19 June 2019
Ref: E32250BDletrev

DAP Woodland Pty Ltd
C/- Lighthouse PM Pty Ltd
56 Berry Street
North Sydney NSW 2060

Attention: Mr Michael Stanton

CONCEPTUAL ACID SULFATE SOIL MANAGEMENT PLAN
PROPOSED RESIDENTIAL DEVELOPMENT
26 WHISTLER STREET, MANLY, NSW

1 INTRODUCTION

Lighthouse PM Pty Ltd on DAP Woodland Pty Ltd ('the client') commissioned Environmental Investigation Services (EIS)[1] to prepare a conceptual acid sulfate soil management plan (ASSMP) for the proposed residential development at 26 Whistler Street, Manly, NSW. The site is identified as SP15752. The site location is shown on Figure 1 and the investigation was confined to the site boundaries as shown on Figure 2.

The investigation was undertaken generally in accordance with an EIS proposal (Ref: EP48937BD) dated 12 March 2019 and a written acceptance from Lighthouse PM Pty Ltd on behalf of DAP Woodland Pty Ltd dated 23 May 2019.

A geotechnical assessment was undertaken previously to the preparation of this conceptual ASSMP by JK Geotechnics[2] and the results are presented in a separate report (Ref: 32250SMrpt, dated 4 March 2019) and summarised in Section 2.1 below.

The aims of this document is to prepare a conceptual ASSMP following a desktop review of the potential for disturbance of ASS during the proposed development works.

1.1 Assessment Guidelines

The ASS assessment and preparation of this report were undertaken with reference to the Acid Sulfate Soil Management Advisory Committee (ASSMAC) Acid Sulfate Soil Manual (1998)[3]. Background information on ASS and the assessment process is provided in the appendices.

[1] Environmental consulting division of Jeffery & Katauskas Pty Ltd (J&K)
[2] Geotechnical consulting division of J&K
[3] Acid Sulfate Soils Management Advisory Committee (ASSMAC), (1998). *Acid Sulfate Soils Manual* (ASS Manual 1998)

1.2 Proposed Development Details

EIS understand that the proposed development includes the demolition of the existing structures and construction of a multistorey building over a single level basement. Excavations are proposed to approximately 2.8m below the current site levels for the basement.

EIS understand that the site includes SP15752, and covers an area of approximately 1,025m^2. The client has advised that there are no existing waste, contamination or ASS related reports for the site.

2 SITE INFORMATION

2.1 Summary of Previous Geotechnical Assessment Report (JK Geotechnics, 2019)

JK Geotechnics have undertaken a desktop assessment for the proposed residential and commercial development (report ref: 32250SMrpt Rev3, dated 17 June 2019).

The desktop assessment included a review of published geological maps, information from nearby investigations undertaken by JK Geotechnics and a site inspection.

The site inspection undertaken suggested that the site is located is in a relatively flat low lying area of Manly, approximately 150m to the east of the toe of the hillside and has a similar set back from Manly Beach. The site measured approximately 30m by 36m with ground surface levels of approximately RL5.8m to RL5.9m. At the time the site was occupied by a 3 storey apartment building over a ground floor parking level. There was a narrow vegetation strip along the site west frontage with Whistler Street that contained small and medium sized trees. On the eastern side of the property was a paved 'right of way' path linking through to Short Street.

Subsurface conditions anticipated by JK Geotechnics at the site included deep sandy soil profile comprising mostly sands and silty sands over sandstone bedrock at depths of approximately 20m to 32m below ground level. Groundwater was expected at depths of approximately 4.7m below ground level (approximately 1.8m below the bulk excavation level).

Based on the desktop and development information, JK Geotechnics suggest that either a continuous shoring pile was drilled using cement grout injected continuous flight auger (CFA) piles or a Cutter Soil Mix (CSM) wall could be suitable for the proposed development.

Further geotechnical intrusive investigation was identified by JK Geotechnics to the development design.

2.2 Regional Geology

The geological map of Sydney (1983)[4] indicates the site to be underlain by underlain by Quaternary aged deposits of medium to fine-grained marine sands with podsols.

2.3 Manly Council Local Environmental Plan (LEP) 2013

A review of the Manly council LEP indicates that the site is located on the boundary of ASS risk Classes 4 (refer to appendices for further details on each risk class).

