

Groundwater and Surface Water Impact Assessment

Adaptive Reuse of Former Berrima Gaol

2-4 Argyle Street
Berrima NSW 2577

Project No. 24150
Version 4

9 September 2025

Reditus Consulting Pty Ltd
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Groundwater and Surface Water Impact Assessment

Adaptive Reuse of Former Berrima Gaol

12-4 Argyle Street, Berrima NSW 2577

Prepared for Blue Sox Group

Issued for SSD Application

DOCUMENT CONTROL

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Executive Summary

Reditus Consulting Pty Ltd (Reditus) were engaged by Bluesox Investments Pty Ltd (the Client) to prepare a Surface Water and Groundwater Impact Assessment for the State Significant Development (SSD) at 2-4 Argyle Street, Berrima NSW 2577 (the Site). The proposed SSD includes the adaptive reuse of the Berrima Correctional Centre which is to include a new boutique accommodation buildings within the grounds of the gaol site, external to the heritage listed sandstone walls a multi-level carpark, a function centre, restaurant, café, bar, hotel amenities along with other tourism related facilities and amenities in and around the gaol making use of the existing buildings and dwellings.

The site, Lot 102 in Deposited Plan (DP) 1283819, covers approximately 19,000 m². The SSD application number is SSD-66876472. This report addresses the NSW Planning Secretary's Environmental Assessment Requirements (SEARs), specifically condition #13 on groundwater and surface water for SSD project 66876472.

The primary objectives of the Groundwater and Surface Water Impact Assessment are to:

- Provide details on the hydrological and hydrogeological setting of the site and a summary of key environmental factors relevant to construction and ongoing management of the proposed development.
- Provide details of the proposed development layout and construction design.
- Predict preliminary dewatering extraction volumes required for the development works during construction.
- Determine the potential impacts to surface water resources (quality and quantity) including related infrastructure, hydrology, dependent ecosystems, drainage lines, downstream assets and watercourses.
- Determine the potential impacts of the dewatering activity to groundwater dependent ecosystems (GDEs), springs, water supply works and potential for subsidence impacts on nearby structures or infrastructure (through assessment against the Minimal Impact thresholds detailed under the NSW DPI (2012) Aquifer Interference Policy, WMA 2000, and the NSW DPE (2022) Groundwater Impact Assessment Criteria.
- Provide management and mitigation strategies to minimise adverse environmental impacts as a result of construction and ongoing operation of the development.
- Provide management strategies to minimise adverse environmental impacts.
- Include an assessment of licencing considerations for the project.

The findings of this report include characterisation of the existing environment at the site, a review of the of potential impacts to the surface water and groundwater environment from the proposed development, review of relevant legislation and policy relating to the development and mitigating measures for the identified impacts. The report considers the impacts that have the potential to adversely affect the surface water and groundwater in the context of the construction phase and the operational phase of the development.

Water quality of the existing environment was of generally good quality. The surface water was generally below the assessment criteria except for e. coli, oxidised nitrogen, total nitrogen and aluminium. The groundwater quality was of generally good quality and was below the assessment criteria with the exception of oxidised nitrogen, total nitrogen, total phosphorous, total suspended solids, turbidity, aluminium, copper, manganese and zinc. The groundwater exceedances can be appropriately managed with treatment measures that can be included within a future Dewatering Management Plans (DMP) that will be required for licencing purposes.

This assessment is primarily concerned with the proposed underground carpark on the southern side of the site and the western elevation where hotel accommodation buildings are proposed. All other areas of the Site will not have below ground structures that will interfere with the groundwater regime, and above ground works would have negligible impacts to the existing overland flow. The front (eastern) elevation of the Site is largely to remain as gardens, with a slight increase in impervious area at the south-east portion, the area surrounding the Governors and Deputy Governors residences are largely to remain as gardens with potentially some additional impervious areas (such as paving for outdoor dining) and there are no proposed works to the northern side of the Site. For these reasons, this report focuses on the areas of below ground basement carpark and hotel accommodation buildings.

The groundwater impacts associated with the basement excavation have been assessed based on the inflow calculations and probable drawdown expectations during the construction phase and operational phase of the

development. The assessment found that in the upper-case (less likely) scenario for drawdown during the development, impact to surrounding groundwater users, GDEs and ASSs are minimal. In the most-likely scenario for drawdown during the development, the impacts will be negligible. Other potential impacts to groundwater and surface water including potential chemical spillages, increase in hardstand areas, increase in potentially contaminating activities such as vehicle movement, incorrect soil stabilisation and other construction related impacts and can be managed with appropriate mitigation measures. A summary of the impacts and mitigation measures are presented below.

RISK	POTENTIAL IMPACTS	LIKELIHOOD	MITIGATION MEASURES
Excavation, dust suppression and land clearing works	Pollute receiving waterbodies (Wingecarribee River and associated water courses) with increased sediment, especially during rain events Changes to the hydrological regime.	Possible	Soil and water management plans incorporated in a Construction Environmental Management Plan (CEMP) to manage risk. Erosion and sediment control measures in accordance with Blue Book (DECC, 2008). Incorporate water quality monitoring plan into the CEMP that will constantly monitor water quality of receiving water bodies during earthworks and construction activities.
Stockpiling	Pollute the receiving water bodies with increased sediments from improper stockpiling of materials. Changes to the hydrological regime.	Possible	Soil and water management plans incorporated in a CEMP to manage risk. Erosion and sediment control measures in accordance with Blue Book (DECC, 2008).
Impervious Areas	Increase overland flow during rain events has potential to transport contaminants and sediments into surface water bodies reduce recharge into aquifers.	Possible	Provide adequate deep soil and permeable landscape areas as vegetation buffer strips. Incorporation, where possible, of permeable pavements and appropriate design of stormwater detention.
Dewatering	Impacts to surrounding GDEs and water supply bores within the vicinity of the basement construction caused by drawdown during dewatering activities	Possible	Extraction rates, drawdown and water quality monitoring requirements incorporated into a dewatering management plan (DMP). the DMP and Groundwater Works Access Licence required to be obtained for the development. Minimise depths of excavation below groundwater table during basement construction. Reduce dewatering time period during basement excavations.
Stormwater discharge	Contamination of receiving water body (Wingecarribee River) and associated water courses down-stream of excavation as a result of discharging water to the	Unlikely	Extraction rates, drawdown and water quality monitoring requirements incorporated into a dewatering management plan (DMP) All construction groundwater to be discharged during basement construction dewatering is to be appropriately treated and to comply with adopted discharge water quality criteria (DWQC)



RISK	POTENTIAL IMPACTS	LIKELIHOOD	MITIGATION MEASURES
	stormwater network during dewatering		
Chemical spills	Contaminate the underlying groundwater via seepage into the ground or surface water via run-off into receiving waterbodies	Unlikely	Storage of hazardous liquids and refuelling operations to take place in bunded areas to reduce chance of spillage causing impacts Incorporate water quality monitoring plan into CEMP that will constantly monitor water quality of receiving water bodies during construction works.

1 Introduction

Reditus Consulting Pty Ltd (Reditus) were engaged by Bluesox Investments Pty Ltd (the Client) to prepare a Surface Water and Groundwater Impact Assessment for the State Significant Development (SSD) at 2-4 Argyle Street, Berrima NSW 2577 (the site). The proposed SSD includes the adaptive reuse of the Berrima Correctional Centre which is to include a new boutique accommodation buildings within the grounds of the gaol site, external to the heritage listed sandstone walls a multi-level carpark, a function centre, restaurant, café, bar, hotel amenities along with other tourism related facilities and amenities in and around the gaol making use of the existing buildings and dwellings. The site location is presented in **Figure F1, Appendix A** and a summary of the site identification details is provided in **Table 1-1** below.

The site, Lot 102 in Deposited Plan (DP) 1283819, covers approximately 19,000 m². The SSD application number is SSD-66876472. This report addresses the NSW Planning Secretary's Environmental Assessment Requirements (SEARs), specifically condition #13 Groundwater and Water Conditions for SSD project 66876472. Conditions #13 (SSD-66876472) states:

Assess potential impacts on soil resources and related infrastructure and riparian lands on and near the site, including soil erosion, salinity and acid sulfate soils.

- *Provide a Surface and Groundwater Impact Assessment that assesses potential impacts on:*
 - *surface water resources (quality and quantity) including related infrastructure, hydrology, dependent ecosystems, drainage lines, downstream assets and watercourses.*
 - *groundwater resources in accordance with the Groundwater Guidelines*

As groundwater will be intercepted and require dewatering during construction of the basement carpark, the proposed development is considered to be an aquifer inference activity requiring assessment and authorisation under the Water Management Act (WMA) 2000 (within a Water Sharing Plan zone, regulated by WaterNSW). Further, as the site is within close proximity to the Wingecarribee River and the overland flow is towards the water body, assessment of the surface water impacts associated with the proposed development is required.

Table 1-1 Site Identification Details

ITEM	DETAIL
Street Address	2-4 Argyle Street, Berrima NSW 2577
Lot and Deposited Plan	Lot 102 in DP 1283819
Local Government Area	Wingecarribee Shire Council
Site Coordinates to the approximate centre of the site (GDA2020 MGA Zone 56)	Easting: 255320.426 Northing: 6180539.895
Site Area	Approximate area of 19,000 m ²
Basement Excavation Area¹	Approximate area of 3,600 m ²
Site Location	Figure F1, Appendix A
Site Layout	Figure F2, Appendix A
Water Sharing Plan	Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023
Groundwater Source	Sydney Basin Nepean Groundwater Source ¹

¹ The site is mapped as being in the Sydney Basin Nepean Groundwater Source. This is mapped from Warragamba in the north to Moss Vale in the south and Marulan in the west to Cataract Dam in the east.

1.1 Objectives

The primary objectives of the Groundwater and Surface Water Impact Assessment are to:

- Provide details on the hydrological and hydrogeological setting of the site and a summary of key environmental factors relevant to construction and ongoing management of the proposed development.
- Provide details of the proposed development layout and construction design.
- Predict preliminary dewatering extraction volumes required for the development works during construction.
- Determine the potential impacts to surface water resources (quality and quantity) including related infrastructure, hydrology, dependent ecosystems, drainage lines, downstream assets and watercourses.
- Determine the potential impacts of the dewatering activity to groundwater dependent ecosystems (GDEs), springs, water supply works and potential for subsidence impacts on nearby structures or infrastructure (through assessment against the Minimal Impact thresholds detailed under the NSW DPI (2012) Aquifer Interference Policy, WMA 2000, and the NSW DPE (2022) Groundwater Impact Assessment Criteria.
- Provide management and mitigation strategies to minimise adverse environmental impacts as a result of construction and ongoing operation of the development.
- Include an assessment of licencing considerations for the project.

1.2 Scope of Works

To meet the objectives of the Surface Water and Groundwater Impact Assessment, the following scope of works was undertaken:

- A desktop site assessment, including review of previous reports where available.
- A review of relevant groundwater and surface water policy, legislation, regulations, and guidelines.
- Review of construction proposal details that may impact on surface water and groundwater receptors, such as dewatering and the proposed dewatering methodology.
- Data analysis and interpretation of rising head (slug test) data and water quality data collected from the site.
- Develop conceptual flow model to replicate the proposed excavation activity. This was completed using a steady-state analytical groundwater flow model for best-case (less likely), most likely, and upper-case (less likely) scenarios, allowing prediction of groundwater inflow volumes and groundwater drawdown extent resulting from the proposed basement excavation and construction design:
 - Completion of analytical equations to derive groundwater extraction volumes using a range of representative aquifer parameters from published literature values and site-specific data.
 - Estimate volume of groundwater required to be removed during the dewatering process and assess the likely impacts of the dewatering activities on other groundwater users/receptors against the Minimal Impact thresholds detailed in the NSW DPE (2022) Groundwater Impact Assessment Criteria.
- Surface Water and Groundwater quality sampling event using low-flow sampling techniques for three (3) newly installed wells and one (1) surface water sample from the river to the west of the site (Sample locations presented on **Figure F3 in Appendix A**) were analysed for the following suite:
 - Alkalinity (bicarbonate, carbonate, hydroxide and total), electrical conductivity (EC), pH, redox potential (Eh), total dissolved solids (TDS), total hardness, temperature, dissolved oxygen (DO).
 - Turbidity* (NTU), total suspended solids* (TSS), total organic carbon* (TOC), sodium absorption ratio* (SAR)
 - Sulfate (SO₄), chloride (Cl), carbonates (CO₃), bromide (Br), fluoride (F)
 - Major Cations and Anions (including ionic balance)
 - Aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (B), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), lithium (Li), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silica (dissolved SiO₂), silver (Ag), strontium (Sr), uranium (U), vanadium (V), zinc (Zn)

- Ammonia (NH₃), nitrate (NO₃), total nitrogen (N), oxidised nitrogen (N), total phosphorus (P), reactive phosphorus (P)
- Faecal coliforms, faecal streptococci, Escherichia coli
- Benzene, toluene, ethylbenzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), total recoverable hydrocarbons (TRH), Organochlorine and organophosphorus pesticides (OC/OP), polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs) and poly- and per-fluoroalkyl substances (PFAS).
- Discussion of the potential impacts to surface water and groundwater associated with the proposed development and outline mitigation measures and management plans required for management of impacts.
- Preparation of a Surface Water and Groundwater Impact Assessment (Site Hydrogeological Report) in general accordance with the NSW DPI (January 2022) *Guidelines for Groundwater Documentation for SSD/SSI Projects - Technical guideline*; and the NSW DPI (October 2022) *Minimum requirements for building site groundwater investigations and reporting*; and the NSW DPI (2023) *Groundwater Impact Assessment Criteria*.

1.3 Limitations

This report is based on the Scope of Work outlined above in **Section 1.2**. Reditus prepared this report in a manner consistent with the normal level of care and expertise exercised by members of the environmental and hydrogeological assessment profession.

This report relates only to the objectives stated and does not relate to any other work undertaken for the Client (Bluesox Investments Pty Ltd). It is a report based on the information reported in previous environmental and geotechnical assessments by others, and data made available to Reditus. These conditions stated in this report may change with time and space.

All conclusions regarding the property area are the professional opinions of Reditus, subject to the qualifications in the report. Whilst normal assessments of data reliability have been made, Reditus assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of Reditus, or developments resulting from situations outside the scope of this project. The client acknowledges that this report is for the exclusive use of the client.

All groundwater models include some degree of uncertainty in their predictions as they are, by necessity, simplifications of complex real-world systems. Whilst every effort is made to ensure that the primary model reflects the 'best case – less likely', 'most likely' case and 'upper case – less likely' understanding of site conditions, this cannot be guaranteed, and any model result presented as a single number should be viewed with a degree of caution.

Factors which significantly affect the groundwater model and impact assessment results include dewatering rate, dewatering design, dewatering period, aquifer characteristics and degree of aquifer variability (including hydraulic conductivity, specific yield/ Storativity, porosity, recharge, heterogeneity).

A suitably qualified geotechnical consultant will be required to determine the potential settlement impacts caused by the potential drawdown as a result of the proposed dewatering activities. Detailed geotechnical considerations are beyond the scope of this assessment

2 Methodology

2.1 General

The assessment of potential surface and groundwater related impacts arising from the proposal have been implemented as follows:

- Review of legislation, policies and guidelines relevant to surface water and groundwater impacts for the proposal as outlined in **Section 3**.
- Characterisation of the existing environment including: climate, topography, geology, hydrology, hydrogeology, water quality and sensitive receiving environments in order to review the potential impacts to surface and groundwater arising from the proposal
- Analytical groundwater calculations to predict potential groundwater inflows and radius of drawdown influence at the boundaries of the basement carpark excavation pit
- Assessment of potential surface water related impacts to satisfy the minimal impact considerations of the National Water Quality Management Strategy (NWQMS)
- Assessment of potential groundwater related impacts to satisfy the minimal impact considerations of the NSW Aquifer Interference Policy (AIP)
- Water quality assessment of surface and groundwater
- Recommendations for monitoring and management of identified impacts and risks, including mitigation measures as appropriate.
- The specific methodologies used for these components are described in the following sections.

2.2 Proposal Setting

The site is located along the eastern embankment of the Wingecarribee River. The river system flows generally towards the north-west from the Wingecarribee Reservoir located approximately 14.9 km south-east of the site. Wingecarribee River runs through Belanglo State Forest and Bangadilly National Park, before reaching its confluence with Wollondilly River. Surface water and groundwater on site are expected to flow west towards Wingecarribee River.

2.3 Desktop Assessment

The desktop assessment undertaken in this report involved review of the proposed development in order to assess potential impacts to sensitive receiving environments (SREs), and the existing environment, including flow (quantity) and quality of surface water and groundwater during the construction and ongoing operation.

The desktop assessment included review of background information, previous reports and proposed development information including:

- Sensitive receiving environments (SREs) near the proposed development including groundwater and surface water dependant ecosystems (GDEs), Key fish habitats (KFH) and threatened aquatic species.
- Publicly available datasets to identify groundwater flow regimes, drainage lines, downstream assets and watercourses.
- Flooding assessment based on publicly available flood study reports from local council.
- Publicly available Wingecarribee River water quality information.
- Review of relevant legislation and guidelines.
- Review of the proposed basement footprint and the development at large.
- Publicly available groundwater data.

A summary of the publicly available data sources used is presented below in **Table 2-1**.

2.3.1 PUBLICLY AVAILABLE DATA SOURCES

A list of publicly available data sources used for the desktop review as part of this assessment is provided in **Table 2-1** below.

Table 2-1 Summary of publicly available data sources

DATA DESCRIPTION	SOURCE
Groundwater users including Water Access Licence (WAL) holders including stock and domestic users	WaterNSW Water Register website (https://waterregister.watarnsw.com.au/water-register-frame)
	WaterNSW real time data website (https://realtimedata.watarnsw.com.au/water.stm)
Registered bore data	Bureau of Meteorology Australian Groundwater Explorer (http://www.bom.gov.au/water/groundwater/explorer/)
Groundwater dependent ecosystem's location and data	Bureau of Meteorology Groundwater Dependent Ecosystems Atlas (http://www.bom.gov.au/water/groundwater/gde/)
	The NSW Environmental Protection Authority (EPA) list of contaminated sites (https://www.epa.nsw.gov.au/your-environment/contaminated-land/notified-and-regulated-contaminated-land/list-of-notified-sites)
Surrounding contaminated site locations	The NSW Environmental Protection Authority (EPA) contaminated land record website (https://app.epa.nsw.gov.au/prclmapp/searchregister.aspx)
	The NSW Environmental Protection Authority (EPA) Protection of the Environment Operations Act (POEO) public register website (https://app.epa.nsw.gov.au/prpoeoapp/)
Regional geology data and mapping	Wollongong 1:250,000 Geological Series Sheet SI 56-9 (Second Edition, 1966)
Key Fish Habitats (KFH) and Fish Freshwater Threatened Species	The NSW Department of Primary Industries (DPI) Fisheries NSW Spatial Data Portal (https://webmap.industry.nsw.gov.au/Html5Viewer/index.html?viewer=FisheriesData Portal)

2.3.2 REVIEW OF PREVIOUS INVESTIGATIONS

A review of relevant information relating to surface water and groundwater from previous investigations is summarised in **Table 2-2** below.

