Willow Tree Waste Management Facility Expansion

Water Impact Assessment

Liverpool Plains Shire Council

1 December 2022

→ The Power of Commitment

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1. Introduction

1.1 Project background

Liverpool Plains Shire Council (Council) developed a 10-year strategy for the ongoing management of waste within their region in 2018 (MRA, 2018). Landfilling forms an essential part of this strategy, along with the waste avoidance and reduction, increased recycling, and diversion of waste from landfill. The waste management strategy proposes to rationalise the landfilling operations across the region by establishing the Willow Tree Management Facility (WMF) (the site) as the primary landfill servicing Council's Local Government Area (LGA). To achieve this the existing landfill site will be expanded within the existing lot boundary as shown on Figure 1.1 with the general site layout shown on Figure 1.2 (the project).

The proposed expansion is a regionally significant development which requires the preparation of an Environmental Impact Statement (EIS). The Secretary's environmental assessment requirements (SEARs) which set out the required scope for the EIS have been received. Council has engaged GHD Pty Ltd (GHD) to prepare the EIS for the WMF expansion and associated environmental assessments to support the development application (DA).

1.2 Purpose of this report

The purpose of this Water Impact Assessment (WIA) report is to identify potential impacts on surface water or groundwater with changing soil and water management due to the WMF expansion and support the EIS for the project.

1.3 Objectives

The key objective of the WIA is to identify and determine the potential impacts of the project on the surface water and groundwater environment by addressing the relevant government agency requirements.

The scope of work for the WIA is:

Surface Water:

– Review existing assessments and data relevant to the project.
– Review relevant statutory requirements.
– Establish the existing local and regional hydrological conditions of the project site.
– Determine the water management requirements for the project.
– Undertake an assessment of the potential impacts of the project on:
    - Surface water flow
    - Surface water quality
– Undertake an assessment of the cumulative impacts of the project in association with other operations in the region.
– Develop measures to avoid, minimise and mitigate potential impacts of the project and provide recommended management, monitoring and reporting requirements.

Groundwater:

– Review existing assessments and data relevant to the project.
– Review relevant statutory requirements.
– Establish the existing local and regional hydrogeological environment including the main aquifer units, groundwater levels and groundwater quality.
– Identify sensitive groundwater receptors, including Groundwater Dependent Ecosystems (GDEs) and registered groundwater bores.

– Assess potential water table and groundwater quality impacts.
– Develop measures to avoid, minimise and mitigate potential impacts of the project and provide recommended management, monitoring and reporting requirements.

1.4 Scope and limitations

This report has been prepared by GHD for Liverpool Plains Shire Council and may only be used and relied on by Liverpool Plains Shire Council for the purpose agreed between GHD and Liverpool Plains Shire Council as set out in Section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Liverpool Plains Shire Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Site layout

FIGURE 1.1

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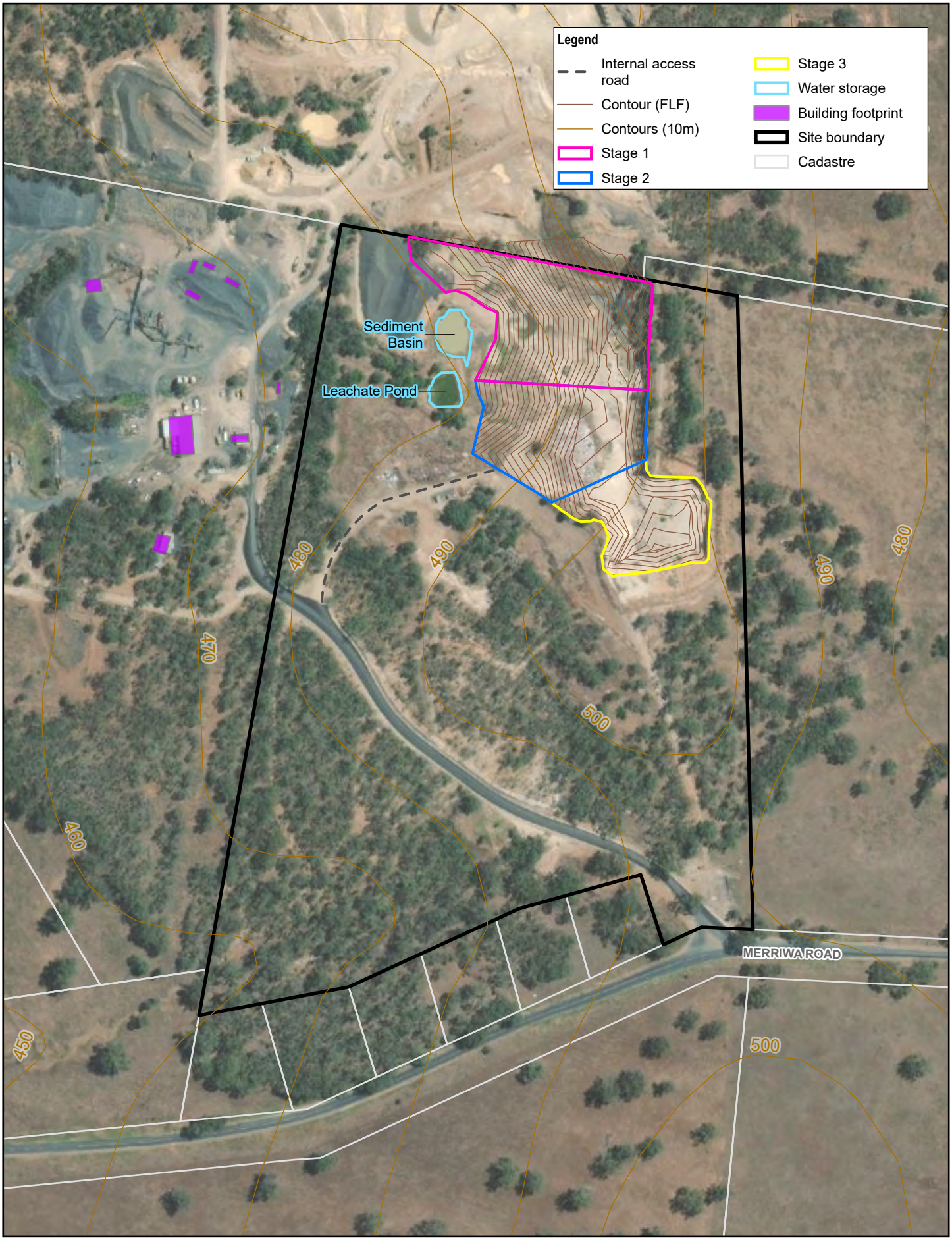
Data source: Elevation - 2011 Elvis DEM, Cadastre, Hydrolines and Contours - NSW Spatial Services 2022World Street Map: Esri, HERE, Garmin, Foursquare, FAO, METI/NASA, USGS, World Imagery: Maxar. Created by: pfernandes



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Site features

FIGURE 1.2

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Data source: Geology - Geoscience Australia, 2021; Cadastre, Hydrolines - NSW Spatial Services 2022World Imagery: Maxar. Created by: pfernandes

2. Regulatory context

2.1 Legislation

2.1.1 Environmental Planning and Assessment Act 1979

The EP&A Act is the core legislation relating to planning and development activities in NSW and provides the statutory framework under which development proposals are assessed. The EP&A Act aims to encourage the proper management, development and conservation of resources, environmental protection and ecologically sustainable development.

The WIA has been developed to address the surface water and groundwater components of the SEARs and accompanying government agency requirements for the project, which are reproduced in Table 2.1, along with a reference to where each requirement has been addressed within this report. Accompanying government agency requirements from the Environment Protection Authority (EPA) and the Biodiversity and Conservation and Science Directorate (BCS) are reproduced in Appendix A.

Table 2.1 Secretary's Environmental Assessment Requirements

Assessment requirement	Where addressed
The EIS must include an assessment of all potential impacts of the proposed development on the existing environment (including cumulative impacts if necessary) and develop appropriate measures to avoid, minimise, mitigate and/or manage these potential impacts. As part of the EIS assessment, the following matters must also be addressed: **Soil and water – including:**	
A description of local soils, topography, drainage and landscapes	Section 3
Details of water usage for the proposal including existing and proposed water licencing requirements in accordance with the Water Act 1912 and/or the Water Management Act 2000	Section 2.1 Section 6.3
An assessment of potential impacts on floodplain and stormwater management and any impact to flooding in the catchment	Section 5.2
Details of sediment and erosion controls	Section 4.3 and Section 6.1.1
A detailed site water balance	Section 4.2.1.1 Section 4.4
An assessment of potential impacts on the quality and quantity of surface and groundwater resources	Section 5
Details of the proposed stormwater and wastewater management systems (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts	Section 4 Section 6.2
Characterisation of the nature and extent of any contamination on the site and surrounding area	Not assessed
A description and appraisal of impact mitigation and monitoring measures	Section 6

2.1.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is administered by the Environment Protection Authority (EPA), which is an independent statutory authority and the primary environmental regulator for NSW. The objectives of the POEO Act are to protect, restore and enhance the quality of the environment, by mechanisms including programs to reduce pollution at the source and monitoring and reporting on environmental quality. The POEO Act regulates and requires licensing for environment protection, including for waste generation and disposal and for water, air, land and noise pollution.

Under the POEO Act, an Environment Protection Licence (EPL) is required for premises at which a 'scheduled activity' is conducted. Schedule 1 of the POEO Act lists activities that are scheduled activities for the purpose of the Act. Licence conditions relate to pollution prevention and monitoring and can control the air, noise, water and waste impacts of an activity. An EPL is yet to be obtained for the Project, however a separate application will be lodged to the EPA at the completion of the assessment process.

Part 5.3, Section 120 of the POEO prohibits the pollution of waters. Pollution of waters may be permitted in instances where the pollution is regulated by an EPL and where conditions specified by the EPL were not breached. This assessment demonstrates how risk of pollution to the environment will be minimised through the proposed site water management infrastructure (Section 4) and mitigation, monitoring and management measures (Section 6).

2.1.3 Water Management Act 2000

The aim of the *Water Management Act 2000* (WM Act) is to ensure that water resources are conserved and properly managed for sustainable use benefiting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and in-stream uses as well as to provide for protection of catchment conditions.

Historically, the Water Act 1912 was the main legislation for managing water resources in NSW; however, this Act has been progressively phased out and replaced by water sharing plans (WSPs) under the WM Act. Once a WSP commenced, existing licences under the Water Act 1912 were converted to water access licences (WALs), water supply works and use approvals (controlled activity approvals) under the WM Act. All new WALs and controlled activity approvals are also issued under the WM Act.

2.1.3.1 Water sharing plans

Fresh water sources throughout NSW are managed via WSPs under the WM Act. Provisions within WSPs provide water to support the ecological processes and environmental needs of groundwater dependent ecosystems and waterways. WSPs also regulate how the water available for extraction is shared between the environment, basic landholder rights, town water supplies and commercial uses. Key rules within the WSPs specify when licence holders can access water and how water can be traded.

In the project area, surface water is managed under the Water Sharing Plan for the Namoi and Peel Unregulated Rivers Water Sources (2012).

In the project area, groundwater is managed under the Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020 and the Water Sharing Plan for the Namoi Alluvial Groundwater Sources 2020.

Under the WM Act, extraction of water for basic landholder rights is protected by allocating and prioritising water for basic landholder rights. There are three types of basic landholder rights in NSW under the WM Act:

– Domestic and stock rights: Landholders are entitled to take water from a river, estuary or lake which fronts their land or from an aquifer which is underlying their land for domestic consumption and stock watering, without the need for a licence. However, a water supply work approval is required to construct a dam, or a groundwater bore.
– Native title rights: Anyone who holds native title with respect to water, as determined by the *Native Title Act 1993,* can take and use water for a range of purposes, including personal, domestic and non-commercial communal purposes. There are no native holder rights identified in the water sources covering the project.
– Harvestable rights: Landholders are entitled to collect a portion of runoff from their property and store it in one or more dams up to a certain capacity that are located on minor streams. This entitlement is known as a 'harvestable right' and is determined from the total contiguous area of land ownership. In the Central inland-draining catchments harvestable rights area of NSW (where the project is located), landholders may capture and use up to 10 percent of the average regional runoff for their property by means of a dam or dams on a first or second order stream without requiring an approval or licence under the WM Act.

Section 4.41 of the EP&A Act removes the need for a number of approvals under the WM Act when development consent has been granted for an SSD. These are a water use approval under section 89 of the Act, a water management work approval under section 90 of the Act and an activity approval (other than an aquifer interference approval) under section 91 of the Act.

There are no surface water access licences or works approvals related to the project. Surface water storages that form part of the water management system are exempt from consideration under water access licensing and harvestable rights, as they are dams solely for the capture, containment and recirculation of drainage, consistent with best management practice to prevent the contamination of a water source. A groundwater licence is also not required for the project, as outlined further in Section 6.3.

2.2 Policies

2.2.1 NSW State Rivers and Estuary Policy

The NSW State Rivers and Estuaries Policy (NSW Water Resources Council 1993) provides objectives and principles to achieve sustainable management of rivers and estuaries in NSW to ensure resource use is consistent with the long-term biological and physical function of the natural system. The objectives of the policy are “To manage the rivers and estuaries in NSW in ways which: slow, halt or reverse the overall rate of degradation in their systems; ensure the long-term sustainability of their essential biophysical functions; and maintain the beneficial use of these resources”. The policy details guiding principles for sustainable management of rivers and estuaries.

2.2.2 NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (AIP) was finalised in September 2012 and clarifies the water licensing and approval requirements for aquifer interference activities in NSW, including the taking of water from an aquifer in the course of carrying out mining.

