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Project 71645.25
24 February 2021
R.001.Rev1
AS:jl

Attention: Robert Lewis

Email: Robert.Lewis@ampcapital.com

Assessment of Contamination Exposure Risk
Proposed Child Care Centre
13-55 Edinburgh Road, Marrickville

1. Introduction

Douglas Partners Pty Ltd (DP) has been engaged by AMP Capital Investors Limited (AMP Capital) to assess the suitability of the above site to support a proposed child care centre as part of the expansion of the Marrickville Metro Shopping Centre to the south of Smidmore Street, Marrickville. The site boundary is shown on Drawing 1, Attachment A. The proposed childcare centre would be located no lower than the first floor of the development (i.e., not on the ground floor).

The assessment was undertaken in accordance with DP's email to Robert Lewis of AMP Capital dated 9 December 2020. It is understood that the report will be used to support a Planning Proposal for Council.

The objective of the assessment is to assess the suitability of the site for the proposed child care centre on the basis, through an appraisal of contamination exposure risk, using data obtained for previous DP investigations and subsequent construction works undertaken by ADCO.

The following key guidelines were consulted in the preparation of this report:

- NEPC *National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) [NEPM]* (NEPC, 2013); and
- NSW EPA *Guidelines for Consultants Reporting on Contaminated Land* (NSW EPA, 2020).

2. Scope of Works

The scope of work for the assessment was as follows:

- Review of DP's previous contamination investigations undertaken at the site;
- Review of information (as relevant) provided by ADCO;

- Collation and tabulation of relevant soil, groundwater and soil vapour data from DP's previous contamination investigations, and comparison of data with relevant Site Assessment Criteria (SAC);
- Review of construction activities and development details for the site; and
- Comment on the site suitability for the proposed child care centre.

3. Site and Development Information

The site is located south of Smidmore Street and covers an approximate area of 0.915 ha. It is bound by Smidmore Street to the North, Murray Street to the East, and Edinburgh Road to the south and west. The site is currently nearing completion as an expansion to the existing Marrickville Metro shopping centre, situated to the north of Smidmore Street. Prior to the current redevelopment, the site was covered by two industrial warehouse buildings, concrete paving, and concrete building slabs with minimal landscaping along the site boundary. A main parking area was located to the west of the warehouse buildings (this layout is shown on Drawing 1, Attachment A).

Based on the architectural drawings provided by AMP Capital and past discussions, it is understood that the redevelopment includes full hardstand coverage across the site with some possible landscaped areas around the site boundary. The new (current) building covers the entire site footprint, and is two storeys high with rooftop parking. There are no basement carparking facilities.

4. Background

4.1 DP (2016)

DP undertook a Detailed Site Investigation (Contamination) (DSI) for the site in 2016 with the objective of assessing its suitability for a commercial land use (i.e., the shopping centre extension). The investigation included a review of site history, drilling of ten boreholes for soil sampling, installation of five groundwater monitoring wells, development of a conceptual site model and comparison of laboratory results with commercial / industrial land use criteria. The DSI incorporated results from DP's Limited Contamination Assessment undertaken at the site (DP, 2010) which included the drilling of three boreholes for soil sampling and installation of three groundwater monitoring wells. Previous test locations are shown on Drawing 2, Attachment A.

The DSI noted that three underground storage tanks (USTs) were formerly located on the southern portion of the site but were since decommissioned. A UST fuel point was located on the footpath of Murray Street, possibly associated with a UST in the eastern portion of the site. The tank was thought to have been decommissioned and either buried below the existing concrete floor or removed from the site. Additionally, an electricity sub-station was noted at the corner of Smidmore and Murray Streets, known to be constructed in 2006. There may have been an electricity sub-station on this part of the site prior to 2006.

Potential sources of contamination identified at the site included:

- A dry cleaner located at the southern end of the existing Marrickville Metro Shopping Centre [approximately 20 m north of site];
- Imported fill used for site levelling;
- Former USTs at the site;
- Possible former site use as a saw mill (southern section of site); and
- The electricity substation at the site and a possible former substation.

The investigation encountered sandy silt and clay fill with some building rubble to depths of up to 1.65 m below ground level (bgl), underlain by natural clay or silty clay to a maximum depth of 10.1 m bgl. Groundwater levels were measured to be between 2.1 m and 2.8 m bgl (RL 1.9 and 2.8 m AHD). Borehole logs from the investigation are attached (Attachment B).

The results of the laboratory analysis indicated that concentrations of contaminants in all soil samples were within the adopted assessment criteria (for a commercial land use) with the exception of copper and zinc in select samples, which exceeded the adopted ecological investigation levels (EIL), and B(a)P in select samples, which exceeded the adopted ecological screening level (ESL). Additionally, a fragment of chrysotile and amosite asbestos was detected from the fill in BH114. The EIL/ESL exceedances were not considered to be significant given the nature of the proposed development (i.e., commercial) with full hardstand.

Due to the presence of asbestos in one of the boreholes, DP recommended that all civil and construction works at the site need to be undertaken under an unexpected finds protocol (UFP).

The results of laboratory analysis indicated that concentrations of contaminants in all groundwater samples were within the adopted assessment criteria (commercial land use) with the exception of some metals. The metals concentrations were considered likely to be representative of background levels in the regional aquifer rather than site specific contaminants. PCE, however, was detected in a shallow well (BH118, outside the northern boundary of the site) and was considered likely to be sourced from the dry cleaner to the north of Smidmore Road. TRH was detected in one of the groundwater monitoring wells (BH6) sampled for DP (2010), located adjacent to the discussed UST fill point.

The report recommended the following:

- Assessment and removal of hazardous building materials from existing buildings prior to demolition;
- Preparation of an asbestos management plan (AMP) and unexpected finds protocol (UFP) for construction works; and
- Waste classification for soils to be removed from the site.

It is noted that extensive monitoring of groundwater impacts associated with the dry cleaner to the north of Smidmore Street over a period of five years has not shown that the contaminant impacts have migrated to the beneath the subject site.

4.2 DP (2017)

DP prepared a contamination Synthesis Report for the Marrickville Metro Shopping Centre in 2017 which reported on soil vapour and groundwater sampling and testing in the vicinity of the former dry cleaner located approximately 20 m north of the site (north of Smidmore Street). One of the five soil vapour wells installed for the investigation was located south of Smidmore Street, adjacent to the site (SV1, refer Drawing 2, Attachment A). SV1 was sampled on six different events between December 2015 and July 2017 (and has also been sampled during subsequent monitoring events).

The investigation found that concentrations of volatile organic compounds (VOCs) PCE and its breakdown products (TCE, DCE and VC), all associated with dry cleaning activities, in SV1 were well below the adopted assessment criteria for a commercial / industrial land use, and that concentrations of VOC were not increasing over time. It was considered that VOC from the dry cleaner had not significantly impacted soil vapour and / or groundwater on the southern side of Smidmore Street.

4.3 ADCO

It is understood that ADCO has undertaken some soil sampling and testing during demolition and construction works associated with the redevelopment, under an unexpected finds protocol. This included (as understood):

- Validation screening of soils around an underground fuel storage tank (UST) in the northern part of the site. No report has been provided to DP in relation to these works, nor the removal or decommissioning of the UST;
- Waste classification of surplus soils (approximately 20 m^3) in the western part of the site in early 2019. The materials classified as general solid waste (non putrescible); and
- Assessment of asbestos impacts in soil in various locations across the site, informing on-site retention suitability and / or waste classification for off-site disposal (a final report on the adopted management of asbestos impacted soils has not been provided to DP).

The absence of some of the reports presumed to have been prepared on behalf of ADCO presents a data gap in the assessment of site suitability for an intended land use.

5. Site Assessment Criteria / Conceptual Site Model

The SAC applied in the current assessment are informed by the Conceptual Site Model (CSM) developed in DP (2016) which identified human and environmental receptors to potential contamination on the site. The analytical results presented in DP (2010), DP (2016) and DP (2017) have been re-assessed (as a Tier 1 assessment) against these SAC comprising primarily the investigation and screening levels of Schedule B1 of NEPC (2013).

The investigation and screening levels applied in the current investigation comprise levels adopted for a generic residential land use scenario which includes children's day care centres. The derivation of the SAC is attached (Attachment C) at the end of this report, and the adopted SAC are listed on the summary analytical results tables (Attachment D).

The proposed child care centre would be situated no lower than Level 1 of the shopping centre development. As such, the potential exposure scenarios discussed in the CSM of DP (2016) are not all relevant. The only potential exposure scenario remaining is:

- "Inhalation" of vapours (through vapour intrusion) potentially originating from volatile contaminants in soil, groundwater and / or soil vapour. Given the relatively open and ventilated ground floor gap between the soils and Level 1, this exposure scenario is likely to never be realised.

6. Assessment of Data

Laboratory data from DP (2010), DP (2016) and DP (2017) with the adopted SAC (applicable for a child care land use) are summarised in the following tables:

- Table 1: Summary of Results of Soil Analysis;
- Table 2: Summary of Results of Water Analysis; and
- Table 3: Summary of Results of Soil Vapour Analysis.

As noted in Section 5, much if not all of the soil and groundwater analytical data is not relevant in the assessment of exposure risk to the proposed child care centre, given the planned location no lower than Level 1. The information is presented more to provide information on the characteristics of contamination with respect to a child care land use, more particularly the potential to generate volatile vapours.