Table 2-2 Summary of previous investigations

ITEM	DETAIL
TARGETED DETAILED SITE INVESTIGATION (JBS&G, 2021)	
Document Information	Targeted Detailed Site Investigation, Berrima Correctional Facility, dated 14 September 2021.
Prepared By	JBS&G Australia Pty Ltd
Prepared for	Property NSW
Information Related to Surface Water and Groundwater	Sections 2.6 and 2.7 of the report discuss the hydrology and hydrogeology of the site including information relating to expected surface water run-off towards Wingecarribee River and a summary of registered bores within a 1km radius of the site. The review of groundwater bore information found that all wells within a 1km radius of the site were for domestic purposes and as such were targeted to screen the deeper bedrock groundwater. The standing water level (SWL) depths in the vicinity of the site ranged between 7 and 16 m. It was assumed that the groundwater level was generally consistent with the water level of Wingecarribee River, approximately 10 metres below the sites ground level. The Conceptual Site model (CSM) in Section 4 of the report identified several sources of contamination which included potential groundwater contamination via leaching of contaminants present in fill soils into the underlying groundwater, potential migration of contaminants via groundwater migration, rainwater infiltration and surface water runoff. As such groundwater analysis for contaminants of potential concern was warranted. Three (3) groundwater monitoring wells were installed on site, specifically in areas hydraulically down-gradient of a former NSW Rural Fire Services (RFS) shed in order to assess PFAS impacts. Samples collected from the wells were compared against the relevant groundwater assessment criteria including the ADWG (2011) recreational criteria, ANZG (2018) 95% species protection criteria and the PFAS NEMP (HEPA 2020) 95% species protection criteria. Groundwater analysis results found that concentrations of contaminants were below the adopted criteria or were reported at levels that were not considered to present a risk to ongoing use of the site.
Other Relevant Information	Review of Acid Sulfate Soils (ASS) in Section 2.8 of the report found that based on review of geology maps, soil maps, topography, section 10.7 planning certificate from council, site elevation and site observations, it is unlikely that acid sulfate soils would be present on the property. Review of climate data in Section 2.9 of the report found that based on the nearest relevant Bureau of Meteorology location (Moss Vale (Hoskins Street) 068045) the site is located in a meteorological setting with an average minimum temperature ranging from 1.3°C to 12.6°C, an average maximum temperature of 11.8°C and 25.8°C, an average annual rainfall of approximately 957.3 mm, and a monthly average rainfall varying between 58.8 mm and 100.8 mm with the wettest periods occurring on average between January and June.
ASBESTOS IN SOIL ASSESSMENT (PRM, 2019)	
Document Information	Asbestos in Soil Assessment, Berrima Correctional Centre, Argyl Street, Berrima NSW, dated December 2019
Prepared By	Progressive Risk Management Pty Ltd

ITEM	DETAIL
Prepared for	BGIS
Information Related to Surface Water and Groundwater	No information related to surface water or groundwater was presented in this assessment.
Other Relevant Information	The Asbestos in Soil (AIS) Assessment was undertaken to determine the extent and nature of asbestos contamination within the southern vegetable patch and western embankment of the site. Sampling included a site walkover and surface sampling of suspected asbestos containing material (ACM) and sampling of shallow fill soils via test pitting. Laboratory results of soil samples submitted for analysis identified five (5) samples across the western embankment exceeded the adopted ACM HSL-A criteria. Three (3) surface fragments were also found to contain asbestos. Soil samples submitted for analysis in the southern veggie patch area were found to be below the adopted ACM criteria. One (1) surface sample was suspected to contain asbestos.
ENVIRONMENTAL AND ASBESTOS MANAGEMENT PLAN (JBS&G, 2021)	
Document Information	Environmental and Asbestos Management Plan, Berrima Correctional Facility, dated 14 September 2021
Prepared By	JBS&G Australia Pty Ltd
Prepared for	Property NSW
Information Related to Surface Water and Groundwater	No information related to surface water or groundwater was presented in this assessment.
Other Relevant Information	The Environmental and Asbestos Management plan (EAMP) was created to manage the identified contamination at the site and is to apply indefinitely during ongoing site operations until the remediation works are to be completed. The plan was intended to apply to routine activities by site employees, visitors or contractors that may be involved in any intrusive works or works that could involve disturbance or exposure of contaminated soils. The EAMP outlines passive and active management procedures to be implemented at the site during typical operations and minor intrusive site activities. An unexpected finds protocol is also outlined for management of contamination (asbestos) identified on site surface.
REMEDIATION ACTION PLAN (PRM, 2020)	
Document Information	Remediation Action Plan, Berrima Correctional Centre, Argyle Street, Berrima NSW, dated February 2020
Prepared By	Progressive Risk Management Pty Ltd
Prepared for	BGIS

ITEM	DETAIL
Information Related to Surface Water and Groundwater	The Remedial Action Plan (RAP) outlined that an erosion, sediment and surface water management sub-plan is required to be prepared by the Principal Contractor as part of the remediation works undertaken at the site. The proposed management strategy is to involve the installation and operation of a number of environmental control measures that will enable the Contractor to prevent soil erosion at the site and protect off-site waters and sediment from being polluted by on-site sources. It was expected that the design approach would involve the following: • Minimise the area of disturbed soil exposure wherever possible by staging the works. • Control water flow entering and exiting the site. • Surface water would be prevented from entering excavations by the construction of bunds and diversion drains around the perimeter of excavation areas. • Runoff from clean areas will be diverted away from unremediated areas of the site.
Other Relevant Information	The Remedial Action Plan (RAP) was created for the management of the proposed remediation of asbestos contaminated fill material within the southern garden patch and western embankment area of the site. The RAP outlines the actions and management practices required for the proposed remediation of asbestos works. This was achieved through the following: • Determination of appropriate remediation methods. • Ensuring human health and environmental risks associated with remediation works and future land use of the site are managed appropriately. • Detail the validation requirements and long-term management for the remedial areas. • Selection of preferred remediation option. • Provision of suitable remedial methodology which enable the remediation works to be conducted. • Establishing remediation goals. • Detailing validation sampling, reporting and quality requirements to be implemented for final validation of the site. The remediation strategy adopted for the western embankment involved a fourteen (14) step remediation method, while the southern veggie patch remediation strategy involved surface (emu-pick) removal of asbestos fragments followed by surface visual clearance inspection.

2.4 Site Investigation

A site investigation was conducted on 26 September 2024 and included the following:

- Groundwater gauging and sampling of three monitoring bores (MW101, MW102 and MW103). MW01 was also gauged but not sampled. Samples were collected using low-flow sampling techniques and analysed for the chemicals outlined in **Section 1.2** above. Physio-chemical parameters were also collected from the monitoring bores that were sampled.
- Slug tests were conducted on three monitoring bores at the site. Rising head tests were conducted on MW101, MW102 and MW103.
- One (1) surface water sample was collected from the Wingecarribee River adjacent to the site, and analysed for the chemicals outlined in **Section 1.2** above.

3 Legislative context

3.1 NSW Legislation

3.1.1 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the primary legislation governing land use planning and development assessment in NSW. It provides a comprehensive legal framework for the management, development, and conservation of both natural and built environments. The Act aims to ensure that development is carried out in a sustainable manner, balancing economic growth with environmental protection.

Key components of the Act include the establishment of planning instruments such as local environmental plans (LEPs), development control plans (DCPs), and state environmental planning policies (SEPPs). These instruments guide decision-making processes and set out the rules and standards for development. The Act also outlines the procedures for development assessment, including the requirements for development applications, public participation, and the consideration of environmental impacts.

This project has been declared an SSD under the State Environmental Planning Policy (State and Regional Development) 2011 and as such, this groundwater and surface water impact assessment has been conducted.

3.1.2 PROTECTION OF THE ENVIRONMENT OPERATIONS (POEO) ACT 1997

The POEO Act 1997 and its associated schedules and regulations are directly relevant to SSDs. In particular, the Act includes requirements prohibiting the pollution of waters, preventing or minimising air and noise pollution, regarding maintenance and operation plant in a proper and efficient condition/manner, and for minimising and managing wastes.

The Act also requires notification to the NSW Environmental Protection Authority (EPA) and Council, when a pollution incident occurs that causes or threatens material harm to the environment (including discharges above the set limits to the stormwater and where any unacceptable impact to the receiving waters is identified).

3.1.3 NSW WATER QUALITY OBJECTIVES (2006)

The NSW Water Quality Objectives are the agreed environmental values and long-term goals for NSW's surface waters. They set out:

- The community's values and uses for our rivers, creeks, estuaries and lakes (i.e., healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water).
- A range of water quality indicators to help us assess whether the current condition of our waterways supports those values and uses.

The flow contours indicate the groundwater at the site is expected to move west towards Wingecarribee River. Aquatic ecosystems, visual amenity, secondary contact recreation, primary contact recreation and aquatic foods have been described as the relevant water quality objectives for the use of the receiving water body.

3.1.4 WINGECARRIBEE SHIRE/NSW DEPARTMENT OF PLANNING, HOUSING AND INFRASTRUCTURE – DEWATERING DISCHARGE APPROVAL/PERMIT

A permit from Council is generally required for any dewatering of groundwater. As this is a state significant development, the Water Supply Works approval will be applied for through the NSW Department of Planning, Housing and Infrastructure – Planning Secretary's Environmental Assessment Requirements. Once granted, and the SSD has been determined, Council approval will be sought for discharge to the stormwater system.

Council generally requires groundwater to be discharged must be compliant with the General Terms of Approval/Controlled Activity permit issued by WaterNSW (if applicable), Landcom's 'Managing Urban Stormwater: Soils and Construction' (2004) (Blue Book), Council's Compliance and Enforcement Policy, and legislation including Protection of the Environment Operations Act 1997 and Contaminated Lands Act 1997.

All approvals, water discharges and monitoring results are to be documented and kept on site. Copies of all records shall be provided to the appropriate regulatory authority, including Council, upon request.

3.1.5 WATER ACT 1912 AND WATER MANAGEMENT ACT 2000

Dewatering for construction purposes is classified as an aquifer interference activity under the NSW Aquifer Interference Policy 2012.

WaterNSW are responsible for waters work approvals under the provisions of the Water Management Act 2000 (WMA) which includes regulation of all aquifer interference activities within Water Sharing Plan management areas. WaterNSW also are responsible for water works approvals for all groundwater extraction in areas outside Water Sharing Plan management areas, as well as State Significant Development.

While minor aquifer interference activities works are generally exempt from the full extent of the WMA 2000, an application for “Approval for Water Supply Works and/or Water Use” (previously known as a Dewatering Licence) is required, regardless of the total volume of groundwater extracted is expected to exceed <3 ML per year. A Water Access License (WAL), or written approval from WaterNSW/NRAR if no licence is required, must be obtained prior to commencement. As the anticipated groundwater take is < 3 ML/year, Reditus do not consider that a WAL is likely to be required..

Further information on the aquifer interference policy and licencing requirements are available from the WaterNSW website.

Reditus note that if/once approval has been provided, an application for a “new water access licence with a zero share component” may be required to be completed and a suitable groundwater entitlement may also need to be obtained from the market to account for the groundwater take within the same groundwater source (in this case, Sydney Basin Nepean Groundwater Source, under the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources (2023). This will need to be obtained within three months of granting of the Zero Access Licence.

Works or activities that intersect or interfere with groundwater systems and where take is incidental to the primary purpose of the activity, or where there is no take, are managed as aquifer interference activities. Aquifer interference activities taking 3 ML or less of groundwater per year are exempt from requiring a Water Access Licence (WAL).

3.1.6 FISHERIES MANAGEMENT ACT 1994

The *NSW Fisheries Management Act 1994* provides the legislative framework for the sustainable management and conservation of fisheries resources in New South Wales. The Act aims to balance the needs of the fishing industry with the protection of aquatic ecosystems, ensuring that resources are available for present and future generations. It sets out regulations for commercial and recreational fishing, aquaculture activities, and provisions for Aboriginal cultural fishing.

Key objectives of the FM Act include protecting key fish habitats (KFH) and the conservation of threatened species, populations and ecological communities of fish and marine vegetation. A review of DPIE KFH mapping indicated that surrounding waterways are composed of KFH, refer to **Section 4.4.2**. No threatened species have been mapped within the waterways surrounding the site.

3.2 Policies and Guidelines

3.2.1 NSW AQUIFER INTERFERENCE POLICY 2012

The purpose of the NSW Aquifer Interference Policy 2012 is to explain the role and requirements of the Minister administering the WMA in the water licensing and assessment processes for aquifer interference activities under the WMA and other relevant legislative frameworks. The NSW Aquifer Interference Policy 2012:

1. Clarifies the requirements for obtaining water licences for aquifer interference activities under NSW water legislation; and
2. Establishes and objectively defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset.

The proposed development will result in aquifer interference under the NSW Aquifer Interference Policy (2012) as groundwater will be removed from at least one aquifer. Accordingly, groundwater licensing may be required.

Licencing of water taken through aquifer interference

A water licence is required under the WMA (unless an exemption applies, or water is being taken under a basic landholder right) where any act by a person carrying out an aquifer interference activity causes:

- The removal of water from a water source; or

- The movement of water from one part of an aquifer to another part of an aquifer; or
- The movement of water from one water source to another water source, such as:
 - from an aquifer to an adjacent aquifer; or
 - from an aquifer to a river/lake; or
 - from a river/lake to an aquifer.

A licence for the removal of water from a water source may be required for the development.

3.2.2 WATER SHARING PLANS (WSPS)

WSPs are being progressively developed for rivers and groundwater systems across NSW following the introduction of the Water Management Act 2000. WSPs made under the WMA are being prepared as Minister's plans under Section 50 of the Act. These plans protect the health of our rivers and groundwater while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through separation of land and water.

WSPs provide a legislative basis for sharing water between the environment and consumptive purposes. Under the WMA, a plan for the sharing of water must protect each water source and its dependent ecosystems and must protect basic landholder rights.

The site is located within the following WSP:

- Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources (2023) – Sydney Basin Nepean Groundwater Source.

Water sharing plan for the Greater Metropolitan region groundwater sources (2023) – Sydney Basin Nepean Groundwater Source

The Sydney Basin Nepean Groundwater Source covers an area of 3,949.3 km² and is bounded by Lake Burragorang to the north, Nepean River and Cataract River to the east, and the Illawarra Range to the south. National parks cover much of the north-western portion of the groundwater source and the bore distribution is concentrated to the north-east around Camden and the south-western areas around Moss Vale.

The geology consists predominantly of sedimentary sandstone (medium to coarse grained) and siltstone formations with intervening coal seams. The Hawkesbury Sandstone, which underlies the large proportion of the area is capable of producing high yields of good quality groundwater. Groundwater sustains many of the GDEs located on the highland areas. Depth to groundwater can range from 15 to 50 mbgl depending on location. Average bore depth and yield are about 90 m and 3.2 L/s respectively while average salinity is approximately 250 mg/L TDS.

The long-term average annual extraction limit (LTAAEL) is 64,785 ML/yr (2022). As of March 2022, there was approximately 2,855 registered bores in the Sydney Basin Nepean Groundwater Source with approximately 2,365 of those registered bores for domestic and stock purposes. The majority of irrigation bores (approximately 225) are located in the Sydney Basin Nepean Groundwater Source.

3.2.3 NSW WATER QUALITY AND RIVER FLOW OBJECTIVES

The NSW Water Quality Objectives are the agreed environmental values and long-term goals for NSW's surface waters. They set out:

- the community's values and uses for our rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water); and
- a range of water quality indicators to help us assess whether the current condition of our waterways supports those values and uses.

Water Quality Objectives have been agreed for Fresh and Estuarine surface waters and Marine Water Quality Objectives.

The Objectives are consistent with the agreed national framework for assessing water quality set out in the ANZECC 2000 Guidelines. These guidelines provide an agreed framework to assess water quality in terms of whether the water is suitable for a range of environmental values (including human uses). The Water Quality Objectives provide environmental values for NSW waters and the ANZECC 2000 Guidelines provide the technical guidance to assess the water quality needed to protect those values.

The River Flow Objectives are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

3.2.4 HEALTHY RIVERS COMMISSION INQUIRY

The Healthy Rivers Commission was established in 1995 (under section 23 of the Pollution Control Act 1970) by the NSW Government as one element of water reforms. The Commissioner for Healthy Rivers is to make recommendations to Government on:

- suitable objectives for water quality, flows and other goals central to achieving ecologically sustainable development in a realistic time frame.
- the known or likely views of stakeholder groups on the recommended objectives
- the economic and environmental consequences of the recommended objectives
- and strategies, instruments and changes in management practices needed to implement the recommended objectives.

The Commission does this through conducting independent public Inquiries for selected rivers. The Inquiries assist the community to consider, in detail, the options that are available in terms of river health and the use of river resources for commercial and recreational purposes.

The interim environmental objectives described on the EPA website will apply until the NSW Government either.

- adopts the longer-term objectives resulting from recommendations by the Healthy Rivers Commission, or
- approves a river management plan for the catchment through the Ministers for Land and Water Conservation and for the Environment. In this case, the environmental objectives would apply for the duration of the plan, subject to review and audit.

At the time the interim environmental objectives were approved by the Government (September 1999) the Healthy Rivers Commission (HRC) had completed or substantially completed public inquiries for the Hawkesbury-Nepean River catchment. Interim environmental objectives are not provided for the Hawkesbury-Nepean River catchment.

3.2.5 AUSTRALIAN GUIDELINES FOR URBAN STORMWATER MANAGEMENT (2000)

The Australian Guidelines for Urban Stormwater Management (2000) aim to provide a nationally consistent approach for managing urban stormwater in an ecologically sustainable manner. The approaches represent current best practice in stormwater planning and management in Australia. In particular, the guidelines will help managers to identify objectives for stormwater management (including protecting social, environmental and economic values) and to integrate management activities at the catchment, waterway, and local development level.

The tools and approaches in the guidelines assist managers to undertake integrated storm water management planning in accordance with the values and conditions of the local environment, while integrating these activities into the catchment context.

3.2.6 MANAGING URBAN STORMWATER – SOILS AND CONSTRUCTION VOLUME 1 (2004)

The Managing Urban Stormwater: Soils and Construction Volume 1 (2004) guidelines are an important element of the NSW Governments' urban stormwater program which aims to improve the health, ecology and amenity of urban streams, rivers estuaries and beaches through better management of stormwater.

The guidelines will help mitigate the impacts of land disturbance activities on soils, landforms and receiving waters by focusing on erosion and sediment control. The aims are to:

- Reduce pollution to downstream areas and receiving waters.
- Reduce land degradation.
- Raise an awareness of ecologically sustainable development (ESD) principles and their application to development.

