Cherrybrook Rezoning Application

Updated Geotechnical Assessment

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Revision 4 – 15-Jun-2016
Prepared for – Grimshaw Architects Pty Ltd – ABN: 40124418364

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Updated Geotechnical Assessment

Client: Grimshaw Architects Pty Ltd

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15-Jun-2016

Job No.: 60310614

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Quality Information

Document Cherrybrook Rezoning Application

Ref 60310614

Date 15-Jun-2016

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Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
1	20-Mar-2015	Draft	Antony Tam Project Manager	
2	16-Apr-2015	Final	Antony Tam Project Manager	
3	10-Jun-2016	Draft for Comment – Expanded Site Area	Anthony Tam Project Manager	
4	15-Jun-2016	Final for Submission	Anthony Tam Project Manager	

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Executive Summary

This report describes the findings of a geotechnical assessment of a number of properties at Cherrybrook which are subject to a rezoning study by Grimshaw Pty Ltd. The assessment included a site walkover and a borehole investigation.

The expanded Site occupies around 11.02 hectares near the Cherrybrook Town Centre along Castle Hill Road in West Pennant Hills. The Site slopes to the south from a ridge along Castle Hill Road. Drainage gullies and channels associated with tributaries of the Darling Mills Creek and Bellbird Creek extend into the Site from the south. The slope gradient varies between around 5º and 25º across the Site, with steeper slopes immediately below Castle Hill Road, and at the head of drainage lines.

A number of properties within the Site area have been developed for residential buildings, including building platforms and landscaped, terraced gardens in a combination of cut and fill.

A number of six to twenty storey residential buildings with one to three basement levels are proposed.

The following information was reviewed:

- twenty seven geotechnical reports relevant to the Site
- A study for the Hills Shire Council and two papers on landslides in the area
- A land capability study of the area
- Aerial photographs taken between 1930 and 2005

The Site is located within an area identified by Hills Shire Council as at risk of landslide.

Site investigations included field mapping and drilling of sixteen geotechnical boreholes. The boreholes were selected to target areas of risk and uncertainty relevant to the Site and to establish the broader geological, hydrogeological and engineering character of the ground.

The Site is underlain by the following geological sequence:

- Bringelly and Ashfield Shales, underlain by Mittagong Formation, then Hawkesbury Sandstone. The weathered shale profile is likely to comprise soils between 2 m to 6 m thick.
- Landslide areas may comprise colluvium several metres thick, underlain by moderately to slightly weathered shale.
- Fill will be encountered where housing platforms and landscaped gardens have been developed.

A qualitative landslide risk assessment was carried out broadly in accordance with AGS guidelines (AGS 2007) using the information gathered in the desktop assessment and in previous site investigations on part of the Site. A number of locations were identified at the Site which are considered to have an elevated level of risk of instability. These areas occupy localised slopes within the larger development area, and it is considered that this risk can be effectively mitigated during development, as has been adopted for neighbouring sites, to reduce them to acceptable levels. Such mitigation approaches could include:

- removal of potentially unstable materials;
- anchoring structures and unstable materials to stable rock with rock socketed retaining structures and engineered basement floor slabs;
- closely managed construction techniques and ground movement monitoring during construction;
- closely managed drainage measures for surface and subsurface water.

It is considered that the land could be rezoned for High Density Residential, provided that design of structures, retaining walls, earthworks, roads and other improvements take into account the potentially unstable nature of the ground. Such designs would be developed after further geotechnical investigations and prior to submission of detailed development applications for future development.

1.0 Introduction

Grimshaw Pty Ltd is undertaking a rezoning study for a number of properties at Cherrybrook and has commissioned AECOM Australia Pty Ltd (AECOM) to update a previous assessment of geotechnical aspects for the proposed rezoning. The expanded Site is located near the Cherrybrook Town Centre along Castle Hill Road in West Pennant Hills. The April 2016 Updated Masterplan for the Site indicates that the proposed development comprises a number of six to twenty storey residential buildings with one to three basement levels.

This report describes the findings of an updated assessment using available existing information based on published knowledge and investigations carried out by both AECOM and others. The updated information is provided to further assist in developing the project through the planning process, and to provide an understanding of possible geotechnical requirements, constraints and opportunities.

2.0 Scope of Works

The scope of works for the earlier Site layout was for a geotechnical assessment that incorporated a staged approach including:

a) desktop based review of available existing information

b) targeted site investigations

c) synthesis of data, assessment of the impacts of the proposed development on the stability of the existing slopes, and provision of recommendations for the proposed development.

As the Site has expanded geotechnical assessment has been carried out for each new area. This report combines the results of three desktop based assessments and three stages of site investigations.

The scope of works for this stage of the project is provided below:

- Undertake additional site investigations targeting additional properties to provide an overview of geotechnical conditions in the expanded Site area. The additional site investigations were recommended in the desktop study of the expanded Site undertaken in June 2015.
- Undertake desktop study of a further 3 properties at 15, 17 and 19 Staley Court
- Prepare an updated geotechnical assessment report, taking into account the results of the updated desktop studies and the combined results of all phases of site investigations (November 2013, May 2014 and February 2016). The assessment is to include recommendations on geotechnical issues relating to the proposed development.

3.0 Site Description

The Site is located in West Pennant Hills, in the north-west of Sydney. The Site occupies around 11.02 hectares and extends for around 900 m along the southern side of Castle Hill Road between Highs Road to the west and Staley Court to the east. A site plan is provided in **Figure 1** below. The Site is situated opposite the recently constructed Cherrybrook Station, which has been constructed as part of the North West Rail Link (NWRL) Project. Forty-four residential lots are included, some currently occupied by detached single residence houses, some currently undeveloped. The properties included in the proposed rezoning are shown in red in **Figure 1**.

Castle Hill Road runs along a ridge which marks the edge of a more elevated area, or escarpment, to the north. The topography is of undulating ground, dropping from between RL170 m and RL180 m Australian Height Datum (AHD) at the Castle Hill Road ridge to around 140 m AHD at the southern end of the Site. The majority of the site lies within the Darling Mills Creek Catchment, with drainage gullies and channels associated with tributaries of the Creek extending into the Site from the south. The catchment to the east of Staley Court flows south into Bellbird Creek.

A number of properties within the Site have been developed for residential buildings, including building platforms and landscaped, terraced gardens in a combination of cut and fill.

The slope gradient varies between around 5º and 20º across the Site, with steeper slopes immediately below Castle Hill and Highs Roads, and at the head of drainage lines.

Much of the Site is within an area identified by the Hills Shire Council as being at potential risk of slope instability, as shown in **Figure 2** (The Hills Local Environmental Plan, 2012).

Figure 1 Site Plan for Cherrybrook Rezoning Application – April 2016

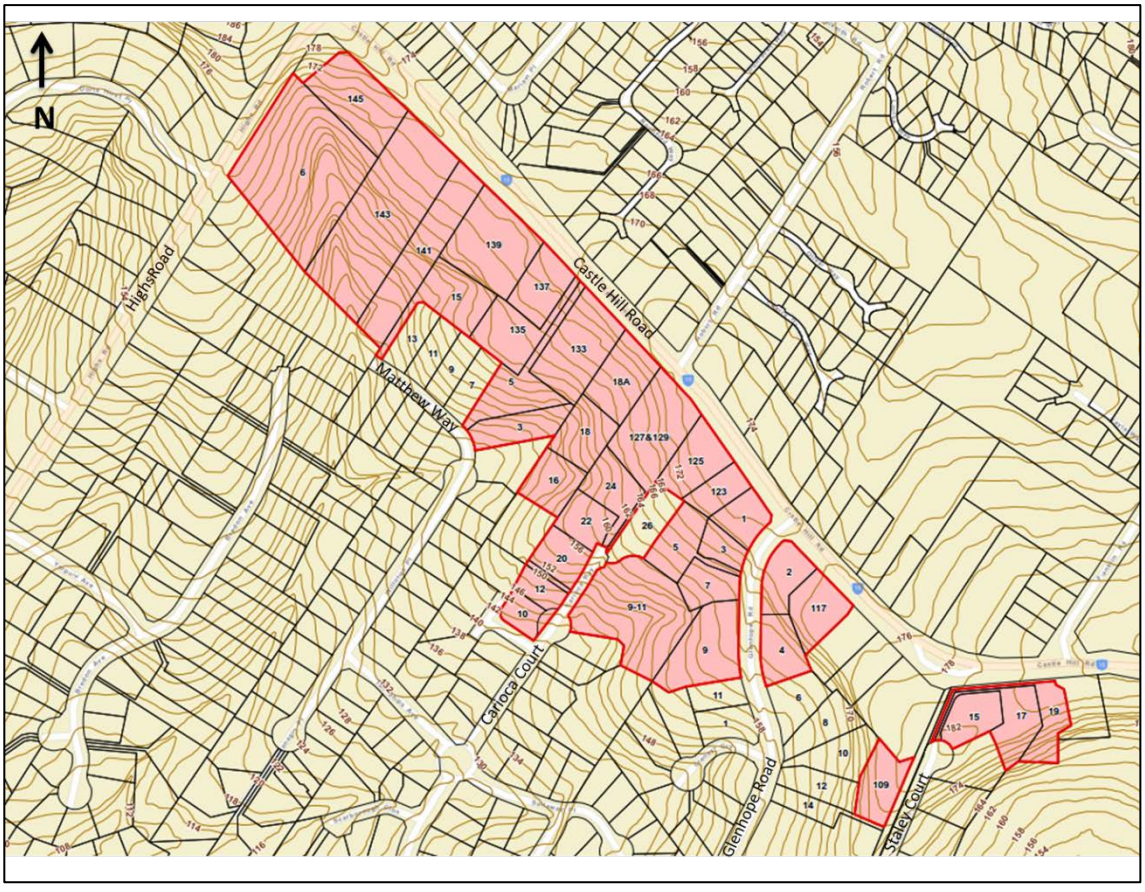
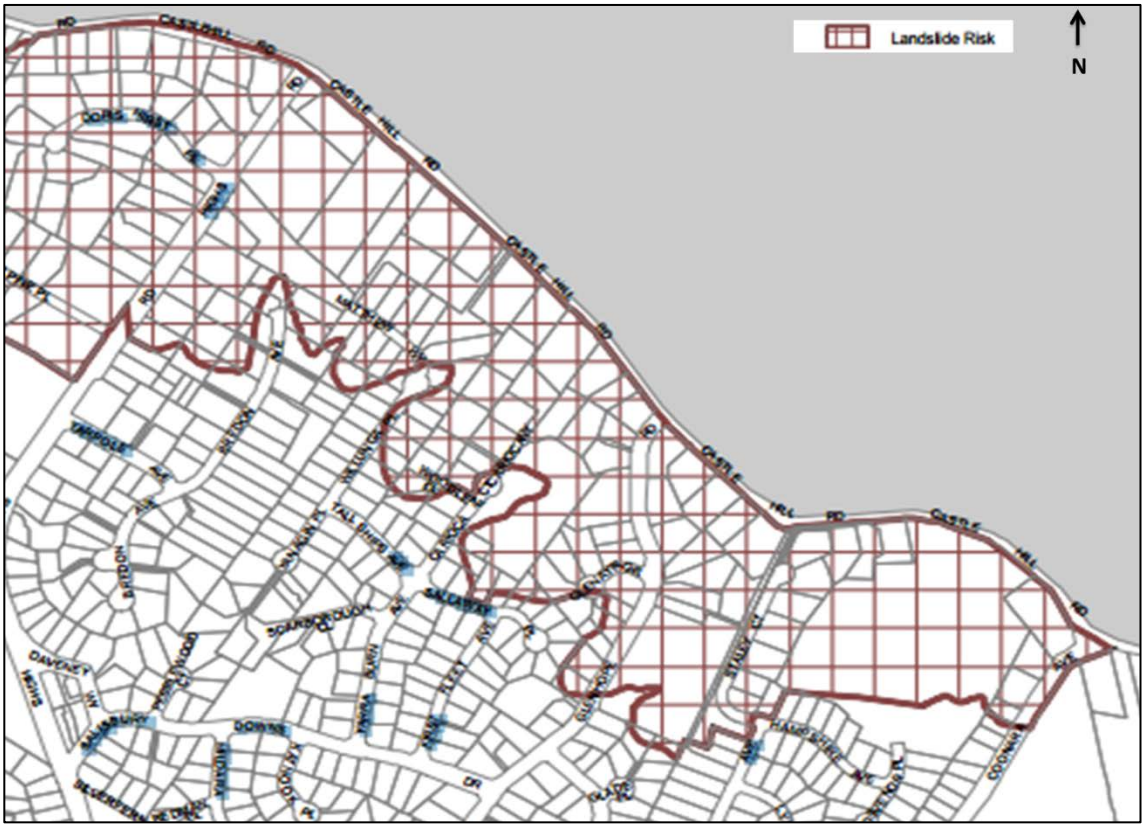


Figure 2 Excerpt from Hills Shire Council - Landslide Risk Map



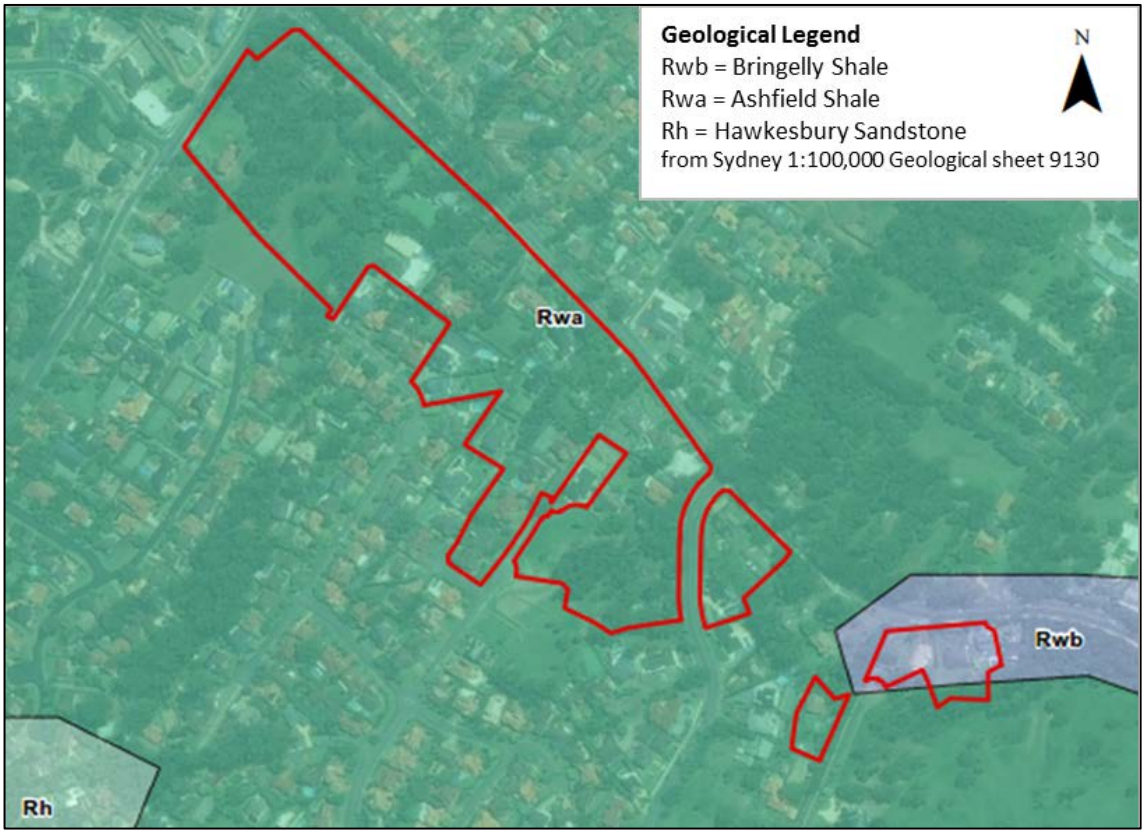
4.0 Published Geology

4.1 Stratigraphy

The Site is located within the Sydney Basin, a major structural basin containing a thick sub-horizontally bedded Permian to Triassic sedimentary sequence. The region was uplifted during the Triassic and has subsequently undergone erosion.

The published 1:100,000 series geological map for Sydney (sheet 9131) indicates that the Site is located on Bringelly Shale and Ashfield Shale of the Wianamatta Group. The Wianamatta Group is conformably underlain by the Mittagong Formation, an interbedded siltstone and sandstone layer generally around 10 m thick, which is in turn underlain by the Hawkesbury Sandstone. An excerpt from the geological map is presented in **Figure 3** below.

Figure 3 Site Geology - From 1:100,000 series geological map for Sydney (sheet 9130)



The Bringelly Shale comprises shale, carbonaceous claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff. The sediments were deposited in a low lying swampy coastal plain with estuarine and alluvial channels. The Bringelly Shale is mapped within the Staley Court properties only and is likely to comprise the basal sequences of this unit, which are dominated by laminite (thinly interbedded shale, siltstone or sandstone).

Ashfield Shales were deposited in a low energy, coastal marine delta environment and comprise black to dark grey shale, siltstone and laminite. The unit is generally around 45 m to 70 m thick, and can be divided into four siltstone and laminite subgroup members as summarised in **Table 1**below.

Table 1 Ashfield Shale Subgroup Units

Ashfield Shale Subgroup	Approximate thickness	General Description
Mulgoa Laminite	17 m to 32 m	Interlaminated siltstone and very fine sandstone
Regentville Siltstone	12 m to 20 m	Dark grey mudstone, shale and siltstone
Kellyville Laminite	1 m to 10 m	Interlaminated siltstone and very fine sandstone
Rouse Hill Siltstone	5 m to 15 m	Dark grey to black mudstone or shale

The Ashfield and Bringelly Shales typically exhibit a weathered profile comprising between 2 m and 6 m of residual clay and extremely weathered shale, generally becoming less weathered with depth. The residual soils may be reactive, shrinking or swelling in response to changes in moisture content.

The Mittagong Formation is also known as a boundary bed, generally around 10 m thickness or less, which separates the Wianamatta Group rocks and Hawkesbury Sandstone over much of the Sydney Basin and represents the transition from terrestrial to a shallow marine depositional environment. The unit is not identified on the 1:100,000 scale map in this area.

The Hawkesbury Sandstone unit was deposited in a large braided river system. The unit comprises fine to coarse grained quartz sandstone with minor shale and laminite lenses. It is generally higher strength than the Ashfield Shale. Regular jointing occurs within the sandstone and preferential weathering along the joints is common. The residual soils are generally thin, less than 1 m thick, but may be deeper in gullies and depressions.

Igneous activity occurred within the Sydney Basin during the Jurassic, resulting in the formation of diatremes (volcanic pipes representing the root of volcanoes) and dykes (generally linear intrusions through zones of weakness in the surrounding rock). No volcanic features are mapped on the 1:100,000 scale map in the Site or nearby, Volcanic diatremes are mapped to the north (Hornsby Quarry) and south (Prospect Reservoir). Dykes and fracture zones linking these volcanic features may cross the Site.

4.2 Structural Geology

The centre of the Sydney Basin, known as the Fairfield Basin, is located to the south of the Site, resulting in a regional dip of up to 3º to the south and southwest. The Site is located in close proximity to a splinter of a structural feature known as the Hornsby Warp which trends roughly east-south-east in the vicinity of the Site. The Hornsby Warp marks the boundary between the low lying Cumberland Basin to the south and west of the project, and the Hornsby Plateau to the north, and is comprised of a series of discontinuous and irregular monoclinal fault zones. Bedding dips of up to 20º have been recorded in the Ashfield Shale in the proximity of the Hornsby Warp at West Pennant Hills (Branagan, 1985). Bedding spacing in the Ashfield Shale varies from around 5 mm to around 500 mm.

Faults are known to occur within both the Hawkesbury Sandstone and the Ashfield Shale. Faulting includes displacement faults and sheared zones as well as low angle thrust faults and bedding shears. The base of the Ashfield Shale is sometimes noted as being a sheared contact.

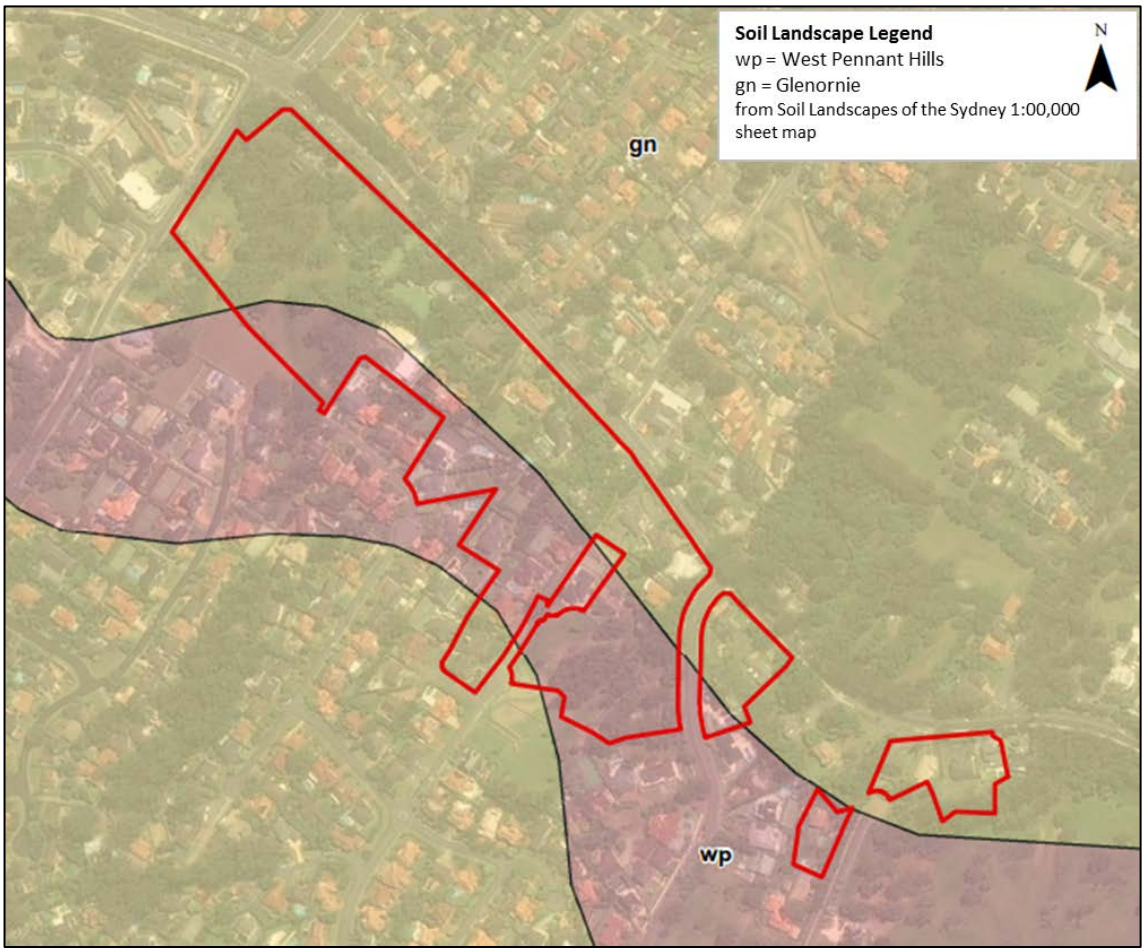
Jointing is widespread throughout the Wianamatta Group and Hawkesbury Sandstone. Published data suggests regional jointing in the Sydney area generally occurs as an orthogonal pair of sub-vertical sets trending approximately north-north-east and east-south-east (Bertuzzi and Pells, 2002). Incised drainage patterns generally follow the joint trends. Joint swarms have also been identified in localised areas.

4.3 Soil Landscape

The Sydney 1:100,000 Soil Landscape Series Sheet (9130) indicates the presence of the following soil landscape groups over the Site. The distributions of these units are shown on **Figure 4** below.

- Glenorie Landscape Group – Described as an erosional landscape. These soils are predominantly mapped on the upper slopes of the Site, but are also mapped south-west of Carioca Way. This group is situated on undulating to rolling low hills on Wianamatta Group Shale at slope gradients of 2º to 11º (5-20%). The soils comprise shallow to moderately deep soils on crests, slopes and along drainage lines. Limitations associated with this group include high soil erosion hazard and localised impermeable, highly plastic, moderately reactive subsoil.
- West Pennant Hills Landscape Group – Described as a colluvial landscape. These soils are mapped on the lower slopes of the Site. This group is situated on rolling to steep side-slopes on Wianamatta Group Shale and shale colluvium at slope gradients >20%. The soils comprise deep soils on upper and mid slopes, on colluvial benches, along drainage lines and poorly drained areas. Limitations associated with this group include mass movement hazard, steep slopes, high soil erosion hazard and localised seasonal waterlogging and impermeable plastic, reactive subsoil.

Figure 4 Soil Landscape of the Site – From Soil Landscapes of Sydney, 1:100,000 Sheet



5.0 Groundwater

Groundwater is likely to flow in a general north to south direction from the high point along Castle Hill Road, with some water feeding into the Darling Mills Creek and its tributaries. The catchment to the east of Staley Court flows south into Bellbird Creek.

The NSW Office of Water (NOW) maintains a groundwater database containing technical details of boreholes registered with the Department. This information may not reflect all boreholes undertaken in the area.

Five groundwater bores exist within a 2km radius of the Site, as shown in **Figure 5**. Three bores have been drilled into shale or sandstone to provide a water supply for domestic purposes and two bores are shallow monitoring bores drilled to record groundwater levels as summarised in **Table 2**.

Figure 5 Bores registered with NOW within 2km of the Site

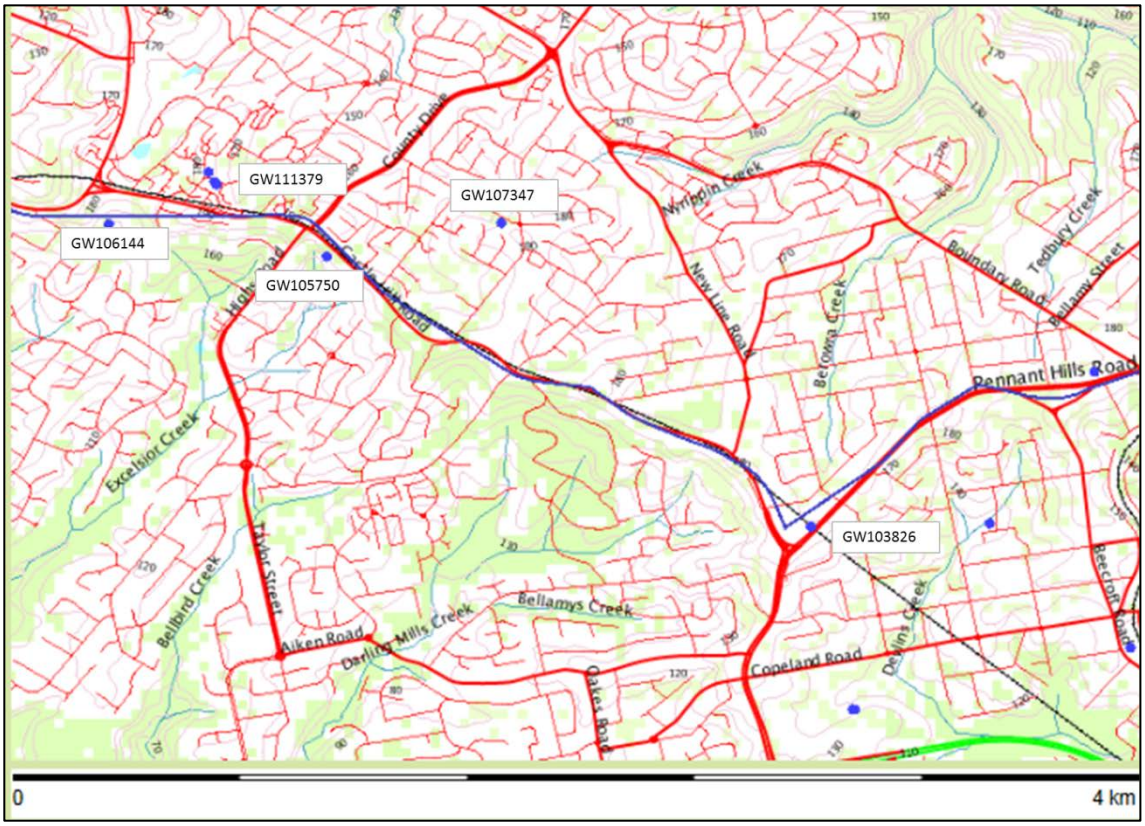


Table 2 Details of Bores registered with NOW within 2km of the Site

Borehole	Year drilled	Bore Depth (m bgl)	Standing Water level (m bgl)	Water Bearing Zones (m bgl)	Geology	Purpose
GW106144	1995	240	52	54-60 228-234	Shale Sandstone	Domestic Bore
GW11378-9	2011	11.8	5.8-6.2		Weathered Shale	Monitoring Bore
GW105750	2004	126.5	70	54.5-58.5 113-114.5 115.2-166.7	Sandstone	Domestic Bore
GW107347	2004	195	60	129-130 148-149 180-181	Sandstone	Domestic Bore
GW103826	1991	5.7	No details		Silty Clay	Monitoring Bore

The bores record a depth of generally silty clay soils to between 1.6m and 8.5m depth, underlain by shale to 29.5 to 51m depth, underlain by sandstone.

Based on the groundwater measurements taken from the groundwater bores, and other boreholes in the vicinity, a series of cascading water bodies may be encountered at the Site. The shallowest groundwater may occur as a perched water body in the colluvial materials or residual soils. Groundwater between around 5 m to 9 m depth was noted within the weathered shale in boreholes in the vicinity of the Site. Groundwater within the underlying Hawkesbury Sandstone was encountered at over 30 m depth.

Vibrating wire piezometers were installed in two boreholes at Lot 2 (8-11) Carioca Way during site investigations carried out in November 2013. The sensors were installed at the boundary between weathered rock and residual soils to assess any build up in porewater pressures relative to rainfall events as recorded at the Sydney Observatory. Hydrographs of the recorded groundwater levels and rainfall volumes over 2014 are presented in **Appendix A**. The groundwater levels did not show significant seasonal variation, but levels varied within BH007 by up to 1 m in apparent response to rainfall events. A third piezometer was installed in a borehole on 144 Castle Hill Road in February 2016. The sensor was placed near the base of an inferred colluvial deposit. A hydrograph of the recorded groundwater levels and rainfall volumes since May 2016 are provided in **Appendix A**. It is noted that an extreme rainfall event occurred on 4-5 June 2016. During this time water levels within BH001 increased by 0.5 m, while the water level within BH011 remained steady. The well locations are shown in **Figure C1, Appendix C**.

6.0 Review of Published Information

The area to the south of Castle Hill Road has historically been subject to land instability, and has been identified on the Hills Shire Council Environmental Plan as at risk of potential instability requiring characterisation for any development. A number of studies have been carried out in the vicinity of the Site, as listed below. The findings from the publications which have been obtained by AECOM are summarised in the sections that follow.

- Soil Conservation Services of NSW: Urban Capability Study: West Pennant Hills, February 1977
- Fell, R., Slope Stability in the Wianamatta Group. In Ed: Pells, P.J.N., Engineering Geology of the Sydney Region, A.A. Balkema, 1985
- Fell, R., Study of Geotechnically Sensitive Sites, Baulkham Hills, Report Prepared for Baulkham Hills Shire Council on behalf of Unisearch Limited, March 2005.
- Fell, R., Landslides in the Wianamatta Group, Baulkham Hills Shire, Sydney. In Australian Geomechanics, Vol 41, No.1, 2006.
- Geoscience Landslide Database: http://www.ga.gov.au/landslides-web/landslips.htm

6.1 Urban Capability Study: West Pennant Hills, 1977

This report describes the capacity of land to support urban use in terms of the inherent stability and erosion potential of the land. The study included examination of aerial photographs, and limited field reconnaissance. The data was used to identify different zones for potential land use based on the character of the soils, the slope gradient, geomorphology and drainage pattern in each zone.

The terrain below Castle Hill Road comprises a steep side-slope immediately below the road, with gradients ranging from 15% (9°) to 40% (22º). Below the side-slope a bench was reported with gradients ranging from 5% (3º) to 15% (9º). Beyond the bench the topography becomes undulating, eventually grading into the sandstone landform.

Two types of movement were reported as described below.

1. Tension cracks develop in steep side slopes, resulting in earthflow along the bench below.
2. Tension cracks develop within the bench itself.

Seasonal waterlogging of the benches was reported, interpreted to be caused by a combination of poorly draining heavy clay soils, and the interception of the water table at the junction of the bench and the steep side-slope. Defined drainage lines were identified as originating below the zone of mass movement.

The reported source of mass movement is from within the clay subsoil in a thick weathered shale profile on the upper slopes. The movement is reported as developing when the subsoil becomes super-saturated during wet periods due its low permeability. The clay then softens, deforms and flows readily.

It was reported that mass movement had only occurred in areas that had been subject to intensive land use.

This Site has been demarcated into Urban Capability Classes, the urban capability classes identified within the Site area are summarised, as defined in the Study, in **Table 3** below. The spatial extent of each zone is shown in **Figure 6**.

Table 3 Urban Capability Classes Relevant to Site – Modified From Soil Conservation Services of NSW

Urban Capability Class	General Description	Land Use Recommendation
Zone A-3	Includes crest and upper slopes, with gradients up to 3º, on stony soils on the shale and sandstone crests (stony brown, and yellow duplex soils), and on skeletal soils associated with sandstone ridges and side-slopes.	Slight erosion hazard is associated with these areas and they will tolerate commercial, industrial, residential or recreational development.
Zone B-1	Comprises slopes of 3º to 6º on soils on the lower shale side-slopes (brown duplex soils).	These slopes will tolerate residential subdivision or passive recreational use.

Urban Capability Class	General Description	Land Use Recommendation
Zone B-1,3m	Comprises slopes of 3º to 6º on the poorly drained and unstable soils of the shale upper-slopes (deep red duplex soils).	High hazard of surface erosion. Particular care is required to stabilise cut batters and the depth and poor drainage of the soil may have implications for design of roadway or building foundations. With care in development, these slopes will tolerate residential subdivision or passive recreational use.
Zone C-1,3m	Includes slopes of 6º to 8.5º on soils of the shale upper-slopes (deep red duplex soils).	The land use potential and limitations are similar to that of the B-1,3m slopes, but the steeper gradient increases the hazards associated with uncontrolled development.
Zone E-1,3m	Comprises slopes with gradients over 14º on the unstable soils of the shale upper-slopes (deep red duplex soils) below Castle Hill Road.	Development on these areas may lead to mass movement, and it is therefore recommended by SCS that they be retained in their present state.
Zone E-3m	Comprises the unstable land in red duplex soils below Castle Hill Road where gradients range from 3º to 11º.	These areas are considered to be prone to mass movement due to their soil characteristics and topographic location. Development is not recommended by SCS.

Figure 6 Land Capability Zones from Urban Capability Study, 1977, West Pennant Hills

6.2 Slope Stability in the Wianamatta Group, 1985

The area south of Castle Hill Road is identified within this paper as subject to creep landslides associated with the Wianamatta Group landform. Such landslides have been identified in several locations on the southern slopes along the full length of Castle Hill Road, and on the western slopes of Old Northern Road between the corner with Castle Hill Road, and just south of the intersection with Blue Gum Drive.

The creep landslides are defined as slow moving landslides on relatively flat slopes (less than 10º, generally only 6º to 8º), where the instability is often not obvious on the surface. The flatter areas are at the base of steeper slopes, 10 m to 30 m high, sloping up to 25º. Landslide extents up to 500 m by 200 m were observed.

The movement of slides is interpreted in the paper as occurring when groundwater pressure in weathered rock underlying the slide builds up in periods of prolonged wet weather. The natural creep sliding may be accelerated with relatively minor disturbance, such as removal of vegetation, leading to distinctly hummocky ground. No groundwater seepage was reported at the toes of the slides.

The slide material was generally reported as stiff to hard gravelly clay, of medium to high plasticity. The gravel component being angular weathered shale.

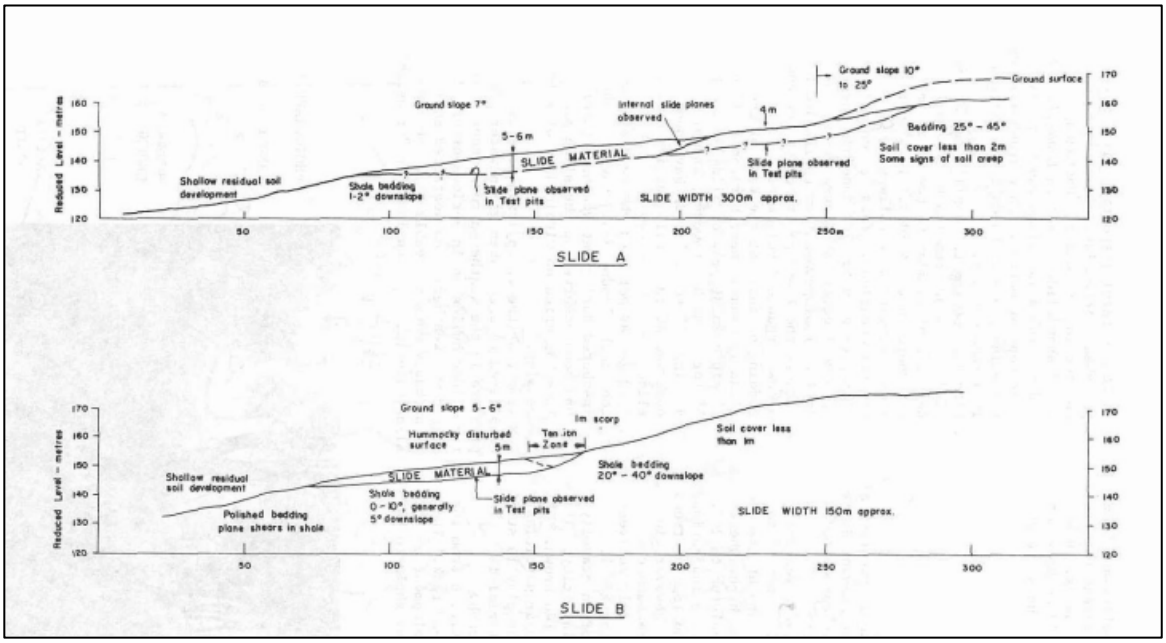
The slide material was reported to be commonly around 6 m in depth. A marked transition was reported from slide material into highly weathered to moderately weathered rock, i.e. no transition through extremely weathered rock.

Where the slide plane was identified, a polished, slickensided surface was reported at the contact in many places. Planar slide planes over 10's of metres were observed.

Loose, deep soil (up to 5m) was observed in some areas towards the uphill edges of slides. This area was considered to be a tension zone where the deep soil had developed from slope-wash from the steeper uphill zone.

The bedding dip in the shale at the base of slide was generally near horizontal (1-5º), but could be steep (25-45º) at uphill margins. Cross sections through two of the studied landslides showing the general features have been reproduced below as **Figure 7**. The exact locations of these slides are not included within the paper.

Figure 7 Sections through creep landslides – From Fell, 1985



6.3 Study of Geotechnically Sensitive Sites, Baulkham Hills, 2005

Professor Robin Fell of the University of New South Wales provided a study to the Hills Shire Council which includes information relevant to this Site. The study was carried out in 2005 and follows on from the work carried out by Fell in 1985. The study includes collation and analysis of information from geotechnical assessments carried out by other consultants for the purposes of subdivision development in the area. It was noted that some consultants had misinterpreted slide debris as in-situ soil or rock.

The Lots 1 and 2 at 9-11 Carioca Court are included in the study. Fell reports that it is unlikely that there is an existing slide on the property, or if there is, it would be limited to the lower extents of 9-11 Carioca, as rock is exposed at shallow depth at the top of 9-11 Carioca and the shape of the land is not typical of the geomorphology of a slide. The site immediately to the south and east of 15 to 19 Staley Court has also been included in the study. Fell reports that the area affected by sliding appears to be confined within the central part of the studied site.

The generalised geometry, geotechnical features and hydrogeological characteristics of the slides are described in detail and some recommended management strategies and remedial works are suggested to allow development of landslide affected sites.

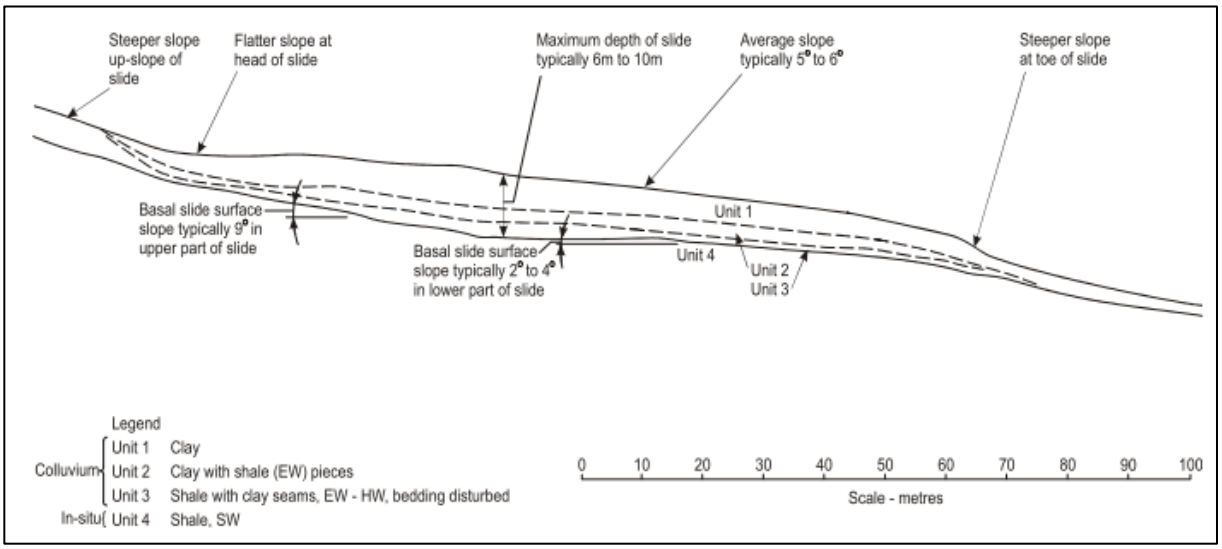
The following general characteristics were noted:

6.3.1 Geometry

Figure 8below illustrates some geometric characteristics of the slides.

- The landslides occur on ground surface slopes typically around 6º. The slopes above the landslides and at the toe are steeper. There may be local changes in slope within the landslide reflecting internal relative movements, or the shape of the slide surfaces.
- Slides are typically 200 m to 300 m wide, and up to 200 m in the downslope direction.
- Slides are commonly up to 6 m deep, but may be up to around 12 m.
- The basal slide surface is usually quite flat (2 – 4º) in the lower part, and steeper (about 9-10º) in the upper part.

Figure 8 Some geometric features of the landslides – From Fell, 2006



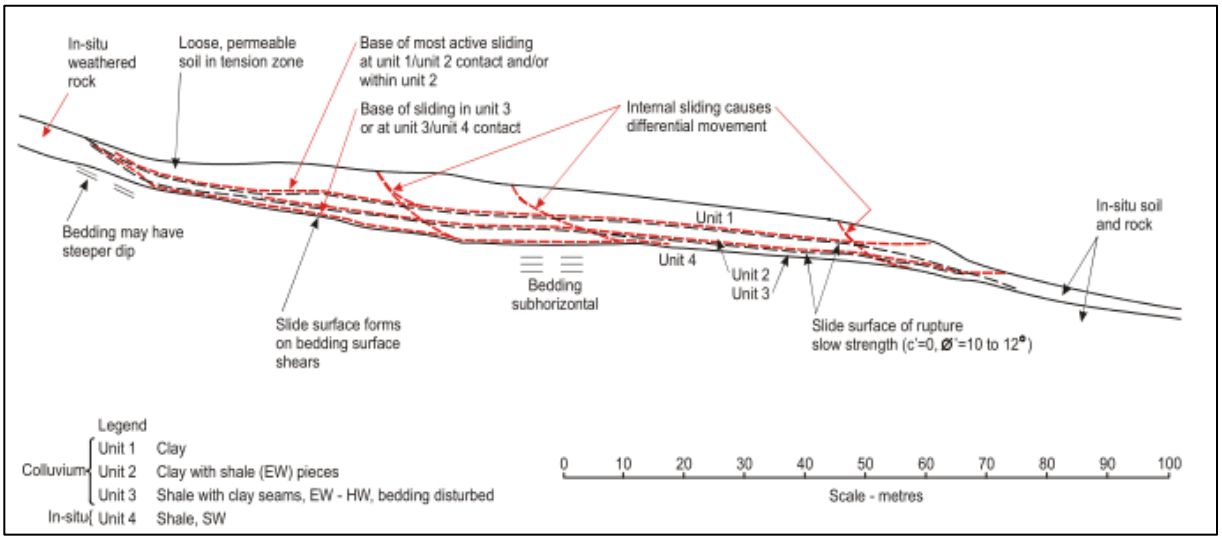
6.3.2 Geotechnical Characteristics

Figure 9 illustrates geotechnical characteristics of the slides.

- The landslides are ancient features, formed in geological time, probably as a result of weathering as the streams to the south and east eroded northwards into the higher terrain.
- Sliding is probably controlled by bedding surface shears formed by stress relief or local folding in the shale.

- Up to four geological units can be distinguished within most slides. Unit 1: clays, Unit 2: clay with gravel sized pieces of shale, siltstone and sandstone, Unit 3: extremely to highly weathered shale, with clay seams, Unit 4: slightly weathered shale (below the basal slide surface).
- It is reported that Units 2 and 3 may have been mislabelled as in-situ soil or rock by some consultants.
- It is recommended in the report that all materials above the slightly weathered shale (Unit 4) are assumed to be landslide colluvium.
- Slide surfaces may occur at the base of Unit 1, within Units 2 and 3, and on the Unit 3 to Unit 4 contact.
- Bedding in the underlying shale is near horizontal (generally 2 to 4º downslope). Steeper bedding dips have been observed near the head of some slides.
- Slide surfaces have low effective shear strengths, with an effective friction angle typically around 10 to 12º, determined by back analysis. The near horizontal surfaces, along the bedding planes, may be lower strength than the steeper upper parts which may cross the bedding.
- The colluvium has a higher drained strength than the slide surfaces.

Figure 9 Some geotechnical features of the landslides – From Fell, 2006

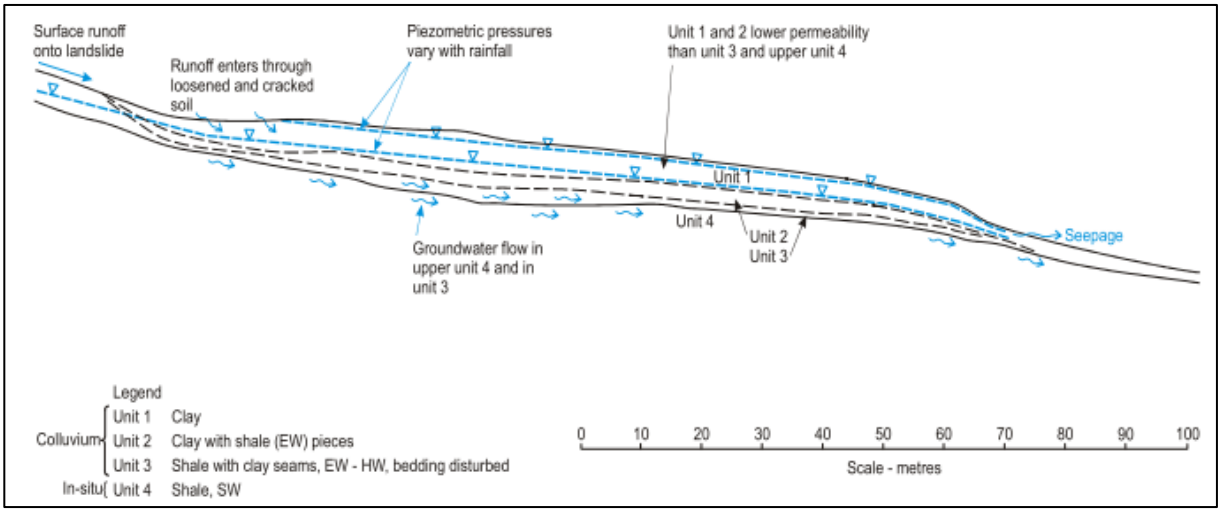


6.3.3 Hydrogeological Characteristics

Figure 10 illustrates some hydrogeological characteristics of the slides.

- The upper clayey units have relatively low permeability. Most groundwater flows occur within the more permeable weathered rock units (Unit 3, and the upper part of Unit 4).
- The upper clay units may confine the groundwater flows in the lower units resulting in artesian pore pressures.
- Looser more permeable material in a “tension zone” at the rear of the slide may be an entry point for water flow into the slide.
- Water also infiltrates the slide from the weathered rock mass up-slope.

Figure 10 Some hydrogeological features of the landslides – From Fell, 2006



6.3.4 Slide Movement

- Some slides move only during periods of wet weather, and usually only a few millimetres at a time, although some may move in the order of metres over a number of years.
- The amount and intensity of rainfall which will cause sliding will be different for different slides, and for different parts of slides.
- Movements within a slide may not be uniform and hummocky ground may form in response.

6.3.5 Management Strategy and Potential Remedial Measures

The report recommends that when considering development of these sites, the quantum of remedial work necessary and the acceptable degree of risk is to be addressed. The Hills Shire Council have adopted a policy that requires risk to be below 1 in a million per annum for loss of life, and “low” for property damage as defined in the Australian Geomechanics Society (AGS) Guidelines for Landslide Risk Management, 2002.

