JKEnvironments

10 June 2021
Ref: E32915Blet

Kincoppal-Rose Bay School
c/- Mahady Management Pty Ltd

Attention: Mr Terry Mahady

DESKTOP PRELIMINARY ACID SULFATE SOIL ASSESSMENT
PROPOSED DEVELOPMENT AT KINCOPPAL-ROSE BAY SCHOOL
CORNER OF NEW SOUTH HEAD AND VAUCLUSE ROADS, VAUCLUSE, NSW

1 INTRODUCTION

Mahady Management Pty Ltd on behalf of Kincoppal-Rose Bay School ('the client') commissioned JK Environments (JKE) to undertake a desktop preliminary acid sulfate soil (ASS) assessment for the proposed development at KRB situated on the corner of New South Head Road and Vaucluse Road, Vaucluse, NSW. The site location is shown on Figure 1.

JKE have previously undertaken a Preliminary Site Investigation (PSI) at the site (JKE Ref: E32915BDrpt, dated 2 March 2020)[1]. Based on the results of the PSI, a remediation action plan (RAP) was developed and issued for the site (Ref: E32915BDrpt-RAP, dated 29 October 2020). The RAP has been prepared to support the lodgement of a State Significant Development Application (SSDA).

Information from the PSI is presented in this report (where relevant) and a summary of the findings is included in Section 2. This letter should be read in conjunction with the JKE PSI and RAP.

The assessment has been designed in response to the comments received from the Department of Planning in relation to the works being within 500m of an area mapped as having a Class 3 ASS risk. Based on the results of the JKE PSI, we are of the opinion that a desktop assessment will be able to conclude that there is a negligible risk of ASS occurrence in the development area and that the proposed development would not be expected to require disturbance or management of ASS material. On this basis, we anticipate that we can state that supervision and compliance with ASS management provisions is not required.

A geotechnical investigation was undertaken in conjunction with the JKE PSI by JK Geotechnics (JKG). The results of the investigation are presented in a separate report (Ref: 32975PHrpt, dated 26 February 2020)[2]. This letter should be read in conjunction with the JKG report.

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[1] JKE, (2020). Report to Kincoppal-Rose Bay School on Preliminary Site Investigation with Limited Sampling for Proposed Development at Kincoppal-Rose Bay School at Corner New South Head Road and Vaucluse Road, Vaucluse, NSW (referred to as the 'PSI').

[2] Referred to as JKG report

The aims of the desktop assessment were to review the site information, establish whether ASS may be disturbed during the proposed development works, and to assess whether an ASS management plan (ASSMP) is required.

1.1 Assessment Guidelines and Background

The ASS assessment and preparation of this report were undertaken with reference to the National Acid Sulfate Soil Guidance (2018) documents and the Acid Sulfate Soil Management Advisory Committee (ASSMAC) Acid Sulfate Soil Manual (1998)[3].

Acid sulfate soil materials include Potential acid sulfate soils (PASS or sulfidic soil materials) and Actual acid sulfate soils (AASS or sulfuric soil materials). These are often found in the same profile, with AASS overlying PASS. AASS and PASS are defined further as follows:

- PASS are soil materials which contain Reduced Inorganic Sulfur (RIS) such as pyrite. The field pH of these soils in their undisturbed state is usually more than pH 4 and is commonly neutral to alkaline (pH 7–9). These soil materials are invariably saturated with water in their natural state. Their texture may be peat, clay, loam, silt or sand and is often dark grey in colour and soft in consistence, but these materials may also exhibit colours that are dark brown, or medium to pale grey to white; and
- AASS are soil materials which contained RIS such as pyrite that have undergone oxidation. This oxidation results in low pH (that is pH less than 4) and often a yellow (jarosite) and/or orange to red mottling (ferric iron oxides) in the soil profile. Actual ASS contains Actual Acidity, and commonly also contains RIS (the source of Potential Sulfuric Acidity) as well as Retained Acidity.

Further background information on ASS and the assessment process is provided in the appendices.

1.2 Proposed Development Details

We understand that the proposed development includes construction of a two-storey Early Learning Centre (ELC) building in Precinct A (northern part of the site), a two-storey bus/carpark in Precinct B (southern part of the site) and a road/elevated walkway in Precinct B (central part of the site). Required earthworks are anticipated to include excavations to a maximum depth of approximately 2m below ground level (BGL) for the proposed ELC building and a new bus/carpark. Proposed new road is assumed to be at, or close to, existing surface levels.

2 SITE INFORMATION

2.1 Summary of Previous JKG Geotechnical Investigation

JKG was commissioned to complete geotechnical investigations for the proposed development at the site. The scope of work included: drilling ten boreholes (BH1 to BH10) across the site to depths ranging between 0.40-9.30m below ground level (mBGL); Standard Penetration Testing (SPT) and Dynamic Cone Penetrometer (DCP) testing at selected borehole locations; groundwater observations during drilling; laboratory testing of

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[3] Acid Sulfate Soils Management Advisory Committee (ASSMAC), (1998). *Acid Sulfate Soils Manual* (ASS Manual 1998)

selected samples for geotechnical parameters; and preparation of three separate reports for each individual development site presenting the results of the investigation.

The soil stratigraphy observed in the boreholes generally comprised:

- Asphaltic concrete, ranging in thickness between 50mm and 90mm, were encountered in BH1, BH2 and BH3;
- FILL: consisting of Silty Sand with inclusions comprising varying sizes and fractions of igneous and sandstone gravel, clay, roots, brick fragments and occasional sandstone cobbles and boulders at depth (in some of the locations). Fill material was encountered in all locations from the surface or beneath the asphaltic concrete extending down to 0.2-6.2mBGL; overlaying
- NATURAL RESIDUAL SOILS: comprising Silty Sand, Clayey Sand and Gravelly Sand, were encountered in BH2, BH6, BH7 and BH8 beneath the fill, extending down to at least between 0.4 and 9.20mBGL; underlain by
- BEDROCK: Sandstone bedrock was encountered in most of the boreholes at varying depths between 0.4-6.2mBGL. Bedrock was not encountered in BH2 only.

All boreholes were dry on completion of drilling. A groundwater monitoring well was installed at BH2 to allow for further groundwater monitoring. In BH2, the groundwater was observed at depths ranging between 8.0-8.5mBGL after completion of drilling and upon return to the site at a later date. In BH8, groundwater was encountered on completion of hand auguring at 1.8m depth, just above the soil/bedrock interface. No long-term monitoring of the groundwater levels was undertaken.

2.2 Summary of Previous JKE PSI Investigation

The JKE PSI included a site inspection, desktop review of historical information and sampling from 10 boreholes and one groundwater monitoring well. The sampling locations are shown on the figures attached in the appendices. The site history is summarised in the following table:

Table 2-1: Summary of Historical Land Uses

Year(s)	Potential Land Use / Activities
Pre-1930 - Current	School grounds and accommodation as well as possibly for religious use.

The potential contamination sources and contaminants of potential concern (CoPC) identified in the PSI are presented in the following table:

Table 2-2: Potential (and/or known) Contamination Sources/AEC and Contaminants of Potential Concern

Source / AEC	CoPC
Fill material – The site appears to have been historically filled to achieve the existing levels. The fill may have been imported from various sources and could be contaminated.	Heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), petroleum hydrocarbons (referred to as total recoverable hydrocarbons – TRHs), benzene, toluene, ethylbenzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), organophosphate

Source / AEC	CoPC
	pesticides (OPPs), polychlorinated biphenyls (PCBs) and asbestos.
Use of pesticides – Pesticides may have been used beneath the buildings and/or around the site.	Heavy metals and OCPs.
Hazardous Building Material – Hazardous building materials may be present as a result of former building and demolition activities. These materials may also be present in the existing buildings/ structures on site.	Asbestos, lead and PCBs.

