Technical report F

Soils and water assessment report

Cleanaway & Macquarie Capital

Western Sydney Energy and Resource Recovery Centre

Soils and Water Assessment Report

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Executive summary

The Western Sydney Energy and Resource Recovery Centre (WSERRC) (the proposal) is an energy-from waste (EfW) facility. This report presents the results of the soils and water assessment of the potential impact of the proposed facility both in construction and operation phases. The study area for the assessment is defined in Section 2.2 of this report, as a 1km radius surrounding the construction footprint.

The scope of the soils and water assessment overlaps with that for Technical report H: Hydrology and flooding assessment, Technical report G: Detailed site (Contamination) investigation (Douglas Partners) and Technical report Q: Biodiversity development assessment report.

The division of assessment requirements between the disciplines is outlined in the assessment requirements section (see Appendix A). As such the soils and water assessment covers the following:

- Existing baseline condition for soil, geology, topography and groundwater.
- Assessment of the proposed development on groundwater and surface water via groundwater interaction and related infrastructure.

A desktop review of public and project available spatial datasets and literature was completed to characterise the baseline soils, geology and groundwater environment including potentially sensitive groundwater receptors.

Impacts were then allocated to those expected during construction and operation. Very few potential groundwater related environmental receptors were identified as the site is underlain by the Bringelly Shale which has a low resource potential, characterized by having low yields and high salinity groundwater.

Key potential receptors which were considered were:

- Groundwater users.
- Surface water features via groundwater interaction.
- Impact to groundwater flow and quality.
- Mobilisation of contaminated groundwater outside the proposed site.

Whereby, a search of registered groundwater bores confirmed that there are no known groundwater users in this area. Calculations of potential travel times of groundwater to the nearest surface water receptors (Reedy and Eastern Creek) indicated negligible risk. Construction includes a 15m excavation of the waste bunker, is expected to intercept shallow/perched groundwater which may cause low intermittent flow during construction however it is not expected to interfere or intercept the deep regional groundwater table. There is a landfill located 50m from the north-east corner of the site which has been assessed for short-term

mobilisation of contaminated groundwater during dewatering for the waste bunker. This assessment concludes that the extremely low permeability of the shale and the overlying residual clays, greatly limits the potential for near-surface pollution to reach groundwater. In addition, testing of the water and groundwater quality on site concluded the site has low potential for water contamination.

Any residual risks are categorised as negligible or very low and would be further managed through standard mitigation measures, to be further detailed in a Construction Environment Management Plan (CEMP) related to the management of soil and water.

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Environmental assessment requirements

The table presented in Appendix A lists the Secretary's environmental assessment requirements (SEARs) and relevant Agency comments relevant to soils and water and where they are addressed in this report.

Abbreviations and glossary

Abbreviations	
EC	Electrical Conductivity
ESP	Exchangeable Sodium Percentage. Proportion of cation exchange sites occupied by sodium.
mAHD	Metres Above Height Datum
Mg/l	Milligrams per litre
pH	Potential for hydrogen. Used to specify how acidic or basic a water based solution is.
Proposal (the)	The purpose of the proposal is to build an energy-from-waste (EfW) facility that can generate up to 55 megawatts (MW) of power by thermally treating up to 500,000 tonnes per year of residual municipal solid waste (MSW) and residual commercial and industrial (C&I) waste streams that would otherwise be sent to landfill.
RL	Reduced Level
Sodicity	Amount of sodium held in a soil

1 Introduction

This Chapter introduces the proposal and applicant while describing the purpose and structure of this report.

1.1 Proposal description

Cleanaway and Macquarie Capital are jointly developing an energy-from-waste (EfW) facility known as the Western Sydney Energy and Resource Recovery Centre (WSERRC) (the proposal).

The proposal will be designed to thermally treat up to 500,000 tonnes per year of residual Municipal Solid Waste (MSW) and residual Commercial and Industrial (C&I) waste streams that would otherwise be sent to landfill. This process would generate up to 58 megawatts (MW) of base load electricity some of which would be used to power the facility itself with the remaining 55MW exported to the grid. The proposal involves the building of all onsite infrastructure needed to support the facility including site utilities, internal roads, weighbridges, parking and hardstand areas, storm water infrastructure, fencing and landscaping.

The proposal site is located at 339 Wallgrove Road in Eastern Creek, NSW (Lot 1 DP 1059698) which is in the Blacktown local government area (LGA). The site is in the Wallgrove Precinct of the Western Sydney Parklands (WSP) Plan of Management.

The 8.23ha site is divided by a small strip of land not part of the proposal site, resulting in a 2.04ha northern section and a 6.19ha southern section. This dividing strip is part of the adjacent lot and includes a right of carriageway benefitting the proposal site allowing vehicles to move between the two parts of the site. The proposal area will be fully contained in the 6.19ha portion of the site. Works to occur on the 2.04 ha northern section of the site include the clearing of weeds and exotic vegetation within the existing overland flow channel which is confined to the eastern section of this parcel of land. The northern section will also be used temporarily to support construction works. No other works will occur on the 2.04 ha northern section of the site as part of this proposal.

The construction activities required for the proposed development that are most relevant (but not limited to) to the soils and water impact assessment are outlined below:

Stage 1: Site establishment and enabling works

- Securing the site and creating designated access/egress points that can be controlled.
- Implementing construction environmental management processes including environmental management controls including truck wheel

wash, erosion and sedimentation and drainage provisions to protect the pipeline corridor and flow pathways to Reedy Creek to the north.

- Notify the public, businesses, Council and other stakeholders before work starts.
- Establishment of site compound, worker amenities, laydown areas and car parking.
- Set out, demark and fence the site to establish routes, accesses, and no-go zones.
- Arranging site access.
- Carry-out ecological pre-clearance inspections, soil sampling for contaminants, geotechnical investigations, road dilapidation surveys, pre-condition surveys, and other investigation work, as needed.
- Clear and level land (vegetation removal, clearing, rubbish removal, grubbing and mulching), undertake building demolition work, and make property adjustments.
- Mark-out, protect, realign and install utilities and service connections where needed (e.g. the stormwater drainage, security lighting, power, sewer and water).
- Establishing haul routes, traffic and speed management controls and diversions.
- Contamination remediation works if required.

Stage 2: Main works

The proposed activities of the main works what are most relevant to the soils and water impact assessment would likely involve:

Activity 1: Cut and fill bulk earthworks and work platforms including:

- Levelling
- Excavation for cut and fill
- Excavation for waste bunker and necessary groundwater management
- Compaction
- Place and compact working platform (typically limestone subbase)

Activity 2: Foundation work and main in-ground services including:

- Piling (if required)
- Constructing the foundations (or pile caps)
- Inground services
- Trench and placement of all in ground service mains (stormwater, water, gas, process water, piping)

Activity 3: Form work and construction of the main buildings and delivery, assembly and installation of infrastructure, plant and equipment.

After the construction phases outlined above have been completed, the likely potential impact to soils and water are greatly reduced.

1.2 Document purpose

The purpose of this document is to undertake assessment of the potential impact of the proposed development on the soils and water environment and to identify any management or mitigation measures that maybe required.

2 Methodology

This Chapter outlines the methodology used to define the baseline and undertake the environmental assessment of potential impacts of the proposal on soils, and water including definition of the study area used as the basis of the assessment. This Chapter also presents relevant regulation, legislation and policy governing management of soils and water as it relates to the proposal.

The scope of the soils and water assessment overlaps with that for Technical report H: Hydrology and flooding assessment report, and Technical report Q: Biodiversity development assessment report. Whereby, Technical report H: Hydrology and flooding assessment report will cover the assessment of surface water features, rivers and drainage and watercourses and management of soils associated with surface water flows. Technical report G: Detailed site (Contamination) investigation (Douglas Partners) will consider any potential impact on soils and contamination. The Technical report Q: Biodiversity development assessment report will provide additional detail on groundwater dependent ecosystems. The division of assessment requirements between the disciplines is outlined in Appendix A.

As such the soils and water assessment covers the following:

- Establishment of the existing baseline condition for soil, geology, topography and groundwater
- Groundwater impact assessment of the proposed development on groundwater and surface water via groundwater interaction and potential groundwater impacts on surrounding nearby infrastructure.

A desktop review of public and project available spatial datasets and literature has been completed to characterise the baseline groundwater environment including potentially sensitive groundwater receptors.

Groundwater impacts have been allocated to those expected during construction and operation.

Key potential receptors which will be considered as part of the groundwater impact assessment are:

- Groundwater users
- Surface water features via groundwater interaction
- Groundwater flow and quality
- Mobilisation of contaminated groundwater outside the proposed site including those associated with saline soils and acid sulfate soils.

2.1 Legislative context

This section contains a summary of relevant commonwealth, state and council legislation, policy and guidelines considered relevant to this assessment.

2.1.1 Commonwealth legislation

- Australian Government Department of Agriculture, Water and the Environment, 1999. Environment Protection and Biodiversity Conservation Act 1999

2.1.2 New South Wales legislation

- NSW Government, 1912. Water Act 1912
- NSW Government, 2000. Water Act 2000

2.1.3 Policy

- Acid Sulfate Soil Advisory Committee 198, 1998. Acid Sulfate Soils Assessment Guidelines
- ANZECC, 2000. Guidelines for Fresh and Marine Water Quality
- ANZG, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian State and Territory governments, Canberra, Australia.
- Blacktown City Council, 2005. Engineering Guide for Development 2005.
- Blacktown City Council, 2013. Water quality and water conservation - WSUD Developer's Handbook Part 4
- DPI, 2012. NSW Aquifer Interference Policy.
- EPA, 1998. Managing Land Contamination. Planning Guidelines SEPP55 – Remediation of Land.
- Landcom, 2004. Managing Urban Stormwater: Soils and Construction.
- NOW, 2011. Water Sharing Plan Greater Metropolitan Unregulated River Water Source
- NHMRC, 2011. Australian Drinking Water Guidelines 6 2011. National Health and Medical Research Council
- NRAR, 2018. Guidelines for Controlled Activities on Waterfront Land

2.2 Study area

This report presents the results of the soils and groundwater assessment for the study area as shown in Figure 1. The study area is defined as a 1km radius from the construction footprint, which is considered to be the maximum spatial extent of impacts relevant to the scope of this technical paper.

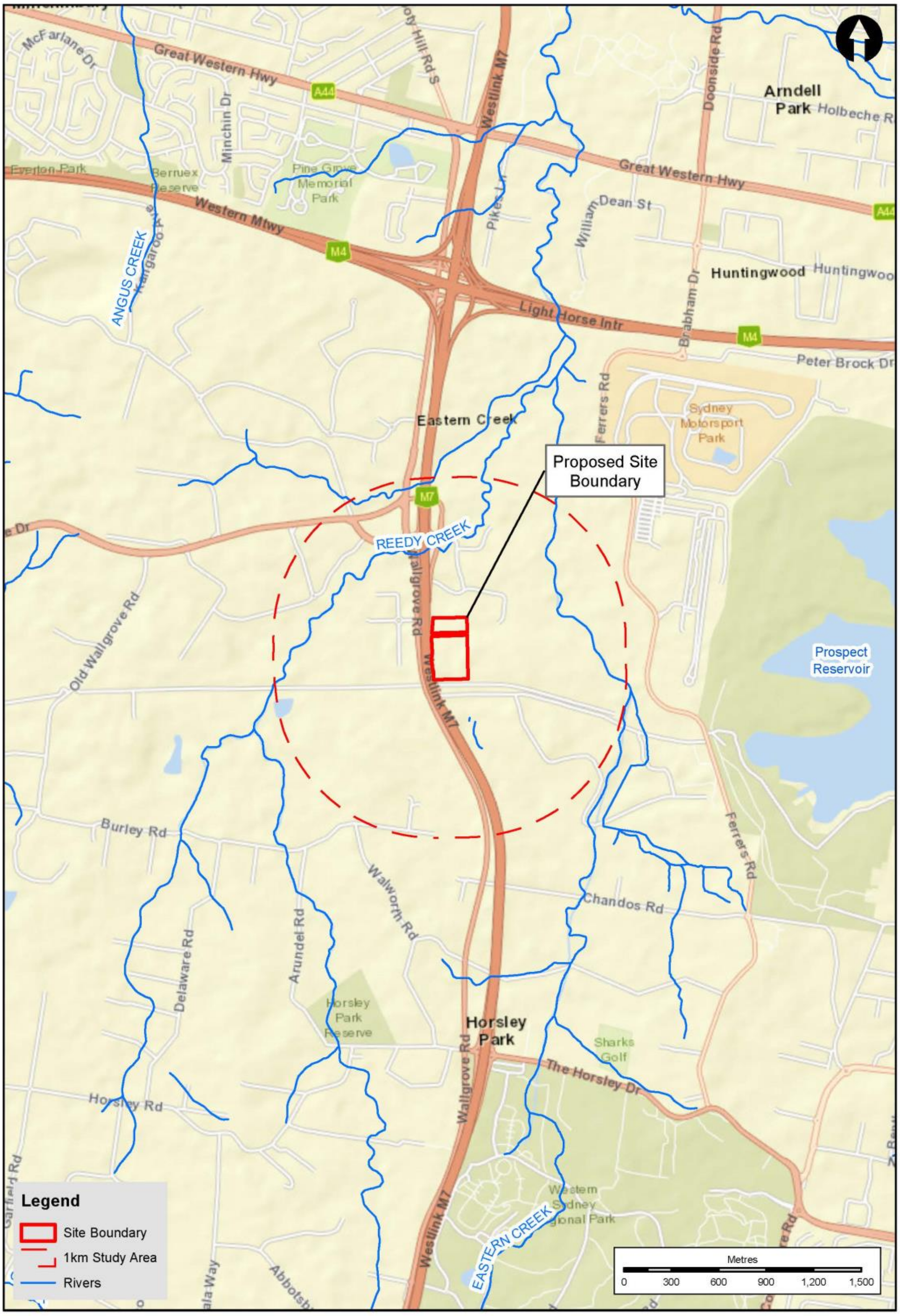

Figure 1: Study Area

2.3 Desk study information

A desk study was undertaken to establish the baseline conditions (i.e. soils, geological and groundwater environment) within the study area which includes information from a site-specific study and public sources of information.

