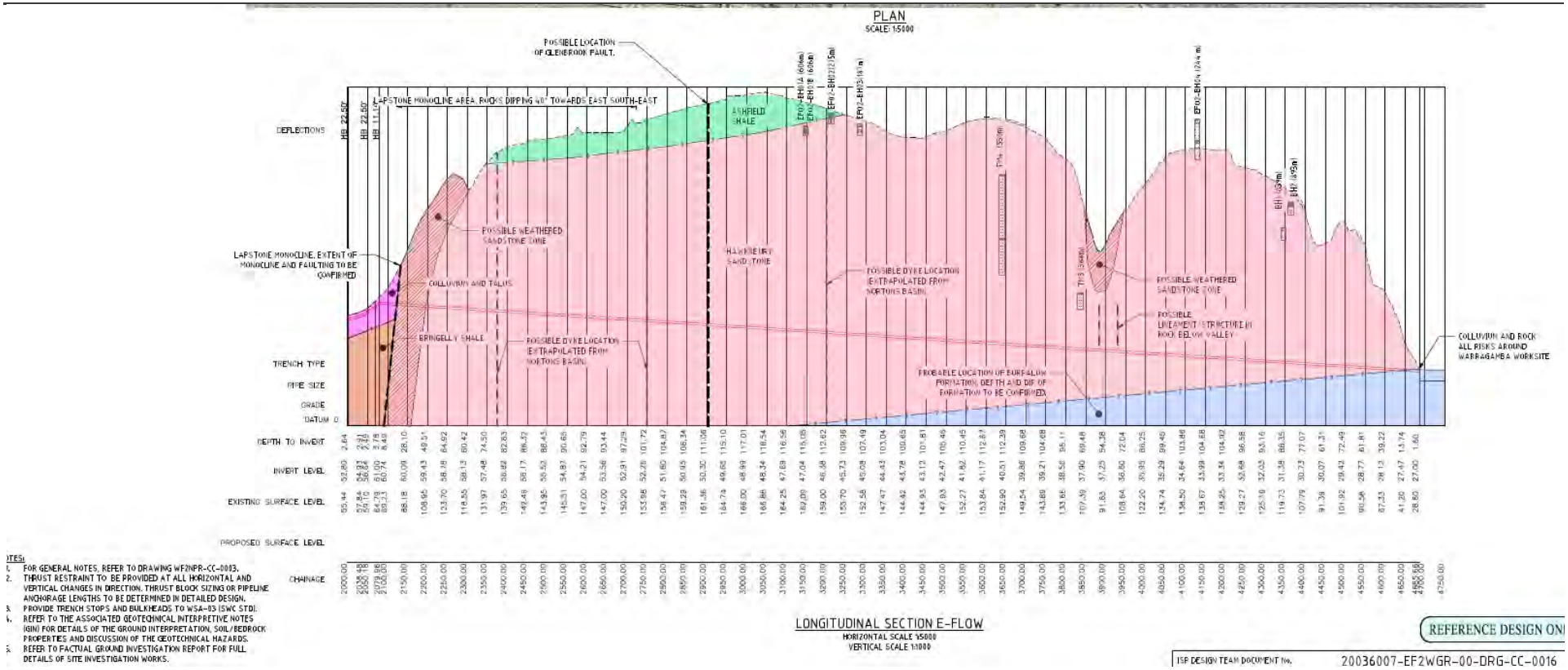


Figure 9: Indicative ground layers and depth of trenchless technique proposed for the pipeline between Bents Basin Road and the release structure location (TP-U1)

7.4.2.2 Drilling operation in Lansvale Reserve (Refer to BP-U14, C14 and C15)

Airborne noise

Assessment scenarios have been developed based on Section 7.1 and Appendix E and are shown in Table 54.

Predicted construction noise levels for the operation of C14 and C15 associated with BP-U14 are tabulated in

Table 52.

Table 54: C14 and C15 Construction activities sound power levels (L_w) - dBA

Equipment	Lw of equipment	% of used within 15 min	Resulting Lw	C14 and C15[1] – number of items						
				Phase 1	Phase 2a	Phase 2b	Phase 2c	Phase 2d	Phase 3	Phase 4
Chainsaw - petrol	119[2]	25	113	1						
Excavator (15t)	100	100	100	1						1
Excavator (30t)	102	100	102			1				
Excavator (30t) + hydraulic hammer	127[2]	50	124		1					
Micro tunnelling/directional drilling	112	100	112				1			
Sideboom/pipe layers	108	100	108					1		
Slurry management	96	100	96				1			
Truck	107	100	107	1	1	1			1	1
Vehicle (Light Commercial (4WD)	111	25	105						1	1
Water pump - Diesel	106	100	106			1	1			
Welder	110	100	110					1		
Total Lw				**114**	**124**	**110**	**113**	**112**	**109**	**110**

Notes:

1. Phase 1: Site establishment, Phase 2a: earthworks with breaker, Phase 2b: earthworks, Phase 2c: Drilling, Phase 2d: pipe welding, Phase 3: Commissioning, Phase 4: Landscaping and restoration
2. Includes a 5dB penalty for special characteristics

Table 55: Predicted construction noise levels at sensitive receivers C14 and C15 – dBA

Compound	Distance to nearest receiver	NCA	Phase	Lw	Predicted Noise Level, $L_{Aeq,15min}$	Noise Management Levels - NMLs					
						Standard hours, $L_{Aeq,15min}$		OOHW, $L_{Aeq,15min}$			Sleep disturbance
						Noise Affected	Highly noise affected	Day	Evening	Night	
C14	8 m (Residential)	NCA B18	Phase 1 - Site establishment	114	88	60	75	55	50	45	55
	60 m (Residential)		Phase 2a - earthworks - with breaker	124	81	60	75	55	50	45	55
	8 m (Residential)		Phase 2b - earthworks	110	84	60	75	55	50	45	55
	60 m (Residential)		Phase 2c - drilling	113	70	60	75	55	50	45	55
	8 m (Residential)		Phase 2d - Pipe welding	112	86	60	75	55	50	45	55
	8 m (Residential)		Phase 3 - Commissioning	109	83	60	75	55	50	45	55
	8 m (Residential)		Phase 4 - Landscaping and restoration	110	84	60	75	55	50	45	55
C15	110 m (Residential)	NCA B18	Phase 1 - Site establishment	114	65	60	75	55	50	45	55
	110 m (Residential)		Phase 2a - earthworks - with breaker	124	75	60	75	55	50	45	55
	110 m (Residential)		Phase 2b - earthworks	110	61	60	75	55	50	45	55
	132 m (Residential)		Phase 2c - drilling	113	63	60	75	55	50	45	55
	110 m (Residential)		Phase 2d - Pipe welding	112	63	60	75	55	50	45	55

Compound	Distance to nearest receiver	NCA	Phase	Lw	Predicted Noise Level, $L_{Aeq,15min}$	Noise Management Levels - NMLs					
						Standard hours, $L_{Aeq,15min}$		OOHW, $L_{Aeq,15min}$			Sleep disturbance
						Noise Affected	Highly noise affected	Day	Evening	Night	
	110 m (Residential)		Phase 3 - Commissioning	109	60	60	75	55	50	45	55
	110 m (Residential)		Phase 4 - Landscaping and restoration	110	61	60	75	55	50	45	55

Notes:

3. Greyed text - Work not anticipated to be conducted during OOHW as per Section 7.1
4. In Red – Noise levels above the 75 dBA Highly Noise Affected NMLs – Receivers experiencing noise levels higher than 75 dBA fall into the Highly noise affected category as defined in Section 7.2.2

Table 55 shows that NMLs will be exceeded at the receivers near the 24 drilling. Noise levels have been predicted to exceed the 75 dBA highly noise affected criteria at the receivers located near C14 when the breaker is used. Mitigation and management measures to reduce noise impacts to nearest receivers should be implemented. Physical mitigation measures such as implementing noise screening in the form of site hoarding between the sites and nearby noise sensitive receiver should be considered. These recommendations should be reviewed prior to commencement of works.

Ground-borne noise (GBN)

There are no receivers within 50 m of the pipeline therefore minimum impacts from GBN are anticipated. (Refer to Section 7.4.2.1).

7.4.3 Long-term support sites

Assessment scenarios have been developed based on Section 7.1 and Appendix E and are shown in Table 56.

Predicted construction noise levels for the operation of the long-term support sites C5, C6, C7, C8, C9, C10, C11, C12 are tabulated in Table 57.

Note that C8 was assessed in Section 7.3.

While potentially subject to change, indicative locations of the site compounds are shown in Appendix B.

Table 56: Long-term support sites sound power levels (L_w) - dBA

Equipment	Lw of equipment	% of used within 15 minutes	Resulting Lw	Support site - number of items	
				C5	C6, C7, C9, C10, C11, C12
Crane (Truck mounted)	108	100	108	-	1
Loader (FEL) 23t	112	100	112	-	1
Truck	108	25	102	-	1
Vehicle (Light Commercial (4WD)	111	25	105	-	1
Total Lw				**-**	**114**

Table 57: Predicted construction noise levels at sensitive receivers (near the long term support sites)

Compound	Distance to nearest receiver (m)	NCA	Lw	Predicted Noise Level, $L_{Aeq,15min}$	Standard hours		OOHW			Sleep disturbance
					Noise Affected NMLs – Standard hours $L_{Aeq,15min}$	Highly noise affected NMLs	Day	Evening	Night	
C6 (East)	40 (Residential)	NCA T5	114	74	55	75	50	45	40	52
C6 (West)	165 (Residential)	NCA T5	114	62	55	75	50	45	40	52
	40 (Commercial)		114	74	75	75	70 (when in use)			N/A
C7	78 (Residential)	NCA T3	114	68	52	75	47	44	38	52
C9	665 (Residential)	NCA B4	114	50	50	75	50	50	45	55
	712 (Commercial)		114	49	70	75	70 (when in use)			N/A
C10	40 (Residential)	NCA B5	114	74	55	75	50	50	45	55
C11	26 (Residential)	NCA B8	114	78	55	75	50	45	40	52
C12	68 (Residential)	NCA B19	114	70	60	75	55	50	45	55

Notes:
In Red – Noise levels above the 75 dBA Highly Noise Affected NMLs – Receivers experiencing noise levels higher than 75 dBA fall into the Highly noise affected category as defined in Section *7.2.2.*

Table 57 indicates that works are predicted to be below the 75 dBA Highly noise affected NMLs at all receivers near the long term support sites except for C11. The NMLs are however predicted to be exceeded at all receivers near the long term support sites, except for support site C9.

Mitigation and management measures to be applied during the construction are provided in Section 7.6 including careful site planning and potentially noise screening in the form of site hoarding between the site and nearby noise sensitive receivers might be required for some long term support sites. These recommendations should be reviewed prior to commencement of works.

Table 58: Physical mitigation measures – long-term support sites

Compound	Physical mitigation measures recommended	Justification
C5	None required	Site to be used as a site office and amenity areas
C6 (East)	Potentially noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers required. Relocate site entry to the north	Exceedance of the NMLs are predicted, noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers is predicted to reduce noise levels at the closest receivers. Review of the plan indicates that site entry is located directly in front of the nearest receiver. Relocating the site entry to the north of the compound would reduce noise levels from trucks entering site.
C6 (West)	Potentially noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers required	Exceedance of the NMLs are predicted, noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers is predicted to reduce noise levels at the closest receivers.
C7	Potentially noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers required	Exceedance of the NMLs are predicted, noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers might help reducing noise levels at the nearest receivers.
C9	None anticipated	Noise levels are anticipated to be below the NMLs for the support site therefore mitigation measures in the form of site hoarding is not considered to be warranted. Furthermore, the nearest residential receivers are located between East of the Westlink which has the potential to cover noise from the operation of the compound.
C10	Potentially noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers required	Exceedance of the NMLs are predicted, noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers might help reducing noise levels at the nearest receivers.

Compound	Physical mitigation measures recommended	Justification
C11	Potentially noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers required	Exceedance of the NMLs are predicted, noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers might help reducing noise levels at the nearest receivers.
C12	Potentially noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers required	Exceedance of the NMLs are predicted, noise screening in the form of site hoarding between the site or noisy piece of equipment and nearby noise sensitive receivers might help reducing noise levels at the nearest receivers.

7.4.4 Vibration from construction equipment

7.4.4.1 General

The minimum working distances in Table 60 provide an indication of the possibility of impact due to vibration generating plant and equipment onto nearby receivers. The minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions.

Anticipated equipment to be used for the construction of the pipes in Section 7.1 and location of sensitive receivers to the work in Appendix B show that some receivers will be potentially at risk of cosmetic damage and human disturbance due to vibration generated by the construction works. Some sensitive equipment might also be impacted.

Mitigation measures in Section 7.6 should be adopted, such as conducting dilapidation surveys before starting construction (refer to Section 7.6.4) and conducting attended vibration measurements at the start of vibration generating activities that are within the minimum working distance to establish if alternative works procedure are required. It is noted that the human comfort criteria (see section 7.2.3) is stringent and may be difficult to comply with while reasonably allowing works to proceed. Notwithstanding the need to minimise vibration where practicable, a focus on community consultation and engagement will be necessary for any extended periods of impact.

7.4.4.2 Tunnelling under WaterNSW Upper Canal

Noting the sensitivity of the Upper Canal as per Section 7.2.3.3 and that trenchless technique is proposed to be used to install the Brine pipeline under the Upper Canal, a more detailed assessment has been conducted to evaluate the impacts of the proposed alignment and to flag potential risks of damage to the Upper Canal.

The geology under the Upper Canal is a mix of sandstone, claystone, clayey sand. The closest distance between the TBM/micro-tunnelling and the Upper Canal is approximately 7 m as per Figure 10.

Predictions using Rahman and Orr prediction [39] method, indicates that the predicted PPV is likely to fall below the DIN criteria for the Upper Canal during tunnelling and therefore cosmetic damage to the Upper Canal is unlikely. It is however recommended that during construction, vibration measurements be conducted at the Upper Canal.

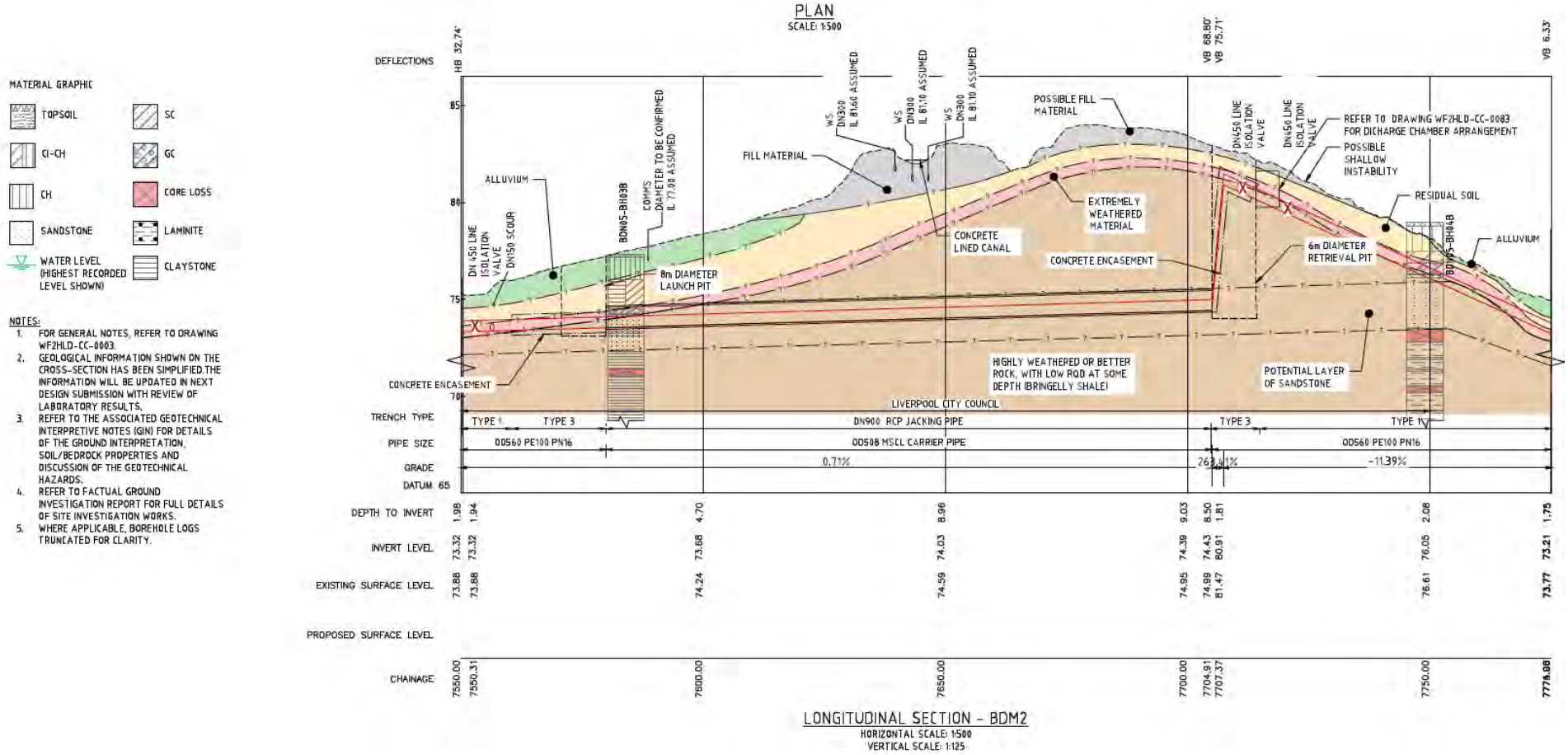


Figure 10 Indicative ground layers and depth of trenchless technique proposed under the WaterNSW Upper Canal

7.5 Construction traffic assessment

Depending on the type of roads used to access work areas, additional traffic generated by the construction of the Project may impact on the amenity of the nearby receivers. Where construction traffic is directed to busy roads, any increase in traffic noise is likely to be negligible. On local roads, there is greater potential for impact, especially during the night-period. Accordingly, construction traffic should be planned to minimise impact on sensitive receivers on lower order roads wherever practicable. Current works planning has identified the following local roads may be used for the Project.

Table 59: Local Roads potentially impacted by traffic during construction

Segment	Local Road
Segment 1	Weir Road, Fourth Street, Farnsworth Avenue
Segment 2/3	Western Road, Clifton Avenue
Segment 3	Cross Street
Segment 3/4	Kensington Close, Stirling Street, Feodore Drive. Frederick Road
Segment 4	Monash Place, Hebblewhite Place
Segment 4/5	John Street
Segment 5	Curtin Street, Fairview Road, Bromley Street, Beckenham Street, Willowbank Crescent, Knight Street, Dale Street, Wilga Street, North Street, East Parade, Lansdowne Road, Tillett Parade

7.6 Mitigation and management measures

Noise and vibration mitigation measures to mitigate impacts from the construction of the Project are described in the following sections and summarised in Table 66. These mitigation measures are considered to represent all ‘feasible and reasonable’ mitigation measures suitable for implementation during construction of the Project. As noted previously, this is a preliminary study, therefore selection of equipment activities and operating hours will be further refined, and a detailed management plan will be implemented by the successful contractor once further information is available.