A summary of the subsurface conditions encountered during PSI is presented in the table below. The borehole logs are attached in the appendices.

Table 2-3: Summary of Subsurface Conditions

Profile	Description
Pavement	Asphaltic Concrete (AC) pavement was encountered at the surface in BH1, BH2 and BH3, ranging in thickness between 50mm and 90mm.
Fill	Fill was encountered at the surface or beneath the AC pavement in all boreholes and extended to depths of approximately 0.2 to 6.2mBGL. BH10 was terminated in the fill at a depth of approximately 0.45m. Relatively deep fill greater than 2mBGL was encountered in boreholes BH2 and BH3 located near the proposed ELC building. The fill typically comprised gravelly silty sand, silty sand, fine to coarse grained, with inclusions comprising of varying sizes and fractions of igneous and sandstone gravel, clay, roots, brick fragments and occasional sandstone cobbles and boulders at depth (in some of the locations).
Natural Residual Soil	Natural soil was encountered in BH2, BH6, BH7 and BH8 beneath the fill and extended down to at least between 0.4 and 9.20mBGL. Residual natural soil typically comprised Silty Sand, Clayey Sand and Gravelly Sand.
Bedrock	Sandstone bedrock was encountered in most of the boreholes at depths varying from approximately 0.4-6.2mBGL. Bedrock was not encountered in BH2 only. BH2 encountered deep sands.
Groundwater	All boreholes were dry on completion of drilling. A groundwater monitoring well was installed at BH2 to allow for further groundwater monitoring. In BH2, the groundwater was observed at depths ranging between 8.0-8.5mBGL after completion of drilling and upon return to the site at a later date. In BH8, groundwater was encountered on completion of hand auguring at 1.8m depth, just above the soil/bedrock interface.

Selected soil and groundwater samples were submitted for laboratory analysis to be assessed for any associated impacts by the CoPC.

Laboratory results identified lead and carcinogenic PAHs concentrations in fill above the adopted site assessment criteria (SAC) in northern and southern parts of the site within areas of proposed development. The source of contamination was identified as the fill material historically imported onto the site. The contaminants requiring remediation include: lead contamination (hotspot) in the northern part of the site where the new ELC building is proposed, carcinogenic PAHs within the southern part of the site area where the new two-storey bus/carpark is proposed, and TRH F3 identified within northern and southern parts of the site which poses a risk to ecological receptors. TRH exceedances where co-located with the identified exceedances of carcinogenic PAHs requiring remediation in BH8. The extent of soil impacted by the contaminants has not been confirmed and constitutes a data gap to be addressed as part of the remediation.

Significant contamination of groundwater was not identified. Elevated concentration of heavy metal zinc was detected in the groundwater sample, though were representative of groundwater conditions within an urban environment and considered to be a regional issue. A number of PAH compounds namely: phenanthrene, anthracene, fluoranthene and benzo(a)pyrene were also detected above the ecological and human health SAC in groundwater. However, JKE are of the opinion that slow groundwater recharge and sediment present within one well sampled as part of the investigation may have cause interference with the PAH analysis.

Based on the preliminary waste classification assessment undertaken for the PSI, the fill material met the classification of General Solid Waste (non-putrescible). It was noted that low concentrations of PAHs were encountered within the sample of natural soil collected from BH8 (1.6-1.8m) and as such natural soils in this area were considered unlikely to meet the definition of VENM for off-site disposal or re-use purposes, and were assigned a preliminary classification of General Solid Waste (non-putrescible). It was recommended that additional testing be undertaken of the natural soil to confirm the final classification for off-site disposal.

Based on the findings of the PSI, the report recommended that the site can be made suitable for the proposed development, subject to the implementation of the following recommendations:

- Prepare a Remediation Action Plan (RAP) to address the contamination issues identified at the site. The RAP will include the requirements for addressing the data gaps identified in this assessment and for the preparation of an unexpected find protocol (UFP); and
- Undertake a validation assessment documenting the remediation works.

An assessment of data gaps was undertaken for the PSI and is provided in the following table:

Table 2-4: Data Gaps from the PSI

Data Gap	Assessment
Groundwater flow direction not confirmed / groundwater assessment limited in scope	The existence of only one groundwater monitoring well on site available for sampling presents limitations and creates data gaps associated with the limited scope of groundwater assessment at this stage. Groundwater flow direction could not be confirmed with great degree of accuracy and sensible assessment of groundwater quality between up-gradient and down-gradient locations at the site is also unable to be properly completed. Actual depth to groundwater table beneath the site was not ascertained. Groundwater conditions and quality could be further confirmed during the remediation/validation process.

Data Gap	Assessment
Delineation of identified contamination hotspot.	This data gap relates to the lack of information associated with the lateral extent of the identified hotspot of lead impacted fill material in the vicinity of BH2. The Carcinogen PAHs detected in BH8 has not been adequately delineated. Given the limited scope of anticipated excavations as part of the construction works this data gap can be addressed as part of RAP protocols including during waste classification for off-site disposal of excavated material as part of the development.
Characterisation of soils for waste classification purposes	Based on the results of the intrusive investigation, the characteristics of fill and natural soils across the site vary considerably. The waste classifications provided within this report are preliminary in nature due to the limited samples and variation encountered, and will require confirmation prior to off-site disposal of soils and bedrock.

2.3 Site Information

Table 2-5: Site Identification

Current Site Owner:	Kincoppal-Rose Bay School
Site Address:	Corner of New South Head Road and Vaucluse Road, Vaucluse, NSW
Lot & Deposited Plan:	Lot 104 in DP1092747
Current Land Use:	Educational Establishment
Proposed Land Use:	Educational Establishment
Local Government Authority:	Woollahra Municipal Council
Current Zoning:	SP2 – Educational Establishment
Site Area (m^2) (approx.):	Approximately 4,500m^2 - the site (i.e. targeted assessment areas as part of the PSI) 60,380 m^2 – the wider site
RL (AHD in m) (approx.):	10-60 mAHD
Geographical Location (decimal degrees) (approx.):	Latitude: -33.862451 Longitude: 151.270816
Site Location & Regional Setting:	The wider site is located in a predominantly residential area of Vaucluse. The wider site is bounded by mainly residential properties to the north, east and south, Hermitage Reserve to the west, Forsyth Park to the south/south-east and St. Michael's Anglican Church which is located on the property adjoining the site to the north/north-east. The wider site is located approximately 28m to the east of Rose Bay.

Current Site Owner:	Kincoppal-Rose Bay School
Topography:	The regional topography is characterised by a west facing hillside that falls towards Rose Bay. The site area is situated across the length of the hillside which has slope towards the west at an approximate average of 10.5°. Parts of the site appear to have been levelled to account for the slope and accommodate the existing buildings and infrastructure across the wider site area.
Surrounding Land Use:	During our inspection, JKE observed the following land uses in the immediate surrounds: • North – residential and St. Michaels Anglican Church; • South – residential and Forsyth Park recreational area; • East – school playing fields and sporting grounds further across Vaucluse Road and residential further across New South Head Road; and • West – Hermitage Foreshore Reserve area and Rose Bay.
Site Plans:	Figures 1 to 3 attached in the appendices.

2.4 Regional Geology

Regional geological information presented in the JKE PSI indicated that the site is underlain by Hawkesbury Sandstone, which typically consists of medium to coarse grained quartz sandstone with minor shale and laminite lenses. The geological map also indicates an igneous dyke to pass through the site. The subsurface conditions within, and adjacent to a dyke can be extremely variable. The bedrock in contact with the dyke can vary considerably in terms of its depth below the surface.

