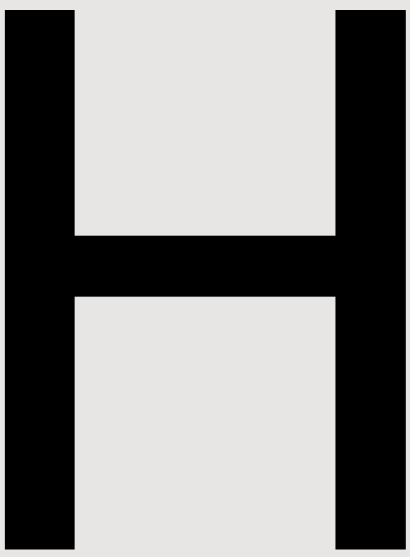
Picton Road upgrade between Nepean River and Almond Street, Wilton

Review of Environmental Factors

Appendix H

Soils, Surface and Groundwater Assessment

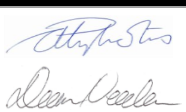


Picton Road upgrade between Nepean River and Almond Street, Wilton

Soils, Surface and Groundwater Assessment

Transport for NSW

January 2024

Project name		Picton Road upgrade between Nepean River and Almond Street, Wilton					
Document title		Picton Road upgrade between Nepean River and Almond Street, Wilton | Soils, Surface and Groundwater Assessment					
Project number		12560200					
File name		12560200_REP-0_Picton Road Upgrade REF_Soils surface and groundwater assessment.docx					
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S4	Final for exhibition	N Bosworth I Gilmore	A Pyliotis D Nealon		K O'Brien		22/1/2024

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Executive summary

Proposal overview

Transport for NSW (Transport) proposes to upgrade Picton Road between the Nepean River and Almond Street in Wilton, NSW (the proposal). The proposal includes upgrading the section of Picton Road from about 1.3 kilometres east of the bridge over the Nepean River to about 200 metres east of Almond Street, including the M31 Hume Motorway interchange.

The proposal is subject to assessment in the form of a review of environmental factors (REF) under Division 5.1 of *Environmental Planning and Assessment Act 1979* (EP&A Act). This report has been prepared as part of the REF to assess the potential impacts of constructing and operating the proposal on soils, surface water and groundwater.

Approach to soils, surface water and groundwater assessment

This report presents an assessment of the potential impacts on soils, surface water and groundwater of constructing and operating the proposal.

The assessment of potential impacts on soils included identifying soil conditions within the proposal site based on public data and field investigations undertaken for the proposal. The erosion and sedimentation potential of soils, and the risks and constraints relating to soils within the proposal site, have been assessed based on publicly available data and the concept design for the proposal.

A qualitative assessment was undertaken of the pollutants that could be introduced during construction and operation of the proposal to determine the potential resulting impacts on surface water quality of the receiving environment. The assessment identified existing and future predicted pollutant loads and water quality controls needed to achieve the pollutant reduction targets for the proposal during operation.

The groundwater assessment included review and analysis of publicly available data and sampling completed during field investigations to characterise the existing environment and identify potential groundwater risks as well as potential impacts of the proposal on groundwater levels and quality.

A qualitative assessment against the Neutral or Beneficial Effect (NorBE) water quality test using the WaterNSW NorBE tool was undertaken to demonstrate that the proposal can be designed, constructed and operated so that there would be a neutral or beneficial effect on water quality.

Overview of potential impacts

Construction

Construction of the proposal would involve a range of activities, including earthworks, vegetation clearing and mulching, the establishment of ancillary facilities and access tracks, road construction, and the construction of bridges for the new Picton Road and M31 Hume Motorway interchange. These construction activities have the potential to impact on soils, surface water and groundwater.

If not adequately managed, potential impacts include:

– erosion of soils and sedimentation of watercourses
– reduced water quality from elevated turbidity, increased nutrients and other contaminants
– smothering of aquatic organisms from increased sediments and low dissolved oxygen
– potential growth of weeds and algal blooms associated with reduced water quality
– accidental leaks or spills of chemicals and fuels
– introduction of gross pollutants (rubbish) into the watercourses.

Construction is not predicted to intercept groundwater from the fractured rock aquifer that is present in the study area. Therefore, the proposal is not predicted to impact on groundwater receptors, including groundwater dependent ecosystems and surrounding landholder bores. As the proposal would not intercept groundwater, the proposal would not impact groundwater quality. There is the potential that a shallow, perched aquifer may temporarily form following significant rainfall events. Although this perched aquifer could be intercepted by excavation during construction, it would be unlikely to result in sufficient volumes to require dewatering.

Operation

No impacts to soils or groundwater are expected during operation.

Operation of the proposal has the potential to impact surface water quality due to:

– erosion of newly stablised or planted areas during the establishment period, resulting in the sedimentation of watercourses
– increase in sediment and pollutant loads in stormwater due to the increase in road surface.

Conclusion

Picton Road does not currently include any water quality treatment or spill containment devices. The concept design includes the installation of water quality treatment devices in the form of stormwater basins at a number of locations to minimise impacts to water quality during operation. The potential effectiveness of these basins in reducing pollutant loads during operation was assessed using the eWater MUSICX water quality modelling software package. The assessment found that that the proposal is unlikely to result in any measurable changes in the quality of the downstream receiving environment and pollutant loads would be sufficiently reduced through the proposed water quality treatment devices. In addition, the proposed water quality treatment devices would cater for spill containment of a minimum volume of 30,000 litres. The water quality treatment devices may be refined as the design progresses to accommodate changes in drainage and other design aspects. However, it is not expected that these changes would impact the water quality outcomes of the proposal as they would be developed and assessed against the same performance targets outlined in this report.

Potential construction impacts would be minimised by implementing the measures provided in section 8 of this report, including a Construction Soil and Water Management Plan and Site-specific Erosion and Sediment Control Plan/s, which would outline procedures for the management of activities such as excavation, stockpiling, discharging from temporary sediment basins and emergency spill response.

It is considered that, with the implementation of the mitigation measures recommended in this report, and the installation of the proposed water quality treatment devices, potential impacts on soils, surface water and groundwater resulting from the construction and operation of the proposal would be minor and manageable.

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Appendices

1. Introduction

1.1 The proposal

Transport for NSW (Transport) proposes to upgrade Picton Road between the Nepean River and Almond Street in Wilton, NSW (the proposal). The proposal includes upgrading the section of Picton Road from about 1.3 kilometres east of the bridge over the Nepean River to about 200 metres east of Almond Street, including the M31 Hume Motorway interchange.

The proposal forms the western section of the broader Picton Road upgrade, which involves upgrading about 30 kilometres of Picton Road between the Nepean River and the M1 Princes Motorway.

The proposal is subject to assessment by a review of environmental factors (REF) under Division 5.1 of *Environmental Planning and Assessment Act 1979* (EP&A Act). For the purposes of these works, Transport is the proponent and the determining authority under Division 5.1 of the EP&A Act.

1.1.1 Proposal location

The proposal is located in Wilton, in the Wollondilly local government area (LGA). The proposal site, shown in Figure 1.1 and Figure 1.2, comprises the area that would be required to construct and operate the proposal, including ancillary facilities and operational infrastructure.

1.1.2 Key features of the proposal

Key features of the proposal include:

– widening and upgrading Picton Road for a distance of about five kilometres between the Nepean River and Almond Street to provide:
  - a minimum of two 3.5 metre-wide traffic lanes in each direction with a central median, increasing to three traffic lanes in each direction approximately between Wilton Park Road / Aerodrome Drive and Pembroke Parade / Greenway Parade
  - three-metre-wide shoulders on the left lane side in each direction
– upgrading the existing Picton Road and M31 Hume Motorway interchange into a diverging diamond layout, including:
  - removing the existing Picton Road bridge and constructing two new bridges over the M31 Hume Motorway
  - upgrading and realigning on and off ramp connections with the M31 Hume Motorway to suit the new interchange layout and to allow free flow of traffic between Picton Road and the M31 Hume Motorway
  - providing a new four-metre-wide shared user path along the southern bridge
  - removing the existing traffic signals on Picton Road and installing new traffic signals with more efficient phasing and more traffic capacity
– new and upgraded shared paths on Picton Road, including underpasses under the southbound on ramp connections to the M31 Hume Motorway and an overpass of the northbound off ramp connection from the M31 Hume Motorway, located:
  - adjacent to the westbound slow lane of the proposal from the western extent to around 420 metres west of Almond Street to connect with planned active transport infrastructure to be delivered as part of the South East Wilton development
  - adjacent to the eastbound slow lane between Aerodrome Drive and the western extent of the proposal and between Pembroke Parade / Greenway Parade and Almond Street

– reconfiguring the existing Picton Road intersections with Wilton Park Road, Aerodrome Drive, Janderra Lane and Almond Street into left in, left out only (the timing of delivery of the reconfigured Almond Street intersection is subject to confirmation of timeframes for delivery of other road works planned at the intersection as outlined in section 1.1.3 and chapter 3 of the REF)
– integration with new traffic signals and widening roadworks constructed in 2023 at the intersection of Picton Road and Pembroke Parade and Greenway Parade
– adjusting the posted speed from the western extent of the proposal, through the interchange and to the east of Pembroke Parade to 60 kilometres per hour (km/h).

Ancillary work and construction activities associated with the proposal would include:

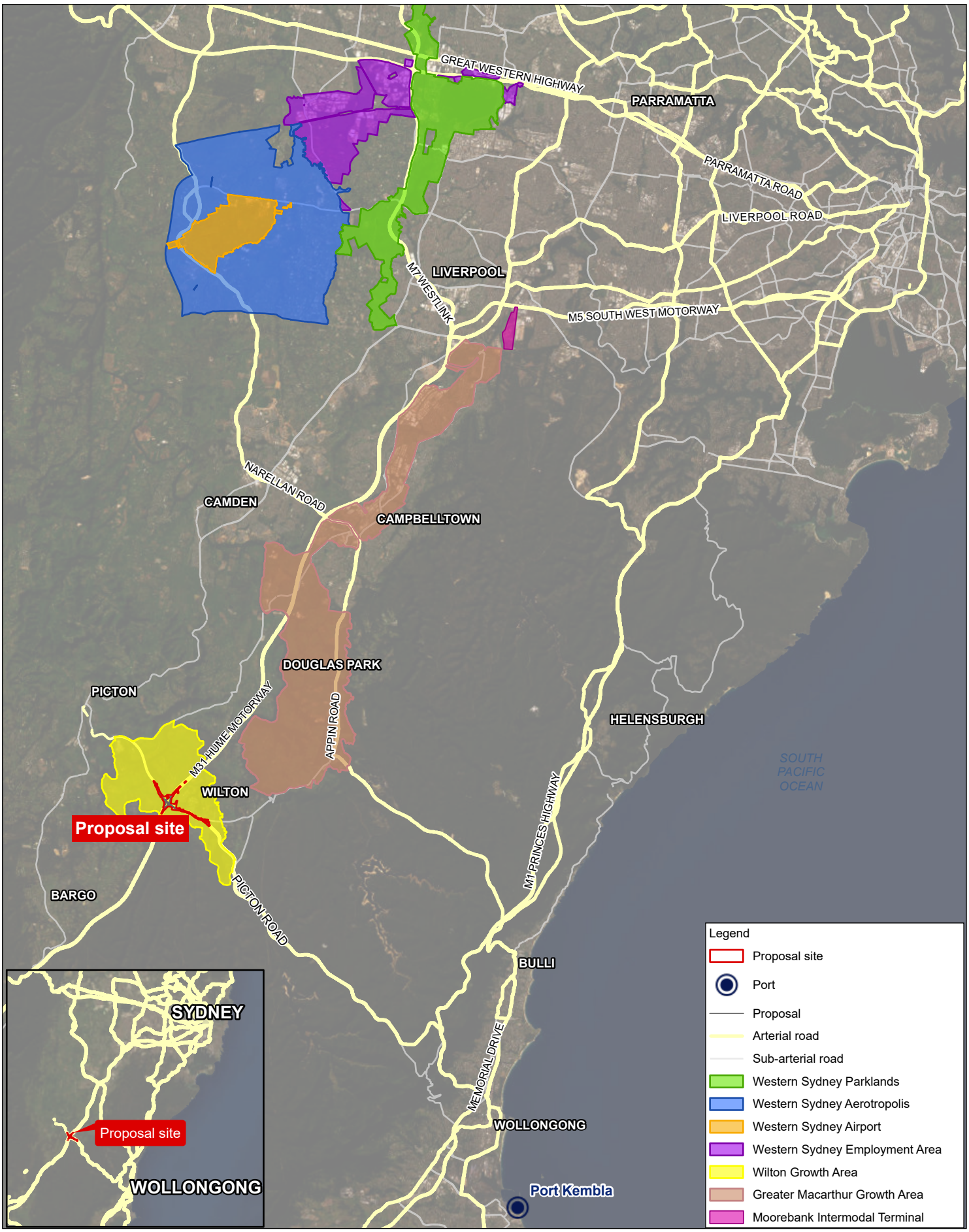
– property works including acquisition, adjustment to existing accesses and fencing, and at-property noise treatments
– civil earthworks and drainage works
– construction and adjustment of retaining walls, road pavement, and water quality devices
– tie-in work to adjoining sections of Picton Road, M31 Hume Motorway and other local roads
– installing and adjusting roadside furniture and delineation, such as safety barriers, kerb and gutter, fencing, lighting, signage, noise treatment and pavement markings
– installing new intelligent transport systems including, but not limited to, closed circuit television and variable message signs
– protecting, adjusting and relocating existing utilities and associated structures
– landscaping and rehabilitation of disturbed areas
– adjustment and provision of noise treatments, including at-property works as required
– establishment of temporary ancillary facilities to support construction including compound sites, site offices, stockpile, access tracks, turning bays and laydown areas
– site preparation works, including vegetation clearing and grubbing, site fencing, temporary drainage measures, traffic management and implementation of environmental management measures.

An overview of the proposal is provided in Figure 1.2. Further information is provided in chapter 3 of the REF.

1.2 Purpose of the report

This report has been prepared by GHD Pty Ltd (GHD) on behalf of Transport as part of the REF. The report has been prepared to assess the potential impacts of constructing and operating the proposal on soils, surface water and groundwater. The report:

– provides a summary of key legislation, policies and procedures relevant to soils and water quality
– describes the existing soils, surface water and groundwater environment
– assesses the potential impacts of construction and operation activities associated with the proposal on soils, surface water and groundwater and relevant environmental values
– recommends measures to avoid, minimise, mitigate and manage the impacts identified.



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Grid: GDA2020 MGA Zone 56

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GHD

Transport for NSW
Picton Road upgrade between Nepean River and Almond Street, Wilton – Soils, surface and groundwater assessment

Location of the proposal

Project No. **12560200**
Revision No. **0**
Date **24/10/2023**

FIGURE 1.1

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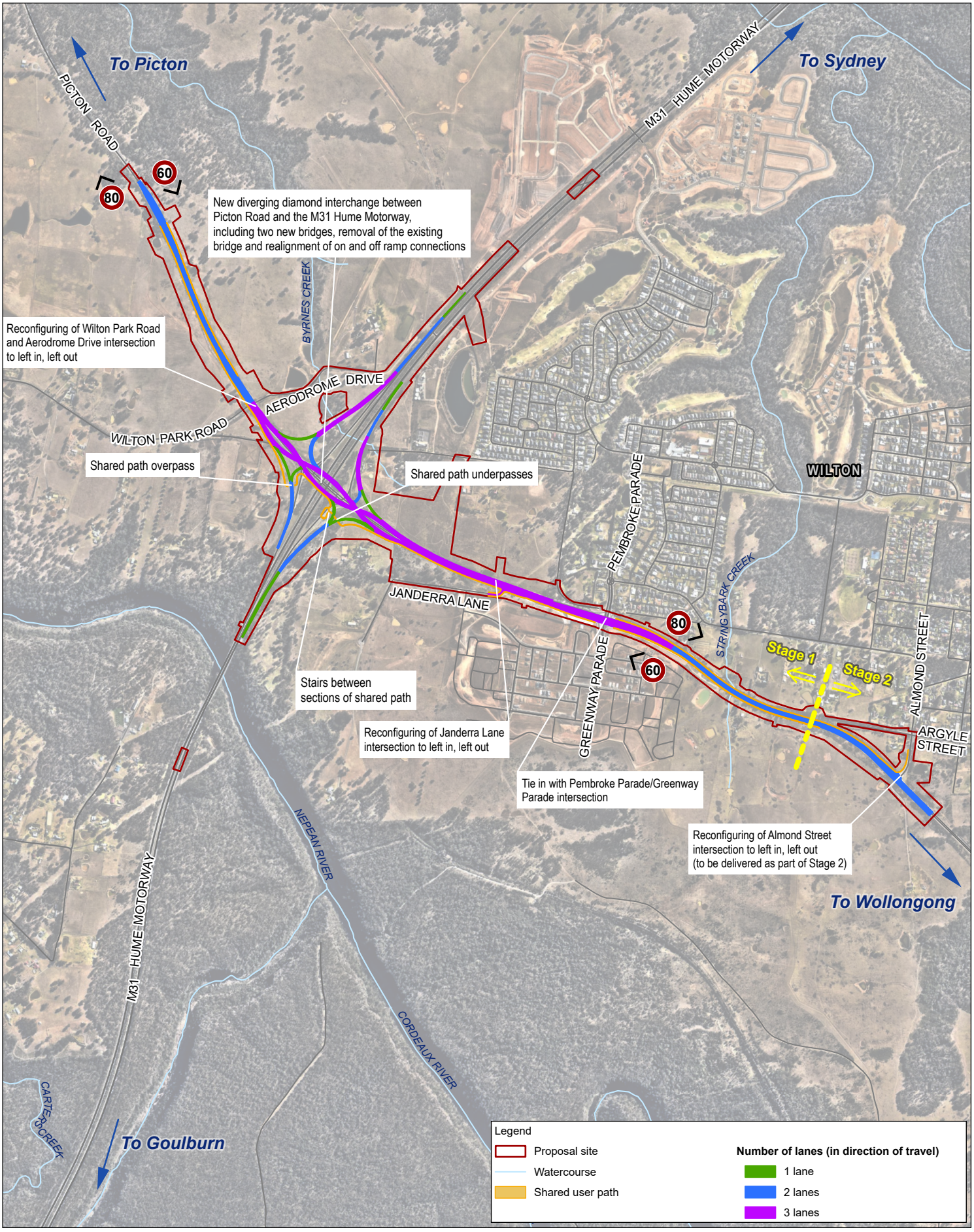
Created by:akildea



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Map Projection: Transverse Mercator
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Grid: GDA2020 MGA Zone 56

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Transport for NSW
Picton Road upgrade between Nepean River and Almond Street, Wilton – Soils, surface and groundwater assessment

The proposal

Project No. **12560200**
Revision No. **0**
Date **24/10/2023**

FIGURE 1.2

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Data source: NSW SS-SDS, Topographic base data, 2023; Transport network - TfNSW, 2023.
Created by:akildea

2. Legislative and policy framework

2.1 Relevant legislation and planning instruments

2.1.1 Water Act 1912, Water Management Act 2000 and Water Management (General) Regulation 2011

The *Water Act 1912* and the *Water Management Act 2000* (WM Act) are the two key pieces of legislation for the management of water in NSW and contain provisions for the licensing of water access and use. The *Water Act 1912* is being progressively phased out and replaced by the WM Act.

The aims of the WM Act are to provide for the sustainable and integrated management of the State's water sources for the benefit of both present and future generations. The WM Act implicitly recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing licence holders with more secure access to water and greater opportunities to trade water through the separation of water licences from land. The WM Act enables the State's water resources to be managed under water sharing plans, which establish the rules for the sharing of water in a particular water source between water users and the environment, and rules for the trading of water in a particular water source.

Under the WM Act the sharing of water must protect the water source and its dependent ecosystems and must protect basic landholder rights. Sharing or extracting water under any other right must not prejudice these rights. Therefore, water for licensed water users is effectively the next priority for water sharing. Water sharing plans provide a legal basis for sharing water between the environment and consumptive purposes.

The proposal is located within an area covered by the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011 for surface water. The proposal is also located within an area covered by the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011.

In addition to water sharing plans and associated water access licences and water use approvals, section 91 of the WM Act identifies approval provisions relating to ‘controlled activities’ which includes (among other definitions) the carrying out of any activity on waterfront land. Of relevance to the proposal, waterfront land is defined as the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river. A river is defined as any watercourse, including any tributary, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved.

As described in section 4.1 of this report, the proposal site is traversed by a number of named and unnamed tributaries; therefore, there would be works undertaken on waterfront land (within 40 metres of a waterway). As such construction of the proposal would usually constitute a ‘controlled activity on waterfront land’ and would require an ‘activity’ approval. However, in accordance with Section 41 and Schedule 4 (Part 1(2)) of the Water Management (General Regulation) 2018, Transport, as a public authority, is exempt from Section 91 of the WM Act in relation to controlled activities specified in Part 2 of Schedule 4 that are carried out in, on or under waterfront land.

Generally, under the WM Act, taking water from a water source requires a water access licence and a works approval. There are existing exemptions in place for the taking of groundwater during construction of road and rail projects. Of relevance, under Section 21, 34 and Schedule 4 of the Water Management Regulation 2018, road authorities are exempt from the need for a water access licence in relation to water required for road construction and road maintenance. However, those exemptions under the WM Act do not include ongoing operational groundwater removal (take) whether passive or intentional. As noted in Scheduled 4 a water access licence is required where the ongoing operation groundwater take exceeds three mega litres per year. The need for a water access licence, particularly where cuttings are proposed, would need to be confirmed during detailed design. However, at this stage it is considered unlikely that groundwater interception during operation would trigger the need for a water access licence.

2.1.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) aims to protect, restore and enhance the quality of the environment. It prescribes offences mainly regarding pollution of the environment and establishes a regime for the licensing of certain scheduled activities.

Section 120 prohibits the pollution of waters. Potential water quality impacts are discussed in section 5.1 and section 6.2. The construction contractor and Transport are obliged to notify the EPA if a pollution incident occurs that causes or threatens material harm to the environment.

Under Part 3.2 of the POEO Act an environment protection licence (EPL) is required for scheduled activities or scheduled development work. Activities requiring licences are defined in Part 3.2 and Schedule 1 of the Act.

In accordance with Schedule 1, clause 35, road construction is listed as an activity that may require licensing. Under the POEO Act, road construction includes road widening work and related earthworks and cuttings. Clause 35(3)(a) provides that a licence is required if road construction involves extraction or processing of more than 50,000 tonnes of material in the regulated area (which includes the Greater Sydney Region) or (3)(b)(ii) involves a main road of four or more traffic lanes for three or more kilometres in length.

Based on the concept design and construction methodologies proposed, an EPL would be required as the proposal would involve:

– extraction of more than 50,000 tonnes of material within the regulated area
– widening about five kilometres of a main road from a two lane road to up to six lanes.

EPL requirements would be confirmed during detailed design. If required, the EPL would be held by the construction contractor.

2.1.3 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) provides for the protection of threatened fish and marine vegetation. The FM Act aims to conserve, develop and share fishery resources and conserve marine species, habitats and diversity. One of the objectives of the FM act is to ‘conserve key fish habitats’.

Watercourses within the study area have been categorised with regard to NSW Fisheries key fish habitat mapping (DPI, 2007) and the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013). While the Nepean River, Byrnes Creek, Allens Creek and Stringybark Creek are all mapped as key fish habitat (see 4.1.2), there are no tributaries that cross the proposal site mapped as key fish habitat as watercourses present are highly degraded first and second order streams.

Part 2 and Part 7 of the FM Act describe the requirements for permits for dredging and/or reclamation works, to obstruct fish passage, and to harm marine vegetation. The tributaries that cross the proposal site are highly degraded, ephemeral streams with no marine vegetation; therefore, the requirements of Part 2 and Part 7 of the FM Act do not apply.

2.1.4 State Environmental Planning Policy (Biodiversity and Conservation) 2021

Chapter 6 (Water catchments) of State Environmental Planning Policy (Biodiversity and Conservation) 2021 (SEPP (Biodiversity and Conservation)) sets out the planning controls that relate to Sydney’s Drinking Water Catchment (as defined by Section 6.60 of SEPP (Biodiversity and Conservation)).

Section 171A(3) of the Environmental Planning and Assessment Regulation 2021 (EP&A Regulation) defines the considerations a determining authority must take into account when considering the likely impact of an activity proposed to be carried out in the Sydney Drinking Water Catchment, including whether the activity will have a neutral or beneficial effect on water quality, and whether it is consistent with the Neutral or Beneficial Effect (NorBE) Guideline within the meaning of Part 6.5 of SEPP (Biodiversity and Conservation) 2021.

The proposal site drains to the Nepean River approximately two kilometres downstream of the Sydney Drinking Water Catchment. Although the proposal site is not located within the Sydney Drinking Water Catchment, and therefore the requirements of Section 171A(3) of the EP&A Regulation do not apply, a qualitative NorBE water quality assessment has been carried out as described in section 6.2.3 and Appendix D. Section 2.2.5 provides further information regarding the NorBE assessment guidelines.

2.2 Guidelines and policies

2.2.1 NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* (DPI, 2012) (the Aquifer Interference Policy) was finalised in September 2012 and clarifies the water licensing 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.

