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ADDENDUM

FOR

BLOCK 5 SECTION 8, BLOCK 1 SECTION 130, BLOCK 1 SECTION 131, BLOCK 1 SECTION 132 AND BLOCK 1 SECTION 133 DIVISION OF CAMPBELL

ISSUED IN ACCORDANCE WITH PARAGRAPH 3.7 OF THE GENERAL SALES INFORMATION

Addendum 1

Subgrade Assessment

The attached document entitled 'Report on Geotechnical Investigation, Subgrade Assessment, Proposed Mix-Use Development, Section 5, Campbell' prepared by Douglas Partners Pty Ltd and dated 8 June 2012 is added to the Background Documentation.

All enquiries in relation to this Addendum must be in writing and emailed to the Sales Agent.

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Subgrade Assessment
Proposed Mix-Use Development
Section 5, Campbell

Prepared for
Cardno Young Pty Ltd

Project 50584.01
June 2012

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	50653	Document No.	1
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Document status and review

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0	1		Cardno Young Pty Ltd

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		8 June 2012
Reviewer		8 June 2012

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Report on Geotechnical Investigation
Proposed Mix-Use Development
Section 5, Campbell

1. Introduction

This report presents the results of a geotechnical investigation carried out for the assessment of subgrade conditions for the proposed roads for the development of Section 5 in Campbell. The work was commissioned by Cardno Young Pty Ltd, civil design engineers for the project.

The proposed development of Section 5, Campbell comprises the creation of five (5) multi-unit blocks, two open space areas and the construction of internal street pavement. Site investigation was carried out to provide preliminary information to assist road designers in site preparation procedures and to provide comment on subgrade and excavation conditions and design CBR parameters.

The investigation comprised the excavation of test pits followed by laboratory testing of collected samples, engineering analysis and reporting. Details of the work undertaken and the results obtained are given in the report, together with comments relating to design and construction practice.

A site plan indicating the proposed road layout and nominated test locations was supplied by the client for the investigation. Important notes *About this Report* are included in Appendix A.

2. Previous Investigation

The site has been previously subject to a contamination assessment undertaken by Douglas Partners (DP). The report (titled: *Phase 1 and Phase 2 Contamination Assessment, Proposed Residential and Commercial Development, Block 2 and 3 Section 5, Campbell*; Project 50584 Doc2 Rev1, dated 17 November 2011 [Ref 1]) included the following information:

- Desktop study of topographic and geological and hydrogeological maps;
- Search of groundwater bore register maintained by ACT Water Resources;
- Regulatory Notices search with ACT Department of Environment and Heritage;
- ACT WorkSafe records search for registered dangerous substances;
- A review of selected historical aerial photography archived with the NSW Land and Property Information Centre;
- A review of previous site ownership records through the Land Titles Office;
- Review of previous investigations;
- Site inspection;
- Soil sampling at 79 locations over the site;

- Laboratory testing of 251 selected soil samples (including 41 QA/QC) for a range of potential organic and inorganic contaminants;
- Interpretation of the results of laboratory testing in the context of field observations, local geology and hydrogeology and history of the site;
- Preparation of a Phase 1 and Phase 2 Contamination Assessment report which discusses the findings of the assessment.

The report found that the desktop review and sampling and analysis for a range of potential chemical contaminants undertaken in the assessment confirmed contamination associated with filling within the southern part of the site. The principal contaminant is asbestos in a bonded form. Minor contamination outside of this area was also identified, including asbestos at three locations. Building wastes were also encountered in the filling in the southern part of the site which was found to be at least 2.5 m deep (where a former dam that has been filled). Building wastes are aesthetically unsuitable to remain on the site and will need to be removed. The removal of asbestos and building wastes will also include the removal of minor heavy fraction petroleum hydrocarbons and lead hot spots.

Although wet conditions were found in the subsurface investigations, these conditions were identified at the interface of the filling and underlying natural soils in an area of a former farm dam in the southern portion of the site. It was considered any intermittent surface water that infiltrates the filling is unlikely to enter the groundwater, but rather migrate along the interface of the filling and natural soils laterally in a southerly direction off site.

The contamination assessment recommended that remediation would need to be undertaken in accordance with a Remedial Action Plan (RAP). Since the assessment was completed a RAP has been developed by DP (Ref 2) for the remediation of the building wastes and asbestos and chemical contaminated filling at the identified locations particularly the southern part of the site. The RAP details the remediation methods required to excavate and remove the impacted soil.

3. Site Description

The site is irregular in shape and approximately 6.4 ha in area, with unrestricted access to the site (refer Drawing 1, Appendix B). The site is identified as Section 5 in Campbell and is “designated” land overseen by the National Capital Authority (NCA) through the National Capital Plan (NCP). The site is currently divided into three blocks (Blocks 2, 4 and 5).

