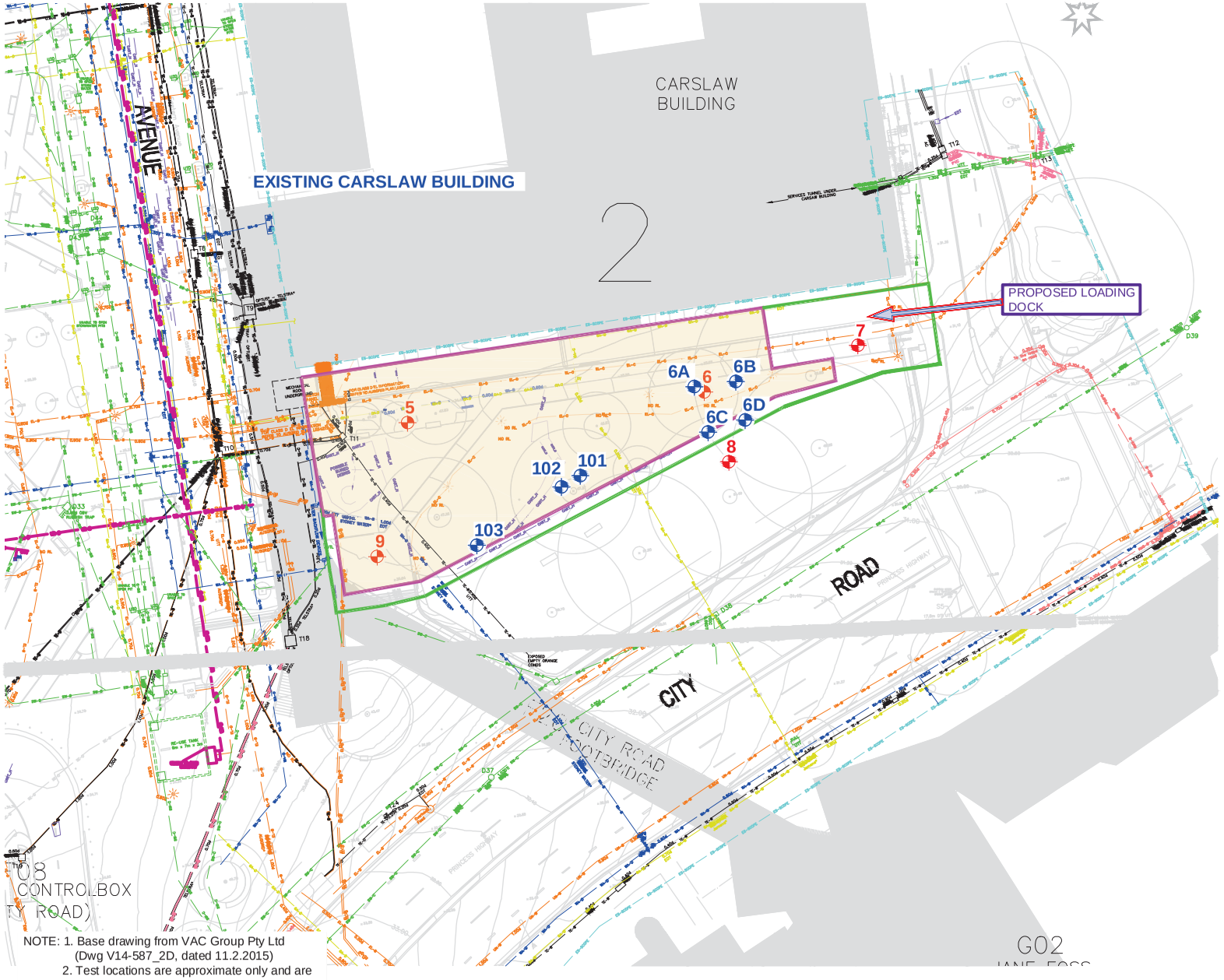
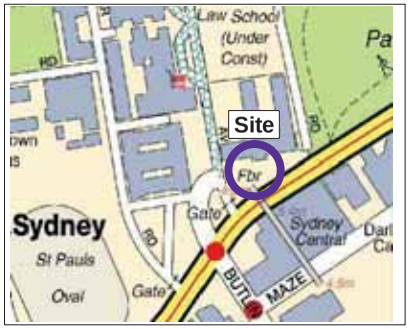


NOTE: 1. Base drawing from VAC Group Pty Ltd (Dwg V14-587_2D, dated 11.2.2015)
2. Test locations are approximate only and are shown with reference to existing site features.

0 5 10 15 20 30 40 50m
1:500 @ A3



Locality Plan

LEGEND

- Current borehole location (4.5.2016)
- Previous borehole location (29.6-1.7.2015)
- Approximate extent of proposed building
- Approximate extent of proposed surrounding public domain works

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Geotechnics | Environment | Groundwater

CLIENT: The University of Sydney		TITLE: **Location of Tests**	PROJECT No: 84897.04
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Carslaw Building Extension**	DRAWING No: 1
SCALE: 1:500 @ A3 approx.	DATE: 5.5.2016	**Eastern Avenue, THE UNIVERSITY OF SYDNEY**	REVISION: 0

Appendix B

Test Bore Log Results

Notes About This Report

About this Report

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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.

Sampling Methods

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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.

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

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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

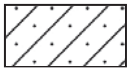
Soils


Topsoil

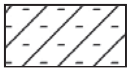

Peat


Clay


Silty clay

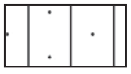

Sandy clay

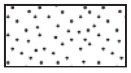

Gravelly clay

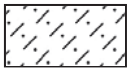

Shaly clay

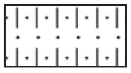

Silt


Clayey silt

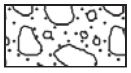

Sandy silt


Sand


Clayey sand


Silty sand


Gravel


Sandy gravel


Cobbles, boulders

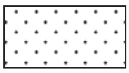

Talus

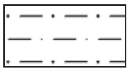
Sedimentary Rocks

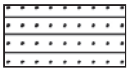

Boulder conglomerate

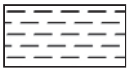

Conglomerate


Conglomeratic sandstone

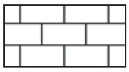

Sandstone


Siltstone

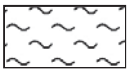

Laminite

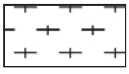

Mudstone, claystone, shale

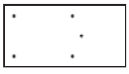

Coal


Limestone

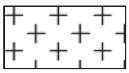
Metamorphic Rocks

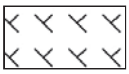

Slate, phyllite, schist

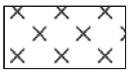

Gneiss

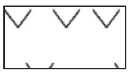

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.3 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6A
PROJECT No: 84897.04
DATE: 4/5/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
33	0.0	FILLING - dark brown, silty sand filling with trace igneous gravel and rootlets		E	0.0				
					0.1				
	0.2	FILLING - dark brown, silty clay filling with trace angular igneous gravel and rootlets		E	0.2				
					0.3				
					0.4				
				E					
	0.5	Bore discontinued at 0.5m - refusal on stiff clay			0.5				
	1								1
32									

RIG: Hand tools **DRILLER:** RJL **LOGGED:** RJL **CASING:** Uncased

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: ^Surface level interpolated from drawing "Consolidated Services Bound" provided by the client

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.2 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6B
PROJECT No: 84897.04
DATE: 4/5/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
33	0.0	FILLING - dark brown, silty sand filling with trace angular igneous gravel and rootlets and angular ironstone gravel		E	0.0				
	0.1	FILLING - brown, silty clay filling with trace angular igneous gravel and rootlets			0.1				
				E*	0.2				
					0.3				
					0.4				
				E	0.5				
					0.6				
		- some ironstone gravel from 0.5m		E					
	0.7	CLAY - orange-brown clay			0.7				
	0.75	Bore discontinued at 0.75m - target depth reached							
32	1								1

RIG: Hand tools **DRILLER:** RJL **LOGGED:** RJL **CASING:** Uncased

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: ^Surface level interpolated from drawing "Consolidated Services Bound" provided by the client
*BD1-0405160 is blind replicate sample from 0.2m to 0.3m

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.2 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6C
PROJECT No: 84897.04
DATE: 4/5/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
33	0.1	FILLING - dark brown, clayey sand filling with trace of angular igneous gravel and rootlets							
		FILLING - brown, sandy clay filling with trace angular igneous gravel, ironstone gravel, rootlets and sandstone gravel							
	0.55	Bore discontinued at 0.55m - refused on possible boulder							
	1								1
32									

RIG: Hand tools **DRILLER:** RJL **LOGGED:** RJL **CASING:** Uncased

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: ^Surface level interpolated from drawing "Consolidated Services Bound" provided by the client

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.2 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6D
PROJECT No: 84897.04
DATE: 4/5/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
33	0.0	FILLING - dark brown, silty sand filling with trace angular igneous gravel and rootlets		E	0.0				
	0.1	FILLING - brown, silty clay filling with trace angular igneous gravel and ironstone gravel			0.1				
				E	0.2				
					0.3				
				E	0.4				
					0.5				
				E	0.6				
					0.7				
	0.8	CLAY - brown-orange mottled light grey clay		E	0.8				
					0.9				
	1 1.0	Bore discontinued at 1.0m - target depth reached							1
32									

RIG: Hand tools **DRILLER:** RJL **LOGGED:** RJL **CASING:** Uncased

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: ^Surface level interpolated from drawing "Consolidated Services Bound" provided by the client

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.8 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 84897.04
DATE: 4/5/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.0	FILLING - dark brown, clayey sand filling with trace angular igneous gravel, rootlets and grass (topsoil)		E	0.0				
	0.1	FILLING - dark brown, sandy clay filling with trace igneous gravel, ash, slag and glass		E	0.1 0.2				
	0.3	FILLING - dark grey, gravelly sand filling with some ash, slag and clinker		E	0.3 0.4				
	0.5	FILLING - brown clay filling with trace igneous gravel and ironstone gravel		E	0.5 0.6				
33	0.8	CLAY - brown-orange clay with trace ironstone gravel		E	0.7 0.8 0.9				
	1.0	Bore discontinued at 1.0m - target depth reached							1
32									

RIG: Hand tools **DRILLER:** RJL **LOGGED:** RJL **CASING:** Uncased

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: ^Surface level interpolated from drawing "Consolidated Services Bound" provided by the client

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.8 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 84897.04
DATE: 4/5/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - dark brown, clayey sand filling with trace angular igneous gravel and grass (topsoil)		E	0.0				
	0.1	FILLING - dark brown, sandy clay filling with some sandstone gravel and trace slag and ceramic tile			0.1				
				E*	0.2				
					0.3				
	0.4	FILLING - dark grey, gravelly sand filling with trace clinker and slag		E	0.4				
	0.5	FILLING - brown clay filling with trace angular igneous gravel			0.5				
	0.55	FILLING - brown sandy clay filling with trace igneous gravel		E	0.6				
33					0.7				
	1			E	0.9				1
					1.0				
	1.1	CLAY - light grey mottled orange clay		E	1.1				
					1.2				
	1.3	Bore discontinued at 1.3m - target depth reached							
32									

RIG: Hand tools **DRILLER:** RJL **LOGGED:** RJL **CASING:** Uncased

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: ^Surface level interpolated from drawing "Consolidated Services Bound" provided by the client
*BD2-040516 is blind replicate sample from 0.2m to 0.3m

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 34.1 AHD^
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 84897.04
DATE: 4/5/2016
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
34	0.0	FILLING - brown, clayey sand filling with trace angular igneous gravel, rootlets and grass (topsoil)		E	0.0				
	0.1	FILLING - brown, sandy clay with some ironstone gravel, trace igneous gravel and slag			0.1				
				E	0.2				
					0.3				
				E	0.4				
	0.5	Bore discontinued at 0.5m - refusal on gravel			0.5				
	1								1
33									

RIG: Hand tools **DRILLER:** RJL **LOGGED:** RJL **CASING:** Uncased

TYPE OF BORING: Hand auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: ^Surface level interpolated from drawing "Consolidated Services Bound" provided by the client

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 34.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 84897
DATE: 29/6/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
34	0.4	FILLING - light grey-brown, fine sand filling with some silt/clay and a trace of concrete gravel and grass roots, humid							A			
		FILLING - apparently poorly compacted, grey, silty clay filling with some fine sand, moist							A/E			
33	1.1	CLAY - stiff, light brown clay, moist							A/E			
									S			3,4,6 N = 10
									E			
32	2.0	SHALE/LAMINITE - extremely low to very low strength, light grey-brown, shale/laminite							E			
									S			18,20/100mm refusal
31								Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°				
	3.9	SHALE/LAMINITE - extremely low and very low to low strength, extremely to highly weathered, fragmented to fractured, light grey to grey and brown, shale/laminite with medium strength ironstone bands						3.9m: CORE LOSS: 450mm				
	4.35							4.35-4.85m: B's 0°, fe				PL(A) = 0.7
30								5.08m: J45°, un, ro, cln 5.16-5.2m: Cs 5.3-5.48m: Cs	C	80	0	
29								5.8m: B10°, fe 5.9m: J60°, un, ro, cly				
	6.2	LAMINITE - low to medium then high strength, slightly weathered, fractured and slightly fractured, grey-brown, laminite with approximately 25% fine sandstone laminations						6.2m: J35°, un, ro, fe 6.25m: J40°- 70°, cu, he, fe 6.5m: J30°, he, fe 6.8-7.3m: B's 0°, fe				PL(A) = 0.3
28									C	100	77	
27								7.4m: J45°- 50°, cu, ro, fe 7.7-7.95m: B's 0°, fe				PL(A) = 1.3
26	8.0	Bore discontinued at 8.0m										
25												