7.6.1 Construction noise and vibration management plan

For all construction works, the contractor would be expected to prepare a detailed Construction Noise and Vibration Management Plan (CNVMP). It is recommended that a Project wide CNVMP be prepared, irrespective of whether separate contractors are appointed. This is to provide consistency of approach and simplify consultation and approvals processes. Site specific Construction Noise and Vibration Impact Statements (CNVISs) can be prepared to inform and justify the site specific mitigation and management measures.

The CNVMP should provide a framework, with clear requirements, and the necessary processes to enable the proponent and contractor(s) to appropriately plan, mitigate and manage noise and vibration risks and/or impacts throughout the construction of the Project.

The CNVMP should aim to succinctly outline the project requirements, as often multiple layers of requirements result from the enforcement of EIS commitments, matters identified in Submissions Reports or Preferred Infrastructure Reports, Conditions of Approval and Environmental Protection Licenses, all of which can include both specific requirements and generic reference to noise management guidelines such as the ICNG and TfNSW CNVS. These multiple layers of requirements can result in unnecessary complexity and conflicting requirements that need to not only be reported against, but often interpreted by the proponent, contractor and approvals authorities. This can unduly burden the project planning and the start of works. The conditioning of project requirements should be cognisant of these implications.

The CNVMP should also be concise to aid its use and adoption and ensure requirements are clearly understood by the all stakeholders. It should also aim to streamline the development of more detailed assessments, management sub plans and approvals for works, including works required outside standard hours.

The CNVMP shall clearly outline the following:

- Roles and responsibilities of the proponent, contractors, subcontractors, authorities and relevant stakeholders etc
- Noise sensitive receiver locations
- Areas of potential impact
- Mitigation strategy
- Monitoring methodology
- Community engagement strategy.

General guidance on the control of construction noise and vibration impacts relevant to this study are discussed in the following sections.

7.6.2 Universal work practices

The following noise mitigation work practices are recommended to be adopted at all times on site:

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- 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.
- 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.

7.6.3 Vibration – minimum working distances

As a guide, the recommended minimum working distances for vibration intensive plant in Table 60 provide an indication of the possibility of impact due to vibration generating plant and equipment onto nearby receivers. While the minimum working distances are indicative only and will vary depending on the item of plant and local geotechnical conditions, if a receiver is located within the minimum working distance, vibration monitoring might be required, and equipment selection and/or method of construction might have to be reviewed.

Table 60: Recommended minimum working distances for vibration intensive plant

Plant Item	Rating / Description	Minimum working distance (m)			
		Cosmetic damage			Human response – Disturbance to building occupants **[8]**
		BS 7385 – Line 1[1]	**BS 7385 - Line 2[2]**	**DIN 4150[3]**	
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	2 m	5 m	11 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	2 m	6 m	13 m	20 m
	< 200 kN (Typically 4-6 tonnes)	5 m	12 m	26 m	40 m
	< 300 kN (Typically 7-13 tonnes)	6 m	15 m	31 m	100 m
	> 300 kN (Typically 13-18 tonnes)	8 m	20 m	40 m	100 m
	> 300 kN (> 18 tonnes)	10 m	25 m	50 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	1 m	2 m	5 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	3 m	7 m	15 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	9 m	22 m	44 m	73 m
Pile Driver - Vibratory	Sheet piles	9 m	22 m	44 m	73 m
Piling Rig - Bored	≤ 800 mm	1 m (nominal)	2 m (nominal)	5 m	10 m (nominal)
Piling Rig – Hammer	12t down force	6 m	15 m	30 m	50 m

Plant Item	Rating / Description	Minimum working distance (m)			
		Cosmetic damage			Human response – Disturbance to building occupants **[8]**
		BS 7385 – Line 1[1]	**BS 7385 - Line 2[2]**	**DIN 4150[3]**	
Jackhammer	Hand-held	1 m (nominal)	1 m (nominal)	3 m	5 m
Mechanised bored tunnelling works (Tunnel Boring Machine, Horizontal Directional Drilling, Micro-tunnelling)[3]	-	1 m to 5 m	2 m to 12 m	4 m to 24 m	6 m to 35 m

Note:

1. Refer to **Table 44** Line 1. Minimum working distance based screening criterion of 25 mm/s as per Section 7.2.3.3.
2. Refer to **Table 44** Line 2. Minimum working distance based screening criterion of 7.5 mm/s as per Section 7.2.3.3
3. Refer to **Table 45** Line 3. Minimum working distance based on screening criterion of 3 mm/s as per Section 7.2.3.3.
4. Plant has been added – calculation based on TRL document **[38]** using Godio et al formula, equation 24

7.6.4 Property condition surveys

Property surveys (or dilapidation surveys) should be conducted before start of construction works where it has been established that the property, structure or utility is at risk of damage (such as a property which is located within the minimum working distance for example (Refer to Section 7.6.3)) during the construction work. The survey findings could require amendment to proposed vibration criteria or management measures and therefore should be undertaken in suitable advance of when the works start.

7.6.5 Alternative accommodation

For works to be conducted during night-time, requirement for alternative accommodation should be evaluated in accordance with the number of nights where highly intrusive noise levels (Defined in the CNVS as >30 dB above RBL) are generated in any particular location.

7.6.6 Mitigation measures summary

Table 66 summarises mitigation measures to be applied for the construction of the Project.

Table 61: Construction noise and vibration mitigation measures

Item where mitigation applies	Impacts	Mitigation measures	Mitigation measures description
All	Construction noise and vibration impacts - General	CNVMP	Develop a CNVMP (Refer to Section 7.6.1)
		Hours of work	Construction works should be scheduled for Standard Construction Hours, where possible. If it is not possible to restrict the works to the day period, then they should be completed as early as possible in each work shift. Appropriate respite should also be provided to affected receivers in accordance with the CNVG and/or the project's conditions of approval.
		Equipment selection	Select low noise emissions equipment. Where possible stationary equipment should be located behind structures such as demountable buildings or stockpiles to maximise shielding to receivers. Consider using electric / hydraulic equipment where possible. Use only the necessary size and power equipment All plant and equipment used on site must be: • maintained in a proper and efficient condition; and • operated in a proper and efficient manner. Turn off all vehicles, plant and equipment when not in use. Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable. If rental equipment is to be used, the noise levels of plant and equipment items are to be considered in rental decisions.
		Location of plant	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site. Plan truck movements to avoid residential streets where possible.

Item where mitigation applies	Impacts	Mitigation measures	Mitigation measures description
		Non-tonal and ambient sensitive reversing alarms	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
		Consultation	Carry out consultation: • with the community and surrounding building owners/occupants during construction including, but not limited to; advance notification of planned activities and expected disruption/effects, construction noise complaints handling procedures. • with proponents or applicants of other State Significant development and infrastructure works near the CSSI to minimise cumulative impacts of noise and vibration and maximise respite for affected sensitive receivers • with medical facilities prior the start of construction to determine if any equipment within the facilities are sensitive to vibration (Refer to Section 4.4 and Section 7.2.3.2)
	Construction vibration impacts – **general**	Vibration monitoring and property survey and equipment selection	Select low vibration generating equipment Equipment selection and/or method of construction are to be reviewed if works are within the minimum working distance. Vibration measurements are required at the start of vibration generating activities that are within the minimum working distances in Table 60. If vibration intensive works are required within the minimum working distances in Table 60 and attended vibration monitoring has established risk of exceedance, extended monitoring should be carried out. Conduct property survey if required. Refer to Section 7.6.3, Section 7.6.4
WaterNSW Upper Canal	Construction vibration impacts	Vibration monitoring – Upper Canal	Conduct vibration monitoring during construction near and under the Upper Canal. Refer to Section 7.4.4

Item where mitigation applies	Impacts	Mitigation measures	Mitigation measures description
24h drilling sites (C1, C2, C14, C15)	Airborne noise	Site planning and site hoarding/enclosure	Physical mitigation measures such as implementing noise screening in the form of site hoarding between the sites and nearby noise sensitive receiver and/or an enclosure around the sites or noisy piece of equipment are required. These recommendations should be reviewed prior to commencement of works. Refer to Section 7.4.2.1 and Section 7.4.2.2
Long term site support	Construction noise impacts	Site planning and site hoarding	Noise mitigation in the form of careful site planning and potentially noise screening in the form of site hoarding between the site and nearby noise sensitive receivers might be required for C6, C7, C8, C10, C11, C12. These recommendations should be reviewed prior to commencement of works. Refer to Section 7.4.3.
Receivers near Pipelines	Construction noise impacts	Alternative accommodation	Establish if alternative accommodation for work to be conducted OOHW should be offered in accordance with guidance in the CNVS. Refer to Section 7.6.5.
Traffic on local roads	Construction noise impacts	Adherence to daytime hours	Where possible, heavy vehicle movements should be limited to daytime hours. Opportunities to reduce road traffic noise during construction should be investigated during construction planning, including restricting heavy vehicle movements to standard construction hours and/or to routes with fewer sensitive receivers. Refer to Section 7.5

8 Conclusion

A noise and vibration impact assessment has been carried out for the AWRC, which included assessment of the operation and construction of the Advanced Water Recycling Centre and associated pipelines onto the nearby receivers.

The operational assessment of the AWRC indicated that the Project can comply with the established criteria for Stage 1 and Future Stages of the Project at all receivers with application of reasonable noise mitigation measures, such as selection of low noise equipment, enclosures and attenuation devices. Notwithstanding, detailed review of the final equipment layout, plant selections and mitigation measures should be carried out prior to commencement of construction.

Potential noise generated by the emission of water from pipeline release locations into the Nepean River and the Warragamba River, are anticipated to comply with the project criteria.

Noise from valves located along the pipeline was also identified as a potential noise source. The assessment concluded that the location and type of valves can be designed to address potential impacts under typical operations, however some residual impact may occur under surge events, however these would be infrequent.

Regarding road traffic noise generated by the AWRC operation, increase in noise levels onto receivers along Elizabeth Drive and Clifton Avenue is predicted to comply with the RNP [3].

Vibration from the AWRC will be not be significant and can readily be addressed by the design and installation of plant and equipment. Furthermore, there are no highly vibration sensitive structures or uses located in the vicinity of the site.

Regarding construction, most works are to be conducted during Standard Hours for which standard practices will be adopted to manage potential impacts. Where works are required to be conducted outside Standard Hours, more detailed consideration of mitigation and management practices are warranted, particularly where they are in proximity to residential receivers. Management measures for each location of works will be clarified in a CNVMP to be prepared for the Project. The CNVMP should outline the necessary processes to enable the proponent and contractor(s) to appropriately plan, mitigate and manage noise and vibration risks and/or impacts throughout the construction of the Project.

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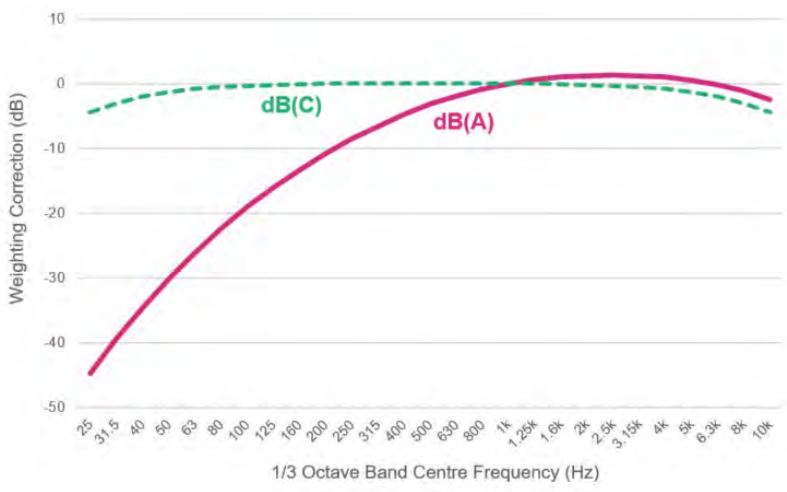
Appendix A

Glossary

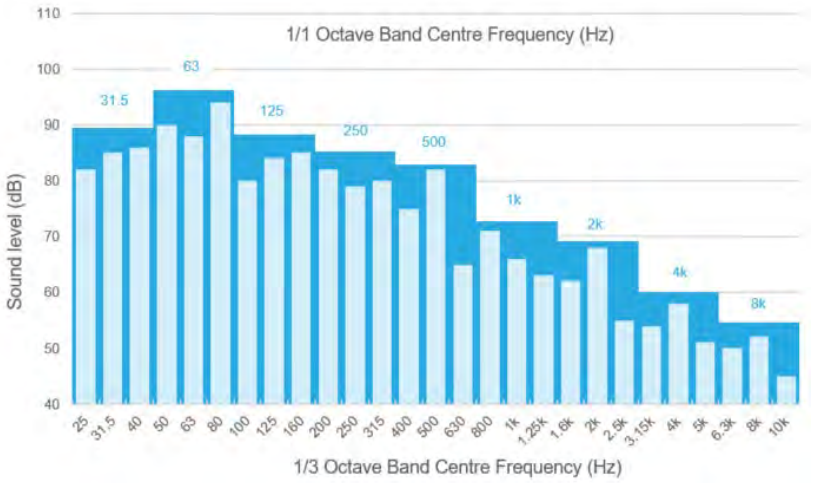
Abbreviation / Term	Definition
Project-Specific Terms	
Upper South Creek Advanced Water Recycling Centre ("The Advanced Water Recycling Centre")	The Advanced Water Recycling Centre when complete will be a sophisticated wastewater treatment and resource recovery centre that will produce recycled water, renewable energy and bio-resources. Initially the Advanced Water Recycling Centre will treat wastewater and produce water suitable for a range of uses including recycling, environmental flows or for a range of industrial/commercial or agricultural uses. The Advanced Water Recycling Centre will also produce renewable energy and by-products suitable for future land applications.
Ancillary infrastructure	This is permanent infrastructure to support operation of the facility and may include a range of infrastructure such as access roads and provision of utilities such as power.
Brine pipeline	A pipeline to transport brine (salty water). Brine water is a by-product of reverse osmosis in the wastewater treatment process.
Construction corridor	The area required to build the Project. It includes the areas where trenched and trenchless techniques are used and temporary ancillary facilities (i.e. equipment storage compounds and laydown areas).
Early works	Before construction starts, we may need to optimise and finalise alignments, and to confirm design and constructability, such as survey works, condition surveys, or investigating utilities. We will have a more comprehensive definition as part of the EIS.
Environmental flows (Or Replacement flows, replacement environmental flows or e-flows)	Water released from a dam or weir to sustain healthy rivers. Some of Sydney Water wastewater treatment and water recycling facilities also release treated wastewater into creeks and rivers. This can help improve conditions for native fish, frogs, birds, plants and other animals. It can also reduce the likelihood of algal blooms and enhance recreational uses. Environmental Flows from the Advanced Water Recycling Centre may be used supplement or replace flows that would have been released from Warragamba Dam
Project	The construction and operation of the Upper South Creek Advanced Water Recycling Centre, pipelines and all ancillary infrastructure. Construction of the Advanced Water Recycling Centre is subject to environmental approval and has been identified as critical infrastructure. There are many stages and we are at the very early planning. Detailed construction staging will be established by the detailed design contractor. Noting that the timelines aren't finalised, it's expected that construction will start in mid-2022.
Release of water	To release water into a creek, river or the ocean

Abbreviation / Term	Definition
Sydney Water	Sydney Water's vision is to create a better life with world-class water services. We own and operate the wastewater network for Sydney, the Illawarra and the Blue Mountains, servicing over five million customers. We're responsible for 26,169 km of wastewater pipes. Customers own about another 20,000 kilometres of wastewater pipes – on private properties. Most of the wastewater in the network flows by gravity along natural catchment drainage lines to a wastewater treatment facility.
Study area	General location or region where work may be undertaken, including surrounding land uses and structures.
Temporary Ancillary facilities	These are temporary facilities to support construction including: • access roads • construction compounds • laydown areas • site offices and amenities • parking
Treated water pipeline	The pipeline that will take the treated water to the environment that will use it, whether that is creek, river or ocean. The pipelines will transport water from the Advanced Water Recycling Centre to release into the Nepean river, Warragamba rivers and to the Malabar systems. These pipelines will range in size from about 0.6 m to 1.5 m in diameter and will generally consist of Steel, Glass Reinforced Plastic (GRP) and Polyethylene pipe materials.
Treated water (or Effluent or wastewater)	What wastewater becomes after it has been treated. Wastewater can go through up to three levels of treatment to remove waste. These are called primary, secondary and tertiary treatment. This means we treat wastewater to suit the environment (creek, river or ocean) that will receive it, or to suit how it will be re-used.
Wastewater	The used water that drains down sinks, toilets and drains into the sewerage system. About 99% of this is water.
Project-Specific Acronyms	
CoA	Condition of Approval
Contractor, The	The company engaged to undertake the Project work.
CSSI	Critical State Significant Infrastructure
DPIE	Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
HDD	Horizontal Direct Drilling
ICNG	NSW Interim Construction Noise Guideline [26]
L_{A90}	A-weighted L_{90} (see **noise-specific terms** below for L_{90} definition)
L_{Aeq}	A-weighted L_{eq} (see **noise-specific terms** below for L_{eq} definition)

Abbreviation / Term	Definition
LGA	Local government area
L_w	See Sound Power in **noise-specific terms** below for L_w definition
NCA	Noise Catchment Area
NSW	New South Wales
RBL	Rated background level (see **noise-specific terms** below for RBL definition)
RMS	Roads and Maritime Services (now Transport for New South Wales)
RO	Reverse Osmosis
SEARs	Secretary's environmental assessment requirements
Secretary	Secretary of the NSW Department of Planning, Industry and Environment (or delegate)
SEPP	State environmental planning policy
SSI	State significant infrastructure
TfNSW	Transport for New South Wales
UF	Ultrafiltration
WSAGA	Western Sydney Aerotropolis Growth Area
WRP	Water Recycling Plant
Noise and Vibration-Specific Terms	
Ambient noise level	The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a building is being investigated, the ambient noise level is the noise level from all other sources without the fan operating, such as traffic, birds, people talking and other noise from other buildings.
Background noise level	The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects. **Assessment Background Level (ABL)** A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night-time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time. **Rating Background Level (RBL / min$L_{A90,1hour}$)** A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night-time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.
CNVMP	Construction Noise and Vibration Management Plan

Abbreviation / Term	Definition
CNVIS	Construction Noise and Vibration Impact Statement
CNVS	Construction Noise and Vibration Strategy
Decibel (dB)	The logarithmic scale used to measure sound and vibration levels. Human hearing is not linear and involves hearing over a large range of sound pressures, which would be cumbersome if presented on a linear scale. Use of a logarithmic scale allows all sound levels to be expressed based on how loud they are relative to a reference sound (typically 20 µPa, which is the approximate human threshold of hearing). For sound in other media (e.g. underwater noise) a different reference level is used. An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.
dB weighting curves	The frequency of a sound affects its perceived loudness and human hearing is less sensitive at low and very high frequencies. When seeking to represent the summation of sound pressure levels across the frequency range of human hearing into a single number, weighting is typically applied. Most commonly, A-weighting, denoted as dB(A), is used for environmental noise assessment. This is often supplemented by the linear or C-weighting curves, where there is the potential for excess low-frequency sound at higher sound pressure levels. 
dB(A)	dB(A) denotes a single-number sound pressure level that includes a frequency weighting ('A-weighting') to reflect the subjective loudness of the sound level. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A). Some typical dB(A) levels are shown below. **Sound Pressure Level dB(A)** — **Example** 130 — Human threshold of pain 120 — Jet aircraft take-off at 100 m 110 — Chain saw at 1 m 100 — Inside nightclub

Abbreviation / Term	Definition	
	90	Heavy trucks at 5 m
	80	Kerbside of busy street
	70	Loud stereo in living room
	60	Office or restaurant with people present
	50	Domestic fan heater at 1m
	40	Living room (without TV, stereo, etc)
	30	Background noise in a theatre
	20	Remote rural area on still night
	10	Acoustic laboratory test chamber
	0	Threshold of hearing
Equipment with special audible characteristics	Refer to a type of equipment/activities Refers to specific activities with characteristics that can cause annoyance and disturbance, containing noticeable factors such as tonality, low frequency noise, impulsive or intermittent noise as listed below and including similar activities: • Use of beeper style reversing or movement alarms, particularly at night-time • use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or steel work • grinding metal, concrete or masonry • rock drilling • line drilling • vibratory rolling • bitumen milling or profiling • jackhammering, rock hammering or rock breaking • Impact piling • Sheet piling Those activities attract a 5 dB penalty to be added to the sound power level to account for the degree of annoyance.	
Feasible and reasonable	Consideration of best practice considering the benefit of proposed measures and their technological and associated operational application in the NSW and Australian context. Feasible relates to engineering considerations and what is practical to build. Reasonable relates to the application of judgement in arriving at a decision, considering mitigation benefits and cost of mitigation versus benefits provided, community views and nature and extent of potential improvements.	

