SYDNEY METRO - WESTERN SYDNEY AIRPORT
STATION BOXES AND TUNNELLING WORKS

Sydney Metro Western Sydney Airport - NSW (Off-airport) Wastewater Discharge Impact Assessment

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

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A.01	24/03/2022	[redacted]	[redacted]	[redacted]	Issued to EPA
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Compliance

No.	Requirement	Reference
SSI 10051 Planning Approval		
E126	The CSSI must be designed and constructed so as to maintain the NSW Water Quality Objectives (NSW WQO) where they are being achieved as at the date of this approval, and contribute towards achievement of the NSW WQO over time where they are not being achieved as at the date of this approval, unless an EPL in force in respect of the CSSI contains different requirements in relation to the NSW WQO, in which case those requirements must be complied with.	Sections 7, 8, 9, 10
E128	Before undertaking any work and during maintenance or construction activities, erosion and sediment controls must be implemented and maintained to prevent water pollution consistent with Managing Urban Stormwater: Soils and Construction Vol 1 4th ed. By Landcom, 2004 (The Blue Book).	Section 7
E129	Unless an EPL is in force in respect to the CSSI and that licence specifies alternative criteria, discharges from construction wastewater treatment plants to surface waters must not exceed: (a) the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (ANZG (2018)) default guideline values for toxicants at the 95 per cent species protection level; (b) for physical and chemical stressors, the guideline values set out in Tables 3.3.2 and 3.3.3 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC/ARMCANZ); and (c) for bioaccumulative and persistent toxicants, the ANZG (2018) guidelines values at a minimum of 99 per cent species protection level. Where the ANZG (2018) does not provide a default guideline value for a particular pollutant, the approaches set out in the ANZG (2018) for deriving guideline values, using interim guideline values and/or using other lines of evidence such as international scientific literature or water quality guidelines from other countries, must be used.	Sections 8, 10
E130	If construction stage stormwater discharges are proposed, a Water Pollution Impact Assessment will be required. Any such assessment must be prepared in consultation with the EPA and be consistent with the National Water Quality Guidelines, with a level of detail commensurate with the potential water pollution risk. Note: If an EPL is required the Water Pollution Impact Assessment will be required to inform licensing consistent with section 45 of the POEO Act.	This Report

Definitions

Term	Description
CEMP	Construction Environmental Management Plan
CPBG	CPB Contractors Ghella Joint Venture
DPIE	Department of Planning, Industry and Environment
DGV	Default Guideline Values
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979
ER	Environmental Representative
Epic	Epic Environment Pty Lid
GIS	Geographic Information System
IC	Independent Certifier
ICNG	NSW Interim Construction Noise Guideline
LGA	Local Government Area
Project	Sydney Metro Western Sydney Airport
REMM	Revised Environmental Mitigation Measure
SBT Works	Station Boxes and Tunnelling Works
TBM	Tunnel boring machine
SEEC	Strategic Environmental and Engineering Consulting Pty Ltd
WSI	Western Sydney International
TRH	Total Recoverable Hydrocarbons
BTEXN	Benzene, Toluene, Ethylbenzene, Xylene, Naphthalene
PAH	Polycyclic Aromatic Hydrocarbons
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
OCP	Organochlorine Pesticides
OPP	Organophosphorus Pesticides
CoA	Conditions of Approval
WQO	Water Quality Objectives
DIA	Discharge Impact Assessment
POEO	Protection of the Environment Operations
EPA	Environment Protection Agency
NWQMS	National Water Quality Management Strategy
ANZG	Australia and New Zealand Guidelines
DLWC	Department of Land and Water Conservation
TDS	Total Dissolved Solids
VOCs	Volatile Organic Compounds
TSS	Total Suspended Solids
STV	Short Term Trigger Values

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1. Introduction

1.1. Purpose and application

This NSW (Off-airport) Wastewater Discharge Impact Assessment (DIA) describes how the CPB Contractors Ghella Joint Venture (CPBG) will minimise and manage surface and groundwater discharge impacts during the design and construction of the Station Boxes and Tunnelling (SBT) Works of the Sydney Metro Western Sydney Airport (the Project) within NSW.

This DIA has been prepared to address the requirements of the:

- Sydney Metro Construction Environmental Management Framework (CEMF)
- Environmental Impact Statement (EIS) and Revised Environmental Mitigation Measures (REMMs) from Section 7 of the Submissions Report,
- Project Planning Approval (reference SSI-10051, dated 23 July 2021)
- Contractual requirements, including the SBT Design and Construction (D&C) Deed and General and Particular Specifications
- Applicable legislation (refer Section 3).

1.2. Background

1.2.1. EIS

The Secretary's Environmental Assessment Requirements (SEARs) issued in February 2020 by the NSW Department of Planning, Industry and Environment (DPIE) and Commonwealth requirements issued on 29 January 2020 required the preparation of a hydrology, flooding and water quality assessment to support the Environmental Impact Statement (EIS) for the Project.

The EIS report including water quality chapter and technical paper was completed in the first quarter of 2021, with project approval granted by the Planning Secretary in July 2021.

The EIS technical report included an assessment of the potential water quality and flow impacts to receiving waterways as a result of construction activities. The EIS identified potential risks to waterways from the following pollutants during construction, if appropriate mitigation measures were not implemented:

- nutrients (primarily nitrogen and phosphorus) – commonly present in agricultural areas that may become mobilised from disturbance of agricultural land for construction work
- sediment from vegetation and topsoil clearing, soil excavation, movement and storage and stormwater runoff through disturbed sites
- chemicals, fuels and hydrocarbons from use, refuelling and maintenance of equipment and construction machinery
- concrete slurry and wastewater – from mobile concrete batching plants
- contaminants of concern related to previous land uses –
  - heavy metals
  - total recoverable hydrocarbons (TRH)
  - benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN)
  - polycyclic aromatic hydrocarbons (PAHs)
  - per- and poly-fluoroalkyl substances (PFAS)
  - organochlorine pesticides (OCPs), and
  - organophosphorus pesticides (OPPs)
- heavy metals such as arsenic (As), zinc (Zn), lead (Pb), copper (Cu), nickel (Ni), cadmium (Cd) and chromium (Cr) from disturbance of contamination and use and maintenance of vehicles and plants
- gross pollutants such as paper and plastic packaging and waste from material use on construction sites and general construction staff litter

The EIS also identified the potential for earthworks to impact surface water quality through:

- changes to surface water run-off, infiltration, evapotranspiration or evaporation due to clearing vegetation. This may increase run-off volumes at both the temporary and long-term time scale
- increased surface water run-off due to soil stabilisation earthworks. Soil stabilisation may result in change to the permeability of the natural soils
- increased turbidity, lowered dissolved oxygen levels and increased nutrients in water ways
- reduction in channel habitat from sediment transport and deposition.

Potential for impacts from spills and litter were also identified, including:

- machinery and equipment operation, refuelling, maintenance and wash down
- spills and failure of machinery
- concrete washout and disposal, treatment and curing
- disturbance of contaminated soils
- inadequate management of chemicals, spoil, material stockpiles and litter from construction sites
- litter generating activities from staff at office and construction areas.

Discharges from Water Treatment Plants (WTPs) were identified as a key method to reduce impacts from discharge of contaminated water into receiving waterways in the South Creek Catchment, which are understood to be highly degraded.

1.2.2. SSI 10051 Planning Approval

The Department's objectives when conditioning SSI projects are to improve environmental performance of the SSI, protect the environment (including the community) and otherwise add value to the management of impacts from the SSI. The Department's preferred approach to conditioning SSI projects is through the provision of performance or outcome-focused conditions where appropriate.

Sydney Metro Western Sydney Airport – Conditions of Approval (CoA) were signed by the Minister for Planning and Public Spaces in July 2021. The CoA included specific key issue conditions (Part E) for Water.

The specific conditions for water and reference to relevant sections of this report are provided in Table 1.

Table 1 SSI 10051 Conditions of Approval – Key Issue Conditions: Water

No.	Requirement	Reference
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E126	The CSSI must be designed and constructed so as to maintain the NSW Water Quality Objectives (NSW WQO) where they are being achieved as at the date of this approval, and contribute towards achievement of the NSW WQO over time where they are not being achieved as at the date of this approval, unless an EPL in force in respect of the CSSI contains different requirements in relation to the NSW WQO, in which case those requirements must be complied with.	Sections 7, 8, 9, 10
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No.	Requirement	Reference
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E130	If construction stage stormwater discharges are proposed, a Water Pollution Impact Assessment will be required. Any such assessment must be prepared in consultation with the EPA and be consistent with the National Water Quality Guidelines, with a level of detail commensurate with the potential water pollution risk. Note: If an EPL is required the Water Pollution Impact Assessment will be required to inform licensing consistent with section 45 of the POEO Act.	This Report
REMM WQ2	Water treatment plants would be designed to ensure that wastewater is treated to a level that is compliant with the ANZECC/ ARMCANZ (2000), ANZG (2018) and draft ANZG (2020) default guidelines for 95 per cent species protection and 99 per cent species protection level for toxicants that bioaccumulate unless other discharge criteria are agreed with relevant authorities.	Sections 8, 10

1.3. Objectives

CPBG's objectives for managing discharges of water are to ensure:

- compliance with the Project Planning Approval (SSI 10051)
- impacts on water quality are minimised through sustainable and practical approaches
- consistency with the water quality objectives (WQOs) for the potentially affected waterways

1.4. CPBG's expert consultants

This DIA has been prepared by both Strategic Environmental and Engineering Consulting Pty Ltd (SEEC) and Epic Environmental Pty Ltd (Epic).

1.4.1. SEEC

SEEC is a small consultancy specialising in soil and water management, particularly during construction. SEEC has prepared DIAs for numerous large-scale transport projects including:

- Warringah Freeway Upgrade
- M12 Motorway (Central)
- Heathcote Road Upgrade, Holsworthy
- Nelligen Bridge replacement.

SEEC's input to this DIA has been coordinated by Bill Johnson. Bill is a Certified Professional in Erosion and Sediment Control (CPESC) and a Civil Engineer with over 25 years' experience with stormwater management.

1.4.2. Epic

Epic is a specialist environmental consultancy with offices located in New South Wales and Queensland, Australia. Epic offers industry leading environmental solutions supporting socially responsible environmental management, and sustainable long term economic development. Epic provides support and solutions across a wide range of national and international projects collaborating to build better environmental solutions and outcomes.

David Harris is an Associate Hydrogeologist, Water Quality Specialist, and Contaminated Land Practitioner with over 11 years of consulting experience in engineering and environmental planning across Australia and the United Kingdom, supporting a wide range of projects including major and state significant infrastructure projects, resource development, commercial development and regional development plans.

David has significant experience in undertaking studies to support environmental planning assessments, including baseline assessments and EIS for surface water, groundwater, hydrology, and contaminated land disciplines.

David has wide ranging experience in the preparation of construction environmental management plans (CEMPs), pollution impact assessments, pollution reduction studies, groundwater and surface water monitoring plans, and risk assessments. David has prepared DIA for a range of major infrastructure projects, including:

- Westconnex New M5
- M6 Stage 1 Tunnel
- M8 Tunnel
- Sydney Gateway Road Project
- Robinsons Road Bypass

David is a committee member of the International Association of Hydrogeologists (IAH), a member of the American Geophysical Union (AGU), and a member of the Australian Institute of Geoscientists (MAIG).

1.5. Structure of this Report

This report is structured as described in Table 1.

Table 1: Structure of this report

Section	Contents
1	Introduction
2	Project description
3	Regulatory framework and relevant guidelines
4	Existing environmental conditions
5	Environmental values of the receiving waterways
6	Description of local water quality
7	CPBG's proposed management measures for water quality and discharge
8	Impact assessment

Section	Contents
9	Adaptive management
10	Proposed EPL discharge criteria
11	Continual improvement
12	Summary and conclusion

2. Project scope

2.1.1. Project overview

The Project forms part of the broader Sydney Metro network. It involves the construction and operation of a 23km new metro rail line that extends from the existing Sydney Trains suburban T1 Western Line (at St Marys) in the north and the Aerotropolis (at Bringelly) in the south. The alignment includes a combination of tunnels and civil structures, including viaduct, bridges, surface and open-cut troughs between the two tunnel sections (**Figure** 1).

The Project will be delivered through a number of works packages including the Station Boxes and Tunnelling Works (SBT Works). The SBT Works includes the design and construction of:

- Two sections of twin tunnels with a total combined length of approximately 9.8km, plus associated portal structures, one from Orchard Hills to St Marys and the other under Western Sydney International (WSI) airport to the new Aerotropolis Station in New South Wales (NSW)
- Excavations at either end to enable trains to turn back and stub tunnels to enable future extensions
- Station box excavations with temporary ground support for four stations at St Marys, Orchard Hills, Airport Terminal and Aerotropolis
- Excavations for two intermediate service facilities, one in each of the tunnel sections at Claremont and Bringelly.

Figure 1: Overview of the Project

2.1.2. SBT construction methodology

The construction methodology for the SBT Works entails:

- Utility works including removal, diversion, protection and connection to SBT Worksites
- Local area works including provision of site accesses and some road upgrades
- Site establishment works including:
  - Fencing
  - Installation of environmental mitigation including erosion and sediment controls and noise barriers and acoustic enclosures
  - Clearing and grubbing of existing vegetation
  - Demolition of existing buildings and structures
  - Site levelling and drainage works
  - Establishment of internal access roads, hardstand areas and onsite parking
  - Erection of demountable buildings including offices and amenities
  - Other ancillary facilities including the erection of sheds, establishment of materials laydown and stockpiling areas and Tunnel Boring Machines (TBMs) support works including spoil conveyors.
- Construction of station, shaft and dive excavations predominately completed by piling and excavators with rippers and hammers, however, roadheaders will also be used at St Marys and Aerotropolis to complete the stub tunnels
- Four TBMs will be used to construct the mainline tunnels as follows:
  - Two earth pressure balance TBMs will be launched from Orchard Hills and tunnel north to St Marys a distance of approximately 4.3 km including traversing the Claremont Shaft and be retrieved from the St Mary's Station Box.
  - Two double shield TBMs will be launched from the Airport Dive and tunnel south, traverse the Airport Terminal Station Box and Shaft, whereupon tunnelling will stop and the conveyor and backend equipment will be demobilised from the Airport Dive and re-established at Airport Terminal Shaft. The TBMs will recommence tunnelling including traversing the Bringelly Shaft and be retrieved from the Aerotropolis Station Box (a distance of 5.5 km from the Airport Dive, with 2.5 km of the southern tunnels located within NSW).
  - Cross passages will be constructed using concrete saws and excavators with hammers.

It is anticipated that the shaft and station excavations will be completed in advance of TBM tunnel construction. The TBMs will be delivered via oversize heavy vehicles to Orchard Hills and the Airport Dive site and retrieved from St Marys and Aerotropolis, subject to relevant approvals.

The SBT Works do not include any surface works between the northern and southern tunnel sections, which are to be undertaken by another contractor.

Tunnelling including station box, shaft and dive excavation and associated support activities including the operation of the precast facility will be undertaken 24 hours a day and seven days per week. Utility and local area works which cannot be completed during standard daytime hours due to Road Occupancy Licence requirements or due to utility authority requirements.

Completed sections of the SBT Works, including established construction worksites, will be progressively handed over to Sydney Metro to enable follow-on contractors to commence works. The exception is temporary precast facility, where the site will be decommissions following the completion of segment manufacture and storage and hydroseeded.

An overview of works at each SBT Worksite is provided in Table 2.

Table 2: SBT Worksite overview

Jurisdiction	Worksite	Indicative scope of works
NSW	St Marys	• Demolition of existing industrial premises • Offices, amenities, car parking and access roads • Piling and Station box excavation using rippers and rock hammers • Stub tunnel excavation using roadheaders • TBM retrieval
NSW	Claremont Meadows	• Offices, amenities, car parking, and access roads • Piling and Services facility shaft excavation using ripper and rock hammers • Construction of part of the cast-in-situ permanent shaft • Cross passage construction support • Invert construction support (subject to Sydney Metro approval)
NSW	Orchard Hills	• Demolition of existing buildings and removal of septic tanks • Offices, amenities, car parking, and access roads • Lansdown Road temporary diversion and construction of the permanent road bridge. • Piling and portal, station box and dive excavation using rippers and rock hammers • Construction of cast-in-situ permanent portal structure • TBM assembly, launch and tunnelling support works • Cross passage construction support
On-Airport	Airport Portal Dive Structure	• Offices, amenities, car parking and access roads • Piling and portal excavation using rippers and rock hammers • Open cut dive excavation using rippers and rock hammers • Construction of cast-in-situ permanent dive structure • TBM assembly, launch and tunnelling support works • Cross passage construction support
On-Airport	Airport Terminal and TBM shaft	• Offices, amenities car parking and access roads • Piling and station box and shaft excavation using rippers and rock hammers • TBM re-launch and tunnelling support works • Cross passage construction support
On-Airport	Primary Spoil Receival	• Access road • TBM Spoil conveyor set up • Earthworks in accordance with Sydney Metro Specifications
NSW	Bringelly	• Offices, amenities, car parking and access roads • Piling and Services facility shaft using rippers and rock hammers • Construction of part of the cast-in-situ permanent shaft. • Cross passage construction support • Invert construction support (subject to Sydney Metro approval)
NSW	Aerotropolis Core	• Offices, amenities, car parking and access roads • Piling and Station box excavation using rippers and rock hammers • Stub tunnel excavation using roadheaders • TBM retrieval

Note: Worksites shown in grey are within the boundary of Western Sydney International (On-Airport) and regulated under the Commonwealth Airports Act, 1996 and are outside the scope of this Plan.

2.1.3. Construction Site Layout Plans

Design construction layout plans for each off-airport site are presented below, including St Marys, Claremont Meadows, Orchard Hills, Bringelly, and Aerotropolis Core **(Figures 2 -6)**

This report principally addresses construction stage discharges from the proposed construction water treatment plants, and from on-site stormwater detention basins.