Three examples of remedial works are reported:

- Complete removal and replacement of landslide colluvium with engineered fill, and a drainage layer at the fill to slightly weathered shale boundary
- Removal of the lower part of the landslide and replacement with a free draining toe berm
- Installation of trench drains to below the base of the landslide and throughout the landslide mass with a small toe berm

6.4 Geoscience Australia Landslide Database

Geoscience Australia has collated reports of landslides throughout Australia within a digital database which can be accessed via their website. A search of this database identified four landslide reports in Castle Hill/West Pennant Hills 1 km to 2 km to the west of the project area.

The reports include an instance of over-excavation during construction, collapse of a road, and failure of hill slopes. Limited information regarding the cause or nature of failure is provided in the database.

The report for a landslide closest to the Site is for Highs Road, affecting lots 103, 104 and 105, which was reported in 1980. The recorded cause of failure is prolonged high precipitation. This area is now occupied by houses in the Doris Hirst Place subdivision on the opposite side of the Highs Road ridge to the project area.

No landslides within the project area are present on the database.

7.0 Review of Previous Geotechnical Investigations

Twenty-six geotechnical reports have been obtained which are relevant to the expanded Site, as listed below. The reports were produced by other consultants for the purpose of subdivision applications for lots on Carioca Court, Castle Hill Road, Glenhope Road, Carioca Way, Glenayr Grove, Highs Road, Staley Court and Matthew Way. **Figure 11** shows the areas covered by these reports. A summary of the information obtained from these reports is provided in the sections that follow.

Carioca Way

1. Martens Consulting Engineers: Geotechnical Assessment: Proposed Subdivision of Lot 2 DP 1057556, Carioca Court, West Pennant Hills, NSW, March 2010
2. Martens Consulting Engineers: Supplementary Geotechnical Assessment: Proposed Subdivision of Lot 2 DP 1057556, Carioca Court, West Pennant Hill, 25 February 2011
3. Martens Consulting Engineers: Salinity Assessment, Proposed Subdivision of Lot 2 DP 1057556, Carioca Court, West Pennant Hill, December 2010
4. Shirley Partners Consulting Engineers: Geotechnical Report on proposed Lot No. 1 in a subdivision of Lot No. 302 DP 812860 Carioca Court, West Pennant Hills, 19 June 2003
5. Coffey Partners International, Geotechnical Assessment, Proposed Subdivision – Lot 2, DP785982 – West Pennant Hills, 23 March 1990
6. Coffey Partners International, Geotechnical Assessment, Subdivision – Lots 100, 101 and 102, Carioca Court, West Pennant Hills, 5 October 1990

Matthew Way

7. G Ring - Geotechnical Engineer, Geotechnical Report – Assessment of Filling, 3 Matthew Way, West Pennant Hills, 9 October 1999.
8. Woodward Clyde, Geotechnical Assessment for Portion of Lots 26 Matthew Way, West Pennant Hills, 17 November 1997.
9. Coffey Partners International, Proposed Subdivision Lots 25 to 29, Willunga Place, West Pennant Hills, Report No. S5988/1-AE April 1992
10. Coffey Partners International, Site Investigation, Proposed Subdivision – 133 Castle Hill Road, West Pennant Hills, 19 July 1990
11. Compaction and Soil Testing Services, Geotechnical Investigation, Proposed Residence Development, Lot 22 in DP828183, No. 13 Matthew Way, West Pennant Hills, 1 April 2008
12. Douglas Partners, Geotechnical Investigation, Proposed Residence – Lot 101 Matthew Way, West Pennant Hills, March 1999

Glenhope Road

13. Shirley Partners Consulting Engineers: Notes on Geotechnical Constraints applying to Proposed Subdivision of Lots No. 1 & 2 Glenhope Road, West Pennant Hills, September 1988
14. Shirley Partners Consulting Engineers: Report on Road Pavement Design for Subdivision under Construction at Glenhope Road, West Pennant Hills, January 1988
15. GDK Keighran Geotechnics, Geotechnical Assessment, Residential Development, Lot 1 Castle Hill and Glenhope Roads, West Pennant Hills, April 1998
16. Shirley Partners Consulting Engineers: Geotechnical Report on Proposed Child Care Centre, No. 1 Lot No. 12 DP 789295, Glenhope Road, West Pennant Hills, 12 July 1993
17. EFA Geotechnical, Geotechnical Investigation, Lot 11 Glenhope Road, West Pennant Hills, Ref No. 9W 1680
18. Network Geotechnics, Site Fill and AS2870 Classification Report, Proposed Lots 2 and 3 of Residential Subdivision, Corner Castle Hill Road and Glenhope Road, West Pennant Hills, 24 September 1996

19. Brink and Co. Consultants, Geotechnical Assessment, Proposed Residential Subdivision, Lot 13 in DP225711, Glenhope Road, West Pennant Hills, 17 November 1994
20. Douglas Partners, Geotechnical Evaluation, Proposed House – Lot 1, 109 Castle Hill Road, West Pennant Hills, 2 June 1998

Glenayr Grove

21. D.J Douglas & Partners, Geotechnical Assessment, Proposed Residence, Lot 8 Glenhope Road, West Pennant Hills, January 1992

Castle Hill Road

22. Network Geotechnics, Geotechnical Assessment, Proposed Residential Subdivision, Lot 4 DP 864230 and Lot 1 DP 537238, Castle Hill Road, West Pennant Hills, January 1999
23. Jeffrey and Katauskas Consulting Engineers, Geotechnical Assessment, Proposed New Residence, 117 Castle Hill Road, West Pennant Hills, 29 July 2008
24. Regional GTS, Geotechnical Assessment, 123 Castle Hill Road, Castle Hill, 15 September 1997
25. Regional and Engineering Consultants, Geotechnical Assessment, Stability of Property Castle Hill Road, DP220867, West Pennant Hills, 21 November 1977

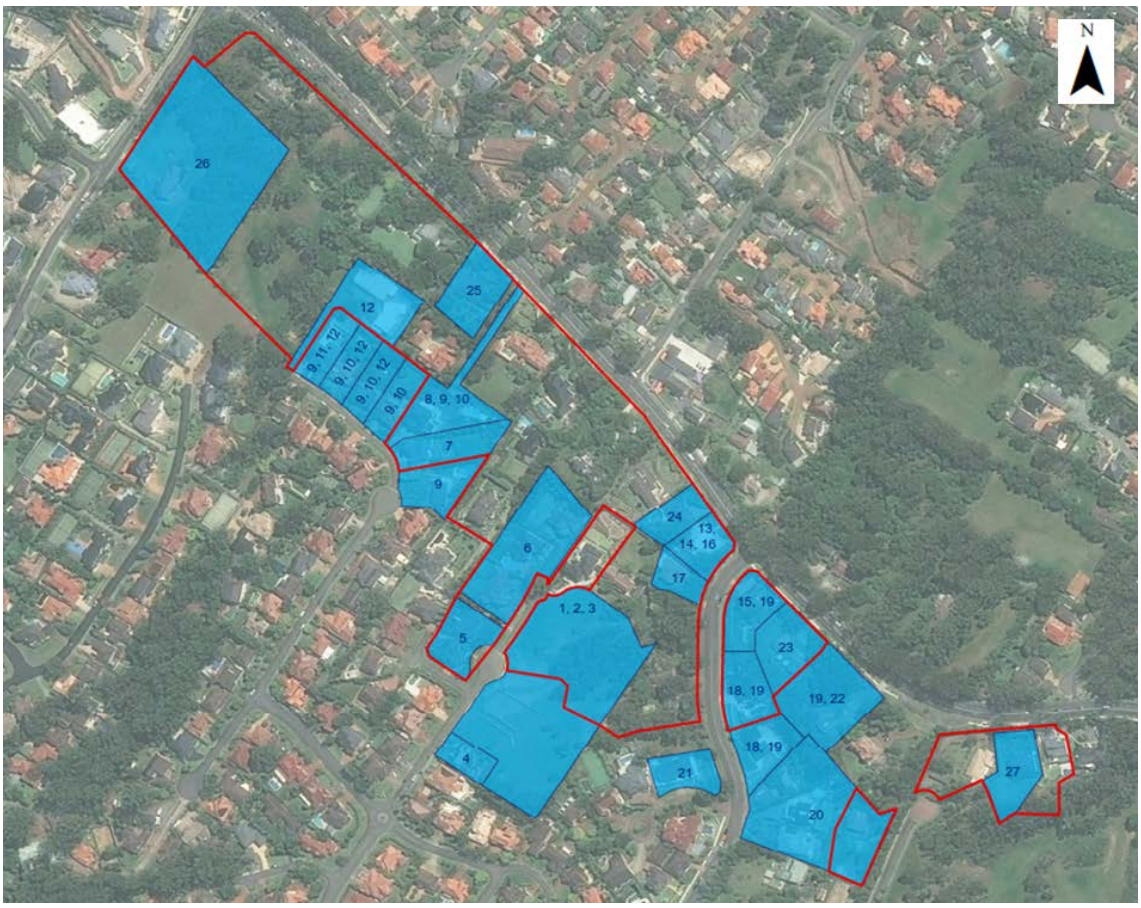
Highs Road

26. Regional Geotechnics, Stability Investigation, Lot 10 Highs Road, Castle Hill, June 1987

Staley Court

27. Asset Geotechnical, Proposed Swimming Pool, 17 Staley Court, West Pennant Hills, Geotechnical Assessment, 2 July 2013

Figure 11 Lots covered by previous Geotechnical Reports by others



7.1 Carioca Way

Five geotechnical assessment reports, and a salinity assessment have been obtained which are relevant to properties on Carioca Way within the expanded Site area. These are summarised below.

7.1.1 Lot 1 and Lot 2 (9-11 and 26) Carioca Way

Three geotechnical assessment reports and a salinity assessment report have been obtained which were carried out on two lots (Lot 1 and Lot 2) at Carioca Way. Investigations included eleven auger holes, nine Dynamic Cone Penetration (DCP) tests and eleven test pits. Holes extended to between 0.7m and 4m depth. Part of Lot 2 is currently within the development proposal area. The southern half of Lot 2 has recently been subdivided. Lot 1 has been subdivided and a house now occupies the Site.

Fill material was encountered, up to 2.2 m depth, in a localised area around the Carioca Court cul-de-sac. The fill was observed to be generally well compacted. The soils beneath the fill in this area extended to past the maximum depth of the investigations. The topography in this area indicates that this is a drainage channel leading towards the Darling Mills/Excelsior Creek.

The soils identified as natural soils generally comprised firm to stiff silty clay, with minor angular shale gravels. A layer of soft to stiff clay, with variable amounts of shale gravel lies between the silty clay and weathered shale in most locations. These soils have been interpreted in the geotechnical assessments as part of a residual weathering profile. The depth to extremely weathered to moderately weathered shale across these sites was noted as being highly variable, and ranged from 0.4 m to over 4 m depth. Two test pits in the south-west of the Site exposed weathered sandstone, but two hand augers in this area logged the bedrock as weathered siltstone. Bedding within the weathered shale and siltstone was measured between 4º and 10º, generally dipping to the north (into the slope).

No permanent groundwater or seepage flow was observed during the investigations. It was noted that soils in the lower portion of the Site had higher moisture content than those on the upper slopes.

Summary

Based on the information provided in Fell, 2006 it is possible that some material encountered at this site is colluvium rather than in-situ weathered shale. The irregular weathering noted, and dip angles measured in a northerly direction suggest that the weathered shale material has been disturbed.

7.1.2 10-12, 20-24 Carioca Way

Two geotechnical assessments relating to subdivision and development of nine lots to the north and west of Carioca Way have been obtained. Both reports were produced by Coffey Partners International (Coffey) and all referenced properties fall within the expanded Site.

The purpose of the respective assessments was to review the earthworks progress across the nine lots (in accordance with an earlier Coffey report) and to assess the suitability of three of these lots for residential development.

The March 1990 assessment of the nine lots noted that the bulk of the proposed earthworks had been completed, with only final grading and surface preparation left to complete. Access to these lots was via an excavated access roadway that was largely at grade, with two notable cuts present along the eastern edge exposing sandy clay colluvium overlying bedrock. These cuts were observed to be unstable and actively slumping in places. A considerable amount of fill was also noted across several Lots, up to 2 m thick in places.

A significant portion of this fill on two of the lots contained a notable amount of organic material, and was subsequently deemed unacceptable for use as engineered fill. Stormwater management was only partially completed across the subdivision, with some surface water ponding evident on three lots, making trafficability difficult in places. A further site visit was recommended on completion of the works, together with assignment of individual lot classifications prior to residential development.

The October 1990 assessment focusses on three lots (20 – 24 Carioca Way) within the Carioca Way subdivision. In similar manner to the broader March assessment, batter slopes in the sandy clay colluvium along the access roadway showed evidence of instability. Fill was observed on the two lower lots, reaching a maximum thickness

of 1.5 m, but generally in the order of 0.5 m. These lots were assessed to have a low to moderate risk of slope instability. The drawing referenced in the report was not attached to the copy made available to AECOM.

Summary

The reports produced by Coffey were requested to document earthworks compliance and assess the suitability of Lots for residential construction. They are based on visual assessment of the landform and observations made during earth moving operations. The reports note the presence of colluvium and significant placement of fill (up to 2 m in places), some of which contained unsuitable organic material. Evidence of instability in shallow cuts within the exposed sandy clay colluvium was also noted. The lower three lots (20 – 24 Carioca Way) were assessed as having low to medium risk of slope instability.

7.2 Matthew Way

Six geotechnical reports have been obtained which relate to the properties on the northern side of Matthew Way (Properties 1 through to 15).

Three assessments have been carried out by Coffey between 1986 and 1992, however only the 1992 report has been obtained in full. This report references the earlier reports, and includes data from, five test pits carried out on the site. The aim of the 1992 assessment was to better define zones identified as having moderate and high risk of instability on the eastern portion of the site (around 1, 3, 5 and 7 Matthew Way). The test pits indicate a zone of soil to around 3 m depth along the boundary between 3 and 5 Matthew Way. Evidence of soil disturbance was observed in the pits. Based on the test pit data and the previous investigations undertaken, a zone of High risk of instability was demarcated on the eastern portions of 1, 3 and 5 Matthew Way, and a zone of Moderate risk of instability to the west of this. The higher risk areas coincide with the drainage paths which historically ran through these sites. Recommended measures to lower the risk of instability during residential development of these areas included provision of surface and subsurface drainage, all buildings to be supported on piers founded in sound rock, and limiting earthworks and placement of fill to no greater than 1 m depth.

7.2.1 3 Matthew Way

G. Ring produced a report on 3 Matthew Way in 1999 assessing an area of fill placed in the back yard. The topography is noted as being within a drainage valley, with two flow paths entering the block from the north and east. Fill has been placed over the eastern flow path, bounded by log retaining walls. The fill is noted as being firm, and of low to moderate erosion potential. The northern corner of the site has a steep gradient (25°) and was assessed as being of Medium risk of instability, based on the Australian Geomechanics Society classification system for land instability, 1985 (AGS, 1985). It was noted that a log wall above the steep slope may create a destabilising effect, possibly countered by the placement of fill at the base of the slope. Recommendations have been made in the report to improve surface drainage on the site to reduce erosion potential.

7.2.2 5 Matthew Way

Woodward-Clyde carried out an assessment of 5 Matthew Way in 1997 to provide geotechnical advice for Development Approval of a residential dwelling. The site was noted as very steep, with the ground surface ranging from 12° to 23°. Mature pine trees on the site showed no sign of curvature. Three test pits were carried out at the site to between 1.3 m and 2.0 m depth. The report notes transported soils should be expected on site to around 2.5m depth. The site was assessed as having a Medium risk of instability, based on AGS, 1985.

7.2.3 13 Matthew Way

Compaction and Soil Testing Services carried out an assessment in 2008 to inform the foundation and earthworks design for a residential dwelling. The site slopes between 10° and 13° towards the road. Four machine augered holes were carried out between 3.0 m and 4.1 m depth. Residual soil was encountered to between 2.4 m and 3.6 m depth, underlain by extremely weathered shale. No comment is made on slope instability at this site.

7.2.4 15 Matthew Way

Douglas Partners carried out a geotechnical assessment in 1999 to inform the planning and design of foundations for a residential dwelling. The site had been modified by earthworks and the natural landforms had been changed. The investigation comprised four test pits to 3.5 m and one machine borehole to 6.4 m. A layer of fill was encountered across most of the site, underlain by an organic rich layer identified as topsoil to between 0.5 m and 3.0 m depth. It is not clear from the report whether this is a stockpile or placed fill. Stiff to very stiff clay was encountered below the topsoil to around 3.4 m depth. The risk of creep movements was noted, and as a result piles socketed into medium strength shale were recommended.

Summary

The reports along Matthew Way are generally consistent, and suggest an area possibly subject to historic creep movement around the drainage channel to the north and east of Willunga Place. This zone has been assessed as Medium to High risk of instability based on AGS, 1985. Clayey soils were encountered at the western end of Matthew Way to 3 m or more depth. The thick soils and the steep landform were identified as being conducive to creep movement, but no evidence of movement was observed. The thick layer of topsoil at 15 Matthew Way, if still present, may decrease stability of the shallow materials at this location.

It is noted in the Ring report on 3 Matthew Way that retaining walls constructed on the site may have an adverse effect on the slope stability, however, the current proposal involves complete redevelopment of the Site, and this feature would be demolished.

7.3 Glenhope Road

Seven geotechnical reports and a report on pavement design have been obtained which relate to properties on Glenhope Road within the expanded Site.

7.3.1 1 Glenhope Road

Shirley Partners Consulting Engineers provided comment on geotechnical constraints at 1 Glenhope Road prior to subdivision in September 1988. The report appears to relate to geotechnical investigations carried out at the site, but there is no detail on what investigations were carried out. It appears that there may be other technical reports related to this area, produced by Shirley Consulting Engineers, which were not obtained during our public search. The Shirley reports provide general advice for development of the “medium, high and very high risk of instability” areas. The extents of these areas are not shown in the reports, which may be referring to the zones identified in the SCS 1977 report. Recommendations included placing a ‘restriction to user’ requirement on the Site to require professional geotechnical advice for any development.

A later report prepared by Shirley Partners in July 1993 relates to the same site prior to construction of a childcare centre. The report refers to test pit investigations carried out, but no data or detailed description from the investigation is provided. Attachments mentioned in this report have not been obtained. Shirley Partners assessed the site as having a Low risk of instability, based on AGS, 1985.

7.3.2 2 Glenhope Road

The site on the eastern side of Glenhope Road was examined by Keighran Geotechnics in 1998. The site is situated on the edge to the Castle Hill Road ridge. No subsurface investigations were carried out. Residual silty clay soils to around 2 m depth were observed within a road cutting along Glenhope Road, underlain by highly weathered laminated shales and siltstones. No evidence of major or surficial instability was observed on the property or on adjacent properties during a site walkover. An assessment of the site was made using AGS, 1985; the site was defined as being of low risk of experiencing instability.

7.3.3 3 Glenhope Road

EFA Geotechnical carried out three test pits on this site to provide a Site Classification for the construction of a residential dwelling in November 1999. The site had been modified by previous earthworks, and construction of access roads. The head of a drainage gully was observed within the site. Rock was reported at around 1.3 m depth close to the southern boundary of the site and around 1.1 m depth at the northern boundary. Fill to over 800 mm depth was encountered close to Glenhope Road, thought to be related to a historic driveway. No comment is made on slope instability. The site is classified in reference to AS2870 1996 – Residential Slabs and Footings, and is identified as being Class P due to the presence of fill which could be certified.

7.3.4 4 and 6 Glenhope Road

Brink and Co carried out investigations in 1994 on the area now occupied by 117 and 119 Castle Hill Road, and 2, 4 and 6 Glenhope Road. The investigation was requested to provide a Site Classification and an assessment of risk of overall slope instability. The investigation comprised excavation of eight test pits between 0.7 m and 3.65 m depth (maximum depth limited by the reach of the machine). Test pits along Castle Hill Road encountered bedrock from 1.65m depth, to over 2.25m depth. Test pits carried out at 4 and 6 Glenhope Road encountered a soil profile over 3 m thick, with the top of rock not encountered in TP2 and TP3. TP4 and TP5 encountered apparent blocks of rock overlying extremely weathered siltstone. The topography of the site includes a relatively level section adjacent to Castle Hill Road, slopes of 10° to 20° towards Glenhope Road, with slopes of 5° to 7° on the southern portion of the site. Several trees in the southern portion of the site were noted as being slightly curved.

The upper site occupied by 117 and 119 Castle Hill Road, and 2 Glenhope Road was assessed as Low risk of slope instability, while the lower portion was assessed as Medium risk using AGS, 1985.

Network Geotechnics carried out an assessment of the fill pads at 4 and 6 Glenhope Road in 1996. The pads were observed as being in cut at the rear of each section, and with up to 2m of fill placed in the south-west corner or each pad. The fill was assessed as meeting the “controlled fill” requirements of AS2870.1-1998.

7.3.5 8, 10, 12 Glenhope Road

Two geotechnical assessments were carried out on these sites by Douglas Partners in 1986 and 1987 to investigate the suitability of the land at 109 Castle Hill Road for subdivision, with a follow up letter dated June 1998. An initial desk based study and site walkover was supplemented with intrusive investigations, including six test pits between 3.7 m and 3.9 m depth (limited by the reach of the machine). The site topography comprised ground sloping between 12° and 20° from a ridge at 109 Castle Hill Road in a south-westerly direction to the headwaters of a tributary of the Darling Mills Creek. Mature trees on the slopes showed no sign of curvature, and no water seepage was observed during site investigations. Disturbed soil material was observed in the test pits on the steeper portion of the site to depths of around 2 m, and highly weathered shale was encountered in the base of the test pits. Potential creep movement has been mentioned, but has been interpreted to be slow moving and relatively shallow (within the upper 2 m). The site was classified as Class P, using AS2870 – Australian Standard for Residential Slabs and Footings, due to the potential for hillside creep.

Summary

The landforms vary along Glenhope Road, and the geotechnical assessment reports reflect this. Properties adjacent to Castle Hill Road have been identified as low risk of instability as they are relatively level. Limited intrusive investigations were carried out on these sites. Evidence of disturbed material in the slope to the east of Glenhope Road (between 4 and 12 Glenhope) has been identified in several test pits. This material has been interpreted consistently in the reports as being indicative of shallow seated, slow, creep movement.

7.4 Castle Hill Road

Six geotechnical assessments relating to the properties within the expanded Site along Castle Hill Road have been obtained.

7.4.1 115 to 119 Castle Hill Road

The assessment carried out at 115 to 119 Castle Hill Road by Network Geotechnics in 1999 notes that the risk of instability on the site is Low, but that the topography drops off at the southern boundary, and the risk of instability within 10 m of the boundary is Medium, based on AGS, 1985. Three test pits were carried out, two pits at the southern boundary of the site, and one adjacent to Castle Hill Road. The ground profile encountered a residual soil profile, with around 1.1 m to 2.6 m of residual soil overlying highly weathered shale. The thickest soil profile was encountered at the Castle Hill Road boundary.

Brink and Co. also investigated this area in 1994, as described in relation to 4-6 Glenhope Road above. The upper site area occupied by 117 and 119 Castle Hill Road was assessed as Low risk of slope instability.

7.4.2 111 to 117 Castle Hill Road

Jeffery and Katauskas carried out an assessment of 111 to 117 Castle Hill Road in 2008 to provide geotechnical advice for the planning and preliminary design of a new residential dwelling. The assessment included a walkover

and four test pits to between 2.35m and 3.5m depth. The site topography comprised a relatively level area at the crest of a hill. The test pits encountered silty clay soil to around 2.0m adjacent to Castle Hill Road, underlain by low to medium strength shale. The test pits along the southern boundary encountered a zone of brecciated shale between around 0.7m and around 2.0m depth, underlain by low to medium strength shale. A qualitative risk analysis of the site was carried out based on the AGS Guidelines for Landslide Risk Management, 2007 (AGS, 2007). The overall risk to property was assessed as Low for the existing and proposed development, provided good engineering practice is adopted.

7.4.3 123 Castle Hill Road

An inspection was carried out by Regional Geotechnical and Testing Services in September 1997 to assess suitability for extension of an existing residential development. No subsurface investigations were carried out. Due to the gentle gradient of the property, the straightness of mature trees and very little cracking observed of the existing building, the site was assessed as Low risk of instability based on AGS, 1985.

7.4.4 137 Castle Hill Road

Regional and Engineering Consultants carried out a walkover assessment of the property in November 1977. At the time of the inspection the site was vacant and sparsely vegetated. Slope gradients between 3° and 8° were noted. The site was assessed as having no instability concerns, provided normal development precautions were taken.

Summary

The geotechnical assessments along Castle Hill Road all note a Low risk of instability along the elevated ridgeline, with a potential increase in risk along the steeper side slopes. Intrusive investigations along Castle Hill Road suggest around 2 m of residual soil overlies shale along the Castle Hill Road Ridge, with localised deeper soils in areas. A zone of loose, brecciated shale was identified in test pits at the break in slope along the boundary of 111 to 117 Castle Hill Road.

7.5 1 Glenayr Grove

One report relating to the construction of a residential dwelling at the site currently occupied by 1 Glenayr Grove has been obtained.

D.J. Douglas & Partners carried out an assessment of the site in January 1992. The assessment was based on a site walkover; no subsurface investigations were carried out. The site was assessed to be Medium risk of instability, using AGS, 1985. This assessment was based on the site exhibiting characteristics similar to sites where creep movement commonly occurs (thick clay soils, slope gradient of around 17 %.)

7.6 6-8 Highs Road

One report relating to 6 Highs Road has been obtained. Regional Geotechnics carried out an assessment in 1987 to inform the design of a proposed residential dwelling. The site was described as sloping between 10° and 18° from a ridge along Highs Road to a watercourse running through the north-west corner. The steepest slopes being closer to the watercourse on the eastern boundary. Three test pits were carried out mid slope between 1.8 m and 3.7 m depth. The test pits encountered slope wash material (colluvium) to around 0.5 m depth, underlain by silty clay soils, interpreted as residual shale, to around 1.0 m to 1.8 m depth, underlain by extremely weathered shale. Slip surfaces were identified in one test pit at the top of the steeper slope to around 1.0 m depth which were noted as signs of creep movement of the residual soils. The site was assessed as being of Medium risk of instability on the upper slopes, and High risk on the steeper lower slopes, using AGS, 1985. Bored pile foundations, careful drainage and gentle batter slopes for cuttings were recommended.

Summary

The investigation data suggests that creep movement has occurred on this slope in the past. Deeper investigations to competent bedrock would be necessary to determine the potential maximum depth of movement on this site.

7.7 15-19 Staley Court

One report has been obtained which relates to properties along Staley Court. Asset Geotechnical carried out an assessment to inform the foundation design for a swimming pool constructed at 17 Staley Court. The investigation included a site walkover and excavation of two hand augers and dynamic cone penetrometer (DCP) testing to between 2.1m and 2.9m depth. The investigation encountered uncontrolled fill, including construction waste to an inferred depth of 2 to 2.9m. Based on refusal of DCP tests, Asset Geotechnical infer the presence of bedrock immediately below the fill. Groundwater was not encountered during the investigation, but was inferred to be present between 2m and 3m depth. Asset did not observe obvious signs of slope instability. Undulations in a garden bed were inferred to be due to settlement of fill. Asset Geotechnical recommended founding the swimming pool on piles socketed into rock.

Summary

The investigation data suggests that fill material has been placed at the crest of the steep slope on the southern side of the property.at 17 Staley Court to extend the garden platform. The fill may have been derived from demolition of previous existing buildings on the site and is likely to have been placed in an uncontrolled manner.

7.8 Investigations along NWRL Corridor

AECOM was involved with geotechnical assessment of the North West Rail Link (NWRL) corridor which runs roughly along Castle Hill Road adjacent to the Site. A number of geotechnical boreholes were drilled along the NWRL alignment in close proximity to the Castle Hill Road ridge.

7.8.1 Landslide Investigation

A component of the geotechnical work involved assessment of a landslide immediately to the east of the Site. This landslide is outside of the project area, but the head-scarp is likely to extend into the properties at 15 to 19 Staley Court, and the slide provides an indication of the characteristics of the landslide materials that may be encountered.

Geotechnical investigations carried out in the landslide identified slide debris to around 10 m depth above a relatively thin weathered shale profile. Perched groundwater levels were encountered within the shale. The slide surface appears to be above the Kellyville Laminite subgroup member. The upslope initiation of the slide may have been within the more argillaceous Regentville Siltstone subgroup.

7.8.2 Potential Faulting

Evidence of shearing was identified in the shale rock core from several boreholes in the vicinity of Cherrybrook, and there is an offset of the lithological layering of around 8 m between Cherrybrook Station and Highs Road to the west. This suggests the presence of faulting and vertical movement in this area. Based on the available information, and geomorphological features, two fault traces have been inferred in the NWRL report, possibly trending around N-S, with around 2 m of vertical offset. One inferred trace crosses the proposed station site, and possibly crosses Glenhope Road to the south. The second inferred fault trace crosses Castle Hill Road close to Mariam Place. The location and orientation of these faults is speculative.

8.0 Aerial Photograph Interpretation

Historic aerial photographs of the Site have been obtained in order to assess any changes in the landscape, identify previous land instability which has occurred over time, and to provide information to assist with identifying potential instability originating from adjacent land. Stereo-pairs were obtained for a selection of years. These can be viewed through a stereoscope to produce an image in three dimensions which enhances some landscape features, and can be used to identify and delineate specific ground features such as the distribution of soil types (e.g. colluvial and alluvial deposits). Photographs from the following years were obtained:

Table 4 Aerial Photographs

Year	Format	Year	Format
2005	Colour Stereo-pair	1961	Black and White Stereo-pair
2002	Colour	1947	Black and White Stereo-pair
1994	Colour	1943	Black and White (from online SIX Maps viewer)
1986	Colour Stereo-pair	1930	Black and White Stereo-pair
1975	Black and White		

The aerial photography images are provided in **Appendix B**. The main geomorphological features identified from the assessment are shown on **Figure C2** in **Appendix C**. A summary of notable observations made from the aerial photography is provided below.

1930 Castle Hill Road is present as a main road. Glenhope Road, Highs Road and Carioca Court are present as minor roads or farm tracks. Matthew Way and Staley Court are yet to be formed.

The Site is mainly occupied with pasture land and orchards. A line of trees follows Glenhope Road and continues east along Castle Hill Road to Staley Court. Established trees are also present around the homestead at 111-113 Castle Hill Road, between 15 and 17 Staley Court, along the southern boundaries of 15 to 19 Staley Court, at the corner of Highs and Castle Hill Roads and along the drainage gullies extending north into143 - 145 Castle Hill Road and 6 Highs Road.

Nos. 5, 7, 9 and 11 Glenhope Road, 1 Glenayr Grove, and 133, 135 and 137 Castle Hill Road are occupied by orchard trees.

Five buildings are present on the Site; all are adjacent to the existing roads, within lots 111-113, 125, 127, 133 and137 Castle Hill Road.

A lake is situated at the southern edge of the 111-113 Castle Hill Road homestead property. The lake extends onto land which is now occupied by the Staley Court cul-de-sac.

Gullies run generally NE to SW through the land now occupied by 1, 3 and 5 Matthew Way and 9 and 11 Carioca Court. Gullies also run N to S through 143 and 145 Castle Hill Road and 6 Highs Road. The main Darling Mills Creek channel runs in a straight NE-SW direction.

Observations outside of the site area:

Four amphitheatre shaped scarps are present around the head of the tributaries leading to Darling Mills Creek. The scarps are in pasture land and no fresh scars are discernible. The lower reaches of the creek are bush covered.

Defined scarps are present adjacent to Castle Hill Road both to the west (two scarps, west of Highs Road) and to the east of the Site (the southern boundaries of 15 to 19 Staley Ct to Coonara Ave and east of Coonara Ave). These scarps are occupied by grassland and bush land. No fresh scars are visible.

1943 The head of the tributaries leading to Darling Mills Creek are now occupied by bushland, but the majority of the trees at the corner of Highs and Castle Hill Road have been cleared and replaced by terraced pasture on 145 Castle Hill Road and the upper slopes of 6 Highs Road.

129 Castle Hill Road is now occupied by orchards.

1947 When viewed with a stereoscope, a faint curved scarp can be observed to the south west of the dwelling at 111-113 Castle Hill Road, above Glenhope Road. The slope below this scarp is vegetated with mature trees. No hummocky ground is discernible. The scarp appears to be an old feature; no fresh scars can be seen.

A new track runs along the base of the Site between Highs Road and through Glenhope Road. This may follow a newly constructed transmission line or underground pipeline.

Terracing of 18A Carioca Way and 127 Castle Hill Road can be observed (this may have been present in 1943, but was not clearly defined).

The cluster of trees at the corner of Castle Hill and Highs Roads has been removed.

Two new buildings have been constructed at 139 and 141 Castle Hill Road.

1961 A fresh head scarp, and bulb of debris can be observed within No 18A to 18 Carioca Way.

A dam has been constructed within Darling Mills Creek at the base of 141 Castle Hill Road

New dwellings are present at 129, 139, 141, 143 and 145 Castle Hill Road.

The pasture land at 145 Castle Hill Road has been replaced by a dwelling and established trees.

The orchards at 125 and 127 Castle Hill Road and 5 Glenhope Road have been removed. A new dwelling with landscaped gardens has been built at 5 Glenhope Road, which appears to be the building currently occupying the Site).

The trees around the headwaters of Darling Mills Creek have matured.

Observations outside of the site area:

Hummocky ground is visible below the scarp to the west of Highs Road.

A large farm dam has been constructed south of 9 Glenhope Road. 15 to 19 Staley Court are occupied by pasture.

1975 The orchards along Glenhope Road have been removed, a dwelling has been constructed at 9 Glenhope Road (the main dwelling currently occupying the site).

The lake associated with 111-113 Castle Hill Road homestead is no longer visible.

Vegetation at 15 to 19 Staley Court has changed from pasture to shrubs and trees.

1986 A road runs south from Castle Hill Road, following the alignment of Willunga Place.

The dwellings at 137, 135 Castle Hill Road have been built (and are still present today)

Dwellings have been constructed at 133, 135 Castle Hill Road and 18A Carioca Way (the dwellings at these locations today have either been substantially extended or rebuilt).

The dam within 141 Castle Hill Road is no longer visible.

Terracing can still be observed on the upper slope at 6 Highs Road.

1994 The subdivision which includes Matthew Way has been developed and occupies the land immediately south of the Site. No houses have been constructed on the northern side of Matthew Way.

The roadway connection between Willunga Place and Castle Hill Road has been blocked.

The dwellings at 1 Matthew Way, 12 and 20 Carioca Way, 8 and 12 Glenhope Road, 1 Glenayr Grove and 109 Castle Hill Road have been built.

The childcare centre at 1 Glenhope Road has been built.

The dwelling at 135 Castle Hill Road has been extended, and now resembles the dwelling currently occupying the site.

2002 All of the buildings currently occupying the Site have been constructed, with the exception of the buildings along Staley Court, and 16, 18 and 18A Carioca Way.

9-11 Carioca Court has been planted with plantation trees.

2005 No obvious changes are visible from 2002, but photo resolution is low.

8.1 Aerial Photograph Interpretation Summary

A number of features relating to ground movement can be identified from the aerial photographs within the Site area and surrounding landscape. The majority of the scarps identified appear to be relict features, which have either not moved within the period of time covered by the photographs, or the movement is too small to observe within the photographs (slow creep movement).

Some features were first clearly observed in a specific year; these may have been present earlier, but due to the variable quality of the photographs and the presence of vegetation or residential development were not clearly defined in previous years.

9.0 Site Walkover

A site walkover was carried out by an engineering geologist on 20 November 2013 to identify possible features related to earlier instability and confirm the air photo interpretation. An additional site walkover of the properties at 15 to 19 Staley Court was undertaken on 9 May 2016. The landforms were observed to be highly modified on sites currently occupied by houses.

The properties at 123 and 125 Castle Hill Road, 15 to 19 Staley Court and at 1 and 2 Glenhope Road are situated on relatively flat ground on the Castle Hill Road Ridge. The remaining Lots on Castle Hill Road drop down steeply from the road. It was noted that the lower boundary of the Lots along Castle Hill Road (125, 129, 133, 135 and 18A Carioca Way) coincides with a step drop in elevation in the order of around 10 m. This elevation drop appears to coincide with the historical extent of head ward erosion by the watercourses draining to the south. This step change is likely to have been accentuated by cutting and filling to develop the lots.

The southern boundaries of 17 and 19 Staley Court extend part way down a steep escarpment, sloping in the order of 25 to 30 degrees; this curved escarpment is inferred to be the head scarp of a large scale historic landslide between Staley Court and Coonara Avenue. The slope is heavily vegetated with trees and shrubs. Of the clearly visible trees, the trunks appeared relatively straight. Tension cracking and slumping of soils was observed on the back slope of 17 Staley Court, extending up to 2m behind the crest. See **Figure 12** below. Temporary retention structures comprising steel fencing posts and black, woven plastic fabric, have been installed at several levels down the slope. These are leaning outward suggesting further movement since these have been installed. Hessian has been placed on the ground surface in places at the crest of the slope, possibly to reduce surface water flows entering the soil. It is possible that this movement is occurring within fill placed at the back of the property at an over-steep angle although deeper seated movement cannot be discounted. The lawn and house appeared to be in good condition with no obvious signs of movement further back from the slope.

Figure 12 Tension cracking crest of slope 17 Staley Court

Slight undulations were evident in the back lawn at 19 Staley Court. This is inferred to be due to settlement of fill. Tension cracks were not observed in the back slope below 19 Staley Court. Exposed soil comprised angular gravelly clay. Apparent settlement or removal of soil was observed around the south eastern corner of the swimming pool foundations. Refer to **Figure 13**. The fencing, stairs and bench behind the pool do not exhibit obvious signs of ground movement.

Figure 13 Loss of soil at base of pool foundation 19 Staley Court

109 Castle Hill Road is situated on the edge of a spur. The terrain drops steeply to the west towards the back of the lots at 6, 8, 10 and 12 Glenhope Road. See **Figure 14** below. Number 4 Glenhope Road is backed by a similar steep slope. Based on the aerial photograph interpretation this has been interpreted as a potential head scarp of a relict landslide.

Figure 14 Panoramic view at 109 Castle Hill Road, looking west

Weathered shale rock was exposed within a cutting at the rear of 4 Glenhope Rd. The rock was thinly bedded at a dip of around 2º to the south west. Sub-vertical fractures were observed at around 0.5 m spacing. The surface was oxidised, and a small amount of debris at the base of the slope indicates that fretting has occurred over time. A recent shallow failure had occurred, likely to have been triggered by the heavy rainfall which occurred days before the site visit. See **Figure 15** below.

Figure 15 Cutting at 4 Glenhope Road

Within the currently vacant Lots the landform and vegetation were observed for any surface indication of slope movement.

The landform at 9-11 Carioca Court is undulating, with a higher flatter area at the rear of the Lot, steeper slopes in the mid-section, and shallower slopes at the base of the Lot at the Carioca Court cul-de sac. A drainage channel runs east to west through this Lot and a large area is currently tree covered. The tree trunks were observed to be generally straight. See **Figure 16** below.

Figure 16 Panorama view of 9-11 Carioca Court, looking east

The landform at 6-8 Highs Road and 141-143 Castle Hill Road was observed from the end of Matthew Way. The slopes are undulating and rounded. The properties are vegetated with mown grass and with widely spaced, mainly eucalypt trees. The tree trunks are generally straight, but there is slight curvature of some trunks close to the base of the gully in 6-8 Highs Road.

The watercourse was flowing with around 30 cm depth of water at Matthew Way during the walkover. Above the end of Matthew Way, the watercourse appears to have been filled and culverted from Castle Hill Road. The western branch has been filled on the lower reaches of 143 Castle Hill Road. Patches of greener grass were observed on the slopes of 6-8 Highs Road and 141-143 Castle Hill Road suggesting potential seepage in these areas, but no water seepage was observed.

Figure 17 Panorama view of 6-8 Highs Road and 141-143 Castle Hill Road

The visit was carried out within days of a period of rainy weather. The ground was generally moist, and water was flowing in the stormwater pipes and streams in the area, but no active seepage were observed. Thick green grass was observed within the drainage gully at 9-11 Carioca Court, and the low lying area was slightly boggy, indicating that this area is still acting as a drainage path.

No signs of active land movement such as tension cracks, notably curved tree trunks, ground seepage, or hummocky ground were observed over most of the site during the site walkover. Potential seepage and slight curvature of trunks was observed at 6-8 Highs Road and 141-143 Castle Hill Road.

The large scale scarps and hummocky landforms which can be observed to the east and west of the Site were not observed in the project area, suggesting that any creep movement in the project area would be of a smaller lateral scale. The depth of colluvium encountered in investigations by others, and previous AECOM investigations appears to confirm this.

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10.0 Geotechnical Ground Investigations

10.1 Investigation Objectives

The geotechnical investigations focused on areas of risk and uncertainty developed in the conceptual ground model for the Site from the desktop based assessment, and aimed at establishing:

- The broader geological and engineering character of the ground;
- The presence of colluvial material in areas suspected of being subject to previous ground movement;
- The depth to competent rock,
- The rock mass properties at potential basement depth;
- Groundwater characteristics.

10.2 Scope of Works

The drilling investigations were undertaken in three phases as the Site area expanded. In total investigations comprised sixteen geotechnical boreholes drilled to depths of between 8.2 m and 15.8 m by Terratest Pty Ltd, as subcontractor to AECOM, between 2 December 2013 and 16 February 2016.

- The boreholes were drilled using 110 mm diameter solid augers in soil and HQ3 (wireline) 96 mm / 63.5 mm diameter coring in extremely weathered to competent rock.
- Borehole locations were decided based on information gathered during the desk-top based assessment.
- Boreholes targeted a minimum depth of 4 m into slightly weathered to fresh, competent rock, with the exception of BH009 which was terminated after 1 m in slightly weathered rock due to time constraints.
- Standard Penetration Tests (SPT's) were typically completed at 1.5 m depth intervals until refusal of the SPT, or a reading of 50 or more blows per 300 mm was recorded.
- A long chain polymer viscosifier was added to the flushing medium used in some of the boreholes to improve core recovery.
- All boreholes were drilled vertically from the surface.
- Vibrating wire piezometers were installed in three of the boreholes to measure groundwater pressures at the base of weathered material.
- A standpipe piezometer was installed in one of the boreholes to measure groundwater levels and allow future installation of a vibrating wire or other datalogging instrument if required.
- The borehole locations were derived using a hand held GPS unit, (expected horizontal accuracy +/- 3.0 m) and the borehole elevations were derived using project ground model data (vertical accuracy +/- 1.0 m).

AECOM technical staff, comprising an Engineering Geologist or a Geotechnical Engineer, were in full time attendance during the drilling operations and were responsible for logging the core and specifying and recording the in-situ testing. Following the core drilling, four of the boreholes were flushed out for well installation. The well design was carried out by the field staff for AECOM, based on the preliminary geological logs.

The locations of the completed boreholes are shown on **Figure C1** in **Appendix C**. The borehole and corehole logs and core photographs are provided in **Appendix D**.

10.3 Monitoring Well Installation and Groundwater Monitoring

Vibrating wire piezometers were installed in BH002, BH007 and BH011 to monitor groundwater. The piezometer sensors were inserted into a sand filled sleeve and saturated in water overnight. The sensors were then lowered to depth within the open borehole and secured to allow backfill of the borehole with a bentonite-cement grout.

A standpipe piezometer was installed in BH009. Installation and construction details are provided on the piezometer installation summary sheets which are presented with the borehole logs in **Appendix D**.

Transmitter units are connected to the vibrating wire piezometers to allow remote collection of water pressure data. The readings are recorded on an hourly basis and can be monitored from the website http://www.itm-soil.com.au. Results of the transmitter readings from 2014, and from May to June 2016 are provided in **Appendix A**.

11.0 Geological Model

A geological model of the Site has been developed based on information gathered in the desktop study, borehole information, site mapping and site walkovers.

Several cross sections through the Site were developed to conceptualise the geological model during this assessment. One representative cross section is included as **Figure C3** in **Appendix C** which illustrates the interrelationships between the topography and the geology at the Site. The Section location is shown on **Figure C1**. Information provided on the cross section includes geological units and weathering profile, as interpreted from borehole information. The terrain model for the ground surface was obtained from Land and Property Information.

11.1 Geomorphology

The major geomorphological features identified in this study are shown on **Figure C1** in **Appendix C**. Major landforms outside the boundaries of the Site have been included. The features include scarps and breaks in terrain associated with previous land instability and erosion by drainage, hummocky ground associated with creep movement, and the location of the main watercourses. The locations of geotechnical investigation boreholes drilled in December 2013, May 2014 and February 2016 are also shown on **Figure C1**.

As described in previous sections, the Site occupies southward facing slopes on the edge of an elevated escarpment. Much of the Site has been modified by residential development, including roads, building platforms and terraced gardens which have largely masked the smaller original geomorphological features. The larger scale features are described below.

The topography is undulating with drainage gullies and channels associated with tributaries of the Darling Mills Creek extending into the Site from the south separated by spurs or lobes of shale bedrock. The deepest gully extends through 6-8 Highs Road and 143-145 Castle Hill Road. The slopes leading into this gully are undulating, inclined at around 15° and appear to be largely undeveloped, although the upper reaches of the watercourse through 143 and 145 Castle Hill Road appear to have been filled and culverted.

The slope gradient varies between around 5º and 20º across the Site. Two distinct breaks in slope have been identified, one at the edge of the Castle Hill Road/ Highs Road Ridge and one lower down the slope which appears to correspond with the extent of head-ward erosion of the drainage gullies, as supported by the presence of colluvium observed in BH001 at the head of a drainage gully. Between 109 Castle Hill Road and Glenhope Road the edge of the plateau is marked by a steepened and arcuate shaped slope, which has the appearance of a historic landslide scarp.

The southern extents of the properties at 15 to 19 Staley Court drop steeply to the south-east in the order of 30 degrees. This landform feature is the head scarp of a large scale historical landslide feature between Staley Court and Coonara Avenue. Although this landslide scarp is referred to in previous reports (NWRL, Coffey-AECOM, 2012), as being a relatively stable relict feature it is noted that development will change the geometry and loads on this scarp. Additional load has been applied to the crest of the scarp with fill during the development of the existing houses, which has led to superficial movement. Consideration will need to be given to potential for instability along this scarp during design of the proposed development.

11.2 Site Lithology

Based on the geological information described above, it is anticipated that the site will be underlain by the four members of the Ashfield Shale, with the stratigraphy dipping generally at around 2º to 5º to the south.

The most recent Ashfield Shale unit, Mulgoa Laminite may be encountered at the Castle Hill Ridge. This unit has been identified within the NWRL boreholes and in BH004, BH006, BH015 and BH016 as the material which forms the Castle Hill Road ridgeline, and steeper upper slope immediately below Castle Hill Road.

The Regentville Siltstone may comprise the top layer of rock across much of the Site. The Regentville may be eroded down to the Kellyville Laminite on the lower slopes. The Kellyville Laminite is underlain by the Rouse Hill Siltstone and then the Mittagong Formation which was encountered between approximately RL137m (AHD) toward the eastern end of the Site, and up to RL145 m at Highs Road.

The Mittagong Formation is likely to underlie the lower extents of the Site with little cover of Ashfield Shale, The Mittagong Formation was identified in BH007 and BH011 to BH013.

In the slope to the west of Glenhope Road, colluvium was encountered in BH001 to a depth of around 5 m. The material encountered within BH002 appears to be in-situ, with an undisturbed weathering profile, but a zone identified at 5.3 m to 5.7 m depth includes disturbed bedding and clay layers which may be indicative of historical movement that allowed the upper units to remain intact, i.e. potentially a raft type of movement. A steeply dipping fractured zone was identified in BH008 which was drilled on the slope between BH001 and BH002. The orientation of this facture zone is not known, but it may represent movement linked to the shear zone within BH002. As such the presence of past movement in the vicinity of 5-7 Glenhope Road and the northern extent of 9-11 Carioca Court cannot be discounted.

At the western end of the Site, surficial colluvial deposits were encountered in the upper and lower reaches of the south facing slope in BH010 and BH012 to between 1.4 m and 2.3 m depth respectively. A deeper colluvial deposit was encountered mid-slope within BH011 to a depth of around 6 m. The base of the slide appears to be within moderately weathered interbedded sandstone and siltstone of the Mittagong Formation.

Where landslide debris is not present, the weathered Shale profile is likely to be between around 2 m to 10 m thick. Around 0.5 m of residual soils were encountered on the ridges along Castle Hill Road and adjacent to Staley Court during the last phase of site investigations. Residual soils on the slopes unaffected by ground movement were observed to be around 1.3 m to 4 m thick. The depth to slightly weathered rock within the boreholes varied between around 3.7 m to 11 m. The depth of rock weathering was greatest in the holes on the ridgelines.

The Hawkesbury Sandstone is likely to be encountered at approximately RL130 m to RL 139 m based on outcrops observed outside of the site area and depths encountered in boreholes.

Localised areas of fill will be encountered throughout the Site. The largest source of fill will be from the development of housing platforms and landscaped gardens over some Lots. Away from the developed residential sites, an area of fill was identified in previous investigations north of the drainage line in Lot 2 Carioca Court; the fill was encountered in BH007 to 3.1m depth.

