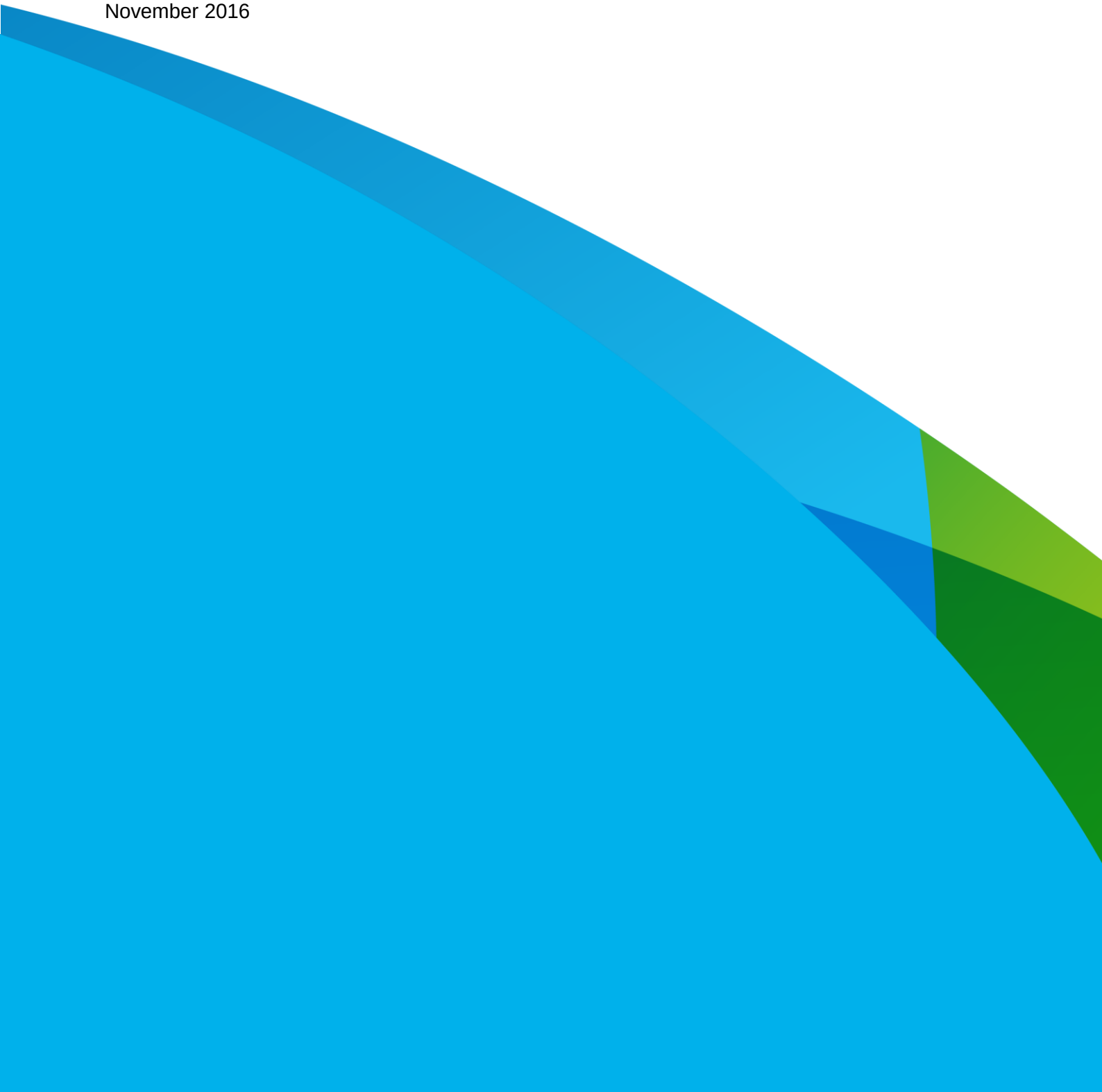


# Newcastle Inner City Bypass – Rankin Park to Jesmond

## Environmental impact statement

Technical Paper 8 – Groundwater Assessment

November 2016

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## **Aurecon Australasia Pty Ltd**

### **Newcastle Inner City Bypass - Rankin Park to Jesmond Technical Paper 8 - Groundwater Assessment**

November 2016

# Executive Summary

The purpose of this groundwater assessment is to assess groundwater quantity and quality impacts from the project operation and construction, and where required, identify feasible and reasonable management measures. Potential water quality impacts on surface water systems are not assessed in this report and have been considered in the Water Quality and Watercourse Assessment report for the project (GHD 2016b).