The irregular shaped site is currently vacant and is bordered by Anzac Park East to the west, Constitution Avenue to the southwest, Creswell Street to the south east, Chowne Street to the east and Page Street to the north with government and commercial development surrounding the southern portion of the site and residential development bounds the site to the north, east and west.

Timber bollards are located on the western and eastern site boundaries with Anzac Park and Creswell Street. Rows of trees are located on the majority of the site boundaries. Six trees are also located within the central southern portion of the site. The remainder of the site is cleared and currently heavily grassed.

The site is positioned at the base of the southern slopes of Mount Ainslie. A broad gully characterises a majority of the site with the overall site sloping to the south. Two drainage gullies enter the site from collected local street drainage. One gully discharges from a headwall to the west of the site into a short drainage channel at the edge of the site, midway along the boundary with Anzac Park East. The second drainage line enters the site from the north, midway along the boundary with Chowne Street. The confluence of the gullies is within the centre of the site and a single gully discharges through the site's southeast corner into the street gutter system.

A knoll of elevated land is located in the western portion of the site. The site slopes slightly to moderately across the site in the directions of east, west and south at estimated grades of 1 in 5 to 1 in 50 (vertical to horizontal) with an estimated overall difference in level of 6 m to 8 m.

4. Regional Geology

Reference to the 1:10 000 Geological Series Sheet for Central Canberra indicates that the site is located on the boundaries of three rock units of Silurian age and an alluvial deposit unit of Tertiary age. These units include:

- Canberra Formation – typically comprising sandstone, siltstone, shale and limestone,
- Narrabundah Ashstone Member – typically comprising tuff, ashstone and chert,
- Ainslie Volcanics - typically comprising dacite, and
- Tertiary alluvial deposits – typically comprising high level deposits of gravel, sand, silt and clay.

A dacitic dyke is also indicated in the south western corner of the site which is likely characterised by a knoll.

5. Field Work Methods

The field investigation comprised the excavation of seven test pits (Pits 1 – 7) to depths of 1.8 – 3.0 m using a JCB 3CX backhoe fitted with a 600 mm wide bucket working under the direction of an experienced geotechnical engineer. Disturbed and bulk samples were collected for laboratory testing and to assist in strata identification. Dynamic cone penetrometer tests (AS1289 6.3.2) were also undertaken to provide an indication of the in-situ strength profile of the site soils at each test location. The approximate location of the test pits are shown on Drawing 1 included in Appendix B. The test pits were located using a hand held GPS unit which is accurate to about 5 m.

6. Field Work Results

6.1 Subsurface Conditions

Details of the subsurface conditions encountered are summarised in the test pit logs included in Appendix C, which should be read in conjunction with the attached notes that define classification methods and descriptive terms. The test pits encountered variable subsurface conditions underlying the site with the principal succession of strata as follows:

TOPSOIL and TOPSOIL FILLING: generally comprising moist, clayey silt and clayey sand with rootlets and organic matter to depths of 0.15 m – 0.7 m.

FILLING: generally comprising, dry to moist, silty clay and clayey silty sand in Pits 103 and 105 to depths of 0.5 m and 1.8 m respectively. Building rubble and other wastes were encountered in Pit 103 and in Pit 105 below a depth of 0.5 m to the termination depth of 1.8 m due to collapsing conditions

SILT: stiff to very stiff, dry to moist, silt with variable clay, sand and gravel content in Pits 102 – 104 and 106 to depths of 0.4 m – 0.9 m.

CLAY, SILT, SAND & GRAVEL: stiff to hard or medium dense, moist variable layers of clay, silt, sand and gravel in Pits 101 – 104, 106 and 107 to depths of 1.4 m – 3.0 m. Pit 102 was discontinued in natural soil at the limit of investigation depth of 3.0 m

BEDROCK: extremely low to vey low strength, extremely to highly weathered bedrock was encountered below depths of 1.4 m – 2.3 m in Pits 101, 103, 104, 106 and 107 to pit termination at 3.0 m depth. The bedrock comprised siltstone sandstone, calcareous claystone and tuff bedrock. High strength limestone cobbles and boulders up to 0.5 m in size were encountered in Pit 106 between 1.5 m and 2.0 m. Very low to low strength siltstone was also encountered in the same pit below a depth of 2.5 m.

6.2 Groundwater

No free groundwater was observed in the test pits during excavation. The pits were backfilled immediately following excavation precluding longer term monitoring of groundwater levels. It should be noted that groundwater levels are affected by weather conditions and soil permeability and will vary with time. For these reasons, it is noted that the moisture condition of the site soils may vary considerably from the time of the investigation compared to at the time of construction.

7. Laboratory Testing

Samples recovered from the test pits were submitted for testing in the laboratory for measurement of field moisture content, compaction properties and California bearing ratio (CBR). The detailed test report sheets are included in Appendix D, with the results summarised in Table 1.

