15 Soil and water quality

This chapter describes the environmental values relating to soil and water quality and identifies the potential impacts on these values as a result of the construction and operation of the M4-M5 Link (the project). A surface water and flooding assessment has been carried out for the project and is included in **Appendix Q** (Technical working paper: Surface water and flooding). The surface water component of that assessment has informed this chapter. The flooding component of that assessment is addressed in **Chapter 17** (Flooding and drainage).

The Secretary of the NSW Department of Planning and Environment (DP&E) has issued environmental assessment requirements for the project. These are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 15-1** sets outs the requirements and the associated desired performance outcomes that relate to soil and water quality, and identifies where those requirements have been addressed in this environmental impact statement (EIS).

Table 15-1 SEARs – Soil and water quality

Desired performance outcome	SEARs	Where addressed in the EIS
10. Water – Hydrology The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved)	1. The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the FBA.	The stream order for each waterway within the study area (as required by the Framework for Biodiversity Assessment (FBA) (NSW Office of Environment and Heritage (OEH) 2014a)) is identified in **Table 15-8**. The hydrological regime for each waterway is described in **Chapter 17** (Flooding and drainage). A description of the FBA methodology is provided in **Chapter 18** (Biodiversity). The hydrological regime for groundwater is considered in **Chapter 19** (Groundwater).
	2. The Proponent must prepare a detailed water balance for ground and surface water including the proposed intake and discharge locations, volume, frequency and duration for both the construction and operational phases of the project.	A surface water balance for construction and operation is provided in **Chapter 17** (Flooding and drainage). Refer to **Chapter 19** (Groundwater) for groundwater inflow predictions.

Desired performance outcome	SEARs	Where addressed in the EIS
	3. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including: (a) natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	Scour and impacts on geomorphology are discussed in **section 15.3.2** and **15.4.2**. Hydrological impacts and impacts on natural processes are included in **Chapter 17** (Flooding and drainage).
	(d) direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses;	Potential impacts on surface water with regard to erosion, siltation, and bank stability are assessed in **section 15.3.1** and **section 15.4.1**. An assessment of the potential impacts of the project on groundwater is included in **Chapter 19** (Groundwater).
	5. The assessment must include details of proposed surface and groundwater monitoring.	A description of surface water monitoring undertaken to inform this EIS, and requirements for operational monitoring are provided in **section 15.1.2** and **section 15.4.2** respectively. Proposed surface water monitoring locations are shown in **Figure 15-2**. Proposed groundwater monitoring locations are provided in **Chapter 19** (Groundwater).

Desired performance outcome	SEARs	Where addressed in the EIS
11. Water – Quality The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable)	1. The Proponent must: (a) state the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values;	A list of the ambient NSW Water Quality Objectives (NSW WQO) for receiving waters within the study area is included in **section 15.1.4**. Specific indicators and associated trigger values for the identified environmental values are included in **Appendix Q** (Technical working paper: Surface water and flooding).
	(b) identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that any discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment;	Potential pollutants of concern are identified in **section 15.3.2**, **section 15.4.2** and **Appendix Q** (Technical working paper: Surface water and flooding). An assessment of the potential for construction to introduce pollutants into receiving waterways is provided in **section 15.3.2**. The outcomes of modelling using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) are provided in **section 15.4.2**.
	(c) identify the rainfall event that the water quality protection measures will be designed to cope with;	**Section 15.3.2** outlines water quality protection measures to be adopted during construction and states the rainfall event that construction sediment basins would be designed for. Discussion and justification for the design of operational management measures based on pollutant load reduction (rather than a rainfall event) are provided in **section 15.4.2**.
	(d) assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes;	The significance of identified impacts on ambient water quality outcomes is assessed in **section 15.3.2** and **section 15.4.2**.

Desired performance outcome	SEARs	Where addressed in the EIS
	(e) demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: • where the NSW WQOs for receiving waters are currently being met they will continue to be protected, and • where the NSW WQOs are not currently being met, activities will not worsen water quality and, where reasonably practical, work toward their achievement over time;	Discussion of whether the NSW WQOs would continue to be met, during construction and operation of the project is provided in **section 15.3.2** and **section 15.4.2** respectively. Management measures to be adopted to ensure that water quality requirements for the project are met are provided in **section 15.5**.
	(f) justify, if required, why the WQOs cannot be maintained or achieved over time;	The ability of the project to meet the NSW WQOs is discussed in **section 15.3.2** and **section 15.4.2**.
	(g) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented;	Practical management measures to be adopted for the project are provided in **section 15.5**. Management measures to ensure the protection of human health are outlined in **Chapter 11** (Human health risk).
	(h) identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments; and	Sensitive receiving environments are identified and described in **section 15.2.2**. Management measures to avoid (or minimise) impacts are provided in **section 15.5**.
	(i) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Proposed monitoring locations are shown in **Figure 15-2**. Further details, including monitoring frequency and indicators are provided in **Appendix Q** (Technical working paper: Surface water and flooding). The proposed monitoring locations, monitoring frequency and indicators of groundwater quality are outlined in **Chapter 19** (Groundwater).

Desired performance outcome	SEARs	Where addressed in the EIS
	2. The assessment should consider the results of any current water quality studies, as available, in the project catchment.	Water quality studies considered for this assessment are listed in **section 15.1.6** and further information is provided in **Appendix Q** (Technical working paper: Surface water and flooding).
12. Flooding The project minimises adverse impacts on existing flooding characteristic	1. The Proponent must assess and (model where required) the impacts on flood behaviour during construction and operation for a full range of flood events up to the probable maximum flood (taking into account sea level rise and storm intensity due to climate change) including: (g) downstream velocity and scour potential;	An assessment of flood behaviour during construction and operation is provided in **Chapter 17** (Flooding and drainage). Downstream velocities and scour potential are also considered in **Chapter 17** (Flooding and drainage). The potential for scour to occur during construction and operation of the project is also outlined in **section 15.3.2** and **section 15.4.2** respectively.
Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure**.**	(j) whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses; and	Potential impacts that could increase erosion and siltation are assessed in **section 15.3.2** and **section 15.4.2**. Potential impacts on riparian vegetation are assessed in **Chapter 18** (Biodiversity).
13. Soils The environmental values of land, including soils, subsoils and landforms, are protected.	1. The Proponent must verify the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) within the area likely to be impacted by, the project.	The risk of acid sulfate soils is verified in **section 15.2.1**.
Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination	2. The Proponent must assess the impact of the project on acid sulfate soils (including impacts of acidic runoff off-site) in accordance with the current guidelines and detail the mitigation measures proposed to minimise potential impacts.	An assessment of the impact of the project on acid sulfate soils is provided in **section 15.3.1**. Mitigation measures recommended to minimise these impacts are outlined in **section 15.5**.

Desired performance outcome	SEARs	Where addressed in the EIS
	3. The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and likely (or potential) future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	Qualitative assessment of the potential contamination risks, and the need for land remediation, is provided in **Chapter 16** (Contamination). Ecological and human health risks posed by contamination are assessed in **Chapter 11** (Human health risk).
	4. The Proponent must assess whether salinity is likely to be an issue and, if so, determine the presence, extent and severity of soil salinity within the project area.	An assessment of the potential for salinity to be present, and the associated impacts, is provided in **section 15.2.1** and **section 15.3.1**.
	5. The Proponent must assess the impacts of the project on soil salinity and how it may affect groundwater resources and hydrology.	An assessment of potential project impacts on soil salinity, including how it may affect hydrology, is provided in **section 15.3.1**. The impacts of soil salinity on groundwater resources are assessed in **Chapter 19** (Groundwater).
	6. The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	An assessment of the project's impact on soil and land resources, with particular emphasis on soil erosion and sediment transport, is provided in **section 15.3.1**.
	7. The Proponent must assess the impact of any disturbance of contaminated groundwater and the tunnels should be carefully designed so as to not exacerbate mobilisation of contaminated groundwater and/or prevent contaminated groundwater flow.	An assessment of contaminated groundwater impacts and a description of how the tunnel has been designed so as to not exacerbate mobilisation of contaminated groundwater and/or prevent contaminated groundwater flow is provided in **Chapter 16** (Contamination).

15.1 Assessment methodology

15.1.1 Soils

The methodology for the assessment of potential impacts of the project on soils included:

- Review of the geological context, soil landscapes, and acid sulfate soils within the study area, including consideration of:

- Regional geology, as described in the Geological Survey of NSW 1:100,000 scale Sydney Map Sheet 9130 (1983)
    - Soil landscapes and characteristics, determined from the Soil Landscapes of the Sydney 1:100,000 Sheet 9130 (1989)
    - Acid sulfate soil mapping, obtained from Australian Soils Resource Information System and NSW Department of Land and Water Conservation (DLWC) to determine areas of higher probability
- Review of the geotechnical investigations carried out for the project
- Identification and assessment of construction and operational activities that may result in erosion or the exposure of acid sulfate soils
- Assessment of erosion risk or hazard and the potential for soil sediment mobilisation
- Assessment of soil stability and the associated potential for subsidence and settlement
- Assessment of the potential for soil salinity to be present within the project footprint and identification of associated environmental impacts
- Identification of environmental management measures, including the type of controls and design criteria required to mitigate potential impacts.

15.1.2 Water quality

The methodology for the assessment of potential impacts of the project on water quality included the following:

- Identification of a surface water assessment study area and the relevant NSW Water Quality Objectives (NSW WQOs) and environmental values for the receiving waters of the project
- Desktop review and analysis of existing information to identify potential sensitive receiving environments, characterise the existing environment and identify potential issues
- Review of existing policies and guidelines applicable to the management of water quality during construction
- Field assessment to understand and assess the existing features and condition of the water quality assessment study area (including implementation of a baseline surface water monitoring program)
- Model for Urban Stormwater Improvement Conceptualisation (MUSIC) modelling to assess the performance of the operational water quality treatment measures against pollutant reduction targets (see **section 15.1.4**)
- Assessment of construction activities that could mobilise sediments and other pollutants into the surface water environment
- Assessment of the quality and volume of proposed discharges of construction wastewater
- Assessment of potential impacts of the project during construction and operation with regard to flooding, drainage, water supply and water quality, and in accordance with the relevant requirements of the SEARs
- Identification of environmental management measures to mitigate potential impacts.

The methodology for the surface water quality assessment is presented in further detail in the following sections and in **Appendix Q** (Technical working paper: Surface water and flooding). **Chapter 17** (Flooding and drainage) includes an assessment of the potential impact the project may have on flood dispersion and drainage.

15.1.3 Study area

The study area for the soil and water quality assessment is located within the Sydney Harbour and Parramatta River and Cooks River catchments and is shown in **Figure 15-1**. This area comprises the project footprint and includes areas where potential impacts could occur as a result of construction or operation of the project.