The information reviewed for the PSI indicated that the subsurface conditions at the site are expected to consist of moderate to high permeability residual sandy soils overlying sandstone bedrock which is typically encountered at moderate to shallow depths. Abstraction and use of groundwater at the site may be viable under these conditions, however the use of groundwater is not proposed as part of the development. There is a reticulated water supply in the area and consumption of groundwater is not expected to occur.

Considering the local topography and surrounding land features, JKE anticipate groundwater to flow east through the site towards Rose Bay.

2.5 Acid Sulfate Soil Risk Map

The site is not located in an acid sulfate soil (ASS) risk area according to the risk maps prepared by the Department of Land and Water Conservation.

ASS information reviewed for the PSI indicated that the site is located within a Class 5 risk area in accordance with the Woollahra Local Environmental Plan (LEP 2014). Works in Class 5 areas that could pose an environmental risk in terms of ASS include works within 500m of adjacent Class 1,2,3,4 land which are likely to lower the water table below 1m AHD on the adjacent Class 1,2,3,4 land. This is unlikely to be the case due to site's elevation above the sea level (i.e. 10-60 mAHD) and the anticipated depth of soil disturbance as part of the proposed development works. Refer to appendices for further details on each risk class.

3 CONCLUSION

Based on the information reviewed for this assessment, JKE are of the opinion that there is a relatively low potential for ASS or PASS to be disturbed during the proposed development works described in Section 1.2 of this report. This conclusion is based on the following:

- The site is not located in an acid sulfate soil (ASS) risk area according to the risk maps prepared by the Department of Land and Water Conservation;
- The geological map and boreholes drilled for the JKG and JKE investigations indicates that the site is underlain by residual natural soils and sandstone bedrock. Inclusions of organic material which are indicative of PASS was not encountered in the boreholes during drilling;
- The development area of the site is located at approximately 35m to 52m Australian Heights Datum (AHD), with excavations to extend to a minimum elevation of approximately 33m to 50m AHD. ASS are not usually associated with soil horizons above 5m AHD; and
- Lowering of the groundwater table is not proposed for the development.

Based on this information, JKE are of the opinion that an ASSMP is not required for the proposed development at the site.

4 LIMITATIONS

The report limitations are outlined below:

- JKE accepts no responsibility for any unidentified AASS or PASS issues at the site. Any unexpected problems/subsurface features that may be encountered during development works should be inspected by an environmental consultant as soon as possible;
- This report has been prepared based on site conditions which existed at the time of the investigation; scope of work and limitation outlined in the JKE proposal; and terms of contract between JKE and the client (as applicable);
- The conclusions presented in this report are based on investigation of conditions at specific locations, chosen to be as representative as possible under the given circumstances, visual observations of the site and immediate surrounds and documents reviewed as described in the report;
- Subsurface soil and rock conditions encountered between investigation locations may be found to be different from those expected. Groundwater conditions may also vary, especially after climatic changes;
- The investigation and preparation of this report have been undertaken in accordance with accepted practice for environmental consultants, with reference to applicable environmental regulatory authority and industry standards, guidelines and the assessment criteria outlined in the report;
- Where information has been provided by third parties, JKE has not undertaken any verification process, except where specifically stated in the report;

- JKE accept no responsibility for potentially asbestos containing materials that may exist at the site. These materials may be associated with demolition of pre-1990 constructed buildings or fill material at the site;
- JKE have not and will not make any determination regarding finances associated with the site;
- Additional investigation work may be required in the event of changes to the proposed development or landuse. JKE should be contacted immediately in such circumstances;
- This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose;
- Copyright in this report is the property of JKE. JKE has used a degree of care, skill and diligence normally exercised by consulting professionals in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report;
- If the client, or any person, provides a copy of this report to any third party, such third party must not rely on this report except with the express written consent of JKE; and
- Any third party who seeks to rely on this report without the express written consent of JKE does so entirely at their own risk and to the fullest extent permitted by law, JKE accepts no liability whatsoever, in respect of any loss or damage suffered by any such third party.

If you have any questions concerning the contents of this letter please do not hesitate to contact us.

Kind Regards

Vittal Boggaram
Principal Associate

Appendices:

Appendix A: JKE PSI Report Figures
Appendix B: JKE PSI Borehole Logs
Appendix C: Information on Acid Sulfate Soils

Appendix A: JKE PSI Report Figures

SOURCE: http://www.whereis.com/ NTS

AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

Title:

SITE LOCATION PLAN

Location: CORNER NEW SOUTH HEAD ROAD AND
VAUCLUSE ROAD, VAUCLUSE, NSW (Lot 104 in DP1092747)

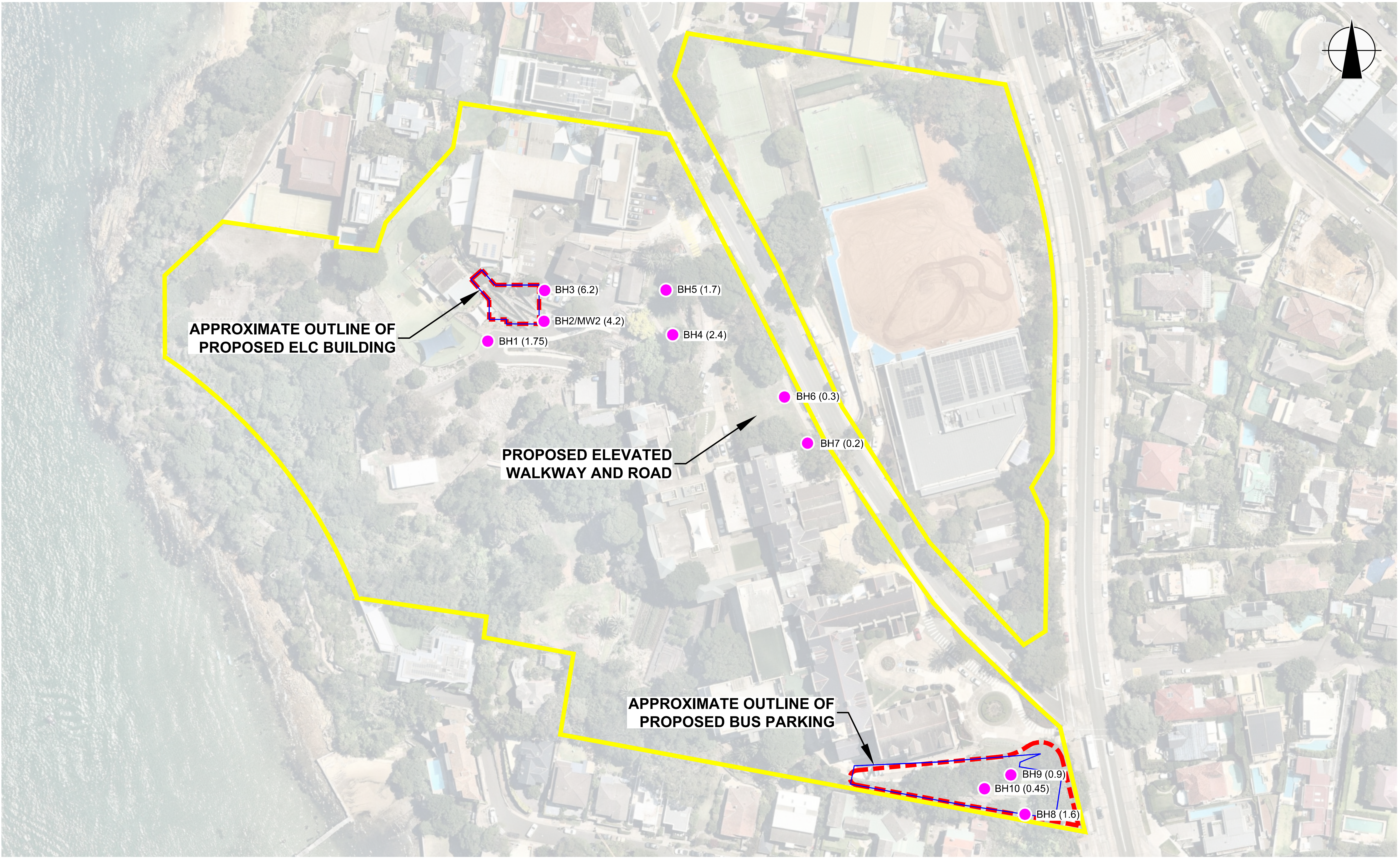
Project No: E32915BD

Figure: 1

JKEnvironments

This plan should be read in conjunction with the Environmental report.