The identified groundwater systems include a deeper regional aquifer and perched aquifers above siltstone layers. The perched groundwater system is present along the ridgeline that runs north to south along the study area. The perched groundwater is expected to flow through localised weathered and fractured zones in the Newcastle Coal Measures. Recharge of the system is from the infiltration of rainfall along the ridgeline, with groundwater discharging at surface seepage zones along the slopes.

The project includes a number of cuttings along the ridgeline that runs north to south along the study area. These proposed cuttings are predicted to intercept perched groundwater in the study area. This local perched groundwater is separate and disconnected to the groundwater system that supports the Ramsar wetlands that are located about six kilometres downstream of the project.

Perched groundwater inflows into each of the proposed cuttings have been estimated by analytical calculations using the methodology outlined in Marinelli and Niccoli (2000). The equations presented by Marinelli and Niccoli (2000) provide a simple means of estimating steady state or long-term average inflows to a pit or cutting. Cumulative groundwater inflows are estimated to be between 12.4 and 403.9 cubic metres per day for all cuttings combined, with the most likely estimate considered to be about 57.7 cubic metres per day. Based on estimated cumulative groundwater inflows of 57.7 cubic metres per day an annual allocation of up to 21 mega litres per year may need to be licensed under the *Water Management Act 2000*.

Potential groundwater impacts have been assessed against the impact criteria specified in the *NSW Aquifer Interference Policy* (DTI 2012) for less productive groundwater sources to address the Secretary's Environmental Assessment Requirements (SEARs). Groundwater impacts have been assessed to be low and consistently below the Level 1 minimal impact considerations defined in the Aquifer Interference Policy. In particular, it was found that it is unlikely that Cutting 2 would impact the known groundwater dependent ecosystem, a *Gahnia clarkei* variant of the Smooth-barked Apple Red Bloodwood open forest. Impacts to intermittent groundwater dependent ecosystems are considered to be low and would be mitigated by discharging groundwater inflow back into the local watercourses that support these groundwater dependent ecosystems.

The contamination assessment (GHD 2016a) carried out for the project identified there are no widespread groundwater contamination issues in the study area and given there are no known users of the local groundwater, with the implementation of management measures it is unlikely there would be any impacts to existing or future groundwater uses. During construction and operation, groundwater inflows would be captured and managed in the water management system before discharge to local watercourses. Proposed controls identified as part of the water quality assessment (GHD, 2016b) would minimise potential risks to surface water quality.

This assessment has identified that the project is unlikely to result in significant impacts to groundwater, surface water, groundwater dependent ecosystems or sensitive downstream receivers including Ramsar wetlands. Management measures have been recommended to manage potential impacts during the detailed design, construction and operation phases of the project, including continued groundwater monitoring to confirm the predictions in this assessment.



# Glossary and acronyms

| Term/acronym                    | Description                                                                                                                                                                                                                                                                                         |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Alluvial                        | Deposition from running waters.                                                                                                                                                                                                                                                                     |
| Aquifer                         | Underground water storage in either disturbed or undisturbed strata.                                                                                                                                                                                                                                |
| Australian Height Datum (AHD)   | A common national surface level datum generally corresponding to mean sea level.                                                                                                                                                                                                                    |
| Bore                            | Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface either naturally or through artificial means.                                                                                                                         |
| Catchment                       | The land area draining through the main stream and tributary streams to a particular location.                                                                                                                                                                                                      |
| Datum                           | A level surface used as a reference in measuring distances.                                                                                                                                                                                                                                         |
| Drawdown                        | A reduction in piezometric head in an aquifer.                                                                                                                                                                                                                                                      |
| Groundwater                     | Water in a saturated zone, stratum or aquifer beneath the surface of the land.                                                                                                                                                                                                                      |
| Groundwater Dependent Ecosystem | Communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater. A groundwater dependent ecosystem may either be entirely dependent on groundwater for survival or it may use groundwater opportunistically or for a supplementary source of water. |
| Hydrogeology                    | The area of geology that deals with the distribution and movement of groundwater in soils and rocks.                                                                                                                                                                                                |
| Perched groundwater             | Groundwater occurring in an aquifer above the regional water table.                                                                                                                                                                                                                                 |
| Recharge                        | Water entering an aquifer from rainfall or surface water.                                                                                                                                                                                                                                           |
| Riparian                        | Pertaining to, or situated on the bank of a river or other water body.                                                                                                                                                                                                                              |
| SEARs                           | Secretary's Environmental Assessment Requirements                                                                                                                                                                                                                                                   |
| Standpipe piezometer            | A construction in a borehole that allows head to be measured.                                                                                                                                                                                                                                       |

