11 Social and amenity impacts

This chapter assesses the project's social and amenity impacts, including on air quality, noise and vibration, landscape character and visual impact, traffic and transport, human health and hazards, and socio-economics.

11.1 Air quality

This section describes the existing air quality and meteorology near the project and the potential air quality impacts during construction and operation. It provides an overview of the key findings of the detailed Air Quality Impact Assessment (AQIA) (Jacobs, 2021) included in Appendix R.

Air quality impact summary

The project has the potential to generate air quality impacts during construction and operation but the significance of these is expected to be low.

During construction, dust may be generated, for short periods of time, from earthworks at the AWRC site and along the pipeline alignments. Standard construction management measures for dust control can effectively manage these impacts.

Pipeline operation is expected to generate negligible air quality impacts, so the focus of the operational assessment is on the AWRC site. During AWRC operation, potential air quality impacts arise from odours (generated by wastewater treatment) and oxides of nitrogen (generated by combustion within the co-generation unit).

AWRC design includes an odour control unit to treat odorous air. Modelling of odour releases completed in accordance with NSW Environment Protection Authority (EPA) guidelines shows that the project can meet EPA odour criteria at the AWRC site boundary and at the nearest sensitive receivers. Modelling of nitrogen dioxide also shows that EPA criteria can be met at the AWRC boundary and nearest sensitive receivers.

11.1.1 Relevant Secretary's Environmental Assessment Requirements

Table 11-1 lists the Secretary's Environmental Assessment Requirements (SEARs) relevant to air quality and where in this section they are addressed.

Table 11-1 Project SEARs relating to air quality impacts

SEARs	EIS section where requirement addressed
40. An air quality impact assessment (AQIA) for construction and operation of the project in accordance with the current guidelines.	Appendix R
41. The Proponent must ensure the AQIA also includes the following: a) demonstrated ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Clean Air) Regulation (2010)	Sections 11.1.2, 11.1.6 and Appendix R
b) a cumulative local and regional air quality impact assessment, including consideration of the impacts associated with cogeneration of energy	Sections 11.1.5 to 11.1.8

11.1.2 Methodology and assumptions

The methodology for the air quality assessment involved:

- defining the existing air quality environment (as described in section 11.1.3)
- identifying the pollutants likely to be emitted during the construction and operation of the project and the relevant air quality criteria against which the project is to be assessed
- developing a meteorological model for the Advanced Water Recycling Centre (AWRC) site, which is representative of the air shed. The pipelines will have negligible air quality impacts, so are not subject to detailed modelling
- modelling the identified pollutants generated by operation of the AWRC combined with background levels and representative meteorology to assess potential impacts.

These steps were undertaken in accordance with the requirements of the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Approved Methods) (NSW Environment Protection Authority (NSW EPA), 2016) as outlined in Appendix R. Different approaches were taken for construction and operation as outlined below.

Construction

Construction of the project could lead to emissions to air from a variety of activities including land clearing, earthworks, material handling, material transport and wind erosion of exposed areas. These could be generated from construction activities across the whole project. These construction-related emissions will mainly comprise particulate matter including:

- total suspended particulates (TSP), typically where particles are less than 30 microns in equivalent aerodynamic diameter
- particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10})

- particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$)
- relatively minor emissions from machinery exhausts such as carbon monoxide (CO), oxides of nitrogen (NOx), particulate matter, and to a lesser extent sulfur dioxide (SO_2).

It is not possible to realistically quantify construction impacts using dispersion modelling due to the dispersed and variable nature of construction activities, and their temporary nature. For this reason, no specific construction air quality criteria were identified and the air quality assessment for the construction phase is qualitative.

Operation

The only potential operational impacts associated with the pipelines are from the air release valves, which will be built into pipelines at various locations to release air build ups. These are typical features of wastewater pipelines to maintain appropriate operating pressures. Impacts to air quality from air release valves are negligible and the operational impacts of pipelines was therefore not considered as part of this assessment. The operational impact assessment therefore focused on the AWRC.

Pollutants and air quality criteria

Operational emissions from the AWRC include:

- generation of odour from the liquid and solid waste streams and associated treatment processes
- generation of oxides of nitrogen (NOx), including nitrogen dioxide (NO_2) through energy recovery from biogas combustion in the co-generation engines and flaring system.

Odour criteria are prescribed in odour units (OU), not to be exceeded more than 1% of the time, for different population densities. The differences between odour criteria are based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For example, in a densely populated area there would be a greater risk that some individuals in the community would find an odour unacceptable than in a sparsely populated area. To account for this, odour criteria are lower when populations are higher. EPA air quality criteria for odour are outlined in Table 11-2 in accordance with the Approved Methods (NSW EPA, 2016). As outlined in section 11.1.6, based on the modelled impact a project specific criterion of 4 OU has been adopted. Table 11-3 outlines the EPA air quality criteria for nitrogen dioxide in accordance with the Approved Methods (NSW EPA, 2016).

Table 11-2 EPA air quality criteria for odour

Population of affected community	Criterion (odour units) (nose response time average, 99th percentile)
Single rural residence (≤~2)	7
~10	6

Population of affected community	Criterion (odour units) (nose response time average, 99th percentile)
~30	5
~125	4
~500	3
Urban (>2000) and/or schools and hospitals	2

Table 11-3 EPA air quality criteria for nitrogen dioxide

Substance	Averaging time	Criterion (micrograms per cubic metre - µg/m3)
Nitrogen dioxide (NO_2)	1-hour	246
Nitrogen dioxide (NO_2)	Annual	62

Meteorological model

Meteorological conditions are important for determining the direction and rate at which emissions from a source would disperse. The key meteorological requirements of air dispersion models are hourly records of wind speed, wind direction, temperature and atmospheric stability. For air quality assessments, a minimum of one year of hourly data is usually required, which means that almost all possible meteorological conditions, including seasonal variations, are considered in the model simulations.

Meteorological monitoring is not carried out at the AWRC site. However, there are several meteorological stations within 10 km of the AWRC. The closest meteorological stations with publicly available data are at Bringelly, Horsley Park, Liverpool, Prospect and St Marys. The Horsley Park station is operated by the Bureau of Meteorology with the other four stations operated by the Department of Planning, Industry and Environment (DPIE).

These stations were all considered in developing a picture of the meteorological condition at the AWRC site, and a summary of the local meteorological conditions is provided in section 11.1.3. For the AQIA the 2019 calendar year was selected as the meteorological modelling year, based on high data capture rate, meeting the EPA's requirement for a 90% complete dataset, and similar wind patterns to other years. The St Marys station was chosen for representative wind data as it is the closest to the AWRC site. The 2019 data was incorporated into the meteorological model (CALMET) for the project to create a year-long model simulation. This was used as an input to the air dispersion model (CALPUFF). Appendix R includes further details of the model settings used in the CALMET meteorological model for the project.

Air dispersion model

The assessment used the CALPUFF (version 6.42) air dispersion model to predict ground level odour and NO_x concentrations that may occur as a result of the project. CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap and are representative of a continuous release. CALPUFF has been approved by the EPA to assess projects and emission sources from operation of facilities such as the AWRC.

For this project, air quality predictions were modelled at 1,551 discrete receivers including sensitive receptors. Appendix R includes full details of the model settings used in the CALPUFF air dispersion model for the project.

11.1.3 Existing environment

Site context

The project, and specifically the AWRC, is located in a rural area of Western Sydney, about 40 km west of the Sydney central business district, and part of the Greater Western Sydney region. The AWRC site is at an elevation of about 40 m above sea level in a natural depression that follows the alignment of South Creek and Badgerys Creek.

The area around the AWRC is largely rural residential. The key local industries and activities that may impact ambient air quality include:

- the SUEZ Kemps Creek Resource Recovery Park which processes waste, about one kilometre to the southwest
- a wholesale nursery, about 1.5 km to the south
- chicken broiler / layer farms to the south, northeast and east.

From a potential cumulative impact perspective these industries do not generate odour that would be of a similar nature and smell to emissions from the AWRC so the potential for these to combine and cause cumulative impacts is minimal. The SUEZ Kemps Creek Resource Recovery Park may be a source of dust (and odour) and its contribution to air quality is represented in the monitoring data discussed in section 11.1.2.

The nearest private residential properties are about 500 m to the south, southeast, east and northeast. The Twin Creeks residential development is located about 1.5 km to the north-west.

Meteorological conditions

Meteorological data from years 2015 to 2019 from the five monitoring stations closest to the project (Horsley Park, Bringelly, Liverpool, Prospect and St Marys) identified the following:

- Wind direction - the most common winds in the area are from the south-southwest and north-northwest. This pattern of winds is common for Western Sydney and reflects the influence of the north to south alignment of the Blue Mountains to the west. Wind patterns were similar in all five years of data which suggests that wind patterns do not vary significantly from year to year.
- Wind speed ranges - the average and maximum wind speeds exhibited similar ranges across all five years and for all five locations. Maximum wind speeds reached around 10 metres per second (m/s) as an hourly average and these winds were not isolated to any particular time of year.
- Annual wind speed - over the five years analysed the mean annual wind speed ranged from 1.3 m/s at St Marys in 2019 to 2.2 m/s at Horsley Park in 2017 and 2018. The percentage of calms (that is, winds less than or equal to 0.5 m/s) ranged from 13% to 35%. The similar trends and statistics for each year suggest that data from any of the years reviewed may be considered as representative for the purposes of modelling.

Appendix R includes wind roses (diagrams showing strength, direction and frequency of wind) illustrating the analysed data.

Air quality conditions

DPIE has established a network of air quality monitoring stations across NSW with the closest monitoring stations to the AWRC at Bringelly, Liverpool, Prospect and St Marys. The AQIA examined data from these stations and compared them to relevant EPA criteria to understand the existing air quality conditions. The focus of this review was on pollutants identified as potential emissions from the project.

A tabulated summary of this data is provided in Appendix R with key points being:

- PM_{10} - the data show that PM_{10} concentrations have exceeded the 24-hour average criterion on at least one day in almost all years, at all locations, and that the number of exceedances increased in 2018 and 2019. One or more exceedances of the 24-hour average criterion per year is not uncommon for most DPIE monitored locations in NSW. Annual average PM_{10} concentrations exceeded the EPA's annual criterion in 2019 at Liverpool and Prospect.
- NO_2 – no exceedances of the EPA's annual average or maximum one-hour concentration criteria were identified in the data analysed.

This background air quality data was incorporated into the air dispersion model to inform the assessment of potential impact from the project.

11.1.4 Legislation and guidelines

The *Protection of the Environment Operations Act 1997* (POEO Act) provides the legislative authority for the NSW EPA to regulate air emissions in NSW. The Protection of the Environment Operations (Clean Air) Regulation 2010 (Clean Air Regulation) prescribes requirements including emission standards for domestic solid fuel heaters, control of burning, motor vehicle emissions and industrial emissions. The Clean Air Regulation is applicable to emissions from the co-generation unit.

The AQIA has been prepared in accordance with the Approved Methods. Section 11.1.2 outlines the methodology for implementing the Approved Methods in the assessment of the project.

11.1.5 Construction impact assessment

The main potential air quality impact during construction is the generation of particulate matter in the form of dust. Dust emissions from construction works have the potential to cause nuisance impacts if not properly managed. Air quality impacts during construction will largely result from dust generated from land clearing, earthworks, material handling, and material transport required to construct and install the AWRC and associated pipelines.

The total amount of dust generated depends on the quantities of material handled, silt and moisture content of the soil, the types of operations being carried out, exposed areas, frequency of water spraying and speed of machinery. The areas potentially impacted depend on weather conditions, the amount of dust generated and how effectively dust generation is managed. However, given the temporary and localised nature of dust generation, the significance of these impacts on adjacent land uses is expected to be low. Construction generated dust is an understood impact, which can be effectively managed through standard construction dust management measures. Section 11.1.9 outlines management measures to minimise the impacts of construction dust.

In addition to dust, construction activities will also generate combustion emissions from construction plant and machinery. These impacts can be managed through the regular maintenance of plant and machinery in accordance with manufacturer recommendations.

11.1.6 Operational impact assessment

Odour

Odour sources from the project include the primary, secondary and tertiary treatment tanks, digesters, biosolids treatment building and the co-generation engine. An odour control unit (OCU) will be used to capture and treat air from the identified odour sources.

Dispersion modelling has quantified the potential odour impacts from the AWRC operating at 50 ML/d. Figure 11-1 shows the predicted odour levels (in odour units) at the 99th percentile, corrected for nose response times and including all identified sources. These results are considered conservative as they assume:

- biosolids loadout emissions for all hours between 7 am and 3 pm, for every day of the year
- emissions from the OCU at the expected upper limit (that is, 500 OU) for every hour of the year.

Figure 11-1 shows that the 2 OU contours, at the 99th percentile, are generally within the boundary of the AWRC and do not encroach on any existing or potential private sensitive receptors or residential areas. A project specific criterion higher than 2 OU is therefore justified on the basis of the low population density within the 2 OU contour.

From Figure 11-1 it has been estimated that there would be no more than a population of 125 within the extent of the 2 OU contour so in accordance with the EPA assessment criteria in Table 11-2, a project specific criterion of 4 OU has been adopted. Figure 11-1 shows that the 4 OU contour is within the AWRC site boundary and does not extend to any existing or potential private sensitive receptors, residential areas or existing or future recreational areas. Some odour may be detected from time-to-time on the green space area on the AWRC site however this impact has been determined as low risk given that even if the area was used for recreation, there would be relatively few people present for short durations.

Based on the air dispersion modelling result, odour impacts of the AWRC are expected to be at low levels and comply with the EPA assessment criteria at the nearest existing and potential private sensitive receptors or residential areas. This conclusion was reached using conservative assumptions in relation to biosolids loadout times and odour control unit operation as outlined in Appendix R. Therefore, the modelled odour impacts of the AWRC represent the potential worst-case impacts.

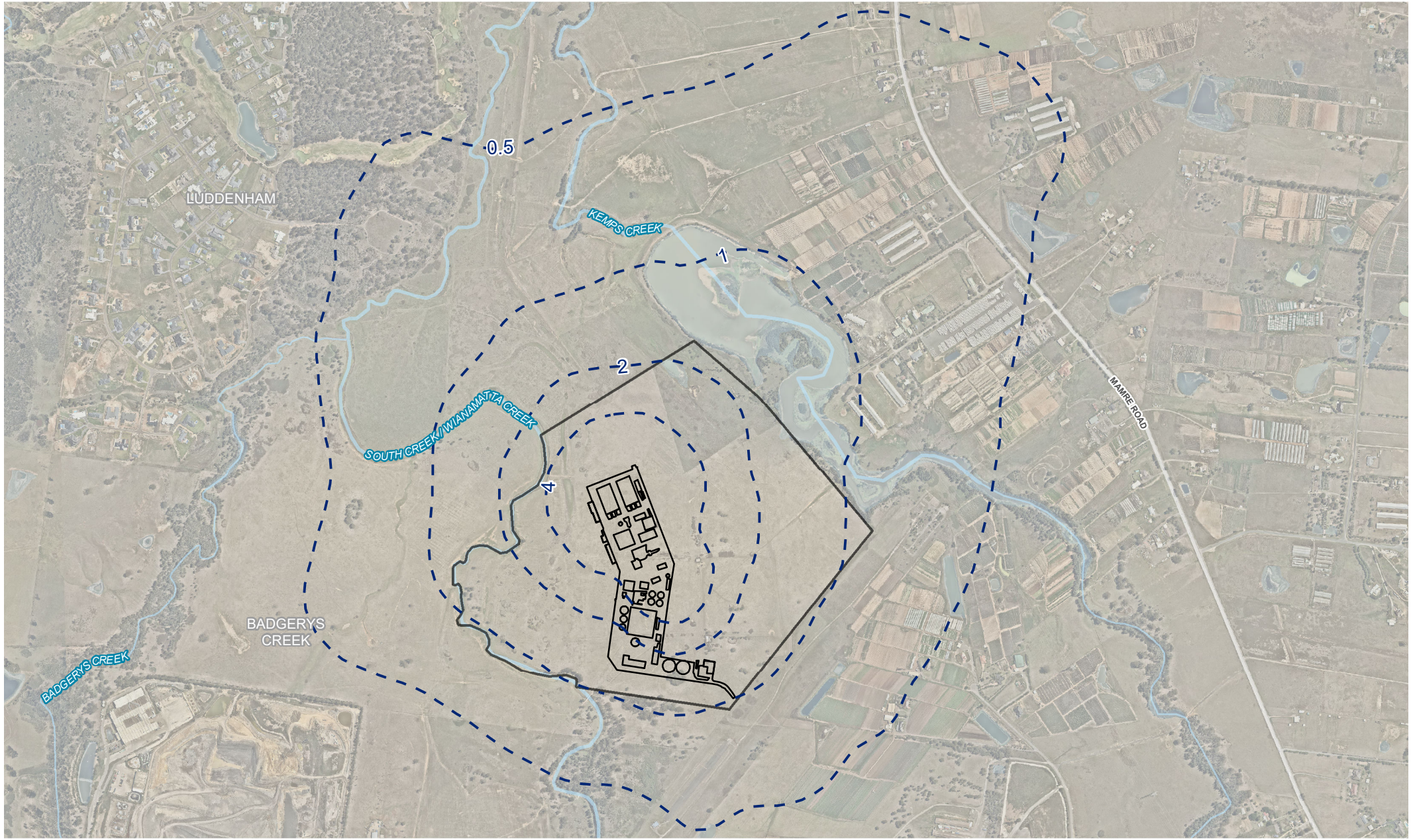


Figure 11-1 Air quality 99th percentile odour units

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

Nitrogen dioxide

Operation of the co-generation unit will result in the release of NO_x. The selected co-generation unit will need to comply with the emission standards in the Clean Air Regulation. For NO_x, the relevant emission standard is 450 mg/Nm^3 for activities operating on or after 1 September 2005 (referred to as Group 6 under the Clean Air Regulation). This assessment assumes a worst-case NO_x emission concentration of 450 mg/Nm^3 and mass emission rate of 0.27 g/s.

Dispersion modelling was undertaken for one-hour average and annual average NO_2 impacts based on worst-case generation (maximum biogas use in co-generation and worst-case NOx emission concentration) that could result from the project. These results assume that 100% of the NO_x is NO_2 at the locations of maximum ground-level concentrations. In reality, NO_2 will be about 20% of the NO_x at the locations of maximum ground-level concentrations, based on data collected by DPIE. This adds a level of conservatism to the impact assessment.

One-hour average

Figure 11-2 shows the predicted maximum one-hour average NO_2 concentrations due to the AWRC operating at 50 ML/day. At the nearest sensitive receptors, the predicted maximum one-hour average NO_2 concentrations are less than 50 µg/m^3. With the addition of maximum background levels for the selected model year (103 µg/m^3) the results demonstrate compliance with the EPA's 246 µg/m^3 criterion.

The 143 µg/m^3 contour represents the EPA criterion assuming a maximum background level of 103 µg/m^3 and that 100% of the NO_x is NO_2.

Annual average

Figure 11-3 shows the predicted annual average NO_2 concentrations due to the AWRC operating at 50 ML/day. These predictions assume that 100% of the NO_x is NO_2. At the nearest sensitive receptors the predicted average NO_2 concentrations are less than 1 µg/m^3. With the addition of background levels (that is, 25 µg/m^3) the results show compliance with the EPA's 62 µg/m^3 criterion.

Based on the model results the AWRC will not result in any adverse air quality impacts with respect to NO_2.

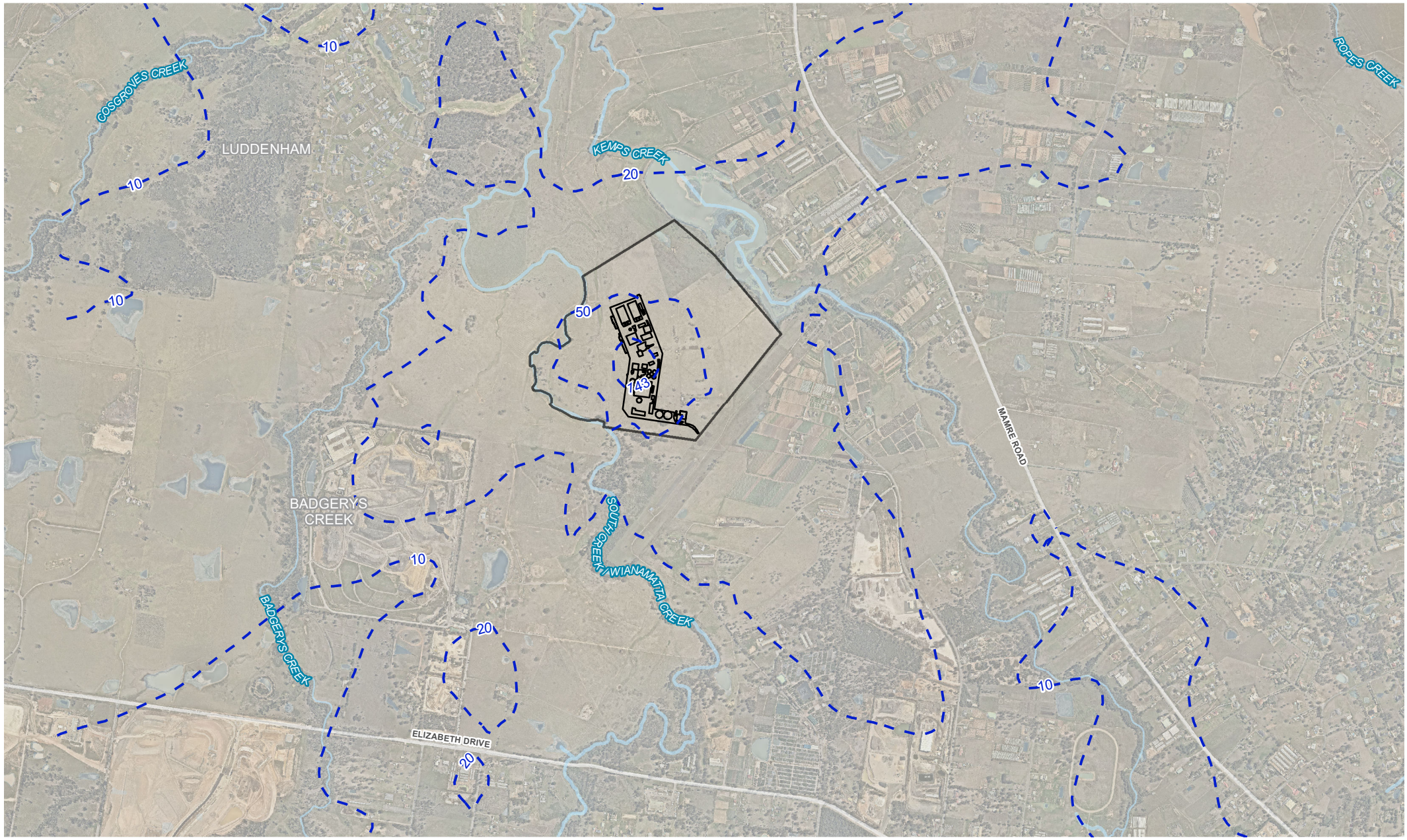
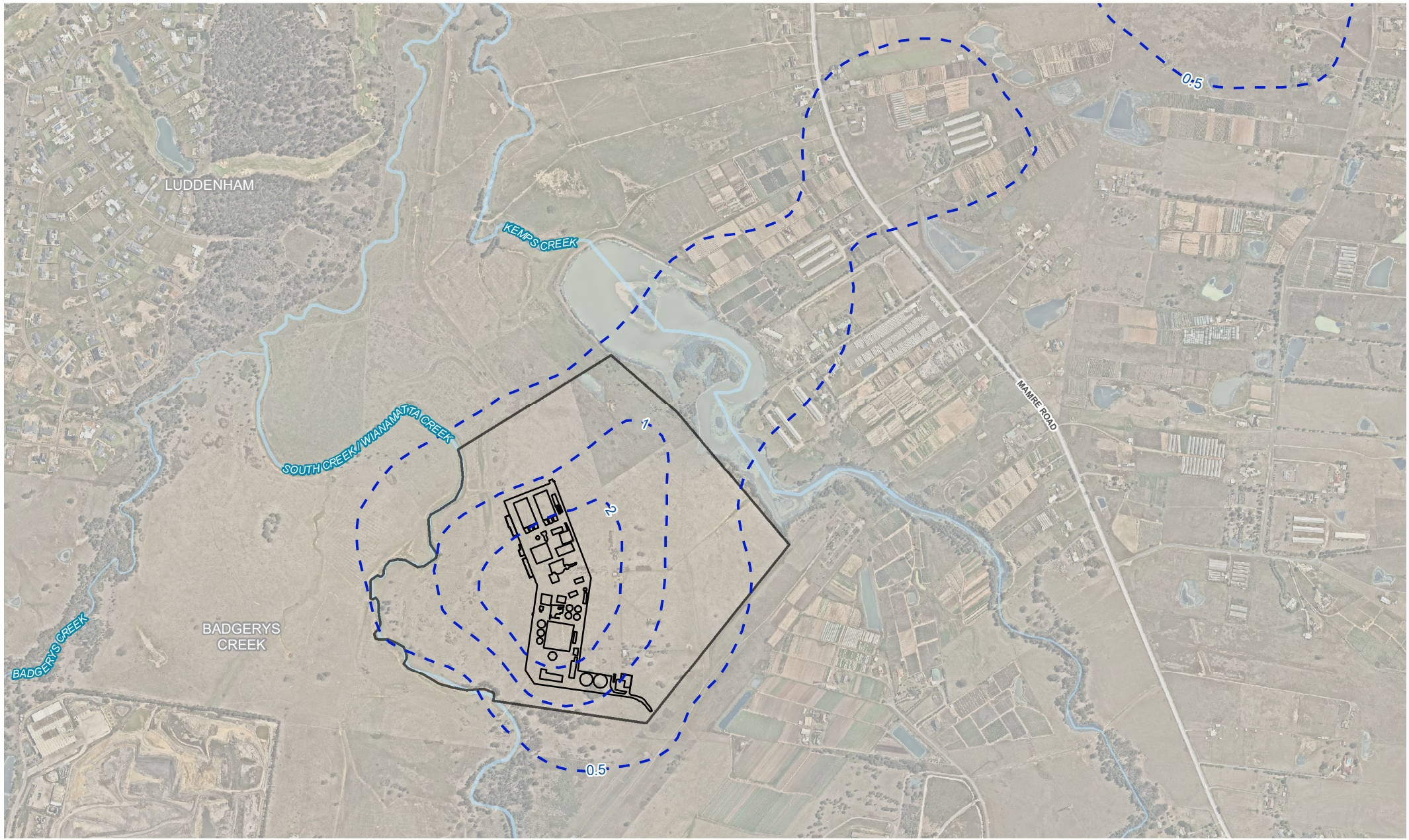


Figure 11-2 Air quality - 1hr average Nitrogen Dioxide(NO_2)

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56



Advanced Water Recycling Centre

Nitrogen Dioxide (µg/m3)

Base Data

Waterbody

Watercourse

1:15,000

0 250 500 m

Figure 11-3 Air quality - annual average Nitrogen Dioxide (NO_2)

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI

Projection: GDA2020 MGA Zone 56

11.1.7 Impact of future stages

Staged approval is being sought for the operation of the ultimate capacity of the AWRC at 100 ML/day. The AQIA also assessed the air quality impact of operating the AWRC at 100 ML/day which found:

- The 4 OU contour will not extend to any existing or potential private sensitive receivers or residential areas under the 100 ML/day operational scenarios.
- For nitrogen dioxide one-hour concentration - doubling the predicted maximum one-hour average NO_2 concentrations in Figure 11-2 provides an indication of potential impacts for the AWRC at 100 ML/day. This complies with the EPA's 246 µg/m^3 criterion at the nearest sensitive receptors.
- For nitrogen dioxide annual average - doubling the predicted annual average NO_2 concentrations in Figure 11-3 provides an indication of potential impacts for the AWRC at 100 ML/day. This complies with the EPA's 62 µg/m^3 criterion at the nearest sensitive receptors.

No adverse odour or nitrogen dioxide impacts are likely to occur as a result of the AWRC operating at a capacity of 100 ML/day.

It is recognised that the future land use of the land around the AWRC is being developed as Western Sydney grows. Future land development would be undertaken in accordance with the planning controls in State Environmental Planning Policy (Western Sydney Aerotropolis) 2020. Proposed land use zoning adjacent to the AWRC site is primarily Environment and Recreation zoning along waterways such as South Creek and Enterprise zoning elsewhere.

11.1.8 Cumulative impacts

Construction

Construction of the project has the potential to overlap with the construction of other nearby projects including the M12 Motorway, the Northern Road upgrade, Warragamba Dam Wall raising, Sydney Metro – Western Sydney Airport and the Western Sydney International Airport.

The primary source of potential construction emissions to air are dust and combustion emissions from machinery. As described in section 11.1.5 these emissions are well understood and can be managed through the implementation of standard management measures.

With all projects implementing similar measures, cumulative impacts as a result of concurrent construction activities would be minor.

Operation

The air dispersion modelling undertaken to assess potential operational impacts associated with the project included assessment of cumulative impacts in relation to the following:

- Nitrogen dioxide – modelling included consideration of background NO_2 present within the airshed, as identified by the regional air quality monitoring network, in addition to project generated NO_2 emissions. An assessment was also made of the cumulative impact of the NOx generated by the project combined with the nearest major project with the potential to generate NOx, the M12 Motorway. This analysis concluded that cumulative NOx would be well below the EPA's criteria of 246 µg/m^3 at any point between the two projects. This includes under the 100 ML/day scenario.
- Odour – whilst it is not possible to monitor odour units from a background perspective, the assessment has taken into consideration the type, quantity, and sensitivity of potential receivers that could experience odour as a result of the project and concluded that the relative change in odour as a result of the project would not be significant.

11.1.9 Management measures

Table 11-4 outlines management measures Sydney Water proposes to manage air quality impacts.

Table 11-4 Air quality management measures

ID	Potential impact	Management measure	Timing
AQ01	Operational NO_2 emissions	Co-generation equipment selection will include consideration of engines with the lowest level of NO_2 generation per unit of energy production as far as practical.	Detailed design
AQ02	Construction dust	Include the following measures in the project's CEMP: • Maintain equipment in good working order to comply with the Clean Air Regulations of the Protection of the Environment Operations Act 1997, having appropriate exhaust pollution controls, and meeting Australian Standards for exhaust emissions. • Water exposed areas using a non-drinking water source, where possible. • Cover exposed areas, where possible (for example with tarpaulins or geotextile fabric). • Modify or cease dust-generating work in windy conditions. • When designing site layout, consider opportunities to maximise distance of dust-generating activities from sensitive receivers.	Prior to construction During construction

ID	Potential impact	Management measure	Timing
AQ03	Operational odour emissions	Manage odour complaints in accordance with Sydney Water's existing management system processes.	Operation

11.2 Noise and vibration

This section describes the existing noise conditions of the project area, and the potential noise and vibration impacts during construction and operation of the project. This section summarises the specialist report (Aurecon Arup, 2021b) in Appendix S.

Noise and vibration impact summary

The project will generate moderate noise impacts during construction, and negligible impacts during operation. No vibration impacts are anticipated throughout construction or operation of the project.

Construction at the Advanced Water Recycling Centre (AWRC) site is likely to exceed some noise management levels at six sensitive receivers, but only when worst-case noise generation and propagation scenarios are considered. This will be reduced (by up to 10 dBA) with management measures. Noise impacts from pipeline construction are typically short-term for individual receivers as the construction process involves activities moving along the pipeline alignment.

The significance of impacts during construction will be greatest where work is required outside of standard construction hours (such as the environmental flows pipeline and along the brine pipeline alignment), where sensitive receivers are located within 100 m of construction activities, and where construction activities are required for extended periods. Extended periods of work will be required at the AWRC site, as well as tunnelling at Bents Basin Road and Lansvale Park, and where night works are required on busy roads to minimise impacts on the traffic network (as residential properties will be located in close proximity). Up to 14 residences along the environmental flows pipeline alignment may be impacted by ground-borne noise.

Operational noise impacts from the AWRC will typically meet noise criteria. Although there is a minor exceedance of 1 dBA at one residential receiver during certain meteorological conditions, Sydney Water expects management measures can be implemented to address this. Operational noise from pipelines and release structures will be minimal.

Careful management of noisy activities (such as selection of types of equipment with lowest noise outputs and installing site noise barriers) and ongoing consultation with nearby sensitive receivers will be essential in managing project noise impacts during construction. Sydney Water will prepare a Construction Noise and Vibration Management Plan (CNVMP) outlining detailed measures to minimise the project's construction noise impacts and ensure effective consultation with sensitive receivers.

11.2.1 Relevant Secretary's Environmental Assessment Requirements

Table 11-5 shows the Secretary's Environmental Assessment Requirements (SEARs) relevant to noise and vibration and where in this section they are addressed.

Table 11-5 Project SEARs relating to noise and vibration impacts

SEARs	EIS section where requirement addressed
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).	Sections 11.2.5 and 11.2.6
39. Details and justification of proposed noise mitigation and monitoring measures.	Section 11.2.9

11.2.2 Methodology and assumptions

The noise and vibration impact assessment methodology includes:

- identifying the nearest sensitive receivers likely to be impacted by project construction and operation and grouping similar land uses and sensitive receivers into noise catchment areas (NCAs)
- establishing the existing and future acoustic environment at relevant surrounding sensitive receivers
- a construction noise impact assessment to predict noise levels generated during project construction, in accordance with NSW Interim Construction Noise Guideline (ICNG) (NSW EPA, 2009). This includes identifying anticipated activities, hours of construction and duration of construction activities and comparing predicted noise levels against noise management levels
- an operational noise impact assessment, focused on the noise levels generated by the AWRC, and the potential impact to surrounding sensitive receivers, in accordance with NSW Noise Policy for Industry (NPfI) (NSW EPA, 2017b). The focus is on the AWRC given noise generation from the pipelines is expected to be minimal
- assessing the project's vibration impacts against the three main categories of vibration – human perception, effects on building contents and effects on structures
- assessing cumulative noise impacts of the project and other nearby major projects

- identifying further design opportunities and management measures for managing noise and vibration during construction and operation.

The assessment uses a qualitative approach for most construction impacts given construction activities are typically short-term in any one location. Quantitative assessments have been completed for the following locations where construction activities are proposed over a longer period:

- AWRC site.
- Tunnelling at Bents Basin Road for the environmental flows pipeline.
- Tunnelling at Lansvale Reserve for the brine pipeline.
- Construction compounds.

To assess noise impacts from AWRC operation, noise modelling was completed using SoundPlan v8.1 adopting the Concawe algorithms in line with NSW Noise Policy for Industry (NPfI) recommendations. This model allowed for the identification of noise levels that exceed compliance at the different sensitive receivers as outlined in section 11.2.2.

