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PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT:
LOT A BURLEY ROAD, HORSLEY PARK EMPLOYMENT PRECINCT, NSW

PREPARED FOR JACFIN PTY LTD.
CES DOCUMENT REFERENCE: CES100606-JBA-AF

Authorised by: **Dr Michael Petrozzi**
Client: Jacfin Pty Ltd
Date: 25 November 2010

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Document Control

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4	CES100606-JBA-AF	25/11/2010	FINAL: PRELIMINARY GEOTECHNICAL REPORT

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1 INTRODUCTION

Consulting Earth Scientists Pty Ltd (CES) was commissioned by Jacfin Pty Ltd, to undertake a geotechnical investigation for the site comprising Lot A Burley Road, Horsley Park Employment Precinct, New South Wales (herein referred to as 'the site'). A Preliminary Environmental Site Assessment (ESA) was also undertaken by CES and is reported separately (CES100606-01-D, 2010). Both the preliminary geotechnical report and the preliminary environmental assessment was undertaken in general accordance with our proposal dated 2 July 2010 (CES100606-JBA-AB).

It is understood by CES that the property is to be developed for industrial and employment purposes including but not limited to warehouse, storage and distribution facilities and manufacturing uses. Refer to Concept Plans "Horsley Park Employment Precinct Lot A Burley Road Part 3A Concept Plan" JBA drawings CP001 - CP017 dated 23 November 2010.

The purpose of this investigation is to obtain preliminary geotechnical information regarding subsurface ground and groundwater conditions. This includes provision of preliminary recommendations regarding earthworks and site preparation, excavation conditions and support, suitable foundation systems, pavement design parameters and construction recommendations. Preliminary geotechnical advice is also provided with regards to groundwater issues, soil erosion issues, assessment of soil salinity, sodicity, dispersion potential and soil aggressivity to buried structural elements and a preliminary assessment of geotechnical constraints identified during the baseline investigation.

2 THE SITE

2.1 SITE LOCATION

The site is located at Lot A in DP 392643 Burley Road, which is situated approximately 0.5km west of the end of Old Wallgrove Road and immediately north-west of the end of Horsley Drive, Horsley Park, NSW.

2.2 SITE DESCRIPTION

The following description of the site is based upon observations made during the fieldwork and information provided by JBA Pty Ltd.

The site covers an area of 100 hectares and is roughly an L-shape orientated north. To the east of the site is a brick pit and associated works as well as residential plots.

The site is characterised by undulating topography with a ridgeline running generally north to south-east through the north western section of the site with a second ridge extending east-west across the southern part of the site. A small dam was located in the centre of the site on a minor ephemeral drainage line that flows to Ropes Creek. The site is currently used for cattle grazing with a demountable cottage observed in the south-east corner of the site.

2.3 REGIONAL GEOLOGY

Review of the Penrith 1:100 000 Geological Series Sheet 9030 (Department of Mineral Resources, 1991) indicates that the site is underlain by the Bringelly Shale Formation of the Wianamatta Group. The Bringelly Shale Formation comprises shale, carbonaceous claystone, siltstone and fine to medium grained sandstone as well as rare coal.

3 METHOD OF INVESTIGATION

3.1 FIELDWORK

Fieldwork was undertaken between 8 and 14 July 2010 and comprised drilling five boreholes. A CES engineering geologist was present during fieldwork to locate and log boreholes, direct sampling and testing.

Boreholes were drilled using a truck mounted drilling rig utilising solid flight augers fitted with a steel ‘V’ shaped bit in soil. Standard Penetration Tests (SPTs) were carried out to assess soil strength and obtain samples for logging and laboratory testing. Drilling was continued into bedrock using triple tube rotary core drilling methods. The recovered cores were boxed onsite and photographed. Borehole logs and rock core photographs are enclosed in Appendix A.

Borehole locations were recorded using a handheld Global Positioning System (GPS) unit and the approximate ground levels of the borehole locations inferred from a site survey plan supplied to CES (RPS drawing reference: Lot A in DP 392643 Horsley Road, Kemps Creek – Control Plan 23-3825-CP). Borehole depths and positions are summarised in Table 1 and shown in Figure 1.

Table 1: Borehole Locations and Depths

Borehole	Easting	Northing	Termination depth	
			(mbgl)	(mAHD)
BH1	298276	6254717	10.0	59.5
BH2	297908	6254069	11.5	56.1
BH3	298337	6253857	11.5	65.3
BH4	297793	6253293	12.7	64.1
BH5	298264	6253383	9.6	78.7

The depth to groundwater, where practicable, was recorded during drilling of each borehole and within 24hrs of completion of drilling. Field screening for potentially saline and acid sulfate soils was also carried out on selected samples.

3.2 GEOTECHNICAL LABORATORY TESTING

Soil samples obtained during fieldwork activities were tested by SGS Australia Pty Ltd (SGS), a NATA accredited testing laboratory, for Emersion Dispersion Classification, California Bearing Ratio (CBR) Tests, Atterberg Limit and Linear Shrinkage Tests and Soil Aggressivity. The laboratory test results are presented in Appendix B and summarised in Table 5.

4 RESULTS OF THE INVESTIGATION

4.1 SUBSURFACE CONDITIONS

The ground conditions, observed in the boreholes, typically comprised topsoil, underlain by alluvial and residual soils over shale bedrock of the Wianamatta Group. Based on the information from the boreholes, a geotechnical model has been developed and is presented in Table 2. For a detailed description of the subsurface conditions encountered at each borehole, refer to the borehole logs in Appendix A, together with the explanatory sheets describing the terms and symbols used.

Table 2: Summary of Subsurface Conditions at Borehole Locations and Inferred Geotechnical Model

Geotechnical Unit	**Depth to base of unit**		**Thickness (m)**	**Description**
	(mbgl)	**(mAHD)**		
1. Topsoil	-	-	0.1 to 0.3	CLAY: • Medium and high plasticity; • Brown; and • Firm.
2. Alluvium	0.5 to 3.0	66.1 to 76.3	0.2 to 2.8	CLAY or sandy CLAY: • Medium and high plasticity; • Orange/brown mottled dark brown; and • Firm to stiff.
3. Residual Soil	1.0 to 4.0	65.6 to 87.3	0.5 to 2.5	Sandy CLAY or gravelly CLAY: • Medium and high plasticity; • Brown, pale grey to grey; and • Stiff to hard.
4a. Weathered Shale	3.75 to 6.5	63.9 to 82.7	1.8 to 4.7	Interbedded SHALE and SANDSTONE: • Medium plasticity; • Dark grey to pale grey and brown ; • Extremely low strength to low strength; • Extremely and highly weathered; • Recovered as a hard, low plasticity gravelly CLAY or very dense clayey GRAVEL; • Relict joints are widely spaced, steeply dipping.
4b. Moderately Weathered to Fresh Sandstone and Shale	Drilled to a maximum depth 12.7	Drilled to a maximum depth of 56.1	-	Interbedded SHALE and SANDSTONE: • Medium to high strength; • Dark grey and pale grey; • Massive to distinctly bedded at 0-5^{o}; • Joints are widely spaced, steeply dipping.

Geotechnical	Depth to base of unit		Thickness	Description
4c. Weathered Volcanic Breccia	7.4	62.1	4.4	VOLCANIC BRECCIA • Dark brown; • massive; • Extremely low strength to low strength; • Extremely and highly weathered.
4c. Moderately Weathered to Fresh Volcanic Breccia	Drilled to a maximum depth 10	Drilled to a maximum depth of 59.5	-	VOLCANIC BRECCIA • Medium to high strength; • Grey/green; • massive; • Joints are widely spaced, moderately to steeply dipping.

4.2 RESULTS OF FIELD SCREENING

The results of the soil salinity and acid sulfate field screening tests are summarised in Table 3.

Table 3: Summary and Assessment of Soil Salinity and Acid Sulfate Field Screening Tests

Borehole and sample depth (mbgl)		**Soil Salinity Test**			**Acid Sulfate Test**	
		(mS)	EC_e (dS/m)	Assessed Salinity Level	pH	Assessed Acidity Level
BH1	0.50 – 0.95	0.10	0.86	Very slightly	7	Neutral
	1.50 – 1.95	0.30	2.58	Moderate	7	Neutral
	3.00 – 3.45	0.20	1.72	Slightly	7	Neutral
BH2	0.50 – 0.95	0.20	1.72	Slightly	6	Neutral
	1.50 – 1.95	0.30	2.58	Moderate	6.5	Neutral
BH3	0.50 – 0.95	0.20	1.72	Slightly	5	Slightly Acidic
	1.50 – 1.95	0.30	2.58	Moderate	5	Slightly Acidic
	3.0 – 3.45	0.50	4.30	Moderate	5	Slightly Acidic
BH4	0.50 – 0.95	0.10	0.86	Very slightly	6	Neutral
	1.50 – 1.95	0.20	1.72	Slightly	5.5	Slightly Acidic
BH5	0.50 - 0.95	0.10	0.86	Very slightly	5	Slightly Acidic
	1.50 – 1.95	0.20	1.72	Slightly	5	Slightly Acidic
	3.00 – 3.45	0.30	2.58	Moderate	6	Neutral

4.3 *GROUNDWATER*

Groundwater seepage was not observed during drilling operations; however groundwater levels measured within 24hrs of the borehole completion are shown in Table 4.

Table 4: Summary of Groundwater Levels

Location	**Observation Details**			**Groundwater Level**	
	Date	Time	Period after drilling	(mbgl)	(mAHD)
BH1	9 July 2010	8:00am	16hrs	2.4	67.1
BH2	14 July 2010	8:00am	16hrs	1.6	66.0
BH3	12 July 2010	8:00am	64hrs	1.8	75.3
BH4	13 July 2010	8:30am	16hrs	2.6	74.2
BH5	13 July 2010	8:30am	16.5hrs	3.8	84.5

5 LABORATORY TEST RESULTS

Laboratory test results are summarised in Table 5 and provided in full in Appendix B.

Table 5: Summary of Laboratory Testing Results

Unit	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Linear Shrinkage (%)	Emerson Classification	CBR (%) (Note 1)	CBR Swell After Soaking (%)	Maximum Dry Density (Tonnes/m^3)	Optimum Moisture Content (%)	pH	Chloride (mg/kg)	Sulphate (mg/kg)
Unit 2 (Alluvium)	56 & 66	19 & 21	37 & 45	15.5 & 16	Class 5	1 & 4	1.2 & 4.1	1.66 & 1.67	18.5 & 19	5 to 7	120	6.9

Note 1: CBR tests carried out on 4 day soaked sample compacted to 100% Standard Maximum Dry Density Ratio.

The laboratory test results indicate that Unit 2 (Alluvium) is a soil of medium plasticity with a moderate potential for volume change. It has a low CBR values of 1% and relatively high CBR swell values, indicating that these materials will provide a soft expansive subgrade. It is noted that within BH4 a higher CBR value of 4% was recorded, however it is believed that this is an isolated elevated value.

The results of the Emersion Dispersion testing shows that Unit 2 (Alluvium) has an Emerson Class of 5, indicating that this material is not likely to be dispersive.

The Unit 2 (Alluvium) has relatively neutral pH values and contains relatively low concentrations of chloride and sulphate.

6 DISCUSSION AND RECOMMENDATIONS

6.1 EARTHWORKS AND SITE PREPARATION

Indicative areas of bulk earthworks are shown in Concept Plan drawing CP015 entitled "Lot A Burley Road, Horsley Park Employment Precinct - Indicative Cut and Fill". The thickness of Unit 1 (Topsoil) varied from 0.1m to 0.3m at the borehole locations and will require striping and stockpiling. Use of Unit 1 should be limited to landscaping fill.

Once vegetation and Unit 1 have been removed, Units 2 (Alluvium) and 3 (Residual Soil) will be exposed. These materials are likely to have poor trafficability characteristics when wet such as after periods of heavy rainfall. Erosion and sediment controls should be implemented during earthworks in accordance with the requirements of the Landcom publication "Managing Urban Stormwater: Soils and Construction".

6.2 EXCAVATION CONDITIONS AND SUPPORT

6.2.1 Excavatability

It is understood that cuttings will be excavated at the site which are likely to encounter all of the geotechnical units outlined in the preliminary geotechnical model (Table 2). A hydraulic excavator or bulldozer blade and bucket should be adequate for excavation in Unit 2 (Alluvium), Unit 3 (Residual Soil), 4a (Weathered Rock) and Unit 4c (Weathered Volcanic Breccia). Unit 4b (Moderately Weathered Rock) is likely to require considerably more effort, such as the use of ripping and Unit 4d (Moderately Weathered Volcanic Breccia) will likely require excavators using a hydraulic breaker.

Contractors should be required to examine the engineering logs and core photographs (Appendix A) to make their own assessment of excavation plant and production rates.

6.2.2 Permanent and Temporary Batter Slopes

Excavations into Unit 2 (Alluvium) and Unit 3 (Residual Soil) should stand at temporary slopes of 1.5H (horizontal): 1V (vertical).

Permanent batter slopes in Unit 2 (Alluvium) and Unit 3 (Residual Soil) should not exceed 2.5H: 1V. Permanent batter slopes in Unit 4a (Weathered Rock) and 4c (Weathered Volcanic Breccia) should not exceed 1.5H:1V unless protected. Permanent batter slopes will begin to deteriorate if left exposed and should be protected against erosion using shotcrete, vegetation, geotextile or similar. Permanent batter slopes in Units 4b (Moderately Weathered Rock) and 4d (Moderately Weathered Volcanic Breccia) may be constructed vertically. Exposed rock faces should be assessed by a geotechnical practitioner for stability. Localised application of shotcrete and installation of rock bolts and other such stabilisation methods may be required.

CES recommends that allowance be made for laying back temporary excavations exceeding 1.5m to 1.5H:1V where workers require access. Surcharge loads should be kept well clear of the crest of cuts.

6.2.3 Excavation support

Where there is insufficient area available to form unsupported batters, Unit 2 (Alluvium) and Unit 3 (Residual Soil) will require support / retaining walls.

The design of any retaining structures should make allowance for all applicable surcharge loading including construction activities around the perimeter of the excavation and adjacent buildings. In addition to lateral earth pressures and surcharge loads, consideration should be given to the possibility of a hydrostatic pressure due to build-up of water behind the wall unless permanent subsurface drainage can be provided.

Exposed rock faces of Unit 4b (Moderately Weathered Rock) and Unit 4d (Moderately Weathered Volcanic Breccia) should be assessed by a geotechnical practitioner for excavation support. Localised application of shotcrete and installation of rock bolts and other such stabilisation measures may be required.

6.3 PAVEMENT SUBGRADE

Unit 2 (Alluvium) and Unit 3 (Residual Soil) are of variable thickness and depth across the site. Laboratory testing indicates that the materials are medium to high plasticity with a low CBR value of 1%. As a result, these units are considered a poor bearing stratum for pavements without modification. Options for subgrade improvement or replacement are outlined in sections 6.3.1 and 6.3.2. More extensive sampling and testing will be required once the requirements of the proposed development have been finalised.