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 3.9m; NMLC-Coring to 8.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 84897
DATE: 30/6/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
33	0.0	FILLING - light grey to dark grey, silty clay filling with some gravel (roadbase) and grass at top							A			
									A/E			
	0.7	CLAY - stiff, orange-brown to red-brown clay, slightly silty, with a trace of ironstone gravel, moist							A/E			
32	1								S			3,3,5 N = 8
									E			
	2.0	SHALE - extremely low to very low strength, light grey shale							E			
31	2											
									S			14,25/100mm refusal
30	3							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°				
	4.0	SHALE - extremely low to very low strength, highly weathered, fractured, light grey-brown shale with medium strength ironstone bands						4.0-4.3m: B's 0°, cly, fe				
	4.35	SHALE - low to medium strength, highly to moderately then slightly weathered, fractured and slightly fractured, grey-brown shale with some extremely low to very low strength bands						4.58m: J, sv, pl, ro, fe 4.66m: J85° & 70°, st, ro, cln 4.85m: J, sv, pl, ro, fe 5.05m: J, sv, un, ro, cln 5.23-5.3m: Cs 5.31m: J70°, pl, ro, cln 5.4m: J30°, un, ro, fe 5.6m: J30°, pl, ro, fe, cly 5.83m: J90°, un, ro, cln 5.93-6.33m: B (x3) 0°, fe	C	100	45	PL(A) = 0.3 PL(A) = 0.3 PL(A) = 0.7
29	5											
28	6											
	6.0	LAMINITE - medium then high strength, slightly weathered, slightly fractured, grey to grey-brown, laminite with approximately 20% fine sandstone laminations						6.5m: J70° & 85°, st, ro, fe 6.62-6.66m: Cs 6.72 & 6.94m: B's 5°, fe 7m: J45°, pl, sm, fe 7.2m: B0°, fe, Cz, 5mm 7.3-7.4m: Cs 7.7m: J35°, pl, ro, fe	C	100	88	PL(A) = 1.2
27	7											
26	8											
	8.0	Bore discontinued at 8.0m										
25	9											
24												

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 4.0m; NMLC-Coring to 8.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 32.4 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 84897
DATE: 1/7/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
32	0.1	CONCRETE SLAB							A			
	0.2	ROADBASE GRAVEL							A/E			
	0.4	FILLING - light brown, silty sand filling, humid							A/E			
31	1	CLAY - stiff, red-brown to light grey-brown clay, slightly silty, moist							S			3,4,9 N = 13
	1.5	SHALY CLAY - hard, light grey-brown, shaly clay, damp							E			
30	2								E			
	3.0	LAMINITE - very low strength, light grey-brown laminite						Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	S			7,14,25 N = 39
29	3											
	4.0	LAMINITE - medium strength, highly to moderately then slightly weathered, slightly fractured, grey-brown, laminite with approximately 20% fine sandstone laminations and some clay bands						4.0-4.7m: cly 4.26m: B5°, fe 4.3m: B0°, cly, 10mm & J55°, pl, sm, cly 4.43-4.46m: Cs 4.5m: J35°, pl, ro, fe 4.63m: B0°, fe 4.81m: B0°, cly, 20mm 5.3 & 5.4m: B0°, fe 5.62m: J35°, un, ro, cln 5.7 & 5.82m: B0°, fe 5.92m: J45°, pl, sm, fe, cly 5.95 & 6.06m: Cs 6.22m: B0°, Cz, 20mm 6.46-6.50m: fg, fe 6.65 & 6.8m: B0°, fe 7.45 & 7.87m: B5°, fe	C	100	86	PL(A) = 0.6 PL(A) = 0.4
28	5											
27	6											
	6.06	LAMINITE - high then high to very high strength, slightly weathered then fresh stained, slightly fractured, light grey to grey, laminite with approximately 30% fine sandstone laminations							C	100	92	PL(A) = 1.3 PL(A) = 3.3
26	7											
25	8											
	8.0	Bore discontinued at 8.0m										
24	9											
23												

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Diatube to 0.1m; Solid flight auger to 2.5m; Rotary to 4.0m; NMLC-Coring to 8.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 33.3 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 84897
DATE: 30/6/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low Very Low Low Medium High Very High Ex High		0.01 0.05 0.10 0.50 1.00	B - Bedding J - Joint S - Shear F - Fault				
33		FILLING - apparently poorly compacted, grey, silty clay filling with some fine sand, moist							A			
									A/E			
32	1.0	CLAY - stiff, light brown clay, moist							A/E			
									S			3,4,6 N = 10
									E			
31	1.8	SHALY CLAY- hard, light grey mottled brown, shaly clay, moist							E			
									S			7,16,28 N = 44
30								Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°				
29	4.0	SHALE/LAMINITE - very low strength, light grey shale/laminite							S			23,25/100mm refusal
	4.5	LAMINITE - low strength, highly to moderately weathered, fractured, grey-brown laminite with some very low strength bands						4.3m: CORE LOSS: 200mm 4.62m: J45°, pl, sm, cly 4.75m: J30° & 90°, st, ro, fe 5.28m: J65°, un, ro, fe 5.4m: J60°, pl, sm, fe 5.5m: J30° & 60°, cu, ro, fe 5.7-5.75m: Cs 5.93m: J35°, pl, ro, fe 6.1-6.55m: B's 0°, fe	C	87	0	PL(A) = 0.2
28	5.9	LAMINITE - medium then high strength, moderately then slightly weathered, fractured and slightly fractured, grey-brown, laminite with approximately 25% fine sandstone lamination						6.55m: J45°- 70°, cu, fe, he 6.8m: J45°, pl, ro, fe 7.2-7.33m: Cs 7.4-7.7m: B's 5°- 10°, fe	C	100	37	PL(A) = 0.7
27												PL(A) = 0.7
26												
25								8.1-8.4m: B's 5°- 10°, fe	C	100	60	PL(A) = 0.8
												PL(A) = 1.3
	8.45	Bore discontinued at 8.45m										

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 4.3m; NMLC-Coring to 8.45m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

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

BOREHOLE LOG

CLIENT: The University of Sydney
PROJECT: LEES1 Carslaw Extension
LOCATION: Eastern Avenue, The University of Sydney

SURFACE LEVEL: 35.0 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 84897
DATE: 29/6/2015
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
35	0.1	PAVERS										
	0.4	FILLING - light grey, fine to medium sand filling with some concrete gravel, humid							A			
34	1	FILLING - apparently poorly compacted, light grey and grey, silty clay filling with some sand and crushed shale fragments, moist							A/E			
	1.3	SILTY CLAY - stiff, brown, silty clay with ironstone gravel, moist							A/E S			3,5,6 N = 11
33	2								E			
	2.0	SHALE/LAMINITE - very low strength, light grey to grey, shale/laminite							E			
32	3							Note: Unless otherwise stated, rock is fractured along rough planar bedding dipping 0°- 10°	S			17,25/100mm refusal
31	4							3.9m: CORE LOSS: 200mm 4.1-4.3m: fg 4.3-4.33m: Cs 4.33-4.53m: B's 0°, fe				PL(A) = 0.2
	4.1	LAMINITE - alternate bands of extremely low to very low and low strength, extremely to highly weathered, fragmented to fractured, grey-brown laminite										
30	5							4.8, 4.88 & 4.94m: Cs, 10-50mm	C	93	13	
								5.27m: J60°, pl, ro, fe 5.37m: J70°, un, ro, fe 5.52-5.65m: Cs 5.65 & 5.82m: fg				PL(A) = 0.2
29	6							6.2 & 6.52m: B10°, fe				PL(A) = 0.2
	6.7	LAMINITE - high strength, moderately then slightly weathered, slightly fractured, grey-brown, laminite with approximately 25% fine sandstone laminations										
28	7							6.7m: J45°, pl, ro, fe 6.8m: J30°, pl, ro, fe 6.9-7.9m: B (x8) 0° - 5°, fe	C	100	100	PL(A) = 1.7
27	8											
	8.0	Bore discontinued at 8.0m										
26	9											

RIG: Bobcat **DRILLER:** SY **LOGGED:** SI **CASING:** HW to 2.5m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 3.9m; NMLC-Coring to 8.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS:

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

Appendix C

QA/QC Procedures and Results

QA/QC PROCEDURES AND RESULTS

Q1. Data Quality Objectives

The Phase 2 contamination investigation has been devised broadly in accordance with the seven step data quality objective (DQO) process which is provided in Appendix B, Schedule B2 of the National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended 2013 (NEPC 2013). The DQO process is outlined as follows:

- Stating the Problem;
- Identifying the Decision;
- Identifying Inputs to the Decision;
- Defining the Boundary of the Assessment;
- Developing a Decision Rule;
- Specifying Acceptable Limits on Decision Errors; and
- Optimising the Design for Obtaining Data.

The DQOs have been addressed within the report as shown in Table Q1.

Table Q1: Data Quality Objectives

Data Quality Objective	Report Section Where Addressed
State the Problem	S1 Introduction
Identify the Decision	S8 Discussion of Results S9 Conclusion
Identify Inputs to the Decision	S1 Introduction S4 Previous Investigations S6 Site Assessment Criteria S9 Field Observations and Analytical Results
Define the Boundary of the Assessment	S3 Site Description
Develop a Decision Rule	S6 Site Assessment Criteria
Specify Acceptable Limits on Decision Errors	S5 Field Work, Analysis and QA/QC
Optimise the Design for Obtaining Data	S2 Scope of Works S5 Field Work, Analysis and QA/QC

Q2. FIELD QUALITY ASSURANCE AND QUALITY CONTROL

The field QC procedures for sampling as prescribed in Douglas Partners' *Field Procedures Manual* were followed at all times during the assessment.

Q2.1 Sampling Team

Field sampling was undertaken by a DP Environmental Scientist, Richard Lamont, on 4 May 2016. Sampling was undertaken during warm and sunny weather conditions.

Q2.2 Sample Collection

Soil samples were collected from hand auger returns. Further details of the sampling methodology are presented in Section 5 of the report.

Q2.3 Logs

Logs for each soil sampling location were recorded in the field. The individual samples were recorded on the field logs along with the sample identity, location, depth, initials of sampler and replicate locations.

Q2.4 Chain of Custody

Chain of custody information was recorded on the Chain-of-Custody (COC) sheets and accompanied samples to the analytical laboratory.

Q2.5 Replicate Sample Results

Replicate samples were collected in the field as a measure of accuracy, precision and repeatability of the results.

Field replicate samples for soil were collected from the same location and an identical depth to the primary sample. Equal portions of the primary sample were placed into the sampling jars and sealed. The sample was split to prevent the loss of volatiles from the soil but not homogenised in a bowl. Replicate samples were labelled with a DP identification number, recorded on DP's test bore logs, so as to conceal their relationship to their primary sample from the analytical laboratory.

A measure of the consistency of results for field samples is derived by the calculation of relative percentage differences (RPDs) for replicate samples. A RPD of 30% is generally considered typically acceptable for inorganic analytes by NSW EPA, although in general a wider RPD range (50%) may be acceptable for organic analytes. RPDs have only been considered where a concentration is greater than five times the PQL.

An intra-laboratory replicate was analysed as an internal check of the reproducibility within the laboratory (Envirolab Services Pty Ltd) and as a measure of consistency of sampling techniques.

A total of seven primary soil samples were analysed to one intra-laboratory soil samples (14%). Therefore, the 10% intra- and inter - laboratory replicate sampling requirement was met.

The comparative results of analysis between original and replicate samples are summarised in Table Q2.

Table Q2: Intra-laboratory Results

Analyte	Primary Sample [Bore 102, depth 0.2-0.3 m] Concentration (mg/kg)	Replicate Sample [BD2/040516] Concentration (mg/kg)	Difference (mg/kg)	RPD (%)
Arsenic	5	7	2	33
Cadmium	0.6	0.4	0.2	40
Chromium	15	16	1	6
Copper	83	95	12	13
Lead	620	290	330	**74**
Mercury	1.6	1.5	0.1	6
Nickel	8	8	0	0
Zinc	180	160	20	12
TRH C_6-C_{10}	<25	<25	0	0
TRH >C_{10}-C_{16}	<50	<50	0	0
TRH >C_{16}-C_{34}	170	330	160	64
TRH >C_{34}-C_{40}	<100	<100	0	0
Naphthalene	<1	<1	0	0
Benzene	<0.2	<0.2	0	0
Toluene	<0.5	<0.5	0	0
Ethylbenzene	<1	<1	0	0
Total Xylene	<3	<3	0	0

The calculated RPD values were within the acceptable range except for lead, however, this elevated RPD is not of concern given the heterogeneous nature of the filling that was sampled and the nature of replicate sampling. Note that high RPDs are listed for arsenic, cadmium and TRH >C_{16}-C_{34}, however, the concentrations were less than five times the PQL.

The intra-laboratory comparisons indicate that the sampling technique was consistent and repeatable and therefore the results are useable and representative of the conditions encountered.

Q3. LABORATORY QUALITY ASSURANCE AND QUALITY CONTROL

Q3.1 Holding Times

A review of the laboratory certificates of analysis and chain-of-custody documentation indicated that recommended holding times were met.

Q3.2 Analytical Methods

The laboratory analytical methods are provided on the laboratory certificates of analysis. The laboratory (Envirolab Services Pty Ltd) is NATA accredited for each of the analytical methods used.

Q3.3 Results of Laboratory QA/QC Procedures

QA/QC procedures were adopted by the laboratory including the use of surrogate spikes, laboratory control samples, laboratory replicates, laboratory blanks and matrix spikes. Notes are provided in the laboratory certificates where QA/QC results are not within the normal range or acceptance standards.

In laboratory certificate 145998, it is noted that the practical quantitation limits (PQL) for the sample from Test Bore 101, depth 0.4 - 0.5 m, were raised for OCP, OPP and PCB analysis due to interference from other analytes. It is also noted that the percent recovery for the surrogate for TRH analysis in the sample from Test Bore 101, depth 0.4 - 0.5 m, was not possible due to the high concentrations of analytes in the sample.

Despite the raised PQL and the absence of a surrogate result mentioned above, it is considered that an acceptable level of laboratory precision and consistency was achieved and that surrogate spikes, LCS, laboratory replicate results, method blanks and matrix spike results were of an acceptable level overall. On the basis of this assessment, the laboratory data sets are considered to be reliable and useable for this assessment.

Q4. QA/QC DATA EVALUATION

Field and laboratory procedures were assessed against the following data quality indicators (DQIs):

- Completeness – a measure of the amount of usable data from a data collection activity;
- Comparability – the confidence (qualitative) that data may be considered to be equivalent for each sampling and analytical event;
- Representativeness – the confidence (qualitative) of data representativeness of media present on-site;
- Precision – a measure of variability or reproducibility of data; and
- Accuracy – a measure of closeness of the data to the ‘true’ value.

The DQIs were assessed as outlined in Table Q3.