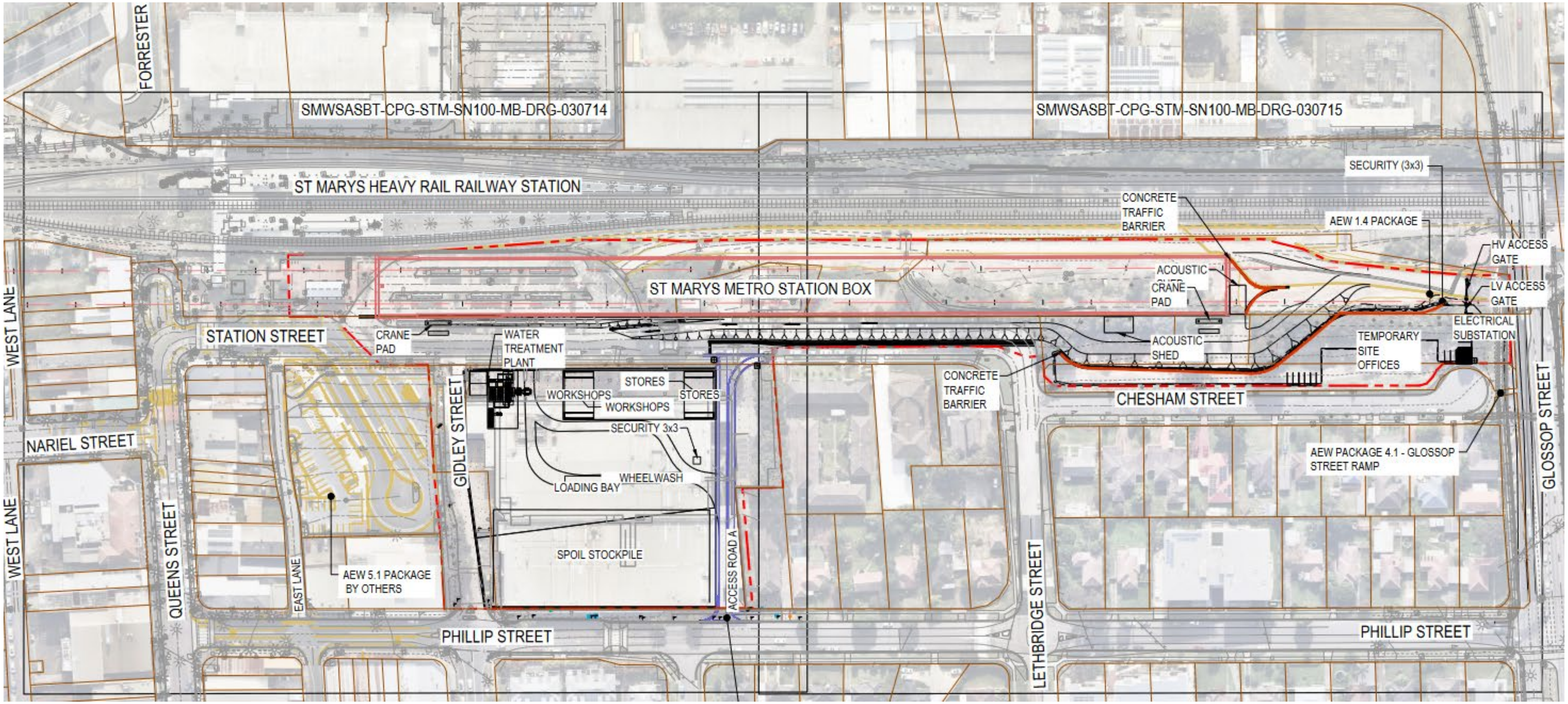


Figure 2: St Marys Site Layout Plan – SBT1

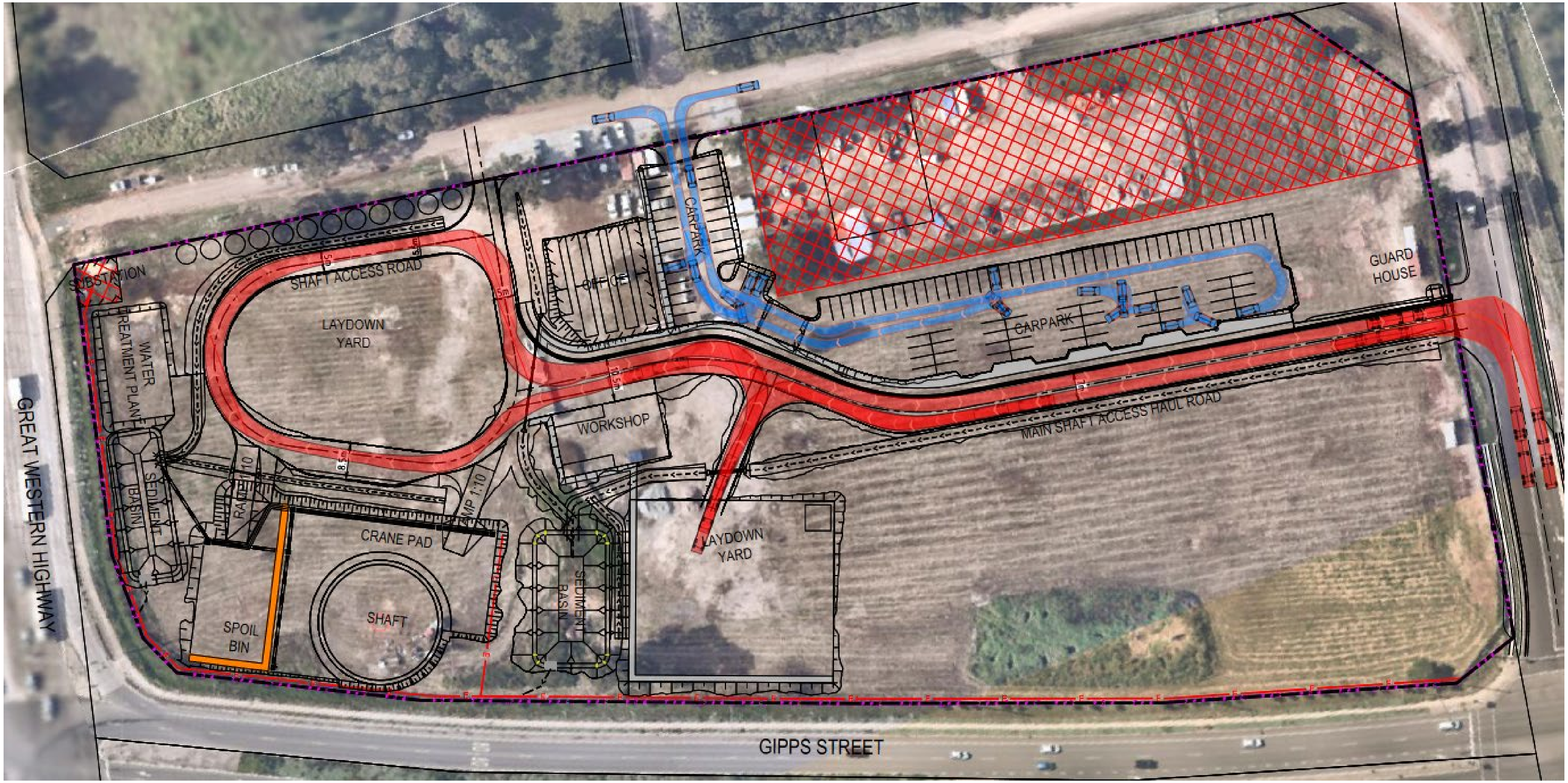


Figure 3: Claremont Meadows Site Layout Plan – SBT 2

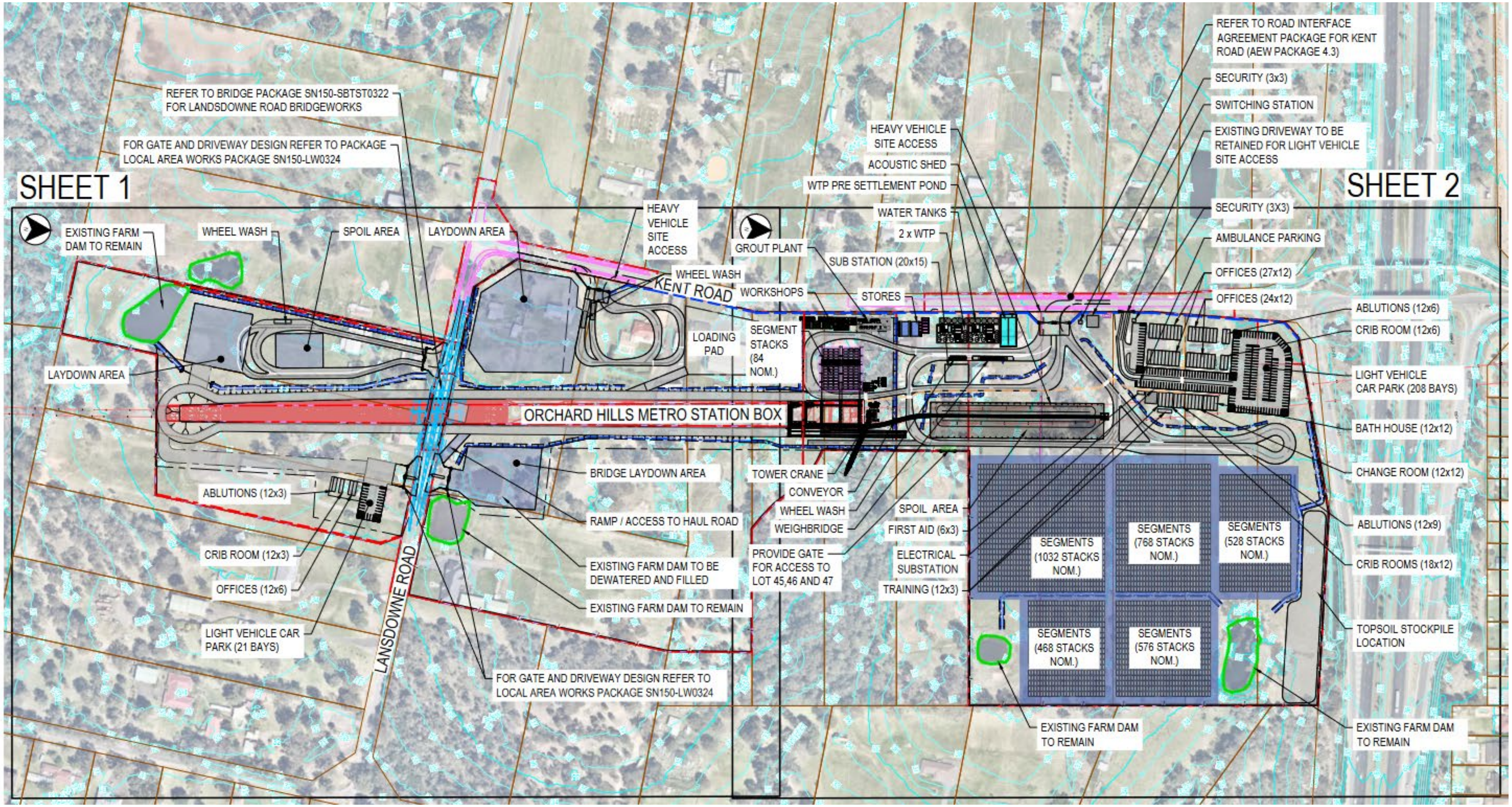


Figure 4: Orchard Hills Site Layout Plan

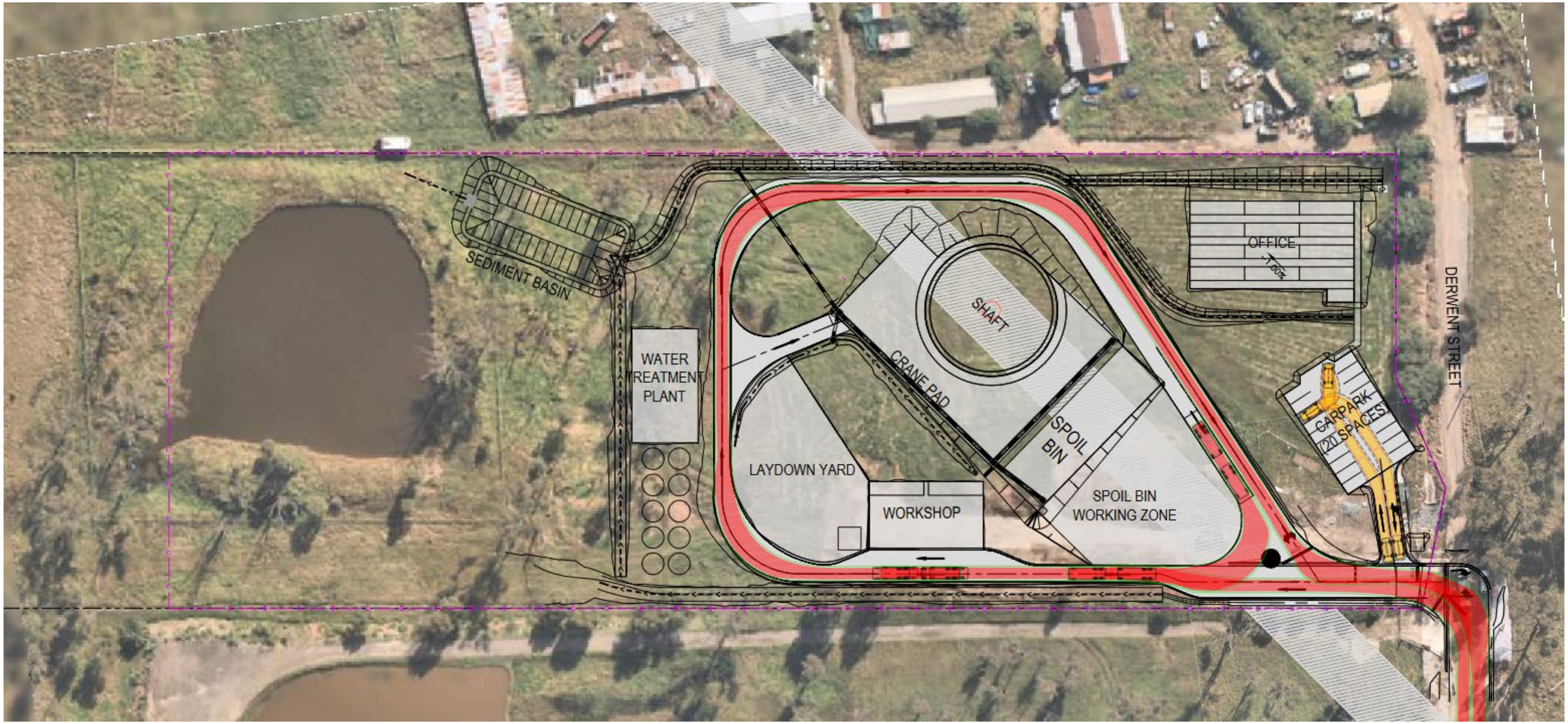
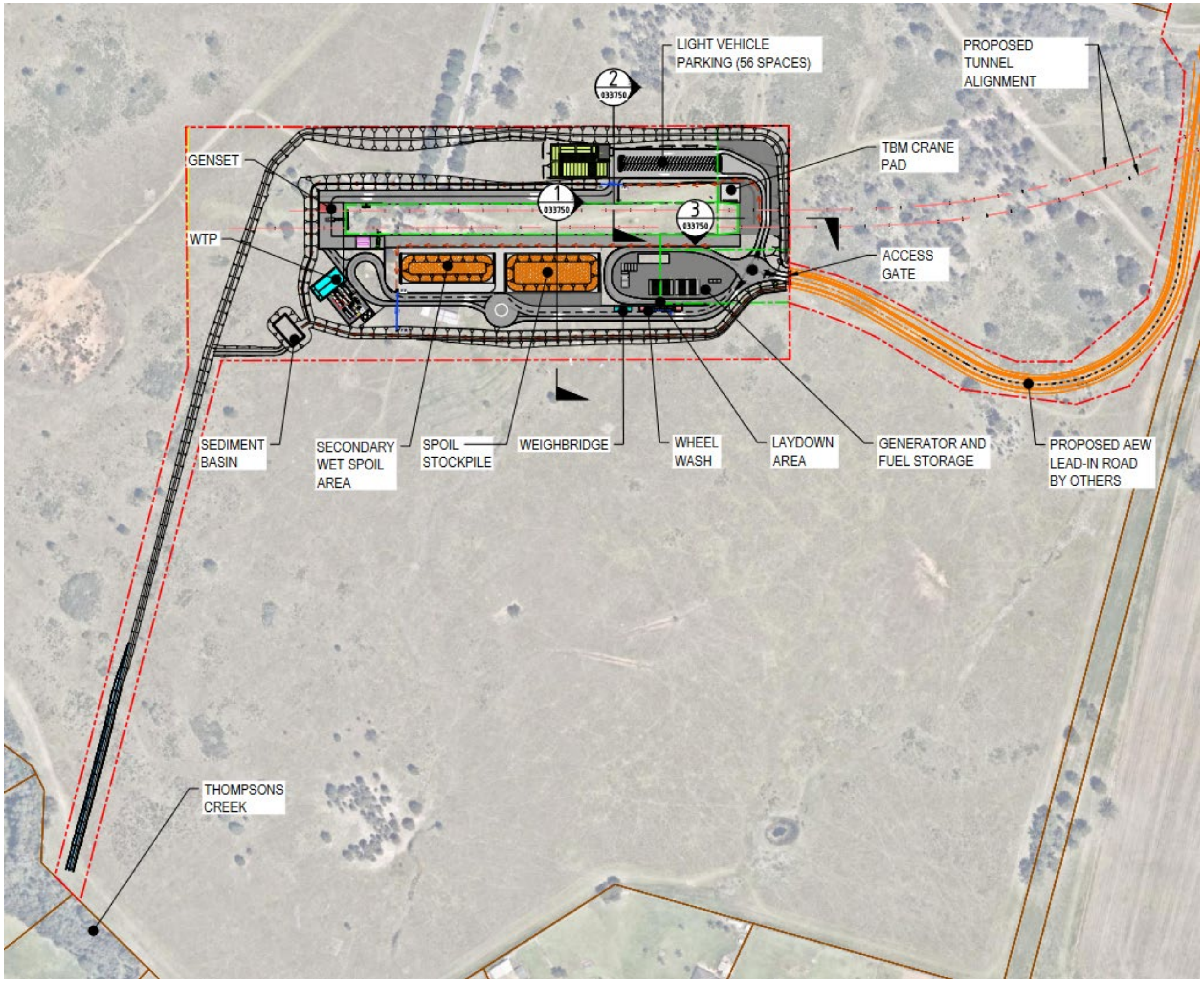


Figure 5: Bringelly Site Layout Plan


LIGHT VEHICLE
PARKING (56 SPACES)
PROPOSED
TUNNEL
ALIGNMENT
GENSET
TBM CRANE
PAD
WTP
ACCESS
GATE
SEDIMENT
BASIN
SECONDARY
WET SPOIL
AREA
SPOIL
STOCKPILE
WEIGHBRIDGE
WHEEL
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FUEL STORAGE
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BY OTHERS
THOMPSONS
CREEK

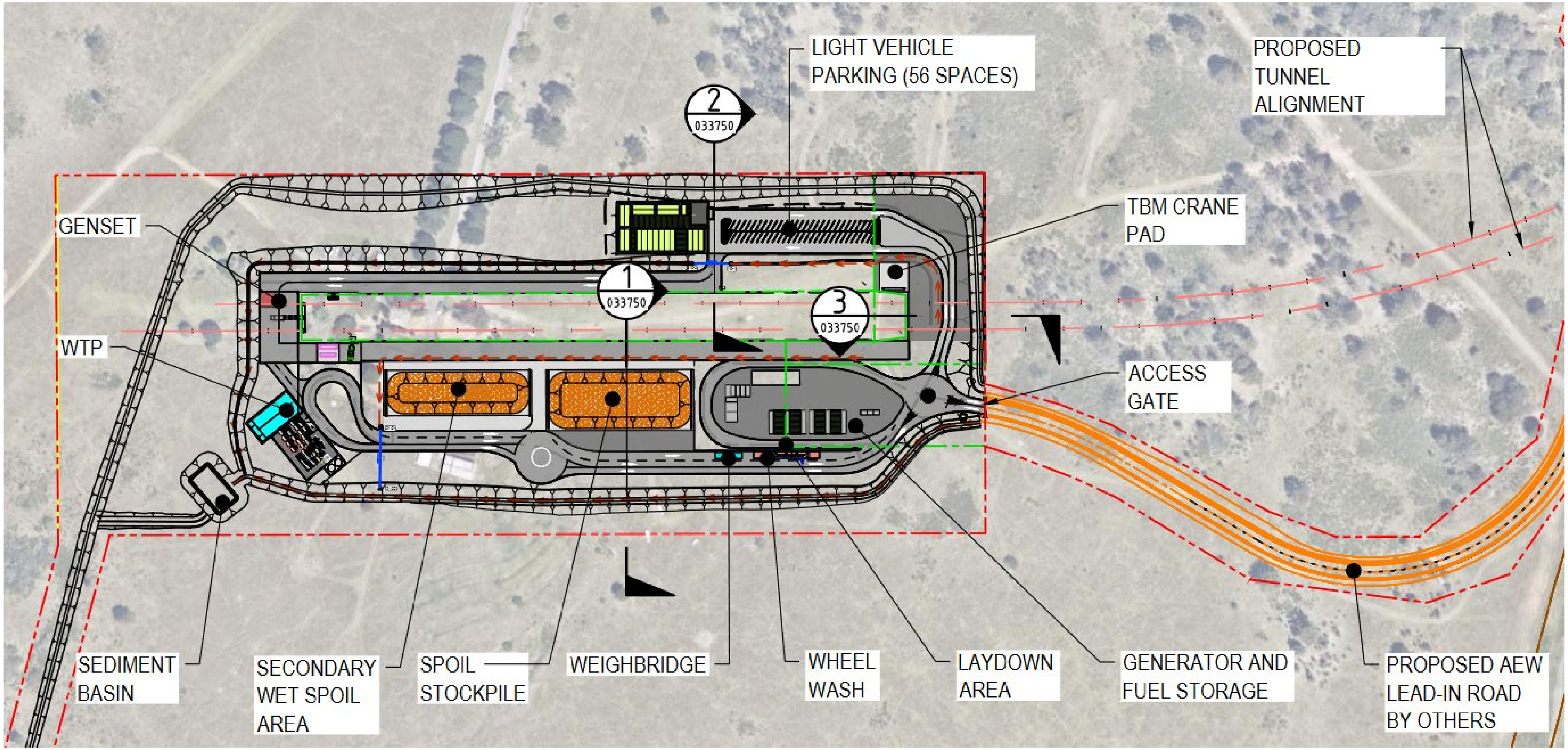

Figure 6: Aerotropolis Core Site Layout Plan

3. Regulatory Framework and Guidelines

3.1. Protection of the Environment Operations Act (1997)

3.1.1. Overview

The *Protection of the Environment Operations Act 1997* (POEO Act) is the key piece of environment protection legislation administered by the EPA. The objects of this act are to:

a. To protect, restore and enhance the quality of the environment in New South Wales, having regard to the need to maintain ecologically sustainable development,
b. To provide increased opportunities for public involvement and participation in environment protection,
c. To ensure that the community has access to relevant and meaningful information about pollution,
d. To reduce risks to human health and prevent the degradation of the environment by the use of mechanisms that promote the following—

- *i. pollution prevention and cleaner production,*
- *ii. the reduction to harmless levels of the discharge of substances likely to cause harm to the environment,*
- *iii. the elimination of harmful wastes,*
- *iv. the reduction in the use of materials and the re-use, recovery or recycling of materials,*
- *v. the making of progressive environmental improvements, including the reduction of pollution at source,*
- *vi. the monitoring and reporting of environmental quality on a regular basis,*

e. to rationalise, simplify and strengthen the regulatory framework for environment protection,
f. to improve the efficiency of administration of the environment protection legislation,
g. to assist in the achievement of the objectives of the Waste Avoidance and Resource Recovery Act 2001.

3.1.2. Application to Construction Wastewater and Surface Water Discharges

The EPA is the appropriate regulatory authority and licencing body for the activities specified in Schedule 1 of the POEO Act (scheduled activities). Under Section 120 of the POEO Act "A person who pollutes any waters is guilty of an offence". The definition of waters includes:

- any river, stream, lake, lagoon, swamp, wetlands, unconfined surface water, natural or artificial watercourse, dam or tidal waters (including the sea), or
- any water stored in artificial works, any water in water mains, water pipes or water channels, or any underground or artesian water.

The EPA can issue a licence to regulate water pollution from a non-scheduled activity. If it does, the EPA becomes the regulator for all environmental impacts from the activity under the POEO Act instead of the local council.

3.2. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)

3.2.1. Overview

The Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality Guidelines provide authoritative guidance on the management of water quality for natural and semi-natural water resources in Australia and New Zealand.

Guidelines for the management of water quality in Australia were developed as part of the National Water Quality Management Strategy (NWQMS). Values, targets, and actions in these guidelines are not mandatory, but support a nationally agreed framework for water quality planning and management.

The Water Quality Management Framework provides users with a step-by-step approach to protect the community values of waterways. In NSW the community values are represented through the New South Wales Water Quality Objectives.

The ANZG (2018) guidelines include default guideline values (DGVs) that are used as a generic starting point for assessing water quality. The DGVs are not mandatory and have no legal status, however, are commonly incorporated into water quality protection policy and regulatory tools for state, territory and local jurisdictions (including the NSW Water Quality Objectives). DGVs have been developed for guidance with aquatic ecosystems, primary industries, drinking water, recreation, and aesthetics. The NWQMS advocates the use of a weight-of-evidence process above rigid application of guideline values to determine if water quality represents a risk to a particular community value.

3.2.2. Application to Construction Wastewater and Stormwater Discharges

The Water Quality Management Framework can be used to assess compliance or any current or potential impacts of a waste discharge on water/sediment quality. Assessing a waste discharge in this way aims to ensure that it complies with the conditions of approval and is not causing environmental harm.

General steps involved in assessing a waste discharge include:

Examination of current understanding, including preparing a conceptual model and undertaking stakeholder and regulator engagement to identify key pressures and potential impacts.

- Identification of community values and management goals (including levels of protection).
- Identification of relevant stressors / toxicants in the waste discharge and indicators for monitoring in the receiving environment.
- Identification of water/ sediment quality guideline values in consultation with the regulator.
- Monitoring and assessment to determine whether water/ sediment quality objectives are being met.
- Considerations of alternative management strategies where water/ sediment quality objectives are not being met.
- Consideration of whether water/ sediment quality objectives are achievable.
- Implementation of an agreed management strategy.

3.3. New South Wales Water Quality Objectives

Guidelines for the management of water quality in Australia were developed as part of the National Water Quality Management Strategy (NWQMS). Values, targets, and actions in these guidelines are not mandatory, but support a nationally agreed framework for water quality planning and management.

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At the time the environmental objectives were approved by the Government (September 1999) the Healthy Rivers Commission (HRC) had completed or substantially completed public inquiries for the catchments of the Clarence, Hawkesbury-Nepean, Williams and Shoalhaven rivers.

The HRC recommended Water Quality Objectives in its Final Reports for these catchments. Government confirmed these Objectives in its response to the reports in Statements of Intent.

It should be noted that the environmental objectives reviewed and approved by the Government were published prior to the revised ANZECC (2000) Guidelines. Subsequent management strategies developed by the NSW Government adopt the ANZECC (2000) Guidelines for the management of both physical & chemical stressors and toxicants in the Hawkesbury Nepean Catchment (DECCW, 2010).

3.4. New South Wales Healthy Rivers Commission (1998)

3.4.1. Overview

The strategic framework for water quality improvement in the Hawkesbury-Nepean is provided by the water quality objectives determined by the NSW Healthy Rivers Commission inquiry into the Hawkesbury-Nepean system in the late 1990s (HRC 1998) and agreed to by the NSW Government through a Statement of Joint Intent in 2001. The water quality objectives recognise the community's 'environmental values and uses of the waterways and provide goals that help in the selection of the most appropriate management options. Water quality objectives consist of three parts: environmental values, water quality indicators and their guideline levels.

The environmental values that have been identified as applying to all of the lower Hawkesbury-Nepean Catchment waterways are:

- Protection of aquatic ecosystems
- Secondary contact recreation
- Visual amenity.

Some sections of the river and its tributaries have also been recognised as providing additional environmental values such as:

- Water for irrigation and general use
- Livestock drinking
- Human consumption of aquatic foods
- Raw drinking water
- Primary contact recreation.

For WQOs other than nutrients, the Commission has recommended adoption of the values provided by ANZECC Guidelines.

Numerical criteria for nutrients were identified for nutrient concentrations for various parts of the Hawkesbury-Nepean River system following the Healthy Rivers Commission inquiry in 1998 (HRC 1998). It should be noted that the water quality criteria prepared by the HRC pre-date the ANZECC/ARMCANZ (ANZECC, 2000) trigger values and provide only specific objectives for total nitrogen, total phosphorous, and chlorophyll-a.

3.5. Blue Book (Landcom, 2004)

3.5.1. Overview

The Blue Book refers collectively to a series of publications titled *Managing Urban Stormwater: Soils and Construction.* Volume 1 was published by Landcom in 2004, and Volumes 2A to 2E were published by DECC in 2008.

Volumes 1 and 2D (Main Road Construction) are most relevant to the construction of the project.

The Blue Book contains guidelines and recommendations for practical application of erosion and sediment control during construction. It is recognised as defining best-practice erosion and sediment control for the construction industry in NSW.

3.5.2. Application to Wastewater and Surface Water Discharges

To assist in the management of erosion and sediment control during construction, the Blue Book recommends a blanket standard of 50mg/L for discharges of stormwater from construction sites in all rainfall events up to and including the “design event” (which is an amount of rain over a specified number of days). At this site, the “design event” would typically be the 5-day, 80th percentile rainfall depth of 27.6mm.

The requirement for discharges not to exceed 50mg/L in all rainfall events up to and including the “design event” is noted in Clause 6.3.3 (d) (ii) of Blue Book Volume 1, along with stipulations that more stringent criteria might be required by a regulatory or consent authority, and/or if the sensitivity of the receiving environment warrants them. Condition E130 of the MCoAs for this project require the preparation of this Assessment to determine appropriate discharge limits, consistent with section 45 of the POEO Act.

3.6. PFAS National Environmental Management Plan, Version 2.0 (Heads of EPA Australia and New Zealand, 2020)

3.6.1. Overview

The per- and poly-fluoroalkyl substances (PFAS) National Environmental Management Plan (NEMP) provides guidance on management of PFAS compounds and preventing and managing PFAS contamination.

The PFAS NEMP has been implemented across much of Australia, including NSW and at a Commonwealth level.

3.6.2. Application to Wastewater and Surface Water Discharges

The PFAS NEMP provides advice on managing stockpiling or storage of PFAS impacted water, and details management of PFAS impacted wastewater, providing environmental guideline values to govern re-use and disposal options.

3.7. EPA Comments on Additional Information for WDIA – EPL No. 21672, (NSW EPA, 2022) [LETTER]

A letter was prepared by NSW EPA (Regulatory Operations) in response to the draft Water Discharge Impact Assessment submitted by CPBG as support for the EPL application for the Project. The letter details site specific water quality objectives for the South Creek Catchment; these values have yet to be published. Notwithstanding, the values provided within the letter may be used in place of the applicable ANZG default guidelines.

The site-specific values provide target criterion against which all surface waters are to be assessed to determine options for off site disposal, environmental discharge or on-site beneficial reuse.

4. Catchment Context

4.1. South Creek Catchment

The project footprint lies entirely within the South Creek Catchment, which covers an area of approximately 620 km^2 and falls entirely within the Cumberland Lowlands physiographic region, consisting of low lying gently undulating plains and low hills formed on sediments of the Wianamatta Group (Rae, 2007). The Catchment extends the length of Western Sydney, with South Creek beginning 4 km north-east of Narellan and 7 km west of Minto in the south-west.

The South Creek Catchment is a typical example of a peri-urban catchment with significant urban development surrounded by peri-urban agriculture activities, including market gardens, greenhouses, nurseries, orchards, turf farming, and improved pastures (Singh et al., 2009b). South Creek is, a major tributary of the Hawkesbury-Nepean Catchment, and flows in a generally northerly direction before joining the Hawkesbury River at Windsor. Seventeen (17) smaller creeks form tributaries to South Creek upstream of its confluence with the Hawkesbury River.

The project alignment crosses South Creek and a number of un-named and named tributaries of South Creek. The named watercourses and tributaries that the alignment crosses include (from north to south):

- South Creek
- Claremont Creek
- Blaxland Creek
- Cosgroves Creek
- Kemps Creek
- Oakys Creek
- Badgerys Creek
- Thompsons Creek.

South Creek is the receiving waterway for creeks within the project footprint. The location of each SBT site in the Context of the South Creek Catchment is presented in **Figure 7.**

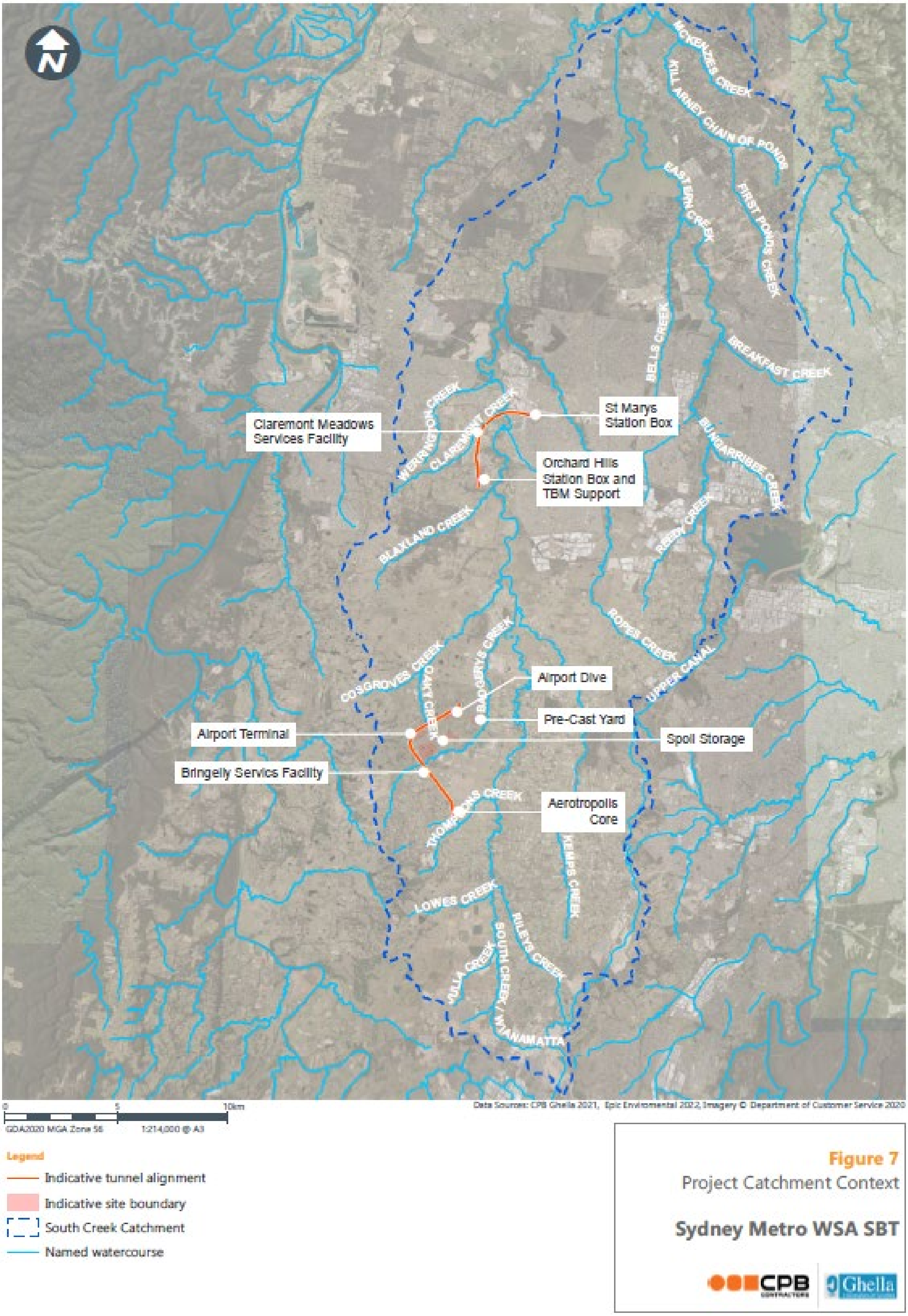


Figure 7: Project Catchment Context

5. Geology and Soils

5.1.1. Geology

The project is located within the Permo-Triassic Sydney Basin. The Sydney Basin is characterised by sub-horizontal sedimentary deposits, which mainly comprise sandstone with interbedded shale layers deposited unconformably on a basement of the Lachlan fold belt (Haworth, R.J., 2003).

In the South Creek Catchment, and along the project alignment, the key geological units comprise:

- Quaternary Alluvial Deposits
- Bringelly Shale
- Igneous Intrusions.

5.1.1.1. Quaternary Alluvial Deposits

Quaternary alluvial deposits are mapped where the alignment crosses local waterways such as the lower lying area of South Creek and its tributaries. The areas of Quaternary Alluvium typically comprise laterally discontinuous layered sequences of silts, clays, and sandy clays with trace carbonaceous inclusions. Localised sandy/gravelly deposits can be found within the alluvial floodplains and in proximity to the existing watercourses and may represent major historical flood events, or creek paleochannels.

5.1.1.2. Bringelly Shale

The Bringelly Shale Formation forms the underlying bedrock for the proposed alignment. It is largely comprised of claystone, siltstone, and laminate, with localised layers of higher strength sandstone. These sandstone beds typically range in thickness from about 0.5 m to 7 m, and often cap the higher hills.

The Bringelly Shale is a complex formation of different lithologies and is believed to be about 150 m thick below the Project area. Lithologies that comprise the Bringelly Shale are, in order of decreasing volumetric significance:

i. Claystone and siltstone
ii. Laminite
iii. Sandstone
iv. Coal and highly carbonaceous siltstone
v. Tuff.

Claystone and siltstone are dominant while thin laminate horizons occur throughout. Sandstone is minor and sporadic, forming prominent "benches" in outcrop. The lower 30 m of the Bringelly Shale is usually distinctive, being relatively thinly bedded and containing the most carbonaceous sediments within the Wianamatta Group. Above this lower zone, claystone, siltstone, and sandstone units are more thickly bedded.

5.1.1.3. Igneous Intrusions

Located within the southern portion of the project area and passing within 700 m of the alignment near the proposed Aerotropolis Station is the northwest-trending Luddenham Dyke (Jd13). This dyke is one of the largest igneous dykes in the Sydney Basin and ranges in width from about 6 m to 12 m. It is comprised of basalt and generally dips to the southwest at about 850 m, with a strike of 1360 m.

In addition to the Luddenham Dyke, and potentially passing across the proposed alignment in the vicinity of the proposed Orchard Hills Metro Station is another smaller north-east trending igneous dyke called the Claremont Dyke (Jd7).

It is possible several unknown dykes will intersect the tunnel perpendicularly. These dykes are likely to be highly variable in weathering and strength, ranging from extremely weathered soil strength margins to slightly weathered to fresh, high to extremely high strength inner cores.

5.1.2. Soil Landscape Mapping

Soil Landscape Mapping sourced from NSW Office of Environment and Heritage eSpade portal reveals that the project lies on several different soil landscapes and soil types. **Figure 8** shows the soil landscapes (sourced from NSW Office of Environment and Heritage eSpade portal) with the extent of the project boundary. Site observations by SEEC confirm the accuracy of the soil landscape mapping.

Table 3 contains a summary of soil landscape key features and potential constraints that might influence erosion and sediment control during construction.

