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31st August 2017

Our Ref: JC17302A-r1

Penrith City Council
PO Box 60
PENRITH NSW 2751

Attention: Mr Steve Stepanovic

Dear Sir

Re Pavement Investigation and Fill Contamination Assessment
Proposed Car Park
North Street Penrith

1.0 Introduction

As requested, we have carried out a pavement and fill contamination assessment for the proposed car park to be located on the southern side of North Street Penrith as shown on the attached Drawing No 1.

This report presents the following;

- Assessment of the existing subsurface conditions including presence of fill and asbestos
- Subgrade assessment including laboratory CBR testing.
- Comments and recommendations on pavement design and construction.
- Assessment on the presence of contaminated fill and asbestos and recommendations to management the fill.

2.0 Investigation Methodology

2.1 Field Investigation

Fieldwork for the investigation was carried out on the 24th February 2017 and included excavation of seventeen test pits TP 1 to TP 17) using a 5-tonne excavator as shown on the attached Drawing No 1. The test pits were excavated through to depths ranging from 0.5m to 1.6m below existing ground surface.

To assess the strength of the subgrade, hand penetrometer tests were carried out on the test pit walls. The test pits were noted for groundwater seepage during and upon completion of the investigation.

The test pit locations are indicated on the attached Drawing No 1. The subsurface profiles encountered in the test pits are summarised on the attached Table 1. The investigation was supervised on a full-time basis by our engineer, who was responsible for locating the test pits, logging the test pits and carrying out insitu testing. Upon completion of the test pit investigation, the test pits were backfilled using excavation spoil and compacted using the excavator bucket.

2.2 Laboratory Testing

Two subgrade samples were taken from the test pits for California Bearing Ratio (CBR) analysis in our NATA accredited laboratory.

Five fibro fragments were taken from the test pits (TP 4, 7, 8, 12 and 15) and sent to Envirolab Services Pty Ltd for asbestos analysis.

In addition, two soil samples (TP 4[0.0-0.1m] and TP 17[0.2-0.3m]) were taken from the test pits for laboratory analysis by Envirolab Services Pty Ltd, a NATA accredited laboratory to aid assessment of soil contamination and waste classification. The soil samples were analysed for contaminants of concern consisting of;

- Heavy Metals - Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury (Hg), Lead (Pb), Nickel (Ni) and Zinc (Zn)
- Organochlorine Pesticides (OCP).
- Polychlorinated Biphenyls (PCB)
- Total Recoverable Hydrocarbons (TRH)
- Benzene, Toluene, Ethyl Benzene and Xylene (BTEX)
- Polycyclic Aromatic Hydrocarbon (PAH)
- TCLP – heavy metals and PAH
- pH.

The analytical program is presented in Table 2. Laboratory results for soil samples are summarised in Tables 2 to 9. The soil analysis was performed by Envirolab Services Pty Ltd, a laboratory accredited by the National Association of Testing Authorities (NATA). The analytical results and methods employed are presented in the attached Laboratory Test Report.

3.0 Results of the Investigation

3.1 Subsurface Conditions

Reference should be made to the attached Table 1 for details of the surface conditions encountered in the boreholes.

The following is a summary of subsurface conditions encountered;

- Topsoil and Topsoil/Fill were encountered in all test pits with thickness typically ranging from 150mm to 500mm. Relatively thick Topsoil/Fill of about 0.6m and 0.7m was encountered in TP 16 and 17. The Topsoil and Topsoil/fill were found to consist predominantly of Clayey Silt and Gravelly Sandy Silt with varying quantities of building debris such as bricks, concrete, glass, tile and porcelain fragments. Some asbestos fragments were encountered in the topsoil/fill in TP 4, 7, 8, 12, 15 and 17.
- A thin layer of crushed sandstone fill about 200mm thick was encountered in TP 7 and 9 and a layer of clayey fill about 100mm thick was encountered beneath the topsoil/fill n TP 13. Some building debris including concrete, tiles and porcelain fragments were encountered in TP 13.

- Natural medium to high plasticity Silty Clay was encountered beneath the topsoil and fill at depths ranging from 0.3m to 0.7m below existing ground surface. Based on the hand penetrometer test results, the natural clay was assessed to be generally very stiff. The natural clay was generally found to be dry.
- Bedrock was not encountered in the test pits which were taken to a maximum depth of 1.6m below existing ground surface.
- A layer of topsoil was encountered below the sandy fill subgrade material in all boreholes except BH 1 consisting of Sandy Silt with a trace of root fibres at depths ranging from 0.6m to 1.0m below existing ground surface. The topsoil was generally found to have thickness of about 100mm to 200mm.
- All test pits were found to be dry during and shortly after completion of the test pit investigation.

3.2 Laboratory Test Results – Pavement Subgrade

Two natural subgrade samples were taken from TP 2 (0.4-0.6m) and TP 15 (0.4-0.6m) were tested for four-day soaked California Bearing Ratio (CBR) and the results obtained are shown on the attached laboratory test results report.

The soaked CBR tests samples were compacted to a dry density ratio of 100% Standard (AS1289 5.1.1) at a moisture content close to Standard Optimum. The following is a summary of the CBR test results;

Sample	Maximum Dry Density (t/m^3)	Optimum Moisture Content (%)	CBR (%)
TP 2 (0.4-0.6m)	1.68	21.0	6.0
TP 15 (0.4-0.6m)	1.79	17.0	6.0

3.3 Laboratory Test Results - Contamination

Assessment Criteria

The results of laboratory analyses for this investigation were compared with published Australian contamination assessment criteria. These Criteria were originally presented in the Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites, January 1992 (ANZECC/NHMRC Guidelines, Reference 3). The OEH endorsed the use of these guidelines for the assessment of contaminated sites.

More recent guidelines such as those published by the OEH and National Environmental Health Forum (NEHF) (Reference 5) are commonly used to assess contaminant concentrations. The NEHF criteria which was recently updated by the National Environment Protection Council Service Corporation (NEPC) in the National Environmental Protection (Assessment of Contaminated Sites) Measure (NEPM) – Schedule B1 (Reference 6) includes health based soil investigation levels (HBILs) and this was adopted by OEH in May 2013.

HBILs are scientifically based, generic assessment criteria designed to be used in the first stage (Tier 1 or 'screening') of an assessment of potential risks to human health from chronic exposure to contaminants. They are intentionally conservative and are based on a reasonable worst-case scenario

For the purpose of assessing the contamination status of the site, the criteria for the Public Open Space, HBILs 'C' has been adopted as the Site Criteria. The criteria for the most sensitive landuse, that being HBIL A residential with garden/accessible soil, is also included in the assessment for comparison.

The more recent updates to the NEPM criteria (Reference 6) have included Health Screening Levels (HSL) developed by the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) leading to the adoption of health criteria for TRH, BTEX and PAH. The HSLs have been developed for selected petroleum compounds and fractions and are applicable to assessing human health risk via the inhalation and direct contact pathways. The HSLs depend on specific soil physicochemical properties, land use scenarios, and the characteristics of building structures and they apply to different soil types and depths below surface up to 4 m depth.

For the purpose of assessing the contamination status of the site for TRH, BTEX and PAH, the HSL A and B (Low to high density residential) have been adopted.