Table Q3: DQI Assessment

DQI	Considerations as specified in NEPM Schedule B2	Comment
Completeness		
Field Considerations	All critical locations sampled	All critical locations sampled based on information presented in the preliminary contamination investigation.
	All samples collected	Samples were collected from the vicinity of BH6 and areas not previously sampled
	Standard operating practices (SOPs) appropriate and complied with	Field staff followed SOPs as defined in the DP *Field Procedures Manual.*
	Experienced sampler	An experienced environmental scientist undertook the sampling
	Documentation correct	Field staff followed SOPs as defined in the DP *Field Procedures Manual.* Documentation reviewed and signed off by project reviewer.
Laboratory Considerations	All critical samples analysed according to site information	All critical samples analysed according to information from the preliminary contamination investigation.
	Analytes analysed	All key analytes analysed according to the information presented in the preliminary contamination investigation.
	Appropriate methods and PQLs/LOR	NATA approved methods have been adopted. Limits of reporting (LORs) and practical quantitation limits (PQLs) in accordance with the method have been used by the contract laboratory.
	Sample Documentation complete	Chain-of-custody (CoC) maintained and appended to the Certificates of Analysis. All Certificates of Analysis are

DQI	Considerations as specified in NEPM Schedule B2	Comment
		complete and appended to the report.
	Sample holding times complied with	Sample holding times complied with the NATA accredited Laboratory.
Comparability		
Field Considerations	Same SOPs used on each occasion	Field staff followed SOPs for each day of sampling as defined in the DP *Field Procedures Manual*
	Experienced sampler	An experienced environmental scientist undertook the sampling
	Climatic conditions	Field staff recorded the climatic conditions at the time of sampling
	Same types of samples collected	Field staff followed SOPs as defined in the DP *Field Procedures Manual* and sampling regime defined in the proposal.
Laboratory Considerations	Sample analytical methods used	Laboratory used is accredited by NATA for the analyses undertaken. Laboratory methods are as stated on the Certificates of Analysis
	Sample PQLs / LORs	PQL or LOR set by the laboratories are below the adopted site criteria or indicate across-the-board lack of detection.
	Same laboratories	Envirolab Services Pty Ltd was used for sample analysis.
	Same units	All laboratory results are expressed in consistent units for each media type.
Representativeness		
Field Considerations	Appropriate media sampled	Appropriate media were sampled based on information presented in the preliminary contamination investigation.
	All media identified was sampled	Filling sampled
Laboratory Considerations	Samples analysed	Samples analysed based on information presented in the preliminary contamination investigation

DQI	Considerations as specified in NEPM Schedule B2	Comment
Precision		
Field Considerations	SOPs appropriate and complied with	Field staff followed SOPs as defined in the DP *Field Procedures Manual*
Laboratory Considerations	Analysis of: 1) laboratory replicates 2) field duplicates	Laboratory acceptance limits are: 1) Average relative percentage difference (RPD) result <5 times PQL/LOR, no limit; results >5 times PQL/LOR, 30% or 50% depending on analyte 2) Average relative percentage difference (RPD) result <5 times PQL/LOR, no limit; results >5 times PQL/LOR, 30% or 50% depending on analyte
Accuracy (bias)		
Field Considerations	SOPs Appropriate and complied with	Field staff to follow SOPs as defined in the DP *Field Procedures Manual*
Laboratory Considerations	Analysis of: 1) reagent blank/method blank 2) matrix spike 3) surrogate spike	Laboratory acceptance limits are 1) Results are within acceptance limits as specified by the laboratory *(recovery usually within 60-140%).* 2) Results are within acceptance limits as specified by the laboratory *(recovery within 70-130% for inorganics and 60-140% for organics).* 3) Results are within acceptance limits as specified by the laboratory (recovery within 70-130% for inorganics and 60-140% for

DQI	Considerations as specified in NEPM Schedule B2	Comment
		organics). The laboratory has noted why a surrogate result was not possible.
	4) reference material	4) Analysis within the acceptable limits of the Certificate of Analysis for the reference material. These results are generally not contained in the Certificate of Analysis.
	5) laboratory control sample	5) Results are within acceptance limits as specified by the laboratory (recovery within 70-130% for inorganics and 60-140% for organics).

Appendix D

Laboratory Certificates

and Chain of Custody

12 Ashley Street, Chatswood, NSW 2067
tel: +61 2 9910 6200

email: sydney@envirolab.com.au
envirolab.com.au

Envirolab Services Pty Ltd - Sydney | ABN 37 112 535 645

CERTIFICATE OF ANALYSIS 145998

Client:
Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: David Walker

Sample log in details:

Your Reference:	**84897.04, LEES1**		
No. of samples:	8 soils		
Date samples received / completed instructions received	04/05/16	/	04/05/16

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	5/05/16	/	5/05/16
Date of Preliminary Report:	Not Issued		

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

vTRH(C6-C10)/BTEXN in Soil					
Our Reference:	UNITS	145998-5	145998-6	145998-7	145998-8
Your Reference	---------- -	101	102	103	BD2/040516
Depth	----------	0.4-0.5	0.2-0.3	0.4-0.5	-
Date Sampled		4/05/2016	4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil	Soil
Date extracted	-	04/05/2016	04/05/2016	04/05/2016	04/05/2016
Date analysed	-	05/05/2016	05/05/2016	05/05/2016	05/05/2016
TRH C_6 - C_9	mg/kg	<25	<25	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1
naphthalene	mg/kg	16	<1	<1	<1
Surrogate aaa-Trifluorotoluene	%	102	95	94	104

svTRH (C10-C40) in Soil						
Our Reference:	UNITS	145998-1	145998-2	145998-3	145998-4	145998-5
Your Reference	---------- -	6A	6B	6C	6D	101
Depth	----------	0.4-0.5	0.4-0.5	0.4-0.5	0.4-0.5	0.4-0.5
Date Sampled		4/05/2016	4/05/2016	4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	04/05/2016	04/05/2016	04/05/2016	04/05/2016	04/05/2016
Date analysed	-	05/05/2016	05/05/2016	05/05/2016	05/05/2016	05/05/2016
TRHC$_{10}$ - C$_{14}$	mg/kg	<50	<50	<50	<50	390
TRHC$_{15}$ - C$_{28}$	mg/kg	240	180	<100	430	12,000
TRHC$_{29}$ - C$_{36}$	mg/kg	230	210	110	380	4,600
TRH>C$_{10}$-C$_{16}$	mg/kg	<50	<50	<50	<50	1,300
TRH>C$_{16}$-C$_{34}$	mg/kg	410	310	130	730	16,000
TRH>C$_{34}$-C$_{40}$	mg/kg	110	140	<100	230	2,000
Surrogate o-Terphenyl	%	95	92	86	98	#

svTRH (C10-C40) in Soil				
Our Reference:	UNITS	145998-6	145998-7	145998-8
Your Reference	---------- -	102	103	BD2/040516
Depth	----------	0.2-0.3	0.4-0.5	-
Date Sampled		4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil
Date extracted	-	04/05/2016	04/05/2016	04/05/2016
Date analysed	-	05/05/2016	05/05/2016	05/05/2016
TRHC$_{10}$ - C$_{14}$	mg/kg	<50	<50	<50
TRHC$_{15}$ - C$_{28}$	mg/kg	100	<100	230
TRHC$_{29}$ - C$_{36}$	mg/kg	<100	<100	140
TRH>C$_{10}$-C$_{16}$	mg/kg	<50	<50	<50
TRH>C$_{10}$ - C$_{16}$ less Naphthalene (F2)	mg/kg	<50	<50	<50
TRH>C$_{16}$-C$_{34}$	mg/kg	170	<100	330
TRH>C$_{34}$-C$_{40}$	mg/kg	<100	<100	<100
Surrogate o-Terphenyl	%	89	86	91

PAHs in Soil Our Reference: Your Reference	UNITS ----------	145998-1 6A	145998-2 6B	145998-3 6C	145998-4 6D	145998-5 101
Depth	-	0.4-0.5	0.4-0.5	0.4-0.5	0.4-0.5	0.4-0.5
Date Sampled	----------	4/05/2016	4/05/2016	4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	04/05/2016	04/05/2016	04/05/2016	04/05/2016	04/05/2016
Date analysed	-	04/05/2016	04/05/2016	04/05/2016	04/05/2016	04/05/2016
Naphthalene	mg/kg	0.2	0.1	<0.1	0.2	51
Acenaphthylene	mg/kg	0.8	0.5	0.2	0.6	140
Acenaphthene	mg/kg	0.2	0.1	<0.1	0.4	20
Fluorene	mg/kg	0.4	0.3	<0.1	0.4	85
Phenanthrene	mg/kg	8.5	5.9	1.1	13	920
Anthracene	mg/kg	1.8	1.3	0.3	2.8	170
Fluoranthene	mg/kg	13	9.7	2.5	23	1,000
Pyrene	mg/kg	13	9.8	2.5	23	870
Benzo(a)anthracene	mg/kg	6.3	4.7	1.3	13	430
Chrysene	mg/kg	6.0	4.4	1.2	11	270
Benzo(b,j+k)fluoranthene	mg/kg	11	8.4	2.4	20	430
Benzo(a)pyrene	mg/kg	6.5	4.9	1.5	12	240
Indeno(1,2,3-c,d)pyrene	mg/kg	3.6	2.9	0.8	6.9	120
Dibenzo(a,h)anthracene	mg/kg	0.8	0.7	0.1	1.6	31
Benzo(g,h,i)perylene	mg/kg	3.3	2.5	0.7	5.5	110
Benzo(a)pyrene TEQ calc (zero)	mg/kg	9.5	7.2	2.1	18	370
Benzo(a)pyrene TEQ calc(half)	mg/kg	9.5	7.2	2.1	18	370
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	9.5	7.2	2.1	18	370
Total Positive PAHs	mg/kg	75	56	15	130	4,900
Surrogate p-Terphenyl-d14	%	86	96	93	96	140

PAHs in Soil Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ---------- - ---------- 	145998-6 102 0.2-0.3 4/05/2016 Soil	145998-7 103 0.4-0.5 4/05/2016 Soil
Date extracted	-	04/05/2016	04/05/2016
Date analysed	-	04/05/2016	04/05/2016
Naphthalene	mg/kg	0.3	<0.1
Acenaphthylene	mg/kg	0.8	0.2
Acenaphthene	mg/kg	0.1	<0.1
Fluorene	mg/kg	0.3	0.1
Phenanthrene	mg/kg	4.7	1.7
Anthracene	mg/kg	1.1	0.4
Fluoranthene	mg/kg	7.2	3.3
Pyrene	mg/kg	6.6	3.3
Benzo(a)anthracene	mg/kg	3.7	1.6
Chrysene	mg/kg	2.9	1.4
Benzo(b,j+k)fluoranthene	mg/kg	5.2	2.6
Benzo(a)pyrene	mg/kg	3.3	1.6
Indeno(1,2,3-c,d)pyrene	mg/kg	1.6	0.8
Dibenzo(a,h)anthracene	mg/kg	0.4	0.1
Benzo(g,h,i)perylene	mg/kg	1.5	0.7
Benzo(a)pyrene TEQ calc (zero)	mg/kg	4.8	2.2
Benzo(a)pyrene TEQ calc(half)	mg/kg	4.8	2.2
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	4.8	2.2
Total Positive PAHs	mg/kg	40	18
Surrogate p-Terphenyl-d14	%	94	101

Organochlorine Pesticides in soil			
Our Reference:	UNITS	145998-5	145998-7
Your Reference	----------	101	103
	-		
Depth	----------	0.4-0.5	0.4-0.5
Date Sampled		4/05/2016	4/05/2016
Type of sample		Soil	Soil
Date extracted	-	04/05/2016	04/05/2016
Date analysed	-	05/05/2016	05/05/2016
HCB	mg/kg	<1	<0.1
alpha-BHC	mg/kg	<1	<0.1
gamma-BHC	mg/kg	<1	<0.1
beta-BHC	mg/kg	<1	<0.1
Heptachlor	mg/kg	<1	<0.1
delta-BHC	mg/kg	<1	<0.1
Aldrin	mg/kg	<1	<0.1
Heptachlor Epoxide	mg/kg	<1	<0.1
gamma-Chlordane	mg/kg	<1	<0.1
alpha-chlordane	mg/kg	<1	<0.1
Endosulfan I	mg/kg	<1	<0.1
pp-DDE	mg/kg	<1	<0.1
Dieldrin	mg/kg	<1	<0.1
Endrin	mg/kg	<1	<0.1
pp-DDD	mg/kg	<1	<0.1
Endosulfan II	mg/kg	<1	<0.1
pp-DDT	mg/kg	<1	<0.1
Endrin Aldehyde	mg/kg	<1	<0.1
Endosulfan Sulphate	mg/kg	<1	<0.1
Methoxychlor	mg/kg	<1	<0.1
Surrogate TCMX	%	90	91

Organophosphorus Pesticides			
Our Reference:	UNITS	145998-5	145998-7
Your Reference	----------	101	103
	-		
Depth	----------	0.4-0.5	0.4-0.5
Date Sampled		4/05/2016	4/05/2016
Type of sample		Soil	Soil
Date extracted	-	04/05/2016	04/05/2016
Date analysed	-	05/05/2016	05/05/2016
Azinphos-methyl (Guthion)	mg/kg	<1	<0.1
Bromophos-ethyl	mg/kg	<1	<0.1
Chlorpyriphos	mg/kg	<1	<0.1
Chlorpyriphos-methyl	mg/kg	<1	<0.1
Diazinon	mg/kg	<1	<0.1
Dichlorvos	mg/kg	<1	<0.1
Dimethoate	mg/kg	<1	<0.1
Ethion	mg/kg	<1	<0.1
Fenitrothion	mg/kg	<1	<0.1
Malathion	mg/kg	<1	<0.1
Parathion	mg/kg	<1	<0.1
Ronnel	mg/kg	<1	<0.1
Surrogate TCMX	%	90	91

PCBs in Soil Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ---------- - ---------- 	145998-5 101 0.4-0.5 4/05/2016 Soil	145998-7 103 0.4-0.5 4/05/2016 Soil
Date extracted	-	04/05/2016	04/05/2016
Date analysed	-	05/05/2016	05/05/2016
Aroclor 1016	mg/kg	<5	<0.1
Aroclor 1221	mg/kg	<5	<0.1
Aroclor 1232	mg/kg	<5	<0.1
Aroclor 1242	mg/kg	<5	<0.1
Aroclor 1248	mg/kg	<5	<0.1
Aroclor 1254	mg/kg	<5	<0.1
Aroclor 1260	mg/kg	<5	<0.1
Surrogate TCLMX	%	90	91

