CHATSWOOD TO SYDENHAM

ENVIRONMENTAL IMPACT STATEMENT

MAY 2016

TECHNICAL PAPER 7: GROUNDWATER ASSESSMENT

Sydney Metro Chatswood to Sydenham

Transport for NSW

Technical Paper 7: Groundwater Assessment

May 2016

Contents

Table of Figures

List of Tables

Executive summary

Project overview

Sydney Metro is a new standalone rail network identified in Sydney's Rail Future. The Sydney Metro network consists of Sydney Metro City & Southwest and Sydney Metro Northwest.

The proposed Sydney Metro City & Southwest comprises two core components:

- The Chatswood to Sydenham project (the project), the subject of this technical paper, would involve construction and operation of an underground rail line between Chatswood and Sydenham
- The Sydenham to Bankstown upgrade would involve the conversion of the 13.5 kilometre Bankstown line to metro standards and upgrade of existing stations between Sydenham and Bankstown.

The Sydenham to Bankstown upgrade will be subject to a separate environmental impact assessment.

Investigations have started on the possible extension of Sydney Metro from Bankstown to Liverpool. The potential extension would support growth in Sydney's south west by connecting communities, businesses, jobs and services as well as improving access between the south west and Sydney's CBD. It would also reduce growth pressure on road infrastructure and the rail network, including the potential to relieve crowding on the T1 Western Line, T2 South Line and T2 Airport Line.

The Sydney Metro Chatswood to Sydenham project (the project) involves the construction and operation of a metro rail line. The project would be mainly located underground in twin tunnels extending from Chatswood on Sydney's north shore, crossing under Sydney Harbour, and continue to Sydenham.

The key components of the project would include:

- About 15.5 kilometres of twin rail tunnels (that is, two tunnels located side-by-side) between Mowbray Road, Chatswood and north of Sydenham Station (near Bedwin Road, Marrickville)
- Realignment of the existing T1 North Shore Line surface track within the existing rail corridor between Chatswood Station and in the vicinity of Brand Street, Artarmon, including a new bridge for a section of the 'down' (northbound) track to pass over the proposed northern dive structure
- About 250 metres of aboveground metro tracks between Chatswood Station and the Chatswood dive structure
- A dive structure (about 400 metres long) and tunnel portal south of Chatswood Station and north of Mowbray Road, Chatswood (the Chatswood dive structure)
- A substation (for traction power supply) at Artarmon
- Metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street and Waterloo; and new underground platforms at Central Station
- A dive structure (about 400 metres long) and tunnel portal between Sydenham Station and Bedwin Road, Marrickville (the Marrickville dive structure)
- A services facility (for traction power supply and an operational water treatment plant) adjacent to the Marrickville dive structure.

The project would also include a number of ancillary components, including new overhead wiring and alterations to existing overhead wiring, signalling, access tracks / paths, rail corridor fencing, noise walls, fresh air ventilation equipment, temporary and permanent alterations to the road network, facilities for pedestrians, and other construction related works.

Approach to groundwater assessment

This groundwater assessment has been prepared on the basis of extensive historical experience of tunnelling in the Hawkesbury Sandstone, Mittagong Formation and Ashfield Shale in the Sydney area.

Project specific investigation comprised geotechnical boring along the project alignment, with the conversion of 14 boreholes to monitoring piezometers. Groundwater testing of these piezometers, including water level logging and water quality analyses would be undertaken in a subsequent stage of the project.

Detailed numerical modelling is recommended to be undertaken during design and construction phase.

Overview of potential impacts

The Sydney Metro Chatswood to Sydenham project is not anticipated to trigger significant impacts to groundwater due to the majority of the project being 'tanked'. 'Tanked' structures entail waterproofing combined with permanent lining. 'Drained' structures do not include waterproofing and would be perpetually dewatered. Project infrastructure elements with a groundwater interface consist:

- Construction of rail tunnels, cross-passages and underground stations, where mined, almost entirely in rock (Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone), combined with a waterproof and permanent lining.
    - Segmental lining of rail tunnels (via tunnel boring machines), would, by design, result in minimal groundwater inflow.
    - Cross-passages within the tunnel would be 'tanked'.
    - A particular design focus would be the harbour crossing and anticipated tunnelling through soft ground. Tunnelling through harbour sediments is anticipated to require ground treatment at rock-sediment transition zones to address construction related risks. The operational tunnel would be 'tanked'.
    - The tunnelling boring machine access point at Blues Point would be 'drained', however, is temporary and would be backfilled following construction.
- At station locations, the design elements comprise underground stations (at rail level) and station shafts (access from rail level to ground surface).
    - Underground stations (at rail level) would be 'tanked', where they are mined, and would be 'drained' where they are cut-and-cover, except for Barangaroo. Crows Nest station would be 'drained'; Victoria Cross would be 'tanked', Barangaroo would be 'tanked'; Martin Place would be 'tanked'; Pitt St would be 'tanked'; Central Station would be 'drained'; Waterloo station would be 'tanked'.
    - Station shafts (access from rail level to ground surface) would be 'drained' structures. An exception would be Barangaroo Station and Waterloo Station, where all elements would be 'tanked', regardless of construction method. .
- The Artarmon substation is assumed to be 'tanked'.
- The Chatswood dive structure and Marrickville dive structure would be 'drained' structures.

Table E.1 summarises the design approach with respect to each groundwater related project element.

Table E.1 : Groundwater Related Project Infrastructure Configuration

Element	Construction Method / Typology	Groundwater Management Approach
Rail Tunnels		
Rail Tunnels	Tunnel Boring Machine (TBM)	Tanked
Cross-Passages and Sumps		
Cross-Passages	Road Header and Rock Breaker	Tanked
Sumps	Road Header and Rock Breaker	Tanked
Dive Structures		
Chatswood dive structure	Bored Pile Wall with Capping Beam	Drained
Marrickville dive structure	Bored Pile Wall with Capping Beam	Drained
Underground Stations		
Crows Nest Station	Cut and Cover	Drained
Victoria Cross Station	Mined Cavern	Tanked
Barangaroo Station	Cut and Cover	Tanked
Martin Place Station	Mined Cavern	Tanked
Pitt St Station	Mined Cavern	Tanked
Central Station	Cut and Cover	Drained
Waterloo Station	Cut and Cover	Tanked
Station Shafts		
Crows Nest Station	Road Header, Rock Breaker and blasting	Drained
Victoria Cross Station	Road Header, Rock Breaker and blasting	Drained
Barangaroo Station	Road Header, Rock Breaker and blasting	Tanked
Martin Place Station	Road Header, Rock Breaker and blasting	Drained
Pitt St Station	Road Header, Rock Breaker and blasting	Drained
Central Station	Road Header, Rock Breaker and blasting	Drained
Waterloo Station	Road Header, Rock Breaker and blasting	Tanked
Operational Ancillary Facilities		
Artarmon substation	Rock Breaker	Tanked

Table E.2 presents the Level 1 Minimum Harm Criteria Assessment with respect to the project.

Table E.2 : Groundwater Related Minimum Harm Criteria Assessment (NSW Office of Water, 2012)

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	There are no high priority groundwater dependent ecosystems or high priority culturally significant sites in the vicinity of the project. Anticipated drawdown, cumulative, at any water supply work, is less than a 2m decline in water table due to the project.

Level 1 Minimal Impact Consideration	Assessment
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Anticipated decline in groundwater elevation due to the project is less than a 2m at any water supply work.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	The project, due to groundwater inflows being captured and discharged, whether locally during construction or transmitted to centralised water treatment plant during operation would not change groundwater quality beyond 40 metres from the activity.

Anticipated change to groundwater level is minor and expected contribution of change in groundwater level to off-site subsidence in hard rock is negligible.

For Waterloo Station, the project alignment would underlie the high permeability Botany Sandbeds Aquifer. The thickness of the Botany Sandbeds Aquifer along the alignment is, however, minimal, and is estimated to be 1 to 10 metres, and occurs at or near to ground surface. The design approach to Waterloo Station would be to 'tank' all project elements. In contrast to the Botany Sandbeds Aquifer, groundwater inflow through the Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone would be orders of magnitude lower. Detailed Site Investigation is on-going to identify areas where jointing and / or faulting may lead to greater inflow. There is no surface water-groundwater interaction anticipated, however, due to the project, including both with respect to Sydney Harbour and Sheas Creek that feeds into Alexandra Canal.

As noted in **Table E-2**, there are no high priority groundwater dependent ecosystems in the vicinity of the project, or potentially affected, and there is anticipated to be negligible impact to groundwater quality due to the project.

Groundwater inflow collected during construction would be managed at water treatment plants at tunnel boring machine support sites as well as additional water treatment plants at other underground stations, as required. Estimated inflow during construction is 11.8L/s. During construction, groundwater inflows would be treated to meet the requirements of an environmental protection licence issued to the project.

During operation, collected groundwater would be transmitted to a centralised water treatment plant adjacent the Marrickville dive structure prior to discharge to the Cooks River via the stormwater channel at that location. The design capacity of the water treatment plant is 15L/s; however, expected groundwater inflow to the project during operation would be less than 11.8L/s. For operation, the project would be designed to achieve a maximum water discharge quality equivalent to the 90th percent protection level specified for freshwater ecosystems in accordance with ANZECC guidelines (ANZECC / ARMCANZ, 2000). The discharge water quality level would be determined in consultation with the NSW Environment Protection Authority during reference design, taking into consideration the current water quality of the receiving watercourse.

There are only 11 water supply works identified within the vicinity of the project. Of these, four are currently licenced under Basic Rights as Domestic and Stock and two hold Water Access Licences for irrigation of sporting fields or parks, with the remainder presumed to be currently inactive. As noted in **Table E.2**, it is not anticipated that the project would lead to adverse impact to any water supply work.

Summary of mitigation responses

Table E.3 presents the proposed mitigation measures with respect to the project.

Table E.3 : Groundwater related management and mitigation measures

Reference	Mitigation measure	Applicable location(s)
GWG1	A detailed geotechnical model for the project would be developed and progressively updated during design and construction. The detailed geotechnical model would include: • Assessment of the potential for damage to structures, services, basements and other sub-surface elements through settlement or strain • Predicted changes to groundwater levels, including at nearby water supply works. Where building damage risk is rated as moderate or higher (as per the CIRIA 1996 risk-based criteria), a structural assessment of the affected buildings / structures would be carried out and specific measures implemented to address the risk of damage. With each progressive update of the geotechnical model, the potential for exceedance of the following target changes to groundwater levels would be reviewed: • Less than 2.0 metres – general target • Less than 4.0 metres – where deep building foundations present • Less than 1.0 metre – residual soils • Less than 0.5 metre – residual soils (Blues Point) (fill / Aeolian sand). Where a significant exceedance of target changes to groundwater levels are predicted at surrounding land uses and nearby water supply works, an appropriate groundwater monitoring program would be developed and implemented. The program would aim to confirm no adverse impacts on groundwater levels or to appropriately manage any impacts. Monitoring at any specific location would be subject to the status of the water supply work and agreement with the landowner.	All
GWG2	Condition surveys of buildings and structures in the vicinity of the tunnel and excavations would be carried out prior to the commencement of excavation at each site.	All

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to undertake a Groundwater Assessment of the Chatswood to Sydenham project, based on currently available information, and present the potential environmental impact of the Chatswood to Sydenham project in accordance with the scope of services set out in the contract between Jacobs and Transport for NSW ('the Client'). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, the Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 Project background

Sydney Metro is a new standalone rail network identified in Sydney's Rail Future. The Sydney Metro network consists of Sydney Metro City & Southwest and Sydney Metro Northwest.

The proposed Sydney Metro City & Southwest comprises two core components:

- The Chatswood to Sydenham project (the project), the subject of this technical paper, would involve construction and operation of an underground rail line between Chatswood and Sydenham
- The Sydenham to Bankstown upgrade would involve the conversion of the 13.5 kilometre Bankstown line to metro standards and upgrade of existing stations between Sydenham and Bankstown.

Both components are subject to assessment by the Department of Planning and Environment and approval by the Minister for Planning under Part 5.1 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). The Sydenham to Bankstown upgrade will be subject to a separate environmental impact assessment.

Sydney Metro Northwest (formerly the North West Rail Link) is currently under construction, services will start in the first half of 2019. This includes a new metro rail line between Rouse Hill and Epping and conversion of the existing rail line between Epping and Chatswood to metro standards.

Investigations have started on the possible extension of Sydney Metro from Bankstown to Liverpool. The potential extension would support growth in Sydney's south west by connecting communities, businesses, jobs and services as well as improving access between the south west and Sydney's CBD. It would also reduce growth pressure on road infrastructure and the rail network, including the potential to relieve crowding on the T1 Western Line, T2 South Line and T2 Airport Line.

The Sydney Metro Delivery Office has been established as part of Transport for NSW to manage the planning, procurement and delivery of the Sydney Metro network.

The Sydney Metro rail network is shown in **Figure 1.1**.

1.2 The Sydney Metro network

The customer experience underpins how Sydney Metro is being planned and designed. The customer experience incorporates all aspects of travel associated with the transport network, service and project including:

- The decision on how to travel
- The travel information available
- The speed and comfort of the journey
- The range and quantity of services available at stations, interchanges and within station precincts.

A high quality 'door to door' transport product is critical to attract and retain customers and also to meet broader transport and land use objectives. This includes providing a system that is inherently safe for customers on trains, at stations and at the interface with the public domain; providing direct, comfortable, legible and safe routes for customers between transport modes; and provide a clean, pleasant and comfortable environment for customers at stations and on trains.

Key features of the metro product include:

- Comfortable carriages with space for customers to sit or stand
- A 'turn-up-and-go' service, with high frequency trains Reduced journey times with faster trains, and new underground routes through the Sydney CBD
- Increased capacity to safely and reliably carry more customers per hour due to the increased frequency of trains
- Reduced dwell times at stations as each carriage would be single-deck with three doors, allowing customers to board and alight more quickly than they can with double-deck carriages.

The Chatswood to Sydenham project would have the capacity to run up to 30 trains per hour through the Sydney CBD in each direction, which would provide the foundation for delivering a 60 per cent increase in the number of trains operating in peak periods, and cater for an extra 100,000 customers per hour.

Figure 1.1 : The Sydney Metro network

1.3 Overview of the project

1.3.1 Location

The Sydney Metro Chatswood to Sydenham project (the project) involves the construction and operation of a metro rail line. The project would be mainly located underground in twin tunnels extending from Chatswood on Sydney's north shore, crossing under Sydney Harbour, and continue to Sydenham.

1.3.2 Key features

The proposed alignment and key operational features of the project are shown in **Figure 1.2** and would include:

- Realignment of T1 North Shore Line surface track within the existing rail corridor between Chatswood Station and Brand Street, Artarmon, including a new bridge for a section of the 'down' (northbound) track to pass over the proposed northern dive structure
- About 250 metres of aboveground metro tracks between Chatswood Station and the Chatswood dive structure
- A dive structure (about 400 metres long) and tunnel portal south of Chatswood Station and north of Mowbray Road, Chatswood (the Chatswood dive structure)
- About 15.5 kilometres of twin rail tunnels (that is, two tunnels located side-by-side) between Mowbray Road, Chatswood and Bedwin Road, Marrickville. The tunnel corridor would extend about 30 metres either side of each tunnel centre line and around all stations
- A substation (for traction power supply) in Artarmon, next to the Gore Hill Freeway, between the proposed Crows Nest Station and the Chatswood tunnel portal
- Metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street and Waterloo; and new underground platforms at Central Station
- A dive structure (about 400 metres long) and tunnel portal between Sydenham Station and Bedwin Road, Marrickville (the Marrickville dive structure)
- A services facility beside the Marrickville dive structure and tunnel portal, including a tunnel water treatment plant and a substation (for traction power supply).

The project would also include:

- Permanent closure of the road bridge at Nelson Street, Chatswood, and provision of an all vehicle right-turn movement from the Pacific Highway (southbound) into Mowbray Road (westbound)
- Changes to arrangements for maintenance access from Hopetoun Avenue and Albert Avenue, Chatswood as well as a new access point from Brand Street, Artarmon
- Underground pedestrian links at some stations and connections to other modes of transport (such as the existing suburban rail network) and surrounding land uses
- Alterations to pedestrian and traffic arrangements and public transport infrastructure (where required) around the new stations and surrounding Central Station
- Installation and modification of existing Sydney Trains rail systems including overhead wiring, signalling, rail corridor fencing and noise walls, within surface sections at the northern end of the project
- Noise barriers (where required) and other environmental protection measures.

The proposed construction activities for the project broadly include:

- Demolishing buildings and structures at the station sites and other construction sites
- Constructing tunnels, dive structures and tunnel portals
- Excavating, constructing and fitting out metro stations
- Fitting out tunnel rail systems and testing and commissioning of stations, tunnels, ancillary infrastructure, rail systems and trains
- Excavating shafts, carrying out structural work and fitting out ancillary infrastructure at Artarmon
- Carrying out structural work and fitting out ancillary infrastructure at Marrickville.

A number of construction sites would be required to construct the project. These include locations for tunnel equipment and tunnel boring machine support at Chatswood, Barangaroo and Marrickville as well as at station sites; a casting yard and segment storage facility at Marrickville and a temporary tunnel boring machine retrieval site at Blues Point.

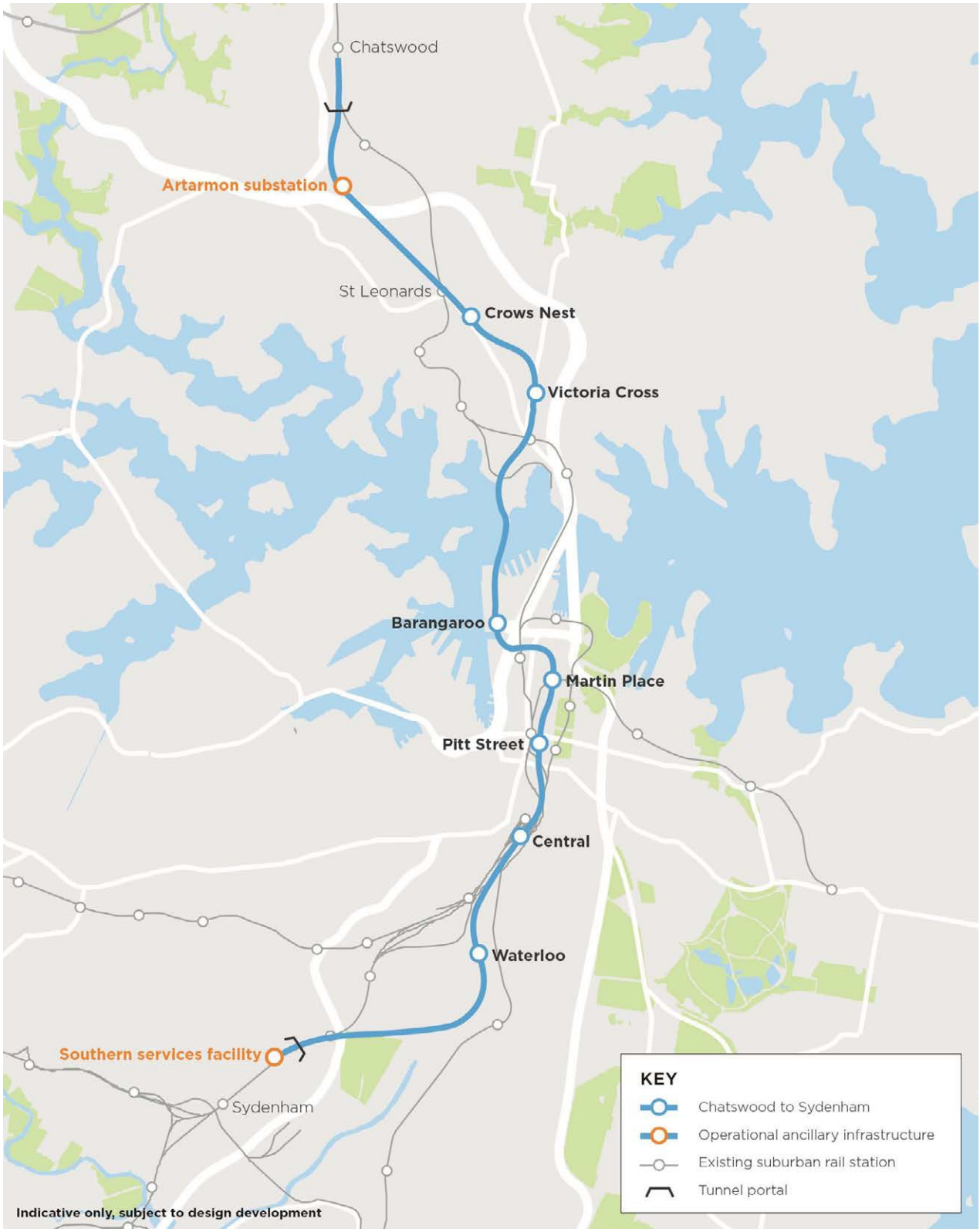


Figure 1.2 : The project

1.4 Purpose and scope of this report

The project has been declared State significant infrastructure and critical State significant infrastructure and therefore is subject to assessment by the Department of Planning and Environment and approval by the Minister for Planning under Part 5.1 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act).

This technical paper, Technical Paper 7: Groundwater Assessment – Sydney Metro Chatswood to Sydenham is one of a number of technical documents that forms part of the EIS. The purpose of this technical paper is to identify and assess the groundwater-related impacts of the project during both construction and operation. In doing so it responds directly to the Secretary's Environmental Assessment Requirements (SEARs) outlined in **Section 1.4**.

This report presents a description of the hydrogeological environment, with acknowledgement that Detailed Site Investigations are on-going at the time of writing of this report to supplement the current environmental dataset. The report presents the anticipated changes to the hydrogeological environment due to the project and presents an assessment of the impact of those anticipated changes to groundwater level, pressure and quality. The report also presents the approach to monitoring and management.

To facilitate review of this Groundwater Assessment, the NSW Office of Water Aquifer Interference Assessment Framework has been completed and is provided as Appendix A.

Accordingly, this report:

- Describes of the aquifer system(s) traversed by the project
- Identifies existing groundwater level along the alignment and near the station and portals
- Identifies sensitive environmental receptors (surrounding land uses, groundwater dependent ecosystems, groundwater users and surface water / groundwater interaction)
- Presents the nature and extent of potential impacts on groundwater associated with construction and the presence of end-of-state project infrastructure including tunnels, portals and station excavations
- Proposes monitoring / management measures to address identified impacts.

The following definitions are used throughout this report. 'Tanked' structures entail waterproofing combined with a permanent lining. 'Drained' structures do not include waterproofing and would be perpetually dewatered.

1.5 Secretary's Environmental Assessment Requirements

The Secretary's environmental assessment requirements relating to groundwater, and where these requirements are addressed in this technical paper, are outlined in **Table 1.1**.

Table 1.1 : Secretary's Environmental Assessment Requirements – Groundwater

Secretary's Environmental Assessment Requirements	Where Addressed
17. Water – Hydrology	
1. The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the FBA.	A description of the existing hydrogeological environment is presented in Section 3.3
2. The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including: 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;	Target changes to groundwater level, groundwater flow, groundwater quality and surface water-groundwater interaction is presented in Section 4.2 to 4.5. Impacts to Surrounding Land Use, Groundwater Dependent Ecosystems, Groundwater Users and Surface Water-Groundwater Interaction are presented in Section 5.3 to 5.6.
c) changes to environmental water availability and flows, both regulated/licensed and unregulated/rules-based sources;	Expected change to surface water-groundwater interaction due to the project is presented in Section 4.5 and an assessment of the impact is presented in presented in Section 5.6. Refer to Surface Water Assessment for assessment of impact of proposed change to flow due to discharge from the project.
f) water take (direct or passive) from all surface and groundwater sources with estimates of annual volumes during construction and operation.	Volumetric take from all groundwater sources presented in Section 6.1 as well as expected take from surface water sources due to groundwater interference.
3. The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	The intended approach to monitoring is presented in Section 6.2.

2. Regulation, Legislation and Policy

This chapter presents relevant regulation, legislation and policy governing management of groundwater as it pertains to the Sydney Metro Chatswood to Sydenham project.

2.1 NSW Legislation

2.1.1 Water Management Act 2000

The *Water Management Act* 2000 (NSW) presents the framework for sustainable and integrated water management in NSW and its objectives are as follows:

- *to apply the principles of ecologically sustainable development, and*
- *to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and*
- *to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:*
  - *benefits to the environment, and*
  - *benefits to urban communities, agriculture, fisheries, industry and recreation, and*
  - *benefits to culture and heritage, and*
  - *benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,*
- *to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,*
- *to provide for the orderly, efficient and equitable sharing of water from water sources,*
- *to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,*
- *to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,*
- *to encourage best practice in the management and use of water.*

The primary instruments applied to achieve these objectives are Water Sharing Plans and the NSW Aquifer Interference Policy (NSW Office of Water, 2012).

The *Water Management (General) Regulation* 2011 (NSW) is the primary regulation instrument under the *Water Management Act* 2000 (NSW). Under the Clause 18(1) of the *Water Management (General) Regulation* 2011 (NSW), Transport for NSW, as a transport authority, is exempt from the requirement to hold an access licence. Transport for NSW is also exempt under Clause 31(1) of the *Water Management (General) Regulation* 2011 (NSW) from the requirement to hold a water use approval. Transport authorities are not exempt, however, from the requirement to hold a water supply work approval.

2.1.2 Water Act 1912

The *Water Act* 1912 (NSW) is being progressively phased out across NSW and replaced by the *Water Management Act* 2000 (NSW). The *Water Act* 1912 (NSW) is relevant where there an activity leads to a take from a groundwater or surface water source not currently covered by a Water Sharing Plan. As a Water Sharing Plan has been developed for the project area, the *Water Act* 1912 (NSW) does not apply.

Temporary dewatering works are identified as aquifer interference activities under the *Water Management Act* 2000 (NSW) and the NSW Aquifer Interference Policy (NSW Office of Water, 2012). Aquifer interference activities require aquifer interference approvals under the *Water Management Act* 2000 (NSW); however, provisions for aquifer interference approvals have yet to be enabled. As such, licensing aspects of these aquifer interference activities are currently administrated under the *Water Act* 1912 (NSW) (NSW Office of Water, pers. comm., 2014). Under Section 8 of the *Water Act* 1912, however, the Crown is exempt from the requirement to hold licences; therefore Transport for NSW would not require a licence for construction dewatering.

2.1.3 Water sharing plans

Water sharing plans, following the introduction of the *Water Management Act* 2000 (NSW), provide the basis for equitable sharing of surface water and groundwater between water users, including the environment.

The majority of NSW is now covered by Water Sharing Plans. If an activity leads to a take from a groundwater or surface water source covered by a Water Sharing Plan, then an approval and / or licence is required.

In general, the *Water Management Act* 2000 (NSW) requires:

- a water access licence to take water
- a water supply works approval to construct a work
- a water use approval to use the water.

For groundwater, the project lies within the Sydney Basin Central Groundwater Source of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (NSW). At Waterloo Station the alignment underlies the Botany Sands Groundwater Source.

Figure 2.1 presents the boundaries of the Water Sharing Plan (groundwater).

It is noted that the Sydney Basin Central Groundwater Source is declared a Less Productive Groundwater Source by the NSW Office of Water; therefore Less Productive Minimal Impact Considerations of the NSW Aquifer Interference Policy, with respect to Porous and Fractured Rock Water Sources, would apply.

For Waterloo Station, the station shaft would intersect the Botany Sands Groundwater Source. Project borehole SRT BH403 indicates that there is around 4 metres of sand at Waterloo Station and then silty clay transitioning to siltstone and sandstone from 8 metres below ground level. The design for the Waterloo station is being refined but is expected to be 'tanked' across the Botany Sands Groundwater Source and therefore the Botany Sands Groundwater Source would be hydraulically isolated from the station shaft. Accordingly, it is proposed that only the Sydney Basin Central Groundwater Source is relevant to this assessment.

For surface water, the project resides within the Water Sharing Plan for the *Greater Metropolitan Region Unregulated River Water Sources* 2011 (NSW). The northern portion (Middle Harbour Creek catchment) of the project resides within the Middle Harbour Management Zone of the Northern Sydney Rivers Water Source. The middle portion (Parramatta River / Port Jackson catchment) of the project resides within the Lower Parramatta River Management Zone of the Northern Sydney Rivers Water Source. The southern portion (Cooks River catchment) of the project resides within the Cooks River and Botany Bay Management Zone of the Southern Sydney Rivers Water Source.

Figure 2.2 presents the boundaries of the Water Sharing Plan (surface water).

Details of potential licensing requirements from each of the abovementioned water sources are presented in **Section 6.1** below.

2.2 NSW Policy

2.2.1 NSW Aquifer Interference Policy

The Aquifer Interference Policy (NSW Office of Water, 2012) presents the requirements of assessment of aquifer interference activities administered by the *Water Management Act* 2000 (NSW). Key components to the policy are:

- all water taken must be properly accounted for
- the activity must address minimal impact considerations with respect to water table, water pressure and water quality
- planning measures in the event that actual impacts are greater than predicted, including making sure there is sufficient monitoring in place.

Level 1 Minimal Harm Considerations for the Sydney Basin Central Groundwater Source include:

- water table
  - less than 10 per cent cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 metres from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the Schedule of the relevant water sharing plan
  - a maximum of a 2 metres decline cumulatively at any water supply work
- water pressure
  - a cumulative pressure head decline of not more than a 2 metres decline, at any water supply work
- water quality
  - any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.

Figure 2.1: Water Sharing Plan of the Greater Metropolitan Region Groundwater Sources 2011 (NSW)

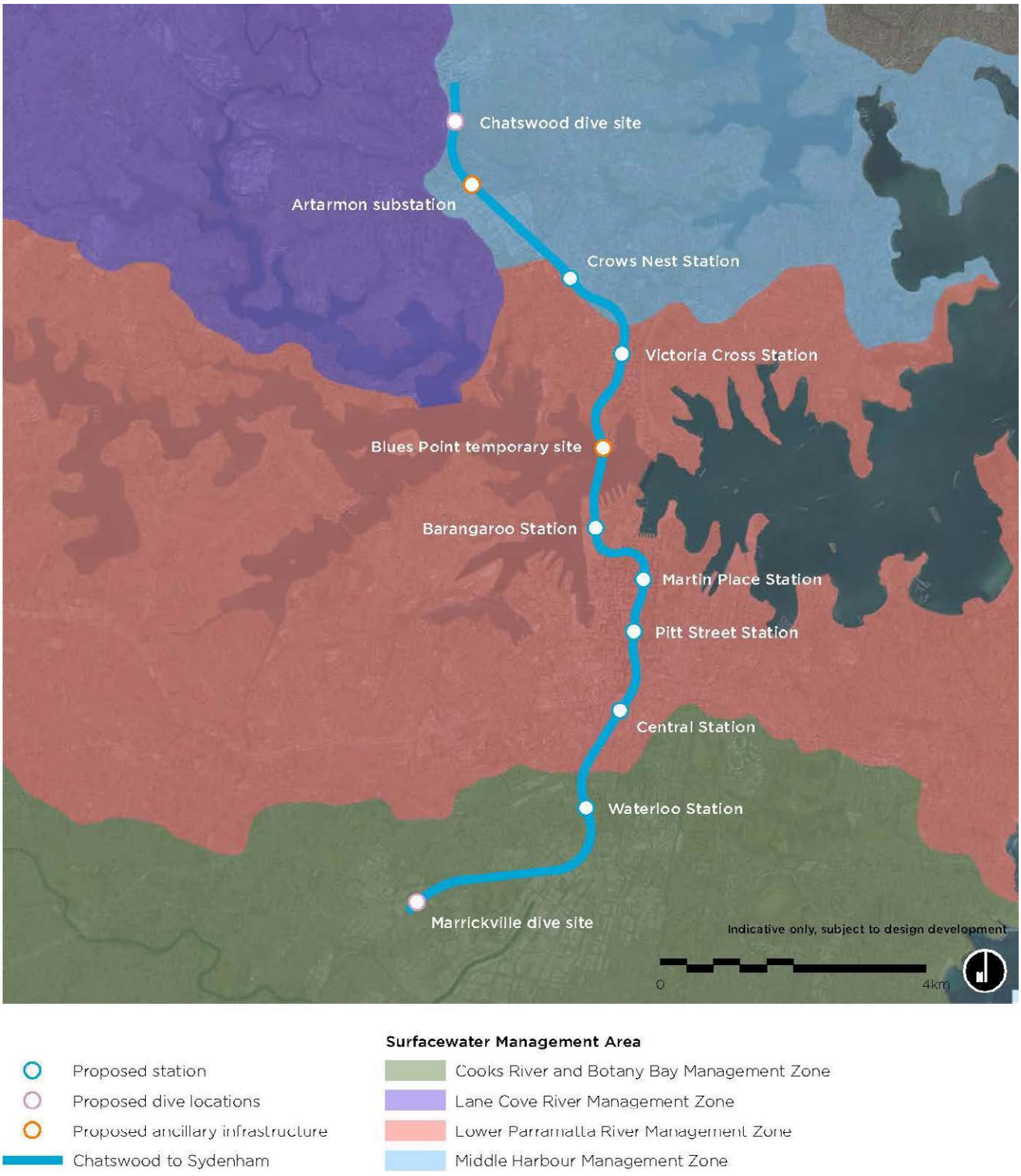


Figure 2.2: Water Sharing Plan of the Greater Metropolitan Region Unregulated River Water Sources 2011 (NSW)

2.2.2 NSW Groundwater Quality Protection Policy

The NSW Groundwater Quality Protection Policy (DLWC, 1998) objectives are:

- All groundwater systems should be managed such that their most sensitive identified beneficial use (or environmental value) is maintained.
- Town water supplies should be afforded special protection against contamination.
- Groundwater pollution should be prevented so that future remediation is not required.
- For new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the groundwater resource.
- A groundwater user shall bear the responsibility for environmental damage or degradation caused by using groundwater that is incompatible with soil, vegetation or receiving waters.
- Groundwater dependent ecosystems will be afforded protection.
- Groundwater quality protection should be integrated with the management of groundwater quantity.
- The cumulative impacts of developments on groundwater quality should be recognised by all those who manage, use, or impact on the resource.
- Where possible and practical, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored.

The following beneficial uses (in decreasing levels of water quality) are adopted by the NSW Groundwater Quality Protection Policy from the National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ANZECC, 1995):

- ecosystem protection
- recreation and aesthetics
- raw water for drinking water supply
- agricultural water
- industrial water.

Specific water quality characteristics are determined on a case-by-case basis with due consideration of existing site conditions and uses within each beneficial class.

2.2.3 NSW Groundwater Dependent Ecosystems Policy

The principles for management of groundwater dependent ecosystems in NSW through the NSW Groundwater Dependent Ecosystems Policy (DLWC, 2002) are:

- The scientific, ecological, aesthetic and economic values of groundwater-dependent ecosystems, and how threats to them may be avoided, should be identified and action taken to ensure that the most vulnerable and the most valuable ecosystems are protected.
- Groundwater extractions should be managed within the sustainable yield of aquifer systems, so that the ecological processes and biodiversity of their dependent ecosystems are maintained and/or restored. Management may involve establishment of threshold levels that are critical for ecosystem health, and controls on extraction in the proximity of groundwater dependent ecosystems.
- Priority should be given to ensuring that sufficient groundwater of suitable quality is available at the times it is needed:
    - for protecting ecosystems which are known to be, or are most likely to be, groundwater dependent
    - for groundwater dependent ecosystems which are under an immediate or high degree of threat from groundwater-related activities.

- Where scientific knowledge is lacking, the Precautionary Principle should be applied to protect groundwater dependent ecosystems. The development of adaptive management systems and research to improve understanding of these ecosystems is essential to their management.
- Planning, approval and management of developments and land use activities should aim to minimise adverse impacts on groundwater dependent ecosystem by:
  - maintaining, where possible, natural patterns of groundwater flow and not disrupting groundwater levels that are critical for ecosystems
  - not polluting or causing adverse changes in groundwater quality
  - rehabilitating degraded groundwater systems where practical.

2.2.4 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act* 1997 (NSW) is the key piece of environment protection legislation administered by the NSW Environment Protection Authority.

Relevant features of this legislation include:

- protection of the environment policies (PEPs)
- integrated environment protection licensing
- regulation of scheduled and non-scheduled activities:
  - the NSW Environment Protection Agency is the regulatory authority for scheduled activities (activities declared under Schedule 1 of the *Protection of the Environment Operations Act* 1997)
  - the NSW Environment Protection Agency is also the regulatory authority for non-scheduled activities, where activities are undertaken by a public authority.

The project is a scheduled activity during construction and an environmental protection licence (EPL) would be required for this stage. An environmental protection licence would not be required for the operational stage.

2.3 Commonwealth Legislation

2.3.1 Environmental Protection and Biodiversity Conservation Act 1999

The project can be referred to the Department of Environment for consideration under the *Environmental Protection and Biodiversity Conservation Act* 1999 (Cth).

The project, however, does not trigger any Matters of National Environmental Significance with respect to a water resource since the project does not relate to coal seam gas or large coal mining development.

Assessment of the project with respect to other Matters of National Environmental Significance is presented in the main text of the environmental impact statement.

3. Hydrogeological setting

This chapter presents the environmental and hydrogeological setting of the Sydney Metro Chatswood to Sydenham project. It also presents available environmental data with respect to groundwater level, flow and quality as well as the conceptual hydrogeological model.

3.1 Environmental setting

3.1.1 Climate

Climate in the vicinity of the project is provided by the BOM Station Observatory Hill (No. 066062) in regard to rainfall. Pan A evaporation is obtained from BOM Station Sydney Airport AWS (No. 066037).

Table 3.1 and **3.2** presents relevant climatic statistics.

Table 3.1 : Average monthly rainfall (mm) (Sydney Observatory Hill No. 066062)

Climate Statistic	J	F	M	A	M	J	J	A	S	O	N	D	Ann.
Mean Monthly (mm)	101.6	117.6	129.2	128.6	119.9	132	97.4	80.7	68.3	76.9	83.9	77.6	1213.4
Decile 1 Monthly (mm)	25.5	19.6	31.2	24.6	19	24.6	11	9.3	14.1	17.9	16	21.6	822.2
Decile 5 Monthly (mm)	79.8	93.6	97.4	97.8	90.9	100.3	74.3	54.5	51.3	55.6	66.9	59.6	1162.2
Decile 9 Monthly (mm)	188.2	254.6	277.3	276.3	266.8	295.5	221.7	187.8	151.6	175.9	158.9	165.4	1649.7
Mean No. of Raindays > 1mm	8.6	9	9.8	9	8.7	8.7	7.5	7.2	7.2	7.9	8.4	8	100
Mean No. of Raindays > 10mm	2.7	3	3.4	3.4	3.2	3.6	2.7	2.1	1.9	2	2.4	2.3	32.7

Table 3.2 : Monthly (mm) and daily evaporation (mm/d) (Sydney Airport AWS No. 066037)

Climate Statistic	J	F	M	A	M	J	J	A	S	O	N	D	Ann.
Mean Monthly (mm)	226.3	179.2	167.4	126.0	93.0	75.0	83.7	114.7	147.0	182.9	195.0	229.4	1826.3
Mean Daily (mm/d)	7.3	6.4	5.4	4.2	3.0	2.5	2.7	3.7	4.9	5.9	6.5	7.4	5.0

From **Table 3.1**, median annual rainfall is 1,162 mm and mean annual rainfall is 1,213 mm. Decile 1 annual rainfall (10^{th} percentile) is 822 mm and Decile 9 annual rainfall (90^{th} percentile) is 1,650 mm. Lowest rainfall occurs during late winter to early spring (August to October) and corresponds with lowest mean number of rain days > 10mm.

Evaporation presented in **Table 3.2** follows a typical distribution, with winter being minimum and summer being maximum.

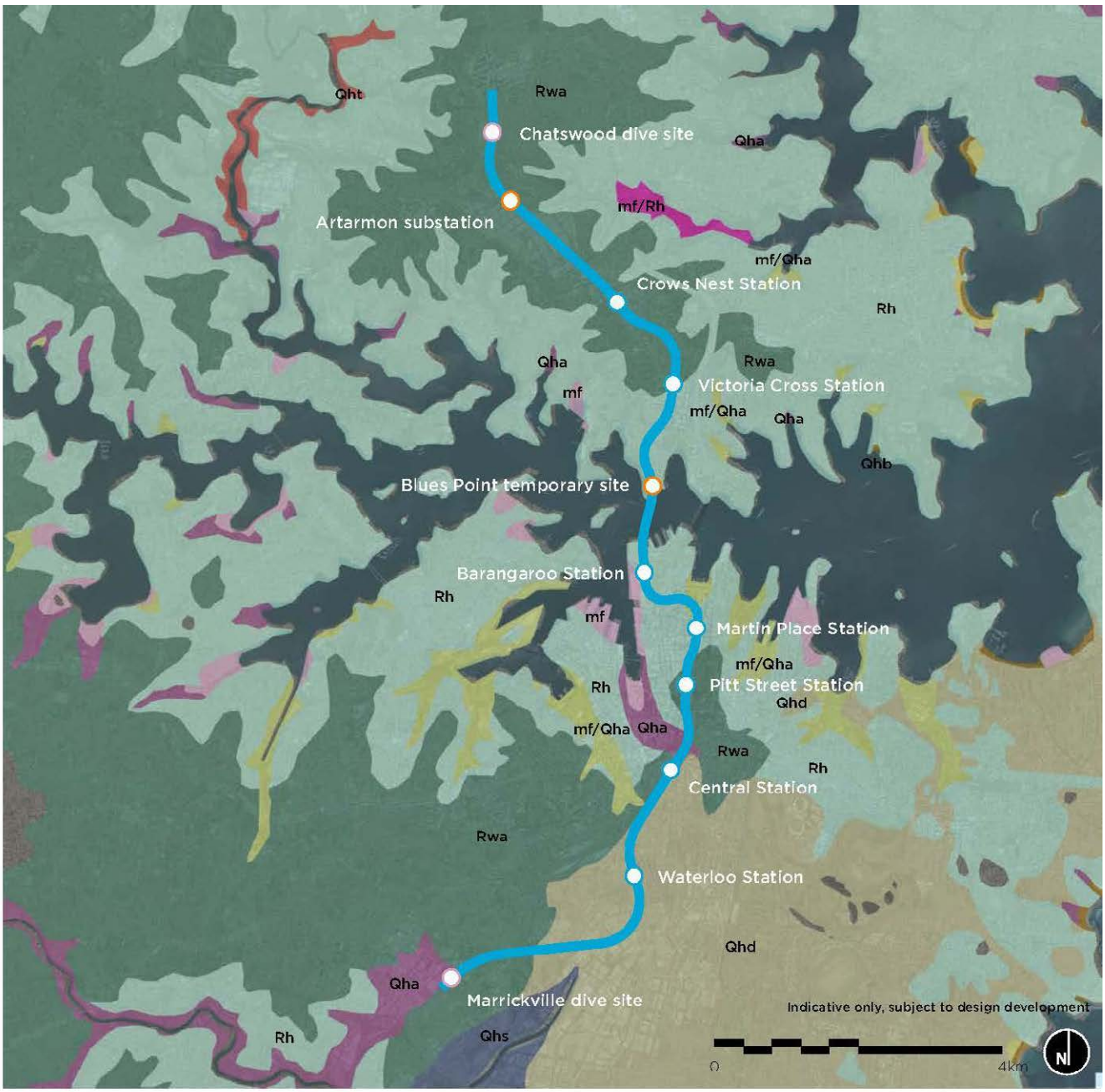
3.1.2 Geology

Information provided by Transport for NSW presents the regional geological units present within the project area based on the 1:100,000 Geological Sheet 9130 for Sydney (Herbert, 1983). The geological units consist:

- Fill – reclaimed areas generally adjacent to the harbour and some parklands
- Holocene alluvium – normally consolidated sediments
- Pleistocene alluvium – over-consolidated sediments (often sandy clays)
- Residual soil – derived from completely weathered siltstone and sandstone
- Wianamatta Group – comprising siltstone and fine-grained lithic sandstone
- Mittagong Formation – comprising interbedded shale and fine-grained sandstone
- Hawkesbury Sandstone – medium to coarse grained quartz sandstone.

Figure 3.1 presents the distribution of surface geological units along the alignment of the project.

Detailed discussion of the project with respect to geological units that are anticipated to be encountered is presented below. Geological long-sections are presented in **Appendix B**.



KEY

- Proposed station location
- Proposed dive locations
- Proposed ancillary infrastructure
- Chatswood to Sydenham

Geology (source: Herbert, 1983)

- Qha: Quaternary alluvium
- Qhb: Quaternary quartz sand
- Qhd: Quaternarymedium to fine grained marine sand with podsols
- Qhf: Quaternary medium to fine marine sand
- Qhs: Qualernary peal, sandy peat and mud
- Qht: Quaternary sandy mud/muddy sand
- Rh: Hawkesbury Sandstone
- Rwa: Ashfield Shale
- mf: Man made fill
- mf/Qha: Man-made fill/Quaternary alluvium
- mf/Rh: Man-made fill/Hawkesbury Sandstone

Figure 3.1 : Regional geology of the project (after Herbert, 1983)

3.2 Soil

3.2.1 Soil landscapes

Information provided by Transport for NSW note several soil landscapes along the alignment of the project after Chapman et. al. (2009). These comprise:

- Birrong
  - silt-sized alluvium derived from Wianamatta Group
  - level to gently undulating alluvial floodplain draining Wianamatta Group shales
  - Yellow Podzolic and Yellow Solodic soils on older alluvial terraces; Solodic soils and Yellow Solonetz on current floodplain
  - limitations include localised flooding, high soil erosion hazard, seasonal water logging, very low to low soil fertility
- Blacktown
  - gently undulating rises on Wianamatta Group shales with slopes usually <5 per cent
  - Red and Brown Podzolic soils on crests, upper slopes and well-drained areas; Yellow Podzolic Soils and Soloths on lower slopes and in areas of poor drainage
  - limitations include moderately reactive highly plastic subsoil, low soil fertility and poor soil drainage
- Lucas Heights
  - gently undulating crests and ridges on plateau surfaces of the Mittagong Formation with slopes to <10 per cent and rock outcrop absent
  - hard-setting Yellow Podzolic soils; Yellow Soloths and Yellow Earths
  - limitations include stony soil, low soil fertility and low available water capacity.
- Gymea
  - undulating to rolling rises and low hills on Hawkesbury Sandstone, localised rock outcrop on low broken scarps
  - Yellow Earths and Earthy Sands on crests and inside benches; Siliceous Sands and Leached Sands along drainage lines
  - limitations include localised steep slopes, high soil erosion hazard, rock outcrop, shallow highly permeable soil and very low soil fertility
- Disturbed Terrain
  - level to hummocky terrain disturbed by human activity
  - turfed fill are commonly capped with 40cm of sandy loam or up to 60cm of compacted clay over fill or waste material
  - limitations include impermeable soil and poor drainage, localised very low soil fertility
- Hawkesbury
  - rugged, rolling to very steep hills on Hawkesbury Sandstone with slopes >25 per cent
  - Lithosols and Siliceous Sands associated with rock outcrop; Yellow Earths on inside of benches and along joints/fractures; localised Yellow and Red Podzolic soils associated with shale lenses; Siliceous Sands and secondary Yellow Earths along drainage lines
  - limitations include extreme soil erosion hazard, shallow, stony highly permeable soil, low soil fertility

- Glenorie
  - undulating to rolling hills on Wianamatta Group shale with slopes 5 to 20 per cent
  - Red and Brown Podzolic soils; Yellow and Gleyed Podzolic soils along drainage lines
  - limitations include high soil erosion hazard, localised impermeable highly plastic soil, moderately reactive.

Figure 3.2 presents the soil landscapes in the vicinity of the project. **Table 3.3** presents the soil landscape at each project element.

Table 3.3 : Soil landscapes

Project Element	Regional Soil Type
Chatswood dive	Blacktown
Artarmon substation	Glenorie / Disturbed Terrain
Crows Nest Station	Blacktown
Victoria Cross Station	Gymea
Blues Point temporary site	Hawkesbury / Gymea
Barrangaroo Station	Gymea / Disturbed Terrain
Martin Place Station	Gymea
Pitt Street Station	Lucas Heights
Central Station	Blacktown / Deep Creek
Waterloo Station	Tuggerah
Marrickville dive	Birrong

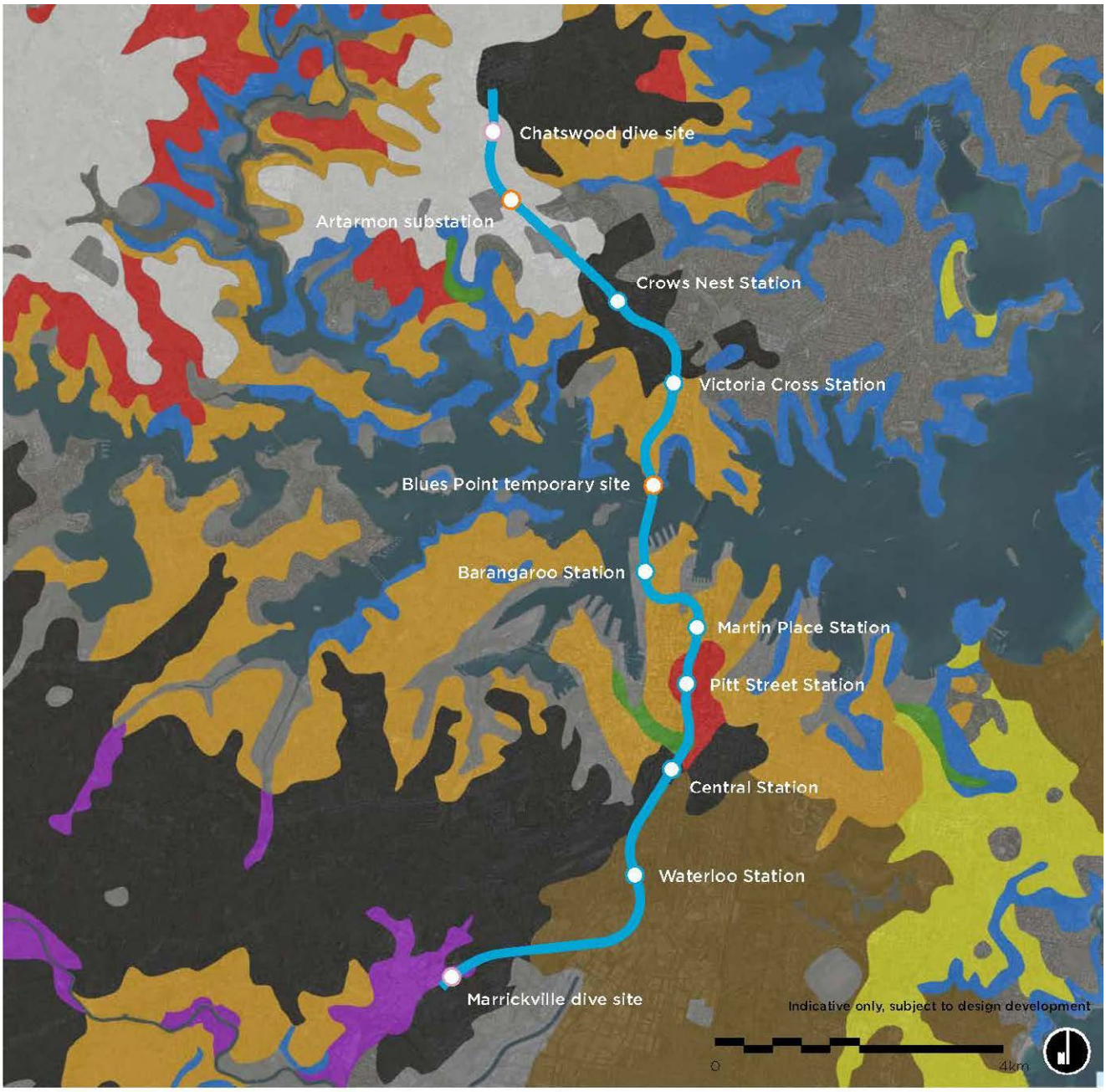


Figure 3.2 : Sydney Soils Landscapes (after Chapman et. al., 2009)

3.3 Hydrogeological environment

3.3.1 Surrounding land uses

The alignment from the Chatswood dive structure resides within the existing rail corridor at surface initially, with commercial premises to the north and residential premises to the west and east, before diving through the Ashfield Shale and Mittagong Formation into the Hawkesbury Sandstone. The alignment underlies commercial premises, including the temporary location of the Artarmon Public School at Artarmon, at depth (more than 25 metres below ground level). The underground station at Crows Nest Station comprises Hawkesbury Sandstone at rail level (65 metres AHD) overlain by Mittagong Formation, Ashfield Shale and residual soil. Ground surface is 86 metres AHD to 93 metres AHD at the top of the station shaft and station rail depth is ~20 to 30 metres below ground. Crows Nest Station is surrounded by commercial premises.

From Crows Nest to Victoria Cross Stations, the alignment travels at depth through the Hawkesbury Sandstone below residential and commercial premises, several of which have deep basements which have influenced the vertical alignment.

At Victoria Cross Station, the station shaft comprises Hawkesbury Sandstone at rail level (32.1 metres AHD) through to ground surface (67 to 79 metres AHD). Station rail depth is 35 to 45 metres below ground. Victoria Cross Station is surrounded by commercial buildings, many of which are high-rise and therefore presumably have deep foundations socketed into rock.

From Victoria Cross to Martin Place Stations, via Barangaroo Station, the alignment travels at depth within the Hawkesbury Sandstone. Overlying land uses on the northern side of the harbour comprise commercial premises, several with deep basements which the design was influenced by, past a school and into residential premises before travelling under the harbour. The depth of the alignment at these locations is more than 40 metres below ground level. On the southern side of the harbour, the alignment transitions from Walsh Bay / Barangaroo east to Martin Place.

At Barangaroo Station, there are semi-detached residential housing to the east and the Barangaroo redevelopment project to the west. The station shaft comprises Hawkesbury Sandstone at rail level (-30.5 metres AHD), with extensive filling near to ground surface. Current ground surface at Barangaroo Station is ~1.0 metres AHD, with station rail depth ~30 metres below ground.

At Martin Place Station, the station shaft comprises Hawkesbury Sandstone at rail level (-6.0 metres AHD) through to ground surface (23 to 25 metres AHD). Station rail depth is ~30m below ground. Martin Place Station is surrounded by high-rise commercial premises, many of which have significant basements.

Between Martin Place and Pitt Street stations, the alignment rises to near the interface between the Mittagong Formation and the Hawkesbury Sandstone, with Pitt Street Station consisting Hawkesbury Sandstone / Mittagong Formation overlain by residual soil and fill. Rail level is 5 metres AHD at Pitt Street Station. Ground surface at that location is 24 to 26 metres AHD and station rail depth is ~20 metres below ground. Pitt Street Station is similar to Martin Place Station insofar are being surrounded by high-rise commercial premises. Pitt Street Station would lie above the Cross City Tunnel (east and west). The groundwater level at this location is anticipated to be influenced by the presence of existing basements and tunnels. Information provided by Transport for NSW notes a major geological feature in the area, which is referred to as the Martin Place Joint Swarm. Information provided by Transport for NSW describes this as a series of vertical to sub-vertical joints / faults along with low angle fault zones.

From Pitt Street to Central Station, the alignment remains within the Hawkesbury Sandstone, with several commercial premises with basements and other infrastructure such as cable tunnels and the existing Eastern Suburbs Rail Lines influencing the vertical alignment. At Central Station, the rail level is -4.5 metres AHD in Hawkesbury Sandstone, overlain by Mittagong Formation, residual, minor lenses of Quaternary alluvium (presumably alluvium associated with local watercourse that discharges to Cockle Bay however is not associated with the Botany Sandbeds aquifer) and fill. Surrounding land uses at Central Station are railway infrastructure with mixed commercial / residential premises to the east and open public space to the north and south.

For Waterloo Station, the alignment would travel through the Hawkesbury Sandstone. The station shaft would intersect the Ashfield Shale and the Botany Sandbeds Aquifer. The Botany Sandbeds Aquifer would be hydraulically isolated / 'tanked' from the station shaft via a permanent lining.

At the Marrickville dive structure, land use is mixed commercial and light industrial to the north and south. Geology at the portal is Ashfield Shale, overlain by residual, alluvium associated with local watercourse and fill. The local watercourse is concrete lined and is located immediately north of the portal site itself. Off-site ground settlement, of which groundwater drawdown is a minor component is the subject of a comprehensive risk-based management strategy so as to avoid adverse differential settlement of the stormwater channel, as the longitudinal gradient of the channel is quite shallow.

Figure 3.3 to **Figure 3.10** presents the project alignment, surrounding land use as well as relevant groundwater works identified from the PINNEENA database (DPI Water). Identified groundwater users are discussed in detail in **Section 3.3.3**.