The Policy outlines the water licensing requirements under the WM Act. A water licence is required whether water is taken for consumptive use or whether it is taken incidentally by the aquifer interference activity (such as groundwater filling a void), even where that water is not being used consumptively as part of the activity’s operation. Under the WM Act, a water licence gives its holder a share of the total entitlement available for extraction from the groundwater source. The WAL must hold sufficient share component and water allocation to account for the take of water from the relevant water source at all times.

Sufficient access licences must be held to account for all water taken from a groundwater or surface water source as a result of an aquifer interference activity, both for the life of the activity and after the activity has ceased. Many mining operations continue to take water from groundwater sources after operations have ceased. This take of water continues until an aquifer system reaches equilibrium and must be licensed.

Clause 37 of the *Water Management (General) Regulation 2018* exempts certain aquifer interference activities from the requirement of a works approval and a WAL, including authorised quarrying activity. Under the *Water Management (General) Regulation 2018*, up to 3 ML of water can be taken per year without a licence.

The AIP has developed minimal impact considerations for highly productive and less productive groundwater sources. Highly productive groundwater is defined as having Total Dissolved Solids (TDS) less than 1,500 mg/L and contains water supply works that can yield water at a rate greater than 5 L/s. Minimal impact considerations are outlined in Table 1 of the Policy. If the predicted impacts meet the Level 1 minimal impact considerations, then these impacts will be considered as acceptable. The adopted Level 1 minimal impact considerations for this project are discussed in Section 5.3.

2.3 Guidelines

2.3.1 Environmental Guidelines for Solid Waste Landfills

The Environmental Guidelines for Solid Waste Landfills (EPA 2016) purpose is to provide guidance on the environmental management of landfills in NSW by specifying minimum standards for design and construction techniques, effective site operation, monitoring and reporting procedures and post closure management. The EPA uses these guidelines to assess new and varied applications for landfill licences, in addition to environmental issues during the life of the landfill under the POEO Act. Specific requirements set out by EPA 2016 for the management of soils and water are considered in Section 4 (proposed water management systems) and Section 6 (mitigation, monitoring and management measures).

2.3.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) provide guidance for assessing and managing ambient water quality in a wide range of water resource types and according to specified environmental values, such as aquatic ecosystems, primary industries, recreation and drinking water. The revised Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) were published in 2018 following scientific review of the ANZECC (2000a) guidelines. The Water Quality Management Framework (ANZG 2018) provides the key requirements for determining appropriate guideline values or performance criteria to evaluate the results of water quality monitoring programs.

The ANZG (2018) guidelines adopt a risk-based approach to assessing ambient water quality by providing the framework to tailor water quality guidelines to local environmental conditions. Guideline values provided by ANZG (2018) can be modified into regional, local or site-specific guideline values (SSGVs) by taking into account factors such as the level of modification of the ecosystem, natural variability in water quality at reference sites, and water hardness. Guideline values are applied to the receiving environment at the edge of the mixing zone and do not apply to water at the point of discharge. Criteria set out in ANZG 2018 were considered in the development of the water quality monitoring program, presented in Section 6.2.

2.3.3 NSW Water Quality and River Flow Objectives

The NSW Water Quality and River Flow Objectives (DECCW 2006) are the agreed environmental values and long-term goals for each catchment in NSW. The objectives are intended to be considered in assessing and managing the potential impacts of activities on waterways.

DECCW (2006) maps the area of the Project to be within the ‘uncontrolled streams’ category, defined as “Uncontrolled streams and waterbodies are those that are not in estuaries or the other categories. Their flow patterns may have been altered in some way through land-use change and extraction. Many of these streams flow into the regulated river sections, and so changes to their flow regime will affect downstream flows.”

The water quality and river flows objectives for the Project are listed and rationalised in Table 2.2 and Table 2.3 respectively.

Table 2.2 NSW Water Quality Objectives

Water quality objective	Detail	Preliminary assessment
Aquatic ecosystems	Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term.	The existing site as a quarry and unmanaged landfill currently has no control of water management including discharge of sediment laden water The site water management system as part of this Project will maintain the downstream ecological condition through water quality control and monitoring measures.

Water quality objective	Detail	Preliminary assessment
Visual amenity	The objective applies to all waters, particularly those used for aquatic recreation and where scenic qualities are important.	The Project is elevated with no visual amenity of waterways impacted by site operations.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed.	Recreation activities within the downstream waterway of Warrah Creek is limited. Water quality likely to be improved through active management in sediment and contaminant laden water discharged to the downstream environment.
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.	
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	Water quality likely to be improved through active management in sediment and contaminant laden water discharged to the downstream environment.
Irrigation water supply	Protecting the quality of waters applied to crops and pasture.	Irrigation likely occurs far downstream of the Project on Warrah. The Project isn't expected to impact on irrigation quality suitability. Monitoring measures will act as an early detection system to inform downstream water users.
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing.	Active water management and monitoring measures of the Project will mitigate water quality risks downstream and act as early detection systems to inform downstream water users.
Drinking water at point of supply – Disinfection only – Clarification and disinfection – Groundwater	Refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment.	The Project is not within a drinking water catchment.
Aquatic foods (cooked)	Refers to protecting water quality so that it is suitable for the production of aquatic foods for human consumption and aquaculture activities.	The Project is not likely to effect water quality where gathering aquatic foods possibly occurs far downstream in the Namoi River.

Table 2.3 NSW River Flow Objectives

River flow objective	Detail	Preliminary assessment
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	The Project has a small water demand relative to the catchment Warrah Creek catchment area and reuse will not require extraction from streams and wetlands in periods of no flow.
Protect natural low flows	Protect natural low flows.	
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows.	Water extraction is not required for the Project operation life in wet times. The release of water from the Project during moderate to high flows will be managed through a site water management plan.
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.	The Project is not expected to influence wetland and flood inundation given the negligible change in catchment area.

River flow objective	Detail	Preliminary assessment
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	Groundwater dependent ecosystems in the Project area are unlikely to be impacted due to the elevated nature of the site and minimal excavation depth below the existing landform.
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	No instream structures proposed for the Project.

2.3.4 Using the ANZECC Guidelines and Water Quality Objectives in NSW

The document Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC 2006) provides guidance on applying the ANZECC (2000a; revised by ANZG 2018) framework for assessing water quality, including the use of water quality objectives for NSW, which is considered in the methodology for assessing water quality in Section 5.1.

2.3.5 Australian Guidelines for Water Quality Monitoring and Reporting

The Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000b) sets out a framework and guidance for the monitoring and reporting of fresh and marine surface water and groundwater. ANZECC (2000b) provides information for all aspects of a water quality monitoring program, including setting objectives, designing monitoring and sampling programs, laboratory analyses, data analysis and interpretation and reporting of results and conclusions.

The recommended water quality monitoring program, presented in Section 6.2, for the project were made in accordance with the framework presented by ANZECC (2000b).

2.3.6 Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales

The document Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales (DEC 2004) lists the sampling and analysis methods to be used when sampling water quality for compliance with environmental protection legislation, a relevant licence or relevant notice. All sample collection, handling and analyses undertaken for the purpose of this WIA is understood to have been undertaken in accordance with the requirements outlined by DEC (2004).

2.3.7 Managing Urban Stormwater: Soils and Construction

Managing Urban Stormwater: Soils and Construction – Volume 1 (the 'Blue Book'; Landcom 2004) outlines the basic principles for the design, construction and implementation of sediment and erosion control measures to improve stormwater management and mitigate the impacts of land disturbance activities on soils and receiving waters. This document relates particularly to urban development sites; however, it is relevant to the project as it provides guidance on the configuration of erosion and sedimentation controls, which may be necessary during construction and operation of the project.

Managing Urban Stormwater: Soils and Construction – Volume 2B Waste Landfills (DECC 2008) provides specific guidelines, principles and minimum design standards for good management practice in erosion and sediment control during the construction and operation of waste landfills. This document also relates specifically to this project as a mine site.

3. Existing environment

3.1 Climate

Climate data were obtained as SILO Patched Point Data from the Science Division of the Queensland Government's Department of Environment and Science. SILO Patched Point Data is based on historical data from a particular Bureau of Meteorology station with missing data “patched in” by interpolating with data from nearby stations.

Climate records were obtained from SILO[1] for the Willow Tree (General Store, station 55063), which is located approximately 2.0 km north west of the site for the period from 1 January 1889 to 1 January 2021.

The cumulative frequency of annual total rainfall and synthetic evaporation from SILO dataset between 1889 and 2021 are compared in Figure 3.1. Synthetic evaporation data are used to supplement observed Class A pan evaporation data, owing to the limited availability of observed data.

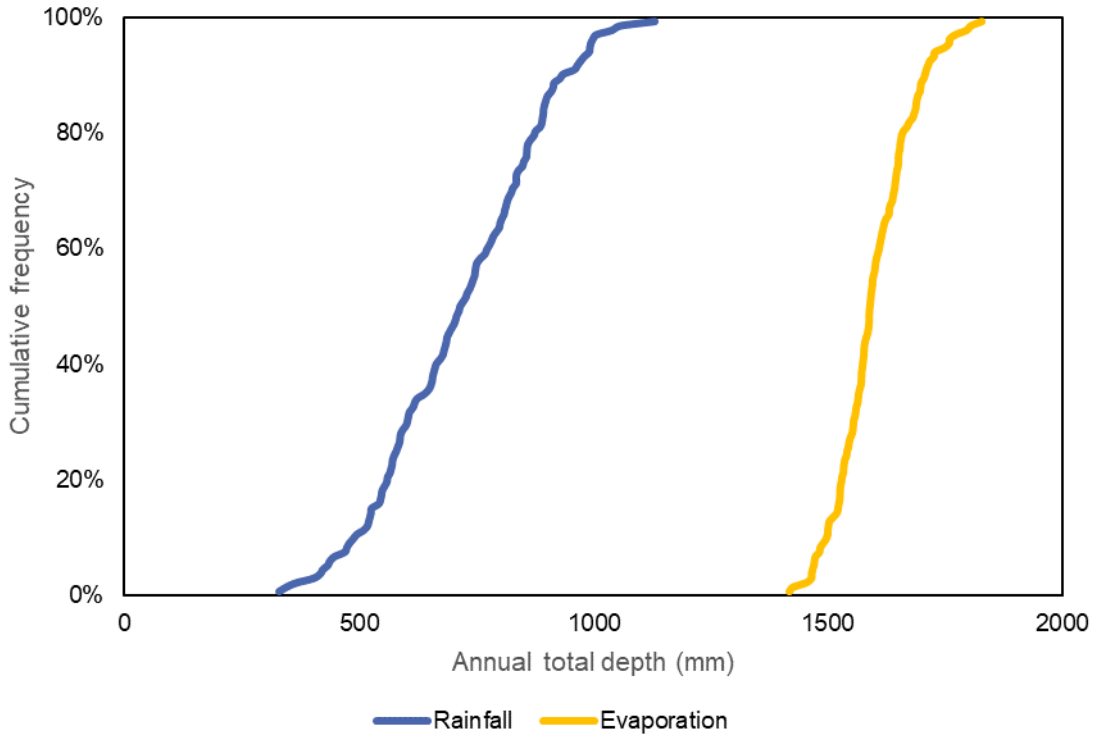


Figure 3.1 Comparison of annual rainfall depths

The statistics of annual totals of the historical rainfall record were:

- Minimum 320 mm (2019)
- Maximum of 1256 mm (1950)
- Median of 714 mm
- Average of 714 mm

Annual evaporation totals have an average of 1599 mm, corresponding to an average annual moisture deficit (the difference between rainfall and evaporation) of 879 mm.

[1] SILO refers to patched point data set from the Scientific Information for Land Owners (SILO) database operated by the Queensland Department of Science, Information Technology and Innovation (DSITI). SILO patched point data is based on observed historical data from a particular Bureau of Meteorology (BOM) station with missing data ‘patched in’ by interpolating with data from nearby stations (DSITI, 2022).

A plot of average daily evaporation is compared to average daily rainfall from the historical record in Figure 3.2.

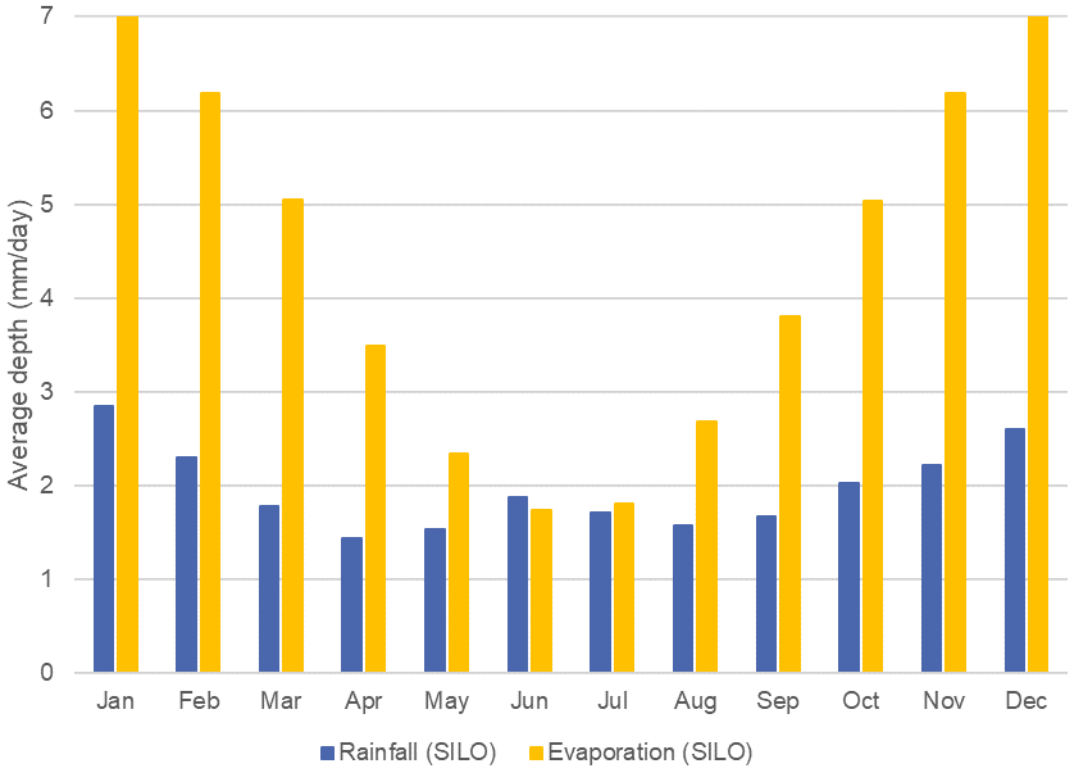


Figure 3.2 Daily evaporation and rainfall

Figure 3.2 show that evaporation and rainfall vary seasonally, both generally having higher records in summer compared to winter. The site has an average monthly net rainfall deficit during all months except for June.