Acid Extractable metals in soil					
Our Reference:	UNITS	145998-5	145998-6	145998-7	145998-8
Your Reference	---------- -	101	102	103	BD2/040516
Depth	----------	0.4-0.5	0.2-0.3	0.4-0.5	-
Date Sampled		4/05/2016	4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	04/05/2016	04/05/2016	04/05/2016	04/05/2016
Date analysed	-	04/05/2016	04/05/2016	04/05/2016	04/05/2016
Arsenic	mg/kg	6	5	10	7
Cadmium	mg/kg	<0.4	0.6	0.4	0.4
Chromium	mg/kg	9	15	14	16
Copper	mg/kg	55	83	68	95
Lead	mg/kg	78	620	100	290
Mercury	mg/kg	0.3	1.6	0.2	1.5
Nickel	mg/kg	4	8	7	8
Zinc	mg/kg	64	180	83	160

Misc Soil - Inorg			
Our Reference:	UNITS	145998-5	145998-7
Your Reference	----------	101	103
	-		
Depth	----------	0.4-0.5	0.4-0.5
Date Sampled		4/05/2016	4/05/2016
Type of sample		Soil	Soil
Date prepared	-	04/05/2016	04/05/2016
Date analysed	-	04/05/2016	04/05/2016
Total Phenolics (as Phenol)	mg/kg	<5	<5

Moisture Our Reference: Your Reference	UNITS ----------	145998-1 6A	145998-2 6B	145998-3 6C	145998-4 6D	145998-5 101
	-					
Depth	----------	0.4-0.5	0.4-0.5	0.4-0.5	0.4-0.5	0.4-0.5
Date Sampled		4/05/2016	4/05/2016	4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	4/05/2016	4/05/2016	4/05/2016	4/05/2016	4/05/2016
Date analysed	-	5/05/2016	5/05/2016	5/05/2016	5/05/2016	5/05/2016
Moisture	%	18	19	17	16	12

Moisture Our Reference: Your Reference	UNITS ----------	145998-6 102	145998-7 103	145998-8 BD2/040516
	-			
Depth	----------	0.2-0.3	0.4-0.5	-
Date Sampled		4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil
Date prepared	-	4/05/2016	4/05/2016	4/05/2016
Date analysed	-	5/05/2016	5/05/2016	5/05/2016
Moisture	%	15	17	14

Asbestos ID - soils				
Our Reference:	UNITS	145998-5	145998-6	145998-7
Your Reference	----------	101	102	103
	-			
Depth	----------	0.4-0.5	0.2-0.3	0.4-0.5
Date Sampled		4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil
Date analysed	-	5/05/2016	5/05/2016	5/05/2016
Sample mass tested	g	Approx. 35g	Approx. 35g	Approx. 35g
Sample Description	-	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected

Method ID	Methodology Summary
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'TEQ PQL' values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'TEQ zero' values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'TEQ half PQL' values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PAHs" is simply a sum of the positive individual PAHs.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-008	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
Inorg-031	Total Phenolics by segmented flow analyser (in line distillation with colourimetric finish). Solids are extracted in a caustic media prior to analysis.
Inorg-008	Moisture content determined by heating at 105+/-5 deg C for a minimum of 12 hours.
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Date analysed	-			05/05/2016	145998-5	05/05/2016 || 05/05/2016	LCS-13	05/05/2016
TRH C_6 - C_9	mg/kg	25	Org-016	<25	145998-5	<25 || <25	LCS-13	84%
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	145998-5	<25 || <25	LCS-13	84%
Benzene	mg/kg	0.2	Org-016	<0.2	145998-5	<0.2 || <0.2	LCS-13	83%
Toluene	mg/kg	0.5	Org-016	<0.5	145998-5	<0.5 || <0.5	LCS-13	79%
Ethylbenzene	mg/kg	1	Org-016	<1	145998-5	<1 || <1	LCS-13	83%
m+p-xylene	mg/kg	2	Org-016	<2	145998-5	<2 || <2	LCS-13	88%
o-Xylene	mg/kg	1	Org-016	<1	145998-5	<1 || <1	LCS-13	81%
naphthalene	mg/kg	1	Org-014	<1	145998-5	16 || 13 || RPD: 21	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%		Org-016	102	145998-5	102 || 100 || RPD: 2	LCS-13	85%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Date analysed	-			05/05/2016	145998-5	05/05/2016 || 05/05/2016	LCS-13	05/05/2016
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	145998-5	390 || 420 || RPD: 7	LCS-13	104%
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	145998-5	12000 || 12000 || RPD: 0	LCS-13	111%
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	145998-5	4600 || 4500 || RPD: 2	LCS-13	108%
TRH >C_{10}-C_{16}	mg/kg	50	Org-003	<50	145998-5	1300 || 1300 || RPD: 0	LCS-13	104%
TRH >C_{16}-C_{34}	mg/kg	100	Org-003	<100	145998-5	16000 || 15000 || RPD: 6	LCS-13	111%
TRH >C_{34}-C_{40}	mg/kg	100	Org-003	<100	145998-5	2000 || 2100 || RPD: 5	LCS-13	108%
Surrogate o-Terphenyl	%		Org-003	83	145998-5	# || #	LCS-13	79%

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base || Duplicate || %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Date analysed	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Naphthalene	mg/kg	0.1	Org-012	<0.1	145998-5	51 || 53 || RPD: 4	LCS-13	93%
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	145998-5	140 || 130 || RPD: 7	[NR]	[NR]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	145998-5	20 || 21 || RPD: 5	[NR]	[NR]
Fluorene	mg/kg	0.1	Org-012	<0.1	145998-5	85 || 91 || RPD: 7	LCS-13	95%
Phenanthrene	mg/kg	0.1	Org-012	<0.1	145998-5	920 || 840 || RPD: 9	LCS-13	99%
Anthracene	mg/kg	0.1	Org-012	<0.1	145998-5	170 || 170 || RPD: 0	[NR]	[NR]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	145998-5	1000 || 970 || RPD: 3	LCS-13	94%
Pyrene	mg/kg	0.1	Org-012	<0.1	145998-5	870 || 860 || RPD: 1	LCS-13	101%
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	145998-5	430 || 380 || RPD: 12	[NR]	[NR]
Chrysene	mg/kg	0.1	Org-012	<0.1	145998-5	270 || 230 || RPD: 16	LCS-13	76%
Benzo(b,j +k)fluoranthene	mg/kg	0.2	Org-012	<0.2	145998-5	430 || 340 || RPD: 23	[NR]	[NR]

QUALITY CONTROL PAHs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	145998-5	240 || 200 || RPD: 18	LCS-13	107%
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	145998-5	120 || 110 || RPD: 9	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	145998-5	31 || 28 || RPD: 10	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	145998-5	110 || 95 || RPD: 15	[NR]	[NR]
Surrogate p-Terphenyl-d14	%		Org-012	93	145998-5	140 || 137 || RPD: 2	LCS-13	90%

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Date analysed	-			05/05/2016	145998-5	05/05/2016 || 05/05/2016	LCS-13	05/05/2016
HCB	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	72%
gamma-BHC	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
beta-BHC	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	85%
Heptachlor	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	85%
delta-BHC	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
Aldrin	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	99%
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	87%
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
pp-DDE	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	87%
Dieldrin	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	91%
Endrin	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	99%
pp-DDD	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	85%
Endosulfan II	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
pp-DDT	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	LCS-13	92%
Methoxychlor	mg/kg	0.1	Org-005	<0.1	145998-5	<1 || <1	[NR]	[NR]
Surrogate TCMX	%		Org-005	92	145998-5	90 || 90 || RPD: 0	LCS-13	78%

QUALITY CONTROL Organophosphorus Pesticides	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Date analysed	-			05/05/2016	145998-5	05/05/2016 || 05/05/2016	LCS-13	05/05/2016
Azinphos-methyl (Guthion)	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	[NR]	[NR]
Bromophos-ethyl	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	[NR]	[NR]
Chlorpyriphos	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	LCS-13	88%
Chlorpyriphos-methyl	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	[NR]	[NR]
Diazinon	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	[NR]	[NR]
Dichlorvos	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	LCS-13	89%
Dimethoate	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	[NR]	[NR]
Ethion	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	LCS-13	84%
Fenitrothion	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	LCS-13	86%
Malathion	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	LCS-13	79%
Parathion	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	LCS-13	90%
Ronnel	mg/kg	0.1	Org-008	<0.1	145998-5	<1 || <1	LCS-13	92%
Surrogate TCMX	%		Org-008	92	145998-5	90 || 90 || RPD: 0	LCS-13	87%

QUALITY CONTROL PCBs in Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Date analysed	-			05/05/2016	145998-5	05/05/2016 || 05/05/2016	LCS-13	05/05/2016
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	145998-5	<5 || <5	[NR]	[NR]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	145998-5	<5 || <5	[NR]	[NR]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	145998-5	<5 || <5	[NR]	[NR]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	145998-5	<5 || <5	[NR]	[NR]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	145998-5	<5 || <5	[NR]	[NR]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	145998-5	<5 || <5	LCS-13	103%
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	145998-5	<5 || <5	[NR]	[NR]
Surrogate TCLMX	%		Org-006	92	145998-5	90 || 90 || RPD: 0	LCS-13	87%

QUALITY CONTROL Acid Extractable metals in soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Date analysed	-			04/05/2016	145998-5	04/05/2016 || 04/05/2016	LCS-13	04/05/2016
Arsenic	mg/kg	4	Metals-020 ICP-AES	<4	145998-5	6 || 4 || RPD: 40	LCS-13	108%
Cadmium	mg/kg	0.4	Metals-020 ICP-AES	<0.4	145998-5	<0.4 || <0.4	LCS-13	106%
Chromium	mg/kg	1	Metals-020 ICP-AES	<1	145998-5	9 || 8 || RPD: 12	LCS-13	106%
Copper	mg/kg	1	Metals-020 ICP-AES	<1	145998-5	55 || 51 || RPD: 8	LCS-13	107%
Lead	mg/kg	1	Metals-020 ICP-AES	<1	145998-5	78 || 58 || RPD: 29	LCS-13	102%
Mercury	mg/kg	0.1	Metals-021 CV-AAS	<0.1	145998-5	0.3 || 0.4 || RPD: 29	LCS-13	78%
Nickel	mg/kg	1	Metals-020 ICP-AES	<1	145998-5	4 || 4 || RPD: 0	LCS-13	101%
Zinc	mg/kg	1	Metals-020 ICP-AES	<1	145998-5	64 || 57 || RPD: 12	LCS-13	102%

QUALITY CONTROL Misc Soil - Inorg	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			04/05/2016	[NT]	[NT]	LCS-1	04/05/2016
Date analysed	-			04/05/2016	[NT]	[NT]	LCS-1	04/05/2016
Total Phenolics (as Phenol)	mg/kg	5	Inorg-031	<5	[NT]	[NT]	LCS-1	103%

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	145998-7	04/05/2016
Date analysed	-	[NT]	[NT]	145998-7	05/05/2016
TRH C_6 - C_9	mg/kg	[NT]	[NT]	145998-7	96%
TRH C_6 - C_{10}	mg/kg	[NT]	[NT]	145998-7	96%
Benzene	mg/kg	[NT]	[NT]	145998-7	95%
Toluene	mg/kg	[NT]	[NT]	145998-7	84%
Ethylbenzene	mg/kg	[NT]	[NT]	145998-7	97%
m+p-xylene	mg/kg	[NT]	[NT]	145998-7	103%
o-Xylene	mg/kg	[NT]	[NT]	145998-7	96%
naphthalene	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate aaa-Trifluorotoluene	%	[NT]	[NT]	145998-7	94%

QUALITY CONTROL svTRH (C10-C40) in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	145998-7	04/05/2016
Date analysed	-	[NT]	[NT]	145998-7	05/05/2016
TRH C_{10} - C_{14}	mg/kg	[NT]	[NT]	145998-7	93%
TRH C_{15} - C_{28}	mg/kg	[NT]	[NT]	145998-7	102%
TRH C_{29} - C_{36}	mg/kg	[NT]	[NT]	145998-7	98%
TRH >C_{10}-C_{16}	mg/kg	[NT]	[NT]	145998-7	93%
TRH >C_{16}-C_{34}	mg/kg	[NT]	[NT]	145998-7	102%
TRH >C_{34}-C_{40}	mg/kg	[NT]	[NT]	145998-7	98%
Surrogate o-Terphenyl	%	[NT]	[NT]	145998-7	86%
QUALITY CONTROL PAHs in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	145998-7	04/05/2016
Date analysed	-	[NT]	[NT]	145998-7	04/05/2016
Naphthalene	mg/kg	[NT]	[NT]	145998-7	103%
Acenaphthylene	mg/kg	[NT]	[NT]	[NR]	[NR]
Acenaphthene	mg/kg	[NT]	[NT]	[NR]	[NR]
Fluorene	mg/kg	[NT]	[NT]	145998-7	106%
Phenanthrene	mg/kg	[NT]	[NT]	145998-7	94%
Anthracene	mg/kg	[NT]	[NT]	[NR]	[NR]
Fluoranthene	mg/kg	[NT]	[NT]	145998-7	91%
Pyrene	mg/kg	[NT]	[NT]	145998-7	97%
Benzo(a)anthracene	mg/kg	[NT]	[NT]	[NR]	[NR]
Chrysene	mg/kg	[NT]	[NT]	145998-7	81%
Benzo(b,j+k)fluoranthene	mg/kg	[NT]	[NT]	[NR]	[NR]
Benzo(a)pyrene	mg/kg	[NT]	[NT]	145998-7	110%
Indeno(1,2,3-c,d)pyrene	mg/kg	[NT]	[NT]	[NR]	[NR]
Dibenzo(a,h)anthracene	mg/kg	[NT]	[NT]	[NR]	[NR]
Benzo(g,h,i)perylene	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate p-Terphenyl-d14	%	[NT]	[NT]	145998-7	100%