Gullies run through the Site at Highs Rd, Castle Hill Road, Matthew Way and Carioca Way draining to the Darling Mills Creek. Alluvial sediments may be present within the base of the gullies, and localised colluvial deposits may be encountered around the steeper sided gullies (as observed in BH001, BH010, BH011 and BH012).

11.3 Faulting

Faulting has been inferred in the area from investigations carried out for the NWRL based on offset of the lithological boundaries of around 5 m between Glenhope Road and Highs Road. The exact location, orientation or direction of movement of these faults is unknown. Shear zones and fracture zones were identified in some of the NWRL boreholes, and within BH002, BH009, BH011 and BH016 in the site specific investigations. These may be associated with fault zones, or with movements along joint or bedding planes.

11.4 Igneous Intrusions

An igneous dyke was intercepted within BH011 at 143 Castle Hill Road. The dyke appears to be dipping at an angle of 50° to 70° and is at least 1 m thick. The orientation of the dyke is not known, and there are no clear surface indications of the presence of this feature. If this feature is dipping in the NNE trend common to dykes within the Sydney Basin, then it is likely that has been encountered during the drilling of the NWRL tunnel. A speculative trend for the Dyke has been sketched on **Figure C1** in **Appendix C**. The rock encountered, at 14.5m depth, was of medium strength.

12.0 Landslide Risk Assessment

Considering the foregoing information, the development of the conceptual ground model and the results of the investigations, an assessment of landslide risk has been undertaken through a hazard and qualitative risk assessment for the Site.

The risk assessment was carried out in accordance with the guidelines provided by the Australian Geomechanics Society (AGS 2007).The assessment is based on qualitative judgements of the likelihood of a landslide in conjunction with judgements of the consequences to property should movement occur. The resulting value provides an indication of the level of risk to property at the Site and on adjacent properties. Tables outlining these values are provided in **Appendix F**.

Based on the landslide assessment it has been interpreted that large areas of the Site are at very low risk of land instability, which is broadly consistent with the designation by the Soil Conservation Service. These areas include the ridges along Castle Hill Road, Highs Road and Staley Court, the spurs extending southward from Castle Hill Road and some of the slopes associated with these spurs.

Evidence of historical instability was detected in the following broad areas:

- the vicinity of drainage channels below Highs Road (geotechnical assessment by others),
- below Castle Hill Road between 143 and 145 Castle Hill Road (borehole investigations),
- between Glenhope Road and Carioca Court (borehole investigations),
- above Matthew Way and above Glenhope Road (historical photographs, geotechnical assessment by others)
- to the south and east of Staley Court (geotechnical assessment by others).

The extent of areas of instability is not clearly defined due to modifications to the landforms which have been made since the area has been developed for residential housing, but the general areas of elevated risk have been mapped in **Figure C2**. The current landslide risk in the zones marked on **Figure C2** is categorised as Moderate in areas that have not previously been developed, and generally Low where the landscape has been modified for residential housing.

12.1 Inferred Landslides

12.1.1 Smaller Scale Slides

A suspected rotational slide occurred at 18 and 18A Mathew Way prior to 1961. The trigger for this slide is unknown; the land was in pasture at the time. There is evidence that similar slides have occurred along the slope further to the west towards Highs Road, probably prior to the 1930's. These slides appear to be associated with head-ward erosion of drainage channels. Failure is likely to have occurred within the surficial soils during a period when the slopes were grassed or sparsely vegetated. Each slide may have occupied an area in the order of 2,500 m^2. Our assessment is that the rate of movement was likely to have been moderate and possibly directly linked to rainfall events.

No fresh slides of this nature were observed in the aerial photographs at the Site for the last 50 years. As the landforms across the majority of the Site have been heavily modified, the likelihood of occurrence of a landslide of this type on the Site is considered to be **Possible** in undeveloped areas and **Unlikely** (in the order of 10,000 year return interval) in areas that have been modified for residential housing. A slide of this nature is unlikely to lead to loss of life, but could potentially cause moderate damage to property, and the consequence to property is interpreted to be **Medium** in accordance with AGS guidelines.

The current risk posed by slides of this nature is categorised as **Moderate** in areas that have not previously been developed, or where uncontrolled fill has been placed, and **Low** where the landscape has been modified for residential housing. The risk can be reduced to **Very Low** by application of construction mitigation measures referred to in **Section 14.0** below. These may include careful management of surface and subsurface water, construction of deep foundations keyed into rock, or removal of weathered materials during development.

12.1.2 Larger Scale Slides

Large scale relic landslide scarps have been observed at the eastern edge (between Staley Court and Coonara Ave) and to the west (Doris Hurst Place) of the Site. These scarps are over 300 m long. Information available from these slides has been used to understand the potential risks of similar slides within the Site. There is no evidence of ground movements of the size observed immediately to the east and west of the Site having occurred within the Site. The steep scarp behind Glenhope Road may be indicative of a landslide of similar type, but of a smaller scale.

Formation of these slides is likely to have occurred in pre-historic times, potentially under differing hydrological and geomorphological conditions to those present today. The slides are probably controlled by bedding surface shears formed by stress relief or local folding (Fell, 2005). The likelihood of further deep seated instability at the crest of the scarp is considered to be **Very Rare** (in the order of >100,000 years return interval). Surficial instability along the scape, such as that observed at the southern boundary of 17 Staley Court, is likely seated within the added fill, and is assessed to be of similar risk to the smaller scale slides noted above.

The landslide debris below the scarp is however subject to ongoing movement in some areas. Studies of the neighbouring slides indicate that movement is very slow and sporadic, generally only occurring in periods of wet weather when ground pore-water pressures are elevated. The likelihood of occurrence of creep type movement is interpreted as **Possible** (in the order of 1,000 years return interval) within the landslide debris.

The low rate of movement realistically has an extremely low likelihood of any result in risk to life, but may result in little damage to structures after each triggered event or potentially limited damage over extended periods of time if the movement is left unchecked. The consequence to property is therefore considered to be **Insignificant** to **Minor** in areas where the slide debris exists below shallow foundations.

The current landslide risk at15-19 Staley Court, 4 Glenhope Road and 109 Castle Hill Road is interpreted as **Low** to **Moderate**. The risk posed by these slides can be reduced to **Very Low** by application of construction mitigation measures referred to in **Section 14.0** below. These may include careful surface and subsurface drainage, construction of deep foundations keyed into rock, or removal of potentially unstable materials during development

13.0 Other Geological Constraints

As described in **Section 12.0** above, parts of the Site may be subject to risk from potential land instability. Further geotechnical constraints for the Site are set out below. All constraints identified have established engineering solutions commonly adopted for civil infrastructure and include mitigation strategies agreed for mitigation of this risk on other neighbouring sites. These are discussed in **Section 14.0** below. It is considered that the Site is suitable for development of the type proposed provided that such engineering solutions are implemented.

13.1 Groundwater

Based on the groundwater measurements taken from boreholes in the vicinity, a series of cascading groundwater bodies may be encountered at the Site. Perched groundwater may be encountered at shallow depths and within the basement excavations. The groundwater may occur as a perched water body in the colluvial materials or residual soils and may also enter the excavations through more permeable zones in the rock, mainly around joints, bedding or other structures. Shear zones and dykes which may cross the area may affect the local hydrogeology and introduce more groundwater into the proposed excavations.

Monitoring of groundwater in vibrating wire piezometers or standpipes installed in the geotechnical investigation boreholes required for design, may be appropriate. Such information would be required for design of dewatering systems and would be required by the NSW Office of Water. If dewatering is required, a detailed programme of pump tests and other aspects may be necessary with significant potential cost implications.

13.2 Existing Fill

Areas of existing fill will require targeted investigations to determine the likely range in geotechnical properties in order to carry out design for civil works.

13.3 Reactive Soils

Near-surface cohesive soils derived from Ashfield Shale may be reactive, subject to shrinking and swelling in response to seasonal variations in their moisture content. This behaviour can cause differential movements that adversely affect near-surface foundations, subsurface drains and pavements, in particular where soil moisture changes are irregular across an area. This can occur around the edges of shallow foundations and near trees (locally reducing soil moisture). Pile foundations are typically not significantly influenced by such movements, though differential movements can occur between pile supported structures and adjacent shallow founded structures.

The depth of influence of reactive soils is typically limited to the top two metres where seasonal moisture content variations are most significant. Soil moisture changes at greater depth can be caused by the roots of vegetation, particularly trees. The movements are more substantial in clayey soils.

The effects of reactive soils are typically managed through a combination of avoidance of susceptible materials for settlement sensitive infrastructure, adopting management measures to reduce seasonal moisture content variability and design and construction to accommodate seasonal movements. Soil testing and regional guidance for seasonal moisture changes can be used to assess the movements as part of engineering design.

13.4 Soft or Compressible Soils

Volcanic dykes may be weathered to a high plasticity clay to several metres depth. Localised soft clays may be encountered where the dyke approaches the ground surface. This material may be significantly softer than surrounding materials. Additional treatment options may be required where this material is exposed in cut, or as a subgrade.

13.5 Aggressive Soils and Groundwater

Soils and groundwater may be aggressive to steel and concrete depending on the chemical composition and pH. The presence of Potential Acid Sulphate Soils, contaminants and saline groundwater increase the likelihood of aggressive ground.

13.5.1 Soil Salinity

A high accumulation of soluble salts in soils or groundwater can cause degradation of concrete, steel or brickwork. Salinity in Western Sydney is generally associated with the Wianamatta Group Shales, and generally occurs in areas of surface and groundwater sinks. The NSW Department of Planning and Infrastructure has developed a map of the salinity potential in Western Sydney. The map depicts the distribution and potential severity of salinity based on a practical understanding of the factors that cause salinity.

The salinity map for Western Sydney indicates that there is moderate salinity potential at the Site. This classification means that in general the salinity levels of the soils are within acceptable bounds, but that scattered saline areas may occur which have not been identified.

Salinity testing carried out by Martens on 9-11 Carioca Court indicated that the soils and the Site are non-saline, but that the groundwater is moderately corrosive due to pH levels. Testing undertaken during the latest phase of investigations recorded similar pH levels (refer to Laboratory Testing Results in **Appendix E**. These results are likely to be reasonably representative of the Site as a whole, but further testing would be required during design development to determine the durability requirements of the underground structures in the development.

13.5.2 Acid Sulfate Soils

Acid Sulfate Soils are naturally occurring sediments which contain iron sulphides and their oxidation products. Iron sulphide minerals accumulate in the sediment as a result of chemical and biological reactions involving brackish or saline water, organic matter, bacteria, sulfate and iron. These soils are usually associated with estuarine environments, salt marshes and coastal rivers and creeks. They remain chemically stable under anaerobic conditions (i.e. no oxygen) but when exposed to air, oxidation of the iron Sulfide minerals produces sulphuric acid. The released acid has potential to acidify groundwater and to corrode concrete and steel structures.

The Australian Soil Resource Information System (ASRIS) National Acid Sulfate Soil dataset provides information on the potential occurrence of acid sulfate soils throughout Australia. The dataset describes the potential for occurrence of Acid Sulfate Soils within the Site as Low Probability of Occurrence (Class B – six per cent to seventy per cent of mapping unit) inferred from wider information sources and with no on-ground verification within the study area.

Site observations and the geological desktop review were consistent with the ASRIS assumptions, indicating that the inferred risk of Acid Sulfate Soils is reasonable and that the likelihood of occurrence of Acid Sulfate Soils at this location is low.

Typically, soil chemical testing is carried as part of engineering design to assess the potential for soils and groundwater to corrode steel and concrete (eg soil acidity, sulfates and chlorides). Such testing would provide a further check of whether acid sulfate soils are present.

14.0 Geotechnical Considerations for Development

Preliminary recommendations for geotechnical aspects of the proposed development at this Site are provided in the following sections. These recommendations are predominantly high level and based on a desktop analysis, high level site walkover and limited geotechnical ground investigations only. All recommendations will require review and confirmation during subsequent design stages, including additional site specific geotechnical investigations.

It is considered that the Site is suitable for development of the type proposed provided that suitable engineering design and construction mitigation measures are implemented and that a low to very low risk of land instability is acceptable to the Hills Shire Council. We understand that neighbouring sites with a higher potential risk of instability have obtained development approvals from Council when the development has incorporated similar mitigation measures.

14.1 Design Considerations and Recommendations

14.1.1 Strategy for Mitigation of Land Instability

Measures are proposed below to mitigate potential land instability, a combination of several of these measures together with localised treatment may be necessary.

14.1.1.1 Removal of Slide Debris and Replacement with Engineered Fill, or with Deep Basements

This measure would involve excavation to the level of slightly weathered shale or sandstone to remove all overlying soils and weathered rock. The excavated materials could be replaced onto a drainage layer and compacted to a high standard, or the building basement could be constructed on the suitably prepared shale subgrade.

Should conditions allow, this measure would provide the highest level of confidence in reduction of the risk of instability.

14.1.1.2 Partial Removal of Slide Debris, with Basement Structures Socketed into Rock

Due to the sloping nature of the site, the currently proposed development will include large cuts on the upslope side of buildings and shallower cuts on the downslope. This will result in substantial removal of soils and weathered rock on one side of the excavation, but may result in limited soil removal on the downslope. In this instance the permanent retaining structures around the excavations and the building foundations can be extended through any potentially unstable material and socketed within competent shale rock. This would have the effect of restraining remaining soil material.

14.1.1.3 Control of Subsurface and Surface Drainage

The following drainage measures are recommended:

- Dish drains and catch drains with an impermeable lining above temporary and permanent slopes. These should be checked and maintained regularly to keep clear of debris and blockages.
- Surface protection of temporary and permanent batter slopes to prevent penetration of water, in the form of geofabric covers, shotcrete or vegetating slopes.
- Subsoil drainage behind retaining structures and beneath engineered fill.
- Trench or counterfort drains in areas where potentially unstable material has not been removed.
- All surface and subsurface drains need to be connected to suitable storage and disposal systems.

14.1.1.4 Temporary stabilisation During Construction

During excavation of potentially unstable material temporary measures should be put in place to limit the risk of ground movement. These would include:

- Limiting the lateral extent and depth of excavation steps
- Limiting the slope angle of temporary batters
- Providing weather protection and diversion of surface water flows away from batter slopes
- Carrying out excavation during dry periods only
- Providing temporary support such as props or anchors to batter slopes
- Avoiding additional loads above batter slopes

14.1.1.5 Monitoring

Where the property boundary crosses a potentially unstable area, a specific ground movement monitoring regime is recommended to assess ground movements in adjacent properties during construction. It is anticipated that RMS are likely to require ground movement monitoring to be undertaken for any excavations with potential to impact upon existing roads, ie Castle Hill Road.

The monitoring regime should include details of movement monitoring methods and locations, frequency of monitoring, suitable alert and alarm levels of movement, and details of actions should either of these levels be reached. In order to develop suitable alert and alarm levels a baseline of existing ground movements will need to be developed prior to the onset of construction.

Groundwater monitoring should also be undertaken over an extended period using the installations constructed during the present investigations and preferably including information from other installations in the area which are known to have been constructed, notably for the NWRL project and the neighbouring property to the east which was subject to previous development proposals. An assessment should be made of the groundwater monitoring and this should be considered in parallel with the ground movement monitoring.

14.1.2 Permanent Earth Retaining Structures

The basement excavations for the proposed buildings could be supported using bored pile concrete retaining walls. Support of the cut face between piles can be provided with application of reinforced shotcrete. The piles will need to be founded within shale or sandstone rock, as described in **Section 14.1.3** below. This system will not be watertight and groundwater inflows will have to be managed through installation of sub-surface drainage and collection systems.

A decision will need to be taken in the design of the basements being either drained or tanked given the presence of groundwater. Basements designed as drained structures will result in permanent drawdown of any affected groundwater profiles. Lowering of the groundwater profile may lead to settlement of surrounding ground due to an increase in the effective stresses in the soils. This can consequently lead to settlement of adjacent buildings, underground utilities or roads. The extent of settlement effects will need to be assessed as part of the design development and construction approach selected.

14.1.3 Foundations

The loads from the proposed structures are not currently known, but expected loads from the multi-story structures in combination with the potential for unstable soils to be encountered on the Site will likely require that the structures are founded within the shale rock. Due to the steep sloping site, a combination of shallow pad foundations and piled foundations will likely be required.

14.1.3.1 Piled Foundations

Piled retaining walls around the basement excavations will need to be socketed into shale or sandstone. In areas where the base of the bulk excavation does not reach competent rock, the foundations for the building structures will require piles extending through the soils and socketed into rock.

The capacity of the rock to support a given structural load may be related to the rock class for preliminary design. Published indicative values of end bearing and shaft resistance have been previously proposed for Shale and Sandstone (Pells et al, 1998) and have been considered in the development of the masterplan and approach to

the rezoning. It is assumed that during design the foundation arrangements would be optimised based on actual ground conditions anticipated from the investigations.

All pile holes should be inspected by an experienced geotechnical engineer to confirm the suitability of the founding materials, the depth of socket, socket roughness and cleanliness of the base.

14.1.3.2 Shallow Foundations on Rock

Where the base of the excavation encounters competent shale or sandstone bedrock it is expected that pad or strip footings could be adopted for the basement floor slabs. Published indicative values of bearing capacity have been previously proposed for Shale and Sandstone (Pells et al, 1998) and have been considered in the development of the masterplan and approach to the rezoning. It is assumed that during design the foundation arrangements would be optimised based on actual ground conditions anticipated from the investigations.

14.1.3.3 Shallow Foundations on Soils

Light structures which are not sensitive to differential settlements may be constructed on shallow foundations within the residual soils. Any potentially unstable soils must be removed and replaced by engineered fill. Where shallow foundations are adopted the bearing capacity of the proposed foundations will be controlled by allowable settlement of the foundation and the strength of the natural materials.

The depth of clay soils at the Site ranges from around 0.5m to over 4.0m. In accordance with AS 2870-2011 (Residential Slabs and Footings), and using Table D2 in Appendix D of AS 2870-2011, a preliminary Site Reactivity Classification of M to H is recommended for shallow footings of lightweight structures.

All footings should be inspected by an experienced geotechnical engineer to confirm the suitability of the founding materials. Level 1 Inspection & Testing should be carried out during construction in accordance with AS3798 - 2007. The exposed subgrade should be clean, dry and compacted to the specification requirements.

14.1.4 Pavement Subgrades

Variable subgrade strength may be encountered within the study area, including low strength subgrade in areas of fill and colluvial soils. These materials may also be subject to seasonal shrink-swell type movements, as discussed in **Section 13.0**. The materials observed are commonly used as pavement subgrades utilising well established pavement design practices.

14.1.5 Seismic Loading

In accordance with AS1170-2007 “Structural Design Actions, Part 4: Earthquake Actions in Australia” a hazard factor (Z) of 0.08 would be appropriate for the Site. The site sub-soil class would be Class C_e based on the boreholes drilled to date on the Site.

14.1.6 Design Considerations at Dyke Zone

Further investigations will be required to characterise the dyke zone, including its geometry and strength characteristics. Investigations to date indicate that the dyke materials may be weaker than the surrounding country rock this may have the following implications for development:

- Bored pile retaining walls: localised closer pile spacing may be required, alternatively temporary or permanent anchors could be considered in this area.
- Piled foundations: piles may need to be offset from the dyke which may lead to the need for some additional piles locally and possibly transfer structures. Alternatively, locally deeper piles may need to be considered
- Additional embedment depth, enlarged footings or piled footings may be required where the foundations straddle the dyke zone.
- Higher groundwater inflows into excavations could be expected and will need to be taken into account for both design and construction.

14.2 Construction Considerations and Recommendations

14.2.1 Excavation and Earthworks

It is understood that the development will be constructed over a number of descending terraces down the slope from Castle Hill Road. Major cuts and, to a lesser extent, fills will be required to construct the terraced development.

The multi-storey residential buildings are likely to be constructed with at least one basement level. Preliminary designs propose a maximum depth of excavation in excess of 15 m on the upslope basement walls in some locations, with the downslope walls excavated to around 1 m to 10 m.

Based on the regional geological information and ground conditions encountered in boreholes drilled on the Site, the excavation is expected to encounter fill and residual soils, colluvium and a weathered shale profile. Excavations at the southern extent of the Site may penetrate into Mittagong Formation or Hawkesbury Sandstone rock.

The following sections provide comment on potential excavation conditions and suggested temporary support structures.

14.2.1.1 Excavatability

Excavation of the soils and weathered shale is expected to be readily achievable using conventional earthworks equipment such as hydraulic excavators with bucket attachments.

Excavation within the shale rock is likely to require use of larger plant and possibly heavy ripping equipment, rock hammers or rock saws. The size of equipment required will depend on the strength of rock on the Site.

Use of heavy excavation equipment in hard rock will produce vibrations which can potentially damage nearby structures. Management plans will need to be developed to deal with the effects of vibrations. These should include developing maximum allowable vibrations limits, monitoring methodology targeting appropriate locations and dilapidation surveys of adjacent structures and infrastructure.

14.2.1.2 Temporary Batter Slopes

Where space permits, temporary batter slopes within the fill and residual soils of 2 Vertical to 1 Horizontal are recommended in the short term, provided that no surcharge loads are placed at the top of the batters. Such slopes may not be possible below the water table depending on the nature of the soils encountered.

14.2.1.3 Temporary Excavation Support

Since excavation to a depth in excess of 15m may be required for the construction of the basements, the retained earth would require temporary support to maintain stability. Temporary support may comprise excavation support using an anchored retention system such as diaphragm walls or embedded piles, or internal struts or inclined props, followed by bottom up construction of the basement walls and floor slabs.

For the bottom up construction, temporary anchors will likely have to extend outside the property boundary and may not be allowed by adjacent owners. Alternative support systems such as internal struts, inclined props or top-down construction methodology may be adopted in this instance.

The effect of ground movements from the excavation on adjacent structures and underground utilities will need to be considered. The influence zone around the excavation should be taken as a horizontal distance at least twice the depth of the excavation behind the walls.

14.2.2 Materials Management

All materials removed from the Site will need to be classified in accordance with the Waste Classification Guidelines (Department of Environment, Climate Change and Water NSW, 2009). Chemical testing will need to be carried out to classify spoil; however the materials encountered to date appear to be inert.

Colluvium or non-engineered fill encountered on Site are likely to require treatment in order to be suitable for re-use.

14.2.3 Site Attendance and Inspection

It is recommended that a Geotechnical Specialist be on site during site works to assess geotechnical aspects of the construction.

Level 1 Inspection & Testing should be carried out during excavation and earthworks in accordance with AS3798 - 2007. The exposed subgrade should be clean, dry and compacted to the specification requirements.

14.2.4 Monitoring

Where deep excavations are to be constructed ground movement monitoring of the adjacent areas will be required to keep ground movements within acceptable levels during construction. Groundwater monitoring should also be undertaken at this time and assessed in conjunction with the ground movement monitoring results. We note that RMS is likely to require ground movement monitoring for any excavations in proximity to their infrastructure, ie Castle Hill Road.

The monitoring regime should include details of movement monitoring methods and locations, frequency of monitoring, suitable alert and alarm levels of movement, and details of actions should either of these levels be reached. In order to develop suitable alert and alarm levels a baseline of existing ground movements will need to be developed prior to the onset of construction.

15.0 Limitations

This report has been prepared for Grimshaw Architects Pty Ltd. This report has not been prepared for use by parties other than the Client, and the Client's respective consulting advisers and construction contractors.

We note that at the time of the preparation of this report, the design was at the option layout stage and the layout had yet to be finalised. If significant changes occur between the investigated areas and the final layouts, then advice should be sought from an AECOM geotechnical engineer to confirm that the existing geotechnical information is appropriate and that no further investigation is required.

As subsurface conditions may vary, the borehole, test pit and hand auger logs represent subsurface conditions at the specific test locations only. Should conditions exposed at the Site during excavation vary significantly from those logs provided in this report, we request that AECOM be informed and have the opportunity to review any of the findings of this report.

This report has been not been written to provide information for design and construction purposes. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided, and perform any additional tests as necessary for their own purposes, and determine the appropriate / most suitable techniques and equipment for the conditions.

There are always some variations in subsurface conditions across a site that cannot be defined even by exhaustive investigation. Hence it is unlikely that the measurements and values obtained from sampling and testing during the investigation will represent the extremes of conditions which exist within the Site.

Furthermore, subsurface conditions, including groundwater levels can change over time. This should be borne in mind, particularly if the report is used after a protracted delay.

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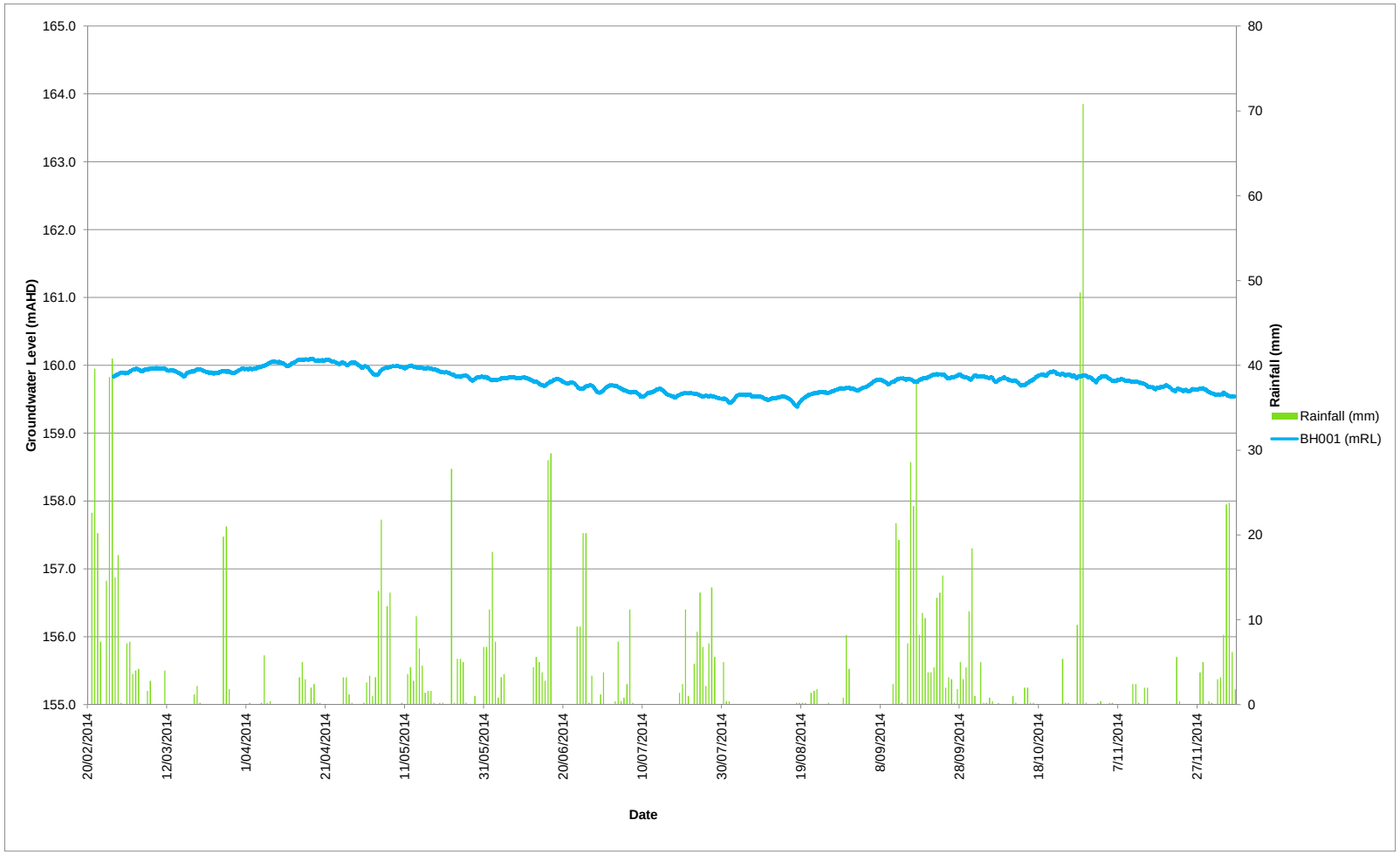
Appendix A

Hydrographs



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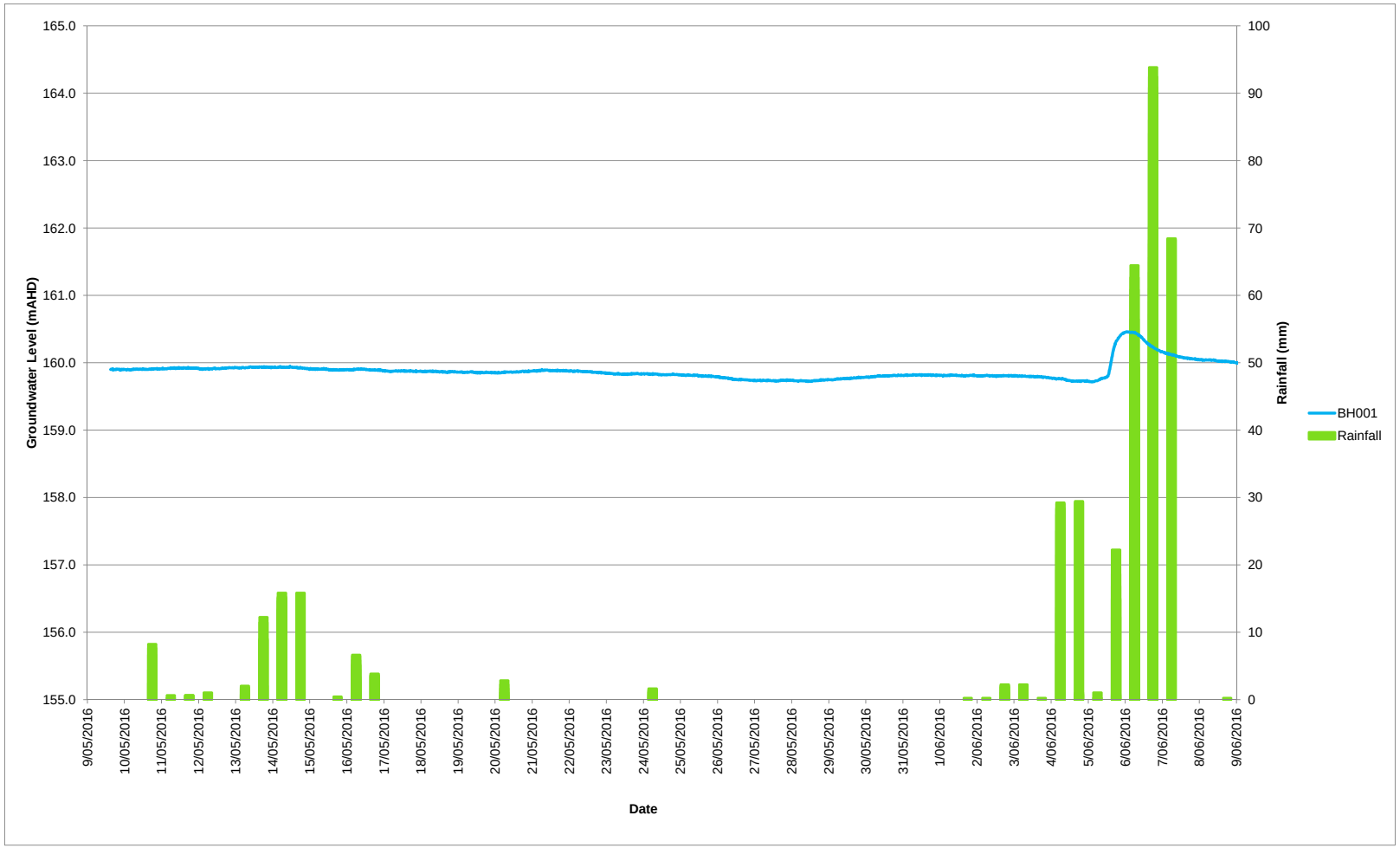
	Project:	Cherrybrook Rezoning Application	Lithology Screened:	Ashfield Shale	Project No: 60310614	
	Client:	Grimshaw	Monitoring well elevation:	163 m AHD		
	Location:	Carioca Way, West Pennant Hills	Rainfall measured at Sydney Observatory BOM WS-1			



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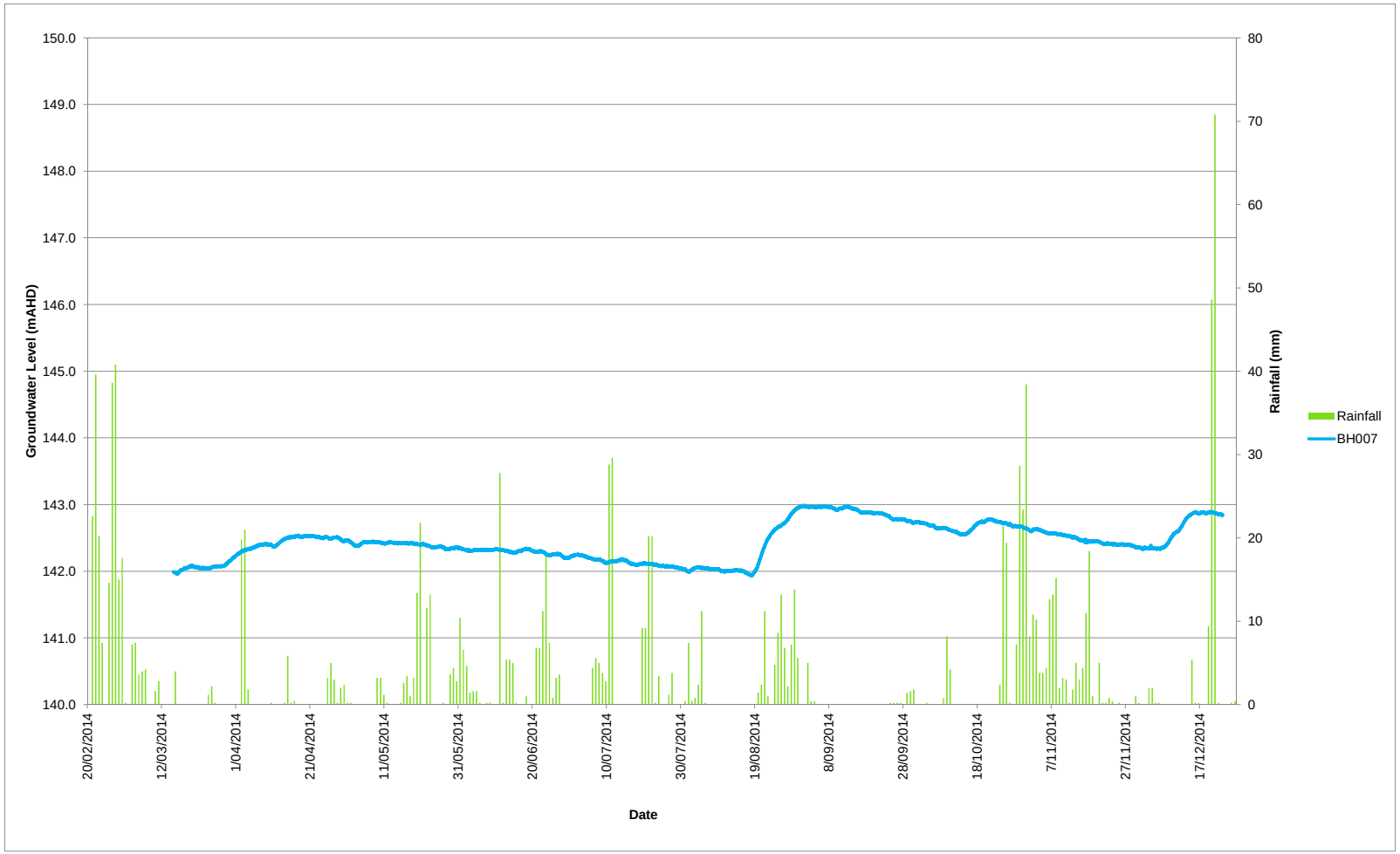
	Client:	Grimshaw	Monitoring well elevation: 163 m AHD		
	Location:	Carioca Way, West Pennant Hills	Rainfall measured at Sydney Observatory BOM WS-1		



AECOM	Title:	Hydrograph BH007	Screen Interval:	6.0m	Figure: A3	BH007
	Project:	Cherrybrook Rezoning Application	Lithology Screened:	Ashfield Shale	Project No: 60310614	
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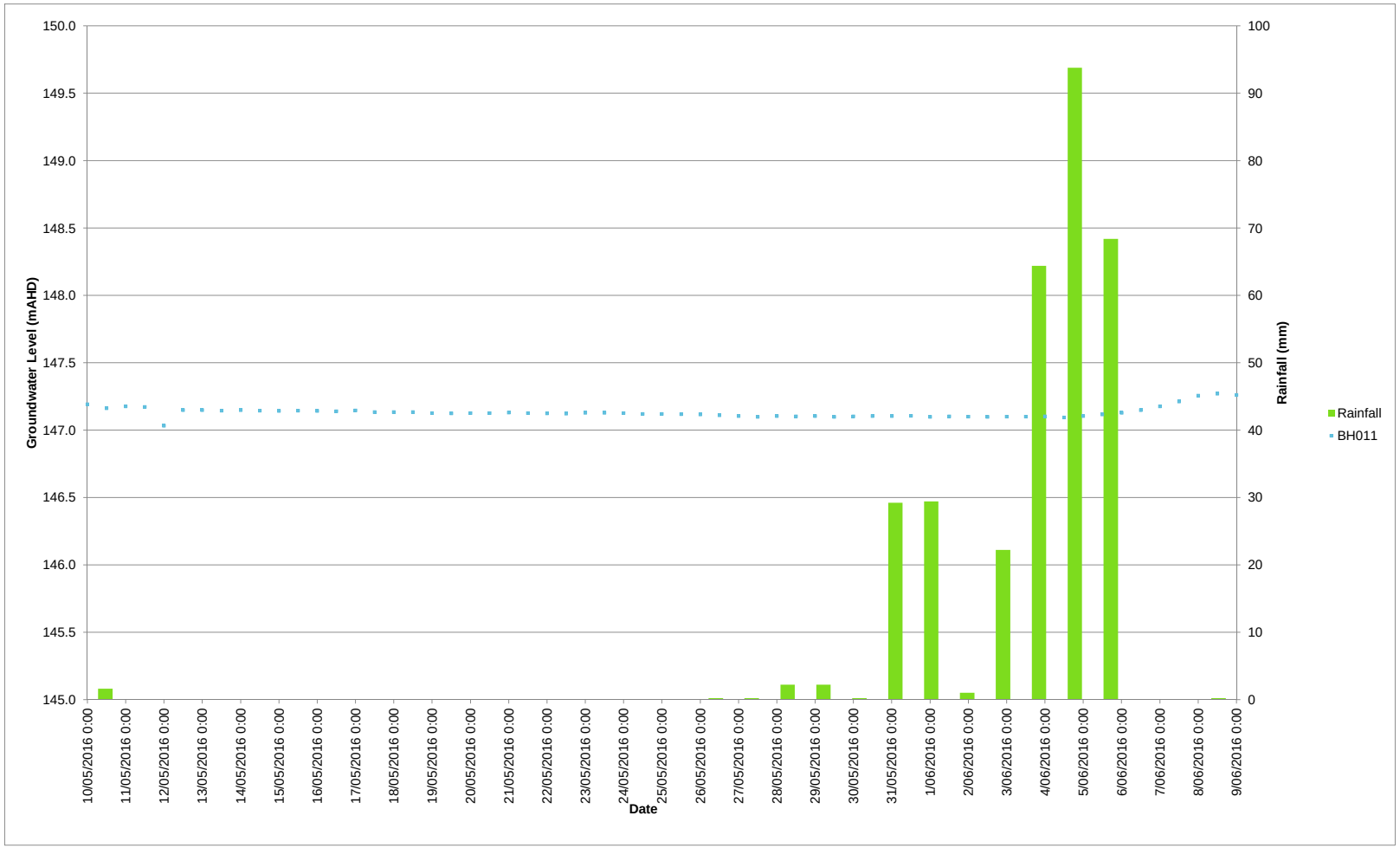
	Location:	Carioca Way, West Pennant Hills	Rainfall measured at Sydney Observatory BOM WS-1			



AECOM	Title:	Hydrograph BH011	Screen Interval: 4.6m	Figure: A4	BH011
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	Client:	Grimshaw	Monitoring well elevation: 145 m AHD		
	Location:	Carioca Way, West Pennant Hills	Rainfall measured at Sydney Observatory BOM WS-1		

Appendix B

Aerial Photographs

CHERRYBROOK
1930 AERIAL

JUN 2016
60310614

0 50 100 200 m

B1

AECOM \\ausyd1fp001\Projects\603X\60310614\4. Tech work area\4.99_GIS\02_Maps\G013_HistoricAerials_160427.mxd Updated 6/06/2016

AECOM

CHERRYBROOK

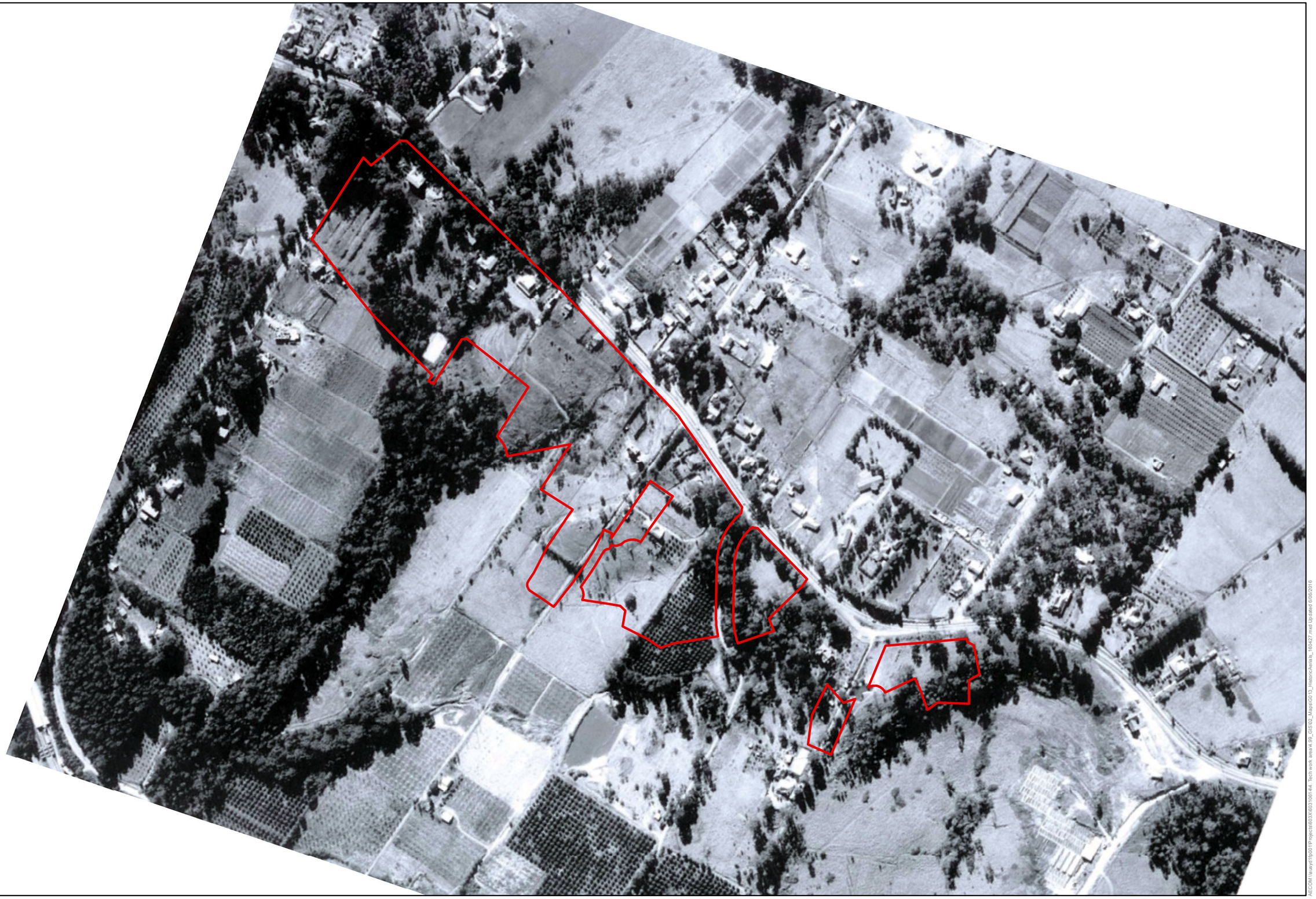
1947 AERIAL

JUN 2016

60310614

0 50 100 200 m

B2



CHERRYBROOK
1961 AERIAL

JUN 2016
60310614

0 50 100 200 m

B3

CHERRYBROOK
1975 AERIAL

JUN 2016
60310614

0 50 100 200 m

B4

AECOM

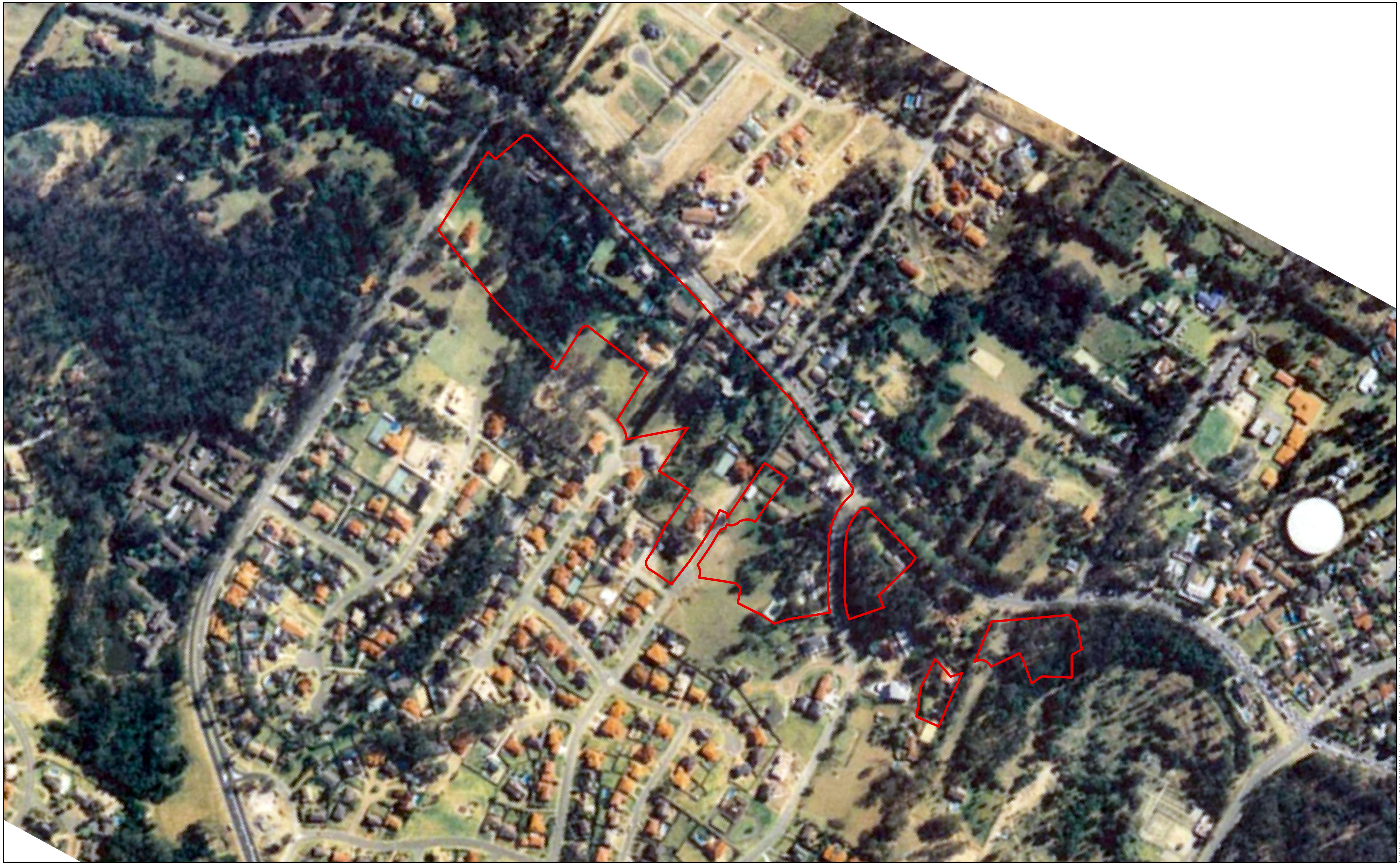
CHERRYBROOK
1986 AERIAL

JUN 2016
60310614

0 50 100 200 m

B5

AECOM



CHERRYBROOK
1994 AERIAL

JUN 2016
60310614

0 50 100 200 m

B6

AECOM

CHERRYBROOK

2002 AERIAL

JUN 2016

60310614

0 50 100 200 m

B7

AECOM

CHERRYBROOK

2005 AERIAL

JUN 2016

60310614

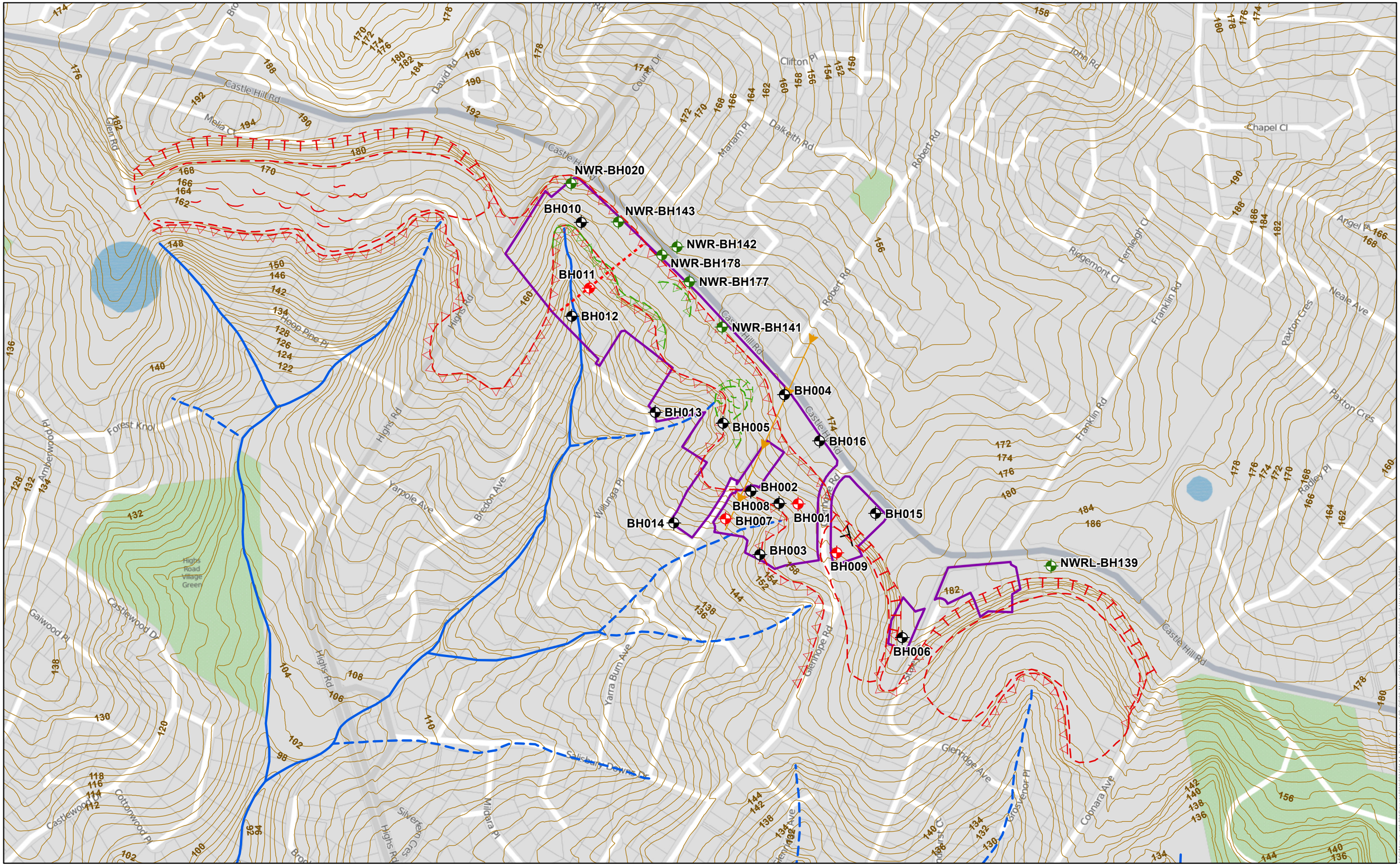
0 50 100 200 m

B8

Appendix C

Site Plans

AECOM



Study area
Rezoning boreholes
Rezoning boreholes with piezometer
2m contours

Sharp break in slope (scarp)
Rounded break in slope
Landslide
Hummocky ground
Bedding dip from rock exposure