The background noise environment is likely to change throughout construction and operation of the project, particularly at the AWRC site. This is largely a result of construction and operation of the nearby M12 Motorway, Western Sydney International Airport and urban development in the Western Sydney Aerotropolis Growth Area (WSAGA). For construction, the assessment considered current background noise levels. For operation, the assessment modelled and assessed several background noise scenarios to reflect the changing noise environment over time. Section 11.2.5 and section 11.2.6 provide more detail on these assessment approaches.

Noise assessment criteria depend on duration, construction equipment and whether out of hours work is required, and were developed in accordance with the Interim Construction Noise Guideline (ICNG). Predicted Noise Levels (PNL) were identified for sensitive receivers and then compared against the Noise Management Levels (NML), including the highly noise affected NMLs, as shown in Table 11-11. These levels give an indication of the potential for the receiver to be impacted by noise. If predicted noise levels reach the NML, then management measures will be implemented to minimise the level of impact. This has formed the basis of determining the level of noise impact during construction and guides the development of management measures.

The assessment used the current noise environment to develop construction noise criteria, as the future surrounding developments and projects will not be in operation during construction of the project.

Appendix S includes a full description of the assessment methodology.

11.2.3 Existing environment

The project is located across rural and residential areas in Western Sydney, about 40 km west of Sydney's central business district. The acoustic environment around the AWRC site is dominated

by natural sounds. The acoustic environment along the pipelines varies by location but is predominantly traffic and other background noise typical of an urban setting.

The assessment identifies 27 noise catchment areas (NCAs) based on the similar land uses and sensitive receivers located near the project. Each NCA is represented by an address or descriptive location as shown in Table 11-6. Background noise levels are from a combination of M12 Motorway EIS data and desktop evaluation of localities from the NSW NPfI, as described in Table 11-8. Each NCA is used to characterise the predicted noise levels from construction and operation of the project.

No background noise monitoring has been completed for the project. This is due to the limitations the COVID-19 pandemic has placed on obtaining accurate background noise levels. The background measurements conducted for the M12 Motorway EIS are considered appropriate for use in the project's noise assessment, as they adequately represent the background noise levels of the project area around the AWRC site and ElizabeSW SW th Drive. Background noise levels along the pipelines are taken from AS 1055 and the NPfI which provide typical background noise levels for different land uses and are used to identify the background rating noise levels of each NCA (AS, 1997; NSW EPA, 2017). These are summarised in Table 11-6 and shown in Figure 11-4.

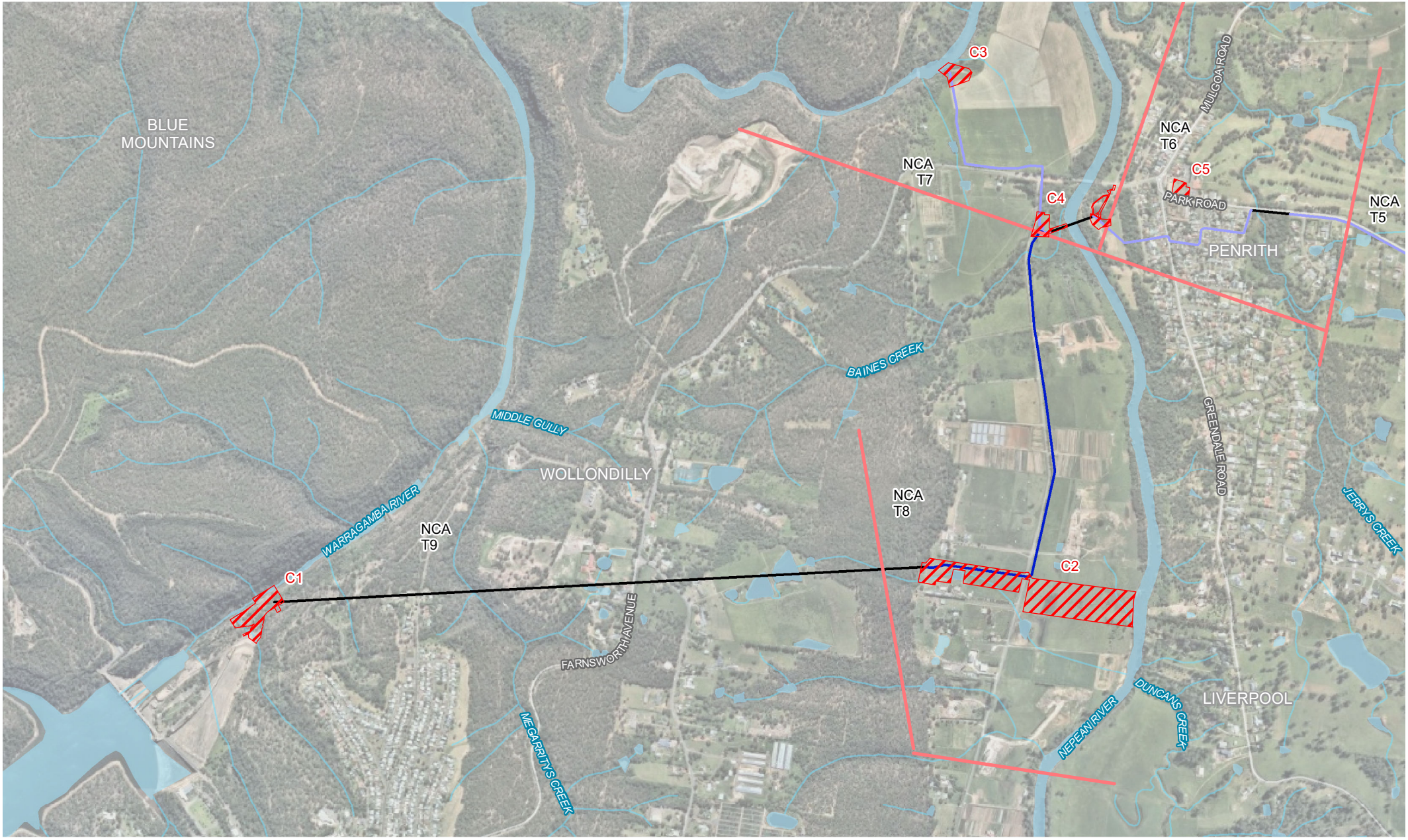
Table 11-6 Noise Catchment Areas (NCAs) for the project

NCA	Description	Basis of background noise levels	Rating Background Level (RBL) A-weighted decibel (dBA)		
			Day	Evening	Night
NCA T1	Residential receiver near the AWRC site	L06 - M12 EIS	35	35	31
NCA T2	Residential receiver along Elizabeth Drive (east)	L12 - M12 EIS	40	37	30
NCA T3	Residential receiver along Elizabeth Drive (west)	L14 - M12 EIS	42	39	33
NCA T4	Residential receiver along Northern Road	Urban - NPfI	50	45	40
NCA T5	Residential receiver along Park Road	Suburban/ Urban – NPfI	45	40	35
NCA T6	Residential receiver Wallacia Town Centre	Suburban/ Urban – NPfI	45	40	35

NCA	Description	Basis of background noise levels	Rating Background Level (RBL) A-weighted decibel (dBA)		
			Day	Evening	Night
NCA T7	Residential receivers along Silverdale Road	Rural - NPfI	40	35	30
NCA T8	Residential receivers along Bents Basin Road	Rural - NPfI	40	35	30
NCA T9	Residential receivers near North Warragamba	Rural - NPfI	40	35	30
NCA B1	Residential receivers along Western Road	L05 - M12 EIS	39	42	35
NCA B2	Residential receivers along Cross Street	L05 - M12 EIS	39	42	35
NCA B3	Residential receivers near Cecil Park	L03 - M12 EIS	54	48	37
NCA B4	Residential receivers along Kensington Place	L01 - M12 EIS	45	44	40
NCA B5	Residential receivers along Stirling Street, Feodore Drive, Frederick Road	L01 - M12 EIS	45	44	40
NCA B6	Residential Receivers along North Liverpool Road	Urban - NPfI	50	45	40
NCA B7	Residential Receivers along Montgomery Road	Urban - NPfI	50	45	40
NCA B8	Residential Receivers along Monash Place and Hebblewhite Place	Suburban/ Urban – NPfI	45	40	35
NCA B9	Residential Receivers along West Cabramatta Road	Urban - NPfI	50	45	40

NCA	Description	Basis of background noise levels	Rating Background Level (RBL) A-weighted decibel (dBA)		
			Day	Evening	Night
NCA B10	Residential Receivers along Meadows Road	Urban - NPfI	50	45	40
NCA B11	Residential Receivers along Edensor Road, Harrington Street, John Street	Suburban/ Urban – NPfI	45	40	35
NCA B12	Residential Receivers on John Street (East of Joseph Street)	Suburban/ Urban – NPfI	45	40	35
NCA B13	Residential receivers along Gladstone Street, St John Road, Barley Street	Urban - NPfI	50	45	40
NCA B14	Receivers along Curtin Street and Fairview Road	Suburban/ Urban – NPfI	45	40	35
NCA B15	Residential receiver along Bareena Street, Vale Street, Chancery Street	Urban - NPfI	50	45	40
NCA B16	Residential receiver along Bromley Street, Beckenham street and Willowbank Crescent	Suburban/ Urban – NPfI	45	40	35
NCA B17	Residential receivers along the Hume Highway	Urban industrial - NPfI	55	50	45
NCA B18	Residential receivers along Knight St	Urban - NPfI	50	45	40

The AWRC is the main source of operational noise from the project. Sydney Water has mapped sensitive receivers around the AWRC site to assist in the impact assessment. These receivers are shown in Figure 11-5 and outlined Table 11-7.



Environmental Flows Pipeline
Treated Water Pipeline
Underbore
NCA Delimitation Lines
Compound Locations
Waterbody

1:20,000
0 0.5 1 km

Fig 11-4a Noise Catchment Areas identified for the project

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

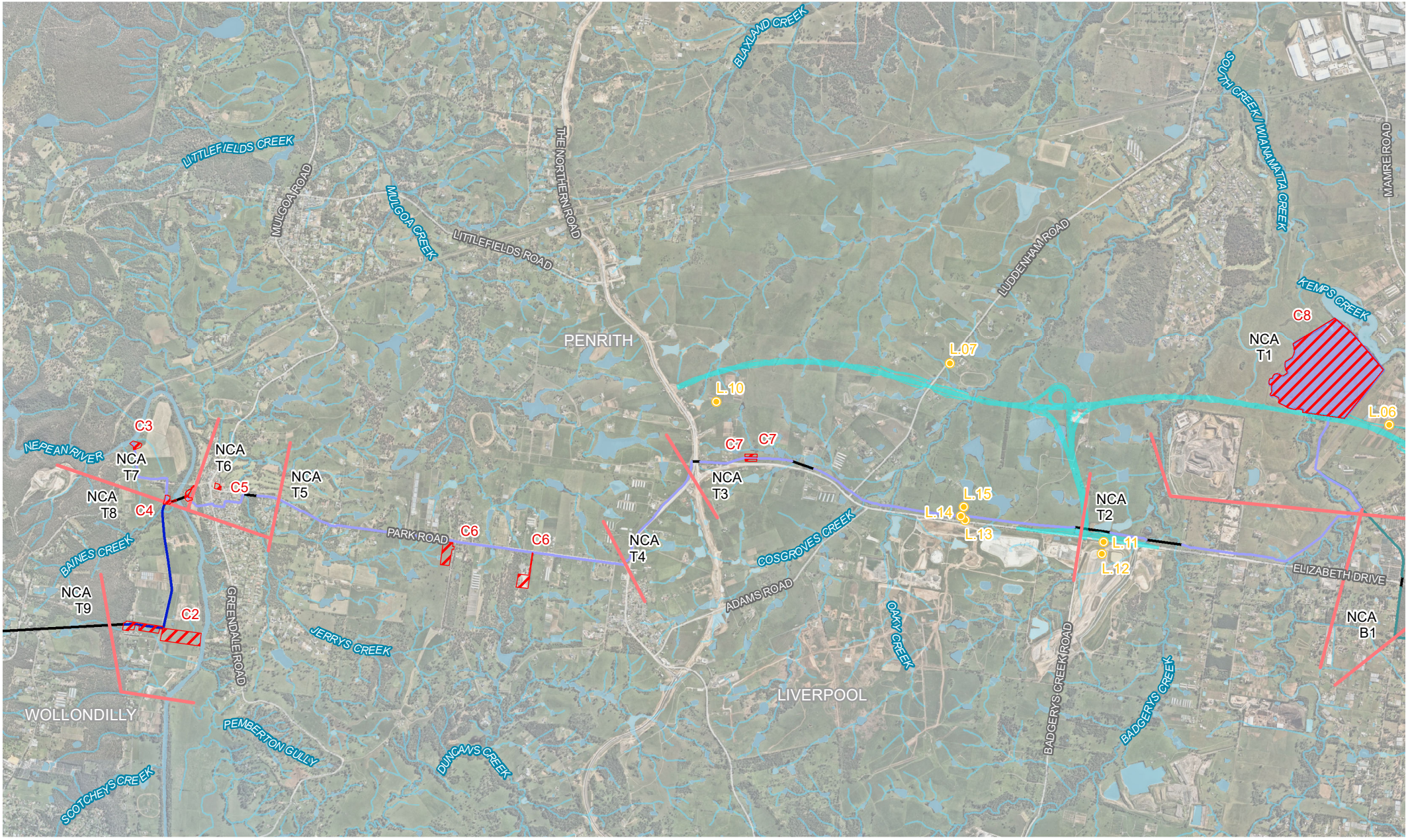


Fig 11-4b Noise Catchment Areas identified for the project

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

Treated Water Pipeline
Brine Pipeline
Underbore
Advanced Water Recycling Centre
M12 EIS Noise Monitoring Location
M12
NCA Delimitation Lines
Compound Locations
Waterbody

1:75,000
0 0.5 1km

Fig 11-4c Noise Catchment Areas identified for the project

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

Table 11-7 Sensitive receivers located near the AWRC

Receiver	ID	Area represented	Address	Approximate distance to AWRC (m)	Rating Background Level (RBL) (dBA)		
					Day	Evening	Night
Residential	R1	Twin Creeks receivers	4 Ganton Way	925	40	40	35
	R2	Twin Creeks receivers	9 Farmingdale Circuit	835	40	40	35
	R3	Mamre Road receivers	901 Mamre Road	490	40	40	35
	R4	Kemps Creek receivers	Kemps Creek	475	40	40	35
	R5	Badgerys Creek receivers	1669 Elizabeth Drive	650	40	40	35
	R6	Kemps Creek receivers	203-229 Clifton Avenue	390	40	40	35
Active recreation	A1	Potential users of the surrounding bushland and parkland areas	Kemps Creek	0	-	-	-
	A2		Kemps Creek	0	-	-	-
	A3		Badgerys Creek	0	-	-	-
	A4		Badgerys Creek	0	-	-	-

Receiver	ID	Area represented	Address	Approximate distance to AWRC (m)	Rating Background Level (RBL) (dBA)		
					Day	Evening	Night
Industrial (future)	I1	Kemps Creek receivers	Kemps Creek	390	-	-	-
	I2	Mamre Road Receivers	Kemps Creek	230	-	-	-
	I3	Badgerys Creek receivers	Badgerys Creek	70	-	-	-

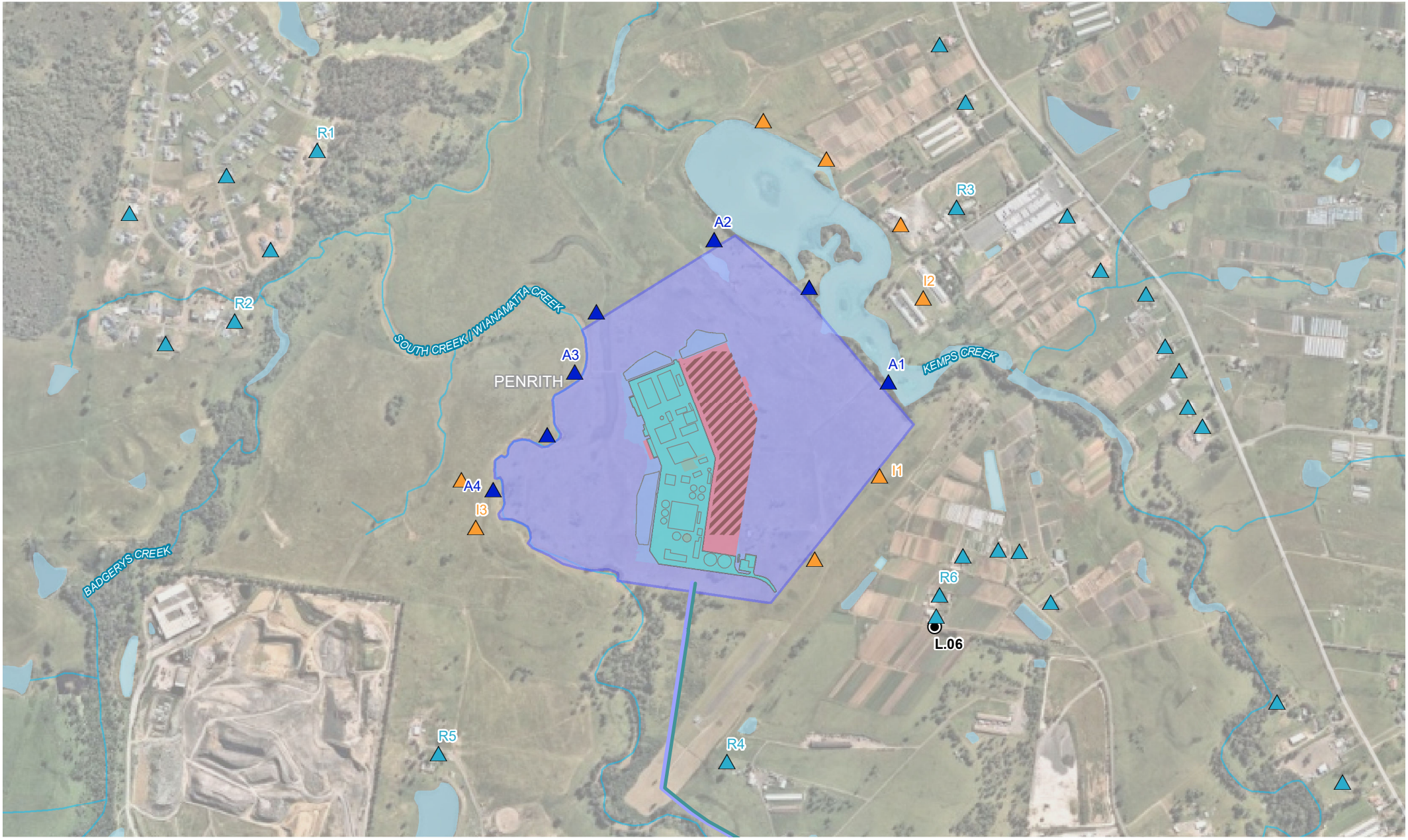


Figure 11-5 Sensitive receivers located near the AWRC

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

11.2.4 Legislation and guidelines

The legislation, policies and guidelines listed in Table 11-8 were used to guide the noise and vibration impact assessment.

Table 11-8 Noise and vibration, legislation, policies and guidelines

Legislation/ Policy/ Guideline	Relevance to project
NSW Noise Policy for Industry (NPfI) (Environment Protection Authority (EPA), 2017)	The NPfI provides guidelines for the assessment of noise impacts from the operation of an industrial development on nearby receivers. The NPfI has superseded the NSW Industrial Noise Policy referred to in the SEARs. The NPfI is used to assess the project's operational noise impacts.
Protection of the Environment Operations Act 1997 (POEO Act) POEO (Noise Control) Regulation 2017	The POEO Act is the key piece of environment legislation in NSW and administered by the Environment Protection Authority (EPA). The Act sets out provisions relating to pollution, including noise pollution which is supported by the POEO (Noise Control) Regulations. This legislation will be used by EPA to monitor compliance of the project during construction and operation.
NSW Road Noise Policy (RNP) (Environment Protection Authority (EPA), 2011)	The RNP is used to assess operational traffic noise associated with the project.
NSW Interim Construction Noise Guideline (ICNG) (Environment Protection Authority (EPA), 2009)	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. This guideline is used to assess the level of impact from noise during construction of the project.
Construction Noise and Vibration Strategy (CNVS), (Transport for NSW (TfNSW), 2018a)	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 is used to source sound power levels for construction equipment and assist in identifying management measures.
Australian Standard AS24360-2010 Guide to Noise Control on Construction, Maintenance and Demolition Sites 2010, (AS, 2010)	This Australian Standard is used to source sound power levels for project construction equipment.

Legislation/ Policy/ Guideline	Relevance to project
BS 5228-1-2009 Code of Practice for noise and vibration control on construction and open sites, (BS, 2009)	This Code of Practice is used to source sound power levels for project construction equipment.
Construction Noise Estimator and Application Notes, Transport for NSW (TfNSW, 2016)	The Construction Noise Estimator and Application Notes is used for assessing noise from construction traffic and assessing noise from rerouting existing traffic.
NSW Assessing Vibration – a technical guideline (AVTG) (Department of Environment and Conservation (DEC), 2006)	The Guideline is used for assessing potential vibration impact disturbances to human occupants of buildings and building contents from project construction.
British Standard BS 6472-1992 Evaluation of human exposure to vibration in buildings (1-80Hz) (BS, 1992)	The Standard is used for assessing potential vibration disturbances to human occupants of buildings and building contents from project construction
British Standard BS 7385: Part 2-1993 Evaluation and measurement of vibration in buildings Part 2 (BS, 1993)	The Standard is used for assessing potential structural or cosmetic damage to buildings/structures from vibration during project construction.
DIN 4150-3 (2016) Vibrations in buildings - Part 3: Effects on structures, English translation (DIN, 2006)	The Standard is used to set guideline values for vibration effects on buildings/structures (including buried pipework), including from trenchless pipeline construction.

11.2.5 Construction impact assessment

The construction noise and vibration assessment considers the potential impacts generated from airborne and ground-borne noise and vibration, from all construction activities. Chapter 4 provides further details of the project's construction methodologies, duration, timing and locations.

Assessment locations

The AWRC site assessment considers construction impacts on nearby existing residential properties as shown in Figure 11-5 and outlined in Table 11-7.

For pipelines, the assessment considers sensitive receivers 100 m each side of the pipeline alignments, based on a desktop survey. These receivers are considered to be the most impacted due to their proximity to construction works. This area is also considered sufficient for assessing vibration impact, particularly any potential structural damage. Where there are no sensitive receivers within 100 m, the closest receivers are identified and assessed.

Construction work hours and program

The project will require construction within and outside of standard hours for construction as outlined in the ICNG (NSW EPA, 2009). The CNVS provides additional guidance on defining work periods outside of the standard hours (out of hours work – OOHW) that account for times when people are more sensitive to noise and vibration. Table 11-9 outlines these work periods.

Table 11-9 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
OOHS 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 7am and 10 pm to 12 am Sundays and public holidays – 12 am to 8am and 10 pm to 12 am

In general, the AWRC will be built within standard construction hours, and the pipelines will require a combination of standard hours and OOHW. Pipeline construction will require OOHW to minimise the impacts on the traffic network, especially along the brine pipeline which is located in highly urbanised areas. OOHW work at the AWRC may be required for some activities such as delivery of equipment and large concrete pours. However, these will be infrequent and of a short duration due to the progressive rate in which construction will occur along the linear pipeline alignments.

Some pipeline tunnelling construction, such as for the environmental flows pipeline, will require OOHW, including 24/7 work. This is required to assist in minimising the risk of tunnel failure due to the length and complexity of the tunnel. Appendix S includes a complete list of all pipeline components, including sections that will be constructed in standard construction hours. Sydney Water will identify the exact locations of OOHW during detailed construction planning.

AWRC construction noise and vibration

The following noise and vibration assessment aims to provide a realistic worst-case noise impact assessment. The scenarios assessed are representative of the noisiest construction activities likely to occur across the project. The predictions assume activities are located at the closest point of the works zone to the nearest sensitive receivers. In practice, the potential construction noise impacts at each location will vary depending on factors including the:

- type of construction activities conducted, and plant and equipment operated

- position of the works within the site and distance to the nearest sensitive receiver
- overall duration of the works
- cumulative operation of works
- weather conditions.

Construction of the AWRC will take about 36 months and will include seven different overlapping phases, each of which involve different activities and different noise emitting plant and equipment. These phases are outlined in more detail in Chapter 4, and generally include:

- Phase 1 – Site establishment (about two months)
- Phase 2 – Earthworks (about 12 months)
- Phase 3 – Civil works (about 12 months)
- Phase 4 – Structure construction (about 18 months)
- Phase 5 – Mechanical and electrical installation (about 18 months)
- Phase 6 – Landscaping and rehabilitation (about three months)
- Phase 7 – Commissioning (about six months).

Table 11-10 summarises the noise levels of plant and equipment likely to be used during construction. The highest noise emitting machinery is the 30 t excavator with a hydraulic hammer. Multiple equipment and machinery will be operating simultaneously across all phases of construction.

Table 11-10 AWRC construction noise sources

Equipment/ machinery	dBA
Backhoe loader	108
Bulldozer	114
Chainsaw	119
Compactor	120
Concrete saw	127
Concrete agitator truck	111
Concrete pump truck	106
Crane (truck mounted)	108
Excavator (15t)	100

Equipment/ machinery	dBA
Excavator (30t)	102
Excavator (30t) + rock breaker	127
Grader	115
Hand tools (electric)	110
Loader (23t)	112
Pavement laying machine	114
Pavement profiler	117
Piling rig (bore)	112
Roller (smooth drum)	107
Truck	107
Truck (dump)	117
Truck (road truck/ truck and dog)	108
Truck (water cart)	108
Water pump (electric)	96
Vehicle (light)	111
Welding equipment	110

Figure 11-6 outlines the noise levels of activities and environments that are more familiar. These provide a point of comparison for noise levels that will be generated by the project.

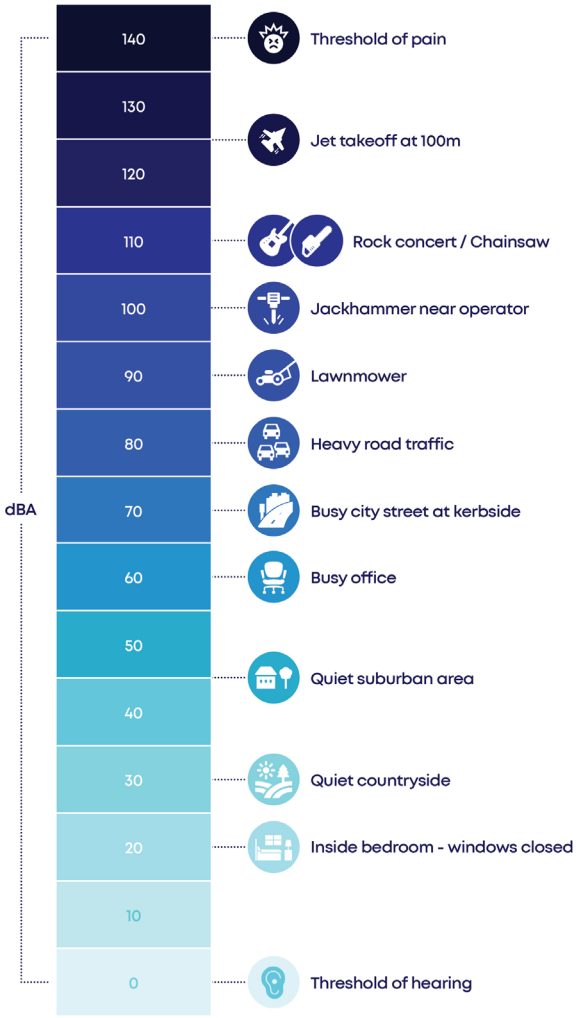


Figure 11-6 Comparison noise levels

AWRC construction noise impact assessment

Table 11-11 summarises the PNL for surrounding sensitive receivers during AWRC construction. Construction noise levels are likely to be above the noise affected NML of 45 dBA as specified in the ICNG until the commissioning phase. Most exceedances will be between 10 and 20 dBA. However, this is likely to be a conservative result given it assumes:

- no mitigation in the form of hoarding, barriers or screens which may provide up to 10 dBA reduction
- the use of 30 t excavator with a rock breaker for any rock breaking. If not required, these numbers will reduce by 9 dBA for each receiver.

Although predicted noise levels exceed the noise affected NML, no exceedances of the highly noise affected NML of 75 dBA are predicted. Table 11-11 shows exceedances of the noise affected NML in red text. These are likely to be highest in the first 18 months of construction when there is a high volume of truck movements associated with earthworks at the site.

Out of hours work is unlikely to be required for construction of the AWRC so the NMLs for night and evening works have not been included or assessed in Table 11-11. All construction noise impacts will be temporary. Management measures have been provided in section 11.2.9 to manage the identified exceedances.

Table 11-11 Predicted construction noise levels at sensitive receivers (unmitigated)

Receiver	Predicted Noise Level (dBA), $LA_{eq,15min}$ Construction phases						Noise affected NMLs (dBA)	Highly noise affected NMLs (dBA)
	1	2	3	4	5	6		
R1	49	56	55	50	42	36	45	75
R2	48	56	53	49	42	36	45	75
R3	52	59	57	53	45	40	45	75
R4	55	62	60	56	48	43	45	75
R5	52	59	57	53	45	40	45	75
R6	55	62	59	55	48	42	45	75

AWRC construction vibration impact assessment

Depending on the equipment used during construction, vibration impacts can occur within 100 m, but no impacts will be experienced beyond 100m. As the closest sensitive receivers to the AWRC are more than 100 m away, vibration impacts are unlikely. All sensitive receivers are located outside of the minimum working distances outlined in Appendix S.

Pipeline construction noise and vibration

Pipeline construction methodology will include both open trenching and tunnelling. Construction will generally be carried out progressively along the alignment with about 70 m – 150 m of active construction at any one pipeline location. However, several areas may be in progress at any one time. The timing and duration of pipeline construction will be confirmed during detailed design and construction planning, when a construction contractor(s) has been engaged. Further information on pipeline construction is provided in Chapter 4.

Table 11-12 summarises predicted air borne construction noise levels emitted by different construction machinery at different distances. Some receivers may experience noise levels above the 45 dBA noise affected NMLs, which are shown in red text. However, impacts above the highly affected noise level of 75 dBA will be minimal. It is assumed that machinery will operate continuously for a 15-minute period only, followed by a stoppage period, and this has been used to calculate the emitted noise dBA in Table 11-12.

Table 11-12 Air noise levels (dBA) from machinery at different distances

Equipment	10 m	30m	50m	75m	100m	150m	200m	300m	500m	700m	1000m	2000m	3000m	Noise affected NMLs	Highly noise affected NMLs
Pump and dewatering equipment	68	58	54	51	48	44	42	38	34	31	28	22	18	45	75
Trenching machine/ excavator (20t)	77	67	63	60	57	53	51	47	43	40	37	31	27	45	75
Sideboom/ crane	80	70	66	63	60	56	54	50	46	43	40	34	30	45	75
Roller (non-vibratory)	81	71	67	64	61	57	55	51	47	44	41	35	31	45	75
Welding equipment	82	72	68	65	62	58	56	52	48	45	42	36	32	45	75
Micro-tunnelling/ directional drilling	84	74	70	67	64	60	58	54	50	47	44	38	34	45	75
Vibratory roller	86	76	72	69	66	62	60	56	52	49	46	40	36	45	75
Dozer D9	88	78	74	71	68	64	62	58	54	51	48	42	38	45	75
Chainsaw	91	81	77	74	71	67	65	61	57	54	51	45	41	45	75
Concrete saw/ excavator breaker (10t)	95	85	81	78	75	71	69	65	61	58	55	49	45	45	75

Equipment	10 m	30m	50m	75m	100m	150m	200m	300m	500m	700m	1000m	2000m	3000m	Noise affected NMLs	Highly noise affected NMLs
Excavator breaker (30t)	99	89	85	82	79	75	73	69	65	62	59	53	49	45	75

Ground-borne noise impact

Ground-borne noise is 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 breakers 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 vibrate and radiate noise.

Ground-borne noise is usually not a significant disturbance to building occupants during daytime periods due to higher background noise levels which mask the audibility of ground-borne noise. During night-time periods, when background noise levels are often much lower, ground-borne noise is more prominent and may result in noise impacts to building occupants.

Pipeline construction using tunnelling will likely generate ground-borne noise. Table 11-13 outlines the ICNG ground-borne noise criteria for residences. Objectives for other land uses are from AS/NZS 2107:2016 (AS, 2016). Exceedances of these levels, when higher than airborne noise levels, trigger the need for the implementation of management measures.

Table 11-13 Ground-borne noise objectives – internal noise levels

Land use	Period	GBN objectives $L_{Aeq(15min)}$
Residential	Daytime (7 am to 6 pm)	Not applicable. Human comfort vibration objectives only (as a guide 45 dBA – internal)
	Evening (6 pm to 10 pm)	40 dBA
	Night (10 pm to 7 am)	35 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

Pipeline construction noise impact assessment

Although pipeline construction noise levels may exceed the highly noise affected NML of 75 dBA as shown in Table 11-12, impacts will be for a limited period. Open trenching pipeline construction progresses in a linear direction along the pipeline alignment. This means that noise impacts will only occur in a specific location for a short period of time before the construction works progress away from the receiver.

Receivers where the highly affected level of 75 dBA may be exceeded are all within 100 m of the machinery emitting the noise. The number of impacted receivers will vary across the pipeline alignments. The most directly impacted receivers will be along the brine pipeline due to its location in more densely populated areas, as well as near the tunnelling locations of the environmental flows pipeline. Section 11.2.9 outlines management measures to minimise the predicted noise levels.

Tunnelling pipeline construction is required for several sections of the pipeline. A complete list of locations is provided in Chapter 4. These works are more static as construction activities are required at a single location for a longer period of time, in some cases up to six months. The highest impacts will be associated with the tunnelled construction at Bents Basin Road for the environmental flows pipeline, and the tunnelled construction at Lansvale Reserve for the brine pipeline. Both of these locations will likely require works 24 hours a day for a period of up to six months, as discussed below. Other pipeline construction locations, such as the main compounds on Park Road, may require a presence for greater than six months, however, it is unlikely any other locations will require 24/7 works. OOWH may also be required to reduce the impacts on traffic by avoiding partial closures during peak traffic periods.

It is predicted that ground-borne noise will be 40 $dBL_{Aeq(15min)}$ at 40 m and 35 $dBL_{Aeq(15min)}$ at 50 m from tunnelling pipeline construction. This will exceed the level specific in the ICNG as outlined in Table 11-13. Up to 14 residences along the environmental flows pipeline alignment may be impacted by ground-borne noise generated during OOHW. Levels of exceedance will need to be verified during detailed design when construction methodologies and plant/ equipment is confirmed. Management measures to minimise impacts from ground-borne noise are outlined in section 11.2.9.