QUALITY CONTROL Organochlorine Pesticides in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	145998-7	04/05/2016
Date analysed	-	[NT]	[NT]	145998-7	05/05/2016
HCB	mg/kg	[NT]	[NT]	[NR]	[NR]
alpha-BHC	mg/kg	[NT]	[NT]	145998-7	89%
gamma-BHC	mg/kg	[NT]	[NT]	[NR]	[NR]
beta-BHC	mg/kg	[NT]	[NT]	145998-7	83%
Heptachlor	mg/kg	[NT]	[NT]	145998-7	84%
delta-BHC	mg/kg	[NT]	[NT]	[NR]	[NR]
Aldrin	mg/kg	[NT]	[NT]	145998-7	95%
Heptachlor Epoxide	mg/kg	[NT]	[NT]	145998-7	85%
gamma-Chlordane	mg/kg	[NT]	[NT]	[NR]	[NR]
alpha-chlordane	mg/kg	[NT]	[NT]	[NR]	[NR]
Endosulfan I	mg/kg	[NT]	[NT]	[NR]	[NR]
pp-DDE	mg/kg	[NT]	[NT]	145998-7	86%
Dieldrin	mg/kg	[NT]	[NT]	145998-7	90%
Endrin	mg/kg	[NT]	[NT]	145998-7	98%
pp-DDD	mg/kg	[NT]	[NT]	145998-7	84%
Endosulfan II	mg/kg	[NT]	[NT]	[NR]	[NR]
pp-DDT	mg/kg	[NT]	[NT]	[NR]	[NR]
Endrin Aldehyde	mg/kg	[NT]	[NT]	[NR]	[NR]
Endosulfan Sulphate	mg/kg	[NT]	[NT]	145998-7	88%
Methoxychlor	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCMX	%	[NT]	[NT]	145998-7	78%

QUALITY CONTROL Organophosphorus Pesticides	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	145998-7	04/05/2016
Date analysed	-	[NT]	[NT]	145998-7	05/05/2016
Azinphos-methyl (Guthion)	mg/kg	[NT]	[NT]	[NR]	[NR]
Bromophos-ethyl	mg/kg	[NT]	[NT]	[NR]	[NR]
Chlorpyriphos	mg/kg	[NT]	[NT]	145998-7	82%
Chlorpyriphos-methyl	mg/kg	[NT]	[NT]	[NR]	[NR]
Diazinon	mg/kg	[NT]	[NT]	[NR]	[NR]
Dichlorvos	mg/kg	[NT]	[NT]	145998-7	87%
Dimethoate	mg/kg	[NT]	[NT]	[NR]	[NR]
Ethion	mg/kg	[NT]	[NT]	145998-7	98%
Fenitrothion	mg/kg	[NT]	[NT]	145998-7	87%
Malathion	mg/kg	[NT]	[NT]	145998-7	78%
Parathion	mg/kg	[NT]	[NT]	145998-7	81%
Ronnel	mg/kg	[NT]	[NT]	145998-7	89%
Surrogate TCMX	%	[NT]	[NT]	145998-7	85%
QUALITY CONTROL PCBs in Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date extracted	-	[NT]	[NT]	145998-7	04/05/2016
Date analysed	-	[NT]	[NT]	145998-7	05/05/2016
Aroclor 1016	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1221	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1232	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1242	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1248	mg/kg	[NT]	[NT]	[NR]	[NR]
Aroclor 1254	mg/kg	[NT]	[NT]	145998-7	102%
Aroclor 1260	mg/kg	[NT]	[NT]	[NR]	[NR]
Surrogate TCLMX	%	[NT]	[NT]	145998-7	85%
QUALITY CONTROL Acid Extractable metals in soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	145998-7	04/05/2016
Date analysed	-	[NT]	[NT]	145998-7	04/05/2016
Arsenic	mg/kg	[NT]	[NT]	145998-7	87%
Cadmium	mg/kg	[NT]	[NT]	145998-7	90%
Chromium	mg/kg	[NT]	[NT]	145998-7	93%
Copper	mg/kg	[NT]	[NT]	145998-7	121%
Lead	mg/kg	[NT]	[NT]	145998-7	129%
Mercury	mg/kg	[NT]	[NT]	145998-7	86%
Nickel	mg/kg	[NT]	[NT]	145998-7	88%
Zinc	mg/kg	[NT]	[NT]	145998-7	124%

Report Comments:

OC/OP/PCB in soil: PQL has been raised due to interference from analytes(other than those being tested) in the sample/s.

TRH_S_NEPM: # Percent recovery is not possible to report as the high concentration of analytes in the sample/s have caused interference.

Asbestos: A portion of the supplied samples were sub-sampled for asbestos analysis according to Envirolab procedures. We cannot guarantee that these sub-samples are indicative of the entire sample. Envirolab recommends supplying 40-50g of sample in its own container.
Note: Samples 145998-1, 2 & 3 were sub-sampled from jars provided by the client.

Asbestos ID was analysed by Approved Identifier: Paul Ching
Asbestos ID was authorised by Approved Signatory: Paul Ching

INS: Insufficient sample for this test
NR: Test not required
<: Less than
PQL: Practical Quantitation Limit
RPD: Relative Percent Difference
>: Greater than
NT: Not tested
NA: Test not required
LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

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Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

12 Ashley Street, Chatswood, NSW 2067
tel: +61 2 9910 6200

email: sydney@envirolab.com.au
envirolab.com.au

Envirolab Services Pty Ltd - Sydney | ABN 37 112 535 645

CERTIFICATE OF ANALYSIS 145998-A

Client:
Douglas Partners Pty Ltd
96 Hermitage Rd
West Ryde
NSW 2114

Attention: David Walker

Sample log in details:

Your Reference:	**84897.04, LEES1**		
No. of samples:	8 soils		
Date samples received / completed instructions received	04/05/16	/	05/05/16

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	6/05/16	/	6/05/16
Date of Preliminary Report:	Not Issued		

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Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

sTPH in Soil (C10-C40)-Silica		
Our Reference:	UNITS	145998-A-5
Your Reference	---------- -	101
Depth	----------	0.4-0.5
Date Sampled		4/05/2016
Type of sample		Soil
Date extracted	-	05/05/2016
Date analysed	-	06/05/2016
$TPHC_{10}$ - C_{14}	mg/kg	65
$TPHC_{15}$ - C_{28}	mg/kg	1,300
$TPHC_{29}$ - C_{36}	mg/kg	250
$TPH{>}C_{10}$-C_{16}	mg/kg	210
$TPH{>}C_{16}$-C_{34}	mg/kg	1,400
$TPH{>}C_{34}$-C_{40}	mg/kg	<100
Surrogate o-Terphenyl	%	136

PAHs in TCLP (USEPA 1311)				
Our Reference:	UNITS	145998-A-4	145998-A-5	145998-A-7
Your Reference	----------	6D	101	103
	-			
Depth	----------	0.4-0.5	0.4-0.5	0.4-0.5
Date Sampled		4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil
Date extracted	-	06/05/2016	06/05/2016	06/05/2016
Date analysed	-	06/05/2016	06/05/2016	06/05/2016
Naphthalene in TCLP	mg/L	<0.001	0.014	<0.001
Acenaphthylene in TCLP	mg/L	<0.001	0.010	<0.001
Acenaphthene in TCLP	mg/L	<0.001	0.002	<0.001
Fluorene in TCLP	mg/L	<0.001	0.003	<0.001
Phenanthrene in TCLP	mg/L	<0.001	0.009	<0.001
Anthracene in TCLP	mg/L	<0.001	0.002	<0.001
Fluoranthene in TCLP	mg/L	<0.001	0.002	<0.001
Pyrene in TCLP	mg/L	<0.001	0.001	<0.001
Benzo(a)anthracene in TCLP	mg/L	<0.001	<0.001	<0.001
Chrysene in TCLP	mg/L	<0.001	<0.001	<0.001
Benzo(bjk)fluoranthene in TCLP	mg/L	<0.002	<0.002	<0.002
Benzo(a)pyrene in TCLP	mg/L	<0.001	<0.001	<0.001
Indeno(1,2,3-c,d)pyrene - TCLP	mg/L	<0.001	<0.001	<0.001
Dibenzo(a,h)anthracene in TCLP	mg/L	<0.001	<0.001	<0.001
Benzo(g,h,i)perylene in TCLP	mg/L	<0.001	<0.001	<0.001
Total +ve PAH's	mg/L	NIL (+)VE	0.044	NIL (+)VE
Surrogate p-Terphenyl-d14	%	109	93	96

Metals in TCLP USEPA1311					
Our Reference:	UNITS	145998-A-4	145998-A-5	145998-A-6	145998-A-7
Your Reference	---------- -	6D	101	102	103
Depth	----------	0.4-0.5	0.4-0.5	0.2-0.3	0.4-0.5
Date Sampled		4/05/2016	4/05/2016	4/05/2016	4/05/2016
Type of sample		Soil	Soil	Soil	Soil
Date extracted	-	06/05/2016	06/05/2016	06/05/2016	06/05/2016
Date analysed	-	06/05/2016	06/05/2016	06/05/2016	06/05/2016
pH of soil for fluid# determ.	pH units	6.1	6.5	6.7	7.5
pH of soil TCLP (after HCl)	pH units	1.6	1.6	1.6	1.7
Extraction fluid used	-	1	1	1	1
pH of final Leachate	pH units	5.0	5.0	5.0	5.1
Lead in TCLP	mg/L	[NA]	[NA]	0.1	[NA]

Method ID	Methodology Summary
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-012	Leachates are extracted with Dichloromethane and analysed by GC-MS.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS.
Inorg-004	Toxicity Characteristic Leaching Procedure (TCLP) using in house method INORG-004.
EXTRACT.7	Toxicity Characteristic Leaching Procedure (TCLP).
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.

QUALITY CONTROL sTPH in Soil (C10-C40)-Silica	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			05/05/2016	[NT]	[NT]	LCS-2	05/05/16
Date analysed	-			06/05/2016	[NT]	[NT]	LCS-2	06/05/16
TPH C_{10} - C_{14}	mg/kg	50	Org-003	<50	[NT]	[NT]	LCS-2	99%
TPH C_{15} - C_{28}	mg/kg	100	Org-003	<100	[NT]	[NT]	LCS-2	71%
TPH C_{29} - C_{36}	mg/kg	100	Org-003	<100	[NT]	[NT]	LCS-2	123%
TPH >C_{10}-C_{16}	mg/kg	50	Org-003	<50	[NT]	[NT]	LCS-2	99%
TPH >C_{16}-C_{34}	mg/kg	100	Org-003	<100	[NT]	[NT]	LCS-2	71%
TPH >C_{34}-C_{40}	mg/kg	100	Org-003	<100	[NT]	[NT]	LCS-2	123%
Surrogate o-Terphenyl	%		Org-003	88	[NT]	[NT]	LCS-2	72%

QUALITY CONTROL PAHs in TCLP (USEPA 1311)	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			06/05/2016	[NT]	[NT]	LCS-W1	06/05/2016
Date analysed	-			06/05/2016	[NT]	[NT]	LCS-W1	06/05/2016
Naphthalene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	LCS-W1	70%
Acenaphthylene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NR]	[NR]
Acenaphthene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NR]	[NR]
Fluorene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	LCS-W1	82%
Phenanthrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	LCS-W1	86%
Anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NR]	[NR]
Fluoranthene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	LCS-W1	82%
Pyrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	LCS-W1	88%
Benzo(a)anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NR]	[NR]
Chrysene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	LCS-W1	70%
Benzo(bjk)fluoranthene in TCLP	mg/L	0.002	Org-012	<0.002	[NT]	[NT]	[NR]	[NR]
Benzo(a)pyrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	LCS-W1	85%
Indeno(1,2,3-c,d)pyrene - TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NR]	[NR]
Dibenzo(a,h)anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NR]	[NR]
Benzo(g,h,i)perylene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NR]	[NR]
Surrogate p-Terphenyl-d14	%		Org-012	116	[NT]	[NT]	LCS-W1	96%

QUALITY CONTROL Metals in TCLP USEPA1311	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			06/05/2016	[NT]	[NT]	LCS-W1	06/05/2016
Date analysed	-			06/05/2016	[NT]	[NT]	LCS-W1	06/05/2016
Lead in TCLP	mg/L	0.03	Metals-020 ICP-AES	<0.03	[NT]	[NT]	LCS-W1	93%

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
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<: Less than	>: Greater than	LCS: Laboratory Control Sample

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Spikes for Physical and Aggregate Tests are not applicable.
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Douglas Partners
Geotechnics · Environment · Groundwater

CHAIN OF CUSTODY

Project Name: LEES1
Project No: 84817.04 Sampler: R. Lamont
Project Mgr: D. Walker Mob. Phone:
Email: @douglaspartners.com.au
Date Required: * 24 Hour TAT * Lab Quote No.

To: Envirolab Services
12 Ashley Street, Chatswood NSW 2068
Attn: Tania Notaras
Phone: 02 9910 6200 Fax: 02 9910 6201
Email: tnotaras@envirolabservices.com.au

	Sample ID	Sample Depth	Lab ID	Sampling Date	Sample Type S - soil W – water	Container type	Analytes: Combo 8A	PAH	TRH C10-C40	Metals (5)	TRH/BTEX	Combo 3A							Other	Notes
1	6A	0.4-0.5		4/5/16	S	Jar		✓	✓											
2	6B	0.4-0.5						✓	✓											
3	6C	0.4-0.5						✓	✓											
4	6D	0.4-0.5						✓	✓											
5	101	0.4-0.5					✓													
6	102	0.2-0.3										✓								
7	103	0.4-0.5					✓													
8	BD2/04	0516								✓	✓									

ENVIROLAB — Envirolab Services, 12 Ashley St, Chatswood NSW 2067, Ph: (02) 9910 6200
Job No: 145998
Date Received: 4/5
Time Received: 4:30
Received by: DH
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Lab Report No.
Send Results to: Douglas Partners Address: 96 Hermitage Road, West Ryde 2114 Phone: (02) 9809 0666 Fax: (02) 9809 4095

Relinquished by: D. Walker	Signed:	Date & Time: 4/5/16	Received By: D.H.	Date & Time: 4/5 16:30
Relinquished by:	Signed:	Date & Time:	Received By:	Date & Time:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

SAMPLE RECEIPT ADVICE

Client Details	
Client	Douglas Partners Pty Ltd
Attention	David Walker

Sample Login Details	
Your Reference	84897.04, LEES1
Envirolab Reference	**145998**
Date Sample Received	04/05/2016
Date Instructions Received	04/05/2016
Date Results Expected to be Reported	**05/05/2016**

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	8 soils
Turnaround Time Requested	24hr
Temperature on receipt (°C)	16.0
Cooling Method	Ice
Sampling Date Provided	YES

Comments
Samples will be held for 1 month for water samples and 2 months for soil samples from date of receipt of samples

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	Phone: 02 9910 6200
Fax: 02 9910 6201	Fax: 02 9910 6201
Email: ahie@envirolabservices.com.au	Email: jhurst@envirolabservices.com.au

Sample and Testing Details on following page

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

Sample Id	vTRH(C6-C10)/BTEXN in Soil	svTRH (C10-C40) in Soil	PAHs in Soil	Organochlorine Pesticides in soil	Organophosphorus Pesticides	PCBs in Soil	Acid Extractable metals in soil	Total Phenolics (as Phenol)	Asbestos ID - soils
6A-0.4-0.5		✓	✓						
6B-0.4-0.5		✓	✓						
6C-0.4-0.5		✓	✓						
6D-0.4-0.5		✓	✓						
101-0.4-0.5	✓	✓	✓	✓	✓	✓	✓	✓	✓
102-0.2-0.3	✓	✓	✓				✓		✓
103-0.4-0.5	✓	✓	✓	✓	✓	✓	✓	✓	✓
BD2/040516	✓	✓					✓		

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Remediation Action Plan

Carslaw Building Extension
Eastern Avenue, The University of Sydney

Prepared for
The University of Sydney

Project 84897.04
May 2016

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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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.