2.3.1 Site-specific study

A summary of all available on-site test and monitoring locations relevant to this report, is shown in Figure 2. The following site-specific studies have been used to inform this technical paper:

- Technical report G: Detailed site (Contamination) investigation (Douglas Partners). The investigation involved further intrusive investigation which included drilling of 12 boreholes, four of which had groundwater/gas wells installed. The investigation also included drilling of 13 shallow auger holes through the site, drilled to between 0.5m to 0.7m below ground level, providing confirmation of the fill depth across the site.
- Technical report G1: Factual report on geotechnical investigation (Douglas Partners). This investigation included drilling nine boreholes, groundwater monitoring, aquifer permeability testing and laboratory testing of samples.

2.3.2 Public sources of information

The following public sources of information were reviewed to inform the soils and water assessment:

- A search for existing utilities located within or adjacent to the site was undertaken using the Dial Before You Dig website, http://1100.com.au/
- Australian Government Bureau of Meteorology (BoM), the National Groundwater Information System
- Blacktown City Council, Flooding Precinct Map
- CSIRO Atlas of Australian Acid Sulfate Soils
- CSIRO Australian Soil Resource Information System (ASRIS) – Digital Atlas of Australian Soils
- ESRI (Environmental Systems Research Institute) aerial imagery
- NSW Government, Environmental Protection Authority Contaminated Land Record
- NSW Government Planning & Environment, Resources & Geosciences Common Ground Mining Information
- NSW Government, Office of Environment & Heritage, Aboriginal Places & State Heritage Register
- NSW Government, Resources & Geosciences MinView Map
- NSW Government Land and Property Information (SIXMaps)

- Penrith 1:100k Geological Map and Explanatory Notes
- Penrith Soil Landscape Map and Report
- Seamless NSW Geological Map.

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Figure 2: Summary of site-specific testing and monitoring locations relevant to this report.

3 Existing environment

This Chapter sets out the existing environment conditions for the soils, geology and hydrogeology across the study area which covers a 1km radius of the proposed development.

3.1 Land use overview

The approach to the assessment of the effects of the proposal in terms of geology, soils and hydrogeology includes understanding the land use both for the proposed site and surrounding areas. The key aspects relating to land use include:

- Understanding how land use may have affected the physical characteristics of the proposed development site and surrounding areas in terms of geology, soils and hydrogeology.
- Locating any water supply installations/water dependent features, or potential existing sources of contamination to the soils and water in the area.
- Integrating this understanding into an assessment of the likely overall sensitivity of various component parts to the proposed development.

The proposal comprises Lot 1 in Deposited Plan DP 1059698 at 339 Wallgrove Road, Eastern Creek. The site is located immediately to the east of the M7 Motorway and approximately 2 km west of the Prospect Reservoir. The site is situated within the local government area of Blacktown City Council.

The most recent land use for the proposed development site was largely poultry farming. A Biosecurity Direction was issued to the previous site owner dated 24 January 2019 from the DPI which relates to the presence of Salmonella on site, associated with previous poultry activities. The current site owners worked with DPI and Stephen McGoldrick from Agribiz to address the Salmonella issue in accordance with established procedures. On the 11th of May 2020, Kristy Saul from DPI confirmed that the sampling completed on the 7/5/2020 indicated that the results have been returned as negative for Salmonella and that formal notification will be provided shortly as soon as it is approved

Technical report G: Detailed site (Contamination) investigation (Douglas Partners) describes the site features which include large poultry sheds, multiple workshops and storage buildings, an at-grade car park at the south-eastern boundary and strip of vacant grass land with isolated tress at the northern boundary. There is a dry channel along the eastern boundary of the site which acts as an overland flow path towards a stormwater detention pond near the eastern boundary. It is noted that this feature is not a permanent waterbody or a watercourse, nor does it have any associated riparian corridor, as such, it will be referred to as “farm dam” in this report. The area of the farm dam pond is measured approximately 3660m^2. The depth of the water pond is not confirmed, similarly its connectivity to groundwater is unknown but expected to be low.

The site has been formed with a number of levels, through cut and filling in the past.

The land uses which bound the site are as follows.

- The nearest residential area is around 1km to the south of the site in Horsley Park with the Minchinbury residential area located around 3km to the north-west. Horsley Park Public School is over 2km south of the site and a childcare centre is within the Eastern Creek industrial area about 1km to the west of the site.
- The site is bounded by the Westlink M7 Motorway to the west with the Eastern Creek industrial area located farther west. The SUEZ Eastern Creek Waste Management Centre, comprising the now-closed landfill site and operational organics recycling facility is located to the north and north-east, with the operational Global Renewables waste management facility located immediately to the east. To the south, the site is bounded by the Warragamba Pipeline Corridor with the Austral Bricks facility located farther south.

3.2 Topography

The regional topographic contour in relation to the site are shown in Figure 3. These contours indicate that the site is moderately sloping from southwest towards the northeast with the north-eastern corner positioned in a low-lying area. The relative elevation of the site varies from approximately 62m AHD at the south-western corner to 52m AHD along the north-eastern boundary.

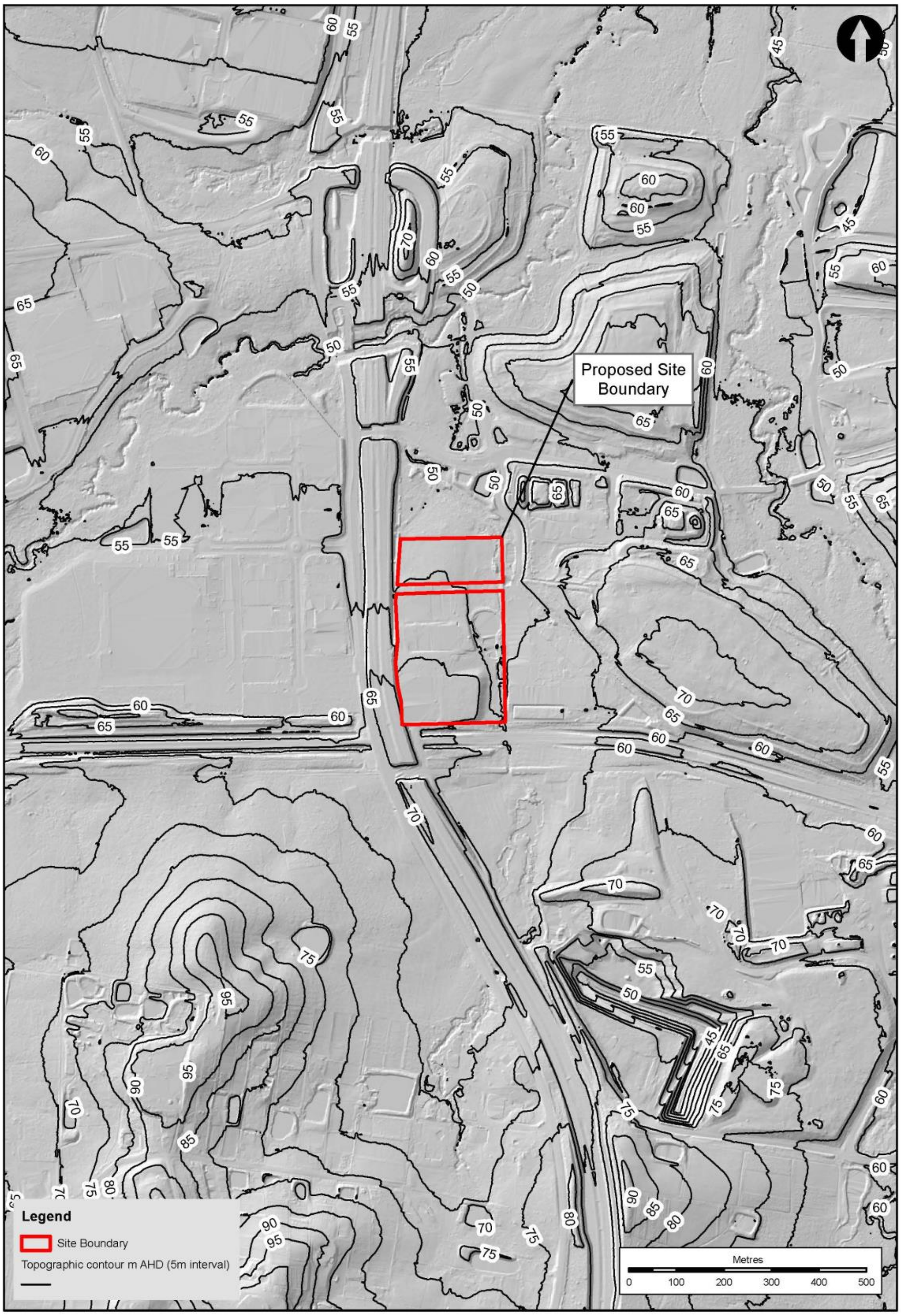

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Figure 3: Site Topography.

3.3 Geology

The 1:100,000 scale Penrith Geological map (Clark et al., 1991) indicates the site is underlain by Bringelly Shale of the Wianamatta Group (Figure 4).

Figure 4: Regional Geology

This shale, which in this area is anticipated to be over 100m thick, is overlain locally by Quaternary Deposits of various types and man-made fill. The Bringelly Shale is described as comprising shale, carbonaceous claystone, claystone, siltstone, fine to medium grained lithic sandstone, rare coal and tuff.

The Bringelly Shale is highly compacted, weakly cemented and is known to comprise a significant amount of swelling clays. It is highly susceptible to weathering owing to the presence of micro cracking in the rock mass.

Ezzat (2005) undertook a comprehensive review of the engineering properties of the Bringelly Shale and concluded that;

- The shale is sensitive to changes to water chemistry, meaning it is susceptible to slaking.
- X-ray diffraction analysis confirmed the presence of illite-smectite, smectite and kaolinite in the shale. The presence of moisture sensitive clays indicates the material is susceptible to shrinking/swelling with changes in moisture content

Groundwater explorer bores from Bureau of Meteorology (BoM, 2019) (within 1km distance to site) suggest bedrock level in the area is 3-6m depth (bore reference: GW104060.1.1, GW104061.1.1, see also Table 8).

Igneous rock bodies occur in the vicinity of the site, the largest being Prospect Picrite. Although not mapped it is possible that basaltic dykes associated with these igneous bodies may be present beneath the site area.