The analytical results for all contaminants tested in soil for DP (2016) and DP (2010) were within the adopted SAC, with the exception of:

- Copper in 4 samples (BH114/0.25-0.35, BD1/290815, BH117/0.4-0.5 and BH5/0.05-0.1) which exceeded the EIL of 170 mg/kg. Exceedances ranged between 170 and 290 mg/kg;
- Lead in 4 samples (BH112/0.9-1, BH113/0.2-0.3, BH117/0.4-0.5 and BH8/0.4-0.5) which exceeded the HIL of 300 mg/kg. Exceedances ranged between 510 and 1000 mg/kg;
- Zinc in 3 samples (BH112/0.9-1, BH113/0.2-0.3 and BH8/0.4-0.5) which exceeded the EIL of 410 mg/kg. Exceedances ranged between 410 and 960 mg/kg;
- TRH F3 (>C16-C34) in 2 samples (BH113/0.2-0.3 and BH116/0.5) which exceeded the EIL of 300 mg/kg. The samples reported concentrations of 620 and 710 mg/kg, respectively;
- Benzo(a)pyrene (B(a)P) in 12 samples which exceeded the ESL of 0.7 mg/kg. Exceedances ranged between 0.9 and 14 mg/kg. It is noted that the CRC (2017) high reliability ecological guideline for fresh B(a)P is 33 mg/kg. As such, those 12 exceedances are not considered to be significant; and

- B(a)P TEQ in 4 samples (BH109/0.9-1, BH113/0.8-1, BH116/0.5 and BH117/0.4-0.5) which exceeded the HIL of 3 mg/kg. Exceedances ranged between 5.2 and 20 mg/kg.

Additionally, a fragment of asbestos containing material (ACM) (chrysotile and amosite) was detected in the fill at BH114/0.25-0.35.

As noted in DP (2016), the EIL and ESL exceedances are not considered to be significant given the nature of the proposed development with full hardstand across the site footprint.

None of the soil contaminants identified are considered likely to generate any significant volatile vapours. As such, the exceedances reported above are not considered to pose a risk of exposure to the proposed child centre on Level 1 or above.

The analytical results for all contaminants tested in groundwater for DP (2016) and DP (2010) were within the adopted SAC with the exception of:

- Aluminium in 2 samples (BH110 and BH112), which exceeded the GIL of 55 µg/l. The samples reported concentrations of 80 and 100 µg/l, respectively;
- Cadmium in BH109, which recorded a concentration of 0.2 µg/l (equivalent to the GIL);
- Chromium in BH6, which recorded a concentration of 2 µg/l, exceeding the GIL of 1 µg/l;
- Copper in 4 samples (BH109, BH110, BH112, BH6) which exceeded the GIL of 1.4 µg/l. Exceedances ranged between 2 and 33 µg/l;
- Lead in BH112, which recorded a concentration of 7 µg/l, exceeding the GIL of 3.4 µg/l;
- Silver in BH113, which recorded a concentration of 2 µg/l, exceeding the GIL of 0.05 µg/l; and
- Zinc in 7 samples (BH109, BH110, BH112, BH113, BH118, BH6 and BD1) which exceeded the GIL of 8 µg/l. Exceedances ranged between 18 and 100 µg/l.

Based on our experience in the area, the concentrations of metals in groundwater are considered likely to be attributed to the background concentrations associated with the regional aquifer.

The concentrations of BTEXN, PAH, OCP, OPP, PCB and phenols were below the laboratory practical quantitation limit (PQL) and therefore the SAC in all groundwater samples. Concentrations of TRH in BH6 and BH118 were above the PQL but below the SAC (although TRH was not detected in BH6 when sampled in 2016). Chloroform was detected in BH109 (1 µg/l) and cis-1,2-dichloroethene was detected in BH118 (3 µg/l).

None of the groundwater contaminants identified are considered likely to generate any significant volatile vapours. As such, the exceedances reported above are not considered to pose a risk of exposure to the proposed child centre on Level 1 or above.

The analytical results for all contaminants tested in soil vapour in SV1 for DP (2017) were within the adopted SAC for all sampling events, with the majority of contaminants being below the laboratory PQL. This trend continued through subsequent monitoring.

All data presented in this section suggests that there are no actual volatile vapours in soil, sourced from the dry cleaner to the north of Smidmore Street, beneath the site that would be considered to present a risk of vapour intrusion into the shopping centre building at the site. Whilst there is a potential for localised volatile vapours associated with former USTs within the site, observations during investigations by DP suggest that this potential is low. Although the report by ADCO for the UST found in the north of the site was not made available, it is likely that the UST found was removed or decommissioned and validated as being suitable under the commercial land use.

The soil and groundwater data presented herein do not suggest any additional potential sources of significant soil vapour.

7. Conclusions and Recommendations

Based on the findings of this assessment, it is considered that there is no contaminant exposure scenario that would render the site unsuitable for a child care centre development on Level 1 (or above) of the shopping centre extension. As such, the child care centre can be located on the site as long as it is located no lower than the first floor (i.e., not at ground level).

If there is a future plan to locate such a facility on ground level, further assessment of contaminant exposure risk will be required.

8. References

DP. (2010). *Report on Limited Stage 2 Contamination Assessment, Marrickville Metro Shopping Centre, 34 Victoria Road and 13-55 Edinburg Road, Marrickville.* Reference 71645.00.R.001.Rev1 dated November 2010: Douglas Partners Pty Ltd.

DP. (2016). *Report on Detailed Site Investigation Part Stage 1B - Marrickville Metro, 34 Victoria Road and 13-55 Edinburg Road, Marrickville, NSW.* Reference 71645.02.R.002.Rev0 dated 4 February 2016: Douglas Partners Pty Ltd.

DP. (2017). *Contamination Synthesis Report, Stage 1B & 2, Marrickville Metro Shopping Centre, Smidmore Street, Marrickville.* Reference 71645.13.R.001.Rev0 dated 6 October 2017: Douglas Partners Pty Ltd.

NEPC. (2013). *National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) [NEPM].* Australian Government Publishing Services Canberra: National Environment Protection Council.

NSW EPA. (2020). *Guidelines for Consultants Reporting on Contaminated Land.* Contaminated Land Guidelines: NSW Environment Protection Authority.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at in accordance with DP's email dated 9 December 2020 and acceptance received from Robert Lewis of AMP Capital. The work was carried out under a formal agreement between DP and AMP. This report is provided for the exclusive use of 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 this investigation. 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.

The assessment of atypical safety hazards arising from this advice is restricted to the environmental components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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.

Asbestos has been detected by observation or by laboratory analysis, either on the surface of the site, or in filling materials at the test locations sampled and analysed. Building demolition materials, such as concrete, brick and tile were also located in previous below-ground filling, and these are considered as indicative of the possible presence of hazardous building materials (HBM), including asbestos.

Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. This is either due to undetected variations in ground conditions or to budget constraints (as discussed above), or to parts of the site being inaccessible and not available for inspection/sampling, or to vegetation preventing visual inspection and reasonable access. It is therefore considered possible that HBM, including asbestos, may be present in unobserved or untested parts of the site, between and beyond sampling locations, and hence no warranty can be given that asbestos is not present.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Alyssa Spencer
Environmental Scientist

Reviewed by

Paul Gorman
Principal

Attachments:
- Notes About this Report
- Site Drawings
- Soil Descriptions
- Symbols and Abbreviations
- Borehole Logs
- Site Assessment Criteria
- Laboratory Test Results

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

LOCALITY MAP

Notes:
1. Basemap from nearmap.com (dated 09/08/2017)

Legend

Investigation Area

0 10 20 30 m

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Geotechnics / Environment / Groundwater

CLIENT:	AMP Capital		
OFFICE:	Sydney	DRAWN BY:	AS
SCALE:	1:600@ A3	DATE:	23.02.2021

TITLE: **Site Layout**
Assessment of Contamination Exposure Risk
Marrickville Metro Shopping Centre Expansion

N

PROJECT No:	71645.25
DRAWING No:	1
REVISION:	0

LOCALITY MAP

Notes:
1. Basemap from nearmap.com (dated 09/08/2017)

Legend

- Investigation Area
- Borehole Locations (DP, 2016)
- Borehole Locations (DP, 2010)
- Groundwater Well Locations (DP, 2016)
- Groundwater Well Locations (DP, 2010)

0 10 20 30 m

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	AMP Capital		
OFFICE:	Sydney	DRAWN BY:	AS
SCALE:	1:600@ A3	DATE:	23.02.2021

TITLE: **Previous Sampling Locations**
Assessment of Contamination Exposure Risk
Marrickville Metro Shopping Centre Expansion

N

PROJECT No:	71645.25
DRAWING No:	2
REVISION:	0

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. 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	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)
- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)
- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with ‘Mix of Soil and Cobbles/Boulders’ with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

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
Friable	Fr	-

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	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

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;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
  Soil tends to stick together.
  Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
  Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- ‘Moist, dry of plastic limit’ or ‘w <PL’ (i.e. hard and friable or powdery).
- ‘Moist, near plastic limit’ or ‘w ≈ PL (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- ‘Moist, wet of plastic limit’ or ‘w >PL’ (i.e. soils usually weakened and free water forms on the hands when handling).
- ‘Wet’ or ‘w ≈LL’ (i.e. near the liquid limit).
- ‘Wet’ or ‘w >LL’ (i.e. wet of the liquid limit).