3.2 Topography and land use

The existing site is a former quarry that has been excavated through a roughly north-south trending ridge. In the project area, the northern part of this ridge has been removed by quarrying such that the highest elevation is now in the central western area of the site. The land slopes away from this high point in all directions. The landfill expansion area slopes south-west towards Merriwa Road.

The northern portion of the site has been modified by quarrying and landfilling whereas the southern portion is largely undisturbed. The northern portion of the site generally drains towards several ponds the were likely formed during quarrying activities.

The topography surrounding the site is generally very low to low undulating hills and rises. The site sits at the top of a hill. Local relief within the area ranges from approximately 480 to 510 m AHD. The area surrounding the site has an elevation of 430 to 450 m AHD. Topographical contours produced from the ELVIS (ICSM 2021) Digital Elevation Model (DEM) of Australia derived from LiDAR 5 metre grid is provided on Figure 1.2.

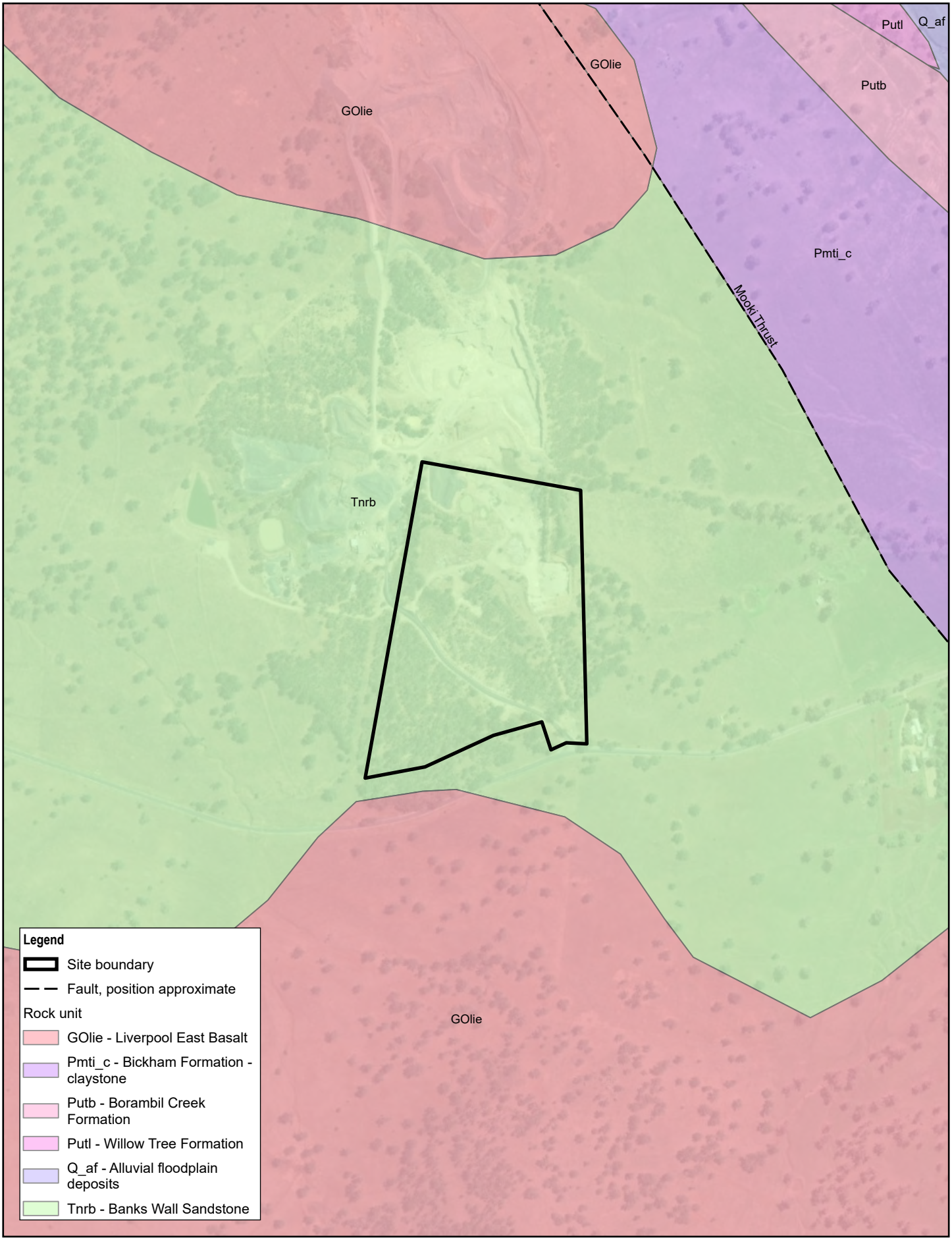
The site is currently used for landfilling and contains quarried land. Cattle grazing is the main land use surrounding the site, with areas of native vegetation to the south and east of the site.

3.3 Geology and soils

Reference to the NSW Seamless Geology dataset (accessed via MinView) indicates the site is situated in the Early Triassic Banks Wall Sandstone unit. The unit consists of quartzose sandstone with a small percentage of lithic fragments and numerous claystone horizons. To the north and south of the site, the Liverpool East Basalt outcrops. Surface geology is shown in Figure 3.3.

The superseded 1:250,000 scale Geological Series Sheet for Tamworth indicates that the site is situated on the Digby Conglomerate of the Narrabeen Group [Rrd]. As observed from bedrock outcrops on the site, this unit has bedding generally dipping toward a bearing of about 190° to 230° at 12° to 18° dip. The local lithology was observed to comprise conglomerate, pebbly sandstone and sandstone beds. The Mooki thrust fault is located about 500 m to the north-east and dolerite capped hills, mapped as Liverpool East Basalt [GOlie], are about 1 km to the north of the site and south of Merriwa Road. Willow Tree Gravel Quarry adjacent to the site quarries both the Liverpool East Basalt and Banks Wall Sandstone units to produce a variety of road and rail construction materials.

Reference to the 1:100,000 scale Soil Landscapes of the Murrurundi map indicate that the site has a Ferrosol and Kandosol soil landscape. The soil landscape is characterised by undulating to rolling low hills with slopes ranging 5-15%. Slopes are typically 375-625 m long with elevation ranging from 400-460 m. Total relief is less than 50 m and a local relief of less than 30 m with minor to moderate erosion hazards. The typical soil profile consists of fine sandy loam to silt loam, overlying a loamy clay to clay. The soil types for the Project and surrounds are mapped on Figure 3.4.



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Liverpool Plains Shire Council
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Geology

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FIGURE 3.3

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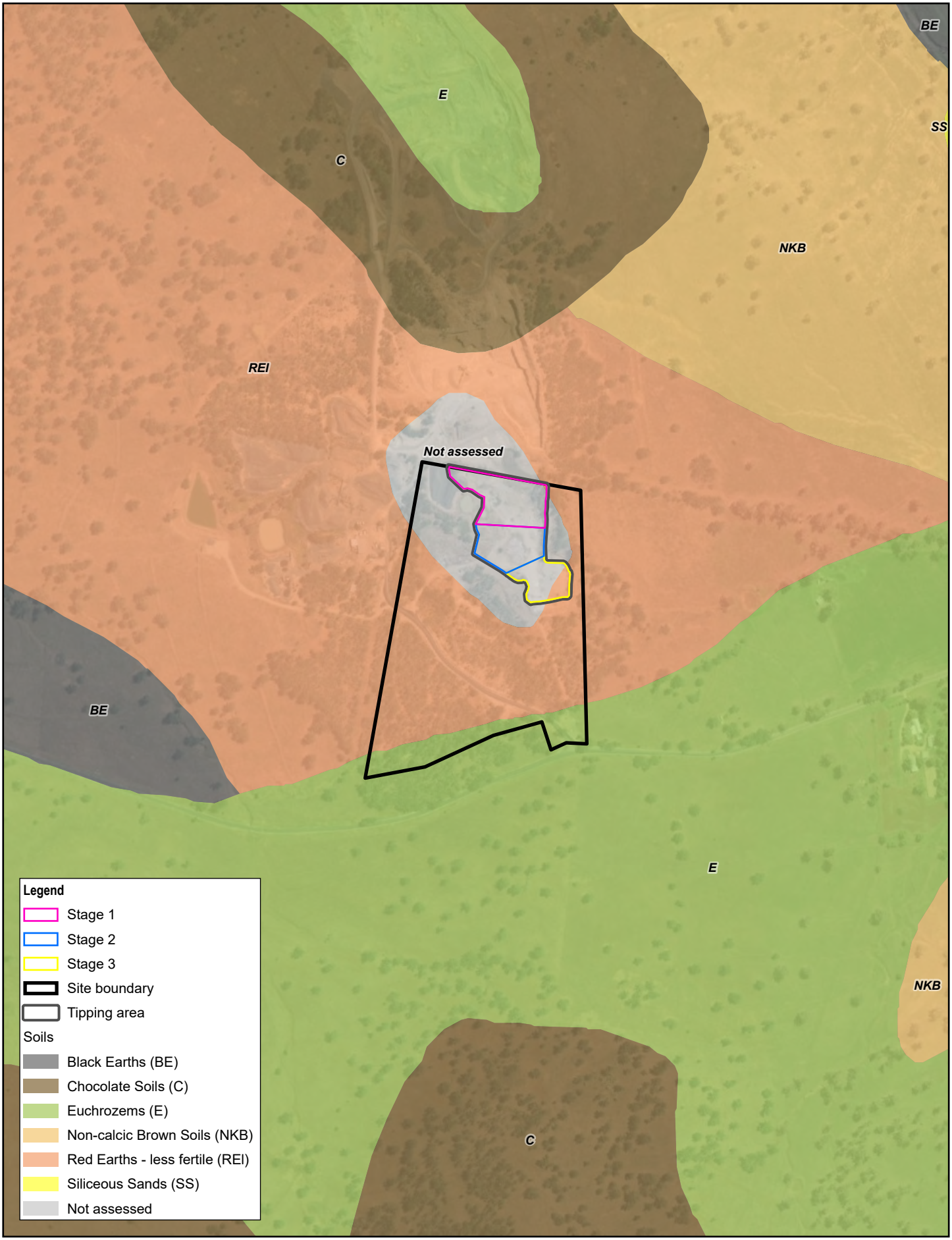

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Soils

FIGURE 3.4

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Data source; Soils - DPE, 2022; World Imagery: Maxar. Created by: pfernandes

3.4 Hydrology and waterways

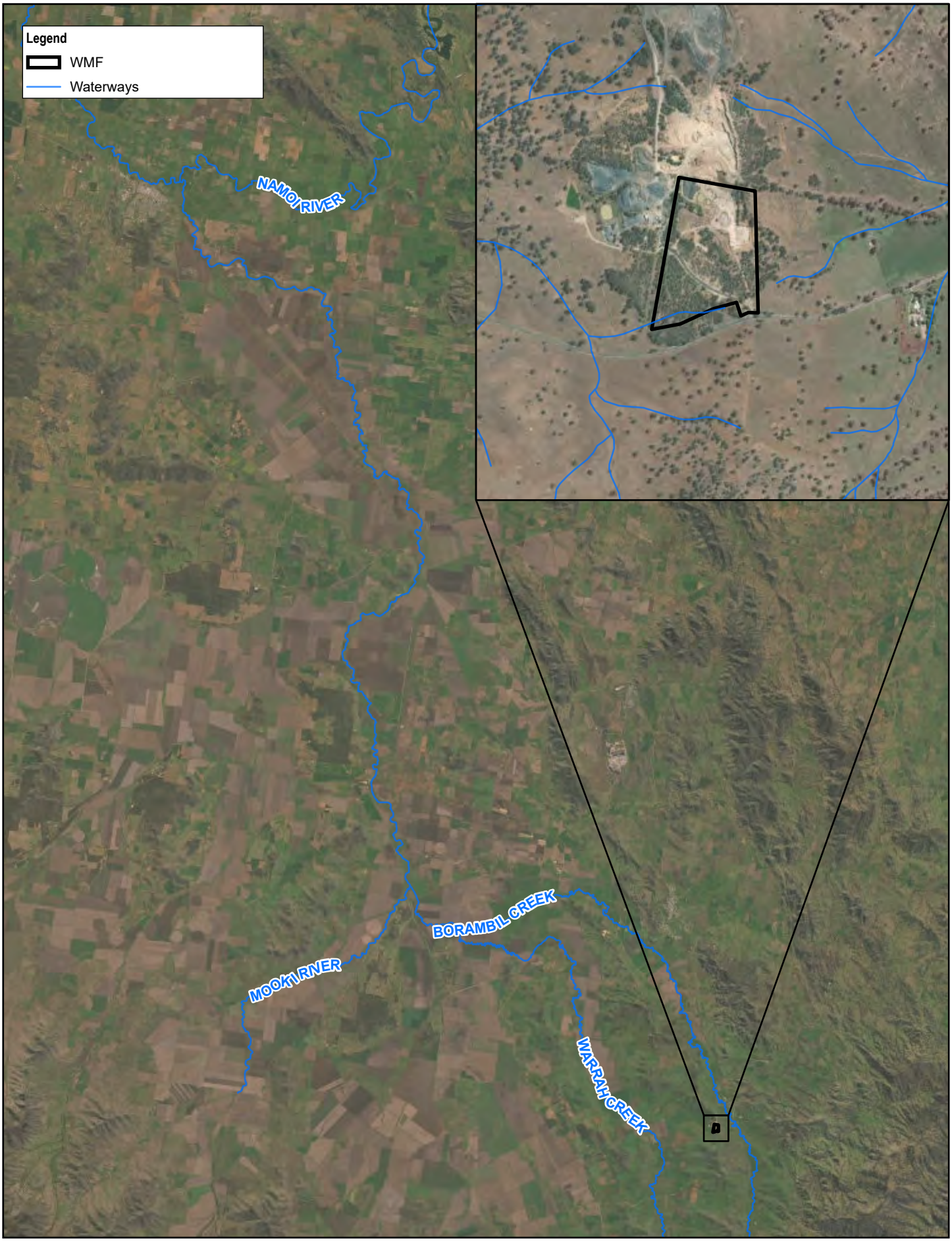
The northern portion of the site has been modified by quarrying and landfilling whereas the southern portion is largely undisturbed. The northern portion generally drains towards several ponds that are central to this area and were likely formed during the quarrying activities. The southern and eastern portions sheet flow away in all directions from the high point, with an intermittent waterbody present in the southwestern corner of the site.