It is expected that management of stormwater will be required for the proposed development as the construction and operational activities have the potential to generate erosion and sediment impacts to the receiving water body.

3.3 Relevant National and NSW EPA Endorsed Guidelines

Approval for the disposal of groundwater to stormwater will be regulated by Council.

The adopted water quality guidelines for discharge waters are the:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018).
- ANZECC/ARMCANZ (2000) Default Trigger Values (TVs) for Physical and Chemical Stressors (used in the absence of ANZG 2018 criteria).
- Guidelines for Managing Risks in recreational Water (NHMRC 2008) / Drinking Water Criteria (NHMRC updated 2022).

Use of the 95% protection level (for the ANZG 2018 Guidelines) is based on an assumption that the surrounding watercourses are moderately disturbed ecosystems (as receiving road and stormwater runoff from adjacent urbanised environment). In the absence of ANZG (2018) DGVs, the ANZECC (2000) trigger values (TVs) were adopted. The freshwater criterion were adopted due to the conditions of the groundwater at the site and the receiving site.

4 Existing Environment

4.1 Land Use

The proposed development area is located on the western embankment of the Wingecarribee River in the central portion of the Wingecarribee Shire Council which is situated to the south of Sydney and west of the Illawarra region. The land is currently occupied by a disused correctional centre and associated buildings. The land is zoned as SP1 – Special Activities Correctional Centre. The surrounding land use includes the following:

- North: Wilshire Street followed by low density residential properties and public recreational area.
- East: Argyle Street and the Old Hume Highway followed by commercial properties zoned as B1 – Neighbourhood Centre,
- South: Wingecarribee Street followed by commercial properties zoned as B1 – Neighbourhood centre and RE1 – Public Recreational.
- West: The Wingecarribee River followed by E3 – Environmental Management areas and residential properties.

A search of historical aerial images of the site indicate that the proposed development area has been used as a correctional centre since at least 1970. Historical aerial images indicate that the site has not undergone a major change in land use since the construction of the correctional centre.

4.2 Climate

Based on daily rainfall data from the nearest operational Bureau of Meteorology (BoM) weather station (Station No. 068239 – Moss Vale) located approximately 8 km to the south-east of the site, average annual rainfall is 800.9 mm/year. (BoM, 2024). Groundwater recharge rate (i.e. the percentage of rainfall that infiltrates into the ground and replenishes the groundwater system) at the site is expected to be approximately 10% based on regional mapping of diffuse groundwater recharge (Lee, et al., 2024). Therefore, diffuse groundwater recharge during an average rainfall year is expected to be 80.0 mm/year.

Monthly rainfall trends from the SILO enhanced climate database (QLD DES, 2021, <https://www.longpaddock.qld.gov.au/silo/>) trends indicate that rainfall amounts are generally higher in the Summer and Autumn months (e.g. from January to June) and lower during Winter and Spring (e.g. July to December). Due to seasonal temperature variation, evaporation rates are typically higher in Spring and Summer. Groundwater recharge potential and overland flow is expected to be higher during months with higher rainfall amounts, and lower evaporation rates.

4.3 Topographical Setting

A detail survey of the site was undertaken by SDG (2024) The site ranges from approximately 661 m Australian Height Datum (AHD) along the north-eastern boundary on Wilshire Street and follows a minor grade towards the south-west before steeply falling to the west along the western boundary and the southern portion of the site. The lowest point of elevation in the south-western portion of the site lies on an elevation of approximately 647.5 metres Australian Height Datum (mAHD). Reditus completed a survey of three (3) onsite monitoring wells, with the TOC of the wells measured between 647.69 and 657.36 mAHD. The site presented in **Figure F2, Appendix A**, and a detail survey for the Site is presented in **Appendix B**.

Based on the local topography, overland flow that occurs on the site and the local stormwater system is likely to flow to the west, towards Wingecarribee River.

4.4 Hydrology

4.4.1 REGIONAL DRAINAGE CATCHMENTS

Wingecarribee Shire LGA is incorporated by several drainage catchments across the LGA and provides potable water supply to residents via the major catchment systems including Wingecarribee Reservoir and the council-owned Bundanoon Dam near Moss Vale and Medway Dam near Berrima. Wingecarribee Shire is located within the Sydney drinking water catchment area. The Sydney drinking water catchment is made up of five water catchments-

Warragamba, Shoalhaven, Upper Nepean, Woronora and Blue Mountains. They stretch from north of Lithgow at the head of the Cocks River in the Blue Mountains, to the source of the Shoalhaven River south of Braidwood - and from Woronora in the east to the source of the Wollondilly River west of Crookwell.

The site is also within the Hawkesbury-Nepean catchment system. The catchment has an area of 21,400 square kilometres, over 70 per cent of the catchment consists of mountainous terrain, with about 10 per cent of flat terrain. The south terrain, around 10 per cent of the total catchment, comprises undulating plateau type country. The maximum elevation is about 1,290 metres. The Wingecarribee River is one of the main river systems that makes up the Hawkesbury-Nepean catchment.

4.4.2 WATERWAYS

There are a number of waterways surrounding the site, and are presented in **Figure F4** in **Appendix A**. These waterways are discussed in **Table 4-1 Error! Reference source not found.** below, in regards to Strahler stream classification system, hydrological and water quality characteristics, and KFHs.



Table 4-1 Waterways within close proximity to the Site and determination of SRE

WATERWAY	DISTANCE FROM SITE	STRAHLER STREAM ORDER	KFH	WATERWAY TYPE	OTHER RELEVANT FEATURES	SRE DETERMINATION
Wingecarribee River	20 m west	Third	Yes	Class 2 – Moderate fish habitat	Wingecarribee River flows towards the north-west and is located adjacent to the site.	SRE – Moderate The Wingecarribee River is determined to be a Moderate sensitive receiving environment.
Cordeaux Creek	1.94 km north-west	Second	Yes	Class 2 – Moderate fish habitat	Cordeaux Creek flows generally towards the south and is located down-stream of the site	SRE – Low Cordeaux Creek is determined to be a Low sensitive receiving environment
Black Spring Creek	2.4 km north-west	Second	Yes	Class 2 – Moderate fish habitat	Black Spring Creek flows towards the north until its confluence with Wingecarribee River and is located down-stream of the site.	SRE – Low Black Spring Creek is determined to be a Low sensitive receiving environment.
Mandemar Creek	5.04 km north-west	Second	Yes	Class 2 – Moderate fish habitat	Mandemar Creek flows towards the south until its confluence with Wingecarribee River and is located down-stream of the site	SRE – Low Mandemar Creek is determined to be a Low sensitive receiving environment.
Stony Creek	1.6 km south-east	Second	Yes	Class 2 – Moderate fish habitat	Stoney Creek flows towards the north until its confluence with Wingecarribee River and is located up-stream of the site	SRE – Low Stony Creek is determined to be a low sensitive receiving environment.
Mittagong Creek	4.8 km south-east	Second	Yes	Class 2 – Moderate fish habitat	Mittagong Creek flows generally towards the south-west until its confluence with Wingecarribee River and is located up stream of the site	SRE – Low Mittagong Creek is determined to be a low sensitive receiving environment.

4.4.3 FLOODING ASSESSMENT

A flood study was conducted on the Wingecarribee River (SMEC, 2014). The Wingecarribee Flood Study assesses flood risks in the Wingecarribee River catchment. The study uses TUFLOW to estimate flood levels and map flood extents for various flood sizes, from common to extreme events. It aims to inform land-use planning, assess risks for future development, and evaluate potential flood mitigation measures. The study also considers the impact of the Wingecarribee Dam on flood behaviour and uses historical flood data to predict future flood risks.

Results of the model indicate that the floodplain is relatively narrow between the hills surrounding Berrima, and in the upper reaches is up to 1 km wide.

4.4.4 SURFACE WATER QUALITY

One surface water sample (SW-1) was collected by a Reditus Hydrogeologist on 27 September 2024 and was submitted to the NATA accredited laboratory Envirolab for analysis.

All analytes were reported below the adopted criteria except for:

- E. coli (200 cfu/100 mL) exceeding the ADWG (2022) health criteria (>0 cfu/mL)
- Nitrogen (total oxidised) (0.2 mg/L) exceeding the ANZECC (2000) South Eastern Australia – Upland River criteria (0.015 mg/L)
- Nitrogen (total) (0.7 mg/L) exceeding the ANZECC (2000) South Eastern Australia – Upland River criteria (0.025 mg/L)
- Aluminium (0.18 mg/L) exceeding the ANZG (2018) Freshwater 95% species protection criteria (0.18 mg/L)

4.5 Hydrogeology

4.5.1 GEOLOGY AND SOILS

Regional Geology

Based on regional geological mapping (Wollongong 1:250,000 Geological Series Sheet SI 56-9, Second Edition, 1966)), the site is underlain by the Hawkesbury Sandstone formation of the Triassic Age. Hawkesbury Sandstone comprises medium to coarse-grained quartz sandstone which typically displays high-angle crossbedding, with minor shale and laminite lenses.

Soil Landscape

The soil landscape was not mapped by the NSW Office of Environment and Heritage (OAH, 2020) accessed via eSPADE 2.0 on 14 October 2024.

Site Specific Geology

Borelogs provided by Martens & Associates (17 September 2024), presented in **Appendix C**, for the three monitoring wells (MW101, MW102 and MW103) found that the site is underlain by fill material described as clayey sand, silty sandy gravel and silty sand to depths between 0.0 and 0.9 mbgl, overlying natural sandy clay to depths of between 0.3 to 1.5 mbgl, followed by medium to coarse grained sandstone from 0.4 mbgl to depth.

4.5.2 HYDROGEOLOGY AND GROUNDWATER ELEVATIONS

The site is located within the Sydney Basin Nepean Groundwater Source, which is managed under the WMA 2000 through the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023. The groundwater source is typically composed of tertiary sandstones, of which, a large portion forms a part of the Hawkesbury Sandstone. The Hawkesbury Sandstone is a dual porosity, porous rock aquifer, with typically high yields. Preferential flow within the aquifer is dominated by fractures (secondary porosity). Features of the Hawkesbury Sandstone which influence the flow regime include layers of siltstone and coal seams which have lower yields.

Groundwater was encountered in bores located on site measured during this assessment and during the DSI (JBS&G, 2021). The depth to groundwater ranged between 641.621 to 652.19 mAHD. Details of the measured standing water levels are shown in **Table 4-2** below.

Table 4-2 Groundwater elevation measures

WELL ID	DATE	TOC (RL ¹ mAHD)	DEPTH OF WELL (mbTOC / mAHD)	DEPTH TO WATER (mbTOC)	GROUNDWATER ELEVATION (RL mAHD)
MW01	September 2021	657.999	10.6 / 647.39	8.429	649.570
MW02	September 2021	651.997	7.0 / 644.99	3.851	648.146
MW03	September 2021	651.149	7.5 / 643.649	7.210	643.939
MW101	27 September 2024	654.857	10.17 / 644.687	8.79	646.067
MW102	27 September 2024	657.361	10.89 / 646.471	5.43	651.931
MW103	27 September 2024	647.691	6.98 / 640.711	6.07	641.621
Minimum:				3.851	641.621
Maximum:				8.79	651.931
Mean:				6.63	646.525
Median:				6.64	647.1065

¹ RL – Relative level.

4.5.3 DATA LOGGERS

Data loggers were used by Martens & Associates to monitor groundwater elevation at monitoring well locations MW01, MW02, MW03 and MW1. The data loggers recorded groundwater elevation measurements every 15 minutes for a period from 1 February 2025 to 1 May 2025 (approximately 3 months). Standing groundwater levels (SWL, mAHD), overlain with the recorded rainfall during this period (Bowral (Orchard Street) AWS 068255) have been plotted in **Figure 1** below. A maximum standing water level at MW02 was noted as being 652.19 mAHD.

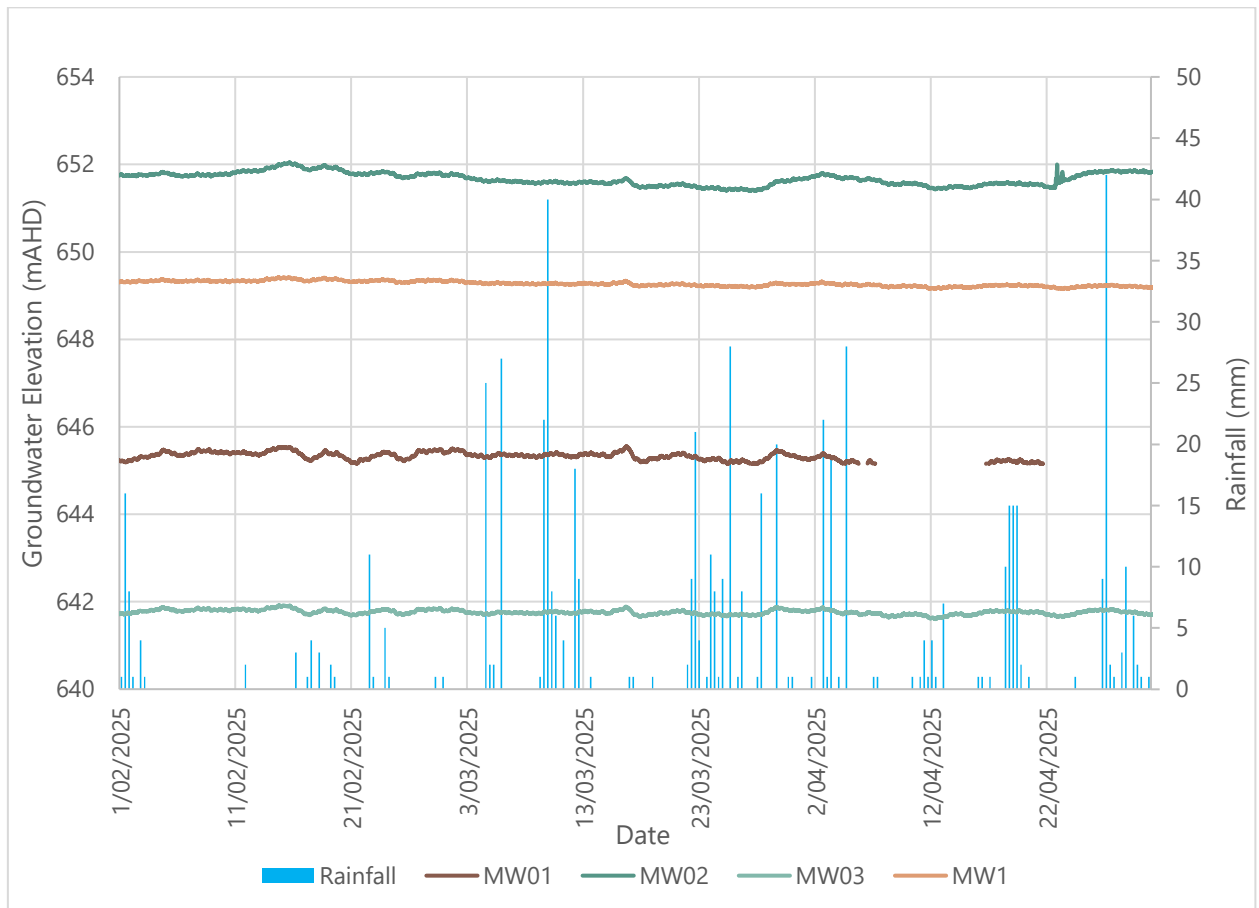


Figure 1 Groundwater monitoring data, MW01, MW02, MW03 and MW1 between 1 February 2025 and 1 May 2025

4.5.4 INFERRED FLOW DIRECTION

Three groundwater monitoring wells were installed by Martens & Associates on 17 September 2024. Groundwater level gauging and surveyed top of casing data was obtained from the wells (MW101 to MW103) during the Reditus site visit on 27 September. This data was used to infer the groundwater flow direction in the southern portion of the site (basement carpark footprint). Groundwater contour and flow direction data has been presented in **Figure F3, Appendix A**. Based on the groundwater contours, groundwater is inferred to flow from east to west towards Wingecarribee River.

4.5.5 SITE SPECIFIC HYDRAULIC CONDUCTIVITY

Rising head slug testing data was obtained from three of the onsite wells (MW101, MW102 and MW103) with the analysis completed using the computational software AQTESOLV. The outputs for each test are presented in **Appendix D**. These tests were completed to measure the change in hydraulic head overtime and to determine the aquifer characteristics of the well. The selected wells were spaced across the edges of the basement boundary and were completed on wells that had depths similar to the inferred base of excavation so that estimation of water volumes captured during the construction phase could be made.

AQTESOLV solutions were based on the Bouwer-Rice and Hvorslev Method for slug tests in an unconfined aquifer. Estimates of hydraulic conductivity were calculated and are summarised in **Table 4-3** below.

Table 4-3 Estimates of Hydraulic Conductivity

WELL ID	DATE	HYDRAULIC CONDUCTIVITY (M/DAY)	HYDRAULIC CONDUCTIVITY (M/DAY)
		BOUWER-RICE 1976 SOLUTION (UNCONFINED AQUIFER)	HVORSLEV 1951 SOLUTION (UNCONFINED AQUIFER)
MW101	27 Sep 2024	2.25×10^{-7}	3.02×10^{-7}
MW102	27 Sep 2024	1.09×10^{-7}	1.36×10^{-7}
MW103	27 Sep 2024	1.23×10^{-6}	1.54×10^{-6}
Minimum:		1.09×10^{-7}	
Maximum:		1.54×10^{-6}	
Mean:		5.89×10^{-7}	
Median:		2.64×10^{-7}	

The above estimates of hydraulic conductivity are noted to be within the range for sandstone in literature values (Fitts, C.R. 2013 Groundwater Science (2nd ed. Academic Press).

4.5.6 GROUNDWATER QUALITY

During the sampling event undertaken by Reditus on 27 September 2024, monitoring wells were sampled and physicochemical parameters were recorded. With the exception of MW101, the monitoring wells were purged until stabilised physicochemical parameters were obtained. The recorded physicochemical parameters for the site were:

- pH ranged between 4.42 (MW101) and 6.23 (MW103), indicating slightly acidic groundwater conditions.
- Electrical conductivity ranged between 0.056 (MW103) and 0.266 mS/cm (MW101) indicating fresh conditions.
- Dissolved oxygen ranged between 11.7% (MW103) to 67.1% (MW101) indicating a low to moderately oxygenated conditions.
- Redox was calculated by adding 199mV to field values to adjust to Standard Hydrogen Electrode (SHE) results. SHE ranged between 315.8 (MW103) and 386.2 (MW102) indicating a high redox potential conditions.