Symbols & Abbreviations

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

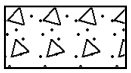
Symbols & Abbreviations

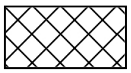
Graphic Symbols for Soil and Rock

General

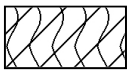

Asphalt

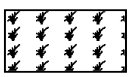

Road base

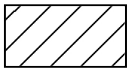

Concrete

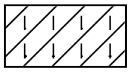

Filling

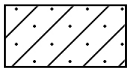
Soils


Topsoil

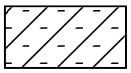

Peat

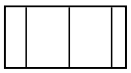

Clay

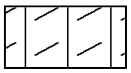

Silty clay

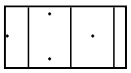

Sandy clay

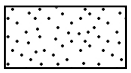

Gravelly clay

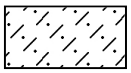

Shaly clay

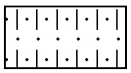

Silt


Clayey silt


Sandy silt

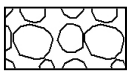

Sand

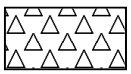

Clayey sand


Silty sand


Gravel

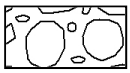

Sandy gravel


Cobbles, boulders

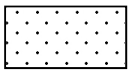

Talus

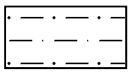
Sedimentary Rocks

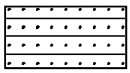

Boulder conglomerate

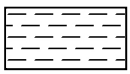

Conglomerate


Conglomeratic sandstone

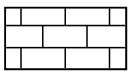

Sandstone


Siltstone

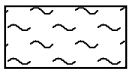

Laminite

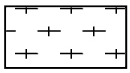

Mudstone, claystone, shale

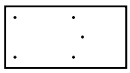

Coal


Limestone

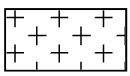
Metamorphic Rocks

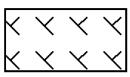

Slate, phyllite, schist

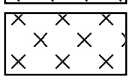

Gneiss

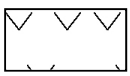

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 5.2 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 71645
DATE: 17 Mar 10
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.05	BITUMINOUS CONCRETE		A	0.05		PID=0.6ppm		
		FILLING - grey sandy gravel filling (gravel is basalt)			0.1				
				A/E	0.4		PID=0.7ppm		
					0.5				
	0.8	FILLING - grey, silty clay with trace of fine gravel filling, moist		A/E	0.8		PID=0.9ppm		
					1.0				
	1.2	CLAY - stiff, mottled orange, light grey clay with trace of silt and ironstone gravel, damp to moist		S			3,5,8 N = 13		
				A/E	1.45		PID=1.2ppm		
					1.5				
	1.8	CLAY - very stiff, light grey clay with trace of ironstone gravel, damp							
				A/E	2.3		PID=1.2ppm		
					2.5				
	2.7	CLAY - very stiff, red brown and grey clay with ironstone bands, moist		S			6,8,10 N = 18		
					2.95				
					3.5				
				A/E			PID=1.8ppm	▼	
				S	4.0		10,10,15 N = 25		
					4.45				
	5.1	CLAY - very stiff, light grey and red brown clay with some ironstone gravel, moist							
				S	5.5		9,13,15 N = 28		
					5.95				
	6.7	SHALY CLAY - very stiff to hard, light grey shaly clay, moist							
				S	7.0		7,11,22 N = 33		
					7.45				
				S	8.5		6,9,16 N = 25		
					8.95				

RIG: DT 100 **DRILLER:** RKE/GH **LOGGED:** CF **CASING:** HQ to 4.2m

TYPE OF BORING: Solid flight auger to 4.0m; Rotary to 10.2m

WATER OBSERVATIONS: Free groundwater observed at 3.8m whilst augering

REMARKS: *Denotes field replicate sample BD1/17032010 collected. E = Environmental sample

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 5.2 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 71645
DATE: 17 Mar 10
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
-5	10.05			S	10.0		24,10/50mm		
-5	10.2	SHALE - extremely low to very low strength, light grey and red brown shale with ironstone bands			10.2		refusal		
		Bore discontinued at 10.2m							
-6	11								
-7	12								
-8	13								
-9	14								
-10	15								
-11	16								
-12	17								
-13	18								
-14	19								

RIG: DT 100 **DRILLER:** RKE/GH **LOGGED:** CF **CASING:** HQ to 4.2m

TYPE OF BORING: Solid flight auger to 4.0m; Rotary to 10.2m

WATER OBSERVATIONS: Free groundwater observed at 3.8m whilst augering

REMARKS: *Denotes field replicate sample BD1/17032010 collected. E = Environmental sample

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 4.46 m AHD **BORE No:** BH6
EASTING: **PROJECT No:** 71645
NORTHING: **DATE:** 16 Mar 10
DIP/AZIMUTH: 90°/-- **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
	0.15	BITUMINOUS CONCRETE			0.15				Gatic cover Bitumen
	0.3	FILLING - grey sandy gravel (roadbase)		A/E	0.3		PID=1.7ppm		
	0.4	FILLING - dark grey brown silty clay filling, moist		A/E*	0.4 0.5		PID=1.8ppm		
	0.8	CLAY - light brown clay with trace of silt, moist			0.8				Bentonite
	1	CLAY - stiff, mottled orange brown and light grey clay with some ironstone gravel, moist		A/E S	1.0 1.45		PID=2.3ppm 4,4,6 N = 10		
	2.0	CLAY - very stiff, mottled orange light grey clay, damp to moist		A/E	1.9 2.0		PID=2.6ppm		Backfilled with gravel
	3			S E E	2.5 2.8 2.95 3.0		5,7,9 N = 16 PID=2.0ppm		Bentonite
	4.0	CLAY - hard, red brown and light grey clay with some ironstone bands, moist		S	4.0 4.45		9,11,18 N = 29		
	5			S	5.5		12,14,20 N = 34		Backfilled with gravel
	6				5.95				
	6.5	SHALY CLAY - very stiff to hard, light grey mottled orange shaly clay with trace of ironstone gravel, moist		S	7.0 7.45		6,13,17 N = 30		Machine slotted PVC screen
	8.5	SHALE - extremely low strength, light grey and red brown shale with ironstone bands		S	8.5 8.85		13,24,20/100mm refusal		
	10.0	Bore discontinued at 10.0m							End cap

RIG: Bobcat **DRILLER:** SY/GH **LOGGED:** CF **CASING:** HW to 4.0m

TYPE OF BORING: Solid flight auger to 4.0m; Rotary to 10.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Denotes field replicate sample BD1/16032010 collected. E = Environmental sample

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 4.91 m AHD **BORE No:** BH7
EASTING: **PROJECT No:** 71645
NORTHING: **DATE:** 23 Mar 10
DIP/AZIMUTH: 90°/-- **SHEET** 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - light grey to grey orange brown, clay filling with some ironstone gravel, shale fragments, moist		A/E	0.1				Gatic cover
				A	0.5				
	1.0			A	1.0				
		FILLING - grey brown, fine to medium grained, clayey sand filling, moist		S			1,2,0 N = 2		
	1.5				1.45				
		FILLING - light grey to grey orange brown, clay filling with some shale fragments and ironstone gravel, moist							Backfilled with gravel
					2.5				
	2.8			S			1,1,1 N = 2		
		CLAY - very stiff, mottled orange light grey to grey, clay with some carbonised organic matter and weak ironstone, moist			2.95				
					4.0				
				S			3,7,10 N = 17		
					4.45				
									Bentonite
					5.5				
				S			4,10,15 N = 25		
	6.0				5.95				
		CLAY - very stiff then very stiff to hard, mottled red brown and grey clay with ironstone bands, moist							Backfilled with gravel
					7.0				
				S			7,11,17 N = 28		
					7.45				
					8.5				
				S			10,14,16 N = 30		
	9.0				8.95				Machine slotted PVC screen
		SHALY CLAY - hard, mottled red brown light grey shaly clay with ironstone bands, damp							

RIG: DT 100 **DRILLER:** Steve Y **LOGGED:** SI/CF **CASING:** HW to 4.0m; HQ to 11.6m

TYPE OF BORING: Hand auger to 1.3m; Solid flight auger to 2.5m; Rotary to 11.6m; NMLC-Coring to 14.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: 100% water loss from 4.0m; Standpipe installed to 12.0m
*Denotes field replicate sample BD1/23032010 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 4.91 m AHD **BORE No:** BH7
EASTING: **PROJECT No:** 71645
NORTHING: **DATE:** 23 Mar 10
DIP/AZIMUTH: 90°/-- **SHEET** 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
-6	11	SHALY CLAY - hard, mottled red brown light grey shaly clay with ironstone bands, damp *(continued)*		S	10.0		9,14,20 N = 34		11
	11.0				10.45				
		SILTSTONE/LAMINITE - very low to low strength, grey brown siltstone/laminite with ironstone bands							
	11.6			S	11.5		25/100mm refusal		
		LAMINITE - medium strength, moderately weathered then fresh stained, fragmented to fractured, light grey brown to grey, laminite with approximately 40% fine grained sandstone laminations			11.6				
-7	12				11.95		PL(A) = 0.8MPa		12 End cap
				C	12.5		PL(A) = 0.6MPa		
	12.65								
-8	13	LAMINITE - high then medium strength, fresh, highly fractured to fractured and slightly fractured, light grey to grey, laminite with approximately 30% fine grained sandstone laminations			12.95		PL(A) = 1.3MPa		13
					13.5		PL(A) = 1.3MPa		
-9	14			C	13.55				14
					14.1		PL(A) = 0.5MPa		
	14.5	Bore discontinued at 14.5m			14.5				
-10	15								15
-11	16								16
-12	17								17
-13	18								18
-14	19								19
-15									

RIG: DT 100 **DRILLER:** Steve Y **LOGGED:** SI/CF **CASING:** HW to 4.0m; HQ to 11.6m