Environmental flows pipeline tunnelling

The tunnelling works will require a compound at each end for the drilling operations, at the Warragamba River end (C1) and at Bents Basin Road (C2), and noise levels have been calculated at these compounds.

C2 is about 17 m from the closest residential receiver (NCA T8). This receiver will likely experience sound levels of between 75 and 91 dBA which is above the highly noise affected NML of 75 for standard hours work and significantly higher than the 35 dBA NML for out of hours night- time work.

C1 is about 225 m from the closest residential receiver. Predicted NMLs are not expected to exceed the highly affected level of 75 dBA. However, exceedances of the 45 dBA affected level during OOHW are likely.

Lansvale Reserve tunnelling

The brine pipeline will be constructed by tunnelling under Henry Lawson Drive and Prospect Creek. This will require a tunnelling site at Lansvale Reserve (compound C14), on the western side of Prospect Creek. This site will be about eight metres from the closest residential receiver (NCAB18). This receiver may experience sound levels of between 70 and 88 $dBL_{Aeq(15min)}$ which includes levels above the highly noise affected NML of 75 dBA for work during standard hours and significantly higher than the 45 dBA NML for out of hours night-time work. Noise level exceedances are only likely to occur if a rock breaker is used. A tunnelling site will also be required on the eastern side of Henry Lawson Drive (compound C15), where the brine pipeline will connect to the Malabar wastewater system. This site is further from sensitive receivers and is likely to have sound levels of between 60 and 75 $dBL_{Aeq(15min)}$.

Tunnelling works at these locations for the environmental flows pipeline and brine pipeline will require 24/7 construction and noise levels are predicted to exceed ICNG levels. The tunnelling compounds are required as close to the work sites as possible as they include processes and activities that directly support the tunnelling operations, such as management of spoil, fluid and housing of the tunnelling equipment. It is not feasible to locate the tunnelling compounds further away from the work area. Section 11.2.9 outlines management measures to minimise these impacts.

Construction compounds impact assessment

Compound sites are required to support project construction. Compounds for environmental flows pipeline tunnelling (C1 and C2), brine pipeline tunnelling at Lansvale Reserve (C14 and C15), and at the AWRC site (C8) are not included as they are assessed in earlier sections of this chapter. Compound sites will be required for different lengths of time and for different activities. The largest compounds may be required for the entire 36-month construction period. Chapter 4 provides more details on their use, location and timing.

Table 11-14 provides an overview of the predicted noise levels at each of the long-term compound sites. Noise levels above the 45 dBA highly noise affected NMLs, which are shown in red text. C3 and C4 have not been included due to the relative short duration, unlikely to require OOHW and distance to sensitive receivers. C5 has also not been included as this compound will only be required for temporary offices which will generate limited noise. All other compound sites, except C9, are predicted to exceed the noise affected NML, with only the C11 compound site likely to exceed the highly noise affected NML of 75 dBA.

The locations, timing and use of compound sites will continue to be refined and optimised during detailed design and construction planning. During these phases, opportunities to minimise noise impacts will be investigated. Section 11.2.9 outlines management measures to minimise the noise impacts from compound sites.

Table 11-14 Predicted construction noise levels at sensitive receivers closest to construction compounds

Compound	Distance to nearest receiver (m)	NCA	Total equipment noise level L_w (dB)	Predicted Noise Level, $L_{Aeq,15min}$	Standard hours		OOHW			Sleep disturbance level (dB)
					Noise affected NMLs, $L_{Aeq,15min}$ (dB)	Highly noise affected NMLs (dB)	Day (dB)	Evening (dB)	Night (dB)	
C6 – east	40 (residential)	T5	114	74	55	75	50	45	40	52
C6 - west	165 (residential)	T5	114	62	55	75	50	45	40	52
	40 (commercial)			74	75	75	70 (when in use)			N/A
C7	78 (residential)	T3	114	68	52	75	47	44	38	52
C9	665 (residential)	B4	114	50	50	75	50	50	45	55
	712 (commercial)		114	49	70	75	70 (when in use)			N/A
C10	40 (residential)	B5	114	74	55	75	50	50	45	55
C11	26 (residential)	B8	114	78	55	75	50	45	40	52

Compound	Distance to nearest receiver (m)	NCA	Total equipment noise level L_w (dB)	Predicted Noise Level, $L_{Aeq,15min}$	Standard hours		OOHW			Sleep disturbance level (dB)
					Noise affected NMLs, $L_{Aeq,15min}$ (dB)	Highly noise affected NMLs (dB)	Day (dB)	Evening (dB)	Night (dB)	
C12	68 (residential)	B19	114	70	75	75	55	50	45	55

Road traffic noise

Assessment criteria

Increased traffic generated on the public road network is assessed in accordance with the NSW Road Noise Policy (NSW EPA, 2011). When assessing noise impact on the existing road network, an initial screening test evaluates whether noise levels are expected to increase by more than 2 dBA due to the additional traffic generated by the proposed development. An assessment of the construction traffic generated by the project is provided in section 11.2.5, and operational traffic in section 11.2.6. Table 11-15 outlines the assessment criteria used to assess the project's traffic noise impact.

Table 11-15 Road traffic noise assessment criteria

Road category	Type of project/ land use	Assessment criteria - dBA	
		Day 7am – 10pm	Night 10pm – 7am
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)	60 $L_{Aeq(9hour)}$ (external)
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)

Impact assessment

Noise from construction traffic will occur within standard construction hours and OOHW. Impacts are not expected during standard construction hours due to noises being consistent with existing background traffic noise levels across the project alignment. However, impacts may occur during OOHW due to reduced background noise given reduced traffic volumes at these times.

Construction traffic on arterial roads will have a negligible impact. Impacts on local roads will be higher due to lower background noise levels. As construction planning and the identification of traffic routes has not yet occurred, an assessment of noise impacts from construction traffic is not possible. However, as most truck movements during construction will be associated with the AWRC, which will mainly be constructed during standard construction hours, impacts from construction traffic are not expected to be significant. The predicted increase in noise levels is below the RNP screening criterion outlined in Table 11-15 and therefore no further assessment is required. Impacts can be adequately managed through the implementation of the management measures in section 11.2.9.

Vibration impact assessment

Construction machinery has the potential to damage surrounding infrastructure as a result of vibration and low frequency noise. Minimum working distances have been identified based on the guidelines outlined in Table 11-8, particularly AS 2187, BS 7385 and DIN 4150 (BS, 1993; AS, 2016; DIN, 2016).

Structural impacts from vibration of construction equipment will depend on the proximity of the work to buildings and structures, as well as the material, condition and dynamic characteristics of the structure. Vibration impacts to buildings and structures from construction of the project are unlikely, due to the type of machinery proposed and the offset distances from the works to sensitive receivers. The project will require minimal tunnelling, with most construction via open trenching which limits vibration generation. Pipelines are also generally located along roadways in urbanised areas which offsets distances from private properties.

The brine pipeline will be tunnelled under the WaterNSW Upper Canal. The closest vertical distance/ clearance between the tunnel and the Upper Canal is seven metres. The geology includes a mixture of sandstone, clay and clayey sand. Predictions of the peak particle velocity (PPV) for the tunnelling suggest it will be below the DIN 4150 criteria that could result in cosmetic or structural damage. As a result, Sydney Water does not expect the tunnelling construction works to impact the Upper Canal.

Vibration and low frequency noise from pipeline construction has the potential to impact adjacent utilities and services. DIN 4150-2:2016 sets out guideline values for vibration effects on buried pipework. This includes impact to steel, concrete, plastic and masonry pipelines of between 50 and 100 peak component particle velocity (PCPV) measures on pipe in millimetres per second. Potential impacts to adjacent utilities and pipelines is unlikely during construction due to the designed offset distances from the works to the adjacent services, and the minimal vibration levels from construction machinery. Management measures for construction noise and vibration impacts are provided in Section 11.2.9.

Appendix S provides a more detailed assessment of vibration impacts to buildings, structures and building occupants.

11.2.6 Operational impact assessment

Assessment locations and scenarios

For the pipelines, the only components with potential to generate noise are the treated water pipeline and environmental flows pipeline release structures and valves along all pipelines.

The potential operational noise impact from Stage 1 of the AWRC is assessed assuming existing sensitive receivers remain, that the M12 Motorway is operational and that that major urban development in nearby areas of WSAGA has not occurred. The M12 Motorway is expected to increase the ambient noise levels by at least 5 dB. As such, the AWRC has been assessed based on this increase to the background acoustic environment. Although the Western Sydney International Airport is likely to increase average noise levels, the background noise level is unlikely to be affected due to the intermittent nature of aircraft movements.

Operational noise and vibration criteria

Operational noise impacts are assessed in accordance with the NPfI, which is primarily concerned with controlling short-term intrusive noise impacts 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 during the night period.

The NPfI 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, indicates a potential noise impact on the community requiring management. The PSNTL relates to noise emissions from fixed facilities, so it is the applicable reference measure for assessing the noise impact from the operation of the project.

Noise impacts are identified based on the PSNTLs. These are established relative to the existing background noise level in accordance with the equation below. This equation essentially means that if the equivalent average continuous sound level over a 15-minute period ($L_{Aeq,15minute}$) is less than or equal to the rated background level (RBL) plus 5 dB then there will not be an impact to residential receivers.

- $L_{Aeq,15minute} \leq$ RBL plus 5 dB

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 the NPfI where feasible and reasonable. To account for the potential cumulative impact of multiple industrial sites, the Project Amenity Noise Level (PANL), is the objective for a single industrial development at a receiver location.

Operational noise sources

All project components will operate 24/7. As the pipelines are located below ground, operational noise is expected to be negligible. Noise from pipeline valves will only occur if there is a malfunction and is not part of their standard operation. Noise from the treated water pipeline and environmental flows pipeline release structures is associated with flowing water being released from the pipelines into the receiving waterway. Whilst essentially negligible, the impacts associated with each of these activities, is considered in further detail, later in this section.

However, this assessment focuses on the AWRC given it is the project's main operational noise source. The following equipment and activities at the AWRC have the potential to generate noise during operation:

- Transfer pump stations.
- Biosolids outloading.
- Vehicles.
- Advanced water treatment.
- Odour control fans.

Appendix S includes a detailed list of equipment, plant and the likely noise levels they produce. This information has been sourced from existing water facilities, and the consultants' noise levels database. All plant and equipment at the AWRC will be subject to further design which may result in improvements to noise levels.

AWRC impact assessment

Table 11-16 outlines the predicted noise levels for different receivers for Stage 1 of the AWRC. Both standard and enhanced weather conditions have been assessed, as per the NPfI. Enhanced meteorological conditions relate to wind and high temperatures which enable sound to travel further and be detected at a higher level by sensitive receivers. A minor exceedance (1 dB) of PSNTLs for receiver R5 is predicted during enhanced weather conditions at night. All other receivers and conditions comply with PSNTLs.

Section 11.2.9 includes management measures, that if implemented will further reduce the noise levels at surrounding sensitive receivers, resulting in compliance in all standard and enhanced meteorological conditions.

Table 11-16 Predicted operational noise levels for Stage 1

Receiver	Standard meteorological conditions						Enhanced meteorological conditions					
	Day/Evening			Night			Day/Evening			Night		
	Predicted level	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance
R1	33	45	Yes	32	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	33	41	Yes	38	45	Yes	38	41	Yes
R5	37	45	Yes	37	41	Yes	42	45	Yes	42	41	No
R6	35	45	Yes	34	41	Yes	39	45	Yes	38	41	Yes

Operational traffic impact assessment

Traffic generated during operation of the AWRC will be minimal. The pipeline will generate infrequent traffic associated with inspections and maintenance, as outlined in Chapter 4. The AWRC will require up to 10 staff to operate. The likely operational traffic generated at the AWRC is outlined in Table 11-17. Most vehicle movements are expected to occur during standard hours, with potential for some infrequent out of hours visits associated with emergency or unplanned maintenance. Other, more infrequent vehicle movements may also occur that are not covered in Table 11-17, and are outlined in Chapter 4.

Table 11-17 Estimated total daily traffic movements at the AWRC

Activity	Vehicle type	Average daily movements (two-way)
Chemical deliveries	Heavy vehicle	7
Biosolids removal	Heavy vehicle	2
Staff trips	Light vehicle	10

Operational traffic will enter the AWRC via Clifton Avenue, off Elizabeth Drive. Table 11-18 outlines the predicted noise levels of these operational traffic movements. The increase in noise levels is expected to be minimal at about 0.01 dB for Elizabeth Drive and between 1.12 and 1.25 dB for Clifton Avenue. This increase is below the RNP screening criterion of 2 dB, and therefore no further assessment is required.

Table 11-18 Predicted traffic and noise level increases from AWRC operational traffic

Road	Road category	Average daily vehicle movements	Additional traffic generated by AWRC	% increase of total traffic	dB increase
Elizabeth Drive (west of Devonshire Road)	Sub-arterial Road	14,337	46	0.3%	0.01
Clifton Avenue	Local	52 (AM Peak) 55 (PM Peak)	10 (AM Peak) 10 (PM Peak)	33.3% (AM Peak) 29.3% (PM Peak)	1.25 (AM Peak) 1.12 (PM Peak)

Release structure impact assessment

Noise assessment from operation of the release structures at Nepean River and Warragamba River is based on the sound power levels, topography and distance to sensitive receivers. Both release locations are in areas inaccessible to the general public. The closest sensitive receiver to the treated water pipeline release structure is about 215 m south, and the closest sensitive receiver to the environmental flows pipeline release structure is about 300 m south east. This minimises the potential for them to impact surrounding sensitive receivers.

The noise from the operation of the release structures is predicted to be less than the 35 $dBL_{Aeq(15minute)}$ criteria specified in the NPfI for 'Acoustics of weirs'. As a result, noise impacts from the operation of the release structures is predicted to be minimal.

Pipeline valves impact assessment

Noise emissions from the normal operation of valves for this project will be minimal. The sizing of valve outlet orifices is standard and will be determined during the detailed design phase. Valves are located below ground in a pit so they can be accessed for maintenance. The pit and cover will further reduce any noise emissions.

Higher noise levels may be generated during a surge event, or if the valves malfunction. While higher noise events may result, the likelihood of a surge event is low (anticipated to occur no more than twice a year) and will generally last about five seconds. While noise levels will be minimised where practicable, it is considered that the standard noise criteria will not apply under surge events given they are infrequent and not part of normal operation. As a result, noise impacts from the operation of the valves along the pipeline is predicted to be minimal.

Green space area on AWRC site

Although use of the green space area as a recreation area is not currently permissible from a planning perspective, Sydney Water has completed an operational noise impact assessment to understand potential impacts on any future users. This assessment considers the cumulative operating noise from the AWRC, M12 Motorway and Western Sydney International Airport. Given noise levels from these combined sources, the green space area is not suitable for permanent education facilities. However, it is suitable for infrequent education purposes and public recreation where people will visit for short periods of time.

11.2.7 Impact of future stages

Operational noise impact assessment of future stages of the AWRC assumes that the AWRC is at its full operating capacity of 100 ML/day, and all surrounding development, including the M12 Motorway and Western Sydney International Airport, have been completed. Both the existing and future receivers are included in this assessment.

Table 11-19 outlines the predicted noise levels for different receivers under this scenario. It is predicted that exceedances will occur at RF1 - RF2 at night under standard weather conditions, and between one and three dB for R5, R6, RF1 and RF2. All other receivers and conditions comply with PSNTLs.

Table 11-19 Predicted operational noise levels for future stages

Receiver	Standard meteorological conditions						Enhanced meteorological conditions					
	Day/Evening			Night			Day/Evening			Night		
	Predicted level	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance
R1	35	45	Yes	34	41	Yes	34	45	Yes	34	41	Yes
R2	32	45	Yes	32	41	Yes	37	45	Yes	37	41	Yes
R3	35	45	Yes	35	41	Yes	40	45	Yes	40	41	Yes
R4	36	45	Yes	36	41	Yes	40	45	Yes	40	41	Yes
R5	37	45	Yes	37	41	Yes	42	45	Yes	42	41	No
R6	40	45	Yes	40	41	Yes	45	45	Yes	44	41	No
RF1	43	45	Yes	42	41	No	42	45	Yes	42	41	No
RF2	44	45	Yes	43	41	No	43	45	Yes	42	41	No
RF3	41	45	Yes	41	41	Yes	41	45	Yes	40	41	Yes
I1	47	68	Yes	N/A	68	N/A	52	68	Yes	N/A	68	N/A
I2	39	68	Yes	N/A	68	N/A	44	68	Yes	N/A	68	N/A
I3	43	68	Yes	N/A	68	N/A	47	68	Yes	N/A	68	N/A
A1	43	53	Yes	N/A	53	N/A	48	53	Yes	N/A	53	N/A

Receiver	Standard meteorological conditions						Enhanced meteorological conditions					
	Day/Evening			Night			Day/Evening			Night		
	Predicted level	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance	Predicted level (dB)	Criteria (dB)	Compliance
A2	47	53	Yes	N/A	53	N/A	47	53	Yes	N/A	53	N/A
A3	47	53	Yes	N/A	53	N/A	51	53	Yes	N/A	53	N/A
A4	44	53	Yes	N/A	53	N/A	48	53	Yes	N/A	53	N/A

11.2.8 Cumulative impacts

Construction

Any cumulative impacts during construction will be temporary. Cumulative noise impacts around the AWRC are likely to occur given the project is close to other major projects such as the M12 Motorway, Western Sydney International Airport, Sydney Metro – Western Sydney Airport, and Northern Road upgrade. However, these impacts are difficult to quantify during this stage of the project due to uncertainties in construction timing. Further consultation and construction planning is required with these project teams to identify and minimise potential for cumulative impacts to occur.

Cumulative noise impacts are also likely from pipeline construction where it is close to the other major projects listed above. The project's contribution to cumulative impacts during pipeline construction is unlikely to be significant due to the progressive nature of pipeline construction and short-term impacts in any one location. The exception to this is the tunnelling locations and compounds where construction is required for a longer period and may be located close to other major projects, including those listed above and the Warragamba Dam wall raising project. As for the AWRC, consultation with these project teams is required to identify and minimise potential for cumulative impacts to occur.

Operation

The project is considered unlikely to contribute to cumulative impacts during operation given the AWRC meets PNSTLs and noise generation from pipelines is minimal.

Section 11.2.9 includes management measures to address potential cumulative impacts.

11.2.9 Management measures

Sydney Water has focused on the following objectives when developing and designing management measures for noise and vibration impacts:

- Undertaking works and associated activities in a manner that minimises noise and vibration impacts on sensitive receivers.
- Minimising unreasonable noise and vibration impacts on residents and businesses.
- Avoiding cosmetic and structural damage to buildings, structures and/or heritage items.
- Undertaking active community consultation.
- Maintaining positive, cooperative relationships with schools, childcare centres, local residents and building owners.

Table 11-20 outlines the noise and vibration management measures Sydney Water will implement during construction and operation of the project. It is expected that implementation of construction management measures, including the use of physical barriers and quieter machinery will result in a reduction of noise levels in some locations by up to 10 dBA.

Table 11-20 Noise and vibration management measures

ID	Potential impact	Management measure	Timing
NV01	Excessive noise generated during construction	Prepare a Construction Noise and Vibration Management Plan (CNVMP) as part of the project's CEMP. This will include: • roles and responsibilities • noise sensitive receiver locations • management measures • monitoring methodology • community engagement.	Prior to construction During construction
NV02	Noise during out of hours work (OOHW)	Schedule construction works for standard construction hours, where possible. If it is not possible to restrict the works to the day period, then they are to be completed as early as possible in each work shift. Provide appropriate respite to affected receivers in accordance with the Interim Construction Noise Guideline (ICNG).	During construction
NV03	Equipment selection during construction generates excessive noise	Select equipment to minimise noise emissions. For example: • Select equipment with lower noise emissions than alternative equipment. • Use electric/ hydraulic equipment where possible. • Use the minimum size and power requirement to complete a task.	Prior to construction During construction
NV04	Inefficient operation and maintenance of equipment resulting in noise impacts	Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise, including: • Site managers to periodically check the site and nearby residences for noise problems so that solutions can be quickly applied. • Avoid the use of radios or stereos outdoors. • Avoid the overuse of public address systems. • Avoid shouting and minimise talking loudly and slamming vehicle doors. • Turn off all plant and equipment when not in use. • Maintain and monitor equipment to ensure proper and efficient operation. • Aligning with Sydney Water's Noise Management Code of Behaviour (SWEMS0056.01)	During construction

ID	Potential impact	Management measure	Timing
NV05	Inefficient use of construction vehicle reverse beepers	Implement and use non-tonal reversing beepers (or an equivalent mechanism) on all construction vehicles and mobile plant, where possible. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.	During construction
NV06	OOHW results in sleep disturbance of sensitive receivers	Consult with residents that will be impacted by OOHW about measures to manage impacts in accordance with the ICNG, including considering alternative accommodation. This includes residents near long term pipeline tunnelling compounds at Bents Basin Road and Lansvale Park.	Prior to construction During construction
NV07	Vibration from construction equipment results in impacts to structures	Investigate opportunities for using alternatives to vibration generating equipment where vibration impacts have the potential to occur.	Prior to construction During construction
NV08	Vibration from construction equipment results in impacts to structures	Undertake in-situ vibration monitoring to confirm vibration levels and assess potential impacts where minimum vibration impact distances cannot be achieved. Where the monitoring identifies exceedances in the relevant criteria, or where impacts are identified, additional management measures will be identified and implemented to appropriately manage impacts.	During construction
NV09	Vibration from construction equipment results in impacts to structures	Complete dilapidation and condition surveys on infrastructure and structures at risk from being damaged by vibration during construction, including heritage items.	Detailed design Prior to construction During construction
NV10	Operation noise impacts	Investigate opportunities to reduce the operational noise from the project, particularly at the AWRC. This will include: • pump selection with reduced noise levels • barriers and enclosures around noisy equipment to comply with AS 2436-2010 • building materials.	Detailed design

ID	Potential impact	Management measure	Timing
	Placement of construction equipment results in noise impacts	This impact is appropriately managed by measure G06 in Chapter 15 (Project synthesis).	Prior to construction
	OOHW truck movements results in noise impacts	This impact is appropriately managed by measures in section 11.4 (Traffic and transport).	Prior to construction During construction
	Significant long-term noise and vibration impacts from pipeline tunnelling	This impact is appropriately managed by measure G08 in Chapter 15 (Project synthesis).	Prior to construction During construction
	Construction traffic on local roads results in noise impacts	This impact is appropriately managed by measures in section 11.4 (Traffic and transport).	Prior to construction During construction
	Cumulative impacts from other major projects	This impact is appropriately managed by measure G10 in Chapter 15 (Project synthesis).	Prior to construction During construction

11.3 Landscape character and visual amenity

This section describes the project's potential impacts on landscape character and visual amenity during construction and operation. It summarises the key findings of the Landscape Character and Visual Impact Assessment (LCVIA) (Aurecon Arup, 2021g) included in Appendix T.

Landscape character and visual impact summary

Both the pipeline and AWRC components of the project will have temporary landscape character and visual impacts during construction, and the main operational impact is associated with the AWRC site.

Visual and landscape character impacts during construction are associated with visible construction activities and machinery and the removal of vegetation, including mature trees. The duration of impacts will be longer in some locations such as the AWRC site and compounds and shorter in others such as pipeline construction areas, where construction moves progressively along the alignment. Depending on the location and its sensitivity, the significance of impacts ranges from negligible to high but these will only be temporary.

Once completed, the AWRC will introduce large buildings and infrastructure into what is currently a rural setting. The visual impact will be high from some nearby viewpoints but there will also be some nearby locations from which the AWRC will not be visible.

Sydney Water has located the AWRC in an area that is expected to change over time to industrial and employment land uses and close to other major infrastructure such as the M12 Motorway. This change in surrounding visual environment will likely reduce the significance of the impact of the AWRC over time. The landscape-led approach to urban design provides opportunities positively enhance the visual impact of the AWRC by softening the buildings and providing visual interest through tree planting and architectural treatments. However, given the scale of the AWRC, this will minimise rather than entirely mitigate visual impacts.

During operation, the main above-ground structures for the pipelines will be the treated water and environmental flows release structures on Nepean and Warragamba Rivers. The visual impact of these structures is considered low because public access is limited and views are restricted by surrounding topography and vegetation.

Given most pipeline infrastructure will be underground, the other main operational impact results from vegetation removal to build the pipelines. Immediately after construction, impacts are likely to be moderate. However, once revegetation establishes, impacts across most of the pipeline alignment will reduce to negligible. In several localised areas, mature trees removed for pipeline construction cannot be replaced given the potential to damage the new pipeline. In these areas (including small areas around Wallacia, Luddenham, Cabramatta, Kemps Creek and Cecil Hills), ongoing impacts are likely to be moderate.

Sydney Water will implement a range of management measures to minimise landscape and visual character impacts, including looking for opportunities to minimise vegetation removal, screening construction areas, restoring and revegetating areas disturbed for pipeline construction and landscaping and architectural design at the AWRC site.

11.3.1 Relevant Secretary's Environmental Assessment Requirements

Table 11-21 summarises the project SEARs relevant to landscape character and visual impact and where in this section they are addressed.

Table 11-21 Project SEARs relating to landscape character and visual impacts

SEARs	EIS section where requirement addressed
46. An assessment of the visual impact of the project and any ancillary infrastructure during construction and operation on:	
a) views and vistas;	Sections 11.3.2, 11.3.5 and 11.3.6
b) key sites and buildings;	Sections 11.3.5 and 11.3.6
c) heritage items including Aboriginal places and non-Aboriginal heritage; and	Sections 11.3.5 and 11.3.6
d) the local community	Sections 11.3.5 and 11.3.6
47. Artist impressions, perspective drawings and view analysis of the project to illustrate how the project has minimised the visual impact through design and landscaping.	Sections 11.3.5, 11.3.6, 11.3.9 and Chapter 4

11.3.2 Methodology and assumptions

The key steps undertaken to assess the project's landscape character and visual impacts were:

- identifying baseline conditions
- selecting representative viewpoints and creating photos and photomontages
- landscape character impact assessment
- visual impact assessment
- identification of measures to manage landscape character and visual impact.

Each of these is described in more detail below.

Identifying baseline conditions in the study area

The study area was defined based on the distance at which project components would likely be discernible to the human eye, and where there are sensitive receivers who may be able to see it.

For the AWRC site, a digital elevation model was used to analyse topography around the AWRC site and identify a visual envelope which identified where the project would be visible at eye level from surrounding ridgelines, residential and rural lands. This resulted in defining the study area as a 3 km radius around the AWRC site.

The treated water and brine pipelines will be mostly located below ground and the visible structures will be low level or not visible to the public. On this basis, the study area defined for the pipelines was the project impact area (as shown in Figure 4-17) with a 50 m buffer to capture nearby sensitive receivers.

A desktop assessment identified existing qualities which define the landscape character of the study area. The aim was to define unifying landscape qualities such as landform, land cover and landscape value and identify recognised panoramas, views and key landmarks. The analysis was based on a review of legislation and planning instruments from local councils, aerial photography, mapping and topographical information, and other project EIS studies.

The desktop assessment identified 11 draft Landscape Character Zones (LCZs) that were verified and confirmed by site visits. The LCZs are described in Table 11-23.

Selecting representative viewpoints and creating photos and photomontages

The selection of key viewpoints was based on the desktop assessment and a site visit. The key viewpoints were selected to illustrate a range of:

- receptor types, including public and private domain views
- view types, including elevated panoramic and filtered views
- viewing distances from the project
- protected views in the study area
- areas of heritage significance.

The site visit investigated potential screening and filtering of these views from topography, existing vegetation and built form. All viewpoints were photographed from publicly accessible locations and private properties to demonstrate and reflect as closely as possible, the potential visual impacts from the project to views, vistas (views observed from specific receptors) and heritage from a representative sample of sensitive receivers.

Ten representative viewpoints around the AWRC site shown in Figure 11-7 indicate where the project will be the most visible. Photomontages were created by combining 3D model information of the AWRC with photographs from each viewpoint. The photomontages provide an indicative representation of the bulk and form of the AWRC in its setting and include landscaping and urban design components.

Eleven representative viewpoints were selected for the treated water pipeline (Figure 11-8) and eight for the brine pipeline (Figure 11-9). These viewpoints are represented by photographs. Photomontages have not been developed for the brine or treated water pipelines as construction impacts will be temporary and the infrastructure will be mostly located below ground or in areas that are not visible or accessible to the public.

The photomontages and photos inform the visual impact assessment.

Landscape character impact assessment

Landscape character is the combined built, natural and cultural aspects that make up an area and give a sense of place. The project's impact to landscape character was assessed by an impact rating based on sensitivity and the magnitude of change using the scale shown in Table 11-22. This rating was applied to each of the eleven LCZs shown in Table 11-23. Direct impacts (in the project's impact area) and indirect impacts (near the project's impact area) were considered.

Sensitivity is an assessment of value placed on the overall quality of each LCZ. It is based on whether the project will 'fit-in' or can be absorbed into the scale, land use, pattern and texture of the existing landscape. Sensitivity is then rated on the extent to which the LCZ can absorb change resulting from the project.

Magnitude of change refers to the nature, scale and duration of change resulting from the project that will affect landscape character. The assessment of the magnitude of change has considered:

- the scale of change, regarding the loss or addition of features in the view and changes in its composition
- degree of contrast or integration based on scale and form, height, colour and texture
- duration of the change
- angle and distance of the project from the LCZ.

