Transport for NSW/Sydney Airport Corporation Limited

Sydney Gateway Road Project

Environmental Impact Statement/ Major Development Plan

Chapter 15 Groundwater

2020

Contents

15. Groundwater.......15.1

15.1 Assessment approach 15.1

15.2 Existing environment 15.5

15.3 Assessment of construction impacts 15.9

15.4 Assessment of operation impacts.......15.17

15.5 Cumulative impacts 15.18

15.6 Management of impacts 15.19

Tables

Table 15.1 Hydraulic conductivity for wells within the Botany Sands aquifer 15.6

Table 15.2 Assessment against the minimal impact criteria of the NSW Aquifer Interference Policy 15.14

Table 15.3 Summary of estimated inflow rates during construction.......15.15

Table 15.4 Preliminary settlement estimate due to groundwater drawdown 15.16

Table 15.5 Groundwater mitigation measures 15.20

Figures

Figure 15.1 Location of monitoring wells and registered groundwater bores.......15.4

Figure 15.2 Regional groundwater flow.......15.8

Figure 15.3 Works with the potential to intersect groundwater 15.11

Figure 15.4 Radii of groundwater influence during construction 15.12

Chapter 15

Groundwater

This chapter describes the existing groundwater environment, identifies potential impacts during construction and operation, and provides measures to mitigate and manage the impacts identified. Further information is provided in Technical Working Paper 7 (Groundwater). Potential groundwater impacts are also considered in Chapter 13 (Contamination and soils) (in terms of the potential for contamination impacts) and in Chapter 16 (Surface water) (in terms of the potential to affect surface water quality once it is removed from the ground).

The SEARs relevant to groundwater, which fall under the headings of 'water – hydrology' and 'water – quality', are listed below. There are no MDP requirements specifically relevant to groundwater, however there is a requirement under section 91(1) of the Airports Act to assess the potential environmental impacts associated with a development (section 91(1)(h)), and to specify how those impacts may be dealt with (section 91(1)(j)). Full copies of the SEARs and MDP requirements, and where they are addressed in this document, are provided in Appendices A and B respectively.

Reference	Requirement	Where addressed[1]
Key issue SEARs		
10	**Water - Hydrology**	
10.1	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 proposal, including rivers, streams, estuaries and wetlands as described in the BAM.	Section 15.2 and Figure 15.2 (groundwater resources) Section 16.2 and Figure 16.1 (surface water resources) Key resources described in the BAM are also considered in Chapter 22 (Biodiversity)
10.2	The Proponent must prepare a detailed water balance for ground and surface water including the proposed intake from all water supply options and discharge locations (including figures showing these locations), volume, frequency, duration and proposed water conservation and reuse measures for both the construction and operation of the proposal.	Sections 15.3.3 and 15.4.3 (groundwater) Sections 16.3.1 and 16.4.1 (surface water)
10.3	The Proponent must assess (and model if appropriate) the impact of the construction and operation of the proposal 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;	Sections 15.3 and 15.4 (groundwater) Sections 16.3.1, 16.3.2, 16.4.1 and 16.4.2 (surface water) Chapter 22 (biodiversity)
	(b) impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement	Sections 15.3.1 and 15.4.1 (groundwater)
	(c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources;	Sections 15.3.3 and 15.4.3 (groundwater) Not relevant for surface water

Reference	Requirement	Where addressed[1]
	(f) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Sections 15.3.3 and 15.4.3 (groundwater) No surface water take proposed
10.4	The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	Section 15.6 (groundwater) No monitoring of hydrological attributes is considered necessary. Baseline water quality monitoring is recommended in section 16.6.1 (surface water).
10.5	The assessment must include details of proposed surface and groundwater monitoring.	Section 15.6 (groundwater) Section 16.6.1 (surface water)
11.	**Water – Quality**	
11.1	The Proponent must: (a) Describe the background conditions for any surface and groundwater resources likely to be affected by the proposal including leachate from Tempe Tip	Section 15.2 (groundwater) Section 16.2.3 (surface water)
	(c) 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 (including contaminated groundwater) that pose a risk of non-trivial harm to human health and the environment	Sections 15.3.1, 15.3.2, 15.4.1 and 15.4.2 (groundwater) Sections 16.3.1, 16.3.2 16.4.1 and 16.4.2 (surface water)
	(d) assess the impacts of leachate generation from proposal related activities on the Tempe Tip site and proposed measures for managing potential impacts during construction and operation	Sections 15.3.3, 15.4.3 and 15.6 (groundwater) Sections 16.3.2 and 16.4.2 (surface water)
	(j) demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented	Section 15.6 (groundwater) Section 16.6 (surface water)
	(l) identify proposed monitoring locations, monitoring frequency and indicators of surface and groundwater quality.	Section 15.6 (groundwater) Section 16.6.1 (surface water)
11.2	The assessment should consider the results of any current water quality studies, as available, for the catchment areas traversed by the proposal.	Section 15.1.2 (groundwater) Sections 16.1.2, 16.1.4 and 16.2.3 (surface water)

15. Groundwater

15.1 Assessment approach

Groundwater is naturally occurring water contained within rocks and sediments below the ground surface. Construction activities that involve excavation have the potential to encounter groundwater, depending on the depth of both the groundwater and excavation required. Interacting with and removing groundwater during construction is regulated by a number of pieces of legislation aimed at avoiding environmental impacts, including a reduction in the availability and quality of water for users and for ecosystems that depend on it. Understanding the existing characteristics of groundwater is therefore a key part of determining the potential for impacts from infrastructure development and developing appropriate strategies to manage potential impacts.

The groundwater assessment included consideration of the construction and operation activities that may impact groundwater within the project site and adjacent areas. For the purposes of the assessment, groundwater which comes into contact with waste material within the former Tempe landfill is considered to be leachate. Such leachate is collected via the landfill leachate system before it is treated and disposed of.

An overview of the approach to the assessment is provided below, including the legislative and policy context and a summary of the assessment methodology.

15.1.1 Legislative and policy context to the assessment

The assessment has been undertaken in accordance with the SEARs and MDP requirements (provided in Appendices A and B) and with reference to the following:

- Relevant legislation, including the EP&A Act, the Airports Act and associated regulations, POEO Act, *Contaminated Land Management Act 1997* (NSW), *Water Act 1912* (NSW), *Water Management Act 2000* (NSW) and Water Management Regulation 2018
- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*
- *NSW Aquifer Interference Policy* (Department of Primary Industries, 2012a)
- *NSW State Groundwater Policy Framework Document* (Department of Land and Water Conservation, 1997)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments (ANZG), 2018)
- *Australian Drinking Water Guidelines* (National Health and Medical Research Council, 2018)
- *Guidelines for Managing Risks in Recreational Water* (National Health and Medical Research Council, 2008)
- *National Water Quality Management Strategy* (Australian and New Zealand Environment and Conservation Council, 2000)
- *Botany Bay and Catchment Water Quality Improvement Plan* (Sydney Metropolitan Catchment Management Authority, 2011)
- *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (NSW EPA, 2004)
- *Risk assessment guidelines for groundwater dependent ecosystems* (Department of Primary Industries, 2012b)
- *Australian groundwater modelling guidelines* (National Water Commission, 2012)
- *Sydney Airport Master Plan 2039* (SACL, 2019a)
- *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b).

15.1.2 Methodology

Study area

The assessment included a review of existing groundwater bores within a one kilometre radius of the project site.

Computer modelling (see below for further detail) was used to establish the radius of groundwater drawdown resulting from dewatering of the construction activities. As a result, the study area for the assessment included all sensitive receptors within the area of drawdown around proposed excavations that could be impacted by the project (see Figure 15.4).