Drainage line
Epiphemeral drainage line
Approximate location of NWRL borehole
Geological cross section
Speculative dyke trace

Red = Relic and/or slow moving features
Green = Fresh feature observed in historical photographs

CHERRYBROOK
GEOTECHNICAL INVESTIGATIONS
Source: LPMA, 2015

0 50 100 200 m

N

JUN 2016
60310614

C1

AECOM

Study area

2m contours

Low to moderate risk

Note: Inferred landslide risk categories and zones are based on qualitative risk assessment in general accordance with AGS 2007 guidelines

CHERRYBROOK

LANDSLIDE RISK ASSESSMENT

Source: LPMA, 2015

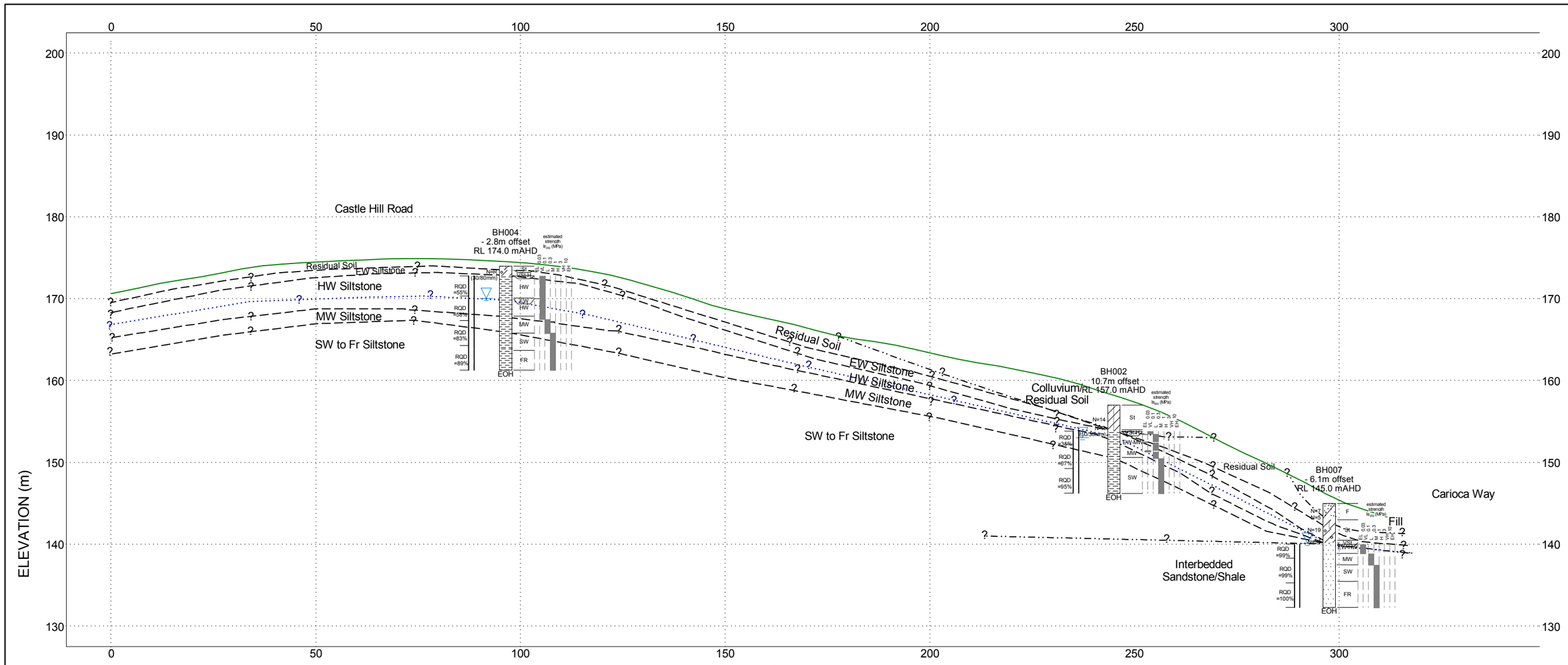
0 50 100 200 m

N

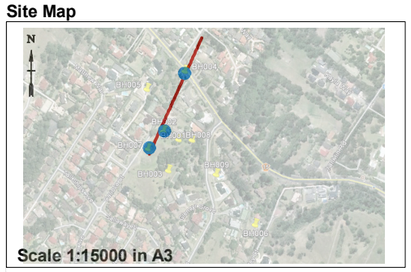
JUN 2016

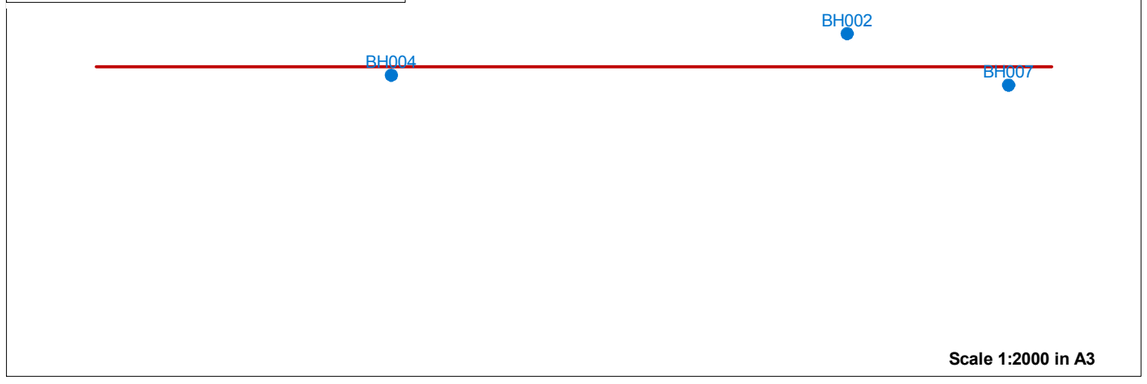
60310614

C2



Site Map





LEGEND

- TOPSOIL
- SILTY CLAY
- SILTSTONE
- GRAVELLY CLAY
- SANDY CLAY
- SILTY SAND
- SANDSTONE

Ground Surface

Inferred Geological Boundary

Inferred Weathering Boundary

Inferred Groundwater Table

EW Extremely Weathered
HW Highly Weathered
MW Moderately Weathered
SW Slightly Weathered
Fr Fresh

Borehole Name
Fence Offset
Elevation

Field Colour

Water after drilling / during drilling

SPT Blowcount N
or
UCS (U): from UCS test
UCS (A): from axial point load index x 15

Consistency or Weathering Grade

Pells Classes
(I, II, III, IV, V: Shale)
(I*, II*, III*, IV*, V*: Sandstone)

Notes:
1. For borehole/Test pit locations, refer to the geotechnical investigation plan.
2. For detailed descriptions of the geological material at specific investigation locations, refer to the respective logs and explanatory notes.
3. Geological boundaries are inferred from the existing investigation records
4. Investigation records which are offset from the line of section have been projected onto the section

Drawn	EC
Approved	PC
Date	02/06/14
Scale	1:1000 (H) : 1:500 (V)
Original size	A3

AECOM

Client	Grimshaw
Project	Cherrybrook
Title	Geotechnical Cross Section
Project no.	60310614
Figure no.	A7

Project: 20131210_CHERRYBROOK.GPJ, Report: FENCE WITH SITE MAP_ST2, Template: AECOM_PER_DATA TEMPLATE.GDT, Script: , 2.6.2014

Appendix D

Borehole Logs and Photographs

Soil Descriptions

Soil is defined as uncemented or partially cemented inorganic or organic material found in the ground. If the material is able to be remoulded with the addition of water or disintegrates in the hands in field conditions with no visible relict (residual) structure, it is described as soil. All other substances can be classified as rock. If the material has a residual origin and still has a relict structure, it is classed as extremely weathered rock. The following definitions are in accordance with AS1726-1993 to describe soil and rock on engineering log sheets.

Grain Size

Grain Size	Shape/Texture	Name
< 2 µm	Not visible to the naked eye	Clay
<75 µm		Silt
0.075-0.2 mm		Fine sand
0.2-0.6 mm		Medium Sand
0.6-2.36 mm		Coarse Sand
2.36-6 mm	angular / sub-angular / sub-rounded / rounded - low/high sphericity	Fine Gravel
6-20 mm		Medium Gravel
20-63 mm		Coarse Gravel
63-200 mm		Cobbles
200-600 mm		Small Boulders
600-2000 mm		Medium Boulders
>2000 mm		Large Boulders

Geological Origin

Term		Description
Topsoil*	Topsoil	Highly organic superficial soil layer
Residual	Residual soil	Structure and fabric of parent rock not visible
Transported Soils	Aeolian soil	Deposited by wind
	Alluvial soil/ Alluvium	Deposited by streams and rivers
	Colluvium	Deposited on slopes (transported downslope)
	Lacustrine soil	Deposited by lakes
	Marine soil	Deposited in oceans, bays, beaches and estuaries
Fill*	Soil Fill	Soil placed by humans in either controlled or uncontrolled conditions
	Rock Fill	Rock placed by humans in either controlled or uncontrolled conditions
	Waste Fill	Refuse from domestic or industrial sources

*Origin provided in main description

Grading

Descriptive Term	Definition
Well Graded	Good representation of all particle size from largest to the smallest.
Poorly Graded	One or more intermediate size poorly represented.
Gap Graded	One or more intermediate sizes absent.
Uniform	Essentially one size.

Minor Components

Name	Criteria (% in mass)	
	Coarse – Grained Soils	Fine – Grained Soils
Trace	<5	<15
With	5-12	15-30
Prefix	Sandy/Gravelly: 12-50	Silty/Clayey: 30-50

Moisture Condition

Term	Symbol	Description	
		Cohesive	Granular
Dry	D	Cohesive; hard and friable or powdery, moisture content < Plastic Limit (PL)	Cohesion-less and free running
Moist	M	Soil feels cool, darkened in colour, can be remoulded, moisture content at or above PL	Soil feels cool, darkened in colour, tends to cohere
Wet	W	Soil feels cool, dark, usually weakened, free water, moisture content > LL	Soil feels cool, darkened in colour, tends to cohere, free water

Density (non-cohesive soils)

Based on range of SPT blow counts for fine to medium grained sands

Term	Symbol	Density Index (%)	SPT (N50) Blow Count
Very Loose	VL	≤ 15	0-4
Loose	L	15 – 35	4-10
Medium Dense	MD	35 – 65	10-30
Dense	D	65 – 85	30 -50
Very Dense	VD	> 85	>50

Consistency (cohesive soils except Fill)

Based on field descriptors or undrained strength (Su) (estimated in field from pocket penetrometer or shear vane)

Term	Symbol	Field Description	Undrained Shear Strength (kPa)
Very Soft	VS	40mm penetration thumb	≤12
Soft	S	10mm penetration by thumb	12 – 25
Firm	F	Thumb impression	25 – 50
Stiff	St	Slight thumb impression	50 – 100
Very Stiff	VSt	Readily indented by thumb nail	100 – 200
Hard	H	Indented by thumb nail with difficulty	> 200

Organic and Fill Material

Organic and fill material cannot be adequately described using the terms above. They are mentioned, at the end of the description using qualitative terms such as “rare”, “occasional” or “frequent”, e.g. “SAND with rare gravel size brick fragments”. These qualitative terms are relative, for which no definition of percentage is given.

Organic matter is described using terms such as fibrous peat, charcoal, wood fragments, roots (>2mm diameter) or root fibres (<2mm diameter)

Waste fill is described using terms such as domestic refuse, oil, bitumen, brickbats, concrete rubble, fibrous plaster, wood pieces, wood shavings, sawdust, iron filings, drums, steel bars, steel scrap, bottles, broken glass, or leather.

Soil Classification Table

Field Identification Procedures (Excluding particles larger than 60mm and basing fractions on estimated mass)						Group Symbol	Typical Names
Coarse Grained Soils More than 50% of material less than 63 mm is larger than 0.075 mm	GRAVELS More than 50% of coarse fraction is larger than 2.36mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			GW	Well graded gravels, gravel-sand mixtures, little or no fines
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels
		GRAVELS WITH FINES (Appreciable amount of fines)	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			GM	Silty gravels, gravel-sand-silt mixtures
			'Dirty' materials with excess of plastic fines, medium to high dry strength			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than 50% of coarse fraction is smaller than 2.36mm	CLEAN SANDS (little or no fines)	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			SW	Well graded sands, gravelly sands, little or no fines
			Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands
		SANDS WITH FINES (Appreciable amount of fines)	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			SM	Silty sands, sand-silt mixtures
			'Dirty' materials with excess of plastic fines, medium to high dry strength			SC	Clayey sands, sand-clay mixtures
Fine Grained Soils More than 50% of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEEDURES ON FRACTIONS < 0.2 mm						
	SILTS AND CLAYS Liquid limit less than 50		DRY STRENGTH	DILATANCY	TOUGHNESS		
			None to low	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with low plasticity. Silts of low to medium Liquid Limit.
			Medium to high	None to very slow	Medium	CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			Low to medium	Slow	Low	OL	Organic silts and organic silt-clays of low to medium plasticity
	SILTS AND CLAYS Liquid limit greater than 50		Low to medium	Slow to none	Low to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, silts of high Liquid Limit
			High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays
			Medium to high	None to very slow	Low to medium	OH	Organic clays of medium to high plasticity, organic clays
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			Pt	Peat and other highly organic soils
Boundary classifications – Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well graded gravel-sand mixture with clay binder.							
Plasticity Boundaries: LOW PLASTICITY: ≤35 % MEDIUM PLASTICITY: 35 to ≤50 % HIGH PLASTICITIY: >50 %							

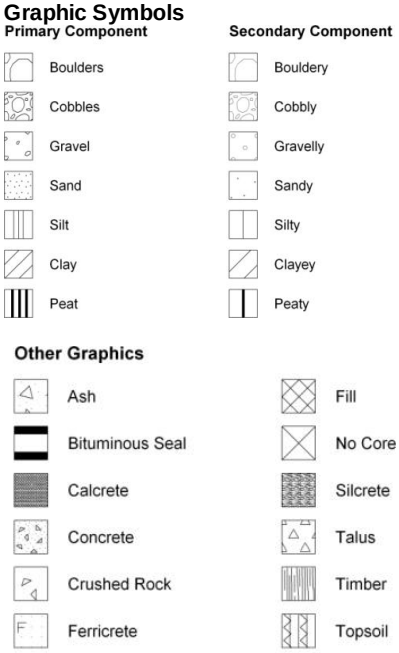
Colour

Colour has been assessed in the "moist" condition using basic colours and the modifiers pale, dark and mottled. Borderline colours are described as a combination of the two colours (e.g. red-brown). When describing the colour of defect infill, the following abbreviations are used in the defect description column.

Colour abbreviations

Term	Pantone Colour Code	RGB Code
Light grey	GC4	R187-G188-B188
Grey	GC10	R99-G102-B106
Dark Grey	405	R61-G57-B53
Brown-grey	409	R133-G120-B116
Green	355	R0-G150-B57
Red	194	R155-G39-B67
Red-brown	696	R152-G72-B86
Orange	803	R175-G109-B4
Orange-brown	471	R184-G97-B37
Yellow-brown	139	R175-G109-B4
Light yellow-brown	7502	R206-G184-B136
Light brown	728	R205-G160-B119
Brown	4635	R148-G96-B55
Dark Brown	462	R92-G70-B44

Graphic Symbols



AECOM

Rock Descriptions

Rock Types

Size/ Spacing Thickness	Soil Grain Size Term	Rock Type		Bedding Thickness Term
		Sedimentary	Igneous Metamorphic	
< 2 µm	CLAY	CLAYSTONE	FINE	Very thinly laminated
<2 - 60 µm	CLAY + SILT	MUDSTONE		
2 - 60 µm	SILT	SILTSTONE		
0.06 - 0.2 mm	fine grained	SANDSTONE	MEDIUM	
0.2 - 0.6 mm	medium grained			
0.6 - 2.0 mm	coarse grained			
2 - 6 mm	fine grained GRAVEL	CONGLOMERATE (rounded boulders, cobbles and gravel cemented in a finer matrix) or BRECCIA (irregular rock fragments in a finer matrix)	COARSE	Thinly laminated
6 - 20 mm	medium grained GRAVEL			Laminated
20 - 60 mm	Coarse grained GRAVEL			Very thinly bedded
60 - 200 mm	COBBLES			Thinly bedded
0.2 - 0.6 m	small BOULDER			Medium bedded
0.6 - 2m	medium BOULDER			Thickly bedded
> 2m	large BOULDER			Very thickly bedded

Defect Type

Log Symbol	Term	Definition
B	Bedding Parting	A discontinuity or crack, parallel or sub-parallel to layering, across which the rock has little or no tensile strength.
J	Joint	A discontinuity or crack, planar, curved or irregular across which the rock usually has little tensile strength.
FZ	Fracture Zone	A zone of extremely closely spaced (<20mm) joints, often intersecting
CZ	Crushed Zone	A zone containing disoriented usually angular rock fragments of variable size.
NF	In filled Seam	A seam of material not resulting from in situ weathering (or growth) The infill is caused by migration of soil into open joints.
EW	Extremely Weathered Seam	Seam of soil substance weathered from host rock.
SZ	Sheared Zone:	A zone with evidence of movement.
VN	Vein	A defect with mineral growth but thicker than cemented joint (>5 mm), or an intrusive feature
HB	Handling Break:	Any artificial break caused by handling of the core following the drilling operation.
DB	Drilling Break	Any break inferred to be caused by the drilling operation

Defect Planarity

Symbol	Description
CU	curved
DIS	discontinuous
IR	irregular
PL	planar
ST	stepped
UN	undulating

Defect Roughness

Symbol	Description
ro	rough
sl	slickensided
sm	smooth

Strength

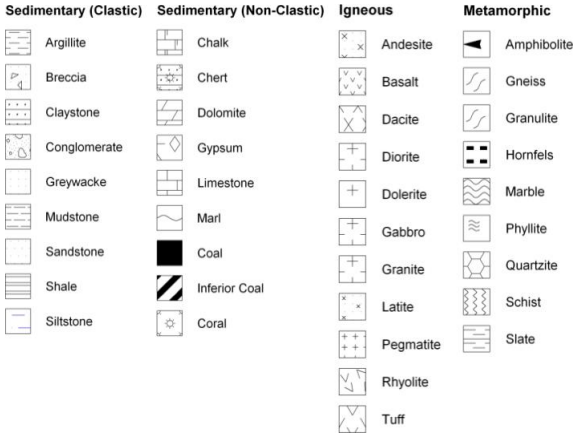
Term	Symbol	Point Load Range $I_{s\,(50)}$ (MPa)	Field Guide
Extremely Low	EL	≤ 0.03	Easily remoulded by hand to a material with soil properties
Very Low	VL	0.03 to 0.1	Material crumbles under firm blow with sharp end of pick. Can be peeled with a knife. Too hard to cut a triaxial sample by hand. Pieces up to 3 cm thick can be broken by finger pressure.
Low	L	0.1 to 0.3	Easily scored with a knife. Indentations of 1mm - 3mm in the specimen with firm blows of the pick point. Has dull sound under hammer. A piece of core 150 mm long 50 mm diameter may be broken by hand
Medium	M	0.3 to 1	Readily scored with a knife. A piece of core 150 mm long 50 mm diameter can be broken by hand with difficulty
High	H	1 to 3	A piece of core 150 mm long 50 mm diameter cannot be broken by hand but can be broken with by a pick with a single firm blow. Rock rings under hammer
Very High	VH	3 to 10	Hand specimen breaks with a pick after more than one blow. Rock rings under hammer
Extremely High	EH	>10	Specimen requires many blows with a geological pick to break through intact material. Rock rings under hammer

Degree of Weathering

Degree of Weathering	Symbol	Weathering Description
Residual Soil	RS	Soil developed from weathering of rock in-situ. The mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Rock	EW	Rock texture retained but can be easily remoulded by hand to a material with soil properties
Highly Weathered Rock	HW	Stained or discoloured throughout. Signs of chemical or physical alteration. Rock texture evident. Rock substance becomes friable.
Moderately Weathered Rock	MW	Staining or discolouration extends through rock substance. Colour of fresh rock not recognisable
Slightly Weathered Rock	SW	Rock surface partly stained or discoloured. Colour and texture of fresh rock recognisable
Fresh Rock	FR	Rock surface unaffected by weathering

Note – Definitions based on RMS in conjunction with AS1726-1993, where possible.

Graphic Symbols



General Symbols and Abbreviations

Field Sampling and Testing Abbreviations

Symbol	Description
BS	Bulk Sample
DCP	Dynamic Cone Penetration Resistance (blows/100 mm)
DS	Disturbed Sample
ES	Environmental Sample
FPM	Field Permeability
HB	SPT Hammer Bouncing
HW	SPT rod and hammer weight (SPT N < 1)
Is(50) (I)	Irregular Point Load Strength Index (MPa)
Is(50)a (lab	Axial Point Load Strength Index (MPa) – Laboratory Testing
Is(50)d (lab)	Diametral Point Load Strength Index (MPa) – Laboratory Testing
Lugeon	Lugeon/Packer Test (L/m/min)
N*	Uncorrected SPT blow count for 300 mm
N (in sample column)	SPT with no recovery
PID	Photoionisation Detector
PP	Pocket Penetrometer (kPa)
R	Refusal
RQD	Rock Quality Designation (%)
RW	SPT rod weight only (SPT N < 1)
SPT	Standard Penetration Test
TCR	Total Core Recovery (%)
U(X)	Undisturbed Sample (X) mm diameter
UP	Undisturbed Piston Sample
V	Uncorrected Vane Shear (kPa) – Peak/Residual

Water

Symbol	Description
	Water level (static)
	Water level (during drilling)
	Water inflow
	Water outflow

Drilling Method

Drilling Method Symbol	Description
AD	Auger Drilling
ADT	Auger Drilling – Tungsten-Bit (100mm)
ADV	Auger Drilling – V-Bit (100mm)
CA	Casing Advancer
CT	Cable Tool
DHH	Down Hole Hammer
DT	Diatube (114mm)
GP	Geoprobe Continuous Sampling
HA	Hand Auger
NDD	Non-destructive Drilling (Excavation by vacuum)
NMLC	NMLC Size Core – Double Tube (50mm diameter)
NQ, HQ, PQ	Wireline Size Core – Triple Tube (45mm, 61mm, 83mm diameter)
PD	Percussion Drilling
RB	Rotary – Blade Bit
RC	Reverse Circulation
RT	Rotary – Tricone Bit
SC	Sonic Coring
WB	Wash Boring
VC	Vibro Coring

Drilling Support

Symbol	Description
C	Casing
M	Mud
U	Unsupported

General terminology used to describe defects in Rock Mass

Defects are described in the description column in the following order, defined by abbreviations: Type, dip/direction, planarity, roughness, infill/coating, colour. E.g. B,30/145°,PL, ro, 1mm,co, Clay; indicates a bedding parting with 30° dip, 145° dip direction, planar, rough surfaces, 1mm thick, filled with clay.

All dips are relative to the plan perpendicular to the core, including in inclined boreholes.

Defects orientated 0° to 10° measured from the horizontal are described as moderately inclined, whereas defects orientated 80° to 90° from the horizontal are described as sub-vertical. Where core orientation has not been carried out, the 'apparent dip' of defects recorded in inclined holes has been recorded relative to a plane perpendicular to the core axis (as for vertical holes).

Defects can be described as cemented (or healed), closed (no obvious cementation) and non-persistent (do not continue through the core).

All discontinuities are clean and tight unless stated otherwise.

Defects up to 5 mm thick are described as bedding joints or joints. Defects 5mm to 100mm thick are described as seams. Defects greater than 100mm thick are also described as new material strata.

AECOM Engineering Log

BOREHOLE No. **BH001**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	7 Glenhope Road		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317555.0 m	**RL:** 163.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265214.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	HWT	3/12/2013 ▽			163.0	0.0		OL	SILT: low plasticity, dark brown, trace clay, fine to coarse sand, gravel and rootlets.	D	St	TOPSOIL
					162.5	0.5		CI	Silty CLAY: medium plasticity, brown, trace sand and sub-angular to angular gravel.	M		COLLUVIUM
					162.0	1.0			At 1.0 m becoming brown-grey mottled red-brown, medium to high plasticity.			
			SPT:3,6,8 N=14	DS	161.5	1.5						
					161.0	2.0						
					160.5	2.5						
			SPT:3,4,7 N=11	DS	160.0	3.0						
					159.5	3.5		GP	Clayey GRAVEL: brown-grey mottled dark grey and brown, gravel is HW Siltstone, extremely low strength, rock fabric evident.			
					4.0				*Borehole BH001 continued as cored borehole from 3.95 m*			
					4.5							
					5.0							

2015_ANZ_BOREHOLE 20160328 _CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH001

Sheet: 2 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	7 Glenhope Road		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317555.0 m	**RL:** 163.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265214.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description					Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering RS EW HW MW SW FR	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) 20 60 200 600 2000	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							163.0								
							162.5	0.5							
							162.0	1.0							
							161.5	1.5							
							161.0	2.0							
							160.5	2.5							
							160.0	3.0							
							159.5	3.5		*Continued from non-cored borehole at 3.95 m*					
HQ3	Run 1	100					159.0	4.0		Clayey GRAVEL: light grey (clay) and dark brown-grey (gravels), fine to coarse sub-rounded to angular Siltstone gravel, trace cobbles, with VSt silty clay matrix(COLLUVIUM)					1 of 2
	Run 2	73					158.5	4.5		SILTSTONE BOULDER: dark brown-grey, bedding 5 mm to 50 mm at 45°, laminations of light brown/grey Sandstone (COLLUVIUM)					
								5.0		NO CORE: 120 mm.					

AECOM Engineering Log

CORED BOREHOLE No. BH001

Sheet: 3 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	7 Glenhope Road		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317555.0 m	**RL:** 163.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265214.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 3	100			SPT:4,8,17 N=25		158.0			CLAY: medium to high plasticity, grey mottled brown, with silt, trace fine sand and gravel, VSt (COLLUVIUM)					
							157.5	5.5		SILTSTONE: dark brown-grey, with light grey fine Sandstone laminations at 5 mm to 20 mm spacing, sub-horizontal.				J, 0°, spaced 10 mm, Joints extremely closely spaced at variable orientations generally closed some iron staining CZ, 0°, fine to coarse gravel with silt	
	Run 4	89	33				157.0	6.0		From 5.8 m to 5.9 m grey mottled orange brown. From 5.9 m dark grey to brown.				J, 45°, ST, ro, vn, clay, FeO CZ, 0°, 150 mm, gravel clay matrix from 6.05 m sub-angular to angular gravel	
														B, 0°, 5 mm, co, clay stiff B, 0°, PL, sm, vn, clay CZ, 0°, 75 mm, fine to coarse gravel with silt J, 90°, PL, sm, co, discontinuous B, 0°, PL, sm, vn, clay B, 0°, PL, sm, stn, FeO	
							156.5	6.5		NO CORE: 110 mm.					1 of 2
										SILTSTONE: dark grey-brown, with light brown-grey Sandstone laminations (10%) spaced at 5 mm to 20 mm, sub-horizontal.				B, 0°, PL, ro, vn, ltbr silt Fe FZ, very closely spaced fractures at variable orientation healed J, 30°, PL, ro, sn, FeO	
							156.0	7.0						B, 0°, PL, ro, vn, silt, FeO	
														J, 65°, PL, ro, vn, silt, FeO, from 7.17m to 7.30m	
														B, 0°, PL, ro, co	
							155.5	7.5		From 7.45 m dark grey with light grey laminations.				J, 20°, PL, ro, co	
HQ3	Run 5	100	90				155.0	8.0							
										LAMINITE: Siltstone (60%), dark grey with light grey, fine grained Sandstone laminations (40%) spaced at 5 mm to 10 mm, sub-horizontal.				B, 0°, PL, ro, stn B, 0°, PL, ro, stn	
							154.5	8.5							
							154.0	9.0							2 of 2
							153.5	9.5							
	Run 6	100	100												
							153.0	10.0							

AECOM Engineering Log

CORED BOREHOLE No. BH001

Sheet: 4 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	7 Glenhope Road		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317555.0 m	**RL:** 163.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265214.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 6	100	100				153.0			LAMINITE: Siltstone (60%), dark grey with light grey, fine grained Sandstone laminations (40%) spaced at 5 mm to 10 mm, sub-horizontal. *continued*					2 of 2
							152.5	10.5							
							152.0	11.0							
							151.5	11.5							
							151.0	12.0							
							150.5	12.5		*BH001 terminated at 12.30 m.* *Reached target depth* Vibrating wire piezometer sensor installed at 5.6m depth within filter sock. Hole backfilled with cement - bentonite grout mix.					
							150.0	13.0							
							149.5	13.5							
							149.0	14.0							
							148.5	14.5							
								15.0							

Cherrybrook Town Center
60310614
BH001
Box 1 of 2
From 4.0m to 8.0m
02/12/2013

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH001\2_BH001 Box 1.JPG printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC		TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	AECOM	BOREHOLE NO: BH001
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 3.95 m to 8.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 2

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH001\2_BH001 Box 2.JPG printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH001
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	8.00 m to 12.30 m
		ORIGINAL SIZE:	A4	BOX No.	2 of 2

AECOM Engineering Log

PIEZOMETER No. **BH001**

Sheet: 1 of 1

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	7 Glenhope Road		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317555.0 m	**RL:** 163.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265214.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data								Rock Description	Piezometer Details
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm) 20 60 200 600 2000
ADT					162.0	0.0		SILT, dark brown	
						2.0		Silty CLAY, brown	
					160.0				
						4.0		Clayey GRAVEL, brown-grey mottled dark grey and brown	
HQ3	Run 1	100						Clayey GRAVEL, light grey (clay) and dark brown-grey (gravels)	
	Run 2								
	Run 3	73			158.0			SILTSTONE BOULDER	
		100				6.0		NO CORE	
	Run 4	89	33					CLAY, grey mottled brown	
HQ3					156.0			SILTSTONE, dark brown-grey	
	Run 5	100	90			8.0		NO CORE	
								SILTSTONE, dark grey-brown	
					154.0			LAMINITE	
						10.0			
	Run 6	100	100		152.0				
						12.0			
					150.0			*BH001 Terminated at 12.30 m.*	
						14.0			

Construction details: NA
Pipe diameter: -
Pipe Top: 5.5 mBGL
Pipe Base: 5.6 mBGL
Screen Top: 5.5 mBGL
Screen/Sensor Base: 5.6 mBGL
Instrument Details: -
Installation Date: 2/12/2013
Development Date: -

Depth 0.0 to 0.1 m — GATIC COVER

Depth 0.1 to 5.5 m — BENTONITE - CEMENT GROUT

Depth 5.5 to 5.6 m — VW SENSOR

Depth 5.6 to 12.3 m — BENTONITE - CEMENT GROUT

REMARKS:
GROUNDWATER MONITORING NOTES:

2015_ANZ_PIEZO 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-01-AA.GDT AECOM_2-03_LIBRARY.GLB 10.6.2016

AECOM Engineering Log

PIEZOMETER No. **BH007**

Sheet: 1 of 1

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	6/12/2013	**End Date:** 6/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317449.0 m	**RL:** 145.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265192.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log
HA					144.0	0.0	
ADT						2.0	
					142.0		
						4.0	
					140.0		
HQ3	Run 2	100	99	Not Recorded		6.0	
					138.0		
		100	99			8.0	
					136.0		
	Run 3					10.0	
		100	100		134.0		
						12.0	
					132.0		
						14.0	

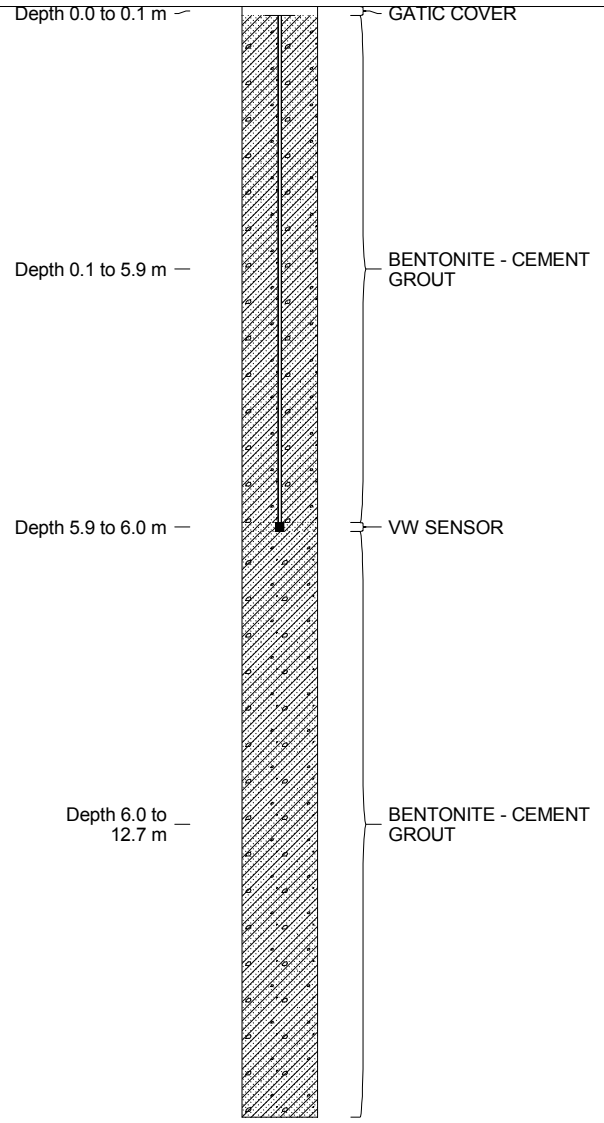
Rock Description

Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm)
SILT, dark brown	
Sandy CLAY, dark brown mottled light red to brown	
Silty CLAY, dark brown mottled red to light brown	
Gravelly CLAY, light grey mottled yellow brown and red-brown	
Silty SAND, fine to coarse grained, light grey to yellow-brown	
SANDSTONE, fine to medium grained, light grey mottled orange and brown	
SANDSTONE, fine to medium grained, light brown and light grey	
SANDSTONE, fine to medium grained, light grey	
BH007 Terminated at 12.70 m.	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction details: NA
Pipe diameter: -
Pipe Top: 5.9 mBGL
Pipe Base: 6.0 mBGL
Screen Top: 5.9 mBGL
Screen/Sensor Base: 6.0 mBGL
Instrument Details: -
Installation Date: 6/12/2013
Development Date: -



REMARKS:
GROUNDWATER MONITORING NOTES:

2015_ANZ_PIEZO 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-01-AA.GDT AECOM_2-03_LIBRARY.GLB 10.6.2016

AECOM Engineering Log

PIEZOMETER No. BH009

Sheet: 1 of 1

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	4 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 21/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317611.0 m	**RL:** 164.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265143.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log
ADT					164.0	0.0	
					162.0	2.0	
					160.0	4.0	
					158.0	6.0	
HQ3	Run 1	100	0		156.0	8.0	
	Run 2	100	0		154.0	10.0	
	Run 3	100	70		152.0	12.0	
					150.0	14.0	

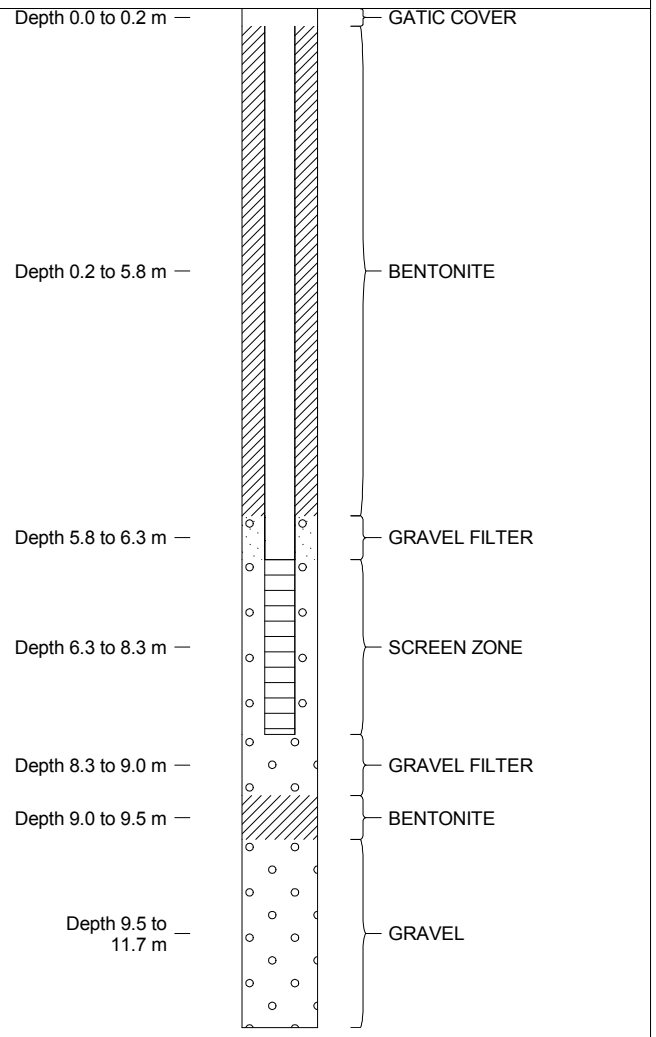
Rock Description

Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm)
Clayey SILT, brown	
Gravelly SILT, brown	
Silty CLAY, red-brown, mottled black	
Silty CLAY, light brown-grey, mottled red-brown	
Silty CLAY, light brown-grey, mottled red-brown	
Clayey SILT, grey, mottled brown, red, orange	
SILTSTONE	
SILTSTONE, dark brown	
SILTSTONE, dark grey	
LAMINITE	
BH009 Terminated at 11.65 m.	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction details:	machine slotted PVC
Pipe diameter:	50 mm
Pipe Top:	6.3 mBGL
Pipe Base:	8.3 mBGL
Screen Top:	5.8 mBGL
Screen/Sensor Base:	9.0 mBGL
Instrument Details:	-
Installation Date:	21/08/2014
Development Date:	-



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

PIEZOMETER No. **BH011**

Sheet: 1 of 1

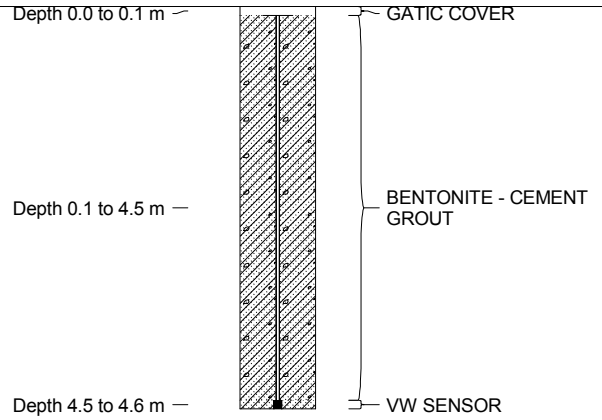
Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317250.0 m	**RL:** 150.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265529.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm)
ADT					150.0	0.0		Clayey SILT, dark brown	
								CLAY, red-brown	
					148.0	2.0			
HQ3	Run 1	80	0					BRECCIA	
	Run 2	61	0		146.0	4.0		SILTSTONE, dark brown-grey	
	Run 3	98	0					NO CORE	
	Run 4	98	0					SILTSTONE	
	Run 5	83	0					NO CORE	
					144.0	6.0		SILTSTONE, dark brown-grey	
	Run 6	100	28					LAMINITE, grey to light grey	
	Run 7	100	61					LAMINITE	
					142.0	8.0		SANDSTONE, fine grained, light brown, mottled grey-brown	
	Run 8	100	100					NO CORE	
								SANDSTONE, fine to medium grained, light grey to light brown	
					140.0	10.0		LAMINITE	
	Run 9	100	69					LAMINITE	
								SANDSTONE, light grey	
					138.0	12.0		SANDSTONE, light yellow-grey	
	Run 10	100	99					SANDSTONE, light grey	
					136.0	14.0		DOLERITE, medium grained, light yellow-grey	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction details: NA
Pipe diameter: -
Pipe Top: 4.5 mBGL
Pipe Base: 4.6 mBGL
Screen Top: 4.5 mBGL
Screen/Sensor Base: 4.6 mBGL
Instrument Details: -
Installation Date: 12/02/2016
Development Date: -



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

BOREHOLE No. **BH002**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317486.0 m	**RL:** 157.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265233.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data								Material Description	Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	M				157.0			OL	SILT: low plasticity, dark brown, trace clay, fine to coarse sand, gravel and rootlets.	PL	St	TOPSOIL
								CH	Silty CLAY: medium to high plasticity, light grey mottled yellow-brown, trace fine sub-angular to rounded gravel and fine sand.			RESIDUAL
					156.5	0.5						
					156.0	1.0						
			SPT:4,6,8 N=14		155.5	1.5			At 1.65 m: thin bed with iron cemented gravel, with rootlets, red-brown.			
					155.0	2.0			From 2.0 m: becoming brown-grey, increase in sand content.			
					154.5	2.5						
			SPT:6,20,10/30mm N=R		154.0	3.0			LAMINITE: brown-grey, EW, inferred very low strength		VSt-H	BEDROCK
									Borehole BH002 continued as cored borehole from 3.23 m			
						3.5						
						4.0						
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328 _CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH002

Sheet: 2 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317486.0 m	**RL:** 157.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265233.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							157.0								
							156.5	0.5							
							156.0	1.0							
							155.5	1.5							
							155.0	2.0							
							154.5	2.5							
							154.0	3.0		*Continued from non-cored borehole at 3.23 m*					
HQ3	Run 1	100	35	3/12/2013 ▽			153.5	3.5		LAMINITE: siltstone (70%), dark brown-grey, with thin laminations of sandstone (30%), fine grained, light grey, at 0°-5°, spacing 5 mm to 50 mm, with orange-brown iron staining. 3.51 m to 3.60 m EW zones along bedding and joints, light grey silty clay, trace sand and fine gravel. From 3.6 m dark grey with light grey sub-horizontal Sandstone laminations, spacing 1 mm to 10 mm.				FZ, 0°, Joints extremely closely spaced at variable orientations generally closed some iron staining B, 0°, 5 mm, co, silty clay B, 0°, 15 mm, co, clay J, 90°, 2 mm, co, silty clay, from 3.33m to 3.70m J, 65°, PL, ro, stn, Fe B, 0°, PL, ro, 1 mm, vn, clay J, 20°, discontinuous, healed B, 0°, PL, ro, 1 mm, vn, clay, Fe	1 of 2
							153.0	4.0						J, 90°, UN, ro, 2 mm, co, clayey silt B, 0°, PL, ro, stn, Fe	
														B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe	
							152.5	4.5		4.45 m to 4.55 mm EW seam, remoulds to light grey silty clay. Upper boundary at 10°, boundaries parallel to bedding.				B, 5°, PL, ro, vn, clay, Fe	
	Run 2	100	67					5.0						B, 0°, ST, pl, stn, Fe J, 45°, UN, closed B, 0°, PL, ro, Fe B, 0°, PL, ro, vn, clay, Fe J, 80°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe J, 45°, PL, ro, stn, Fe	

AECOM Engineering Log

CORED BOREHOLE No. BH002

Sheet: 3 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317486.0 m	**RL:** 157.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265233.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	100	67				152.0			LAMINITE: siltstone (70%), dark grey, with thin laminations of sandstone (30%), fine grained, light grey, at 0-5°, spacing 5 mm to 50 mm, with orange-brown iron staining. At 5.35 m to 5.70 m shear zone, jointing extremely closely spaced variable orientation, bedding variable at 5° to 15°.				J, 45°, UN, ro, co, 1mm to 5mm, clay, Fe J, 40°, stn, Fe, healed B, 0°, PL, ro, vn, clay, Fe J, 35°, stn, Fe, healed B, 0°, PL, ro, stn, Fe J, 35°, stn, Fe, healed B, 0°, PL, ro, vn, silty clay, Fe J, 45°, healed J, 45°, healed B, 0°, PL, ro, 5 mm, co, silty clay EW, 0°, 50 mm, silty clay trace gravel, along joint at 30° CZ, 0°, gravelly clay B, 0° EW, 0°, 50 mm, silty clay, with gravel J, 30°, stn, Fe B, 0°, PL, ro, stn, Fe J, 45°, closed B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe CZ, 0°, 110 mm, bedding spaced 10 mm to 15 mm discontinuous jointing perpendicular to bedding ve to co of Fe up to 2 mm J, 5°, PL, ro, vn, clay B, 0°, PL, ro, cn J, 35°, PL, ro, cn, spaced 20 mm, x 5 J, 20°, PL, ro, vn, gravelly clay, Fe	1 of 2
							151.5	5.5							
							151.0	6.0							
							150.5	6.5		SILTSTONE: grey and dark grey, with occasional thin laminations of sandstone, fine grained, light grey, at 0-5°.					
							150.0	7.0							
							149.5	7.5							
							149.0	8.0						J, 40°, healed B, 0°, PL, ro, vn, clay	
							148.5	8.5						B, 0°, PL, ro, vn, clay J, 40°, PL, ro, cn J, 40°, PL, ro, cn, opposing direction to J above	2 of 2
	Run 3	100	95				148.0	9.0							
							147.5	9.5						J, 40°, PL, ro, stn, Fe J, 40°, PL, ro, stn, Fe, opposing direction to J above	
							147.0	10.0							