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 proposal are less than the minimal impact considerations, then the potential groundwater impacts of the proposal are acceptable.

The 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. Potential impacts of the proposal on groundwater are considered acceptable if they are less than the minimal impact considerations.

The proposal has been assessed against the requirements of the *NSW Aquifer Interference Policy* in section 5.1.3.

2.2.2 NSW Groundwater Strategy

The objective of the *NSW Groundwater Strategy* (Department of Planning and Environment (DPE), 2022) is to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW. The N*SW Groundwater Strategy* has three strategic priorities:

– protect groundwater resources and the ecosystems that depend on them
– build community and industry resilience through sustainable groundwater use
– improve groundwater information and knowledge.

The groundwater impact assessment described in section 3.2.3 has had regard to the *NSW Groundwater Strategy*.

2.2.3 Managing Urban Stormwater – Soils and Construction

The principles for the management of stormwater during construction are documented in *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom 2004) and *Volume 2D – Main road construction* (DECC 2008). These guidelines are 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. Implementation of management measures listed in the Blue Book would be defined by the Construction Soil and Water Management Plan (CSWMP) developed as part of the Construction Environmental Management Plan (CEMP) for the proposal (see section 8).

2.2.4 Water Sensitive Urban Design Guidelines

The *Water Sensitive Urban Design Guidelines* (Wollondilly Shire Council, 2020) seek to minimise the influence of impervious surfaces on watercourses, reuse water on site, incorporate retention basins to reduce peak flows, and incorporate treatment systems to remove pollutants from impacting on watercourses in accordance with Wollondilly Shire Council's Integrated Water Management Policy and Strategy.

Although, as a proposal subject to Division 5.1 of the EP&A Act, approval from Wollondilly Shire Council is not required for the proposal, an assessment has been completed against Council's targets to determine the performance of the proposal's water quality treatment devices for comparison purposes (see Appendix C).

2.2.5 Neutral or Beneficial Effect on Water Quality Assessment Guideline

The *Neutral or Beneficial Effect on Water Quality Assessment Guideline* (WaterNSW, 2022) (the NorBE Guideline) was developed by WaterNSW in response to SEPP (Biodiversity and Conservation), to be used as a framework to consider development proposals under Part 5 of the EP&A Act. The NorBE Guideline outlines the meaning of a NorBE on water quality, how to achieve it, and the process of assessment against the NorBE water quality test using the 'Neutral or Beneficial Effect on Water Quality Assessment Tools' (the NorBE tool).

The proposal is located downstream and not within the Metropolitan Special Area in the Greater Sydney Drinking Water Catchment, and a NorBE assessment is not required under section 171A(3) of the EP&A Regulation. However, as described in section 6.2.3, a qualitative NorBe assessment has been completed using the NorBE tool for comparison purposes. The assessment is provided in Appendix D.

2.2.6 National Water Quality Management Strategy

The National Water Quality Management Strategy (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 contains guidelines for setting water quality objectives to sustain current or likely future environmental values for water resources. The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments (ANZG), 2018) (the ANZG Water Quality Guidelines) are part of the NWQMS and are relevant to the proposal as discussed in section 2.2.7.

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

The Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) published Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) to provide benchmarks against which to assess the existing water quality of watercourses. The guidelines were updated in 2018 to incorporate new science and knowledge developed over the past 20 years (ANZG, 2018).

The ANZG Water Quality Guidelines have been applied to understand the current health of the watercourses in the study area and the ability to support nominated water quality objectives, particularly the protection of aquatic ecosystems. The ANZG Water Quality Guidelines provide default guideline values which have been considered when describing the existing water quality and key indicators of concern. However, many of the guideline values are still in a draft form. Currently, physical and chemical stressors for aquatic ecosystems for the Southeast Coast (the geographic region relevant to this proposal) have not yet been completely updated.

The ANZG Water Quality Guidelines are not intended to directly apply to contaminant concentrations in industrial discharges or stormwater quality (unless stormwater systems are regarded as having relevant community value). They have been derived to apply to the ambient waters that receive effluent or stormwater discharges and protect the water quality objectives they support.

2.2.8 NSW Water Quality and River Flow Objectives

The NSW Water Quality and River Flow Objectives (DECCW, 2006) (NSW Water Quality Objectives) are the agreed environmental values and long-term goals for NSW's surface waters. They set out the community's values and uses for our rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water).

The water quality objectives identify environmental values for NSW waters and the ANZG Water Quality Guidelines provide the technical guidance to assess the water quality needed to protect these values.

At the time the water quality objectives were approved by the NSW Government (1999) for catchments across NSW the Hawkesbury-Nepean catchment was subject to an independent inquiry by the Healthy Rivers Commission (HRC). Thus, water quality objectives for the Hawkesbury-Nepean system were developed by the HRC and agreed to by the NSW Government in 2001 and environmental values outlined in the HRC Inquiry align with environmental values set out by the DECCW Water Quality Objectives (DECCW, 2006).

The ANZG Water Quality Guidelines default trigger values for water quality take precedence for assessment of the existing water quality of the receiving environments as they supersede the values recommended in the HRC Inquiry (HRC, 1998). Environmental values and related numerical criteria which have been nominated for each environmental value using the ANZG Water Quality Guidelines are provided in section 3.2.2.

2.2.9 Other guidelines

Other guidelines used by Transport, and/or applicable to the management of soils and water, include:

– Groundwater assessment guideline, EMF-WA-GD-0017 (Transport for NSW, 2022)
– Procedure for selecting treatment strategies to control road runoff, Version 1.1 (Road and Traffic Authority NSW (RTA), 2003)
– Water sensitive urban design guideline: Applying water sensitive urban design principles to NSW Transport projects (Transport for NSW, 2023)
– Beyond the Pavement 2020 (Centre for Urban Design and Transport for NSW, 2020)
– Technical Guideline: Temporary stormwater drainage for road construction (Road and Maritime Services, 2011)
– Draft Erosion and sedimentation management procedure, EMF-WA-PR-0100 (Transport for NSW, 2022)
– Draft Construction water reuse and disposal procedure, EMF-WA-PR-0101 (Transport for NSW, 2022)
– Draft Guideline for assessing the impacts of treated water discharge from licenced construction sites, EMF-WA-GD-0021 (Transport, 2022)
– Stockpile Site Management Guideline, EMS-TG-10 (Road and Maritime Services, 2015)
– Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (Roads and Traffic Authority, 2005)
– Acid Sulfate Soils Assessment Guidelines (Ahern et al.,1998).

These guidelines have been considered as relevant in the impact assessment and the development of appropriate mitigation measures.

3. Methodology

3.1 Study area

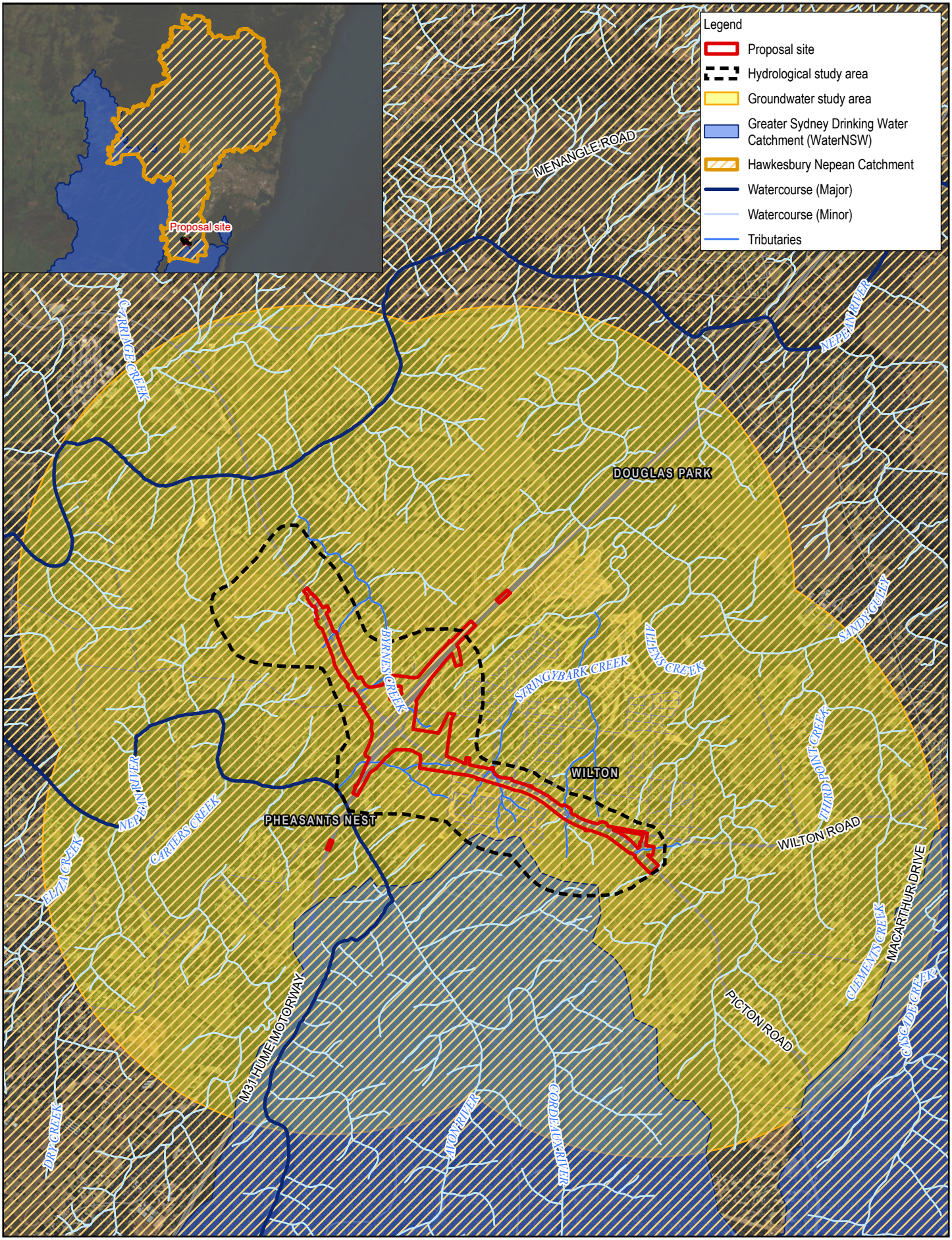
For the purposes of this assessment, the groundwater study area comprises the proposal site and a buffer of about three kilometres around the proposal site to incorporate groundwater receptors with the potential to be directly or indirectly impacted. The hydrological study area comprises the surface water catchments of the proposal. The groundwater study area and hydrological study area are shown on Figure 3.1.

3.2 Assessment methodology

3.2.1 Soils

The soils assessment involved:

– reviewing the outcomes of the contamination preliminary site investigation and geotechnical investigations carried out for the proposal
– reviewing publicly-available data and web-based information searches, background information relevant to the study area, survey data, and topography including:
  - historical aerial photographs from the NSW Government Land and Property Information website
  - Australian Soil Resource Information System (maintained by the Commonwealth Scientific and Industrial Research Organisation (CSIRO))
  - geology of the Wollongong-Port Hacking 1:100,000 (Sheet 9029 to 9129) (Stroud et al, 1985)
  - soil landscape maps of Wollongong-Port Hacking 1:100,000 (Sheet 9029 to 9129) (Hazelton et al, 1990)
  - maps published by the Geological Survey of NSW, former Department of Conservation and Land Management, and Australian Soils Resource Information System
– identifying the potential to disturb acid sulfate soils and areas of salinity
– identifying safeguards and management measures.



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Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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Transport for NSW
Picton Road upgrade between Nepean River and Almond Street, Wilton – Soils, surface and groundwater assessment

Study area

Project No. **12560200**
Revision No. **0**
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FIGURE 3.1

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Print date: 24 Oct 2023 - 13:54

Data source: Vegetation Zones - Biosis 2023, World Imagery: Earthstar Geographics
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3.2.2 Surface water

The surface water assessment involved:

- reviewing existing environmental conditions and water quality data in the study area including (but not limited to):
  - information from the WaterNSW Annual Water Quality Monitoring reports for the period from 2017 to 2023 2017-2018: Sydney Catchment Area. WaterNSW Paramatta
  - baseline water quality sampling data collected at 10 locations across the study area during March 2023 (see section 3.2.2.1)
- identifying assessment criteria for the proposal based on:
  - *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC/ARMCANZ, 2000) (the ANZECC guidelines) which are the same as those adopted by the ANZG Water Quality Guidelines
  - NSW Water Quality Objectives for catchments affected by the proposal
- identifying activities that could affect surface water hydrology and quality during construction and operation
- assessing potential impacts during construction based on a qualitative desktop assessment
- assessing potential impacts on hydrology and water quality during operation, including:
  - identifying existing and future predicted pollutant loads using the eWater Model for Urban Stormwater Improvement Conceptualisation (MUSICX) modelling software (see section 3.2.2.2)
  - assessing future predicted pollutant loads against pollutant load reduction targets in the *Water Sensitive Urban Design Guideline* (Roads and Maritime Services, 2017), *Water Sensitive Urban Design Guidelines* (Wollondilly Shire Council, 2020) and the *Wilton Growth Area Development Control Plan 2021* (Department of Planning, Industry and Environment (DPIE), 2021) (the Wilton Growth Area DCP)
  - assessing potential changes to surface water flow by calculating the runoff for the existing and proposal scenarios using the MUSICX modelling software
- recommending safeguards and management measures, including proposed treatment measures and water quality monitoring for identified impacts.

3.2.2.1 Surface water quality monitoring data

In March 2023 surface water sampling was undertaken at 10 locations across the study area, as listed in Table 3.1 and shown on Figure 3.2.

Surface water samples were collected and submitted to a NATA accredited laboratory for analysis of the following:

- total recoverable hydrocarbons (TRH)
- benzene, toluene, ethylbenzene, xylenes, naphthalene (BTEXN)
- organochlorine pesticides (OCPs)
- polynuclear aromatic hydrocarbons (PAHs)
- organophosphate pesticides (OPPs)
- heavy metals (aluminium, arsenic, cadmium, chromium, copper, nickel, lead, zinc, manganese, selenium, boron)
- alkalinity, chloride, anions/cations, total hardness, ammonia, silver, mercury
- oil and grease.

Further information regarding the sampling locations is provided in Table 3.1 and Figure 3.2.

Table 3.1 Summary of surface water sampling locations

Location ID	Coordinates	Approximate distance from proposal site (m)	Location description
SW01	286279 m E 6209283 m S	Within	Unnamed tributary to Stringybark Creek; location recently modified with a sediment basin.
SW02	286232 m E 6209483 m S	Within	Drainage line below Picton Road. Flow is low to still. Received water from road and adjoining paddock. Upstream of Condell Park Road. Unnamed tributary to Stringybark Creek.
SW03	284240 m E 6211351 m S	130 m upstream to south-west	Unnamed tributary to Byrnes Creek. Discontinuous sections of pooled water. Slightly cloudy. Cattle have access to creek.
SW04	284296 m E 6211434 m S	90 m to north	Unnamed tributary to Byrnes Creek adjacent to culvert below Picton Road. Water dark brown to black. Some aquatic plants.
SW05	284572 m E 6210913 m S	Within	Farm dam. Water levels low. Surrounding paddock for grazing cattle. Cattle near dam.
SW06	284180 m E 6211649 m S	300 m to north	Ponded water. Discharge point dry. Between pond and Picton Road. Rock outcrops in areas surrounding pond. Grass and shrubs.
SW07	284007 m E 6211787 m S	500 m to north north-west	Farm dam. Rock (sandstone) and sediment banks. Sandy clay/clayey sand shore area, some cobbles and boulders.
SW08	281652 m E 6212713 m S	1300 m to north north-west	Nepean River at weir upstream of Maldon Bridge.
SW09	284783 m E 6213092 m S	1700 m to north north-east	Nepean River, rocky banks, vegetation on mid-upper banks.
SW10	284742 m E 6209429 m S	350 m to south-west	Unnamed tributary to the Nepean River. Rocky creek bed. Colluvial banks. Water cloudy, pooled in small rock ponds. Slight trickle between pools.

3.2.2.2 MUSIC Modelling

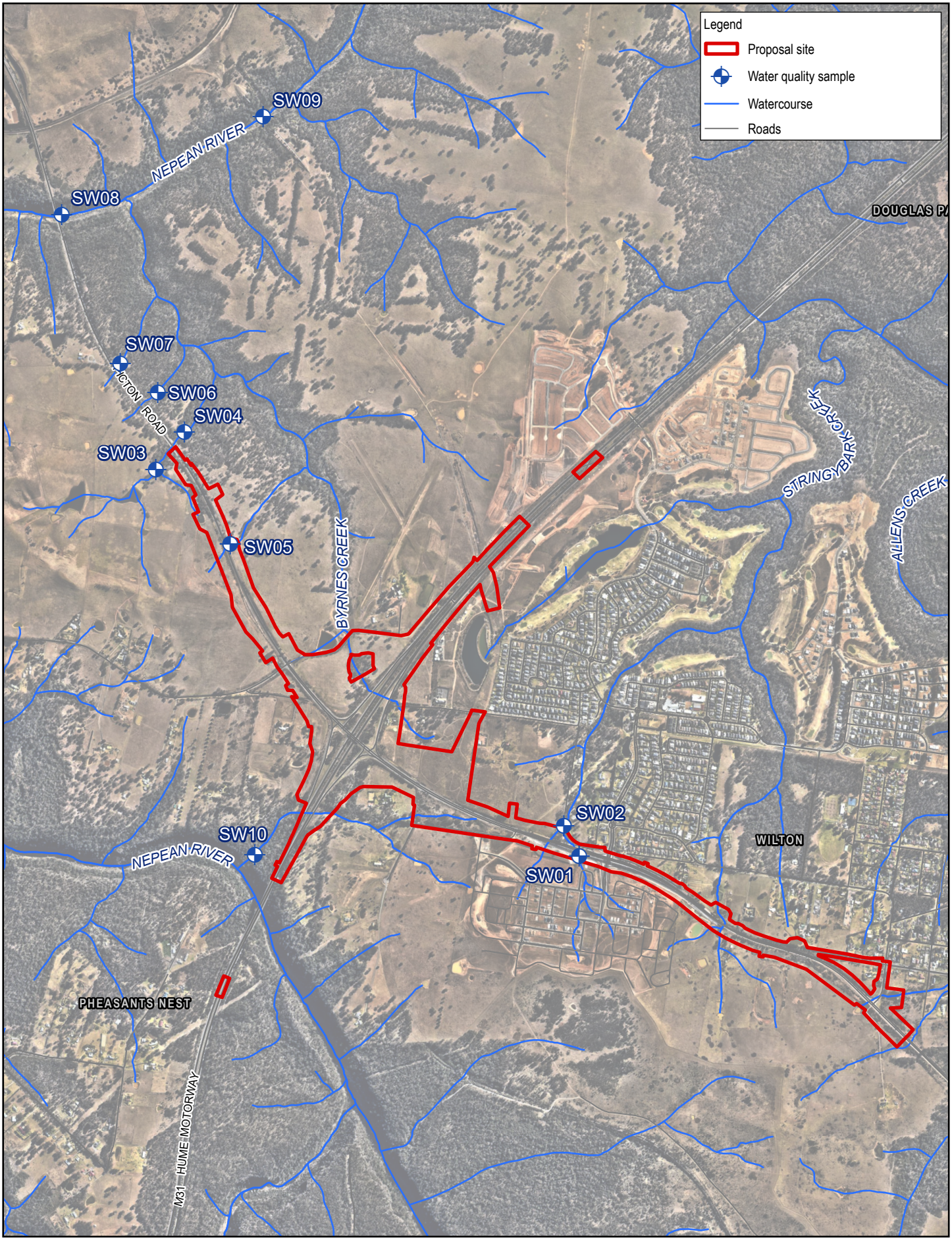
The performance of the proposed water quality treatment devices(which form part of the concept design for the proposal as described in section 3.2.3 of the REF) has been assessed by modelling using the Model for Urban Stormwater Improvement Conceptualisation (MUSICX, Version 1.10.0.12491). The model is used to:

– identify existing pollutants and those that could be generated by the proposal
– assess the performance of potential water quality treatment devices against pollutant removal targets.

The modelling of design catchment conditions within the proposal site has been developed based on proposed land type and area. Modelling uses pollutant generation relationships within MUSICX and has not been calibrated to the catchment. The results of the modelling are used to estimate pollutant export loading for the modelled catchment in the proposal scenario, allowing an assessment of the effectiveness of the proposed treatment measures.

Preliminary modelling was completed using simple catchment nodes based on the concept design. This modelling will be updated during detailed design (as required) if modifications, alterations and relocations of treatment measures occur. The modelling carried out for this investigation provides an indication of the relative effectiveness of the proposed treatment measures in reducing the weight and concentrations of pollutants entering the receiving drainage lines based on the concept design.

The modelling investigated the effect of water quality treatment devices to identify potential reductions that could be achieved for key pollutants (gross pollutants, total suspended solids, total phosphorous and total nitrogen) against existing conditions.



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Grid: GDA2020 MGA Zone 56

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Water quality sampling locations

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FIGURE 3.2

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Data source: Vegetation Zones - Biosis 2023, Nearmap WMS Server: . Created by: akildea

3.2.2.3 Assessment criteria

Construction water quality

Environmental values associated with water quality

As described in section 2.2.8 the NSW Water Quality Objectives provide the agreed environmental values and long-term goals for NSW's surface waters. The objectives are consistent with the national framework for assessing water quality set out in the ANZG Water Quality Guidelines. The water quality objectives provide environmental values for NSW waters and the Water Quality Guidelines provide the technical guidance to assess the water quality needed to protect those values.

Establishing ambient water quality in receiving waters

The Water Quality Guidelines recommend default trigger values associated with the identified environmental values for various physical, biological and chemical pollutants that could be present in water. Trigger values are the criteria used for concentrations that, if exceeded, would indicate a potential environmental problem, and so 'trigger' the need for a management response.

Water quality data for the receiving waters in the study area indicate that the values for many toxicants regularly exceed the default trigger values specified in the Water Quality Guidelines.

Defining ambient water quality for the proposal generally involved:

– identifying trigger values (as per the Water Quality Guidelines) for long-term goals based on relevant environmental values – known as long-term (or default) trigger values
– comparing the results of baseline monitoring of existing water quality against the default trigger values (see section 4.2 for a description of existing water quality for watercourses in the study area)
– identifying ambient water quality values based on baseline water quality monitoring data – while these values are different to the long-term (default) trigger values, they can indicate whether existing water quality would be affected during, and shortly after, construction, particularly where water quality monitoring results indicate that contaminants currently exceed the default trigger values.

Relevant environmental values

The proposal is located within the Hawkesbury-Nepean catchment which has been categorised as 'Mixed Use Rural'. As such, the watercourses within the study area have been nominated for protection of the following values, outlined in the NSW Water Quality Objectives::

– aquatic ecosystems
– visual amenity
– primary and secondary contact recreation
– livestock water supply
– irrigation water supply
– aquatic foods (cooked).

The long-term goal of the NSW Water Quality Objectives is to return the sub-catchments to a condition where the watercourses are suitable for primary contact activities and aquatic food. However, the watercourses are highly degraded, and primary contact activities and aquatic food are either not recommended or prohibited. While all of the above values apply, the majority of them have less relevance given the characteristics of the watercourses that drain to the proposal site (ephemeral).

For the purposes of managing the potential short-term impacts of the proposal, the primary environmental value is considered to be 'aquatic ecosystems' and the water quality objective for aquatic ecosystems is to 'maintain or improve the ecological condition of waterbodies and their riparian zones over the long term', which is relevant in all watercourses.

The indicators and criteria (trigger values) for this objective are listed below for lowland rivers draining to the coast, as drawn from the ANZG Water Quality Guidelines:

– Total phosphorus – 25 µg/L
– Total nitrogen – 350 µg/L
– Chlorophyll-a – 5 µg/L
– Turbidity – 6–50 Nephelometric Turbidity Unit (NTU)
– Salinity (electrical conductivity) – 125–2200 µS/cm
– Dissolved oxygen – 85–110%
– pH – 6.5–8.5.

As noted above, trigger values are the numeric criteria that if exceeded indicate potential for harmful environmental effects to occur. If they are not exceeded, a very low risk of environmental damage can be assumed. If they are exceeded, further investigation is 'triggered' for the pollutant concerned.

Establishing appropriate discharge criteria

Some water may need to be discharged during construction, such as from sediment basins from runoff during construction. The quality of the water discharged would influence whether there are any impacts on water quality and aquatic ecosystems in the receiving waters.

ANZG promotes the use of local (site specific) data to determine baseline conditions, which is the preferred approach. However, as described in section 4.2, the available water quality data is not sufficient to establish baseline conditions. As such the default trigger values noted above would be used as discharge criteria during construction.

Operation water quality (pollutant reduction targets)

In the absence of water quality criteria specific to the operation of a roadway, the water quality targets from Appendix B: Setting water quality objectives of the *Water Sensitive Urban Design Guideline* (Roads and Maritime Services, 2017) were adopted for the operational impact assessment (see Table 3.2). These water quality objectives were used as pollutant reduction targets to compare with the future predicted pollutant loads generated as part of the MUSIC modelling (see section 3.2.2.2). .