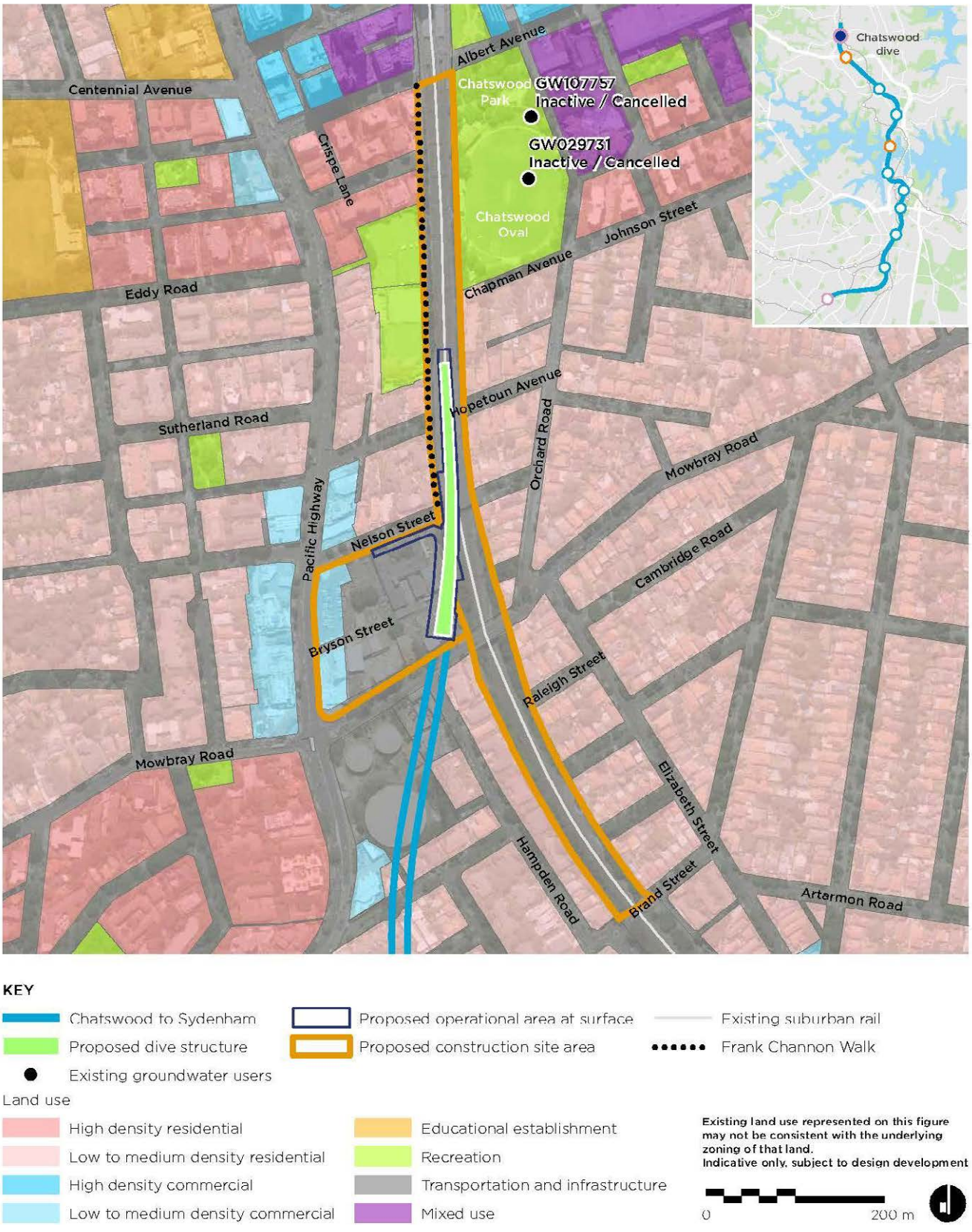


Figure 3.3 : Surrounding Land Use – Chatswood dive

Figure 3.4 : Surrounding Land Use – Artarmon substation

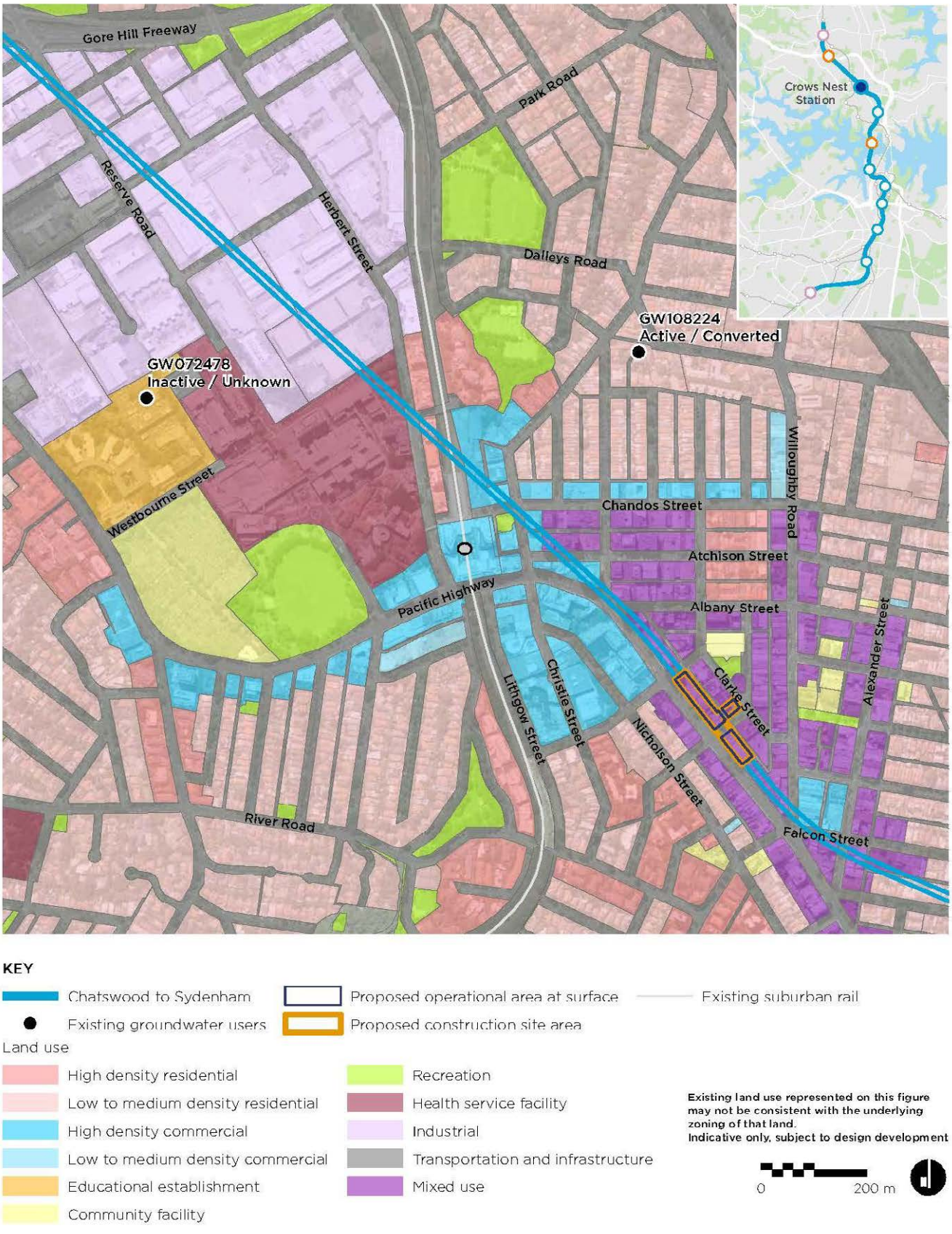


Figure 3.5 : Surrounding Land Use – Artarmon substation to Crows Nest Station

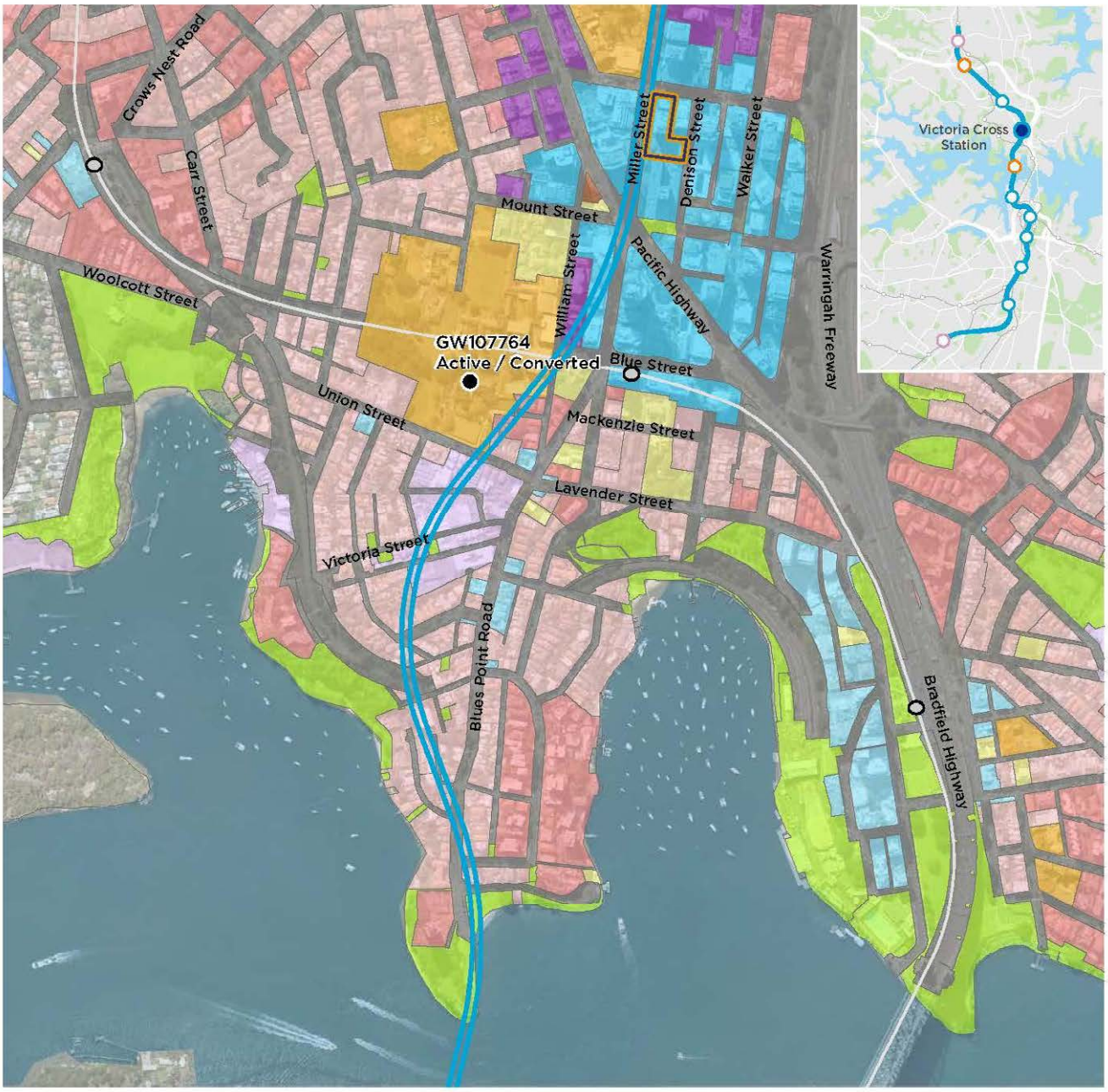


Figure 3.6 : Surrounding Land Use – Victoria Cross Station to Sydney Harbour

Figure 3.7 : Surrounding Land Use – Barangaroo Station to Martin Place Station

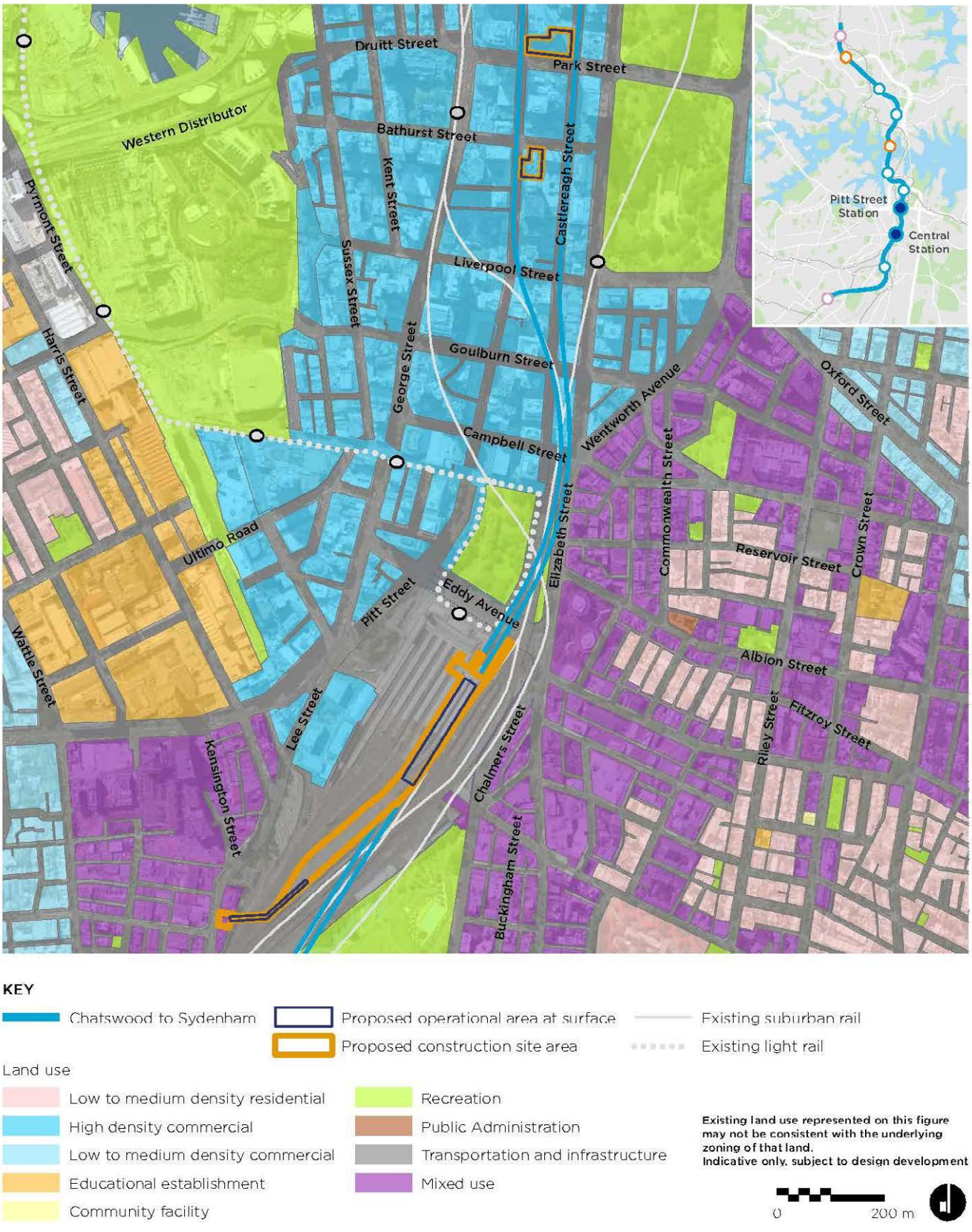


Figure 3.8 : Surrounding Land Use – Pitt Street Station to Central Station

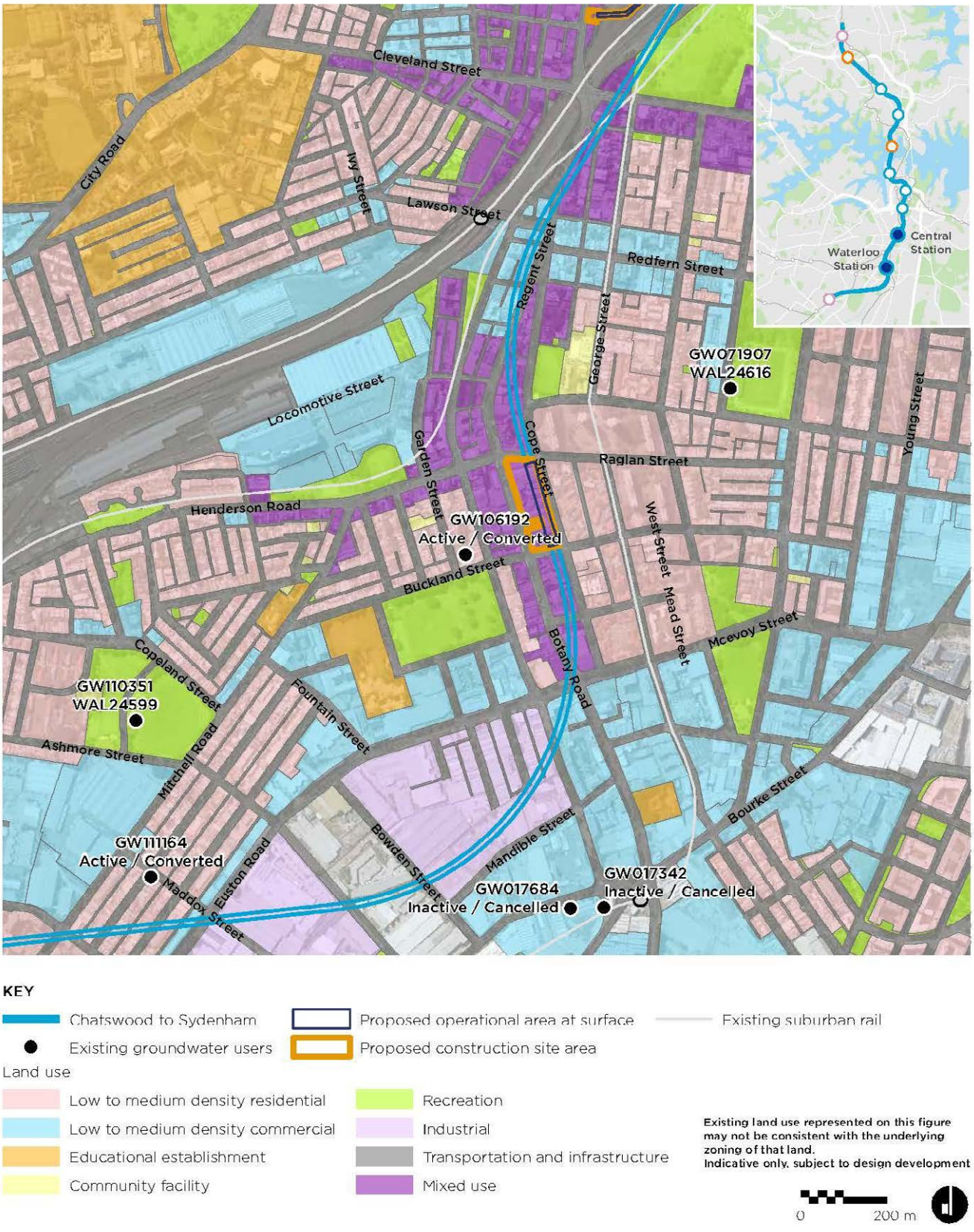


Figure 3.9 : Surrounding Land Use – Waterloo Station

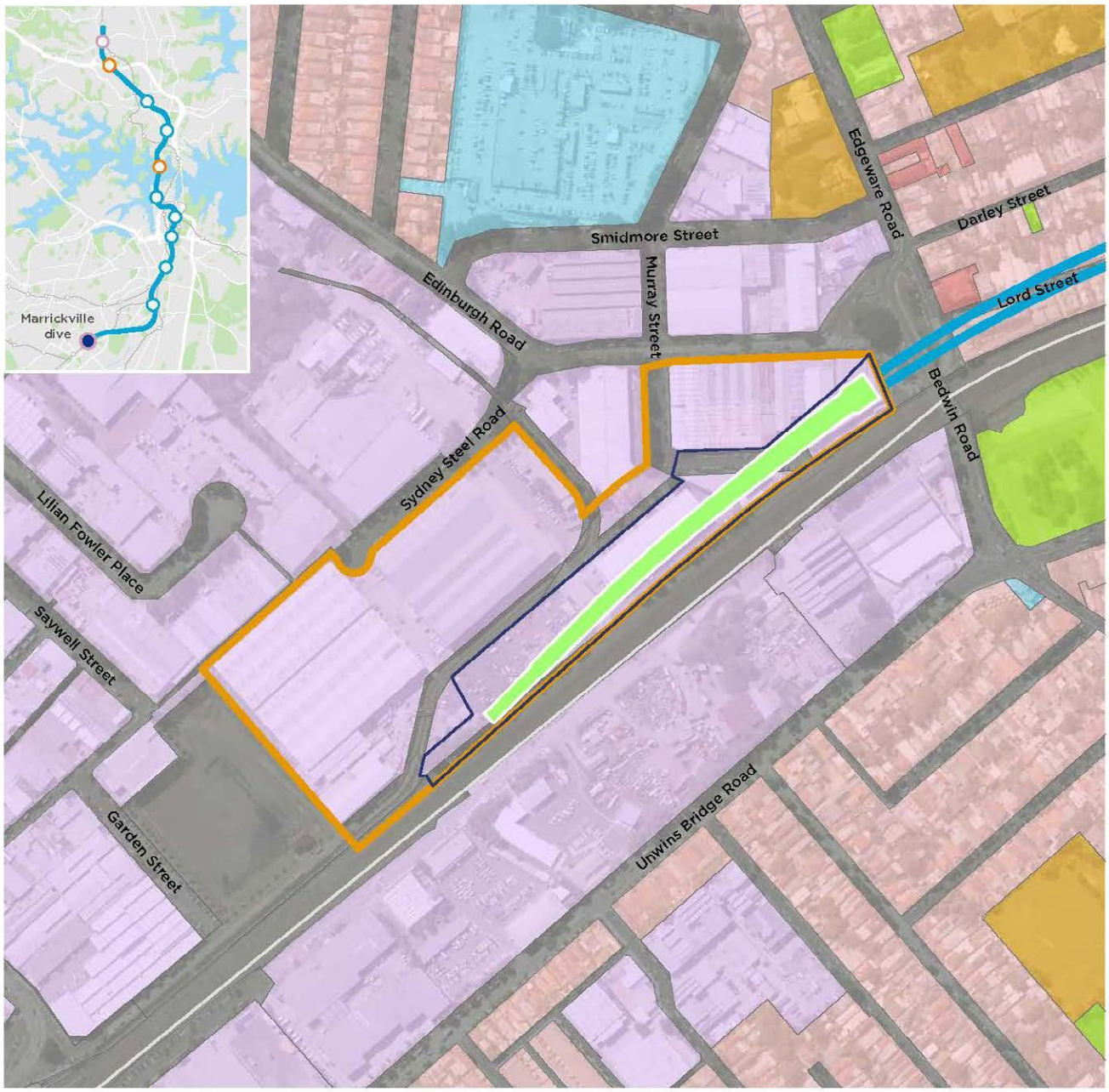


Figure 3.10 : Surrounding Land Use – Marrickville dive

3.3.2 Groundwater Dependent Ecosystems

High priority groundwater dependent ecosystems are listed in the schedule of the relevant Water Sharing Plan, in this case the Water Sharing Plan for the *Greater Metropolitan Region Groundwater Sources* 2011 (NSW). There are no high priority groundwater dependent ecosystems within the Sydney Basin Central Groundwater Source in the vicinity of the project.

Review of the Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems also does not identify other potential groundwater dependent ecosystems along the project alignment.

At Waterloo Station, there is around four metres of sand near ground surface. The sand layer forms part of the Botany Sands Groundwater Source. The sand layer would be hydraulically isolated (via permanent lining) from the station shaft, by design. The Botany Wetlands are a high priority groundwater dependent ecosystem in the Botany Sands Groundwater Source.

3.3.3 Groundwater users

There is limited groundwater use near the alignment of the project due to the geological environment comprising low permeability shale, siltstone and sandstone. The current version of the PINNEENA database (NSW Office of Water) was reviewed to identify any groundwater works (excluding monitoring piezometers).

A summary of groundwater users is presented in **Table 3.4**, with detailed discussion presented below.

Near the Chatswood dive structure, there are two irrigation wells (GW107757 and GW029731) at Chatswood Oval; however, review of the NSW Water Register indicates these water supply works are inactive. The works are located ~200 metres to the north of the Chatswood dive structure. The well construction (GW107757) comprises slotted screen openings at 14.7 to 17.7 metres below ground level (Ashfield Shale) and 23.7 to 29.7 metres below ground level (Mittagong Formation?) and presumably open hole below 44.7 to 162 metres below ground level in Mittagong Formation and Hawkesbury Sandstone. Standing water level is noted as 25.6 metres below ground level or 67.8 metres AHD. GW029731 is reported to be 21.6 metres deep, and open hole below 6.4 metres below ground level in Ashfield Shale and Mittagong Formation.

There is a domestic water supply well (GW108224) around 450 metres northeast of the existing St Leonards Station. At its closest point, the work is 380m northeast of the alignment. This well appears to be have been completed as open hole from 71.6 metres below ground level in sandstone (borehole depth is 132.4 metres below ground level). Two water bearing units are noted, one at 29 to 35 metres below ground level within sandstone bounded, above and below by shale (estimated yield 0.1 litres per second, salinity 1,750 milligrams per litre), and another at 98 to 100 metres below ground level within sandstone (estimated yield 0.2 litres per second, salinity 970 milligrams per litre). The composite groundwater level below 71.6 metres below ground level, assuming open hole, is 35 metres below ground level (37 metres AHD). It is presumed that the upper water bearing zone is Mittagong Formation and the lower one is Hawkesbury Sandstone. There is also a domestic water supply well (GW072478) around 600 metres northwest of St Leonards Station. At its closest point, the work is 290m southwest of the alignment. This well appears to have been completed as open hole from 5.4 metres below ground level in sandstone (borehole depth is 180.5 metres below ground level). The groundwater works summary from PINNEENA reports moist clay at 2.5 to 5.4 metres below ground level and a water bearing zone, presumably Mittagong Formation, at 29.7 to 30.1 metres below ground level in medium sandstone (estimated yield 0.1 litres per second, salinity 230 milligrams per litre) and another two zones between 138 and 144.5 metres below ground level in water bearing quartz (estimated yield 0.2 to 0.3 litres per second, salinity 270 milligrams per litre). The composite groundwater level, assuming open hole below 5.4 metres below ground level, is 48 metres below ground level (50 metres AHD).

The location of these groundwater works are presented in **Figure 3.3** to **Figure 3.9**.

Table 3.4 : Groundwater users identified along the project alignment

Location	GW ID	Completed	Easting	Northing	Elevation (mAHD)	Depth (mBGL)	Screen	Screened Unit	SWL (mBMP)	Yield (L/s)	Salinity (mg/L)	Status
Chatswood Oval	GW107757	29/07/2005 Council	331718	6258624	93.4	162.6	14.7 to 17.7m 23.7 to 29.7m	Ashfield Shale, Mittagong Formation?	25.6	0.6 (16.8 to 17.5m) 0.3 (28.7 to 29.0m)	725 1,360	Inactive, Recreation N/A
Chatswood Oval	GW029731	01/04/1967 Council	331715	6258555	92.9	21.6	Open hole below 6.4m?	Ashfield Shale, Mittagong Formation?	unkn	unkn	unkn	Inactive, Recreation N/A
St Leonards TAFE	GW072478	10/01/1995 Education	332277	6256317	97.0	180.5	Open hole below 5.4m?	Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone	48.0	0.2 (at 29.7 to 30.1m) 0.3 (at 138 to 139.3m) 0.2 (at 143.8 to 144.5m)	230 270 270	Inactive, Domestic N/A
Private Well near St Leonards Station	GW108224	05/06/2006 Private	333214	6256404	70.5	132.4	Open hole below 71.6m?	Hawkesbury Sandstone	35.0	0.1 (at 29 to 35m) 0.2 (at 98 to 100m)	1,750 970	Active, Domestic Basic Right
Shore School	GW107764	22/01/2007 Education	333832	6254006	67.5	unkn	unkn	unkn	unkn	unkn	unkn	Active, Domestic Basic Right
Redfern Park	GW071907	15/05/2008 Council	334034	6247997	31.7	180.0	Open hole below 57.7m?	Hawkesbury Sandstone	11.6	0.1 (at 30m) 0.3 (at 60m) 0.1 (at 90m) 0.1 (at 120m)	152 190 206 345	Active, Recreation WAL24616 (12ML/y)
Private Spear near Waterloo Station	GW106192	10/12/2004 Private	333418	6247611	15.7	6	Spear	Botany Sands Groundwater Source	4.0	0.5 (at 4.0 to 6.0m)	Good	Active, Domestic Basic Right

Location	GW ID	Completed	Easting	Northing	Elevation (mAHD)	Depth (mBGL)	Screen	Screened Unit	SWL (mBMP)	Yield (L/s)	Salinity (mg/L)	Status
Industrial Water Supply, Bourke Rd	GW017342	01/12/1946	333739	6246789	10.8	15.5	7.3 to 15.5	unkn	unkn	unkn	unkn	Inactive, Industrial N/A
Industrial Water Supply, Bourke Rd	GW017684	01/09/1947	333662	6246787	9.5	14.9	6.7 to 14.9	unkn	unkn	unkn	unkn	Inactive, Industrial N/A
Erskenville Oval	GW110351	01/01/1975 Council	332651	6247224	12.5	60.0	unkn	Hawkesbury Sandstone	25.0	1.0 (unkn)	unkn	Active, Recreation WAL24599 (10ML/y)
Private Spear in Alexandria	GW111164	12/10/2010 Private	332686	6246860	9.2	8.0	Spear	Botany Sands Groundwater Source	unkn	unkn	unkn	Active, Domestic Basic Right

There is a well 240 metres west of the existing North Sydney Station (GW107764) and would be ~80 metres northwest of the alignment at its closest point (refer to Figure 3.3). There are no construction details available from PINNEENA and this water supply well should be inspected and details obtained (completion details, standing water level, water quality, yield, current status) during preparation of the construction environmental management plan. The well was constructed in ~2007 and is associated with Shore School and is presumably used for irrigation of sporting fields. Review of the Register of Water Approvals refers to the work as a collector system and therefore the work may be quite shallow. The project at that location would be rail tunnels at depth, installed into the Hawkesbury Sandstone.

GW071907 is a water supply to Redfern Park. GW071907 is located 500m northeast of Waterloo Station. The work is 490m east of the alignment at its closest point. It is a 180 metres deep, presumable open hole, below 57.7 metres below ground level in Hawkesbury Sandstone. Standing water level at this work is reported to be 11.6 metres below ground level, equivalent to 20.1 metres AHD. This work is attached to WAL24616 and has an entitlement of 12 megalitres per year.

GW106192 is located 200 metres southwest of Waterloo Station and is a privately held spear to 6 metres in sand. The reported standing water level is 4.0 metres below ground level.

There are two water supply works (GW017342 and GW017684) located approximately 900 metres south of Waterloo Station. At its closest point, the alignment is 250 metres to the northwest of the works. Review of the NSW Water Register indicates these works are, however, inactive and were likely to be industrial water supply associated with previous land-use at that location. The works are both installed into the Botany Sands Groundwater Source and extend to a depth of 15.5 and 14.9 metre below ground level respectively.

Other works in the vicinity of this area are noted in the PINNEENA database as monitoring piezometers and presumably reflect previous and current groundwater investigation.

There is a water supply work (GW110351) operated by local government to irrigate Erskineville Oval. The work is licensed to extract 10 megalitres per year (WAL24599) from the Botany Sandbeds Aquifer. Drilled depth of GW110351 is 60 metres below ground level; however, there are no construction details available from the PINNEENA database. The project is rail tunnels in Hawkesbury Sandstone at depth and segmentally lined at that location. It is noted that GW110351 is screened in both the Botany Sands Groundwater Source and the Sydney Basin Central Groundwater Source.

There is a groundwater work in Alexandria, GW111164 and is a privately held spear installed to 8.0 metres below ground level in the Botany Sands Groundwater Source. The work is located 120 metres to the north of the alignment at its closest point and is a privately held spear to 8 metres in sand. A standing water level is not reported but is presumed to be 4 metres below ground level. The project at that location, however, would be rail tunnels at depth, installed into the Mittagong Formation/Hawkesbury Sandstone and therefore there would be no hydraulic connection between the work and the project.

To the southeast of the Marrickville dive structure itself; there is a flood detention basin. It is understood that the pump infrastructure at this location are surface works, with a local minor sump rather than a groundwater water supply.

3.3.4 Surface water / groundwater interaction

From the Chatswood dive structure, the alignment of the project coincides, in general, with the topographic ridgeline. Anticipated groundwater levels are presented in **Section 3.4** below, however, aside from local shallow water tables within residual soils, the groundwater level within the Mittagong Formation and Hawkesbury Sandstone is anticipated to be encountered at depth and therefore there is no surface water-groundwater interaction anticipated.

Figure 3.11 presents the layout of the Chatswood dive structure and **Figure 3.12** presents the layout of the Artarmon substation.

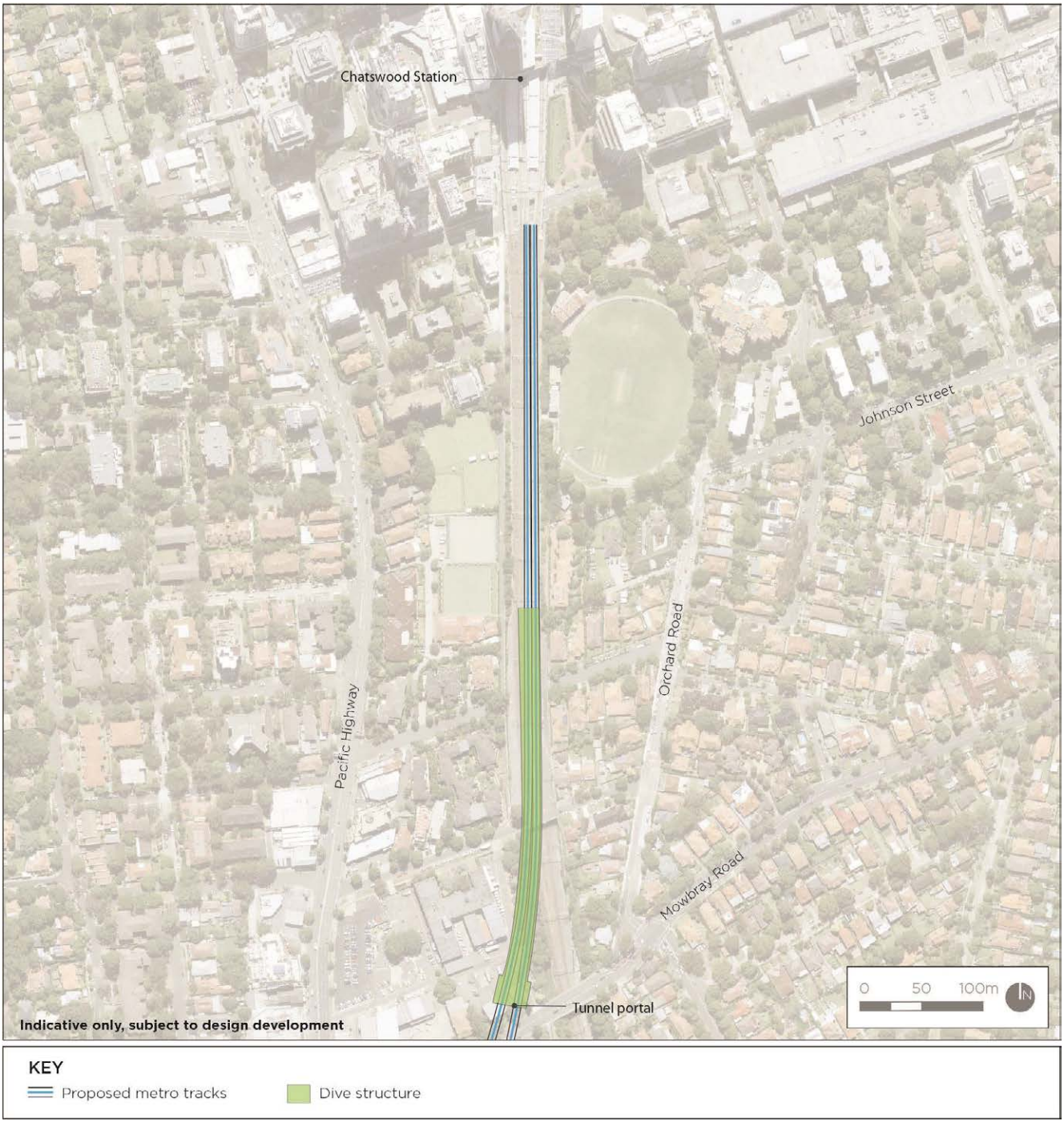


Figure 3.11 : Layout of the Chatswood dive structure

Figure 3.12 : Layout of the Artarmon substation

For the Harbour crossing component, it is also anticipated that there would be no surface water-groundwater interaction, by design, with the project rail tunnels, segmentally lined, potentially including compression gaskets between segments if required. As noted in the project description, **Section 4.1.1**, at the deepest section of the tunnel, the definition design involves tunnelling through harbour sediments following ground treatment works to reduce construction related risk at the rock-soil transition zone. The Blues Point temporary site is located adjacent Sydney Harbour. The site is proposed to be a 'drained' structure, whilst it is required, and would be backfilled following construction. **Figure 3.13** presents the layout of the Blues Point temporary site. SRT BH015 in **Appendix C**, presents the stratigraphic log at this location. The log implies unweathered sandstone is encountered from -12 metres AHD and below.

Figure 3.13 : Layout of the Blues Point temporary site

Between the Harbour crossing and Central Station the alignment is essentially north-south parallel to the topographic ridgeline after slewing eastward from Barangaroo Station to Martin Place. There is no anticipated interaction between surface water and groundwater at Barangaroo, Martin Place, Pitt Street and Central Station. All stormwater would be diverted around station shafts and dive structures to prevent ingress to tunnels. Due to the proximity of Barangaroo to Sydney Harbour and the presence of remediated land, Barangaroo Station would be a 'tanked' structure with respect to all elements. **Figure 3.14** presents the layout of Barangaroo Station.

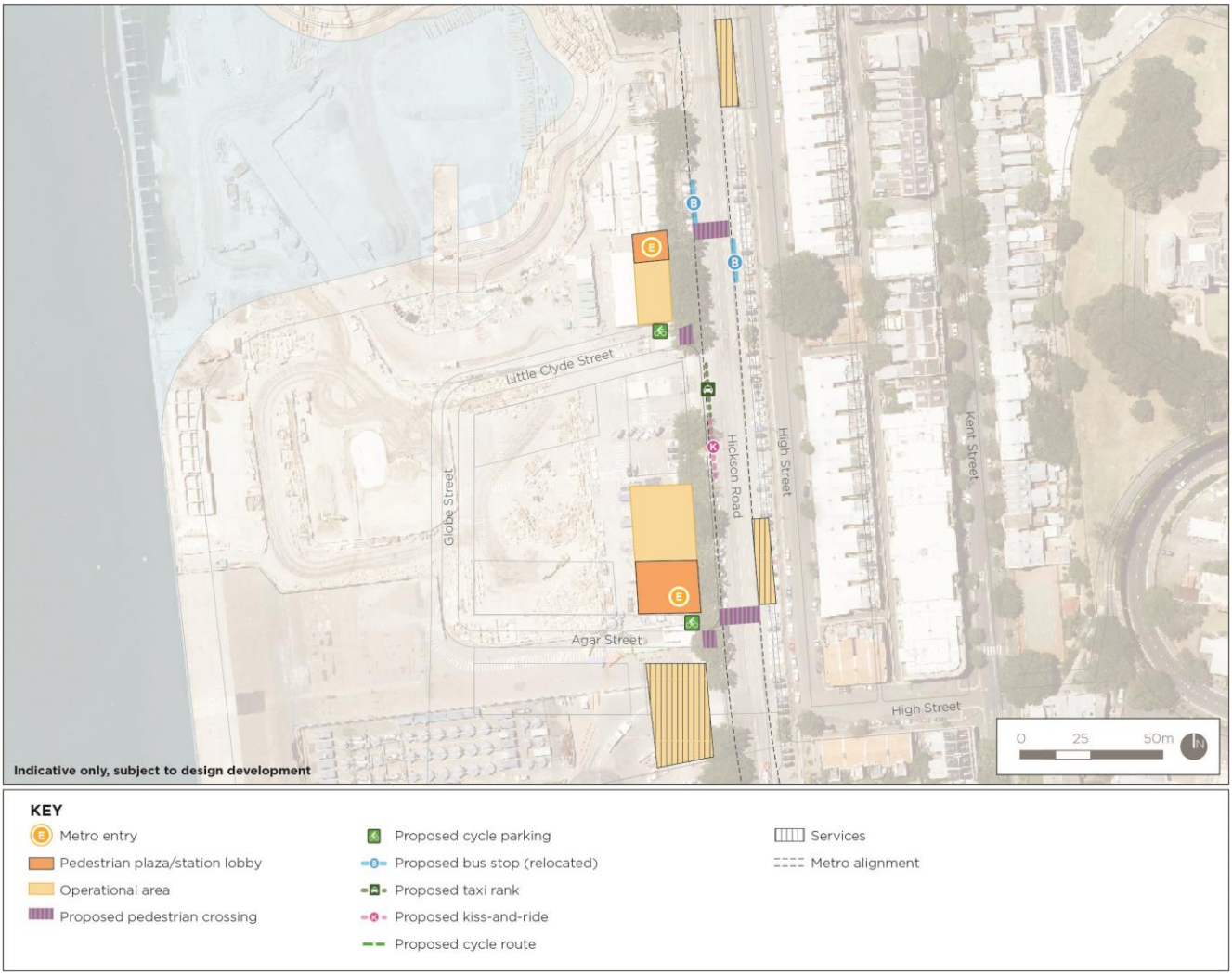


Figure 3.14 : Layout of Barangaroo Station

The Marrickville dive structure is located adjacent an existing significant lined stormwater channel. There is no anticipated interaction between surface water and groundwater at this location. SRT BH002 and BH002A have been installed at this location. The groundwater elevation in BH002 (installed into laminite/Ashfield Shale, 14 to 17 metres below ground level) is 2.8 metres AHD, equivalent to 2.5 metres below ground level. The water table elevation in BH002A (residual clay / siltstone), 1.1 to 5.6 metres below ground level) is 3.5 metres AHD, equivalent to 1.8 metres below ground level. As noted in **Section 4.1.3**, the Marrickville dive structure would be a 'drained' structure. **Figure 3.15** presents the layout of the Marrickville dive structure.

Figure 3.15 : Layout of the Marrickville dive structure

3.4 Hydrogeological investigation

3.4.1 Groundwater monitoring network

At present, there are 14 piezometers installed specifically associated with the project. These were installed for the purpose of project investigation and may be incorporated into the construction monitoring program. **Table 3.5** presents a summary of the project piezometers. Water level information is presented in **Table 3.5** and monitoring of water level is on-going via electronic logging.

Appendix E presents time-series change in water level and groundwater quality information, as available.

Groundwater levels, stratigraphy, water quality and the interpreted conceptual hydrogeological model presented below are based on publically available information, in particular the extensive borehole database generated during earlier railway projects, investigation works to inform concept planning between Chatswood and St Leonards as well as extensive historical experience of tunnel and civil construction in Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone.

Table 3.5 : Project monitoring piezometers

ID	Completed	Easting	Northing	Elevation (mAHD)	Depth (mBGL)	Screen (mBGL)	Screened Unit	SWL[a] (mBMP)	SWL[a] (mAHD)	Yield (L/s)	Salinity (mg/L)	Status	Comment
BH026	25/09/2015	331603	6258046	104.0	30.0	22.2 to 28.2	Ashfield Shale	9.2	94.8	n/a	800	Active	Chatswood dive structure
BH023	02/07/15	331693	6258112	105.5	35.1	11.5 to 14.5	Ashfield Shale	n/a	n/a	n/a	n/a	Active	Chatswood dive structure
BH020	01/05/15	332695	6256655	78.5	35.9	15.1 to 21.1	Mittagong Formation	3.9	74.6	n/a	396	Active	Artarmon
BH019	17/04/15	333308	6255819	84.4	36.1	4.0 to 7.0	Residual	2.5	81.9	n/a	495	Active	Crows Nest Station
BH018	30/04/15	333390	6255706	90.75	46.5	19.3 to 25.3	Mittagong Formation	12.9	77.8	n/a	420	Active	Crows Nest Station
BH017	12/05/15	334111	6254365	62.9	49.5	35.0 to 38.8	Hawkesbury Sandstone	19.4	43.5	n/a	435	Active	Victoria Cross Station
BH012	18/05/15	334486	6251171	24.3	49.0	25.2 to 31.2	Hawkesbury Sandstone	15.4	8.9	n/a	355	Active	Martin Place Station
BH009	06/07/15	334356	6250387	25.4	35	19.1 to 21.0	Hawkesbury Sandstone	12.4	13.0	n/a	450	Active	Pitt Street Station
BH008	17/06/15	334259	6250394	24.1	42.3	17 to 21.5	Hawkesbury Sandstone	21.4	2.7	n/a	818	Active	Pitt Street Station
BH006	02/08/15	334064	6249133	20.6	33	26.5 to 29.5	Hawkesbury Sandstone	?14.75	?5.85	n/a	220	Active	Central Station
BH404	26/06/15	333621	6247735	15.4	45.0	16.5 to 22.5	Hawkesbury Sandstone	6.1	9.2	n/a	856	Active	Waterloo Station
BH403	18/06/15	333619	6247626	15.1	45.1	16.5 to 22.5	Mittagong Formation / Hawkesbury Sandstone	4.5	10.5	n/a	522	Active	Waterloo Station
BH002A	20/04/15	331226	6246467	5.3	7.1	1.1 to 5.6	Residual	1.8	3.5	n/a	736	Active	Marrickville dive structure
BH002	21/04/15	331227	6246461	5.3	31.2	14 to 17	Ashfield Shale	2.5	2.8	n/a	402	Active	Marrickville dive structure

a. SWL is standing water level; mBMP is metres below measuring point; mAHD is metres above Australian Height Datum (equivalent to mean sea level).

3.4.2 Hydrogeological properties

Stratigraphy

As described in **Section 4.1**, the project consists of twin tunnels isolated from the groundwater environment by pre-cast segmental lining. The rail tunnels are anticipated to have an internal diameter of 6.2 metres and would transition through Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone.

Central Station, Martin Place, Barangaroo and Victoria Cross Stations would be constructed within Hawkesbury Sandstone. Waterloo Station would be constructed in Ashfield Shale or Hawkesbury Sandstone, depending on the vertical alignment option selected. Pitt Street Station would be constructed in Mittagong Formation and Hawkesbury Sandstone. Crows Nest Station would be constructed within Mittagong Formation and Hawkesbury Sandstone.

The station shafts at Central Station would intersect Mittagong Formation, residual, Quaternary alluvium (not Botany Sandbeds) and fill. The station shaft at Waterloo Station would encounter residual, aeolian sand and Hawkesbury Sandstone. Pitt Street and Martin Place station shaft would intersect Mittagong Formation, residual and fill. The Barangaroo Station shaft would intersect extensive near surface filling and then Hawkesbury Sandstone. The Victoria Cross Station is not anticipated to encounter units other than Hawkesbury Sandstone. The Crows Nest Station shaft would intersect Ashfield Shale and residual.

The Artarmon substation would be installed through Hawkesbury Sandstone.

The temporary site at Blues Point would be installed through Hawkesbury Sandstone and be backfilled following construction.

The Chatswood dive structure would be constructed in the Ashfield Shale and residual. The Marrickville dive structure would be constructed through variable depths of residual soils and then the Ashfield Shale.

Stratigraphic long-sections are presented in **Appendix B**.

Permeability

In general, the permeability of shale, siltstone and sandstone is low to very low, with the majority of groundwater flow transmitted through joints and fractures rather than matrix porosity.

Table 3.6 presents the anticipated permeability of the various hydrogeological units based on literature values.

Table 3.6 : Anticipated Hydraulic Conductivity of Hydrogeological Units

Unit	Horizontal Hydraulic Conductivity, K (m/s)	Lugeons (L/min/m at 1000kPa)	Vertical to Horizontal Anisotropy[a]	Comment
Fill	$1x10^{-5}$ to $1x10^{-7}$	100 to <1	1:1	variable
Residual Soil / Clay	$1x10^{-6}$ to $1x10^{-8}$	15 to <1	1:10	low to very low
Ashfield Shale	$1x10^{-7}$ to $1x10^{-9}$	<1	1:10 to 1:100	very low to negligible
Mittagong Formation	$1x10^{-5}$ to $1x10^{-8}$	100 to <1	1:10 to 1:100	interbedded shale and sandstone, low to very low
Hawkesbury Sandstone	$1x10^{-5}$ to $1x10^{-7}$	100 to <1	1:10 to 1:100	low to very low

a. Anisotropy is the difference in magnitude of a physical property in one direction compared to another.

As part of an earlier railway project, there was an extensive program of investigation. That program comprised boreholes as well as packer testing at selected locations. Packer tests were also conducted for the Sydney Metro project. **Table 3.7** presents the interpreted permeability, based on Lugeon Tests. Lugeon tests, or packer tests are conducted on open boreholes. It is noted that Lugeon values are significantly influenced by the presence of discontinuities in the rock matrix within the test interval. As such they do not necessarily represent the bulk permeability of a hydrogeological unit, however, can provide a useful local scale assessment. It is critical, however, whether there is hydraulic connection to significant storage, as storage within rock aquifers themselves is very low to negligible.

Storage

Storativity is the volume of water that a permeable unit will absorb or expel from storage per unit area per unit change in hydraulic head.

In a confined aquifer, the hydraulic head may decline yet the potentiometric surface remains above the top of the unit (Fetter, 1994). In this case, storativity is defined as $S = Ss * b$ where Ss is the specific storage and b is the aquifer thickness.

Specific storage, Ss, is defined as $Ss = \rho_w * g(\alpha + n * \beta)$ where ρ is density of water (~1,000kg/m^3), g is gravitational acceleration (9.806m/s^2), α is compressibility of aquifer skeleton (m^2/N), n is porosity and β is compressibility of water (4.6x10^{-10}m^2/N).

The value of storativity of confined aquifers is of the order of 0.005 or less (Fetter, 1994).

For an unconfined aquifer, the level of saturation rises and falls with changes in the amount of water in storage (Fetter, 1994). As the water level falls, groundwater is drained from connected pore spaces. In this case, storativity is defined as $S = S_y + h * S_s$ where S_y is specific yield, h is thickness of saturated zone and Ss is specific storage.

Specific yield is the drainable porosity. By way of example, clay has a high porosity, say 0.45 to 0.55, however, its specific yield is very low, normally 0.02 to 0.05. By contrast, a well sorted sand can have a porosity of 0.25 and its specific yield can be 0.20.

The storativity of unconfined aquifers ranges from 0.02 to 0.30 (Fetter, 1994).

Table 3.7 : Estimated hydraulic conductivity derived from packer testing (earlier investigations and Sydney Metro City & Southwest[a])

ID	Location	X (mMGA)	Y (mMGA)	Z (mAHD)	Test Interval (mBGL)	Unit	Lugeons (L/min/m at 1000kPa)	Hydraulic Conductivity, K (m/s)
BH003[a]	Marrickville dive	331274	62246575	5.5	12.3-19.7	Ashfield Shale	<1	<1.00E-07
BH003[a]	Marrickville dive	331274	62246575	5.5	19.5-25.65	Ashfield Shale	<1	<1.00E-07
BH003[a]	Marrickville dive	331274	62246575	5.5	25.5-33.5	Mittagong Formation	<1	<1.00E-07
BH006[a]	Marrickville dive to Central Station	334070	6249138	20.5	9.0-16.5	n/a	<1	<1.00E-07
BH006[a]	Marrickville dive to Central Station	334070	6249138	20.5	16.0-24.0	n/a	<1	<1.00E-07
BH006[a]	Marrickville dive to Central Station	334070	6249138	20.5	23.5-33.0	n/a	<1	<1.00E-07
BH007[a]	Marrickville dive to Central Station	334156	6249248	21.2	10.8-14.9	n/a	1.0	1.00E-07
BH007[a]	Marrickville dive to Central Station	334156	6249248	21.2	14.7-19.9	n/a	2.5	1E-07 to 6E-07
R246_BH2103_66	Marrickville dive to Central Station	333937	6249326	15.61	14.88-20.88	Mittagong Formation	1.8	1E-07 to 6E-07
R246_BH2103_66	Marrickville dive to Central Station	333937	6249326	15.61	20.73-26.98	Hawkesbury Sandstone	1.0	1.00E-07
R246_BH2103_66	Marrickville dive to Central Station	333937	6249326	15.61	26.53-32.78	Hawkesbury Sandstone	>100	>1E-05
R246_BH2103_66	Marrickville dive to Central Station	333937	6249326	15.61	26.53-32.78	Hawkesbury Sandstone	>100	>1E-05
R246_BH2103_65	Marrickville dive to Central Station	333959	6249381	15.23	12.00-15.80	Dolerite within Hawkesbury Sandstone	4.5	6.00E-07
R246_BH2103_65	Marrickville dive to Central Station	333959	6249381	15.23	15.30-20.40	Dolerite within Hawkesbury Sandstone	8.0	6E-07 to 2E-06

ID	Location	X (mMGA)	Y (mMGA)	Z (mAHD)	Test Interval (mBGL)	Unit	Lugeons (L/min/m at 1000kPa)	Hydraulic Conductivity, K (m/s)
R246_BH2103_65	Marrickville dive to Central Station	333959	6249381	15.23	20.10-25.93	Dolerite within Hawkesbury Sandstone	>100	>1E-05
R246_BH2103_65	Marrickville dive to Central Station	333959	6249381	15.23	25.60-32.00	Dolerite within Hawkesbury Sandstone	>100	>1E-05
R246_BH2103_65	Marrickville dive to Central Station	333959	6249381	15.23	31.70-38.00	Hawkesbury Sandstone	0.5	<1E-07
R246_BH2103_65	Marrickville dive to Central Station	333959	6249381	15.23	37.70-42.00	Hawkesbury Sandstone	3.0	1E-07 to 6E-07
R246_BH2103_64	Marrickville dive to Central Station	334004	6249400	18.62	18.00-24.00	Hawkesbury Sandstone	80.0	6E-06 to 1E-05
R246_BH2103_64	Marrickville dive to Central Station	334004	6249400	18.62	23.75-30.03	Hawkesbury Sandstone	3.0	1E-07 to 6E-07
R246_BH2103_64	Marrickville dive to Central Station	334004	6249400	18.62	29.75-36.00	Hawkesbury Sandstone	>100	>1E-05
R246_BH2103_39	Central Station to Pitt Street Station	334161	6249530	15.78	11.00-16.50	Mittagong Formation	6.8	6E-07 to 2E-06
R246_BH2103_39	Central Station to Pitt Street Station	334161	6249530	15.78	16.00-20.30	Hawkesbury Sandstone	1.8	1E-07 to 6E-07
R246_BH2103_39	Central Station to Pitt Street Station	334161	6249530	15.78	19.30-26.50	Hawkesbury Sandstone	23.0	2E-06 to 6E-06
R246_BH2103_39	Central Station to Pitt Street Station	334161	6249530	15.78	26.10-32.65	Hawkesbury Sandstone	4.5	1E-07 to 6E-07
R246_BH2103_63	Central Station to Pitt Street Station	334217	6249563	12.24	24.00-29.40	Dolerite within Hawkesbury Sandstone	3.5	1E-07 to 6E-07
R246_BH2103_63	Central Station to Pitt Street Station	334217	6249563	12.24	25.30-32.35	Dolerite within Hawkesbury Sandstone	1.0	1.00E-07
R246_BH2103_63	Central Station to Pitt Street Station	334217	6249563	12.24	31.00-35.25	Dolerite within Hawkesbury Sandstone	100.0	1.00E-05

ID	Location	X (mMGA)	Y (mMGA)	Z (mAHD)	Test Interval (mBGL)	Unit	Lugeons (L/min/m at 1000kPa)	Hydraulic Conductivity, K (m/s)
R246_BH2103_63	Central Station to Pitt Street Station	334217	6249563	12.24	35.00-41.25	Hawkesbury Sandstone	>100	>1E-05
R246_BH2103_25	Central Station to Pitt Street Station	334278	6249642	9.61	12.00-17.30	Hawkesbury Sandstone	0.8	<1E-07
R246_BH2103_25	Central Station to Pitt Street Station	334278	6249642	9.61	17.10-24.00	Hawkesbury Sandstone	20.0	2E-06 to 6E-06
R246_BH2103_25	Central Station to Pitt Street Station	334278	6249642	9.61	23.50-30.00	Hawkesbury Sandstone	5.0	6.00E-07
R246_BH2103_22	Central Station to Pitt Street Station	334323	6249843	16.44	12.00-18.00	Mittagong Formation	20.0	2E-06 to 6E-06
R246_BH2103_22	Central Station to Pitt Street Station	334323	6249843	16.44	18.00-24.00	Hawkesbury Sandstone	1.0	1.00E-07
R246_BH2103_22	Central Station to Pitt Street Station	334323	6249843	16.44	24.00-30.00	Hawkesbury Sandstone	1.0	1.00E-07
R246_BH2103_38	Pitt Street Station to Martin Place Station	334267	6250350	24.75	9.00-13.00	Mittagong Formation	4.3	1E-07 to 6E-07
R246_BH2103_38	Pitt Street Station to Martin Place Station	334267	6250350	24.75	12.75-19.00	Mittagong Formation	8.0	6E-07 to 2E-06
R246_BH2103_38	Pitt Street Station to Martin Place Station	334267	6250350	24.75	18.75-25.00	Hawkesbury Sandstone	1.1	1.00E-07
R246_BH2103_75	Pitt Street Station to Martin Place Station	334269	6250403	23.75	14.00-17.00	Mittagong Formation	0.6	<1E-07
R246_BH2103_75	Pitt Street Station to Martin Place Station	334269	6250403	23.75	16.75-20.00	Mittagong Formation	4.2	1E-07 to 6E-07
R246_BH2103_75	Pitt Street Station to Martin Place Station	334269	6250403	23.75	19.75-23.00	Hawkesbury Sandstone	2.0	1E-07 to 6E-07
R246_BH2103_75	Pitt Street Station to Martin Place Station	334269	6250403	23.75	22.75-26.00	Hawkesbury Sandstone	3.5	1E-07 to 6E-07

ID	Location	X (mMGA)	Y (mMGA)	Z (mAHD)	Test Interval (mBGL)	Unit	Lugeons (L/min/m at 1000kPa)	Hydraulic Conductivity, K (m/s)
R246_BH2103_75	Pitt Street Station to Martin Place Station	334269	6250403	23.75	25.75-29.00	Hawkesbury Sandstone	>100	>1E-05
R246_BH2103_75	Pitt Street Station to Martin Place Station	334269	6250403	23.75	28.75-32.00	Hawkesbury Sandstone	>100	>1E-05
R246_BH2103_75	Pitt Street Station to Martin Place Station	334269	6250403	23.75	31.75-37.50	Hawkesbury Sandstone	35.0	2E-06 to 6E-06
BH008[a]	Pitt Street Station to Martin Place Station	334259	6250394	24.2	9.3-13.8	Mittagong Formation	<1	<1E-07
BH008[a]	Pitt Street Station to Martin Place Station	334259	6250394	24.2	13.6-20.3	Mittagong Formation	12.2	6E-07 to 2E-06
BH008[a]	Pitt Street Station to Martin Place Station	334259	6250394	24.2	22.3-27.5	Hawkesbury Sandstone	25.2	2E-06 to 6E-06
BH009[a]	Pitt Street Station to Martin Place Station	334356	6250387	25.5	9.2-15.2	Mittagong Formation	1.4	1E-07
BH009[a]	Pitt Street Station to Martin Place Station	334356	6250387	25.5	15.0-21.2	Mittagong Formation	<1	<1E-07
BH009[a]	Pitt Street Station to Martin Place Station	334356	6250387	25.5	21.0-27.2	Hawkesbury Sandstone	7.9	6E-07 to 2E-06
BH009[a]	Pitt Street Station to Martin Place Station	334356	6250387	25.5	27.0-30.8	Hawkesbury Sandstone	18	2E-06 to 6E-06
R246_BH2103_40	Pitt Street Station to Martin Place Station	334270	6250420	23.43	22.20-28.30	Hawkesbury Sandstone	80.0	6E-06 to 1E-05
R246_BH2103_40	Pitt Street Station to Martin Place Station	334270	6250420	23.43	27.00-34.30	Hawkesbury Sandstone	13.6	6E-07 to 2E-06

ID	Location	X (mMGA)	Y (mMGA)	Z (mAHD)	Test Interval (mBGL)	Unit	Lugeons (L/min/m at 1000kPa)	Hydraulic Conductivity, K (m/s)
R246_BH2103_40	Pitt Street Station to Martin Place Station	334270	6250420	23.43	33.80-40.30	Hawkesbury Sandstone	1.3	1E-07 to 6E-07
BH010[a]	Pitt Street Station to Martin Place Station	334267	6250606	20.3	7.1-15.1	Mittagong Formation	17.6	2E-06 to 6E-06
BH010[a]	Pitt Street Station to Martin Place Station	334267	6250606	20.3	14.9-21.1	Mittagong Formation	4.1	1E-07 to 6E-07
BH010[a]	Pitt Street Station to Martin Place Station	334267	6250606	20.3	20.9-27.1	Hawkesbury Sandstone	<1	<1E-07
R246_BH2103_44	Pitt Street Station to Martin Place Station	334347	6250827	13.39	14.80-21.50	Hawkesbury Sandstone	0.0	<1E-07
R246_BH2103_44	Pitt Street Station to Martin Place Station	334347	6250827	13.39	21.00-26.95	Hawkesbury Sandstone	0.0	<1E-07
R246_BH2103_37	Pitt Street Station to Martin Place Station	334407	6250984	22.79	19.50-25.50	Hawkesbury Sandstone	<0.1	<1E-07
R246_BH2103_37	Pitt Street Station to Martin Place Station	334407	6250984	22.79	25.25-31.50	Hawkesbury Sandstone	0.8	<1E-07
R246_BH2103_37	Pitt Street Station to Martin Place Station	334407	6250984	22.79	31.25-37.50	Hawkesbury Sandstone	2.6	1E-07 to 6E-07
R246_BH2103_37	Pitt Street Station to Martin Place Station	334407	6250984	22.79	37.25-43.50	Hawkesbury Sandstone	unk	n/a
R246_BH2103_19	Pitt Street Station to Martin Place Station	334427	6251138	19.91	21.00-27.00	Hawkesbury Sandstone	2.2	1E-07 to 6E-07
R246_BH2103_19	Pitt Street Station to Martin Place Station	334427	6251138	19.91	26.70-33.00	Hawkesbury Sandstone	0.4	<1E-07
R246_BH2103_19	Pitt Street Station to Martin Place Station	334427	6251138	19.91	32.75-39.00	Hawkesbury Sandstone	1.5	1E-07 to 6E-07
R246_BH2103_19	Pitt Street Station to Martin Place Station	334427	6251138	19.91	38.70-45.00	Hawkesbury Sandstone	21.0	2E-06 to 6E-06

ID	Location	X (mMGA)	Y (mMGA)	Z (mAHD)	Test Interval (mBGL)	Unit	Lugeons (L/min/m at 1000kPa)	Hydraulic Conductivity, K (m/s)
BH012[a]	Martin Place Station to Barangaroo Station	334486	6251171	24.3	16.8-24.0	Hawkesbury Sandstone	<1	<1E-07
BH012[a]	Martin Place Station to Barangaroo Station	334486	6251171	24.3	23.8-30.0	Hawkesbury Sandstone	<1	<1E-07
BH012[a]	Martin Place Station to Barangaroo Station	334486	6251171	24.3	29.8-37.5	Hawkesbury Sandstone	<1	<1E-07
BH014[a]	Martin Place Station to Barangaroo Station	333707	6252000	2.4	20.4-27.0	Hawkesbury Sandstone	0	<1E-07
BH014[a]	Martin Place Station to Barangaroo Station	333707	6252000	2.4	26.8-34.0	Hawkesbury Sandstone	0	<1E-07
BH014[a]	Martin Place Station to Barangaroo Station	333707	6252000	2.4	33.8-42.0	Hawkesbury Sandstone	0	<1E-07
BH017[a]	Barangaroo Station to Victoria Cross Station	334111	6254365	~66	25.3-32.5	Hawkesbury Sandstone	<1	<1E-07
BH017[a]	Barangaroo Station to Victoria Cross Station	334111	6254365	~66	32.3-39.5	Hawkesbury Sandstone	<1	<1E-07
BH017[a]	Barangaroo Station to Victoria Cross Station	334111	6254365	~66	39.3-46.5	Hawkesbury Sandstone	<1	<1E-07
BH018[a]	Victoria Cross Station to Crows Nest Station	333390	6255706	~93	15.0-22.2	Mittagong Formation	<1	<1E-07
BH018[a]	Victoria Cross Station to Crows Nest Station	333390	6255706	~93	22.0-29.0	Hawkesbury Sandstone	<1	<1E-07
BH018[a]	Victoria Cross Station to Crows Nest Station	333390	6255706	~93	28.8-36.0	Hawkesbury Sandstone	<1	<1E-07
BH019[a]	Victoria Cross Station to Crows Nest Station	333308	6255819	~88	10.2-15.1	Mittagong Formation	2.4	1E-07 to 6E-07
BH019[a]	Victoria Cross Station to Crows Nest Station	333308	6255819	~88	14.9-21.1	Hawkesbury Sandstone	1.1	1E-07

ID	Location	X (mMGA)	Y (mMGA)	Z (mAHD)	Test Interval (mBGL)	Unit	Lugeons (L/min/m at 1000kPa)	Hydraulic Conductivity, K (m/s)
BH019[a]	Victoria Cross Station to Crows Nest Station	333308	6255819	~88	20.9-27.1	Hawkesbury Sandstone	<1	<1E-07
BH023[a]	Crows Nest Station to Chatswood dive	331693	6258113	~106	13.0-18.0	Ashfield Shale	<1	<1E-07
BH023[a]	Crows Nest Station to Chatswood dive	331693	6258113	~106	17.5-22.0	Ashfield Shale	<1	<1E-07
BH023[a]	Crows Nest Station to Chatswood dive	331693	6258113	~106	22.0-28.9	Ashfield Shale	3.3	1E-07 to 6E-07

The storativity of shale, siltstone and sandstone is anticipated to be low to very low and through design, groundwater ingress would be largely excluded. Whilst site specific investigation is on-going, due to the low bulk permeability and overall low storativity of the hydrogeological units likely to be encountered, it is not anticipated that project-scale testing such as pumping tests would be required. It is understood that laboratory based testing of recovered core material would inform relevant requirements for geotechnical modelling. During the reference design stage, it is anticipated that hydrogeological modelling would be undertaken, in particular, where it is intended that a permanent lining may not be required, such as at station shafts.

Table 3.8 presents the anticipated compressibility, porosity, specific storage and specific yield of the various hydrogeological units based on literature values.

Table 3.8 : Anticipated storage properties of hydrogeological units

Unit	Compressibility, α, m^2/N	Porosity, n	Specific Storage, Ss	Specific Yield, Sy	Comment
Fill	$5.2x10^{-8}$	0.25	$5x10^{-4}$	0.10 to 0.20	variable
Residual Soil / Clay	$5x10^{-7}$	0.45	$5x10^{-3}$	0.02 to 0.05	plastic clay
Ashfield Shale	$1x10^{-10}$	0.05	$1x10^{-6}$	0.005 to 0.02	very low to negligible
Mittagong Formation	$3.3x10^{-10}$	0.20	$4x10^{-6}$	0.02 to 0.07	low to very low, can be affected by joints
Hawkesbury Sandstone	$3.3x10^{-10}$	0.20	$4x10^{-6}$	0.02 to 0.07	low to very low, can be affected by joints

3.4.3 Groundwater levels

There has been extensive geotechnical investigation programs associated with earlier railway projects. Whilst piezometers were not necessarily installed, groundwater levels, and estimated elevation where drill fluid pressure was lost, were interpreted from notes in the borehole logs and are discussed below. This data is supplemented by the water level information from the project.

Groundwater level from available groundwater works is collated in **Table 3.9** below, excluding the project monitoring piezometers which are presented in **Table 3.5** above. **Figure 3.16** and Figure 3.17 present the location of water level measurements as groundwater elevation and groundwater depth to water of available groundwater works, excluding the project piezometers.

It is anticipated that the vertical hydraulic gradient would be vertically downwards at each station location, given that the stations are located on the topographic ridgeline, with the exception of Barangaroo Station. At Barangaroo, groundwater elevation within fill is 0 metres AHD (2 to 4 metres below ground level) and it is anticipated that the groundwater elevation within the Hawkesbury Sandstone would also be 0 metres AHD.

At the Marrickville dive structure, there is a shallow local water table within the residual of the Ashfield Shale at 3.5 metres AHD, due to the dive site being located adjacent a lined stormwater channel. The groundwater level within the Ashfield Shale is 2.5 metres AHD.

At the Chatswood dive structure, BH026 indicates there is approximately 10 metres of residual of Ashfield Shale. The groundwater level within the Ashfield Shale is 94.8 metres AHD, equivalent to 9.2 metres below ground level.