Table 11-22 Scale of impact to landscape character and visual amenity

		Magnitude of impact			
		High	**Moderate**	**Low**	**Negligible**
Sensitivity	**High**	High	High-moderate	Moderate	Negligible
	Moderate	High-moderate	Moderate	Moderate-low	Negligible
	Low	Moderate	Moderate-low	Low	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

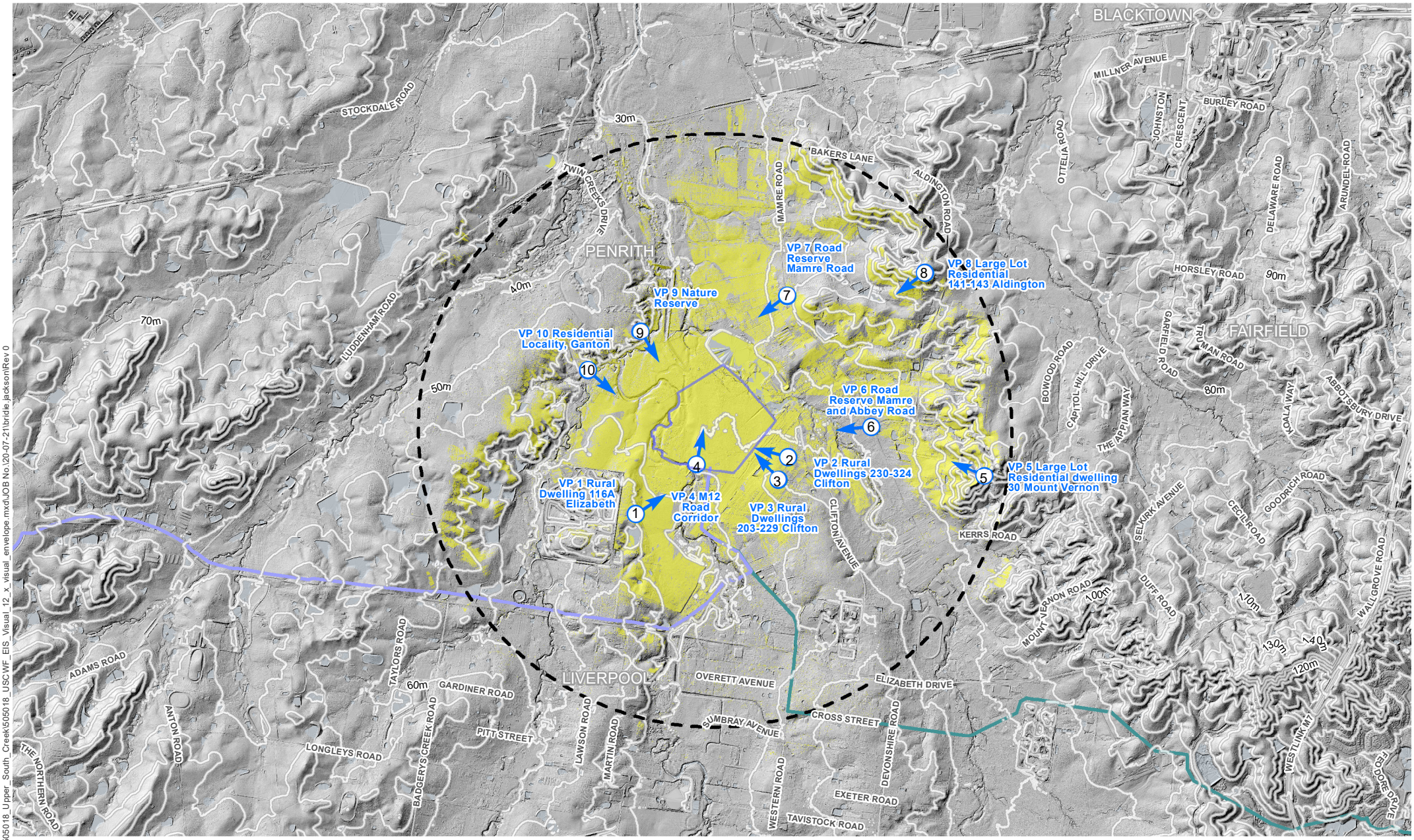
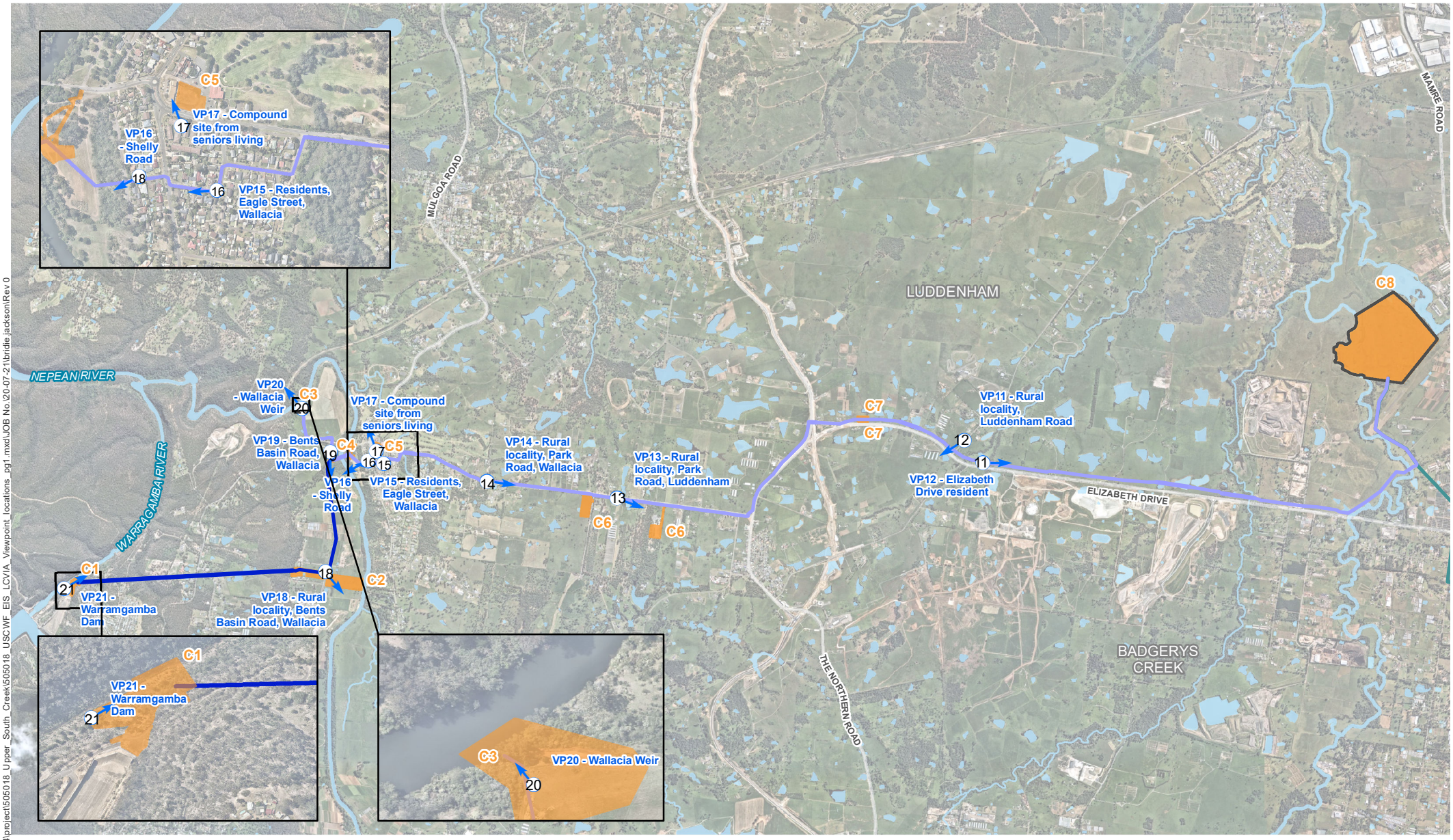


Figure 11-7 Representative viewpoints AWRC site

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56



Environmental Flows Pipeline
Treated Water Pipeline
Brine Pipeline
Advanced Water Recycling Centre

1 Viewpoint and direction*

*Arrow indicates general direction of the view and is not to scale

Compound Locations
Waterbody
Watercourse

1:62,500
0 0.5 1km

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

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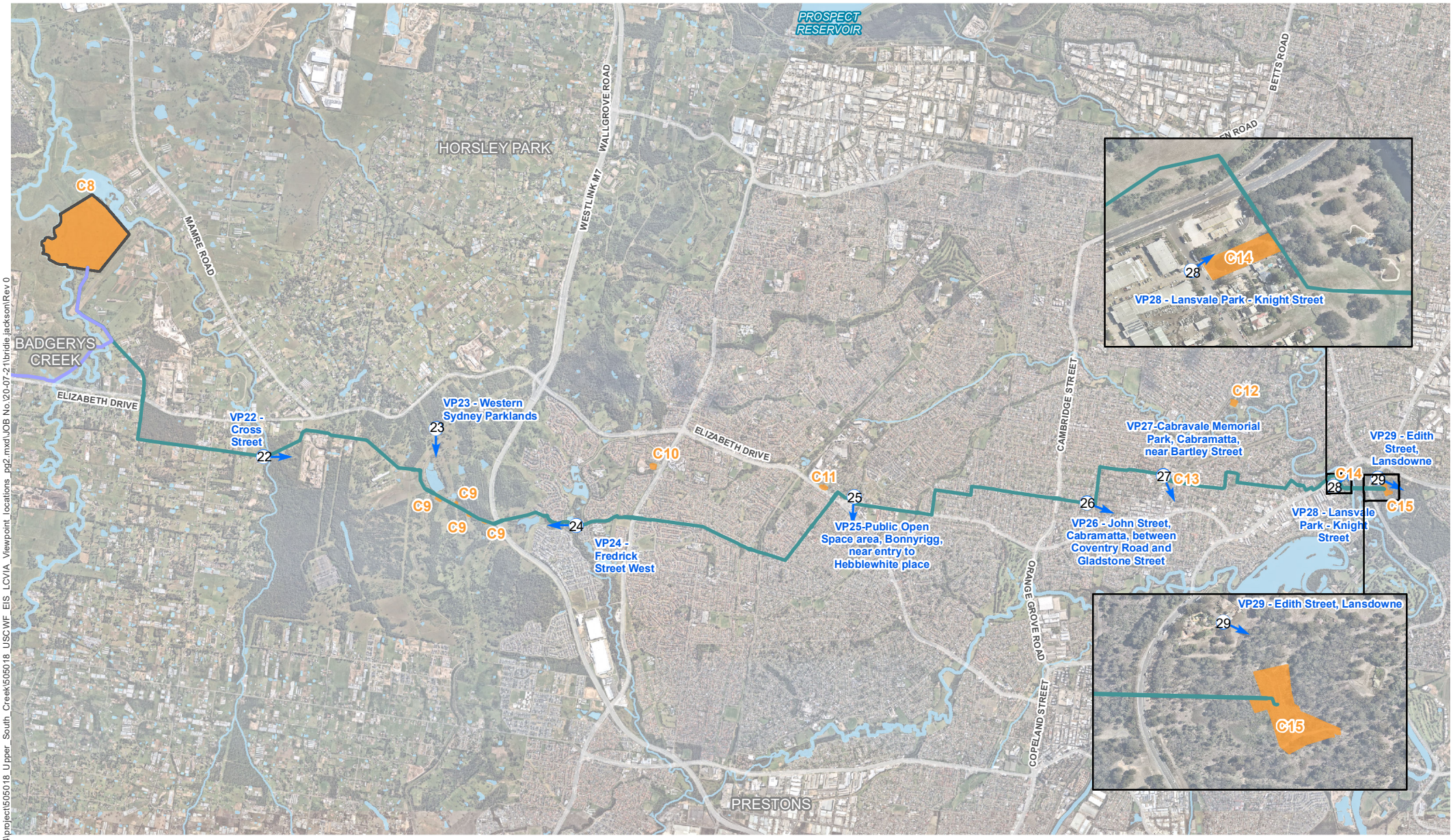
Figure 11-8 Representative viewpoints treated water pipeline



Treated Water Pipeline
Brine Pipeline
Advanced Water Recycling Centre
Compound Locations

Viewpoint and direction*

*Arrow indicates general direction of the view and is not to scale

Waterbody
Watercourse

1:74,000
0 1 2km

Figure 11-9 Representative viewpoints brine pipeline

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

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Visual impact assessment

Similar to landscape character, the assessment considered visual sensitivity and the magnitude of change to key viewpoints using Table 11-22.

Sensitivity is based on:

- scenic quality of the view
- value of the view
- duration of viewer activity
- the number of viewers exposed to the project
- the nature of the visual receptor (type and volume of sensitive receptors or viewers experiencing the view).

Magnitude of change refers to the scale, size and character of the project, its proximity to the viewer and the degree to which its effect has been mitigated by urban design or landscaping. Assessment of magnitude considers:

- scale, regarding the loss or addition of features in the view and changes in its composition
- degree of contrast or integration based on scale and form, height, colour and texture
- nature of view in relation to the project accounting for angle distance and extent
- mitigation, accounting for its effectiveness at reducing impacts over time.

Assumptions

The LCVIA makes the following key assumptions:

- Impacts were considered during project construction and operation of Stage 1 at one year and ten years after construction is complete. Considering impacts ten years after construction captures the effectiveness of management measures such as landscaping. This assessment of Stage 1 assumed limited changes to the existing environment resulting from urban development in the Western Sydney Aerotropolis Growth Area (WSAGA).
- Impacts of future project stages assumed some change to the existing surrounding environment as a result of urban development in the WSAGA.
- The assessment assumed all vegetation in the impact area (as showing on Figure 4-16 and Figure 4-17) will be removed during construction. Revegetation management measures for the treated water and brine pipelines assume that revegetation will be like for like except where infrastructure does not allow (for example, where deep tree roots may interfere with underground pipelines). In these areas, planting will be low lying for example, grasses and low shrubs.

- The assessment assumed the urban design approach for the AWRC site as outlined in section 4.4 will be implemented and that this contributes to mitigation of the project's visual impacts. The assessment identified particular locations and infrastructure on the AWRC site where future development of the urban design should incorporate design features to minimise visual impact.
- If the project cannot be seen there is no impact.

11.3.3 Existing environment

The project spans five local government areas in Western Sydney including Wollondilly Shire, City of Penrith, City of Liverpool, City of Fairfield and City of Canterbury-Bankstown.

The AWRC site is at a low point near South Creek, making it visible from high points, with views from some locations filtered through existing vegetation. It is vegetated with low level grasses and significantly modified from its natural state due to decades of clearing. Around the AWRC site, land uses include rural and rural residential lots and market garden businesses. Smaller creeks and farm dams are commonly found throughout the landscape. Twin Creeks Estate is a residential estate to the north west of the AWRC site which contains newly developed detached dwellings. The SUEZ Kemps Creek Resource Recovery Park is located south west of the AWRC site, off Elizabeth Drive.

Key land uses along the brine pipeline include residential suburban areas such as Cecil Hills, Bonnyrigg, Cabramatta West and Canley Heights which are predominantly low density single and double storey detached dwellings. There are also several commercial areas, including Cabramatta, and recreational areas including Western Sydney Parklands.

The treated water pipeline crosses rural residential lots along Elizabeth Drive and the villages of Wallacia, Mulgoa and Luddenham also contain low density rural residential lots.

Penrith City Council has prepared the Penrith Scenic Cultural Landscapes Study that categorises the landscape structure of Penrith LGA into eight broad landscape character units based on characteristics such as landform, landuse and vegetation cover. The project is located in:

- south western hills and valleys which are mostly intact rural settings with high tree cover. The treated water pipeline runs through this unit in the village of Wallacia
- south eastern low hills and valleys, containing many vegetated creeklines and green breaks across the landscape. The AWRC site is in this unit.

The study is a strategic level investigation that identifies highly visually sensitive landscapes and places and significant scenic and cultural landscapes associated with the landscape units. The AWRC and treated water pipeline are not located in highly visually sensitive landscapes. However, the treated water pipeline crosses the Mulgoa Valley significant scenic landscape which contains the township of Wallacia.

The 11 LCZs identified across the project study area are described in Table 11-23 and shown in Figure 11-10, Figure 11-11 and Figure 11-12. These LCZs are based on areas of landscape with unified characteristics that make them distinct from one another.

Table 11-23 Landscape character zones

Landscape Character Zone (LCZ)	Landscape character description
LCZ 1	**Rural land/future flexible employment land** This LCZ contains primarily agricultural and rural living land uses. Remnants of native vegetation and scattered trees remain.
LCZ 2	**Mount Vernon and Kemps Creek rural residential** The AWRC is close to the Mount Vernon and Kemps Creek rural and rural residential areas, which are zoned environmental living and primary production small lots. The LCZ includes undulating topography with multiple hills and ridgelines which allow open sweeping outlooks across surrounding lower lying land. Large residential dwellings are a common built form in rural residential areas with large residential lots.
LCZ 3	**Twin Creeks residential community and golf club** This LCZ is zoned for environmental living and private recreation. It includes high-quality detached dwellings on large landscaped lots.
LCZ 4	**Environmental conservation and future environment/ recreational zones** This LCZ is zoned for environment and recreation uses. The existing and future environmental and recreational parkland areas surrounding the AWRC site follow existing creek and riparian corridors. Native bushland vegetation exists near Warragamba and Nepean Rivers and existing pipeline and transmission line infrastructure are evident in the area. The Blue Mountains World Heritage area is located on Warragamba and Nepean Rivers.
LCZ 5	**Western Sydney International Airport** The airport is currently under construction. When complete the LCZ will be highly modified containing airport infrastructure.
LCZ 6	**Wallacia residential area** This LCZ is characterised by low density residential areas with commercial facilities and places of worship, a caravan park and a hotel present. Street trees and grassed nature strips exist on suburban streets.
LCZ 7	**Luddenham residential area** This LCZ is characterised by low density residential areas with commercial and community facilities. Street trees and grassed nature strips exist on suburban streets.
LCZ 8	**Warragamba/Silverdale township** This LCZ is characterised by low density residential areas with associated community facilities including sporting facilities, parks, places of worship, schools, and childcare centres.

Landscape Character Zone (LCZ)	Landscape character description
LCZ 9	**Resource recovery and quarrying** This LCZ contains the SUEZ Kemps Creek Resource Recovery Park. It is highly disturbed with considerable earthworks and landfill.
LCZ10	**Western Sydney Parklands** This LCZ contains Western Sydney Parklands which is used for recreational purposes. The LCZ includes ephemeral waterways such as Kemps Creek and large areas of native woodland.
LCZ11	**Residential localities** The LCZ is characterised by low density residential and commercial facilities through the City of Liverpool and City of Fairfield LGAs. Street trees and grassed nature strips exist on suburban streets and recreational areas are present.

11.3.4 Legislation and guidelines

Although there are no legislative provisions that explicitly apply to visual impacts, Chapters 2 and 5 outline a range of strategic and policy documents, many of which have aspirations associated with maintaining or improving visual character. These include the Western Sydney Aerotropolis Plan ((Western Sydney Planning Partnership, 2020a), State Environmental Planning Policy (Western Sydney Aerotropolis) 2020 and local government local strategic planning statements. This landscape character and visual impact assessment considers these strategic statements in assessing impacts and design of management measures.

The assessment used the following guidelines and standards relevant to landscape character and visual impact assessment:

- Guideline for Landscape Character and Visual Impact Assessment – EIA N04 (TfNSW, 2018b).
- Guidelines for Landscape and Visual Impact Assessment (third edition) (Landscape Institute of Environment Management and Assessment (IEMA, 2013)).
- Guidance Note for Landscape and Visual Assessment (AILA (Queensland chapter), 2018).
- AS4282-1997 Control of the obtrusive effect of outdoor lighting (AS,1997b).
- Institution of Lighting Professionals; Guidance Notes for the Reduction of Obtrusive Light GN01:2011 (ILP, 2011)

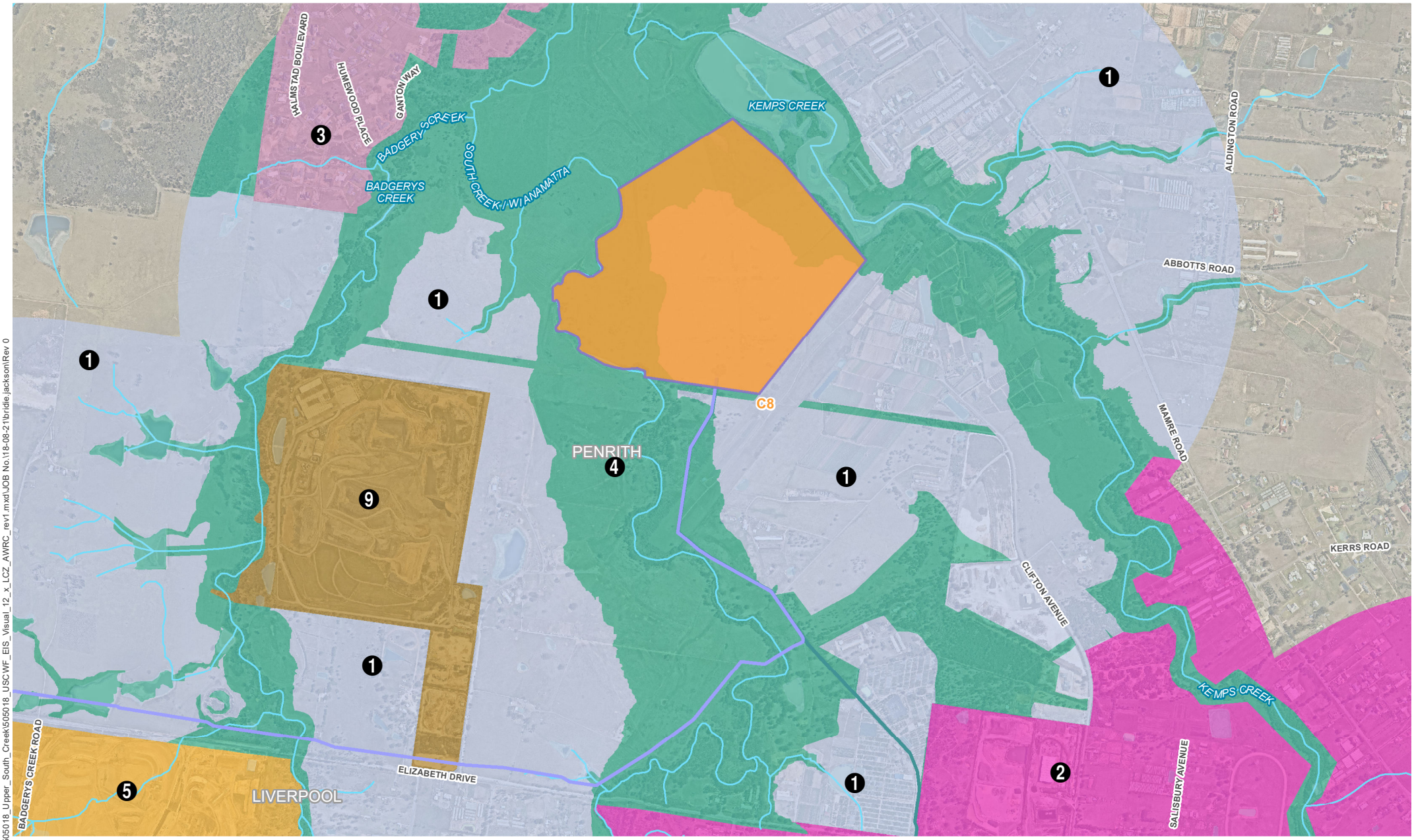

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Figure 11-10 Landscape character zones around AWRC site

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

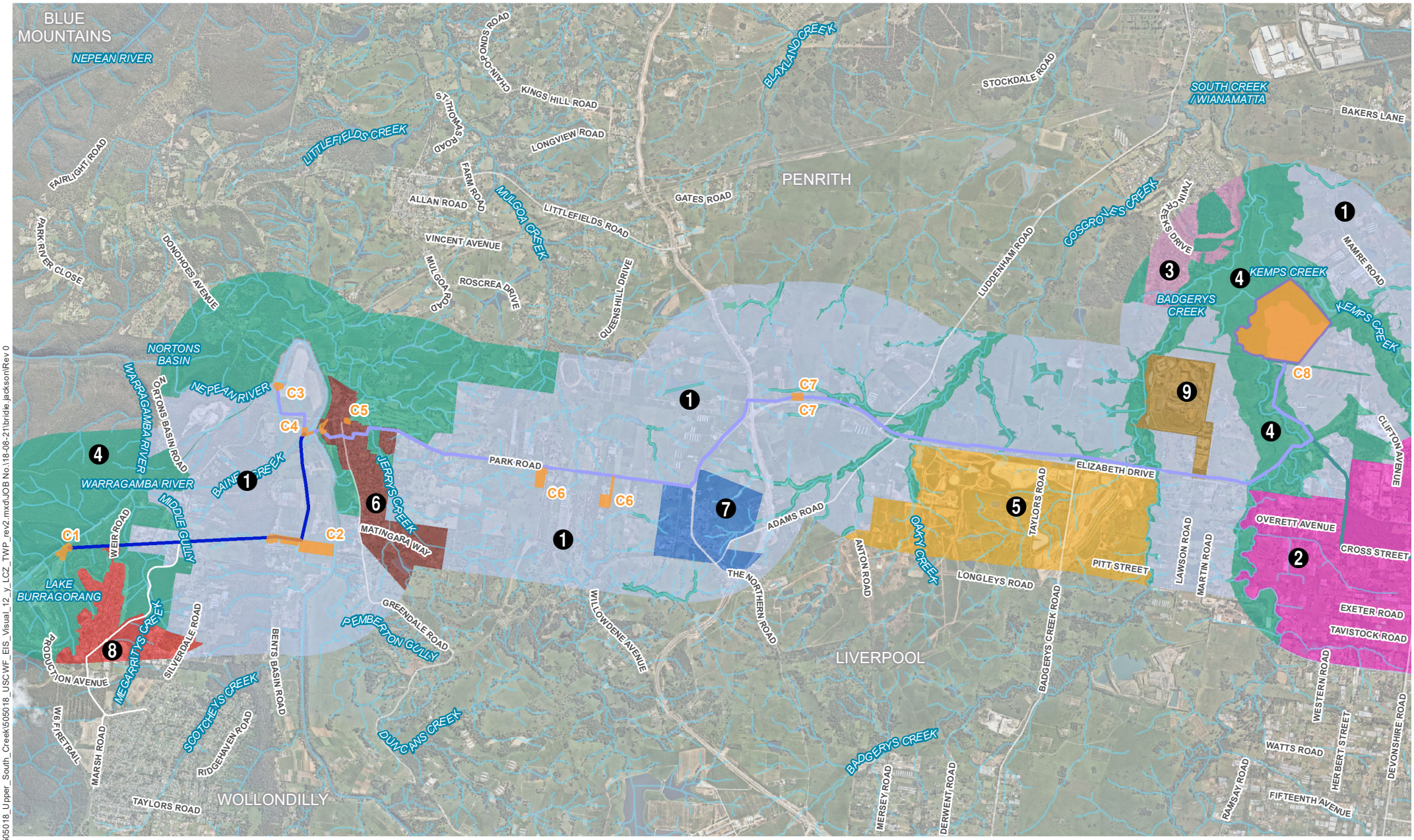

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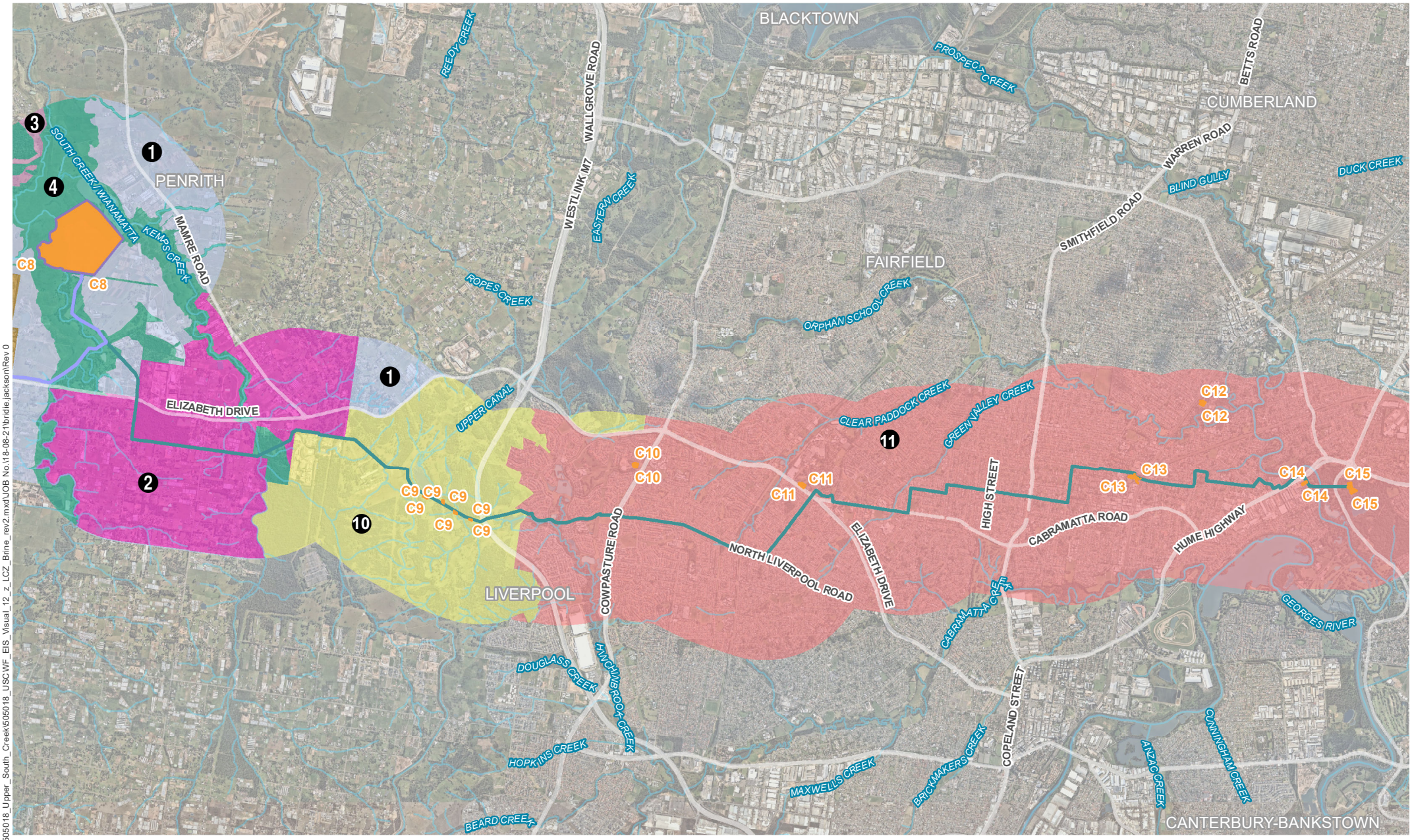
Figure 11-11 Landscape character zones along treated water and environmental flows pipeline

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56



Treated Water Pipeline
Brine Pipeline
Advanced Water Recycling Centre
Compound Locations

Landscape Character Zones

1 - Rural Land / Future Flexible Employment land
2 - Mount Vernon and Kemps Creek Rural Residential
3 - Twin creeks Golf Club and Residential Community
4 - Environmental Conservation and Future Environment/Recreational Zones
9 - Resource Recovery and Quarrying
10 - Western Sydney Parkland Area
11 - Residential Localities
Waterbody
Watercourse

1:73,000
0 0.5 1 km

Figure 11-12 Landscape character zones along brine pipeline

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

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11.3.5 Construction impact assessment

The project's construction landscape character and visual impacts will be temporary and the duration of construction impacts varies depending on location. The following sections describe these impacts associated with the AWRC site and pipelines. As construction impacts are temporary, only those temporary landscape character impacts that are assessed to be high to high moderate are included. LCZs with negligible, low, low moderate or moderate impacts are detailed in Appendix T.

Appendix T includes a full description of construction impacts on each of the 11 LCZs.

Landscape character

Table 11-24 describes the project's impacts on each LCZ. For the AWRC, moderate indirect impacts may occur for LCZ2 and LCZ4 because they are close to where the AWRC is being constructed. Construction impacts for LCZ3, LCZ5 and LCZ9 are expected to be negligible.

All other construction impacts associated with the pipeline construction are moderate (LCZ1 and LCZ2) to negligible (LCZ5 and LCZ8)

Table 11-24 Summary of landscape character construction impacts for LCZs

LCZ	Sensitivity	Magnitude	Impact	Description of potential impact
AWRC				
LCZ1	Moderate	High	High-moderate	LCZ1 has moderate sensitivity due to existing agricultural land uses and nearby rural residential receivers. Impacts will be due to the establishment of a large construction site, vegetation clearing, machinery and buildings within this LCZ for the duration of the construction period.
Treated water pipeline				
LCZ4	High	High	High	The established environmental and conservation areas have a high level of sensitivity. Impacts will be due to vegetation clearing and pipeline construction activities such as trenching and associated earthworks. Construction activities will be noticeable to nearby residents on Park Road and compounds C4 and C5 are located in this LCZ.
LCZ6	High	High	High	The residential area of Wallacia along Park Road and local streets contains low density dwellings with some commercial and community facilities including places of worship, a caravan park and a hotel. The sensitivity is high because this is a residential area and people are sensitive to changes to their surrounds. Impacts will be due to pipeline construction activities such as trenching and associated earthworks. Construction compounds C4 and C5 are located in this LCZ.
LCZ7	High	Moderate	High-moderate	The sensitivity is high because Luddenham is a residential area and people are sensitive to changes to their surrounds. Impacts will be localised due to construction activities such as trenching and associated earthworks near the main point of access to Luddenham, the junction of Park Road and the Northern Road.

LCZ	Sensitivity	Magnitude	Impact	Description of potential impact
Brine pipeline				
LCZ10	High	Moderate	High-moderate	Construction in Western Sydney Parklands will be mostly within cleared parcels of land, however the sensitivity is high because it is valued as a conservation and recreational area. Impacts are due to the construction compounds (C9) and associated activities and vegetation removal to the east of Kemps Creek near Brandown Quarry and to the north of Brandown Quarry.
LCZ11	High	High	High	For LCZ11 there are residential, commercial and recreational land uses such as shops, supermarkets, parks and reserves. The sensitivity is high because construction will be close to existing receivers who may be sensitive to changes in their surrounds. Impacts to this LCZ are due to pipelaying construction activities and active construction compounds (C11-C15), including a tunnelling compound in Cabravale Park (C13).

Visual impact

Table 11-25 and Table 11-26 summarise potential construction impacts on representative viewpoints across the project. As construction impacts are temporary, only those temporary visual impacts that are assessed to be high to high moderate are included. Viewpoints with negligible, low, low moderate or moderate impacts are detailed in Appendix T.

As was the case with landscape character, the duration of construction impacts varies depending on location and the type of activity. Viewpoints with the potential to be impacted by the longest duration construction activities include compound sites such as the AWRC site. For these viewpoints the visibility of construction compounds to sensitive receivers is associated with high to high moderate construction impacts.

During construction, potential visual impacts to non-Aboriginal heritage items are associated with:

- views from the Blue Mountains World Heritage Area to the release structure at Warragamba River (VP21)
- views to and from Blaxland's Farm close to the Nepean River release location (VP20)
- views across the Fleurs Radio Telescope Site at the AWRC site (VPs 1-5 and VPs 7-8)
- views of the Cabravale Memorial Park bandstand (VP27).

Impacts to views associated with construction of the release structure are moderate and mitigated by existing vegetation and limited public access. Impacts to views of the Cabravale Memorial Park which include the bandstand may be high however impacts associated with construction will be temporary. Impacts to views of the AWRC during construction are moderate to high in some locations (Table 11-25) and are partly due to the removal of existing structures including structures associated with the Fleurs radiotelescope site. There are no visual impacts associated with Aboriginal heritage for the project. Sections 10.1 and 10.2 discuss the project's impacts on Aboriginal and non-Aboriginal heritage in detail.

During construction, there will be no visual impacts associated with key sites or buildings other than the above heritage items.

Construction will require night-works in some locations, particularly along pipeline alignments on major roads to minimise traffic impacts. These works will require artificial lighting. Light spill from construction activities may result in visual impacts and impacts to the amenity of residents and occupants nearest to pipeline construction works and ancillary facilities. Light spill impacts for nearby residential receivers will be temporary. Provided the management measures in section 11.3.9 are implemented the impact of nightworks to nearby receivers is expected to be low.

Overall construction impacts

Although construction impacts to landscape character and visual amenity are high or high-moderate in some locations, and may impact the local community, these are temporary impacts. Sydney Water has considered a range of options to minimise environmental and community impacts as outlined in Chapter 3. Sydney Water has also identified management measures in section 11.3.9 to minimise remaining impacts as far as practical.

Table 11-25 Summary of construction impacts on representative AWRC viewpoints

Viewpoint	Location	Sensitivity	Magnitude	Impact	Description of potential impact
VP1	Rural dwelling – 1669A Elizabeth Drive Badgerys Creek	High	Moderate	High-moderate	The view is a rural landscape with scattered mature trees. The sensitivity is high because of the natural setting with little built form. The impacts are due to the visibility of the AWRC construction site and construction activities such as removal of vegetation and existing structures earthworks, hoardings, machinery, construction vehicles and buildings even though seen from a distance.
VP2	Rural Dwellings – 230-234 Clifton Avenue Kemps Creek	High	High	High	The view is of a rural setting with agricultural landscapes. The sensitivity is high because of the rural setting with little built form. The impacts are due to the visibility of the AWRC construction site and construction activities. Construction of the M12 Motorway may also be apparent from receivers at this viewpoint.
VP3	Rural Dwellings – 203-229 Clifton Avenue Kemps Creek	High	High	High	The view is of cropped fields with tree covered hills in the background. The sensitivity is high due to the natural landscape and little built form. The impacts are due to visibility of construction activities being a contrast to the existing rural setting.
VP8	Residential dwellings – 141-143 Aldington Road, Kemps Creek	High	Moderate	High-moderate	The view is of large lot residential dwellings located cleared agricultural land, some buildings and distant views to the Blue Mountains. The sensitivity is high because of the elevated view over the rural landscape. The impacts are due the visibility of construction activities being a contrast to the existing rural setting.

Table 11-26 Summary of construction impacts on representative treated water and brine pipeline viewpoints

Viewpoint	Location	Sensitivity	Magnitude	Impact	Description of potential impact
Treated water pipeline					
VP11	Rural locality, Luddenham Road, near 889 Luddenham Road, Luddenham	High	High	High	The view consists of fenced rural properties and mature trees. Potential impacts are due to the visibility of pipeline construction works and construction vehicles along Luddenham Road to road users and rural residents.
VP12	Rural residential locality, Elizabeth Drive, Luddenham	High	High	High	The view looks east along Elizabeth Drive. The sensitivity is high because of large mature trees that can be seen from this viewpoint. Impacts are due to construction works that may result in the removal of mature trees. The construction compound C7 is located further west and cannot be seen from this view.
VP13	Rural locality, Park Road, Luddenham	Moderate	High	High-moderate	The view is of fenced rural properties, a nature strip and mature trees looking east along Park Road. The sensitivity is moderate. Impacts are due to construction activities that may result in the removal of mature trees and the visibility of the construction compound (C6).
VP14	Rural locality, Park Road, Wallacia	Moderate	High	High-moderate	The view is of a typical roadside area with a large set-back for rural properties. The sensitivity is moderate due to the large trees on the edge of the road and the visibility of electrical infrastructure. Impacts are due to construction activities that may result in the removal of mature trees.
VP15	Residents, Eagle Street, Wallacia	High	High	High	The view is of residential dwellings, mature trees in property boundaries and nature strips. The sensitivity is high because the mature trees screen dwellings and have high visual amenity. Impacts are due to construction activities that may result in the removal of trees and the visibility of a construction compound.