For off-site disposal of surplus fill to a landfill, the material to be excavated from sites is regulated by the provision of the Protection of the Environment Operations Act (POEO Act 1997) and associated regulations and guidelines including the NSW EPA Waste classification Guidelines (Reference 9)

The relevant criteria are presented in the summary table of results (Table 3 to 9)

Chemical Results

The laboratory test results indicate the following;

- The concentrations of heavy metals in the soil samples were found to be within the Site Criteria for open space (ie HBIL 'C'). The concentrations of Lead of 320mg/kg and 330mg/kg in the soil samples were found to exceed the HBIL 'A' criteria for residential.
- The concentrations of OCP in the soil samples were found to be negligible or below laboratory detection limits and therefore within the Site Criteria.
- The concentrations of PCB in the soil samples were found to be below laboratory detection limits and therefore within the Site Criteria.
- The concentrations of TRH in the soil samples were found to be below laboratory detection limits and therefore within the Site Criteria.
- The concentrations of BTEX in the soil samples were found to be below laboratory detection limits and therefore within the Site Criteria.

- The concentrations of PAH in the soil sample from TP 4 were found to be negligible or below laboratory detection limits and therefore within the Site Criteria. Slightly elevated concentrations of PAH were encountered in the soil sample from TP 17 with Total PAH of 31mg/kg, however such a concentration is within the Site Criteria.
- Both soil samples did not encounter asbestos fibre (Fibre Asbestos-FA or Asbestos Fibre – AF). All asbestos fragments (Asbestos Cement Material – ACM) obtained from TP 4, 7, 8, 12 and 15 were found to contain Chrysotile, Amosite and Crociolite.

4.0 Comments and Recommendations

We understand that the proposed development will include construction of a temporary car park. Details of the proposed temporary car park are not available at this stage and it may include some site regrading by cut and fill.

The site investigation revealed the site to be generally underlain by a layer of topsoil/fill with thickness typically ranging from 150mm to 500mm and in two test pit locations (ie TP 16 and 17), the topsoil/fill was found to be 600mm and 700mm thick. Natural Silty Clay was encountered beneath the topsoil/fill and this natural clay was assessed to be very stiff.

For the proposed development, the following geotechnical and contamination issues will need to be considered;

- The topsoil/fill material is not considered to be suitable as subgrade material for the proposed car park from the geotechnical perspective without improvement by mixing with some better quality compactable fill material.
- The topsoil/fill material is impacted by ACM (Asbestos) and therefore removal of this material will incur costly landfill tip fees as this material would be classified as "Special Waste – Asbestos" in accordance to NSW EPA guidelines (Reference 9). We understand that at this stage, there is minimal cost allowance to dispose or treat the asbestos impacted topsoil/fill.
- Mixing and blending of the topsoil/fill with good quality fill to improve subgrade properties for the proposed car park will result in contaminating good quality fill with asbestos and therefore lead to higher clean up cost in future.
- Filling directly over the topsoil/fill with good quality subgrade material to improve the subgrade characteristic and regrade the site for the car park will result potential difficulty in separating the good fill from the underlying asbestos contaminated topsoil/fill should the site be redeveloped in future.

Based on the foregoing, we recommend the asbestos impacted fill material be managed on site by isolation and encapsulation within a designated area preferably in an area which will not be developed in future (eg future parkland, reserve or road shoulders). This will typically involve;

- Stripping and excavation of asbestos impacted topsoil/fill to expose the natural clay.
- Excavation of a burial cell and the size of the cell should be proportioned to the estimated volume of the asbestos impacted fill. The burial cell should ideally be situated below the zone of future ground disturbance (ie service trenches).
- Survey of the extent of excavation works and documentation for future reference.

- Placement of the asbestos impacted topsoil/fill in layers and compacting to a minimum 95% Standard Maximum Dry Density (SMDD) at close to Optimum Moisture Content (OMC).
- Placement of a layer of geofabric over the top to delineate the buried asbestos impacted topsoil/fill.
- Placement of clean and validated fill to form a 1m thick capping barrier
- The surface should be turfed and vegetated to control erosion and scouring of barrier or covered with car park pavements.

An environmental management plan should be in placed to ensure;

- The asbestos impacted fill are not unknowingly disturbed in the future
- The barrier is maintained and not breached.
- No subsurface water is introduced into the ground resulting in weathering/disintegration of bonded asbestos and potential migration asbestos off site.
- All future redevelopment of the site do not pose an occupation health hazard to workers.

The laboratory test results indicate the underlying natural subgrade to have a CBR value of 6%. We recommend a more conservative CBR value of 5.0% be adopted for the carpark pavement design.

The pavement thickness of the proposed car park will depend on the design assumptions adopted for the traffic loadings. Note that traffic loadings are commonly measured in terms of Equivalent Standard Axles (ESA) of commercial vehicles exceeding 3 tonnes and loads from private vehicles are not considered significant enough to be taken into consideration for pavement design.

However, as pavement damaging effect is a function of the "Fourth Power" law (ie damage effect equal axle load over standard load to the power of four), over loading of axles will have exponential effects on the damage to the pavement. We therefore suggest the proposed car park pavement be designed to accommodate some commercial vehicles particularly in the entrance/exist and access roadway, otherwise adequate physical barriers or signs should be erected to prohibit entry of heavy vehicles.

The following pavement design may be adopted depending on the design traffic loading adopted;

Pavement Material	**Strictly Car Park ESA = 5 x 10^3**	**ESA = 5 x 10^4**	**ESA = 1 x 10^5**
Asphaltic Concrete (AC10)	25mm	25mm	25mm
DGB20 Base Course Material	100mm	100mm	100mm
Sandstone Subbase Material	150mm-	210mm	260mm
Total	**275mm**	**335mm**	**385mm**

The above pavement construction should take into account the following construction procedure;

- The subgrade should be wetted and the surface rolled with a minimum 10 tonne vibrating roller with a minimum 7 passes. The surface should be observed for soft and heaving areas and any soft and heaving areas encountered should be excavated and replaced with good quality granular material (ie subbase quality) compacted to a minimum 98% SMDD.
- Subbase and base course material should be compacted to achieved a minimum 98% MMDD compaction.
- The pavement construction should be supervised and tested by a NATA accredited laboratory.
- Adequate surface and subsurface drainages should be in placed to keep the subgrade dry.

5.0 Limitations

The interpretation and recommendations submitted in this report are based in part upon data obtained from a limited number of boreholes at discrete locations. There is no investigation which is thorough enough to determine all site conditions and anomalies, no matter how comprehensive the investigation program is as site data is derived from extrapolation of limited test locations. The nature and extent of variations between test locations may not become evident until construction.

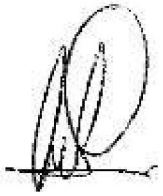
In view of the above, the subsurface conditions between the test locations may be found to be different or interpreted to be different from those expected. If such differences appear to exist, we recommend that this office be contacted without delay.

The statements presented in this document are intended to advise you of what should be your realistic expectations of this report and to present you with recommendations on how to minimise the risk associated with groundworks for this project. The document is not intended to reduce the level of responsibility accepted by GeoEnviro Consultancy Pty Ltd, but rather to ensure that all parties who may rely on this report are aware of their responsibilities.

Your attention is drawn to the attached "Explanatory Notes" and this document should be read in conjunction with our report

If you have any queries regarding the above, please contact the undersigned.