Table 3.9 : Collated groundwater levels (mAHD)

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
Fill / Residual												
GW110122	Marrickville dive	329500	6245833	4.4	3.5	0.5-3.5	Residual (Ashfield Shale)	2.5	1.9	unk (unk)	unk	Railway Corridor
GW109730	Marrickville dive to Central Station	332089	6247634	20.7	6.5	3.0-6.5	Residual (Ashfield Shale)	1	19.7	unk (1.0-6.5)	unk	NSW Housing Corporation
SRT_BH002A	Marrickville dive to Central Station	331226	6246467	5.30	5.6	1.1-5.6	Residual (Ashfield Shale)	1.07	3.3	unk (1.1-5.6)	404.8	
R425_BH04	Marrickville dive to Central Station	332309	6247692	18.64	8	n/a	Residual (Ashfield Shale)	4.6	14.04	unk (unk)	unk	Borehole; Macdonaldtown Gasworks
R425_BH02	Marrickville dive to Central Station			18.81	8	n/a	Residual (Ashfield Shale)	3.5	15.31	unk (unk)	unk	Borehole; Macdonaldtown Gasworks
R187_BH2	Marrickville dive to Central Station	332560	6247969	25.17	6	n/a	Residual (Ashfield Shale)	3	22.17	unk (unk)	unk	Borehole; North Eveleigh Development
R187_BH12	Marrickville dive to Central Station	332895	6248117	24.8	7.5	n/a	Residual (Ashfield Shale)	dry	n/a	n/a	n/a	Borehole; North Eveleigh Development
R187_BH19B	Marrickville dive to Central Station	333209	6248264	25.6	6	n/a	Residual (Ashfield Shale)	dry	n/a	n/a	n/a	Borehole; North Eveleigh Development
R256_NSR96	Marrickville dive to Central Station	333810	6248700	32.1	4.5	n/a	Residual (Ashfield Shale)	3	29.1	unk (unk)	unk	Borehole; New Southern Railway
R246_BH2103_66	Marrickville dive to Central Station	333937	6249326	15.61	3.2	n/a	Residual (Mittagong Formation)	dry?	n/a	n/a	n/a	Borehole;
R246_BH2103_41	Marrickville dive to Central Station	334019	6249370	19.79	8.4	n/a	Residual (Mittagong Formation)	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_39	Central Station to Pitt Street Station	334161	6249530	15.78	8.5	n/a	Residual (Mittagong Formation)	dry	n/a	n/a	n/a	Borehole;
R063_ES109	Central Station to Pitt Street Station	334312	6249443	13.47	8.2	n/a	Fill	2.4	11.07	unk (unk)	unk	Borehole; Eastern Suburbs Railway Line

56

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
R246_BH2103_63	Central Station to Pitt Street Station	334217	6249563	12.24	12.2	n/a	Fill / Residual (Mittagong Formation)	unk	unk	Partial Drill Fluid Loss from 11.4mBGL	unk	Borehole;
R246_BH2103_25	Central Station to Pitt Street Station	334278	6249642	9.61	7.2	n/a	Residual (Mittagong Formation)	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_22	Central Station to Pitt Street Station	334323	6249843	16.44	2.1	n/a	Fill	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_21	Central Station to Pitt Street Station	334260	6250192	21.44	4.2	n/a	Fill	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_38	Pitt Street Station to Martin Place Station	334267	6250350	24.75	5.7	n/a	Residual (Mittagong Formation)	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_40	Pitt Street Station to Martin Place Station	334270	6250420	23.43	6.1	n/a	Residual (Mittagong Formation)	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_44	Pitt Street Station to Martin Place Station	334347	6250827	13.39	1	n/a	Residual (Mittagong Formation)	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_37	Pitt Street Station to Martin Place Station	334407	6250984	22.79	1	n/a	Residual (Mittagong Formation)	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_19	Pitt Street Station to Martin Place Station	334427	6251138	19.91	3	n/a	Fill	dry	n/a	n/a	n/a	Borehole;
R246_BH2103_36	Martin Place Station to Barangaroo Station	334057	6251359	20.84	0.5	n/a	Fill	unk	unk	unk	unk	Borehole;
R246_BH2103_12	Martin Place Station to Barangaroo Station	333870	6251406	15.91	2.4	n/a	Fill	dry	n/a	n/a	unk	Borehole;
R382_GS19	Martin Place Station to Barangaroo Station	333791	6251710	2.6	4	n/a	Fill	3	-0.4	unk	unk	Borehole; Hickson Road
R060_BH042	Martin Place Station to Barangaroo Station	333729	6251757	2.24	7	n/a	Fill / Residual (Hawkesbury Sandstone)	2.5	-0.26	unk	unk	Borehole; Barangaroo
R060_BH147	Martin Place Station to Barangaroo Station	333712	6251933	2.65	9.2	n/a	Fill / Residual (Hawkesbury Sandstone)	3.8	-1.15	unk	unk	Borehole; Barangaroo

57

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
R060_BH029	Martin Place Station to Barangaroo Station	333709	6251984	2.55	9.5	n/a	Fill / Residual (Hawkesbury Sandstone)	2.5	0.05	unk	unk	Borehole; Barangaroo
R060_BH034	Martin Place Station to Barangaroo Station	333680	6252069	2.55	3.2	n/a	Fill / Residual (Hawkesbury Sandstone)	2.5	0.05	unk	unk	Borehole; Barangaroo
R382_GS2	Barangaroo Station to Victoria Cross Station	333773	6252278	2.5	6	n/a	Fill	2.9	-0.4	unk	unk	Borehole; Hickson Road
R271_BH1	Victoria Cross Station to Crows Nest Station	334034	6254455	70	3.4	n/a	Fill / Residual (Hawkesbury Sandstone)	dry	n/a	unk	unk	Borehole; 177PacificHwy
R397_BH5	Victoria Cross Station to Crows Nest Station	334170	6254452	64.9	3.1	n/a	Fill / Residual (Hawkesbury Sandstone)	dry	n/a	unk	unk	Borehole; CnrDenisonBerry
R271_BH3	Victoria Cross Station to Crows Nest Station	334038	6254483	69.5	1.5	n/a	Residual (Hawkesbury Sandstone)	dry	n/a	unk	unk	Borehole; 177PacificHwy
R397_BH4	Victoria Cross Station to Crows Nest Station	334172	6254470	65.95	3.4	n/a	Fill / Residual (Hawkesbury Sandstone)	dry	n/a	unk	unk	Borehole; CnrDenisonBerry
R272_BH10	Victoria Cross Station to Crows Nest Station	334111	6254524	69.7	2.3	n/a	Fill / Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; MonteStAngelo
R272_BH9	Victoria Cross Station to Crows Nest Station	334111	6254540	70.3	1.85	n/a	Fill / Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; MonteStAngelo
R271_BH3	Victoria Cross Station to Crows Nest Station	334114	6254660	76.6	5.4	n/a	Fill / Residual (Ashfield Shale)	dry	n/a	unk	unk	Borehole; 177PacificHwy(Site3)
R371_BH12	Victoria Cross Station to Crows Nest Station	334336	6254747	75.3	1.8	n/a	Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; CrowsNest-NorthSyd-Cammeray
R371_BH13	Victoria Cross Station to Crows Nest Station	334199	6254981	84.7	4.1	n/a	Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; CrowsNest-NorthSyd-Cammeray
R371_BH08	Victoria Cross Station to Crows Nest Station	333970	6255101	86.7	4.15	n/a	Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; CrowsNest-NorthSyd-Cammeray
R371_BH07	Victoria Cross Station to Crows Nest Station	334007	6255360	83.5	4.5	n/a	Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; CrowsNest-NorthSyd-Cammeray

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
R427_BH1	Victoria Cross Station to Crows Nest Station	333185	6255523	74.25	3	n/a	Residual (Mittagong Formation)	dry?	n/a	unk	unk	Borehole; 1ChristieSt
R427_BH2	Victoria Cross Station to Crows Nest Station	333160	6255523	75.2	2	n/a	Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; 1ChristieSt
SRT_BH019	Crows Nest Station to Chatswood dive	333308	6255819	84.43	7	4-7	Residual (Ashfield Shale)	1.44	82.99	unk (4.0-7.0)	272.3	
R277_BH2	Crows Nest Station to Chatswood dive	333289	6255935	85.3	1.6	n/a	Residual (Ashfield Shale)	unk	unk	unk	unk	Borehole; 88 Christie St
R277_BH1	Crows Nest Station to Chatswood dive	333181	6255944	91.3	2.5	n/a	Residual (Ashfield Shale)	dry	n/a	unk	unk	Borehole; 88 Christie St
R421_CSL-BH02	Crows Nest Station to Chatswood dive	332872	6256283	74.9	2.8	n/a	Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; ChatswoodToStLeonards
R281_BH8	Crows Nest Station to Chatswood dive	332917	6256324	75.4	6	n/a	Fill	dry	n/a	unk	unk	Borehole; St Leonards Station
R281_BH3	Crows Nest Station to Chatswood dive	332912	6256356	75.9	7	n/a	Fill / Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; St Leonards Station
R281_BH5	Crows Nest Station to Chatswood dive	332875	6256405	73.2	5.3	n/a	Fill / Residual (Mittagong Formation)	dry	n/a	unk	unk	Borehole; St Leonards Station
Ashfield Shale												
GW109824	Marrickville dive	331393	6245635	7.6	20.7	13.4-18.4	Ashfield Shale	4.51	3.09	unk (13.0-20.0)	4350	Alexandria Landfill
GW109825	Marrickville dive	331689	6245853	11.6	22	16.0-22.0	Ashfield Shale	14.9	-3.3	unk (17.5-22.0)	1800	Alexandria Landfill
GW109821	Marrickville dive	331819	6245899	9.7	35	29.0-35.0	Ashfield Shale	14.5	-4.8	unk (29.0-35.0)	4400	Alexandria Landfill
SRT_BH002	Marrickville dive to Central Station	331227	6246461	5.30	17	14-17	Ashfield Shale	2.94	2.36	unk (14-17)	221	

59

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
R186_D14	Marrickville dive to Central Station	333247	6248164	21.7	30	n/a	Ashfield Shale	7.2	14.5	unk (unk)	unk	Borehole; Transgrid Cable Tunnel
R186_D13	Marrickville dive to Central Station	333184	6248352	28.1	36	n/a	Ashfield Shale	13.5	14.6	unk (unk)	unk	Borehole; Transgrid Cable Tunnel
R186_D10	Marrickville dive to Central Station	333326	6248499	25	43.6	n/a	Ashfield Shale	10.7	14.3	unk (unk)	unk	Borehole; Transgrid Cable Tunnel
R256_NSR95	Marrickville dive to Central Station	333846	6248750	27.6	8.55	n/a	Ashfield Shale	7	20.6	unk (unk)	unk	Borehole; New Southern Railway
SRT_BH018	Crows Nest Station to Chatswood dive	333390	6255706	90.75	25.3	19.3-25.3	Ashfield Shale	10.35	80.40	unk (19.3-25.3)	231	
R277_BH2	Crows Nest Station to Chatswood dive	333289	6255935	85.3	16	n/a	Ashfield Shale	6.6	78.7	unk	unk	
R277_BH1	Crows Nest Station to Chatswood dive	333181	6255944	91.3	14.85	n/a	Ashfield Shale	unk	unk	Full Return to 14.85mBGL	unk	
SRT_BH026	Crows Nest Station to Chatswood dive	331603.3	6258046	104	28.2	22.2-28.2	Ashfield Shale	7.05	96.95	unk (22.2-28.2)	440	Chatswood Ausgrid Depot
Mittagong Formation												
R246_BH2103_66	Marrickville dive to Central Station	333937	6249326	15.61	14.6	n/a	Mittagong Formation	unk	unk	unk	unk	
R246_BH2103_65	Marrickville dive to Central Station	333959	6249381	15.23	8.5?	n/a	Mittagong Formation	6.8	8.43	unk (unk)	unk	Borehole;
R246_BH2103_41	Marrickville dive to Central Station	334019	6249370	19.79	8.4	n/a	Mittagong Formation	unk	unk	unk	unk	
R246_BH2103_39	Central Station to Pitt Street Station	334161	6249530	15.78	4.88	n/a	Mittagong Formation	unk	unk	Partial Drill Fluid Loss from 10.9mBGL	unk	
R063_ES164	Central Station to Pitt Street Station	334312	6249507	12.41	21.3	n/a	Mittagong Formation	9.75	2.66	unk (unk)	unk	Borehole; Eastern Suburbs Railway Line

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
R246_BH2103_63	Central Station to Pitt Street Station	334217	6249563	12.24	18	n/a	Mittagong Formation	unk	unk	unk (unk)	unk	
R246_BH2103_25	Central Station to Pitt Street Station	334278	6249642	9.61	9	n/a	Mittagong Formation	unk	unk	unk	unk	
R246_BH2103_22	Central Station to Pitt Street Station	334323	6249843	16.44	14	n/a	Mittagong Formation	13.2	3.24	Partial Drill Fluid Loss from 12.0mBGL; Full Drill Fluid Loss from 13.5mBGL	unk	
R324_PB_BH11	Central Station to Pitt Street Station	334469	6250138	30	4.1	n/a	Mittagong Formation	dry	n/a	n/a	n/a	Borehole; Museum Station
R246_BH2103_21	Central Station to Pitt Street Station	334260	6250192	21.44	16.44	n/a	Mittagong Formation	13.8	7.64	Full Drill Fluid Return to 34.85mBGL	unk	
R246_BH2103_38	Pitt Street Station to Martin Place Station	334267	6250350	24.75	20	n/a	Mittagong Formation	13.6	11.15	unk	unk	
R246_BH2103_40	Pitt Street Station to Martin Place Station	334270	6250420	23.43	15.8?	n/a	Mittagong Formation	14	9.43	Partial Drill Fluid Loss from 14.5mBGL	unk	
R063_ES126	Pitt Street Station to Martin Place Station	334231	6250666	19.51	20.04	n/a	Mittagong Formation	7.3	12.21	unk (unk)	unk	Borehole; Eastern Suburbs Railway Line
R246_BH2103_44	Pitt Street Station to Martin Place Station	334347	6250827	13.39	10?	n/a	Mittagong Formation	unk	unk	Full Return	unk	
R246_BH2103_37	Pitt Street Station to Martin Place Station	334407	6250984	22.79	6?	n/a	Mittagong Formation	unk	unk	unk	unk	
R246_BH2103_19	Pitt Street Station to Martin Place Station	334427	6251138	19.91	5?	n/a	Mittagong Formation	unk	unk	Full Return	unk	
R371_BH13	Victoria Cross Station to Crows Nest Station	334199	6254981	84.7	8	n/a	Mittagong Formation	dry	n/a	unk	unk	Borehole; CrowsNest-NorthSyd-Cammeray
R427_BH1	Victoria Cross Station to Crows Nest Station	333185	6255523	74.25	7.9	3.0-7.5	Mittagong Formation	3.15	71.1	unk	unk	Piezometer; 1ChristieSt

61

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
R421_CSL-BH01	Crows Nest Station to Chatswood dive	332827	6256316	75.8	30.45	24.0-30.0	Mittagong Formation	dry	n/a	unk	unk	Piezometer; ChatswoodToStLeonards
SRT_BH020	Crows Nest Station to Chatswood dive	332695	6256655	78.50	21.1	15.1-21.1	Mittagong Formation	3.4	75.10	unk (15.1-21.1)	217.8	
R421_CSL-BH06	Crows Nest Station to Chatswood dive	332782	6256692	73.8	25	n/a	Mittagong Formation	dry	n/a	unk	Unk	Borehole; ChatswoodToStLeonards
R421_CSL-BH09	Crows Nest Station to Chatswood dive	332807	6256896	76.2	15	9.0-15.0	Mittagong Formation	dry	n/a	unk	unk	Piezometer; ChatswoodToStLeonards
Hawkesbury Sandstone												
GW110351	Marrickville dive to Central Station	332651	6247224	12.5	60	unk	unk (Quaternary Sand/Hawkesbury Sandstone)	25	-12.5	1 (unk)	unk	Well; Erskineville Oval
GW110247	Marrickville dive to Central Station	332357	6248363	41.3	210	open hole <41.7	Hawkesbury Sandstone	unk	unk	0.05 (22.0-23.0)	3750	Well; Moore Theological College
								unk	unk	0.10 (74.0-76.0)	3300	
								31	10.3	0.13 (188.0-188.5)	4400	
SRT_BH403	Marrickville dive to Central Station	333619	6247626	15.03	22.5	16.5-22.5	Hawkesbury Sandstone	3.05	11.98	unk (16.5-22.5)	287.1	Waterloo Station
SRT_BH404	Marrickville dive to Central Station	333621	6247735	15.3	22.5	16.5-22.5	Hawkesbury Sandstone	4.22	11.08	unk (16.5-22.5)	470.8	Waterloo Station
R246_BH2103_66	Marrickville dive to Central Station	333937	6249326	15.61	35	n/a	Hawkesbury Sandstone	16.23	-0.62	Full Drill Fluid Loss from 16.6mBGL	unk	
R246_BH2103_65	Marrickville dive to Central Station	333959	6249381	15.23	42		Hawkesbury Sandstone	unk	unk	unk (unk)	unk	
SRT_BH006	Marrickville dive to Central Station	334064	6249133	20.60	29.5	26.5-29.5	Hawkesbury Sandstone	17.75	2.85	unk (26.5-29.5)	121	

62

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
R246_BH2103_41	Marrickville dive to Central Station	334019	6249370	19.79	8.4	n/a	Hawkesbury Sandstone	unk	unk	Partial Drill Fluid Loss from 35.2mBGL; Full Drill Fluid Loss from 36.8mBGL	unk	
R246_BH2103_64	Marrickville dive to Central Station	334004	6249400	18.62	36	n/a	Hawkesbury Sandstone	19.2	-0.58	Full Drill Fluid Loss from 21.6mBGL	unk	Borehole;
R246_BH2103_39	Central Station to Pitt Street Station	334161	6249530	15.78	35.32	n/a	Hawkesbury Sandstone	18.2	-2.42	Full Drill Fluid Loss from 20.8mBGL	unk	
R246_BH2103_63	Central Station to Pitt Street Station	334217	6249563	12.24	45.63	n/a	Hawkesbury Sandstone / Dolerite	unk	unk	Partial Drill Fluid Loss (90%) from 25mBGL (corresponding with Dolerite)	Unk	
R246_BH2103_25	Central Station to Pitt Street Station	334278	6249642	9.61	35.1	n/a	Hawkesbury Sandstone	unk	unk	Partial Drill Fluid Loss from 17.3mBGL; Full Drill Fluid Loss from 19.3mBGL	unk	
R246_BH2103_22	Central Station to Pitt Street Station	334323	6249843	16.44	35.07	n/a	Hawkesbury Sandstone	unk	unk	Full Drill Fluid Loss from 13.5mBGL	unk	
R246_BH2103_21	Central Station to Pitt Street Station	334260	6250192	21.44	34.85	n/a	Hawkesbury Sandstone	unk	unk	Full Drill Fluid Return to 34.85mBGL	unk	
R246_BH2103_38	Pitt Street Station to Martin Place Station	334267	6250350	24.75	34.95	n/a	Hawkesbury Sandstone	unk	unk	Full Drill Fluid Return to 34.95mBGL	unk	
SRT_BH009	Pitt Street Station to Martin Place Station	334356	6250387	25.40	21	18-21	Hawkesbury Sandstone	11.26	14.14	unk (18-21)	247.5	
SRT_BH008	Pitt Street Station to Martin Place Station	334259	6250394	23.80	21.5	17-21.5	Hawkesbury Sandstone	19.04	4.76	unk (17-21.5)	449.9	
R246_BH2103_40	Pitt Street Station to Martin Place Station	334270	6250420	23.43	45.12	n/a	Hawkesbury Sandstone	24	-0.57	Full Drill Fluid Loss from 22.8mBGL	unk	

63

ID	Location	X mMGA	Y mMGA	Z mAHD	Depth mBGL	Screen mBGL	Screened Unit	SWL mBMP	SWL mAHD	Yield (L/s) (water bearing zone)	Salinity mg/L	Comment
R246_BH2103_44	Pitt Street Station to Martin Place Station	334347	6250827	13.39	35	n/a	Hawkesbury Sandstone	unk	unk	Partial Drill Fluid Loss from 15.5mBGL	unk	
R246_BH2103_37	Pitt Street Station to Martin Place Station	334407	6250984	22.79	45	n/a	Hawkesbury Sandstone	unk	unk	Full Return	unk	
R246_BH2103_19	Pitt Street Station to Martin Place Station	334427	6251138	19.91	51	n/a	Hawkesbury Sandstone	unk	unk	Full Return	unk	
SRT_BH012	Pitt Street Station to Martin Place Station	334486	6251171	23.91	31.2	25.2-31.2	Hawkesbury Sandstone	14.45	9.46	unk (25.2-31.2)	195.3	
R246_BH2103_36	Martin Place Station to Barangaroo Station	334057	6251359	20.84	56.97	n/a	Hawkesbury Sandstone	unk	unk	Full Drill Fluid Loss from 10.6mBGL	unk	
R246_BH2103_12	Martin Place Station to Barangaroo Station	333870	6251406	15.91	50	n/a	Hawkesbury Sandstone	unk	unk	Full Return to 50mBGL	unk	
GW072478	Crows Nest Station to Chatswood dive	332277	6256317	97	180.5	open hole <5.4?	Ashfield Shale, Mittagong Formation, Hawkesbury Sandstone	48	49	0.2 (at 29.7 to 30.1)	230	Well; Domestic
										0.3 (at 138.0 to 139.3)	270	
										0.2 (at 143.8 to 144.5)	270	
SRT_BH017	Crows Nest Station to Chatswood dive	334111	6254365	62.90	39.8	35-39.8	Hawkesbury Sandstone	16.25	46.65	unk (35.0-39.8)	239.3	
GW108224	Crows Nest Station to Chatswood dive	333214	6256404	70.5	132.4	open hole <71.6?	Hawkesbury Sandstone	35	35.5	0.1 (at 29.0 to 35.0)	1750	Well; Domestic
										0.2 (at 98.0 to 100.0)	970	

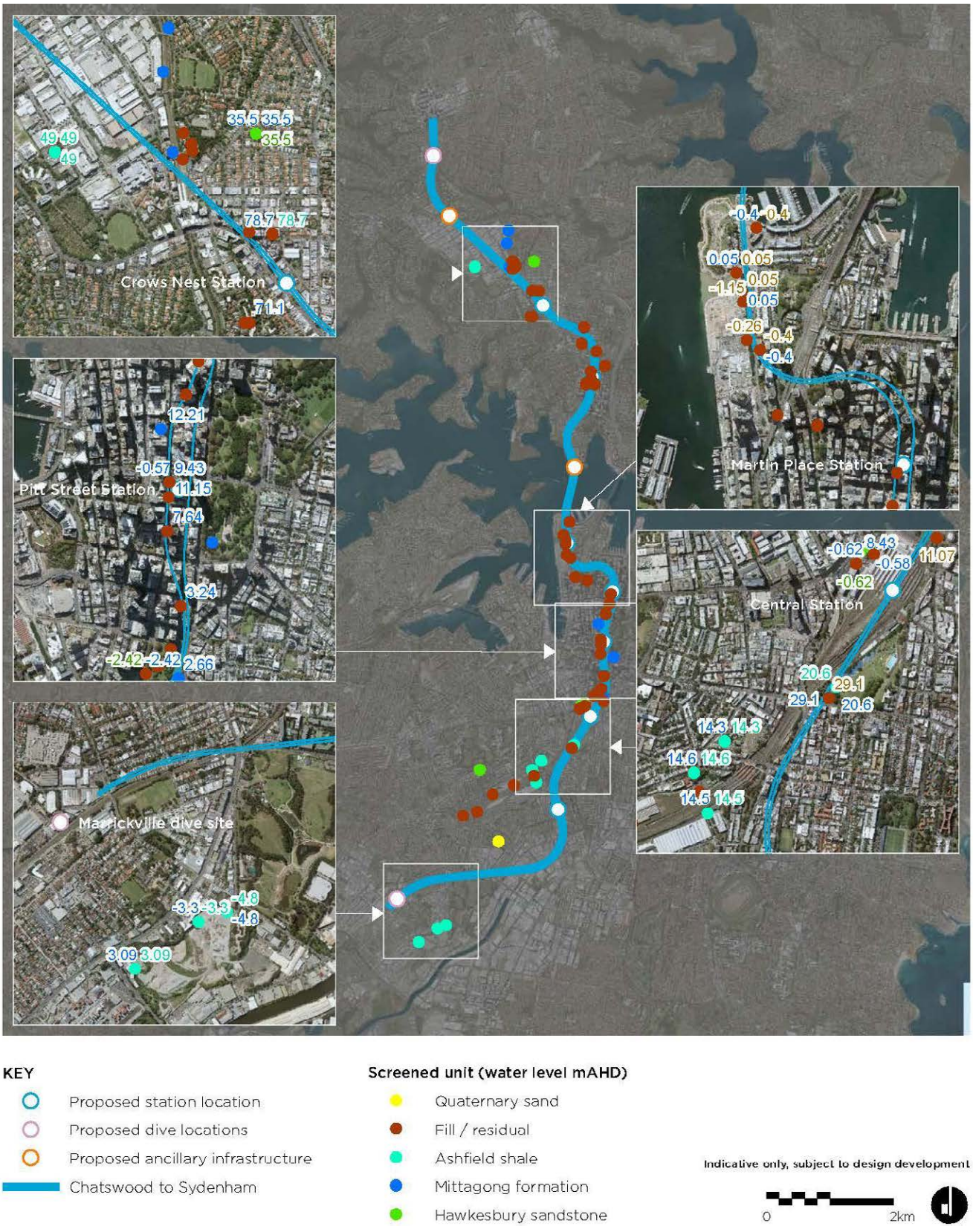


Figure 3.16 : Groundwater elevations

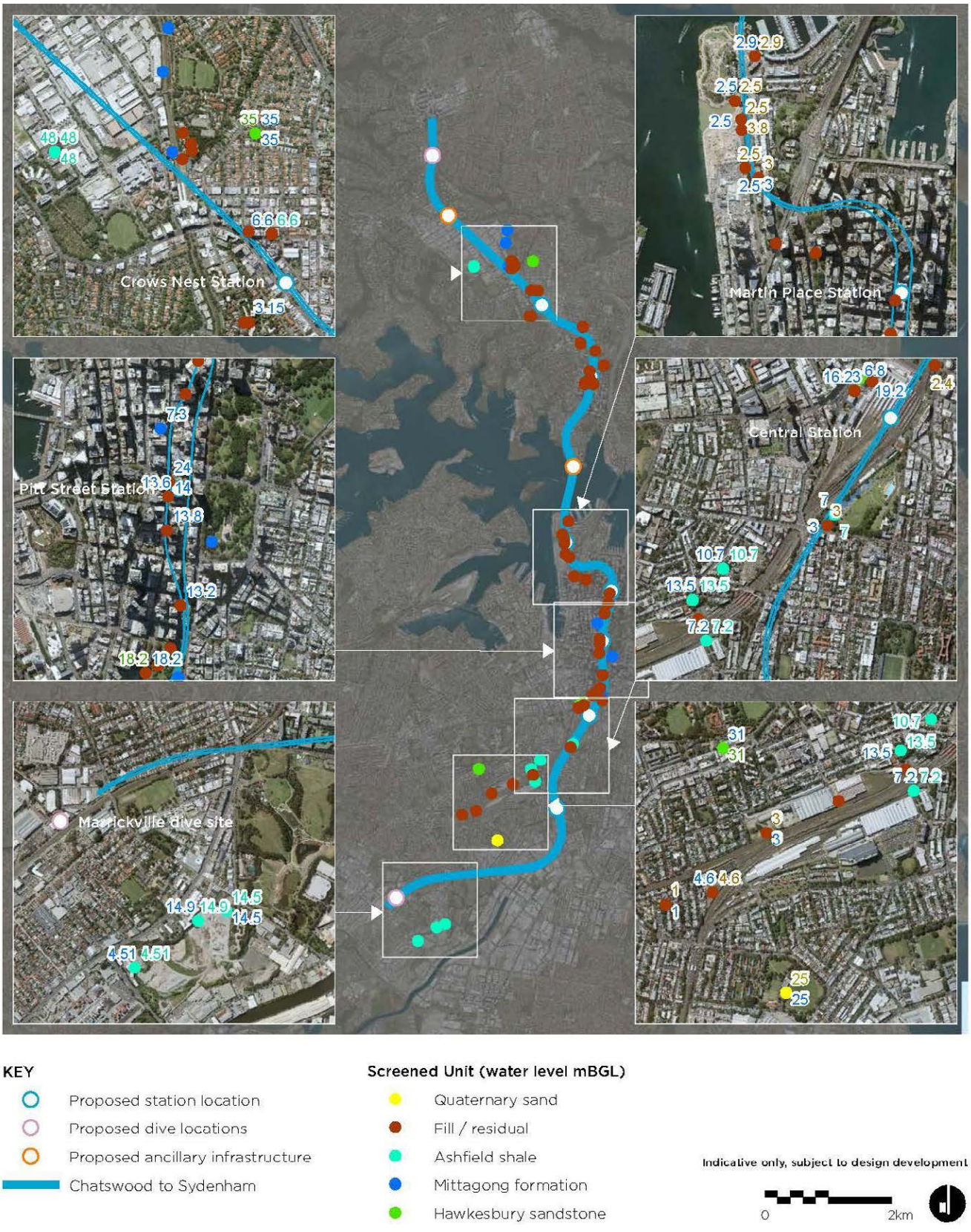


Figure 3.17 : Depth to groundwater

Fill / Residual

Review of the PINNEENA database, where shallow monitoring piezometers were installed, primarily for contamination investigations at distance from the project alignment, indicates that the shallow local water table in residual soils, where present, may be encountered at around 2 to 5 metres below ground level.

Ashfield Shale

From review of the geotechnical data compendium from the information provided by Transport for NSW, groundwater level within the Ashfield Shale was encountered between around 4.5 to 15 metres below ground level.

At the Marrickville dive structure the groundwater elevation is approximately 3 metres AHD.

In the vicinity of the existing surface station at Redfern (**Table 3.9**), groundwater elevation is 14 to 15 metres AHD (7 to 13 metres below ground level). At the northern end of project, a water level observation was obtained north of the Crows Nest Station and was 78.7 metres AHD (6.6 metres below ground level).

At the Chatswood dive structure the groundwater elevation is 94.8 metres AHD (9.2 metres below ground level).

Mittagong Formation

From the geotechnical data compendium, where the Mittagong Formation was not dry, the observed / reported groundwater level was 3 to 14 metres below ground level. From **Table 3.9** in the vicinity of Central Station, this was equivalent to a groundwater elevation of 3 to 8 metres AHD. Between Pitt Street and Martin Place, groundwater elevation ranges from 7 to 12 metres AHD. At the northern end of the project, a single observation near to the Crows Nest Station is 71.7 metres AHD (3.2 metres below ground level). A piezometer, CSL-BH01, installed in the vicinity of the existing St Leonards Station, with screened interval 29 to 32 metres below ground level, is reported as being dry.

Hawkesbury Sandstone

Available groundwater observations indicate groundwater level in Hawkesbury Sandstone is encountered between 15 and 30 metres below ground level.

Within the Sydney CBD, the groundwater elevation of the Hawkesbury Sandstone ranges between 0 and 15 metres AHD (BH012 at Martin Place Station is 8.9 metres AHD, equivalent to 15.4 metres below ground level; BH008 at Pitt Street Station is 2.7 metres AHD, equivalent to 21.4 metres below ground level and BH009 is 13 metres AHD, equivalent to 12.4 metres below ground level; BH006 at Central Station is 5.9 metres AHD, equivalent to 14.75 metres below ground level).

3.4.4 Groundwater extraction

Review of the NSW Office of Water PINNEENA database indicates there is limited groundwater extraction being carried out in the vicinity of the project. This is primarily due to the low yield and variable quality obtained from the Mittagong Formation and Hawkesbury Sandstone. The yield of the Ashfield Shale is even lower, with higher salinity.

The project resides within the Sydney Central Basin Groundwater Source. At the commencement of the Water Sharing Plan, the share components of access licences for this groundwater source were as follows:

- domestic and stock licences, 0 shares (megalitres per year)
- local water utility, 0 shares (megalitres per year)
- major utility access licences, 0 shares (megalitres per year)
- aquifer access licences, 2,592 shares (megalitres per year).

From the NSW Water Register, for the water year 2014/2015, July 2014 to June 2015, the total number of Water Access Licences (WALs) was 150, with a total share component of 2925.5 megalitres. There was no share component allocated to domestic and stock water use. The range in individual share component of aquifer access licences is 0.5 megalitres per year to 274 megalitres per year.

A search was carried out of the Register of Water Approvals, with respect to the groundwater works identified. Of the groundwater works identified, four hold approval as Basic Rights and therefore do not need a Water Access Licence. The anticipated take, as a basic right, is minor and is presumably less than one megalitre per year. There are two works that hold Water Access Licences, with both of these works being in the Botany Sands Groundwater Source. The remaining groundwater works do not hold a Water Supply Work Approval and therefore are assumed to be inactive and not taking groundwater.

Table 3.10 presents the groundwater works identified from the database and their Licence Types, Water Approvals status and estimated extraction.

Table 3.10 : Status of Water Works Approvals in the vicinity of the project

Location	GW ID	Lot / DP	Licence Type	Works Approval No.	Work Type	WAL No.	Estimated Extraction (ML/y)
Chatswood Oval	GW107757	7119/93907	Water Supply Work, Inactive	N/A	Bore	N/A	N/A
Chatswood Oval	GW029731	7119/93907	Water Supply Work, Inactive	N/A	Bore	N/A	N/A
St Leonards TAFE	GW072478	101/1075748	Basic Rights (Domestic), Inactive	N/A	Bore	N/A	N/A
Private Well near St Leonards Station	GW108224	1/306386	Basic Rights (Domestic)	10WA109080	Bore	N/A	<1ML/y
Shore School	GW107764	1/229912	Basic Rights (Domestic)	10WA109154	Collector System	N/A	<1ML/y
Redfern Park	GW071907	1/135313	Water Supply Work	10WA114785	Bore	24616	12ML/y[1]
Private Spear near Waterloo Station	GW106192	8/248162	Basic Rights (Domestic)	10WA113750	Spearpoint	N/A	<1ML/y[1]
Industrial Water Supply	GW017342	100/1152506	Water Supply Work, Inactive	N/A	Bore	N/A	N/A
Industrial Water Supply	GW017684	101/1152506	Water Supply Work, Inactive	N/A	Bore	N/A	N/A
Erskenville Oval	GW110351	10/1163738	Water Supply Work	10WA114781	Bore	24599	10ML/y[1]
Private Spear in Alexandria	GW111164	1/797656	Basic Rights (Domestic)	10WA114125	Spearpoint	N/A	<1ML/y[1]

1. licensed in Botany Sands Groundwater Source.

3.4.5 Groundwater quality

Field sampling of groundwater quality has been carried out on available monitoring piezometers. These data are discussed with respect to hydrogeologic unit and is presented below. If a monitoring piezometer was installed into residual, then that data was grouped with respect to the parent unit.

General information provided by Transport for NSW describes groundwater quality in the Sydney area, that flows into existing underground structures, as generally high in iron, may contain manganese, other contaminants, has a relatively high salinity (as total dissolved salts) and a slightly acidic pH. Information provided by Transport for NSW indicates typical parameters from existing tunnel projects are as follows:

- Energy Australia Cable Tunnel: iron 110 milligrams per litre; total dissolved solids 10,000 milligrams per litre; pH 5.9
- Sydney Harbour Tunnel: iron 40 milligrams per litre
- Epping to Chatswood Railway: iron 90 milligrams per litre; total dissolved solids 1,300 milligrams per litre average to 6,000 milligrams per litre; pH 5.9
- Cross City Tunnel: iron 50 milligrams per litre.

Information provided by Transport for NSW summaries the potential treatment issues of groundwater likely to be encountered for Sydney Metro and this is replicated in **Table 3.11** below.

Table 3.11 : Anticipated groundwater treatment issues (after information provided by Transport for NSW)

Issue	Comment	Treatment Strategy	Perceived Risk Sandstone	Shale
Water salinity	The receiving environment for the Sydenham Water Treatment Plant is into stormwater channel which discharges into the lower Cooks River. As this is a marine environment, there is no requirement for further reduction in total dissolved solids on the treated groundwater	Reverse osmosis is not required	No	No
Dissolved iron	Oxidisation at drainage system leads to accumulation of precipitates and clogging / staining	Typically removed by oxidising the ferric ion to ferrous which enables precipitation and physical removal	Yes	Yes (minor)
Turbidity	Water too turbid for discharge to creeks	Settling / filters	Yes	Yes (minor)
Iron reducing bacteria	Combine with oxidised iron at drainage points to produce sludge; durability issues	Biocide dosing	Yes	No

Ashfield Shale

Ashfield Shale is typically brackish (1,000 to 20,000 milligrams per litre as total dissolved solids) and neutral pH. These characteristics reflect its depositional history in a low energy marine environment.

Available analytes are presented in **Table 3.12**, together with ANZECC (2000) default water quality trigger criteria for the protection of aquatic ecosystems (both freshwater and marine, 95th percentile).

During operation, following treatment, groundwater would be discharged to the Cooks River via the stormwater network adjacent the Marrickville dive structure. During construction, local, temporary water treatment plants would treat captured water to meet the discharge requirements of an environment protection licence issued to the project.

From **Table 3.12**, salinity ranges between 269 and 493 milligrams per litre as total dissolved solids and pH ranges between 4.93 and 5.13. Groundwater quality obtained for the Ashfield Shale is significantly fresher than expected and presumably reflects leaching of all available connate salts from the formation. Connate salts are salts associated with the depositional environment and are liberated through water-rock interaction.

Table 3.12 : Groundwater quality results – Ashfield Shale

Parameters	Units	ANZECC (2000) guidelines: Freshwater aquatic ecosystems[a]	ANZECC (2000) guidelines: Marine aquatic ecosystems[b]	BH023	BH026	BH002A residual	BH002
				Chatswood dive structure		Marrickville dive structure	
General Parameters							
pH (field)	pH units	6.5 – 8.0[d]	8.0 – 8.4[e]	n/a	5.13	4.93	5.00
Conductivity	µS/cm	125-2200[d]	–	n/a	800	402	736
Temperature	°C	–	–	n/a	19.7	20.9	20.8
Dissolved oxygen	% sat	85-110[d]	90 – 110[e]	n/a	1.31 mg/L	1.02 mg/L	1.25 mg/L
Total Dissolved Solids	mg/L	–	–	n/a	536	269	493
Redox	mV	–	–	n/a	-5	140	75

(a) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: 95th% protection levels (trigger values).

(b) ANZECC (2000) guidelines for the protection of marine water aquatic ecosystems: 95th% protection levels (trigger values).

(c) assuming a conversion factor of 0.67 x EC (uS/cm) = TDS (mg/L)

(d) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: trigger values for lowland rivers in south-east Australia.

(e) ANZECC (2000) guidelines for the protection of marine aquatic ecosystems: trigger values for marine environments in south-east Australia.

ID indicates insufficient data for trigger value to be established.

Mittagong Formation

Water quality is anticipated to range between fresh (<1,000 milligrams per litre as total dissolved solids) to brackish (1,000 to 20,000 milligrams per litre as total dissolved solids) with neutral pH, reflecting the depositional history that led to interbedded shale and medium-grained quartz sandstone.

Table 3.13 presents groundwater quality data obtained from project piezometers, as available.

Table 3.13 : Groundwater quality results – Mittagong Formation

Parameters	Units	ANZECC (2000) guidelines: Freshwater aquatic ecosystems[a]	ANZECC (2000) guidelines: Marine aquatic ecosystems[b]	BH020	BH019 residual	BH018	BH403
				Artarmon	Crows Nest Station	Crows Nest Station	Waterloo Station
General Parameters							
pH (field)	pH units	6.5 – 8.0[d]	8.0 – 8.4[e]	5.08	5.15	5.62	4.71
Conductivity	µS/cm	125-2200[d]	–	396	495	420	522
Temperature	^{o}C	–	–	20.1	19.7	20.1	20.1
Dissolved oxygen	% sat	85-110[d]	90 – 110[e]	1.33 mg/L	1.04 mg/L	1.31 mg/L	1.29 mg/L
Total Dissolved Solids	mg/L	–	–	265	332	281	350
Redox	mV	–	–	-8	45	-33	69

(a) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: 95th% protection levels (trigger values).

(b) ANZECC (2000) guidelines for the protection of marine water aquatic ecosystems: 95th% protection levels (trigger values).

(c) assuming a conversion factor of 0.67 x EC (uS/cm) = TDS (mg/L)

(d) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: trigger values for lowland rivers in south-east Australia.

(e) ANZECC (2000) guidelines for the protection of marine aquatic ecosystems: trigger values for marine environments in south-east Australia.

ID indicates insufficient data for trigger value to be established.

From **Table 3.13**, salinity is 265 to 350 milligrams per litre as total dissolved solids and pH ranges between 4.71 and 5.62. Groundwater quality obtained for the Mittagong Formation is fresher than is expected and pH is slightly more acidic.

Hawkesbury Sandstone

Table 3.14 presents groundwater quality data obtained from project piezometers, as available.

Elevated concentrations of iron are typically experienced in the Hawkesbury Sandstone, leading to red-brown staining of exposed seepage faces. This is due to oxidation of iron in groundwater that was previously in an anoxic or reduced redox state. Manganese can also be elevated in the Hawkesbury Sandstone.

From **Table 3.14**, reported salinity in the Hawkesbury Sandstone ranges between 147 and 574 milligrams per litre as total dissolved solids. pH is slightly acidic to near-neutral and ranges between 5.21 and 6.82. Groundwater quality obtained for the Hawkesbury Sandstone is fresher than is expected.

Table 3.14 : Groundwater quality results – Hawkesbury Sandstone

Parameters	Units	ANZECC (2000) guidelines: Freshwater aquatic ecosystems[a]	ANZECC (2000) guidelines: Marine aquatic ecosystems[b]	BH017	BH012	BH008	BH009	BH006	BH404
				Victoria Cross Station	Martin Place Station	Pitt Street Station	Pitt Street Station	Central Station	Waterloo Station
General Parameters									
pH (field)	pH units	6.5 – 8.0[d]	8.0 – 8.4[e]	5.21	5.24	5.49	5.43	6.82	5.25
Conductivity	µS/cm	125-2200[d]	–	435	355	818	450	220	856
Temperature	°C	–	–	20.4	20.1	21.4	21.4	19.3	19.7
Dissolved oxygen	% sat	85-110[d]	90 – 110[e]	1.01 mg/L	1.36 mg/L	1.22 mg/L	1.30 mg/L	0.78 mg/L	1.34 mg/L
Total Dissolved Solids	mg/L	–	–	291	238	548	302	147	574
Redox	mV	–	–	-2	15	-12	18	-19	66

(a) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: 95th% protection levels (trigger values).

(b) ANZECC (2000) guidelines for the protection of marine water aquatic ecosystems: 95th% protection levels (trigger values).

(c) assuming a conversion factor of 0.67 x EC (uS/cm) = TDS (mg/L)

(d) ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems: trigger values for lowland rivers in south-east Australia.

(e) ANZECC (2000) guidelines for the protection of marine aquatic ecosystems: trigger values for marine environments in south-east Australia.

ID indicates insufficient data for trigger value to be established.

Beneficial use classes

Beneficial use classes are defined in the NSW Groundwater Quality Protection Policy (DLWC, 1998) based on ANZECC/ARMCANZ (1995). For groundwater, in the vicinity of the project, relevant classes include Ecosystem Protection (both freshwater and marine).

ANZECC/ARMCANZ (2000) presents default water quality trigger criteria for freshwater and marine ecosystems. The adopted level of protection is subject to the status of the ecosystem; however, compliance with the discharge criteria in an environment protection licence issued to the project for construction water discharge, and a 90th percentile protection level for operational water discharge are appropriate targets without site specific investigation. It is highlighted that both freshwater and marine water quality guidelines may be relevant, dependent on whether groundwater is discharging to the harbour or local water course, as well as whether the local water course is influenced by the tide.

Groundwater naturally contains higher concentration of some trace ions such as zinc, iron and manganese. Elevated concentrations of these analytes does not necessary indicate prior impact to water quality and site specific trigger values should be developed for use as baseline data in the management plans when they are prepared.

3.4.6 Groundwater yield

Information provided by Transport for NSW presents a summary of measured inflows collated for Sydney tunnels and that dataset is replicated in **Table 3.15** below. These inflow rates were obtained from 'drained' structures. As noted in information provided by Transport for NSW, experience in Sydney is that long term inflow into 'drained' tunnels is one litre per second per kilometre.

Information provided by Transport for NSW describes the approach in older rail tunnels and stations in Sydney as being 'drained' structures. Groundwater collected from these assets is discharged to stormwater. Information provided by Transport for NSW highlighted that this is permitted due to the age of these assets, reflecting a previous period where such practices were accepted. Information provided by Transport for NSW note that Airport Line also discharges to stormwater but is supplemented by a small water treatment plant at International Station to address leachate that occurs in certain lengths of the rail tunnels. Treated water from the International Station is discharged to the Cooks River. At Epping to Chatswood Rail Line, information provided by Transport for NSW, note that it is a predominantly 'drained' structure, however, uses a centralised groundwater treatment plant, primarily to remove iron.

Table 3.15 : Measured onflows in Sydney tunnels (after information provided by Transport for NSW)

Project	Type	Length (km)	Span / Diameter (m)	Maximum Rock Cover (m)	Dominant Rock Type	Measured Inflow (L/s/km)
Northside storage	Water	20	6	90	Hawkesbury Sandstone	0.9
Epping to Chatswood Rail Line	Rail	13	7.2 (twin)	60	Hawkesbury Sandstone	0.9
M5 East	Road	3.9	8 (twin)	4 to 60	Hawkesbury Sandstone	0.8
Eastern Distributor	Road	1.7	12 (double deck)	40	Hawkesbury Sandstone	1
MetroGrid	Electrical	3.5	2	10 to 40	Narrabeen Group	0.8
Cross City Tunnel	Road	2.1	8 (twin)	53	Hawkesbury Sandstone	<3
Lane Cove Tunnel	Road	3.6	9 (twin)	60	Hawkesbury Sandstone	<3

3.5 Conceptual hydrogeological model

The project comprises rail tunnels constructed through Wianamatta group (Ashfield Shale), Mittagong Formation and Hawkesbury Sandstone via tunnel boring machines incorporating pre-cast segmental lining as the tunnel progresses. As such, groundwater encountered within the rock units would be, in a practical sense, excluded.

The groundwater level within these rock units is anticipated to range between 10 to 30 metres below ground level along the alignment of the project. Local shallow water table within residual soils is anticipated at 2 to 5 metres below ground level, with the top of the underlying rock formations potentially being unsaturated. Accordingly, it is anticipated that both the shallow water table within the residual soils, where present, and rock units would be unconfined.

Residual soils are recharged by rainfall and percolation from irrigation of residential gardens and open spaces, as well as incidental runoff from impervious surfaces. When exposed at surface, it is anticipated that there is direct recharge of the rock aquifers, with transmission primarily through contacts and joints and secondarily through the matrix. Recharge to the rock aquifers elsewhere is by downward percolation through the residual soil or fill via an unsaturated zone in some instances.

Groundwater yield in both rock aquifers and residual soils is anticipated to be low to very low. Typical inflows of water supply works screened in the Mittagong Formation and Hawkesbury Sandstone identified in the review of the PINNEENA database are in the order of 0.1 to 0.3 litres per second. The anticipated groundwater yield in Ashfield Shale is very low to negligible, likely to be less than 0.01 litres per second.

It is anticipated that groundwater inflow to rail tunnels would be negligible by design and that inflow to cross-passages and mined station caverns would also be negligible due to these structures being 'tanked'. The Artarmon substation is assumed to be a 'tanked' structure. Station shafts would be 'drained' structures, with the exception of Barangaroo Station and Waterloo Station which will be 'tanked'. The Chatswood dive structure and Marrickville dive structure would also be 'drained'. Anticipated inflows are presented in **Section 4**.

The NSW Office of Water's objectives for groundwater management in NSW are expressed in the Aquifer Interference Policy (NSW Office of Water, 2012). Groundwater extraction from all aquifers, including hard rock aquifers, must be properly accounted for and managed to their highest environmental value or beneficial use.

Groundwater quality is usually brackish in the Ashfield Shale, with salinity ranging between 2,000 to 20,000 milligrams per litre as total dissolved solids, near-neutral pH and water type being sodium-chloride or sodium-chloride-sulphate. Groundwater sampling indicates that the Ashfield Shale along the alignment of the project is fresher than expected and slightly more acidic.

Groundwater quality within the Mittagong Formation and Hawkesbury Sandstone is usually fresh to brackish, with salinity ranging from <1,000 to 10,000 milligrams per litre as total dissolved solids, near-neutral pH and water type being sodium-chloride or sodium-chloride-bicarbonate. Groundwater sampling indicates the Mittagong Formation and Hawkesbury Sandstone along the alignment of the project is fresher than expected and also slightly more acidic. The concentration of trace ions in the Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone is naturally low, with slightly elevated iron and manganese being associated with the Hawkesbury Sandstone. The concentration of dissolved metals and nutrients in the Ashfield Shale, Mittagong Formation or Hawkesbury Sandstone, including residual soils, is naturally very low. Organic compounds are not associated with Ashfield Shale, Mittagong Formation or Hawkesbury Sandstone, unless occurring via anthropogenic (man-made) sources.

During the harbour crossing, it is anticipated that groundwater pressure would be elevated at the deepest section and the definition design for the harbour crossing has taken this into account. The harbour crossing would be 'tanked' and therefore groundwater inflow would be negligible, by design.

The geological long section in **Appendix B** presents the conceptual model, diagrammatically, with respect to the various aspects and components of the project.

4. Hydrogeological analysis

This chapter presents the target changes to groundwater level, flow and groundwater quality as a result of the Sydney Metro Chatswood to Sydenham project.

The design approach for the project is being finalised, therefore target changes are provided. Target changes, where required, would be updated to predicted changes during finalisation of the reference design. It is highlighted that there is a comprehensive risk-based management process for the project with respect to subsidence and the expected contribution of drawdown to subsidence in hard rock is minor to negligible.

4.1 Project infrastructure elements with groundwater interface

Aspects of the project design relevant to this Groundwater Assessment are presented below.

This deep underground portion of the Sydney Metro project involves construction of tunnels and caverns almost entirely in rock. This component of the Sydney Metro would be designed to minimise ground movements for critical infrastructure to within tolerable limits, with instrumentation and monitoring plan implemented to validate the design and ensure the integrity of existing assets is maintained.

Table 4.1 presents a summary of the approach to various project elements with each aspect discussed in greater detail below.

Table 4.1 : Groundwater related project infrastructure configuration

Element	Construction Method / Typology	Groundwater Management Approach
Rail Tunnels		
Rail Tunnels	Tunnel Boring Machine (TBM)	'Tanked'
Cross-Passages and Sumps		
Cross-Passages	Road Header and Rock Breaker	'Tanked'
Sumps	Road Header and Rock Breaker	'Tanked'
Dive Structures		
Chatswood dive structure	Bored Pile Wall with Capping Beam	'Drained'
Marrickville dive structure	Bored Pile Wall with Capping Beam	'Drained'
Underground Stations		
Crows Nest Station	Cut and Cover	'Drained'
Victoria Cross Station	Mined Cavern	'Tanked'
Barangaroo Station	Cut and Cover	'Tanked'
Martin Place Station	Mined Cavern	'Tanked'
Pitt St Station	Mined Cavern	'Tanked'
Central Station	Cut and Cover	'Drained'
Waterloo Station	Cut and Cover	'Tanked'
Station Shafts		
Crows Nest Station	Road Header, Rock Breaker and blasting	'Drained'
Victoria Cross Station	Road Header, Rock Breaker and blasting	'Drained'
Barangaroo Station	Road Header, Rock Breaker and blasting	'Tanked'
Martin Place Station	Road Header, Rock Breaker and blasting	'Drained'
Pitt St Station	Road Header, Rock Breaker and blasting	'Drained'

Element	Construction Method / Typology	Groundwater Management Approach
Central Station	Road Header, Rock Breaker and blasting	'Drained'
Waterloo Station	Road Header, Rock Breaker and blasting	'Tanked'
Service Facilities		
Artarmon substation	Rock Breaker	'Tanked'

4.1.1 Rail tunnels

Rail tunnels would be excavated using tunnel boring machines (TBMs) to form circular profiles that would be supported using a pre-cast concrete segmental lining that would aid in preventing groundwater inflow into the tunnel. Double shield tunnel boring machines would be used for the majority of the rail tunnels. A dedicated slurry type tunnel boring machine has been assumed for the harbour crossing. Pre-cast segmental lining can be made essentially watertight through the provision of compression gaskets, if required. As presented in information provided by Transport for NSW, these gaskets circumscribe the tunnel segments, with connectors between tunnel segments needed to compress the gaskets during construction. It is noted that these are an additional component to the segmental lining and would be anticipated to be deployed where needed.

4.1.2 Cross-passages and sumps

Road headers and rock breakers would be used to construct cross-passages. It is anticipated that some groundwater inflow would occur during the construction of the cross-passages, but once cross-passages are constructed, incorporating permanent lining, then groundwater inflow is anticipated to be negligible.

There are sumps that would also be included, at appropriate intervals, within the rail tunnels. These would serve as contingency storage in the circumstance of a fire hydrant malfunction and / or operation. These sumps can also serve as storage for groundwater ingress during construction of cross-passages.

A formed shallow drain associated with the track configuration would transmit surface flow within the tunnels to these sumps. Surface works at tunnel entrances and at other points of access would be designed to prevent any ingress of stormwater to the tunnel system.

4.1.3 Dive structures

Information provided by Transport for NSW indicates that both the Chatswood dive structure and the Marrickville dive structure would likely consist of a bored pile wall with capping beam and base slab on ground. Subject to ground conditions, the portal face may be stabilised using methods such as shotcrete and fibreglass rock bolts, with anchor soldier piles to retain poorer surface material.

The Chatswood site and Marrickville dive structures would be 'drained'. The water table elevation within the residual Ashfield Shale at the Chatswood dive structure is not known, however, monitoring indicates the groundwater elevation within the Ashfield Shale immediately underlying the residual is 94.8 metres AHD, equivalent to 9.2 metres below ground level and implies the residual Ashfield Shale may be dry. Monitoring indicates the water table at the Marrickville dive structure is 3.5 metres AHD within residual derived from Ashfield Shale.

Accordingly, the expected inflow into both the dive structures is anticipated to be minor to negligible.

4.1.4 Underground stations

Underground stations (at rail level) would either be cut and cover structures or mined caverns. The station platforms (at rail level) would consist of either a central island or binocular arrangement.

Table 4.1 presents a summary of the intended station typology and approach to management of groundwater at each of the underground stations.

During construction, local water treatment plants are likely to be deployed at each site, as required. During operation, groundwater collected at station locations would be transmitted to a centralised water treatment plant. The water treatment plant would be located adjacent the Marrickville dive structure.

Due to the permeability of the Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone, the expected inflow into the underground stations where they are 'drained' and is anticipated to be minor and negligible where the design approach for underground stations is 'tanked'.

4.1.5 Station shafts

Station shafts (access from rail level to ground surface) would generally be 'drained' structures. An exception is Barangaroo and Waterloo which would be 'tanked' with respect to all elements.

Due to the permeability of the Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone, the expected inflow into station shafts is anticipated to be minor, subject to the proposed method of construction, to be finalised during the reference design.

4.1.6 Operational ancillary facilities

It is assumed that the Artarmon substation would be constructed as a 'tanked' structure and accordingly groundwater inflow would be negligible.

4.1.7 Blues Point temporary site

At Blues Point, a temporary site for the extraction of TBM cutter heads, would be required. Following completion of construction, the access point would be backfilled and restored. Accordingly, it is assumed that this temporary structure would be 'drained' and groundwater inflow would be minor.

4.2 Target change to groundwater levels

4.2.1 Methodology

Site specific investigation is on-going; however, a review of available data has provided information on which to establish target impacts to groundwater level.

4.2.2 Target change

There is limited to negligible anticipated change to groundwater level associated with the rail tunnels. Cross-passages and underground stations that are to be 'tanked' are similarly anticipated to lead to negligible change to groundwater level.

There is potential for off-site impact at station shafts, where they are 'drained', and at underground stations that are to be 'drained' and the anticipated changes to groundwater level are presented below. There is no anticipated change at the Artarmon substation shaft due to these being assumed to be 'tanked'. It is anticipated that there may be changes to groundwater level at the Blues Point temporary site during the construction period only.

Detailed numerical modelling is recommended to be undertaken during reference design with respect to impacts to groundwater level at Barangaroo Station and the Blues Point temporary site given their proximity to Sydney Harbour.

Surrounding land uses

Table 4.2 presents a summary of the target change to groundwater levels at surrounding land uses with respect to the various components of the project. Construction related changes are also encompassed in **Table 4.2**. For the purpose of presentation, the provided target change is assumed to be applied perpendicularly, immediately outside (less than or equal to one metre) of the station shaft, ventilation shaft and / or portal. The intent of setting the target immediately outside (less than or equal to one metre) of the various components of the project is to accommodate the circumstance where the project component lies immediately adjacent other land uses. Where this is not the case, the target location is less than or equal to one metre, perpendicularly, from the site boundary, or as otherwise agreed.

As already noted, there is a comprehensive risk-based management process for subsidence and the contribution of drawdown to subsidence in rock is minor to negligible. Accordingly the target changes presented in **Table 4.2** are expected to be superseded by subsidence assessment.

Table 4.2 : Target change to groundwater level at surrounding land uses

Location	Anticipated Design	Surrounding Land Use	Hydrogeological Unit	Current GWL	Target Change (m)[1]
Chatswood dive structure	Piled Retained Wall, 'Drained'	Commercial and Residential	Residual, if present	2 to 5mBGL, if present	<0.5m (residential in the vicinity)
Chatswood dive structure	Piled Retained Wall, 'Drained'	Commercial and Residential	Ashfield Shale	9.2mBGL 94.8mAHD	<2m (residential in the vicinity)
Chatswood dive structure	Rail Tunnels with Segmental Lining	Commercial	Ashfield Shale	9.2mBGL 94.8mAHD	<4m (assuming deep foundations), else <2m
Artarmon substation	Assumed 'Tanked' Services Shaft	Residential	Residual, if present	Dry	<0.5m (residential in the vicinity)
Artarmon substation	Assumed 'Tanked' Services Shaft	Residential	Ashfield Shale	~70mAHD	<1m (residential in the vicinity)
Artarmon substation	Assumed 'Tanked' Services Shaft	Residential	Mittagong Formation	Unknown	<1m (residential in the vicinity)
Artarmon substation	Assumed 'Tanked' Services Shaft	Residential	Hawkesbury Sandstone	~50mAHD	<2m (residential in the vicinity)
Crows Nest Station	'Drained' Station Shaft	Commercial	Residual	2.5mBGL 81.9mAHD	<1m
Crows Nest Station	'Drained' Station Shaft	Commercial	Ashfield Shale	6 to 8mBGL	<2m
Crows Nest Station	'Drained' Station Shaft	Commercial	Mittagong Formation	12.9mBGL 77.8mAHD	<2m
Crows Nest Station	'Drained' Cut and Cover Station	Commercial	Mittagong Formation	12.9mBGL 77.8mAHD	<2m

Location	Anticipated Design	Surrounding Land Use	Hydrogeological Unit	Current GWL	Target Change (m)[1]
Crows Nest Station	Rail Tunnels with Segmental Lining	Commercial	Hawkesbury Sandstone	20mBGL	<4m
Victoria Cross Station	'Drained' Station Shaft	High-rise Commercial	Residual, if present	Dry	<1m
Victoria Cross Station	'Drained' Station Shaft	High-rise Commercial	Hawkesbury Sandstone	19.4mBGL 43.5mAHD	<4m (assuming deep foundations), else <2m
Victoria Cross Station	'Tanked' Mined Cavern Station	High-rise Commercial	Hawkesbury Sandstone	19.4mBGL 43.5mAHD	<4m (assuming deep foundations), else <2m
Victoria Cross Station	Rail Tunnels with Segmental Lining	High-rise Commercial	Hawkesbury Sandstone	19.4mBGL 43.5mAHD	<4m (assuming deep foundations), else <2m
Blues Point temporary site	'Drained' Services Shaft during construction and would be backfilled following construction.	Residential	Residual, if present	Dry	<1m (residential in the vicinity but elevated compared to the site)
Blues Point temporary site	'Drained' Services Shaft during construction and would be backfilled following construction.	Residential	Hawkesbury Sandstone	1.7mBGL 0.3mAHD	<2m (residential in the vicinity)
Harbour Crossing	Rail Tunnels with Segmental Lining, and compression gaskets, if required	N/A	Harbour Sediments / Hawkesbury Sandstone	0mAHD	N/A (no change presented since, by design, groundwater inflow must be negligible)
Barangaroo Station	'Tanked' Station Shaft	Residential and Commercial	Fill / Residual	0 to 2mAHD	<1m (residential in the vicinity but at distance)
Barangaroo Station	'Tanked' Station Shaft	Residential and Commercial	Hawkesbury Sandstone	0 to 2mAHD	<2m (residential in the vicinity)
Barangaroo Station	'Tanked' Cut and Cover Station	Residential and Commercial	Hawkesbury Sandstone	0 to 2mAHD	<2m (residential in the vicinity)
Barangaroo Station	Rail Tunnels with Segmental Lining	Residential and Commercial	Hawkesbury Sandstone	0 to 2mAHD	<2m (residential in the vicinity)
Martin Place Station	'Drained' Station Shaft	High-rise Commercial	Fill / Residual, if present	Dry?	<1m
Martin Place Station	'Drained' Station Shaft	High-rise Commercial	Hawkesbury Sandstone	15.4mBGL 8.9mAHD	<4m (assuming deep foundations), else <2m
Martin Place Station	'Tanked' Mined Cavern Station	High-rise Commercial	Hawkesbury Sandstone	15.4mBGL 8.9mAHD	<4m (assuming deep foundations), else <2m
Martin Place Station	Rail Tunnels with Segmental Lining	High-rise Commercial	Hawkesbury Sandstone	15.4mBGL 8.9mAHD	<4m (assuming deep foundations), else <2m
Pitt Street Station	'Drained' Station Shaft	High-rise Commercial	Fill / Residual	Dry?	<1m
Pitt Street Station	'Drained' Station Shaft	High-rise Commercial	Mittagong Formation	3 to 8mBGL	<2m

Location	Anticipated Design	Surrounding Land Use	Hydrogeological Unit	Current GWL	Target Change (m)[1]
Pitt Street Station	'Drained' Station Shaft	High-rise Commercial	Hawkesbury Sandstone	12 to 21mBGL 2.7 to 13mAHD	<4m (assuming deep foundations), else <2m
Pitt Street Station	'Tanked' Mined Cavern Station	High-rise Commercial	Hawkesbury Sandstone	12 to 21mBGL 2.7 to 13mAHD	<4m (assuming deep foundations), else <2m
Pitt Street Station	Rail Tunnels with Segmental Lining	High-rise Commercial	Hawkesbury Sandstone	12 to 21mBGL 2.7 to 13mAHD	<4m (assuming deep foundations), else <2m
Central Station	'Drained' Station Shaft	Residential, Commercial and Industrial	Fill / Residual, if present	2 to 5mBGL, if present	<1m (residential in the vicinity but at distance)
Central Station	'Drained' Station Shaft	Residential, Commercial and Industrial	Mittagong Formation	3 to 8mAHD	<2m (residential in the vicinity)
Central Station	'Drained' Station Shaft	Residential, Commercial and Industrial	Hawkesbury Sandstone	14.8mBGL 5.9mAHD	<2m (residential in the vicinity)
Central Station	'Drained' Cut and Cover Station	Residential, Commercial and Industrial	Hawkesbury Sandstone	14.8mBGL 5.9mAHD	<2m (residential in the vicinity)
Central Station	Rail Tunnels with Segmental Lining	Residential, Commercial and Industrial	Hawkesbury Sandstone	14.8mBGL 5.9mAHD	<2m (residential in the vicinity)
Waterloo Station	'Tanked' Station Shaft	Residential	Fill / Aeolian Sand	2 to 5mBGL, if present	<0.5m (residential in the vicinity)
Waterloo Station	'Tanked' Station Shaft	Residential	Mittagong Formation	4.5mBGL 10.5mAHD	<2m (residential in the vicinity)
Waterloo Station	'Tanked' Station Shaft	Residential	Hawkesbury Sandstone	6.1mBGL 9.2mAHD	<2m (residential in the vicinity)
Waterloo Station	'Tanked' Cut and Cover Station	Residential	Mittagong Formation / Hawkesbury Sandstone	4.5mBGL 10.5mAHD	<2m (residential in the vicinity)
Waterloo Station	Rail Tunnels with Segmental Lining	Residential	Hawkesbury Sandstone	6.1mBGL 9.2mAHD	<2m (residential in the vicinity)
Marrickville dive structure	Piled Retained Wall, 'Drained'	Commercial and Industrial	Fill / Residual, if present	1.8mBGL 3.5mAHD	<0.5m (due to stormwater channel)
Marrickville dive structure	Piled Retained Wall, 'Drained'	Commercial and Industrial	Ashfield Shale	2.5mBGL 2.8mAHD	<2m (due to stormwater channel)

1. Target changes need to take typical climatic variation into account.

Groundwater Dependent Ecosystems

As identified above, there are no high priority groundwater dependent ecosystems listed in the Water Sharing Plan in the vicinity of the project with respect to the Sydney Basin Central Groundwater Source. There is, however, a high priority groundwater dependent ecosystem within the Botany Sands Groundwater Source.

Groundwater users

Groundwater users in the vicinity of the project are of sufficient distance (both horizontally and vertically) that there is no anticipated change in groundwater level at any water supply work.

4.3 Target change to groundwater flow

Information provided by Transport for NSW presents some potential groundwater inflow limits for the Sydney Metro. These are replicated below in **Table 4.3**. The limits presented in **Table 4.3** reflect the groundwater seepage criteria established for the Epping to Chatswood Rail Line for cavern structures and for the Sydney Metro Northwest for rail tunnels, nozzle enlargements and crossover caverns.

Table 4.3 : Potential groundwater inflow limits for Sydney Metro (after information provided by Transport for NSW)

	Drained	Tanked
Stations / Shafts / Caverns	0.75L/s per 10,000m^2 of excavated area (equivalent to 270mL per hour per m^2)[a]	Minimum: 2.0 mL per hour per m^2 of concrete lining surfaces[b] Maximum: 5.0 mL per hour per m^2 of concrete lining surfaces for any 10m length[b]
Rail Tunnels and Cross-Passages	N/A, as would be 'Tanked'	Minimum: 2.0 mL per hour per m^2 of concrete lining surfaces[a] Maximum: 5.0 mL per hour per m^2 of concrete lining surfaces for any 10m length[a]

a. Performance criteria for groundwater seepage for cavern structures (after information provided by Transport for NSW); b. Groundwater seepage criteria for the Sydney Metro Northwest for rail tunnels, nozzle enlargements and crossover caverns (after information provided by Transport for NSW).