Key tasks

The assessment generally involved:

- Reviewing relevant proprietary databases detailing the existing groundwater, geological and hydrogeological environments, including:
  - Hydrogeology of the Botany Basin (Hatley, 2004)
  - Bureau of Meteorology online database
  - WaterNSW online database for registered groundwater bores
- Existing hydrology/flooding, surface water quality, leachate monitoring (for the former Tempe landfill only) and groundwater monitoring data provided by (then) Roads and Maritime, Sydney Airport Corporation and publicly available data
- Reviewing similar assessments for other projects within or close to the study area
- Characterising the current hydrogeological and groundwater conditions in the study area
- Undertaking field investigations, including drilling, permeability testing, monitoring well installation, and water level and quality monitoring
- Developing an analytical computer groundwater model
- Undertaking calculations to predict groundwater inflows and drawdown as a result of the project
- Assessing potential groundwater-related impacts, including a preliminary settlement estimate for adjacent development
- Identifying mitigation measures.

Further information on key activities is provided below.

Field investigations

Baseline groundwater data within the study area was obtained from previous studies and from monitoring undertaken for the project. Groundwater monitoring undertaken for the project since December 2018 included:

- Screening of 27 groundwater wells within or around the former Tempe landfill, 47 wells in the Botany Sands aquifer, and eight wells in bedrock aquifers (primarily Hawkesbury Sandstone) – the location of these monitoring wells is shown on Figure 15.1 and the details of sampling completed at each well is provided in Appendix A of Technical Working Paper 7 (Groundwater)
- Manually monitoring 74 wells for groundwater levels and 73 wells for groundwater quality
- Installing data loggers in 14 wells to monitor groundwater levels
- Hydraulic testing in 16 wells.

Impact assessment

The construction and operation impact assessment focussed on changes to the following groundwater conditions as outlined by the *NSW Aquifer Interference Policy*:

- Groundwater drawdown – including a comparison of the depth of excavation that could require dewatering against interpreted groundwater levels, with consideration of natural variations in groundwater levels
- Groundwater recharge – including a comparison of the change in sealed areas relative to unsealed areas during construction and operation to assess the impacts on recharge
- The potential for beneficial reuse of the groundwater source – including consideration of the suitability of extracted groundwater for beneficial reuse to ensure that the receiving environment is not affected by any discharges.

The assessment assumed that each excavation would be undertaken separately. To allow for overlapping excavations, worst-case construction conditions were considered. This assumed that excavations would be larger and remain open for a longer duration than actually expected. The potential impacts of constructing the following project features, where excavation would be required, were considered:

- Utilities and services installation, augmentation and protection
- Stormwater drainage infrastructure including pipes, channels and the proposed flood mitigation basin (locations and depths shown on Figure 15.3)
- Retaining walls (locations shown on Figure 15.3)
- Bridges, bridge ramps and underpasses (locations shown on Figure 15.3)
- Road cuttings.

Groundwater modelling

An analytical modelling approach was undertaken to inform the impact assessment. This approach was selected for the following reasons:

- The project would mainly interact with shallow unconsolidated aquifers
- Potential drawdown impacts would be temporary, localised and associated with construction
- The aquifer with the potential to be impacted is considered to be a single unit and is well understood as a result of previous assessments.

The inflow rate and radius of influence for individual construction areas were calculated to inform the proposed approach to managing potential groundwater impacts. The radius of influence is the maximum distance from the centre of the excavation where groundwater drawdown can be detected. Radius of influence calculations were completed to assess the potential impacts of the project against the *NSW Aquifer Interference Policy* criteria. Receptors inside the radius of influence were considered to be potentially affected.

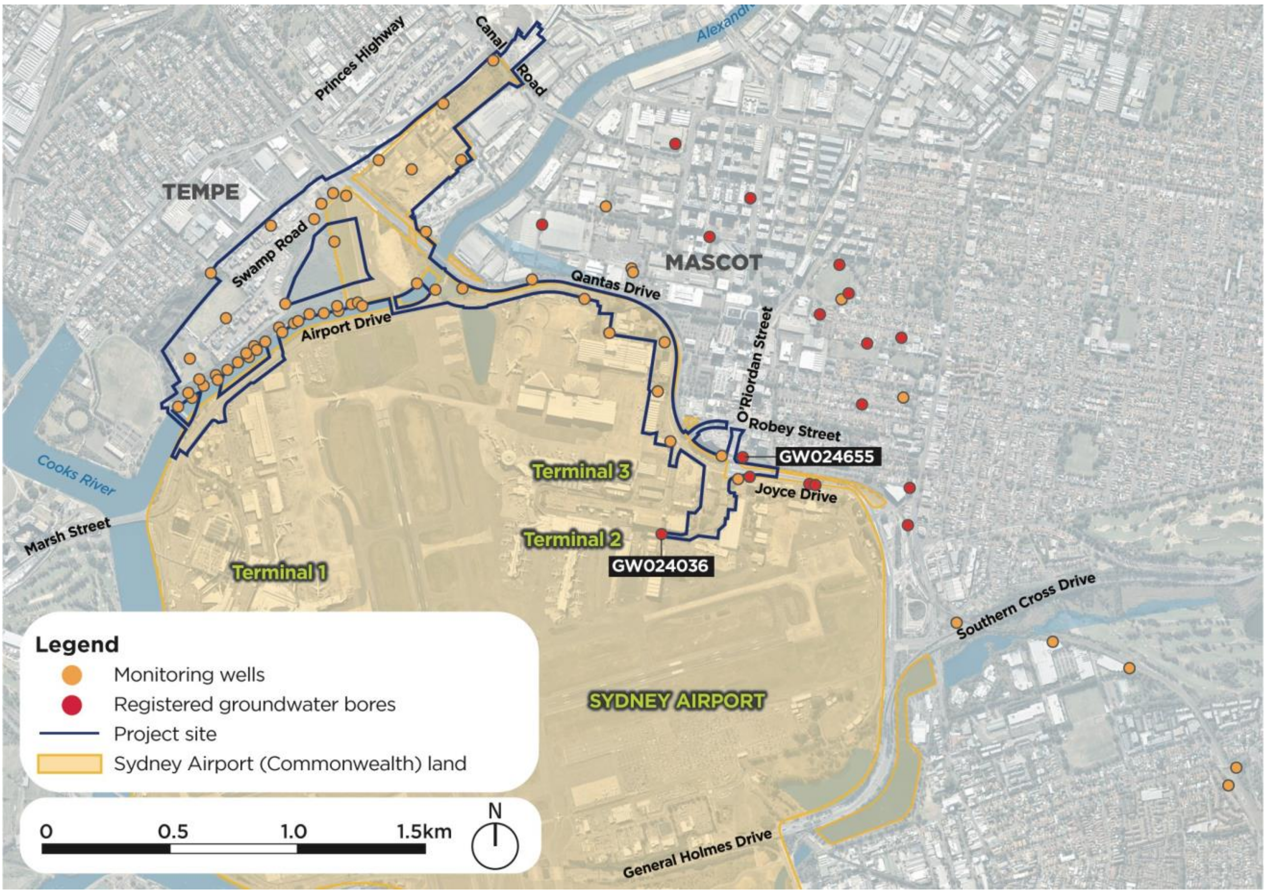

Figure 15.1 Location of monitoring wells and registered groundwater bores

Assessment criteria

Potential groundwater impacts were assessed with reference to the minimal impact considerations for highly productive groundwater sources for coastal sand water sources in the *NSW Aquifer Interference Policy*. A highly productive (high yields and total dissolved solids less than 1,500 milligrams per litre (mg/L)) system was selected based on the conceptual understanding of hydrogeological conditions within the study area. The criteria include:

- Water table – Less than or equal to 10 per cent cumulative variation in the water table at a distance of 40 metres from any high priority groundwater dependant ecosystem or high priority culturally significant site. A criteria of 0.05 metres was set to protect groundwater dependant ecosystems.
- Water table – A maximum two metre water table decline at any water supply location such as a bore (impacts are considered as the total impact of all works associated with the project)
- Water pressure – A pressure head decline of not more than two metres at any water supply location such as a bore (impacts are considered as the total impact of all works associated with the project)
- Water quality – Any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond a distance of 40 metres from the activity.