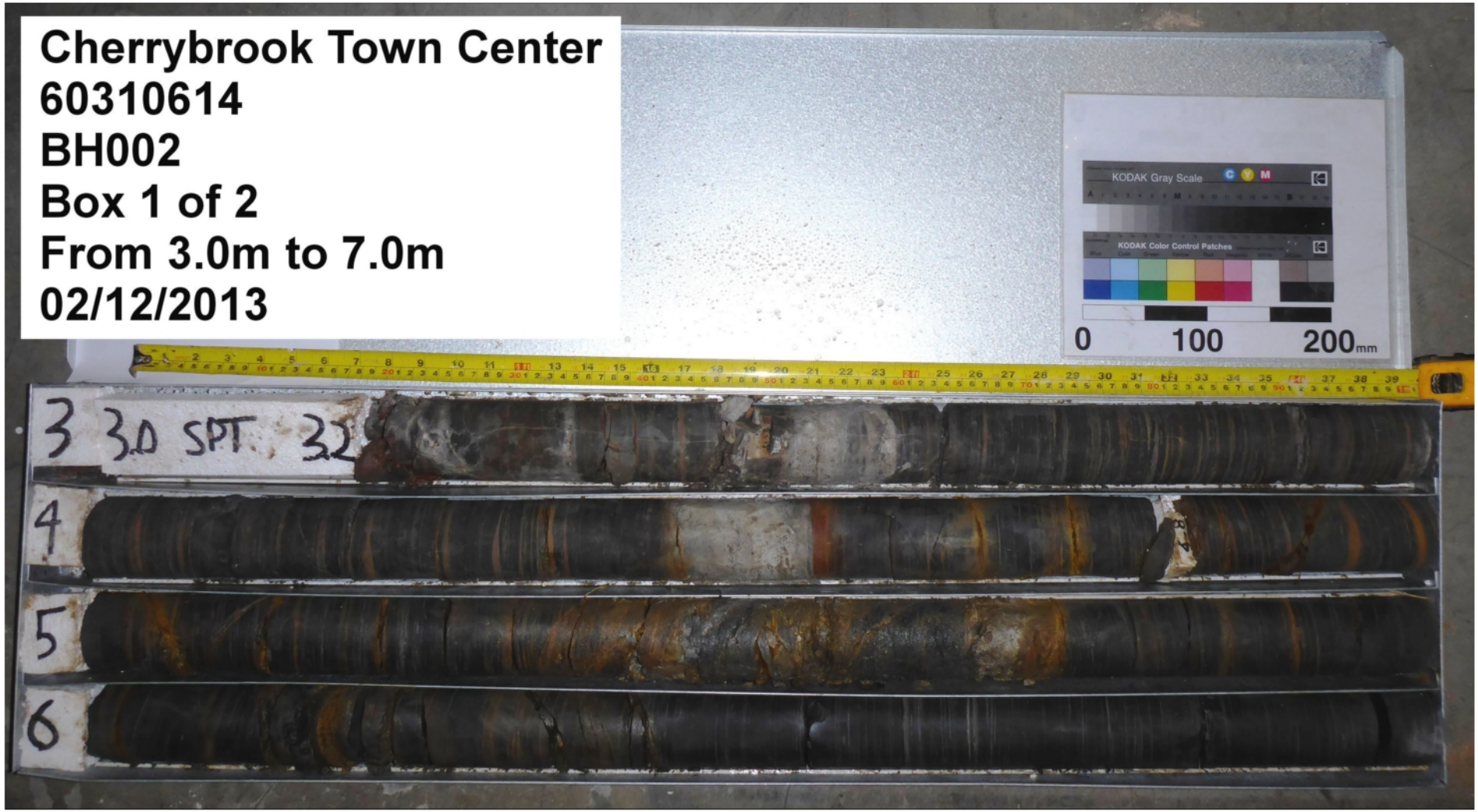
AECOM Engineering Log

CORED BOREHOLE No. BH002

Sheet: 4 of 4

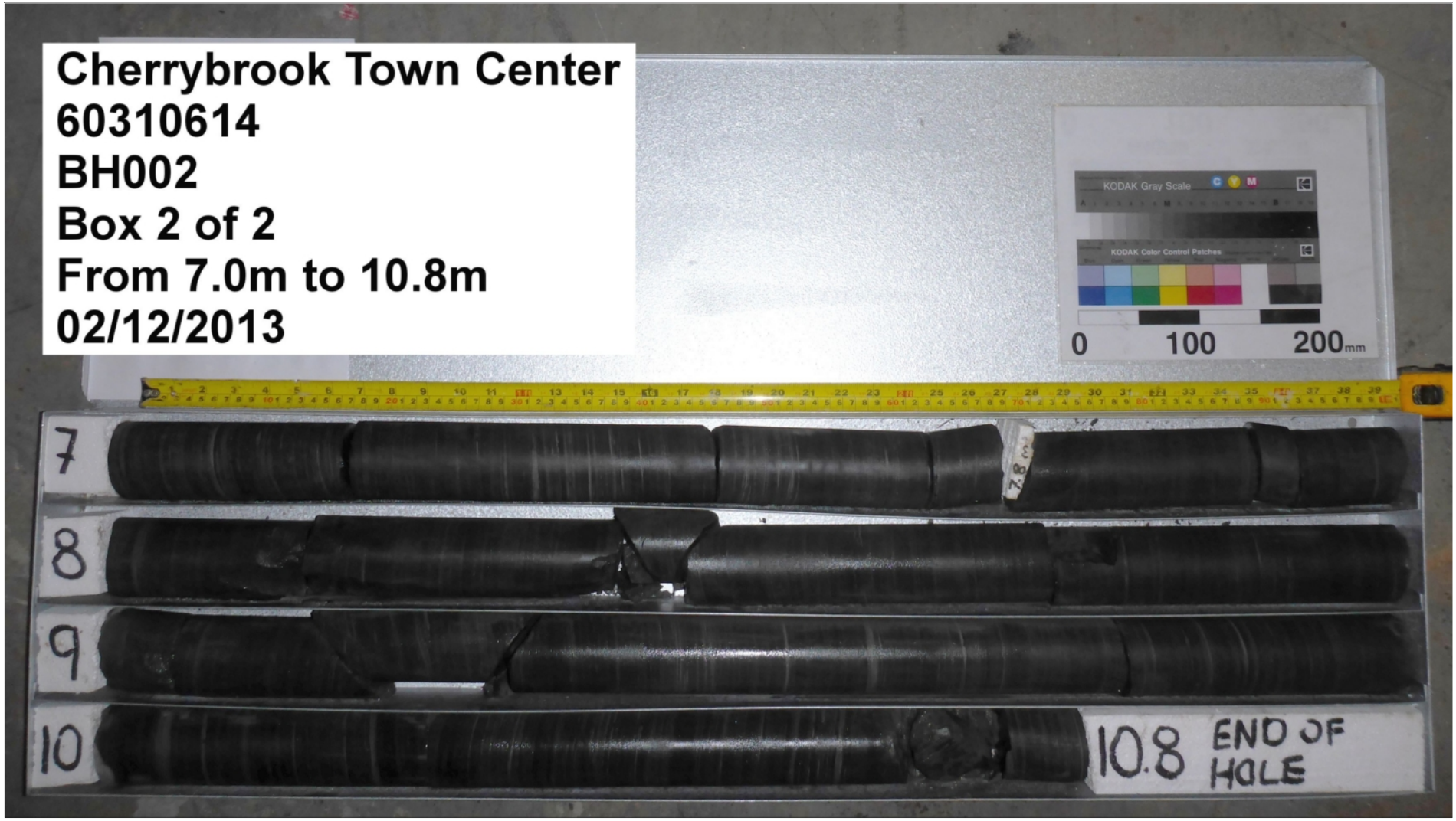
Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317486.0 m	**RL:** 157.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265233.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 3	100	95				147.0			SILTSTONE: grey and dark grey, with occasional thin laminations of sandstone, fine grained, light grey, at 0-5°. *continued* From 10.2 m laminations at 5°.					2 of 2
							146.5	10.5						CZ, 0°, drilling induced	
							146.0	11.0		*BH002 terminated at 10.80 m. Reached target depth*					
							145.5	11.5							
							145.0	12.0							
							144.5	12.5							
							144.0	13.0							
							143.5	13.5							
							143.0	14.0							
							142.5	14.5							
								15.0							



P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH002\2_BH002 Box 1.JPG printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH002
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	3.20 m to 7.00 m
		ORIGINAL SIZE:	A4	BOX No.	1 of 2



P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH002\2_BH002 Box 2.JPG printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH002
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	7.00 m to 10.80 m
		ORIGINAL SIZE:	A4	BOX No.	2 of 2

AECOM Engineering Log

BOREHOLE No. **BH003**

Sheet: 1 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317499.0 m	**RL:** 153.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265140.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data								Material Description	Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	HWT	▽			153.0	0.0		OL	SILT: low plasticity, dark brown, trace clay, fine to coarse sand, gravel and rootlets.	M	St	TOPSOIL
								CH	Silty CLAY: high plasticity, brown-grey mottled light grey and orange, trace sand.			RESIDUAL
					152.5	0.5						
					152.0	1.0						
			SPT:3,21,25 N=46						LAMINITE: light brown, EW, remoulds to silty CLAY, high plasticity, trace of gravel.			BEDROCK
					151.5	1.5						
									Borehole BH003 continued as cored borehole from 1.60 m			
						2.0						
						2.5						
						3.0						
						3.5						
						4.0						
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH003

Sheet: 2 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317499.0 m	**RL:** 153.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265140.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (A:● D:○ I:◆) (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							153.0	0.5							
							152.5	1.0							
							152.0	1.5							
				3/12/2013			151.5			*Continued from non-cored borehole at 1.60 m*					
HQ3	Run 1	100	35				151.0	2.0		LAMINITE: siltstone (70%), dark grey, with thin laminations of sandstone, fine grained, light grey and orange, at 0°, spacing 1 mm to 10 mm. From 1.95 m to 2.7 m, EW seams 2 mm to 30 mm thick, spaced at 10 mm to 200 mm.				B, 0°, PL, ro, 2 mm, co, clay B, 0°, PL, ro, 4 mm, co, clay B, 0°, PL, ro, 15 mm, EW, clay J, 45°, ST, closed B, 0°, PL, ro, 2 mm, co, clay J, 45°, ST, closed B, 0°, PL, ro, 3 mm, co, clay B, 0°, PL, ro, 2 mm, co, clay B, 0°, PL, ro, stn, spaced 20 mm, Fe, x 4 J, 90°, closed EW, 0°, 30 mm, co, ltgy silty clay S to VSt parallel to bedding Fe B, 0°, PL, ro, stn, Fe CZ, 0°, intact core with gravel and clay along bedding and subvertical joint B, 0°, PL, ro, vn, spaced 50 mm, clay, Fe, x 3 J, 60°, ro, Fe J, 80°, co, clay J, 45°, PL, ro, stn, Fe EW, 0°, 50 mm, co, silty clay B, 0°, 10 mm, co, gravelly clay	1 of 3
							150.5	2.5							
							150.0	3.0						B, 0°, 4 mm, co, gravelly clay B, 0°, PL, ro, stn, Fe	
							149.5	3.5						B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, vn, clay Fe B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, vn, gravelly clay B, 0°, PL, ro, cn B, 0°, PL, ro, cn J, 20°, PL, ro, stn, Fe	
	Run 2	100	84				149.0	4.0		From 4.0 m iron staining becomes rare.				B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, vn, clay B, 0°, PL, ro, vn, clay, Fe B, 0°, PL, ro, stn, Fe J, 90°, CU, ro EW, 0°, 30 mm, co, clay B, 0°, PL, ro, stn, Fe	
							148.5	4.5		From 4.8 m to 5.2 m bedding at 30°.				B, 0°, PL, ro, vn, clay, Fe 20 mm either side	
								5.0						B, 0°, PL, ro, cn J, 10°, PL, ro, stn, Fe 20 mm either side J, 10°, PL, ro, stn, Fe 20 mm either side	

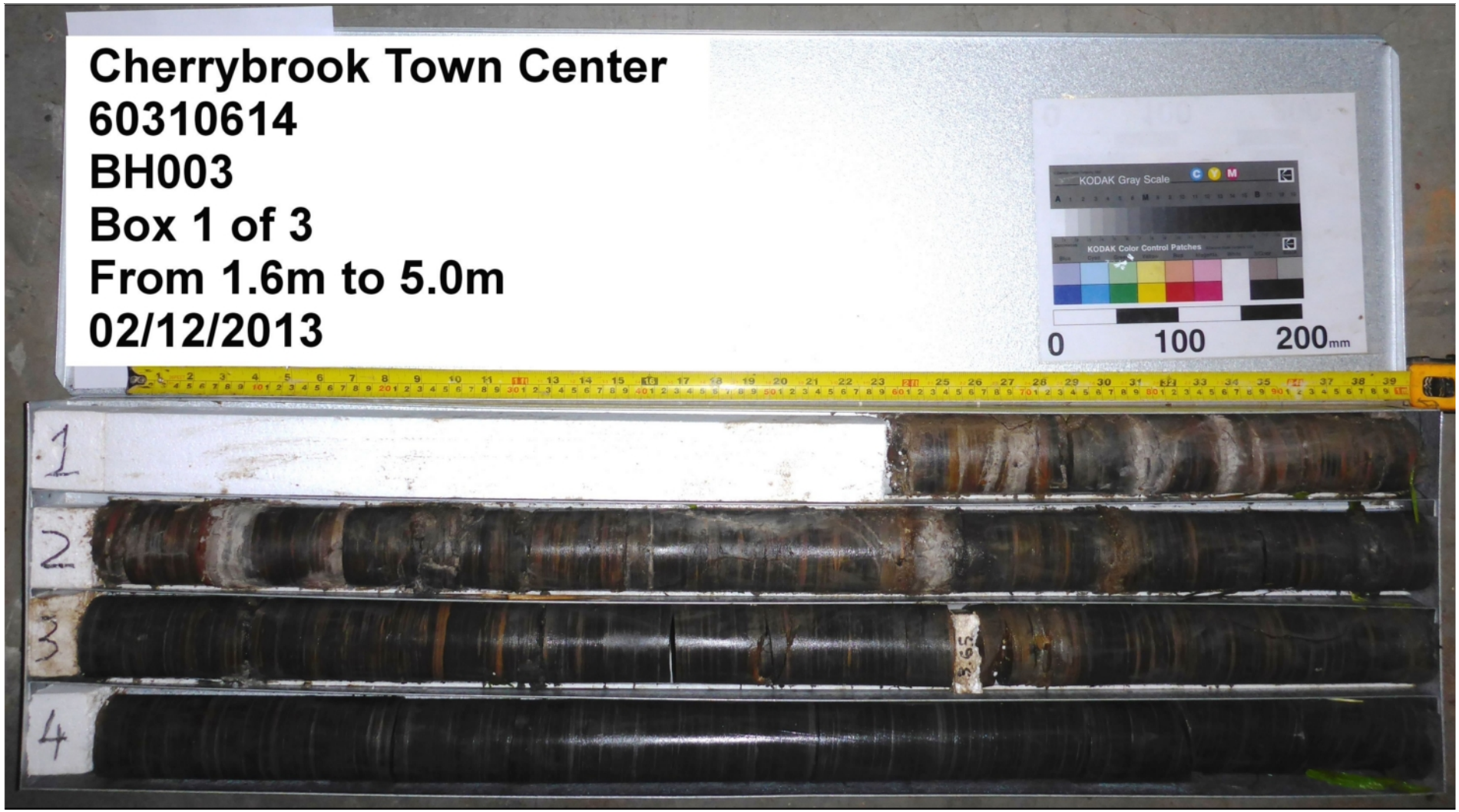
AECOM Engineering Log

CORED BOREHOLE No. BH003

Sheet: 3 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	2/12/2013	**End Date:** 2/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317499.0 m	**RL:** 153.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265140.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	100	84				148.0			LAMINITE: siltstone (70%), dark grey, with thin laminations of sandstone (30%), fine grained, light grey, at 0°, spacing 1 mm to 10 mm.				J, 50°, CU, ro, stn, Fe	
							147.5	5.5						J, 45°, PL, ro, vn, clay	
							147.0	6.0		SILTSTONE: dark grey, with occasional sandstone laminations.				B, 0°, PL, ro, stn, Fe 30 mm either side	
							146.5	6.5						B, 0°, PL, ro, vn, clay Fe	
							146.0	7.0						B, 0°, PL, ro, vn, clay Fe	
							145.5	7.5						B, 0°, PL, ro, stn, Fe	2 of 3
	Run 3	100	100				145.0	8.0						B, 0°, PL, ro, stn, Fe 5 mm either side	
							144.5	8.5						J, 20°, PL, ro, stn, Fe	
							144.0	9.0						J, 20°, PL, ro, stn, Fe	
							143.5	9.5						J, 30°, PL, ro, stn, Fe	
														B, 0°, PL, ro, stn, Fe	
														J, 80°, PL, ro, from 9.17m to 9.30m	3 of 3
														J, 5°, PL, ro, cn	
							10.0			*BH003 terminated at 9.70 m. Reached target depth*					



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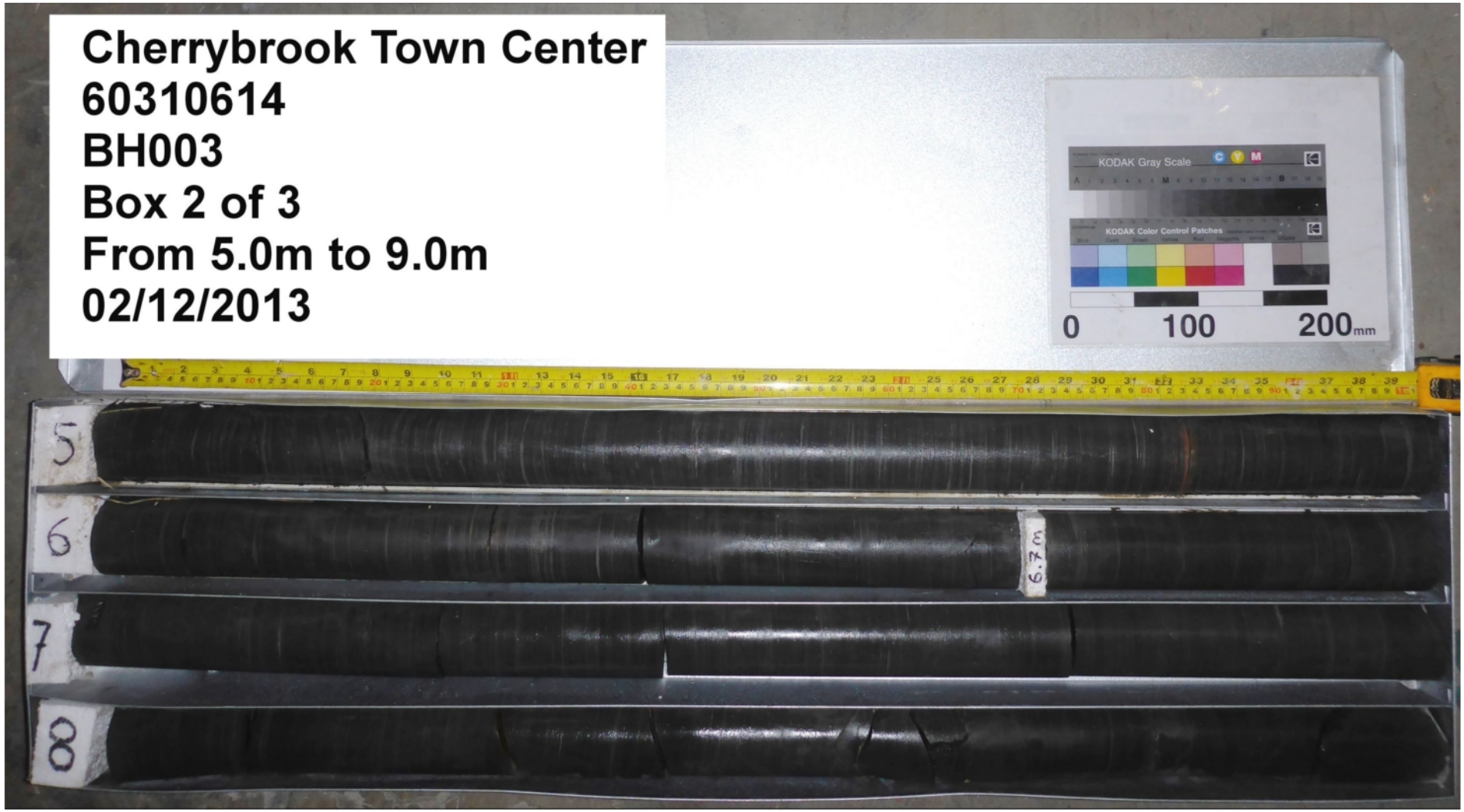
CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH003
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	1.59 m to 5.00 m
		ORIGINAL SIZE:	A4	BOX No.	1 of 3



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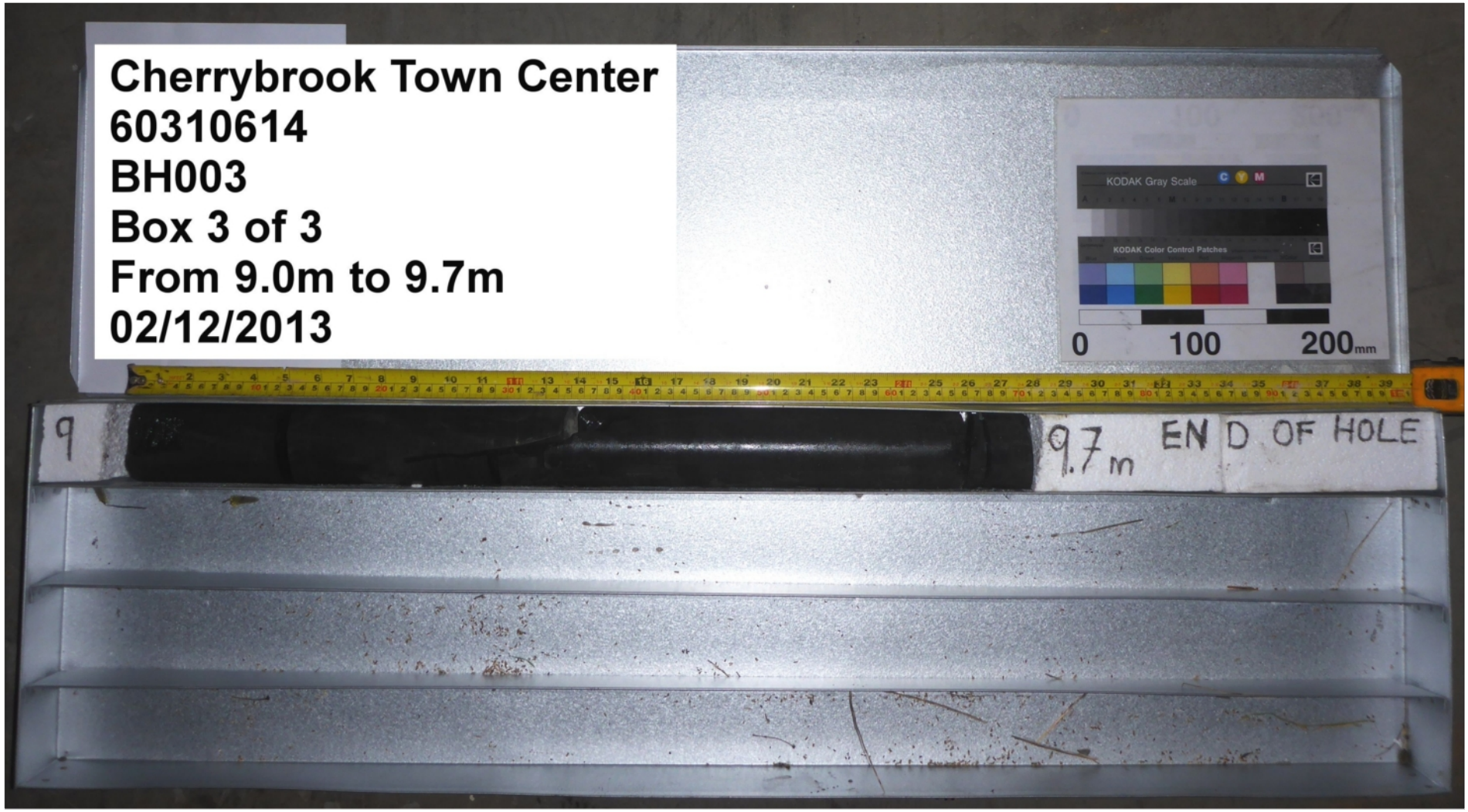
CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH003
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	5.00 m to 9.00 m
		ORIGINAL SIZE:	A4	BOX No.	2 of 3



P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH003\2_BH003 Box 3.JPG printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH003
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	9.00 m to 9.70 m
		ORIGINAL SIZE:	A4	BOX No.	3 of 3

AECOM Engineering Log

BOREHOLE No. **BH004**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	127 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317535.0 m	**RL:** 174.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265374.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	HWT				174.0	0.0		OL	SILT: low plasticity, dark brown, trace clay, fine to coarse sand, gravel and rootlets.	D	St	TOPSOIL
								CI	Silty CLAY: medium plasticity, light brown, trace sand and fine to coarse angular to sub-rounded gravel.			RESIDUAL
					173.5	0.5			LAMINITE: EW, grey, mottled brown, inferred very low strength			BEDROCK
			SPT:6,30/80mm N=R		173.0	1.0						
									Borehole BH004 continued as cored borehole from 1.20 m			
						1.5						
						2.0						
						2.5						
						3.0						
						3.5						
						4.0						
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH004

Sheet: 2 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	127 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317535.0 m	**RL:** 174.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265374.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH) A:● D:○ I:◆	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							174.0								
							173.5	0.5							
							173.0	1.0		*Continued from non-cored borehole at 1.20 m*					
HQ3	Run 1	100	55				172.5	1.5		LAMINITE: siltstone (60%), dark brown-grey, with thin laminations of sandstone (40%), fine grained, light grey and orange, at 0-5°, spaced at 1 mm to 10 mm From 1.2 m to 5.2 m, with EW seams 2 mm to 15 mm thick, spaced 10 mm to 500 mm.				B, 0°, PL, ro, 3 mm, co, gravelly clay J, 45°, ST, healed B, 0°, PL, ro, 2 mm, co, gravelly clay	
							172.0	2.0						EW, 0°, 20 mm, co, gravelly clay B, 0°, PL, ro, vn, clay, Fe	
							171.5	2.5						B, 0°, PL, ro, vn, clayey gravel, Fe B, 0°, PL, ro, vn, clayey gravel, Fe J, 45°, vn, clay, healed J, 45°, vn, clay, healed B, 0°, vn, clay, Fe B, 0°, PL, ro, vn, clay, Fe J, 45°, healed B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, 2 mm, co, clay, Fe B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, 3 mm, co, clay J, 90°, healed J, 90°, vn, clay, closed	
							171.0	3.0						EW, 0°, 10 mm, co, clay B, 0°, 5 mm, co, clay B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, 2 mm, co, spaced 30 mm, clay, Fe, x 3 B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, 2 mm, co, clayey gravel, Fe	
							170.5	3.5						J, 60°, healed, form 3.41m to 3.60m	
				4/12/2013			170.0	4.0						CZ, drilling induced EW, 0°, 15 mm, co, gravelly clay J, 45°, CU, healed J, 45°, ST, stn, Fe, healed B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe EW, 0°, 100 mm, co, clay B, 0°, PL, ro, stn, Fe J, 50°, healed B, 0°, PL, ro, vn, clay, Fe J, 90°, healed	
	Run 2	100	58				169.5	4.5						EW, 0°, 10 mm, co, clay trace fine gravel J, 5°, PL, ro, vn, clay J, 60°, healed B, 0°, PL, ro, cn J, 60°, healed B, 0°, PL, ro, vn, clay EW, 45°/45° on upper surface 0° on lower surface 10mm gravelly clay VSt	
							169.0	5.0						EW, 0°, co, clay	

1 of 3

2015_ANZ_COREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH004

Sheet: 3 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	127 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317535.0 m	**RL:** 174.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265374.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering RS EW HW MW SW FR	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) 20 60 200 600 2000	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	100	58				169.0			LAMINITE: siltstone (60%), dark brown-grey, with thin laminations of sandstone (40%), fine grained, light grey and orange, at 0-5°, spaced at 1 mm to 10 mm *continued*				EW, 0°, 15 mm, co, clay J, 70°, vn, clay J, 30°, CU, ro, vn, clay B, 0°, PL, ro, vn, clay J, 40°, PL, ro, stn, Fe B, 0°, PL, ro, 2 mm, co, clay, Fe J, 45°, closed B, 0°, PL, ro, vn, clay, Fe	
							168.5	5.5						J, 45°, PL, ro, 8 mm, co, gravelly clay	
														J, 90°, healed, from 5.50m to 5.65m	
										From 5.72 m to 5.78 m fracture zone, 60º				FZ, 60 mm fine to coarse angular gravel and clay J, 80°, PL, ro, stn, Fe J, 80°, PL, ro, stn, Fe	
							168.0	6.0		From 6.00 m: iron staining reducing, still present on defects.				CZ, 30 mm f to c gravel and clay EW, clay	
							167.5	6.5						J, 50°, PL, ro, cn B, 0°, PL, ro, vn, clay	
	Run 3	100	83											B, 0°, PL, ro, vn, clay J, 85° J, 45°, healed J, 45°, healed, opposing above direction	
							167.0	7.0		SILTSTONE: dark grey, with occasional thin laminations of sandstone, fine grained, light grey, at 0º				B, 0°, PL, ro, vn, clay	2 of 3
														J, 60°, PL, ro, stn, Fe B, 0°, PL, ro, vn, clay	
							166.5	7.5						B, 0°, PL, ro, vn, clay, Fe extends 10 mm either side	
														B, 0°, PL, ro, vn, clay, Fe extends 10 mm either side B, 0°, PL, ro, vn, clay, Fe extends 10 mm either side B, 0°, PL, ro, vn, clay FZ, multiple bedding and clay seams up to 20 mm thick joints at 20° typically B, 0°, PL, ro, cn	
							166.0	8.0		From 7.95 m to 8.05 m: fracture zone, 20º.				B, 25°, PL, ro, cn	
										From 8.2 m bedding transitioning to 10° to 20°.					
							165.5	8.5						B, 5°, PL, ro, vn, clay, Fe	
														J, 60°, closed B, 10°, PL, ro, vn, clay J, 60°, closed	
							165.0	9.0						J, 20°, PL, ro, stn, Fe	
														B, 0°, PL, ro, cn J, 20°, PL, ro	3 of 3
	Run 4	100	89				164.5	9.5						J, 35°, PL, ro, vn, clay with fine gravel	
							10.0								

2015_ANZ_COREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

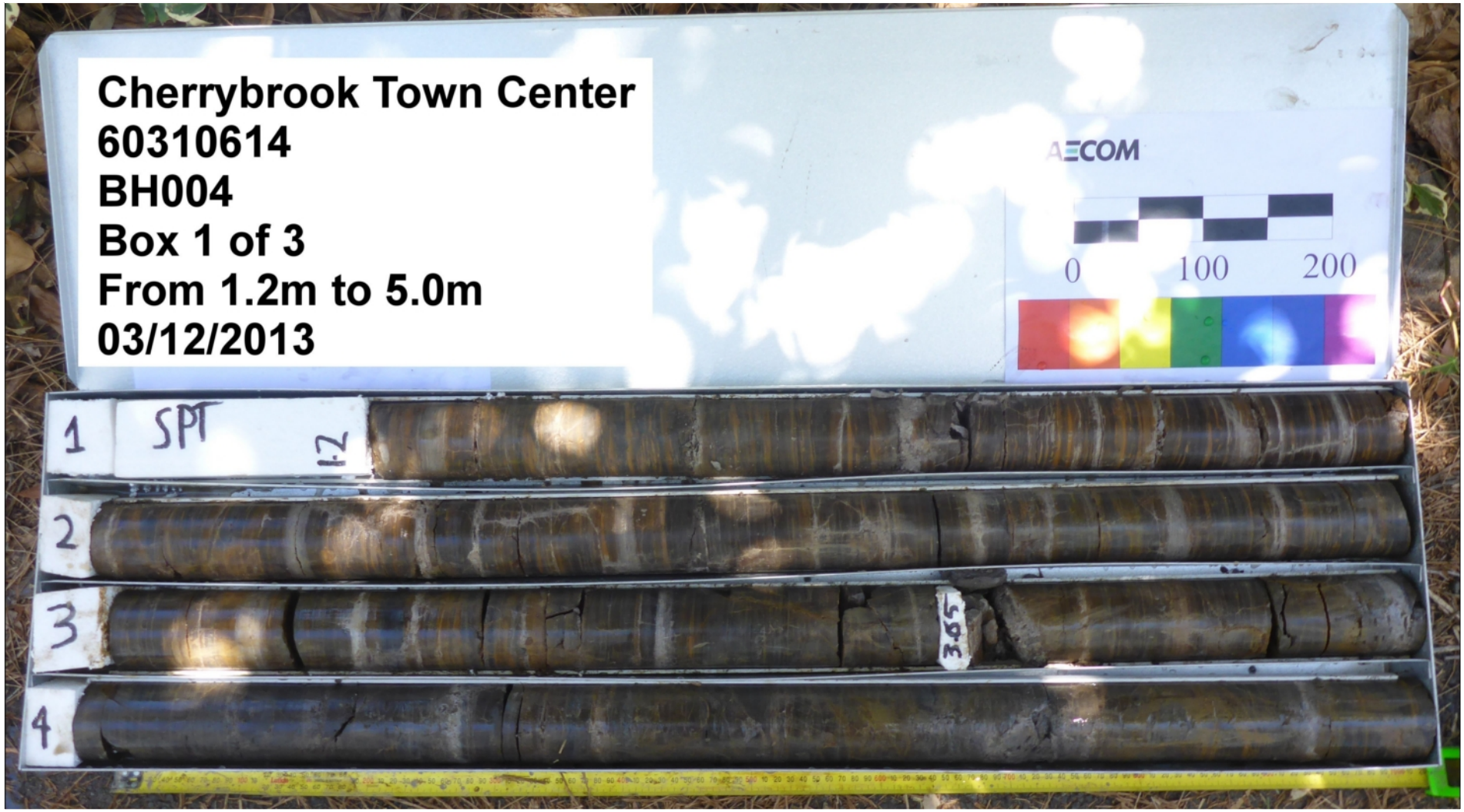
AECOM Engineering Log

CORED BOREHOLE No. BH004

Sheet: 4 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	127 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317535.0 m	**RL:** 174.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265374.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 4	100	89				164.0			SILTSTONE: dark grey, with occasional thin laminations of sandstone, fine grained, light grey, at 10-20º				CZ, 60 mm, drilling induced	
							163.5	10.5						B, 0°, PL, ro, cn J, 45°, PL, ro B, 0°, PL, ro, vn, gravelly clay J, 45°, PL, ro, cn	
							163.0	11.0		From 11.0 m to 12.0 m bedding transitioning to 0°.				J, 40°, PL, ro, vn, clay	
							162.5	11.5						J, 80°, closed	3 of 3
							162.0	12.0							
							161.5	12.5							
							161.0	13.0		*BH004 terminated at 12.70 m.* *Reached target depth*					
							160.5	13.5							
							160.0	14.0							
							159.5	14.5							
								15.0							



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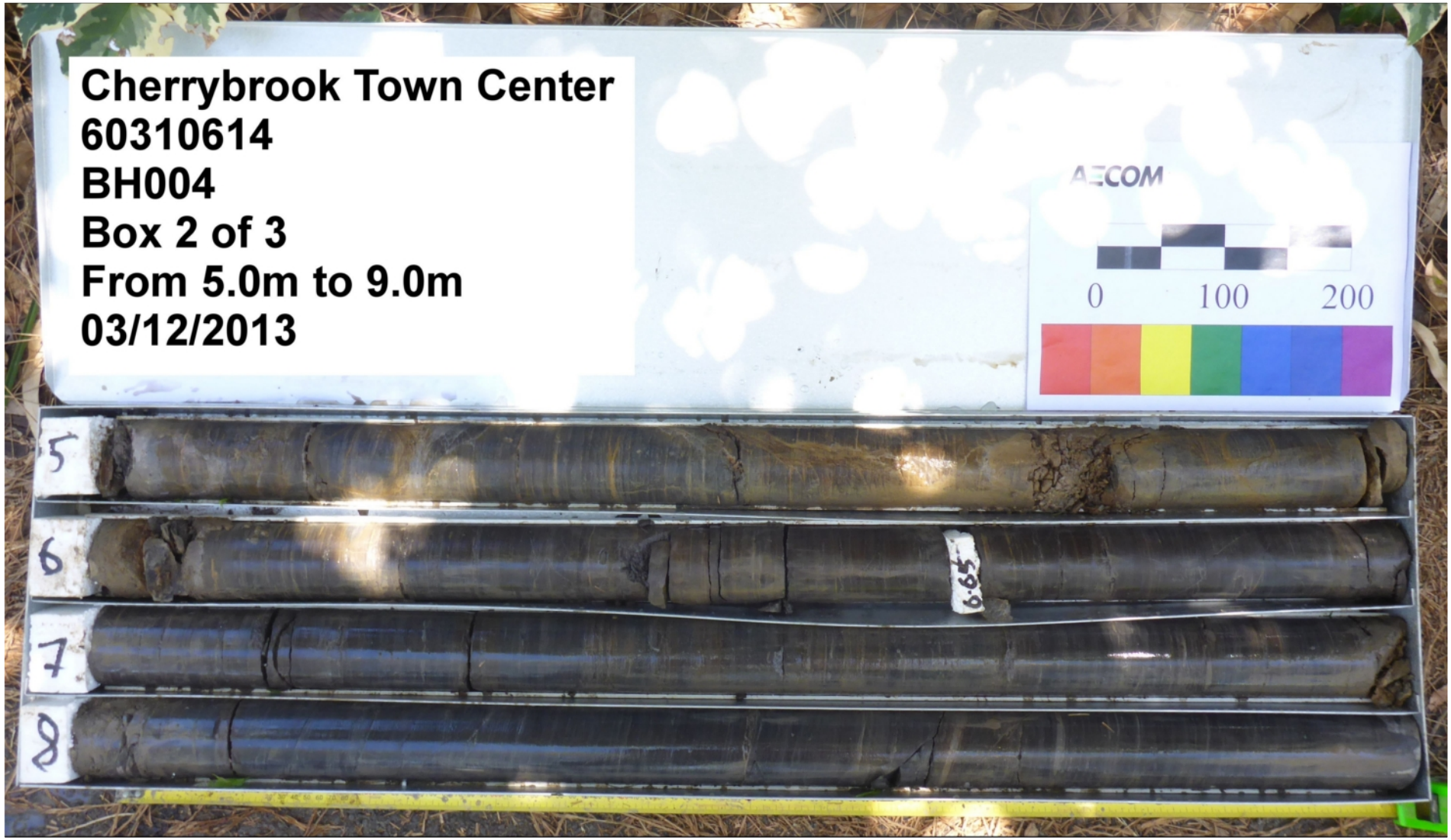
CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH004
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	1.20 m to 5.00 m
		ORIGINAL SIZE:	A4	BOX No.	1 of 3



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CLIENT:	Grimshaw	APPROVED:	PC	AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016		BOREHOLE NO: BH004
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 5.00 m to 9.00 m
		ORIGINAL SIZE:	A4		BOX No. 2 of 3

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CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH004
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	9.00 m to 12.70 m
		ORIGINAL SIZE:	A4	BOX No.	3 of 3

AECOM Engineering Log

BOREHOLE No. **BH005**

Sheet: 1 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	18 Carioca Way		**Start Date:**	4/12/2013	**End Date:** 4/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317445.0 m	**RL:** 155.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265332.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	HWT				155.0	0.0		ML	Sandy SILT: low plasticity, brown, bedding at 0° to 5°	D	St	TOPSOIL
									LAMINITE: EW-HW, dark grey, mottled light brown, inferred extremely low strength. Remoulds to sandy clay, medium plasticity, trace fine to coarse sand, gravel and rootlets.	M		BEDROCK
					154.5	0.5						
					154.0	1.0						
			SPT:22,4/0mm N=R		153.5	1.5			At 1.6 m iron stained gravels.			
		Not Recorded				2.0			*Borehole BH005 continued as cored borehole from 1.65 m*			
						2.5						
						3.0						
						3.5						
						4.0						
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH005

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	18 Carioca Way		**Start Date:**	4/12/2013	**End Date:** 4/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317445.0 m	**RL:** 155.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265332.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH; A:● D:○ I:◆)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							155.0								
							154.5	0.5							
							154.0	1.0							
							153.5	1.5		*Continued from non-cored borehole at 1.65 m*					
HQ3	Run 1	100	46	Not Recorded			153.0	2.0		LAMINITE: dark grey to grey, siltstone (70%), dark brown-grey, with thin laminations of with fine to coarse, angular to sub-rounded gravels.				B, 0°, PL, ro, vn, clay, Fe B, 0°, PL, ro, 2 mm, co, clay, Fe B, 0°, PL, ro, vn, gravelly clay, Fe B, 0°, PL, ro, vn, spaced 10 mm, gravelly clay, Fe, x 6 B, 0°, PL, ro, 5 mm, co, clay B, 0° B, 0°, PL, ro, vn, gravelly clay, Fe B, 0°, PL, ro, vn, gravelly clay, Fe	
							152.5	2.5							
							152.0	3.0						B, 0°, PL, ro, vn, gravelly clay, Fe B, 0°, PL, ro, 2 mm, co, fine angular gravel, Fe B, 0°, PL, ro, vn, gravelly clay, Fe B, 0°, PL, ro, vn, gravelly clay, Fe	
							151.5	3.5						B, 0°, PL, ro, stn, Fe	
							151.0	4.0		from 4.0 m: reduction in iron staining on rock mass.				B, 0°, PL, ro, 10 mm, co, gravelly clay, Fe J, 15°, PL, ro, stn, Fe J, 50°, stn, Fe, healed J, 50°, opposing direction to above J, 50°, stn, Fe, healed J, 50°, stn, Fe, healed B, 0°, PL, ro, stn, Fe J, 50°, stn, Fe, healed J, 50°, stn, Fe, healed B, 0°, PL, ro, stn, spaced 30 mm, Fe, x 6 J, 45°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe J, 45°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe	1 of 3
	Run 2	100	71				150.5	4.5						J, 45°, PL, ro, vn, clay, Fe B, 0°, PL, ro, vn, clay CZ, 20 mm, bedding and joints, vn, clay, Fe B, 0°, UN, ro, stn, Fe J, 40°, PL, ro, stn, Fe J, 90°, healed, from 4.33m to 4.46m, ends on bedding J, 40°, PL, ro, stn, discontinuous through upper bedding Fe J, 45°, closed J, 45°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe J, 40°, closed B, 0°, PL, ro, stn, Fe J, 40°, closed	
							150.0	5.0							

AECOM Engineering Log

CORED BOREHOLE No. BH005

Sheet: 3 of 3

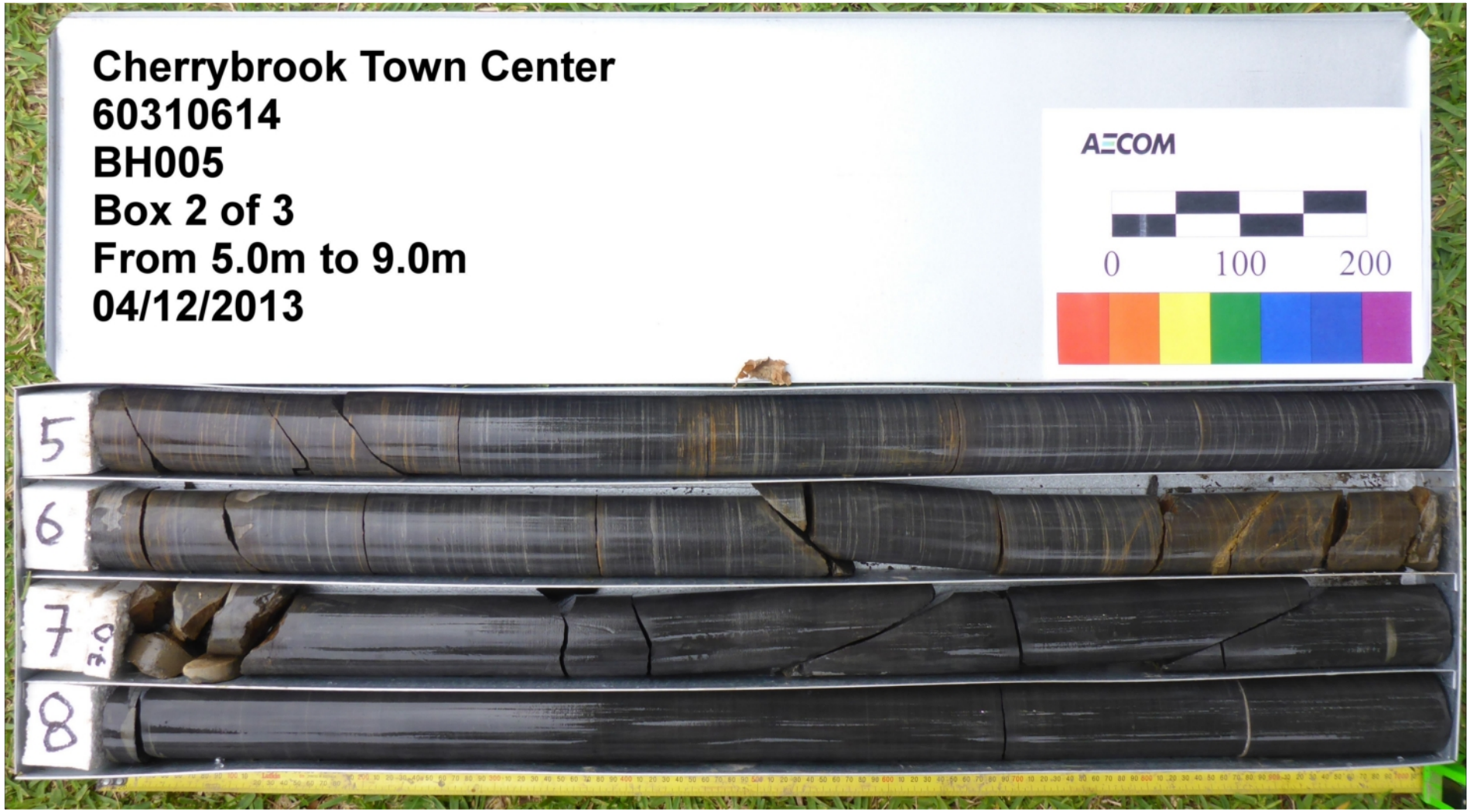
Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	18 Carioca Way		**Start Date:**	4/12/2013	**End Date:** 4/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317445.0 m	**RL:** 155.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265332.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description			Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	100	71	Not Recorded			150.0	0.0		LAMINITE: dark grey to grey, siltstone (70%), dark brown-grey, with thin laminations of with fine to coarse, angular to sub-rounded gravels. *continued*				J, 45°, PL, ro, stn, Fe J, 40°, PL, ro, vn, clay, Fe J, 40°, PL, ro, vn, clay, Fe extends either side J, 40°, PL, ro, vn, clay, Fe extends either side	
							149.5	5.5						B, 0°, PL, ro, stn, Fe extends either side B, 0°, PL, ro, stn, Fe extends either side	
							149.0	6.0						B, 0°, PL, ro, stn, Fe extends either side J, 30°, CU, ro, co, gravelly clay B, 0°, PL, ro, stn, Fe extends either side B, 0°, PL, ro, stn, Fe extends either side	
							148.5	6.5						J, 50°, PL, ro, stn, Fe B, 0°, PL, ro, vn, gravelly clay B, 0°, PL, ro, stn, Fe extends either side J, 40°, closed J, 10°, ir, ro, stn, Fe	
							148.0	7.0		from 6.83 m to 7.60 m: multiple iron stained joints, variable spacing and orientation.				FZ, multiple joints at 5 mm to 40 mm spacing 45° ro pl Fe	2 of 3
	Run 3	100	79				147.5	7.5		SILTSTONE: dark grey to black, with occasional thin laminations of sandstone, fine grained, light grey, at 0-5°, 1 mm to 2 mm thick, with red-brown iron staining.				J, 70°, PL, ro, vn, fine gravel, from 7.47m to 7.60m	
							147.0	8.0						J, 70°, PL, ro, cn	
							146.5	8.5							
							146.0	9.0		At 8.83 m: white lamination, 0°, 2 mm.				J, 45°, PL, ro, cn	
							145.5	9.5						B, 0°, PL, ro, cn J, 20°, PL, ro, cn J, 20°, CU, ro, cn J, 20°, closed	3 of 3
							145.0	10.0		*BH005 terminated at 10.00 m.* *Reached target depth*				B, 0°, PL, ro, 2 mm, co, clayey fine gravel	

2015_ANZ_COREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH005\2_BH005 box 1.JPG printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC	AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016		BOREHOLE NO: BH005
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 1.65 m to 5.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 3



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CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH005
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	5.00 m to 9.00 m
		ORIGINAL SIZE:	A4	BOX No.	2 of 3

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CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH005
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	9.00 m to 10.00 m
		ORIGINAL SIZE:	A4	BOX No.	3 of 3

AECOM Engineering Log

BOREHOLE No. **BH006**

Sheet: 1 of 5

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	109 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317707.0 m	**RL:** 178.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265019.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	HWT				178.0			ML	Sandy SILT: low plasticity, brown, trace clay, fine to coarse sand, gravel and rootlets.	M	St	TOPSOIL
									LAMINITE: EW, light red to brown, remoulds to sandy clay, medium plasticity, with fine to coarse gravel, trace rootlets			BEDROCK
					177.5	0.5						
					177.0	1.0						
			SPT:30/130 N=R			1.5						
					176.5				*Borehole BH006 continued as cored borehole from 1.50 m*			
						2.0						
						2.5						
						3.0						
						3.5						
						4.0						
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH006