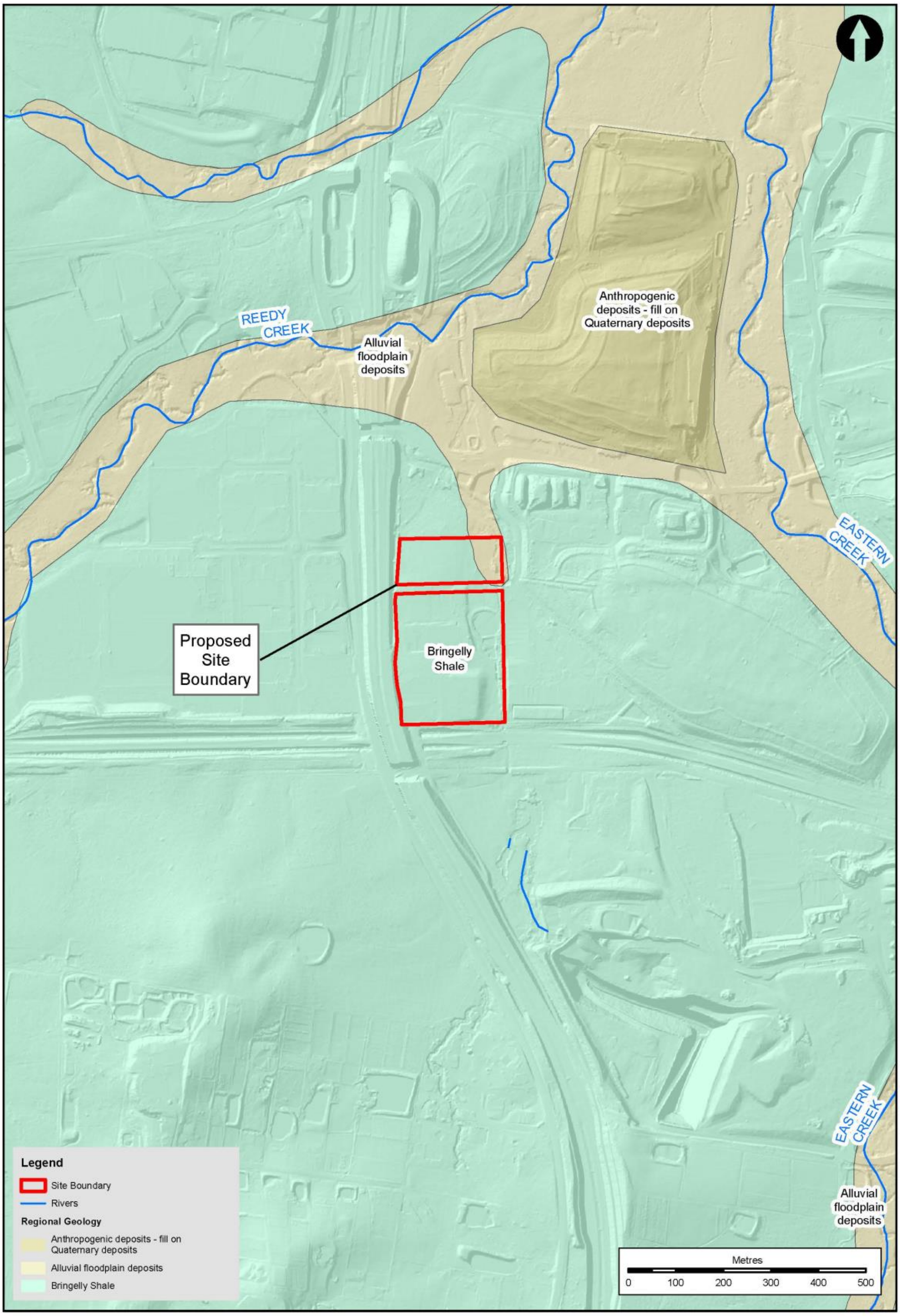

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Figure 4: Regional Geology

3.3.1 Geological structures

The 1:100,000 Geological Series Sheet for Penrith map (Clark et al., 1991) shows no mapped structural features affecting the site. However, several notable features are mapped nearby and are discussed briefly.

A liniment trends NNE 1km to the west of the site. There are no nearby lineaments and it does not appear to have any adjacent structures, so it may be isolated.

The Penrith Basin Syncline runs north west to south east and is mapped 2.8km to the north of the site. This may imply that the bedrock dips to the north east.

3.3.2 Local geology

The anticipated ground profile of the site is interpreted from information available in the Technical report G1: Factual report on geotechnical investigation (Douglas Partners) and Technical report G: Detailed site (Contamination) investigation (Douglas Partners).

A summary of the anticipated subsoil ground profile of the site is provided in Table 1 below.

Table 1: Anticipated ground profile

Unit	Description	Approximate Thickness (m)
Pavement	Material unknown	Unknown, if present
Fill / topsoil	Fill – material type and condition unknown	Varies from 0.5m to 6.0m
Alluvium	Alluvium – fine-grained sand, silt and clay. Alluvium zones located predominantly on the low-lying extents of the eastern edge of the site.	0 to 1.0m
Residual	Residual soil – silty clay and clayey sand	1.0 to 2.0m
Bedrock	Bringelly Shale – mainly claystone and siltstone	Thickness not confirmed.

3.3.2.1 Fill

Fill is likely to consist predominantly of silty clay and clay. The quality of placement of the fill material is unknown, however, the presence of debris in the fill matrix indicates that it is likely to have been placed in an uncontrolled nature. Reviewing historic imagery, it is unclear what date the fill was placed it is likely to have been placed between 1986 and 2004.

Although fill is present across much of the site, two main zones of fill are identified from the existing geotechnical investigation Technical report G1: Factual report on geotechnical investigation (Douglas Partners) (see also, Figure 2 for previous site investigation test locations) and the topography of the site. The first area is in the south-east portion of the site and another adjacent to the man-made pond. The two areas are divided by what is assumed to be a natural sloping grade towards the man-made pond.

The information available in previous investigation indicates that the fill depth in the south-east portion of the site varies between 2.5m to 5.7m (confirmed by boreholes BH09 and BH14, Technical report G1: Factual report on geotechnical investigation (Douglas Partners)). The fill is observed to be thickest at the crest of the fill batter on the east and tapers to a thickness of 0.5m towards the west of the site. The fill in this area is observed to contain plastic, brick, concrete fragments and trace charcoal which supports the statement that the fill was likely placed in an uncontrolled nature. SPT N values within the fill in this area range between 6 to 14.

The fill in the central east portion of the site adjacent to the pond is observed to be between 1.2m to 2.7m in depth (confirmed by boreholes BH07 and BH205, Technical report G1: Factual report on geotechnical investigation (Douglas Partners)). The fill is observed to be thickest near on the access track next to the pond and tapers to a thickness of 0.5m towards the west of the site. Like the other fill zone, the fill in this area is observed to contain trace amounts of plastic, brick, concrete and trace charcoal.

Outside of the two main fill zones, fill is observed to be approximately 0.5m across the site. Fill in the general area of the site is also observed to contain unsuitable materials such as glass, concrete fragments and charcoal. Increased filling thickness (between 1.0 to 2.5m thick) is observed in boreholes BH15 and BH20, likely placed for the construction of the access road on the site.

3.3.2.2 Alluvium

The geological map presented in Figure 4 indicates the site has deposits of quaternary floodplain alluvium in the north-east corner of the site. Investigation of the ground conditions near the north-east corner found the alluvial layer to be predominantly clay, red-brown colouration with soft consistency.

This unit was observed in boreholes BH01, BH02, BH06 and BH204, indicating the soft alluvial deposits are between 0.5 to 1.7m thick (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)). The alluvial layer was observed to overlay residual soils. In situ testing using standard penetration testing (SPT) indicates an SPT N value ranging between 0 to 4.

3.3.2.3 Residual Soil

Residual soil is observed in the locations where fill and alluvial soils are present (i.e. over much of the site). This unit is found to be predominantly a clay material with a consistency of firm to stiff with medium plasticity. The soil is typically grey mottled orange in colouration.

The depth to the top of residual soil varies between 0.4m to 2.0m below ground level and is underlain by Bringelly Shale geological unit.

3.3.2.4 Bringelly Shale

The geological map in Figure 4 indicates the site is underlain by Bringelly Shale. The Bringelly Shale is a middle Triassic geological unit and is predominantly comprised by shale.

The Shale is observed between 0.8 to 4.8m below ground level. The observable trend of the Bringelly Shale is that the top of rock level typically dips from west to east, changing in elevation 58mRL to 51mRL across the site.

Extremely weathered shale is approximately 1.3m in thickness overlying slightly weathered shale. Selected samples of rock core from BH02 and BH20 (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)) were tested in the slightly weathered rock using point load index [$I_{S(50)}$] methods. Point load tests were only undertaken in axial orientation. The point load results are given on the borehole logs and generally in the range of 0.2MPa to 0.7MPa, indicating a strength range of low to medium. High strength rock was observed in BH20 at an elevation of 51.5mAHD, with point load results of 1.2MPa and 1.7MPa being recorded.

The fracture frequency of the shale is observed to reduce with depth, with fracture spacing ranging from 0.1m to 0.5m from 2.5 to 6.5m below ground level. Fracture spacing below 6.5m below ground level was observed to increase to 0.5m to 1.0m spacing.

3.3.3 Acid Sulphate Soils

A review of the NSW Acid Sulfate Soil Risk Map indicates that the site is located in an area of “Extremely low probability of occurrence” of encountering acid sulphate soils (ASS). The site is located at an elevation of approximately 58mAHD, so it is unlikely that acid sulfate soils are present in the study area.

As part of the Douglas Partners Ground Investigation (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)) soil screening tests (see Table 2) were completed on two soil samples in accordance with the

NSW Acid Sulfate Soil Management Advisory Committee, Acid Sulfate Soil Manual, August 1998 (ASSMAC).

Table 2: Results of ASS screening tests

Sample location	Sample depth	Screening Test Results			
		pH			Strength of Reaction
		pH_F	$pH_{FOX\ (avg)}$	pH_F-pH_{FOX}	
ATP04	0.5 – 0.6	6.4	4.6	1.8	Volcanic
ABH05	0.5 – 0.6	5.4	3.4	2.0	Low Reaction

The ASSMAC guidelines suggest that ASS have a pH in H_2O (pH_F) < 4. Results of the screening tests for pH_F were in the range of 5.4 to 6.4 pH units. This usually indicates that actual acid sulfate soil conditions (AAS) are not present. However, the ASSMAC guidelines also suggest the potential acid sulfate soil conditions (PASS) may be present where the pH in hydrogen peroxide solution (pH_{FOX}) is less than 3.5 pH units.

Overall, due to the single sample that resulted in a value less than 3.5 pH_{FOX}, the initial screening test therefore indicate that PASS conditions on site maybe present. As this categorisation is the result of one sample it should not be considered conclusive.

3.3.4 Aggressivity potential of the soil

Soil samples were tested by Douglas Partners (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)) to determine pH, sulfate and chloride ion concentrations as well as electrical conductivity (EC) and textural classification for assessment of aggressivity potential of the soil.

3.3.4.1 Sodicity

Sodic Soil classification is determined by assessing the Exchangeable Sodium Percentage (ESP) of the soil. Sodic Soil rating is split into three categories, these are non-sodic (ESP<6%), sodic (6%<ESP<14%) and strongly sodic (ESP>14%). The rating for sodic soil has been defined by Northcote and Skete (1972). Australia Soil Resource Information System ASRIS maps (CSIRO, 2014) have been reviewed and indicate that the site area is likely to contain soil with the following chemical ranges:

- Exchangeable Sodium Percentage (ESP) results are likely to be between 15% and 25% for the soil layers within the project area.
- Electrical Conductivity (EC) results are likely to be between 0.15 dS/m and 0.25 dS/m

These expected ranges were confirmed by laboratory testing completed by Technical report G1: Factual report on geotechnical investigation (Douglas Partners). The eight samples tested resulted in ESP range of 8% to 27%. EC values with two samples, within the “sodic” category and six samples “strongly sodic”. EC results were found to be between 0.095 dS/m to 1.3 dS/m also, generally within and above the expected range.

Based on the reviewed information, the natural soils on site are expected to be strongly sodic. This will have impacts on the anticipate salinity of the soil and the potential for dispersion and erosion.

Witheridge (2012) states that most sodic soils are dispersive, however, not all dispersive soils may be classified as sodic. IECA (2008) defines dispersive soils as structurally unstable soil that readily disperses into its constituent particles when placed in water. Moderately to highly dispersive soils are normally highly erodible and are likely to be susceptible to tunnel erosion.

3.4 Hydrogeology

The site is underlain by a porous, extensive aquifer of low to moderate productivity (see Figure 5), which could more accurately be described as an aquitard. The strata of the Wianamatta Shale group are characterised generally as low permeability with limited potential to transmit groundwater flow. Groundwater flow is via fractures and bedding planes with negligible flow through the rock mass.

The formation generally forms a layered aquifer system, with discrete aquifers occurring within horizontal fracture zones and with limited inter-connection between zones (IGGC, 2007). The groundwater pressure surface generally follows the topography, with groundwater flowing from recharge areas on high ground to discharge areas (generally creeks, rivers and wetland areas). The weathered shale until likely makes up a shallow aquifer system which is likely better characterised as an aquitard due to it’s low permeability. Due to varying pockets of low permeability there are likely separate shallower pockets of water contained within perched aquifers of finite extent above this shallow aquifer. More regionally it is expected that there is a regionally groundwater table in the Hawkesbury Sandstone, however this was not encountered in the drilling investigation which penetrated up to 25.5m bgl Technical report G1: Factual report on geotechnical investigation (Douglas Partners).

Regional groundwater quality is generally poor, with high salinity levels from connate salts within the formation or alternatively from leaching of accumulated salt from the lower soil profile (McNally, 2009) and the limited flushing due to low groundwater flow rates.

In the overlying soils and weathered bedrock, a perched shallow groundwater system can occur. Within this stratum groundwater flow occurs through the upper more permeable layers. It should be noted although perched water may be encountered the system will still behave more as an aquitard, which retards that the flow of water.