Table 3: Soil landscape descriptions (sourced from NSW Office of Environment and Heritage eSpade portal, 2022)

Soil landscape name	Description	Sediment type	Key landscape and soil constraints for erosion and sediment control
South Creek	Alluvial deposits associated with major creeklines. Slopes generally less than 5%. Soils primarily consist of Quaternary alluvium derived from Wianamatta Group sediments. Deep sandy, sandy clay and clay soils were deposited by the present South Creek drainage network.	Type D	Flooding hazard. Seasonal waterlogging of soils. Localised salinity. Localised high water tables. Localised sodicity (dispersive soils).
Blacktown	Broad rounded crests and ridges with gently inclined slopes and undulating rises on Wianamatta Group shales. Local relief to 30 m and slopes usually >5%. Red and brown duplex soils on crests and midslopes, grading to yellow duplex soils on lower slopes and around drainage lines.	Type D	Localised impermeable highly plastic subsoil. Moderately reactive soils. Low wet strength soils. Low plant-available waterholding capacity. Low permeability soils. Low fertility subsoils. Localised dispersive (sodic) subsoils. Highly acidic topsoils with aluminium toxicity potential. Localised salinity

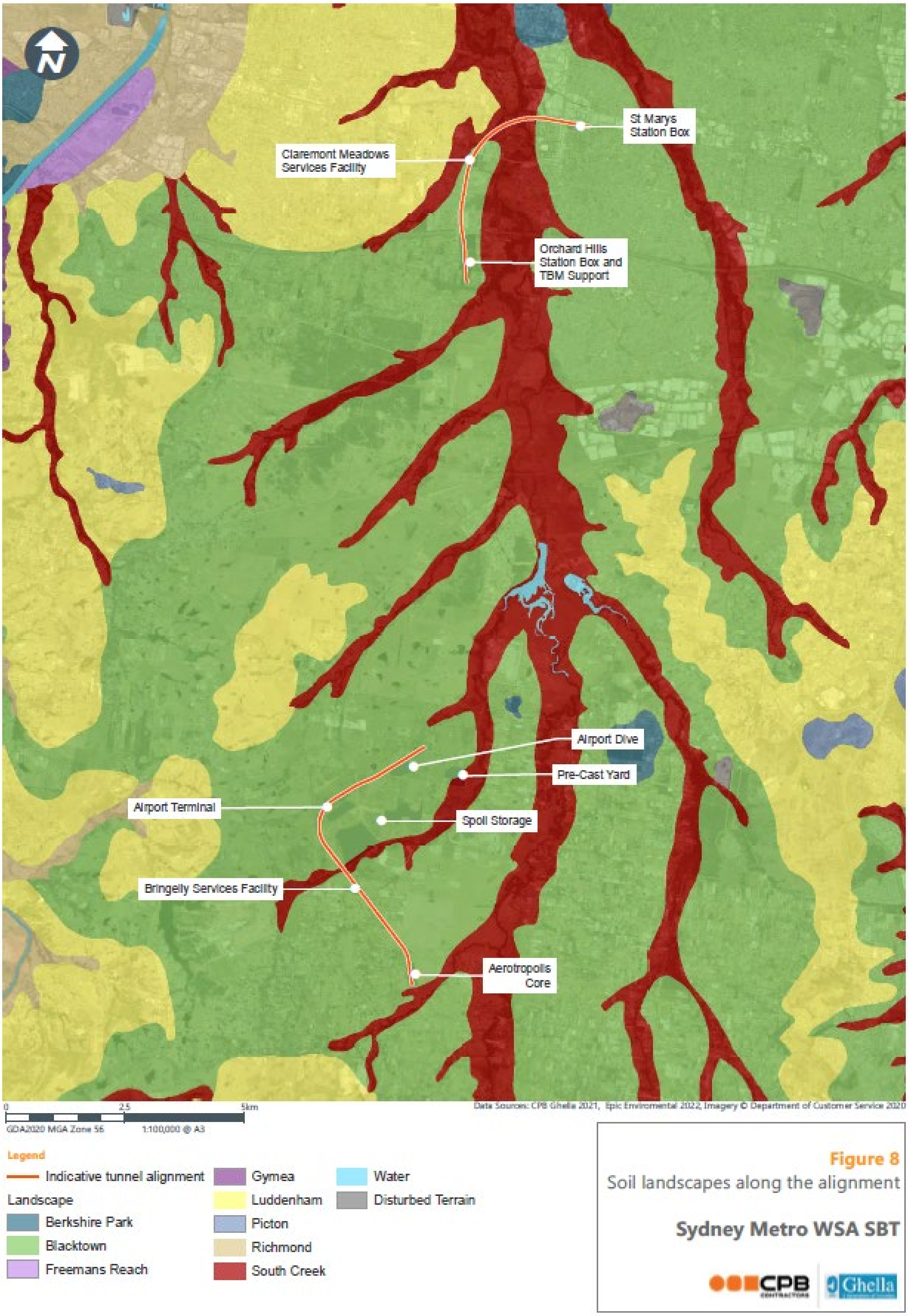


Figure 8: Soil landscapes along the alignment. (sourced from NSW Office of Environment and Heritage eSpade portal, 2022).

5.1.3. Acid Sulfate Soils

Acid Sulfate Soil Risk Mapping (DLWC, 1997) did not identify the project site as having a risk of acid sulfate soils (confirmed via the NSW Government eSpade portal, 2022). Site observations did not identify any landscape indicators that suggest acid sulfate soils might be present within the project boundaries.

6. Aquatic Ecology

Investigations of aquatic assessment were undertaken throughout the catchment in 2016 (GHD 2016) and 2022 (Aquatic Ecological Investigations [AEI], 2022). A summary of AEI (2022) is provided below..

The AEA investigation comprised assessment of aquatic habitat, water quality, fish and macroinvertebrates at five locations within the wider catchment, including:

- South Creek (Site SC1)
- South Creek (SC2)
- Claremont Creek (Site CC)
- Thompsons Creek (Site TC)
- Badgerys Creek (Site BC).

6.1. Aquatic Habitat

Aquatic habitats within the study area are highly modified and have previously been subject to extensive land clearing for agricultural and urban land use. The majority of sampled locations displayed evidence of recent flooding, including presence of scour and debris.

Four of the five sites reported poor water clarity, with one site (CC) reported to have moderate visibility; all study sites reported a highly modified channel as a result of surrounding agricultural and urban land use.

In general, the riparian vegetation is commonly dominated by invasive species, with the exception of occasional *Casuarina spp*. and *Eucalypt.* trees, *Lomandra longifolia* (Spiny-head mat-rush) and *Persicaria decipiens* (Slender knotweed).

The overall condition of aquatic habitat at the sites sampled was classified as 'fair', with RCE scores of between 25 and 35. Nevertheless, the presence of *Anguilla reinhardtii* (Long-finned eel) and *Anguilla australis* (Short-finned eel) and *Gobiomorphus australis* (Striped gudgeon) indicates that creeks within the study area are providing habitat for native species of fish.

6.2. Water Quality

Several water quality parameters measured were reported above ANZECC (2000) criteria for slightly disturbed systems, however full analysis of water quality (including nutrients) would need to be conducted to determine the impact of water quality on macroinvertebrates.

It is considered that the anthropogenic disturbance located throughout the catchment has contributed to a reduction in water quality across the sites; elevated salinity specifically is likely to be attributable to an increase in groundwater table, itself likely caused by local irrigation, and reduced abundance of deep-rooted vegetation.

6.3. Fish

All of the species caught are common within NSW (McDowall, 1996; Howell and Creese, 2010). No threatened species of fish listed under the NSW FM Act or the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) were observed.

A total of five native species (Firetail gudgeon (*Hypseleotris galii*), Western carp gudgeon (*Hypseleotris klunzingerii*), Australian smelt (*Retropinna semoni*), an un-identified Gudgeon species, and Long-finned eels) and three alien species (Goldfish (*Carassius auratus*), Common carp (*Cyprinus carpio*) and Mosquito fish) were recorded by the survey undertaken by GHD (2016), with *Gambusia holbrooki* (mosquito fish) also observed during the AEA (2022) investigation.

Gambusia holbrooki are known to thrive in disturbed habitats and still waters common across the five sites investigated and the wider catchment. Predation by Gambrusia holbrooki is listed as a Key Threatening Process (NSW Biodiversity Conservation Act 2016) due to the potential effect on aquatic macroinvertebrates, reptiles and native fish.

South Creek was noted to be highly altered from its natural state due to the surrounding rural, agricultural and urban land uses. Despite this, it is listed as a 'Type 1 – Highly sensitive key fish habitat' in the NSW Department of Primary Industries (2013). The EES indicated the potential for Australian Grayling, Macquarie Perch, and Murray Cod to be present at the site, which is listed as threatened species by EPBC Act.

6.4. Aquatic Macroinvertebrates

The macroinvertebrate communities present in South Creek were noted to have a high tolerance to severe pollution levels but included two threatened invertebrate species listed by the FM Act; Adam's Emerald Dragonfly and the Sydney Hawk Dragonfly.

Low values of both the SIGNAL2 score (≤ 4.00) and macroinvertebrate diversity (< 15 taxa) were obtained at the tributary sites (i.e., Claremont Creek, Thompsons Creek and Badgerys Creek). Sites with low diversity and SIGNAL 2 scores are likely to be suffering from one or more forms of human impact, such as urban, industrial, and agricultural pollution and/or the downstream effects of dams (see Chessman, 2003).

Relatively high SIGNAL 2 scores but low diversity at the South Creek sites indicates that these sites are likely to be exposed to toxic pollution or harsh physical conditions, such as flooding (see Chessman, 2003). Floods can wash macro-invertebrates away, so that few types are collected if sampling occurs soon after the flood has receded. This survey was done after recent flood events, which is likely to have contributed to the lower diversity recorded at the sites sampled.

Elevated levels of conductivity and salinity can also influence the diversity and abundance of aquatic macroinvertebrates. Nevertheless, some pollution sensitive taxa were present, including caddis fly and mayfly families, and at the time that surveys were carried out in autumn 2015 (GHD, 2016).

It is noted that macroinvertebrates identified within the system may have become tolerant to reduced water quality over time, offsetting the impact of short-term elevations in concentrations of concern or decreases in water quality.

7. Environmental Values, Water Quality and River Flow Objectives

7.1. FWater Quality

The following sections provide an overview of the WQOs for South Creek based on a review of available catchment studies and community values. The adopted WQOs encompass:

- Protection of Aquatic Ecosystems
- Visual Amenity
- Primary Contact Recreation
- Secondary Contact Recreation
- Aquatic Foods (Cooked)
- Irrigation Water Supply
- Livestock Water Supply
- Drinking Water Supply.

It should be noted that the criteria and guideline values specified under these WQOs have been used only as screening criteria in this report to assess discharges from groundwater and stormwater against known species protection values, and do not represent discharge criteria. Proposed discharge criteria for stormwater discharges and construction water treatment plant discharges are discussed in **Section 14**.

7.1.1. Protection of Aquatic Ecosystems

The specific WQO's for protection of aquatic ecosystems within the South Creek Catchment and intersected or affected by the project include trigger values for both water quality indicators and for chemical contaminants or toxicants.

Water quality indicators are addressed in the ANZECC 2000 Guidelines include direct effect non-toxic physical / chemical stressors (total phosphorous, total nitrogen, turbidity), indirect stressors (dissolved oxygen, pH), and effect indicators (Chlorophyll-a). Chemical contaminants of concern are addressed in the ANZG 2018 guidelines and include a wide range of parameters under the parameter groups listed in **Table 4.**

Table 4: ANZG (2018) / ANZECC (2000) Chemical Toxicant Groups

ANZG (2018) / ANZECC (2000) Chemical Toxicant Groups	
Chloroethanes	Polychlorinated Biphenyls (PCBs) & Dioxins
Chlorinated Alkenes	Triazine Herbicides
Chloropopanes	Organophosphorus Pesticides
Chlorobenzenes & Chloronaphthalenes	Aromatic Hydrocarbons
Nitrobenzenes	Organic Sulfur Compounds
Phenols and Xylenols	Oil Spill Dispersants
Phenoxyacetic Acid Herbicides	Carbamate & other Pesticides
Nitrophenols	Chloromethanes
Nitrotoluenes	Pyrethroids
Anilines	Phthalates
Miscellaneous Herbicides	Miscellaneous Industrial Chemicals
Surfactants	Bypyridilium Herbicides
Organochlorine Pesticides	Urea Herbicides
Metals and Metalloids	Organic Alcohols

ANZG (2018) / ANZECC (2000) Chemical Toxicant Groups	
Non-metallic Inorganics	Sulfonylurea herbicides
Polycyclic Aromatic Hydrocarbons	Thiocarbamate Herbicides

Trigger values are the numeric criteria that if exceeded indicate potential for harmful environmental effects to occur. The default trigger values provided in ANZECC 2000, and ANZG 2018 Guidelines are essentially conservative and precautionary. If they are not exceeded, a very low risk of environmental damage can be assumed. If they are exceeded, further investigation is "triggered" for the pollutant concerned. Assessing whether the exceedance means a risk of impact to the Water Quality Objective requires site-specific investigation, using decision trees provided in the Guidelines.

The ANZG (2018) default guideline values for toxicants at the adopted species protection criteria of 95% and 99% (for bioaccumulating compounds) have been adopted as screening criteria in a manner consistent with recommendations from the EPA in response to the EIS Water Quality Technical Paper..

The water quality indicators and specific trigger values for physical and chemical stressors specific to South Creek and associated tributaries affected by the project are outlined in Table 5, and are consistent with the default guideline values as identified in Tables 3.3.2 and 3.3.3 of the ANZECC (2000) guidelines, and NSW EPA advised Site Specific Trigger Values (SSTV) for the South Creek Catchment.

Table 5: South Creek Water Quality Trigger Values – Physical and Chemical Stressors

Category	Indicator	Source	Adopted Trigger Value
Direct Effect Non-Toxic Physical / Chemical Stressors	Total Nitrogen (mg/L)	South Creek Catchment SSTV	1.72
	Oxides of Nitrogen (mg/L)	South Creek Catchment SSTV	0.66
	Total Phosphorous (mg/L)	South Creek Catchment SSTV	0.14
	Turbidity (NTU)	South Creek Catchment SSTV	50
Direct Effect Toxic Physical / Chemical Stressors	Total Ammonia (mg/L)	ANZG 2018 95% SP	0.9
	Salinity (µS/cm)	ANZECC 2000 (3.3.2)	125 - 2,200
	pH (units)	ANZECC 2000 (3.3.2)	6.5 – 8.0
	Dissolved Oxygen (%sat)	ANZECC 2000 (3.3.2)	85- 110

7.1.2. Visual Amenity

This objective applies to all waters, particularly those used for aquatic recreation and where scenic qualities are important. Indicators that may be used to assess and monitor visual amenity in the South Creek catchment are summarised in **Table 6.**

Table 6: South Creek Water Quality Visual Amenity Indicators

Indicator	Criteria
Visual Clarity and Colour	Natural visual clarity should not be reduced by more than 20%.
	Natural hue of the 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%.
Indirect Stressors	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.
Effect Indicator	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.

7.1.3. Primary Contact

This objective applies in the immediate future to waters within and immediately upstream of recognised recreation sites. For many other waters, this is a long-term objective. Secondary contact recreation levels should apply in areas where primary contact recreation, such as swimming, is unlikely to be achieved in the immediate future, owing to pollution.

Indicators that may be used to assess and monitor water for primary contact recreation in the South Creek catchment are summarised in Table 7.

Table 7: South Creek Water Quality Primary Contact Indicators

Indicator	Criteria
Turbidity	A 200 mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6 m (approximately 6 NTU).
Faecal coliforms	Beachwatch considers waters are unsuitable for swimming if:The median faecal coliform density exceeds 150 colony forming units per 100 millilitres (cfu/100mL) for five samples taken at regular intervals not exceeding one month, or
	Beachwatch considers waters are unsuitable for swimming if: The second highest sample contains equal to or greater than 600 cfu/100mL (faecal coliforms) for five samples taken at regular intervals not exceeding one month.
	ANZECC 2000 Guidelines recommend: Median over bathing season of < 150 faecal coliforms per 100 mL, with 4 out of 5 samples < 600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
Enterococci	Beachwatch considers waters are unsuitable for swimming if: the median enterococci density exceeds 35 cfu/100mL for five samples taken at regular intervals not exceeding one month, or; the second highest sample contains equal to or greater than 100 cfu/100mL (enterococci) for five samples taken at regular intervals not exceeding one month.
	ANZECC 2000 Guidelines recommend: Median over bathing season of < 35 enterococci per 100 mL (maximum number in any one sample: 60-100 organisms/100 mL).

7.1.4. Secondary Contact

This objective applies to all waters but may not be achievable for some time in some areas. Secondary contact recreation applies in waterways where communities do not require water quality of a level suited to primary contact recreation, or where primary contact recreation will be possible only in the future.

Indicators that may be used to assess and monitor water quality for secondary contact recreation in the South Creek Catchment are summarised in Table 8.

Table 8: South Creek Water Quality Secondary Contact Indicators

Indicator	Criteria
Faecal Coliforms	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL).

Algae & Blue-Green Algae	< 15 000 cells/mL
Nuisance Organisms	Use 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 for recreation.
	Toxic substances should not exceed values in tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines.
Visual Clarity and Colour	Use visual amenity guidelines.
Surface Films	Use visual amenity guidelines.

7.1.5. Irrigation Water Supply

This objective applies to all current and potential areas of irrigated crops, both small- and large-scale. Local requirements for irrigation water quality, such as salinity, apply.

Indicators that may be used to assess and monitor water quality for irrigation water supply in the South Creek Catchment are summarised in Table 9.

Table 9: South Creek Water Quality Irrigation Water Supply Indicators

Indicator	Criteria
Algae & 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, a number of interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscape and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC 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 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 2000 Guidelines.

7.1.6. Livestock Water Supply

This objective applies to all surface and groundwaters used to water stock.

Indicators that may be used to assess and monitor water quality for livestock water supply in the South Creek Catchment are summarised in Table 10.

Table 10: South Creek Water Quality Livestock Water Supply Indicators

Indicator	Criteria
Algae & blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3 µg/L expressed as microcystin-LR toxicity equivalents.
Salinity (electrical conductivity)	Recommended concentrations of total dissolved solids in drinking water for livestock are given in table 4.3.1 (ANZECC 2000 Guidelines).
Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median value).

Chemical contaminants	Refer to Table 4.3.2 (ANZECC 2000 Guidelines) for heavy metals and metalloids in livestock drinking water. Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC 2004) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water.

7.1.7. Drinking Water (Disinfection Only)

All drinking water should comply with the Australian Drinking Water Guidelines (NHMRC & NRMMC 2004) at the point of use. Refer to the Summary in the Australian Drinking Water Guidelines.

Key indicators for raw water for drinking water supply that is to undergo coarse screening only are listed in Table 11. These indicators are drawn from the National Health and Medical Research Council Australian Drinking Water Guidelines (NHMRC & NRMMC 2004).

Table 11: South Creek Water Quality Drinking Water Supply Indicators

Indicator	Criteria
Blue-green algae	Recommend twice weekly inspections during danger period for storages with history of algal blooms.
	>500 algal cells/mL - increase monitoring.
	< 2000 algal cells/mL - water may be used for potable supply.
	>2000 algal cells/mL - immediate action indicated; seek expert advice.
	>6500 algal cells/mL - seek advice from health authority.
	>15 000 algal cells/mL - may not be used for potable supply except with full water treatment, which incorporates filtration and activated carbon.
Turbidity	Site-specific determinant.
Salinity (electrical conductivity)	<1500 µS/cm
	> 800 µS/cm causes a deterioration in taste.
Faecal coliforms*	0 faecal coliforms per 100 mL (0/100 mL)
Total coliforms*	95% of samples should be 0 coliforms/ 100 mL throughout the year.
	Up to 10 coliform organisms may be accepted occasionally in 100 mL.
	Coliform organisms should not be detected in 100 mL in any two consecutive samples.
Dissolved oxygen	> 6.5 mg/L (> 80% saturation)
pH	6.5-8.5
Chemical contaminants	See ANZECC 2000 guidelines, section 6.2.2.

7.2. River Flow Objectives

ANZECC (2018) provides little guidance on River Flow Objectives however the Lower Hawkesbury-Nepean River Nutrient Management Strategy (DECCW, 2010) provides the following strategic priorities:

- Manage urban stormwater to maximise outcomes for river health, minimise stormwater flooding risks and optimise its use as an alternative water source where stormwater harvesting improves flow patterns.

- The implementation of new environmental flow regimes for major dams and weirs in the Hawkesbury-Nepean catchment and a water sharing plan for Sydney.

The focus is to remove weirs and dams to encourage a more natural flow regime to reduce residence times and improve "flushing" flows and provide opportunities to trigger the migration of animals.

8. Groundwater

8.1. Aquifers

The aquifers present across the project alignment can be broadly characterised as:

a. Semi-confined to confined aquifers in the bedrock formations comprising the Wianamatta Group fracture bedrock and Hawkesbury Sandstone formation.
b. Unconfined to semi-confined aquifers associated with Quaternary alluvium deposit aquifers along drainage lines of tributaries of South Creek.

The Quaternary alluvial aquifer overlies bedrock along the main drainage channels and creek lines including South Creek and its tributaries. Quaternary alluvial deposits typically comprise a mixture of gravels, sands, silts and clays. The alluvial deposits within the channels associated with watercourses typically act as zones of discharge of groundwater from the underlying residual soil and rock.

Fill in the form of a mixture of sand, gravel and clay is present in places over the site. Fill is typically thin (less than 2 m thick) and is almost invariably above the groundwater table. Fill may be saturated in places where infiltrated water is perched on the underlying residual clay soil.

The bedrock units of the Wianamatta Group (Bringelly Shale, Minchinbury Sandstone and Ashfield Shale) and underlying Mittagong Formation and Hawkesbury Sandstone form heterogeneous fractured rock aquifers where groundwater flows occur within defects (such as joints, sheared zones and bedding partings) within the rock mass.

Bringelly Shale is the upper rock unit beneath the tunnel alignment. It comprises shale with sandstone bands. Defects including faults, dykes and shear zones are present. Permeability of the intact shale is low with flow occurring through defects associated with bedding, joints, shear zones and fractures. On exposure, the shale swells, and its exposed surface deteriorates with time.

8.2. Groundwater Quality

Groundwater quality within the South Creek Catchment is influenced by both the geochemistry of water bearing units, and historic anthropogenic activities across the catchment.

Groundwater quality may be expressed in terms of both principal physiochemical characteristics (including electrical conductivity, pH, temperature, dissolved oxygen, reduction-oxidation potential, and concentrations of major ions), and by the concentrations of lesser ions comprising those classed as nutrients and/or toxicants.

Within the WSA a two-aquifer system is believed to exist with respect to groundwater quality; namely an upper/ regolith aquifer that is relatively fresh and pervious, but limited in depth and extent, and a lower shale bedrock aquifer, which is distinctly saline. These two aquifers are generally poorly interconnected by narrow fracture networks. This conceptual model is believed to be reflective of why streams within the WSA can run fresh in shale areas despite most of the deeper waters being saline. It also explains increases in salinity of surface waters during drought conditions, or in certain reaches of creeks.

The elevated salinity of the Bringelly Shale may be attributed to either the presence of connate marine water (Old, 1942) and/or the accumulation of salt from evapotranspiration below the root zone of soils (Mcnally 2009). Coupled with an extended history of agricultural and landfilling activities throughout the South Creek catchment, the resulting groundwater quality is both highly saline and elevated with respect to concentrations of nutrients (nitrogen and phosphorous) and toxicants.

8.2.1. Groundwater Monitoring Network

Groundwater quality monitoring was undertaken by Cardno between May and December 2021 on boreholes located along the length of the project (**Figure 9**).

For the purpose of assessing discharge impacts, the groundwater monitoring network and results from groundwater monitoring have been sub-divided into boreholes located within the following project areas:

a. Northern station boxes and associated tunnels (SBT North), comprising:
   i. St. Marys Station
   ii. Claremont Meadows Services Facility (Shaft)
   iii. Orchard Hills Station.

b. Southern station boxes (SBT South), comprising:
   i. Bringelly Services Facility (Shaft)
   ii. Aerotropolis Core Station.

Airport Business Park Station, Airport Drive, and Airport Terminal Station are all located within the boundary of Western Sydney International Airport, which is subject to Commonwealth regulation under the *Commonwealth Airports Act, 1996*. Discharges from these sites will be managed under separate processes to satisfy commonwealth requirements.

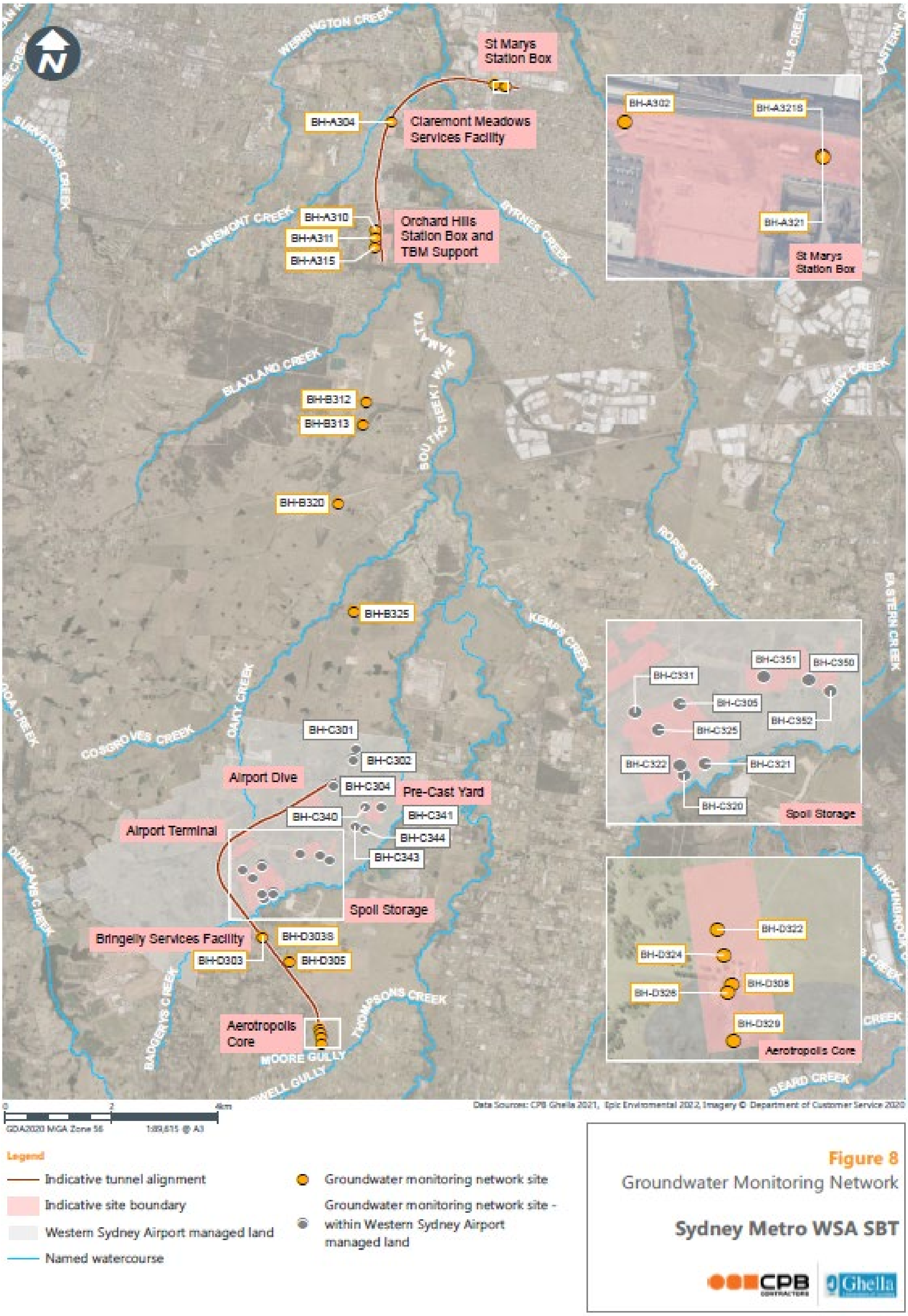


Figure 9: Groundwater Monitoring Network

8.2.1.1. SBT North

Eight (8) groundwater monitoring wells are present within the SBT North study area. The details of the groundwater monitoring bores are presented in Table 12.

Table 12: SBT North Groundwater Monitoring Wells

Borehole ID	Location	Easting	Northing
BH-A302	St Mary Station Area	293999.1956	6261951.403
BH-A321	St Mary Station Area	294199.7605	6261917.041
BH-A321S	St Mary Station Area	294200.1335	6261914.636
BH-A304	Claremont Meadows Service Facility	292037.3094	6261245.822
BH-A310	Orchard Hills Station Area	291736.6020	6259192.488
BH-A310S	Orchard Hills Station Area	291736.6089	6259190.538
BH-A311	Orchard Hills Station Area	291738.0600	6259050.542
BH-A315S	Orchard Hills Station Area	291726.6430	6258863.784

8.2.1.2. SBT South

Seven (7) groundwater monitoring wells are present within the SBT South study area comprising the Bringelly Services Facility, and the Aerotropolis Core Station. The details of the groundwater monitoring bores are presented in Table 13.

Table 13: SBT North Groundwater Monitoring Wells

Borehole ID	Location	Easting	Northing
BH-B303	Bringelly Services Facility	289600.5168	6245800.763
BH-D303S	Bringelly Services Facility	289598.8768	6245794.263
BH-D308	Aerotropolis Core Station	290714.7925	6243914.263
BH-D322	Aerotropolis Core Station	290676.6525	6244059.847
BH-D324	Aerotropolis Core Station	290694.8945	6243992.131
BH-D326	Aerotropolis Core Station	290704.1035	6243891.981
BH-D329	Aerotropolis Core Station	290720.0724	6243765.456

8.2.2. Laboratory Testing Programme

Groundwater quality samples were submitted for laboratory testing at a NATA accredited laboratory for the parameter groups listed in Table 14.