Table 1: Results of CBR Tests

Pit No	Depth (m)	FMC (%)	OMC (%)	MDD (t/m^3)	CBR (%)	Field Description
101	0.6 – 0.8	29.8	27.5	1.52	1.0	Clay
102	0.9 – 1.1	16.9	14.0	1.91	7	Silty Clay
104	0.5 – 0.7	23.8	21.5	1.66	4.0	Silty Clay/Clayey Silt
107	0.5 – 0.7	17.2	16.5	1.82	8	Silty Clay

Where: FMC = Field moisture content; OMC = Optimum moisture content; MDD = Maximum dry density (modified); CBR = California bearing ratio

The CBR samples tested were compacted to about 95% modified dry density ratio at close to optimum moisture content and soaked for four days under a surcharge loading of 4.5 kg.

The compaction test results show the samples tested were predominantly 1 to 3 percentage points wet of optimum moisture content. The results also indicate a variable range in CBR value however with the more clayey samples exhibiting lower soaked CBR strength.

8. Proposed Development

It is understood that the proposed development will comprise the construction of four intersections (with Anzac Park East, Constitution Ave and Creswell Street) and internal roads pavements. Site regrading plans had not been finalised at the time of the investigation. However, it is anticipated that cut and fill depths of around 0.5 – 2.0 m for the roads may be required based on current site levels. As remediation works are required particularly in the southern parts of the site, excavation depths of at least 2.5 m are anticipated followed by the placement of controlled fill to development design levels.

9. Comments

9.1 Site Preparation and Earthworks

9.1.1 Stripping

Site preparation for the construction of road formations should include the removal of vegetation, uncontrolled filling, topsoil and other deleterious materials from the proposed construction areas. Based on the results of the investigation, a topsoil stripping depth of around 0.2 m is expected. Deeper excavations (such as in gullies) could occur should localised deeper topsoils (Pit 102) or unsuitable materials/filling (Pits 103 and 105) be encountered, if inclement weather precedes construction or if the contractor adopts inappropriate stripping methods.

Silty and sandy soils were encountered underlying the topsoil and allowance should be made for at least partial removal (say 0.2 m following topsoil stripping) of these soils. The depth of silty soil is expected to be in the range 0.2 – 0.3 m.

The silty soils could prove to be difficult to handle and compact upon, particularly if subject to water infiltration, and would require careful moisture control.

It is recommended that inspection of stripped surfaces be undertaken by a suitably qualified geotechnical engineer to assess the need for further removal of unsuitable material or for any other remedial measures.

9.1.2 Site Trafficability

Following periods of wet weather, the natural surface across the site may be boggy and effectively untrafficable to all but tracked construction vehicles. Some measures that can be undertaken to reduce the impact of wet weather on the earthworks construction include:

- retain grass cover wherever possible;
- provide cut surfaces with an slight but even cross-gradient to assist surface drainage;
- "seal" exposed fill surfaces at the end of each work day by running over with a smooth-wheeled roller;
- armour temporary access roads with rockfill;
- form swale drains at upslope locations to help intercept surface and near-surface seepage water and to redirect it into existing drainage gullies or dams, or to sediment retention ponds.

9.1.3 Excavation Conditions

The filling, silty topsoil, natural soils and extremely low to low strength bedrock could be expected to be excavated using conventional earthmoving plant and as such no difficulties are anticipated with the exception of any boulder sized particles or larger limestone inclusions in the bedrock.

Based on the subsurface investigation to date, rock strengths of low or greater strength are not anticipated within the likely excavation depths noted in Section 8.

No free groundwater or groundwater seepage was observed during excavation of the test pits, however due to the position of the site at the base of Mount Ainslie in a broad gully with the confluence of two drainage lines within the site, groundwater seepage may occur within excavations. It is noted that the extent and volume of groundwater inflow into excavations would be dependent on prior weather conditions. Groundwater seepages should be anticipated following rainfall.

9.1.4 Excavation Batters

For permanent excavations in the topsoil, natural soils and rock, maximum gradients of 2.5H:1V (horizontal:vertical) for natural soils/very low strength bedrock and 1H:1V in low or greater strength bedrock are recommended. To minimise surface erosion the batters should be protected with toe and spoon drains and vegetated or armoured using other protective measures as soon as possible after construction.

For temporary excavations, maximum gradients of 1H:1V is suggested for natural soils/very low strength rock.

9.1.5 Reuse of Excavated Material

The topsoil and upper silty layer (underlying the root zone) is not considered suitable for engineering applications. The silty soil could be spread thinly (<100 mm thick) over controlled filling before the blocks are topsoiled or else mixed and blended with other suitable soil and/or rock for use as general filling in road embankments, verges or landscaped areas.