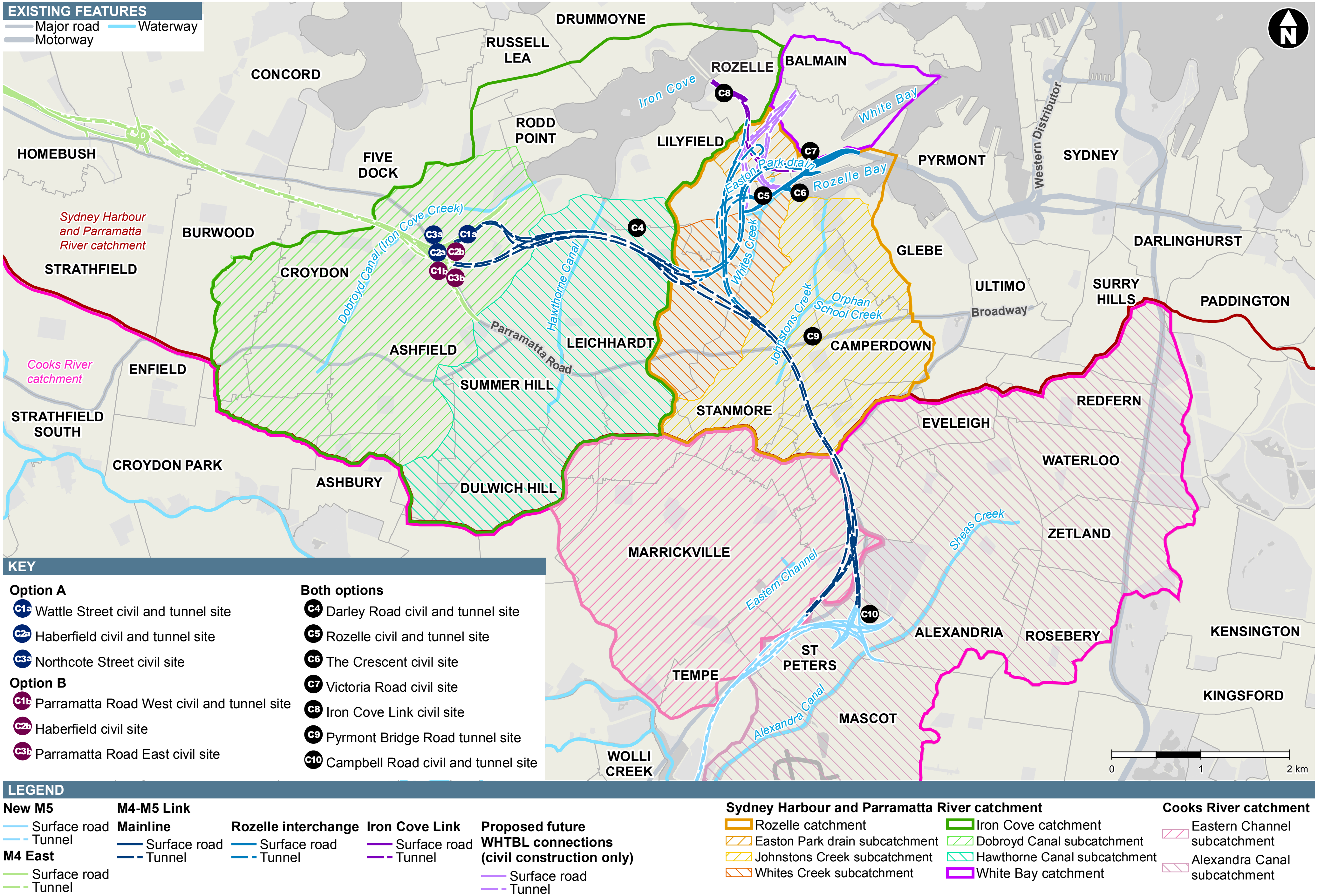

Figure 15-1 Soil and surface water quality assessment study area

15.1.4 Legislative and policy framework

Relevant legislation

The *Water Act 1912* (NSW) and the *Water Management Act 2000* (NSW) (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* (NSW) is being progressively phased out and replaced by the WM Act*,* but its provisions remain in force in respect of areas of NSW where water sharing plans under the WM Act have not yet been made.

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.

The project is located within an area covered by the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources (NSW Department of Primary Industries (DPI) 2011). This plan applies to surface water sources and includes rules for protecting the environment, water extraction, managing licence holders' water accounts, and water trading within the plan area. The Greater Metropolitan Region Groundwater Source Water Sharing Plan DPI (2011) is also relevant to the project and is further discussed in **Chapter 19** (Groundwater).

Relevant guidelines

Soil

The impact assessment of the project on soils has been prepared in accordance with the following key relevant guidelines and policies:

- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and Volume 2 (NSW Department of Environment and Climate Change (DECC) 2008)
- *Soil and Landscape Issues in Environmental Impact Assessment* (DLWC 2000)
- *Urban and regional salinity – guidance given in the Local Government Salinity Initiative booklets* (including Site Investigations for Urban Salinity) (DLWC 2002)
- *Landslide risk management guidelines* (Australian Geomechanics Society 2007).

Water quality

The water quality assessment has been prepared in accordance with the following key relevant guidelines and policies:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council (ANZECC)/ Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000)
- NSW Water Quality and River Flow Objectives *(*NSW Department of Environment, Climate Change and Water (DECCW) 2006)
- Sydney Harbour Water Quality Improvement Plan (Sydney Metropolitan Catchment Management Authority (SMCMA) 2010)
- Botany Bay and Catchment Water Quality Improvement Plan (SMCMA) (2011).

Further detail on relevant water quality policies and guidelines is included in **Appendix Q** (Technical working paper: Surface water and flooding).

15.1.5 Design criteria

Project water quality objectives

Water quality treatment design for the project would take into account the ambient NSW WQOs that apply to the Sydney Harbour and Parramatta River catchment water quality objectives. The NSW WQOs aim to maintain or improve water quality in the Sydney Harbour and Parramatta River catchment. Discharge from the Campbell Road civil and tunnel site (C10) would be treated at the treatment facility being built by the New M5 project, eventually draining to Alexandra Canal and Cooks River.

The following mean annual pollutant load reduction targets would be adopted as part of the water quality treatment design for the project, where practicable:

- 85 per cent reduction in the mean annual load of Total Suspended Solids (TSS)
- 65 per cent reduction in the mean annual load of Total Phosphorous (TP)
- 45 per cent reduction in the mean annual load of Total Nitrogen (TN)
- 90 per cent reduction in the mean annual load of Gross Pollutants (GP) more than five millimetres in diameter.

The surface water quality assessment for the project has been based on an indicative design for stormwater treatment measures. The type and design of specific stormwater treatment measures would be further refined as part of the detailed design process, including confirmation of performance with modelling, if required. Further detail is provided in **Appendix Q** (Technical working paper: Surface water and flooding).

NSW Water Quality and River Flow Objectives

The ambient NSW Water Quality and River Flow Objectives (DECCW 2006) are consistent with the agreed national framework of the ANZECC Water Quality Guidelines and are 'primarily aimed at maintaining and improving water quality, for the purposes of supporting aquatic ecosystems, recreation and where applicable, water supply, and the production of aquatic foods suitable for consumption and aquaculture activities' (DECCW 2006).

The NSW Water Quality and River Flow Objectives have been developed for the Cooks River catchment and the Sydney Harbour and Parramatta River catchment. The classifications of receiving waterways in the study area are provided in **Table 15-2**. The water quality and river flow objectives for catchments and waterways relevant to the project are summarised in **Table 15-3**.

Appendix Q (Technical working paper: Surface water and flooding) provides further detail on the ambient NSW Water Quality and River Flow Objectives and environmental values for the relevant receiving waters, including specific indicators and associated trigger values for the identified environmental values.

Table 15-2 Receiving waterway catchment and classification

Catchment	Receiving waterway within study area	Classification of waterway in accordance with NSW Water Quality and River Flow Objectives
Sydney Harbour and Parramatta River	Dobroyd Canal (Iron Cove Creek)	Waterways affected by urban development
	Hawthorne Canal	Waterways affected by urban development
	Whites Creek	Waterways affected by urban development
	Easton Park drain	Waterways affected by urban development
	Johnstons Creek	Waterways affected by urban development

Catchment	Receiving waterway within study area	Classification of waterway in accordance with NSW Water Quality and River Flow Objectives
	Rozelle Bay	Lower estuary
	Iron Cove	Upper estuary
Cooks River	Alexandra Canal	Waterways affected by urban development Estuaries

Table 15-3 NSW water quality and river flow objectives relevant to the project

Objective	Description	Applicable catchment(s)/waterways
Water quality objectives		
Protect aquatic ecosystems	Ecological condition of waterways and their riparian zone	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment • Upper estuary in the Sydney Harbour and Parramatta River catchment • Lower estuary in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment
Protect visual amenity	Aesthetic qualities of waters	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment • Upper estuary in the Sydney Harbour and Parramatta River catchment • Lower estuary in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment
Protect secondary contact recreation	Water quality suitable for activities, such as boating and wading	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment • Upper estuary in the Sydney Harbour and Parramatta River catchment • Lower estuary in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment – for achievement within five years
Protect primary contact recreation	Water quality for activities, such as swimming	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment – for achievement in 10 years or more • Upper estuary in the Sydney Harbour and Parramatta River catchment • Lower estuary in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment – for achievement in 10 years or more

Objective	Description	Applicable catchment(s)/waterways
Aquatic foods (to be cooked before eating)	Water quality suitable for production of aquatic foods for human consumption, and aquaculture activities	• Upper estuary in the Sydney Harbour and Parramatta River catchment • Lower estuary in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment – for achievement in 5 to 10 years
River flow objectives		
Protect pools in dry times	Protect natural water levels in pools of creeks, rivers and wetlands during periods of no flows	• Urban waterways in the Sydney Harbour and Parramatta River catchment
Protect natural low flows	Manage water extraction and storage to allow sufficient low flows to avoid stress on aquatic plants and animals	• Urban waterways in the Sydney Harbour and Parramatta River catchment
Protect important rises in water levels	Protect or restore a proportion of moderate flows and high flows	• Estuaries in the Cooks River catchment
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution or floodwaters supporting natural wetland and floodplain ecosystems	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment • Upper estuary in the Sydney Harbour and Parramatta River catchment • Lower estuary in the Sydney Harbour and Parramatta River catchment
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability that are critical to surface flows and ecosystems	• Upper estuary in the Sydney Harbour and Parramatta River catchment

Objective	Description	Applicable catchment(s)/waterways
Minimise effects of weirs and other structures	Minimise the impact of instream structures	• Waterways affected by urban development in the Sydney Harbour and Parramatta River catchment • Upper estuary in the Sydney Harbour and Parramatta River catchment • Lower estuary in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment
Maintain or rehabilitate estuarine processes and habitats	Maintain or rehabilitate estuarine processes and habitats	• Upper estuary in the Sydney Harbour and Parramatta River catchment • Lower estuary in the Sydney Harbour and Parramatta River catchment • Estuaries in the Cooks River catchment

15.1.6 Desktop assessment

The desktop assessment involved a review of the existing surface water environment across the study area, including:

- Information obtained from geotechnical investigations and assessments carried out as part of the project
- Information and previous studies relevant to surface water within the study area including those prepared for the M4 East EIS and the New M5 EIS
- Other technical working papers prepared to inform this EIS including **Appendix T** (Technical working paper: Groundwater), **Appendix R** (Technical working paper: Contamination), **Appendix S** (Technical working paper: Biodiversity) and the review of environmental factors (REF) for site management works at the Rozelle Rail Yards (NSW Roads and Maritime Services (Roads and Maritime) 2016)
- Data relevant to the existing surface water conditions in the study area from sources including the Inner West Council and the City of Sydney Council, Sydney Motorway Corporation and NSW Government agencies including UrbanGrowth NSW, Sydney Water, Roads and Maritime and Transport for NSW (in respect of the Central Business District (CBD) and South East Light Rail)
- Water quality monitoring data collected for the M4 East and New M5 projects (CPB Samsung John Holland Joint Venture 2016a).

15.1.7 Field assessment

A baseline surface water monitoring program has been implemented since 2016 to establish existing surface water quality conditions and to provide a baseline for assessment of water quality during and after implementation of the project. The program was implemented to:

- Evaluate the existing surface water quality at key locations in the study area
- Identify potential pathways of pollutants to surface water receivers
- Monitor and assess the surface water quality in the study area to form a baseline of environmental conditions, to measure the environmental performance of the project during the construction and operation of the project.

Table 15-4 summarises the field assessments undertaken during 2016. These included a visual assessment of the relevant waterways, assessment of the current state of surface water receivers and potential pathways to the receivers.

Table 15-4 Summary of surface water field assessments

Date	Location	Waterways assessed
May 2016	St Peters, Rozelle Rail Yards, Wattle Street, Darley Road	Dobroyd Canal (Iron Cove Creek), Hawthorne Canal, Easton Park drain, Whites Creek, Rozelle Bay, Johnstons Creek, Alexandra Canal
July 2016	Rozelle Rail Yards	Whites Creek, Easton Park drain, Rozelle Bay
September 2016	Rozelle Rail Yards and Victoria Road	Whites Creek, Easton Park drain, Rozelle Bay, Iron Cove

Water quality monitoring locations are located upstream and downstream of construction ancillary facilities, as shown in **Figure 15-2** and listed in **Table 15-5**. Further detail is provided in **Appendix Q** (Technical working paper: Surface water and flooding). These sites were chosen to provide general characterisation of the waterways. For operational monitoring, these locations may need to be adjusted to better suit the final construction ancillary facility locations selected to support construction as determined during detailed design. **Figure 15-2** also includes water quality monitoring locations for data collected for the M4 East and the New M5 projects.

MUSIC modelling was carried out to assess potential impacts on receiving waters during operation associated with pollutant loads generated from runoff and the performance of the project's water treatment systems. Details of the MUSIC modelling are included in **Appendix Q** (Technical working paper: Surface water and flooding).