The groundwater samples collected during this investigation from MW101, MW102 and MW103 were submitted to the NATA accredited laboratory Envirolab (primary laboratory) for analysis. Tabulated analytical results and laboratory certificates are presented in **Appendix E** and **Appendix F**, respectively. All samples were reported below the adopted criteria with the exception of:

- Nitrogen (total oxidised) at locations MW101 (1.9 mg/L), MW102 (14 mg/L) and MW103 (0.2 mg/L) exceeding the ANZECC (2000) South Eastern Australia – Upland River criteria (0.015 mg/L) at locations.
- Nitrogen (total) at locations MW101 (2.0 mg/L), MW102 (15 mg/L) and MW103 (0.5 mg/L) exceeding the ANZECC (2000) South Eastern Australia – Upland River criteria (0.025 mg/L) at locations.
- Total Phosphorous (Organic phosphate) at location (MW103 (0.05 mg/L) exceeding the ANZECC (2000) South Eastern Australia – Upland River criteria (0.02 mg/L) at location.
- Aluminium at locations MW101 (0.72 mg/L), MW102 (0.08 mg/L) and MW103 (0.01 mg/L) exceeding the ANZG (2018) Freshwater 95% species protection criteria (0.055 mg/L) at locations.
- Copper at locations MW101 (0.07 mg/L), MW102 (0.11 mg/L) and MW103 (0.004 mg/L) exceeding the ANZG (2018) Freshwater 95% species protection criteria (0.0014 mg/L) at locations.
- Manganese at location MW103 (2.9 mg/L) exceeding the ANZG (2018) Freshwater 95% species protection criteria (1.9 mg/L) at location.
- Zinc at locations MW101 (0.021 mg/L), MW102 (0.028 mg/L) and MW103 (0.015 mg/L) exceeding the ANZG (2018) Freshwater 95% species protection criteria (0.008 mg/L) at locations.

Requirements for the discharge of groundwater during basement excavation dewatering generally must adhere to the following criteria:

- Concentration of suspended solids must not exceed 50 mg/L.
- The pH of the water must be between 6.5 and 8.5.
- The water must contain no visible oil or grease.
- The water must not contain any substance known to be toxic to aquatic life.

It is anticipated that treatment of the water prior to will be required and will be further discussed in the future DMP.

4.5.7 GROUNDWATER USERS AND WATER SHARING PLAN

Water Sharing Plans (WSPs) have been developed for groundwater systems in NSW to preserve water resources by establishing rules for sharing water between different types of water uses. The site is located within the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023 – Sydney Basin Nepean Groundwater Source – Nepean Management Zone 2*.

A search of the WaterNSW Registered Groundwater Bore Database (<https://realtimedata.watarnsw.com.au/water.stm>) identified thirteen (13) registered groundwater bores with a 500 m radius of the site. Review of the registered bores found that all bores were for domestic/stock purposes. All bores targeted the deeper bedrock aquifer with depths of bores ranging from 18.3 to 79.0 m. The standing water levels (SWLs) ranged between 1.0 and 71.0 mbgl. Summary of the registered bores is presented in **Table 4-4** below.

Table 4-4 Summary of registered bores

BORE ID	USE	DEPTH OF BORE (M)	STANDING WATER LEVEL (MBGL ¹)	DISTANCE/DIRECTION
GW103142	Domestic, Stock	49.0	10.0	Approx. 75m north-west
GW104200	Domestic	37.0	8.0	Approx. 85m south
GW102303	Domestic, Stock	18.3	7.0	Approximately 100 m south-east
GW018979	Domestic	21.0	6.7	Approx. 230 m south-east
GW106857	Domestic, Stock	48.0	16.0	Approx. 280 m north
GW101111	Domestic	79.0	48.0-49.0 70.0-71.0	Approximately 260 m east
GW102797	Domestic	26.0	7.0	Approx. 310 m north
GW107009	Domestic, Stock	60.0	23.0	Approx. 320 m north-east
GW103055	Domestic	24.0	1.0	Approx. 350 m north-east
GW105094	Domestic, Stock	37.0	9.0	Approx. 350 m west
GW112458	Domestic	66.0	23.0-24.0	Approx. 415m east
GW117795	Domestic, Stock	30.0	7.0	Approx. 420 m south-west
GW104888	Domestic, Stock	48.0	13.0	Approx. 425 m west

¹ mbgl: Metres below ground level.

4.5.8 GROUNDWATER DEPENDENT ECOSYSTEMS

Groundwater dependent ecosystems (GDEs) are a diverse and important component of biological diversity. The term GDE takes into account ecosystems that use groundwater as part of their survival strategies. GDEs can potentially include wetlands, vegetation, mound springs, river base flows, cave ecosystems, playa lakes and saline discharges, springs, mangroves, river pools, billabongs and hanging swamps and near-shore marine ecosystems.

The groundwater dependence of ecosystems can range from complete to partial reliance on groundwater, such as might occur during droughts. The degree and nature of groundwater dependence will influence the extent to which they are affected by changes to the groundwater system, both in quality and quantity.

Many land and water use activities within a catchment can affect groundwater dependent ecosystem function and viability. It is important to manage these land and water use activities within a regulatory and licensing framework. Risk assessment guidelines for groundwater dependent ecosystems have been developed to operate within the regulatory and licensing framework provided by the Water Management Act 2000 and Water Sharing Plans (WSPs). The guidelines are based on an assessment of various ecological and risk factors that are important to decisions on allowing a proposed activity or development.

WSPs have been developed for groundwater systems in NSW to preserve water resources by establishing rules for sharing water between different types of water uses. The site is located within the following WSP:

- Sydney Basin Nepean Groundwater Source, which is managed under the WMA 2000 through the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2023.

According to the GDE Atlas, the following Groundwater Dependant Ecosystems are located within a 500 m radius of the site:

- Aquatic GDE:
 - Wingecarribee River – Moderate potential GDE – from national assessment located adjacent to the western boundary of the site.
- Terrestrial GDE:
 - Three (3) unnamed low potential GDEs – from national assessment with GDE description of Wingecarribee-Burraborang Sandstone Forest
 - Two (2) unnamed moderate potential GDEs – from national assessment with GDE description of Wingecarribee-Burraborang Sandstone Forest

The closest moderate terrestrial GDE (Wingecarribee-Burraborang Sandstone Forest) is located approximately 40 m west of the site while the closest aquatic GDE is located approximately adjacent to the site and are therefore at the greatest risk of potential drawdown impacts from the proposed development. The Wingecarribee-Burraborang Sandstone Forest is a large forest biome typically found to the south and east of Berrima, with a smaller section to the west of the Site.

4.5.9 ACID SULFATE SOILS

No Acid Sulfate Soils mapping was available in the Wingecarribee Local Environmental Plan 2010.

4.6 Contaminated Sites

A search was undertaken on 15 October 2024 of the NSW EPA Contaminated Land Register and the NSW EPA List of Notified Sites under the Contaminated Land Management Act (1997). The search did not identify any properties within a 1km radius that were listed or registered as contaminated sites.

A search was undertaken on 15 October 2024 of Environmental Protection Notices and Licences under the NSW EPA Protection of the Environment Operations Act (1997). The search did not identify any notices or licences for the site or surrounding properties within a 1km radius.

5 The Proposal

5.1 Development Details

The most recent relevant development plans, are provided as **Appendix B**, and include the following Architectural Drawings:

- Turner (8 September 2025) Site Plan, Berrima Gaol Adaptive Reuse
- Turner (8 September 2025) Lower Basement, Berrima Gaol Adaptive Reuse
- Turner (8 September 2025) Upper Basement, Berrima Gaol Adaptive Reuse
- Turner (8 September 2025) Lower Ground Upper Escarpment, Berrima Gaol Adaptive Reuse

It is understood that the proposed redevelopment of the site will include the adaptive reuse of the heritage site of Berrima Correctional Centre. The development plans include boutique accommodation buildings along the western boundary of the site facing Wingecarribee River, a two-level basement carpark in the southern portion of the site and adaptation of the existing correctional centre building into a function room, courtyards, restaurant, arrival lounge, hotel suites and associated amenities.

The proposed works are a State Significant Development and are noted under application number SSD-66876472 issued on 1 March 2024. The SSD is currently being prepared in accordance with the Department of Planning's Secretary's Environmental Assessment Requirements (SEARs).

The proposed basement development plans are provided as **Appendix B**. The proposed basement footprint at the site is presented in **Figure F2, Appendix A**.

The finished floor level (FFL) on the gaol ground level is Reduced Level (RL) 659.00 mAHD with the hotel ground level (hotel suites on the western boundary) is RL 650.45 mAHD. The lowest elevation of the FFL of the lower carpark level is RL 645.79 mAHD. The bulk excavation level (BEL) expected to be approximately RL 645.29 mAHD. It is assumed at detailed design stage that the basement will be proposed to be constructed as a 'Drained Basement'.

A summary of the proposed basement excavation parameters is provided in **Table 5-1** below.

Table 5-1 Summary of Proposed Excavation Parameters

ITEM	DESCRIPTIONS
Basement Excavation Footprint Area (m²)¹	Approximately 3,600 m ²
Site Surface Elevation	Based on the detailed site survey conducted by SDG in 2024, the site has an approximate elevation of 661 mAHD in the north-eastern corner (highest point) and 647.5 mAHD in the south-western corner (lowest point). The site follows a general gradient towards the west/south-west, and a steep gradient towards the west along the western boundary and in the southern portion of the site. The basement is located in the southern portion of the site and will be situated within an elevation setting of approximately 657.5 mAHD in the north-eastern corner and 648 mAHD in the south-western corner of the excavation.
Basement Finished Floor Level (FFL)	<u>Lower Carpark Level:</u> 645.79 RL mAHD
Bulk Excavation Level (BEL)	645.29 RL mAHD

¹ Determined from the outline of the entire basement carpark.

6 Surface Water Impact Assessment

6.1 Construction Phase

6.1.1 SOILS

The proposed development will involve earth work activities including land clearing and basement excavation works which will disturb soils in the southern portion of the site (basement construction area) and the western boundary of the site (hotel construction works). Soil disturbance during construction works has the potential to impact surface water by:

- Alteration of hydrological flow regimes through excavations, stockpiles and erosion of soils which may either increase or reduce the amount of water discharging into the surrounding surface water bodies.
- Changes in water quality in the Wingecarribee river through discharge of water from stockpiled material following rainfall events.

6.1.2 WATER QUALITY IMPACTS

The proposed development will involve construction phase works which have the potential to impact surface water through increased pollutant generation activities that may discharge into local surface water bodies following rainfall. Potential pollutant generation may include:

- Leaching of heavy metals from construction materials.
- Chemical spillages including hydrocarbons from fluids associated with construction machinery.
- Dust and airborne pollutants being generated during construction and earthworks which can settle in surface water bodies.

These activities also have the potential to impact groundwater quality via seepage into the ground, however it is more likely that contaminants would be transported via overland flow into receiving water bodies.

6.1.3 IMPERVIOUS AREAS

The proposed development will increase the impervious areas during the construction phase through compaction of soils from plant movement, and as a result of on-going operation through an increase in hardstand areas, particularly in the footprint of the proposed basement carpark (southern portion of the site) and the proposed hotel suites along the western boundary of the site.

This may increase the overland flow through a reduction in infiltration in these areas and has the potential to increase discharge to surrounding SREs as well as reducing groundwater recharge rates on site. We note however that the proposal is to incorporate rainwater collection & storage through rainwater tanks as part of the hotel development so this would have the effect of alleviating any increase in overland flow and discharge to surrounding SRE's

6.2 Operational Phase

Impacts to surface water due to the ongoing operation of the project are anticipated to be negligible. An increase in impervious areas as a result of concreting for the project (construction of paths, walkways and buildings) is only considered to be a marginal increase to the current site features and will require appropriate designed stormwater detention and allowance for deep soil infiltration, as such will have a negligible impact to the long term overall hydrological flow regime. Further, impacts as a result of ongoing discharge of groundwater due to the drained basement design are also considered to be negligible. Groundwater levels in the aquifer are likely to equilibrate following construction of the basement, leading to a decrease in discharge water. Additionally, this discharged water will be treated to acceptable criteria prior to discharge to stormwater. Additional considerations of the following potential impacts have been made:

- Irrigation – ongoing irrigation of the landscaped areas for the life of the development.
- Accidental chemical spills from maintenance areas or future constructions
- Leakage from cars parked on-site.

7 Groundwater Impact Assessment

7.1 Dewatering

Based on the groundwater data sourced from this assessment, the highest groundwater elevation was at RL 652.19 mAHD at MW102 which was located on the eastern side of the proposed basement footprint (highest ground level) and at RL 641.621 mAHD at location MW103 which was located on the western side of the proposed basement footprint (lowest ground level). The depth of excavation for the basement car park is proposed to be RL 645.79 mAHD. The assumed Bulk Excavation Level (BEL) for the site is taken at 0.5 m below the proposed depth of excavation and therefore, the basement excavation will intercept the groundwater. As such, dewatering will be required during the construction phase of the basement, and ongoing operation, as it is assumed at the design stage that the development includes a 'drained' basement. An analytical model has been conducted to assess the potential impacts of dewatering during the construction phase and operation phase of the site. Should the basement design change to a tanked basement, then impacts to groundwater as a result of dewatering during the operational phase are removed.

Additionally, a review of groundwater contours from JBS&G (2021) indicate that groundwater in the north western corner of the Site is found between 643.9m AHD (MW03) and 649.57 mAHD (MW01). Footings in this area are assumed to be installed up to 1 m below the base of the Hotel Ground Level (659.0 mAHD), to a depth of 658.00 mAHD. As these footings are likely to be at least 8m above the groundwater level, they are not expected to impact groundwater, and are not considered in this assessment.

7.1.1 ANALYTICAL MODEL

Summary of Geology and Hydrogeology

Based on the borehole logs completed by Martens & Associates on 16 September 2024 (**Appendix D**), the generalised subsurface profile at the site is comprised of fill material (to a max. depth of 0.9 mbgl), residual material (to a max. depth of 1.5 mbgl); overlying sandstone (from between 0.4 - 1.5 mbgl onwards). The groundwater system within the development extent on the site is described as:

The groundwater standing levels manually recorded onsite by Reditus on 27 September 2024 and from data loggers installed by Martens & Associates ranged between 641.62 mAHD at MW103 to 652.19 mAHD at MW102. **As a condition of approval it is anticipated that a DMP and associated Groundwater Works Approval Licence will need to be obtained prior to performing aquifer interference activities.**

Based on the maximum standing water level of 652.19 mAHD in the eastern portion of the basement excavation area and the basement Bulk Excavation Levels (BELs) of RL 645.29 mAHD, there is likely to be 6.064 m of groundwater which will be encountered and require dewatering during development works at the site (i.e., proposed drained basement). It is noted that based on the standing water level of 641.62 mAHD (MW103) in the western portion of the basement excavation, it is unlikely that groundwater will be encountered during excavation works. As such, MW103 has been removed from the analytical model.

Conceptual Flow Model:

A conceptual model is a description of the site, site works, and groundwater systems presented both as text and graphically. This description can then be approximated using an analytical solution to allow prediction of groundwater behaviour.

The groundwater drawdown estimate comprises two key components to be considered:

- a) The component of groundwater present within the aquifer matrix, which will be removed as part of the excavation process (pore water).
- b) The component of inflow into the excavation from the surrounding aquifer (walls and base) during the dewatering activity.

The conceptual flow models developed for this assessment are "steady state" models – a snapshot in time representing average conditions. This snapshot was completed based on conservative assumptions of the excavation depth, which estimate the greatest groundwater inflow. Note that a more detailed analysis can be provided through a three-dimensional flow model (beyond the scope of the current assessment).

Conceptually, the drained basement design will not limit any groundwater inflow into the excavation void and is assumed to be in direct connection with the surrounding Fractured Sandstone Unconfined Aquifer.

To estimate the groundwater extracted present within the aquifer matrix, which will be removed as part of the excavation process, the porosity of the matrix is multiplied by the saturated excavation volume. The saturated excavation volume was calculated by determining the difference between the conservative standing groundwater level and the BEL, multiplied by the approximate excavation area for the basement.

To estimate the groundwater inflow volumes, Reditus used the Marinelli and Niccoli (2000)¹ steady-state analytical solution. This solution provides a convenient means for estimating groundwater inflows into excavations and is considered applicable to use as a conservative assessment for the proposed drained basement design.

The analytical method of Marinelli and Niccoli (2000) requires a simplification of the hydrogeological environment and was used to provide a broad range of potential drawdown and groundwater inflow. The equations calculate groundwater inflow from the aquifer based on the conceptual model.

The conceptual flow model was approximated by analytical models, which are divided into two zones separated by a conceptual no-flow boundary where horizontal flow will occur level with the excavation base:

- **Zone 1** – exists above the base of the excavation and represents lateral flow to the excavation via the surrounding walls and drainage layer.
- **Zone 2** – extends from the bottom of the excavation downward and considers vertical upward groundwater inflow through the excavation base into the void and drainage layer.

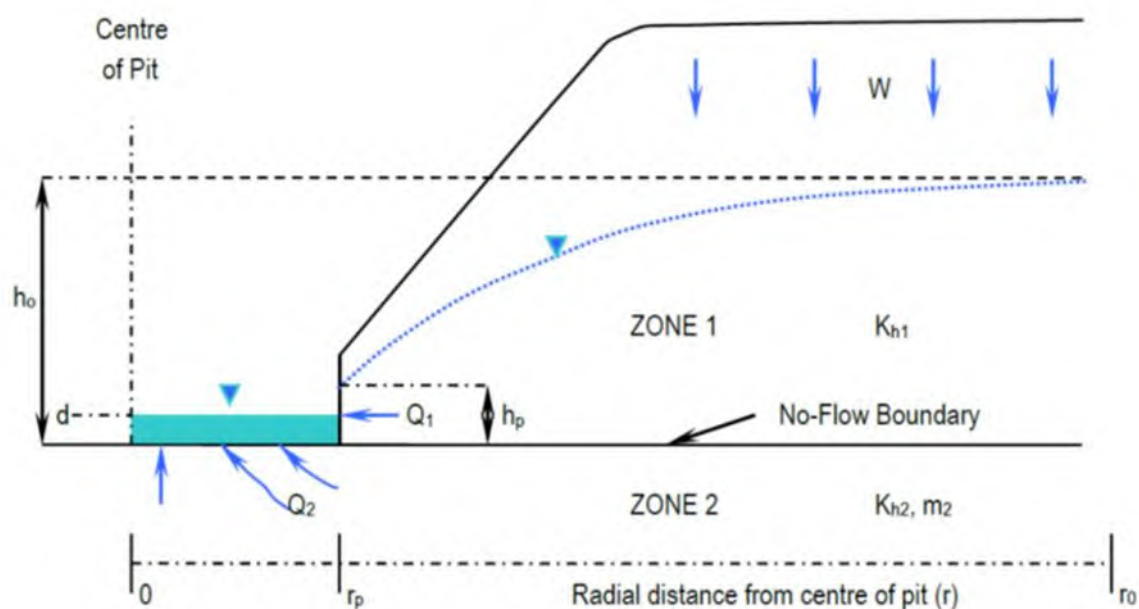


Figure 2. Conceptual Model of the Analytical Solution

The analytical solution for Zone 1 considered steady state, unconfined, horizontal radial flow, with uniformly distributed recharge at the water table. This represents the volume of water laterally flowing into the excavation through the excavation walls.