There is no record of groundwater use in the area. The National Groundwater Information System (BoM, 2020) has been consulted for groundwater data within a 3km radius of the site (see Table 8). The results found that there is no historic groundwater investigation data available within 100m of this site and no publicly available groundwater level information available within 1km of this site.

The nearest surface water receptors to groundwater are Reedy Creek located 450m to the south of the site and Eastern Creek located around 800m to the east of the site.

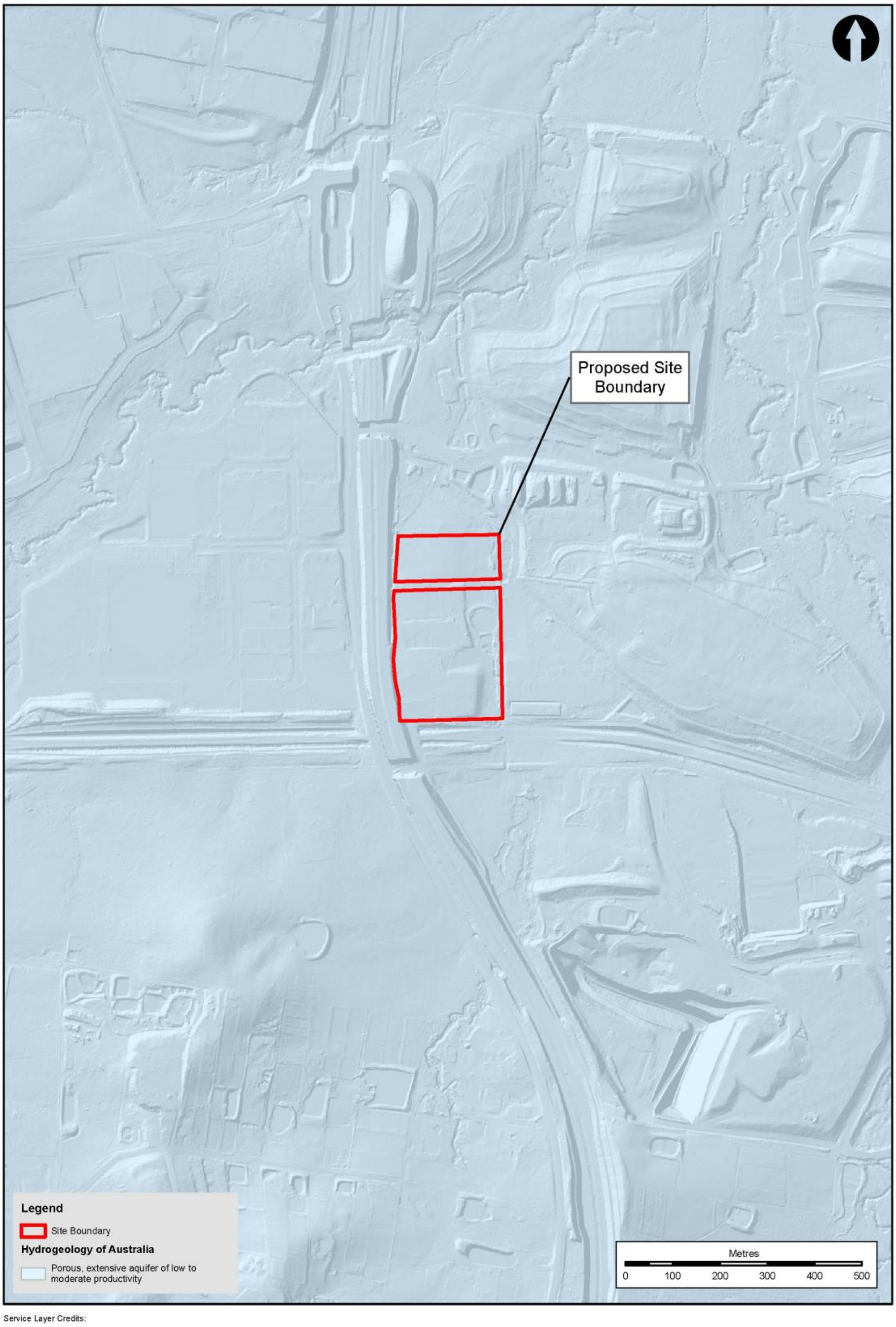


Figure 5: Regional Hydrogeology Map

3.4.1 Local hydrogeology

The groundwater monitoring network is comprised of 11 bores (see Table 3). The majority of these have shallow response zones which target perched groundwater within the soil deposits and weathered bedrock (0.5 to 10mbgl). Four bores (BH2, ABH01, AB02 and ABH08) target the shallow shale bedrock (4.5 to 15mbgl). These investigations provide groundwater level monitoring data from several occasions as summarised in the bullet points below (locations of the monitoring wells are provided in Figure 2).

- 2015, May 15: One groundwater level reading was measured from three monitoring standpipes (BH2, BH4 and BH20).
- 2019, September 20 or 24: One groundwater level reading was taken from six monitoring standpipes (BH201, BH204, BH208, BH213, BH2 and BH4)
- 2020, February 20 to March 6: Data loggers were placed in four monitoring standpipes (ABH01, AB02, AB03 and ABH08), recording water levels at hourly intervals between 20 February to 6 March. In addition, manual water level readings were taken on three occasions, 20 February, 27 February, 6 March 2020.
- 2020 February 28: One groundwater level reading was taken from 9 standpipes (BH2, BH4, BH201, BH204, BH208, BH213, ABH01, AB02, AB03)

Table 3: Summary of groundwater monitoring installations installed on site

Bore	Year installed	Total bore depth (mbgl)	Screened section depth (mbgl)		Target strata
BH2	2015	10	4.5	10	Shale bedrock
BH4	2015	5	0.5	5	Soil and weathered bedrock
BH20	2015	10	2.5	10	Soil and weathered bedrock
BH201	2019	5.4	0.5	5.4	Soil and weathered bedrock
BH204	2019	8.1	1	8	Soil and weathered bedrock
BH208	2019	10	1	10	Soil and weathered bedrock
BH213	2019	4.5	1.2	4.5	Soil and weathered bedrock
ABH01	2020	15	4.5	15	Shale bedrock
ABH02	2020	15	6	15	Shale bedrock
ABH03	2020	5	0.5	4	Soil and weathered bedrock
ABH08	2020	16.5	7	15	Shale bedrock

This data provides groundwater levels that vary from 47.5mAHD to 55.3mAHD across the site. This equates to groundwater depths of between 0.1m (eastern boundary) to 5.7m (southern boundary) below ground level (bgl). It is noted that the shallowest water level of 0.1mbgl, recorded in BH4, preceded heavy rainfall.

Douglas Partners (2019) plotted the measured groundwater levels recorded using the computer software Surfer, which derived a groundwater flow direction to the north-east following the topographic gradient. In addition, groundwater levels recorded on site on the 28 February 2020 (the largest single groundwater level recording taken in one day) are plotted in Figure 6 below. For consistency the groundwater level contours are interpreted from groundwater levels recorded in the soil and weathered bedrock only.

The interpreted groundwater flow direction results from the 2020 measured groundwater levels broadly correlate with the 2019 results. In the southern area of the site, groundwater flow is to the north-east towards the farm dam. Beyond the dam groundwater flow is northerly.

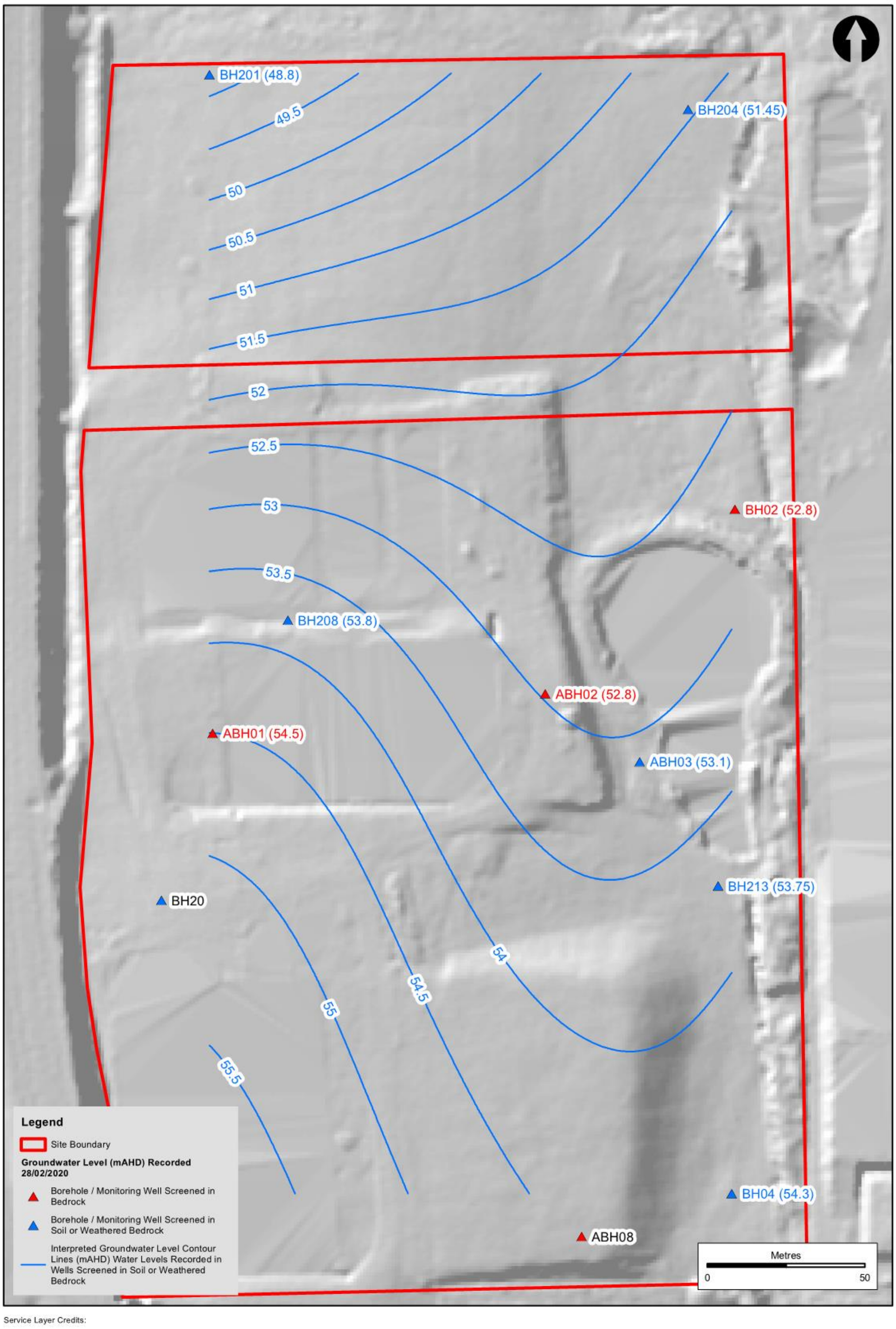


Figure 6: Groundwater levels recorded 28 February 2020 and interpreted groundwater flow direction.

3.4.1.1 Permeability Estimates

Douglas Partners (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)) completed rising head permeability tests on three monitoring wells (see Table 4). Two of the wells have screened sections or response zones located within the Bringelly Shale formation (ABH01 and ABH02). The third well is screened across the overlying alluvium (silty CLAY) and into the top of the Bringelly Shale formation.

The results indicate very low permeabilities on site with values between 6.5×10^{-9} m/sec and 2.6×10^{-9} m/sec for the Bringelly Shale formation. Similarly, the overlying alluvium and weathered shale resulted in a permeability value of 2.3×10^{-9} m/sec.

Table 4: Summary of permeability estimates from rising head permeability tests (Technical report G1: Factual report on geotechnical investigation (Douglas Partners))

Well	Screened zone (mbgl)	Geology at screened zone	Estimated permeability (m/sec)
ABH01	4.5 to 15	Bringelly Shale	2.6×10^{-9}
ABH02	6 to 15	Bringelly Shale	6.5×10^{-9}
ABH03	0.5 to 4	Silty CLAY and weathered Bringelly Shale	2.3×10^{-9}

3.4.2 Groundwater and surface water quality

The surface water and groundwater samples collected during previous investigations (Technical report G1: Factual report on geotechnical investigation (Douglas Partners) and Technical report G: Detailed site (Contamination) investigation (Douglas Partners)) were tested for a broad range of parameters which include polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls, inorganics/organics, cyanide, metals, total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylene (BTEX) and trimethylbenzene (1,2,4 and 1,3,5).

Electric conductivity (EC), pH and Dissolved Oxygen (DO) readings were collected from the six surface water samples as part of the 2020 site investigation. These resulted in an EC range of between 420 and 1600µS/cm, pH between 6.6 and 8.9 and DO between 6.6 and 9.3mg/l.