Table 14: Groundwater Quality Laboratory Testing Suites – Western Sydney Metro SBT Project

Groundwater Quality - Laboratory Testing Suites	
Physical Parameters	Non-Metallic Inorganics
Chlorinated Hydrocarbons	Polycyclic Aromatic Hydrocarbons
Halogenated Hydrocarbons	Aromatic Hydrocarbons
Nitrobenzenes and Nitrotoluenes	Monocyclic Aromatic Hydrocarbons
Phenols and Xylenols	Organics and Organic Sulfur Compounds

Groundwater Quality - Laboratory Testing Suites	
Anilines	Phthalates
Herbicides	Total Petroleum Hydrocarbons
General Pesticides	Semi-Volatile Organic Compounds
Organochlorine Pesticides	Perfluorocarbons
Metals and Metalloids	Nutrients

The laboratory testing covered a comprehensive suite of 342 analytes including 101 of the 175 parameters listed in the adopted ANZG (2018) default guideline values. The following ANZG (2018) chemical parameters for toxicants were not included in the laboratory testing results from groundwater monitoring:

- Non-Metallic Inorganics: Ammonium, Chlorine, Cyanide, Hydrogen Sulfide
- Organic Sulfur Compounds: Bis(Diethylthiocarbamyl)Disulfide, Bis(Dimethylthiocarbamyl)Sulfide
- Metals And Metalloids: Antimony, Arsenic (As Iii), Chromium (Cr Iii), Chromium (Cr VI) Silver, Thallium, Uranium
- Organochlorine Pesticides: Dicofol, Mirex
- Organophosphate Pesticides: Profenofos, Temephos
- General Pesticides: Carbofuran, Deltamethrin, Esfenvalerate, Methomyl, S-Methoprene
- Herbicides: 2,4,5-T, Acrolein, Atrazine, Diquat, Diuron, Glyphosate, Mcpa, Metolachlor, Metsulfuron-Methyl, Molinate, Paraquat, Simazine, Tebuthiuron, Thiobencarb, Thiram
- Phenols And Xylenols: 2,3,5,6-Tetrachlorophenol, 2,3-Dichlorophenol, 4-Chlorophenol, 2,4,6-Trinitrophenol
- Chlorobenzenes and Nitrobenzenes: 1,2,4,5-Tetrachloro-3-nitrobenzene, 1,2-Dichlorobenzene, 1,3,5-Trinitrobenzene, 1,3-Dinitrobenzene, 1,4-Dinitrobenzene, 1-Chloro-3-nitrobenzene, 1-Methoxy-2-nitrobenzene, Monochlorobenzene
- Nitrotoluenes and Nitroanilines: 2,4,6-Trinitrotoluene, 2,4-D, 2,4-Dichloroaniline, 2-Nitrotoluene, 3,4-Dichloroaniline, 3-Nitrotoluene, 4-Nitrotoluene
- Chloroethanes and Chloropropanes: Pentachloroethane, 1,1-Dichloropropane,
- Chlorinated Alkenes: 1,1,2,2-Tetrachloroethylene. 1,1,2-Trichloroethylene, 1,1-Dichloroethylene
- Polychlorinated Biphenyls: Aroclor 1242, Aroclor 1254
- Surfactants: Alcohol ethoxylated sulfate (AES), Alcohol ethoxylated surfactants (AE), Linear alkylbenzene sulfonates (LAS)
- Oil Spill Dispersants: BP 1100X, Corexit 9527, Corexit 9550
- Miscellaneous Industrial Chemicals: Dimethylformamide, Isophorone, Poly(acrylonitrile-co-butadiene-co-styrene)
- Organic Alcohols: Ethanol, Ethylene glycol, Isopropyl alcohol

The concentrations of most ANZG (2018) parameter suites were partially or fully quantified in groundwater samples with the exception of herbicides, surfactants, oil spill dispersants, miscellaneous industrial chemicals, and organic alcohols.

The laboratory limits of reporting (LOR) were higher than the ANZG (2018) 95% and 99% species protection default guideline values for the following 20 parameters:

- Non-Metallic Inorganics: Nitrate & Nitrite (as N)
- Polycyclic Aromatic Hydrocarbons: Anthracene
- Phenols: 2,4-dimethylphenol, Aldrin, DDT, Methoxychlor, Azinophos methyl, Chlorpyrifos, Diazinon, Dimethoate, Fenitrothion, Malathion, Trifluralin
- Pesticides: Parathion, 2,4,6-trichlorophenol, Pentachlorophenol
- Halogenated Hydrocarbons: 1,2,3,4-tetrachlorobenzene, 1,2,3,5-Tetrachlorobenzene, Pentachlorobenzene
- Phthalates: Bis(2-ethylhexyl) phthalate.

8.2.3. Laboratory Testing Results – SBT North Project Area

Up to three rounds of groundwater sampling have been completed for groundwater monitoring wells located within the SBT North Study Area. The results from laboratory testing have been screened against the adopted ANZG (2018) and ANZECC (2000) Default Guideline Values.

The elevated salinity and concentrations of nutrients / toxicants of groundwater in the Bringelly Shale represents a key factor affecting the management approach to the discharge of treated groundwater inflows / construction water to receiving waterways. The adopted management measures are discussed further in **Section 7**.

8.2.3.1. St Marys Station

The results from two (2) rounds of laboratory testing for groundwater samples taken at the three (3) monitoring wells within the footprint of St Marys Station have found exceedances of the NSW EPA (2022), ANZG (2018) 95% and 99% species protection criteria and ANZECC (2000) DGV for seventeen (17) parameters. The parameters exceeding the ANZG (2018) and ANZECC (2000) DGV are listed in Table 15 alongside summary statistics from the laboratory testing results.

Table 15: St Marys Station Water Quality DGV Exceedances in Groundwater

Parameter Group	Parameter	DGV	Min	Max	Average
Physical and Chemical Stressors	Electrical Conductivity (µs/cm)	125- 2,200	16,000	23,000	19,500
	Nitrogen (mg/L)	1.72	0.2	0.6	0.33
	Phosphorous (mg/L)	0.14	0.02	0.19	0.09
	Reactive Phosphorous (mg/L)	0.02	0.01	0.04	0.03
Filtered Metals and Metalloids [1]	Cadmium (mg/L)	0.0002	0.0002	0.0008	0.0004
	Chromium (mg/L)	0.001	0.001	0.002	0.0013
	Cobalt (mg/L)	0.0014	0.009	0.034	0.0177
	Copper (mg/L)	0.0014	0.001	0.022	0.0083
	Lead (mg/L)	0.0034	0.001	0.004	0.002
	Manganese (mg/L)	1.9	0.41	6.4	2.603
	Mercury (mg/L)	0.00006	0.00001	0.0001	0.00005
	Nickel (mg/L)	0.011	0.017	0.046	0.0277
	Vanadium (mg/L)	0.006	0.005	0.019	0.0097
	Zinc (mg/L)	0.008	0.021	0.029	0.025
Inorganics	Ammonia (mg/L)	0.9	0.03	1.3	0.843
Organochlorine Pesticides	Endosulfan (µg/L)	0.03	0.01	0.23	0.11
	Methoxychlor (µg/L)	0.005	0.01	0.2	0.12

* Results based on filtered samples for all metals

1 Total (unfiltered) concentrations of aluminium and iron recorded above adopted DGV

Result exceeds adopted default guideline value

8.2.3.2. Claremont Meadows Service Facility

The results from two rounds of laboratory testing for groundwater samples taken at the monitoring well within the vicinity of Claremont Meadows have found exceedances of the ANZG (2018) and ANZECC (2000) DGV for ten (10) parameters. The parameters exceeding the ANZG (2018) and ANZECC (2000) DGV are listed in Table 16 alongside summary statistics from the laboratory testing results.

Table 16: Claremont Meadows Water Quality DGV Exceedances in Groundwater

Parameter Group	Parameter	DGV	Min	Max	Average
Physical and Chemical Stressors	Electrical Conductivity (µs/cm)	125 - 2,200	16,000	16,000	16,000
	Nitrogen (mg/L)	1.72	0.2	0.9	0.55
	Phosphorous (mg/L)	0.14	0.02	0.5	0.28
	Reactive Phosphorous (mg/L)	0.02	0.01	0.05	0.03
Filtered Metals and Metalloids [1]	Arsenic (mg/L) [1]	0.013	0.017	0.017	0.017
	Cobalt (mg/L)	0.0014	0.003	0.003	0.003
	Copper (mg/L)	0.0014	0.002	0.002	0.002
	Iron (mg/L)	0.3	4.1	4.1	4.1
	Vanadium (mg/L)	0.006	0.015	0.015	0.015
Inorganics	Ammonia (mg/L)	0.9	0.62	0.97	0.795

* Results based on filtered samples for all metals

1 Total (unfiltered) concentrations of aluminium and zinc recorded above adopted DGV

Result exceeds adopted default guideline value

8.2.3.3. Orchard Hills

The results from two (2) rounds of laboratory testing for groundwater samples taken at the four (4) monitoring wells within the vicinity of Orchard Hills Station have found exceedances of the ANZG (2018) and ANZECC (2000) Default Guideline Values for fourteen (14) parameters. The parameters exceeding the ANZG (2018) and ANZECC (2000) Default Guideline Values are listed in Table 17 alongside summary statistics from the laboratory testing results.

Table 17: Orchard Hills Water Quality DGV Exceedances in Groundwater

Parameter Group	Parameter	DGV	Min	Max	Average
Physical and Chemical Stressors	Electrical Conductivity (µs/cm)	125 - 2,200	21,000	29,000	26,000
	pH (units)	6.5 -8.0	5.00	8.00	6.20
	Nitrogen (mg/L)	1.72	0.2	1.5	0.525
	Phosphorous (mg/L)	0.14	0.02	3.7	0.77
	Reactive Phosphorous (mg/L)	0.02	0.02	0.05	0.038
Filtered Metals and Metalloids [1]	Aluminium (mg/L)	0.055	0.05	0.19	0.138
	Cadmium (mg/L)	0.0002	0.0002	0.0004	0.00025
	Cobalt (mg/L)	0.0014	0.22	0.87	0.49
	Copper (mg/L)	0.0014	0.003	0.012	0.00575
	Iron (mg/L)	0.3	0.3	9.7	4.9
	Manganese (mg/L)	1.9	1.9	43	13.98
	Mercury (mg/L)	0.00006	0.00001	0.018	0.00465
	Nickel (mg/L)	0.011	0.1	0.24	0.148
	Zinc (mg/L)	0.008	0.041	0.27	0.16

* Results based on filtered samples for all metals

1 Total (unfiltered) concentrations of aluminium and iron recorded above adopted DGV

Result exceeds adopted default guideline value

8.2.4. Laboratory Testing Results – SBT South Project Area

Up to three (3) rounds of groundwater sampling have been completed for groundwater monitoring wells located within the SBT South Study Area. The results from laboratory testing (excluding on-airport sites) have been screened against the adopted ANZG (2018) and ANZECC (2000) Default Guideline Values.

8.2.4.1. Bringelly Services Facility

The results from three (3) rounds of laboratory testing for groundwater samples taken at the two (2) monitoring wells within the vicinity of Bringelly Services Facility have found exceedances of the ANZG (2018) and ANZECC (2000) Default Guideline Values for ten (10) parameters. The parameters exceeding the ANZG (2018) and ANZECC (2000) Default Guideline Values are listed in Table 18 alongside summary statistics from the laboratory testing results.

Table 18: Bringelly Services Facility Water Quality DGV Exceedances in Groundwater

Parameter Group	Parameter	DGV	Min	Max	Average
Physical and Chemical Stressors	Electrical Conductivity (µs/cm)	125 - 2,200	21,000	32,000	27,166
	Nitrogen (mg/L)	1.72	0.2	3.4	1.675
	Phosphorous (mg/L)	0.14	0.01	0.17	0.088
	Reactive Phosphorous (mg/L)	0.02	0.07	0.16	0.097
Filtered Metals and Metalloids [1]	Cobalt (mg/L)	0.0014	0.001	0.004	0.0023
	Copper (mg/L)	0.0014	0.001	0.016	0.0043
	Iron (mg/L)	0.3	0.05	0.68	0.232
	Nickel (mg/L)	0.011	0.006	0.095	0.0235
	Zinc (mg/L)	0.008	0.005	0.04	0.0206
Inorganics	Ammonia (mg/L)	0.9	0.07	4.4	1.91

* Results based on filtered samples for all metals

1 Total (unfiltered) concentrations of aluminium and iron recorded above adopted DGV

Result exceeds adopted default guideline value

8.2.4.2. Aerotropolis Core Station

The results from three (3) rounds of laboratory testing for groundwater samples taken at the five (5) monitoring wells within the vicinity of Aerotropolis Core Station have found exceedances of the ANZG (2018) and ANZECC (2000) Default Guideline Values for twelve (12) parameters. The parameters exceeding the ANZG (2018) and ANZECC (2000) Default Guideline Values are listed in Table 19 alongside summary statistics from the laboratory testing results.

Table 19: Aerotropolis Core Station Water Quality – DGV Exceedances in Groundwater

Parameter Group	Parameter	DGV	Min	Max	Average
Physical and Chemical Stressors	Electrical Conductivity (µs/cm)	125 - 2,200	8,500	20,000	14,625
	pH (units)	6.5 -8.0	7.6	8.2	7.9
	Nitrogen (mg/L)	1.72	0.4	4.9	2.917
	Nitrate & Nitrite	0.66	0.05	1.9	0.38
	Phosphorous (mg/L)	0.14	0.01	0.55	0.183
	Reactive Phosphorous (mg/L)	0.02	0.01	0.14	0.0567
	Cobalt (mg/L)	0.0014	0.001	0.005	0.0027

Parameter Group	Parameter	DGV	Min	Max	Average
Filtered Metals and Metalloids 1	Copper (mg/L)	0.0014	0.001	0.01	0.047
	Iron (mg/L)	0.3	0.05	0.9	0.413
	Nickel (mg/L)	0.011	0.003	0.024	0.0137
	Zinc (mg/L)	0.008	0.012	0.022	0.016
Inorganics	Ammonia (mg/L)	0.9	0.29	3.8	1.856

* Results based on filtered samples for all metals
Result exceeds adopted default guideline value

8.2.5. Summary

Groundwater monitoring has been undertaken on several occasions for boreholes located across the project area. Groundwater monitoring has included the collection and scheduling of samples for laboratory testing, including testing of the parameter groups listed in Table 14.

The results from laboratory testing of groundwater samples have detected elevated concentrations of toxicant compounds at values exceeding the adopted screening criteria, including trace metals and metalloids, inorganics, and organochlorine pesticides.

Laboratory testing results have also detected elevated levels of physical and chemical stressors at values exceeding the adopted screening criteria, including salinity (electrical conductivity), pH, total nitrogen, oxidised nitrogen, phosphorous and reactive phosphorous

Groundwater inflows are anticipated to occur into excavations and tunnels where they extend beneath the water table. To enable construction, groundwater inflows will be pumped or drained away from active construction areas and into dedicated water treatment plants (discussed further in **Section 8)**.

The elevated salinity and concentrations of nutrients / toxicants of groundwater in the Bringelly Shale represents a key factor affecting the management approach to the discharge of treated groundwater inflows / construction water to receiving waterways (discussed further in **Section 8).**

9. Surface Water

9.1. Background Water Quality

South Creek Catchment in Western Sydney is one of the most heavily degraded catchments in Australia (Hawkesbury-Nepean CMA, 2007). The catchment has suffered from high pollution loads, increased impervious surfaces from urbanisation, and long-term clearing of vegetation resulting in a rise of saline groundwater into streams and increased sediment runoff (Boon, 2017).

Extensive water quality sampling has been conducted in South Creek catchment by a range of NSW government departments including the EPA and DLWC, Sydney Water Corporation, Sydney Catchment Authority, and local governments including Blacktown, Camden, Hawkesbury and Penrith City Councils (Rae, 2007).

The major water quality issues in South Creek are related to high nutrient concentrations derived from both point and diffuse pollution sources and subsequent algal and aquatic weed growth.

Diffuse pollution sources are often more difficult to quantify and manage than point sources, and in the South Creek Catchment typically comprise agricultural runoff. Sydney Water Sewage Treatment Plants represent a significant source of point source pollution to the South Creek Catchment. Ongoing water quality monitoring is being conducted in South Creek catchment by Sydney Water as part of their performance assessment required to satisfy environmental protection licences.

Monitoring of the volumes of water and pollutant loads being discharged from licensed premises within South Creek catchment is conducted by NSW EPA in order to determine pollutant fees under the load-based licensing system (DEC 2005b). Load based licence data and details about non-compliance are provided on the NSW EPA Public Register under section 308 of the Protection of the Environment Operations Act 1997. In addition to the 5 STPs licensed to discharge to waterways in South Creek catchment, there are around 20 other activities, but these are usually only licensed for wet weather discharge.

9.2. Background Flow Conditions and Water Cycle

The water cycle of the South Creek catchment is quite complex due to a range of water sources and users. The urban areas are supplied with potable water, from dams outside the catchment, by the Sydney Water Corporation. There are sewage treatment plants, which discharge treated effluent into the South Creek and its main tributary, the Eastern Creek (Singh et al., 2009a).

The annual rainfall for the whole of the South Creek catchment has historically varied from 457 to 995 mm per year with an average of 681 mm per year (Rae, 2007). Average runoff has varied from 19 to 445 mm per year with runoff coefficients ranging from 0.04 to 0.45 in different subcatchments with an average of 0.20 for whole of the South Creek catchment.

The minimum monthly runoff volume in the South Creek catchment was estimated about 68 ML in October 2002, and the maximum about 1,13,537 ML in February 1992. The average monthly runoff volume varied from 3,252 ML in June to 21,083 ML in February (Rae, 2007). Monthly rainfall and runoff statistics for the South Creek Catchment from Rae, 2007 are provided in Table 20.

Table 20: Surface Water Monitoring Network

Month	Rainfall Average	Rainfall Min	Rainfall Max	Runoff Average	Runoff Min	Runoff Max
January	53,327	10,437	97,561	9,235	973	36,490
February	64,832	8,528	186,703	21,083	1,012	113,537
March	43,014	12,560	126,417	8,072	1,505	31,444
April	24,816	907	80,517	4,447	366	15,395
May	33,480	4,418	92,510	8,348	382	46,388
June	18,887	758	42,627	3,252	317	17,374

Month	Rainfall Average	Rainfall Min	Rainfall Max	Runoff Average	Runoff Min	Runoff Max
July	22,102	640	70,740	3,628	605	16,130
August	20,557	8	126,005	7,496	241	83,885
September	27,775	3,122	93,921	4,364	290	21,579
October	32,233	1,611	110,789	4,686	68	21,438
November	45,999	9,359	100,107	6,201	794	19,462
December	38,490	13,142	117,088	5,752	1,133	19,628

The annual wastewater generated from residential and non-residential indoor water use varied from 23.9 to 30.1 GL per year, with an average of 26.2 GL per year in the South Creek catchment from 1992 to 2006. Nearly 11 per cent of the wastewater generated in the catchment was discharged through on-site sewage disposal systems (Rae, 2007).

The Sydney Water Corporation also supplies potable water for irrigation of some recreation spaces (golf courses, sporting field and parks) and some intensive horticultural activities such as market gardens, hydroponics, greenhouses and nurseries. There are also properties that have entitlements to extract water from surface water and groundwater sources mainly for irrigation purposes (Singh et al., 2009a).

The Water Balance Components in the South Creek Catchment are as follows (Singh, et al., 2009):

- Water supply sources:
  - Potable water supply from outside the catchment
  - Surface water extractions from streamflows
  - Stormwater harvesting from urban areas
  - Treated effluent from sewage treatment plants
  - Groundwater
- Catchment inflows:
  - Rainfall that leads to runoff, infiltration, and streamflow
  - Potable water supplied for indoor water use in residential, non-residential and commercial properties, generally returned as effluent discharge through sewage treatment plants
  - Potable water supplied for outdoor water use in gardening and irrigation of periurban horticultural activities, sporting fields, parks, etc
- Catchment outflows:
  - Evapotranspiration
  - Streamflow (to the Hawkesbury River)
- Catchment storages
  - Surface water storage (mainly farm ponds)
  - Soil water storage (unsaturated zone)
- Activities that modify streamflow:
  - Rainfall-runoff (from infiltration excess runoff over impervious and pervious surfaces, soil saturation excess subsurface runoff, and baseflow runoff)
  - Effluent discharges
  - Surface water extractions
- Principal water users (stakeholders):
  - Residential indoor and outdoor (lawn/garden watering)
  - Non-residential/Commercial/Community properties

- Irrigated agriculture and horticulture activities
- Recreational space, i.e. golf courses, sporting fields and parks
- Environmental flows (ecosystems)

The use of groundwater in the South Creek catchment is not significant mainly due to low groundwater yields (< 1 litre per second), high salinity (> 3,000 mg per litre TDS), slow rates of vertical and horizontal groundwater flow, and low porosity and permeability of the Hawkesbury Sandstone aquifer underneath the Cumberland Plains in Western Sydney (Singh et al., 2009a; Russell, 2007).

9.3. Catchment Flow Monitoring

South Creek has two stream gauges managed by WaterNSW located at Elizabeth Drive (212320) and at the Great Western Highway (Station 212048). The gauges have reported streamflow in South Creek at Elizabeth Drive since 1970 and since 1986 at the Great Western Highway. The catchment areas to both stream gauges are provided in **Figure 10**. Plots of the streamflow over these periods are provided as **Figure 11**.

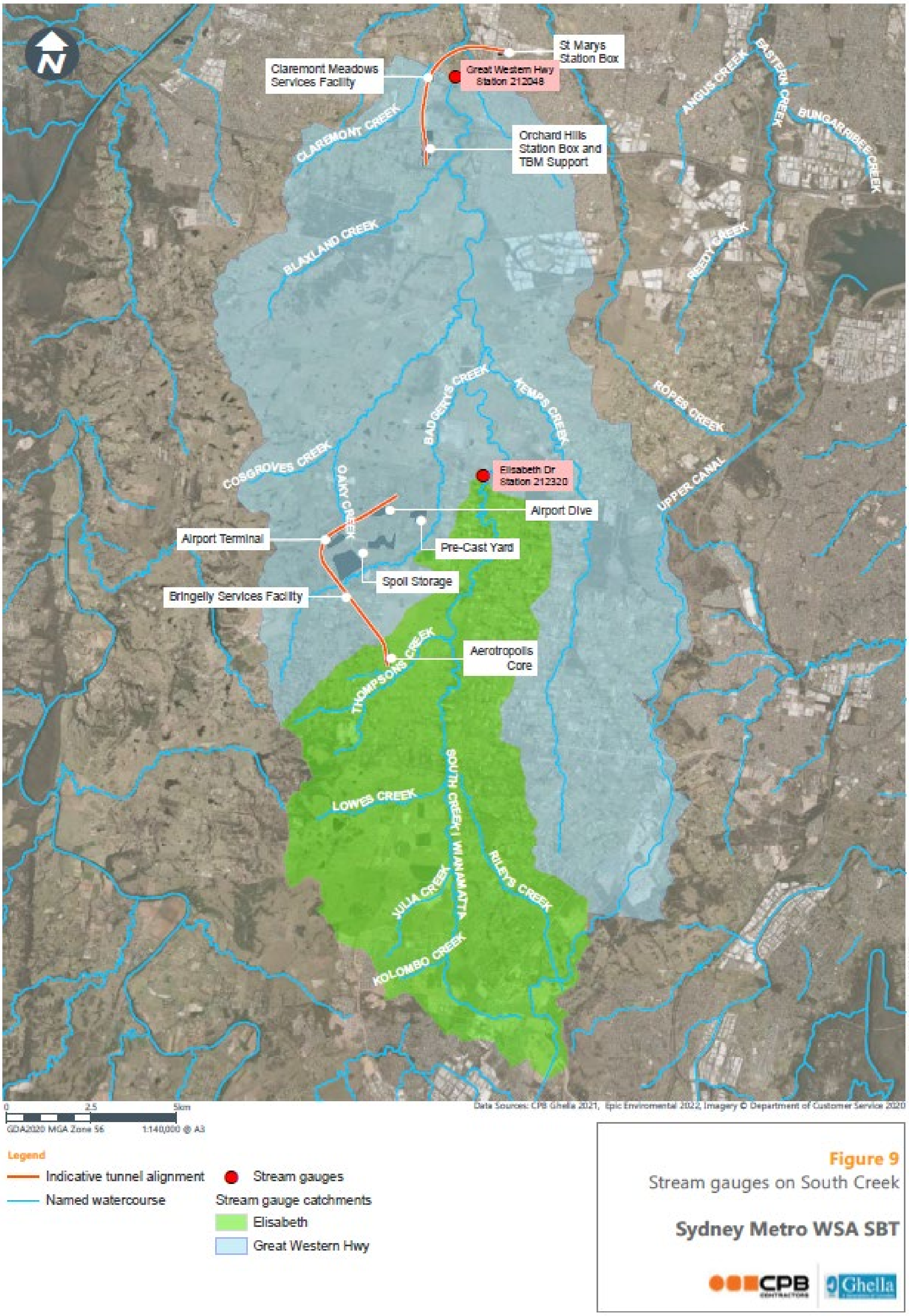
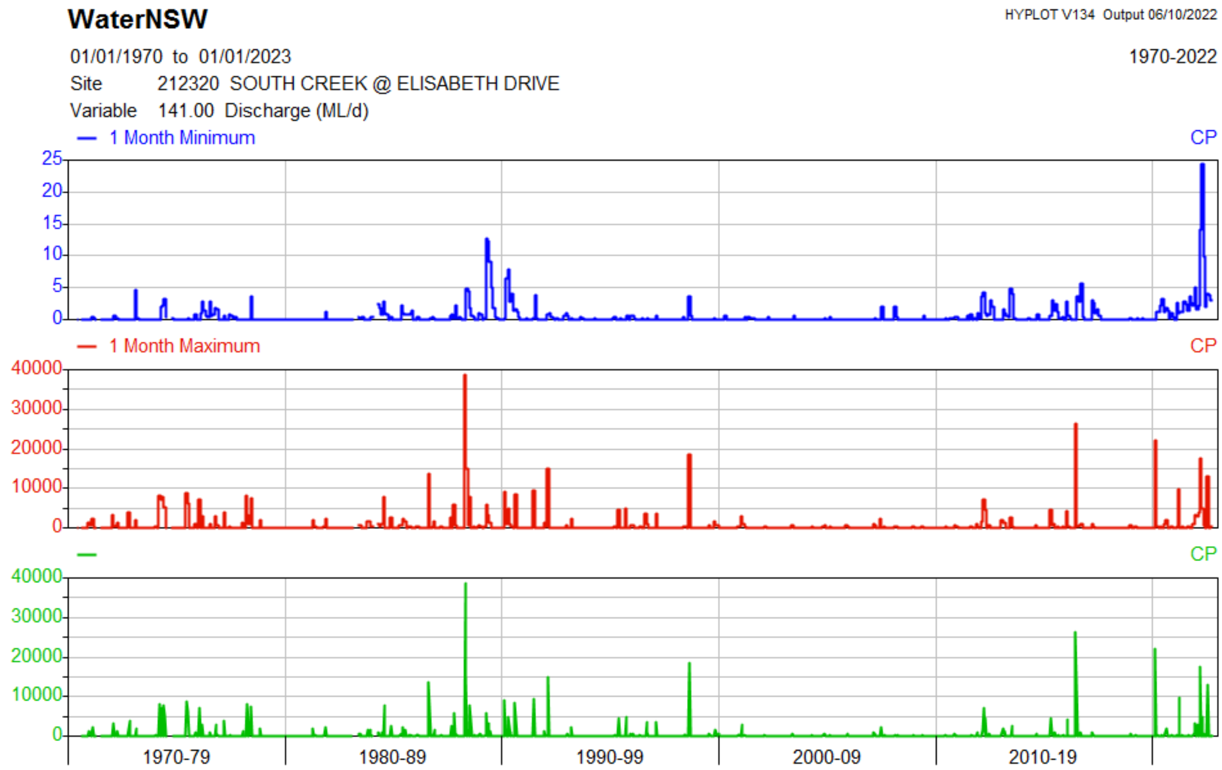


Figure 10: Stream gauges on South Creek (Source WaterNSW portal, 2022)



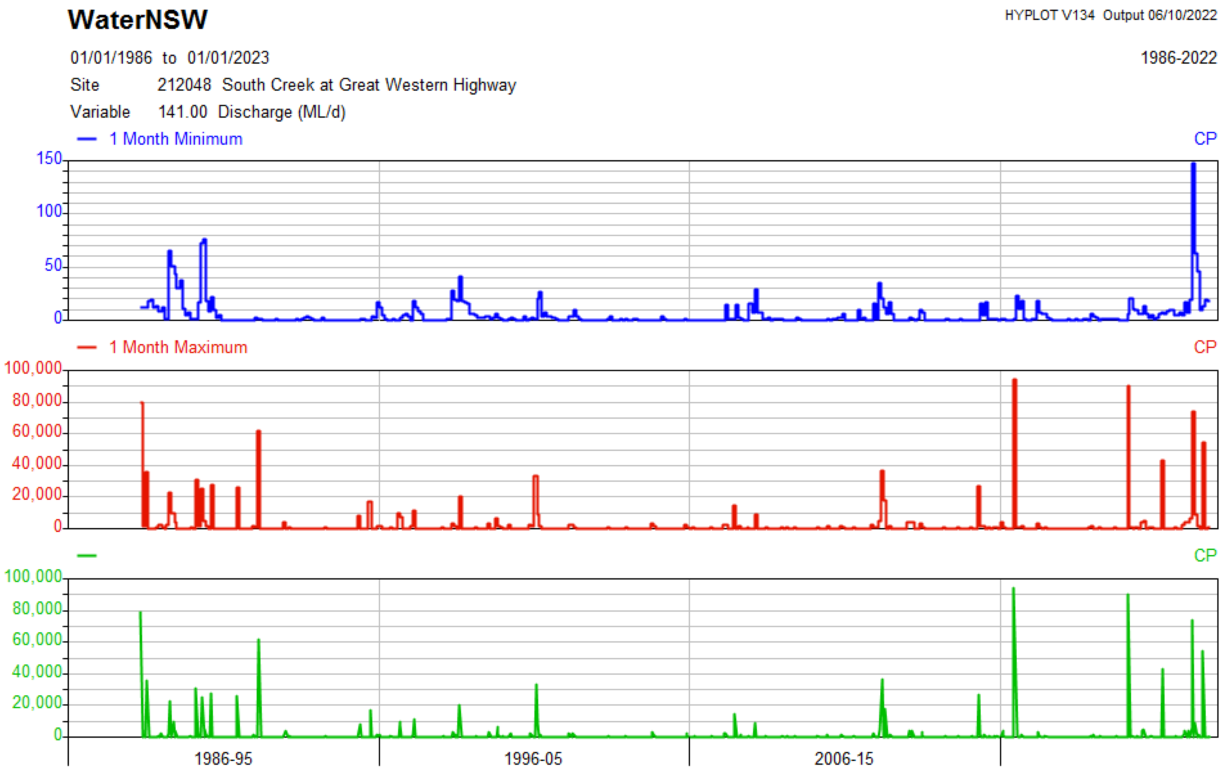


Figure 11: Stream flows for gauges on South Creek (Source WaterNSW portal, 2022)

9.4. Project Specific Flow Modelling

As discussed in the previous section, South Creek has two streamflow gauges with one at Elizabeth Drive and the other at the Great Western Highway. There are no known gauges on the other waterways.

An Australian Water Balance Model (AWBM) has been developed through the Rainfall Runoff Library and calibrated to the recorded gauge flows at Elizabeth Drive to quantify flows in receiving waterways for the project, including South Creek, Thompsons Creek, Badgerys Creek, and Claremont Creek.