The analytical solution for Zone 2 is based on steady-state flow to one side of a circular disk sink of constant and uniform drawdown. The circular disk sink represents the volume of water needing to be removed to dewater the site to the target dewatering level of RL 645.29 mAHD.

For the development of the conceptual flow model for the proposed excavation, the circular disk sink was assumed to encompass the approximate area of the excavation footprint. The total excavation is approximated as a single large well and as such the circular disk sink was assigned a radius of based on the footprint of the proposed excavation.

¹ Marinelli, F, and Niccoli, W.L. (2000) Simple analytical equations for estimating ground water inflow to a mine pit: *Groundwater*, v. 38, no.2, p. 311-314

An average annual rainfall of 800.9 mm of rain was registered at the nearest weather station (Station No. 068239 – Moss Vale) over the period of 2001 to 2024. These statistics have been used as the average annual rainfall for inflow calculations. These statistics from the Australian Government Bureau of Meteorology (BoM) have been used as the average annual rainfall for inflow calculations. This converted to an assumed average daily rainfall of 0.00219 m/day.

- A review of Hydrogeology map of Australia (Geoscience Australia) indicates the aquifer type beneath the site are **porous, extensive with high productivity**.

Summary of Aquifer Parameters

The hydraulic conductivity of the porous rock will be restricted by the connectivity and extent of the bedding layers and joints or faults, as well as the degree of connection to the drainage layer.

Site specific test data of the porous sandstone has provided an estimate of the hydraulic conductivity (summarised in **Table 7-1** Error! Reference source not found. below), which has been used to predict groundwater inflow volumes. These values are presented as representative averages over the area of the site, and localised natural variation up to an order of magnitude is to be expected in parts of the site. It is noted that MW103 has been excluded from the summary as the groundwater elevation is lower than the BEL.

Table 7-1. Summary of Hydraulic Conductivity Values

		HYDRAULIC CONDUCTIVITY (m/day)
Fractured sandstone	Minimum	9.37×10^{-3}
	Maximum	2.61×10^{-2}
	Average	1.54×10^{-2}
	Median	1.56×10^{-2}

Site specific porosity values were not measured. As such, representative porosity values were adopted from literature sources. Given groundwater storage of the aquifer is likely confined to secondary porosity features (fractures), a porosity value 1% was assumed for the fractured sandstone unit. An anisotropy ratio of 0.1 was applied, which assumes 10% more inflow of water comes through the horizontal walls compared to vertically.

Model Scenarios

All groundwater models include some degree of uncertainty in their predictions as they are, by necessity, simplifications of complex real-world systems. Whilst every effort is made to ensure that the primary model reflects the best-case, most-likely case and upper-case (less likely) understanding of site conditions, this cannot be guaranteed, and any model result presented as a single number should be viewed with a degree of caution.

Factors which affect the dewatering rate, groundwater take and extent of drawdown within the steady state model include dewatering rate, dewatering design, dewatering period, aquifer characteristics and degree of aquifer variability (including hydraulic conductivity, specific yield/Storativity, porosity, recharge, heterogeneity).

It is considered impractical to determine these factors by pumping tests and further analytical assessment, based on the relatively small scale of the development and the likely relatively low risk of impact to groundwater in the shallow water bearing zone in the top of the low yielding porous aquifer.

Typical representative values were used in the model. Assessment of the range of typical values and their effects on the model predictions were made to allow sound management decisions using **Best Case (Less Likely), Most Likely, and Upper-Case (Less Likely)** scenarios.

Table 7-2. Analytical Model Scenarios. MW103 has been removed from the analytical model.

SCENARIO	DESCRIPTION
Best Case – Less Likely	<u>Minimum</u> hydraulic conductivity used for both Zone 1 and Zone 2: • 9.37×10^{-3} m/day (horizontal hydraulic conductivity) • 9.37×10^{-4} m/day (vertical hydraulic conductivity based on an Anisotropy Ratio of 0.1 which assumes vertical flow is 10% of horizontal flow) The lowest of the SWLs of the manually recorded data from all wells was used to determine an initial groundwater level of 646.067 RL mAHD
Most Likely	<u>Mean</u> hydraulic conductivity used for both Zone 1 and Zone 2: • 1.67×10^{-2} m/day (horizontal hydraulic conductivity) • 1.67×10^{-3} m/day (vertical hydraulic conductivity based on an Anisotropy Ratio of 0.1 which assumes vertical flow is 10% of horizontal flow). The average of the SWLs of the manually recorded data from all wells was used to determine an initial groundwater level of 648.999RL mAHD
Upper Case – Less Likely	<u>Maximum</u> hydraulic conductivity used for both Zone 1 and Zone 2: • 2.61×10^{-2} m/day (horizontal hydraulic conductivity) • 2.61×10^{-3} m/day (vertical hydraulic conductivity based on an Anisotropy Ratio of 0.1 which assumes vertical flow is 10% of horizontal flow). The maximum SWL of the logger data from all wells was then used to determine an initial groundwater level of 652.19 RL mAHD

7.1.2 ANALYTICAL MODEL EQUATIONS

Groundwater Take Volume within the excavation matrix.

The following equation was utilised to estimate the groundwater volume present in the aquifer matrix directly removed through excavation:

$$V = \phi \times m \quad (1)$$

$$m = (H_0 - BEL) \times A \quad (2)$$

where:

V = groundwater volume present in the aquifer matrix directly removed through excavation (m³).

ϕ = matrix porosity

m = volume of saturated aquifer matrix to be excavated

H_0 = initial water table elevation (RLm)

BEL = basement excavation level (RLm)

A = area of excavation

Groundwater Inflow Take Volume

The steady state inflow rate into the disk sink is given by the following equations²:

Zone 1:

$$Q_1 = W\pi(r_o^2 - r_p^2) \quad (3)$$

$$h_o = \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r_o}{r_p} \right) - \frac{(r_o^2 - r_p^2)}{2} \right]} \quad (4)$$

Zone 2:

$$Q_2 = 4r_p \left(\frac{K_{h2}}{m_2} \right) (h_o - d) \quad (5)$$

$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}} \quad (6)$$

where:

Q = groundwater flux (m³/day)

K_{h1} = horizontal hydraulic conductivity (m/day) at Zone 1

K_{h2} = horizontal hydraulic conductivity (m/day) at Zone 2

K_{v2} = vertical hydraulic conductivity (m/day) at Zone 2

m₂ = vertical hydraulic conductivity anisotropy parameter

d = depth of water (above target dewatering level) within final excavation (m) (*assumed to be 0 at final excavation depth*)

r_p = radius from centre of excavation (circular disk sink) (m)

r_o = drawdown radius from centre of excavation (iterative calculation)

h₀ = initial saturated thickness above base of excavation (m)

h_p = saturated thickness above the base of excavation at the excavation wall (r_p), which is assumed 0 m

W = rainfall recharge rate (assumed % of the mean daily rainfall)

Groundwater Drawdown extent

The following equations were used to calculate the groundwater drawdown resulting from the groundwater take into the excavation²:

$$H_{1(r)} = H_0 - h_0 + \sqrt{h_p^2 + \frac{W}{K_{h1}} \left[r_o^2 \ln \left(\frac{r}{r_p} \right) - \frac{(r^2 - r_p^2)}{2} \right]} \quad (7)$$

where:

H_{1(r)} = hydraulic head elevation (m) at a radial distance (r) from excavation centre

H₀ = initial groundwater elevation (mRL)

h₀ = initial saturated thickness above base of excavation (m)

r = radial distance from excavation centre (m)

z = vertical depth below the excavation bottom (assumed to be 0 m)

W = rainfall recharge rate (assumed % of the mean daily rainfall)

K_{h1} = horizontal hydraulic conductivity (m/day) at Zone 1

7.1.3 MODEL ASSUMPTIONS AND INPUT PARAMETERS

Assumptions

The analytical solution was based on the following assumptions, after Marinelli and Niccoli (2000):

- Steady state, unconfined, horizontal radial flow, with uniformly distributed recharge at the water table.
- The excavation walls are approximated as a circular cylinder.
- Groundwater flow is horizontal. The Dupuit-Forchheimer approximation (McWhorter and Sunada 1977) is used to account for changes in saturated thickness due to depression of the water table.
- The static (pre-excavation) water table is approximately horizontal.
- Uniform distributed recharge occurs across the site as a result of surface infiltration. All recharge within the radius of influence (cone of depression) of the pit assumed to be captured by the excavation. A 10% recharge rate due to surface water infiltration through the deep soil zones around the perimeter of the basement excavation.
- Groundwater flow toward the pit is axially symmetric.
- Hydraulic head is initially uniform (hydrostatic) throughout Zone 2. Initial head is equal to the elevation of the initial water table in Zone 1.
- The disk sink has a constant hydraulic head equal to the elevation of the "pit lake water surface". If the pit is completely dewatered, the disk sink head is equal to the elevation of the pit bottom – in this case the target dewatering level.
- Flow to the disk sink is three dimensional and axially symmetric.
- Materials within Zone 2 are anisotropic, and the principal coordinate directions for hydraulic conductivity are horizontal and vertical. It has been assumed that horizontal permeability is greater than vertical permeability by a factor of 10.

Parameters

The parameters used to estimate the groundwater removal (excavation and inflow) within the analytical solution for the basement carpark and lower basement at the site are provided in **Table 7-3** **Error! Reference source not found.** below.

Table 7-3. Groundwater Inflow Analytical Model Input Parameters

PARAMETER	UNIT	BEST CASE – LESS LIKELY	MOST LIKELY	UPPER CASE – LESS LIKELY
Excavation Matrix Storage				
Effective Porosity (ϕ)	-	0.01%	0.01%	0.01%
Bulk Excavation Level (BEL)	RL mAHD	645.29	645.29	645.29
Excavation Area	m ²	3,600	3,600	3,600
Zone 1				
r_p	m	33.91	33.91	33.91
r_o	m	38.88	62.95	96.52
W	m/day	2.19 x 10 ⁻⁴ (10% of average annual rainfall)	2.19 x 10 ⁻⁴ (10% of average annual rainfall)	2.19 x 10 ⁻⁴ (10% of average annual rainfall)
h₀*	m	0.777	3.7090	6.9000
h_p**	m	0	0	0
K_{h1}	m/day	9.37 x 10 ⁻³	1.67 x 10 ⁻²	2.61 x 10 ⁻²
Zone 2				
K_{h2}	m/day	9.37 x 10 ⁻³	1.67 x 10 ⁻²	2.61 x 10 ⁻²
K_{v2}	m/day	9.37 x 10 ⁻⁴	1.67 x 10 ⁻³	2.61 x 10 ⁻³
d	RL m	0	0	0

7.1.4 SUMMARY OF ANALYTICAL MODEL RESULTS

Estimate of Groundwater Matrix Volume Removed within excavations.

The groundwater matrix removal was estimated using equation 1 and equation 2, with predictions provided in **Table 7-4** below.

Table 7-4. Prediction of Groundwater Volume Removed within the Excavation Matrix

DEWATERING AREA	GROUNDWATER VOLUME REMOVED FROM MATRIX (ML)		
	BEST CASE (LESS LIKELY)	MOST LIKELY	UPPER CASE (LESS LIKELY)
Basement carpark	0.028	0.134	0.249

Prediction of Groundwater inflow

The annual groundwater inflow was estimated using equation 3, 4, 5 & 6, with predictions provided in **Table 7-5****Error! Reference source not found.** below, assuming a 12-month dewatering program and continued dewatering during the site operation phase.

Table 7-5. Prediction of Annual Groundwater Inflows

DEWATERING AREA	GROUNDWATER INFLOW (ML) – ZONE 1 & ZONE 2		
	BEST CASE (LESS LIKELY)	MOST LIKELY	UPPER CASE (LESS LIKELY)
Basement carpark	0.20	1.68	4.87

Summary of 'Most Likely' total predicted groundwater take.

Based on the initial 12-months of dewatering for the basement carpark (including both the initial matrix storage removed via excavation over the first ~6 months, and the groundwater inflow over the 12-month period) the following total groundwater extraction volumes for the proposed basement carpark was predicted and is presented in **Table 7-6****Error! Reference source not found.** below.

Table 7-6. 'Most Likely' Predicted Groundwater Take

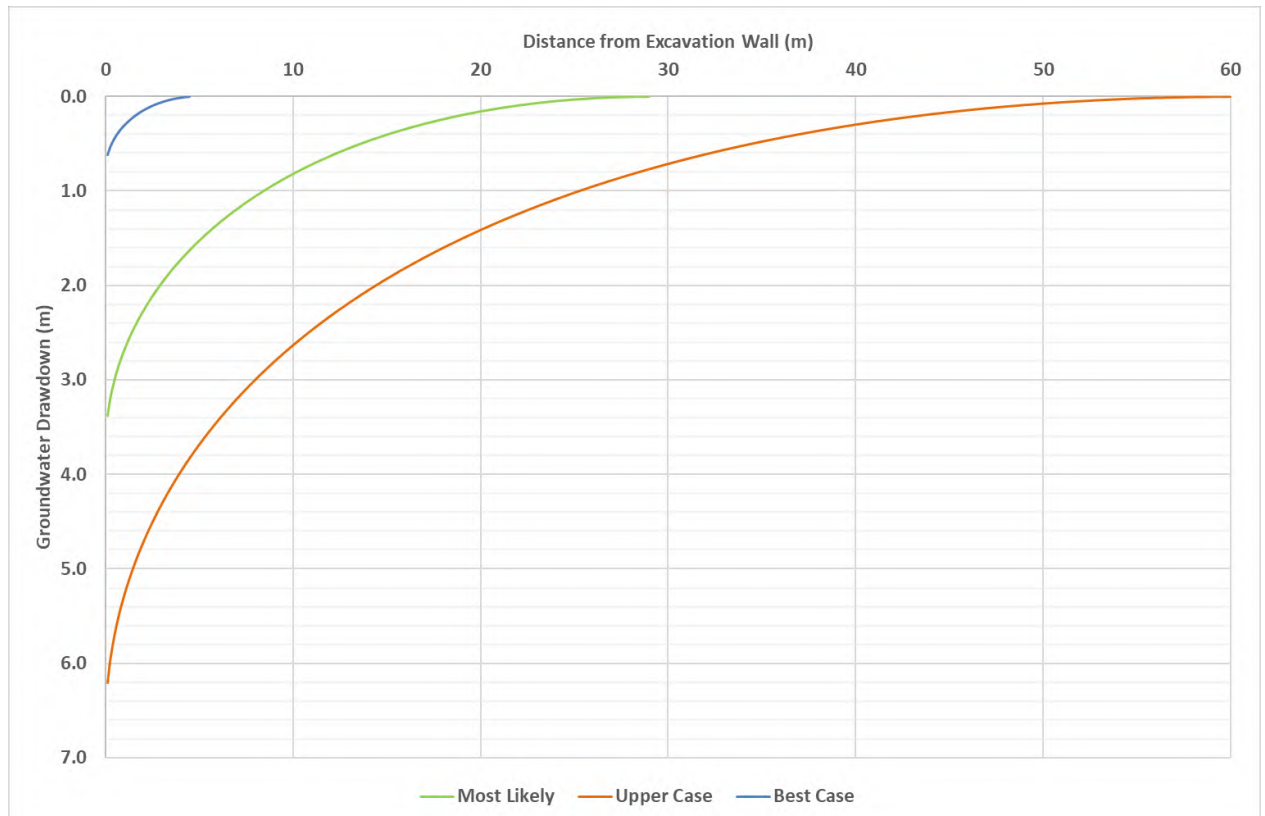
DEWATERING AREA	PREDICTED MATRIX TAKE (ML)	PREDICTED ANNUAL GROUNDWATER INFLOW TAKE (ML/YR)	TOTAL GROUNDWATER TAKE DURING CONSTRUCTION (ML)
Basement carpark	0.134	1.68	1.81

7.1.5 PREDICTION OF DRAWDOWN DISTANCE

As part of the dewatering assessment, the extent of groundwater drawdown was estimated at regular distance intervals from the edge of the circular disk sinks (approximate excavation edge). Drawdown reaches 0 m at the following radial distance from the edge of the approximate excavation edge:

- Best Case (Less Likely): 4.5m
- Most Likely: 29 m
- Upper Case (Less Likely): 60m

The estimated drawdown at distance from the excavation/basement walls have been provided in **Graph 1** below. It is noted that drawdown will equilibrate back to pre-construction conditions following construction if design is changed to a tanked basement.



Graph 1. Extent of Drawdown from Basement/Excavation Wall – Basement carpark

It is the professional experience of Reditus that the groundwater levels in porous rock can vary naturally by several metres or more during prolonged periods of dry or wet weather. Accordingly, a temporary drop in the water table of 1 m or less is considered unlikely to result in off-site geotechnical settlement impacts, particularly within rock.

There is potential that drawdown outside the site may be sufficient to induce settlement in overlying buildings unless an appropriate DMP is implemented. A suitability qualified geotechnical consultant will be required to determine the potential settlement impacts caused by the potential drawdown as a result of the proposed dewatering activities. Detailed geotechnical considerations are beyond the scope of this assessment.

7.2 Aquifer Interference Policy

The Aquifer Interference Policy includes a set of minimal impact considerations for assessing the impacts of all aquifer interference activities, including those regulated under the WMA 2000, the Water Act 1912 and those decided under other legislation. The NSW DPE (2022) Groundwater Impact Assessment Criteria provides a framework for the Minimal Impact threshold criteria.

Aquifer interference approvals are not to be granted unless the Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to any water source, or its dependent ecosystems, as a consequence of its being interfered with in the course of the activities to which the approval relates.

Whilst aquifer interference approvals are not required to be granted, the minimal harm test under the WMA is not activated for the assessment of impacts. Therefore, this Policy establishes and objectively defines minimal impact considerations as they relate to water-dependent assets and these considerations will be used as the basis for providing advice to the Minister.

All NSW groundwater sources have been categorised as being either highly productive or less productive, based on the general character of the water source meeting or not meeting the criteria of 1500 mg/L total dissolved solids and a bore yield rate of greater than 5 L/s. This categorisation applies to a whole groundwater source as it is defined in a water sharing plan, not to the specific groundwater conditions at a particular location. The minimal impact considerations for the highly productive groundwater sources are different to those for the less productive groundwater sources.

Thresholds for minimal impact considerations have been developed for each groundwater source in NSW. Within the WMA, Table 1 – Minimal Impact Considerations for Aquifer Interference Activities are categorised into type of groundwater sources and are presented in **Table 7-7** below. The thresholds relate to impacts on groundwater table and pressure, and to groundwater and surface water quality.