PLOT DATE: 2/03/2020 1:39:28 PM DWG FILE: Z:\5 EIS\5C EIS JOBS\32000'S\E32915BD VAUCLUSE\CADE32915BD.DWG



LEGEND

🟥	APPROXIMATE SITE BOUNDARY
🟨	APPROXIMATE WIDER PROPERTY BOUNDARY
● BH(Fill depth)	BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)

0 13 26 39 52 65
SCALE 1:1300 @A3 METRES

This plan should be read in conjunction with the Environmental report.

Title:
SAMPLE LOCATION PLAN

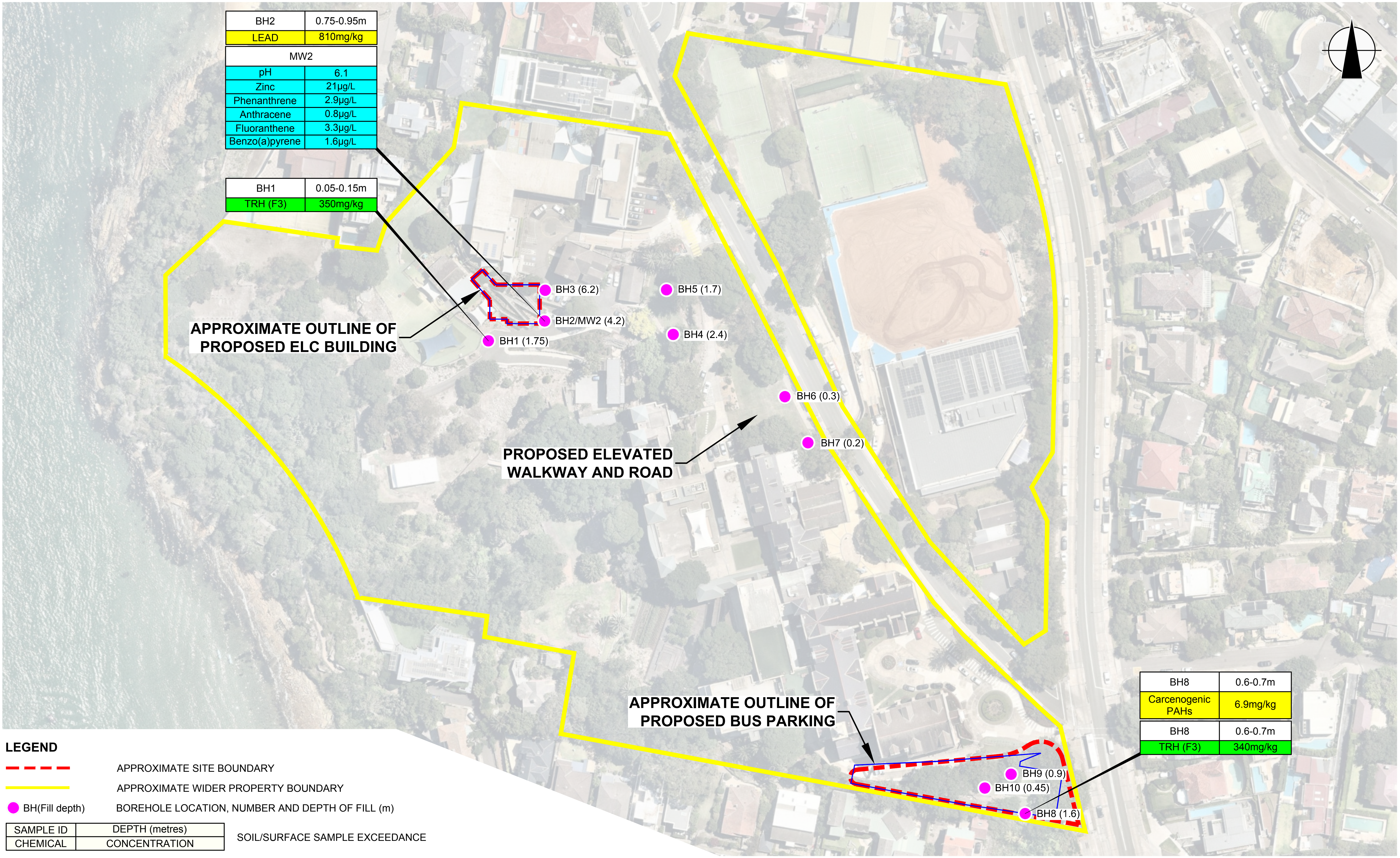
Location: CORNER NEW SOUTH HEAD ROAD AND VAUCLUSE ROAD, VAUCLUSE, NSW (Lot 104 in DP1092747)

Project No: E32915BD

Figure: 2

JKEnvironments

PLOT DATE: 3/03/2020 2:13:03 PM DWG FILE: Z:\5 EIS\5C EIS JOBS\32000'S\E32915BD VAULCLUSE\CAD\E32915BD.DWG



BH2	0.75-0.95m
LEAD	810mg/kg

MW2	
pH	6.1
Zinc	21µg/L
Phenanthrene	2.9µg/L
Anthracene	0.8µg/L
Fluoranthene	3.3µg/L
Benzo(a)pyrene	1.6µg/L

BH1	0.05-0.15m
TRH (F3)	350mg/kg

BH8	0.6-0.7m
Carcenogenic PAHs	6.9mg/kg

BH8	0.6-0.7m
TRH (F3)	340mg/kg

LEGEND

- APPROXIMATE SITE BOUNDARY
- APPROXIMATE WIDER PROPERTY BOUNDARY
- ● BH(Fill depth) BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)

SAMPLE ID	DEPTH (metres)
CHEMICAL	CONCENTRATION

SOIL/SURFACE SAMPLE EXCEEDANCE

SAMPLE ID	-
CHEMICAL	CONCENTRATION (µg/L)

GROUNDWATER SAMPLE EXCEEDANCE

- 🟨 SOIL/SURFACE CONTAMINATION ABOVE SAC FOR HUMAN HEALTH RISK
- 🟩 SOIL CONTAMINATION ABOVE SAC FOR ECOLOGICAL RISK
- 🟦 GROUNDWATER CONTAMINATION ABOVE SAC

0 13 26 39 52 65
SCALE 1:1300 @A3 METRES

This plan should be read in conjunction with the Environmental report.