TYPE OF BORING: Hand auger to 1.3m; Solid flight auger to 2.5m; Rotary to 11.6m; NMLC-Coring to 14.5m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: 100% water loss from 4.0m; Standpipe installed to 12.0m
*Denotes field replicate sample BD1/23032010 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 4.91 m AHD **BORE No:** BH7A
EASTING: **PROJECT No:** 71645
NORTHING: **DATE:** 22-24/03/2010
DIP/AZIMUTH: 90°/-- **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 - light grey and orange brown, silty clay with some ironstone gravel filling		A/E	0.1				
				A/E	0.5				
	1.0			A/E	1.0				
		FILLING - light brown to orange brown, silty sand filling		S			1,2,0 N = 2		
	1.4				1.45				
		FILLING - brown clay filling		E	2.0				
	2.3				2.5				
		FILLING - crushed sandstone/concrete filling		S			1,1,1 N = 2		
	3.0			E	2.95				
		Bore discontinued at 3.0m - auger refused on crushed sandstone/concrete			3.0				

RIG: DT 100 **DRILLER:** Steve Y **LOGGED:** SI/CF **CASING:** Uncased

TYPE OF BORING: Hand auger to 1.3m; Solid flight auger to 3.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: E = Environmental sample. No sample/refer to driller's log

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 4.8 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH8
PROJECT No: 71645
DATE: 23-24/03/2010
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
	0.14	CONCRETE		A/E	0.15		PID=3.0ppm		
		FILLING - grey sandy gravel filling		A/E	0.2				
				A/E	0.3		PID=2.7ppm		
	0.6			A/E	0.4				
		FILLING - dark grey, sandy silty clay with some concrete gravel filling, moist		A/E	0.5				
				A/E	0.8		PID=2.1ppm		
				A/E	1.0				
	1.25	SILTY CLAY - firm, light brown silty clay, moist		S			1,2,2 N = 4		
				E	1.4		PID=1.6ppm		
				E	1.45				
				E	1.5				
	2.0	CLAY - stiff, grey clay with trace of silt and gravel, moist		E	2.4		PID=2.3ppm		
				E	2.5				
				S			4,4,7 N = 11		
	3.0				2.95				
		CLAY - very stiff, mottled orange brown and light grey clay with some ironstone gravel, moist		E	3.0		PID=2.5ppm		
					3.2				
				S	4.0		7,10,11 N = 21		
					4.45				
	5.0	CLAY - hard, mottled orange grey clay with some ironstone gravel, moist		S	5.5		8,13,22 N = 35		
					5.95				
				S	7.0		6,13,20 N = 33		
					7.45				
	8.5	CLAYEY GRAVEL - hard, red brown, clayey gravel (ironstone), damp		S	8.5		19,25/150mm refusal		
					8.8				
	9.4	Bore discontinued at 9.4m - refusal on possible weathered rock							

RIG: DT 100 **DRILLER:** Steve Y **LOGGED:** SI/CF **CASING:** HQ to 4.0m

TYPE OF BORING: Diatube to 0.14m; Solid flight auger to 4.0m; Rotary to 9.4m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: E = Environmental sample. *Denotes field replicate sample BD1 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 4.5 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 71645
DATE: 22 Mar 10
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - grey brown, fine to medium grained sand with some concrete gravel filling		A	0.1				
				E	0.2		PID=2.4ppm		
	0.4				0.3				
		SILTY CLAY - grey brown silty clay with trace of fine grained sand, moist (possible filling)		A/E	0.4		PID=3.1ppm		
					0.5				
	0.8				0.8				
		SILTY CLAY - stiff, mottled orange brown and light grey silty clay with trace of ironstone gravel, moist		E	0.9		PID=1.2ppm		
				E	1.0				
				A			5,8,7		
				S			N = 15		
	1.4				1.4				
		CLAY - stiff, mottled orange brown and light grey clay with some ironstone gravel, moist		A/E*	1.45		PID=2.4ppm		
					1.5				
					1.9				
				E			PID=0.2ppm		
					2.4				
				A/E	2.5		PID=3.8ppm		
							5,6,7		
	2.8			S			N = 13		
		CLAY - very stiff, red brown and light grey clay with some ironstone bands, moist			2.95				
					4.0				
				S			5,8,13		
					4.45		N = 21		
	5.0	SHALY CLAY - hard, light grey shaly clay, damp							
					5.5				
				S			8,15,20		
					5.95		N = 35		
					7.0				
	7.2			S			12,20,10/50mm		
		SILTSTONE/LAMINITE - extremely low to very low strength, light grey siltstone/laminite			7.35		refusal		
	8.0				8.0				
		LAMINITE - low and low to medium strength, slightly weathered then fresh, fractured and slightly fractured, light grey brown and grey, laminite with approximately 30% fine grained sandstone laminations. Some very low strength bands			8.2		PL(A) = 0.3MPa		
					8.55		PL(A) = 0.2MPa		
	9.11			C					
					9.85		PL(A) = 0.3MPa		

RIG: DT 100 **DRILLER:** Rhett **LOGGED:** CF/SI **CASING:** HW to 2.6m; HQ to 8.0m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 8.0m; NMLC-Coring to 12.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Denotes field replicate sample BD1/220300 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Bovis Lend Lease
PROJECT: Stage 2 Contamination Assessment
LOCATION: Marrickville Metro, Marrickville

SURFACE LEVEL: 4.5 m AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: BH9
PROJECT No: 71645
DATE: 22 Mar 10
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
-6	10.4	LAMINITE - see previous page			10.0				
		LAMINITE - medium strength, fresh, slightly fractured, light grey to grey laminite with approximately 20% fine grained, sandstone laminations. Some extremely and very low strength bands		C	10.75		PL(A) = 0.4MPa		
-7	11				11.5		PL(A) = 0.6MPa		11
-8	12 12.0	Bore discontinued at 12.0m			12.0				12
-9	13								13
-10	14								14
-11	15								15
-12	16								16
-13	17								17
-14	18								18
-15	19								19

RIG: DT 100 **DRILLER:** Rhett **LOGGED:** CF/SI **CASING:** HW to 2.6m; HQ to 8.0m

TYPE OF BORING: Solid flight auger to 2.5m; Rotary to 8.0m; NMLC-Coring to 12.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Denotes field replicate sample BD1/220300 collected

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

SURFACE LEVEL: 5.0 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 109
PROJECT No: 71645.02
DATE: 19/8/2015
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
	0.18	CONCRETE SLAB							Gatic cover
		FILLING - light grey and grey, clayey, fine to coarse sand filling with some ripped sandstone gravel, damp		A/E	0.3 0.4		PID<1		Backfill 0.0-0.5m
	0.6	FILLING - dark grey, sandy clay filling with some fine gravel, moist (gravels are ironstone and sandstone)		A/E	0.9 1.0		PID<1		Bentonite 0.5-1.5m
	1.6	CLAY - yellow-brown, clay with trace ironstone gravel,							
	1.85	damp		A/E	1.9 2.0		PID<1		
		SILTY CLAY - red-brown and grey, silty clay with some ironstone gravel, humid							Gravel 1.5-10.0m
		- possible laminite or shale at approximately 8.0m							Machine slotted PVC screen 2.5-10.0m
	10.1	Bore discontinued at 10.1m - target depth reached							End cap

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

TYPE OF BORING: Diacore to 0.18m; Solid flight auger to 2.5m; Rotary to 10.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 10.0m (screened 2.5-10.0m; gravel 1.5-10.0m; bentonite 0.5-1.5m; gatic cover)

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

SURFACE LEVEL: 4.9 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 110
PROJECT No: 71645.02
DATE: 21/8/2015
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
		CONCRETE SLAB							Gatic cover
	0.28	FILLING - dark grey to black, sandy, fine gravel filling, moist, gravel igneous		A/E	0.3 0.4	BD7 BD8	PID<1		Backfill 0.0-0.5m
	0.95	FILLING - grey-brown, slightly sandy clay filling with some igneous gravel, damp		A/E	0.9 1.0		PID<1		Bentonite 0.5-1.5m
	1.45	CLAY - yellow-brown and grey, slightly silty clay with trace ironstone gravel, damp		A/E	1.9 2.0		PID<1		
	2.7	SILTY CLAY - red-brown and grey, silty clay with trace ironstone gravel, humid							Gravel 1.5-10.0m
		- possible laminite or shale at approximately 8.5m							Machine slotted PVC screen 2.5-10.0m
	10.1	Bore discontinued at 10.1m - target depth reached							End cap

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

TYPE OF BORING: Diacore to 0.28m; Solid flight auger to 2.5m; Rotary to 10.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 10.0m (screened 2.5-10.0m; gravel 1.5-10.0m; bentonite 0.5-1.5m; gatic cover)

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

SURFACE LEVEL: 5.0 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 111
PROJECT No: 71645.02
DATE: 19/8/2015
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
5		CONCRETE SLAB							
	0.2	FILLING - brown-grey, light brown and purple, clayey, fine to coarse sand filling with some ripped sandstone gravel		A/E	0.3		PID<1		
	0.35	FILLING - grey and dark grey, sandy clay filling with some igneous gravel			0.4				
4	1			A/E	0.9		PID<1		1
					1.0				
	1.65	CLAY - yellow-brown, clay with trace ironstone gravel, damp							
3	1.9	SILTY CLAY - orange-brown and grey, silty clay with trace ironstone gravel, humid		A/E	1.9		PID<1		
	2				2.0				2
	2.5	Bore discontinued at 2.5m - target depth reached							
2	3								3
1	4								4

RIG: Bobcat **DRILLER:** SY **LOGGED:** MP **CASING:** Uncased

TYPE OF BORING: Diacore to 0.2m; Solid flight auger to 2.5m

WATER OBSERVATIONS: No free groundwater observed

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)