Watercourses in the vicinity of the Project area are shown on Figure 3.5 and include tributaries of:

– Borambil Creek: located approximately 1.3 km to the east of the site.
  - Flows northwest into Warrah Creek, intersecting about 26 km northwest of the Project
– Warrah Creek: located approximately 4.8 km to the west of the site.
  - Flows northwest into the Mooki River, intersecting about 31 km northwest of the Project

The Mooki River flows north where it meets the Namoi River approximately 87 km north northwest of the site, which is located within the Namoi River catchment.

Surface water discharge from the WMF would flow west to a tributary of Warrah Creek.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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FIGURE 3.5

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Data source; Waterways, Waterbodies - NSWSS, 2022; World Imagery: Earthstar Geographics, World Imagery: Maxar. Created by: pfernandes

3.5 Hydrogeology and groundwater sources

The project is located within the Gunnedah-Oxley Basin Murray Darling Basin Groundwater Source which is managed under the WSP for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2020. Groundwater occurs in the porous Permian and Triassic rocks associated with the Gunnedah Basin and overlying younger Jurassic and Cretaceous rocks associated with the Oxley Basin (NSW DPI 2012).

Near the project, groundwater also occurs in the Upper Namoi Zone 1 Borambil Creek Groundwater Source which is managed under the WSP for the Namoi Alluvial Groundwater Sources 2020. This water source is an alluvial aquifer with a high degree of connectivity with the Borambil Creek. The alluvial aquifer is made up of sediments deposited by the Borambil Creek and its tributaries and is comprised of clay, silt, sand and gravel (NSW DPI 2020).

Previous geotechnical investigations involved the excavation of 24 test pits ranging in depth from 0.1 to 1.9 m arranged on a 50 m by 50 m grid (GHD 2021a). No groundwater was observed in these test pits.

3.5.1 Environmental values of groundwater

3.5.1.1 Landholder bores

A search of the Australian Groundwater Explorer (BOM 2022a) and Water NSW (2022) was undertaken to identify registered bores in the vicinity of the Project. The search identified 43 bores within a five-kilometre radius. Of the registered bores, 26 were registered as stock and domestic, six as irrigation, three as water supply, two as monitoring, one as exploration and the remaining five unknown. Standing water level (SWL), salinity description and yield data were sourced from Water NSW Work Summary reports and BOM (2022a). Reported yields range from 0.25 L/s to 10.1 L/s. Standing water levels range from three to 37 m below ground level.

Based on the drillers log in the Water NSW Work Summary reports and referring to the NSW Seamless Geology dataset, the registered bores are screened in several different aquifer units, including alluvial, porous rock (sandstone and conglomerate) and fractured rock aquifers (basalt).

GW900378 and GW902655 are located within one kilometre of the site. GW900378 is 108 m deep with a SWL of 37 m at the time of construction. No groundwater level data was available for GW902655 however the bore was drilled to a depth of 42.7 m. GW969822 is located approximately 1.2 km from site and targets the sandstone aquifer. The reported SWL at the time of drilling was 4.5 m (18/05/2011).

Registered bore details are summarised in Table 3.1 and shown in Figure 3.6.

Table 3.1 Registered bore details

Bore ID	Purpose	Easting (MGA Zone 56)	Northing (MGA Zone 56)	Date completed	Total depth (m)	Yield (L/s)	Salinity description	SWL (m)
GW016518	Irrigation	283881	6496533	1/02/1961	11	3.16	NA	7.3
GW017502	Water Supply	284165	6496498	1/08/1960	13.4	0.63	NA	11
GW018696	Unknown	284269	6492803	1/01/1956	30.8	NA	NA	NA
GW019219	Exploration	284383	6496164	1/10/1960	8.7	5.05	NA	5.8
GW022501	Irrigation	284419	6495702	1/01/1965	3.7	NA	NA	NA
GW022502	Unknown	284452	6495364	1/01/1965	6.1	NA	Good	NA
GW022503	Stock and Domestic	284390	6495856	1/01/1965	7.6	NA	NA	NA
GW022549	Irrigation	278378	6493510	1/10/1960	12.2	10.1	NA	3
GW031841	Stock and Domestic	283182	6499405	NA	15.2	NA	NA	NA
GW049423	Irrigation	278902	6493645	1/04/1979	15.2	NA	1255 µS/cm (28/04/1982)	NA
GW054764	Stock and Domestic	283544	6489676	1/12/1980	91.4	NA	NA	NA
GW055443	Unknown	283205	6497033	NA	9.8	NA	Good	NA

Bore ID	Purpose	Easting (MGA Zone 56)	Northing (MGA Zone 56)	Date completed	Total depth (m)	Yield (L/s)	Salinity description	SWL (m)
GW056815	Stock and Domestic	286915	6492272	1/01/1983	48.7	NA	NA	NA
GW060374	Irrigation	278753	6494443	1/06/1983	9.1	NA	NA	NA
GW062029	Irrigation	278316	6495142	1/01/1982	9.1	NA	NA	NA
GW062855	Stock and Domestic	283150	6498387	1/02/1985	9.1	1.26	NA	4.2
GW070709	Stock and Domestic	285238	6495422	11/06/1993	31.7	0.63	NA	15.2
GW900245	Stock and Domestic	286657	6492012	22/12/1993	18.3	1.5	NA	6.4
GW900378	Stock and Domestic	282699	6494488	1/05/1996	108	0.45	490 mg/L	37
GW901146	Stock and Domestic	285961	6490581	12/03/1998	67	0.25	NA	17.4
GW901600	Stock and Domestic	285413	6493598	22/09/1998	52.7	0.37	NA	7
GW902655	Stock and Domestic	284030	6494154	27/07/1995	42.7	NA	NA	NA
GW903005	Stock and Domestic	287401	6493980	7/06/2018	50.3	NA	NA	NA
GW904396	Stock and Domestic	284025	6491959	28/02/2020	66	NA	NA	NA
GW904658	Unknown	285797	6490588	6/03/2019	22	NA	NA	NA
GW904959	Unknown	285342	6492703			NA	NA	NA
GW965002	Stock and Domestic	280365	6490502	1/01/1925	30.5	NA	NA	NA
GW965123	Stock and Domestic	284681	6494537	23/07/2000	73.1	1.26	NA	8.2
GW965574	Monitoring	278638	6493415	10/06/2002	15	1	NA	6.96
GW965739	Stock and Domestic	285424	6492209	3/04/2002	64	0.9	NA	27.4
GW966126	Stock and Domestic	284897	6495884	11/11/2003	27.7	1.26	NA	16.1
GW966172	Stock and Domestic	284833	6495778	30/01/2004	13.1	0.63	NA	10.6
GW966807	Stock and Domestic	285077	6493436	6/07/2004	61	0.76	NA	12.4
GW967015	Stock and Domestic	284420	6496836	6/01/2005	55	0.9	NA	8.7
GW968552	Monitoring	284628	6495316	18/10/2007	7.2	6.3	NA	7.8
GW969437	Water Supply	280275	6493645	7/03/2007	284	1.4	NA	NA
GW969475	Stock and Domestic	285125	6494050	21/02/2008	61	0.5	NA	5.5
GW969633	Stock and Domestic	282977	6497354	19/04/2007	90	2.2	NA	20
GW969822	Stock and Domestic	284475	6494805	18/05/2011	58	2.52	NA	4.5
GW970542	Stock and Domestic	284655	6495915	5/04/2013	57	0.25	Very Good	16.5
GW970552	Stock and Domestic	287980	6493555	22/01/2013	42.7	0.5	NA	15
GW971064	Stock and Domestic	287190	6496765	26/09/2014	35.6	2.52	NA	14.6
GW971461	Water Supply	284003	6496552	14/05/2015	21	NA	NA	NA

NA - no data available

Most registered bores near the project have yield less than 5 L/s, and therefore in the absence of any site-specific groundwater data, the groundwater source can be defined as “less productive” as per the NSW AIP.

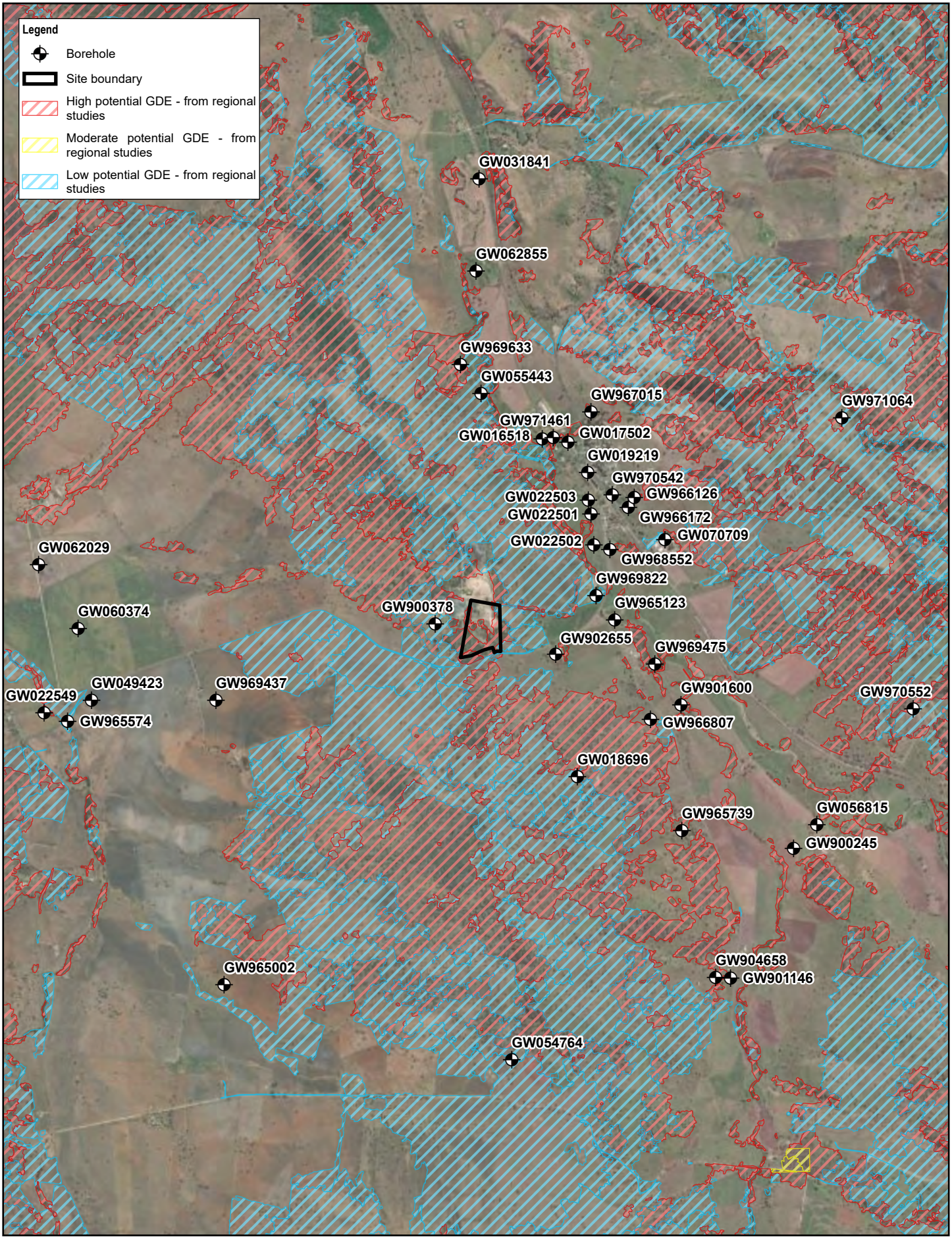
Groundwater level data was available for GW965574, located approximately 4.7 km from the site. Groundwater levels fluctuate between approximately four and eight metres below ground level.