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Report on Remediation Action Plan
Carslaw Building Extension
Eastern Avenue, The University of Sydney

1. Introduction

This report presents the results of a remediation action plan (RAP) undertaken for the proposed Carslaw Building extension at Eastern Avenue, The University of Sydney. The preparation of this RAP was commissioned in an email dated 27 April 2017 by Sam Gibson of The University of Sydney and was undertaken in accordance with Douglas Partners' (DP) email proposal dated 27 April 2016.

The proposed development is for an eight level building extension to the existing Carslaw Building, which is to be used for teaching services. Some peripheral works are also proposed (in public domain areas) such as for loading dock access and very minor landscaping to tie in with existing surrounding structures and landscaping. Excavation will be required for Level 01 of the proposed building. Development plans (by Rice Daubney Group (NSW) P/L architects, dated 5 April 2015) showing Level 01 (Drawing Number DA 01), Level 02 (Drawing Number DA02) and a building cross section (Drawing Number DA 11) are provided in Appendix A.

2. Objectives and Scope

The remediation goals are to:

- Render the site suitable for the proposed residential land use;
- Maintain records of the remediation works undertaken and validate the success of the remediation;
- Mitigate adverse impacts on surrounding land and waterways during the remediation by the management of dust and water; and
- Maximise the protection of workers involved with remediation and earthworks.

In this regard, the objectives of the RAP are to:

- Establish an appropriate remediation strategy so as to render the site suitable for the proposed development from a contamination perspective;
- Establish the site assessment criteria to be adopted for the remediation of the site and the validation requirements to confirm the successful implementation of the remediation strategy;
- Establish appropriate environmental safeguards required to complete the remediation works in an environmentally acceptable manner; and
- Establish appropriate work health and safety (WHS) procedures required to complete the remediation works in a manner that would not pose a threat to the health of site workers or users.

3. Site Description and Geology

The site of the proposed extension is located on the southern side of the Carslaw Building on Eastern Avenue, The University of Sydney. The approximate extent of the proposed building is shown on Drawing 1, Appendix A. The approximate extent of surrounding public domain works for a loading dock and pedestrian access is also shown on Drawing 1. The site covers an area of approximately 0.15 ha.

The site is currently occupied by an access laneway excavated into a slope adjacent to the Carslaw Building and a landscaped area containing gardens, lawn and a footpath. A pedestrian bridge (which is to remain for the proposed development) is located at the eastern site boundary. The laneway is relatively level and the garden rises gently to the west with a difference in levels of nearly 3 m over approximately 70 m. A retaining wall separates the laneway from the landscaped area above.

4. Previous Investigations

Previous geotechnical and contamination investigations have been conducted at the site and findings were reported in:

- DP, *Preliminary Site Investigation, Proposed Campus Improvement Program, Camperdown and Darlington Campus, University of Sydney,* November 2013 (Project 73716.00) [DP, 2013];
- DP, *Report on Geotechnical Investigation, Proposed LEES1 Carslaw Extension, Eastern Avenue, The University of Sydney*, July 2015 (Project 84897.00) [DP, 2015]; and
- DP, Report on *Phase 2 Contamination Investigation, Proposed Carslaw Building Extension, Eastern Avenue, The University of Sydney, Prepared for The University of Sydney,* May 2016 [DP, 2016].

The RAP is primarily based on findings and recommendations presented in DP (2016). Findings relevant to the contamination elements of the investigations are summarised in the subsections below.

4.1 DP (2013)

DP (2013) comprised a preliminary investigation for the university campus which included the current investigation area.

According to DP (2013), the site was acquired by the University of Sydney in 1912 and has been operated as university grounds since that time. A significant portion of the campus was previously used for farming. The University of Sydney holds licences for the storage of a variety of chemicals for experimental purposes; however, records did not indicate that any of these chemical stores were present in the current investigation area. The use of fill for the formation of the campus appears to be extensive, with filling at some areas found to contain asbestos, slag and ash. There is also potential for asbestos to be present in near surface soils as a result of the demolition of former structures. Hazardous materials registers have identified hazardous building materials (including asbestos and lead based paint) in many of the older buildings within the university grounds.

4.2 DP (2015)

Field work for DP (2015) included the drilling of five boreholes (Bores 5 to 9) at the locations shown on Drawing 1, Appendix A. The subsurface conditions encountered are presented on the borehole logs, Appendix B. Notes defining descriptive terms and classification methods are also provided in Appendix B.

The subsurface conditions encountered in the boreholes are summarised as:

- FILLING – grey-brown and grey sand, grey silty clay and brown silty sand with some gravel to depths of between 0.4 m and 1.3 m. Bores 7 and 9 also had a footpath over the top of the filling;
- CLAY / SILTY CLAY / SHALY CLAY – brown, orange-brown, red-brown and grey-brown clays to depths of between 2.0 m and 4.0 m; and
- ROCK – grey, brown and grey-brown laminate or shale.

Free groundwater was not observed in any of the bores whilst augering. The use of drilling fluid prevented groundwater observations during rotary wash-boring and coring.

Selected soil samples were analysed for the range of potential contaminants comprising heavy metals; polycyclic aromatic hydrocarbons (PAH); total recoverable hydrocarbons (TRH); benzene, toluene, ethylbenzene, and xylenes (BTEX), organochlorine pesticides (OCP); organophosphate pesticides (OPP); polychlorinated biphenyls (PCB); total phenols and asbestos. Toxicity characteristic leaching procedure analysis (TCLP) for lead and PAH was conducted on selected samples for waste classification purposes. The results are summarised in Table C1 and C2, Appendix C.

Analytical results were compared to assessment criteria primarily sourced from Schedule B1, National Environment Protection Council, *National Environment Protection (Assessment of Site Contamination) Measure* 1999, as amended 2013 (NEPC, 2013) for a generic commercial land use scenario. The site assessment criteria are further discussed in Section 8.

The analyte concentrations in the soil samples analysed were generally within the adopted assessment criteria with the following exceptions:

- Benzo(a)pyrene TEQ in sample BH6/0.5: 400 mg/kg which exceeded the health investigation level of 40 mg/kg; and
- TRH >C_{16}-C_{34} in sample BH6/0.5: 13,000 mg/kg which exceeded the management limit of 3500 mg/kg.

No asbestos was detected in the soil samples and no significant building rubble was observed in the boreholes. It was noted, however, that there were limitations to the borehole method with regards to detecting asbestos and therefore it is possible that asbestos may be present in the fill material.

It was recommended that additional investigation be conducted in the vicinity of Bore 6 to define the extent and possible source of (PAH and TRH) contamination and to determine if a remediation action plan (RAP) is warranted.

4.3 DP (2016)

Field work for DP (2016) included the drilling of seven boreholes. To attempt to define the extent and possible source of the elevated PAH and TRH concentrations in filling at Bore 6 (DP, 2015), four boreholes (Bores 6A to 6D) were positioned in the garden as "step-out" sampling locations in the vicinity of Bore 6. Bores 101 and 103 were positioned to provide site coverage and Bore 102 was positioned as a step-out sampling location from Bore 101. The borehole locations are shown in Drawing 1, Appendix A.

Bores 6A to 6D were drilled through a surface layer of dark brown silty sand and clayey sand filling with trace gravel and rootlets. At Bores 6A, 6B and 6D, this surficial filling was underlain by brown silty clay filling with trace gravel and rootlets to depths of 0.5 m, 0.7 m and 0.55 m, respectively. At Bore 6C, surficial filling was underlain by brown sandy clay filling with trace gravel and rootlets to a depth of 0.55 m. Natural orange brown clay was penetrated at Bores 6B and 6D to depths of 0.75 m and 1 m, respectively.

Bores 101 and 102 were drilled through a surface layer of brown clayey sand filling with trace gravel, rootlets and grass. Various filling types were encountered beneath the surficial filling including dark brown sandy clay filling with trace gravel, grey gravelly sand filling and brown clay filling with trace gravel. At Bore 101, ash, slag and glass were observed at a depth of 0.1 m to 0.3 m and ash, slag and clinker was observed at a depth of 0.3 m to 0.5 m. At Bore 102, slag and ceramic tile were observed at a depth of 0.1 m to 0.4 m and clinker and slag were observed at a depth of 0.4 m to 0.5 m. Natural orange brown clay was encountered at Bore 101 at a depth of 0.8 m and at Bore 102 at a depth of 1.1 m.

Bore 103 was drilled through a surface layer of brown clayey sand filling with trace gravel, rootlets and grass. Surficial filling was underlain by brown sandy clay filling with some gravel and trace slag to a depth of 0.5 m.

Selected soil samples were analysed for the range of potential contaminants including heavy metals, PAH, TRH; BTEX, OCP; OPP; PCB, total phenols and asbestos. Toxicity characteristic leaching procedure analysis (TCLP) for lead and PAH was conducted on selected samples for waste classification purposes. Results are summarised in Table C1 and C2, Appendix C.

Concentrations of PAH were within the site assessment criteria except for the sample from Bore 101, depth 0.4 - 0.5 m. This sample had a benzo(a)pyrene TEQ concentration of 370 mg/kg which is more than 250 % of the health investigation level (40 mg/kg), and a total PAH concentration of 4900 mg/kg which is above the health investigation level of 4000 mg/kg. Some ash and slag was observed in the filling represented by this sample and are considered to be likely contributing sources of PAH. It was noted that ash was not recorded in the filling samples from other bores, and therefore, it was considered that ash may be the primary source of the recorded concentration of PAH

The primary source of the PAH (and TRH >C_{10}-C_{40}) recorded in the filling at Bore 6, depth 0.5 m, is considered likely to be ash (or possibly slag) rather than a petroleum fuel product. Ash or slag, however, was not noted in the filling samples at Bores 6A to 6D, which recorded considerably lower concentrations of PAH.

It was recommended that, given that excavation of filling is proposed to accommodate Level 01 of the proposed building extension, filling contaminated with PAH (including at Bore 6 and Bore 101) can be

excavated and disposed offsite as part of these works. Filling observed to contain ash and/or slag (likely sources of PAH) whilst excavating should be designated for offsite disposal to a licenced landfill. Further assessment by an environmental consultant would be required where filling is proposed to be reused or retained on site for the development.

It was recommended that, further testing or assessment (preferably *ex situ*) should be carried out to provide final waste classification, particularly in the vicinity of Bores 6 and 6D where the source of the PAH and TRH C_{10}-C_{36} has not been confirmed by visual means. Apart from filling at Bores 6 and 6D, filling was given a preliminary waste classification as General Solid Waste (non-putrescible).

An unexpected finds protocol should be prepared for bulk excavation and construction works to manage unexpected contamination finds (if not already prepared).

Following the excavation of fill soils for Level 01, the underlying natural soil should be inspected and validated to determine if the underlying natural soil can be classified as virgin excavated natural material (VENM).

5. Conceptual Site Model

A conceptual site model (CSM) is a representation of site-related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The CSM provides the framework for identifying how the site became contaminated and how potential receptors may be exposed to contamination either in the present or the future i.e. it enables an assessment of the potential source – pathway – receptor linkages (complete pathways).

Table 1 provides the possible pathways (P1 to P4) between the known contamination source (S1) and receptors (R1 to R6). The CSM has been adopted from DP (2016).

Table 1: Summary of Potential Complete Pathways

Potential Source	Transport Pathway	Receptor
(S1) PAH contaminated filling	(P1) Ingestion and dermal contact (P2) Inhalation of dust	(R1) Site users (Students, university employees, etc.) (R2) Construction workers (for the proposed development) (R3) Maintenance workers (post-development)
	(P2) Inhalation of dust	(R4) Adjacent site users
	(P3) Surface water run-off	(R5) Surface water

Given that proposed development will essentially result in the site being covered by the building and surrounding pavements with very minor peripheral landscaping, terrestrial ecology at the site has not been considered as a potential receptor.

Given that results from DP (2016) do not indicate a significant potential for groundwater contamination from filling at the site, groundwater has not been listed at a potential receptor.

6. Remediation Extent and Options

6.1 Areas of Environmental Concern

Based on the results of DP (2016), the areas of environmental concern are the PAH (and TRH) impacted filling identified at Bore 6 (depth 0.5 m) and Bore 101 (depth 0.4-0.5 m). Given that the PAH contamination has been attributed to ash and slag in the filling (at the garden area), similar contamination may exist in filling at other parts of the site (at the garden area).

6.2 Typical Remediation Options

A number of remediation / management options were assessed. In accordance with NSW Department Environment and Conservation (DEC), *Contaminated Sites: Guidelines for the NSW Site Auditor Scheme*, 2006, the suitability of the remediation options was examined.

Possible remediation options to achieve the remediation goals are identified as follows:

- No action;
- Treatment (on- or off- site);
- Off-site disposal to an approved / licensed site / waste facility; and
- Physical barrier systems.

6.3 Preferred Remediation Option

Based on the proposed bulk excavation to accommodate Level 01, significant volumes of filling and natural soil will need to be disposed off-site for the development. As such, off-site disposal of contaminated soil is the preferred option for remediation.

7. Adopted Remediation Strategy

7.1 Overview and Site Management

The remediation works should be conducted by experienced and appropriately licensed contractors. An experienced environmental consultant will be engaged to inspect the progress of the works and to provide ongoing advice and recommendations as required. The success of the remediation works will be validated by the environmental consultant.

The Principal Contractor (referred to herein as the Contractor) is foreseen to be the party responsible for the day to day implementation of this RAP and shall fulfil the responsibilities of the Principal Contractor as defined by SafeWork NSW. It is noted that the Contractor may appoint appropriately qualified sub-contractors or sub-consultants to assist in fulfilling the requirements of the procedures.