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

SURFACE LEVEL: 4.9 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 112
PROJECT No: 71645.02
DATE: 20/8/2015
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
		CONCRETE SLAB							Gatic cover
	0.35	FILLING - dark grey and grey, sandy clay filling with some ripped sandstone gravel, brick fragments, nails and building rubble, moist		A/E	0.35 0.45		PID<1		Backfill 0.0-0.5m
				A/E	0.9 1.0	BD5 BD6	PID<1		
	1.5	CLAY - yellow-brown, slightly silty clay with trace fine ironstone gravel, damp							Bentonite 0.5-1.5m
	1.65	SILTY CLAY - red-brown and grey, silty clay with trace ironstone gravel, humid		A/E	1.9 2.0		PID<1		
		- possible laminite below 8.0m							Gravel 1.5-10.0m
	9.65	SILTSTONE/SHALE - probable depth of extremely low strength siltstone/shale							Machine slotted PVC screen 2.5-10.0m
	10.1	Bore discontinued at 10.1m - target depth reached							End cap

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

TYPE OF BORING: Diacore to 0.35m; Solid flight auger to 2.5m; Rotary to 10.1m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Standpipe installed to 10.0m (screened 2.5-10.0m; gravel 2.0-10.0m; bentonite 1.0-2.0m; gatic cover)

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

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

BORE No: 113
PROJECT No: 71645.02
DATE: 29/8/2015
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
	0.18	CONCRETE							Gatic cover Charcoal mix 0.0-0.2m Gravel 0.2-0.25m
	0.3	FILLING - dark brown, silty sand filling with some sandstone gravel		A/E/AS	0.2 0.3		PID<1		
				A/E/AS	0.4 0.5		PID<1		
	0.6	FILLING - red-brown, sandstone cobble/boulder filling			0.8				
1		FILLING - brown, clayey silt filling		A/E/AS	1.0		PID<1		Bentonite 0.25-1.5m
	1.1	CLAY - stiff, yellow-brown clay			1.3				
				A/E/AS	1.5		PID<1		
2		1.8m: becoming very stiff, red-brown clay		A/E/AS	2.0 2.1		PID<1		
		2.0m: becoming hard, red-brown clay							
3									
		3.5m: becoming grey clay with ironstone bands							Gravel 1.5-10.0m
				S/AS	3.7		4,13 refusal		
4					4.0				
5									
				S/AS	5.3 5.5		8,14,20/120mm refusal		
6									Machine slotted PVC screen 2.0-10.0m
7									
				S/AS	7.8 8.0		5,14,13 N = 27		
8									
9	9.0	SILTSTONE/LAMINITE							
	10.0	Bore discontinued at 10.0m - target depth reached							End cap

RIG: Bobcat **DRILLER:** SS **LOGGED:** W Yuan **CASING:** HW to 2.5m; HQ to 10.0m

TYPE OF BORING: Diatube to 0.18m; Solid flight auger to 2.5m; Rotary to 10.0m incorporating SPT's

WATER OBSERVATIONS: No free groundwater observed due to rotary drilling

REMARKS: AS = Acid sulphate soil sample. Became too hard to auger - changed to rotary at 2.5m incorporating SPT's

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

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

BORE No: 114
PROJECT No: 71645.02
DATE: 29/8/2015
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
	0.25	CONCRETE			0.25				
		FILLING - dark brown-black, silty sand with some clinker, concrete fragments and potential ACM fragments		A*/E	0.3				
				A/E	0.5		PID<1		
	0.7	CLAY - soft, dark yellow-brown clay			0.7				
	1			A/E	1.0		PID<1		1
					1.5				
	1.7			A**/E	1.7		PID<1		
	2	Bore discontinued at 1.7m - target depth reached							2
	3								3
	4								4
	5								5
	6								6
	7								7
	8								8
	9								9

RIG: DT250 **DRILLER:** SS **LOGGED:** W Yuan **CASING:** HW

TYPE OF BORING: Diatube to 0.25m; Solid flight auger to 1.7m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *BD1-290815 taken at 0.25-0.3m; **BD2-1090818 taken at 1.5-1.7m; ACM fragment sampled at 0.25-0.3m

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,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▽	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

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

BORE No: 115
PROJECT No: 71645.02
DATE: 29/8/2015
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
	0.18	CONCRETE							
	0.3	FILLING - sand filling with concrete fragments		A/E	0.2–0.3		PID<1		
		FILLING - dark brown-black, silty sand filling with some clinker and sandstone gravel		A/E	0.4–0.5		PID<1		
	0.65	Bore discontinued at 0.65m - refusal on concrete (possibly services or concrete fragment)							

RIG: DT250 **DRILLER:** SS **LOGGED:** W Yuan **CASING:** HW

TYPE OF BORING: Diatube to 0.18m; Solid flight auger to 0.65m

WATER OBSERVATIONS: No free groundwater observed

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)

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

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

BORE No: 116
PROJECT No: 71645.02
DATE: 29/8/2015
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
	0.11	CONCRETE							
		FILLING - crushed red-orange sandstone and brick/tile		A/E/AS	0.2 0.3		PID<1		
	0.5	FILLING - dark brown-black, silty sand filling with crushed brick/tile		A/E/AS	0.5		PID<1		
	0.8				0.8				
	0.9	CLAY - soft, dark grey clay (possibly filling), moist		A/E/AS	1.0		PID<1		
1		CLAY - stiff, brown clay, humid							1
				A/E/AS	1.3 1.4		PID<1		
		1.5m: becoming red-brown mottled grey clay							
				A/E/AS	1.8		PID<1		
2	2.0	Bore discontinued at 2.0m - in clay			2.0				2
3									3
4									4
5									5
6									6
7									7
8									8
9									9

RIG: DT250 **DRILLER:** SS **LOGGED:** W Yuan **CASING:** HW

TYPE OF BORING: Diatube to 0.11m; Solid flight auger to 2.0m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: AS = Acid sulphate soil sample

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,	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▽	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

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

BORE No: 117
PROJECT No: 71645.02
DATE: 29/8/2015
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
	0.15	CONCRETE							
	0.3	FILLING - orange-brown, sand filling with some concrete fragments		A/E/AS	0.2 0.3		PID<1		
	0.5	FILLING - dark brown-black, silty sand filling with some clinker		A/E/AS	0.4 0.5		PID<1		
	1	CLAY - soft, yellow-brown clay, moist		A/E/AS	0.8 1.0		PID<1		
		1.2m: becoming stiff, yellow-brown clay, humid		A/E/AS	1.3		PID<1		
	1.5	Bore discontinued at 1.5m - in clay			1.5				

RIG: DT250 **DRILLER:** SS **LOGGED:** W Yuan **CASING:** HW

TYPE OF BORING: Diatube to 0.15m; Solid flight auger to 1.5m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: AS = Acid sulphate soil sample

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: AMP Capital Shopping Centres
PROJECT: Marrickville Metro DSI
LOCATION: 34 Victoria Rd, 13-55 Edinburgh Rd, Marrickville

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

BORE No: 118
PROJECT No: 71645.02
DATE: 11/12/2016
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 - light brown, silty sand filling with trace subangular and angular igneous gravel							Gatic cover
	0.5	FILLING - light brown, fine to medium sand filling							Backfill 0.0-0.3m; Casing 0.2-2.5m
	1.2	SILTY SANDY CLAY - light brown and orange, silty sandy clay							Bentonite 1.0-2.0mm
	2.7	2.7m: grey, silty sandy clay with trace ironstone gravel							Gravel 2.0-8.5m
	3.5	SILTY CLAY - grey and pink mottled orange, silty clay with trace ironstone gravel							Machine slotted PVC screen 2.5-8.5m
	5.3	5.3m: red, silty clay with trace ironstone gravel							
	8.5	Bore discontinued at 8.5m - target depth reached							End cap

RIG: Bobcat **DRILLER:** GM **LOGGED:** RJL **CASING:** Uncased

TYPE OF BORING: Solid flight auger to. 8.5m

WATER OBSERVATIONS: Free groundwater observed at 6.5m

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)

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Site Assessment Criteria
Marrickville Metro Shopping Centre Expansion

1.0 Introduction

1.1 Guidelines

The following key guidelines were consulted for deriving the site assessment criteria (SAC):

- NEPC National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) [NEPM] (NEPC, 2013).
- CRC CARE *Health screening levels for petroleum hydrocarbons in soil and groundwater* (CRC CARE, 2011).
- ANZG *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018).

1.2 General

The SAC applied in the current investigation are informed by the CSM developed for DP (2016) which identified human and environmental receptors to potential contamination on the site. Analytical results are assessed (as a Tier 1 assessment) against the SAC comprising primarily the investigation and screening levels of Schedule B1 of NEPC (2013).

The following inputs are relevant to the selection and/or derivation of the SAC:

- Land use: Child Care Centre
  - Corresponding to land use category 'A', defined as residential with garden / accessible soil, also includes children's day care centres, preschools and primary schools.
- Soil type: Sand
  - Fill material at the site comprised sand, silt and clay. Investigation levels for a sand matrix have been adopted as a conservative input parameter.

2.0 Soils

2.1 Health Investigation and Screening Levels

The generic health investigation levels (HIL) and health screening levels (HSL) are considered to be appropriate for the assessment of human health risk via all relevant pathways of exposure associated with contamination at the site. The adopted soil HIL and HSL for the contaminants of concern are in Table 1 and Table 2.

