ARTC

CABRAMATTA LOOP PROJECT

TECHNICAL REPORT

TECHNICAL REPORT 7 —

SURFACE WATER AND GROUNDWATER QUALITY IMPACT ASSESSMENT

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Australian Rail Track Corporation

Cabramatta Loop Project

Environmental Impact Statement

Technical Report 7 - Surface Water and Groundwater Quality Impact Assessment

August 2019

Table of contents

Table index

Figure index

Glossary and abbreviations

Term	Definition
Annual exceedance probability (AEP)	The annual exceedance probability is a measure of the frequency of a rainfall event. It is the probability that a given rainfall total, accumulated over a given duration, will be exceeded in any one year. A one % AEP event is a rainfall event with a one % chance of being exceeded in magnitude in any year. The current Australian Rainfall and Runoff Guideline (Commonwealth of Australia, 2016) recommends the use of AEP terminology whereas historically, the term average recurrence interval (ARI) was used. Where reference documents have used ARI, this has been converted to an equivalent AEP using the information below (Bureau of Meteorology, 2016). ARI (years) / AEP (%): 1 / 63; 2 / 39; 5 / 18; 10 / 10; 20 / 5; 50 / 2; 100 / 1
Afflux	With reference to flooding, afflux refers to the predicted change, usually in flood levels, between two scenarios. It is frequently used as a measure of the change in flood levels between an existing scenario and a proposed scenario.
Australian Height Datum (AHD)	A common reference level used in Australia which is approximately equivalent to the height above sea level.
Average recurrence interval (ARI)	The average recurrence interval is a measure of the frequency of a rainfall event. It is the expected average value of the periods between exceedances of a given rainfall total accumulated over a given duration eg. 1 in 100 years. However, this sometimes resulted in the term being misinterpreted as implying that the associated magnitude is only exceeded at regular intervals, and that it was referring to the elapsed time to the next exceedance. In fact, the periods between events of a similar magnitude are random and unpredictable. For these reasons, the annual exceedance probability (AEP) is now the preferred terminology.
Blue Book	Managing Urban Stormwater: Soils and Construction Handbook (see References in section 9).
Catchment	The area drained by a stream or body of water or the area of land from which water is collected.
Climate change event	In this report, the 1 % AEP climate change event is a 1 % AEP event including a 10 % increase in peak rainfall intensity to incorporate the possible future effects of climate change.
Datum	A level surface used as a reference in measuring elevations.
Discharge	Quantity of water per unit of time flowing in a stream, for example cubic meters per second or megalitres per day.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.

Term	Definition
Flood	For the purposes of this report, a flood is defined as the inundation of normally dry land by water which escapes from, is released from, is unable to enter, or overflows from the normal confines of a natural body of water or watercourse such as rivers, creeks or lakes, or any altered or modified body of water, including dams, canals, reservoirs and stormwater channels.
Flood immunity	Flood immunity has been used in this report to describe the minimum AEP above which infrastructure must be set. So the flood level of a building required to have a flood immunity of the 1 % AEP must be set at a level above the 1 % AEP flood.
Flood liable land	Land which is within the extent of the probable maximum flood and therefore prone to flooding. See probable maximum flood.
Floodplain	The area of land subject to inundation by floods up to and including the probable maximum flood.
Floodway	The area of the floodplain where a significant portion of flow is conveyed during floods. Usually aligned with naturally defined channels.
Formation	A fundamental unit used in the classification of rock or soil sequences, generally comprising a body with distinctive physical and chemical features.
Geomorphology	Scientific study of landforms, their evolution and the processes that shape them. In this report, geomorphology relates to the form and structure of watercourses.
Groundwater	Subsurface water stored in pores of soil or rocks.
Hazard	The potential or capacity of a known or potential risk to cause adverse effects. See also Flood Hazard, which has a particular definition in the NSW Floodplain Development Manual and is described in this report
Hydraulics	The physics of channel and floodplain flow relating to depth, velocity and turbulence.
Hydrology	The study of rainfall and surface water runoff processes.
Impervious	In the context of this report, impervious surfaces are surfaces non-permeable to water. These include areas such as paved surfaces or rooves.
Infiltration	The downward movement of water into soil and rock, which is largely governed by the structural condition of the soil, the nature of the soil surface (including presence of vegetation) and the antecedent moisture content of the soil.
Landform	A specific feature of the landscape or the general shape of the land.
LPI	NSW Land and Property Information.
Meteorology	The science concerned with the processes and phenomena of the atmosphere, especially as a means of forecasting the weather.
Overbank	The portion of the flow that extends over the top of watercourse banks.
Overland flow path	The path that water can follow if it leaves the confines of the main flow channel. Overland flow paths can occur through private property or along roads. Water travelling along overland flow paths, often referred to as 'overland flows', may either re-enter the main channel or may be diverted to another watercourse.
Permeability	The capacity of a porous medium to transmit water.
Probable maximum flood (PMF)	The probable maximum flood is the maximum flood which can theoretically occur based on the worst combination of the probable maximum precipitation and flood-producing catchment conditions that are reasonably possible at a given location.
Project	The construction and operation of the Cabramatta Loop

Term	Definition
Project site	Refers to the area that would be directly disturbed by construction of the project (for example, as a result of ground disturbance and the construction of foundations for structures). It includes the location of the construction activities, compounds and works site, and the location of permanent operational infrastructure.
Riparian	Pertaining to, or situated on, the bank of a river or other water body.
Risk	The chance of something happening that will have an impact measured in terms of likelihood and consequence.
Risk assessment	Systematic process of evaluating potential risks of harmful effects on the environment from exposure to hazards associated with a particular product or activity.
Runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
Salinity	The total soluble mineral content of water or soil (dissolved solids); concentrations of total salts are expressed as milligrams per litre (equivalent to parts per million).
Sediment	Material of varying sizes that has been or is being moved from its site of origin by the action of wind, water or gravity.
Stream order	Stream classification system, where order 1 is for headwater (new) streams at the top of a catchment. Order number increases downstream using a defined methodology relating to the branching of streams.
Study area	The study area for this report includes the catchments of Cabramatta Creek and the as shown on the figures. See also 'project site'.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Topography	Representation of the features and configuration of land surfaces.
Watercourse	Generic term used to refer to rivers, streams and creeks.
Water quality	Chemical, physical and biological characteristics of water. Also the degree (or lack) of contamination.
Water sharing plan	A legal document prepared under the *Water Management Act 2000* (NSW) that establishes rules for sharing water between the environmental needs of the river or aquifer and water users and also different types of water use.
Water table	The surface of saturation in an unconfined aquifer, or the level at which pressure of the water is equal to atmospheric pressure.

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Executive Summary

Australian Rail Track Corporation (ARTC) proposes to construct and operate a passing loop for up to 1,300 metre length trains on the Southern Sydney Freight Line (SSFL) between Sydney Trains' Cabramatta and Warwick Farm stations. The Cabramatta Loop Project ('the project') would allow freight trains to pass and provide additional rail freight capacity along the SSFL.

The project is State significant infrastructure in accordance with Division 5.2 of the New South Wales (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act). As State significant infrastructure, the project needs approval from the NSW Minister for Planning and Public Spaces.

This Surface Water Quality and Groundwater Impact Assessment Technical Report has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued on 17 May 2018 to describe the surface water and groundwater environment present at the study area, assess impacts of the project on groundwater and surface water and identify mitigation measures to manage the project impact.

The assessment was based on a desktop review of available information regarding surface water and groundwater and analysis and modelling undertaken by the designers for the project.

The project site from Cabramatta Road West overbridge to Hume Highway overbridge is located near Cabramatta Creek which drains to the Georges River.

The land use of Cabramatta Creek catchment is mainly residential. Areas of parkland, as well commercial and industrial development are also present. The project site is mainly located through Jacquie Osmond Reserve and Stroud Park.

According to recent studies undertaken by Georges River Combined Councils Committee (GRCC, 2018) water quality in Lower Cabramatta Creek is considered "good". Water quality near the outlet of Cabramatta Creek into Georges River Estuary at Chipping Norton Lakes is also rated as "fair".

Key construction stage impacts on water quality include the potential for increased sediment being discharged to downstream systems from soil disturbances and stockpiles. A minor potential impact would be a change to the flow regime due to increased impervious areas within the construction worksites and compounds.

Construction impacts would be managed through the implementation of a soil and water management plan in accordance with the *Managing urban stormwater - soils and construction-Volume 1 (Landcom, 2004)*. A surface water monitoring framework would be implemented to monitor surface water quality in the vicinity of the project.

Key construction impacts on groundwater could result from piling activities which may intercept groundwater. Dewatering of intercepted groundwater may be required to allow construction to occur. Potential groundwater inflows and the associated radius of drawdown has been estimated by analytical calculations. The calculations indicate groundwater drawdown associated with the project would range from 9.4 to 74.6 metres of any excavation that intercepts groundwater.

Operational water quality impacts would be managed through implementation of water sensitive urban design measures. A water quality monitoring program is being implemented currently to monitor water quality outcomes against the NSW Water Quality Objectives.

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1. Introduction

1.1 Overview

Australian Rail Track Corporation (ARTC) proposes to construct and operate a passing loop for up to 1,300 metre length trains on the Southern Sydney Freight Line (SSFL) between Sydney Trains' Cabramatta and Warwick Farm stations. The Cabramatta Loop Project ('the project') would allow freight trains to pass and provide additional rail freight capacity along the SSFL.

The project is State significant infrastructure in accordance with Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). As State significant infrastructure, the project needs approval from the NSW Minister for Planning and Public Spaces.

This report has been prepared to accompany the environmental impact statement (EIS) to support the application for approval of the project, and address the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs), issued on 17 May 2018.

1.2 The project

1.2.1 Location

The project is generally located within the existing rail corridor between the Hume Highway and Cabramatta Road East road overbridges in the suburbs of Warwick Farm and Cabramatta. In addition, the project includes works to Broomfield Street adjacent to the rail corridor in Cabramatta.

The rail corridor is owned by the NSW Government (RailCorp) and leased to ARTC.

The location of the project is shown on Figure 1.1.

1.2.2 Key features

The key features of the project include:

- New rail track – providing a 1.65 kilometre long section of new track with connections to the existing track at the northern and southern ends
- Track realignment – moving about 550 metres of existing track sideways (slewing) to make room for the new track
- Bridge works – constructing two new bridge structures adjacent to the existing rail bridges over Sussex Street and Cabramatta Creek
- Road works – reconfiguring Broomfield Street for a distance of about 680 metres between Sussex and Bridge streets.

Ancillary work would include communication upgrades, works to existing retaining and noise walls, drainage work and protecting/relocating utilities. In addition, minor work in the form of new signalling would be installed at a number of locations within the rail corridor (indicative locations provided in the EIS).

The key features of the project are shown on Figure 1.2.

Further information on the project is provided in the EIS.

Figure 1.1 Location of the project

Figure 1.2 Key features of the project

1.2.3 Timing

Subject to approval of the project, construction is planned to start in early 2021, and is expected to take about two years. Construction is expected to be completed in early 2023.

It is anticipated that some features of the project would be constructed while the existing rail line continues to operate. Other features of the project would need to be constructed during programmed weekend rail possession periods when rail services along the line cease to operate. Possession periods typically occur for 48 hours four times per year.

1.2.4 Operation

The project would operate as part of the SSFL and would continue to be managed by ARTC. ARTC is not responsible for the operation of rolling stock. Train services are currently, and would continue to be, provided by a variety of operators.

Following the completion of works, the existing functionality of Broomfield Street would be restored, with one travel lane in each direction, kerb-side parking on both sides and a shared path on the western side of the street.

1.3 Purpose and scope of this report

The purpose of this report is to assess the potential surface and groundwater water quality impacts from the operation and construction of the proposal. This surface and groundwater quality assessment addresses the relevant SEARs for the EIS, as outlined in Table 1.1 and additionally the comments by other stakeholders as outlined in Table 1.2. The report:

- describes the existing environment with respect to the project
- assesses the impacts of constructing and operating the proposal on the surrounding environment with respect to surface and groundwater quality
- recommends measures to mitigate the impacts identified.