Table 3.2 Pollutant reduction targets

Stormwater pollutant	Pollutant reduction target (%)
Gross pollutants (> 5 mm)	90
Total suspended solids	85
Total phosphorus	65
Total nitrogen	45

These targets are consistent with other documentation, including the requirements of the *Sydney Metropolitan Catchment Management Authority, Draft NSW MUSIC Modelling Guidelines,* and have been used to assess the potential impacts during operation on the overall receiving environment.

In addition, although not directly relevant to the proposal as an activity subject to Division 5.1 of the EP&A Act, the Wilton Growth Area DCP provides objectives and controls that development needs to satisfy in relation to water cycle management (including water quality). These controls include water quality targets for total suspended solids, total nitrogen and total phosphorous to achieve a '*Neutral or Beneficial Effect on Water Quality – meaning loads of pollutants from future development must be equivalent to or less than that from the existing rural land use prior to development'*.

3.2.3 Groundwater

The groundwater assessment was a qualitative assessment undertaken in accordance with Transport's Draft Groundwater Assessment Guideline (2022). The assessment involved:

- reviewing publicly available information, including geological maps, groundwater monitoring data, groundwater allocations, registered groundwater monitoring bores, climate data and any groundwater dependent ecosystems to characterise the existing environment and identify potential groundwater risks
- reviewing groundwater monitoring data collected between November 2022 and April 2023 from 10 groundwater monitoring bores installed across the proposal site as part of the geotechnical and contamination investigations (see section 3.2.3.1)
- reviewing groundwater level observations recorded during pavement coring, which was undertaken to a depth of 1.5 metres as part of the geotechnical investigations (see section 4.4.3.1)
- assessing the potential impacts due to construction and operation of the proposal on groundwater levels and quality including:
  - qualitative assessment of the potential for groundwater in-flow to proposed cuttings
  - assessment of potential changes to groundwater levels against the Aquifer Interference Policy's Level 1 minimal impact considerations
  - assessment of groundwater quality with reference to the ANZG Water Quality Guidelines, the CEPA (2019) Environmental Screening Levels (ESL) for Groundwater, Aquatic Habitat Goals - Freshwater Ecotoxicity (for petroleum hydrocarbons), and the HEPA (2020) PFAS National Environmental Management Plan (NEMP) (for per- and poly-fluoroalkyl substances (PFAS))
- recommending safeguards and management measures for identified impacts.

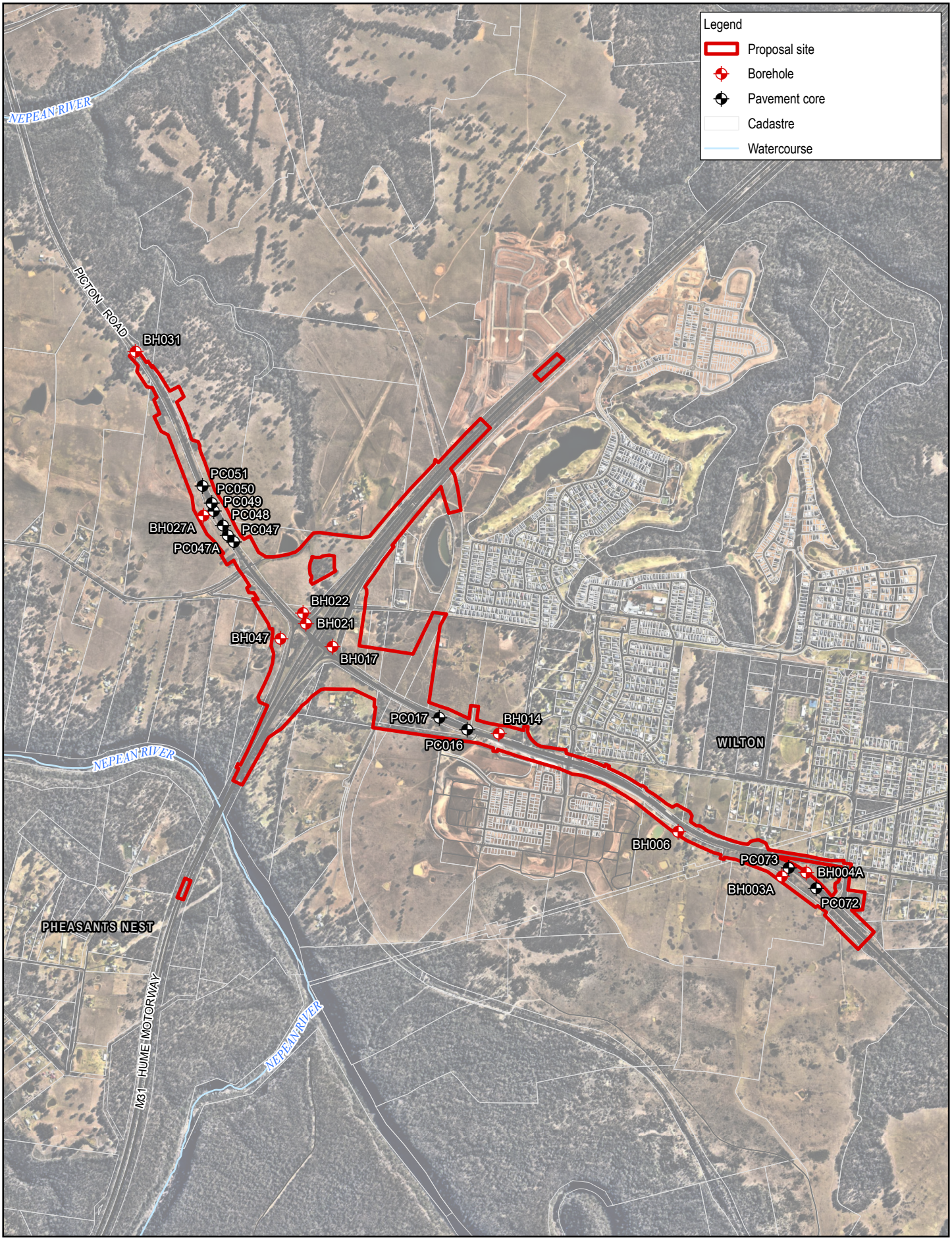
3.2.3.1 Groundwater monitoring data

In November to December 2022 eight groundwater monitoring bores were installed as part of the geotechnical investigation to inform the proposal design. An additional two bores were installed in January to March 2023. The details of these bores are outlined in Table 3.3 and locations are shown on Figure 3.3 while Figure 3.4 shows the location of the bores relative to cut and fill sections of the proposal site.

Groundwater levels were monitored from between November 2022 to April 2023 and groundwater sampling was undertaken in February 2023. Groundwater samples were collected and submitted to a NATA accredited laboratory for analysis of a broad suite of potential contaminants of concern (COPC) as shown in Table 3.3. Groundwater samples were not collected at the bores installed in January to March 2023.

Table 3.3 Summary of groundwater sampling

Site section	Chainage (main alignment)		Location ID	Installation date	Bore depth (mbgl)	Screen interval (mbgl)	Lithology	COPC
	From	To						
Cut 10	12,447	12,800	BH003A	18/11/2022	14.00	8.00 to 14.00	Siltstone / Sandstone from 2.83 m	Heavy metals, OCP, OPP, TRH, BTEX, PAH, pesticides
			BH004A	17/11/2022	11.12	5.00 to 11.12	Siltstone from 1.75 m Siltstone / Sandstone from 10.32 m	Heavy metals, OCP, OPP, TRH, BTEX, PAH, pesticides
N/A – outside the extent of cut or fill at western end of proposal site	7,890	8,000	BH031	29/11/2022	19.98	10.00 to 19.98	Sandy clay and clay Sandstone from 11.9 m	Heavy metals, OCP, OPP, TRH, BTEX, PAH, pesticides
Cut 5	8,890	9,235	BH027A	1/11/2022	21.10	12.00 to 21.10	Siltstone from 1 m	Heavy metals, OCP, OPP, TRH, BTEX, PAH, pesticides
Fill 5	9235	9,593	BH017	15/11/2022	12.00	6.00 to 12.00	Siltstone from 2.9 m	Heavy metals, OCP, OPP, TRH, BTEX, PAH, pesticides
			BH021	9/11/2022	12.00	6.00 to 12.00	Sandstone from 2.74 m Siltstone from 7.23 m Sandstone from 9.69 m	Heavy metals, OCP, OPP, TRH, BTEX, PAH, pesticides, PFAS
Fill 7	10,798	11,148	BH014	8/12/2022	6.25	3.25 to 6.25	Sandstone from 2.65 m	Heavy metals, OCP, OPP, TRH, BTEX, PAH, pesticides
Fill 9	11,757	12,030	BH006	30/01/2023	8.09	5 to 8.09	Siltstone / Sandstone from 2.63 m	Nil – groundwater levels only
Fill 5	North-bound on ramp		BH022	7/12/2022	8.41	5.41 to 8.41	Siltstone / Sandstone from 2.83 m	Heavy metals, OCP, OPP, TRH, BTEX, PAH, pesticides
Cut 12	North-bound off ramp Pedestrian bridge		BH047	24/03/2023	9.88	4.00 to 9.88	Siltstone / Sandstone from 3.2 m	Nil – groundwater levels only



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Groundwater monitoring locations

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FIGURE 3.3

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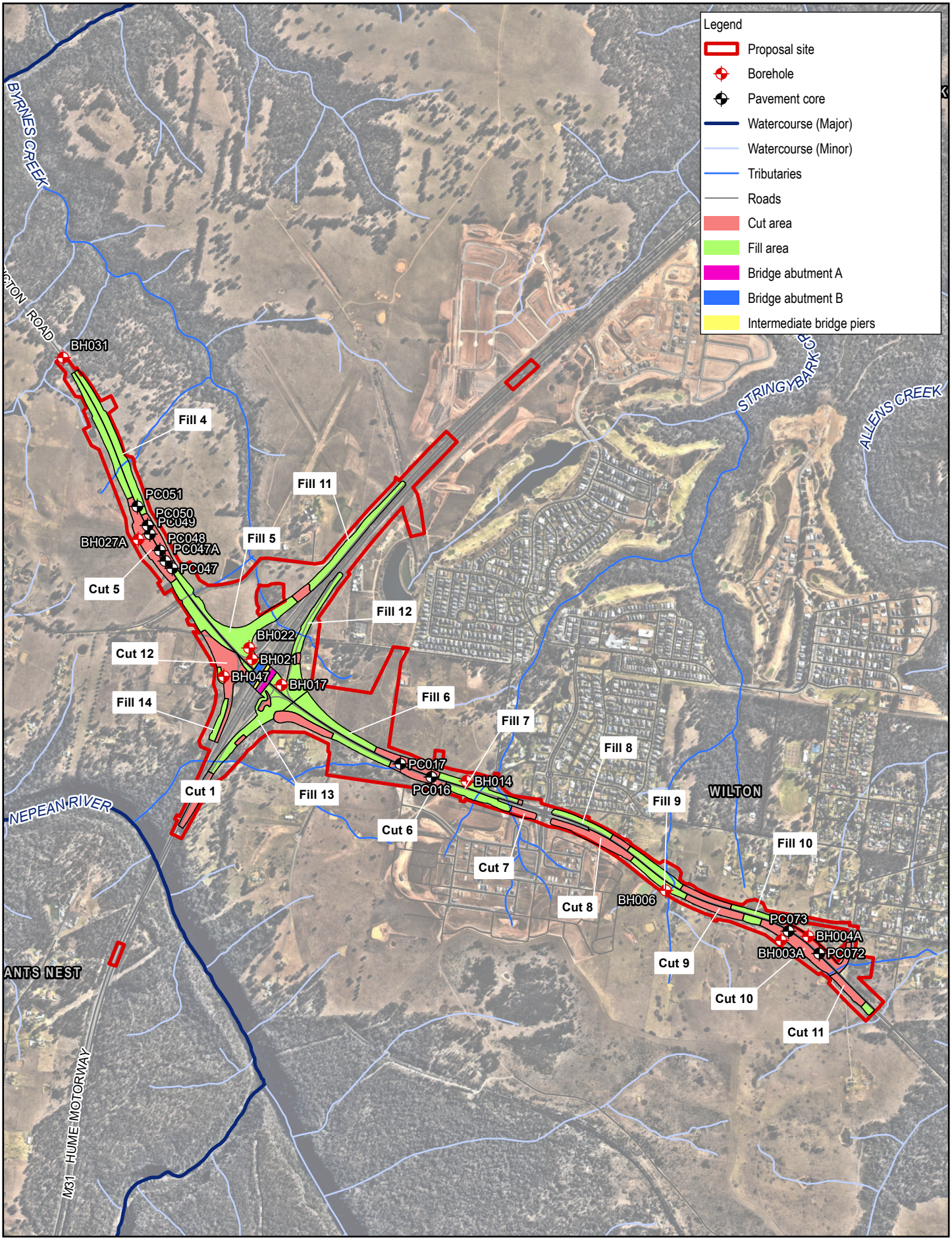

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Overview of cut and fill locations along the proposal site

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FIGURE 3.4

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Print date: 24 Oct 2023 - 14:09

Data source: Vegetation Zones - Biosis 2023, Nearmap WMS Server: . Created by: akildea

3.2.4 Data sources

Data sources used for the assessment are listed in Table 3.4.

Table 3.4 Existing environment data sources

Name	Related information	Access date	Published		Link
			Organisation	Year	
Wollongong – Port Hacking 1:1000000 geological map	Geological map	28/02/2023	Department of Mineral Resources, Sydney	1985	https://minview.geoscience.nsw.gov.au/#/?lon=150.8274&lat=-34.26090&z=10&l=sm148:y:100
1:25,000 scale Acid Sulfate Soil Risk Map	Acid Sulfate Soil risk map	28/02/2023	Department of Planning and Environment	1998	https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU&runWorkflow=AppendLayerCatalog&CatalogLayer=SEED_Catalog.337
Australian Groundwater Explorer	Registered landholder bores	28/02/2023	Bureau of Meteorology, Australia Government	2022	http://www.bom.gov.au/water/groundwater/explorer/map.shtml
Water Sharing Plans	Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011	28/02/2023	Department of Planning and Environment – Water	2011	https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU&runWorkflow=AppendLayerCatalog&CatalogLayer=DPE_Water_Catalog.3.Water%20Sharing%20Plan%20-%20Groundwater%20Sources
	Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011	28/02/2023	Department of Planning and Environment – Water	2011	https://geo.seed.nsw.gov.au/Public_Viewer/index.html?viewer=Public_Viewer&locale=en-AU&runWorkflow=AppendLayerCatalog&CatalogLayer=DPE_Water_Catalog.5.Water%20Sharing%20Plan%20-%20Unregulated%20River%20Water%20Sources
Annual Water Quality Monitoring Report	Water quality sampling at station N86 (approx 2 km upstream)	2021-22 (most recent)	Water NSW	2022	https://www.waternsw.com.au/__data/assets/pdf_file/0004/232357/Annual-Water-Quality-Monitoring-Report-2022.PDF

3.3 Limitations

This report has been prepared by GHD for Transport for NSW and may only be used and relied on by Transport for NSW for the purpose agreed between GHD and Transport for NSW as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Transport for NSW arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

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

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

GHD has prepared this document on the basis of information provided by Transport for NSW and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

4. Existing environment

4.1 Topography and drainage

4.1.1 Topography

The topography generally slopes gently upwards from 160 metres Australian Height Datum (m AHD) in the north-west of the proposal site, to elevations of 250 m AHD in the south-east.

4.1.2 Watercourses and surface water catchments

The proposal is located within the Hawkesbury-Nepean surface water catchment. The Hawkesbury-Nepean Catchment covers about 22,000 square kilometres and flows about 470 kilometres from Goulburn to Broken Bay. The catchment provides drinking water, recreational opportunities, agriculture and fisheries produce and tourism resources for the Sydney Metropolitan area.

The proposal site drains in three main directions to the Nepean River, which is located to the west and south of the proposal site, flowing south to north-east, as shown in Figure 4.1. The main watercourses located within the study area, as shown on Figure 4.1, are:

– Nepean River
– Byrnes Creek
– Allens Creek
– Stringybark Creek.

Additional information about these watercourses is provided in the following sections. Further information about the hydrology and flooding environment of the proposal is provided in the Hydrology and Hydraulics Assessment (Appendix G of the REF).

4.1.2.1 Nepean River

The upstream point to which the proposal site drains to the Nepean River is located about 500 metres south-west of the proposal site, taking flows from the westbound carriageway and southern side of the Picton Road and M31 Hume Motorway interchange. At this location the Nepean River is perennial, located within a steep sided and narrow valley, mapped as key fish habitat, and rated as Fair Freshwater Fish Community Status on the Fisheries NSW Spatial Data Portal.

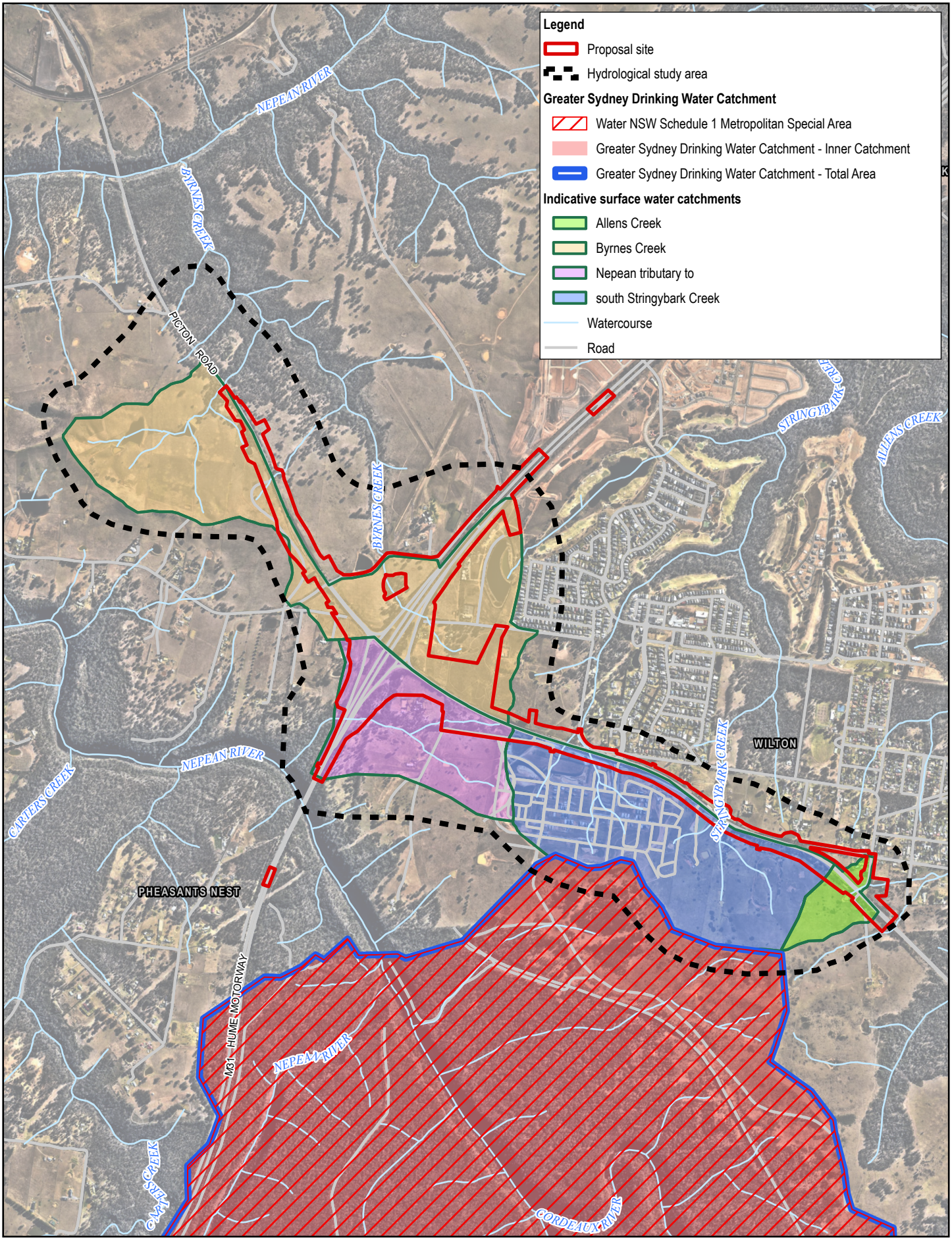
4.1.2.2 Byrnes Creek

The northern and western section of the proposal site drains via several small watercourses to a tributary of Byrnes Creek. Byrnes Creek is located about 300 metres east of the proposal site approximately parallel to Picton Road, as shown on Figure 3.1. Byrnes Creek is an ephemeral, steep sided creek, mapped as key fish habitat and rated as Fair Freshwater Fish Community Status on the Fisheries NSW Spatial Data Portal.

Three tributaries of Byrnes Creek cross the proposal site:

– a tributary at the eastern end of Byrnes Creek, which crosses the proposal site at the northern end of the Picton Road and M31 Hume Motorway interchange
– two unnamed tributaries, one located approximately one kilometre west of the Picton Road and M31 Hume Motorway interchange, the other located near the western end of the proposal site.

As described in the Biodiversity Assessment Report for the REF (see section 6.1 of the REF) these tributaries are not mapped as, nor are consistent with the definition of, key fish habitat under Section 3.2.1 of the *Fisheries NSW Policy and guidelines for fish habitat conservation and management* (Fairfull, 2013) as they are first and second order streams.



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Surface water features

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FIGURE 4.1

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4.1.2.3 Allens Creek / Stringybark Creek

The eastern section of the proposal site generally drains through the Bingara Gorge residential area through two minor tributaries of the Nepean River – Allens Creek and its tributary Stringybark Creek. Allens Creek and Stringybark Creek are both ephemeral steep sided creek and are listed as key fish habitat and rated as Fair Freshwater Fish Community Status on the Fisheries NSW Spatial Data Portal. A first order, ephemeral tributary of Allens Creek crosses the proposal site at the eastern end. Three tributaries of Stringybark Creek cross the proposal site to the east of the Picton Road and M31 Hume Motorway interchange, all of which are highly modified by ongoing urban development as part of the Wilton Growth Area. As described in the Biodiversity Assessment Report these tributaries are not mapped as, nor are consistent with the definition of key fish habitat under Section 3.2.1 of the *Fisheries NSW Policy and guidelines for fish habitat conservation and management* (Fairfull, 2013) as they are first and second order streams.

4.1.3 Land use

Land within the proposal site is mainly transport infrastructure, with smaller areas subject to rural land uses. Within the study area land uses generally consist of rural, residential, infrastructure and transport.

The proposal is located within the Wilton Growth Area, which surrounds Picton Road and the M31 Hume Motorway. DPE and Wollondilly Shire Council are planning for Wilton to become a new town providing about 15,000 homes and 15,000 jobs across six precincts, including a new town centre (the Wilton Town Centre) adjoining the north-western side of the Picton Road and M31 Hume Motorway interchange.

Further information about existing and future land uses within and around the proposal site is provided in section 6.11.2 of the REF.

4.1.4 Climate

Long term climate data collected from the Wollondilly Shire Council Picton Depot Automatic Weather Station indicated that:

– Annual mean maximum and minimum temperatures are 23.4 degrees Celcius (°C) and 8.8°C respectively.
– January experiences the hottest temperatures recording a mean maximum and minimum temperature of 29.3°C and 15.2°C respectively, while the coolest temperatures are experienced in July recording a mean maximum and minimum temperature of 16.8°C and 1.7°C respectively.
– The area receives an annual mean rainfall of 797.7 millimetres per year.
– February is the wettest month receiving 91 millimetres of rain, while September is the driest month receiving 43.5 millimetres of rainfall.

While this is the closest automatic weather station with climate data, a review of data available through the Bureau of Meteorology (BOM) – Monthly Statistics: Climate Data Online (BOM, 2021a) indicates that the nearest automatic weather stations with a long-term six-minute interval rainfall record suitable for use in MUSICX modelling are:

– Lucas Heights (ASNTO) (Station #66078) 33 kilometres away, with an average annual rainfall of 1006 millimetres
– Port Kembla (BSL Central Lab) (Station 68131) 32 kilometres away, with an average annual rainfall of 1260 millimetres.

Data from these automatic weather stations has been used in the development of the water quality modelling using the MUSICX software, as discussed in Appendix C. These stations have been selected as they have a long-term (greater than 10 year) period dataset of six-minute interval rainfall data. Approximately 99.3 per cent of the data used in the MUSIC modelling has been obtained from the Lucas Heights site, with the remaining data obtained from the Port Kembla site.

Monthly rainfall data for these stations used in the modelling is shown by Figure 4.2.