6.3.1 Lime Modification

Subgrade improvement could be by lime stabilisation. The addition of 4% hydrated lime (percentage dry weight of soil) by specialist pulverising, mixing and recompacting to a maximum dry density ratio of 100% (Standard Compaction) should raise the insitu CBR value of the subgrade and a design value of 3% could be adopted. CES's previous experience of similar Unit 2 (Alluvium) and Unit 3 (Residual Soil) soil indicates that CBR values greater than this may be achievable with the addition of greater proportion of lime. The effectiveness of the lime stabilisation is dependant on many factors such as construction method, construction plant used, the degree of original soil pulverisation, the original moisture content of the soil, the type and properties of the lime and the mineralogy of the clay in the soil. The effectiveness of lime stabilisation and the optimum percentage should be ascertained and checked by laboratory testing and field trials.

In accordance with AS3798-2007 it is recommended that Level 1 earthworks control is used during bulk earthworks and pavement construction. All pavements should be provided with long term surface and subsurface drainage to protect the subgrade from moisture ingress.

6.3.2 Subgrade Replacement

Subgrade replacement could be carried out by placing well graded, durable, non-expansive granular material of 60mm maximum size. The fill should be placed in maximum 200mm compacted layer thicknesses and compacted to 100% Standard Density Ratio at a moisture content within ±2% of Standard Optimum Moisture Content.

A preliminary assessment indicates that placing a 300mm thick layer of suitable fill with a remoulded CBR value of at least 20% should raise the insitu CBR value of the subgrade to at least 3%. Pavements should however be designed on the basis of the CBR value of the actual replacement material and the effectiveness of the subgrade replacement should be checked by laboratory testing and field trials.

Although not expected for this site, the importation of fill material onto site should be undertaken in such a manner that all obligations under the *Protection of the Environment and Operations Act 1997* and the *Environmental Planning Assessment Act 1979*, are met.

6.4 GROUNDWATER ISSUES

Groundwater was encountered in all boreholes between levels of 1.6mbgl and 3.8mbgl (RL 66mAHD and RL 85mAHD) at the interfaces between Units 2 (Alluvium) and 3 (Residual Soil), and Units 3 (Residual Soil) and 4 (Weathered Rock).

In consideration of the above it is expected that groundwater will be encountered in excavations below about 1mbgl (RL 65mAHD and RL 85mAHD), particularly after periods of heavy rain. Where the cuttings do not extend to significant depths below groundwater level such seepage is expected to be controllable by conventional sump pumping methods. However, in areas where the cuttings extend to a depth considerably below groundwater level, consideration to a formal dewatering system such as the installation of dewatering wells may be necessary.

Should earthworks be proposed at significant depths below the groundwater table, it is recommended that further investigation to adequately characterise the hydrological regime in areas of deep cuts be carried out. Measures should also be included as part of the development to ensure that adequate drainage is in place to facilitate the controlled and environmentally responsible removal of surface and groundwater.

6.5 FOUNDATIONS

6.5.1 Pad and Strip Footings

The bearing capacity of the ground will be dependent on the foundation type adopted for the various structures to be constructed. The choice of foundation will depend on cost, the applied loads, loading arrangement and the resulting total and differential settlements anticipated and the sensitivity of the structures to movement. As a general design guide, the following preliminary allowable bearing pressures should be able to be adopted for pad and strip footings or the edge and internal beams of raft slabs:

Table 6: Preliminary Allowable Bearing Pressures for Shallow Footings

Material	**Preliminary Allowable Bearing Pressure (kPa)**
Unit 2 (Alluvium)	100
Unit 3 (Residual Soil)	150
Unit 4a and 4c (Weathered Rock)	700

Settlement of up to 1% of footing width could occur for footings designed for the above bearing pressures. Where the depth to rock exceeds 1.5m it may be necessary to adopt bored piles unless footings excavations are shored or battered. The above is a preliminary assessment and specific foundation design should be carried out once the requirements of the proposed development have been finalised.

It should be noted that Units 2 (Alluvium) and Unit 3 (Residual Soil) are assessed to have a significant potential for volume change on wetting and drying (shrink/swell). Shallow footings founded in these materials should be designed to consider this soil characteristic. Furthermore, Unit 2, Unit 3 and Unit 4a and 4c (Weathered Rock) may soften in footing excavations. The footing should be dewatered, cleaned and concreted within 12 hours of excavation or a blinding layer of concrete should be placed to protect the base. An experienced geotechnical practitioner should visually inspect the footing excavations prior to blinding to confirm that the founding material is suitable for the adopted design parameters.

6.5.2 Piles

Open bored piles or continuous flight auger piles could be adopted where the depth to rock exceeds practical excavation depths for strip and pad footings. We would expect that with appropriate capacity piling rigs, piles should be able to penetrate to Unit 4b (Moderately Weathered Rock) and Unit 4d (Moderately Weathered Volcanic Breccia). An experienced geotechnical practitioner should observe boring of the piles in order to assess the rock levels and to confirm that the rock is suitable for the adopted design parameters. Allowable design parameters for bored piles are provided in Table 7. The use of the recommended allowable bearing pressures would be expected to result in pile settlement of about 1% of pile diameters.

Table 7: Preliminary Foundation Design Parameters

Geotechnical Unit	Allowable Bearing Pressures (kPa)	Allowable Shaft Adhesion for Piles (kPa) (1)
Unit 4a and 4c (Weathered Rock)	700	50
Unit 4b and 4d (Moderately Weathered Rock)	3000	300

Note 1: Shaft adhesion should only be assumed where piles have a minimum embedment of at least 3 pile diameters into the nominated stratum and a rough socket (at least grooves of depth 1mm to 4mm and width greater than 5mm spacing of 50mm to 200mm). The socket should be cleaned and roughened by a suitable scraper such as a tooth, orientated perpendicular to the auger shaft.

Open bored piles may require temporary liners through Units 2 and 3 or if groundwater seepage occurs. Piles should be cleaned, dewatered and concreted without delay to prevent softening of the pile base.

For uplift capacity, the shaft adhesion value should be multiplied by 0.6. In addition to shaft adhesion, the uplift capacity should be checked for a cone pullout failure mode assuming a cone angle of 70° considering the submerged weight of the soil or rock and adopting a factor of safety of 1.0 against pullout.

This assessment is a preliminary investigation, further boreholes should be drilled at the proposed structures to assess founding levels across the footprint of the structure. Piling contractors should undertake their own assessment of rock core to assess suitability of piling plant.

6.5.3 Slab On-Ground Construction

The potential for uplift pressures and ground movements acting on the ground floor slab of the building due to shrinkage and swelling of the Unit 2 (Alluvium) and Unit 3 (Residual Soil) should be considered. This may be done by moisture conditioning through tyning and recompaction during earthworks. A sub-base of good quality crushed rock should be placed beneath floor slabs.

6.6 LOT CLASSIFICATION IN ACCORDANCE WITH AS2870

For the design of residential structures and structures with areas and loads consistent with residential structures, classifications of individual lots should be carried out in accordance with AS2870-1996 "Residential Slabs and Footings". A limited number of tests were carried out as part of this investigation on samples from the boreholes, which were generally located in areas underlain by Unit 2 (Alluvium) and Unit 3 (Residual soils). The Atterberg limits and linear shrinkage test results infer a high shrink swell potential, which may result in an 'H' Lot classification in areas underlain by Units 2 and 3.

It should be noted that the above classification is preliminary and that further, lot specific assessments should be carried out once the requirements of the proposed development have been finalised.

6.7 ASSESSMENT OF SOIL SALINITY AND SODICITY

Field screening for salinity levels within Units 2 (Alluvium) and Unit 3 (Residual Soil) indicate that these geotechnical units are typically very slightly to moderately saline.

Saline and Sodic Soils are characterised by slow rates of water infiltration (from rain or irrigation), poor water and nutrient transport within the soil, restricted vegetation growth and severe surface crusting. When wet, these soils are boggy and soft. If saline/sodic material is exposed or brought close to the surface by the development, it may prevent or retard the establishment of vegetation and where excess water enters the site, this material may also prevent or retard water from moving vertically through the soil profile. This may result in soil erosion issues and/or problematic drainage conditions.

Typical mitigation measures for saline soils include:

- Avoiding exposure and disturbance of the sodic soil e.g. minimising cutting and filling.
- Minimise the infiltration of stormwater and provide good surface and sub-surface drainage. Establish adequate drainage measures in poorly drained areas.
- Minimise water input and maintain natural water balance.
- Use of gypsum or lime to ameliorate sodic soils.
- Retain existing vegetation and planting of suitable vegetation in areas susceptible to erosion.
- Provision of damp proof membranes under slabs and foundations, typically underlain by at least 50mm of sand to allow free drainage.

Once the requirements for the proposed development is finalised, it is recommended that further assessment of the soils in low-lying areas of the site is carried out to assess whether or not a Salinity Management Plan is necessary for the proposed development.

6.8 SOIL DISPERSION POTENTIAL

The results of the Emerson classification testing indicate that Unit 2 (Alluvium) is Class 5 and as such are not anticipated to have a tendency to be dispersive. This assessment is further supported by the electrical conductivity, pH and cation exchange capacity test results.

6.9 ACID SULFATE SOILS

The acid sulfate soil field screening (Table 3) indicates that acid sulfate soils are unlikely to be present at the site.

6.10 SOIL AGGRESSIVITY

The results of soil aggressivity testing of Unit 2 (Alluvium) and Unit 3 (Residual Soil) indicate that these soils may be considered non-aggressive to concrete and steel as determined with reference to Australian Standard AS 2159-1995 Piling –Design and Installation.

6.11 GEOTECHNICAL CONSTRAINTS

Based on the results of this preliminary geotechnical investigation, the following geotechnical constraints are assessed:

- Low CBR values for Unit 2 (Alluvium), indicating a poor foundation for roads and pavements and a potential requirement for ground improvement (Refer to Section 6.3).
- Groundwater in areas of cutting that require further investigation and may require active groundwater management measures during and following construction (Refer to Section 6.4).
- Soils (Unit 2 and Unit 3) with a high potential for significant volume change with change in moisture content i.e. Reactive Soils (Refer to Section 6.6).
- The possible presence of Saline Soils in low-lying areas (Refer to Section 6.7).

7 RESPONSE TO DIRECTOR GENERALS REQUIREMENTS

CES has reviewed the requirements stated by the Director General of the NSW Department of Planning in his letter dated 13 August 2010 and the enclosed comments from Penrith City Council and Fairfield City Council. CES's response to items applicable to our scope of work is as follows (items applicable to CES scope of work are shown in italics).

Section	Title	DGR Comment	CES Response
Key Issues	- Soil and Water	Including water supply and efficiency, *proposed erosion and sediment controls (during construction)*; the proposed stormwater management system for site; detailed considerations of any potential. Offsite drainage or flooding impacts; consideration of the potential for rainwater harvesting, wastewater disposal; and *soil salinity and contamination.*	Erosion and sediment controls during construction are described in Section 6.1 of this report. An assessment of soil salinity is presented in Section 6.7 of this report. A Stage 1 Preliminary Site Investigation was carried out by CES to identify and assess likely contaminants or potential environmental issues, resulting from past and/or present activities undertaken on or adjacent to the site which may affect the sites suitability for the proposed commercial/industrial land use. The results of this investigation are presented in CES document: CES100604-JBA-01-D
Fairfield City Council	State Government Technical and Policy Guidelines	Soil and Water: Water Quality –Add "Managing Urban Stormwater Environmental Targets Consultation Draft-October 2007" (Dept of Environment & Climate Change-CMA Sydney Metropolitan)	A preliminary assessment of soil attributes described in the Draft October 2007 document is provided in Section 6.6 to 6.11 and Appendix B of this report.

8 LIMITATIONS

This is a preliminary geotechnical investigation report, CES recommends further investigation for detailed design and to confirm the ground conditions at the proposed building locations once the development details are finalised.

The findings within this report are the result of discrete/specific investigations methodologies used in accordance with normal practices and standards. Subsurface conditions can change over relatively short distances and the subsurface conditions revealed at the test locations may not be representative of subsurface conditions across the site. We recommend that an experienced geotechnical practitioner be engaged during construction to confirm the subsurface conditions are consistent with design assumptions.

FIGURES

Source Aerial Photography: Google Earth

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Title

Figure 1: Site Layout Plan and Borehole Locations

CES Project ID: CES100606-JBA

Date: 23/07/2010

Prepared By: S.Burnett

Checked By: M.Pickett

APPENDIX A

BOREHOLE LOGS, CORE PHOTOGRAPHS & EXPLANTORY NOTES

Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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Sheet: 1 of 2

X-Coord: 298276
Y-Coord: 6254717
Surface Elevation (R.L) : 69.5 m AHD
Date Commenced: 8/07/2010
Date Completed: 8/07/2010
Hole Diameter (mm): 76
Logged by: C. Aylott
Checked by: M. Pickett

Drilling Information				LITHOLOGY				Samples	Tests		Notes and additional observations
Depth (mBGL)	R.L. (m)	Method (Support)	Water	USCS Symbol	**Description** SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Sample ID	SPT	Pocket Penetrometer (kPa) 100 200 300 400	
0		ADV		CH	CLAY: high plasticity, brown with organic matter (roots)	Fm	>Wp				TOPSOIL
	69			CL	CLAY: pale brown, medium plasticity with some fine grained gravel and plants roots	St		SPT0.5MGHPBH1	2,3,6 N*=9		ALLUVIAL CLAY
1	68			CL	GRAVELLY CLAY: Low plasticity, brown, gravel is fine to medium angular to subangular shale	H		SPT1.5.GHPBH1	21,17,23 N*=40		RESIDUAL SOIL
2	67	ADT	▽		VOLCANIC BRECCIA: Dark brown, extremely weathered, (estimated very low strength)						SPT Refusal
3								SPT3.0MGHPBH1	30,-,- N*=R		SHALE
	66				Begin Core Drilling						
4	65										
5	64										
6	63										
7	62										
8	61										
9	60										
10											