The testing resulted in detection of some metals in the groundwater and surface water. The samples collected as part of the 2019 investigation were compared to drinking water standard exceedances and ANZECC exceedances (see Table 5 for drinking water standard exceedances and Table 6 for ANZECC exceedances). These standards were subsequently superseded and the final water quality samples collected as part of the 2020 investigation were compared to the ANZG 2018 standard. All sample results are considered to be reflective of regional conditions and not significant.

The following exceedances of drinking water standards were recorded as part of the 2019 site investigation (see summarised in Table 5 below):

- Sulphate, with a drinking water standard of 500 mg/l, all six groundwater samples exceeded with detected levels between 510 and 11,000mg/l.
- Nickel, with a drinking water standard of 0.02mg/l one groundwater sample exceeded with 0.027mg/l.

Table 5: Summary of all exceedances of drinking water standards (NHMRC, 2011) detected in surface water or groundwater samples taken in 2019

Parameter	Drinking water standard (mg/l)	Sample type	Total number of samples	Total number of exceedances	Range of exceedances (mg/l)
Sulphate	500	Groundwater	6	6	500 to 11,000
		Surface water	6	0	
Nickel	0.02	Groundwater	8	1	0.027
		Surface water	6	0	

From the 2019 investigation the exceedances of the Australian and New Zealand Environment and Conservation Council (ANZECC) 2000 Fresh Water guidelines that occurred are summarised in Table 6 below.

Table 6: Summary of exceedances of ANZECC standard detected in surface water or groundwater samples taken in 2019

Parameter	ANZECC Standard (mg/l)	Sample type	Total number of samples	Total number of exceedances	Range of exceedances (mg/l)
Ammonia	0.9	Groundwater	6	2	1.3 to 1.7
		Surface water	6	1	1.1
Cadmium	0.0002	Groundwater	7	1	0.0004
Copper	0.0014	Groundwater	6	5	0.002 to 0.009
		Surface water	6	6	0.002 to 0.011
Lead	0.0034	Surface water	6	3	0.004 to 0.006
Zinc	0.008	Groundwater	7	5	0.012 to 0.059
		Surface water	6	6	0.012 to 1.5

From samples taken in 2020 investigation the following exceedances of the ANZG 2018 Guidelines are summarized in Table 7 below.

Table 7: Summary of exceedances of ANZG standard detected in surface water or groundwater samples taken in 2020

Parameter	ANZG Standard (mg/l)	Sample type	Total number of exceedances	Sample ID	Range of exceedances (mg/l)
Ammonia	0.9	Groundwater	2	ABH02 & BH204	1.4 to 4.1
Total Chromium	0.00045	Groundwater	2	ABH02 & BH204	0.004 to 0.005
Copper	0.0014	Groundwater	6	ABH01, ABH02, BH2, BH201, BH208, BH213	0.002 to 0.016
			6	SW01, SW02, SW03, SW04, SW05, SW06	0.002 to 0.056
Manganese	1.9	Groundwater	3	ABH03, BH4, BH213	2.1 to 17
		Surface water	2	SW03, SW04	1.9 to 3.6
Zinc	0.13	Surface water	1	SW06	1.5

Douglas Partners contamination report (Technical report G: Detailed site (Contamination) investigation (Douglas Partners)) concludes that the site has low potential for water contamination therefore it is expected that seepage water will be suitable for transfer to the construction-phase stormwater management systems.

Given the proximity to the landfill, located around 50m from the north-east corner of the site, it is possible that the current groundwater flow direction is temporarily reversed, and contaminants maybe drawn onto the site. To address this risk, continued rounds of soil, gas and groundwater sampling shall occur before and during construction.

On-site treatment, blending with stormwater or transfer off-site to a suitable, licensed disposal site may be necessary as a last resort. It is considered unlikely an EPL will be required, as even if contaminants are mobilised the construction of the bunker would be completed well before the time it would take for the contaminants to flow into the bunker.

3.4.3 Conceptual hydrogeological model

A Conceptual Site Model (CSM) was developed based on the available site investigation information as outlined in Section 2.2. The information has been captured with Leapfrog, a workflow-based 3D modelling software tool to help conceptualise all the available data on site.

The CSM comprises of two cross-sections, one which transects the site east to west, the second section north to south (see Figure a and 8b). The sections include the 15m deep excavation for the waste bunker required as part of the construction phase of the proposed development. The CSM interprets the ground conditions on site using all available data from previous intrusive investigations and monitoring data (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)).

In addition to the soil and bedrock levels the model illustrates the local shallow/perched groundwater flow direction recorded on site which follows local topography towards the north east. The deep regional groundwater table is thought to follow the overall gradient and flow to the north, towards Reedy and Eastern Creek.

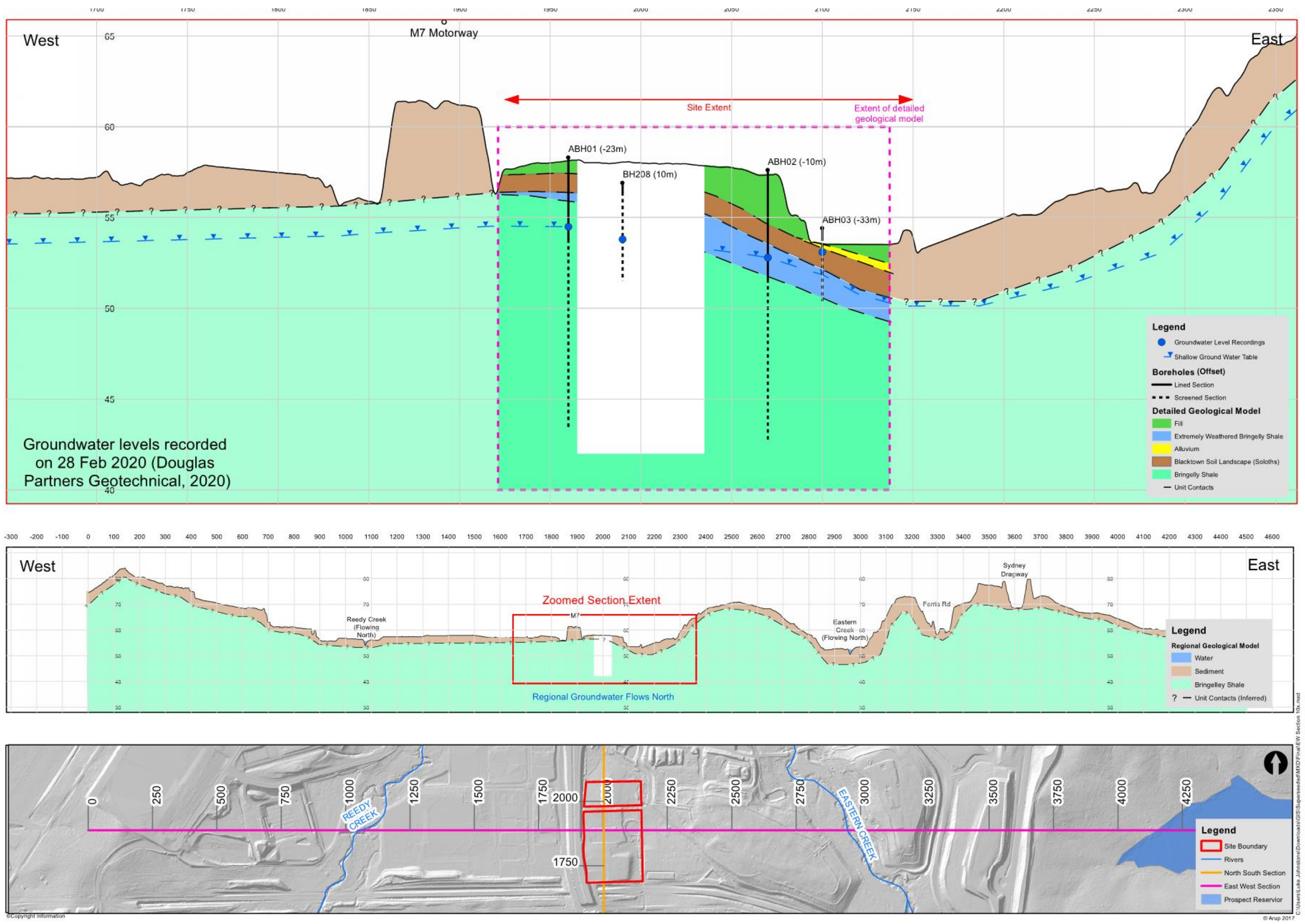


Figure 7a: East-west soil and water conceptual model cross-section of site

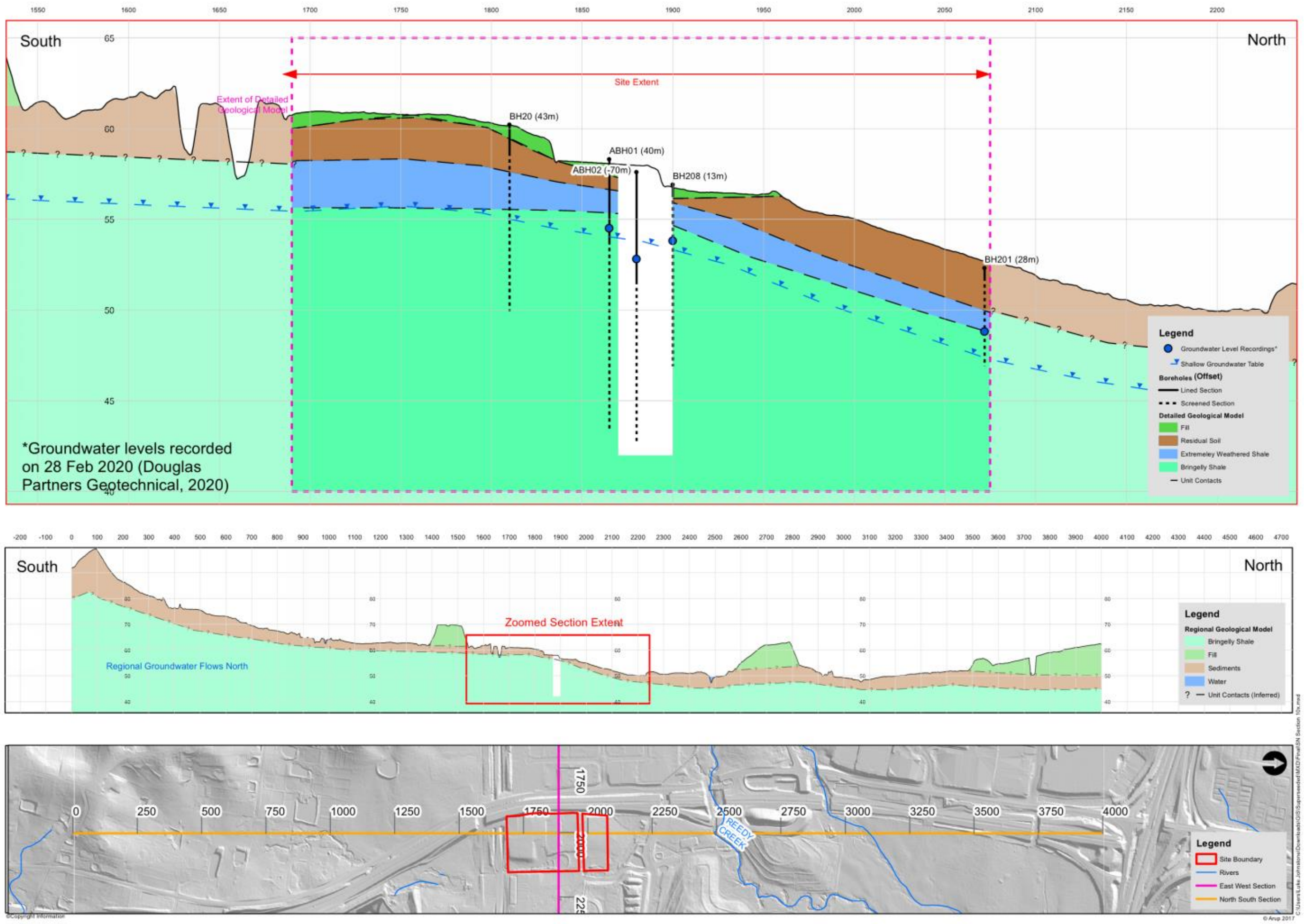


Figure 8b: North-south soil and water conceptual cross-section of site

3.5 Groundwater users

Groundwater users describe any known wells or boreholes which are used as a groundwater abstraction sources for monitoring, industrial or domestic uses, or any utilities that maybe affected by changes to the groundwater regime which may lead to settlement.

