

Surface Water Quality and Aquatic Ecology Assessment

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Sydney Water
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Quakers Hill WRRF Advanced Treatment Upgrade project
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Surface Water Quality and Aquatic Ecology Assessment

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Executive summary

Sydney Water is planning to upgrade the Quakers Hill Water Resource Recovery Facility (WRRF) to accommodate forecast growth in the catchment and treat water to more stringent water quality requirements that are being introduced in an update to the site's Environment Protection Licence (EPL). The proposed upgrades include expanding the secondary wastewater treatment process and installing an advanced water treatment plant (AWTP) within the existing Quakers Hill WRRF site to provide ultrafiltration, reverse osmosis and chemical dosing. During operation, before a potential future PRW Treatment Plant comes online, water treated by the new secondary treatment and AWTP processes would be discharged to Breakfast Creek. A new pipeline would be built to transport brine (produced as a byproduct of filtration processes) to the Northern Suburbs Ocean Outfall Sewer (NSOOS) at Seven Hills.

This report has been prepared to inform a review of environmental factors for this project. The specific objectives of this report are to describe the existing environment with respect to surface water quality and aquatic ecology; assess the impact on surface water and aquatic ecology of constructing and operating the proposed infrastructure; and provide recommendations to mitigate and manage the impacts identified.

The project is situated within the Wianamatta-South Creek catchment, which is part of the larger Hawkesbury-Nepean catchment. Watercourses within the study area include Breakfast Creek, a highly urbanised waterway that has been significantly modified with concrete channels. Eastern Creek a fourth order stream of which Breakfast Creek flows into downstream of the Quakers Hill WRRF; and Blacktown Creek, also an urban stream that is influenced by stormwater runoff and wastewater discharges. Water quality in Breakfast Creek is generally poor, particularly downstream of the WRRF discharge point. Elevated nutrient concentrations (total nitrogen, oxidised nitrogen, filterable reactive phosphorus) exceed recommended limits. Similarly, the water quality of Eastern Creek is poorer downstream of the confluence with Breakfast Creek due to higher nutrient concentrations. In Blacktown Creek, water quality is also poor, with high nutrient concentrations and occasional exceedances of chlorophyll-*a*, indicating potential for algal blooms.

The AWTP will improve water quality of Breakfast Creek by reducing most contaminants below current treated levels. Some indicators such as total suspended solids and filterable aluminium may increase slightly but are expected to remain within acceptable limits. Several discharge scenarios have been modelled (average dry weather flow, moderate wet weather flow, and peak wet weather flow). The results show compliance with EPL limits, though some indicators may exceed recommended guidelines during wet weather discharges, as in current operation.

Nutrient loads analysis confirms that the upgrade of Quakers Hill WRRF and other WRRFs will result in a reduction of total nitrogen and total phosphorus loads in the Sackville 2 sub-zone so that discharges meet future EPL load limits. Thereby improving the water quality and aquatic ecology of Breakfast Creek, Eastern Creek and other downstream receiving waterways.

During project construction, there is potential for impacts on water quality and aquatic ecology in these watercourses due to earthworks, road works, vegetation clearing, concrete works, construction compounds and material laydown, trenching and horizontal directional drilling operations, and dewatering and construction discharges. During project operation, impacts would be mostly associated with brine discharges and potential untreated wastewater releases.

Appropriate erosion and sediment controls would be required to mitigate impacts during project construction. The strategy includes controlling erosion by implementing measures to prevent or reduce erosion at the source; controlling sediment mobilisation by capturing and retaining sediment close to its source; directing on-site dirty water towards sediment basins; and capturing sediments using adequately sized sediment basins. Physical sediment control measures that would be implemented include catch and diversion drains, level spreaders, sediment fencing and filters, and sediment basins.

A Model for Urban Stormwater Improvement Conceptualisation has been developed to estimate the annual pollutant loads generated under current and future conditions, and to assess the effectiveness of proposed mitigation measures. Model results indicate that post-construction the proposed works would increase impervious areas, leading to higher pollutant loads in Breakfast Creek. Installation of a water quality basin or gross pollutant trap with cartridge filtration would be effective options to mitigate project-related impacts on Breakfast Creek, the latter option being more effective in reducing pollutant loads to the creek.

Overall, the assessment concludes that impacts to surface water quality and aquatic ecology of Breakfast Creek and Blacktown Creek from project construction are low to medium while project operation presents a low risk to the environmental values of these waterways. Given that changes in contaminant loads from current condition are predicted to be low, and that water quality is expected to be consistent with maintaining compliance with the applicable water quality guidelines and licence limits, it is considered that the project will allow Sydney Water to meet the limits set by the current EPL.

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Acronyms and abbreviations

ADWF	Average dry weather flow
AHD	Australian Height Datum
ANZG	Australian and New Zealand Guidelines
AWTP	Advanced Water Treatment Plant
BoM	Bureau of Meteorology
°C	degrees Celsius
cells/mL	cells per millilitre
CEMP	Construction Environmental Management Plan
cm	centimetre
CSWMP	Construction Soil and Water Management Plan
DECCW	Department of Environment, Climate Change and Water
DPE	NSW Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2021
EPA	NSW Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPL	Environment Protection Licence
FM Act	Fisheries Management Act 1994
GPT	Gross pollutant trap
ha	hectares
HDD	Horizontal directional drilling
HRC	Healthy Rives Commission
IDALs	Intermittently Decanted Aerated Lagoons
KFH	Key Fish Habitat
kg/year	kilograms per year
km	kilometres
km ²	square kilometres
LGA	Local Government Area
m	metre
m ²	square metres
m ³	cubic metres
mg/L	milligrams per litre

ML/d	megalitres per day
mm	millimetres
MNES	Matters of National Environmental Significance
MUSIC	eWater Model for Urban Stormwater Improvement Conceptualisation
n	number
NSOOS	Northern Suburbs Ocean Outfall Sewer
NTU	Nephelometric Turbidity Unit
POEO Act	Protection of the Environment Operations Act 1997
PRW	Purified Recycled Water
RCE	Riparian, Channel and Environmental
REF	Review of Environmental Factors
SRE	Sensitive Receiving Environment
SSTV	Site Specific Trigger Values
The project	The Quakers Hill WRRF Advanced Treatment Upgrade project
µg/L	Microgram per litre
µS/cm	microsiemens per centimetre
WM Act	Water Management Act (2000)
WQOs	Water Quality Objectives
WRRF	Water Resource Recovery Facility
WWF	Wet weather flow

1. Introduction

1.1 Background

This surface water quality and aquatic ecology assessment has been prepared to inform the review of environmental factors (REF) for the Quakers Hill Water Resource Recovery Facility (WRRF) Advanced Treatment Upgrade project (the project). The proposed upgrades include expanding the secondary wastewater treatment process and installing an advanced water treatment plant (AWTP) within the existing Quakers Hill WRRF site to provide ultrafiltration, reverse osmosis and chemical dosing. During operation, before a potential future Purified Recycled Water (PRW) Treatment Plant comes online, treated water would be discharged to Breakfast Creek. A new pipeline would be built to transport brine (produced as a by-product of filtration processes) to the Northern Suburbs Ocean Outfall Sewer (NSOOS) at Seven Hills (Figure 1-1).

This project is required to accommodate forecast growth in the catchment and treat water to more stringent quality requirements that are being introduced in an update to the site's Environment Protection Licence (EPL). The upgrades are also important to ensure high quality feedwater for the potential future PRW Treatment Plant and meeting health and environmental requirements. Sydney Water is the proponent of this project.

This report provides a review of the existing surface water quality and aquatic ecology of the waterways in the project impact assessment area. It also identifies how the construction and operation of the project would potentially impact the waterways and provides recommendations for avoiding or minimising these impacts.

1.2 Project overview

Upgrades to Sydney Water's Quakers Hill WRRF are required to:

- Accommodate growth in wastewater service demand: The current average dry weather flow capacity of the Quakers Hill WRRF is 28 megalitres per day (ML/d). Current and projected growth in the area requires an increase in the wastewater treatment capacity of the WRRF. An average dry weather capacity of 48 ML/d is anticipated to be required by 2056. To cater for this growth, an additional 20 ML/d of treatment capacity is required.
- Ensure EPL compliance: The Quakers Hill, Riverstone and St Marys Water Resource Recovery Facilities, along with the Upper South Creek Advanced Water Recycling Centre share a combined 'bubble' licence for nutrient discharge limits in the Sackville 2 subzone, requiring upgrades to meet reduced nutrient limits set by the EPA.

Additionally, the project will provide high quality water treatment that enables a future PRW scheme and its introduction into Prospect Reservoir (separate project being assessed in an Environmental Impact Statement).

The project is in the Blacktown Local Government Area (LGA), in largely urbanised areas with a mix of residential, industrial, and recreational land uses.

The key features of the project are shown in Figure 1-2 and include:

- secondary wastewater treatment process upgrade to increase treatment capacity of the WRRF from 28 ML/day to 48 ML/day and provide suitable feedwater for the new AWTP
- a new advanced treatment plant, including reverse osmosis, ultrafiltration and stabilisation
- a range of ancillary infrastructure such as new buildings, tanks, pipes, services and chemical storage
- demolition and restoration of previously decommissioned structures

- new brine pipeline to transfer the brine generated as a by-product of the reverse osmosis process into the existing wastewater network. The pipeline would:
 - have flow capacity of up to 12.5 ML/d
 - be about 8 kilometres (km) long and about 500-millimetre (mm) diameter
 - be installed largely along shared paths, public parkland, and road corridors
 - be mostly underground and built using open trench and trenchless methods
 - be connected into Sydney Water's existing NSOOS.

The advanced treatment plant is required to treat the wastewater to meet more stringent nutrient limits. However, it would also produce high quality water that could be further treated to produce PRW.

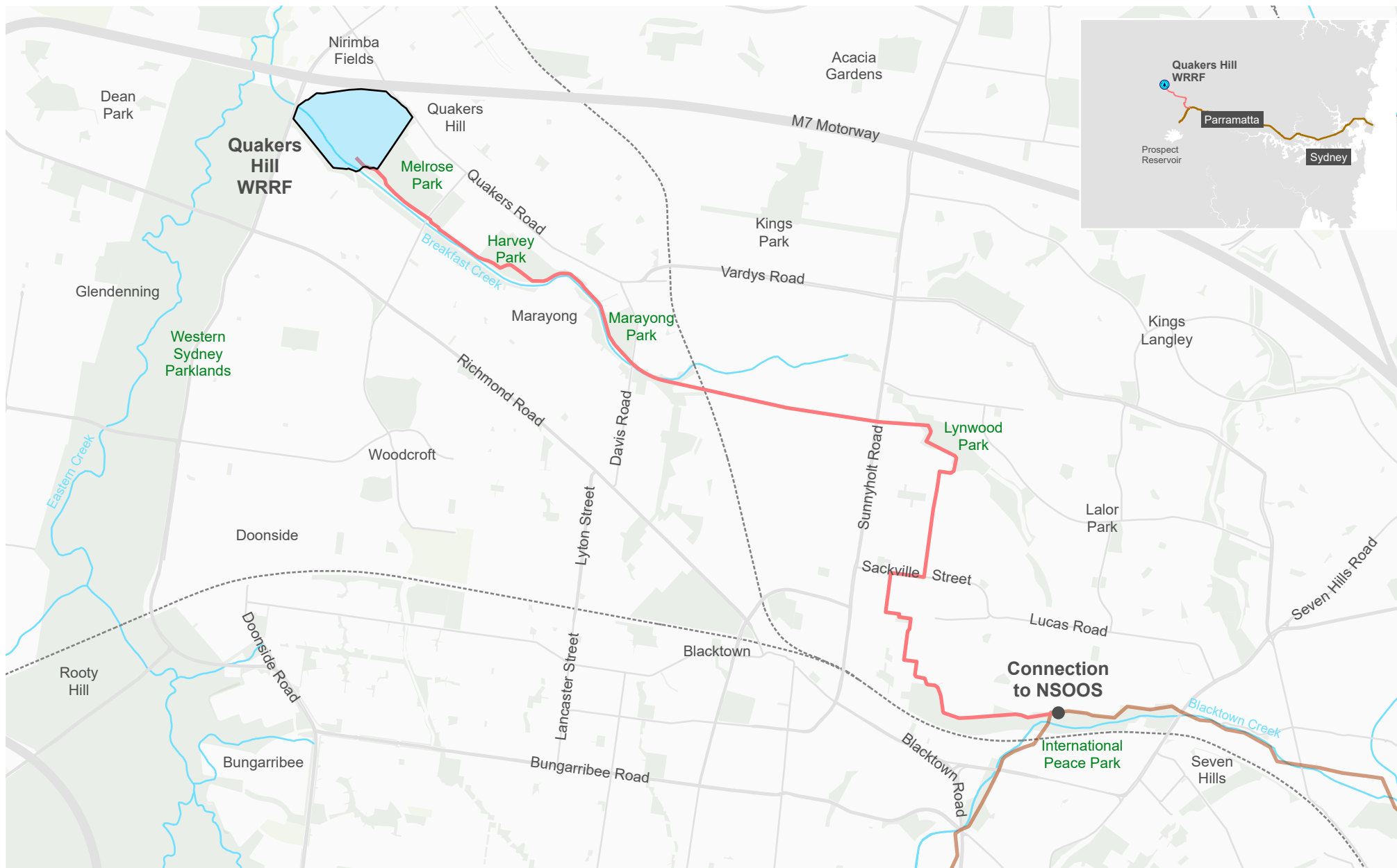
Sydney Water is preparing a Review of Environmental Factors (REF) for the project. This report has been prepared to support that REF. PRW is not part of the scope of this assessment. Sydney Water is separately assessing the potential introduction of PRW in an Environmental Impact Statement (EIS).

1.3 Purpose of this report

The purpose of this report is to assess the potential surface water quality and aquatic ecology impacts from constructing and operating the proposal. This report:

- Describes the existing environment with respect to surface water quality and aquatic ecology.
- Assesses the impact of constructing and operating the proposal on surface water and aquatic ecology.
- Recommends measures to mitigate and manage the impacts identified.

The assessment forms part of the REF for the project for which Sydney Water is the determining authority under Division 5.1 of the Environmental Planning and Assessment Act 1979.



- Quakers Hill Water Resource Recovery Facility (WRRF)
- Brine pipeline
- NSOOS pipeline
- Parks and open space

Figure 1-1 Overview of the proposed scheme

0 1 km

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:35,000 @ A4
GDA2020 MGA Zone 56



1	UF Feed Tank	AWTP Area
2	UF Feed Pumps	AWTP Area
3	UF Building	AWTP Area
4	UF CIP	AWTP Area
5	RO Feed Tank	AWTP Area
6	RO Building	AWTP Area
7	RO Permeate Building	AWTP Area
8	LP RO Pumps	AWTP Area
9	Cartridge Filters	AWTP Area
10	HP RO Pumps	AWTP Area
11	RO CIP	AWTP Area
12	Enhanced Treatment	AWTP Area
13	Enhanced Treatment Feed Pumps	AWTP Area
14	Service Water & RO Flush Pumps	AWTP Area
15	Chemical Dosing Area	AWTP Area
16	AWTP and PRW Switchrooms	AWTP Area
17	AWTP pH Correction & Stabilisation Standpipe	AWTP Area
18	AWTP Flow Splitter Tank	AWTP Area
19	Odour Control Facility	AWTP Area
20	Bioreactor	Secondary Treatment Area
21	MBR	Secondary Treatment Area
22	MBR Permeate Pumps	Secondary Treatment Area
23	MBR & Bioreactor Switchroom	Secondary Treatment Area
24	MBR & Bioreactor Switchroom	Secondary Treatment Area
25	Blower Room	Secondary Treatment Area
26	WAS/Scum Pumping Station	Secondary Treatment Area
27	MBR Pre-screen	Secondary Treatment Area
28	Brine Pump Station	Secondary Treatment Area
29	Cover existing sludge tank	AWTP Area
30	Clean Water Lab	AWTP Area
31	AWTP/PRW Transformers	AWTP Area
32	Existing Brine Storage Tanks	Secondary Treatment Area

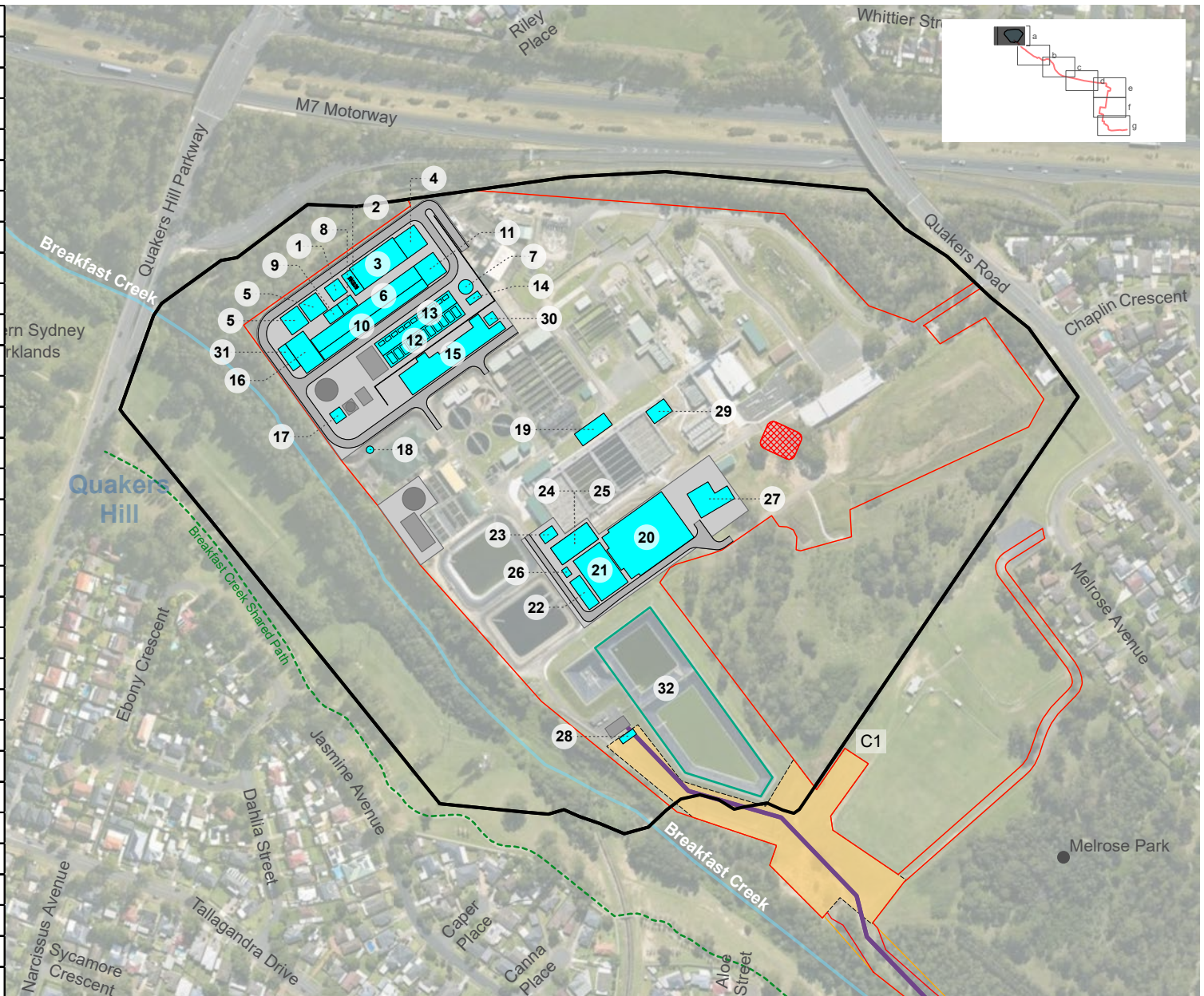


Figure 1-2 Indicative location of the secondary treatment plant upgrade, AWTP, brine pipeline and impact area

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56



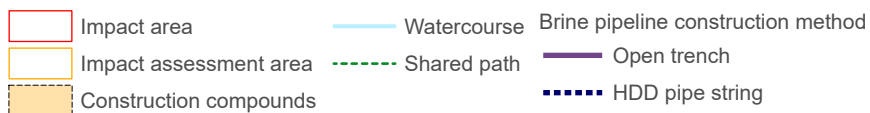


Figure 1-2b Indicative location of the secondary treatment plant upgrade, AWTP, brine pipeline and impact area

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56





- | | | | | | |
|--|------------------------|--|------------------------------------|--|-----------------|
| | Impact area | | Watercourse | | HDD |
| | Impact assessment area | | Brine pipeline construction method | | HDD pipe string |
| | Construction compounds | | Open trench | | |

Figure 1-2c Indicative location of the secondary treatment plant upgrade, AWTP, brine pipeline and impact area

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56





- Impact area
- Impact assessment area
- Construction compounds
- Watercourse
- Brine pipeline construction method
- HDD

Figure 1-2d Indicative location of the secondary treatment plant upgrade, AWTP, brine pipeline and impact area

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56





- Impact area
- Construction compounds
- HDD
- Impact assessment area
- Brine pipeline construction method
- HDD pipe string
- Open trench

Figure 1-2e Indicative location of the secondary treatment plant upgrade, AWTP, brine pipeline and impact area

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56



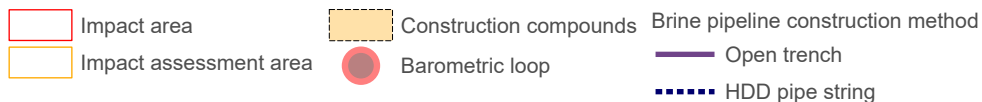


Figure 1-2f Indicative location of the secondary treatment plant upgrade, AWTP, brine pipeline and impact area

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56





Figure 1-2g Indicative location of the secondary treatment plant upgrade, AWTP, brine pipeline and impact area



1.4 Report structure

The structure and content of this report are outlined in Table 1-1 .

Table 1-1 Structure and content of this report

Chapter	Description
Chapter 1 Introduction	Outlines the key elements of the project and the structure of this report (this chapter)
Chapter 2 Statutory context	Provides an outline of the statutory context, including applicable legislation and planning policies and guidelines
Chapter 3 Assessment methodology	Provides a description of the assessment methodology for this assessment
Chapter 4 Existing environment	Provides a preliminary description of the existing environment
Chapter 5 Impact assessment-construction	Presents the outcomes of the impact assessment for the construction phase
Chapter 6 Impact assessment-operation	Presents the outcomes of the impact assessment for the operational phase
Chapter 7 Cumulative impacts	Presents the outcomes of the cumulative impact assessment
Chapter 8 Surface water quality controls	Provides a discussion on the water quality controls and modelling that has been undertaken to manage erosion and sedimentation
Chapter 9 Mitigation measures	Presents the surface water quality and aquatic ecology management measures applicable to the project
Chapter 10 Summary and Recommendations	Summarises the findings of this report and provides recommendations for further work and/or subsequent stages of the project
References	Provides a list of referenced material used to inform the assessment
Appendices	Appendix A. Provides an example of a Riparian, Channel, and Environmental scoresheet used to assess the habitat aquatic condition of Breakfast Creek. Appendix B. Provides site photographs and descriptions from the aquatic habitat assessment Appendix C. Presents the method used to determine the size of sediment basins. Appendix D. Provides additional information on rainfall data used in modelling of pollutant loads.

2. Statutory context

2.1 Legislation and statutory regulations

Table 2-1 outlines the legislation and statutory regulations which apply to the water quality and aquatic ecology assessment.

Table 2-1 Legislation relevant to the water quality and aquatic ecology assessment

Legislation or regulation	Abbreviation	Applicable to this assessment
Commonwealth		
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (DCCEEW 2025a)	EPBC Act	The EPBC Act protects Matters of National Environmental Significance (MNES). Under the EPBC Act, an action requires approval from the Minister for the Environment if the action has, will have, or is likely to have, significant impact on MNES. A search of the Protected Matters Search Tool (DCCEEW 2025b) found two aquatic MNES potentially present in the vicinity of the project area: - Macquarie Perch (<i>Macquaria australasica</i>), listed as Endangered under the EPBC Act, is rated as "Species or species habitat may occur within area" for most of the study area. There are no records of Macquarie Perch in Eastern Creek, Blacktown Creek, or Breakfast Creek (ALA 2025). - Australian Grayling (<i>Prototroctes maraena</i>) listed as Vulnerable under the EPBC Act, is rated as "Species or species habitat may occur within area" west of the Prospect Reservoir. There are no records of Australian Grayling in Eastern Creek, Blacktown Creek, or Breakfast Creek (ALA 2025). Based on available records, it is unlikely that Macquarie Perch or Australian Grayling are present in the project area or, if present, would be affected by changed conditions in Eastern Creek, Blacktown Creek, or Breakfast Creek.
State		
<i>Environmental Planning and Assessment Act 1979</i> (NSW Government 2025a)	EP&A Act	The EP&A Act and EP&A Regulation provide the framework for development impact assessment in NSW. These statutes include provisions to ensure that the potential environmental impacts of a development are considered in the decision-making process prior to construction. Evaluation of this project is to be undertaken in accordance with Division 5.1 of the EP&A Act and clause 171 of the EP&A Regulation.
<i>Environmental Planning and Assessment Regulation 2021</i> (NSW Government 2025b)	EP&A Regulation	
<i>Protection of the Environment Operations Act 1997</i> (NSW Government 2025c)	POEO Act	The POEO Act is administered by the NSW Environment Protection Authority (EPA). The POEO Act regulates air and water pollution, noise control and waste management. The Act prescribes pollution controls and requirements for granting environmental protection licence for scheduled activities under Schedule 1. The project includes the release of treated wastewater from Quakers Hill WRRF to Breakfast Creek under EPL 1724 and the release of brine into the wastewater collection network which operates under EPL 378. The EPL stipulates loads and concentration limits for a variety of pollutants. An assessment of the impacts from the AWTP treated discharge and additional brine discharge under the respective EPLs and to the receiving environment is provided in Section 6.1.

Legislation or regulation	Abbreviation	Applicable to this assessment
<i>Water Act 1912, Water Management Act 2000 and Water Management (General) Regulation 2011 (NSW Government 2016, 2018, 2025d)</i>	WM Act	The <i>Water Act 1912</i> and the WM Act are the two key pieces of legislation for the management of water in NSW and contain provisions for the licensing of water access and use. The aims of the WM Act are to provide for the sustainable and integrated management of the State's water sources for the benefit of both present and future generations. The WM Act implicitly recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing license holders with more secure access to water and greater opportunities to trade water through the separation of water licenses from land. The WM Act enables the State's water resources to be managed under water sharing plans, which establish the rules for the sharing of water in a particular water source between water users and the environment, and rules for the trading of water in a particular water source. The project is located within an area covered by the following water sharing plan (surface waters) and respective water source: Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources (NSW Government 2023) ▪ Wianamatta-South Creek Water Source ▪ Parramatta River Water
<i>Fisheries Management Act 1994 (NSW Government 2024)</i>	FM Act	The FM Act provides the conservation, protection and management of fisheries, aquatic and habitats in NSW. The FM Act is administered by the Department of Primary Industries and Regional Development and establishes mechanisms for: ▪ The listing of threatened species, populations and ecological communities or key threatening processes; ▪ The declaration of critical habitat; and ▪ Consideration and assessment of threatened species impacts in the development assessment process. Part 7A, Division 12 of the FM Act relates to the environmental assessment of a development under Part 5 of the EP&A Act. As set out in Division 12, Part 7A of the FM Act, a preliminary assessment of the potential impacts on threatened species, populations or ecological communities listed under the FM Act, must be made. A search of a 10-km radius around the project site in the Fisheries Spatial Data Tool (DPI 2025) found the following: ▪ Breakfast Creek is defined as Key Fish Habitat. ▪ No freshwater fish threatened species listed under the FM Act are modelled in the project area. ▪ The freshwater fish community status for Breakfast Creek is rated as Fair.

2.2 Policies and guidelines

Several policies and guidelines apply to this water quality and aquatic ecology assessment, including:

- National Water Quality Management Strategy (Australian Government 2018)
- Australia and New Zealand National Water Quality Guidelines for Fresh and Marine Water Quality (ANZG 2018)
- NSW Water Quality and River Flow Objectives (DECCW 2006) and Healthy Rivers Commission Inquiry (HRC of NSW 1998)
- Guidelines for Managing Risks in Recreational Waters (NHMRC 2008)
- Performance criteria for protecting and improving the blue grid in the Wianamatta-South Creek catchment (DPE 2022)
- Regulating nutrients from sewage treatment plants in Lower Hawkesbury Nepean River catchment (EPA 2019)
- Policy and Guidelines for Fish Habitat Conservation and Management (DPI 2013)
- Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge 2003)
- State Environmental Planning Policy (Biodiversity and Conservation) 2021 (NSW Government 2025e)
- Habitat Protection Plan No. 3 – The Hawkesbury-Nepean River System (DPI 1998)
- Guidelines for Controlled Activities on Waterfront Land (DPIE 2018)
- Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Volume 2 (DECC 2008).

3. Assessment methodology

3.1 Study area

For the purposes of this surface water quality and aquatic ecology assessment, the study area is defined as the area directly impacted by the project and any additional areas likely to be impacted by the project either directly or indirectly with a 500-metre (m) buffer (Figure 3-1). This was adopted for works such as the construction impacts at Quakers Hill WRRF and along the brine pipeline to encapsulate a conservative estimate for the maximum distance that sediments and pollutants may mobilise from a point source discharge. For the purposes of the impacts associated with releases from the WRRF, this buffer was extended to include downstream of the confluence of Breakfast Creek and Eastern Creek.

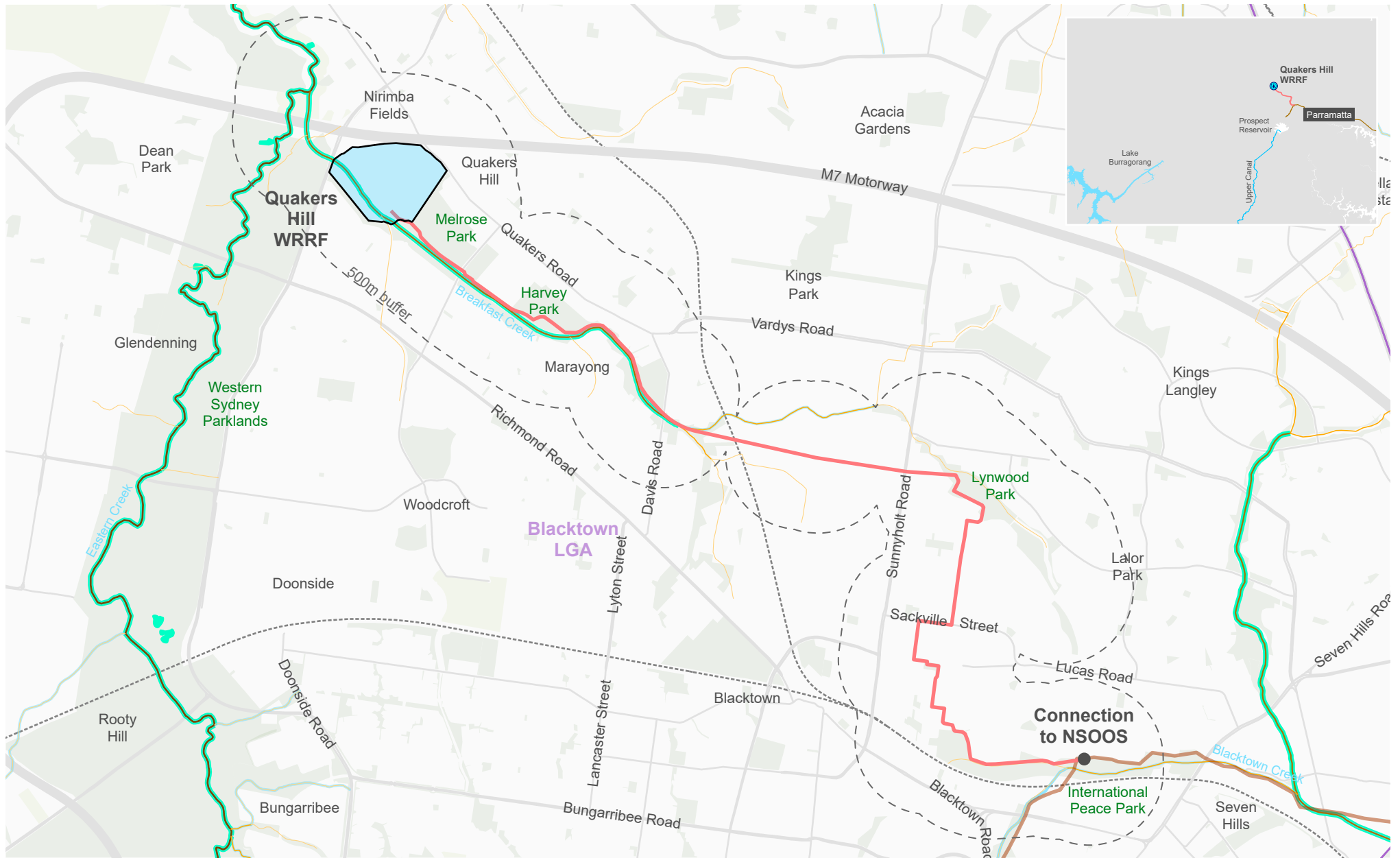
3.2 Desktop assessment

3.2.1 Desktop review

Existing conditions across the study area were reviewed to understand the potential impacts of the project on surface water quality and aquatic ecology during construction and operation. The information reviewed was sourced from project design and operation plans, public databases, scientific literature, and analysis of water quality and aquatic biodiversity monitoring data to aid in determining the existing baseline conditions within the project area. The information sources included:

- The Bionet – the Atlas of NSW Wildlife Threatened Species Profile Database (DPE 2025) which was searched for records of Commonwealth and state-listed aquatic flora and fauna within the study area.
- Atlas of Living Australia which was searched for records of Commonwealth and state-listed aquatic flora and fauna within the study area.
- The Protected Matters Search Tool (DCCEEW 2025b), which was searched to determine predicted presence of MNES within 10 km of the study area.
- Key Fish Habitat (KFH) mapping and threatened species distribution mapping (DPI 2025) available on the NSW Fisheries data portal, which were examined to determine aquatic values and potential presence of threatened species in the study area.
- Water quality data collected by Sydney Water, including routine water quality monitoring data from July 2018 to June 2024 for the following sites:
 - Breakfast Creek at Quakers Hill Parkway (downstream of Quakers Hill WRRF) (NS087)
 - Breakfast Creek at Falmouth Road (upstream of Quakers Hill WRRF) (NS090)
 - Eastern Creek downstream of Breakfast Creek confluence (NS085)
 - Eastern Creek at Richmond Road (NS094/NS0861)
- Water quality data collected by Blacktown City Council between December 2018–December 2024 during both dry weather and wet weather for two sites:
 - Breakfast Creek opposite 31 Jasmine Ave, Quakers Hill (BF1)
 - Blacktown Creek end of Powers Road, Seven Hills (BK1)
- Summarised aquatic macroinvertebrate and riparian vegetation collected annually by Blacktown City Council at Breakfast Creek upstream of the WRRF outfall, two locations in Eastern Creek, and Blacktown Creek.
- Assessments of ecological values and modelled impacts of the project on waterbodies performed by Streamology (2024, 2025).
- Review of scientific literature and technical reports and analysis of water quality monitoring data.

It is important to note that, for the purposes of this report, the aquatic ecology assessment focuses on species of aquatic fauna which live most, if not all, of their life cycle in the aquatic environments within the study area.



- Quakers Hill Water Resource Recovery Facility (WRRF)
- Brine pipeline
- NSOOS pipeline
- Project 500m buffer
- LGA boundaries
- Parks and open space
- Key Fish Habitat (NSW DPI)

Strahler

- 1
- 2
- 3
- 4

Figure 3-1 Study Area

0 1 km



Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:35,000 @ A4
GDA2020 MGA Zone 56

3.2.2 Identification of sensitive receiving environments

Sensitive receiving environments (SREs) have a high conservation value or support ecosystem/human uses of water that are particularly sensitive to pollution or degradation of water quality (von Schiller et al. 2017). It is important to identify SREs that are directly impacted by the project or are located downstream of project activities so that environmental values may be adequately protected (see applicable environmental values in Section 3.2.3).

SREs were identified within the 500 m buffer (upstream and downstream) based on the following conditions:

- Waterway classification (Strahler 1952)
- Key Fish Habitat mapping (DPI 2025)
- Key Fish Habitat field assessment completed in accordance with the requirements of DPI (2013). KFH type was determined based on the presence of habitat features such as snags, woody debris, macrophytes, and boulders
- Predicted presence of threatened aquatic species listed under Commonwealth and state legislation
- Groundwater and surface water dependent vegetation and fauna communities listed in Commonwealth and state legislation
- Proximity to a drinking water catchment
- Areas that contribute to aquaculture and commercial fishing.