Discharges of treated tunnel water were quantitatively assessed for potential impacts during construction to Hawthorne Canal, Dobroyd Canal (Iron Cove Creek), Rozelle Bay and Johnstons Creek and during operation to Hawthorne Canal and Rozelle Bay (see **section 15.3.2** and **15.4.2** and **Appendix Q** (Technical working paper: Surface water and flooding)).

Table 15-5 Surface water sampling locations

Sample ID	Sample location	Waterway
SW01	Whites Creek outlet at City West Link/The Crescent, Rozelle	Rozelle Bay (downstream)
SW02	Whites Creek Valley Park, Railway Parade, Annandale	Whites Creek (downstream)
SW03	Smith Park pedestrian bridge, Neilson Lane, Annandale	Johnstons Creek (downstream)
SW04	Adjacent to playground, Chester Street, Annandale (non-tidal, ie not influenced by the ocean tides)	Johnstons Creek (downstream)
SW05	Hawthorne Canal Reserve, Canal Road, Leichhardt	Hawthorne Canal (upstream)
SW06	Canal Road (between City West Link and Lilyfield Road) Lilyfield	Hawthorne Canal (downstream)
SW07	Adjacent to 88-90 Lilyfield Road, Lilyfield	Easton Park drain (downstream)
SW08	Pedestrian bridge between Timbrell Park and Reg Coady Reserve, Dobroyd Parade, Haberfield	Dobroyd Canal (Iron Cove Creek) (downstream)
SW09	West of Ramsay Road bridge at Dobroyd Parade, Haberfield	Dobroyd Canal (Iron Cove Creek) (upstream)
SW10	South side of Huntley Street, Alexandria	Sheas Creek (upstream)
SW11	Under Iron Cove Bridge, Rozelle	Iron Cove (downstream)

Sample ID	Sample location	Waterway
SW12	King George Park, Rozelle	Iron Cove (downstream)
SW14	Cruikshank Street, Stanmore	Johnstons Creek (upstream)

Note:

SW13 was monitored as part of the contamination assessment (refer to **Appendix R** (Technical working paper: Contamination)) and is not relevant to the surface water assessment

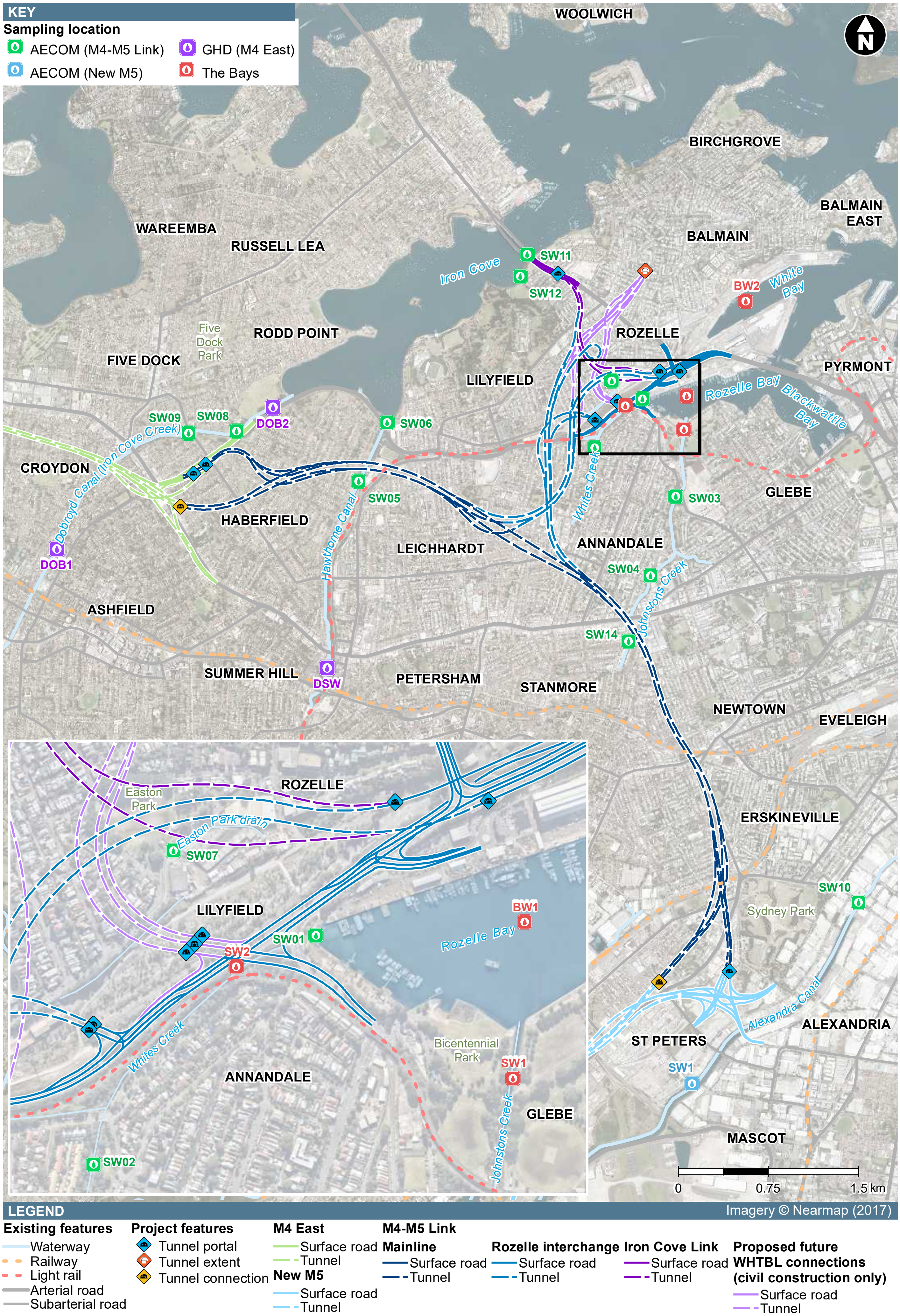

Figure 15-2 Surface water quality data locations

15.2 Existing environment

15.2.1 Soils

Topography and geolog

The project is located in the Sydney Basin and is predominantly underlain by Ashfield Shale and Hawkesbury Sandstone, which outcrop in topographically high areas. In lower lying areas such as Rozelle Bay and White Bay, the bedrock is overlain by fill and alluvium. The thickness of the alluvium is variable and can be up to 20 metres deep in the palaeochannels under Hawthorne Canal and Johnstons Creek. The alluvium comprised clay, silt, sand, gravel or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream or other body of running water. Fill materials are typically uncontrolled anthropogenic deposits.

The landform of the study area is relatively flat and low-lying, with gentle undulating hills ranging between 30 metres and 40 metres above Australian Height Datum (AHD).

Soil landscapes

The Soil Landscapes of the Sydney 1:100,000 Sheet 9130 (NSW Department of Conservation and Land Management 1989) indicates that the project footprint is underlain by four soil landscapes. These are shown in **Figure 15-3**. Characteristics of the soil landscapes, as well as their potential for erosion, are summarised in **Table 15-6**.

Table 15-6 Soil landscape characteristics and erosion potential

Soil landscape	Characteristics	Erosion/mass movement potential
Residual Blacktown	• Occurs on gently undulating rises on Wianamatta Group Shales • Poorly drained	No appreciable erosion occurs on this landscape as most of the surface is covered by buildings, structures, roads etc
Erosional Gymea	• Occurs on undulating to rolling rises and low hills on Hawkesbury Sandstone • Localised steep slopes • High soil erosion hazard	The soil is generally stabilised by urban infrastructure across the study area, despite the majority of remnant vegetation having been removed
Colluvial Hawkesbury	• Occurs on rugged, rolling to very steep hills on Hawkesbury Sandstone • Extreme soil erosion and mass movement hazard	The ground surface is generally stabilised by urban infrastructure across the study area
Disturbed Terrain	• Terrain extensively disturbed by human activity, including complete disturbance, removal or burial of soil • Variable relief and slopes	Erosion hazard varies according to site characteristics including slope, aspect and exposure. The ground surface within the study area is generally stabilised by urban infrastructure

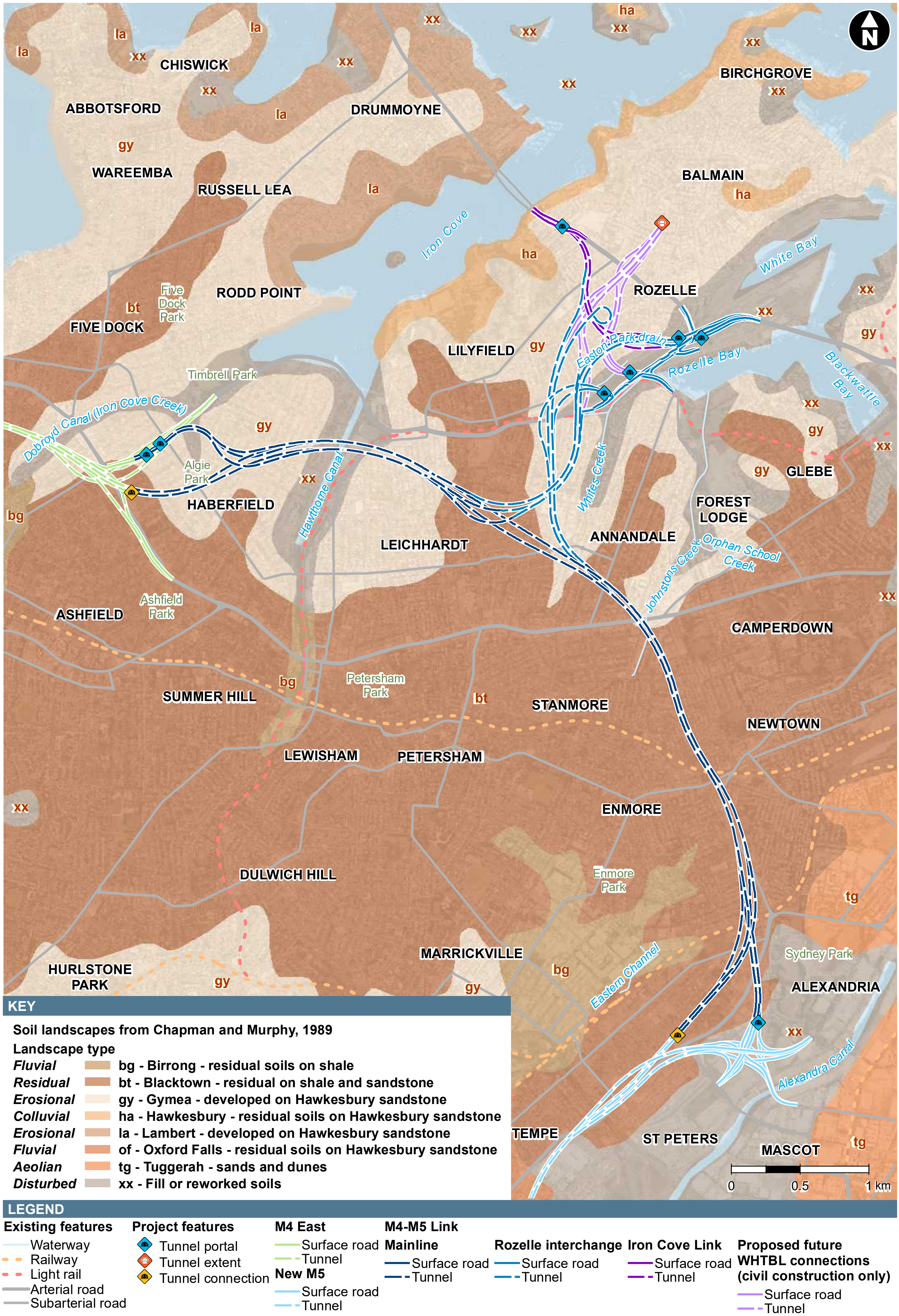

Figure 15-3 Soil landscapes within the study area

Soil salinity

Salinity refers to the salt content of soil. Saline soils form part of the natural landscape of the Sydney Harbour and Parramatta River catchment, particularly within or adjacent to estuarine environments where the natural salt content of tidal waterways is transported to adjacent soils. This may occur adjacent to tidal waterways within the study area, around the concrete canals (Whites Creek, Hawthorne Canal and Alexandra Canal) and Rozelle Bay.

The risk of salinity can be increased by clearing vegetation, irrigation or other activities that can lead to a rise in the groundwater table. The project footprint does not affect land known to be naturally saline, based on a review of the Salinity Potential in Western Sydney Map (NSW Department of Infrastructure, Planning and Natural Resources 2002).