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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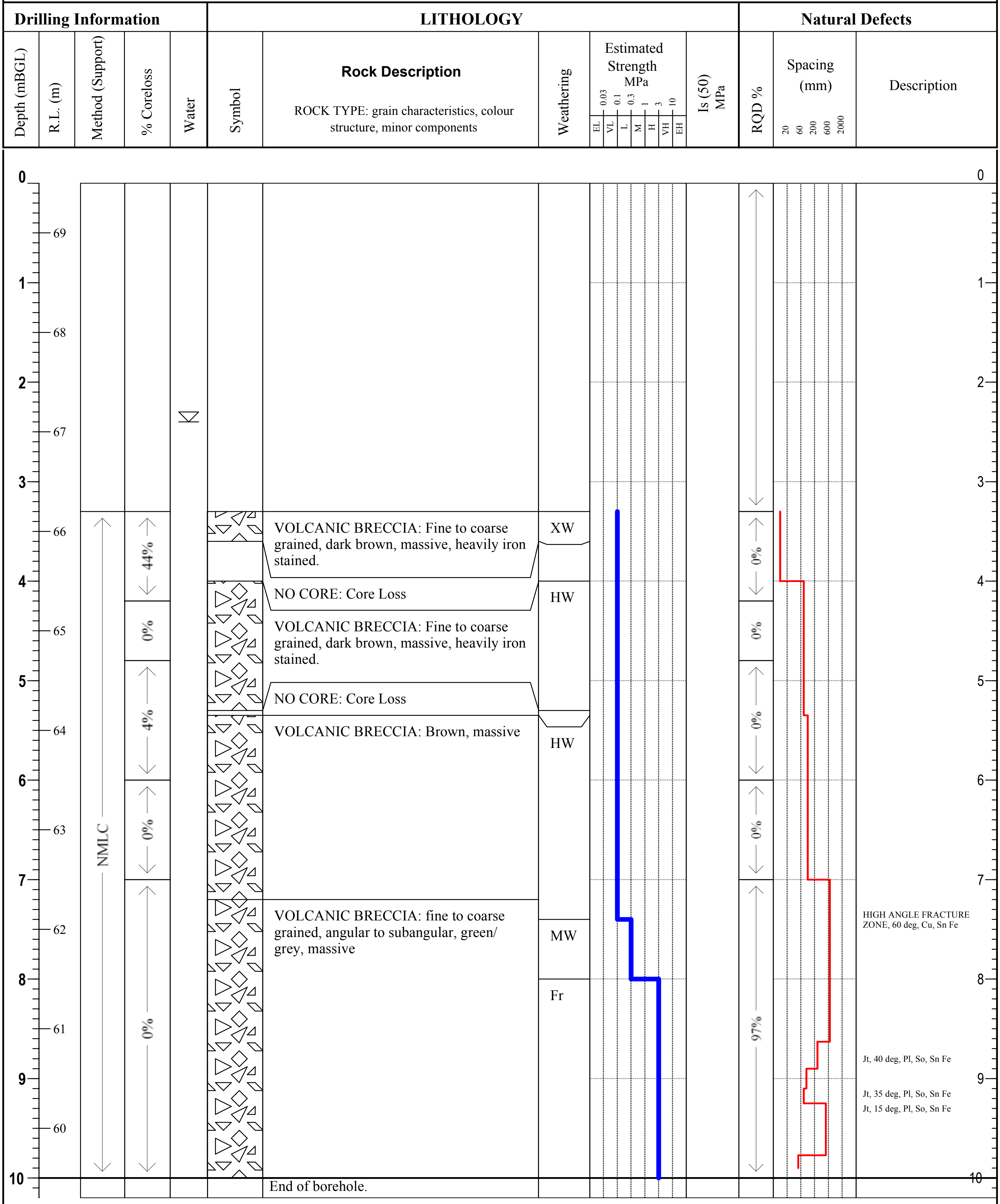
Corehole ID: BH1

Sheet: 2 of 2

X-Coord: 298276
Y-Coord: 6254717
Surface Elevation (R.L): 69.5 m AHD
Date Commenced: 8/07/2010
Date Completed: 8/07/2010
Hole Diameter (mm): 76
Logged by: C. Aylott
Checked by: M. Pickett



VOLCANIC BRECCIA: Fine to coarse grained, dark brown, massive, heavily iron stained. — XW

NO CORE: Core Loss

VOLCANIC BRECCIA: Fine to coarse grained, dark brown, massive, heavily iron stained. — HW

NO CORE: Core Loss

VOLCANIC BRECCIA: Brown, massive — HW

VOLCANIC BRECCIA: fine to coarse grained, angular to subangular, green/ grey, massive — MW, Fr

End of borehole.

HIGH ANGLE FRACTURE ZONE, 60 deg, Cu, Sn Fe

Jt, 40 deg, Pl, So, Sn Fe

Jt, 35 deg, Pl, So, Sn Fe

Jt, 15 deg, Pl, So, Sn Fe

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Date:	22/07/2010	Title:	BH1 Horsley Park 3.30m to 10.00m
Prepared by:	M. Pickett		
Checked by:	D. Lowe	CES Project ID:	CES100606-JBA
Scale:	NTS		
Size:	A4	Client:	Jacfin Pty Ltd

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Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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LOG ID: BH2

Sheet: 1 of 3

X-Coord: 297908
Y-Coord: 6254069
Surface Elevation (R.L) : 67.6 m AHD
Date Commenced: 13/07/2010
Date Completed: 13/07/2010
Hole Diameter (mm): 76
Logged by: C. Aylott
Checked by: M. Pickett

Drilling Information				LITHOLOGY					Samples	Tests		
Depth (mBGL)	R.L. (m)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Sample ID	SPT	Pocket Penetrometer (kPa) 100 200 300 400	Notes and additional observations
0		ADV			CL	CLAY: High plasticity, brown with organic matter (roots)	Fm	>Wp				TOPSOIL
	-68				CH	CLAY: high plasticity, dark brown/ orange with some organic matter (plant roots). At 0.5m with trace of fine to medium, subangular to subrounded ironstone gravel	St		SPT0.5MGHPBH2	2,4,5 N*=9		ALLUVIAL CLAY
1	-69		▽		CL	CLAY: medium plasticity, pale grey, with some orange mottle			SPT1.5.GHPBH2	4,6,8 N*14		RESIDUAL SOIL
2	-70	ADT				SHALE: pale brown, extremely to highly weathered (estimated very low to low strength).						SHALE V-Bit Refusal
3	-71									30,-,- N=R		
4	-72					Begin Core Drilling						
5	-73											
6	-74											
7	-75											
8	-76											
9	-77											
10												

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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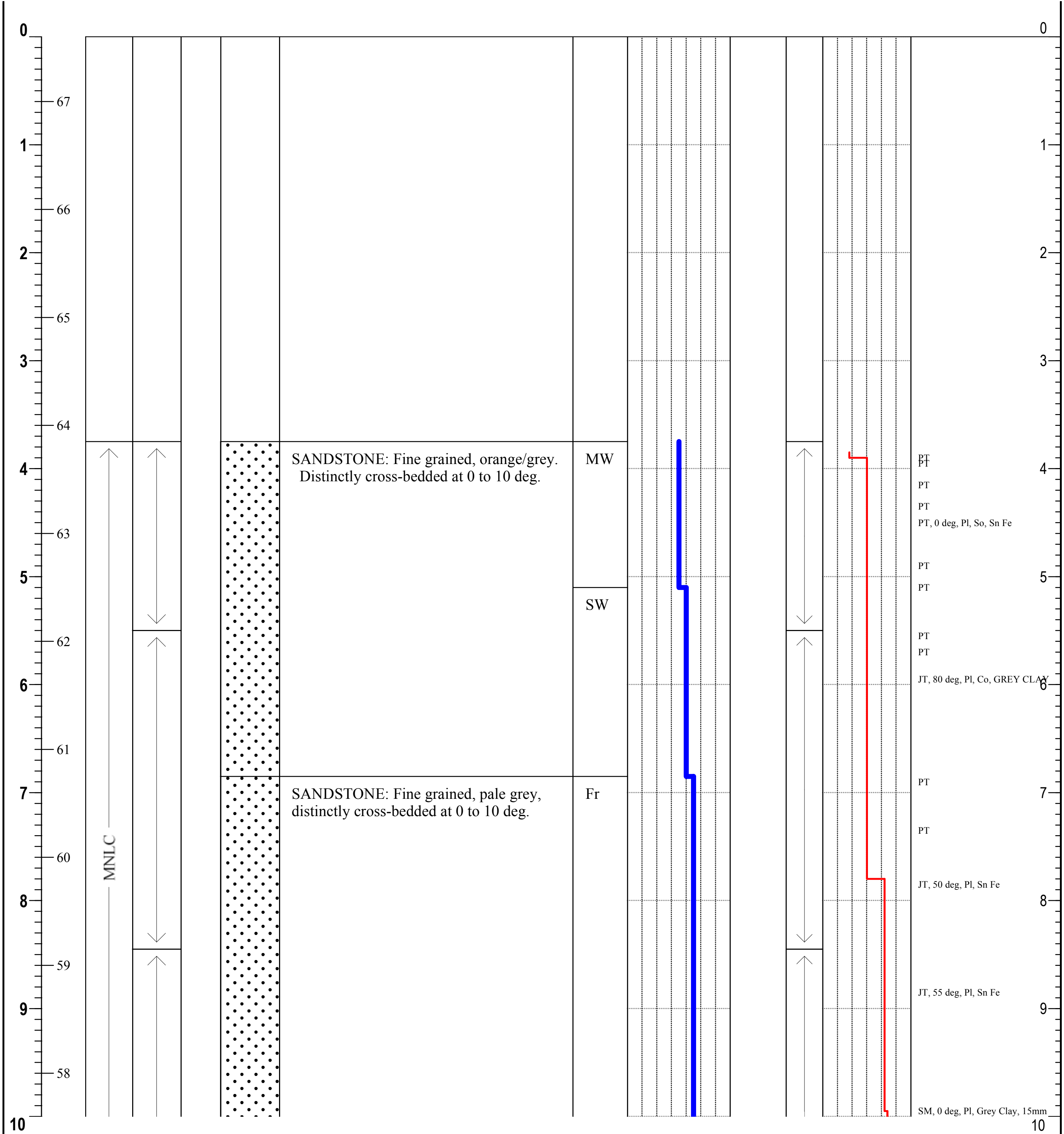
Corehole ID: BH2

Sheet: 2 of 3

X-Coord: 297908
Y-Coord: 6254069
Surface Elevation (R.L): 67.6 m AHD
Date Commenced: 13/07/2010
Date Completed: 13/07/2010
Hole Diameter (mm): 76
Logged by: C. Aylott
Checked by: M. Pickett

Drilling Information					LITHOLOGY					Natural Defects		
Depth (mBGL)	R.L. (m)	Method (Support)	% Coreloss	Water	Symbol	Rock Description ROCK TYPE: grain characteristics, colour structure, minor components	Weathering	Estimated Strength MPa 0.03 0.1 0.3 1 3 10 EL VL L M H VH EH	Is (50) MPa	RQD %	Spacing (mm) 20 60 200 600 2000	Description



SANDSTONE: Fine grained, orange/grey. Distinctly cross-bedded at 0 to 10 deg. — MW, SW

SANDSTONE: Fine grained, pale grey, distinctly cross-bedded at 0 to 10 deg. — Fr

PT
PT
PT
PT
PT, 0 deg, Pl, So, Sn Fe
PT
PT
PT
PT
JT, 80 deg, Pl, Co, GREY CLAY
PT
PT
JT, 50 deg, Pl, Sn Fe
JT, 55 deg, Pl, Sn Fe
SM, 0 deg, Pl, Grey Clay, 15mm

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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Corehole ID:
BH2

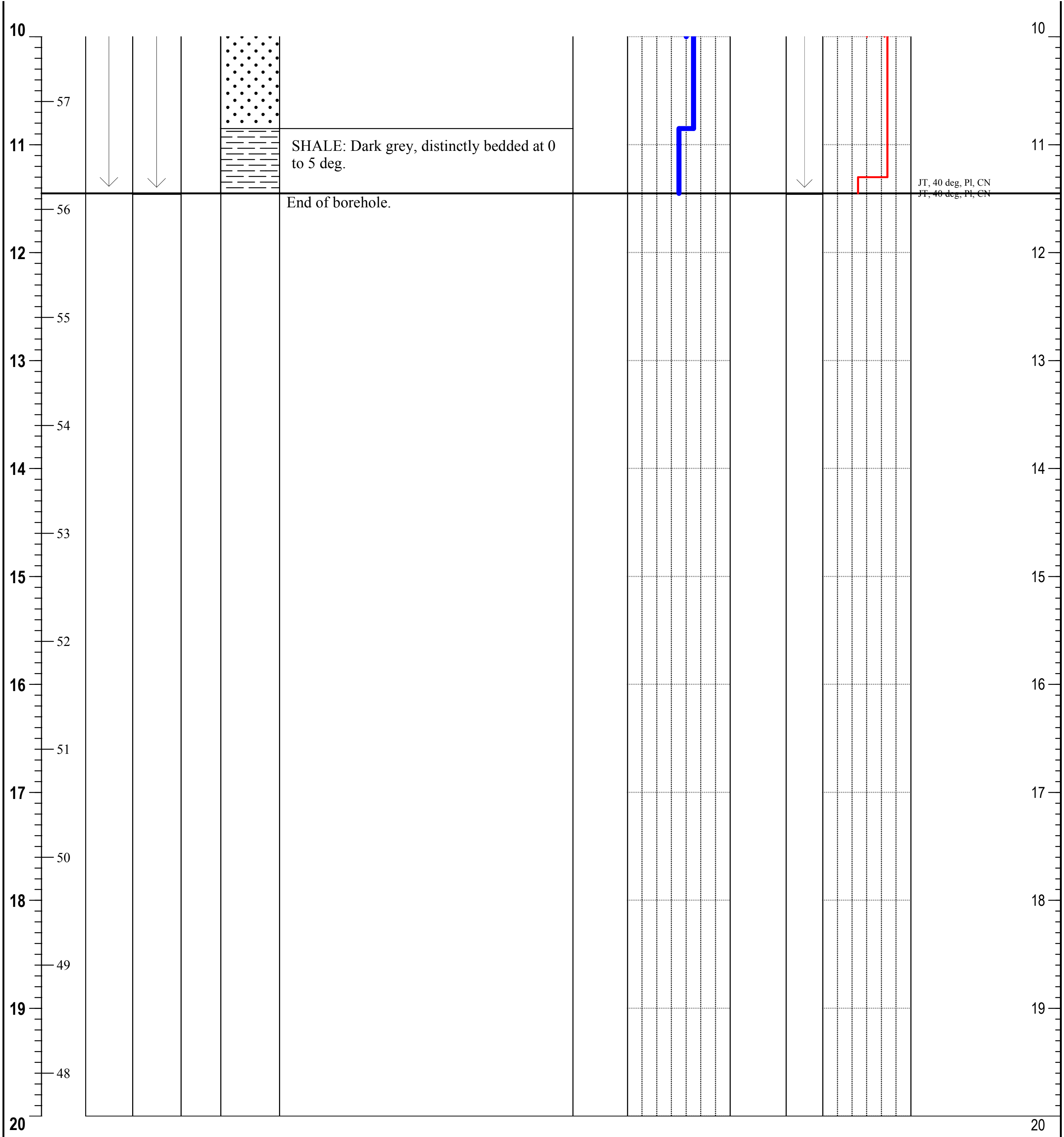
Sheet: 3 of 3

X-Coord: 297908
Y-Coord: 6254069
Surface Elevation (R.L): 67.6 m AHD

Date Commenced: 13/07/2010
Date Completed: 13/07/2010
Hole Diameter (mm): 76

Logged by: C. Aylott
Checked by: M. Pickett

Drilling Information					LITHOLOGY					Natural Defects		
Depth (mBGL)	R.L. (m)	Method (Support)	% Coreloss	Water	Symbol	**Rock Description** ROCK TYPE: grain characteristics, colour structure, minor components	Weathering	Estimated Strength MPa 0.03 0.1 0.3 1 3 10 EL VL L M H VH EH	Is (50) MPa	RQD %	Spacing (mm) 20 60 200 600 2000	Description



SHALE: Dark grey, distinctly bedded at 0 to 5 deg.

End of borehole.