Sensitive receiving environments in the study area have been considered in the design of the project and the implementation of water quality controls to minimise potential impacts to SREs.

3.2.3 Environmental values and water quality criteria

Most of the study area is in the Wianamatta-South Creek region of the Hawkesbury-Nepean catchment which has been categorised as 'Predominantly Urban' in the Healthy Rivers Commission Independent Inquiry (1998) and DPE (2022). As such, the waterways within the study area have been nominated for environmental values of aquatic ecosystems, visual amenity, secondary contact recreation and irrigation water supply which correspond with the definitions of the environmental values outlined by DECCW (2006). A small section of the study area is close to Blacktown Creek in the Parramatta River catchment. Blacktown Creek is in an area mapped by DECCW (2006) as 'waterways affected by urban development' and has the nominated environmental values of aquatic ecosystems, visual amenity and secondary contact recreation for protection.

The environmental values for the waterways within the study area are described in Table 3-1. These environmental values have been considered in the assessment of existing water quality conditions and potential impacts associated with the project.

Table 3-1 Environmental values that apply to waterways in the study area

Environmental value	Description
Aquatic ecosystems	Aquatic ecosystems comprise the animals, plants and micro-organisms that live in water and the physical and chemical environment in which they interact. Aquatic ecosystems have historically been impacted upon by multiple pressures including changes in flow regime, modification and destruction of key habitats, development and poor water quality. There are several naturally occurring physical and chemical stressors that can cause degradation of aquatic ecosystems. These parameters include nutrients, dissolved oxygen, pH, salinity, and turbidity (suspended solids). The objectives for aquatic ecosystems are consistent with the agreed national framework for assessing water quality set out in the ANZG (2018) guidelines.
Visual amenity	The aesthetic appearance of a waterbody is an important aspect with respect to visitation and recreation. The water should be free from noticeable pollution, floating debris, oil, scum and other matter. Substances that produce objectionable colour, odour, taste or turbidity and substances and conditions that produce undesirable aquatic life should not be apparent (NHMRC 2008). The key aesthetic indicators are transparency, odour and colour.
Secondary contact recreation	Secondary contact recreation implies some direct contact with the water would be made but ingestion is unlikely in activities such as boating, fishing and wading. Bacteriological indicators are used to assess the suitability of water for recreation.
Irrigation water supply	The purpose of the irrigation water supply objective is to protect quality of waters applied to crops and pasture. Indicators monitored for this objective include algae and blue-green algae, salinity, faecal coliforms and heavy metals.
Cultural activities	Indigenous and non-indigenous cultural activities: First Nations cultural activities/Care for Country activities, other spiritual and ceremonial uses (e.g. meditation, prayer), visiting cultural or historic sites.

Sources: DECCW (2006), HRC of NSW (1998) and DPE (2022).

Key water quality indicators and related numerical criteria have been nominated for each environmental value using the ANZG (2018) water quality guidelines and the site-specific trigger values (SSTV) nominated for waterways and waterbodies in the Wianamatta-South Creek catchment (DPE 2022). These values are provided in Table 3-2.

Blacktown Creek falls within the Parramatta River catchment and therefore the SSTVs developed for waterways in the Wianamatta-South Creek catchment do not apply. Blacktown Creek and much of the Parramatta River catchment are classified as urban streams. Urban streams can be defined as 'a stream where a significant part of the contributing catchment consists of development where the combined area of roofs, roads and paved surfaces results in an impervious surface water characterising greater than 10% of the catchment (Sinclair 2013). In these instances, ANZG (2018) recommend deriving SSTVs. Tippler et al. (2013) adopted this approach for an urban catchment within Greater Sydney whereby they created SSTVs using existing monitoring data for a range of ecosystem types, with consideration of current state (degraded water quality, riparian vegetation and macroinvertebrate communities) and percentage of impervious surfaces. Blacktown Creek is located within a similarly highly urbanised and modified catchment that is impacted by stormwater, industry and wastewater overflows. As such, the SSTVs for urban streams with 6%–19% impervious surfaces have been adopted in this assessment (Tippler et al. 2013). These values are also provided in Table 3-2.

Table 3-2 Key water quality indicators and related numerical criteria for environmental values that apply to Breakfast Creek and Blacktown Creek

Environmental value	Indicator	Guideline value - Breakfast Creek and Eastern Creek (lowland river)	Guideline value – Blacktown Creek
Aquatic ecosystems – maintaining or improving the ecological condition of waterbodies and riparian zones over the long term	Total nitrogen (milligrams per litre; mg/L)	1.72 ^[b]	0.5 ^[c]
	Dissolved inorganic nitrogen (mg/L)	0.74 ^[b]	-
	Ammonia (mg/L)	0.08 ^[b]	0.04 ^[c]
	Oxidised nitrogen (mg/L)	0.66 ^[b]	0.11 ^[c]
	Total phosphorus (mg/L)	0.14 ^[b]	0.05 ^[c]
	Filterable reactive phosphorus (mg/L)	0.04 ^[b]	-
	Turbidity (Nephelometric Turbidity Unit; NTU)	50 ^[b]	11 ^[c]
	Total suspended solids (mg/L)	37 ^[b]	7 ^[c]
	Conductivity (µS/cm ²)	1,103	371 ^[c]
	pH	6.20–7.60 ^[b]	<7.88 ^[c]
	Dissolved oxygen (% saturation or mg/L)	43–75% ^[b] 8 ^[b]	>65% ^[c]
	Chlorophyll- <i>a</i> (micrograms per litre; µg/L)	3 ^[a]	
	Toxicants	As per ANZG (2018) toxicant default guidelines values (95% level of protection for slightly to moderately disturbed ecosystems and 99% level of protection for toxicants that bioaccumulate) ^[a] .	
Visual amenity – aesthetic qualities of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50% ^[a] .	
	Surface films and debris ^[a]	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter. No quantitative value specified.	
	Nuisance organisms ^[a]	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts. No quantitative value specified.	

Surface Water Quality and Aquatic Ecology Assessment

Environmental value	Indicator	Guideline value - Breakfast Creek and Eastern Creek (lowland river)	Guideline value – Blacktown Creek
Secondary contact recreation – maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed	Faecal coliforms, enterococci, algae and blue-green algae	As per the NHMRC (2008) Guidelines for managing risks in recreational water.	
	Nuisance organisms	As per the visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.	
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable of recreation. Toxic substances should not exceed values in Table 9.3 of NHMRC (2008) guidelines.	
	Visual clarity and colour	As per the visual amenity guidelines.	
	Surface films	As per the visual amenity guidelines.	
Irrigation water supply – protecting the quality of waters applied to crops and pastures	Algae and blue-green algae	Should not be visible. No more than low algal levels are desired to protect irrigation equipment.	
	Salinity (electrical conductivity)	To assess the salinity and sodicity of water for irrigation use, several interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscapes and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC & ARMCANZ (2000) Guidelines.	
	Thermotolerant coliforms (faecal coliforms)	Trigger values for thermotolerant coliforms in irrigation water used for food and non-food crops are provided in table 4.2.2 of the ANZECC & ARMCANZ (2000) Guidelines.	
	Heavy metals and metalloids	Long term trigger values (LTV) and short-term trigger values (STV) for heavy metals and metalloids in irrigation water are presented in table 4.2.10 of the ANZECC & ARMCANZ (2000) guidelines	

Notes:

Sources: ANZG (2018), DPE (2022) SSTV and Tippler et al. (2013).

^[a] ANZG (2018) guideline value.

^[b] DPE (2022) SSTV.

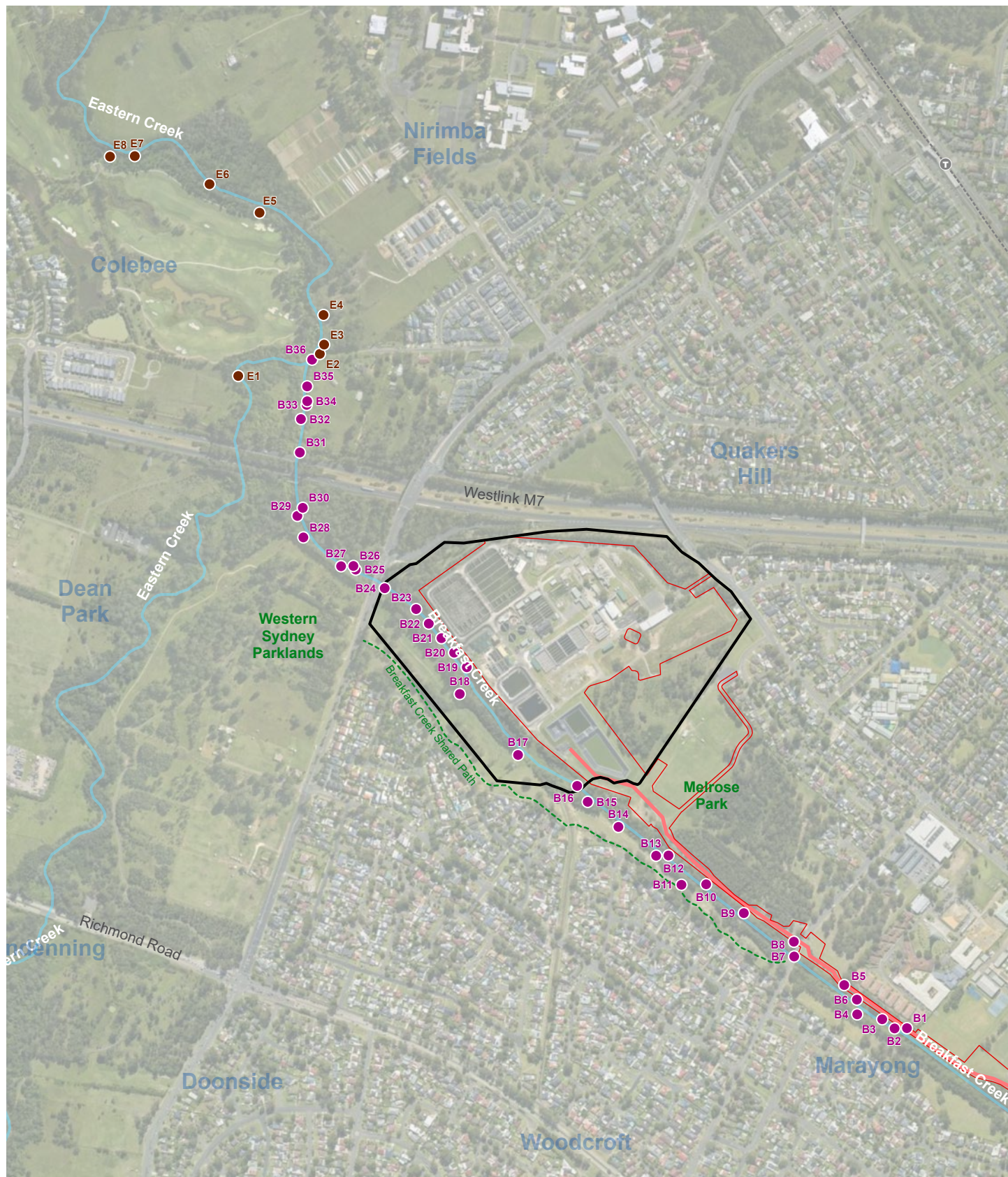
^[c] Tippler et al. (2013).

3.3 Rapid field-based assessment of aquatic habitat condition

Breakfast Creek is a naturally ephemeral and stormwater-dependent watercourse. Its section upstream of the Quakers Hill WRRF discharge point frequently dries or experiences low flows. As a result, project-related impacts on Breakfast Creek and Eastern Creek downstream of the WRRF can be demonstrated by comparing monitoring data collected downstream of the discharge with data collected upstream.

A rapid field assessment of aquatic habitat condition was performed in Breakfast Creek (between the storm drain upstream of Wright Street Bridge and the confluence with Eastern Creek) and Eastern Creek (1 km stretch of the creek downstream of the confluence with Breakfast Creek) on 17 and 18 September 2024. The sampling sites are shown in Figure 3-2. Further details on the river segments surveyed are shown in Figure 4-16 through Figure 4-20. Note that sites B1 through B19 are upstream of the WRRF outfall. Sites B20 through B36 and E1 through E8 are all downstream of the outfall Impact Assessment methodology

Field observations were used to assess habitat quality at 36 sites in Breakfast Creek and 8 sites Eastern Creek. A Riparian, Channel, and Environmental (RCE) inventory (Chessman et al. 1997) was used to assess habitat quality at each site based on surrounding land use, bank vegetation and structure, habitat features (such as boulders and snags), and watercourse structure. An example RCE scoresheet is included in Appendix A. Other negative features, such as rubbish, foams, and oil sheens, were noted. Riparian and aquatic vegetation were identified to the lowest possible level and noted if native or introduced/invasive.



- Quakers Hill Water Resource Recovery Facility (WRRF)
- Brine pipeline
- Impact area

- Rapid field assessment sites
- Breakfast Creek sites
- Eastern Creek sites
- Watercourse



Figure 3-2 Rapid field assessment sites

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment, Basemap: MetroMap 2024

Scale: 1:11,000 @ A4
GDA2020 MGA Zone 56



Existing water quality data collected by Sydney Water and Blacktown City Council between 2018 and 2024 were reviewed to characterise existing water quality and assess whether the nominated water quality objectives (WQOs) are being achieved based on associated guideline values for relevant indicators. The data were used to qualitatively assess impacts associated with the construction and operation of the project.

3.3.1 Assessment of construction impacts

The assessment of potential impacts of the project on surface water quality and aquatic ecology during the construction phase involved:

- Identifying unmitigated risks to surface water quality and aquatic ecology from the proposed construction activities.
- Identifying potential impacts to downstream waterways and SREs.
- Assessing potential impacts to the nominated WQOs with consideration to relevant guidelines.
- Identifying appropriate measures to mitigate and manage the potential impacts to surface water quality resulting from construction of the project.

3.3.2 Assessment of operational impacts

The assessment of potential impacts during operation involved:

- Identifying potential unmitigated risks to surface water quality and aquatic ecology from operation of the project.
- Identifying potential impacts to Breakfast Creek from changes in volume and contaminant concentrations in the Quakers Hill WRRF discharge.
- Determining compliance of discharge quality with Environment Protection Licence (EPL) requirements, including changes in discharge quality associated with project operation and identification of any requirement for licence variation.
- Assessing potential impacts of the project on the nominated WQOs with consideration to relevant guidelines.
- A nutrient loads assessment of the impacts associated with changes in water quality parameter concentrations and loads in waterways associated with upgrade and operation of the Quakers Hill WRRF discharge for representative dry and wet years. Assessment undertaken by Arup (2025).
- Identification of appropriate measures to mitigate the residual impact from project operation.

4. Existing environment

4.1 Catchment overview

Broadly, the study area is in the Hawkesbury-Nepean catchment, which covers approximately 22,000 km². The Hawkesbury-Nepean catchment provides drinking water, recreational opportunities, agricultural and fisheries produce, and tourism resources for the Sydney Metropolitan area. More specifically, the project falls predominantly within the Wianamatta-South Creek catchment located in the Blacktown LGA which covers 624 km² and is one of the flattest, hottest and driest parts of Greater Sydney (DPHI 2025). The Wianamatta-South Creek flows around 80 km and comprises several tributaries ranging from 1st order to 6th order streams, including Breakfast Creek, Eastern Creek, Bungarribee Creek, and South Creek. A small section of the study area falls within the Blacktown Creek sub-catchment located within the Upper Parramatta River Catchment (also located within the Blacktown LGA).

The Quakers Hill WRRF is in Quakers Hill and is surrounded by nearby residential areas. The western boundary of the site is adjacent to Breakfast Creek and there is a drainage channel at the northern boundary of the site that discharges to Breakfast Creek. Within the WRRF site itself, there are areas designated for environmental protection and biodiversity offset (as part of the Lower South Creek offsets). The proposed brine pipeline would be approximately 7.7 km long and located underground between the Quakers Hill WRRF in the west and the International Peace Park at Seven Hills in the east, where it would connect into the NSOOS. Land use

According to the Blacktown Local Environmental Plan (NSW Government 2015), the study area is zoned for a variety of uses including infrastructure at the WRRF itself with most of the brine pipeline traversing through residential, public recreation, industrial, education, and productivity support zones (Figure 4-1).

4.1.1 Soils

There are two main soil types in the study area according to the Penrith 1:100,000 Soil Landscape map: the Blacktown and South Creek which generally reflect the underlying geology dominated by alluvial and shales¹. The characteristics of these soil types are presented in Table 4-1.

The study area is outside of area mapped as having risk of acid sulphate soils (Naylor et al. 1998) indicating that activities within the project impact area are unlikely to be affected by or have an effect on acid sulphate soils. As such, the potential impacts of the project on acid sulphate soils have not been considered further.

Table 4-1 Soil landscape characteristics in the study area

Soil landscape	Soil type	Landscape and occurrence	Limitations
South Creek	Alluvial. Often very deep layered sediments over bedrock or relict soils. Structured Plastic Clays or Structured Loams in and immediately adjacent to drainage lines. Red and Yellow Podzolic Soils are most common terraces with small areas of Structured Grey Clays leached clays and Yellow Solodic Soils.	Floodplains, valley flats and drainage depressions of the channels on the Cumberland Plain. Usually flat with incised channels; mainly cleared. This soil landscape comprises the present active floodplain of many drainage networks of the Cumberland Plain. This includes the Breakfast Creek and Blacktown Creek within the project study area.	Flood hazard, seasonal waterlogging, localised permanently high-water tables, localised water erosion hazard, localised surface movement potential.

¹ A third soil type (Luddenham) occurs in the northeast of the study area but does not underlie any of the proposed project elements.

Soil landscape	Soil type	Landscape and occurrence	Limitations
Blacktown	Residual. Shallow to moderately deep (<100 centimetres; cm) Red and Brown Podzolic Soils on crests, upper slopes and well-drained areas; deep (150–300 cm) Yellow Podzolic Soils and Soloths on lower slopes and in areas of poor drainage.	Gently undulating rises on Wianamatta Group shales and Hawkesbury shale. Local relief to 30 m, slopes are usually <5%. Broad rounded crests and ridges with gently inclined slopes. Cleared eucalypt woodland and tall open forest (wet sclerophyll forests). Underlies all project areas not underlain by South Creek Soil.	Moderately reactive highly plastic subsoil, low soil fertility, poor soil drainage.

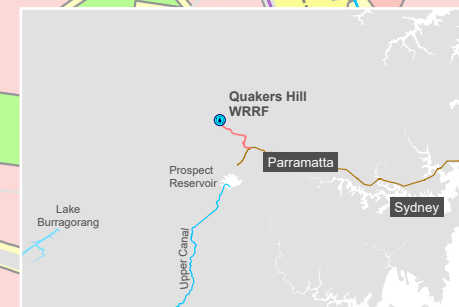
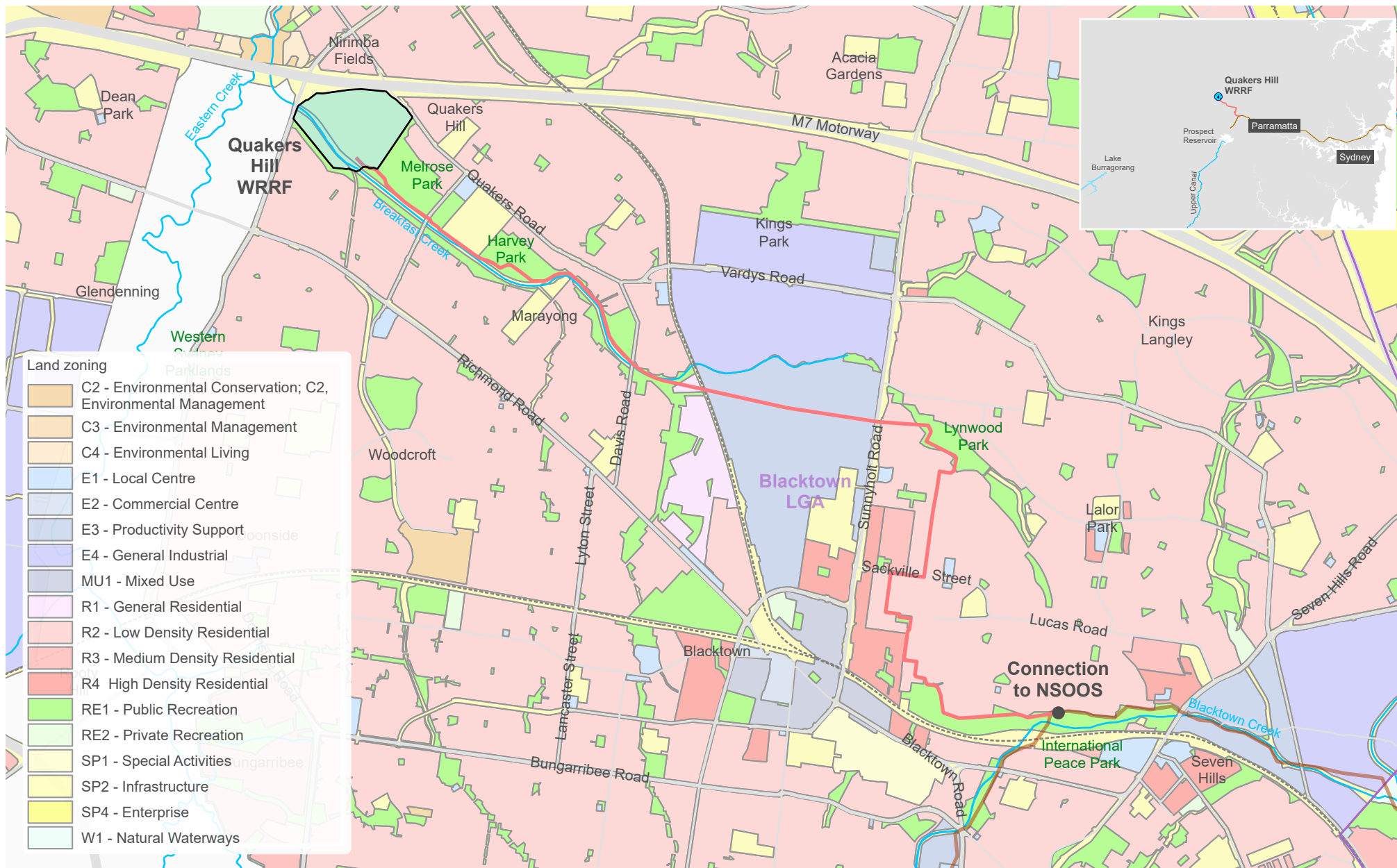


Figure 4-1 Land use

0 1 km

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:35,000 @ A4
GDA2020 MGA Zone 56



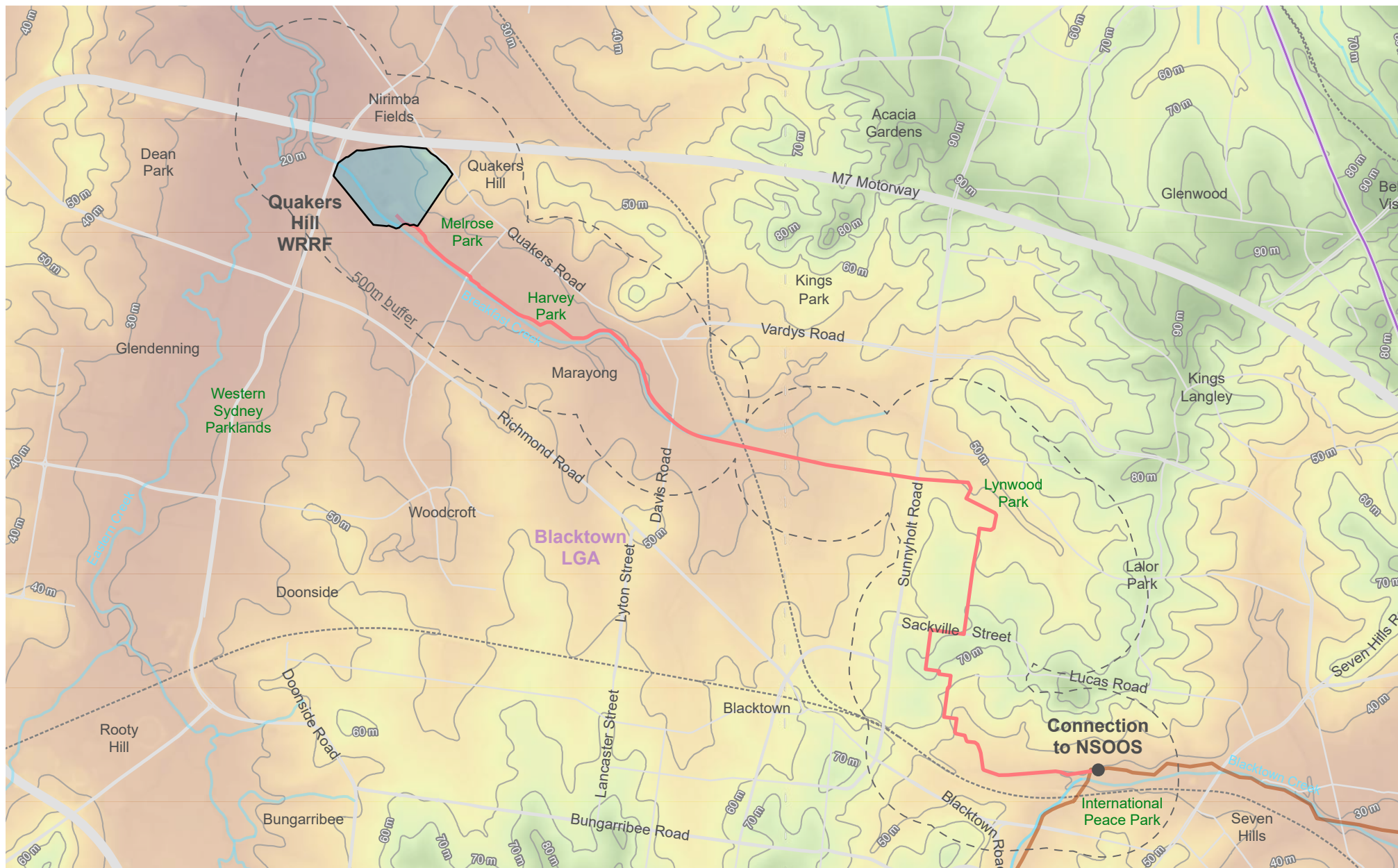
4.1.2 Topography and drainage

The study area consists of low hills and gently undulating rises and plains, with long and low colluvial/alluvial foot slopes and plains (often ponding and eroded, incised and extensive floodplains). Local relief generally ranges from 20 m to 60 m, with some peaks and ridgelines reaching heights of 80–90 m (Figure 4-2). Slopes are generally less than 20%.

Breakfast Creek drains a broad valley flowing to the northwest before joining Eastern Creek to the northwest of the Quakers Hill WRRF. Breakfast Creek is naturally ephemeral and stormwater-dependent, with the reaches upstream of the Quakers Hill WRRF frequently drying or experiencing low or no flow. Upstream of Breakfast Road, Breakfast Creek transitions to a concrete lined stormwater channel.

In the south, Blacktown Creek drains eastward near the southeastern terminus of the pipeline alignment. Blacktown Creek corridor is highly modified comprising of large sections of concrete channels and adjacent open space and is influenced by stormwater runoff and wastewater discharges/overflows.

The Quakers Hill WRRF is at an elevation of 30–35 m Australian Height Datum (AHD). From the WRRF, the brine pipeline alignment follows Breakfast Creek up valley to an elevation of approximately 45 m from which point tunnelling beneath the catchment divide emerging in the adjoining catchment in Lynwood Park at an elevation of approximately 55 m AHD. The maximum elevation of the catchment divide is approximately 65 m AHD. From Lynwood Park, the alignment heads southwards climbing to a maximum elevation of approximately 70 m AHD before dropping again in elevation towards the final elevation of approximately 50 m AHD at the International Peace Park in Seven Hills.



- Quakers Hill Water Resource Recovery Facility (WRRF)
- Brine pipeline
- NSOOS pipeline
- Project 500m buffer
- LGA boundaries
- Parks and open space

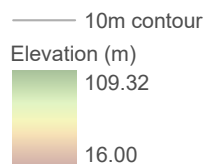


Figure 4-2 Topography and drainage



4.1.3 Climate

The nearest Bureau of Meteorology (BoM) weather station with a comprehensive record of rainfall and temperature data is the Prospect Reservoir weather station (#067019) located approximately 9 km south from the Quakers Hill WRRF. Rainfall data for the period 1995–2024 were analysed to represent inter- and intra-annual variations in climate (BoM 2025). The average total monthly rainfall for this period is presented in Figure 4-3.

The rainfall data show that the project area experiences a moderate level of rainfall throughout the year. The wettest period is typically between January and March with average rainfall ranging between 102 mm and 122 mm. The driest period is generally between July and September with average monthly rainfall ranging between 42 mm and 50 mm.

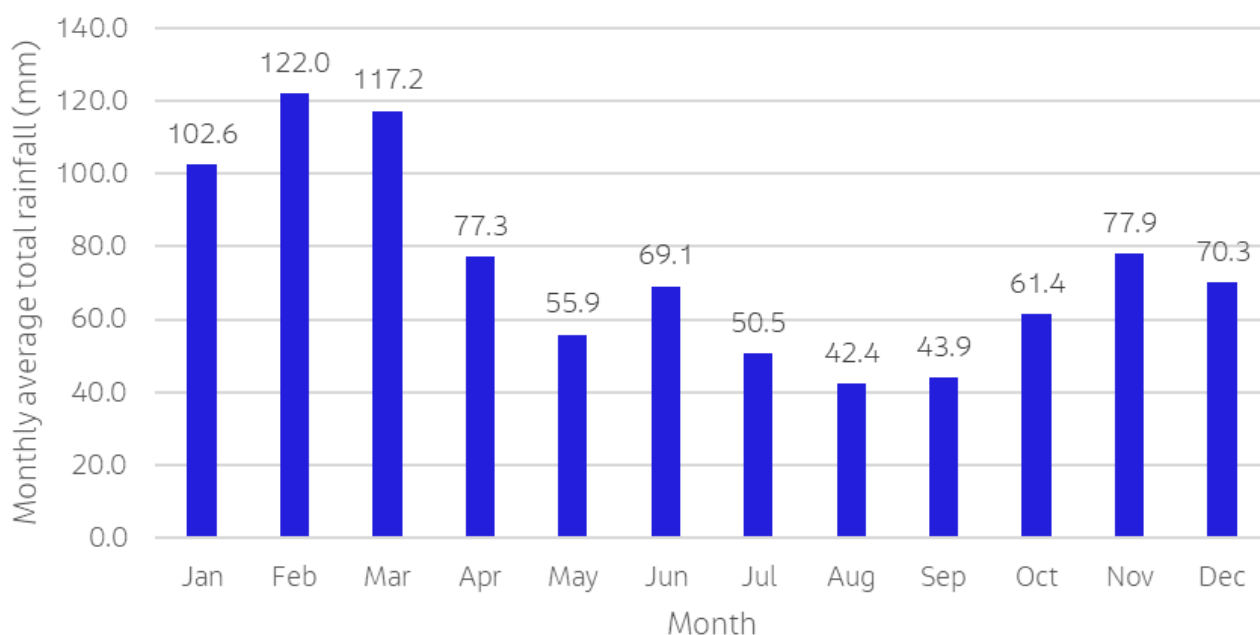


Figure 4-3 Average total monthly rainfall recorded by Prospect Reservoir Weather Station between 1995 and 2024

Source: BoM (2025).

Temperature data from Prospect Reservoir weather station for the period 1995–2024 were also reviewed (BoM 2025). Data were not available from 2018 onwards and therefore the temperature dataset was supplemented by data from Horsley Park Equestrian Centre Weather Station (#067119).

Average monthly maximum and minimum temperature ranges between 1995 and 2024 are presented in Figure 4-4. The study area is positioned within a temperate climate zone characterised by warm summers and cool winters. Seasonal average minimum and maximum temperatures range from approximately 6 degrees Celsius (°C) to 19.5°C (June–August) and 16°C to 29°C (December–February), with predominately mild to moderate autumn and spring months.

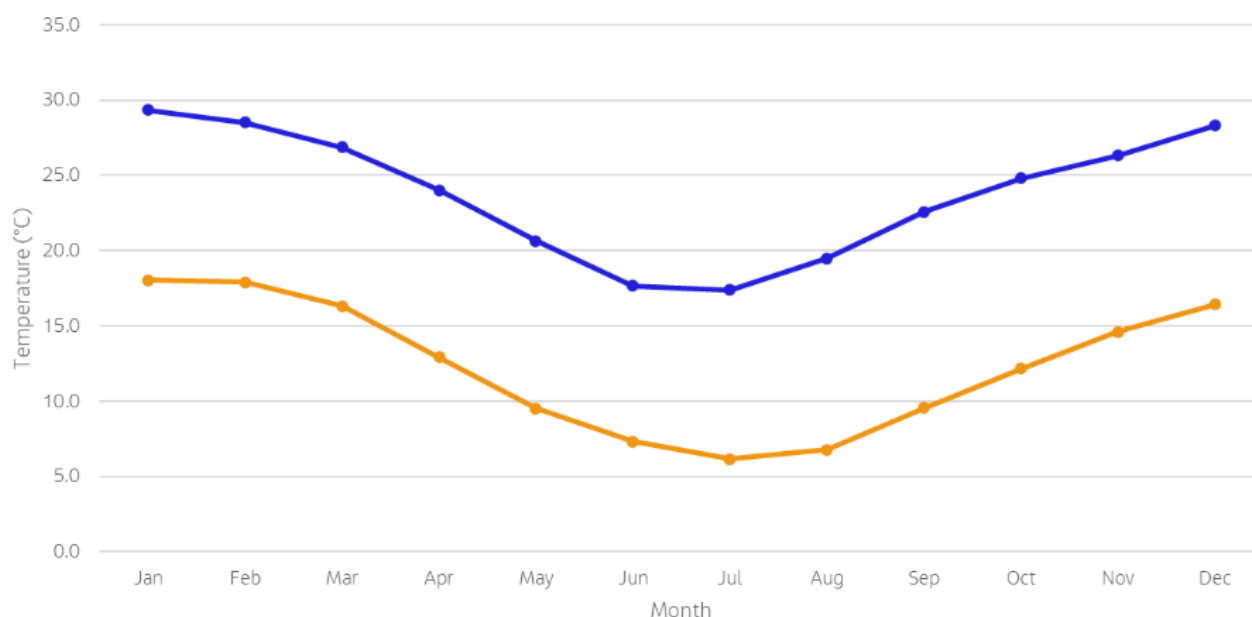


Figure 4-4 Average monthly minimum and maximum temperatures recorded by Prospect Reservoir and Horsley Park Equestrian Centre weather stations between 1995 and 2024

Source: BoM (2025).

4.2 Watercourses

The main watercourses within the study area are Breakfast Creek, Eastern Creek, and Blacktown Creek (Figure 1-1). The geomorphological condition of these creeks is poor. For the purposes of aquatic habitat characterisation (results presented in Section 4.2.1.2), Breakfast Creek has been described according to:

- The Strahler stream classification system where waterways are given an order according to the number of additional tributaries associated with each waterway (Strahler 1952).
- Whether the waterway is classified as Key Fish Habitat (KFH), based on KFH Mapping.

4.2.1 Breakfast Creek

Breakfast Creek is a tributary of Eastern Creek. It is a highly urbanised waterway that flows northwest for approximately 7 km from Lalor Park in Western Sydney where it originates to the confluence of Eastern Creek downstream of Quakers Hill WRRF. The hydraulic and geomorphic diversity of Breakfast Creek increase downstream of the Quakers Hill WRRF (Streamology 2025). The creek has been significantly modified, including a 900-metre concrete channel and numerous barriers to fish that disrupt natural flow and connectivity to the floodplain. Riparian vegetation is limited, and the exotic/introduced fish species carp is known to be present. Sediments are fine-grained with low resistance to erosion.

Breakfast Creek receives discharge of treated wastewater from the WRRF. As flow data for Breakfast Creek has not historically been measured, a gauge of Eastern Creek and WRRF discharge data were used by Streamology (2025) to model baseline flows in Breakfast Creek upstream and downstream of the WRRF discharge point. Streamology (2025) calculated that upstream of the WRRF, flows vary between <1 ML/d and 10 ML/d, with very occasional higher flow events less than 5% of the time due to high rainfall events. However, downstream of the WRRF, the flow in Breakfast Creek is very consistent due to the steady treated effluent discharge, varying between 30 ML/d and 60 ML/d due to high rainfall events (Figure 4-5), with only rare higher flow events due to rainfall and practically no low flow or cease-to-flow events.