Acid sulfate soils

Acid sulfate soils are naturally occurring soils that contain iron sulfides which, when exposed to the air, can oxidise to form sulfuric acid. Sulfuric acid formed from acid sulfate soils can pose a risk to the environment if not appropriately managed. Potential acid sulfate soils are generally waterlogged soils, rich in pyrite that have not been oxidised.

Disturbance of acid sulfate soils and/or potential acid sulfate soils can result in adverse impacts on surface and groundwater quality, flora and fauna, and degradation of habitats.

In NSW, land is classified based on the likelihood of acid sulfate soils being present in particular areas and at certain depths. In accordance with the *Guidelines for the Use of Acid Sulfate Soils Risk Maps* (DLWC 1998), there are five classifications:

- Class 1: Acid sulfate soils are likely to be found on and below the natural ground surface. Any works would trigger the requirement for assessment and may require management
- Class 2: Acid sulfate soils are likely to be found below the natural ground surface. Any works beneath the natural ground surface, or works which are likely to lower the water table, would trigger the requirement for assessment and may require management
- Class 3: Acid sulfate soils are likely to be found more than one metre below the natural ground surface. Any works that extend beyond one metre below the natural ground surface, or works which are likely to lower water table beyond one metre below the natural ground surface, would trigger the requirement for assessment and may require management
- Class 4: Acid sulfate soils are likely to be found more than two metres below the natural ground surface. Any works that extend beyond two metres below the natural ground surface, or works which are likely to lower the water table beyond two metres below the natural ground surface, would trigger the requirement for assessment and may require management
- Class 5: Acid sulfate soils are not typically found in Class 5 areas. Areas classified as Class 5 are located within 500 metres on adjacent Class 1, 2, 3 or 4 land. Works in a Class 5 area that are likely to lower the water table below one metre AHD on adjacent Class 1, 2, 3 or 4 land would trigger the requirement for assessment and may require management.

The acid sulfate soil risk across the project footprint is shown in **Figure 15-4**. Areas identified as containing acid sulfate soils (or potential acid sulfate soils) within the project footprint were identified include:

- Rozelle civil and tunnel site (C5) – mapped as Class 1, 3 and 5 acid sulfate soil risk. Potential acid sulfate soils have been detected within the alluvial sediments across the Rozelle Rail Yards
- The Crescent civil site (C6) – mapped as Class 1 and 3 acid sulfate soil risk
- Surface works at Rozelle near Rozelle Bay
- Bioretention facility at Manning Street – southern part of the site mapped as Class 2 acid sulfate soil risk
- Campbell Road civil and tunnel site (C10) – mapped as Class 3 and 5 acid sulfate soil risk.

Acid sulfate soils within the areas listed above have been identified as contaminants of concern (refer to **Appendix R** (Technical working paper: Contamination)). Further assessment of potential impacts associated with acid sulfate soils and other sources of contamination is provided in **Chapter 16** (Contamination).

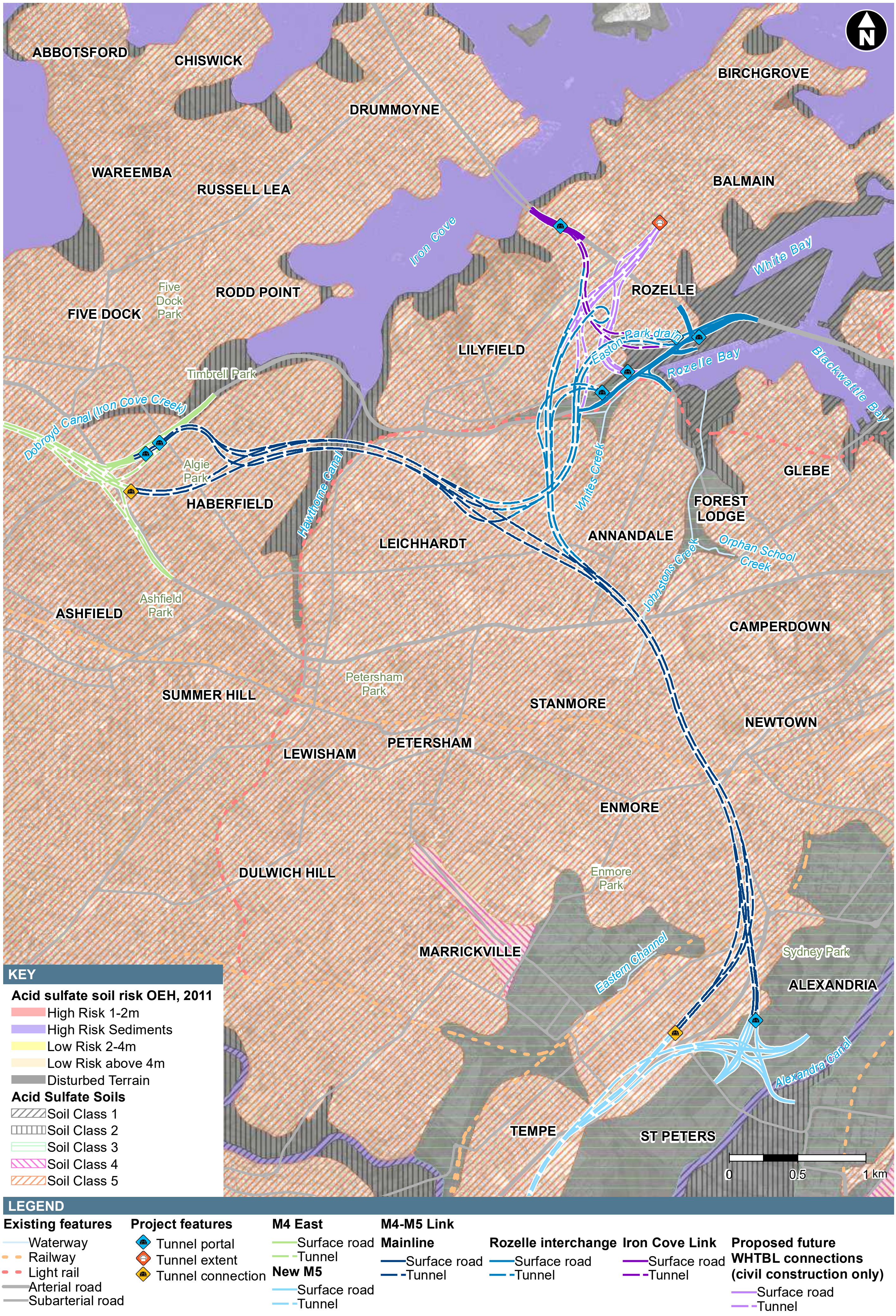

Figure 15-4 Acid sulfate soil risk areas within the study area

15.2.2 Water quality

Catchments and waterways

Table 15-7 outlines the sub-catchments which form part of the larger Sydney Harbour and Parramatta River and Cooks River catchments as relevant to the project. These sub-catchments, including the relevant project activities, are shown in **Figure 15-1**.

Table 15-7 Sub-catchments relevant to the project

Catchment	Sub-catchment	Project components
Sydney Harbour and Parramatta River catchment	Dobroyd Canal (Iron Cove Creek)	Wattle Street interchange and associated construction ancillary facilities at Haberfield/Ashfield (C1a, C2a/C2b, C3a, C1b and C3b)
	Hawthorne Canal	Darley Road civil and tunnel site (C4) and associated water treatment facility
	Whites Creek	Rozelle interchange, surrounding roads and associated construction ancillary facilities and works (C5, C6 and C7)
	Easton Park drain	Rozelle interchange and associated construction ancillary facilities (C5, C6 and C7)
	Rozelle Bay	Rozelle interchange, surrounding roads and associated construction ancillary facilities (C5, C6 and C7)
	White Bay	Victoria Road surface runoff
	Iron Cove	Iron Cove Link civil site (C8), surface works and water treatment facility
	Johnstons Creek	Pyrmont Bridge Road tunnel site (C9)
Cooks River catchment	Alexandra Canal	St Peters interchange and Campbell Road civil and tunnel site (C10)

The majority of the project footprint is located within the Sydney Harbour and Parramatta River catchment, the main tributary of which is the Parramatta River. The southern portion of the project footprint is located within the Cooks River catchment, which discharges into Botany Bay at Mascot. The waterways and associated catchments within the study area are shown in **Figure 15-1**.

Key waterways within the Sydney Harbour and Parramatta River catchment and the parts of the project relevant to those waterways are outlined in **Table 15-8** and described in detail in **Appendix Q** (Technical working paper: Surface water and flooding).

Table 15-8 Summary description of key waterways within the study area

Waterway	Description	Project components
Dobroyd Canal (Iron Cove Creek)	Dobroyd Canal (Iron Cove Creek) drains parts of the inner western suburbs of Ashfield, Burwood, Haberfield, Croydon, Drummoyne and Canterbury and discharges into Iron Cove (Cardno Lawson Treloar 2008). Dobroyd Canal (Iron Cove Creek) is a 1st order stream and is mapped as Key Fish Habitat downstream of Ramsay Street, Haberfield.	Dobroyd Canal (Iron Cove Creek) runs parallel to the Wattle Street interchange and the proposed tunnel portal of the M4-M5 Link. The Wattle Street civil and tunnel site (C1a), Haberfield civil and tunnel site (C2a)/ Haberfield civil site (C2b), Northcote Street civil site (C3a), Parramatta Road West civil and tunnel site (C1b) and Parramatta Road East civil site (C3b) are located within the Dobroyd Canal (Iron Cove Creek)catchment. The Wattle Street interchange and remaining project land at construction ancillary facilities

Waterway	Description	Project components
		at Haberfield and Ashfield would drain to Dobroyd Canal (Iron Cove Creek) during operation.
Hawthorne Canal	Hawthorne Canal starts at Lewisham and flows into Iron Cove at Dobroyd Point. It was originally a natural waterway known as Long Cove Creek but has since been straightened and given artificial banks. The channel is generally constructed from unreinforced concrete with the base of the channel comprising paved brick for a section upstream of Parramatta Road. Hawthorne Canal is a 1st order stream and is mapped as Key Fish Habitat downstream around Marion Street, Leichhardt.	The mainline tunnel alignment crosses beneath Hawthorne Canal adjacent to Hawthorne Parade, around 300 metres upstream of Iron Cove. The proposed operational water treatment facility at Darley Road at Leichhardt would discharge to Hawthorne Canal. The Darley Road civil and tunnel site (C4) is located within the catchment.
Whites Creek	Whites Creek is a brick and concrete-lined channel that flows through the suburbs of Leichhardt and Marrickville and discharges into Rozelle Bay. The Whites Creek catchment is heavily urbanised and comprises an area of around 262 hectares. Whites Creek at The Crescent is a 1st order stream.	The lower reach of Whites Creek is located to the south of the Rozelle interchange and associated road upgrades. Project works in this area would include the redevelopment of City West Link and The Crescent intersection, raising the level of sections of these roads, upgrade of the existing bridge structure that crosses Whites Creek at The Crescent and naturalisation of Whites Creek. The Crescent civil site (C6) is located at the confluence between Whites Creek and Rozelle Bay.
Easton Park drain	The Easton Park drain runs between Denison Street (adjacent to Easton Park) and Rozelle Bay at Rozelle and conveys runoff from a heavily urbanised catchment of around 55 hectares. Easton Park drain is a 1st order stream.	It is proposed to divert the Easton Park drain into a new channel to convey flows through Rozelle Rail Yards, with the former Easton Park drain decommissioned. An upgraded culvert would be provided to discharge flows into Rozelle Bay. An overland flow component would also be provided in the Rozelle Rail Yards to convey flooding to Rozelle Bay via box culverts below City West Link.
Johnstons Creek	The Johnstons Creek catchment is located within the suburbs of Glebe, Annandale, Petersham and Newtown. The catchment is heavily urbanised and comprises a total area of around 460 hectares (WMA Water 2014) and at this location, is a 1st order stream.	The mainline tunnel traverses beneath Johnstons Creek adjacent to Bridge Road at Stanmore, south of Parramatta Road. The Pyrmont Bridge Road tunnel site (C9) is located within the Johnstons Creek catchment.