JT, 40 deg, Pl, CN
JT, 40 deg, Pl, CN

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Date:	22/07/2010	Title:	BH2 Horsley Park 3.75m to 11.46m
Prepared by:	M. Pickett		
Checked by:	D. Lowe	CES Project ID:	CES100606-JBA
Scale:	NTS		
Size:	A4	Client:	Jacfin Pty Ltd

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Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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LOG ID: BH3

Sheet: 1 of 3

X-Coord: 298337
Y-Coord: 6253857
Surface Elevation (R.L) : 76.8 m AHD
Date Commenced: 9/07/2010
Date Completed: 9/07/2010
Hole Diameter (mm): 76
Logged by: C. Aylott
Checked by: M. Pickett

Depth (mBGL)	R.L. (m)	Method (Support)	Water	Symbol	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Sample ID	SPT	Pocket Penetrometer (kPa) 100 200 300 400	Notes and additional observations
0		ADV			CH	HP, Brown, with organic matter (roots)	Fm	>Wp				
					CH	CLAY: High plasticity, dark brown/ mottled orange, with some organic material including plant roots. Becoming pale grey with orange mottle						ALLUVIAL CLAY
	76								SPT0.5MGHPBH3	2,2,3 N*=5		
1							St					
	75		▽						SPT1.5.GHPBH3	3,4,6 N*=10		
3	74				Cl	CLAY: medium plasticity, pale grey with red/ orange mottle	VSt		SPT3.0MGHPBH3	5,8,11 N*=19		RESIDUAL SOIL
	73											ADV Refusal
4		ADT				SHALE: pale grey/ pale brown with orange mottle, highly weathered (estimated low strength)						SHALE
	72								SPT4.5MGHPBH3	16,30,29 N*=59		
6	71								SPT6.0MGHPBH3	25,-,- N*=R		SPT Refusal
	70					Begin Core Drilling						
7												
8	69											
9	68											
10	67											

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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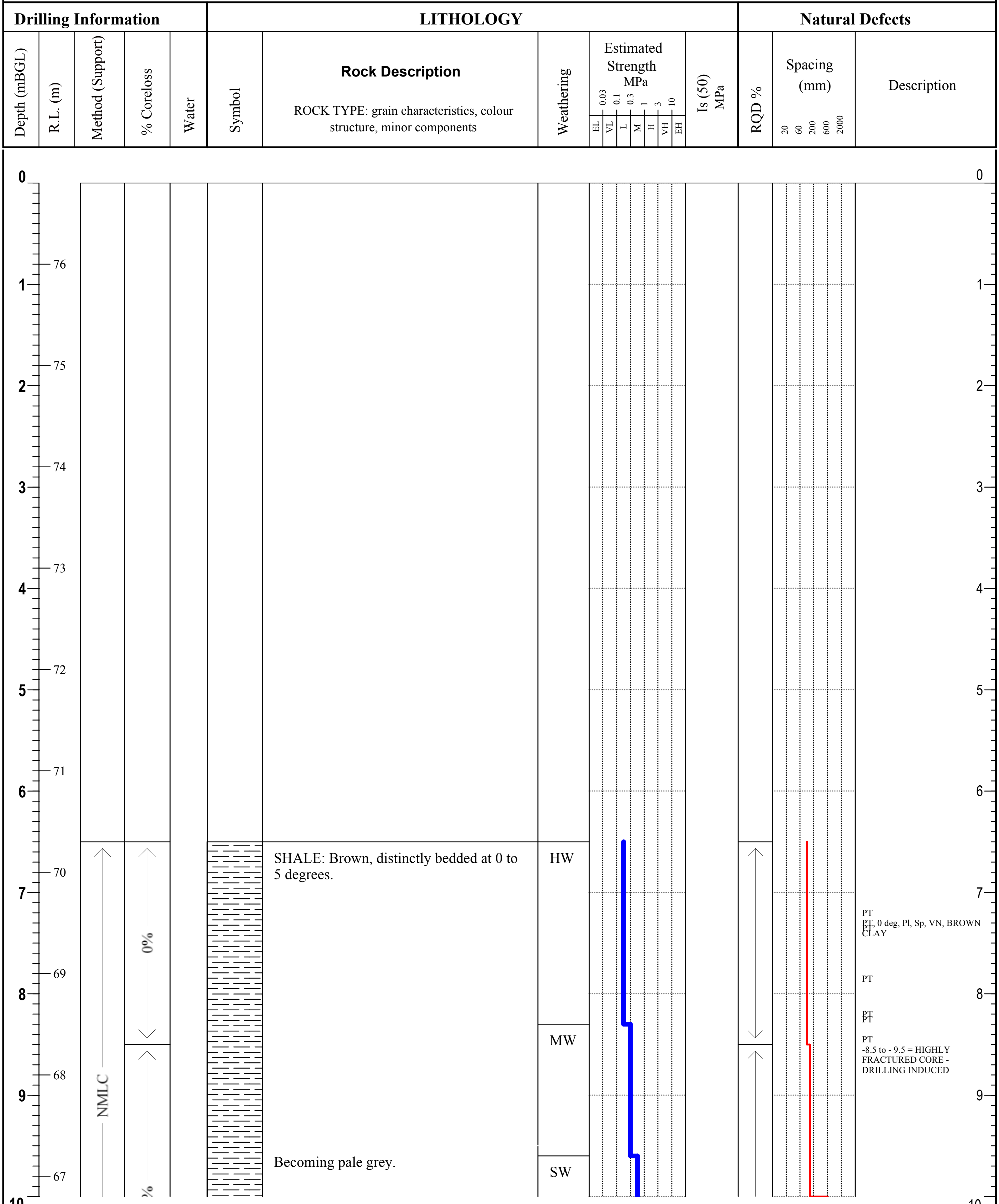
Corehole ID: BH3

Sheet: 2 of 3

X-Coord: 298337
Y-Coord: 6253857
Surface Elevation (R.L): 76.8 m AHD

Date Commenced: 9/07/2010
Date Completed: 9/07/2010
Hole Diameter (mm): 76

Logged by: C. Aylott
Checked by: M. Pickett



SHALE: Brown, distinctly bedded at 0 to 5 degrees.

Becoming pale grey.

PT
PT, 0 deg, Pl, Sp, VN, BROWN
PT
CLAY

PT

PT
PT

PT
-8.5 to - 9.5 = HIGHLY FRACTURED CORE - DRILLING INDUCED

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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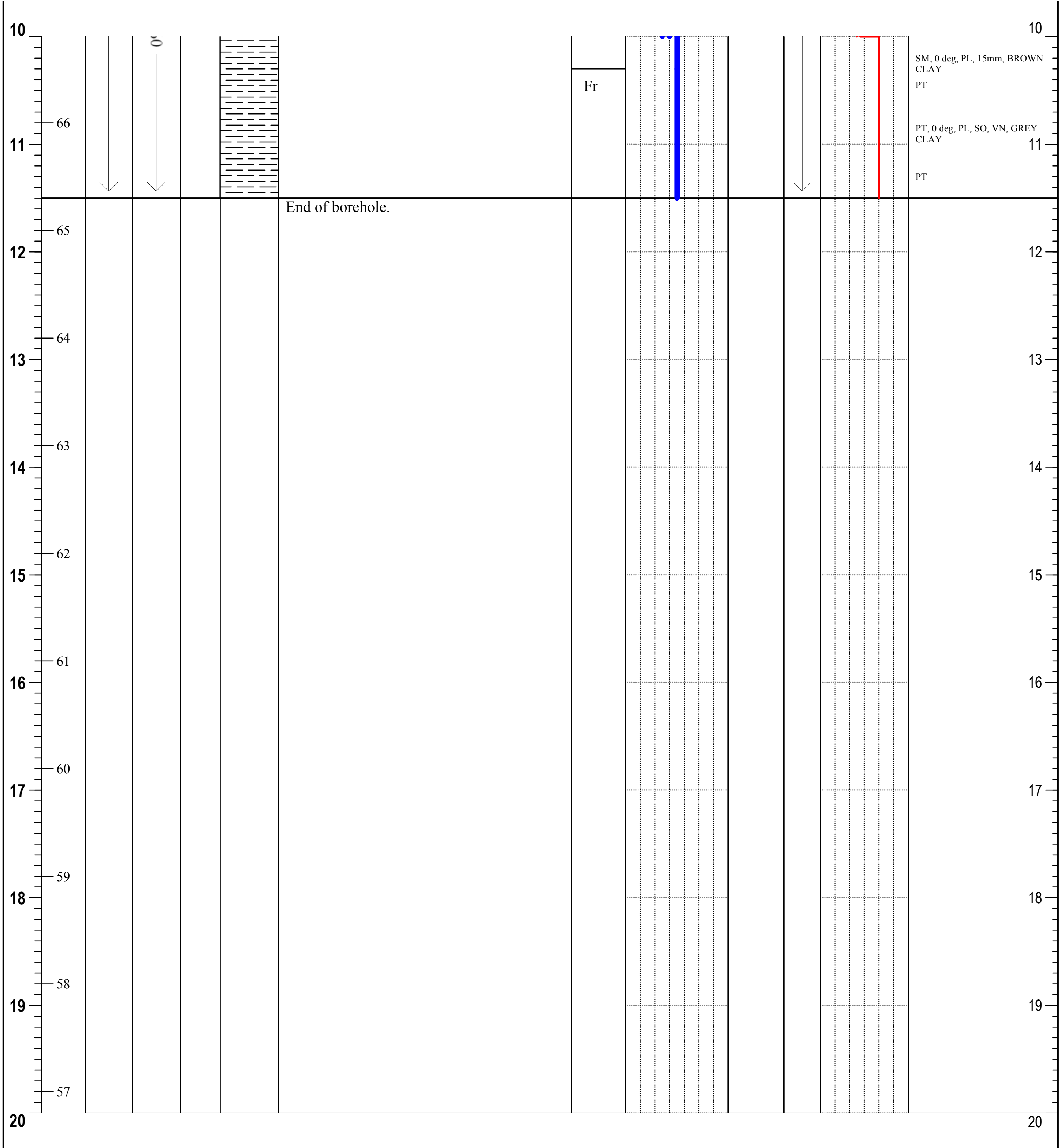
Corehole ID: BH3

Sheet: 3 of 3

X-Coord: 298337
Y-Coord: 6253857
Surface Elevation (R.L): 76.8 m AHD
Date Commenced: 9/07/2010
Date Completed: 9/07/2010
Hole Diameter (mm): 76
Logged by: C. Aylott
Checked by: M. Pickett

Drilling Information | **LITHOLOGY** | **Natural Defects**

Depth (mBGL) | R.L. (m) | Method (Support) | % Coreloss | Water | Symbol | **Rock Description** ROCK TYPE: grain characteristics, colour structure, minor components | Weathering | Estimated Strength MPa | Is (50) MPa | RQD % | Spacing (mm) | Description



Fr

End of borehole.

SM, 0 deg, PL, 15mm, BROWN CLAY

PT

PT, 0 deg, PL, SO, VN, GREY CLAY

PT

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Date:	22/07/2010	Title:	BH3 Horsley Park 6.50m to 11.50m
Prepared by:	M. Pickett		
Checked by:	D. Lowe	CES Project ID:	CES100606-JBA
Scale:	NTS		
Size:	A4	Client:	Jacfin Pty Ltd

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Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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LOG ID: BH4

Sheet: 1 of 3

X-Coord: 297793
Y-Coord: 6253293
Surface Elevation (R.L) : 76.8 m AHD
Date Commenced: 12/07/2010
Date Completed: 12/07/2010
Hole Diameter (mm): 76
Logged by: C. Aylott
Checked by: M. Pickett

Depth (mBGL): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
R.L. (m): -77, -78, -79, -80, -81, -82, -83, -84, -85, -86

Drilling Information				**LITHOLOGY**					**Samples**	**Tests**		
Depth (mBGL)	R.L. (m)	Method (Support)	Water	Symbol	USCS Symbol	**Description** SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Sample ID	SPT	Pocket Penetrometer (kPa) 100 200 300 400	**Notes and additional observations**
		ADV		▨	CH	CLAY: HP, Brown with organic matter (roots)	Fm	>Wp				TOPSOIL
				▨	CH							ALLUVIAL CLAY
				▨	CH	CLAY: medium to high plasticity, dark orange/ dark brown, with some small angular to subangular gravel of shale and some organic matter (plant roots)	St		SPT0.5MGHPBH4	2,5,8 N*=13	◆	RESIDUAL SOIL
				▨	Cl	CLAY: high plasticity, pale grey, mottled orange and red	VSt		SPT1.5.GHPBH4	7,9,13 N*=22	◆	
			▽	▨		CLAY: medium plasticity, pale grey mottled orange and yellow with trace of fine grained sand						V-Bit Refusal
		ADT		▤		SHALE: pale grey/ green with some orange mottle, highly weathered (estimated low strength)			SPT3.0MGHPBH4	30,-,- N=R		SHALE -3.1 = SPT Refusal
						Begin Core Drilling						

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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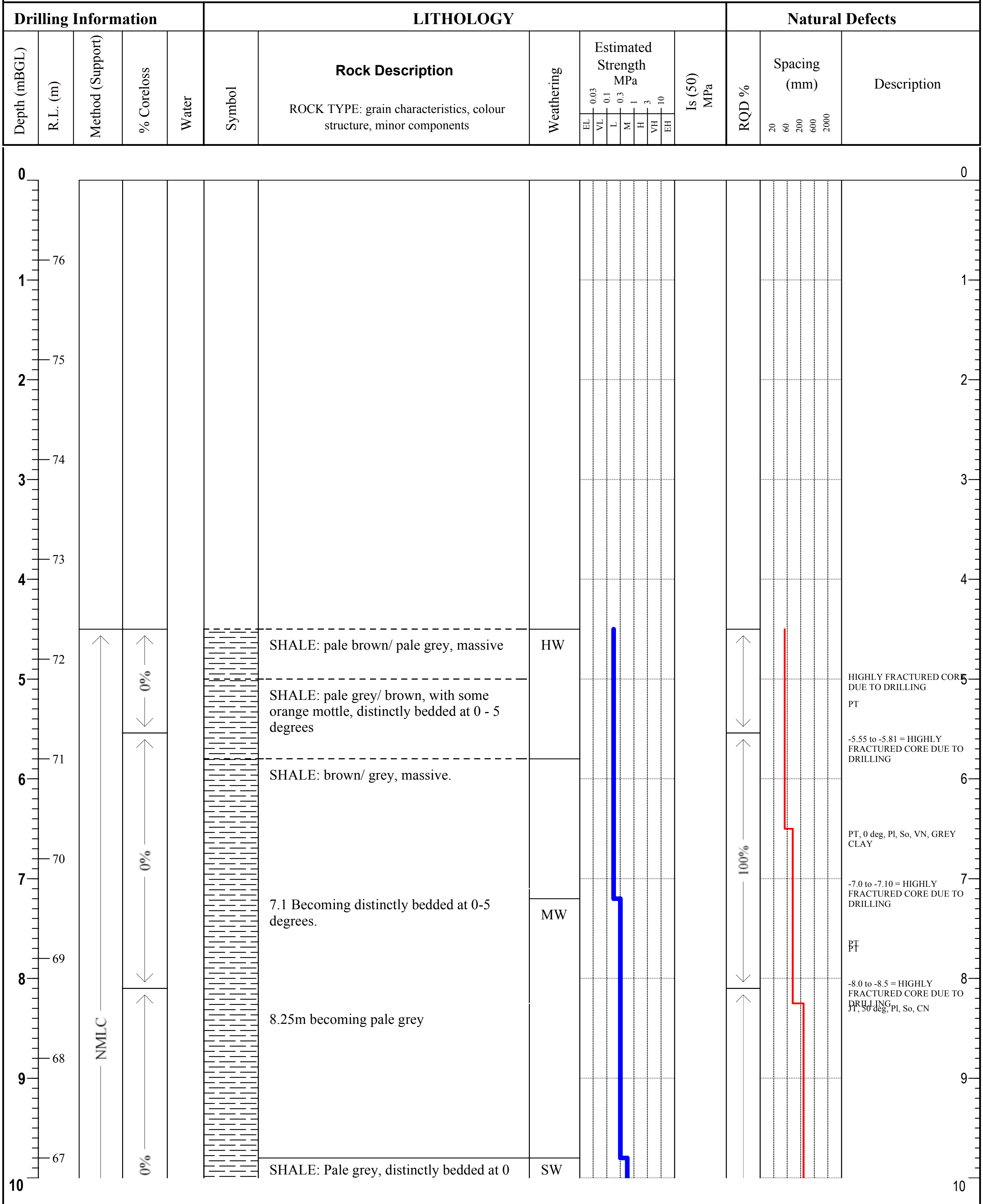
Corehole ID:
BH4