3.5.1.2 Groundwater dependent ecosystems

A search of the Groundwater Dependent Ecosystem Atlas (BOM 2022b) was undertaken to identify groundwater dependent ecosystems in the vicinity of the Project. The GDE atlas indicates there are areas of low and high potential terrestrial GDEs in the area (within 10 km of the project area). Potential GDEs are identified based on regional assessments of groundwater levels, remote sensing of vegetation and surface topography. Potential GDEs within 10 km of the project area are shown in Figure 3.6.

Based on the GDE atlas (BOM 2022b) there are no known GDEs within 10 kilometres of the project area.

The High Priority Groundwater Dependent Ecosystem maps (GDE023 and GDE017) and the relevant WSPs were reviewed to identify any high priority GDEs within the Gunnedah-Oxley Basin Murray Darling Basin Groundwater Source and the Borambil Creek Groundwater Source. No high priority groundwater-dependent ecosystems were listed in the WSPs within the area potentially impacted by the project, however high priority groundwater dependent vegetation ecosystems within the Gunnedah-Oxley Basin Murray Darling Basin Groundwater Source may occur near the project.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Registered groundwater users and GDEs

FIGURE 3.6

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GDE - BoM, 2022; Boreholes - MinView, Water NSW - 2022; World Imagery: Earthstar Geographics. Created by: pfernandes

3.6 Flooding

The Project site is not mapped within the Large Design Flood Map extents of the Floodplain Management Plan for the Upper Namoi Valley Floodplain (DPI Water 2019). Topographically, the Project sits at a minimum approximated relief of 480 m AHD, with Borambil Creek to the east at approximately 427 m AHD and Warrah Creek to the west at approximately 375 m AHD.

The site is not located within the study area for the Murrurundi-Blandford-Willow Tree Flood Management Study (Murrurundi Shire Council, 1998). The study details a January 1996 flood peak close to the 100-year average recurrence interval (ARI) flood that affected the nearby primary school, located 1.8 km from the site.

The site is not located within the Warrah Creek Floodplain Management Plan's (NSW OEH 2012) 'FMP Floodplain' zone which defines flood zones for creeks surrounding the Project site of Warrah Creek and Borambil Creek as shown on Figure 3.7. The FMP Floodplain zone includes land within the Warrah Creek catchment of less than 2% slope. The design event adopted for the FMP floodplain was the five-year average recurrence interval (ARI) event, which is similar to the 1992 flood event within the catchment (NSW OEH 2012).

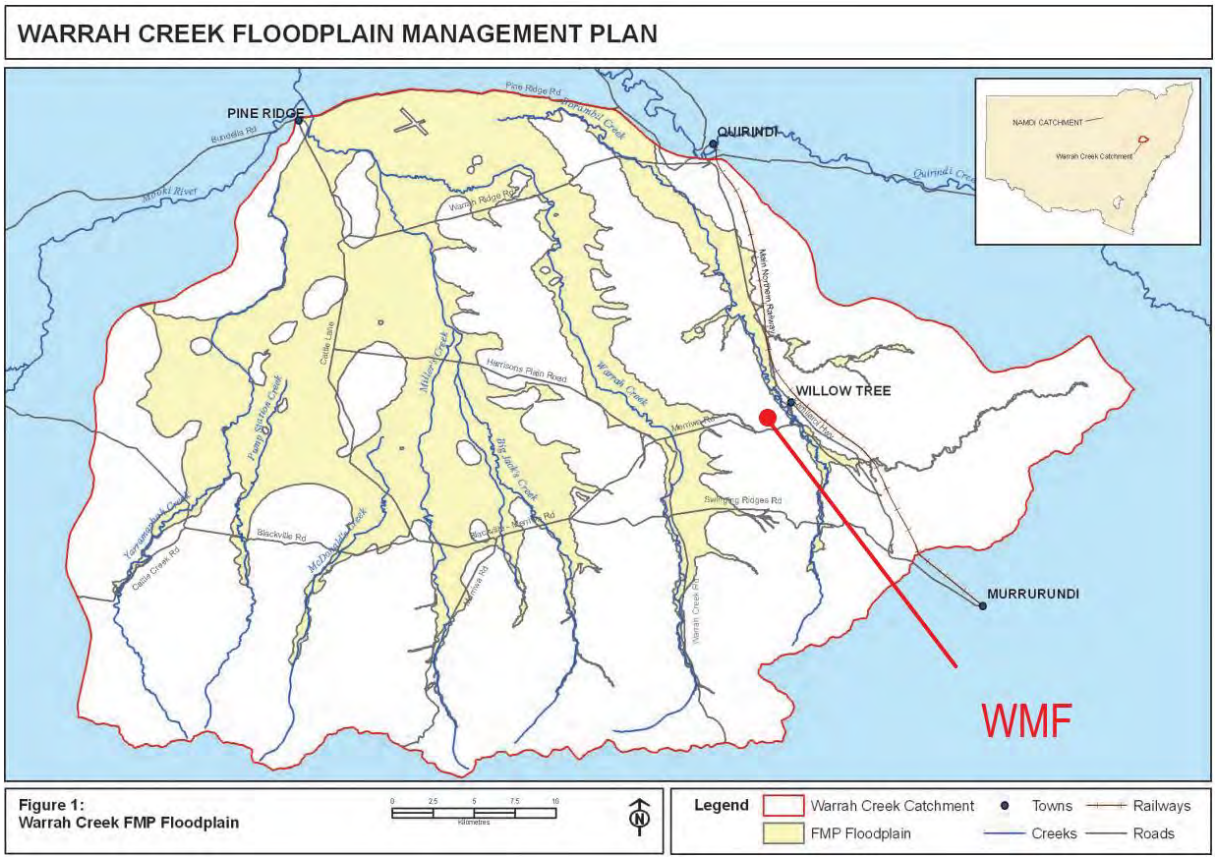


Figure 3.7 Warrah Creek FMP Floodplain map (NSW OEH 2012)

3.7 Downstream water users

Downstream water users for this assessment have been limited to users of the Warrah Creek water source being the water source which would be potentially impact due to the WMF. Downstream users were identified through searches of the WaterNSW – NSW Water Register and are detailed in Table 3.2.

Table 3.2 Warrah Creek water source water users

Water Access Licence (WAL)	Works approval	Category	Lot / DP	Status	Location relative to the WMF
6242	90WA804256	Domestic and Stock	1/1001734	Inactive	Upstream
6243	90WA804256	Unregulated River			
6244	90CA804258	Unregulated River	143/751033	Active	~17.3 km downstream on Warrah Creek
13226	90CA804261	Domestic And Stock	75/7215	Active	~8.8km downstream on Borambil Creek
13227	90CA804261	Unregulated River			
7285	90CA804263	Unregulated River	6/95986	Active (expired)	~2.0 km downstream on Borambil Creek
6245	90CA804265	Unregulated River	29/751016	Active	Upstream
6246	90CA804267	Unregulated River	1/751019	Active	Upstream

Those which are downstream of the Project and hold an active WAL are WAL6244, WAL13226, and WAL13227. As detailed in Section 2.1.3.1, downstream water users can extract water in NSW under the WM Act via basic landholder rights without needed a WAL. Potential impacts to these downstream water users are assessed in Section 5.4.

3.8 Relevant future projects

A search of 'relevant future projects' as defined by the Cumulative Impact Assessment Guidelines for State Significant Projects Guideline (DPIE 2021) was undertaken to assess whether cumulative impacts to and from the WMF would be applicable. The search was conducted using the NSW Planning Portal's: Major Projects website (NSW Gov 2022) on 1 November 2022 and identified SSD-48590227 for the Willow Tree Gravel Extension which is the adjoining property to the WMF and is therefore relevant for cumulative impact assessment for this WIA.

4. Proposed water management system

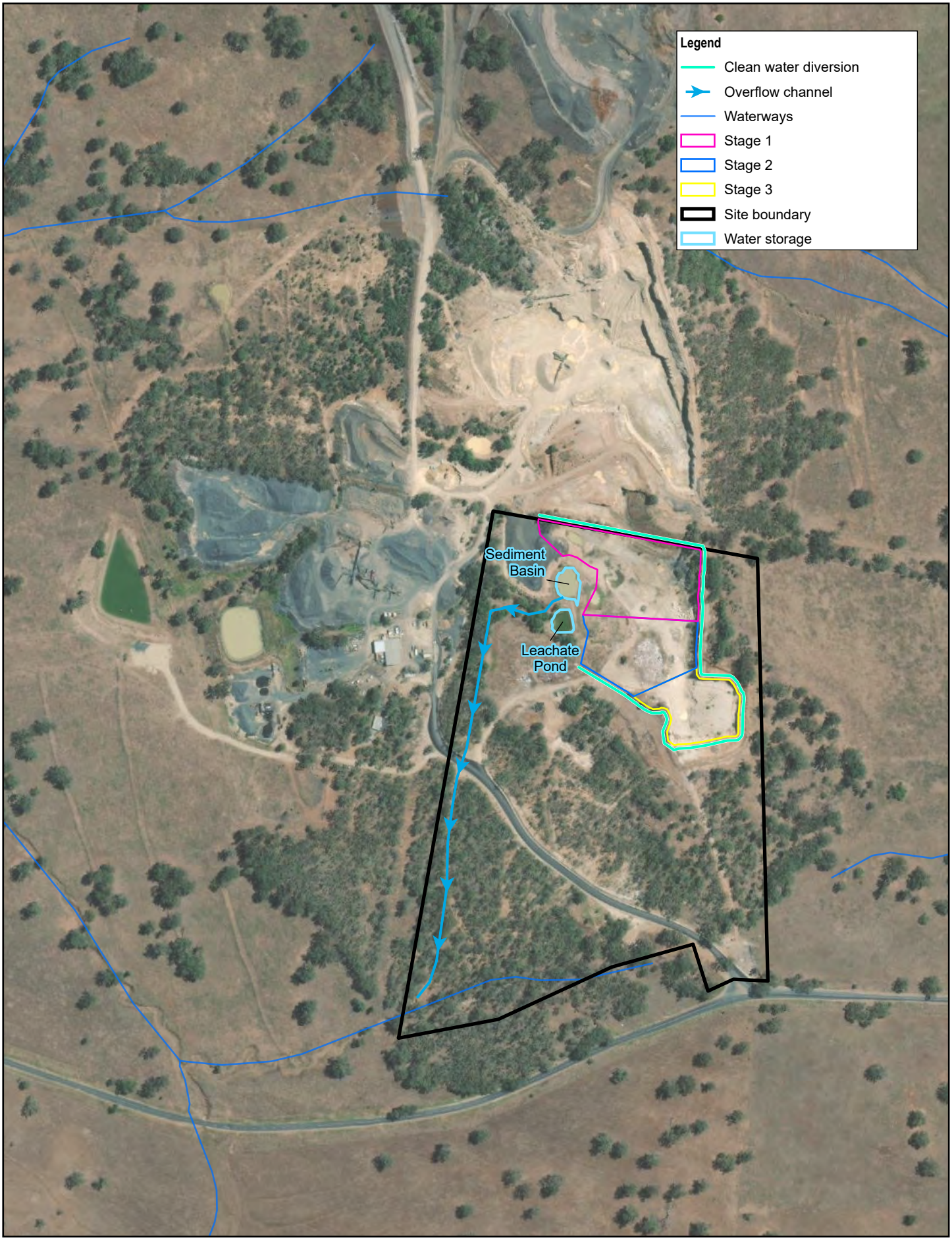
As part of the project, the proposed water management system at the WMF will generally include:

– Perimeter screening bunds to divert upslope catchment runoff around the WMF.
– A Sediment Basin to collect catchment runoff from the disturbed area of the quarry.
– A leachate pond to store and treat captured leachate.

The proposed surface water management system is intended to manage clean and dirty (sediment laden) separately, thereby minimising the volume of clean water captured within the dirty water systems. The are no groundwater inflows expected into the expansion area as only minimal excavation is proposed to establish suitable grades for the landfill floor.

A potable water supply would be connected for use in site amenities consisting of a toilet block, lunchroom and laboratory. Potable water supply has not been assessed for water security purposes given the minor volumes required for operation of the Project.

The proposed surface water management system has been based on concept design drawings in Appendix A of Willow Tree Waste Management Facility – Landfill Expansion Masterplan (GHD 2021b) is presented in Figure 4.1.



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Proposed water management system

FIGURE 4.1

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Data source; Waterways - NSWSS, 2022; World Imagery: Maxar. Created by: pfernandes

4.1 Clean water management system

The clean water management system consists of perimeter screening bunds intended to divert overland surface flows around the expansion area with design to be confirmed during detailed design. Perimeter screening bunds are designed to divert clean water runoff generated within the undisturbed areas upslope of the site.

4.2 Wastewater management system

4.2.1 Leachate

Leachate generated by the project operation will be separated from the clean and dirty water management systems and will be designed to avoid contact with stormwater. Any runoff containing potentially containing leachate will be directed to the Leachate Pond with an aim to minimise discharges.

Leachate will be managed in accordance with EPA (2016), as determined via the Leachate Water Balance (GHD 2022) and would generally include:

– A leachate barrier and collection system that captures generated leachate from the WMF
– A drainage and pipework system to direct generated leachate to the Leachate Pond
– An above ground lined Leachate Pond designed to store leachate and treat it through the following mechanisms in the preferred order of:
    1. Pond evaporation
    2. Irrigation over the rehabilitated landfill
    3. Reinjection into the waste during exceptional circumstances.
– Typical cover and capping profiles utilised during the life of a landfill:
    - Daily cover: Cover profile used on a daily basis to cover exposed waste at the active tipping face
    - Interim cover: Cover profile used to close off a cell that will not receive additional lifts of waste for some time or will not be finally capped for some time (>90 days)
    - Final capping: Capping profile applied to waste that has been landfilled to the final approved levels

4.2.1.1 Leachate water balance

As part of the concept design for the landfill expansion of the WMF, GHD (2022) undertook infiltration modelling and a leachate water balance to determine leachate management options. Infiltration estimation was modelled using the United States Environmental Protection Agency's Hydrologic Evaluation of Landfill Performance (HELP) model and provided an input to the leachate water balance to determine leachate generation estimation. Modelled results for Stage 1 are shown in Table 4.1.