Sheet: 2 of 5

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	109 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317707.0 m	**RL:** 178.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265019.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering RS EW HW MW SW FR	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) 20 60 200 600 2000	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							178.0								
							177.5	0.5							
							177.0	1.0							
								1.5		*Continued from non-cored borehole at 1.50 m*					
HQ3	Run 1	100	64	4/12/2013			176.5			LAMINITE: siltstone (60%), brown-grey, with thin laminations of sandstone (40%), fine grained, light grey, at 0°, spaced at 1 mm to 50 mm, with red-brown iron staining. From 1.63 m to 10 m: with occasional EW seams 2 mm to 50 mm.				J, 60°, one half of core EW gravelly clay, from 1.6 m to 1.7 m	
							176.0	2.0						B, 0°, PL, ro, stn, Fe FZ, very closely spaced joints, various orientations, healed Fe	
														B, 0°, PL, ro, vn, clay	
														EW, 0°, 10 mm, co, clay	
														EW, 0°, 10 mm, co, clay	
														EW, 0°, 10 mm, co, clay	
							175.5	2.5						EW, 0°, 10 mm, co, clay B, 0°, 5 mm, co, clay	
														B, 0°, PL, ro, 8 mm, co, clay, Fe	
														B, 0°, PL, ro, stn, Fe	
														B, 0°, PL, ro, vn, clay, Fe	
							175.0	3.0						B, 0°, PL, ro, vn, clay, Fe	
														B, 0°, PL, ro, vn, clay, Fe	
							174.5	3.5						EW, 0°, 50 mm, co, layered grey and brown clay	1 of 4
														CZ, 0°, 80 mm, fine to coarse angular gravel	
	Run 2	100	80				174.0	4.0						J, 90°, from 3.6 m to 3.8 m CZ, 0°, 20 mm, angular gravel with clay in lower half B, 0°, PL, ro, stn, Fe	
														B, 10°, PL, ro, vn, clay, Fe	
														B, 0°, PL, ro, 4 mm, co, clay J, 90°, UN, ro, cn, spaced 30 mm, x2 J, 50°, CU, ro, 2 mm, co, spaced 20 mm, gravelly clay, Fe, x 4 J, 60°, vn, clay, Fe	
							173.5	4.5						J, 90°, CU, stn, Fe B, 0°, 10 mm, EW, fine gravelly clay	
														J, 60°, vn, clay, Fe	
														J, 45°, closed EW, 0°, fine to coarse gravel EW, 0°, clay	
								5.0							

AECOM Engineering Log

CORED BOREHOLE No. BH006

Sheet: 3 of 5

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	109 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317707.0 m	**RL:** 178.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265019.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	100	80				173.0			LAMINITE: siltstone (70%), dark grey to brown-grey, with thin laminations of sandstone (30%), fine grained, light grey, at 0°, spaced at 1 mm to 50 mm, with red-brown iron staining. with occasional EW seams 2 mm to 50 mm to 10 m depth. From 5.0 m to 11.0 m: multiple joints variable orientations, spacing from 10 mm to 300 mm healed, iron stained.				EW, 0°, clay J, 20°, PL, ro, stn, Fe	
							172.5	5.5						EW, 0°, clay, Fe	
							172.0	6.0						EW, 0°, gravelly clay B, 0°, PL, ro, stn, Fe	
							171.5	6.5						B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, 3 mm, co, clay	
	Run 3	100	90				171.0	7.0						CZ, 0°, 80 mm, due to joint B, 0°, PL, ro, vn, clay, Fe B, 0°, PL, ro, vn, clay, Fe	2 of 4
							170.5	7.5						B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe J, 10°, PL, ro, vn, clay, Fe J, 30°, PL, ro, stn, Fe J, 30°, PL, ro, stn, Fe	
							170.0	8.0						J, 30°, 20 mm, EW, clay J, 30°, PL, ro, stn, spaced 10 mm, Fe, x 2	
							169.5	8.5						J, 70°, PL, ro, stn, Fe discontinuous through bedding	
							169.0	9.0						J, 45°, PL, ro, vn, gravelly clay, Fe	
							168.5	9.5						B, 5°, PL, ro, stn, Fe J, 20°, PL, ro, stn, Fe	3 of 4
														EW, 0°, 20 mm, co, clay B, 0°, PL, ro, vn, clay, Fe	
	Run 4	100	97				10.0							J, 65°, PL, ro, stn, Fe, from 9.8 m to 9.93 m	

AECOM Engineering Log

CORED BOREHOLE No. BH006

Sheet: 4 of 5

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	109 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317707.0 m	**RL:** 178.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265019.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

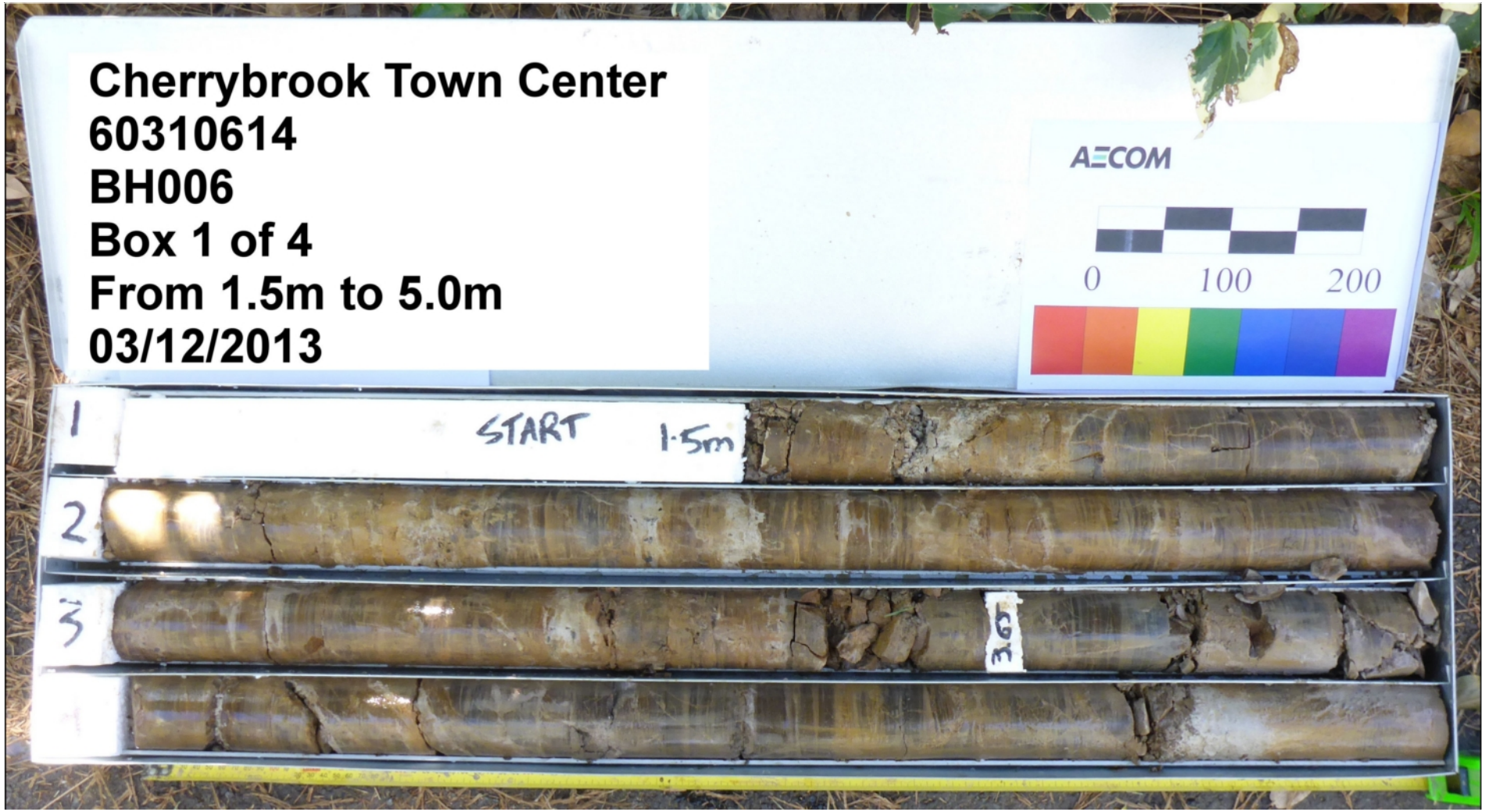
Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 4	100	97				168.0			LAMINITE: siltstone (70%), dark grey to brown-grey, with thin laminations of sandstone (30%), fine grained, light grey, at 0°, spaced at 1 mm to 50 mm, with red-brown iron staining. *continued*				B, 0°, PL, ro, 8 mm, co, gravelly clay	
							167.5	10.5		From 10.60 m to 10.95 m: bedded at 10°.				B, 0°, PL, ro, stn, Fe J, 90° B, 0°, PL, ro, 10 mm, co, gravelly clay	
							167.0	11.0		SILTSTONE: dark grey, with thin laminations of sandstone (10%), fine grained, light grey, bedded at 0°, spaced at 1 mm to 10 mm.				J, 45°, PL, ro, vn, clay	
														B, 0°, PL, ro, vn, clay, Fe extends either side	
														B, 0°, PL, ro, vn, clay, Fe extends either side	
							166.5	11.5						B, 0°, PL, ro, vn, clay, Fe extends either side	3 of 4
														B, 0°, PL, ro, vn, clay, Fe extends either side	
							166.0	12.0						B, 0°, PL, ro, vn, clay, Fe extends either side	
							165.5	12.5						B, 0°, PL, ro, vn, clay, Fe extends either side	
							165.0	13.0						J, 40°, PL, ro, cn	
	Run 5	100	97				164.5	13.5						B, 0°, PL, ro, vn, gravelly clay	
							164.0	14.0						B, 0°, PL, ro, stn, Fe	4 of 4
							163.5	14.5						J, 90°, ir, ro, stn, Fe, from 14.27m to 14.41m, ends on bedding B, 0°, PL, ro, cn	
														J, 90°, PL, ro, stn, from 14.55 m to 14.70 m	
														J, 90°, from 14.70 m to 14.84 m B, 0°, PL, ro, cn	
							163.0	15.0							

AECOM Engineering Log

CORED BOREHOLE No. BH006

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	109 Castle Hill Road		**Start Date:**	3/12/2013	**End Date:** 3/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317707.0 m	**RL:** 178.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265019.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 5	100	97				163.0			SILTSTONE: dark grey, with thin laminations of sandstone (10%), fine grained, light grey, bedded at 0°, spaced at 1 mm to 10 mm. *continued*				B, 0°, PL, ro, 3 mm, co, gravelly clay	4 of 4
							162.5	15.5							
										BH006 terminated at 15.80 m. Reached target depth					
							162.0	16.0							
							161.5	16.5							
							161.0	17.0							
							160.5	17.5							
							160.0	18.0							
							159.5	18.5							
							159.0	19.0							
							158.5	19.5							
								20.0							



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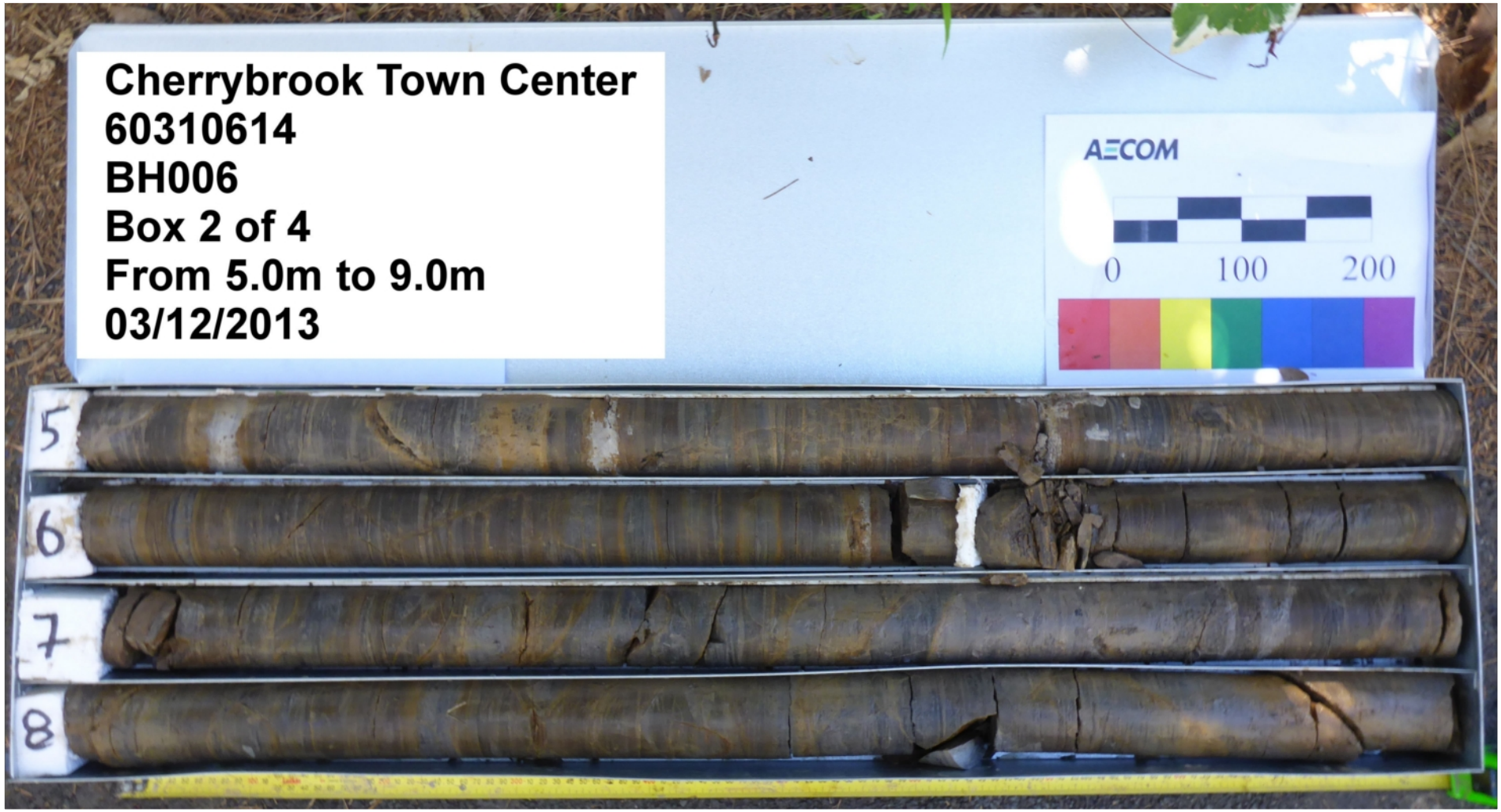
CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH006
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	1.50 m to 5.00 m
		ORIGINAL SIZE:	A4	BOX No.	1 of 4



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CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH006
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	5.00 m to 9.00 m
		ORIGINAL SIZE:	A4	BOX No.	2 of 4

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CLIENT:	Grimshaw	APPROVED:	PC	AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016		BOREHOLE NO: BH006
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 9.00 m to 13.00 m
		ORIGINAL SIZE:	A4		BOX No. 3 of 4

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CLIENT:	Grimshaw	APPROVED:	PC	AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016		BOREHOLE NO: BH006
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 13.00 m to 15.80 m
		ORIGINAL SIZE:	A4		BOX No. 4 of 4

AECOM Engineering Log

BOREHOLE No. **BH007**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	6/12/2013	**End Date:** 6/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317449.0 m	**RL:** 145.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265192.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
HA	HWT				145.0			OL	SILT: low plasticity, dark brown, with clay, fine to coarse sand, gravel and rootlets.	M		FILL
								CI	Sandy CLAY: medium to high plasticity, dark brown mottled light red to brown, with sub-rounded to angular, iron stained gravels and cobbles, trace fine to medium sand and rootlets			
					144.5	0.5						
			SPT:2,3,4 N=7									
					144.0	1.0			at 1.0 m: light grey mottled dark brown clay layer 10 mm thick, VSt.			
			SPT:2,3,2 N=5		143.5	1.5			at 1.7 m: soft pockets and voids.			
ADT	HWT	Not Recorded 8/09/2014			143.0	2.0		CH	Silty CLAY: high plasticity, dark brown mottled red to light brown, trace sand and fine to coarse, sub-rounded to angular siltstone gravel.			
					142.5	2.5						
		12/03/2014	SPT:5,8,11 N=19		142.0	3.0		CI	Gravelly CLAY: medium plasticity, light grey mottled yellow brown and red-brown, trace sand, gravel is fine to coarse, angular, iron indurated		VSt	RESIDUAL
					141.5	3.5						
					141.0	4.0						
					140.5	4.5						
			SPT:7,12,22 N=34									
					140.0	5.0			Silty SAND: fine to coarse grained, light grey to yellow-brown		MD	

Borehole BH007 continued as cored borehole from 5.00 m

AECOM Engineering Log

CORED BOREHOLE No. BH007

Sheet: 2 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	6/12/2013	**End Date:** 6/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317449.0 m	**RL:** 145.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265192.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data | **Rock Description** | **Discontinuities**

Method: HQ3 | Core Run: Run 2, Run 3 | TCR (%): 100, 100 | RQD (%): 99, 100 | Ground Water: Not Recorded | Field Samples and Tests | WPT (Lugeons)

Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
140.0			*Continued from non-cored borehole at 5.00 m*					
			SANDSTONE: fine to medium grained, light grey mottled orange and brown, with EW seams of sandy clay up to 200 mm thick.					
139.5	5.5							
139.0	6.0						B, 0°, PL, ro, stn, Fe B, 0°, UN, ro, vn, sandy clay, Fe	
			SANDSTONE: fine to medium grained, light brown and light grey, with thin, dark grey laminations and lenses, at 0° to 10°, with red-brown iron staining.					
138.5	6.5							
138.0	7.0		SANDSTONE: fine to medium grained, light grey, with thin, dark grey laminations and lenses, at 0° to 10°, occasional red-brown iron staining.					
			from 7.27 m to 7.57 m: medium grained, iron stained.					
137.5	7.5						B, 0°, PL, ro, 4 mm, co, sandy clay, Fe extends 20 mm past B	
			from 7.59 m to 7.95 m: with frequent undulating, thin laminations of siltstone, dark grey, at 0-5°, 5 to 10mm spacing				EW, 0°, 30 mm, co, silty sand and fine to coarse angular gravel, Fe	
137.0	8.0							
136.5	8.5							
136.0	9.0							
			from 9.15 m to 9.30 m: with frequent undulating, thin laminations of siltstone, dark grey.				EW, 0°, 10 mm, co, sandy clay, fine to coarse angular gravel B, 0°, PL, sm	
135.5	9.5							
	10.0							2 of 2

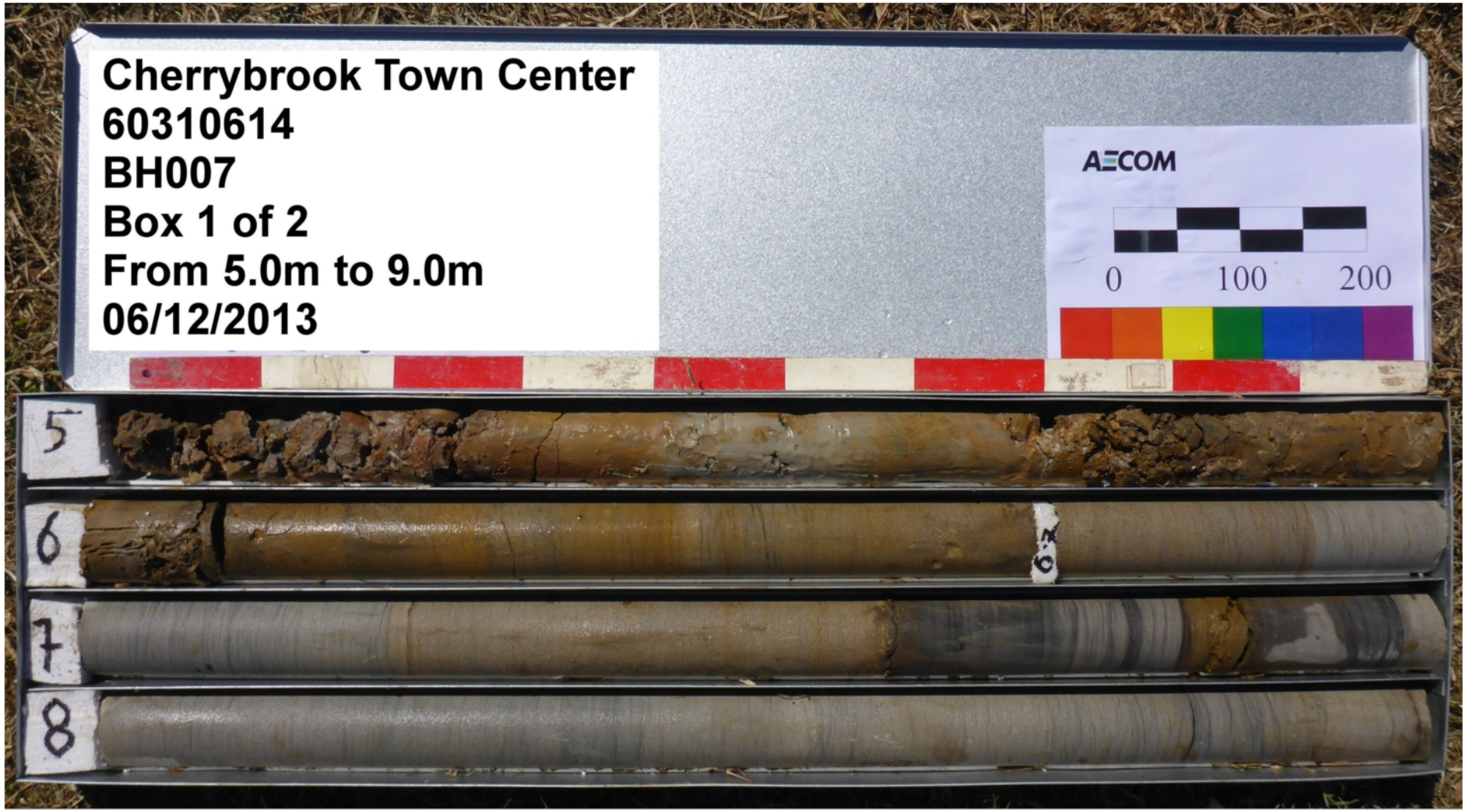
AECOM Engineering Log

CORED BOREHOLE No. BH007

Sheet: 3 of 4

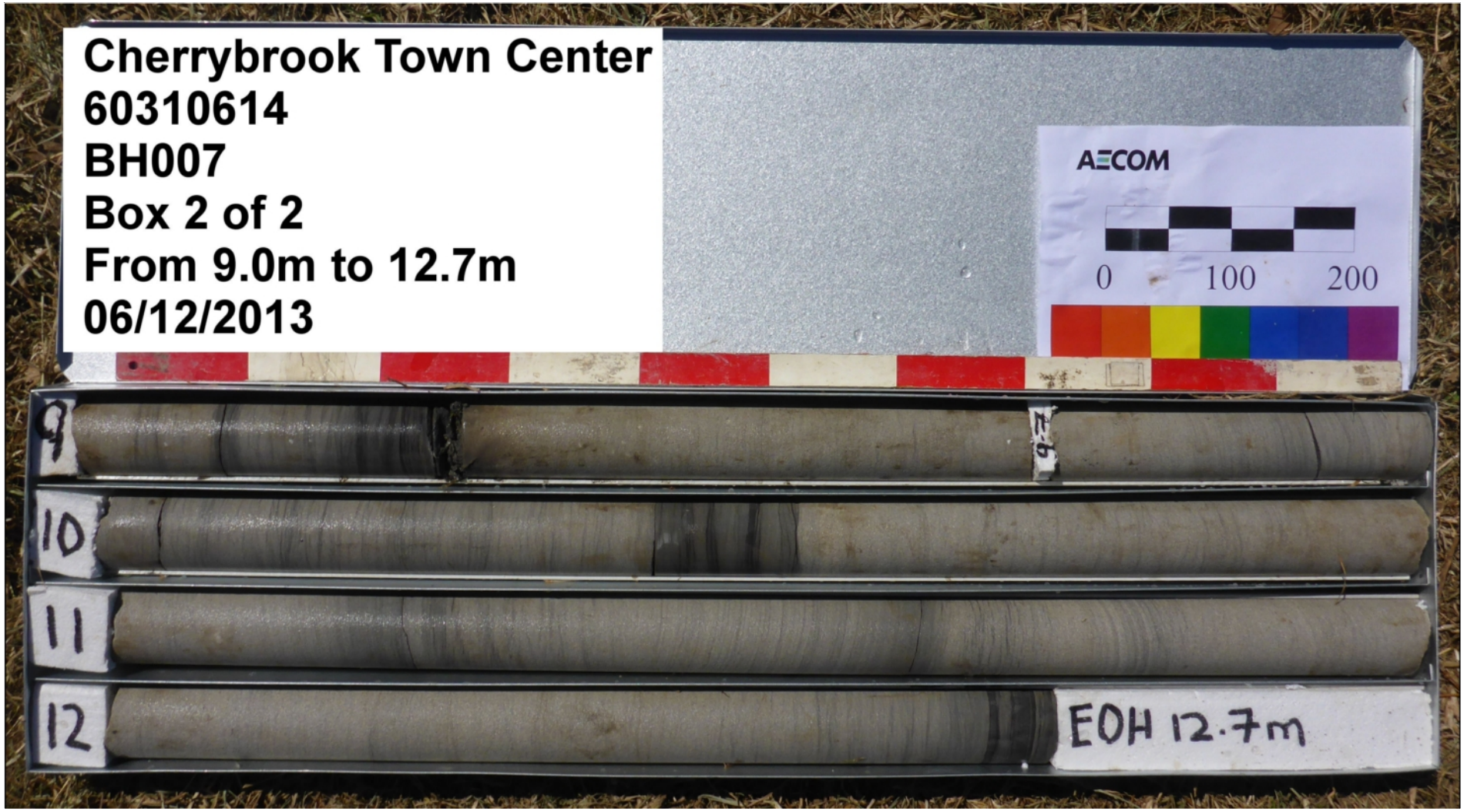
Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	6/12/2013	**End Date:** 6/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317449.0 m	**RL:** 145.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265192.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 3	100	100	Not Recorded			135.0			SANDSTONE: fine to medium grained, light grey, with thin, dark grey laminations and lenses, at 0° to 10°, occasional red-brown iron staining. *continued*					
							134.5	10.5		from 10.41 m to 10.51 m: fine grained, grey, with frequent laminations of siltstone, dark grey.				B, 0°, PL, sm, cn	
							134.0	11.0		from 11.1 m to 11.8 m: cross bedded at 10°.					
							133.5	11.5		From 11.4 m to 11.7 m bedded at 10°, opposite direction to 11.1 m to 11.3 m.					2 of 2
							133.0	12.0							
							132.5	12.5		from 12.65 m to 12.70 m: with thin laminations of siltstone, dark grey, at 0°, 1 mm to 20 mm thick.					
							132.0	13.0		*BH007 terminated at 12.70 m.* *Reached target depth*					
							131.5	13.5							
							131.0	14.0							
							130.5	14.5							
								15.0							



P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH007\2_BH007 Box 1.JPG printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH007
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	4.95 m to 9.00 m
		ORIGINAL SIZE:	A4	BOX No.	1 of 2



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CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH007
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	9.00 m to 12.70 m
		ORIGINAL SIZE:	A4	BOX No.	2 of 2

AECOM Engineering Log

PIEZOMETER No. **BH007**

Sheet: 1 of 1

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	CF	**Checked by:** EC
Location:	9-11 Carioca Court		**Start Date:**	6/12/2013	**End Date:** 6/12/2013
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317449.0 m	**RL:** 145.00 m
Drill Rig:	Comacchio Geo 305	**Inclination:** -90°	**Northing:**	6265192.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log
HA					144.0	0.0	
ADT						2.0	
					142.0		
						4.0	
					140.0		
HQ3	Run 2	100	99	Not Recorded		6.0	
					138.0		
		100	99			8.0	
					136.0		
	Run 3					10.0	
		100	100		134.0		
						12.0	
					132.0		
						14.0	

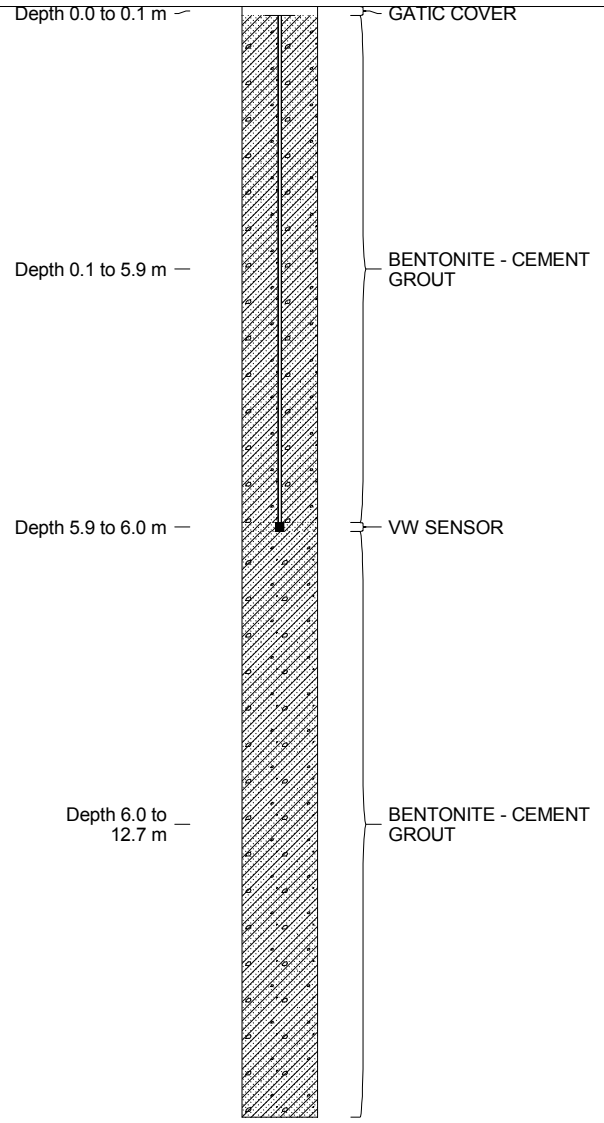
Rock Description

Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm)
SILT, dark brown	
Sandy CLAY, dark brown mottled light red to brown	
Silty CLAY, dark brown mottled red to light brown	
Gravelly CLAY, light grey mottled yellow brown and red-brown	
Silty SAND, fine to coarse grained, light grey to yellow-brown	
SANDSTONE, fine to medium grained, light grey mottled orange and brown	
SANDSTONE, fine to medium grained, light brown and light grey	
SANDSTONE, fine to medium grained, light grey	
BH007 Terminated at 12.70 m.	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction details: NA
Pipe diameter: -
Pipe Top: 5.9 mBGL
Pipe Base: 6.0 mBGL
Screen Top: 5.9 mBGL
Screen/Sensor Base: 6.0 mBGL
Instrument Details: -
Installation Date: 6/12/2013
Development Date: -



REMARKS:
GROUNDWATER MONITORING NOTES:

2015_ANZ_PIEZO 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-01-AA.GDT AECOM_2-03_LIBRARY.GLB 10.6.2016

AECOM Engineering Log

BOREHOLE No. **BH008**

Sheet: 1 of 2

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	7 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 20/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317527.0 m	**RL:** 159.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265215.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	HWT	Not encountered			159.0	0.0		OH	Clayey SILT: medium plasticity, dark brown, trace fine to medium sand and rootlets	M	St	TOPSOIL
								MH	Clayey SILT: medium to high plasticity, light brown-grey, mottled red-brown, trace fine sand			RESIDUAL
					158.5	0.5						
					158.0	1.0		CH	Silty CLAY: medium to high plasticity, light brown-grey, mottled orange		VSt	
			SPT:4,6,12 N=18									
					157.5	1.5			from 1.34 m to 1.45 m: iron cemented bed, dark orange-brown, low strength, recovered as gravels from 1.45 m: trace fine to coarse, sub-rounded gravel of EW siltstone			
					157.0	2.0						
			SPT:9,12,20 N=32		156.5	2.5			LAMINITE: EW, grey, mottled orange-brown, extremely low strength, remoulds to clayey silt under finger pressure			BEDROCK
					156.0	3.0			LAMINITE: HW, dark brown-grey, very low strength, orange iron stained laminations at 0º			
ADT	None				155.5	3.5						
					155.0	4.0			*Borehole BH008 continued as cored borehole from 4.00 m*			
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

AECOM Engineering Log

CORED BOREHOLE No. BH008

Sheet: 2 of 2

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	7 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 20/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317527.0 m	**RL:** 159.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265215.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (A:● D:○ I:◆; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							159.0								
							158.5	0.5							
							158.0	1.0							
							157.5	1.5							
							157.0	2.0							
							156.5	2.5							
							156.0	3.0							
							155.5	3.5							
							155.0	4.0		*Continued from non-cored borehole at 4.00 m*					
HQ3	Run 1	100	17	Not encountered			154.5	4.5		LAMINITE: siltstone (60%), dark brown-grey with undulating, thin laminations of sandstone (40%), fine grained, light grey and orange, at 0°-5°, 1 mm to 5 mm thick, at 5 mm spacing				J, 30°, CU, ro, vn, clay B, 0°, PL, sm, 3 mm, co, clay EW, 0°, PL, ro, 50 mm, co, clay B, 5°, PL, ro, vn, spaced 5 mm, Fe, x 3 B, 0°, PL, sm, 20 mm, co, spaced 20 mm, clay, x 3 EW, 0°, PL, ro, 30 mm, co, clay B, 0°, PL, ro, vn, clay CZ, 5°, PL, ro, 20 mm, co, gravel B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, 5 mm, co, clay CZ, 0°, PL, ro, 50 mm, co, gravel B, 0°, PL, ro, vn, clay B, 5°, PL, ro, stn, Fe B, 5°, PL, ro, cn B, 0°, PL, ro, stn, Fe	1 of 1
							155.0	4.0							

2015_ANZ_COREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

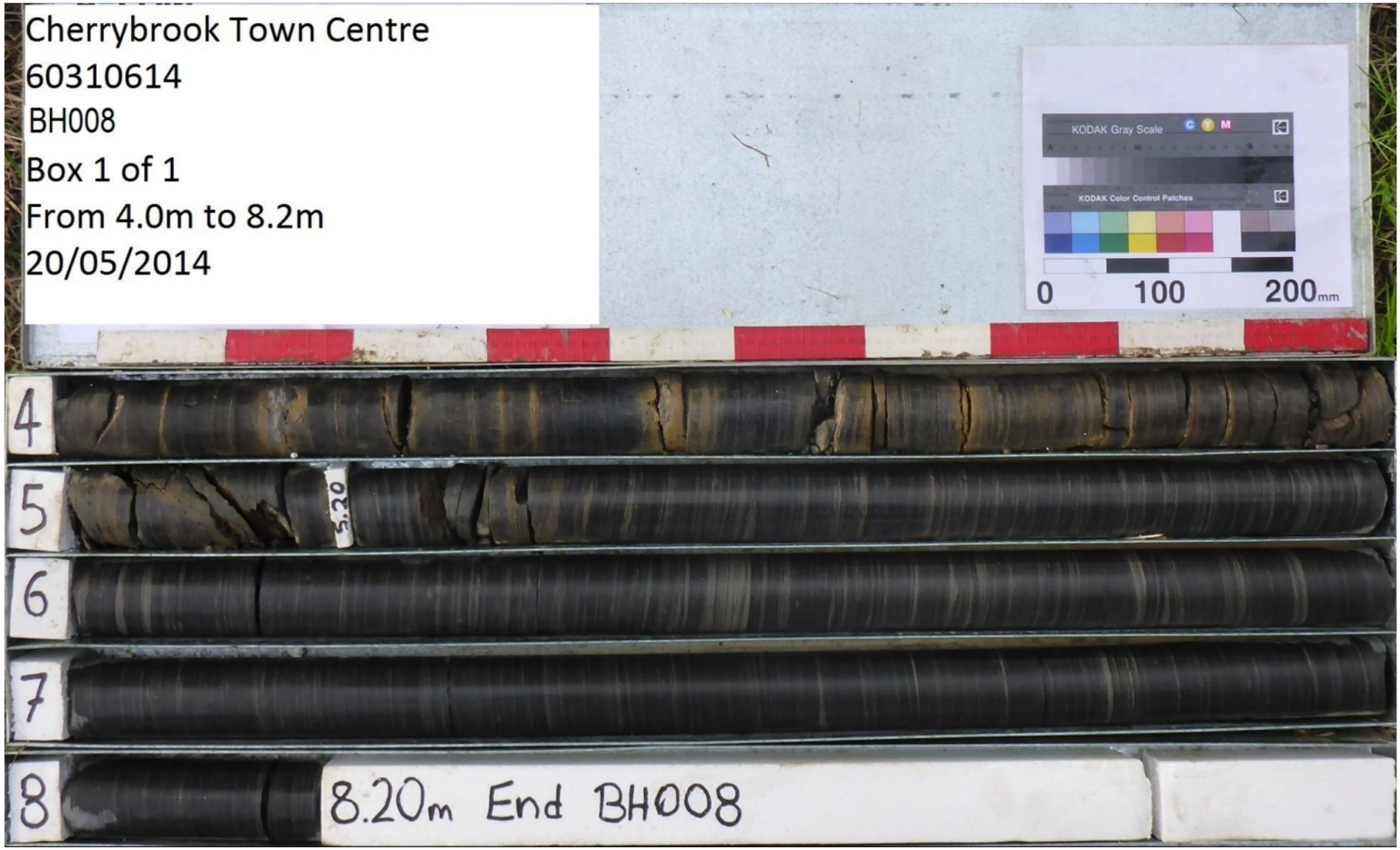
AECOM Engineering Log

CORED BOREHOLE No. BH008

Sheet: 3 of 2

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	7 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 20/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317527.0 m	**RL:** 159.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265215.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data								Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m) / Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 1	100	17	Not encountered			154.0 / 5.0		from 4.95 m to 5.15 m, fracture zone, 70º, 50 mm thick, extremely closely spaced fractures, iron stained LAMINITE: siltstone (60%), dark brown-grey with undulating, thin laminations of sandstone (40%), fine grained, light grey and orange, at 0°-5°, 1 mm to 5 mm thick, at 5 mm spacing *continued* from 5.30 m: dark grey, laminated light grey (iron staining absent)				J, 45°, PL, ro, stn, Fe J, 30°, PL, ro, stn, Fe CZ, 0°, PL, ro, 5 mm, co, gravel FZ, 70°, PL, ro, 50 mm, co, extremely closely spaced joints, fine gravel J, 30°, PL, ro, stn, Fe J, 50°, PL, ro, cn, healed B, 0°, PL, ro, stn, Fe	1 of 1
	Run 2	100	95				153.5 / 5.5							
							153.0 / 6.0							
							152.5 / 6.5							
							152.0 / 7.0		from 7.00 m: reduction in sandstone laminations (to 20%)					
							151.5 / 7.5							
							151.0 / 8.0							
							150.5 / 8.5		*BH008 terminated at 8.20 m.* *Reached target depth*					
							150.0 / 9.0							
							149.5 / 9.5							
							10.0							



P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH008\BH008_Box1.jpg printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH008
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	4.00 m to 8.20 m
		ORIGINAL SIZE:	A4	BOX No.	1 of 1

AECOM Engineering Log

BOREHOLE No. **BH009**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	4 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 21/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317611.0 m	**RL:** 164.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265143.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	None	18/02/2016 ▼ 9/06/2016			164.0	0.0			Clayey SILT: medium plasticity, brown, with fine to coarse, sub-angular to angular, shale, concrete & siltstone gravel, trace sand.	M	St	FILL
					163.5	0.5			Gravelly SILT: low plasticity, brown, with clay and sand		MD	
									Silty CLAY: medium to high plasticity, red-brown, mottled black, trace of fine to coarse, angular to rounded SW siltstone gravel		St	
			SPT:3,5,7 N=12		163.0	1.0			from 1.00 m: light brown-grey, mottled red-brown, trace fine sand, trace fine to medium, sub-rounded fresh siltstone			
					162.5	1.5						
								CH	Silty CLAY: high plasticity, light brown-grey, mottled red-brown, trace fine sub-rounded to sub-angular gravel, trace rootlets			RESIDUAL
					162.0	2.0						
			SPT:3,5,7 N=12		161.5	2.5						
					161.0	3.0						
					160.5	3.5						
			SPT:4,5,7 N=12		160.0	4.0			from 4.00 m: trace fine sand, trace HW siltstone gravel, orange-brown			
					159.5	4.5						
		▽ 21/05/2014				5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 10.6.2016

AECOM Engineering Log

BOREHOLE No. **BH009**

Sheet: 2 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	4 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 21/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317611.0 m	**RL:** 164.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265143.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	None				159.0	0.0		CH	Silty CLAY: high plasticity, light brown-grey, mottled red-brown, trace fine sub-rounded to sub-angular gravel, trace fine sand	W	St	RESIDUAL
			SPT:7,8,10 N=18		158.5	5.5			Clayey SILT: medium plasticity, grey, mottled brown, red, orange, with sand and fine to coarse, angular iron-indurated gravel		VSt	
					158.0	6.0			from 6.30 m: becoming dark brown-grey			
			SPT:23,29/150mm N=R		157.5	6.5			SILTSTONE: EW, extremely low strength, dark grey, mottled orange, grey, remoulds to clayey silt. Laminated at 0°			BEDROCK
					157.0	7.0			from 7.15 m to 7.19 m: silty CLAY bed, dark grey to light grey, medium to high plasticity			
						7.5			from 7.40 m, dark brown-grey			
									Borehole BH009 continued as cored borehole from 7.45 m			
						8.0						
						8.5						
						9.0						
						9.5						
						10.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 10.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH009

Sheet: 3 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	4 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 21/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317611.0 m	**RL:** 164.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265143.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering RS EW HW MW SW FR	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) 20 60 200 600 2000	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							159.0								
							158.5	5.5							
							158.0	6.0							
							157.5	6.5							
							157.0	7.0		*Continued from non-cored borehole at 7.45 m*					
HQ3	Run 1	100	0				156.5	7.5		SILTSTONE: dark brown, with orange iron stained laminations at 1 mm to 50 mm spacing, at 0°, with extremely closely spaced, healed joints, and frequent EW seams.				EW, 0°, PL, ro, 50 mm, co, clay EW, 5°, PL, ro, 40 mm, co, clay EW, 0°, PL, ro, 70 mm, co, clay B, 5°, PL, ro, vn, clay J, 40°, CU, ro, vn, clay	
							156.0	8.0		from 8.04 m to 8.15m: EW seam				B, 0°, PL, ro, vn, clay B, 0°, PL, ro, vn, clay EW, 0°, PL, ro, 110 mm, stn, clay B, 0°, PL, ro, stn, FE J, 80°, PL, ro, co, spaced 20 mm, 2mm to 10mm, gravelly clay, Fe, partially healed EW, 0°, PL, ro, 60 mm, co, gravelly clay B, 0°, PL, sm, vn, clay B, 0°, PL, ro, 2 mm, co, clay, healed EW, 0°, PL, ro, 4 mm, co, clay J, 75°, PL, ro, 2 mm, stn, clay	1 of 1
							155.5	8.5							
	Run 2	100	0				155.0	9.0						J, 15°, PL, ro, vn, clay J, 15°, PL, ro, vn, clay	
							154.5	9.5						B, 0°, PL, ro, vn, clay B, 0°, PL, ro, co, clay B, 0°, PL, ro, 2 mm, stn, silty clay J, 80°, PL, ro, stn, Fe, healed	
							154.0	10.0							

2015_ANZ_COREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH009

Sheet: 4 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	4 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 21/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317611.0 m	**RL:** 164.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265143.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	100	0				154.0			SILTSTONE: dark brown, with orange iron stained laminations at 1 mm to 50 mm spacing, at 0º, with extremely closely spaced, healed joints, and frequent EW seams. *continued*				J, 50°, PL, ro, stn, Fe, discontinuous	
								10.5						J, 45°, PL, ro, vn, Fe EW, 0°, PL, ro, 10 mm, stn, clay EW, 0°, PL, ro, 10 mm, stn, clay	
							153.5								
	Run 3	100	70							SILTSTONE: dark grey, with occasional thin laminations of sandstone, fine grained, light grey, at 0º. Joints becoming closely to moderately widely spaced.				J, 5°, PL, ro, stn, Fe J, 20°, PL, ro, healed J, 20°, PL, ro, healed J, 20°, PL, ro, healed J, 20°, PL, ro, healed B, 0°, PL, ro, stn, Fe EW, 0°, PL, ro, co, silty clay J, 50°, PL, ro, stn, Fe B, 0°, PL, ro, cn J, 40°, PL, ro, healed J, 40°, PL, ro, healed B, 0°, PL, ro, stn, Fe B, 0°, PL, ro, stn, Fe	1 of 1
							153.0	11.0							
										from 11.28 m to 11.33 m: radial nodules in core, 10 mm to 20 mm diameter					
							152.5	11.5		LAMINITE: siltstone (60%), dark grey, with thin laminations of sandstone (40%), fine grained, light grey, at 0°, at 10 mm typical spacing				B, 0°, PL, ro, 2 mm, co, silty clay B, 0°, PL, ro, 2 mm, co, silty clay	
										BH009 terminated at 11.65 m. *Reached target depth*					
							152.0	12.0		Standpipe monitoring well installed: Gatic cover, flush with ground Bentonite plug - 0.2m to 5.8m Sand screen - 5.8m to 9.0m sSotted pipe - 6.3m to 8.3m Bentonite plug 9.0m to 9.5m Sand 9.5m to 11.65m					
							151.5	12.5							
								13.0							
							151.0								
								13.5							
							150.5								
								14.0							
							150.0								
								14.5							
							149.5								
								15.0							

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Phase 2 Site Investigations\Drilling Photos\BH009\BH009_Box1.jpg printed 15.3.2016

CLIENT:	Grimshaw	APPROVED:	PC	TITLE:	Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	15/03/2016	BOREHOLE NO:	BH009
PROJECT No:	60310614	SCALE:	N.T.S.	DEPTH RANGE:	7.00 m to 11.65 m
		ORIGINAL SIZE:	A4	BOX No.	1 of 1

AECOM Engineering Log

PIEZOMETER No. BH009

Sheet: 1 of 1

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PC
Location:	4 Glenhope Road		**Start Date:**	20/05/2014	**End Date:** 21/05/2014
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317611.0 m	**RL:** 164.00 m
Drill Rig:	Comacchio Geo 205	**Inclination:** -90°	**Northing:**	6265143.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log
ADT					164.0	0.0	
					162.0	2.0	
					160.0	4.0	
					158.0	6.0	
HQ3	Run 1	100	0		156.0	8.0	
	Run 2	100	0		154.0	10.0	
	Run 3	100	70		152.0	12.0	
					150.0	14.0	

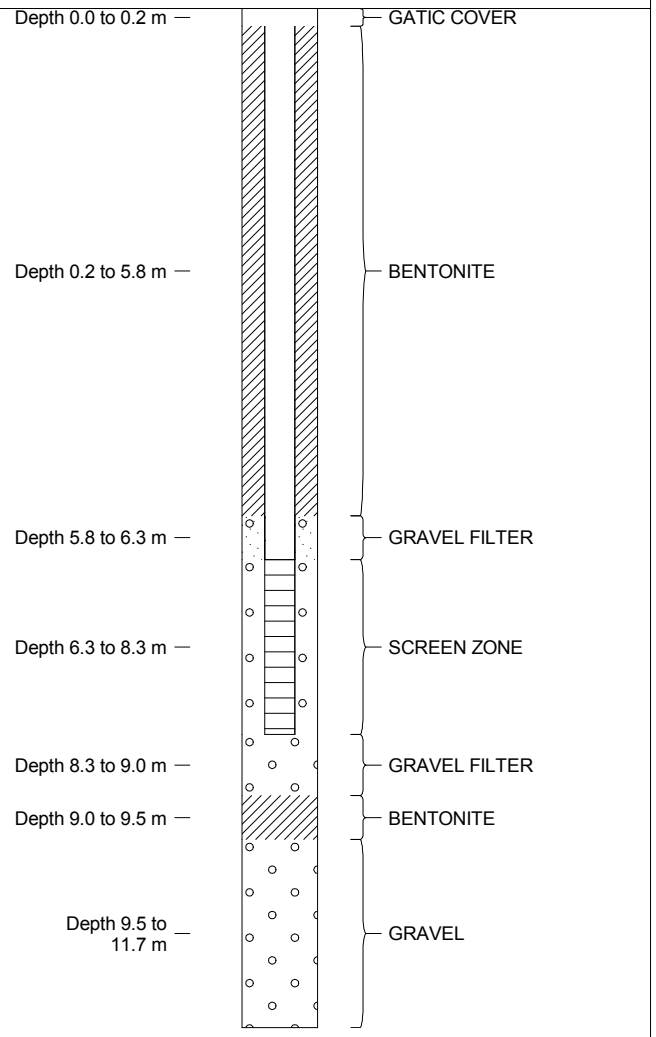
Rock Description

Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm)
Clayey SILT, brown	
Gravelly SILT, brown	
Silty CLAY, red-brown, mottled black	
Silty CLAY, light brown-grey, mottled red-brown	
Silty CLAY, light brown-grey, mottled red-brown	
Clayey SILT, grey, mottled brown, red, orange	
SILTSTONE	
SILTSTONE, dark brown	
SILTSTONE, dark grey	
LAMINITE	
BH009 Terminated at 11.65 m.	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction details:	machine slotted PVC
Pipe diameter:	50 mm
Pipe Top:	6.3 mBGL
Pipe Base:	8.3 mBGL
Screen Top:	5.8 mBGL
Screen/Sensor Base:	9.0 mBGL
Instrument Details:	-
Installation Date:	21/08/2014
Development Date:	-