X-Coord: 297793
Y-Coord: 6253293
Surface Elevation (R.L): 76.8 m AHD

Date Commenced: 12/07/2010
Date Completed: 12/07/2010
Hole Diameter (mm): 76

Logged by: C. Aylott
Checked by: M. Pickett



Depth (mBGL)	Rock Description	Weathering
4.5	SHALE: pale brown/ pale grey, massive	HW
5.0	SHALE: pale grey/ brown, with some orange mottle, distinctly bedded at 0 - 5 degrees	
5.8	SHALE: brown/ grey, massive.	
	7.1 Becoming distinctly bedded at 0-5 degrees.	MW
	8.25m becoming pale grey	
9.8	SHALE: Pale grey, distinctly bedded at 0	SW

Natural Defects – Description:

HIGHLY FRACTURED CORE DUE TO DRILLING

PT

-5.55 to -5.81 = HIGHLY FRACTURED CORE DUE TO DRILLING

PT, 0 deg, Pl, So, VN, GREY CLAY

-7.0 to -7.10 = HIGHLY FRACTURED CORE DUE TO DRILLING

PT
PT

-8.0 to -8.5 = HIGHLY FRACTURED CORE DUE TO DRILLING

JT, 50 deg, Pl, So, CN

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Project ID: CES100606-JBA
Client: Jacfin Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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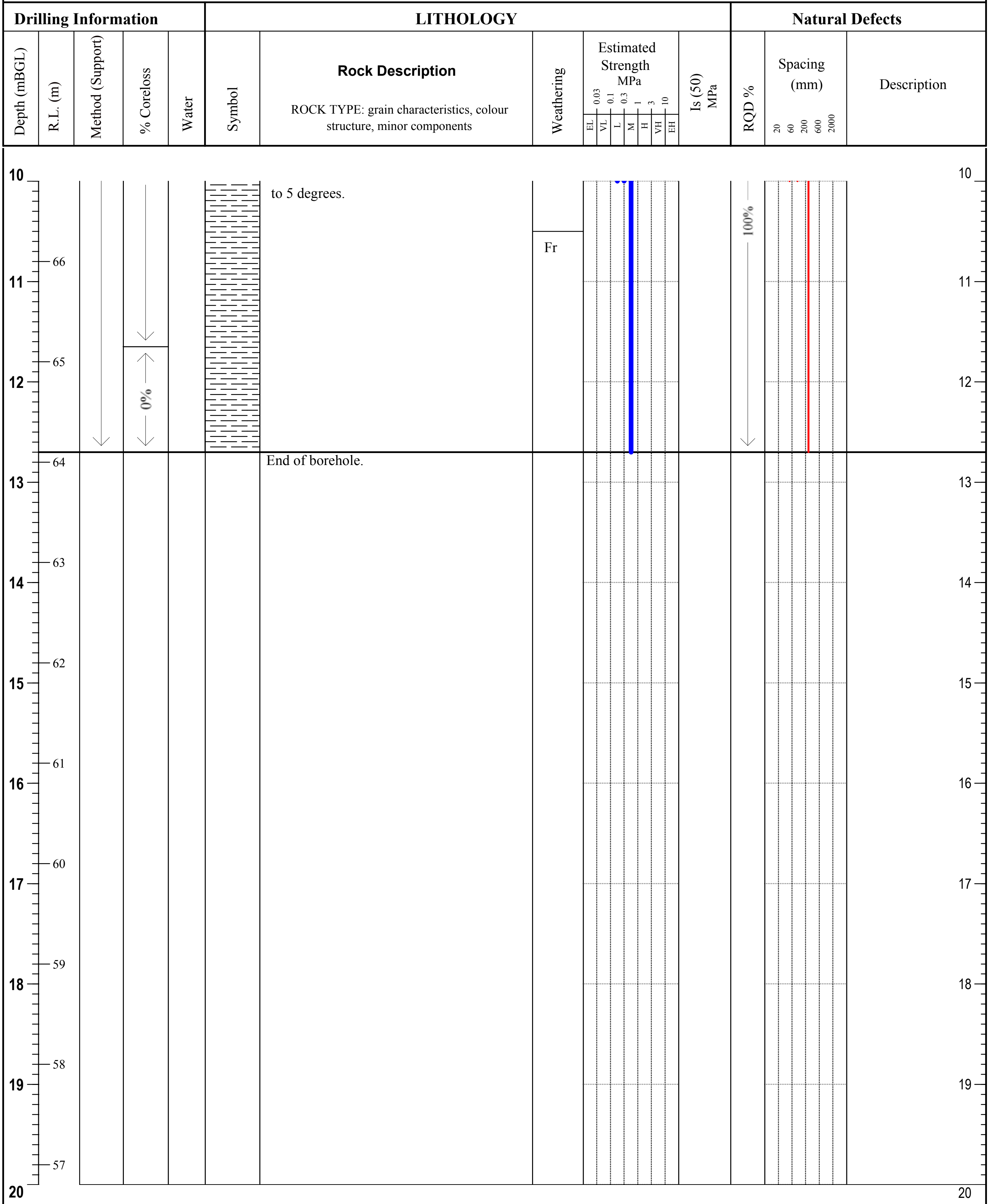
Corehole ID: BH4

Sheet: 3 of 3

X-Coord:	297793	**Date Commenced:**	12/07/2010	**Logged by:**	C. Aylott
Y-Coord:	6253293	**Date Completed:**	12/07/2010	**Checked by:**	M. Pickett
Surface Elevation (R.L):	76.8 m AHD	**Hole Diameter (mm):**	76		

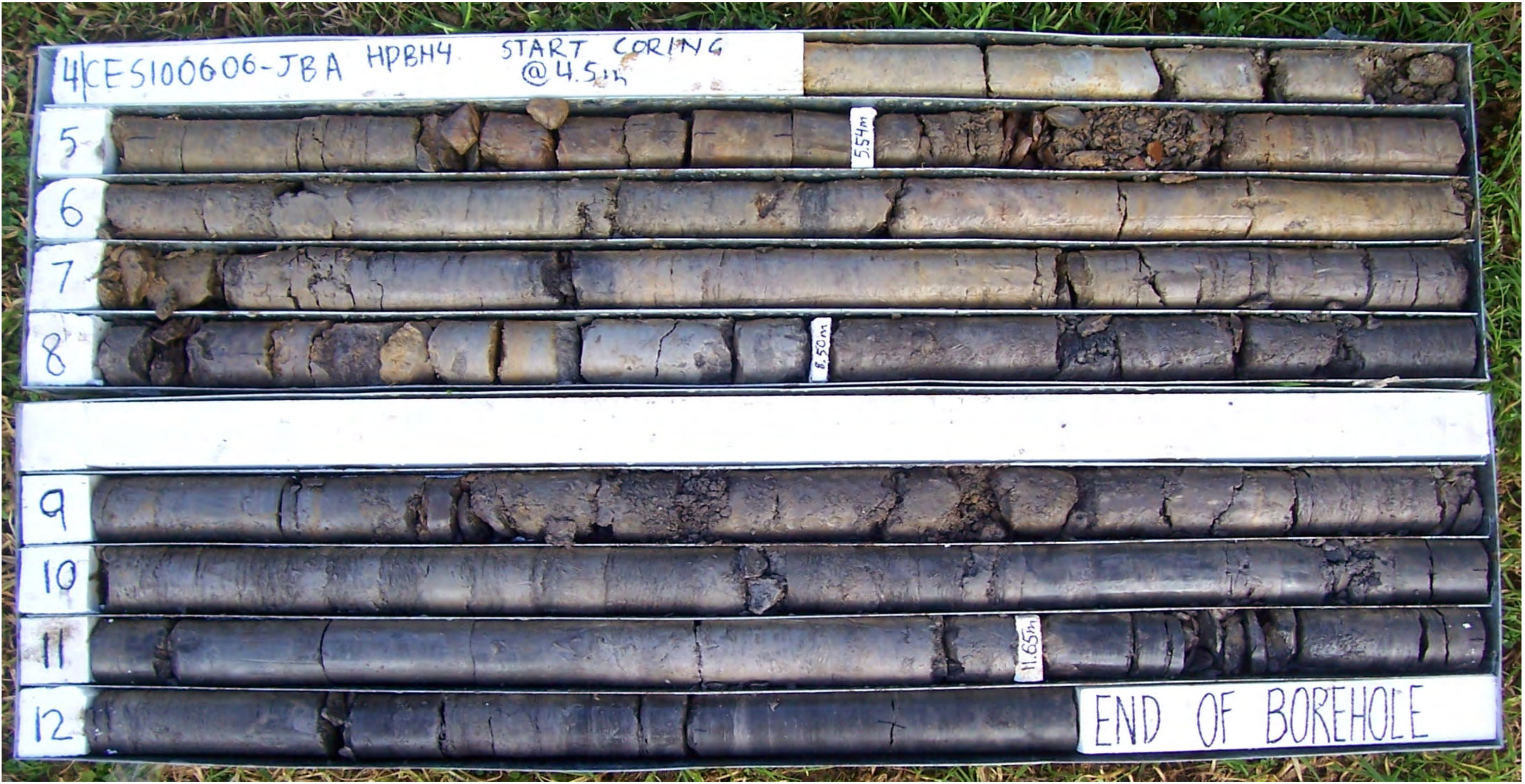


to 5 degrees.

End of borehole.

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations



Date:	22/07/2010	Title:	BH4 Horsley Park 4.50m to 12.70m
Prepared by:	M. Pickett		
Checked by:	D. Lowe	CES Project ID:	CES100606-JBA
Scale:	NTS		
Size:	A4	Client:	Jacfin Pty Ltd

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Project ID: CES100606-JBA
Client: JBA Planning Pty Ltd
Project: Horsley Park
Location: Lot A, Burley Road, Horsley Park, Employment Precinct

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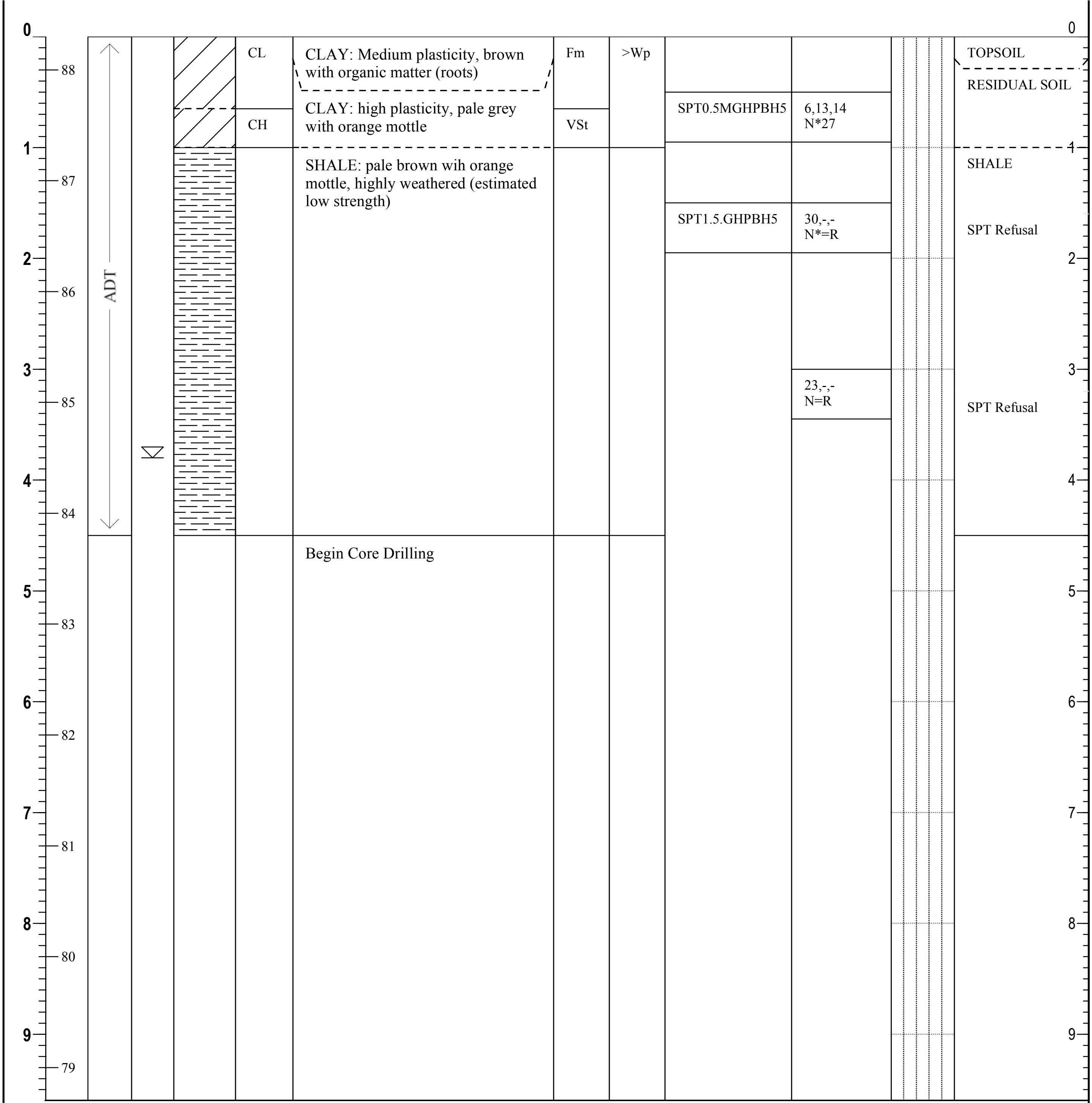
LOG ID: BH5