Waterway	Description	Project components
Rozelle Bay	The Rozelle Bay catchment is highly urbanised and comprises a total area of around 857 hectares. Rozelle Bay is located between the suburbs of Glebe, Annandale, Lilyfield and Rozelle with flow inputs from Whites Creek, Johnstons Creek and Easton Park drain.	Rozelle Bay would be a receiving waterway for discharge from the operational water treatment facility at the Rozelle Rail Yards for runoff from the proposed Rozelle interchange and associated road upgrades. A new outlet would be constructed within Rozelle Bay to receive the flows from the Rozelle interchange. The Rozelle civil and tunnel site (C5), The Crescent civil site (C6) and Victoria Road civil site (C7) are located within the Rozelle Bay catchment.
Iron Cove	The Iron Cove catchment is a bay within the Parramatta River estuary. It is highly urbanised and comprises a total area of around two hectares. Iron Cove is a 2nd order stream and has been mapped as Key Fish Habitat.	A portion of the surface road upgrades (ie the widening of a section of Victoria Road) associated with the Iron Cove Link would drain into Iron Cove, using existing outlets. The Iron Cove Link civil site (C8) and proposed bioretention facility and car park improvement works within King George Park (adjacent to Manning Street at Rozelle) are located within the Iron Cove catchment.
White Bay	The White Bay catchment is highly urbanised and comprises a total area of around 163 hectares.	A portion of the proposed Victoria Road upgrade between Hornsby Street and Robert Street would drain to White Bay via the existing surface drainage network.
Alexandra Canal	The Alexandra Canal catchment (including Sheas Creek) comprises an area of around 23 square kilometres and receives runoff from Alexandria, Rosebery, Erskineville, Beaconsfield, Zetland, Waterloo, Redfern, Newtown, Eveleigh, Surry Hills and Moore Park. Near St Peters interchange, Alexandra Canal is a 2nd order stream.	The St Peters interchange is located in the catchment of Alexandra Canal. The underground connections to the St Peters interchange and ventilation facility are located in the catchment of Alexandra Canal. The Campbell Road civil and tunnel site (C10) is located within the Alexandra Canal catchment. Alexandra Canal is a 2nd order stream within the vicinity of St Peters interchange.

Rozelle Bay, Iron Cove, White Bay, Alexandra Canal and downstream portions of Dobroyd Canal (Iron Cove Creek) and Hawthorne Canal have been mapped as Key Fish Habitat, as defined in the *Fisheries Policy and Guidelines for Fish Habitat Conservation and Management* (update 2013) (Fairfull 2013). The project's receiving waters are marine environments and include the intertidal and subtidal ecosystem of Sydney Harbour and its estuarine tributaries. An assessment of the potential impacts of the project on Key Fish Habitat is provided in **Chapter 18** (Biodiversity).

Geomorphology

The waterways within the study area are hard lined (eg concrete channel, piped channel, brick channel, underground concrete channel) stormwater channels, with the exception of Alexandra Canal, which has an unlined base and hard lined banks. Sea walls have been constructed around the shoreline of Rozelle Bay and White Bay where development occurs up to the shoreline, with boat vessel moorings also located within the bays. The Iron Cove shoreline comprises a mixture of sea wall and vegetated zones with parkland and residential development occurring adjacent to the shoreline.

Current naturalisation proposals

Sydney Water is investigating the potential naturalisation of a section of Whites Creek at Annandale. The area being investigated is a 400 metre length of the creek corridor upstream of its outlet to Rozelle Bay. The concrete lined creek channel is in need of repair and the proposal would remove the deteriorated concrete banks and naturalise and rehabilitate the channel. A concept design for the works has been prepared by Sydney Water but at this stage, the design and construction timelines are not known.

Similar investigations are also underway by Sydney Water to rehabilitate about 600 metres of the concrete lined Johnstons Creek channel from the outlet at Rozelle Bay at Annandale, and about 200 metres of Iron Cove Creek east of Ramsay Street at Haberfield, both of which are in need of repair. Sydney Water is looking to develop naturalising solutions where possible. The early concept design for the naturalisation of the section of Iron Cove Creek proposes features like creek banks made of rocks and native plants and some banks turned into salt marsh areas. A similar, final concept design for the Johnstons Creek channel has been prepared. The design and construction timelines for these works are still being investigated.

Sydney Water is also preparing a proposal to implement drainage upgrades at Easton Park at Rozelle. This would involve diversion of an existing drain to a bioretention basin, designed to treat a portion of stormwater flows. The basin would remove a portion of pollutants generated by the urban catchment and may also provide the potential for re-use as irrigation for the park. The design for the project is understood to be prepared in 2017 with construction scheduled for 2018.

Surface water quality

Surface water quality in the study area is influenced by several factors including:

- Current and former polluting land uses within the catchments
- Stormwater and sewage overflows and leachate from contaminated and/or reclaimed land
- Urbanisation of the catchments and subsequent reduction in permeable area, increasing run-off and pollutant loads entering waterways
- Illegal dumping.

A review of water quality data was undertaken (including samples collected as part of the water quality monitoring program for the project as outlined in **section 15.1.7**) to determine the water quality of waterways in the study area. These are detailed in **Appendix Q** (Technical working paper: Surface water and flooding) and summarised in **Table 15-9**. Water quality monitoring results are presented in Annexure A of **Appendix Q** (Technical working paper: Surface water and flooding).

Table 15-9 Existing water quality conditions in the study area

Waterway	Samples collected/data obtained	Description of water quality
Dobroyd Canal (Iron Cove Creek)	• Samples collected at SW08 and SW09 • Water quality data from samples collected as part of the M4 East project	• Elevated concentrations of heavy metals (copper, chromium, lead, nickel and zinc) and nutrients (phosphorus, nitrogen and nitrate) were recorded in tidal and non-tidal zones • The pH was outside guideline levels and the turbidity exceeds guideline levels on some occasions • High electrical conductivity (EC) indicates brackish conditions on occasion, indicating this location may be tidally influenced • Total recoverable hydrocarbons were detected

Waterway	Samples collected/data obtained	Description of water quality
Hawthorne Canal	• Samples collected at SW05 and SW06 • Water quality data from samples collected as part of the M4 East project	• Elevated concentrations of heavy metals (chromium, copper, lead and zinc) and nutrients (phosphorus, nitrogen and nitrate) were recorded • On some occasions, the pH was outside guideline levels and the turbidity exceeds guideline levels
Whites Creek	• Samples collected at SW02 • Samples collected by The University of Sydney on behalf of UrbanGrowth NSW within a tidally influenced location (at SW02) as part of The Bays Precinct transformation project between June and September 2016	• Elevated concentrations of heavy metals (chromium, copper, lead and zinc), phosphorus, nitrogen, nitrate and oxides of nitrogen were recorded • On some occasions the pH was outside guideline levels and the turbidity exceeds guideline levels
Easton Park drain	• Samples collected at SW07	• Elevated concentrations of heavy metals (copper, lead, and zinc) and nutrients (nitrogen phosphorus and nitrate) were recorded • On some occasions, the pH was outside guideline levels and the turbidity exceeded guideline levels
Johnstons Creek	• Samples collected at SW03, SW04 and SW14 • Samples collected by The University of Sydney on behalf of UrbanGrowth NSW within a tidally influenced location (at SW01) as part of The Bays Precinct transformation project between June and September 2016	• Elevated concentrations of heavy metals (cadmium, copper, chromium, lead, nickel and zinc), nitrogen, phosphorous and nitrate were recorded • On some occasions the pH was outside guideline levels and the turbidity exceeded guideline levels • EC indicates brackish conditions and that this location may be tidally influenced • Total recoverable hydrocarbons have been detected at SW04
Rozelle Bay	• Samples collected at SW01 • Samples collected by The University of Sydney on behalf of UrbanGrowth NSW at BW1 as part of The Bays Precinct transformation project between June and September 2016	• Elevated concentrations of heavy metals (copper, chromium, lead and zinc), nitrogen, phosphorous, nitrate, oxides of nitrogen, ammonia and chlorophyll have been recorded • On some occasions the pH is outside guideline levels and the turbidity exceeds guideline levels

Waterway	Samples collected/data obtained	Description of water quality
Iron Cove	• Samples collected at SW11 and SW12	• Elevated concentrations of metals (copper, chromium, lead, mercury and zinc), nitrogen, nitrate and phosphorous have been recorded • Turbidity exceeds guideline values • The pH was outside guideline levels on occasions
White Bay	• Samples collected by The University of Sydney on behalf of UrbanGrowth NSW at BW2 as part of The Bays Precinct transformation project between June and September 2016	• Elevated concentrations of metals (copper and zinc), nitrogen, nitrate and phosphorous have been recorded • Turbidity also exceeds the guideline values
Alexandra Canal	• Samples collected at SW10 • Samples collected at SW01 as part of the New M5 project surface water sampling conducted between June 2015 and November 2015	• Elevated pH, concentrations of metals (copper, lead, chromium, nickel, manganese and zinc) and nutrients (nitrogen, nitrate and phosphorus) and turbidity have been recorded • The pH was also outside guideline levels on occasions

Sensitive receiving environments

A sensitive receiving environment is an environment that has high conservation or community value, or that supports ecosystem or human uses of water, and that is particularly sensitive to pollution or degradation of water quality.

The project has the potential to interact with the following sensitive receiving environments:

- Protected wetlands at Iron Cove
- Iron Cove (classified as a water recreation zone)
- Johnstons Creek constructed wetland at Federal Park
- Whites Creek constructed wetland at Whites Creek Valley Park
- Mapped Key Fish Habitat at Rozelle Bay, Iron Cove, White Bay, Alexandra Canal and downstream portions of Dobroyd Canal (Iron Cove Creek) and Hawthorne Canal
- Parramatta River Estuary, Cooks River and Botany Bay
- Cooks River
- Seagrasses in Botany Bay.

15.3 Assessment of potential construction impacts

15.3.1 Soils

Erosion and sedimentation

Construction of the project has the potential to result in erosion and sediment migration. Surface disturbance and vegetation removal exposes soils and may weaken surface soil structure. This could lead to erosion sedimentation and soil slippage within and around waterways and slopes in the study area, particularly during periods of high wind or rainfall. Areas of high erosion potential are at a higher risk of being subject to erosion and sedimentation. These areas are identified in **section 15.2.1**.

Uncompacted or unconsolidated materials (such as excavated and stockpiled soils) have the potential to leave construction areas during rain (through surface water run-off) causing downstream sedimentation. Sedimentation in natural waterways can result in reduced water quality as well as smothering of vegetation and clogging of channels, impacting the natural flow paths of the waterway.

During construction, soil erosion would be adequately managed in accordance with Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) and Managing Urban Stormwater: Soils and Construction Volume 2 (NSW Department of Environment and Climate Change 2008a), commonly referred to as the 'Blue Book'. The number, location and size of sediment basins would be confirmed during detailed design. The Blue Book recommends that where receiving waters are sensitive, sediment basins should be sized for an 80th percentile or 85th percentile five-day rainfall depth for disturbance periods of less than or greater than six months respectively.

Erosion and sediment control would be focussed on areas of surface disturbance (ie surface road works, construction ancillary facility sites and areas of excavation and vegetation removal). Particular emphasis would be given to areas of surface disturbance near waterways, including at Rozelle Bay, where Whites Creek naturalisation and drainage works and Easton Park drain outfall works would be undertaken. These measures would minimise the potential for sedimentation at Rozelle Bay.

There is a risk that any erosion and/or runoff within the Rozelle Rail Yards could be contaminated. Further details about water management within the Rozelle Rail Yards during construction are provided in **Chapter 16** (Contamination). To help avoid and minimise these potential impacts, a soil conservation consultant would be engaged to provide input during detailed design so as to minimise the potential for erosion and sediment migration, from the Rozelle Rail Yards specifically. The soil conservation consultant would provide input to a Construction Soil and Water Management Plan (CSWMP) which would form part of the Construction Environmental Management Plan (CEMP) that would be prepared during detailed design.

Soil salinity

Construction of the project has the potential to contribute to urban salinity through soil compaction at areas of surface disturbance, such as the construction ancillary facility sites, which can restrict groundwater flow and result in a concentrate of salt in one area. As outlined in **section 15.2.1**, urban salinity is not considered a significant concern within the project footprint.

Acid sulfate soils

The risk of acid sulfate soil varies across the project footprint. There is a high probability of encountering these soils around Rozelle Bay, Manning Street at Rozelle and St Peters interchange (see **Figure 15-4**).