It is noted that the *NSW Aquifer Interference Policy* assessment criteria were also applied to the assessment of the potential impacts of those parts of the project within Sydney Airport land, as there are no groundwater guidelines or criteria specific to Commonwealth land.

15.1.3 Risks identified

An environmental risk assessment was undertaken as an input to the impact assessment (see Appendix G). This involved identifying potential environmental risks during construction and operation, and rating the potential risks according to likelihood, consequence and overall level of risk, in general accordance with *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. Groundwater risks with an overall assessed risk rating of medium or above, identified by the environmental risk assessment, included:

- Dewatering of excavations may cause drawdown of the groundwater table, impacting sub-surface flows and potentially affecting the stability of nearby structures
- Dewatering of excavations causing drawdown could result in migration of existing contaminated groundwater plumes
- These potential risks and impacts were considered as part of the groundwater assessment.

15.2 Existing environment

15.2.1 Groundwater setting and characteristics

Hydrogeology and aquifers

Groundwater is located within the following hydrogeological units in the study area:

- Hawkesbury Sandstone – A semi-confined dual porosity (fractured and secondary porosity) regional aquifer extending across the Sydney Basin. Groundwater flow is predominantly through the open and connected fractures and bedding plane of the rock mass. Reduced water quality within the upper portion of the sandstone unit may be due to the natural leakage of saline groundwater from the Wianamatta Group (Ashfield Shale).
- Ashfield Shale – A low-yielding aquifer. Like the Hawkesbury Sandstone, its permeability is controlled by fracture intensity, persistence and joint aperture. Groundwater within this unit is highly saline.
- Quaternary Sediments – The Botany Sands is an unconfined, high permeability aquifer. In coastal sand aquifers, including the Botany Sands aquifer, groundwater is contained in the pore spaces in the unconsolidated sand sediments. The level of connection between surface water and groundwater is significant. The estimated travel time between groundwater and surface watercourses is days to months.
- Fill – Two main types of fill materials are located in the study area – landfill material at the former Tempe landfill, and fill associated with reclaimed land in the vicinity of and including Sydney Airport land. The reclaimed material is generally reworked local estuarine deposits and is similar in composition to the underlying natural materials. There are also intermittent areas of fill across the project site associated with development/infrastructure.

The project site is likely to intersect the shallow, unconsolidated Botany Sands aquifer.

Hydraulic conductivity

Hydraulic conductivity is a fundamental aquifer property that assists in understanding the local drawdown that may be imposed on the local hydrogeological regime. Hydraulic conductivity is measured in metres per day and is a calculation of how quickly groundwater flows through a porous medium (soil matrix or rock mass) under natural conditions. The higher the value of hydraulic conductivity, the greater the movement of groundwater expected.

Hydraulic conductivity data from previous investigations and those undertaken for the assessment within the Botany Sands aquifer and unconsolidated fill (a total of 31 test points) are summarised in Table 15.1.

Table 15.1 Hydraulic conductivity for wells within the Botany Sands aquifer

Value	Conductivity (metres per day)
Average	10.03
Minimum	0.09
Maximum	52
Median	1.86

Groundwater recharge

Recharge to the Botany Sands aquifer is mainly via direct rainfall infiltration, with recharge from infiltration ranging from six per cent over estuarine sediments and 37 per cent over sands. The main area of recharge is located to the north-east of the project site at Centennial Parklands. Other green areas, such as the golf courses and the Botany Wetlands to the east of the project site, are also key recharge areas. The project site is mapped as an impervious surface, as developments such as roads, Sydney Airport and other structures and paving reduce the amount of surface infiltration. Therefore, it is expected that the project site would have lower groundwater recharge from rainfall infiltration compared with that of pervious spaces (open spaces such as Tempe Recreation Reserve) overlying the same aquifer. Leakage from water supply and drainage networks generally compensate for decreased direct recharge in urban areas.

Groundwater depth and flow

Monitoring results for 10 bores within the project site identified:

- Shallow groundwater depths, ranging between one and four metres below ground level in the north and north-west of the project site
- The depth of groundwater within the uncontrolled fill in the former Tempe landfill is recorded at an average of 12 metres below ground surface.

Flow directions within the Botany Sands aquifer are generally controlled by topography. From the recharge areas located at higher elevations east and north-east of the Botany Basin, groundwater flows south and south-west towards rivers and other tributaries and into Botany Bay. Based on available well monitoring data, groundwater is located at about 35 metres Australian height datum near Centennial Parklands, with elevations gently declining south to Botany Bay. Regional groundwater flow directions for the Botany Bay catchment are shown on Figure 15.2.

15.2.2 Groundwater quality

The quality of groundwater within and surrounding the project site has historically been poor due to contamination by surrounding industry and other contaminating activities. Investigations carried out for the project have identified that groundwater within and surrounding the project site exceeds the relevant criteria for a number of contaminants. Baseline monitoring undertaken for the assessment identified exceedances of the following criteria:

- Human health (recreational) criteria for arsenic, chromium, total phosphorus, manganese, naphthalene, total recoverable hydrocarbon, iron, ammonia, chloride, sodium, total dissolved solids and pH, lead and PFAS
- Airports (Environment Protection) Regulations 1997 fresh and marine water (exceedances for freshwater and marine unless stated) criteria for aluminium, arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, iron and total petroleum hydrocarbons (freshwater only)
- Ecological criteria from the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018):
  - Freshwater criteria for aluminium, nickel, zinc, copper, boron, cadmium, manganese
  - Marine criteria for cobalt, copper, lead, zinc

– Freshwater and marine criteria for naphthalene, ammonia and PFOS.

As a result of the historical contamination, restrictions on groundwater extraction from the Botany Sands aquifer were implemented by the NSW Government in 2006 for a number of suburbs, including Mascot, Tempe and St Peters. Within these areas, groundwater extraction is prohibited for domestic use, and use for industrial and irrigation purposes is restricted, subject to testing and treatment (if required). Extracted groundwater may be used for remediation, temporary construction dewatering, testing or monitoring purposes.

Further information on contamination is provided in Chapter 13 (Contamination and soils).

15.2.3 Groundwater users

A total of 23 registered groundwater wells, used for household, recreational, irrigation, commercial/industrial, dewatering or unknown purposes, are located within a one kilometre radius of the project site. The majority of the wells are shallow (less than 20 metres deep) and are expected to be within the Botany Sands aquifer and alluvial sediments. The locations of registered groundwater wells are shown on Figure 15.1.

15.2.4 Water balance

Botany Sands aquifer

The average daily rainfall recharge of the Botany Sands aquifer to the north and east of Cooks River (where the project site is located) is estimated to be about 53,950 cubic metres per day. About 19,135 cubic metres per day of this is estimated to be used by water access licences (mainly in the northern areas of Botany Sands aquifer) and about 34,815 cubic metres per day is estimated to discharge from the aquifer to surface waters.

About 4,874 cubic metres per day of the groundwater discharged to surface water passes beneath the project site to Alexandra Canal. The groundwater discharge to Alexandra Canal from beneath the eastern areas of the project site is about 3,825 cubic metres per day. As the project site represents less than one per cent of the Botany Sands aquifer, the existing recharge within the project site would be less than one per cent of the total rainfall recharge in the Botany Sands aquifer (ie less than 540 cubic metres per day). The total rainfall recharge rates within the project site are considered to be lower than 540 cubic metres per day (based on average recharge by area) as the project site includes more sealed areas compared with the overall area of the Botany Sands aquifer.

Former Tempe landfill

The water balance provided in Technical Working Paper 16 (Former Tempe Landfill Assessment) indicates that daily discharges of leachate range from between 40 cubic metres per day and 108 cubic metres per day. Daily extraction rates in the order of 60 to 100 cubic metres per day generally allow leachate levels to be maintained at or about the elevation of the bentonite cut-off wall, preventing the flow of leachate to Alexandra Canal.