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

BOREHOLE No. **BH010**

Sheet: 1 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	145 Castle Hill Road		**Start Date:**	12/02/2016	**End Date:** 15/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317238.0 m	**RL:** 165.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265625.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
					165.0			CI	Clayey SILT: medium plasticity, dark brown, with fine grained sand, trace rootlets	PL		TOPSOIL
ADT	HWT							CH	Silty CLAY: high plasticity, brown, mottled light brown and red, trace fine grained sand and fine, sub-angular to rounded, highly weathered siltstone gravel		St	COLLUVIUM
					164.5	0.5						
					164.0	1.0						
			SPT:6,7,8 N=15 PP=520 kPa PP=520 kPa	DS-1	163.5	1.5		CH	Silty CLAY: high plasticity, light brown-grey, mottled orange, with fine to coarse, sub-angular to angular, highly weathered siltstone gravel			RESIDUAL
		▽ 15/02/2016			163.0	2.0			SILTSTONE: grey, inferred highly weathered to moderately weathered, low strength			BEDROCK
						2.5			*Borehole BH010 continued as cored borehole from 2.30 m*			
						3.0						
						3.5						
						4.0						
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

AECOM Engineering Log

CORED BOREHOLE No. BH010

Sheet: 2 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	145 Castle Hill Road		**Start Date:**	12/02/2016	**End Date:** 15/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317238.0 m	**RL:** 165.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265625.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (A:● D:○ I:◆; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							165.0								
							164.5	0.5							
							164.0	1.0							
							163.5	1.5							
							163.0	2.0		*Continued from non-cored borehole at 2.30 m*					
HQ3	Run 1	76	0				162.5	2.5		SILTSTONE: dark brown-grey, with thin laminations of brown, fine grained, sandstone (20%), dipping at 0°, variable spacing, with frequent EW seams, 5-30 mm thick along bedding and fractures				EW, 70°, ST, ro, 10 mm, gravelly clay EW, 70°, UN, ro, 10 mm, gravelly clay EW, 0°, PL, ro, 20 mm, clay CZ, 0°, PL, sm, vn, fine to coarse, angular gravel B, 0°, PL, ro, 2-4,co, spaced 40 mm, clay EW, 45°, CU, ro, 10 mm, clay J, 50°, PL, ro, 2 mm, co, clay	
							162.0	3.0						EW, 0°, UN, ro, 20 mm, gravelly clay	
										NO CORE					
	Run 2	75	0				161.5	3.5		SILTSTONE: dark brown-grey, with thin laminations of brown, fine grained, sandstone (20%), dipping at 0°, variable spacing, with frequent EW seams, 5-100 mm thick along bedding and fractures				EW, 0°, PL, ro, 150 mm, gravelly clay EW, 0°, UN, ro, 20 mm, clay CZ, 0°, UN, ro, 180 mm, clayey fine to coarse gravel, FeO J, 70°, PL, ro, stn, FeO J, 40°, CU, sm, stn, FeO CZ, 5°, UN, ro, 120 mm, fine to coarse gravelly clay B, 0°, PL, ro, stn, spaced 40 mm, x 3 EW, 0°, PL, ro, 50 mm, clay	1 of 2
							161.0	4.0							
							160.5	4.5		from 4.30 m to 4.42 m: crushed zone, with fine to medium grained gravelly clay					
										NO CORE					
							160.0	5.0							

AECOM Engineering Log

CORED BOREHOLE No. BH010

Sheet: 3 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	145 Castle Hill Road		**Start Date:**	12/02/2016	**End Date:** 15/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317238.0 m	**RL:** 165.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265625.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (A:● D:○ I:◆; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	75	0				160.0			NO CORE *continued*					1 of 2
	Run 3	100	43		$Is_{(50)}$(A)= 0.65 MPa $Is_{(50)}$(D)= 0.23 MPa		159.5	5.5		SILTSTONE: dark brown-grey, with thin laminations of sandstone (5%), fine grained, brown-grey, dipping at 0°, variable spacing				CZ, 0°, PL, sm, coarse gravel, drilling induced J, 30°, PL, ro, 2 mm, co, clay J, 35°, PL, ro, 1-5,co, spaced 5 mm, FeO, clay, x 7	
							159.0	6.0							
							158.5	6.5						J, 40°, PL, ro, cn	
					$Is_{(50)}$(A)= 0.82 MPa $Is_{(50)}$(D)= 0.24 MPa									B, 0°, UN, ro, cn	
							158.0	7.0		LAMINITE: siltstone (70%) dark grey, with undulating, thin laminations of sandstone (30%), fine grained, light grey, dipping at 0°					
					UCS= 34 MPa										
	Run 4	100	100		$Is_{(50)}$(A)= 2.7 MPa $Is_{(50)}$(D)= 0.78 MPa		157.5	7.5						J, 70°, PL, ro, cn, from 7.47m to 7.65m	
														J, 60°, UN, ro, cn, discontinuous, from 7.75m to 7.90m	
							157.0	8.0							2 of 2
					$Is_{(50)}$(A)= 2.2 MPa $Is_{(50)}$(D)= 0.69 MPa		156.5	8.5							
							156.0	9.0							
							155.5	9.5							
	Run 5	100	100		$Is_{(50)}$(A)= 3.8 MPa $Is_{(50)}$(D)= 1.0 MPa										
								10.0		*BH010 terminated at 10.00 m. Reached target depth. Hole backfilled with cuttings and sand/gravel*					

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Sept 2015 Geotech Investigations\gINT\CorePhotos\BH010_Box01of2.jpg printed 14.3.2016

CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH010
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 2.30 m to 6.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 2

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Sept 2015 Geotech Investigations\gINT\CorePhotos\BH010_Box02of2.jpg printed 14.3.2016

CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH010
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 6.00 m to 10.00 m
		ORIGINAL SIZE:	A4		BOX No. 2 of 2

AECOM Engineering Log

BOREHOLE No. **BH011**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317250.0 m	**RL:** 150.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265529.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data								Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure		Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
ADT	None	12/02/2016 ▽			150.0	0.0		ML	Clayey SILT: medium plasticity, dark brown, trace fine gravel sized carbonaceous fragments		PL	F- St	TOPSOIL
					149.5	0.5							
								CH	CLAY: medium to high plasticity, red-brown, trace fine, sub-angular, highly weathered siltstone and carbonaceous gravel and fine grained sand from 0.80 m: light brown, mottled red, grey			VSt	COLLUVIUM
					149.0	1.0							
			SPT:4,6,9 N=15 PP=450 kPa PP=530 kPa	DS-1	148.5	1.5			from 1.50 m: with fine to coarse, highly weathered siltstone and laminite gravel				
					148.0	2.0							
					147.5	2.5							
		10/05/2016 ▼											
			SPT:7,12,16 N=28 PP=380 kPa PP=400 kPa PP=400 kPa PP=450 kPa		147.0	3.0							
									BRECCIA: angular siltstone cobbles, dark grey, in light grey to red clay matrix				
					146.5	3.5			*Borehole BH011 continued as cored borehole from 3.50 m*				
						4.0							
						4.5							
						5.0							

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 10.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH011

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317250.0 m	**RL:** 150.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265529.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							150.0								
							149.5	0.5							
							149.0	1.0							
							148.5	1.5							
							148.0	2.0							
							147.5	2.5							
							147.0	3.0							
								3.5		*Continued from non-cored borehole at 3.50 m*					
HQ3	Run 1	80	0				146.5			SILTSTONE: dark brown-grey, highly fractured / brecciated, with multiple clay and gravel infilled seams (COLLUVIUM)				FZ, UN, ro, 2-20 mm,co, clay with fine gravel, 10-50°, variable orientation, brecciated core	
										NO CORE				FZ, UN, ro, 2-20 mm,co, clay with fine gravel, 10-50°, variable orientation	
	Run 2	61	0				146.0	4.0		SILTSTONE: as above (COLLUVIUM)				J, 50°, UN, ro, 8 mm, co, clay with gravel, from 3.75 m to 3.80 m J, 65°, UN, ro, 10 mm, co, clay with gravel	1 of 3
										NO CORE					
	Run 3	98	0				145.5	4.5		SILTSTONE: dark brown-grey, highly fractured / brecciated, becoming increasingly brecciated with depth, with multiple clay and gravel infilled seams (COLLUVIUM)				FZ, 1050 mm, brecciated core, with clay matrix	
	Run 4	98	0					5.0							

AECOM Engineering Log

CORED BOREHOLE No. BH011

Sheet: 3 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317250.0 m	**RL:** 150.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265529.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description					Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 4	98	0				145.0							FZ, 1050 mm, brecciated core, with clay matrix	
	Run 5	83	0				144.5	5.5		LAMINITE: grey to light grey, remoulds to clay				EW, 0°, PL, ro, 100 mm, co, clay	
										LAMINITE: siltstone (70%), dark brown-grey, with thin laminations of brown, fine grained sandstone (30%), dipping at 0°				CZ, 5°, UN, sm, vn, clay veneer, with fine to coarse, angular gravel	
										SANDSTONE: fine grained, light brown, mottled grey-brown, with red-brown iron staining				EW, 5°, UN, sm, 40 mm, co, clay CZ, 30°, ST, ro, stn, FeO, coarse angular gravel J, 40°, UN, ro, stn, FeO	
										from 5.90 m: fine to medium grained, light grey				EW, 0°, UN, ro, 80 mm, co, clay, fine gravel EW, 50 mm, sandy clay	
							144.0	6.0		NO CORE					1 of 3
	Run 6	100	28		$Is_{50}(A)$= 0.54 MPa $Is_{50}(D)$= 0.24 MPa					SANDSTONE: fine to medium grained, light grey to light brown, with undulating, thin carbonaceous laminations				EW, 0°, PL, ro, 20 mm, co, sandy clay B, 5°, ST, ro, stn, FeO B, 0°, PL, ro, 5 mm, co, FeO, sand J, 70°, UN, ro, 2 mm, co, FeO, healed, from 6.30 m to 6.60 m	
							143.5	6.5							
														B, 0°, PL, sm, stn, FeO, grinding marks B, 10°, PL, sm, stn, FeO B, 5°, PL, ro, stn, FeO	
							143.0	7.0						J, 20°, ST, ro, stn, FeO	
	Run 7	100	61		$Is_{50}(A)$= 1.8 MPa $Is_{50}(D)$= 0.42 MPa					LAMINITE: sandstone (50%) fine to medium grained, light grey, with thin laminations of silstone (50%), dark grey, dipping at 0°, 5-10mm typcial spacing				J, 60°, PL, ro, stn, spaced 10 mm, FeO, healed, x 2 B, 0°, PL, ro, vn, spaced 5 mm, FeO, x 3	
							142.5	7.5							
										from 7.74 m to 7.93 m: bed of sandstone, medium grained, brown, iron stained				B, 0°, PL, ro, 2 mm, co, FeO B, 0°, PL, ro, 2 mm, co, FeO J, 90°, UN, ro, vn, FeO B, 0°, UN, ro, stn, spaced 10 mm, FeO, x 8	
							142.0	8.0		LAMINITE: siltstone (60%), dark grey, with undulating, thin laminations of sandstone (40%), fine grained, light grey, dipping at 0-5°				J, 40°, UN, ro, cn, from 8.20 m to 8.25 m	
	Run 8	100	100		$Is_{50}(A)$= 1.7 MPa $Is_{50}(D)$= 0.59 MPa		141.5	8.5						J, 45°, PL, ro, stn, FeO, from 8.49 m to 8.52 m	2 of 3
										at 8.85 m: 50mm thick bed of sandstone, medium grained, light grey				B, 5°, PL, ro, stn, FeO	
	Run 9	100	69		$Is_{50}(A)$= 1.1 MPa $Is_{50}(D)$= 0.57 MPa		141.0	9.0							
							140.5	9.5							
								10.0						B, 5°, UN, sm, stn, FeO	

AECOM Engineering Log

CORED BOREHOLE No. BH011

Sheet: 4 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317250.0 m	**RL:** 150.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265529.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 9	100	69				140.0			LAMINITE: siltstone (60%), dark grey, with undulating, thin laminations of sandstone (40%), fine grained, light grey, dipping at 0-5° *continued*				J, 60°, UN, ro, vn, FeO, partially healed	2 of 3
					$Is_{(50)}$(A)= 2.0 MPa $Is_{(50)}$(D)= 1.2 MPa		139.5	10.5		SANDSTONE: light grey, fine to medium grained, with undulating, thin carbonaceous and siltstone laminations and lenses (10-20%), dipping at 0-5°				B, 5°, UN, ro, 2 mm, co, spaced 5 mm, FeO, x 2	
							139.0	11.0		from 10.75 m: siltstone laminations increase to 40%					
														CZ, 0°, PL, ro, 10 mm, co, fine to medium gravel, bedding contact	
					$Is_{(50)}$(A)= 0.86 MPa $Is_{(50)}$(D)= 1.1 MPa		138.5	11.5		SANDSTONE: light yellow-grey, medium grained, faintly cross bedded at 10-20°, 10mm typical spacing					
														B, 10°, PL, ro, vn, carbonaceous	
							138.0	12.0		SANDSTONE: light grey, medium grained, with frequent undulating, thin carbonaceous laminations and lenses (<10%)					
					$Is_{(50)}$(A)= 1.2 MPa $Is_{(50)}$(D)= 1.1 MPa		137.5	12.5							
							137.0	13.0							3 of 3
	Run 10	100	99				136.5	13.5						J, 45°, PL, spaced 60 mm, healed, x 3	
					$Is_{(50)}$(A)= 1.1 MPa $Is_{(50)}$(D)= 1.1 MPa										
							136.0	14.0		from 14.00 m: tight, sub-vertical, irregular contact with dyke				J, partially healed, irregular	
														CZ, 50°, 40 mm, contact with dyke	
					UCS= 13.9 MPa		135.5	14.5		DOLERITE: medium grained, light yellow-grey, with frequent vesicles (5-10mm in diameter), some infilled with white mineral, main dyke contact at 50°					
					$Is_{(50)}$(A)= 0.77 MPa $Is_{(50)}$(D)= 0.70 MPa										
							135.0	15.0		at 14.90 m: quartz vein dipping at 70°				J, 60°, PL, ro, 5-10 mm,co, quartz, healed FZ, UN, healed, 30-50°, variable orientation	

BH011 terminated at 15.00 m.
Reached target depth. Hole backfilled, well

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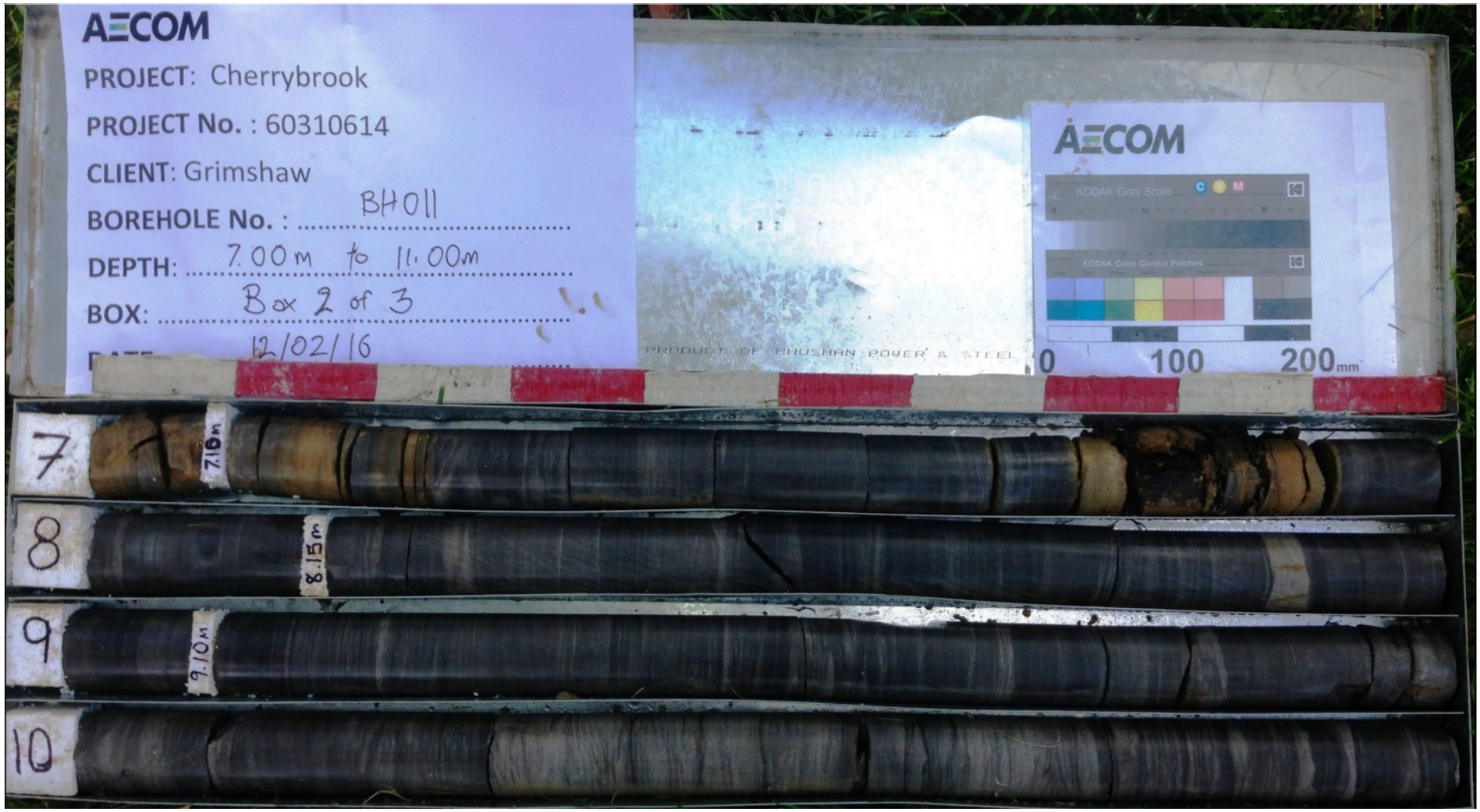
CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH011
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 3.00 m to 7.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 3



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CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH011
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 7.00 m to 11.00 m
		ORIGINAL SIZE:	A4		BOX No. 2 of 3

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CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH011
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 11.00 m to 15.00 m
		ORIGINAL SIZE:	A4		BOX No. 3 of 3

AECOM Engineering Log

PIEZOMETER No. **BH011**

Sheet: 1 of 1

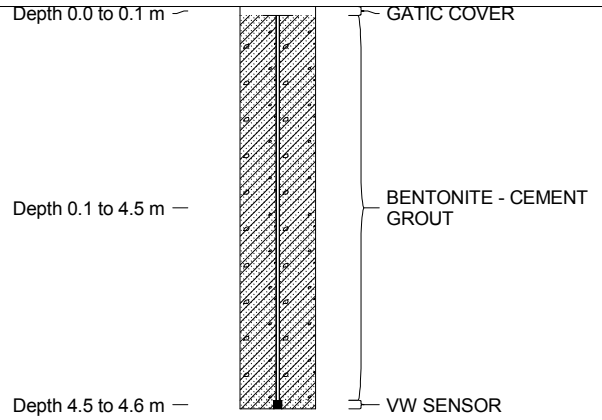
Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317250.0 m	**RL:** 150.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265529.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Reduced Level (m)	Depth (m)	Graphic Log	Summary Geology (refer to geological log for full descriptions)	Defect Spacing (mm)
ADT					150.0	0.0		Clayey SILT, dark brown	
								CLAY, red-brown	
					148.0	2.0			
HQ3	Run 1	80	0					BRECCIA	
	Run 2	61	0		146.0	4.0		SILTSTONE, dark brown-grey	
	Run 3	98	0					NO CORE	
	Run 4	98	0					SILTSTONE	
	Run 5	83	0					NO CORE	
					144.0	6.0		SILTSTONE, dark brown-grey	
	Run 6	100	28					LAMINITE, grey to light grey	
	Run 7	100	61					LAMINITE	
					142.0	8.0		SANDSTONE, fine grained, light brown, mottled grey-brown	
	Run 8	100	100					NO CORE	
								SANDSTONE, fine to medium grained, light grey to light brown	
					140.0	10.0		LAMINITE	
	Run 9	100	69					LAMINITE	
								SANDSTONE, light grey	
					138.0	12.0		SANDSTONE, light yellow-grey	
	Run 10	100	99					SANDSTONE, light grey	
					136.0	14.0		DOLERITE, medium grained, light yellow-grey	

Defect Spacing (mm): 20, 60, 200, 600, 2000

Piezometer Details

Construction details: NA
Pipe diameter: -
Pipe Top: 4.5 mBGL
Pipe Base: 4.6 mBGL
Screen Top: 4.5 mBGL
Screen/Sensor Base: 4.6 mBGL
Instrument Details: -
Installation Date: 12/02/2016
Development Date: -



REMARKS:
GROUNDWATER MONITORING NOTES:

AECOM Engineering Log

BOREHOLE No. **BH012**

Sheet: 1 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317224.0 m	**RL:** 140.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265488.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
					140.0			ML	Clayey SILT: medium plasticity, dark brown, with fine grained sand, trace rootlets	M		TOPSOIL
					139.5	0.5						
		11/02/2016						MH	Clayey SILT: medium to high plasticity, brown, mottled red and grey, trace carbonaceous fragments and fine, angular to rounded, highly weathered siltstone gravel	PL	St	COLLUVIUM/ ALLUVIUM
					139.0	1.0						
		12/02/2016										
			SPT:5,5,7 N=12 PP=240 kPa		138.5	1.5						
ADV	HWT		PP=320 kPa	DS-1								
					138.0	2.0				>PL		
								CH	Silty CLAY: medium plasticity, light yellow-brown, with fine to coarse, angular to sub-rounded, highly weathered siltstone gravel, trace fine grained sand		VSt	RESIDUAL from 2.50 m: Drillers note - increased auger resistance
					137.5	2.5						
			SPT:8,11,11 N=22 PP=320 kPa		137.0	3.0						
			PP=400 kPa	DS-2								
					136.5	3.5			*Borehole BH012 continued as cored borehole from 3.50 m*			
						4.0						
						4.5						
						5.0						

AECOM Engineering Log

CORED BOREHOLE No. BH012

Sheet: 2 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317224.0 m	**RL:** 140.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265488.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							140.0								
							139.5	0.5							
							139.0	1.0							
							138.5	1.5							
							138.0	2.0							
							137.5	2.5							
							137.0	3.0							
							136.5	3.5		*Continued from non-cored borehole at 3.50 m*					
HQ2	Run 1	100	0							Silty CLAY: high plasticity, light grey, mottled brown and orange, trace fine grained, micaceous sand					
HQ2	Run 2	100	0				136.0	4.0		INTERBEDDED SILTSTONE/SANDSTONE: sandstone (60%), fine grained, brown, with beds 50-250mm thick of siltstone (40%), light grey, weathered to silty clay, with undulating, thin, dark brown carbonaceous laminations and lenses				EW, 20°, CU, ro, 100 mm, silty clay EW, 20°, CU, ro, 120 mm, clayey fine sand	1 of 2
HQ3	Run 3	100	0				135.5	4.5						EW, 0°, UN, ro, 230 mm, silty clay EW, 10°, UN, ro, 40 mm, silty clay	
								5.0							

AECOM Engineering Log

CORED BOREHOLE No. BH012

Sheet: 3 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317224.0 m	**RL:** 140.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265488.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data | **Rock Description** | **Discontinuities**

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (A:● D:○ I:◆) (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 3	100	0				135.0			INTERBEDDED SILTSTONE/SANDSTONE: sandstone (60%), fine grained, brown, with beds 50-250mm thick of siltstone (40%), light grey, weathered to silty clay, with undulating, thin, dark brown carbonaceous laminations and lenses *continued*				EW, 5°, UN, ro, 100 mm, silty clay	
								5.5						EW, 0°, UN, ro, 140 mm, silty clay, sandy clay	
	Run 4	100	0				134.5							EW, 5°, UN, ro, 250 mm, silty clay	
										SANDSTONE: brown, fine to medium grained, with undulating, thin laminations of siltstone (20%), dark brown-grey, dipping at 0-10°				J, 90°, UN, ro, stn, FeO, from 5.60 m to 5.80 m	
								6.0						B, 0°, PL, sm, stn, spaced 50 mm, FeO, x8	1 of 2
					$Is_{(50)}$(A)= 0.34 MPa		134.0								
					$Is_{(50)}$(D)= 0.15 MPa									EW, 0°, PL, ro, 10 mm, clayey silt	
	Run 5	100	0											J, 90°, UN, ro, stn, FeO, from 6.35m to 6.60m	
								6.5						EW, 0°, PL, sm, 20 mm, clay	
							133.5							J, 90°, UN, ro, stn, FeO, from 6.70m to 6.90m	
								7.0							
							133.0							B, 5°, UN, ro, 2 mm, co, FeO	
														B, 0°, UN, ro, 4 mm, co, FeO	
														J, 80°, CU, ro, vn, FeO, healed	
								7.5						B, 5°, UN, ro, 4 mm, co, spaced 20 mm, FeO, x 2	
							132.5							EW, 0°, PL, ro, 10 mm, co, clayey silt, FeO	
														B, 0°, PL, ro, 4 mm, co, FeO	
	Run 6	100	24											J, 50°, UN, ro, stn, FeO	
								8.0							
							132.0								
					$Is_{(50)}$(A)= 0.22 MPa					SANDSTONE: medium grained, light brown-grey, with orange iron-staining, with thin, black, undulating carbonaceous and siltstone laminations (5%), at 0-5°, variable spacing				B, 5°, UN, ro, vn, X	
					$Is_{(50)}$(D)= 0.12 MPa									B, 5°, PL, sm, vn, clay	
								8.5						J, 20°, PL, ro, 15 mm, co, gravelly clay	
							131.5							J, 20°, UN, ro, stn, FeO	
														J, 60°, UN, ro, vn, FeO, from 8.65m to 8.72m	
														CZ, 0°, PL, ro, 10 mm, co, gravelly clay	
														CZ, 5°, UN, ro, 15 mm, co, gravelly clay	
								9.0						CZ, 5°, PL, ro, 40 mm, op, gravelly clay	
							131.0							EW, 0°, PL, sm, 5 mm, clay	
														J, 50°, ST, ro, stn, FeO	
														J, 50°, PL, ro, 2 mm, co, FeO, clay	
										from 9.09 m to 9.50 m: siltstone interbeds, dipping at 0-5°, 5-20mm thick					
								9.5							2 of 2
	Run 7	100	57	30%			130.5							B, 5°, PL, sm, vn, clay	
										SANDSTONE: medium grained, light grey, faint cross bedding at 5-10°, variable spacing, occasional thin carbonaceous laminations				B, 0°, PL, ro, stn, FeO	
														B, 5°, UN, ro, stn, FeO	
														J, 30°, PL, ro, stn, FeO	
														B, 10°, UN, ro, stn, FeO	
					$Is_{(50)}$(A)= 0.30 MPa									B, 10°, UN, ro, stn, FeO	
					$Is_{(50)}$(D)= 0.45 MPa		10.0								

2015_ANZ_COREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH012

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	143 Castle Hill Road		**Start Date:**	11/02/2016	**End Date:** 12/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317224.0 m	**RL:** 140.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265488.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 7	100	57				130.0								2 of 2
														J, 20°, UN, ro, stn, FeO	
										BH012 terminated at 10.20 m. Reached target depth. Hole backfilled with cuttings and sand/gravel					
							129.5	10.5							
							129.0	11.0							
							128.5	11.5							
							128.0	12.0							
							127.5	12.5							
							127.0	13.0							
							126.5	13.5							
							126.0	14.0							
							125.5	14.5							
								15.0							

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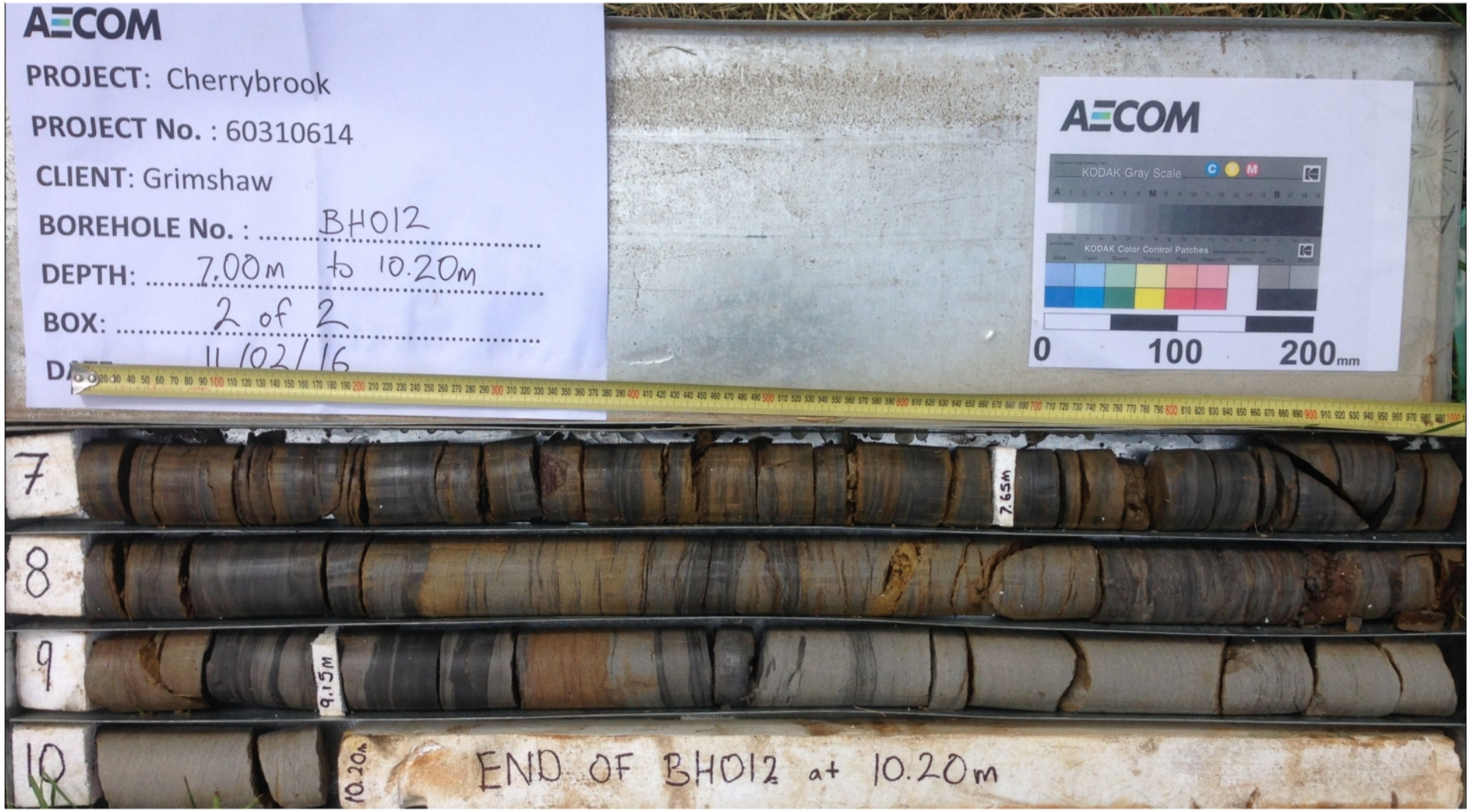
CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH012
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 3.50 m to 7.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 2



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CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH012
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 7.00 m to 10.20 m
		ORIGINAL SIZE:	A4		BOX No. 2 of 2

AECOM Engineering Log

BOREHOLE No. **BH013**

Sheet: 1 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	3-5 Matthew Way		**Start Date:**	8/02/2016	**End Date:** 8/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317346.0 m	**RL:** 142.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265348.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data							Material Description			Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
NDD	HWT				142.0				Sandy SILT: low plasticity, dark brown, with clay, trace rootlets and fine, angular gravel	D		TOPSOIL
									Silty GRAVEL: fine to coarse grained, sub-rounded to sub-angular, grey-brown, with clay, trace sand, rootlets and cobbles, tightly packed			FILL
					141.5	0.5			COBBLES: angular, brown-grey and brown, with coarse gravel and silt, trace sand			
					141.0	1.0						
						1.5						
ADT	HWT		SPT:10,24,18 N=42 PP=150 kPa PP=420 kPa	DS-1	140.5			CH	Silty CLAY: medium plasticity, light grey, mottled brown and orange, trace fine sand, with brown, iron-indurated nodules	PL	VSt	RESIDUAL
					140.0	2.0			*Borehole BH013 continued as cored borehole from 2.00 m*			
						2.5						
						3.0						
						3.5						
						4.0						
						4.5						
						5.0						

AECOM Engineering Log

CORED BOREHOLE No. BH013

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	3-5 Matthew Way		**Start Date:**	8/02/2016	**End Date:** 8/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317346.0 m	**RL:** 142.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265348.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description					Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH) A:● D:○ I:◆	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							142.0								
							141.5	0.5							
							141.0	1.0							
							140.5	1.5							
							140.0	2.0		*Continued from non-cored borehole at 2.00 m*					
HQ3	Run 1	100	0				140.0			Clayey SILT: medium plasticity, dark brown, mottled light grey, trace fine grained sand				CZ, 0°, UN, ro, 130 mm, silty clay, medium to coarse gravel	
										SILTSTONE: dark brown-grey					
										Silty CLAY: high plasticity, light grey				J, 20°, UN, ro, stn, FeO	
							139.5	2.5		LAMINITE: siltstone (70%) dark brown, with thin laminations of sandstone (30%), fine grained, grey and brown, at 0-10°, 5-10mm spacing, frequent EW seams 2-50 mm thick				EW, 0°, PL, ro, 10 mm, co, clay J, 20°, UN, ro, stn, FeO EW, 5°, UN, ro, 10 mm, co, clay EW, 5°, UN, ro, 20 mm, co, clay	
														B, 5°, PL, ro, stn, FeO	
							139.0	3.0		SANDSTONE: light grey to brown, fine to medium grained, with undulating, thin carbonaceous laminations, dipping at 0-5°, 10mm typical spacing				EW, 5°, PL, ro, 70 mm, co, sandy clay EW, 20°, UN, ro, 80 mm, co, sandy clay B, 10°, UN, ro, 2 mm, co, silt, MnO staining	
														CZ, 5°, UN, ro, 20 mm, co, clay and fine to coarse gravel	
							138.5	3.5		SANDSTONE: light brown to orange, medium grained, with occasional undulating, carbonaceous laminations, dipping at 0-5°				B, 5°, UN, ro, 2-5 mm,co, clayey sand J, 40°, ST, ro, stn, FeO, MnO	
					$Is_{(50)}$(A)= 0.68 MPa $Is_{(50)}$(D)= 0.93 MPa										
	Run 2	100	86				138.0	4.0		at 3.80 m: vug, 50mm diameter, light grey rind					1 of 2
							137.5	4.5						EW, 5°, PL, ro, 30 mm, co, clay	
					$Is_{(50)}$(A)= 1.4 MPa $Is_{(50)}$(D)= 1.2 MPa					from 4.65 m: light grey, with orange iron staining in beds					
							137.0	5.0						EW, 5°, PL, ro, 10 mm, co, clayey sand, FeO	

AECOM Engineering Log

CORED BOREHOLE No. BH013

Sheet: 3 of 3

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	3-5 Matthew Way		**Start Date:**	8/02/2016	**End Date:** 8/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317346.0 m	**RL:** 142.00 m
Drill Rig:	Drill Cat	**Inclination:** -90°	**Northing:**	6265348.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	100	86		UCS= 29.6 MPa		137.0			SANDSTONE: light brown to orange, medium grained, with occasional undulating, carbonaceous laminations, dipping at 0-5° *continued*				B, 0°, PL, ro, vn, spaced 5 mm, X, x 2	1 of 2
							136.5	5.5						B, 0°, PL, ro, 3 mm, co, sand, FeO	
					$Is_{(50)}$(A)= 1.6 MPa $Is_{(50)}$(D)= 1.1 MPa										
							136.0	6.0						B, 5°, PL, sm, vn, FeO J, 30°, PL, ro, stn, FeO	
	Run 3	100	80							from 6.26 m to 6.32 m: concentration of carbonaceous laminations, dipping at 0°				J, 30°, PL, ro, vn, healed, 5mm offset of beds B, 0°, PL, ro, vn, spaced 30 mm, X, x 3 J, 50°, CU, ro, vn, FeO, partially healed, splintered J, 20°, UN, ro, stn, FeO	
					$Is_{(50)}$(A)= 1.1 MPa $Is_{(50)}$(D)= 0.46 MPa		135.5	6.5							
							135.0	7.0						B, 5°, UN, ro, 2-5 mm,co, silt	
														B, 5°, UN, ro, stn, FeO J, 30°, UN, ro, stn, FeO, healed B, 5°, UN, ro, vn, spaced 10 mm, FeO, X, x 2 B, 0°, UN, ro, stn, FeO B, 5°, UN, ro, vn, FeO, X	
							134.5	7.5		from 7.48 m to 7.60 m: dark grey, concentration of carbonaceous laminations, dipping at 0-5° from 7.60 m: light grey				B, 5°, UN, ro, stn, FeO	
					$Is_{(50)}$(A)= 1.3 MPa $Is_{(50)}$(D)= 1.2 MPa										
							134.0	8.0		SANDSTONE: light grey, medium grained, with occasional thin, undulating, black carbonaceous laminations, dipping at 0-10°, variable spacing					2 of 2
	Run 4	100	100		$Is_{(50)}$(A)= 1.3 MPa $Is_{(50)}$(D)= 1.3 MPa		133.5	8.5						B, 5°, PL, sm, vn, silt	
							133.0	9.0						B, 10°, PL, sm, vn, X	
					$Is_{(50)}$(A)= 1.1 MPa $Is_{(50)}$(D)= 0.96 MPa		132.5	9.5							
								10.0		*BH013 terminated at 10.00 m.* *Reached target depth. Hole backfilled with cuttings and sand/gravel*					

2015_ANZ_COREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Sept 2015 Geotech Investigations\gINT\CorePhotos\BH013_box01of2.jpg printed 14.3.2016

CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH013
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 2.00 m to 6.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 2

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Sept 2015 Geotech Investigations\gINT\CorePhotos\BH013_box02of2.jpg printed 14.3.2016

CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH013
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 6.00 m to 10.00 m
		ORIGINAL SIZE:	A4		BOX No. 2 of 2

AECOM Engineering Log

BOREHOLE No. **BH014**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	Woodleaf Close		**Start Date:**	18/02/2016	**End Date:** 18/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317373.0 m	**RL:** 141.00 m
Drill Rig:	Comacchio 205	**Inclination:** -90°	**Northing:**	6265186.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data								Material Description	Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
HA	HWT				141.0			ML	SILT: low to medium plasticity, dark brown, with clay and fine grained sand, trace rootlets	D	F	TOPSOIL
					140.5	0.5			Silty CLAY: medium to high plasticity, dark red-brown, mottled light grey, trace fine grained sand, rootlets and fine to medium grained, angular sandstone gravel	PL	VSt	FILL
									Silty CLAY: medium to high plasticity, light brown-grey, mottled red and brown, trace fine grained sand and fine grained sandstone gravel			RESIDUAL
ADT	HWT		SPT:7,9,14 N=23 PP=420 kPa PP=400 kPa PP=550 kPa	DS-1	140.0	1.0						
					139.5	1.5						
					139.0	2.0						
ADT	None				138.5	2.5						
									SANDSTONE: fine to medium grained, light grey, mottled red, HW, with iron-indurated beds			BEDROCK
					138.0	3.0			*Borehole BH014 continued as cored borehole from 3.00 m*			
						3.5						
						4.0						
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

Engineering log should be read in conjunction with AECOM soil and rock description sheets.

AECOM Engineering Log

CORED BOREHOLE No. BH014

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	Woodleaf Close		**Start Date:**	18/02/2016	**End Date:** 18/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317373.0 m	**RL:** 141.00 m
Drill Rig:	Comacchio 205	**Inclination:** -90°	**Northing:**	6265186.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering RS EW HW MW SW FR	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Defect Spacing (mm) 20 60 200 600 2000	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							141.0								
							140.5	0.5							
							140.0	1.0							
							139.5	1.5							
							139.0	2.0							
							138.5	2.5							
							138.0	3.0		*Continued from non-cored borehole at 3.00 m*					
HQ3	Run 1	100	0				137.5	3.5		SANDSTONE: fine to medium grained, light grey, with red-brown iron-indurated beds and nodules, remoulds to sandy clay					1 of 2
	Run 2	100	44		$Is_{50}(A)$= 1.1 MPa $Is_{50}(D)$= 1.5 MPa		137.0	4.0		SANDSTONE: medium grained, light grey, with brown iron stained zones, faintly cross bedded at 0-5° from 4.05 m to 4.40 m: sub-vertical, clay filled vein / fracture 10-20mm thick				J, 90°, UN, ro, 10-20 mm,co, clay, from 4.05 m to 4.40 m	
							136.5	4.5							
								5.0		from 4.90 m: light brown, iron stained				J, 40°, UN, ro, 2 mm, co, clay EW, 0°, UN, ro, 30 mm, sandy clay B, 5°, UN, ro, 2 mm, co, clay	

AECOM Engineering Log

CORED BOREHOLE No. BH014

Sheet: 3 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	Woodleaf Close		**Start Date:**	18/02/2016	**End Date:** 18/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317373.0 m	**RL:** 141.00 m
Drill Rig:	Comacchio 205	**Inclination:** -90°	**Northing:**	6265186.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data | **Rock Description** | **Discontinuities**

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (A:● D:○ I:◆) (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 3	100	62		$Is_{50}(A)$= 1.6 MPa $Is_{50}(D)$= 0.93 MPa		136.0	5.5		SANDSTONE: medium grained, light grey, with brown iron stained zones, faintly cross bedded at 0-5° *continued* from 5.05 m to 5.20 m: EW seam, iron staining at base				EW, 0°, UN, ro, 150 mm, sandy clay, FeO B, 0°, UN, ro, vn, spaced 10 mm, FeO, black MnO, x 3 B, 5°, PL, ro, stn, spaced 10 mm, FeO, x 3	1 of 2
							135.5	6.0						J, 35°, UN, ro, cn J, 80°, UN, ro, stn, FeO, healed, from 5.80 m to 6.00 m	
							135.0	6.5		from 6.15 m to 6.25 m: EW seam, siltstone laminations dipping at 0°				EW, 0°, PL, ro, 90 mm, silty clay	
	Run 4	100	96		$Is_{50}(A)$= 1.4 MPa $Is_{50}(D)$= 0.80 MPa		134.5	7.0		from 6.40 m: light grey, faintly cross bedded dipping at 0-5°, with thin grey carbonaceous laminations				B, 0°, PL, ro, stn, spaced 5 mm, FeO, x 3	
							134.0	7.5		from 7.25 m to 7.30 m: concentration of carbonaceous laminations					
					$Is_{50}(A)$= 2.8 MPa $Is_{50}(D)$= 1.4 MPa		133.5	8.0		from 7.70 m to 7.90 m: concentration of carbonaceous laminations				B, 5°, PL, sm, cn B, 5°, PL, sm, cn	
	Run 5	100	100		$Is_{50}(A)$= 1.1 MPa $Is_{50}(D)$= 1.3 MPa		133.0	8.5		SANDSTONE: medium grained, light grey, faintly cross bedded at 0-5°, with thin grey carbonaceous laminations				B, 5°, PL, sm, vn, X	2 of 2
					$Is_{50}(A)$= 1.7 MPa $Is_{50}(D)$= 1.3 MPa		132.5	9.0							
							132.0	9.5						B, 5°, PL, ro, vn	
	Run 6	100	99				131.5	10.0		from 9.80 m to 9.85 m: dark grey siltstone bed				J, 20°, ST, ro, 2 mm, co, clay, ends at siltstone bed	

2015_ANZ_COREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH014

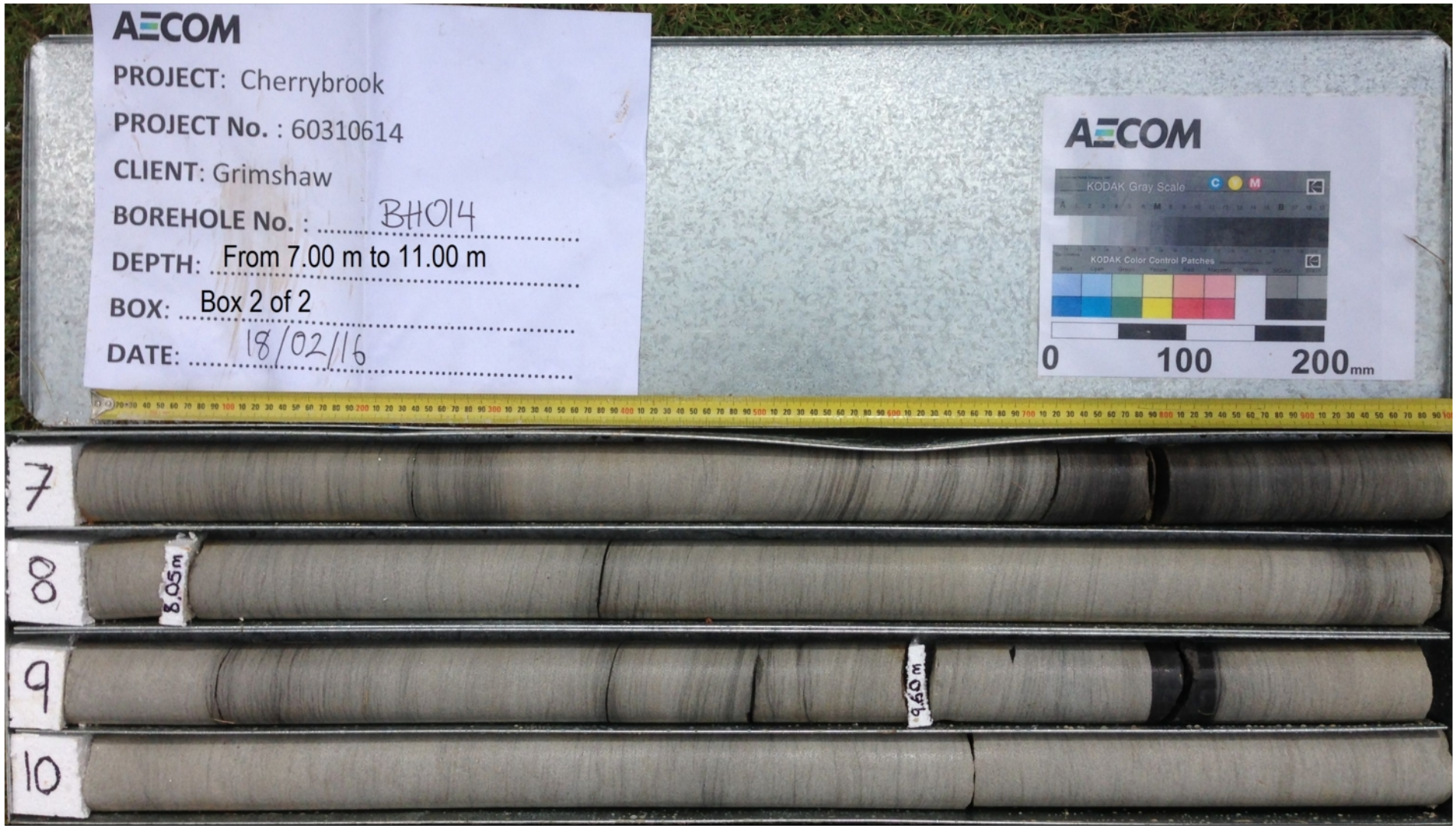
Sheet: 4 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	Woodleaf Close		**Start Date:**	18/02/2016	**End Date:** 18/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317373.0 m	**RL:** 141.00 m
Drill Rig:	Comacchio 205	**Inclination:** -90°	**Northing:**	6265186.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Grass

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 6	100	99				131.0			SANDSTONE: medium grained, light grey, faintly cross bedded at 0-5°, with thin grey carbonaceous laminations *continued*					
							130.5	10.5							2 of 2
							130.0	11.0		*BH014 terminated at 11.00 m. Reached target depth. Hole backfilled with cuttings and sand/gravel*					
							129.5	11.5							
							129.0	12.0							
							128.5	12.5							
							128.0	13.0							
							127.5	13.5							
							127.0	14.0							
							126.5	14.5							
								15.0							

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Sept 2015 Geotech Investigations\gINT\CorePhotos\BH014_Box01of2.jpg printed 14.3.2016

CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH014
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 3.00 m to 7.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 2



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CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH014
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 7.00 m to 11.00 m
		ORIGINAL SIZE:	A4		BOX No. 2 of 2

AECOM Engineering Log

BOREHOLE No. **BH015**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	117 Castle Hill Road		**Start Date:**	16/02/2016	**End Date:** 16/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317668.0 m	**RL:** 174.00 m
Drill Rig:	Geoprobe 600	**Inclination:** -90°	**Northing:**	6265200.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Gravel Driveway

Field Data								Material Description	Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	Classification Symbol	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
HA	None				174.0	0.0			Gravelly SILT: low plasticity, light brown to brown, fine to coarse, sub-rounded to sub-angular, gravel, with clay	D		PAVEMENT
									Silty CLAY: high plasticity, red-brown, trace fine, sub-rounded, gravel, fine to medium grained sand and black carbonaceous fragments	PL		FILL
					173.5	0.5			from 0.60 m: grades to light brown			
					173.0	1.0		CH	Silty CLAY: high plasticity, light grey, mottled red to brown, trace fine sand	>PL	St	RESIDUAL
ADT	None		SPT:9,21,30 N=51 PP=550 kPa PP=600 kPa PP=600 kPa	DS-1	172.5	1.5			SILTSTONE: light yellow-grey, mottled red to brown, inferred EW, inferred extremely low strength			BEDROCK
									from 1.80 m: with iron indurated beds, 20mm thick			
					172.0	2.0			*Borehole BH015 continued as cored borehole from 2.00 m*			
						2.5						
						3.0						
						3.5						
						4.0						
						4.5						
						5.0						