Further soil testing would be conducted in areas with a high risk of acid sulfate soils prior to disturbance to confirm the presence of acid sulfate material. Testing would be carried out in areas identified as containing acid sulfate soils (or potential acid sulfate soils) as identified in **section 15.2.1** including:

- Rozelle civil and tunnel site (C5)
- The Crescent civil site (C6)
- Bioretention facility at Manning Street in Rozelle
- Campbell Road civil and tunnel site (C10).

If acid sulfate soils are identified, they would be managed in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee 1998). The manual includes procedures for the investigation, handling, treatment and management of such soils.

Appropriate measures to manage acid sulfate soils are provided in **section 15.5**. Further measures to manage acid sulfate soils would be included as part of the CSWMP which would form part of the CEMP.

15.3.2 Water quality

Discharge of tunnel wastewater

During construction, tunnelling works would result in large volumes of wastewater being generated from the following sources:

- Groundwater seepage
- Rainfall runoff into tunnel portals and ventilation shafts
- Machinery washdown runoff
- Heat and dust suppression water.

Most of the wastewater generated during tunnelling would be collected from groundwater seepage. Estimated volumes of construction wastewater are included in **Chapter 23** (Resource use and waste minimisation).

There is the potential for groundwater that seeps into the tunnels and other areas of excavation during construction to contain elevated levels of salinity. Existing groundwater quality along the tunnel alignments is variable, with Ashfield Shale typically being more saline than Hawkesbury Sandstone. Groundwater closer to Sydney Harbour and Botany tends to be more saline due to increased tidal influences. In low lying areas, groundwater may also be acidic due to acid sulfate materials.

However, considering the total amount of groundwater tunnel ingress, saline groundwater would make up a small fraction of the total volume. Further discussion around the quality of discharged groundwater is included in **Chapter 19** (Groundwater).

Previous and current land use practices, including light industrial activities, may have introduced contaminants such as hydrocarbons or heavy metals, which could impact groundwater quality at some locations. The use of chemicals in the treatment and curing process of concrete, as well as the concrete dust itself, could also result in tunnel wastewater having increased alkalinity.

Groundwater monitoring carried out for the project indicates that there are elevated levels of ammonia, total nitrogen and total phosphorus compared to ANZECC (2000) guideline levels (marine, freshwater and recreational protection levels). Other heavy metals including copper, chromium, lead, nickel and zinc were also recorded at elevated levels on a limited number of occasions (refer to **Chapter 19** (Groundwater)). Tunnel wastewater, if discharged untreated or poorly treated, has the potential to impact the receiving waterways by introducing increased nutrient loading and result in algal growth with increased risk to human health. There is also potential for reduction in visual amenity and impacts on aquatic species as a result of heavy metal or other toxicants.

The total volume of wastewater generated during construction would depend on construction activities taking place, the amount of groundwater infiltrating the tunnel, and the length of the tunnel that has been excavated. Indicative daily volumes of wastewater at each site and associated indicative discharge points are summarised in **Table 15-10**.

Tunnel wastewater would be treated prior to discharge (or disposal) to minimise impacts on receiving waterways, including Dobroyd Canal (Iron Cove Creek), Hawthorne Canal, Whites Creek, Easton Park drain, Johnstons Creek, Rozelle Bay, Iron Cove, White Bay and Alexandra Canal.

Table 15-10 Estimated daily discharge rate (kL/day) and indicative discharge points for construction wastewater

Site	Estimated daily discharge rate (kL/day)	Indicative discharge points
Wattle Street civil and tunnel site (C1a)	Managed by Haberfield civil and tunnel site	Discharges to a stormwater pipe under Parramatta Road that connects to Dobroyd Canal (Iron Cove Creek)
Haberfield civil and tunnel site (C2a)	1,200	Discharging to a stormwater pipe under Parramatta Road, connected to Dobroyd Canal (Iron Cove Creek)

Site	Estimated daily discharge rate (kL/day)	Indicative discharge points
Northcote Street civil site (C3a)	Managed by Haberfield civil and tunnel site	Discharges to a stormwater pipe under Parramatta Road that connects to Dobroyd Canal (Iron Cove Creek)
Parramatta Road West civil and tunnel site (C1b)	1,200	Discharging to a stormwater pipe under Parramatta Road that connects to Dobroyd Canal (Iron Cove Creek)
Haberfield civil site (C2b)	Managed by Parramatta Road West civil and tunnel site	Discharging to a stormwater pipe under Parramatta Road that connects to Dobroyd Canal (Iron Cove Creek)
Parramatta Road East civil site (C3b)	Managed by Parramatta Road West civil and tunnel site	Discharging to a stormwater pipe under Parramatta Road that connects to Dobroyd Canal (Iron Cove Creek)
Darley Road civil and tunnel site (C4)	700	Existing drainage system draining to Hawthorne Canal
Rozelle civil and tunnel site (C5)	2,400	Existing drainage system at City West Link draining to Rozelle Bay Easton Park drain discharging to Rozelle Bay
The Crescent civil site (C6)	10	Existing drainage system at City West Link draining to Rozelle Bay
Victoria Road civil site (C7)	200	Existing drainage system at Victoria Road draining to White Bay
Iron Cove Link civil site (C8)	300	Existing drainage system at Victoria Road draining to Iron Cove
Pyrmont Bridge Road tunnel site (C9)	1,200	Discharging to a stormwater pipe under Parramatta Road, connected to Johnstons Creek
Campbell Road civil and tunnel site (C10)	1,200	Discharging to a stormwater pipe connected to Alexandra Canal

During construction, the wastewater collected in the tunnel would be tested and treated at construction water treatment facilities prior to reuse or discharge. The type, arrangement and performance of construction water treatment facilities would be further refined during detailed design, and may consist of:

- Primary settling tanks/ponds to remove sand and silt sediment fractions as well as oil and grease
- A pH balance/metals oxidation tank with primary flocculation whereby individual particles of clay are clumped together
- Secondary flocculation tanks
- Clarifiers to remove sediment and residual oil
- Filtration/settlement.

Temporary construction water treatment facilities within the construction ancillary facilities would be designed to treat dirty construction water and groundwater and would be based on the targets outlined in **section 15.1.5**, which would be refined during detailed design. The level of treatment provided would consider the characteristics of the waterbody, any operational constraints or practicalities and associated environmental impacts and be developed in accordance with ANZECC (2000) and in consideration of the relevant NSW WQOs.

Considering the highly disturbed nature of all receiving waterways and temporary nature of the construction phase, an ANZECC (2000) species protection level of 90 per cent for toxicants is considered appropriate for adoption as a discharge criterion, where practical and feasible. The discharge criteria for the treatment facilities would be finalised and included in the CSWMP.

Mobilisation of sediments and pollutants during surface works

Surface construction activities may disturb soils and other materials that have the potential to impact water quality if not effectively managed, including:

- Exposure of soils during earthworks has the potential to result in soil erosion and off-site movement of eroded sediments by wind and/or stormwater to receiving waterways
- Demolition works have the potential to disturb and/or spread sources of pollutants that could affect water quality (including asbestos and other contaminated building materials, hydrocarbons or fluids associated with demolition processes and dust)
- Disturbance of contaminated land, which could be mobilised by stormwater runoff and transported to downstream waterways, potentially increasing contaminant concentrations in the receiving environment (refer to **section 15.3.1** and **Chapter 16** (Contamination))
- Exposure of potential acid sulfate soils, which may result in generation of sulfuric acid and subsequent acidification of waterways and mobilisation of heavy metals into the environment if poorly managed
- Rinse water from plant washing and concrete slurries may contain polluting contaminants which, if discharged off-site, could impact on surface water quality
- Potential spills or leaks of fuels and/or oils from maintenance or re-fuelling of construction plant and equipment or vehicle/truck incidents could potentially be conveyed to downstream waterways via drainage infrastructure
- Disturbance of Whites Creek and Rozelle Bay during bridge construction works as part of the realignment of The Crescent and channel widening of Whites Creek to manage flooding and drainage and naturalisation works. This may lead to disturbance of contaminated sediments and erosion of exposed banks once the existing channel concrete lining has been removed (and prior to construction of the naturalised channel treatment)
- Construction of new stormwater outlets to receiving bays (Rozelle Bay and Iron Cove) would cause localised mobilisation of potentially contaminated sediments. Sediments settled on top of the hard, lined base of Whites Creek would also be disturbed.

Table 15-11 summarises the potential water quality impacts during construction of the project. These impacts are regularly encountered on major construction projects, are well understood and management measures are well developed and consistently applied to minimise impact during construction.

Residual impacts on water quality during construction

The proposed surface water management measures outlined in **section 15.5** aim to minimise short term impacts on the receiving waterways during construction. With the implementation of the management measures, and in the context of the overall catchment, any potential short term impacts are unlikely to have a material impact on ambient water quality within the receiving waterways.

Therefore, the project is likely to have a negligible influence on whether NSW WQOs are protected (if currently met) or achieved (if currently not met) during construction.

Table 15-11 Construction surface water quality impact summary

Location	Construction activities / incidents	Potentially affected waterways	Potential impacts
Civil and tunnel sites (excluding Rozelle civil and tunnel site) including their adjacent footprints, including: • Wattle Street civil and tunnel site at Haberfield (C1a) • Haberfield civil and tunnel site at Haberfield (C2a) • Northcote Street civil site at Haberfield (C3a) • Parramatta Road West civil and tunnel site at Ashfield (C1b) • Haberfield civil site at Haberfield (C2b) • Parramatta Road East civil site at Haberfield (C3b) • Darley Road civil and tunnel site at Leichhardt (C4) • The Crescent civil site at Annandale (C6) • Victoria Road civil site at Rozelle (C7) • Iron Cove Link civil site at Rozelle (C8) • Pyrmont Bridge Road tunnel site at Annandale (C9) • Campbell Road civil and tunnel site at St Peters (C10).	• Vegetation clearance and topsoil stripping • Demolition works • Establishment of construction ancillary facilities, access and utility supply • Excavations • Concrete works • Stockpiling of spoil, construction materials and demolition materials • Relocation of utilities • Access and egress of vehicles to construction ancillary facilities and public roads • Accidental spills/material drops during transportation of building waste from demolition sites with pollutants mobilised into waterways • Spills of chemicals/fuel stored on site • Operation of construction water treatment facility • Activities associated with construction for permanent works	• Dobroyd Canal (Iron Cove Creek) • Hawthorne Canal • Iron Cove • White Bay • Johnstons Creek • Alexandra Canal	• Erosion and mobilisation of exposed soils, open cuts and stockpiles by stormwater runoff and wind leading to sedimentation of waterways • Exposure of acid sulfate soils or contaminated soils which, if mobilised via stormwater runoff, could acidify or pollute waterways • Dust, litter and pollutants associated with building materials and demolition waste being mobilised by wind and stormwater runoff into waterways • Leakage/spills of hydrocarbons or other chemicals from machinery with pollutants conveyed by stormwater runoff into waterways • Increased alkalinity due to transport of chemicals used in treatment and curing of concrete and concrete dust to waterways by stormwater or wind • Vehicles transferring soil to adjacent roads and stormwater runoff conveying soil and pollutants into waterways

Location	Construction activities / incidents	Potentially affected waterways	Potential impacts
Construction works at Rozelle including the Rozelle civil and tunnel site (C5) and wider Rozelle surface works	• Vegetation clearance and topsoil stripping • Demolition works • Establishment of construction ancillary facilities, access and utility supply • Excavations • Concrete works • Stockpiling of spoil, construction materials and demolition materials • Relocation of utilities • Access and egress of vehicles to construction ancillary facilities and public roads • Accidental spills/material drops during transportation of building waste from demolition sites with pollutants mobilised into waterways • Spills of chemicals/fuel stored on site • Operation of machinery • Operation of construction water treatment facility (C5 only) • Activities associated with construction for permanent works	• Rozelle Bay • Easton Park drain • White Bay • Whites Creek	• Erosion and mobilisation of exposed soils and open cuts by stormwater runoff and wind leading to sedimentation of waterways • Scour of exposed channel bank material during Whites Creek naturalisation works and subsequent soil mobilisation and sedimentation • Exposure of acid sulfate soils or contaminated soils which, if mobilised via stormwater runoff, could acidify or pollute waterways • Dust, litter and other building materials being mobilised by wind and stormwater runoff into waterways • Leakage/spills of hydrocarbons or other chemicals from machinery with pollutants conveyed by stormwater runoff into waterways • Increased alkalinity due to transport of chemicals used in treatment and curing of concrete and concrete dust to waterways by stormwater or wind • Vehicles transferring soil to adjacent roads and stormwater runoff conveying soil and pollutants into waterways