Yours faithfully
GeoEnviro Consultancy Pty Ltd



Solern Liew CPEng
Director

Attachment: Drawing No 1: Test Pit Location Plan
Table 1: Summary of Subsurface Profile
Table 2 to 9: Summary of Laboratory Analytical Results
Laboratory Test Reports
Explanatory Notes

C:\17JOB\302\JC17302A-r1.DOC

REFERENCES

1. *1:100,000 Soil Landscape Map of Penrith – Soil Conservation Service of NSW ; Sheet 9029-9129*
2. *1:100,000 Geological Map of Penrith– Geological Series Sheet 9029-9129 (Edition 1) 1985*
3. *Australian & New Zealand Guidelines for the Assessment and Management of Contaminated Sites, Australian and New Zealand Conservation Council and National Health and Medical Research Council, 1992.*
4. *Assessment of Orchard and Market Garden Contamination - Contaminated Sites Discussion Paper, NSW EPA 1999.*
5. *Health Based Soil Investigation Levels, National Environmental Health Forum Monographs Soil series No. 1 – 1996*
6. *National Environment Protection (Assessment of Site Contamination) Measure 1999(including updated Schedule B1 – 2013*
7. *Guidelines for Assessment Service Station Sites – NSW EPA 1994*
8. *Guidelines for the NSW Auditor Scheme, NSW EPA*
9. *Part 1 – Classifying Waste – 2014 , NSW DEC*

Legend

Test Pit

GeoEnviro Consultancy
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Drawn By: AT	Date: 24/8/17	Penrith City Council
Checked By: SL	Date: 24/8/17	North Street Penrith
Revision By:	Date:	Test Pit Location Plan
Scale: Not to Scale	A3	Project No: JC17302A / Drawing No: 1

c:\\lab\report\R012

Form No. R012/Ver02/06/07

Sample	Depths (m)	Sample Date	Sample Type	Analysis															
				pH	Heavy Metals								OCP	PCB	TRH	BTEX	PAH	Asbestos	TCLP (Heavy Metals + PAH)
					As	Cd	Cr	Cu	Pb	Hg	Ni	Zn							
TP4	0.0-0.1	24/07/2017	Soil/ACM	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
TP7	Fragments	24/07/2017	ACM															o	
TP8	Fragments	24/07/2017	ACM															o	
TP12	Fragments	24/07/2017	Soil/ACM															o	
TP15	Fragments	24/07/2017	ACM															o	
TP17	0.2-0.3	24/07/2017	Soil	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

Note: O denotes tested

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TABLE 1

Analytical Program

Penrith City Council
Proposed Temporary Car Park
North Street Penrith

Sample	Depths (m)	pH	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
TP 4	0.00-0.10	6.6	7	0.6	15	37	320	0.1	9	580
TP17	0.2-0.3	5.4	15	<0.4	15	100	330	1	8	120
HBILs 'A' Criteria			100	20	100 (VI)	600	300	40	400	7400
HBILs 'C' Criteria			300	90	300 (VI)	17000	600	80	1200	30000

Notes

1) All results are expressed as mg/kg and pH (units).

2) Figures in bold italics exceed the EIL Criteria

3) Figures in bold italics exceed the HBIL 'A' Criteria

4) Ambient Background Concentrations

5) Added Contaminant Limits

* EIL = ABC+ACL

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TABLE 2

Summary of Analytical Results - Heavy Metals

Penrith City Council

Proposed Temporary Car Park

North Street Penrith

Prepared By: SL Date: 7/09/2017
Checked By:__SG___Date:7/09/2017

Sample	Depths (m)	HCB	alpha-BHC	gamma-BHC	beta-BHC	Heptachlor	delta-BHC	Aldrin	Heptachlor Epoxide	gamma-Chlordane	alpha-chlordane	Endosulfan I	pp-DDE	Dieldrin	Endrin	pp-DDD	Endosulfan II	pp-DDT	Endrin Aldehyde	Endosulfan Sulphate	Methoxychlor	Total OCP
TP 4	0.00-0.10	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	0.2	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND
TP17	0.2-0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND
HBILs 'A' Criteria		10				6		6		50		270	240	6	10	240		240			300	
HBILs 'C' Criteria		10				10		10		70		340	400	10	20	400		400			400	

Notes

1) All results are expressed as mg/kg and pH (units).

2) Figures in bold italics exceed the HBILs 'A' Criteria

3) Figures in bold italics and underlined exceed the HBILs 'C' Criteria

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TABLE 3
Summary of Analytical Results - OCP

Penrith City Council

Proposed Temporary Car Park

North Street Penrith

Prepared by: SL Date: 7/09/2017
Checked By:__SG___Date:7/09/2017

Sample	Depths (m)	Arochlor 1016	Arochlor 1221	Arochlor 1232	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	Total PCB
TP 4	0.00-0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND
TP17	0.2-0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	ND
HBILs 'A' Criteria									1
HBILs 'C' Criteria									1

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TABLE 4
Summary of Analytical Results - PCB

Penrith City Council
Proposed Temporary Car Park
North Street Penrith

Notes

1) All results are expressed as mg/kg and pH (units).
2) Figures in bold italics exceed the HBILs 'A' Criteria
3) Figures in bold italics and underlined exceed the HBILs 'C' Criteria

Sample	Depths (m)	C_6-C_9	C_{10}-C_{14}	C_{15}-C_{28}	C_{29}-C_{36}	C_{10}-C_{36}	F1 [4] C_6-C_{10}	F2 [5] $>C_{10}$-C_{16}	F3 C_{16}-C_{34}	F4 C_{34}-C_{40}	Volatile Organic Compounds (VOC)					
											Benzene	Toluene	Ethylbenzene	m+p-xylene	o-Xylene	Naphthalene
TP 4	0.00-0.10	<25	<50	<100	<100	<250	<25	<50	<100	<100	<0.2	<0.5	<1	<2	<1	<1
TP17	0.2-0.3	<25	<50	<100	<100	<250	<25	<50	<100	<100	<0.2	<0.5	<1	<2	<1	<1
NSW DEC (1994)		65				1000					1	1.4	3.1	14		
HSLs 'A and B' Criteria (CLAY)	0m to <1m						50	280			0.7	480	480	110		5
	1m to <2m						90				1			310		
	2m to < 4m						150				2					
	4m+						290				3					
ESL Criteria							180	120	1300	5600	65	105	125	45		

Notes

1) All results are expressed as mg/kg unless otherwise specified

2) Figures in bold exceed the NSW DEC criteria

3) ND Not detected

4) F1 is C_6-C_{10} minus the sum of the BTEX concentrations

5) F2 is $>C_{10}$-C_{16} Minus Napthalene

6) Figures in bold italics exceed the ESL Criteria

7) Figures in bold italics that have been underlined exceed the HSLs 'A and B' Criteria

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TABLE 5

Summary of Analytical Results - TRH and VOC

Penrith City Council

Proposed Temporary Car Park

North Street Penrith

Sample	Depths (m)	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b+k)fluoranthene	Benzo(a)pyrene	Indeno(1,2,3-c,d)pyrene	Dibenzo(a,h)anthracene	Benzo(g,h,i)perylene	Benzo(a)pyrene TEQ	Total PAHs
TP 4	0.00-0.10	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.2	0.2	<0.1	0.1	<0.2	0.1	0.1	<0.1	0.1	<0.5	1
TP17	0.2-0.3	<0.1	0.2	<0.1	0.1	2.4	0.5	6.5	5.8	2.2	2.1	3.8	2.4	2	0.5	1.9	3.8	31
HBILs 'A' Criteria		3															3*	300
HBILs 'C' Criteria																	3*	300
ESL Criteria													0.7					

Notes

1) All results are expressed as mg/kg

2) Figures in bold italics exceed the HBILs 'A' Criteria

3) Figures in bold italics and underlined exceed the HBILs 'C' Criteria

4) Figures in bold italics that have been underlined and shaded exceed the ESL Criteria

* B(a)P TEQ is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF, given below, and summing these products