The Environmental Consultant will provide advice on implementing this RAP and validate that the site has been appropriately remediated. In general terms, the Environmental Consultant will:

- Provide advice to their client as required for the remediation works;
- Undertake all validation assessment work, including inspections, sampling and reporting;
- Provide advice and recommendations arising from inspections/ observations;
- Notify their client with the results of any assessments and any observed non-conformances in a timely manner; and
- Undertake the required assessments for disposal of liquid and solid wastes.

7.2 Overview and Site Management

The Contractor will track all soil materials imported onto or disposed of off the site. These will include the tracking of:

- Off-site disposal records for soils (trucking records, landfill dockets, etc.);
- Sources, volumes, dates and location of any imported materials; and
- Estimated volume(s) of any soils imported to or exported from the site.

7.3 Minimising Cross Contamination

Prevention of cross contamination during remediation works is vital to the successful remediation of the site. The following measures must be conducted to manage the potential for cross contamination:

- Undertaking all work in accordance with the RAP; and
- Segregating soils with different contaminant profiles / waste classification during handling works. This includes separation during excavation and loading into trucks and/ or placement of clearly identified, separate stockpiles.

7.4 Programme

The detailed programme and timing of works will depend on the progress of remediation and earthworks, and is the responsibility of the Contractor.

7.5 Further Assessment and Remediation Works

Further assessment and remediation works to be undertaken are described below.

7.5.1 Further Assessment at Bores 6 & 6D

PAH (and TRH) impacted filling has been identified at Bores 6 and 6D, however, the source of the contamination has not been confirmed by visual means. This filling material (within the site boundary) will be disposed off site.

Prior to bulk excavation, further assessment will include:

- Excavate filling down to natural soil from a nominal area (of approximately 8m by 8m is suggested) that includes filling at Bores 6 and 6D and place in a stockpile (separate from other filling materials);
- The Environmental Consultant is to inspect the stockpile and excavation to observe for the possible source of the PAH and TRH. Samples will be collected from the stockpile and the excavation (in accordance with Section 10), and will be analysed (as a minimum) for TRH with silica gel cleanup, PAH and asbestos; and
- Following receipt of laboratory results, the Environmental Consultant will provide advice regarding the source of the contamination, waste classification of the material and the need for further work, if required. The stockpile is to be disposed off site (to a licenced landfill) in accordance with the final waste classification.

7.5.2 General Filling Removal

According to Drawing Number DA 11 (Appendix A), the floor level for Level 01 is at RL 32.2 m and thus, bulk excavation for Level 01 should be to a depth that is below the filling including at Bore 101 where PAH contamination was identified. These excavated materials are designated for off-site disposal.

Following the bulk excavation and offsite disposal of filling, the base and walls of the excavation are to be inspected and sampled by the Environmental Consultant (in accordance with Section 10). Samples will be analysed (as a minimum) for TRH, PAH and metals and any other potential contaminants identified by the Environmental Consultant.

7.5.3 Filling to Remain On Site

Any filling proposed to remain on site (following bulk excavation) will need to be assessed by the Environmental Consultant for its suitability to remain on site. The assessment would include inspection, sampling, analysis and/or a review of existing data. If contamination is identified above the RAC from the assessment, the Environmental Consultant will provided advice on remediation or management of the contamination.

8. Remediation Acceptance Criteria

The remediation works will be validated as meeting an acceptable standard for the proposed land use. The validation will be undertaken by the Environmental Consultant by means of visual inspection, analysis of samples and review of any available plans, as discussed below.

This section provides remediation acceptance criteria (RAC), which will be used to judge the success or otherwise of the remediation by the Environmental Consultant, and are based on a variety of considerations, including field observations and laboratory results.

Analytical results from laboratory testing will be assessed against the (Tier 1) investigation and screening levels sourced from Schedule B1 of the National Environment Protection Council, *National Environment Protection (Assessment of Site Contamination) Measure 1999*, as amended 2013 (NEPC, 2013). This guideline has been endorsed by the NSW EPA under the *Contaminated Land Management* (CLM) *Act* 1997. Schedule B1 of NEPC (2013) provides investigation and screening levels for commonly encountered contaminants which are applicable to generic land uses and include consideration of, where relevant, the soil type and the depth of contamination. The investigation and screening levels are not intended to be used as clean up levels. They establish concentrations above which further appropriate investigation (e.g. Tier 2 or Tier 3) should be undertaken.

The following sub-sections outline the relevant investigation and screening levels adopted for soils and groundwater as documented in the NEPC (2013).

8.1 Soils

8.1.1 Health Investigation Levels

Table 2 shows the health investigation levels (HIL) that have been adopted as RAC for assessing the human health risk from a contaminant via all relevant pathways of exposure. As the site is proposed to be developed into a university building for teaching, HIL have been adopted from Column D (for commercial/industrial sites). The table does not contain the complete list of HIL provided in NEPC (2013).

Table 2: Health Investigation Levels

Contaminant	HIL – D (mg/kg)
Metals	
Arsenic	3000
Cadmium	900
Chromium (VI)	3600
Copper	240 000
Lead	1500
Mercury (inorganic)	730
Nickel	6000
Zinc	400 000
PAH	
Carcinogenic PAH (as Benzo(a)pyrene TEQ)	40
Total PAH	4000

Contaminant	HIL – D (mg/kg)
OCP	
DDT+DDE+DDD	3600
Aldrin + Dieldrin	45
Chlordane	530
Endosulfan	2000
Endrin	100
Heptachlor	50
HCB	80
Methoxychlor	2500
Phenols	
Phenol	240 000
Pentachlorophenol	660
Cresols	25 000
Other Pesticides	
Chlorpyrifos	2000
Other Organics	
PCB	7

8.1.2 Health Screening Level for Vapour Intrusion

Table 3 shows the health screening levels (HSL) for petroleum hydrocarbon compounds adopted for the assessment and are based on the exposure to petroleum hydrocarbons through the dominant vapour inhalation exposure pathway only (i.e. not direct contact to soils). The HSL have been adopted from Column HSL D (for commercial/industrial sites). The HSL derivation has assumed a slab-on-ground construction for building structures, and, therefore is only considered relevant to parts of the site with building structures (yet to be constructed). As clay, sand and silt have been identified at the site, the most conservative HSL for the three soil types have been listed in Table 3.

Table 3: Soil Health Screening Levels for Vapour Intrusion

Contaminant	HSL – D (mg/kg)
	Depth 0 m to <1 m
Toluene	NL
Ethylbenzene	NL
Xylenes	230
Naphthalene	NL
Benzene	3
TPH C_6-C_{10} less BTEX	250
TPH >C_{10}-C_{16} less Naphthalene	NL

Notes: NL is 'not limiting'

HSL for direct contact which were developed for exposure through dermal contact incidental oral ingestion and dust inhalation, have not been listed as they are unlikely to become drivers for further investigation, remediation or site management.

8.1.3 Ecological Investigation Levels and Ecological Screening Levels

Given that the proposed development will essentially result in the site being covered by the building and surrounding pavements with very minor peripheral landscaping it is considered that there will have very limited ecological value and, thus, ecological investigation levels (EIL) and ecological screening levels (ESL) have not been adopted as RAC. If the proposed development is altered to include significant landscaped areas, the use of ecological criteria as RAC will need to be reassessed by the Environmental Consultant.

8.1.4 Management Limits

In addition to appropriate consideration and application of the HSL and ESL, there are additional considerations which reflect the nature and properties of petroleum hydrocarbons, including:

- Formation of observable light non-aqueous phase liquids (LNAPL);
- Fire and explosion hazards; and
- Effects on buried infrastructure e.g. penetration of, or damage to, in-ground services.

Management Limits to avoid or minimise these potential effects have been adopted in NEPC (2013) as interim Tier 1 guidance. The adopted Management Limits, from Table 1B(7), Schedule B1 of NEPC (2013) are shown in the following Table 4. The more conservative Management Limits are shown for from both 'fine' and 'coarse' soil textures given that various soil types were encountered.

Table 4: Management Limits

Contaminant	Management Limit – Commercial and industrial (mg/kg)
TRH C_6 – C_{10}	700
TRH >C_{10}-C_{16}	1000
TRH >C_{16}-C_{34}	3500
TRH >C_{34}-C_{40}	10 000

8.1.5 Asbestos is Soil

According to Schedule B1 of NEPC (2013), the health screening levels for asbestos contamination in soil for a commercial / industrial site are:

- Bonded asbestos-containing materials (ACM): 0.05% w/w;
- Fibrous asbestos (FA) and asbestos fines (AF): 0.001%; and
- All forms of asbestos: no visible asbestos for surface soil.

Asbestos was not identified in DP (2015) or DP (2016). In the case that asbestos is encountered in filling during excavation works, the above screening levels may be adopted for filling/soils to be retained on site.

8.1.6 Potential Impacts on Groundwater

Any soils with potential residual impacts which are to remain on the site will be assessed with respect to the potential contamination risks to groundwater. The scope of this assessment will vary depending on the contaminant of potential concern and the location of the impacted soil. The assessment may include a review of the potential for impacts based on the total concentrations present, the likelihood of migration of water through the soils and/or leachability testing.

8.2 Groundwater

Site assessment criteria for groundwater contaminants are not provided herein as remediation of groundwater is not proposed. If, at a later stage, further assessment of groundwater is considered warranted, GILs will be adopted from ANZECC & ARMCANZ (2000). Generic HSLs for vapour intrusion in Schedule B1 of NEPC (2013) will also be adopted, if applicable.

8.3 Classification for Off-Site Disposal

All soils to be disposed off-site will be assessed and classified in accordance with the POEO Act (1997). For disposal to landfill, the relevant guidelines are the EPA Waste Classification Guidelines 2014.

9. Soil Management

9.1 Importation of Soil

As bulk excavations will result in off-site disposal of soil, importing of significant volumes of soil onto the site is not expected.

If soils are to be imported onto the site they must meet the following requirements (from a contamination perspective):

- The soils must be legally able to be imported onto the site in accordance with the *Protection of the Environment Operations (Waste) Regulation* 2014 and any required Council approvals;
- The soils must meet the RAC (Section 8);
- The soils must be classified as Virgin Excavated Natural Material (VENM), Excavated Natural Material (ENM) or other materials legally able to be imported onto the site based on a Resource Recovery Order. Soils must be assessed in accordance with the EPA requirements. For VENM this generally includes having no signs of concern, metal concentrations at background levels and organic compounds below appropriate laboratory limits of reporting. For non-VENM materials the

EPA requirements would generally include assessment in accordance with the appropriate resource recovery order; and

- The material must be inspected during importation by the Contractor, and any materials not meeting the description given in the provided documentation or displaying signs of contamination will be rejected.

Prior to the importation of soil, advice from the Environmental Consultant should be sought to confirm that the material meets the above requirements.

9.2 Stockpiling of Contaminated Material

Stockpiles should be managed to minimise the risk of dust generation, erosion and leaching. The measures required to achieve this will depend on the materials in the stockpile and the length of time the stockpile is to remain on site, but should include:

- Restrict the height of stockpiles to reduce dust generation;
- Construct erosion and sediment control measures;
- Cover stockpiles of asbestos impacted soils to be left on site for more than a day;
- Cover stockpiles of chemically contaminated soils to be left on site for a continuous non-work period of more than one night (e.g. a long weekend), or if windy conditions are expected;
- Keep temporary stockpiles moist, by using water spray where required; and
- Manage the potential for leaching from stockpiles (where required) by placing on a low permeability base and/ or validating the base of the stockpile following its removal. Where this is a potential issue, specific advice should be sought from the Environmental Consultant.

9.3 Waste Disposal

All off-site disposal of wastes, where required, will be undertaken in accordance with the POEO Act.

Any soils removed from the site will be classified in accordance with either:

- The EPA *Waste Classification Guidelines* 2014; or
- A General or Specific Order under the *Protection of the Environment Operations (Waste) Regulation* 2014.

No soils will leave the site without a formal waste classification.

9.3.1 Assessment of Soil

A waste classification/ resource recovery order assessment will be required for any soils to be disposed off-site. Assessment works will be undertaken by the Environmental Consultant based on previous analytical data, field observation and additional testing results. The process of assessment will comprise:

- Inspection for signs of concern (e.g. asbestos-containing materials, staining, odours);
- Determination of the source of the material to determine what previous results may be relevant;
- Additional testing and analysis where necessary based and the material type/ condition. Any testing will need to characterise the subject material appropriately (e.g. including sampling from depth in stockpiles); and
- Provision of a report (to the Contractor) clearly stating the classification of the subject material.

Based on the results the Environmental Consultant will provide advice on the appropriate disposal options for the material.

9.3.2 Spoil Contingency Plan

This plan caters for the storage, treatment and disposal of excavated spoil which fails to meet the criteria for direct disposal to a landfill (i.e. Hazardous Waste). Any suspected Hazardous Waste materials should have their classification confirmed by the Environmental Consultant, including additional sampling and analysis as appropriate, prior to implementing this contingency plan.

Hazardous Waste (if encountered) will be handled as follows:

- Materials of the same spoil category/ contamination issue will be carefully excavated and placed as separate stockpiles at demarcated and contained locations. The categorisation would be done on the basis of on-site observations and the contaminant exceedances detected;
- Stockpiles of excavated materials will be appropriately bunded (e.g. with sandbags) and covered with anchored geotextile or impermeable plastic sheeting, or alternatively placed in an appropriate container e.g. waste skip, with appropriate cover. Materials considered to have the potential to produce contaminated leachate will be stockpiled in an area with an appropriate leachate collection system;
- Sampling and analysis of segregated stockpiles will be conducted to determine the concentrations of the target parameters in the excavated materials (e.g. leachability of the contaminants of concern, treatability studies);
- Should the sampling and testing confirm the Hazardous Waste category, a treatment methodology will be determined, which may to treat the material for re-use on-site or to a suitable standard for landfill disposal;
- If the material is to be disposed off-site, appropriate applications will be made to the EPA. It is foreseen that treatment and management of Hazardous Wastes to be disposed off-site would be conducted by a specialised contractor. Agreement as to the appropriateness of the treatment and disposal method for materials must be obtained from the EPA, and disposal consent must be sought from the Hazardous Waste Regulation Unit of the EPA prior to the removal of such wastes from the site; and
- An appropriately licensed Hazardous Waste remediation contractor will be appointed to manage the waste and remove from site in accordance with the methodology agreed with the EPA.