Viewpoint	Location	Sensitivity	Magnitude	Impact	Description of potential impact
VP16	Residents, Byron Avenue, Wallacia	High	Moderate	High-moderate	The view looking west to vegetation on the top of a slope that falls away to Nepean River. The sensitivity is high because of the lack of development and the bushland setting. Impacts will be due to construction activities that may require the removal of trees. The construction compound (C4) would not likely be visible from this viewpoint.
VP17	Wallacia rural village area, Park Road, Wallacia	Moderate	High	High-moderate	The view consists of an overflow car parking area behind local shops in Wallacia. The sensitivity is moderate due to the developed landscape and residential receivers. Impacts will be due to the visibility of the compound (C5).
VP18	Rural locality, Bents Basin Road, Wallacia	Moderate	High	High-moderate	The view is looking south east and of fenced rural landscape with mostly cleared vegetation and without built structures. The sensitivity is moderate. Impacts will be due to the visibility of the compound (C2) and associated construction activities.
Brine pipeline					
VP22	Rural locality, Cross Street Kemps Creek, near Pratten Street	High	Moderate	High-moderate	The view looks east towards the Western Sydney Parklands boundary. The sensitivity is moderate due to mature tree canopies and fenced rural property boundaries in viewpoint. Impacts will be due to the removal of mature trees.
VP23	Western Sydney Parklands, near Liverpool Offtake Reservoir	High	Moderate	High-moderate	The view is taken from the Wylde Mountain Biking trail looking south and is representative of the view within the parklands experienced by recreational users. The sensitivity is high and impacts will be due the visibility of construction compounds (C9).

Viewpoint	Location	Sensitivity	Magnitude	Impact	Description of potential impact
VP24	Feodore Drive, Cecil Hills/Elizabeth Hills, near Lascelles Street	High	Moderate	High-moderate	The view looks west and consists of a streetscape with residential properties, maintained nature strips mature street trees. The sensitivity is high. Impacts will be due to pipeline construction activities that may require the removal of mature trees.
VP25	Public Open Space area, Bonnyrigg, near entry to Hebblewhite Place	High	High	High	The view is looking south towards Cabramatta Road and consists of maintained grass areas and property boundaries. The sensitivity of the viewpoint is high because of the amenity provided by the recreational area. Impacts will be due to the removal of mature trees and the construction compound (C10) which will occupy the public space.
VP26	Residents John Street, Cabramatta, between Coventry Road and Gladstone Street	High	High	High	The view is a streetscape of residential dwellings and mature trees. The sensitivity of the viewpoint is high because the street trees provide amenity to the built-up residential area. Impacts will be due to construction activities that may require the removal of street trees.
VP27	Cabravale Memorial Park, Cabramatta, near Bartley Street	High	High	High	The view is of Cabravale Memorial Park. The sensitivity of the viewpoint is high because the local heritage item 'bandstand' is located within the park. The park has maintained grass, matured trees and has recreational value. Impacts will be due to construction activities associated with the compound (C13) which will include drilling, earthworks, spoil and equipment storage.

Viewpoint	Location	Sensitivity	Magnitude	Impact	Description of potential impact
VP28	Lansvale Park, Knight Street, Lansvale	High	High	High	The view looks east towards Lansvale recreational reserve and consists of maintained grass and large mature trees. The sensitivity is high because of high visual amenity and recreational use by the public. Impacts will be due to the visibility of the compound (C14) and construction activities such as drilling, spoil and equipment storage. The removal of mature trees may be required.
VP29	Edith Street, Lansdowne	High	High	High	The view looks south towards Lansdowne Reserve. There is a grassed area which adjoins bushland area with large mature trees. The sensitivity is high. Impacts will be due to the visibility of the compound (C15) and associated activities including drilling, earthworks, spoil storage, pipe welding and materials laydown.

11.3.6 Operational impact assessment

Landscape character

Most operational impacts are negligible for LCZs at year 10, with moderate impacts remaining for LCZ1 and LCZ4 associated with the AWRC and LCZ4 for the treated water pipeline. Accordingly, a brief description is provided here but a full description of operational impacts is included in Appendix T.

AWRC

The overall operational impact of the AWRC for LCZ1 and LCZ4 is expected to be high to moderate prior to establishment of landscaped areas (year 1), due to the large infrastructure associated with the AWRC and the moderate to high sensitivity of these LCZs. These impacts will reduce to moderate when landscaping and urban design becomes established (year 10). Impacts to remaining LCZs during operation will be negligible.

Surrounding landscape character is also expected to change over time with the completion of the M12 Motorway and as surrounding areas of WSAGA develop which are currently proposed as enterprise zones. These surrounding landuse changes will further mitigate impacts to landscape character. High to moderate impacts are acceptable because they will reduce to moderate over time and the AWRC is essential infrastructure providing essential services to the Western Sydney community.

Pipelines

Although most pipeline infrastructure will be underground, some moderate impacts may occur in year 1 prior to revegetation. These impacts reduce to negligible when vegetation becomes established however there may be a medium-term impact until this occurs. The main longer-term change to landscape character will be due to the removal of mature trees which cannot be replaced over the pipeline given the potential for their roots to damage infrastructure. These areas are expected to be small and localised, with impacts reducing over time as surrounding vegetation becomes established.

Potential moderate impacts (year 1) to LCZ4 and LCZ6 have been identified due to the removal of trees in a several small localised areas such as:

- Byron Avenue, Eagle Street and Park Road in Wallacia
- Park Road, Elizabeth Drive, and Luddenham Road in Luddenham.

Once vegetation is established, moderate impacts may remain for LCZ4.

Moderate impacts may occur in LCZs 10 and 11 due to small areas where tree removal may occur (John Street in Cabramatta, Cross Street in Kemps Creek, and Feodore Drive in Cecil Hills) and potential to increase visibility of Brandown Quarry in LCZ10.

Visual impact

AWRC

Table 11-27 summarises the visual impacts of the AWRC during operation from key viewpoints and considers established landscaping (year 10) implemented as part of the project. Figure 11-13 to Figure 11-26 show photos from the representative viewpoints taken in 2020 and photomontages from the same viewpoints providing an indicative representation of Stage 1 of the AWRC. The AWRC is not expected to be visible from VP7, VP9 and VP10 and these are not included in the table and figures below. Appendix T includes detailed assessment and photomontages for these viewpoints.

During operation the AWRC may result in ongoing visual impacts to nearby receivers and the local community due to the bulk and size of the facility present within the landscape. High-moderate to high impacts have been assessed for nearby residential receivers at viewpoints VP2 and VP3. VP1, VP4-7 and VP8 -10 have moderate to negligible impacts as the AWRC is visible from nearby high points but not a significant contrast from existing built structures visible from the viewpoints.

Permanent changes to the AWRC site resulting in moderate-high impacts will include the removal of existing heritage structures associated with the Fleurs Radio Telescope site. Section 10.2 provides further consideration of the heritage impacts on this item, including opportunities for heritage interpretation.

Implementing an Urban Design and Landscaping Plan that aligns with the urban design principles described in Chapter 4, will contribute to minimising visual impacts to the local community through tree plantings, and architectural treatments will assist with blending into the landscape and providing visual interest. However, given the scale of the AWRC, this will minimise rather than entirely mitigate visual impacts.

The AWRC is a large facility and the extent to which its bulk can be reduced is limited by operational and engineering needs. However, Sydney Water has been through a comprehensive site selection process for the AWRC as outlined in Chapter 3, including locating it in an area that is expected to change over time to industrial and employment land uses and be close to other major infrastructure such as the M12 Motorway. Sydney Water has also proposed measures to minimise visual impacts as far as practical through urban design and landscaping and given the essential nature of the infrastructure, the residual impacts are considered acceptable.

Operational lighting on the AWRC site also has the potential to impact nearby residential receivers (such as those located at VP2 and VP3). However, the nearest receiver is 400 m from the site boundary. There is also potential for operational lighting to impact overhead aircraft from Western Sydney Airport. Provided operational lighting design is undertaken in accordance with Australian Standard 4282-1997 *Control of the obtrusive effect of outdoor lighting to minimise light spill* and with Civil Aviation Safety Authority (CASA) requirements the visual impacts arising from operational lighting are expected to remain low.

Pipelines

Table 11-28 summarises the visual impacts of the treated water pipeline, environmental flow pipeline and brine pipeline. Given the pipelines are largely below ground with limited low-level structures, this table focuses on the key above-ground components which are the treated water release structures at Nepean and Warragamba Rivers. Figure 11-27 and Figure 11-28 show existing viewpoints at these locations.

During operation the treated water and brine pipelines may result in visual impacts to nearby receivers and the local community until vegetation and planting becomes established. Potential high-moderate impacts may occur for viewpoints VP12, 15, 16, 22, 26 and 27 and are due to the potential removal of mature trees. All impacts reduce in severity as vegetation becomes established, although high moderate impacts for VP15 and VP26 will remain because pipeline infrastructure may limit like for like revegetation.

All other potential impacts to viewpoints are assessed as negligible to moderate with moderate impacts being due to the high sensitivity of receptors.

Potential visual impacts to non-Aboriginal heritage items are associated with views from the Blue Mountains World Heritage Area to the release locations to Warragamba River (VP21), views to and from Blaxland's Farm close to the Nepean River release location (VP20), and views of the Cabravale Memorial Park bandstand (VP27). Impacts to views of the release structures are low to low moderate and mitigated by existing vegetation and limited public access. Views of the Cabravale Memorial Park bandstand will not be impacted during the operational stage. There are no visual impacts associated with Aboriginal heritage for the project.

There are no visual impacts associated with key buildings or sites other than the above heritage structures.

Table 11-27 Summary of visual impact of AWRC during operation

Viewpoint	Receptor	Sensitivity	Magnitude	Impact	Description of potential impact
VP1	Rural dwelling – 1669A Elizabeth Drive Badgerys Creek 800 metres from AWRC	High	Low	Moderate	The view is a rural landscape with scattered mature trees. The sensitivity is high because of the natural setting with little built form. The impacts are due to the visibility of some of the taller AWRC structures however the M12 Motorway is expected to dominate the viewpoint.
VP2	Rural Dwellings – 230-234 Clifton Avenue Kemps Creek 400 metres from AWRC	High	High	High	The view is of a rural setting with agricultural landscapes. The sensitivity is high because of the rural setting with little built form. The nearest receptor is 400 m from the AWRC and impacts are due the visibility of the AWRC which will be prominent to these receivers.
VP3	Rural Dwellings – 203-229 Clifton Avenue Kemps Creek 540 metres from AWRC	High	Moderate	High moderate	The view is of cropped fields with tree covered hills in the background. The sensitivity is high due to the natural landscape and little built form. The impacts are due to the tallest AWRC components being visible above the horizon. The M12 Motorway will be visible from this location.
VP4	M12 road corridor, Fleurs Farm 60 metres from AWRC	Low	High	Moderate	The view is of the AWRC site from the location of the future M12 Motorway. The sensitivity is low because the view for road users will be short in duration. Impacts are due to the close proximity and the apparent bulk of the AWRC to M12 Motorway users.

Viewpoint	Receptor	Sensitivity	Magnitude	Impact	Description of potential impact
VP5	Residential dwellings – 30 Mount Vernon Road, Mount Vernon 2.6 kilometres from AWRC	High	Low	Moderate	The view is of undulating hills looking towards the AWRC with cleared land, some mature trees, buildings and the Blue Mountains in the distance. The sensitivity is high because it is currently a largely undeveloped rural landscape. The impacts are due to the AWRC being visible above existing tree canopies. The AWRC will appear small in the view.
VP7	Road reserve – Mamre Road 1.6 kilometres from the AWRC	Moderate	Low	Moderate low	The view contains tall grass and cultivated fields, large mature trees and electricity transmission lines. The SUEZ Kemps Creek Resource Recovery Park is visible in the background. The sensitivity in moderate to residential receptors as the viewpoint is modified. Impacts are due to AWRC components being visible over the tree canopy.
VP8	Residential dwellings – 141-143 Aldington Road, Kemps Creek 2.4 kilometres from the AWRC.	High	Moderate	Moderate	The view is from an elevated point on a hill looking down over the rural landscape containing some built elements. The sensitivity is high. Impacts are due to visibility of larger AWRC components such as the digesters.

Figure 11-13 Viewpoint 1 (VP1) – 1669A Elizabeth Drive Badgerys Creek looking north-east towards the AWRC

Figure 11-14 VP1 indicative photomontage of Stage 1 operational area of the AWRC

Figure 11-15 VP2 – 230-234 Clifton Ave looking north west towards the AWRC

Figure 11-16 VP2 indicative photomontage of Stage 1 operational area of the AWRC

Figure 11-17 VP3 – 203-229 Clifton Ave looking north west towards the AWRC

Figure 11-18 VP3 indicative photomontage of Stage 1 operational area of the AWRC

Figure 11-19 VP4 – Looking north towards AWRC from proposed M12 corridor

Figure 11-20 VP4 indicative photomontage of Stage 1 operational area of the AWRC

Figure 11-21 VP5 – existing view from 30 Mount Vernon Road looking north west towards the AWRC

Figure 11-22 VP5 indicative photomontage of Stage 1 operational area of the AWRC

Figure 11-23 VP7 – existing view looking south west towards AWRC near 845-857 Mamre Road

Figure 11-24 VP7 indicative photomontage of Stage 1 operational area of the AWRC

Figure 11-25 VP8 – existing view looking south west towards AWRC at 141-143 Aldington Road, Kemps Creek

Figure 11-26 VP8 indicative photomontage of Stage 1 operational area of the AWRC

Figure 11-27 VP20 existing view looking southwest towards Wallacia Weir and Nepean River

Figure 11-28 VP21 existing view looking northeast towards the location of the proposed release structure at Warragamba River

Table 11-28 Summary of visual impacts of treated water and brine pipeline during operation

Viewpoint	Receptor	Sensitivity	Magnitude	Impact	Description of potential impact
VP20	Nepean River – Wallacia Weir, Wallacia	Moderate	Low	Moderate low	This view is looking from farmland near Nepean River looking south west towards the outlet. The sensitivity is moderate due to the low number of receivers with private access limitations. Blaxlands Farm is located further upstream from this viewpoint. The heritage structures are barely visible with intervening vegetation which will also restrict views. Impacts are due to the limited visibility of the release structure and permanent removal of several medium sized trees.
VP21	Warragamba Dam spillway	Low	Low	Low	This view looking northeast towards the environmental flows release structure on Warragamba River. The sensitivity is low due to restricted public access to the release location. Views from firetrails located within the Blue Mountains National Park towards the release structure are restricted by tall native trees.

11.3.7 Impact of future stages

Overall, the impact of the future stages of AWRC will reduce as the landscape in the WSAGA becomes more urbanised. The potential visual impact for future stages was assessed as negligible for all viewpoints except VP4 which is the viewpoint from the M12 Motorway. The potential future impact to visual amenity from this viewpoint is considered low.

Photomontages indicative of future AWRC stages have been produced for representative sensitive receivers close the AWRC (VP2) and further away (VP5), to demonstrate the scale and extent of the project. These are included in Appendix T.

Future stages are likely to be built once Western Sydney International Airport is operational and future environmental impact assessment will therefore need to consider the impacts on aircraft of any night-time lighting at the AWRC site during construction. Section 13.1 considers airport safety impacts in more detail.

11.3.8 Cumulative impacts

Cumulative impacts have been considered in relation to the following projects:

- Urban development in WSAGA.
- Sydney Metro – Western Sydney Airport.
- Western Sydney International Airport.
- M12 Motorway.
- Northern Road upgrade – Glenmore Road to Bringelly.
- Warragamba Dam wall raising.

Cumulative visual impacts from construction are mainly associated with the Western Sydney Airport and the M12 Motorway. Construction of these will overlap with construction of the project, and cumulative visual impacts will be associated with increased construction activities and associated construction traffic.

Urban development in WSAGA will have cumulative visual impacts with the project as construction activities occur. However, over the long-term landscape character and visual impacts associated with the project are likely to be less significant due to the overall changing landscape character of the area. It is therefore expected that future development will reduce the project's overall prominence.

The Western Sydney International Airport will be operational at about the same time as the project and will be part of the changing landscape and increased urbanisation of the immediate area, reducing the visual and landscape character impacts associated with the project.

Transport infrastructure such as the M12 Motorway, Sydney Metro – Western Sydney Airport and Northern Road will contribute to the changing landscape character increasing urbanisation, reducing the landscape character and visual impacts associated with the project. The M12 Motorway will be adjacent to the AWRC at the southern boundary and is expected to be dominant from several viewpoints, reducing the visual impact of the AWRC from these locations.

Warragamba Dam wall raising is not expected to have a cumulative visual impact on the release structure associated with the environmental flows pipeline, given limited public viewpoints in this area.

11.3.9 Management measures

Table 11-29 details measures to manage the project's landscape character and visual impacts.

Table 11-29 Landscape character and visual impact management measures

ID	Potential impact	Management measure	Timing
LCV01	Visual impact of construction areas	Consider opportunities to install temporary screens/ hoarding with finishes to minimise visibility of construction areas and to minimise noise impacts to surrounding sensitive receivers. As a minimum, install temporary screens at compounds C7 from viewpoint (VP) 12, C6 from VP13, C5 from VP17, C2 from VP18, C3 from VP20, C9 from VP23, C10 from VP25, C13 from VP27, C14 from VP28, C15 from VP29.	Detailed design During construction
LCV02	Light pollution impacting sensitive receivers and biodiversity	Ensure lighting for construction night-work and operations is in accordance with AS4282-1997 *Control of the obtrusive effect of outdoor lighting to minimise light spill.* Design and implement lighting at AWRC site to reduce light spill towards residential receptors for VP1-5 and VP7-10 and in accordance with NASF Guideline E – Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports.	Detailed design During construction During operation
	Visual impact of AWRC	This impact is appropriately managed by measure G05 in Chapter 15 (Project synthesis).	During operation
	Visual impact of construction compounds	This impact is appropriately managed by measure G05 in Chapter 15 (Project synthesis).	During construction
	Visual impact of AWRC	This impact is appropriately managed by the ‘Urban design’ measures in Chapter 15 (Project synthesis).	Detailed design
	Visual impact from treated water and brine pipeline from tree removal or inappropriate rehabilitation	This impact is appropriately managed by measure G05 in Chapter 15 (Project synthesis) and the measures in section 9.1 (Biodiversity).	During construction

11.4 Traffic and transport

This section describes the existing traffic conditions of the project area, and the potential traffic and transport impacts during construction and operation of the project. This section summarises the specialist report (Aurecon Arup, 2021h) in Appendix U.

Traffic and transport impact summary

Construction and operation of the AWRC project will generate relatively small numbers of vehicle movements (a vehicle movement is defined as a two-way movement, to the destination and back). Where impacts are experienced, in most cases, it will be for the relatively short period of construction. Most of these impacts can be effectively mitigated with a series of management measures.

In particular, project operation will generate an average of about 19 two-way vehicle movements each day, primarily light vehicle movements associated with staff trips, but also a small number of heavy vehicles providing chemical deliveries and biosolids removal from the AWRC site. This is unlikely to significantly impact the road network.

Project construction will generate more vehicle movements, including worker vehicles and trucks to transport waste, equipment and materials to the AWRC and pipeline construction sites. For most roads, the additional construction traffic volumes from the project are within their capacity and will have limited impact on user experience. However, some roads in the project area are already under stress from existing traffic volumes, which in some cases will be exacerbated by construction traffic from several major projects in the area (such as the Western Sydney International Airport and the M12 Motorway). These roads include the Elizabeth Drive/Clifton Avenue intersection near the AWRC site, the Northern Road and Hume Highway.

A large proportion of the project's construction vehicle movements will be to and from the AWRC site, with vehicle movements between the AWRC and Northern Road at peak times estimated at about 400 light vehicle movements and 300 heavy vehicle movements each day. Sydney Water expects these traffic movements to be greatest during the first 18 months of the three-year construction period. This is when extensive earthworks will be undertaken, requiring moving spoil to and from the site.

Pipeline construction will also generate construction traffic, particularly associated with construction compounds including those required for tunnelling near Bents Basin Road, at Wallacia and in Cabravale Park, Cabramatta. Construction work for pipelines will also temporarily disrupt active transport (through disruptions to footpaths and cycleways), public transport (through temporary displacement of bus stops) and access to properties and parking in some areas. This is particularly relevant along the brine pipeline. Disruptions are typically short-term in any one location as pipeline construction moves along the alignment.

Construction Traffic Management Plans are essential to effectively manage construction traffic impacts. These will outline management measures to control and minimise impacts at each work location, including the use of best practice traffic control measures and coordination with

other projects to minimise the amplification of any traffic impacts. Prior to any potential traffic disruption occurring, local residents and businesses will be consulted.

11.4.1 Relevant Secretary's Environmental Assessment Requirements

Table 11-30 summarises the Secretary's Environmental Assessment Requirements (SEARs) relevant to traffic and transport and where in this section they are addressed.

Table 11-30 Project SEARs relating to traffic and transport impacts

SEARs	EIS section where requirement addressed
33. Assessment of the construction transport and traffic (vehicle, pedestrian and cyclists) impacts, including, but not necessarily limited to: a) construction schedule (stages and timing)	Section 11.4.5, section 11.4.7 and Chapter 4
b) route identification and scheduling of transport movements	Section 11.4.7
c) the number (daily and peak), frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements), including consideration of heavy vehicles participating in the Safety, Productivity and Environment Construction Transport Scheme	Section 11.4.5 Appendix U details consideration of the Safety, Productivity and Environment Construction Transport Scheme
d) details of construction site access arrangements and swept path details for relevant turning movements	Sections 11.4.5 and 11.4.7. Swept path analysis will be completed during detailed design.
e) construction worker parking	Sections 11.4.5 and 11.4.7
f) the nature of existing traffic (types and number of movements) on construction access routes (including consideration of strategic freight routes, peak traffic times, sensitive road users and parking arrangements)	Sections 11.4.3 and 11.4.5
g) access constraints and impacts on public transport, pedestrians and cyclists	Section 11.4.5
h) the need to close, divert or otherwise reconfigure elements of the road and cycle network associated with construction of the project	Sections 11.4.5 and 11.4.7
i) mitigation of construction vehicle and excavation work on the classified road and rail network.	Section 11.4.5
34. Assessment (including traffic modelling) of the operational transport impacts of the project, including:	Section 11.4.6

SEARs	EIS section where requirement addressed
a) forecast travel demand and traffic volumes for the project and the surrounding road, cycle and public transport network;	
b) travel time analysis;	Section 11.4.6
c) performance of key interchanges and intersections by undertaking a level of service analysis at key locations	Section 11.4.6 and Table 11-42
d) wider transport interactions (local and regional roads, cycling, public and freight transport);	Section 11.4.6
e) induced traffic and operational implications for public transport (particularly with respect to strategic bus corridors and bus routes) and consideration of opportunities to improve public transport;	Section 11.4.6
f) impacts on cyclists and pedestrian access and safety;	Section 11.4.6
g) opportunities to integrate cycling and pedestrian elements with surrounding networks and in the project;	Section 11.4.6
h) impacts on future transport corridors including Greater Sydney Metro, M12 Motorway, the Northern Road, Elizabeth Drive and the Outer Sydney Orbital; and	Section 11.4.6
i) impacts on the M7 Motorway (including any proposed vegetation removal, excavation, construction access, etc).	Section 11.4.6
35. Civil plans showing details of excavation and utility works within/across the classified road and rail corridors. It is noted that the current design proposes micro tunnelling under the road surface. Any works impacting on a classified road will need to be reviewed for concurrence under the Roads Act, 1993.	As discussed with DPIE and TfNSW, detailed civil plans will be developed during detailed design, which will occur during the post approval phase.
36. Preparation of a draft Construction Traffic Management Plan to demonstrate the proposed management of the impact of the proposal on road, rail, pedestrian and cyclist corridors and facilities. The Construction Traffic Management Plan should detail construction vehicle routes, number of trucks, hours of operation, access arrangements and traffic control.	Section 11.4.7 and Appendix U

11.4.2 Methodology and assumptions

Appendix U contains the complete Traffic and Transport Assessment which assesses traffic and transport impacts during construction and operation. The methodology for assessing these impacts included:

- reviewing available data and documentation to understand traffic generated by the project in construction and operation

- using historic traffic data and commissioning additional traffic surveys to understand existing traffic conditions on the surrounding road network and establish a baseline for the assessment
- assessing the potential impacts of construction and operational traffic on the road network, including through Signalised and Unsignalised Intersection Design and Research Aid (SIDRA) intersection modelling
- reviewing other infrastructure projects where construction is likely to overlap with project construction to assess cumulative impact on the surrounding road network
- identifying management measures to minimise the impacts of the project on the traffic network.

The following sections provide further detail about how baseline data was used and approaches to impact assessment.

Assessment years

The impact assessment considered four scenarios to address likely changes in baseline traffic volumes over time and capture construction and operational traffic impacts:

- 2023 baseline – representing the estimated traffic volumes in 2023 considering background traffic growth and major projects.
- 2023 with construction traffic – the 2023 baseline scenario with the addition of construction traffic generated by the project.
- 2025 baseline – representing the estimated traffic volumes in 2025 considering background traffic growth and other major projects.
- 2025 with operational traffic – the 2025 baseline scenario with the addition of operational traffic generated by the project.

The first two scenarios apply to the construction phases, and 2023 was selected because this is when peak construction vehicle movements are expected. For operation, covered in the third and fourth scenarios, 2025 was chosen because this is when the AWRC is planned to start operating. No scenarios beyond 2025 were considered as the project's operational traffic load is not expected to increase and it is not possible to accurately forecast the traffic generated by other projects further into the future.

Traffic baseline data

The assessment used historic traffic data from 2019 and traffic survey data from 2020 to calculate baseline daily and peak hour traffic volumes across the project area. The traffic impact assessment commenced in 2020 during the COVID-19 pandemic, with traffic surveys during this time expected to show reduced traffic volumes due to people working from home or limiting their movements. For this reason, Transport for NSW's Sydney Coordinated Adaptive Traffic System (SCATS) data from March 2019 was collated for nearby intersections and compared with traffic surveys undertaken in 2020. This comparison showed that the 2020 traffic volumes were 31% lower than traffic volumes from March 2019, and the data was adapted to take this into consideration. Figure 11-29 outlines

the approach for obtaining the baseline data for use in the assessment scenarios outlined above and how the standard growth rate outlined below was applied to determine the 2023 and 2025 baseline traffic volumes.

Appendix U provides further details on how Sydney Water considered impacts of the COVID-19 pandemic in understanding baseline traffic conditions.

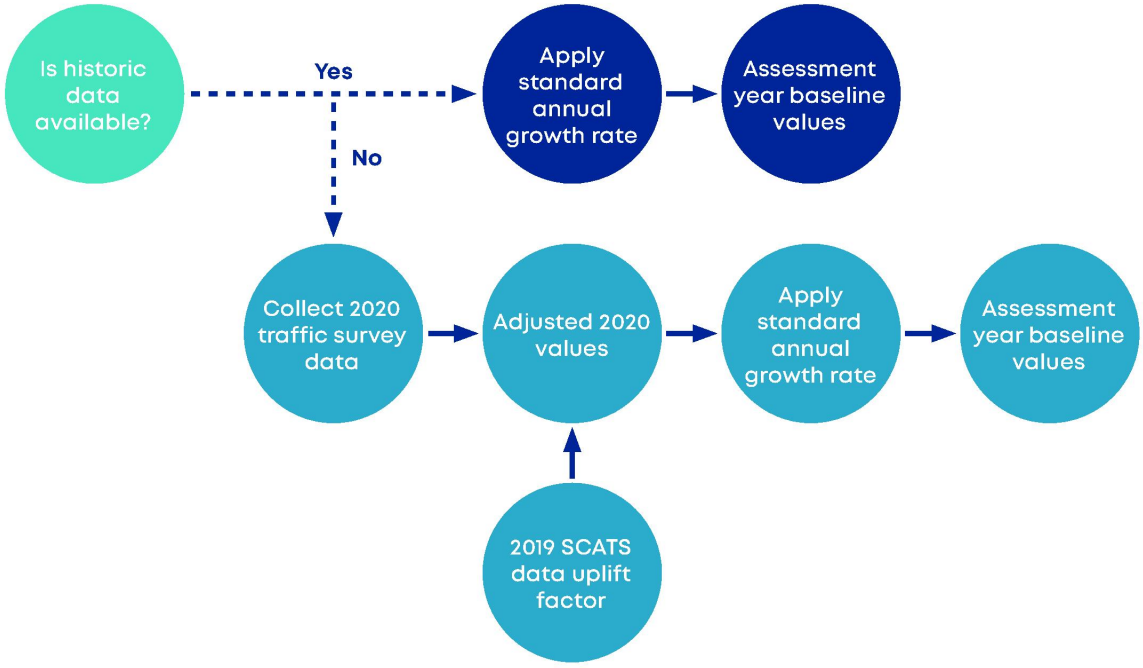


Figure 11-29 Process for developing baseline traffic data

Growth factors

The assessment applied growth factors to uplift the 2019 and 2020 data and estimate baseline traffic for 2023 and 2025. An average annual growth rate was calculated for the eastbound and westbound movements on Elizabeth Drive by comparing historic traffic survey data from 2015 collected by Roads and Maritime (RMS) on Elizabeth Drive to predicted 2024 traffic volumes on Elizabeth Drive provided in the M12 Motorway Environmental Impact Statement (EIS) (RMS, 2019a). The 2015 traffic data was considered appropriate because it was collected prior to the COVID-19 pandemic and was conducted on the same roads in which the project is located, along Elizabeth Drive near the AWRC site. Table 11-31 shows how the annual growth rate was determined through this comparison. An annual growth rate of 3% was calculated, which was then applied more broadly to traffic flows on all links potentially impacted by the project. Basing growth rates on one road in the project area and applying them across the project is a standard approach in traffic assessments.

Table 11-31 Annual growth rates for Elizabeth Drive

Location	Direction	AM peak hour volume		Annual growth rate
		2015 survey	M12 EIS 2024	
Elizabeth Drive, east of Mamre Road	Eastbound	1,178	1,213	0.3%
	Westbound	831	935	1.3%
Elizabeth Drive, west of Devonshire Road	Eastbound	1,095	1,143	0.5%
	Westbound	511	588	1.6%
Elizabeth Drive, east of Luddenham Road	Eastbound	463	980	8.7%
	Westbound	435	718	5.7%
Eastbound average				3.2%
Westbound average				2.9%
Combined average				3.0%

Construction impact assessment methodology

The construction impact assessment included:

- identifying traffic generated in the construction phase
- distributing the expected traffic volumes across the road network
- undertaking a link-based assessment to identify roads where construction traffic volumes may have a detrimental impact
- identifying any impacts to the traffic network, including impacts to sensitive road users and strategic freight routes, public transport and active transport. Impacts were classified based on the following levels of significance:
    - Low indicates minimal impact with management measures not likely to be required.
    - Medium indicates local impacts to the road network, with implementation of management measures required.
    - High indicates impacts that may cover a larger area along the project corridor, with implementation of management measures required.
- developing measures to manage identified impacts

- producing a draft Framework Construction Traffic Management Plan to outline appropriate traffic management controls for the construction phase of the project. This includes approaches to key haulage routes, scheduling transport movements, construction site access arrangements and worker parking. This Framework Construction Traffic Management Plan will guide development of Site Specific Construction Traffic Management Plans (SSCTMPs) once the construction contractor(s) are engaged.

Two criteria were used to identify areas where construction traffic may have a detrimental impact:

- Criteria 1 - additional construction traffic relating to the project generates an increase in traffic greater than 5% compared to the baseline flows on the link.
- Criteria 2 - the traffic flow per lane increases beyond 900 passenger car units (pcu) per hour with the addition of the project's construction traffic. This value is consistent with the *Austroads Guide to Traffic Management Part 3* (Austroads, 2013) which provides guidance on the lane capacity of urban roads and traffic lanes.

Some traffic links in the project area already meet criteria 2. These links were assessed in greater detail to understand to what degree project construction traffic volumes contribute to further impacts on these roads.

Construction segments and compounds

To assess the traffic impacts in different areas, the project was separated into five segments. These include the construction areas associated with the AWRC, treated water pipeline, environment flows pipeline and the brine pipeline, and the 15 proposed construction compounds. It was assumed that all compounds will be in peak construction use concurrently. However, this is unlikely to be the case with pipeline construction occurring in a progressive manner along each alignment. This means the assessment represents worst-case impacts.

The segments and compounds are shown in Figure 11-30 and include:

- Segment 1 – Warragamba River, Core Park Road, Warragamba to The Northern Road, Luddenham
- Segment 2 – The Northern Road, Luddenham to Clifton Avenue, Kemps Creek (AWRC site access)
- Segment 3 – Clifton Avenue, Kemps Creek to M7 Motorway
- Segment 4 – M7 Motorway to Joseph Street, Canley Heights
- Segment 5 – Joseph Street, Canley Heights to Lansdowne Reserve, Lansdowne.