The natural soils underlying the topsoil and silty layer comprise a variable mix of sand, silt, clay and gravel. Generally these soils appear adequate for re-use as general fill or as controlled filling provided they are well blended.

The extremely low to very low strength rock is considered suitable for reuse in all areas of controlled filling or embankment filling.

9.1.6 Filling Placement and Compaction

In areas that require filling, the stripped surfaces should be test rolled in the presence of a geotechnical engineer. Any areas exhibiting significant deflections under test rolling should be treated by over-excavation and replaced with approved filling. Depending on prior weather conditions it may also be necessary to use a geofabric separation layer.

It is noted that the subgrade clays are wet of optimum moisture values and as such, additional over-excavation and replacement with predominantly weathered rock may be required to achieve appropriate “bridging” over the soils to facilitate pavement construction. The extent of subgrade replacement can only be determined onsite following inspection and test rolling of the exposed subgrade.

All controlled filling should be placed in horizontal layers of maximum 250 mm loose thickness. The material should be placed in accordance with the ACT Government Standard Specification for Urban Infrastructure Works – Earthworks. Moisture content should be within the range ±2% of modified optimum.

All constructed fill batters should be constructed no steeper than 2.5:1 (horizontal:vertical), protected against erosion by vegetating the exposed surface and construction of toe and spoon drains as a means of controlling surface water flows on the batters.

All filling placed within construction platforms should be compacted to a minimum of 95% modified maximum dry density (ACT Government Standard Specification for Urban Infrastructure Works – Earthworks).

To validate the filling quality, field inspections and in-situ testing of future earthworks must be undertaken in order to satisfy the requirements for controlled filling AS 3798 – 2007 (Ref 2).

9.2 Pavement Design Considerations

The CBR results are given in Table 1 and the test report sheet is provided in Appendix D. Whilst the laboratory CBR result is an accurate determination of a small remoulded laboratory sample, it is considered that some samples tested overstate the insitu strength of the material tested and as such downgrading of the CBR values have been suggested for design purposes.

Based on the results of the field investigation, laboratory testing and previous experience in the Canberra area, Table 2 gives suggested design CBR values for the various likely subgrade conditions.

Table 2 – Design CBR Values

Subgrade Material	Design CBR (%)
Imported Filling	3*
Clayey Soils	2
Gravelly & Sandy Soils (subject to inspection)	4
Weathered Rock	7 in-situ
	4 recompacted

Note (*) – To be determined based on soil type, subject to change.

Subgrade conditions should be reviewed during construction. The review should be carried out by a suitably qualified engineer and would involve additional CBR tests to confirm the design assumptions regarding subgrade strength. Subgrade replacement may be required where soaked CBR values of less than 2% are obtained i.e.: Pit 101.

All earthworks should be undertaken under close supervision and consultation with the geotechnical consultant in order to avoid any unnecessary over excavation.

The standard of construction, the selection of materials and quality of workmanship for the roads should satisfy the requirements of the latest edition of the ACT Standard Specification for Urban Infrastructure Works.

Surface and subsoil drainage should be installed and maintained to protect the pavement and subgrade. Subsoil drains should be located at a minimum of 0.5 m depth below the subgrade level.

10. References

1. Phase 1 and Phase 2 Contamination Assessment, proposed Residential and Commercial Development, Block 2 and 3 Section 5, Campbell, Project 50584 Doc2 Rev1, dated 17 November 2011.

2. Remediation Action Plan, Proposed Residential and Commercial Development, Section 5 Campbell, ACT, Project 50584 Doc3 Rev4, dated 14 March 2012.

3 Geology of Central Canberra 1:10 000 Engineering Geology Series Sheet 208-600, Bureau of Mineral Resources, Commonwealth of Australia (1985).

4. Australian Standard AS 3798 – 2007 Guidelines on Earthworks for Commercial and Residential Developments.

11. Limitations

Douglas Partners (DP) has prepared this report for the assessment of subgrade conditions for the proposed development of Section 5, Campbell. The report is provided for the exclusive use of Cardno Young Pty Ltd for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About this Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