Table 1.1 SEARS – surface and groundwater quality

Key issue	Requirement	Where is this addressed?
3 (2) Assessment of Key Issues	For each key issue the Proponent must: (a) describe the biophysical and socio-economic environment, as far as it is relevant to that issue	Section 3
	(b) describe the legislative and policy context, as far as it is relevant to the issue	Section 1.5
	(c) identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts	Section 2.4
	(d) demonstrate how potential impacts have been avoided (through design, or construction or operation methodologies);	Refer to the EIS
	(e) detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant)	Section 7
7. Water – Hydrology	2. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including:	Refer below and also to Technical Report 6 - Hydrology and flooding impact assessment
	(a) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement;	Section 5.3 and 6.3
	(b) direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	Section 5.2.1 and 6.2.3 and refer also to Technical Report 6 - Hydrology and flooding impact assessment.
8. Water - Quality	1. The Proponent must: (a) State the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values;	Section 1.5.2 and Table 1.4
	(b) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented;	Section 6.2.1
	(c) identify sensitive receiving environments which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; and	Section 3 Section 7.1 and 7.2
	(d) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Section 7.2.1

Table 1.2 Comments on this assessment by stakeholders– surface and groundwater quality

Stakeholder	Key issue	Comment	Where is this addressed?
Fairfield City Council	Water Quality	A management plan is required for gross pollutants generated by the construction works	To be addressed by contractor during detailed design stage
Liverpool City Council	Water Quality	Erosion protection should be provided on creek banks upstream/downstream of the new bridge at Cabramatta Creek	Section 6.2.3
Liverpool City Council	Water Quality	A water quality assessment should be undertaken	This report
Liverpool City Council	Water Quality	Mitigation measures should be considered to address the potential risk of pollution of the creek during construction	Section 7
Liverpool City Council	Water Quality	Water quality improvement devices should be considered to treat storm runoff from project sites before discharging to the creek	To be addressed by contractor during detailed design stage
Office of Environment and Heritage	Water Quality	This EIS must describe the background conditions for any water resource likely to be affected by the development, including: (a) Existing surface and groundwater; (b) Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations; (c) Water Quality Objectives (as endorsed by the NSW Government (http://www.environment,nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters; (d) Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality; (e) Risk-based Framework for Considering Health Outcomes in Strategic Land-Use Planning Decisions http://www.environment.nsw.gov.au/research-and-publications/publications-search/risk-based-framework-for-considering-waterway-health-outcomes-in-strategic-land-use-planning	a. Section 3 b. Section 4 (no intake or water extraction proposed) c and d. Section 1.5.2 e. Section 5 and 6
Office of Environment and Heritage		The EIS must assess the impacts of the development on water quality including: (f) The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards	f. Section 5 and 6 (no wastewater to be encountered or introduced on site) g. Section 7.2.1

Stakeholder	Key issue	Comment	Where is this addressed?
		achievement of the Water Quality Objectives over time where they are currently not being achieved; (g) Identification of proposed monitoring of water quality and consistency with any relevant certified Coastal Management Program (or Coastal Zone Management Plan). This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.	
Office of Environment and Heritage		The EIS must assess the impact of the development on hydrology, including (h) Water balance including quantity, quality and source; (i) Effect to downstream rivers, wetlands, estuaries, marine waters and floodplain areas; (j) Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems; (k) Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches); (l) Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water; (m) Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options; (n) Identification of proposed monitoring of hydrological attributes.	h. No intake or water extraction proposed i. Section 5 and 6 j. Section 5.3 and 6.3 k. Section 5 and 6 l. No intake or water extraction proposed m. Section 7 n. Section 7.2.1
Office of Environment and Heritage	Water Quality	This EIS must describe the background conditions for any water resource likely to be affected by the development, including: (a) Existing surface and groundwater; (b) Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations; (c) Water Quality Objectives (as endorsed by the NSW Government (http://www.environment,nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters; (d) Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality; (e) Risk-based Framework for Considering Health Outcomes in Strategic Land-Use Planning Decisions http://www.environment.nsw.gov.au/research-and-publications/publications-search/risk-based-	a. Section 3 b. Section 4 (no intake or water extraction proposed) c and d. Section 1.5.2 e. Section 5 and 6

Stakeholder	Key issue	Comment	Where is this addressed?
		framework-for-considering-waterway-health-outcomes-in-strategic-land-use-planning	
Department of Primary Industries (DPI) Water	Water Quality	Assessment of impacts on surface and groundwater sources, related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems	Section 5 and 6
	Water Quality	Proposed surface and groundwater monitoring activities and methodologies	Section 7
	Water Quality	Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy, the DPI Water Guidelines for Controlled Activities on Waterfront Land and the Water Sharing Plans for the Greater Metropolitan Region Groundwater	Section 1.5 and 5.3.3. No intake or water extraction proposed

1.4 Structure of this report

The structure of the report is outlined below.

- Section 1 provides an introduction to the report, including the legislative and policy context for the assessment, and relevant guidelines.
- Section 2 describes the methodology for the assessment.
- Section 3 describes the existing environment as relevant to the assessment.
- Section 4 describes the proposed drainage works.
- Section 5 describes the potential construction impacts of the project.
- Section 6 describes the potential operational phase impacts of the project.
- Section 7 describes the recommended mitigation measures for both construction and operational phase of the project.

1.5 Relevant legislation and guidelines

The following legislation and guidelines are relevant to this technical report:

1.5.1 Legislation

Water Management Act 2000

The *Water Management Act 2000*, (WM Act) is administered by regulators including WaterNSW and Department of Industry: Water to manage water resources. The aim of the Act is to ensure that water resources are conserved and properly managed for sustainable use benefiting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions. Fresh water sources throughout NSW are managed by water sharing plans (WSPs) under the WM Act.

Principles of the WM Act relating to drainage and floodplain management include the need to avoid or minimise land degradation including soil erosion, compaction, geomorphic instability and waterlogging.

Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations (POEO) Act 1997*, is administered by the NSW Environment Protection Authority (EPA) and is implemented throughout NSW to protect, restore and enhance the quality of the environment. The aim of the POEO Act is to reduce risks to human health, provide increased opportunities for public involvement and participation in environment protection, rationalise, simplify and strengthen the regulatory framework for environment protection and improve the efficiency of administration of environment protection legislation.

Fisheries Management Act 1994

The *Fisheries Management Act 1994*, is administered by the Department of Primary Industries (DPI) and is implemented throughout NSW to develop, conserve and share the fishery resources for the state for the present and future generations. The aim of the Act is to conserve fish stock and key fish habitats, to conserve threatened species, populations and ecological communities of fish and marine vegetation, promote ecologically sustainable development, promote viable commercial fishing and aquaculture industries, promote quality recreational fishing opportunities, appropriately share fisheries resources among other aims.

Crown Land Management Act 2016

The *Crown Land Management Act 2016*, is administered by the NSW Department of Industry and is implemented to provide ownership, use and management of the Crown land of NSW. The aim of the Act is to provide clarity concerning the law applicable to Crown land, to require environmental, social, cultural heritage and economic considerations to be taken into account in decision-making about Crown land, provide for the consistent, efficient, fair and transparent management of Crown land, facilitate the use of Crown land by Aboriginal people of NSW and provide for the management of Crown land having regard to the principles of Crown land management.

Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011

The *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011,* sits under the Water Management Act and is implemented to provide healthy and enhanced water sources and water dependent ecosystems and equitable water sharing among users in these groundwater sources. The aim of the Plan is to protect, preserve, maintain and enhance the high priority groundwater dependent ecosystems as well as protect, preserve and maintain the integrity of aquifers.

1.5.2 Policies, guidelines and standards

Key guidelines referenced in the assessment include:

- *Managing Urban Stormwater: Soils and Construction Volume 1*, (Landcom, 2004) (the Blue Book)
- *Australian Runoff Quality*, (Engineers Australia, 2006)
- *National Water Quality Management Strategy*, (ANZECC and ARMCANZ, 1994)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000) (the ANZECC guidelines)
- *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006)
- *Approved methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC, 2004)

- *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* (OEH, 2017)
- *Water Sensitive Urban Design Guideline*, (Roads and Maritime Services, 2017)
- *Guidelines for controlled activities on waterfront land – Riparian corridors* (NSW Department of Industry, 2018)
- NSW Aquifer Interference Policy.
- *NSW State Groundwater Policy Framework Document* (NSW Department of Land and Water Conservation (DLWC), 1997)

A detailed list of reference material is provided in section 9.

Managing Urban Stormwater – Soils and Construction Volume 1

The principles for the management of stormwater during construction are documented in this publication, which is also commonly referred to in the construction industry as “the Blue Book”. The Blue Book provides guidelines to help mitigate the impacts of land disturbance activities on soils, landforms and receiving waters by focussing on erosion and sediment control.

National Water Quality Management Strategy

Since 1992, the National Water Quality Management Strategy (NWQMS) has been developed by the Australian and New Zealand Governments in cooperation with state and territory governments. The NWQMS aims to protect the nation's water resources, by improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development. The NWQMS consists of three major elements: policy, process and guidelines. The main policy objective of the NWQMS is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development. The process strives to form a nationally consistent approach to water quality management through the development of high-status national guidelines. The guidelines provide the point of reference when issues are being determined on a case-by-case basis. These include guidance on regulatory and market-based approaches to managing water quality as well as regional water quality criteria. The ANZECC guidelines are relevant to this assessment.

ANZECC Guidelines

In 2000, the former Australian and New Zealand Environment and Conservation Council (ANZECC) released the ANZECC guidelines to provide a nationally consistent approach to water quality management based on the principle of ecological sustainable development of water resources. The guidelines contain a set of tools for the assessment and management of water quality across a range of water resource types based on designated environmental values. The objective of the ANZECC, relevant to the project, is to maintain and enhance the ‘ecological integrity’ of freshwater and marine ecosystems, including biological diversity, relative abundance and ecological processes. The framework categorises ecosystems on a three point scale from high conservation and ecological value to highly disturbed systems. Indicators include biological indicators, physical and chemical stressors, toxicant and sediments.

Using the ANZECC Guidelines and Water Quality Objectives in NSW

The document provides technical practitioners applying the ANZECC guidelines in New South Wales practical guidance to the use of this document. The document has been produced by the former Department of Environment and Conservation NSW. It outlines a flow chart procedure to follow in applying the guideline as well as giving reference to ‘indicators' in the environmental value context and trigger values.

Approved methods for the Sampling and Analysis of Water Pollutants in NSW

The document has been produced by the Department of Environment and Conservation NSW as well as the NSW EPA. It outlines sampling and analysis methods to be used when complying with a requirement by, or under, the environment protection legislation, or a licence or notice under that legislation, to test for the presence or concentration of matter in water and the volume, depth and flow of water or wastewater.

Water Sensitive Urban Design Guideline Rail

The design criteria outlined in the *Water Sensitive Urban Design Guideline Rail* are provided in Table 1.3.

Table 1.3 Water quality and water re-use requirements

Water quality and use	Design requirements
Water quality	Water Sensitive Urban Design (WSUD) measures will be included in station precincts, stabling facilities and car parks.
Water re-use	All on-grade car park stormwater

These guidelines have not been adopted for this assessment as they only cover elements not covered as part of the design. For example, there are no stabling facilities, station precincts or commuter car-parks as this project proposes only to construct a rail passing loop on an existing freight rail line. Other Transport for NSW guidelines not adopted for this assessment included:

- Water Discharge and reuse Guideline (not adopted as not relevant, discharge and re-use not required)
- Environmental Incident Classification and Reporting (to be considered and adopted as necessary during operation and maintenance stages)
- Chemical Storage and Spill Response Guidelines (relevant during the development of the Construction Environmental Management Plan (CEMP))
- Concrete Washout Guideline (relevant again during the development of the CEMP)

NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* (Department of Trade and Investment (DTI) 2012) was finalised in September 2012 and clarifies the water licencing and approval requirements for aquifer interference activities in NSW. Many aspects of this policy will be given legal effect in the future through an Aquifer Interference Regulation. Stage 1 of the Aquifer Interference Regulation started on 30 June 2011.