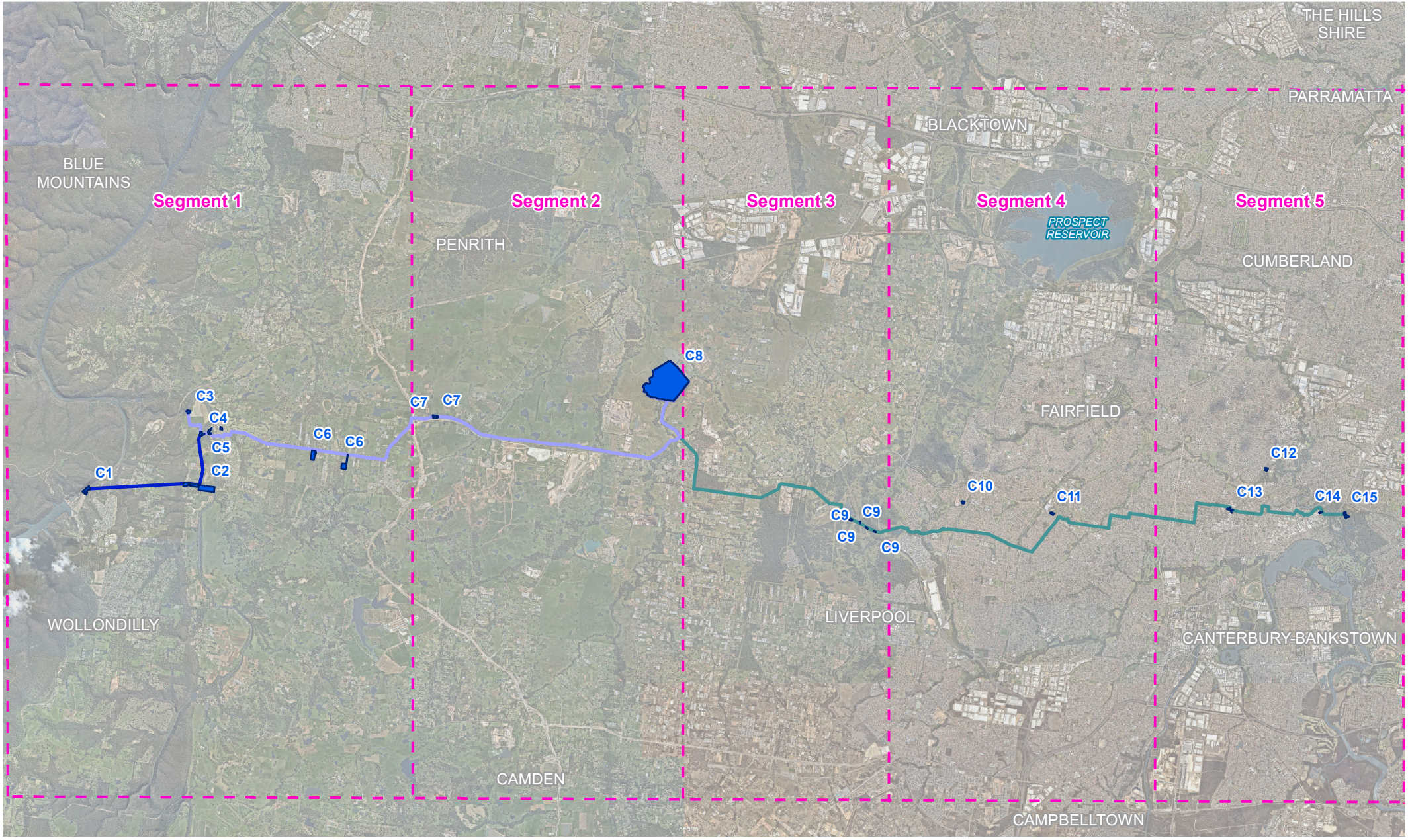


Figure 11-30 Construction segments and compounds

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

Impacts to other infrastructure projects

Project construction will overlap with construction of the Western Sydney International Airport and M12 Motorway. Peak construction years for these projects are expected to occur in 2021 and 2024, respectively, and traffic generated from both projects has been incorporated into the baseline assessment.

Traffic data was obtained from the Western Sydney Airport EIS (Department of Infrastructure and Regional Development, 2016) and the M12 Motorway EIS (RMS, 2019), and included peak AM light vehicle and heavy vehicle movements. Peak AM flows were chosen as this represents the time of day when traffic volumes on the road are at their highest. Section 11.4.9 includes further information on the project's cumulative impacts with these projects.

Operational impact assessment methodology

The operational impact assessment mainly focused on the AWRC as the pipelines will generate infrequent traffic associated with periodic maintenance. The operational impact assessment included:

- identifying proposed access routes to the AWRC, and the suitability of these roads
- identifying the estimated traffic volumes generated during operation
- undertaking traffic modelling at intersections used to access the AWRC to identify any potential impacts
- identifying impacts to other modes of transport and how these can be managed
- developing measures to manage identified impacts.

Assessment criteria

The following assessment criteria were used to identify the level of traffic impact during construction and operation of the project.

Loss of service (LoS)

LoS is a measure of the average delay experienced by vehicles. Table 11-32 outlines the different categories used to assess the impact of operational traffic on the network. These criteria were adopted from the RMS Traffic Modelling Guidelines (RMS, 2013).

Table 11-32 Loss of service categories

Grade	Average delay (seconds)	Description
A	Less than 14	Good operation
B	15 to 28	Good with acceptable delays and spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity

Grade	Average delay (seconds)	Description
E	57 to 70	At capacity
F	Greater than 70	Unsatisfactory

Degree of saturation (DoS)

DoS is a ratio of demand to capacity of the traffic network. A DoS of 1.0 indicates that the demand and capacity at an approach or intersection are equal, and DoS of less than 1.0 implies that the demand is lower than the capacity. The RMS Traffic Modelling Guidelines outline practical DoS for different intersection types. The desirable maximum DoS for different types of intersections are:

- Signalised intersection – 0.9.
- Roundabout – 0.85.
- Priority intersection – 0.8.

95th percentile queue length

This modelling parameter relates to the queue length that has a 5% probability of being exceeded during the analysis time period. This parameter is used to calculate lane lengths but is not representative of a queue a normal driver would experience, which is captured in the LoS and DoS assessments above.

11.4.3 Existing environment

Background

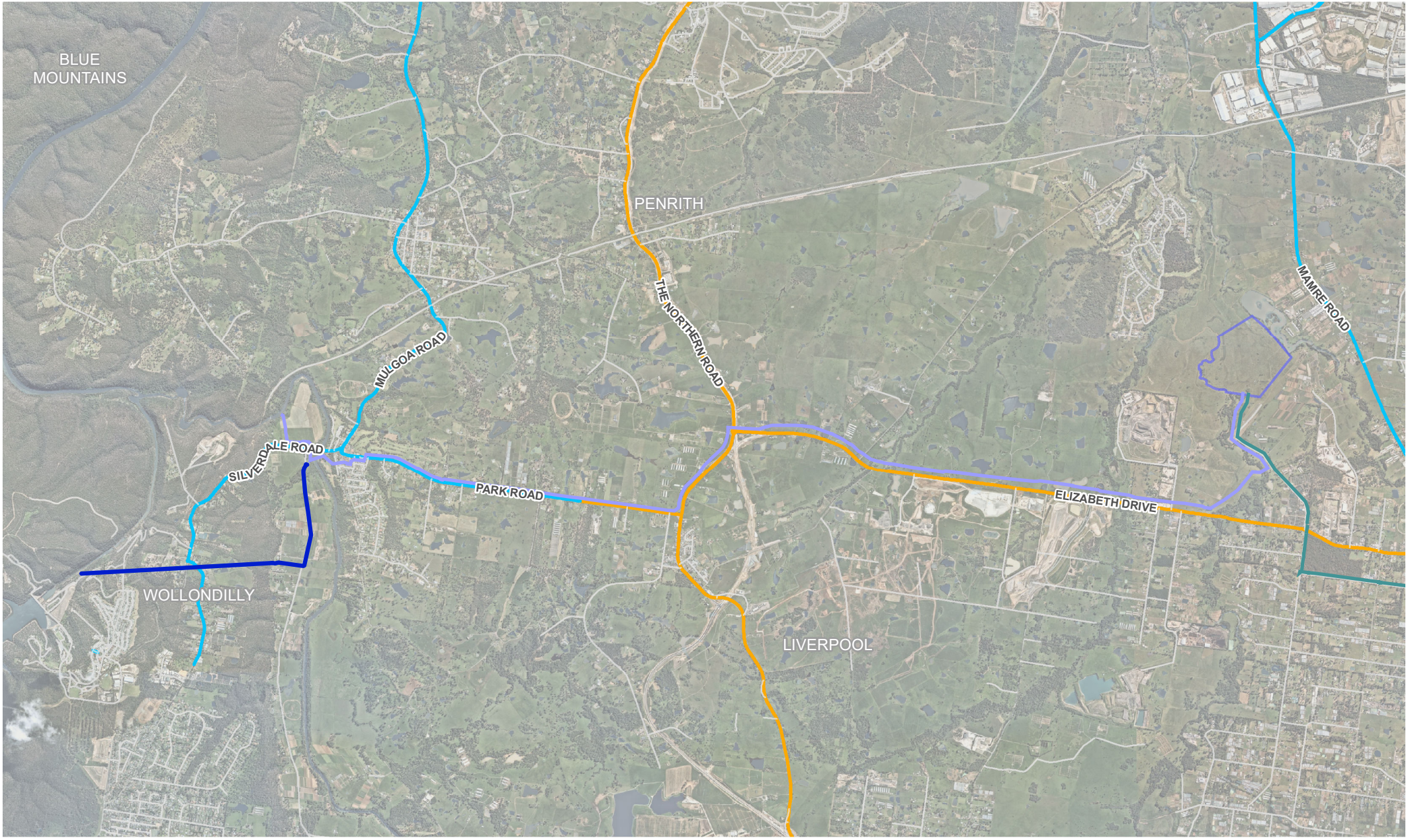
The project is in Western Sydney, about 40 km west of the Sydney central business district. The area east of the M7 Motorway is largely urbanised and the area west of the M7 is largely rural residential.

Existing road network

The project interfaces with a range of different road categories. Transport for NSW uses the following classification system for roads based on their function, including the typical traffic volumes experienced:

- Arterial road.
- Sub-arterial road.
- Collector and distributor road.
- Local road.

Figure 11-31 and Figure 11-32 show road classification for roads near the project.

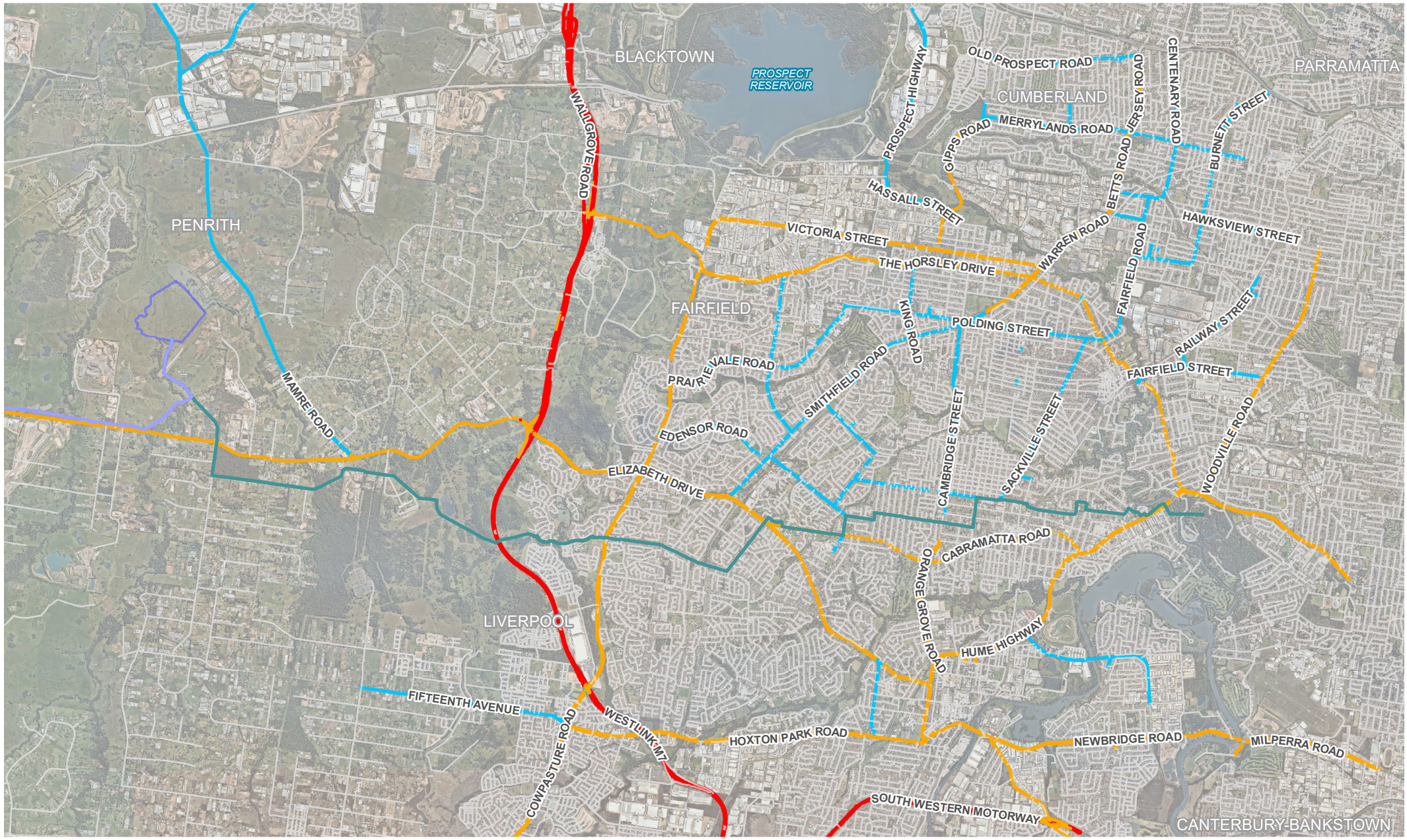


Advanced Water Recycling Centre
Treated water pipeline
Brine pipeline
Environmental flows pipeline
Arterial road
Sub arterial road
Local road
Waterbody

1:68,000
0 1 2km

Figure 11-31 Road classifications near treated water pipeline

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56



Advanced Water Recycling Centre
Treated water pipeline
Brine pipeline
Arterial road
Motorway
Sub arterial road
Local road
Waterbody

1:90,000
0 1 2km

Figure 11-32 Road classifications near brine pipeline

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

The AWRC site at Kemps Creek does not currently have road access and is not connected to the wider traffic network. The closest paved road to the AWRC site is Clifton Avenue which connects to Elizabeth Drive at its southern end. Sydney Water will construct a permanent access road off Clifton Avenue to the AWRC site prior to construction of the AWRC and has determined this under Division 5.1 of the EP&A Act.

The project is not located within a strategic freight route or in close proximity to sensitive road users. A search of the Commonwealth Government Department of Infrastructure, Transport, Regional Development and Communications (DITRDC) National Key Freight Routes Web App has identified the M7 Motorway and the train line at Cabramatta as key freight routes intersected by the project.

Parking

West of the M7 Motorway

Street parking along the pipeline route between the AWRC and Wallacia is minimal due to safety concerns of parking along Elizabeth Drive and Park Road which are busy arterial roads. There is minimal demand for street parking along these roads as parking for residents is on private property. The greatest demand for parking is at the urban centres around Wallacia and Warragamba where there are shops and businesses.

East of the M7 Motorway

Parking to the east of the M7 is in higher demand due to the more developed nature of the urban landscape. Street parking is provided in most areas along the brine pipeline route which is used by residents and local businesses. Off street parking is also provided around the Cabramatta train station and small local shopping centres.

Public transport

West of the M7 Motorway

There are minimal public transport services west of the M7 close to the project alignment. The train station closest to the AWRC site is Leppington station, which is about 15 kilometres south. Low frequency bus services are provided along The Northern Road and Elizabeth Drive near the treated water pipeline.

East of the M7 Motorway

The public transport network east of the M7 is more extensive. The brine pipeline crosses the T2, T3 and T5 train lines at Cabramatta, about 450 m north of Cabramatta train station. The bus network is extensive, with numerous services provided along the proposed brine pipeline alignment.

Appendix U provides further details on the locations and extent of the public transport services across the project alignment.

Active transport

West of the M7 Motorway

Near the project, active transport, such as walking and cycling paths, is limited west of the M7. Cycleways exist along isolated sections of The Northern Road, Elizabeth Drive and Mamre Road. Pedestrian footpaths are common throughout the townships of Wallacia and Warragamba.

East of the M7 Motorway

East of the M7 the areas near the project have extensive pedestrian footpaths and cycleways. Near the brine pipeline, cycleways exist in Cecil Hills, Busby and Canley Heights. As the brine pipeline is predominantly located in existing urban areas, pedestrian footpaths are common across the project footprint.

11.4.4 Legislation and guidelines

The legislation, policies and guidelines listed in Table 11-33 have been used to guide the traffic and transport impact assessment.

Table 11-33 Traffic and transport legislation, policies and guidelines

Legislation/ Policy/ Guideline	Relevance to project
NSW Roads and Traffic Authority (RTA) Guide to Traffic Generating Development, 2002 (RTA, 2002)	The project is a traffic generating development. This guide has been used as it provides the appropriate methodology for assessing all types of traffic generating developments.
Austroads Guide to Traffic Management Part 12: Traffic Impacts of Developments, 2019 (Austroads, 2019)	The project is a traffic generating development. This guide has been used as it provides the appropriate methodology for assessing all types of traffic generating development.
Austroads Guide to Traffic Management Part 3, 2013 (Austroads, 2013)	This provides guidance on the lane capacity of urban roads and traffic lanes which has been used to determine the level of impact the project will have on the road network.
NSW RTA Traffic Modelling Guidelines, 2013 (RMS, 2013)	This document provides guidance on the appropriate methodology for traffic modelling conducted as part of the project.
NSW RTA Road Design Guide, 1988 (RTA, 1988)	This document outlines the appropriate design standards for new and adjusted intersections. Although out of scope for the EIS, this has been used for designing required changes along Clifton Avenue for access to the AWRC.
Future Transport 2056 (TfNSW, 2018c)	This document outlines strategies for regional NSW and Greater Sydney to align planning of future transport networks. This strategy has been used to assist in identifying TfNSW projects close to the project.

Legislation/ Policy/ Guideline	Relevance to project
NSW Roads Act 1993	This Act addresses requirements related to public roads which include: • Process for opening and closing roads. • Any activities impacting public roads. • Access for the community. • Road classification and corresponding road authorities. • Function of the road authorities. This Act outlines the approval process required for undertaking any works on public roads, and the relevant road authorities. The project will require consent under clause 138 of the Act where works are required on public roads. Under clause 5.24 of the *Environmental Planning and Assessment Act 1979* this consent cannot be refused if is necessary for carrying out an approved State significant infrastructure project and must be substantially consistent with the approval.
Commonwealth Disability Discrimination Act 1992	This Act seeks to eliminate any discrimination against a person based on the grounds of disability ensuring equality as the rest of the community. This Act specifies requirements for vulnerable road users who may be impacted by the project.

11.4.5 Construction impact assessment

This section outlines the impacts from construction vehicle movements on the traffic network and impacts to parking, public transport, access and pedestrians.

Construction traffic generation

The following project activities will generate construction traffic:

- Work crews undertaking construction along the pipeline alignments and at the AWRC site.
- Light vehicles accessing site compounds and work sites.
- Heavy vehicles accessing site compounds for delivery and removal of raw materials and equipment, including the AWRC site.

Traffic impacts are assessed based on peak daily volumes from light vehicles and heavy vehicles during both standard and outside of standard hours of construction. As the construction schedule (including staging and timing) has not been finalised, for the purposes of this assessment, it is assumed that all compounds will be in peak construction use concurrently. However, this is unlikely to be the case with pipeline construction occurring in a progressive manner along each alignment. This means the assessment represents worst-case impacts. The construction period will differ across the project, with some areas, such as the AWRC, being in construction for longer than other areas. Chapter 4 provides more information on construction timing and duration.

Table 11-34 shows the estimated peak construction traffic volumes during standard construction hours across all segments. The numbers represent two-way movements - to the destination and back again.

Segment 2 will generate the highest volumes of construction traffic. This is mainly due to construction activities associated with the AWRC site, with peak volume of vehicle movements occurring in the excavation and earthworks phase. This will likely occur in the first 18 months of the construction program. During this phase, the site will experience a large number of truck movements removing spoil and bringing in engineered fill, prior to the construction of the civil and structural components.

The increased traffic volumes for segment 1 are mainly associated with construction of the environmental flows pipeline, and the release structures for the treated water and environmental flows pipelines. As with the AWRC, truck movements will be highest during the excavation and earthworks phases.

Segment 5 includes several tunnelled pipeline crossings, including Hume Highway and Prospect Creek. These construction sites will also have compounds to support the construction work. Vehicle movements in this segment will mainly relate to these tunnelled pipeline locations.

Segments 3 and 4 include most of the brine pipeline alignment, including some construction compounds. Construction traffic volumes are lower in these areas as work sites are of a smaller scale than in segments 1, 2 and 5.

Table 11-34 Estimated peak daily construction traffic volumes during standard construction hours

Construction segment	Light vehicle movements	Heavy vehicle movements
Segment 1	180	34
Segment 2	400	302
Segment 3	40	1
Segment 4	140	51
Segment 5	115	29

Work outside of standard construction hours will be required for some construction areas. This is mainly to minimise impacts on the traffic network during peak road usage. Night works will be most common along the brine pipeline (segments 4 and 5) where the pipeline will be built in urbanised areas with high existing traffic volumes. Table 11-35 shows the estimated peak construction traffic volumes during out of hours work.

Out of hours work will also be required for the environmental flows pipeline tunnel between Bents Basin Road and Warragamba River (segment 1). This is due to the drilling machinery needing to operate 24 hours a day, seven days a week for about six months to ensure a safe and successful bore hole construction.

Table 11-35 Estimated peak daily construction traffic volumes during out of hours work

Construction segment	Light vehicle movements	Heavy vehicle movements
Segment 1	75	26
Segment 2	30	0
Segment 3	10	0
Segment 4	70	25
Segment 5	70	26

Table 11-36 outlines the roads that are located between segments. These areas are of particular importance as they will receive traffic volumes from multiple segments.

Table 11-36 Roads interfacing segment boundaries

Segment interface	Roads applicable
Segment 1/2	• Park Road (west of compound C6 to The Northern Road) • The Northern Road (between Park Road and Elizabeth Drive) • Elizabeth Drive (between The Northern Road and Badgerys Creek Road)
Segment 2/3	• Elizabeth Drive (between Western Road and Clifton Avenue) • Clifton Avenue • Western Road (between Elizabeth Drive and Cross Street)

Segment interface	Roads applicable
Segment 3/4	• Elizabeth Drive (east of site compound C9 to the M7 Motorway) • Kensington Close (west of Stirling Street) • Stirling Street (east of Kensington Close) • Feodore Drive (east of Stirling Street) • Frederick Road (between Spencer Road and Cowpasture Road) • Cowpasture Road (between North Liverpool Road and Elizabeth Drive)
Segment 4/5	• Edensor Road (between Meadows Road and Harrington Street) • John Street (between Harrington Street and Gladstone Street)

Construction traffic impacts

Construction traffic impacts are assessed based on the methodology outlined in section 11.4.2.

Construction traffic impacts are based on peak construction traffic for the AWRC and each site compound which is likely to occur during the earthworks and civil works phase. To assess worst-case impacts, this assessment assumes peak traffic generation will occur at all compounds at the same time. This is unlikely to occur in practice due to the staged construction approach and linear progression of pipeline construction. Traffic generation and timing across the full construction timeframe will be updated during the development of site-specific construction traffic management plans as outlined in section 11.4.7.

Criteria 1 impacts – greater than 5% increase in traffic volumes

Figure 11-33 shows road links that meet criteria 1 because they contribute to a greater than 5% increase in traffic volumes. This includes roads across the project area, including Park Road, Silverdale Road, Mulgoa Road, Cross Street, John Street and some roads around Warragamba. Increases in traffic volumes beyond the baseline are likely to be less than 10%. Traffic volumes remain within the estimated capacity of the links and therefore it is anticipated that the significance of the impact will be low.

Criteria 2 impacts - traffic flow per lane increases beyond 900 passenger car units (pcu) per hour

Figure 11-33 shows road links that meet criteria 2, where the road is at capacity. This mainly includes arterial roads such as Elizabeth Drive (between The Northern Road and M7 Motorway), The Northern Road and Hume Highway. These results show that links where traffic volumes exceed the estimated road capacity (criteria 2) are already under stress due to the baseline flows on the surrounding road network. Construction traffic volumes generated by the project contribute to impacts on these links but are not the main cause of road capacity exceedances. In the case of Elizabeth Drive, other contributions to traffic volumes include construction of other infrastructure projects, including the M12 Motorway and the Western Sydney International Airport. These links are arterial and sub-arterial roads that typically experience high volumes of traffic during peak hour. The significance of anticipated impacts will range from high to low as outlined in Table 11-40.

Road closures are unlikely to be required during construction. Partial closures and temporary diversions, especially along the brine pipeline route, may be required. It is anticipated that the significance of the impact will be low, due to the implementation of out of hours construction work to avoid temporary partial closures during the AM and PM peak traffic movements.

The project will not impact upon any strategic freight routes as identified by the DITRDC National Key Freight Routes Web App. The brine pipeline will be tunnelled beneath the M7 Motorway and the train line at Cabramatta which have been identified as Key Freight Routes. Construction traffic may use the M7 Motorway. Potential impacts of this construction traffic on the M7 Motorway are expected to be negligible but will be addressed in the SSCTMP.

Consideration of cumulative impacts from other infrastructure projects has identified the Clifton Avenue / Elizabeth Drive intersection as a potential pinch point. This is because Clifton Avenue will be serving as the key access route to several construction sites including the AWRC site and M12 Motorway site compounds AF4 and AF12.

Clifton Avenue serves as a local road providing access to several residential properties and industrial developments. Additional construction traffic may impact the performance of the intersection where Clifton Avenue joins Elizabeth Drive. For these reasons, intersection modelling has been completed for this intersection. This has modelled the movement of vehicles into Clifton Avenue from both approaches along Elizabeth Drive. Other intersections and roads have not been modelled as the proposed construction traffic volumes are unlikely to have a significant impact.

Table 11-37 and Table 11-38 show the intersection modelling results for 2023 with and without the project construction traffic volumes which have been used to assess the impact of the project during construction in the 2023 assessment year. These numbers represent peak construction activities at the AWRC site rather than average movements across the entire 36-month construction program. Appendix U includes detailed modelling outputs.

Table 11-37 Construction in 2023 without project

Approach	2023 AM without project				2023 PM without project			
	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)
Elizabeth Drive (E)	1,030	A	0.668	18.9	1,084	A	0.595	2.1
Elizabeth Drive (W)	1,328	A	0.735	0	1,010	A	0.553	0
Clifton Avenue	22	F	> 1	113	130	F	> 1	> 100

Table 11-38 Construction in 2023 with project

Approach	2023 AM with project				2023 PM with project			
	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)
Elizabeth Drive (E)	1,091	F	> 1	> 100	1,108	A	0.593	7.4
Elizabeth Drive (W)	1,389	A	0.773	0	1,034	A	0.572	0
Clifton Avenue	70	F	> 1	> 100	252	F	> 1	> 100

Table 11-37 shows that without the project, both east and west approaches of Elizabeth Drive are operating at LoS A. However, the approach of Clifton Avenue to Elizabeth Drive is shown to be operating at LoS F, due to the comparatively high through movement on Elizabeth Drive which limits the ability of vehicles to find an appropriate gap to turn out of Clifton Avenue. Table 11-38 shows that with the construction traffic from the project, Elizabeth Drive is unlikely to be impacted on the west approach with an LoS of A and a DoS of 0.773. However, the east approach will be impacted with a LoS of F and DoS of >1. The impact here is associated with trucks turning right into Clifton Avenue off Elizabeth Drive which is resulting in a queuing of traffic on the east approach beyond the capacity of the turning bay. Clifton Avenue is shown to be operating at LoS F, which is consistent with the rating without the project. Without mitigation the Elizabeth Drive east approach will be highly impacted.

Figure 11-33 also shows roads impacted by project construction traffic, but not to a level in which criteria 1 and 2 are met. These include Silverdale Road, and some roads along the brine pipeline alignment. It is anticipated that the significance of the impact of project construction traffic on these roads will be low.

Construction compounds

Construction traffic associated with compounds will depend on the use and purpose of the compound. Chapter 4 includes a complete list of compounds, including location and use. Several compounds are related to tunnelled pipeline construction, such as the environmental flows pipeline (C1 and C2), M7 Motorway crossing (C9) and Prospect Creek crossing (C14 and C15). These compounds will only be required for the duration of that trenchless pipeline construction. Other larger compounds, such as the compound at the AWRC site (C8) and the compounds along Park Road (two options for C6) are likely to be required for the entire 36-month construction duration. Chapter 4 provides more information on the indicative timing and phases of construction.

Table 11-39 provides an initial summary of potential construction traffic issues at each proposed compound.

Table 11-39 Potential site-specific traffic management considerations at construction compounds

Construction compound	Potential issues
C1	• Conflicts with operational vehicles accessing the Warragamba Dam via Core Park Road. • Constraints on two-way operation of heavy vehicles on Core Park Road due to the existing carriageway width.
C2	• Proximity to existing access roads may minimise access options to this compound. • Construction movements and the extent of the compound may impact access to agricultural land. • Disruption to residential properties in the vicinity.
C3	• Construction movements and the extent of the compound may impact access to agricultural land.
C4	• Proximity to existing accesses such as Alwyn Avenue. • Disruption to residential properties on Shelly Road.
C5	• Construction movements may impact adjacent businesses such as: Wallacia Country Club, TAB, Wallacia Takeaway, Admire Beaute and Wallacia Christian Church. • Proximity to existing access roads may reduce access options to the site. • Access may need to be shared with other surrounding uses.
C6	• Proximity to existing access roads may minimise access options to this compound. • Construction movements and the extent of the compound may impact access to agricultural land.
C7	• Cumulative traffic volumes on Elizabeth Drive could delay construction vehicle movements. • Any access point onto Elizabeth Drive may need to be left / left out due to through traffic volumes.

Construction compound	Potential issues
C8	• Construction vehicle may experience delays when exiting onto Elizabeth Drive from Clifton Avenue at peak times. • Cumulative traffic volumes on Elizabeth Drive and Clifton Avenue from the M12 Motorway project. • Disruption to agricultural uses and residential properties along Clifton Avenue.
C9	• Cumulative traffic volumes on Elizabeth Drive could delay construction vehicle movements. • Limited access through the parklands may restrict vehicles types that can access this compound.
C10	• Cumulative traffic volumes on Elizabeth Drive could delay construction vehicle movements. • Disruption to residential properties adjacent to Cowpasture Road and Elizabeth Drive. • Footpaths adjacent to the site will need to be managed appropriately.
C11	• Cumulative traffic volumes on Elizabeth Drive could delay construction vehicle movements. • Construction movements may impact adjacent businesses such as Unique Liquor Pty and Liquor Stax Bonnyrigg. • Disruption to residential properties adjacent to Elizabeth Drive and Bonnyrigg Avenue. • Footpaths adjacent to the site will need to be managed appropriately.
C12	• Disruption to residential properties on East Parade and other local roads. • Footpaths adjacent to the site will need to be managed appropriately.
C13	• Construction movements may impact adjacent businesses such as PCYC Fairfield Cabramatta. • Access road into the site may impact existing on-street parking. • Construction movements and the extent of the compound may partially impact access to Cabravale Memorial Park. • Footpaths adjacent to the site will need to be managed appropriately.
C14	• Disruption to businesses and residential properties on Knight Street. • Footpaths adjacent to the site will need to be managed appropriately.
C15	• Access may need to be shared with other surrounding uses.

Management measures to minimise the impact of construction traffic on the road network are provided in section 11.4.10.

Advanced Water Recycling Centre
Treated water pipeline
Brine pipeline
Environmental flows pipeline

2023 Construction traffic link assessment
Within threshold
Roadways meeting Criteria 1
Roadways meeting Criteria 2

Waterbody

1:137,000
0 1 2km

Figure 11-33 Roads meeting criteria 1 and 2 for the project

Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56

Construction impacts to public transport

Public transport services to the west of the M7 Motorway are minimal and impacts from the project are unlikely to be significant. There may be localised impacts to bus stops in Wallacia. Impacts to public transport during construction will likely occur along the brine pipeline alignment, east of the M7. This will mainly affect bus stops and bus routes. The bus route network is more extensive along the brine pipeline, especially around Cabramatta, with several bus routes converging at Cabramatta Railway Station and Bonnyrigg. There may be localised impacts to bus stop locations in the area, with all impacts being temporary as the brine pipeline is constructed.

The brine pipeline will cross beneath the rail line at Cabramatta via tunnelling construction to avoid impacts on the rail line.

As the construction program for the project has not been developed, the exact location and extent of impacts to public transport are not known. However, impacts to public transport during construction are anticipated to be low. Sydney Water will continue to consult with relevant stakeholders to minimise any potential impacts to public transport during construction. Section 11.4.10 includes management measures for impacts to public transport.

Construction impacts to active transport

There are minimal active transport opportunities west of the M7 Motorway, especially between the M7 Motorway and Wallacia. Impacts to active transport, especially footpaths, will be primarily east of the M7. Impacts will mainly be associated with pipeline construction in road verges where footpaths may be diverted. Impacts are unlikely to be significant with any diversions to footpaths being temporary as the pipelines are constructed. As the construction program for the project has not been developed, the exact location and extent of impacts to active transport are not known. Section 11.4.10 includes management measures for impacts to active transport.

Construction impacts to parking and access

Construction at the AWRC site is not expected to impact on parking and access as all activities and parking will be located on the AWRC site.

The activities associated with pipeline construction will result in temporary impacts to street parking availability. Where pipelines are located in roadways and road verges, parking lanes may be temporarily impacted by the construction site and associated vehicles. Where possible construction staff parking will be in the impact area or compounds but staff parking on local roads is also likely to be required in some locations.

Access to private properties and businesses may also be temporarily impacted during construction. These impacts will be mainly in urban areas, such as along the brine pipeline and in Wallacia, where the physical work site may block access to driveways. Pipeline construction will progress along the alignment, with access and parking impacts likely only to occur for short periods of time. Sydney Water will consult with potentially impacted stakeholders to minimise any potential impacts to parking and access.

As the construction program for the project has not been developed, the exact location and extent of impacts to parking and access are not known. Section 11.4.10 includes management measures for impacts to parking and access.

Summary of construction impacts

Table 11-40 summarises the potential traffic impacts during construction. The impact significance is based on the impact assessment methodology outlined in section 11.4.2. Impacts that have a medium and high impact will require further management as outlined in section 11.4.10.

Table 11-40 Summary of project construction traffic impacts

Potential impact	Location	Impact significance
Congestion around the Clifton Avenue and Elizabeth Drive intersection	Clifton Avenue, Elizabeth Drive	High
Congestion related to traffic exceeding the estimated capacity on certain links	Elizabeth Drive, Cowpasture Road, Hume Highway	High
Congestion related to traffic increasing by greater than 5% on certain links	Warragamba - Weir Road, Fourth Street, Farnsworth Avenue Wallacia - Mulgoa Road, Greendale Road, Park Road Kemps Creek - Clifton Avenue, Cross Street Cecil Hills - Kensington Close, Feodore Drive, Frederick Road Edensor Park - Edensor Road, John Street Canley Vale - Bareena Street, Chancery Street, Gordon street Fairfield - Vine Street	Low
Temporary disruption to bus stops and routes along the construction corridor	Roads used by bus routes, such as Montgomery Road and Cabramatta Road in Bonnyrigg, and John Street in Cabramatta West	Medium
Temporary removal of on-street parking along the construction corridor	Streets in urban areas, such as Wallacia and Cabramatta town centres	Low

Potential impact	Location	Impact significance
Partial road closures restricting traffic flow – impact duration likely to be about 2-3 weeks in each location	Immediate vicinity of work areas along pipeline alignments.	Low
Temporary disruption to footpaths and cycle routes	Cycle routes and streets in urban areas, mainly along the brine pipeline alignment	Medium
Temporary impacts to dwelling and business access	All dwellings and businesses adjacent to the construction corridor. This is mainly associated with the brine pipeline.	Medium

11.4.6 Operational impact assessment

This section outlines impacts from operational vehicle movements on the traffic network, and impacts to parking, public transport, access and pedestrians.