Information provided by Transport for NSW has estimated inflows assuming 'drained' conditions for all project elements. These estimates are summarised in **Table 4.4**, however, it is noted that inflows, post-construction, would be less, since the majority of the project is 'tanked'.

Table 4.4 : Estimated groundwater inflows for Sydney Metro (after information provided by Transport for NSW)

Station	Prediction Inflow (L/s) Empirical prediction assuming 'drained' conditions for all project elements
Crows Nest Station	0.12
Victoria Cross Station	0.78
Barangaroo Station	2.86
Martin Place Station	1.97
Pitt Street Station	2.86
Central Station	0.03[a]
Waterloo Station	2.86
Tunnels and cross passages	0.319
Total (L/s)	11.8

a. Information provided by Transport for NSW noted that the inflow estimate at Central Station does not take into account existing seepage inflows at Central Station.

It is expected that inflows presented in **Table 4.4** are indicative of construction related dewatering estimates (after initial works). Following construction, it is expected that inflows would be less, since the majority of the project is 'tanked'.

For the purpose of contingency, the estimated inflow rate at Pitt Street Station of 3 litres per second (100 megalitres per year) could be used as a contingency limit for construction related dewatering at each underground station site.

4.4 Target change to groundwater quality

During construction, collected groundwater would be treated at temporary water treatment plants at tunnel boring machine support sites and it is likely that temporary water treatment plant would be deployed at the location of each underground station and service facility. During construction, groundwater inflows would be treated to meet the requirements of an environmental protection licence issued to the project.

During operation, groundwater collected from 'drained' station shafts and cut-and-cover stations would be transmitted to a centralised water treatment plant prior to disposal to stormwater. For operation, the project would be designed to achieve a maximum water discharge quality equivalent to the 90th percent protection level specified for freshwater ecosystems in accordance with ANZECC guidelines (ANZECC / ARMCANZ, 2000). The discharge water quality level would be determined in consultation with the NSW Environment Protection Authority during reference design, taking into consideration the current water quality of the receiving watercourse.

Due to the design approach, there is no change to off-site groundwater quality anticipated, since all inflow to the project would be captured.

4.5 Target change to surface water – groundwater interaction

All components of the Sydney Metro Chatswood to Sydenham project are being designed to prevent ingress of stormwater into the stations and rail tunnels.

The adoption of a segmental lining for all rail tunnels and the 'tanked' approach to underground stations, where they are mined, would reduce the potential for interaction between surface water and groundwater sources, where change to groundwater flow induces a change in flow within a connected surface water source.

Station shafts are located on the topographic ridgeline, with the exception of Barangaroo Station and Waterloo Station, which would be 'tanked' rather than 'drained'. These structures are therefore not anticipated to induce a 'take' from overlying surface water sources (creeks, harbour, rivers) and as noted above stormwater would be explicitly excluded from entering the station shafts. At Barangaroo Station, the design approach would be 'tanked' and therefore anticipated groundwater take would be minor to negligible and thereby there would be negligible take from surface water sources such as Sydney Harbour. It is recommended that numerical modelling is undertaken to confirm this is negligible interaction between the station at Barangaroo and Sydney Harbour.

The substation at Artarmon is not located in the vicinity of a delineated surface watercourse and the construction method at Artarmon is assumed to be 'tanked'. The temporary site at Blues Point is assumed to be a 'drained' structure and given its proximity to Sydney Harbour, it is recommended that numerical modelling is undertaken to confirm that there is negligible interaction between the shaft and Sydney Harbour.

Between Waterloo Station and the Marrickville dive structure, the alignment underlies Sheas Creek / Alexandra Canal. The depth of rail tunnels is, however, more than 30 metres below ground level at that point and therefore interaction between the project and this surface watercourse would be negligible. As noted above, the design approach at Waterloo Station would be 'tanked' with respect to all project elements.

The potential impact to surface water quality due to discharge from the water treatment plant is noted above in **Section 4.4** and discussed in detail in the Surface Water Assessment. The potential impact of discharge quantity on surface water courses is also addressed in the Surface Water Assessment.

5. Impact assessment

This chapter presents and discusses the potential impacts of the target changes to groundwater level, flow and groundwater quality of the Sydney Metro Chatswood to Sydenham project on surrounding land uses, groundwater dependent ecosystems, other groundwater users and surface water – groundwater interaction.

The minimal harm criteria presented in the Aquifer Interference Policy (NSW Office of Water, 2012) is addressed with respect to each of these aspects and is presented below. For completeness, the Aquifer Interference Assessment Framework has been completed and is also provided in Appendix A.

The compliance of the project with the rules of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 is also presented below.

5.1 Minimum harm criteria assessment

Table 5.1 presents the Level 1 minimum harm criteria for less productive porous and fractured rock.

Table 5.1 : Level 1 Minimal Impact Consideration (NSW Office of Water, 2012)

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	There are no high priority groundwater dependent ecosystems or high priority culturally significant sites in the vicinity of the project. Anticipated drawdown, cumulative, at any water supply work, is less than a 2m decline in water table due to the project.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Anticipated decline in groundwater elevation due to the project is less than a 2m at any water supply work.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	The project, due to groundwater inflows being captured and discharged, whether locally during construction or transmitted to a centralised water treatment plant during operation, would not change groundwater quality beyond 40 metres from the activity.

5.2 Compliance with rules of the Water Sharing Plan

Rules for granting access licences, managing access licences, water supply works approvals and access licence dealings are provided in the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. Details of mandatory conditions are provided in the Water Sharing Plan with respect to access licences and water supply works approvals.

Table 5.2 presents a summary of the rules of the Water Sharing Plan in regard to the project.

Table 5.2 : Project compliance with rules of the Water Sharing Plan

Rule	Assessment
Part 7 - Rules for granting access licences	Transport for NSW, as a transport authority, is exempt from the requirement to hold an access licence and therefore this rule does not apply to the project.
Part 8 - Rules for managing access licences	As per response to Part 7
Part 9 - Rules for water supply work approvals	As presented in **Section 2.2**, Transport for NSW are not exempt from the requirement to hold a water supply work approval. In the case of this project, the water supply work would be the station shafts, underground stations where they are 'drained' and dive structures.
Part 9 – 39 Distance restrictions to minimise interference between water supply works	
Distance restriction from an approved water supply work nominated by another access licence is 400 metres	There are no water supply works nominated by another access licence within 400 metres of 'drained' elements of the project.
Distance restriction from an approved water supply work for basic landholder rights only is 100 metres	There is a spear point adjacent Waterloo Station, however, this is more than the 100 metres distance restriction. In any regard, the spear point is installed into the Botany Sands Groundwater Source and the station shaft at Waterloo would be hydraulically isolated from this water source.
Distance restriction from the property boundary is 50 metres	'Drained' elements of the project would not comply with the 50 metre distance restriction with respect to property boundaries, however, this is considered acceptable given the highly developed state of the project alignment and that there are no water supply works in the immediate vicinity.
Distance restriction from an approved water supply work nominated by a local water utility or major utility access licence is 1000 metres	There are no local or major water utilities in the vicinity of 'drained' elements of the project.
Distance restriction from a Department observation bore is 200 metres	'Drained' elements of the project are more than 200 metres from a Department (NSW Office of Water) observation bore (monitoring piezometer).
Part 9 – 40 Rules for water supply works located near contamination sources	Barangaroo Station is located within a known remediation area. Accordingly, a 'tanked' approach to all elements of the station at Barangaroo would be adopted to isolate the station from the surrounding groundwater environment.
Part 9 – 41 Rules for water supply works located near sensitive environmental areas	'Drained' elements of the project are not located within 200 metres of a high priority groundwater dependent ecosystem. 'Drained' elements of the project are also not located within 40 metres of a lagoon or any third order or higher order stream. 'Drained' elements of the project are also not located within 40 metres of a first or second order stream. 'Drained' elements of the project are also not located within 100 metres from the top of an escarpment.
Part 9 – 42 Rules for water supply works located near groundwater dependent culturally significant sites	'Drained' elements of the project are not located within 200 metres of a groundwater dependent culturally sensitive site.
Part 9 – 44 Rules for water supply works located within distance restrictions	Does not apply since project compliant with distance restrictions.
Part 10 - Access licence dealing rules	As per response to Part 7

5.3 Impact to surrounding land uses

A change in water level is likely to be the main consideration in assessing the potential impact to surrounding land uses as it could result in ground settlement. Other impacts that include change in water table level at a high priority groundwater dependent ecosystem or decline in water table level or groundwater pressure at a water supply works are addressed below.

The project comprises rail tunnels that would be progressively segmentally lined and station caverns, where they are to be mined, being 'tanked'. This would result in minimal to negligible inflow into the tunnels and negligible change in groundwater levels. As noted above, the contribution of drawdown to subsidence in hard rock is minor to negligible and in any regard, a comprehensive risk-based management process for subsidence has been developed.

Station shafts would be 'drained' structures as would the dive structures. Cut-and-cover stations would be 'drained', with the exception of Barangaroo Station and Waterloo Station which would be 'tanked'. Target drawdowns are presented in **Table 4.2**. The target changes presented in **Table 4.2** would be refined during reference design, potentially including numerical analysis. Predicted settlement is presented in the main volume of the Environmental Impact Statement.

5.4 Impact to Groundwater Dependent Ecosystems

There are no groundwater dependent ecosystems in the vicinity of the project with respect to the Sydney Basin Central Groundwater Source.

The near-surface sediments at Waterloo Station lies within the Botany Sands Groundwater Source, within which resides the Botany Wetlands high priority groundwater dependent ecosystem, however, the around 4 metres of aeolian sands at Waterloo Station would be isolated due to all project elements being 'tanked'. As such, there would be no hydraulic connection between the project and the Botany Sands Groundwater Source and thereby no impact to the Botany Wetlands groundwater dependent ecosystem.

5.5 Impact to groundwater users

Groundwater users identified in the vicinity of the project are of sufficient distance from 'drained' elements of the project that there is no anticipated change in groundwater level at these water supply works due to the project.

5.6 Impact to surface water / groundwater interaction

As presented in **Section 4.5**, by design there is no surface water – groundwater interaction due to the project with respect to interception of surface water courses and stormwater flows at station shafts and dive structures.

In regard to Sydney Harbour, rail tunnels, with segmental lining, including compression gaskets, if required, would by design, necessarily exclude interaction with the Harbour and / or groundwater within the deep harbour sediments.

At Barangaroo, the design approach would be 'tanked' for all project elements. At the Blues Point temporary site, the design approach would be 'drained' since the shaft would be backfilled following construction. Review of the borehole log, SRT BH015, presented in **Appendix C**, indicates fresh rock is encountered at -12 metres AHD and below.

6. Licensing, management, mitigation and monitoring

This presents the anticipated licensing requirements of the Sydney Metro Chatswood to Sydenham project, as well as indicative management, mitigation, monitoring and reporting requirements.

6.1 Licensing

6.1.1 Water Management Act 2000

The design approach to underground stations, station shafts and dive structures would be finalised during reference design. As the design includes 'drained' elements, groundwater take from the Sydney Basin Central Groundwater Source would need to be accounted for. In the circumstance that a 'tanked' approach is adopted for all elements of the Sydney Metro Chatswood to Sydenham then the estimated take is negligible and the requirement for a Water Access Licence may not be necessary. It is noted, however, that Transport for NSW, as a transport authority under Clause 18 of the *Water Management (General) Regulation* 2011 (NSW), in any regard, is exempt from the requirement to hold a water access licence.

Table 6.1 presents the estimated volumetric take from the Sydney Basin Central Groundwater Source for the project. This estimate is conservative since it is based on the assumption that all project elements are 'drained', whereas the approach to water management for the project is instead a 'drained' approach to station shafts (except for Barangaroo Station and Waterloo Station), dive structures, temporary site at Blues Point and underground stations where cut-and-cover; and a 'tanked' approach to rail tunnels, mined cavern stations and substation (Artarmon). Further detail on inflow estimates is presented in **Section 4.3**.

Table 6.1 : Estimated volumetric licence requirement (ML/y) from the Sydney Basin Central Groundwater Source (Conservative)

Project	Predicted Inflow (ML/y) Estimate (conservative) based on 'drained' conditions for all project elements.	Required Licence Holding (ML/y)
Sydney Metro Chatswood to Sydenham	372 megalitres per year[a]	Zero megalitres per year due to exemption

a. An upper limit of 11.8L/s was made to the estimate provided in information from Transport for NSW to account for additional stations and extended rail tunnels; The Artarmon substation is assumed to be 'tanked' and therefore were not included in the inflow estimate; To define the capacity of the Water Treatment Plant, a maximum permissible inflow of 12.5L/s has been assumed consistent with Metro Northwest, with a further 3L/s for additional volumes of water (for example, from fire suppression).

There is no anticipated take from surface water from the Northern Sydney Rivers Water Source or the Southern Sydney Rivers Water Source due to extraction from the Sydney Basin Central Groundwater Source at station shafts and this is summarised in **Table 6.2** and **Table 6.3**. This is due to the location of station shafts being along the topographic ridgeline, with the exception of Barangaroo Station and Waterloo Station which would adopt a 'tanked' approach. As noted in **Section 4.5**, it is recommended that numerical modelling is undertaken to confirm that there is negligible surface water/groundwater with respect to Barangaroo Station and the Blues Point temporary site.

Table 6.2 : Estimated volumetric licence requirement (ML/y) from the Northern Sydney Surface Water Source

Project	Predicted Take (ML/y)	Required Licence Holding (ML/y)
Sydney Metro Chatswood to Sydenham	Zero megalitres per year	Zero megalitres per year

Table 6.3 : Estimated volumetric licence requirement (ML/y) from the Southern Sydney Surface Water Source

Project	Predicted Take (ML/y)	Required Licence Holding (ML/y)
Sydney Metro Chatswood to Sydenham	Zero megalitres per year	Zero megalitres per year

6.1.2 Water Act 1912

Temporary dewatering during construction is currently managed by the NSW Office of Water through the *Water Act* 1912 (NSW). As established in **Section 2.1.2**, the Crown is exempt from all requirements under the *Water Act* 1912 (NSW) and therefore is exempt from the requirement to hold licences with respect to construction dewatering.

6.2 Management, mitigation and monitoring

This section presents the management approach for groundwater and potential mitigation measures. It also presents the monitoring approach and intended reporting process.

Table 6.4 presents the monitoring and mitigation measures that would be implemented to address potential impacts on groundwater.

Table 6.4 : Management and mitigation measures

Reference	Mitigation measure	Applicable location(s)[1]
GWG1	A detailed geotechnical model for the project would be developed and progressively updated during design and construction. The detailed geotechnical model would include: • Assessment of the potential for damage to structures, services, basements and other sub-surface elements through settlement or strain • Predicted changes to groundwater levels, including at nearby water supply works. Where building damage risk is rated as moderate or higher (as per the CIRIA 1996 risk-based criteria), a structural assessment of the affected buildings / structures would be carried out and specific measures implemented to address the risk of damage. With each progressive update of the geotechnical model the potential for exceedance of the following target changes to groundwater levels would be reviewed: • Less than 2.0 metres – general target • Less than 4.0 metres – where deep building foundations present • Less than 1.0 metre – residual soils • Less than 0.5 metre – residual soils (Blues Point) (fill / Aeolian sand). Where a significant exceedance of target changes to groundwater levels are predicted at surrounding land uses and nearby water supply works, an appropriate groundwater monitoring program would be developed and implemented. The program would aim to confirm no adverse impacts on groundwater levels or to appropriately manage any impacts. Monitoring at any specific location would be subject to the status of the water supply work and agreement with the landowner.	All
GWG2	Condition surveys of buildings and structures in the vicinity of the tunnel and excavations would be carried out prior to the commencement of excavation at each site.	All

1 STW: Surface track works; CDS: Chatswood dive site; AS: Artarmon substation; CN: Crows Nest Station; VC: Victoria Cross Station; BP: Blues Point temporary site; GI: Ground improvement works; BN: Barangaroo Station; MP: Martin Place Station; PS: Pitt Street Station; CS: Central Station; WS: Waterloo Station; MDS: Marrickville dive site; Metro rail tunnels: Metro rail tunnels not related to other sites (eg TBM works); PSR: Power supply routes.

7. References

ANZECC/ARMCANZ, 1995. *National Water Quality Management Strategy – Guidelines for Groundwater Protection in Australia.* Canberra, ACT. Reference No. ISBN 0-642-19558-7, dated September 1995.

ANZECC/ARMCANZ, 2000. *National Water Quality Management Strategy – Paper No. 4: Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Volume 1.* Canberra, ACT. Reference No. ISBN 09578245-0-5, dated October 2000.

Chapman G.A., Murphy, C.L., Tille P.J., Atkinson G. and Morse R.J., 2009. *Soil Landscapes of the Sydney 1:100,000 Sheet Map, 4th Edition*. Department of Environment, Climate Change and Water, Sydney, NSW.

Department of Land and Water Conservation, 1998. *NSW Groundwater Quality Protection Policy*. Sydney, NSW. Reference No. ISBN 0-7313-0379-2, dated December 1998.

Department of Land and Water Conservation, 2002. The *NSW State Groundwater Dependent Ecosystems Policy*. Sydney, NSW. Reference No. ISBN 0-7347-5225-3, dated April 2002.

Fetter, 1994. *Applied Hydrogeology, 3rd Edition*. Prentice-Hall, New Jersey. Reference No. ISBN 0-02-336490-4.

Herbert C., 1983. *Sydney 1:100 000 Geological Sheet 9130, 1st Edition*. Geological Survey of New South Wales, Sydney, NSW.

NSW Office of Water, 2012. *NSW Aquifer Interference Policy: NSW Government policy for the licensing an assessment of aquifer interference activities*. Sydney, NSW. Reference No. ISBN 978-1-74256-338-1, dated September 2012.

Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 (NSW). Current version 1 January 2015. Accessed 29 October 2015.

Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011 (NSW). Current version 8 January 2015. Accessed 26 June 2015.

Appendix A. Aquifer Interference Assessment Framework

Department of Primary Industries
Office of Water

AQUIFER INTERFERENCE ASSESSMENT FRAMEWORK

Assessing a proposal against the NSW Aquifer Interference Policy – step by step guide

Note for proponents

This is the basic framework which the NSW Office of Water uses to assess project proposals against the **NSW Aquifer Interference Policy (AIP).**

The NSW Aquifer Interference Policy can be downloaded from the NSW Office of Water website (www.water.nsw.gov.au under Water management > Law and policy > Key policies > Aquifer interference).

While you are not required to use this framework, you may find it a useful tool to aid the development of a proposal or an **Environmental Impact Statement (EIS).**

We suggest that you summarise your response to each AIP requirement in the tables following and provide a reference to the section of your EIS that addresses that particular requirement. Using this tool can help to ensure that all necessary factors are considered, and will help you understand the requirements of the AIP.

Table 1. Does the activity require detailed assessment under the AIP?

	Consideration	Response
1	Is the activity defined as an aquifer interference activity?	If **NO,** then no assessment is required under the AIP. If **YES,** continue to Question 2.
2	Is the activity a defined minimal impact aquifer interference activity according to section 3.3 of the AIP?	If **YES**, then no further assessment against this policy is required. Volumetric licensing still required for any water taken, unless exempt. If **NO**, then continue on for a full assessment of the activity.

Note for proponents

Section 3.2 of the AIP defines the framework for assessing impacts. These are addressed here under the following headings:

1. Accounting for or preventing the take of water
2. Addressing the minimal impact considerations
3. Proposed remedial actions where impacts are greater than predicted.

1. Accounting for, or preventing the take of water

Where a proposed activity will take water, adequate arrangements must be in place to account for this water. It is the proponent's responsibility to ensure that the necessary licences are held. These requirements are detailed in Section 2 of the AIP, with the specific considerations in Section 2.1 addressed systematically below.

Where a proponent is unable to demonstrate that they will be able to meet the requirements for the licensing of the take of water, consideration should be given to modification of the proposal to prevent the take of water.

Table 2. Has the proponent:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Described the water source(s) the activity will take water from?	Sydney Basin Central Groundwater Source	
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	Construction related dewatering estimates for 'drained' elements of the project assumed represented by estimated operational inflows presented in Table 4.4. Rail tunnels will be constructed using segmental lining, applied progressively, therefore construction-related dewatering from this component assumed to be minimal. Construction of mined cavern stations via road headers and rock breakers will be followed by permanent lining. A 'drained' approach would be adopted for full cut-and-cover stations. These include Central Station, Crows Nest Station. A 'tanked' approach is proposed at Barangaroo Station and Waterloo Station. Dive structures are proposed to be 'drained'. Expected inflows during the construction phase would be less than 11.8L/s. A contingency for construction related dewatering at each underground station is 3L/s (100ML/y) based on the estimated inflow to Pitt Street Station provided in Table 4.4 of this report.	
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	372ML based on empirical predictions assuming all elements of the project are 'drained'. It is highlighted that this is a conservative estimate since the majority of the project would be 'tanked'.	

	AIP requirement	Proponent response	NSW Office of Water comment
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (refer to Table 3, below)	Yes. Empirical method used to estimate inflows, which will be confirmed during reference design. Impacts to groundwater level are nominated in this report based on expectation and are expected to be formally calculated, as required, from the geotechnical model.	
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	All to Sydney Basin Central Groundwater Source.	
6	Described how any licence exemptions might apply?	Transport for NSW holds an exemption, as a transport authority, under Clause 18(1) of *Water Management (General) Regulation* 2011 (NSW), from the requirement to hold a water access licence. Under Clause 31(1), they also hold exemption from requirement to hold a water use approval. Transport for NSW, however, do not hold exemption from a water supply works approval. Transport for NSW also hold exemption (Crown) from the requirement to hold a construction dewatering licence under *Water Act* 1912 (NSW).	
7	Described the characteristics of the water requirements?	There is no water requirement associated with the project.	
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	For water year 2014/15, total number of water access licences was 150, with total share component of 2925.5ML. Individual share components ranged from 0.5 to 274ML/y. Transport for NSW hold exemption from the requirement to hold a water access licence.	
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	The project is compliant with rules of the Water Sharing Plan and details are provided in Section 5.2 except with respect to distance restriction from the property boundary of 50m, however, is considered acceptable.	
10	Determined how it will obtain the required water?	There is no water requirement associated with the project.	

	AIP requirement	Proponent response	NSW Office of Water comment
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	As indicated in response to Table 2(8), expected licence requirement is 12.7 per cent of current total entitlement, based on conservative empirical estimate assuming all project elements are 'drained'; however, Transport for NSW hold exemption from the requirement to hold a water access licence. It is noted that expected groundwater inflow would be significantly less than 11.8L/s due to the majority of the project being 'tanked'.	
12	Considered actions required both during and post-closure to minimize the risk of inflows to a mine void as a result of flooding?	N/A, as not a mining project, however, in response to context of question, rail tunnels will be segmentally lined, therefore risk of inflow is minimised. Station shafts and dive structures are designed such that there is no ingress of surface water flow or stormwater to the rail tunnels.	
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Given a 'drained' approach would be adopted for some project elements, then it is expected that a water access licence would need to be held in perpetuity; however, Transport for NSW hold exemption from the requirement to hold a water access licence.	

Will uncertainty in the predicted inflows have a significant impact on the environment or other authorised water users?

If **YES,** items 14-16 must be addressed.

14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?	Use of tunnel boring machine deliberate to minimise impact to surrounding strata. Geotechnical design primarily focused on mitigation of settlement beyond tolerance limits with respect to all aspects of the project. Accordingly, the risk of enhanced hydraulic connection is considered to be low to minor.	
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?	Empirical estimates of inflow accounts for potential range of uncertainty. Detailed calculation of groundwater inflow for the project would be undertaken during preparation of the geotechnical model as part of the reference design, in accordance with Section 6.2.	

16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	Groundwater inflow to the project is expected to be significantly less than 11.8L/s and therefore flow monitoring at individual project elements is not proposed. During operation, throughput of the centralised water treatment plant would be available.	

Table 3. Determining water predictions in accordance with Section 3.2.3
(complete one row only – consider both during and following completion of activity)

	AIP requirement	Proponent response	NSW Office of Water comment
1	**For the Gateway process**, is the estimate based on a simple modelling platform, using suitable baseline data, that is, fit-for-purpose?		
2	**For State Significant Development or mining or coal seam gas production**, is the estimate based on a complex modelling platform that is: • Calibrated against suitable baseline data, and in the case of a **reliable water source,** over at least two years? • Consistent with the Australian Modelling Guidelines? • Independently reviewed, robust and reliable, and deemed fit-for-purpose?		
3	In all other processes, estimate based on a desk-top analysis that is: • Developed using the available baseline data that has been collected at an appropriate frequency and scale; and • Fit-for-purpose?	Critical State Significant Infrastructure Project No. 15-7400. Baseline database informed by historical and project specific data, including borehole investigation program, packer tests as well as installation of monitoring piezometers. Empirical methods used to estimate groundwater inflow plus recent experience on Sydney Metro Northwest. Target changes to groundwater level provided in this report based on expected impacts.	

Other requirements to be reported on under Section 3.2.3

Table 4. Has the proponent provided details on:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Establishment of baseline groundwater conditions?	Anticipated hydraulic conductivity provided in Section 3.4, together with groundwater elevations and anticipated groundwater quality. Detailed geological sections provided in Appendix B.	
2	A strategy for complying with any water access rules?	Project is compliant with access rules, as outlined in Section 5.2, with exception of distance of works to prop boundary of 50m, however, is considered acceptable.	
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	Assessed and found to be less than Level 1 Minimum Harm Criteria. See Section 5.1 and below for further details.	
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?	N/A, due to station shafts being located on the topographic ridgeline, with the exception of Barangaroo and Waterloo, which is to be 'tanked' due to its proximity to Sydney Harbour and location with respect to Botany Sands Aquifer respectively. The Blues Point temporary access point is proposed to be 'drained' and it is recommended that numerical modelling between undertaken to confirm negligible take from Sydney Harbour.	
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?	N/A, there are no high priority groundwater dependent ecosystems in the Sydney Basin Central Groundwater Source that would be impacted by the project. The Botany Wetlands in the Botany Sands Groundwater Source would not be impacted due to hydraulic isolation of the Botany Sands Groundwater Source at Waterloo Station.	
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?	N/A, due to majority of the project being 'tanked', there would be negligible groundwater interference. The 'drained' approach adopted for station shafts, are not immediately adjacent saline water sources and where potential contamination exists, such as at Barangaroo Station, a 'tanked' approach is to be adopted. As noted above, the Blues Point temporary access point is located immediately adjacent Sydney Harbour and numerical	

	AIP requirement	Proponent response	NSW Office of Water comment
		modelling is recommended to confirm negligible inflow from the harbour.	
7	Potential to cause or enhance hydraulic connection between aquifers?	N/A, due to rail tunnels being 'tanked' and geotechnical design for project, adopting a tunnel boring machine construction method, primarily focussed on minimising settlement beyond acceptable tolerances. At station shafts, multiple hydrogeologic units will be connected, however, the impact will be localised and minor to negligible in magnitude.	
8	Potential for river bank instability, or high wall instability or failure to occur?	N/A	
9	Details of the method for disposing of extracted activities (for coal seam gas activities)?	A 'drained' approach would be adopted for station shafts, station caverns where a full cut-and-cover approach is to be used, except for Barangaroo and Waterloo and at dive structures. During construction, groundwater inflow would be managed at each tunnel boring machine support site via a water treatment plant and it is likely that a water treatment plant would be deployed at the site of each underground station and at dive structures. Following treatment, groundwater inflows would be discharged to stormwater. During operation, groundwater inflows will be directed to a centralised water treatment plant located adjacent the Marrickville dive site (southern) before being discharged via the stormwater network. The primary focus of water treatment is elevated concentrations of iron, which is naturally occurring in the Hawkesbury Sandstone. Further detail is provided in Section 4.4.	

2. Addressing the minimal impact considerations

Note for proponents

Section 3.2.1 of the AIP describes how aquifer impact assessment should be undertaken.

1. Identify all water sources that will be impacted, referring to the water sources defined in the relevant water sharing plan(s). Assessment against the minimal impact considerations of the AIP should be undertaken for each ground water source.
2. Determine if each water source is defined as 'highly productive' or 'less productive'. If the water source is named in then it is defined as highly productive, all other water sources are defined as less productive.
3. With reference to pages 13-14 of the Aquifer Interference Policy, determine the sub-grouping of each water source (eg alluvial, porous rock, fractured rock, coastal sands).
4. Determine whether the predicted impacts fall within Level 1 or Level 2 of the minimal impact considerations defined in Table 1 of the AIP, for each water source, for each of water table, water pressure, and water quality attributes. The tables below may assist with the assessment. There is a separate table for each sub-grouping of water source – only use the tables that apply to the water source(s) you are assessing, and delete the others.
5. If unable to determine any of these impacts, identify what further information will be required to make this assessment.
6. Where the assessment determines that the impacts fall within the Level 1 impacts, the assessment should be 'Level 1 – Acceptable'
7. Where the assessment falls outside the Level 1 impacts, the assessment should be 'Level 2'. The assessment should further note the reasons the assessment is Level 2, and any additional requirements that are triggered by falling into Level 2.
8. If water table or water pressure assessment is not applicable due to the nature of the water source, the assessment should be recorded as 'N/A – reason for N/A'.

Table 5. Minimal impact considerations – *example tables*

Aquifer	**Alluvial aquifer**
Category	**Highly Productive**

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	
Water pressure A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the base of the water source to a maximum of a 2 metre decline, at any water supply work. **OR**, for the Lower Murrumbidgee Deep Groundwater Source: A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the top of the relevant aquifer to a maximum of a 3 metre decline, at any water supply work.	
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200 metres laterally from the top of high bank or 100 metres vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a reliable water supply. Not more than 10% cumulatively of the three dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200 metres laterally from the top of high bank and 100 metres vertically beneath a highly connected surface water source that is defined as a reliable water supply.	

Aquifer	Coastal sands
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	

Aquifer	Porous Rock – except Great Artesian Basin
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	

Aquifer	Porous Rock – Great Artesian Basin – Eastern Recharge and Southern Recharge
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	
Water pressure Less than 0.2 metre cumulative variation in the groundwater pressure, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. A cumulative pressure level decline of not more than 15 metres, allowing for typical climatic 'post-water sharing plan' variations. The cumulative pressure level decline of no more than 10% of the 2008 pressure level above ground surface at the NSW State border, as agreed between NSW and Queensland.	
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	

Aquifer	Porous Rock – Great Artesian Basin – Surat, Warrego and Central
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table NOT APPLICABLE	
Water pressure Less than 0.2 metre cumulative variation in the groundwater pressure, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. A cumulative pressure level decline of not more than 30 metres, allowing for typical climatic 'post-water sharing plan' variations. The cumulative pressure level decline of no more than 10% of the 2008 pressure level above ground surface at the NSW State border, as agreed between NSW and Queensland.	
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	

Aquifer	Fractured Rock
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem; or • high priority culturally significant site; listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	

Aquifer	Alluvial
Category	Less productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work unless make good provisions apply	
Water pressure A cumulative pressure head decline of not more than 40% of the 'post-water sharing plan' pressure head above the base of the water source to a maximum of a 2 metre decline, at any water supply work.	
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200 metres laterally from the top of high bank or 100 metres vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a 'reliable water supply'.	

Aquifer	Porous rock or fractured rock
Category	Less productive

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	There are no high priority groundwater dependent ecosystems or high priority culturally significant sites in the vicinity of the project. Expected drawdown, cumulative, at any water supply work, is less than 2m decline in water table due to the project.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Expected decline in groundwater elevation due to the project is less than 2m at any water supply work.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	The project, due to groundwater inflows being captured and discharged, whether locally during construction or transmitted to centralised water treatment plant during operation will not change groundwater quality beyond 40m from the activity.

3. Proposed remedial actions where impacts are greater than predicted.

Note for proponents

Point 3 of section 3.2 of the AIP provides a basic framework for considerations to consider when assessing a proponent's proposed remedial actions.

Table 6. Has the proponent:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Considered types, scale, and likelihood of unforeseen impacts *during operation*?	Potential impacts are change to groundwater level and change to groundwater inflow. By design, impacts to groundwater level and flow are minimised through adoption of a tunnel boring machine construction method incorporating segmental lining, as well as a 'tanked' approach to underground stations, where they are mined. A 'drained' approach is to be adopted for cut-and-cover stations, dive structures and station shafts (except for Barangaroo and Waterloo). If groundwater inflows significantly exceed expectations then remedial works would be able to be implemented, ultimately resulting in a 'tanked' design, if required. Details of sequential mitigation measures are presented in Section 6.2.	
2	Considered types, scale, and likelihood of unforeseen impacts *post closure*?	Design life for project is 100 years. It is expected, however, that the asset will be maintained in perpetuity. It is unlikely that impacts not identified during the 100 year design life period will be identified subsequently.	
3	Proposed mitigation, prevention or avoidance strategies for each of these potential impacts?	During construction, monitoring piezometers and direct settlement monitoring will confirm expected impact to groundwater level outside of construction footprint will be achieved, as per Section 6.2. Should inflows significantly exceed expectations then remedial works on project components could be considered.	
4	Proposed remedial actions should the risk minimization strategies fail?	Historical experience in Sydney Tunnels is 1L/s/km and inflows of this magnitude or equivalent at station shafts and cut-and-cover stations would be manageable, again should water tightness remedial works not be successful. In that circumstance, the	

	AIP requirement	Proponent response	NSW Office of Water comment
		water treatment capacity has been designed to accommodate inflows of up to 15L/s.	
5	Considered what further mitigation, prevention, avoidance or remedial actions might be required?	The design approach to the Chatswood to Sydenham project is to adopt a 'tanked' design for rail tunnels and mined station caverns, with 'drained' approach adopted for station shafts, cut-and-cover stations (except for Barangaroo and Waterloo) as well as dive structures. Retrospective change to the design from a 'drained' approach would be expensive as would need to resist full hydrostatic pressure.	
6	Considered what conditions might be appropriate?	Suggested conditions comprise agreed inflow limits for all project components. For the City Metro Northwest this comprised "2.0mL per hr per m^2 of concrete lining surface and maximum of 5.0mL per hr per m^2 of concrete lining surface for any 10m length" for 'tanked' structures. From the Epping to Chatswood Railway, for 'drained' structures, 0.75L/s/10,000m^2 of excavated area.	

4. Other considerations

Note for proponents

These considerations are not included in the assessment framework outlined within the AIP, however are discussed elsewhere in the document and are useful considerations when assessing a proposal.

Table 7: Has the proponent:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Addressed how it will measure and monitor volumetric take? (page 4 of the AIP)	As presented in Section 6.2 it is not proposed to monitor groundwater inflow as expected inflow would be significantly less than 9L/s. Throughput of the water treatment plant, during operation, would be available and can be reported.	
2	Outlined a reporting framework for volumetric take? (page 4 of the AIP)	Project performance would be reported in construction environmental management plan and asset management and maintenance plan respectively.	

More information

www.water.nsw.gov.au

Published by the NSW Department of Primary Industries.

Reference 12279.1

Appendix B. Geological Long-Sections

These long-sections are replicated from information provided by Transport for NSW and are presented here for the purpose of reference.

GEOTECHNICAL LEGEND

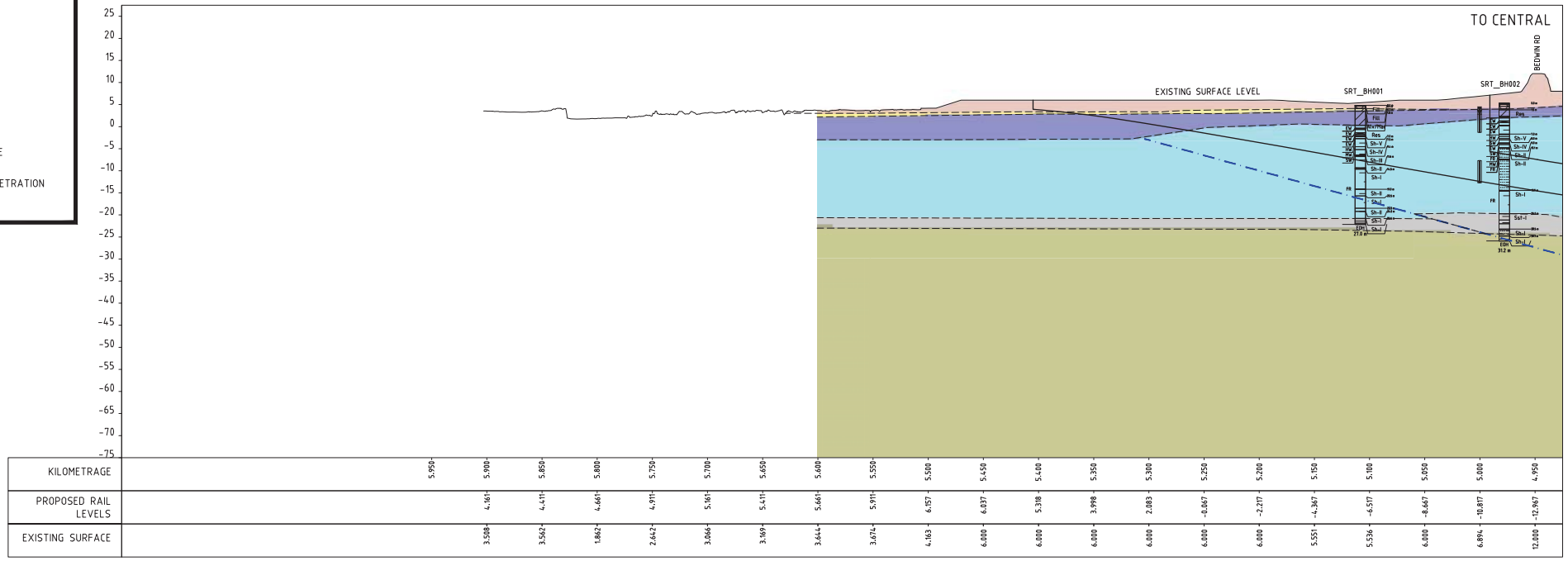
- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST

PLAN
SCALE 1:2000



KILOMETRAGE	5.950	5.900	5.850	5.800	5.750	5.700	5.650	5.600	5.550	5.500	5.450	5.400	5.350	5.300	5.250	5.200	5.150	5.100	5.050	5.000	4.950
PROPOSED RAIL LEVELS		4.461	4.411	4.461	4.911	5.161	5.411	5.661	5.911	6.157	6.037	5.318	3.998	2.083	-0.067	-2.217	-4.367	-6.517	-8.667	-10.817	-12.967
EXISTING SURFACE		3.588	3.562	1.862	2.642	3.066	3.169	3.644	3.674	4.163	6.000	6.000	6.000	6.000	6.000	6.000	5.551	5.536	6.000	6.894	12.000

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:03

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST

SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 1

STATUS: ISSUED FOR INFORMATION | SHEET 1 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300950 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

Cad File: X:\09_CADD\Drawings\30_SHCSysWide\NWRLSRT-PBA-SHC-GE-DWG-300950.dwg Plot Date: 03/03/16 - 14:03 100mm AT FULL SIZE

GEOTECHNICAL LEGEND

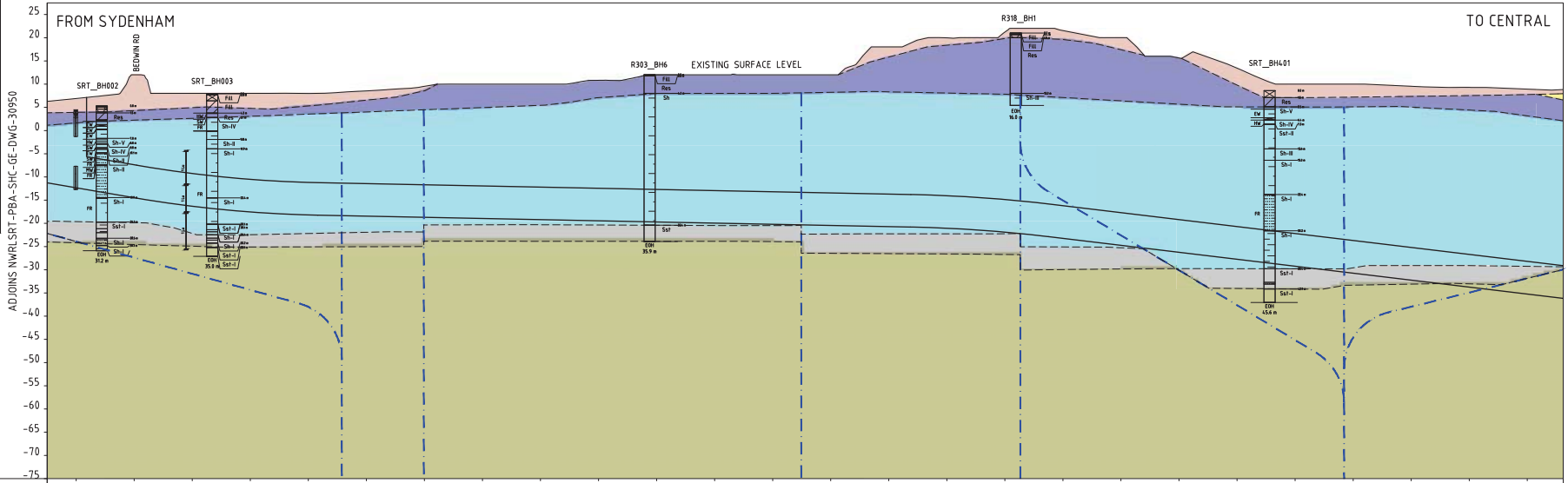
- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST

PLAN
SCALE 1:2000



KILOMETRAGE	5.000	4.950	4.900	4.850	4.800	4.750	4.700	4.650	4.600	4.550	4.500	4.450	4.400	4.350	4.300	4.250	4.200	4.150	4.100	4.050	4.000	3.950	3.900	3.850	3.800	3.750
PROPOSED RAIL LEVELS	-10.817	-12.967	-14.801	-16.040	-16.686	-16.945	-17.195	-17.445	-17.695	-17.945	-18.195	-18.445	-18.695	-18.945	-19.195	-19.548	-20.386	-21.731	-23.231	-24.731	-26.231	-27.731	-29.231	-30.731	-32.231	-33.731
EXISTING SURFACE	6.894	12.000	8.000	8.000	8.000	8.521	9.519	10.000	10.000	10.808	12.000	12.000	12.000	12.000	18.000	19.959	21.283	21.529	20.000	15.625	13.425	10.000	10.000	10.000	10.000	10.000

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:04

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST
SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 2

STATUS: ISSUED FOR INFORMATION | SHEET 2 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300951 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

Cad File: X:\09_CADD\Drawings\30_SHC\SysWide\NWRLSRT-PBA-SHC-GE-DWG-300951.dwg Plot Date: 03/03/16 - 14:04 100mm AT FULL SIZE

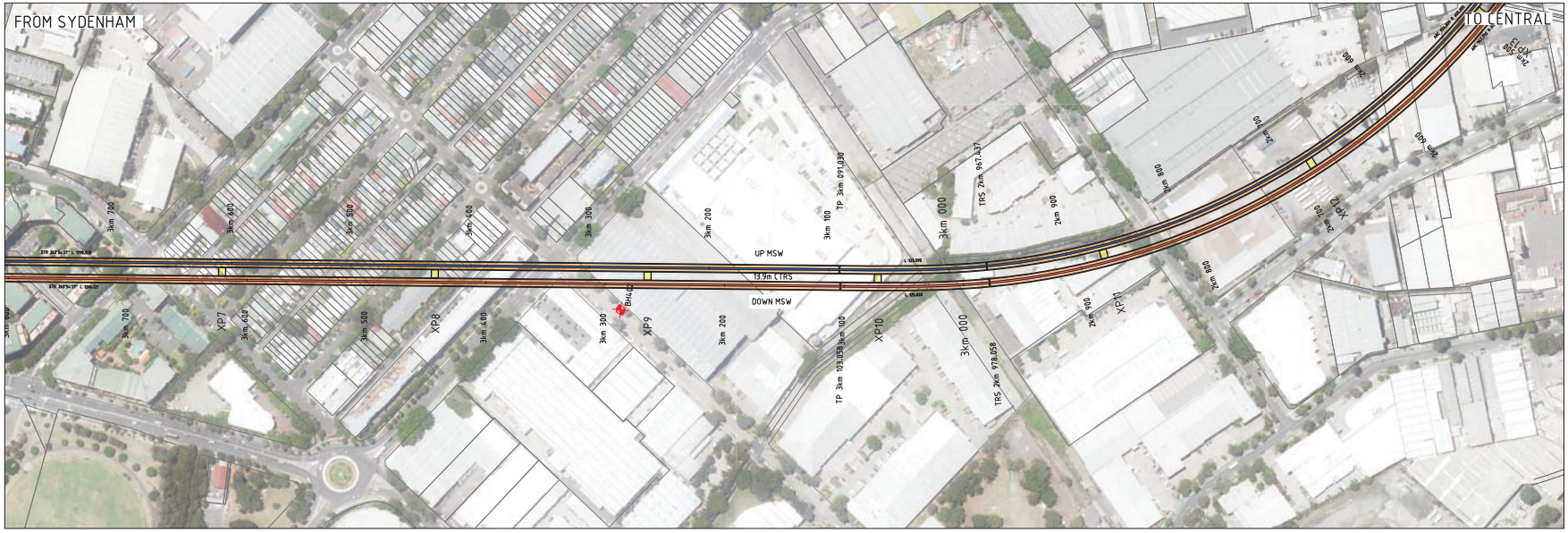
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

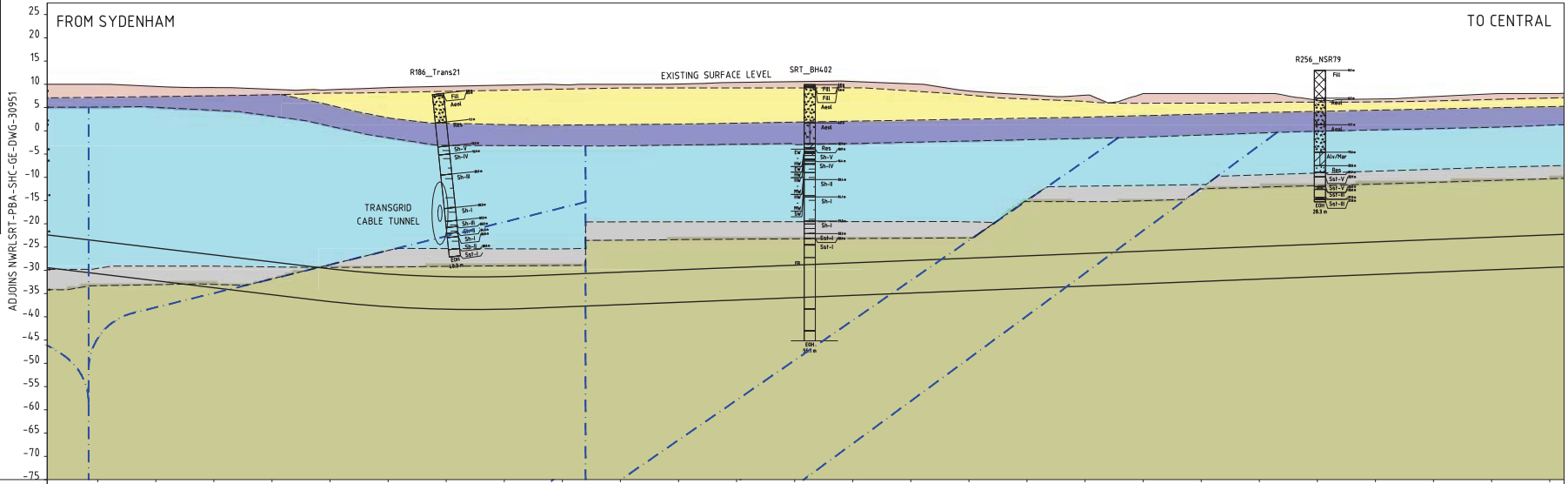
HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST



PLAN
SCALE 1:2000



DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:04

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST

SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 3

STATUS: ISSUED FOR INFORMATION | SHEET 3 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300952 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

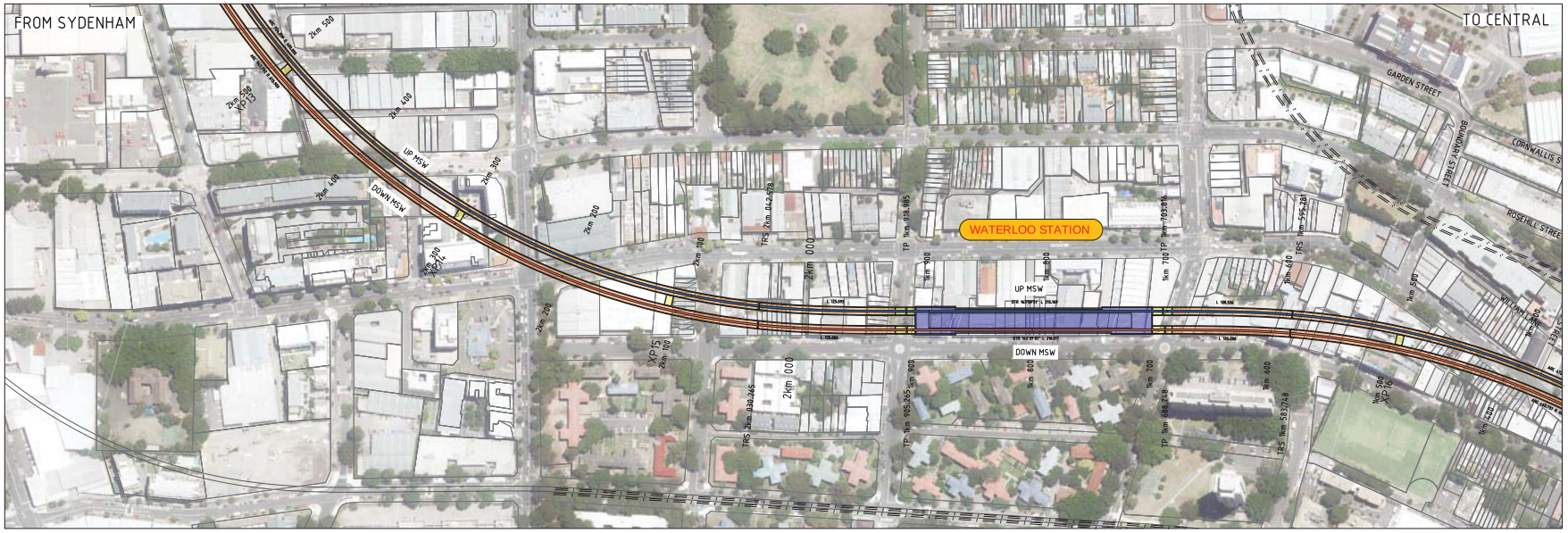
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

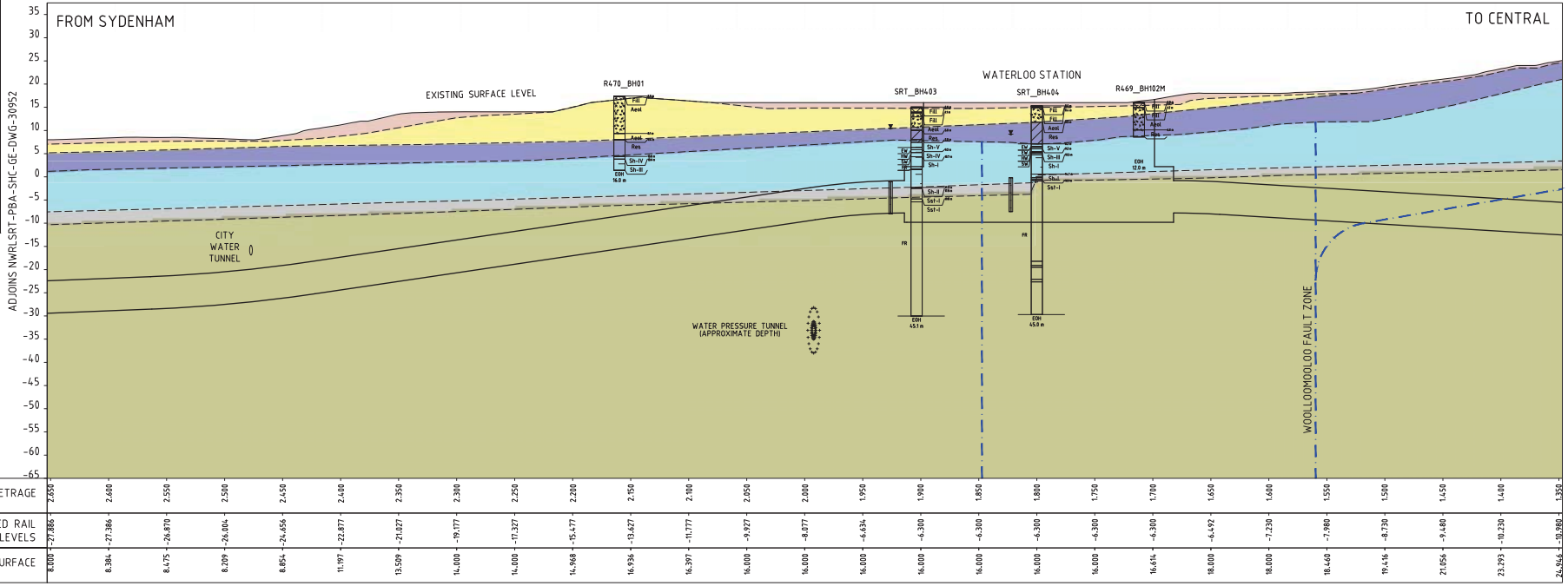
HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST



PLAN
SCALE 1:2000



DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:04

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX, HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST
SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 4

STATUS: ISSUED FOR INFORMATION | SHEET 4 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300953 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

Cad File: X:\09_CADD\Drawings\30_SHCSysWide\NWRLSRT-PBA-SHC-GE-DWG-300953.dwg Plot Date: 03/03/16 - 14:04 100mm AT FULL SIZE

GEOTECHNICAL LEGEND

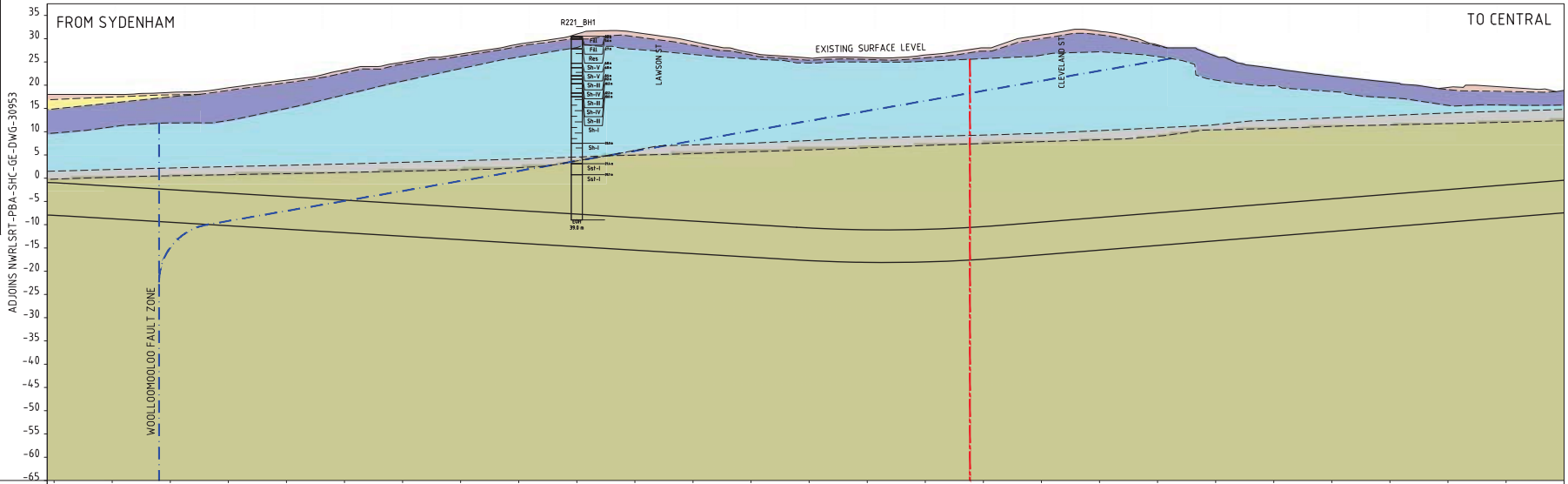
- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST

PLAN
SCALE 1:2000



KILOMETRAGE	1.650	1.600	1.550	1.500	1.450	1.400	1.350	1.300	1.250	1.200	1.150	1.100	1.050	1.000	0.950	0.900	0.850	0.800	0.750	0.700	0.650	0.600	0.550	0.500	0.450	0.400
PROPOSED RAIL LEVELS	-6.492	-7.230	-7.980	-8.730	-9.480	-10.230	-10.980	-11.730	-12.480	-13.230	-13.980	-14.730	-15.480	-16.216	-16.605	-16.508	-15.925	-14.957	-13.957	-12.957	-11.957	-10.957	-9.957	-8.957	-7.957	-6.957
EXISTING SURFACE	18.000	18.000	18.460	19.416	21.056	23.293	24.946	26.689	28.805	30.966	31.343	29.350	26.952	25.829	25.899	26.471	28.000	30.780	31.571	28.636	26.222	23.589	21.966	20.621	19.508	19.557

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES: 1:2000 FULL SIZE A1; 1:500 FULL SIZE A1

Plot Date: 03/03/16 - 14:05

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST

SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 5

STATUS: ISSUED FOR INFORMATION | SHEET 5 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300954 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

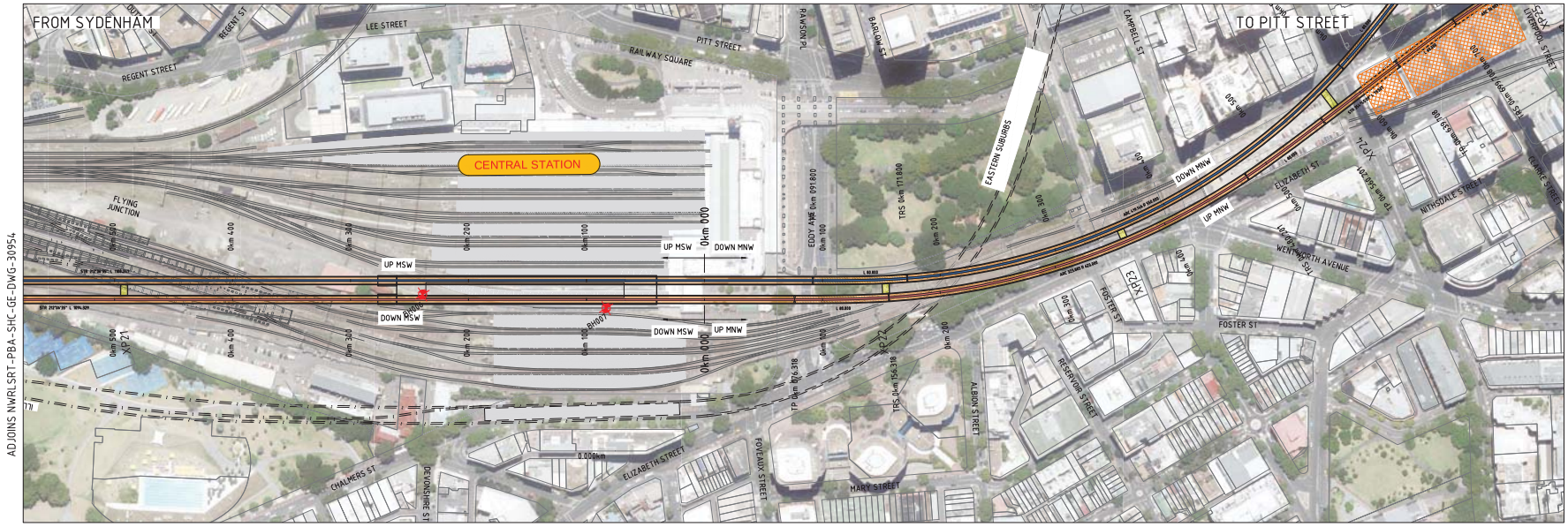
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

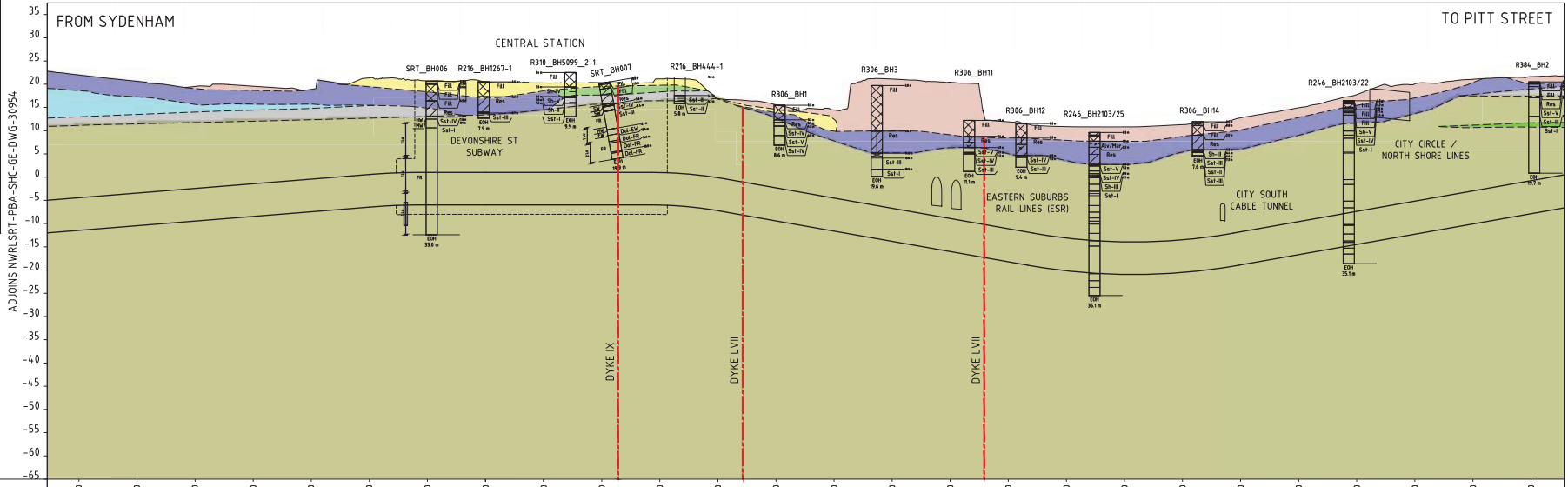
HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST



PLAN
SCALE 1:2000



KILOMETRAGE	0.550	0.500	0.450	0.400	0.350	0.300	0.250	0.200	0.150	0.100	0.050	0.000	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.400	0.450	0.500	0.550	0.600	0.650	0.700
PROPOSED RAIL LEVELS	-9.957	-8.957	-7.957	-6.957	-5.957	-4.957	-4.500	-4.500	-4.500	-4.500	-4.519	-5.698	-7.895	-10.095	-12.295	-14.495	-16.695	-16.839	-19.436	-19.011	-17.366	-15.166	-12.966	-10.766	-8.566	-6.366
EXISTING SURFACE	21.966	20.621	19.508	19.557	18.878	22.987	20.738	20.478	20.255	20.333	21.137	16.903	15.561	14.439	21.103	20.420	11.893	18.841	10.792	11.282	12.777	14.975	17.764	20.093	21.050	21.614

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:05

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST

SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 6

STATUS: ISSUED FOR INFORMATION | SHEET 6 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300955 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