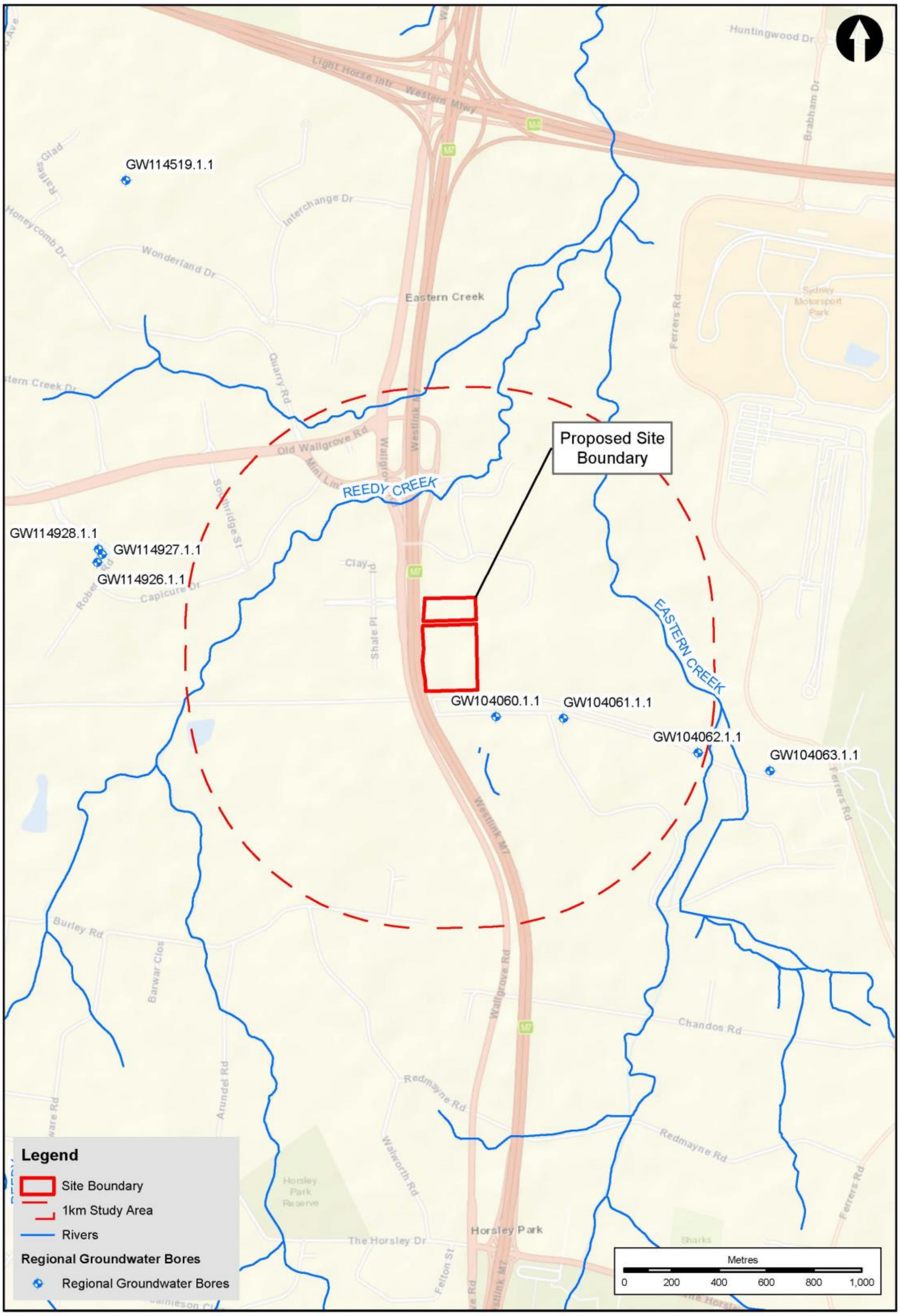
3.5.1 Groundwater boreholes

A search of registered groundwater bores (BoM, 2020) within a 3km radius of the site are listed below in Table 8 and location shown in

Figure 8: Groundwater Borehole Map

Table 8: Summary of groundwater bores within 3km of the site

Bore ID	Registered usage	Screen top (m bgl)	Screen bot (m bgl)	Bore Depth (m bgl)	Distance to site +- 50m
GW104060.1.1	Monitoring well	8.6	23.6	24.6	410
GW104061.1.1	Monitoring well	8.5	23.5	24.5	610
GW104062.1.1	Monitoring well	5.4	23.4	24.4	1180
GW114927.1.1	Monitoring well	0.151	18	18	1480
GW104063.1.1	Monitoring well	8.4	26.4	27.4	1490
GW114926.1.1	Monitoring well	0.151	13.5	13.5	1490
GW114928.1.1	Monitoring well	0.151	11.5	11.5	1500
GW114519.1.1	Monitoring well	0.001	8	12	2340



Service Layer Credits: World Street Map: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Comm

Figure 8: Groundwater Borehole Map

3.5.2 Utilities and services

Key utilities identified in the area are Warragamba Dam No. 1 pipeline near the southern boundary of the site. A Sydney Water pipe crosses the northeast of the site; several major HV networks exist near the site; and Telecommunication networks are running under the verge/footway of Wallgrove Road immediately west of M7. Sydney Water Prospect Dam Reservoir is located around 1.6km to the east of the site.

A summary of the affected utilities and asset owners within and adjacent to the site, this information was obtained from a Dial Before You Dig (DBYD) search (see Table 9 below).

Table 9: Summary of utilities asset owners

Utilities Asset Owner	Asset Affected	Note
AARNet	No	Asset located on the western side of the Westlink M7 highway.
Endeavour Energy	Yes	Duct and Duct section observed in the central western portion of the site
Jemena	No	No assets affected
Westlink M7	No	Utilities located adjacent to the Westlink M7 highway.
NBN	No	Assets located on the industrial area on the western side of Westlink M7 highway.
Nextgen	No	Asset located on the western side of the Westlink M7 highway.
Optus	No	Asset located on the western side of the Westlink M7 highway.
RMS	No	Assets located at Roussell Road and Wallgrove Road intersection. Second assets located at Wallgrove Road and Waste Management Centre Access intersection.
Superloop	No	Asset located on the western side of the Westlink M7 highway.
Sydney Water	Yes	Sydney Water asset traverses' northeast corner of the northern lot of the site.
Telstra	No	No asset observed in the study area.
TPG	No	No asset observed in the study area.

3.6 Groundwater dependent ecosystems

A review of the National Groundwater Dependent Ecosystems (GDE) Atlas (BAP 2016) mapped potential Groundwater Dependent Ecosystem on site (see Figure 9). Ground-truthing of mapping during field surveys indicates that these features comprise exotic grassland only. No GDEs were confirmed for the proposed development site.

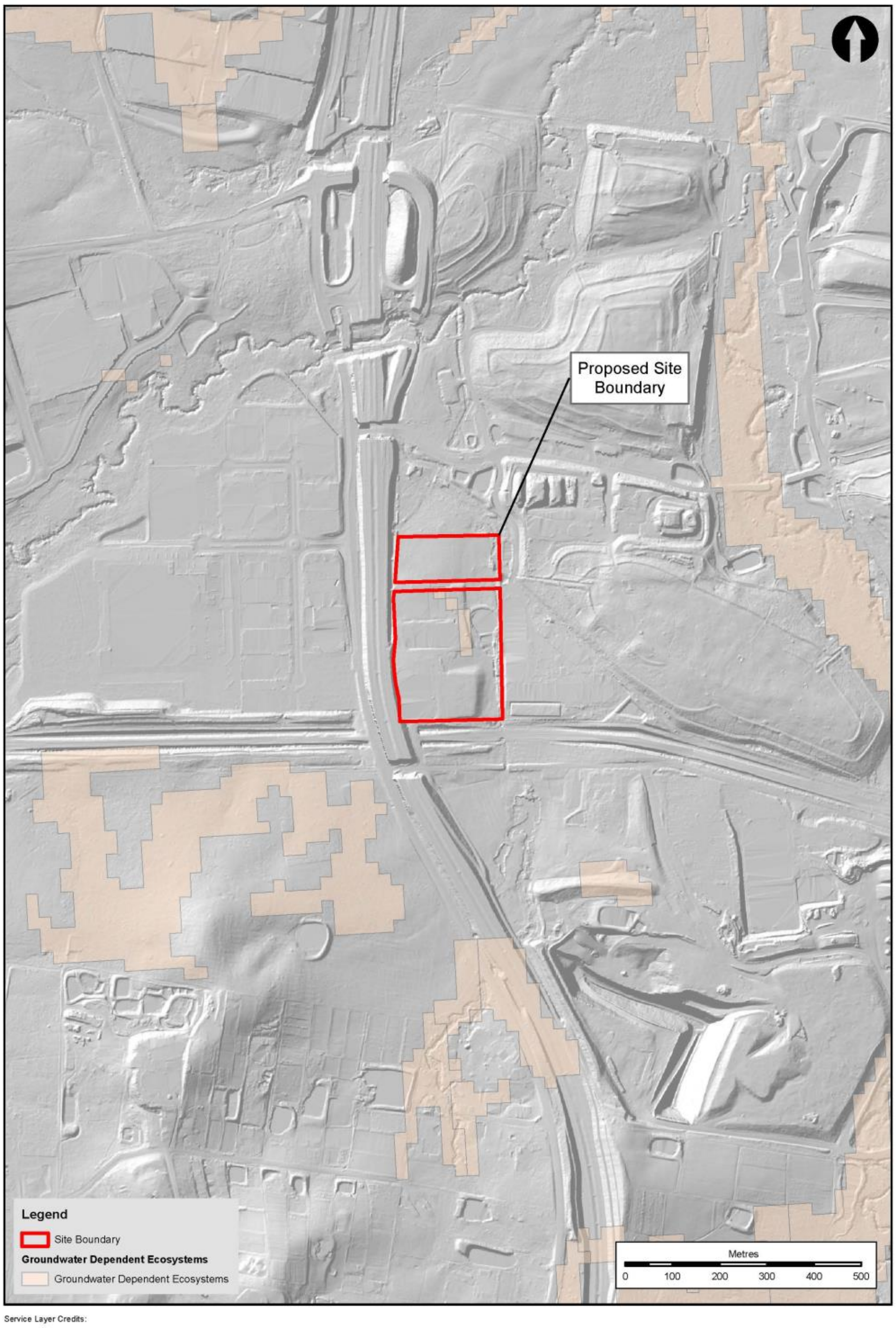


Figure 9: National Groundwater Dependent Ecosystems (GDE) Atlas.

3.7 Water Balance

The site water requirements for both the construction and operation phase of this proposed development are outlined in the EIS proposal description as well as Technical report H Hydrology and flooding assessment report.

4 Impact assessment

This Chapter details the soils and groundwater impact assessment in relation to both construction and operational impacts.

4.1 Soil Classification

Based on the results of the Technical report G: Detailed site (Contamination) investigation (Douglas Partners) the filling material encountered at the site is preliminarily classified for off-site disposal purposes.

General Solid Waste (non-putrescible) and Special Waste under the NSW EPA (2014) waste classification guidelines.

Special Waste areas are identified in the surface soils in the footprints of, poultry sheds and other buildings and the ground where vehicles were stored on site may be impacted with asbestos, some metals and hydrocarbons. This may require these soils to be stripped, waste classified and disposed off-site separately to the remaining fill material onsite. In addition, following demolition or alteration, the surrounding soils may be additionally affected. A detailed buildings materials survey and appropriate removal of these materials is recommended before demolition (see areas identified in Douglas Partners, Contamination 2020 – Drawing 3, Appendix A).

Natural soils to be removed from the site are likely to be classified as virgin excavated natural material (VENM). Douglas Partners (Technical report G: Detailed site (Contamination) investigation (Douglas Partners) collected 12 primary samples from natural soils on site for which a preliminary VENM assessment was completed including testing and recorded concentrations within ANZECC background ranges and visual field observations. This assessment described the samples as consistent with VENM. It is noted that if VENM is to be re-used on a receiving site, the material should be checked to comply with the receiving site's requirements.

4.2 Spoil disposal

Based on the results of the 2020 Detailed Site (Technical report G: Detailed site (Contamination) investigation report the filling material encountered at the site is preliminarily classified, under the NSW EPA (2014) waste classification guidelines, for off-site disposal as:

- General Solid Waste (non-putrescible)
- Special Waste (asbestos)

Natural soils to be removed from the site are likely to be classified as VENM.

As per the Volume 1, Chapter 3 Proposal description, depending on the nature, type and quantity of material, it would either be stored at the site compound and transferred to its point of use when needed; otherwise, it may be brought to site at its intended point of use.

As per Chapter 14 Hazards and risk, certain controlled, dangerous and/or potentially impacting materials and goods, such as fuels and paints, would be stored in designated secured areas, which would be covered and bunded in accordance with regulations. Where needed, isolated stormwater drainage would be provided in these areas. Material transfer, and in some instances use, would also only take place in these areas. Equally, certain repair and maintenance activities may be restricted to these areas.