Title:
SITE CONTAMINATION PLAN

Location: CORNER NEW SOUTH HEAD ROAD AND
VAUCLUSE ROAD, VAUCLUSE, NSW (Lot 104 in DP1092747)

Project No: E32915BD
Figure: 3

JKEnvironments

PLOT DATE: 3/03/2020 1:59:07 PM DWG FILE: Z:\5 EIS\5C EIS JOBS\32000'S\E32915BD VAULCLUSE\CAD\E32915BD.DWG

Appendix B: JKE PSI Borehole Logs

JKGeotechnics

BOREHOLE LOG

Borehole No.
1
1 / 1

PROPOSED ELC BUILDING

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH1
Method: SPIRAL AUGER
R.L. Surface: 35.1 m
Date: 28/1/20
Datum: AHD
Plant Type: JK205
Logged/Checked By: D.A.F./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION	■					35		■		ASPHALTIC CONCRETE: 50mm.t	M			
								▩	-	FILL: Gravelly silty sand, fine to coarse grained, light grey, fine to medium grained igneous gravel.				APPEARS MODERATELY COMPACTED
	■ ■ ■			■ ■	N = 11 5,6,5 N > 3 2,3/ 100mm REFUSAL	34	1	▩		FILL: Silty sand, fine to coarse grained, light brown, trace of clay and fine to medium grained sandstone gravel.				
	■			■				░	-	SANDSTONE: fine to coarse grained, light grey and red brown.	DW	M - H		HAWKESBURY SANDSTONE
						33	2			END OF BOREHOLE AT 2.00 m				HIGH 'TC' BIT RESISTANCE 'TC' BIT REFUSAL
						32	3							
						31	4							
						30	5							
						29	6							

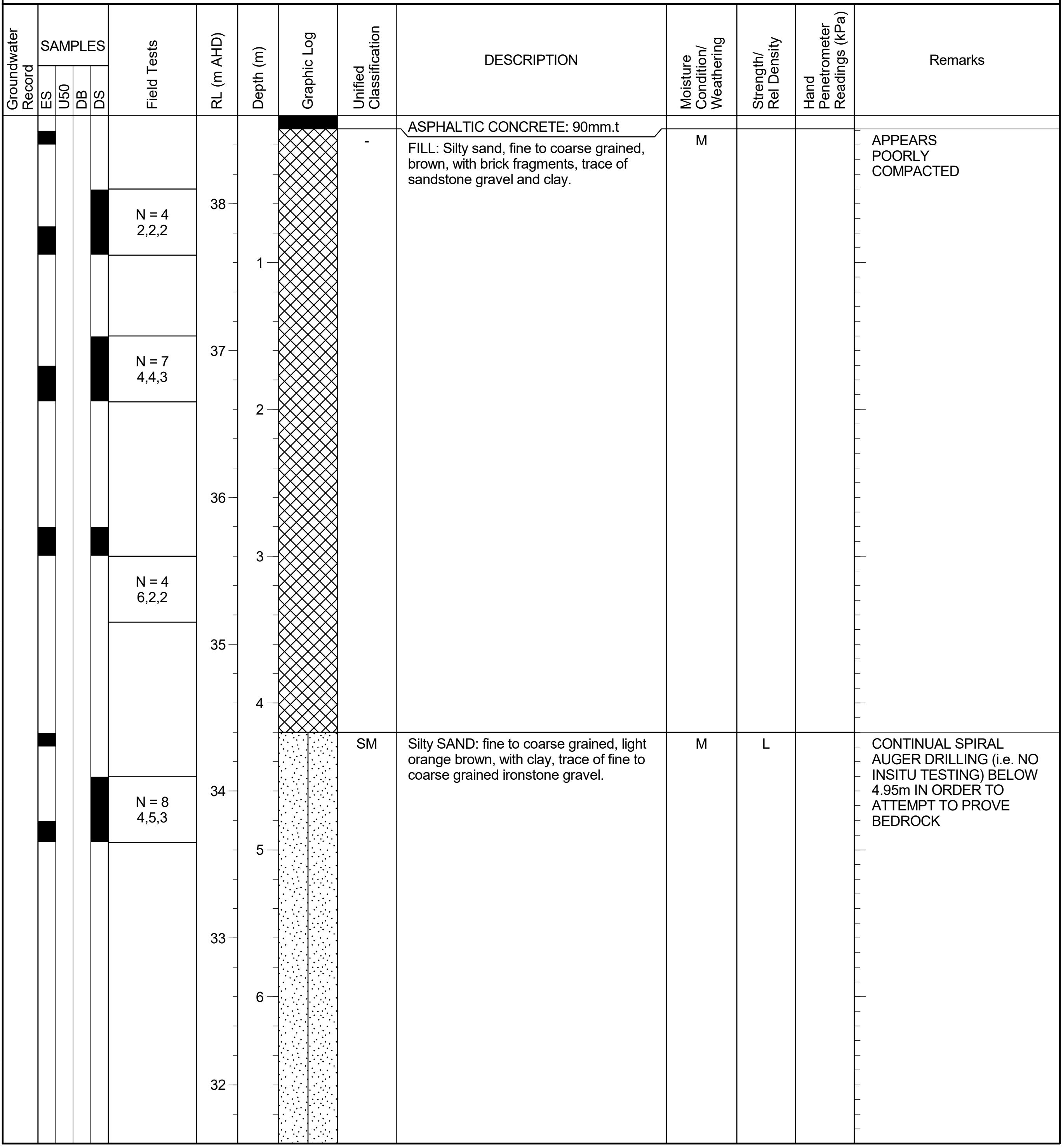
BOREHOLE LOG

Borehole No.
2
1 / 2

PROPOSED ELC BUILDING

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH1
Method: SPIRAL AUGER
R.L. Surface: 38.6 m
Date: 28/1/20
Datum: AHD
Plant Type: JK205
Logged/Checked By: D.A.F./A.J.H.



Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
						38				ASPHALTIC CONCRETE: 90mm.t				
					N = 4 2,2,2 N = 7 4,4,3 N = 4 6,2,2	38 37 36 35	1 2 3 4		-	FILL: Silty sand, fine to coarse grained, brown, with brick fragments, trace of sandstone gravel and clay.	M			APPEARS POORLY COMPACTED
					N = 8 4,5,3	34 33 32	5 6		SM	Silty SAND: fine to coarse grained, light orange brown, with clay, trace of fine to coarse grained ironstone gravel.	M	L		CONTINUAL SPIRAL AUGER DRILLING (i.e. NO INSITU TESTING) BELOW 4.95m IN ORDER TO ATTEMPT TO PROVE BEDROCK

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32915PH1 VAUCLUSE.GPJ <<DrawingFile>> 25/02/2020 11:45 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

BOREHOLE LOG

Borehole No.
2
2 / 2

PROPOSED ELC BUILDING

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH1
Method: SPIRAL AUGER
R.L. Surface: 38.6 m
Date: 28/1/20
Datum: AHD
Plant Type: JK205
Logged/Checked By: D.A.F./A.J.H.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
ON 3/2/20						31	8		SM	Silty SAND: fine to coarse grained, light orange brown, with clay, trace of fine to coarse grained ironstone gravel.	M	L		
ON COMPLETION OF AUGERING	■			■		30	9		SW	Gravelly SAND: fine to coarse grained, light orange brown, fine to coarse grained ironstone gravel, with clay .	W			
						29 28 27 26 25	10 11 12 13			END OF BOREHOLE AT 9.20 m				GROUNDWATER MONITORING WELL INSTALLED TO 9.2m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 3.2m TO 9.2m. CASING 3.2m TO 0.2m. 2mm SAND FILTER PACK 2.8m TO 9.2m. BENTONITE SEAL 2.4m TO 2.8m. BACKFILLED WITH CUTTINGS TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.

BOREHOLE LOG

Borehole No.
3
1 / 2

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH1 **Method:** SPIRAL AUGER **R.L. Surface:** 40.6 m
Date: 28/1/20 **Datum:** AHD
Plant Type: JK205 **Logged/Checked By:** D.A.F./A.J.H.