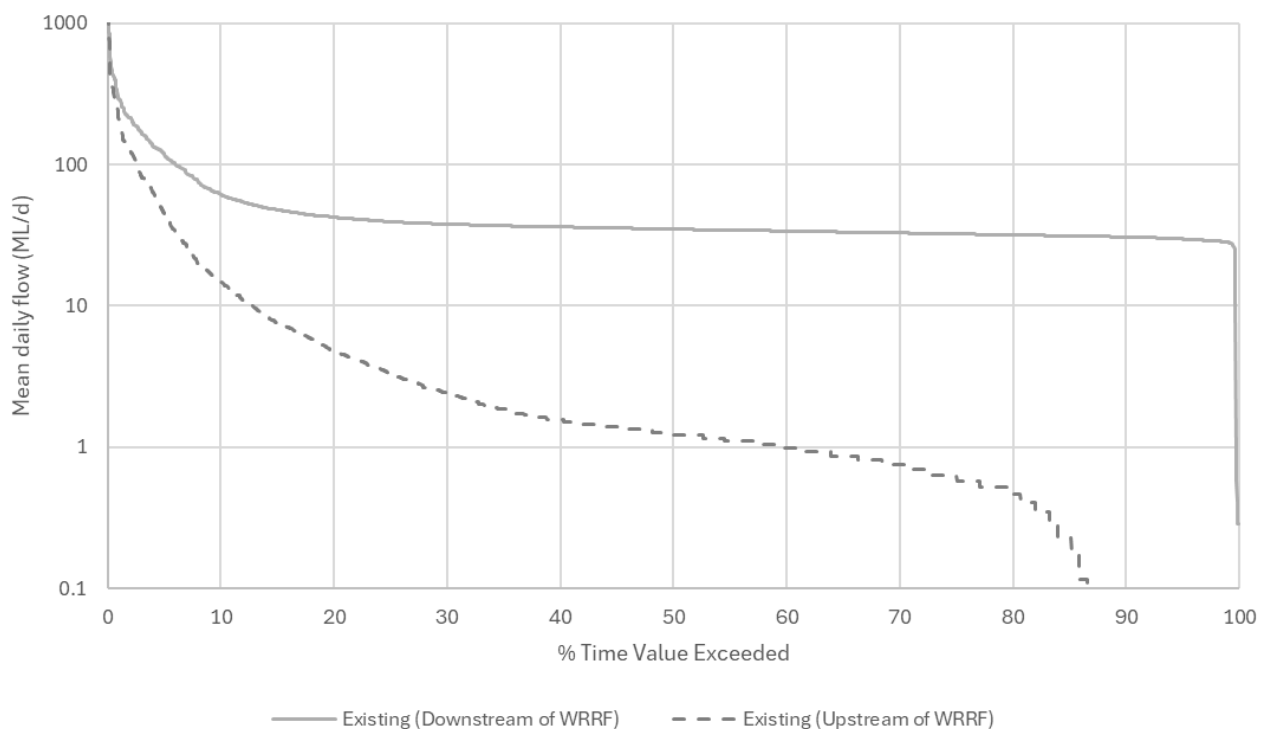


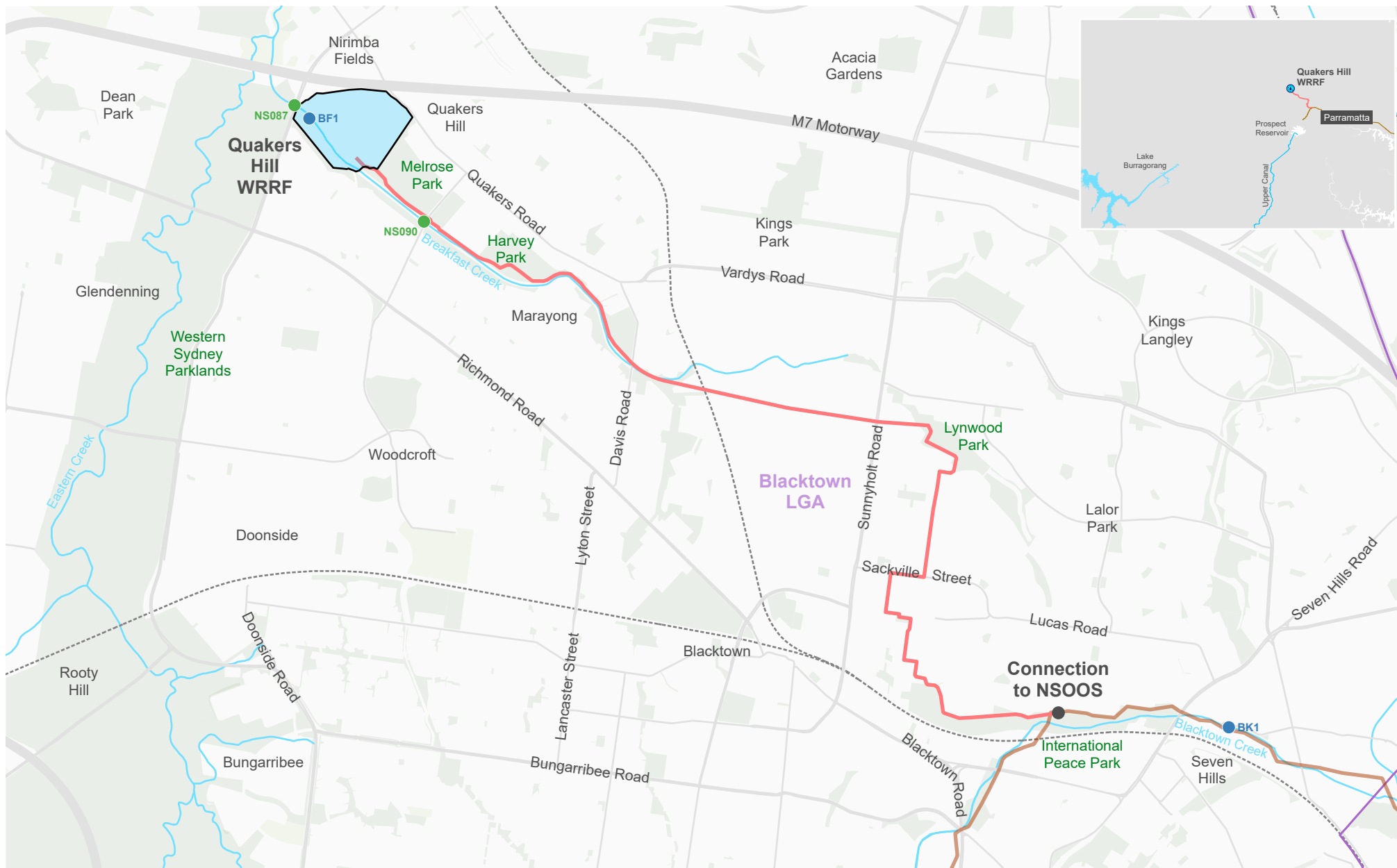
Figure 4-5 Flow duration curves for Breakfast Creek

Source: Streamology (2025).

4.2.1.1 Water quality

4.2.1.1.1 General

The water quality of Breakfast Creek has been monitored by both Sydney Water and Blacktown City Council. Sydney Water sample at two sites in Breakfast Creek during dry weather conditions: upstream of the Quakers Hill WRRF discharge point (NS090) and downstream of the discharge point (NS087); Blacktown City Council sample at a site opposite the Quakers Hill WRRF (BF1) during both dry weather and wet weather conditions. The location of the sampling sites is shown in Figure 4-6.



- Quakers Hill Water Resource Recovery Facility (WRRF)
- Brine pipeline
- NSOOS pipeline
- LGA boundaries
- Parks and open space

- Water Quality Monitoring Sites
- Blacktown City Council
 - Sydney Water

Figure 4-6 Water quality monitoring sites

0 1 km

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:35,000 @ A4
GDA2020 MGA Zone 56



Median concentrations of 22 physico-chemical indicators monitored during the period 2018–2024 show that the water quality of Breakfast Creek is generally poorer downstream of the Quakers Hill WRRF (Table 4-2). Overall, exceedance of guideline limits was observed for the same group of parameters, irrespective of location, except for dissolved oxygen and nutrients. At the upstream site (NS090), median concentrations of all indicators complied with the respective guidelines for protection of aquatic ecosystems except for filterable reactive phosphorus, total aluminium and total copper, and total and filterable zinc. At the downstream sites (NS087 and BF1), nutrient concentrations were notably higher with total and oxidised nitrogen and filterable reactive phosphorus exceeding the recommended limits. Following wet weather, water quality data collected opposite the Quakers Hill WRRF (BF1) indicate that whilst nitrogen still exceeded recommended limits the concentrations were slightly lower due to likely dilution with rainwater. Concentrations of total metals, except for cobalt, exceeded the recommended limits and were generally higher at the downstream sites than upstream of the WRRF release.

In summary, the water quality of Breakfast Creek can be considered poor and not suitable for protection of aquatic ecosystems, particularly downstream of the WRRF discharge point. This indicates that the discharge of treated wastewater influences the water quality in this stretch of Breakfast Creek.

Table 4-2 Median concentrations of physico-chemical indicators in Breakfast Creek and corresponding guideline values

Indicator	NS090 (upstream of the WRRF discharge)	NS087 (downstream of the WRRF discharge)	BF1 (downstream, opposite WRRF discharge)	Guideline for protection of aquatic ecosystems
Electrical conductivity ($\mu\text{S}/\text{cm}$)	1,075	959.5	937.5 (dry) 751 (wet)	1,103 ^[a]
Dissolved oxygen (% saturation)	71.5	95.65	78.8 (dry) 71.4 (wet)	43–75 ^[a]
pH	7.61	7.47	7.51 (dry) 7.41 (wet)	6.2–7.6 ^[a]
Temperature ($^{\circ}\text{C}$)	18.7	21.7	22.95 (dry) 22.3 (wet)	No guideline
Turbidity (NTU)	8.7	1.55	2.96 (dry) 6.82 (wet)	50 ^[a]
Suspended solids (mg/L)	ND	ND	2.5 (dry) 6.6 (wet)	36
Ammonium (mg/L)	0.05	0.02	0.04 (dry) 0.04 (wet)	0.08 ^[a]
Oxidised nitrogen (mg/L)	0.17	2.705	2.57 (dry) 2.48 (wet)	0.66 ^[a]
Total nitrogen (mg/L)	0.81	3.91	3.75 (dry) 3.55 (wet)	1.72 ^[a]
Filterable reactive phosphorus (mg/L)	0.047	0.0615	0.03 (dry) 0.045 (wet)	0.04 ^[a]
Total phosphorus (mg/L)	0.087	0.084	0.08 (dry) 0.105 (wet)	0.14 ^[a]
Chlorophyll- <i>a</i> ($\mu\text{g}/\text{L}$)	2.3	1.2	1 (dry) 0.5 (wet)	3 ^[b]

Indicator	NS090 (upstream of the WRRF discharge)	NS087 (downstream of the WRRF discharge)	BF1 (downstream, opposite WRRF discharge)	Guideline for protection of aquatic ecosystems
Total aluminium (mg/L)	0.2	0.106	ND	0.055 ^[b]
Filterable aluminium (mg/L)	0.007	0.051	ND	0.055 ^[b]
Total cobalt (mg/L)	0.0004	0.0003	ND	0.0014 ^[b]
Filterable cobalt (mg/L)	0.0003	0.0003	ND	0.0014 ^[b]
Total copper (mg/L)	0.0032	0.0039	ND	0.0014 ^[b]
Filterable copper (mg/L)	0.002	0.0038	ND	0.0014 ^[b]
Total nickel (mg/L)	0.0017	0.0015	ND	0.011 ^[b]
Filterable nickel (mg/L)	0.0014	0.0015	ND	0.011 ^[b]
Total zinc (mg/L)	0.02	0.016	ND	0.008 ^[b]
Filterable zinc (mg/L)	0.012	0.015	ND	0.008 ^[b]

Notes: Data sources: Sydney Water and Blacktown City Council.

^[a] South Creek performance criteria.

^[b] ANZG (2018) Water quality guidelines.

Orange cells denote exceedance of guideline; green cells denote compliance with guideline; yellow cells denote a dry or wet weather value non-compliance.
ND - no data.

4.2.1.1.2 Nutrients

While nutrients are essential for all forms of life, nutrients can enter waterways from a variety of anthropogenic sources, including stormwater, treated wastewater, and wastewater overflows. Elevated nutrient concentrations in the water can cause excessive plant growth leading to algal blooms and lowered levels of dissolved oxygen, particularly under dry and warm weather conditions. Nutrient monitoring data for two sites in Breakfast Creek were available from 2018 to 2024 (except during the period August 2019 to June 2021 due to a major upgrade of the Quakers Hill WRRF).

Nutrient concentrations at upstream and downstream of the Quakers Hill WRRF discharge point are visually displayed for total nitrogen, oxidised nitrogen, ammonia, total phosphorus and filterable reactive phosphorus in Figure 4-7 through Figure 4-15 together with the relevant performance criteria.

Total nitrogen concentrations upstream of the discharge point are mostly below the recommended performance criteria of 1.72 mg/L and range between 0.5 mg/L and 2.58 mg/L (Figure 4-7). Downstream of the discharge point, total nitrogen concentrations were generally higher than both the performance criteria and upstream concentrations, ranging between 1.18 mg/L and 7.43 mg/L. These results indicate that treated Quakers Hill WRRF discharges are contributing total nitrogen into Breakfast Creek.

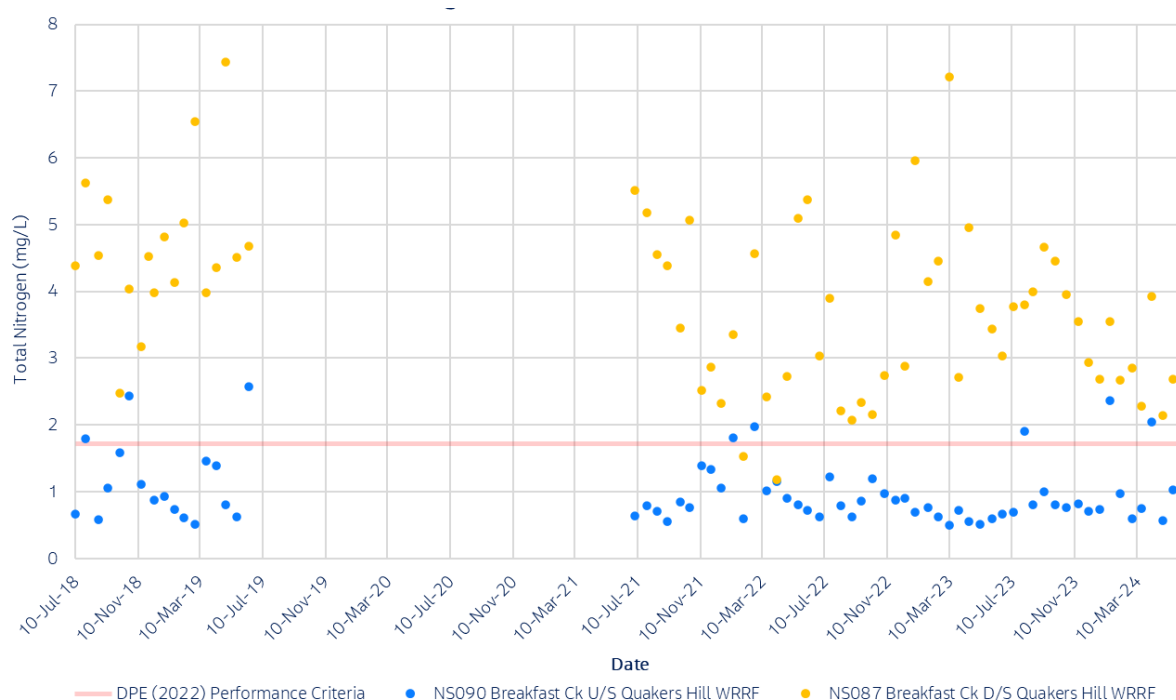


Figure 4-7 Concentrations of total nitrogen at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge point

Nitrogen can occur in bioavailable forms, such as oxidised nitrogen and ammonia which are the forms of nitrogen that plants, microorganisms, and animals can readily use. Similarly to total nitrogen, oxidised nitrogen concentrations were notably lower upstream of the Quakers Hill discharge point (Figure 4-8). Concentrations at the upstream site ranged between 0.005 mg/L and 1.81 mg/L compared to concentrations at the downstream site which ranged between 0.29 mg/L and 6.37 mg/L. Downstream site concentrations were generally always higher than the DPE (2022) performance criteria of 0.66 mg/L.

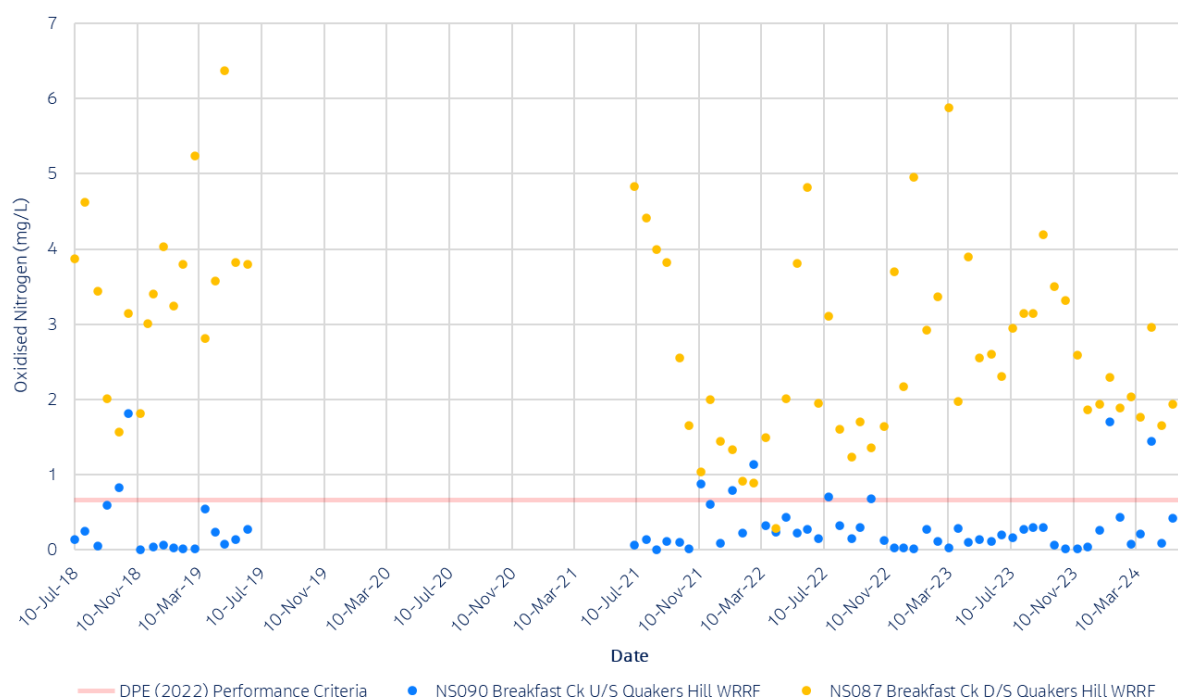


Figure 4-8 Concentrations of oxidised nitrogen at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge point

Ammonia concentrations were slightly higher upstream the Quakers Hill WRRF discharge ranging between 0.005 mg/L and 1.49 mg/L (Figure 4-9). Whilst the downstream site recorded a broader range in concentrations (0.005–2.6 mg/L), the median concentration was generally lower at the downstream site (0.02 mg/L) compared to that at the upstream site (0.05 mg/L). These results suggest that the discharge of treated wastewater from Quakers Hill WRRF does not generally contribute ammonia to elevate concentrations above the DPE performance criteria.

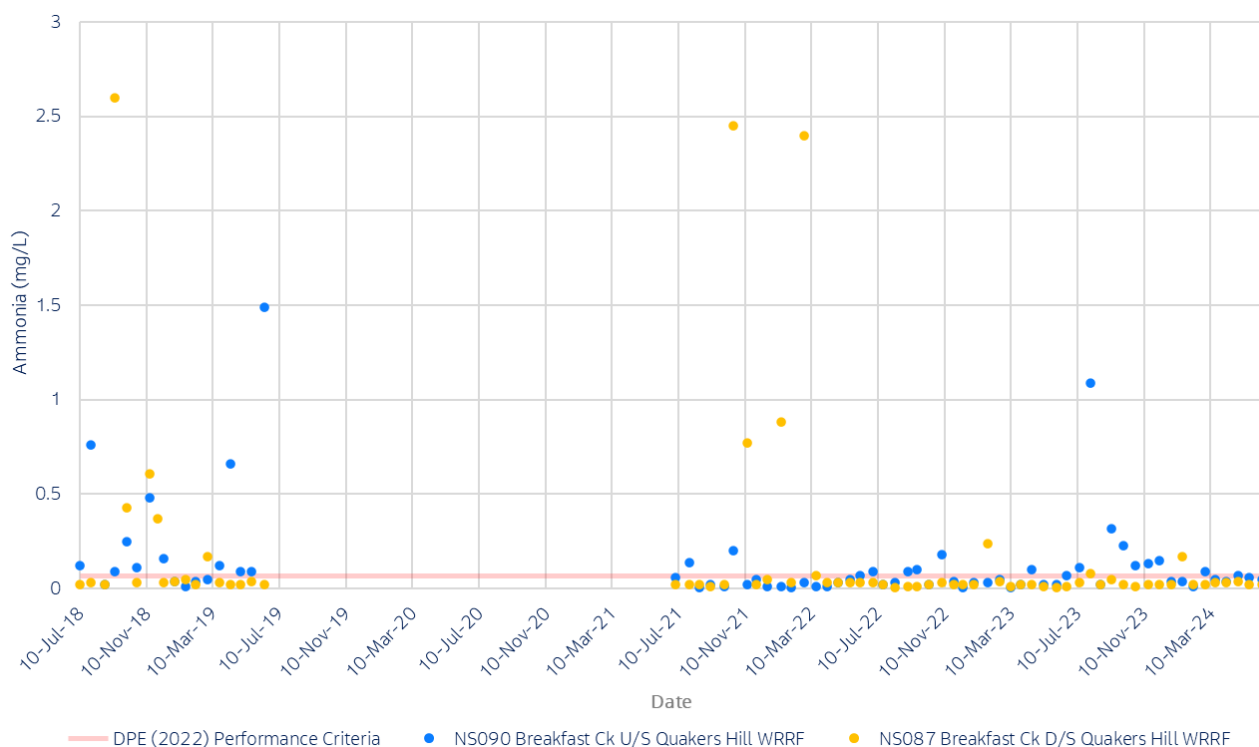


Figure 4-9 Concentrations of ammonia at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge point

Total phosphorus concentrations in Breakfast Creek shown in Figure 4-10 do not appear to be influenced by the Quakers Hill WRRF discharge, with concentrations upstream of the discharge ranging between 0.046 mg/L and 0.396 mg/L. There were, however, samples in 2023 and 2024 with elevated total phosphorus concentrations at the downstream site (concentrations ranging between 0.029 mg/L and 0.6mg/L).

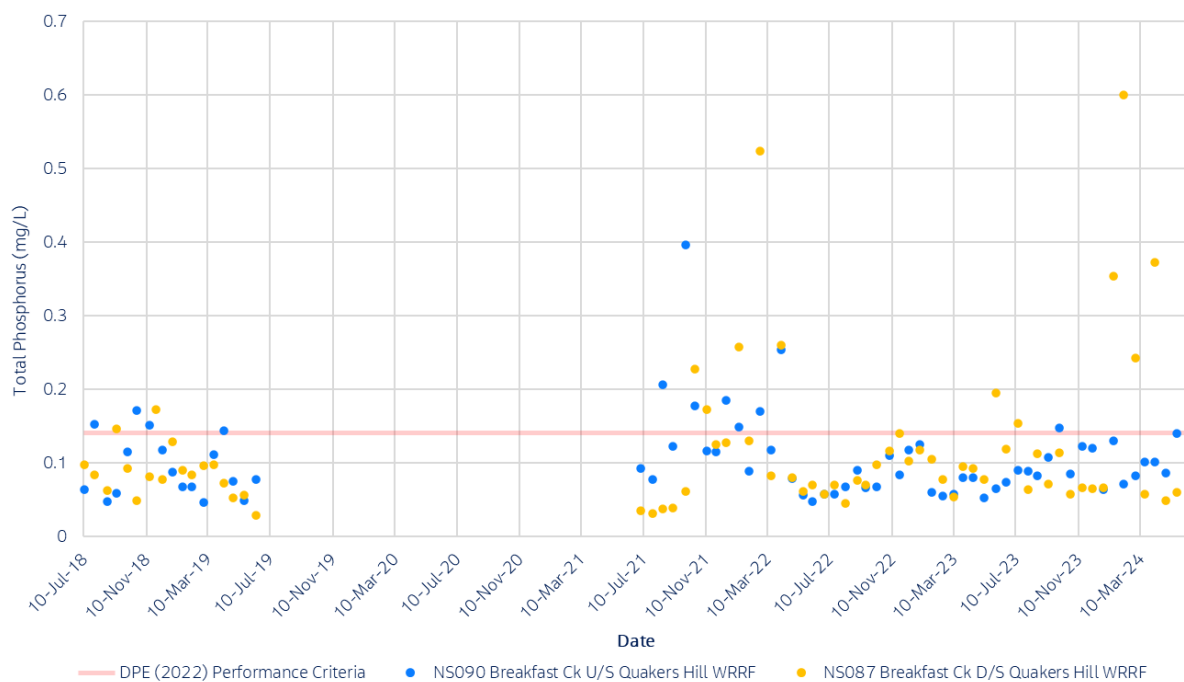


Figure 4-10 Concentrations of total phosphorus at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge point

Filterable reactive phosphorus concentrations in Breakfast Creek were frequently higher than the performance criteria of 0.04 mg/L at both upstream and downstream sites (Figure 4-11). In recent years, there were instances of elevated filterable reactive phosphorus at the downstream site. These results, together with those for total phosphorus, suggest a contribution of the Quakers Hill WRRF discharge to phosphorus concentrations in Breakfast Creek at levels above the DPE performance criteria.

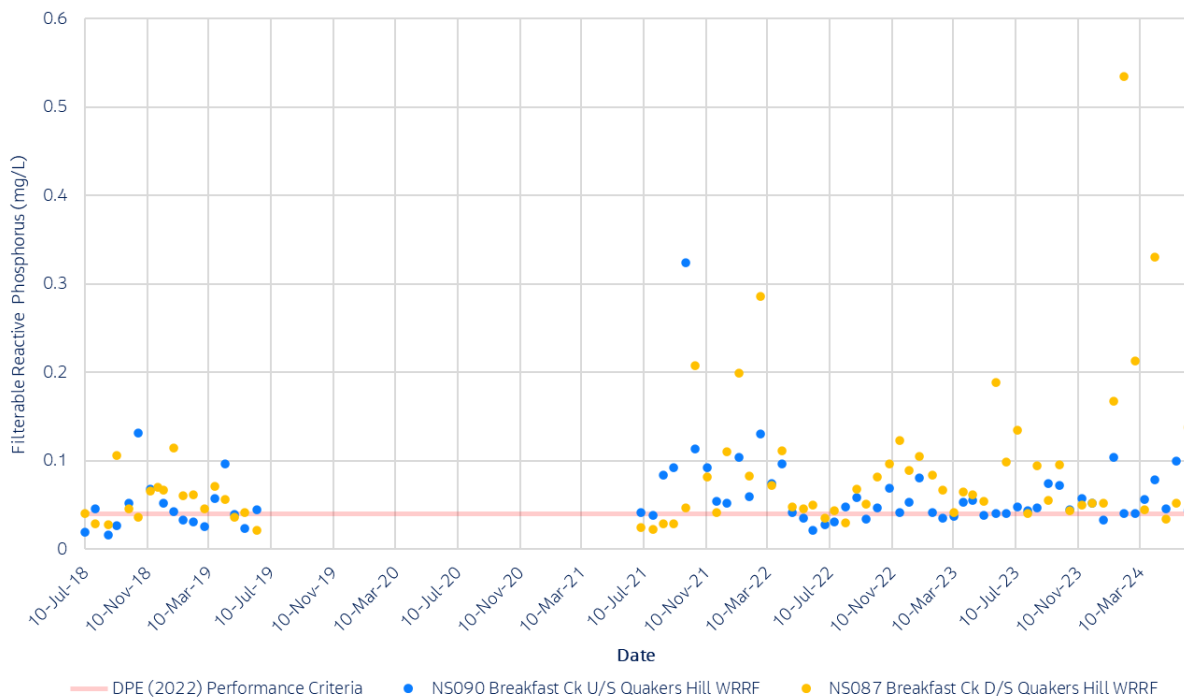


Figure 4-11 Concentrations of filterable reactive phosphorus at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge point

4.2.1.1.3 Chlorophyll-*a* and algae

Chlorophyll-*a* is a green pigment found in plants that is used to absorb sunlight during photosynthesis. Chlorophyll-*a* concentrations provide an indicator of algal or cyanobacteria biomass and therefore the trophic status of waterways. Figure 4-12 presents the chlorophyll-*a* concentrations recorded in Breakfast Creek between July 2018 and June 2024. The results show that concentrations are generally higher upstream of the Quakers Hill WRRF discharge compared to those downstream. Concentrations ranged from 0.4 µg/L to 26.2 µg/L at the upstream site and from 0.2 µg/L to 19.6 µg/L at the downstream site. These results suggest that discharges from the WRRF dilute upstream chlorophyll-*a* concentrations and likely reduce the risk of excessive algal growth.

There are limited corresponding data to understand the presence of algae in Breakfast Creek. Algal biovolumes were sampled at the upstream site on 12 occasions when water samples contained elevated concentrations of chlorophyll-*a*. Potentially toxic cyanobacteria were recorded in low numbers on three occasions (all results <620 cells/mL). By comparison, toxic cyanobacteria were detected in one of the four samples that were analysed with a count of 208 cells/mL.

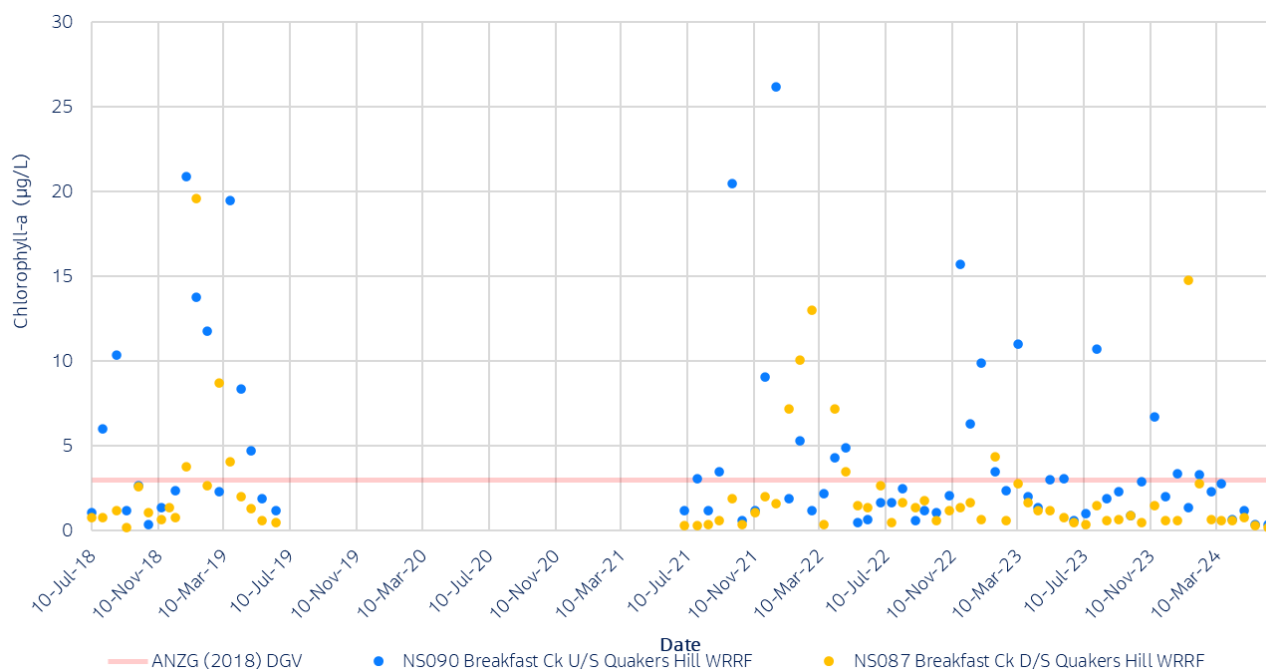


Figure 4-12 Concentrations of chlorophyll-*a* at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge

4.2.1.1.4 Other indicators of concern

Electrical conductivity

Monitoring data for electrical conductivity in Breakfast Creek is shown in Figure 4-13 for upstream and downstream of the Quakers Hill discharge together with the DPE (2022) performance criteria of 1,103 µS/cm.

Electrical conductivity data show that concentrations are more variable upstream of the Quakers Hill WRRF discharge to Breakfast Creek compared to those downstream. Upstream concentrations also frequently exceeded the DPE (2022) performance criteria which could be attributable to low flow, or urban runoff, depending on the prevailing conditions at the time of sampling. Concentrations at the downstream site were much lower and more compliant. Although exceedances did occur, these are likely due to the high background concentrations upstream of the discharge point. Whilst the flows from the Quakers Hill WRRF

discharge would provide some dilution, the results suggest that it is insufficient to reduce concentrations to levels below the performance criteria.

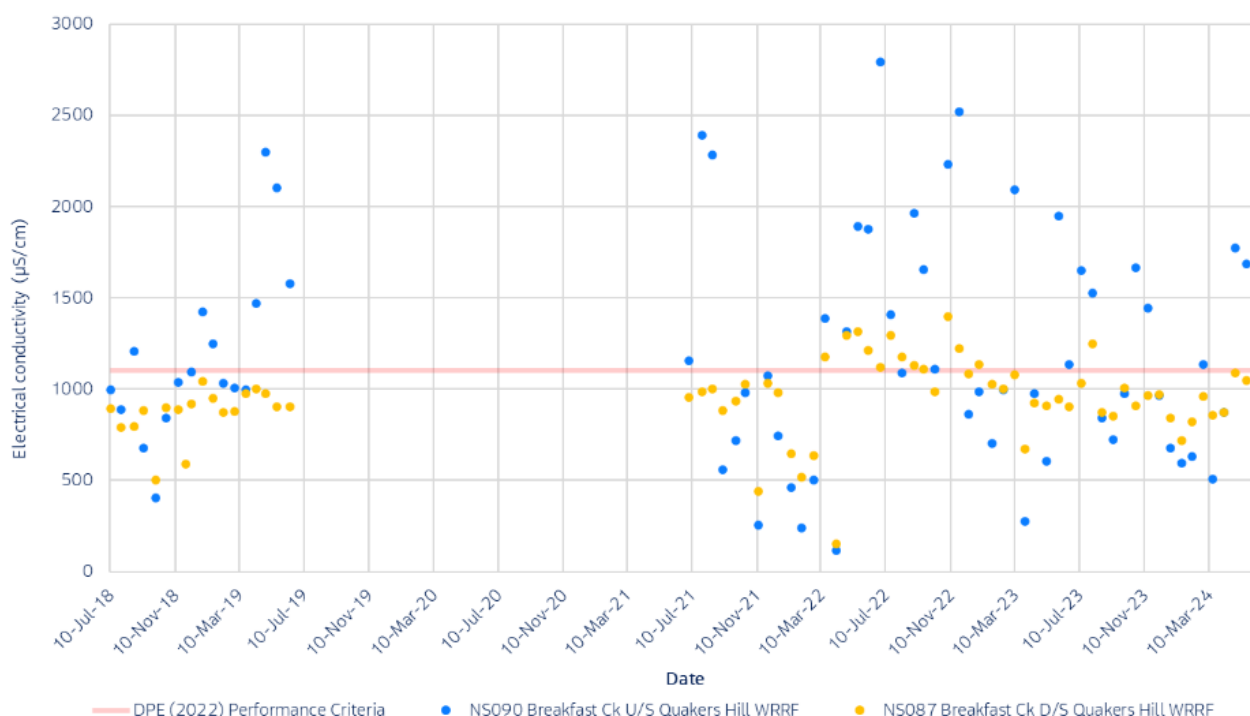


Figure 4-13 Electrical conductivity at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge

Turbidity

Turbidity is a measure of the degree to which light is scattered in water by particles, such as sediment and algae and provides a measure of water clarity. Water clarity is important for the healthy functioning of waterways. Elevated turbidity can affect the amount of photosynthesis of aquatic plants and reduce the feeding efficiency of fish.