15.2.5 Groundwater dependent ecosystems

There are no groundwater dependent ecosystems located within the project site. The nearest groundwater dependent ecosystems are:

- The Botany Wetlands and Lachlan Swamps, located about two kilometres south-east of the project site
- Vegetation along Wolli Creek, located about one kilometre west of the project site.

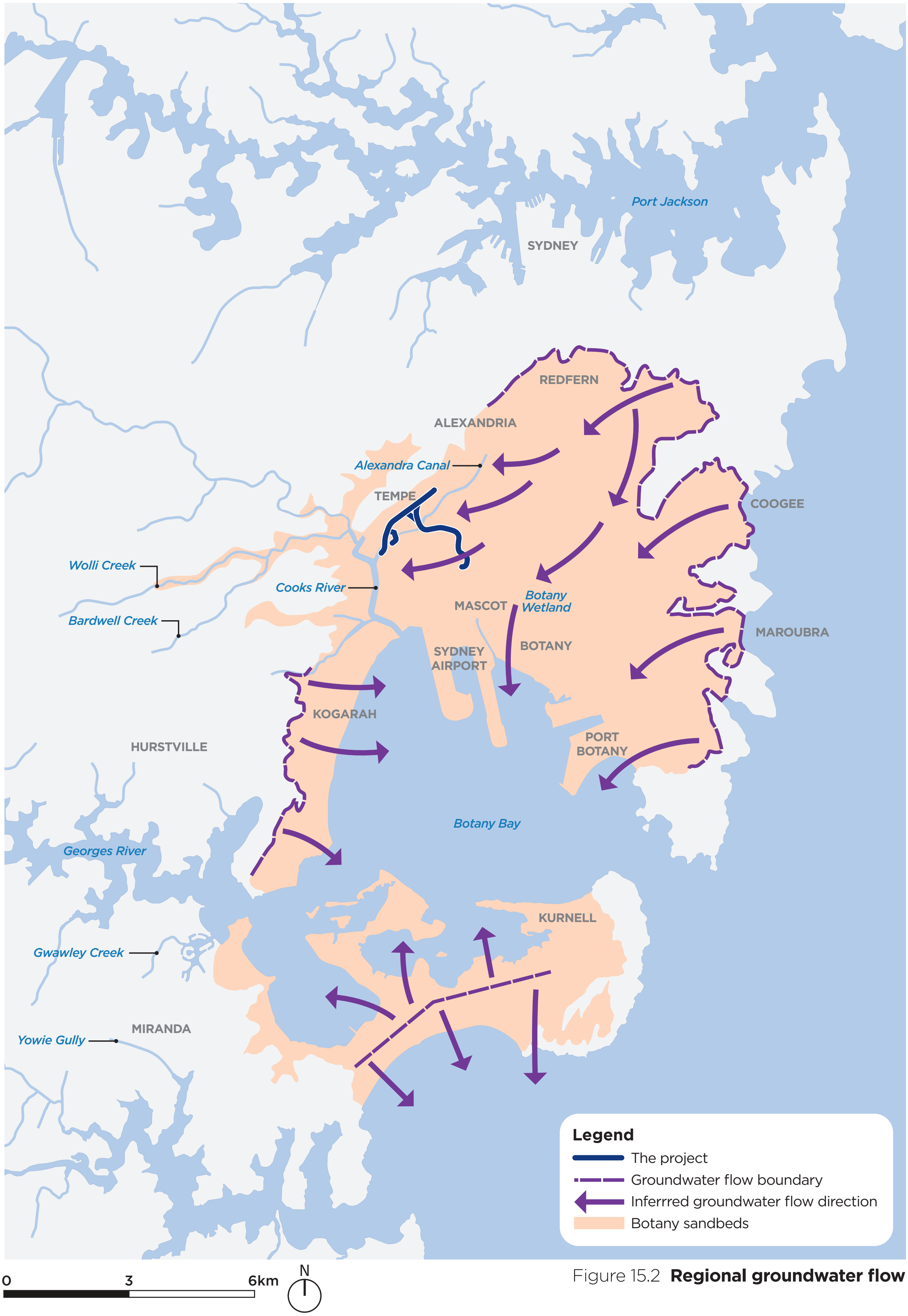

Figure 15.2 **Regional groundwater flow**

15.2.6 Summary of groundwater characteristics on Sydney Airport (Commonwealth) land

Sydney Airport land within the project site is located above the Botany Sands aquifer, with flows of groundwater from north to south below Sydney Airport land towards Botany Bay. Groundwater within this aquifer is contaminated with a number of these sources located on Sydney Airport land including the Sydney Airport Jet Base and taxi staging area east of Terminal 1.

The groundwater resource within Sydney Airport land is similar to the study area as a whole.

One existing groundwater bore is located on Sydney Airport land within the project site (GW24036).

15.3 Assessment of construction impacts

Excavation during construction has the potential to intersect groundwater. The locations of construction works with the potential to intersect groundwater are shown on Figure 15.3.

15.3.1 Aquifer interference

Area of groundwater influence

The radii of influence for groundwater drawdown for the identified excavation areas are shown on Figure 15.4. The results assume that no measures are implemented to limit the inflow of groundwater into excavations.

Given the relatively short duration and progressive nature of excavation for activities such as utilities adjustments, stormwater drainage installation and retaining wall construction, the radius of groundwater drawdown resulting from dewatering is estimated to be less than 100 metres from these activities. Due to the similarity between the radius of groundwater drawdown influence for stormwater lines and utilities, the radius of groundwater drawdown influence for utilities has not been presented on Figure 15.4.

Constructing the cutting associated with the eastbound terminal link and excavating the flood mitigation basin are expected to result in a much larger radius of influence. This is a result of the larger excavation depths for these elements and the need for continuous dewatering to maintain the groundwater levels below the base of the excavations and minimise inflows. The radii of influence for construction of the flood mitigation basin are estimated to be about 570 metres under worst-case conditions (established to account for groundwater level response to long term climatic conditions and rainfall) and 470 metres under likely conditions (established through the monitoring of existing wells on site), while construction of the eastbound terminal link would result in a radius of influence of 500 metres under the worst-case conditions.

Water table changes

There are no groundwater dependent ecosystems located within the radii of influence for groundwater drawdown resulting from dewatering. The closest groundwater dependent ecosystem is located around one kilometre west of the site. The maximum distance that the radius of influence extends from the eastern boundary of the site is about 80 metres.

Two registered groundwater wells lie within the radii of influence. Well GW024036 is an irrigation well on Sydney Airport land within the project site. As new road infrastructure is proposed directly above this well, it would be removed during construction. Well GW024655, located in a former Caltex property, is on the edge of the radius of influence of the nearest area of excavation.

The radii of influence also intersect Alexandra Canal in a number of areas. This is considered to be the only surface water ecosystem potentially affected by drawdown. The canal is tidally influenced and has a constant water supply. As a result, it is unlikely to be adversely impacted by groundwater drawdown or small groundwater discharge reductions associated with excavation.

Water pressure

The Botany Sands aquifer is an unconfined aquifer. As a result, no pressure changes could occur that would affect the elevation of the water table.

15.3.2 Groundwater quality

Acid sulfate soils

The radii of drawdown influence intersects areas mapped as Class 2 and Class 3 acid sulfate soils (see Chapter 13 (Contamination and soils)). The exposure of acid sulfate soils to oxygen has the potential to generate sulfuric acid and lower the pH of groundwater. If not managed appropriately, this could result in the corrosion of sub-surface infrastructure, and impacts on surface water quality and riparian ecology.

As a result of the natural variation in groundwater levels however, particularly close to Alexandra Canal which is subject to tidal influence, it is likely that some areas mapped as potential acid sulfate soils have already been exposed to oxygen, with resulting oxidisation of sediments.

While groundwater would be captured during groundwater dewatering, any oxidised sediments would potentially continue to generate low pH groundwater that could discharge to surface water environments. This would significantly lower the beneficial use potential (environmental values) of these waterways on a short-term basis. Further information on acid sulfate soils and how they would be managed during construction is provided in Chapter 13.