2.4 Acid Sulfate Soil Risk Map

A review of the ASS risk maps prepared by Department of Land and Water Conservation (1997)[5] indicates that the site is located in an area classed as having 'low risk' of encountering ASS

3 DESKTOP ASS REVIEW AND CONCLUSIONS

Based on the results of the desktop assessment, including the review of the JK Geotechnics report, EIS are of the opinion that the there is a low to moderate potential for ASS to occur between the ground surface and the proposed bulk excavation and piling works (returning soil) beneath the groundwater table. A conceptual ASSMP is provided in the following subsections of this report. Soil sampling and testing is recommended to assess the extent of potential ASS (PASS) at the site

4 CONCEPTUAL ACID SULFATE SOIL MANAGEMENT PLAN (ASSMP)

4.1 Summary of Requirements

The key assumption of this ASSMP is that the soils at the site are PASS unless demonstrated otherwise, and must therefore be managed as such. The following management actions are required:

1) Implement the *Investigation Plan* outlined in Section 4.2;
2) In the event that the investigation indicates that the soils are not PASS/ASS, submit the report to Manly Council to demonstrate compliance with this ASSMP; and
3) In the event that the investigation indicates that the soils are PASS, implement this ASSMP and provide a compliance report to council on completion.

4.2 Investigation Plan

The ASS Manual 1998 recommend a minimum of four sampling locations for a site with an area up to 1ha (10,000m^2). Soil sampling is to be undertaken from the four locations to a depth of at least 1m below the maximum depth of disturbance (this includes disturbance for the bulk excavation and for piling/shoring).

[4] Department of Mineral Resources, (1983). *1:100,000 Geological Map of Sydney (Series 9130)*
[5] Department of Land and Water Conservation, (1997). *1:25,000 Acid Sulfate Soil Risk Map (Series 9130N2, Ed 2).*

Samples are to be collected at regular intervals and at each distinct change in soil lithology. An adequate selection of samples are to be analysed using the suspension Peroxide Combined Acidity and Sulfur (sPOCAS) methods detailed in AS4969-2008/09[6], and an assessment of the data is to be undertaken in accordance with the ASS Manual 1998.

On completion of the investigation, a report is to be prepared detailing the results. The report will form part of the compliance requirements under this ASSMP and is to be used to establish whether management is required.

An adequate time period should be factored into the project timetable for completing the investigation prior to commencing any piling/excavation works. A minimum of four weeks' notice will be required to organise an investigation and prepare a report.

4.3 Management of PASS

The plan assumes that all soil to be disturbed/excavated for the development is PASS. Although the most effective management strategy for dealing with PASS is to avoid disturbing the material, this is not possible when a basement and piling is proposed. The objective of the proposed management is to reduce the potential on-site and off-site environmental impacts associated with disturbance of PASS. The ASSMP has been prepared generally in accordance with the ASS Manual 1998. Reference has also been made to the Queensland Acid Sulfate Soil Technical Manual v 3.8 (2002)[7].

The following issues are addressed in the ASSMP:

- Strategies for the management of PASS during development;
- Implementation of a soil and groundwater monitoring program; and
- Contingency procedures to be implemented in the event of the failure of management strategies.

4.3.1 Management Option for PASS

Management options for PASS have been outlined and evaluated by EIS in the following table:

Table 3-1: Management of PASS

Option	Details	EIS Evaluation of Applicability
Option A: Disposal of PASS beneath the water table at a landfill	Immediate transport of natural PASS to landfill for disposal beneath the water table. A number of conditions have to be satisfied for burial beneath the water table to be viable. This option is not suitable for fill material or natural soil that has been impacted by contaminants.	Potential option for the natural soil provided the material is free of contamination.

[6] Standards Australia, (2008/2009). *Analysis of acid sulfate soil – Dried samples – Methods of test, Parts 1 to 14.* (AS4969-2008/09)
[7] Queensland Department of Natural Resources and Mines, (2002). *Queensland Acid Sulfate Soil Technical Manual. Soil Management Guidelines* version 3.8.