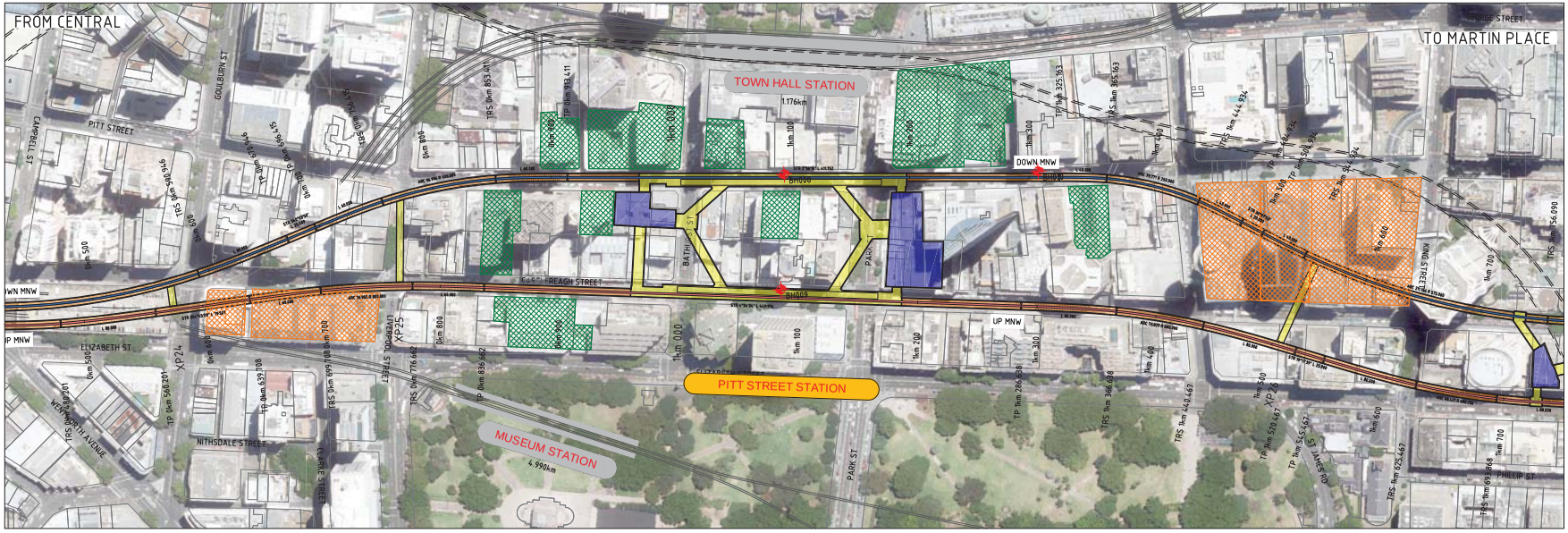
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

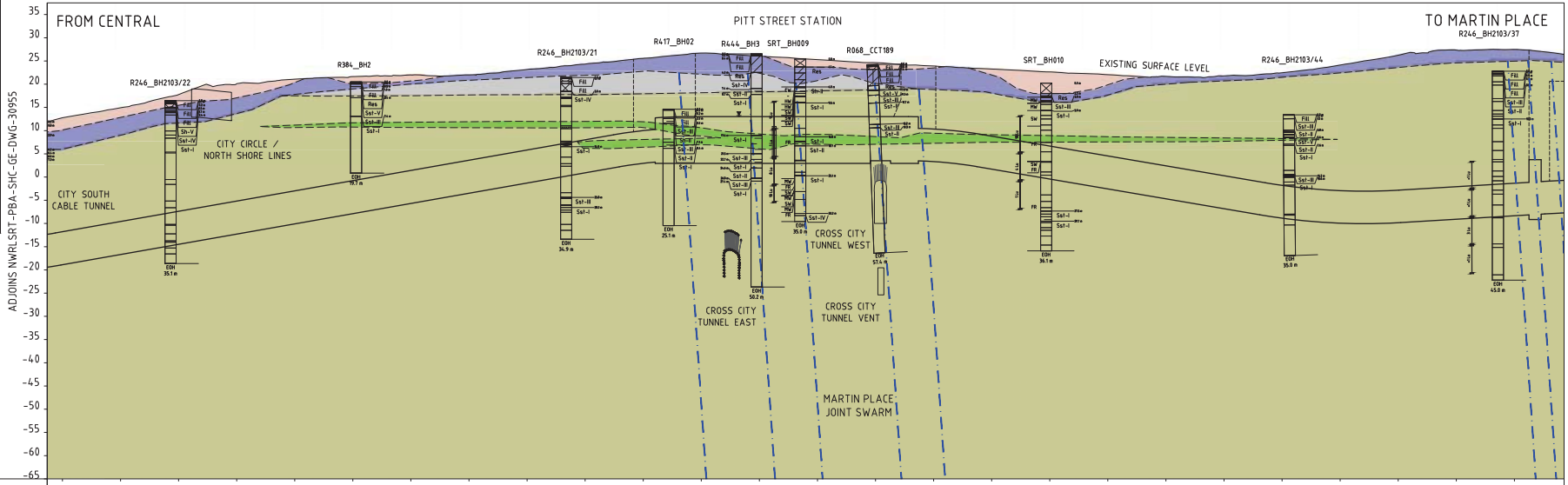
HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST



PLAN
SCALE 1:2000



KILOMETRAGE	0.450	0.500	0.550	0.600	0.650	0.700	0.750	0.800	0.850	0.900	0.950	1.000	1.050	1.100	1.150	1.200	1.250	1.300	1.350	1.400	1.450	1.500	1.550	1.600	1.650	1.700
PROPOSED RAIL LEVELS	-17.366	-15.166	-12.966	-10.766	-8.566	-6.366	-4.166	-1.966	0.234	2.434	4.462	5.000	5.000	5.000	5.000	4.833	3.224	1.094	-1.036	-3.166	-5.296	-7.347	-8.442	-8.337	-7.588	-6.838
EXISTING SURFACE	12.777	14.915	17.764	20.093	21.050	21.614	21.974	21.982	23.750	24.312	25.551	26.675	26.031	25.257	24.612	23.904	23.245	22.616	22.021	21.659	21.778	22.446	24.186	26.221	27.333	27.459

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:05

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST
SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 7

STATUS: ISSUED FOR INFORMATION | SHEET 7 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300956 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

Cad File: X:\09_CADD\Drawings\30_SHCSysWide\NWRLSRT-PBA-SHC-GE-DWG-300956.dwg Plot Date: 03/03/16 - 14:05 100mm AT FULL SIZE

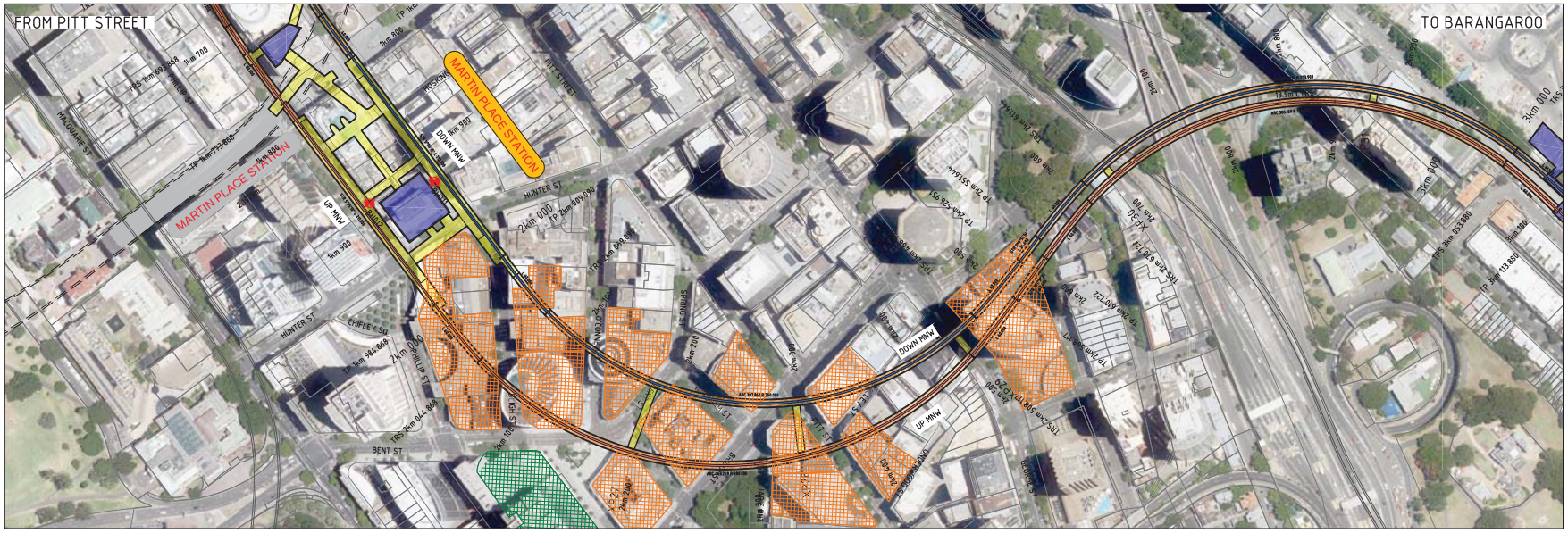
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

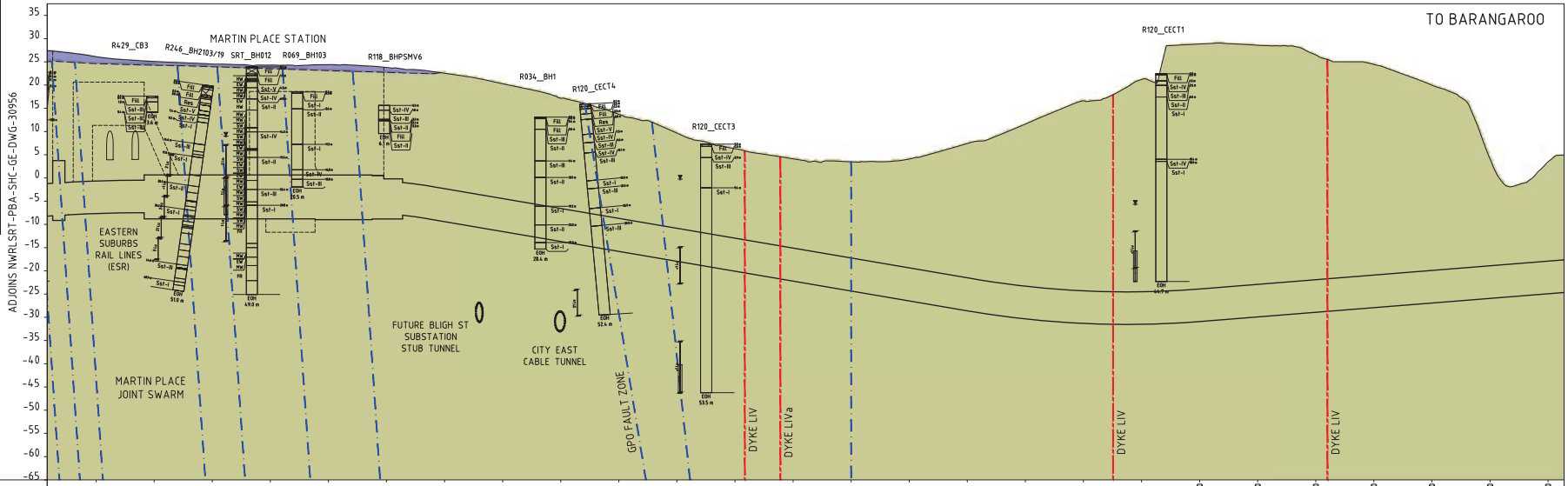
HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST



PLAN
SCALE 1:2000



KILOMETRAGE	1.750	1.800	1.850	1.900	1.950	2.000	2.050	2.100	2.150	2.200	2.250	2.300	2.350	2.400	2.450	2.500	2.550	2.600	2.650	2.700	2.750	2.800	2.850	2.900	2.950	3.000
PROPOSED RAIL LEVELS	-6.161	-6.000	-6.000	-6.000	-6.000	-6.207	-7.883	-10.015	-12.148	-14.280	-16.413	-18.545	-20.678	-22.810	-24.943	-27.075	-28.835	-29.812	-30.006	-29.417	-28.418	-27.418	-26.418	-25.418	-24.418	-23.418
EXISTING SURFACE	26.086	25.025	24.513	24.274	24.379	23.769	22.550	20.276	17.162	13.764	9.645	6.298	4.115	3.469	4.073	7.407	11.602	16.579	21.201	28.576	26.491	24.439	19.969	4.091	3.475	

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES: 1:2000 FULL SIZE A1; 1:500 FULL SIZE A1

Plot Date: 03/03/16 - 14:06

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN: JULIAN SINGH
DESIGNED: DAVID OCH
DRG CHECK:
DESIGN CHECK:
APPROVED:

SYDNEY METRO CITY & SOUTHWEST

SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 8

STATUS: ISSUED FOR INFORMATION | SHEET 8 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300957 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

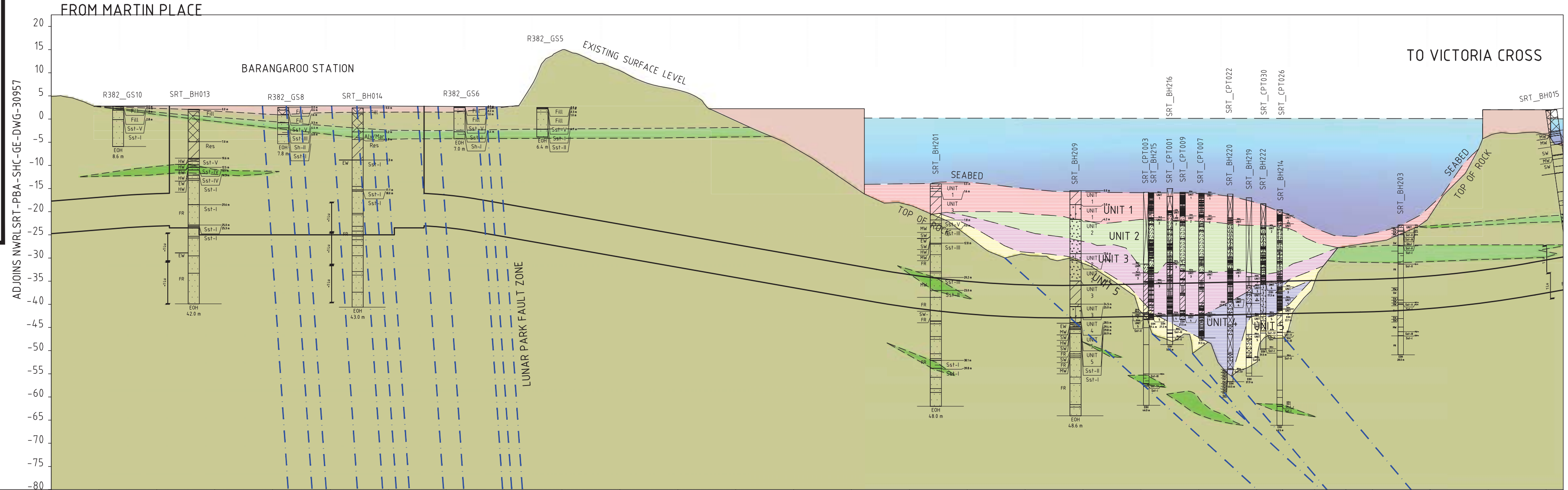
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS
- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST

PLAN
SCALE 1:2000



KILOMETRAGE	PROPOSED RAIL LEVELS	EXISTING SURFACE
3.050	-22.418	2.467
3.100	-21.612	2.115
3.150	-21.500	1.031
3.200	-21.500	0.648
3.250	-21.500	0.057
3.300	-21.500	-1.494
3.350	-21.927	-1.401
3.400	-23.881	-0.604
3.450	-26.081	14.920
3.500	-28.281	10.457
3.550	-30.481	6.243
3.600	-32.681	-0.606
3.650	-34.881	-6.112
3.700	-37.081	-14.243
3.750	-39.139	-18.000
3.800	-40.560	-25.215
3.850	-41.300	-32.000
3.900	-41.360	-33.349
3.950	-41.110	-41.615
4.000	-40.860	-47.730
4.050	-40.610	-46.000
4.100	-40.360	-32.962
4.150	-40.095	-26.475
4.200	-39.382	-20.334
4.250	-38.018	0.284
4.300	-36.019	0.228

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES: 1:2000 FULL SIZE A1; 1:500 FULL SIZE A1

Plot Date: 03/03/16 - 14:06

CLIENT: NSW GOVERNMENT Transport for NSW

The information shown on this drawing is for the purposes of the North West Rail Link (NWRL) Project only. No warranty is given or implied as to its suitability for any other purpose. The Service Providers accept no liability arising from the use of this drawing and the information shown thereon for any purpose other than the North West Rail Link (NWRL) Project.

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN: JULIAN SINGH
DESIGNED: DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST
SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 9

STATUS: ISSUED FOR INFORMATION | SHEET 9 OF 15 | ©
NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300958 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

100mm AT FULL SIZE Plot Date: 03/03/16 - 14:06 Cad File: X:\09_CADD\Drawings\30_SHCSysWide\NWRLSRT-PBA-SHC-GE-DWG-300958.dwg

GEOTECHNICAL LEGEND

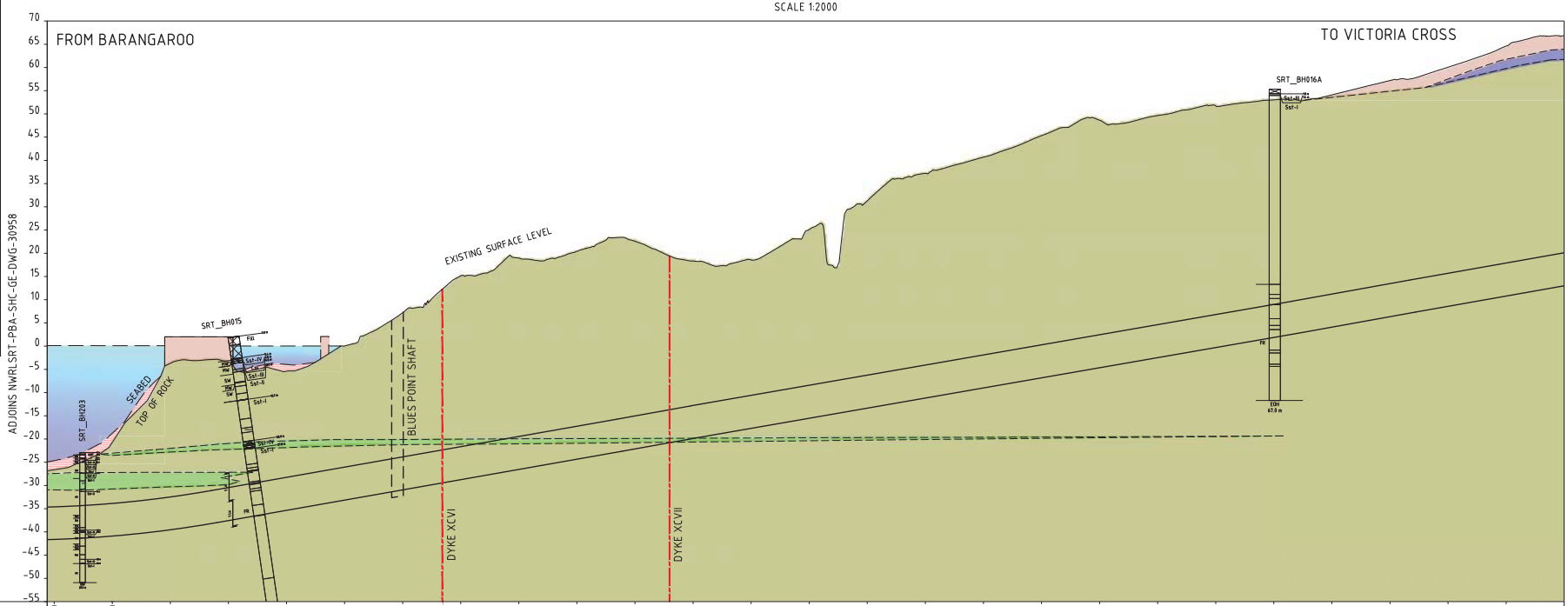
- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST

PLAN
SCALE 1:2000



DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:06

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST

SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 10

STATUS: ISSUED FOR INFORMATION | SHEET 10 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300959 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

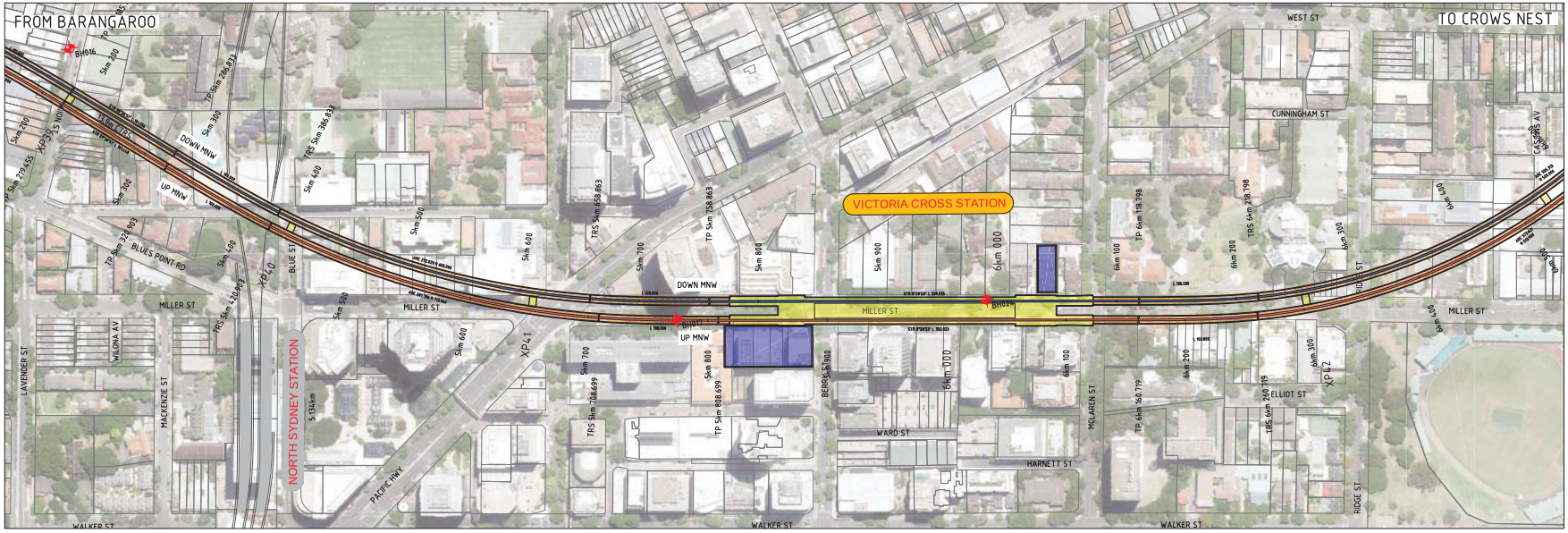
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

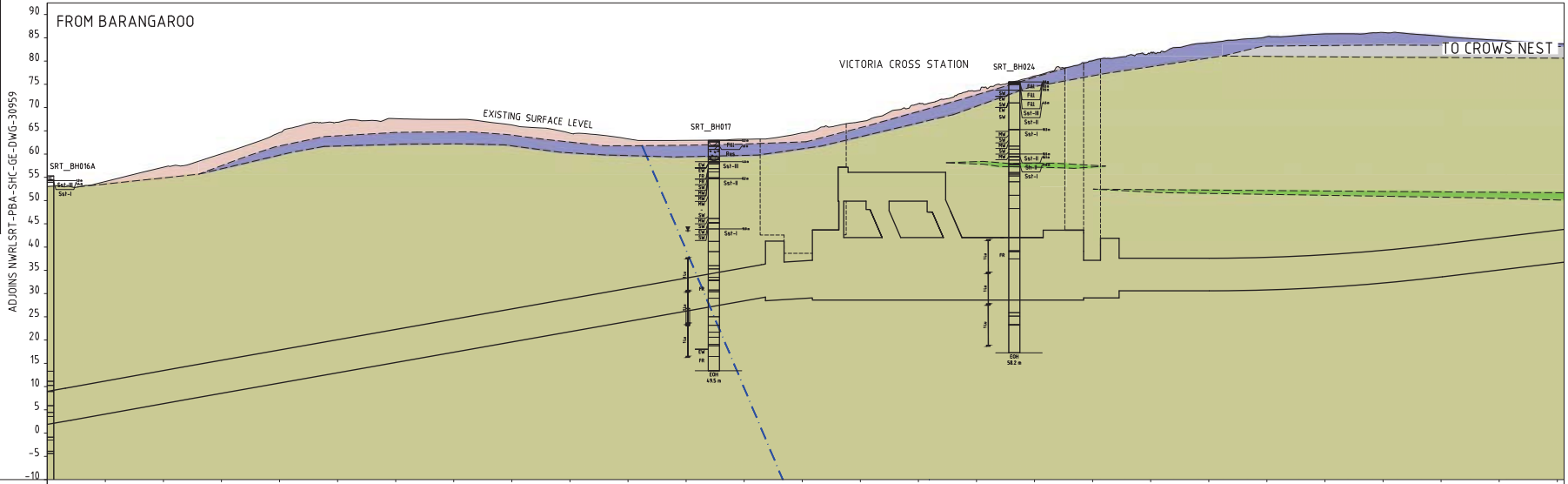
HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST



PLAN
SCALE 1:2000



KILOMETRAGE	5.250	5.300	5.350	5.400	5.450	5.500	5.550	5.600	5.650	5.700	5.750	5.800	5.850	5.900	5.950	6.000	6.050	6.100	6.150	6.200	6.250	6.300	6.350	6.400	6.450	6.500
PROPOSED RAIL LEVELS	5.616	7.866	10.091	12.299	14.506	16.714	18.921	21.129	23.336	25.544	27.751	29.959	31.801	32.100	32.100	32.100	32.100	32.100	32.100	32.100	32.285	32.844	33.779	35.089	36.589	38.089
EXISTING SURFACE	54.086	57.169	60.045	64.591	66.820	67.683	67.439	66.242	64.495	63.253	62.931	63.167	64.573	66.946	70.855	73.582	76.777	80.060	81.826	83.916	85.218	85.838	86.156	85.308	84.459	83.712

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:07

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST

SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 11

STATUS: ISSUED FOR INFORMATION | SHEET 11 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300960 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

GEOTECHNICAL LEGEND

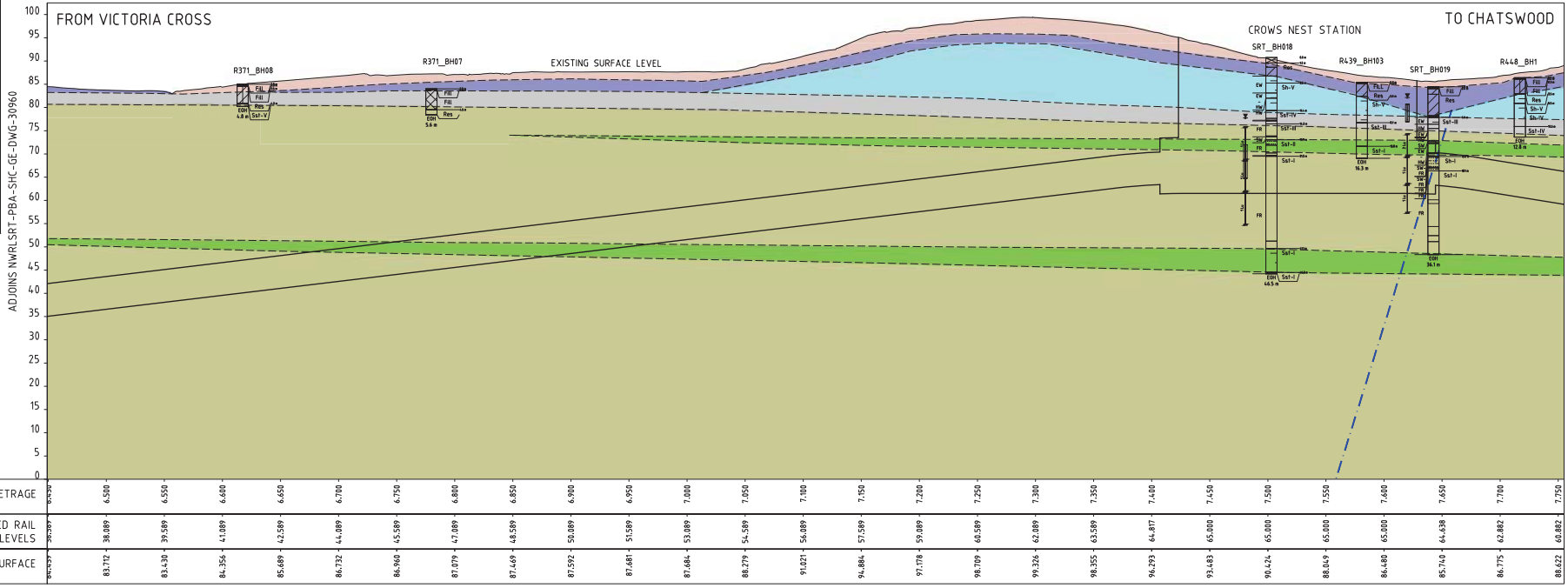
- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST

PLAN
SCALE 1:2000



DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:07

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST
SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 12

STATUS: ISSUED FOR INFORMATION | SHEET 12 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300961 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

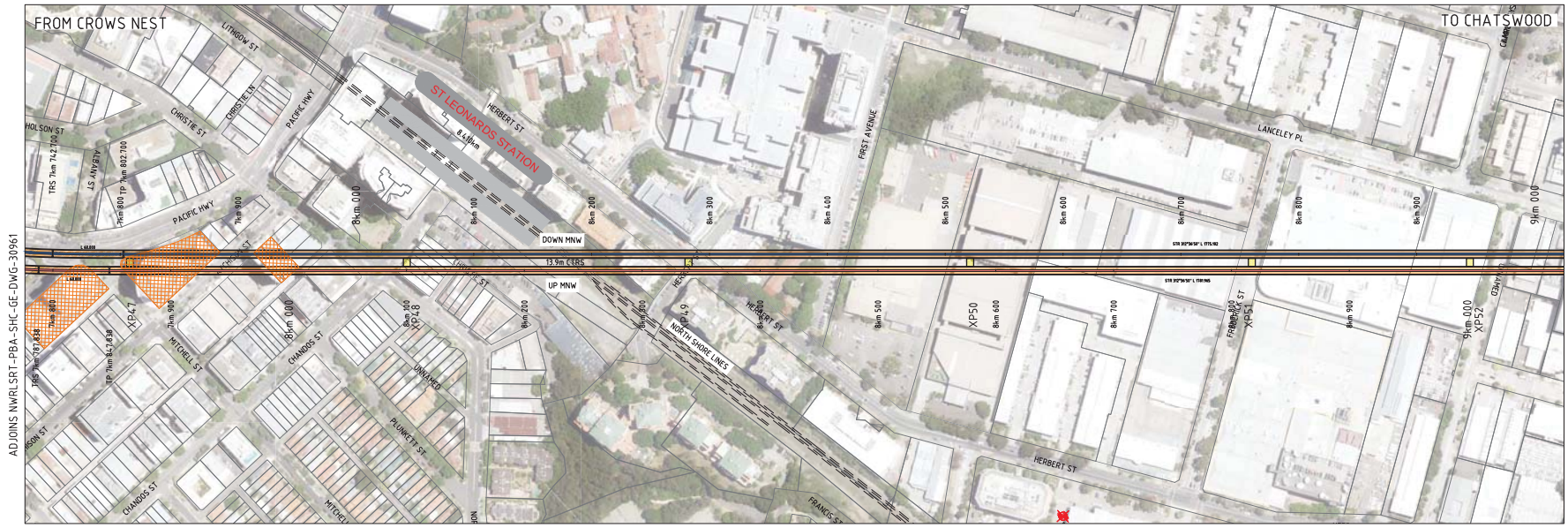
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

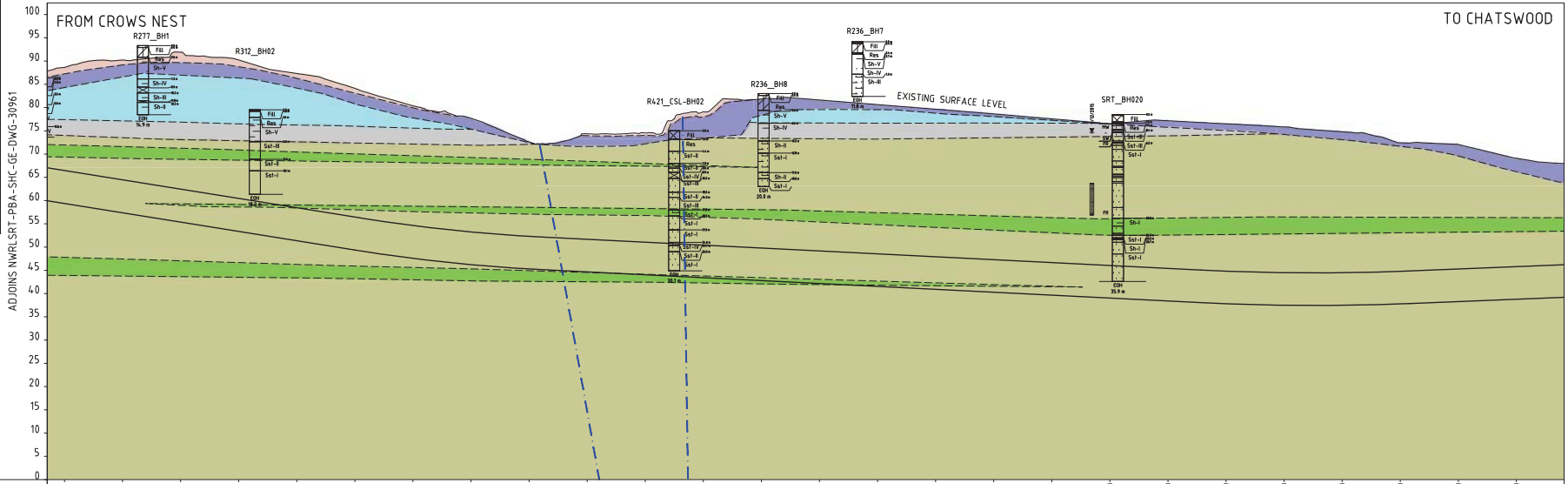
HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST



PLAN
SCALE 1:2000



KILOMETRAGE	7.750	7.800	7.850	7.900	7.950	8.000	8.050	8.100	8.150	8.200	8.250	8.300	8.350	8.400	8.450	8.500	8.550	8.600	8.650	8.700	8.750	8.800	8.850	8.900	8.950	9.000
PROPOSED RAIL LEVELS	60.882	58.882	56.882	54.882	52.882	50.882	49.091	47.730	46.799	46.164	45.539	44.914	44.289	43.664	43.039	42.414	41.789	41.164	40.539	39.914	39.322	38.998	38.985	39.286	39.782	40.282
EXISTING SURFACE	88.622	90.197	91.880	90.205	87.317	84.093	80.391	77.679	72.593	74.348	74.531	79.081	81.853	81.607	80.617	79.627	78.624	77.545	77.727	77.154	76.497	75.814	74.777	72.409	72.035	69.111

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:07

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST
SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 13

STATUS: ISSUED FOR INFORMATION | SHEET 13 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300962 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

GEOTECHNICAL LEGEND

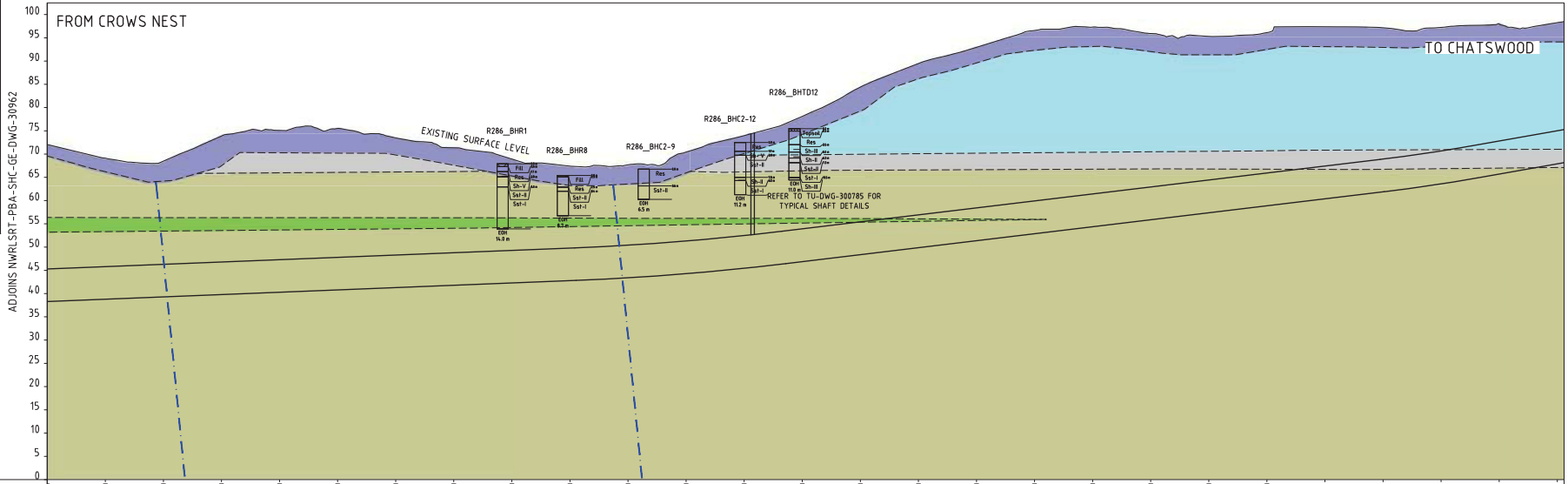
- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST

PLAN
SCALE 1:2000



DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
D	JS	03.03.16	v09 ISSUED FOR EIS	SM
C	JS	02.12.15	ISSUED FOR INFORMATION ONLY	SM
B	JS	18.11.15	ISSUED FOR INFORMATION ONLY	SM
A	JS	28.08.15	ISSUED FOR DRAFT DEFINITION DESIGN	SM

SCALES: 1:2000 FULL SIZE A1; 1:500 FULL SIZE A1

Plot Date: 03/03/16 - 14:07

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN: JULIAN SINGH
DESIGNED: DAVID OCH
DRG CHECK:
DESIGN CHECK:
APPROVED:

SYDNEY METRO CITY & SOUTHWEST

SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 14

STATUS: ISSUED FOR INFORMATION | SHEET 14 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300963 | NWRL REV. D

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

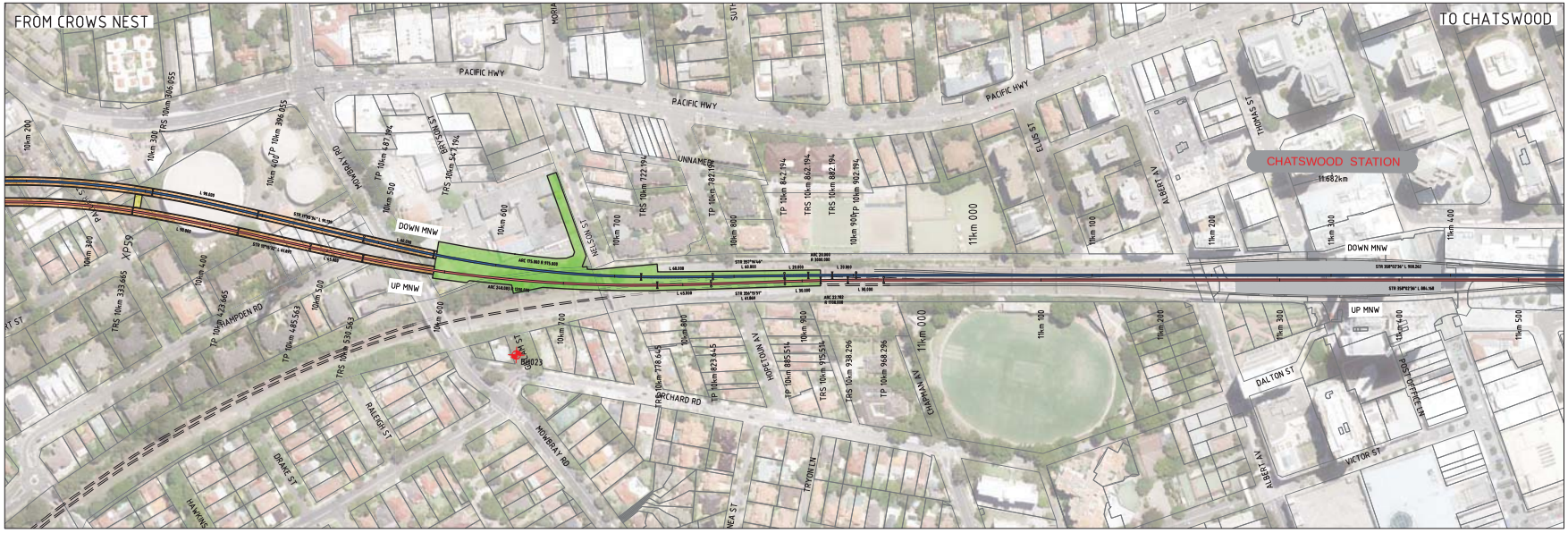
GEOTECHNICAL LEGEND

- FILL
- QUATERNARY SEDIMENTS
- RESIDUAL
- SILTSTONE / LAMINITE
- ASHFIELD SHALE
- MITTAGONG FORMATION
- HAWKESBURY SANDSTONE

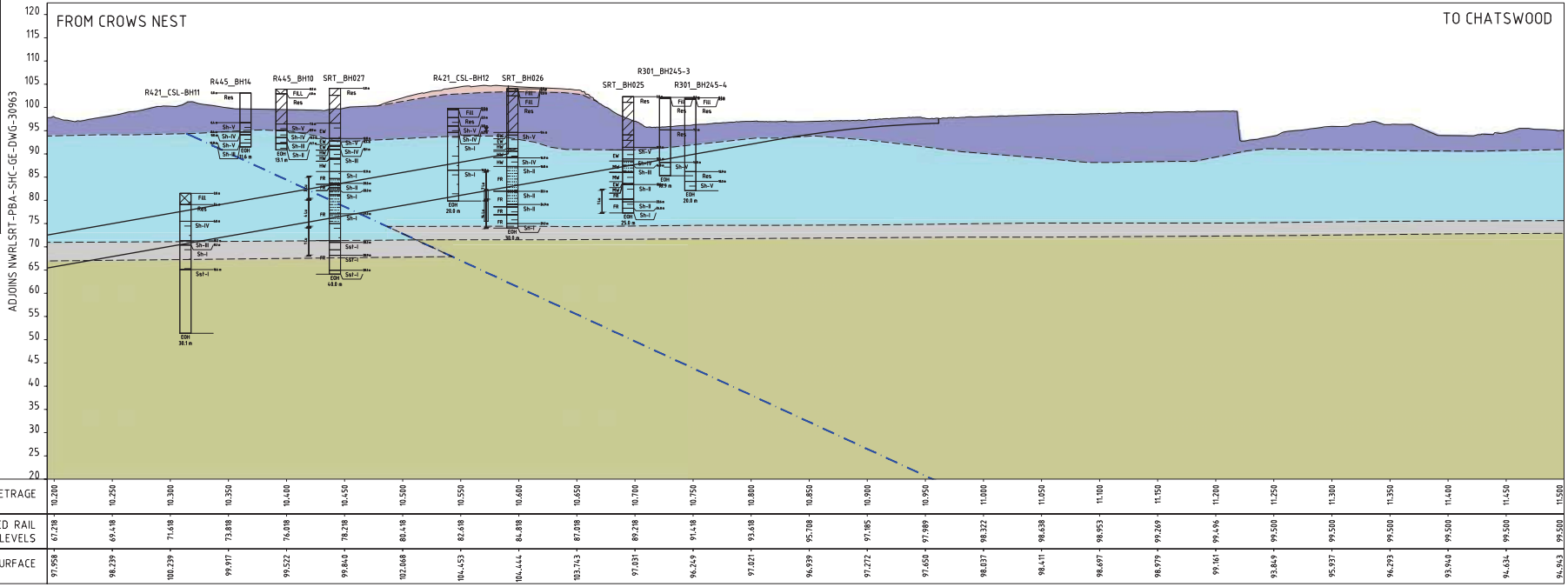
HARBOUR SEDIMENTS

- UNIT 1 — SILTY SAND WITH INTERBEDS OF SILTY CLAY AND SAND WITH SHELLS
- UNIT 2 — SAND WITH MINOR INTERBEDS OF CLAYEY SAND AND SANDY CLAY WITH SHELLS
- UNIT 3 — SILTY CLAY WITH INTERBEDS OF CLAY, SANDY SILT, SANDY CLAY AND MINOR SAND LENSES WITH SHELLS
- UNIT 4 — SILTY SAND WITH INTERBEDS OF SILTY CLAY, SAND WITH CHARCOAL AND WOODY FRAGMENTS, NO SHELLS
- UNIT 5 — COLLUVIUM, SANDY CLAY AND SILTY CLAY WITH COBBLES AND BOULDERS OF SANDSTONE WITH CHARCOAL AND WOODY FRAGMENTS

- FAULT LINE (INFERRED)
- DYKE (INFERRED)
- GROUNDWATER LEVEL & SCREEN DEPTH
- PACKER TEST INTERVAL (LUGEON)
- BH — SYDNEY METRO BOREHOLE
- CPT — SYDNEY METRO CONE PENETRATION TEST



PLAN
SCALE 1:2000



KILOMETRAGE	10.200	10.250	10.300	10.350	10.400	10.450	10.500	10.550	10.600	10.650	10.700	10.750	10.800	10.850	10.900	10.950	11.000	11.050	11.100	11.150	11.200	11.250	11.300	11.350	11.400	11.450	11.500
PROPOSED RAIL LEVELS	67.218	69.418	71.618	73.818	76.018	78.218	80.418	82.618	84.818	87.018	89.218	91.418	93.618	95.708	97.185	97.989	98.322	98.638	98.953	99.269	99.496	99.500	99.500	99.500	99.500	99.500	99.500
EXISTING SURFACE	97.958	98.239	100.239	99.917	99.522	99.840	102.068	104.453	104.444	103.743	97.031	96.249	97.021	96.939	97.272	97.650	98.037	98.411	98.697	98.979	99.161	93.849	95.937	96.293	93.940	94.634	91.943

DOWN MSW / UP MNW LONGITUDINAL SECTION
SCALE 1:2000 (HORIZONTAL) SCALE 1:500 (VERTICAL)

FOR INFORMATION ONLY

REV.	BY	DATE	DESCRIPTION	APPD.
A	JS	03.03.16	v09 ISSUED FOR EIS	SM

SCALES
1 : 2000 FULL SIZE A1
1 : 500 FULL SIZE A1

Plot Date: 03/03/16 - 14:08

CLIENT: NSW GOVERNMENT Transport for NSW

SERVICE PROVIDERS: PARSONS BRINCKERHOFF, AECOM, COX HASSELL

DRAWN JULIAN SINGH
DESIGNED DAVID OCH
DRG CHECK
DESIGN CHECK
APPROVED

SYDNEY METRO CITY & SOUTHWEST
SECOND HARBOUR CROSSING SYSTEM WIDE
GEOTECHNICAL
GEOTECHNICAL PROFILE - DOWN MSW / UP MNW (SOUTHBOUND)
SHEET 15

STATUS: ISSUED FOR INFORMATION | SHEET 15 OF 15 | ©

NWRL Drg No. NWRLSRT-PBA-SHC-GE-DWG-300964 | NWRL REV. A

A1 Original | Co-ordinate System: MGA Zone 56 | Height Datum: A.H.D. | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

Appendix C. Selected Borehole Logs along the Alignment

These data were obtained from information provided by Transport for NSW from boreholes and piezometers installed as part of the Sydney Metro City & Southwest project.

Project Alignment (north to south):

BH023 and BH026 – Chatswood dive structure

BH020 – Artarmon

BH018 and BH019 – Crows Nest Station

BH017 – Victoria Cross Station

BH015 – Blues Point temporary site

BH014 – Barangaroo Station

BH012 – Martin Place Station

BH008 and BH009 – Pitt Street Station

BH006 – Central Station (piezometer construction only)

BH403 – Waterloo Station

BH002 and BH002A – Marrickville dive structure

BOREHOLE: SRT BH002

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 1 OF 5 REV: F

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Edgeware Road, Marrickville
PROJECT No: PSC No.00013/10464

COORDS: 331227.0 m E 6246461.0 m N MGA94 56
SURFACE RL: 5.30 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 31.20 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 14/4/15
CHECKED: DF/LM FINISH: 21/4/15

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DTC			0	5.22					ROAD SURFACE: ASPHALT			ROAD SURFACE
				0.30					BASECOURSE: Clayey GRAVEL medium grained, angular, igneous, dark grey			BASECOURSE
HA	H			5.00					FILL: Silty CLAY high plasticity, mottled grey and pale orange, trace dark grey clay layers	M (<PL)		FILL
				0.70								
				4.60	DS 0.70-0.80 m Rec = 100/100 mm							
	L		1	1.00					FILL: Silty CLAY low plasticity, dark brown grey, trace organic fragments (timber), trace fine grained, sub-angular carbonaceous black gravel	M (>PL)		
				4.30	DS 1.00-1.20 m Rec = 200/200 mm							
				1.30					no organic fragments or carbonaceous gravel			
				4.00	SPT 1.30-1.75 m 3, 3, 5 N=8							RESIDUAL SOIL
ADT	M	GWNE							Silty CLAY high plasticity, pale grey and red, trace fine to medium grained sand, trace fine to medium grained ironstone gravel		F - St	
					DS 1.80-2.00 m Rec = 200/200 mm					M (<PL)		
	H		2								VSt	
					SPT 2.50-2.95 m 4, 9, 13 N=22 Rec = 450/450 mm							
			3						For Continuation Refer to Sheet 2			
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F01a RL3

BOREHOLE: SRT BH002

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 2 OF 5 REV: F

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Edgeware Road, Marrickville
PROJECT No: PSC No.00013/10464

COORDS: 331227.0 m E 6246461.0 m N MGA94 56
SURFACE RL: 5.30 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 31.20 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 14/4/15
CHECKED: DF/LM FINISH: 21/4/15

Drilling					Field Material Descriptio				Defect Informatio	
METHOD	WATER	TCR	ROD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (Ei, VL, L, M, H, VH, Ex)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)
				0							
				1							
				2							
				3	3.00		Continuation of Sheet 1				
					2.30		CORE LOSS				
					3.32						
			70	0 (0)	1.98		SILTSTONE red-brown, with ironstone gravel	EW			
					4.00						
					1.30		CORE LOSS				
			60	0 (0)	4.38						
					0.92		SILTSTONE mottled pale grey and red-brow	EW			
					5.00						
					0.24		CORE LOSS	EW		PP 5.00 m =250 - 350 kPa	
					5.45		SILTSTONE pale brow				
			95	0 (0)	-0.15		possible relic joint expressed as fine grained ironstone gravel dipping at approximately 40 to 50 degrees			PP 5.50 m =250 - 350 kPa	
					6.00					DS 5.75-5.80 m DS 5.80-6.00 m PP 6.00 m =300 - 350 kPa	
					-0.70		pale grey				
			100	0 (0)						PP 6.50 m =350 - 400 kPa	
					7.12					PP 7.00 m =350 - 400 kPa	
					-1.82		SILTSTONE grey and orange brown, sub-horizontal bedding	HW		7.31 m: B, 0°, Pl, Sm, Fe S	
			100	80 (80)	7.58			SW			
					-2.28		SILTSTONE grey, sub-horizontal bedding			8.00 m: B, 0°, Pl, Sm, C	
					8.30						
HQ3	GWNO		100	85 (95)	-3.00		SILTSTONE dark grey, sub-horizontal bedding			8.57 m: B, 0°, Pl, Sm, C	
								EW			
					9.08			SW			
					-3.78		LAMINITE dark grey and pale grey, well developed sub-horizontal bedding			9.25 m: B, 0°, Un, Sm, C	
			95	55 (70)	9.37						
					-4.07		SILTSTONE dark grey, sub-horizontal bedding	FR			
				10							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH002

SHEET: 3 OF 5 REV: F

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Edgeware Road, Marrickville
PROJECT No PSC No.00013/10464

COORDS: 331227.0 m E 6246461.0 m N MGA94 56
SURFACE RL: 5.30 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 31.20 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 14/4/15
CHECKED: DF/LM FINISH: 21/4/15

Drilling						Field Material Descriptio				Defect Informatio	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	GWNO	95	55 (70)	10	10.12						
					-4.82		LAMINITE dark grey and pale grey, well developed sub-horizontal bedding, 35% sandstone, 65% siltstone, dark grey	FR		10.02 m: J, 35-45°, Un, Sm, C	
										10.28 m: J, 30°, Pl, Sm, C	
				11				MW		10.49-11.64 m: DS, 0°, sp = 50-100 mm, Pl, Sm, clay Vr, <=12 mm, decomposed seams contain very low strength siltstone, some sheared zones	
								FR			
		80	68 (70)	12	12.65					12.22 m: B, 0°, Pl, Sm, clay Vr 12.32 m: SS, 0°, Pl, Sm, clay Vr, 20mm 12.50 m: SS, 0°, Pl, Sm, clay Vr, 3mm 12.55 m: DS, 0°, Pl, Sm, clay Ct, =9 mm	
					12.80		CORE LOSS				
					-7.50		LAMINITE dark grey and pale grey, well developed sub-horizontal bedding, 35% sandstone, 65% siltstone, dark grey	FR		12.84 m: B, 0°, Pl, Sm, C	
		100	100 (100)	14							
				15							
					16.00						
					-10.70		becoming 20% sandstone, 80% siltstone, well developed bedding at 0° to 5°				
		100	100 (100)	17							
										17.70 m: J, 45°, Pl, Sm, clay Vr	
				18							
					18.90						
		100	99 (83)	19	-13.60					19.46 m: B, 15°, Pl, Sm, C 19.48 m: J, 50°, Pl, Sm, C 19.69 m: CZ, 40°, Un, Sm, Cn, 40mm	
					19.95					19.85 m: SZ, Along bedding 40mm	
				20							

BOREHOLE: SRT BH002

SHEET: 4 OF 5 REV: F

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Edgeware Road, Marrickville
PROJECT No PSC No.00013/10464

COORDS: 331227.0 m E 6246461.0 m N MGA94 56
SURFACE RL: 5.30 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 31.20 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 14/4/15
CHECKED: DF/LM FINISH: 21/4/15

Drilling						Field Material Descriptio				Defect Informatio	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	GWNO	100	99 (83)	20	-14.65		SILTSTONE dark grey, sub-horizontal bedding	FR		19.90 m: J, 15°, Pl, Sm, C	
										20.51 m: J, 5°, Pl, Sm, C	
				21							
										21.78 m: J, 5°, Pl, Sm, C	
		100	100 (100)	22						22.09 m: J, 45°, Pl, Sm, C 22.22 m: J, 45°, Pl, Sm, C 22.29 m: B, 0°, Pl, Sm, Cn, 1mm white material - tuff? marker bed	
				23							
		100	95 (95)	24						24.51 m: B, 0°, Pl, Sm, C	
					25.05						
					-19.75		SANDSTONE AND SILTSTONE fine grained, pale grey, disturbed bedding, 60% sandstone, 40% siltstone				
		100	100 (100)	26							
					26.45						
					-21.15		SANDSTONE AND SILTSTONE fine to medium grained, pale grey and grey, irregular bedding, 50% sandstone, 50% siltstone			26.44 m: J, 15°, Un, Ro, C 26.63 m: B, 0°, Un, Ro, C	
				27	27.31						
		100	100 (100)		-22.01		SANDSTONE WITH SILTSTONE LAMINATIONS fine to medium grained, sub-horizontal bedding				
					27.95						
				28	-22.65		laminite 200mm thick, 50% sandstone, 50% siltstone				
					28.62						
					-23.34		conglomeratic sandstone layer, fine grained sub-rounded gravels			28.71 m: B, 5°, Un, Ro, C	
		100	97 (100)	29			LAMINITE dark grey and pale grey, well developed bedding at 5° to 10°, 65% siltstone, 35% sandstone				
				30							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a
RL3

BOREHOLE: SRT BH002

CLIENT:	Transport for New South Wales	COORDS: 331227.0 m E 6246461.0 m N MGA94 56	SHEET: 5 OF 5 REV: F
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 5.30 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Edgeware Road, Marrickville	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 31.20 m	LOGGED: AMS START: 14/4/15
			CHECKED: DF/LM FINISH: 21/4/15

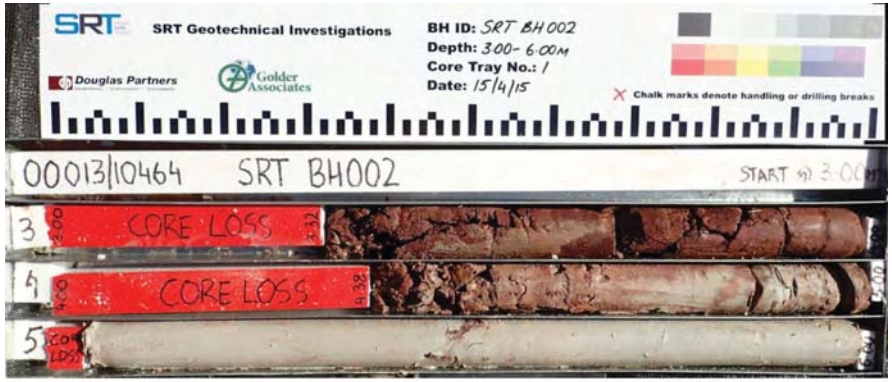
Drilling						Field Material Descriptio				Defect Informatio	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH >10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	GWNO	100	97 (100)	30	30.73		SANDSTONE WITH FLECKS OF SILTSTONE fine to medium grained, horizontally bedded	FR		30.10 m: J, 40°, Pl, Ro, C 30.19 m: B, 0°, Un, Ro, C	
					30.80 -25.50		SANDSTONE WITH SILTSTONE LAMINATIONS fine to medium grained, well developed bedding				
				31	31.20 -25.90		END OF BOREHOLE @ 31.20 m TARGET DEPTH PIEZOMETER INSTALLED				
				32							
				33							
				34							
				35							
				36							
				37							
				38							
				39							
				40							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

CORE PHOTOGRAPHS: SRT BH002

CLIENT:	Transport for New South Wales	COORDS: 331227.0 m E 6246461.0 m N MGA94 56	SHEET: 1 OF 4 REV: F
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 5.30 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Edgeware Road, Marrickville	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 31.20 m	LOGGED: AMS START: 14/4/15
			CHECKED: DF/LM FINISH: 21/4/15



This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH002

CLIENT:	Transport for New South Wales	COORDS: 331227.0 m E 6246461.0 m N MGA94 56	SHEET: 2 OF 4 REV: F
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 5.30 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Edgeware Road, Marrickville	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 31.20 m	LOGGED: AMS START: 14/4/15
			CHECKED: DF/LM FINISH: 21/4/15

CORE PHOTOGRAPHS: SRT BH002

CLIENT:	Transport for New South Wales	COORDS: 331227.0 m E 6246461.0 m N MGA94 56	SHEET: 3 OF 4 REV: F
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 5.30 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Edgeware Road, Marrickville	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 31.20 m	LOGGED: AMS START: 14/4/15
			CHECKED: DF/LM FINISH: 21/4/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH002

SHEET: 4 OF 4 REV: F

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Edgeware Road, Marrickville
PROJECT No PSC No.00013/10464

COORDS: 331227.0 m E 6246461.0 m N MGA94 56
SURFACE RL: 5.30 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 31.20 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 14/4/15
CHECKED: DF/LM FINISH: 21/4/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

FINAL STANDPIPE INSTALLATION: SRT BH002

SHEET: 1 OF 1 REV: Final

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Edgeware Road, Marrickville
PROJECT No PSC No.00013/10464

COORDS: 331227.0 m E 6246461.0 m N MGA94 56
SURFACE RL: 5.30 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 31.20 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 14/4/15
CHECKED: DF/LM FINISH: 21/4/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
HA/DTC		0	5.22		ASPHALT	Gatic cover
			1.30		FILL: CLAY	
ADT	GW/NE		4.00		SILTY CLAY	<5mm sand/gravel
			3.00			
			2.30		SILTSTONE	
		5				4.50, RL0.80
						Cement Bentonite Grout
		10	10.12			
			-4.82		LAMINITE	
						12.00, RL-6.70
						Bentonite
						13.00, RL-7.70
						<5mm sand/gravel
						14.00, RL-8.70
H 3	GW/NO	15				PVC slotted screen with filter sock
						17.00, RL-11.70
						<5mm sand/gravel
						18.00, RL-12.70
						Bentonite
		20	19.95			20.40, RL-15.10
			-14.65		SILTSTONE	
		25	25.05			Cement Bentonite Grout
			-19.75		SANDSTONE AND SILTSTONE	
		30				
			31.20		END OF BOREHOLE @ 31.20 m TARGET DEPTH	31.20, RL-25.90

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17 RL1

NALSDTITP ISNALEELAIOS: NRA BH002L

SHEET: 1 OF 1 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Edgeware Road, Marrickville
PROJECT NoPSC No.00013/10464

COORDS: 331226.0 m E 6246467.0 m N MGA94 56
SURFACE RL: 5.30 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 7.10

DRILL RIG: Scout 4
CONTRACTOR: Ground Test
LOGGED: AMS START: 18/4/15
CHECKED: DF FINISH: 20/4/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
DTC		0	0.08 5.22		ASPHALT FILL: CLAY	Gatic cover Cement Bentonite Grout 0.50, RL4.80 Bentonite 1.10, RL4.20
HA		1	1.30			
ADT		2	4.00		SILTY CLAY	
		3	3.00 2.30		SILTSTONE	PVC Slotted screen with filter sock
		4				
		5				5.60, RL-0.30 <5mm sand/gravel
		6				6.60, RL-1.30
		7	7.10 -1.80		END OF BOREHOLE @ 7.10 STRATIGRAPHY INFERRED FROM BOREHOLE SRT BH002 MONITORING WELL INSTALLED	Bentonite 7.10, RL-1.80

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17 RL1

STANDPIPE INSTALLATION: SRT BH006

SHEET: 1 OF 1 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: South of Platform 15, Central Station
PROJECT NoPSC No.00013/10464

COORDS: 334063.6 m E 6249133.1 m N MGA94 56
SURFACE RL: 20.60 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 33.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: LJH/JS START: 1/8/15
CHECKED: HB/LM FINISH: 2/8/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
NDD		0	0.50		GRAVEL	
ADT	GWNO		20.00		CONCRETE SAND	
WB		5	4.20 16.40		CLAY	
			7.50			
HQ3		10	12.96		CORE LOSS SANDSTONE	Cement bentonite grout
		15				
		20				
		25				25.50, RL-4.90 26.00, RL-5.40 Bentonite 26.50, RL-5.90 Filter sand Slotted PVC screen with filter sock 29.50, RL-8.90 Filter sand
		30	33.00 -12.40		END OF BOREHOLE @ 33.00 m TARGET DEPTH GROUTED	31.00, RL-10.40 Bentonite 32.00, RL-11.40 Cement bentonite grout 33.00, RL-12.40

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17 RL1

STANDPIPE INSTALLATION: SRT BH008

SHEET: 1 OF 1 REV: D

CLIENT: Transport for New South Wales
COORDS: 334259.3 m E 6250393.5 m N MGA94 56
DRILL RIG: Hanjin D&

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 23.80 m DATUM: AHD
CONTRACTOR: Total Drilling

LOCATION: Adjacent to 309-313 Pitt Street, Sydney
INCLINATION: -90°
LOGGED: AMS START: 9/6/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 42.28 m
CHECKED: DF/LM FINISH: 17/6/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
NDD		0	23.80		NON-DESTRUCTIVE DIGGING	Gatic cover
			2.00			Bentonite
AST			21.80		SILTY CLAY	2.00, RL21.80
HQ3		5	5.50			
			18.30		SANDSTONE	
		10				Cement Bentonite Grout
		15				17.50, RL6.30
						Bentonite
		20				<5mm sand/gravel
						PVC slotted screen with filter sock
						21.50, RL2.30
						22.40, RL1.40
HQ3		25				Bentonite
						25.60, RL-1.80
		30				Cement Bentonite Grout
		35				
		40	42.28		END OF BOREHOLE @ 42.28 m TARGET DEPTH PIEZOMETER INSTALLED	42.28, RL-18.48

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17
RL1

BOREHOLE: SRT BH009

SHEET: 1 OF 5 REV: D

CLIENT: Transport for New South Wales
COORDS: 334355.5 m E 6250386.5 m N MGA94 56
DRILL RIG: Hanjin D&B

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 25.40 m DATUM: AHD
CONTRACTOR: Total Drilling

LOCATION: Adjacent to 197-199 Castlereagh Street, Sydney
INCLINATION: -90°
LOGGED: AMS START: 24/6/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 35.00 m
CHECKED: HB FINISH: 6/7/15