Turbidity levels at sites in Breakfast Creek upstream and downstream of the Quakers Hill discharge and the corresponding DPE (2022) performance criteria of 50 NTU are shown in Figure 4-14. Turbidity levels at both sites generally complied with the criteria and were lower at the downstream site. Elevated turbidity (above the guideline limit) was occasionally detected upstream of the discharge point; this is likely due to rainfall events and the contribution of sediment-laden runoff transported into Breakfast Creek. On most of these high turbidity occasions, levels downstream were also elevated, but concentrations were not as high, indicating that the lower turbidity in the treated discharge provides dilution to levels below background.

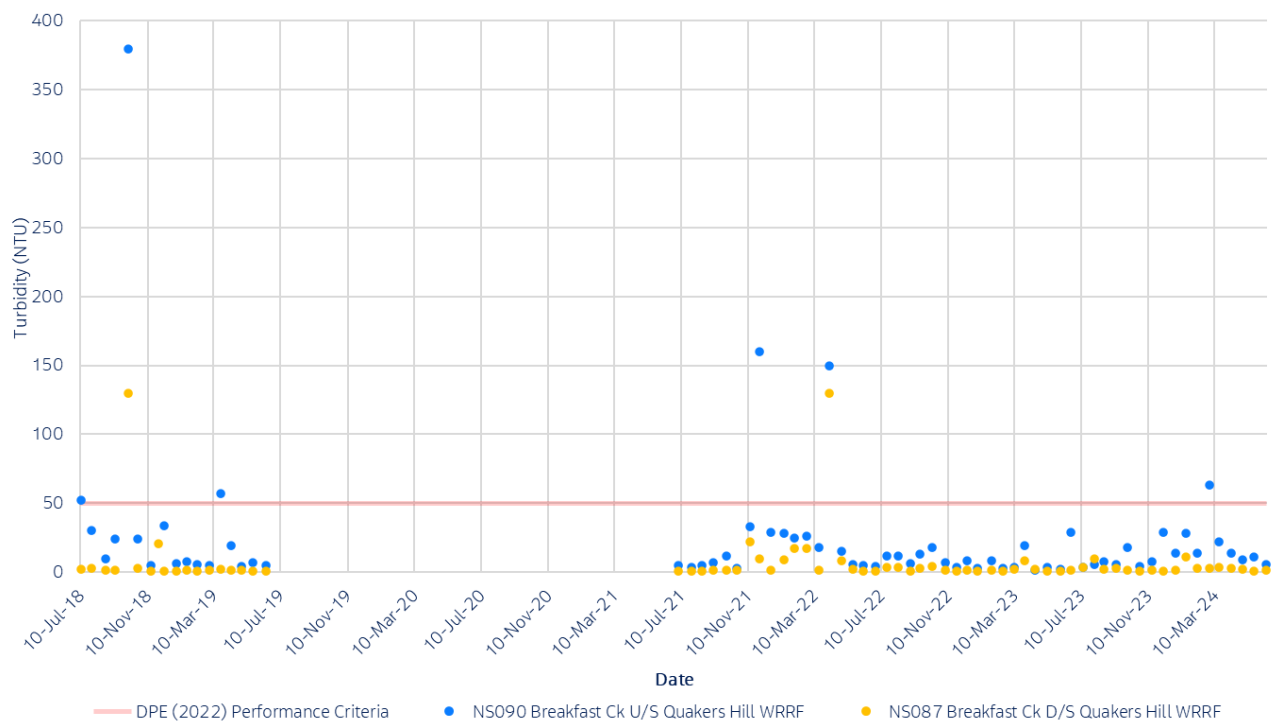


Figure 4-14 Turbidity levels at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge

Water temperature

Temperature affects many biological and chemical functions in aquatic ecosystems. Water temperatures outside the limits tolerated by aquatic organisms can therefore disrupt the natural balance of an ecosystem. Water temperature is measured both upstream and downstream of the Quakers Hill discharge point as shown in Figure 4-15. As can be seen, water temperature downstream of the discharge point is generally warmer than upstream, with the greatest differences in temperature recorded during the winter months, when instream temperatures are naturally much cooler. Data collected during these cooler months (June–August) show an average temperature difference of 6.8°C but it can be as high as 9°C. During warmer months, the difference in water temperature between upstream and downstream is small.

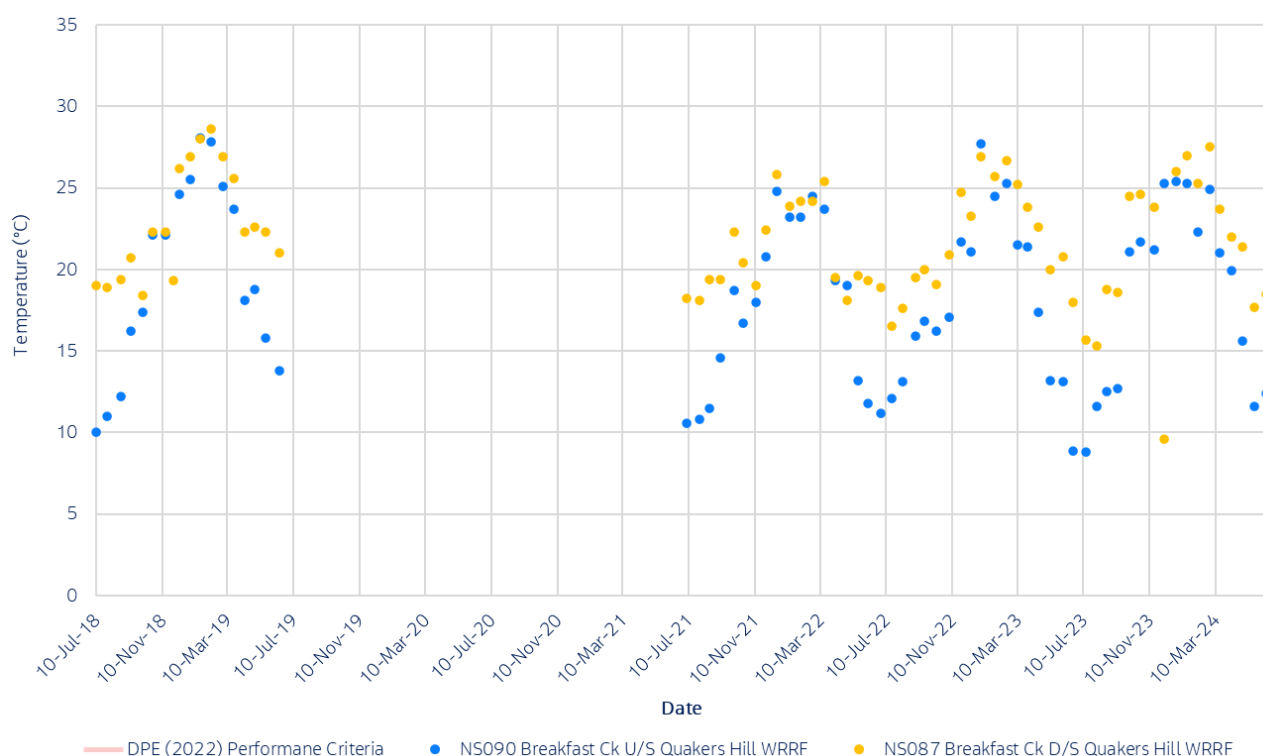


Figure 4-15 Water temperature at sites in Breakfast Creek upstream and downstream of the Quakers Hill WRRF discharge

In summary, the water quality monitoring results for Breakfast Creek show that water quality is generally better upstream of the Quakers Hill WRRF discharge point. Median concentrations of most water quality indicators at the upstream site comply with guidelines for protection of aquatic ecosystems, except for filterable reactive phosphorus, total aluminium, total copper, and total and filterable zinc. Chlorophyll-a concentrations are higher concentrations upstream compared to downstream, indicating dilution by Quakers Hill WRRF discharge. At the downstream sites, nutrient concentrations (total nitrogen, oxidised nitrogen, filterable reactive phosphorus) have exceeded their respective recommended limits. Water temperatures are generally warmer downstream, especially during winter months. Wet weather data show slightly lower nitrogen concentrations due to dilution.

4.2.1.2 Breakfast Creek aquatic habitat

Breakfast Creek is classified as a third order stream based on the Strahler method (Strahler 1952). The waterway is mapped as KFH (DPIRD 2025) based on Strahler rating, including the sections upstream and downstream of the WRRF. The KFH designation is also applied to the concrete-lined portion beginning upstream of Breakfast Road, although concrete-lined channels are by definition not KFH (DPI 2013).

The freshwater fish community status for Breakfast Creek is ranked as "fair" in accordance with Fisheries Spatial Data Portal (DPIRD 2025). The exotic/introduced fish species Common Carp was observed during the field assessment and is also recorded in the region in ALA (2025) and BioNet (2025).

Blacktown City Council releases an annual Waterway Health Report Card in which water quality and riparian condition are assessed based on surveys of aquatic macroinvertebrate communities and riparian vegetation. Breakfast Creek is assessed just upstream of the WRRF outfall. Breakfast Creek water quality was rated in 2024 as "fair," indicating a presence of only pollution-tolerant macroinvertebrates, and the riparian health was rated as "poor" indicating dominance of weeds and low diversity of riparian vegetation (BCC 2024). Invertebrate community diversity was rated as "fair" in 2020 and "good" in 2022, indicating possible variability between years, although riparian vegetation has consistently rated as "poor" (BCC 2020, 2022).

Streamology (2024) assessed the ecological condition and values of the South Creek catchment, including Breakfast Creek. They noted that urban runoff, a fragmented riparian corridor, barriers to flow and fish passage, and stagnant conditions combined to make a poor condition habitat. Streamology (2024) identified several ecological values supported by flows in Breakfast Creek in field and desktop surveys:

- Poor-to-moderate condition remnant native terrestrial vegetation communities
- Potential habitat for Grey-headed Flying-fox, microbats, and Cumberland Snail (all terrestrial organisms)
- Groundwater-dependent ecosystems (discussed in Groundwater Report; Jacobs (2025a))
- Native freshwater fish (although none were identified specifically in Breakfast Creek in the study, and the barriers to fish passage are noted).

Breakfast Creek was surveyed from the storm drain upstream of Falmouth Road to the confluence with Eastern Creek on 17 and 18 September 2024. Similar to the Streamology (2024) observations, it was observed that Breakfast Creek consists of limited and heavily modified habitat, negatively impacted by poor-condition riparian vegetation corridors, barriers to flow and fish passage, and areas of heavy silting upstream of the WRRF. Downstream of the WRRF outfall, Breakfast Creek habitat is somewhat improved, with less silting on the streambed, more habitat features such as aquatic macrophytes and woody debris, and less frequent breaks in native riparian vegetation.

With the results of the field assessment and other inputs on the aquatic habitat of Breakfast Creek, it can be concluded that Breakfast Creek does not constitute a Sensitive Receiving Environment upstream of the WRRF, despite official designation as a KFH based on the Strahler classification. However, the reach of Breakfast Creek downstream of the WRRF outfall to the Eastern Creek confluence may be classified as a Sensitive Receiving Environment.

Field observations are described below and in Appendix B.

4.2.1.2.1 Storm drain to Falmouth Road

This section of Breakfast Creek is upstream of the WRRF outfall and was predominantly shallow and low-flowing, with dominant invasive weeds including Trad (*Tradescantia fluminensis*) and Mustard (*Brassica* sp.) on the banks and small patches of Alligator Weed (*Alternanthera philoxeroides*) in the creek. The area around the bridge was dominated by invasive Canadian Pondweed (*Elodea canadensis*) with a few individuals of native Blunt Pondweed under the bridge (*Potamogeton ochreatus*) (Figure 4-16).

RCE scores range from 26 to 38 out of 52, indicating a moderately disturbed environment. The scores were influenced by frequent breaks in bank vegetation, frequent bank undercutting, and heavily silted stream bottoms. Rubbish and debris were common at each survey location, and an oily sheen on the water surface was often observed.

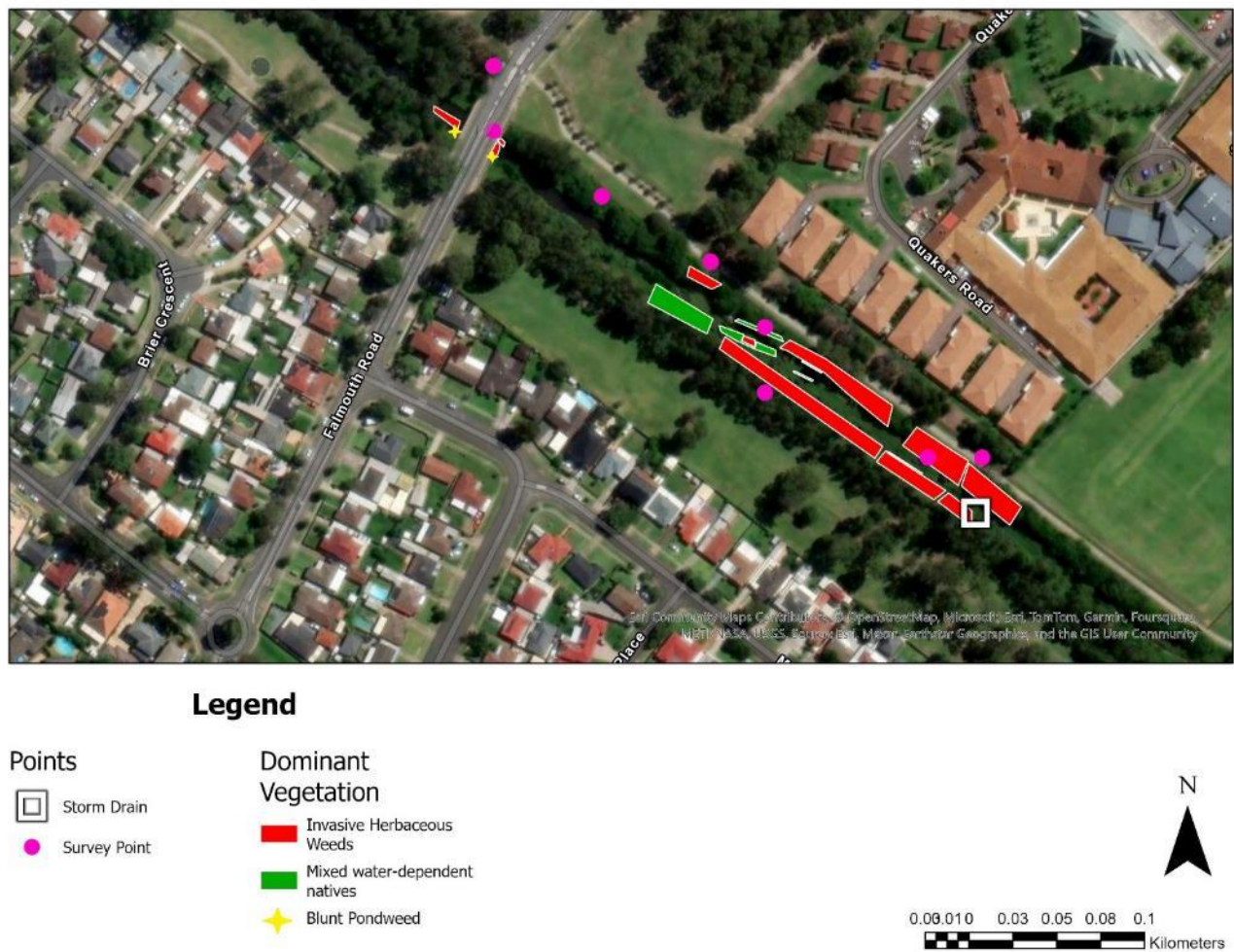


Figure 4-16 Survey points and dominant vegetation in Breakfast Creek from the storm drain to Falmouth Road

4.2.1.2.2 Falmouth Road to large storm drainage canal

This section is upstream of the WRRF outfall. Downstream of the bridge, a road crossing is present which is not culverted and forms a complete water obstruction outside of flood conditions. At the time of the survey, no water was passing over the crossing and it would form a complete fish barrier. Water downstream of the barrier was stagnant where the creek bed was not completely dry. Patches of bullrushes were present as well as some mustards but much of the bank was bare soil or lawn grass (Figure 4-17). The bullrushes were not flowering or seeding and could not be identified to species level.

The habitat was ranked as severely to moderately disturbed with RCE scores ranging from 15 to 24, based on collapsed, poorly vegetated banks and loose sediment and silt.



Figure 4-17 Survey points and dominant vegetation in Breakfast Creek from Falmouth Road to the large storm drainage canal

4.2.1.2.3 Storm drain to Water Resource Recovery Facility

This section is upstream of the WRRF outfall, ending just upstream of the discharge. A second road crossing is present in this portion of Breakfast Creek. Although a small trickle was passing over the barrier during the time of the survey, it provided a complete barrier to fish passage. The concrete channel storm drain empties downstream of the barrier; a small trickle was present at the time of the survey. Mustards and Trad dominated the banks, with native bullrushes and invasive Canna Lilies (*Canna* sp.) in the stream bed (Figure 4-18).

RCE scores ranged from 24 to 30, indicating a moderately disturbed habitat. Influencing factors included frequently undercut banks, loose silt and sediment, and lack of habitat features such as snags and submerged rocks.

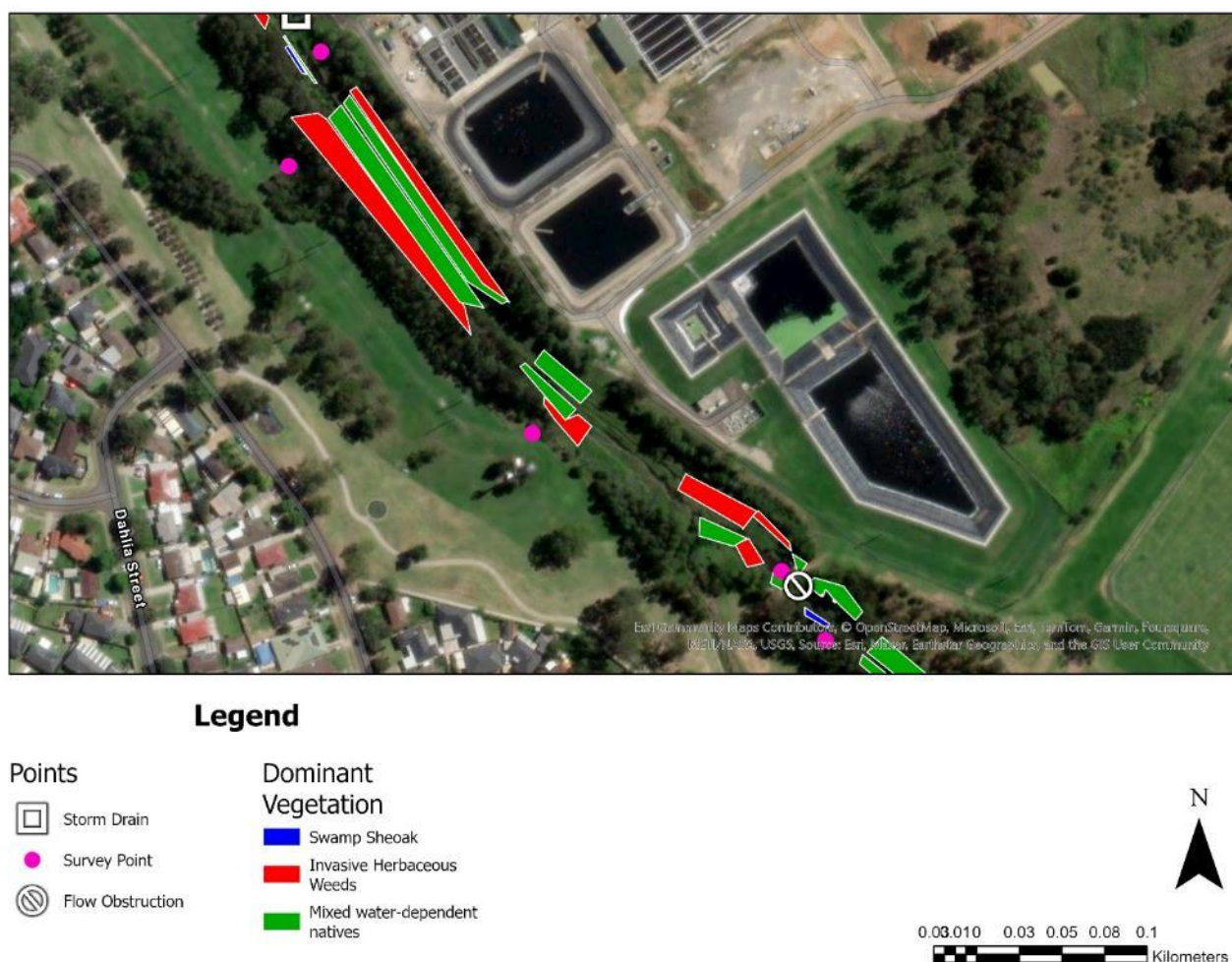


Figure 4-18 Survey points and dominant vegetation in Breakfast Creek from the large storm drainage canal to the WRRF

4.2.1.2.4 Water Resource Recovery Facility to Quakers Hill Parkway

The WRRF discharges to Breakfast Creek at the start of this section, resulting in a noticeably different environment compared to upstream of the outfall. Water flowed constantly, the stream bed in the survey locations had higher composition of cobble and boulder, and distinct riffle and pool sequences. Submerged macrophytes (*Vallisneria* sp., Blunt Pondweed), emergent macrophytes (reeds and bullrushes), and Swamp Sheoaks (*Casuarina glauca*) were common; although not dominant, a few invasive species were observed (Umbrella Sedge *Cyperus involucratus*, Mustards) (Figure 4-19). A few Common Carp (*Cyprinus carpio*) were observed slightly downstream of the outfall; the only fish observed in the entire survey.

RCE scores ranged from 31 to 34, indicating a moderately disturbed habitat. Habitat features that scored highly that were commonly present included snags and boulders, alternating riffle/pool sequences, and a lack of loose sediment accumulation, however the scores were lowered by a continuing presence of bank undercutting and breaks in bank vegetation.



Figure 4-19 Survey points and dominant vegetation in Breakfast Creek from the WRRF to Quakers Hill Parkway

4.2.1.2.5 M7 to Eastern Creek confluence

This section is downstream of the WRRF outfall. Downstream of the M7 motorway, the banks became much steeper on both sides of the creek. These survey locations were similar to those just downstream to the WRRF, with fast-slowing water, submerged macrophytes, and less silted stream bottoms (Figure 4-20). Common Carp were once again observed.

RCE scores ranged from 35 to 39, indicating a moderately disturbed habitat. Habitat features that scored highly (commonly present) included snags and boulders, alternating riffle/pool sequences, and a lack of loose sediment accumulation. Bank undercutting and frequent breaks in bank vegetation continued to reduce the scores.

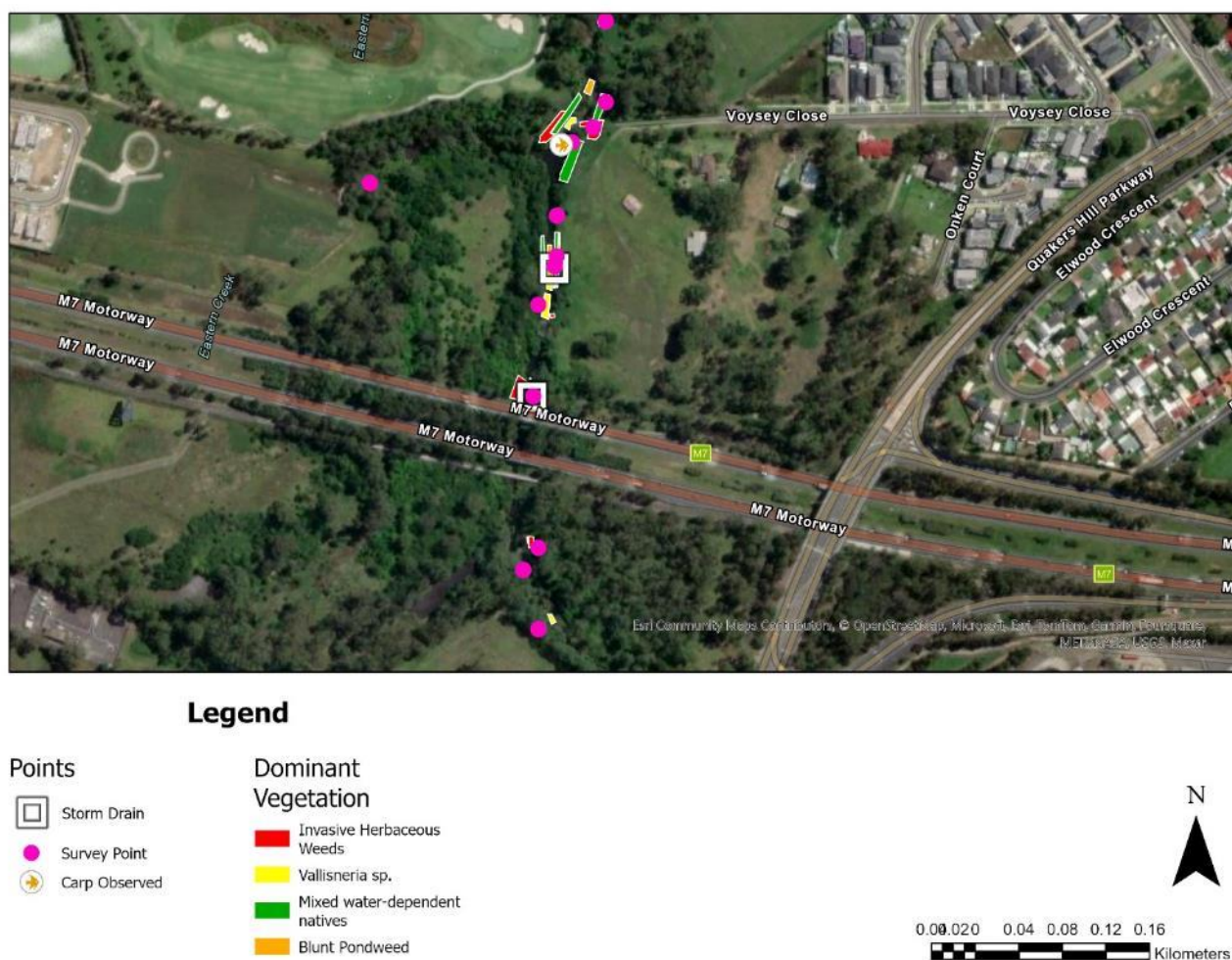


Figure 4-20 Survey points and dominant vegetation in Breakfast Creek from the M7 to the confluence with Eastern Creek

4.2.2 Eastern Creek

4.2.2.1 Catchment description

The Eastern Creek catchment is located in Western Sydney, approximately 35 km west of Sydney and 15 km east of Penrith, covering an area of approximately 118 km² (NSW SES 2017). The catchment drains to South Creek which, in turn, drains into the Hawkesbury River near Windsor (NSW SES 2014). Catchment land uses include a mix of residential, industrial, and natural landscapes with much of the catchment composed of unzoned or rural land, although progressive rezoning is slated to occur in the region for urban development as part of the Greater Sydney Region Plan (NSW SES 2017, NSW DPE 2023).

4.2.2.2 Waterway description

Eastern Creek is a watercourse within the Hawkesbury-Nepean catchment (Figure 4-1). It rises near Sugarloaf Ridge in Western Sydney Regional Park and flows north for approximately 30 km where it joins South Creek at Vineyard. There are several tributaries that feed into Eastern Creek including Reedy, Angus, Bungarribee, and Breakfast Creeks.

Eastern Creek is a fourth order stream according to the Strahler ranking system. The main pressure affecting Eastern Creek is urban development which leads to changes in land use and hydrology resulting in increased runoff and impacts on water quality. Over recent years, the ecological health of Eastern Creek has been

variable and generally reports as fair, meaning water quality indicators are within guideline limits 70% of the time and the waterbug community only contains pollution-tolerant species (BCC 2024).

Generally, riparian vegetation is lacking native diversity and coverage, and weeds are likely to be present and possibly dominating (BCC 2024). In addition to the water quality of Eastern Creek being influenced by urban runoff, treated wastewater from Quakers Hill WRRF and Riverstone Wastewater Treatment Plant is discharged into the creek as part of Sydney's water management system.

Eastern Creek receives Quakers Hill WRRF discharge via its confluence with Breakfast Creek. Based on assessments by Streamology (2025), Breakfast Creek contributes very regular flows approximately 80% of the time, with variation occurring only with high rainfall events and practically no low flow cease-to-flow events. Upstream of the confluence with Breakfast Creek, Eastern Creek has less regular flows, with rare, but possible, low-flow events (Figure 4-21).

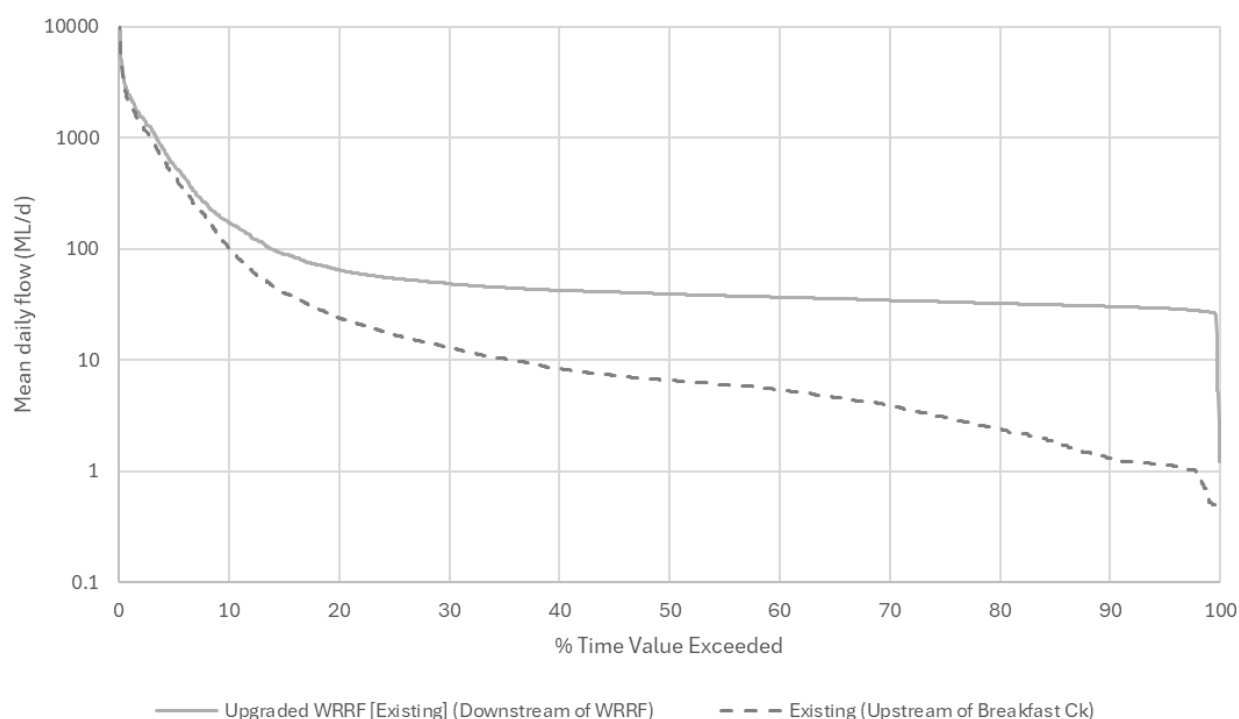


Figure 4-21 Flow duration curves for Eastern Creek

Source: Streamology (2025).

4.2.2.3 Water quality

The water quality of Eastern Creek has been sampled by both Sydney Water and Blacktown City Council. Sydney Water have monitored Eastern Creek at Richmond Road, upstream of the confluence with Breakfast Creek as well as downstream of the confluence at Voysey Close. The Blacktown Council monitoring site is located downstream of Garfield Road Crossing, Riverstone which is approximately 8 km downstream of the confluence with Breakfast Creek and impacted by discharges from other sources, including treated wastewater from the Riverstone WRRF. As such it has not been included in the assessment.

Median water quality data are presented in Table 4-3. Monitoring data were available between May 2017 and September 2024. However, sampling effort was unequal with only 5 sampling events at the downstream site (NS085), compared to 24 events at the upstream site (NS085). For this reason, no time series analysis of monitoring data has been undertaken and only summary results are presented for Eastern Creek.

Available monitoring data indicate that:

- Medians of electrical conductivity, whilst compliant, were higher at the downstream site.
- Medians of turbidity and suspended solids were low at both the upstream and downstream sites.
- Medians of ammonium were similar between sites and below the recommended guideline limits.
- Medians of total and oxidised nitrogen were low at the upstream site and below recommended guideline limits. The limited results available at the downstream site indicate that concentrations are notably higher and exceed recommended guidelines which is likely due to the contribution of poorer water quality from Breakfast Creek inflows.
- Medians of total phosphorus were similar between sites and complied with the relevant guidelines. In contrast, medians of filterable reactive phosphorus were elevated at both sites, but higher at the downstream site.
- Medians of chlorophyll-*a* were low and compliant at both sites.

Table 4-3 Median water quality results at two sites in Eastern Creek

Indicator	NS094/ NS0861 (upstream of the WRRF) (n=24)	NS085 (downstream of the WRRF) (n=5)	Guideline for protection of aquatic ecosystems
Electrical conductivity (µS/cm)	690	1,049	1,103 ^[a]
Dissolved oxygen (% saturation)	76.2	91.95	43–75 ^[a]
pH	7.47	7.46	6.2–7.6 ^[a]
Temperature (°C)	17.2	20.8	No guideline
Turbidity (NTU)	12	10.25	50 ^[a]
Suspended solids (mg/L)	6.5	5	36
Ammonium (mg/L)	0.03	0.035	0.08 ^[a]
Oxidised nitrogen (mg/L)	0.19	3.22	0.66 ^[a]
Total nitrogen (mg/L)	0.66	4.05	1.72 ^[a]
Filterable reactive phosphorus (mg/L)	0.04	0.073	0.04 ^[a]
Total phosphorus (mg/L)	0.078	0.072	0.14 mg/L ^[a]
Chlorophyll- <i>a</i> (µg/L)	1.6	0.9	3 ^[b]

Data source: Sydney Water.

^[a] Eastern Creek performance criteria.

^[b] ANZG (2018) Water quality guidelines.

Orange cells denote exceedance of guideline; green cells denote compliance with guideline.

4.2.2.4 Eastern Creek Aquatic Habitat

Eastern Creek is classified as KFH based on Strahler classification and the freshwater fish community status is ranked as 'Fair' in accordance with Fisheries Spatial Data Portal (DPIRD 2025). The aquatic ecosystem condition of Eastern Creek has not been thoroughly reported. However, Blacktown City Council releases an annual Waterway Health Report Card in which water quality and riparian condition are assessed based on surveys of aquatic macroinvertebrate communities and riparian vegetation, and Eastern Creek is surveyed in two locations: one near Prospect Reservoir, well upstream of the Quakers Hill WRRF; and one well downstream near the confluence with Bells Creek.

In the downstream direction, Eastern Creek water quality was rated as “good” in 2024, indicating a moderately diverse population of aquatic macroinvertebrates, and the riparian health was rated as “good” indicating moderate density and diversity of native riparian vegetation, with some weeds. Upstream of the WRRF, Eastern Creek was rated as having “good” riparian vegetation but a “poor” macroinvertebrate community consisting only of pollution-tolerant species (BCC, 2024). In the 2022 Report Card, both sites were rated “good” for macroinvertebrate populations and “fair” for riparian vegetation (indicating dominant weeds and low native diversity), and in 2020 they rated “good” to “fair” for both categories, indicating that these conditions may vary somewhat year-to-year (BCC, 2020; 2022).

Streamology (2024) assessed the ecological condition and values of the South Creek catchment, including Eastern Creek downstream of the Riverstone WRRF (approximately 12 km downstream of the Quakers Hill WRRF and outside of the study area for this REF, and downstream from Blacktown city Council’s monitoring point). They noted that in this reach of Eastern Creek, poor quality aquatic habitat was present as a result of land clearing and livestock grazing, and the channel was heavily silted. Streamology (2024) identified several ecological values supported by flows in this reach of Eastern Creek in field and desktop surveys:

- Groundwater-dependent ecosystems
- Native freshwater fish (although none were identified specifically in Eastern Creek in the study, and a barrier to fish passage is noted).

Approximately 1 km of Eastern Creek was surveyed by Jacobs from the confluence with Breakfast Creek to Stonecutters Ridge Golf Club on 17 and 18 September 2024. This reach of Eastern Creek provides somewhat better quality aquatic habitat compared to the Riverstone reach of Eastern Creek, with in-stream habitat features and a lack of silting. Although the aquatic habitat of Eastern Creek is moderately disturbed, it is defined as a SRE in the vicinity of the study area due to the KFH designation and presence of some habitat features for aquatic life.