This policy outlines the water licensing requirements under the Water Act 1912 and WM Act. A water access licence is required whether water is taken for consumptive use or whether it is taken incidentally by the aquifer interference activity (such as groundwater filling a void) even where that water is not being used consumptively as part of the activity’s operation.

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

The NSW Aquifer Interference Policy requires that potential impacts on groundwater sources, including their users and groundwater dependant ecosystems, be assessed against the minimal impact considerations outlined in the policy. If the predicted impacts of the project are less than the minimal impact considerations, then the potential groundwater impacts of the project are acceptable.

NSW State Groundwater Policy Framework Document

The objective of the NSW State Groundwater Policy Framework Document (NSW Department of Land and Water Conservation (DLWC) 1997) is to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW. The policy has three component parts:

- NSW Groundwater Quantity Protection Policy
- NSW Groundwater Quality Protection Policy
- NSW Groundwater Dependent Ecosystem Policy

Water quality objectives

The NSW Water Quality and River Flow Objectives provide water quality objectives for the Georges River catchments (the downstream receiving waterway for flows from Cabramatta Creek), for the protection of the following within waterways affected by urban development, or estuaries:

- aquatic ecosystems
- visual amenity
- secondary contact recreation
- primary contact recreation.

Waterways affected by urban development are defined as streams within urban areas, which are frequently substantially modified and generally carry poor quality stormwater. The majority of waterways within the study area meet this definition.

The water quality objectives for the receiving watercourses for the study area are provided in Table 1.4, together with default trigger values for various indicators drawn from ANZECC on how the stated water quality objectives may be achieved or maintained. These water quality objectives have been extracted from NSW OEH website (DECCW, 2006a and 2006b).

Table 1.4 NSW water quality objectives

Water quality objective	Indicators	Associated trigger values or criteria	Catchments to which it applies
Aquatic ecosystems			
Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	Total phosphorus	Lowland rivers: 0.025 mg/L for rivers flowing to the coast	Georges River (Cabramatta Creek)
	Total nitrogen	Lowland rivers: 0.350 mg/L for rivers flowing to the coast	
	Chlorophyll-a	Lowland rivers: 0.005 mg/L.	
	Turbidity	Lowland rivers: 6–50 NTU	
	Salinity (electrical conductivity)	Lowland rivers: 125–2200 µS/cm	
	Dissolved oxygen	Lowland rivers: 85–110 %	
	pH	Lowland rivers: 6.5–8.5	

Water quality objective	Indicators	Associated trigger values or criteria	Catchments to which it applies
Visual amenity			
Maintain aesthetic qualities of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20 % Natural hue of water should not be changed by more than 10 points on the Munsell Scale Natural reflectance of water should not be changed by more than 50 %	Georges River (Cabramatta Creek)
	Surface film and debris	Oils and petrochemicals should not be noticeable as a visible form on the water, nor should they be detectable by odour Waters should be free from floating debris and litter	
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts	
Secondary contact recreation			
Maintain or improve water quality for activities such as boating and wading, where this is a low probability of water being swallowed	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)	Georges River (Cabramatta Creek)
	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	Large numbers of midges and aquatic worms are undesirable and as per visual amenity guidelines	
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation	
Primary contact recreation			
Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed	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)	Georges River (Cabramatta Creek)
	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	

Water quality objective	Indicators	Associated trigger values or criteria	Catchments to which it applies
		intervals not exceeding one month, or 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)	
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water. (Note, it is not necessary to analyse water for these pathogens unless temperature is greater than 24 degrees Celsius)	
	Algae & blue-green algae	< 15 000 cells/mL	
	Nuisance organisms	Use visual amenity guidelines.	
		Large numbers of midges and aquatic worms are undesirable.	
	pH	5.0-9.0	
	Temperature	15°-35°C for prolonged exposure.	
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation	

2. Assessment methodology

2.1 Overview

The aim of this study is to assess the potential water quality and groundwater impacts associated with the construction and operation of the passing loop between Cabramatta and Warwick Farm Railway Station.

The desktop review incorporated high level consideration of a wider area than just the project site. This included the entire Cabramatta Creek catchment including upstream areas and continuing downstream to the confluence with the Georges River.

2.2 Desktop review

The desktop review included consideration of the catchments of Cabramatta Creek (which drains to the Georges River waterway). Refer to section 3.2 describing the study area and Figure 3.1 for the study area map. The review included:

- collation and review of background information, previous reports and project information including:
  - existing cross drainage location and capacity data, including Dial Before You Dig data
  - potential sensitive receiving environments near the project site.
  - existing water quality data for the waterway and downstream
  - review of guidelines as listed in section 1.5.2
  - review of proposed construction areas/compound locations and wider project site
  - publically available groundwater data
  - results of geotechnical investigations undertaken for this project

2.3 ARTC design criteria

ARTC criteria is to align with government legislation and approvals. With this in mind the NSW WQO are adopted for this assessment.

2.4 Impact assessment

The following tasks were undertaken:

- consideration of the location of the project site in the context of surrounding and upstream catchment areas and potential influence of downstream waterways
- identification of construction activities likely to impact on surface water quality and groundwater
- review of the reference design and activities likely to cause an impact on water quality and groundwater
- identification and assessment of impacts on water quality with respect to potential increases or decreases in pollutant loading both at construction stage and during operation
- broad assessment of the likely impact of climate change on the project
- identification of potential impacts and opportunities to stormwater quality during:
  - the construction phase of the project
  - the operational phase of the project, based on concept design information

- calculation of groundwater inflows for construction elements that may intercept groundwater using the analytical equations and approach outlined in Marinelli and Niccoli (2000)
- assessment of potential groundwater impacts against the criteria specified in the NSW Aquifer Interference Policy.

2.5 Mitigation measures

Mitigation measures were identified to reduce potential adverse impacts on the surface water quality and groundwater environment. This included:

- identification of measures and controls to mitigate impacts on surface water quality and groundwater
- broad assessment of the expected residual impacts on surface water following implementation of measures and controls
- implementation of water quality monitoring prior to, during construction as well as during operation.

2.6 Groundwater inflow modelling methodology

Preliminary groundwater inflow estimates have been carried out using the analytical equations and approach outlined in Marinelli and Niccoli (2000). The equations presented by Marinelli and Niccoli (2000) provide a simple means of estimating steady state or long-term average inflows to a pit. The equation calculates groundwater inflow through the base of the pit separately to inflow through the walls of the pit. As part of the calculations, Zone 1 refers to inflow into the pit walls and Zone 2 refers to inflow through the floor of the pit.

The solutions presented consider:

- the effect of decreased saturated thickness near the pit walls
- distributed recharge to the water table
- upward flow through the pit bottom.

Separate flow calculations are carried out for inflow into the pit walls (Q_1, Zone 1) and pit base (Q_2, Zone 2) (Figure 2.1). Assumptions inherent in the flow calculation for Zone 1 include:

- Pit walls are approximated as a circular cylinder.
- Groundwater flow is horizontal (Dupuit – Forchheimer approximation is valid).
- The static (pre-excavation) water table is horizontal.
- Groundwater flow towards the pit is axially symmetric.
- Uniform distributed recharge occurs across the site as a result of surface infiltration.
- All recharge in the radius of influence is captured by the pit.
- The aquifer extends below the base of the pit.

Assumptions relevant to Zone 2 include:

- Hydraulic head is initially uniform throughout the zone. Initial head is equal to the elevation of the initial water table in Zone 1.
- The disk sink has constant hydraulic head equal to the elevation of the pit lake water surface. If the pit is completely dewatered the disk sink is equal to the elevation of the pit bottom.

- Flow to the disk sink is three dimensional and axially symmetric.
- Materials in Zone 2 are anisotropic and the principal co-ordinate directions for hydraulic conductivity are horizontal and vertical.

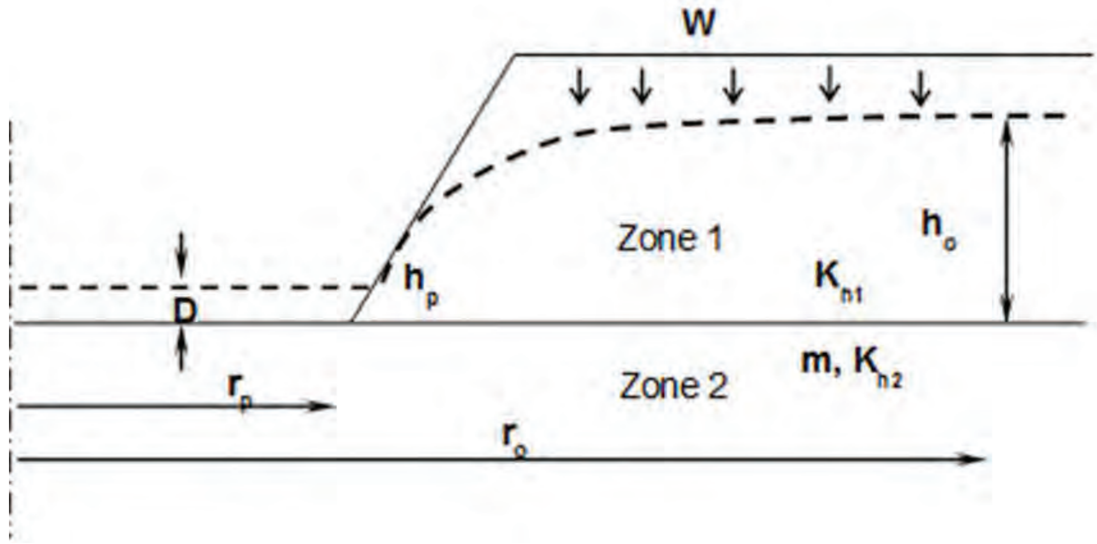

Figure 2.1 Pit inflow hydraulic model (Marinelli and Niccoli 2000)

Relevant equations in Marinelli and Niccoli (2000) are as follows:

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

$$Q_1 = W\pi\left(r_o^2 - r_p^2\right)$$

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

$$m_2 = \sqrt{\frac{K_{h2}}{K_{v2}}}$$

Where:

- h_o = Initial (pre-excavation) saturated thickness (metres above base of pit)
- h_p = Saturated thickness at pit wall (metres above base of pit)
- W = Distributed recharge flux (metres per day)
- Kh_1 = Horizontal hydraulic conductivity Zone 1 (metres per day)
- Kh_2 = Horizontal hydraulic conductivity Zone 2 (metres per day)
- Kv_2 = Vertical hydraulic conductivity Zone 2 (metres per day)
- r_p = Effective pit radius (metres)
- r_o = Radius of influence (metres)
- d = Depth of the pit lake (metres)

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3. Existing environment

3.1 Existing Rail Corridor

The existing rail corridor containing the current SSFL runs adjacent to the Sydney Trains suburban network. This corridor contains track drainage elements that capture runoff generated within the rail corridor. The runoff generated through the northern section of the corridor north of the Sussex Street overpass, is conveyed via a system of channels and underground pipes that connect in to the existing Fairfield City Council stormwater pipe system. In the southern section of the corridor south of the Cabramatta Creek bridge, the corridor has two drains, one flowing south starting at the southern abutment of the Cabramatta Creek bridge, the other flowing north starting just north of Warwick Farm Station. Both outlet around the corner of the rail corridor shared with Peter Warren Automotive and Jacquie Osmond Reserve.

The surface water runoff within this corridor is not captured and treated for any potential water quality pollutants via any formalised system. However due to the ability for surface water flows to drain overland through earthen vegetated channels for a distance before either discharging off site and/or in to an underground system, there will be some informal treatment provided by these channels.

3.2 Regional drainage catchments

The study area is shown on Figure 1.1 and incorporates the catchments for Cabramatta Creek and associated waterways to its confluence with Georges River.

The rail corridor through the entire study area drains to Cabramatta Creek and its tributaries. The project site, being largely developed and urbanised, is mostly impervious. Pervious areas are generally limited to the parks and landscaped areas adjacent to the project site, some of which would be used for construction activities during the construction period. These areas exist in the floodplain of Cabramatta Creek meaning this risk should be considered for these activities.