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (met es)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
NDD			0	25.40					NON-DESTRUCTIVE DIGGING			
			1	1.70								
WB		GWNE		23.70				CI	Silty CLAY medium plasticity, pale grey and red-brown, trace fine to medium grained, sub-angular ironstone gravel	M (<PL)	VSt	RESIDUAL SOIL
			2		SPT 2.50-2.95 m 5, 8, 12 N=20 Rec = 450/450 mm							
				3.00								
HQ3			3	22.40	C 3.00-4.00 m Rec = 1000/1000 mm			CI-CH	Gravelly CLAY medium to high plasticity, pale grey and orange-brown, medium to course grained, sub-angular ironstone gravel, with some silt		VSt	
				3.40								
			4	22.00	C 4.00-5.00 m Rec = 1000/1000 mm				pale grey and dark red			
				4.44								
				20.96				CI-CH	Silty CLAY medium to high plasticity, pale grey		H	
		GWNO	5		C 5.00-6.18 m Rec = 1200/1180 mm							
			6						For Continuation Refer to Sheet 2			
			7									
			8									
			9									
			10									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared fo geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are fo information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F01a
RL3

BOREHOLE: SRT BH009

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 2 OF 5 REV: D

CLIENT: Transport for New South Wales
COORDS: 334355.5 m E 6250386.5 m N MGA94 56
DRILL RIG: Hanjin D&B

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 25.40 m DATUM: AHD
CONTRACTOR: Total Drilling

LOCATION: Adjacent to 197-199 Castlereagh Street, Sydney
INCLINATION: -90°
LOGGED: AMS START: 24/6/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 35.00 m
CHECKED: HB FINISH: 6/7/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	9 DEPT RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, Ex 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4							
				5							
				6	3.00		Continuation of Sheet 1				
HQ3					3.48		SANDSTONE medium grained, dark red and pale grey	EW - HW			
					19.22		SANDSTONE medium grained, pale orange, poorly developed bedding	HW		6.32-6.92 m: J, 85°, Un, Ro, iron stained	
				7	5.04						
					18.39		INTERBEDDED SANDSTONE AND SILTSTONE fine to medium grained, grey and dark grey, horizontally bedded	SW		7.03-7.05 m: B, 0°, Pl, Ro, Cn 7.05-7.52 m: Jx 2, 85°, Pl, Ro, Cn 7.10-7.28 m: Bx 4, 0-5°, Pl, Ro, Cn 7.25-7.62 m: Bx 4, 0-5°, Pl, Ro, Cn	
					5.17						
		95	45 (90)		18.01		SANDSTONE medium grained, grey, poorly developed bedding				
					5.76						
				8	8.07		CORE LOSS				
					17.31		SANDSTONE WITH SILTSTONE LAMINATIONS medium grained, pale grey, irregular bedding			8.18 m: J, 5°, Pl, Ro, iron stained Sn 8.20-8.80 m: J, 85°, Pl, Ro, iron stained Sn	
					8.68						
					16.92		from 8.48 to 8.89 m: occasional carbonaceous layers				
				9							
					7.12					9.34-9.35 m: DS, 0°, Pl, Ro, clay 9.47-9.48 m: DS, 0°, Pl, Ro, clay	
		95	95 (95)		15.95		CORE LOSS				
							SANDSTONE WITH SILTSTONE LAMINATIONS medium grained, pale grey, irregular bedding			9.80-10.00 m: J, 80°, Pl, Ro, iron stained Sn	
				10							

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

BOREHOLE: SRT BH009

SHEET: 3 OF 5 REV: D

CLIENT: Transport for New South Wales
COORDS: 334355.5 m E 6250386.5 m N MGA94 56
DRILL RIG: Hanjin D&B

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 25.40 m DATUM: AHD
CONTRACTOR: Total Drilling

LOCATION: Adjacent to 197-199 Castlereagh Street, Sydney
INCLINATION: -90°
LOGGED: AMS START: 24/6/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 35.00 m
CHECKED: HB FINISH: 6/7/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	9 DEPT RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, Ex 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				10			SANDSTONE WITH SILTSTONE LAMINATIONS medium grained, pale grey, irregular bedding	FR			
		95	95 (95)	11						11.05 m: B, 5°, Un, Ro, Cn 11.38 m: B, 10°, Pl, Ro, Cn	
				12						11.89 m: B, 5°, Pl, Ro, sandy clay Vr 12.03 m: B, 5°, Pl, Ro, sandy clay Vr	
		100	100 (100)							12.35 m: B, 10°, Pl, Ro, Cn 12.72 m: B, 10°, Pl, Ro, sandy clay Vr 12.84 m: B, 10°, Pl, Ro, sandy clay Vr	
				13						13.03 m: B, 20°, Pl, Ro, sandy clay Vr 13.13 m: B, 15°, Pl, Ro, carbonaceous Vr	
										13.55 m: B, 10°, Un, Ro, sandy clay Vr 13.72 m: B, 5°, Pl, Ro, carbonaceous Vr	
				14							
HQ3					46.70						
				15	10.50		SANDSTONE WITH CARBONACEOUS LAMINATIONS medium grained, pale grey, poorly developed cross bedding at 10-20°			14.83-14.86 m: DS, 20°, Pl, Ro, very low strength sandstone 15.58 m: B, 15°, Pl, Ro, carbonaceous Vr	
		95	95 (95)								
				16						16.23 m: B, 20°, Pl, Ro, carbonaceous Vr	
				17	45.60						
					8.00		SILTSTONE WITH SANDSTONE LAMINATIONS fine grained, pale grey and dark grey, sub-horizontal bedding			17.40 m: B, 0°, Pl, Ro, Cn	
					45.37						
					45.81						
					7.57		CORE LOSS				
				18			SANDSTONE WITH CARBONACEOUS LAMINATIONS medium grained, pale grey, sub-horizontally bedded				
					48.3H						
					6.78		SANDSTONE medium grained, massive, pale grey, with a trace of irregular bedding			18.82 m: J, 60°, Pl, Ro, Cn	
		100	100 (100)	19						19.17 m: B, 5°, Pl, Ro, clay Ct, <=6 mm	
				20						19.90 m: B, 20°, Pl, Ro, clay Vr	

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH009

SHEET: 4 OF 5 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 197-199 Castlereagh Street, Sydney
PROJECT No PSC No.00013/10464

COORDS: 334355.5 m E 6250386.5 m N MGA94 56
SURFACE RL: 25.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 35.00 m

DRILL RIG: Hanjin D&B
CONTRACTOR: Total Drilling
LOGGED: AMS START: 24/6/15
CHECKED: HB FINISH: 6/7/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	9 DEPT RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	50% water / ss	100	100 (100)	20			SANDSTONE medium grained, massive, pale grey, with a trace of irregular bedding	FR		20.31 m: B, 10°, Pl, Ro, Cn	
				21						21.03-21.20 m: J, 75°, Pl, Ro, Cn 21.10 m: B, 10°, Pl, Ro, clay Ct, <=4 mm	
					H4.58					21.71 m: B, 15°, Pl, Ro, clay Ct, =2 mm	
					3.52		CORE LOSS				
		100	100 (100)	22			SANDSTONE WITH SILTSTONE LAMINATIONS medium to coarse grained, pale grey, poorly developed cross bedding at 10-20°			21.90 m: B, 20°, Pl, Ro, clay Vr 22.58 m: J, 70°, Pl, Ro, Cn	
				23						23.32 m: B, 0°, Un, Ro, Cn 23.55 m: B, 15°, Un, Ro, Cn 23.73 m: B, 15°, Pl, Ro, Cn 23.88 m: B, 10°, Pl, Ro, clay Vr	
					H6.13						
					1.04		SANDSTONE medium grained, grey, with occasional carbonaceous laminations, poorly developed bedding at 10-20°				
				25	H2.08					25.01-25.26 m: J, 70°, Pl, Ro, Cn	
					0.23		CORE LOSS				
		95	95 (95)				SANDSTONE medium to coarse grained, grey, poorly developed cross bedding with a trace of siltstone laminae	MW		25.69 m: Bx 2, 5°, Pl, Ro, clay Vr 25.82 m: B, 15°, Pl, Ro, iron stained Sn 25.87 m: B, 0°, Un, Ro, iron stained Sn 25.90 m: Bx 2, 15°, Un, Ro, iron stained Sn	
				26				FR		26.13 m: J, 30°, Pl, Ro, Cn 26.14 m: B, 10°, Pl, Ro, Cn 26.47 m: B, 10°, Pl, Ro, Cn	
					H5.41						
					-1.73		at 27.13 m: carbonaceous layer	SW		27.34-27.35 m: Bx 2, 0°, Pl, Ro, iron stained Sn	
				28				MW		27.73 m: B, 5°, Pl, Ro, iron stained Sn 27.79 m: B, 10°, Pl, Ro, iron stained Sn 28.04-28.06 m: Bx 2, 0°, Pl, Ro, iron stained Sn	
								SW		28.18 m: B, 10°, Un, Ro, iron stained Sn 28.33-28.38 m: Jx 3, 10-30°, Un, Ro, iron stained Sn	
					H8.26					28.44 m: B, 0°, Pl, Ro, clay Ct, <2 mm	
	100% water / ss	100	70 (100)		-3.14		SANDSTONE coarse grained, massive, pale orange, with quartz grains up to 8 mm	MW		28.51 m: B, 0°, Pl, Ro, iron stained Sn	
				29						29.17 m: B, 5°, Pl, Ro, Cn	
										29.56-29.61 m: Bx 2, 20°, Pl, Ro, Cn 29.62-29.84 m: J, 75°, Un, Ro, Cn	
				30						29.85 m: B, 0°, Pl, Ro, Cn	

BOREHOLE: SRT BH009

SHEET: 5 OF 5 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 197-199 Castlereagh Street, Sydney
PROJECT No PSC No.00013/10464

COORDS: 334355.5 m E 6250386.5 m N MGA94 56
SURFACE RL: 25.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 35.00 m

DRILL RIG: Hanjin D&B
CONTRACTOR: Total Drilling
LOGGED: AMS START: 24/6/15
CHECKED: HB FINISH: 6/7/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	9 DEPT RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100		30	10.HH			MW		29.98 m: B, 20°, Pl, Ro, Cn	
					-4.82						
		100	100 (100)		-4.83		SANDSTONE medium to coarse grained, pale grey, with occasional siltstone laminations, poorly developed bedding, with quartz grains up to 8 mm from 30.22 to 30.28 m: siltstone fragments to 10 mm	FR			
		100	100 (100)	31						31.53 m: B, 20°, Pl, Ro, Cn	
		100	100 (100)	32						32.34 m: B, 10°, Pl, Ro, clay Ct, <=3 mm 32.44 m: B, 5°, Pl, Ro, clay Vr	
		100	85 (100)	33						33.29-33.44 m: Jx 3, 50°, Pl, Ro, Cn 33.48 m: J, 60°, Pl, Ro, Cn 33.62 m: J, 40°, Pl, Ro, Cn 33.71 m: J, 70°, Pl, Ro, Cn	
				34						34.00-34.92 m: J, 80°, Un, Ro, clay Vr 34.34 m: B, 5°, Pl, Ro, clay Vr	
					12.00						
				35	-9.60		END OF BOREHOLE @ 35.00 m TARGET DEPTH PIEZOMETER INSTALLED				
				36							
				37							
				38							
				39							
				40							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a
RL3

CORE PHOTOGRAPHS: SRT BH009

CLIENT:	Transport for New South Wales	COORDS:	334355.5 m E 6250386.5 m N MGA94 56
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL:	25.40 m DATUM: AHD
LOCATION:	Adjacent to 197-199 Castlereagh Street, Sydney	INCLINATION:	-90°
PROJECT No	PSC No.00013/10464	HOLE DEPTH:	35.00 m

SHEET:	1 OF 5 REV: D
DRILL RIG:	Hanjin D&B
CONTRACTOR:	Total Drilling
LOGGED:	AMS START: 24/6/15
CHECKED:	HB FINISH: 6/7/15

CORE PHOTOGRAPHS: SRT BH009

CLIENT:	Transport for New South Wales	COORDS:	334355.5 m E 6250386.5 m N MGA94 56
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL:	25.40 m DATUM: AHD
LOCATION:	Adjacent to 197-199 Castlereagh Street, Sydney	INCLINATION:	-90°
PROJECT No	PSC No.00013/10464	HOLE DEPTH:	35.00 m

SHEET:	2 OF 5 REV: D
DRILL RIG:	Hanjin D&B
CONTRACTOR:	Total Drilling
LOGGED:	AMS START: 24/6/15
CHECKED:	HB FINISH: 6/7/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH009

CLIENT:	Transport for New South Wales	COORDS:	334355.5 m E 6250386.5 m N MGA94 56
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL:	25.40 m DATUM: AHD
LOCATION:	Adjacent to 197-199 Castlereagh Street, Sydney	INCLINATION:	-90°
PROJECT No	PSC No.00013/10464	HOLE DEPTH:	35.00 m

SHEET: 3 OF 5 REV: D
DRILL RIG: Hanjin D&B
CONTRACTOR: Total Drilling
LOGGED: AMS START: 24/6/15
CHECKED: HB FINISH: 6/7/15

CORE PHOTOGRAPHS: SRT BH009

CLIENT:	Transport for New South Wales	COORDS:	334355.5 m E 6250386.5 m N MGA94 56
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL:	25.40 m DATUM: AHD
LOCATION:	Adjacent to 197-199 Castlereagh Street, Sydney	INCLINATION:	-90°
PROJECT No	PSC No.00013/10464	HOLE DEPTH:	35.00 m

SHEET: 4 OF 5 REV: D
DRILL RIG: Hanjin D&B
CONTRACTOR: Total Drilling
LOGGED: AMS START: 24/6/15
CHECKED: HB FINISH: 6/7/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH009

		SHEET: 5 OF 5	REV: D
CLIENT: Transport for New South Wales	COORDS: 334355.5 m E 6250386.5 m N MGA94 56	DRILL RIG: Hanjin D&B	
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 25.40 m DATUM: AHD	CONTRACTOR: Total Drilling	
LOCATION: Adjacent to 197-199 Castlereagh Street, Sydney	INCLINATION: -90°	LOGGED: AMS	START: 24/6/15
PROJECT No PSC No.00013/10464	HOLE DEPTH: 35.00 m	CHECKED: HB	FINISH: 6/7/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

FINAL STANDPIPE INSTALLATION: SRT BH009

		SHEET: 1 OF 1	REV: Final
CLIENT: Transport for New South Wales	COORDS: 334355.5 m E 6250386.5 m N MGA94 56	DRILL RIG: Hanjin D&B	
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 25.40 m DATUM: AHD	CONTRACTOR: Total Drilling	
LOCATION: Adjacent to 197 Castlereagh Street, Sydney	INCLINATION: -90°	LOGGED: AMS	START: 24/6/15
PROJECT No PSC No.00013/10464	HOLE DEPTH: 35.00 m	CHECKED: HB	FINISH: 6/7/15

Drilling				Field Material Description	Instrumentation Details
MET OD	WATER	DEPT (metres)	DEPTH RL	SOIL/ROCK MATERIAL DESCRIPTION	
NDD	GWNE	0	25.40	NON-DESTRUCTIVE DIGGING	Gatic cover
			1.70		
			23.70	SILTY CLAY	
			3.00		
Q3			22.40	GRAVELLY CLAY	
	GWNO		4.44		
		5	20.96	SILTY CLAY	
			6.00		
			19.40	SANDSTONE	Cement bentonite grout
		10			
		15			13.90, RL11.50 Bentonite 14.50, RL10.90
					<5mm sand
					18.00, RL7.40
Q3		20			PVC slotted screen with filter sock
					21.00, RL4.40
					21.50, RL3.90
					Bentonite
					23.00, RL2.40
		25			
		30			Cement bentonite grout
		35	35.00		35.00, RL-9.60
			-9.60	END OF BOREHOLE @ 35.00 m	

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17 RL1

BOREHOLE: SRT BH012

SHEET: 1 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 5 Elizabeth Street, Sydney
PROJECT No PSC No.00013/10464

COORDS: 334485.5 m E 6251171.0 m N MGA94 56
SURFACE RL: 23.91 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.00 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AP/AS START: 16/5/15
CHECKED: DF/JCB FINISH: 18/5/15

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
NDD		GWNE	0	23.86					ROAD SURFACE: ASPHALT			ROAD SURFACE
				0.28					CONCRETE			
				23.63					NON-DESTRUCTIVE DIGGING inferred sandy gravel filling			FILL
			1	1.50								
ADT	M-H			22.41					FILL: Sandy GRAVEL medium to coarse grained, yellow and dark brown, fine to medium grained sand, trace cobbles			
				1.90								
			2	22.01					SANDSTONE highly weathered, very low to low strength			WEATHERED BEDROCK
				2.10								
				21.81					extremely weathered, extremely low to very low strength			
									For Continuation Refer to Sheet 2			
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

BOREHOLE: SRT BH012

SHEET: 2 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 5 Elizabeth Street, Sydney
PROJECT No PSC No.00013/10464

COORDS: 334485.5 m E 6251171.0 m N MGA94 56
SURFACE RL: 23.91 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.00 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AP/AS START: 16/5/15
CHECKED: DF/JCB FINISH: 18/5/15

Drilling						Field Material Descriptio			Defect Informatio	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 1, H 3, VH 10, Ex)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2	7.12		Continuation of Sheet 1				
HQ3		45	15 (45)		7.33		CORE LOSS				
				3	21.25		SANDSTONE medium grained, pale grey and red brown, iro stained	HW			
					7.04						
					8.51		CORE LOSS				
					20.76		SANDSTONE medium grained, pale grey and orange brown, irregular bedding	HW		3.15 m: DS, 0°, Pl, Ro, sandy clay Ct, =10 mm 3.31 m: DS, 0-10°, Pl, Ro, sandy clay Ct, =10 mm	
		90	85 (90)								
				4				EW HW		4.10 m: B, 0-5°, Pl, Ro, C	
										4.37 m: J, 10°, Pl, Ro, C 4.42 m: J, 20°, Pl, Ro, C 4.60 m: B, 0°, Pl-Un, Ro, C	
				5						4.85 m: B, 10°, Pl-Un, Ro, C	
		100	75 (100)							5.28 m: B, 15°, Pl, Ro, iron S	
										5.66 m: B, 0°, Pl, Ro, iron S	
				6						6.22 m: B, 10°, Pl, Ro, sandy clay Vr 6.29-6.35 m: Bx 3, 0-10°, Pl, Ro, carbonaceous Ct, healed 6.40 m: SS, rock and 10 mm clay, 60 mm 6.47 m: B, 0°, Un, Ro, clay Vr	
					3.02					6.73 m: B, 0°, Un, Ro, clay Vr 6.77 m: B, 5°, Pl, Ro, sandy clay Ct 6.77-7.25 m: J, 80-90°, Pl, Ro, Cn, healed 6.77 m: B, 5°, Pl, Ro, sandy clay Ct 6.77-7.25 m: J, 80-90°, Pl, Ro, Cn, healed 6.80 m: CZ, 80 mm crushed rock 6.81-6.83 m: Bx 2, 0-5°, Pl, Ro, sandy clay Ct	
				7	17.01		SANDSTONE medium grained, pale grey, bedded at 0° to 10° typically				
		100	85 (100)								
				8						8.11 m: B, 5°, Un, Ro, C	
										8.68 m: B, 5°, St, Ro, C	
				9						9.13 m: SS, 5°, Pl, Ro, clay Ct, rock fragments	
					0.82					9.30 m: J, 0-30°, St, Ro, C 9.38 m: J, 70°, Un, Ro, iron S	
		100	95 (100)		14.61		SANDSTONE medium to coarse grained, pale grey and mottled yellow brown, cross bedded up to 20°	MW			
				10							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

BOREHOLE: SRT BH012

SHEET: 3 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 5 Elizabeth Street, Sydney
PROJECT No PSC No.00013/10464

COORDS: 334485.5 m E 6251171.0 m N MGA94 56
SURFACE RL: 23.91 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.00 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AP/AS START: 16/5/15
CHECKED: DF/JCB FINISH: 18/5/15

Drilling						Field Material Descriptio				Defect Informatio	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	95 (100)	10			SANDSTONE medium to coarse grained, pale grey and mottled yellow brown, cross bedded up to 20°	MW		10.39 m: B, 5°, Pl, Ro, C 10.53 m: SS, 0°, 20 mm 10.63 m: DS, =8 mm, sandy clay 10.79 m: B, 0-5°, Pl, Ro, C	
				11				SW		11.28 m: B, 10°, St, Ro, iron S 11.48 m: J, 10°, Un, Ro, iron S 11.51 m: J, 5°, Un, Ro, iron Sn, 50 mm 11.60 m: J, 20°, Un, Ro, iron S	
				12				HW SW		12.43 m: SS, =15 mm, rock fragments	
				13	58.28			MW			
		95	70 (95)		10.80		CORE LOSS SANDSTONE medium grained, pale grey and mottled yellow brown, cross bedded	EW MW		13.21 m: B, 0-5°, Pl, Ro, iron S 13.24 m: SS, 0-10°, 20 mm, rock fragments 13.61 m: J, 45°, Un, Ro, C	
				14						14.00 m: J, 45°, Pl, Ro, C 14.12 m: B, 0°, Pl, Ro, sandy clay Ct 14.36 m: SZ, 20-60°, Ct, 380 mm, rock fragments and sandy clay 14.61 m: DS, 20 mm, VL 14.70 m: SS, 30°, clay Vr, 100 mm, rock fragments and clay	
				15						15.29-15.42 m: Bx 3, 0-5°, Pl, Ro, C	
		90	80 (90)	16				SW		15.67 m: SS, 30 mm, rock fragments 15.75 m: B, 0-5°, Pl, Ro, C 15.82 m: B, 5°, Pl, Ro, C 16.75 m: B, 0°, Pl, Ro, clay Vr 16.92 m: J, 20-50°, Un, Ro, sandy clay Ct	
				17				EW SW		17.11 m: J, 70°, Un, Ro, sandy clay Ct 17.30 m: J, 40°, Un, Ro, sandy clay Ct 17.37 m: J, 45°, Pl, Ro, C 17.45 m: J, 15°, Pl, Ro, C	
					57.37			EW			
					6.29		CORE LOSS				
		100	95 (100)	18	57.01 5.96		SANDSTONE medium to coarse grained, pale grey and mottled yellow brown (iron stained), cross bedded up to 25°	MW		18.10 m: B, 0°, Pl, Ro, clay Vr 18.23 m: J, 30°, Un, Ro, C 18.24 m: J, 30°, Un, Ro, C 18.26 m: J, 60°, Pl, Ro, C	
				19				EW		18.81 m: J, 45-60°, Un, Ro, ironstained S 19.09 m: J, 35°, Pl, Ro, clay Ct 19.33 m: J, 10°, Pl, Ro, C 19.45 m: J, 30°, Pl, Ro, clay Vr	
				20				MW			

BOREHOLE: SRT BH012

SHEET: 4 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 5 Elizabeth Street, Sydney
PROJECT No PSC No.00013/10464

COORDS: 334485.5 m E 6251171.0 m N MGA94 56
SURFACE RL: 23.91 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.00 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AP/AS START: 16/5/15
CHECKED: DF/JCB FINISH: 18/5/15

Drilling						Field Material Descriptio				Defect Informatio	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	95 (100)	20			SANDSTONE medium to coarse grained, pale grey and mottled yellow brown (iron stained), cross bedded up to 25°			20.62 m: B, 5°, Pl, Ro, C	
				21				SW		21.10 m: B, 25°, Pl, Ro, clay Vr	
		100	100 (100)	22	75.01 1.96		red brown, bedded at 15° typically	MW			
				23						23.75 m: SS, 110 mm, rock fragments formed by 4 joints	
		100	100 (100)	24	7HHI -0.54		SANDSTONE medium to coarse grained, pale grey, sub-horizontal bedding	SW		24.33 m: B, 5°, Pl, Ro, sand Ct	
		100	100 (100)	25						25.10 m: B, 20°, Pl, Ro, clay Vr	
		95	90 (95)	26	71.TT -1.86		from 25.77 m to 27.20 m: pale grey and red brow	MW		25.64 m: J, 15°, Pl, Ro, C 25.76 m: J, 20°, Pl, Ro, C 26.64 m: J, 30°, Pl, Ro, C 26.88 m: SS, 25°, 50 mm	
		100	92 (95)	27				SW		27.33 m: SS, 50 mm, VL rock fragments	
		100	95 (95)	28						27.90 m: possible SS on bedding	
		100	85 (100)	29	70.23 -5.15		SANDSTONE medium to coarse grained, pale grey and orange brown, cross bedded, iron stained	MW		28.93 m: SZ, 0°, clayey sand, 40 mm 29.26 m: B, 10°, Pl, Ro, clay Ct, =8 mm 29.48 m: B, 15°, Pl, Ro, sandy clay Ct, 2 mm 29.59 m: B, 15°, Pl, Ro, sandy clay Ct, 2 mm 29.69-29.72 m: Bx 2, 5-15°, Pl, Ro, C	
				30	70.42 -5.89			FR		29.87 m: B, 0°, Pl, Ro, sandy clay Vr	

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH012

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 5 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 5 Elizabeth Street, Sydney
PROJECT No PSC No.00013/10464

COORDS: 334485.5 m E 6251171.0 m N MGA94 56
SURFACE RL: 23.91 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.00 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AP/AS START: 16/5/15
CHECKED: DF/JCB FINISH: 18/5/15

Drilling						Field Material Descriptio				Defect Informatio	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	30			SANDSTONE medium to coarse grained, pale grey with grey bands, bedded at 0° to 15° typically, with occasional carbonceous laminations	FR		30.24 m: B, 0°, Un, Ro, sandy clay Vr	
					82.T2 -6.79					30.60 m: DS, 15°, sandy clay Ct, =20 mm	
		100	100 (100)	31			30.7 m to 32.0 m: massive, poorly developed bedding				
		100	100 (100)	32							
				33						32.87 m: B, 5°, Pl, Ro, clay C	
					88.T0 -9.88					33.79 m: B, 10°, Pl, Ro, sandy clay Vr	
				34			33.79 m to 35.0 m: massive, poorly developed bedding				
				35							
					81.H6 -11.52		siltstone clasts 20-30 mm				
		100	100 (100)	36							
					83.54 -12.27		36.18 m to 37.0 m: massive, poorly developed bedding			36.21 m: B, 0°, Un, Ro, sandy clay Vr	
				37						37.17 m: B, 0°, Pl, Ro, carbonaceous/clay Vr 37.30 m: B, 0°, Pl, Ro, Vr	
				38	84.22 -14.09		SANDSTONE medium to coarse grained, pale grey, irregular bedding				
		100	100 (100)		84.02 -14.99						
				39			SANDSTONE WITH SILTSTONE FLECKS medium to coarse grained, pale grey				
										39.50 m: B, 5°, Pl, Ro, clay Vr	
				40							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH012

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 6 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 5 Elizabeth Street, Sydney
PROJECT No PSC No.00013/10464

COORDS: 334485.5 m E 6251171.0 m N MGA94 56
SURFACE RL: 23.91 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.00 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AP/AS START: 16/5/15
CHECKED: DF/JCB FINISH: 18/5/15

Drilling						Field Material Descriptio				Defect Informatio	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	40	H0.24 -16.17		SANDSTONE WITH SILTSTONE FLECKS medium to coarse grained, pale grey orange brow	MW EW MW		40.48-40.55 m: Bx 3, 0-5°, Un-St, Ro, carbonaceous/clay Ct	
				41	H2.03 -17.05		SANDSTONE medium to coarse grained, pale grey, bedded at 0° to 10° typically	FR		40.96-40.97 m: DS, 5°, Pl, Ro, clay Ct, =8 mm	
		100	100 (100)							41.55 m: B, 15°, Pl, Ro, C	
				42						42.23 m: B, 10°, Pl, Ro, sandy clay Ct	
					H7.TT -18.86		SANDSTONE WITH SOME SILTSTONE FRAGMENTS medium grained, pale grey and grey, bedded at 0° to 10° typically			42.77 m: B, 15°, St, Ro, carbonaceous/clay Ct	
				43							
					H8.T4 -19.87		from 43.78 to 44.84 m: siltstone bed or clast				
				44							
					HHH7 -20.51		from 44.42 to 44.5 m: conglomeratic bed with siltstone clasts, 30 mm				
		100	100 (100)	45						44.76 m: B, 0°, Pl, Ro, clay Ct, 3 mm	
				46	H3.22 -22.09		SANDSTONE medium to coarse grained, pale grey, irregular bedding, some siltstone laminations				
				47						47.15 m: B, 5°, Pl, Ro, clay Ct, 3 mm	
		100	100 (100)	48							
				49	H0.22 -25.09		END OF BOREHOLE @ 49.00 m TARGET DEPTH PIEZOMETER INSTALLED				
				50							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

CORE PHOTOGRAPHS: SRT BH012

CLIENT:	Transport for New South Wale	COORDS: 334485.5 m E 6251171.0 m N MGA94 56	SHEET: 1 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Service	SURFACE RL: 23.91 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 5 Elizabeth Street, Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.00 m	LOGGED: AP/AS START: 16/5/15
			CHECKED: DF/JCB FINISH: 18/5/15

CORE PHOTOGRAPHS: SRT BH012

CLIENT:	Transport for New South Wale	COORDS: 334485.5 m E 6251171.0 m N MGA94 56	SHEET: 2 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Service	SURFACE RL: 23.91 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 5 Elizabeth Street, Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.00 m	LOGGED: AP/AS START: 16/5/15
			CHECKED: DF/JCB FINISH: 18/5/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH012

CLIENT:	Transport for New South Wale	COORDS: 334485.5 m E 6251171.0 m N MGA94 56	SHEET: 3 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Service	SURFACE RL: 23.91 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 5 Elizabeth Street, Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.00 m	LOGGED: AP/AS START: 16/5/15
			CHECKED: DF/JCB FINISH: 18/5/15

CORE PHOTOGRAPHS: SRT BH012

CLIENT:	Transport for New South Wale	COORDS: 334485.5 m E 6251171.0 m N MGA94 56	SHEET: 4 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Service	SURFACE RL: 23.91 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 5 Elizabeth Street, Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.00 m	LOGGED: AP/AS START: 16/5/15
			CHECKED: DF/JCB FINISH: 18/5/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH012

CLIENT:	Transport for New South Wale	COORDS: 334485.5 m E 6251171.0 m N MGA94 56	SHEET: 5 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Service	SURFACE RL: 23.91 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 5 Elizabeth Street, Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.00 m	LOGGED: AP/AS START: 16/5/15
			CHECKED: DF/JCB FINISH: 18/5/15

CORE PHOTOGRAPHS: SRT BH012

CLIENT:	Transport for New South Wale	COORDS: 334485.5 m E 6251171.0 m N MGA94 56	SHEET: 6 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Service	SURFACE RL: 23.91 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 5 Elizabeth Street, Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.00 m	LOGGED: AP/AS START: 16/5/15
			CHECKED: DF/JCB FINISH: 18/5/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

FINAL STANDPIPE INSTALLATION: SRT BH012

SHEET: 1 OF 1 REV: Final

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 5 Elizabeth Street, Sydney
PROJECT No: PSC No.00013/10464

COORDS: 334485.5 m E 6251171.0 m N MGA94 56
SURFACE RL: 23.91 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.00 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AP/AS START: 16/5/15
CHECKED: DF/JCB FINISH: 18/5/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
ADT NDD	GWNE	0	23.63		ASPHALT	1.00, RL22.91 Gatic cover; Bentonite
			1.90		CONCRETE	
			22.01		FILL: SANDY GRAVEL	
					SANDSTONE	
		5				
		10				Cement bentonite grout
		15				
		20				23.00, RL0.91
HQ3	GWNO					24.00, RL-0.09 Bentonite
		25				25.20, RL-1.29 <5mm sand
						PVC slotted screen with filter sock
		30				31.20, RL-7.29
		35				Bentonite
						39.00, RL-15.09
		40				
		45				Cement bentonite grout
			49.00			49.00, RL-25.09
			-25.09		END OF BOREHOLE @ 49.00 m	
		50				

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17
RL1

BOREHOLE: SRT BH014

SHEET: 1 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No: PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
HA	L-M		0	2.40					FILL: Sandy GRAVEL fine to medium grained, orange brown, fine to medium grained sand	D - M		FILL
			1	1.25								
				1.15					FILL: Gravelly Clayey SAND fine to medium grained, dark grey			
ADT		06/07/15			Rec = 450/450 mm SPT 1.50-1.95 m 2, 1, 2 N=3							
	H		2		Rec = 450/450 mm SPT 2.50-2.95 m 5, 3, 5 N=8					W		
			3									
			4		Rec = 450/450 mm SPT 4.00-4.45 m 0, 0, 0 N=0							
			5	5.20								
				-2.80				CI	Sandy CLAY medium plasticity, pale brown and orange brown	M (>PL)	St	ALLUVIUM
			6		Rec = 450/450 mm SPT 5.50-5.95 m 0, 5, 11 N=16							
WB				6.80								
			7	-4.40	SPT 6.70-7.15 m 2, 5, 9 N=14			CI	Silty CLAY low to medium plasticity, pale grey and red brown, with fine to medium grained ironstone gravel			RESIDUAL SOIL
	M-H				Rec = 450/450 mm							
			8								St	
					Rec = 450/450 mm SPT 8.20-8.65 m 3, 6, 9 N=15					M (>PL)		
			9	9.50								
				-7.10					orange brown			
					Rec = 450/450 mm						VSt	
			10									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F01a
RL3

BOREHOLE: SRT BH014

SHEET: 2 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB	M-H		10		Rec = 450/450 mm SPT 9.75-10.20 m 8, 13, 17 N=30			CI	Silty CLAY low to medium plasticity, pale grey and red brown, with fine to medium grained ironstone gravel	M (>PL)	VSt	RESIDUAL SOIL
SHT		100% Water RETURN	11		Rec = 50/50 mm SPT 11.20-11.25 m 25/50mm N=R				For Continuation Refer to Sheet 3			
			12									
			13									
			14									
			15									
			16									
			17									
			18									
			19									
			20									

BOREHOLE: SRT BH014

SHEET: 3 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

Drilling					Field Material Description				Defect Information
METHOD	WATER	TCR	ROD (SCR)	DEPTH (metres)	RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	DEFECT DESCRIPTION & Additional Observations
				10					
				11	77.12		Continuation of Sheet 2		
HQ3		95	95 (95)	12	-8.90		CORE LOSS SANDSTONE medium to coarse grained, pale grey, poorly developed cross bedding at 0 to 10°, with some carbonaceous laminations and siltstone fragments	FR	12.31-12.48 m: J, 75°, Un, Ro, Cn
		100	100 (100)	13					
				14					14.26 m: B, 5°, Pl, Ro, sandy clay Ct, =4 mm
		100	100 (100)	15					
				16					
				17	73.02 -14.55		SANDSTONE coarse grained, massive, pale grey, with a trace of siltstone flecks		
				18	74.48 -15.31		siltstone and quartz fragments to 30mm SANDSTONE medium to coarse grained, pale yellow brown and pale grey, a trace of siltstone laminations, irregularly bedded to massive		
		100	100 (100)	19					
				20					

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

BOREHOLE: SRT BH014

SHEET: 4 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

Drillin						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	569DE RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, Ex 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100		20			SANDSTONE medium to coarse grained, pale yellow brown and pale grey, a trace of siltstone laminations, irregularly bedded to massive	FR			
				21						21.45-21.73 m: J, 75°, Un, Ro, Cn	
		100	100 (100)	22	11.28 -20.10		becoming coarse grained with included gravel				
					11.44 -20.37		CONGLOMERATIC SANDSTONE medium to coarse grained, pale and dark grey				
				23	1P,8T -20.68		SANDSTONE medium to coarse grained, pale yellow brown and pale grey, with a trace of siltstone laminations, irregularly bedded to massive				
				24	1H,7B -21.70		siltstone fragments				
		100	100 (100)	25							
				26	12.22 -23.15		SANDSTONE medium to coarse grained, pale yellow grey, massive, with a trace of siltstone flecks				
					13.38 -24.20		SANDSTONE WITH SILTSTONE INCLUSIONS medium to coarse grained, pale and dark grey, with irregular siltstone inclusions, bands and clasts, irregular beddin			27.14-27.15 m: weathered siltstone band (washed out)	
		100	100 (100)	27	14.48 -25.30		SANDSTONE medium to coarse grained, pale yellow grey, massive, with a trace of siltstone flecks				
				28	1T,H2 -26.05		SANDSTONE WITH SILTSTONE INCLUSIONS medium to coarse grained, pale and dark grey, with irregular siltstone clasts and laminations, irregular beddin			28.84 m: DS	
		100	100 (100)	29	10.48 -27.30					29.67 m: quartz/siltstone band (washed out)	
				30							

BOREHOLE: SRT BH014

SHEET: 5 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

Drillin						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	569DE RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, Ex 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3				30			SANDSTONE medium to coarse grained, pale grey and yellow brown with grey bands, irregular bedding, with occasional carbonaceous laminations and siltstone fragments	FR			
		100	100 (100)	31	P8,0Z -28.55		siltstone bed				
					P7,0B -29.50		SANDSTONE medium to coarse grained, massive, pale grey, with a trace of siltstone flecks and clasts <20mm				
		100	100 (100)	32	P1,P2 -29.95		siltstone band and clasts				
				33						33.17 m: quartz/siltstone band (washed out)	
		100	100 (100)	34						33.81-33.82 m: weathered band (extremely low strength sandstone)	
		100	100 (100)	35	P2,P1 -32.92		SANDSTONE medium grained, grey, poorly developed horizontal beddin				
				36	P3,7B -33.70		SANDSTONE medium to coarse grained, pale grey, irregular bedding, with occasional carbonaceous laminations				
		100	100 (100)	37							
				38						37.87-37.90 m: CZ	
					PT,H7 -36.01		siltstone clasts to 30mm				
		100	100 (100)	39							
				40	P0,4T -37.38						

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH014

SHEET: 6 OF 6 REV: D

CLIENT: Transport for New South Wales
COORDS: 333706.6 m E 6251999.6 m N MGA94 56
DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 2.40 m DATUM: AHD
CONTRACTOR: Groundtest

LOCATION: Hickson Road, Barangaroo Site, Gate 4
INCLINATION: -90°
LOGGED: AP START: 6/7/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 43.00 m
CHECKED: FM FINISH: 10/7/15

Drillin						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	569DE RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	40			SANDSTONE medium to coarse grained, pale grey, massive, with a trace of siltstone flecks	FR			
				41							
		100	100 (100)	42							
				43	HP 88 40.60		END OF BOREHOLE @ 43.00 m TARGET DEPTH GROUTED				
				44							
				45							
				46							
				47							
				48							
				49							
				50							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a
RL3

CORE PHOTOGRAPHS: SRT BH014

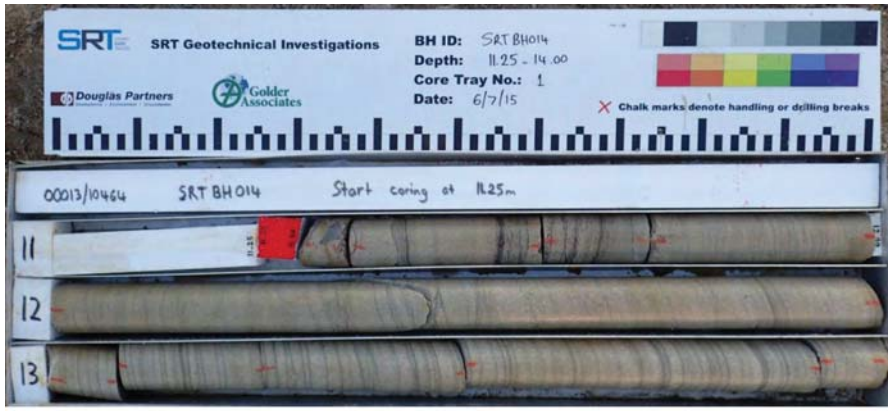
SHEET: 1 OF 5 REV: D

CLIENT: Transport for New South Wales
COORDS: 333706.6 m E 6251999.6 m N MGA94 56
DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 2.40 m DATUM: AHD
CONTRACTOR: Groundtes

LOCATION: Hickson Road, Barangaroo Site, Gate 4
INCLINATION: -90°
LOGGED: AP START: 6/7/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 43.00 m
CHECKED: FM FINISH: 10/7/15



This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28
RL1

CORE PHOTOGRAPHS: SRT BH014

SHEET: 2 OF 5 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtes
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

CORE PHOTOGRAPHS: SRT BH014

SHEET: 3 OF 5 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtes
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH014

SHEET: 4 OF 5 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtes
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

CORE PHOTOGRAPHS: SRT BH014

SHEET: 5 OF 5 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Hickson Road, Barangaroo Site, Gate 4
PROJECT No PSC No.00013/10464

COORDS: 333706.6 m E 6251999.6 m N MGA94 56
SURFACE RL: 2.40 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 43.00 m

DRILL RIG: Explora
CONTRACTOR: Groundtes
LOGGED: AP START: 6/7/15
CHECKED: FM FINISH: 10/7/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

BOREHOLE: SRT BH015

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 1 OF 8 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Blues Point Headland Reserve
PROJECT No: PSC No.00013/10464

COORDS: 333834.8 m E 6253018.7 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -60°
HOLE DEPTH: 70.00 m

DRILL RIG: Explora
CONTRACTOR: Ground Test
LOGGED: AP START: 8/4/15
CHECKED: DF/LM/JCB FINISH: 16/4/15

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADT	L		0	0.10 1.91					TOPSOIL: Silty CLAY dark brown, with some rootlets			TOPSOIL
				0.70 1.39					FILL: Gravelly SAND fine to medium grained, dark grey, with some clay, with some slag, fine to medium grained igneous gravel			FILL
	H		1						from 0.7-1.6 m: sandstone boulder	M		
					DS 1.50-1.60 m Rec = 100/100 mm							
		08/04/15	2	2.00 0.27					FILL: Gravelly SAND medium to coarse grained, brown, with some medium to coarse grained sandstone gravel, trace clay			
	L		3		DS 3.00-3.10 m Rec = 100/100 mm					W		
				3.80 -1.29					from 3.8-4.0 m: sandstone cobble			
	H		4	4.00 -1.46								
	L		5									
				5.35 -2.63					SANDSTONE medium to coarse grained, yellow brown, extremely weathered extremely low strength			WEATHERED BEDROCK
WB	H		6						For Continuation Refer to Sheet 2			
			7									
			8									
			9									
			10									

BOREHOLE: SRT BH015

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 2 OF 8 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Blues Point Headland Reserve
PROJECT No: PSC No.00013/10464

COORDS: 333834.8 m E 6253018.7 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -60°
HOLE DEPTH: 70.00 m

DRILL RIG: Explora
CONTRACTOR: Ground Test
LOGGED: AP START: 8/4/15
CHECKED: DF/LM/JCB FINISH: 16/4/15

Drilling						Field Material Description			Defect Information	
METHOD	WATER	TCR	ROD (SCR)	DEPTH (metres)	RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)
				0						
				1						
				2						
				3						
				4						
				5						
					7.12		Continuation of Sheet 1			
HO3	30-50% Water RETURN	85	75 (85)	-2.85			SANDSTONE medium to coarse grained, orange red brown, well developed bedding, iron stained	MW	Note: Dip of defects measures from plane normal to core axis	
				1.22 -3.20			CORE LOSS (void - possible buried cave, slight shell return)			
				1.30 -3.60			SANDSTONE medium to coarse grained, orange red brown, well developed bedding, iron stained	MW	6.88 m: J, 70°, Un, Ro, Cn 7.05 m: J, 45°, Un, Ro, Cn 7.12 m: J, 40°, Un, Ro, Cn 7.27 m: B, 60°, Pl, Ro, Iron Sn 7.58 m: B, 60°, Pl, Ro, Cn 8.11 m: Bx2, 40-50°, Un, Ro, Cn	
				4.17 -5.49			SANDSTONE WITH CARBONACEOUS FLECKS medium to coarse grained, grey, massive	SW		
		100	95 (100)							
				10						

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

BOREHOLE: SRT BH015

SHEET: 3 OF 8 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Blues Point Headland Reserve
PROJECT No PSC No.00013/10464

COORDS: 333834.8 m E 6253018.7 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -60°
HOLE DEPTH: 70.00 m

DRILL RIG: Explora
CONTRACTOR: Ground Test
LOGGED: AP START: 8/4/15
CHECKED: DF/LM/JCB FINISH: 16/4/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	8569D RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	30-50% Water RETURN	100	95 (100)	10			SANDSTONE WITH CARBONACEOUS FLECKS medium to coarse grained, grey, massive	SW			
				11	EE.E1						
					EE.PP		SANDSTONE medium to coarse grained, grey, with siltstone fragments, massive			11.24 m: B, 10°, Pl, Ro, Sn	
					-7.81		SANDSTONE WITH CARBONACEOUS FLECKS medium to coarse grained, grey, massive	MW SW		11.46 m: B, 15°, Un-St, Ro, Iron Sn 11.70 m: SZ, 45°, Pl-Un, Ro, Iron Sn	
				12	ET.TT					12.14 m: B, 30°, Pl-Un, Ro, Iron Sn-Ct	
					-8.58		SANDSTONE WITH CARBONACEOUS LAMINATIONS medium to coarse grained, grey			12.20 m: J, 50°, Tight, healed 12.55 m: J, 75°, Un, Ro, Iron Sn	
		100	100 (100)	13							
				14	E3.27					13.85 m: B, 10°, Un, Ro	
					-10.17		SANDSTONE WITH CARBONACEOUS LAMINATIONS medium to coarse grained, brown/grey			14.24-14.32 m: SZ, 30°, Pl, Ro, Silty Clay 14.41 m: J, 20°, Pl, Ro, Sandy Clay Ct	
				15						14.98 m: J, 70°, Pl, Ro, Iron Sn 15.15 m: B, 15°, Pl, Ro, Iron Sn	
	0% Water RETURN				E7.17						
					-11.59		CORE LOSS	FR		15.62 m: J, 70°, Pl, Ro, Iron Cn-Sn	
		100	100 (100)	16			SANDSTONE medium to coarse grained, grey, trace carbonaceous laminations				
				17							
				18						18.42 m: B, 20°, Pl, Ro, Clay Ct	
		100	100 (100)	19							
				20							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH015

SHEET: 4 OF 8 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Blues Point Headland Reserve
PROJECT No PSC No.00013/10464

COORDS: 333834.8 m E 6253018.7 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -60°
HOLE DEPTH: 70.00 m

DRILL RIG: Explora
CONTRACTOR: Ground Test
LOGGED: AP START: 8/4/15
CHECKED: DF/LM/JCB FINISH: 16/4/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	8569D RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	0% Water RETURN			20				FR			
					T2.P7						
		100	100 (100)		-15.62		SANDSTONE WITH CARBONACEOUS FLECKS medium grained, grey, poorly developed bedding				
				21							
		100	100 (100)	22							
					TT.74						
					-17.55		SANDSTONE WITH SILTSTONE LAMINATIONS (20%) fine to medium grained, grey to dark grey, well developed bedding			22.95 m: J, 80°, Pl, Ro, Cn	
				23							
					TP.02						
					-18.52		SANDSTONE WITH CARBONACEOUS FLECKS medium grained, grey, massive				
				24						24.29 m: B, 10°, Pl, Ro, Vr	
		100	100 (100)							24.74 m: SZ, 45°, Un, Sm, Clay Vr, 30mm	
				25							
					T7.H2						
					-20.43		SANDSTONE fine to medium grained, mottled grey to dark grey, disturbed bedding with siltstone interbeds				
				26	T1.17					26.48 m: J, 15°, Pl, Ro, Clay	
					-21.08		CORE LOSS				
					T0.22						
				27	-21.38		SANDSTONE AND SILTSTONE fine to medium grained, grey and dark grey, well developed bedding			27.00-27.48 m: Parting on bedding	
					T0.34						
					-21.80		CORE LOSS			27.48 m: J, 80°, Un, Ro, Clay	
					T0.02					27.70 m: J, 50°, Un, Ro, Clay	
		80	65 (80)		-21.99		SANDSTONE WITH CARBONACEOUS FLECKS medium grained, grey, massive				
				28							
				29							
		100	100 (100)	30							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH015

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 5 OF 8 REV: E

CLIENT: Transport for New South Wales
COORDS: 333834.8 m E 6253018.7 m N MGA94 56
DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 2.00 m DATUM: AHD
CONTRACTOR: Ground Test

LOCATION: Blues Point Headland Reserve
INCLINATION: -60°
LOGGED: AP START: 8/4/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 70.00 m
CHECKED: DF/LM/JCB FINISH: 16/4/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	8569D RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	0% Water RETURN	100	100 (100)	30			SANDSTONE WITH CARBONACEOUS FLECKS medium grained, grey, massive	FR			
				31							
					PE12						
					-25.37		SANDSTONE fine grained, grey, some carbonaceous laminations				
				32							
					P1.72					32.35 m: B, 55°, Pl, Ro, Cn	
					-26.15		SANDSTONE WITH CARBONACEOUS FLECKS medium to coarse grained, massive, grey, with fine gravel-sized quarte and siltstone fragments				
				33							
					PP.E7						
					28.71		SANDSTONE fine to medium grained, grey and dark grey, with fine gravel-sized quartz and siltstone fragments				
					PP.P7						
					-26.88		SANDSTONE WITH CARBONACEOUS FLECKS medium to coarse grained, grey, massive				
		100	100 (100)	34							
				35							
					P7.H7						
					-29.13		SANDSTONE WITH SILTSTONE FRAGMENTS medium to coarse grained, grey and dark grey, massive				
				36							
					P1.37						
					P1.74		36.45-36.55m: Conglomeratic sandstone				
					-29.68		SANDSTONE WITH CARBONACEOUS FLECKS medium grained, grey, massive				
				37							
		100	100 (100)		P0.10						
					-30.62		SANDSTONE WITH CARBONACEOUS FLECKS AND SILTSTONE LAMINATIONS medium to coarse grained, grey, irregular bedding			37.76 m: J, 80°, Pl, Ro, Vr	
				38							
					P4.T0						
					-31.14		SANDSTONE medium to coarse grained, grey, some carbonaceous laminations			38.24 m: B, 10-20°, Pl, Ro, Clay Vr	
				39							
		100	100 (100)								
				40							

BOREHOLE: SRT BH015

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 6 OF 8 REV: E

CLIENT: Transport for New South Wales
COORDS: 333834.8 m E 6253018.7 m N MGA94 56
DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 2.00 m DATUM: AHD
CONTRACTOR: Ground Test

LOCATION: Blues Point Headland Reserve
INCLINATION: -60°
LOGGED: AP START: 8/4/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 70.00 m
CHECKED: DF/LM/JCB FINISH: 16/4/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	8569D RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	0% Water RETURN			40			SANDSTONE medium to coarse grained, grey, some carbonaceous laminations	FR			
				41							
		100	100 (100)		3E12						
					3E0P		41.60-41.73m: Siltstone and laminate layer				
					-34.14		SANDSTONE WITH OCCASIONAL CARBONACEOUS FLECKS medium grained, grey, massive				
				42						42.34 m: J, 75-80°, Pl, Ro, Cn	
				43							
				44							
					33.3T						
		100	95 (100)		-36.47		SANDSTONE medium grained, grey, with some carbonaceous laminations				
				45							
										45.60 m: B, 30°, Pl, Ro, Clayey sand Ct, 5mm	
				46						46.00 m: B, 55°, Pl, Ro, Cn	
					31.H2						
				47	-38.62		46.90-46.95: Siltstone bed				
		100	100 (100)								
				48							
				49							
		100	100 (100)								
					3H47						
				50	-41.17		49.85-49.88m: Laminite bed				

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH015

SHEET: 7 OF 8 REV: E

CLIENT: Transport for New South Wales
COORDS: 333834.8 m E 6253018.7 m N MGA94 56
DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 2.00 m DATUM: AHD
CONTRACTOR: Ground Test

LOCATION: Blues Point Headland Reserve
INCLINATION: -60°
LOGGED: AP START: 8/4/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 70.00 m
CHECKED: DF/LM/JCB FINISH: 16/4/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	8569D RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	0% Water RETURN	100	100 (100)	50			SANDSTONE medium grained, grey, with some carbonaceous laminations	FR			
				51							
				52							
					7T,07						
					-43.68						
		100	100 (100)	53			52.75-52.77m: Siltstone fragment				
				54							
		100	100 (100)	55							
				56						56.05 m: B, 30°, Pl, Clay Ct	
		100	100 (100)	57							
					74,22						
					-48.23						
		100	100 (100)	58			58.00m: Flaserbedding in places below 58.00m				
				59							
				60	12,22						

BOREHOLE: SRT BH015

SHEET: 8 OF 8 REV: E

CLIENT: Transport for New South Wales
COORDS: 333834.8 m E 6253018.7 m N MGA94 56
DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 2.00 m DATUM: AHD
CONTRACTOR: Ground Test

LOCATION: Blues Point Headland Reserve
INCLINATION: -60°
LOGGED: AP START: 8/4/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 70.00 m
CHECKED: DF/LM/JCB FINISH: 16/4/15

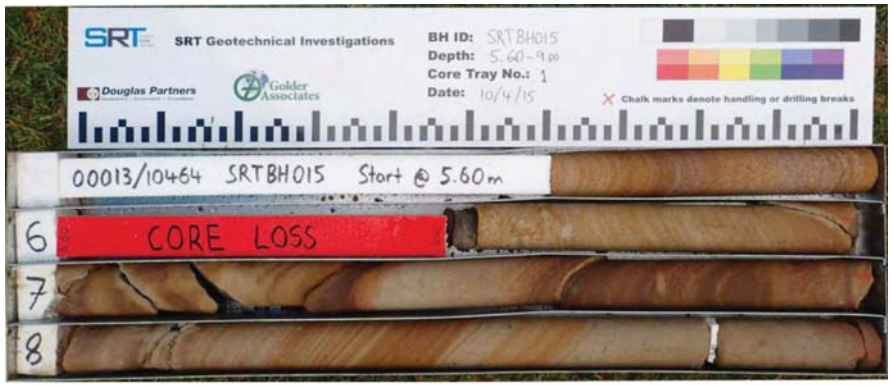
Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	8569D RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3	0% Water RETURN			60	-49.96		SANDSTONE medium grained, grey, cross bedded, with some carbonaceous laminations 60.35-60.49m: Siltstone clast	FR			
					12,P7						
		100	100 (100)		-50.26						
				61						60.90 m: J, 80°, Pl, Ro, Cn, Partly healed	
										61.67 m: J, 15°, Pl-Un, Ro, Clayey sand 20mm	
				62						62.16-62.18 m: SS, 15°, Clayey sand, 20mm	
		100	100 (100)	63							
				64							
				65							
					17,P7						
					-54.59						
		100	100 (100)		17,77		65.35-65.40m: coarse grained				
					-54.77		65.55-65.65m: coarse grained				
				66						66.42 m: B, 20°, Pl, Ro, Clayey sand Ct, 3mm	
					11,3P						
					-55.53		SANDSTONE WITH CARBONACEOUS FLECKS medium grained, grey, massive				
				67							
				68							
					14,77						
		100	100 (100)		-57.37		SANDSTONE WITH OCCASIONAL CARBONACEOUS LAMINATIONS medium grained, grey				
				69						69.02 m: B, 10°, Pl, Ro, Clayey sand Ct, 1mm	
				70	02,22		END OF BOREHOLE @ 70.00 m				

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

CORE PHOTOGRAPHS: SRT BH015

CLIENT:	Transport for New South Wales	COORDS: 333834.8 m E 6253018.7 m N MGA94 56	SHEET: 1 OF 9 REV: E
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 2.00 m DATUM: AHD	DRILL RIG: Explora
LOCATION:	Blues Point Headland Reserve	INCLINATION: -60°	CONTRACTOR: Ground Test
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 70.00 m	LOGGED: AP START: 8/4/15
			CHECKED: DF/LM/JCB FINISH: 16/4/15



CORE PHOTOGRAPHS: SRT BH015

CLIENT:	Transport for New South Wales	COORDS: 333834.8 m E 6253018.7 m N MGA94 56	SHEET: 2 OF 9 REV: E
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 2.00 m DATUM: AHD	DRILL RIG: Explora
LOCATION:	Blues Point Headland Reserve	INCLINATION: -60°	CONTRACTOR: Ground Test
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 70.00 m	LOGGED: AP START: 8/4/15
			CHECKED: DF/LM/JCB FINISH: 16/4/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

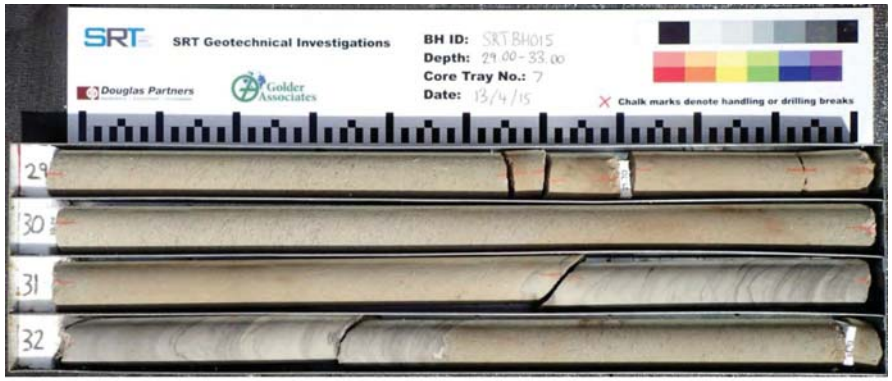
GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH015

CLIENT:	Transport for New South Wales	COORDS: 333834.8 m E 6253018.7 m N MGA94 56	SHEET: 3 OF 9 REV: E
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 2.00 m DATUM: AHD	DRILL RIG: Explora
LOCATION:	Blues Point Headland Reserve	INCLINATION: -60°	CONTRACTOR: Ground Test
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 70.00 m	LOGGED: AP START: 8/4/15
			CHECKED: DF/LM/JCB FINISH: 16/4/15

CORE PHOTOGRAPHS: SRT BH015

CLIENT:	Transport for New South Wales	COORDS: 333834.8 m E 6253018.7 m N MGA94 56	SHEET: 4 OF 9 REV: E
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 2.00 m DATUM: AHD	DRILL RIG: Explora
LOCATION:	Blues Point Headland Reserve	INCLINATION: -60°	CONTRACTOR: Ground Test
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 70.00 m	LOGGED: AP START: 8/4/15
			CHECKED: DF/LM/JCB FINISH: 16/4/15



This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28
RL1

CORE PHOTOGRAPHS: SRT BH015

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Blues Point Headland Reserve
PROJECT No PSC No.00013/10464

COORDS: 333834.8 m E 6253018.7 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -60°
HOLE DEPTH: 70.00 m

SHEET: 5 OF 9 REV: E
DRILL RIG: Explora
CONTRACTOR: Ground Test
LOGGED: AP START: 8/4/15
CHECKED: DF/LM/JCB FINISH: 16/4/15

CORE PHOTOGRAPHS: SRT BH015

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Blues Point Headland Reserve
PROJECT No PSC No.00013/10464

COORDS: 333834.8 m E 6253018.7 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -60°
HOLE DEPTH: 70.00 m

SHEET: 6 OF 9 REV: E
DRILL RIG: Explora
CONTRACTOR: Ground Test
LOGGED: AP START: 8/4/15
CHECKED: DF/LM/JCB FINISH: 16/4/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28
RL1

CORE PHOTOGRAPHS: SRT BH015

CLIENT:	Transport for New South Wales	COORDS: 333834.8 m E 6253018.7 m N MGA94 56	SHEET: 7 OF 9 REV: E
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 2.00 m DATUM: AHD	DRILL RIG: Explora
LOCATION:	Blues Point Headland Reserve	INCLINATION: -60°	CONTRACTOR: Ground Test
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 70.00 m	LOGGED: AP START: 8/4/15
			CHECKED: DF/LM/JCB FINISH: 16/4/15

CORE PHOTOGRAPHS: SRT BH015

CLIENT:	Transport for New South Wales	COORDS: 333834.8 m E 6253018.7 m N MGA94 56	SHEET: 8 OF 9 REV: E
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 2.00 m DATUM: AHD	DRILL RIG: Explora
LOCATION:	Blues Point Headland Reserve	INCLINATION: -60°	CONTRACTOR: Ground Test
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 70.00 m	LOGGED: AP START: 8/4/15
			CHECKED: DF/LM/JCB FINISH: 16/4/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH015

SHEET: 9 OF 9 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Blues Point Headland Reserve
PROJECT No PSC No.00013/10464

COORDS: 333834.8 m E 6253018.7 m N MGA94 56
SURFACE RL: 2.00 m DATUM: AHD
INCLINATION: -60°
HOLE DEPTH: 70.00 m

DRILL RIG: Explora
CONTRACTOR: Ground Test
LOGGED: AP START: 8/4/15
CHECKED: DF/LM/JCB FINISH: 16/4/15

Blues Point Headland

BOREHOLE: SRT BH017

SHEET: 1 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 155 Miller Street, North Sydney
PROJECT No PSC No.00013/10464

COORDS: 334111.0 m E 6254365.0 m N MGA94 56
SURFACE RL: 62.90 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.48 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 5/5/15
CHECKED: DF/JCB FINISH: 12/5/15

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION / CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
NDD	H		0	0.10 62.80					ROAD SURFACE: ASPHALT		ROAD SURFACE
				0.30 62.60					CONCRETE		CONCRETE
	L								FILL: Sandy CLAY low plasticity, brown, with some silt, with some bricks		FILL
			1	1.20 61.70				CL	Sandy CLAY low plasticity, pale brown, with some silt	M (<<PL) VSt	RESIDUAL SOIL
ADT		GWNE			Rec = 450/450 mm SPT 1.50-1.95 m 4, 8, 10 N=18						
			2	1.90 61.00	U 2.00-2.35 m Rec = 350/350 mm			SC	Clayey SAND fine to medium grained, mottled brown and red, with some fine to medium grained, sub-angular ironstone gravel, with some silt		
	M			2.60 60.30	Rec = 450/450 mm SPT 2.50-2.95 m 6, 8, 12 N=20				with some medium grained, sub-angular ironstone gravel	D MD	
WB		GWNO	3	3.50 59.40				SP	SAND fine to medium grained, pale grey, with some clay		
			4						For Continuation Refer to Sheet 2		
			5								
			6								
			7								
			8								
			9								
			10								

BOREHOLE: SRT BH017

SHEET: 2 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 155 Miller Street, North Sydney
PROJECT No PSC No.00013/10464

COORDS: 334111.0 m E 6254365.0 m N MGA94 56
SURFACE RL: 62.90 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.48 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 5/5/15
CHECKED: DF/JCB FINISH: 12/5/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, Ex 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3				0							
				1							
				2							
				3							
				4	7.11		Continuation of Sheet 1				
					58.90		CORE LOSS				
		45	0 (0)		7.22						
					58.30		Sandy GRAVEL medium grained, pale grey	EW			
				5	2.11		SANDSTONE medium to coarse grained, pale grey				
					57.85		CORE LOSS	EW			
		95	65 (90)				SANDSTONE medium to coarse grained, pale grey, bedded at 0° to 15°	FR			
				6	3.11						
					56.87		CORE LOSS				
							SANDSTONE medium to coarse grained, pale grey, cross bedded at 10° typically			6.35 m: B, 20°, Pl, Ro, Cn 6.51 m: B, 3°, Pl, Ro, clay Vr	
		95	95 (95)	7	3.02						
					56.15		SANDSTONE medium grained, pale grey and pale orange, cross bedded at 5° to 20° typically	SW		6.84 m: DS, 15°, Un, Ro, clay, 18 mm	
				8	4.11						
					4.85		SANDSTONE coarse grained, pale grey and dark orange red ironstained	MW		8.16 m: DS, 15°, Pl, Ro, clay, 30 mm 8.28 m: J, 20°, Un, Ro, Cn	
					54.67		CORE LOSS	MW		8.42 m: J, 10°, Pl, Ro, Cn	
		100	100 (100)				SANDSTONE coarse grained, pale grey and dark orange red bedded at 0° to 20° typically, ironstained			8.67 m: J, 45°, Pl, Ro, Cn	
				9							
										9.48 m: B, 30°, Pl, Ro, Cn	
				10							

BOREHOLE: SRT BH017

SHEET: 3 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 155 Miller Street, North Sydney
PROJECT No PSC No.00013/10464