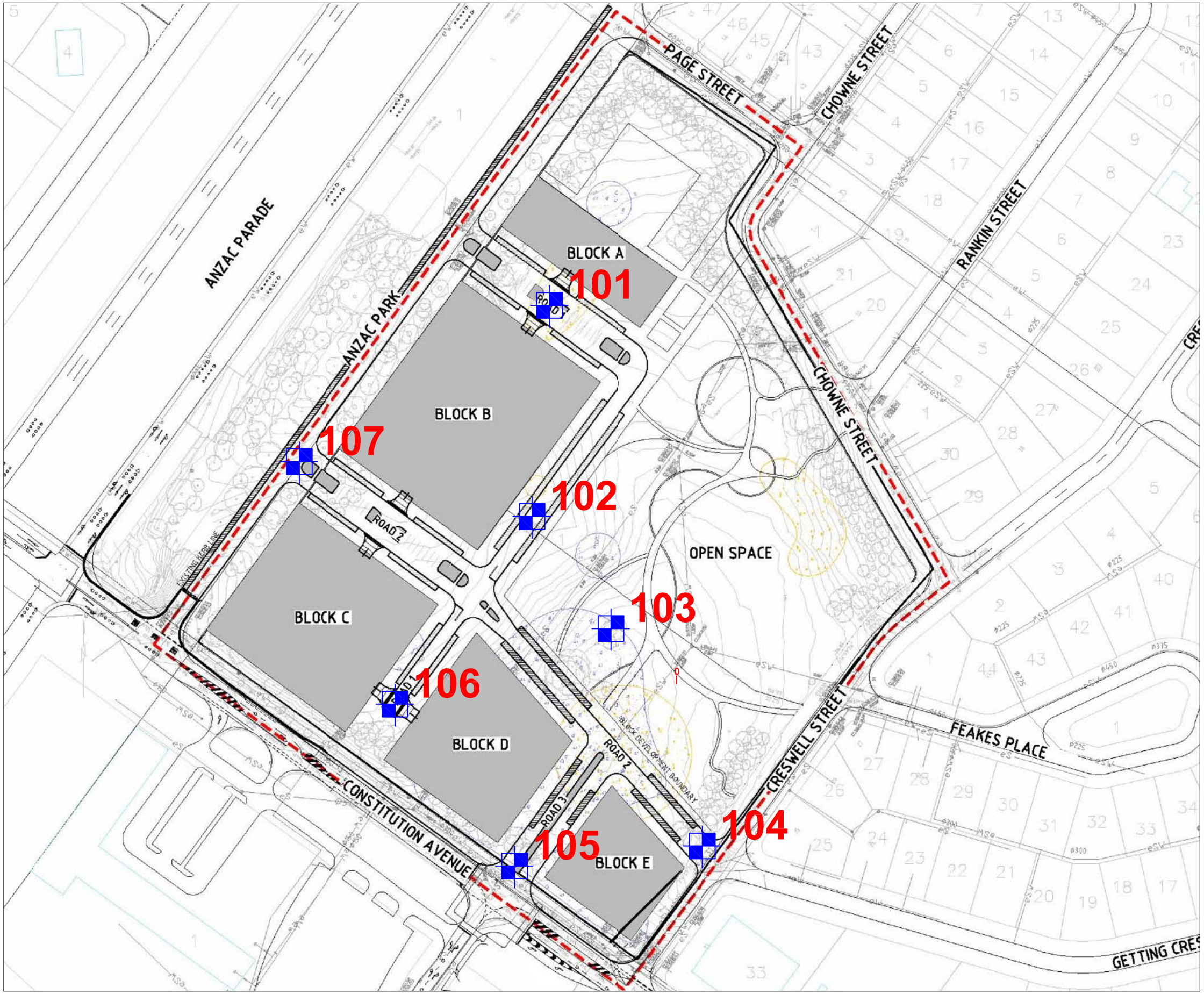
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

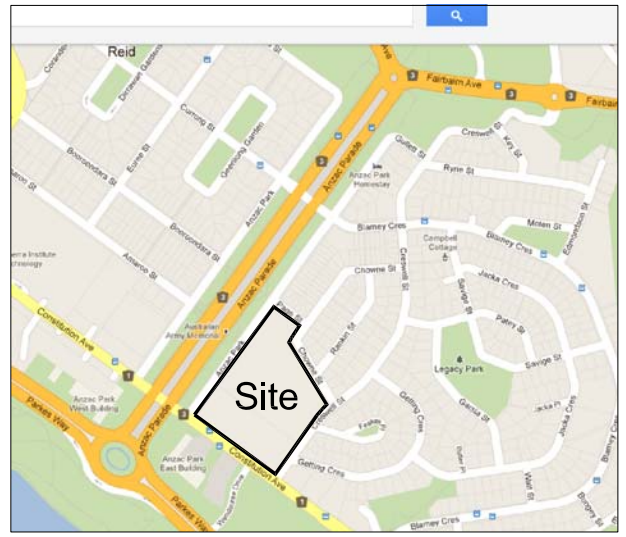
Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawing 1





Locality Plan

LEGEND

Approximate Test Pit Location

0 50 100m

APPROXIMATE SCALE

NOTE: Base drawing courtesy of Cardno Ltd (Drawing Number 110029-F202-CQP Revision 2)

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Cardno Young Pty Ltd	TITLE: **Location of Test Pits**	PROJECT No: 50584.01
	OFFICE: Canberra / DRAWN BY: AZR	**Subgrade Assessment - Proposed Mix-Use Development**	DRAWING No: 1
	SCALE: As shown / DATE: 07.05.2012	**Section 5, Campbell**	REVISION: A