The wider study area (upstream and downstream catchment) has also been highly modified from its natural state by various forms of urban development and transport infrastructure.

The project site traverses the Liverpool and Fairfield City Council local government areas (LGAs) which are separated by Cabramatta Creek.

3.3 Topography

The elevation of the rail corridor varies from around eight metres Australian Height Datum (m AHD) at the crossing of Cabramatta Creek to 14.5 metres AHD near Cabramatta Station and is at around nine metres AHD at Warwick Farm Station.

The track is located on fairly low lying land approximately 1.2 kilometres from the confluence of Cabramatta Creek. The natural topography is generally flat through the Cabramatta Creek floodplain and gently rising out of the low lying terrain towards Cabramatta Station. The rail corridor traverses through the floodplain, is located upon a large embankment varying in height up to three metres and is in a cutting through to Cabramatta Station. At the Warwick Farm end of the main study area, the rail corridor is located generally at the same level as the surrounding land, with the Hume Highway at this location raised on an embankment to separate the road from the rail corridor.

The wider project site encompasses Broomfield Street and Jacquie Osmond Reserve. Broomfield Street generally falls north to south towards Cabramatta Creek and the alignment follows the rail corridor. The Jacquie Osmond Reserve area is generally flat and sits well within the Cabramatta Creek floodplain. Surface levels for the rest of the project site vary from 13.59 metres AHD near Cabramatta Station to around five metres AHD on the southern side of Cabramatta Creek.

3.4 Acid sulfate soils

A review of the NSW Government Sharing and Enabling Environmental Data website and both the Fairfield City Council and Liverpool City Council LEP acid sulfate soils maps indicated there are no known occurrences of acid sulfate soils (ASS) within the project site. Proposed signalling works located near Liverpool Station (refer to Figure 7.2) are in an area classified as Class 5, however acid sulfate soils are not typically found within Class 5 areas.

A review of the Australian Soil Resource Information System indicated that there was a low probability of acid sulfate soils occurring within the project site. The closest mapped occurrence of acid sulfate soils to the project site is about one kilometre east where Cabramatta Creek feeds into the Georges River.

Further discussion on acid sulfate soils is provided in Technical Report 6 – Targeted contamination assessment

3.5 Geology

Reference to the 1:25,000 scale Newcastle to Wollongong Gap mapping of NSW coastal Quaternary geology (Department of Industry, 2015) shows that much of the site is underlain by Quaternary and Tertiary alluvial deposits associated with a floodplain system.

An exception is noted on the hill slope immediately south of Cabramatta Station (at the northern (City) end of the site), where reference to the 1:100,000 Geological Series Sheet 9030 for Penrith shows that this area is underlain by Bringelly Shale of Triassic Age, typically comprising shale, carbonaceous claystone, claystone, laminite and fine to medium grained lithic sandstone.

The site is generally underlain by variable fill material of gravel, sand and clay typically of a depth of one metre. The fill is underlain by a deep alluvial profile that generally consists of alluvial clay. Investigations undertaken as part of this project indicate that the alluvial clays extend over six metres in depth within the site.

3.6 Cabramatta Creek

3.6.1 Overview

Cabramatta Creek is a major tributary of the Georges River, located in the south-west of the Sydney Metropolitan region. The catchment has an area of about 74 kilometres squared. Most of the catchment area is located within the Liverpool City Council LGA. The north side of Lower Cabramatta Creek, downstream of Elizabeth Drive, is located within the Fairfield City Council LGA. A small proportion of the upper catchment is also located within the Campbelltown City Council area, and the Ingleburn Military Camp.

The land use of Cabramatta Creek catchment is mainly high density residential buildings. Areas of parkland, as well as commercial and industrial development are also present. The project site is mainly located through parkland, with the catchment generally consisting of parkland and open spaces concentrated along the creek reserve/floodplain areas. Some of these areas within the floodplain will be used for construction activities during the construction period. This includes bushland and riparian vegetation which are of ecological and recreational importance including the Elouera Nature Reserve, according to *Cabramatta Creek Floodplain Risk Management*

Study and Plan (Bewsher, 2004). Management of the river is shared between Fairfield City Council and Liverpool City Council.

The Cabramatta Creek commences in the rural residential suburb of Denham Court, near the southern extent of the catchment. The upper reaches consists of a number of stormwater detention basins, built in conjunction with development in the area.

Numerous urban developments have taken shape throughout the catchment within a number of suburbs. Tributaries of the creek including Maxwells Creek have been modified from their natural state and turned in to a grassed trapezoidal channel downstream of Jedda Road, continuing through to the confluence with Cabramatta Creek. Refer to the regional drainage catchments shown on Figure 3.1.

3.6.2 Tributaries

The main tributaries of Cabramatta Creek are:

- Hinchinbrook Creek
- Maxwells Creek
- Brickmakers Creek.

3.7 Groundwater

3.7.1 Geotechincal investigations

As part of geotechnical investigations undertaken for the project, a number of boreholes and test pits were undertaken. The geotechnical investigation included borehole drilling at eight locations within the rail corridor, test pits at four locations within the rail corridor and test pits at ten locations outside the rail corridor. Boreholes were drilled to a depth of 6.45 metres and test pits were excavated to up to two metres. Details regarding the boreholes and test pits are provided in Table 3.1.

During the geotechnical investigations, groundwater was identified in a number of boreholes undertaken in the Sydney Trains corridor. These bores were located in the southern end of the site between Jacquie Osmond Reserve and Warwick Farm Station. Monitoring of groundwater levels was undertaken in these boreholes after drilling, and no ongoing monitoring was undertaken as boreholes were backfilled upon completion. No preliminary indicators of gross contamination were noted during drilling (odour or staining) and the potential for dewatering is limited to piling activities which would not generate significant volumes of water. Therefore it was determined that ongoing groundwater monitoring was not required. Observed groundwater levels in these boreholes are reported to vary from three metres below ground level (bgl) to six metres bgl as detailed in Table 3.1.

In the southern end of the site between Jacquie Osmond Reserve and Warwick Farm Station, alluvial groundwater flow is to the south based on monitoring of groundwater levels during the geotechnical investigations. Within the remainder of the site, alluvial groundwater levels are generally expected to increase as natural surface elevations increase and decrease as natural surface elevations decrease. Therefore, alluvial groundwater flow is expected to be towards Cabramatta Creek.

Table 3.1 Geotechnical investigation details and groundwater strikes

Investigation ID	Investigation type	SSFL Chainage (km)	Easting (m)	Northing (m)	Ground RL (m AHD)	Depth to groundwater (m bgl)
GHD_DCP-BH01	Borehole	33724	309166.9	6245895.4	7.6	N/A
GHD_BH02	Borehole	33421	309191.0	6246197.6	7.4	3.0
GHD_BH03	Borehole	33488	309182.3	6246131.4	7.1	3.0
GHD_BH04	Borehole	33555	309170.6	6246065.3	6.9	3.0
GHD_BH05	Borehole	33620	309162.2	6246000.3	7.4	Perched groundwater in fill at 0.5 m bgl
GHD_BH06	Borehole	33685	309153.5	6245936.7	8.0	5.5
GHD_BH07	Borehole	33722	309146.0	6245900.0	8.2	N/A
GHD_BH08	Borehole	33753	309144.2	6245869.4	8.3	6.0
GHD_BH09	Borehole	33824	309132.5	6245798.6	8.2	5.5
GHD_TP01	Test pit	32255	309392.1	6247346.0	13.6	N/A
GHD_TP02	Test pit	32350	309378.7	6247252.9	11.9	N/A
GHD_TP03	Test pit	32456	309363.4	6247148.4	9.7	N/A
GHD_TP04	Test pit	32551	309349.0	6247054.2	8.9	N/A
GHD_TP05	Test pit	32643	309335.6	6246962.7	8.3	N/A
GHD_TP06	Test pit	32753	309318.9	6246854.3	6.7	N/A
GHD_TP07	Test pit	32854	309304.4	6246754.4	4.9	N/A
GHD_TP101	Test pit	33153	309255.1	6246459.0	5.4	N/A
GHD_TP102	Test pit	33246	309241.4	6246366.9	5.2	N/A
GHD_TP103	Test pit	33354	309225.3	6246260.6	5.7	N/A
GHD_TP104	Test pit	33455	309206.4	6246162.0	7.1	N/A
GHD_TP105	Test pit	33624	309180.7	6245993.4	7.4	N/A
GHD_TP106	Test pit	33825	309151.4	6245794.5	7.9	N/A
GHD_TP107	Test pit	33923	309137.0	6245697.9	8.3	N/A

Note to table:
All coordinates in the MGA94 Zone 56 coordinate system
N/A denotes no groundwater intercepted.

3.7.2 Groundwater receptors

Registered bores

A search of the NSW groundwater map (WaterNSW, carried out on 7 November 2018) was carried out to identify registered bores within approximately 1500 metres of the site. The search identified 28 bores, the majority of which (22) were registered as monitoring bores. Of the remaining bores, two were identified as registered for groundwater exploration, irrigation and recreation respectively. Bore details are provided in Table 3.2.

The two irrigation bores are located in Warwick Farm Racecourse to the east of the site. The two bores registered for recreation are located on the eastern side of the Georges River.

Yields were not reported for any bores with the exception of GW058697, GW102026 and GW062422 where yields of 0.13 litres per second, 3.7 litres per second and 6 litres per second were reported respectively. Note that as shown in Table 3.2, GW062422 screens a sandy alluvial lens.

Table 3.2 Registered bores

Bore	Easting	Northing	Depth (m)	Registered purpose	Strata	Salinity
GW103797	309207	6248562	8	Monitoring Bore	Gravelly fill, clay, shale	–
GW103790	309207	6248562	5	Monitoring Bore	Fill, clay	–
GW103788	309207	6248562	4	Monitoring Bore	Clay	–
GW103798	309207	6248562	1.7	Monitoring Bore	Sandy fill, clay	–
GW103786	309207	6248562	7	Monitoring Bore	Clay, sandy clay	–
GW103796	309207	6248562	3.5	Monitoring Bore	Fill, clay, sandy clay	–
GW103795	309207	6248562	5	Monitoring Bore	Clay, sand, shale	–
GW103792	309207	6248562	3	Monitoring Bore	Clay	–
GW103787	309207	6248562	4	Monitoring Bore	Fill/sandy clay, clay	–
GW103793	309207	6248562	1.7	Monitoring Bore	Clay	–
GW103789	309207	6248562	6	Monitoring Bore	Sandy fill, clay	–
GW103794	309207	6248562	2.7	Monitoring Bore	Sandy fill, clay	–
GW103791	309207	6248562	5	Monitoring Bore	Sandy fill, clay	–
GW017355	309981	6246281	9.4	Irrigation	Clay, sand	–
GW113073	308929	6244416	10	Monitoring Bore	–	–
GW113070	308968	6244520	10	Monitoring Bore	–	–
GW113074	309029	6244353	10	Monitoring Bore	–	–
GW113071	309065	6244495	10	Monitoring Bore	–	–
GW113075	309045	6244297	9.5	Monitoring Bore	–	–
GW113069	308869	6244531	10	Monitoring Bore	–	–
GW113072	308832	6244429	9.5	Monitoring Bore	–	–
GW058698	309117	6244568	19.5	Groundwater Exploration	Clay, sandy clay, shale	–
GW113068	308749	6244469	10	Monitoring Bore	–	–
GW058697	309271	6244541	19.2	Groundwater Exploration	Clay, sand, silty clay	–
GW113075	309045	6244297	9.5	Monitoring Bore	–	–
GW017343	310382	6245518	30.4	Irrigation	–	3001-7000 ppm
GW102026	310858	6246144	19	Recreation (Groundwater)	–	–
GW062422	310807	6246112	16	Recreation (Groundwater)	Sand	Good

Note to table: '–' denotes unknown information

The NSW Groundwater Quality Protection Policy outlines a number of beneficial use categories for groundwater resources. Based on the groundwater quality, the beneficial use of groundwater resources can be classified as ecosystem protection (environmental water), recreation, drinking water, agricultural water or industrial water.