Operational traffic generation

During operation, most traffic generated will be associated with the day-to-day operation of the AWRC.

The pipelines, release structure and flow split structure will only require infrequent vehicle access to carry out routine inspection and maintenance. This will likely occur about once every 6-12 months in any one location, with impacts on traffic considered negligible. On this basis, the operational traffic impact assessment has only assessed the AWRC which has a more consistent generation of operational traffic.

AWRC traffic generation

The AWRC will be accessed via a new access road off Clifton Avenue. The construction of the access road is not part of the EIS, however, its location is shown in Chapter 4. The operational traffic impact assessment has been conducted on the Clifton Road/ Elizabeth Drive intersection as the key intersection relevant to operational traffic movements. The modelled impacts are based on the 2025 predicted traffic volumes given this is when the AWRC will start operating.

The AWRC will operate 24/7 and up to 10 workers will be required during Stage 1. Workers will likely arrive between 6 am and 9 am Monday to Friday and depart between 3 pm and 7 pm. Truck movements associated with chemical deliveries and biosolids removal are likely to occur between 6 am and 7 pm.

Vehicle movements during operation of the AWRC will be related to:

- staff journeys (up to 10 two-way trips each day)
- biosolids removal (about two trucks per day at peak biosolids production)
- screening removal (about one truck per week)
- grit removal (about one truck per fortnight)
- other deliveries (typically between three and seven vehicles each day for chemical deliveries)
- maintenance requirements (ranging from daily to every six months).

Operational traffic impacts

Table 11-41 provides the traffic volumes in 2025 without operational traffic generated by the AWRC. Table 11-42 provides the traffic volumes in 2025 with operational traffic generated by the AWRC included. Section 11.4.2 explains the different modelling parameters used to assess the impacts.

Table 11-42 shows the project's operational traffic does not change LoS categories for Elizabeth Drive and Clifton Avenue. The modelled traffic volumes along Elizabeth Drive and Clifton Avenue do not significantly increase, with a LoS of A in the AM and B in the PM. The LoS category of F for Clifton Avenue relates to the queueing of vehicles on Clifton Avenue due to the high traffic volumes on Elizabeth Drive delaying vehicles accessing Elizabeth Drive from Clifton Avenue. This occurs with and without operational traffic from the AWRC.

There is potential that the traffic volumes on Elizabeth Drive may reduce during operation of the AWRC, as traffic may use the M12 Motorway. Future potential upgrades to Elizabeth Drive may also assist in reducing traffic volumes.

Due to the small numbers of operational traffic generated by the project, impacts to future projects including the Greater Sydney Metro, M12 Motorway, the Northern Road, Elizabeth Drive and the Outer Sydney Orbital are considered to be negligible. The project will also not impact on the M7 Motorway due to the low numbers of traffic generated during operation. The operational traffic will not impact on the surrounding freight transport network.

The AWRC will have a car park on site for operational staff and other visitors to the site.

Table 11-41 Operation in 2025 without the project

Approach	2025 AM without project				2025 PM without project			
	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)
Elizabeth Drive (east)	760	B	0.427	5.4	1,289	A	0.707	0.8

Approach	2025 AM without project				2025 PM without project			
	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)
Elizabeth Drive (west)	1,240	A	0.683	0	632	A	0.352	0
Clifton Avenue	14	F	0.903	34.9	28	F	>1	48.9

Table 11-42 Operation in 2025 with the project

Approach	2025 AM with project				2025 PM with project			
	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)	Traffic volume (vehicles/hr)	LoS	DoS	95%ile queue (m)
Elizabeth Drive (east)	765	B	0.427	6.5	1,290	A	0.704	0.9
Elizabeth Drive (west)	1,245	A	0.687	0	633	A	0.353	0
Clifton Avenue	16	F	0.860	30.8	38	F	>1	84.4

Operational impacts to active transport

There are minimal existing walking and cycling provisions, such as footpaths and bicycle paths, near the AWRC site. This is due to high volumes of fast-moving traffic especially along Elizabeth Drive and Park Road. The small number of vehicle movements added to the network during project operation is not expected to impact walking and cycling routes. The project will also not result in any permanent loss of (or increase in demand for) active transport infrastructure, such as cycleways and footpaths.

The Penrith City Council DCP specifies that bicycle parking is only required for workplaces with greater than 20 staff. Opportunities to integrate cycling and pedestrian elements, will be investigated further during detailed design. There are limited opportunities to integrate cycling and pedestrian elements with the surrounding network due to the location of the AWRC and minimal surrounding existing active transport infrastructure. There is potential for opportunities in the green space area at the AWRC site if the public recreation component progresses.

Operational impacts to public transport

There are minimal existing public transport provisions near the AWRC site. It is not expected that the AWRC site will impact any public transport or travel times. The pipelines will be located below ground and will not impact on public transport. The project is unlikely to improve public transport as this is outside of the project scope and Sydney Water's remit.

Table 11-43 summarises the potential traffic impacts during operation. The impact significance is based on the impact assessment methodology outlined in section 11.4.2.

Table 11-43 Summary of project operation traffic impacts

Potential impact	Location	Impact significance
Clifton Avenue approach is operating at a LoS F with through flows restricting movements at peak times	Clifton Avenue, Elizabeth Drive	Medium

11.4.7 Framework Construction Traffic Management Plan

Sydney Water will develop a detailed Construction Traffic Management Plan (CTMP) during detailed design once construction contractor(s) have been engaged. The SEARs require the EIS to include a Draft CTMP, to present a framework that will guide the development of more detailed site-specific construction traffic management plans (SSCTMP). A draft CTMP is provided in Appendix U and includes amongst other matters, construction phases, consideration of route identification and scheduling of transport movements, details of construction site access and worker parking, the need for road and cycleway diversions.

The key aim of the Draft CTMP is to minimise impacts to the surrounding transport network during construction. The following objectives have been developed to support this overarching aim:

- Minimise the overall impacts to road users.
- Ensure minimal disruptions to public transport operations, including schedules, stop location and routes.
- Maintain access for existing road users, including the local community, public transport operators, pedestrians and cyclists.
- Ensure safety of pedestrians, cyclists, construction workers, road users and the local community.

- Ensure disruption to residents, local businesses and agricultural uses are minimised including appropriate consultation, particularly in areas which are vulnerable to changes including temporary road diversions or temporary impacts to parking.
- Ensure construction vehicle movements remain below the volumes specified in the EIS, particularly during the peak hours.
- Minimise disruption to existing road furniture and kerbside provisions including existing bus stops, cycleways and on-street parking.
- Comply with all relevant legislation and other requirements specified by relevant authorities.

The Draft CTMP includes approaches to a range of traffic management matters, including route identification and scheduling of transport movements, construction site access and worker parking, including across different construction stages. The SSCTMPs will built on these to capture management measures and approaches for specific areas across the project. The project has not yet reached a design stage where more detailed information such as swept path analysis is available and this will be developed as part of detailed design.

Site specific Construction Traffic Management Plans

The CTMP will consist of several SSCTMPs which will cover all construction areas of the project. Each plan will include a variety of issues for management, depending on the specific context of the area it covers. This might include:

- construction worker parking arrangements, including any changes or impacts to existing street parking
- designated access points to and from construction sites
- haulage routes
- public transport stops
- pedestrian and cyclist facilities
- general traffic management.

These plans are required as part of the construction phase to assess the local traffic impacts of work sites. A SSCTMP may cover several work sites depending on a range of factors including proximity and expected activities onsite.

The SSCTMPs will be prepared in consultation with relevant stakeholders and interest groups where the area may be particularly vulnerable to change or impact. The Social Impact Assessment has identified at least one area (Cabramatta town centre) where this is the case. This consultation process will allow the plans to be prepared in a way that maximises the input of people affected by the project and forms the basis for developing the most appropriate and specific mitigation and management responses. This is the approach that will be taken for developing all SSCTMPS required for the project.

11.4.8 Impact of future stages

The timing and scope of future stages of the AWRC have not been determined. The pipelines have been sized to ultimate capacity, so the only additional traffic movements in future stages would be associated with the AWRC site.

The future road network will be significantly different to that of the current network, as a result of the completion of projects such as the M12 Motorway, Northern Road Upgrade and Elizabeth Drive Upgrade. This means it is difficult to accurately predict and assess impacts from future stages of the project. However, given the future stages involve increasing capacity of the AWRC from up to 50 ML/day to up to 100 ML/day, it is likely that future stages will at worst double the operational traffic movements of the Stage 1 AWRC. This is unlikely to have a significant impact on the traffic network.

11.4.9 Cumulative impacts

Cumulative impacts around the AWRC are likely to occur due to the close proximity and overlap of construction timeframes with the M12 Motorway and Western Sydney International Airport projects. Sydney Water is working closely with TfNSW regarding the timing and planning of construction around key areas such as Clifton Avenue and Elizabeth Drive. Other projects in which cumulative traffic impacts may also arise include Sydney Metro Western Sydney Airport and The Northern Road upgrade. As noted in section 11.4.2, construction traffic generated from M12 Motorway and Western Sydney International Airport has been incorporated into the baseline assessment given there are known overlaps in construction timing and information on traffic generation is available for these projects.

Cumulative impacts during construction of the pipelines are unlikely to be significant due to the progressive nature of construction of linear infrastructure. The Cabramatta Loop project is located close to Cabramatta railway station and the alignment of the brine pipeline. The Warragamba Dam wall raising project is located close to the environmental flows release structure. Potential overlap in construction timeframe may occur between these projects, which may result in cumulative traffic impacts in the area.

Construction staging and timing will be completed in consultation with surrounding land holders and adjacent construction projects, and where possible, completed when cumulative impacts from other developments are unlikely. Section 11.4.10 includes management measures to address cumulative impacts.

11.4.10 Management measures

Table 11-44 outlines the traffic and transport management measures that Sydney Water will implement for the project.

Table 11-44 Traffic and transport management measures

ID	Potential impact	Management measure	Timing
TT01	Traffic related impacts to traffic exceeding the estimated capacity on certain links	Prepare Site Specific Construction Traffic Management Plans (SSCTMP) in consultation with relevant local councils, impacted residents and businesses, TfNSW and in accordance with relevant guidelines and the Framework Construction Traffic Management Plan (CTMP) (Appendix U). Each SSCTMP will outline: • staging and timing of construction for each area of the project • any changes to traffic conditions, including road closures or diversions • identification of haulage routes • safe alternative routes for pedestrians, cyclists and other active transport in accordance with relevant safety standards • parking arrangements for construction workers • construction access points • measures to minimise impacts on public transport network, including bus stops • opportunities to reduce road traffic noise, including restricting heavy vehicle movements to standard construction hours • measures to minimise impacts to businesses • measures to outline construction interface management with the M12 Motorway project. In addition to the above, SSCTMP will include: • Signage at key locations across the local influence area including Wallacia, and Luddenham to ensure the visitor experience is made as clear and easy as possible. Signage mitigation will also be required throughout busier areas where facilities are clustered together and subject to frequent access such as: – Luddenham Main Street (the Old Northern Road) in Luddenham – Elizabeth Drive in Luddenham and Kemps Creek – Liverpool Road North in Bonnyrigg – St Johns Road, Cabramatta Road and Bartley Street in Cabramatta • Specific consideration of the highly urbanised setting in Cabramatta within the local influence area. This includes planning parking changes to reduce	Detailed design Prior to construction During construction

ID	Potential impact	Management measure	Timing
		potential impacts and planning traffic diversions in consultation with Fairfield Council.	
TT02	Congestion related to traffic exceeding the estimated capacity on certain links	Finalise the Framework CTMP to guide the development of the SSCTMPs.	Prior to construction
TT03	Cumulative impacts to the road network	Investigate opportunities to minimise cumulative impacts along Clifton Avenue and Elizabeth Drive with the M12 Motorway project. Measures outlined in TT01 will also help minimise cumulative impacts from the project on the traffic network.	Detailed design During construction
TT04	Cumulative impacts to the road network	Prioritise the use of arterial and sub-arterial roads over collector and local roads, especially during AM and PM peaks, for construction haulage routes. This will include planning traffic routes to minimise impacts to sensitive receivers on local roads.	Prior to construction During construction
TT05	Operational traffic from the AWRC impacting the traffic network	Where possible, schedule operational deliveries and other operational vehicle movements outside of peak traffic movements on Elizabeth Drive to minimise queuing on Clifton Avenue.	During operation

11.5 Human health and hazards

This section describes the potential health impacts during construction and operation of the project. It provides an overview of the key findings of the detailed Health Impact Assessment (HIA) (EnRisks, 2021) in Appendix V, and the Preliminary Hazard Analysis (PHA) (Aurecon Arup, 2021l) in Appendix W.

Human health and hazards impact summary

A Health Impact Assessment has been completed for the project to identify potential impacts on human health during construction and operation. Potential impacts on human health can occur from water quality, air quality, noise and vibration, soil contamination, hazardous chemicals, traffic and transport, waste, bushfire and subsidence. The assessment determined that human health impacts and exposure to hazards, during construction and operation of the AWRC, is expected to be low or negligible

Potential health impacts during construction relate to noise and vibration, especially when work outside of standard construction hours is required. Contaminated soil (including soil containing asbestos) and contaminated groundwater may also be encountered during construction, both of which could impact the health of workers and the community. Based on detailed noise, vibration and contamination studies, the potential impacts from these matters will be minor and temporary. Implementing the management measures identified in these studies, will further minimise the potential for construction-related impacts on human health.

The main areas of potential operational impact on human health relate to altered water quality, exposure to waste, and the transport, storage, handling and use of dangerous goods at the AWRC. Water quality modelling of the potential impact of treated water release to waterways informed human health considerations. The results from these studies found that due to the high level of treatment, the released water will be of high quality and exceedances of water quality related human health guidelines are not expected.

The assessment also considered the risk of exposure to construction and operational hazards in a Preliminary Hazard Analysis. The focus is on the AWRC site during operation as hazards associated with project construction and pipeline operation are negligible. The potentially most significant hazards are exposure to dangerous goods and waste products. The assessment of dangerous goods required during operation identified that the handling and storage of methanol and biogas posed a potential risk but there is no risk of significant harm. Exposure to operational waste was also found to be of low risk to human health.

Offsite operational impacts to human health are therefore unlikely to be significant, and can be adequately managed through the implementation of processes and procedures in existing Sydney Water management systems.

11.5.1 Relevant Secretary's Environmental Assessment Requirements

Table 11-45 shows the Secretary's Environmental Assessment Requirements (SEARs) relevant to human health and hazards, and where in this section they are addressed.

Table 11-45 Project SEARs relating to human health and hazards impacts

SEARs	EIS section where requirement addressed
50. A Health Impact Assessment of the project in accordance with the current guidelines.	Sections 11.5.5 and 11.5.6
51. An assessment of the likely risks of the project to public safety including flooding risk, subsidence risks, bushfire risks and the handling and use of dangerous goods.	Sections 11.5.5 and 11.5.6

11.5.2 Methodology and assumptions

The methodology outlined below relates to the overall HIA process, and the PHA for dangerous goods. The HIA has drawn from the findings and recommendations from other specialist technical reports that support the Environmental Impact Statement (EIS). The methodology presented here does not provide details on how those assessments were completed, but these can be found in each respective section of the EIS.

Health impact assessment

The methodology for the human health and hazards impact assessment included:

- reviewing project design and technical assessments where impacts have potential to result in impacts to human health, including impacts related to:
  - water quality
  - air quality
  - noise and vibration
  - soil contamination
  - hazardous chemicals
  - traffic and transport
  - waste
  - bushfire
  - subsidence
- identifying the populations in the study area which may be exposed to impacts from the project. This included using information from the Australian Bureau of Statistics (ABS) Census 2016 to understand the health status of those existing populations

- completing a hazard assessment to identify the adverse health effects associated with the key pollutants and stressors identified from each of the technical assessments
- characterising the risk of hazards occurring using quantitative and qualitative assessment methods
- identifying management measures to avoid or minimise the potential impact to human health from construction and operation of the project.

Preliminary Hazard Analysis

The methodology for the PHA included hazard screening and risk assessment in accordance with Hazardous and Offensive Development Application Guidelines - Applying SEPP 33 (Department of Planning, Industry and Environment (DPIE), 2011a).

The PHA focused on the operational phase because only small volumes of fuels or chemicals will be required during construction. These small volumes can be stored and handled in accordance with safety data sheets (SDS) requirements which means there is negligible risk of impact to human health during this phase.

During operation, the PHA focused on the AWRC site because pipeline operation will not require the handling or storage of dangerous goods.

Hazard screening

Hazard screening involved classifying each potential dangerous good stored at the site and reviewing quantities and transport requirements against thresholds in DPIE (2011). A hazard identification study (HAZID) was also completed during the project's reference design to identify potential hazards, eliminate potential hazards where possible, or identify appropriate management measures.

Level of risk assessment

The level of risk assessment required was determined using NSW DPIE's Multi-level Risk Assessment (MLRA) (DPIE, 2011b).

The MLRA identifies three levels of risk assessment that can be completed, depending on the potential for off-site impacts to occur and how well their severity and likelihood are understood. These include:

- Level 1 – qualitative analysis, primarily based on hazard identification techniques
- Level 2 – partially quantitative analysis, using hazard identification and the focused quantification of key potential off-site risk contributors
- Level 3 – quantitative risk analysis, based on the full and detailed quantification of risks, consistent with Hazardous Industry Planning Advisory Paper (HIPAP) 6 – Hazard Analysis (DPIE, 2011c).

In accordance with the MLRA, the appropriate level of analysis was determined to be Level 2 – partially quantitative due to the potential for offsite impacts arising from the methanol storage area and digester gas holders.

Risk assessment

The risk assessment identified the potential offsite risks and mitigation measures associated with dangerous goods. It was completed using criteria in HIPAP 4 – Risk Criteria for Land Use Safety Planning (DPIE, 2011d).

Given the AWRC site will require the storage and use of dangerous goods for wastewater treatment, a PHA was completed to:

- identify all potential hazards and incident scenarios
- analyse the consequences of the incidents on people
- analyse the likelihood (frequency) of such events occurring
- quantify the resultant risk levels (individual risk and societal risk)
- compare the risk levels with established risk criteria and identification of opportunities for risk reduction.

Appendix W provides further detail about the methodology for modelling different impact scenarios.

Health impact assessment assumptions

The following assumptions and limitations were made in the assessment of potential human health impacts from the project:

- The assessment does not present an evaluation of the health status of any specific individuals in the community. Instead, for aspects where a more quantitative assessment was undertaken, the potential for community exposure to project impacts was estimated. This estimate was compared to regulatory and published estimates of such exposures that a person may be exposed to over a lifetime without unacceptable risks to their health.
- Potential for exposures considered a worst-case scenario rather than just average levels to ensure risks were assessed appropriately.
- The HIA used both qualitative and quantitative assessment methods. Where qualitative assessment was used, it provides a general indication of potential impacts only.
- The HIA relied on data provided from other studies prepared for the EIS.
- The HIA only considered health impacts related to the project. For example, because the recycled water network and wastewater collection network are not part of project scope, the assessment does not consider the health impacts of using recycled water or of operating the wastewater collection network.
- The HIA reflects the current state of knowledge regarding the potential health effects of identified chemicals and pollutants for this project.

- Chapter 2 of the EIS references Department of Planning, Industry and Environment (DPIE) population growth projections which are used to inform Sydney Water's infrastructure planning. Despite this, it is standard practice to use ABS data in HIA as it provides a wide range of data, in addition to population projections, that can be reviewed collectively to provide a holistic characterisation of the community.

11.5.3 Existing environment

This section outlines the geographic location of the project, and the population and health profile of the communities that live and work nearby. It also addresses the nature of wastewater likely to be generated from the Upper South Creek Servicing Area.

Land use

Most of the AWRC site is currently zoned Rural Landscape under Penrith Local Environmental Plan 2010, whilst the riparian corridors along South Creek and Kemps Creek are zoned Environment and Recreation under State Environmental Planning Policy (Western Sydney Aerotropolis Plan) 2020. Historically, the AWRC site has been used for agriculture and for scientific and research land uses such as the Fleurs Radio Telescope. The nearest private residential properties are about 500 m to the south, south-east, east and north-east of the AWRC. The Twin Creeks residential development is located about 1.5 km to the north-west.

West of Luddenham, most of the current land use zoning along the treated water and environmental flows pipelines is Rural Landscape, Primary Production, Enterprise or Environment and Recreation zones, intersecting a small area of rural village and public recreation at Wallacia. The environmental flows pipeline runs past residential properties on Elizabeth Drive and Park Road. The treated water pipeline also passes near Western Sydney International Airport which is currently under construction. The closest private residential properties are adjacent to the treated water pipeline in Wallacia along Golfview Drive, Green Street, Eagle Street and Byron Avenue.

The brine pipeline alignment crosses areas zoned Enterprise and Environment and Recreation south-east of the AWRC, before passing through a mixture of low/medium density residential, public recreation and business development areas around Cecil Hills, Bonnyrigg and Cabramatta. Private residential properties are located adjacent to most of the brine pipeline alignment, as it passes through more developed and urbanised areas compared to the AWRC, treated water pipeline and environmental flows pipeline.

Population and health profile

The project is located in the local government areas of Penrith, Wollondilly, Liverpool, Fairfield and Canterbury-Bankstown.

Appendix V provides further information on the population and health profile of existing communities near the project. Key content summarised here is:

- population statistics of the study area based on 2016 Australian Bureau of Statistics Census Data (Table 11-46)

- key health indicators for the local community compared with Greater Sydney and wider NSW statistics based on data obtained from Health Statistics NSW (Table 11-47).

Table 11-46 Summary of population statistics in the study area

Location	Total population		Population by age group (%)					
	Male	Female	0-4	5-19	20-64	65+	1-14*	30+*
Local government area								
Penrith	98,822	99,243	7.4	20.3	60.7	11.7	21.1	57.5
Wollondilly	24,207	24,314	6.8	22.2	57.6	13.2	22	59.1
Liverpool	101,351	102,975	7.6	22.4	59.6	10.4	22.7	55.9
Fairfield	97,959	100,855	6.1	20.1	59.9	13.8	19.1	58.9
Canterbury-Bankstown	172,327	173,977	7.2	19.6	59.3	14	20.5	58.6
SA4 statistical area								
Sydney – outer west and Blue Mountains	150,470	156,457	6.8	20	59.2	13.8	20.2	59.6
Sydney – south west	200,618	205,344	7	21.3	59.9	12	21.1	57.4
Sydney, NSW and Australia								
Greater Sydney	2,376,766	2,444,221	6.4	18.2	61.4	13.9	17.4	60.4
NSW (excluding Sydney)	1,301,717	1,341,813	5.8	18.5	55.1	20.6	17.3	64.6

Location	Total population		Population by age group (%)					
NSW (including Sydney)	3,686,014	3,794,217	6.2	18.3	59.1	16.2	18.5	61.8
Australia	11,546,638	11,855,248	6.3	18.5	59.7	15.8	18.7	61.7

Notes on table:

* relevant for the characterisation of risk

Table 11-47 Summary of key health indicators

Health indicator	Rate per 100,000							
	Penrith	Wollondilly	Liverpool	Fairfield	Canterbury-Bankstown	Western Sydney	Greater Sydney	NSW
Mortality								
All causes – all ages	593.5 (2017/18)	522.4 (2017/18)	510 (2017/18)	500.4 (2017/18)	485.5 (2017/18)	470.3 (2018)	-	506.4 (2018)
All causes (non-trauma) ≥30 years	-	-	-	-	-	-	976.5	-
All causes ≥30 years	-	-	-	-	-	-	1,026	-

Health indicator	Rate per 100,000							
	Penrith	Wollondilly	Liverpool	Fairfield	Canterbury-Bankstown	Western Sydney	Greater Sydney	NSW
Cardiopulmonary ≥30 years	-	-	-	-	-	-	412	-
Cardiovascular – all ages	160.6 (2017/18)	155.3 (2017/18)	140 (2017/18)	143.4 (2017/18)	129.8 (2017/18)	125.6 (2017/18)	191.8	136 (2017/18)
Respiratory – all ages	-	-	-	-	-	45.2 (2017/18)	51.5	-
Hospitalisations								
Coronary heart disease	518.7 (2017/19)	558.8 (2017/19)	499.6 (2017/19)	433.6 (2017/19)	456.2 (2017/19)	482 (2018/19)	-	492.5 (2017/19)
COPD >65 years	-	-	-	-	-	-	-	1,351.9 (2018/19)
COPD All ages	263 (2017/19)	208.9 (2017/19)	250.5 (2017/19)	174.5 (2017/19)	220.8 (2017/19)	-	-	224.8 (2018/19)
Cardiovascular disease	-	-	-	-	-	-	-	-
All ages	1,698.4 (2017/19)	1,756.5 (2017/19)	1,625.2 (2017/19)	1,395.4 (2017/19)	1,589.7 (2017/19)	1,587.2 (2018/19)	1,976	1,672.4 (2018/19)

Health indicator	Rate per 100,000							
	Penrith	Wollondilly	Liverpool	Fairfield	Canterbury-Bankstown	Western Sydney	Greater Sydney	NSW
>65 years	-	-	-	-	-	-	9,235	-
Respiratory disease	-	-	-	-	-	-	-	-
All ages	-	-	-	-	-	1,647 (2018/19)	2,003	1,675.2 (2018/19)
>65 years	-	-	-	-	-	-	3,978	-
Asthma	-	-	-	-	-	-	-	-
Asthma hospitalisations (ages 5–34 years)	-	-	-	-	-	198.2 (2018/19)	-	154.7 (2018/19)
Asthma hospitalisations (all ages)	172.5 (2017/19)	111.9 (2017/19)	203.3 (2017/19)	142.2 (2017/19)	156.6 (2017/19)	165.1 (2018/19)	-	142.1 (2017/19)
Asthma emergency department hospitalisations (1–14 years)	-	-	-	-	-	-	1209	-

Health indicator	Rate per 100,000							
	Penrith	Wollondilly	Liverpool	Fairfield	Canterbury-Bankstown	Western Sydney	Greater Sydney	NSW
Asthma emergency department hospitalisations (5-34 years)	-	-	-	-	-	-	-	349.3 (2018/19)
Asthma emergency department hospitalisations (all ages)	-	-	-	-	-	-	-	297.2 (2018/19)
Asthma prevalence (current) for children aged 2–15 years	-	-	-	-	-	10.4% (2017/19)	-	12.9% (2018/19)
Current asthma for ages 16 and over	-	-	-	-	-	11.7% (2019)	-	11.5% (2019)

Notes on table:

- No data available

Wastewater characterisation in Upper South Creek Servicing Area

During consultation, NSW Health raised a question about how the wastewater catchment is characterised and any particular health risks from catchment sources in the wastewater.

Given the project is developing a new wastewater system to service population growth, the Upper South Creek Servicing Area will change over time as urban development occurs, to include a mix of residential, commercial and industrial uses that do not yet exist. It is expected to be predominantly residential, with non-residential customers expected to be mostly data centres and warehouses. Sydney Water has designed AWRC treatment processes based on influent quality in other similar systems across Sydney, which also have a mix of these uses.

Trade waste contributions to the catchment are expected to be similar to that typically observed in Sydney Water's other wastewater systems. Consistent with its other systems, Sydney Water will require commercial and industrial premises in the Upper South Creek Servicing Area to hold trade waste agreements to ensure pollutants in that wastewater are appropriately managed.

11.5.4 Legislation and guidelines

The guidelines for the overall health impact assessment and PHA are outlined below.

Health impact assessment

The HIA has been completed in accordance with the following guidelines that are endorsed and accepted by NSW and Australian health and environmental authorities:

- Health Impact Assessment Guidelines, Environmental Health Committee (enHealth, 2017).
- Health Impact Assessment Guidelines, Environmental Health Committee (enHealth, 2001).
- Harris, P., Harris-Roxas, B., Harris, E. & Kemp, L., 2007, Health Impact Assessment: A Practical Guide, Centre for Health Equity Training, Research and Evaluation (CHETRE). Part of the UNSW Research Centre for Primary Health Care and Equity. University of NSW, Sydney (Harris et al, 2007).
- Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards, 2012 (enHealth, 2012).
- Schedule B8 Guideline on Community Engagement and Risk Communication, National Environment Protection (Assessment of Site Contamination) Measure, 1999 (National Environment Protection Council (NEPC, 2013)).
- National Environmental Protection (Air Toxics) Measure, Impact Statement for the National Environment Protection (Air Toxics) Measure, 2003 (NEPC, 2003).
- Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance or Inhalation Risk Assessment), EPA-540-R-070-002, January 2009 (United States Environment Protection Agency (USEPA 2009)).

Preliminary Hazard Analysis

The PHA has been completed in accordance with the following legislation and guidelines:

- State Environment Planning Policy No. 33 – Hazardous and Offensive Development.
- Applying SEPP 33 Guideline, NSW DPIE (DPIE, 2011a).
- Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 – Hazard Analysis, NSW DPIE (DPIE, 2011c).
- HIPAP 4 – Risk Criteria for Land Use Safety Planning, NSW DPIE (DPIE, 2011d).
- Australian Dangerous Goods Code, National Transport Commission (NTC), (NTC, 2020).

11.5.5 Construction impacts

The project's impacts on human health during construction are assessed below, focusing on water quality, air quality, noise and vibration, contamination, traffic and transport, waste, bushfire and subsidence. This includes screening of the human health hazards and assessing the potential risk of each hazard to human health.

Water quality

Runoff from construction areas has the potential to cause on and offsite erosion and sedimentation, particularly where earthworks are being undertaken. Accidental spills of fuels or chemicals used during construction also has the potential to enter receiving water which may then lead to exposure of these fuels or chemicals to humans who are in contact with that water.

These impacts are common with all types of construction. A range of management measures are recommended in other sections of the EIS for the management and release of stormwater from construction areas and for the appropriate storage and handling of any fuels or chemicals. This includes sediment and erosion controls and stormwater retention ponds which slow the movement of water so the particles can drop out. The project will also rehabilitate disturbed areas as soon as practical following construction works to limit the potential movement of soils offsite

With these measures in place, no unacceptable impacts on water quality from stormwater and dewatering runoff or spills from construction areas are expected for the project. As a result, potential construction-related water quality impacts are unlikely to impact human health.

Air quality

The project's construction activities have the potential to generate dust from earthworks and ground disturbance for construction of the AWRC and the pipelines. Dust particles are always present in the air and construction activities will add to existing background levels. Dust particles at excessive levels have the potential to cause respiratory issues in humans.

Due to the variability of activities, equipment, specific work locations and meteorological conditions, construction dust cannot be reasonably modelled. Despite this, the generation of dust from construction activities is a common occurrence and well understood. The construction dust management measures proposed in the project's Air Quality Impact Assessment (Jacobs, 2021) are considered suitable to manage construction dust and no adverse human health impacts are expected associated with dust from project construction.

Noise and vibration

Noise and vibration impacts have the potential to impact human health, including in relation to:

- sleep disturbance (sleep fragmentation that can affect psychomotor performance, memory consolidation, creativity, risk-taking behaviour and risk of accidents)
- annoyance, including from vibration
- hearing impairment
- interference with speech and other daily activities
- impacts on children's school performance (through effects on memory and concentration)
- impacts on cardiovascular health.

The project will produce noise and vibration as a result of construction activities at the AWRC and along the pipeline alignments.

Construction at the AWRC site and along the pipelines is likely to exceed noise management levels at the nearest sensitive receivers. Noise impacts from pipeline construction are typically short-term for individual receivers, as construction progresses along the pipeline alignment.

Construction works will be completed both within and outside standard construction hours. In general, out of hours work (OOHW) will be required in urbanised areas along the brine pipeline alignment to minimise significant disruptions to the traffic network, as well as for some sections of tunnelled pipeline construction, such as for the environmental flows pipeline.

Impacts will be greatest where work is required outside of standard construction hours, where sensitive receivers are located within 100 m of construction activities, and where construction activities are required for extended periods. This includes construction activities at the AWRC site, tunnelling at Bents Basin Road and Lansvale Park, and where night works are required on busy roads to minimise impacts on the traffic network.

Based on the outcomes of the noise and vibration assessment, although there is the potential to impact sensitive receivers (particularly during night works), with the proposed management measures in place these impacts are unlikely to impact human health.

Safe working distances for construction equipment which may generate vibration have been established for cosmetic and structural impacts to buildings and infrastructure as well human comfort. With these implemented during construction, health impacts as a result of vibration are unlikely.

Contamination

The project has the potential to encounter contaminated soils and groundwater during construction. This could occur during excavation dewatering, stormwater management and the installation of infrastructure. Contaminated material has the potential to impact construction workers, as well as the community if it is not appropriately handled, transported and disposed.

There is potential for asbestos sheeting to be present, as well as contaminated groundwater in some locations, such as the AWRC site. These matters are not uncommon for developments in urban areas. There is also one location along the brine pipeline where soils contaminated by petroleum hydrocarbons may need to be managed adjacent to a service station.

The desktop review of existing information and contamination reports for the AWRC and pipeline alignments, as well as the results of project specific soil sampling, has indicated that the potential to encounter contamination is low. As such, the potential for contamination to impact on human health is also considered to be low.

Traffic and transport

The project will generate traffic during the construction phase. This has the potential to impact the road network, as well as public transport, pedestrian footpaths and cycling.

Project construction will generate traffic including worker vehicles and trucks to transport waste, equipment and materials. For most roads, the additional construction traffic volumes from the project are within their capacity and will have limited impact on user experience. However, some roads in the project area are already under stress from existing traffic volumes, which in some cases will be exacerbated by construction traffic from several major projects in the area (including this project and the M12 Motorway). These roads include the Elizabeth Drive/Clifton Avenue intersection near the AWRC site, the Northern Road and Hume Highway.

A large proportion of the project's construction vehicle movements will be to and from the AWRC site, with vehicle movements between the AWRC and Northern Road at peak times estimated at about 400 light vehicle movements and 300 heavy vehicle movements each day. Traffic movements are expected to be the greatest during the first 18 months of the AWRC construction when extensive earthworks will be undertaken, requiring moving spoil to and from the site.

Construction of the project may also temporarily impact public transport, walking and cycling. These impacts will be minimal and restricted to urban areas along the brine pipeline alignment, such as Cabramatta. Public transport, cycleways and pedestrian footpaths are limited around the AWRC and the treated water and environmental flows pipeline alignments. These impacts are not expected to directly impact human health due to the relatively small increase in traffic and associated impacts relative to existing traffic conditions. Management measures will be in place to address construction impacts to surrounding businesses and residents. As such, traffic and transport impacts to human health during construction are considered negligible.