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## Appendices

Appendix A – Groundwater level data

Appendix B – Groundwater quality data

*This report has been prepared by GHD for Aurecon Australasia Pty Ltd and may only be used and relied on by Aurecon Australasia Pty Ltd for the purpose agreed between GHD and the Aurecon Australasia Pty Ltd as set out in section 1.4 of this report.*

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# 1. Introduction

## 1.1 Project overview

Roads and Maritime Services (Roads and Maritime) is seeking approval to construct the fifth section of the Newcastle Inner City Bypass between Rankin Park and Jesmond (the project). The approval is sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Newcastle Inner City Bypass is part of Roads and Maritimes' long-term strategy to provide an orbital road within Newcastle's road network to connect the Pacific Highway at Bennetts Green with the Pacific Highway at Sandgate.

Construction of the project would form part of the Newcastle Inner City Bypass. This would provide improved traffic flows across the western suburbs of Newcastle and connect key regional destinations such as Bennetts Green, Charlestown and Jesmond shopping centres, John Hunter Hospital precinct, The University of Newcastle and the Pacific Highway.

The north-south road corridor was first planned in the 1950s and incorporated into the Northumberland County Planning Scheme in 1957.

Sections of the Newcastle Inner City Bypass have opened progressively since the early 1980s as outlined in Table 1-1.

**Table 1-1 Newcastle Inner City Bypass sections status**

| Section | Route                   | Length | Status                            |
|---------|-------------------------|--------|-----------------------------------|
| A       | West Charlestown Bypass | 6 km   | Completed in 2003                 |
| B       | Kotara to Rankin Park   | 2.4 km | Completed in 1983                 |
| C       | Rankin Park to Jesmond  | 3.4 km | Subject to this planning approval |
| D       | Jesmond to Shortland    | 3.2 km | Completed in 1993                 |
| E       | Shortland to Sandgate   | 2.3 km | Completed in 2014                 |

A strategic design for the Rankin Park to Jesmond project was displayed for community comment in 2007. Community feedback was considered to finalise the preferred route corridor, which was reserved in Newcastle City Council's local environmental plan.

In June 2014 the NSW Government announced it would complete the \$280 million Rankin Park to Jesmond section of the bypass, including \$150 million from Restart NSW to progress the project. Roads and Maritime has since carried out a comprehensive review of the 2007 strategic design and a refined strategic design was displayed for community feedback in May and June 2016. A concept design has since been developed for the project, which forms the basis of this assessment that has been prepared to support the environmental impact statement (EIS) for the project.

## 1.2 The project

The project would involve the construction of about 3.4 kilometres of new four lane divided road between Lookout Road at New Lambton Heights and Newcastle Road at Jesmond. The project is located in the Newcastle local government area (LGA), about 11 kilometres west of the Newcastle central business district and about 160 kilometres north of Sydney (Figure 1-1).

Key features of the project (Figure 1-2) include:

- New road with two lanes in each direction, separated by a median.
- Three interchanges, consisting of:
  - Northern interchange providing access to Newcastle Road and the existing Jesmond to Shortland section of the Newcastle Inner City Bypass. The full interchange provides all movements to/from the bypass and Newcastle Road.
  - Hospital interchange providing access between John Hunter Hospital precinct and the bypass. The half-interchange providing access to/from the north.
  - Southern interchange providing access to Lookout Road and the existing Kotara to Rankin Park section of the Newcastle Inner City Bypass. The bypass would travel under McCaffrey Drive. The half interchange provides connection in both directions on Lookout Road.
- Structures along the road to allow for drainage, animal and bushwalker access.
- Tie in and upgrades to connecting roads, including Lookout Road, McCaffrey Drive and Newcastle Road.
- Large cut and fill embankments due to steep and undulating terrain.
- Pedestrian and cycling facilities, including a shared path bridge over Newcastle Road.
- Noise barriers and/or architectural treatment, as required.
- Permanent operational water quality measures.