COORDS: 334111.0 m E 6254365.0 m N MGA94 56
SURFACE RL: 62.90 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.48 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 5/5/15
CHECKED: DF/JCB FINISH: 12/5/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, Ex 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3				10							
		100	100 (100)				SANDSTONE coarse grained, pale grey and dark orange red bedded at 0° to 20° typically, ironstained	MW			
				11						10.71 m: B, 20°, Pl, Ro, Cn 10.86 m: DS, 20°, Pl, Ro, clay, 18 mm	
										11.05 m: B, 15°, Pl, Ro, Cn, iron Sn	
		100	95 (100)	12				MW - SW			
					8T.21					12.23 m: B, 20°, Pl, Ro, Cn	
					50.40		with occasional carbonaceous laminations			12.45 m: B, 20°, Un, Ro, Cn	
				13							
										14.12 m: B, 0°, Pl, Ro, Cn	
		100	100 (100)	15							
										15.77 m: B, 15°, Pl, Ro, Cn	
				16				MW			
					83.02					16.66 m: B, 5°, Un, Ro, Cn	
					46.15		SANDSTONE medium to coarse grained, pale grey, bedded at 0° to 15° typically	SW		17.04 m: J, 30°, Pl, Ro, Cn 17.10 m: DS, 0°, Un, Ro, clay, 18 mm	
				17	80.33						
					45.17		CORE LOSS			17.65 m: DS, 0°, Pl, Ro, clayey sand, 150 mm	
		100		18			SANDSTONE medium to coarse grained, pale grey, bedded at 0° to 15° typically				
										18.67 m: SS, 10°, clay Vr, 10 mm 18.73 m: CS, 10°, clay Ct, 5 mm 18.82 m: B, 0-10°, Un, Ro, Cn	
				19				FR			
		100	95 (100)							19.65 m: B, 0-5°, Pl, Ro, Cn	
				20							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH017

SHEET: 4 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 155 Miller Street, North Sydney
PROJECT No PSC No.00013/10464

COORDS: 334111.0 m E 6254365.0 m N MGA94 56
SURFACE RL: 62.90 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.48 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 5/5/15
CHECKED: DF/JCB FINISH: 12/5/15

Drilling						Field Material Description			Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	95 (100)	20	T1.72 42.65		SANDSTONE medium to coarse grained, pale grey, bedded at 0° to 15° typically	FR			
							from 20.25 m to 20.33 m: coarse grained quartz sand and flecks of siltstone			20.46 m: B, 10-15°, Pl, Ro, Cn 20.63 m: J, 0°, Pl, Ro, Cn	
				21	T8.34 41.22		SANDSTONE medium to coarse grained, massive, pale grey			21.63 m: B, 0-5°, Un, Ro, Cn 21.68 m: B, 10°, Pl, Ro, clay Vr	
		100	100 (100)	22	TH44 39.02		SANDSTONE medium to coarse grained, pale grey, some carbonaceous laminations at 0° to 30°, irregular bedding			23.90 m: B, 10°, Pl, Ro, clay Vr 24.38 m: B, 15°, Pl, Ro, clay Vr	
				23							
				24							
				25						25.83 m: B, 15°, Un, Ro, clay Vr	
				26	T3.51 36.00		SANDSTONE medium to coarse grained, massive, pale grey			26.70 m: B, 5°, Pl, Ro, clay Ct, =2 mm 26.77 m: J, 20°, Pl, Ro, clay Vr	
		100	100 (100)	27	T0.24 35.32		SANDSTONE medium to coarse grained, pale grey, cross bedded at ~20°				
				28							
				29	T5.78 33.49		SANDSTONE AND SILTSTONE INTERBEDS irregular bedding, 50% siltstone, 50% sandstone			29.22 m: B, 10°, Pl, Ro, Cn 29.42 m: DS, 0°, Pl, Sm, clay, <=15 mm 29.59 m: B, 0°, Pl, Sm, Cn 29.71 m: J, 80°, Pl, Sm	
		100	100 (100)	30	T5.53						

BOREHOLE: SRT BH017

SHEET: 5 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 155 Miller Street, North Sydney
PROJECT No PSC No.00013/10464

COORDS: 334111.0 m E 6254365.0 m N MGA94 56
SURFACE RL: 62.90 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.48 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 5/5/15
CHECKED: DF/JCB FINISH: 12/5/15

Drilling						Field Material Description			Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	30	HT.8H 32.77		SANDSTONE WITH CARBONACEOUS LAMINATIONS medium grained, pale grey and dark grey, cross bedded to 20°	FR		29.97 m: B, 15°, Pl, Sm, clay Vr 30.14 m: B, 15°, Pl, Ro, clay Vr	
				31			SANDSTONE WITH CARBONACEOUS LAMINATIONS medium grained, pale grey and dark grey, cross bedded to 20°				
					HB.2T 31.38		SANDSTONE WITH FLECKS OF SILTSTONE / CARBONACEOUS medium to coarse grained, massive, pale grey				
		100	94 (100)	32	HT.8H 30.77		poorly developed bedding			31.64 m: J, 0°, Pl, Ro, clay Vr 31.74 m: J, 0°, Pl, Ro, clay Vr 31.80 m: J, 80°, Pl, Ro, clay Vr, offset bedding planes indicate displacements upto 2 mm across defect from 31.5 m to 32.12 m 32.09 m: B, 0°, Pl, Ro, Cn	
					HT.21 30.40		SANDSTONE WITH SILTSTONE FRAGMENTS medium to coarse grained, pale grey and dark grey with fine grained sub-rounded quartz gravel			32.55 m: J, 80°, Pl, Ro, Cn	
				33			SANDSTONE WITH FLECKS OF SILTSTONE / CARBONACEOUS medium to coarse grained, massive, pale grey				
		100	100 (100)	34	HH51 29.00		SANDSTONE medium to coarse grained, pale grey, cross bedded at up to 20°			33.97 m: J, 30°, Pl, Ro, clay Vr 34.04 m: J, 0°, Pl, Ro, Cn 34.25 m: J, 0°, Pl, Ro, Cn 34.53 m: B, 20°, Pl, Ro, Cn	
				35	H7.58 27.99		bedded at 0° to 10° typically				
				36							
				37						37.21 m: B, 0°, Pl, Ro, Cn	
				38	H0.0T H0.43 25.04		from 37.72 m to 37.79 m: dark grey, siltstone clast from 37.79 m to 37.86 m: fine grained sub-rounded quartz gravel				
		100	95 (100)				SANDSTONE WITH SILTSTONE AND CARBONACEOUS LAMINATIONS medium to coarse grained, pale grey and grey, cross bedded to 15°			38.62 m: B, 10-15°, Pl, Ro, Cn	
				39						39.25 m: B, 5°, Pl, Ro, Cn	
		100	100 (100)	40	H5.0T 23.18					39.72 m: B, 10°, Pl, Ro, Cn	

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH017

CLIENT:	Transport for New South Wales	COORDS: 334111.0 m E 6254365.0 m N MGA94 56	SHEET: 6 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 62.90 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 155 Miller Street, North Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.48 m	LOGGED: AMS START: 5/5/15
			CHECKED: DF/JCB FINISH: 12/5/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	40			SANDSTONE medium to coarse grained, pale grey, irregular bedding, poorly developed bedding	FR			
				41	78.85						
					21.71		SANDSTONE WITH FLECKS OF SILTSTONE / CARBONACEOUS medium grained, massive, pale grey, bedded at 0° to 10° typically			41.19 m: J, 0°, Pl, Ro, Cn	
		100	100 (100)	42	77.H1						
					20.60		SANDSTONE medium to coarse grained, pale grey, bedded at 0° to 10° typically			42.57 m: B, 10°, Pl, Ro, Cn	
				43							
		100	100 (100)		7H75						
					19.41		cross bedded at 20°				
					7H48						
					19.09		SANDSTONE fine to medium grained, grey, horizontally bedded			43.80 m: B, 5°, Pl, Ro, Cn 43.86 m: B, 0°, Pl, Ro, carbonaceous material Vr	
				44	77.87						
					18.76		SANDSTONE WITH SILTSTONE FRAGMENTS medium grained, pale grey, irregular and cross bedded			44.12 m: B, 10°, Pl, Ro, Cn	
										44.76 m: B, 20°, Un, Ro, carbonaceous material Vr 44.88 m: DS, 20°, Un, Ro, clay	
				45	72.84						
		100	90 (90)		17.72		from 45.18 m to 45.34 m: siltstone clasts				
				46							
					73.77						
					16.48		SANDSTONE WITH SOME CARBACEOUS FLECKS medium grained, massive, pale grey			46.22 m: J, 80°, Pl, Ro, Cn	
				47							
		100	100 (100)	48							
				49							
					75.74						
					13.42		END OF BOREHOLE @ 49.48 m TARGET DEPTH PIEZOMETER INSTALLED				
				50							

CORE PHOTOGRAPHS: SRT BH017

CLIENT:	Transport for New South Wales	COORDS: 334111.0 m E 6254365.0 m N MGA94 56	SHEET: 1 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 62.90 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 155 Miller Street, North Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.48 m	LOGGED: AMS START: 5/5/15
			CHECKED: DF/JCB FINISH: 12/5/15

CORE PHOTOGRAPHS: SRT BH017

SHEET: 2 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 155 Miller Street, North Sydney
PROJECT No PSC No.00013/10464

COORDS: 334111.0 m E 6254365.0 m N MGA94 56
SURFACE RL: 62.90 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.48 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 5/5/15
CHECKED: DF/JCB FINISH: 12/5/15

CORE PHOTOGRAPHS: SRT BH017

SHEET: 3 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 155 Miller Street, North Sydney
PROJECT No PSC No.00013/10464

COORDS: 334111.0 m E 6254365.0 m N MGA94 56
SURFACE RL: 62.90 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 49.48 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: AMS START: 5/5/15
CHECKED: DF/JCB FINISH: 12/5/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH017

CLIENT:	Transport for New South Wales	COORDS: 334111.0 m E 6254365.0 m N MGA94 56	SHEET: 4 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 62.90 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 155 Miller Street, North Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.48 m	LOGGED: AMS START: 5/5/15
			CHECKED: DF/JCB FINISH: 12/5/15

CORE PHOTOGRAPHS: SRT BH017

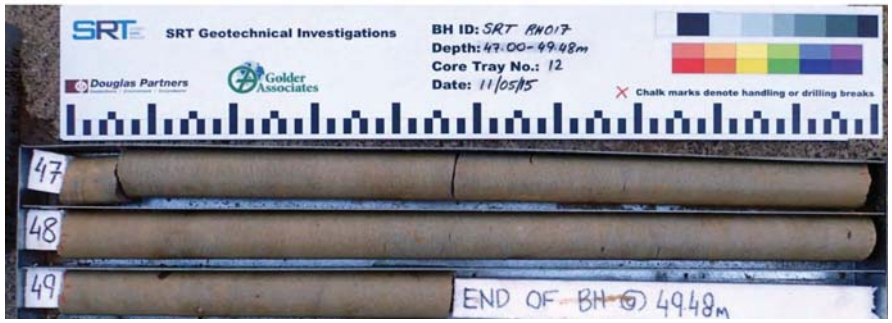
CLIENT:	Transport for New South Wales	COORDS: 334111.0 m E 6254365.0 m N MGA94 56	SHEET: 5 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 62.90 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 155 Miller Street, North Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.48 m	LOGGED: AMS START: 5/5/15
			CHECKED: DF/JCB FINISH: 12/5/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH017

CLIENT:	Transport for New South Wales	COORDS: 334111.0 m E 6254365.0 m N MGA94 56	SHEET: 6 OF 6 REV: D
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 62.90 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Adjacent to 155 Miller Street, North Sydney	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 49.48 m	LOGGED: AMS START: 5/5/15
			CHECKED: DF/JCB FINISH: 12/5/15

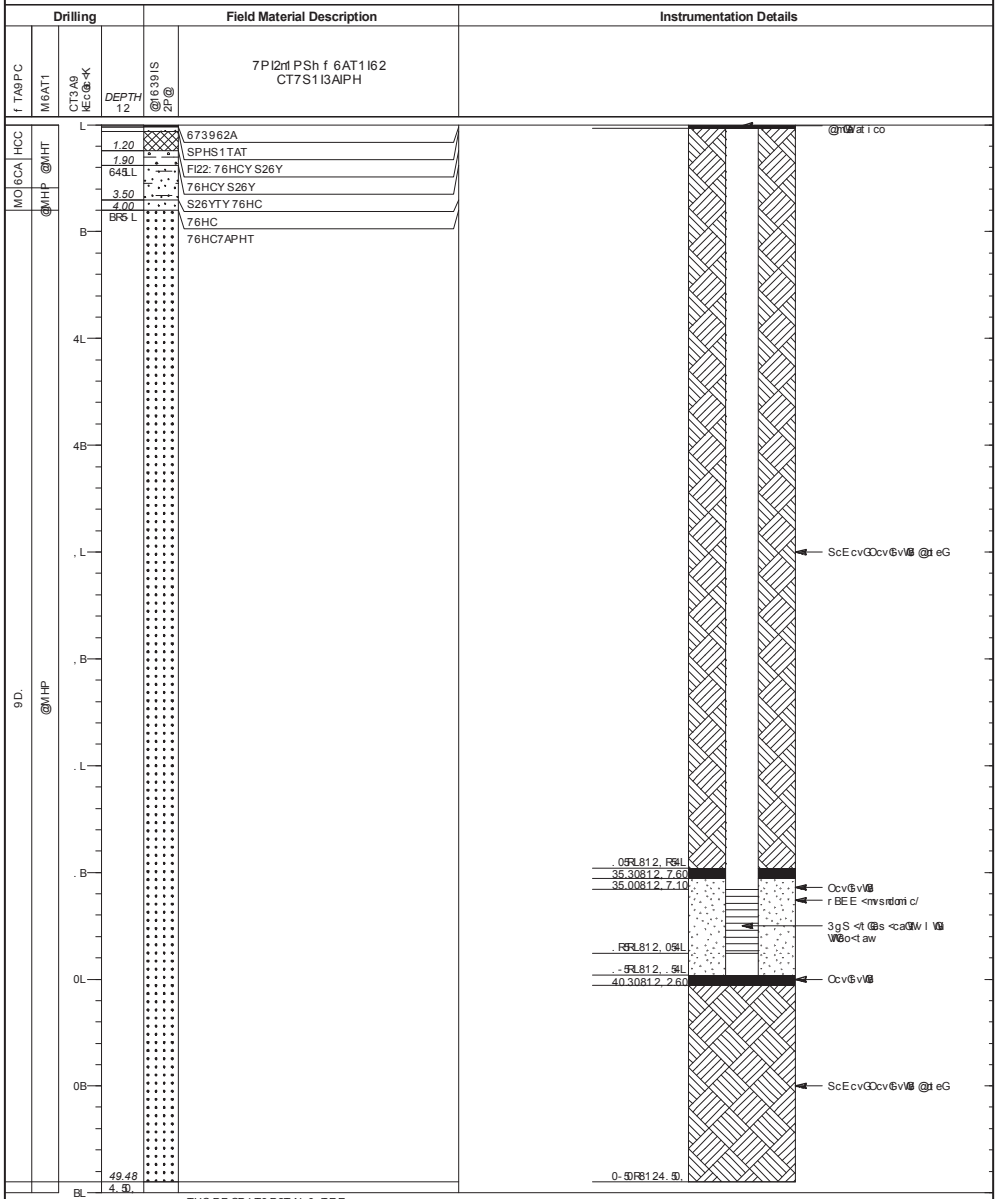


This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

FINAL STANDPIPE INSTALLATION: SRT BH017

S2ITHA:	Acmv<pt oQ/oHcl 7t eQi Mmtc<	SPP1C7: . . 04445L E T 6, B0. 6B5L E H f @6- 0 B	79TTA: 4 PF 4 1Tg: FWhf
31P(TSA:	71A@ct Qauv\Ahf lvi c<QWhQW 7coi Wc<	7U1F6ST 12: 6, 5 L E C6AUf : 69C	C1I22 1i@ 7at eQ0
2PS6AIPH:	6sjmacvQ6 4BBf Wco7Qcc8Ht oQ 7ysvcy	IHS2IH6AIPH: °- LJ	SPHA16SAP1: @t evsQ<G
31P(TSA Ht 37S Ht 5LLL4. m4L060		9P2T CT3A9: 0- 5)RE	2P@@TC: 6f 7 7A61A: BrB4B
			S9TShTC: CFn(SO FIHI79: 4, rB4B



THC PF OP1T9P2T N. 0- 5)RE

AuWcopt oQt V<Qavsp\pc vW<Qa/mQW E e<Qbc ocms Wat vjevaQW I WQ maat E pmvyWd vt Q< mvs mbbci WQW<5 IQum<bccv pocpmocs
Vrodct Qauv\Ahf peopt <c< t v/y8l WQt eQmQBE pQB ms<c<< pt <<WvC at vQBE WmQW5 6 vy ocVcocvac< 6 pt Qv QWat vQBE WmQW moc
VroWWdE mQW t v/y mvs st vt Qvcac<<mdWWs\AmQ Qic poc<cvac t omb<cvac t V<t WrodcLevsI mQoat vQBE WmQW5

@63 dIHA FH5F4)
1.24

STANDPIPE INSTALLATION: SRT BH018

TBHHFk 0 AD 0 1HYk P

: 2C9 Fk Fra<dj ort for 9eV Tostw(aued : AA1PTk RRRR7L.L m H 3566- L3.L m 9 MON74 63 P1C22 1Ck Tcost 4

G1AbH: Fk T1F Oeotecw<icauGvedtil atio< Terviced TI 1DN: H 12k 7L.- 6 m PNFI Mk NBP : A9F1N: FA1k Oros</ Fedt

2A: NFCA9k Bsme Tt8: roVd 9edt C9 : 29NFCA9k S7LJ 2AOOHPk NMT TFN1Fk 54g4g06

G1AbH: F 9oiGT: 9o.LLL0R9L434 BA2H PHGFBk 43.6Rm : BH: KHPk PDg: D9 CBk RLg4g06

Drilling				Field Material Description	Instrumentation Details
MHFBAP	(NFH1	PHGFB)metredp	DEPTH 12	O1NGBC 2AO TAC2gIA: K MNFH1 C2 PHT: 1 C2FCA9	
9PP		L	7L.-6	9A9SPHTF1I : FCYHPCDC9O	Oatic cover
			1.20		
NPF			2.10	: 2NEHE O1NYH2	
			, , .36	TC2FE : 2NE	
			4.00		
			, 3.-6	TC2FTFA9H	
		6			: eme<t 6e<to<ite Orost
		0L	11.25		
			- 7.6L	TN9PTFA9H	
		06			
			17.71		
			- RL4	2NM9CFH	0, .RL81 2- 5.46 6e<to<ite
					07.66812- 0.5L n6mm da</ g raveu
		5L	20.55		
			- L.5L	TN9PTFA9H	GY: dwtte/ dectio< Vitw hider docf
B WR		56			56.RL81 236.46 6e<to<ite
		RL			
		R6			: eme<t 6e<to<ite Orost
		4L	41.10		
			47.36	2NM9CFH	
		46			
			45.77		
			46.53	TN9PTFA9H	43.6R81 244.55
			44.55	H9P AD6A1HBA2H @ 43.6Rm FN1OHF PHGFB TFN9RGCH C TFN22HP	

Fwid rej ort ondta</ j fj e i<dtaliatio< msdt ye rea/ i< co<ls<ctio< Vitwaccomj a<°i<l <oted a</ ayyreviatio<d. Cwad yee< j rej are/ for I eotecw<icauj srj oded o<18Vitwost attemj t to addedd j oddiyue co<tami<atio<. N<° rehere<ced to j ote<tiauco<tami<atio< are for i<formatio< o<u a</ / o <ot <eceddarid i</ icate twe j rede<ce or ayde<ce ohdoiuor I ros</ Vater co<tami<atio<.

ONGI C9F D9. D0-120

BOREHOLE: SRT BH019

SHEET: 1 OF 5 REV: D

CLIENT: Transport for New South Wales COORDS: 333308.0 m E 6255819.0 m N MGA94 56 DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services SURFACE RL: 84.43 m DATUM: AHD CONTRACTOR:

LOCATION: Oxley St, Crows Nest INCLINATION: -90° LOGGED: AP START: 17/4/15

PROJECT No PSC No.00013/10464 HOLE DEPTH: 36.10 m CHECKED: DF/LM FINISH:

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	84.43								
				0.20					ROAD SURFACE: ASPHALT			FILL
				0.38					FILL: Roadbase fine - medium grained, brown, sandy gravel			
NDD				84.05				CH	FILL: Silty CLAY grey-brown			RESIDUAL SOIL
			1						Silty CLAY high plasticity, orange-brown			St
				1.60								
		17/04/15 10.00am		82.83	U75 1.65-1.95 m Rec = 300/300 mm			CH	Silty CLAY high plasticity, red brown and grey, with some fine to coarse grained ironstone gravel			
			2		PP 1.95 m >400 kPa							
ADT					SPT 2.50-2.95 m 9, 15, 24 N=39 Rec = 450/450							
	M		3		C 3.00-3.40 m Rec = 480/1000 mm							
HQ3												
		24/04/15 3.00pm	4		SPT 4.20-4.65 m 12, 16, 20 N=36 Rec = 450/450						VSt - H	
WB	M-H		5									
					SPT 5.30-5.75 m 10, 18, 25 N=43 Rec = 450/450							
			6									
									For Continuation Refer to Sheet 2			
			7									
			8									
			9									
			10									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F01a RL3

BOREHOLE: SRT BH019

CLIENT: Transport for New South Wales	COORDS: 333308.0 m E 6255819.0 m N MGA94 56	SHEET: 2 OF 5	REV: D
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 84.43 m DATUM: AHD	DRILL RIG: Explora	
LOCATION: Oxley St, Crows Nest	INCLINATION: -90°	CONTRACTOR:	
PROJECT No PSC No.00013/10464	HOLE DEPTH: 36.10 m	LOGGED: AP	START: 17/4/15
		CHECKED: DF/LM	FINISH:

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4							
				5							
				6	3.04		Continuation of Sheet 1				
HQ3		0	0 (0)		78.23		CORE LOSS				
				7	3.82 77.86		SILTSTONE pale grey with orange brown sandstone bands	EW			
		100	0 (0)								
		100	40 (90)	8	7.45 76.39		SANDSTONE medium grained, red brown, iron staining and cementing	HW		8.19-8.45 m: Bx 6, 0-10°, Pl, Ro, iron Sn	
					7.84 75.93		orange brown			8.80-9.10 m: Bx 6, 0-10°, Un, Ro, iron cementing Vr-Ct	
				9	7.12 75.46		SANDSTONE WITH SOME SILTSTONE LAMINATIONS fine to medium grained, pale orange brown, horizontal bedding			9.25 m: SS, 0-5°, sandy clay	
		100	63 (100)							9.60-9.75 m: DS, 0°, sandy clay	
				10				SW			

BOREHOLE: SRT BH019

CLIENT: Transport for New South Wales	COORDS: 333308.0 m E 6255819.0 m N MGA94 56	SHEET: 3 OF 5	REV: D
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 84.43 m DATUM: AHD	DRILL RIG: Explora	
LOCATION: Oxley St, Crows Nest	INCLINATION: -90°	CONTRACTOR:	
PROJECT No PSC No.00013/10464	HOLE DEPTH: 36.10 m	LOGGED: AP	START: 17/4/15
		CHECKED: DF/LM	FINISH:

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				10			SANDSTONE WITH SOME SILTSTONE LAMINATIONS fine to medium grained, pale orange brown, horizontal bedding	SW		10.38 m: SS, 0°, clay, 10 mm	
		100	63 (100)	11	TT.7T 72.62					10.82 m: SS, clay, 10 mm 11.10 m: Bx 3, 0°, Pl, Ro, clay Vr 11.28 m: Bx 2, 0°, Pl, Ro, clay Vr 11.45 m: SS, 5°, Un-St, Ro, 30 mm 11.63 m: SS, 0°, clay, 20 mm 11.76 m: SS, 0°, clay, 10 mm	
				12	T0.04 72.23		LAMINITE fine to medium grained, pale grey and grey, laminated	EW - HW		11.80 m: B, 5°, Un-St, Ro, clay Ct	
		90	90 (90)				SANDSTONE WITH SILTSTONE LAMINATIONS fine to medium grained, pale and dark grey, horizontal bedding, laminations typically extremely low to very low strength siltstone, 15% siltstone, 85% sandstone; 12.4-12.6m 30% siltstone	SW - FR		12.17 m: SS, 0°, 20 mm 12.41 m: SS, 0°, clay, 15 mm	
				13						12.80 m: B, 0-5°, Pl, Ro, Vr	
					TH.58 70.98		30% siltstone to 13.6m			13.26 m: SS, 0°, Pl, Ro, clay Ct 13.43 m: B, 0-5°, St, Ro, Cn	
				14	T5.T2					13.72 m: SS, 5°, Pl, Ro, 20 mm 13.82 m: J, 10°, Pl, Ro, Cn 13.95 m: SS, 0-5°, Pl, Ro, 10 mm	
					T5.HI		CORE LOSS				
					70.13		SANDSTONE WITH SILTSTONE LAMINATIONS: as above	SW - FR			
HQ3				15	T8.44 69.43		LAMINITE fine to medium grained sandstone, pale and dark grey, 50% sandstone, 50% siltstone	FR		14.83 m: Bx 2, 0°, St, Ro, clay Vr	
		95	95 (95)							15.73 m: B, 0°, Pl, Sm, clay Vr	
				16							
				17	T2.HI		CORE LOSS				
					67.03		LAMINITE: as above	FR			
				18	T7.41 66.34		SANDSTONE medium to coarse grained, pale grey with grey bands, horizontally to cross bedded with occasional carbonaceous laminations	FR		17.95 m: B, 0°, Pl, Sm, clay Vr 18.17 m: B, 15°, Pl, Ro, Cn 18.30 m: J, 80°, Pl, Ro, Cn	
		100	95 (100)	19							
				20						19.61 m: B, 0°, Un, Ro, sandy clay Ct	

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH019

SHEET: 4 OF 5 REV: D

CLIENT: Transport for New South Wales
COORDS: 333308.0 m E 6255819.0 m N MGA94 56
DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 84.43 m DATUM: AHD
CONTRACTOR:

LOCATION: Oxley St, Crows Nest
INCLINATION: -90°
LOGGED: AP
START: 17/4/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 36.10 m
CHECKED: DF/LM
FINISH:

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	95 (100)	20			SANDSTONE medium to coarse grained, pale grey with grey bands, horizontally to cross bedded with occasional carbonaceous laminations	FR		19.95 m: SS, 0°, 3 mm	
				21							
		100	100 (100)	22						21.90 m: B, 0°, Pl, Ro, clay Ct	
				23							
				24							
					05,H4 60.13		24.3 m to 25.10 m cross bedded at 10° to 20°				
		100	100 (100)	25						25.50 m: B, 0°, Un, Ro, Cn	
				26							
				27						26.76 m: B, 0°, Pl, Ro, Cn 26.90 m: B, 5°, Pl, Ro, Cn	
					02,53 56.97		carbonaceous lamination				
		100	100 (100)	28							
				29							
				30							

BOREHOLE: SRT BH019

SHEET: 5 OF 5 REV: D

CLIENT: Transport for New South Wales
COORDS: 333308.0 m E 6255819.0 m N MGA94 56
DRILL RIG: Explora

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 84.43 m DATUM: AHD
CONTRACTOR:

LOCATION: Oxley St, Crows Nest
INCLINATION: -90°
LOGGED: AP
START: 17/4/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 36.10 m
CHECKED: DF/LM
FINISH:

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	69 DEP RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	30	54.48 54.33		SANDSTONE WITH CARBONACEOUS LAMINATIONS medium to coarse grained, pale grey, horizontally t cross bedded up to 15°	FR			
				31							
				32	H0,44 52.43		SANDSTONE WITH SILTSTONE FRAGMENTS medium to coarse grained, pale grey, sub-horizontally bedded			32.13 m: B, 0°, Pl, Ro, clay Ct 32.46 m: SS, clayey sand, 20 mm	
		100	100 (100)	33							
					HH,H4 51.13		SANDSTONE WITH SILTSTONE AND CARBONACEOUS FLECKS medium to coarse grained, pale grey with grey bands, generally horizontally bedded			33.29 m: SS, very low strength 33.50 m: J, 80°, Pl-Un, Ro, Cn	
				34							
				35							
				36	H3,T4 48.33		END OF BOREHOLE @ 36.10 m TARGET DEPTH GROUTED			35.84 m: B, 0°, Pl, Ro, clay Vr	
				37							
				38							
				39							
				40							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

CORE PHOTOGRAPHS: SRT BH019

			SHEET: 1 OF 6	REV: D	
CLIENT:	Transport for New South Wales	COORDS: 333308.0 m E 6255819.0 m N MGA94 56	DRILL RIG: Explora		
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 84.43 m DATUM: AHD	CONTRACTOR:		
LOCATION:	Oxley St, Crows Nest	INCLINATION: -90°	LOGGED: AP	START: 17/4/15	
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 36.10 m	CHECKED: DF/LM	FINISH:	

CORE PHOTOGRAPHS: SRT BH019

			SHEET: 2 OF 6	REV: D	
CLIENT:	Transport for New South Wales	COORDS: 333308.0 m E 6255819.0 m N MGA94 56	DRILL RIG: Explora		
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 84.43 m DATUM: AHD	CONTRACTOR:		
LOCATION:	Oxley St, Crows Nest	INCLINATION: -90°	LOGGED: AP	START: 17/4/15	
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 36.10 m	CHECKED: DF/LM	FINISH:	

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH019

		SHEET: 3 OF 6	REV: D
CLIENT: Transport for New South Wales	COORDS: 333308.0 m E 6255819.0 m N MGA94 56	DRILL RIG: Explora	
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 84.43 m DATUM: AHD	CONTRACTOR:	
LOCATION: Oxley St, Crows Nest	INCLINATION: -90°	LOGGED: AP	START: 17/4/15
PROJECT No PSC No.00013/10464	HOLE DEPTH: 36.10 m	CHECKED: DF/LM	FINISH:

CORE PHOTOGRAPHS: SRT BH019

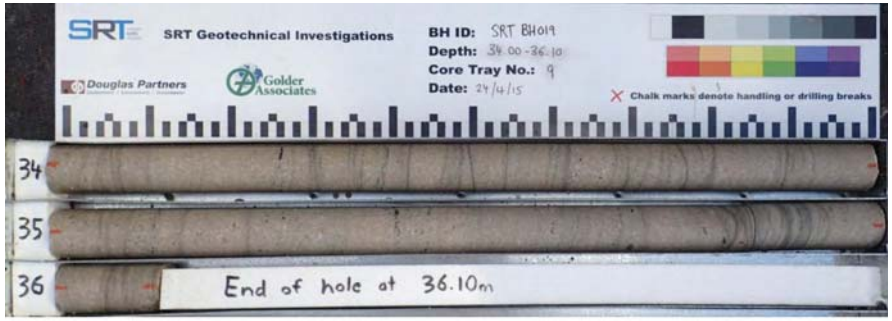
		SHEET: 4 OF 6	REV: D
CLIENT: Transport for New South Wales	COORDS: 333308.0 m E 6255819.0 m N MGA94 56	DRILL RIG: Explora	
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 84.43 m DATUM: AHD	CONTRACTOR:	
LOCATION: Oxley St, Crows Nest	INCLINATION: -90°	LOGGED: AP	START: 17/4/15
PROJECT No PSC No.00013/10464	HOLE DEPTH: 36.10 m	CHECKED: DF/LM	FINISH:

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH019

		SHEET: 5 OF 6	REV: D
CLIENT: Transport for New South Wales	COORDS: 333308.0 m E 6255819.0 m N MGA94 56	DRILL RIG: Explora	
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 84.43 m DATUM: AHD	CONTRACTOR:	
LOCATION: Oxley St, Crows Nest	INCLINATION: -90°	LOGGED: AP	START: 17/4/15
PROJECT No PSC No.00013/10464	HOLE DEPTH: 36.10 m	CHECKED: DF/LM	FINISH:



CORE PHOTOGRAPHS: SRT BH019

		SHEET: 6 OF 6	REV: D
CLIENT: Transport for New South Wales	COORDS: 333308.0 m E 6255819.0 m N MGA94 56	DRILL RIG: Explora	
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 84.43 m DATUM: AHD	CONTRACTOR:	
LOCATION: Oxley St, Crows Nest	INCLINATION: -90°	LOGGED: AP	START: 17/4/15
PROJECT No PSC No.00013/10464	HOLE DEPTH: 36.10 m	CHECKED: DF/LM	FINISH:

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

FINAL STANDPIPE INSTALLATION: SRT BH019

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 1 OF 1 REV: Final

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Oxley St, Crows Nest
PROJECT NoPSC No.00013/10464

COORDS: 333308.0 m E 6255819.0 m N MGA94 56
SURFACE RL: 84.43 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 36.10 m

DRILL RIG: Explora
CONTRACTOR:
LOGGED: AP START: 17/4/15
CHECKED: DF/LM FINISH:

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
NDD		0	84.05		ASPHALT	Gatic cover
					FILL	Cement Bentonite Grout
ADT					SILTY CLAY	
	24/04/15, 3.00pm					3.25, RL81.18 Bentonite
	24/04/15, 10.00am					3.75, RL80.68
						4.00, RL80.43 <5mm sand/gravel
HQ3		5	6.20			
			78.23		SILTSTONE	7.00, RL77.43 PVC slotted
			8.04			7.50, RL76.93
			76.39		SANDSTONE WITH SILTSTONE LAMINATIONS	8.00, RL76.43 Bentonite
		10				
			15.00			
		15	69.43		LAMINITE	
			18.04			
			66.39		SANDSTONE	
		20				
		25				Cement Bentonite Grout
		30				
		35	36.10			36.10, RL48.33
			48.33		END OF BOREHOLE @ 36.10 m	

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17 RL1

NALSDTITP ISNALEELAIOS: NRA BH020

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 1 OF 1 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 39 Herbert Street, Artarmon
PROJECT NoPSC No.00013/10464

COORDS: 332695.0 m E 6256655.0 m N MGA94 56
SURFACE RL: 78.50 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 35.90

DRILL RIG: Explora
CONTRACTOR: Ground Test
LOGGED: AP START: 28/4/15
CHECKED: DF/LM FINISH: 1/5/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
SPT NDD		0	78.30		CONCRETE	Gattic cover
			1.60		FILL: SANDY CLAY	
	04/05/15 08:30		2.00		SILTY CLAY	
			76.50		SANDSTONE	
		5				
		10				Cement bentonite grout
		15				14.35, RL64.15 Bentonite
						14.85, RL63.65
						<5mm sand
HQ3		20				PVC slotted screen with filter sock
						21.10, RL57.40
						21.60, RL56.90
						22.10, RL56.40 Bentonite
			22.28			
			56.22		LAMINITE	
		25	23.75			
			54.75		SANDSTONE AND SILTSTONE	
			26.66			
			51.84		SANDSTONE	
		30				Cement bentonite grout
		35				35.00, RL43.50
			35.90			
			42.60		END OF BOREHOLE @ 35.90	

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17 RL1

BOREHOLE: SRT BH023

SHEET: 1 OF 5 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Gilham Street (reserve), Chatswood
PROJECT No PSC No.00013/10464

COORDS: 331693.3 m E 6258111.5 m N MGA94 56
SURFACE RL: 105.50 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 35.10 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: LJH START: 26/6/15
CHECKED: FM FINISH: 2/7/15

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (met es)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADT	L	GWNE	0	105.50					TOPSOIL: Silty CLAY medium to high plasticity, dark grey-brown, with some fine grained ironstone gravel and rootlets	M		TOPSOIL
				0.30								
				105.20				CI-CH	Silty CLAY medium to high plasticity, red-brown, with some fine grained ironstone gravel		St	RESIDUAL SOIL
			1	1.00								
	M			104.50	U75 1.00-1.30 m Rec = 300/300 mm PP 1.30 m >500 kPa				with some grey mottling	D - M	VSt	
			2	2.00								
				103.50				CI-CH	Silty CLAY medium to high plasticity, red-brown and grey mottled, with some fine to medium grained ironstone gravel			
				2.50								
	H		3	103.00	Rec = 450/450 mm SPT 2.50-2.95 m 7, 15, 20 N=35				with iron rich bands		H	
				3.80						D		
HQ3	H-R		4	101.70	C 4.00-5.70 m Rec = 1700/1700 mm			GC	Clayey GRAVEL fine to medium grained, sub-angular to angular, red-brown and pale grey			
			5						For Continuation Refer to Sheet 2			
			6									
			7									
			8									
			9									
			10									

BOREHOLE: SRT BH023

SHEET: 2 OF 5 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Gilham Street (reserve), Chatswood
PROJECT No PSC No.00013/10464

COORDS: 331693.3 m E 6258111.5 m N MGA94 56
SURFACE RL: 105.50 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 35.10 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: LJH START: 26/6/15
CHECKED: FM FINISH: 2/7/15

Drilling						Field Material Description			Defect Information
METHOD	WATER	TCR	ROD (SCR)	DEPTH (metres)	0 4 8 5 6 RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa Ei 0.03 VL 0.03 L 0.1 M 1 H 3 VH 10 Ex	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) 10 30 100 300 1,000 3,000
				0							
				1							
				2							
				3							
				4							
				5	7.12 100.60		Continuation of Sheet 1 SILTSTONE pale grey and red-brown, some ironstone staining	EW		5.10 m: J, 70°, Pl, Sm, Cn	
HQ3		100	0 (100)	6						6.15 m: J, 60°, Pl, Sm, Cn	
		100	0 (100)	7						6.90 m: J, 45°, Pl, Sm, Cn	
				8						8.32 m: J, 50°, Pl, Sm, Cn	
		100	0 (100)	9	1.73 96.07		SILTSTONE grey-orange, irregular bedding, with iron stained sandstone laminations	HW			
		100	0 (100)								
		100	45 (85)	10							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

BOREHOLE: SRT BH023

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 3 OF 5 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Gilham Street (reserve), Chatswood
PROJECT No PSC No.00013/10464

COORDS: 331693.3 m E 6258111.5 m N MGA94 56
SURFACE RL: 105.50 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 35.10 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: LJH START: 26/6/15
CHECKED: FM FINISH: 2/7/15

Drilling						Field Material Description			Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)
HQ3		100	45 (85)	10			SILTSTONE grey-orange, irregular bedding, with iron stained sandstone laminations	HW		
				11					10.92-11.07 m: fragmented 11.15-11.25 m: fragmented 11.30-11.55 m: SS	
		100	70 (100)	12					12.00-12.09 m: DS, ironstained 12.48-12.84 m: Jx 4, 45°, Pl, Sm, iron Sn	
				13	9D1D 92.58		SILTSTONE WITH SANDSTONE LAMINATIONS dark grey, with some fine grained sandstone laminations dipping at 0-5°	SW	13.16 m: B, 5°, Pl, Ro, iron oxide Ct 13.51 m: J, 45°, Pl, Sm, Cn 13.80-14.90 m: Jx 4, 75°, Pl, Ro, Cn	
		40	25 (40)	14						
				15				MW	15.00-15.12 m: Jx 2, 40°, Pl, Ro, Cn 15.20-15.27 m: fragmented	
				16	9E7E 90.05		CORE LOSS			
				17						
		100	75 (100)	18	9P9P 88.33		SILTSTONE WITH SANDSTONE LAMINATIONS grey-orange, with fine grained sandstone laminations	HW	17.20-17.34 m: DS	
				19	9P1E 87.55		SILTSTONE WITH SANDSTONE LAMINATIONS dark grey, with 20-30% siltstone laminae dipping at 0-5°	FR	18.00-19.79 m: Bx5, 0°, Pl, Sl, Cn	
		100	0 (100)	20						

BOREHOLE: SRT BH023

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 4 OF 5 REV: E

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Gilham Street (reserve), Chatswood
PROJECT No PSC No.00013/10464

COORDS: 331693.3 m E 6258111.5 m N MGA94 56
SURFACE RL: 105.50 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 35.10 m

DRILL RIG: Scout 4
CONTRACTOR: Groundtest
LOGGED: LJH START: 26/6/15
CHECKED: FM FINISH: 2/7/15

Drilling						Field Material Description			Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm)
HQ3		100	0 (100)	20			SILTSTONE WITH SANDSTONE LAMINATIONS dark grey, with 20-30% siltstone laminae dipping at 0-5°	FR	20.30-21.10 m: Bx2, 0°, Pl, Sl, clay, <5 mm	
		100	75 (100)	21					21.21 m: J, 80°, Pl, Sl, clay Vr, discontinuous 21.65 m: B, 0°, Pl, Sl, clay, 10 mm	
		100	100 (100)	22						
				23						
				24					24.54-24.74 m: Bx 4, 0°, Pl, Sl, clay, <5 mm	
		100	55 (100)	25	DE22 80.50		thinly laminated dipping at 10-15°		24.83 m: J, 40°, Pl, Sl, Cn 24.92 m: J, 50°, Pl, Sl, Cn 25.09-25.53 m: Bx 5, 10-15°, sp = 30-100 mm, Pl, Sl, clay Vr-Ct 25.23 m: J, 30°, Pl, Sl, clay Vr 25.36-25.38 m: Jx 2, 30-40°, Pl, Ro, Cn 25.45 m: J, 30-40°, Un, Ro, Cn 25.58 m: J, 10°, Pl, Ro, Cn 25.66 m: J, 30°, Pl, Ro, Cn	
				26	DE12 79.60		thinly laminated dipping at 0-5°		25.73 m: J, 20°, Pl, Ro, Cn 25.74-25.90 m: J, 70-90°, Un, Ro, Cn 25.90 m: SS, 60-70°	
				27	DT3T 79.14		SILTSTONE dark grey, with occasional fine grained sandstone laminations dipping at 5°		25.97 m: J, 30°, Pl, Ro, Cn 25.98-26.15 m: Jx 2, 70°, Pl, Ro, Cn 26.07 m: J, 60°, tight 26.23 m: J, 60°, Pl, Ro, Cn 26.41-26.71 m: Jx 3, sp = 80-200 mm, Pl, Sm, Cn 26.64 m: J, 20°, Pl, Sm, Cn 26.87 m: J, 50°, Pl, Sm, Cn 27.06 m: J, 40°, tight 27.38 m: B, 5°, Pl, Sm, clayey sand Ct 27.70 m: J, 60°, Pl, Sm, Cn	
		100	100 (100)	28					28.01 m: J, 20-40°, Un, Sm, Cn	
				29						
		100	90 (100)	30						

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH023

SHEET: 5 OF 5 REV: E

CLIENT: Transport for New South Wales
COORDS: 331693.3 m E 6258111.5 m N MGA94 56
DRILL RIG: Scout 4

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 105.50 m DATUM: AHD
CONTRACTOR: Groundtest

LOCATION: Gilham Street (reserve), Chatswood
INCLINATION: -90°
LOGGED: LJH START: 26/6/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 35.10 m
CHECKED: FM FINISH: 2/7/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	04856 RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	90 (100)	30			SILTSTONE dark grey, with occasional fine grained sandstone laminations dipping at 5°	FR		30.15 m: J, 20°, St, Ro, Cn 30.20-30.34 m: SZ	
					32 P2 74.80					30.45 m: J, 80°, Pl, Sm, discontinuous Cn 30.48 m: J, 50°, tight, discontinuous 30.58-30.78 m: SZ	
				31			SANDSTONE fine grained, dark grey, disturbed bedding and thinly laminated at 0-5°, with some siltstone laminations				
				32	3D2H						
					73.42 3D33		SILTSTONE dark grey, with some sandstone laminations				
					73.17		SANDSTONE AND SILTSTONE fine grained, dark grey and grey, interbedded with disturbed bedding				
					33 22						
		100	95 (100)	33	72.50 3D41		SANDSTONE fine to medium grained, grey, bedded at 0-5°, with carbonaceous laminations			33.28 m: B, 0°, Pl, Ro, clay Vr	
					72.22		33.28m to 33.58m: with siltstone laminations			33.49 m: B, 5°, Un, Ro, clay, 5 mm 33.57 m: B, 0-15°, Un, Ro, clay Vr	
				34						33.89-33.94 m: SS, 5-10°	
		100	100 (100)	35	3E92						
					70.40		END OF BOREHOLE @ 35.10 m TARGET DEPTH PIEZOMETER INSTALLED				
				36							
				37							
				38							
				39							
				40							

CORE PHOTOGRAPHS: SRT BH023

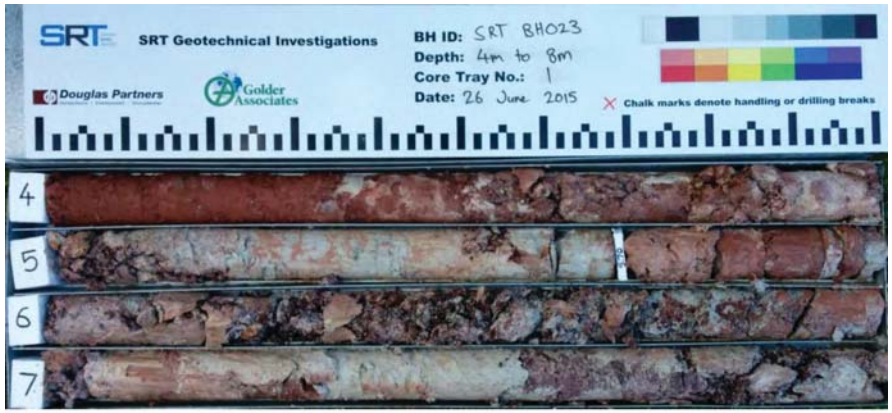
SHEET: 1 OF 4 REV: E

CLIENT: Transport for New South Wales
COORDS: 331693.3 m E 6258111.5 m N MGA94 56
DRILL RIG: Scout 4

PROJECT: SRT Geotechnical Investigation Services
SURFACE RL: 105.50 m DATUM: AHD
CONTRACTOR: Groundtest

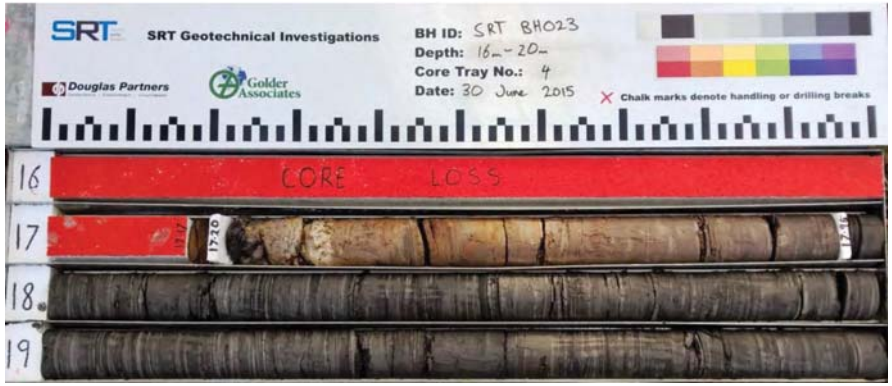
LOCATION: Gilham Street (reserve), Chatswood
INCLINATION: -90°
LOGGED: LJH START: 26/6/15

PROJECT No PSC No.00013/10464
HOLE DEPTH: 35.10 m
CHECKED: FM FINISH: 2/7/15



CORE PHOTOGRAPHS: SRT BH023

CLIENT:	Transport for New South Wales	COORDS: 331693.3 m E 6258111.5 m N MGA94 56	SHEET: 2 OF 4 REV: E
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 105.50 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Gilham Street (reserve), Chatswood	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 35.10 m	LOGGED: LJH START: 26/6/15
			CHECKED: FM FINISH: 2/7/15



CORE PHOTOGRAPHS: SRT BH023

CLIENT:	Transport for New South Wales	COORDS: 331693.3 m E 6258111.5 m N MGA94 56	SHEET: 3 OF 4 REV: E
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 105.50 m DATUM: AHD	DRILL RIG: Scout 4
LOCATION:	Gilham Street (reserve), Chatswood	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 35.10 m	LOGGED: LJH START: 26/6/15
			CHECKED: FM FINISH: 2/7/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH023

CLIENT:	Transport for New South Wales	SHEET: 4 OF 4	REV: E
PROJECT:	SRT Geotechnical Investigation Services	COORDS: 331693.3 m E 6258111.5 m N MGA94 56	DRILL RIG: Scout 4
LOCATION:	Gilham Street (reserve), Chatswood	SURFACE RL: 105.50 m DATUM: AHD	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	INCLINATION: -90°	LOGGED: LJH START: 26/6/15
		HOLE DEPTH: 35.10 m	CHECKED: FM FINISH: 2/7/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

FINAL STANDPIPE INSTALLATION: SRT BH023

CLIENT:	Transport for New South Wales	SHEET: 1 OF 1	REV: Final
PROJECT:	SRT Geotechnical Investigation Services	COORDS: 331693.3 m E 6258111.5 m N MGA94 56	DRILL RIG: Scout 4
LOCATION:	Gilham Street (reserve), Chatswood	SURFACE RL: 105.50 m DATUM: AHD	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	INCLINATION: -90°	LOGGED: LJH START: 26/6/15
		HOLE DEPTH: 35.10 m	CHECKED: HB FINISH: 2/7/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
ADT	GWNE	0	105.20		TOPSOIL	0.50, RL105.00 Gatic cover Concrete
					SILTY CLAY	Coarse sand
			7.12			
HQ3			101.70		CLAYEY GRAVEL	4.00, RL101.50
			3.02			
		5	100.60		SILTSTONE	Cement bentonite grout
						9.50, RL96.00
		10				Bentonite 10.50, RL95.00
						11.50, RL94.00
						Slotted PVC screen with filter sock
						14.50, RL91.00
		15				15.00, RL90.50 Bentonite
						16.00, RL89.50
HQ3	100% RETURN		48.73			
			88.16		LAMINITE	
		20				
		25				Cement bentonite grout
			56.76			
			79.14		SILTSTONE	
		30				
			72.82			
			74.80		SANDSTONE AND SILTSTONE	
		35	79.42			35.10, RL70.40
			70.40		END OF BOREHOLE @ 35.10 m TARGET DEPTH GROUNDWATER NOT OBSERVED STANDPIPE INSTALLED	

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17 RL1

STANDPIPE INSTALLATION: SRT BH026

CLIENT: Transport for New South Wales	COORDS: 331603.3 m E 6258046.0 m N MGA94 5	SHEET: 1 OF 1	REV: D
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 104.00 m DATUM: AHD	DRILL RIG: Explora	
LOCATION: Ausgrid Chatswood Depot Mowbray Road	INCLINATION: -90°	CONTRACTOR: Groundtest	
PROJECT No PSC No.00013/10464	HOLE DEPTH: 29.96 m	LOGGED: AP	START: 21/9/15
		CHECKED: HB/LM	FINISH: 25/9/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
NDD		0	0.50 103.50		FILL	Gatic cover
			1.50 102.50		FILL	
					GRAVELLY SILTY CLAY	
WB		5				
			9.40 94.60		SILTSTONE	Cement bentonite grout
		10				
		15				
			16.70 87.30		LAMINITE	
HQ3		20				21.00, RL83.00 Bentonite
						21.70, RL82.30
						22.20, RL81.80 Filter sand
						PVC slotted section
		25	24.90 79.10		SILTSTONE	
			29.96 74.04		END OF BOREHOLE @ 29.96 m TARGET DEPTH PIEZOMETER INSTALLED	28.20, RL75.80

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

BOREHOLE: SRT BH403

CLIENT: Transport for New South Wales	COORDS: 333618.5 m E 6247626.4 m N MGA94 56	SHEET: 1 OF 6	REV: D
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 15.03 m DATUM: AHD	DRILL RIG: Explora	
LOCATION: Adjacent to 129 Wellington Street, Waterloo	INCLINATION: -90°	CONTRACTOR: Groundtest	
PROJECT No PSC No.00013/10464	HOLE DEPTH: 45.05 m	LOGGED: AP	START: 15/6/15
		CHECKED: LBM	FINISH: 18/6/15

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (met es)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADT	H		0	0.10 14.93					ROAD SURFACE: ASPHALT	D	MD	ROAD SURFACE
				0.20 14.83					FILL: Sandy GRAVEL fine to medium grained, grey			FILL
									FILL: Gravelly SAND medium to coarse grained, dark grey brown			
			1	1.10 13.93				SP	SAND fine to medium grained, yellow brown			ALLUVIUM
				1.30 13.73	Rec = 450/450 mm SPT 1.50-1.95 m 4, 10, 20 N=30			SC	Clayey SAND fine to medium grained, orange brown and grey			
	L		2	2.10 12.93				SP	SAND fine to medium grained, pale grey			
		15/06/15 09:30			Rec = 450/450 mm SPT 2.50-2.95 m 5, 6, 9 N=15							
			3									
					Rec = 450/450 mm SPT 4.00-4.45 m 7, 13, 18 N=31					W		
			4									
			5	5.00 10.03				CI	Silty CLAY medium plasticity, pale grey and red brown			RESIDUAL SOIL
WB	M		6		Rec = 450/450 mm SPT 5.70-6.15 m 8, 19, 27 N=46					M (>PL)	VSt - H	
			7		Rec = 270/270 mm SPT 6.75-7.02 m 12, 25/120mm N>25							
	H			7.60 7.43					SILTSTONE grey and orange brown, extremely weathered, extremely low strength			WEATHERED BEDROCK
			8		Rec = 260/260 mm SPT 8.25-8.51 m 21, 25/110mm N>25							
			9						For Continuation Refer to Sheet 2			
			10									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared fo geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are fo information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

BOREHOLE: SRT BH403

SHEET: 2 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 129 Wellington Street, Waterloo
PROJECT No PSC No.00013/10464

COORDS: 333618.5 m E 6247626.4 m N MGA94 56
SURFACE RL: 15.03 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 45.05

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 15/6/15
CHECKED: LBM FINISH: 18/6/15

Drilling						Field Material Description			Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	04856 RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4							
				5							
				6							
				7							
				8							
					7.12		Continuation of Sheet 1				
HQ3		100	0 (100)	6.33			SILTSTONE grey and orange brown, inferred extremely weathered to highly weathered, extremely low strength	EW		8.73 m: B, 15°, Pl, Ro, iron Sn	
				9						9.05 m: B, 15°, Pl, Ro, iron Sn	
		100	35 (100)					HW		9.24-9.67 m: Bx 7, 0-5°, Pl, Ro, iron Sn-Ct	
					3.72						
				10	5.23					9.74-9.95 m: SSx 3, =10	

BOREHOLE: SRT BH403

SHEET: 3 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 129 Wellington Street, Waterloo
PROJECT No PSC No.00013/10464

COORDS: 333618.5 m E 6247626.4 m N MGA94 56
SURFACE RL: 15.03 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 45.05

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 15/6/15
CHECKED: LBM FINISH: 18/6/15

Drilling						Field Material Description			Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	04856 RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				10			SILTSTONE dark grey, some sandstone laminations (5%) at 0°-5° typ.	SW		10.16 m: DS, 0°, Pl, Ro, clay/iron Ct, =20	
				11				FR		10.41 m: J, 10°, Pl, Ro, iron Ct, =8 10.62 m: J, 80-90°, Un, Sm, Cn, discontinous 10.57-10.66 10.69 m: J, 10°, Pl, Sm, Cn 10.78-10.83 m: SS, 10-15°, 50mm healed	
		100	35 (100)							11.53 m: SS, 10°, 10mm rock fragments 11.55 m: SS, 10°, 10mm rock fragments 11.65 m: J, 50°, Pl-Un, Sm, Cn 11.80 m: J, 30°, Pl, Sm, Cn	
				12							
				13						13.21-13.33 m: inferred broken by drilling	
					9DDD						
		95	90 (95)		9DE1		CORE LOSS			13.47-13.57 m: inferred broken by drilling	
				14	1.56		SILTSTONE dark grey, some sandstone laminations (5%) at 0°-5° typ.	FR		13.68 m: J, 80°, Pl, Sm, Cn 14.12 m: J, 15°, Pl, Sm, Cn 14.50 m: J, 40°, Pl, Sm, Cn	
				15						15.52 m: J, 80°, Pl, Sm, Cn, healed	
HQ3		100	95 (100)								
				16						16.62-16.65 m: SS, 5°, 30mm rock fragments	
				17							
					91P2						
				18	-2.47		SANDSTONE fine to medium grained, pale grey with grey bands, cross bedded at 0° to 15°, with occasional carbonaceous laminations			17.47-17.50 m: SS, 0°, 30mm rock fragments 18.20 m: SS, 50°, 50mm rock fragments 18.56 m: B, 15°, Pl, Ro, Cn	
		100	100 (100)	19							
					93T2						
				20	-4.57		irregular carbonaceous laminae and siltstone bed 150mm thick				

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH403

SHEET: 4 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 129 Wellington Street, Waterloo
PROJECT No PSC No.00013/10464

COORDS: 333618.5 m E 6247626.4 m N MGA94 56
SURFACE RL: 15.03 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 45.05

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 15/6/15
CHECKED: LBM FINISH: 18/6/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	04856 RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	20	H2 ED -5.40		SANDSTONE medium grained, pale grey, with occasional carbonaceous laminations at 0°-20°	FR			
				21						21.08 m: B, 0°, Pl, Ro, sandy clay Ct	
		100	100 (100)	22							
				23						23.23 m: B, 5°, Pl, Ro, clay 1	
				24							
		100	100 (100)	25							
				26							
				27						27.30 m: SS, 0°, 10mm rock fragments	
				28						27.91 m: B, 5°, Pl, Ro, sandy clay Ct	
		100	100 (100)	29							
				30							

BOREHOLE: SRT BH403

SHEET: 5 OF 6 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 129 Wellington Street, Waterloo
PROJECT No PSC No.00013/10464

COORDS: 333618.5 m E 6247626.4 m N MGA94 56
SURFACE RL: 15.03 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 45.05

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 15/6/15
CHECKED: LBM FINISH: 18/6/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	04856 RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	30			SANDSTONE medium grained, pale grey, with occasional carbonaceous laminations at 0°-20°	FR			
				31							
				32						32.35 m: SS, 0°, 5mm rock fragments	
		100	100 (100)	33							
				34							
				35						35.25 m: B, 0°, Pl, Ro, sandy clay Ct	
				36							
				37	D1.97 -22.15		fine to medium grained, grey				
		100	100 (100)	38	D1.1T -22.73		medium grained, pale grey				
					D7.P2 -23.47		38.5m: some siltstone clasts to 5mm and coarse sandstone 50mm thick				
				39							
		100	100 (100)	40							

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F02a RL3

BOREHOLE: SRT BH403

CLIENT: Transport for New South Wales	COORDS: 333618.5 m E 6247626.4 m N MGA94 56	SHEET: 6 OF 6	REV: D
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 15.03 m DATUM: AHD	DRILL RIG: Explora	
LOCATION: Adjacent to 129 Wellington Street, Waterloo	INCLINATION: -90°	CONTRACTOR: Groundtest	
PROJECT No PSC No.00013/10464	HOLE DEPTH: 45.05	LOGGED: AP	START: 15/6/15
		CHECKED: LBM	FINISH: 18/6/15

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.03, L 0.1, M 0.3, H 1, VH 3, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
HQ3		100	100 (100)	40			SANDSTONE medium grained, pale grey, with occasional carbonaceous laminations at 0°-20° abundant siltstone laminations from 40.3m to 40.8	FR			
				41							
				42							
		100	100 (100)	43	EH31 -27.94		coarse grained, with occasional siltstone and quartz clasts to ~3				
				44							
				45	EP2P -30.02		END OF BOREHOLE @ 45.05 TARGET DEPTH PIEZOMETER INSTALLED				
				46							
				47							
				48							
				49							
				50							

E2 D2 -25.27

CORE PHOTOGRAPHS: SRT BH403

CLIENT: Transport for New South Wales	COORDS: 333618.5 m E 6247626.4 m N MGA94 56	SHEET: 1 OF 5	REV: D
PROJECT: SRT Geotechnical Investigation Services	SURFACE RL: 15.03 m DATUM: AHD	DRILL RIG: Explora	
LOCATION: Adjacent to 129 Wellington Street, Waterloo	INCLINATION: -90°	CONTRACTOR: Groundtest	
PROJECT No PSC No.00013/10464	HOLE DEPTH: 45.05 m	LOGGED: AP	START: 15/6/15
		CHECKED: LBM	FINISH: 18/6/15

CORE PHOTOGRAPHS: SRT BH403

CLIENT:	Transport for New South Wales	COORDS: 333618.5 m E 6247626.4 m N MGA94 56	SHEET: 2 OF 5 REV: D
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 15.03 m DATUM: AHD	DRILL RIG: Explora
LOCATION:	Adjacent to 129 Wellington Street, Waterloo	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 45.05 m	LOGGED: AP START: 15/6/15
			CHECKED: LBM FINISH: 18/6/15

CORE PHOTOGRAPHS: SRT BH403

CLIENT:	Transport for New South Wales	COORDS: 333618.5 m E 6247626.4 m N MGA94 56	SHEET: 3 OF 5 REV: D
PROJECT:	SRT Geotechnical Investigation Services	SURFACE RL: 15.03 m DATUM: AHD	DRILL RIG: Explora
LOCATION:	Adjacent to 129 Wellington Street, Waterloo	INCLINATION: -90°	CONTRACTOR: Groundtest
PROJECT No	PSC No.00013/10464	HOLE DEPTH: 45.05 m	LOGGED: AP START: 15/6/15
			CHECKED: LBM FINISH: 18/6/15

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

CORE PHOTOGRAPHS: SRT BH403

SHEET: 4 OF 5 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 129 Wellington Street, Waterloo
PROJECT No PSC No.00013/10464

COORDS: 333618.5 m E 6247626.4 m N MGA94 56
SURFACE RL: 15.03 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 45.05 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 15/6/15
CHECKED: LBM FINISH: 18/6/15

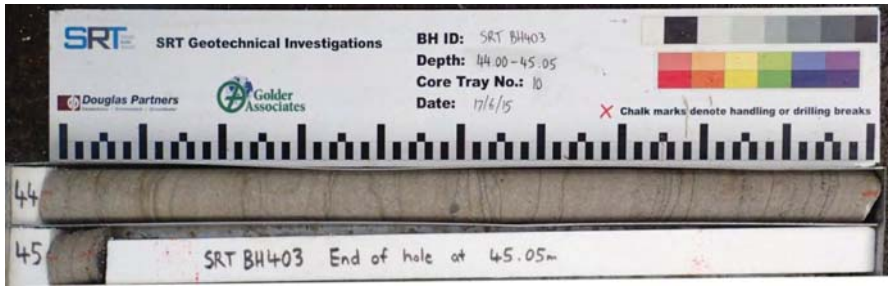
CORE PHOTOGRAPHS: SRT BH403

SHEET: 5 OF 5 REV: D

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 129 Wellington Street, Waterloo
PROJECT No PSC No.00013/10464

COORDS: 333618.5 m E 6247626.4 m N MGA94 56
SURFACE RL: 15.03 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 45.05 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 15/6/15
CHECKED: LBM FINISH: 18/6/15



This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28 RL1

FINAL STANDPIPE INSTALLATION: SRT BH403

Golder Associates | Douglas Partners Geotechnics | Environment | Groundwater

SHEET: 1 OF 1 REV: Final

CLIENT: Transport for New South Wales
PROJECT: SRT Geotechnical Investigation Services
LOCATION: Adjacent to 129 Wellington Street, Waterloo
PROJECT No PSC No.00013/10464

COORDS: 333618.5 m E 6247626.4 m N MGA94 56
SURFACE RL: 15.03 m DATUM: AHD
INCLINATION: -90°
HOLE DEPTH: 45.05 m

DRILL RIG: Explora
CONTRACTOR: Groundtest
LOGGED: AP START: 15/6/15
CHECKED: FINISH: 18/6/15

Drilling				Field Material Description		Instrumentation Details
METHOD	WATER	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	
AST	15/06/15 09:30	0	15.03			Gatic cover
			1.10		FILL	
			13.93		SAND AND CLAYEY SAND	
		5	5.00			
WB			10.03		SILTY CLAY	
			7.60			
WB			7.43		SILTSTONE	
100	Water RETURN	10				Cement bentonite grout
		15				15.75, RL-0.72 Bentonite
			17.50			<5mm sand
			-2.47		SANDSTONE	
		20				PVC slotted screen with filter sock
						22.50, RL-7.47 Bentonite
HQ3		25				
95	Water RETURN	30				
		35				
		40				Cement bentonite grout
		45	45.05			45.00, RL-29.97
			-30.02		END OF BOREHOLE @ 45.05 m	

This report of standpipe installation must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F17
RL1

Appendix D. Water Supply Works along the Alignment

These data were obtained from a search of the NSW Office of Water PINNEENA database. Borehole logs of other groundwater works, such as monitoring piezometers are presented in Appendix C, where relevant.