4.3 Erosion and sediment controls

Soils present on the site are expected to exhibit high erodibility. The presence of dispersive soils is also likely. These characteristics will need to be considered as part of the construction phase sediment and erosion control strategy. A preliminary sediment and erosion control plan has been prepared for the project and includes shaker pads at construction access points, sediment fences, sediment basins, cut-off drains (Technical report H: Hydrology and flooding assessment report)

4.4 Acid Sulfate Soils

Acid Sulfate Soils (ASS) can be either potential acid sulphate soils (PASS) or actual acid sulphate soils (AASS). PASS are acid sulphate soils which have not been disturbed; they remain reduced and the sulphides within the soils remain unoxidised.

A review of the NSW Acid Sulfate Soil Risk Map indicates that the site is not located in an area of potential ASS, however as part of Technical report G1: Factual report on geotechnical investigation (Douglas Partners) two soils were tested for ASS. The result of this test was that one sample had a pH_{FOX} value of 3.4 (lower than the guidance value of pH_{FOX}3.5). The initial screening test therefore indicate that PASS conditions on site maybe present. As this categorisation is the result of one sample it should not be considered conclusive.

ASS can affect works and development on sites in ways including but not limited to:

- Determining where/if excavated material can be stockpiled onsite to avoid leaching into water systems
- Can impact if excavated material is suitable for reuse in construction
- If excavated material needs to be properly disposed of off-site

- Design of building foundations/concrete durability

Characterisation of the ground in areas of potential disturbance is essential to quantify the quantity of sulphides and the neutralisation required to mitigate risk of ASS production.

4.5 Aggressivity potential of the soil

Soil samples were tested by Douglas Partners (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)) to determine pH, sulfate and chloride ion concentrations as well as electrical conductivity (EC) and textural classification for assessment of aggressivity potential of the soil.

Sodic Soil classification is determined by assessing the Exchangeable Sodium Percentage (ESP) of the soil. Sodic Soil rating is split into three categories, these are non-sodic (ESP<6%), sodic (6%<ESP<14%) and strongly sodic (ESP>14%).

Based on the reviewed information, the natural soils on site are expected to be strongly sodic. This will have impacts on the anticipate salinity of the soil and the potential for dispersion and erosion.

Witheridge (2012) states that most sodic soils are dispersive, however, not all dispersive soils may be classified as sodic. IECA (2008) defines dispersive soils as structurally unstable soil that readily disperses into its constituent particles.

4.6 Proposed development groundwater control

Excavation to a depth of up to 15 meters for a waste bunker will be required as part of the proposed development. It is considered that the regional aquifer will not be impacted by this excavation, but the shallow/perched groundwater table will be intercepted which may cause low intermittent flow during construction.

The low permeability of the strata on site means that depressurisation results in a steep drawdown cone and a relatively small zone around the excavation in which groundwater levels will be altered. The extent of depressurisation is expected to be limited to the shallow aquifers within the soil/weathered profile and the upper shale, as identified in groundwater investigations (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)).

Dupuit-Forcheimer equation for steady state flow into a pit was used to provide an initial assessment to the likely flow into the excavation assuming the highest permeability value of 6.5×10^{-9} m/s provided by Douglas Partners of (Technical report G1: Factual report on geotechnical investigation (Douglas Partners)), see equation below.

$$Q = 2\Pi T \frac{(s_1 - s_2)}{2.3\log(\frac{r_2}{r_1})} = 2\Pi T \frac{(H - h_w)}{2.3\log(\frac{R_0}{r_w})}$$

Where: T is the transmissivity [m^2/s] with an assumed aquifer thickness of 20m, H is the initial water table level in the aquifer [m], h_w is the lowered water level [m], r_w is the effective radius of the excavation (70m×30m), R_0 is the radius of influence[m]

The results of this tier 1 assessment indicate a potential inflow into the excavation in the order of <10m^3/day. This analysis was then verified using a 2D numerical simulation of groundwater flow using SEEPW groundwater modelling software. This study further reduced the potential inflow to less than 5m^3/d (less than 0.5L/s). and with a cone of depression of around 120-meter radius (site boundary is around 200m from the bunker) from the excavation after a 90-day period (see Figure 10 below).

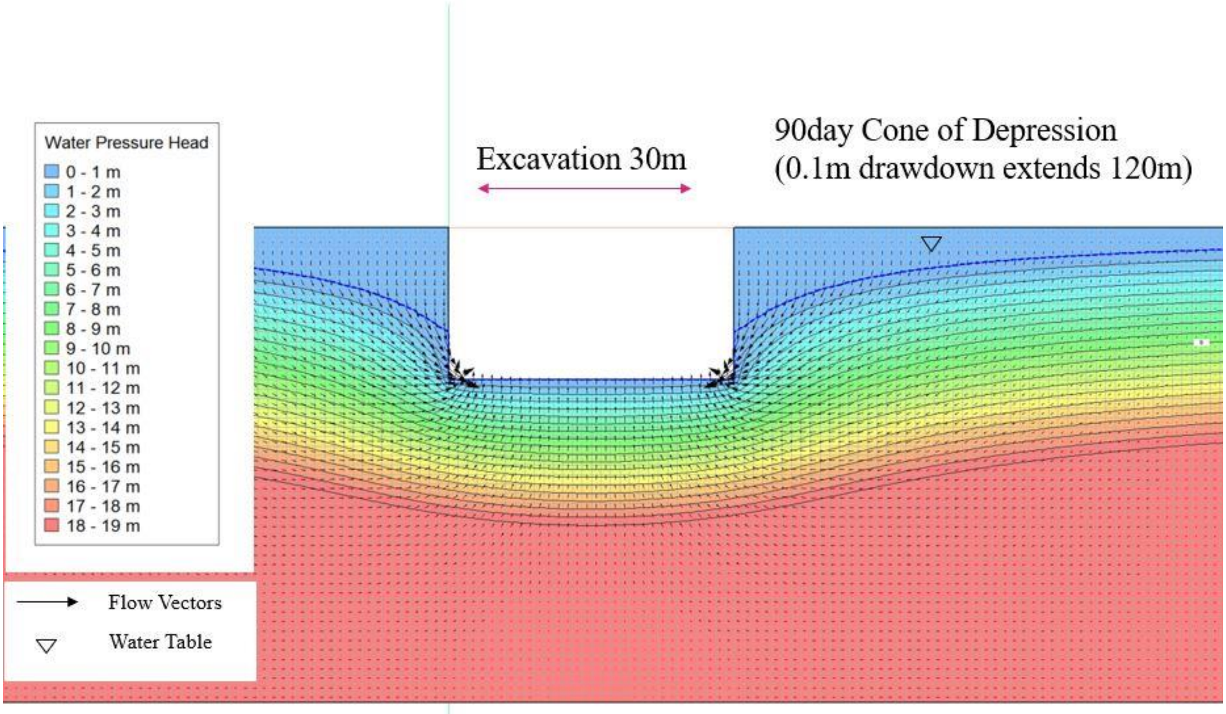


Figure 10: 2D numerical simulation output (SEEPW software) of potential groundwater ingress into the waste bunker excavation.

It should be considered that this calculated potential inflow is extremely conservative as it is considered likely that after a short period, inflow into the excavation will slow and become intermittent as there is likely to be insufficient available groundwater in the surrounding soil and bedrock.

A license for temporary construction dewatering issued by the NSW Office of Water (NOW) is unlikely to be required as the total groundwater inflow is expected to be less than 3 ML/yr.

Minimal impact considerations have been considered under the aquifer interference policy. Under the framework the residual weathered shale would be considered a less productive porous rock. The site does not qualify for minimum impact considerations as the groundwater impacts are:

1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any:
   - High priority groundwater dependent ecosystem
   - High priority culturally significant site

Listed in the water sharing plan. Or a maximum of a 2m decline cumulatively at any water supply work.

2. More than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any:
   a. High priority groundwater dependent ecosystem; or
   b. High priority culturally significant site.

There are no high priority GDE's within 500m of the site. Additionally, it is not foreseen that groundwater quality will lower the beneficial use category source beyond 40m of the construction activity as any groundwater intercepted due to construction activities will be captured and disposed of offsite at an appropriate waste management facility or treated to an acceptable quality prior to discharge to the environment.

4.7 Groundwater recharge

Groundwater recharge from rainwater infiltration through the soil can be impacted by land use change and an increase in impermeable surfaces such as hard standing and concrete. The site currently contains various warehouse and building structures, paved areas and carparks. The proposed developed will be developed and fully contained on the southern 6.19ha portion. The only works undertaken on the northern 2 ha section as part of this proposal relate to exotic vegetation clearance within the existing overland flow channel which will act as the outfall route for stormwater drainage serving the site. As the proposed development will be fully contained on the southern portion of the site which currently contains building structures and paved areas, the overall change in land area available for recharge via rainfall is considered negligible.

4.8 Groundwater flow

The development will require an excavation for the waste bunker, some 15 m deep which will intercept and possibly obstruct shallow groundwater flow. As no significant groundwater is expected to be encountered at the proposed excavation depths, the potential impacts to shallow groundwater flow are considered to be negligible.

4.9 Groundwater quality

Redevelopment and land use changes can potentially impact on groundwater quality. This generally occurs due to intentional or accidental discharge of polluting substances to soils or groundwater, as a result of poorly designed drainage systems, leaking underground storage tanks, discharges from septic tanks, inadequate pollution prevention measures around fuel storage areas etc.

The low permeability of the shale and the overlying residual clays which underlie the proposed development greatly limit the potential for near-surface pollution to reach groundwater. The proposed development does not include any activities that pose a particular risk to groundwater quality. The development will be sewered, and stormwater drainage will be directed to the local surface water system. The development therefore does not pose an unacceptable risk to groundwater quality, subject to standard pollution prevention measures.

During the construction phase of the development the excavation may cause a cone of depression in the shallow groundwater table. This could potentially locally reverse groundwater flow, drawing contaminants from the nearby landfill downgradient of the site. Although, the low permeability of the shales and overlying clays limits the potential for mobilisation of pollution, as a precaution, it is understood that periodic monitoring groundwater levels and quality will occur throughout the dewatering period.

No disposal of intercepted groundwater is expected to be required under normal operating conditions for the lifetime of the facility. As such, no significant change is expected in the groundwater levels when the proposed development is in operation.

4.9.1 Groundwater / surface water interactions

The quality of surface water could potentially be impacted by contaminated groundwater. The potential receptors of impacted groundwater from the site include:

1. Reedy Creek located 450m to the south or 750m to the west of the site.
2. Eastern Creek located around 800m to the east of the site.

3. Prospect reservoir located around 1.6km to the east of the site.

Reedy Creek, the nearest potential receptor, at 450m has been used to assess the risk from potentially impacted groundwater.

Darcy's Law was used to provide an initial assessment to the likely flow and travel time from groundwater beneath the site to this receptor (see equation below)

Darcy's Law:

$$v = -Ki$$

$$i = \frac{h1 - h2}{L}$$

Where: v is the flow velocity [m/s], K is the hydraulic conductivity [m/s], i is the average hydraulic gradient, h1-h2 is the change in piezometric head at two points across the length L

Groundwater flows from high elevations to low elevations. Assuming a direct flow path from the highest point on the surface of the site, 63 m AHD to the river at around 50m AHD, this would result in a groundwater gradient of 0.28, using the highest recorded permeability of the aquifer on site Technical report G1: Factual report on geotechnical investigation (Douglas Partners)), of 6.5×10^{-9} m/s a travel time from the site to Reedy Creek of over 75,000 years. As such the risk to Reedy Creek and Eastern Creek, located even further away, is considered negligible.

Prospect reservoir is located 2km east of the site at an elevation of around 60m AHD. The highest recorded groundwater elevation on site is 55m AHD. As such, there is no downgradient flow path from groundwater beneath the site to the reservoir.

Dam failure at the reservoir, causing flooding at the site is also not considered a risk. The reservoir has an average ground surface elevation of around 60m AHD, our site is between 63m AHD and 53m AHD. Between the reservoir and the site is Eastern Creek (around 50m AHD – lower than the site). Water will flow downgradient, therefore the majority of water from the reservoir would follow the incline of the topography to the north, any additional water that fans out from the reservoir towards the west will be drawn towards the low elevation of the Creek and continue to flow along the river basin to the north.

4.10 Groundwater users and utilities

The proposed development can potentially impact on the availability of groundwater resources. Impacts on groundwater resource availability can occur if land use changes result in a substantial reduction in rainfall recharge to productive aquifers. With the sites current land use including buildings and areas of hard standing there is no considerable change to rainfall recharge due to the proposed development.

The site setting is one of low sensitivity with respect to potential groundwater impacts. The underlying Bringelly Shale has a low resource potential, with water bores generally having low yields of high salinity groundwater. A search of registered groundwater bores confirmed that there are no known groundwater users in this area (see Section 3.5). In addition, there are no groundwater dependent ecosystems, therefore the perceived impact on groundwater sources is negligible.