Ancillary work to facilitate construction of the project (Figure 1-3), including:

- Adjustment, relocation and/or protection of public utilities and services.
- Mine subsidence treatment, as required.
- Temporary construction facilities, including sedimentation basins, compounds and stockpile sites.
- Temporary and permanent access tracks.
- Concrete/asphalt batching plant, as required.

## 1.3 Project objectives

The key objectives of the project are to:

- Provide continuity of the Newcastle Inner City Bypass between Bennetts Green and Sandgate.
- Reduce travel times and congestion on the Newcastle Inner City Bypass.
- Provide traffic relief on key parts of the surrounding road network.

In so doing, it is intended to:

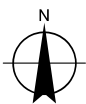
- Improve road safety.
- Minimise impacts on the natural and built environment.
- Provide value for money.



#### LEGEND

- The Project
- National Parks and Wildlife Service Estate and bushland reserves
- Road
- - - Local government area
- Watercourse area

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Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 56



Rankin Park to Jesmond  
Groundwater Assessment

Job Number 22-17656  
Revision 0  
Date 26 Aug 2016

Project locality

Figure 1-1

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Data source: Geoscience Australia: 250k Topographic Series 3, 2012; Aurecon: The project, 2015; LPI: DTDB, 2006. Created by: fmnackay

To support the project objectives, the concept design and EIS has been developed by:

- Designing the project to consider the environmental constraints and avoid or minimise impacts to the environment
- Satisfying the technical requirements for the design of the project
- Optimising the concept design to ensure the project can be constructed and maintained both practically and efficiently
- Applying appropriate urban design, landscape and visual principles in the concept design of the project elements
- Carrying out appropriate community and stakeholder consultation
- Designing all connections, modifications and improvements necessary to link the project to the existing road network
- Planning temporary arrangements which minimise disruption to local and through traffic and maintain access to adjacent properties during construction.

The overall project goal is to achieve the best possible result for each of these tasks, both in isolation and when considered together.

## 1.4 Purpose of this report

The purpose of this study is to assess groundwater impacts from the project operation and construction, and where required, identify feasible and reasonable management measures.

This groundwater assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) for the Newcastle Inner City Bypass between Rankin Park and Jesmond for the purpose of seeking project approval for state significant infrastructure under Part 5.1 of the *Environmental Planning and Assessment Act 1979*. Table 1-2 outlines the requirements relevant to this assessment and where they are addressed in the report.

**Table 1-2 Secretary's Environmental Assessment Requirements**

| Requirement                                                                                                                                                                                                                                                                                       | Where addressed                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| The environmental impact statement must include the following:                                                                                                                                                                                                                                    |                                                              |
| Water quantity and stormwater impacts, including: <ul style="list-style-type: none"><li>• Details of any works likely to intercept, connect with or infiltrate groundwater resources and of any proposed groundwater extraction</li><li>• Impacts on groundwater recharge and flow path</li></ul> | Section 3<br><br>Sections 3.3 and 3.4                        |
| Impacts on water sources, sharing and licensing, including: <ul style="list-style-type: none"><li>• Consistency with relevant water sharing plans</li><li>• Potential cumulative impacts on water sources and mitigation measures to manage the cumulative impacts</li></ul>                      | Section 1.7,<br>Section 3.3,<br>Section 3.5 and<br>Section 4 |

## 1.5 Study area

The study area subject to this assessment is between Lookout Road, Rankin Park and Newcastle Road, Jesmond. It consists of the operational and construction footprints in addition to areas which could be indirectly impacted by the project and includes the extent of potential drawdown of perched groundwater sources. The study area is shown in Figure 2-1.

## 1.6 Methodology

The methodology for the groundwater assessment was developed in consultation with the Department of Primary Industries Water (DPI Water) to address the requirements of the groundwater assessment listed in Section 1.4.

This groundwater assessment includes characterisation of the existing groundwater conditions including groundwater level, groundwater quality and identification of potential groundwater receptors. The assessment included identification of locations where groundwater may be intercepted by the project. At locations where groundwater may be intercepted analytical equations using the Marinelli and Niccoli (2000) method has been used to estimate the groundwater take and groundwater drawdown. Further information on the modelling methodology is provided in Section 3.2. Groundwater impacts have been assessed against the criteria specified in the NSW Aquifer Interference Policy (Department of Trade and Investment (DTI) 2012). Groundwater management measures have been identified as part of this groundwater assessment.