Groundwater Record	SAMPLES				Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS										
DRY ON COMPLETION	■		■						-	ASPHALTIC CONCRETE: 50mm.t FILL: Silty sand, fine grained, brown, trace of clay.	M			APPEARS WELL COMPACTED
	■			■	N = 21 10,11,10	40				FILL: Silty sand, fine to medium grained, brown and light brown.				
							1			FILL: Silty sand, fine to coarse grained, brown and dark brown, trace of igneous gravel and brick fragments.				
	■			■	N = 6 5,4,2	39	2							APPEARS POORLY COMPACTED
						38	3							
	■			■	N = 15 7,4,11	37								APPEARS WELL COMPACTED
	■					36 35	4 5 6			as above, but with sandstone boulders and cobbles.				BANDS OF LOW 'TC' BIT RESISTANCE
					Nc = 12									
	■			■	15 11 /100mm REFUSAL	34			-	SANDSTONE: fine to coarse grained, light grey, grey and red brown, with occasional medium strength bands.	XW - DW	Hd - VL		HAWKESBURY SANDSTONE VERY LOW RESISTANCE WITH MODERATE BANDS

BOREHOLE LOG

Borehole No.
3
2 / 2

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH1 **Method:** SPIRAL AUGER **R.L. Surface:** 40.6 m
Date: 28/1/20 **Datum:** AHD
Plant Type: JK205 **Logged/Checked By:** D.A.F./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
				■					-	SANDSTONE: fine to coarse grained, light grey and grey, with occasional medium strength iron indurated bands.	XW - DW	Hd - VL		VERY LOW RESISTANCE WITH MODERATE BANDS
						33								
							8							
						32								
							9							
				■							DW	M - H		HIGH RESISTANCE
										END OF BOREHOLE AT 9.30 m				'TC' BIT REFUSAL
						31								
							10							
						30								
							11							
						29								
							12							
						28								
							13							
						27								

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BOREHOLE LOG

Borehole No.
4
1 / 1

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH2
Method: SPIRAL AUGER
R.L. Surface: N/A
Date: 28/1/20
Datum: AHD
Plant Type: JK205
Logged/Checked By: D.A.F./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION	■						▩		FILL: Silty sand, fine to coarse grained, brown and light brown, trace of root fibres.	M			GRASS COVER APPEARS POORLY COMPACTED
	■						▩						
	■			■	N = 7 3,4,3	1	▩						
	■			■	N = 2 5,1,1		▩		as above, but light orange brown.				
						2	▩						
	■						⁙	-	SANDSTONE: fine to coarse grained, orange brown.	XW - DW	Hd - VL		HAWKESBURY SANDSTONE VERY LOW 'TC' BIT RESISTANCE
						3	⁙		as above, but light grey.	SW	M - H		MODERATE TO HIGH RESISTANCE
									END OF BOREHOLE AT 3.20 m				'TC' BIT REFUSAL
						4							
						5							
						6							

BOREHOLE LOG

Borehole No.
5
1 / 1

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH2
Method: SPIRAL AUGER
R.L. Surface: N/A
Date: 28/1/20
Datum: AHD
Plant Type: JK205
Logged/Checked By: D.A.F./A.J.H.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION	■ ■ ■			■	N > 13 6,13/ 150mm REFUSAL	1	▨		FILL: Silty sand, fine to coarse grained, brown and dark brown, with sandstone cobbles and boulders, trace of root fibres.	M			GRASS COVER APPEARS MODERATELY COMPACTED
	■			■		2	░	-	SANDSTONE: fine to coarse grained, light brown.	DW	M		HAWKESBURY SANDSTONE MODERATE TO HIGH 'TC' BIT RESISTANCE
						3 4 5 6			END OF BOREHOLE AT 2.50 m				'TC' BIT REFUSAL

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BOREHOLE LOG

Borehole No.
6
1 / 1

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH2 **Method:** HAND AUGER **R.L. Surface:** 51.4 m
Date: 3/2/20 **Datum:** AHD
Plant Type: **Logged/Checked By:** D.A.F./A.J.H.

Groundwater Record	SAMPLES ES	 U50	 DB	 DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION	■		■	■	REFER TO DCP TEST RESULTS			▨		FILL: Silty sand, fine to coarse grained, dark brown, trace of roots and root fibres.	M			GRASS COVER
	■			■		51		⁘	SM	Silty SAND: fine to medium grained, orange brown, trace of clay.	M	MD		RESIDUAL
										END OF BOREHOLE AT 0.50 m				HAND AUGER REFUSAL ON INFERRED SANDSTONE BEDROCK

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BOREHOLE LOG

Borehole No.
7
1 / 1

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH2
Method: HAND AUGER
R.L. Surface: 51.8 m
Date: 3/2/20
Datum: AHD
Plant Type:
Logged/Checked By: D.A.F./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION	■				REFER TO DCP TEST RESULTS			▨		FILL: Silty sand, fine to coarse grained, dark brown, trace of roots and root fibres.	M			
	■			■				░	SM	Silty SAND: fine to coarse grained, light orange brown.	M	D		RESIDUAL
										END OF BOREHOLE AT 0.40 m				HAND AUGER REFUSAL ON INFERRED SANDSTONE BEDROCK
						51								
							1							
						50								
							2							
						49								
							3							
						48								
							4							
						47								
							5							
						46								
							6							
						45								

BOREHOLE LOG

Borehole No.
8
1 / 2

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH3
Method: HAND AUGER
R.L. Surface: N/A
Date: 3/2/20
Datum:
Plant Type:
Logged/Checked By: D.A.F./A.J.H.

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	■		■		REFER TO DCP TEST RESULTS		▨		FILL: Silty sand, fine to medium grained, brown, trace of roots and root fibres.	M			GRASS COVER APPEARS MODERATELY COMPACTED
	■					1	▨		as above, but grey and light brown, trace of fine to medium grained ironstone gravel, concrete fragments and slag.				APPEARS POORLY COMPACTED
ON COMPELTION OF AUGERING ▽	■						░	SC	Clayey SAND: fine to coarse grained, light brown.	W	VL		RESIDUAL
						2 3 4 5 6			REFER TO CORED BOREHOLE LOG				

CORED BOREHOLE LOG

Borehole No.
8
2 / 2

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH3
Date: 3/2/20
Plant Type: MELVELLE
Core Size: TT56
Inclination: VERTICAL
Bearing: N/A
R.L. Surface: N/A
Datum:
Logged/Checked By: D.A.F./A.J.H.

Water Loss\Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL 0.1, L 0.3, M 1, H 3, VH 10, EH	DEFECT DETAILS SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific General	Formation
				START CORING AT 1.80m						
100% RETURN		2		NO CORE 0.32m						
				SANDSTONE: fine to coarse grained, light grey, orange brown and red brown, bedded at 0-15°.	DW	M	0.50 0.80		(2.36m) Be, 0°, Fe Sn	Hawkesbury Sandstone
		3		as above, but light grey and grey.	FR					
				NO CORE 0.15m						
		4 5		SANDSTONE: fine to coarse grained, light grey. with grey laminae, bedded at 0-20°.	FR	M	0.60 0.90 1.0 1.0 0.80 1.0			Hawkesbury Sandstone
		6 7		END OF BOREHOLE AT 5.95 m						

JK 9.02.4 LIB.GLB Log JK CORED BOREHOLE - MASTER 32915PH3 VAUCLUSE.GPJ <<DrawingFile>> 25/02/2020 12:42 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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BOREHOLE LOG

Borehole No.
9
1 / 2

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH3
Method: HAND AUGER
R.L. Surface: N/A
Date: 3/2/20
Datum:
Plant Type:
Logged/Checked By: D.A.F./A.J.H.