The Elizabeth Drive gauge (Site 212320) was selected as the reference site for the calibration as it has a contributing catchment of 88km^2 which is similar to the smaller worksite catchments, and has streamflow records dating back to September 1970. These data were downloaded and utilised in the AWBM model.

Rainfall was obtained for the same period from the BOM Station Number 67084 (Orchard Hills Treatment Works). Where there were gaps in the rainfall record at Station 67084 data from the closest rainfall stations were used to infill those gaps. These included data from:

- Station Number 67024 (St Marys Bowling Club);
- Station Number 67068 (Badgerys Creek McMasters F.Stn)
- Station Number 67016 (Minchinbury);
- Station Number 67019 (Prospect Reservoir); or
- Station Number 67026 (Seven Hills – Collins St).

Evapotranspiration data was obtained from the Badgerys Creek site noted above.

The adopted parameters were then run for the Great Western Highway catchment and compared against the observed streamflow records to validate the adopted AWBM parameters. The adopted AWBM model parameters are listed below in **Table 21**.

Table 21: Calibrated AWBM parameters

AWBM Parameter	Adopted Value
A1	0.134
A2	0.433
Base Flow Index (BFI)	0.26
C1	14.1
C2	191.2
C3	80.4
KBase	0.935
KSurf	0.055

The values in **Table 21** were applied to the project catchment area to simulate flow conditions in the receiving waterways for SBT1 – SBT5. Simulated streamflow was estimated for the period 2015-2021 to match with the observed water quality data.

The model was run and auto calibrated to determine key runoff parameters to generate a simulated runoff time series as close as possible to the recorded data. The model provided a reasonable calibration with a Nash-Sutcliffe Criterion for calibration of 0.504. The model slightly underestimates rare flows and the frequent low flows and slightly overestimates moderate flows as shown in the flow duration curve in **Figure 12**. This plot is a graphical representation of a ranking of all the flows, from the lowest to the highest, where the rank is the percentage of time the flow value is equalled or exceeded.

The graph shows that the simulated flows with a frequency of around 0.005 (0.5% of the adopted time period) are slightly lower than the observed flows, however the more frequent flows show a good correlation. As this assessment is primarily concerned with discharges after frequent rainfall events during lower and moderate flow periods, the calibration is considered satisfactory.

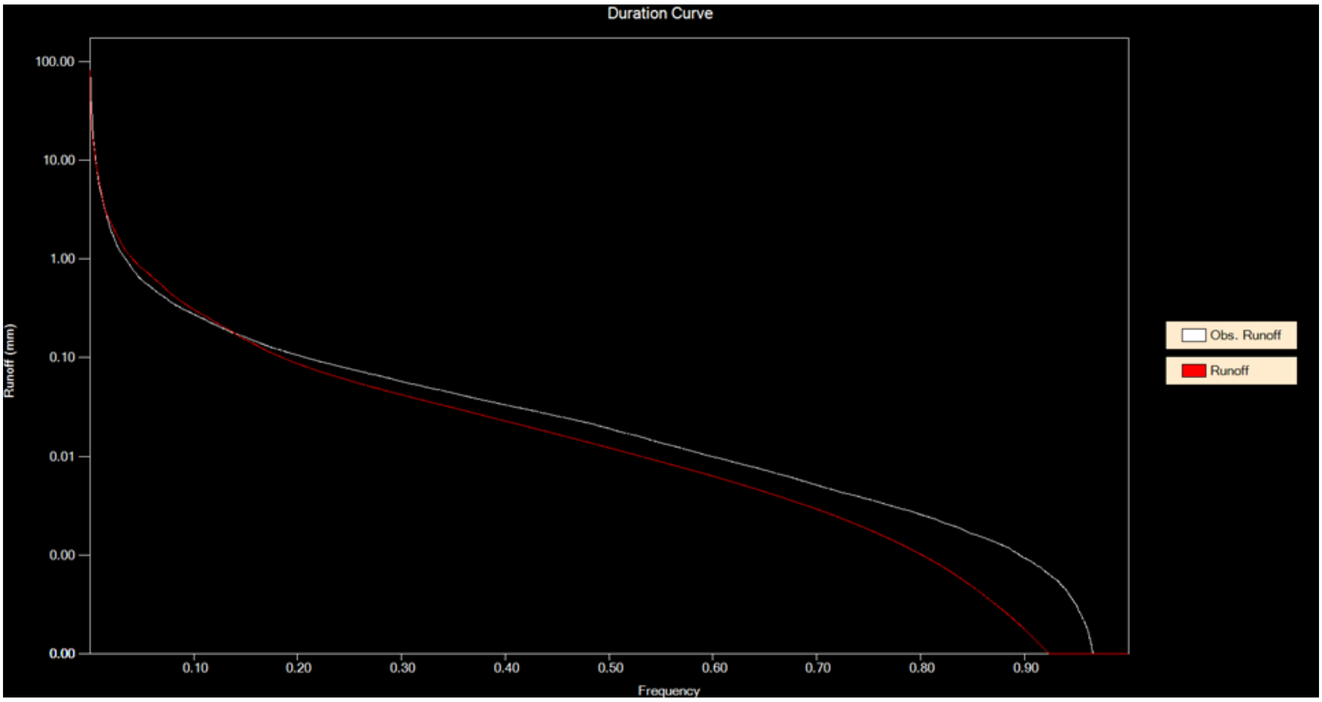


Figure 12: AWBM Calibration flow duration curve of observed vs simulated runoff at South Creek – Great Western Highway.

Flow statistics for receiving waterways are summarized in Table 22 and Table 23, including:

- Thompsons Creek (Aerotropolis Core Station)
- Badgerys Creek (Bringelly Services Facility)
- South Creek at Great Western Highway (Orchard Hills Station)
- Claremont Creek (Claremont Meadows Services Facility)
- South Creek at Elizabeth Drive (St Marys Station).

Table 22: Receiving Environment Flow Statistics (m3/s)

Flow Statistic	Thompsons Creek (m^3/s)[1]	Badgerys Creek (m^3/s)[1]	Claremont Creek (m^3/s)[1]	South Creek at Great Western Highway (m^3/s)[2]	South Creek at Elizabeth Drive (m^3/s)[2]
Min	3.21×10^{-9}	3.74×10^{-9}	4.08×10^{-9}	0	0
Max	12.10	14.09	15.37	562.37	189.81
Average	0.039	0.045	0.049	1.45	0.342
Q10	3.31×10^{-5}	3.85×10^{-5}	4.20×10^{-5}	3.47×10^{-3}	0
Q20	1.67×10^{-4}	1.95×10^{-4}	2.12×10^{-4}	9.50×10^{-3}	0
Median	1.76×10^{-3}	2.05×10^{-3}	2.23×10^{-3}	7.84×10^{-2}	1.38×10^{-3}
Q80	1.36×10^{-2}	1.58×10^{-2}	1.72×10^{-2}	0.42	0.04
Q90	4.40×10^{-2}	5.13×10^{-2}	5.59×10^{-2}	1.09	0.14

[1] Source: SEEC (2022)

[2] Source: WaterNSW (2022)

Table 23: Receiving Environment Flow Statistics (ML/d)

Flow Statistic	Thompsons Creek (ML/d)[1]	Badgerys Creek (ML/d)[1]	Claremont Creek (ML/d)[1]	South Creek at Great Western Highway (ML/d)[2]	South Creek at Elizabeth Drive (ML/d)[2]
Min	2.77×10^{-7}	3.22×10^{-7}	3.52×10^{-7}	0	0

Flow Statistic	Thompsons Creek (ML/d)[1]	Badgerys Creek (ML/d)[1]	Claremont Creek (ML/d)[1]	South Creek at Great Western Highway (ML/d)[2]	South Creek at Elizabeth Drive (ML/d)[2]
Max	1,045.58	1,217.25	1,328.17	48588.73	16399.51
Average	3.34	3.88	4.24	125.06	29.73
Q10	0.0029	0.0033	0.0036	0.30	0
Q20	0.014	0.017	0.018	0.82	0
Median	0.15	0.18	0.19	6.78	0.13
Q80	1.17	1.36	1.49	36.01	3.31
Q90	3.80	4.43	4.83	94.18	12.43

[1] Source: SEEC (2022)

[2] Source: WaterNSW (2022)

The flow statistics show that downstream South Creek (median 6.78 ML/d) experiences significantly greater flow rates than it's contributing tributaries (median 0.15 – 0.19 ML/d).

It is noted that the Elizabeth Drive monitoring location (median 0.13 ML/d) is located at the outfall of the Elizabeth Catchment, with the Great Western Highway flow monitoring location located at the outfall of the hydraulically downgradient, and much more expansive, Great Western Highway catchment.

The variance observed between the two South Creek sampling locations is considered representative of the respective catchment areas of 250 km^2 and 88 km^2 (Great Western catchment and Elizabeth catchment respectively) (Water NSW 2022).

9.4.1. Project Monitoring and Sampling Activities

Baseline surface water monitoring for both flow and water quality has been undertaken by CPB to provide an assessment of existing conditions prior to potential impacts from construction activities.

A total of five (5) surface water monitoring locations were chosen to represent the hydraulically upgradient and downgradient conditions within the catchment. Details on the monitoring locations are provided in Table 24.The location of the monitoring network is shown in **Figure 13**. Survey cross sections of each monitoring site are presented in **Figures 14-18**.

Table 24: Surface Water Monitoring Network

Sampling Location ID	Sampling Location Description	Rationale	Easting	Northing
SBT1	South Creek at Claremont Meadows	Downstream of Orchard Hills Discharge, and all other monitoring points	292826.416	6263376.829
SBT2	Claremont Creek at Werrington	Downstream of Claremont Meadows Discharge	292414.553	6261639.247
SBT3	South Creek at St Mary's	Downstream of St Marys Discharge	293221.851	6261549.896
SBT4	Badgerys Creek	Downstream of Bringelly Discharge	290828.193	6246740.045
SBT5	Thompsons Creek, Bringelly	Adjacent to Aerotropolis Discharge	291596.151	6244007.727

Water quality parameters that have been tested include:

- Total recoverable hydrocarbons (TRH).
- Polycyclic aromatic hydrocarbons (PAHs) and trace phenols.
- Volatile organic compounds (VOCs).
- Benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN).

- Metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn).
- Trace organochlorine and organophosphorus pesticides.
- Nutrients (nitrate, nitrite, ammonia, total Kjeldahl nitrogen, total phosphorous, reactive phosphorous, total nitrogen).
- Total suspended solids (TSS).
- Turbidity.

9.4.1.1. Flow Monitoring

Flow monitoring was undertaken between 16 August and 15 September 2022 by CPBGJV to validate data obtained through the Water NSW database; a total of nine flow monitoring events were undertaken across five locations. Details on flow rate observations are provided in Table 25.

Water levels at each monitoring location were not available for each flow monitoring event. As such the discharge rates cannot be calculated for receiving waterways beyond the initial surveyed waters levels on 08/09/2022.

Table 25: Flow Monitoring

Flow Monitoring Location (Site ID)	Surveyed Cross Sectional Wetted Area (m^2)	Monitoring Date	Observed Velocity (m/s)	Indicative Flow Rate (m^3/s)
South Creek at Claremont (SBT1)	3.44	16/08/2022	0.1	ND
		17/08/2022	0.1	ND
		24/08/2022	0.1	ND
		25/08/2022	0.1	ND
		31/08/2022	0.1	ND
		6/09/2022	0.1	ND
		8/09/2022	0.1	0.344
		13/09/2022	0.1	ND
		15/09/2022	0.1	ND
Claremont Creek (SBT2)	0.88	16/08/2022	0.2	ND
		17/08/2022	0.2	ND
		24/08/2022	0.1	ND
		25/08/2022	0.3	ND
		31/08/2022	0.1	ND
		6/09/2022	0.2	ND
		8/09/2022	0.1	0.088
		13/09/2022	0.1	ND
		15/09/2022	0.1	ND
South Creek at St Mary's (SBT3)	0.51	16/08/2022	0.7	ND
		17/08/2022	0.8	ND
		24/08/2022	0.8	ND
		25/08/2022	0.8	ND
		31/08/2022	0.8	ND
		6/09/2022	1	ND
		8/09/2022	0.8	0.408
		13/09/2022	0.8	ND
		15/09/2022	0.8	ND
Badgerys Creek (SBT4)	0.48	16/08/2022	0.5	ND
		17/08/2022	0.4	ND
		24/08/2022	0.3	ND
		25/08/2022	0.4	ND
		31/08/2022	0.3	ND
		6/09/2022	0.2	ND
		8/09/2022	0.2	0.096
		13/09/2022	0.2	ND
		15/09/2022	0.2	ND
Thompsons Creek (SBT5)	0.08	16/08/2022	0.4	ND
		17/08/2022	0.5	ND
		24/08/2022	0.6	ND

Flow Monitoring Location (Site ID)	Surveyed Cross Sectional Wetted Area (m^2)	Monitoring Date	Observed Velocity (m/s)	Indicative Flow Rate (m^3/s)
		25/08/2022	0.7	ND
		31/08/2022	0.6	ND
		6/09/2022	0.2	ND
		8/09/2022	0.2	0.016
		13/09/2022	0.2	ND
		15/09/2022	0.2	ND

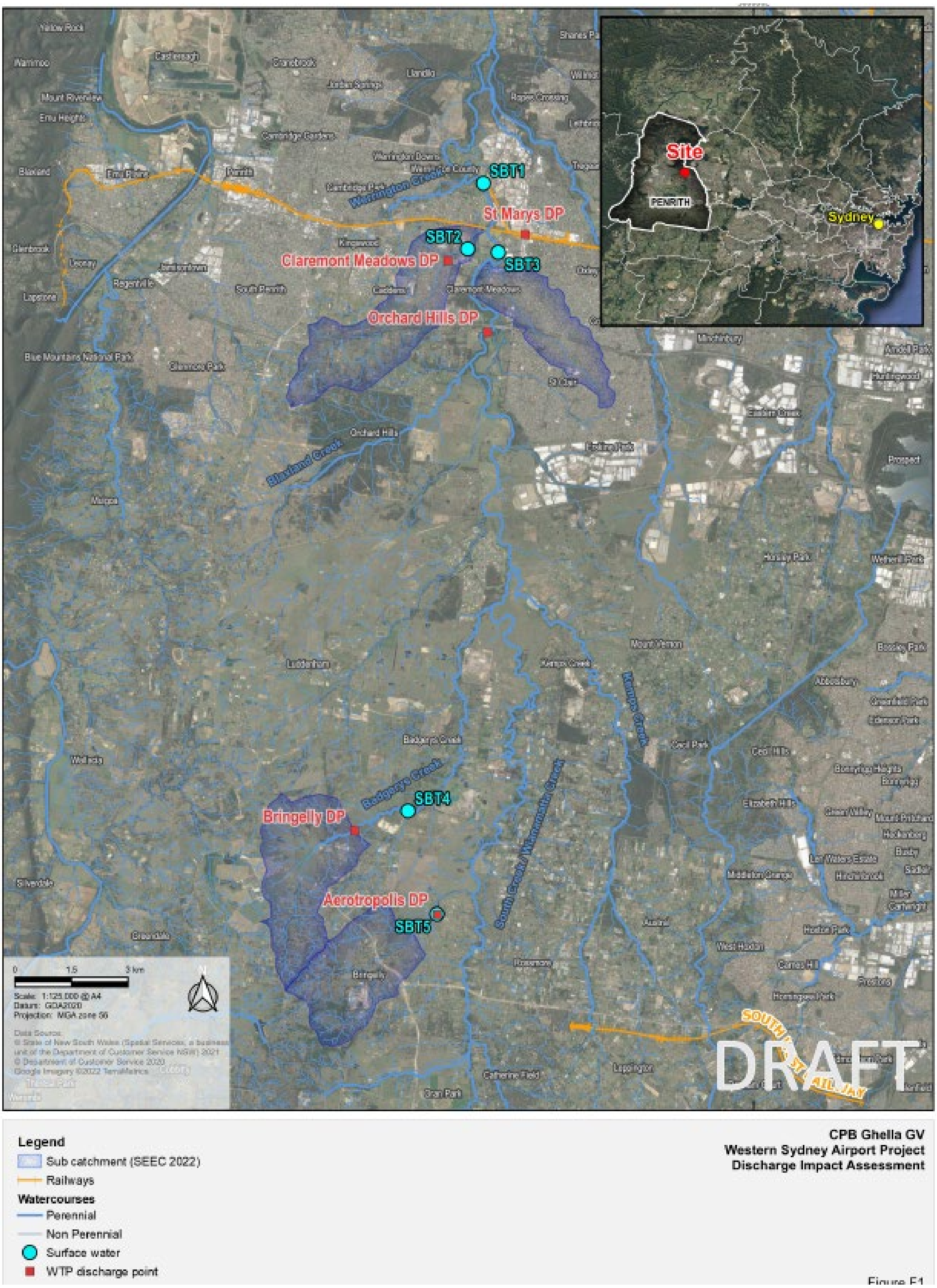


Figure 13: Surface Water Monitoring Network

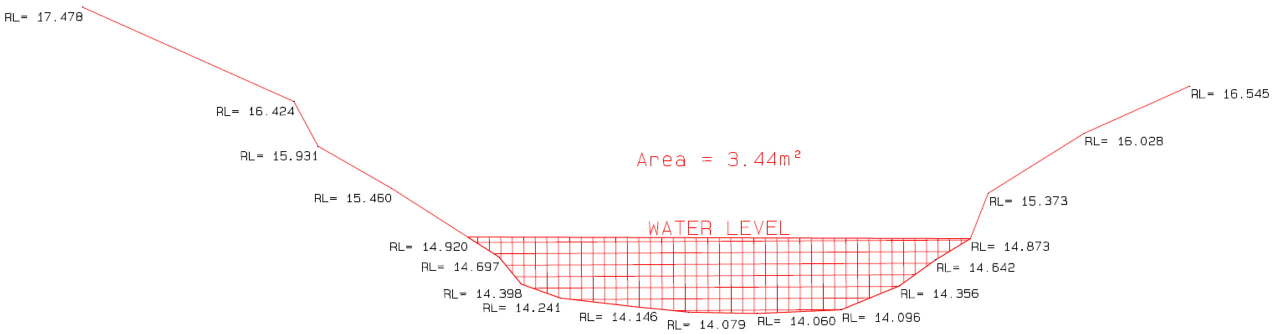


Figure 14: SBT1 Discharge Site – South Creek Survey Cross Section

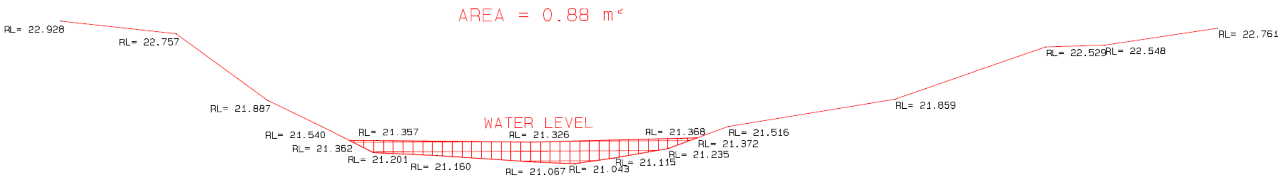


Figure 15: SBT2 Discharge Site – Claremont Creek Survey Cross Section

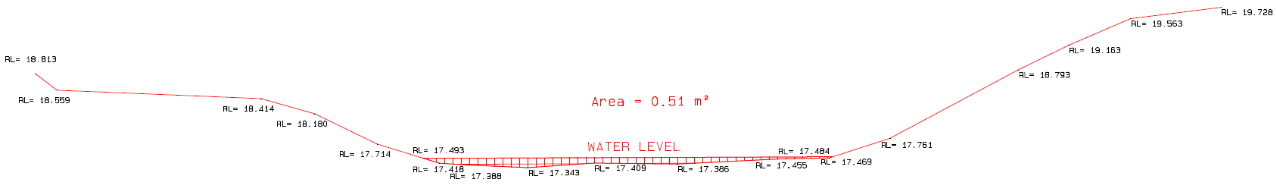


Figure 16: SBT3 Discharge Site – South Creek Survey Cross Section

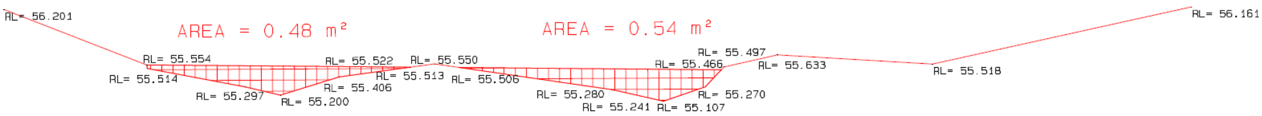


Figure 17: SBT4 Discharge Site – South Creek Survey Cross Section

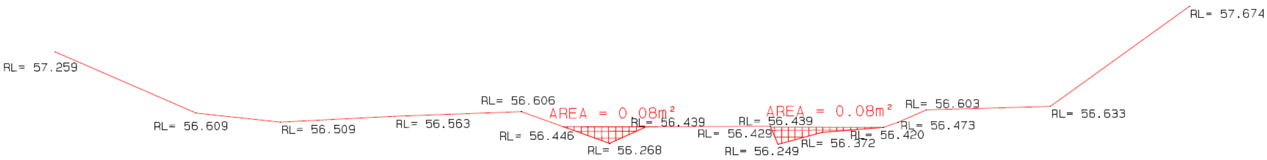


Figure 18: SBT5 Discharge Site – Thompsons Creek Survey Cross Section

9.4.2. Laboratory Testing Results

Table 27 through Table 29 present a summary of water quality data for toxicants and stressors in surface waters that have site-specific guideline values (NSW EPA 2022), or that were recorded in groundwater with one or more samples exceeding ANZECC (2000) / ANZG (2018) 95% and 99% species protection default guideline values.

Table 26: Surface Water Quality South Creek – St Marys (SBT3)

Parameter Group	Parameter	DGV	Min	Max	Average of lab results
Physical and Chemical Stressors	pH	6.5 – 8.0	7.62	8.14	7.92
	Electrical Conductivity (µS/cm)	125 -2,200	768	3,020	1,273
	Dissolved Oxygen (mg/L)	8	9.2	11.4	10.1
	Dissolved Oxygen (% Saturation)	43 – 75	96.9	110	103.4
	Turbidity (NTU)	50	15.7	229	84.09
	Total Nitrogen (mg/L)	1.72	0.8	2.2	1.36
	Total Phosphorous (mg/L)	0.14	0.04	0.16	0.091
	Nitrite and Nitrate (mg/L)	0.66	0.12	0.9	0.42
Metals and Metalloids (total)	Aluminium (mg/L)	0.055	0.25	4.03	1.46
	Cadmium (mg/L)	0.0002	<0.0001	<0.0001	<0.0001
	Cobalt (mg/L)	0.001	0.001	0.002	0.002
	Copper (mg/L)	0.0014	0.001	0.013	0.006
	Iron (mg/L)	0.3	Not Analysed		
	Lead (mg/L)	0.0034	0.001	0.004	0.002
	Manganese (mg/L)	1.9	0.15	0.295	0.245
	Mercury (mg/L)	0.0006	0.0004	0.0005	0.0003
	Nickel (mg/L)	0.011	0.001	0.004	0.003
	Vanadium (mg/L)	0.05	0.01	0.01	0.01
	Zinc (mg/L)	0.008	<0.001	0.031	0.014
Inorganics	Ammonia (mg/L)	0.9	ND	0.03	0.018

Result exceeds adopted ANZG (2018) / ANZECC (2000) / NSW EPA (2022) default guideline value

Table 27: Surface Water Quality South Creek – Claremont (SBT1)

Parameter Group	Parameter	DGV	Min	Max	Average of lab results
Physical and Chemical Stressors	pH	6.5 – 8.0	7.08	8.04	7.78
	Electrical Conductivity (µS/cm)	125 -2,200	786	1,430	1,130
	Dissolved Oxygen (mg/L)	8	9.2	11.2	9.95

Parameter Group	Parameter	DGV	Min	Max	Average of lab results
	Dissolved Oxygen (% Saturation)	43 – 75	98.2	115	106.75
	Turbidity (NTU)	50	15.1	184	105.8
	Total Nitrogen (mg/L)	1.72	0.7	1.9	1.33
	Total Phosphorous (mg/L)	0.14	0.04	0.24	0.14
	Nitrite and Nitrate (mg/L)	0.66	0.08	1.01	0.44
Metals and Metalloids (total)	Aluminium (mg/L)	0.055	<0.0001	0.0001	-
	Cadmium (mg/L)	0.0002	<0.0001	<0.0001	<0.0001
	Cobalt (mg/L)	0.001	<0.001	0.009	0.002
	Copper (mg/L)	0.0014	<0.001	0.028	0.008
	Iron (mg/L)	-	Not Analysed		
	Lead (mg/L)	0.0034	<0.001	0.016	0.004
	Manganese (mg/L)	1.9	0.155	1.21	0.326
	Mercury (mg/L)	0.0006	<0.0004	<0.0004	<0.0004
	Nickel (mg/L)	0.011	0.001	0.064	0.007
	Vanadium (mg/L)	0.05	0.02	0.02	-
	Zinc (mg/L)	0.008	<0.001	0.092	0.030
Inorgnics	Ammonia (mg/L)	0.9	<0.01	0.04	0.02

Result exceeds adopted ANZG (2018) / ANZECC (2000) / NSW EPA (2022) default guideline value

Table 28: Surface Water Quality Claremont Creek (SBT2)

Parameter Group	Parameter	DGV	Min	Max	Average of lab results
Physical and Chemical Stressors	pH	6.5 – 8.0	7.89	8.26	8.08
	Electrical Conductivity (µS/cm)	125 -2,200	1,180	3,190	2,598
	Dissolved Oxygen (mg/L)	8	8.7	11	10.1
	Dissolved Oxygen (% Saturation)	43 – 75	90.5	117	105.8
	Turbidity (NTU)	50	3.2	170	45.56
	Total Nitrogen (mg/L)	1.72	0.6	1.5	1.01
	Total Phosphorous (mg/L)	0.14	0.04	0.14	0.09
	Nitrite and Nitrate (mg/L)	0.66	0.24	0.84	0.40
Metals and Metalloids (total)	Aluminium (mg/L)	0.055	0.06	3.62	0.92
	Cadmium (mg/L)	0.0002	<0.0001	<0.0001	<0.0001
	Cobalt (mg/L)	0.001	0.001	0.006	0.002
	Copper (mg/L)	0.0014	0.005	0.018	0.008

Parameter Group	Parameter	DGV	Min	Max	Average of lab results
	Iron (mg/L)	0.3	Not Analysed		
	Lead (mg/L)	0.0034	0.001	0.008	0.001
	Manganese (mg/L)	1.9	0.214	2.10	0.51
	Mercury (mg/L)	0.0006	0.0004	0.0018	0.0007
	Nickel (mg/L)	0.011	0.001	0.007	0.003
	Vanadium (mg/L)	0.05	0.01	0.01	0.01
	Zinc (mg/L)	0.008	0.001	0.116	0.039
Inorganics	Ammonia (mg/L)	0.9	0.01	0.03	0.02

Result exceeds adopted ANZG (2018) / ANZECC (2000) / NSW EPA (2022) default guideline value

Table 29: Surface Water Quality Thompsons Creek (SBT5)

Parameter Group	Parameter	DGV	Min*	Max*	Average of lab results*
Physical and Chemical Stressors	pH	6.5 – 8.0	7.29	8.09	7.89
	Electrical Conductivity (µS/cm)	125 -2,200	754	3,060	2,140
	Dissolved Oxygen (mg/L)	8	9.1	11.1	9.79
	Dissolved Oxygen (% Saturation)	43 – 75	93.8	111	104.4
	Turbidity (NTU)	50	12.1	64.8	29.9
	Total Nitrogen (mg/L)	1.72	0.5	0.8	0.64
	Total Phosphorous (mg/L)	0.14	0.02	0.06	0.04
	Reactive Phosphorous (µg/L)	20	Not Analysed		
	Nitrite and Nitrate (mg/L)	0.66	0.04	0.17	0.13
Metals and Metalloids (total)	Aluminium (mg/L)	0.055	0.11	2.18	0.81
	Cadmium (mg/L)	0.0002	<0.0001	<0.0001	<0.0001
	Cobalt (mg/L)	0.001	<0.001	<0.001	<0.001
	Copper (mg/L)	0.0014	<0.001	0.012	0.003
	Iron (mg/L)	0.3	Not Analysed		
	Lead (mg/L)	0.0034	<0.001	<0.001	<0.001
	Manganese (mg/L)	1.9	0.068	0.940	0.432
	Mercury (mg/L)	0.0006	<0.0004	0.003	-
	Nickel (mg/L)	0.011	<0.001	0.005	0.002
	Vanadium (mg/L)	0.05	<0.001	<0.001	-
	Zinc (mg/L)	0.008	<0.001	0.016	0.010
Inorganics	Ammonia (mg/L)	0.9	<0.1	0.13	0.09

Result exceeds adopted ANZG (2018) / ANZECC (2000) / NSW EPA (2022) default guideline value

Table 30: Surface Water Quality Badgerys Creek (SBT4)

Parameter Group	Parameter	DGV	Min*	Max*	Average of lab results*
Physical and Chemical Stressors	pH	6.5 – 8.0	7.71	8.1	7.93
	Electrical Conductivity (µS/cm)	125 -2,200	757	2,760	1,614
	Dissolved Oxygen (mg/L)	8	8.6	11.2	9.97
	Dissolved Oxygen (% Saturation)	43 – 75	85.1	123	106.55
	Turbidity (NTU)	50	17.4	163	46.3
	Total Nitrogen (mg/L)	1.72	0.6	8.2	2.39
	Total Phosphorous (mg/L)	0.14	0.06	0.61	0.16
	Reactive Phosphorous (µg/L)	20	Not Analysed		
	Nitrite and Nitrate (mg/L)	0.66	0.04	1.26	0.44
Metals and Metalloids (total)	Aluminium (mg/L)	0.055	0.31	2.78	1.05
	Cadmium (mg/L)	0.0002	<0.0001	<0.0001	<0.0001
	Cobalt (mg/L)	0.001	ND	0.002	0.001
	Copper (mg/L)	0.0014	0.001	0.027	0.005
	Iron (mg/L)	0.3	Not Analysed		
	Lead (mg/L)	0.0034	<0.001	0.003	0.001
	Manganese (mg/L)	1.9	0.068	1.04	0.238
	Mercury (mg/L)	0.0006	<0.0004	<0.0004	<0.0004
	Nickel (mg/L)	0.011	0.001	0.003	0.002
	Vanadium (mg/L)	0.05	<0.001	<0.001	<0.001
	Zinc (mg/L)	0.008	<0.001	0.015	0.009
Inorganics	Ammonia (mg/L)	0.9	<0.1	5.5	1.16

Result exceeds adopted ANZG (2018) / ANZECC (2000) / NSW EPA (2022) default guideline value

9.4.3. Discussion

Surface water monitoring has been conducted in receiving waterways to assess baseline environmental conditions prior to potential impact from project construction activities.