Sheet: 1 of 2

X-Coord: 298264
Y-Coord: 6253383
Surface Elevation (R.L) : 88.3 m AHD
Date Commenced: 9/07/2010
Date Completed: 12/07/2010
Hole Diameter (mm): 76
Logged by: C. Aylott
Checked by: M. Pickett



Drilling Information	LITHOLOGY				Samples	Tests	Notes and additional observations
Method (Support)	USCS Symbol	Description SOIL TYPE: plasticity or particle characteristics colour, moisture, secondary and minor component	Consistency / Density	Moisture	Sample ID	SPT	
ADT	CL	CLAY: Medium plasticity, brown with organic matter (roots)	Fm	>Wp			TOPSOIL
	CH	CLAY: high plasticity, pale grey with orange mottle	VSt		SPT0.5MGHPBH5	6,13,14 N*27	RESIDUAL SOIL
		SHALE: pale brown wih orange mottle, highly weathered (estimated low strength)			SPT1.5.GHPBH5	30,-,- N*=R	SHALE SPT Refusal
						23,-,- N=R	SPT Refusal
		Begin Core Drilling					

Drill Company: Macquarie Drilling
Machine Type: Hydropower
Operator Name: Glen Garsive

Refer to Standard Sheets for details of abbreviations

Project ID:	CES100606-JBA		
Client:	Jacfin Pty Ltd		
Project:	Horsley Park		
Location:	Lot A, Burley Road, Horsley Park, Employment Precinct		

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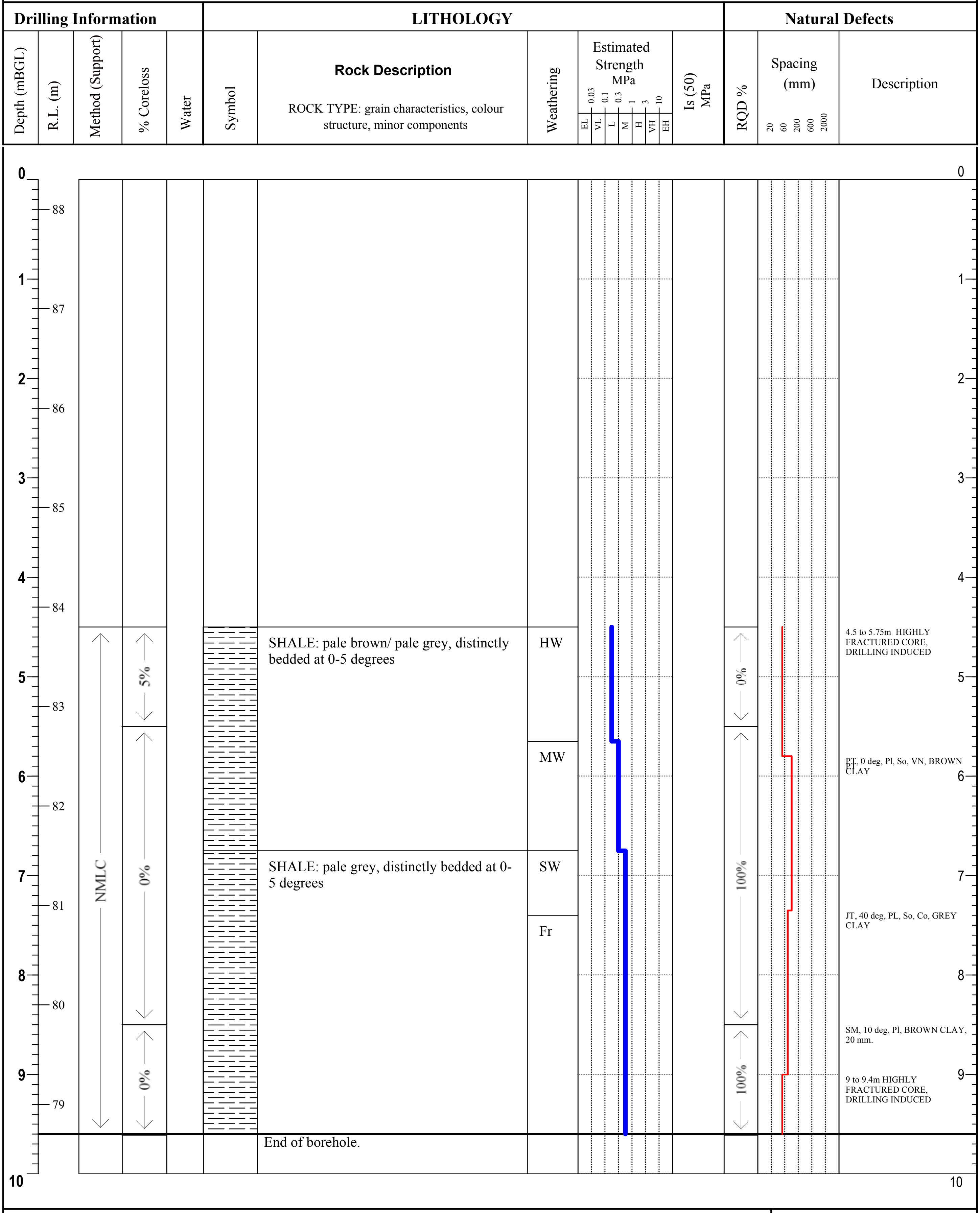
Corehole ID: BH5

Sheet: 2 of 2

X-Coord:	298264	**Date Commenced:**	9/07/2010	**Logged by:**	C. Aylott
Y-Coord:	6253383	**Date Completed:**	12/07/2010	**Checked by:**	M. Pickett
Surface Elevation (R.L):	88.3 m AHD	**Hole Diameter (mm):**	76		



Rock Description ROCK TYPE: grain characteristics, colour structure, minor components	Weathering
SHALE: pale brown/ pale grey, distinctly bedded at 0-5 degrees	HW MW
SHALE: pale grey, distinctly bedded at 0-5 degrees	SW Fr
End of borehole.	

Natural Defects – Description:

4.5 to 5.75m HIGHLY FRACTURED CORE, DRILLING INDUCED

PT, 0 deg, Pl, So, VN, BROWN CLAY

JT, 40 deg, PL, So, Co, GREY CLAY

SM, 10 deg, Pl, BROWN CLAY, 20 mm.

9 to 9.4m HIGHLY FRACTURED CORE, DRILLING INDUCED

Drill Company:	Macquarie Drilling	**Operator Name:**	Glen Garsive
Machine Type:	Hydropower		

Refer to Standard Sheets for details of abbreviations

Date:	22/07/2010	Title:	BH5 Horsley Park 4.50m to 9.61m
Prepared by:	M. Pickett		
Checked by:	D. Lowe	CES Project ID:	CES100606-JBA
Scale:	NTS		
Size:	A4	Client:	Jacfin Pty Ltd

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SUMMARY OF SOIL LOGGING PROCEDURES (Based on AS 1726-1993 *Geotechnical Site Investigations*)

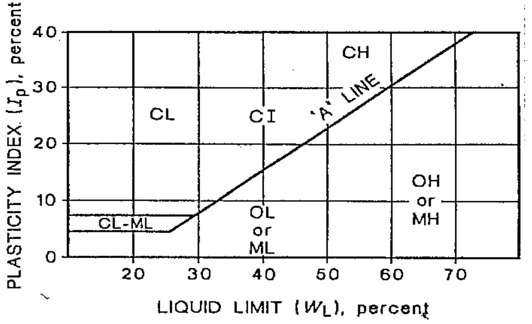
Coarse Material (Gravel and Sands): SOIL NAME: colour - grain size - particle shape - secondary components - minor constituents - moisture condition - relative density - origin - additional observations.
Example (Coarse material): Clayey SAND: dark grey, fine to medium sand, low plasticity, trace of fine gravel, moist and loose. (Alluvial)

Fine Material (Silts and Clays): SOIL NAME: colour - plasticity - secondary components - minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations.
Example (Fine Material): sandy CLAY: dark grey, low to medium plasticity,fine grained sand, MC > PL, firm to stiff (Alluvial).

Guide to the Description, Identification and Classfication of Soils

Major Divisions				USCS Symbol	Typical Names
>200mm	BOULDERS				
63 to 200mm	COBBLES				
COARSE GRAINED SOILS	More than 50% by dry mass less than 60mm is greater than 0.076m	Gravel Gravelly Soils	More than 50% of coarse fraction > 2.36mm	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
				GM	Silty gravels, gravel-sand-silt mixtures.
				GC	Clayey gravels, gravel-sand-clay mixtures.
		SANDS Sandy Soils	More than 50% of coarse fraction < 2.36mm	SW	Well-graded sands, gravelly sands, little or no fines.
				SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
				SM	Silty sands, sand-silt mixtures.
				SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	More than 50% by dry mass less than 60mm is less than 0.076m	Liquid Limit < 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts.
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
				OL	Organic silts and organic silty clays of low plasticity.
		Liquid Limit > 50%		MH	Inorganic silts, micaceous or diatomaneous fine sandy or silty soils, elastic silts.
				CH	Inorganic clays of high plasticity, fat clays.
				OH	Organic clays of medium or high plasticity, organic silts.
HIGHLY ORGANIC SOILS				Pt	Peat and other highly organic soils.

Grain Sizes			
Gravel		Sand	
Coarse -	63 to 20mm	Coarse -	2.36 to 0.6mm
Medium -	20 to 6mm	Medium -	0.6 to 0.2mm
Fine -	6 to 2.36mm	Fine -	0.2 to 0.075mm



GEOLOGICAL ORIGIN:

Fill	- artificial soils / deposits
Alluvial	- soils deposited by the action of water
Aeolian	- soils deposited by the action of wind
Topsoil	- soils supporting plant life containing significant organic c
Residual	- soils derived from insitu weathering of parent rock.
Colluvial	- transported debris usually unsorted, loose and deposited by gravity towards the base of terrain of high relief

Field Identification of Fine Grained Soils - Silt or Clay?

Dry Strength - Allow the soil to dry completely and then test its strength by breaking and crumbling between the fingers.
High dry strength - Clays; Very slight dry strength - Silts.
Toughness Test - The soil is rolled by hand into a thread about 3mm in diameter. The thread is then folded and re-rolled repeatedly until it has dried sufficiently to break into lumps. In this condition inorganic clays are fairly stiff and tough while inorganic silts produce a weak and often soft thread which may be difficult to form and readily breaks and crumbles.
Dilatancy Test - Add sufficient water to the soil, held in the palm of the hand, to make it soft but not sticky. Shake horizontally, striking vigorously against the other hand several times. Dilatancy is indicated by the appearance of a shiny film on the surface of the soil. If the soil is then squeezed or pressed with the fingers, the surface becomes dull as the soil stiffens and eventually crumbles. These reactions are pronounced only for predominantly silt size material. Plastic clays give no reaction.

Descriptive Terms for Material Portions

COARSE GRAINED SOILS			FINE GRAINED SOILS	
% Fines		*Term/Modifier*	*% Coarse*	*Term/Modifier*
< 5		Omit, or use "trace"	< 15	Omit, or use "trace"
> 5, < 12		"with clay/silt" as applicabl	> 15, < 30	"with sand/gravel" as applicable
> 12		Prefix soil as "silty/clayey"	> 30	Prefix as "sandy/gravelly"

Moisture Condition

Terminology		*for non cohesive soils:*	*for cohesive soils:*
Dry -		cohesionless, free running.	MC < PL. Typically hard and friable.
Moist -		Soils tend to cohere, no free water visible.	MC ~ PL. Soil can be moulded
Wet -		free water visible on soil su	MC > PL. Free water forms on hands during handling

* The plastic Limit (PL) is defined as the moisture content at which the soil crumbles when rolled into threads of 3mm dia.

Plasticity - for Clays & Silts

Low Plasticity		LL ≤ 35 %. A 3mm dia thread can barely be rolled at any water content.
Medium Plasticity		LL >35 % ≤ 50 %. The thread is easy to roll and not much time is required to reach PL. Cannot be re-rolled after reaching PL.
High Plasticity		LL > 50 %. It takes considerable time rolling and kneading to reach the PL. The thread can be rerolled several times after reaching the PL.

* Liquid Limit (LL) is defined as the moisture content (%) at which the soil begins to flow.

Consistency - for Clays & Silts

Description	*SPT "N" Value*	*UCS or q_u (kPa) **	*Field guide to consistency*
Very Soft		<25	Exudes between the fingers when squeezed in hand
Soft		25 - 50	Can be moulded by light finger pressure
Firm		50 - 100	Can be moulded by strong finger pressure
Stiff		100 - 200	Cannot be moulded by fingers. Can be indented by thumb
Very Stiff		200 - 400	Can be indented by thumbnail
Hard		>400	Can be indented with difficulty by thumbnail

* UCS = Unconfined Compressive Strength. Can be estimated using a pocket penetrometer although it may overestimate UCS by a factor of 1.5 - 2.0

Relative Density for Gravels and Sands

Description	*SPT "N" Value*	*Relative Density %*	*Field guide (For sand)*
Very Loose	0 - 4	<15	Easily penetrated
Loose	4 - 10	15 - 35	Can be excavated
Medium Dense	10 - 30	35 - 65	Hard shoveling.
Dense	30 - 50	65 - 85	Penetrated 300mm
Very Dense	>50	>85	Penetrated only 25 - 50 mm with 13mm reinforcing rod driven

SUMMARY OF ROCK LOGGING PROCEDURES

DESCRIPTION ORDER: ROCK TYPE: grain size - colour - strength - weathering - structure - defects - minor constituents - additional observations.

EXAMPLE: SANDSTONE: medium to coarse grained, grey with orange streaks, medium strength, distinctly weathered, laminated, with rare quartz gravel

Rock Type

Rock Type is described on the basis of origin (sedimentary, pyroclastic, metamorphic and igneaous). Common rock types are listed below.

Origin	Definition	Common Types
☐ Sedimentary Rocks:	Formed at the Earth's surface from the weathered and eroded fragments of pre-existing rocks (ie. clastic sedimentary rocks), from the hard parts of animals or plants (organic sedimentary rocks), or from the precipitation out of solution of dissolved minerals (chemical sedimentary rocks)	Clastic - conglomerate, sandstone, siltstone*, claystone*, shale. Organic - shelley limestone, coal. Chemical - limestonerock salt, gypsum, chert.
☐ Pyroclastic	Fragmented (clastic(rock material) formed by a volcanic explosion or eruption from a volcanic vent	Tuff, agglomerate, volcanic breccia
☐ Metamorphic Rocks:	Formed from the mineralogical and/or textural transformation, in the solid state, of pre-existing rocks due to the action of temperature and/or pressure. Metamorphic rocks that have been subjected to deep burial typically display a foliated texture due to the parallel alignment of some constituent minerals (as in schist) or the segregation of minerals into separate bands of different composition (as in gneiss)	Slate, Gneiss, Schist, Quartzite, Phylite
☐ Igneous rocks:	Formed by the cooling and solidification of magma, a hot molten material formed by localised melting within the Earth. If formed beneath the Earth's surface, the rock formed is an 'intrusive igneous rock. Magma extruded at the Earth's surface is known as lava which gives rise to extrusive igneous or volcanic rocks.	Intrusive - Granite, Dolerite, Porphyrite, Diorite. Extrusive - Basalt, Andesite.