## 1.7 Relevant legislation and guidelines

### 1.7.1 Water Act 1912

Groundwater sources in the study area are no longer regulated under The *Water Act 1912* due to the start of the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (Department of Primary Industries 2016).

### 1.7.2 Water Management Act 2000

The *Water Management Act 2000* (WM Act) is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions.

From 1 July 2016, the groundwater sources in the study area are now regulated by the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016* (WSP). The site is located within the Sydney Basin North Coast groundwater source of this WSP. According to the WSP, there is 96,047 ML/year of entitlement within this groundwater source all of which is currently allocated to existing users. Therefore, a licensed groundwater user will only be able to obtain additional entitlement via trading within the groundwater source (or via a controlled allocation order) (refer to Section 3.6 for further discussion).

### 1.7.3 NSW Aquifer Interference Policy

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

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

Sufficient access licences must be held to account for all water taken from a groundwater or surface water source as a result of an aquifer interference activity, both for the life of the activity

and after the activity has ceased. This take of water continues until an aquifer system reaches equilibrium and must be licensed.

The *NSW Aquifer Interference Policy* requires that potential impacts on groundwater sources, including their users and groundwater dependant ecosystems, be assessed against the minimal impact considerations outlined in the policy. The minimal impact considerations include a requirement that any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres of the activity. If the predicted impacts are less than the minimal impact considerations for less productive fractured rock groundwater sources, then the potential groundwater impacts of the project are acceptable. Further details regarding the minimal impact considerations adopted for this project and the assessment of the project against the adopted minimal impact considerations is provided in Section 3.4.

#### **1.7.4 NSW State Groundwater Policy Framework Document**

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

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

##### ***NSW Groundwater Quantity Protection Policy***

The principles of this policy include:

- Maintain total groundwater use within the sustainable yield of the aquifer from which it is withdrawn.
- Groundwater extraction shall be managed to prevent unacceptable local impacts.

All groundwater extraction for water supply is to be licensed. Transfers of licensed entitlements may be allowed depending on the physical constraints of the groundwater system.

##### ***NSW Groundwater Quality Protection Policy***

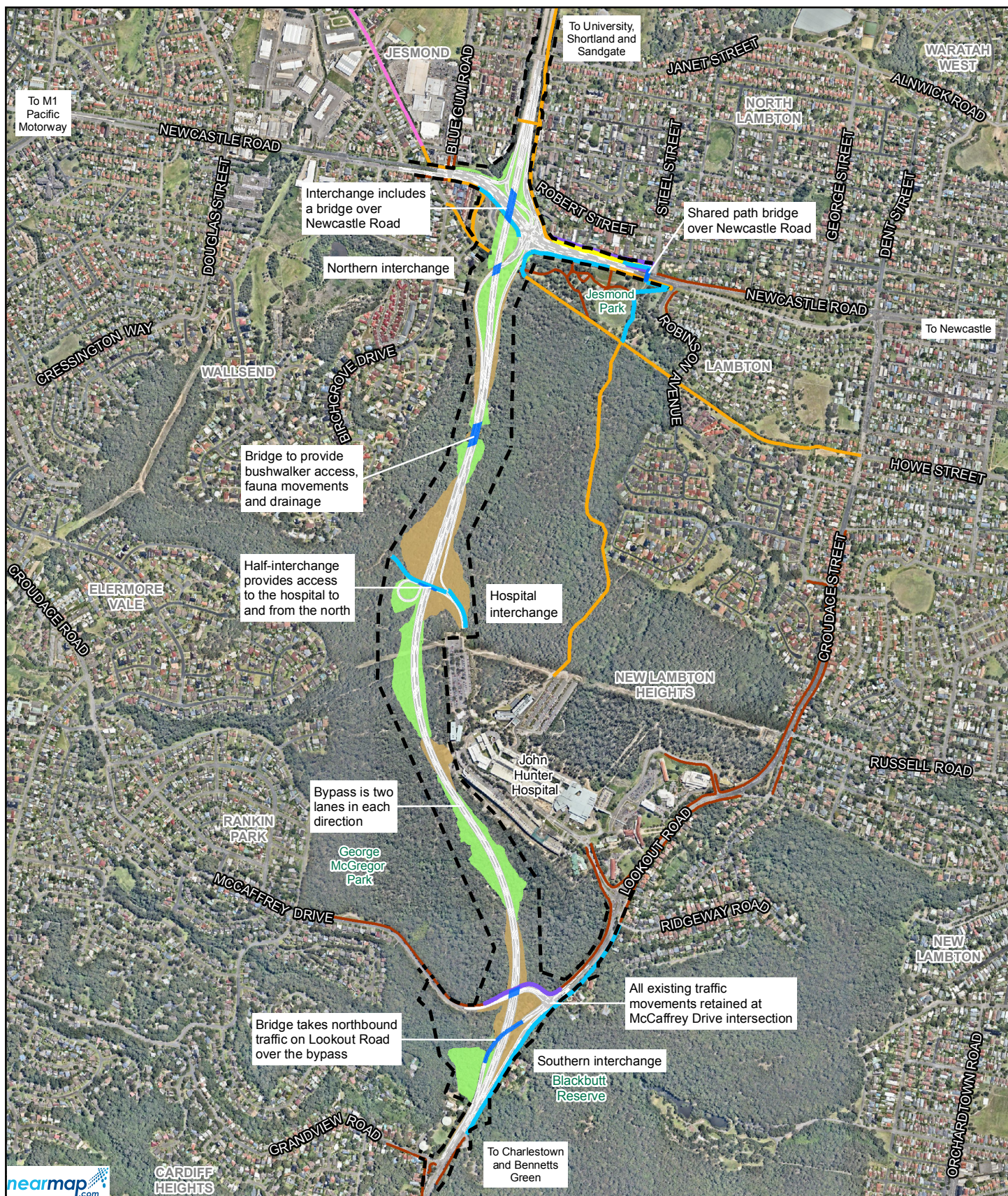
The objective of this policy is the ecologically sustainable management of the State's groundwater resources so as to:

- Slow and halt, or reverse any degradation in groundwater resources.
- Direct potentially polluting activities to the most appropriate local geological setting so as to minimise the risk to groundwater.
- Establish a methodology for reviewing new developments with respect to their potential impact on water resources that will provide protection to the resource commensurate with both the threat that the development poses and the value of the resource.
- Establish triggers for the use of more advanced groundwater protection tools such as groundwater vulnerability maps or groundwater protection zones.

##### ***NSW Groundwater Dependent Ecosystems Policy***

This policy was designed to protect ecosystems, which rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of these dependent ecosystems are maintained or restored for the benefit of present and future generations.

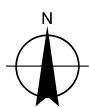




#### LEGEND

|          |                        |                           |                           |
|----------|------------------------|---------------------------|---------------------------|
| Design   | Earthworks cut         | Existing on-road cycleway | Existing footpath         |
| Pavement | Earthworks fill        | Existing shared path      | Proposed footpath         |
| Bridge   | Proposed road corridor | Proposed shared path      | Proposed on-road cycleway |

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Horizontal Datum: GDA 1994  
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Rankin Park to Jesmond  
Groundwater Assessment

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Date 26 Aug 2016

Project overview

Figure 1-2

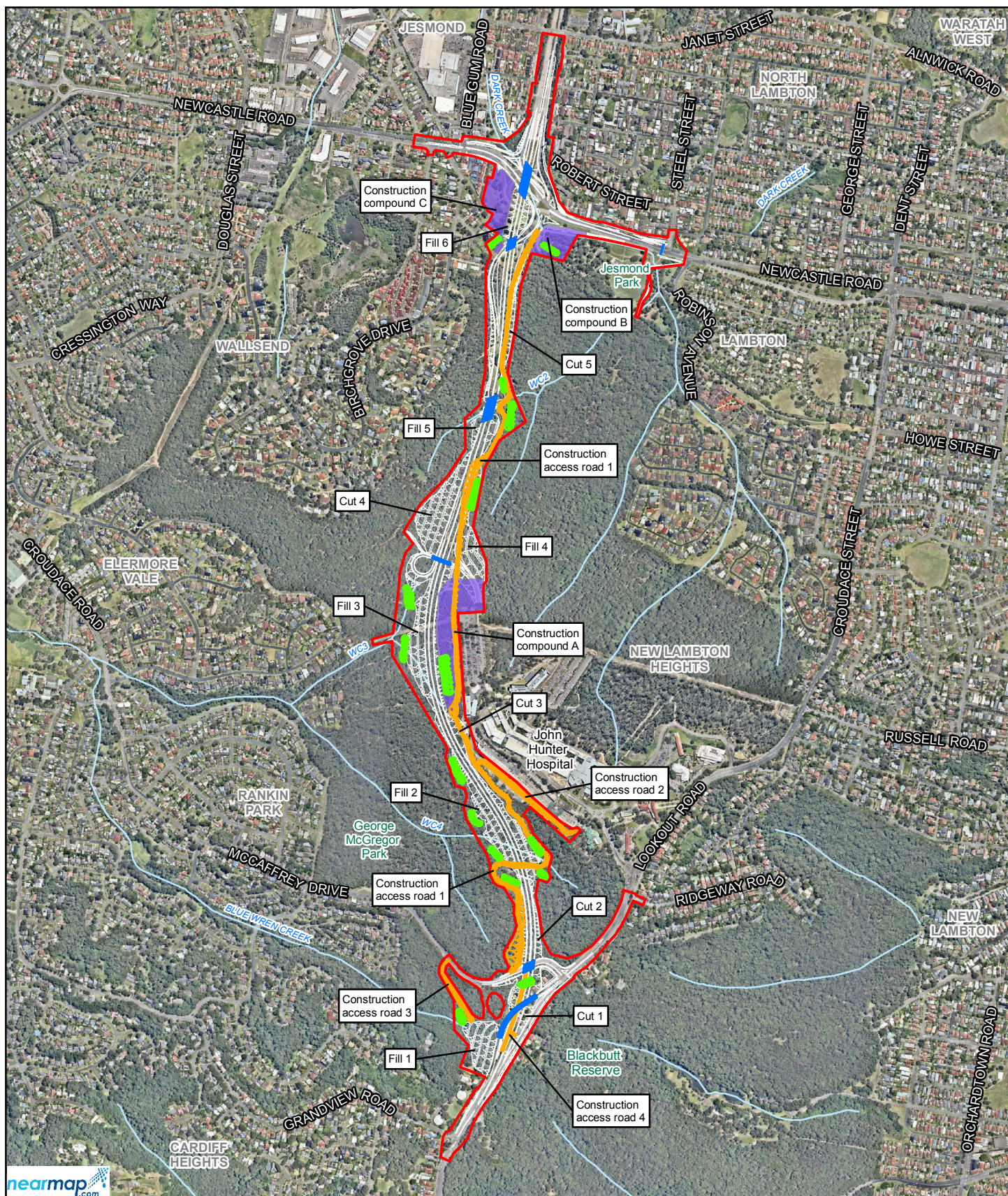
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Data source: RMS: Project corridor, 2016; Aurecon: Design / cycleways, 2016; Neamap: Aerial Imagery, 20160331; LPI: DTDB, 2012. Created by: fmacKay

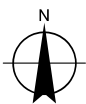




#### LEGEND

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|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| <span style="border: 2px solid red; display: inline-block; width: 20px; height: 10px;"></span> Construction footprint             | <span style="border-bottom: 2px solid grey; width: 20px; display: inline-block;"></span> Design        |