MGA

Appendix C

Explanatory Notes
Results of Field Work (Pits 1 – 7)

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 1993. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approx Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and loner sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq \text{100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

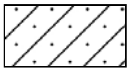
Soils


Topsoil

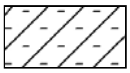

Peat


Clay

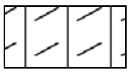

Silty clay

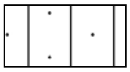

Sandy clay

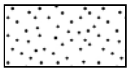

Gravelly clay

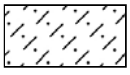

Shaly clay

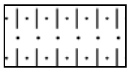

Silt


Clayey silt


Sandy silt

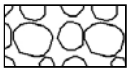

Sand

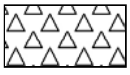

Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

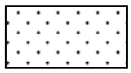

Talus

Sedimentary Rocks

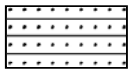

Boulder conglomerate

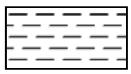

Conglomerate


Conglomeratic sandstone

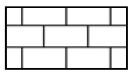

Sandstone


Siltstone


Laminite

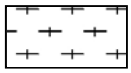

Mudstone, claystone, shale

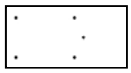

Coal


Limestone

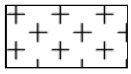
Metamorphic Rocks

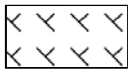

Slate, phyllite, schist

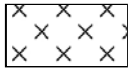

Gneiss

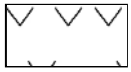

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

TEST PIT LOG

CLIENT: Cardno Young Pty Ltd
PROJECT: Subgrade Assessment - Proposed Mix-Use Development
LOCATION: Section 5, Campbell

SURFACE LEVEL: --
EASTING: 694946
NORTHING: 6092864
DIP/AZIMUTH: 90°/--

PIT No: 101
PROJECT No: 50581.01
DATE: 4/5/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	TOPSOIL - generally comprising moist, dark brown clayey silt with some sand and abundant rootlets							
	0.2	SILTY CLAY - very stiff to hard, moist, dark brown and orange brown silty clay with some sand and minor rootlets		D	0.3		pp = 380->400		
	0.55	CLAY - very stiff to hard, moist, orange brown clay with trace medium grained sub-angular/sub-rounded gravel, high plasticity			0.6				
				B	0.7		pp = 380->400		
					0.8				
1		- very stiff, some sand							1
				D	1.3		pp = 350-380		
					1.7		pp = 300		
2	2.0	SANDSTONE - extremely low to very low strength, extremely to highly weathered, light brown and yellow orange brown fine to medium grained sandstone		D	2.3				2
				D	2.9				
3	3.0	Pit discontinued at 3.0m - limit of investigation							3

Dynamic Penetrometer Test (blows per 150mm): 5 10 15 20

RIG: JCB 3CX backhoe (9 tonne) - 600mm bucket
LOGGED: Reid
SURVEY DATUM:

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Cardno Young Pty Ltd
PROJECT: Subgrade Assessment - Proposed Mix-Use Development
LOCATION: Section 5, Campbell

SURFACE LEVEL: --
EASTING: 694947
NORTHING: 6092779
DIP/AZIMUTH: 90°/--

PIT No: 102
PROJECT No: 50581.01
DATE: 4/5/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL FILLING - generally comprising moist, dark brown clayey silt with trace sand and abundant rootlets and minor grass		D	0.2				
	0.7	CLAYEY SILT - stiff, moist, brown clayey silt, slightly sandy with some fine grained quartz gravel		D	0.8		pp = 120		
	0.9	SILTY CLAY - very stiff, moist, red brown silty clay, slightly sandy		B	0.9 1.0 1.1		pp = 300		
	1.2	CLAYEY SANDY GRAVEL - medium dense, moist, red fine to coarse grained clayey sandy gravel, sub-rounded		D	1.6				
	1.8	SANDY GRAVELLY CLAY - very stiff, moist, light brown and orange brown sandy gravelly clay, sub-rounded gravel		D	2.1		pp = 200-300		
	2.4	CLAYEY SANDY GRAVEL - medium dense, moist, orange brown fine to coarse grained, flat and sub-rounded clayey sandy gravel with some cobbles		D	2.8				
	3.0	Pit discontinued at 3.0m - limit of investigation							

RIG: JCB 3CX backhoe (9 tonne) - 600mm bucket
LOGGED: Reid
SURVEY DATUM:

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Cardno Young Pty Ltd
PROJECT: Subgrade Assessment - Proposed Mix-Use Development
LOCATION: Section 5, Campbell