The results from laboratory testing of surface water samples have detected elevated concentrations of a range of toxicant compounds and physico-chemical stressors at values exceeding the adopted screening criteria, including:

- South Creek at St Marys:
  - stressors: pH, salinity, turbidity, total nitrogen, total phosphorous, oxidised nitrogen
  - toxicants: aluminium, cobalt, copper, lead, zinc
- South Creek at Claremont:
  - stressors: pH, turbidity, total nitrogen, total phosphorous, oxidised nitrogen

    - toxicants: cobalt, copper, lead, nickel, zinc
- Claremont Creek:
    - stressors: pH, salinity, turbidity, oxidised nitrogen
    - toxicants: aluminium, cobalt, copper, lead, manganese, mercury, zinc
- Thompsons Creek:
    - stressors: pH, salinity, turbidity
    - toxicants: aluminium, copper, zinc
- Badgerys Creek
    - stressors: pH, salinity, turbidity, total nitrogen, total phosphorous, oxidised nitrogen
    - toxicants: aluminium, cobalt, copper, zinc, ammonia

Salinity (as electrical conductivity) is generally reported at values exceeding the DGV of 2,200 µS/cm. These conditions suggest that the ANZECC DGV may not be a suitable DGV for the South Creek Catchment. Evidence from literature indicates that the salinity of surface waters in the South Creek Catchment is intrinsically linked to the high salinity of local geological units and dry deposition of windblown dust, and is therefore a natural condition of the catchment.

Turbidity was reported above DGV in all monitoring locations in at least two events, indicating that high sediment loads are typical in the South Creek Catchment under baseline conditions.

10. Construction Environmental Management Measures

10.1. Erosion and Sediment Control

The Blue Book will be used to guide erosion and sediment control throughout construction on the project following the nine principles listed in Table 31.

Table 31: Erosion and Sediment Control Principles Sydney Metro Western Sydney Airport SBT Project

No	Erosion and Sediment Control Principle	Examples
1	Assess constraints and opportunities for erosion and sediment control during the planning/design phase.	• Undertake site specific ESC plans that include an assessment of constraints and opportunities for erosion and sediment control.
2	Plan early for erosion and sediment control.	• Prepare Progressive ESCPs showing the location of controls for each stage of work. • Maintain an up-to-date register of ESCPs during construction. • Install controls early, generally as part of site establishment in any area.
2	Minimise the extent and duration of disturbance.	• Establish clearing limits that take into account biodiversity constraints. • Minimise the time taken for works, especially where works occur within waterways.
4	Manage soils, including conserving topsoil for later reuse in rehabilitation.	• Manage and maintain topsoils so they are suitable for re-use for rehabilitation. • Test soils that will be used for revegetation and fertilize/ameliorate as required. • Ensure sediment controls are considerate of subsoil dispersiveness.
5	Control water flow on, through and off the site.	• Separate clean and dirty water as much as possible. • Install temporary drainage to control the movement of water onto, through and off the project worksites. • Divert dirty water to sediment controls
6	Minimise erosion as much as possible.	• Minimise dust rise. • Use temporary ground covers on inactive areas or when significant weather is forecast. • Provide ground covers on flowpaths. • Slow the velocity of water as much as possible to reduce erosion. • Cover stockpiles of erodible materials.
7	Maximise sediment retention onsite.	• Minimise sediment tracking onto surrounding roads. • Establish sediment controls that are considerate of catchment size, risk and soil type. • Use chemical flocculants or coagulants to settle sediment that are considerate of the local water quality and receiving environment.
8	Progressive, effective rehabilitation	• Rehabilitate completed areas progressively as works are completed. • Ensure rehabilitation techniques are considerate of soils, aspect, final landform, land use etc. • Ensure topsoil is spread on areas to be revegetated.
9	Ongoing inspection and maintenance	• Monitor weather forecasts and prepare accordingly. • Control weeds on revegetated areas. • Inspect sites regularly and fix any potential problems. • Clean out and repair controls as required.

10.2. Stormwater Discharges

10.2.1. Sediment Control Measures

The Blue Book (Landcom, 2004 and DECC, 2008) notes that a sediment basin should be included in catchments where the erosion hazard exceeds 150 m^3/year (which is translated as 200 tonnes/year of saturated sediment) of soil loss. It is standard practice that each affected catchment on a project be assessed against this requirement.

An evaluation of the erosion hazard was made using the approach in Chapter 4 of the Blue Book (Landcom, 2004). This process involves calculating the predicted annual average soil loss using the Revised Universal Soil Loss Equation (RUSLE) as follows:

$$A = R \times K \times LS \times P \times C$$

Table 32 details the above equation and the values used in assessing erosion hazard.

Table 32: RUSLE definitions and adopted values

Parameter	Definition	Typical values for this site
A	Total calculated soil loss (t/ha/yr)	66 t/ha/yr.
R	Rainfall erosivity factor	2500
K	Soil erodibility factor	0.050 (assumed)
LS	Slope length and gradient factor	5% and 80m (LS of 1.19)
P	Conservation practice factor	Maximum of 1.3 assumed
C	Ground cover factor	Maximum of 1.0 assumed
Erosion hazard (from Landcom, 2004)		195 t/ha/yr (Low)
Catchment size trigger for sediment basins		1.02 ha

Construction-phase sediment basins are to be sized based on the following criteria (Landcom, 2004):

- Design rainfall depth: 27.6 mm (5-day, 80^{th} percentile, as used for the bulk earthworks at Western Sydney International Airport);
- Basins designed for Type F/D (dispersible) sediment;
- Volumetric runoff coefficient (Cv): 0.56 (Hydrologic Group D) for all areas.

The size of the basins will vary depending on catchment size and conditions. However, a general estimation of sediment basin sizing based on the above criteria necessitates 188 m^3 of basin capacity per hectare of disturbed contributing catchment.

10.2.1.1. Sediment Basin Management

The sediment basins are sized to catch all runoff from the nominated storm event, in this case the 5-day, 80^{th} percentile rainfall event of 27.6 mm. The basins will be a single chamber that includes a water storage volume and a sediment store volume that will require periodic de-silting. Water will be captured and retained within the basin and treated using coagulants and flocculants such as gypsum.

10.2.2. Stormwater Basins and Discharge Points

The location of the project construction stormwater detention (water quality) basins and proposed stormwater discharge points are provided in Figures 19 - 23. Table 33 provides a summary of the location along with sizing details of water quality basins and identification of the receiving waterway.

Table 33: Stormwater Basin Locations and Discharge Points

Site Location	Location Description	Easting	Northing	Receiving Waterway	Basin Size
St Marys	The outlet of the sediment basin(s) on the St Marys site North of Station street	E:294119.4684	N:6261927.807	South Creek	TBC by survey
St Marys	The outlet of the sediment basin(s) on the St Marys site at former Plaza	E:294041.6184	N:6261905.9783	South Creek	400m3
Claremont Meadows	The outlet of the sediment basin on the Claremont Meadows Site south of Great Western Highway	E:292018.2099	N:6261255.3813	Claremont creek	185m3
Claremont Meadows	The outlet of the sediment basin on the Claremont Meadows site West of Gipps Street	E:292072.0196	N:6261326.0789	Claremont Creek	539m3
Orchard Hills	The outlet of the sediment basin on the Orchard Hills site	E:292053.3538	N:6259530.3707	South Creek	1249m3
Orchard Hills	The outlet of the sediment basin on the Orchard Hills site south of M5	E:292065.7524	N:6259303.9277	South Creek	440m3
Orchard Hills	The outlet of the sediment basin on the Orchard Hills site east of Kent Road	E:291857.7443	N:6259276.8491	South Creek	580m3
Orchard Hills	The outlet of the sediment basin on the Orchard Hills site east of Kent Road	E:291857.4535	N:6259221.8921	South Creek	510m3
Orchard Hills	The outlet of the sediment basin on the Orchard Hills site north of Lansdowne Road	E:291808.8936	N:6258854.9307	South Creek	352m3
Orchard Hills	The outlet of the sediment basin on the Orchard Hills site north of Lansdowne Road	E:291963.0058	N:6258833.1224	South Creek	299m3
Orchard Hills	The outlet of the sediment basin on the Orchard Hills site south of Lansdowne Road	E:291975.5092	N:6258798.5199	South Creek	551m3
Orchard Hills	The outlet of the sediment basin on the Orchard Hills site south of Lansdowne Road	E:291803.9504	N:6258604.2804	South Creek	247m3
Bringelly	The outlet of the sediment basin on the Bringelly site west of Derwent Road	E:289481.8143	N:6245851.2954	Badgerys Creek	317m3
Aerotropolis	The outlet of the sediment basin on the Orchard Hills site east side of Aerotropolis	E:290853.6384	N:6243780.4655	Thompsons Creek	1085m3
WSA SM SBT FS01	The outlet of the sediment basin on the Airport FS01 site west of Badgerys Creek Road	E: 289839.678	N: 6246601.538	Badgerys Creek	TBC by survey

Site Location	Location Description	Easting	Northing	Receiving Waterway	Basin Size
WSA Basin 03	The outlet of the sediment basin on the Airport WSA Basin 3 site west of Badgreys Creek Road	E: 290666.548	N: 6246869.994	Badgerys Creek	TBC by survey

10.2.3. Discharges

De-watering is assumed to occur within five days of the cessation of a rainfall event using a nominal pump rate over a 24–72-hour period (adopted flow rate of at least 5 L/s per volume of detained water). De-watering occurs after chemical treatment of the water using coagulants and flocculants such as gypsum to ensure that required water quality is achieved.

The treated water is typically pumped or piped out of the basin when the rain has ceased and flows in the receiving watercourse have dropped or are rapidly dropping.

Excess flow from an event that is greater than the nominated design storm of 27.6 mm is to be discharged via a stabilised spillway to prevent the basin embankment/crest from being overtopped.

Figure 19: Construction Water Quality Basins – St Marys Station Box

Figure 20: Construction Water Quality Basins – Claremont Meadows Services Facility

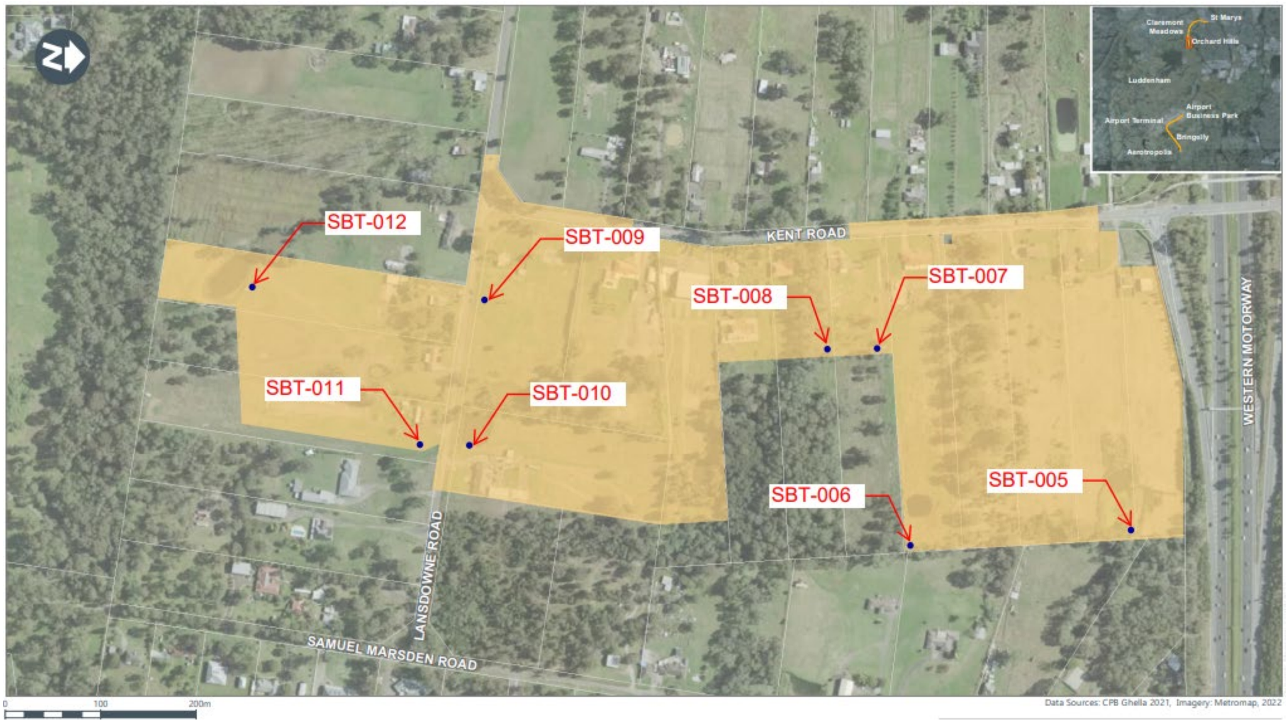


Figure 21: Construction Water Quality Basins – Orchard Hills Station Box and TBM Support

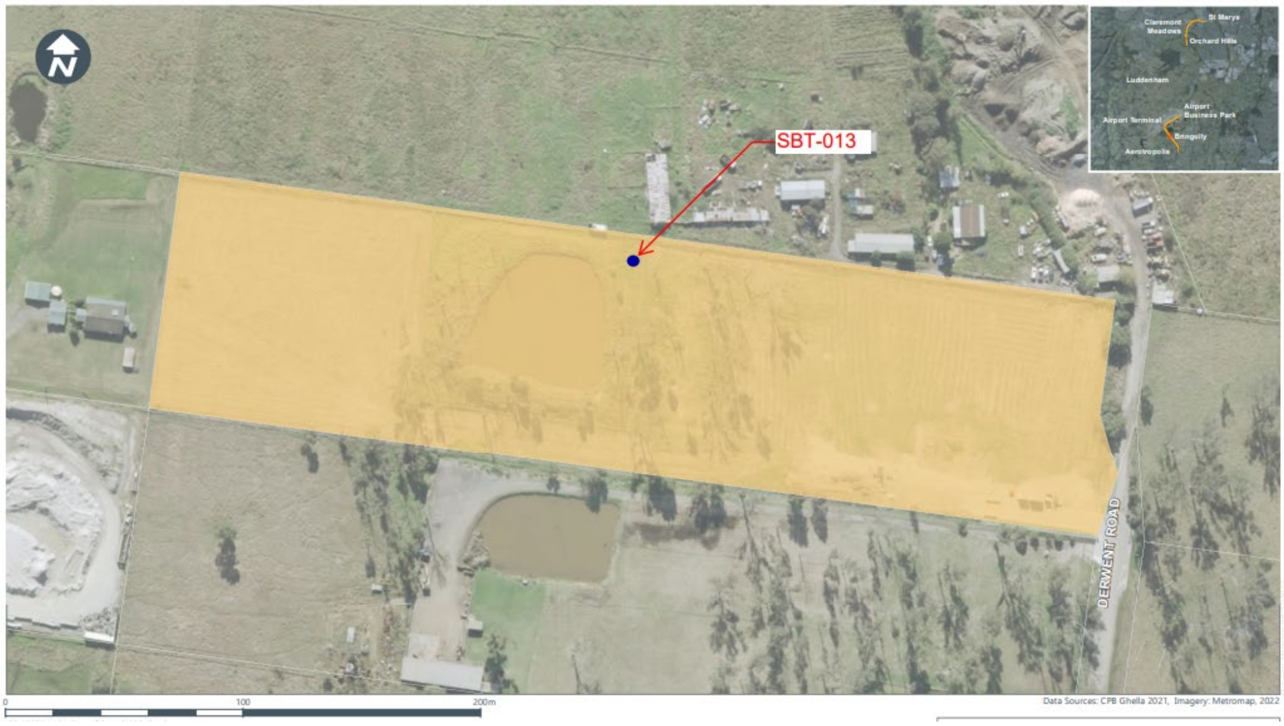


Figure 22: Construction Water Quality Basins – Bringelly Services Facility

Figure 23: Construction Water Quality Basins – Aerotropolis Core

10.3. Water Treatment Plant Inflows, Treatment, and Discharge

10.3.1. SBT North Project Area

Construction activities within the SBT North Project area will include:

- Bulk earthworks, excavations, and construction of St. Mary's and Orchard Hills Station Boxes and Claremont Meadows Services Facility.
- Tunnelling using a Tunnel Boring Machine (TBM) between St. Marys and Orchard Hills.

Groundwater inflows associated with excavation and construction activities at the St. Mary's and Orchard Hills station boxes is anticipated to result in drawdown extending out to 340 – 440m radially over a two-year period, with similar drawdown likely to occur around the excavation at Claremont Meadows.

Groundwater inflows, TBM process water, and washdown water from construction activities in the SBT North Project area will be treated using the dedicated water treatment plants (WTPs) at St Mary's, Claremont Meadows, and Orchard Hills prior to discharge into receiving waterways, offsite disposal and/or on-site beneficial re-use.

The WTPs located at St Marys and Claremont Meadows have been designed to treat construction stage inflows within the open excavations only. However, the WTP at Orchard Hills has been designed to treat construction stage inflows to both open excavation of the station box and dive, and inflows to the mainline and cross passage tunnels, which link St Marys, Claremont Meadows, and Orchard Hills.

10.3.2. SBT South Project Area

Construction activities within the SBT South Study Project area will include:

- Bulk earthworks, excavations and construction of Aerotropolis Core Station Box and Bringelly Services Facility.
- Tunnelling using a tunnel TBM between Aerotropolis Core, Bringelly and Airport Terminal.

Excavation and construction of Airport Business Park Station, Airport Drive, Airport Terminal Station, and the tunnels connecting Airport Business Park with Aerotropolis Core have not been included in this assessment as discharges from the tunnels will occur over airport land, which is regulated under the *Commonwealth Airports Act, 1996*. Discharge impacts from these sites will be managed under separate discharge impact assessment submitted to satisfy Commonwealth requirements.

Groundwater inflows to construction stage excavations and washdown water from construction activities at sites located in the SBT South Project area will be treated using dedicated water treatment plants (WTPs) at Aerotropolis Core Station Box and Bringelly Services Facility, prior to discharge to receiving waterways, offsite disposal, and/ or on-site beneficial reuse.

The WTPs located at Aerotropolis Core Station Box and Bringelly Services Facility have been designed to treat construction stage inflows within the open excavations only.

10.3.3. Sources of Inflow to Water Treatment Plants

Inflows to the construction WTPs will comprise a combination of groundwater inflows to the station excavation, groundwater inflows to tunnels during construction, process water and washdown water from tunnelling activities and surface works, and incidental rainfall over the excavation footprint.

Daily inflow volumes for groundwater, process water, washdown water and incidental rainfall are highly variable over the course of the construction activities in response to both progression of the project and natural variability. Anticipated average groundwater inflow rates and process water inflow rates to the construction WTPs are presented in Table 34.

Incidental rainfall into excavations is unlikely to generate significant volumes of additional inflow to WTPs, with most stormwater captured and treated through stormwater management systems. Additional inflows from rainfall will be highly variable in response to variable intensity-duration and antecedent soil conditions. However, additional inflows from rainfall are considered unlikely to exceed the treatment capacity of the WTPs (discussed in the following section).

Table 34: WTP Averaged Construction Stage Inflow Rates (L/day)

Site Location	Estimated Long Term Groundwater Inflow (L/day)	Process Water Inflow (L/day)	Rainfall (L/day)	Total (L/day)
St Marys	69,120	43,200	6,575	118,895
Claremont Meadows	38,016	43,200	822	82,038
Orchard Hills	141,696	432,000	13,151	586,847
Bringelly Services Facility	38,016	43,200	822	82,038
Aerotropolis Core	42,336	43,200	13,151	98,687

* Based on forecasted monthly data. May not account for peak flows in response to significant rainfall events.

Table 35: WTP Averaged Construction Stage Inflow Rates (L/s)

Site Location	Estimated Long Term Groundwater Inflow (L/s)	Process Water Inflow (L/s)	Rainfall (L/s)	Total (L/s)
St Marys	0.8	0.5	0.07	1.37
Claremont Meadows	0.44	0.5	0.009	0.949
Orchard Hills	1.64	5	0.15	6.79
Bringelly Services Facility	0.44	0.5	0.009	0.949
Aerotropolis Core	0.49	0.5	0.15	1.14

10.3.4. WTP Influent Water Quality

Except for Orchard Hills, the influent water quality to each of the construction water treatment plants (WTP) is expected to closely reflect a mixture of the following sources:

- Groundwater inflows from local geological units
- Process water (potable supply)
- Stormwater inflows to excavations

Process water used for tunnel boring will be required to meet potable standards at all times to mitigate any potential risks of damage to TBM components, which may cause breakdowns and stoppages. As a result, the process water used for tunnel boring and general construction activities will typically be fresh (<500 mg/L TDS) and low in concentrations in suspended sediments and dissolved contaminants.

The resulting wastewater stream from the TBMs and general construction activities will be pumped back to the WTPs along with any groundwater inflows for treatment prior to discharge into receiving waterways offsite disposal and/or on-site beneficial re-use.

The chemistry of the influent (feed water) stream will reflect a mixture of both groundwater and process water. The composition of the influent may vary significantly along the length of the alignment in response to heterogeneity in geological conditions and localised sources of soil / rock contamination.

Dilution of groundwater by process water will significantly improve the water quality of feed water inflows to the construction water treatment plants.

Despite dilution effects inflows to construction water treatment plants are likely to retain variably elevated levels of salinity (~6,800 – 13,000 µs/cm) and concentrations of total nitrogen (~0.1 – 1.45 mg/L). It is anticipated that most trace metals and inorganic pollutants will be largely attenuated by process dilution prior to treatment.

10.3.5. Minimum Water Treatment Plant Specifications (All Sites)

All WTPs will include a minimum seven-step treatment process that has been designed to significantly improve water quality, prior to the discharge of treated effluent into receiving waterways.

Details of the proposed water treatment processes and the resulting effects on water quality are summarised in Table 36.

Discharge will cease once the “low water” trigger level is reached. Treatment and discharge will occur on a continuous basis at the anticipated discharge rates specified in Table 41.

Table 36: Minimum Water Treatment Plant Processes (All WTP Sites)

WTP Process	Desired Outcome
1. Primary Solids Removal	First order reduction of suspended solids and suspended contaminants.
2. Flocculation / Coagulation	Second order reduction of turbidity suspended solids, and suspended contaminants. Coagulant aids may be used to improve softening of water and enhance reduction in concentrations of dissolved solids / contaminants.
3. Clarification	Third order reduction of turbidity suspended solids, and suspended contaminants. Combination softening-clarification units may improve and enhance reduction in concentrations of dissolved solids / contaminants.
4. Media Filtration	Fourth order reduction of turbidity and suspended solids, and suspended contaminants. May be used with softening process to reduce concentrations of dissolved solids / contaminants.
5. Breakpoint Chlorination and Dechlorination	Removal of ammonia through chemical oxidation (breakpoint chlorination), and removal of excess chlorine and chloramines through dechlorination.
6. Activated Carbon Filtration	Remove organic contaminants, hydrocarbons, chlorine, PFAS, improve colour and odour.
7. pH Correction	Adjustment of pH to appropriate discharge limits.

10.3.6. Reverse Osmosis Treatment Assessment

Reverse osmosis (R.O) has not been adopted as a treatment technology for the project following extensive risk assessment, which has included traffic impacts, brine disposal costs, power consumption, capital cost, operational cost, and maintenance and reliability metrics. Assessment has included engagement with Sydney Water on brine disposal options. Discussions identified that the significant salinity of R.O. generated brine is unsuitable for trade waste discharge due to severe risks of corrosion to Sydney Water infrastructure and loading on the St Marys wastewater treatment plant. A summary breakdown of the risks and findings associated with implementing R.O. treatment technology for the project is summarised in Table 37.

Table 37: Reverse Osmosis Treatment Technology Risk Review

Risk Area	Risk Statement	Risk Rating	Control
Brine Disposal - Traffic Impacts	Operation of Reverse Osmosis water treatment plants at all Project sites will result in the generation of approximately 87.5ML of concentrated brine over the life of the Project. This would require approximately 5,800 trucks or 11,600 truck movements for the disposal of brine over the life of the project.	A - Very High	Discharging concentrated brine to local trade waste connection has been assessed but is not acceptable to Sydney Water due to the elevated salinity of the brine.
Brine Disposal - Cost	Operation of Reverse Osmosis water treatment plants at all Project sites would require all brine to be trucked to a licensed facility for disposal. Quotes obtained from licensed facilities indicate an approximate cost of $58 million over the life of the Project (based on 5,800 trucks at $10,000 per truck).	A - Very High	Discharging concentrated brine to local trade waste connection has been assessed but is not acceptable to Sydney Water due to the elevated salinity of the brine.
Reverse Osmosis WTP Operation - Power Consumption	The operation of Reverse Osmosis water treatments plants will result in significantly increased power consumption when compared to a non-RO water treatment plant. The significant power consumption will result in increased greenhouse gas emissions and increased operating costs.	A - Very High	Discharging concentrated brine to local trade waste connection has been assessed but is not acceptable to Sydney Water due to the elevated salinity of the brine.
Reverse Osmosis WTP - Capital Cost	The use of Reverse Osmosis water treatment plants will result in a significant increase in capital costs for the plants. Initial quotes indicate a cost of $900,000 per water treatment plant for RO modules resulting in a total cost of $6.3 million.	A - Very High	Trade waste agreements are being obtained for the discharge of treated water where the salinity levels exceed EPL criteria but meet Sydney Water's acceptance criteria. However due to capacity constraints with Sydney Water infrastructure the approved volume is not sufficient to meet project requirements.
Reverse Osmosis WTP - Maintenance and Reliability	The operation of Reverse Osmosis water treatments on major tunnelling projects presents significant operational risks and maintenance costs. Based on feedback from other projects that have used Reverse Osmosis maintenance issues include the frequent blocking and fouling of the RO membrane and the need for frequent replacement of the membrane.	A - Very High	Trade waste agreements are being obtained for the discharge of treated water where the salinity levels exceed EPL criteria but meet Sydney Water's acceptance criteria. However due to capacity constraints with Sydney Water infrastructure the approved volume is not sufficient to meet project requirements.

10.3.7. Ion Exchange Treatment Assessment

Ion exchange (IX) has not been adopted as a treatment technology following extensive risk assessment, which has included, brine disposal costs, regeneration requirements, power consumption, capital cost, operational cost, and maintenance and reliability metrics.

The assessment has identified that weekly regeneration of resin would be required resulting in up to 5 kilolitre (kL) per week of liquid waste brine requiring offsite disposal to a licenced liquid waste disposal facility. In addition to this, assessment on suitability of the use of IX has identified a significant risk that saline water native to the local catchment will significantly affect the efficacy of the IX treatment due to fouling of the IX filter media, resulting in progressive degeneration of IX filter media, which will prompt the regular replacement of the filter media at significant cost.

The above limitations are summarised in Table 38.

Table 38: Ion Exchange Treatment Technology Risk Review

Risk Area	Risk Statement	Risk Rating	Control
Nitrogen Treatment - Capital Cost	The addition of Ion Exchange (IX) filters to the water treatment plants will result in a significant increase in capital costs for the plants. Initial quotes indicate a cost of $253,000 per water treatment plant for the Ion Exchange filters resulting in a total cost of approximately $2.3 million.	A - Very High	N.A.
Nitrogen Treatment - Waste Products	Operation of IX filters on water treatment plants at all Project sites will require regular (weekly) regeneration of the resin to remove contaminants and ensure effective operation of the resin. Regeneration of the resin is undertaken by flushing with a brine solution. The resulting liquid brine waste will contain the contaminants removed from the resin and will need to be trucked to a licensed disposal location. Initial estimates will require approximately 5kL per week of waste brine to be disposed of for each WTP, at a cost of approximately $10,000 per month. This volume has been calculated at approximately 1% of the total volume being treated by each WTP.	A - Very High	Discharging waste brine to local trade waste connection has not yet been investigated but is unlikely to be acceptable to Sydney Water due to the elevated salinity and contaminants in the brine.
Nitrogen Treatment - Operating Uncertainty	The use of IX filters for water treatment is a relatively new concept that hasn't been used extensively for major tunnelling Projects to date. Some projects that have used the technology have reported performance and maintenance issues associated with achieving performance targets and the need for very frequent regeneration of the media. The performance and ability of IX filters to achieve specific discharge criteria is unknown and may be impacted by the high level of salinity in groundwater.	A - Very High	N.A.