| <span style="background-color: purple; display: inline-block; width: 20px; height: 10px;"></span> Construction compound           | <span style="background-color: blue; display: inline-block; width: 20px; height: 10px;"></span> Bridge |
| <span style="background-color: orange; display: inline-block; width: 20px; height: 10px;"></span> Construction access tracks      | <span style="border-bottom: 2px dashed blue; width: 20px; display: inline-block;"></span> Watercourse  |
| <span style="background-color: green; display: inline-block; width: 20px; height: 10px;"></span> Construction sedimentation basin |                                                                                                        |

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Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 56



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#### Construction ancillary facilities

Figure 1-3

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Data source: Neamap: Aerial Imagery, 20160331; Aurecon: Construction footprint/ Design / Water quality structures, 2016; LPI: DTDB, 2012. Created by: tmorton, fmacKay



## 2. Existing environment

### 2.1 Landforms and watercourses

The topography of the site is dominated by a ridgeline that runs with a general north-south orientation through most of the study area. This ridgeline reaches a peak of about 142 metres Australian Height Datum (AHD) near the southern extent of the study area. From this southern end, this ridgeline follows Lookout Road as it gradually dips to an elevation of about 108 metres AHD just outside the study area to the east of John Hunter Hospital precinct. From the hospital precinct elevations generally decrease towards a valley near Newcastle Road, although there is another peak in the ridgeline of about 90 metres AHD to the north-west of the hospital precinct. To the east and west of this ridgeline elevations decrease to flatter areas that occur along creek and drainage lines surrounding the study area.