Groundwater Record	SAMPLES				Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
	ES	U50	DB	DS									
DRY ON COMPLETION OF AUGERING	■			■	REFER TO DCP TEST RESULTS		▨		FILL: Silty sand, fine to coarse grained, brown and dark brown, trace of fine to medium grained sandstone gravel, roots and root fibres.	M			GRASS COVER APPEARS POORLY COMPACTED
	■ ■			■			▨		FILL: Silty sand, fine to coarse grained, light orange brown and brown, with fine to medium grained sandstone gravel and clay.				
						1			REFER TO CORED BOREHOLE LOG				
						2							
						3							
						4							
						5							
						6							

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 32915PH3 VAUCLUSE.GPJ <<DrawingFile>> 25/02/2020 12:42 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

CORED BOREHOLE LOG

Borehole No.
9
2 / 2

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH3
Core Size: TT56
R.L. Surface: N/A
Date: 3/2/20
Inclination: VERTICAL
Datum:
Plant Type: MELVELLE
Bearing: N/A
Logged/Checked By: D.A.F./A.J.H.

Water Loss\Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ VL -0.1, L -0.3, M -1, H -3, VH -10, EH	SPACING (mm) 600 200 60 20	DEFECT DETAILS DESCRIPTION Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness Specific	General	Formation
				START CORING AT 0.90m							
100% RETURN		1		SANDSTONE: fine to coarse grained, red brown and orange brown, bedded at 10-20°.	DW	H	1.2 1.1		(1.40m) Be, 10°, Fe Sn		Hawkesbury Sandstone
		2			SW - FR	M	0.70		(2.42m) Be, 10°, Fe Sn		
		3		SANDSTONE: fe to coarse grained, light grey, with occasional grey laminae, bedded at 5-15°.			0.90 0.60				
				NO CORE 0.13m							
		4		SANDSTONE: fine to coarse grained, light grey, with occasional grey laminae, bedded at 5-15°.	FR	M	0.80 0.80				Hawkesbury Sandstone
		5		END OF BOREHOLE AT 4.70 m							
		6									

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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BOREHOLE LOG

Borehole No.
10
1 / 1

Client: KINCOPPAL - ROSE BAY SCHOOL
Project: PROPOSED DEVELOPMENTS AT KINCOPPAL ROSE BAY SCHOOL
Location: CNR NEW SOUTH HEAD ROAD & VAUCLUSE ROAD, VAUCLUSE, NSW

Job No.: 32915PH3
Method: HAND AUGER
R.L. Surface: N/A
Date: 3/2/20
Datum:
Plant Type:
Logged/Checked By: D.A.F./A.J.H.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION	■ ■		■		REFER TO DCP TEST RESULTS		▨		FILL: Silty sand, fine to coarse grained, dark brown, trace of fine to coarse grained sandstone gravel.	M			APPEARS POORLY COMPACTED
									END OF BOREHOLE AT 0.45 m				HAND AUGER REFUSAL ON INFERRED SANDSTONE BEDROCK
						1							
						2							
						3							
						4							
						5							
						6							

ENVIRONMENTAL LOGS EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the environmental report in regard to classification methods, field procedures and certain matters relating to the logging of soil and rock. Not all notes are necessarily relevant to all reports.

Where geotechnical borehole logs are utilised for environmental purpose, reference should also be made to the explanatory notes included in the geotechnical report. Environmental logs are not suitable for geotechnical purposes.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Environmental studies include gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geoenvironmental practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

Cohesive soils are classified on the basis of strength (consistency) either by use of a hand penetrometer, vane shear, laboratory testing and/or tactile engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	Strength not attainable – soil crumbles	

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) are referred to as 'laminite'.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for a large excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of limited reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock cuttings. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'.*

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

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

  N = 13
  4, 6, 7

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

  N > 30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

A modification to the SPT is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as 'N_c' on the borehole logs, together with the number of blows per 150mm penetration.

LOGS

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

The terms and symbols used in preparation of the logs are defined in the following pages.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or 'reverted' chemically if reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably assess the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse environmental characteristics or behaviour. If the volume and nature of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing has not been undertaken to confirm the soil classification and rock strengths indicated on the environmental logs unless noted in the report.

SYMBOL LEGENDS

SOIL

- ▩ FILL
- ≋ TOPSOIL
- ▨ CLAY (CL, CI, CH)
- ▥ SILT (ML, MH)
- ░ SAND (SP, SW)
- ▒ GRAVEL (GP, GW)
- ▨ SANDY CLAY (CL, CI, CH)
- ▨ SILTY CLAY (CL, CI, CH)
- ▨ CLAYEY SAND (SC)
- ░ SILTY SAND (SM)
- ▨ GRAVELLY CLAY (CL, CI, CH)
- ▨ CLAYEY GRAVEL (GC)
- ▥ SANDY SILT (ML, MH)
- ▒ PEAT AND HIGHLY ORGANIC SOILS (Pt)

ROCK

- ▒ CONGLOMERATE
- ░ SANDSTONE
- ▤ SHALE/MUDSTONE
- ▥ SILTSTONE
- ▤ CLAYSTONE
- ■ COAL
- ▥ LAMINITE
- ▦ LIMESTONE
- ≋ PHYLLITE, SCHIST
- ▤ TUFF
- ▒ GRANITE, GABBRO
- ▒ DOLERITE, DIORITE
- ▒ BASALT, ANDESITE
- ≋ QUARTZITE

OTHER MATERIALS

- ▦ BRICKS OR PAVERS
- ▒ CONCRETE
- ■ ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity *Cu* > 4 and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

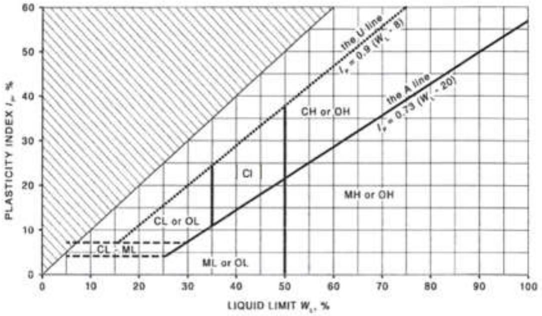
$$C_U = \frac{D_{60}}{D_{10}} \quad and \quad C_C = \frac{(D_{30})^2}{D_{10}\,D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

1. For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.
2. Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.
3. Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.
4. The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



LOG SYMBOLS

Log Column	Symbol	Definition		
Groundwater Record	─▼─	Standing water level. Time delay following completion of drilling/excavation may be shown.		
	─C─	Extent of borehole/test pit collapse shortly after drilling/excavation.		
	▶─	Groundwater seepage into borehole or test pit noted during drilling or excavation.		
Samples	ES	Sample taken over depth indicated, for environmental analysis.		
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.		
	DB	Bulk disturbed sample taken over depth indicated.		
	DS	Small disturbed bag sample taken over depth indicated.		
	ASB	Soil sample taken over depth indicated, for asbestos analysis.		
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.		
	SAL	Soil sample taken over depth indicated, for salinity analysis.		
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.		
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.		
	VNS = 25	Vane shear reading in kPa of undrained shear strength.		
	PID = 100	Photoionisation detector reading in ppm (soil sample headspace test).		
Moisture Condition (Fine Grained Soils)	$w > PL$	Moisture content estimated to be greater than plastic limit.		
	$w \approx PL$	Moisture content estimated to be approximately equal to plastic limit.		
	$w < PL$	Moisture content estimated to be less than plastic limit.		
	$w \approx LL$	Moisture content estimated to be near liquid limit.		
	$w > LL$	Moisture content estimated to be wet of liquid limit.		
(Coarse Grained Soils)	D	DRY – runs freely through fingers.		
	M	MOIST – does not run freely but no free water visible on soil surface.		
	W	WET – free water visible on soil surface.		
Strength (Consistency) Cohesive Soils	VS	VERY SOFT – unconfined compressive strength ≤ 25kPa.		
	S	SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.		
	F	FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.		
	St	STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.		
	VSt	VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.		
	Hd	HARD – unconfined compressive strength > 400kPa.		
	Fr	FRIABLE – strength not attainable, soil crumbles.		
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.		
Density Index/ Relative Density (Cohesionless Soils)			**Density Index (I_D) Range (%)**	**SPT 'N' Value Range (Blows/300mm)**
	VL	VERY LOOSE	≤ 15	0 – 4
	L	LOOSE	> 15 and ≤ 35	4 – 10
	MD	MEDIUM DENSE	> 35 and ≤ 65	10 – 30
	D	DENSE	> 65 and ≤ 85	30 – 50
	VD	VERY DENSE	> 85	> 50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other assessment.		
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.		