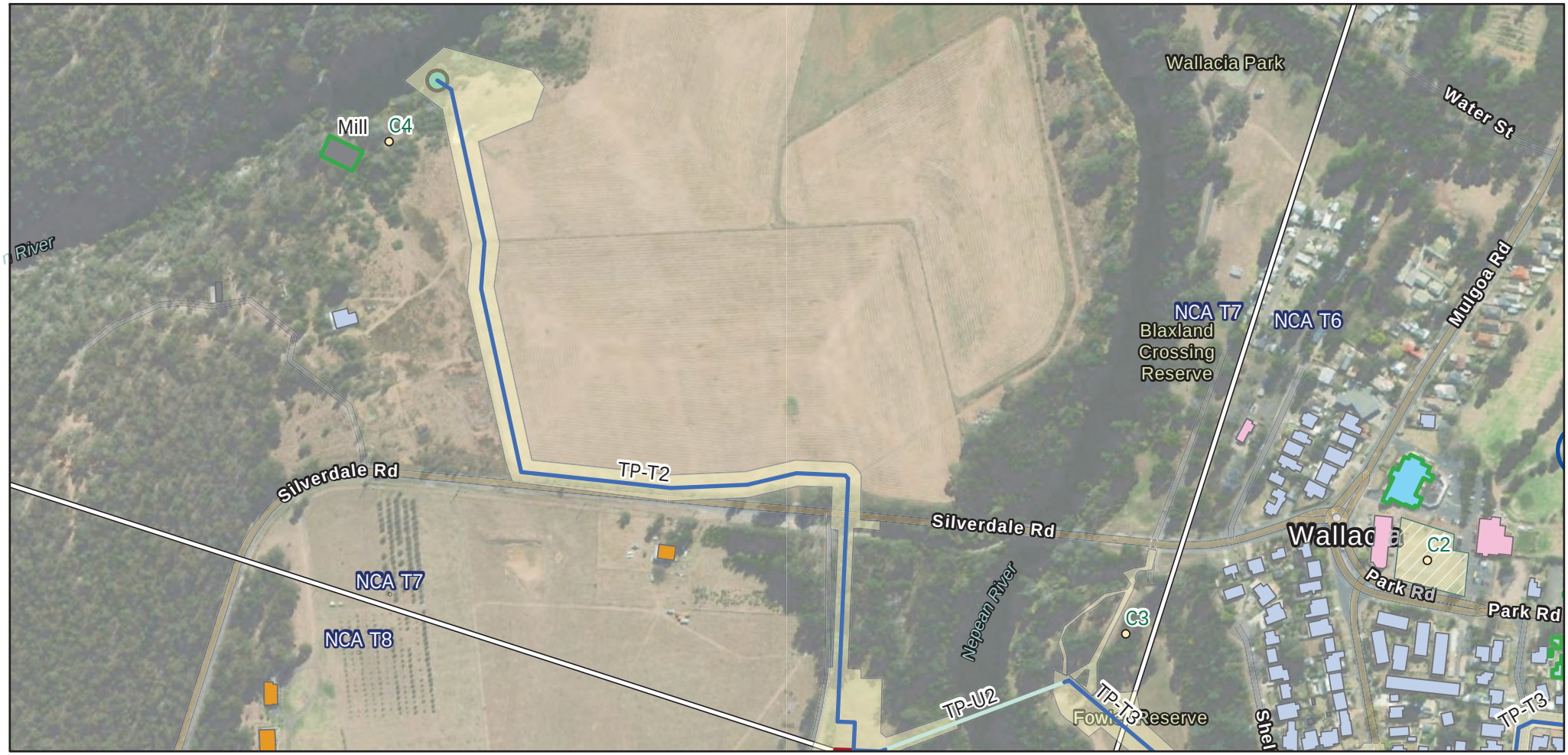
Abbreviation / Term	Definition
Frequency	Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as 'pitch'. Human hearing ranges approximately from 20 Hz to 20 kHz. Sounds towards the lower end of the human hearing frequency range are perceived as 'bass' or 'low-pitched' and sounds with a higher frequency are perceived as 'treble' or 'high pitched'. Frequency analysis is often grouped into bands, or 'octave bands. 1/1 octave or 1/3 octave bands are most commonly utilised and named based on the nominal centre frequency of the band (e.g. 31.5 Hz), are a summation of all frequencies between a defined lower and upper frequency. 
$L_{10(period)}$	The sound level exceeded for 10% of the measurement period, or alternatively, the sound levels would be lower for 90% of the time. The L_{10} is often defined as the 'average maximum' sound levels, as in AS1055-1984 with the advent of statistical sound level meters.
$L_{90(period)}$	The sound level exceeded for 90% of the measurement period. The L_{90} is often defined as the 'average minimum' or 'background' noise level for a period of measurement. For example, 45 $dBL_{A90,15min}$ indicates that the sound level is higher than 45 dB(A) for 90% of the 15-minute measurement period.
$L_{eq(period)}$	The equivalent ('eq') continuous sound level, used to describe the level of a time-varying sound or vibration measurement. The L_{eq} is often defined as the 'average' level, and mathematically, is the energy-average level over a measurement period – i.e. the level of a constant sound that contains the same sound energy as the measured sound.
L_{max}	The L_{max} is the 'absolute maximum' level of a sound or vibration recorded over the measurement period. As the L_{max} is often caused by an instantaneous event, it can vary significantly between measurements.
NCA	Noise catchment area
NML	Noise management level
OOH	Out-of-hours (i.e. outside of the standard construction hours stipulated in planning approval conditions)
OOHW	Out of Hours Work

Abbreviation / Term	Definition
Peak Particle Velocity (PPV)	The highest velocity of a particle (such as part of a building structure) as it vibrates. PPV is commonly used as a vibration criterion for the assessment of cosmetic and structural damage.
RNP	NSW EPA Road Noise Policy [3]
Sensitive receiver	Includes residences, temporary accommodation such as caravan parks and camping grounds, and health care facilities (including nursing homes, hospitals). Also includes the following, when in use: educational institutions (including preschools, schools, universities, TAFE colleges), religious facilities (including churches), child care centres, passive recreation areas, commercial premises (including film and television studios, research facilities, entertainment spaces, restaurants, office premises and retail spaces), and others as identified by the Secretary.
Sound Power and Sound Pressure	The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of the environment and distance from a source. The sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.
Vibration	Waves in a solid material are called ‘vibration’, as opposed to similar waves in air, which are called ‘sound’ or ‘noise’. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage. A vibrating structure (e.g. a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space. Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.
VDV	Vibration Dose Values
Airborne noise levels terminology (applies to residential receivers only)	
Clearly audible	All periods: For construction noise levels >10 to 20 dB above RBL
Highly intrusive	All periods: For construction noise levels >30 dB above RBL
Highly noise affected	All hours: For construction noise levels 75 dB(A) or greater
Moderately intrusive	All periods: For construction noise levels <20 to 30 dB above RBL
Noticeable	Standard hours and OOHW period 1: For construction noise levels 5 to 10 dB above RBL OOHW Period 2: For construction noise level 0 to 10 dB above RBL

Appendix B

Land use survey

aurecon ARUP



- Treated water pipeline
- Treated water pipeline - Underbore
- Active Recreation
- Commercial/Business
- Hotel
- Industrial/Utilities
- Residential
- Worship
- all other receivers
- Construction compound
- Heritage
- NCA boundary
- Discharge location
- EIS M12 Noise Monitoring Location
- Construction corridor

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Treated water pipeline

- Treated water pipeline
- Treated water pipeline - Underbore
- Active Recreation
- Commercial/Business
- Hotel
- Industrial/Utilities
- Residential
- Worship
- all other receivers
- Construction compound
- Heritage
- NCA boundary
- EIS M12 Noise Monitoring Location
- Construction corridor

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Treated water pipeline

- Treated water pipeline
- Active Recreation
- Commercial/Business
- Hotel
- Industrial/Utilities
- Residential
- Worship
- all other receivers
- Construction compound
- Heritage
- NCA boundary
- EIS M12 Noise Monitoring Location
- Construction corridor

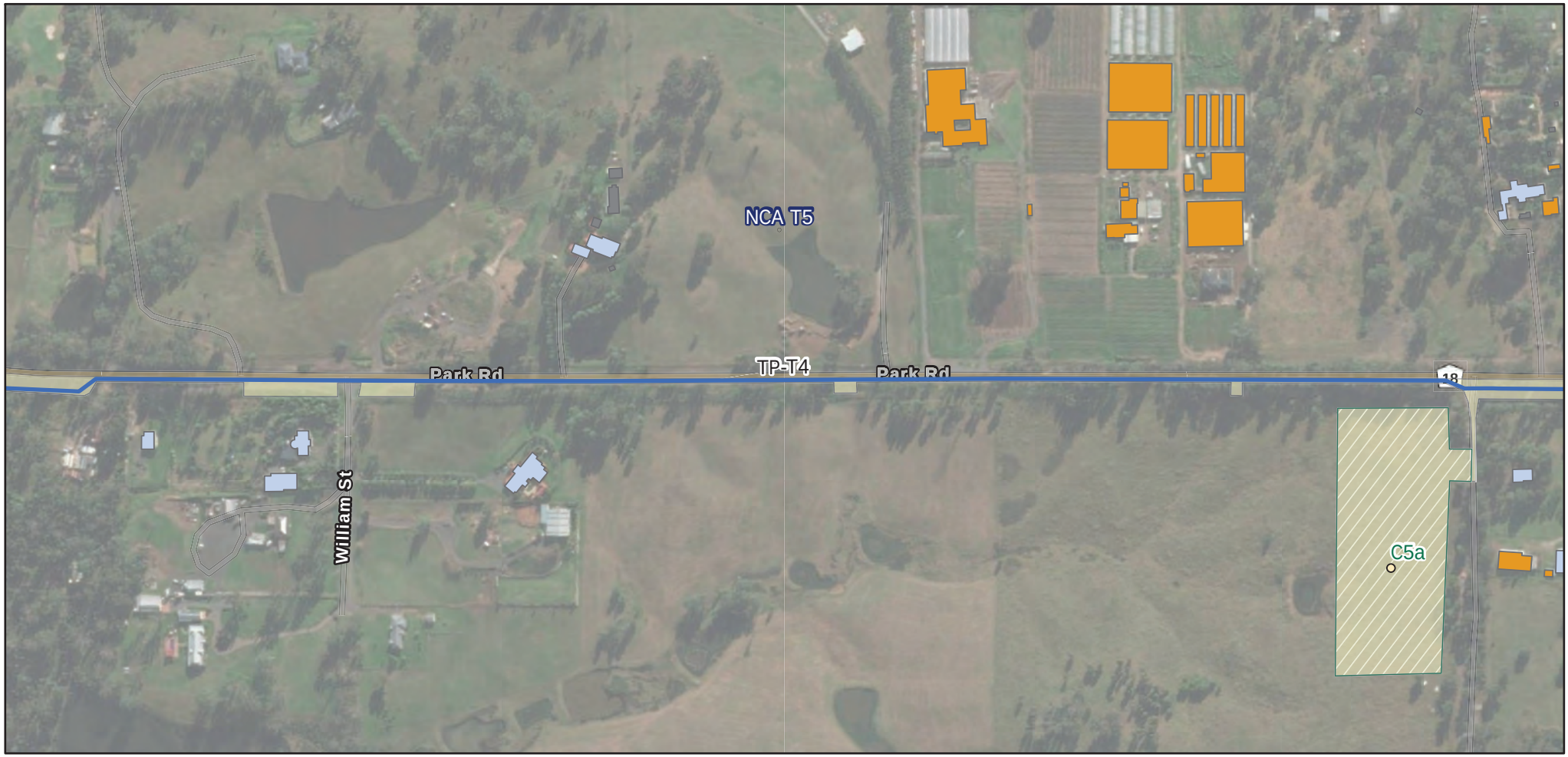
Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Treated water pipeline



- Treated water pipeline
- Active Recreation
- Commercial/Business
- Hotel
- Industrial/Utilities
- Residential
- Worship
- all other receivers
- Construction compound
- Heritage
- NCA boundary
- EIS M12 Noise Monitoring Location
- Construction corridor

Source: ESRI
Date: 30/03/2021

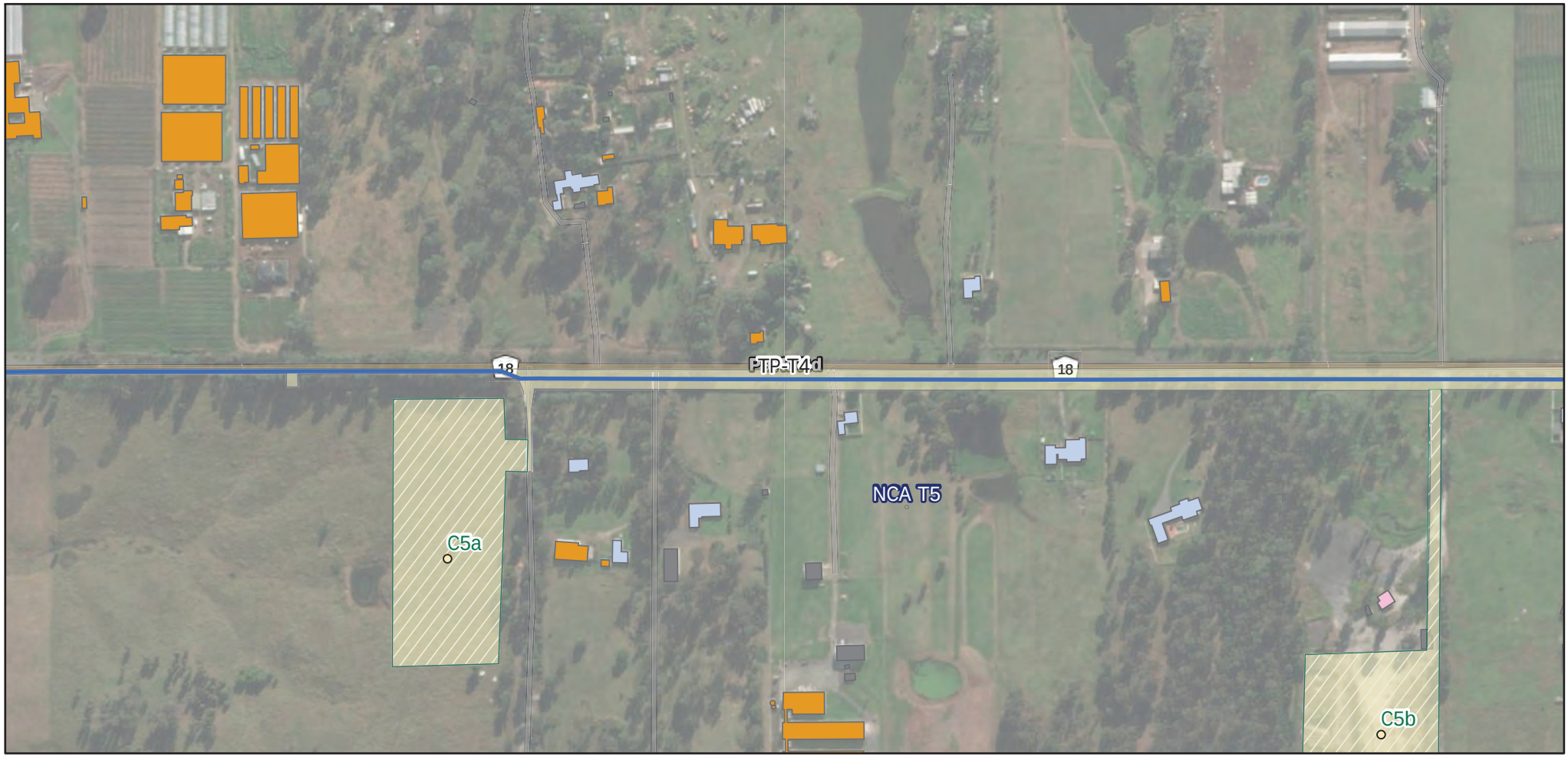
0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Treated water pipeline

aurecon ARUP



- Treated water pipeline
- Active Recreation
- Commercial/Business
- Hotel
- Industrial/Utilities
- Residential
- Worship
- all other receivers
- Construction compound
- Heritage
- NCA boundary
- EIS M12 Noise Monitoring Location
- Construction corridor

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Treated water pipeline

- Treated water pipeline
- Active Recreation
- Commercial/Business
- Hotel
- Industrial/Utilities
- Residential
- Worship
- all other receivers
- Construction compound
- Heritage
- NCA boundary
- EIS M12 Noise Monitoring Location
- Construction corridor

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Treated water pipeline

- Treated water pipeline
- Active Recreation
- Commercial/Business
- Hotel
- Industrial/Utilities
- Residential
- Worship
- all other receivers
- Construction compound
- Heritage
- NCA boundary
- EIS M12 Noise Monitoring Location
- Construction corridor