Table 1: Health Investigation Levels (mg/kg)

Contaminant	HIL-A
Metals	
Arsenic	100
Cadmium	20
Chromium (VI)	100
Copper	6000
Lead	300
Mercury (inorganic)	40
Nickel	400
Zinc	7400
PAH	
B(a)P TEQ	3
Total PAH	300
Phenols	
Phenol	120
OCP	
DDT+DDE+DDD	240
Aldrin and dieldrin	6
Chlordane	50
Endosulfan	270
Endrin	10
Heptachlor	6
HCB	10
Methoxychlor	300
OPP	
Chlorpyrifos	160
PCB	
PCB	1

Table 2: Health Screening Levels (mg/kg)

Contaminant	HSL-A&B
SAND	**0 m to <1 m**
Benzene	0.5
Toluene	160
Ethylbenzene	55
Xylenes	40
Naphthalene	3
TRH F1	45
TRH F2	110

Notes: TRH F1 is TRH F1 minus BTEX

TRH F2 is TRH F2 minus naphthalene

The soil saturation concentration (Csat) is defined as the soil concentration at which the porewater phase cannot dissolve any more of an individual chemical. The soil vapour that is in equilibrium with the porewater will be at its maximum. If the derived soil HSL exceeds Csat, a soil vapour source concentration for a petroleum mixture could not exceed a level that would results in the maximum allowable vapour risk for the given scenario. For these scenarios, no HSL is presented for these chemicals and the HSL is shown as 'not limiting' or 'NL'

The HSL for direct contact derived from CRC CARE (2011) are in Table 3. The direct contact HSLs are relevant to parts of the site that are not covered by hardstand, i.e. garden beds and vegetated areas.

Table 3: Health Screening Levels for Direct Contact (mg/kg)

Contaminant	DC HSL-A
Benzene	100
Toluene	14 000
Ethylbenzene	4500
Xylenes	12 000
Naphthalene	1400
TRH F1	4400
TRH F2	3300
TRH F3	4500
TRH F4	6300

Notes: TRH F1 is TRH F1 minus BTEX

TRH F2 is TRH F2 minus naphthalene

2.2 Asbestos in Soil

Based on the CSM developed for DP (2016) and site access limitations at the time of undertaking field work, a detailed asbestos assessment was not considered to be warranted at this stage. However, due to the history of widespread use of ACM products across Australia, ACM can be encountered unexpectedly and sporadically at a site. Therefore, the presence or absence of asbestos at a limit of reporting of 0.1 g/kg (AS:4964) has been adopted for this investigation / assessment as an initial screen.

2.3 Ecological Investigation Levels

Ecological investigation levels (EIL) and added contaminant limits (ACL), where appropriate, have been derived in NEPC (2013) for arsenic, copper, chromium (III), nickel, lead, zinc, DDT and naphthalene. The adopted EIL, derived using the interactive (excel) calculation spreadsheet on the NEPM toolbox website are shown in Table 5, with inputs into their derivation shown in Table 4.

Table 4: Inputs to the Derivation of the Ecological Investigation Levels

Variable	Input	Rationale
Age of contaminants	"Aged" (>2 years)	Likely contamination source being historical site use and fill
pH	6.8	Measured in DP (2016)
CEC	8 $cmol_c/kg$	Measured in DP (2016)
Clay content	5%	Variable fill material (sand, silt and clay), considered to be a conservative input parameter
Traffic volumes	High	Site located in commercial / industrial area
State / Territory	NSW	Site located in Marrickville, NSW

Table 5: Ecological Investigation Levels (mg/kg)

Contaminant	EIL-A-B-C
Metals	
Arsenic	100
Copper	170
Nickel	100
Chromium III	320
Lead	1100
Zinc	410
PAH	
Naphthalene	170

Contaminant	EIL-A-B-C
OCP	
DDT	180

2.4 Ecological Screening Levels

Ecological screening levels (ESL) are used to assess the risk of selected petroleum hydrocarbon compounds, BTEX and benzo(a)pyrene to terrestrial ecosystems. The adopted ESL are shown in Table 6.

Table 6: Ecological Screening Levels (mg/kg)

Contaminant	Soil Type	EIL-A-B-C
Benzene	Coarse	50
Toluene	Coarse	85
Ethylbenzene	Coarse	70
Xylenes	Coarse	105
TRH F1	Coarse	180*
TRH F2	Coarse	120*
TRH F3	Coarse	300
TRH F4	Coarse	2800
B(a)P	Coarse	0.7

Notes: ESL are of low reliability except where indicated by * which indicates that the ESL is of moderate reliability
TRH F1 is TRH F1 minus BTEX
TRH F2 is TRH F2 including naphthalene

2.5 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.

The adopted management limits are in Table 7.

Table 7: Management Limits (mg/kg)

Contaminant	Soil Type	ML-A-B-C
TRH F1	Coarse	700
TRH F2	Coarse	1000
TRH F3	Coarse	2500
TRH F4	Coarse	10 000

Notes: TRH F1 is TRH F1 including BTEX
TRH F2 is TRH F2 including naphthalene

3.0 Soil Vapour

3.1 Interim Soil Vapour Health Investigation Levels

Soil vapour interim HIL for specific chlorinated VOC were published by NEPC (2013) to assess the vapour intrusion exposure pathway.

The interim HIL for chlorinated VOC methodology employs a simple though conservative approach using an attenuation factor that relates the concentration of a volatile contaminant in indoor air to the concentration in soil gas immediately below a building foundation slab.

The interim health investigation levels (IHIL) derived from NEPC (2013) are in Table 8.

Table 8: Soil Vapour Interim Health Investigation Levels for Chlorinated Hydrocarbons (µg/m^3)

Chemical	IHIL-A&B
TCE	20
1,1,1–TCA	60 000
PCE	2000
cis-DCE	80
VC	30

Notes: TCE Trichloroethene
1,1,1–TCA 1,1,1-trichloroethane
PCE Tetrachloroethene
cis-DCE cis-1,2-dichloroethene
VC Vinyl chloride

3.2 Health Screening Levels

Soil vapour HSL for petroleum hydrocarbons were published by NEPC (2013) to assess the vapour intrusion exposure pathway.

The HSL derived from NEPC (2013) are in Table 9.

Table 9: Soil Vapour Health Screening Levels for Vapour Intrusion (µg/m^3)

Contaminant	HSL-A&B
SAND	0-1 m
Benzene	1000
Toluene	1 300 000
Ethylbenzene	330 000
Xylene Total	220 000
Naphthalene	800
TRH F1	180 000
TRH F2	130 000

Notes: TRH F1 is TRH F1 minus BTEX

TRH F2 is TRH F2 minus naphthalene

The maximum possible soil vapour concentrations have been calculated based on vapour pressures of the pure chemicals. Where soil vapour HSL exceed these values, a soil-specific source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable vapour risk for the given scenario. For these scenarios, no HSL is presented for these chemicals and the HSL is shown as 'not limiting' or 'NL'

4.0 Groundwater

4.1 Introduction

The groundwater investigation levels (GIL) used for interpretation of the groundwater data (as a Tier 1 assessment) have been selected based on the potential risks posed from contamination sourced from the site to receptors at or down-gradient of the site, as identified by the CSM developed for DP (2016). The receptors, exposure points and pathways are summarised in Table 10.

Table 10: Summary of Potential Receptors and Potential Risks

Receptor	Location	Exposure Point	Exposure Pathway
Surface water aquatic ecosystem [Sheas Creek]	Down-gradient from site.	Receiving surface water body at the groundwater discharge point.	Exposure to contaminants.
Occupants of buildings	On site and down-gradient from site.	Enclosed buildings (proposed Child Care Centre in shopping centre)	Inhalation of VOC (including TRH and BTEX) overlying VOC impacted groundwater via the vapour intrusion pathway.

The rationale for the selection of GIL is in Table 11.

Table 11: Groundwater Investigation Level Rationale

Receptor / Beneficial Use	GIL	Source	Comments / Rationale
Aquatic ecosystem	DGV	ANZG (2018)	Freshwater 99% LOP for bioaccumulative contaminants 95% LOP for non-bioaccumulative contaminants
Building occupants (vapour intrusion)	HSL	NEPC (2013)	2 m to <4 m

Notes: DGV default guideline value
% LOP percentage level of protection of species
HSL health screening level

4.2 Groundwater Investigation Levels for Aquatic Ecosystems

The DGV for the protection of aquatic ecosystems derived from ANZG (2018) are in Table 12. Given the exhaustive list of Volatile Organic Compound (VOC) contaminants, only those VOC concentrations detected above the laboratory reporting limits and with Groundwater Investigation Levels have been included in this table.