Option B: Treatment of PASS, waste classification and disposal to landfill	PASS is excavated and neutralised with lime and a waste classification is assigned for the off-site disposal of the treated PASS to landfill.	Most viable and preferred option considering proposed development details, which includes excavation for the proposed basement and piling beneath the groundwater table.
Option C: Treatment of PASS and on-site re-use.	PASS is excavated and neutralised with lime. The treated material is re-used on site with adequate capping. This option is not suitable for PASS that has been impacted by contaminants.	Not the preferred option for this project as material is not required for filling.

4.4 Preferred Option for Management of PASS

As outlined in the above table, the most viable and therefore the preferred option for managing PASS during the proposed development works is Option B (treatment of PASS, waste classification and off-site disposal). The management procedure for Option B is outlined in Section 4.4.1.

Procedures for Option A are included in Section 4.5 for reference purposes. This option could be considered further in consultation with a suitably qualified environmental consultant and the relevant contractors and landfill operators, if required by the client.

4.4.1 Treatment, Waste Classification and Disposal to Landfill (Option B)

Potential acid generation is typically managed by the addition of lime to neutralise acid that may be generated during and after the excavation works. The treated material should then be assigned a waste classification in accordance with the NSW EPA Waste Classification Guidelines - Part 1: Classifying Waste (2014)[8] and Waste Classification Guidelines Part 4: Acid Sulfate Soils (2014)[9], and disposed of to a NSW EPA licensed landfill facility.

Table 3-2: Management Procedure for Option B

Procedure	Details
Step 1: Lime selection	A slightly alkaline, low solubility product such as agricultural lime should be used. This form of lime is chemically stable and any excess lime takes a significant period of time (years) to influence soil pH beyond the depth of mixing. The lime particles eventually become coated with an insoluble layer of ferrihydrite ($Fe[OH]_3$) that inhibits further reaction. Long term alteration of groundwater conditions is not expected to occur as a result of the use of lime during the proposed development works.
Step 2: Set up treatment area/s	Treatment of PASS is to be undertaken within the proposed basement footprint. It is anticipated that treatment of small volumes of material will initially be required during

[8] NSW EPA, (2014). *Waste Classification Guidelines, Part 1: Classifying Waste.* (Part 1 of the Waste Classification Guidelines 2014)
[9] NSW EPA, (2014). *Waste Classification Guidelines, Part 4: Acid Sulfate Soils.* (Part 4 of the Waste Classification Guidelines 2014)

Procedure	Details
	construction of the shoring wall and piling, followed by treatment of larger quantities of soils during the bulk excavation. A treatment area for the mixing of excavated piling spoil with agricultural lime should be established. This could consist of dusting the treatment surface with lime. The purpose of this guard layer is to minimise the risk of acidic water leaching from the base of the treatment area into the groundwater. Alternatively the treatment could be undertaken in a skip bin or dedicated bunded area. The treatment area for the bulk excavation will be stablished by default by the shoring wall and all treatment is to be undertaken within the confines of the shoring wall/basement footprint. An earthworks strategy should be prepared to ensure there are sufficient provisions to accommodate treatment of the PASS.
Step 3: Manage water run-off	Installation of detention tanks or construction of ponds may not be viable on this site therefore all the stockpiles should be covered with builders plastic or similar during rain to prevent the water coming into contact with the stockpiled material. If skip bins are used, bunding should not be necessary. However, the bins should be covered to prevent them from filling with rainwater. The application of neutralising agents into natural water bodies or water courses should be avoided unless carefully planned and approved by council and relevant authorities.
Step 4: Excavation & handling	PASS disturbed during development piling works should be immediately transferred to the designated treatment area and spread out in 150mm to 300mm thick layers. If possible the layers should be kept dry in order to aid the mixing process. The layers should then be interspersed with the appropriate amount of lime to aid in the effective mixing of lime and soil. Lime should be applied to the excavated material within the treatment area as soon as possible. If circumstances prevent the spreading/treatment of the material and stockpiling is necessary, the surface area of the stockpile should be minimised by forming a relatively high coned shape and avoiding 'spreading-out' of the stockpile. This will limit the surface area exposed to oxidation. Water infiltration should be minimised by covering the stockpile during wet weather. This will limit the formation and transport of acid leachate due to rainfall. The stockpile should be bunded to prevent erosion of the PASS and any movement of potentially acid leachate. Upstream surface runoff water should also be diverted around the stockpile. PASS disturbed during bulk excavation should be disturbed and treated in 150mm to 300mm thick layers. An appropriate amount of lime should be applied across the surface of the excavation and mixed in to the target depth of each layer using the teeth of a large excavator