PAH Species	TEF
Benzo(a)anthracene	0.1
Benzo(a)pyrene	1
Benzo(b+j)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Benzo(g,h,i)perylene	0.01
Chrysene	0.01
Dibenzo(a,h)anthracene	1
Indeno(1,2,3-c,d)pyrene	0.1

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TABLE 6
Summary of Analytical Results - PAH

Penrith City Council
Proposed Temporary Car Park
North Street Penrith

Sample	Depths (m)	Asbestos
TP4	0.0-0.1	ACM - Chrysotile and Amosite/No Friable
TP7	Fragments	ACM - Chrysotile, Amosite and Crocidolite
TP8	Fragments	ACM - Chrysotile and Amosite
TP12	Fragments	ACM - Chrysotile, Amosite and Crocidolite
TP15	Fragments	ACM - Chrysotile, Amosite and Crocidolite
TP17	0.2-0.3	ACM - Chrysotile and Amosite/No Friable
HBILs 'A' Criteria		0.01% / 0.001% [1]
HBILs 'C' Criteria		0.02% / 0.001% [1]

Note: ND = Not detected

Measured in %w/w

1) Bonded Asbestos Contaminaint Material / Fiberous Asbestos and Asbestos Fines

2) Figures in bold italics exceed the HBILs 'A' Criteria

3) Figures in bold italics and underlined exceed the HBILs 'A' Criteria

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TABLE 7

Summary of Analytical Results - Asbestos

Penrith City Council

Proposed Temporary Car Park

North Street Penrith

Sample	Depths (m)	Arsenic	Cadmium	Chromium	Lead	Mercury	Nickel	PAH
TP 4	0.00-0.10	<0.05	<0.01	<0.01	0.07	<0.0005	<0.02	0.001
TP17	0.2-0.3	<0.05	<0.01	<0.01	0.1	<0.0005	<0.02	ND

Notes

1) All results are expressed as mg/L

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TABLE 8

Summary of Analytical Results - (TCLP) Heavy Metals an

Penrith City Council

Proposed Temporary Car Park

North Street Penrith

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Test Results - California Bearing Ratio

Client / Address: Penrith City Council / Penrith — Job No: JC17302A

Project: Proposed Car Park — Date: 24/8/17

Location: North Street Penrith — Report No: R01A

SAMPLE INFORMATION Test Methods						
Lab Reference No.			SR11408	SR11409		
Date Sampled			24-Jul-17	24-Jul-17		
Date Tested			31-Jul-17	31-Jul-17		
Sample Identification			TP 2 (0.4-0.6m)	TP 15 (0.4-0.6m)		
Laboratory Specimen Description			Silty Clay: red brown	Silty Clay: brown		
TEST RESULTS						
Laboratory Compaction & Moisture Content - Test Methods AS1289 5.1.1 Mould A and AS1289 2.1.1						
Maximum Dry Density t/m3			1.68	1.79		
Optimum Moisture Content %			21.0	17.0		
Field Moisture Content %			19.0	16.0		
% Of Oversize 19mm			-	-		
Replacement of Oversize (See note B)			-	-		
California Bearing Ratio - Test Method AS1289 6.1.1						
CBR Test	Dry Density t/m3	Before Soaking	1.69	1.81		
		After Soaking	1.68	1.81		
	Density Ratio %	Before Soaking	101.0	101.0		
		After Soaking	100.0	101.0		
	Moisture Content %	Before Soaking	20.0	17.0		
		After Soaking	22.0	18.0		
	Number of Days Soaked		4	4		
	Surcharge kg		6.75	4.5		
	Moisture Content After Test %	Top 30mm	24.0	19.0		
		Whole Sample	22.0	18.0		
	Swell After Soaking %		1.1	0.4		
	Penetration mm		2.5	5.0		
	CBR Value %		6.0	6.0		

Notes: (A) Test specimen was compacted to a target dry density of 100 percent standard (AS 1289 5.1.1)

(B) If specified the percentage of oversize retained on the 19mm may be replaced by an equal portion of –19mm to +4.75mm

Remarks

Authorised Signatory _____ Solern Liew Date 24/8/17

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CERTIFICATE OF ANALYSIS 172091

Client Details

Client	Geoenviro Consultancy Pty Ltd
Attention	Solern Liew
Address	PO Box 1543, Macquarie Centre, North Ryde, NSW, 2113

Sample Details

Your Reference	**JC17302A, Penrith**
Number of Samples	2 soils 5 materials
Date samples received	25/07/2017
Date completed instructions received	25/07/2017

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.

Report Details

Date results requested by	03/08/2017
Date of Issue	03/08/2017

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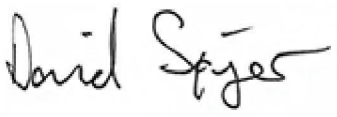
Report Comments

Asbestos: A portion of the supplied sample was sub-sampled for asbestos analysis according to Envirolab procedures. We cannot guarantee that this sub-sample is indicative of the entire sample. Envirolab recommends supplying 40-50g of sample in its own container.
Note: Samples 172091-1 & 7 were sub-sampled from jars provided by the client.

Asbestos Approved By
Analysed by Asbestos Approved Identifier: Lucy Zhu
Authorised by Asbestos Approved Signatory: Lulu Scott

Results Approved By
Dragana Tomas, Senior Chemist
Long Pham, Team Leader, Metals
Lulu Scott, Asbestos Supervisor
Steven Luong, Chemist

Authorised By



David Springer, General Manager

vTRH(C6-C10)/BTEXN in Soil			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date extracted	-	27/07/2017	27/07/2017
Date analysed	-	27/07/2017	27/07/2017
TRH C_6 - C_9	mg/kg	<25	<25
TRH C_6 - C_{10}	mg/kg	<25	<25
vTPH C_6 - C_{10} less BTEX (F1)	mg/kg	<25	<25
Benzene	mg/kg	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1
m+p-xylene	mg/kg	<2	<2
o-Xylene	mg/kg	<1	<1
Total +ve Xylenes	mg/kg	<1	<1
naphthalene	mg/kg	<1	<1
Surrogate aaa-Trifluorotoluene	%	101	107

svTRH (C10-C40) in Soil			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date extracted	-	27/07/2017	27/07/2017
Date analysed	-	28/07/2017	28/07/2017
TRH C_{10} - C_{14}	mg/kg	<50	<50
TRH C_{15} - C_{28}	mg/kg	<100	<100
TRH C_{29} - C_{36}	mg/kg	<100	<100
TRH >C_{10} -C_{16}	mg/kg	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	mg/kg	<50	<50
TRH >C_{16} -C_{34}	mg/kg	<100	<100
TRH >C_{34} -C_{40}	mg/kg	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	<50
Surrogate o-Terphenyl	%	90	92

PAHs in Soil			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date extracted	-	27/07/2017	27/07/2017
Date analysed	-	28/07/2017	28/07/2017
Naphthalene	mg/kg	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	0.2
Acenaphthene	mg/kg	<0.1	<0.1
Fluorene	mg/kg	<0.1	0.1
Phenanthrene	mg/kg	0.1	2.4
Anthracene	mg/kg	<0.1	0.5
Fluoranthene	mg/kg	0.2	6.5
Pyrene	mg/kg	0.2	5.8
Benzo(a)anthracene	mg/kg	<0.1	2.2
Chrysene	mg/kg	0.1	2.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	3.8
Benzo(a)pyrene	mg/kg	0.1	2.4
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	2.0
Dibenzo(a,h)anthracene	mg/kg	<0.1	0.5
Benzo(g,h,i)perylene	mg/kg	0.1	1.9
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	3.8
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	3.8
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	3.8
Total +ve PAH's	mg/kg	1.0	31
Surrogate p-Terphenyl-d14	%	91	100