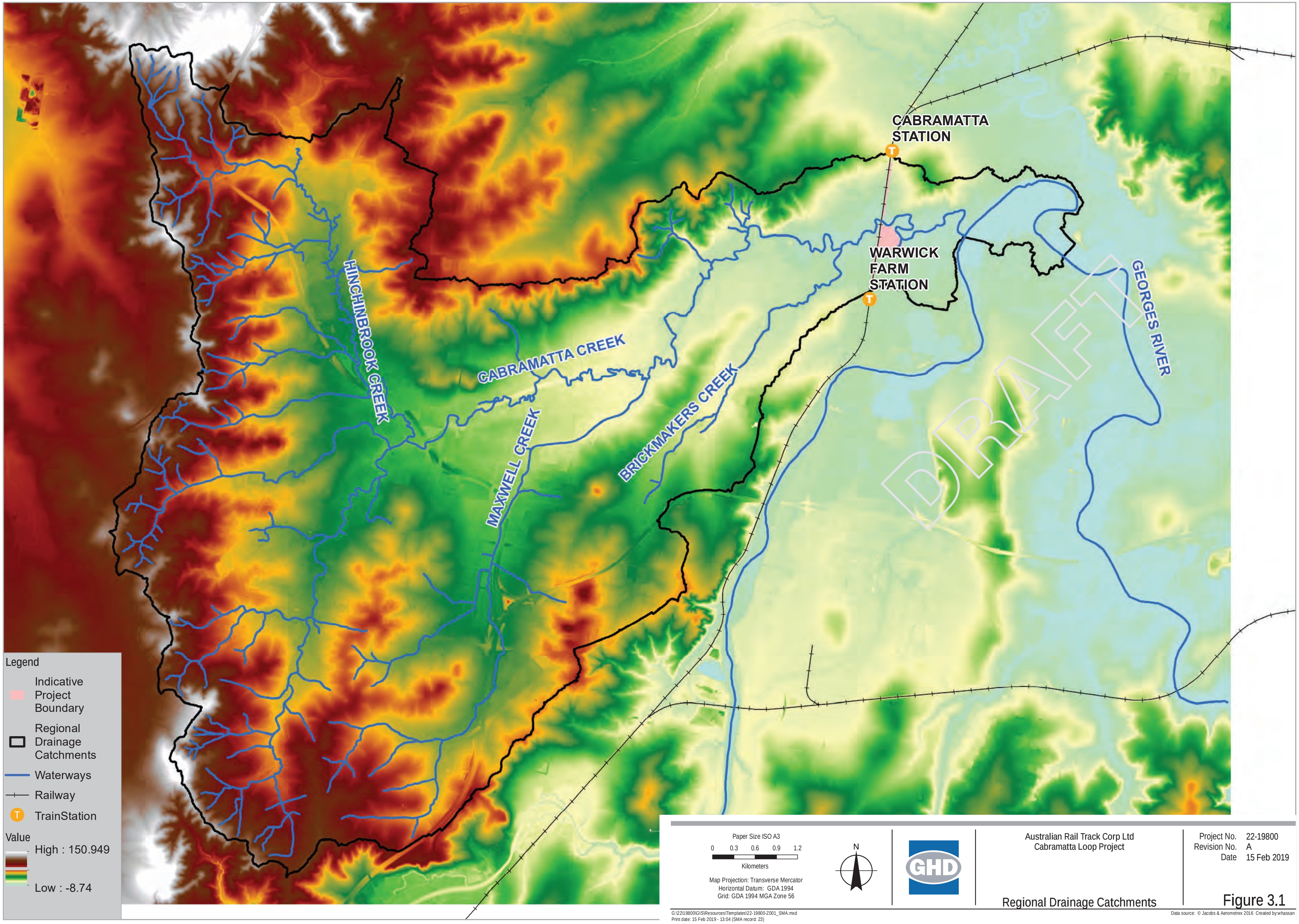
While there is no groundwater quality data available as part of this assessment, a beneficial use category has been assigned based on groundwater receptors. Overall, based on review of groundwater receptors, groundwater use is limited and the primary beneficial use of groundwater in the vicinity of the site would be environmental (i.e. providing base flow to waterways).

Groundwater dependent ecosystems

The closest high priority groundwater dependent ecosystem (GDE) to the site listed in the WSP for the Greater Metropolitan Region Groundwater Sources is Salt Pan Creek, located approximately 11 kilometres to the east south-east of the site.

As part of Technical Report 4 – Biodiversity Development Assessment Report (BDAR), dependence (or interaction) of the vegetation communities identified within the study area on groundwater was determined by searching the Atlas of GDEs (BOM 2018). This Atlas predicts the occurrence of groundwater dependent ecosystems and ecosystems that potentially use groundwater. It shows ecosystems that interact with the subsurface expression of groundwater (including vegetation ecosystems) or the surface expression of groundwater (such as rivers and wetlands. The Atlas also shows the likelihood that landscapes are accessing water in addition to rainfall, such as soil water, surface water or groundwater.

Native vegetation within the study area is not mapped as vegetation with a potential for being reliant on the subsurface presence of groundwater. The BDAR assessed vegetation within the study area and concluded vegetation is unlikely to be a GDE and is likely to be reliant on rainfall and on surface water associated with Cabramatta Creek and areas of surface water accumulation on its floodplain.



Australian Rail Track Corp Ltd
Cabramatta Loop Project

Project No. 22-19800
Revision No. A
Date 15 Feb 2019

Regional Drainage Catchments

Figure 3.1

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Data source: © Jacobs & Aerometrex 2016 Created by:whassan

3.8 Water quality

Detailed water quality monitoring data specific to the project site was not identified during the desktop review. A review of publicly available water quality data was undertaken including both Fairfield City Council and Liverpool City Councils information as well as OEH and Water NSW. No detailed information was available from these sources. Limited information would be expected given Cabramatta Creek is not a drinking water catchment. However, typical surface pollutants from the existing project site, including the rail corridor, stations, car parks and ancillary facilities could include:

- oils and hydrocarbons
- heavy metals
- chemicals from spills or inappropriate waste disposal
- sediments
- gross pollutants including litter and debris
- stormwater pollutants (eg. nitrogen, phosphorous).

No existing water quality treatment measures within the project site were identified in the desktop research.

3.8.1 Cabramatta Creek catchment

According to the Cabramatta Creek Floodplain Management Study and Plan, Cabramatta Creek was noted to have the poorest water quality in the Georges River system in 2004. The major sources of pollution in Cabramatta Creek includes urban runoff and sewage effluent, most likely due to sewage overflows from the sewerage system during wet weather.

However the water quality has improved in the ensuing years through the efforts of local councils and others for the lower reaches of the creek (to which this investigation applies). The most recently available report, the *2016-2017 River Health Report Card for the Georges River* (GRCCC, 2018), identified the overall water quality health of Lower Cabramatta Creek as “good” (A-) which is considered ‘good’ as defined by the GRCCC when assessing against environmental guidelines.

4. Proposed works

This section summarises relevant aspects of the project design criteria, design considerations and construction activities particular to surface water and groundwater that informed the assessment of potential construction and operational stage impacts.

4.1 Water quality

Assessment of the water quality outcomes against NSW WQO which draw from ANZECC guidelines will be undertaken during detailed design once a water quality monitoring program has been implemented with sufficient water quality data being available. The detailed design would then take into consideration the findings of the ANZECC assessment and the implications for water quality treatment measures.

Further to this, presented below in Table 4.1 are the relevant Council guidelines reviewed which included those documented in the *Fairfield City Council Stormwater Management Policy 2017* and the *Liverpool City Council Development Control Plan 2008.*

Table 4.1 Water quality design criteria

Pollutant	Fairfield Stormwater Management Policy 2017	Liverpool DCP 2018
Total suspended solids	80% reduction in the mean annual load of total suspended solids	80% reduction in the mean annual load of total suspended solids
Total Phosphorus	55% reduction in the mean annual load of total phosphorus	45% reduction in the mean annual load of total phosphorus
Total Nitrogen	40% reduction in the mean annual load of total nitrogen	45% reduction in the mean annual load of total nitrogen
Gross pollutants	90% reduction in the mean annual load of gross pollutants	-

The need for water treatment measures and proposed location will be further assessed during the detailed design stage and may include gross pollution traps to treat litter and debris. If necessary the Council guidelines should be considered during this design

4.1.1 Pre-construction works

During the early stages of construction, various preparatory works would be undertaken such as site establishment works and construction access provision. Early stage works would also include:

- installation of environmental controls, including sediment and erosion controls following best practice guidelines such as the Blue Book (DECC, 2008)
- stormwater drainage channel protection and diversion works where necessary to allow function of the system during the construction period
- any necessary flood mitigation measures to manage overland flows and minimise adverse impacts on surrounding environment where possible.

4.1.2 Construction during rain events

Construction of the project would commence once all necessary approvals are obtained, and the detailed design is complete. Where possible, construction and drainage activities would be planned considering the upcoming weather forecast to minimise the risks of potential heavy rainfall and major surface runoff events.

Although planning of activities in this manner would not prevent construction during periods of potentially heavy rainfall, the risk of having disturbed construction areas or unpreparedness during heavy rainfall periods would be reduced.

Further, as it is proposed to stockpile materials within the floodplain areas, this poses as an erosion and sedimentation risk and is discussed further in section 5.1.2.

4.2 Excavations

The majority of construction activities are not expected to be greater than three metres in depth and are therefore not expected to intercept groundwater. The exception to this is the following:

- Underboring will be undertaken as part of the relocation of the Sydney Water rising mains. This will occur as in Jacquie Osmond Reserve and will be undertaken to a depth of about four metres below ground surface.
- Piling will be undertaken as part of construction of new bridges over Sussex Street and Cabramatta Creek, to a maximum depth of 20 metres below ground surface.
- Piling will also be undertaken as part of the retaining wall construction to a maximum depth of 10 metres below ground surface.

5. Construction impacts

Construction of the project would broadly involve the following main work phases:

- enabling works
- main construction works
- testing and commissioning works

Key construction areas, including compounds and work sites, are shown on Figure 1.1.

Enabling works

Enabling works for major infrastructure (also known as early works) are typically carried out before the start of substantial construction to establish key construction sites and provide protection to the public and environment as required. This phase involves site establishment and protection or relocation of utilities.

Main construction works

The main construction works involves building new track for the passing loop (to be installed within the new wider rail corridor area), realigning the existing SSFL track, construction of new bridges over Sussex Street and Cabramatta Creek, road works, ancillary infrastructure and works, and finishing and rehabilitation of surrounding area.

Testing and commissioning

Testing and commissioning (checking) of the rail line and communication/signalling systems would be undertaken to ensure that all systems and infrastructure are designed, installed, and operating according to ARTC's operational requirements.

5.1 Risk assessment

An assessment of the potential impacts and measures to avoid, mitigate or minimise them during the construction phase is provided in Table 5.1. The risks and impacts listed are discussed in sections 5.2 and 5.3.

Table 5.1 Potential construction risks and mitigation measures

Risk	Potential impacts	Measures to avoid, mitigate or minimise impacts
Water quality		
Construction activities mobilising sediment due to disturbed soil from excavation and clearing	Pollution of receiving drainage networks and watercourses	• Locate construction compounds outside flood prone areas • Prepare wet weather working and construction flood management plans and incorporate in the CEMP • Install Sediment and Erosion Control measures in accordance with the Blue Book (DECC, 2008)
Groundwater		
Chemical or hydrocarbon spill	Contamination of groundwater	• Storage of hazardous goods and refuelling activities to take place in bunded areas
Interception and dewatering of groundwater by excavations	Drawdown in groundwater level	• Minimise excavations below groundwater table. • Minimise duration of time that excavations below the water table are open for
Discharge of excess groundwater	Pollution of receiving drainage networks and watercourses	• Use of intercepted groundwater for dust suppression or irrigation on-site • Prepare water quality monitoring plan and incorporate in the CEMP

5.1.1 Impact of widening the rail corridor

During the construction period, widening the rail corridor has the potential to:

- slightly increase the impervious area due to the removal of a small portion of landscaped garden on Broomfield Street
- result in increased pollutant generation from disturbed soils during construction activities, including sedimentation discharging uncontrolled into the downstream environment if left unmitigated. This source has the potential to mobilise during any wet weather event.