Field observations are described in Section 4.2.2.4.1.

4.2.2.4.1 Confluence with Breakfast Creek to Stonecutters Ridge Golf Club

This section of Eastern Creek was predominantly slow-flowing and deep. The area just downstream of the confluence with Breakfast Creek (bottom right of Figure 4-22) had some macrophytes such as *Vallisneria* sp. but for the most part aquatic vegetation was absent. The banks were dominated by Swamp Sheoak and little other riparian vegetation was present for much of the surveyed area.

RCE scores ranged from 32 to 38, indicating a moderately disturbed habitat. Habitat features that scored highly that were commonly present included snags and boulders, alternating riffle/pool sequences, and a lack of loose sediment accumulation. Bank undercutting and frequent breaks in bank vegetation reduced the scores.

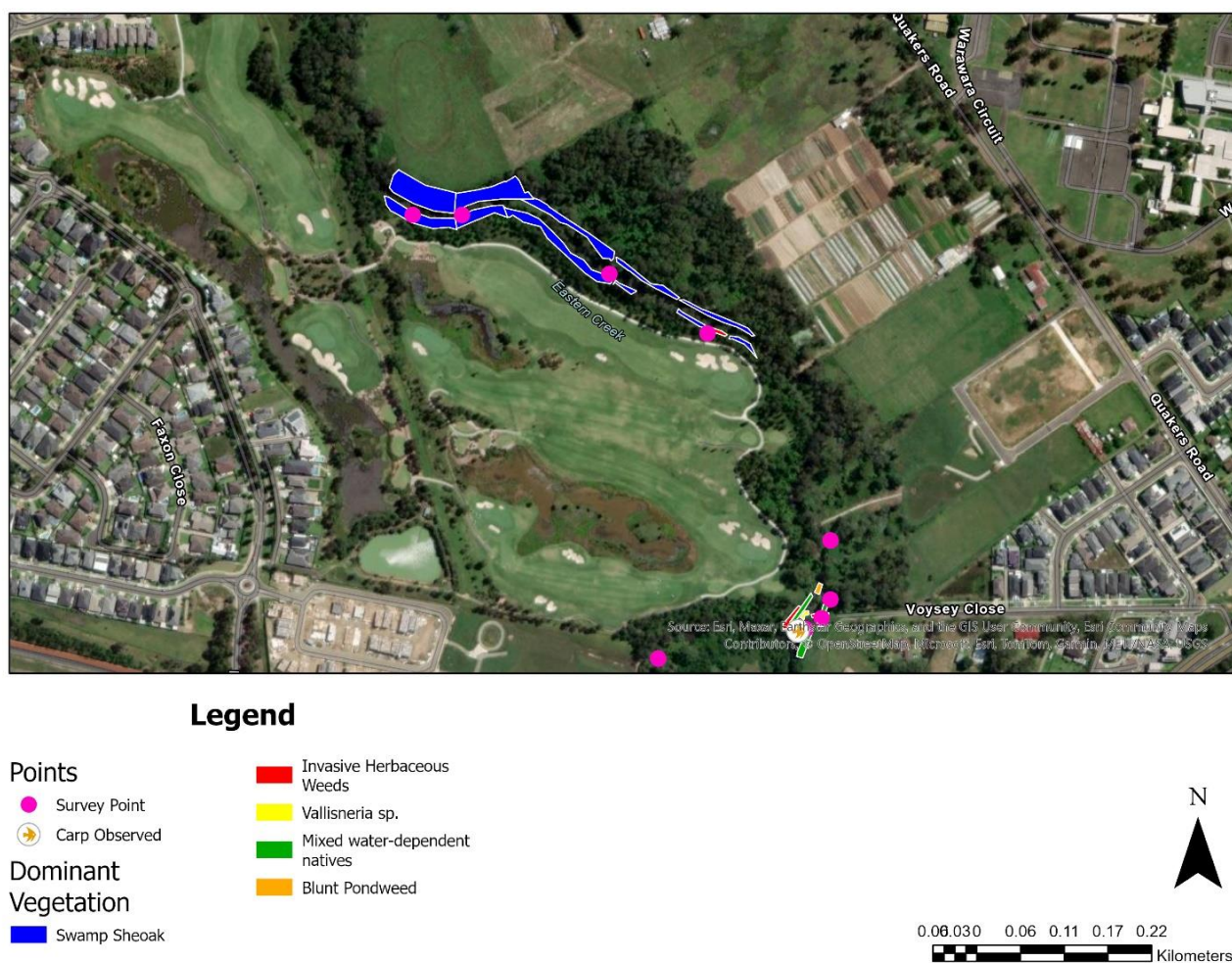


Figure 4-22 Eastern Creek from the Breakfast Creek confluence to Stonecutters Ridge Golf Club

4.2.3 Blacktown Creek

Blacktown Creek is an urban stream located in the upper Parramatta River catchment. It originates to the north of Prospect Reservoir, flowing north towards the railway line before heading east to where it meets Toongabbie Creek at Seven Hills (Figure 1-1). Blacktown Creek corridor is highly modified, comprising of large sections of concrete channels and adjacent open space and is influenced by stormwater runoff and wastewater discharges/overflows.

The water quality of Blacktown Creek has been monitored by Blacktown City Council at Powers Road, Seven Hills (BK1) during both dry weather and wet weather since 2018. The monitoring site, shown in Figure 4-6, is approximately 1.2 km downstream of where the brine pipeline would connect to the NSOOS.

Median concentrations of 12 physico-chemical indicators monitored during the period 2018–2024 are presented in Table 4-4 together with the relevant ANZG (2018) guidelines and Tippler et al. (2013) SSTVs for urban areas. The results indicate that the water quality of Blacktown Creek is poor and does not meet the recommended guidelines for protection of aquatic ecosystems, predominantly due to elevated nutrient concentrations (Table 4-4). Median concentrations of nitrogen (total nitrogen, ammonium, and oxidised nitrogen) and phosphorus (total and filterable) exceeded the recommended SSTVs during both dry weather and wet weather conditions, with median concentrations typically higher following rainfall. Despite the high nutrient concentrations, median chlorophyll-a concentrations only exceeded the recommended guideline in dry weather samples, although concentrations in individual samples were occasionally high (maximum 182 µg/L). This indicates that Blacktown Creek is generally mesotrophic but can be eutrophic and is likely to

exhibit phytoplankton growth during certain periods of the year. Median concentrations of other indicators such as dissolved oxygen, pH, turbidity, and electrical conductivity were within their respective guideline limits.

Table 4-4 Median concentrations of physico-chemical indicators in Blacktown Creek and corresponding guideline values

Indicator	Blacktown Creek end of Powers Road, Seven Hills (BK1; dry weather)	Blacktown Creek end of Powers Road, Seven Hills (BK1; wet weather)	Guideline for protection of aquatic ecosystems
Electrical conductivity ($\mu\text{S}/\text{cm}$)	832	604	125–2,200 ^[a]
Dissolved oxygen (% saturation)	80.6	66.55	>65 ^[b]
pH	7.95	7.45	6.5–8.5 ^[a]
Temperature ($^{\circ}\text{C}$)	20.2	22.25	No guideline
Turbidity (NTU)	5.43	14.66	50 ^[a]
Suspended solids (mg/L)	16	9	7
Ammonium (mg/L)	0.05	0.075	0.04 ^[b]
Oxidised nitrogen (mg/L)	0.155	0.615	0.11 ^[b]
Total nitrogen (mg/L)	1	1.2	0.5 ^[b]
Filterable reactive phosphorus (mg/L)	0.04	0.05	0.02 ^[a]
Total phosphorus (mg/L)	0.11	0.105	0.05 ^[b]
Chlorophyll- <i>a</i> ($\mu\text{g}/\text{L}$)	4	1.5	3 ^[a]

Notes:

Data source: Blacktown City Council.

^[a] ANZG (2018) Water quality guidelines.

^[b] SSTVs for urban streams (Tipler et al. 2013).

Orange cells denote exceedance of guideline; green cells denote compliance with guideline.

The aquatic ecosystem condition of Blacktown Creek has not been thoroughly reported. However, Blacktown City Council releases an annual Waterway Health Report Card in which water quality and riparian condition are assessed based on surveys of aquatic macroinvertebrate communities and riparian vegetation. Blacktown Creek water quality was rated in 2024 as “good,” indicating a presence of diverse aquatic macroinvertebrates, and the riparian health was rated as “poor” indicating dominance of weeds and low diversity of riparian vegetation (BCC 2024). Invertebrate community diversity was rated as “fair” in 2020 and 2022, although riparian vegetation has consistently rated as “poor” (BCC 2020, 2022). Blacktown Creek is not designated as KFH (DPIRD 2025). Due to the lack of KFH status and poor habitat quality, Blacktown Creek is not assessed to be a Sensitive Receiving Environment.

4.3 Threatened species

A search of the Protected Matters Search Tool (DCCEEW 2025b), Fisheries Spatial Data Tool (DPI 2025), Bionet Atlas (DPIE 2025), and Atlas of Living Australia (ALA 2025) found two threatened fish species potentially present in the study area, which are detailed in Table 4-5 and discussed in Sections 4.3.1 and 4.3.2. No threatened aquatic invertebrates or plants are recorded or modelled in the study area.

Table 4-5 Threatened aquatic species presence recorded in the study area

Species	EPBC Status	FM Act Status	Protected Matters Search Tool	Fisheries Spatial Data Tool	Bionet Atlas	Atlas of Living Australia
Macquarie Perch (<i>Macquaria australasica</i>)	Endangered	Endangered	Species or species habitat may occur within area	Not mapped in area	No records	No records
Australian Grayling (<i>Prototroctes maraena</i>)	Vulnerable	Endangered	Species or species habitat may occur within area	Not mapped in area	No records	No records

4.3.1 Macquarie Perch (*Macquaria australasica*)

The Macquarie Perch is a moderate sized carnivore that predominantly inhabits rivers. Once widespread and abundant in the southern Murray-Darling Basin, this species has undergone considerable declines in range and is now fragmented into small discrete, reproductively isolated populations. It is now mostly restricted to the upper reaches of catchments generally inhabiting reaches where natural flow and temperature regimes remain and riparian zones are intact. It has been translocated within and outside its natural range (Lintermans et al. 2019; Koehn et al. 2020).

Macquarie Perch is a riverine species, that can survive well in impoundments where there is access to suitable riverine habitats for spawning. The species lives in cool, clear waters at well-defined home sites, generally in deep, slow flowing pools with suitable cover (e.g. undercut banks, woody debris, boulders) (Lintermans et al. 2019; Koehn et al. 2020).

Macquarie Perch are obligate river spawners, with spawning occurring in October to late December day length increases and water temperatures are 13–18°C. Spawning aggregations form at specific sites at the base of pools. After spawning, eggs lodge in gravels and cobbles in riffle habitat immediately downstream of the spawning location (Lintermans et al. 2019; Koehn et al. 2020).

Adults are relatively sedentary and have small core home ranges (<4 km). Fish move on average 8–12 km to spawning sites, with movements coinciding with increases in flows. Dispersal of larvae and juveniles is likely to be an important life history process (Lintermans et al. 2019; Koehn et al. 2020).

Breakfast Creek is unlikely to support Macquarie Perch. As identified in the habitat assessment, upstream of the WRRF, Breakfast Creek is largely narrow and shallow, without the slow-flowing pools to support adult fish. Downstream of the WRRF, Breakfast Creek is uniformly quick-flowing, as modelled by Streamology (2025) and observed in the field assessment. However, Breakfast Creek downstream of the WRRF and Eastern Creek lack the deep pools preferred by Macquarie Perch. As no Macquarie Perch have been recorded in Breakfast Creek, Eastern Creek, or Blacktown Creek, the species presence is unlikely in the study area and unlikely to be impacted by construction and operation of the project. As a result, no further assessment of impacts to Macquarie Perch is included in the impact assessments.

4.3.2 Australian Grayling (*Prototroctes maraena*)

The Australian Grayling is a small to medium sized fish, that is commonly found to measure 170–180 mm in length but can grow to 300 mm in length. The species is relatively short-lived, with the maximum known age of 5 years, but with very few surviving more than 3 years. The Australian Grayling is slender with a small head and rounded snout, and its body colour varies from silvery with an olive grey back and whitish belly to olive-green or brownish on the back with clear to greyish fins and extremely thin and deciduous scales. It has a distinctive small, fleshy fin between the dorsal fin and tail and the pectoral fin site below.

The Australian Grayling is endemic to southeastern Australia including Victoria, Tasmania and New South Wales. It is a migratory species that inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and stream as an adult where they remain for the rest of their lives. Current population estimates indicate that the Australian Grayling is relatively uncommon and generally only caught in small numbers. In NSW, the Australian Grayling has been recorded in the Shoalhaven River, Bega River and Clyde River. The Australian Grayling spend most of their lives in freshwater, inhabiting rivers and streams in cool, clear, moderate flowing waters with a gravel substrate and alternating pool and riffle sequence. The species is omnivorous, feeding on crustaceans, aquatic and terrestrial insects, their own larvae, and aquatic plants including macrophytes and algae.

Australian Grayling generally migrates downstream to the lower freshwater reaches of rivers to spawn which usually occurs from late summer to mid-winter and is largely dependent on water temperature and water flow. Females can lay up to 47,000 small eggs that are about 0.9 mm in diameter which settle among the gravel of the streambed. Hatching occurs after 10–20 days when larvae are approximately 6.5 mm long. They then drift downstream and out to sea migrating back into the freshwaters in spring when they are ~45–55 mm long and 4 to 6 months of age (NSW DPI 2015).

The precise reasons for the decline of this species are unknown, but likely factors include barriers to migration in coastal rivers (such as dams and weirs), changes to rivers including altered flow and temperature regimes as well as increased nutrients and sediment loads and possible predation by alien species (such as trout). Additionally, due to the relatively short lifespan, most individuals spawn only once before they die, and so populations are vulnerable to disruptions of spawning and recruitment (Backhouse et al. 2008).

Breakfast Creek is unlikely to support Australian Grayling. Upstream of the WRRF, the ephemerality and obstructions to flow and fish passage result in unlikely habitat for Australian Grayling. Downstream of Quakers Hill WRRF, Breakfast Creek is uniformly quick-flowing, as observed in the field assessment and modelled by Streamology (2025). As no Australian Grayling have been recorded in Breakfast Creek, Eastern Creek, or Blacktown Creek, the species presence is unlikely in the study area and unlikely to be impacted by construction and operation of the project. As a result, no further assessment of impacts to Australian Grayling is included in the impact assessments.

5. Impact assessment – construction

Construction of the project would involve several activities including vegetation clearing and subsequent mulching, earthworks, trenching, horizontal directional drilling (HDD) and shaft excavation, concrete works and the establishment of construction compounds and ancillary facilities (Table 5-1). These construction activities present a potential risk to downstream water quality and aquatic ecology if appropriate management measures are not implemented, monitored, and maintained throughout the construction phase.

Table 5-1 Construction activities associated with the project elements

	Existing infrastructure modifications	Secondary wastewater treatment upgrade	AWTP and interconnecting piping	Brine pipeline
Earthworks	X	X	X	X
Demolition	X			
Roadworks	X			
Vegetation clearing	X	X	X	X
Concreting		X	X	
Construction compounds	X	X	X	X
Trenching	X	X	X	X
Stockpiling	X	X	X	X
Sediment controls	X	X	X	X
Laydown areas	X	X	X	X
Parking and construction amenities	X	X	X	X
Movement of construction vehicles	X	X	X	X
Relocation of underground services		X		
Tunnelling				X
Dewatering				X

5.1 Impacts to water quality and aquatic ecology from construction activities

5.1.1 Earthworks

Construction of most project elements would require excavation or earthworks thereby disturbing and exposing soils. Earthworks are required at all work areas which, as a minimum, will include clearing and preparing sites for works. Excavation works at the WRRF have the potential to encounter contaminated soil (if present) and there is potential for erosion of disturbed and stockpiled soil. Discharges of sediment-laden water can occur during or following wet-weather, transporting sediment to downstream receiving waterways. Once sediments enter waterways, they can directly and indirectly impact the aquatic environment as detailed below:

- Increased sedimentation and sediment deposition can alter the geomorphology of waterways if large amounts of sediment are mobilised downstream.

- Sedimentation can increase turbidity and reduce water clarity, impacting visual amenity and lead to smothering of aquatic organisms (i.e. by clogging fish gills or smothering aquatic plants), as well as decrease trophic interactions between aquatic organisms due to reduced water clarity.
- Sediments may contain high concentrations of nutrients which can lead to algal blooms and subsequently result in reduced light penetration and limit growth of aquatic vegetation. If nutrient concentrations exceed the assimilative capacity of the waterways, algal blooms may occur which can subsequently reduce dissolved oxygen and, in extreme circumstances, lead to fish kills.
- Sediments may also contain high concentrations of metals and other chemical contaminants which can cause toxic effects in aquatic organisms, as well as reduce the suitability of the water for other beneficial uses (e.g. recreation and irrigation).

Earthworks near watercourses will be required to install the pipelines delivering waste brine to the sewerage line to the outfall. In order to reach the connection point to the NSOOS at International Peace Park in Seven Hills, the brine pipeline construction will require earthworks near watercourses in the following locations:

- The pipeline will run parallel to the north bank of Breakfast Creek. There will be no instream earthworks. The installation method will be trenching from Quakers Hill WRRF until Marayong Park, at which point an HDD method will be used. The pipe will cross under the creek near Davis Road.
- The HDD retrieval shaft will be in Lynwood Park, approximately 30 m from Breakfast Creek. The construction staging area will then run parallel to Breakfast Creek for approximately 900 m, although earthworks will not be performed here.
- Pipe installation will run parallel to Blacktown Creek for approximately 600 m to the connection with the NSOOS. The pipeline will not cross Blacktown Creek and there will be no instream earthworks.

The Quakers Hill WRRF site has known fill material beneath some areas of the site. Fill materials have been reported to have elevated concentrations of hydrocarbon compounds (TRH, BTEX, PAH), selected heavy metals, polychlorinated biphenyls (PCB) and asbestos which could present a risk to surface water quality if exposed and mobilised off site (Jacobs 2025c).

There is no known NSW EPA-notified site within 100 m of proposed earthworks for the installation of the brine pipeline (EPA 2025), with the exception on one site near the intermediate HDD shaft (discussed in Section 5.1.8). Although there are no known sources of soil contamination along the project pathway, it is possible the undocumented soil contamination exists at some sites including the open trenching north of Breakfast Creek to Marayong Park, and at the locations where excavation of HDD launch and retrieval will occur. As such an unexpected finds protocol is required to manage potential contamination (Jacobs 2025c).

Whilst disturbance from earthworks can result in sediment-laden runoff and pollutants temporarily reduce downstream water quality, impacts to surrounding waterways and aquatic life are considered unlikely to occur. This is because construction runoff would be managed within the implementation of site erosion and sediment controls and water quality control measures outlined in Section 8, as well as other mitigation measures outlined in Section 9. Measures to manage and divert runoff at construction sites would be established as the first step in commencement of construction activities to minimise erosion and sedimentation impacts associated with earthworks.

5.1.2 Road works

Access to the operational Quakers Hill WRRF site is already established from Quakers Road. The existing internal road network within the Quakers Hill WRRF site is proposed to be extended to border the secondary wastewater treatment plant on three sides and encompass the AWTP to facilitate construction and operation activities.

Access to the brine pipeline construction would be from nearby existing public roads and therefore no roadworks are associated with the pipeline construction. As such, roadworks present a risk to Breakfast Creek

in the vicinity of the WRRF as soils in the road corridor and the road material are at risk of being washed via stormwater runoff into the creek. Once sediments enter the waterway, they have the potential to temporarily reduce downstream water quality by increased turbidity and smothering aquatic ecosystems (see further detail on these impacts in Section 5.1.1).

Site erosion and sediment controls would be established as soon as practicable after commencement of construction works to avoid and/or manage potential impacts. Additionally, other mitigation measures outlined in Section 9 would be established and adopted during the construction phase to manage potential impacts.

5.1.3 Vegetation clearing

Establishment of all construction work areas could require some vegetation clearing in areas pre-approved for vegetation clearance. Vegetation clearance exposes soils to weathering processes, thereby increasing the risk of erosion and sedimentation. This can impact on water quality of downstream waterways if runoff is allowed to mobilise exposed soils or tannin leachates and can result in increased turbidity, suspended solids, nutrients and other contaminants. Any clearing and trimming of vegetation required for construction of the project will be done to avoid tannin leachate entering downstream waterways.

Given the relatively flat to low sloping gradient of the project area and the small amount of vegetation to be removed, the risk that runoff may transport sediment or tannin leachate downstream is expected to be low. Runoff from areas where vegetation clearing is required will be managed primarily through erosion and sediment controls described in Section 8 in addition to the mitigation measures outlined in Section 9. These would be established on site, prior to undertaking any vegetation clearance work.

5.1.4 Concrete works

Concrete pouring would be required during construction of base slabs for pumps, tanks, and other structures. The main concrete works will occur for the following project components:

- An 8 m-long concrete slab would be required for construction of the Odour Control Facility (including the stack).
- Concrete slab for all treatment units, including bioreactor and switch rooms.
- Concrete bunds for the installation of specialised tanks required for chemical storage.
- Concrete slab at Billy Goat Reserve for the barometric loop as part of the brine pipeline.

Concrete work can generate concrete dust, concrete slurries or result in washout water being discharged to downstream waterways. Concrete and its by-products, if mobilised to downstream waterways, can increase alkalinity and pH which can be harmful to aquatic life. Additionally, water from concrete curing can be high in metals such as chromium (Zielina et al. 2022) and cause toxicity to aquatic organisms.

The direct risk to water quality and aquatic ecology from concrete works associated with the project is low as no concreting would occur near waterways nor within the riparian zone. However, concrete works have the potential to impact downstream waterways indirectly if any runoff or by-products enter the stormwater network due to elevated concentrations of highly alkaline and toxic compounds. The risk of indirect impacts from concrete works on aquatic organisms from project-related concrete works is considered unlikely as appropriate mitigation strategies such as uses of sediment traps and bunds to capture pollutants will be installed and any wastewater from concrete washdown will be collected and treated in designated facilities.

5.1.5 Construction compounds and material laydown

Construction compounds are designated areas for use by contractors to facilitate construction activities. Generally, construction compounds would be used to deliver and temporarily store construction equipment and materials but may also be used as muster points and include amenities for workers. Sheds may be

installed at some construction compounds to house construction equipment and materials. For works associated with the secondary wastewater treatment upgrades and AWTP, construction compounds will be located at or near the construction footprint within the existing Quakers Hill WRRF site (Figure 1-2). For the construction of the brine pipeline, up to 20 compounds (C1-C20) may be required along the alignment (Figure 1-2). The main compounds for construction are C1, C19 and C20. These compounds would be active for the entire construction period and include temporary buildings, stocking and storage of equipment.

Compounds C1 to C9, and C12 to C20 are small transient compounds that will be used for laydown areas located at brine pipeline trenching sites. Construction compounds C5 to C15 would be used for mobilisation for HDD work with compounds C9 and C13 including launch pits for the HDD work and C10 and C11 including retrieval pits. Spoil generated from the drill will be stockpiled within the construction compound areas.

As much of the pipeline will follow the Breakfast Creek alignment, construction compounds associated with the pipeline (C1-C12 and C12-C15) will be located adjacent to Breakfast Creek and therefore present the greatest risk to water quality in this watercourse. There is also a construction compound (C20) located adjacent to Blacktown Creek. Risks to water quality in these watercourses include sediment-laden runoff from construction compounds, stockpile and laydown areas as well as accidental leaks or spills, rubbish and debris being transported downstream.

With the implementation of erosion and sediment controls and water quality measures outlined in Sections 8 and 9, it is considered that direct and indirect impacts from construction compounds and material laydown to Breakfast Creek and Blacktown Creek are unlikely to occur.

5.1.6 Spoil stockpiling and emplacement

Two stockpiles are currently located at the Quakers Hill WRRF from previous construction work. These include:

- A stockpile (QHSP01) of approximately 36,000 m³ is located in the northeastern portion of the site. Samples collected from this site (22 in total) contained anthropogenic materials but no levels of contamination were reported (Jacobs 2025c)
- A stockpile soil containing known asbestos is present within the northeastern corner of the site (Jacobs 2025c).

During construction of the project, it is proposed to reuse stockpiled material (if suitable) in the refurbishment of the Intermittently Decanted Aerated Lagoons (IDALs). Where excess spoil generated by the secondary wastewater treatment upgrade works is not required for infilling the IDALs, this would be stockpiled within the area of the existing stockpile in the east of the Quakers Hill WRRF site.

Spoil will also be generated during HDD construction and will be stockpiled within the construction compound. Stockpiled material will be tested to determine if it is classified as Virgin Excavated Natural Material which is natural material like clay, sand, soil and rock that is excavated from uncontaminated areas and have not been processed or Excavated Natural Material that comprises of naturally occurring rock and soils with at least 98% natural material by weight. If classified as Virgin Excavated Natural Material or Excavated Natural Material, the material will be reused on sites for fill or landscaping. If unsuitable for reuse, the spoil would be transported off-site by a licensed waster carrier to a licensed waste management facility.

Unstabilised stockpiles may lead to material eroding away during windy conditions or high rainfall events, releasing sediments, nutrient, hydrocarbons, metals, and gross pollutants into downstream waterways. These contaminants can affect water quality and aquatic ecosystem health (see Section 5.1.1 for further detail on these effects).

Stockpile management during construction would be detailed in a Construction Soil and Water Management Plan (CSWMP). Management measures would include locating stockpiles away from overland flow paths and providing stabilisation, watering, and covering of stockpiles where necessary.

5.1.7 Trenching

It is proposed to construct 5.1 km of the overall 8 km brine pipeline using an open-cut trench method which would involve laying prefabricated pipe in a trench about 1–1.5 m underground. Based on the proposed location of open-cut trenching (Figure 1-2), water quality is at risk of deterioration in Breakfast Creek between the WRRF to approximately 1.1 km upstream of the site and approximately 700 m of Blacktown Creek at its upstream reaches.

The method for open-cut trenching will include:

- Where the pipeline traverses grassy areas, excavators will remove grass and topsoil from the trench site and stockpile material for backfilling/restoration. Where the pipeline route traverses hard stand areas, pneumatic drilling, concrete cutting or jackhammering may be required to excavate the trench.
- Subsoil would be dug out and temporarily stockpiled within with construction corridor.
- A trench will be excavated to accommodate the prefabricated pipe sections. The width of the trench will depend on site-specific constraints and the construction methodology adopted by the delivery contractor.
- The trench bed will be lined with sand or fine-grained fill material to protect the pipe from damage.
- Prefabricated pipes will be placed on top of the protective layer within the trench.
- Where necessary, fine-grained material may be added around the pipe for stability. If suitable ground conditions exist, excavated material may be reused to backfill the excavation around the pipe, finishing with topsoil and grass. Any surplus of soil will be transported to other locations along the pipeline route where required or transported off-site for disposal at a licensed waste management facility.

Trenching poses a risk to surface water quality due to excavation and soil disturbance. This, in turn, can result in increased turbidity and nutrient concentrations and reduced visual amenity. Additionally, the increased sediments can smother downstream aquatic organisms. Trenching through hardstand areas can generate fine particles and dust that can contaminate water. When these particles enter waterways, they can increase turbidity and suspended sediment loads, raising water alkalinity due to lime content in concrete (dust) and harm aquatic life.

To mitigate impacts on water quality and aquatic organisms from trenching, the construction methodology is to progressively excavate the trench, place bedding material, install the pipeline within the trench and then backfill/overfill the disturbed area together with progressive rehabilitation. With this method, impacts are expected to be low as the trenches for the pipeline will be open for a short duration and controls aimed at preventing soil erosion and sedimentation will be implemented.

5.1.8 Horizontal directional drilling

Approximately 2.6 km of the PRW pipeline will be constructed using a trenchless technique such as Horizontal Directional Drilling (HDD) which comprises of a launch pit and retrieval pit and drilling of an underground bore in which the pipe is installed as shown in Figure 5-1. The following method for HDD is proposed:

- Mobilisation at construction compounds C5–C15 with launch and retrieval pits of approximately 12 m long by 4 m wide at compounds C9 and C13 and C10 and C11 respectively.
- The pipe section to be installed using HDD will be laid out along the alignment, connected, and pressure tested.

- The HDD rig will be assembled and calibrated at the launch pits and adequate water supply, cooling fluids and a lubricant (for example, bentonite) will be provided for the drilling rig. Excess drilling fluids will be treated on site and disposed of in accordance with the project's Construction Environmental Management Plan (CEMP).
- Once drilling is activated, it will operate continually along the pre-defined path between the launch and retrieval pit. Spoil generated during drilling will be stockpiled within the designated construction compound areas. Once drilling is completed, the pipe string will be pulled from the drilled hole.
- As mentioned in Section 5.1.6, stockpiled soil will be reused where deemed suitable.
- Commissioning of the pipeline will be undertaken prior to pulling the pipeline through the tunnel bore.
- Following completion, the HDD rig will be demobilised and removed from the site together with other plant, equipment, materials and wastes associated with HDD activities.

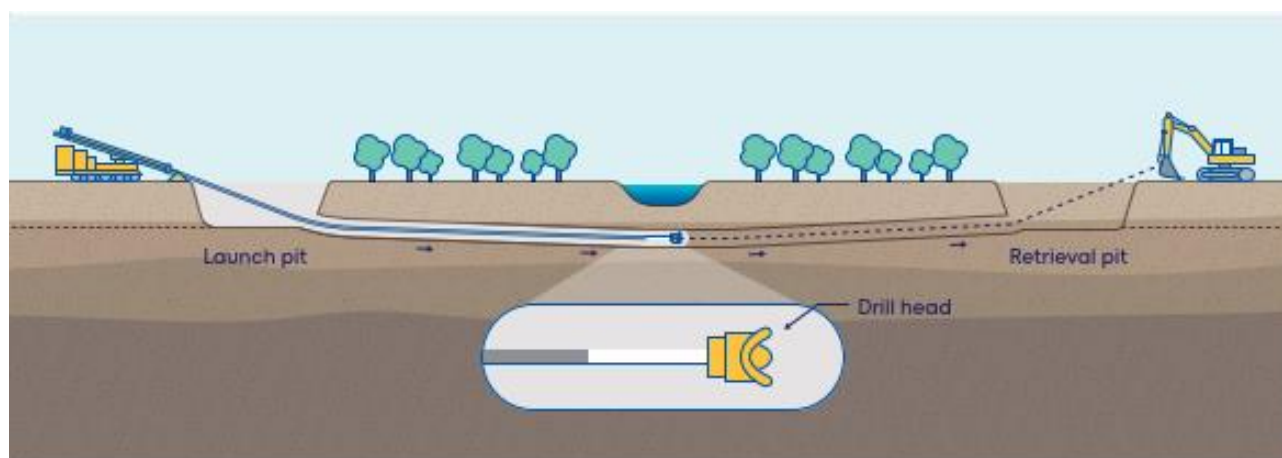


Figure 5-1 Illustration of horizontal directional drilling for tunnelling

Whilst construction using HDD results in less surface disturbance, it can still pose a risk to surface water quality and aquatic ecology. The accidental discharge or leakage during construction may contain drilling fluids such as bentonite clay could lead to elevated turbidity if large volumes are discharged to downstream waterways.

Other potential contaminants of concern include hydrocarbons, oil and grease, hydraulic fluids, zinc, and other hazardous chemicals which can result in oily films on surface waters and cause a range of detrimental impacts on downstream waterways. One NSW EPA-notified site is within 100 m of proposed earthworks for the installation of the brine pipeline: Valspar Blacktown, which is 100 m east of the intermediate HDD shaft location on Gate Road, however EPA has assessed that regulation of the site is not required (EPA 2025). Although there are no other known sources of soil contamination along the project pathway, it is possible the undocumented soil contamination exists, especially in the industrial areas.

Water quality control measures for HDD need to be designed to capture all drilling fluids and groundwater inflows to the works. Water that cannot be treated and reused will need to be disposed of off-site. Water from all forms of commissioning will need to be captured (see Section 8.1.1). If this water cannot be treated and reused, it will need to be disposed of off-site unless the Construction Contractor can secure an EPL and other approvals to allow discharge of treated water to the creeks. The water quality control measures to address HDD-related impacts will be outlined in the CEMP for the project.

5.1.9 Dewatering and construction-related discharges

The construction of trenches, shafts, and tunnels would generate tunnel process water with a mix of collected groundwater and water used in the tunnelling process. This water would be captured within underground workings and require dewatering with excess water needing to be discharged if it cannot be reused. As a result

of the construction process, tunnel process water is likely to contain elevated levels of suspended solids, acid rock drainage and hydrocarbons, as well as any known contaminants (for example, metals) associated with groundwater in the area. If this water is discharged untreated or poorly treated, there is potential to impact the receiving waterways. Further discussion on the impacts associated with groundwater and dewatering are discussed in the *Groundwater Quality Assessment* (Jacobs, 2025a).

5.1.10 Testing and commissioning

Testing and commissioning of the brine pipeline would include the following activities:

- Flushing the pipeline with water
- Pressurising the pipeline and testing valves and scour chambers
- Flow testing of the barometric loop
- Ensuring the correct and proper functioning of each maintenance access point.

Water from initial commissioning is expected to be of poor quality and will need to be captured and disposed of off-site unless the construction contractor obtains an EPL to discharge treated water into Breakfast Creek or Blacktown Creek. Measures to mitigate against potential water quality impacts from testing and commissioning will be outlined in the Operational Environmental Management Plan for the project.

6. Impact assessment – operation

The operation of the project is needed to accommodate forecast growth in the catchment and treat water to a higher standard to reduce both concentration and loads of key indicators (notably nutrients) to Breakfast Creek. The secondary treatment upgrade will increase the capacity of the system, and the advanced water treatment plant will treat water to a higher standard to meet the more stringent water quality requirements that are being introduced in an update of the Quakers Hill WRRF EPL. Therefore, the potential impacts to surface water in waterways associated with this phase relate to operation of the upgraded Quakers Hill WRRF, associated assets including the secondary wastewater treatment plant and AWTP, operation of the brine pipeline, transfer of brine to the NSOOS, and commissioning and testing of the pipeline. Potential impacts to surface water quality and aquatic ecology during operation are identified in this Section. Impacts associated with stormwater runoff from an increase in impervious surfaces are discussed in Section 8.2.

6.1 Impacts to water quality and aquatic ecology from operation

6.1.1 Wastewater treatment

6.1.1.1 Operation of the advanced water treatment/treated wastewater discharge

Treated water is currently being released into Breakfast Creek in accordance with the EPL 1724 under the operation of the existing Quakers Hill WRRF (EPA 2024). This EPL nominates concentration limits, which must not be exceeded at specific discharge points. The limits applicable to discharge point 1 ('discharge to waters') located at the outlet drain to Breakfast Creek are provided in Table 6-1.

Table 6-1 Pollutant concentration limits for the Quakers Hill WRRF discharge to waters at Point 1 prescribed by the Environment Protection Licence 1724

Pollutant	Average concentration limit	50 th percentile concentration limit	90 th percentile concentration limit	100 th percentile concentration limit
Aluminium (µg/L)	120	-	190	-
Cadmium (µg/L)	0.2	-	0.3	-
Chlorine (total residual) (mg/L)	-	-	0.1	-
Chromium (µg/L)	3	-	4	-
Copper (µg/L)	5	-	6	-
Hydrogen sulphide (un-ionised) (µg/L)	30	-	60	-
Nitrogen (ammonia) (mg/L)	-	0.9	1.4	-
Total nitrogen (mg/L)	-	6	-	-
Total phosphorus (mg/L)	-	0.1	-	-
Zinc (µg/L)	34	-	41	-

Source: EPA (2024).

As part of this project, water will be treated by the AWTP to meet nutrient limits and produce high quality water that could be further treated to produce PRW. Following treatment, most of the wastewater flows will be discharged to Breakfast Creek; a small proportion of flows will be transferred to St Marys WRRF (with sludge and sewage), NSOOS (with brine), and Stonecutters Ridge Golf Course (as recycled water, during dry weather only) (refer Figure 6-1). Due to the advanced water treatment processes, the quality of the discharge will have different characteristics from those of the current discharges. The composition of the discharge from

the AWTP has been modelled under different scenarios to provide a comparison of the anticipated discharge water quality, compared to the quality of the existing discharge, and compared to existing water quality in Breakfast Creek. The following scenarios were modelled:

- Average dry weather flow (ADWF): the new treatment infrastructure will increase wastewater treatment capacity from 28 ML/d to 48 ML/d, which is the projected average dry weather flow. Of this 48 ML/d of inflow, 34 ML/d will be discharged to Breakfast Creek. This water quality of this discharge flow was modelled to determine median (50th percentile) quality and extreme (90th percentile) to compare to EPL requirements.
- Wet weather flow (WWF): the operation of the AWTP and associated infrastructure will also provide increased hydraulic capacity to accommodate WWFs. Moderate WWFs are the equivalent of 3 x ADWF, leading to an inflow of 144 ML/d and a discharge to Breakfast Creek of 140 ML/d. The peak WWF considered is 6 x ADWF or 288 ML/d of which 284 ML/d could be discharged to Breakfast Creek. Both these scenarios were modelled.