NSW Office of Water
Work Summary

GW017342

Licence: 10BL008345 **Licence Status:** CANCELLED

Authorised Purpose(s): INDUSTRIAL
Intended Purpose(s): INDUSTRIAL

Work Type:
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date: **Final Depth:**
Completion Date: 01/12/1946 **Drilled Depth:**

Contractor Name:
Driller:
Assistant Driller:

Property: N/A **Standing Water Level (m):**
GWMA: 018 - BOTANY BAY SAND BEDS **Salinity Description:**
GW Zone: - **Yield (L/s):**

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.001	99999
Licensed:	CUMBERLAND	ALEXANDRIA	Whole Lot //

Region: 10 - Sydney South Coast **CMA Map:** 9130-3S
River Basin: 213 - SYDNEY COAST - GEORGES RIVER **Grid Zone:** **Scale:**
Area/District:

Elevation: 0.00 m (A.H.D.) **Northing:** 6246789.0 **Latitude:** 33°54'22.3"S
Elevation Source: (Unknown) **Easting:** 333739.0 **Longitude:** 151°12'06.2"E

GS Map: - **MGA Zone:** 0 **Coordinate Source:** GD.,PR. MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
7.30	13.20	5.90	Unconsolidated						
14.30	15.50	1.20	Unconsolidated						

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	Made Ground	Fill	
0.30	2.74	2.44	Sand Peaty	Sand	
2.74	2.89	0.15	Peat	Peat	
2.89	7.31	4.42	Sand Grey Oozy Wet	Sand	
7.31	10.05	2.74	Sand Water Supply	Sand	
10.05	13.25	3.20	Sand Grey Water Supply	Sand	
13.25	14.17	0.92	Peat	Peat	
14.17	14.32	0.15	Clay Grey	Clay	
14.32	15.54	1.22	Sand Grey Water Supply	Sand	

Remarks

19/02/1975: SITED BOURKE RD. ALEXANDRIA

***** End of GW017342 *****

NSW Office of Water
Work Summary

GW017684

Licence: 10BL008347 **Licence Status:** CANCELLED

Authorised Purpose(s): INDUSTRIAL
Intended Purpose(s): INDUSTRIAL

Work Type: Bore
Work Status:
Construct.Method: Cable Tool
Owner Type: Private

Commenced Date:
Completion Date: 01/09/1947
Final Depth: 14.90 m
Drilled Depth: 14.90 m

Contractor Name:
Driller:
Assistant Driller:

Property: N/A
GWMA: 018 - BOTANY BAY SAND BEDS
GW Zone: -
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.001	411
Licensed:	CUMBERLAND	ALEXANDRIA	Whole Lot //

Region: 10 - Sydney South Coast
River Basin: 213 - SYDNEY COAST - GEORGES RIVER
Area/District:
CMA Map: 9130-3S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6246787.0
Easting: 333662.0
Latitude: 33°54'22.3"S
Longitude: 151°12'03.2"E

GS Map: -
MGA Zone: 0
Coordinate Source: GD.,PR. MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing		0.00	11.00	203			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
2.40	6.30	3.90	Unconsolidated						
6.70	10.00	3.30	Unconsolidated						
10.60	11.50	0.90	Unconsolidated						
12.10	14.80	2.70	Unconsolidated						

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.43	2.43	Sand Peaty Fossils:peat	Sand	
2.43	6.40	3.97	Sand White Water Supply	Sand	
6.40	6.70	0.30	Sand Hard Cemented	Sand	
6.70	10.05	3.35	Sand Light Yellow Water Supply	Sand	
10.05	10.66	0.61	Clay White Grey	Clay	
10.66	11.58	0.92	Sand Grey Water Supply	Sand	
11.58	12.19	0.61	Clay Grey Some Peaty	Clay	
12.19	14.93	2.74	Sand Grey Water Supply	Sand	

Remarks

07/08/1974: SITED BOURKE RD. ALEXANDRIA

***** End of GW017684 *****

NSW Office of Water
Work Summary

GW029731

Licence: 10BL019677 **Licence Status:** CANCELLED

Authorised Purpose(s): RECREATION (GROUNDWATER)
Intended Purpose(s): RECREATION (GROUNDWATER)

Work Type: Bore open thru rock
Work Status:
Construct.Method: Cable Tool
Owner Type: Local Govt

Commenced Date:
Completion Date: 01/04/1967
Final Depth: 21.60 m
Drilled Depth: 21.60 m

Contractor Name:
Driller:
Assistant Driller:

Property: N/A
GWMA: 603 - SYDNEY BASIN
GW Zone: -
Standing Water Level (m):
Salinity Description:
Yield (L/s):

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.057	294
Licensed:	CUMBERLAND	GORDON	Whole Lot //

Region: 10 - Sydney South Coast
River Basin: 213 - SYDNEY COAST - GEORGES RIVER
Area/District:
CMA Map: 9130-3N
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6258555.0
Easting: 331715.0
Latitude: 33°47'59.3"S
Longitude: 151°10'55.5"E

GS Map: -
MGA Zone: 0
Coordinate Source: GD.,PR. MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing		0.00	6.40	152			Suspended in Clamps

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	3.45	3.45	Clay Red Sandy	Clay	
3.45	6.70	3.25	Clay Red Yellow Puggy Sandy	Clay	
6.70	17.98	11.28	Shale Grey Black Hard	Shale	
17.98	21.64	3.66	Sandstone Grey Very Fractured Medium-coarse	Sandstone	
0.00	3.45	3.45	Boulders Large	Boulders	
3.45	6.70	3.25	Ironstone Gravel	Ironstone Gravel	
17.98	21.64	3.66	Clay Bands	Clay	
0.00	3.45	3.45	Gravel	Gravel	

Remarks

07/08/1974: SITED CHATSWOOD OVAL WILLOUGHBY

***** End of GW029731 *****

NSW Office of Water
Work Summary

GW071907

Licence: 10BL152224 **Licence Status:** CANCELLED

Authorised Purpose(s): RECREATION (GROUNDWATER)
Intended Purpose(s): RECREATION (GROUNDWATER)

Work Type: Bore
Work Status: Supply Obtained
Construct.Method: Down Hole Hammer
Owner Type: Local Govt

Commenced Date:
Completion Date: 15/05/2008
Final Depth: 180.00 m
Drilled Depth: 180.00 m

Contractor Name: INTERTEC DRILLING SERVICES
Driller: Paul Sheehy
Assistant Driller:

Property: REDFERN PARK CHALMERS ST REDFERN 2016 NSW
GWMA: -
GW Zone: -
Standing Water Level (m): 11.600
Salinity Description:
Yield (L/s): 0.100

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.1	1 135313
Licensed:	CUMBERLAND	ALEXANDRIA	Whole Lot 1//135313

Region: 10 - Sydney South Coast
River Basin: 213 - SYDNEY COAST - GEORGES RIVER
Area/District:
CMA Map: 9130-3S
Grid Zone:
Scale:

Elevation: 30.00 m (A.H.D.)
Elevation Source: Est. Contour 8-15M.
Northing: 6247997.0
Easting: 334034.0
Latitude: 33°53'43.3"S
Longitude: 151°12'18.5"E

GS Map: -
MGA Zone: 0
Coordinate Source: GD.,ACC.MAP

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	17.50	240			Rotary Air
1		Hole	Hole	17.50	120.00	159			Down Hole Hammer
1		Hole	Hole	120.00	180.00	156			Down Hole Hammer
1	1	Casing	Pvc Class 9	-0.30	57.70	140			Held in Clamp, Screwed and Glued
1	1	Casing	Steel	-0.30	17.70	156			Driven into small hole, Welded

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth	Duration (hr)	Salinity (mg/L)
24.50	24.70	0.20	Unknown			0.10	30.00 (m)		152.00
55.00	55.50	0.50	Unknown			0.30	60.00		190.00
82.00	85.00	3.00	Unknown			0.10	90.00		206.00
138.00	154.00	16.00	Unknown	11.60		0.10	162.00		345.00

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	3.00	3.00	SANDY CLAY	Sandy Clay	
3.00	8.50	5.50	CLAY	Clay	
8.50	24.00	15.50	SHALE	Shale	
24.00	24.50	0.50	SANDSTONE GREY	Sandstone	
24.50	24.70	0.20	SANDSTONE GREY FRACTURED	Sandstone	
24.70	44.00	19.30	SANDSTONE GREY	Sandstone	
44.00	55.00	11.00	SANDSTONE QUARTZ	Sandstone	
55.00	55.50	0.50	SANDSTONE GREY FRACTURED	Sandstone	
55.50	82.00	26.50	SANDSTONE GREY	Sandstone	
82.00	85.00	3.00	SANDSTONE QUARTZ	Sandstone	
85.00	128.00	43.00	SANDSTONE GREY	Sandstone	
128.00	130.00	2.00	SANDSTONE QUARTZ	Sandstone	
130.00	138.00	8.00	SANDSTONE GREY	Sandstone	
138.00	154.00	16.00	SANDSTONE QUARTZ	Sandstone	
154.00	180.00	26.00	SANDSTONE GREY	Sandstone	

Remarks

24/09/2008: Previously 10BL152224.
02/09/2009: Previous Lic No:10BL602472.
19/11/2012: Nat Carling, 19-Nov-2012; Corrected owner type & added work name. Added Rock Type codes to driller's log.

***** End of GW071907 *****

NSW Office of Water
Work Summary

GW072478

Licence: **Licence Status:**

Authorised Purpose(s):
Intended Purpose(s): DOMESTIC

Work Type:
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 10/01/1995

Final Depth: 180.50 m
Drilled Depth: 180.50 m

Contractor Name:
Driller:
Assistant Driller:

Property:
GWMA:
GW Zone:

Standing Water Level: 48.000
Salinity:
Yield: 0.700

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:			
Licensed:	CUMBE	CUMBE.57	101//1075748

Region: 10 - Sydney South Coast
River Basin: - Unknown
Area/District:

CMA Map: 9130-3N
Grid Zone: ?
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source:

Northing: 6256317.0
Easting: 332277.0

Latitude: 33°49'12.3"S
Longitude: 151°11'15.8"E

GS Map: -

MGA Zone: 56

Coordinate Source: Unidentified Location

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1	1	Casing	Steel	-0.50	5.40	168	158		driven into

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
29.70	30.10	0.40	Unknown			0.20	30.50		230.00
138.00	139.80	1.80	Unknown			0.30	142.50		270.00
143.80	144.50	0.70	Unknown	48.00		0.20	180.50		270.00

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	2.50	2.50	CONCRETE OVERBURDEN	Overburden	
2.50	5.10	2.60	MOIST CLAY	Clay	
5.10	28.70	23.60	L/G MED. GRAIN SANDSTONE	Sandstone	
28.70	30.10	1.40	LIGHT GREY MED. GRAIN S/STONE QUARTZ MATRIX	Sandstone	
30.10	35.90	5.80	L/GREY GRAIN SANDSTONE	Sandstone	
35.90	37.20	1.30	L/GREY MED GRAIN S/STONE QUARTZ MATRIX	Sandstone	
37.20	45.30	8.10	L/GREY MED GRAIN S/STONE	Sandstone	
45.30	54.30	9.00	DARK GREY SHALE	Shale	
54.30	72.40	18.10	L/GREY CEMENTED S/STONE	Sandstone	
72.40	75.40	3.00	DARK GREY SHALE	Shale	
75.40	109.70	34.30	L/GREY MED GRAIN S/STONE	Sandstone	
109.70	110.60	0.90	QUARTZ LAYER	Quartz	
110.60	121.80	11.20	L/GREY MED GRAIN S/STONE	Sandstone	
121.80	123.30	1.50	DARK GREY SHALE	Shale	
123.30	135.40	12.10	L/GREY MED GRAIN S/STONE	Sandstone	
135.40	138.00	2.60	L/GREY MED GRAIN S/STONE QUARTZ MATRIX	Sandstone	
138.00	139.80	1.80	WATER BEARING QUARTZ	Quartz	
139.80	143.80	4.00	L/GREY MED GRAIN S/STONE QUARTZ MATRIX	Sandstone	
143.80	144.40	0.60	WATER BEARING QUARTZ	Quartz	
144.40	154.10	9.70	L/GREY CEMENTED SANDSTONE	Sandstone	
154.10	163.70	9.60	L/GREY MED GRAIN S/STONE QUARTZ MATRIX	Sandstone	
163.70	166.90	3.20	QUARTZ LAYER	Quartz	
166.90	168.70	1.80	GREY MED GRAIN S/STONE	Sandstone	
168.70	180.50	11.80	L/GREY MED GRAIN SANDSTONE	Sandstone	

Remarks

11/11/2009: Nat Carling, 11-Nov-2009: Updated coordinates as per IPW info, old cadastre was '8//233037'.
19/03/2013: Nat Carling, 19-Mar-2013; Added rock type codes to driller's log & added missing information (based on existing data).

***** End of GW072478 *****

NSW Office of Water
Work Summary

GW105938

Licence: 10BL162977 **Licence Status:** CONVERTED

Authorised Purpose(s): DOMESTIC
Intended Purpose(s):

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 20/05/2005
Final Depth:
Drilled Depth:

Contractor Name:
Driller:
Assistant Driller:

Property: BRISCOE 39 BRANDLING ST ALEXANDRIA 2015
GWMA: -
GW Zone: -
Standing Water Level:
Salinity:
Yield:

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.39	3 787010
Licensed:	CUMBERLAND	PETERSHAM	Whole Lot 3//787010

Region: 10 - Sydney South Coast
River Basin: 213 - SYDNEY COAST - GEORGES RIVER
Area/District:
CMA Map: 9130-3S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6247637.0
Easting: 332733.0
Latitude: 33°53'54.2"S
Longitude: 151°11'27.6"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

***** End of GW105938 *****

NSW Office of Water
Work Summary

GW106192

Licence: 10BL164184 **Licence Status:** CONVERTED

Authorised Purpose(s): DOMESTIC
Intended Purpose(s): DOMESTIC

Work Type: Spear
Work Status: Supply Obtained
Construct.Method: Jetted - Water
Owner Type: Private

Commenced Date:
Completion Date: 10/12/2004
Final Depth: 6.00 m
Drilled Depth: 6.00 m

Contractor Name: B & B DRILLING INC
Driller: Michael Gerard Barrett
Assistant Driller:

Property: DYER 114 GARDEN ST ALEXANDRIA 2015 NSW
GWMA: -
GW Zone: -
Standing Water Level: 4.000
Salinity: Good
Yield: 0.500

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.1	8//248162
Licensed:	CUMBERLAND	ALEXANDRIA	Whole Lot 8//248162

Region: 10 - Sydney South Coast
River Basin: 213 - SYDNEY COAST - GEORGES RIVER
Area/District:
CMA Map: 9130-3S
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: (Unknown)
Northing: 6247611.0
Easting: 333418.0
Latitude: 33°53'55.5"S
Longitude: 151°11'54.2"E

GS Map: -
MGA Zone: 0
Coordinate Source: GIS - Geographic Information System

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	6.00	90			Jetted - Water
1	1	Casing	P.V.C.	0.00	5.40	32	26		Seated on Bottom, Glued
1	1	Opening	Screen - Wire Wound	5.40	6.00	50		1	Stainless Steel, Screwed, A: 0.15mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
4.00	6.00	2.00	Unknown	4.00		0.50		00:05:00	

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	topsoil	Topsoil	
0.30	2.20	1.90	sand, yellow	Sand	
2.20	2.30	0.10	rock, coffee	Rock	
2.30	4.50	2.20	sand, brown	Sand	
4.50	6.00	1.50	sand, grey	Sand	

Remarks

07/12/2009: updated from original form A

***** End of GW106192 *****

NSW Office of Water
Work Summary

GW107757

Licence: 10BL165399 **Licence Status:** CANCELLED

Authorised Purpose(s): TEST BORE
Intended Purpose(s): RECREATION (GROUNDWATER)

Work Type: Bore
Work Status:
Construct.Method: Rotary Air
Owner Type:

Commenced Date:
Completion Date: 29/07/2005
Final Depth: 162.60 m
Drilled Depth: 162.60 m

Contractor Name: INTERTEC DRILLING SERVICES
Driller: Brett Roy Wyatt
Assistant Driller:

Property: CHATSWOOD OVAL ORCHARD ROAD CHATSWOOD 2057
GWMA: -
GW Zone: -
Standing Water Level: 25.600
Salinity:
Yield: 0.300

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.57	7119 93907
Licensed:	CUMBERLAND	WILLOUGHBY	Whole Lot 7119//93907

Region: 10 - Sydney South Coast
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6258624.0
Easting: 331718.0
Latitude: 33°47'57.1"S
Longitude: 151°10'55.6"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	5.60	202			Down Hole Hammer
1		Hole	Hole	5.60	162.60	159			Down Hole Hammer
1	1	Casing	Pvc Class 9	-0.30	44.70	140			Suspended in Clamps, Screwed and Glued
1	1	Casing	Steel	-0.30	5.70	159	149		Driven into Hole
1	1	Opening	Slots - Diagonal	14.70	17.70	140		1	Sawn, PVC Class 9, SL: 100.0mm, A: 3.00mm
1	1	Opening	Slots - Diagonal	23.70	29.70	140		1	Sawn, PVC Class 9, SL: 100.0mm, A: 3.00mm

Water Bearing Zones

From	To	Thickness	WBZ Type	S.W.L.	D.D.L.	Yield	Hole	Duration	Salinity
(m)	(m)	(m)		(m)	(m)	(L/s)	Depth (m)	(hr)	(mg/L)
16.80	17.50	0.70	Unknown			0.60	18.00		725.00
28.70	29.00	0.30	Unknown	25.60		0.30	30.00		1360.00

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	1.40	1.40	FILL	Fill	
1.40	4.30	2.90	CLAY:BROWN,RED, WHITE	Clay	
4.30	5.10	0.80	SHALE; BROWN,WEATHERED	Shale	
5.10	5.50	0.40	CLAY BROWN	Clay	
5.50	16.80	11.30	SHALE GREY	Shale	
16.80	18.50	1.70	SANDSTONE GREY,SHALE GREY	Sandstone	
18.50	28.70	10.20	SANDSTONE GREY	Sandstone	
28.70	29.00	0.30	SANDSTONE GREY,FRACTURED	Sandstone	
29.00	42.40	13.40	SANDSTONE L/GREY	Sandstone	
42.40	42.80	0.40	SILTSTONE D/GREY	Siltstone	
42.80	51.10	8.30	SANDSTONE L/GREY	Sandstone	
51.10	65.70	14.60	SANDSTONE L/GREY,QUARTZ	Sandstone	
65.70	66.70	1.00	SHALE,GREY,SILTY	Shale	
66.70	74.60	7.90	SANDSTONE L/GREY	Sandstone	
74.60	76.10	1.50	SANDSTONE L/GREY	Sandstone	
76.10	76.30	0.20	SHALE L/GREY,SOFT	Shale	
76.30	88.00	11.70	SANDSTONE L/GREY	Sandstone	
88.00	88.60	0.60	SHALE,SILTY,D/GREY	Shale	
88.60	162.60	74.00	SANDSTONE L/GREY,GREY	Sandstone	

Remarks

11/06/2008: Previous Lic No:10BL165399

***** End of GW107757 *****

NSW Office of Water
Work Summary

GW107764

Licence: 10BL601165 **Licence Status:** CONVERTED

Authorised Purpose(s): DOMESTIC
Intended Purpose(s):

Work Type: Bore
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 22/01/2007
Final Depth:
Drilled Depth:

Contractor Name:
Driller:
Assistant Driller:

Property: SHORE SCHOOL 18 - 40 WILLIAM ST NORTH SYDNEY 2060 NSW
GWMA: -
GW Zone: -
Standing Water Level:
Salinity:
Yield:

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.57	1 229912
Licensed:	CUMBERLAND	WILLOUGHBY	Whole Lot 1//229912

Region: 10 - Sydney South Coast
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6254006.0
Easting: 333832.0
Latitude: 33°50'28.1"S
Longitude: 151°12'14.7"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

16/04/2010: no form A in file

***** End of GW107764 *****

NSW Office of Water
Work Summary

GW108224

Licence: 10WA109080 **Licence Status:** CURRENT

Authorised Purpose(s): DOMESTIC
Intended Purpose(s): DOMESTIC

Work Type:
Work Status:
Construct.Method:
Owner Type:

Commenced Date:
Completion Date: 05/09/2006
Final Depth: 132.40 m
Drilled Depth: 132.40 m

Contractor Name:
Driller:
Assistant Driller:

Property: PITTORINO 1 ROSS LANE NAREMBURN 2065 NSW
GWMA:
GW Zone:
Standing Water Level: 35.000
Salinity:
Yield: 0.300

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.57	1 306386
Licensed:	CUMBERLA	WILLOUGH	Whole Lot 1//306386

Region: 10 - Sydney South Coast **CMA Map:**
River Basin: - Unknown **Grid Zone:** ? **Scale:**
Area/District:

Elevation: 0.00 m (A.H.D.) **Northing:** 6256404.0 **Latitude:** 33°49'10.0"S
Elevation Source: **Easting:** 333214.0 **Longitude:** 151°11'52.3"E

GS Map: - **MGA Zone:** 56 **Coordinate Source:** Google Earth

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Annulus	Concrete	0.00	2.50	203			
1	1	Casing	Pvc Class 9	-0.40	71.60	140			suspended in, Screwed and Glued
1	1	Casing	Steel	-0.40	2.60	165	155		driven into, suspended in

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
29.00	35.00	6.00	Unknown			0.10		00:25:00	1750.00
98.00	100.00	2.00	Unknown			0.20		00:05:00	970.00

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.60	0.60	clay, sandy	Clay	
0.60	2.80	2.20	sandstone, weathered	Sandstone	
2.80	3.10	0.30	clay	Clay	
3.10	25.50	22.40	sandstone, weathered	Sandstone	
25.50	27.00	1.50	sandstone, grey quartz	Sandstone	
27.00	29.00	2.00	shale	Shale	
29.00	35.00	6.00	sandstone, quartz grey	Sandstone	
35.00	41.00	6.00	shale	Shale	
41.00	52.00	11.00	sandstone, grey	Sandstone	
52.00	54.00	2.00	sandstone, quartz grey	Sandstone	
54.00	61.00	7.00	sandstone, grey	Sandstone	
61.00	65.00	4.00	shale	Shale	
65.00	81.00	16.00	sandstone, grey	Sandstone	
81.00	84.00	3.00	sandstone, grey quartz siltstone	Sandstone	
84.00	98.00	14.00	sandstone, grey	Sandstone	
98.00	100.00	2.00	sandstone, grey quartz	Sandstone	
100.00	106.50	6.50	sandstone, grey	Sandstone	
106.50	109.00	2.50	sandstone, dark brown	Sandstone	
109.00	110.50	1.50	sandstone, grey quartz	Sandstone	
110.50	112.00	1.50	siltstone	Siltstone	
112.00	132.40	20.40	sandstone, grey	Sandstone	

Remarks

04/05/2010: updated from original form A

***** End of GW108224 *****

NSW Office of Water
Work Summary

GW110351

Licence: 10BL602742 **Licence Status:** CONVERTED

Authorised Purpose(s): RECREATION (GROUNDWATER)
Intended Purpose(s): RECREATION (GROUNDWATER)

Work Type: Bore
Work Status:
Construct.Method:
Owner Type: Local Govt

Commenced Date:
Completion Date: 01/01/1975
Final Depth: 60.00 m
Drilled Depth:

Contractor Name: INTERTEC DRILLING SERVICES
Driller: Unkown Unknown
Assistant Driller:

Property: ERSKINVILLE OVAL 149 MITCHELL ROAD ERSKINVILLE 2043 NSW
GWMA:
GW Zone:
Standing Water Level: 25.000
Salinity:
Yield: 1.000

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.1	2//135627
Licensed:			

Region: 10 - Sydney South Coast
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6247224.0
Easting: 332651.0
Latitude: 33°54'07.6"S
Longitude: 151°11'24.1"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	60.00	0			Unknown
1	1	Casing	Steel	0.00	0.00	150			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log

Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments

Remarks

***** End of GW110351 *****

NSW Office of Water
Work Summary

GW111164

Licence: 10BL600213 **Licence Status:** CONVERTED

Authorised Purpose(s): DOMESTIC
Intended Purpose(s): DOMESTIC

Work Type: Spear
Work Status: Supply Obtained
Construct.Method:
Owner Type: Private

Commenced Date:
Completion Date: 22/10/2010
Final Depth: 8.00 m
Drilled Depth: 8.00 m

Contractor Name:
Driller: Simon Matthew Hancock
Assistant Driller:

Property: FREUND 298 - 300 BELMONT ST ALEXANDRIA 2015
GWMA:
GW Zone:
Standing Water Level:
Salinity:
Yield:

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.1	1//797656
Licensed:			

Region: 10 - Sydney South Coast
River Basin: - Unknown
Area/District:
CMA Map:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6246860.0
Easting: 332686.0
Latitude: 33°54'19.4"S
Longitude: 151°11'25.2"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	8.00	100			Unknown

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	8.00	8.00	SAND	Sand	

Remarks

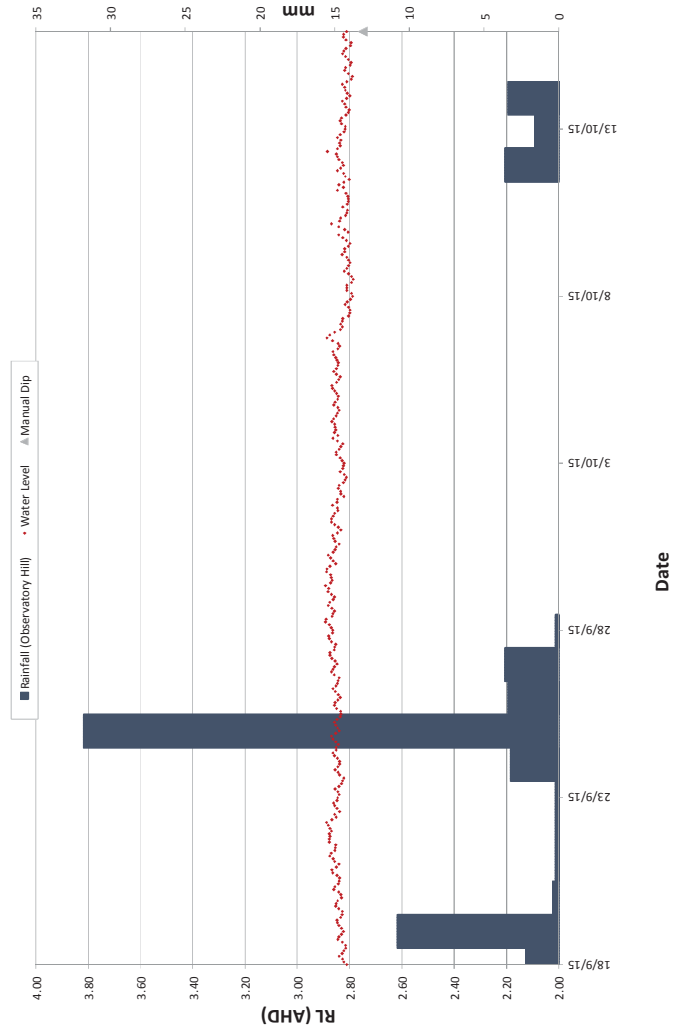
*** End of GW111164 ***

JACOBS

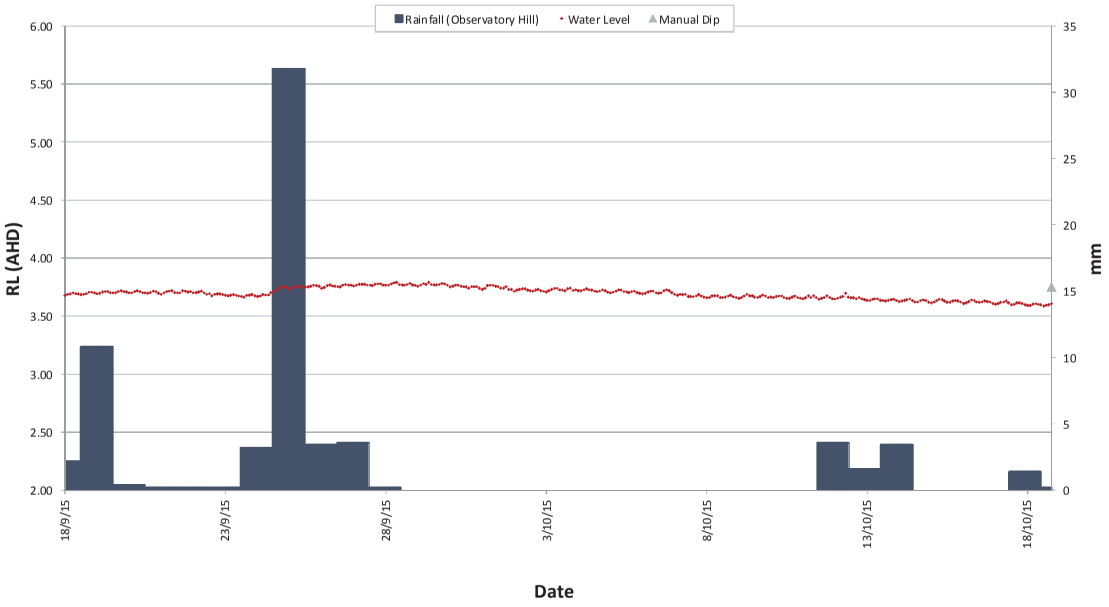
Appendix E. Water Level and Water Quality Data from Groundwater Monitoring Network

Groundwater Levels

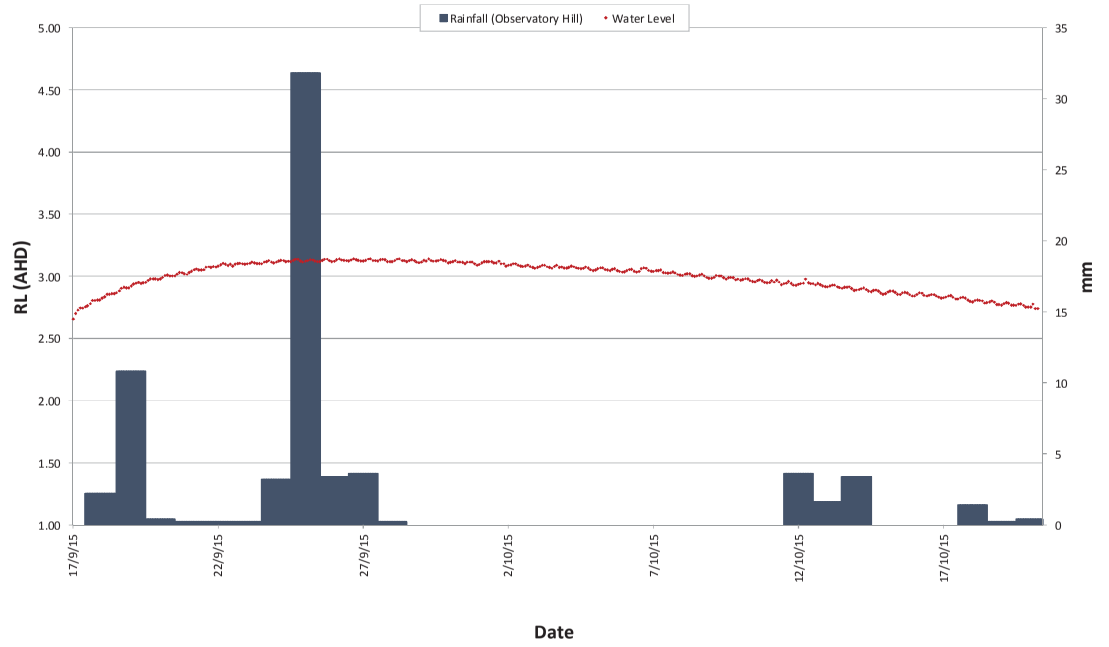
SRT BH002



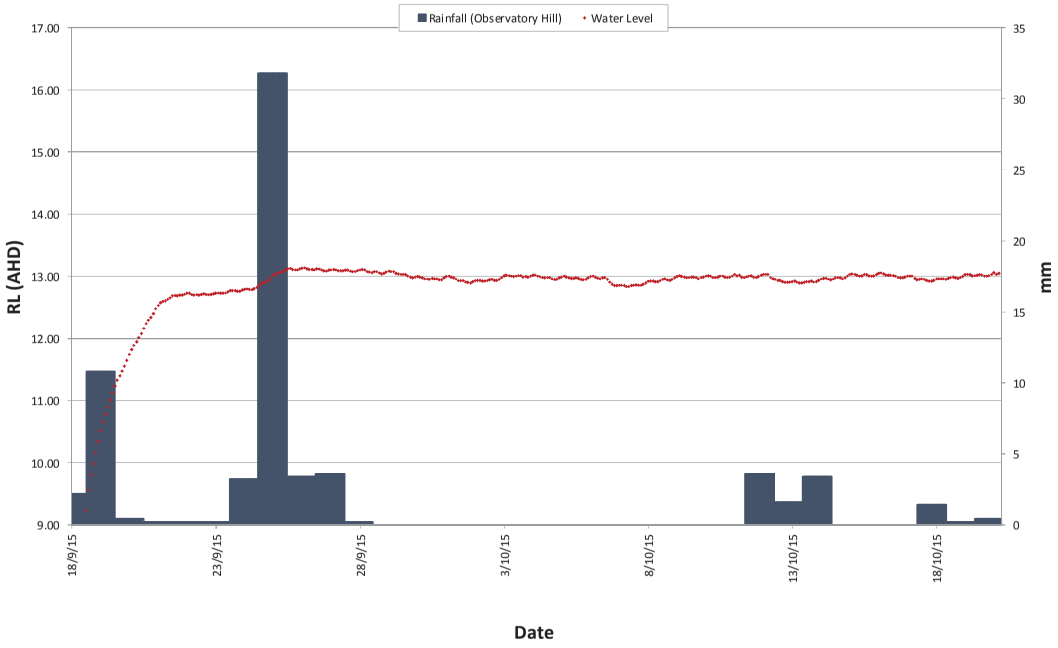
SRT BH002A



SRT BH008

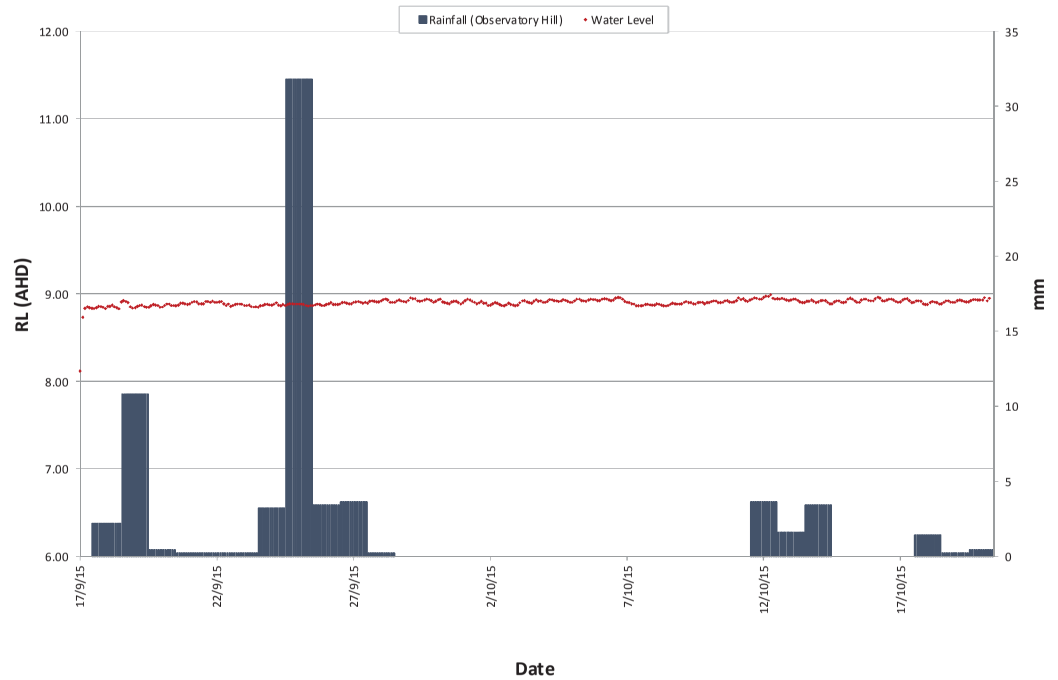


SRT BH009

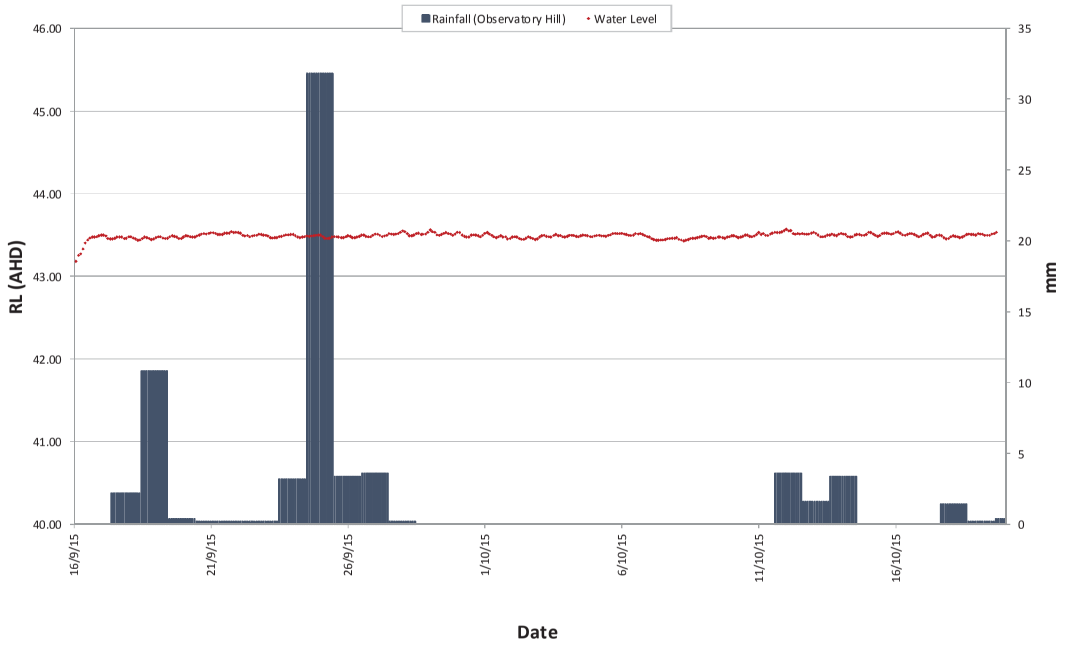


Appendix Groundwater Levels

SRT BH012

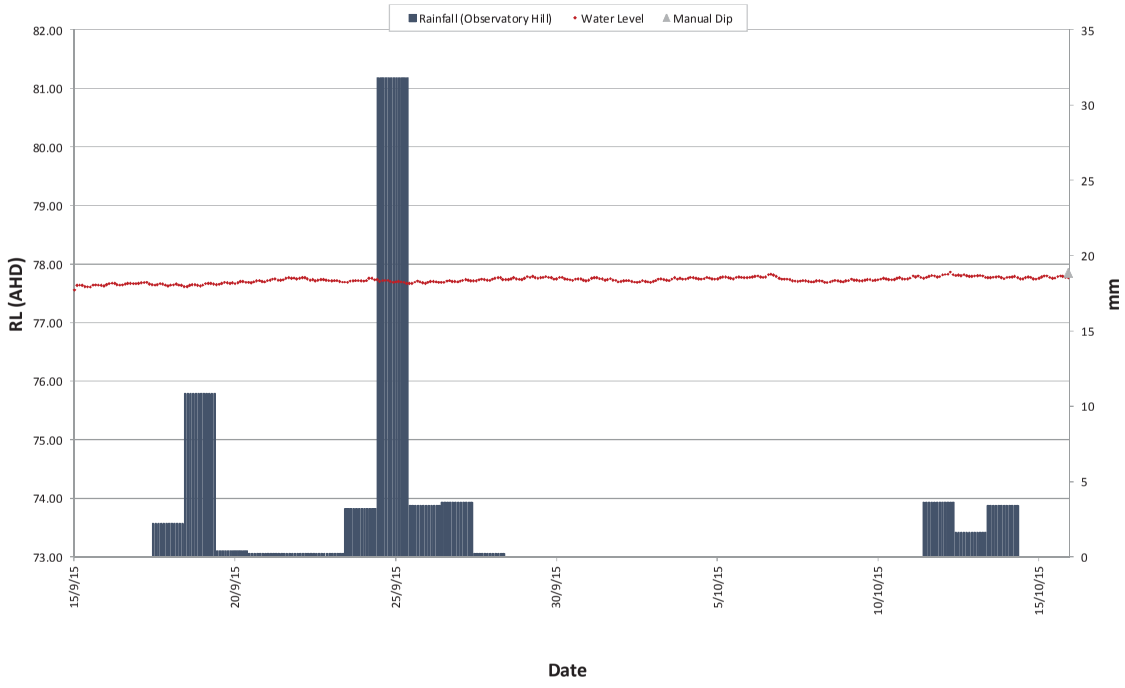


SRT BH017



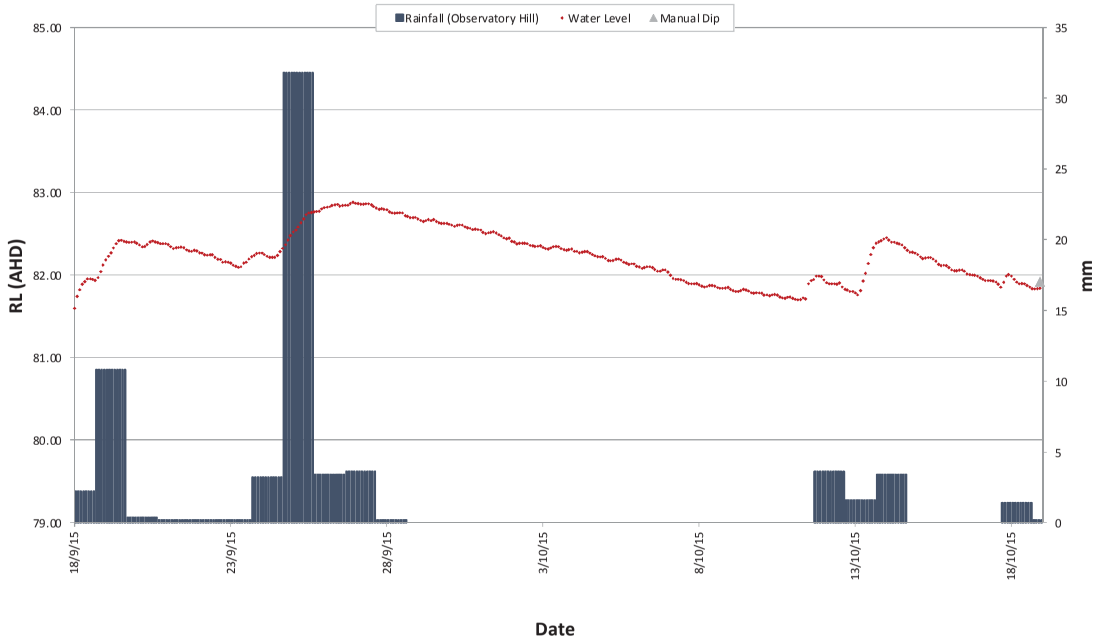
sydney METRO
Appendix Groundwater Levels

SRT BH018



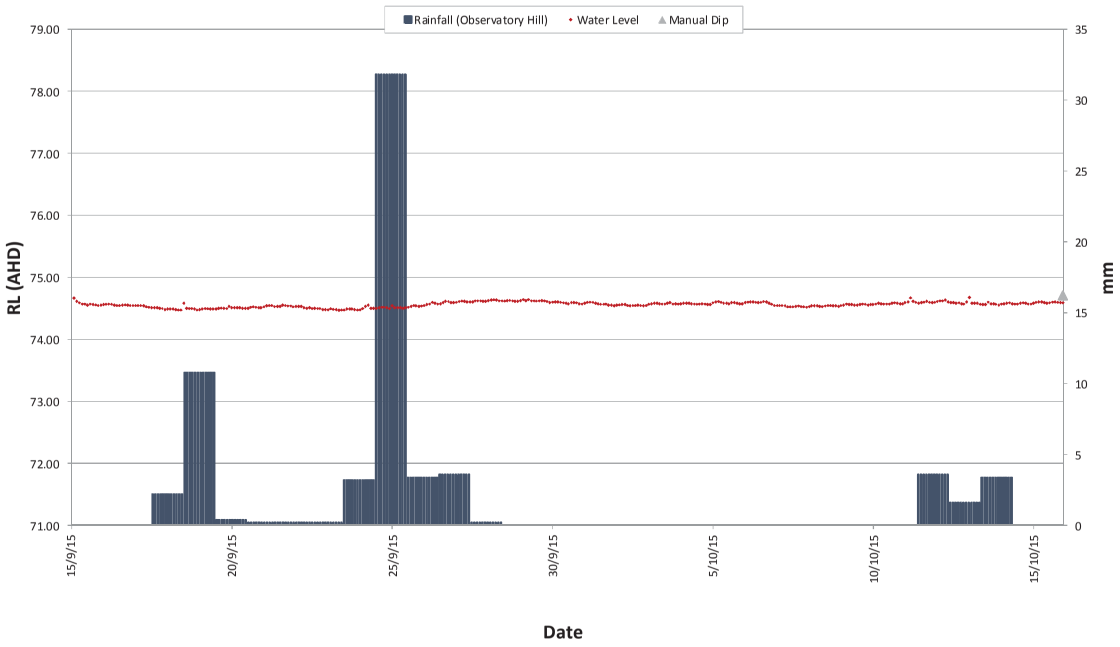
Douglas Partners Geotechnics | Environment | Groundwater
Golder Associates

SRT BH019



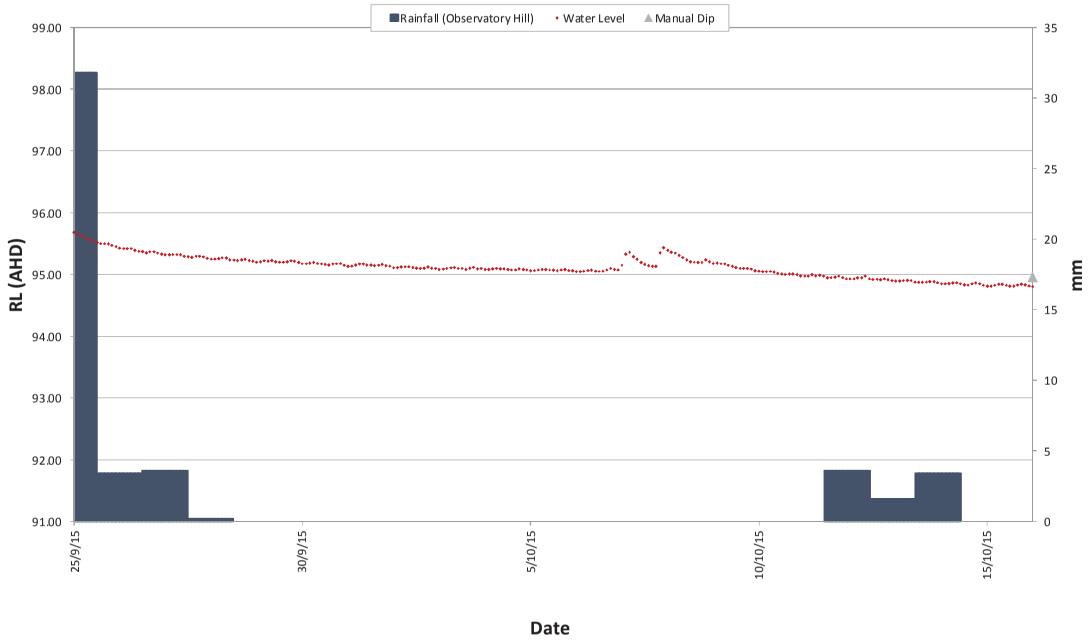
sydney METRO
Appendix Groundwater Levels

SRT BH020



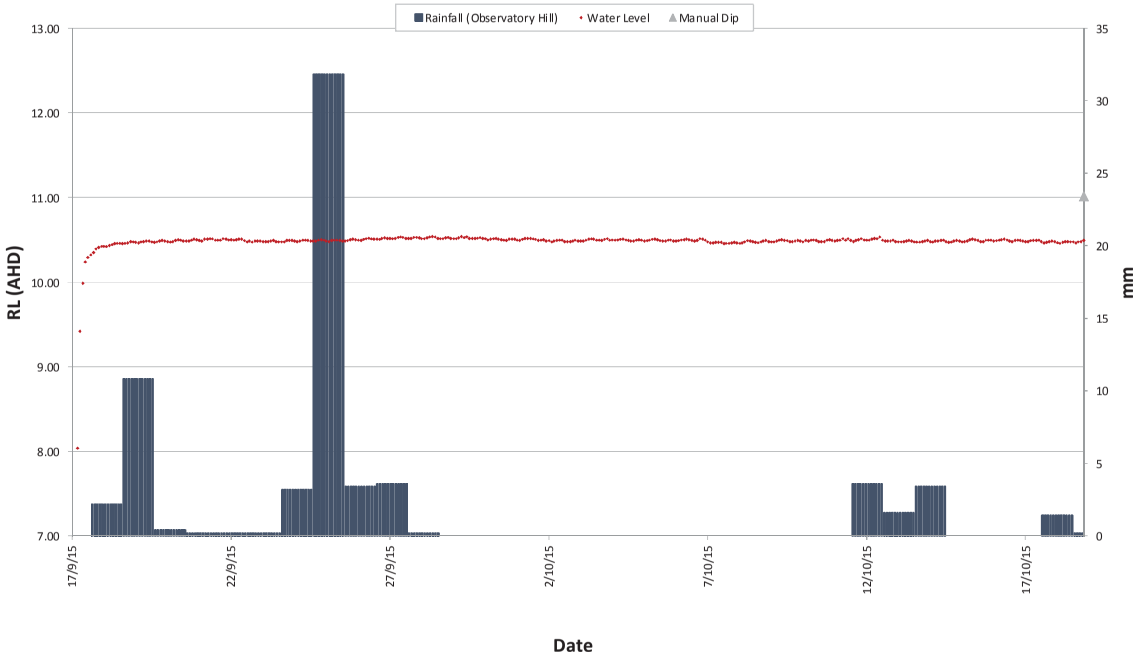
Douglas Partners Geotechnics | Environment | Groundwater
Golder Associates

SRT BH026

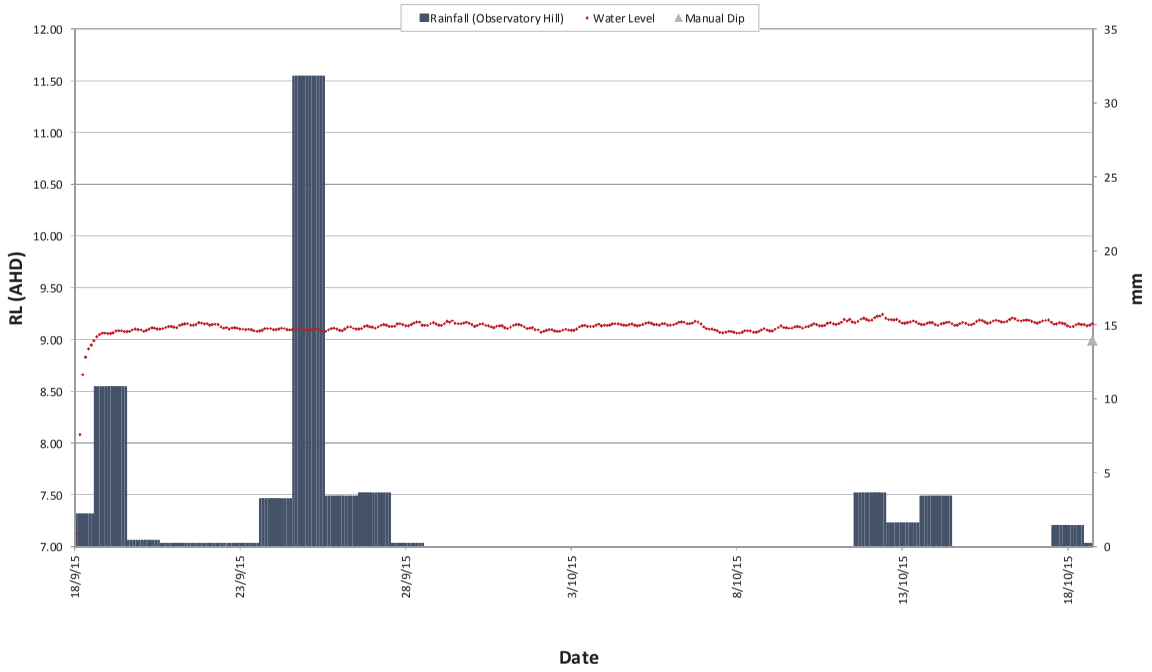


Appendix Groundwater Levels

SRT BH403



SRT BH404



Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Data Sheets

sydney METRO

GDR - SYDNEY METRO CITY AND SOUTHWEST
GEOTECHNICAL INVESTIGATION

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH002**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Edgeware Road / Edinburgh Road, Marrickville (West site of road)		
Bore Easting:	331227	Northing:	6246461
Installation Date:	25/09/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	17.1 m bgl		
Screened Interval:	14 - 17 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	25/09/2015		
Purged By:	LJH		
GW Level (pre-purge):	2.94 m bgl		
GW Level (post-purge):	3.34 m bgl		
PSH observed:	No		
Observed Well Depth:	17.1 m bgl		
Estimated Bore Volume:	27.8 L		
Total Volume Purged:	40 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	21.5	0.95	453	5.17	158
10 mins	21.2	0.96	425	5.07	152
15 mins	20.9	1.01	410	4.96	146
20 mins	20.9	1.02	404	4.94	142
25 mins	20.9	1.02	402	4.93	140

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH002A**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Next to BH002		
Bore Easting:	331226	Northing:	6246467
Installation Date:	22/04/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	5.6 m bgl		
Screened Interval:	1.1 - 5.6 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	25/09/2015		
Purged By:	LJH		
GW Level (pre-purge):	1.07 m bgl		
GW Level (post-purge):	1.57 m bgl		
PSH observed:	No		
Observed Well Depth:	5.4 m bgl		
Estimated Bore Volume:	8.5 L		
Total Volume Purged:	20 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	21.3	1.19	784	5.25	93
10 mins	21.1	1.20	760	5.14	85
15 mins	20.8	1.23	748	5.02	81
20 mins	20.8	1.24	738	5.01	78
25 mins	20.8	1.25	736	5.00	75

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH006**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	South of Platform 15, South, Central Station		
Bore Easting:	334063.6	Northing:	6249133.1
Installation Date:	3/08/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	29.5 m bgl		
Screened Interval:	26.5 - 29.5 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	4/08/2026		
Purged By:	AP		
GW Level (pre-purge):	Not able to mea m bgl		
GW Level (post-purge):	14.75 m bgl		
PSH observed:	No		
Observed Well Depth:	29.5 m bgl		
Estimated Bore Volume:	L		
Total Volume Purged:	L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	19.9	0.72	260	6.91	-33
10 mins	19.7	0.74	246	6.88	-9
15 mins	19.4	0.76	231	6.83	-14
20 mins	19.3	0.77	225	6.82	-17
25 mins	19.3	0.78	220	6.82	-19

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH008**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Adjacent to 309-313 Pitt Street, Sydney		
Bore Easting:	334259.3	Northing:	6250393.5
Installation Date:	16/06/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	20.6 m bgl		
Screened Interval:	17 - 21.5 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	24/09/2015		
Purged By:	LJH		
GW Level (pre-purge):	19.04 m bgl		
GW Level (post-purge):	20.04 m bgl		
PSH observed:	No		
Observed Well Depth:	21.8 m bgl		
Estimated Bore Volume:	5.4 L		
Total Volume Purged:	10 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	21.9	1.15	870	5.67	8
10 mins	21.7	1.20	840	5.61	3
15 mins	21.5	1.21	828	5.50	-4
20 mins	21.4	1.22	820	5.49	-8
25 mins	21.4	1.22	818	5.49	-12

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Rev 2 August 2015

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH009**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Adjacent to 197-199 Castlereagh Street, Sydney		
Bore Easting:	334355.5	Northing:	6250386.5
Installation Date:	7/07/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	22.1 m bgl		
Screened Interval:	18 - 21 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	24/09/2015		
Purged By:	LJH		
GW Level (pre-purge):	11.26 m bgl		
GW Level (post-purge):	12.06 m bgl		
PSH observed:	No		
Observed Well Depth:	21.3 m bgl		
Estimated Bore Volume:	19.7 L		
Total Volume Purged:	30 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	21.9	1.22	504	5.60	38
10 mins	21.6	1.26	483	5.54	30
15 mins	21.5	1.29	460	5.45	26
20 mins	21.4	1.30	455	5.44	22
25 mins	21.4	1.30	450	5.43	18

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH012**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Elizabeth Street, Sydney		
Bore Easting:	334485.5	Northing:	6251171
Installation Date:	18/05/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	31.2 m bgl		
Screened Interval:	25.2 - 31.2 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	25/09/2015		
Purged By:	LJH		
GW Level (pre-purge):	14.45 m bgl		
GW Level (post-purge):	14.85 m bgl		
PSH observed:	No		
Observed Well Depth:	20.3 m bgl		
Estimated Bore Volume:	11.5 L		
Total Volume Purged:	40 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	20.4	1.30	411	5.39	32
10 mins	20.3	1.31	397	5.30	26
15 mins	20.2	1.34	367	5.26	21
20 mins	20.1	1.35	358	5.24	18
25 mins	20.1	1.36	355	5.24	15

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Rev 2 August 2015

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH017**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Adjacent to 155 Miller Street, North Sydney (Eastern side Parking)		
Bore Easting:	334111	Northing:	6254365
Installation Date:	11/05/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	38.8 m bgl		
Screened Interval:	35 - 39.8 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	23/09/2015		
Purged By:	LJH		
GW Level (pre-purge):	16.25 m bgl		
GW Level (post-purge):	17.05 m bgl		
PSH observed:	No		
Observed Well Depth:	36.05 m bgl		
Estimated Bore Volume:	38.9 L		
Total Volume Purged:	110 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	20.7	0.92	471	5.44	17
10 mins	20.6	0.96	459	5.35	10
15 mins	20.5	1.00	446	5.23	5
20 mins	20.4	1.00	437	5.21	0
25 mins	20.4	1.01	435	5.21	-2

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH018**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Hume St, Crows Nest		
Bore Easting:	333390	Northing:	6255706
Installation Date:	1/05/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	25.3 m bgl		
Screened Interval:	19.3 - 25.3 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	22/09/2015		
Purged By:	AP		
GW Level (pre-purge):	10.35 m bgl		
GW Level (post-purge):	11.25 m bgl		
PSH observed:	No		
Observed Well Depth:	24.2 m bgl		
Estimated Bore Volume:	27.2 L		
Total Volume Purged:	40 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	20.6	1.24	494	5.84	-15
10 mins	20.4	1.27	464	5.72	-20
15 mins	20.3	1.30	435	5.64	-25
20 mins	20.2	1.31	425	5.63	-29
25 mins	20.1	1.31	420	5.62	-33

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH019**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Oxley St , Crows Nest		
Bore Easting:	333308	Northing:	6255819
Installation Date:	28/04/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	7.2 m bgl		
Screened Interval:	4 - 7 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	23/09/2015		
Purged By:	AP		
GW Level (pre-purge):	1.44 m bgl		
GW Level (post-purge):	2.14 m bgl		
PSH observed:	No		
Observed Well Depth:	7.15 m bgl		
Estimated Bore Volume:	11.2 L		
Total Volume Purged:	30 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	19.9	0.95	535	5.29	61
10 mins	19.8	0.98	525	5.26	54
15 mins	19.7	1.03	505	5.18	50
20 mins	19.7	1.04	497	5.16	47
25 mins	19.7	1.04	495	5.15	45

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH020**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	39 Herbert Street, Artarmon, next to speed bump		
Bore Easting:	332695	Northing:	6256655
Installation Date:	4/05/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	21.1 m bgl		
Screened Interval:	15.1 - 21.1 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	22/09/2015		
Purged By:	AP		
GW Level (pre-purge):	3.4 m bgl		
GW Level (post-purge):	3.8 m bgl		
PSH observed:	No		
Observed Well Depth:	19.85 m bgl		
Estimated Bore Volume:	32.3 L		
Total Volume Purged:	100 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:	Not applicable		
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):			
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	20.4	1.24	438	5.32	14
10 mins	20.3	1.28	426	5.22	7
15 mins	20.2	1.32	402	5.09	0
20 mins	20.2	1.33	397	5.08	-5
25 mins	20.1	1.33	396	5.08	-8

Sample Details	
Sampling Depth (rationale):	Not applicable
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH026**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Chatswood Ausgrid Depot, Mowbray Road		
Bore Easting:	331603.3	Northing:	6258046
Installation Date:	25/09/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	28.2 m bgl		
Screened Interval:	28.2 - 22.2 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	25/09/2015		
Purged By:	AP		
GW Level (pre-purge):	7.05 m bgl		
GW Level (post-purge):	8.05 m bgl		
PSH observed:	No		
Observed Well Depth:	28.2 m bgl		
Estimated Bore Volume:	41.5 L		
Total Volume Purged:	100 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:			
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):	Not applicable		
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	20.1	1.25	866	5.25	14
10 mins	20.0	1.28	845	5.21	7
15 mins	19.7	1.29	815	5.15	2
20 mins	19.7	1.30	805	5.13	-2
25 mins	19.7	1.31	800	5.13	-5

Sample Details	
Sampling Depth (rationale):	
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	Not applicable
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH403**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Adjacent to 129 Wellington Street Waterloo		
Bore Easting:	333618.5	Northing:	6247626.4
Installation Date:	19/06/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	22.5 m bgl		
Screened Interval:	16.5 - 22.5 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	24/09/2015		
Purged By:	LJH		
GW Level (pre-purge):	3.05 m bgl		
GW Level (post-purge):	3.35 m bgl		
PSH observed:	No		
Observed Well Depth:	22.28 m bgl		
Estimated Bore Volume:	37.8 L		
Total Volume Purged:	90 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:			
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):	Not applicable		
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	20.5	1.18	582	4.87	90
10 mins	20.3	1.23	562	4.81	83
15 mins	20.2	1.27	534	4.73	76
20 mins	20.2	1.28	525	4.72	73
25 mins	20.1	1.29	522	4.71	69

Sample Details	
Sampling Depth (rationale):	
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	Not applicable
Sampling Containers and filtration:	
Comments / Observations:	

Douglas Partners
Geotechnics / Environment / Groundwater

Golder Associates

Groundwater Field Sheet

Project and Bore Installation Details			
Bore / Standpipe ID:	**SRT_BH404**		
Project Name:	Sydney Metro City and Southwest		
Project Number:	PSC No. 00013/10464		
Site Location:	Adjacent to Flats 49-51 213 Cope Street Waterloo		
Bore Easting:	333621.3	Northing:	6247734.9
Installation Date:	25/06/2015		
GW Level (during drilling):	GWNO m bgl		
Well Depth:	22.5 m bgl		
Screened Interval:	16.5 - 22.5 m bgl		
Contaminants/Comments:	None known		
Bore Development Details			
Date/Time:	25/09/2015		
Purged By:	LJH		
GW Level (pre-purge):	4.22 m bgl		
GW Level (post-purge):	5.22 m bgl		
PSH observed:	No		
Observed Well Depth:	20.9 m bgl		
Estimated Bore Volume:	32.8 L		
Total Volume Purged:	90 L		
Equipment:	Twister pump		
Micropurge and Sampling Details			
Date/Time:			
Sampled By:			
Weather Conditions:			
GW Level (pre-purge):			
GW Level (post sample):	Not applicable		
PSH observed:			
Observed Well Depth:			
Estimated Bore Volume:			
Total Volume Purged:			
Equipment:			

Water Quality Parameters

Time / Volume	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Redox (mV)
5 mins	20.2	1.30	908	5.45	86
10 mins	20.1	1.32	886	5.36	79
15 mins	19.9	1.33	869	5.26	73
20 mins	19.8	1.34	860	5.25	70
25 mins	19.7	1.34	856	5.25	66

Sample Details	
Sampling Depth (rationale):	
Sample Appearance (e.g. colour, siltiness, odour):	
Sample ID:	
QA/QC Samples:	Not applicable
Sampling Containers and filtration:	
Comments / Observations:	