Location	Construction activities / incidents	Potentially affected waterways	Potential impacts
	• Bridgeworks associated with new road and pedestrian bridges across and adjacent to Whites Creek • Whites Creek naturalisation works • Realignment of The Crescent • Upgraded culvert under City West Link		
Potential new permanent drainage outlets to Rozelle Bay, Iron Cove and Whites Creek	• Construction of the drainage outlets • Discharges from the outlets during construction	• Rozelle Bay • Iron Cove • Whites Creek	• Mobilisation of sediments and contaminants within the sediments at outlet locations • Scouring of sediments at outlet locations
Drainage infrastructure adjustments and upgrades	• Earthworks during drainage upgrades • Earthworks and construction of the Easton Park drain diversion	• Iron Cove • Whites Creek • Easton Park drain • Rozelle Bay	• Mobilisation of exposed soils by stormwater runoff leading to sedimentation of waterways • Exposure of acid sulfate soils or contaminated soils which, if mobilised via stormwater runoff, could acidify or pollute waterways • Increased alkalinity due to curing of concrete
Construction of new stormwater quality treatment facilities	• Vegetation removal • Earthworks to facilitate construction of the devices • Access and egress of vehicles to construction ancillary	• Iron Cove • Rozelle Bay	• Erosion and mobilisation of exposed soils and open cuts by stormwater runoff and wind leading to sedimentation of waterways • Exposure of acid sulfate soils or contaminated soils which if mobilised

Location	Construction activities / incidents	Potentially affected waterways	Potential impacts
	facilities and public roads • Activities associated with construction for permanent works • Operation of machinery		via stormwater runoff could acidify or pollute waterways • Leakage / spills of hydrocarbons or other chemicals from machinery with pollutants conveyed by stormwater runoff into waterways • Vehicles transferring soil to adjacent roads and stormwater runoff conveying soil and pollutants into waterways

15.4 Assessment of potential operational impacts

15.4.1 Soils

Erosion and sedimentation

During operation of the project, there is potential for recently disturbed soils to be susceptible to erosion, particularly during initial periods of landscaping and re-establishment of vegetation. This may occur in areas where soft landscaping is proposed for the project, including open space areas at the Rozelle interchange, adjacent to disturbed areas, along embankments and in the reinstatement of temporary ancillary facilities where topsoil is settling and vegetation is establishing. Landscaping at the Rozelle interchange also presents the greatest risk of sediment loads entering waterways through the stormwater system, due to the extent of landscaping proposed and the proximity to waterways.

Soil stabilisation work may be required following construction to prevent further erosion, topsoil loss or soil migration. This work is likely to be required following severe storms. Measures to manage erosion will be included in the Operational Environmental Management Plan (OEMP).

15.4.2 Water quality

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

- Increased stormwater runoff from an overall increase in impervious area
- Spills or leaks of fuels and/or oils from vehicle accidents and/or operational facility and equipment
- Erosion of recently disturbed areas resulting in sedimentation of waterways
- Scour and mobilisation of contaminated sediments at proposed new drainage outlet locations and increased flow to existing locations (eg Rozelle Bay and Alexandra Canal).

These processes and activities, and their potential impacts on surface water quality in the study area are described in more detail in the following sections.

Operational water quality

The project would increase impervious areas (such as road pavement) that would be exposed to direct rainfall and increase runoff volume and associated pollutant mobilisation. 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 waterways.

MUSIC modelling was carried out to assess the performance of the proposed water quality treatment measures against pollutant reduction targets (see **section 15.1.7**). A summary of the MUSIC modelling results are provided in **Table 15-12**. The modelling results for the main locations where water would be discharged (Rozelle Bay, Iron Cove, White Bay and Whites Creek) and for the project as a whole indicate that:

- The project would generally reduce the mean annual stormwater pollutant loads being discharged to the Sydney Harbour and the Parramatta River estuary, when compared to the existing conditions
- The project would generally reduce the mean annual stormwater pollutant loads being discharged to the five receiving waterways, when compared to the existing conditions (except for total phosphorus loading to Dobroyd Canal (Iron Cove Creek), which would be slightly higher than the existing loading)
- The stormwater mean annual pollutant load reduction targets (see **section 15.1.5**) would not be achieved for the project or for the individual catchments, based on the treatment measures that could practically or readily be implemented.

The pollutant load reduction targets were not achievable given the lack of available space within the highly constrained project footprint. Oversizing other treatment measures to offset the reduced treatment for the project is not practical within the available project footprint, given that improvements in treatment performance are reduced as treatment facility footprint increases. An increased treatment size at Rozelle would reduce the area available for operational road infrastructure and open space.

In these highly constrained areas, good practice treatment techniques would be deployed where feasible and practical, as outlined in **section 15.5**. By reducing the mean annual stormwater pollutant load compared to existing conditions, the project would provide a beneficial effect in terms of reducing stormwater pollutant loads to the Sydney Harbour and Parramatta River catchment.

Table 15-12 MUSIC modelling results for operational water quality (kilograms per year)

Location	M4-M5 Link operation source load	M4-M5 Link operation residual load (following treatment)	Per cent reduction	Existing residual load	Impact compared to existing conditions
Project wide					
Total suspended solids	48,600	8,450	83%	33,900	-25,450
Total Phosphorus	81	39	52%	58	-19
Total Nitrogen	353	209	41%	271	-62
Gross Pollutants	3,520	242	93%	2,530	-2,288
Rozelle Bay					
Total suspended solids	36,500	5,300	86%	24,500	-19,200
Total Phosphorus	61	28	55%	42	-15
Total Nitrogen	271	156	43%	202	-46
Gross Pollutants	2,710	108	96%	1,860	-1,752
Iron Cove					
Total suspended solids	7,470	2,170	71%	6,680	-4,510
Total Phosphorus	13	6	56%	11	-6
Total Nitrogen	51	31	39%	49	-18
Gross Pollutants	501	103	80%	488	-385
White Bay					
Total suspended solids	1,130	240	79%	1,080	-840
Total Phosphorus	2	1	27%	2	-0.4
Total Nitrogen	8	5	30%	7	-2
Gross Pollutants	76	8	90%	72	-65
Whites Creek					
Total suspended solids	1,850	395	79%	1,650	-1,255
Total Phosphorus	3	2	27%	3	-1
Total Nitrogen	13	9	30%	12	-3

Location	M4-M5 Link operation source load	M4-M5 Link operation residual load (following treatment)	Per cent reduction	Existing residual load	Impact compared to existing conditions
Gross Pollutants	124	13	90%	115	-103
Dobroyd Canal (Iron Cove Creek)					
Total suspended solids	1,600	343	79%	640	-301
Total Phosphorus	3	2	27%	1	1
Total Nitrogen	11	8	30%	8	-0.4
Gross Pollutants	108	10.9	90%	92	-81

Notes:

Green shading indicates target is achieved

Orange shading indicates target not achieved

Blue shading indicates reduced load compared to existing conditions

Yellow shading indicates increased load compared to existing conditions

Stormwater runoff from the project would be controlled by a stormwater quality treatment system, designed in accordance with the project stormwater quality objectives based on pollutant load reduction consistent with the Sydney Harbour and Botany Bay water quality improvement plans rather than a specific rainfall event (see **section 15.1.5**). These would be developed during detailed design and included in the CSWMP. This would achieve the environmental outcome required from a treatment device and is standard practice for construction projects of this nature.

Where practical and appropriate, operational treatment systems would incorporate a high flow bypass for a minimum of a three-month annual recurrence interval. This would enable treatment of the majority of most runoff events, while protecting the treatment devices from scour or damage associated with larger rainfall events.

Refer to **Appendix Q** (Technical working paper: Surface water and flooding) for full details of the stormwater drainage infrastructure and proposed stormwater quality treatment systems.

Tunnel drainage and treatment

Tunnel drainage

The tunnels would include drainage infrastructure to capture groundwater and stormwater ingress, spills, maintenance wastewater, fire suppressant deluge and other potential water sources. The two tunnel drainage streams are expected to produce flows containing a variety of pollutants that require slightly different treatment before discharge to manage adverse impacts on the receiving environment. The pre-treatment water quality of each wastewater stream is expected to vary considerably, and consequently it is likely that the two streams would need to be collected and treated separately.

Tunnel wastewater from the mainline tunnels would be pumped to a water treatment facility at the Darley Road motorway operations complex (MOC1) at Leichhardt. Options for discharge of treated water from the Darley Road water treatment plant include:

- Direct discharge to Hawthorne Canal, which would require a pipe to be installed along Canal Road and the construction of a new outlet in the wall of the Hawthorne Canal
- Direct discharge to the existing stormwater pipework in an adjoining road (ie Canal Road), which would require a pipe to be installed to connect to existing piped drainage
- Direct discharge into the sewer system located on the site, which would require a Trade Waste Agreement with Sydney Water.

Further detail regarding these discharge options is included in **Appendix F** (Utilities Management Strategy). The preferred option for treated water discharge from the Darley Road water treatment plant would be confirmed during detailed design.

Tunnel wastewater from the Rozelle interchange tunnels and Iron Cove Link would be pumped to an operational water treatment facility at the Rozelle East motorway operations complex (MOC3), with flows being treated at the constructed wetland at Rozelle civil and tunnel site (C5) and then discharged into Rozelle Bay.

At the St Peters interchange, a small portion (around 1.6 kilometres) of tunnel would also drain to the New M5 operational water treatment facility at Arncliffe, draining to the Cooks River. Other sources of water captured by the tunnel drainage system (ie washdown or a spill) would be collected in one of the tunnel sumps, assessed to determine the source, tested, and either pumped to and discharged at the surface or removed directly from the sump by tanker for treatment, and disposal elsewhere.

The combined mainline tunnel (23 litres per second) and Rozelle interchange tunnel (22 litres per second) would generate up to around 1,418 megalitres per year of groundwater.

Tunnel wastewater treatment

Elevated metals and nutrients were recorded during groundwater sampling and groundwater was identified as brackish (refer to **Chapter 19** (Groundwater)). Metal, nutrient and ammonia loading to Hawthorne Canal and Rozelle Bay is likely to increase as a result of the continuous treated groundwater discharges. To prevent adverse impacts on downstream water quality within Rozelle Bay and Hawthorne Canal, treatment facilities would be designed so that tunnel wastewater would be of suitable quality for discharge to the receiving environment.

The operational water treatment facilities would be designed such that effluent would be of suitable quality for discharge to the receiving environment and developed in accordance with the ANZECC (2000) and relevant NSW WQOs. The ANZECC (2000) 'marine' default trigger values for 95 per cent level of species protection are considered appropriate for establishing discharge criteria for parameters which require treatment, where practical and feasible (refer to **Appendix Q** (Technical working paper: Surface water and flooding)).

The project water treatment facilities would treat iron and manganese (as no 'marine' trigger value is available for iron and manganese; alternative discharge criteria are provided in **Table 15-13**). The proposed constructed wetland at Rozelle would provide 'polishing' treatment to treated groundwater flows from the Rozelle interchange and Iron Cove Link tunnels, which would likely remove a proportion of the nutrient and metal load. As no constructed wetland is proposed at Darley Road (due to space constraints), opportunities to incorporate other forms of nutrient treatment within the facility at Darley Road would be investigated during detailed design if subsequent groundwater monitoring indicates it may be required.

A qualitative assessment (refer to **Appendix Q** (Technical working paper: Surface water and flooding)) of the risk posed by treated groundwater discharges to ambient water quality within Rozelle Bay and Hawthorne Canal determined the following:

- Considering the groundwater quality and proposed treatment, impacts on ambient water quality within Rozelle Bay are likely to be negligible
- Considering the groundwater quality and proposed treatment, impacts on ambient water quality within Hawthorne Canal are likely to be negligible and localised to near the outlet.

Impacts associated with discharge quality from the Arncliffe operational water treatment facility were assessed as part of the New M5 EIS. No adverse impacts are likely to occur as a result of the minor additional flow (1.6 litres per second) draining to the Arncliffe operational water treatment facility.

Indicative operational discharge locations are provided in **Figure 15-5**.

Scour and channel geomorphology

There is potential for sediment to be scoured and mobilised where stormwater or wastewater is discharged to receiving waterways and bays including Hawthorne Canal, Dobroyd Canal (Iron Cove Creek), Rozelle Bay, Iron Cove and Whites Creek. This could increase turbidity and lead to mobilisation of contaminants that are bound to sediments.