It is noted that the project would be timed such that construction work should not occur during severe wet weather events. Consideration by the construction contractor and ARTC would need to be given to flood warning and emergency management under rare to extreme flood conditions (generally 5% AEP events or higher) for the site. Also, the increase in impervious area that gives potential to increased pollutant loads, is a small increase relative to the overall catchment.

5.1.2 Impact of stockpiles and construction materials in the floodplain

During the construction period and as mentioned above in section 4.1.2, stockpiles and construction materials are proposed to be stored within the floodplain. This has the potential to:

- cause uncontrolled discharges into the downstream environment
- contaminate the waterways or groundwater from chemical or hydrocarbon spills.

Timing of the project and specific tasks to minimise the risk from severe weather events on construction would be considered and appropriate bunding arrangements would be put in place.

5.2 Water quality management

The following potential impacts on surface water quality and groundwater are expected:

- increased erosion and sedimentation from a range of construction activities resulting in an increase in sedimentation in downstream waterways from uncontrolled runoff discharged within the project site
- contamination of the waterways or groundwater from chemical or hydrocarbon spills.

To manage these potential impacts a Soil and Water Management Plan (SWMP) would be prepared and implemented and include measures to manage and reduce the risk of water quality impacts associated with the works. This should also consider the impact of working and implementing a construction site within a floodplain area. This would mean a high potential for impact from the activities proposed.

Mitigating any potential impacts will need to consider best practice in managing the site, in accordance with the Blue Book (DECC, 2008).

5.2.1 Erosion and sedimentation

Soil is the most likely potential contaminant that can impact surface water quality during the construction phase if runoff is allowed to mobilise exposed underlying soils. This can result in increased erosion and sedimentation, which is influenced by the severity of a storm event and the slope and footprint of the disturbed area.

Ground disturbance works affect all construction sites in one form or another and pose the greatest risk where they occur near waterways and steep slopes such as the existing railway embankments.

The earthworks and construction of the above ground components of the project would require the removal of existing vegetation (for example tree removal and vegetation clearing) and structures (for example fences and existing noise walls/retaining walls) in some locations, thereby disturbing and exposing the soils. The earthworks, roadworks and the movement of construction vehicles (for example dump trucks transporting material on and off site) within the project site could increase erosion and sediment deposition in the waterways, particularly in proximity to inlets to the existing railway drainage or council stormwater drainage network.

There is also the potential for the disturbance of sediments during excavation works to amend utilities including changes and additions to the existing stormwater drainage networks. For example, relocation of utilities on Broomfield Street.

The location of existing surface water quality treatment devices in Cabramatta Creek and Georges River catchments downstream of the project site has not been confirmed but it is not likely that devices such GPTs and bioretention basins are present given the location of the project site relative to the overall catchment as well as the size of the catchment and the effectiveness of these devices in catchment areas of this size. Devices such as GPTs largely treat gross pollutants such as rubbish and leaf litter and would provide very limited treatment of sediments that may be generated by the construction works. In excessive amounts, increased sediments from construction works have the potential to cause siltation of these devices, thus requiring additional maintenance. Bioretention devices or basins also retain sediments but excessive sediment loads have the potential to reduce their effectiveness.

As the construction program is anticipated to run over two years, the probability of a rainfall event occurring in excess of the minor drainage capacity is likely and appropriate flow or temporary diversion measures would be necessary. There is potential for large quantities of sediments to be directed into the downstream waterways potentially resulting in siltation and sedimentation issues.

5.2.2 Potential for spills/leaks

The release of potentially harmful chemicals and other substances in the environment may occur accidentally during construction due to spills, as a result of equipment refuelling, malfunction and maintenance, via treatment and curing processes for concrete, as a result of inappropriate storage, handling and use of the substances or from the disturbance and inappropriate handling of contaminated soils. This has the potential to impact on water quality in receiving waters downstream of the project or impact the beneficial use of groundwater for irrigation activities. These contaminants could include acids and chemicals from washing processes, construction fuels, oils, lubricants, hydraulic fluids and other chemicals. Water quality and associated ecological impacts could result if these contaminants end up in the waterways and ultimately Georges River and Botany Bay downstream of the works areas.

In accordance with the Chemical Work Instruction (WHS-WI-214 guidelines by ARTC) (as well as any specific guidelines in place by the contractor undertaking the construction activities), responsible managers should assess whether spill kits are needed and the best location for such equipment. Storage of hazardous goods, maintenance activities and refuelling activities would be undertaken in bunded areas and away from waterways, including flood prone locations. These locations would be identified in the SWMP.

5.2.3 Construction works

There are key activities and areas within the project site that have the potential to result in downstream water quality or groundwater quality impacts. Examples of sources of pollutants that could affect water quality from these works are as follows:

- contaminated soils including fertilisers and pesticides (see further discussion in Technical Report 6 – Targeted contamination assessment)
- heavy metals
- chemicals including hydrocarbons and fluids associated with construction processes and machinery
- dust and airborne pollutants.

Typical impacts on the waterways would be through mobilised dust, litter and other materials being deposited or picked up by surface water runoff, waterways or stormwater management infrastructure thereby degrading the quality of the receiving environment. The transportation of waste from the construction sites could potentially impact the quality of the waterways and groundwater through inappropriate storage locations or accidental spills/material drops. Some materials that are typically found in construction activities, such as chemicals, can be easily transported from the site through off site stormwater runoff or seepage to groundwater. These pollutants can be ingested by aquatic fauna and result in dead or sick aquatic life.

Working near watercourses or in low-lying areas introduces increased risks of contaminants being washed into the receiving stormwater network. Activities and areas which present a higher risk of impacting on the receiving waters would be outlined in the (SWMP), along with specific controls to reduce the risk of these impacts occurring.

5.3 Groundwater level

The majority of construction activities are not expected to be greater than 3 metres in depth and are therefore not expected to intercept groundwater. The exception to this is piling as part of construction of new bridges over Sussex Street and Cabramatta Creek, a bored pile retaining wall from Bridge Street to Sussex Street Bridge and underboring as part of the relocation of the Sydney Water rising main in Jacquie Osmond Reserve. Note that the retaining wall from Bridge Street to Sussex Street Bridge will be a partial bored pile and partial cantilever retaining wall.

Piling and underboring will only intercept groundwater during the period of excavation.

Groundwater inflows have been estimated for the proposed excavations that may intercept groundwater using the analytical equations developed by Marinelli and Niccoli (2000) as described in section 2.6.

5.3.1 Modelling input data

Data sources and assumptions used to derive input values for each of the parameters required for the equations developed by Marinelli and Niccoli (2000) are outlined in the following section:

Initial (pre-construction) saturated thickness (h_o)

The initial (pre-construction) saturated thickness was estimated to be equal to the height of groundwater (indicated by the groundwater monitoring data) above the base of the pit. It should be noted that monitored groundwater levels are indicative of conditions at the time at which monitoring occurred and that groundwater levels may increase over time. Also groundwater monitoring data were not available for the whole of the project site. Therefore observed groundwater levels have been extrapolated from observations and were assumed to be 4.5 metres bgl for excavations associated with piling. The closest observed groundwater level to Jacquie Osmond Reserve was 3 metres bgl at GHD_BH02 (Table 3.1). Therefore, the groundwater level at the underboring site was assumed to be 3 metres bgl.

The depth of the piling excavation as part of retaining wall construction was assumed to be 10 metres. The depth of piling excavation as part of bridge construction was assumed to be 20 metres. The depth of excavations associated with piling will likely vary across the site as the excavations are assumed to extend to the base of the alluvial clay and the depth of the alluvium varies across the site.

The depth of the launch and receival pits as part of underboring was assumed to be four metres. This depth is associated with the depth of the Sydney Water rising main that is to be relocated as part of the project.

Saturated thickness at pit wall (h_p)

The excavations are assumed to be fully dewatered during construction and fully drained during operation. Therefore, the saturated thickness at pit wall (h_p) was assumed to be equal to zero.

Distributed recharge flux (W)

Based on the alluvial clay nature of the strata, a net recharge rate of two to four per cent of long term average rainfall at Bankstown Airport AWS Bureau of Meteorology Station (station number 066137) was adopted for the assessment. This station was adopted for the assessment based on the length and the quality of the data record and the proximity to the site. Long-term average annual rainfall over the period July 1968 to February 2019 was 868 millimetres per year. A net recharge rate of two per cent gives an estimated long-term average recharge rate of 17.36 millimetres per year or 4.76×10^{-5} metres per day. A net recharge rate of four per cent gives an estimated long-term average recharge rate of 34.72 millimetres per year or 9.51×10^{-5} metres per day.

Hydraulic conductivity Zones 1 and 2 (Kh_1, Kh_2 and Kv_2)

Hydraulic conductivities of the alluvial clay aquifer have been assumed to be equal to generally accepted values for clay. Boreholes across the site indicate that the strata is generally fill that overlies a layer of alluvial clay. Based on the hydraulic conductivity values adopted by Kruseman and de Ridder (1994) for clay of 1 x 10^{-8} metres per day to 1 x 10^{-2} metre per day, a horizontal hydraulic conductivity of 1 x 10^{-2} metres per day was adopted. Excavations are expected to extend to the base of the alluvial clay.

Based on data identified in the geological investigation (section 3.5), in the vicinity of the Sussex Street overbridge and the Cabramatta Creek Bridge, the alluvial clay is underlain by a thin (less than one metre thick) layer of weathered shale over fresh to slightly weathered sandstone. Based on the hydraulic conductivity values adopted by Kruseman and de Ridder (1994) for shale of 1 x 10^{-7} metres per day; for sandstone of 1 x 10^{-3} meters per day to 1 metre per day; and for fractured rock of up to 300 metres per day a horizontal hydraulic conductivity of 1 x 10^{-1} metres per day was adopted.

It was assumed that the horizontal hydraulic conductivity is 10 times greater than vertical hydraulic conductivity.

Effective pit radius (r_p)

Effective pit radius is equal to the radius of the excavation. Boreholes are drilled as part of the piling process. The pile foundation is then constructed in the borehole. The radius of each excavation for each borehole has been assumed to be 150 millimetres.

The dimensions of the underboring launch and receival pits has been assumed to be three metres by three metres. The area of each pit (nine metres squared) was input into the formulae for the area of a circle (ie $A = \pi r_p^2$). The effective pit radius of each pit was calculated as 1.69 metres.

Radius of influence (r_o)

The radius of influence (r_o) of any groundwater abstraction represents a balance between the hydraulic conductivity of the strata and the rate of recharge incident at the water table. The radius of influence has been estimated from the calculation.

5.3.2 Predictions of inflow and radius of influence

Groundwater inflows have been estimated for the proposed excavations that may intercept groundwater using the analytical equations developed by Marinelli and Niccoli (2000) as described in section 2.6 and using data described in section 5.3.1.

Inflows into the underboring launch and receival pits have been calculated separately to boreholes for piling. Groundwater inflow has been calculated for one excavation at a time. It has been assumed that drawdown associated with one borehole will not impact on surrounding boreholes. Due to differing assumed depths, inflows for boreholes as part of bridge construction have been calculated separately to inflows for boreholes as part of construction of the retaining wall.

Predicted inflows have been calculated for the following scenarios:

- Scenario 1 is considered to be a best case, where the best estimate for hydraulic conductivity, mean recharge and initial saturated thickness (height of groundwater level above pit floor) were used in the assessment.
- Scenario 2 reduced the recharge to two per cent of rainfall.

- Scenario 3 increased the water level at the site by 1.5 metres to 3 m bgl at piling boreholes and to 1.5 m bgl at the underboring launch and receival pits.
- Scenario 4 increased the hydraulic conductivity by 10 times relative to Scenario 1.
- Scenario 5 decreased the hydraulic conductivity by 10 times relative to Scenario 1.