Organochlorine Pesticides in soil			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date extracted	-	27/07/2017	27/07/2017
Date analysed	-	27/07/2017	27/07/2017
HCB	mg/kg	<0.1	<0.1
alpha-BHC	mg/kg	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1
Heptachlor	mg/kg	0.2	<0.1
delta-BHC	mg/kg	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1
Heptachlor Epoxide	mg/kg	0.2	<0.1
gamma-Chlordane	mg/kg	0.3	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1
Surrogate TCMX	%	94	94

PCBs in Soil			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date extracted	-	27/07/2017	27/07/2017
Date analysed	-	27/07/2017	27/07/2017
Aroclor 1016	mg/kg	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1
Surrogate TCLMX	%	94	94

Acid Extractable metals in soil			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date prepared	-	27/07/2017	27/07/2017
Date analysed	-	27/07/2017	27/07/2017
Arsenic	mg/kg	7	15
Cadmium	mg/kg	0.6	<0.4
Chromium	mg/kg	15	15
Copper	mg/kg	37	100
Lead	mg/kg	320	330
Mercury	mg/kg	0.1	1.0
Nickel	mg/kg	9	8
Zinc	mg/kg	580	120

Moisture			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date prepared	-	27/07/2017	27/07/2017
Date analysed	-	28/07/2017	28/07/2017
Moisture	%	7.8	11

Metals in TCLP USEPA1311			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date extracted	-	27/07/2017	27/07/2017
Date analysed	-	27/07/2017	27/07/2017
pH of soil for fluid# determ.	pH units	9.4	8.4
pH of soil TCLP (after HCl)	pH units	1.5	1.5
Extraction fluid used	-	1	1
pH of final Leachate	pH units	5.0	4.9
Arsenic in TCLP	mg/L	<0.05	<0.05
Cadmium in TCLP	mg/L	<0.01	<0.01
Chromium in TCLP	mg/L	<0.01	<0.01
Lead in TCLP	mg/L	0.07	0.1
Mercury in TCLP	mg/L	<0.0005	<0.0005
Nickel in TCLP	mg/L	<0.02	<0.02

PAHs in TCLP (USEPA 1311)			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date extracted	-	28/07/2017	28/07/2017
Date analysed	-	28/07/2017	28/07/2017
Naphthalene in TCLP	mg/L	<0.001	<0.001
Acenaphthylene in TCLP	mg/L	<0.001	<0.001
Acenaphthene in TCLP	mg/L	<0.001	<0.001
Fluorene in TCLP	mg/L	<0.001	<0.001
Phenanthrene in TCLP	mg/L	0.001	<0.001
Anthracene in TCLP	mg/L	<0.001	<0.001
Fluoranthene in TCLP	mg/L	<0.001	<0.001
Pyrene in TCLP	mg/L	<0.001	<0.001
Benzo(a)anthracene in TCLP	mg/L	<0.001	<0.001
Chrysene in TCLP	mg/L	<0.001	<0.001
Benzo(bjk)fluoranthene in TCLP	mg/L	<0.002	<0.002
Benzo(a)pyrene in TCLP	mg/L	<0.001	<0.001
Indeno(1,2,3-c,d)pyrene - TCLP	mg/L	<0.001	<0.001
Dibenzo(a,h)anthracene in TCLP	mg/L	<0.001	<0.001
Benzo(g,h,i)perylene in TCLP	mg/L	<0.001	<0.001
Total +ve PAH's	mg/L	0.001	NIL (+)VE
Surrogate p-Terphenyl-d14	%	74	82

Asbestos ID - soils			
Our Reference		172091-1	172091-7
Your Reference	UNITS	TP4	YP 17
Depth		0.0-0.1	0.2-0.3
Date Sampled		24/07/2017	24/07/2017
Type of sample		Soil	Soil
Date analysed	-	3/08/2017	3/08/2017
Sample mass tested	g	Approx. 40g	Approx. 45g
Sample Description	-	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
Trace Analysis	-	No asbestos detected	No asbestos detected

Asbestos ID - materials						
Our Reference		172091-2	172091-3	172091-4	172091-5	172091-6
Your Reference	UNITS	TP4 ACM	TP7 ACM	TP8 ACM	TP12 Fibro and ACM	TP15 ACM
Depth		-	0.2-0.21	-	-	-
Date Sampled		24/07/2017	24/07/2017	24/07/2017	24/07/2017	24/07/2017
Type of sample		material	material	material	material	material
Date analysed	-	1/08/2017	1/08/2017	1/08/2017	1/08/2017	1/08/2017
Mass / Dimension of Sample	-	48x35x5mm	33x20x5mm	60x50x5mm	90x80x5mm	80x55x5mm
Sample Description	-	Grey compressed fibre cement material	Grey fibrous sheet material	Grey compressed fibre cement material	Grey compressed fibre cement material	Grey compressed fibre cement material
Asbestos ID in materials	-	Chrysotile asbestos detected Amosite asbestos detected	Chrysotile asbestos detected Amosite asbestos detected Crocidolite asbestos detected	Chrysotile asbestos detected Amosite asbestos detected	Chrysotile asbestos detected Amosite asbestos detected Crocidolite asbestos detected	Chrysotile asbestos detected Amosite asbestos detected Crocidolite asbestos detected

Method ID	Methodology Summary
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.
EXTRACT.7	Toxicity Characteristic Leaching Procedure (TCLP) using Zero Headspace Extraction (zHE) using AS4439 and USEPA 1311.
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.
Inorg-004	Toxicity Characteristic Leaching Procedure (TCLP) using in house method INORG-004.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Metals-020	Determination of various metals by ICP-AES.
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-021 CV-AAS	Determination of Mercury by Cold Vapour AAS.
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-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. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-006	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore" Total +ve PCBs" is simply a sum of the positive individual PCBs.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS.
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. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013. For soil results:- 1. 'EQ 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. 'EQ 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. 'EQ 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-014	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.
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-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. Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Date analysed	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
TRH C_6 - C_9	mg/kg	25	Org-016	<25	[NT]	[NT]	[NT]	[NT]	94	[NT]
TRH C_6 - C_{10}	mg/kg	25	Org-016	<25	[NT]	[NT]	[NT]	[NT]	94	[NT]
Benzene	mg/kg	0.2	Org-016	<0.2	[NT]	[NT]	[NT]	[NT]	104	[NT]
Toluene	mg/kg	0.5	Org-016	<0.5	[NT]	[NT]	[NT]	[NT]	94	[NT]
Ethylbenzene	mg/kg	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	88	[NT]
m+p-xylene	mg/kg	2	Org-016	<2	[NT]	[NT]	[NT]	[NT]	92	[NT]
o-Xylene	mg/kg	1	Org-016	<1	[NT]	[NT]	[NT]	[NT]	90	[NT]
naphthalene	mg/kg	1	Org-014	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-016	110	[NT]	[NT]	[NT]	[NT]	104	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Date analysed	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
TRH C_{10} - C_{14}	mg/kg	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	105	[NT]
TRH C_{15} - C_{28}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	106	[NT]
TRH C_{29} - C_{36}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	91	[NT]
TRH >C_{10} -C_{16}	mg/kg	50	Org-003	<50	[NT]	[NT]	[NT]	[NT]	105	[NT]
TRH >C_{16} -C_{34}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	106	[NT]
TRH >C_{34} -C_{40}	mg/kg	100	Org-003	<100	[NT]	[NT]	[NT]	[NT]	91	[NT]
Surrogate o-Terphenyl	%		Org-003	90	[NT]	[NT]	[NT]	[NT]	91	[NT]