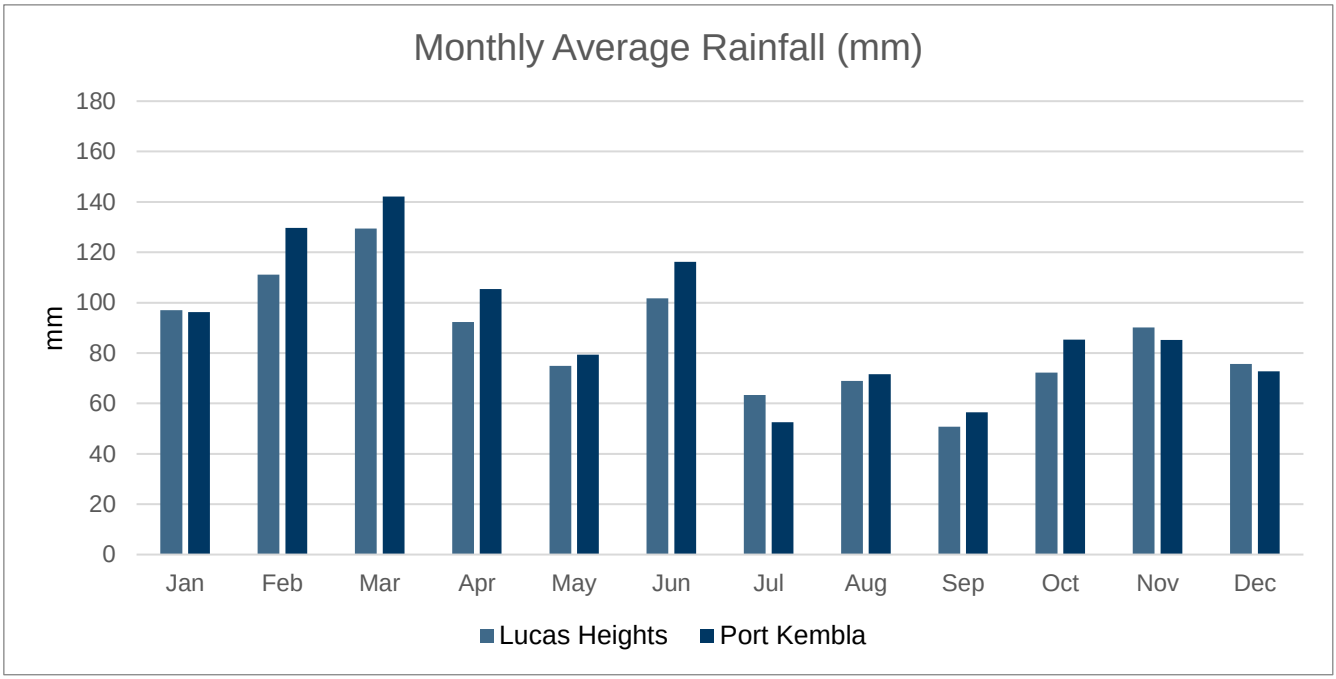


Figure 4.2 Monthly average rainfall

4.2 Surface water quality

The proposal is located within the catchment of the upper Nepean River. Runoff from the proposal site enters local watercourses and tributaries (described in section 4.1.2) through the existing stormwater system (which consists mostly of roadside swales) and as overland flow. There are currently no purpose built measures for road stormwater runoff quality improvement within the proposal site.

The quality of surface water entering local watercourses would largely be a function of contaminants on the roads and adjacent areas, in particular, runoff from Picton Road, along with urban development and light industrial areas. Typical surface pollutants from the proposal site could include:

– oils and hydrocarbons, primarily from Picton Road, from the asphalt surface and vehicular deposition
– heavy metals, primarily from vehicular deposition on Picton Road
– chemicals from spills or inappropriate waste disposal
– sediments, primarily from construction activities within the Wilton Growth Area
– gross pollutants including litter and debris
– nutrients including nitrogen and phosphorous, primarily from construction activities within the Wilton Growth Area.

Field data

As described in section 3.2.2 surface water samples were collected from 10 locations within the proposal site. Table 4.1 provides a summary of analytes that exceeded the default trigger values detailed in section 3.2.2. The detailed laboratory results are provided in Appendix B.

Table 4.1 Summary of analytes exceeding default trigger levels

Water quality monitoring location	Total phosphorous results (mg/L) (Default trigger level – 0.025 mg/L)	Total nitrogen results (mg/L) (Default trigger level – 0.35 mg/L)
SW01	1.44	1.9-5.3
SW02	0.17	1.1-2.0
SW03	0.17	1.1-4.9
SW04	Not exceeded	0.4-1.5
SW05	0.46 – 1.69	3.2-7.4
SW06	0.1 – 0.11	1.3-2.3
SW07	0.08	1.7-1.8
SW08	0.03	Not exceeded
SW09	Not exceeded	Not exceeded
SW10	0.03	0.5-1.2

Additionally, concentrations of aluminium (nine samples), chromium (four samples), copper (five samples), lead (two samples), and zinc (two samples) exceeded the water quality ecological assessment criteria (ANZG, 2018) adopted for surface water. It is noted that vegetation and aquatic species within and adjacent to the waterbodies samples did not appear distressed. Pesticides and other industrial chemical concentrations were generally reported at levels below the measurement thresholds.

Desktop

The *Annual Water Quality Monitoring* Report by WaterNSW for the years 2017 through 2023 reported water quality results across the Upper Nepean catchment, in particular at sampling station N86, located on the Nepean River approximately two kilometres upstream of the proposal site. Results indicated a variation across sites according to land use and natural characteristics. Reports referenced indicated exceedances of ANZECC benchmarks for nitrogen and phosphorus, which had varied between reporting periods but were below ANZECC threshold values for the latest report published in 2023. Dissolved oxygen showed improvements across the catchment.

The sampling undertaken for the proposal, along with available water quality data from the Nepean River, Byrnes Creek and Allens Creek, is not adequate to provide a representation of the baseline water quality within the study area in terms of period of record or changes to the catchment over time due to to ongoing development in the study area.

4.2.1 Sensitive receiving environments

Sensitive receiving environments are environments that have a high conservation value or support ecosystems/human uses of water that are particularly sensitive to pollution or degradation of water quality. It is important to identify sensitive receiving environments that have the potential to be directly impacted by the proposal or are located downstream of proposal activities so that these values can be adequately protected.

Typically sensitive receiving environments are determined using aquatic habitat as an indicator. As described in section 4.1.2 and as per the Biodiversity Assessment Report prepared for the REF, the Nepean River represents the only significant key fish habitat within the study area. As this waterway is likely to contain substantial in-stream habitat and is a major waterway, it would be considered a sensitive receiving environment. The ephemeral tributaries that flow to Byrnes Creek, Allens Creek and Stringybark Creek have not been considered as sensitive receiving environments as the waterways are highly degraded as a result of historic clearing and ongoing land management practices including livestock grazing.

4.3 Soil landscapes and characteristics

4.3.1 Soil landscapes

The Wollongong-Port Hacking 1:100,000 scale Soil Landscape Series Sheet 9029 (Hazleton and Tille, 1990), shows that three soil landscape units are mapped across the proposal site. The majority of the proposal site is mapped the 'Blacktown' ('bt') soil landscape. The 'Luddenham' ('lu') soil landscape is mapped in small sections to the west and north of the M31 Hume Motorway intersection, with the 'Lucas Heights' ('lh') soil landscape mapped at the western and southern ends of the proposal. An extract from the NSW Office of Environment and Heritage eSPADE V2.2 website mapping is provided as Figure 4.3.

The Luddenham soil landscape unit is characterised by undulating to rolling low hills on Wianamatta Group shales, often associated with Minchinbury Sandstone. Slope gradients are typically between five and 20 per cent. The dominant soils include whole-coloured, strongly pedal clay, and the typical soil profile consists of a brown clay loam and dark brown loam topsoil. Landscape limitations include high soil erosion hazard, localised impermeable highly plastic, moderately reactive subsoils and potential mass movement hazard.

The Blacktown soil landscape is characterised by gently undulating rises on Wianamatta Group shale. Slope gradients are typically less than five per cent. The typical soil profile consists of a brown loam and greyish clay loam topsoils underlain by plastic mottled clay. Limitations within this unit are reported to include moderately reactive, highly plastic subsoils and low soil fertility.

The Lucas Heights soil landscape unit is characterised by gently undulating crests, ridges and plateau surfaces of the Mittagong Formation (alternating bands of shale and fine-grained sandstones). Slope gradients are typically less than 10 per cent. The dominant soil is yellowish brown clay, and the typical soil profile consists of a sandy clay loam and greyish brown fine sandy loam topsoil overlying a yellowish-brown sandy clay loam subsoil. Landscape limitations include stoniness, hard-setting surfaces and low soil fertility.

4.3.2 Soil erodibility and dispersive soils

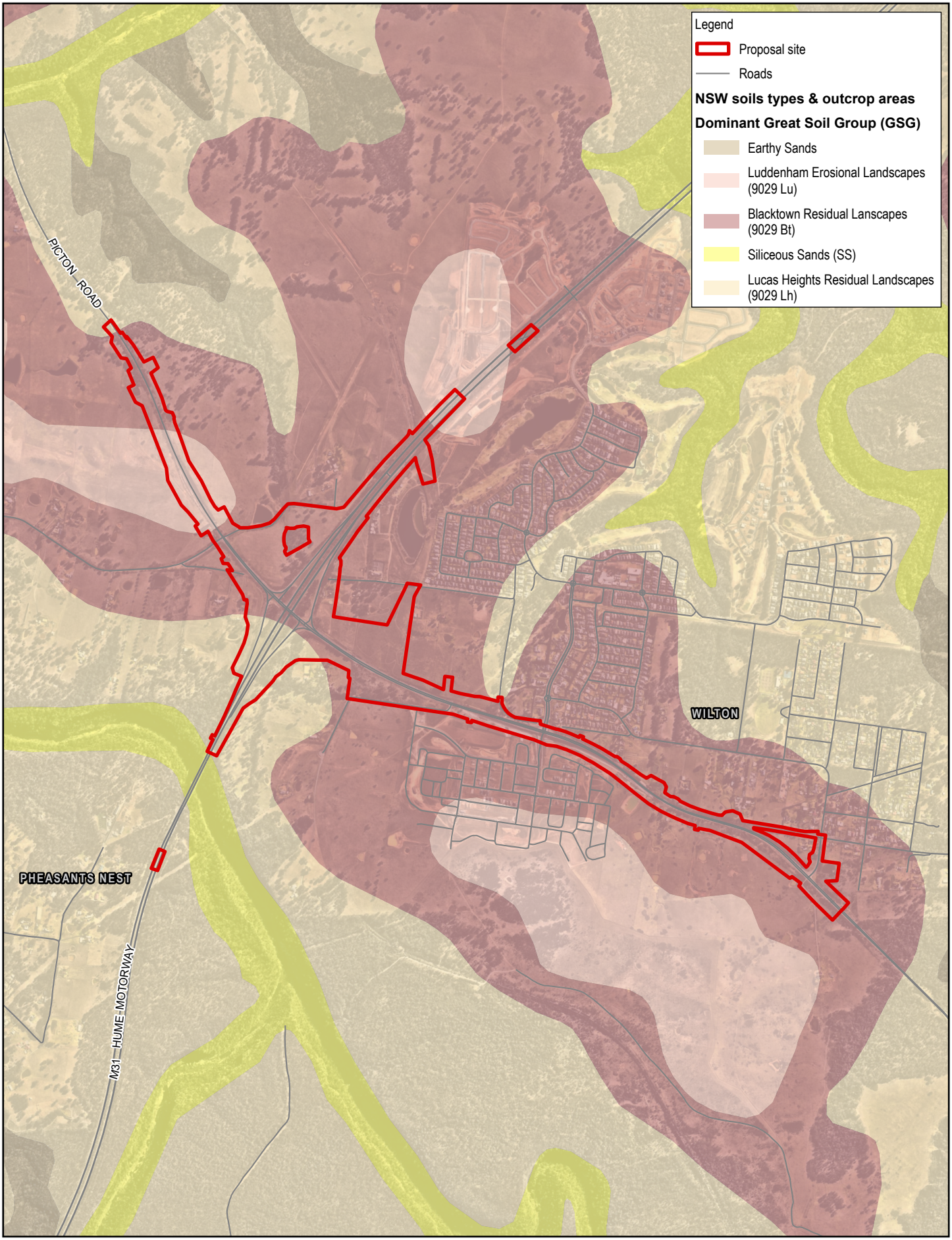
Dispersive soils are those which by the nature of their minerology, and the chemistry of the water in the soil, are susceptible to separation of the individual clay particles, and subsequent erosion of the very small particles. These smaller particles can then transmit through fine fissures or cracks in the soil under groundwater seepage flows.

Pipes or tunnels can form within dispersive materials through internal erosion. This 'piping erosion' can cause major damage, particularly to earthworks embankments, weakening the internal embankment structure and potentially leading to embankment failure. In addition, if embankments containing dispersive soils become saturated, cyclic traffic loading can promote pumping of water beneath the pavement formation into the overlying ground, potentially affecting the structural integrity of the soils/foundations. Of relevance to this impact assessment, dispersive soils are also susceptible to scouring due to surface runoff, which is often exacerbated where flows are concentrated (i.e., at low points such as gullies and culvert locations).

Laboratory testing undertaken as part of geotechnical assessment to inform the design confirmed that fill, residual soils and weathered materials that are derived from Ashfield Shale are inferred to have moderate to high dispersion potential. The areas of main concern for dispersive potential within the proposal site were determined to be at the large cutting west of Wilton Park Road, the cutting west of Janderra Lane, and the cutting west of Almond Street (cut 5, cut 6 and cut 10, respectively, shown in Figure 3.4).

The erosion hazard is qualitatively categorised as moderate to extreme for the Luddenham soil landscape, as moderate for the Lucas Heights soil landscape, and as low to very high for the Blacktown soil landscape.

Areas of high-risk for soil erosion along the proposal alignment include steep and rugged terrain, and terrain with erodible soils. These include the majority of the construction footprint for the intersection with the Hume Highway and the large cut and fill batters.



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
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Soil landscapes

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FIGURE 4.3

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Data source: Vegetation Zones - Biosis 2023, Nearmap WMS Server: . Created by: akildea

4.3.3 Acid sulfate soils

The CSIRO Atlas of Australian Acid Sulfate Soils indicates that the proposal site has an extremely low probability of occurrence of acid sulfate soils. Land management activities in the proposal site are not likely to be affected by acid sulfate soil materials. Therefore, the potential for impacts due to the presence of acid sulfate soils has not been considered further.

4.3.4 Acid sulfate rock

Acid sulfate rock is defined as a geological rock unit that contains sulfide or sulfate minerals (commonly pyrite), which have the potential to oxidise during construction and produce sulfuric acid that can affect structural integrity or local environmental conditions.

Acid sulfate rock is potentially an issue when sulfide-bearing strata that have previously been protected from weathering become exposed to oxygen (such as within deep cuttings), giving opportunity for the oxidation of sulfate minerals.

Pyrite is the most common sulfur bearing mineral in nature with the most common form being sedimentary pyrite. Sedimentary pyrite forms when available sulfate (which occurs widely in seawater, sediment, or water-rich decaying organic material) reacts with reactive dissolved iron and iron minerals forming iron sulphide minerals, the most common being pyrite. This process is typically associated with chemically reducing environments such as swamps and deep marine sediments. As a result, pyrite is a common constituent of organic rich, typically fine-grained, marine sedimentary rocks and organic rich anoxic terrestrial sediments.

As described further in section 4.3.6 the proposal site is underlain by Ashfield Shale, Mittagone Formation and Hawkesbury Sandstone, belonging to the Wianamatta Group. The Wianamatta Group consists of sediments that were deposited in a large river delta, and hence contain a mixture of freshwater and marine sedimentary bands including mudstones which contain pyrite. Acid sulfate rock is only likely to be present within the fresher rock cuts in bedrock and areas above existing groundwater levels. Pyrite in weathered rock would likely have already oxidised and therefore no longer have the potential to form acid.

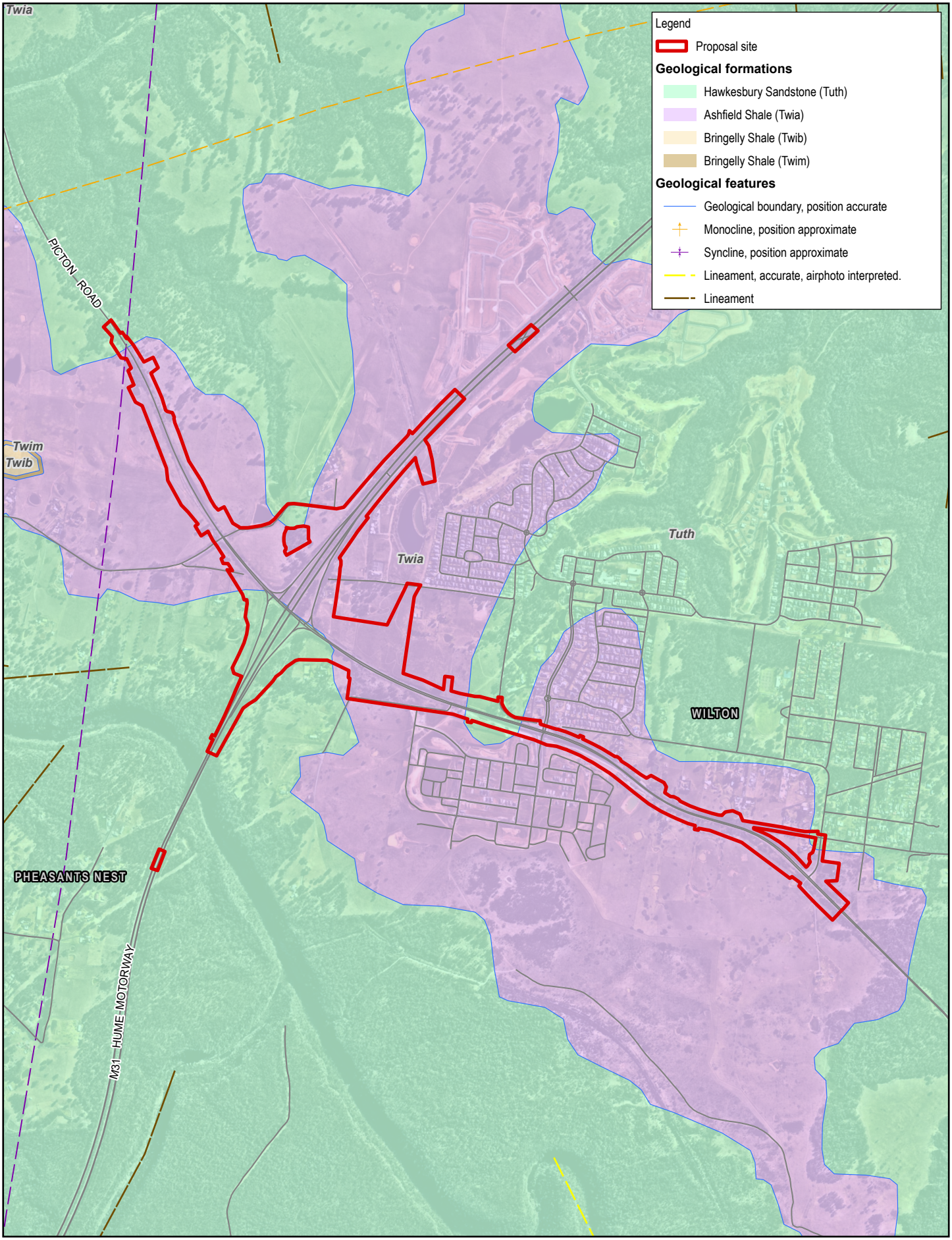
4.3.5 Salinity

The proposal site is generally mapped as having moderate salinity potential (DIPNR, 2003). The exception to this is a small area in the north-west of the Picton Road and M31 Hume Motorway interchange, which is mapped as having high salinity potential.

High salinity soil can reduce or preclude vegetation growth. Impacts could also occur as a result of the erosion and off-site transport of saline sediments, resulting in impacts on the receiving environment.

4.3.6 Geology

As shown in Figure 4.4, the 1:100,000 scale Wollongong Geological Series Sheet (Department of Mineral Resources, 1985), indicates that the proposal site is underlain by the Triassic-aged Ashfield Shale (characterised by weathered black to grey shale, mudstone or siltstone), Mittagong Formation (characterised by interbedded quartz sandstone and black siltstone formation) and Hawkesbury Sandstone (medium to coarse-grained quartz, with minor shale and laminate lenses) belonging to the Wianamatta Group.



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Metres

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Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

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Geological map

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FIGURE 4.4

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Data source: Vegetation Zones - Biosis 2023, Nearmap WMS Server: . Created by: akildea

4.4 Existing groundwater

Available data indicates that the regional groundwater system consists of a deep groundwater system (where groundwater flows through joints and other discontinuities in the underlying rock) and a more localised surface, or 'perched', groundwater system (where groundwater flows through overlying alluvium, residual soils and fill). The residual soil above the Ashfield Shale / Hawkesbury Sandstone can act as an aquitard. The surface groundwater system is likely recharged by rainfall and percolation from irrigation of open spaces, as well as incidental runoff from impervious surfaces such as roads and footpaths.

The groundwater regionally is likely to be deep within the Sandstone / Shale; however, there is the potential to be shallow perched groundwater present within the residual soils near to creek lines.

4.4.1 Landholder bores

A search of the NSW Groundwater Bore Database (WaterNSW, 2023) was carried out on 21 February 2023 to identify registered bores within a three kilometre radius of the proposal site. The search identified 33 bores and their locations are shown in Figure 4.5. Bore details are provided in Appendix A.

Of the identified bores, the majority (19 bores) were registered as water supply or stock and domestic bores, while the remaining bores were registered for irrigation purposes (five bores), monitoring (five bores) or unknown purpose (four bores).

A total of nine existing groundwater boreholes were identified within a one kilometre radius of the proposal site, one of which was identified as a stock and domestic bore, two for monitoring, two for irrigation, three for water supply and one unknown purpose. The nearest borehole was identified approximately 120 metres east of the proposal site and is licensed as a monitoring bore. Information for these nine boreholes is provided in Table 4.2.

Salinity of the groundwater in the boreholes as summarised in Table 4.2. ranges from 1.74 mg/L to 7000 mg/L with qualitative descriptors including fresh, good and brackish. Overall, the water is indicated to range from fresh to moderately brackish as salinities from 1000 mg/L to 30,000 mg/L are typically considered to be brackish.

A review of the bore details in Appendix A indicates that all of the stock, domestic, farming, or irrigation bores are installed within the fractured rock strata. This indicates that in the vicinity of the proposal site, there is limited reliance on the fractured rock aquifer and no reliance on the alluvial aquifer for stock, domestic, farming, or irrigation purposes. Reported yields are very low, less than 1.3 litres per second (L/s).

Table 4.2 Groundwater bores within one kilometre of the proposal site, as sourced from Water NSW

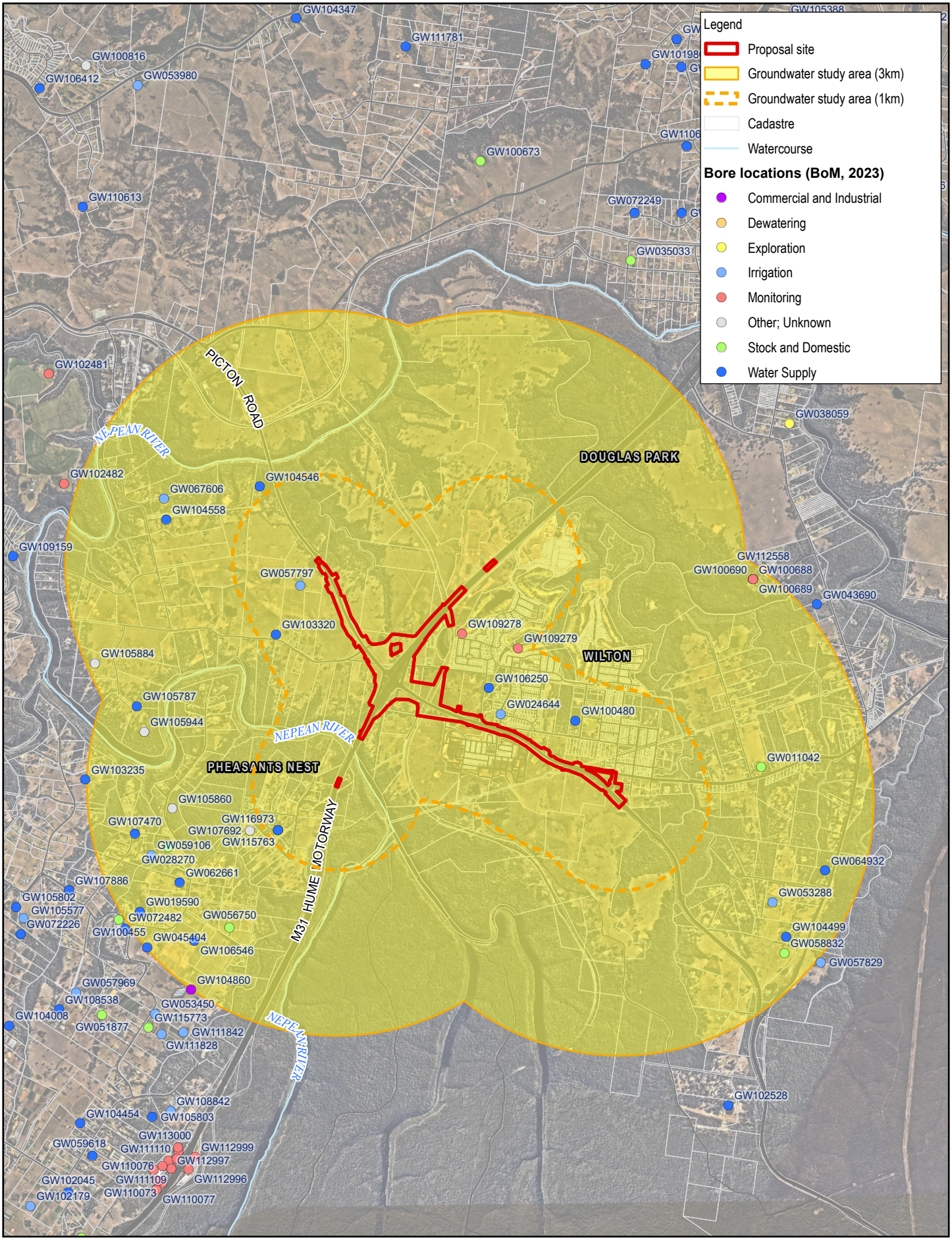
Borehole ID	Purpose	Bore depth (m)	Standing water level (mbgl)	Salinity (mg/L)	Drillers log	Approximate distance from the proposal site (m)
GW024644	Irrigation	77.4	48.7-56	3001-7000	0.9 m soil clay overlaying sandstone	134
GW057797	Irrigation	106.7	-	Good	0.3 m topsoil overlaying sandstone and shale	261
GW100480	Water supply	148	85	Brackish	1 m brown soil overlaying sandstone and shale	472
GW103320	Water supply	183	-	-	1.8 m clay overlying shale and sandstone	811
GW106250	Water supply	151	62	-	2 m topsoil overlaying sandstone and shale	332
GW109278	Monitoring	180	48	1.74	6 m clay overlaying sandstone and shale	117
GW109279	Monitoring	193	44	5.11	72 m sandstone overlying shale, siltstone, and claystone.	810

Borehole ID	Purpose	Bore depth (m)	Standing water level (mbgl)	Salinity (mg/L)	Drillers log	Approximate distance from the proposal site (m)
GW115763	Stock, Domestic	150	-	-	1 m clay overlying sandstone.	879
GW116973	Unknown	162	-	-	-	879

4.4.2 Groundwater dependent ecosystems

The Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 specifies that high priority groundwater dependent ecosystems (GDEs) include Cumberland Plain Woodland, which has been identified within the study area (see section 6.1 of the REF).