A range of scenarios have been assessed as there are uncertainties regarding input parameters. Groundwater levels may vary across the site and groundwater levels and rainfall recharge may vary over time due to climatic factors. Additionally, field tests to estimate hydraulic conductivity have not been undertaken and therefore actual hydraulic conductivity is unknown. Calculating groundwater inflow for a number of scenarios allows a reasonable range of potential inflow rates to be estimated.

Predicted inflows for boreholes constructed for the retaining wall are shown in Table 5.2. Predicted inflows for boreholes constructed as part bridge construction are shown in Table 5.3. Predicted inflows for underboring launch and receival pits are shown in Table 5.4.

Table 5.2 Boreholes as part of retaining wall construction predicted groundwater inflows and radius of influence

Scenario	Distributed recharge flux, W (m/d)	Zone 1 Horizontal hydraulic conductivity k_{h1} (m/d)	Zone 2 Horizontal hydraulic conductivity k_{h2} (m/d)	Radius of influence r_o (m)	Initial saturated thickness h_o (m)	Horizontal groundwater inflow Q_1 (m^3/day)	Vertical groundwater inflow Q_2 (m^3/day)	Total groundwater inflow Q_t (m^3/day)
1	9.51×10^{-5}	0.01	0.1	26.1	5.5	0.21	0.03	0.24
2	4.76×10^{-5}	0.01	0.1	35.7	5.5	0.19	0.03	0.22
3	9.51×10^{-5}	0.01	0.1	32.5	7	0.32	0.04	0.36
4	9.51×10^{-5}	0.1	1	74.6	5.5	1.66	0.33	1.99
5	9.51×10^{-5}	0.001	0.01	9.4	5.5	0.03	0.003	0.033

Note to table:
m – metres
m/d – metres per day
m^3/day – cubic metres per day

Table 5.3 Boreholes as part of bridge construction predicted groundwater inflows and radius of influence

Scenario	Distributed recharge flux, W (m/d)	Zone 1 Horizontal hydraulic conductivity k_{h1} (m/d)	Zone 2 Horizontal hydraulic conductivity k_{h2} (m/d)	Radius of influence r_o (m)	Initial saturated thickness h_o (m)	Horizontal groundwater inflow Q_1 (m^3/day)	Vertical groundwater inflow Q_2 (m^3/day)	Total groundwater inflow Q_t (m^3/day)
1	9.51×10^{-5}	0.01	0.1	67.1	15.5	1.35	0.09	1.44
2	4.76×10^{-5}	0.01	0.1	92.3	15.5	1.27	0.09	1.36
3	9.51×10^{-5}	0.01	0.1	73.1	17	1.60	0.10	1.70
4	9.51×10^{-5}	0.1	1	194.6	15.5	11.32	0.93	12.25
5	9.51×10^{-5}	0.001	0.01	23.5	15.5	0.17	0.01	0.18

Note to table:
m – metres
m/d – metres per day
m^3/day – cubic metres per day

Table 5.4 Underboring launch and receival pit groundwater inflows and radius of influence

Scenario	Distributed recharge flux, W (m/d)	Zone 1 Horizontal hydraulic conductivity k_{h1} (m/d)	Zone 2 Horizontal hydraulic conductivity k_{h2} (m/d)	Radius of influence r_o (m)	Initial saturated thickness h_o (m)	Horizontal groundwater inflow Q_1 (m^3/day)	Vertical groundwater inflow Q_2 (m^3/day)	Total groundwater inflow * Q_t (m^3/day)
1	9.51×10^{-5}	0.01	0.1	9.3	1	0.03	0.02	0.05
2	4.76×10^{-5}	0.01	0.1	12.0	1	0.02	0.02	0.04
3	9.51×10^{-5}	0.01	0.1	18.6	2.5	0.10	0.05	0.15
4	9.51×10^{-5}	0.1	1	22.4	1	0.15	0.21	0.36
5	9.51×10^{-5}	0.001	0.01	4.4	1	0.005	0.002	0.007

Note to table:

m – metres

m/d – metres per day

m^3/day – cubic metres per day

* total inflow into each pit

Based on the analytical calculations, cumulative groundwater inflows into each borehole associated with retaining wall construction are between 0.03 and 1.99 cubic metres per day with the most likely estimate considered to be 0.24 cubic metres per day (based on scenario 1).

Based on the analytical calculations, cumulative groundwater inflows into each borehole associated with bridge construction are between 0.18 and 12.25 cubic metres per day with the most likely estimate considered to be 1.44 cubic metres per day (based on scenario 1).

Based on the analytical calculations, cumulative groundwater inflows into the underboring launch pit and receival pit are between 0.007 and 0.36 cubic metres per day per pit with the most likely estimate considered to be 0.05 cubic metres per day per pit (based on scenario 1).

Note that groundwater inflow rates into the boreholes may vary from the estimated values as groundwater levels may vary across the site and the required depth of excavation varies.

The radius of influence on groundwater of each borehole has been estimated. Estimated radius of influence of dewatering of each borehole associated with retaining wall construction is between 9.4 metres and 74.6 metres with the most likely estimate considered to be 26.1 meters (based on scenario 1). Estimated radius of influence of dewatering of each borehole associated with bridge construction is between 23.5 metres and 194.6 metres with the most likely estimate considered to be 67.1 meters (based on scenario 1). Estimated radius of influence of dewatering of launch and receival underboring pits is between 4.4 metres and 22.4 metres for each pit with the most likely estimate considered to be 9.3 meters (based on scenario 1). Similarly to estimated groundwater inflow rates, the radius of influence may vary from estimated values as groundwater levels may vary across the site and the required depth of excavation varies.

5.3.3 Aquifer interference policy

Due to the generally clayey, low yielding nature of the alluvial aquifer, the alluvial aquifer has been classified as a less productive fractured rock groundwater source under the NSW Aquifer Interference Policy. A less productive groundwater source is defined by the AIP as a groundwater source having total dissolved solids greater than 1500 milligrams per litre or does not contain water supply works that can yield water at a rate greater than five litres per second.

The NSW Aquifer Interference Policy requires that potential impacts on groundwater sources, including their users and groundwater dependant ecosystems, be assessed against the minimal impact considerations outlined in the policy. If the predicted impacts are less than the Level 1 minimal impact considerations for less productive fractured rock groundwater sources, then the potential groundwater impacts of the project are acceptable. The Level 1 minimal impact considerations for less productive alluvial groundwater sources are:

- less than or equal to 10 per cent cumulative variation in the water table, allowing for typical climatic ‘post-water sharing plan’ variations, at a distance of 40 metres from any high priority GDEs or high priority culturally significant site listed in the schedule of the relevant water sharing plan
- a maximum of a two metre water table decline cumulatively at any water supply work
- water pressure – a cumulative pressure head decline of not more than 40 per cent of the ‘post-water sharing plan’ pressure head above the base of the water source to a maximum of a two metre decline at any water supply work
- any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres of the activity
- no increase of more than one per cent per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity.

The project has been assessed against the adopted Level 1 minimal impact considerations below.

Water supply works

Based on analytical calculations, the radius of influence estimated in section 5.3.2 extends up to 194.6 metres. There are no water supply works within 400 metres of the project. Therefore, the project would not result in any impacts to a water supply work.

High priority culturally significant sites

There are no high priority culturally significant sites listed in the WSP for the Greater Metropolitan Region Groundwater Sources. Therefore, the project would not result in any impacts to a culturally significant site.

Groundwater dependent ecosystems

As discussed in section 3.7.2, the closest high priority groundwater receptor is located approximately 11 kilometres from the site. Therefore the project will not impact on any high priority GDEs.

As discussed in section 3.7.2, the assessment undertaken in the BDAR identified vegetation within the study area is unlikely to be a GDE and is likely to be reliant on rainfall and on surface water associated with Cabramatta Creek and areas of surface water accumulation on its floodplain. Therefore the project will not impact on any GDEs.

Summary

Overall, it is predicted that the groundwater impacts from the project would be less than the Level 1 minimal impact considerations specified in the AIP and therefore are considered to be acceptable.

The project is not predicted to result in any decline in groundwater pressure or groundwater head at any water supply work and is not predicted to alter the beneficial use of the alluvial groundwater. There are no culturally significant sites or GDEs in or immediately near the study area.

5.4 Cumulative impacts

There are no other substantial or major projects proposed which could potentially impact water quality in the project site.

There is a minor development proposal current for a multi-storey residential development on the corner of Broomfield Street and Cabramatta Road East. This proposal could potentially impact on the study area given it sits upstream of the area with part of the site within the same surface water catchment as the project. Given the existing nature of the site is urban development, this development would not be expected to have a large additional impact on surface water quality in the area.

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6. Operational impacts

6.1 Risk assessment

An assessment of the potential water quality and groundwater risks, and measures to avoid, mitigate or minimise them during operation is provided in Table 6.1. The risks and impacts listed are discussed in the following sections.

Table 6.1 Potential impacts and mitigation measures

Risk	Potential impacts	Measures to avoid, mitigate or minimise impacts
Minor increase in hard stand areas across the operational project site relative to existing conditions	Increases in pollutant generation Changes in groundwater recharge	Install water quality treatment devices Minimise areas of additional hard stand
Piling creating barriers to groundwater flow	Changes in groundwater flow paths	Proposed piling associated with Sussex Street and Cabramatta Creek bridges to match layout of piles of existing bridges
Increase in rail movements within the corridor	Increase in potential for pollutant generation	Ensure adequate water quality treatment and capture devices are installed to prevent uncontrolled discharges of pollutants generated within the rail corridor

6.1.1 Impact of minor increase in impervious area

Widening the rail corridor would slightly increase the impervious areas of the rail corridor (and potentially surrounding areas as well) notably where the landscaped garden on Broomfield Street currently exists. The change in land use will result in the current landscaped garden becoming part of the rail ballast and sub-grade part of the corridor, representing an increase in impervious area. The increase in impervious area will not create hard-stand areas of similar characteristic to traditional hard-stand areas like concrete which typically generate more runoff than, for example, rail ballast.

Notwithstanding this, the change could result in increased or at least change in generation of surface runoff, litter and other pollutants being conveyed to receiving waterways. Excessive pollutants generated within the railway corridor should be contained within the rail corridor and existing systems. The surface water runoff from the rail corridor containing excessive pollutants will be treated on-site before discharging to Cabramatta Creek through swale drains and if further treatment is required a gross-pollutant traps (GPTs) or similar device should be provided.

6.1.2 Impact of increased rail movements within the rail corridor

The increase in capacity of the freight rail network as a result of this project will see an increase in rail movements through the corridor in the study area. This will increase the likelihood of pollutants being generated within the rail corridor due to the increase in trains moving through the corridor.

Excessive pollutants generated within the rail corridor should be contained within the rail corridor and existing systems and water quality treatment devices. The surface water runoff from the rail corridor containing excessive pollutants will be treated on-site before discharging to

Cabramatta Creek through swale drains and if further treatment is required GPTs or similar device should be provided.

6.1.3 Impact on surrounding areas

Roadworks on Broomfield Street and reconfiguring the shared path adjacent to the rail line will occur as part of the project. No changes to Jacquie Osmond Reserve or Peter Warren Automotive are proposed as part of the operational phase of the project.

The impact to surface water quality of the changes to Broomfield Street and the shared path are discussed in section 6.1.1 where minor increases in impervious areas are proposed. These increases are very minor and any treatment should be provided by swale drains. If further treatment is required a GPT or similar device should be provided.

6.2 Water quality outcomes

The potential operational impacts of the project include slight increases to the impervious areas within the catchment as well as increased rail movements within the rail corridor.

The operational areas sit outside the floodplain for more frequent rainfall events. Only in very infrequent rainfall events does the floodplain encroach on operational areas. Further discussion on this is provided in Technical Report 5 – Hydrology and flooding impact assessment.

Both of these impacts could result in increased pollutant generation potential within the rail corridor.

Discussions of the potential operational risk and impacts on water quality associated with the operation of the project is provided in the following sections.