Table 12: Groundwater Investigation Levels for Protection of Aquatic Ecosystems (µg/L)

Contaminant	Fresh Water
Metals	
Arsenic	13
Cadmium	0.2
Chromium (VI)	1
Copper	1.4
Lead	3.4
Mercury (inorganic)	0.06
Nickel	11
Zinc	8
BTEX	
Benzene	950
Toluene	180
Ethylbenzene	80
m+p-xylene	72 as m-xylene; 200 as p-xylene

Contaminant	Fresh Water
o-xylene	350
PAH	
B(a)P	0.1
Naphthalene	16
Anthracene	0.01
Fluoranthene	1
Phenanthrene	0.6
OCP	
DDT	0.01
DDE	0.03
Aldrin	0.001
Dieldrin	0.01
Chlordane	0.03
Endosulfan	0.03
Endrin	0.01
Heptachlor	0.01
HCB	0.05
Lindane	0.2
Methoxychlor	0.005
OPP	
Chlorpyrifos	0.01
Azinphos methyl	0.02
Diazinon	0.01
Dimethoate	0.15
Fenitrothion	0.2
Malathion	0.05
Parathion	0.004
VOC	
1,1,1-trichloroethane	270
1,1,2,2-tetrachloroethane	400
tetrachloroethene	70

Contaminant	Fresh Water
1,1,2-trichloroethane	6500
1,1,2-trichloroethylene	330
1,1-Dichloroethene	700
1,2,3-trichlorobenzene	10
1,2,4-trichlorobenzene	170
1,2-dichlorobenzene	160
1,2-dichloroethane	1900
1,2-dichloropropane	900
1,3-dichlorobenzene	260
1,3-dichloropropane	1100
1,4-dichlorobenzene	60
carbon tetrachloride	240
Vinyl Chloride	100
Chloroform	370
isopropylbenzene (cumene)	30
Monochlorobenzene	55
Other	
Cyanide	7

Notes: Where the contaminant does not have a % LOP, the 'unknown' LOP has been adopted

4.3 Health Screening Levels for Vapour Intrusion

The HSL to evaluate potential vapour intrusion risks derived from NEPC (2013) are in Table 13.

Table 13: Groundwater Health Screening Levels for Vapour Intrusion (µg/L)

Contaminant	HSL-A&B	Solubility Limit
SAND	**2 m to <4 m**	**-**
Benzene	800	59 000
Toluene	NL	61 000
Ethylbenzene	NL	3900
Xylenes	NL	21 000
Naphthalene	NL	170
TRH F1	1000	9000
TRH F2	1000	3000

Notes: TRH F1 is TRH F1 minus BTEX

TRH F2 is TRH F2 minus naphthalene

The solubility limit is defined as the groundwater concentration at which the water cannot dissolve any more of an individual chemical based on a petroleum mixture. The soil vapour that is in equilibrium with the groundwater will be at its maximum. If the derived groundwater HSL exceeds the water solubility limit, a soil vapour source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable vapour risk for the given scenario. For these scenarios, no HSL is presented for these chemicals and the HSL is shown as 'not limiting' or 'NL'.

5.0 References

ANZG. (2018). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Canberra, ACT: Australian and New Zealand Governments and Australian state and territory governments.

CRC CARE. (2011). *Health screening levels for petroleum hydrocarbons in soil and groundwater.* Parts 1 to 3, Technical Report No. 10: Cooperative Research Centre for Contamination Assessment and Remediation of the Environment.

NEPC. (2013). *National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) [NEPM].* Australian Government Publishing Services Canberra: National Environment Protection Council.

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Table 1A: Summary of Laboratory Results – Metals, TRH, BTEX, PAH

			Metals									TRH						BTEX				PAH			
			Arsenic	Cadmium	Total Chromium	Copper	Lead	Manganese	Mercury (inorganic)	Nickel	Zinc	TRH C6 - C10	TRH >C10-C16	F1 ((C6-C10)-BTEX)	F2 (>C10-C16 less Naphthalene)	F3 (>C16-C34)	F4 (>C34-C40)	Benzene	Toluene	Ethylbenzene	Total Xylenes	Naphthalene [b]	Benzo(a)pyrene (BaP)	Benzo(a)pyrene TEQ	Total PAH
		PQL	4	0.4	5	1	1		0.1	1	1	25	50	25	50	100	100	0.2	0.5	1	1	0.1	0.05	0.5	0.1
Sample ID	Depth	Sample Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
DP (2016)																									
BH109	0.3 - 0.4 m	19/08/2015	<4	<0.4	6	11	48	NT	<0.1	9	59	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	0.3	0.5	3
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH109	0.9 - 1 m	19/08/2015	<4	<0.4	18	28	98	93	0.3	8	83	<25	<50	<25	<50	190	<100	<0.2	<0.5	<1	<3	0.2	3.8	5.2	38
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH110	0.3 - 0.4 m	21/08/2015	11	<0.4	5	25	30	140	<0.1	19	49	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	<0.5	<0.5	0.56
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BD8	0.3 - 0.4 m	21/08/2015	5	<0.4	<5	15	19	NT	0.16	18	31	<20	<50	<20	<50	<100	<100	<0.1	<0.1	<0.1	<0.3	<0.5	1.2	1.2	0.7
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH111	0.9 - 1 m	19/08/2015	6	0.6	14	74	230	190	0.2	14	330	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	1.7	2.3	17
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH112	0.9 - 1 m	20/08/2015	<4	3	18	53	1000	110	0.3	9	710	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.5	0.2	<0.5	1.8
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH113	0.2 - 0.3 m	29/08/2015	9	1	17	120	510	NT	1.3	8	960	<25	<50	<25	<50	620	170	<0.2	<0.5	<1	<3	0.3	11	16	100
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH113	0.8 - 1 m	29/08/2015	<4	<0.4	11	10	32	38	<0.1	3	11	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	0.4	0.6	5
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH114	0.25 - 0.3 m	29/08/2015	5	<0.4	9	290	200	79	0.2	13	260	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	0.1	<0.5	1.8
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BD1/290815	0.25 - 0.3 m	29/08/2015	<4	<0.4	5	170	39	79	<0.1	14	54	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	0.2	<0.5	2.5
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BD2/1090818 (BH114)	1.5 - 1.7 m	29/08/2015	3.1	<0.4	13	6.6	18	NT	<0.05	<5	9.3	<20	<50	<20	<50	<100	<100	<0.1	<0.1	<0.1	<0.3	<0.5	1.2	1.2	1.2
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH115	0.4 - 0.5 m	29/08/2015	<4	<0.4	14	56	72	88	<0.1	39	300	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	0.06	<0.5	0.49
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH116	0.2 - 0.3 m	29/08/2015	<4	<0.4	11	37	94	110	<0.1	4	84	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	0.9	1.3	9
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH116	0.5 m	29/08/2015	6	0.4	15	110	200	NT	0.7	7	160	<25	<50	<25	<50	710	170	<0.2	<0.5	<1	<3	1.1	11	15	120
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH117	0.2 - 0.3 m	29/08/2015	<4	<0.4	13	34	86	NT	<0.1	8	88	<25	<50	<25	<50	<100	<100	<0.2	<0.5	<1	<3	<0.1	0.1	<0.5	1.3
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH117	0.4 - 0.5 m	29/08/2015	5	0.4	13	170	530	270	0.6	9	240	<25	<50	<25	<50	1000	230	<0.2	<0.5	<1	<3	1.3	14	20	140
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
DP (2010)																									
BH5	0.05 - 0.1 m	17/03/2010	<4	<0.5	3	260	8	NT	<0.1	8	49	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	<0.05	NT	<0.1
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH5	2.3 - 2.5 m	17/03/2010	<4	<0.5	21	20	17	NT	<0.1	11	16	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	0.1	NT	0.5
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH6	0.15 - 0.3 m	16/03/2010	5	0.7	18	70	28	NT	<0.1	33	62	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	1.2	NT	7.1
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH6	1.9 - 2 m	16/03/2010	<4	<0.5	20	14	17	NT	<0.1	5	7	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	<0.05	NT	<0.1
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH7	0.4 - 0.5 m	23/03/2010	6	<0.5	16	28	72	NT	0.2	5	74	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	5	NT	58
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH7	2.8 - 3 m	23/03/2010	14	<0.5	17	28	110	NT	0.2	5	100	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	2.4	NT	27
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH8	0.4 - 0.5 m	24/03/2010	6	0.5	12	61	510	NT	0.3	9	410	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	3.6	NT	33
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH8	3 - 3.2 m	24/03/2010	<4	<0.5	14	9	35	NT	<0.1	3	22	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	0.09	NT	0.7
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH9	0.2 - 0.3 m	22/03/2010	<4	<0.5	8	62	57	NT	<0.1	7	200	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	0.1	NT	0.5
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC
BH9	2.4 - 2.5 m	22/03/2010	<4	<0.5	19	8	16	NT	<0.1	2	15	NT	NT	NT	NT	NT	NT	<0.5	<1	<0.5	<3	NT	<0.05	NT	<0.1
			100 100	20 NC	100 320	6000 170	300 1100	3800 NC	40 NC	400 100	7400 410	NC NC	NC 120	45 180	110 120	NC 300	NC 2800	0.5 50	160 85	55 70	40 105	3 170	NC 0.7	3 NC	300 NC

Lab result

HIL/HSL value EIL/ESL value

HIL/HSL exceedance; EIL/ESL exceedance; HIL/HSL and EIL/ESL exceedance; ML exceedance; ML and HIL/HSL or EIL/ESL exceedance

Indicates that asbestos has been detected by the lab below the PQL, refer to the lab report **Blue** = DC exceedance

Bold = Lab detections NT = Not tested NL = Non limiting NC = No criteria NA = Not applicable NAD = No asbestos detected at the reporting limit

Notes:

HIL/HSL/DC	NEPC, Schedule B1 - HIL A (residential), HSL A/B (residential), DC HSL A (residential)
EIL/ESL	NEPC, Schedule B1 - EIL UR/POS (urban recreational/public open space), ESL UR/POS (urban recreational/public open space)
ML	NEPC, Schedule B1 - ML R/P/POS (residential/parkland/public open space)
a	QA/QC replicate of sample listed directly below the primary sample
b	Reported naphthalene laboratory result obtained from BTEXN suite
c	Criteria applies to DDT only

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Table 2A: Summary of Laboratory Results – METALS, TRH, BTEX, PAH