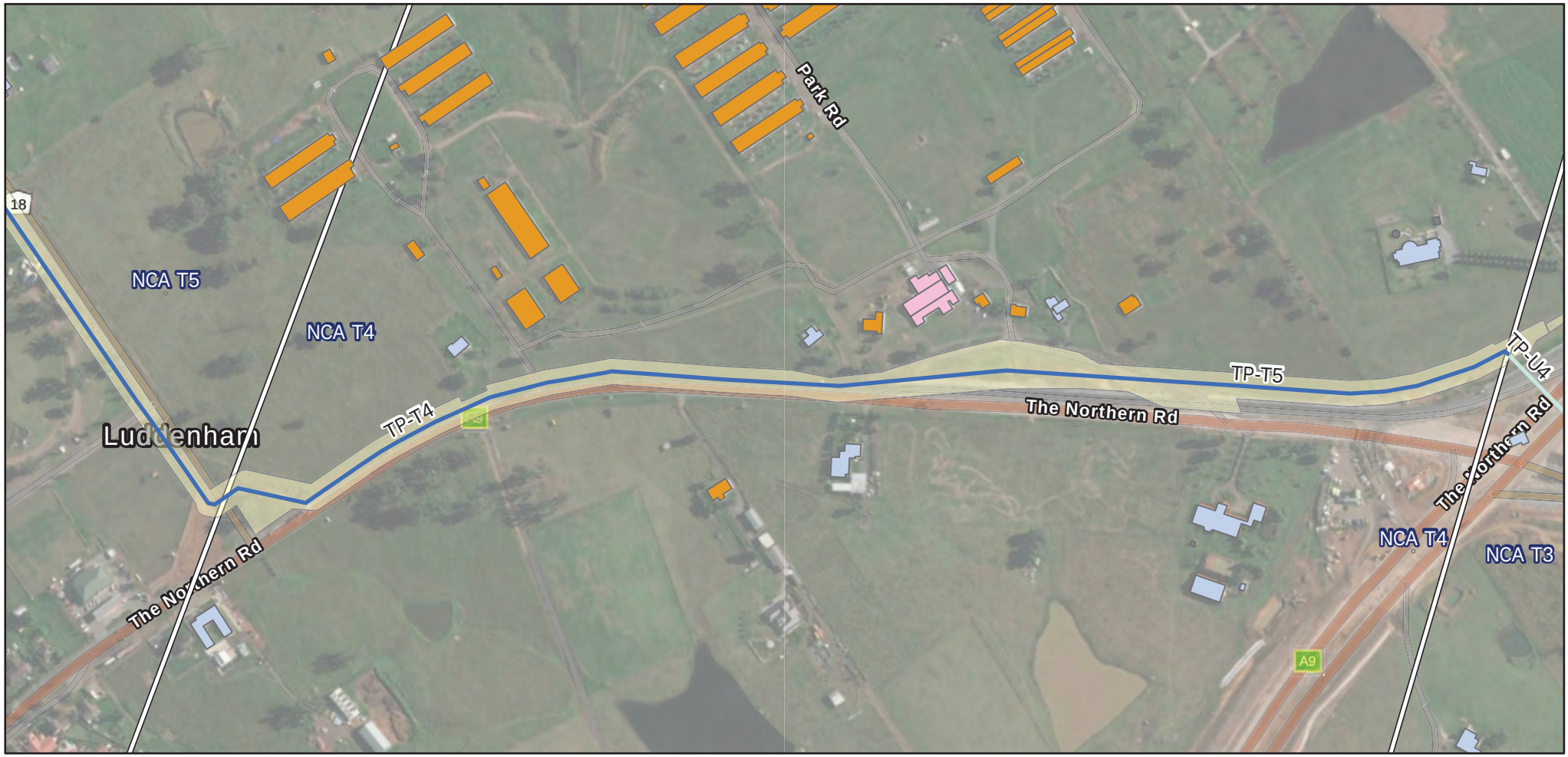
Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Treated water pipeline



Treated water pipeline
Treated water pipeline - Underbore
Active Recreation
Commercial/Business
Hotel
Industrial/Utilities
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Worship
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Construction compound
Heritage
NCA boundary
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Construction corridor

Source: ESRI
Date: 30/03/2021

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Projection: MGA56 GDA94

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aurecon ARUP

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Projection: MGA56 GDA94

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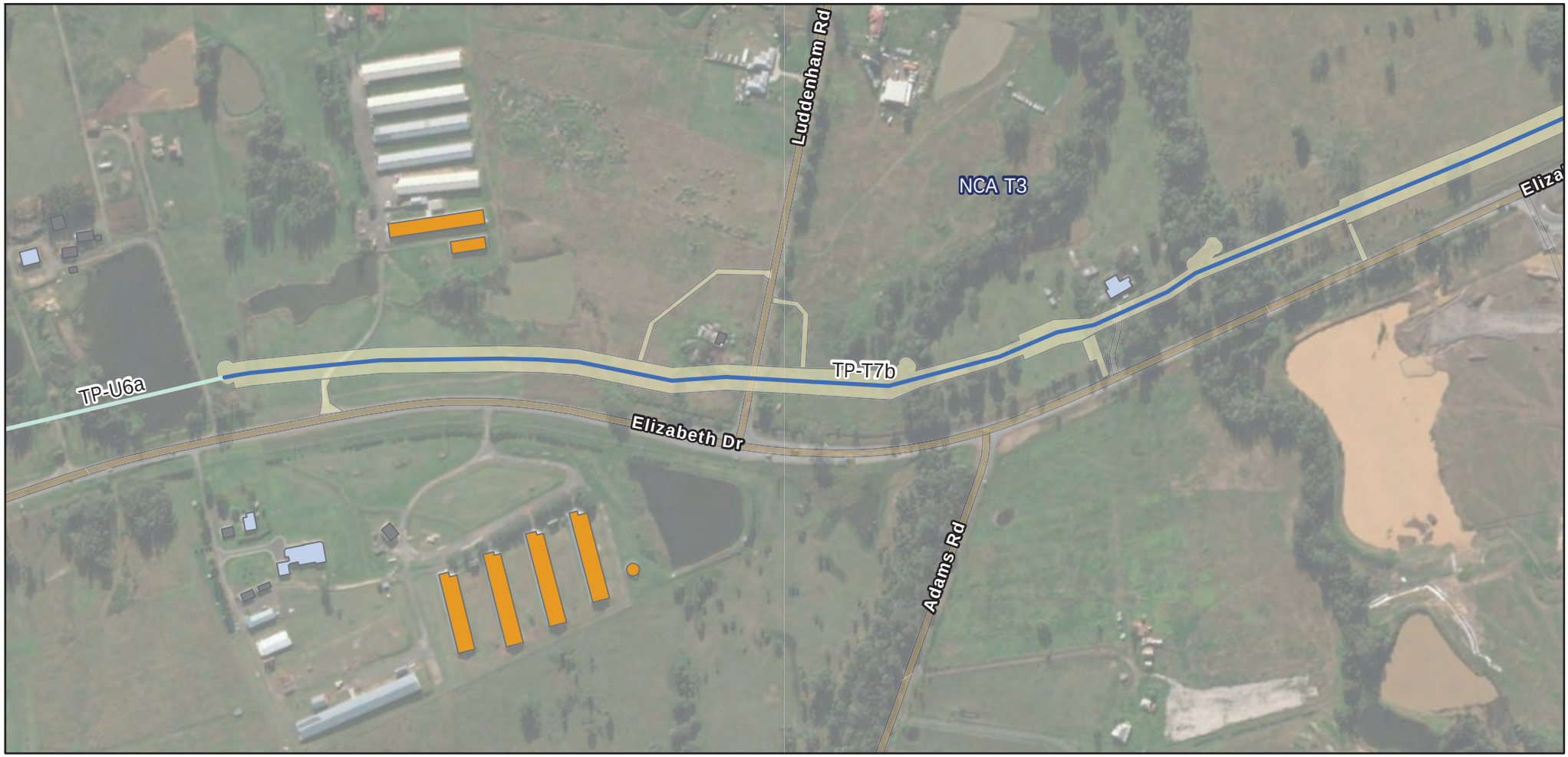

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Projection: MGA56 GDA94

Treated water pipeline

Treated water pipeline
Brine pipeline
Active Recreation
Commercial/Business
Hotel
Industrial/Utilities
Residential
Worship
all other receivers
Construction compound
Heritage
NCA boundary
EIS M12 Noise Monitoring Location
Construction corridor

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Treated water pipeline

- Treated water pipeline
- Environmental flows pipeline
- Active Recreation
- Commercial/Business
- Hotel
- Industrial/Utilities
- Residential
- Worship
- all other receivers
- Heritage
- NCA boundary
- Discharge location
- Construction corridor

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Environmental flows pipeline

Environmental flows pipeline
Active Recreation
Commercial/Business
Hotel
Industrial/Utilities
Residential
Worship
all other receivers
Heritage
NCA boundary
Discharge location
Construction corridor

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Environmental flows pipeline

Environmental flows pipeline - Underbore
Environmental flows pipeline
Active Recreation
Commercial/Business
Hotel
Industrial/Utilities
Residential
Worship
all other receivers
Heritage
NCA boundary
Discharge location
Construction corridor

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

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Projection: MGA56 GDA94

Environmental flows pipeline

Environmental flows pipeline - Underbore
Active Recreation
Commercial/Business
Hotel
Industrial/Utilities
Residential
Worship
all other receivers
Heritage
NCA boundary
Discharge location

Source: ESRI
Date: 30/03/2021

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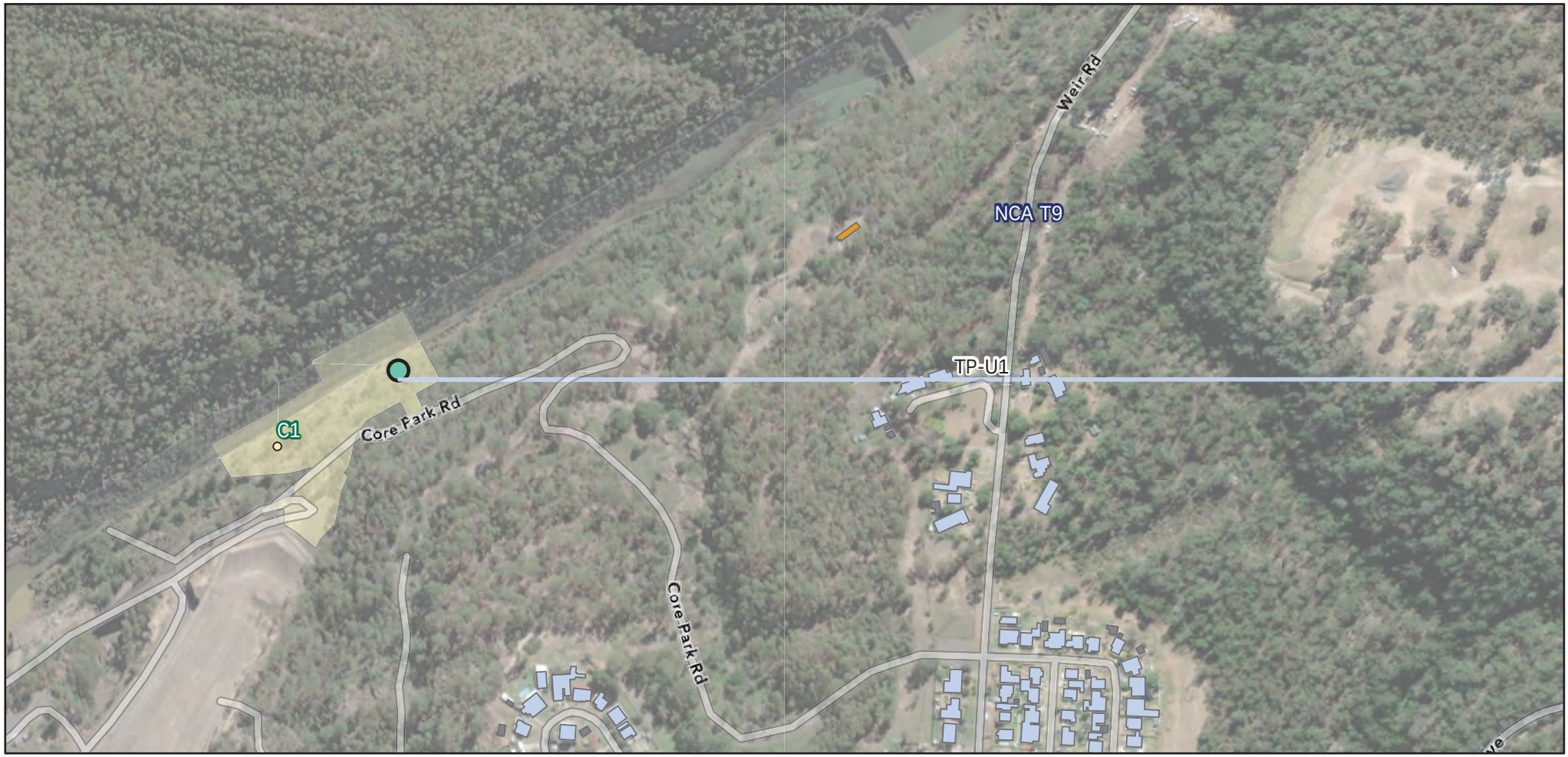
Projection: MGA56 GDA94

Environmental flows pipeline



Environmental flows pipeline - Underbore
Active Recreation
Commercial/Business
Hotel
Industrial/Utilities
Residential
Worship
all other receivers
Heritage
NCA boundary
Discharge location
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Projection: MGA56 GDA94

Environmental flows pipeline

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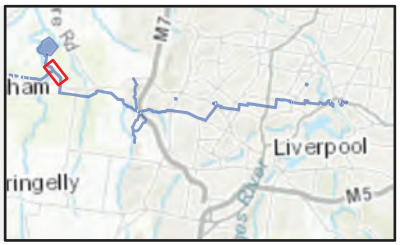
Brine pipeline - Underbore
Treated water pipeline
Active Recreation
Child Care
Commercial/Business
Industrial/Utilities
Medical
Passive Recreation
Residential
School
Worship
all other receivers
Construction compound
Heritage
Upper canal
Construction corridor
NCA boundary
Indicative valve location
EIS M12 Noise Monitoring Location



Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline

aurecon ARUP

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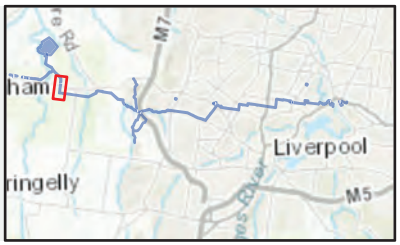

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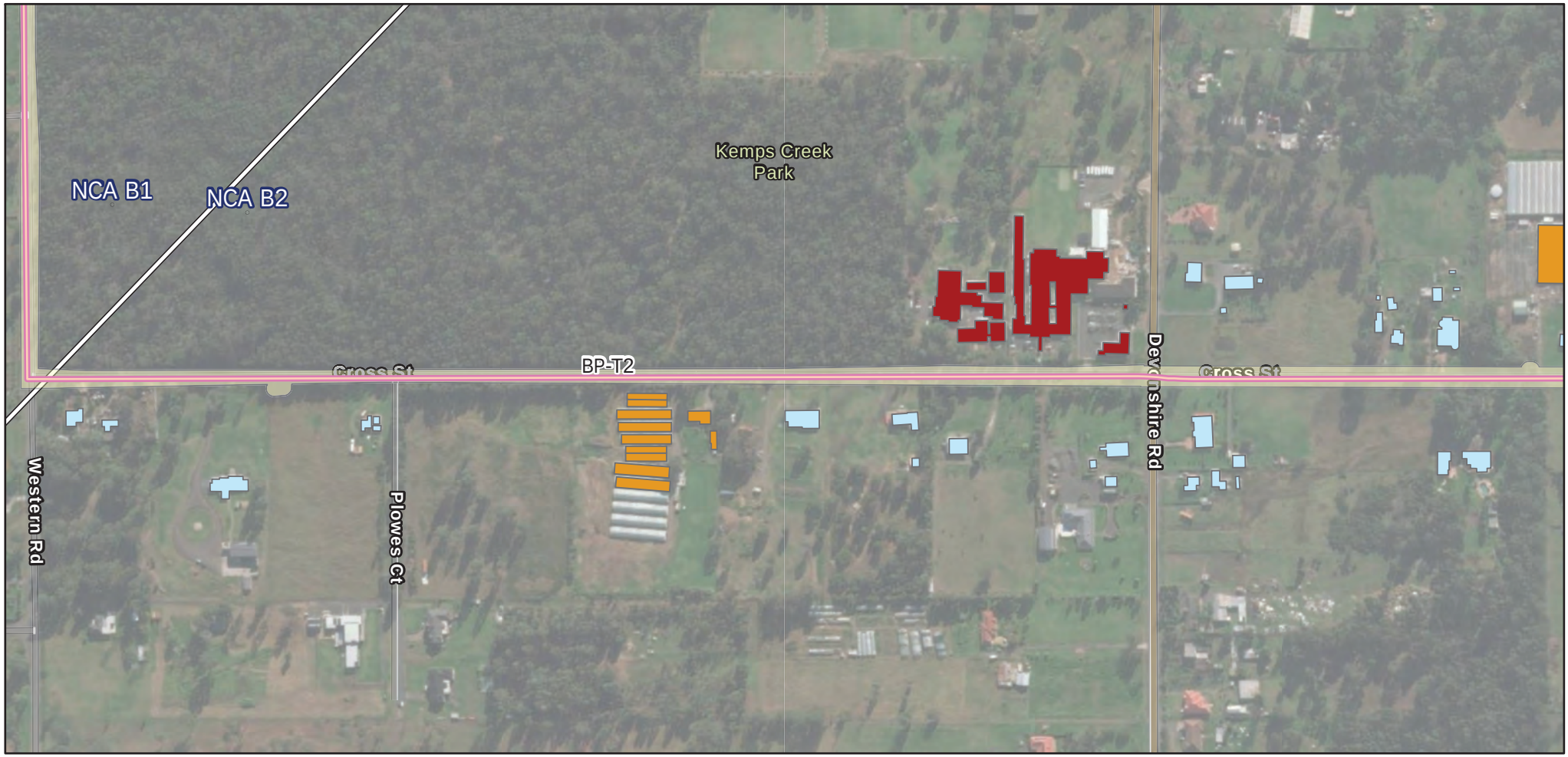

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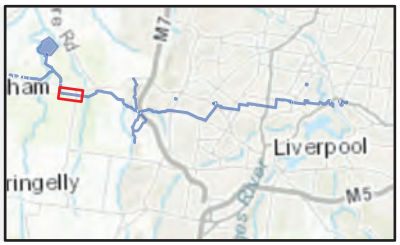