The Whites Creek widening and improvement works would follow Sydney Water's naturalisation works and extend between Rozelle Bay and the realigned The Crescent. The design of the naturalisation works would be finalised during detailed design, but are likely to incorporate features such as sandstone blocks and vegetated benches to provide ecological benefits to the channel. The proposed channel bed and bank treatments would be hard lined.

As a result, impacts on channel form and geomorphology are unlikely to occur once the works are complete. Any vegetated zones (eg benches) would be susceptible to erosion and would be protected during the vegetation establishment period. Management measures to minimise the potential for scour are outlined in **section 15.5** and would be incorporated into the CSWMP.

Spills and leakages

Vehicle or plant and equipment leakages or a vehicle crash may cause spills of oils, lubricants, hydraulic fluids and chemicals during the operation of the project. Spills and leakages within the project footprint have the potential to pollute downstream waterways, as a result of being conveyed to waterways via the stormwater network. The severity of the potential impact would depend on the magnitude and/or location of the spill in relation to sensitive receivers, emergency response procedures and/or management measures implemented on site and the nature of the receiving environment.

Further discussion on accidental spills is included in **Chapter 25** (Hazard and risk). Spill control measures, as outlined in **section 15.5**, would be implemented to reduce and manage the potential for environmental impacts to occur.

Residual impacts on water quality during operation

As discussed in **section 15.2.2**, receiving waterways in the study area do not achieve all the Sydney Harbour and Parramatta River catchment WQOs, with records of elevated levels of some heavy metals, nutrients, turbidity and pH. MUSIC modelling carried out indicates that the project would reduce the stormwater pollutant loading to the receiving waterways when compared to the existing conditions. Therefore, residual impacts on receiving waterways are anticipated to be negligible and/or beneficial. The project is not expected to worsen the existing conditions of receiving waterways.

Tunnel water would be treated, and spill controls and water quality monitoring would be implemented to manage operational impacts on ambient water quality within the receiving waterways. With consideration to groundwater quality, proposed treatment and receiving water quality, residual impacts associated with treated tunnel water discharges to ambient water quality are likely to be negligible.

As no constructed wetland is proposed at Darley Road, opportunities to incorporate other forms of nutrient treatment (eg ion exchange or reverse osmosis) within the water treatment plant at Darley Road will be investigated during detailed design with consideration to the ongoing groundwater quality monitoring and other factors such as available space, increased power requirements and increased waste production.

In the context of the entire catchment draining to Sydney Harbour, the project is likely to have a negligible influence on achieving the Sydney Harbour and Parramatta River WQOs.

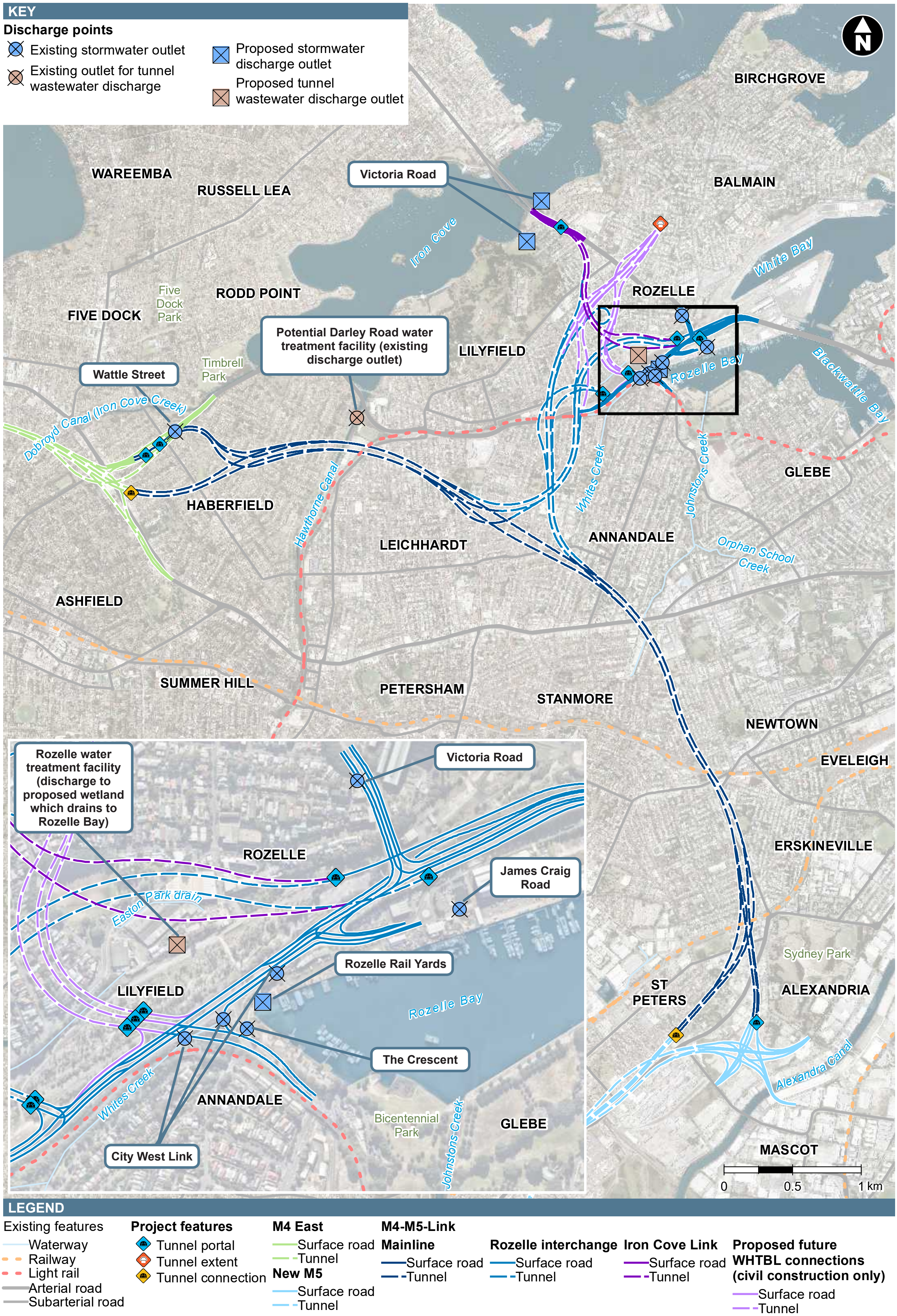

Figure 15-5 Indicative operational discharge points

15.5 Environmental management measures

Management measures would be implemented to avoid, minimise or mitigate impacts on soil and water quality within the study area. These management measures are outlined in **Table 15-13**.

Table 15-13 Environmental management measures – soil and water quality

Impact	No.	Environmental management measure	Timing
Construction			
Impacts on surface water quality	SW01	A CSWMP will be prepared for the project. The plan will include the measures that will be implemented to manage and monitor potential surface water quality impacts during construction. The CSWMP will be developed in accordance with the principles and requirements in Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom 2004) and Volume 2D (DECCW 2008), commonly referred to as the 'Blue Book'.	Construction
	SW02	A program to monitor potential surface water quality impacts due to the project will be developed and included in the CSWMP. The program will include the water quality monitoring parameters and the monitoring locations identified in Annexure E of **Appendix Q** (Technical working paper: Surface water and flooding) to the EIS where appropriate. The monitoring program will commence prior to any ground disturbance to establish appropriate baseline conditions and continue for the duration of construction, as well as for a minimum of three years following the completion of construction or until the affected waterways are certified by a suitably qualified and experienced independent expert as being rehabilitated to an acceptable condition (or as otherwise required by any project conditions of approval). Further details to be included in the program are outlined in **Appendix Q** (Technical working paper: Surface water and flooding).	Construction
Sedimentation of waterways	SW03	Erosion and Sediment Control Plans (ESCPs) will be prepared for all work sites in accordance with the Blue Book. ESCPs will be implemented in advance of site disturbance and will be updated as required as the work progresses and the sites change.	Construction
	SW04	A soil conservation specialist will be engaged for the duration of construction to provide advice regarding erosion and sediment control.	Construction
	SW05	The extent of ground disturbance and exposed soil will be minimised to the greatest extent practicable to minimise the potential for erosion.	Construction
	SW06	Disturbed ground and exposed soils will be temporarily stabilised prior to extended periods of site inactivity to minimise the potential for erosion.	Construction
	SW07	Disturbed ground and exposed soils will be permanently stabilised and proposed landscaped areas will be suitably profiled and vegetated as soon as possible following disturbance to minimise the potential erosion.	Construction

<table>
<tr><th>Impact</th><th>No.</th><th>Environmental management measure</th><th>Timing</th></tr>
<tr><td rowspan="2">Impacts on the form and aquatic habitat of Whites Creek</td><td>SW08</td><td>The proposed bridge crossing over and widening of Whites Creek, including all associated temporary and permanent infrastructure, will be designed and constructed in a manner consistent with:
NSW Guidelines for Controlled Activities Watercourse Crossings (DPI 2012)
Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge 2003)
Policy and Guidelines for Fish Friendly Waterway Crossings (NSW Fisheries February 2004)
Policy and Guidelines for Fish Habitat Conservation and Management (DPI Fisheries, 2013).
Appropriate fish passage will be provided for crossings of fish habitat streams.</td><td>Construction</td></tr>
<tr><td>SW09</td><td>Consultation will be undertaken with Sydney Water regarding the timing of the works at Whites Creek and compatibility of the proposed design and Sydney Water's naturalisation works.</td><td>Construction</td></tr>
<tr><td>Impacts on water quality from the discharge of treated wastewater</td><td>SW10</td><td>Temporary construction water treatment plants will be designed and managed so that treated water would be of suitable quality for discharge to the receiving environment. The level of treatment provided will consider the characteristics of the waterbody, any operational constraints or practicalities and associated environmental impacts and be developed in accordance with ANZECC (2000) and with consideration to the relevant NSW WQOs and Protection of the Environment Operations Act 1997 (NSW).

An ANZECC (2000) species protection level of 90 per cent is considered appropriate for adoption as discharge criteria for toxicants where practical and feasible.

The discharge criteria for the treatment facilities will be included in the CSWMP.</td><td>Construction</td></tr>
<tr><td>Impacts on water quality from disturbance of acid sulfate soils</td><td>SW11</td><td>Procedures, prepared in accordance with the requirements of the Acid Sulfate Soil Manual (Acid Sulfate Soil Management Advisory Committee 1998), will be included in the CSWMP and implemented in the event that acid sulfate soils, rocks or monosulfidic black oozes are encountered during construction of the project.</td><td>Construction</td></tr>
<tr><td colspan="4">Operation</td></tr>
<tr><td>Impacts on surface water quality</td><td>OSW12</td><td>Stormwater from the project will be treated prior to discharge. Where space is available, bioretention systems or constructed wetlands will be installed. Where space is not available, other smaller devices, such as proprietary stormwater treatment devices, will be installed. The final design of treatments will be supported by MUSIC modelling and water sensitive urban design principles.</td><td>Construction and operation</td></tr>
</table>

Impact	No.	Environmental management measure	Timing
	OSW13	Maintenance requirements for all stormwater treatment systems and devices installed as part of the project will be identified and included in relevant operational maintenance schedules/systems.	Construction and operation
	OSW14	Spill containment will be provided on the motorway. Spill management and emergency response procedures will be documented in the OEMP or Emergency Response Plan.	Construction and operation
	OSW15	The constructed wetland at the Rozelle interchange will be appropriately designed to cater for the continuous flow of treated groundwater from the water treatment plant and onsite stormwater flows.	Construction and operation
	OSW16	The operational water treatment facilities will be designed such that effluent will be of suitable quality for discharge to the receiving environment. Discharge criteria will be developed in accordance with the ANZECC (2000) and relevant NSW WQOs, including the following discharge criteria: • 0.3 milligrams per litre for iron • 1.8 milligrams per litre for manganese. The discharge criteria for the treatment facilities will be included in the OEMP.	Construction and operation
Sedimentation or scouring effects at discharge locations	OSW17	New discharge outlets will be designed with appropriate energy dissipation and scour protection measures as required to minimise the potential for sediment disturbance and resuspension in the receiving waters. Outlet design and energy dissipation/scour protection measures will be informed by drainage modelling.	Construction
	OSW18	Existing drainage outlets that will be subject to increased inflow from the project will be assessed. If necessary, energy dissipation or scour protection will be added to prevent sediment disturbance and resuspension in receiving waters.	Construction