Contaminated sites

Soils within and in the vicinity of the project site feature a range of contaminants depending on the location and historical land uses in the study area. As a result, there is potential to intersect contaminated groundwater during excavation, which if not managed appropriately, could contaminate receiving environments.

There is also potential for contaminated groundwater to migrate towards excavations due to groundwater drawdown as a result of works outlined in Figure 15.3. The following contaminated sites (described in Chapter 13) are located within the radii of influence of proposed excavations:

- Former Tempe landfill
- Alexandra Canal bed sediments
- Boral recycling and concrete, St Peters
- Taxi staging area located south of Keith Smith Avenue
- Joint user hydrant installation site on Sydney Airport land
- Cooks River Intermodal Terminal
- Sydney Airport Jet Base.

Groundwater dewatering is unlikely to result in significant changes to the dimensions and behaviour of the contamination plumes associated with these sites. This is because excavation times would be relatively short and the capture zones (the distance that particles would travel to enter the excavation) are small. If excavations intersect these plumes, any extracted groundwater would be managed in accordance with the management measures defined by the dewatering management strategy (see section 15.6) to minimise the potential for impacts.

In addition, no sensitive receptors (such as groundwater dependant ecosystems and water supply wells) are located between the identified contaminated sites and proposed excavations such that potential water quality impacts could occur. As such, no adverse impacts on groundwater receptors are expected.