Table 4.1 Leachate storage and disposal results

Scenario	Storage and disposal requirements for 50% AEP rainfall year			Storage and disposal requirements for 10% AEP rainfall year		
	Average monthly storage (kL)	Peak monthly storage (kL)	Peak additional storage required above pond and freeboard (kL)	Average monthly storage (kL)	Peak monthly storage (kL)	Peak additional storage required above pond and freeboard (kL)
Stage 1	1,390	3,160	120	2,610	3,160	960

The report summarised that:

– The leachate pond has sufficient capacity for leachate storage and disposal across the various stages, with the exception of Stage 1 which potentially requires additional storage due to the initial open subcell arrangement. However, there is sufficient volume available within the 300 mm thick leachate drainage layer at the base of the subcell to temporarily address this shortfall during this scenario.

– For future stages, the storage volume within the leachate drainage layer will increase as more subcells are brought online, hence providing additional temporary storage volume should it be needed it wetter conditions. In addition, this could be supplemented by leachate irrigation across the daily and interim cover areas for each stage (with suitable environmental controls to prevent leachate migration beyond these areas) to further increase the disposal capacity.

The findings of the leachate water balance in the context of the WIA suggest that:

– There is a potential for uncontrolled discharge of leachate to the downstream environment via overflow of the Leachate Pond during excessive rainfall.
– Leachate irrigation across daily and interim cover areas can provide additional disposal capacity following wetter conditions.
– Increasing the Leachate Pond should be considered during the detailed design phase to mitigate the occurrence of uncontrolled discharge.

Leachate impacts are further assessed in Section 5.1.1.4.

4.2.2 Sewage

Wastewater collected from site facilities such as toilets, lunchroom and washing, and the laboratory are to be directed to a site Advanced Wastewater Treatment System (AWTS) for on-site treatment. The clarified effluent would be irrigated for disposal to the tipping area for dust suppression and vegetation establishment as required. Alternatively, clarified effluent may be directed to the Leachate Pond for evaporation.

4.3 Dirty water management system

The dirty water management system consists minor surface drainage works direct sediment laden stormwater to the Sediment Basin. The Sediment Basin is proposed to be a repurposed existing surface water storage likely formed during historical quarry operations. Surface flows from within the expansion area would drain to the Sediment Basin. Figure 4.1 outlines the key features of the system, with construction details to be confirmed via a full detailed design of all stormwater controls undertaken before installation. The basin would naturally overflow to the west, via an open channel and would eventually discharge to Warrah Creek as the receiving water. The estimated dirty water catchment is approximately 3.7 ha.

4.3.1 Sizing of the Sediment Basin

The Project has the potential to result in sediment runoff and scour as a result of ground disturbance and sediment mobilisation required for the operations. To minimise the potential impacts of the land disturbances from the WMF, a Soil and Water Management Plan would be prepared based on the requirements of the Environmental Guidelines: Solid waste landfills (EPA 2016), and NSW Soils and Construction – Managing Urban Stormwater Volume 1 ‘the Blue Book’ (Landcom, 2004).

EPA (2016) requires sediment basins to be designed, constructed, operated and maintained in accordance with the Blue Book. Sediment Basins are designed to manage sediment-laden runoff from disturbed areas and are typically constructed in areas where disturbance activities are expected to result in soil loss greater than 150 m^3/yr. The design of sediment basins should consider cleanout requirements, stable banks and pump out facilities. The water intercepted by the sediment basin will be reused for dust suppression or discharged off site via the drainage drain. The following calculations follow the methodology for sizing sediment basins for landfills.

Table 4.2 presents the site constraints that have been considered in the computation of the RUSLE Two Month Calculated Soil Loss and settling zone capacity for the sediment basin.

Table 4.2 Constraints table

Aspect	Factor	Reference
Design rainfall depth	90th percentile, 5-day rainfall event– 39.2 mm	Blue Book, Table 6.3a for Murrurundi For a standard sensitivity of receiving environment and longer than three-year duration of disturbance
Soil landscape	Willow Tree (wt)	eSpade (DPIE, 2022)
Soil Type	F (fine dispersible material)	Blue Book, Appendix C - Table C11. Murrurundi Soil Landscapes for Willow Tree (wt)
Soil Hydrologic Group	D	Blue Book, Appendix C -Table C11. Murrurundi Soil Landscapes for Willow Tree (wt)
Soil Erodibility – K Factor	0.022	eSpade (DPIE, 2022)
Rainfall – R Factor	1500	Blue Book, Appendix B – Map 6: Rainfall Erosivity of the Tamworth 1:250,000 topographic Sheet
Volumetric Runoff Coefficient	0.64	Blue Book, Appendix F - Table F2

In the absence of site-specific soil data, information on the likely soil type has been sourced from the Murrurundi Soil Landscape section of the Blue Book (Appendix C – Table C2) for Willow Tree (wt). Conservatively, soil type for the WMF has been adopted as 'Type F'.

The total volume of a 'Type F' sediment basin is the sum of the following two components:

– A settling zone, within which water is stored allowing the settlement of suspended sediment, and
– A sediment storage zone, where deposited sediment is stored until the basin is cleaned out.

The settling zone volume is determined from the 90th percentile, 5-day rainfall event of 39.2 mm, with a volumetric runoff coefficient (Cv) of 0.64. The adopted Cv is described to have a runoff potential of high. Contributing catchment areas to the Sediment Basin is represented by the extent of the three stages as shown in Figure 4.1.

The sediment storage zone is taken as either the:

– 50% of the settling zone capacity, or
– Two months soil loss as calculated with the Revised Universal Soil Loss Equation (RUSLE).

Results are summarised in Table 4.3.

Table 4.3 Sediment Basin sizing

Storage	5-day, 90th percentile rainfall event	Volumetric Runoff Coefficient, Cv	Catchment area (ha)	Required Settling Zone	Required Sediment Storage Zone			Required Sedimentation Basin Volume (m³)
					50% of Settling Zone volume (m³)	RUSLE Two Month Calculated Soil Loss (m³)	Adopted Sediment Storage Zone (m³)	
Sediment Basin	39.2	0.64	3.7	928.3	464.1	41.1	464.1	1,392

Results indicates that 50% of the settling zone capacity yields a larger storage volume compared to the RUSLE two month calculated soil loss and was therefore adopted for calculating the total sediment storage volume of 1,392 m^3.

This conservatism allows for a longer period between required desilting of the Sediment Basin.

4.4 Site water balance

A site water balance model was developed to quantify the potential impacts to water security, and of dirty water discharges under a range of rainfall conditions. The model considers all major surface and groundwater interactions of the project site with the exclusion of leachate which is addressed in Section 4.2.1. The purpose of this section is to provide a brief summary of the key inputs and assumptions and to assess the potential impacts of the project based on the modelling results.

The model was used to estimate the average annual transfers between water cycle components of the project under proposed conditions. This represents the Stage 1 of the proposed operations as part of the project, as this reflects the 'worst case' scenario as the largest operational disturbance area of the landfill compared to the other two stages.

The model was simulated using a historical time series of daily rainfall data extending over 133 years, from January 1889 to January 2022. A total of 133 realisations were applied, with each realisation modelling a different rainfall pattern from the record.

The principal sources of water for the Project are:

– Catchment runoff from disturbed catchments captured in the Sediment Basin.
– Direct rainfall on the Sediment Basin.

The principal demands of water for the Project are:

– Evaporation losses.
– Landform stabilisation demand.

Water demands for the Project, such as landform stabilisation and evaporation losses, will vary in response to the climatic conditions. It is assumed that immediately after a rain event in each realisation, the basins will be dosed (with an appropriate dosing agent as required following water quality testing). Stored rainwater in the Sediment Basin is pumped out (controlled discharges) within 5 days to allow the 90th percentile, 5-day storm volume to remain free in the Sediment Basin. Remaining water in the sediment basin may be reused on-site. The model was initialized with empty storage for the Sediment Basin.

4.4.1 Methodology

To estimate the runoff contributing to the surface water storages at the site, the Australian Water Balance Model (AWBM) was incorporated into the wider water balance model. The AWBM was adopted as the most suitable model as it is widely used throughout Australia and has been verified through comparison with large amounts of recorded streamflow data and literature is available to assist in estimating input parameters based on recorded streamflow data (Boughton and Chiew, 2003). Another advantage of the AWBM is the consideration of soil moisture retention when determining runoff.

The estimation of operational areas has been based on concept design drawings in Appendix A of GHD (2021b) which have been reproduced on Figure 4.1.

4.4.2 Operational demands

Operational data relating to water management for the Project were used to develop the water balance model. This site-specific information was used as input to the model (i.e., modelling parameters) and is listed in Table 4.4.

Table 4.4 Modelled operational demands

Demand	Description	Input
Landform stabilisation demand	To control and eliminate spread of dust and other fine particles in the air: – Water sprayed to unsealed roads – Irrigation of capping and revegetation areas Applied during dry days (evaporation > rainfall). Assumed that the maximum demand for dust suppression would be during Stage 1 of the tipping design. Assumed that dust suppression would be required for 5% of Stage 1 at any one time to be representative of the tipping face and progressive rehabilitation demands.	Estimated dust suppression and irrigation required for 5% of Stage 1 design at any one time. – Estimated Stage 1 area = 16,785 m² – 5% of Estimated Stage 1 area = **840 m²**
Controlled discharge	Stored rainwater in the sediment basin that is pumped out within 5 days to allow the 90th percentile, 5-day storm volume to remain free in the sediment basin.	Calculation based on dewatering rate required to reduce Sediment Basin volume. – Pump rate = **0.1857 ML/day**

4.4.3 Annual water transfers

The average annual forecast water transfers for the Project for proposed conditions is summarised in Table 4.5.

Table 4.5 Annual average water transfers

Water management element	Proposed conditions (m^3/year)
INPUTS	
Direct Rainfall	204
Catchment runoff	2048
TOTAL INPUTS	**2252**
OUTPUTS	
Evaporation	353
Reuse	773
Controlled discharges	836
Uncontrolled discharges (overflows)	290
TOTAL OUTPUTS	**2252**
CHANGE IN STORAGE	
Surface water storages (sediment basin)	0
TOTAL CHANGE IN STORAGE	
Inputs – outputs – change in storage	0

Table 4.5 shows that, on average, majority of the inflows for the Project come from catchment runoff. Most of this either goes toward on-site reuse for landform stabilisation demand or taken out as controlled discharge, reflecting the pumping out of stored stormwater to maintain an environmental containment freeboard for the 90th percentile, 5-day storm volume and sediment basin overflows during heavy rainfall events. A relatively minor volume of total inflow is released either by uncontrolled discharge or through evaporation.

4.4.4 Water security

The site water balance model was used to estimate the annual exceedance probability (AEP) of total water deficit for reuse demands for the Stage 1 surface of the proposed conditions, as shown in Figure 4.2. Annual exceedance probability of total water deficit is a performance measure that quantifies the expected likelihood of any total water deficit for reuse demands during a given year based on modelling results.

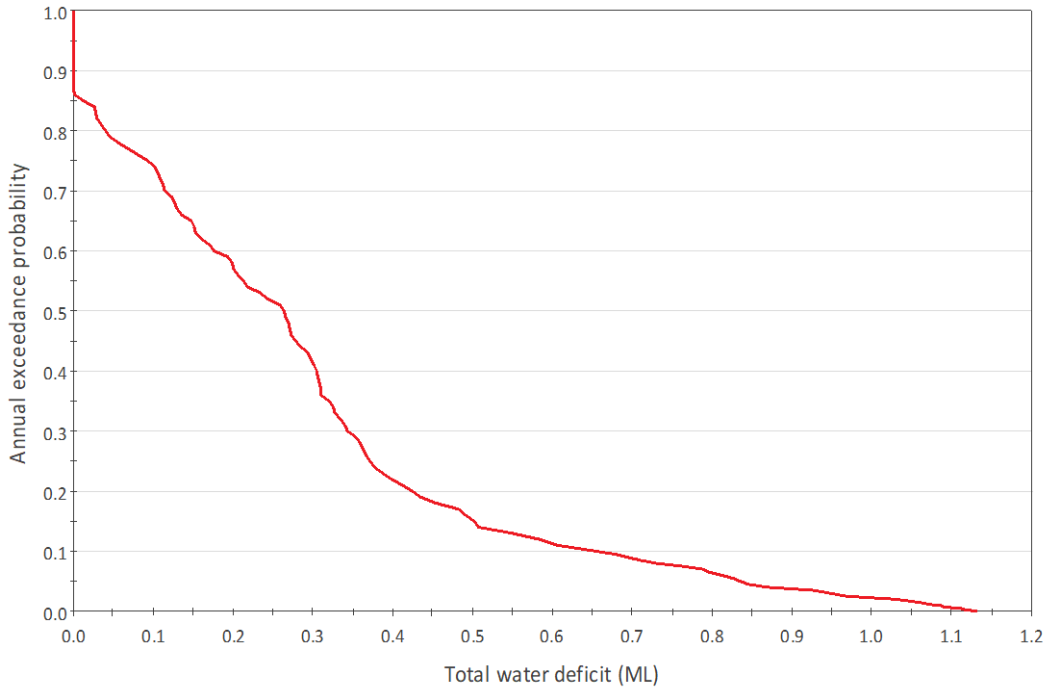

Figure 4.2 Annual exceedance probability of total water deficit

Figure 4.2 indicates that the average total water deficit (50% annual exceedance probability) for reuse demands is approximately 0.27 ML/year or approximately 740 L/day. Water security could be improved by increasing the size of the basin, so it is larger than is required for sediment control, but sufficiently sized to satisfy operational water demands of the Project. As mentioned in Section 4.2.1, water security may be offset by leachate re-use for land stabilisation which also assists in freeing up leachate storage capacity and hence reducing potential leachate discharge, however excess leachate volumes are unlikely to coincide with dirty water deficits and therefore this is not a reliable mitigation measure.