Procedure	Details
	bucket or similar appropriate equipment. This process would then be repeated after excavation of each treated layer.
Step 5: Lime treatment & pH testing	An approximate limning rate to stabilise the PASS will be provided by the laboratory following PASS/ASS sampling activities proposed in the Investigation plan in Section 4.1. An excavator or other suitable equipment (as deemed appropriate by the excavation contractor) should be used to thoroughly mix the lime through the soil. Alternatively use of a pug mill may be considered dependent upon the volume of soil to be treated in a timely fashion. The pH of the soil should be checked using the test method(s) outlined in the ASS Manual 1998 (Methods 21A and or 21Af) to confirm that PASS have been neutralised by lime addition. If required, additional lime should be added to the soil and additional mixing undertaken. Following treatment with lime the pH of the soil should be in the 5.5 to 8.5 range.
Step 6: Monitoring by qualified personnel	Monitoring should be undertaken by qualified personnel to ensure the mixing is undertaken to a suitable extent as the success of the neutralisation method relies on the effectiveness of the mixing process.
Step 7: Waste classification and off-site disposal	Following treatment, the material should be tested and assigned a waste classification in accordance with the Parts 1 and 4 of the Waste Classification Guidelines 2014. All neutralised material should be disposed of off-site to a NSW EPA landfill licensed to accept treated PASS/ASS.

4.5 Alternative Management Options for PASS

As outlined in Sections 4.3.1, Option A is also considered an appropriate option for managing PASS during the proposed development works. An outline of the management requirements for disposing of PASS beneath the water table is provided below and could be considered further in consultation with a suitably qualified environmental consultant, landfill operator and the relevant contractors if required by the client.

Natural soil classed as PASS may be disposed of below the water table at a landfill facility without lime treatment provided that the following conditions are met:

- The material is disposed below the water table within **24 hours** of excavation;
- The material meets the definition of 'virgin excavated natural material' (VENM) under the *Protection of the Environment Operations Act* (1997[10]), even though it contains sulfidic ores;
- The receiving landfill is licensed by the NSW EPA to dispose of PASS below the water table; and
- The material meets the highly stringent pH criteria.

[10] *Protection of Environment Operations Act,* NSW Government, 1997 (POEO Act 1997)

The procedures outlined in the following table should be implemented for this option:

Table 3-3: Management Procedure for Option A

Procedure	Details
Step 1: Contact Landfill	Prior to commencement of excavation works, the landfill should be contacted and the necessary approvals should be obtained for disposal.
Step 2: Excavation & Handling	Natural soil classed as PASS should be excavated/disturbed in stages. PASS must be kept wet at all times during excavation and subsequent handling, transport and storage until they can be disposed of safely.
Step 3: pH testing	The pH of the soil should be checked using the test method(s) outlined in the ASS Manual 1998 (Methods 21A and or 21Af). The pH of each load and the time of extraction should be recorded and forwarded to the landfill. If the pH **is less than 5.5** then the material is not suitable for burial beneath the water and Option B should be implemented.
Step 4: Transport	Provided that the pH of the excavated PASS is **not less than 5.5** the material can be loaded onto trucks and transported immediately to the landfill. Prior to burial the landfill will check the pH of each load. Any loads that do not meet the acceptance pH criteria will be turned away.

4.6 Groundwater Seepage and Dewatering

Based on the proposed development details, groundwater seepage and dewatering is unlikely to be required during construction, however this is still to be confirmed by intrusive investigation which should include the installation of groundwater monitoring wells. If groundwater is encountered the procedure for managing groundwater seepage and dewatering during development works is outlined in the following table:

Table 3-4: Procedure for Managing Groundwater Seepage and Dewatering

Procedure	Details
Step 1: Minimise the depth of dewatering	Where possible the depth of dewatering should be minimised to reduce the generation of ASS and/or acidic conditions. Excavation and dewatering works should be staged over short durations to reduce the time and volume of PASS exposed to oxidation.
Step 2: Approvals for Groundwater Disposal	Reference should be made to the Manly Council, NSW Office of Water / WaterNSW, Sydney Water and other relevant authority's approval requirements for further information in relation to disposal of water to either the sewer or stormwater systems.
Step 2: pH Testing and Neutralisation	Water pumped from the excavation should be placed in a portable tank, or appropriate holding facility, where samples can be obtained for testing.