Table 7-7. Highly and Less Productive Groundwater Source Types

HIGHLY PRODUCTIVE	LESS PRODUCTIVE
• Alluvial • Coastal Sands • Porous Rock – Great Artesian Basin - Eastern Recharge and Southern Recharge. – Great Artesian Basin – Surat, Warrego and Central – other porous rock • Fractured Rock	• Alluvial • Porous Rock • Fractured Rock

The proposed development is considered to be located in a 'Less Productive' groundwater source as yields are less than 5 L/s and total dissolved solids are likely <1,500 mg/L. An assessment of the 'Minimal Impact Considerations' is provided in **Table 7-8** below.

Table 7-8. Minimal Impact Considerations under the Aquifer Interference Policy (2012) & NSW Department of Planning and Environment (2022) *Groundwater Impact Assessment Criteria*

AQUIFER GROUNDWATER SOURCE	SYDNEY BASIN NEPEAN GROUNDWATER SOURCE – NEPEAN MANAGEMENT ZONE 2.
CATEGORY	Semi-Confined System (Less Productive)
IMPACT ASSESSMENT CRITERIA	Water table: Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic ‘post water sharing plan’ variations, 40m from any: High priority GDE or high priority culturally significant site listed in the schedule of the relevant water sharing plan. OR A maximum 2m water table decline cumulatively at any water supply work. Water pressure: A cumulative pressure head decline of not more than a 2m decline, at any water supply work. Water quality: Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity.
ASSESSMENT RESULTS	Water table: There are no high priority groundwater dependent ecosystems or high priority culturally significant sites in the vicinity of the project. The expected project related drawdown, cumulative, at any water supply work is < 2m. Water pressure: The expected decline in groundwater elevation due to the project would be < 2m at any water supply work. Water quality: In the upper-case (less likely) scenario the project is expected to change groundwater quality beyond 40 m from the activity as groundwater inflows will be captured and discharged. There are registered groundwater supply bores within a 1 km radius of the site, but drawdown a drawdown of 0 m was calculated at a distance of 60 m from the edge of the excavation. The closest groundwater user is 450 m from the site and is therefore not expected to be impacted.

7.3 Construction Phase

7.3.1 DEWATERING

Dewatering will be required during the construction of the basement carpark. A review of the analytical modelling results against the NSW DPE (2022) *Groundwater Impact Assessment Criteria*, NSW DPI (2012) AIP and WMA 200, presented in **Table 7-8** above, found the following impact assessment results:

- Expected project related drawdown, cumulative, at any water supply work is < 2m.

- No high priority GDEs or high priority culturally significant sites within the vicinity of the project.
- In the upper-case (less likely) scenario the project is expected to change groundwater quality beyond 40 m from the activity as groundwater inflows will be captured and discharged.
- There are registered groundwater supply bores within a 1 km radius of the site.

As such, dewatering activities are considered to be of **Minimal Impact** to the water table, water pressure and water quality. Additionally, construction of the proposed hotel suites along the western boundary of the site will likely involve minor earthworks and grading of the site surface, however it is unlikely that groundwater will be intercepted.

Three bores are located within 150 m of the site, with the closest bore being approximately 85 m south of the basement excavation boundary and therefore located outside the upper-case (less likely) scenario for potential drawdown.

The upper-case (less likely) scenario predicts a drawdown of 0.3 m at 40 m from the site. As such, this is considered to impact groundwater quality. As the drawdown is only a negligible amount, and the best-case and most likely scenarios predict a drawdown of 0 m at 40 m from the site, this is expected to be a low risk and impacts to groundwater quality are considered to be negligible. Additionally, as the Wingecarribee River is located approximately 40m from the basement, the upper-case (less likely) scenario may lead to a reduction of 0.28m of potential throughflow to the River. This reduction is considered to be a negligible amount, and is unlikely to effect the larger flow volumes of the River. Further, as drawdown modelled for the best case (less likely) and most likely case reported 0 m of drawdown at the River, then impacts are considered to be unlikely and negligible.

A search of the BoM Australian Groundwater Explorer indicated that the closest low to medium potential GDE (Central and Southern Tableland River Oak Forest) is located approximately 40 m from the edge of the basement excavation. The predicted upper case (Less Likely) scenario drawdown at approximately 40 m from the edge of the basement excavation is expected to be 0.3 m. It should be noted that these predictions of drawdown impact are based off the upper-case (less likely) scenario, whereas based on the most likely scenario, no drawdown impact on surrounding bores or local GDEs is expected.

7.3.2 POLLUTANTS AND CHEMICAL CONTAMINATION

The proposed development will involve construction phase works which have the potential to impact groundwater through increased pollutant generation activities that may infiltrate into the aquifer below the site. Potential pollutant generation may include:

- Leaching of heavy metals from construction materials.
- Chemical spillages including hydrocarbons from fluids associated with construction machinery. To reduce the potential for material leaching and chemical spills during construction a site specific Construction Environmental Monitoring Plan (CEMP) should be developed for the project prior to construction works commencing.

7.3.3 IMPERVIOUS AREAS

The proposed development will increase the impervious areas during the construction phase through compaction of soils from plant movement, and as a result of on-going operation through an increase in hardstand areas, particularly in the footprint of the proposed basement carpark (southern portion of the site) and the proposed hotel suites along the western boundary of the site. This may cause a reduction in infiltration and recharge into the aquifer below the site. It is noted that these impacts may be offset by removal of hardstand areas during site development including the demolition of existing buildings outside the gaol and existing tennis court (western elevation), removal of hardstand area inside the gaol and replacement with landscaping (internal perimeter, from the gaol wall to 5m inside, being the former "sterile zone" for inmate access).

7.4 Operational Phase

7.4.1 DEWATERING

As the basement will incorporate a 'drained basement' design, ongoing dewatering will be required. Annual dewatering rates are presented in **Table 7-5**, and dewatering impacts are considered to be consistent with impacts encountered during the construction phase. As such, minimal impacts from ongoing dewatering are considered. It is noted that should design be changed to incorporate a drained basement, operation impacts to groundwater as a result will be removed.

Based on the upper-case (less likely) scenario for estimated drawdown, the operational phase dewatering for the proposed drained basement is unlikely to impact any of the local registered bores.

The low to medium potential GDE (Central and Southern Tableland River Oak Forest) is located 40 m south-west of the edge of the basement excavation and within the radius of drawdown influence. As discussed in **Section 7.3.1** the expected drawdown at 40 m distance from the basement is 0.3 m.

Water quality of the discharge waters will need to be treated with a permanence water treatment system and monitored to confirm the quality of the discharge water. This will need to be detailed within the DMP and Groundwater Works Access Licence required to be obtained for the development.

7.4.2 IMPERVIOUS AREAS

With reference to the proposed development, it is expected that there will be an increase in impervious (hardstand) areas, particularly in the footprint of the basement carpark and in the areas along the western boundary where the proposed hotel suites are to be built. The likely impacts from the increase in hardstand includes reduced infiltration and recharge into the underlying aquifer. This can potentially have negative long-term effects on drawdown impacts to surrounding GDEs and local bores. It is noted that these impacts may be offset by removal of current hardstand areas, including the removal of buildings outside the gaol and existing tennis court (western elevation), removal of hardstand area inside the gaol and replacement with landscaping (internal perimeter, from the gaol wall to 5m inside, being the former "sterile zone" for inmate access).

8 Cumulative Impacts

Assessment of the impacts resulting from the proposed development may include the cumulative impacts of developments occurring in the surrounding area and nearby proposals that have the potential to increase the risk to ground and surface water. The surrounding area of the proposed development is considered rural in nature which indicates that minimal development is likely to occur, unless land zoning should change. Review of the Wingecarribee Local Environmental Plan 2010 – Land Zoning Map (Sheet LZN_007C) indicates that the surrounding land is zoned as neighbourhood centres, large residential lots, public recreational areas, low density residential areas and environmental management areas. Under the current land zoning, it is considered highly unlikely that large developments have the potential to have a cumulative environmental impact on the local groundwater and surface water.

Furthermore, for future developments that would have the potential to create a cumulative impact on groundwater and surface water, impact assessments would be required to outline the potential impacts of the development. The future management and mitigation strategies would be expected to minimise those impacts.



9 Mitigation and Management Measures

Assessment of potential surface water and groundwater impacts, associated risks during construction works and mitigation measures are presented below.

A summary of impacts to surface water and groundwater during the construction phase, and mitigation measures are presented in **Table 9-1** below.



Table 9-1 Potential Construction Risks and Mitigation Measures

RISK	IMPACT TYPE	PHASE	POTENTIAL IMPACTS	MITIGATION MEASURES
Excavation, dust suppression and land clearing works	Surface water	Construction	Pollute receiving waterbodies (Wingecarribee River and associated water courses) with increased sediment, especially during rain events Changes to the hydrological regime.	Soil and water management plans incorporated in a Construction Environmental Management Plan (CEMP) to manage risk. Erosion and sediment control measures in accordance with Blue Book (DECC, 2008). Incorporate water quality monitoring plan into the CEMP that will constantly monitor water quality of receiving water bodies.
Stockpiling	Surface water	Construction	Pollute the receiving water bodies with increased sediments from improper stockpiling of materials. Changes to the hydrological regime.	Soil and water management plans incorporated in a CEMP to manage risk. Erosion and sediment control measures in accordance with Blue Book (DECC, 2008).
Stormwater discharge	Surface water	Construction / Operation	Contamination of receiving water body (Wingecarribee River) and associated water courses down-stream of excavation as a result of discharging water to the stormwater network during dewatering	Extraction rates, drawdown and water quality monitoring requirements incorporated into a dewatering management plan (DMP) All construction groundwater to be discharged during basement construction dewatering is to be appropriately treated and to comply with adopted discharge water quality criteria (DWQC).
Impervious Areas	Groundwater / Surface water	Construction / Operation	Increase overland flow during rain events has potential to transport contaminants and sediments into surface water bodies reduce recharge into aquifers.	Provide adequate deep soil and permeable landscape areas as vegetation buffer strips. Incorporation, where possible, of permeable pavements and appropriate design of stormwater detention.
Chemical spills	Groundwater / Surface water	Construction / Operation	Contaminate the underlying groundwater via seepage into the ground or surface water via run-off into receiving waterbodies	Storage of hazardous liquids and refuelling operations to take place in bunded areas to reduce chance of spillage causing impacts Incorporate water quality monitoring plan into CEMP that will constantly monitor water quality of receiving water bodies.

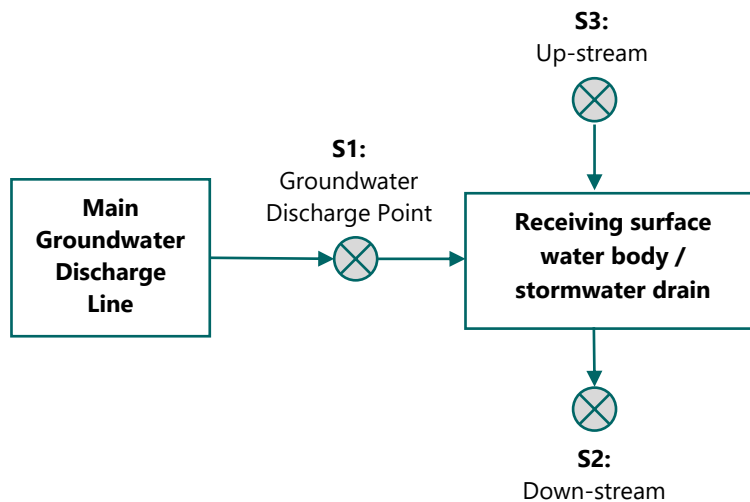


RISK	IMPACT TYPE	PHASE	POTENTIAL IMPACTS	MITIGATION MEASURES
Dewatering	Groundwater	Construction	Impacts to surrounding GDEs and water supply bores within the vicinity of the basement construction caused by drawdown during dewatering activities	Extraction rates, drawdown and water quality monitoring requirements incorporated into a dewatering management plan (DMP) Reduce dewatering time period during basement excavations.

9.1.1 DEWATERING MANAGEMENT AND MONITORING MEASURES

Monitoring of the discharge water is to be completed in accordance with a future DMP. Construction phase groundwater and surface water monitoring is to be completed by a suitably qualified person, using calibrated equipment to collect and analyse samples that are representative of the water to be discharge from the basement excavation works. Results will be compared to discharge water quality criteria. Council will be notified if any results indicate an adverse impact to the environment.

Furthermore, surface water quality monitoring will be undertaken in accordance with future DMP. Water quality samples will be collected from the following locations as presented in the flow chart below.



The future DMP will establish the monitoring frequency and staging of monitoring requirements. This is to include initial assessment/trial run period, construction dewatering discharge monitoring period, identification of roles and responsibilities, inspection requirements, contingencies for non compliance and records and reporting to be held throughout the life of the construction project.

9.1.2 DEWATERING IMPACT MEASURES AND MITIGATION

The potential impacts to surface water and groundwater via drawdown of the water table during basement excavation include impact to groundwater users, GDEs and ASSs. Based on the analytical model discussed in **Section 6.3**, the upper-case (less likely) scenario for drawdown has the potential to impact surrounding GDEs. Assessment of the impacts discussed from drawdown have been provided in **Section 6.4** and indicate that any potential impacts are considered marginal. However, it would be considered prudent to include mitigation and management measures for the identified potential impacts. The future DMP would include strategies to manage potential impacts during both construction, and ongoing operation, including:

- Staging of construction works which would include assessment of drawdown impacts to assess if the construction works are adversely impacting the environment.
- Monitoring of groundwater elevations surrounding the basement excavation during the construction period.
- Outlining mitigation and management measures in the instance that groundwater discharge quantities exceed the expected discharge quantity which would include ceasing of dewatering activities.
- Although it is expected that the water table will stabilise, climatic conditions, including prolonged wet and dry periods can have significant impacts to groundwater levels. Operational long-term dewatering for the life of the development will be required for the proposed drained basement. Implementation of filtration systems that will allow constant management of groundwater discharge is required to ensure that the water being collected in the basement sump meets the discharge water quality criteria before being discharge to the stormwater system and ultimately the Wingecarribee River. Discussion, recommendations and implementation of the systems required for drained basement groundwater discharge will be presented in future DMP. Should a tanked basement be incorporated, then impact measures and mitigation will not be required for the ongoing operation.

9.1.3 POLLUTION OF GROUNDWATER AND SURFACE WATER

To appropriately manage the impacts of pollutants and sediments on surface water and groundwater during the construction works. A Construction Environment Management Plan (CEMP) is to be implemented. The CEMP will address the potential risks and impacts to the receiving water body associated with hazardous chemical spillages, loose soil and increased run-off from increased hardstand areas, and will develop adequate mitigation measures that would typically include:

- Bunding of storage areas that contain hazardous goods
- Staging of construction works to minimise impacts
- Implement adequate site drainage to prevent ponding of water in active areas that can potentially mobilise contaminants and seep into groundwater or via overland flow into surface water bodies.
- Soil management plans to appropriately manage revegetation and proper compaction of soils to reduce sedimentation impact to receiving water bodies.
- Implement stormwater management designs that appropriately manage potentially contaminated surface water run-off.

Construction related risks such as earthworks, spills and stockpiling of soils will be generally managed in accordance with the Blue Book (Landcom 2004/DECC, 2008).

9.2 Reporting

Appropriate management systems will include the reporting and recording of monitoring outcomes, significant water quality impacts and associated intervention measures should occur as frequently as once a month for the construction period and the operational period of the development, or when necessary, such in the instance that an incident was to occur. The requirements, roles and responsibilities of the principal contractors including reporting responsibilities to the relevant government bodies will be discussed in further detail in future DMP.

10 Conclusion

The findings of this report include characterisation of the existing environment at the site, a review of the of potential impacts to the surface water and groundwater environment from the proposed development, review of relevant legislation and policy relating to the development and mitigation measures for the identified impacts.

A summary of the findings of this assessment include:

- The groundwater quality was of generally good quality and was below the assessment criteria with the exception of oxidised nitrogen, total nitrogen, total phosphorous, total suspended solids, turbidity. Aluminium, copper, manganese and zinc. The groundwater exceedances can be managed with appropriate measures set in future DMP
- Water quality of the existing environment was of generally good quality. The surface water was generally below the assessment criteria with the exception of e. coli, oxidised nitrogen, total nitrogen and aluminium.
- The groundwater impacts associated with the basement excavation have been assessed based on the inflow calculations and probable drawdown expectations during the construction phase and operational phase of the development.
 - The assessment found that in the upper-case (less likely) scenario for drawdown during the development, impact to surrounding groundwater users, GDEs and ASSs are minimal.
 - In the most-likely scenario for drawdown during the development, the impacts will be negligible.
- Other potential impacts to groundwater and surface water including potential chemical spillages, increase in hardstand areas, increase in potentially contaminating activities such as vehicle movement, incorrect soil stabilisation and other construction related impacts.

All identified potential impacts are considered to be manageable with appropriate mitigation measures that include:

- Soil and water management plans incorporated in a CEMP to manage risk.
- Erosion and sediment control measures in accordance with Blue Book (DECC, 2008).
- Appropriately designed deep soil, landscaping buffers and stormwater detention to mitigate impacts associated with increases in impervious surfaces.
- Incorporate water quality monitoring plan into the CEMP that will constantly monitor water quality of receiving water bodies.
 - Soil and water management plans incorporated in a CEMP to manage risk.
- Extraction rates, drawdown and water quality monitoring requirements incorporated into a DMP
 - Minimise depths of excavation below the groundwater table during basement construction
 - Reduce the dewatering time period during basement excavations.
- All water to be discharged during basement construction dewatering to comply with adopted discharge water quality criteria (DWQC).
- Storage of hazardous liquids and refuelling operations to take place in bunded areas to reduce chance of spillage causing impacts
- Incorporate water quality monitoring plan into CEMP that will constantly monitor water quality of receiving water bodies during construction.