4.4.5 Off-site discharges

The annual average water balance results presented in Section 4.4 represents the average (mean) conditions but do not necessarily reflect the potential for off-site discharges due to rare rainfall events that exceeds the design capacity of the water management system.

As per Table 6.2 of Managing Urban Stormwater: Soils and Construction – Volume 2B Waste Landfills (DECC 2008), the indicative average annual sediment basin overflow frequency is 2 to 4 spills per year for 90th percentile design storm event.

The average number of annual exceedances of offsite discharge for the sediment basin is summarised in Table 4.6. Results are rounded to the nearest whole number.

Table 4.6 Summary of off-site discharges from sediment basin

Storage	Adopted basin volume (ML)	Number of outflow events per year		Outflow volume per year (ML/year)	
		Average	Maximum	Average	Maximum
Sediment Basin	1.4	0	9	0	5

Table 4.6 indicates an average number of 0 outflow events per year from the sediment basin with a maximum outflow volume of 5 ML/year. This is acceptable to the spill frequency suggested in Table 6.2 of DECC (2008).

5. Impact assessment

5.1 Surface water

5.1.1 Surface water quality

The Project has the potential to cause impacts to surface water quality. Impacts to surface water quality could occur through the following activities:

– General earthworks
– Transportation and stockpiling of excavated material
– Potential for leaks and spills
– Leachate management.

These potential risks to surface water quality are discussed in further detail in the following subsections.

5.1.1.1 General earthworks

Construction and operation of the WMF area has potential to impact surface water quality in the downstream tributaries of Warrah Creek:

– Removal of vegetated groundcover, exposing bare soil to water erosion in rainfall events, causing sedimentation in receiving waters.
– Extraction of soil, mobilising sediment through extraction and transportation of capping material, causing opportunity for sedimentation in receiving waters.

It is expected that sediment control structures and the Sediment Basin presented in Section 4 will be sufficient to adequate mitigate potential impacts to downstream water quality from dirty water produced from the WMF in accordance with the relevant guidelines. The water balance demonstrates that the water management system can allow for re-use of excess water for suppression during operation to minimise discharges.

The proposed surface water management system is expected to mitigate potential surface water quality impacts. The residual potential impacts of the project to surface water are considered low and would have minimal impact on NSW Water Quality objectives as presented in Section 2.3.3. A Site Water Management Plan will be required to be developed for the Project as detailed in Section 6.1.1.

5.1.1.2 Transportation and stockpiling of excavated material

The earthworks and movement of construction vehicles within the Project areas could increase erosion and sediment deposition in waterways. Construction activities adjacent to waterways could introduce contaminants such as oil and greases or disturb contaminated sediments, potentially having an adverse impact on water quality. All waterways within the Project area are at risk of being impacted, particularly the downstream catchment of Warrah Creek.

Stockpiles of raw materials or spoil would be located as close as practical to the work area with implementation of appropriate environmental protection measures to minimise impacts on receiving waters from erosion and sedimentation. Stockpile sedimentation control measures would be designed as part of detailed design once stockpile locations and volume are defined for the Project.

5.1.1.3 Potential for leaks and spills

The release of potentially harmful chemicals and other substances in the environment may occur accidentally due to leakage or spills of petroleum, oils and other toxicants from construction machinery, plant equipment, and vehicles travelling to and from site. Spills and leakages could potentially be transported to downstream waterways. This can result in oily films on surface water reducing the visual amenity and a decrease in biodiversity, loss of habitat and fish kills from elevated concentrations of toxicants.

Containment of spills and leaks will be in accordance with EPA's guidelines section 'Bunding and Spill Management' and the most recent versions of the Australian Standards referred to in the Guidelines. Containment would be designed for no-discharge.

5.1.1.4 Leachate management

The generation of leachate from the WMF operation has the potential to introduce leachate into downstream watercourses, impacting surface water quality. The leachate management system as described in Section 4.2 is deemed sufficient at mitigating potential surface water quality impacts for the operation of the WMF up to the 10% AEP (wet) rainfall year (GHD 2022). However, monitoring measures would need to be implemented to reduce residual risk of leachate impacting surface water quality as detailed in Section 6.2.1. Management measures to reduce Leachate Pond overflow events are provided in Section 6.1.4.

5.1.2 Surface water flow

There may be impact to downstream hydrologic features during construction and operation of the Project and would occur through:

– Removal of vegetation and general earthworks
– Transportation and stockpiling of excavated material

These potential risks to surface water flow are discussed in further detail in the following subsections.

5.1.2.1 Removal of vegetation and general earthworks

The removal of vegetation causes a reduction in overland flow resistance, and earthworks can alter existing surface water flow paths and potentially concentrate flows, both resulting increased flow velocities. Increased overland flow velocity increases the potential for stream bank erosion.

Potential impacts on flow regimes in Warrah Creek and the tributary have been assessed by consideration of the site water balance with respect to modelled off-site discharges presented in Section 4.4.5. Discharges of surface water from the site are modelled to be infrequent and would only occur during storm events. Given the project is in the upper reaches of the Warrah Creek catchment, discharging into an ephemeral stream (tributary), such discharges are to be expected and would have minimal impact NSW River Flow objectives as presented in Section 2.3.3. The re-use of Sediment Basin water for landform stabilisation has been assessed in Section 4.4 that discharges would be infrequent and of minor volumes given the relatively small change in catchment due the project in comparison to the overall Warrah Creek catchment.

Final design of the Sediment Basin and erosion controls would be determined as part of detailed design and would be managed through implementation of a Construction Environmental Management Plan (CEMP) (see Section 6.1.1).

5.1.2.2 Stockpiling of excavated material

The stockpiling of excavated material can divert existing surface water flow paths, potentially increasing or decreasing flows to tributaries, resulting in a changed flow regime for tributaries.

Clean water diversions would need to be constructed around stockpiled material to avoid clean water contact with disturbed areas. Rainfall runoff from stockpiles would need to be diverted towards sediment basins for treatment and reuse. Stockpile diversions would be designed as part of detailed design once stockpile locations and volume are defined for the project.

5.2 Flooding

There is no expected significant change to the extent of flooding and the stability of downstream watercourses, as it is not expected there will be changes to catchment area as a result of the project. The project has a relatively small catchment area compared to the immediate downstream watercourses' catchment for Warrah Creek. Potential changes may be considered minor and are not expected to have a significant impact on the extent and depth of flooding. Section 3.6 outlines that the Project is unlikely to be impacted by flooding events given the elevated nature of the Project site to surrounding waterways.

Therefore, there is not anticipated to be any potential flood impacts on, or due to, the construction and operation of the project.

5.3 Groundwater

Groundwater is not expected to be encountered during project construction based on a review of publicly available data and geotechnical investigations, therefore groundwater interception assessment was not considered necessary. Additionally, the AIP minimal impact considerations were not required to be assessed due to Project activities falling under the AIP 'defined minimal impact aquifer interference activities.' The project will not rely on groundwater as a supply for operational water demand.

There is a potential for leachate generation to cause impact to groundwater quality through poor design and operation of leachate management controls. Monitoring measures would need to be implemented to reduce residual risk of leachate impacting groundwater quality as detailed in Section 6.2.2.

5.4 Downstream water users

There is a potential for WMF impacted surface water to enter downstream waterways and be beneficially reused by WAL holders. Section 3.7 shows that downstream WAL's holders relevant to the project site are unlikely to be impacted by the project given the likelihood of potential contaminated discharges from site, and the location of these users relative to the project, with:

– WAL6244 identified approximately 17.3 km downstream on Warrah Creek. Unlikely to be impacted due to proximity to the project.
– WAL13226 and WAL13227 approximately 8.8 km downstream on Borambil Creek. Unlikely for impact from the project on this watercourse.

Downstream water users excising basic landholder rights to water extraction have the right to access water from a river, lake, estuary or aquifer. It is unlikely any of these users to be impacted since:

– There is a minimal impact potential to groundwater
– Lakes and estuaries do not form part of the Warrah Creek water source
– Site discharges would be infrequent and of minor volumes given the relatively small change in catchment due the project in comparison to the overall Warrah Creek catchment
– The nature of Warrah Creek and its tributaries being in an agricultural dominated land setting, and predominately ephemeral flows mean that is unlikely for there to be downstream drinking water users
– Impacts to 'rivers' (defined under the WM Act as "any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved") from uncontrolled discharges would be managed via monitoring measures.

Monitoring measures as detailed in Section 6.2.1 would act as early detection in the unlikely case of potential impacting surface water quality to downstream water users.

5.5 Cumulative impacts

As identified in Section 3.8, SSD-48590227 for the Willow Tree Gravel Extension requires assessment for cumulative water impacts. Table 5.1 adopted from DPIE (2021) summarises details from the Willow Tree Gravels Quarry Scoping Report (Groundwork Plus 2022) relevant for cumulative water impact assessment.

Table 5.1 Cumulative impact assessment scoping summary

Future projects	Approx. distance to project	Project Status / Indicative timing / overlap	Potential overlap between impact of project on assessment matter and impact of other project on the same assessment matter
SSD-48590227	0.1 km	– Project under assessment – Anticipated project life of 25 years	The project includes key works in regard to water impacts including: – Earthworks for cell formation including extraction and stockpiling of materials and the reapplication to form the leachate barrier (cell liner) as well as for daily, intermediate and final cover – Installation of leachate management infrastructure including the leachate barrier, collection, storage and disposal system – Installation of a leachate management system – Installation of a stormwater management system – Rehabilitation of closed cells

It is assumed that project SSD-48590227 will follow a similar WIA during the EIS phase given the project key works identified in Table 5.1. It is expected that the greatest potential cumulative impact would be for uncontrolled discharge to the tributary of Warrah Creek as both operations are assumed to discharge into this waterway. To minimise impacts to the downstream environment and water users, consultation between both operations may be undertaken as part of development of a surface water monitoring program, similar to what is provided in Section 6.2.1.

6. Mitigation, monitoring and management

6.1 Management

Management mitigation measures that will be implemented to minimise the impacts on water are provided in subsequent subsections.

6.1.1 Construction environmental management plan

A Construction Environmental Management Plan (CEMP), inclusive of a site water management plan, will be prepared for the Project with measures to mitigate the impact of soil and water associated with the project and will include:

- Erosion and sediment control plans
  - Project erosion and sediment control will be developed in accordance with the erosion and sediment control framework. Any activities that result in ground disturbance associated with the Project will have a detailed Erosion and Sediment Control Plan (ESCP) prepared based on specific construction methodologies. The objective of the ESCP is to ensure that appropriate structures and programs of work are in place to:
    - Identify activities that could cause erosion and generate sediment
    - Describe the location, function and capacity of erosion and sediment control structures required to minimise soil erosion and the potential for transport of sediment downstream
    - Ensure erosion and sediment control structures are appropriately maintained
    - Minimise areas of disturbance and ensure that progressive rehabilitation is undertaken
    - Fulfil the statutory conditions of the Project approval
    - Consider industry standard practice, specifically:
      - Landcom 2004. Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition
      - Department of Environment and Climate Change (DECC) 2008. Managing Urban Stormwater: Soils and Construction – Volume 2B Waste Landfills.
- Stockpile management
  - Measures to manage stockpiles including locations, separation of waste types, sediment controls and stabilisation.
  - Minimising the quantity, lifespan and size of stockpiles.
  - Stabilising stockpiles, establishing appropriate sediment controls and suppressing dust as required.
  - Locating stockpiles away from drainage lines, waterways and areas where they may be susceptible to wind erosion.
- Sediment basin management
  - Processes for dewatering of water that has accumulated on site and from sediment basins, including relevant discharge criteria.
- Monitoring
  - Details of surface water and groundwater quality monitoring to be undertaken prior to, throughout, and following construction. See Section 6.2.
- Exclusion zones
  - Establish exclusion zones for construction plant and equipment.
- Spill management
  - Measures to manage accidental spills including the requirement to maintain materials such as spill kits.
  - Procedures for spill incident management. Containment of spills and leaks shall be in accordance with EPA's guidelines section 'Bunding and Spill Management'.

- Provision of preventative controls for spills such as alarm systems, regular training and routine inspection of potential contamination sources.
- Remediation of potential contamination sources and where possible removal of the contamination source.

6.1.2 Water resource

Water use would be managed through re-use of captured dirty water and leachate for construction and operational water demands, with make-up from alternative water supply options such as potable mains and/or water carting to be further refined during detailed design with the aim of reusing water from recycled water sources where feasible. It is recommended to construct a basin larger than is required for sediment control to provide added water security. In event of water deficit, external water sources such as water trucks or farm dams may be used to cover for the total water deficit. Alternatively, there is opportunity to access up to 3 ML groundwater from an aquifer without a licence.

6.1.3 Groundwater

If groundwater is unexpectantly intersected during excavations, excavations should cease in that area and the date, location, level and depth of groundwater interception should be documented by the contractor.

There is currently an exemption from having a WAL for taking less than or equal to 3 ML of groundwater per year in any water source (3 ML or less exemption). The 3 ML or less exemption applies only to aquifer interference activities not involving take of water for consumptive use or supply.

Consultation with hydrogeologist on the appropriate course of action may be required. Such a course of action may include re-location of excavations to higher areas of elevation where groundwater would likely be deeper and establishment of routine monitoring of the monitoring bores in the vicinity of the works.