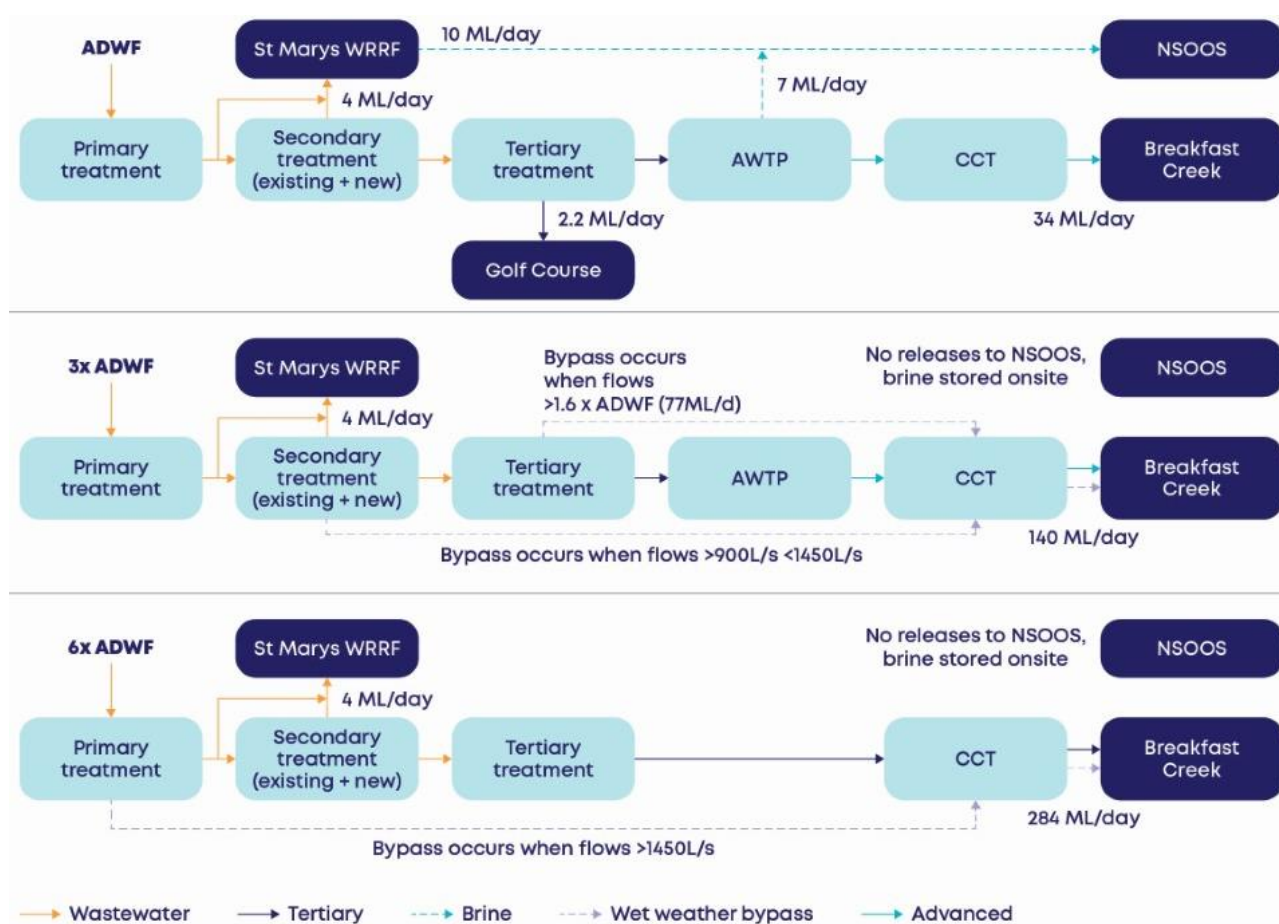


Figure 6-1 Treatment flow diagram under the project

As the wastewater entering the Quakers Hill WRRF will be receiving a higher level of treatment with the operation of the AWTP compared to that in the existing plant, concentrations of most indicators have lower concentrations compared to existing treatment and are anticipated to be below the recommended guideline and median background concentrations (as reported in Table 4-2). Median projected concentrations of physio-chemical indicators for different release scenarios are presented in Table 6-2 together with concentrations under current ADWF conditions. Water quality data are not available for existing wet weather due to the location of the sampling point, therefore only comparison to guidelines can be made. However, it should be noted that the new stream will significantly improve wet weather performance as the majority of wet weather flows will be secondary treated, except in extreme wet weather events.

The water quality modelling used water quality data from Quakers Hill WRRF and modelled the change in parameter concentrations across treatment process units based on measured data from Quakers Hill WRRF, measured data from similar Sydney Water plants, the outcomes of process-specific modelling such as BioWin and WAVE, and empirical or assumed performance. Where available, the modelling preferentially used measured process unit performance data, falling back to modelling or input assumptions where this information was not available or applicable. This water quality modelling was then combined with the plant flow balance and plant flow data from the 2012–2018 period, extrapolated to an average day demand of 48 ML/d, to determine parameter loads discharged from each process stream.

Table 6-2 Results of water quality modelling in the treated discharge from the advanced water treatment plant under different discharge scenarios

Indicator	Existing ADWF discharge (Mar 2010–Mar 2025)		Modelled projected discharge (50 th percentile concentrations)			Modelled ADWF predicted discharge 90 th percentile	Guideline
	50 th percentile	90 th percentile	ADWF	Moderate wet weather flow (3 x ADWF) ^[d]	Peak wet weather flow (6 x ADWF) ^[d]		
Ammonia (mg/L as N)	0.04	0.49	0.03	1.40	1.40	0.1	0.08 ^[a] 0.9 ^[b]
Total nitrogen (mg/L as N)	4.71	6.31	0.35	8.40	4.10	0.75	1.72 ^[a]
Oxidised nitrogen (mg/L as N)	3.38	5.13	0.22	4.00	2.60	0.45	0.66 ^[a]
Total phosphorus (mg/L as P)	0.065	0.13	0.009	2	0.7	0.015	0.14 ^[a]
Soluble reactive phosphorus (mg/L as P)	0.031	0.096	0.006	1.2	1	0.004	0.04 ^[a]
Total suspended solids (mg/L)	2	3	0.5 ^[e]	2	4	1 ^[e]	37 ^[a]
Filtered aluminium (mg/L)	0.065	0.102	0.08	0.17	0.08	0.1	0.055 ^[b]
Cadmium (µg/L)	0.15	0.19	0.14	0.07	0.04	0.15	0.2 ^[b]
Chromium (µg/L)	0.4	1.09	0.08	0.20	0.12	1.74	1 ^[b]
Cobalt (µg/L)	0.5	1.1	0.13	0.15	0.10	0.14	1.4 ^[b]
Copper (µg/L)	3	4.22	0.04	0.86	0.58	1.97	1.4 ^[b]
Filtered iron (mg/L)			0.07	0.04	0.01	0.1	0.3 ^[c]
Total iron (mg/L)	0.047	0.074	0.07	0.04	0.01	0.28	0.3 ^[c]
Manganese (µg/L)	28	59.5	19.06	11.74	5.53	22.34	1,900 ^[b]
Molybdenum (µg/L)	2.1	7.6	0.13	0.57	0.39	0.15	34 ^[b]
Nickel (µg/L)	2.2	3	0.58	0.70	0.44	0.64	11 ^[b]
Zinc (µg/L)	21	30	5.23	6.89	2.18	14.41	8 ^[b]
Total residual chlorine (mg/L as Cl ₂)	-	-	0	0.1	0.1	0	-

Indicator	Existing ADWF discharge (Mar 2010–Mar 2025)		Modelled projected discharge (50 th percentile concentrations)			Modelled ADWF predicted discharge 90 th percentile	Guideline
	50 th percentile	90 th percentile	ADWF	Moderate wet weather flow (3 x ADWF) ^[d]	Peak wet weather flow (6 x ADWF) ^[d]		
Hydrogen sulphide (un-ionised) (mg/L)	-	-	0	0.3	0.3	0	-

Notes:

Orange cells denote exceedance of the recommended guideline for protection of aquatic ecosystems; green cells denote values below the guideline.

^[a] DPE (2022) performance criteria.

^[b] ANZG (2018) toxicant guidelines for 95% species protection. Aluminium guideline specified for pH>6.5.

^[c] ANZECC & ARMCANZ (2000) interim guideline.

^[d] Modelled wet weather results.

^[e] Based on reference data for plants with lime addition post-RO at a 1:1 TSS:NTU ratio.

Overall, the results show that while some modelled indicators exceed the corresponding guideline values, these are similar to those in the existing discharge (except for ammonia) and modelled concentrations are all below the EPL limits (where applicable) (Table 6-1 and Table 6-2). Consequently, no contaminant chemical toxicity modelling is required to inform this assessment. The modelled results also show that:

- Concentrations of most modelled indicators are of better quality than the median and 90th percentile concentrations under existing conditions. Due to process requirements (the need for lime stabilisation), total suspended solids, total iron, and filtered aluminium in the 50th percentile for ADWF are slightly higher than those in the existing 50th percentile discharge. Modelled 90th percentile ADWF concentrations of total suspended solids, total iron, and chromium are higher than in the existing 90th percentiles for ADWF. Filtered aluminium concentrations despite the higher modelled concentrations remain below the EPL specified limits.
- Median (50th percentile) concentrations of all indicators except for filtered aluminium would meet the recommended guideline limits for Breakfast Creek. The 90th percentile concentration of ammonia for ADWF would exceed recommended DPE (2022) performance criteria but would comply with the ANZG (2018) toxicant guideline. The 90th percentile concentrations of zinc, copper, chromium, and aluminium for ADWF would exceed the ANZG (2018) toxicant guidelines. However, the modelled 90th percentile concentrations of zinc, copper, and aluminium are lower than those in the current treatment scenario and would not present an increased risk to aquatic life.
- Concentrations of filtered aluminium would exceed the recommended ANZG 2018 guideline criteria under all scenarios. Aluminium concentrations in the discharge are also greater than median concentrations recorded in Breakfast Creek both upstream and downstream of the existing discharge point noting that these already exceed the guideline value. Modelled concentrations are slightly higher than the 50th percentile and are similar to the 90th percentile concentrations in the current discharge.
- No existing wet weather data for 3 x ADWF and 6 x ADWF exist, as such results have been compared to existing water quality of Breakfast Creek and relevant guideline criteria. All nutrient species would exceed the recommended guidelines during wet weather discharges (3 x ADWF and 6 x ADWF) and exceed median background concentrations during wet weather (refer Table 4-2). However, the frequency of such occurrences is low. It has been estimated that over the modelling period (2012–2018), flows would exceed 3 x ADWF on only 1.1% of the monitoring period. Additionally, the wet weather water quality projections incorporate conservative inputs, including the assumption that nutrient concentrations reach the maximum levels permissible under the EPL. Despite exceedances, impacts to the receiving environment are not expected as these discharges whilst of poorer quality are typically of short-duration and highly diluted by instream wet weather flows which typically have high nutrient concentrations from stormwater runoff, therefore reducing the risk of long-term water quality and aquatic ecology impacts.

- Median concentrations of ammonia in the ADWF scenario (0.03 mg/L as N) would comply with the recommended DPE (2022) performance criteria and the ANZG (2018) toxicant guidelines but would be slightly higher than the median ammonium concentration of 0.02 mg/L recorded at the monitoring sites downstream of the Quakers Hill WRRF discharge point (NS087). However, the concentration in the discharge is lower than median concentrations recorded upstream (0.05 mg/L). This suggests that Breakfast Creek provides enough dilution to reduce concentrations and/or has the capacity to naturally assimilate ammonia through biological processes such as nitrification. As such, ADWF discharges are unlikely to impact on the water quality of Breakfast Creek.
- As mentioned previously, concentrations of total suspended solids in treated wastewater discharges are expected to increase slightly relative to existing concentrations but would remain significantly below the guideline criteria. Under ADWF and 6 x ADWF scenarios, concentrations of total suspended solids would be higher than median concentrations of 2.5 mg/L recorded during dry weather and higher than median concentrations of 6.6 mg/L recorded during wet weather at BF1 (Table 4-2). The increased total suspended solids during this scenario are due to higher solids carryover from the treatment process and bypassing. Under scenarios up to 3 x ADWF, solids are introduced into the product water due to the need for lime stabilisation of the effluent. However, they remain significantly lower than the recommended guideline values and are expected to settle relatively easily onto the creek bed without deteriorating existing water quality. Despite the higher total suspended solids in the discharge, it is expected that due to treatment the solids in the discharge will be relatively inert and free of organic matter. While an increase in sedimentation of the streambed is expected to result from the discharge, this is anticipated to cause minimal impacts on the receiving water quality and aquatic ecology of Breakfast Creek.
- Aquatic life in Breakfast Creek and Eastern Creek is unlikely to be negatively impacted by the changes in discharge concentrations. Although the 90th percentile concentrations of some toxicants (aluminium, copper, and zinc) will continue to be in exceedance of guideline values, they are modelled to be in lower concentrations than at present, which does not represent an increase in risk to aquatic life.
- The 90th percentile concentration of one toxicant, chromium, is modelled to be slightly increased under the new treatment regime and in exceedance of the guideline value. The guideline value of 1 µg/L for chromium is specific to hexavalent chromium (chromium VI) while the modelled concentrations are for total chromium, which includes trivalent (chromium III) and hexavalent chromium. Trivalent chromium is generally less toxic to aquatic life than hexavalent chromium, with a default guideline value of 3.3 µg/L. Continued use of a coagulant (ferric oxide or alum), which is already part of the treatment process, is expected to reduce hexavalent chromium in the effluent to trivalent chromium. As a result, risk to aquatic life from chromium is anticipated to be much lower than indicated by the concentration.

In summary, modelled results indicate that most water quality indicators will improve, with concentrations generally better than current median and 90th percentile values, and most remaining below the EPL limits. Ammonia and filtered aluminium levels are projected to meet or be lower than recommended guidelines, while other metals such as zinc, copper, and chromium are also expected to comply with relevant toxicity criteria and, therefore, further toxicity assessment is not required. Overall, the projected discharges are unlikely to degrade existing water quality in Breakfast Creek, as improved treatment will reduce pollutant concentrations compared to current conditions.

6.1.1.2 Breakfast Creek and Eastern Creek flows

Streamology (2025) have modelled the impacts on the operation of the AWTP on Breakfast Creek and Eastern Creek downstream of the WRRF outfall, the later defined as a SRE. Breakfast Creek downstream of the WRRF outfall will maintain a constant and steady, but reduced, flow from effluent discharge (Streamology 2025). Flows will be reduced between 4 and 8 per cent for the most regular flow rates, for 80th percentile flows between 30.7–42.5 ML/d to 28.3–39.4 ML/d (Figure 6-2). However, as discharge will be constant, cease-to-flow events are not anticipated.

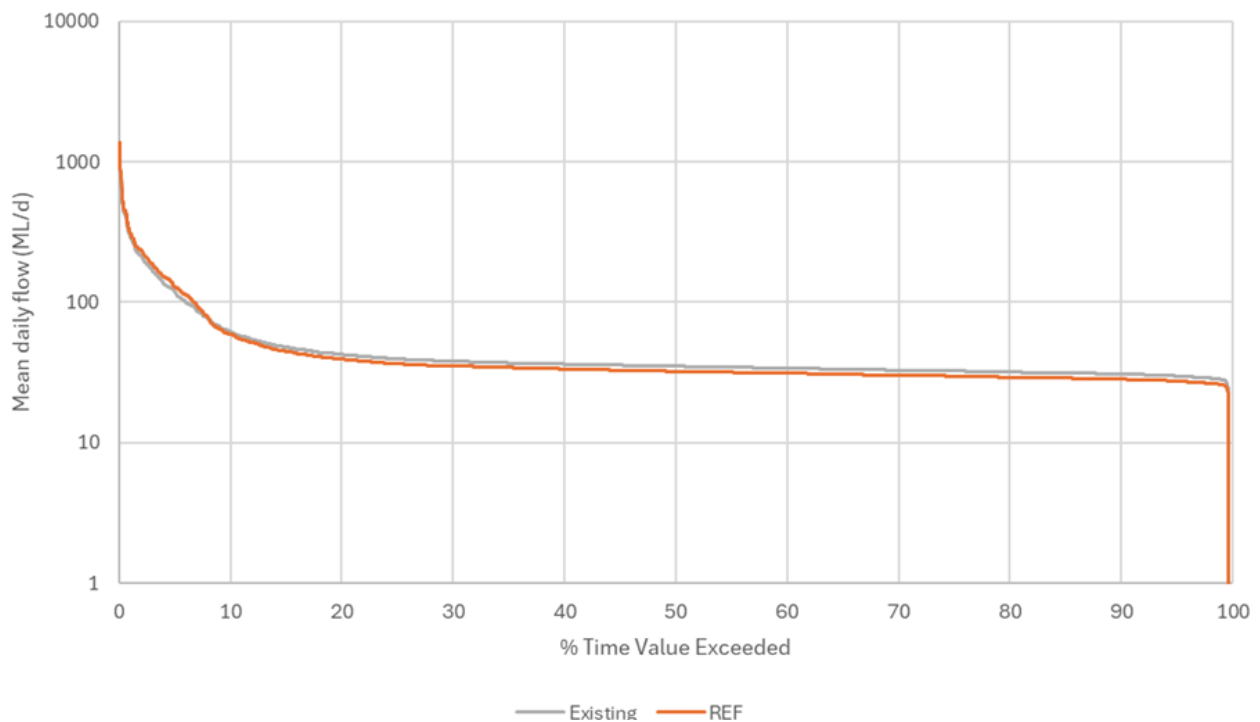


Figure 6-2 Flow duration curve for Breakfast Creek downstream of the WRRF with the existing and upgraded WRRF operations

Source: Streamology (2025).

Flows in Eastern Creek at the Breakfast Creek confluence will be slightly reduced from the 80th percentile of 33–68 ML/d to 30–65 ML/d (Figure 6-3). As with Breakfast Creek, discharges will be constant, with no anticipated cease-to-flow events.

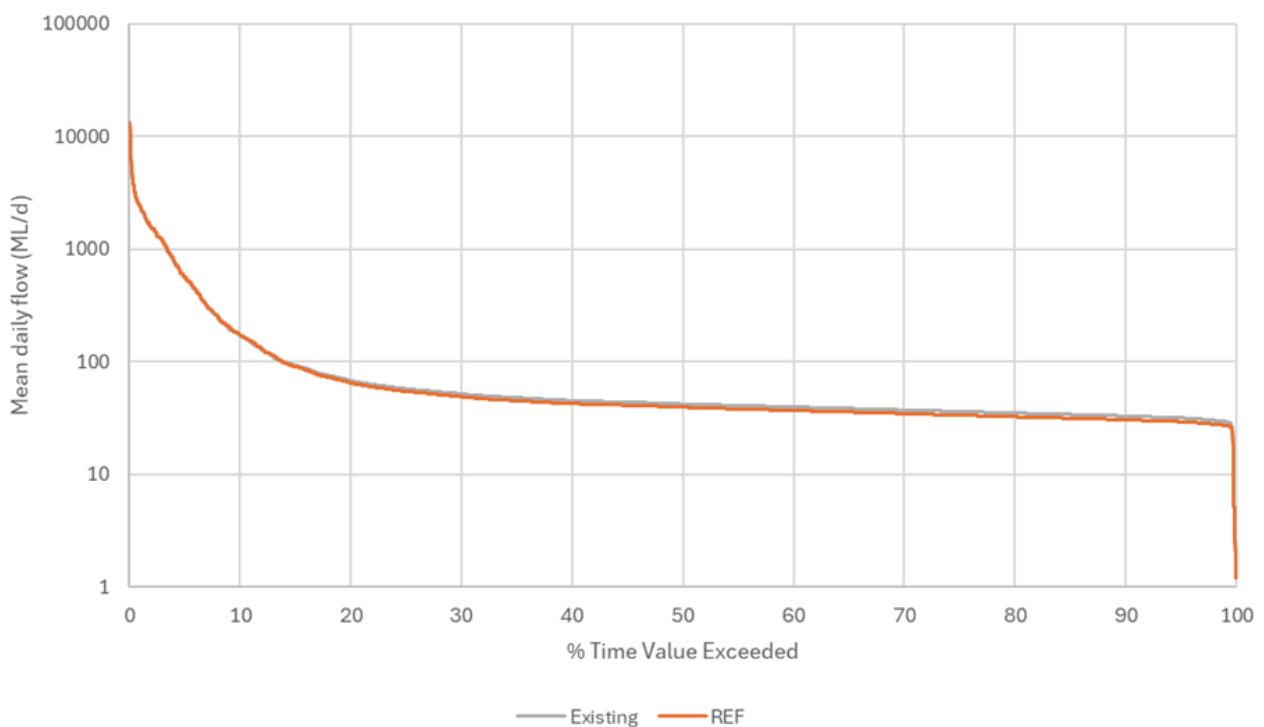


Figure 6-3 Flow duration curve for Eastern Creek at the confluence with Breakfast Creek with the existing and upgraded WRRF operations

Source: Streamology (2025).

Changes to the watercourses as a result of operation of the project are anticipated to be negligible to minor (Streamology 2025). Breakfast Creek downstream of the WRRF will experience a reduction in depth of less than 0.01 m, a reduction of velocity of up to 0.2 m/s and a reduction of less than 0.2 m of wetted perimeter in most locations. These changes are considered insignificant and present low risk to the present ecological community of Breakfast Creek. The reduced flow conditions are slightly closer to, although still exceeding, the South Creek Waterway Objectives and will still support the local ecosystem which is adapted to an already highly modified waterway (Streamology 2025).

The results of flow modelling for Eastern Creek at the confluence are similar to those obtained for Breakfast Creek, with an anticipated reduction in depth of up to 0.1 m, reduction in velocity of up to 0.2 m/s, and a reduction of less than 0.3 m of wetted perimeter in most locations. Streamology (2025) assessed the risks to Eastern Creek at the confluence as 'Low', as there would be minimal alterations to the SRE of Eastern Creek as a result of the project. However, as with Breakfast Creek, the reduction in flows is expected to increase the likelihood of Eastern Creek meeting the South Creek Waterway Objectives while still being expected to support the local creek-dependent ecosystem. For both Breakfast Creek and Eastern Creek, total cease of discharge from the Quakers Hill WRRF would be required to meet the South Creek Waterway Objectives for flow.

Overall, it is anticipated that there is minimal risk of significant modification of the aquatic habitats of Breakfast Creek and Eastern Creek as a result of the proposed upgrade in Quakers Hill WRRF operations and resulting slight reduction in discharge to Breakfast Creek.

6.1.1.3 Nutrient loads analysis for the Sackville 2 subzone

Arup (2025) undertook a loads analysis to determine the change in nutrient loads and concentrations with the upgrades to the Quakers Hill WRRF and other facilities (Riverstone WRRF, St Marys WRRF and Upper South Creek Advanced Water Recycling Centre) within the Sackville 2 subzone. The requirement for upgrades is due to the change in EPL nutrient load limits being implemented by the Environment Protection Authority which are provided in Table 6-3. In addition to the Quakers Hill WRRF upgrade, upgrades are also proposed at Riverstone WRRF and there will be improvements to the AWTP reliability and operational optimisation for total nitrogen at St Marys WRRF.

Table 6-3 Sackville 2 sub-zone EPL nutrient load limits

EPL Load Limits	Total nitrogen (kg/year)	Total phosphorus (kg/year)
Existing Annual Load Limits	222,000	2,300
Future annual Load Limits (1 July 2025)	126,000	2,710
Future 5-year Rolling Average Load Limits (1 July 2025)	126,000	2,710

Note: future load limits were estimated by the EPA in 2024.

The nutrient loads (TN and TP) for both baseline and proposed upgrades for WRRFs in the Sackville 2 sub-zone are provided in Table 6-4. The upgrades are projected to keep nitrogen loads well below future EPL limits even under wet year conditions which typically result in higher loads. Total phosphorus loads however are only lower during a dry year and would exceed the EPL nutrient load limits in a wet year or when wet years comprised more of the five-year rolling average period.

Nutrient loads analysis of Quakers Hill WRRF between 2011 and 2018, shows that with the upgrades there will be an average annual reduction of 75% in total nitrogen loads and 59% in total phosphorus loads (Arup 2025). The reduction in nutrient loads will result in water quality improvements including:

- Lower risk of algal blooms as the reduced nutrient concentrations will help prevent eutrophication and minimise the likelihood of nuisance algal growth, improving aquatic habitat and recreation value.
- Better ecosystem health and long-term sustainability as the lower pollutant loads will support healthy fish and macroinvertebrate populations and improve overall biodiversity.

- Long-term sustainability as the upgrade ensure ongoing compliance with future EPL limits therefore contributing to the long-term ecological health of Breakfast Creek and downstream environments.

Table 6-4 Dry and wet year performance of WRRFs against EPL nutrient load limits (Arup 2025)

Dry and Wet Year Performance	Baseline - Total Annual Nutrient Load (kg/year)		Proposed - Total Annual Nutrient Load (kg/year)		EPL Nutrient Load Limit (kg/year)	
	TN	TP	TN	TP	TN	TP
Dry year (2013–2014)	106,198	2,122	76,985	1,647	126,000	2,710
Wet year (2014–2015)	149,763	3,075	109,248	4,294	126,000	2,710
2 dry years and 3 wet years average	132,337	2,694	96,307	3,235	126,000	2,710
3 dry years and 2 wet years average	123,624	2,503	89,836	2,706	126,000	2,710

6.1.1.4 Release of wastewater

During the operation of the AWTP, there may be instances when wastewater needs to be released to Breakfast Creek without full advanced water treatment. Such instances could occur under the following circumstances:

- If there is an unforeseen failure of the reverse osmosis process preventing treatment of all or some of the feedwater.
- For planned maintenance, which requires the reverse osmosis process to be taken offline.
- If the AWTP needs to be shut down to avoid damage during prolonged periods of wet weather.

The design of the project has taken possible reverse osmosis failures into account in the forecast models. These forecasts already allow for some outage of the reverse osmosis systems. Only outages that are longer than planned for, or total power outages (noting that backup power will be available), would have potential to impact on water quality as discussed below.

Depending on the stage at which a breakdown occurs, the turbidity of water could be of varying quality and present a risk to the water quality of Breakfast Creek. As a worst case, water would be tertiary treated and may be higher in contaminants such as dissolved solids, heavy metals, microorganisms, and nutrients that are usually removed during reverse osmosis. Generally, though the quality of water discharged would be equivalent to the current operating situation. Therefore, water discharged during times that the AWTP is not operating would still meet the EPL and most guideline criteria. Due to the nature of planned wastewater releases being short-term, lasting impacts such as increased toxicity to aquatic organisms, altered nutrient cycles, and increased risk of algal blooms is unlikely.

Release of wastewater could introduce pathogens which may impact on the recreational suitability of the water. Secondary contact recreation has been nominated as an environmental value for Breakfast Creek (see Section 3.2.3) and therefore the risk of increased pathogens could present a risk to downstream recreational users. Given recreating in waters following rainfall is not recommended, the greatest risk would be due unforeseen failures or planned maintenance of the reverse osmosis unit.

6.1.2 Brine pipeline

Brine would be produced as a by-product of the treatment process at the AWTP. It will be mixed with brine currently generated from St Marys AWTP and will be transferred to the NSOOS via an existing pipeline or a new brine pipeline constructed as part of this project. Under normal operating conditions, minimal activities would be required directly for the operation of the brine pipeline. However, initial testing and commissioning, maintenance work or unexpected breakdowns could potentially affect water quality of the downstream

receiving environment. Once operational, the brine pipeline will become part of Sydney Water's network and subject to Sydney Water's standard management and operational controls.

6.1.2.1 Brine transfer

Brine generated in the PRW treatment process will be transferred to the newly constructed brine pipeline which will connect to Sydney Water's existing sewer infrastructure and discharge to the Pacific Ocean via the North Head WRRF. Discharge will be in accordance with Sydney Water's existing operating licence.

It is estimated that the volume of brine storage and release will increase under the different AWTP flow discharge scenarios. Under ADWF, 7 ML/d of brine would be produced by the Quakers Hill AWTP. Under peak ADWF the volume of brine to be transferred would increase to 10 ML/d. In addition to the brine generated from the Quakers Hill AWTP, up to 10 ML/d of brine would continue be released as per current situation (irrespective of ADWF scenario) from the existing dry weather St Marys AWTP brine transfers to Quakers Hill WRRF.

The transfer of brine to the North Head wastewater system has the potential to impact on EPL pollutant loads and concentrations. The brine transferred to the NSOOS would need to meet the conditions of the Northern Suburbs Sewage Treatment System EPL (EPL378) (EPA 2021). This EPL includes load and concentration limits for several pollutants. Load projections and expected concentrations have been completed for Quakers Hill AWTP to understand the impact of brine transfer. The expected annual loads for key pollutants of brine (including St Marys AWTP) compared to current EPL load limits and actual loads in 2023/24 is provided in Table 6-5. It should be noted that the brine will be re-treated at the North Head WRRF before discharge and comprises a small volume of the overall ocean discharge from the WRRF.

Additionally, there will be no brine during moderate (3 x ADWF) or peak wet weather flow (6 x ADWF), although there is the potential for brine overflow during wet weather. In wet weather, when the brine transfer to the NSOOS needs to stop due to capacity constraints, the existing Quakers Hill WRRF brine storage ponds of up to 28 ML capacity will hold the brine for the majority of wet weather events. However, when the storage tanks reach capacity, the advanced treatment process will become inhibited and will be temporarily switched off, so brine does not continue to be produced. Modelling shows that this will occur about 5 days per year. These measures will avoid brine being released to local waterways. Oil and grease are not expected to be present in the brine and therefore this indicator has not been included in Table 6-5.

The forecast loads of key contaminants in the brine being transferred to NSOOS are expected to have a minimal impact on the annual loads discharged at the North Head WRRF. Current ocean discharge loads based on 2023-24 data contribute between 1% and 85% of the annual load limit depending on the indicators. With the addition of the modelled annual loads, there would be a slight increase in overall loads (up to 3.5%). Total nitrogen which currently is at 85% of total load limit would see an increase to 87.9% of load limit, but other indicators such as biochemical oxygen demand, total suspended solids and copper would increase by less than 1%. Overall, it is considered that the brine stream loads would comprise a small percentage of the overall loads and therefore would not impact on compliance with the EPL nor the on the environment. Similarly, the indicative concentration limits of the brine from the Quakers Hill AWTP would not present a risk to meeting the limits specified in the EPL, particularly as the AWTP brine stream would be further treated and diluted with other inflows. Therefore, the discharge of brine from the North head WRRF when the Quakers Hill AWTP is operational will adhere to environmental protection standards designed to protect ecological harm, ensuring the marine environment remains unaffected by the increase in a brine as a result of the operation of this project.

Table 6-5 Forecast contaminant loads in brine stream to be transferred to the Northern Suburbs Ocean Outfall Sewer compared to EPL limits

Indicator	Current load (2023–24) (kg/year)	EPL licenced load (kg/year)	Modelled 50 th percentile (kg/year)	Modelled 90 th percentile (kg/year)
Biochemical oxygen demand	24,532,850	35,010,800	124,100	41,367
Total suspended solids	25,300,414	35,010,800	4,137	4,137
Total nitrogen	6,730,340	7,957,000	132,952	263,919
Total phosphorus	863,572	1,909,680	4,286	21,693
Cadmium	8	283	8	8
Chromium	766	3,011	25	83
Copper	15,399	37,583	124	207
Lead	544	3,568	-	-
Mercury	4	60	-	-
Selenium	67	2,387	-	-
Zinc	33	51,066	951	792
Pesticides and polychlorinated biphenyls	2	370	-	-

In conclusion, the transfer of brine to the North Head WRRF will constitute only a small proportion of the total annual load, with projected increases in key pollutants expected to be minimal and well within existing licence limits. As such, compliance with environmental protection licence requirements will be maintained, and no significant impact on the marine environment is anticipated as a result of this project.

6.1.2.2 Leaks or bursts

All pipes will be built to the relevant specifications to ensure that risks are effectively managed. However, there is a residual risk with all pipelines for failure to occur. Incidental discharges of brine water from pipe leaks or bursts could impact the water quality of Breakfast Creek or Blacktown Creek. Based on the expected concentrations of contaminants in the brine, the key risk to water quality would be increased salinity and the introduction of toxic substances in elevated concentrations. Additionally, the discharge could cause scouring of the waterway where the leak or burst occurs, thereby increasing turbidity. Should a pipe leak or burst occur, the impacts are expected to be temporary and localised and will be managed in accordance with the Sydney Water's standard management and operational controls.

6.1.2.3 Maintenance

Whenever the brine pipeline requires maintenance during operation, drainage of the pipeline via the scour valve outlets (approximately 17 in total) would be required. This drainage has the potential to impact on water quality and aquatic species of Breakfast Creek or Blacktown Creek should water be discharged and mobilised downstream due to the higher concentration of contaminants in brine compared to the existing water quality and recommended guideline limits for Breakfast Creek and Blacktown Creek. To avoid these impacts, no water will be released to the waterways. Any water released during maintenance will be captured and released off-site to a nearby network connection or tanked away and transferred to a designated discharge point.

7. Cumulative impacts

Cumulative impacts are a result of incremental, sustained and combined effects of human action and natural variations over time and can be both positive and negative. They can be compounded when the potential impacts of a project are combined with past, current, planned, or reasonably anticipated future impacts (DPIE 2022). Cumulative impacts can result in a greater extent, magnitude or duration of impacts and may also arise where multiple or consecutive construction for development impact the same receivers.

Cumulative impacts to surface water may arise from the interaction and operation of activities of the project and other approved projects in the area. When considered in isolation, specific project impacts may be considered minor. However, impacts may be more substantial when multiple projects impact on the same receivers. As such, the surface water quality impacts discussed in Sections 5 and 6 were assessed in consideration of recently completed and proposed projects within the broader regional area as described in Table 7-1. The identified projects are in varying stages of delivery and planning. Table 7-1 summarises surface water quality impacts based on the most current publicly available information on the nominated projects.

Table 7-1 Summary of potential cumulative impacts

Project name	Brief project description	Common receivers	Potential impacts on common receivers (construction and operation phases)
Securing our water supply – Quakers Hill to Prospect	A new PRW Treatment Plant. A new PRW pipeline from the treatment plant to Prospect Reservoir. Infrastructure to release PRW into Prospect Reservoir and ensure adequate mixing and aeration.	Breakfast Creek Blacktown Creek	The securing our water supply – Quakers Hill to Prospect and the Quakers Hill WRRF Advanced Water Treatment Plant and Secondary Treatment Upgrade have a similar study area with the proposed construction and operation activities from both projects impacting on Breakfast Creek and Blacktown Creek. Construction of this project components would commence from early 2027 and would take around 24 months. The project components of the Securing our Water Supply – Quakers Hill to Prospect has a construction timeframe of 2029–2030. As such, there is likely to be a small overlap in construction staging of both projects which could result in increased physico-chemical and microbiological contamination in these waterways. To reduce the risk of impacts, erosion and sediment control measures would be implemented in accordance with the Blue Book, construction work would be staged, stockpiles will be managed, and monitoring would be undertaken. This project will be operational before the operation of the securing our water supply – Quakers Hill to Prospect, as such no cumulative impacts are expected.
Honeman Close Data Centre	Construction and operation of a new 96 MW data centre with associated civil works.	No common receiver	The Honeman Close Data Centre would be located near Bungarabee Creek, approximately 1.3 km from Blacktown Creek. Construction of the brine pipeline as part of this project would be 4 km downstream of Breakfast Creek near Honeman Close. Due to the distance between the two projects and no common receivers within the 500 m buffer, there would be no cumulative impacts from construction and operation of these projects.

Project name	Brief project description	Common receivers	Potential impacts on common receivers (construction and operation phases)
Augusta Street Warehouse and Distribution Centre	Construction and operation of a warehouse and distribution centre comprising: - Four warehouse buildings including one multi-level building with a total area of covered floor space of 134,565 m² and maximum height of 34.84 m - Car parking, intersection and access works.	Blacktown Creek	The proposed site for the Augusta Street Warehouse and Distribution Centre would be near the upstream reaches of Blacktown Creek. The brine pipeline would be 4 km downstream of this creek. Construction of August Street Warehouse and Distribution Centre was due to commence in early 2025 and would take around 16 months to complete therefore would be unlikely to overlap with the construction of this project. Construction of both projects presents a similar risk to water quality with the key risk to Blacktown Creek being sediment-laden runoff from construction compounds, stockpile and laydown areas, as well as accidental leaks or spills, rubbish and debris being transported downstream. Given the distance between the two projects and Blacktown Creek and the implementation of appropriate mitigation measures, cumulative impacts would be minimal.