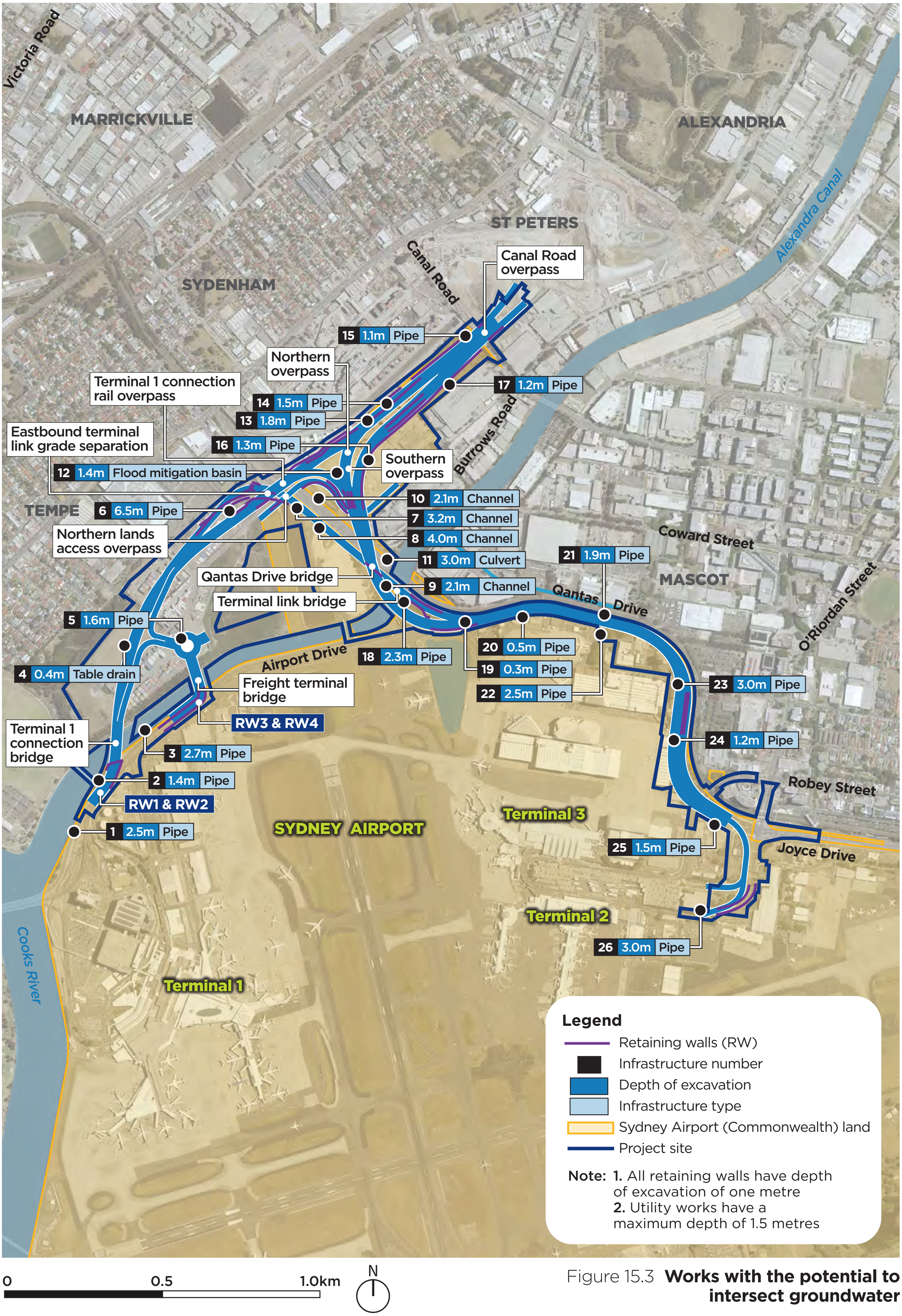

Figure 15.3 **Works with the potential to intersect groundwater**

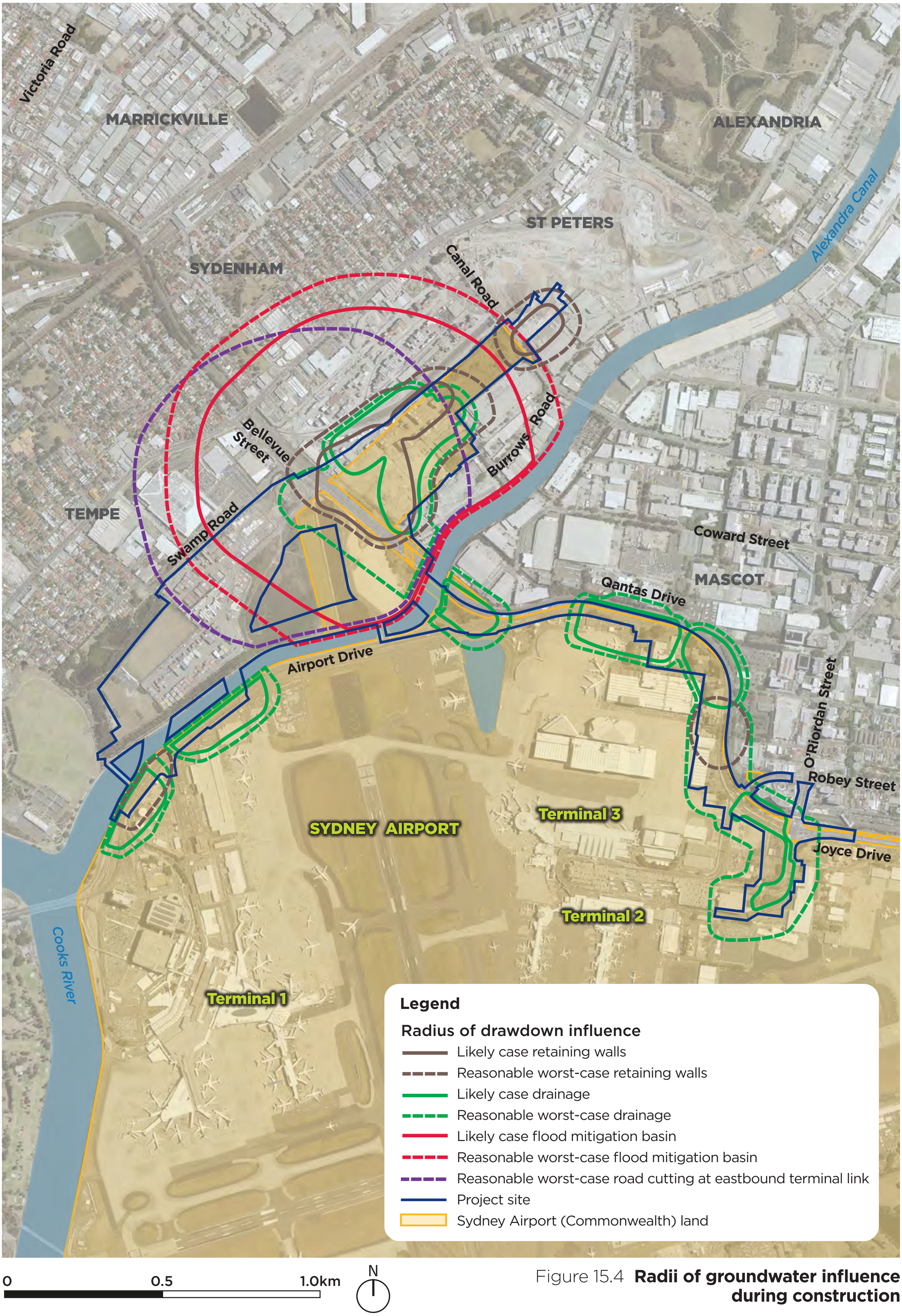

Figure 15.4 **Radii of groundwater influence during construction**

Excavation dewatering

Dewatering excavations would result in groundwater being brought to the surface. Extracted groundwater could be managed by a number of methods, including reinjection, infiltration, reuse during construction, discharge to stormwater or waterbodies, disposal to the wastewater system, and collection for off-site disposal at a waste facility. The most appropriate method would depend on a variety of factors, including the volume and quality of the groundwater, and the extraction location.

One method for managing extracted groundwater would be to discharge it to the stormwater drainage network or nearby surface waters (including discharge to land that then potentially flows to nearby watercourses). This could affect surface water quality if the groundwater being discharged is not of suitable quality.

Transport for NSW has established the baseline characteristics of key watercourses within the study area (see section 16.2) through an ongoing surface and groundwater monitoring program. Transport for NSW has also developed project-specific discharge criteria for extracted surface and groundwater (see Chapter 16) to minimise the potential for impacts on surface water quality.

If dewatering activities are not appropriately managed, discharges of groundwater have the potential to impact surrounding receiving environments (including surface water quality). A dewatering management strategy would be developed to minimise the need to dewater and confirm the appropriate management of extracted groundwater (see section 15.6).

Implementation of these measures would minimise the potential for impacts on surface water quality and ensure that extracted groundwater would be treated to a level that, at a minimum, matches the existing water quality characteristics of key surface waterbodies and their dependent ecosystems.

Other potential groundwater quality issues

Other potential risks to groundwater quality during construction include contamination by:

- Hydrocarbons from accidental fuel and chemical spills
- Contaminants contained in turbid runoff from impervious surfaces.

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

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

The potential groundwater impacts as a result of such incidents would be managed by implementing best practice construction management measures defined in Chapters 13 (Contamination and soils), 16 (Surface water) and 23 (Health, safety and hazards).

Summary

An assessment of the project against the minimal impact criteria in the *NSW Aquifer Interference Policy* is provided in Table 15.2. The outcome of the assessment is that the project is expected to have only a minimal impact on groundwater within the study area.

Table 15.2 Assessment against the minimal impact criteria of the NSW Aquifer Interference Policy

Criteria	Response summary
Water table – less than or equal to 10% cumulative variation in the water table at a distance of 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule of the relevant water sharing plan	There are no high priority groundwater dependent ecosystems located within the radii of influence of the project. The radii of influence intersect Alexandra Canal, which is the only surface water ecosystem potentially affected by drawdown. The canal is tidally influenced and has a constant water supply. As a result, no decline in the water table is expected.
Water table – a maximum 2 m water table decline cumulatively at any water supply work	Two registered groundwater wells have been identified within the radii of influence. Well GW024655 is located on the edge of the expected radius of influence and is therefore not expected that a drawdown of more than 2 m would occur. Well GW024036 is located within the footprint of the project site and it is estimated that the drawdown would be about 2.4 m. The well would however be destroyed during construction. Make good provisions would be implemented for this well if required.
Water pressure – a cumulative pressure head decline of not more than a 2 m decline at any water supply work	Not relevant for the Botany Sands aquifer.
Water quality – any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond a distance of 40 m from the activity	Transport for NSW has established baseline surface water quality conditions in key surface waterbodies within the study area. By setting discharge criteria for extracted groundwater that are protective of the receiving environments, there would be no lowering of the beneficial use category of these surface waterbodies.

15.3.3 Water balance

Water required for construction would not be sourced from groundwater. Potential water sources would include recycled construction water or mains water.

Groundwater recharge of the Botany Sands aquifer

Stripping of existing sealed roads and other hard stand surfaces to enable construction of new sections of road may result in a temporary increase in groundwater recharge. The increase in average recharge, assuming that the existing surface is entirely sealed and the entire construction footprint (excluding the former Tempe landfill) would be stripped at once, is expected to be about 47 cubic metres per day. This is a small amount (less than one per cent) relative to the overall water balance estimated for the project, of about 3,825 cubic metres per day. This increase in recharge would have a negligible impact on the overall groundwater elevation (less than one millimetre) across the site.

Individual rainfall events would result in larger rainfall infiltration rates recharging the aquifer system and subsequent groundwater response. However, this is expected to be small relative to the overall groundwater response occurring in the wider aquifer due to the same rainfall event.

Leachate generation within the former Tempe landfill

A leachate generation assessment was undertaken as part of Technical Working Paper 16 (Former Tempe Landfill Assessment). The assessment concluded that removing sections of the capping layer at the former Tempe landfill would increase the rainfall infiltration rate, resulting in an increase in leachate generation.

Compared to existing leachate extraction rates of between 60 and 100 cubic metres per day, the leachate generation rate (once sections of the capping layer have been removed) is expected to increase to:

- About 200 cubic metres per day under average rainfall year conditions
- About 450 cubic metres per day under 90th percentile wet weather conditions (if they occur) at the start of construction.

- Without appropriate adjustment to the volume of leachate being treated and discharged, leachate might overtop the bentonite cut-off wall installed around the former Tempe landfill and migrate into Alexandra Canal.

A leachate management strategy (see section 15.6) would be developed to consider the management of leachate during construction and to ensure the former Tempe landfill continues to meet the objectives of the site's voluntary remediation proposal.

Groundwater dewatering volumes and inflow rates

The maximum volume of groundwater that would be dewatered from the project site is estimated to be between about 1,144 cubic metres per day (likely groundwater level conditions) and 4,970 cubic metres per day (worst-case groundwater level conditions). The actual volume of groundwater extracted would depend on the number of excavations, the excavation depths compared to groundwater levels, and the length of time that excavations are open.

Table 15.3 outlines the likely and worst-case inflow rates for construction of the main project features predicted to intersect groundwater as a result of excavation. Further information on inflow rates is provided in Table 5-1 of Technical Working Paper 7 (Groundwater).

Based on the three and a half year construction period, it is estimated that the total volume of water to be extracted would be between about 262,000 cubic metres and 1,433,000 cubic metres. Actual groundwater extraction rates and the total volume of water extracted would depend on the final construction methodology, which would be developed by the construction contractor(s). The management of this water would be determined as part of the dewatering management strategy (see section 15.6) and would ensure impacts on the environment are minimised.

Table 15.3 Summary of estimated inflow rates during construction

Project feature	Likely case inflow rates (m^3/day)	Worst-case inflow rates (m^3/day)
Retaining walls	9 to 224	151 to 740
Stormwater outlet/lines	3 to 410	400 to 1,620
Stormwater channels	184 to 550	1,262 to 2,135
Flood mitigation basin	579	1,725
Utilities	58 to 170	50 to 1,025
Eastbound terminal link	-	510

15.3.4 Preliminary settlement estimate

The area of groundwater drawdown (see Figure 15.4) is located below a number of developed areas around Qantas Drive, Airport Drive and north-west of the Sydney Airport northern lands. Lowering the groundwater table in these locations may change the groundwater pressure, which could result in ground movement in the short term and settlement in the long term. A preliminary settlement assessment indicated that the groundwater table may be affected (lowered) at a number of locations as a result of dewatering of excavations, which could affect structures at these locations.