10.3.8. Treatment Capacity

The design treatment process and flow capacities for each water treatment plant have been summarized in Table 39. The design flow capacity of each water treatment plant accounts for both dry condition inflows, process / washdown water, and wet-weather inflows resulting from direct precipitation over excavations and hardstand areas

Table 39: Design Treatment and Flow Capacities – WSA SBT Water Treatment Plants

Site Location	Treatment Processes	Design Capacity
St Marys	Standard (Table 35)	15 L/s
Claremont Meadows	Standard (Table 35)	10 L/s
Orchard Hills	Standard (Table 35)	30 L/s
Bringelly Services Facility	Standard (Table 35)	10 L/s
Aerotropolis Core	Standard (Table 35)	15 L/s

Mitigation measures for scenarios where inflow rates may exceed treatment capacity, or where treatment capacity is reduced due to mechanical issues or maintenance requirements are discussed further in **Section 9**.

10.3.9. WTP Discharge Points and Receiving Waterways

The discharge points and receiving waterways for each of the WSA construction WTPs are identified in **Table 40** and **Figure 14.** The location of the construction WTPs within the boundary of each project construction site are presented in **Figures 2 - 6**.

The treated effluent at St Marys and Claremont Meadows will be discharged to stormwater, which will convey water to South Creek and Claremont Creek respectively. Discharge infrastructure from Orchard Hills, Bringelly, and Aerotropolis Core will be discharged directly to receiving waterways through proposed methods that are currently in planning stages.

Table 40: Discharge Points and Receiving Waterways – WSA SBT Water Treatment Plants

Site Location	Receiving Waterway
St Marys	South Creek
Claremont Meadows	South Creek via Claremont Creek
Orchard Hills	South Creek
Bringelly Services Facility	South Creek via Badgerys Creek
Aerotropolis Core	South Creek via Thompsons Creek

10.3.10. WTP Discharge Regime

Treated effluent from the construction WTPs will be released to the receiving waterways under a regime of continuous discharge. **Table 41** provides a summary of the design capacity and anticipated discharge rates from each construction WTP.

Table 41: WTP Effluent Discharge Points and Discharge Rates

Site Location	Contributions to Effluent Discharge	Discharge Scenario	Design Capacity (L/s)	Anticipated Discharge Rates (L/s)	Daily Discharge Volume (m^3)
St Marys	Groundwater inflows, incident rainfall, washdown water	Continuous release to South Creek	15	1.37	118
Claremont Meadows	Groundwater inflows, incident rainfall, washdown water	Continuous release to Claremont Creek	10	0.95	82

Site Location	Contributions to Effluent Discharge	Discharge Scenario	Design Capacity (L/s)	Anticipated Discharge Rates (L/s)	Daily Discharge Volume (m^3)
Orchard Hills	Groundwater inflows, incident rainfall, washdown water, process water	Continuous pulsed release to South Creek	30	6.79	587
Bringelly Services Facility	Groundwater inflows, incident rainfall, washdown water	Continuous pulsed release to Badgerys Creek	10	0.95	82
Aerotropolis Core	Groundwater inflows, incident rainfall, washdown water	Continuous pulsed release to Thompsons Creek	15	1.14	98

10.3.11. WTP Effluent Water Quality

All construction water treatment plants will include, as a minimum, the seven-stage treatment process outlined in Table 36. The treatment process has been designed to balance pH, reduce suspended solids, and reduce the concentrations of contaminants associated with local groundwater conditions, with the objective of achieving compliance with the to the ANZECC (2000) default guideline values for physical and chemical stressors, and ANZG (2018) default guideline values for toxicants.

The treatment processes for the construction of WTPs are not able to reduce the salinity (electrical conductivity) of treated water to the ANZECC (2000) default guideline value of 125 – 2200 μs/cm, or reduce oxides of nitrogen to the default guideline value of 15 μg/L.

There is a low probability / moderate risk of encountering elevated concentrations of contaminants in groundwater outside treatment capacity of WTPs (except for salinity and total nitrogen / total oxidised nitrogen).

There is a moderate risk of nitrogen and oxidised nitrogen in effluent exceeding default guideline values however effluent concentrations may likely be lower than ambient water quality resulting in net improvement of water quality in receiving waterways.

Potential risks to effluent quality achieving the desired DGV for stressors (NSW EPA, 2022 and ANZECC, 2000) and toxicants (ANZG, 2018) may include:

- Inflow of groundwater containing contaminants at concentrations beyond treatment design specifications.
- Inflow of groundwater containing contaminants that have not been accounted for in design specifications.
- Increased concentrations / ratios of organic nitrogen which cannot be treated to achieve target criteria for total nitrogen.
- Surges of inflows at rates exceeding the treatment capacity of the receiving WTP.
- Mechanical failure of plant and/or equipment used to treat influent prior to discharge.
- Incorrect dosing of chemicals to concentrations of suspended solids and contaminants.
- Reduced efficiency of processes resulting from overloading or accumulation of suspended solids and salts.

Adaptive management measures and contingency options to mitigate these potential performance issues at the construction WTPs that may affect effluent water quality are discussed further in **Section 13**.

10.3.12. Trade Waste Agreement

Consultation with Sydney Water is ongoing in relation to the potential disposal of treated water into Sydney Water infrastructure where salinity exceeds environmental discharge criteria, with the potential for significant impacts to water quality in the receiving environment. Initial discussions have indicated that where water quality permits and EPL discharge criteria are met, CPBG will prioritise discharge to the environment under the approved EPL over trade waste disposal.

10.3.13. On-Site Beneficial Re-Use

On-site beneficial re-use of treated effluent has been considered as an alternative to discharge into receiving waterways. Options for beneficial re-use will be investigated during the construction phase of the Project.

Standard pre-treatment will be required for use of treated effluent in dust suppression to minimise potential risks to soil and water quality. It is anticipated that quantities of treated effluent used for dust suppression will vary both seasonally and in response to varying demands throughout the life cycle of the project.

11. Environmental Monitoring

11.1. Sediment Basins

Water quality samples will be collected from sediment basins prior to treatment or discharge to determine appropriate management action. The Soil and Water Management Plan will include a Procedure for the management and monitoring of sediment basins, as well as recording of results.

11.2. Groundwater

CPBG will implement a program of ongoing groundwater monitoring as part of the construction soil and water management plan (SWMP) for the project. Details of the groundwater monitoring plan are provided in the SWMP, and includes the following:

- The existing groundwater monitoring network
- Proposed additional piezometers to address knowledge gaps for construction monitoring
- Piezometers to be used for regular and ongoing monitoring during construction
- Timing and frequency of groundwater monitoring
- Field records to be collected from each piezometer
- Laboratory testing suite for monthly and quarterly scheduling
- Methodology for groundwater monitoring and collection of samples for laboratory testing
- Reporting requirements.

Information collected and recorded as part of groundwater monitoring will be used as an ongoing means to assess potential risks to WTPs and effluent water quality.

11.3. Water Treatment Plants

CPBG will implement a program of ongoing water quality monitoring at each construction water treatment plant to provide an ongoing assessment of effluent water quality and potential risks to the Water Quality Objectives in receiving waterways.

The monitoring program will provide monitoring data for effluent water quality retained within the storage tank prior to discharge, including:

- Live continuous monitoring of pH, turbidity and electrical conductivity
- Monthly sampling and laboratory testing for the following parameters at limits of reporting below the NSW EPA (2022) / ANZECC (2000) / ANZG (2018) 95% and 99% species protection criteria:

– Electrical conductivity (EC), ph, TSS
– Heavy metals (filtered): aluminium (Al), trivalent arsenic (As III), pentavalent arsenic (As V), cadmium (Cd), trivalent chromium (Cr III), hexavalent chromium, cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), inorganic mercury (Hg), nickel (Ni), zinc (Zn)
– Nutrients and inorganics: total nitrogen (TN), oxides of nitrogen (NOx) total ammonia (NH3), ammonium (NH_4+) total phosphorous (TP), filterable reactive phosphate (FRP)
– Total recoverable hydrocarbons: TRH fractions C_6-C_{40}
– Aromatic hydrocarbons: benzene, toluene, ethylbenzene, xylene
– Organochlorine and organophosphate pesticides
– Herbicides

- Quarterly sampling and laboratory testing for additional parameters at limits of reporting below the HEPA (2020), ANZECC / ANZG (2018) 95% and 99% species protection criteria:

– Perfluoroalkyl and polyfluoroalkyl substances: perfluorooctane sulphonate (PFOS), perfluorooctanoic acid (PFOA)
– Phenols and Xylenols
– Polycyclic aromatic hydrocarbons (PAHs)
– Semi-volatile organic compounds (SVOCs)

- Volatile organic compounds (VOCs)
- Oil spill dispersants, surfactants, miscellaneous industrial chemicals, and organic alcohols

All laboratory testing will be undertaken to quantify contaminants at levels commensurate with comparison against the adopted discharge criteria and HEPA (2020), ANZECC (2000) and ANZG (2018) default guideline values. Contaminants for which practical quantification limits (PQL) are greater than default guideline values will be noted within each monitoring report.

The following information will be included with the results from water quality monitoring:

a. The date(s) on which the sample was taken
b. The time(s) at which the sample was collected
c. The point at which the sample was taken
d. The name of the person who collected the sample

All monitoring records will include a comparison of the laboratory testing / field testing results against the adopted discharge criteria. The records will include a statistical comparison of monitoring data against the adopted concentrations of licence conditions (where appropriate) to determine any immediate or ongoing risks to water quality.

All records will be:

a. Kept in a legible form, or in a form that can be readily reduced to a legible form
b. Kept for at least 4 years after the monitoring or event to which they relate
c. Produced in a legible form to any authorised officer of the EPA who asks to see them.

11.4. Receiving Waterways

A Surface Water Quality Monitoring Program (SWQMP) has been prepared for the project and will be implemented during construction (refer to Annexure B of the Soil and Water Management Sub-Plan).

12. Discharge Impact Assessment

12.1. Discharges from Sediment Basins

A desktop-based assessment method was adopted for this study to estimate the mixed turbidity of discharged treated stormwater and the background receiving waters. The calculations are presented in **Section 12.2.**

12.1.1. Methodology

This study has adopted the Draft Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls (TfNSW, 2020) to estimate the potential impact from the discharge of detained stormwater from the project. The guideline is based on the risk-based framework for waterways developed by the NSW Environmental Protection Authority and NSW Office of Environment and Heritage and the water management framework adopted in ANZECC (2018). The framework is shown as **Figure 24.**

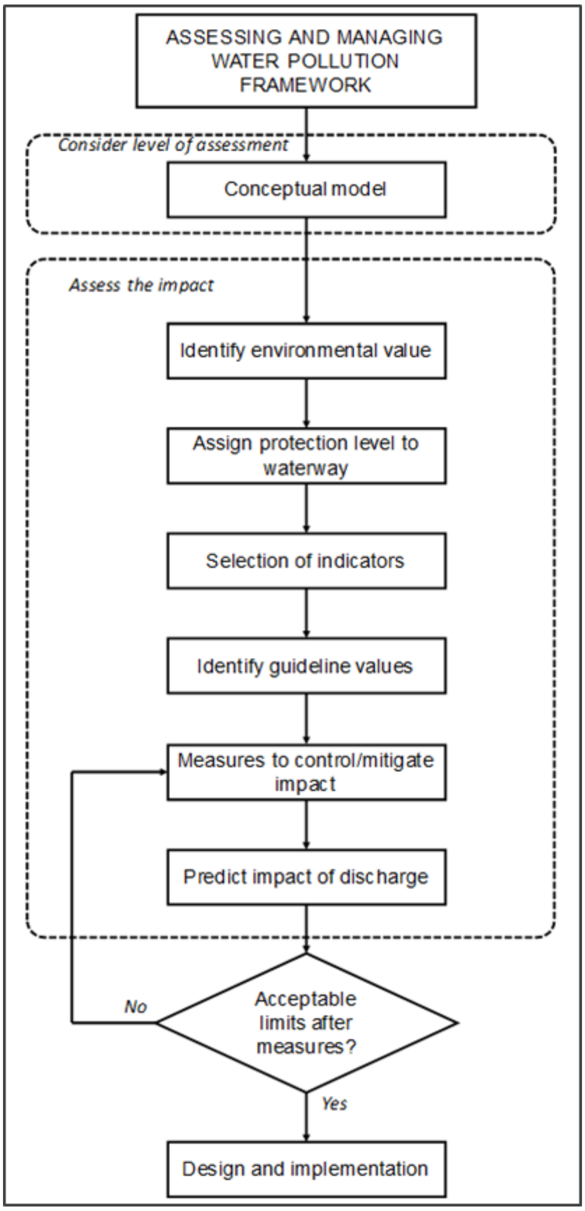


Figure 24: Framework for assessing and managing water pollution (TfNSW, 2020).

The key component of the assessment is developing a conceptual model that incorporates an understanding of the existing environment, expected discharge volumes and water quality to assess potential impacts. The purpose of a conceptual model is to ensure that all activities, processes and responses are identified and considered.

The catchments have been assumed to be large enough to generate baseflow between rainfall events. Discharges from the sediment basins will therefore be pumped into the waterways after the rainfall event when flows have reduced as shown in **Figure 25.** The assimilation capacity will depend on the flow of the waterway compared to the discharge flow rate.

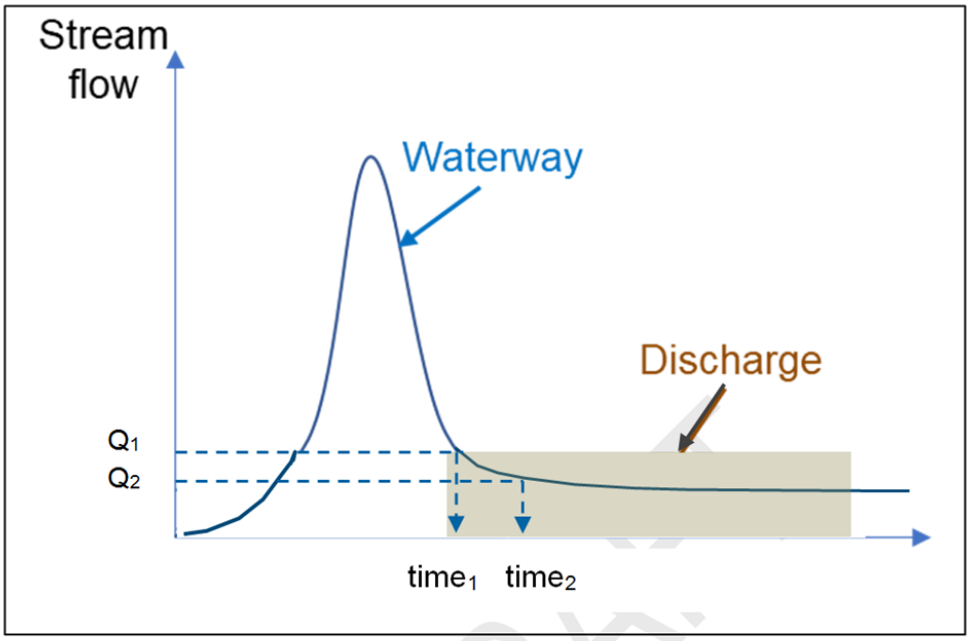


Figure 25: Conceptual model for treated water for sediment control basin discharging into a waterway (based on TfNSW 2020).

The Blue Book (Landcom, 2004) suggests that water discharged from construction sites should not contain more than 50 mg/L of suspended sediment. Turbidity is the preferred parameter to undertake the discharge assessment as it can be directly compared to the WQOs in the field.

Until such time as a site-based correlation is completed to convert TSS to Turbidity, the default value suggested in the TfNSW Draft Guideline will be adopted:

- Turbidity: TSS = 2:1 (e.g., 50 NTU equates to 25 mg/L).

12.1.2. Discharge Points

The location of the project construction stormwater detention (water quality) basins and proposed stormwater discharge points are provided in **Section 8.2**.

12.1.3. Discharge Conditions

The construction-phase sediment basins will be discharged within five days of the cessation of a rainfall event using a nominal pump rate over a 24–72-hour period (adopted flow rate of at least 5L/s per basin). Typically, basins are de-watered after treatment, when the rain has ceased and flows in the receiving water course have dropped or are rapidly dropping.

The flow rate of water discharged to each watercourse is expected to vary based on the number and volume of basins. The flow rate from sediment basin discharge would peak early when all basins are being discharged and then taper off as the smaller basins are emptied and only the larger basins remain in a state of discharge.

All construction phase sediment basins will discharge to local waterways except any sediment basins at the St Marys station site which will discharge directly into the stormwater system. All basins will be designed and operated such that discharge criteria as outlined in Section 10.2 is satisfied.

Discharge from all sediment basins will comply with a turbidity limit of 50 NTU prior to release into receiving waterways to maintain or improve ambient background water quality within the ANZECC 2000 default guideline values. This condition will apply for all discharges that do not exceed the design 5-day 80th percentile rainfall depth. A controlled water overflow strategy (described below) will be developed for release of any stormwater that exceeds the design threshold value.

12.1.4. Controlled Water Overflow Strategy

CPBG will develop a Controlled Water Overflow Strategy that will be implemented during the Project to allow for the off-site discharge of rainwater collected during rainfall events that exceed the 5 day, 80th percentile rainfall depth.

The Strategy is based on the approach that rainwater will be captured within the excavation, dive structure, station box or shaft in a formalised sump. A pump will be installed in the sump and will be isolated until such time that a Dewatering Permit is issued under the Water Reuse and Discharge Management Procedure and certified by the site Environment Officer/Advisor and the relevant Construction Manager.

The pump will be appropriately sized and will move captured water from the sump to an intercept point which would typically be a water tank. The intercept point will be designed to be appropriately sized to capture the total volume of the 5 day, 80th percentile rainfall depth for the relevant catchment per location. The intercept point will act as a first flush system to retain potential sediment.

The overflow mechanism from the intercept point will be designed to moderate the rate of overflow to mimic a sediment basin.

Once a rainfall event ceases and the sump capacity is restored, pumping from the sump will stop. The overflow of the intercept point will continue until the water level reaches equilibrium with the overflow mechanism. The remnant water will be diverted into the water treatment plant (WTP) and treated within the permitted 5 days.

This system has been implemented successfully on previous Sydney Metro projects and allows for risks to personnel and equipment from flooding to be effectively managed.

12.2. Discharges from Construction Water Treatment Plants

12.2.1. Discharge Points

The discharge points and receiving waterways for each of the WSA construction WTPs are identified in **Table 40** and **Figure 14.** The location of the construction WTPs within the boundary of each project construction site are presented in **Figures 2 - 6**.

12.2.2. Flow Conditions

Construction WTPs are estimated to discharge water at a rate of between approximately <5 and 30 L/s (<0.005 and 0.030m3/s) during the construction period for the project. The frequency and total daily volume of discharge will be dependent on the daily inflow rates related to groundwater inflows, process water, washdown, and incident rainfall into excavations and tunnels.

Under dry conditions and average groundwater inflows, excavations will likely discharge between approximately 17,000 and 34,000 litres per day to WTPs. Discharge volumes may increase up to 432,000 litres per day (432 m^3/day) at Orchard Hills in response to additional loads from TBM process water, washdowns, and general use within the mainline tunnels, which will use potable water sources.

Additional volumes of inflow to WTPs will result in an increased frequency of effluent discharge from the construction WTPs from repeated filling and draining, however will not significantly affect discharge rates as these are determined by the storage tank and pump design specifications.

Cumulatively the estimated discharges from all off-airport construction WTPs under dry conditions will add up to approximately 0.5 ML/d into the South Creek Catchment at the peak of construction activity, at discharge rates of up to 30 L/s.

A comparison of the predicted flow rates from water treatment plants against measured flow rates in corresponding receiving waterways is presented in **Table 42**. Flow comparison indicates that discharges from the water treatment plants are significantly lower than the average ambient flow rates through receiving waterways.

Based on measured average flow rates, discharges from water treatment plants (under dry weather conditions) are likely to increase average flows in receiving waterways between 0.09% and 2.56%. Discharges from water treatment plants will be diluted by ambient flows in receiving waterways. Dilution factors for discharges into receiving waterways vary from a dilution factor of 39:1 in Thompsons Creek, to 1,115:1 in South Creek.

Table 42: Effluent Discharge Vs Ambient Flow Rates in Receiving Waterways

Location	Water Treatment Plant	WTP Discharge (m^3/s)	Average Modelled Ambient Flow (m^3/s)	Percentage Flow Increase (%)	Receiving Environment Dilution Factor
South Creek at Great Western Highway	St Marys	0.0013	1.45	0.09	1,115
Claremont Creek	Claremont Meadows	0.0009	0.049	1.84	54
South Creek at Elizabeth Drive	Orchard Hills	0.0066	0.34	1.94	52
Badgerys Creek	Bringelly Services Facility	0.0009	0.045	2.00	50
Thompsons Creek	Aerotropolis Core	0.001	0.039	2.56	39

12.2.3. Water Quality

The proposed construction WTPs that will be installed by CPBG for WSA will enable effective treatment of the following influent sources of water prior to discharge into receiving waterways offsite disposal, trade waste disposal, and/or on-site beneficial re-use:

- Groundwater inflows,
- Incident rainfall into excavations,
- Process water derived from tunnel boring operation
- Washdown used in excavations and tunnels.

The WTPs have been designed with the objective of achieving the following criteria prior to discharge into receiving waterways:

- NSW Water Quality Objectives for the South Creek Catchment
- ANZG (2018) default guideline values for 90% / 95% species protection for general toxicants, and 95% / 99% species protection for bio-accumulating toxicants
- ANZECC (2000) default guideline values for physical and chemical stressors (Table 3.3.2 and 3.3.3 of ANZECC 2000 guidelines)[1]
- NSW EPA (2022) site specific DGV for South Creek Catchment.

The specific NSW Water Quality Objectives that have been adopted for the South Creek Catchment (summarised in **Section 5**), are presented in Table 51 alongside:

a) The relevant WTP treatment processes that have been selected to improve water quality prior to discharge

[1] With the exception of salinity

b) The relative risk of effluent discharges adversely impacting water quality objectives in the South Creek Catchment.

Treatment of salinity can only be managed through reverse osmosis (RO). RO has been explored as part of the design process and have been found to be impractical for the management of construction stage discharges due to generation of large volumes of extreme salinity brines, which cannot be disposed to either the environment or trade waste due to the significant risks of impact to both the environment and built infrastructure.

The treatment and removal of nitrogen including oxidised forms of nitrogen can only be achieved on the industrial scale through use of ion exchange processes. Due to the high salinity of local water quality and significant variability of influent chemistry to the water treatment plants, it is not considered feasible to implement an ion exchange system, without a period of pilot testing for the proposed seven step treatment process.

The predicted ranges in effluent water quality for the WTPs associated with the Project are summarised in Table 43.

Table 43: Predicted Effluent Water Quality – Western Sydney Airport SBT Water Treatment Plants

Parameter	Unit of Measure	Default Guideline Value (95% & 99% species protection)	Effluent Water Quality – All WTPs
pH	pH Units	6.5 – 8.0	6.5 – 8.0
Electrical Conductivity*	µs/cm	2,200	~6,800 – 13,000
Turbidity	NTU	50	<50
Total Phosphorous	mg/L	0.14	<0.14
Total Nitrogen	mg/L	1.72	<1.72
Total Oxidised Nitrogen	mg/L	0.66	<1.72
Total Ammonia	mg/L	0.90	0.90
Aluminium	mg/L	0.055	<0.07
Arsenic (As V)	mg/L	0.013	<0.013
Arsenic (As III)	mg/L	0.024	<0.024
Cadmium	mg/L	0.0002	<0.0002
Chromium (Cr VI)	mg/L	0.001	<0.006
Chromium (Cr III)	mg/L	0.0033	<0.0033
Copper	mg/L	0.0014	<0.002
Iron	mg/L	0.3	<0.3
Lead	mg/L	0.0034	<0.0034
Manganese	mg/L	1.9	<1.9
Mercury	mg/L	0.0006	<0.0006
Nickel	mg/L	0.011	<0.011
Vanadium	mg/L	0.006	<0.006
Zinc	mg/L	0.008	<0.015
TPH C10-C36 Fraction	µg/L	No Data	<600
TPH C6-C9 Fraction	µg/L	No Data	<150

Electrical conductivity likely to vary significantly based on groundwater quality. Orchard Hills salinity predicted 4,500 us/cm accounting for process water dilution effects.

The predicted effluent water quality from construction water treatment plants is predicted to achieve the adopted default guideline values, except for:

- Salinity (electrical conductivity)
- Total oxidised nitrogen
- Metals comprising aluminium, chromium, copper, and zinc

An analytical assessment has been undertaken to determine the potential water quality impacts associated with the release of the anticipated effluent profiles for each water treatment plant into receiving waterways.

The analytical assessment compares predicted effluent water quality from construction water treatment plants (following both initial dilution from process water and removal via the adopted seven-step treatment process) against ambient water quality in receiving waterways and the DGVs. The analytical assessment calculates the anticipated water quality following mixing with receiving waters including an assessment of the predicted percentage change of contaminant concentrations in receiving waterways in response to mixing.

The results of the assessments are presented in Tables 44 – 50.

Table 44: Estimated Salinity in Receiving Waterways with Dilution

Salinity DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m^3/s)	Concentration (mg/L)	Max Discharge Q (m^3/s)	Concentration (mg/L)		
South Creek at Claremont (SBT1) – Orchard Hills WTP							
2,200 (us/cm)	Min	0.28	768	0.0066	6,800	908	18.2
	Max	2.43	3,020	0.0066	6,800	3,030	0.3
	Average	0.67	1,218	0.0066	6,800	1,272	4.5
Claremont Creek (SBT2) – Claremont Meadows WTP							
2,200 (us/cm)	Min	0.06	1,800	0.0009	7,755	1,892	5.1
	Max	0.06	3,190	0.0009	7,755	3,260	2.2
	Average	0.06	2,759	0.0009	7,755	2,836	2.8
South Creek at St Marys (SBT3) – St Marys WTP							
2,200 (us/cm)	Min	0.28	930	0.0013	12,200	982	5.6
	Max	0.89	1,440	0.0013	12,200	1,456	1.1
	Average	0.48	1,148	0.0013	12,200	1,178	2.6
Badgerys Creek (SBT4) – Bringelly WTP							
2,200 (us/cm)	Min	0.06	937	0.0009	13,000	1,140	21.6
	Max	0.06	2,760	0.0009	13,000	2,932	6.2
	Average	0.06	1,672	0.0009	13,000	1,862	11.4
Thompsons Creek (SBT5) – Aerotropolis WTP							
2,200 (us/cm)	Min	0.05	943	0.0010	7,500	1,077	14.2
	Max	0.05	3,060	0.0010	7,500	3,150	3.0
	Average	0.05	2,180	0.0010	7,500	2,289	5.0

Table 45: Estimated Nitrogen in Receiving Waterways with Dilution

Nitrogen DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m^3/s)	Concentration (mg/L)	Max Discharge Q (m^3/s)	Concentration (mg/L)		
South Creek at Claremont (SBT1) – Orchard Hills WTP							
1.72 mg/L	Min	0.28	0.7	0.0066	0.1	0.7	-2.0
	Max	2.43	1.9	0.0066	0.1	1.9	-0.3
	Average	0.77	1.3	0.0066	0.1	1.3	-0.8
Claremont Creek (SBT2) – Claremont Meadows WTP							
1.72 mg/L	Min	0.06	0.04	0.0009	0.3	0.04	10.0

Nitrogen DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m^3/s)	Concentration (mg/L)	Max Discharge Q (m^3/s)	Concentration (mg/L)		
	Max	0.06	0.14	0.0009	0.3	0.14	1.8
	Average	0.06	0.10	0.0009	0.3	0.10	3.3
South Creek at St Marys (SBT3) – St Marys WTP							
1.72 mg/L	Min	0.28	1.0	0.0013	0.2	1.0	-0.3
	Max	0.89	1.7	0.0013	0.2	1.7	-0.1
	Average	0.48	1.3	0.0013	0.2	1.3	-0.2
Badgerys Creek (SBT4) – Bringelly WTP							
1.72 mg/L	Min	0.06	0.6	0.0009	0.8	0.6	3.0
	Max	0.06	8.2	0.0009	0.8	8.1	-1.3
	Average	0.06	2.8	0.0009	0.8	2.8	-0.7
Thompsons Creek (SBT5) – Aerotropolis WTP							
1.72 mg/L	Min	0.05	0.5	0.0010	1.5	0.5	3.9
	Max	0.05	0.8	0.0010	1.5	0.8	1.7
	Average	0.05	0.6	0.0010	1.5	0.6	2.7

Table 46: Estimated Oxides of Nitrogen in Receiving Waterways with Dilution

Oxides of Nitrogen DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m^3/s)	Concentration (mg/L)	Max Discharge Q (m^3/s)	Concentration (mg/L)		
South Creek at Claremont (SBT1) – Orchard Hills WTP							
0.66 mg/L	Min	0.28	0.1	0.0066	0.1	0.1	0.6
	Max	2.43	1.0	0.0066	0.1	1.0	-0.2
	Average	0.77	0.4	0.0066	0.1	0.4	-0.7
Claremont Creek (SBT2) – Claremont Meadows WTP							
0.66 mg/L	Min	0.06	0.24	0.0009	0.3	0.2	0.4
	Max	0.06	0.30	0.0009	0.3	0.3	0.0
	Average	0.06	0.26	0.0009	0.3	0.3	0.2
South Creek at St Marys (SBT3) – St Marys WTP							
0.66 mg/L	Min	0.28	0.1	0.0013	0.2	0.13	0.25
	Max	0.89	0.9	0.0013	0.2	0.85	-0.11
	Average	0.48	0.4	0.0013	0.2	0.40	-0.14
Badgerys Creek (SBT4) – Bringelly WTP							
0.66 mg/L	Min	0.06	0.04	0.0009	0.8	0.1	31.9
	Max	0.06	1.3	0.0009	0.8	1.3	-0.6
	Average	0.06	0.5	0.0009	0.8	0.5	1.2
Thompsons Creek (SBT5) – Aerotropolis WTP							
0.66 mg/L	Min	0.05	0.1	0.0010	1.5	0.1	22.6
	Max	0.05	0.2	0.0010	1.5	0.2	15.3
	Average	0.05	0.1	0.0010	1.5	0.2	18.8