	The water should be in the pH range of 6.5 to 8.5 (Schedule 5 of Protection of the Environment Operations (General) Regulation 2009)[11]. If the pH is outside of this range, treatment will be necessary prior to disposal. Based on the disposal option chosen for the development, additional screening for contaminants may be required by the relevant authorities prior to disposal.
Step 3: On-going groundwater monitoring	In the event that extended pumping of water is necessary during the construction period, the quality of the groundwater should be monitored on a regular basis over the entire construction period. The pH should be measured and recorded on a regular basis. Immediate advice is to be sought from an experienced consultant if the pH at any location is not within 10% of the initial pH at the commencement of pumping. If required, corrective action should be taken as soon as possible. Laboratory analysis will be required on water samples as part of the corrective action to assess the quantity of neutralising agents required if treatment is necessary.

4.7 Contingency Plan

In the event the results of soil neutralisation or groundwater monitoring tests indicate a significant change in acidic conditions, the contingency plan should be implemented.

If soil monitoring indicates the presence of significantly more acidic material than expected or water monitoring indicates that the pH of the pumped water has become significantly more acidic, all excavation works should be placed on hold until further action is taken to limit the oxidation of PASS in the development area. Contingency works will be undertaken as follows:

- The depth to groundwater (i.e. the extent of de-watering) in the area of excavation will be measured;
- The pH of soils exposed to oxygen within the excavation will be measured to establish the source of the acidic conditions;
- Material found to be acidic will be excavated and neutralised in accordance with the methods presented in presented previously in this ASSMP;
- Where suitable, in-place treatment involving lime addition and mixing may by adopted; and
- In the event unacceptable acidic levels are recorded by the groundwater monitoring, installation of a neutralisation trench (or similar) may be required to intercept and treat acidic groundwater prior to discharge. This could consist of an excavation filled with a sand/lime mixture designed to filter, intercept and treat groundwater flowing across the trench.

[11] NSW Government, (2009). *Protection of Environment Operations (General) Regulation,* Schedule 5 Prescribed matter for the definition of water pollution (page 124) (POEO Regulation 2009)

4.8 Disposal Information

The costs associated with the treatment and off-site disposal of PASS can be significant and may affect project viability. These costs should be assessed at an early stage of the project to avoid significant future unexpected additional costs.

Section 143 of the POEO Act1997 states that if waste is transported to a place that cannot lawfully be used as a waste facility for that waste, then the transporter and owner of the waste are each guilty of an offence. The transporter and owner of the waste have a duty to ensure that the waste is disposed of in an appropriate manner. EIS accepts no liability whatsoever for the unlawful disposal of any waste from any site.

5 LIMITATIONS

The report limitations are outlined below:

- EIS accepts no responsibility for any unidentified ASS 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 EIS proposal; and terms of contract between EIS 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, EIS has not undertaken any verification process, except where specifically stated in the report;
- EIS 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;
- EIS 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. EIS should be contacted immediately in such circumstances;
- Material considered to be suitable from a geotechnical point of view may be unsatisfactory from a soil contamination viewpoint, and vice versa;
- 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 EIS. EIS 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 EIS; and
- Any third party who seeks to rely on this report without the express written consent of EIS does so entirely at their own risk and to the fullest extent permitted by law, EIS 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