4.11 Construction phase

As per the EIS Chapter 3 Proposal description:

- Water would be needed onsite to control dust and provide staff ablutions. The amount of water would be confirmed by the contractor and would depend on the final construction methods.
- Potable water for construction staff facilities could come from the existing water supply that serves the site (i.e. a 50mm feed from the Warragamba Pipelines). The alternative to this, is that potable water is transported to the site via water tanker and stored in tanks.
- Rainwater would be used in the first instance before taking water from the local supply network for irrigation and dust suppression. Rainwater would be directed via drainage to a sediment control pond and pumped from this location.
- De-watering of excavated areas would likely be pumped from the excavation to an overland channel/swale which would form part of the measures treating run-off.
- Stormwater run-off would need to be treated (primarily sediment removal) and controlled prior to discharge to the nearby watercourses.
- Water to be re-used on site would be tested for elevated levels of contaminants and disposed of to an appropriately licenced facility if not suitable for re-use on site.

The detail of water management during construction will be provided in the CEMP in response to a condition of consent. Table 10 contains a summary of construction phase impacts identified throughout Section 4.

Table 10: Summary of potential construction related soil and groundwater impacts

Potential impact	Likelihood	Consequence	Risk rating
Possible intersection of the groundwater table due to excavation activities for the 15m deep excavation for the waste bunker and installation of subsurface services.	Possible	Minimal	Low
Dewatering of excavation short-term localised impact on groundwater level and flow direction.	Likely	Minimal	Very Low

Potential impact	Likelihood	Consequence	Risk rating
Dewatering of excavation may cause short-term mobilisation of contaminated groundwater from nearby landfill	Possible	Minimal	Low
Impacts to registered bores.	Unlikely	Minimal	Negligible
Impacts to Groundwater Dependent Ecosystems (GDE's).	Unlikely	Minimal	Negligible
Disposal of groundwater during construction (if intercepted). Possible water quality impacts if not disposed of adequately.	Possible	Minimal	Very Low
Potential impact on groundwater quality during earthworks. This may include spills and leaks from fuels, lubricants and hydraulic oils resulting in a contamination plume.	Possible	Minimal	Very Low
Potential impact on surface water quality via potentially contaminated groundwater sources during earthworks.	Unlikely	Minimal	Negligible
Potential impact on existing utilities due to ground movement during construction phase.	Unlikely	Minimal	Very Low

4.12 Operation Phase

It is not expected that groundwater will be intercepted during the operational phase of the project as the waste bunker will be impermeable. There is a possible likelihood of groundwater quality being impacted from leaks and spills however will be managed under the CEMP. Groundwater recharge is not expected to be impacted beyond negligible impacts predicted during the construction phase.

As per the Volume 1, Chapter 3 Proposal description, there are a variety of uses for water within the facility. Water uses include:

- Boiler first fill
- Boiler make up-water (including blow down loss)
- Flue gas conditioning pre-treatment
- Ash quenching

Other small water consumption from general facilities (such as toilets and kitchen) alongside wash down water used for maintenance. None of this water use is expected to interact with the groundwater environment.

The primary objective with respect to water use is to re-use at much water as possible. The following water saving techniques have been identified:

- Excess water from the wet scrubber will be captured and used within the flue gas conditioning stage

- Rejected water from the make-up plant and from boiler blow down will be used within the ash quench.

This means that no wastewater must be treated outside of the facility during normal operation. A small water treatment plant will be installed to ensure that the water quality of feedwater is suitable for use within the boiler. This water will not interact with the groundwater environment.

Table 11 contains a summary of operation phase impacts identified throughout Section 4

Table 11: Summary of potential operation related groundwater impacts

Potential impact	Likelihood	Consequence	Risk rating
Potential impact on groundwater quality during operation. This may include spills and leaks from fuels, lubricants and hydraulic oils resulting in a contamination plume.	Possible	Minimal	Low
Land use change can result in reduced area for rainfall recharge to productive aquifers.	Unlikely	Minimal	Negligible
The 15m deep waste bunker may potentially obstruct/ divert shallow groundwater flow.	Likely	Minimal	Low
Cumulative impacts	Unlikely	Minimal	Negligible

4.13 Cumulative impacts

This assessment has found the proposed development will only have low and temporary potential impacts to the groundwater and related environments during the construction phase of the development. In addition, are no known groundwater users or developments within the study area which may be affected, as such the cumulative impacts of the proposal is considered negligible.

5 Proposed mitigation measures

This Chapter describes the measures to mitigate against, monitor and manage the predicted adverse impacts described in Chapter 4 of this report.

Table 12: Proposed mitigation measures

ID	Description	Mitigation measure	Timing	Responsibility
GW1	Potential disturbance and erosion of soil during groundworks.	An Erosion and Sediment Control Plan (ESCP) will be prepared for the construction phase of the proposed development. Surface water monitoring program should be implemented to demonstrate the effectiveness of erosion control and sediment control measures, assist with construction site management and identify any impacts	Construction	Construction contractor
GW2	Potential presence of dispersive and saline soils	Sediment basins in the ESCP are to be designed to account for dispersive soils. Visual observation maintained during excavation for evidence of high salinity soils (visible salt crystals etc). If identified removed in covered stockpiles.	Construction	Construction contractor
GW3	Possible presence of Acid Sulphate Soils	Regular testing and characterisation of the ground in areas of potential disturbance is essential to quantify the quantity of sulphides and the neutralisation required to mitigate risk of AASS production.	Construction	Construction contractor
GW4	Intersection of the shallow groundwater table or perched water due to excavation activities for the 15m deep excavation for the waste bunker	Based on current design it is not considered that the regional deep groundwater table would be intercepted. It is expected that only the shallow/perched water table will be intersected by the excavation activities which is considered to have negligible impact to the productive aquifer. Groundwater inflow during construction cannot be mitigated however the installation of an impermeable cut off wall will eliminate any operation phase impacts	Construction	Project Proponent /
GW5	Dewatering of excavation short-term localised impact on groundwater level and flow direction.	Impact on the shallow/perched groundwater cannot be mitigated however the installation of an impermeable cut-off wall will eliminate any operational phase impacts.	Pre-construction	Project Proponent

ID	Description	Mitigation measure	Timing	Responsibility
GW6	Dewatering of excavation may cause short-term mobilisation of contaminated groundwater from nearby landfill	Regular monitoring of encountered groundwater should occur during the construction period. Monitoring should assess any increase in background groundwater quality conditions from those previously recorded (See Section 3.4.1) to identify contaminant level trends and any groundwater impacts. Contingency mitigation measures to maintain groundwater quality.	Construction	Construction Contractor
GW7	Impacts to registered bores.	There are only two registered bores within the 1km Study Area. Their use is as monitoring wells so are unlikely to be a risk to the project. The installation of an impermeable bunker cut off wall will prevent the cone of depression extending any further out during the operational phase minimising the potential for impact on registered bores.	Pre-construction	Project Proponent
GW8	Impacts to Groundwater Dependent Ecosystems (GDE's).	Although Groundwater Dependent Ecosystems are identified within the Study Area, further analysis of these Ecosystems (see Biodiversity Report) confirmed this is erroneous and there are no Groundwater Dependent Ecosystems within the Study Area. Should evidence of a potential Groundwater Dependent Ecosystem exist during any flora and fauna mapping, further biodiversity and groundwater impact assessment should be completed to confirm and manage risk.	Construction	Construction Contractor
GW9	Disposal of groundwater during construction (if intercepted).	It is unlikely that construction would intercept the regional aquifer during construction works. It is expected the shallow/perched groundwater will be intercepted and may cause low intermittent flow during construction however this is likely to be short lived and managed as a temporary flow. Mitigation measures should be further defined in a Construction Environmental Management Plan (CEMP) which will include the treatment and disposal of groundwater to a licenced facility.	Construction	Construction Contractor
GW10	Potential impact on groundwater quality during earthworks. This may include spills and leaks from fuels, lubricants and hydraulic oils resulting in a contamination plume.	Mitigation measures should be developed as part of a CEMP and include standard mitigation measures to control spill related risks.	Construction	Construction Contractor

ID	Description	Mitigation measure	Timing	Responsibility
GW11	Potential impact on surface water quality via potentially contaminated groundwater sources during earthworks.	Due to the low permeability of the aquifer, the travel times in the order of 200,000 years to the nearest potential surface water receptor (Reedy Creek) result in negligible risk. Installation of an impermeable bunker cut-off wall allow the groundwater table to recover to pre-construction levels removing the potential for potentially contaminated material to be further mobilised	Construction	Construction Contractor
GW12	Potential impact on existing utilities due to ground movement during construction phase.	Existing utilities will be marked out and protected during construction.	Construction	Construction Contractor
GW13	Potential impact on groundwater quality during operation. This may include spills and leaks from fuels, lubricants and hydraulic oils resulting in a contamination plume.	Mitigation measures should be developed as part of a Construction Environmental Management Plan and include standard mitigation measures to control spill related risks.	Construction	Construction Contractor
GW14	Land use change can result in reduced area for rainfall recharge to productive aquifers.	Any unplanned design changes that may drastically increase paved areas should be reassessed by a hydrogeologist at present these risks remain low.	Pre-construction	Project Proponent

6 Conclusions

A soil and groundwater impact assessment was completed within the study area. This included characterising the baseline soils, geology and groundwater and integrating this understanding into an assessment of the impact of the proposed development on soils, groundwater and on surface water via groundwater interaction both in the construction phase and operation phase.

Key potential receptors which were considered as part of the assessment were:

- Groundwater users
- Surface water features via groundwater interaction
- Impact to groundwater flow and quality
- Mobilisation of contaminated groundwater outside the proposed development.

It was found that due to the extremely low permeability and potential for high salinity, the underlying shale and residual soils are not a viable water resource and there are no registered ground users in the area. Similarly, the low permeability of the underlying bedrock would result in extremely long groundwater travel times (in the order of thousands of years) to reach identified surface water features, and this also greatly limits potential for near-surface pollution to reach groundwater.

There are therefore negligible risks related to the Proposals impact on the surrounding soils and groundwater environment.

All residual risks are either categorised as either negligible or low. These risks can be managed through standard mitigation measures that would be further detailed in a Construction Environment Management Plan related to the management of soil and water.

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Appendix A

SEARs and Agency Comments

SEARs and Agency comments cross reference table

Assessment Requirements	Reference in this specialist report
SEARS	
Soils and Water	
A description of existing baseline conditions including soil, water, groundwater resources, topography, hydrology, drainage lines, watercourses and riparian lands on or nearby to the site.	Section 3
An assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, watercourses and riparian land and measures proposed to reduce and mitigate these impacts.	Section 4
Proposed surface and groundwater monitoring activities and methodologies.	Section 5
Consideration of relevant NSW government guidelines and legislation, including the water act 1912 and water management act 2000, NSW water quality and river flow objectives, guidelines for controlled activities on waterfront land (2018).	Section 2.1, Section 4.1, Section 4.2
Blacktown City Council submission to SEARs request for SSD 10395	
Overall and General Requirements	
The EIS must include a detailed assessment of the key issues specified below, and any other significant issues identified in the risk assessment, which includes:	Section 3, Section 4, Section 5
· a description of the existing environment, using sufficient baseline data.	Section 3
· an assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant guidelines, policies, plans and statutes.	Section 4
· a description of the measures that would be implemented to avoid, minimise and, if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage significant risks to the environment and the health of the community.	Section 5
Soil and Water	
A detailed assessment of potential soil, surface and groundwater impacts.	Section 4
EPA recommendations for SEARs for the Western Sydney Energy and Resource Recovery Centre (SSD 10395)	

Assessment Requirements	Reference in this specialist report
Soils, Contamination and Construction	
Identify any likely impacts resulting from the construction or operation of the proposal, including the likelihood of:	Section 4
· Soil erosion	Section 4.2
· Ground water interaction	Section 4.5, Section 4.6, Section 4.7, Section 4.8
· Disturbing acid sulfate or potential acid sulfate soils.	Section 4.3
· Environment protection measures, including noise mitigation measures, dust control measures and erosion and sediment control measures.	Section 4.2
Describe and assess the effectiveness or adequacy of any soil management and mitigation measures during construction and operation of the proposal including:	Section 5
· Proposals for the management of potential acid sulfate soils — see *Acid Sulfate Soil Manual* (Acid Sulfate Soil Advisory Committee 1998) and *Acid Sulfate Soils Assessment Guidelines* (Acid Sulfate Soil Advisory Committee 1998).	Section 4.3
Water	
Provide details of the project that are necessary for predicting and assessing impacts to waters including:	Section 3
· The quantity and physio-chemical properties of all potential water pollutants and the risks they pose to the environment and human health, including the risks they pose to Water Quality Objectives in the ambient waters (as defined on http://www.environment.nsw.gov.au/ieo/index.htm, using technic at criteria derived from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC 2000).	Section 4.7
DPIE Water and the Natural Resources Access Regulator (NRAR)	
General Assessment Requirements	
Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	Section 4
Proposed surface and groundwater monitoring activities and methodologies.	Section 5

Assessment Requirements	Reference in this specialist report
Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans (available at https://www.industry.nsw.gov.au/water).	Soils and Water, Section 2, Section 3