11 References

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- SMEC (15 January 2014) Wingecarribee River Flood Study, prepared for Wingecarribee Shire Council
- Turner (8 September 2025) Site Plan, Berrima Gaol Adaptive Reuse
- Turner (8 September 2025) Lower Basement, Berrima Gaol Adaptive Reuse
- Turner (8 September 2025) Upper Basement, Berrima Gaol Adaptive Reuse
- Turner (8 September 2025) Lower Ground Upper Escarpment, Berrima Gaol Adaptive Reuse

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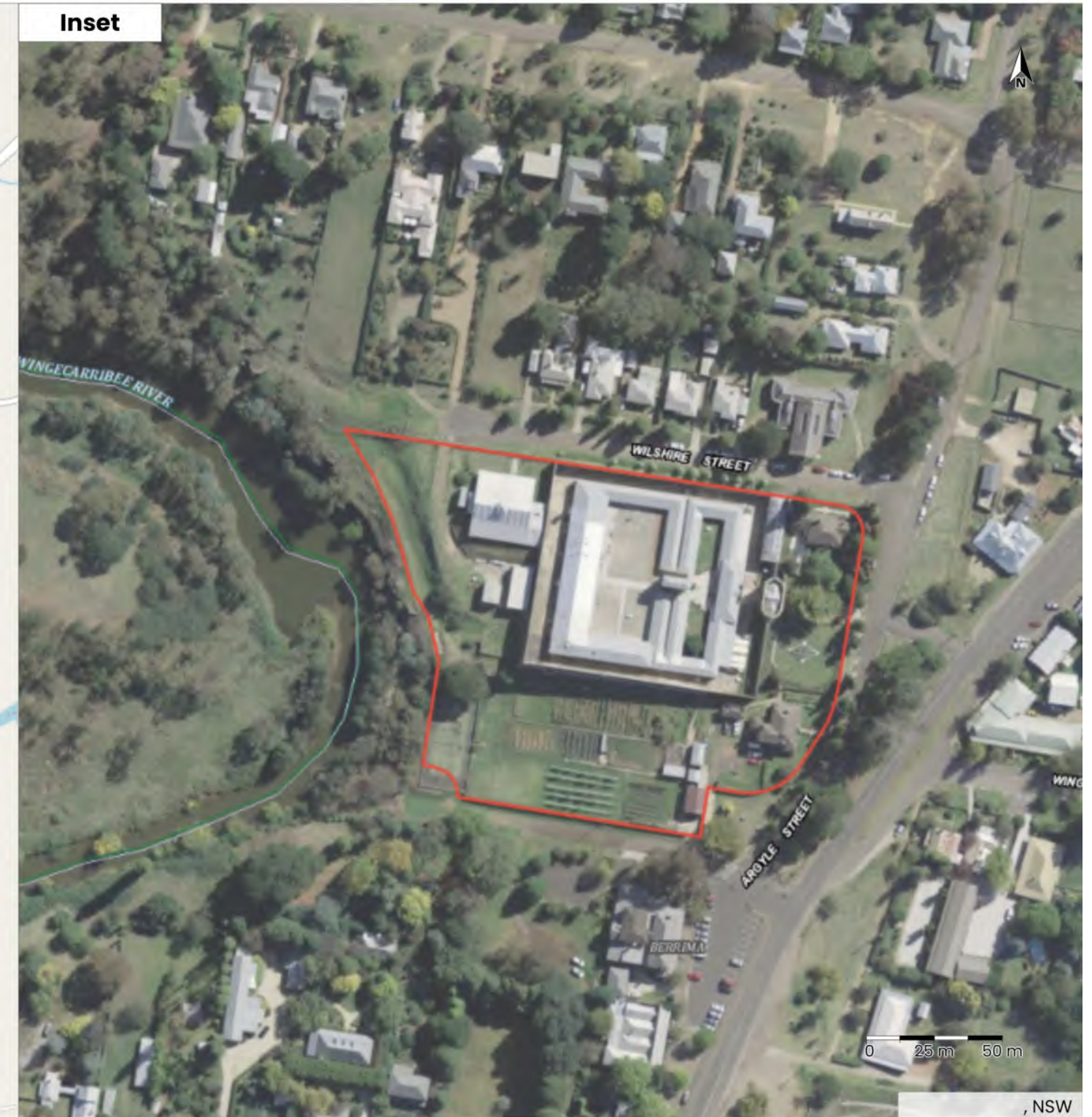
Figures



Overview



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Legend

Site Boundary

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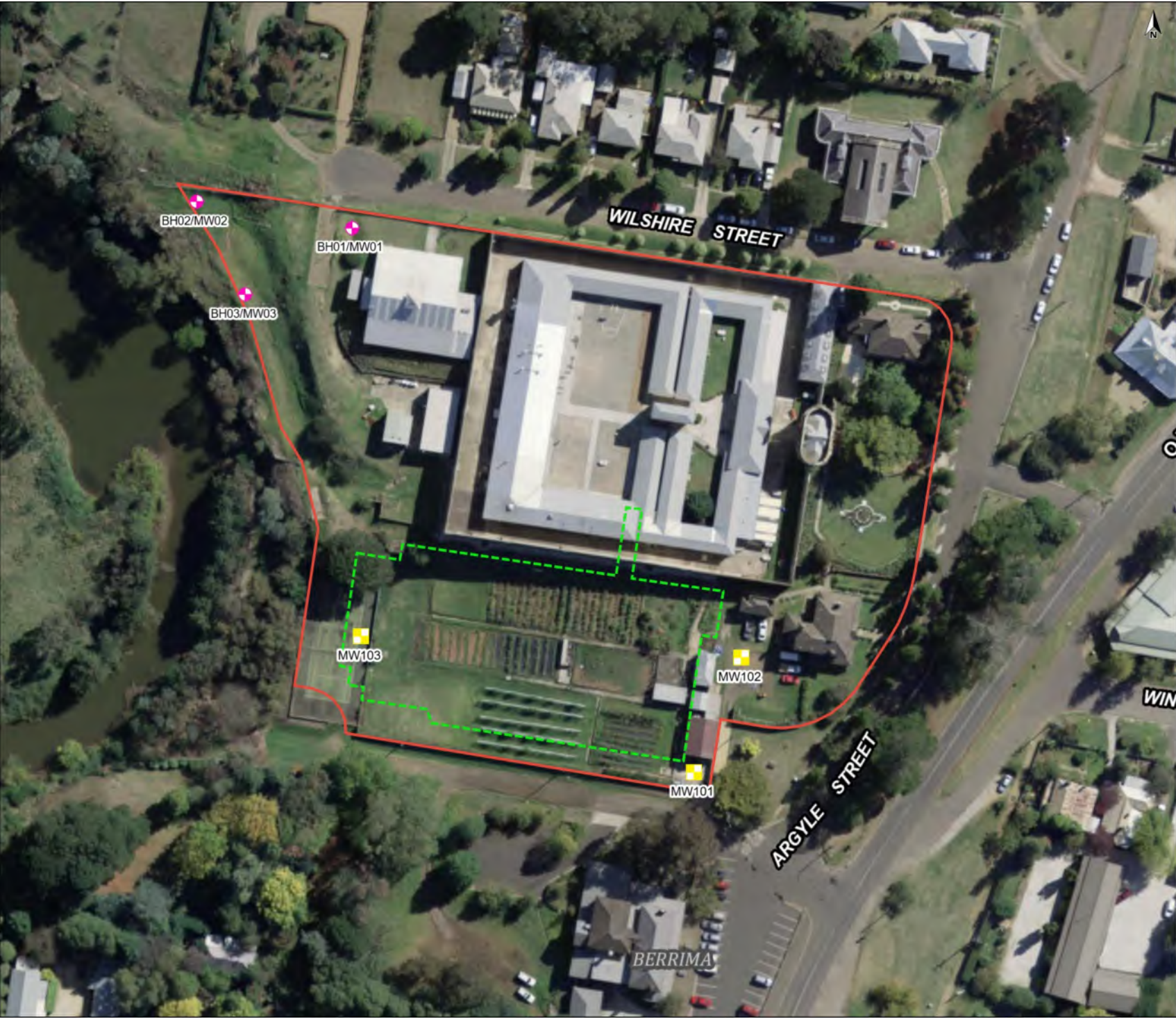
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Date: 18-10-2024

Author: TG

Approver: SM

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- Legend**
- PRM (2019) Borehole/Monitoring Well
 - Reditus (2024) Monitoring Wells
 - Site Boundary
 - Updated Lower Basement Footprint

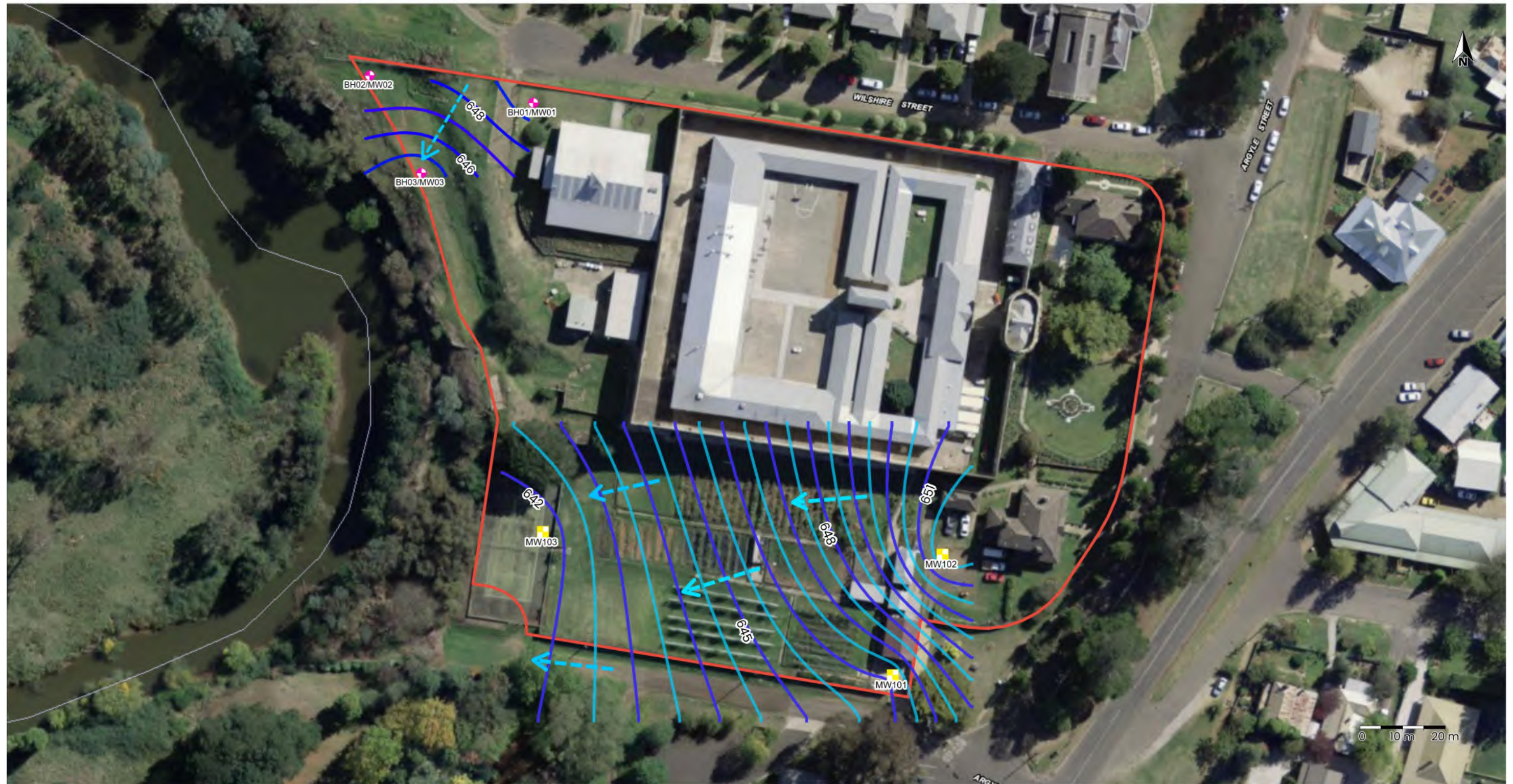
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Title: Figure 2 - Basement Layout

Client: Blue Sox Group		Size: A4
Project: Berrima Gaol Surface Water and Groundwater Impact Assessment	Drawn: TG	Figure No.: 2
Date: 15-10-2024	Checked: SM	
Proj No: 24150	Scale: 1:1282	Version: draft



Legend

-  PRM (2019) Borehole/Monitoring Well
-  Reditus (2024) Monitoring Wells
-  Groundwater Flow Direction
-  1 m Elevation Contours (mAHD)
-  0.5m Elevation Contours (mAHD)
-  Site Boundary

Proj No: 24150

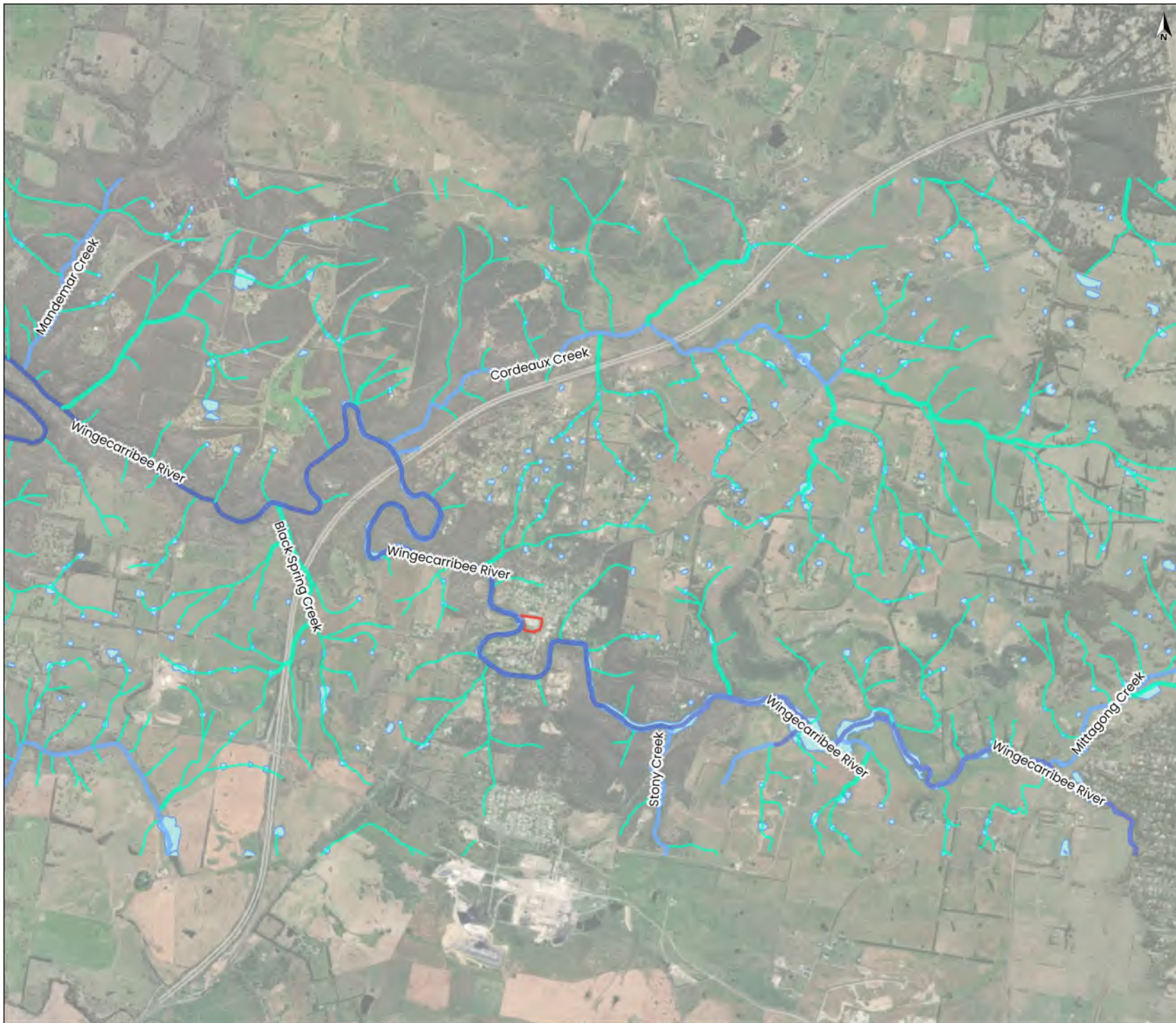
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Date: 18-10-2024

Author: TG

Approver: SM

Data Source: © Department of Finance, Services & Innovation 2018, © Department of Finance,



- Legend**
- Waterways
Rivers and Creeks
- 5
 - 7
 - 8
- Surface Waterbodies
- Site Boundary

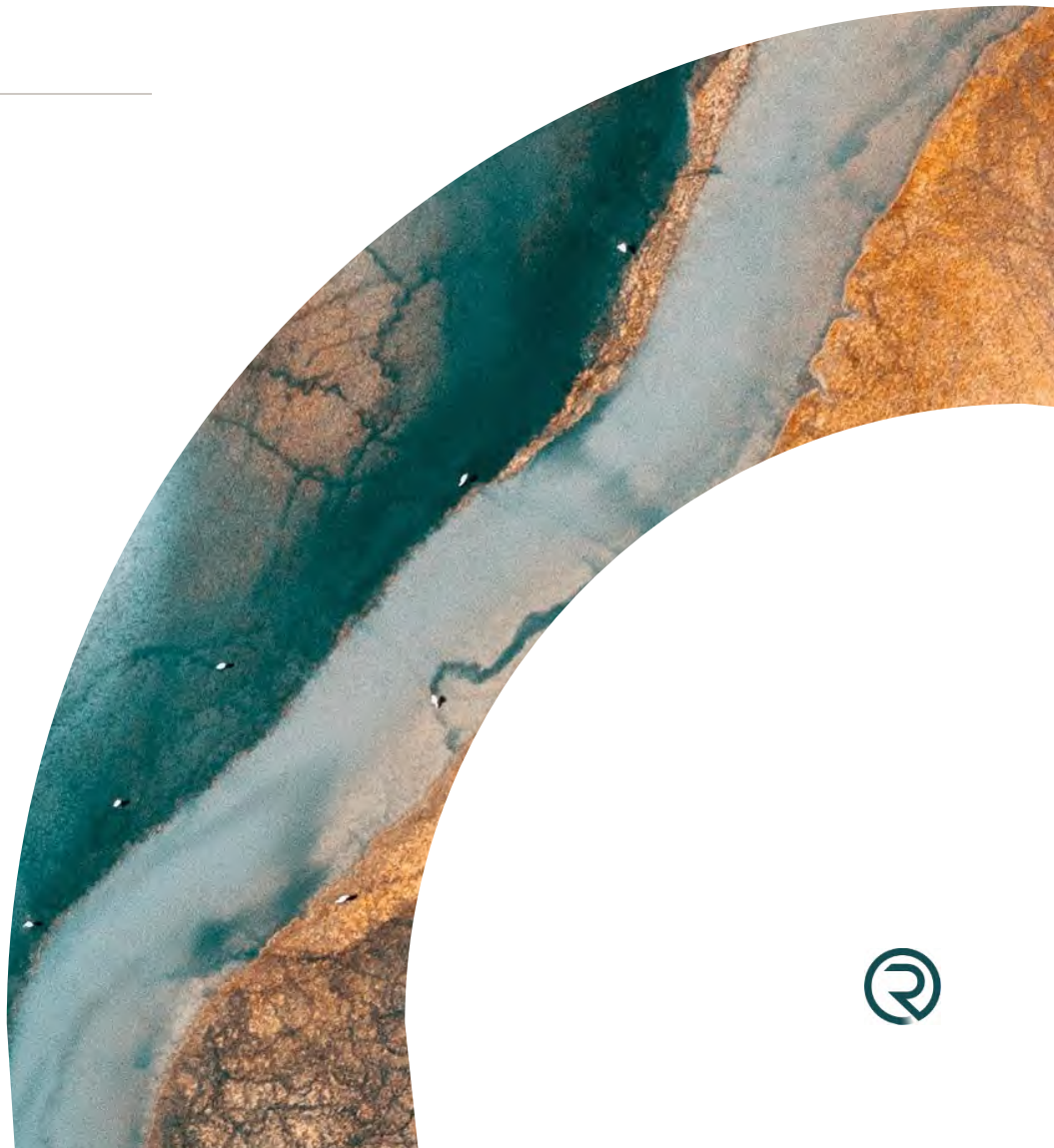


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Client: Blue Sox Group		Size: A4
Project: Berrima Gaol Groundwater and Surface Water Impact Assessment	Drawn: TG	Figure No.: 4
Date: 11-11-2024	Checked: SM	
Proj No: 24150	Scale: 1:47000	Version: draft