* Both siltstone and claystone are also known as mudstone and commonly called shale if thinly laminated with a tendancy to split in parallel planes

Grain Size

Grain size is often only provided for conglomerate and sandstone sedimentary rocks.

* It is noted that the limit of unaided vision is 0.06mm.

Conglomerate		Sandstone	
Coarse -	> 20 mm	Coarse -	0.6 to 2mm
Medium -	6 to 20 mm	Medium -	0.2 to 0.6 mm
Fine -	2 to 6 mm	Fine -	0.06* to 0.2 mm

Colour

Colour is usually described in the as-received moisture condition (ie. wet). Although both wet and dry colours descriptions may be appropriate if significantly different.

Strength

The strength of rock based on point load testing is presented below. Note: the field guide assessment should be confirmed by point load testing when used in earthworks and foundation ir

Rock Strength Descriptions

Term	Letter Symbol	Point load index (Mpa) Is (50) *	Field Guide
Extremely Low	EL	≤ 0.03	Easily remoulded by hand to a material with soil properties.
Very Low	VL	0.03 - 0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low	L	0.1 - 0.3	A piece of core 150 mm long x 50 mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium	M	0.3 - 1.0	A piece of core 150 mm long x 50 mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.
High	H	1.0 - 3	A piece of core 150 mm long x 50 mm dia core cannot be broken by unaided hands, can be slightly scratched or scored with knife.
Very High	VH	3.0 - 10	A piece of core 150 mm long x 50 mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.
Extremely High	EH	≥ 10	A piece of core 150 mm long x 50 mm dia. is difficult to break with hand held hammer. Rings when struck with a hammer.

* rock strength defined by point load strength (Is 50) in direction normal to bedding

Weathering

The classification system for weathering in accordance with AS1726-1993 is provided below.

Weathering		
Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a change in volume but the soil has not significantly transported.
Extremely Weathered	EW	Rock is weathered to such an extent that it has "soil" properties; i.e. it either disintegrates or can be remoulded, in water.
Highly Weathered	HW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron-staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly Weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

Structure

The structure of the rock mass (as opposed to the rock 'material') should be describbed using the following common terms:

☐ Sedimentary Rocks:	Bedded (ie. layers greater than 20 mm thick on average); or Laminated (ie. layers less than 20mm thick on average)
☐ Metamorphic Rocks:	Foliated, Banded or Cleaved.
☐ Igneous rocks:	Massive or Flowbanded

Defects

Defects are 'natural' fractures in the rock mass and include: joints, faults, sheared planes, seams, bedding partings and veins. They do not include fractures caused by the drilling process or subsequent handling. Defects are an important feature which can have a significant bearing on the engineering behaviour of a rock mass. As such, they should be individually described including: orientation, infilling (eg. clay, Iron oxide, clean etc), shape, roughness and whether the defect is open or tight.

Defect spacing in accordance with P.J.N. Pells et al, 1998, is described below.

Defect Spacing (P.J.N. Pells et al, 1998)*

Defect Spacing (mm)	Description
>2000	Very Widely Spaced
600 - 2000	Widely Spaced
200 - 600	Moderately Spaced
60 -200	Closely Spaced
20 - 60	Very Closely Spaced
0 - 20	Extremely Closely Spaced

* Spacing relates to of all types of natural fractures, but not articficial breaks, in cored bores

Rock Quality Designation (RQD):

The fracture spacing is shown where applicable and the Rock Quality Designation is

$$\text{RQD (\%)} = \frac{\text{sum of unbroken core pieces 100 mm or longer}}{\text{Length of Core}}$$

RQD provides information on the extent of fracturing and hence the competency of the rock mass.

Borelog Symbols and Notes

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DRILLING INFORMATION:

Support

None	No support provided
Mud	Drilling mud used
NQ	NQ size drilling pipe (69.9 mm ODia)
HQ	HQ size drilling pipe (88.9 mm ODia)

Method

HA	HAND AUGER
RR	ROCK ROLLER
ADV	Auger 'V'-STEEL BIT
ADTC	Auger 'TUNGSTEN-CARBIDE' BIT
NMLC	DIAMOND CORING

Water

▷	Inflow of water
◁	Water Loss
▽	Water Level during drilling / excavation
▼	Stabilised Water Level

SAMPLING:

Sample ID

ddmmyy-01-SM	Date-Sample Number-Initials of Sampler

Note : Sample Depth is indicated by horizontal lines which define the start and end depths

Type

D	Small Disturbed Sample
U50	Undisturbed 50mm dia. tube sample
B	Bulk Disturbed Sample
PT	Geoprobe Push Tube Sample in
J	Environmental Sample collected in a laboratory supplied glass jar
SPT	SPT Split Tube Sampler

FIELD TESTS:

Standard Penetration Test (SPT)

2 / 3 / 4	Number of blows per 150mm over a depth of 450mm
N = 7	SPT "N" number = sum of last two blow counts
R	Refusal. SPT not able to penetrate

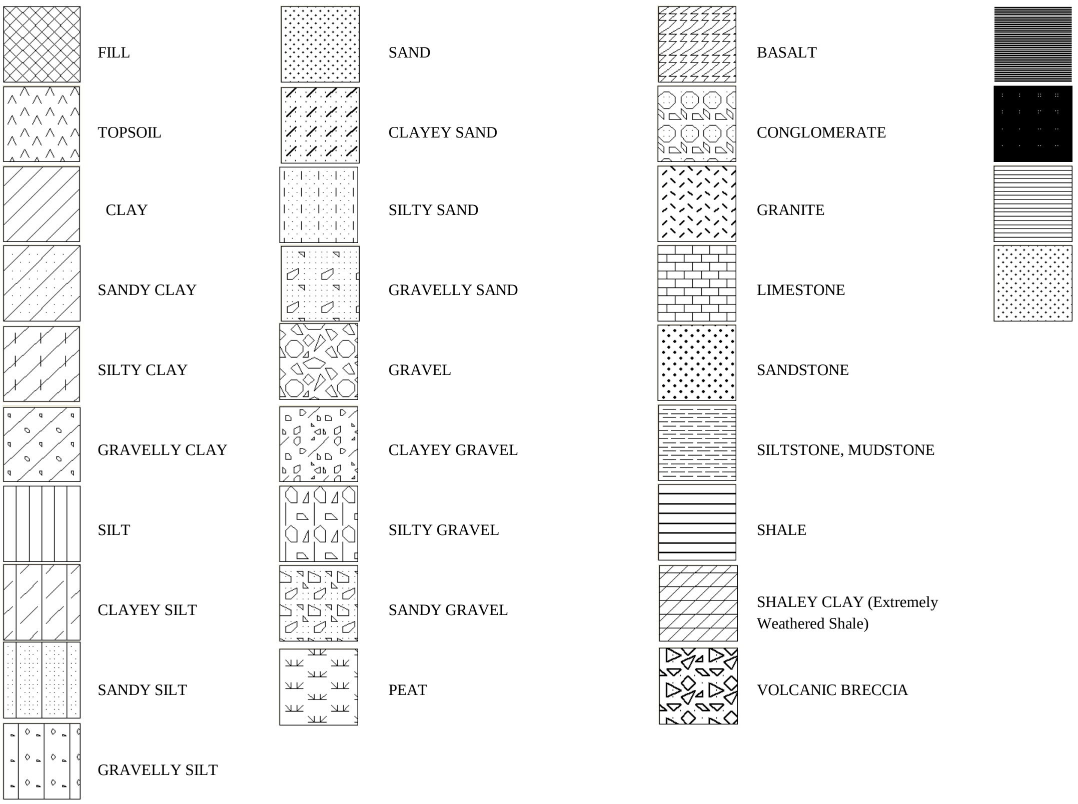
Vane Shear

VS=30	Vane Shear Reading of 30 kPa

Pocket Penetromenter

PP=100	Pocket Penetrometer Reading of 100 kPa

SYMBOLS:



Soils		Rocks	Other
FILL	SAND	BASALT	ASPHALT
TOPSOIL	CLAYEY SAND	CONGLOMERATE	BENTONITE PLUG
CLAY	SILTY SAND	GRANITE	WELL SCREEN
SANDY CLAY	GRAVELLY SAND	LIMESTONE	WELL BACKFILL SAND
SILTY CLAY	GRAVEL	SANDSTONE	
GRAVELLY CLAY	CLAYEY GRAVEL	SILTSTONE, MUDSTONE	
SILT	SILTY GRAVEL	SHALE	
CLAYEY SILT	SANDY GRAVEL	SHALEY CLAY (Extremely Weathered Shale)	
SANDY SILT	PEAT	VOLCANIC BRECCIA	
GRAVELLY SILT			

NATURAL ROCK DEFECTS:

Description Order:
Fracture Type, Orientation, Infilling, Shape, Roaghness, Other

Fracture Type

JT	Joint
BP	Bedding Plane Parting
SM	Seam
FZ	Fragmented Zone
SZ	Shear Zone
VN	Vein

Orientation

VT	Vertical
HZ (or 0o)	Horizontal
X o	X' degrees from Horizontal

Infilling

CN	Clean
X	Carbonaceous
CLAY	Clay
CA	Calcite
FE	Iron Oxide
MI	Micaceous
QZ	Quartz

Shape

PLN	Planar
CU	Curved
UN	Undulose
ST	Stepped
IR	Irregular

Roughness

POL	Polished
SLK	Slickensided
SO	Smooth
RF	Rough
VR	Very

Others

DIS	Discontinuous
TI	Tight

APPENDIX B

LABORATORY TESTING RESULTS

TEST CERTIFICATE

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EMERSON CRUMB TEST

CLIENT: Consulting Earth Scientists
Suite 55 Upper Level, 26-32 Pirrama Road Pyrmont NSW 2009
PROJECT: Jacfin Pty Ltd, Horsley Park CES100606-JBA

Laboratory Number: 59462

Sample Source: BH1 0.5m

Sample Description: SILTY CLAY: brown, high plasticity, trace of fine to medium sand.

1. IMMERSION

Does not slake	→	Class 7 swells (Organic Soils)	
Slakes	YES	Class 8 does not swell (Laterised)	

2. COMPLETE DISPERSION

Class 1 complete	
Class 2 partial	
No Dispersion	YES

3. REMOULDING

Class 3 disperses	
Does not disperse	YES

4. CARBONATE & GYPSUM (Acid Indicator)

Class 4 present	
Absent	YES

5. VIGOROUS SHAKING

Class 5 disperses	YES
Class 6 no dispersion	

EMERSION CLASS NO.: 5

Water used:	Distilled water at 20°C	Date Tested:	22.07.10
Tested By:	SM	Sampled By:	Client
Test Procedure:	AS 1289 3.8.1	Job Number:	133-084

Approved Signatory: Chris Lloyd **Date:** 22.7.10

This document is issued in accordance with NATA's accreditation requirements

Accreditation No. 1459

TEST CERTIFICATE

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EMERSON CRUMB TEST

CLIENT: **Consulting Earth Scientists**
Suite 55 Upper Level, 26-32 Pirrama Road Pyrmont NSW 2009
PROJECT: **Jacfin Pty Ltd, Horsley Park CES100606-JBA**

Laboratory Number: 59463

Sample Source: BH2 0.5m

Sample Description: SILTY CLAY: red-brown (mottled) grey, high plasticity, trace of fine to coarse sand.

1. IMMERSION

Does not slake → Class 7 swells (Organic Soils) ☐

Slakes **YES** Class 8 does not swell (Laterised) ☐

2. COMPLETE DISPERSION

Class 1 complete ☐
Class 2 partial ☐
No Dispersion **YES**

3. REMOULDING

Class 3 disperses ☐
Does not disperse **YES**

4. CARBONATE & GYPSUM (Acid Indicator)

Class 4 present ☐
Absent **YES**

5. VIGOROUS SHAKING

Class 5 disperses **YES**
Class 6 no dispersion ☐

EMERSION CLASS NO.: **5**

Water used: Distilled water at 20°C
Date Tested: 22.07.10

Tested By: SM
Sampled By: Client

Test Procedure: AS 1289 3.8.1
Job Number: 133-084

Approved Signatory: Chris Lloyd **Date:** 22.7.10

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CALIFORNIA BEARING RATIO

CLIENT: **Consulting Earth Scietists**
Suite 55 Upper Level, 26-32 Pirrama Road Pyrmont NSW 2009
PROJECT: **Jacfin Pty Ltd, Horsley Park CES100606-JBA**

Sample Source:	BH2 / 0.4-0.6m	
Sample Description:	SILTY CLAY: brown, medium plasticity, with fine to coarse sand.	
Job Number:	133-084	
Laboratory Number:	59464	
CBR Value @ 2.5mm	1.0	(%)
CBR Value @ 5.0mm	1.0	(%)

Sample Data

Compaction Specification	100% of MDD at OMC	
Maximum Dry Density (MDD)	1.66	(t/m^3)
Optimum Moisture Content (OMC)	19.0	(%)
Mass of Surchages	4.5	(kg)
Number of Days Soaked	3	

Sample Preparation

Dry Density - Before Soaking	1.66	(t/m^3)
Dry Density - After Soaking	1.59	(t/m^3)
Retained on 19mm Sieve	0	(%)
Moisture Content - Before Soaking	19.1	(%)
Laboratory Density Ratio	100.0	(%)
Laboratory Moisture Ratio	100.0	(%)

Moisture Content - After Soaking

Top 30mm of Test Sample	29.6	(%)
Remainder of Test Sample	26.4	(%)
Swell After Soaking	4.1	(%)
Compactive Effort	Standard	
Number of Layers	3	
Blows per Layer	53	
Mass of Rammer	2.7	(kg)
Drop of Rammer	300	(mm)

Comments

Date Tested: 18.7.10

Tested in accordance with AS1289.6.1.1 Determination of the California Bearing Ratio of a soil Standard Laboratory Method for a remoulded specimen.

Approved Signatory: Chris Lloyd **Date:** 23.7.10

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File C:\Electronic Excel Reports\AS1289 6.1.1 California Bearing Ratio, Issue 2, May 2010, JL

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CALIFORNIA BEARING RATIO

CLIENT: **Consulting Earth Scietists**
Suite 55 Upper Level, 26-32 Pirrama Road Pyrmont NSW 2009

PROJECT: **Jacfin Pty Ltd, Horsley Park CES100606-JBA**

Sample Source: BH3 / 0.5-0.75m

Sample Description: SILTY CLAY: brown, medium plasticity, with fine to coarse sand.