	METALS												TRH				BTEX					PAH
		Arsenic	Aluminium	Cadmium	Total Chromium	Copper	Lead	Manganese	Mercury (inorganic)	Nickel	Silver	Zinc	F1 ((C6-C10)-BTEX)	F2 (>C10-C16 less Naphthalene)	C6 - C9	C10 - C36	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene	Total PAH
	PQL	1	1	0.1	1	1	1	1	0.05	1	1	1	10	50	10	250	1	1	1	2	1	-
Sample ID	Sample Date	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
DP (2016)																						
BH109	2/10/2015	<1	20	0.2	<1	2	<1	25	<0.05	1	<1	21	<10	<50	<10	<250	<1	<1	<1	<2	<1	<PQL
BH110	2/10/2015	<1	80	0.1	<1	2	1	47	<0.05	2	<1	23	<10	<50	<10	<250	<1	<1	<1	<2	<1	<PQL
BH112	2/10/2015	<1	100	0.1	<1	4	7	63	<0.05	2	<1	66	<10	<50	<10	<250	<1	<1	<1	<2	<1	<PQL
BH113	2/10/2015	<1	40	<0.1	<1	<1	<1	130	<0.05	4	2	25	<10	<50	<10	<250	<1	<1	<1	<2	<1	<PQL
BH6	11/12/2015	<1	NT	<0.1	<1	6	<1	NT	<0.05	3	NT	21	<10	<50	<10	<250	<1	<1	<1	<2	<1	<PQL
BH118	17/12/2015	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	28	<50	28	<250	<1	<1	<1	<2	<1	NT
DP (2010)																						
BH6	30/03/2010	<1	NT	<0.1	2	33	3	NT	<0.05	3	NT	100	<10	NT	<10	420	<1	<1	<1	<2	<1	<PQL
BH7	30/03/2010	<1	NT	<0.1	<1	<1	<1	NT	<0.05	1	NT	18	<10	<5	<10	<250	<1	<1	<1	<2	<1	<PQL
BD1	30/03/2010	<1	NT	<0.1	<1	<1	<1	NT	<0.05	1	NT	18	<10	<50	<10	<250	<1	<1	<1	<2	<1	<PQL
Ground Water Criteria																						
ANZG (2018) 95% LOP Fresh		24 as As (III); 13 as As(V)	55	0.2	3.3 as Cr(III); 1 as Cr(VI)	1.4	3.4	1900	0.06	11	0.05	8					950	180	80	75 as m-xylene; 200 as p-xylene	350	0.4
NEPC (2013) HSL 2-<4m													1000	1000			800	NL	NL	NL	NL	

Notes:

* QA/QC replicate of sample listed directly below the primary sample

PQL Practical quantitation limit

\- No criterion / not defined / not tested / not applicable

Shaded cell is exceedance of guideline value

Where one or more guideline value is exceeded, the cell is shaded to the colour of the highest guideline value exceeded

ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 95% level of protection of species for Fresh aquatic ecosystems [NB: 99% level of protection adopted for bioaccumulative chemicals]

ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, orange text is 'unknown' level of protection

NEPC (2013) National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013), health screening level, sand 2-<4m

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Table 3: Summary of Soil Vapour Analysis

				Location		SV1	SV1	SV1	SV1	SV1-can	SV1-can
				Sample Date		17/12/2015	14/07/2016	19/10/2016	20/01/2017	27/04/2017	12/07/2017
				NEPC (2013) HSL-A SAND	NEPC (2013) Interim HIL-A						
Analyte Group	**Analyte**	**Units**	**PQL**	**0-1m**							
	2-Propanol (IPA)	µg/m3	1.2			<1.2	<1.2	120	54	110	44
TO15 in Canisters	1,2-Dichlorotetrafluoroethane	µg/m3	2.5			<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
BTEX	Benzene	µg/m3	1.6	**1000**		16	<1.6	<1.6	<1.6	<1.6	4
	Ethylbenzene	µg/m3	2.2	**330,000**		10	<2.2	<2.2	5	9	<2.2
	Toluene	µg/m3	1.9	**1,300,000**		31	3	4	23	43	5
	Xylene (m & p)	µg/m3	4.3	**220,000**		10	<4/3	5	10	30	<4.3
	Xylene (o)	µg/m3	2.2			7	<2.2	<2.2	4	7	<2.2
MAH	1,2,4-trimethylbenzene	µg/m3	2.5			3	<2.5	<2.5	4	4	3
	1,3,5-trimethylbenzene	µg/m3	2.5			<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	1-methyl-4-ethyl benzene	µg/m3	2.5			<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Styrene	µg/m3	2.1			<2.1	4	4	10	10	<2.1
Chlorinated Hydrocarbons	1,1,1-trichloroethane (1,1,1-TCA)	µg/m3	2.7		**60,000**	<2.7	5	4	3	5	4
	1,1,2,2-tetrachloroethane	µg/m3	3.4			<3.4	<3.4	<3.4	<3.4	<3.4	<3.4
	1,1,2-trichloroethane	µg/m3	2.7			<2.7	<2.7	<2.7	<2.7	<2.7	<2.7
	1,1-dichloroethane	µg/m3	2			<2	<2	<2	<2	<2	<2
	1,1-dichloroethene	µg/m3	2			<2	<2	<2	<2	<2	<2
	1,2-dichloroethane	µg/m3	2			<2	<2	<2	<2	<2	<2
	1,2-dichloropropane	µg/m3	2.3			<2.3	<2.3	<2.3	<2.3	<2.3	<4.6
	Benzyl chloride	ug/m3	2.6			<2.6	<2.6	<2.6	<2.6	<2.6	<2.6
	Bromodichloromethane	µg/m3	3.4			<3.4	<3.4	<3.4	<3.4	<3.4	<3.4
	Bromoform	µg/m3	5.2			<5.2	<5.2	<5.2	<5.2	<5.2	<5.2
	Carbon tetrachloride	µg/m3	3.1			<3.1	<3.1	<3.1	<3.1	<3.1	<3.1
	Chlorodibromomethane	µg/m3	1.6			<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
	Chloroethane	µg/m3	1.3			<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
	Chloroform	µg/m3	2.4			32	<2.4	<2.4	<2.4	<2.4	<2.4
	Chloromethane	µg/m3	1			<1	<1	<10	<1	<1	<1
	cis-1,2-dichloroethene	µg/m3	2		**80**	<2	<2	<2	<2	<2	<2
	cis-1,3-dichloropropene	µg/m3	2.3			<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
	Dichloromethane	µg/m3	20			NT	<20	<20	<20	<20	<20
	Hexachlorobutadiene	µg/m3	5.3			<5.3	<5.3	<5.3	<5.3	<5.3	<5.3
	Trichloroethene (TCE)	µg/m3	2.7		**20**	7	4	4	<2.7	3	<2.7
	Tetrachloroethene (PCE)	µg/m3	3.4		**2000**	43	51	68	90	60	62
	trans-1,2-dichloroethene	µg/m3	2			<2	<2	<2	<2	<2	<2
	trans-1,3-dichloropropene	µg/m3	2.3			<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
	Vinyl chloride	µg/m3	1.3		**30**	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Halogenated Hydrocarbons	1,2-dibromoethane	µg/m3	3.8			<3.8	<3.8	<3.8	<3.8	<3.8	<3.8
	Bromomethane	µg/m3	1.9			<1.9	<1.9	<1.9	<1.9	<1.9	<1.9
	Propylene	µg/m3	0.9			6	<2.5	<2.5	3	3	<2.5
	Dichlorodifluoromethane	µg/m3	2.5			<2.5	<2.5	<2.5	<2.5	<2.5	<5
	Trichlorofluoromethane	µg/m3	2.8			<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
Halogenated Benzenes	1,2,4-trichlorobenzene	µg/m3	3.7			<3.7	<3.7	<3.7	<3.7	<3.7	<3.7
	1,2-dichlorobenzene	µg/m3	3			<3	<3	<3	<3	<3	<3
	1,3-dichlorobenzene	µg/m3	3			<3	<3	<3	<3	<3	<3
	1,4-dichlorobenzene	µg/m3	3			70	20	36	78	31	<3
	Chlorobenzene	µg/m3	2.3			<2.3	<2.3	<2.3	<2.3	<2.3	<2.3
VOCs	1,3-Butadiene	µg/m3	1.1			<1.1	<1.1	<1.1	<1.1	<1.1	<1.1
	Acrolein	µg/m3	11			<11	<11	<11	<11	<11	<1.1
	Methyl Methacrylate	µg/m3	2			<2	<2	<2	<2	<2	<2
Solvents	1,4-Dioxane	µg/m3	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
	Methyl Ethyl Ketone (MEK)	µg/m3	1.5			<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
	2-hexanone (MBK)	µg/m3	2			<2	<2	<2	<2	<2	<2
	4-Methyl-2-pentanone (MIBK)	µg/m3	2			<2	<2	<2	<2	<2	<2
	Acetone	ug/m3	11.9			NT	<11.9	<11.9	10	20	<11.9
	Carbon disulfide	µg/m3	1.6			<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
	Cyclohexane	ug/m3	1.7			<1.7	<1.7	<1.7	<1.7	<1.7	<1.7
	Ethanol	µg/m3	0.9			<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
	Ethyl acetate	µg/m3	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
	Heptane	µg/m3	2			10	<2	<2	<2	3	<2
	Hexane	µg/m3	1.8			240	3	<1.8	59	44	<1.8
	MTBE	ug/m3	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
	Tetrahydrofuran	µg/m3	1.5			<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
	Vinyl acetate	µg/m3	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
PAH/Phenols	Naphthalene	µg/m3	2.6	**800**		<2.6	<2.6	<2.6	<2.6	<2.6	<2.6