SURFACE LEVEL: --
EASTING: 694973
NORTHING: 6092725
DIP/AZIMUTH: 90°/--

PIT No: 103
PROJECT No: 50581.01
DATE: 4/5/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	TOPSOIL FILLING - generally comprising, moist, grey brown clayey silt with some sand and abundant rootlets and roots							
	0.2	FILLING - generally comprising moist, brown clayey silty sand with abundant building rubble including bricks, glass, concrete, fibre cement sheeting							
	0.5	SANDY SILT - medium dense, moist grey brown sandy silt							
	0.6	SILTY CLAY - very stiff, moist grey and light brown silty clay with trace sand and gravel, medium plassticity			0.6				
				B	0.7		pp = 300		
	0.8	CLAY - stiff to very stiff, moist, light brown clay, high plasticity			0.8				
1					1.0		pp = 180-220		1
	1.2	SILTY CLAY - stiff, moist, grey mottled orange brown silty clay with some sand							
				D	1.5		pp = 150		
	1.7	CLAYEY SAND - medium dense, moist, brown fine to coarse grained clayey sand							
2				D	2.0				2
	2.3	SANDSTONE - extremely low to very low strength, extremely to highly weathered, light brown and orange brown fine to medium grained sandstone			2.5				
3	3.0	Pit discontinued at 3.0m - limit of investigation							3

RIG: JCB 3CX backhoe (9 tonne) - 600mm bucket

LOGGED: Reid

SURVEY DATUM:

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Cardno Young Pty Ltd
PROJECT: Subgrade Assessment - Proposed Mix-Use Development
LOCATION: Section 5, Campbell

SURFACE LEVEL: --
EASTING: 695008
NORTHING: 6092625
DIP/AZIMUTH: 90°/--

PIT No: 104
PROJECT No: 50581.01
DATE: 4/5/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		TOPSOIL - generally comprising moist, grey brown clayey sandy silt with abundant rootlets and roots							
	0.2	CLAYEY SILT - stiff, moist, grey red brown clayey silt with some sand			0.3		pp = 150		
	0.35	SILTY CLAY/CLAYEY SILT - hard, red and light brown silty clay/clayey silt with trace sand and fine grained gravel			0.5				
				B	0.6		pp > 400		
					0.7				
	0.8	CLAY - very stiff to hard, moist, brown clay with trace silt and sand							
1				D	1.2		pp - 350->400		1
		- some gravel							
		- grading to tuff							
2									2
	2.1	TUFF - extremely low to very low strength, extremely to highly weathered, light grey brown tuff		D	2.2				
		- fine to coarse grained tuffaceous sandstone							
				D	2.8				
3	3.0	Pit discontinued at 3.0m - limit of investigation							3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: JCB 3CX backhoe (9 tonne) - 600mm bucket

LOGGED: Reid

SURVEY DATUM:

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Cardno Young Pty Ltd
PROJECT: Subgrade Assessment - Proposed Mix-Use Development
LOCATION: Section 5, Campbell

SURFACE LEVEL: --
EASTING: 694939
NORTHING: 6092612
DIP/AZIMUTH: 90°/--

PIT No: 105
PROJECT No: 50581.01
DATE: 4/5/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.2	TOPSOIL FILLING - generally comprising moist, dark brown clayey sandy silt with abundant rootlets and roots							
	0.5	FILLING - generally comprising moist, yellow brown silty clay with some sand and gravel		D	0.4				
	1	FILLING - generally comprising dry to moist, grey and orange fine to coarse grained clayey silty sand and building rubble and rubbish including bricks, glass, steel, machine parts and fibre cement sheeting							
	1.8	Pit discontinued at 1.8m - collapsing conditions							
	2								
	3								

Dynamic Penetrometer Test (blows per mm): 5, 10, 15, 20

RIG: JCB 3CX backhoe (9 tonne) - 600mm bucket
LOGGED: Reid
SURVEY DATUM:

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Cardno Young Pty Ltd
PROJECT: Subgrade Assessment - Proposed Mix-Use Development
LOCATION: Section 5, Campbell

SURFACE LEVEL: --
EASTING: 694894
NORTHING: 6092693
DIP/AZIMUTH: 90°/--

PIT No: 106
PROJECT No: 50581.01
DATE: 4/5/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	TOPSOIL - generally comprising moist, brown clayey sitly sand with some gravel and abundant rootlets							
		GRAVELLY SANDY SILT - stiff, moist, red brown gravelly sandy silt, sub-rounded medium grained gravel			0.2		pp = 150		
	0.4	GRAVELLY SILTY CLAY - stiff to very stiff, moist, red orange brown gravelly silty clay			0.5		pp = 180-200		
				D	0.7		pp = 300		
	0.8	CLAY - very stiff to hard, moist, brown clay with some silt and sand, high plasticity							
1					1.0		pp = 380->400		1
				D	1.2		pp > 400		
	1.4	SILTSTONE - extremely low to very low strength, extremely to highly weathered, yellow brown siltstone - high strength, moderately to slightly weathered limestone cobbles and boulders up to 0.5m size between 1.5 - 2.0m							
2				D	2.1				2
		- very low to low strength, highly weathered							
3	3.0	Pit discontinued at 3.0m - limit of investigation							3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: JCB 3CX backhoe (9 tonne) - 600mm bucket