Plant Community Types (PCTs) within and in the vicinity of the proposal site have been mapped as part of the Biodiversity Assessment Report for the REF (see section 6.1 of the REF). The potential for these PCTs to be GDEs has been considered, and one PCT (PCT 1395 Narrow-leaved Ironbark – Broad-leaved Ironbark – Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion) is considered to have a high to moderate potential of being a GDE. This PCT is located within the proposal site. However, the Biodiversity Assessment Report concluded that PCT 1395 is likely to be an opportunistic facultative GDE that depends on the subsurface presence of groundwater in some locations but not in others, and that PCT 1395 is more likely to be a GDE when rainfall cannot be accessed to maintain an ecological function. The location of this potential GDE shown on Figure 4.6.



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Landholder bores

FIGURE 4.5

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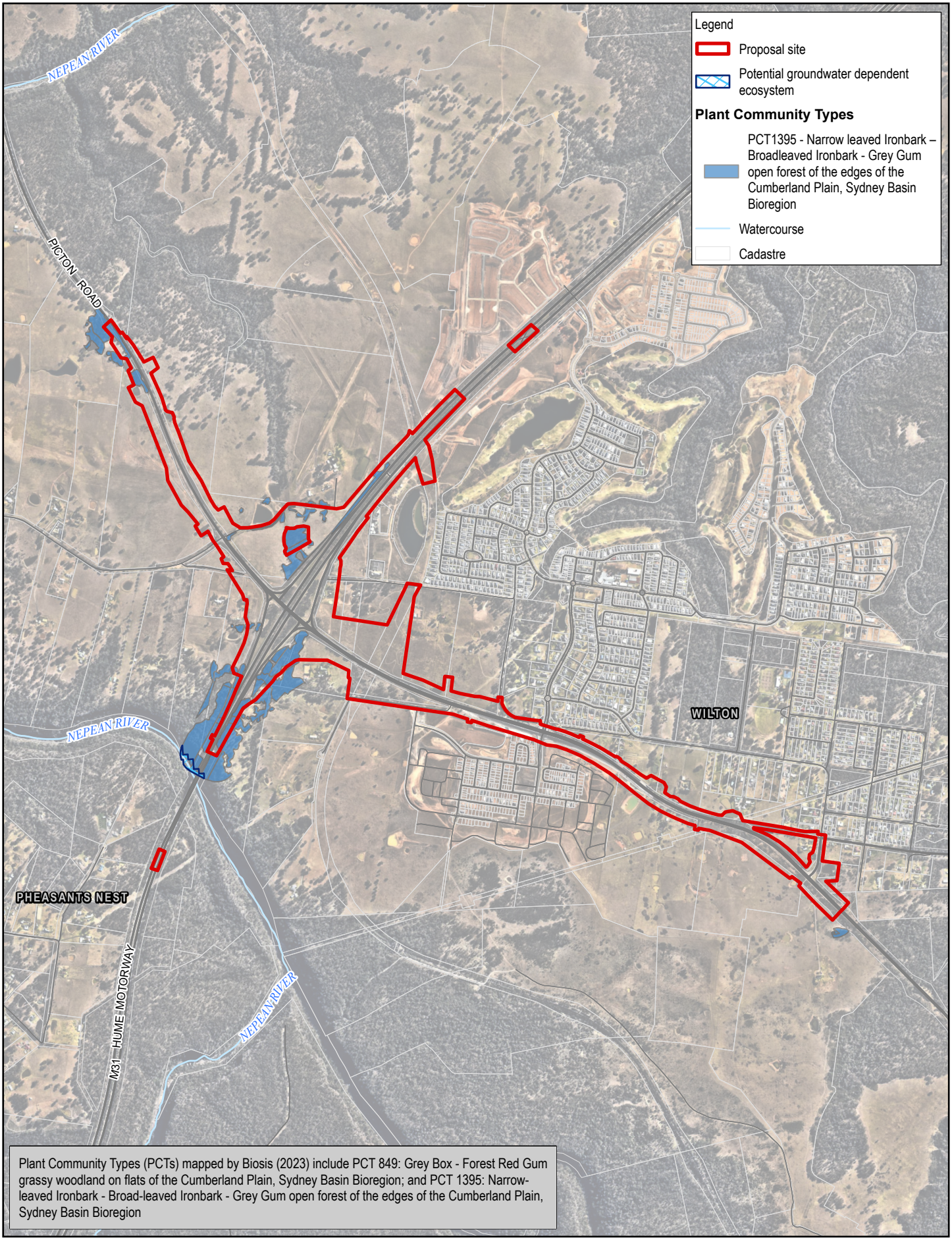

Plant Community Types (PCTs) mapped by Biosis (2023) include PCT 849: Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion; and PCT 1395: Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion

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Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
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Transport for NSW
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Groundwater dependent ecosystems

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FIGURE 4.6

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Data source: Vegetation Zones - Biosis 2023, Nearmap WMS Server: . Created by: akildea

4.4.3 Groundwater monitoring

Geotechnical investigations carried out as part of the proposal included installing ten groundwater monitoring bores at the locations shown in Figure 3.3 to record water levels and testing of groundwater quality.

4.4.3.1 Groundwater level

Groundwater levels were monitored between November 2022 to April 2023. Groundwater level monitoring results are summarised in Table 4.3. Local groundwater levels within the proposal site are about five to 20 metres below ground level based on geotechnical investigations.

Groundwater monitoring results have been presented based on the monitoring bore locations relative to sections of the proposal site, as shown in Figure 3.4.

Table 4.3 Summary of groundwater monitoring results

Borehole	Proposal section	Surface elevation (m AHD)	Screen range (m AHD)	Screened geotechnical unit	Monitoring period	Observed trend in water level
BH003A	Cut 10	229.96	221.96-215.96	Siltstone	Nov 2022 - Apr 2023	Fluctuates between 4.45 metres below ground level (mbgl) to 5.73 mbgl
BH004A	Cut 10	229.78	224.78-218.66	Interlaminated Siltstone/ Sandstone; Siltstone	Nov 2022 - Apr 2023	Groundwater gradually decreased from 3.51 mbgl becoming relatively consistent around 5.36 to 6.13 mbgl.
BH027A	Cut 5	215.02	203.02-193.92	Siltstone;	Nov 2022 - Mar 2023	Groundwater gradually increased from 18.10 mbgl after well development/ water sampling events, stabilising around 10.44 mbgl.
BH031	N/A – outside the extent of cut or fill at western end of proposal site	167.55	157.55-147.57	Sandy clay, clay, sandstone;	Nov 2022 - Apr 2023	Fluctuates between 15.20 mbgl to 14.84 mbgl
BH017	Fill 5 Picton Road – M31 Hume Motorway interchange bridge abutments	200.05	194.05-188.05	Interlaminated Siltstone/ Sandstone, siltstone;	Nov 2022 - Apr 2023	Fluctuates between 7.08 mbgl to 7.91 mbgl
BH021	Fill 5	198.11	186.11-192.11	Interlaminated Siltstone/ Sandstone	Nov 2022 - Apr 2023	Fluctuates between 6.37 mbgl to 7.07 mbgl
BH014	Fill 7	208.90	205.65-202.65	Sandstone	Dec 2022 - Mar 2023	Fluctuates between 4.98 mbgl to 5.30 mbgl
BH022	Fill 5	196.18	190.77-187.77	Interlaminated Siltstone/ Sandstone	Nov 2022 - Mar 2023	Fluctuates between 4.44 mbgl to 4.68 mbgl
BH006	Fill 9	213.64	208.64-205.55	Interlaminated Siltstone/ Sandstone	Feb 2023 - Mar 2023	Standpipe well was found to be dry when attempting development. Monitoring shows slight increase peak of 6.70 mbgl

Borehole	Proposal section	Surface elevation (m AHD)	Screen range (m AHD)	Screened geotechnical unit	Monitoring period	Observed trend in water level
BH047	Cut 12	199.62	195.62-189.74	Interlaminated Siltstone/ Sandstone, siltstone	Mar 2023 - Apr 2023	Groundwater stabilised around 4.56 mbgl

Pavement core investigations have been undertaken in existing cuttings on Picton Road. Pavement core details are summarised in Table 4.4.

The results of pavement coring indicate that groundwater levels are below the base of existing cuttings (existing road surface).

Based on the groundwater monitoring results, it is evident that groundwater levels vary spatially across the proposal site. At Cut 5 groundwater levels decrease towards the east, with groundwater levels varying from approximately 204.6 m AHD at BH027A (approximately 60 metres west of the existing Picton Road alignment) to approximately 198 m AHD at PC047A under the existing Picton Road. At Cut 10 groundwater levels decrease towards the existing Picton Road, with groundwater levels varying from approximately 223.65 m AHD to 225.5 m AHD at BH03 and BH04 (approximately 50 metres from the existing Picton Road alignment) to lower than 223.25 m AHD to 223.1 m AHD at PC073 and PC072 respectively.

Table 4.4 Summary of pavement core investigations

Pavement core	Proposal section	Surface elevation (m AHD)	Core depth (m)	Groundwater level observations
PC016	Cut 6	216.42	1.5	No groundwater encountered
PC017	Cut 6	217.19	1.5	No groundwater encountered
PC047	Cut 5	199.24	1.5	No groundwater encountered
PC047A	Cut 5	199.07	1.5	Groundwater seepage at 1.1 mbgl
PC048	Cut 5	199.58	1.5	No groundwater encountered
PC049	Cut 5	199.90	1.5	No groundwater encountered
PC050	Cut 5	199.34	1.5	No groundwater encountered
PC051	Cut 5	198.67	1.5	No groundwater encountered
PC072	Cut 10	224.58	1.5	No groundwater encountered
PC073	Cut 10	224.75	1.5	No groundwater encountered

4.4.3.2 Groundwater quality

Groundwater sampling was undertaken in February 2023. Groundwater quality field parameters are summarised in Table 4.5. Groundwater quality in the fractured rock aquifer varies from slightly acidic to circumneutral and varies from fresh to saline.

Table 4.5 Groundwater quality – summary of field parameters

Location	Temperature (degrees Celsius)	pH (pH units)	Dissolved oxygen (mg/L)	Total dissolved solids (mg/L)	Electrical conductivity (µS/cm)	Redox (mg/L)
BH003A	17.8	7.02	3.41	2977.0	3969	13.6
BH017	18.4	7.03	2.81	3419	4597	32.2
BH021	19.6	6.75	1.40	182.0	6221	46.2
BH004A	19.3	6.49	0.58	1924	2624	53.6
BH31	20.9	5.12	0.09	2983	4290	-18.2
BH14	19.6	6.65	1.05	1800	2494	-20.4
BH27A	20.1	6.59	5.27	3880.90	5492	52.1
BH22	21.2	6.71	1.31	7293.00	10520	71.2

Exceedances of adopted criteria for groundwater quality are summarised in Table 4.6.

Table 4.6 Summary of analytes exceeding adopted guidelines in groundwater

Analyte[1]	Location	Result	Guideline
Chromium	BH003A	0.018 mg/L	ANZG 95% Freshwater (hardness adjusted) 0.014 mg/L
Copper	BH031	0.003 mg/L[2]	ANZG 95% Freshwater 0.0014 mg/L
	BH027A	0.012 mg/L	
	BH003A	0.015 mg/L[3]	
	BH017	0.002 mg/L	
	BH014	0.004 mg/L	
	BH022	0.059 mg/L	
Nickel	BH031	0.177 mg/L	ANZG 95% Freshwater (hardness adjusted) 0.153 mg/L
Zinc	BH031	0.269 mg/L	ANZG 95% Freshwater (hardness adjusted) 0.111 mg/L
PFOS	BH021	0.0057 µg/L	HEPA[4] 99% Freshwater 0.00023 µg/L ANZG 99% Freshwater 0.0091 µg/L

Notes: 1. Cadmium, chromium, lead, nickel and zinc guidelines were adjusted for hardness as per Warne et al. (2018).
2. Duplicate sample – primary sample BH031.
3. Duplicate sample – primary sample BH003A
4. *PFAS National Environmental Management Plan 2.0* (HEPA, DCCEEW, 2020)

5. Construction impact assessment

5.1 Construction impacts

Construction of the proposal would involve a range of activities, including earthworks, vegetation clearing and mulching, the establishment of ancillary facilities and access tracks, road construction, and the construction of bridges for the new Picton Road and M31 Hume Motorway interchange. These construction activities have the potential to impact on soils, surface water and groundwater.

The indicative construction methodology, activities and facilities that would be used to construct the proposal are described in section 3.3 of the REF. The potential impacts of these activities on soils, surface water and groundwater are described in the following sections.

5.1.1 Soils

5.1.1.1 Soil erosion and sediment transport

Construction would temporarily expose the natural ground surface and sub-surface through the removal of vegetation, general excavation and soil disturbance, and the removal of hardstand surfaces such as affected sections of existing roadway.

Excavation and ground disturbance activities would expose and disturb soils, which if not managed adequately, could result in the potential for the following impacts on soils:

– Erosion of exposed soil and stockpiled materials could occur, particularly where construction activities are undertaken in soil landscapes characterised by dispersive soils, given their susceptibility to erosion. As noted in section 4.3.2 dispersive soils are potentially present within the majority of the proposal site.
– Increases in salinity levels in soil could occur (see section 5.1.1.2).
– Impacts to topsoil structure and removal of soil fertility by construction practices including clearing and grubbing, topsoil stockpiling and management.
– Mobilisation of contaminated sediments and mobilisation via surface water runoff, with resultant potential for environmental and human health impacts (discussed in the Preliminary Site Investigation Report (Appendix I of the REF)).

A rehabilitation strategy for exposed surfaces would be prepared as part of the Construction Environmental Management Plan (CEMP) (see chapter 7 of the REF) to guide the approach to rehabilitation of disturbed areas.

The presence of dispersive soils could impact the size and frequency of cleaning of the proposed sediment controls. This would be considered as part of the Site-specific Erosion and Sediment Control Plan/s prepared as part of the Construction Soil and Water Management Plan (see section 8).

Other potential soil impacts would be minimised by implementing the measures provided in section 8 of this report.

5.1.1.2 Acid sulfate rock

As noted in section 4.3.4, there is the potential for sulfide-bearing strata (acid sulfate rock) to underly the proposal site. However, this is only an environmental concern if this strata becomes exposed to oxygen (such as within deep cuttings), giving opportunity for the oxidation of sulfate minerals. No excavation or cuttings within bedrock are proposed; therefore, there would be no potential for the exposure to oxygen of acid sulfate rock during construction.

5.1.1.3 Salinity

Excavation would be undertaken in areas with moderate or high salinity hazard as noted in section 4.3.5. In addition, construction could disturb soils in areas with unidentified salinity potential.

The potential for any impacts due to the presence of saline soils is considered to be low. Any potential impacts would be temporary and managed by implementing standard erosion and sediment control measures. Soils associated with areas of high salinity potential would be considered during detailed design and mitigation measures developed and implemented as appropriate to minimise impacts associated with salinity.

5.1.1.4 Contamination

If inadequately managed, construction activities have the potential to result in the contamination of soil due to:

– accidental spills and leaks of fuel, oils, and other potentially contaminating substances, from plant and equipment or mishandling of dangerous goods stored on site
– inadequate handling of contaminated materials and excavated waste.

Potential contamination impacts would be mitigated by implementing the safeguards and management measures provided in section 6.7.5 of the REF.

5.1.2 Surface water

Construction activities could present a risk to water quality in receiving watercourses/waterbodies if mitigation and management measures are not effectively implemented. Potential sources of water quality impacts and implications for the proposal associated with these include the following:

– Increased sediment loads from exposed soil could be transported off site during rainfall events, particularly in areas of dispersive soils as identified in section 4.3.2, and from the discharge of sediment-laden water. For the proposal, this could have the potential for soil erosion to discharge into receiving watercourses and decrease water quality.
– Increased levels of nutrients, metals and other pollutants from construction near watercourses and stormwater drains could be transported in sediments to downstream watercourses or via discharge of wastewater to nearby watercourses. The proposal could result in higher rates of export for the pollutants relative to existing conditions.
– Contamination of watercourses due to runoff from potentially contaminated land (discussed in the Preliminary Site Investigation Report (Appendix I of the REF).
– Spills or leaks from construction machinery (including chemicals, oils, grease, and petroleum hydrocarbons), hazardous materials from chemical storage areas and gross pollutants such as litter could pollute downstream watercourses
– Tannins and other organic leachate from vegetation stockpiles could enter watercourses via runoff or discharge.

The downstream effects of water quality impacts include:

– reduced hydraulic capacity of the watercourse or drainage system
– increased pollutant loads within the catchment
– increased potential for bioaccumulation of heavy metals in aquatic species
– reduced dissolved oxygen levels that could impact aquatic species
– increased sedimentation smothering aquatic life and affecting aquatic ecosystems
– increased turbidity levels affecting aquatic species and the aesthetics of the water for recreational activities
– changes to water temperature due to reduced light penetration.

The likelihood and magnitude of potential impact would vary depending on the stage of construction, the area of disturbance, and occurrence of high rainfall or wind weather events.

Potential impacts to water quality, including the sensitive receiving environment of Nepean River, would be minimised by implementing the measures provided in section 8 of this report. The CSWMP would define measures and procedures, including those defined by the Blue Book, to minimise potential impacts to water quality during construction. The Blue Book requires that treated runoff discharging from a construction site contain TSS concentrations of no greater than 50 mg/L and have a pH of between 6.5 and 8.5, which is in accordance with the water quality objectives provided in section 3.2.2.

5.1.2.1 Earthworks, stockpiling and general runoff from construction sites

Excavations, embankment construction and general construction activities that result in ground disturbance, in particular close to drainage systems and on steeper slopes, could result in water quality impacts through erosion and sedimentation. Runoff from stockpiles has the potential to impact downstream water quality during rainfall if stockpiles are not managed appropriately. Sediments from the stockpiles have the potential to wash into watercourses, increasing levels of turbidity and resulting in transport of contaminants and impacts generally as described above.

Stockpiling cleared vegetation creates a risk of tannins leaching into watercourses, resulting in an increased organic load. Discharge of water high in tannins can increase the biological oxygen demand of the receiving environment, which can in turn result in a decrease in available dissolved oxygen. Once discharged to the environment, tannins can also reduce visibility, light penetration, and change the pH of receiving waters. The limited removal of trees and vegetation for the proposal, as described in section 6.1 of the REF, is unlikely to result in large volumes of tannins entering receiving waterbodies.

Sediment loads in watercourses can increase in the vicinity of hard surfaces (such as roads) and compacted areas (such as construction compounds) due to increased surface runoff.

Gross pollutants (such as litter) from construction areas and accidental spills or leaks (including chemicals, oils, grease, and petroleum hydrocarbons) could occur from the use, maintenance or re-fuelling of construction plant and equipment at construction sites. These can affect general water quality including through accumulation of material in watercourses and changes in chemical composition of receiving waters. In addition, these pollutants can be ingested by aquatic fauna and result in dead or sick aquatic life.

5.1.3 Groundwater

5.1.3.1 Groundwater levels

Construction would include excavation for a number of cuttings. The potential location of cuttings is shown in Figure 3.4.

Pavement coring in existing cuttings on Picton Road did not intercept groundwater, with the exception of one pavement core in Cut 5 where groundwater seepage was observed 1.1 metres below ground level. Cut 5 is an existing cutting where the base of the proposed cut is equal to the level of the existing. Observations during field investigations did not identify visible seepage on existing cuttings of Picton Road. As a result, it is unlikely that cuttings associated with the proposal would intercept groundwater, including at Cut 5.

There is potential that a shallow, perched aquifer could temporarily form following periods of above average rainfall. However, a shallow, perched aquifer was not intercepted or identified during groundwater monitoring. While groundwater levels can fluctuate seasonally, the groundwater monitoring was undertaken during a period where rainfall levels were substantially above average, so the levels are considered representative of a worst-case scenario. If a perched aquifer was to form, any groundwater inflow would be temporary only and would likely only form gradually. This groundwater inflow would be unlikely to be at sufficient volumes to require dewatering. As such, the potential for drawdown of the surrounding groundwater aquifer is considered negligible.

The proposal design for bridge foundation and associated retaining walls adopts shallow foundation on bedrock. It is likely that these foundations would be less than two metres deep while the proposed pedestrian bridge includes piling that would be terminated, at a depth of about five metres. Additionally, the foundations of the existing bridge would only be demolished to a depth of at least one metre below the design finished surface level, with deeper existing foundations left undisturbed. Available groundwater level data summarised in section 4.4.3 indicates that groundwater is approximately six to eight metres below ground level at the proposed bridge locations. Therefore, the excavations for the bridge demolition, construction and associated retaining walls would not intercept groundwater.

5.1.3.2 Groundwater quality

As existing groundwater is predominately perched and recharged by rainfall infiltration (see section 4.4), the volumes of potential infiltration into excavations is expected to be minimal, resulting in negligible long-term impacts. Potential risks to groundwater quality from changes to surface water include:

– contamination by hydrocarbons from accidental fuel and chemical spills
– contaminants contained in turbid runoff from unpaved surfaces.

Surface water from site runoff can infiltrate and impact groundwater sources. As the infiltration process is generally effective in filtering polluting particles and sediment, the risk of contamination of groundwater from any pollutants bound in particulate form in surface water, such as heavy metals, is generally low.

Soluble pollutants, such as pH altering solutes, salts and nitrates, as well as soluble hydrocarbons, can infiltrate soils and contaminate the groundwater system. Under certain pH conditions, metals may also become soluble and could infiltrate groundwater.

The safeguards and management measures provided in section 8 would be implemented to minimise the potential for groundwater quality impacts.

5.1.3.3 Aquifer interference policy

As the study area is underlain by Wianamatta Group Shales, it is classed as a 'less productive groundwater source' in accordance with the Aquifer Interference Policy. A less productive groundwater source is defined by the Aquifer Interference Policy as a groundwater source having total dissolved solids greater than 1500 milligrams per litre or a source that does not contain water supply works that can yield water at a rate greater than five litres per second.

The Aquifer Interference Policy requires that potential impacts on groundwater sources, including their users and GDEs, 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 proposal would be acceptable. The Level 1 minimal impact considerations for less productive porous and fractured rock water 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
– any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres of the activity.

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

Water supply works

As discussed in section 4.4, there are 38 bores within three kilometres of the proposal site. All of these bores are installed in the fractured rock strata. As the proposal is not predicted to intercept groundwater in the fractured rock aquifer, the proposal would not impact water supply works.

High priority culturally significant sites

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

Groundwater dependent ecosystems

Potential GDEs are described in section 4.4.2. The proposal is not predicted to intercept the regional water table. However, there is potential that the proposal could intercept temporary, perched groundwater. As described in section 4.4.2 the GDEs in the proposal site are considered to be opportunistic facultative GDEs, which would continue to be able to rely on alternative sources of water (i.e. rainfall). Therefore, the proposal is not predicted to result in impacts to GDEs.

Summary

The proposal is not predicted to result in any decline in groundwater pressure or groundwater head at any water supply works or GDEs, and is not predicted to alter the beneficial use of the groundwater. There are no high priority cultural significant sites listed by the relevant Water Sharing Plan in the vicinity of the proposal.

As groundwater levels can vary both spatially and over time in response to rainfall and climatic trends, continued groundwater monitoring is recommended (see section 8) to confirm groundwater levels, particularly in the vicinity of cuttings.