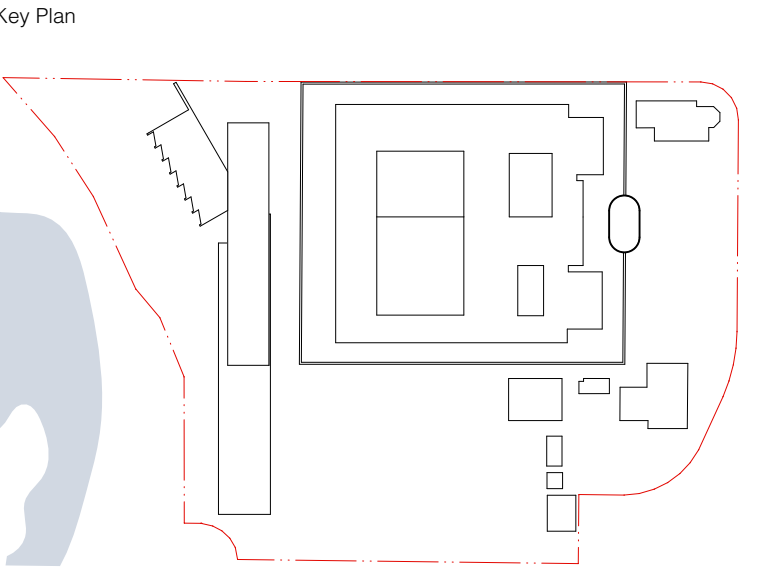
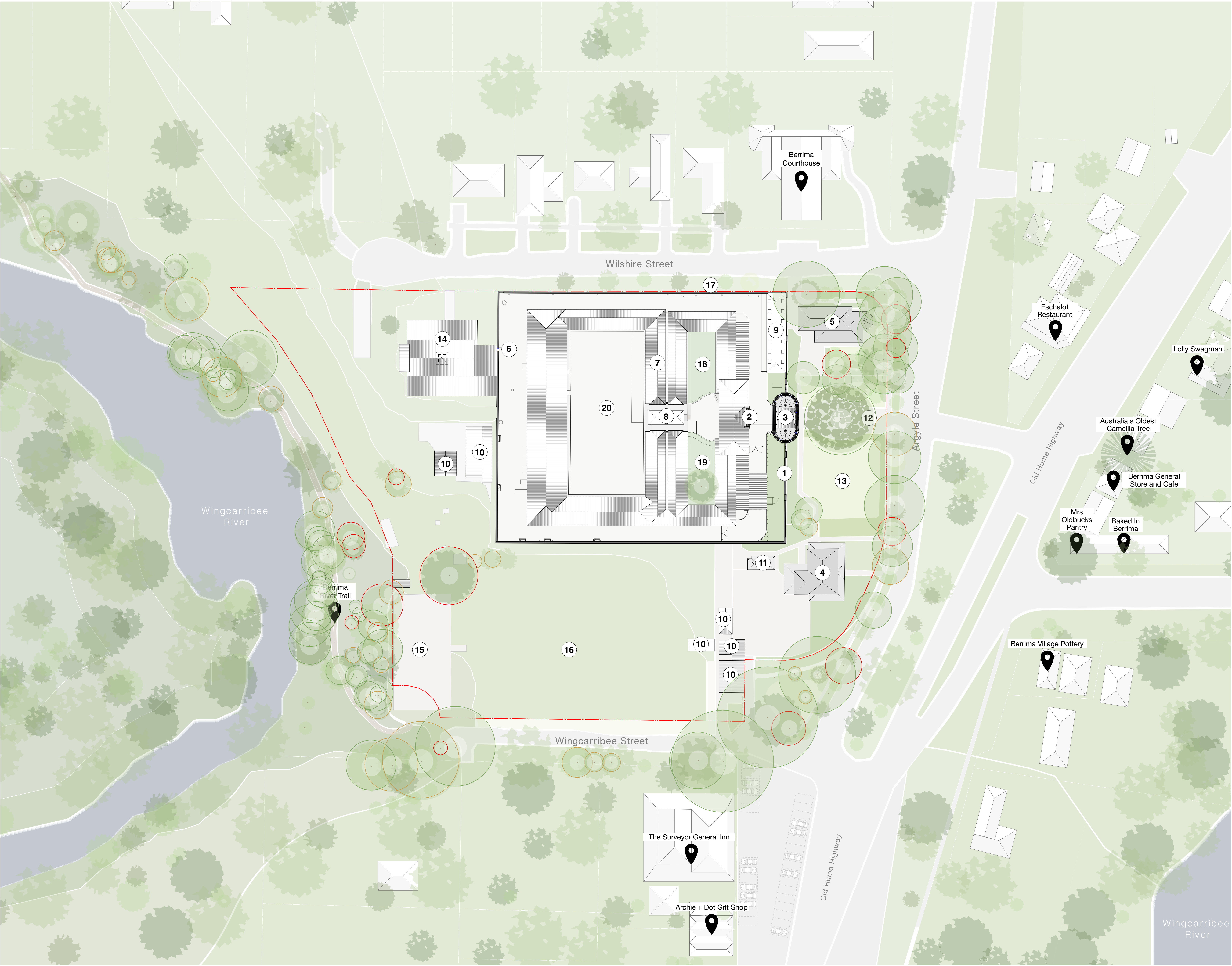
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Development Plans & Survey



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DOLCS Quality Endorsed Company ISO 9001:2015, Registration Number 20476
 Verisign Accredited: Nicholas Turner 66666, AON 95 064 084 911



Notes

1. Refer to the Design Report submitted as part of the SSD application for further information.

2. Refer to the Tree Data prepared by the Arborist consultant dated 20th August 2024.

Tree Retention Value

Low

Moderate

High

- Existing**
- 1 Gaol Wall
 - 2 1839 Former Entrance Gate
 - 3 1866 Entrance Gate
 - 4 Governor's Residence
 - 5 Deputy Governor's Residence
 - 6 'The Secret Door'
 - 7 Cell Blocks
 - 8 Guard Tower
 - 9 Science Block
 - 10 Sheds
 - 11 Police Cells
 - 12 Central Access Path to Front Gate
 - 13 Rose Garden & Frontage
 - 14 Industries Building
 - 15 Tennis Court
 - 16 Vegetable Gardens
 - 17 Bulls Head Fountain
 - 18 West 'Double Bay' Courtyard
 - 19 East 'Vaucluse' Courtyard
 - 20 West Courtyard

A	01.08.25	CM	Draft SSDA Package
Rev	Date	Approved by	Change Note

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Project Title

Berrima Gaol Adaptive Reuse

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Drawing Title

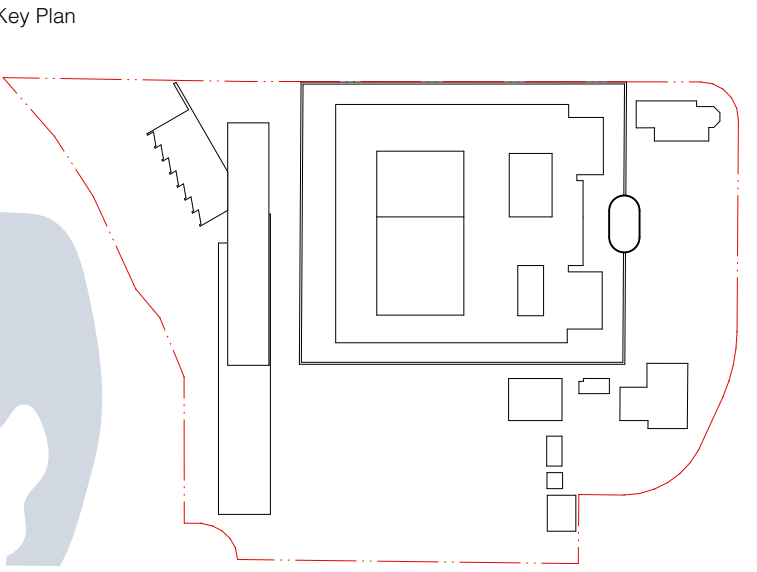
Context & Analysis Site Plan

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DLCS Quality Endorsed Company ISO 9001:2015 Registration Number 05478
Heritage Architect: Nicholas Turner, 0455 400 85 85 for 911



1. Refer to the Design Report submitted as part of the SSD application for further information.

A	01.08.25	CM	Draft SSDA Package
Rev	Date	Approved by	Change Note

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Project Title

Berrima Gaol Adaptive Reuse

2-4 Argyle Street, Berrima NSW 2577, Australia

Drawing Title

Context & Analysis

Site Analysis - Heritage

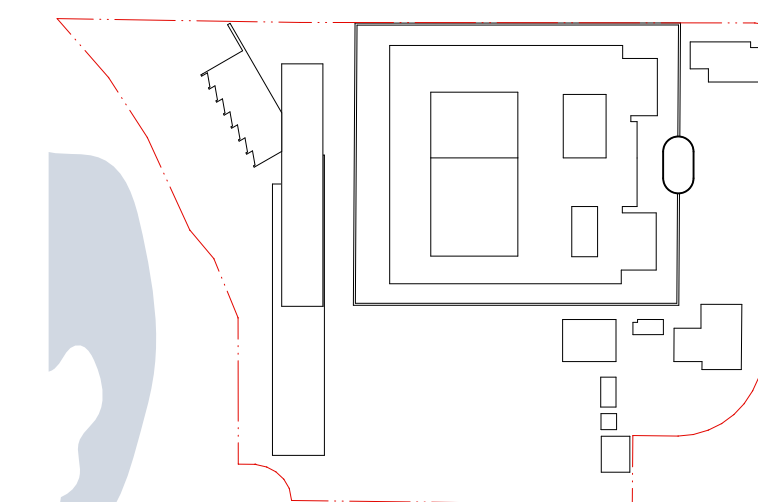
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For Information	23014	A

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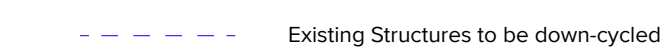


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DCLCS Quality Endorsed Company ISO 9001:2015, Registration Number 20476
Nominated Architect: Nicholas Turner 6655, ABN 95 064 084 911



1. Refer to the Design Report submitted as part of the SSD application for further information.
2. Refer to Landscape Architect and Civil engineer documentation for Public Domain and Landscape areas



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□

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Lower Basement

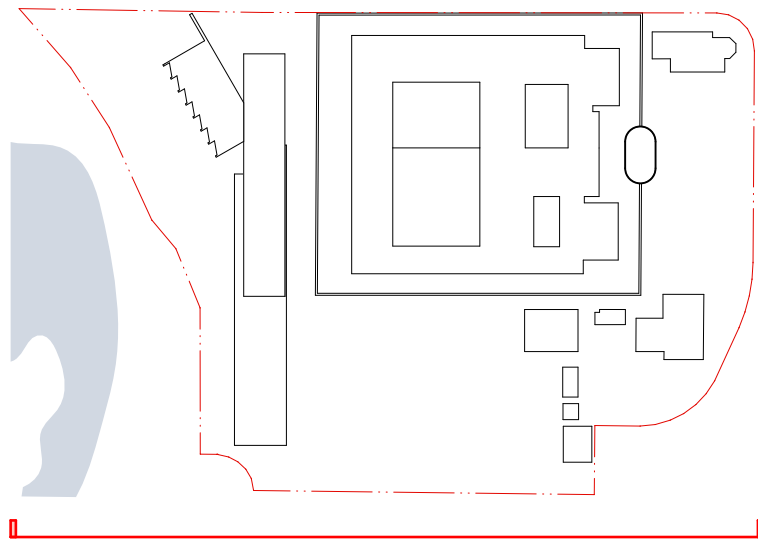
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 Nominations Arbitrator: Nicholas Turner, ESQ., MDN 05 064 034 011

DLC8 Quality Endorsed Company ISO 9001:2015, Registration Number 20476
Nominatiedirectie Architectuur: Nicholas Turner, E055, A001 05 064 054 011



1 South Elevation_Wingecarribee Street
1:250

Key Plan



Notes

1. Refer to the Design Report submitted as part of the SSD application for further information.
2. Refer to DA-890-001 for further information in material & finishes descriptions.
3. Refer to Landscape Architect and Civil engineer documentation for Public Domain and Landscape areas

C	01.08.25	CM	Draft SSDA Package
B	25.07.25	CM	For Coordination
A	11.07.25	CM	For Coordination
Rev	Date	Approved by	Change Note

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Project Title

Berrima Gaol Adaptive Reuse

2-4 Argyle Street, Berrima NSW 2577, Australia

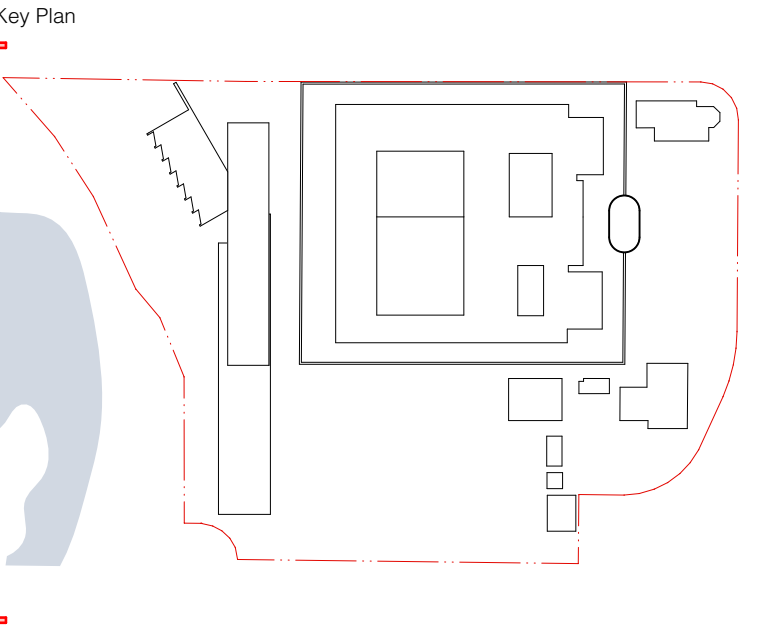
Drawing Title

GA Elevations

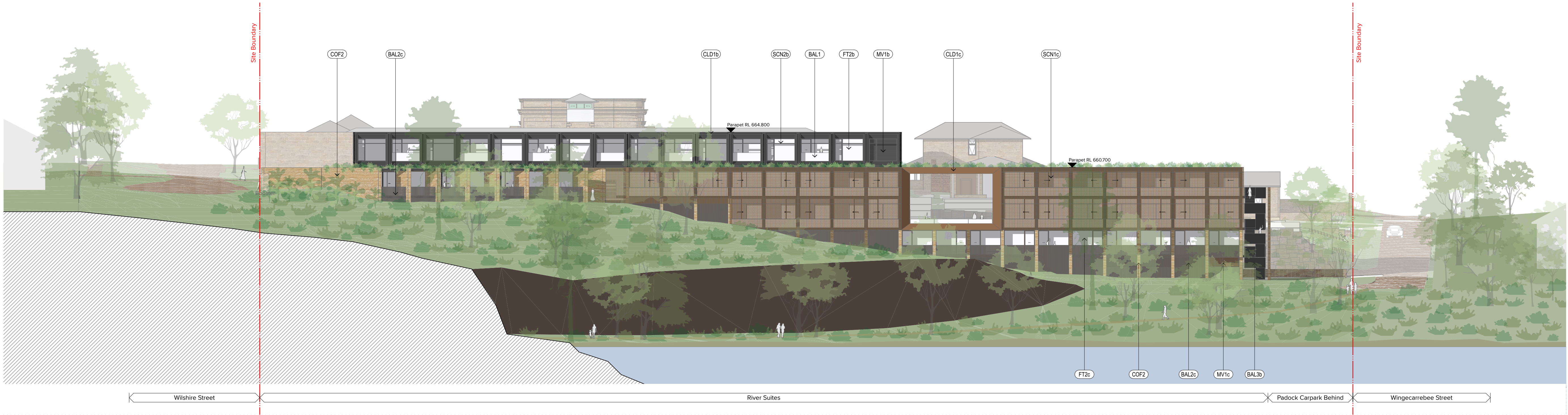
Wingecarribee Street - South Elevation

Status	Project No.	Rev
For Information	23014	C
Scale	Dwg No.	
1:250 @ B1	DA-210-301	





- Notes
1. Refer to the Design Report submitted as part of the SSD application for further information.
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1 West Elevation_Wingecarribee River
1:250

C	01.08.25	CM	Draft SSDA Package
B	25.07.25	CM	For Coordination
A	11.07.25	CM	For Coordination
Rev	Date	Approved by	Change Note

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Project Title

**Berrima Gaol
Adaptive Reuse**

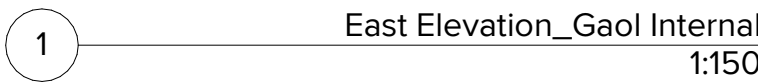
2-4 Argyle Street, Berrima NSW 2577, Australia

Drawing Title

**GA Elevations
Wingecarribee River - West Elevation**

Status	Project No.	Rev
For Information	23014	C
Scale	Dwg No.	
1:250 @ B1	DA-210-401	



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Berrima Gaol Adaptive Reuse

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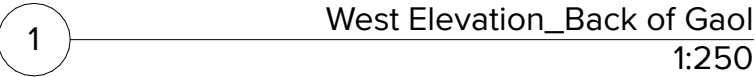
Internal Elevations

East Elevation - Gaol Internal

Scale Dwg No.
1:150 @ B1 DA-220-201



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3. Refer to Landscape Architect and Civil engineer documentation for Public Domain and Landscape areas

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Berrima Gaol Adaptive Reuse

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Internal Elevations

West Elevation - Secret Door

A horizontal number line with four tick marks. The first three tick marks are grouped by a bracket above them, and the last tick mark is separate. To the right of the number line is a clock face showing the time 12:00.