LOGGED: Reid

SURVEY DATUM:

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Cardno Young Pty Ltd
PROJECT: Subgrade Assessment - Proposed Mix-Use Development
LOCATION: Section 5, Campbell

SURFACE LEVEL: --
EASTING: 694849
NORTHING: 6092804
DIP/AZIMUTH: 90°/--

PIT No: 107
PROJECT No: 50581.01
DATE: 4/5/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	0.2	TOPSOIL - generally comprising dry to moist, brown sandy silt with some clay and abundant roots and rootlets						
	0.5	SILT - stiff to very stiff, dry to moist orange brown silt with some sand and minor roots and rootlets						
		SILTY CLAY - hard, dry, yellow brown silty clay with some quartz gravel and cobbles		B	0.5 0.6 0.7		pp > 400	
	1.1	CLAY - very stiff to hard, dry to moist, brown clay with trace sand and gravel - stiff to very stiff, moist		D	1.5		pp = 180-220	
	1.9	CALCAREOUS CLAYSTONE - extremely low strength, extremely weathered, light grey brown calcareous claystone		D	2.5			
	3.0	Pit discontinued at 3.0m - limit of investigation						

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: JCB 3CX backhoe (9 tonne) - 600mm bucket
LOGGED: Reid
SURVEY DATUM:

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Appendix D

Results of Laboratory Testing (1 page)

TESTCRETE
LABORATORIES PTY LIMITED
16 Kemble Court
MITCHELL ACT 2911
Telephone 02 6241 1322
Fax 02 6241 7593
ABN: 35 102 659 754

Job No.
TS 018

California Bearing Ratio Test Certificate

Client: ..... Douglas Partners Pty Ltd, HUME ACT
Principal: ..... Douglas Partners Pty Ltd
Project: ..... Proposed Mix-use Development, Project # 50584.01
Location: ..... CAMPBELL, ACT

Date of test: 14.05.12
Tested by: ..... J.S.
Checked by: ..... G.C.

Test procedure: ..... AS1289 6.1.1 for C.B.R. Sampled by Client Submitted 07.05.12

Laboratory compaction method: ..... AS1289 5.2.1 for M.D.D. *Blows per Layer (5 Layers) with Standard Hammer for C.B.R.

Sample No.			TS 018/ S2418	TS 018/ S2419	TS 018/ S2420	TS 018/ S2421
Depth			0.6 m - 0.8 m	0.9 m - 1.1 m	0.5 m - 0.7 m	0.5 m - 0.7 m
Location			Client ID : Pit 101	Client ID : Pit 102	Client : Pit 104	Client ID : Pit 107
Date sampled			Sampled by Client	Sampled by Client	Sampled by Client	Sampled by Client
Description of sample			Clay Red Brown	Clay Grey Brown	Silty Clay / Clayey Silt Red Yellow Brown	Silty Clay Red Yellow Brown
Max dry density		t/m^3	1.52	1.91	1.66	1.82
Optimum moisture content		%	27.5	14.0	21.5	16.5
Material Retained 19.0mm A.S. Sieve		%	0	0	0	0
Field moisture content		%	29.8	16.9	23.8	17.2
CBR Test	Dry density t/m^3	Before soaking	1.45	1.81	1.59	1.72
		After soaking	1.34	1.79	1.56	1.71
	Density ratio %	Before soaking	95.0	95.0	96.0	95.0
		After soaking	88.0	94.0	94.0	94.0
	Moisture content %	Before soaking	27.0	14.2	21.0	16.8
		After soaking	39.5	18.5	26.5	23.2
	Number of days soaked		4	4	4	4
	Surcharge	kg	4.5	4.5	4.5	4.5
	Moisture content after test %	Top 30mm	48.2	20.8	30.5	23.8
		Whole sample	39.5	18.5	26.5	23.2
	Swell after soaking	%	7.0	0.5	1.5	0.0
	C.B.R. value	%	**1.0 @ 2.5 mm**	**7 @ 2.5 mm**	**4.0 @ 2.5 mm**	**8 @ 2.5 mm**
	*Number of Blows per Layer		52* Blows	25* Blows	25* Blows	31* Blows

Remarks: **CBR Value Reported @ Determined Penetration Depth**

Form No 7. R1289 F1.1

Authorised Signature
G.W.Collins

NATA ACCREDITED LABORATORY Number 1742.
Accredited for compliance with ISO/IEC 17025.

Date of Issue: 15/05/2012