6.1.4 Leachate

The Landfill, the Environmental Guidelines: Solid waste Landfills (EPA 2016) will be followed for specific design of the Landfill during detailed design. EPA (2016) will be adhered to for operation of the Landfill pertaining to requirements for leachate management, water management and monitoring, and cover/capping requirements. The requirements would be included under the CEMP and include:

– Implementing leachate irrigation across daily and interim cover areas to provide additional disposal capacity following wetter conditions. The intent of this would be to free up capacity within both the leachate drainage layer and the Leachate Pond through increased evapotranspiration.
– Increasing the Leachate Pond to provide greater capacity and hence insurance to maintain leachate capture within the Leachate Pond. Doing so would allow for:
    - A greater evaporative surface
    - Additional residence time of stored leachate for treatment and management
    - A reduction of active management of leachate by site personnel
    - A reduction in contaminant flux discharged offsite

These should be considered during the detailed design phase once the final landfill staging has been confirmed.

6.2 Monitoring

6.2.1 Surface water

Surface water quality monitoring would be managed by the proposed surface water management systems detailed in a proposed CEMP and would continue through the operational phase of the project. Dewatering procedures would be outlined in the CEMP and will include (but not be limited to):

– Routine and pre-discharge sampling and analysis to confirm absence of contaminants exceeding applicable criteria as recommended in Table 6.1
– Pre-discharge confirmation of compliance with water quality performance criteria able to be analysed
– The methodology for dewatering including use flocculants and pH balancing agents as required

6.2.1.1 Discharge monitoring

Controlled discharges from the project during construction and operation would occur in accordance with a site EPL (see Section 6.3) with sampling derived from EPA (2016) guidelines and will include compliance with water quality monitoring as specified in Table 6.1 prior to discharge.

Table 6.1 EPL recommended water quality concentration limits

Parameter	Units	Guideline value
pH	pH units	6.5-8.5
Oil and Grease	mg/L	10
Total suspended solids	mg/L	50
Nitrogen (ammonia)	mg/L	0.9

The following is also to be recorded with controlled discharges: time of initial discharge, duration and estimated volume, as well as the rainfall event preceding each overflow.

It is also recommended to employ a water quality sampling program inclusive of the analysis presented in Table 6.2 adopted from Table B.5 of DECC (2008).

Table 6.2 Recommended surface water monitoring

Parameter	Units	Sampling method
pH	pH units	Probe
Dissolved oxygen	mg/L	Probe
Electrical conductivity	µS/cm	Probe
Turbidity	NTU	Onsite meter or grab sample
Total suspended solids	mg/L	Grab sample
Total dissolved solids	mg/L	
Major cations (calcium, magnesium, sodium, potassium)	mg/L	
Bicarbonate as $CaCO_3$	mg/L	
Sulfate (filtered)	mg/L	
Chloride	mg/L	
Total organic carbon	mg/L	
Thermotolerant coliforms	cfu/100 mL	
Nitrogen – ammonia	mg/L	
Nitrate as N	mg/L	

Parameter	Units	Sampling method
Total Kjeldahl nitrogen as N	mg/L	
Total phosphorus as P	mg/L	
Reactive phosphorus as P	mg/L	

Monitoring locations would need to include: the Sediment Basin, Leachate Pond, upstream on Warrah Creek, and downstream on Warrah Creek. Warrah Creek surface water monitoring locations would be determined on suitability and access requirements.

Water quality trigger values are to be developed in the Site Water Management Plan to assess potential impact of discharged water quality on the receiving water. Where monitoring indicates a water quality exceedance in discharges off site, an investigation will be undertaken and a notification to the EPA shall be undertaken in accordance with the EPL.

A notification protocol for downstream water users would need to be generated in consultation with downstream water users and the adjoining Willow Tree Gravels quarry, should EPL water quality limits be exceeded. Such a protocol would be implemented through a site pollution incident reduction management plan (PIRMP) as required by the POEO Act for operations with EPLs.

6.2.1.2 Regular monitoring

EPA (2016) recommends regular monitoring of surface water should be undertaken to determine the possibility of leachate impact on the stormwater system. Quarterly surface water monitoring should be implemented at Sediment Basin, Leachate Pond, upstream on Warrah Creek, and downstream on Warrah Creek for the analytes presented in Table 6.2.

Where leachate irrigation is used, regular monitoring (weekly or monthly) will be done in accordance with guidelines on effluent irrigation ‘Environmental Guidelines: Use of Effluent by Irrigation’ (NSW DEC, 2004).

6.2.2 Groundwater

As described in Section 6.1.3, if groundwater is encountered during excavations, advice shall be sought suitably qualified hydrogeologist as to whether groundwater monitoring is required for impact assessment. This degree of proposed monitoring is commensurate with the low risk of intercepting the water table.

It is recommended that a groundwater monitoring network is commissioned and monitored prior to landfilling activities beginning to gain a better understanding of the site groundwater regime. It is recommended that at least three groundwater wells are installed to establish baseline groundwater quality and groundwater flow direction (and rate if deemed necessary). Once baseline groundwater conditions are defined, a quarterly groundwater monitoring program would be required for inclusion in the site EPL and would include a monitoring program (derived from EPA (2016)) to monitor potential impact from WMF operation as per Table 6.3.

Table 6.3 Recommended regular groundwater monitoring

Parameter	Frequency	Sampling method
pH, Redox potential, temperature	Quarterly	Probe
Standing water level		In situ
Electrical conductivity, total dissolved solids		Grab sample
Major cations and anions		
Alkalinity		
Total organic carbon		
Ammonia and nutrients		
Dissolved metals	Annually	
Organic contaminants		

Where groundwater monitoring indicates potential impact from the WMF, an investigation would be undertaken with the provision of a groundwater assessment report.

6.3 Licensing

No surface water or groundwater licences are expected to be required for the project. However, if additional water access from groundwater or surface water sources were deemed necessary through subsequent design phases, these would likely be exempt from licences as:

– Under the WM Act, surface water storages that form part of the water management system are exempt from consideration under water access licensing
– Under the Water Management (General) Regulation 2018, up to 3 ML of water can be taken per year from an aquifer without a licence.

The project would require a site EPL to be developed and issued under the POEO Act through consultation with NSW EPA. The EPL would include conditions regulating the monitoring measures as presented in Section 6.2.

7. References

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Appendices

Appendix A

Additional regulator requirements

The Environmental Protection Authority (EPA), the Biodiversity and Conservation and Science Directorate (BCS) have provided additional environmental assessment requirements for the Project., outlined in Table A.1 and Table A.2.

Table A.1 EPA Environmental Assessment Requirements (1636)

Assessment requirement	Where addressed
Water and Soils including leachate management systems, site water balance and sediment and erosion controls during construction and operation phases.	Section 4.4 Section 4.4 Section 4.2
The EA must demonstrate how the proposed development will meet the requirements of section 120 of the POEO Act.	Section 2.1.2 Section 4 Section 6
The EA must include a water balance for the development including water requirements (quantity, quality and source(s)) and proposed storm, wastewater and leachate disposal, including type, volumes, proposed treatment and management methods and re-use options.	Section 4.4
If the proposed development intends to discharge waters to the environment, the EA must demonstrate how the discharge(s) will be managed in terms of water quantity, quality and frequency of discharge and include an impact assessment of the discharge on the receiving environment. This should include: – Description of the proposal including position of any intakes and discharges, volumes, water quality and frequency of all water discharges. – Description of the receiving waters including upstream and downstream water quality as well as any other water users. – Demonstration that all practical options to avoid discharge have been implemented and environmental impact minimised where discharge is necessary.	Section 3.4 Section 5.1 Section 4 Section 4.4 Section 3.7
The EA must refer to Water Quality Objectives for the receiving waters and indicators and associated trigger values or criteria for the identified environmental values of the receiving environment. This information should be sourced from the ANZECC (2000) Guidelines for Fresh and Marine Water Quality (http://www.environment.gov.au/water/policy-programs/nwqms/).	Section 2.3.3
The EA must describe how stormwater will be managed in all phases of the development, including details of how stormwater and runoff will be managed to minimise pollution. Information should include measures to be implemented to minimise erosion, leachate and sediment mobilisation at the site. The EA should consider the guidelines *Managing urban stormwater: soils and construction,* vol. 1 (Landcom 2004) and vol. 2 (A. Installation of services; C. Unsealed roads; D. Main Roads; E. Mines and quarries) (DECC, 2008).	Section 4.1
The EA must provide details of: – Onsite leachate management systems including any treatment of leachate through a wastewater treatment plant. – Any proposed transport and disposal of leachate off-site.	Section 4.2
The EA must describe any water quality monitoring programs to be carried out at the development site. Water quality monitoring should be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutant in NSW* (2004) which is available at: http://www.epa.nsw.gov.au/resources/legislation/approvedmethods-water.pdf.	Section 6.2

Table A.2 BSC's Recommended Environmental Assessment Requirements

Assessment requirement	Where addressed
General Requirements	
The EIS must map features relevant to water, including: – Rivers, streams, estuaries (as described in s4.2 of the Biodiversity Assessment Method). – Wetlands (as described in s4.2 of the Biodiversity Assessment Method). – Groundwater. – Groundwater dependent ecosystems.	 Figure 3.5 N/A Figure 3.6
The EIS must describe background conditions for any water resource likely to be affected by the proposal, including: – Existing surface and groundwater. – Hydrology – Water Quality Objectives (as endorsed by the NSW Government) including groundwater as appropriate that represent the community's uses and values for the receiving waters. – Indicators and trigger values/criteria for the identified environmental values in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and / or local objectives, criteria or targets endorsed by the NSW Government – Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions (OEH/EPA, 2017).	Section 3.4 Section 3 Section 5.1 Section 2.3.3 Section 6.2
The EIS must assess the impacts of the proposal on water quality, including: – The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the proposal protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality – Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction. Identification of proposed monitoring of water quality. – Consistency with any relevant certified Coastal Management Program (or Coastal Zone Management Plan).	Section 5 Section 6
The EIS must assess the impact of the proposal on hydrology, including: – Water balance including quantity, quality and source. – Effects upon rivers, wetlands, estuaries, marine waters and floodplain areas. – Effects upon water-dependent fauna and flora including groundwater dependent ecosystems. – Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g., river benches). – Changes to environmental water availability, both regulated / licensed and unregulated /rules-based sources of such water.	Section 5
Project specific requirements	
Water	
A description of existing water quality / hydrology based on suitable data (meaning data collection may be required) and must include: – Water chemistry. – A description of receiving water processes, circulation and mixing characteristics and hydrodynamic regimes. – Lake or estuary flushing characteristics. – Sensitive ecosystems or species conservation values. – Specific human uses and values (e.g., fishing, proximity to recreation areas). – A description of any impacts from existing industry or activities on water quality. – A description of the condition of the local catchment e.g., erosion, soils, vegetation cover. – An outline of baseline groundwater information, including, for example, depth to water table, – Flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment. – Historic river flow data.	Section 3

Assessment requirement	Where addressed
An assessment of the impacts of the proposal on water quality and hydrology including: – Water circulation, current patterns, water chemistry and other appropriate characteristics such as clarity, temperature, nutrient and toxicants, and potential for erosion. – Changes to hydrology – Stream bank stability and impacts on macro invertebrates. – Water quality and hydrology modelling and / or monitoring, where necessary.	Section 5.1
Proposed water quality monitoring in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC 2004). The water quality and aquatic ecosystem monitoring program must include: – Adequate data for evaluating maintenance, or progress towards achieving, the relevant Water Quality Objectives. – Measurement of pollutants identified or expected to be present.	Section 6.2
Flooding	
The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: – Flood prone land (i.e., land susceptible to the probable maximum flood event). – Flood planning area, the area below the flood planning level. – Hydraulic categorisation (floodway and flood storage areas). – Flood hazard.	Section 3.6
The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 10% Annual Exceedance Probability (AEP), 1% AEP flood levels and the probable maximum flood, or an equivalent extreme event.	N/A
The EIS must model the effect of the proposal (including fill) on the current flood behaviour for a range of design events as identified above, and the 0.5% AEP and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.	N/A
All site drainage, stormwater quality devices and erosion / sedimentation control measures should be identified in the EIS and the onsite treatment of stormwater and effluent runoff and predicted stormwater discharge quality from the proposal should be detailed.	Section 4
Modelling in the EIS must consider and document: – Existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies. – The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood (PMF), or an equivalent extreme flood. – Impacts of the proposal on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazard categories and hydraulic categories. – Impacts of earthworks and stockpiles within the flood prone land up to the PMF level. The assessment should be based on understanding of cumulative flood impacts of construction and operational phases. – Relevant provisions of the NSW Floodplain Development Manual 2005.	Section 3.6
The EIS must assess the impacts on the proposal on flood behaviour, including: – Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. – Consistency with Council floodplain risk management plans. – Consistency with any Rural Floodplain Management Plans. – Compatibility with the flood hazard of the land. – Compatibility with the hydraulic functions of flow conveyance in flood ways and storage in flood storage areas of the land. – Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.	Section 3.6 Section 5.2

Assessment requirement	Where addressed
– Whether there will be a direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses. – Appropriate mitigation measures to offset potential flood risk arising from the proposal. Any proposed mitigation work should be modelled and assessed on the overall catchment basis in order to ensure it fits its purpose and meets the criteria of the Council where it is located, and to ensure it has no adverse impact to surrounding areas. – Any impacts the proposal may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council. – Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council. – Emergency management, evacuation and access, and contingency measures for the proposal during both construction and operational phases considering the full range of flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the NSW SES. – Any impacts the proposal may have on the social and economic costs to the community as a consequence of flooding.	

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