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH015

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	117 Castle Hill Road		**Start Date:**	16/02/2016	**End Date:** 16/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317668.0 m	**RL:** 174.00 m
Drill Rig:	Geoprobe 600	**Inclination:** -90°	**Northing:**	6265200.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Gravel Driveway

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (A:● D:○ I:◆; EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							174.0								
							173.5	0.5							
							173.0	1.0							
							172.5	1.5							
							172.0	2.0		*Continued from non-cored borehole at 2.00 m*					
HQ3	Run 1	100	0				171.5	2.5		SILTSTONE: light brown-grey, with red-brown iron-indurated beds up to 50mm thick, remoulds to silty clay, high plasticity					
							171.0	3.0							
							170.5	3.5		NO CORE					1 of 4
	Run 2	98	18				170.0	4.0		SILTSTONE: light brown-grey, with red-brown iron-indurated beds up to 200mm thick					
							169.5	4.5							
								5.0							

AECOM Engineering Log

CORED BOREHOLE No. BH015

Sheet: 3 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	117 Castle Hill Road		**Start Date:**	16/02/2016	**End Date:** 16/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317668.0 m	**RL:** 174.00 m
Drill Rig:	Geoprobe 600	**Inclination:** -90°	**Northing:**	6265200.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Gravel Driveway

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL VL L M H VH EH; 0.03 0.1 0.3 1 3 10)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	98	18		$Is_{50}(A)$= 0.17 MPa $Is_{50}(D)$= 0.19 MPa		169.0	5.0		SILTSTONE: dark brown-grey, with brown iron staining, thin laminations and lenses of sandstone (10%), fine grained, light brown-grey, dipping at 0° *continued* from 5.05 m to 5.30 m: with EW seams, 20mm thick, 70mm spacing				EW, 0°, UN, ro, 30 mm, co, clay EW, 0°, UN, ro, 30 mm, co, clay EW, 0°, UN, ro, 20 mm, co, clay EW, 0°, CU, ro, 30 mm, co, clay J, 60°, UN, ro, vn, clay, from 5.30 m to 5.50 m CZ, 0°, UN, ro, 10 mm, co, clayey gravel J, 60°, UN, ro, vn, FeO EW, 0°, PL, ro, 10 mm, co, gravelly clay	1 of 4
							168.5	5.5							
							168.0	6.0						B, 0°, PL, ro, 5 mm, co, FeO J, 30°, ST, ro, stn, FeO B, 0°, PL, ro, stn, FeO B, 0°, ST, ro, stn, FeO J, 90°, UN, ro, stn, FeO B, 0°, PL, ro, vn, FeO B, 0°, PL, ro, 4 mm, co, FeO	
							167.5	6.5		NO CORE					
	Run 3	90	79		$Is_{50}(A)$= 0.44 MPa $Is_{50}(D)$= 0.43 MPa		167.0	7.0		SILTSTONE: dark grey, with thin laminations of sandstone (5-10%), fine grained, light grey, dipping at 0°, with iron staining at some bedding partings				CZ, 0°, PL, ro, stn, FeO, clayey gravel, fine to coarse, disturbed by drilling B, 0°, PL, ro, 4 mm, co, FeO	
							166.5	7.5		NO CORE					
							166.0	8.0		SILTSTONE: dark grey, with thin laminations of fine grained, light grey sandstone (5-10%), dipping at 0°				J, 80°, UN, ro, cn, core washed away either side, from 7.27 m to 7.56 m	2 of 4
					$Is_{50}(A)$= 0.49 MPa $Is_{50}(D)$= 0.40 MPa		165.5	8.5							
							165.0	9.0						B, 0°, ST, ro, stn, FeO B, 0°, PL, ro, 10 mm, co, FeO, open bedding	
					$Is_{50}(A)$= 0.70 MPa $Is_{50}(D)$= 0.31 MPa		164.5	9.5						J, 40°, PL, ro, cn	
	Run 4	100	100					10.0							

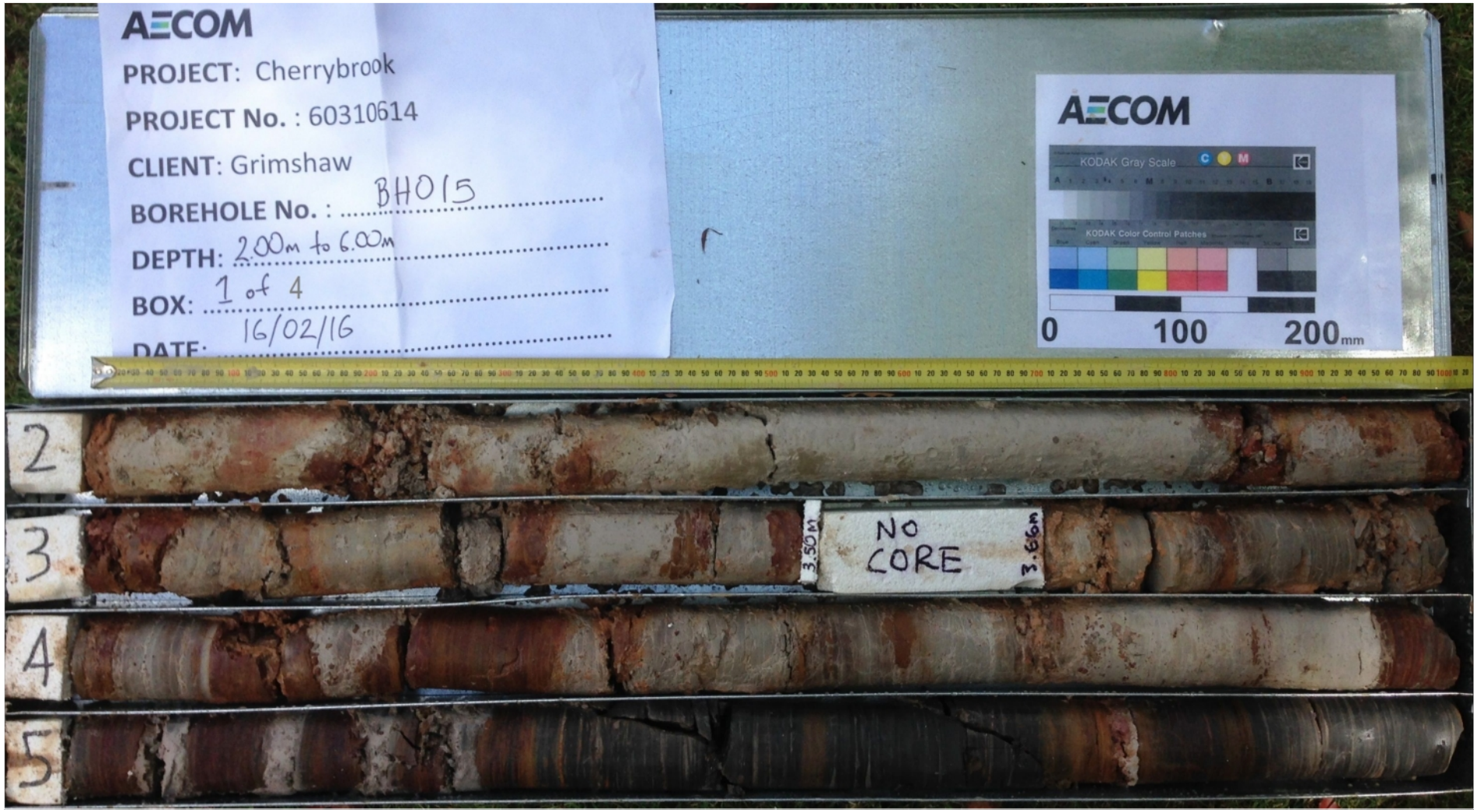
AECOM Engineering Log

CORED BOREHOLE No. BH015

Sheet: 4 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	117 Castle Hill Road		**Start Date:**	16/02/2016	**End Date:** 16/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317668.0 m	**RL:** 174.00 m
Drill Rig:	Geoprobe 600	**Inclination:** -90°	**Northing:**	6265200.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Gravel Driveway

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 4	100	100		$Is_{(50)}$(A)= 0.64 MPa $Is_{(50)}$(D)= 0.30 MPa		164.0			SILTSTONE: dark grey, with thin laminations of fine grained, light grey sandstone (5-10%), dipping at 0° *continued*				J, 70°, UN, ro, cn	
							163.5	10.5							
							163.0	11.0							
					$Is_{(50)}$(A)= 0.51 MPa $Is_{(50)}$(D)= 0.26 MPa		162.5	11.5							
							162.0	12.0							3 of 4
							161.5	12.5		from 12.15 m: massive siltstone				J, 50°, UN, ro, cn	
					$Is_{(50)}$(A)= 0.57 MPa $Is_{(50)}$(D)= 0.74 MPa										
							161.0	13.0						J, 45°, PL, ro, cn	
	Run 5	100	100		$Is_{(50)}$(A)= 0.65 MPa $Is_{(50)}$(D)= 0.090 MPa		160.5	13.5							
							160.0	14.0							
					$Is_{(50)}$(A)= 0.42 MPa $Is_{(50)}$(D)= 0.14 MPa		159.5	14.5							4 of 4
							159.0	15.0		*BH015 terminated at 15.00 m. Reached target depth. Hole backfilled with cuttings and sand/gravel*					



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CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH015
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 2.00 m to 6.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 4

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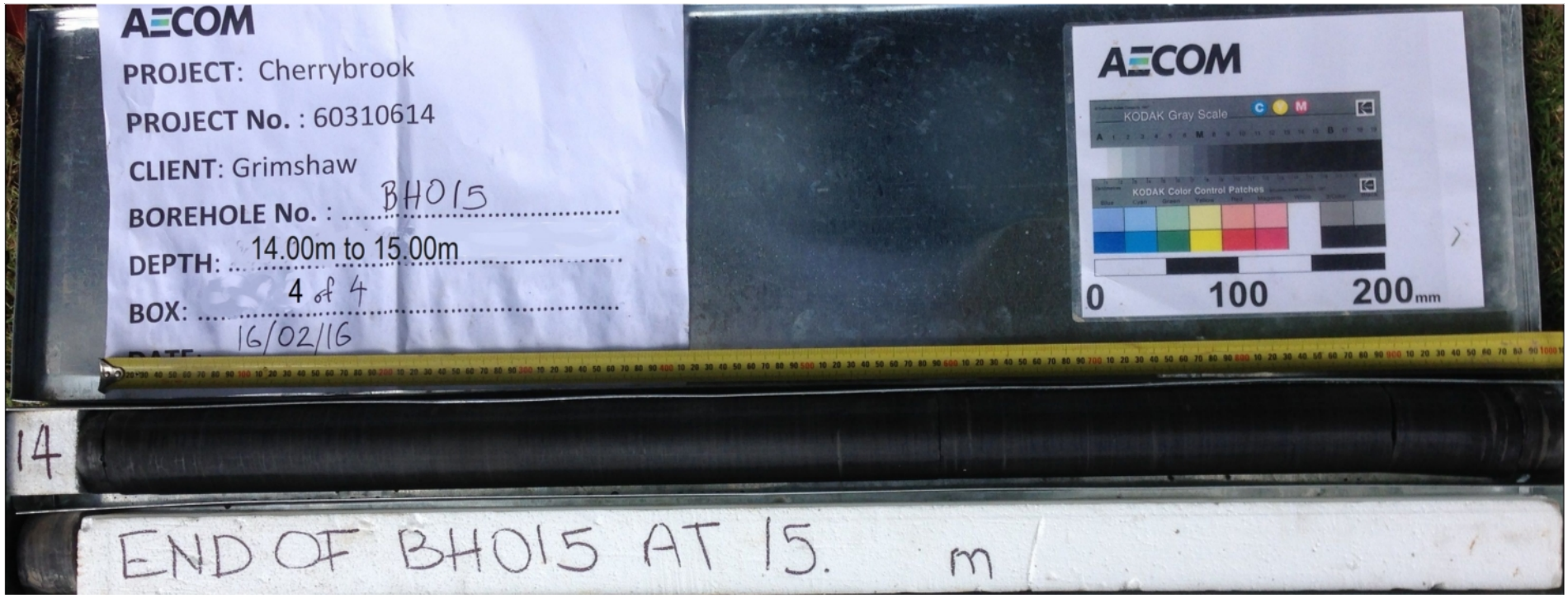
CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH015
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 6.00 m to 10.00 m
		ORIGINAL SIZE:	A4		BOX No. 2 of 4

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Sept 2015 Geotech Investigations\gINT\CorePhotos\BH015_Box03of4.jpg printed 14.3.2016

CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH015
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 10.00 m to 14.00 m
		ORIGINAL SIZE:	A4		BOX No. 3 of 4



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CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH015
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 14.00 m to 15.00 m
		ORIGINAL SIZE:	A4		BOX No. 4 of 4

AECOM Engineering Log

BOREHOLE No. **BH016**

Sheet: 1 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	123 Castle Hill Road		**Start Date:**	15/02/2016	**End Date:** 15/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317586.0 m	**RL:** 174.00 m
Drill Rig:	Geoprobe 600	**Inclination:** -90°	**Northing:**	6265306.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Concrete Driveway

Field Data								Material Description	Soil Condition		Comments
Method	Support	Ground Water	Field Tests	Samples	Reduced Level (m)	Depth (m)	Graphic Log	SOIL NAME: plasticity/particle characteristics, colour, secondary and other minor components, structure	Moisture Condition	Density / Consistency	Additional Observations (Geological Unit)
HA	HWT				174.0			CONCRETE			PAVEMENT
					173.5	0.5		Gravelly CLAY: low to medium plasticity, light brown, mottled grey, with fine grained sand. Gravel is fine to coarse, sub-angular to angular, MW siltstone	D		FILL
					173.0	1.0					
			SPT:11,24,25/130mm N=R	DS-1	172.5	1.5		LAMINITE: light brown-grey, mottled light brown, EW inferred extremely low strength, remoulds to clayey silt, medium plasticity, trace fine grained sand			BEDROCK
ADT	HWT				172.0	2.0					at 2.00 m: Drillers comment - auger resistance reduced
					171.5	2.5					
			SPT:21,25/80mm N=R	DS-2	171.0	3.0		LAMINITE: brown, mottled red-brown, HW, inferred low strength			at 2.80 m: auger resistance increased slightly
						3.5		*Borehole BH016 continued as cored borehole from 3.23 m*			
						4.0					
						4.5					
						5.0					

2015_ANZ_BOREHOLE 20160328_CHERRYBROOK_COMBINED.GPJ AECOM_2-02-PROJ-DEV-RMW.GPJ AECOM_2-03_LIBRARY.GLB 7.6.2016

AECOM Engineering Log

CORED BOREHOLE No. BH016

Sheet: 2 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	123 Castle Hill Road		**Start Date:**	15/02/2016	**End Date:** 15/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317586.0 m	**RL:** 174.00 m
Drill Rig:	Geoprobe 600	**Inclination:** -90°	**Northing:**	6265306.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Concrete Driveway

Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
							174.0								
							173.5	0.5							
							173.0	1.0							
							172.5	1.5							
							172.0	2.0							
							171.5	2.5							
							171.0	3.0		*Continued from non-cored borehole at 3.23 m*					
HQ3	Run 1	100	0		$Is_{50}(A)$= 0.15 MPa $Is_{50}(D)$= 0.060 MPa		170.5	3.5		LAMINITE: siltstone (70%), dark brown-grey, with thin laminations of sandstone (30%), fine grained, light brown, dipping at 0°, with iron stained healed fractures at varying orientations				EW, 0°, ST, ro, 20 mm, co, clay CZ, 0°, PL, ro, 30 mm, co, clayey gravel EW, 0°, PL, sm, 120 mm, co, clay B, 0°, PL, ro, stn, spaced 10 mm, FeO EW, 60°, PL, ro, 10 mm, co, clay EW, 0°, PL, ro, 70 mm, co, clay	1 of 3
							170.0	4.0							
	Run 2	97	10				169.5	4.5						B, 0°, PL, ro, 2-5 mm,co, spaced 60 mm, clay, FeO	
								5.0							

AECOM Engineering Log

CORED BOREHOLE No. BH016

Sheet: 3 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	123 Castle Hill Road		**Start Date:**	15/02/2016	**End Date:** 15/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317586.0 m	**RL:** 174.00 m
Drill Rig:	Geoprobe 600	**Inclination:** -90°	**Northing:**	6265306.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Concrete Driveway

Field Data | **Rock Description** | **Discontinuities**

Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa (A:● D:○ I:◆) (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 2	97	10		$Is_{(50)}$(A)= 0.47 MPa $Is_{(50)}$(D)= 0.26 MPa		169.0	5.5		LAMINITE: siltstone (70%), dark brown-grey, with thin laminations of sandstone (30%), fine grained, light brown, dipping at 0°, with iron stained healed fractures at varying orientations *continued*				J, 50°, PL, ro, 2-5 mm,co, spaced 10 mm, clay, x 5 B, 0°, PL, ro, 2-5 mm,co, spaced 60 mm, clay, FeO EW, 0°, PL, ro, 10 mm, co, gravelly clay J, 45°, ST, ro, vn, FeO J, 50°, ST, ro, stn, FeO, healed EW, 0°, PL, ro, 10 mm, co, clay J, 80°, PL, ro, vn, clay, FeO, from 6.57 m to 6.80 m	1 of 3
							168.5	6.0							
							168.0	6.5							
							167.5	7.0		SILTSTONE: dark grey, with thin laminations of sandstone (20%), fine grained, light grey, dipping at 0°, 10 mm typical spacing				FZ, 50°, UN, ro, 2 mm, co, extremely closely spaced fractures, brecciated core, clay infill J, 50°, PL, ro, 4 mm, co, spaced 30 mm, clay, FeO, x 3 CZ, 0°, PL, ro, 10 mm, co, clayey gravel	
							167.0	7.5							
					$Is_{(50)}$(A)= 1.1 MPa $Is_{(50)}$(D)= 0.11 MPa		166.5	8.0							
							166.0	8.5							
	Run 3	100	100		$Is_{(50)}$(A)= 2.8 MPa $Is_{(50)}$(D)= 0.17 MPa		165.5	9.0						J, 60°, PL, ro, cn, from 8.70 m to to 8.92 m	2 of 3
							165.0	9.5							
					$Is_{(50)}$(A)= 0.76 MPa $Is_{(50)}$(D)= 0.060 MPa		164.5	10.0							

AECOM Engineering Log

CORED BOREHOLE No. BH016

Sheet: 4 of 4

Client:	Grimshaw		**Project No:**	60310614	
Project:	Cherrybrook Town Centre		**Logged by:**	EC	**Checked by:** PP
Location:	123 Castle Hill Road		**Start Date:**	15/02/2016	**End Date:** 15/02/2016
Driller:	Terratest Pty Ltd	**Hole Diameter:** -	**Easting:**	317586.0 m	**RL:** 174.00 m
Drill Rig:	Geoprobe 600	**Inclination:** -90°	**Northing:**	6265306.0 m	**Ver. Datum:** mAHD
		Bearing: N/A	**Hor. Proj/Dat:**	MGA94/GDA94-56H	**Surface:** Concrete Driveway

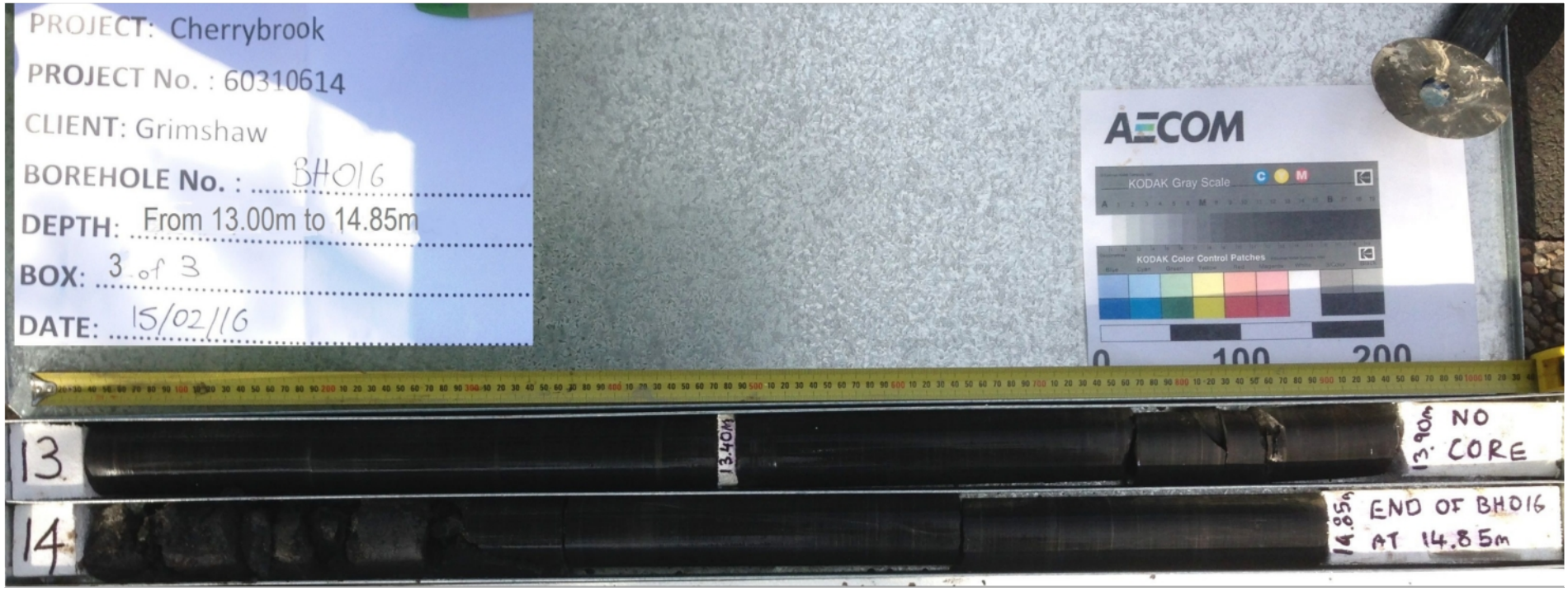
Field Data									Rock Description				Discontinuities		
Method	Core Run	TCR (%)	RQD (%)	Ground Water	Field Samples and Tests	WPT (Lugeons)	Reduced Level (m)	Depth (m)	Graphic Log	ROCK TYPE: grain size, colour, texture and fabric, structure, bedding dip (Soil) moisture, consistency/density (Geological Origin)	Weathering (RS EW HW MW SW FR)	Inferred Strength $Is_{(50)}$ MPa A:● D:○ I:◆ (EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH)	Defect Spacing (mm) (20 60 200 600 2000)	Additional Observations, Discontinuities Descriptions. *Discontinuities are inferred as mechanical breaks unless listed below*	Core Box No.
HQ3	Run 3	100	100				164.0			SILTSTONE: dark grey, with thin laminations of sandstone (20%), fine grained, light grey, dipping at 0°, 10 mm typical spacing *continued*					
							163.5	10.5							
					$Is_{(50)}$(A)= 0.65 MPa $Is_{(50)}$(D)= 0.12 MPa					from 10.70 m to 10.90 m concentration of sandstone laminations (60%)		○●		J, 30°, PL, ro, cn, from 10.70 m to 10.78 m	
							163.0	11.0							
	Run 4	100	100		$Is_{(50)}$(A)= 0.38 MPa $Is_{(50)}$(D)= 0.21 MPa		162.5	11.5				○●			2 of 3
							162.0	12.0						B, 0°, PL, ro, stn, FeO	
														J, 60°, UN, ro, vn, MU, healed	
														J, 60°, UN, ro, cn	
					$Is_{(50)}$(A)= 0.84 MPa $Is_{(50)}$(D)= 0.070 MPa		161.5	12.5				○●			
							161.0	13.0							
					$Is_{(50)}$(A)= 0.82 MPa $Is_{(50)}$(D)= 0.15 MPa		160.5	13.5				○●			
								14.0		NO CORE					3 of 3
	Run 5	117	87				160.0			SILTSTONE: dark grey, with thin laminations of sandstone (10%), fine grained, light grey, dipping at 0°, variable spacing from 14.01 m to 14.25 m inferred sheared zone, 50°, brecciated core				SZ, 50°, UN, ro, 270 mm, co, breccia, fine to coarse gravel in clay matrix	
														J, 80°, ST, ro, cn, discontinuous, from 14.27 m to 14.40 m	
					$Is_{(50)}$(A)= 0.63 MPa $Is_{(50)}$(D)= 0.070 MPa		159.5	14.5				○●			
							159.0	15.0		*BH016 terminated at 14.85 m.* *Reached target depth. Hole backfilled with cuttings and sand/gravel*						

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Sept 2015 Geotech Investigations\gINT\CorePhotos\BH016_Box01of3.jpg printed 14.3.2016

CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH016
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 3.23 m to 8.00 m
		ORIGINAL SIZE:	A4		BOX No. 1 of 3

P:\603X\60310614\4. Tech work area\4.1 Geotechnical\Sept 2015 Geotech Investigations\gINT\CorePhotos\BH016_Box02of3.jpg printed 14.3.2016

CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH016
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 8.00 m to 13.00 m
		ORIGINAL SIZE:	A4		BOX No. 2 of 3



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CLIENT:	Grimshaw	APPROVED:		AECOM	TITLE: Core Photographs
PROJECT NAME:	Cherrybrook Town Centre	DATE:	14/03/2016		BOREHOLE NO: BH016
PROJECT No:	60310614	SCALE:	N.T.S.		DEPTH RANGE: 13.00 m to 14.85 m
		ORIGINAL SIZE:	A4		BOX No. 3 of 3

Appendix E

Laboratory Test Results

TEST CERTIFICATE

Aaron.Lacey@sgs.com
ABN: 44 000 964 278
ph: +61 (0)2 8594 0481
fx: +61 (0)2 8594 0499

SGS Australia Pty Ltd
PO Box 6432 Alexandria NSW 2015
Unit 15, 33 Maddox Street
Alexandria NSW 2015

Client:	AECOM Australia Pty Ltd	Client Job No:	
Order No:	60310614 Task 1.3	Project:	Cherrybrook Rezoning
Tested Date:	1/03/2016	Location:	
SGS Job Number:	16-32-38	Sample No:	16-AC-389
Lab:	Alexandria CMT	Sample ID:	BH016 (1.50 - 1.93)

Atterberg Limits (1 Point Casagrande) with Linear Shrinkage

AS 1289.3.1.2(Liquid Limit), 3.2.1(Liquid Limit), 3.3.1(Plasicity Index), 3.4.1(Linear Shrinkage)

Liquid Limit (%):	**24**
Plastic Limit (%):	**16**
Plastic Index (%):	**8**
Linear Shrinkage (%):	**5.5**
Nature of shrinkage:	Cracked
Length of Mould (mm):	125
History of Sample:	Air Dried
Method of Preparation:	Dry Sieved

Note: Sample supplied by client.

This Certificate replaces the previously issued Certificate No.:16-AC-389-S312

Approved Signatory: (Aaron.Lacey) Date: 21/03/2016

Accredited for compliance with ISO/IEC 17025

Site No.: 1452
Cert No.: 16-AC-389-S312/1
Form No.

Accreditation No.: 2418
Client Address: PO Box 1307 FORTITUDE VALLEY Qld 4006

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Simon Rosam	Manager	Huong Crawford
Client	SGS Industrial CMT Eastern Sydney	Laboratory	SGS Alexandria Environmental
Address	Unit 15, 33 Maddox Street PO Box 6432 ALEXANDRIA NSW 2015	Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	(02) 8594 0481	Telephone	+61 2 8594 0400
Facsimile	02 8594 0499	Facsimile	+61 2 8594 0499
Email	simon.rosam@sgs.com	Email	au.environmental.sydney@sgs.com
Project	**16-32-38 - 60310614-1.3 Cherrybrook**	SGS Reference	**SE149452 R0**
Order Number	**CMT150731050**	Date Received	25 Feb 2016
Samples	5	Date Reported	02 Mar 2016

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Andy Sutton
Senior Organic Chemist

Miliana Colati
Chemist / 2IC Inorganics

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	SE149452.001 Soil 25 Feb 2016 16-AC-363 BH010 1.5-1.95m	SE149452.002 Soil 25 Feb 2016 16-AC-367 BH011 1.5-1.95m	SE149452.003 Soil 25 Feb 2016 16-AC-373 BH012 1.5-1.95m	SE149452.004 Soil 25 Feb 2016 16-AC-377 BH013 1.5-1.95m
pH in soil (1:2) Method: AN101 Tested: 1/3/2016							
pH (1:2)	pH Units	-		**4.1**	-	**4.3**	**4.4**
Conductivity (1:2) in soil Method: AN106 Tested: 1/3/2016							
Conductivity (1:2) @25 C*	µS/cm	1		**190**	**270**	**75**	**310**
Resistivity (1:2)*	ohm cm	-		**5300**	**3800**	**13000**	**3200**
Salinity (by calculation)*	mg/kg	0.1		-	-	-	-
Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: AN245 Tested: 26/2/2016							
Chloride	mg/kg	0.25		**40**	-	**12**	**45**
Sulphate	mg/kg	0.5		**100**	-	**39**	**97**
Moisture Content Method: AN002 Tested: 26/2/2016							
% Moisture	%w/w	0.5		**16.9**	**16.6**	**19.5**	**10.8**

Parameter	Units	LOR	Sample Number: SE149452.005 Sample Matrix: Soil Sample Date: 25 Feb 2016 Sample Name: 16-AC-389 BH016 1.5-1.93m
pH in soil (1:2) Method: AN101 Tested: 1/3/2016			
pH (1:2)	pH Units	-	**4.0**
Conductivity (1:2) in soil Method: AN106 Tested: 1/3/2016			
Conductivity (1:2) @25 C*	µS/cm	1	**150**
Resistivity (1:2)*	ohm cm	-	**6600**
Salinity (by calculation)*	mg/kg	0.1	-
Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography Method: AN245 Tested: 26/2/2016			
Chloride	mg/kg	0.25	**16**
Sulphate	mg/kg	0.5	**80**
Moisture Content Method: AN002 Tested: 26/2/2016			
% Moisture	%w/w	0.5	**9.9**

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Conductivity (1:2) in soil **Method: ME-(AU)-[ENV]AN106**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity (1:2) @25 C*	LB096126	µS/cm	1	<1	5%	100%
Resistivity (1:2)*	LB096126	ohm cm	-		5%	

Moisture Content **Method: ME-(AU)-[ENV]AN002**

Parameter	QC Reference	Units	LOR	DUP %RPD
% Moisture	LB095947	%w/w	0.5	3 - 7%

pH in soil (1:2) **Method: ME-(AU)-[ENV]AN101**

Parameter	QC Reference	Units	LOR	DUP %RPD	LCS %Recovery
pH (1:2)	LB096126	pH Units	-	1%	99%

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography **Method: ME-(AU)-[ENV]AN245**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Chloride	LB095918	mg/kg	0.25	<0.25	7%	97%
Sulphate	LB095918	mg/kg	0.5	<0.5	3%	100%

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:2 and the pH determined and reported on the extract after 1 hour extraction (pH 1:2) or after 1 hour extraction and overnight aging (pH (1:2) aged). Reference APHA 4500-H+.
AN106	Conductivity : Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:2 and the EC determined and reported on the extract basis after the 1 hour extraction (EC(1:2)) or after the 1 hour extraction and overnight aging (EC(1:2) aged). Reference APHA 2510 B.
AN106	Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis.
AN245	Anions by Ion Chromatography: A water sample or extract is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

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TEST CERTIFICATE

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SGS Australia Pty Ltd
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Australia

POINT LOAD STRENGTH INDEX

CLIENT: **AECOM Australia Pty Ltd**
PO Box 1307 FORTITUDE VALLEY Qld 4006
PROJECT: **Cherrybrook Rezoning**
LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION DIAM (mm)	PLATEN SEPARATION HEIGHT (mm)	TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH $Is_{(50)}$ (MPa)	Type OF FAILURE
16-AC-364	BH010 5.80-5.90m	MW-Fr Siltstone	61.0		Diametral	0.21	0.23	FB
				40.0	Axial	0.61	0.65	FOB
16-AC-364	BH010 6.60-6.70m	Fr Siltstone	61.0		Diametral	0.22	0.24	FOB
				42.0	Axial	0.77	0.82	FOB
16-AC-364	BH010 7.30-7.40m	Fr Siltstone	61.0		Diametral	0.71	0.78	FOB
				45.0	Axial	2.49	2.68	FOB
16-AC-364	BH010 8.40-8.50m	Fr Siltstone	62.0		Diametral	0.63	0.69	FOB
				42.0	Axial	2.05	2.18	FOB
16-AC-364	BH010 9.60-9.70m	Fr Siltstone	61.0		Diametral	0.91	1.00	FOB
				39.0	Axial	3.64	3.80	FOB

NOTES TO TESTING

Testing Device	ELE Point Load Tester
Sample History	Unsoaked
Sampled By:	Client
Job Number:	16-32-38
Date Tested:	22/02/2016
Test Method:	AS 4133.4.1 2007

Failure Type

FOB	Fracture through fabric of specimen oblique to bedding not influenced by weak planes
FB	Fracture along bedding
FIP	Fracture influenced by pre-existing plane, microfracture, vein, chemical alteration
CPF	Chip or partial fracture

Approved Signatory: Aaron Lacey **Date:** 9/03/2016

Accreditation No. 2418

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PO Box 1307 FORTITUDE VALLEY Qld 4006
PROJECT: **Cherrybrook Rezoning**
LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION DIAM (mm)	PLATEN SEPARATION HEIGHT (mm)	TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH $Is_{(50)}$ (MPa)	Type OF FAILURE
16-AC-368	BH011 6.55-6.65m	Sandstone	61.0		Diametral	0.22	0.24	FOB
				43.0	Axial	0.50	0.54	FOB
16-AC-368	BH011 7.47-7.57m	MW to Fr Laminate	61.0		Diametral	0.38	0.42	FOB
				41.0	Axial	1.71	1.80	FOB
16-AC-368	BH011 8.65-8.75m	MW to Fr Laminate	61.0		Diametral	0.54	0.59	FOB
				42.0	Axial	1.56	1.66	FOB
16-AC-368	BH011 9.43-9.53m	MW to Fr Laminate	61.0		Diametral	0.52	0.57	FOB
				54.0	Axial	0.98	1.11	FOB
16-AC-368	BH011 10.45-10.55m	MW to Fr Laminate	61.5		Diametral	1.08	1.18	FOB
				38.0	Axial	1.96	2.04	FOB
16-AC-368	BH011 11.45-11.55m	Fr Sandstone	62.0		Diametral	0.62	0.68	FOB
				44.0	Axial	0.80	0.86	FOB
16-AC-368	BH011 12.45-12.55m	Fr Sandstone	62.0		Diametral	1.00	1.10	FOB
				38.0	Axial	1.18	1.23	FOB
16-AC-368	BH011 13.60-13.70m	Fr Sandstone	61.5		Diametral	1.03	1.13	FOB
				53.0	Axial	1.00	1.12	FOB

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Unsoaked

Sampled By: Client

Job Number: 16-32-38

This report cancels and replaces the report dated 9/03/2016

Date Tested: 22/02/2016

Test Method: AS 4133.4.1 2007

Failure Type
- FOB Fracture through fabric of specimen oblique to bedding not influenced by weak planes
- FB Fracture along bedding
- FIP Fracture influenced by pre-existing plane, microfracture, vein, chemical alteration
- CPF Chip or partial fracture

Approved Signatory: Aaron Lacey **Date:** 21/03/2016

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CLIENT: **AECOM Australia Pty Ltd**
PO Box 1307 FORTITUDE VALLEY Qld 4006
PROJECT: **Cherrybrook Rezoning**
LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH	POINT LOAD STRENGTH	Type OF FAILURE
			DIAM (mm)	HEIGHT (mm)		Is (MPa)	$Is_{(50)}$ (MPa)	
16-AC-368	BH011 14.60-14.70m	Dolereite	62.0		Diametral	0.64	0.70	FOB
				55.0	Axial	0.68	0.77	FOB

NOTES TO TESTING

Testing Device	ELE Point Load Tester
Sample History	Unsoaked
Sampled By:	Client
Job Number:	16-32-38
Date Tested:	22/02/2016
Test Method:	AS 4133.4.1 2007

Failure Type

FOB	Fracture through fabric of specimen oblique to bedding not influenced by weak planes
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PROJECT: **Cherrybrook Rezoning**
LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION DIAM (mm)	PLATEN SEPARATION HEIGHT (mm)	TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH $Is_{(50)}$ (MPa)	Type OF FAILURE
16-AC-375	BH012 6.00-6.10m	EM-MW Lamintie	61.5		Diametral	0.13	0.15	FOB
				40.5	Axial	0.32	0.34	FOB
16-AC-375	BH012 8.30-8.40m	MW to FR Laminite Sandstone	61.0		Diametral	0.11	0.12	FOB
				41.0	Axial	0.21	0.22	FOB
16-AC-375	BH012 9.77-9.87m	Sandstone	61.0		Diametral	0.41	0.45	FIP
				58.0	Axial	0.27	0.30	FOB

NOTES TO TESTING

Testing Device	ELE Point Load Tester
Sample History	Unsoaked
Sampled By:	Client
Job Number:	16-32-38
Date Tested:	22/02/2016
Test Method:	AS 4133.4.1 2007

Failure Type

FOB	Fracture through fabric of specimen oblique to bedding not influenced by weak planes
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PROJECT: **Cherrybrook Rezoning**
LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION DIAM (mm)	PLATEN SEPARATION HEIGHT (mm)	TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH $Is_{(50)}$ (MPa)	Type OF FAILURE
16-AC-378	BH013 3.60-3.70m	SW Sandstone	61.0		Diametral	0.85	0.93	FOB
				59.0	Axial	0.59	0.68	FOB
16-AC-378	BH013 4.65-4.75m	SW Sandstone	62.0		Diametral	1.09	1.20	FOB
				49.0	Axial	1.28	1.41	FOB
16-AC-378	BH013 5.60-5.70m	SW Sandstone	62.0		Diametral	0.95	1.05	FOB
				56.0	Axial	1.42	1.62	FOB
16-AC-378	BH013 6.70-6.80m	MW to Fr Sandstone	61.0		Diametral	0.42	0.46	FOB
				41.0	Axial	1.01	1.07	FOB
16-AC-378	BH013 7.65-7.75m	MW to Fr Sandstone	62.0		Diametral	1.07	1.18	FOB
				46.0	Axial	1.30	1.41	FOB
16-AC-378	BH013 8.40-8.50m	MW to Fr Sandstone	62.0		Diametral	1.21	1.33	FOB
				40.0	Axial	1.47	1.55	FOB
16-AC-378	BH013 9.40-9.50m	MW to Fr Sandstone	62.0		Diametral	0.87	0.96	FOB
				53.0	Axial	1.01	1.14	FOB

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Unsoaked

Sampled By: Client

Job Number: 16-32-38

This report cancels and replaces the report dated 9/03/2016

Date Tested: 22/02/2016

Test Method: AS 4133.4.1 2007

Failure Type
- FOB Fracture through fabric of specimen oblique to bedding not influenced by weak planes
- FB Fracture along bedding
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- CPF Chip or partial fracture

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LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION DIAM (mm)	PLATEN SEPARATION HEIGHT (mm)	TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH $Is_{(50)}$ (MPa)	Type OF FAILURE
16-AC-382	BH014 4.60-4.70m	EW to Fr Sandstone	62.0		Diametral	1.01	1.11	FOB
				39.0	Axial	1.15	1.21	FOB
16-AC-382	BH014 5.37-5.47m	EW to Fr Sandstone	62.0		Diametral	0.84	0.93	FOB
				49.0	Axial	1.46	1.61	FOB
16-AC-382	BH014 6.40-6.50m	EW to Fr Sandstone	61.0		Diametral	0.73	0.80	FOB
				46.0	Axial	1.33	1.44	FOB
16-AC-382	BH014 7.90-8.00m	Fr Sandstone	60.5		Diametral	1.27	1.39	FOB
				51.5	Axial	2.55	2.83	FOB
16-AC-382	BH014 8.65-8.75m	Fr Sandstone	61.0		Diametral	1.18	1.29	FOB
				55.0	Axial	0.94	1.06	FOB
16-AC-382	BH014 9.20-9.30m	Fr Sandstone	61.0		Diametral	1.18	1.29	FOB
				45.0	Axial	1.57	1.70	FOB

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Unsoaked

Sampled By: Client

Job Number: 16-32-38

This report cancels and replaces the report dated 9/03/2016

Date Tested: 22/02/2016

Test Method: AS 4133.4.1 2007

Failure Type
- FOB Fracture through fabric of specimen oblique to bedding not influenced by weak planes
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POINT LOAD STRENGTH INDEX

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PROJECT: **Cherrybrook Rezoning**
LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION DIAM (mm)	PLATEN SEPARATION HEIGHT (mm)	TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH $Is_{(50)}$ (MPa)	Type OF FAILURE
16-AC-385	BH015 5.50-5.60m	EW to MW Laminite	61.0		Diametral	0.17	0.19	FOB
				58.0	Axial	0.15	0.17	FOB
16-AC-385	BH015 6.05-6.15m	MW to SW Laminite			Diametral			Un-testable
					Axial			Un-testable
16-AC-385	BH015 7.65-7.75m	MW to SW Laminite	60.5		Diametral	0.40	0.43	FOB
				52.0	Axial	0.39	0.44	FOB
16-AC-385	BH015 8.30-8.40m	MW to SW Laminite	61.0		Diametral	0.37	0.40	FOB
				49.0	Axial	0.45	0.49	FOB
16-AC-385	BH015 9.30-9.40m	MW to SW Laminite	61.0		Diametral	0.29	0.32	FOB
				52.0	Axial	0.42	0.47	FOB
16-AC-385	BH015 10.35-10.45m	FR Siltstone	61.0		Diametral	0.27	0.30	FOB
				52.0	Axial	0.57	0.64	FOB
16-AC-385	BH15 11.30-11.40m	FR Siltstone	61.0		Diametral	0.24	0.26	FOB
				39.0	Axial	0.49	0.51	FOB
16-AC-385	BH15 12.64-12.74m	FR Siltstone	61.0		Diametral	0.68	0.74	FOB
				58.0	Axial	0.50	0.57	FOB

NOTES TO TESTING

Testing Device: ELE Point Load Tester

Sample History: Unsoaked

Sampled By: Client

Job Number: 16-32-38

Date Tested: 22/02/2016

Test Method: AS 4133.4.1 2007

Failure Type
- FOB Fracture through fabric of specimen oblique to bedding not influenced by weak planes
- FB Fracture along bedding
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PROJECT: **Cherrybrook Rezoning**
LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH	POINT LOAD STRENGTH	Type OF FAILURE
			DIAM (mm)	HEIGHT (mm)		Is (MPa)	$Is_{(50)}$ (MPa)	
16-AC-385	BH015 13.40-13.50m	FR Siltstone	62.0		Diametral	0.08	0.09	FOB
				40.4	Axial	0.62	0.65	FOB
16-AC-385	BH015 14.30-14.40m	FR Siltstone	61.0		Diametral	0.12	0.14	FOB
				37.0	Axial	0.41	0.42	FOB

NOTES TO TESTING

Testing Device	ELE Point Load Tester
Sample History	Unsoaked
Sampled By:	Client
Job Number:	16-32-38
Date Tested:	22/02/2016
Test Method:	AS 4133.4.1 2007

Failure Type

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LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION DIAM (mm)	PLATEN SEPARATION HEIGHT (mm)	TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH $Is_{(50)}$ (MPa)	Type OF FAILURE
16-AC-390	BH016 4.20-4.28m	EW - MW Laminate	51.5		Diametral	0.06	0.06	FOB
				32.0	Axial	0.16	0.15	FOB
16-AC-390	BH016 5.15 5.25m	EW - MW Laminate	52.0		Diametral	0.26	0.26	FOB
				42.0	Axial	0.46	0.47	FOB
16-AC-390	BH016 7.60-7.70m	EW - MW Laminate	52.0		Diametral	0.11	0.11	FOB
				35.0	Axial	1.12	1.11	FOB
16-AC-390	BH016 8.45-8.55 M	SW to FR Siltstone	52.0		Diametral	0.16	0.17	FOB
				42.0	Axial	2.75	2.82	FOB
16-AC-390	BH 016 9.36-9.46m	SW to FR Siltstone	52.0		Diametral	0.06	0.06	FON
				32.0	Axial	0.79	0.76	FO{
16-AC-390	BH016 10.55-10.65	SW to FR Siltstone	52.0		Diametral	0.12	0.12	FOB
				46.0	Axial	0.62	0.65	FOB
16-AC-390	BH016 11.35-11.45m	SW to FR Siltstone	51.5		Diametral	0.21	0.21	FOB
				36.0	Axial	0.38	0.38	FOB
16-AC-390	BH016 12.50-12.60	SW to FR Siltstone	52.0		Diametral	0.06	0.07	FOB
				50.0	Axial	0.78	0.84	FOB

NOTES TO TESTING

Testing Device: ELE Point Load Tester
Sample History: Unsoaked
Sampled By: Client
Job Number: 16-32-38
Date Tested: 22/02/2016
Test Method: AS 4133.4.1 2007

Failure Type
FOB Fracture through fabric of specimen oblique to bedding not influenced by weak planes
FB Fracture along bedding
FIP Fracture influenced by pre-existing plane, microfracture, vein, chemical alteration
CPF Chip or partial fracture

Approved Signatory: Aaron Lacey **Date:** 9/03/2016

Accreditation No. 2418

Accredited for Compliance with ISO/IEC 17025

TEST CERTIFICATE

ABN 44 000 964 278
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SGS Australia Pty Ltd
Unit 15, 33 Maddox Street
(PO Box 6432)
Alexandria NSW 2015
Australia

POINT LOAD STRENGTH INDEX

CLIENT: **AECOM Australia Pty Ltd**
PO Box 1307 FORTITUDE VALLEY Qld 4006
PROJECT: **Cherrybrook Rezoning**
LOCATION:

LAB. NO.	SAMPLE SOURCE	LITHOLOGY	PLATEN SEPARATION		TEST ORIENTATION	POINT LOAD STRENGTH Is (MPa)	POINT LOAD STRENGTH $Is_{(50)}$ (MPa)	Type OF FAILURE
			DIAM (mm)	HEIGHT (mm)				
16-AC-390	BH016 13.20-13.30m	SW to FR Siltstone	51.5		Diametral	0.14	0.15	FOB
				30.0	Axial	0.87	0.82	FOB
16-AC-390	BH016 14.40-14.50m	SW to FR Siltstone	52.0		Diametral	0.07	0.07	FOB
				42.0	Axial	0.61	0.63	FOB

NOTES TO TESTING

Testing Device	ELE Point Load Tester
Sample History	Unsoaked
Sampled By:	Client
Job Number:	16-32-38
Date Tested:	22/02/2016
Test Method:	AS 4133.4.1 2007

Failure Type

FOB	Fracture through fabric of specimen oblique to bedding not influenced by weak planes
FB	Fracture along bedding
FIP	Fracture influenced by pre-existing plane, microfracture, vein, chemical alteration
CPF	Chip or partial fracture

Approved Signatory: Aaron Lacey **Date:** 9/03/2016

Accreditation No. 2418

Accredited for Compliance with ISO/IEC 17025

Appendix F

AGS Guidelines

Rate of Movement

Figure B3 shows the velocity scale proposed by Cruden & Varnes (1996) which rationalises previous scales. The term "creep" has been omitted due to the many definitions and interpretations in the literature.

Velocity Class	Description	Velocity (mm/sec)	Typical Velocity	Probable Destructive Significance
7	Extremely Rapid			Catastrophe of major violence; buildings destroyed by impact of displaced material; many deaths; escape unlikely
		5×10^{3}	5 m/sec	
6	Very Rapid			Some lives lost; velocity too great to permit all persons to escape
		5×10^{1}	3 m/min	
5	Rapid			Escape evaluation possible; structures; possessions, and equipment destroyed
		5×10^{-1}	1.8 m/hr	
4	Moderate			Some temporary and insensitive structures can be temporarily maintained
		5×10^{-3}	13 m/month	
3	Slow			Remedial construction can be undertaken during movement; insensitive structures can be maintained with frequent maintenance work if total movement is not large during a particular acceleration phase
		5×10^{-5}	1.6 m/year	
2	Very Slow			Some permanent structures undamaged by movement
		5×10^{-7}	15 mm/year	
	Extremely **SLOW**			Imperceptible without instruments; construction **POSSIBLE WITH PRECAUTIONS**

Figure B3: Proposed Landslide Velocity Scale and Probable Destructive Significance.

REFERENCES AND ACKNOWLEDGEMENT

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PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}	$5x10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5x10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5x10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5x10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5x10^{-6}$	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	**1: CATASTROPHIC 200%**	**2: MAJOR 60%**	**3: MEDIUM 20%**	**4: MINOR 5%**	**5: INSIGNIFICANT 0.5%**
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY	10^{-2}	VH	VH	H	M	**L**
C - POSSIBLE	10^{-3}	VH	H	M	M	**VL**
D - UNLIKELY	10^{-4}	H	M	**L**	**L**	**VL**
E - RARE	10^{-5}	M	**L**	**L**	**VL**	**VL**
F - BARELY CREDIBLE	10^{-6}	**L**	**VL**	**VL**	**VL**	**VL**

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		**Example Implications** (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.