8. Surface water quality controls

8.1 Construction phase

8.1.1 Erosion and sediment control strategy – WRRF

During project construction, erosion and sediment controls will be required. In addition to the controls that will need to be implemented within the disturbed catchment boundary, temporary sediment basins will also be installed as the primary mechanism to capture and treat runoff from all disturbed areas within the construction footprint before discharging into the receiving waterways (Breakfast Creek). Where land disturbance is not large and does not result in a high potential for erosion and sediment export, only local sediment controls, for example sediment fences or filter logs, would be required.

The overall erosion and sediment control design strategy for the Quakers Hill WRRF site is to prevent or reduce erosion and sediment impacts during construction. Where erosion does occur, the aim is to capture it as close to its source as practicable.

The proposed concept Erosion and Sediment Control Plan for the construction stage of the project is based on five principles:

1. Controlling the occurrence of erosion.
2. Controlling the movement of sediment.
3. Diverting off-site “clean” water away from construction areas.
4. Diverting onsite “dirty” water towards a sediment basin.
5. Capturing sediments that are transported through diversion drains in adequately sized sediment basins.

The *Technical guidelines for achieving Wianamatta - South Creek stormwater management targets* (DPE 2022), have been considered and adopted. These guidelines are consistent with the requirements of the Blue Book (NSW Soils and Construction Guidelines) for the construction phase. For the operational phase, these criteria are very difficult to achieve and are considered to be aspirational targets but not requirements, the proposed controls have contributed towards reducing the loads in South Creek by improving the pollutant loads from the existing site conditions by up to 25% which is considered to be a reasonable contribution from this site to improve the water quality in South Creek. It would not be practical nor feasible to contribute beyond this level

8.1.1.1 Physical sediment control measures

Whilst the installation of appropriate erosion control measures would greatly reduce the quantity of soil eroded from a construction site, some erosion would inevitably occur, and measures are therefore required to ensure that eroded material is trapped and retained. Such measures include catch and diversion drains, check dams, level spreaders, sediment fences, constructed drainage, and sediment basins.

8.1.1.1.1 Catch and diversion drains

Either individually or in combination, these structures are used to intercept and direct runoff water to a desired location. By doing so, sheet flow is converted to concentrated flow, and the time of concentration for runoff is decreased. There are two types of drains for clean and dirty runoff used during the construction phase, and they are often used in conjunction with level spreaders and check dams:

- Upslope runoff diversion (“clean” runoff diversion drain)

This diversion drain is an earth channel with lining designed to intercept and direct “clean” runoff from the undisturbed upstream catchment and divert it to an existing waterway, so that it does not enter the construction site. Drains would be lined with biodegradable organic fibre mesh hydro seeding and anionic bitumen emulsion. Other suitable linings can also be used.

- Onsite runoff diversion (“dirty” runoff diversion drain)

A diversion drain would be installed at the downstream end of disturbed areas to convey contaminated runoff to sediment basins.

8.1.1.1.2 Level spreaders

A level spreader is an excavated outlet constructed with zero grade. It converts an erosive, concentrated flow of runoff into sheet flow, and discharges it at a non-erosive velocity onto an undisturbed area stabilised by vegetation.

Level spreaders are to be used as outlets for diversion or perimeter banks or channels, where storm runoff has been intercepted and diverted to stable areas. They should be used only where the spreader can be constructed on undisturbed soil. The area directly below the spreader sill should be uniform in slope and well vegetated, allowing water to spread out as sheet flow.

8.1.1.1.3 Sediment fencing and filters

Sediment fences/filters act as sediment mitigation measures for disturbed areas where it is impracticable to direct the runoff to sediment basins by diversion drains. Sediment fences/filters function by intercepting and filtering small volumes of runoff, which mainly occur as sheet flow.

8.1.1.1.4 Sediment basins

Sediment basins have been located where they will collect a high proportion of sediment-laden runoff from disturbed areas of the construction, and where they are accessible for maintenance. The ideal location of the sediment basins is on the downstream side of the proposed construction area and immediately upstream of proposed culvert crossings. An assessment has been undertaken to determine the location and sizes of the proposed temporary construction phase sediment basins.

The sizing of the basins has been undertaken using the design methodology outlined in Volumes 1 and 2 of the Blue Book (Soils and Construction):

- Managing Urban Stormwater, Soils and Construction guidelines, Volumes 1 (Landcom 2004) and 2 (2008) (known as the Blue Book).
- Managing Urban Stormwater, Volume 2D: Main Road Construction (DECC 2008).

The relevant design criteria and input parameters are shown in Table 8-1.

Table 8-1 Design criteria for sizing the temporary sediment basins (construction phase)

Parameter	Value	Comments
Rainfall Parameters		
Rainfall depth duration (days)	5-day	5-day adopted as standard duration used in the NSW EPA requirements.
Rainfall percentile	85 th	85 th percentile has been adopted as the anticipated EPA requirements.
Rainfall depth (mm) – 5-day	85 th – 32.2 mm	Blacktown station is the closest at 32.2 mm in Table 6.3a of the Blue Book (24.6 mm for 80 th percentile).
Volumetric runoff coefficient, cv	Varies (0.51 to 0.64)	0.64 has been adopted for soil hydrologic group D with high runoff potential.

Parameter	Value	Comments
Rainfall intensity for 2-year Average Recurrence Interval, 6 h duration	9.7 mm/h	9.7 mm/h has been adopted for the 39.35% AEP, refer to Appendix C. Also refer to derived rainfall erosivity in this table.
RUSLE Parameters		
Soil/sediment type	C, D or F	Varies along the alignment. Mainly type F, type D and small localised pockets of types C. Type D has been adopted for deeper subsoils.
Erodibility, k	Varies k=0.02 to k=0.06	k=0.05 was adopted for the typical soils found in Western Sydney, however, this selection can be further improved at detailed design stage through site specific soil testing.
Rainfall erosivity, R	2,096	Adopted value is based on the Bureau of Meteorology rainfall intensities for the site.
Hydrologic soil group	D	For high runoff potential, Reference: Appendix F of the Blue Book.
Soil cover, C	1	Corresponding to expected type of activities on site.
Soil conservation practices, P	1.3	Corresponding to expected type of activities on site.
Length Slope Factors, LS	Variable	Determined separately for disturbed area and steeper clean stockpile area.
Sediment yield time period (months)	2 to 6 months	4 months adopted as a reasonable period that accounts for the likely maintenance frequency during construction for the removal of capture sediments.

The sediment basins have been sized in accordance with the requirements of the Blue Book by using the site-specific input parameters and design criteria listed in Table 8-1. The sizes of the three proposed sediment basins are listed in Table 8-2. At locations where the catchment areas were not sufficiently large to warrant sediment basins, sediment sumps with a minimum size of 10 m³ have been recommended (not shown on the concept Erosion and Sediment Controls Plan).

The NSW EPA normally requires the basins to be designed to a nominated percentile for the 5-day rainfall depth (typically this is the 85th percentile). As such, temporary sediment basins have been provided and sized to satisfy the EPA requirements.

Surface runoff from this construction site will discharge into Breakfast Creek. If the proposed erosion and sediment control measures including the sediment basins are implemented during the construction phase of the project, the potential impact onto the downstream receivers will be managed and adequately controlled.

Table 8-2 Proposed temporary construction phase sediment basins

Sediment basin No.	Estimated catchment area (ha)	Water surface area (m ²)	Water volume (m ³)
SB1 for AWTP area	2.2	420	510
SB2 for clean stockpile area	1.5	400	475
SP3 for secondary treatment area	1.4	300	325

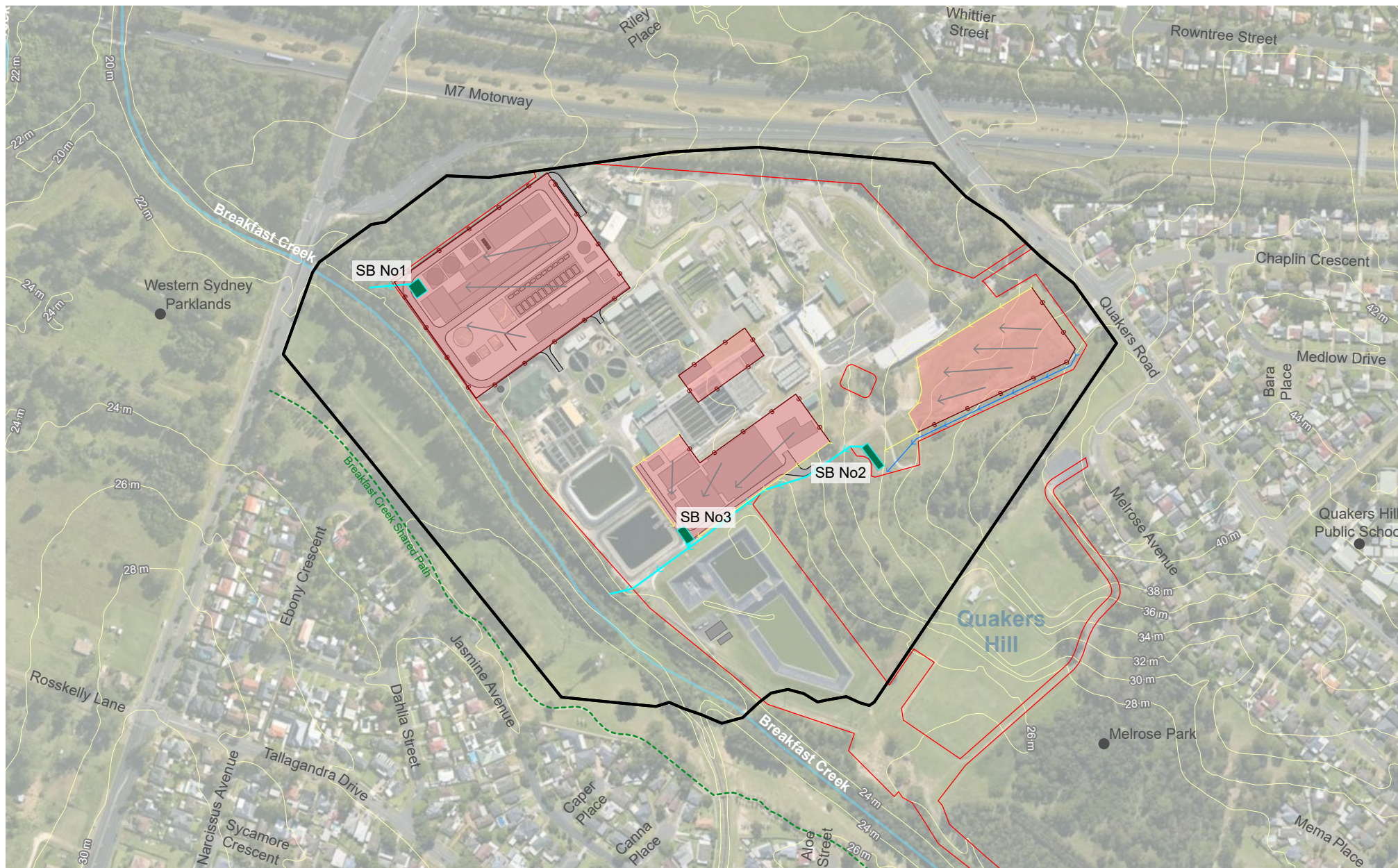
For proposed sediment basin SB1 at the AWTP area shown in Figure 8-1 on the concept Erosion and Sediment Controls Plan, the basin will need to be built below the lowest level of the AWTP excavation works.

For SB2 located downstream of the clean stockpile area, this existing basin which is approximately 200 m² will need to be augmented to approximately 400 m² to comply with the Blue Book requirements. For SB3 located downstream of the secondary treatment area, this existing basin which is approximately 155 m² will need to be augmented to approximately 300 m² to comply with the Blue Book requirements.

All sediment basins should have V:H side slopes of 1:2 with a maximum water depth of 2 m and a preferred length to width ratio of L:W=3:1. Refer to Appendix D for details of the basins sizing summary outputs.

Flocculation may be required at all the sediment basins prior to discharging into Breakfast Creek, depending on the total suspended solids and turbidity values specified in any EPA requirements, which should generally be less than 50 mg/L.

The proposed erosion and sediment controls, including the sediment basins are based on a concept design only. If the locations and extent of the proposed land disturbance is modified during detailed design, the contractor may update these controls to suit the detailed design changes.



- | | | | | | |
|--|--|--|---------------------------------|--|----------------|
| | Quakers Hill Water Resource Recovery Facility (WRRF) | | Diversion drain, 'clean' runoff | | Disturbed area |
| | Impact area | | Diversion drain, 'dirty' runoff | | 2m contours |
| | Flow over disturbed area | | Sediment fence | | Sediment basin |
| | Outflow path from basin (by gravity or pumped) | | | | |

Figure 8-1 Proposed erosion and sediment controls for the WRRF site

0 200 m

Data sources: State of NSW (Spatial Services), NSW Department of Planning and Environment
Basemap: MetroMap 2024

Scale: 1:5,000 @ A4
GDA2020 MGA Zone 56



8.1.2 Erosion and sediment control strategy – brine pipeline

An erosion and sediment control strategy is required for the construction phase of the brine pipeline. The pipeline will be constructed via a combination of open trench and horizontal directional drilling as shown in Figure 8-2. Open trenching of pipeline will have a total length of 5.2 km. The HDD line of approximately 2.4 km does not have any trenches. There are also several areas that will be disturbed along the brine pipeline such as compound and construction equipment laying and storage areas which will need to be considered in the erosion and sediment control strategy.

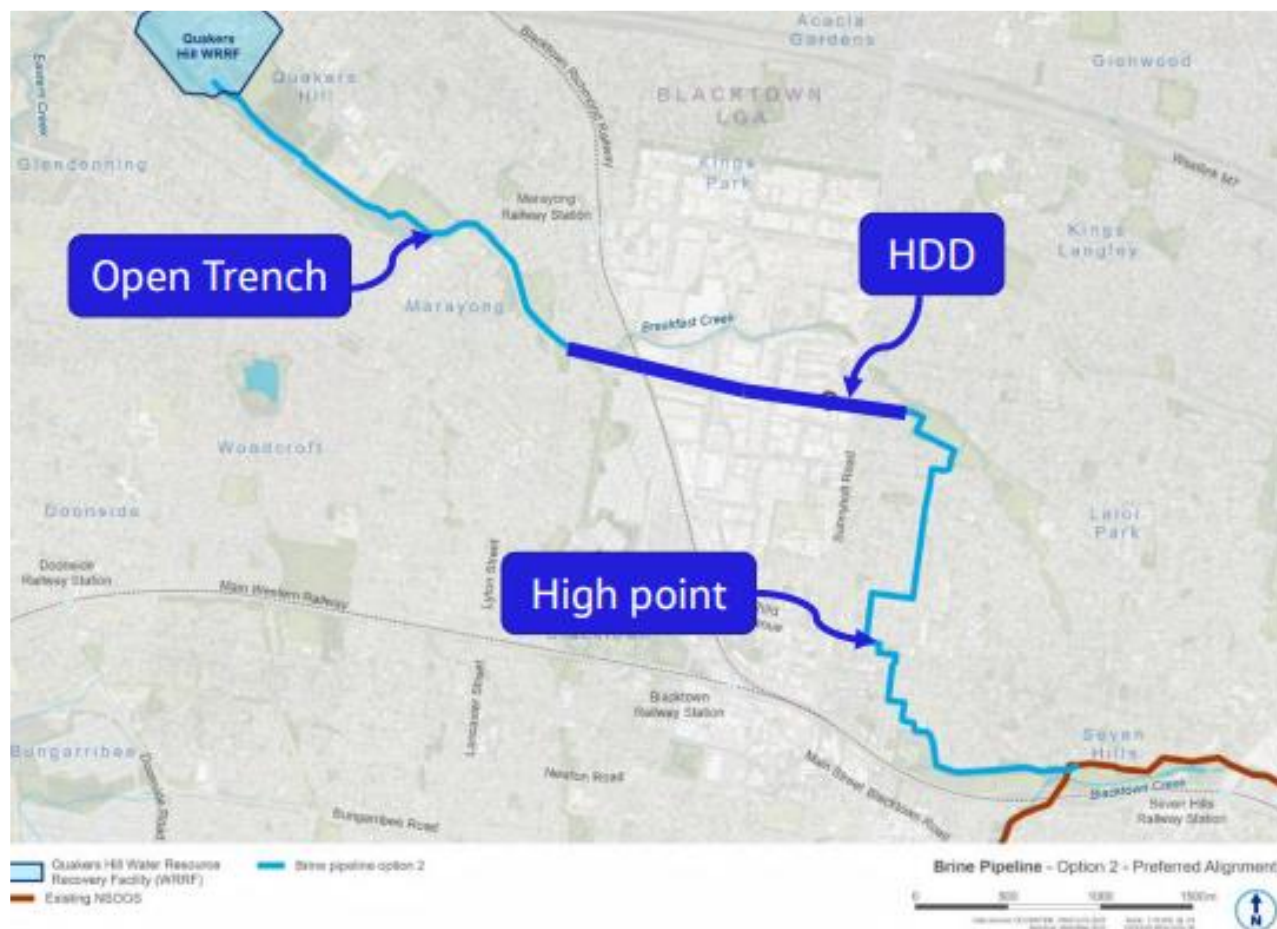


Figure 8-2 Extent of the open trenches for the brine pipeline

Similarly to the WRRF, the erosion and sediment control strategy for the brine pipeline is to prevent or reduce erosion and sediment impacts during construction. Where erosion does occur, the aim is to capture it as close to this source as practicable.

The proposed concept erosion and sediment control plan for the construction stage of the project is based on four principles:

1. Controlling the occurrence of erosion.
2. Controlling the movement of sediment.
3. Diverting offsite “clean” water away from the pipe trench construction areas through diversion drains.
4. Capturing sediments that may be transported through diversion sediment fences.

Figure 8-3 provide a typical detail of the proposed open trench excavation for the construction of the brine pipeline. The existing land along the pipeline alignment and its surrounding areas will be disturbed. A corridor for the pipeline open trench and stockpiling will be required during the excavation period. Erosion and sediment controls will be needed on both sides of the existing open channel.



Figure 8-3 Typical illustration of the proposed excavation for the brine pipeline

8.1.2.1 Physical sediment controls

Whilst the installation of appropriate erosion control measures would greatly reduce the quantity of soil eroded from a construction site, some erosion would inevitably occur, and measures are therefore required to ensure that eroded material is trapped and retained. Such measures include sediment fences and external runoff diversion drains, check dams and level spreaders.

8.1.2.1.1 Sediment fencing and filters

Sediment fences/ filters act as sediment mitigation measures for disturbed areas where it is impracticable to direct the runoff to sediment basins by diversion drains, or when a sediment basin is not warranted for relatively small areas of disturbance. Sediment fences/ filters function by intercepting and filtering small volumes of runoff, which mainly occur as sheet flow.

It is proposed to use sediment fences around all sides of the soil stockpile areas to provide capture of sediments in runoff from the stockpiles during a rainfall event.

8.1.2.1.2 Diversion drains

These structures are used to direct external runoff water to a desired location. By doing so, sheet flow is converted to concentrated flow, and they are often used in conjunction with level spreaders and check dams. This diversion drain is an earth channel with lining designed to intercept and direct “clean” runoff from the undisturbed upstream catchment and divert it to an existing waterway, so that it does not enter the pipeline trenches during construction. Drains would be lined with biodegradable organic fibre mesh hydro seeding and anionic bitumen emulsion. Other suitable linings can also be used.

It is proposed that diversion drains and sandbags be provided where required at some isolated locations upslope of the disturbed area of the open trench. A detailed ground survey will be required for the detailed erosion and sediment controls plans that will need to be prepared so that all discharge points of the diversion drains are identified.

8.1.3 Site compound areas

Several site compound and construction equipment laying areas are proposed along the alignment of the brine pipeline. An example of such a site compound area is given in Figure 8-4. Temporary sediment basins would not be required for these areas as they are not very large areas, and such would not warrant sediment basins. Sediment fences would be required at all downslope areas of the site and external runoff diversion drains would also be required for all upslope areas. Stabilised access points would also be required at the entrance to the site to prevent soil deposition on public roads from construction vehicles exiting the site.



Figure 8-4 Example of a site compound area

8.2 Operational phase

8.2.1 Surface water quality strategy and treatment

For the operational phase of project, following the proposed upgrade works, there are two main areas on site where changes in imperviousness will impact on surface runoff and discharges, hence an impact on pollutant loads into Breakfast Creek. The main pollutants of concern during this phase are total suspended solids, total phosphorus, and total nitrogen.

Figure 8-5 shows the locations of the AWTP and secondary treatment system.



Figure 8-5 Advanced water treatment plant and secondary treatment system at Quakers Hill WRRF

The 50% design report indicates the total area of the site is approximately 29.3 ha (Jacobs 2025b). The percentage imperviousness for the existing conditions has been estimated to be approximately 50% of the total site area. This means that approximately 14.65 ha of the existing site is impervious. For the proposed conditions, this imperviousness would increase to 55% because of the proposed 1.62 ha increase in impervious area on the site. Therefore, the new impervious area would be 16.27 ha and the pervious area would reduce from 14.65 ha to 13.03 ha.

The water quality assessment estimated the increases in pollutant loads so that mitigation measures can be identified to reduce or eliminate the impacts from the proposed works and ensure that pollutant loads for the proposed mitigated conditions do not exceed those for existing conditions.

The *Technical guidelines for achieving Wianamatta - South Creek stormwater management targets* (DPE 2022), have been considered in this assessment and the MUSIC modelling that has been undertaken is consistent with these technical guidelines.

8.2.2 Modelling of pollutant loads

A model has been developed to estimate annual pollutant loads generated for current and future (project-related) conditions. The eWater Model for Urban Stormwater Improvement Conceptualisation (MUSIC X model) is the industry standard model used to quantify pollutant load exports for proposed conditions and treatment reductions for proposed water quality controls. The MUSIC model procedure undertaken for the Quakers Hill WRRF site is outlined below.

The MUSIC model has been set up with all the relevant input parameters obtained from the Blacktown City Council MUSIC-link library in the model.

8.2.2.1 Rainfall and evaporation data

Rainfall data with a 6-minute time step for Blacktown recorded by BoM was selected as the most appropriate data to be adopted for the site, as recommended by Blacktown City Council for modelling in its LGA. The rainfall data time series is shown in Figure 8-6. Other relevant input parameters such as event mean concentrations for the site's land use have also been obtained from the Blacktown City Council MUSIC-link database.

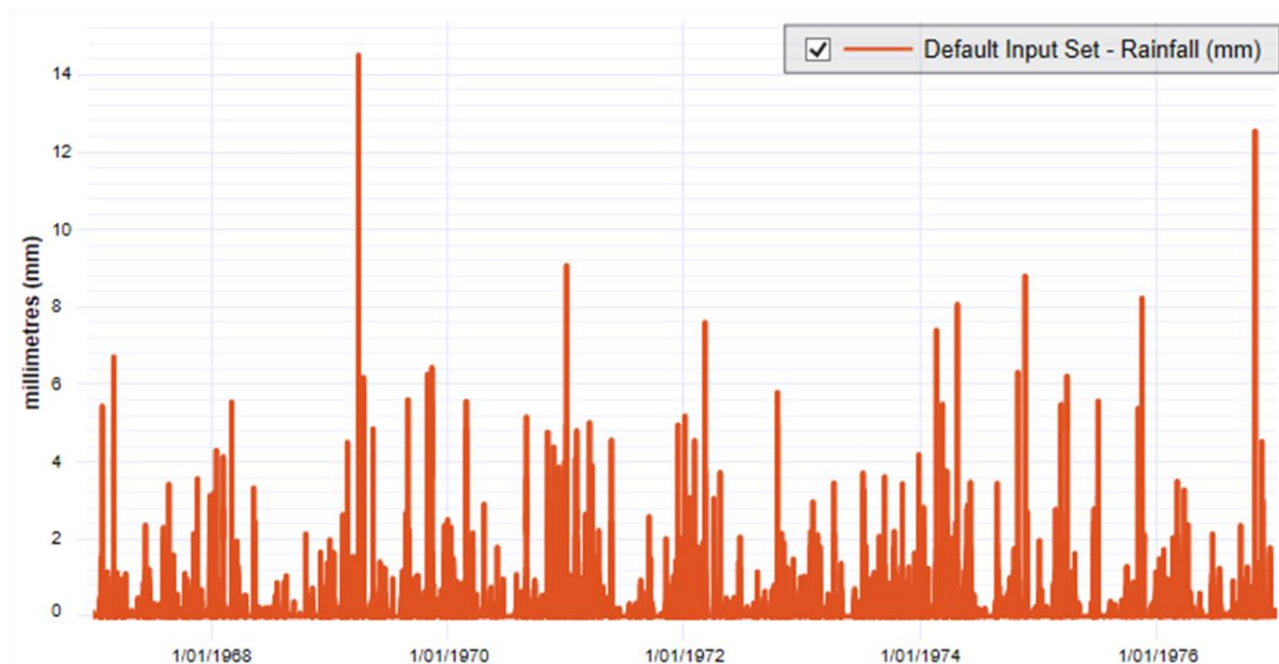


Figure 8-6 Time series of rainfall levels at Blacktown used in the MUSIC link database

Evaporation data have also been obtained from the Blacktown City Council recommended values as shown in Figure 8-7.

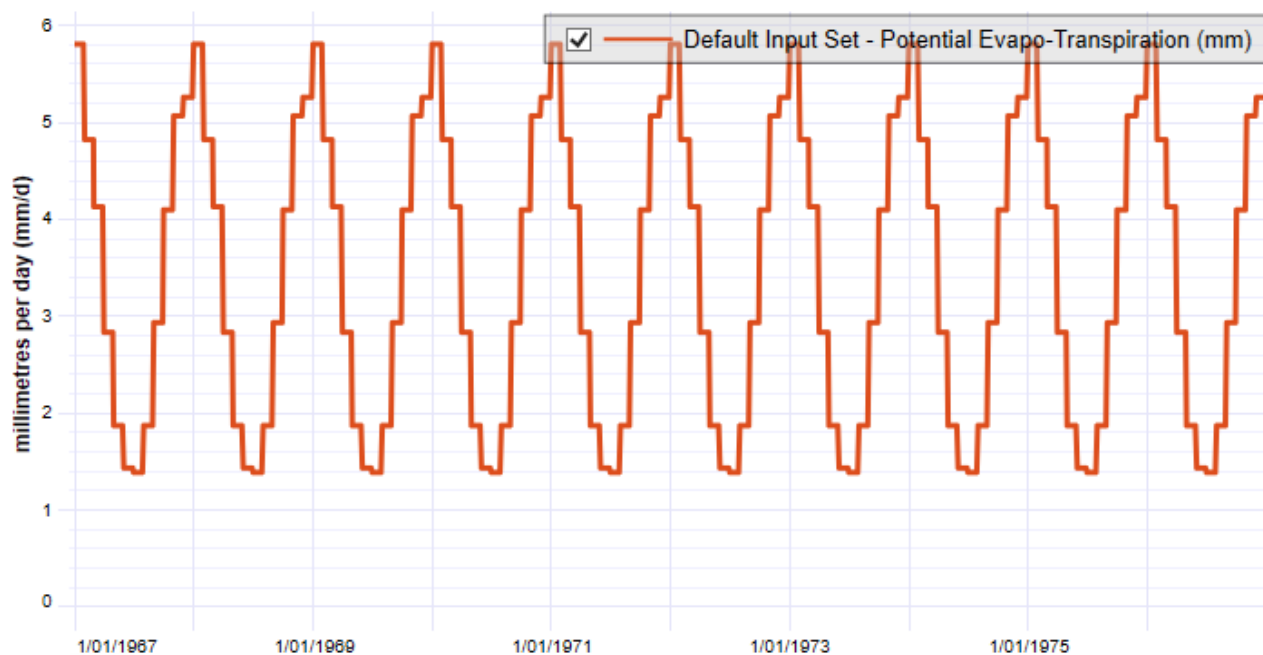


Figure 8-7 Time series of evaporation levels at Blacktown used in the MUSIC link database

The layout of the MUSIC X model developed for existing and proposed conditions is represented in Figure 8-8.

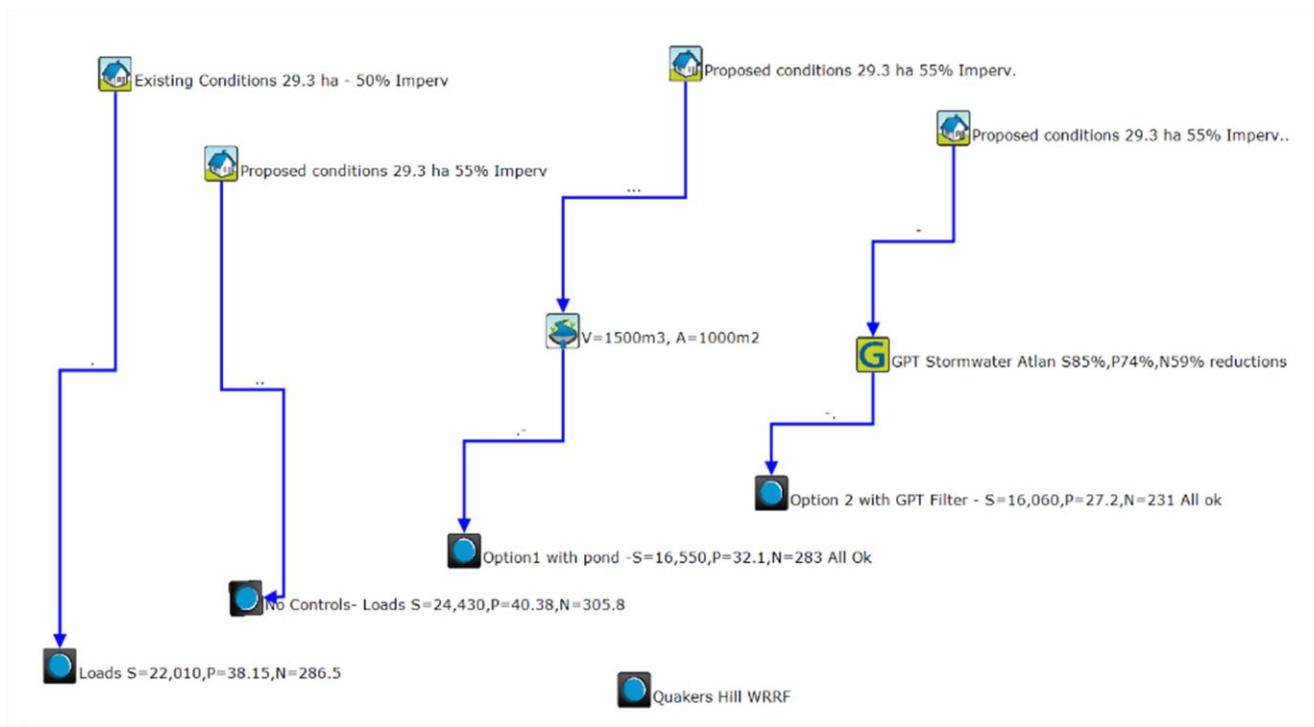


Figure 8-8 Water quality model layout

8.2.2.2 Results and proposed controls

The results of the water quality modelling indicate that there will be an increase in annual pollutant loads discharging into Breakfast Creek ranging from 6% for total phosphorus to 11% for total suspended solids as shown in Table 8-3.

Table 8-3 Annual loads for existing and proposed conditions

Pollutant	Pollutant loads for existing conditions (kg/year)	Pollutant loads for proposed conditions without any controls (kg/year)	Percentage increase in loads
Total suspended solids	22,010	24,430	+11%
Total phosphorus	38.1	40.4	+6%
Total nitrogen	286	306	+7%

This increase in pollutant loads will need to be reduced such that there is no increase or there is a small decrease. Two mitigation options have been assessed to determine the size of water quality controls that would be required to achieve a result with no impact on pollutant loads:

- Option 1 – Proposed water quality basin (Figure 8-9)
- Option 2 – Proposed propriety type Gross Pollutant Trap (GPT) with Cartridge Filtration (Figure 8-10)



Figure 8-9 Example of a water quality basin

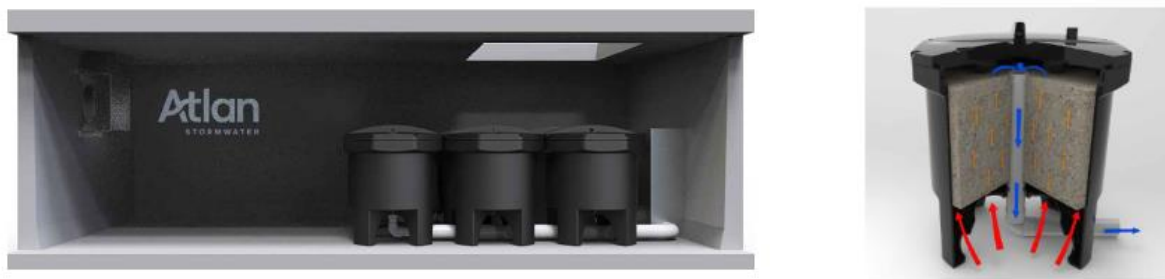


Figure 8-10 Underground gross pollutant trap concrete chamber (left) and cartridge filtration device (right)

Source: Atlan

The treatment efficiencies for the water quality basin are provided by the Music X model, and those for the GPT cartridge filtration are provided by the suppliers and were entered into the water quality model. The treatment efficiencies and percentage load reductions provided by one supplier (Stormwater Atlan) are 85% for total suspended solids, 74% for total phosphorus, and 59% for total nitrogen which are high end performance for a GPT. The results of the annual pollutant load assessment are shown in Table 8-4.

For option 1, the results indicate that the minimum size of a water quality basin would be 1,000 m² and a water volume of 1,500 m³, with a 5 m³/s high flow bypass. For option 2, the results indicate that a GPT chamber with approximately 25 cartridge filters would be required with a smaller bypass of 75 L/s due to the limitations of the filters (the maximum treatable flow rate is 3 L/s).

The model results provide a site-wide assessment of the overall controls and sizes that would be required on site but do not identify individual drainage outlet locations or sizes where these controls should be implemented.

As the design progresses, these locations will be identified, for instance the proposed first flush tank of the 90% design would be incorporated into the water quality assessment. This first flush tank, depending on where it is discharged and how large it is, would remove total suspended solids loads and some particle-bound total phosphorus but would not remove total nitrogen loads. The total nitrogen removal would still require the proposed controls in Table 8-4 (Options 1 and 2).

Table 8-4 Annual pollutant loads for two options to mitigate increases

Pollutant	Option 1		Option 2	
	Proposed water quality basin (kg/year)	Percentage load reduction from existing conditions	GPT cartridge filter (kg/year)	Percentage load reduction from existing conditions
Total suspended solids	16,550	-25%	16,060	-27%
Total phosphorus	32.1	-15%	27.7	-27%
Total nitrogen	283	-1%	231	-19%

8.2.2.3 Conclusion

The proposed works on site will increase the impervious areas that discharge surface runoff to Breakfast Creek. Consequently, there would be an increase in annual average pollutant loads to the creek from the works. To mitigate against detrimental impacts associated with these increases, it is recommended that option1 (water quality basin) be adopted. Further work is required to identify all the drainage outlets on site and their catchment areas so that space availability or space limitations are identified. Water quality basins may not be required at all the outlets as the proposed treatment for the larger catchments would compensate for smaller catchments.

9. Mitigation measures

Environmental mitigation measures would form an integral part of construction activities and project operation. This section provides an overview of the identified measures to minimise potential impacts to surface water quality and aquatic ecology from the construction and operation of the project.

9.1 Management and mitigation measures

The mitigation measures detailed in Table 9-1 have been developed to specifically manage potential surface water quality and aquatic ecology impacts which have been predicted during construction and operation of the project.