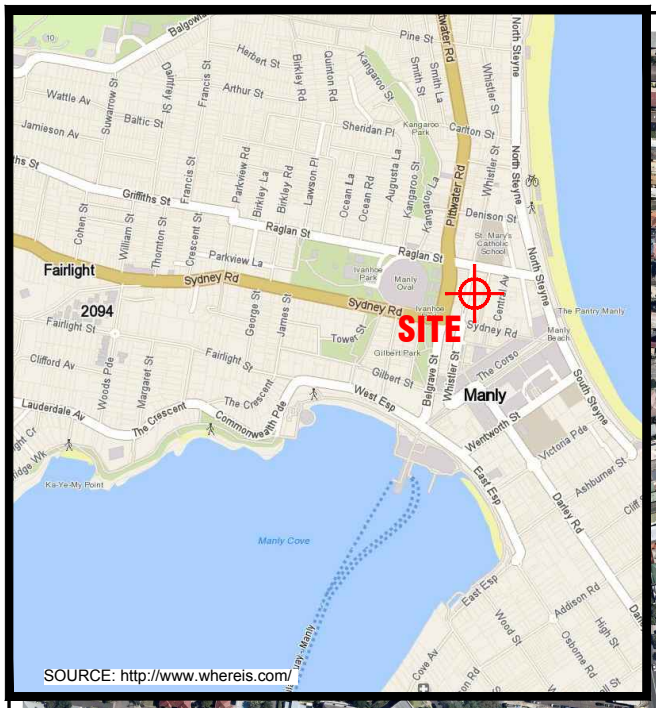
Mitch Delaney
Senior Associate |Environmental Scientist

Adrian Kingswell
Principal Consultant | Environmental Scientist

Appendices:

Appendix A: Report Figures
Appendix B: Information on Acid Sulfate Soils

Appendix A: Report Figures



AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM, 27 DEC 2018.

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

Title: **SITE LOCATION PLAN**

Location: 26 WHISTLER STREET
MANLY, NSW

Report No: E32250BD

Figure No: 1

JKEnvironments

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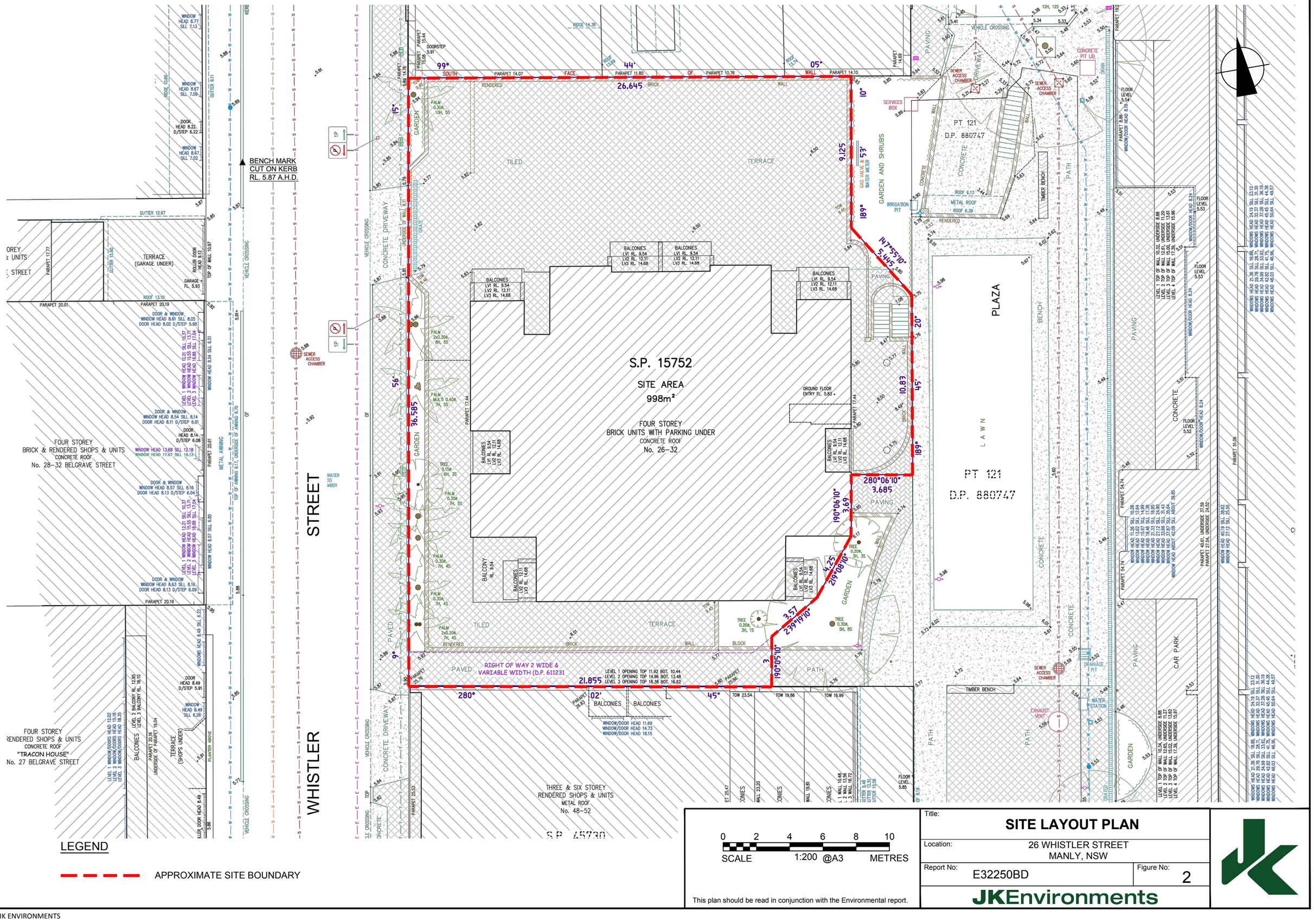