QUALITY CONTROL: PAHs in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Date analysed	-			28/07/2017	[NT]	[NT]	[NT]	[NT]	28/07/2017	[NT]
Naphthalene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	80	[NT]
Acenaphthylene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	91	[NT]
Phenanthrene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	84	[NT]
Anthracene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	83	[NT]
Pyrene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	85	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	90	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-012	<0.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-012	<0.05	[NT]	[NT]	[NT]	[NT]	83	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-012	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	99	[NT]	[NT]	[NT]	[NT]	118	[NT]

QUALITY CONTROL: Organochlorine Pesticides in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Date analysed	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
HCB	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
alpha-BHC	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	86	[NT]
gamma-BHC	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	101	[NT]
Heptachlor	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	89	[NT]
delta-BHC	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	99	[NT]
Heptachlor Epoxide	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	91	[NT]
gamma-Chlordane	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Dieldrin	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	97	[NT]
Endrin	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	78	[NT]
pp-DDD	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	93	[NT]
Endosulfan II	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	86	[NT]
Methoxychlor	mg/kg	0.1	Org-005	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate TCMX	%		Org-005	92	[NT]	[NT]	[NT]	[NT]	120	[NT]

QUALITY CONTROL: PCBs in Soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date extracted	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Date analysed	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Aroclor 1016	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	100	[NT]
Aroclor 1260	mg/kg	0.1	Org-006	<0.1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate TCLMX	%		Org-006	92	[NT]	[NT]	[NT]	[NT]	93	[NT]

QUALITY CONTROL: Acid Extractable metals in soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-6	[NT]
Date prepared	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Date analysed	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Arsenic	mg/kg	4	Metals-020	<4	[NT]	[NT]	[NT]	[NT]	114	[NT]
Cadmium	mg/kg	0.4	Metals-020	<0.4	[NT]	[NT]	[NT]	[NT]	109	[NT]
Chromium	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	111	[NT]
Copper	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	112	[NT]
Lead	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	105	[NT]
Mercury	mg/kg	0.1	Metals-021	<0.1	[NT]	[NT]	[NT]	[NT]	104	[NT]
Nickel	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	106	[NT]
Zinc	mg/kg	1	Metals-020	<1	[NT]	[NT]	[NT]	[NT]	108	[NT]

QUALITY CONTROL: Metals in TCLP USEPA1311						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Date analysed	-			27/07/2017	[NT]	[NT]	[NT]	[NT]	27/07/2017	[NT]
Arsenic in TCLP	mg/L	0.05	Metals-020 ICP-AES	<0.05	[NT]	[NT]	[NT]	[NT]	116	[NT]
Cadmium in TCLP	mg/L	0.01	Metals-020 ICP-AES	<0.01	[NT]	[NT]	[NT]	[NT]	120	[NT]
Chromium in TCLP	mg/L	0.01	Metals-020 ICP-AES	<0.01	[NT]	[NT]	[NT]	[NT]	114	[NT]
Lead in TCLP	mg/L	0.03	Metals-020 ICP-AES	<0.03	[NT]	[NT]	[NT]	[NT]	99	[NT]
Mercury in TCLP	mg/L	0.0005	Metals-021 CV-AAS	<0.0005	[NT]	[NT]	[NT]	[NT]	96	[NT]
Nickel in TCLP	mg/L	0.02	Metals-020 ICP-AES	<0.02	[NT]	[NT]	[NT]	[NT]	113	[NT]

QUALITY CONTROL: PAHs in TCLP (USEPA 1311)						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	[NT]
Date extracted	-			28/07/2017	[NT]	[NT]	[NT]	[NT]	28/07/2017	[NT]
Date analysed	-			28/07/2017	[NT]	[NT]	[NT]	[NT]	28/07/2017	[NT]
Naphthalene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	76	[NT]
Acenaphthylene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Acenaphthene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluorene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	74	[NT]
Phenanthrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	71	[NT]
Anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Fluoranthene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	70	[NT]
Pyrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	71	[NT]
Benzo(a)anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Chrysene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	73	[NT]
Benzo(bjk)fluoranthene in TCLP	mg/L	0.002	Org-012	<0.002	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(a)pyrene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	74	[NT]
Indeno(1,2,3-c,d)pyrene - TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Dibenzo(a,h)anthracene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzo(g,h,i)perylene in TCLP	mg/L	0.001	Org-012	<0.001	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-012	92	[NT]	[NT]	[NT]	[NT]	78	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

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.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

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.

Measurement Uncertainty estimates are available for most tests upon request.

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	Geoenviro Consultancy Pty Ltd
Attention	Solern Liew

Sample Login Details	
Your Reference	JC17302A, Penrith
Envirolab Reference	**172091**
Date Sample Received	25/07/2017
Date Instructions Received	25/07/2017
Date Results Expected to be Reported	**03/08/2017**

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	2 soils 5 materials
Turnaround Time Requested	Standard
Temperature on receipt (°C)	15.5
Cooling Method	Ice Pack
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*	*PCBs in Soil*	*Acid Extractable metals in soil*	*Metals in TCLP USEPA1311*	*PAHs in TCLP (USEPA 1311)*	*Asbestos ID - soils*	*Asbestos ID - materials*
TP4-0.0-0.1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
TP4 ACM										✓
TP7ACM-0.2-0.21										✓
TP8ACM										✓
TP12 Fibro and ACM										✓
TP15 ACM										✓
YP 17-0.2-0.3	✓	✓	✓	✓	✓	✓	✓	✓	✓	

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Laboratory Test Request/Chain of Custody Record

Job Details
Job Number: JC17302A
Client:
Project: Proposed Pavement Design
Location: North Street, Penrith

Sample Date: 24/07/2017
Sampled By: SG
Project Manager: SL
Store Location:

External Laboratory Details:
Laboratory name: Envirolab Services Pty Ltd
Address: 12 Ashley Street
Chatswood
Contact: Tania Notaris

Sampling Details			Sample Type		Test Required (\) / Test Performed(X)																								
Location	Depth (m)		Soil	Water	Metals (As Cd Cr Cu Pb Zn Ni Hg)	OCP / PCB	Combination 12a	Combination 5a	Combination 5	Asbestos		pH	EC	CEC/ESP	Cl / SO4	Resistivity													Keep Sample
	From	To																											
1 TP 4	0.00	0.10	DG				/																						
2 TP 4 ACM	-	-	DG							/																			
3 TP 7 ACM	0.20	0.21	DG							/																			
4 TP 8 ACM	-	-	DG							/																			
5 TP 12 Fibro and ACM	-	-	DG							/																			
6 TP 15 ACM	-	-	DG							/																			
7 YP 17	0.20	0.30	DG				/																						

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 172091
Date Received: 25.7.17
Time Received: 16.10
Received by: JE
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Relinquished by				Received By			
Laboratory	Name	Signature	Date	Laboratory	Name	Signature	Date
GeoEnviro Consultancy	Steven Goss	SMGoss	25/07/2017	ELS	JE		25.7.17

Legend

DB Disturbed Sample (Bulk, Plastic bag)
DS Disturbed Sample (Small, Plastic bag)
DG Disturbed Sample (Glass Jar)
STP Standard Penetration Test Sample
U50 Undisturbed Sample, 50mm Tube
U75 Undisturbed Sample, 75mm Tube
WG Water Sample, Amber Glass Jar
WP Water Sample, Plastic Bottle
Y Keep Sample
N Discard Sample

EXPLANATORY NOTES

Introduction

These notes have been provided to amplify the geotechnical report with regard to investigation procedures, classification methods and certain matters relating to the Discussion and Comments sections. Not all notes are necessarily relevant to all reports.