Table 9-1 Proposed surface water quality and aquatic ecology management and mitigation measures

Reference	Impact	Management measure	Timing
SW01	General water quality	A Construction Soil and Water Management Plan (CSWMP) would be prepared as a sub-plan of the Project's Construction Environmental Management Plan (CEMP). The plan will outline measures to manage soil and water impacts associated with the construction and commissioning works. The SWMP will include but not be limited to: - Measures to minimise/manage erosion and sediment transport within the construction footprint and office. - Measures to manage stockpiles including location, sediment controls and stabilisation and detailed in a Stockpile management plan. - Measures to manage accidental spills in accordance with the Australian Spill Control Industry Standard for Spill Response Kits (ASCIC 2695) (AusSpill 2018) and maintain material such as spill kits. - Details of surface water quality monitoring to be undertaken before, during and after construction. - Measures to manage water (including dewatering of trenches), groundwater ingress into vertical shafts and tunnels, drilling fluids, grout and cement-contaminated water from construction, including water collection protocols, water quality standards to be achieved for various reuse (e.g. dust suppression) purposes, and transportation to disposal facilities. Alternatively, the Construction Contractor would be required to obtain and comply with an EPL and any other approvals to discharge treated water into a downstream receiving environment such as Breakfast Creek or Blacktown Creek. - Measures to manage discharge/collection of water during commissioning, including outlining water collection protocols and transportation to disposal facility or discharge to downstream waterway.	Detailed design Prior to construction Construction

Reference	Impact	Management measure	Timing
SW02	Erosion and sedimentation	A Construction Erosion and Sediment Control Plan would be developed as a sub-plan of the SWMP and would detail the erosion and sediment control measures to be implemented at all works sites in accordance with the principles and requirements in <i>Managing Urban Stormwater – Soils and Construction Volume 1</i> (Landcom 2004) and <i>Volume 2D</i> (NSW Department of Environment Climate Change and Water 2008), commonly referred to as the 'Blue Book'. The ESCP would include but not be limited to: - Plans for temporary drainage, scour protection and control measures to reduce erosion and water quality impacts from increased sediment loads from construction and ancillary sites. These water quality controls will likely consist of sediment fencing and sediment basins. The Construction Erosion and Sediment Control Plan would identify locations of proposed construction sediment basins. - The location of construction sediment basins, sediment fences, diversion drains, etc. - Truck loads to be adequately covered when transporting loose material (i.e. spoil). - Dust suppression, spoil rehabilitation/emplacement to ensure no sedimentation or air quality impacts.	Prior to construction During construction
SW03	Spills and leakages	Site-specific controls and procedures would be developed and implemented as part of the CSWMP to reduce the risk of the release of potentially harmful chemicals from spills entering downstream watercourse. The CSWMP would include the following measures: - Storage of chemicals, fuels and oils in bunded areas onsite. - Functioning spill kits will be kept on site for clean-up of accidental chemicals/fuels spills. Spill kits will be stocked and located for easy access and all site personnel will be appropriately trained in the use of spill response equipment. - A spill response procedure will be prepared in accordance with the Australian Spill Control Industry Standard for Spill Response Kits (ASCIS 2695). - Refuelling of vehicles and plant and equipment maintenance will be limited to designated areas with established spill capture and management controls and documented in a refuelling procedure.	Prior to construction During construction
SW04	Impacts of stockpiles	Include a Stockpile Management Plan as part of the SWMP to adequately manage any proposed temporary and permanent stockpiles. This will include detail on: Exact location of stockpiles including locating stockpiles and equipment storage areas away from drainage pathways and flood prone area and, where possible, in elevated positions or at alternative sites.	Prior to construction During construction

Reference	Impact	Management measure	Timing
		- Keep stockpiles to a minimum and ensure adequate contingency measures are in place to prevent sedimentation of waterways in the event of a large flood event. The height slopes and batters of the stockpiles should be documented together with the propped erosion and sediment controls. - Minimise stockpile size and ensure delineation between different stockpiled material to prevent mixing and cross contamination. - Consideration for future maintenance and restoration of stockpiles. - Inspecting controls at least weekly and immediately after rainfall, rectifying damaged controls and removing controls once surfaces have been stabilised, including removing trapped sediment in drainage lines.	
SW05	Water quality	The location and details of all water quality controls (including but not limited to temporary sediment basins) would be further considered during pre-construction and may be updated by the construction contractor to suit detailed design changes. Diversion drains and erosion and sediment control measures recommended include but not limited to: - Three temporary drainage lines to construction sediment basins at the WRRF. - Sediment fences and diversion drains located as per Figure 8-1.	Prior to construction During construction
SW06	Concrete works	To avoid ingress of concrete waste material into downstream waterways, the CEMP would outline procedures to capture, contain, and appropriately dispose of any concrete waste for concrete works associated with the establishment of slabs for pumps, tanks and other structures.	Prior to construction During construction
SW07	Construction discharges	Prior to disposal of construction water collected in sediment basins, water should be treated to the appropriate standard specified in the CSWMP and repurposed on site wherever possible. Water that cannot be repurposed on site will require the Construction Contractor to seek approval and discharge criteria from the relevant Sydney Water Network Area Manager prior to discharge of water to the wastewater system. Otherwise, tanker construction discharges by a licenced waste contractor and disposed off-site to an appropriately licenced facility.	During construction
SW08	Tunnelling under waterways reduce bank stability and causes erosion and sedimentation	Locate the retrieval shaft back from the channel, beyond the top of bank to allow containment of any sediment or other substances above top of bank. Restore entry and exit points to pre-construction conditions.	Detailed design Construction
SW09	Trenching	Store materials excavated from the trench above the top of bank until the materials can be backfilled into the trench.	Construction

Reference	Impact	Management measure	Timing
SW10	Drilling fluid entering downstream surface waters	Prepare a Drilling Fluid Management Plan, including measures to: - Contain and monitor drilling fluids at enter/exit points - Re-use and/or dispose of drilling fluids.	Prior to construction During construction
SW11	Water quality monitoring – construction	A Construction Surface Water Monitoring Program would be developed and included in the CEMP to establish baseline conditions, to observe any changes in surface water quality and condition in watercourses that have the potential to be directly impacted during construction of the proposal and inform appropriate management responses. As a minimum, Breakfast Creek and Eastern Creek would continue to be monitored (NS090, NS087, NS085, NS094, NS0861). An additional site in Blacktown Creek is recommended in closer proximity to construction works associated with the brine pipeline. Should the results of monitoring identify that the water quality management measures are not effective in adequately mitigating water quality impacts, works would stop until suitable additional mitigation measures are identified and implemented, as required.	Prior to construction During construction
AQ01	Aquatic ecology – riparian vegetation removal	Rehabilitation of disturbed areas of riparian vegetation will be undertaken as soon as practical, progressively and in accordance with the rehabilitation strategy. Rehabilitation of removed riparian vegetation will involve replacing topsoil and re-planting native trees and plants.	Construction

10. Summary and recommendations

The present water quality and aquatic ecology assessment for the construction and operation of the project has been informed by preliminary project design information and a review and analysis of the available monitoring data and applicable legislation, policies and guidelines, database searches of aerial photography and topography, and a site visit.

The desktop review and site visit identified waterways and SREs within the study area. Waterways potentially impacted by project activities include Breakfast Creek, Eastern Creek (assessed to be an SRE), and Blacktown Creek. Existing water quality and aquatic habitat data were obtained and reviewed for these waterways and an aquatic habitat field assessment was completed for Breakfast Creek.

Analysis of existing water quality data included comparison of key water quality indicators against relevant water quality guidelines (ANZG 2018, DPE 2022, Tippler et al. 2013). Water quality indicators analysed included turbidity, total suspended solids, dissolved oxygen, pH, temperature, nutrients, and metals. The analysis found that the water quality of Breakfast Creek is poor and not suitable for protection of nominated environmental values. Water quality is generally poorer downstream of the Quakers Hill WRRF indicating that the current discharge of treated wastewater influences the water quality in this stretch of Breakfast Creek. Total and oxidised nitrogen and water temperature were the key indicators which were notably elevated in concentration at downstream sites compared to upstream. Blacktown Creek has been monitored at one location and data also indicate that water quality in this watercourse is poor and does not meet the recommended guidelines for protection of aquatic ecosystems, predominantly due to elevated nutrient concentrations.

The consistent discharge from the Quakers Hill WRRF also maintains a very constant flow downstream of the Quakers Hill WRRF, with little variability in daily discharge except for wet weather events. By comparison, upstream of the Quakers Hill WRRF, Breakfast Creek experiences low flow and cease-to-flow events. Aquatic habitat in Breakfast Creek was found to be severely to moderately disturbed upstream of the Quakers Hill WRRF, with heavily silted stream bottoms, abundant invasive plants, and few instream habitat features such as boulder complexes and woody debris. The creek was dry or nearly dry downstream of two complete flow obstructions. Downstream of the Quakers Hill WRRF, where Breakfast Creek is influenced by effluent discharge, the habitat was of higher quality, although still disturbed. Although pool/riffle sequences, woody debris, and boulders were more common and the creek bottom much less silted, habitat quality is still reduced by frequent breaks in stabilising bank vegetation and invasive species. Desktop reviews of publicly available databases have found no records of threatened species in either Breakfast Creek, Eastern Creek, or Blacktown Creek. Arup (2025) modelling shows that nutrient loads will be reduced during baseline (dry weather) conditions due to upgraded water treatment facilities. This will result improved health and resilience of aquatic ecosystems by minimising pollution, supporting biodiversity and enhancing overall ecological balance.

Table 10-1 Summary of risks to water quality and aquatic ecology associated with project construction and operation summarises risks to water quality and aquatic ecology associated with project construction and operation. Construction of the project will include several activities which have the potential to impact on the water quality and aquatic ecology of Breakfast Creek, Eastern Creek, and Blacktown Creek. These activities include earthworks, roadworks, vegetation clearing, concrete works, establishment of construction compounds, stockpiling, trenching and horizontal directional drilling for pipeline installation and associated dewatering, and testing and commissioning. Risks to water quality and aquatic ecology from these construction-related activities have been scored as 'Medium', except for concrete and commissioning works which have been scored as presenting 'Low' risk (Table 10-1). These activities are associated with the following potential impacts (if no mitigation measures were implemented):

- Erosion and sedimentation of waterways.
- Reduced water quality from elevated turbidity, increased nutrients and other contaminants.

- Smothering of aquatic organisms from increased sediments and associated low dissolved oxygen levels.
- Potential increased occurrence of algal blooms associated with reduced water quality.
- Contamination from accidental leaks or spills of chemicals and fuels.

These potential impacts would be managed through implementation of erosion and sediment controls and other identified management measures based on five principles: controlling the occurrence of erosion; controlling the movement of sediment; diverting off-site “clean” water away from construction areas; diverting onsite “dirty” water towards a sediment basin; and capturing sediments that are transported through diversion drains in adequately sized sediment basins.

A suite of mitigation measures is recommended to reduce the risk of identified impacts on surface water quality and aquatic ecology. During construction, these measures would be outlined in a CSWMP and should include but not be limited to:

- Measures to minimise/manage erosion and sediment transport within the disturbance areas including development and implementation of erosion and sediment control strategy.
- Measures to manage spoil and stockpiles.
- Measures to manage accidental spills.
- Measures to treat water collected in sediment basins for reuse on site or discharge to downstream waters.
- Implementation of a water quality monitoring program.

Operation of the upgraded Quakers Hill WRRF will include operation of the secondary wastewater treatment plant and AWTP, operation of the brine pipeline and transfer of brine to the NSOOS. Potential impacts to surface water quality and aquatic ecology would be associated with the release of treated and tertiary treated wastewater from the Quakers Hill AWTP, transfer and discharge of brine and release of water through leaks and maintenance. Risks to water quality and aquatic ecology associated with these activities have been scored as ‘Low’ (Table 10-1).

With the operation of the Quakers Hill AWTP, the quality of discharge to Breakfast Creek under ADWF is expected to improve, and the volume slightly decrease. Modelled concentrations of indicators would meet recommended guideline and EPL limits except for aluminium and chromium which would exceed the ANZG (2018) toxicant guidelines for protection of aquatic species. During significant wet weather events, concentrations of some indicators would increase to exceed recommended limits. Operation of the brine pipeline under normal operating conditions would not impact on downstream water quality and aquatic ecology. However, maintenance work or unexpected breakdowns could potentially affect water quality of the downstream receiving environment through scouring at outlet or discharge of brine to waterways. With the implementation of scour protection measures and capturing and transporting any water off-site impacts to surface water quality and aquatic ecology are unlikely.

During operation, controls would be outlined in the Operational Management Plan which should include:

- Procedures and protocols for maintaining scour protection at the outlets and ongoing rehabilitation of disturbed areas.
- Measures to control risks of water leakage from pipelines.
- Operational surface water quality monitoring (established during initial testing and commissioning) to verify if impacts are acceptable. Standard wastewater discharge and receiving environment monitoring is undertaken by Sydney Water to determine general trends in water quality over time, monitor treatment and discharge performance, and determine the contribution of the Quakers Hill WRRF discharge to water quality and human health of Breakfast Creek and Blacktown Creek, as detailed in the *Sewage Treatment System Impact Monitoring Program* developed with and endorsed by the EPA (Sydney Water 2023).
- Monitoring at scour valve discharge locations when water is released for maintenance.

The planned upgrades to the Quakers Hill WRRF together with other WRRFs in the Sackville 2 sub-zone will result in substantial reduction in nutrient loads which will directly benefit the water quality of Breakfast Creek and Eastern Creek by reducing pollution, supporting ecological health and ensuring compliance with future EPL nutrient limits.

Overall, based on the review of the existing environment and review of project design information and on the assumption that recommended mitigation measures are implemented, the assessment concludes that impacts to surface water quality and aquatic ecology of Breakfast Creek and Blacktown Creek from project construction are low to medium while project operation presents a low risk to the environmental values of these waterways (localised impact that is temporary, short-term and effectively mitigated through standard environmental safeguards). The upgrade of the WRRF and subsequent increase in impervious surfaces would result in a small increase in stormwater contaminant loads from current condition (6% for total phosphorus; 7% for total nitrogen; 11% for total suspended solids). To mitigate against the increase in pollutant loads, permanent water quality controls are proposed such as a water quality basin which would reduce total suspended solids, total phosphorus and total nitrogen loads by 25%, 15% and 1%, respectively, from existing conditions. The operation of the upgraded Quakers Hill WRRF is expected to produce water quality consistent with maintaining compliance with the applicable water quality guidelines and EPL limits, it is considered that the project would allow Sydney Water to meet the limits set by the current EPL.

Table 10-1 Summary of risks to water quality and aquatic ecology associated with project construction and operation

Type of risk	Source of risk	Risk consequence	Risk consequence description	Risk likelihood	Overall risk rating	Applicable controls
Project construction						
Earthworks	Soil disturbance and exposure from excavation and earthworks. Clearing and preparing sites for works	Moderate	Increased erosion and sedimentation, increased turbidity, reduced water clarity, smothering of aquatic organisms in waterways	Unlikely	Medium	Runoff would be managed and diverted within the implementation of site erosion and sediment controls and water quality control measures outlined in Section 8 and other mitigation measures outlined in Section 9
Roadworks	Extension of the existing internal road network within the Quakers Hill WRRF site to encompass the AWTP	Moderate	Increased erosion and sedimentation, increased turbidity, reduced water clarity, smothering of aquatic organisms in waterways	Unlikely	Medium	Site erosion and sediment controls and water quality control measures
Vegetation removal	Clearing and trimming exposing soils to weathering processes and increasing risk of erosion and sedimentation	Moderate	Increased erosion, tannin leachate affecting water quality	Unlikely	Medium	Minimise vegetation removal, implement erosion controls, revegetation
Concrete works	Concrete pouring during construction of base slabs for pumps, tanks, and other structures	Minor	Increased alkalinity and pH, possible metal contamination causing toxicity to aquatic organisms	Rare. No concreting would occur near waterways nor within the riparian zone	Low	Proper disposal of concrete waste, washout water management
Construction compounds and material laydown	Temporary buildings, stocking and storage of equipment	Moderate	Sediment-laden runoff, accidental leaks or spills, rubbish and debris being transported downstream	Unlikely	Medium	Site erosion and sediment controls and water quality control measures

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Type of risk	Source of risk	Risk consequence	Risk consequence description	Risk likelihood	Overall risk rating	Applicable controls
Spoil stockpiling and emplacement	Stockpiled material will be reused (if suitable) in the refurbishment of the IDALs	Moderate	Unstabilised stockpiles may lead to material eroding away during windy conditions or high rainfall events, releasing contaminants to downstream waterways	Unlikely	Medium	Stockpile management measures as per Construction Soil and Water Management Plan (CSWMP)
Trenching	Installation of pipes, trenching	Moderate	Sediment mobilisation, increased turbidity	Unlikely	Medium	Progressive rehabilitation, erosion and sediment controls
Horizontal directional drilling	Launch and retrieval pits and drilling of an underground bore for installation of the PRW pipeline	Moderate	Accidental discharge or leakage during construction may contain drilling fluids. Hydrocarbons, oil and grease, hydraulic fluids, zinc, and other hazardous chemicals can result in oily films on surface waters	Unlikely	Medium	Water quality control measures to address HDD-related impacts as per CEMP
Dewatering	Tunnel process water mixed with collected groundwater from construction of trenches, shafts, and tunnels	Moderate	Increased suspended solids, acid rock drainage and hydrocarbons, and metal contamination associated with groundwater	Unlikely	Medium	Water quality control measures to address dewatering-related impacts as per CEMP
Commissioning works	Water from initial testing and commissioning of the brine pipeline	Minor	Wastewater generation, potential contamination	Unlikely	Low	Capture and treat commissioning water, compliance with discharge standards
Project operation						
Wastewater treatment	Following treatment, the wastewater will be discharged to Breakfast Creek, with a small proportion of flows being transferred to St Marys WRRF, transferred to NSOOS (with brine), and transferred to Stonecutters Ridge Golf Course (as recycled water, during dry weather only)	Minor	Wastewater entering the Quakers Hill WRRF will receive higher level of treatment with the operation of the AWTP compared to that in the existing plant. Concentrations of most indicators have lower concentrations compared to existing treatment and are anticipated to be below the recommended guideline and median background concentrations	Rare	Low	Water quality monitoring to maintain quality consistent with maintaining compliance with the EPL limits ^[a] . Sydney Water's standard management and operational controls

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Type of risk	Source of risk	Risk consequence	Risk consequence description	Risk likelihood	Overall risk rating	Applicable controls
Brine pipeline	Initial testing and commissioning, maintenance work or unexpected breakdowns	Minor	Breakdowns could potentially affect water quality of the downstream receiving environment	Rare	Low	Sydney Water's standard management and operational controls

^[a] Wastewater discharge and receiving environment monitoring requirements are outlined in the Sydney Water Aquatic Monitoring (SWAM) Program report (Sydney Water 2023).

Likelihood scale:

Level	Likelihood	Description
1	Rare	Will only occur in exceptional circumstances
2	Unlikely	Could occur but not expected
3	Possible	Could occur at some time
4	Likely	Will probably occur in most circumstances
5	Almost certain	Expected to occur in most circumstances

Consequence scale:

Level	Consequence	Description
1	Insignificant	Insignificant impacts on water quality and/or aquatic ecology
2	Minor	Minor impacts on water quality and/or aquatic ecology
3	Moderate	Clearly visible impacts on water quality and/or aquatic ecology
4	Major	Major impacts on water quality and/or aquatic ecology. Require remediation.
5	Catastrophic/extreme	Widespread and irreversible impacts on water quality and/or ecological communities

Risk rating matrix:

	Consequence				
Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	High	High	Extreme	Extreme	Extreme
Likely	Medium	High	High	Extreme	Extreme
Possible	Low	Medium	High	High	Extreme
Unlikely	Low	Low	Medium	High	Extreme
Rare	low	Low	Medium	High	Extreme

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Appendix A. Example of Riparian, Channel, and Environmental scoresheet

Sydney Water – Breakfast Creek water quality and aquatic ecology field sheets

Jacobs

Riparian Channel Environment Datasheet (Chessman *et al.*, 1997)

Site:

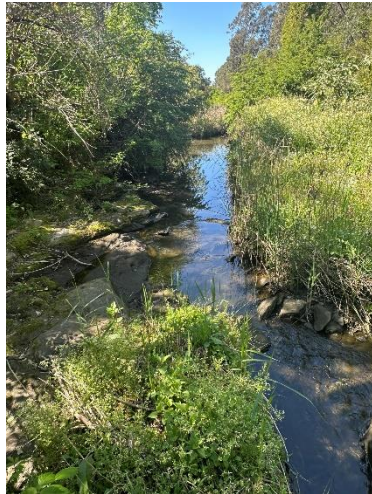
Date

Description and Category	Value	Description and Category	Value
1 Land use pattern beyond the immediate riparian zone	8	Riffle / pool sequence	
Undisturbed native vegetation	4	Frequent alternation of riffle and pools	4
Mixed native vegetation and pasture/exotics	3	Longpools with infrequent short riffles	3
Mainly pasture, crops or pine plantation	2	Natural channel without riffle / pool sequence	2
Urban	1	Artificial channel; no riffle / pool sequence	1
2 Width of riparian strip of woody vegetation	9	Retention devices in stream	
More than 30 m	4	Many large boulders and/or debris dams	4
Between 5 and 30 m	3	Rocks / logs present; limited damming effect	3
Less than 5 m	2	Rocks / logs present, but unstable, no damming	2
No woody vegetation	1	Stream with few or no rocks / logs	1
3 Completeness of riparian strip of woody vegetation	10	Channel sediment accumulations	
Riparian strip without breaks in vegetation	4	Little or no accumulation of loose sediments	4
Breaks at intervals of more than 50 m	3	Some gravel bars but little sand or silt	3
Breaks at intervals of 10 - 50 m	2	Bars of sand and silt common	2
Breaks at intervals of less than 10 m	1	Braiding by loose sediment	1
4 Vegetation of riparian zone within 10 m of channel	11	Stream bottom	
Native tree and shrub species	4	Mainly clean stones with obvious interstices	4
Mixed native and exotic trees and shrubs	3	Mainly stones with some cover of algae / silt	3
Exotic trees and shrubs	2	Bottom heavily silted but stable	2
Exotic grasses / weeds only	1	Bottom mainly loose and mobile sediment	1
5 Stream bank structure	12	Stream detritus	
Banks fully stabilised by trees, shrubs etc	4	Mainly unsilted wood, bark, leaves	4
Banks firm but held mainly by grass and herbs	3	Some wood, leave etc. with much fine detritus	3
Banks loose, partly held by sparse grass etc	2	Mainly fine detritus mixed with sediment	2
Banks unstable, mainly loose sand or soil	1	Little or no organic detritus	1
6 Bank undercutting	13	Aquatic vegetation	
None, or restricted by tree roots	4	Little or no macrophyte or algal growth	4
Only on curves and constrictions	3	Substantial algal growth; few macrophytes	3
Frequent along all parts of stream	2	Substantial macrophyte growth; little algae	2
Severe, bank collapses common	1	Substantial macrophyte and algal growth	1
7 Channel form			
Deep: width / depth ratio less than 7:1	4		
Medium: width / depth ratio 8:1 to 15:1	3		
Shallow: width / depth ratio greater than 15:1	2		
Artificial: concrete or excavated channel	1		

Total Score:

Appendix B. Aquatic habitat site photos and field observations

Table B-1 Site assessment results

Site reach and sites	Site photographs			Description
Breakfast Creek – Storm drain to Falmouth Rd (Sites B1 to B8)				Eight sites (B1–B8) were visited within this stretch of Breakfast Creek. The creek appears to be in moderate ecological health with healthy riparian vegetation and relatively clear water, although invasive weeds were present. Breakfast Creek has both natural banks and sections passing under manmade structures such as bridges and culverts (B8). These structures impact on both habitat connectivity and flow. Generally, the banks are well vegetated with dense grasses, reeds and shrubs (B2, B5). Both submerged and emergent vegetation was visible in sections of the creek (B6, B8). Aquatic habitat complexity varied throughout the reach and included woody debris, overhanging branches and a variety of plant types (B3, B5). There was evidence of algae and dense growth of aquatic plants which indicates that nutrient enrichment may be an issue. Additionally, the creek appears impacted by stormwater with rubbish and debris accumulating in sections (B5, B3).
	B2	B5		
				
	B3	B5	B6	

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Site reach and sites	Site photographs			Description
				
	B6	B8	B8	
Breakfast Creek Falmouth Road to large storm drain canal (Sites B9 – B15)				Seven sites (B9–B15) were visited in this stretch of Breakfast Creek between Falmouth Road to large storm drain canal (refer Figure 4- 17). Breakfast Creek in this reach exhibits a mix of natural and impacted conditions. Flow at the time was low and obstructed in some sections by an unculverted concrete crossing (B9) and build-up of sediment and rubbish (B10, B11). Several sites along the creek show evidence of bank erosion with exposed soil and undercut banks, likely a result of altered flow conditions and limited bank stabilising vegetation (B9, B12).
	B9	B9		

Surface Water Quality and Aquatic Ecology Assessment

Site reach and sites	Site photographs	Description
		Water clarity varied throughout the reach, with some sections exhibiting relatively clear water (B14) and others were murky (B9) likely due to creek/sediment substrate and organic matter. The creek is impacted by high flow events which wash rubbish and debris into the waterway (B10). Overall, the creek in this reach exhibits a combination of semi-natural to degraded sections with limited riparian vegetation.
		
		
		

Surface Water Quality and Aquatic Ecology Assessment

Site reach and sites	Site photographs		Description
Breakfast Creek Storm drain to Water Resource Recovery Facility (Sites B16- B19)			Four sites (B9–B15) were visited in this stretch of Breakfast Creek between the large storm drain canal to just upstream of the WRRF discharge. The creek in this reach exhibited shallow banks, with very low flow and sections of stagnant water. The banks of the creek generally have significant growth of grasses and vegetation, with limited evidence of erosion. The presence of both open water and vegetated margins (B17) increases the habitat complexity and is likely able to support a community of invertebrates and small fish. Flow is variable due to the unculverted concrete crossing (B16) and overgrown vegetation within the creek bed which can impede flow (B16) and would provide a barrier to fish passage outside of flood conditions. The creek bed comprises of sediment and gravel with some debris, an indication of the variable flow conditions experienced by this creek. Water clarity was generally poor with murky conditions observed likely due to stagnant water (B19).
	B16	B16	
			
	B16	B17	

Surface Water Quality and Aquatic Ecology Assessment

Site reach and sites	Site photographs	Description
	 B19	
Breakfast Creek WRRF to Quakers Hill Parkway (Sites B20 – B24)	 B20  B20	Five sites (B20–B24) were visited between the WRRF and Quakers Hill Parkway. This section of the creek exhibits a relatively natural riparian zone comprising of grasses shrubs and trees. Due to the vegetated banks, there was limited evidence of erosion (B20, B23). Flow in this reach significantly increases just downstream of the discharge point from the WRRF (B21). Despite the increased flow there were section of the creek where water appears shallow or stagnant, likely due to the dense aquatic stands of aquatic macrophytes impeding flow in sections (B23).

Site reach and sites	Site photographs		Description
			There are also sections of submerged aquatic plants, this together with emergent aquatic vegetation indicates eutrophication and nutrient enrichment of the creek (B23, B24). The presence of both submerged and emergent aquatic macrophytes would provide habitat for aquatic species. Additionally, the mix of open water, vegetated banks and rocky features would provide microhabitats for fish and macroinvertebrates. In this section of the creek there was limited evidence of rubbish aside from a shopping trolley and water appeared relatively clear (B22). The creek was flowing under the Quakers Hill Parkway, although water was shallow, and bed substrate comprised of fine silty sediment with small boulders (B24).
	B21	B22	
			
	B23	B24	

Surface Water Quality and Aquatic Ecology Assessment

Site reach and sites	Site photographs	Description
	 B24	
Breakfast Creek M7 to Eastern Creek confluence (Sites B25 – B36	 B25  B27	Twelve sites (B25–B36) were visited in Breakfast Creek between the M7 motorway and the confluence with Breakfast Creek. The creek in this reach appeared to be in fair to good ecological condition with diverse aquatic habitats, a mostly natural channel with healthy riparian vegetation. The creek provides a variety of aquatic habitats including shallow riffles, deeper pools and overhanging vegetation and woody debris (B25, B27). In this reach of the creek there was less evidence of emergent or submerged aquatic macrophytes which were only observed at B31, B32 and B34.

Surface Water Quality and Aquatic Ecology Assessment

Site reach and sites	Site photographs	Description
		The water clarity was generally good, particularly in areas of rocky substrate (B27), but where sediment was the dominant substrate water appeared slightly murky.
		
		
		

Site reach and sites	Site photographs		Description
Eastern Creek Confluence with Breakfast Creek to Stonecutters Ridge Golf Club (Sites E1 – E8)			Eight sites (E1–E8) were visited in Eastern Creek from just upstream of the confluence with Breakfast Creek to Stonecutters Ridge Golf Course. Site E1 was located upstream of the confluence and all other sites were located downstream. Eastern Creek varied between flowing to stagnant with large slow flowing pools where the invasive fish species Carp were observed (E2). Flow upstream of the confluence (E1) was lower than downstream, E1 also showed evidence of erosion and exposed banks. Aquatic habitat comprised of submerged and emergent woody debris, which can offer shelter and breeding grounds for fish and macroinvertebrates. Submerged aquatic plants were also observed (E3). Good riparian vegetation including Swamp She-oak was observed along the length of the creek. Water clarity varied along the creek with a greenish tint observed at some sites suggesting the presence of algae (E6).
	E1	E2	
			
	E3	E4	

Surface Water Quality and Aquatic Ecology Assessment

Site reach and sites	Site photographs	Description
	 	

E6

E7

Appendix C. Method for determining the size of sediment basins

Design of Sediment Basins (construction phase) - Summary output					JACOBS®	
Job Description:		QH WRRF				
Project data						
Sediment Basin No:		SB1 for AWTP area				
Receiving downstream waterway :		Breakfast Ck				
Sensitive receiving waterway? (Y/N)		Y				
Sedimentation basin dimensions						
Basin Volume (at water line) :		507 m3				
Basin Surface Area (at water line):		420 m2				
Length at water line: (see note below)		35 m			L=	38.0
Width at water line: (see note below)		12 m			W=	15.0
Max water depth:		2 m			Overall approx footprint assumed	
Basin Side slopes:		2 :1 side slopes H:V			42.0 m	
Length to width ratio of basin at water line		2.9 to 1 (L:W)			19.0 m	
Note: Length and width dimensions have been estimated to provide a guide for the 12d modelling only						
Site specific input parameters						
Total catchment area		2.2 ha				
Disturbed Area:		2.2 ha				
Percentage of total area as batters		0.11 ha or 5% of total area				
Soil Type:		D				
5 Day rainfall depth		32.2 mm			85th 'ile, for sensitive receiving environment	
Rainfall Zone (Closest to site)		0				
2 year ARI, 6 hour rainfall intensity		9.7 mm/hr				
Rainfall Erosivity (R)		2096			Derived from the rainfall intensity data	
Volumetric runoff coefficient (Cv)		0.64			for 5 Day rainfall depth	
Soil Hydrologic Group		D			High runoff potential	
Soil Erodibility (K)		0.05			High	
Sediment Yield Time Period:		4 months				
Main disturbed area gradient:		3%				
Embankment gradient:		50%			1 in 2 V:H	

Design of Sediment Basins (construction phase) - Summary output				JACOBS®	
Job Description:		QH WRRF			
Project data		SB2 for clean stockpile area			
Sediment Basin No:		Breakfast Ck			
Receiving downstream waterway :		Y			
Sensitive receiving waterway? (Y/N)					
Sedimentation basin dimensions					
Basin Volume (at water line) :		475 m3			
Basin Surface Area (at water line):		396 m2		With FB Overall approx footprint assumed	
Length at water line: (see note below)		33 m		L= 36.0 40.0 m	
Width at water line: (see note below)		12 m		W= 15.0 19.0 m	
Max water depth:		2 m			
Basin Side slopes:		2 :1 side slopes H:V			
Length to width ratio of basin at water line		2.8 to 1 (L:W)			
Note: Length and width dimensions have been estimated to provide a guide for the 12d modelling only					
Site specific input parameters					
Total catchment area		1.5 ha			
Disturbed Area:		1.5 ha			
Percentage of total area as batters		0.075 ha or 5% of total area			
Soil Type:		D			
5 Day rainfall depth		32.2 mm		85th 'ile, for sensitive receiving environment	
Rainfall Zone (Closest to site)		0			
2 year ARI, 6 hour rainfall intensity		9.7 mm/hr			
Rainfall Erosivity (R)		2096		Derived from the rainfall intensity data	
Volumetric runoff coefficient (Cv)		0.64		for 5 Day rainfall depth	
Soil Hydrologic Group		D		High runoff potential	
Soil Erodibility (K)		0.05		High	
Sediment Yield Time Period:		4 months			
Main disturbed area gradient:		10%			
Embankment gradient:		50%		1 in 2 V:H	

Design of Sediment Basins (construction phase) - Summary output			
Job Description:	QH WRRF	JACOBS®	
Project data			
Sediment Basin No:	SB3 for Secondary treatment area		
Receiving downstream waterway :	Breakfast Ck		
Sensitive receiving waterway? (Y/N)	Y		
Sedimentation basin dimensions			
Basin Volume (at water line) :	323 m3		
Basin Surface Area (at water line):	300 m2	With FB	Overall approx footprint assumed
Length at water line: (see note below)	30 m	L=	33.0 37.0 m
Width at water line: (see note below)	10 m	W=	13.0 17.0 m
Max water depth:	2 m		
Basin Side slopes:	2 :1 side slopes H:V		
Length to width ratio of basin at water line	3.0 to 1 (L:W)		
Note: Length and width dimensions have been estimated to provide a guide for the 12d modelling only			
Site specific input parameters			
Total catchment area	1.4 ha		
Disturbed Area:	1.4 ha		
Percentage of total area as batters	0.07 ha or 5% of total area		
Soil Type:	D		
5 Day rainfall depth	32.2	mm	85th 'ile, for sensitive receiving environment
Rainfall Zone (Closest to site)	0		
2 year ARI, 6 hour rainfall intensity	9.7	mm/hr	
Rainfall Erosivity (R)	2096	Derived from the rainfall intensity data	
Volumetric runoff coefficient (Cv)	0.64	for 5 Day rainfall depth	
Soil Hydrologic Group	D	High runoff potential	
Soil Erodibility (K)	0.05	High	
Sediment Yield Time Period:	4 months		
Main disturbed area gradient:	3%		
Embankment gradient:	50%	1 in 2 V:H	

Appendix D. Rainfall data used in water quality modelling of pollutant loads

Design Rainfall Data System (2016)

[Conditions of Use](#) | [Help](#) | [New IFD feedback](#)

New Search >

Analysis - Multiple Points

Design Rainfalls

☐ Very Frequent

☒ IFDs (Frequent and Infrequent)

☐ Rare

Standard Durations

☐ 1 - 45 minutes

☒ 1 - 18 hours

☐ 24 - 168 hours

- Non-Standard Durations

Duration: minutes

+ Observed Rainfalls

Other Options

☐ Coefficients

☐ Seasonality

Current Values

Download all CSV (.zip)

Download all PNG (.zip)

Location

Label: Not provided

Latitude: -33.7357 [Nearest grid cell: 33.7375 (S)]

Longitude: 150.876 [Nearest grid cell: 150.8875 (E)]

IFD Design Rainfall Intensity (mm/h)

Issued: 22 March 2025

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
[FAQ for New ARR probability terminology](#)

Table

Chart

Unit:

Duration	Annual Exceedance Probability (AEP)						
	63.2%	50%#	20%*	10%	5%	2%	1%
1 hour	24.0	26.9	36.1	42.6	49.1	57.8	64.8
1.5 hour	18.3	20.4	27.1	31.9	36.7	43.4	48.7
2 hour	15.1	16.7	22.2	26.1	30.0	35.5	40.0
3 hour	11.5	12.8	16.9	19.9	22.9	27.2	30.7
4.5 hour	8.89	9.86	13.1	15.4	17.8	21.3	24.1
6 hour	7.43	8.25	11.0	13.0	15.2	18.2	20.6
9 hour	5.81	6.48	8.76	10.4	12.2	14.7	16.8
12 hour	4.89	5.48	7.50	9.00	10.6	12.8	14.6
18 hour	3.83	4.33	6.04	7.34	8.73	10.6	12.0

Note: 6hr 2 Yr ARI intensity is interpolated between 20% and 50% AEP as approximately 9.7 mm/hr for 39.35% AEP.

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Note:

- The 50% AEP IFD **does not** corresponds to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.
- The 20% AEP IFD **does not** corresponds to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

Australian Rainfall and Runoff terminology

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI	Uses in Engineering Design
Very frequent	12				Water sensitive urban design
	6	99.75	1.002	0.17	
	4	98.17	1.02	0.25	
	3	95.02	1.05	0.33	
	2	86.47	1.16	0.50	
Frequent	1	63.2	1.58	1.00	Stormwater/pit and pipe design
	0.69	50.00	2	1.44	
	0.5	39.35	2.54	2.00	
	0.22	20.00	5	4.48	
	0.2	18.13	5.52	5.00	

Note: 2yr ARI corresponds to 39.35% AEP.