Job Number:	133-084	
Laboratory Number:	59465	
CBR Value @ 2.5mm	4.0	(%)
CBR Value @ 5.0mm	4.0	(%)

Sample Data

Compaction Specification	100% of MDD at OMC	
Maximum Dry Density (MDD)	1.67	(t/m^3)
Optimum Moisture Content (OMC)	18.5	(%)
Mass of Surchages	4.5	(kg)
Number of Days Soaked	3	

Sample Preparation

Dry Density - Before Soaking	1.68	(t/m^3)
Dry Density - After Soaking	1.66	(t/m^3)
Retained on 19mm Sieve	0	(%)
Moisture Content - Before Soaking	17.8	(%)
Laboratory Density Ratio	101.0	(%)
Laboratory Moisture Ratio	96.0	(%)

Moisture Content - After Soaking

Top 30mm of Test Sample	23.5	(%)
Remainder of Test Sample	19.6	(%)
Swell After Soaking	1.2	(%)

Compactive Effort	Standard	
Number of Layers	3	
Blows per Layer	53	
Mass of Rammer	2.7	(kg)
Drop of Rammer	300	(mm)

Comments

Date Tested: 19.7.10

Tested in accordance with AS1289.6.1.1 Determination of the California Bearing Ratio of a soil Standard Laboratory Method for a remoulded specimen.

Approved Signatory: Chris Lloyd **Date:** 23.7.10

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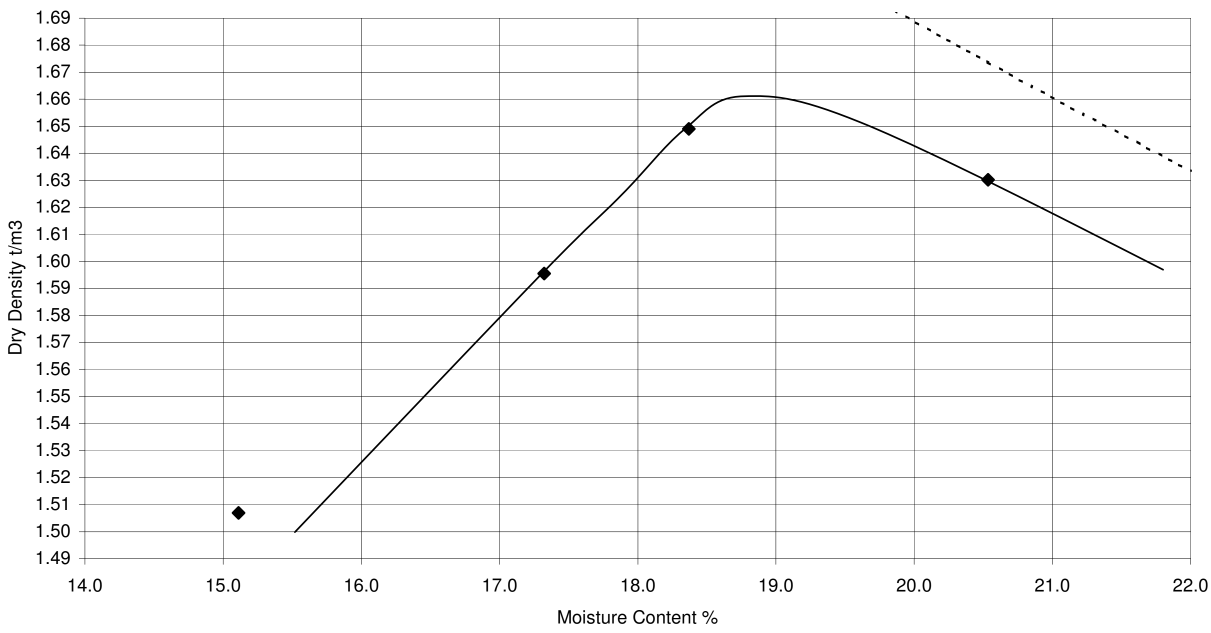
DRY DENSITY/MOISTURE CONTENT RELATION

CLIENT: Consulting Earth Scietists
Suite 55 Upper Level, 26-32 Pirrama Road Pyrmont NSW 2009
PROJECT: Jacfin Pty Ltd, Horsley Park CES100606-JBA



Job Number:	133-084	
Laboratory Number:	59464	
Sample Source:	BH2 / 0.4-0.6m	
Sample Description:	SILTY CLAY: brown, medium plasticity, with fine to coarse sand.	
Maximum Dry Density:	1.66	t/m^3
Optimum Moisture Content:	19.0	%
Oversize Material:	19	mm
% Oversize:	0	%
Date Tested:	18.07.10	
Sampled By:	Client	
Compactive Effort:	Standard	
Test Method:	**AS 1289 5.1.1**	
No. of Layers:	3	
Blows per Layer:	25	
Mass of Rammer:	2.7	kg
Drop of Rammer:	300	mm
Zero Air Voids Line - Particle Density:	2.55	t/m^3
Comments:		

Approved Signatory: Chris Lloyd **Date:** 23.7.10

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DRY DENSITY/MOISTURE CONTENT RELATION

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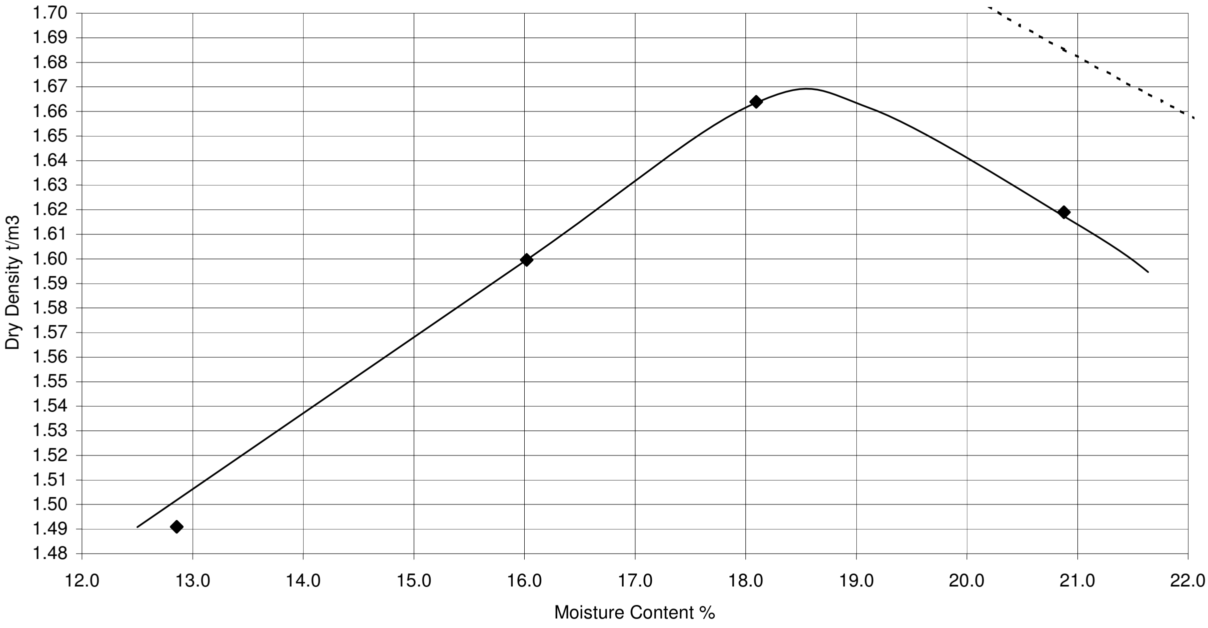

Job Number:	133-084	
Laboratory Number:	59465	
Sample Source:	BH3 / 0.5-0.75m	
Sample Description:	SILTY CLAY: brown, medium plasticity, with fine to coarse sand.	
Maximum Dry Density:	1.67	t/m^3
Optimum Moisture Content:	18.5	%
Oversize Material:	19	mm
% Oversize:	0	%
Date Tested:	18.07.10	
Sampled By:	Client	
Compactive Effort:	Standard	
Test Method:	**AS 1289 5.1.1**	
No. of Layers:	3	
Blows per Layer:	25	
Mass of Rammer:	2.7	kg
Drop of Rammer:	300	mm
Zero Air Voids Line - Particle Density:	2.60	t/m^3
Comments:		

Approved Signatory: Chris Lloyd **Date:** 23.7.10

This document is issued in accordance with NATA's accreditation requirements

Accreditation No. 1459

TEST CERTIFICATE

SGS Australia Pty Ltd
24 Bermill Street (PO Box 2014)
Rockdale DC NSW 2216
Australia

ABN 44 000 964 278
ph: +61 (0)2 9597 5599
fax: +61 (0)2 9597 3442

SOIL CLASSIFICATION TEST DATA

CLIENT: **Consulting Earth Scietists**
Suite 55 Upper Level, 26-32 Pirrama Road Pyrmont NSW 2009

PROJECT: **Jacfin Pty Ltd, Horsley Park CES100606-JBA**

LAB NO.	SAMPLE SOURCE	SAMPLE DESCRIPTION	MOISTURE CONTENT (%) 1	DRY DENSITY (t/m^3)	LIQUID LIMIT 2	PLASTIC INDEX 3	PREPAR-ATION & HISTORY 4	LINEAR SHRINK. (%) 5
59462	BH1 0.5m	SILTY CLAY: brown, high plasticity, trace of fine to medium sand.	-	-	66	45	N N	16.0
59463	BH2 0.5m	SILTY CLAY: red-brown (mottled) grey, high plasticity, trace of fine to coarse sand.	-	-	56	37	N N	15.5

NOTES TO TESTING

1 Test Method: AS 1289 2.1.1
2 Test Method: AS 1289 3.1.2
3 Test Method: AS 1289 3.2.1, 3.3.1
4 Preparation: DS = Dry Sieved
WS = Wet Sieved
N = Natural State With No Sieving
Sample History: AD = Air Dried
OD = Oven Dried at 50°C
N = Natural State As Received
5 Test Method: AS 1289 3.4.1
Mould Size: 125mm
Dry State: Linear

Sampled By: Client

Job Number: 133-084

Date Tested: 22.07.10

Approved Signatory: Chris Lloyd Date: 23.7.10

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ANALYTICAL REPORT

23 July 2010

SGS Industrial CMT Eastern Sydney
24 Bermill Street
PO Box 2014
ROCKDALE
NSW 2216

Attention: **Alex Bell**

Your Reference: CES - HORSLEY - 133-084

Our Reference: SE80048

Samples: 1 Soil
Received: 21/07/2010

Preliminary Report Sent: Not Issued

These samples were analysed in accordance with your written instructions.

For and on Behalf of:
SGS ENVIRONMENTAL SERVICES

Sample Receipt:	Angela Mamalicos	AU.SampleReceipt.Sydney@sgs.com
Production Manager:	Huong Crawford	Huong.Crawford@sgs.com

Results Approved and/or Authorised by:

Dong Liang

Dong Liang
Quality Manager

Anions in soil Our Reference: Your Reference Sample Matrix	UNITS ------------- ------------	SE80048-1 BH 1 0.5m Soil
Date Extracted		23/07/2010
Date Analysed		23/07/2010
Sulphate, SO4 1:5 soil:water	mg/kg	6.9
Chloride, Cl 1:5 soil:water	mg/kg	120

Inorganics Our Reference: Your Reference Sample Matrix	UNITS ------------- ------------	SE80048-1 BH 1 0.5m Soil
Date Extracted- (pH 1:5 soil: Water)		23/07/2010
Date Analysed (pH 1:5 Soil: Water)		23/07/2010
pH 1:5 soil:water	pH Units	8.1

Moisture Our Reference: Your Reference Sample Matrix	UNITS ------------- ------------	SE80048-1 BH 1 0.5m Soil
Date Analysed (moisture)		22/07/2010
Moisture	%	24

Method ID	Methodology Summary
SEI-038	Water Soluble Chloride After carrying out a 1:5 soil:water extraction, an aliquot of the extract is reacted with mercuric thiocyanate forming a mercuric chloride complex. In the presence of ferric iron, highly coloured ferric thiocyanate is formed which is proportional to the chloride concentration. Reference NEPM, Schedule B(3), 401 and APHA 4500Cl- Water Soluble Sulphate After carrying out a 1:5 soil:water extraction ,sulphate in the extract is precipitated in an acidic medium with barium chloride. The resulting turbidity is measured photometrically at 405nm and compared with standard calibration solutions to determine the sulphate concentration in the sample. Reference NEPM, Schedule B(3), 401 and APHA 4500-SO42-.
AN101	pH - Measured using pH meter and electrode based on APHA 21st Edition, 4500-H+. For water analyses the results reported are indicative only as the sample holding time requirement specified in APHA was not met (APHA requires that the pH of the samples are to be measured within 15 minutes after sampling).
AN002	Preparation of soils, sediments and sludges undergo analysis by either air drying, compositing, subsampling and 1:5 soil water extraction where required. Moisture content is determined by drying the sample at 105 ± 5°C.

QUALITY CONTROL Anions in soil	UNITS	LOR	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Date Extracted				23/07/10	[NT]	[NT]	LCS	23/07/10
Date Analysed				23/07/10	[NT]	[NT]	LCS	23/07/10
Sulphate, SO4 1:5 soil:water	mg/kg	0.5	SEI-038	<0.5	[NT]	[NT]	LCS	100%
Chloride, Cl 1:5 soil:water	mg/kg	0.25	SEI-038	<0.2	[NT]	[NT]	LCS	102%

QUALITY CONTROL Inorganics	UNITS	LOR	METHOD	Blank
Date Extracted- (pH 1:5 soil: Water)				[NT]
Date Analysed (pH 1:5 Soil: Water)				[NT]
pH 1:5 soil:water	pH Units	0	AN101	0.0

QUALITY CONTROL Moisture	UNITS	LOR	METHOD	Blank
Date Analysed (moisture)				[NT]
Moisture	%	1	AN002	<1

Result Codes

[INS] :	Insufficient Sample for this test	[RPD] :	Relative Percentage Difference
[NR] :	Not Requested	* :	Not part of NATA Accreditation
[NT] :	Not tested	[N/A] :	Not Applicable
[LOR] :	Limit of reporting		

Report Comments

Samples analysed as received. Solid samples expressed on a dry weight basis.
Date Organics extraction commenced:
NATA Corporate Accreditation No. 2562, Site No 4354
Note: Test results are not corrected for recovery (excluding Air-toxics and Dioxins/Furans*)
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Quality Control Protocol

Method Blank: An analyte free matrix to which all reagents are added in the same volume or proportions as used in sample processing. The method blank should be carried through the complete sample preparation and analytical procedure. A method blank is prepared every 20 samples.
Duplicate: A separate portion of a sample being analysed that is treated the same as the other samples in the batch. One duplicate is processed at least every 10 samples.
Surrogate Spike: An organic compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples. Surrogates are added to samples before extraction to monitor extraction efficiency and percent recovery in each sample.
Internal Standard: Added to all samples requiring analysis for organics (where relevant) or metals by ICP after the extraction/digestion process; the compounds/elements serve to give a standard of retention time and/or response, which is invariant from run-to-run with the instruments.
Laboratory Control Sample: A known matrix spiked with compound(s) representative of the target analytes. It is used to document laboratory performance. When the results of the matrix spike analysis indicates a potential problem due to the sample matrix itself, the LCS results are used to verify that the laboratory can perform the analysis in a clean matrix.
Matrix Spike: An aliquot of sample spiked with a known concentration of target analyte(s). The spiking occurs prior to sample preparation and analysis. A matrix spike is used to document the bias of a method in a given sample matrix.

Quality Acceptance Criteria

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.au.sgs.com/sgs-mp-au-env-qu-022-qa-qc-plan-en-09.pdf