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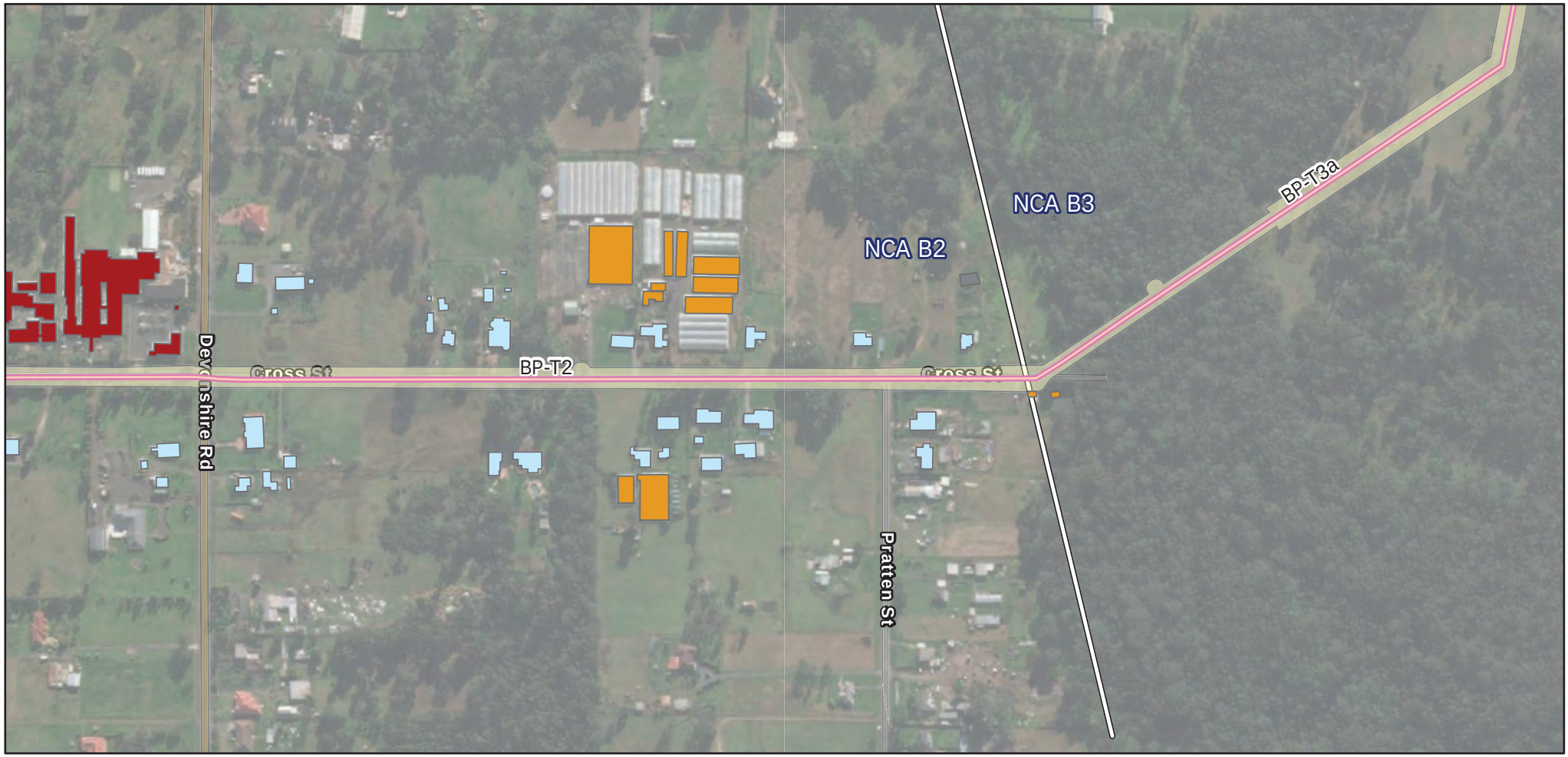

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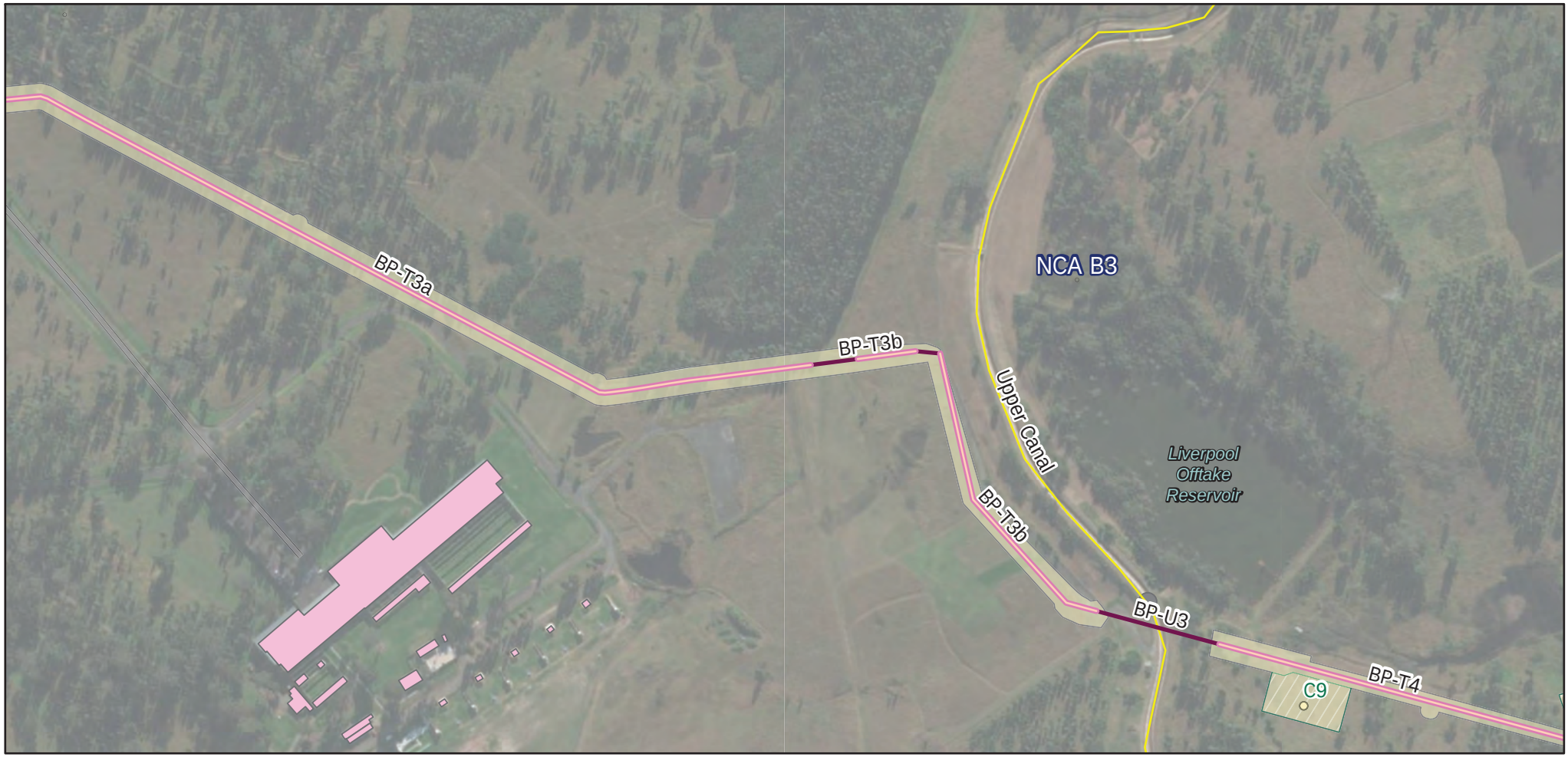

Brine Pipeline
Brine pipeline - Underbore
Active Recreation
Child Care
Commercial/Business
Industrial/Utilities
Medical
Passive Recreation
Residential
School
Worship
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Construction compound
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Upper canal
Construction corridor
NCA boundary
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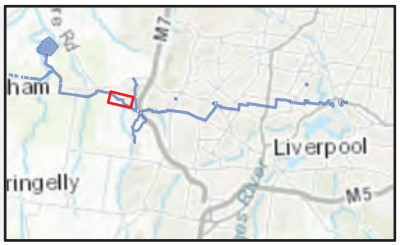

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Date: 30/03/2021

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Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline

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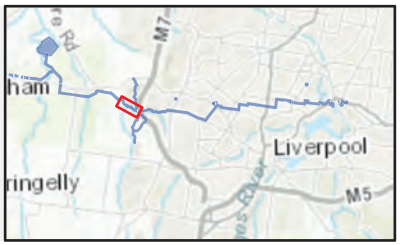

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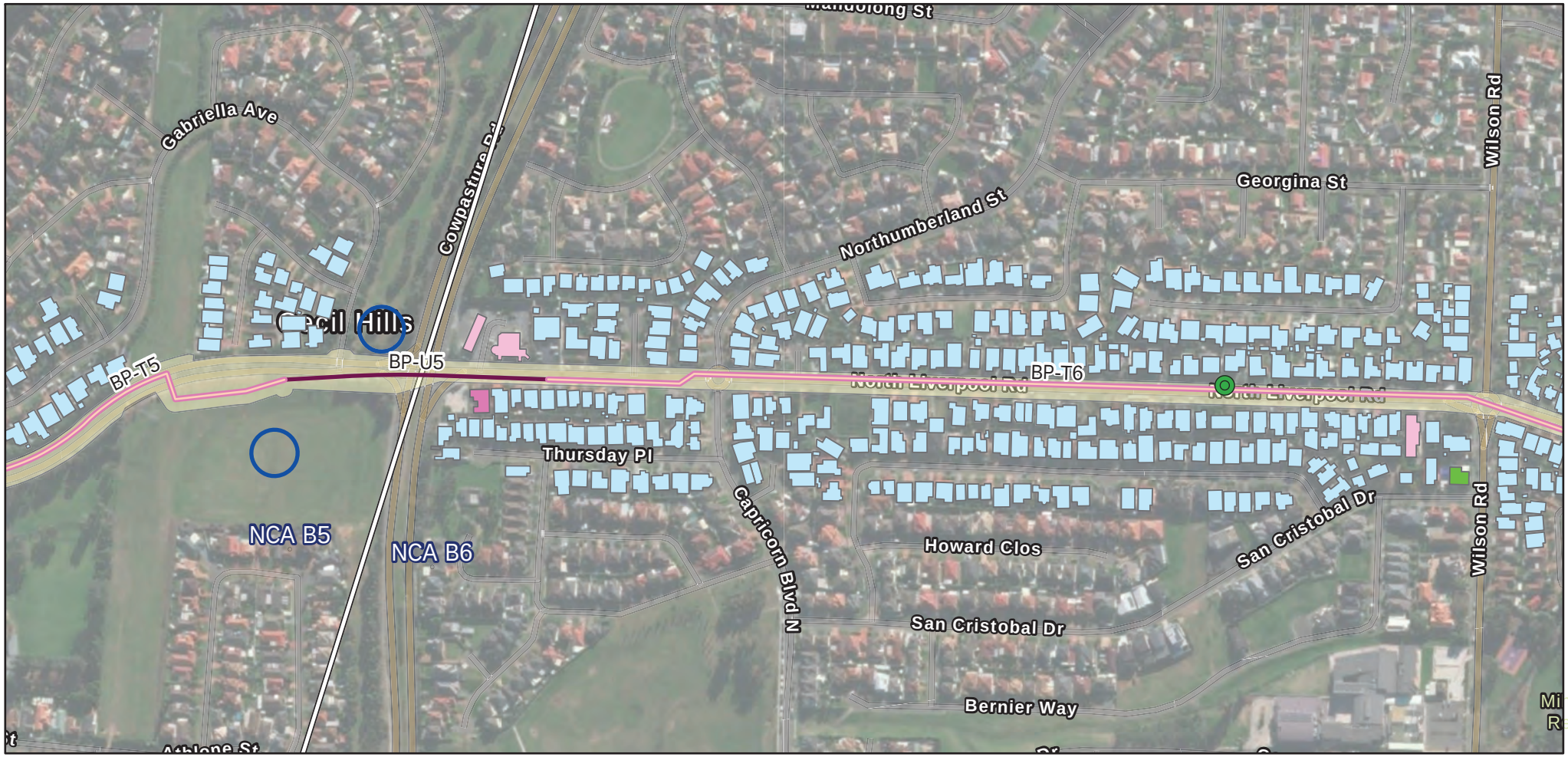

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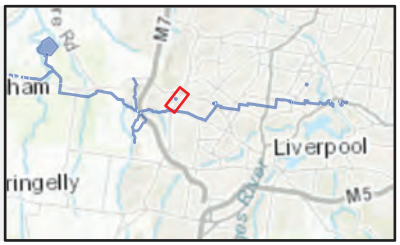

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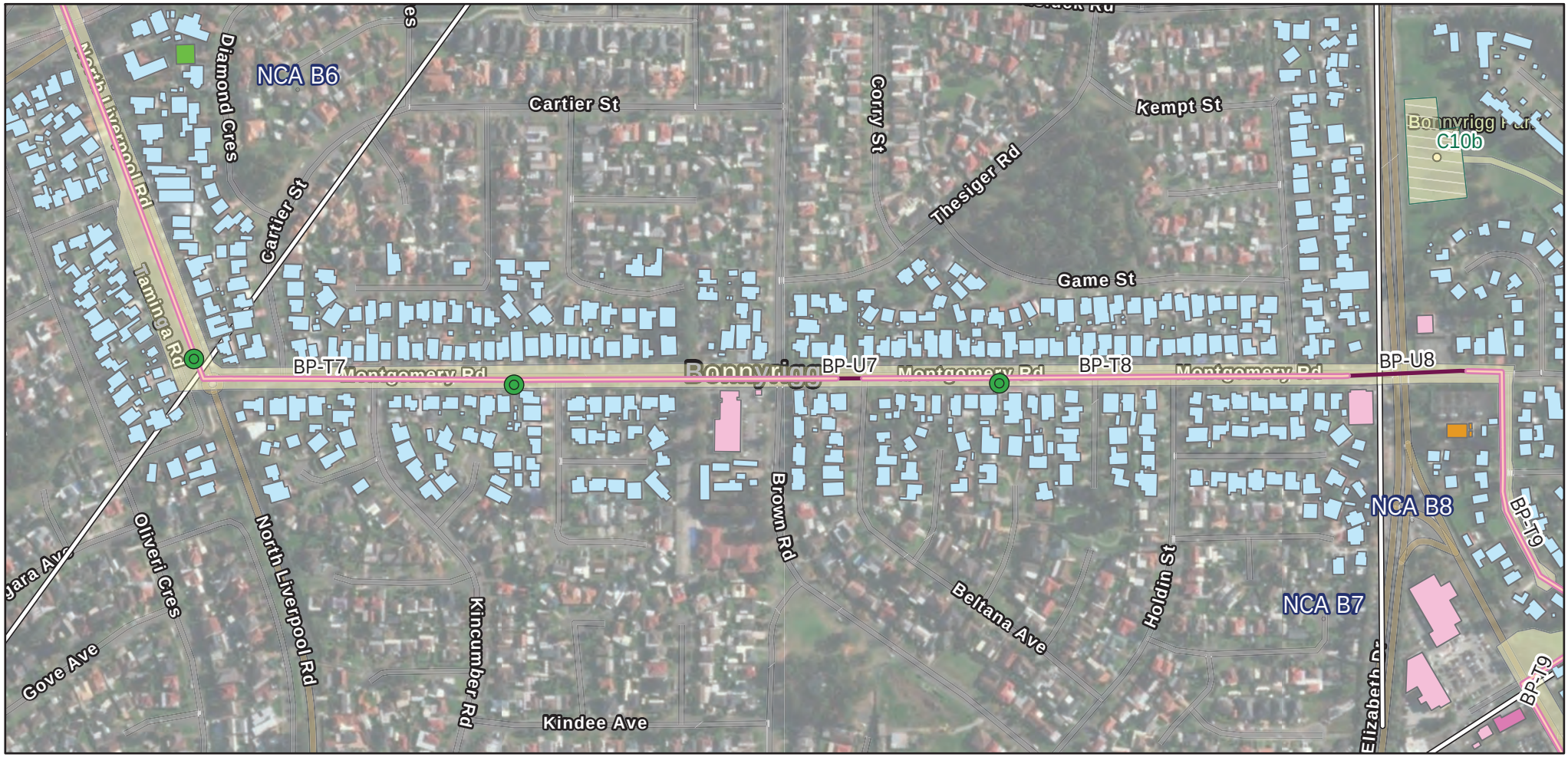

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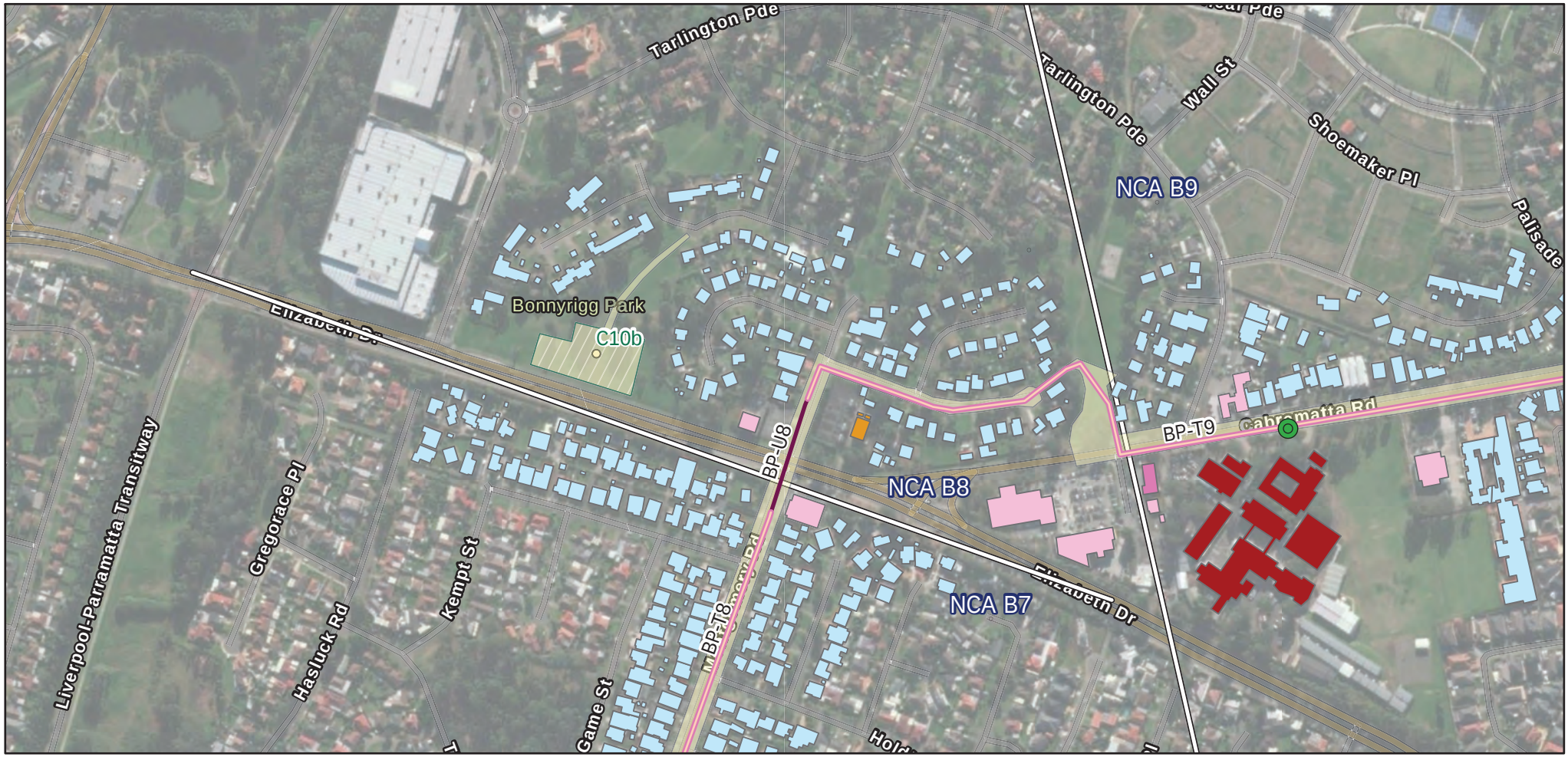