Log Column	Symbol	Definition
Remarks	‘V’ bit	Hardened steel ‘V’ shaped bit.
	‘TC’ bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description ‘slopewash’ is used for thinner surficial deposits. LITTORAL – beach deposited soil.

Classification of Material Weathering

Term		Abbreviation		Definition
Residual Soil		RS		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely Weathered		XW		Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly Weathered	Distinctly Weathered (Note 1)	HW	DW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately Weathered		MW		The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly Weathered		SW		Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh		FR		Rock shows no sign of decomposition of individual minerals or colour changes.

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

			Guide to Strength	
Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Point Load Strength Index $I_{s(50)}$ (MPa)	Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Appendix C: Information on Acid Sulfate Soils

A. Background

Acid Sulfate Soil (ASS) is formed from iron rich alluvial sediments and sulfate (found in seawater) in the presence of sulfate reducing bacteria and plentiful organic matter. These conditions are generally found in mangroves, salt marsh vegetation or tidal areas and at the bottom of coastal rivers and lakes. ASS materials are distinguished from other soil or sediment materials (referred to as 'soil materials' throughout the National Acid Sulfate Soils Guidance) by having properties and behaviour that have either:

1) Been affected considerably by the oxidation of Reduced Inorganic Sulfur (RIS), or
2) The capacity to be affected considerably by the oxidation of their RIS constituents.

Acid sulfate soil materials include Potential acid sulfate soils (PASS or sulfidic soil materials) and Actual acid sulfate soils (AASS or sulfuric soil materials). These are often found in the same profile, with AASS overlying PASS. PASS and AASS are defined further below:

- PASS are soil materials which contain RIS such as pyrite. The field pH of these soils in their undisturbed state is usually more than pH 4 and is commonly neutral to alkaline (pH 7–9). These soil materials are invariably saturated with water in their natural state. Their texture may be peat, clay, loam, silt or sand and is often dark grey in colour and soft in consistence, but these materials may also exhibit colours that are dark brown, or medium to pale grey to white; and
- AASS are soil materials which contained RIS such as pyrite that have undergone oxidation. This oxidation results in low pH (that is pH less than 4) and often a yellow (jarosite) and/or orange to red mottling (ferric iron oxides) in the soil profile. Actual ASS contains Actual Acidity, and commonly also contains RIS (the source of Potential Sulfuric Acidity) as well as Retained Acidity.

B. The ASS Planning Maps

The ASS planning maps provide an indication of the relative potential for disturbance of ASS to occur at locations within the council area. These maps do not provide an indication of the actual occurrence of ASS at a site or the likely severity of the conditions.

The maps are divided into five classes dependent upon the type of activities/works that if undertaken, may represent an environmental risk through the development of acidic conditions associated with ASS:

Table 1: Risk Classes

Risk Class	Description
Class 1	All works.
Class 2	All works below existing ground level and works by which the water table is likely to be lowered.
Class 3	Works at depths beyond 1m below existing ground level or works by which the water table is likely to be lowered beyond 1m below existing ground level.
Class 4	Works at depths beyond 2m below existing ground level or works by which the water table is likely to be lowered beyond 2m below existing ground level.
Class 5	Works within 500m of adjacent Class 1, 2, 3, 4 land which are likely to lower the water table below 1m AHD on the adjacent land.

C. The ASS Risk Maps

The ASS risk maps provide an indication of the probability of occurrence of PASS at a particular location based on interpretation from geological and soil landscape maps. The maps provide classes based on high probability, low probability, no known occurrence and areas of disturbed terrain (site specific assessment necessary) and the likely depth at which ASS are likely to be encountered.

D. Interpretation of ASS Field Tests

Tables A1 and A2 below provide some guidance on the interpretation of pH_F and pH_{FOX} test results, as detailed in the *National Acid Sulfate Soil Guidance: National acid sulfate soils sampling and identification methods manual* (2018):

Table A1: Interpretation of some pH_F test ranges

pH value	Result	Comments
$pH_F \leq 4$, jarosite not observed in the soil layer/horizon	May indicate an AASS indicating previous oxidation of RIS or may indicate naturally occurring, non ASS soils.	Generally not conclusive as naturally occurring, non ASS soils, such as many organic soils (for example peats) and heavily leached soils, often also return $pH_F \leq 4$.
$pH_F \leq 4$, jarosite observed in the soil layer/horizon	The soil material is an AASS.	Jarosite and other iron precipitate minerals in ASS such as schwertmannite require a pH < 4 to form and indicate prior oxidation of RIS.
$pH_F > 7$	Expected in waterlogged, unoxidised, or poorly drained soils.	Marine muds commonly have a pH > 7 which reflects a seawater (pH 8.2) influence. Oxidation of samples with H_2O_2 can help indicate if the soil materials contain RIS.

Source: Adapted from DER (2015a).

Table A2: Interpretation of pH_{FOX} test results

pH value and reaction	Result	Comments
Strong reaction of soil with H_2O_2 (that is X or V)	Useful indicator of the presence of RIS but cannot be used alone	Organic rich substrates such as peat and coffee rock, and soil constituents like manganese oxides, can also cause a reaction. Care must be exercised in interpreting these results. Laboratory analyses are required to confirm if appreciable RIS is present
pH_{FOX} value at least one unit below field pH_F and strong reaction with H_2O_2 (that is X or V)	May indicate PASS	The difference between pH_F and pH_{FOX} is termed the ΔpH. Generally the larger the ΔpH the more indicative of PASS. The lower the final pH_{FOX} the better the likelihood of an appreciable RIS content. For example, a change from pH_F of 8 to pH_{FOX} of 7 (that is a ΔpH of 1) would not indicate PASS, however, a unit change from pH_F of 3.5 to pH_{FOX} of 2.5 would be indicative of PASS. Laboratory analyses are required to confirm if appreciable RIS is present
$pH_{FOX} < 3$, large ΔpH and a strong reaction with H_2O_2 (that is X or V)	Strongly indicates PASS	The lower the pH_{FOX} below 3, the greater the likelihood that appreciable RIS is present. A combination of all three parameters – pH_{FOX}, ΔpH and reaction strength – gives the best indication of PASS. Laboratory analyses are required to confirm that appreciable RIS is present
A pH_{FOX} 3–4 and Low, Medium or Strong reaction with H_2O_2	Inconclusive	RIS may be present; however, organic matter may also be responsible for the decrease in pH. Laboratory analyses are required to confirm the presence of RIS

pH value and reaction	Result	Comments
pH_{FOX} 4–5	Inconclusive	RIS may be present in small quantities, or poorly reactive under rapid oxidation, or the sample may contain shell/ carbonate which neutralises some or all acid produced on oxidation. Equally, the pH_{FOX} value may be due to the production of organic acids with no RIS present. Laboratory analyses are required to confirm if appreciable RIS is present
pH_{FOX} > 5, small or no ΔpH, but Low, Medium or Strong reaction with H_2O_2	Inconclusive	For neutral to alkaline pHF with shell or white concretions, the fizz test with 1 M HCl can be used to identify the presence of carbonates. Laboratory analyses are required to confirm if appreciable RIS is present and further testing is required to confirm that effective self-neutralising materials are present

Source: Adapted from DER (2015a).