Geotechnical reports are based on information gained from finite sub-surface probing, excavation, boring, sampling or other means of investigation, supplemented by experience and knowledge of local geology. For this reason they must be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods
The methods the description and classification of soils and rocks used in this report are based on Australian standard 1726, the SSA Site investigation Code, in general descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions. Identification and classification of soil and rock involves to a large extent, judgement within the acceptable level commonly adopted by current geotechnical practices.

Soil types are described according to the predominating particle size, qualified by the grading or other particles present (eg sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	Less than 0.002mm
Silt	0.002 to 0.6mm
Sand	0.6 to 2.00mm
Gravel	2.00m to 60.00mm

Soil Classification	Particle size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2.00mm
Gravel	2.00mm to 60.00mm

Cohesive soils are classified on the basis of strength, either by laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Undrained Shear Strength kPa
Very Soft	Less than 12
Soft	12 - 25
Firm	25 - 50
Stiff	50 - 100
Very Stiff	100 - 200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer test (CPT), as below:

Relative Dense	SPT 'N' Value (blows/300mm)	CPT Cone Value (q_c-Mpa)
Very Loose	Less than 5	Less than 2
Loose	5 - 10	2 - 5
Medium Dense	10 - 30	5 - 15
Dense	30 - 50	15 - 25
Very Dense	> 50	> 25

Rock types are classified by their geological names, together with descriptive terms on degrees of weathering strength, defects and other minor components. Where relevant, further information regarding rock classification, is given on the following sheet.

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

Disturbed samples taken during drilling provided information on plasticity, grained size, colour, type, moisture content, 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 (normally know as U_{50}) into the soil and withdrawing 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. Details of the type and method of sampling are given in the report.

Field Investigation Methods
The following is a brief summary of investigation methods currently carried out by this company and comments on their use and application.

Hand Auger Drilling
The borehole is advanced by manually operated equipment. The diameter of the borehole ranges from 50mm to 100mm. Penetration depth of hand augered boreholes may be limited by premature refusal on a variety of materials, such as hard clay, gravels or ironstone.

Test Pits
These are excavated with a tractor-mounted backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3.0m for a backhoe and up to 6.0m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Care must be taken if construction is to be carried out near, or within the test pit locations, to either adequately recompact the backfill during construction, or to design the structure or accommodate the poorly compacted backfill.

Large Diameter Auger (eg Pengo)
The hole is advanced by a rotating plate or short spiral auger generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 05m) 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 sampling.

Continuous Spiral Flight Augers
The hole is advanced by using 90mm - 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the augers flights, but they are very disturbed and may be highly mixed with soil of other stratum.

Information from the drilling (as distinct from specific sampling by SPT or undisturbed samples) is of relatively low reliability due to remoulding, mixing or softening of samples by ground water, resulting in uncertainties of the original sample depth.

Continuous Spiral Flight Augers (continued)
The spiral augers are usually advanced by using a V - bit through the soil profile refusal, followed by Tungsten Carbide (TC) bit, to penetrate into bedrock. The quality and continuity of the bedrock may be assessed by examination of the recovered rock fragments and through observation of the drilling penetration resistance.

Non - core Rotary Drilling (Wash Boring)
The hole is advanced by a rotary bit, with water being pumped down the drill rod and returned up the annulus, carrying the cuttings, together with some information from the "feel" and rate of penetration.

Rotary Mud Stabilised Drilling
This is similar to rotary drilling, but uses drilling mud as a circulating fluid, which may consist of a range of products, from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg SPT and U_{50} samples).

Continuous Core Drilling
A continuous core sample is obtained using a diamond tipped core barrel. Providing full core recovery is achieved (which is not always possible in very weak rock and granular soils) this technique provides a very reliable (but relatively expensive) method of investigation. In rocks an NMLC triple tube core barrel which gives a core of about 50mm diameter, is usually used with water flush.

Portable Proline Drilling
This is manually operated equipment and is only used in sites which require bedrock core sampling and there is restricted site access to truck mounted drill rigs. The boreholes are usually advanced initially using a tricone roller bit and water circulation to penetrate the upper soil profile. In some instances a hand auger may be used to penetrate the soil profile. Subsequent drilling into bedrock involves the use of NMLC triple tube equipment, using water as a lubricant.

Standard Penetration Tests
Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils, as a means of determining density or strength and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289 "Methods of testing Soils for Engineering Purpose"- Test F31.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63Kg hammer with a free fall of 769mm. It is normal for the tube to be driven in three successive 150mm increments and the "N" value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rocks, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In a case where full penetration is obtained with successive blows counts for each 150mm of, say 4, 6, and 7 blows.

  as 4, 6, 7
  N = 13

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm.

  as 15,30/40mm

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally the test methods is used to obtain samples in 50mm diameter thin walled samples tubes in clays. In these circumstances, the best results are shown on the bore logs in brackets.

Dynamic Cone Penetration Test
A modification to the SPT test is where the same driving system is used with a solid 60^0 tipped steel cone of the same diameter as the SPT hollow sampler. The cone can be continuously driven into the borehole and is normally used in areas with thick layers of soft clays or loose sand. The results of this test are shown as 'N_c' on the bore logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing and Interpretation
Cone penetrometer testing (sometimes referred to as Dutch Cone-CPT) described in this report, has been carried out using an electrical friction cone penetrometer and the test is described in Australian Standard 1289 test F5.1.

In the test, a 35mm diameter rod with cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig, which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130mm long sleeve, immediately behind the cone. Transducer in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart recorders. The plotted results in this report have been traced from the original records. The information provided on the charts comprises:

- Cone resistance - the actual end bearing force divided by the cross sectional area of the cone, expressed in Mpa.
- Sleeve friction - the frictional force on the sleeve divided by the surface area, expressed in kPa.
- Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percentage.

There are two scales available for measurement of cone resistance. The lower "A" scale (0-5Mpa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main "B" scale (0-50Mpa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative frictions in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and very soft clays, rising to 4% to 10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

$$q_c \text{ (Mpa)} = (0.4 \text{ to } 0.6)\ N \text{ (blows per 300mm)}$$

In clays the relationship between undrained shear strength and cone resistance is commonly in the range:

$$q_c = (12 \text{ to} 18)\ C_u$$

Interpretation of CPT values can also be made to allow estimate of modulus or compressibility values to allow calculation of foundation settlements. Inferred stratification, as shown on the attached report, is assessed from the cone and friction traces, from experience and information from nearby boreholes etc.

Cone Penetrometer Testing and Interpretation continued
This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties and where precise information or soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometer (AS1289)
Portable dynamic cone penetrometer tests are carried out by driving a rod in to the ground with a falling weight hammer and measuring the blows per successive 100mm increments of penetration.

There are two similar tests, Cone Penetrometer (commonly known as Scala Penetrometer) and the Perth Sand Penetrometer. Scala Penetrometer is commonly adopted by this company and consists of a 16mm rod with a 20mm diameter cone end, driven with a 9kg hammer, dropping 510mm (AS 1289 Test F3.2).

Laboratory Testing
Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedures are given on the individual report forms.

Engineering Logs
The engineering logs presented herein are an engineering and/or geological interpretation of the sub-surface conditions and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, however, this is not always practicable or possible to justify economically. As it is, the boreholes represent only a small sample of the total sub-surface profile. Interpretation of the information and its application to design and construction should take into account the spacing of boreholes, frequency of sampling and the possibility of other than "straight line" variations between the boreholes.