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Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

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Brine Pipeline

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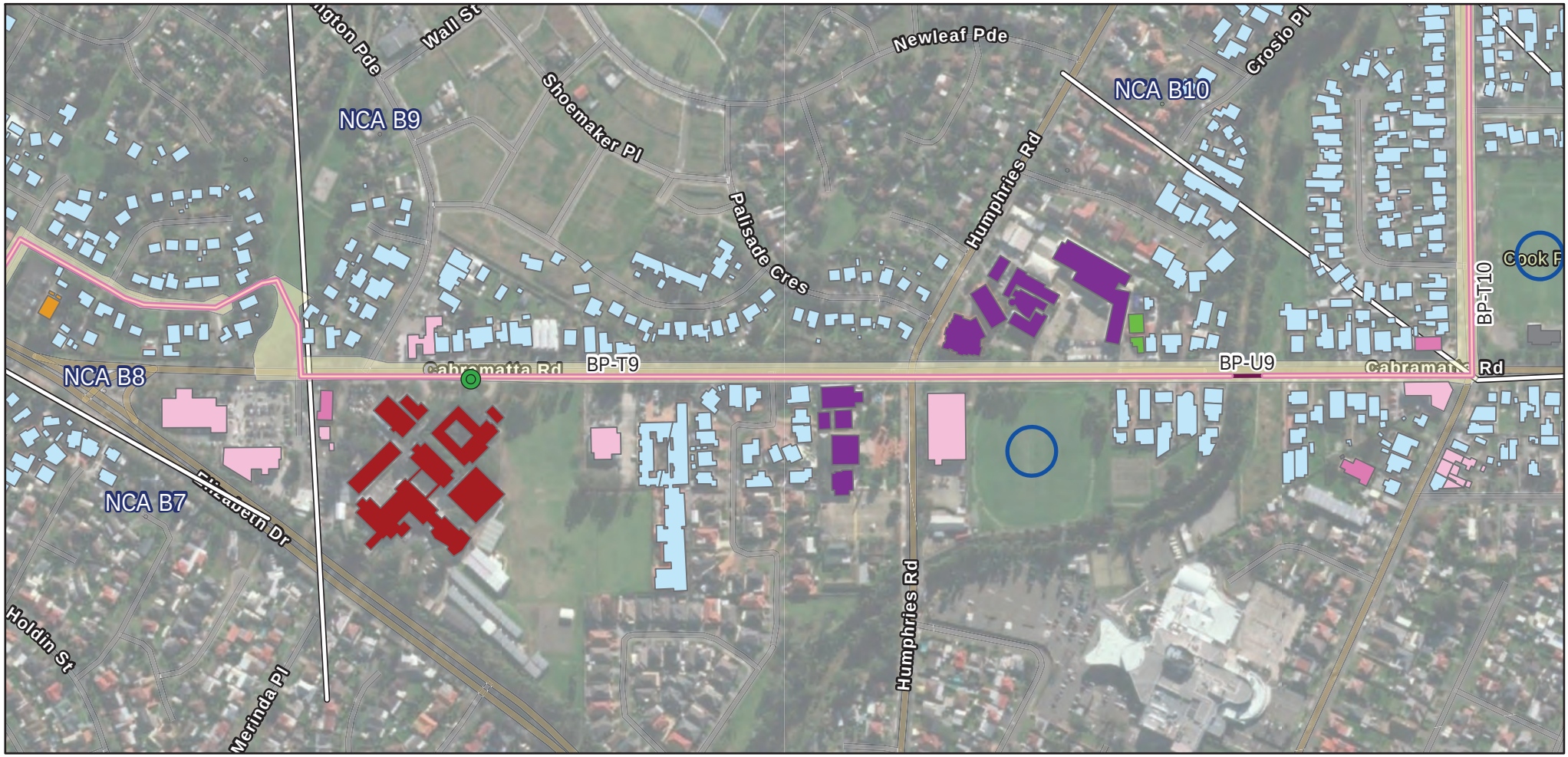

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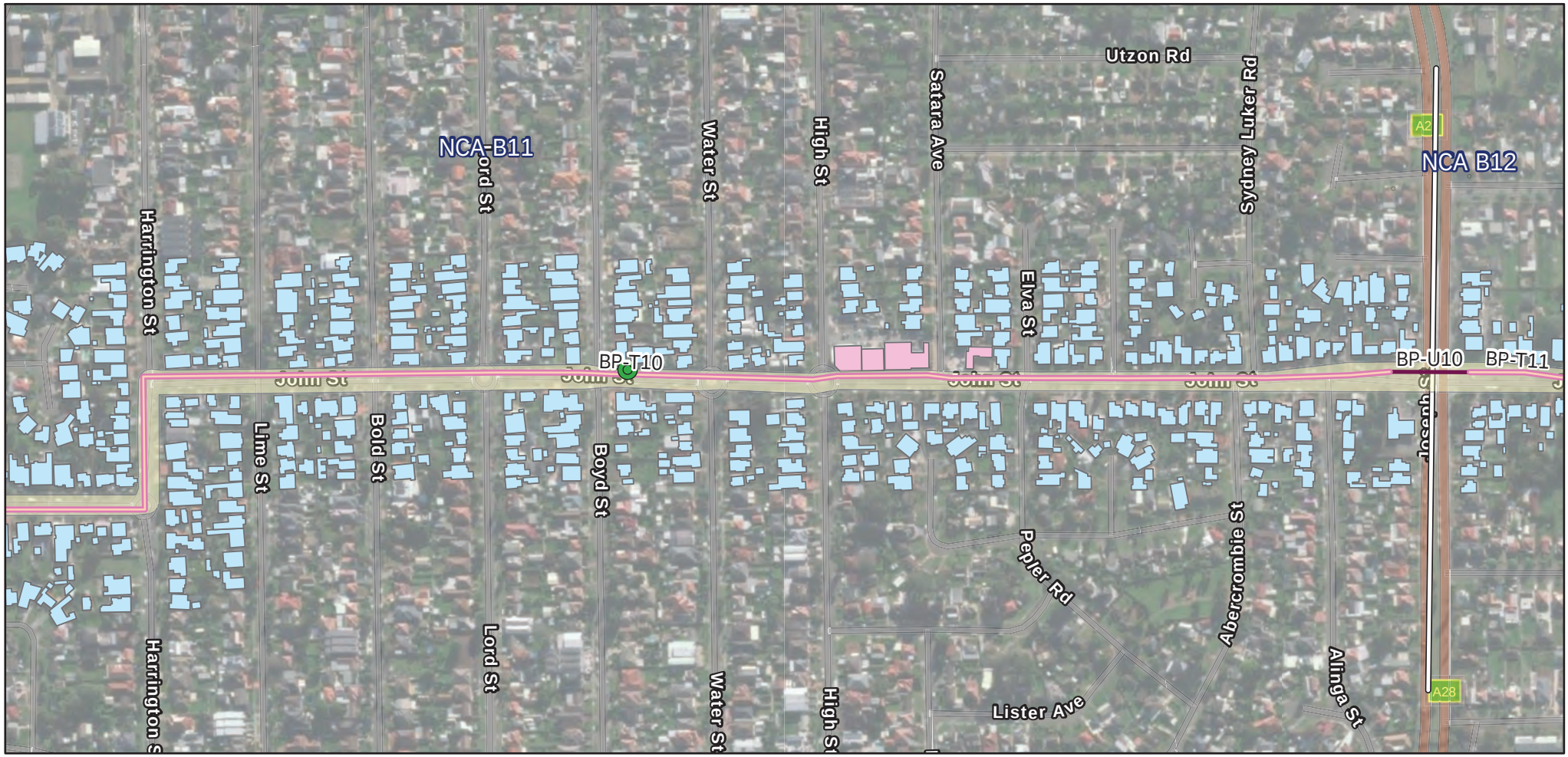

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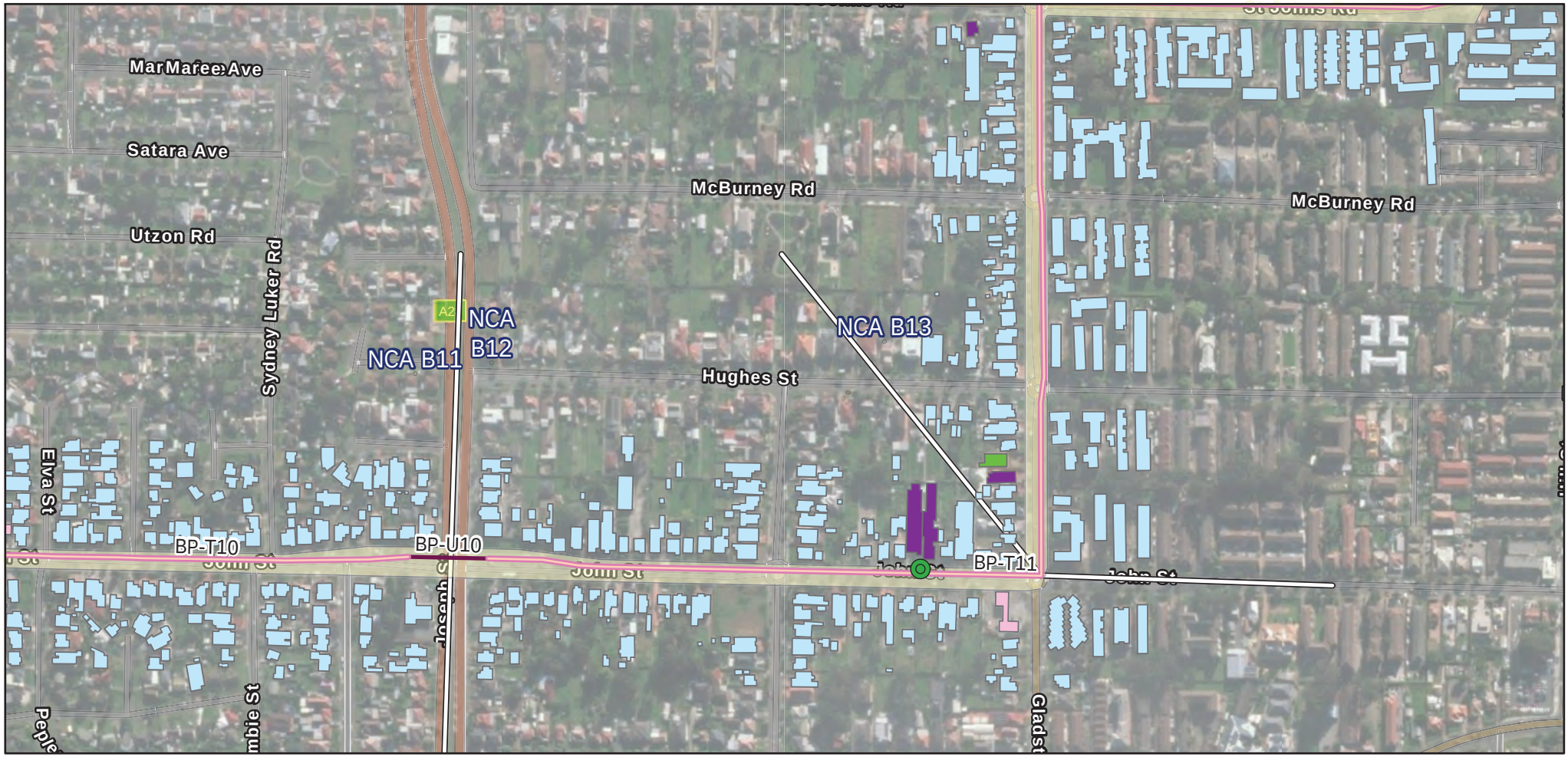

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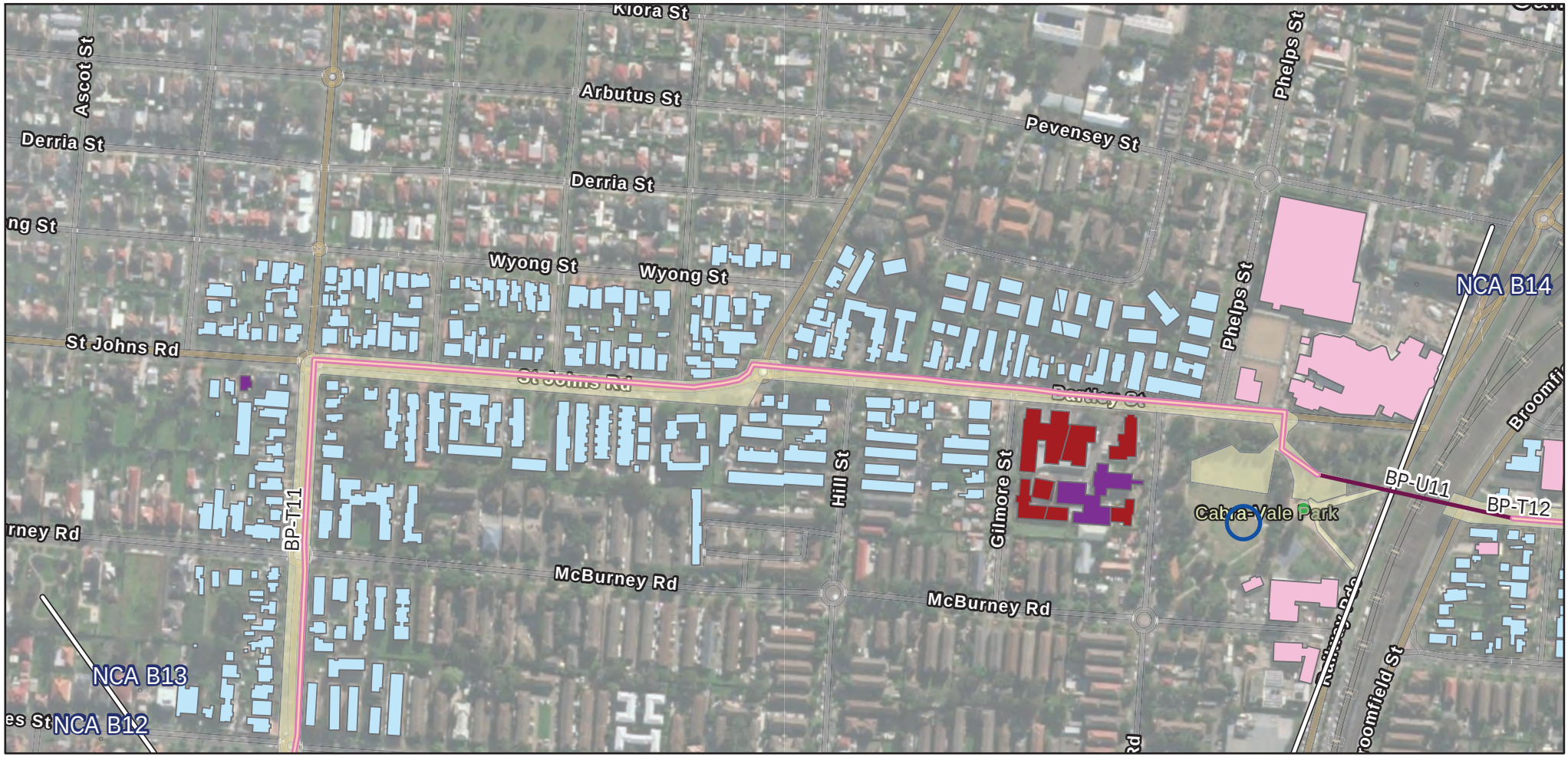

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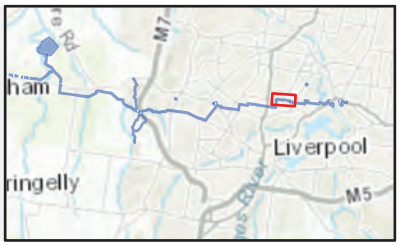
- EIS M12 Noise Monitoring Location



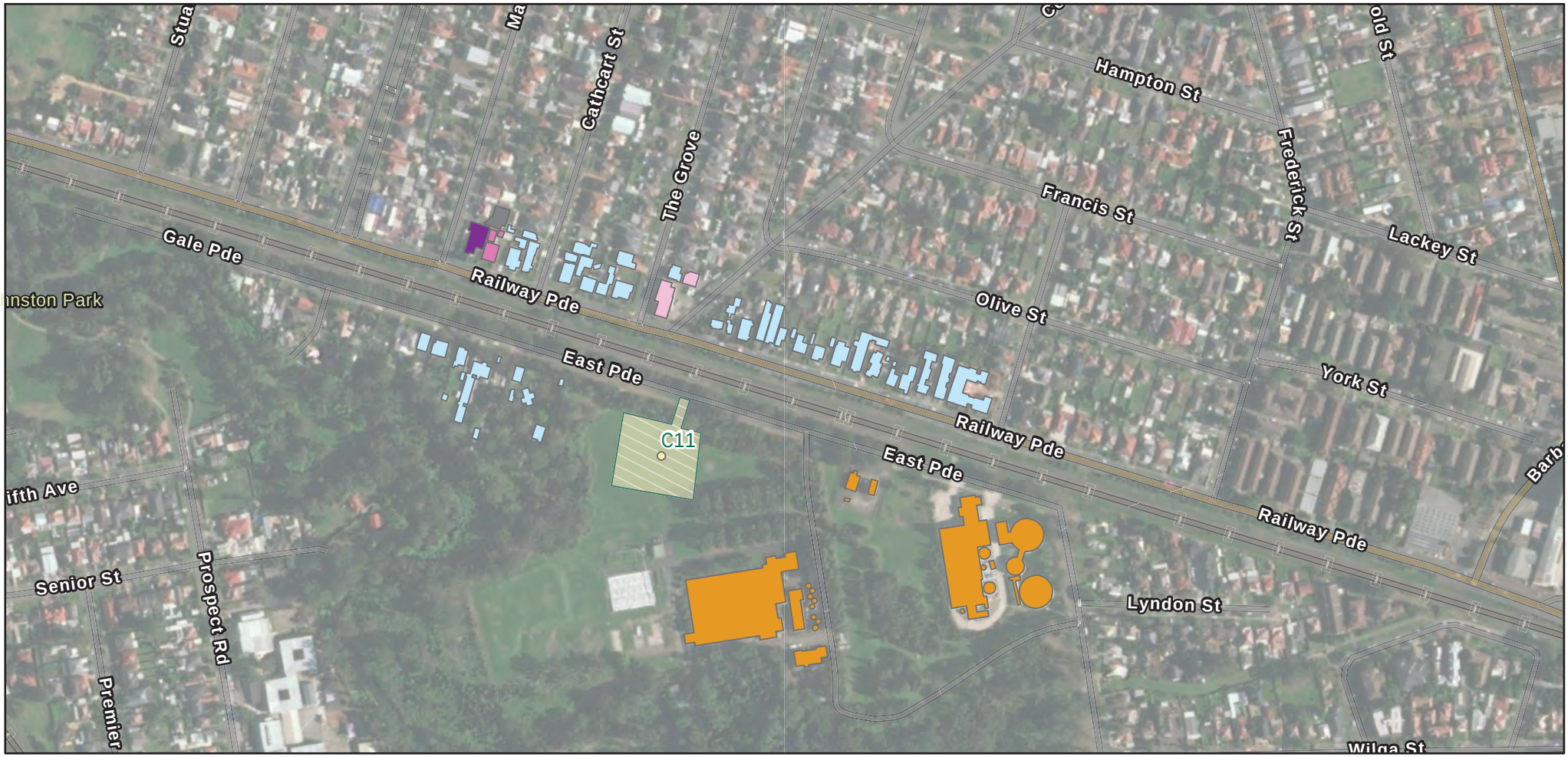
Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline



- Active Recreation
- Child Care
- Commercial/Business
- Industrial/Utilities
- Medical
- Passive Recreation
- Residential
- School
- Worship
- all other receivers
- Construction compound
- Heritage
- Upper canal
- Construction corridor
- NCA boundary
- Indicative valve location
- EIS M12 Noise Monitoring Location

Source: ESRI
Date: 30/03/2021

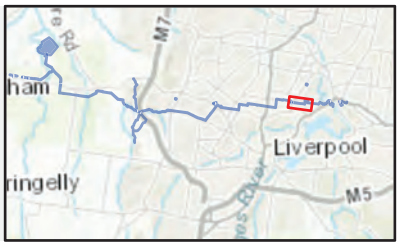
0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline

- Brine Pipeline
- Brine pipeline - Underbore
- Active Recreation
- Child Care
- Commercial/Business
- Industrial/Utilities
- Medical
- Passive Recreation
- Residential
- School
- Worship
- all other receivers
- Construction compound
- Heritage
- Upper canal
- Construction corridor
- NCA boundary
- Indicative valve location
- EIS M12 Noise Monitoring Location



Source: ESRI
Date: 30/03/2021

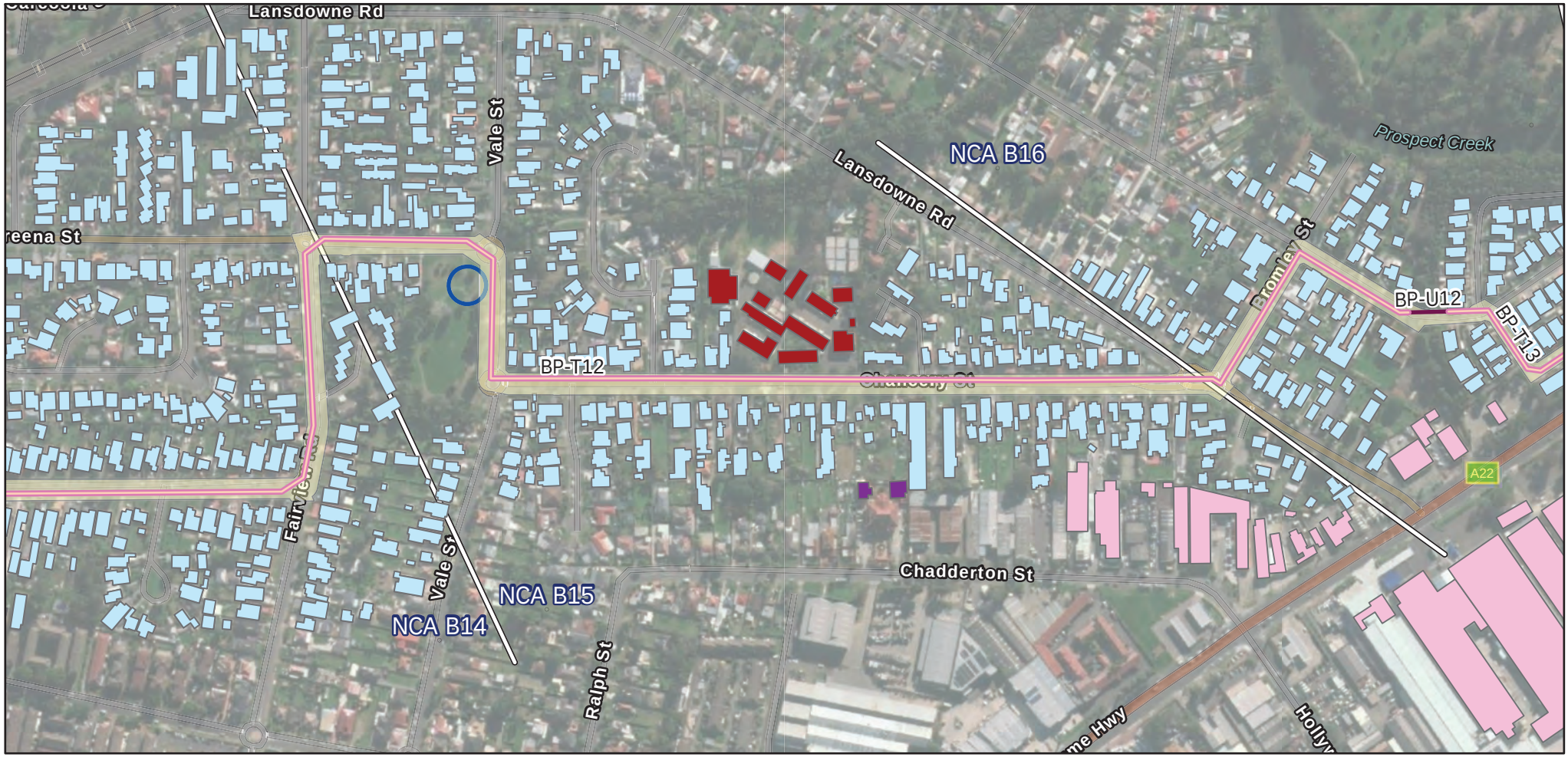
0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline

aurecon ARUP



- Brine Pipeline
- Brine pipeline - Underbore
- Active Recreation
- Child Care
- Commercial/Business
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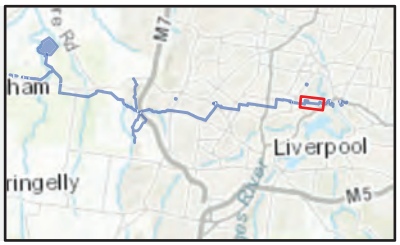

Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline

aurecon ARUP

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- Construction corridor
- NCA boundary
- Indicative valve location
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Source: ESRI
Date: 30/03/2021

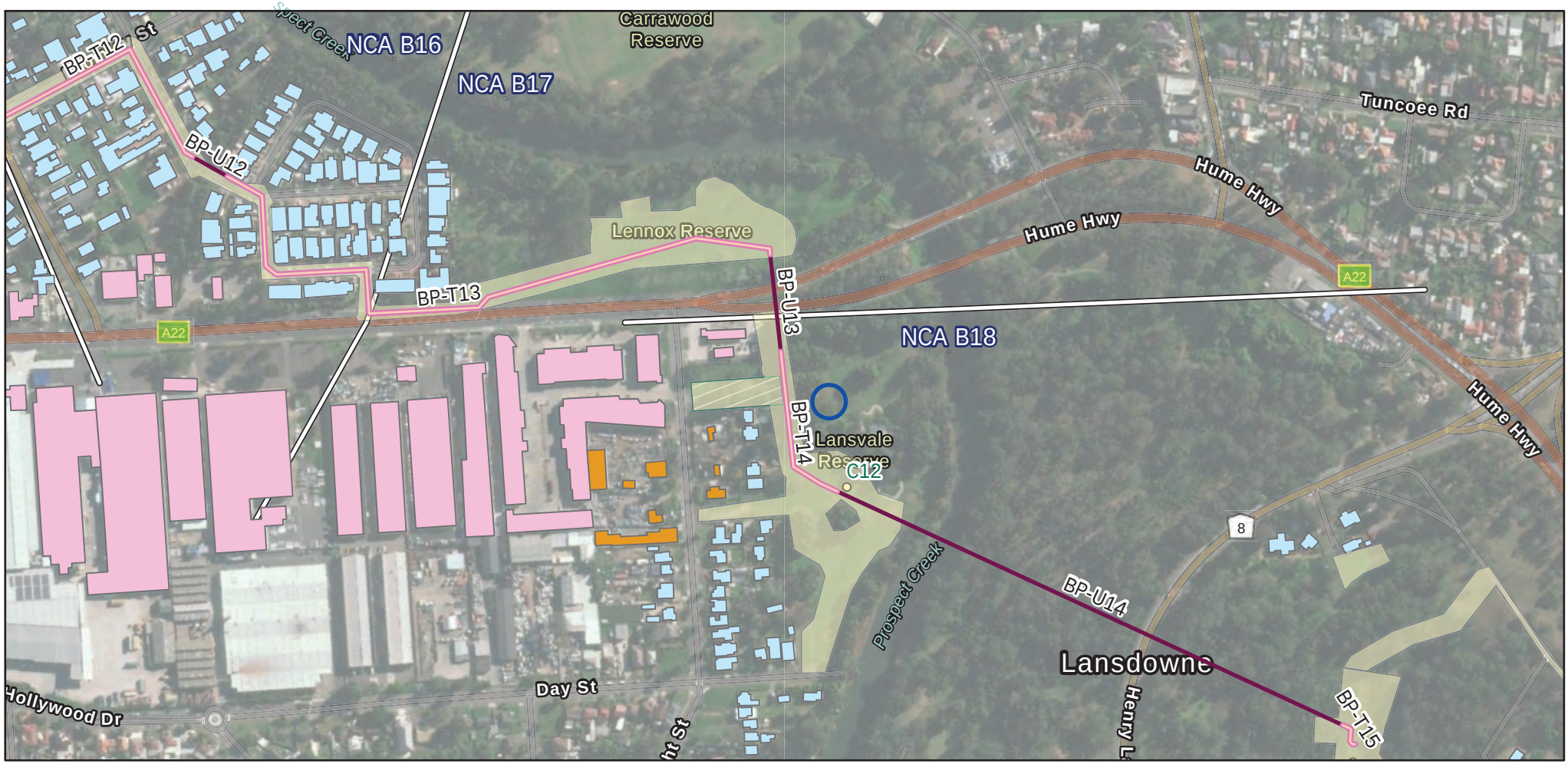
0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline

aurecon ARUP



- Brine Pipeline
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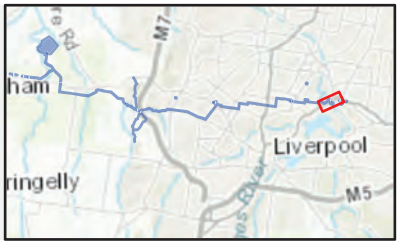


Source: ESRI
Date: 30/03/2021

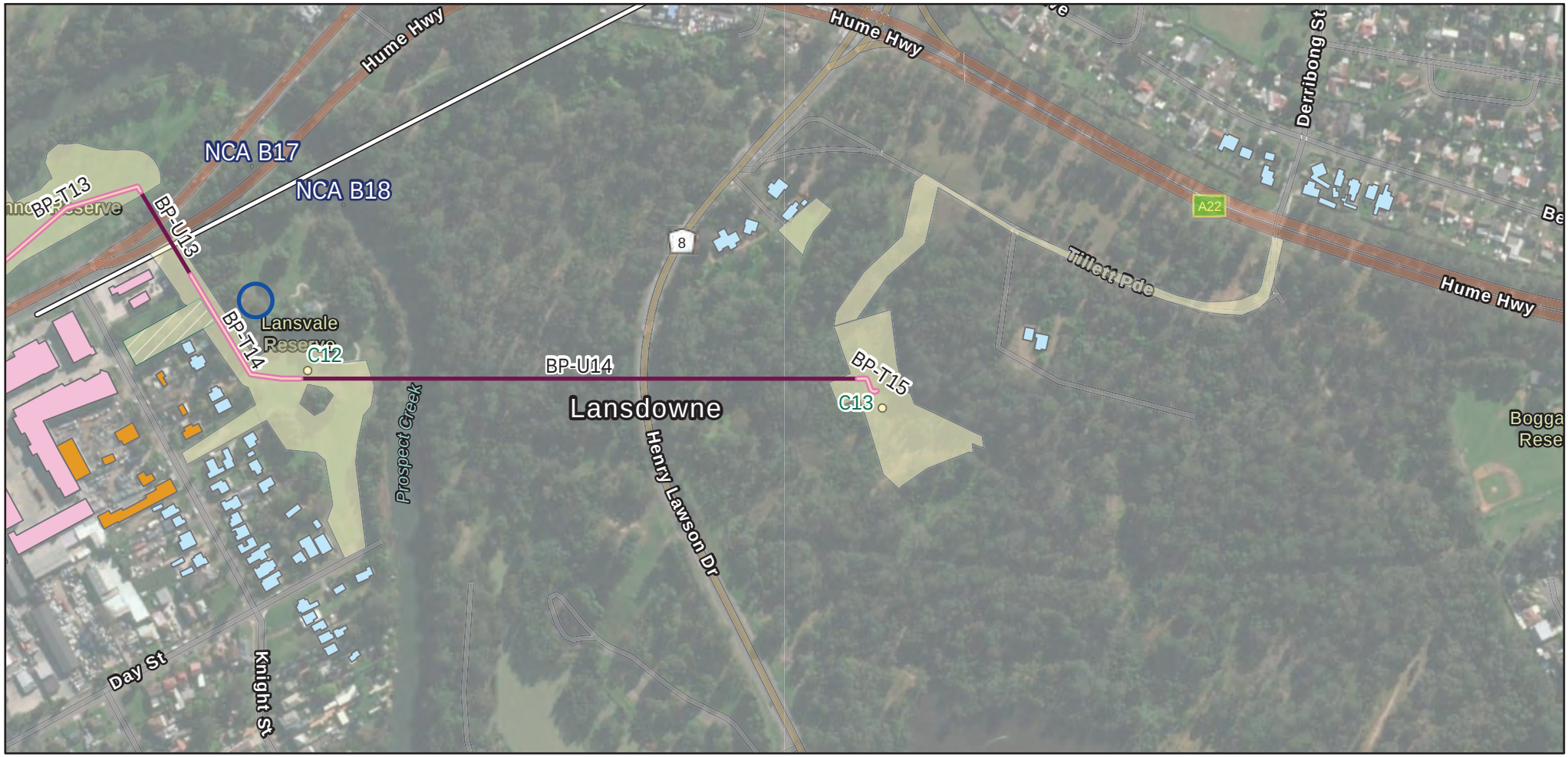
0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline

aurecon ARUP



- Brine Pipeline
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Source: ESRI
Date: 30/03/2021

0 100 200 Meters

Upper South Creek Advanced Water Recycling Centre **269002-AC04_v1**

Projection: MGA56 GDA94

Brine Pipeline

Appendix C

Background noise levels

For residential premises, the NML are determined based on measured background or estimated background for an area. For this preliminary assessment, reference has been made to long-term noise monitoring carried out as part of nearby infrastructure projects along with comparisons of typical background levels outlined in relevant standards and guidelines.

M12 monitoring data

Unattended background noise monitoring was conducted in June and July 2017 as part of the EIS for the M12 [13]. Monitoring was conducted at several locations along Elizabeth Drive near the proposed pipeline alignment and near the proposed Advanced Water Recycling Centre. Relevant monitoring locations for this assessment are shown in Appendix B and monitoring results are reproduced in Table 62.

Table 62: Background noise measurements from the EIS M12

M12 EIS Location ID	Address	Rating Background Noise Levels (RBL), dB(A)[1]				
		Morning shoulder	Day	Evening	Evening Shoulder	Night
L01	Adjacent to Toulouse Street, Cecil Hills	51	45	44	46	40
L02	Western Sydney Parklands, Cecil Hills	47	36	39	41	34
L03	1383 Elizabeth Drive, Kemps Creek	60	54	48	56	37
L04	1219 Mamre Road, Kemps Creek	54	48	46	52	37
L05	12-20 Salisbury Avenue, Kemps Creek	49	39	42	45	35
L06	203 Clifton Avenue, Kemps Creek	43	34	35	39	31
L07	740 Luddenham Road, Luddenham	46	40	36	42	31
L10	2828 The Northern Road, Luddenham	51	40	44	49	37
L11	15 m south of Elizabeth Dr – 2300 Elizabeth Drive, Badgerys Creek	57	46	40	51	31
L12	145 m south of Elizabeth Dr – 2300 Elizabeth Drive, Badgerys Creek	50	40	37	44	30
L13	20 m north of Elizabeth Dr – 1953-2109 Elizabeth Drive, Badgerys Creek	50	42	38	48	33

M12 EIS Location ID	Address	Rating Background Noise Levels (RBL), dB(A)[1]				
		Morning shoulder	Day	Evening	Evening Shoulder	Night
L14	50 m north of Elizabeth Dr – 1953-2109 Elizabeth Drive, Badgerys Creek	50	42	39	48	33
L15	150 m north of Elizabeth Dr – 1953-2109 Elizabeth Drive – Badgerys Creek	50	39	40	47	34

Notes:

1. Monitoring periods for the M12 EIS are based on extended construction hours:
    a. Morning shoulder is 6 am to 7 am Monday to Friday;
    b. Daytime is 7 am to 6 am Monday to Saturday and 8 am to 6 pm Sunday and Public Holidays;
    c. Evening is 7 pm to 10 pm Monday to Friday and 6 pm to 10 pm Saturday, Sunday and Public Holidays;
    d. Evening shoulder is 6 pm to 7 pm Monday to Friday;
    e. Night-time is 10 pm to 6 am Monday to Friday, 10 pm to 7 am Saturday and 10 pm to 8 am Sunday and Public Holidays.

The M12 EIS processed measured data in Table 62 in accordance with extended hours of construction. While those hours differ slightly from the NPfI assessment periods for evening and night-time (as they include evening shoulder period and morning shoulder period respectively), the evening and night-time RBL are not anticipated to vary significantly.