Table 15.4 provides a summary of preliminary settlement estimates as a result of groundwater drawdown. Settlement risks were found to be very slight (cracks of between 0.1 and one millimetre) or slight (cracks of between one and five millimetres).

The results of the settlement assessment would be reviewed during detailed design following confirmation of the preferred construction approach. The aim of the review would be to ensure settlement is avoided, or where predicted, would remain within an acceptable range, to minimise impacts on surrounding land uses and structures.

Table 15.4 Preliminary settlement estimate due to groundwater drawdown

Infrastructure (see Figure 15.3)	Item description	Identified nearby asset	Calculated surface settlement at the asset (mm)	Estimated level of severity
RW1 & RW2	Retaining wall	Joint User Hydrant Installation	25	Slight
RW1 & RW2	Retaining wall	High pressure gas main	30	Slight
RW3 & RW4	Retaining wall	Airport infrastructure	30	Slight
3	Stormwater outlet/line	High pressure gas main	35	Slight
7	Stormwater channel	Car park	10	Slight
8	Stormwater channel	Car park	5	Very slight
9	Stormwater channel	Botany Rail Line	10	Slight
10	Stormwater channel	Botany Rail Line	25	Slight
11	Stormwater channel	Botany Rail Line	20	Slight
11	Stormwater channel	Tank within Boral site	20	Slight
12	Sedimentation basin	Botany Rail Line	20	Slight
18	Stormwater outlet/line	Botany Rail Line	30	Slight
18	Stormwater outlet/line	Building	5	Very slight
22	Stormwater outlet/line	Airport infrastructure	30	Slight

15.3.5 Summary of impacts on Sydney Airport (Commonwealth) land

In summary, construction would have the potential for the following groundwater impacts on Sydney Airport land:

Impact to water supply wells

Water supply well GW024036 would be decommissioned as part of the project.

Settlement of built structures

Settlement risks ranging from very slight to slight have been identified at the Joint User Hydrant Installation near Terminal 1 and along Airport Drive and Qantas Drive. The settlement assessment would be reviewed during detailed design following confirmation of the preferred construction approach, with the aim of minimising the potential for impacts on surrounding land uses and structures.

Impacts on groundwater pH

The radii of groundwater drawdown would intersect areas within Sydney Airport land mapped as class 2 and 3 acid sulfate soils. Any drawdown may potentially generate low pH groundwater, which could corrode sub-surface infrastructure and impact surface water and riparian ecology at any discharge points on Sydney Airport land. As only a small amount of works are proposed within the Mill Stream catchment, no water quality impacts are expected.

Migration of contaminant plumes

Dewatering large volumes of groundwater may mobilise contaminant plumes, such as those under the Sydney Airport Jet Base and taxi staging area south of Keith Smith Avenue. The groundwater capture zones for excavations would be small (in the order of 10 metres) and would therefore not significantly affect the shape and behaviour of existing contaminant plumes. Such impacts would be minimised where possible by minimising impacts on groundwater during detailed design and construction planning.

Discharge of contaminated groundwater to surface water bodies within Sydney Airport land

Water quality impacts would not be expected as:

- Only a small amount of works are proposed within the Mill Stream catchment
- Any discharges would need to meet the project-specific criteria (see Technical Working Paper 8 (Surface Water)) that have been developed in accordance with the Airports (Environment Protection) Regulations 1997).

Potential impacts are not considered to be significant with effective implementation of the mitigation measures provided in section 15.6.2.

15.4 Assessment of operation impacts

15.4.1 Aquifer interference

Water required during operation would not be sourced from groundwater. As a result there would be no risk of drawdown. In relation to the minimal impact criteria of the *NSW Aquifer Interference Policy*:

- Groundwater pressure or water table changes in water supply wells would not exceed two metres. As such, impacts associated with groundwater drawdown would be negligible.
- Water table changes would be less than 10 per cent of the cumulative variation in the water table 40 metres from any groundwater dependent ecosystem (noting that there are no such ecosystems in the vicinity of the project site). As such, impacts associated with groundwater drawdown are also considered to be negligible.
- As there would be no groundwater drawdown during operation, no impacts on acid sulfate soils are expected. Groundwater flow patterns would be the same as the existing situation, as there would be no ongoing groundwater dewatering or more than a negligible change to rainfall recharge. As a result, there would be no lowering of the beneficial use category of the groundwater source beyond 40 metres of the activity.

There may be isolated occasions where groundwater dewatering is required for maintenance activities. However, the details of such activities are not known. Separate approvals would be sought for any future works requiring dewatering as required.

15.4.2 General operational activities

There is the potential for groundwater quality to be impacted as a result of spills or leaks of fuels and/or oils from vehicle accidents and/or maintenance equipment.

The project's stormwater runoff and drainage infrastructure, including the flood mitigation basin, would be designed to minimise infiltration of contaminants to groundwater by directing rainfall and runoff from roads/pavements to the proposed infrastructure. This infrastructure would not be connected to the groundwater system. Further information on the management of accidental spills is provided in Chapter 23 (Health, safety and hazards).

15.4.3 Water balance

Any water required during operation would be sourced from non-groundwater sources.

The project site already includes impervious surfaces and other features that reduce infiltration. The project would result in only a minor increase in impervious surfaces. As a result, minimal reduction in groundwater recharge is expected.

Following excavation within the former Tempe landfill the project would include increasing the thickness of the existing capping layer which is expected to generally lower the generation of leachate compared to existing conditions.

As the potential changes in flows would be very small, any changes to the overall water balance would be negligible.

15.4.4 Summary of impacts on Sydney Airport (Commonwealth) land

Operation would result in negligible potential impacts on Sydney Airport land:

- Impacts on surface water features, water supply wells, acid sulfate soils and settlement of sediments – as groundwater would not be used to operate the project, impacts associated with groundwater drawdown are considered to be negligible
- Impacts on groundwater quality – as there would be no ongoing dewatering or significant changes to recharge, negligible changes in groundwater elevations are expected
- Water balance – minimal reduction in recharge is expected, as the project site already includes impervious surfaces and other features that generally reduce infiltration.

The impacts that have been identified would not reduce the quantity, quality or availability of groundwater at identified receptors and are unlikely to be significant.

Consistency with the Sydney Airport Master Plan

The *Sydney Airport Master Plan 2039* (SACL, 2019a) identifies water quality and water use as a key environmental issue. This includes preventing groundwater contamination and managing existing contamination (mainly contamination of the Botany Sands aquifer). The five year plan for water quality and water use in the *Sydney Airport Environment Strategy 2019-2024* (SACL, 2019b) (the Environment Strategy) includes a range of actions to address issues associated with water-related impacts, however it does not include actions specific to groundwater.

Sydney Airport Corporation plans to manage potential impacts on groundwater by implementing the contaminated sites strategy, which includes a groundwater monitoring program to provide early detection of any leaks.

The project is consistent with the objectives of the Environment Strategy, in that the project would prevent soil and groundwater contamination from occurring on Sydney Airport land. It would also seek to manage existing known contaminated groundwater within the Botany Sands aquifer in line with relevant objectives.

15.5 Cumulative impacts

15.5.1 Construction

Potential impacts on groundwater resulting from the project would be limited to the construction phase. Other major infrastructure projects with the potential for cumulative impacts include the New M5, M4-M5 Link, Botany Rail Duplication and Airport North Precinct road works. The Botany Rail Duplication would not use construction techniques that involve groundwater dewatering and therefore no cumulative impacts are predicted.