The ridgeline that dominates the study area marks the boundary of a number of catchments intersecting the study area. North of the hospital precinct the study area drains to Dark Creek and then into Ironbark Creek. Areas east of Lookout Road drain towards a number of unnamed tributaries that flow towards Styx Creek. To the west of Lookout Road, the study area drains into Blue Wren Creek and an unnamed creek that both flow into Ironbark Creek.

A Water Quality and Watercourse Assessment has been carried out for the project (GHD, 2016b). The assessment identified that the study area intersects five mapped watercourses. Most of these watercourses are un-named, first order streamlines, typically characterised by a steep gradient channel occupying a narrow v-shaped valley. Of these, Dark Creek is a highly modified system consisting of a concrete lined stormwater drain leading into a culvert that flows under the Newcastle Road roundabout at Jesmond. The remaining four un-named creeks drain into either Dark Creek or Ironbark Creek (some via Blue Wren Creek) of variable morphology and existing extents of erosion.

### 2.2 Geology

The Newcastle Coalfields Regional Geology 1:100,000 map (NSW Department of Mineral Resources, Edition 1 1995) indicates that the Permian Newcastle Coal Measures outcrop in most of the study area. The outcropping Newcastle Coal Measures typically consist of Permian coals, tuffs, conglomerates, sandstones and shales. The Tomago Coal Measures outcrop to the north of Newcastle Road.

### 2.3 Hydrogeology

The upper groundwater source in the study area is considered to be low yielding perched groundwater. The deeper regional groundwater table is reported to be at about sea level (Coffey 1983). There is no known alluvial groundwater in the study area.

According to the *NSW Aquifer Interference Policy* (DTI 2012), groundwater is defined as all water that occurs beneath the ground surface in the saturated zone. The policy does not contain a definition for perched water, although it is well understood that perched water refers to water that occurs in the unsaturated zone above the saturated groundwater system (although there may be part of the perched system that are saturated). Therefore, it is noted that the perched groundwater that occurs in the study area is not technically groundwater, as defined by the policy. However, there are known groundwater dependent ecosystems in the study area (Figure 2-4) and these are likely to be supported by perched groundwater. Therefore, for the purposes of this assessment the potential impacts on perched groundwater have been assessed in accordance with the policy.

In the local perched groundwater system groundwater is expected to flow through localised weathered and fractured zones in the underlying Newcastle Coal Measures. Recharge of the system is from the infiltration of rainfall along the ridgeline, with perched groundwater discharging at surface seepage zones along the slopes above siltstone and claystone layers. Groundwater elevations in the study area are summarised in Section 2.3.1.

Previous studies have identified seepage of water on and below sloped areas in the study area and surrounds (RTA 2006). This seepage is likely to be perched groundwater.

The upper groundwater source in the study area is considered to be low yielding perched groundwater. The perched aquifer is a highly localised system that is limited in extent to the higher areas of topography immediately surrounding the study area. It is not connected with any other aquifers in the surrounding area.

Perched groundwater is generally separated from regional groundwater by layers of lower permeability, collectively referred to in this assessment as the siltstone/claystone aquitard. As a result of this aquitard and the presence of seepage zone, the natural vertical movement of perched groundwater to the regional groundwater source is minimal. The regional groundwater source is mostly recharged in areas where the strata of the lower Newcastle Coal Measures outcrops ie to the north of the study area, rather than from the overlaying perched groundwater source.

Due to the relatively shallow depth of the perched groundwater and local topography, it typically seeps out on the existing side slopes and enters ephemeral watercourses. The amount of seepage is proportional to the amount of rainfall with typically little to no seepage during dry periods. The perched groundwater would be recharged during rainfall events through infiltration.

### **2.3.1 Groundwater monitoring data**

A number of standpipe piezometers were installed in 2015 as part of geotechnical investigations carried out for the project. The groundwater monitoring locations are shown in Figure 2-1 and details are provided in Table 2-1. Most of the standpipe monitoring bores are located along the ridgeline that dominates the study area.