Ground water
Where ground water levels are measured in boreholes, there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all, during the investigation period.
- A localised perched water table may lead to a erroneous indication of the true water table.
- Water table levels will vary from time to time, due to the seasons or recent weather changes. They may not be the same at the time of construction as indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole if any water observations are to be made.

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

Engineering Reports
Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal is changed, say to a twenty storey building. If this occurs, the company will be pleased to review the report and sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussions of geotechnical aspects and recommendations or suggestions for design and construction. However, the company cannot always anticipate or assume responsibility for:

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

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

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, the company request immediate notification. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes
Attention is drawn to the document “Guidelines for the Provision of Geotechnical Information trader Documents”, published by the Institute of Engineers Australia. Where information obtained for this investigation is provided for tender 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. The Company would be pleased to assist in this regard and/or make additional copies of the report available for contract purpose, at a nominal charge.

Site Inspection

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

Review of Design
Where major civil or structural developments are proposed, or where only a limited investigation has been completed, or where the geotechnical conditions are complex, it is prudent to have the design reviewed by a Senior Geotechnical Engineer.

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IMPORTANT INFORMATION REGARDING YOUR ENVIRONMENTAL SITE ASSESSMENT

This Environmental Assessment Report was performed in general conformance with our understanding of the guidelines by the Australian and New Zealand Conservation Council (ANZECC), the Office of Environment and Heritage (OEH) and the National Environmental Protection (Assessment of Site Contamination) Measure 1999 (amended 2013).

These accompanying notes have been prepared by GeoEnviro Consultancy Pty Ltd, using guidelines prepared by ASFE; The Association of Engineering Firms Practising in the Geosciences. The notes are offered as an aid in the interpretation of your environmental site assessment report.

REASONS FOR AN ENVIRONMENTAL SITE ASSESSMENT

Environmental site assessments are typically, though not exclusively, performed in the following circumstances:

- As a pre- acquisition assessment on behalf of either a purchaser or a vendor, when a property is to be sold
- As a pre-development assessment, when a property or area of land is to be redeveloped, or the land use has change, eg from a factory to a residential subdivision
- As a pre-development assessment of greenfield sites, to establish baseline conditions and assess environmental, geological and hydrological constraints to the development of, eg, a landfill
- As an audit of the environmental effects of previous and present site usage

Each circumstance requires a specific approach to the assessment of soil and groundwater contamination. In all cases the objective is to identify and if possible, quantify the risks which unrecognised contamination poses to the ongoing or proposed activity. Such risk may be both financial (clean-up costs or limitations in site use) and physical (health risks to site users or the public).

ENVIRONMENTAL SITE ASSESSMENT LIMITATIONS

Although information provided by an environmental site assessment can reduce exposure to the risk of the presence of contamination, no environmental site assessment can eliminate the risk. Even a rigorous professional assessment may not detect all contamination within a site. Contaminants may be present in areas that were not surveyed or sampled, or may migrate to areas which did not show signs of contamination when sampled. Contaminant analysis cannot possibly cover every type of contaminant which may occur, only the most likely contaminants are screened.

AN ENVIRONMANTAL SITE ASSESSMENT REPORT IS BASED ON A UNIQUE SET OF PROJECT SPECIFIC FACTORS

Your environmental assessment report should not be used;

- When the nature of the proposed development is changed, eg, if a residential development is proposed, rather than a commercial development
- When the size or configuration of the proposed development is altered, eg, if a basement is added
- When the location or orientation of the proposed structure is modified
- When there is a change of land ownership, or
- For application to an adjacent site

In order to avoid costly problems, you should ask your consultant to assess any changes in the project since the assessment and the implications, if any, to recommendations made in the assessment.

ENVIRONMENTAL SITE ASSESSMENT FINDINGS ARE PROFESSIONAL ESTIMATES

Site assessment identifies actual sub-surface conditions only at those points where samples are taken, when they are taken. Data obtained from the sampling and subsequent laboratory analyses are interpreted by geologists, engineers or scientist and opinions are drawn about the overall subsurface conditions, the nature and extent of contamination, the likely impact on any proposed development and appropriate remediation measures. Actual conditions may differ from those inferred, because no professional, no matter how qualified and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from predictions. Nothing can be done to prevent the unanticipated, however, steps can be taken to help minimise the impact. For this reason, site owner should retain the services of their consultants throughout the development stage of the project in order to identify variances, conduct additional tests which may be necessary and to recommend solutions to problems encountered on site.

Soil and groundwater contamination is a field in which legislation and interpretation of legislation by government departments is changing rapidly. Whilst every attempt is made by GeoEnviro Consultancy Pty Ltd to be familiar with current policy, our interpretation of the investigation findings should not be taken to be that of the relevant authority. When approval from a statutory authority is required for a project, that approval should be directly sought.

STABILITY OF SUB-SURFACE CONDITIONS

Sub-surface conditions can change by natural processes and site activities. As an environmental site assessment is based on conditions existing at the time of the investigation, project decisions should not be based on environmental site assessment data which may have been affected by time. The consultant should be requested to advise if additional tests are required.

ENVIRONMENTAL SITE ASSESSMENTS ARE PERFORMED FOR SPECIFIC PURPOSES AND CLIENTS

Environmental site assessments are prepared in response to a specific scope of work required to meet the specific needs or specific individuals. An assessment prepared for a consulting civil engineer may not be adequate to a construction contractor or another civil engineer.

An assessment should not be used by other persons for any purpose, or by the client for a different purposes. No individual, other than the client, should apply an assessment, even for its intended purposes, without first conferring with the consultant. No person should apply an assessment for any purposes other than that originally contemplated, without first conferring with the consultant.

MISINTERPRETATION OF ENVIRONMENTAL SITE ASSESSMENTS

Costly problems can occur when design professionals develop plans based on misinterpretation of an environmental site assessment. In order to minimise problems, the environmental consultant should be retained to work with appropriate design professionals, to explain relevant findings and to review the adequacy of plans and specifications relative to contamination issues.

LOGS SHOULD NOT BE SEPARATED FORM THE REPORT

Borehole and test pit logs are prepared by environmental scientists, engineers or geologist, based upon interpretation of field conditions and laboratory evaluation of field samples. Field logs normally provided in our reports and these should not be redrawn for inclusion in site remediation or other design drawings, as subtle but significant drafting errors or omissions may occur in the transfer process. Photographic reproduction can eliminate this problem, however, contractors can still misinterpret the logs during bid preparation if separated from the test of the assessment. Should this occur, delays and disputes , or unanticipated costs may result.

To reduce the likelihood of boreholes and test pit logs misinterpretation, the complete assessment should be available to persons or organisations involved in the project, such as contractors, for their use. Denial of such access and disclaiming responsibility for the accuracy of sub-surface information does not insulate an owner from the attendant liability. It is critical that the site owner provides all available site information to persons and organisations, such as contractors.

READ RESPONSIBILITY CLAUSES CLOSELY

An environmental site assessment is based extensively on judgement and opinion, therefore, it is necessarily less exact than other disciplines. This situation has resulted in wholly unwarranted claim being lodged against consultants. In order to aid in prevention of this problem, model clauses have been developed for use in written transmittals. These are definitive clauses, designed to indicate consultant responsibility. Their use helps all parties involved recognise individual responsibilities and formulate appropriate action. Some of these definitive clauses are likely to appear in the environmental site assessment and you are encouraged to read them closely. Your consultant will be happy to give full and frank answers to any questions you may have.