Both the New M5 and M4-M5 Link are subsurface roads which will result in substantial groundwater drawdown zones, particularly during operation. The closest project is the mainline tunnels for the New M5, which is under construction about 300 metres to the north and west of the project site. Groundwater drawdown from the New M5 tunnels could intersect leachate within the former Tempe landfill and parts of the Sydney Gateway project site. Constructing the Sydney Gateway road project is not expected to exacerbate these impacts as the predicted groundwater impacts would be minor and short-term. Conversely, other projects may result in greater potential exposure of acid sulfate soils and long term settlement of unconsolidated sediments.

The Airport North Precinct Upgrade works may result in similar effects in combination with the Sydney Gateway road project. The potential for cumulative impacts would be assessed further during detailed design when the scheduling and construction methodology for each project is available. Any cumulative impacts associated with construction would be temporary.

15.5.2 Operation

As described in section 15.3 the potential for impacts on groundwater during operation is considered low, therefore no cumulative groundwater impacts with other projects are expected.

15.6 Management of impacts

15.6.1 Approach

Approach to mitigation and management

The assessment identified that, if groundwater is not adequately managed during construction (including appropriate handling, storage, treatment and discharge of potentially contaminated groundwater and any changes to the water table), the project would have the potential to impact the receiving environment and sensitive receptors. Construction would also have the potential to increase leachate generated during excavation at the former Tempe landfill. To minimise the potential for these impacts, detailed design and construction planning would emphasise (in order of priority):

- Avoiding the need to extract groundwater, including adjusting the design (where practicable) to avoid the groundwater table
- Minimising inflow volumes into excavations by selecting appropriate construction methods
- Managing extracted groundwater in accordance with the outcomes of the dewatering and leachate management strategies, described below.

Approach to managing the key potential impacts identified

A dewatering management strategy would be developed to ensure groundwater is appropriately managed when intersected during various construction activities. The strategy would include:

- Reviewing existing groundwater conditions to provide adequate background information
- Identifying proposed management options, including discharge to surface water, infiltration, reinjection, disposal to the wastewater network and disposal at a waste facility
- Assessing the feasibility of each proposed option, considering site-specific constraints, details of when each option is appropriate and any associated environmental impacts
- Developing procedures to limit exposure of receptors (eg personal protective equipment requirements for construction workers)
- Identifying requirements of affected landowners and relevant regulatory authorities in relation to each management option
- Confirming the measures to be implemented to manage groundwater during dewatering activities.

A leachate management strategy would be developed to manage leachate at the former Tempe landfill prior to construction and ensure that the objectives of the site's voluntary remediation agreement continue to be met. The strategy would include:

- Identifying specific methodologies and measures for leachate management including the collection, transfer, storage, treatment and disposal of leachate
- Developing a framework for monitoring leachate levels and quality, including frequency, notification and reporting requirements

- Identifying management measures to be implemented to minimise the risk of overtopping of the bentonite wall, including but not limited to pumping from leachate sumps
- Identifying changes to the existing leachate management plan or the need for a new plan.

These strategies would complement the Construction Soil and Water Management Plan (see below).

Approach to managing other impacts

In accordance with mitigation measure CS5 (see section 13.6), a Construction Soil and Water Management Plan would be prepared as part of the CEMP and implemented during construction. The plan would detail processes, responsibilities and measures to manage potential soil and water quality impacts (including potential impacts on groundwater) during construction. Further information, including an outline of the plan, is provided in Chapter 27 (Approach to environmental management and mitigation). Other measures are provided in section 15.6.2.

During operation, impacts on groundwater would be negligible with groundwater conditions expected to return to the existing conditions soon after construction is completed. As a result, no specific mitigation measures are required.

Expected effectiveness

Transport for NSW is experienced in the management of groundwater impacts associated with major road projects, particularly as a result of recent experience with tunnelling projects. The proposed measures are considered appropriate to manage the potential impacts and ensure the works are undertaken in accordance with all relevant guidelines which have been used for a wide range of project types.

Implementing a groundwater monitoring program would confirm the effectiveness of mitigation measures. The results would provide information to drive further development of additional or optimised measures to ensure that any subsequent impacts are appropriately managed.

Transport for NSW also has recent, site-specific experience undertaking works within the Botany Sands aquifer, during the Airport East Precinct Upgrade project to the east of Qantas Drive. Managing groundwater for this project has provided Transport for NSW with site-specific knowledge of how to manage groundwater impacts within the Botany Sands aquifer.

15.6.2 List of mitigation measures

Measures that will be implemented to address potential impacts on groundwater are listed in Table 15.5.

Table 15.5 Groundwater mitigation measures

Impact/issue	Ref	Mitigation measure	Timing
Avoiding impacts on groundwater	GW1	Detailed design and construction planning will seek to minimise impacts on groundwater by: ▪ Avoiding the need to extract groundwater ▪ Minimising groundwater inflows and volumes into excavations.	Detailed design
Settlement of unconsolidated sediments	GW2	Modelling of settlement induced by groundwater drawdown will be undertaken in accordance with relevant guidelines, based on detailed geotechnical information obtained from the site investigations and the proposed construction approach. Should modelling identify any settlement issues, measures to reduce settlement will be confirmed.	Detailed design
Impacts on existing groundwater well	GW3	A survey of GW024036 will be undertaken to confirm the use of this bore. If this bore is in use, alternative water sources will be considered to ensure ongoing water supply as required.	Detailed design

Impact/issue	Ref	Mitigation measure	Timing
Dewatering of excavation	GW4	A dewatering management strategy will be developed to confirm the approach to managing dewatering of excavations during construction. The strategy will: ▪ Outline measures to minimise groundwater inflow ▪ Describe likely groundwater quality based on sampling data ▪ Estimate potential groundwater inflow rates and volumes for proposed excavations ▪ Identify proposed methods for managing extracted water, which could include reuse, infiltration, reinjection, discharge to stormwater, disposal to the wastewater system, and collection for off-site disposal ▪ Include a feasibility assessment of each proposed management option for extracted groundwater ▪ Identify any groundwater treatment requirements and methods for any of the proposed management options ▪ Describe any applicable monitoring requirements.	Pre-construction
Managing leachate within the former Tempe landfill	GW5	A leachate management strategy will be developed to manage leachate at the former Tempe landfill during construction and ensure that the objectives of the site's voluntary remediation agreement continue to be met. The strategy will: ▪ Identify predicted changes in leachate volumes due to the project, based on the detailed construction methodology ▪ Identify any required changes to the existing leachate management system due to predicted changes in leachate volume and concentration and any other changes due to the project ▪ Describe a framework for monitoring leachate levels and quality to ensure that no leachate migrates into Alexandra Canal during construction. The strategy will be developed in consultation with relevant stakeholders, including Inner West Council, Sydney Water and the NSW EPA.	Pre-construction
Monitoring of construction impacts	GW6	The existing groundwater monitoring program will continue during construction, and will be supplemented as required, to: ▪ Confirm groundwater quality to inform the selection management options for extracted groundwater, including treatment requirements for discharge ▪ Monitor potential migration contaminants due to groundwater extraction (if it is a credible risk) ▪ Confirm if acidification of groundwater is occurring due to exposure of acid sulfate soils ▪ Confirm local groundwater levels to inform estimation of potential inflows and dewatering rates ▪ Monitor drawdown levels and radii of influence to allow comparison against predictions ▪ Confirm any changes to groundwater levels due to the cumulative impacts of other projects.	Construction

15.6.3 Managing residual impacts

Residual impacts are impacts of the project that may remain after implementation of:

- Design measures to avoid and minimise impacts (see sections 6.4 and 6.5)
- Construction planning and management approaches to avoid and minimise impacts (see sections 6.4 and 6.5)
- Specific measures to mitigate and manage identified potential impacts (see section 15.6.2).

Residual impacts on groundwater are not expected to be present following the implementation of mitigation measures outlined in section 15.6.2 and through the development of the design. Monitoring of groundwater during construction would identify if there are any residual impacts following implementation of the measures proposed. Should monitoring identify residual impacts, further measures would be developed to ensure that impacts on groundwater are minimised