6. Operational impact assessment

6.1 Soils

There is the potential for recently disturbed soils to be susceptible to erosion, particularly during initial periods of landscaping and re-establishment of vegetation. This could occur in areas where planting is proposed, including adjacent to disturbed areas, along embankments, and in the reinstatement of temporary ancillary facilities where topsoil is settling and vegetation is establishing. Temporary soil stabilisation would be required immediately following construction to prevent potential erosion, topsoil loss or soil migration. This is particularly likely to be required following severe storms. In areas that are likely to expose dispersive materials, such as cut or fill batters in the Ashfield Shale, measures to stabilise the batters would be required to prevent degradation and transport of sediment into stormwater runoff.

Effective implementation of management measures during construction (as described in sections 5 and 8) would minimise the potential for impacts extending into the operation phase.

Operation is not likely to result in any significant impacts on soils, topography or geology. The risk of soil erosion during operation would be minimal, as all areas impacted during construction would be sealed or rehabilitated and landscaped to prevent soil erosion. Maintenance activities involving ground disturbance would be undertaken in accordance with Transport's standard operating procedures.

As noted in section 4.3.2 the presence of dispersive soils can cause internal erosion to earthwork embankments and can affect the structural integrity of the soils/foundation. The design has considered the potential for embankments constructed as part of the proposal to contain dispersive soils and suitable treatment measures would be incorporated in detailed design. Additionally, the reuse of dispersive soils within the proposal site would only occur if suitable treatment and management is applied.

6.2 Surface water

During operation, there is potential for surface water quality to be impacted by the following processes and activities:

– erosion of newly stabilised or planted areas during the establishment period, resulting in sedimentation of watercourses
– increase in sediment and pollutant loads in stormwater due to the increase in road surface.

These potential impacts are described in more detail below.

6.2.1 Sedimentation

As noted in section 6.1 there is the potential for areas of recently disturbed soils to be susceptible to erosion. Runoff from these areas has the potential to increase levels of turbidity and impact downstream water quality if the areas are not appropriately stabilised and rehabilitated.

6.2.2 Change in pollutants in stormwater

The proposal would increase impervious areas (such as road pavement and shared user paths) that would be exposed to direct rainfall and would therefore increase runoff volume and associated pollutant mobilisation. The proposal includes an increase in road surface area of approximately 6.2 hectares, or an increase of about 64 per cent relative to existing paved area. Runoff from road pavement would typically contain pollutants such as sediments, nutrients, oils and greases, petrochemicals and heavy metals, which could potentially impact on water quality when discharged into receiving watercourses.

Picton Road does not contain any existing water quality treatment devices within the proposal site, and the increase in impervious surface area means there is potential for higher pollutant loads to be discharged to the receiving environments of the unnamed tributaries that intersect the proposal site. Water quality treatment measures in the form of stormwater basins, including spill basins, have been included in the concept design to

manage runoff from the proposal and the associated water quality impacts. Modelling was carried out to assess the performance of the proposed water quality treatment devices against the targets described in section 3.2.2. The modelling considered flows and runoff at a sub catchment level, (rather than individual discharge locations) so the proposed treatment devices would also treat the existing case rather than just the changes in impervious areas associated with the proposal.

A summary of the modelling results and performance against the selected removal targets is provided in Table 6.1. Further information regarding the basis of design for the proposed water quality treatment devices, including their proposed location, is provided in Appendix C. The modelling results indicate that with the installation of the proposed treatment devices the adopted pollutant reduction targets would be achieved within each sub catchment.

The ultimate location, types and sizing of these treatment devices may be refined as the design progresses to accommodate changes in drainage and other design aspects. However, it is not expected that these changes would impact the water quality outcomes of the proposal as they would be developed and assessed against the same performance targets.

Contamination of watercourses could also occur through increased stormwater runoff containing typical pollutants, such as oils and greases, petrochemicals, and heavy metals, as a result of uncontrolled spills during vehicle accidents or maintenance activities. Any contamination of watercourses could affect water quality without mitigation; however, the proposed water quality treatment devices would cater for spill containment of a minimum volume of 30,000 litres.

Table 6.1 Modelling results for operational water quality based on proposed water quality treatment devices

Sub catchment	Total Suspended Solids (TSS)	Total Phosphorous (TP)	Total Nitrogen (TN)	Gross Pollutants
	Pollutant load reduction achieved % (Target 85%)	Pollutant load reduction achieved % (Target 65%)	Pollutant load reduction achieved % (Target 45%)	Pollutant load reduction achieved % (Target 90%)
Byrnes Creek	86	66	50	100
Nepean River tributary to south	87	65	52	100
Stringybark Creek	85	65	49	100
Allens Creek	88	67	52	100

6.2.3 Neutral or beneficial effects (NorBE) analysis

The proposal site is located downstream and not within the Metropolitan Special Area in the Greater Sydney Drinking Water Catchment, and therefore a NorBE assessment is not required under section 171 (A3) of the EP&A Regulation. However, an assessment has been completed using the NorBE tools for comparison purposes only. This section outlines the quantitative analysis completed using the MUSICX water quality modelling software to complement the qualitative assessment provided in Appendix D.

The MUSICX water quality modelling was undertaken to assess the performance of the water quality treatment devices against the NorBE principles for no pollutant load increases when compared to existing conditions. The pollutants modelled were TSS, TN and TP.

The results of the water quality assessment are shown in Table 6.2. These results indicate that the unmitigated pollutant loads for the upgraded road scenario would increase when compared to existing conditions. This means that, without the proposed mitigation measures, there would be a potential impact on downstream receiving environments. However, the annual average pollutant load in stormwater runoff from Picton Road with the proposed water quality treatment devices included in the proposal (see section 6.2.2) would be lower than the annual average pollutant load under existing conditions. These results demonstrate compliance with the NorBE principles.

Table 6.2 NorBE analysis

Parameter	Existing conditions (kg/year)	Proposed conditions without any water quality controls (kg/year)	Proposed conditions with water quality controls (kg/year)	Percentage relative to existing conditions	NorBE Compliant? Y/N
TSS	36,609	56,217	6,073	18%	Y
TP	60	97	31	58%	Y
TN	285	436	203	79%	Y

6.3 Groundwater

6.3.1 Groundwater levels

6.3.1.1 Cuttings intercepting groundwater

As discussed in section 5.1.3, groundwater is unlikely to be intercepted by cuttings of the proposal.

There is potential for a shallow, perched aquifer to temporarily form following periods of significantly above average rainfall. This perched groundwater could be intercepted by cuttings. It is likely that groundwater inflow into the cuttings would be temporary only and would be able to be managed by the stormwater management system and subsoil drainage of the proposal.

6.3.1.2 Changes to groundwater recharge

The increased hardstand areas could result in some local changes to the rates of rainfall infiltration. The main groundwater receptor is considered to be baseflow to watercourses. Runoff from hard stand areas would continue to flow towards the Nepean River. Therefore, any reduction in rainfall infiltration is likely to have a negligible effect in flows available to groundwater receptors in the study area.

6.3.2 NSW Aquifer Interference Policy

The proposal has been assessed against the adopted Level 1 minimal impact considerations for the construction phase of the proposal in section 5.1.3.3.

The potential for impacts during operation would be the same as during construction.

Overall, it is predicted that the groundwater impacts from the proposal would be less than the Level 1 minimal impact considerations specified in the Aquifer Interference Policy and are considered to be acceptable. The proposal is not predicted to result in any decline in groundwater pressure or groundwater head, and is not predicted to alter the beneficial use of the groundwater, any water supply work, culturally significant sites or GDEs.

7. Cumulative impacts

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of a proposal when added to other existing, planned, and/or reasonable anticipated future projects.

The proposal forms the western section of the broader Picton Road upgrade, which involves upgrading about 30 kilometres of Picton Road between the Nepean River and the M1 Princes Motorway. The area surrounding the proposal site would be subject to significant development as part of the Wilton Growth Area, which comprises a number of development precincts, including South East Wilton, North Wilton, Wilton Town Centre, West Wilton, Maldon and Bingara Gorge. Further information about land use and development around the proposal site is provided in section 6.11 of the REF.

Cumulative water quality impacts from proposed urban developments around the proposal site would be managed in accordance with the Wilton Growth Area DCP, which outlines objectives and controls for developments in the Wilton Growth Area. Relevant to the potential for water quality impacts, these objectives include:

- To ensure an integrated approach to drinking water, wastewater and stormwater services is considered to drive more sustainable water management outcomes.
- To ensure that water management measures for development incorporate key principles of water sensitive urban design to help protect, maintain or restore waterway health of identified high value waterways with a minimum requirement of maintaining current health, involving:
  - protecting existing hydrological and ecological processes of these waterways including natural features and systems including watercourses, wetlands, lagoons and aquatic, riparian and groundwater dependant ecosystems
  - where applicable, protecting the water quality of surface and groundwaters.

The Wilton Growth Area DCP's controls (listed in section 3.3.2) include water quality targets for total suspended solids, total nitrogen and total phosphorous to achieve a '*Neutral or Beneficial Effect on Water Quality – meaning loads of pollutants from future development must be equivalent to or less than that from the existing rural land use prior to development'*.

In accordance with the objectives and controls of the Wilton Growth Area DCP, future developments would include measures to minimise the impacts of the proposal on water quality and achieve the objectives of the DCP.

The construction footprint is small compared to the footprints of existing and proposed developments that could have the potential to impact local groundwater systems and catchments for the Nepean River and Byrnes, Stringybark and Allens creeks. The proposal has been designed to minimise the potential for surface water and groundwater impacts. As a result, potential impacts of the proposal are expected to be negligible over the long term compared to the potential impacts of other developments. The proposal is not considered to present a significant risk of cumulative impacts in the broader area.

With regards to future upgrades of Picton Road, given that construction of the proposal would have been completed (including water quality treatment measures to manage pollutant loads during operation) and future upgrades would also include similar treatment measures, there is expected to be minimal potential for cumulative impacts.

8. Recommended safeguards and management measures

Table 8.1 Summary of safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Managing potential impacts to soil, surface water and groundwater quality	A Construction Soil and Water Management Plan (CSWMP) will be prepared and implemented as part of the CEMP. The CSWMP will identify reasonably foreseeable risks relating to soil erosion and surface and groundwater quality and describe how these risks will be addressed during construction. The CSWMP will be reviewed by a soil conservationist on the Transport for NSW list of Registered Contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services. The CSWMP will then be revised to address the outcomes of the review.	Contractor	Detailed design / pre-construction
	Site-specific Erosion and Sediment Control Plan/s will be prepared and implemented as part of the CSWMP. The plan/s will include: – arrangements for managing wet weather events, including monitoring of potential high-risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather – erosion and sediment controls appropriate for dispersive soils – stabilisation measures to control discharge from stormwater outlets to manager erosion and scour.	Contractor	Detailed design / pre-construction
Water quality	Stormwater management infrastructure will be designed and implemented to meet proposed operational water quality pollutant reduction targets (90% Gross pollutants, 85% total suspended solids, 65% total phosphorus and 45% total nitrates).	Transport for NSW	Detailed design
Water quality monitoring	A surface water quality monitoring program will be developed and implemented as part of the CSWMP in accordance with the *Guidelines for Construction Water Quality Monitoring* (RTA, 2003). The program will define: – monitoring parameters – monitoring locations – frequency and duration of monitoring. The monitoring program will include monitoring prior to the commencement of construction and during construction to inform the implementation of the CSWMP.	Contractor	Pre-construction / construction
Groundwater impacts	Impacts on groundwater during construction will be minimised as far as practicable by: – avoiding the need to extract groundwater – minimising groundwater inflows and volumes into excavations – managing any groundwater encountered during excavations in accordance with the *Technical Guideline – Environmental Management of Construction Site Dewatering* (Roads and Maritime, 2011c).	Contractor	Pre-construction / construction

Impact	Environmental safeguards	Responsibility	Timing
Soil erosion and sedimentation	During any construction and maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction, Volume 1* (Landcom, 2004).	Transport for NSW	Construction / Operation
	Where possible, the rehabilitation of disturbed areas will be undertaken progressively, as construction stages are completed, in accordance with the Urban Design and Landscaping Plan and Appendix G (Rehabilitation recommendations) of *Managing Urban Stormwater – Soils and Construction – Volume 1* (Landcom, 2004).	Contractor	Construction

9. Conclusion

This report has assessed and identified soil, surface water and groundwater impacts that could occur as a result of the construction and operation of the proposal.

The assessment indicated that the proposal is unlikely to result in serious adverse impacts to soils, surface water and groundwater, and the potential construction and operation impacts discussed in this report are common on major road projects.

Construction and operation of the proposal is not predicted to intercept groundwater and therefore the proposal is not predicted to impact groundwater receptors, including groundwater dependent ecosystems and surrounding landholder bores.

Operational impacts on water quality would be mitigated by the construction of stormwater basins that incorporate bio-retention media and planting. The potential increases in pollutant loads resulting from the increase in road surface and imperviousness over the proposal site is unlikely to result in any measurable changes to the water quality of the downstream receiving environments of the minor tributaries of the Nepean River catchment.

With the implementation of the safeguards and management measures provided in this report, and the installation of the proposed water quality treatment devices, potential impacts on soils, surface water and groundwater are considered minor and manageable.

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11. Glossary of terms and abbreviations

Term	Definition
AEP	Annual exceedance probability
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council, 2000
ANZG	Australian and New Zealand Governments
Australian Height Datum (AHD)	A common reference level used in Australia which is approximately equivalent to the height above sea level.
BC Act	*Biodiversity Conservation Act 2016*
bgl	Below ground level
Blue Book	Managing Urban Stormwater – Soils and Construction Volume 1 (Landcom 2004) and Volume 2D – Main Road construction (DECC 2008).
BOM	Bureau of Meteorology
BTEXN	Benzene, toluene, ethylbenzene, xylenes, and naphthalene
Catchment	The area drained by a stream or body of water or the area of land from which water is collected.
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
COPC	Potential contaminants of concern
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSWMP	Construction Soil and Water Management Plan
Datum	A level surface used as a reference in measuring elevations.
DCP	Development Control Plan
DPE	Department of Planning and Environment
DTIRIS	Department of Trade and Investment, Regional Infrastructure and Services
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	NSW Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
ESL	Environmental Screening Levels
GDE	Groundwater dependent ecosystem
GHD	GHD Pty Ltd
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.
HRC	Healthy River Commission
Impervious	In the context of this report, impervious surfaces are surfaces non-permeable to water. These include areas such as paved surfaces or rooves.
Kg/year	Kilograms per year
Km/h	Kilometres per hour
L/s	Litres per second
Landform	A specific feature of the landscape or the general shape of the land.

Term	Definition
LGA	Local government area
m	Metres
m/day	Metres per day
m^3/day	Metres cubed per day
Meteorology	The science concerned with the processes and phenomena of the atmosphere, especially as a means of forecasting the weather.
MUSICX	Model for Urban Stormwater Improvement Conceptualisation
NEMP	National Environmental Management Plan
NorBE	Neutral or Beneficial Effect
NSW	New South Wales
NTU	Nephelometric Turbidity Unit
NWQMS	National Water Quality Management Strategy
OCPs	Organochlorine pesticides
OPPs	Organophosphate pesticides
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', can either re-enter the main channel or be diverted to another watercourse.
PAHs	Polynuclear aromatic hydrocarbons
PCTs	Plant community types
PFAS	Per- and poly-fluoroalkyl substances
PFOS	Perfluorooctane sulfonate
pH	Measure of the acidity or basicity of aqueous or other liquid solutions
POEO Act	*Protection of the Environment Operations Act 1997*
ppm	Parts per million
REF	Review of Environmental Factors
Risk	The chance of something happening that will have an impact measured in terms of likelihood and consequence.
RTA	Roads and Traffic Authority
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.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
SWMP	Soil and Water Management Plan
Transport	Transport for New South Wales
Topography	Representation of the features and configuration of land surfaces.
TN	Total nitrogen
TP	Total phosphorus
TRH	Total recoverable hydrocarbons
TSS	Total suspended solids
Watercourse	Generic term used to refer to rivers, streams and creeks.

Term	Definition
Water quality	Chemical, physical and biological characteristics of water. Also the degree (or lack) of contamination.
Water table	The surface of saturation in an unconfined aquifer, or the level at which pressure of the water is equal to atmospheric pressure.
WM Act	*Water Management Act 2000*
WSP	Water Sharing Plan
WSUD	Water sensitive urban design
µg/L	Micrograms per litre
µS/cm	Microsiemens per centimetre

Appendix A

Registered landholder bores

Table A.1 Registered landholder bores

Borehole ID	Purpose	Bore depth (m)	Standing water level (mbgl)	Salinity (ppm)	Drillers log	Approx. distance from the proposal site (metres)	Drilling date	Easting	Northing	Yield (L/s)	Geology description
GW011042	Stock	47.3	26.8	1001-3000 ppm	1.52 m soil overlying sandstone and shale	1,681	01/01/1954	289617	6208862	-	0.06
GW019590	Farming/ General use	80	44.1	1001-3000 ppm	1.52 m clay overlying shale and sandstone	2,798	01/02/1963	282131	6207118	0.01 - 0.51	Sandstone
GW024644	Irrigation	77.4	48.7 - 56	3001-7000 ppm	0.91 m soil overlying sandstone	134	01/07/1964	286479	6209500	0.03 - 0.19	Sandstone
GW028270	Stock	83.8	38.1 - 39.60	-	1.21 m soil overlying sandstone	2,143	01/11/1966	282471	6207897	0.51	Sandstone
GW045404	Domestic, Stock/ General use	53.3	-	Hard	Sandstone to 53.34 m	2,986	01/01/1952	282217	6206689	-	Sandstone
GW053288	Irrigation	92	28 - 30	1001-3000 ppm	0.4 m topsoil overlying shale and sandstone	2,154	01/10/1981	289756	6207231	0.10 - 1.25	Sandstone
GW056750	Stock	68.9	-	1001-3000 ppm	0.3 m topsoil overlying clay, sandstone, and shale	2,127	01/02/1982	283210	6206928	0.25	Sandstone
GW057797	Domestic, Stock/ Irrigation	106.7	-	Good	0.3 m topsoil overlying shale and sandstone	261	01/08/1982	284062	6211047	0.25 - 0.45	Sandstone
GW058832	Stock	219.5	-	3001-7000	-	2,652		289897	6206618	-	-

Borehole ID	Purpose	Bore depth (m)	Standing water level (mbgl)	Salinity (ppm)	Drillers log	Approx. distance from the proposal site (metres)	Drilling date	Easting	Northing	Yield (L/s)	Geology description
GW059106	Domestic, Stock/ Irrigation	75	-	-	-	2,367	01/01/1982	282268	6207800	-	-
GW062661	Domestic	126.5	-	Good	0.3 m topsoil overlying clay, shale, and sandstone.	2,206	01/10/1985	282609	6207469	0.10 - 0.75	Sandstone
GW064932	Domestic	42	17.8	Good	-	2,545	31/10/1988	290387	6207615	0.3	-
GW067606	Stock, Domestic, Farming	150	94.0 - 98.0	Fresh	0.3 m topsoil overlying shale and sandstone.	1,970	03/10/1989	282421	6212095	0.30 - 2.50	Sandstone
GW100480	Stock, Domestic	148	85	500	1 m soil overlying shale and sandstone.	472	27/03/1995	287377	6209419	0.5	Sandstone, shale
GW100688	Monitoring bore	8	5.42	-	1 m sand with gravel overlying sandstone, sandy clay, and silty clay.	2,849	08/08/1996	289519	6211122	-	Sandstone, silt clay
GW100689	Monitoring bore	8	-	-	0.05 m blue metal gravel overlying sand, sandy clay, and sandstone.	2,848	08/08/1996	289518	6211121	-	Sandstone, sand
GW100690	Monitoring bore	8	4	-	1.6 m sandstone overlying sandy clay and sandstone.	2,849	06/08/1996	289519	6211122	-	-
GW103320	Stock, Domestic	183	76	-	1.8 m clay overlying shale and sandstone.	811	28/08/2000	283769	6210457	0.8	Sandstone

Borehole ID	Purpose	Bore depth (m)	Standing water level (mbgl)	Salinity (ppm)	Drillers log	Approx. distance from the proposal site (metres)	Drilling date	Easting	Northing	Yield (L/s)	Geology description
GW104499	Stock, Domestic	103	34.6	540 – 1180 ppm	3 m clay overlying sandstone.	2,537	01/09/2001	289920	6206816	0.23 - 0.43	Sandstone
GW104546	Stock, Domestic	186	80	-	4 m soil overlying shale and sandstone.	1,112	11/12/2002	283573	6212241	0.04 - 0.33	Sandstone
GW104558	Domestic	186	103	-	-	1,864	11/12/2002	282447	6211841	0.16 - 0.26	Sandstone
GW105787	Stock, Domestic	126	80	-	3 m clay overlying shale and sandstone.	2,579	06/12/2002	282092	6209593	0.38	Sandstone
GW105860	Stock, Domestic	-	-	-	-	1,984	05/05/2005	282520	6208359	-	-
GW105884	Stock, Domestic	-	-	-	-	2,931	09/05/2005	281588	6210112	-	-
GW105944	Stock, Domestic	-	-	-	-	2,394	20/05/2005	282182	6209287	-	-
GW106250	Stock, Domestic	151	62	-	2 m topsoil overlying shale and sandstone.	332	24/05/2004	286336	6209811	0.08 - 0.37	Sandstone
GW106546	Stock, Domestic	116	49	Good	2 m clay overlying shale and sandstone.	2,524	13/11/2002	282785	6206765	0.30 - 0.68	Sandstone
GW107470	Stock, Domestic	132	-	Good	2 m clay overlying shale and sandstone.	2,483	12/03/2004	282069	6208057	0.30 - 0.45	Sandstone
GW107692	Domestic	-	-	-	-	1,160	22/12/2006	283455	6208096	-	-

Borehole ID	Purpose	Bore depth (m)	Standing water level (mbgl)	Salinity (ppm)	Drillers log	Approx. distance from the proposal site (metres)	Drilling date	Easting	Northing	Yield (L/s)	Geology description
GW109278	Test bore	180	48	-	6 m clay overlying greenstone, obsidian, sandstone, shale, gravel, and basalt.	117	27/08/2008	286012	6210468	0.1 - 0.23	Sandstone, shale
GW109279	Test bore	193	44	-	72 m sandstone overlying shale, siltstone, and claystone.	810	28/08/2008	286688	6210293	0.2 - 0.91	Sandstone
GW115763	Stock, Domestic	150	-	-	1 m clay overlying sandstone.	879	05/11/2017	283792.3	6208097.2	0.05 - 0.40	Sandstone
GW116973	-	162	-	-	-	879	-	283792.3	6208097.2	-	-

Notes: SWL: standing water level
'-' denotes no data recorded
m: metres
L/s: litres per second