This plan should be read in conjunction with the Environmental report.

Title: **SITE LAYOUT PLAN**

Location: 26 WHISTLER STREET
MANLY, NSW

Report No: E32250BD

Figure No: 2

JKEnvironments

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Appendix B: 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. These soils include those that are producing acid (termed actual ASS) and those that can become acid producing (termed potential ASS or 'PASS'). PASS are naturally occurring soils and sediment that contain iron sulfides (pyrite) which, when exposed to oxygen generate sulfuric acid.

B. The ASS Management Advisory Committee (ASSMAC)

The NSW government in 1994 formed the ASSMAC to coordinate a response to ASS issues. In 1998 this group released the Acid Sulfate Soil Manual[12] providing best practice advice for planning, assessment, management, laboratory methods, drainage, groundwater and the preparation of ASS management plans (ASSMP).

In 1997 the Department of Land and Soil Conservation (now part of the Office of Environment and Heritage[13]) developed two series of maps with respect to ASS for use by council and technical staff implementing the ASS Manual 1998:

- ASS Planning Maps – issued to councils and government units; and
- ASS Risk Maps – issued to interested parties.

C. 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.

[12] Acid Sulfate Soils Management Advisory Committee (ASSMAC), (1998). *Acid Sulfate Soils Manual* (ASS Manual 1998)
[13] http://www.environment.nsw.gov.au/acidsulfatesoil/index.htm

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.

D. 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.

E. Investigation and Laboratory Testing for ASS

The ASS Manual 1998 includes information on assessment of the likelihood of PASS, the need for an ASSMP, and the development of mitigation measures for a proposed development located in PASS risk areas.

The ASS Manual 1998 recommends a minimum of four sampling locations for a site with an area up to 1ha. For sites greater than 4ha, the manual recommends the use of a reduced density of two locations per hectare subject to the proposed development. For lineal investigations, the manual recommends sampling every 50-100m.

The sampling locations should include all areas where significant disturbance of soils will occur and/or areas with a high environmental sensitivity. In some instances a varied sampling plan may be more suitable, particularly for sites less than 1,000m^2 in area.

The depth of investigation should extend to at least 1m beyond the depth of proposed excavation/disturbance or estimated drop in water table height, or to a minimum of 2m below existing ground level, whichever is greatest.

Standard methods for the laboratory analysis of samples are presented in the Australian Standard AS4969-2008/09[14] (part 1 to 14). The principal analytical method is suspension Peroxide Oxidation Combined Acidity and Sulfur (sPOCAS).

The sPOCAS method specified in AS4969-2008/09 supersedes the POCAS method specified in the ASS Manual 1998. When S_{POS} (peroxide oxidisable sulfur) values are close to the action criteria confirmation of the result can be undertaken by the chromium reducible sulfur (S_{CR}) method.

The endpoint for the pH titration in AS4969-2008/09 is pH6.5 as opposed to pH5.5 adopted in the ASS Manual. Therefore the values for Total Actual Acidity (TAA), Total Sulfide Acidity (TSA) and Total Potential Acidity (TPA) will more conservative when analysed using the sPOCAS method specified in AS4969-2008/09.

[14] Standards Australia, (2008/2009). *Analysis of acid sulfate soil – Dried samples – Methods of test, Parts 1 to 14.* (AS4969-2008/09)