9.3.3 Loading and Transport of Spoil

All transport of waste and disposal of materials must be conducted in accordance with the requirements of the POEO Act. All licences and approvals required for disposal of the material will be obtained prior to removal of the materials from the site.

Removal of waste materials from the site shall only be carried out by a licensed contractor holding appropriate licence, consent and/ or approvals to dispose of the waste materials according to the assigned waste classification and the corresponding requirements outlined in the EPA *Waste Classification Guidelines* 2014, and with the appropriate approvals obtained from the EPA, if required.

Details of all soils removed from the site (including VENM) shall be documented by the Contractor with copies of weighbridge slips, trip tickets and consignment disposal confirmation (where appropriate) provided to the Environmental Consultant and the PR. A site log shall be maintained by the Contractor to track disposed loads against on-site origin.

Transport of spoil shall be via a clearly delineated, pre-defined haul route. The proposed waste transport route will be notified to the local Council and truck dispatch shall be logged and recorded by the Contractor for each load leaving the site.

9.3.4 Disposal of Material

All materials excavated and removed from the site shall be disposed in accordance with the POEO Act to a facility/ site legally able to accept the material. Copies of all necessary approvals from the receiving site shall be given to the PR prior to any contaminated material being removed from the site. A record of the disposal of materials will be maintained.

All relevant analysis results, as part of waste classification reports, shall be made available to the Contractor and proposed receiving site/ waste facility to enable selection of a suitable disposal location. Holding arrangements, treatment and disposal requirements for excavated materials which fail to meet the landfill disposal guideline levels are discussed in Section 9.3.2.

Copies of all consignment notes for the transport, receipt and disposal of all materials will be maintained as part of the site log.

10. Validation Plan and Sampling Plan

10.1 Data Quality Objectives and Indicators

The validation assessment will be conducted in accordance with Data Quality Objectives (DQOs) and Quality Assurance/Quality Control (QA/QC) procedures to assess the repeatability and reliability of the results.

The validation assessment will be planned in accordance with the following DQOs:

- State the Problem;
- Identify the Decision;

- Identify Inputs to the Decision;
- Define the Boundary of the Assessment;
- Develop a Decision Rule;
- Specify Acceptable Limits on Decision Errors; and
- Optimise the Design for Obtaining Data.

A checklist of Data Quality Indicators (DQI) in accordance with NEPC (2013) Schedule B2 will be completed as part of the validation assessment. The DQIs are:

- Documentation completeness;
- Data completeness;
- Data comparability and representativeness; and
- Data precision and accuracy.

Based on fulfilment of the DQOs and DQIs an assessment of the overall data quality will be presented in the validation assessment report.

10.2 Soil Sampling Frequencies

The soil sampling frequency will depend on the volume or area to be assessed and the previous results. As a guide, the following sampling frequencies will be used for validation works and may be reduced for larger volumes or areas:

Excavations

Small to medium excavations (base <500 m^2):

- Base of excavation: one sample per 25 m^2 to 50 m^2 or part thereof. Where high local variation is expected, a minimum of three samples will be collected.
- Sides of excavation: one sample per 10 m length or part thereof. Additional samples will be collected at depths of concern where there is more than one depth of concern.

Large excavations (base ≥500 m^2):

- Base of excavation: sampling on a grid at a density in accordance with the EPA *Contaminated Sites: Sampling Design Guidelines* (1995) or a minimum of 10 samples. In sub-areas with any specific signs of concern, a higher sampling density may be required.
- Sides of excavation: one sample per 20 m length or part thereof (where possible). Additional samples will be collected at depths of concern where there is more than one depth of concern.

Stockpiles

Assessment of stockpiled soils (note that the actual frequency will be determined based on volume, contamination risk, exiting data and homogeneity of the material):

- Stockpiles ≤250 m^3: one sample per 25 m^3 or a minimum of three samples;

- Stockpiles 250 m^3 to 1,000 m^3: one sample per 50 m^3 to 100 m^3, or a minimum of 10 samples; and
- Stockpiles >2,500 m^3: one sample per 100 m^3 to 250 m^3, or a minimum of 12 samples.

Samples will be collected from stockpiles at various depths to characterise the full depth of the stockpile.

10.3 Field Sampling Methods

10.3.1 Soils

The following general sampling methodology is to be implemented for soil sampling:

- Preparing records of samples, including sample date, location, description, signs of concern, and any field results;
- Sampling from surface or from the utilised plant using disposable sampling equipment or stainless steel hand tools;
- Decontaminating all re-useable sampling equipment prior to collecting each sample using a 3% solution of phosphate free detergent (Decon 90) and distilled water;
- Transferring samples into laboratory-prepared glass jars with Teflon-lined lid, and capping immediately (for chemical analytes);
- Labelling sample containers with individual and unique identification, including project number and sample number;
- Collecting of an additional replicate set of samples in sealed plastic bags for visual identification, volatiles screening using a photoionisation detector (PID) (if required), and/or records purposes;
- Placing the glass jars for chemical analysis into a cooled, insulated and sealed container for transport to the laboratory; and
- Using chain-of-custody documentation so that sample tracking and custody can be cross-checked at any point in the transfer of samples from the field to hand-over to the laboratory.

10.3.2 Water

It is noted that water sampling has not been proposed for validation sampling; however, in the case that water samples are to be collected, the following general sampling methodology is to be implemented for water sampling:

- Preparing record of samples, including sample date, location, description, signs of concern, and any field results;
- Decontaminating all re-useable sampling equipment prior to collecting each sample using a 3% solution of phosphate free detergent (Decon 90) and distilled water;
- Immediate placement of sample in laboratory prepared sample containers and capping;
- Labelling sample containers with individual and unique identification, including project number and sample number;

- Placing the samples into a cooled, insulated and sealed container for transport to the laboratory; and
- Using chain-of-custody documentation so that sample tracking and custody can be cross checked at any point in the transfer of samples from the field to hand-over to the laboratory.

If a groundwater monitoring well is to be sampled, micro-purging of the well using a low flow pump until field parameters (such as pH, temperature, dissolved oxygen, EC and redox) have stabilised should be undertaken prior to sampling.

10.4 Field Quality Control and Quality Assurance

QA/QC procedures will be adopted to assess the repeatability and reliability of the results.

Field QA/QC testing will include the following:

- 5% sample inter-laboratory analysis, analysed for the same suite as the primary sample;
- 5% sample intra-laboratory analysis, analysed for the same suite as the primary sample; and
- Rinsate samples (where re-useable sampling equipment is used), analysed for the suite as the majority of the primary samples.

10.5 Laboratory Analysis

Laboratory analysis of samples will be undertaken by laboratories with NATA accreditation for the analyte being tested. The laboratory will undertake in-house QA/QC procedures.

Samples will be analysed for the contaminants of concern identified for the sampling purpose. These contaminants will be identified based on available laboratory results from previous testing, field observations and the objective of the analysis.

10.6 Validation Reporting and Supporting Documents

The following documents will need to be reviewed as part of the validation assessment, and will need to be provided by the referenced companies and/or personnel.

The Contractor is to provide:

- Records of any liquid waste removal and disposal, including disposal dockets;
- Disposal dockets: for any soil materials disposed off-site, the contractor will supply records of: transportation, spoil disposal location, receipt provided by the receiving waste facility (where available);
- Imported materials records: records for any soil imported onto the site, including source site, classification reports;
- Photographic evidence of remediation works (at times when the Environmental Consultant is not at site during remediation works); and

- Records relating to any unexpected finds and contingency plans implemented.

The Environmental Consultant will prepare or obtain the following documents:

- Chain-of-Custody documentation;
- Letters/ memos as required to provide instruction or information to the Contractor; and
- A validation report.

The validation report shall detail the methodology, results and conclusion of the assessment and include photographic evidence of the remediation. The validation report is to make a clear statement regarding the suitability of the site for the proposed land use.

11. Site Management Plan

11.1 Standard Site Management Plan Requirements

It is the responsibility of the Contractor to develop a site management plan(s) (SMP) detailing site management, environmental management and work health and safety (WHS) (including site emergency response) plans for the site. The SMP that is developed by the contractor, must include the details of the remediation scheduling, contact details of relevant personnel for the project (including contact details for community liaison) and management plans for construction and implementation of the project.

Works will comply with all legislative requirements including, but not limited to, those set out under the following Acts (and their subsequent amendments and regulations):

- Environmentally Hazardous Chemicals Act, 1985;
- Hazardous Chemicals Act, 1985;
- Environmental Offences and Penalties Act, 1989;
- Agricultural and Veterinary Chemicals Act, 1994;
- Protection of the Environment Operations Act, 1997 (POEO Act);
- Contaminated Land Management Act, 1997 (CLM Act);
- Pesticide Act, 1999;
- Work Health and Safety Act, 2011 (WHS Act);
- OHS Amendment (Dangerous Goods) Act, 2003 (including OHS Amendment (Dangerous Goods) Regulation 2005); and
- POEO Amendment Act, 2005 (including POEO Amendment (Scheduled Activities and Waste) Regulation 2008).

11.2 Site Operations

Remediation works will be restricted to the hours as may be set in the Consent Conditions.

It is the site owner's/ project proponent's responsibility to ensure appropriate personnel are appointed to manage and conduct the remediation and validation works.

The Contractor will be responsible for preparing a list of contacts, including emergency contacts for the site operations and provision of signage at the site to allow the public to contact nominated site personnel out of hours.

Prior to the commencement of site remediation works, the following interim controls will be in place:

- The construction of permanent fences around the subject area meeting appropriate specifications to prevent unauthorised entry; and
- Any pits or unstable areas on site that may generate potential WHS or operational risk will be demarcated and taped off, with appropriate rectification action undertaken (e.g. backfilling of pits as soon as practicable to prevent undue injuries to workers etc.).

11.3 Environmental Management

The work will be undertaken with all due regard to the minimisation of environmental effects and to meet all statutory requirements. The contractor will have in place a Construction Environmental Management Plan (CEMP) for the work which covers, as necessary, the following items:

- Site stormwater management;
- Soil management;
- Noise and vibration control;
- Dust control;
- Odour control; and
- Contingency measures for environmental incidents.

The contractor will also be responsible to ensure that the site works comply with the following conditions:

- Fugitive dust leaving the confines of the site is minimised;
- No water containing suspended matter or contaminants leaves the site in a manner which could pollute the environment;
- Vehicles are cleaned and secured so that no mud, soil or water are deposited on any public roadways or adjacent areas;
- Spoil is managed in accordance with this RAP; and
- Noise and vibration levels at the site boundaries comply with the legislative requirements.

11.4 Specific Requirements for Chemical Contaminants

The risk to workers during construction works from the chemical contaminants is considered to be generally low. However, as with all contaminated soils, measures should be undertaken to minimise the potential exposure of workers to contamination. These include:

- Minimising dermal contact with contaminated soil/ water;
- Minimising ingestion with contaminated soil/ water, including of dust; and
- Minimising inhalation of vapours from with contaminated soil/ water.

The above can be achieved by the use of appropriate PPE and good hygiene (e.g. washing hands prior to eating/ upon completion of work).

12. Unexpected Finds Protocol

All site personnel will be inducted into their responsibilities under this Unexpected Finds Protocol (UFP), which should be included in the Contractors SMP.

All site personnel are required to report the following to the Site Manager if observed during the course of their works:

- Signs of unexpected environmental concern, e.g. presence of unexpected fibre cement, petroleum, or other chemical odours, unnatural staining, potential contamination sources (such as buried drums or tanks) or chemical spills.

Should signs of concern be observed, the Contractor will, as soon as practical:

- Place barricades around the affected area and cease work in that area;
- Notify authorities needed to obtain emergency response for any health or environmental concerns (e.g. fire brigade);
- Notify any of the authorities that the Contractor is legally required to notify (e.g. EPA, Council); and
- Notify the Environmental Consultant.

The Environmental Consultant will inspect the issue of concern and determine the nature of the issue, whether it comprises an area of environmental concern (AEC), and the appropriate approach to assessing or (if appropriate) managing the issue. If contamination is found and remediation action is considered necessary, a remediation strategy for the area of environmental concern will be prepared by the Environmental Consultant. If the AEC or proposed remediation strategy is significantly different than that detailed in the RAP, the Consent Authority will be provided notification of the proposed works.

12.1 Specific Requirements for Unexpected Finds of Asbestos in Soil

If possible asbestos is identified in filling during site development works the following specific protocol is to be applied:

- Upon discovery of suspected asbestos-containing material, the site manager is to be notified and the affected area closed off by the use of barrier tape and warning signs. Warning signs shall be specific to Asbestos Hazards and shall comply with the Australian Standard 1319-1994 – Safety Signs for the Occupational Environment;
- An Occupational Hygienist is to be notified to inspect the area and confirm the presence of asbestos and to determine the extent of remediation works to be undertaken. A report detailing this information would be compiled by the Occupational Hygienist and provided to the Contractor;
- If the impacted soil is to be disposed off site, it should be classified in accordance with the NSW EPA, *Waste Classification Guidelines,* 2014 and disposed of, as a minimum, as asbestos contaminated waste to a landfill licensed to receive such waste;
- In dry and windy conditions the stockpile would be lightly wetted and/or covered with plastic sheet whilst awaiting disposal;
- All work associated with asbestos in soil would be undertaken by an appropriately licenced asbestos removalist. WorkCover must be notified at least five days in advance of any asbestos works;
- Monitoring for airborne asbestos fibres is to be carried out during the soil excavation in asbestos contaminated materials (as per advice from the Occupational Hygienist);
- At the completion of the excavation, a clearance inspection is to be carried out by the Occupational Hygienist. Written advice of the clearance is to be provided by the Occupational Hygienist;
- Following clearance by an Occupational Hygienist, the area may be reopened for further excavation or construction work; and
- Details of the asbestos removal works are to be kept in the site record.

13. Conclusion

It is considered that the site can be rendered suitable for the proposed development subject to appropriate remediation and management in accordance with this RAP.

It is considered that conformance with this RAP would minimise the potential for environmental impacts during the remedial and construction works at the site.

The success of the remediation will need to be validated as detailed herein.

14. Limitations

Douglas Partners (DP) has prepared this report (or services) for the Carslaw Building extension project at Eastern Avenue, The University of Sydney in accordance with DP's proposal dated 27 April 2016 and acceptance received from Sam Gibson on 27 April 2016. This report is provided for the exclusive use of The University of Sydney for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. 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 on the site only at the specific sampling and/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 human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during previous investigations. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing 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 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 stated 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

Drawings