Appendix B

Water quality testing results

					SW01		SW02				SW03		SW04		SW05				SW06		SW07		SW08		SW09		SW10	
					15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023			15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023			30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023	31 Mar 2023
					SW01	SW01	SW02	SW02	SWQC02A	SWQC02	SW03	SW03	SW04	SW04	SW05	SWQC01	SWQC01A	SW05	SW06	SW06	SW07	SW07	SW08	SW08	SW09	SW09	SW10	SW10
					Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
					Normal	Normal	Normal	Normal	Interlab_D	Field_D	Normal	Normal	Normal	Normal	Normal	Field_D	Interlab_D	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
					ES2308626	ES2310922	ES2308626	ES2310922	320146	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2308626	318826	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922
	Unit	EQL	ANZG (2018) - FW - 95% (updated 26 July 2021)	CEPA tier 1 aquatic habitat goal level - Freshwater Ecotox																								
Acidity & Alkalinity																												
Hardness as CaCO3 (filtered)	mg/L	1			51	95	147	294	-	294	137	152	144	168	72	79	-	79	125	145	202	215	40	20	66	219	203	214
Major Ions																												
Calcium (filtered)	mg/L	0.5			14	-	26	-	40	-	17	-	18	-	14	15	14	-	17	-	23	-	6	-	10	-	45	-
Magnesium (filtered)	mg/L	0.5			4	-	20	-	37	-	23	-	24	-	9	10	9.3	-	20	-	35	-	6	-	10	-	22	-
Potassium (filtered)	mg/L	0.5			3	-	5	-	-	-	11	-	12	-	17	16	15	-	7	-	7	-	5	-	8	-	4	-
Sodium (filtered)	mg/L	0.5			23	-	138	-	-	-	77	-	81	-	29	30	27	-	95	-	128	-	51	-	58	-	56	-
Chloride	mg/L	1			15	-	212	-	-	-	149	-	151	-	24	24	22	-	230	-	283	-	44	-	67	-	90	-
Cations Total	meq/L	0.01			2.10	-	9.07	-	-	-	6.72	-	6.70	-	3.14	3.28	-	-	6.90	-	9.90	-	3.14	-	4.05	-	6.59	-
Anions Total	meq/L	0.01			2.18	-	9.96	-	-	-	7.24	-	7.16	-	3.27	3.23	-	-	7.55	-	11.0	-	3.46	-	4.42	-	7.28	-
Ionic Balance	%	0.01			-	-	4.65	-	-	-	3.73	-	3.27	-	2.17	0.78	-2.0	-	4.50	-	5.48	-	4.93	-	4.33	-	4.93	-
Nutrients																												
Ammonia as N	mg/L	0.005	0.9[#1]		0.02	<0.01	0.01	0.12	-	0.12	0.19	0.08	0.07	0.10	0.26	0.25	-	0.28	0.34	0.58	0.03	0.02	<0.01	<0.01	<0.01	0.01	0.02	0.01
Ammonia as N (filtered)	mg/L	0.005	0.9[#1]		-	-	-	-	0.064	-	-	-	-	-	-	-	0.22	-	-	-	-	-	-	-	-	-	-	-
Nitrogen (Total Oxidised) (as N)	mg/L	0.01			-	0.41	-	0.95	-	1.01	-	0.08	-	0.48	-	-	-	<0.01	-	0.04	-	<0.01	-	0.12	-	0.16	-	0.10
Nitrogen (Total)	mg/L	0.1			5.3	1.9	1.1	2.0	1.6	2.1	4.9	1.1	0.4	1.5	3.2	3.9	1.0	7.4	1.3	2.3	1.8	1.7	0.3	0.3	0.3	0.4	1.2	0.5
Kjeldahl Nitrogen Total	mg/L	0.1			-	1.5	-	1.1	-	1.1	-	1.0	-	1.0	-	-	-	7.4	-	2.3	-	1.7	-	0.2	-	0.2	-	0.4
Phosphorus (Total)	mg/L	0.01			1.44	0.25	0.17	0.07	<0.05	0.09	0.17	0.06	0.02	0.06	0.46	0.64	0.26	1.69	0.10	0.11	0.08	0.08	0.03	0.02	0.02	0.03	0.06	0.03
Metals																												
Aluminium	mg/L	0.01	0.055[#2]		15.4	3.28	1.37	0.91	-	1.04	0.08	0.04	0.16	0.11	4.34	3.89	3.1	13.2	0.02	0.01	0.08	0.10	0.01	0.04	0.04	0.07	0.15	0.08
Aluminium (filtered)	mg/L	0.01	0.055[#2]		0.03	0.03	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Arsenic	mg/L	0.001	0.013[#3]		0.004	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	0.001	<0.001	0.003	0.004	0.003	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Arsenic (filtered)	mg/L	0.001	0.013[#3]		-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Boron	mg/L	0.02	0.94		0.06	<0.05	0.06	<0.05	-	<0.05	0.05	<0.05	0.05	<0.05	0.06	0.05	0.04	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05
Boron (filtered)	mg/L	0.02	0.94		<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	0.0002		<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium (filtered)	mg/L	0.0001	0.0002		-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
Chromium (III+VI)	mg/L	0.001	0.001[#4]		0.014	0.003	0.001	<0.001	-	0.002	<0.001	<0.001	<0.001	<0.001	0.005	0.005	0.004	0.016	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (III+VI) (filtered)	mg/L	0.001	0.001[#4]		-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Copper	mg/L	0.001	0.0014		0.025	0.007	0.003	0.001	-	0.002	<0.001	<0.001	<0.001	<0.001	0.012	0.011	0.011	0.036	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Copper (filtered)	mg/L	0.001	0.0014		-	0.007	0.006	0.002	0.003	0.002	0.006	0.004	0.005	0.002	0.005	0.001	-	0.005	0.003	0.002	0.005	0.002	0.004	0.006	0.005	0.005	0.008	0.004
Lead	mg/L	0.001	0.0034		0.021	0.005	0.002	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.009	0.01	0.033	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (filtered)	mg/L	0.001	0.0034		-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Manganese	mg/L	0.001	1.9		0.609	0.353	0.393	0.307	-	0.371	0.383	0.271	0.209	0.119	1.17	1.25	1	1.19	0.294	0.687	0.429	0.423	0.017	0.141	0.096	0.099	0.047	0.072
Manganese (filtered)	mg/L	0.001	1.9		0.044	0.017	0.208	0.279	0.27	0.275	0.305	0.260	0.147	0.095	0.651	0.634	-	0.425	0.178	0.327	0.051	0.185	<0.001	0.110	0.051	0.067	0.036	0.067
Mercury	mg/L	0.00004	0.0006		0.00004	<0.00004	<0.00004	<0.00004	-	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00005	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Mercury (filtered)	mg/L	0.00004	0.0006		<0.00004	<0.00004	<0.00004	<0.00004	<0.00005	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	-	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Nickel	mg/L	0.001	0.011		0.012	0.003	0.002	0.001	-	0.001	0.001	<0.001	<0.001	<0.001	0.008	0.008	0.006	0.017	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	0.003	0.002	<0.001	<0.001
Nickel (filtered)	mg/L	0.001	0.011		-	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	-	0.002	<0.001	<0.001	<0.001	<0.001	0.004	0.001	0.003	<0.001	0.001	0.001
Selenium	mg/L	0.001	0.011		<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (filtered)	mg/L	0.001	0.011		<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.00001	0.00005		-	-	-	-	-	-	-	-	-	-	-	-	<0.001	-	-	-	-	-	-	-	-	-	-	-
Silver (filtered)	mg/L	0.00001	0.00005		<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.0001	-	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001
Zinc	mg/L	0.001	0.008		0.034	0.015	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	0.008	0.032	0.079	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (filtered)	mg/L	0.001	0.008		-	<0.005	<0.005	<0.005	0.002	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005
BTEXN																												
Benzene	µg/L	1	950		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	1	180		<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	1	80		<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	1	350		<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2			<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2			<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
BTEX (Sum of Total) - Lab Calc	µg/L	1			<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	0.02	16		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
TRH - NEPM 2013																												
F1 (C6-C10 minus BTEX)	µg/L	10			<20	<20	<20	<20	<10	<20	<20	<20	<20	<20	<20	<20	<10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C6-C10 Fraction	µg/L	10		443	<20	<20	<20	<20	<10	<20	<20	<20	<20	<20	<20	<20	<10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
F2 (>C10-C16 minus Naphthalene)	µg/L	50			<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	250
>C10-C16 Fraction	µg/L	50		640	<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	250
F3 (>C16-C34 Fraction)	µg/L	100			<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	180	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F4 (>C34-C40 Fraction)	µg/L	100			<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10-C40 (Sum of Total)	µg/L	50			<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	180	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	250
TPH																												

					SW01		SW02				SW03		SW04		SW05				SW06		SW07		SW08		SW09		SW10	
					15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023			15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023			30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023	31 Mar 2023
					SW01	SW01	SW02	SW02	SWQC02A	SWQC02	SW03	SW03	SW04	SW04	SW05	SWQC01	SWQC01A	SW05	SW06	SW06	SW07	SW07	SW08	SW08	SW09	SW09	SW10	SW10
					Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
					Normal	Normal	Normal	Normal	Interlab_D	Field_D	Normal	Normal	Normal	Normal	Normal	Field_D	Interlab_D	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
					ES2308626	ES2310922	ES2308626	ES2310922	320146	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2308626	318826	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922
	Unit	EQL	ANZG (2018) - FW - 95% (updated 26 July 2021)	CEPA tier 1 aquatic habitat goal level - Freshwater Ecotox																								
Oil & Grease	µg/L	5,000			<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	5,000	<5,000	<5,000	<5,000	<5,000	<5,000	6,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000
PAHs - standard 16																												
Acenaphthene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthylene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Anthracene	µg/L	0.01	0.4		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benz(a)anthracene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(a)pyrene	µg/L	0.005	0.2		<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[b+j]fluoranthene	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(k)fluoranthene	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(g,h,i)perylene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chrysene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dibenz(a,h)anthracene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	µg/L	0.01	1.4		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluorene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Indeno(1,2,3-c,d)pyrene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phenanthrene	µg/L	0.01	2		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Pyrene	µg/L	0.01			<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PAHs (Sum of total) - Lab calc	µg/L	0.005			<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.005			<0.005	<0.005	<0.005	<0.005	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
PAHs - extended																												
Benzo(b+j+k)fluoranthene	µg/L	0.02			-	-	-	-	<0.02	-	-	-	-	-	-	-	<0.02	-	-	-	-	-	-	-	-	-	-	-
OC Pesticides																												
4,4'-DDE	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
a-BHC	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Aldrin	µg/L	0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin + Dieldrin	µg/L	0.002			<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
b-BHC	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlordane	µg/L	0.001	0.08		<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (cis)	µg/L	0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (trans)	µg/L	0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
d-BHC	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4 DDD	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4 DDT	µg/L	0.001	0.01		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
DDT+DDE+DDD - Lab Calc	µg/L	0.002			<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Dieldrin	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan	µg/L	0.002	0.2		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan I (alpha)	µg/L	0.002			<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan II (beta)	µg/L	0.002			<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan Sulfate	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin	µg/L	0.001	0.02		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin aldehyde	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin ketone	µg/L	0.002			<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
g-BHC (Lindane)	µg/L	0.001	0.2		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor	µg/L	0.001	0.09		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor epoxide	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachlorobenzene	µg/L	0.001	0.1		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methoxychlor	µg/L	0.001			<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Oxychlordane	µg/L	0.002			<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
OP Pesticides																												
Bensulide	µg/L	0.1			<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Naftalofos	µg/L	1			<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Azinphos methyl	µg/L	0.02	0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Bolstar (Sulprofos)	µg/L	0.05			<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bromophos-ethyl	µg/L	0.1			<0.10	<0.10	<0.10	<0.10	<0.2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Carbophenothion	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Azinphos Ethyl	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chlorfenvinphos	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chlorpyrifos	µg/L	0.009	0.01		<0.02	<0.02	<0.02	<0.02	<0.009	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.009	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chlorpyrifos-methyl	µg/L	0.2			<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Coumaphos	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Demeton-O	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Demeton-S	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Demeton-S-methyl	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Diazinon	µg/L	0.01	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dichlorvos	µg/L	0.2			<0.20	<0.20	<0.20	<0.20	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Dimethoate	µg/L	0.02	0.15		<0.02	<0.02	<0.02	<0.02	<0.15	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.15	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Disulfoton	µg/L	0.05			<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
EPN	µg/L	0.05			<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

					SW01		SW02				SW03		SW04		SW05				SW06		SW07		SW08		SW09		SW10	
					15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023			15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023			30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023	31 Mar 2023
					SW01	SW01	SW02	SW02	SWOC02A	SWQC02	SW03	SW03	SW04	SW04	SW05	SWQC01	SWQC01A	SW05	SW06	SW06	SW07	SW07	SW08	SW08	SW09	SW09	SW10	SW10
					Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
					Normal	Normal	Normal	Normal	Interlab_D	Field_D	Normal	Normal	Normal	Normal	Normal	Field_D	Interlab_D	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
					ES2308626	ES2310922	ES2308626	ES2310922	320146	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2308626	318826	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922
	Unit	EQL	ANZG (2018) - FW - 95% (updated 26 July 2021)	CEPA tier 1 aquatic habitat goal level - Freshwater Ecotox																								
Ethion	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ethoprop	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fenamiphos	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fenitrothion	µg/L	0.2	0.2		<2	<2	<2	<2	<0.2	<2	<2	<2	<2	<2	<2	<2	<0.2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Fensulfothion	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fenthion	µg/L	0.05			<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Malathion	µg/L	0.02	0.05		<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Methidathion	µg/L	0.1			<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methyl parathion	µg/L	0.2			<0.5	<0.5	<0.5	<0.5	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mevinphos (Phosdrin)	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Monocrotophos	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Omethoate	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Parathion	µg/L	0.004	0.004		<0.2	<0.2	<0.2	<0.2	<0.004	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.004	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phorate	µg/L	0.1			<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pirimphos-ethyl	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pirimiphos-methyl	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Profenofos	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Prothiofos	µg/L	0.1			<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrazophos	µg/L	0.1			<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ronnel	µg/L	0.2			<10	<10	<10	<10	<0.2	<10	<10	<10	<10	<10	<10	<10	<0.2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sulfotepp	µg/L	0.005			<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Terbufos	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thiometon	µg/L	0.5			<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloronate	µg/L	0.5			<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetrachlorvinphos	µg/L	0.01			<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pesticides																												
Acephate	µg/L	0.5			<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-O & Demeton-S	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Formothion	µg/L	20			<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Temephos	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trichlorfon	µg/L	0.02			<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Triazophos	µg/L	0.005			<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fungicides																												
Fosetyl-al	µg/L	10			<10	<10	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Comments
#1 Measured as NH3-N at pH 8
#2 (pH >6.5, 0.8 ug/L for pH<6.5)
#3 In absence of total As guideline, As (V) guideline has been adopted.
#4 In absence of total Cr guideline, Cr (VI) guideline has been adopted.

			Field ID	SW01	SW01	SW02	SW02	SWQC02	SW03	SW03	SW04	SW04	SW05	SWQC01	SW05	SW06	SW06	SW07	SW07	SW08	SW08	SW09	SW09	SW10	SW10
Analyte	Unit	EQL	ANZG (2018) - FW - 95% (updated 26 July 2021)	Round 1	Round 2	Round 1	Round 2	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2	Round 1	Round 2
Acidity & Alkalinity				51	95	147	294	294	137	152	144	168	72	79	79	125	145	202	215	40	20	66	219	203	214
Hardness as CaCO3 (filtered)	mg/L	1																							
Hardness adjusted criterion				0.0003	0.0006	0.0008	0.0015	0.0015	0.0008	0.0008	0.0008	0.0009	0.0004	0.0005	0.0005	0.0007	0.0008	0.0011	0.0012	0.0003	0.0001	0.0004	0.0012	0.0011	0.0011
Cadmium	mg/L	0.0001	0.0002	<0.0001		<0.0001			<0.0001		<0.0001		<0.0001	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Cadmium (filtered)	mg/L	0.0001	0.0002	-		<0.0001			<0.0001		<0.0001		<0.0001	<0.0001		<0.0001		<0.0001		0.0001		<0.0001		0.0002	
Hardness adjusted criterion				0.002	0.003	0.004	0.006	0.006	0.003	0.004	0.004	0.004	0.002	0.002	0.002	0.003	0.004	0.005	0.005	0.001	0.001	0.002	0.005	0.005	0.005
Chromium (III+VI)	mg/L	0.001	0.001	0.014	0.003	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.005	0.005	0.016	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (III+VI) (filtered)	mg/L	0.001	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Hardness adjusted criterion				0.007	0.015	0.026	0.062	0.062	0.023	0.027	0.025	0.030	0.010	0.012	0.012	0.021	0.025	0.038	0.041	0.005	0.002	0.009	0.042	0.039	0.041
Lead	mg/L	0.001	0.003	0.021	0.005	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.01	0.033	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (filtered)	mg/L	0.001	0.003	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Hardness adjusted criterion				0.017	0.029	0.042	0.077	0.077	0.040	0.044	0.042	0.048	0.023	0.025	0.025	0.037	0.042	0.056	0.059	0.014	0.008	0.022	0.060	0.056	0.058
Nickel	mg/L	0.001	0.011	0.012	0.003	0.002	0.001	0.001	0.001	<0.001	<0.001	<0.001	0.008	0.006	0.017	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	0.003	0.002	<0.001	<0.001
Nickel (filtered)	mg/L	0.001	0.011	-	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.002	-	0.002	<0.001	<0.001	<0.001	<0.001	0.004	0.001	0.003	<0.001	0.001	0.001
Hardness adjusted criterion				0.013	0.021	0.031	0.056	0.056	0.029	0.032	0.030	0.035	0.017	0.018	0.018	0.027	0.031	0.040	0.043	0.010	0.006	0.016	0.043	0.041	0.042
Zinc	mg/L	0.001	0.008	0.034	0.015	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	0.032	0.079	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (filtered)	mg/L	0.001	0.008	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005

				SW01		SW02				SW03		SW04		SW05				SW06		SW07		SW08		SW09		SW10	
				15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023			15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023			30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023	31 Mar 2023
				SW01	SW01	SW02	SW02	SWOC02A	SWQC02	SW03	SW03	SW04	SW04	SW05	SWQC01	SWQC01A	SW05	SW06	SW06	SW07	SW07	SW08	SW08	SW09	SW09	SW10	SW10
				Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
				Normal	Normal	Normal	Normal	Interlab_D	Field_D	Normal	Normal	Normal	Normal	Normal	Field_D	Interlab_D	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
				ES2308626	ES2310922	ES2308626	ES2310922	320146	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2308626	318826	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922
	Unit	EQL	ADWG 2011 Recreational (v 3.7 updated 2022)																								
Acidity & Alkalinity																											
Hardness as CaCO3 (filtered)	mg/L	1		51	95	147	294	-	294	137	152	144	168	72	79	-	79	125	145	202	215	40	20	66	219	203	214
Major Ions																											
Calcium (filtered)	mg/L	0.5		14	-	26	-	40	-	17	-	18	-	14	15	14	-	17	-	23	-	6	-	10	-	45	-
Magnesium (filtered)	mg/L	0.5		4	-	20	-	37	-	23	-	24	-	9	10	9.3	-	20	-	35	-	6	-	10	-	22	-
Potassium (filtered)	mg/L	0.5		3	-	5	-	-	-	11	-	12	-	17	16	15	-	7	-	7	-	5	-	8	-	4	-
Sodium (filtered)	mg/L	0.5		23	-	138	-	-	-	77	-	81	-	29	30	27	-	95	-	128	-	51	-	58	-	56	-
Chloride	mg/L	1		15	-	212	-	-	-	149	-	151	-	24	24	22	-	230	-	283	-	44	-	67	-	90	-
Cations Total	meq/L	0.01		2.10	-	9.07	-	-	-	6.72	-	6.70	-	3.14	3.28	-	-	6.90	-	9.90	-	3.14	-	4.05	-	6.59	-
Anions Total	meq/L	0.01		2.18	-	9.96	-	-	-	7.24	-	7.16	-	3.27	3.23	-	-	7.55	-	11.0	-	3.46	-	4.42	-	7.28	-
Ionic Balance	%	0.01		-	-	4.65	-	-	-	3.73	-	3.27	-	2.17	0.78	-2.0	-	4.50	-	5.48	-	4.93	-	4.33	-	4.93	-
Nutrients																											
Ammonia as N	mg/L	0.005		0.02	<0.01	0.01	0.12	-	0.12	0.19	0.08	0.07	0.10	0.26	0.25	-	0.28	0.34	0.58	0.03	0.02	<0.01	<0.01	<0.01	0.01	0.02	0.01
Ammonia as N (filtered)	mg/L	0.005		-	-	-	-	0.064	-	-	-	-	-	-	-	0.22	-	-	-	-	-	-	-	-	-	-	-
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		-	0.41	-	0.95	-	1.01	-	0.08	-	0.48	-	-	-	<0.01	-	0.04	-	<0.01	-	0.12	-	0.16	-	0.10
Nitrogen (Total)	mg/L	0.1		5.3	1.9	1.1	2.0	1.6	2.1	4.9	1.1	0.4	1.5	3.2	3.9	1.0	7.4	1.3	2.3	1.8	1.7	0.3	0.3	0.3	0.4	1.2	0.5
Kjeldahl Nitrogen Total	mg/L	0.1		-	1.5	-	1.1	-	1.1	-	1.0	-	1.0	-	-	-	7.4	-	2.3	-	1.7	-	0.2	-	0.2	-	0.4
Phosphorus (Total)	mg/L	0.01		1.44	0.25	0.17	0.07	<0.05	0.09	0.17	0.06	0.02	0.06	0.46	0.64	0.26	1.69	0.10	0.11	0.08	0.08	0.03	0.02	0.02	0.03	0.06	0.03
Metals																											
Aluminium	mg/L	0.01		15.4	3.28	1.37	0.91	-	1.04	0.08	0.04	0.16	0.11	4.34	3.89	3.1	13.2	0.02	0.01	0.08	0.10	0.01	0.04	0.04	0.07	0.15	0.08
Aluminium (filtered)	mg/L	0.01		0.03	0.03	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Arsenic	mg/L	0.001	0.1	0.004	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	0.001	<0.001	0.003	0.004	0.003	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Arsenic (filtered)	mg/L	0.001	0.1	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Boron	mg/L	0.02	40	0.06	<0.05	0.06	<0.05	-	<0.05	0.05	<0.05	0.05	<0.05	0.06	0.05	0.04	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05
Boron (filtered)	mg/L	0.02	40	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	mg/L	0.0001	0.02	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium (filtered)	mg/L	0.0001	0.02	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
Chromium (III+VI)	mg/L	0.001		0.014	0.003	0.001	<0.001	-	0.002	<0.001	<0.001	<0.001	<0.001	0.005	0.005	0.004	0.016	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium (III+VI) (filtered)	mg/L	0.001		-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Copper	mg/L	0.001	20	0.025	0.007	0.003	0.001	-	0.002	<0.001	<0.001	<0.001	<0.001	0.012	0.011	0.011	0.036	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Copper (filtered)	mg/L	0.001	20	-	0.007	0.006	0.002	0.003	0.002	0.006	0.004	0.005	0.002	0.005	0.001	-	0.005	0.003	0.002	0.005	0.002	0.004	0.006	0.005	0.005	0.008	0.004
Lead	mg/L	0.001	0.1	0.021	0.005	0.002	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	0.009	0.01	0.033	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (filtered)	mg/L	0.001	0.1	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Manganese	mg/L	0.001	5	0.609	0.353	0.393	0.307	-	0.371	0.383	0.271	0.209	0.119	1.17	1.25	1	1.19	0.294	0.687	0.429	0.423	0.017	0.141	0.096	0.099	0.047	0.072
Manganese (filtered)	mg/L	0.001	5	0.044	0.017	0.208	0.279	0.27	0.275	0.305	0.260	0.147	0.095	0.651	0.634	-	0.425	0.178	0.327	0.051	0.185	<0.001	0.110	0.051	0.067	0.036	0.067
Mercury	mg/L	0.00004	0.01	0.00004	<0.00004	<0.00004	<0.00004	-	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00005	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Mercury (filtered)	mg/L	0.00004	0.01	<0.00004	<0.00004	<0.00004	<0.00004	<0.00005	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	-	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
Nickel	mg/L	0.001	0.2	0.012	0.003	0.002	0.001	-	0.001	0.001	<0.001	<0.001	<0.001	0.008	0.008	0.006	0.017	<0.001	<0.001	<0.001	<0.001	0.005	<0.001	0.003	0.002	<0.001	<0.001
Nickel (filtered)	mg/L	0.001	0.2	-	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	-	0.002	<0.001	<0.001	<0.001	<0.001	0.004	0.001	0.003	<0.001	0.001	0.001
Selenium	mg/L	0.001	0.1	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (filtered)	mg/L	0.001	0.1	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	mg/L	0.00001	1	-	-	-	-	-	-	-	-	-	-	-	-	<0.001	-	-	-	-	-	-	-	-	-	-	-
Silver (filtered)	mg/L	0.00001	1	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.0001	-	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001	<0.0001	<0.00001
Zinc	mg/L	0.001		0.034	0.015	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	0.008	0.032	0.079	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (filtered)	mg/L	0.001		-	<0.005	<0.005	<0.005	0.002	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	<0.005
BTEXN																											
Benzene	µg/L	1	10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	1	8000	<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Ethylbenzene	µg/L	1	3000	<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (o)	µg/L	1		<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<1	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene (m & p)	µg/L	2		<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Xylene Total	µg/L	2	6000	<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
BTEX (Sum of Total) - Lab Calc	µg/L	1		<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
TRH - NEPM 2013																											
F1 (C6-C10 minus BTEX)	µg/L	10		<20	<20	<20	<20	<10	<20	<20	<20	<20	<20	<20	<20	<10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
C6-C10 Fraction	µg/L	10		<20	<20	<20	<20	<10	<20	<20	<20	<20	<20	<20	<20	<10	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
F2 (>C10-C16 minus Naphthalene)	µg/L	50		<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	250
>C10-C16 Fraction	µg/L	50		<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	250
F3 (>C16-C34 Fraction)	µg/L	100		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	180	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F4 (>C34-C40 Fraction)	µg/L	100		<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
>C10-C40 (Sum of Total)	µg/L	50		<100	<100	<100	<100	<50	<100	<100	<100	<100	<100	<100	<100	180	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	250
TPH																											
Oil & Grease	µg/L	5,000		<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	5,000	<5,000	<5,000	<5,000	<5,000	<5,000	6,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000	<5,000