Waste

The generation of waste during construction of the project cannot be avoided. The hierarchy of reduce, reuse, recycle and recover, waste, will be used to develop plans to minimise as much waste going to landfill as possible. The project will produce waste during construction, including:

- tyres (from normal use of plant and equipment)
- oils (from normal use of plant and equipment)
- fuels, paints etc (normal use during construction)
- batteries (from normal use of plant and equipment)
- excavated soils
- green waste (vegetation cleared from the site prior to excavation)
- construction wastes (electrical materials, plumbing materials, metals (nuts, bolts etc), packaging, geotextile offcuts, wood etc)
- office wastes (paper, cardboard)
- stormwater system wastes (litter, sediment etc)
- food waste (from construction workforce)
- drilling muds (from pipeline tunnelling)
- asbestos containing soils (potential)
- wood waste (pallets, crates).

The potential for waste to impact human health mainly relates to incorrect handling, transport and disposal of wastes which may result in human exposure to these waste materials. There is also potential for interaction with contaminated material, as outlined above which could lead to impacts on human health. However, the risk of impacts to human health from contaminated waste are considered low. If the frameworks, guidelines and legislation to guide waste management are implemented, the potential impact to human health from waste is considered negligible.

Section 12.2 provides further details on the quantities of waste the project will produce, including the management measures that will be implemented.

Bushfire

The AWRC site and the pipeline alignments are partially located on bushfire prone land. Construction works will include activities such as welding and the use of equipment that has the potential to ignite flammable materials. Stopping these activities during total fire bans (TOBAN), in accordance with the NSW Rural Fire Service recommendations, will avoid the potential for construction works to cause fire.

The location of construction activities in bushfire prone land also presents a hazard to construction workers, particularly around the environmental flows pipeline and the western portions of the treated water pipeline. Measures have been recommended including to remove workers from these locations during times of elevated Fire Danger Ratings to remove exposure to the bushfire hazard.

Subsidence

The construction area for the project is not located within any mine subsidence districts as defined by Subsidence NSW. Impacts to subsidence from construction activities, or impact from subsidence on the construction of the project is not anticipated.

Flooding

Construction activities will have a negligible impact on the intensity or duration of a flood event. During construction, some activities will be undertaken on flood-prone land. With an emergency management plan in place to make construction works safe and direct the evacuation of construction workers during a flood event potential impacts to human health will be minor.

11.5.6 Operational impacts

The project's impacts on human health during operation are assessed below, focusing on water quality, air quality, noise and vibration, contamination, traffic and transport, waste, bushfire, flooding and subsidence. This includes screening the human health hazards and assessing the potential risk each hazard has to human health.

Water quality

Depending on the operational status of the AWRC (normal operation or wet weather operation), the project may result in releases of water of varying levels of treatment to the following waterways. Figure 11-34 shows the level of treatment and waterway releases under normal and wet weather operations:

- Nepean River:
  - Advanced treatment
  - Tertiary treatment.
- Warragamba River:
  - Advanced treatment.
- South Creek:
  - Primary treatment – wet weather flows
  - Advanced treatment – wet weather flows.

Where people are exposed to changes to water quality (particularly microorganisms and certain chemicals) that exceed the relevant guideline values there is potential for human health impact to occur as a result of drinking the water, skin contact with the water and incidentally ingesting the water during water related activities. For example, microorganisms can cause disease and some chemicals may not break down quickly and have the potential to bioaccumulate or be transported downstream. To determine the potential human health impact of the project as a result of water quality impacts this assessment:

- details the effectiveness of the proposed treatment processes and water quality characteristics of the treated water from the AWRC
- characterises the water quality of the receiving environments
- characterises the water quality impact to the receiving catchments from the treated water releases – comparing treated water quality to background water quality in the above waterways
- examines the potential human health impacts from exposure of humans to water in the above waterways.

Treatment processes

The treatment processes include:

- **Primary treatment** will remove some organic solids from the wastewater. This typically occurs in sedimentation tanks where solids settle at the bottom. The solids are pumped to the thickening process for further treatment, and the liquid portion continues on to secondary treatment.
- **Secondary treatment** involves the biological removal of nutrients, particularly organics, nitrates, ammonia and phosphorus from the wastewater. Secondary treatment will use a combination of anoxic and aerobic treatment. Anoxic relates to oxygen not being present, and aerobic relates to the presence of oxygen. Secondary treatment uses biological processes to remove organics and nutrients such as nitrogen and phosphorus.
- **Tertiary treatment** removes further organic and inorganic solid components and can be designed to remove nutrients such as nitrogen and phosphorus. Some bacteria, virus and parasites which are harmful to public health are also removed at this stage. The AWRC will likely use membrane technology for tertiary treatment. This involves the wastewater from secondary treatment being pushed through a semi-permeable filtration barrier which acts to retain impurities. The retained impurities are returned to prior treatment phases. The tertiary treated wastewater continues to the advanced treatment process.
- **Advanced treatment** removes any remaining impurities in the wastewater following the primary, secondary and tertiary treatment processes. This includes smaller-sized particles of biological, organic and inorganic material that may have passed through the previous stages due to their small size. The AWRC is likely to use Reverse Osmosis (RO) which achieves a high quality of treatment by forcing the wastewater through a membrane under high pressure. The outputs of the advanced treatment process are the treated water stream

and the brine stream. The brine stream consists of the waste products from the advanced treatment process.

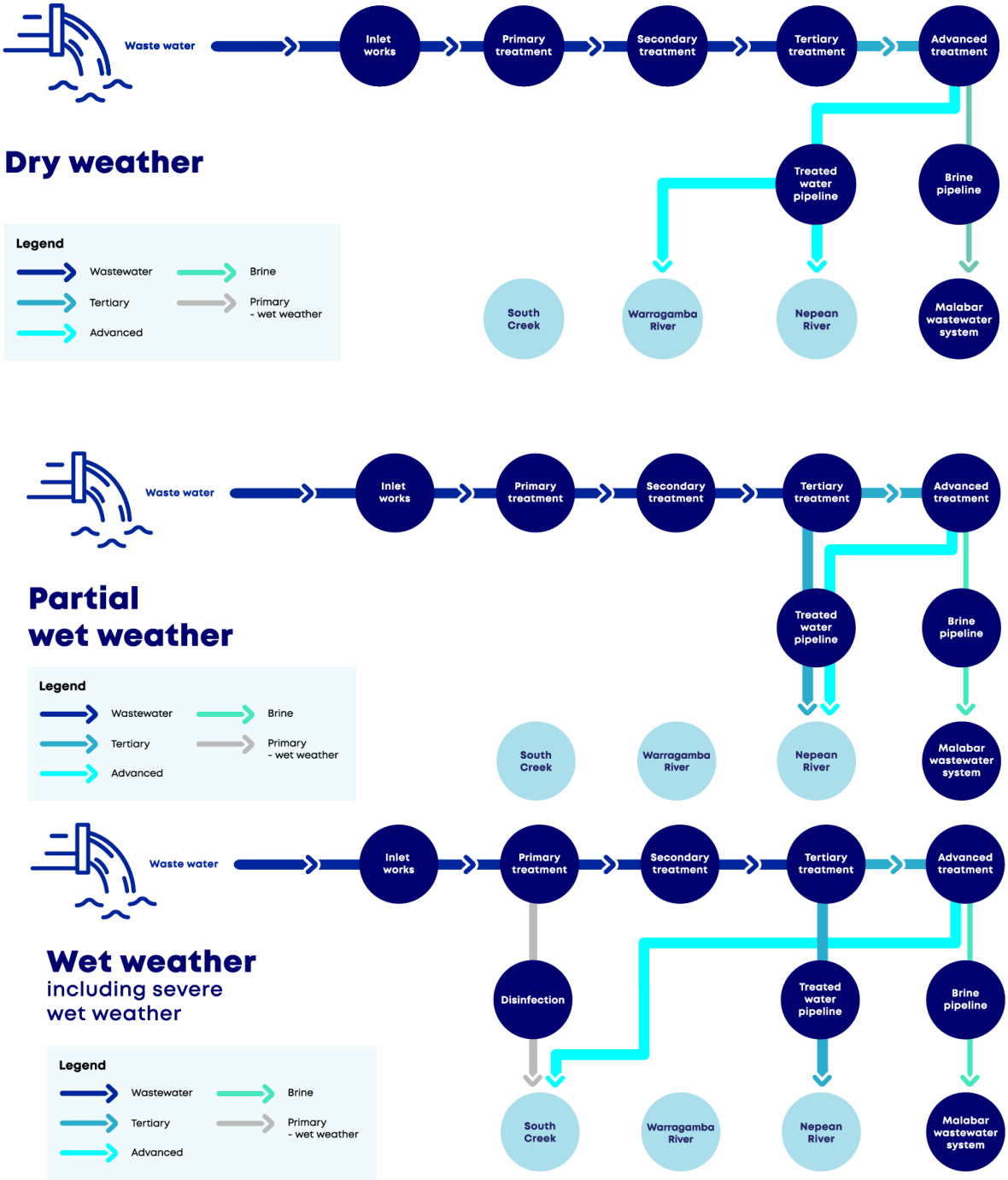


Figure 11-34 Water treatment streams and release scenarios

Chapter 4 provides a more detailed explanation of the treatment process. Under normal operating conditions only advanced treated water will be released to waterways.

Treated water quality produced by the AWRC

Table 11-48 provides indicative concentrations and measurements of different water quality parameters for the different levels of treatment. These parameters are useful for determining potential human health impacts of the project.

Table 11-48 Indicative primary water quality concentrations under different treatment levels

Parameter	Units	Median concentrations		
		Advanced treated water	Tertiary treated water	Wet weather treated water
Total nitrogen (TN)	mg/L	0.35	2.5	18
Total phosphorus (TP)	mg/L	0.009	1	1
Oxides of nitrogen (NOx)	mg/L	0.12	1.8	0
Ammonia (NH3)	mg/L	0.03	0.2	15
Filterable reactive phosphorus (FRP)	mg/L	0.006	0.66	0.66
Chlorophyll a (Chl a)	ug/L	0	0	0
Dissolved oxygen (DO)	mg/L	9.2	5.9	0
Total Suspended Solids (TSS)	mg/L	0	1	35
Total Dissolved Solids (TDS)	mg/L	20	540	240
Acid	pH	7	7	7
Conductivity	uS/cm	150	1,500	1,500
Enterococci	CFU/100mL	0	0	7,400

Analysis of treated water quality at other plants

To determine the effectiveness of the wastewater treatment processes proposed for the project, performance of similar treatment plants in Sydney Water's network was reviewed.
Appendix Fprovides a detailed analysis of current and historical water quality data for the Fairfield Water Recycling Plant (WRP) and other treatment plants (including St Marys WRP) which have similar water treatment technology for primary, secondary, tertiary and advanced water treatment as proposed for the AWRC. Given the similar treatment processes, similar results can be expected from treated water produced by the AWRC.

The focus of this analysis is on advanced and tertiary treated water as this is the water quality that will be released most of the time. In an average year, Sydney Water estimates that for 337 days treated water releases from the project will be only advanced treated water, with tertiary treated water released on 28 days. Primary treated water releases will occur infrequently to South Creek, and will be disinfected and diluted with advanced treated water. The primary treated water releases are estimated to occur for three days in an average year.

The existence of toxicants in wet weather treated water is variable, depending on the level of treatment, stormwater ingress and the type of development in the catchment. It would be harder to draw reliable conclusions from the review of such data from existing treatment plants.

Up to 350 individual chemicals and microorganisms were evaluated in treated water from the Fairfield WRP as part of a detailed monitoring program over 2019 and 2020. Monitoring of chemicals and microorganisms also occurred at St Marys, Rouse Hill and Penrith WRPs. Appendix F includes a full list of assessed parameters, their results, and how the key water quality parameters list was refined.

Advanced treated water

Microorganisms that were analysed in advanced treated water were:

- cryptosporidium and giardia
- faecal coliforms and bacteria
- viruses
- parasites including helminths.

The key finding of the microorganism analysis at Fairfield WRP was that none of the above microorganisms were identified in any of the treated water samples (or were below reporting limits). At St Marys WRP, the 90th percentile from 2010 data was less than one organism per 100 mL for cryptosporidium, giardia, faecal coliforms, bacteria and viruses.

Chemicals that were analysed in advanced treated water included:

- metals
- pesticides/herbicides/fungicides
- nutrients
- disinfection by-products
- per and polyfluoroalkyl substances (PFAS)
- other organic chemicals (those that contain carbon chains)
- organotin compounds
- antibiotics
- illicit pharmaceuticals
- general pharmaceuticals.

The key findings of the chemical analysis were that many chemicals were not detectable in the treated water samples. Where they were detectable, the samples met drinking water and recreational water quality guidelines. Seven chemicals identified in samples do not have drinking water or recreational water guideline values.

Tertiary treated water

For tertiary treated water samples, most chemicals and microorganisms were either below detection limits, below recreational and drinking water guidelines or did not have a guideline value. Guideline values for microorganisms were typically met with some microorganisms detected in a small number of historical samples at one treatment plant (enterovirus, adenovirus and cryptosporidium).

Catchment water quality

Sydney Water is currently implementing a background water quality monitoring in South Creek, Nepean River and Warragamba River which helps inform background water quality in the waterways potentially impacted by treated water releases. The results of the monitoring program are detailed in Chapter 8 with key findings summarised in Table 11-49.

Table 11-49 Summary of catchment water quality

Waterway	Key results
South Creek	South Creek is a highly disturbed ecosystem as evidenced by elevated physical, chemical and microbial stressors in accordance with ANZECC (2000). Enterococci levels at all sample locations were above the primary and secondary contact criteria. Elevated concentrations of total nitrogen, oxidised nitrogen, total phosphorus and chlorophyll a were found throughout the catchment combined with generally low levels of dissolved oxygen.
Nepean River	Nepean River is considered a slightly-to-moderately disturbed ecosystem in accordance with ANZECC (2000). Elevated enterococci densities were identified at all five sampled locations including three locations that exceeded the primary contact criteria and two locations that exceeded the secondary contract criteria. Elevated concentrations of total nitrogen, oxidised nitrogen and chlorophyll-a are evidenced at all sites while low levels of total phosphorus and well oxygenated waters generally low in turbidity are also typical of the river system.

Waterway	Key results
Warragamba River	Warragamba River is considered a slightly-to-moderately disturbed ecosystem in accordance with ANZECC (2000). Elevated enterococci densities were identified at all three sampled locations including one location that exceeded the primary contact criteria and two locations that exceeded the secondary contract criteria. Elevated total and oxidised nitrogen concentrations, low total phosphorus, ammonium and chlorophyll-a concentrations coupled with well oxygenated waters low in turbidity and enterococci densities. This water quality profile is generally typical of forested catchments with low to no urban and agricultural sources of pollution.

Water quality modelling

To quantify the potential water quality and related human health impacts from the project, a water quality model was developed which assessed the impacts of treated water releases from the project. Chapter 8 includes a detailed description of the water quality modelling methodology and results. Table 11-50 summarises the modelling findings for parameters of key concern to human health.

Table 11-50 Key human health findings from water quality modelling

Parameter	Key finding
South Creek	
Cyanobacteria	Modelling indicated no change to the overall risk index was predicted between any of the impact scenarios and the corresponding background scenarios. This was considered a result of the releases occurring in times of wet weather with rapid flushing of the creek as well as any additional nutrient loads occurring away from sustained dry periods when conditions that favour cyanobacteria growth are more prominent.
Enterococci and E.Coli	Modelling indicated that most scenarios will not impact on the background enterococci and E. coli level due to the highly treated nature of the release water. As noted in Table 11-5, existing catchment water quality has elevated levels of enterococci which are above the project water quality objectives. Where primary treated water is to be released it will only occur during times of high flow and/or be diluted with advanced treated water. Advanced treated water released to South Creek would improve catchment enterococci levels as a result of dilution due to the highly treated nature of this water.
Nutrients	During more severe wet weather, higher concentrations of nutrients, including chlorophyll *a* which influences algal growth, were introduced in the AWRC releases due to higher content of primary treated water. These 'spikes' presented localised downstream effects but were short-lived, and the nutrient concentrations were predicted to drop quickly to levels lower than the background simulation within a few days. The frequency of these more severe weather events is relatively low.

Parameter	Key finding
Nepean River	
Cyanobacteria	Modelling results indicate minor changes but no increased risk relative to the background scenarios. Slightly warmer temperature near the AWRC release in winter can increase risk slightly at this time, but in summer when blooms are likely, the AWRC also has a cooling effect on the river water.
Enterococci and E.Coli	Modelled enterococci concentrations were predicted to be marginally lower in the reaches within and downstream of Wallacia Weir. Reductions were also predicted near, and downstream of the confluence with South Creek. Other sites showed similar to background concentrations. With the introduction of the AWRC releases, it was predicted that the project may result in lower pathogenic concentrations compared to background levels.
Nutrients	Modelling identified potential reductions in nutrient concentrations as well as increases in dissolved oxygen levels. The chlorophyll a concentrations and risk of algal blooms was also generally improved due to reduced nutrient concentrations and improved flushing under dry conditions, but small changes in water clarity and temperature mean that overall the median algal biomass is likely to be similar to background conditions with introduction of the AWRC releases.
Warragamba River	
Cyanobacteria	Modelling indicates no increased risk in the downstream reaches based on the conditions that are considered conducive to growth of cyanobacteria. Slightly warmer temperature near the AWRC releases in winter can increase risk slightly at this time, but in summer when blooms are likely, the AWRC also has a cooling effect on the river water. Along with small changes to water clarity and nutrient availability there is likely to be some change to biomass, but no material change in risk.
Enterococci and E.Coli	Due to the low pathogenic content of the AWRC treated water releases, dilution of the enterococci concentrations was predicted downstream of the Warragamba release point. No significant change in the annual median concentration profiles were predicted between the Nepean River and Warragamba River release scenarios and the Nepean River release scenarios.
Nutrients	With introduction of the AWRC releases, increases in some nutrient species were predicted within the downstream reaches of Warragamba River, upstream of the confluence with Nepean River. Combined with lower suspended sediment, a potential risk of increased algal growth was identified from the modelling. The magnitude of the blooms was however not predicted to be significant and this growth in biomass was not seen immediately downstream of the confluence with Nepean River.

An analysis of the background catchment water quality for South Creek, Nepean River has shown that there are elevated level of enterococci and E.Coli at or above the project secondary and in some cases primary water quality objectives. Elevated levels of nutrients such as nitrogen, oxidised nitrogen and chlorophyll were identified in the South Creek and Nepean River catchments which is connected to the agricultural and urban land uses impacting runoff. Although there are some existing background exceedances for these analytes the project would not exacerbate these exceedances and would have a negligible impact during wet weather flow releases. In some cases, there is potential for a positive impact, for example through the release of advanced treated water to the Nepean during dry weather that could dilute high background enterococci levels.

The Warragamba River's low total phosphorus, ammonium and chlorophyll-a and enterococci concentrations are evidence of the forested and less disturbed nature of the catchment. As only advanced treated water is proposed to be released to the Warragamba River there would be minor change in nutrients or bacteria relative to the already low background levels. Therefore impacts to the Warragamba River would have a negligible impact on the health of downstream users.

Potential impacts from brine

Brine from the advanced treatment process will be discharged into Sydney Water's Malabar wastewater collection system via the brine pipeline. Water in the brine pipeline is treated at the existing Malabar Wastewater Treatment Plant (WWTP) prior to offshore disposal in accordance the disposal requirements of the Malabar WWTP's Environment Protection Licence. There is no release or potential for community interaction with water in the brine pipeline and therefore no human health risks associated with this water.

Overall potential human health impacts and benefits

The project provides wastewater treatment to support the growth in demand in Western Sydney. The AWRC will provide a high level of wastewater treatment compared to a base case of existing on-site treatment systems such as septic tanks, resulting in improvements to community health through improved sanitation systems.

In terms of impacts, the project is expected to meet relevant human health criteria for all assessed analytes. Considering all the above analysis, the assessment concluded treated water releases are unlikely to impact on community health.

Air quality

Operation of the project has the potential to generate air quality emissions including:

- odour
- oxides of nitrogen, measured as nitrogen dioxide from the cogeneration unit.

Quantitative air quality modelling of potential odour and nitrogen dioxide emissions from the project was undertaken in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Approved Methods) (NSW EPA, 2016). The modelling found that the operation of the project will meet the EPA's criteria for:

- Odour Units (OU) experienced at the nearest receivers

- nitrogen dioxide for both the annual average and one hour averaging times.

Assessment of potential human health impacts of these emissions concluded that there is:

- no acute inhalation exposure risk of concern for air emissions
- no chronic inhalation exposure risk of concern for air emissions.

Section 11.1 includes management measures to minimise air quality impacts.

Noise and vibration

Operational noise impacts from the pipelines will be negligible as they are located below ground. Noise will be generated at the release structures of the treated water and environment flows pipelines, however, due to their remote locations and the lack of nearby sensitive receivers, no impacts to surrounding land uses are expected. Pipeline operation will see some periodic air releases from valves, which may generate some noise but this will be minor.

Operational noise impacts from the AWRC will typically meet the required noise criteria. There is a minor exceedance of 1 dBA at one residential receiver during certain meteorological conditions. The design of the AWRC, as well as the proximity to existing and proposed future residential properties, means the generation of noise that can impact human health is unlikely. The implementation of management measures will likely minimise the occurrence and impact of any exceedances.

Management measures to minimise the generation of noise and vibration have been provided in Section 11.2.9.

Contamination

Operation of the project has the potential to encounter and produce contaminated material. This is mainly restricted to the AWRC site, as the pipelines are located below ground and will require minimal maintenance. Activities with the potential to encounter or produce contamination material include:

- Stormwater runoff from the AWRC site may contain low to medium levels of hydrocarbons, metals, suspended sediments and nutrients resulting from the operation of vehicles and machinery (similar to any site with vehicles and heavy machinery).
- Chemical spills at the AWRC site may result in other harmful contaminants being transported to the environment.
- Wastewater overflows or leakages from process tanks at the AWRC may result in partially treated or untreated wastewater being entering the soil and groundwater systems.
- Brine leaking into the environment from leaks or failures of the brine pipeline could result in human exposure to brine which also includes other wastes removed during the treatment process.

The AWRC is designed to capture any runoff or spills before they enter the environment. The brine pipeline has been designed to avoid overflows and releases to the environment. Sydney Water has processes and procedures in place to manage these activities at operational sites, which will be implemented for the project during operation. With the AWRC and pipelines appropriately designed and Sydney Water's operational standards applied, the risk of impact to human health from contamination during operation of the project is considered low.

Management measures to identify and manage contamination during operation of the project have been provided in section 9.5.9.

Dangerous goods

Table 11-51 lists the dangerous goods that will be transported, stored and used at the AWRC, including which of the storage volume thresholds in DPIE (2011a) have been exceeded. The threshold was exceeded for methanol and the collective group of chemicals that are considered corrosive. The need to store methanol at the AWRC site will be determined during detailed design so for the purposes of the PHA, it has been assumed that storage is required.

Table 11-51 Dangerous goods storage at the AWRC

Chemical	Class	Anticipated storage volume (KL or t) or distance from boundary	Threshold	Threshold Exceeded
Methanol	3	36 m from boundary	10 m from boundary and sensitive receivers	No
Methanol	6.1	200	2.5 tonnes	Yes
Corrosive chemicals: Ferric Chloride, Sodium Hydroxide, Sodium Hypochlorite, Sodium Bisulfite, Sulfuric Acid, Phosphonic Acid	8	294	25 tonnes	Yes
Carbon Dioxide	2.2	28	N/A	N/A

The following events are assessed as having the potential to result in offsite impacts to human health:

- Methanol is a flammable substance so a fire could occur if there was a leak from a storage tank and a spark occurred or if a tanker delivering methanol to the site had an accident.
- Biogas is produced in the digester and will be stored for use in co-generation – this is mostly methane and so could explode if it were to leak from the storage vessel and find an ignition source.

- Corrosive substances can react with other chemicals if incorrectly stored – these reactions
  can lead to fire.

Although methane is not a dangerous good, the AWRC will require the storage of about 6,200 m^3 which exceeds the threshold of 16 m^3 set by SEPP 33.

The most credible onsite hazards at the AWRC with the potential to cause offsite impacts to human health are the methanol storage area, methanol transport and the digester gas holders. The following sections consider each of these.

Methanol storage area

The potential primary health impact from the methanol storage area is a pool fire following immediate ignition after a loss on containment (LOC) of the methanol from the dosing equipment.

A pool fire in the bund of the methanol dosing point was modelled. This calculated a heat radiation of 0.8 kW/m^2 at the AWRC boundary, which is less than the heat radiation felt by the sun at noon in the summer.

A vapour cloud explosion (VCE) as the result of a leak and immediate ignition of the methane from the digester gas holder was modelled. This calculated an overpressure of 1.4 kPa at the AWRC boundary, which is comparable to the pressures felt by a very strong wind.

Methanol transport

The transport of methanol to the AWRC can result in:

- a pool fire after a loss of containment (LOC) of the methanol from a tanker accident
- the dispersion of a toxic cloud following a leak from a tanker accident.

A pool fire as a result of an accident involving a tanker transporting methane to the AWRC on a road adjacent to a sensitive receptor (school) was modelled with a heat radiation of 4.7 kW/m^2 extending over the boundary of the school. It should be noted that only a heat radiation of 2.1 kW/m^2 was found to extend to an area where an individual could be exposed.

The dispersion of a toxic cloud of methanol vapour was modelled, with a short-term exposure limit (STEL) of 250 ppm extending 100 m from the centre of the toxic cloud. This extends into the boundary of the sensitive receptor, but it is expected that the likelihood of such an incident is extremely low and individuals would be able to shelter-in-place if it did occur.

Digester gas holders

Digester gas holders store the methane produced during wastewater treatment prior to use in cogeneration or flaring. Potential hazards include:

- a VCE after a LOC of the methane
- a boiling liquid expanding vapour explosion (BLEVE) following direct flame impingement from a jet fire from another digester gas holder.

A BLEVE as the result of the direct flame impingement from a jet fire from another digester gas holder was modelled. This calculated an overpressure of 1.2 kPa at the AWRC boundary, comparable to the pressures felt by a very strong wind.

The consequence modelling for all three scenarios demonstrate a negligible offsite impact and that there is no offsite fatality risk. As such, the transport, storage, handling and use of dangerous goods for the project is unlikely to result in offsite impacts to human health. Section 11.5.9 outlines management measures that will minimise the potential for offsite impacts associated with dangerous goods.

Appendix W includes further details on the PHA process.

Traffic and transport

During operation, most traffic generated will be associated with the day-to-day operation of the AWRC.

The pipelines, release structure and flow split structure will only require infrequent vehicle access to carry out routine inspection and maintenance. This will likely occur about once every 6-12 months in any one location, with impacts on traffic considered negligible. On this basis, the operational traffic impact assessment has only assessed the AWRC which has a more consistent generation of operational traffic.

The AWRC will be accessed via a new access road off Clifton Avenue. The operational traffic impact assessment has been conducted on the Clifton Road/ Elizabeth Drive intersection as the key intersection relevant to operational traffic movements. The modelled impacts are based on the 2025 predicted traffic volumes given this is when the AWRC will start operating.

The AWRC will operate 24/7 and up to 10 workers will be required during Stage 1. Workers will likely arrive between 6 am and 9 am Monday to Friday and depart between 3 pm and 7 pm. Truck movements associated with chemical deliveries and biosolids removal are likely to occur between 6 am and 7 pm.

Vehicle movements during operation of the AWRC will be related to:

- staff journeys (up to 10 two-way trips each day)
- biosolids removal (about two trucks per day at peak biosolids production)
- screening removal (about one truck per week)
- grit removal (about one truck per fortnight)
- other deliveries (typically between three and seven vehicles each day for chemical deliveries)
- maintenance requirements (ranging from daily to every six months).

This is unlikely to significantly impact the road network. The project will not result in any permanent impacts to public transport, walking and cycling. As such, traffic and transport impacts to human health during operation are considered negligible.

Section 11.4 includes management measures to minimise traffic and transport impacts.

Waste

In addition to the waste produced during construction, operation of the project will also generate waste streams including:

- chemicals including for wastewater treatment and odour control
- e-waste (such as computers)
- spent filters from odour control equipment
- office waste such as paper, cardboard, plastic
- food waste from operational workforce
- maintenance supplies such as lightbulbs and materials for equipment maintenance.

The AWRC will also produce a waste brine stream which is assessed above in relation to operational water quality impacts. The waste produced during operation is typical for a project of this scale. Operational waste mainly relates to the operation of the AWRC as this site will require up to 10 staff to operate. Potential impact to human health from operational waste is considered negligible.

Section 12.2 provides further details on the types and quantities of waste the project will produce during operation, including the management measures that will be implemented.

Bushfire

The AWRC site is located on bushfire prone land and has considered the aims and objectives of Planning for Bush Fire Protection guideline (NSW Rural Fire Service (RFS), 2019). A Bushfire Constraints and Opportunities Assessment was completed for the AWRC during reference design. The assessment concluded that the AWRC can meet the general aims and objectives of sections 1 and 8 of the guideline based on the current design.

Parts of project pipelines are located in bushfire prone land, such as the environmental flows pipeline release structure, treated water pipeline along Park Road, Wallacia and the brine connection point at Lansdowne. Periodic maintenance and inspections will be required for these assets. Sydney Water has policies and procedures regarding working in bushfire prone land and on designated TOBAN days which will be implemented by workers during operation.

As a result, impacts from bushfire to human health during operation of the project is considered low.

Subsidence

The project is not located within any mine subsidence districts as defined by Subsidence NSW and subsidence is therefore unlikely during operation.

Flooding

A detailed flood impact assessment was undertaken for the project and its findings are discussed in detail in section 9.3. In relation to the operation of the pipelines it was found that they are not expected to influence floodwaters or change the flooding conditions, because they will be below ground. The discharge rates from the environmental flows pipeline and treated water pipeline at Warragamba River and Nepean River are negligible compared to the waterway flood flows at the location of discharges. Therefore, they are unlikely to result in changes in flooding conditions or affect adjacent properties.

In relation to the AWRC site, based on the modelling results, for all design events up to 0.2% AEP, the project will not significantly impact flood behaviour, or result in any detrimental impacts to other developments or land. The project will not cause any redirection of flow, significant changes in flow velocities, flood levels, hazards and hydraulic categories. In summary, no significant adverse effect is expected to flood behaviour on, adjacent to, or downstream of the site, as a result of developing the proposal. However, under the PMF event, the AWRC operational area encroaches into the PMF floodplain, resulting in a blockage of flow and loss of flood storage, which subsequently increases flood levels upstream of the site along Kemps Creek in the order of 100 mm. These flood level increases are localised and do not impact on any significant infrastructure or emergency evacuation routes, with the exception of flooding of the site access road, which occurs in the PMF event.

As the development will not impact on the local flooding behaviour, or impede access to existing road networks, it is not expected to have any impacts on the existing community emergency management arrangements for flooding.

11.5.7 Impact of future stages

The pipelines will be built to their ultimate capacity in Stage 1 of the project, so no additional human health impacts are expected during future stages.

Any impacts from future stages will be restricted to the AWRC site. The specialist assessment used to inform the human health and hazards impact assessment contained in this section also considered the potential impacts of future expansion of the AWRC site to enable processing of up to 100 ML/day. The following conclusions were made:

- Water quality – impacts have been assessed at processing up to 100 ML/day. No additional impacts expected.
- Air quality – emissions from the AWRC plant have been assessed at processing up to 100 ML/day. No additional impacts expected.
- Noise and vibration – some minor additional impacts during the future construction of additional stages. Minor impacts from the operation of future stages readily managed by recommended measures.
- Dangerous goods – increase in dangerous good for the operation of the future stage. With relevant guidelines followed as applied to Stage 1 any additional risk to human health will be within acceptable limits.

- Traffic and transport – temporary short-term increase in construction workers for future stages and some minor increase in operational staff numbers. These will result in minor impacts.
- Waste – minor increase in waste generation from future stages. Management measures will be consistent with Stage 1.
- Bushfire – negligible change in bushfire risk from futures stages.
- Subsidence – no future stages will occur within any mine subsidence districts therefore no further subsidence impacts are anticipated.
- Flooding – impacts to flooding from future stages will be negligible.

Future stages are unlikely to increase any potential risk to human health.

11.5.8 Cumulative impacts

Any cumulative impacts to human health during construction will be temporary. Cumulative impacts around the AWRC relating to noise and traffic are likely to occur due to the close proximity of the project to other major projects such as the M12 Motorway, Western Sydney International Airport, Sydney Metro – Western Sydney Airport, and Northern Road upgrade. These projects have relatively larger footprints with any additional cumulative impacts from the project being relatively minor. Cumulative health impacts relating to air quality, water, soil contamination, safety and waste are unlikely to occur.

Cumulative impacts during operation of the project are unlikely to be significant. As with construction, cumulative noise impacts may occur from the operation of the M12 Motorway and Western Sydney International Airport. However, noise generated by the project during operation will be minimal and is unlikely to contribute to any significant impacts to human health. Cumulative impacts relating to air quality, water, soil contamination, safety and waste are unlikely to occur during operation of the project.

Measures to manage human health and hazard impacts outlined in section 11.5.9, combined with those outlined in the water quality, air, noise, contamination, traffic and waste sections of the EIS, are considered appropriate to manage cumulative impacts.

11.5.9 Management measures

The water quality, air quality, noise and vibration, contamination, traffic and transport and waste sections of the EIS include relevant management measures that cover both environmental and human health impacts. The management measures outlined in Table 11-52 are in addition to those covered elsewhere in the EIS.

Table 11-52 Health management measures

ID	Impact	Mitigation measure	Timing
HIA01	Explosion or spillage of methanol during transport	Complete a detailed route evaluation for methanol transport to the AWRC in accordance with HIPAP 11 – Route Selection.	Detailed design During operation
HIA02	Impact to human health	In accordance with the NSW Work Health and Safety Regulations 2011: • Store Class 8 substances at the AWRC in accordance with AS 3780-2008. • Prepare a manifest of the hazardous chemicals exceeding manifest quantities. • Prepare an emergency plan that will be provided to NSW Fire and Rescue. • Display warning placards regarding quantities of hazardous chemicals at any entrance where emergency services may enter the workplace.	Detailed design During operation
HIA03	Construction bushfire hazard	No hot works will be undertaken if the Fire Danger Rating is very high or above.	During construction
HIA04	Construction bushfire hazard	All works in bushfire prone areas will be stopped and workers evacuated from the area during Fire Danger Rating of extreme or above.	During construction
HIA05	Impact to human health	Ensure adequate capacity in the AWRC stormwater system to contain water used for firefighting for testing prior to disposal, if required.	Detailed design During operation