6.2.1 Stormwater runoff

Within an operating rail corridor, typically contamination of the waterways can be caused through stormwater runoff containing typical pollutants such as oils and greases, petrochemicals and heavy metals as a result of rolling stock operations and wear. The contamination of waterways by these pollutants can result in habitat degradation and negatively impact on the health of aquatic flora and fauna species. However by and large, the rail corridor will be widened outside of the existing footprint of an existing operating railway and the potential for increase in contamination levels from these types of pollutants is expected to be very small relative to the existing situation.

It is noted that the increase in impervious area due to the proposed rail corridor widening is very small relative to the total catchment area (less than 0.1 per cent of the respective catchment area). Consequently, there is very little influence on the overall catchment water quality expected.

Water quality outcomes have been assessed against water quality guidelines provided in section 1.5. The assessment of the water quality outcomes against ANZECC guidelines will be undertaken once the water quality monitoring program has been completed. This is subject to the water quality monitoring program being implemented with sufficient water quality data being available.

Provision of the proposed water quality treatment measures where necessary is expected to contribute to improved water quality overall against the existing conditions, though further analysis would be required at detailed design stage to confirm. The further analysis at detailed design stage would account for any design development since concept design, as well as account for the outcomes of the ANZECC assessment once the water quality monitoring program has been undertaken. Implementation of effective water quality treatment measures where necessary for the project would mean no adverse impacts in meeting the water quality objectives for the catchments over time.

6.2.2 Potential for spills/leaks

The potential impacts on water quality from the operation of the rail corridor would be related to the spill of vehicle oils, lubricants, hydraulics fluids and other accidental spills including chemicals in transit through leakage.

Any such spill has the potential to pollute the downstream waterways and therefore cause detrimental effects for the riparian Georges River and ultimately Botany Bay receiving environments or groundwater environment.

However, the project footprint is similar to the existing condition and therefore the potential extent of any increased spills or leaks is expected to be small relative to the existing situation. There is opportunity to incorporate some spill containment capability within the water quality treatment train. However it should be noted that the ballast would contain spills to an extent without resulting in conveyance directly to the stormwater system. Once the outcomes of the water quality monitoring and subsequent assessment are available, the need for inclusion of spill containment capability within any required treatment devised should be reviewed and confirmed during design development.

6.2.3 Erosion and sedimentation

Once the construction of the project is completed, there is a subsequent period where recently disturbed soils are susceptible to scour and erosion from stormwater runoff.

The modification of overland flow paths can cause an increase in scour of surface soil, banks or bed material and resultant sedimentation in downstream waterways. Any change of this nature would be required to achieve the design criteria set out in Technical Report 5 – Hydrology and flooding impact assessment. The potential impacts would occur in the event that appropriate reestablishment of embankments was not undertaken and poor stabilisation resulted in additional soils being mobilised and affecting water quality. To this end the proposed embankments finishes should match with existing embankment cover to provide appropriate protection and stabilisation.

With the projected small increase in impervious area as a result of the project, there would be a comparable increase in stormwater runoff which can potentially scour surface soil and increase sediment loading in downstream waterways. The increase is considered negligible however and any increase noted should achieve the design criteria set out in Technical Report 5 – Hydrology and flooding impact assessment.

The potential for sediment transport is influenced by factors such as severity of storm events, the slope and scale of the disturbed area and the quality of revegetation. As the disturbance area and change in impervious areas are in this case small relative to the catchment as a whole, the potential impacts would be expected to be limited in nature and less than the construction phase.

6.3 Groundwater level

Any excavations that may intercept groundwater including boreholes for piling and excavations associated with underboring will be backfilled after construction. Therefore no long term impacts from interception of groundwater are expected.

Installation of piles are expected to have negligible impact on groundwater flow paths. This is due to the large extent of the alluvial aquifer (the alluvial aquifer extends to Georges River in the south and the east) compared to the relatively small footprint of proposed piling. Additionally, proposed piling associated with Sussex Street and Cabramatta Creek bridges will match layout of piles of existing bridges.

The increased hard stand areas may result in some local changes to the rates of rainfall infiltration into the alluvial aquifer. As outlined in section 3.7.2 the main groundwater receptor is considered to be baseflow to waterways. Runoff from hard stand areas will continue to flow to Cabramatta Creek and Georges River. Therefore reduction in rainfall infiltration into the alluvial aquifer is likely to have negligible effect in flows available to groundwater receptors such as Cabramatta Creek and Georges River.

Due to the lack of long term interaction of the project with groundwater, the project will not result in long term impact on groundwater level or quality. Therefore it is predicted that the groundwater impacts from the project would be less than the Level 1 minimal impact considerations specified in the NSW Aquifer Interference Policy and are therefore considered acceptable.

6.4 Cumulative impacts

There are no other substantial or major projects proposed which could potentially impact water quality in the project site.

There is a minor development proposal current for a multi-storey residential development on the corner of Broomfield Street and Cabramatta Road East. This proposal could potentially impact on the study area given it sits upstream of the area but with part of the site within the same surface water catchment as the project. Given the existing nature of the site is urban development, this development would not be expected to have a large additional impact on surface water quality in the area.

7. Recommended mitigation measures

7.1 Construction

7.1.1 Surface water quality

As a general guiding principle for major civil design and construction works, water quality mitigation and management measures should be implemented in accordance with the relevant requirements of:

- Managing Urban Stormwater Soils and Construction Volume 2A (The Blue Book) (DECC, 2008)
- the ANZECC guidelines
- the Australian Guidelines for Water Quality Monitoring and Reporting (NWQMS, 2000)
- Australian Runoff Quality – A Guide to Water Sensitive Urban Design (Engineers Australia, 2006)
- Other water quality criteria and guidelines identified in this report.

A Soil and Water Management Plan (SWMP) would be prepared as part of the CEMP. The SWMP would define the control and mitigation of potential surface water quality impacts during construction. The SWMP would be developed to incorporate the most appropriate or 'best practice' controls and measures in accordance with the Blue Book. The SWMP would be staged to suit the changing needs as the works progress. Due consideration would also be given to the extent of works and situation relative to the sensitivity of the surrounding environment in relation to the construction activity.

Both the CEMP and SWMP would typically include strategies such as:

- bunding of storage areas containing hazardous goods and undertaking of refuelling activities in bunded areas
- construction staging.

With appropriate strategies in place, the risk of sedimentation of the local watercourses in the vicinity of the works location would be substantially reduced.

Further, existing open swale drains and any other open drainage channels provided through construction areas will help provide an opportunity to cut off, via emergency bunding where required, any spills and leaks that may begin running off-site or into underground stormwater drainage networks. This would be in the unlikely event of the any chemical spills and leaks occurring within the rail corridor.

Construction-related risks, such as earthworks, spills, and location of stockpiles and equipment, are fairly common for projects of this size and type, and would be managed in accordance with The Blue Book (DECC, 2008).

Management of construction work sites proposed in the floodplain would be undertaken to avoid mobilisation of sediments or other contaminants due to overland flooding (refer also to the section 7.1.2). The CEMP and SWMP would include a component specifically addressing the management of risks associated with operating a construction site in the floodplain, which would incorporate measures to address the resulting potential impacts on water quality. This risk and any potential mitigation is discussed further in Technical Report 5 – Hydrology and flooding impact assessment.

7.1.2 Groundwater

Impacts on groundwater due to excavations below the groundwater table and associated dewatering may be mitigated by minimising time that excavations are left open, minimising size of excavations and siting excavations away from groundwater receptors including watercourses and landholder bores. Any dewatered groundwater will be used on-site for dust suppression or irrigation.

Bunding of storage areas containing hazardous goods and undertaking of refuelling activities in bunded areas would reduce the risk of the project impacting on groundwater quality. All hazardous goods and re-fuelling activities would be undertaken in these bunded areas. These practices would be outlined in the SWMP outlined in section 7.1.1.

7.1.3 Management of water from dewatering

Groundwater intercepted during dewatering will be stored and reused on site for wetting down and reducing dust in disturbed areas (within existing erosion and sediment controls), or for irrigation in grassed areas. Requirements for testing and the management of this water would be included in the SWMP and would include the following at a minimum:

- No visible sheen or odour is noted.
- Water pH is between 6.5 and 8.5.
- Total suspended solids are less than 60 mg/L (approximately equivalent to a turbidity level of 50 NTU). Water may be dosed with gypsum, alum or a similar product to reduce sediment levels if required.
- All litter and debris must be filtered out and removed prior to reuse.
- Sludge from the bottom of the trench or tank can be placed in a shallow pit lined with heavy duty plastic sheeting to dry out (evaporation pit). Once the sludge has dried out sufficiently to allow it to be spaded this waste can be stored with excess excavated spoil and disposed in accordance with the findings of the preliminary waste classification assessment (refer to Technical Report 6 – Soils and contamination assessment).

7.1.4 Residual impacts

It is expected that with the appropriate mitigation measures in place, including review of the location of construction worksites and compounds relative to the floodplain, the residual potential construction impacts would be successfully managed using similar approaches to other measures employed for major infrastructure projects in Sydney.

7.2 Operation

7.2.1 Water quality

The intent of the project design with regard to surface water quality and groundwater quality would be to minimise impacts on the receiving systems and implement the design criteria.

Further design development is required to confirm treatment types and locations as well as implementation of any spill containment measures should any relevant changes to the design occur and on review of additional water quality data that will become available following the water quality monitoring program (see below). Potential elements that could be considered include swales, gully traps and GPTs.

A water quality monitoring program has been developed to monitor water quality outcomes against the water quality objectives for Cabramatta Creek and Georges River. The surface water quality monitoring program would monitor key parameters, including nutrients, coliforms, sediments, hydrocarbons and heavy metals. As these watercourses form the main receptor of groundwater, sampling of these parameters would be sufficient to ensure the project is not impacting on groundwater receptors. It is proposed that this water quality sampling would be undertaken on a monthly basis over a twelve month period.

Final locations for water quality sampling points would be selected based on:

- the concept drainage design
- review of accessibility to sampling points
- selection, where possible, of upstream and downstream sampling points limiting inflows from sources other than the rail corridor
- consideration of monitoring locations for current water quality monitoring undertaken by GRCCC.

Due to the extensive surface water drainage network in and surrounding the project site, as well as the linear nature of the rail corridor, identification of sampling points which effectively isolate the influence of the rail corridor may not be possible and locations should be further considered as the design develops.

7.2.2 Residual impacts

Residual impacts of the project may include slightly increased surface runoff and generation of litter and other pollutants being conveyed to receiving watercourses. Water quality impacts would be managed through implementation of water sensitive urban design measures and a water quality monitoring program which would be developed during subsequent phases of the project.

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8. Conclusion

A surface water quality and groundwater impact assessment was carried out for the project.

The assessment drew on the following sources of information including:

- a desktop review of available water quality and groundwater information
- various reference design documentation.

The project site is located in a highly urbanised environment that has been substantially altered from its natural state and water quality is typical of that for urban catchments in Sydney.

Key construction stage impacts include the potential for increased sediment being discharged to downstream systems as a result of construction activities. Construction impacts would be managed through implementation of SWMPs in accordance with the Blue Book and detailed planning and management of construction sites to avoid impacting overland flow paths without appropriate mitigation.

Drainage works are proposed as a component of the altered rail corridor and there would be a low risk of construction stage water quality impacts due to a limited footprint for the construction and a relatively short construction window.

Water quality impacts would be managed through implementation of water sensitive urban design measures. A water quality monitoring program will be undertaken to monitor water quality outcomes against long term water quality objectives including tying in with existing water quality monitoring within the wider catchment.

Construction stage impacts on groundwater may occur due to interception of groundwater by excavations associated with construction. These excavations may require dewatering which would result in drawdown in groundwater levels. Impacts on groundwater level due to dewatering would occur during the construction stage only.

Impacts on groundwater level due to dewatering would be managed by minimising the number of excavations below groundwater table, minimising time that excavations are left open, minimising size of excavations and siting excavations away from groundwater receptors.

There are no other substantial or major projects which could potentially impact water quality or groundwater in the project site.

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