Typical background noise levels

Due to the extent and nature of the Project, the existing environment has not been quantified along the rest of the proposed alignment. Guidance to establish the background noise levels for the remaining of the alignment can be taken from AS 1055 [14] and Table 2.3 of the NPfI [1] which provides typical background noise levels for different area descriptions (Reproduced in Table 63 and Table 64).

Table 63: AS1055 Typical background noise levels for different areas

Area type	Description of area	Rating background level (RBL), dB(A)		
		Day	Evening	Night
Rural	Areas with negligible transportation	40	35	30
Suburban/Urban	Areas with low density transportation	45	40	35
Urban	Areas with medium density transportation OR some commerce or industry	50	45	40
Urban/Industrial	Areas with dense transportation OR with some commerce or industry	55	50	45

Table 64: Extract from Table 2.3 of the NPfI including typical existing background noise levels and description of the typical acoustical environment

Receiver category	Typical planning zoning - standard instrument	Description	Typical existing Rating background level (RBL), dB(A)		
			Day	Evening	Night
Rural Residential	RU1 – Primary production RU2 – Rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Rural – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented in column 3 due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.	< 40	< 35	< 30
Suburban residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Suburban – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area has the following characteristics: evening ambient noise levels defined by the natural environment and human activity.	< 45	< 40	< 35

Receiver category	Typical planning zoning - standard instrument	Description	Typical existing Rating background level (RBL), dB(A)		
			Day	Evening	Night
Urban residential	R1 – general residential R4 – High density residential B1 – neighbourhood centre (Boarding houses and shop-top housing) B2 – local centre (Boarding houses) B4 – mixed use	Urban – an area with an acoustical environment that: Is dominated by "Urban hum" or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources Has through-traffic with characteristically heavy and continuous traffic flows during peak periods Is near commercial districts or industrial districts Has a combination of the above.	> 45	> 40	> 35

Background noise levels adopted for this assessment

Residences near the proposed **Advanced Water Recycling Centre**

There are scattered residences located all around the AWRC. L06 is representative of the existing environment for receivers located directly to the north west of the AWRC (Twin Creeks residential receivers), to the east of the AWRC (Mamre Road residential receivers), to the south east of the AWRC (Kemps Creeks residential receivers) and to the south west of the AWRC (Badgerys creek receivers).

Residences along the proposed **Treated water / environmental flow pipe alignment**

Residences along the proposed treated water pipe alignment are mainly scattered rural residential receivers. L14 was measured at approximately 50 m from Elizabeth drive and was considered to be representative of the receivers in the area and will be used for this assessment as representative of the receivers in the area along Elizabeth Drive. Attended measurement at this location (conducted during daytime) reported that ambient noise environment was dominated at the time of measurement by road traffic noise from Elizabeth Drive.

Background for receivers located along the Northern Road, Park Road and Silverdale road has been estimated based on AS1055, Table 2.3 of the NPfI and M12 measurement L14.

Comparing measured data from the M12 EIS location L14 and typical background noise levels, while the land use might be best described as rural residential, the acoustic environment corresponds to the suburban residential typical background as defined in Table 64, most likely due to the proximity of Elizabeth Drive.

Receivers along the remaining of the alignment along Northern Road, Park Road and Silverdale Road are also identified as scattered rural residential but likely to fall into the category suburban residential due to the proximity of the Northern Road, Park Road, Silverdale Road, attracting the AS1055 typical suburban criteria. Receivers near Wallacia area would also fall into the suburban residential category.

While using the typical suburban residential background would be a reasonable approach, L14 background measurements have been adopted in the assessment for all residential receivers as it provides a conservative approach.

Residences along the proposed **Brine water pipe alignment**

Residences along the first part of the brine water pipe alignment are scattered residential (from the AWRC to the M7). L05 and L02 correlated with Table 63, have been used as a basis to establish NMLs.

For receivers along local roads (such as Stirling Street, Frederick Road, Montgomery Road, Edensor Road, Monash Place, Hebblewhite place, Harrington Street, John Street, Bromley Street, Curtin Street, Fairview Road, Beckenham Street and Willowbank Crescent), the suburban/urban category in Table 63 has been adopted.

For receivers along roads with medium density transportation (such as North Liverpool Road, Meadows Road, Gladstone Street, St Johns Road, Barley Street, Bareena Street, Chancery Street) the urban category in Table 63 has been adopted.

For receivers along roads with high dense transportation (such as Cowpasture Road, Elizabeth Drive, along Cabramatta Road West, along the Hume Highway the urban/industrial category in Table 63 has been used.

Note that for receivers located on lower order road at the intersection with higher order road, the background might be higher.

Re-monitoring of background noise levels

Where specific background monitoring has not been carried out, and accurate background noise is required to determine the appropriate noise mitigation and management measures to be put in place, background noise should be conducted. Example of when monitoring could be reconducted are as follows:

- when OOHW are proposed to be conducted more than 2 consecutive nights in a week
- At the discretion of the contractor where it is believed that background noise levels are higher than estimated.

Appendix D

Operational noise modelling data

Table 65: Internal sound pressure levels within buildings

Item		Broadband $dBL_{Aeq15minute)}$	Octave Band Centre Frequency Hz (dB)							
			63	125	250	500	1 k	2 k	4 k	8 k
Blower Building		85	104	82	79	84	81	66	57	55
Outloading Building		84	83	89	85	82	76	74	71	69
AWTP Building		79	90	72	73	74	75	71	66	59
Transfer Pump Station	Pump Room	87	87	91	85	81	83	80	75	67
	Fan Room	93	92	97	93	89	88	86	81	80

Table 66: External building surfaces – Sound power per unit area – L_w/m^2

Building	No. of buildings		Façade	Surface	Surface area (m^2)	Broadband $dBL_{Aeq(15minute)}$[1]	Octave Band Centre Frequency Hz (dB)[1]							
	Stage 1	Stage 1 + Future Stages					63	125	250	500	1 k	2 k	4 k	8 k
Blower Building	1	2	Façade – short side 1	Metal Cladding	67	58	83	56	53	50	45	30	21	19
			Façade – long side	Metal Cladding	205	58	83	56	53	50	45	30	21	19
			Façade – short side 2	Metal Cladding	67	58	83	56	53	50	45	30	21	19
			Façade – (louvre façade)	Metal Cladding	186	58	83	56	53	50	45	30	21	19

Building	No. of buildings		Façade	Surface	Surface area (m^2)	Broadband $dBL_{Aeq(15minute)}$[1]	Octave Band Centre Frequency Hz (dB)[1]							
	Stage 1	Stage 1 + Future Stages					63	125	250	500	1 k	2 k	4 k	8 k
			Louvres	Open	18 (combined)	79	98	76	73	78	75	60	51	49
			Roof	Metal deck	379	66	89	64	58	63	59	40	28	26
Outloading Building	1	2	Façade – short side 1	Metal cladding	222	54	62	63	59	48	40	38	35	33
			Opening -short side 1	Open	23	78	77	83	79	76	70	68	65	63
			Façade – long side 1	Metal cladding	793	54	62	63	59	48	40	38	35	33
			Façade – short side 2	Metal cladding	184	54	62	63	59	48	40	38	35	33
			Opening – short side 2	Open	22	78	77	83	79	76	70	68	65	63
			Façade – long side	Metal cladding	798	54	62	63	59	48	40	38	35	33
			Roof	Metal deck	274	62	68	71	64	61	54	48	42	40
AWTP Building	1	2	Façade – long side 1	Metal cladding	349	47	69	46	47	40	39	35	30	23
			Façade – short side 1	Metal cladding	470	47	69	46	47	40	39	35	30	23
			Façade – long side 2	Metal cladding	353	47	69	46	47	40	39	35	30	23
			Façade – short side 2	Metal cladding	468	47	69	46	47	40	39	35	30	23

Building	No. of buildings		Façade	Surface	Surface area (m^2)	Broadband $dBL_{Aeq(15minute)}$[1]	Octave Band Centre Frequency Hz (dB)[1]							
	Stage 1	Stage 1 + Future Stages					63	125	250	500	1 k	2 k	4 k	8 k
			Roof	Metal deck	4673	57	75	54	52	53	53	45	37	30
Transfer Pump Station	1	1	Pump Room Façade - South	Blockwork	451	36	42	50	39	27	21	11	0	0
			Doors – South	Hollow Metal	30	53	69	64	51	45	45	47	33	26
			Exhaust fan outlet – South	Acoustic louvre	37	82[2]	86	85	85	78	74	69	68	73
			Pump Room Façade - East	Blockwork	144	36	42	50	39	27	21	11	0	0
			Fan Room Façade - East	Blockwork	22	43	48	56	48	35	26	16	5	0
			Doors – East	Hollow Metal	2	53	69	64	51	45	45	47	33	26
			Pump Room Façade - North	Blockwork	325	36	42	50	39	27	21	11	0	0
			Fan Room Façade - North	Blockwork	109	43	48	56	48	35	26	16	5	0
			Pump Room Inlets – North	Acoustic louvre	40	61	75	73	64	54	53	47	44	41
			Fan Room inlet – North	Acoustic louvre	5	68	80	79	72	62	58	53	50	54
			Pump Room Façade - West	Blockwork	137	36	42	50	39	27	21	11	0	0
			Fan Room Façade - West	Blockwork	20	43	48	56	48	35	26	16	5	0

Building	No. of buildings		Façade	Surface	Surface area (m^2)	Broadband $dBL_{Aeq(15minute)}$[1]	Octave Band Centre Frequency Hz (dB)[1]							
	Stage 1	Stage 1 + Future Stages					63	125	250	500	1 k	2 k	4 k	8 k
			HV VSD Room Doors – West	Hollow Metal	4	53	69	64	51	45	45	47	33	26
			Fan Room Doors - West	Hollow Metal	2	59	75	69	60	53	49	53	40	38
			HV VSD Room Louvres – West	Acoustic louvre	8	61	75	73	64	54	53	47	44	41
			Transfer Pump Room - Roof	Metal deck	1800	65	72	73	64	60	61	54	46	38
			Fan Room - Roof	Metal deck	49	71	77	79	72	68	66	60	52	51

Notes:

1. Noise levels consider transmission loss of elements (Refer to Table 15)
2. Lw for entire outlet (not per m^2)

Table 67: Sound Power Levels used in the model – others noise sources

Item	Quantity		Location	Horsepower (kW)	RPM	Broadband $dBL_{Aeq(15minute)}$	Octave Band Centre Frequency Hz (dB)							
	Stage 1	Stage 1 + Future Stages					63	125	250	500	1 k	2 k	4 k	8 k
Permeate pump	12	24	Membranes	75	975	95	86	87	89	89	92	89	85	79
Backpulse pump	2	4	AWTP Balance Tank	11	1500	86	76	77	79	79	82	79	75	69
Extraction fan	2	4	Odour Control	90	-	92	94	98	97	89	84	79	74	74

Item	Quantity		Location	Horsepower (kW)	RPM	Broadband $dBL_{Aeq(15minute)}$	Octave Band Centre Frequency Hz (dB)							
	Stage 1	Stage 1 + Future Stages					63	125	250	500	1 k	2 k	4 k	8 k
Dewatering / centrifuge feed pump	2	4	Feed Averaging Tank	18.5	300	86	77	78	80	80	83	80	76	70
Digester FAT mixing centrifugal pump	1	2	Feed Averaging Tank	15	1500	87	78	79	81	81	84	81	77	71
Digester feed pump	2	4	Feed Averaging Tank	15	300	85	76	77	79	79	82	79	75	69
TWAS pump	1	2	Thickening and Poly	18.5	300	86	77	78	80	80	83	80	76	70
Sludge transfer pump	2	4	Digesters	11	300	84	74	75	77	77	80	77	73	67
Mixing pumps	4	8	Digesters	90	1500	95	86	87	89	89	92	89	85	79
Heating pumps	4	8	Digesters	22	1500	89	79	80	82	82	85	82	78	72
Fill and spill transfer pumps	2	4	Digesters	22	300	87	77	78	80	80	83	80	76	70
Recuperative thickening feed pump	2	4	Digesters	18.5	300	86	77	78	80	80	83	80	76	70
Exhaust (with silencer)	1	2	Co-gen	-	-	96	98	96	94	89	86	89	90	88
Engine (in enclosure)	1	2	Co-gen	-	-	96	86	97	94	90	85	87	91	88

Item	Quantity		Location	Horsepower (kW)	RPM	Broadband $dBL_{Aeq(15minute)}$	Octave Band Centre Frequency Hz (dB)							
	Stage 1	Stage 1 + Future Stages					63	125	250	500	1 k	2 k	4 k	8 k
Flare	1	2	Co-gen	-	-	95	73	80	86	90	89	89	84	89
RO Feed Pump	8	16	AWTP	200	2985	99	89	90	92	92	95	92	88	82
UF Feed Pump	8	16	AWTP	150	975	96	87	88	90	90	93	90	86	80
Reclaimed effluent pump	2	4	Tank	37	1500	91	82	83	85	85	88	85	81	75
Inverter (0.55m x 1.6m x 0.8m)	50	100	Within the AWRC site	-	-	84	74	73	75	73	74	81	66	58
Weir	2	2	Site Boundary	-	-	76	65	67	70	71	71	69	68	68
Reclaimed effluent pump	4	8	Tank	55	1500	93	83	84	86	86	89	86	82	76
Duct opening	8	16	Blower Building	-	-	71	90	68	65	70	67	52	43	41

Appendix E

Equipment sound power levels

All plant and equipment used for the construction of the Project should have operating sound power or sound pressure levels below or equal to the allowable noise levels presented in Table 68. Those noise levels have been compiled from a selection of field measurements conducted between 2004 and 2008 of plant and equipment operating on construction projects throughout NSW and are therefore considered to be representative of plant and equipment sound power levels which are readily achieved by current plant and equipment normally used on construction sites.

Plant and equipment with higher Sound power levels than those presented in Table 68 would be deemed to be emitting an excessive level of noise and should not be permitted to operate on construction sites.

Table 68: Recommended Equipment Sound Power Levels - L_w

Equipment	Lw (dB) L_{Aeq}	Penalty (dB)	Data reference
Asphalt Paver	112		AS2436
Angle Grinder	108		BS5228
Asphalt Rotomill	111		AS2436
Backhoe	108		AS2436
Backhoe (with Auger)	111		AS2436
Bulldozer	114		AS2436
Bulldozer (CAT D9)	116		CNVS
Bulldozer (CAT D10)	121		CNVS
Circular Saw (Hand-held)	115		BS5228
Chainsaw - petrol	114		CNVS
Compactor	115	5	AS2436
Compressor	110		AS2436
Concrete Agitator Truck	111		AS2436
Concrete Pencil Vibrator	105	5	BS5228
Concrete Pump	106		AS2436
Concrete Pump Truck	113		AS2436
Concrete Saw	122		AS2436
Concrete Vibratory Screed	115		AS2436
Crane (Franna)	98		CNVS
Crane (Mobile)	113		AS2436
Crane (Tower)	105		AS2436

Equipment	Lw (dB) L_{Aeq}	Penalty (dB)	Data reference
Crane (Truck Mounted)	108		CNVS
Elevated Work Platform (Cherry Picker)	105		AS2436
Excavator	117		AS2436
Excavator (Idling) (25t)	95		BS5228
Excavator (3t)	90		CNVS
Excavator (6t)	95		CNVS
Excavator (6t) + hydraulic hammer	115	5	CNVS
Excavator (10t)	100		CNVS
Excavator (10t) + hydraulic hammer	118	5	CNVS
Excavator (15t)	100		BS5228
Excavator (25t)	95		BS5228
Excavator (30t)	102		BS5228
Excavator (30t) + hydraulic hammer	122	5	CNVS
Excavator (40t)	106		BS5228
Filtration Unit	109		AS2436
Forklift	106		AS2436
Fuel Tanker Pump	100		BS5228
Generator (Diesel)	113		AS2436
Grader	115		AS2436
Grit Blaster (Grit & Nozzle Air Noise)	129		AS2436
Hand Tools (Electric)	110		AS2436
Hand Tools (Pneumatic)	117		AS2436
Hydraulic Power Pack	106		BS5228
Jack Hammer	121	5	AS2436
Lighting Tower	80		CNVS
Lighting - Daymakers	98		CNVS
Light Vehicle - 4WD	103		CNVS
Line Marking Truck	108		CNVS
Loader (Front-end) (23t)	112		CNVS
Loader - Skidsteer (Bobcat) (1/2t)	107		CNVS
Loaders - Skidsteer (Bobcat) (1t)	110		CNVS
Loader - Tracked (0 - 50kW)	115		CNVS
Loaders - Tracked (200 -300kW)	121		CNVS

Equipment	Lw (dB) L_{Aeq}	Penalty (dB)	Data reference
Lorry with Lifting Boom	105		BS5228
Machine Mounted Hydraulic Drill	115	5	AS2436
Machine Mounted Percussive Drill	116	5	AS2436
Machine Mounted Pneumatic Drill	121	5	AS2436
Micro tunnelling/directional drilling	112		Based on Lw for a piling rig - bored
Mulcher (Chipper)	116		CNVS
Pavement Laying Machine	114		CNVS
Pavement Profiler	117		CNVS
Piling (Bored)	112		CNVS
Piling (Impact Sheet)	147	5	BS5228
Piling (Vibratory)	133		AS2436
Piling rig (Impact)	129	5	CNVS
Pneumatic Spade	115		BS5228
Pulveriser (mounted on Excavator)	108		AS2436
Rattle Gun (hand-held)	104		CNVS
Road Lorry (Empty)	111		BS5228
Road Lorry (Full)	108		BS5228
Rigid Road Lorry	110		BS5228
Road Sweeper	104		BS5228
Rock Breaker	118		AS2436
Roller (Smooth drum)	107		CNVS
Roller (Large Pad Foot)	109		CNVS
Roller (Vibrator)	109	5	CNVS
Scraper	116		AS2436
Sideboom/Pipe layers	108		Based on Lw for a crane
Slurry management equipment	96		Based on Lw for a water pump (Electric)
Spreader	95		AS2436
Trenching Machine (25kW)	105		BS5228
Truck	107		AS2436
Truck (Dump)	117		AS2436
Truck (Road Truck/Truck & Dog)	108		CNVS
Truck (Vacuum)	109		CNVS
Truck (Water Cart)	108		AS2436

Equipment	Lw (dB) L_{Aeq}	Penalty (dB)	Data reference
Vehicle (Light Commercial e.g. 4WD)	111		AS2436
Water Pump	93		BS5228
Water Pump (Diesel)	106		BS5228
Water Pump (Electric)	96		BS5228
Water Jet Pump	91		BS5228
Wrench (Impact)	111	5	CNVS
Welder	110		AS2436

Note that the penalty is to be applied to the sound power level Lw as the equipment is characterised as containing special audible characteristics.

To establish sleep disturbance impacts, in lieu of plant specific noise level data, the L_{max} level may be estimated by adding 8 dBA to the Lw listed in Table 68. Where OOHW work is proposed for more than two consecutive nights in a week, then L_{max} data should be justified with plant specific data.