Table 47: Estimated Chromium in Receiving Waterways with Dilution

Chromium DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m^3/s)	Concentration (mg/L)	Max Discharge Q (m^3/s)	Concentration (mg/L)		
South Creek at Claremont (SBT1) – Orchard Hills WTP							
0.001 mg/L	Min	0.28	0.005	0.0066	0.006	0.005	0.5
	Max	2.43	0.005	0.0066	0.006	0.005	0.1
	Average	0.77	0.005	0.0066	0.006	0.005	0.2
Claremont Creek (SBT2) – Claremont Meadows WTP							
0.001 mg/L	Min	0.06	0.003	0.0009	0.006	0.003	1.5
	Max	0.06	0.003	0.0009	0.006	0.003	1.5

Chromium DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m³/s)	Concentration (mg/L)	Max Discharge Q (m³/s)	Concentration (mg/L)		
	Average	0.06	0.003	0.0009	0.006	0.003	1.5
South Creek at St Marys (SBT3) – St Marys WTP							
0.001 mg/L	Min	0.28	0.005	0.0013	0.006	0.005	0.09
	Max	0.89	0.005	0.0013	0.006	0.005	0.03
	Average	0.48	0.005	0.0013	0.006	0.005	0.05
Badgerys Creek (SBT4) – Bringelly WTP							
0.001 mg/L	Min	0.06	0.001	0.0009	0.006	0.001	8.4
	Max	0.06	0.001	0.0009	0.006	0.001	8.4
	Average	0.06	0.001	0.0009	0.006	0.001	8.4
Thompsons Creek (SBT5) – Aerotropolis WTP							
0.001 mg/L	Min	0.05	0.002	0.0010	0.006	0.002	4.1
	Max	0.05	0.002	0.0010	0.006	0.002	4.1
	Average	0.05	0.002	0.0010	0.006	0.002	4.1

Table 48: Estimated Copper in Receiving Waterways with Dilution

Copper DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m³/s)	Concentration (mg/L)	Max Discharge Q (m³/s)	Concentration (mg/L)		
South Creek at Claremont (SBT1) – Orchard Hills WTP							
0.0014 mg/L	Min	0.28	0.0010	0.0066	0.0014	0.0010	1.0
	Max	2.43	0.0280	0.0066	0.0014	0.0279	-0.3
	Average	0.77	0.0084	0.0066	0.0014	0.0084	-0.7
Claremont Creek (SBT2) – Claremont Meadows WTP							
0.0014 mg/L	Min	0.06	0.004	0.0009	0.0009	0.004	-1.2
	Max	0.06	0.018	0.0009	0.0009	0.018	-1.5
	Average	0.06	0.009	0.0009	0.0009	0.009	-1.4
South Creek at St Marys (SBT3) – St Marys WTP							
0.0014 mg/L	Min	0.28	0.001	0.0013	0.002	0.001	0.46
	Max	0.89	0.012	0.0013	0.002	0.012	-0.12
	Average	0.48	0.005	0.0013	0.002	0.005	-0.16
Badgerys Creek (SBT4) – Bringelly WTP							
0.0014 mg/L	Min	0.06	0.0010	0.0009	0.0020	0.0010	1.7
	Max	0.06	0.0070	0.0009	0.0020	0.0069	-1.2
	Average	0.06	0.0034	0.0009	0.0020	0.0034	-0.7
Thompsons Creek (SBT5) – Aerotropolis WTP							
0.0014 mg/L	Min	0.05	0.0010	0.0010	0.0020	0.0010	2.0
	Max	0.05	0.0120	0.0010	0.0020	0.0118	-1.7
	Average	0.05	0.0032	0.0010	0.0020	0.0032	-0.8

Table 49: Estimated Aluminium in Receiving Waterways with Dilution

Aluminium DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m³/s)	Concentration (mg/L)	Max Discharge Q (m³/s)	Concentration (mg/L)		
South Creek at Claremont (SBT1) – Orchard Hills WTP							
0.055 mg/L	Min	0.28	0.270	0.0066	0.070	0.265	-1.7
	Max	2.43	7.690	0.0066	0.070	7.669	-0.3
	Average	0.77	2.149	0.0066	0.070	2.132	-0.8
Claremont Creek (SBT2) – Claremont Meadows WTP							
0.055 mg/L	Min	0.06	0.060	0.0009	0.070	0.060	0.3
	Max	0.06	3.620	0.0009	0.070	3.565	-1.5
	Average	0.06	1.020	0.0009	0.070	1.005	-1.4

Aluminium DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m^3/s)	Concentration (mg/L)	Max Discharge Q (m^3/s)	Concentration (mg/L)		
South Creek at St Marys (SBT3) – St Marys WTP							
0.055 mg/L	Min	0.28	0.330	0.0013	0.070	0.329	-0.36
	Max	0.89	4.030	0.0013	0.070	4.024	-0.14
	Average	0.48	1.419	0.0013	0.070	1.415	-0.26
Badgerys Creek (SBT4) – Bringelly WTP							
0.055 mg/L	Min	0.06	0.310	0.0009	0.070	0.306	-1.3
	Max	0.06	1.170	0.0009	0.070	1.152	-1.6
	Average	0.06	0.588	0.0009	0.070	0.579	-1.5
Thompsons Creek (SBT5) – Aerotropolis WTP							
0.055 mg/L	Min	0.05	0.110	0.0010	0.070	0.109	-0.7
	Max	0.05	1.250	0.0010	0.070	1.226	-1.9
	Average	0.05	0.636	0.0010	0.070	0.624	-1.8

Table 50: Estimated Zinc in Receiving Waterways with Dilution

Zinc DGV	Statistic	Receiving Environment		WTP Effluent		Mixed Concentration (mg/L)	% Change
		Simulated Q (m^3/s)	Concentration	Max Discharge Q (m^3/s)	Concentration		
South Creek at Claremont (SBT1) – Orchard Hills WTP							
0.008 mg/L	Min	0.28	0.005	0.0066	0.015	0.005	4.6
	Max	2.43	0.092	0.0066	0.015	0.092	-0.2
	Average	0.77	0.024	0.0066	0.015	0.023	-0.3
Claremont Creek (SBT2) – Claremont Meadows WTP							
0.008 mg/L	Min	0.06	0.005	0.0009	0.015	0.005	3.1
	Max	0.06	0.116	0.0009	0.015	0.114	-1.3
	Average	0.06	0.043	0.0009	0.015	0.042	-1.0
South Creek at St Marys (SBT3) – St Marys WTP							
0.008 mg/L	Min	0.28	0.005	0.0013	0.015	0.005	0.92
	Max	0.89	0.020	0.0013	0.015	0.020	-0.04
	Average	0.48	0.010	0.0013	0.015	0.010	0.13
Badgerys Creek (SBT4) – Bringelly WTP							
0.008 mg/L	Min	0.06	0.005	0.0009	0.015	0.005	3.4
	Max	0.06	0.013	0.0009	0.015	0.013	0.3
	Average	0.06	0.006	0.0009	0.015	0.006	2.5
Thompsons Creek (SBT5) – Aerotropolis WTP							
0.008 mg/L	Min	0.05	0.005	0.0010	0.015	0.005	4.1
	Max	0.05	0.016	0.0010	0.015	0.016	-0.1
	Average	0.05	0.008	0.0010	0.015	0.009	1.6

The results from analytical assessment of discharge impacts indicates the following outcomes with respect to discharge of treated effluent at the anticipated concentrations.

12.2.3.1. Salinity

The salinity of influent cannot be reduced with the available treatment technology. Reverse osmosis treatment methods have been assessed as non-viable owing to significant Capex, Opex, and operational limitations.

The predicted effluent salinity accounts for mixing with process water prior to discharge. The process water volumes significantly reduce salinity, however mixing cannot achieve the required DGV of 2,200 µg/L prior to discharge.

Impacts from the discharge of brackish water to receiving waterways are varied in accounting for the available dilution capacities of the receiving waterways. At St Marys, discharge is unlikely to cause an increase in salinity beyond the DGVs. At other locations existing conditions typically already exceed the ANZECC DGV of 2,200 µg/L and there is limited additional impact from WTP discharges.

Review of the predicted percentage changes for salinity of receiving waters indicates that discharge of brackish effluent is likely to result in a net 5-10% increase in salinity under typical flow conditions. Significant rainfall events will provide a flushing effect that will largely mitigate any long term or ongoing increase in salinity as a result of effluent discharge.

12.2.3.2. Oxidised Nitrogen

The concentration of oxidised nitrogen cannot be reduced with the available treatment technology. Ion exchange treatment methods have been assessed as non-viable owing to significant Capex, Opex, and operational limitations.

The predicted concentrations of oxidised nitrogen in effluent accounts for mixing with process water prior to discharge. The process water volumes significantly reduce oxidised nitrogen, however mixing cannot achieve the required DGV of 0.66 mg/L prior to discharge.

Impacts from the discharge of effluent containing elevated oxides of nitrogen are varied in accounting for the available dilution capacities of the receiving waterways.

In South Creek and Claremont Creek effluent concentrations of oxidised nitrogen are lower than the ambient background concentrations in receiving waterways, resulting in a net improvement of water quality in response to discharge.

In Badgerys Creek and Thompsons Creek, effluent concentrations of oxidised nitrogen are typically higher than ambient background concentrations. However, at these locations mixing and dilution of effluent with ambient flows are largely predicted to result in water quality remaining below the DGV of 0.66 mg/L.

Accordingly, the overall impacts from discharge of effluent containing elevated concentrations are oxidised nitrogen are predicted to have a neutral to beneficial effect on water quality in receiving waterways.

12.2.3.3. Metals (aluminium, copper, chromium, zinc)

Concentrations of the heavy metals comprising aluminium (Al), copper (Cu), chromium (Cr), and zinc (Zn) will be reduced by both mixing with process water prior to discharge and by the selected treatment technologies. Treatment and removal of these contaminants to the required DGVs is considered to be inhibited by the significant concentrations in groundwater that will provide feed water to the construction WTPs.

Impacts from the discharge of effluent containing elevated concentrations of Al, Cu, Cr, and Zn are varied in accounting for the available dilution capacities of the receiving waterways and ambient concentrations of contaminants.

Copper and aluminium in effluent discharge are anticipated to result typically in a net improvement of water quality in receiving waterways owing to the significantly elevated concentrations of these contaminants under ambient conditions. Chromium and zinc are expected to have varied impacts accounting for the varied receiving water conditions, however, the impacts typically account for less than a 5% change in water quality and as such are relatively minor.

It is recommended that Chelex based testing of contaminant concentrations for heavy metals is undertaken during construction stage discharges to determine the bioavailable concentrations of heavy metals and thus determine actual ecotoxicological risk from the heavy metals that are predicted to or may exceed the ANZG (2018) DGVs for 95% species protection.

12.2.4. Summary

It is anticipated that there will be a **low** to **very low** likelihood of discharges from WTPs resulting in measurable or significant adverse impacts to water quality in the South Creek Catchment based on available groundwater monitoring data and the proposed treatment processes. Table 51 provides a summary discussion of the treatment processes and residual risks to water quality objectives from construction stage discharges associated with the project.

Table 51: Summary Assessment of Water Treatment Processes and Residual Risks to Water Quality

Environmental Objective	Relevant WTP Treatment Processes / Limitations	Risk to Water Quality Objective
Protection of Aquatic Ecosystems	Treatment processes will reduce concentrations of a range of contaminants, turbidity, and buffer pH to the adopted default guideline values prior to discharge. There is a moderate risk of salinity and NOx to exceed default guideline values in treated effluent, however mixing with the receiving waterways is generally expected to lower salinity and NOx back to near ambient conditions. Average anticipated changes in salinity resulting from discharge are between 2.6% and 11%. Average anticipated changes in NOx resulting from discharge are between-0.7% and 17%. While water treatment plants are not capable of removing total nitrogen or NOx, the mixing of groundwater with process water provides dilution and attenuation of contaminant risk by significantly diluting concentrations in influent (feed water) to WTPs..	Low - moderate
Visual Amenity	Treatment processes will reduce turbidity, enhance clarity, remove oils and petrochemicals, and any debris or litter prior to discharge.	Very Low
Primary Contact Recreation *	Treatment processes will reduce turbidity, enhance clarity prior to discharge. Faecal coliforms and enterococci are not expected at significant concentrations in groundwater, however, are likely to be reduced by treatment processes.	Very Low
Secondary Contact Recreation *	Treatment processes will reduce turbidity, enhance clarity prior to discharge. Faecal coliforms and enterococci are not expected at significant concentrations in groundwater, however, are likely to be reduced by treatment processes.	Very Low
Aquatic Foods *	Treatment processes will reduce concentrations of contaminants, salinity and buffer pH to the adopted default guideline values prior to discharge. Faecal coliforms are not expected at significant concentrations in groundwater, however, are likely to be reduced by treatment processes.	Very Low
Irrigation Water Supply *	Treatment processes will reduce concentrations of contaminants, and turbidity. Coliforms are not expected at significant concentrations in groundwater, however, are likely to be reduced by treatment processes.	Very Low
Livestock Water Supply *	Treatment processes will reduce concentrations of organic / inorganic contaminants, turbidity, and salinity, and buffer pH to the adopted default guideline values prior to discharge. Coliforms are not expected at significant concentrations in groundwater, however, are likely to be reduced by treatment processes.	Very Low
Drinking Water Supply	Treatment processes will reduce concentrations of contaminants, turbidity, and salinity, and buffer pH. Coliforms and Faecal Coliforms are not expected at significant concentrations in groundwater, however, are likely to be reduced by treatment processes. It should be noted that WTPs have not been specifically designed for the purpose of treating water to potable water standards for human health, and as such are not required to meet potable water standards.	Not Considered

* Likelihood of achieving criteria does not include treatment for coliforms, faecal coliforms, and enterococci, however it is considered unlikely that these biological contaminants are present in groundwater at significant concentrations.

Despite the robust water treatment processes that are proposed, there are potential residual risks that effluent water quality may exceed the adopted ANZECC (2000) and ANZG (2018) default guideline values, under the following circumstances:

- Concentrations of toxicants / stressors in groundwater are encountered at levels exceeding the treatment capacity of the WTP
- Additional unexpected toxicants are encountered in groundwater beyond the treatment capacity of the WTP and beyond acceptable limits for discharge following treatment (e.g., salinity).
- Inflows to WTPs occur at rates exceeding the treatment capacity
- Maintenance requirements result in a decreased or limited treatment capacity at the WTP.

Adaptive management measures and contingency options for the discharge of treated effluent are discussed in **Section 11** and provide a means to account for and plan alternative strategies where there is or may be an increased risk to water quality in receiving waterways from the factors described above.

Section 10 provides recommendations for the setting of discharge criteria (including pollutants and pollutant limits for regulation) to be included on the EPL for the project that account for both the practical limitations of treatment processes and risks to water quality objectives. Limits presented within this report have been included as a means for maintaining and/or improving water quality within the South Creek Catchment.

Review of historic baseline surface water quality monitoring data indicates that discharges from the proposed construction WTPs may act to improve ambient water quality within South Creek and its associated tributaries by a reduction in ambient turbidity and concentrations of nutrients and trace metals. Although WTP effluent discharge rates may be limited in volume compared to ambient flow, the net improvement in water quality for these parameters is in line with the objective of maintaining and improving water quality in the catchment.

12.3. Cumulative Impacts

12.3.1. Water Quality

South Creek Catchment in Western Sydney is one of the most heavily degraded catchments in Australia (Hawkesbury-Nepean CMA, 2007). The catchment has suffered from high pollution loads, increased impervious surfaces from urbanisation, and long-term clearing of vegetation resulting in a rise of saline groundwater into streams and increased sediment runoff (Boon, 2017).

Without appropriate management measures, the expansion of impervious surfaces in urbanised catchments can lead to adverse changes in hydrology and geomorphology of streams through increased runoff volumes and presence of suspended loads that may contain elevated concentrations of chemical toxicants and physical / chemical stressors.

Industrial discharges associated with urban expansion can also affect water quality, increasing loads of chemical and biological toxicants and physical / chemical stressors (e.g., discharges from municipal wastewater treatment plants) and an overall loss of natural ecological productivity.

Without appropriate management measures catchment urbanisation can lead to declines in the richness of algal, invertebrate, and fish communities in urban and peri-urban waterways at downstream locations.

Baseline water quality monitoring data has been made available for South Creek and Badgerys Creek around Bringelly, and for South Creek at St Marys (WaterNSW monitoring station #212048).

13. Adaptive Management Measures / Contingency Options

13.1. Water Treatment Plants

CPBG are proposing to maintain a range of adaptive management measures and contingency options to mitigate potential impacts to receiving waterways from WTP effluent discharge. The proposed adaptive management measures and contingency options (summarised in Table 52 will account for potential variability in effluent quality that may result from operational issues at WTPs, and/or variability in influent (feed water) quality outside the WTP specifications.

Table 52: Potential Risks and Contingency Measures – WSA Construction WTP's

Potential Risk	Contingency Measures
Effluent water quality exceeds adopted discharge limits for one or more contaminants due to increased concentrations in groundwater	1. Beneficial reuse on-site for dust suppression
	2. Undertake mixing zone modelling to assess suitable site-specific discharge limits to surface water (in consultation with EPA for EPL variation).
	3. Mix with other wastewater streams until discharge criteria are achieved.
	4. Dispose off-site to a licensed disposal facility.
Effluent water quality exceeds adopted discharge limits for one or more contaminants due to maintenance requirements at WTP	1. The WTP design incorporate two parallel treatment processing units. One unit may be taken offline for maintenance whilst the other remains functioning, minimising risk of discharge being impacted by maintenance requirements.
	2. Mix with other wastewater streams until discharge criteria are achieved.
	3. Dispose off-site to a licensed disposal facility.
	4. Tanker water to nearest appropriate WTP for secondary treatment.
Turbidity of treated effluent exceeds adopted discharge limits	1. Recirculate treated effluent through the WTP until required discharge limits are achieved.
	2. Beneficial reuse on-site for dust suppression
	3. Tanker to nearest alternative site for secondary treatment
Salinity of treated effluent exceeds adopted discharge limits	1. Beneficial reuse on-site for dust suppression
	2. Mix with other wastewater streams until discharge criteria are achieved.
	3. Dispose off-site to a licensed disposal facility.
	4. Dispose off-site to trade waste under trade waste agreement
	5. Tanker to nearest alternative site for secondary treatment

13.2. Stormwater

13.2.1. Alternate Management Strategies

The project aims to avoid discharge if at all possible through:

- Beneficial re-use of detained surface water from sediment basins, sumps and excavations; or
- Land application of detained surface water onto vegetated or rehabilitation areas.

A discharge from the project will only occur when the above options are exhausted. This typically occurs when:

- Heavy rainfall has made the site too wet for beneficial onsite re-use such as dust suppression; and/or

- The volume of detained surface water in sediment basins exceeds what can be feasibly re-used onsite within the 5-day period for basin maintenance; and/or
- Heavy rainfall has made land application onto nearby vegetated or revegetation areas impossible; and/or
- There are no suitable onsite re-use options available in reasonable proximity to the detained body of surface water.

Consequently, the capture and retention of sediment on site using the best practice management principles outlined in the Blue Book (Landcom, 2004 and DECC, 2008) decreases the potential for a range of other pollutants degrading the receiving environment.

14. Proposed Environmental Protection Licence Discharge Criteria

14.1. WTP Discharge

Construction WTPs will discharge treated effluent to the receiving waterways outlined in Table 40. The construction WTPs have been designed with the objective of treating water to the following criteria:

- NSW Water Quality Objectives for the South Creek Catchment
- ANZG (2018) default guideline values for 95% species protection for general toxicants, and 99% species protection for bio-accumulating toxicants
- ANZECC (2000) default guideline values for physical and chemical stressors (Table 3.3.2 and 3.3.3 of ANZECC 2000 guidelines)
- NSW EPA (2022) site specific DGV for South Creek Catchment.

Table 53 provides proposed interim discharge criteria to be included on the Environmental Protection Licence (EPL) for the purpose of regulating effluent discharges from the construction WTPs until a program of performance monitoring can be completed to assess empirical effluent water quality outcomes.

Limits have been determined based on adoption of various levels of species protection from the ANZG (2018) default guideline values, South Creek Catchment SSTVs and the anticipated likely effluent water quality outcomes in response to treatment processes. A summary of guidance documents used is provided below:

- NSW EPA (2022) Wiannamatta-South Creek Catchment Water Quality Objectives (default guidelines)
- ANZG (2018) 95% species protection for freshwater (where NSW EPA 2022 doesn't provide criteria)
- ANZG (2018) 95% species protection for marine waters (where freshwater criteria is not provided)

The proposed criteria in Table 53 provides proposed water quality trigger values that can be regularly met accounting for practical limitations of treatment technology and transient variability in flow and influent water quality, which may affect the efficacy of treatment measures.

It is recommended that these values are adopted as interim limits subject to a proof of performance monitoring program, which should be undertaken to determine empirical outcomes from the adopted water treatment measures. The proposed proof of performance program will assist in providing verifiable information on attainable and sustainable discharge limits for the project. Further detail on a proposed performance monitoring program is provided in Section 15.

Table 53: Proposed Interim Discharge Criteria

Parameter	Unit of Measure	Proposed Discharge Limit	Reference
pH	pH Units	6.5 – 8.0	ANZECC 2000
Electrical Conductivity	µs/cm	13,000	Anticipated Effluent
TSS	mg/L	50.0	ANZECC 2000
Total Phosphorous	mg/L	0.14	ANZECC 2000
Total Nitrogen	mg/L	1.72	South Creek SSTV
Total Ammonia	mg/L	0.9	ANZG 2018 95% SP
Aluminium	mg/L	0.08	Anticipated Effluent / ANZG 2018 90% SP
Arsenic (total)	mg/L	0.013	ANZG 2018 95% SP
Cadmium	mg/L	0.0002	ANZG 2018 95% SP

Parameter	Unit of Measure	Proposed Discharge Limit	Reference
Chromium (Cr VI)	mg/L	0.006	Anticipated Effluent / ANZG 2018 90% SP
Copper	mg/L	0.002	Anticipated Effluent
Iron	mg/L	0.3	CCME Guidelines
Lead	mg/L	0.0034	ANZG 2018 95% SP
Manganese	mg/L	1.9	ANZG 2018 95% SP
Mercury	mg/L	0.00006	ANZG 2018 99% SP
Nickel	mg/L	0.011	ANZG 2018 95% SP
Zinc	mg/L	0.015	Anticipated Effluent / ANZG 2018 90% SP
TPH C10-C36 Fraction	µg/L	<100	Limit of Reporting
TPH C6-C9 Fraction	µg/L	<100	Limit of Reporting

14.2. Stormwater Discharge

The discharge impact assessment indicates that the construction phase sediment basin discharges of no more than 50 NTU is unlikely to result in a significant increase to average turbidity levels in the receiving waterways. It is proposed that a limit of 50 NTU is adopted for licence conditions.

15. Performance Monitoring and Improvement

15.1. Water Treatment Plants

CPBG are proposing to undertake a program of performance monitoring and improvement over a 6-month period as part of the commissioning program for the proposed construction water treatment plants.

CPBG intend to undertake the following activities as part of the commissioning for each water treatment plant:

- Fortnightly monitoring of influent water quality and treated effluent water quality, including all parameters listed in the proposed EPL Licence Criteria and those identified in groundwater at concentrations exceeding the Default Guideline Values
- Fortnightly monitoring of receiving surface waters at locations upstream, downstream, and adjacent to the effluent discharge point
- Screening of all water quality data against EPL Licence Criteria, SSTVs, and ANZG / ANZECC DGVs
- Monitoring and reporting of chemicals, dosing rates, contact times, filters, and approaches taken to optimise and maintain optimised performance of the water treatment plants in removing contaminants from feed water

During the commissioning monitoring period CPBG will ensure that impacts from treated effluent on the receiving environment are minimised through:

- Use of contingency measures where there is a risk of effluent exceeding discharge criteria, including (where suitable):
    - Discharge to trade waste
    - Beneficial reuse on-site
    - Recirculation through the water treatment plant
- Regular maintenance of WTP plant, machinery, dosing rates, and filters to ensure optimal efficiency of WTPs is maintained.

The outcomes from performance monitoring will be incorporated into a technical report, which will include:

- Results from fortnightly monitoring of influent (feed water) and effluent water quality, screened against the proposed EPL licence criteria, SSTVs, and ANZG / ANZECC DGVs
- Results from fortnightly monitoring of receiving surface waters at upstream, downstream and discharge point monitoring sites, screened against the proposed EPL licence criteria, SSTVs, and ANZG / ANZECC DGVs
- Summary of the treatment processes, including chemicals, dosing rates, and approaches taken to optimise and maintain performance over the commissioning period
- Recommendations for any further monitoring and/or assessment to further assess potential environmental impact
- Recommendations for any additional water treatment processes to further minimize potential environmental impacts

It is recommended to adopt Chelex testing methods for laboratory testing of water quality samples to assess the bioavailable concentrations in both effluent and receiving waters. The Chelex method (NATA accredited) is preferred over standard ICP MS methods as a more accurate means to assess potential risks to aquatic ecosystems with respect to ANZG standards.

15.2. Stormwater

Notwithstanding the above conclusions and primary recommendations for discharge limits, for this project a range of additional management measures are recommended to reduce the potential environmental impacts associated with construction-phase sediment basin discharges. The following management measures are recommended for the construction-phase works component of this proposal:

- Amendment of DGV to reflect known status and contamination state of the receiving environment. Receiving waters currently exceed adopted DGV across a number of parameters.
- Apply a risk-based approach regarding the re-use of water in construction-phase sediment basins in preference to discharge. This will include a process for reusing surface water detained on the site. Construction is an activity that requires considerable water volumes for earthworks compaction and dust control. During drier periods (minimal or no rainfall predicted), construction sediment basin water would typically be utilised for this purpose rather than discharged.
- Irrigation of sediment basin water to approved land where feasible and the water quality meets the required irrigation standards.
- All construction-phase sediment basin outlets would be rock armoured to meet Blue Book design requirements. Where nominated discharge points are located away from waterways, the rock armouring provides an opportunity for infiltration of discharged water into the underlying soil prior to discharge into the receiving environment.
- Basin dewatering activities should be undertaken in accordance with CPBGs approved construction environmental management plan (CEMP).
- Use of floating siphon devices where possible to minimise resuspension of sediment during dewatering operations. Floating siphon devices remove water from the top of the water column where the supernatant is likely to be the best quality.
- This analysis highlights that the proposed discharge limits result in an average turbidity level less than the water quality objective trigger values. Additional monitoring within the mixing zones during operation of the basins will confirm the desktop assessment that anticipates that discharges will be quickly mixed with the receiving waters.

16. Summary and Recommendations

16.1. WTP Discharge

The construction stage WTPs that will be commissioned by CPBG for WSA will enable the treatment of the following sources of water prior to discharge into receiving waterways:

- Groundwater inflows,
- Incident rainfall into excavations,
- Process water derived from tunnel boring operation
- Washdown used in excavations and tunnels.

The WTPs have been designed with the objective of achieving the following criteria prior to discharge into receiving waterways:

- NSW Water Quality Objectives for the South Creek Catchment
- NSW EPA endorsed (2022) site specific DGV for South Creek Catchment.
- ANZG (2018) default guideline values for 95% species protection for general toxicants, and 99% species protection for bio-accumulating toxicants
- ANZECC (2000) default guideline values for physical and chemical stressors (Table 3.3.2 and 3.3.3 of ANZECC 2000 guidelines); or

Based on the available groundwater monitoring data and proposed treatment processes it is considered highly likely that WTP processes will sufficiently reduce toxicants and stressors (except for salinity, oxidised nitrogen, and several heavy metals (Al, Cu, Cr, Zn) to achieve the adopted catchment Water Quality Objectives, including 95% and 99% species protection values for aquatic ecosystems.

Contaminants that cannot be treated to the adopted DGVs are likely to have limited impact on receiving waterway conditions, with analytical modelling indicating minor increases, and or neutral to beneficial impacts on water quality.

Alternative interim discharge limits are proposed for the contaminants that cannot be treated to the DGV. It is recommended that interim discharge limits are adopted until performance monitoring as part of the commissioning of water treatment plants can be completed to verify water quality outcomes.

CPBG are proposing to undertake a program of performance monitoring and pollution reduction as part of the commissioning period for construction WTPs. These measures have been established to ensure that the potential risks to water quality are anticipated and appropriately mitigated throughout construction lifecycle of the project.

16.2. Stormwater

The current quality of water in the local waterways varies based on rainfall and runoff patterns. Natural turbidity values within the receiving environment are expected to exceed the nominated WQOs during and after heavy rainfall.

CPBG will implement erosion controls on site to minimise sediment generation. Nevertheless, sediment basins will be constructed across sites to collect and treat potentially sediment laden water. Basins will be sized to meet the Blue Book (Landcom 2004) 5-day 80th percentile rainfall depth (27.4mm for closest location, Penrith). Within 5 calendar days of the conclusion of any rainfall causing runoff, the sediment basin(s) is to be empty, ready for the next rainfall event. This might include testing water, treating (e.g. flocculating), de-watering and de-silting basins.

A desktop methodology has been adopted to review the potential impact of construction-phase sediment basin discharges to local waterways. The methodology has been adopted for other approved construction projects within the catchment that have similar recommended discharge limits.

This assessment indicates that expected discharges are relatively small compared to the natural flow volume within the waterways. Discharged water will be within adopted DGVs, and as such discharge events are not expected to impact water quality within the receiving environments. The design rainfall event for the sediment basins in 27.4mm. It is assumed that the basins could overflow in an event of more than 27.4mm over any 5-day period.

CPBG will adopt alternate management strategies that will look to re-use treated water on site with discharge only after all other practical reuse options have been exhausted.

The analysis is based on preliminary sizing of sediment basins and expected discharge volumes and final designs may result in smaller sediment basin volumes.

17. References

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