				SW01		SW02				SW03		SW04		SW05				SW06		SW07		SW08		SW09		SW10	
				15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023			15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023			30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023	31 Mar 2023
				SW01	SW01	SW02	SW02	SWOC02A	SWQC02	SW03	SW03	SW04	SW04	SW05	SWQC01	SWQC01A	SW05	SW06	SW06	SW07	SW07	SW08	SW08	SW09	SW09	SW10	SW10
				Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
				Normal	Normal	Normal	Normal	Interlab_D	Field_D	Normal	Normal	Normal	Normal	Normal	Field_D	Interlab_D	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
				ES2308626	ES2310922	ES2308626	ES2310922	320146	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2308626	318826	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922
	Unit	EQL	ADWG 2011 Recreational (v 3.7 updated 2022)																								
PAHs - standard 16																											
Acenaphthene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Acenaphthylene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Anthracene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benz(a)anthracene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(a)pyrene	µg/L	0.005	0.1	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Benzo[b+j]fluoranthene	µg/L	0.02		<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(k)fluoranthene	µg/L	0.02		<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(g,h,i)perylene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chrysene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Dibenz(a,h)anthracene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluorene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Indeno(1,2,3-c,d)pyrene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phenanthrene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Pyrene	µg/L	0.01		<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PAHs (Sum of total) - Lab calc	µg/L	0.005		<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total 8 PAHs (as BaP TEQ)(zero LOR) - Lab Calc	µg/L	0.005		<0.005	<0.005	<0.005	<0.005	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
OC Pesticides																											
4,4'-DDE	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
a-BHC	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Aldrin	µg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Aldrin + Dieldrin	µg/L	0.002	3	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
b-BHC	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Chlordane	µg/L	0.001	20	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (cis)	µg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane (trans)	µg/L	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
d-BHC	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4 DDD	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4 DDT	µg/L	0.001	90	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
DDT+DDE+DDD - Lab Calc	µg/L	0.002		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Dieldrin	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan	µg/L	0.002	200	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan I (alpha)	µg/L	0.002		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan II (beta)	µg/L	0.002		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endosulfan Sulfate	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin aldehyde	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin ketone	µg/L	0.002		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
g-BHC (Lindane)	µg/L	0.001	100	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor	µg/L	0.001	3	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor epoxide	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Hexachlorobenzene	µg/L	0.001		<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Methoxychlor	µg/L	0.001	3000	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Oxychlordane	µg/L	0.002		<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
OP Pesticides																											
Bensulide	µg/L	0.1		<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Naftalofos	µg/L	1		<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Azinphos methyl	µg/L	0.02	300	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Bolstar (Sulprofos)	µg/L	0.05	100	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bromophos-ethyl	µg/L	0.1	100	<0.10	<0.10	<0.10	<0.10	<0.2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Carbophenothion	µg/L	0.02	5	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Azinphos Ethyl	µg/L	0.02		<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chlorfenvinphos	µg/L	0.02	20	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chlorpyrifos	µg/L	0.009	100	<0.02	<0.02	<0.02	<0.02	<0.009	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.009	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chlorpyrifos-methyl	µg/L	0.2		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Coumaphos	µg/L	0.01		<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Demeton-O	µg/L	0.02		<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Demeton-S	µg/L	0.02		<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Demeton-S-methyl	µg/L	0.02		<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Diazinon	µg/L	0.01	40	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dichlorvos	µg/L	0.2	50	<0.20	<0.20	<0.20	<0.20	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Dimethoate	µg/L	0.02	70	<0.02	<0.02	<0.02	<0.02	<0.15	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.15	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Disulfoton	µg/L	0.05	40	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
EPN	µg/L	0.05		<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethion	µg/L	0.02	40	<0.02	<0.02	<0.02	<0.02	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.2	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ethoprop	µg/L	0.01	10	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fenamiphos	µg/L	0.01	5	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

				SW01		SW02				SW03		SW04		SW05				SW06		SW07		SW08		SW09		SW10	
				15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023			15 Mar 2023	31 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023			30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	14 Mar 2023	30 Mar 2023	15 Mar 2023	31 Mar 2023
				SW01	SW01	SW02	SW02	SWOC02A	SWQC02	SW03	SW03	SW04	SW04	SW05	SWQC01	SWQC01A	SW05	SW06	SW06	SW07	SW07	SW08	SW08	SW09	SW09	SW10	SW10
				Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
				Normal	Normal	Normal	Normal	Interlab_D	Field_D	Normal	Normal	Normal	Normal	Normal	Field_D	Interlab_D	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
				ES2308626	ES2310922	ES2308626	ES2310922	320146	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2308626	318826	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922	ES2308626	ES2310922
	Unit	EQL	ADWG 2011 Recreational (v 3.7 updated 2022)																								
Fenitrothion	µg/L	0.2	70	<2	<2	<2	<2	<0.2	<2	<2	<2	<2	<2	<2	<2	<0.2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Fensulfothion	µg/L	0.01	100	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fenthion	µg/L	0.05	70	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Malathion	µg/L	0.02	700	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Methidathion	µg/L	0.1	60	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methyl parathion	µg/L	0.2	7	<0.5	<0.5	<0.5	<0.5	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mevinphos (Phosdrin)	µg/L	0.02	50	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Monocrotophos	µg/L	0.02	20	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Omethoate	µg/L	0.01	10	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Parathion	µg/L	0.004	200	<0.2	<0.2	<0.2	<0.2	<0.004	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.004	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phorate	µg/L	0.1		<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pirimphos-ethyl	µg/L	0.01	5	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pirimiphos-methyl	µg/L	0.01	900	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Profenofos	µg/L	0.01	3	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Prothiofos	µg/L	0.1		<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrazophos	µg/L	0.1	200	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ronnel	µg/L	0.2		<10	<10	<10	<10	<0.2	<10	<10	<10	<10	<10	<10	<10	<0.2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sulfotepp	µg/L	0.005		<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Terbufos	µg/L	0.01	9	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thiometon	µg/L	0.5	40	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloronate	µg/L	0.5		<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetrachlorvinphos	µg/L	0.01	1000	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pesticides																											
Acephate	µg/L	0.5	80	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-O & Demeton-S	µg/L	0.02		<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Formothion	µg/L	20	500	<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Temephos	µg/L	0.02	4000	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Trichlorfon	µg/L	0.02	70	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Triazophos	µg/L	0.005		<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Fungicides																											
Fosetyl-al	µg/L	10		<10	<10	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

Appendix C

Stormwater basin design

C1 Stormwater treatment design criteria and options analysis

C1.1 Pollutant reduction targets

As part of the water quality investigations for the proposal, a series of workshops were held with Transport to determine appropriate water quality treatment targets and assess potential water quality treatment measures to meet these targets.

The proposed treatment targets for water quality treatment measures have been designed with regard to the following:

– *Water Sensitive Urban Design Guideline* (Roads and Maritime Services, 2017)
– *Water Sensitive Urban Design Guidelines* (Wollondilly Shire Council, 2020
– *Wilton Growth Area Development Control Plan 2021* (DPIE, 2021).

The per cent reduction in pollutant load targets for the proposal, are based on the water quality objectives specified in the *Water Sensitive Urban Design Guideline* (Roads and Maritime Services, 2017), and are listed in Table C.1.

Table C.1 Pollutant load reduction targets

Stormwater pollutant	Pollutant reduction target (%)
Gross pollutants (> 5 mm)	90
Total suspended solids	85
Total phosphorus	65
Total nitrogen	45

These targets are consistent with other relevant guidelines and plans, including the requirements of the *Sydney Metropolitan Catchment Management Authority, Draft NSW MUSIC Modelling Guidelines.*

In addition, although not directly relevant to the proposal as an activity subject to Division 5.1 of the EP&A Act, the Wilton Growth Area DCP provides objectives and controls that development needs to satisfy in relation to water cycle management (including water quality). These controls (defined in section 3.3.2 of the DCP) include water quality targets for total suspended solids, total nitrogen and total phosphorous to achieve a '*Neutral or Beneficial Effect on Water Quality – meaning loads of pollutants from future development must be equivalent to or less than that from the existing rural land use prior to development'*.

C1.2 Potential treatment measures

Selection of the drainage network/potential treatment measures for the proposal is influenced by the following features and constraints:

– a pit and pipe network for collection and transfer of water from the road surface, i.e. concentrated flow within the drainage network, noting that this includes the existing road surface and developed surface and surrounding areas draining to the network
– several upstream catchments that drain through the proposal site
– an undulating alignment that crosses several catchments, with several discharge locations
– grades of approximately four per cent on local slopes
– large cut and fill batters
– a limitation on the available land area for treatment due to development pressures for the Wilton Growth Area
– an increase in paved surface resulting from the proposal of approximately 6.2 hectares, or 64 per cent increase relative to existing road surface area
– spill containment measures that require a volume of 30,000 litres of storage at drainage outlets.

The following treatment measures have been considered in terms of their suitability for use as part of the proposal's drainage network.

C1.2.1 Do nothing

This option was not considered feasible as it would not address the existing pollutant loads or increases in pollutant loads resulting from the proposal and would not meet spill storage volume requirements.

C1.2.2 Vegetated swales

Vegetated swales are unlined open channels with vegetation planted within the channel to slow the flow of water and provide treatment by sedimentation, infiltration, sorption to soil and biological treatment by plants and soil.

Vegetated swales require overland sheet flow from a road surface, rather than a piped system that concentrates flow, as is the case with the proposal. The grades at Picton Road (approximately four per cent) would require extensive earthworks to accommodate swales along cut or fill batters. Swales would not meet spill storage volume requirements.

C1.2.3 Gross pollutant traps

A gross pollutant trap is a device the is generally located at the outlet of a piped drainage system to remove large debris such as litter, often with the capacity to remove larger sediments. These are often proprietary devices that have been designed for ease of maintenance, minimal head loss and are able to function without creating flooding or drainage issues when full of trapped material.

The use of gross pollutant traps for the proposal was not preferred as they require additional maintenance requirements. They can be considered further in detailed design as they enhance the performance, life and reduce the maintenance requirements for additional treatment measures such as bio-retention basins.

C1.2.4 Sediment basin

A sediment basin is a large open basin, lined or unlined, that traps runoff, retaining litter, debris and sediment through settlement. Sediment basins are proposed for use during the construction period of the proposal, where sediment laden runoff form open construction and disturbed areas would be trapped, and sediment settles out prior to manual release once water quality parameters have been met.

Sediment basins would require large surface areas (with associated acquisition requirements) at the drainage network outlet. Sediment basins would also require maintenance after each storm event to allow discharge once treatment has occurred. Sediment basins are also prone to resuspension of material.

C1.2.5 Tree pits

Tree pits are biological treatment systems attached to drainage pits that incorporate a deep soil filter media and plants. They remove pollutants by sedimentation, filtration, sorption and biological uptake. Tree pits can be installed on a standard pit and pipe network but would require protection from traffic in the high speed area of Picton Road.

C1.2.6 Open water wetlands/treatment ponds

Open water ponds for water quality treatment provides little interaction with soil biota and plant roots, the location of biological treatment. As a result of this limited interaction, open water would require large surface areas (and associated acquisition requirements) at the drainage network outlet, along with extensive earthworks to retain water. Open water would require protection from traffic in the high speed area of Picton Road.

C1.2.7 Bio-retention basin

Bio-retention basins are lined or unlined stormwater basins, usually located at the end of a standard pit and pipe drainage network. Bio-retention basins prove treatment by filtering stormwater flows through a vegetated, biologically active soil media. Bio-retention basins are designed to maximise contact with soil and plant systems and provide a higher degree of treatment per unit area relative to other common treatment measures.

These systems would be appropriate for the proposal as they could be installed at the end of the traditional drainage network and would limit the requirement for land acquisition.

C1.2.8 Deep soil bio-retention with trees (additional option)

The option to develop bio-retention systems with deeper root zones and tree species planted in the basin is an option that would require additional investigation at during detailed design. It has the potential to reduce land acquisition and maintenance requirements.

C2 Basis of design

Stormwater basins have been incorporated into the concept design at the outlet of the road and verge drainage system. The proposed basins, shown on Figure C.1, would be located at the outlet of the proposed drainage network and have been designed to incorporate measures for the management of water quality and quantity.

Each basin is approximately rectangular in shape and would incorporate the following features:

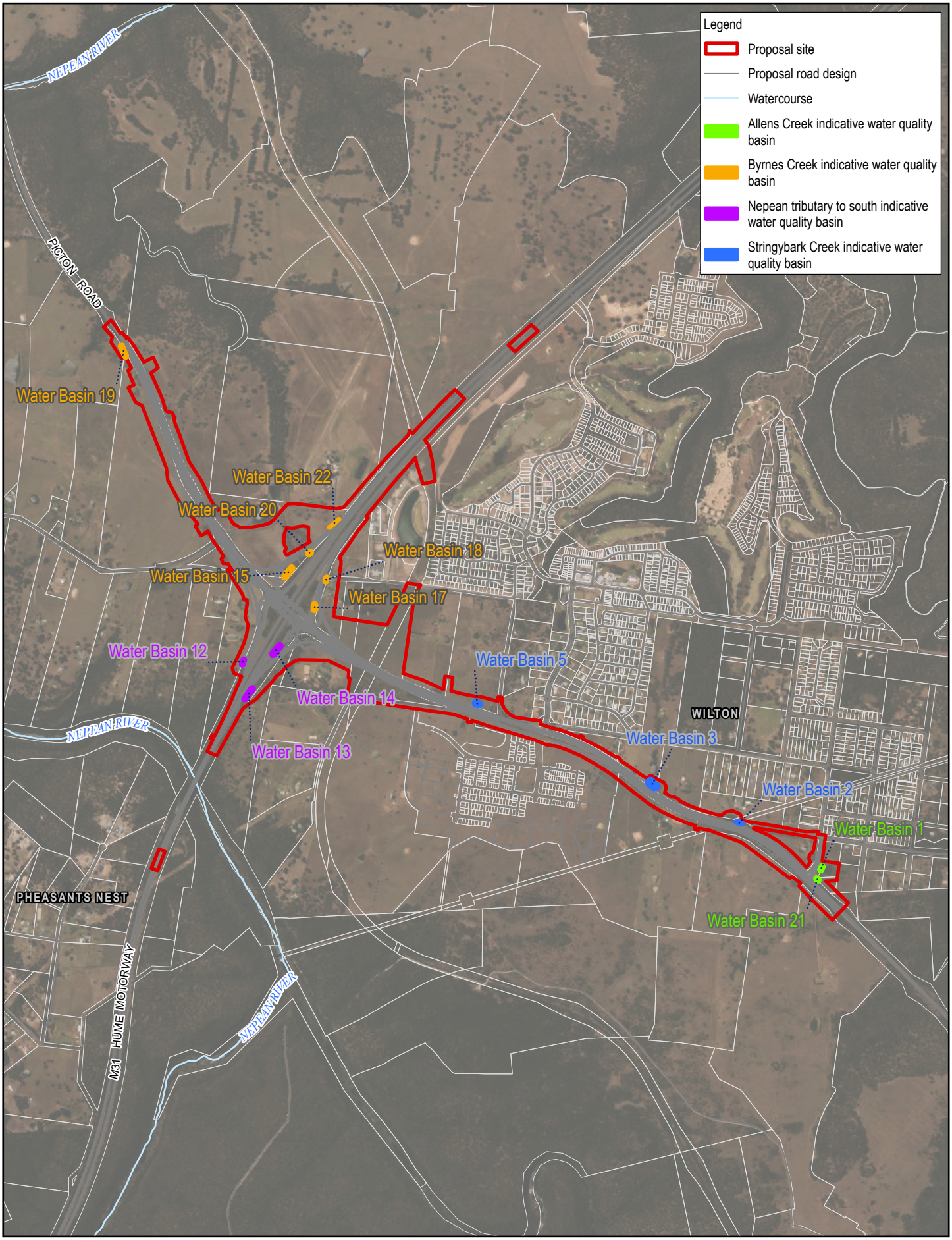
– basin inlet
– internal basin flow distribution measures
– bio-retention filter media and planting
– bio-retention outlet network
– stormwater basin outlet and connection to downstream creek, including scour protection
– maintenance access path for light vehicle access to the basin.

The stormwater basins do not incorporate a gross pollutant trap as noted in section C1.2.3.

Flows from the upstream drainage network would be distributed into the bio-retention cells with rip rap scour protection, level spreaders and cross drainage pipes aiding in the reduction of entry velocities and flow distribution throughout the whole system.

Treated flows from the bio-retention cells would be collected by a subsoil drainage network within the filtration media cells and directed into collector pipes before being directed towards the outlet of the basin. Flows in excess of the capacity of the treatable volume of the cells would flow over a series of weirs before exiting into the main basin storage area.

Drainage from within the main storage area of the basins would be through a discharge control pit located in the downstream end of the basin, while the high-level weir would direct the high flows to a rip rap protection area to local creek lines.



Paper Size ISO A4

0 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 56

N

GDA2020

GHD

Transport for NSW
Picton Road upgrade between Nepean River and Almond Street, Wilton – Soils, surface and groundwater assessment

Stormwater basin locations

Project No. **12560200**
Revision No. **0**
Date **24/10/2023**

FIGURE C.1

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Print date: 24 Oct 2023 - 14:11

C3 Summary of design inputs

The basins have been designed with consideration of the following:

– basin design criteria, including pollutant removal targets, developed in consultation with Transport
– design constraints on the proposal, including drainage outlet locations, engineering, land use, property and environmental constraints
– design of the proposal, including pipe sizes and road vertical and horizontal geometry, developed as part of the concept design
– existing and developed catchment model peak flow rates developed for the concept design, hydrology and flooding investigations
– bio-retention design constraints
– maintenance access design constraints.

The water quality modelling, catchment areas, parameters and surrounding road levels were developed as part of the concept design and assessment process. The basin was modelled using the civil design software package *12d*.

Key considerations are outlined below.

C3.1 Inlet design

The design does not include gross pollutant traps upstream of bio-retention treatment measures. The basin inlet structures would need to incorporate a flow diversion structure, and would be prone to blockage due to sedimentation and debris.

The inlet of each stormwater basin would incorporate a diversion structure constructed of concrete, and measures to remove debris blockages and sedimentation.

C3.2 Internal basin flow

Flows lower than the three month event would be directed to the bio-retention filter areas for treatment. Larger flows, greater than the three month event, would directed via high flow bypass channels into energy dissipation measures within the main basin storage area. The flows out of the basin would controlled by the discharge control pits in downstream end, to facilitate adequate length to width ratio to avoid flows bypassing the bio-retention media. High flows would controlled by the energy dissipation measures and when above the treatment capacity of the basin, directed to the high level weir of the basin.

C3.3 Bio-retention media and planting

The bio-retention basins have been designed to allow operation during maintenance periods, with the total filter area divided into cells. Each cell would comprise of the media filter and be planted with appropriate species (to be determined during the detailed design process). The size of each cell would be limited to a maximum width of 15 metres, with a maximum area for each cell of 500 square metres. Maintenance access around and between cells would be designed to allow routine maintenance by light vehicles.

An extended detention depth of 300 millimetres has been set in accordance with the requirements of Wollondilly Shire Council and Transport. The maintenance access path has been set to be 100 millimetres above the extended detention depth elevation to allow maintenance during rainfall events.

C3.4 Bio-retention outlet design

Flow from the bio-retention basin would be collected by a subsoil drainage network within the filtration media. Collection pits would be located on the downstream end of the bio-retention cells, with treated flows directed from the collection pit to the outlet of the basin before being sent directly to receiving watercourses.

C3.5 Stormwater basin outlet and creek connection design

Flows from the bio-retention basin and overflow discharge weir would be directed to a rock protected channel, directing flows to the receiving watercourse. This rock lined channels incorporate erosion control measures to mitigate again erosion and scour.

C4 MUSICX modelling

The performance of the basins in terms of water quality improvements has been modelled using the *MUSICX* water quality model (Version 1.10.0.12491).

The stormwater treatment strategy for the proposal has been developed to meet the pollutant reduction requirements as described above. These criteria were based on the *Water Sensitive Urban Design Guideline* (Roads and Maritime Services, 2017) and the pollutant reduction targets for the proposal developed in consultation with Transport.

The *MUSIC* model adopted to estimate the pollutant loads from the developed catchments and assess the performance of the proposed stormwater treatment approach was developed using the design criteria. Catchment areas were adjusted for the proposal site footprint and grading, to match those adopted in the drainage design and modelling.

Catchments were split in accordance with *NSW MUSIC Modelling Guidelines* recommendations to define roads, roof, pervious and other pervious areas separately. The six minute time step rainfall data was taken from the rainfall stations as outlined in section 4.1.4. The 10-year period from 11 April 2011 to 17 April 2021 was selected for the model duration.

C4.1 Concept design basin water quality modelling results

The preliminary water quality modelling using *MUSICX* has been developed using the same catchments as used in the design and modelling. The results of modelling of the concept design presented on Figure C.1 are presented in Table C.2.

Table C.2 Concept design basin pollutant loads and treatment rates

Basin name	Basin size (m^2)	Total Suspended Solids (TSS)	Total Phosphorous (TP)	Total Nitrogen (TN)	Gross Pollutants
		Pollutant load reduction achieved % (Target 85%)	Pollutant load reduction achieved % (Target 65%)	Pollutant load reduction achieved % (Target 45%)	Pollutant load reduction achieved % (Target 90%)
Byrnes Creek		**86**	**66**	**50**	**100**
Basin 15	495	89	68	54	100
Basin 17	335	89	68	54	100
Basin 18	30 (spill basin only)	59	45	11	100
Basin 19	340	90	70	55	100
Basin 20	65	87	68	50	100
Nepean tributary to south		**87**	**65**	**52**	**100**
Basin 12	70	72	51	33	100
Basin 13	200	96	76	67	100
Basin 14	600	94	70	61	100
Stringybark Creek		**85**	**65**	**49**	**100**
Basin 02	30 (spill basin only)	53	38	7	100
Basin 03	400	92	71	58	100

Basin name	Basin size (m^2)	Total Suspended Solids (TSS)	Total Phosphorous (TP)	Total Nitrogen (TN)	Gross Pollutants
Basin 05	450	97	75	68	100
Allens Creek		**88**	**67**	**52**	**100**
Basin 01	125	87	65	51	100
Basin 21	75	89	69	54	100

The results in Table C.2 indicate that while individual basins may not meet pollutant removal targets, the overall treatment train proposed for each catchment provides pollutant removal well above the target removal rates of the modelled pollutants. A reduction in treatment area would not be appropriate as this would not meet target removal rates for Total Suspended Solids and Total Phosphorous.

Appendix D

Assessment of Neutral or Beneficial Effects (NorBE) on water quality

Neutral or Beneficial Effects

While the proposal site is not within the Metropolitan Special Area in the Greater Sydney Drinking Water Catchment, and a NorBE assessment is not required in accordance with section 171A(3) of the Environmental Planning and Assessment Regulation 2021, it is downstream of the catchment area.

An assessment has been completed using the NorBE tool for comparison purposes. This assessment for the proposal is provided in Table D.1 for reference only and accompanies the water quality assessment undertaken for the proposal.

Table D.1 NorBE assessment

Factor	Impact
1. Are there any identifiable potential impacts on water quality?	Identified potential pollutants are sediments (fine and coarse), nitrogen, phosphorus, pathogens, hazardous chemicals and contaminants such as oil/fuel.
What pollutants are likely?	These pollutants are not new to the catchment as there is no new land use proposed as part of the proposal. The proposal increases the generation of these pollutants as increased pavement areas reduce the pervious portions of the catchment which provide treatment for runoff and filtration of the pollutants.
During construction and/or post construction?	Specific water quality pollutant generation during construction result from the disturbance of soil in demolition and excavation, stockpiling and sedimentation from unfinished surfaces.
2. For each pollutant, list the safeguards needed to prevent or mitigate potential impacts on water quality (these may be WaterNSW endorsed current recommended practices and/or equally effective other practices)	Safeguards, or water quality protection measures, that would be in place during the construction. – perimeter sedimentation control (fence) and swale drains/bunds – stabilised construction access including shaker pads – wash down facilities for trucks and plant – temporary sediment basins and sediment traps – spill control/oil separator at discharge locations. The water quality protection measures that would be in place during operational stages of the proposal would be stormwater basins. The above safeguards or water quality protection measures would minimise the potential for pollutant such as sediments, nutrients, oils and greases, petrochemicals and heavy metal which are associated with road upgrade projects.
3. Will the safeguards be adequate for the time required? How will they need to be maintained?	The impacts identified are common and major road projects and the safeguards proposed would be adequate for the time required. The Construction Environmental Management Plan (CEMP) will include the regular maintenance of the construction stage water quality improvement measures including roles and responsibilities for monitoring the quality and effectiveness of the measures at each stage of construction. This includes regular inspection and cleanout of the mitigation measures which will capture varying loads of pollutants at stages of construction dependent on the current activities on-site. Operational phases of the proposal would include maintenance regimes to the stormwater reticulation network, gross pollutant trap and bioretention/ stormwater attenuation facilities. This includes the management of vegetation, removal of pollutant loads and system blockages, and replacement of any filtration media to a maintenance program dependent on the size and specification of the measures selected during detailed design stages.

Factor	Impact
4. Will all impacts on water quality be effectively contained on the site by the identified safeguards (above) and not reach any watercourse, waterbody or drainage depression? Or will impacts on water quality be transferred outside the site for treatment? How? Why?	The proposal site drains to an area downstream of the Metropolitan Special Area in the Greater Sydney Drinking Water Catchment. As part of the assessment of the proposal MUSICX modelling has been undertaken to determine the impacts and treatment required to achieve no worsening of pollutants in discharge water reaching the receiving environment. These results indicate that the unmitigated pollutant loads for the upgraded road scenario would increase when compared to existing conditions. This means that without the proposed mitigation measures, there would be an impact onto downstream receiving environments. However, with the proposed mitigation measures, this increase has been reduced to levels that are better than existing. The annual average pollutant loads for the upgraded road conditions with the proposed water quality controls are lower than the annual average pollutant loads for existing conditions. These results demonstrate compliance with the NorBE requirements.
5. Is it likely that a neutral or beneficial effect on water quality will occur? Why?	When the activity has been completed, the level of pollutants will be lower than before construction. Current water quality improvement measures for the discharge of stormwater are minimal and mainly comprise treatment through informal measures such as overland flows routed through vegetation providing filtration through infiltration. The post developed treatment measures would remove gross pollutants and further reduce residual pollutants through biofiltration prior to discharge.

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