

**Brown Commercial Building
PO Box 596
East Maitland NSW 2323**

**Project 91501.01
4 April 2019
R.001.Rev0
PH:kd**

Attention: Kimberley Keath

Email: kkeath@brownbuild.com.au

Dear Kimberley

**Acid Sulfate Soil Management Plan
Proposed Mixed Use Development
79 Barrenjoey Road, Mona Vale**

1. Introduction

This Acid Sulfate Soil Management Plan (ASSMP) has been prepared for the proposed mixed use development at 79 Barrenjoey Road Mona Vale. The work was commissioned in a purchase order dated 19 March 2019 by Ms Kimberley Keith from Brown Commercial Building, undertaken with reference to Douglas Partners Pty Ltd (DP) proposal NCL190167 dated 18 March 2019.

It is understood that the proposed development will comprise a service station, associated store and pavements/car parking area. It is anticipated that localised excavations will be required for construction activities including, pavement construction, service trenches, fuel lines/vents, underground fuel storage tanks and foundations.

At this stage, DP has not conducted ASS testing at the site. Preliminary ASS assessment has, however, been conducted by others at the site (EIS, 2015). Supplementary ASS assessment is recommended prior to construction to confirm subsurface and ASS conditions for the proposed excavations at the site. The results of previous assessment at the site have been used to provide indicative ASS conditions and subsequent ASS management measures for the subject site and the proposed development.

This ASSMP provides methods and strategies to minimise the potential for adverse impact associated with the disturbance of ASS during construction works associated with the proposed commercial development. The ASSMP includes the following information:

- Acid Sulfate soil management strategies;
- Monitoring program; and
- Contingency plan.

This ASSMP was prepared with reference to the NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC), Acid Sulfate Soil Manual, August 1998 (ASSMAC 1998) and the Queensland Government, Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines, V4.0, June 2014 (Dear et al 2014).

2. Site Description and Regional Geology

The site comprises Lot A DP405025, 79 Barrenjoey Road Mona Vale. The lot is currently vacant and subject to the proposed development plans.

The site comprises a rectangular area of approximately 1,630 m² and has a frontage of about 50 m to Barrenjoey Road. The approximate site area is shown in Figure 1 below.

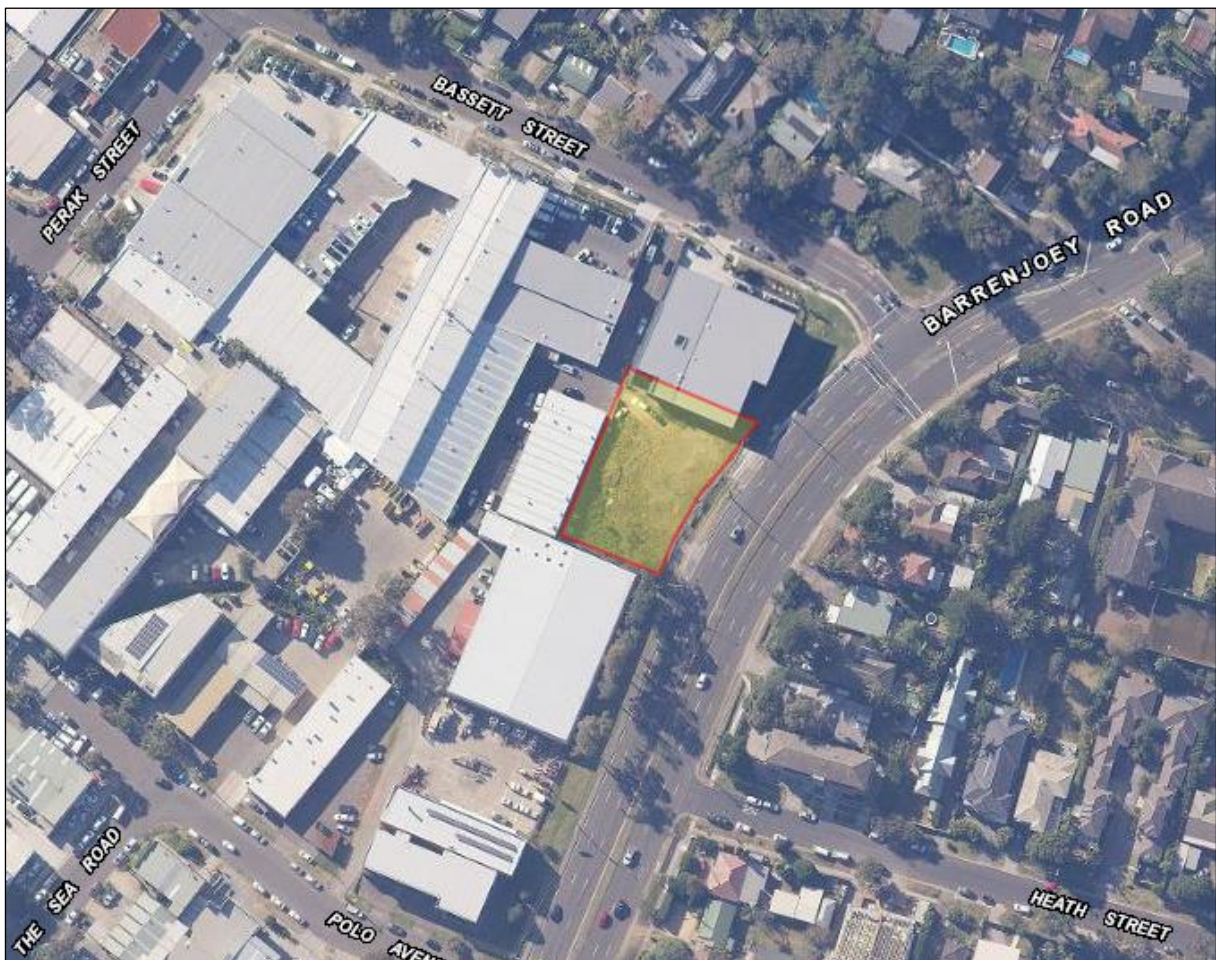


Figure 1: Subject site shown in yellow

The site is bounded by the following:

- North – Commercial properties and Bassett Street beyond the commercial properties;
- South – Commercial properties;

- East – Barrenjoey Road and residential properties beyond Barrenjoey Road and
- West – Commercial properties.

Reference to mapped 2 m topography contours for the site indicates that surface levels are in the order of RL 4 m AHD, with the site generally flat.

Reference to the Geology map indicates that the site is underlain by Triassic aged Newport Formation and Garie Formation of the Narrabeen Group, generally comprising interbedded laminate, shale and quartz to lithic quartz sandstone. It is noted that the area immediately south of the site is mapped as Quaternary aged stream alluvium and estuarine sediment.

Reference to the Hornsby/Mona Vale Acid Sulphate Soil Risk Map prepared by the Department of Land & Water Conservation indicates that the site is mapped as having a high probability of ASS between 1 m and 3 m below the ground surface. The ASS map is reproduced in Figure 2 below.

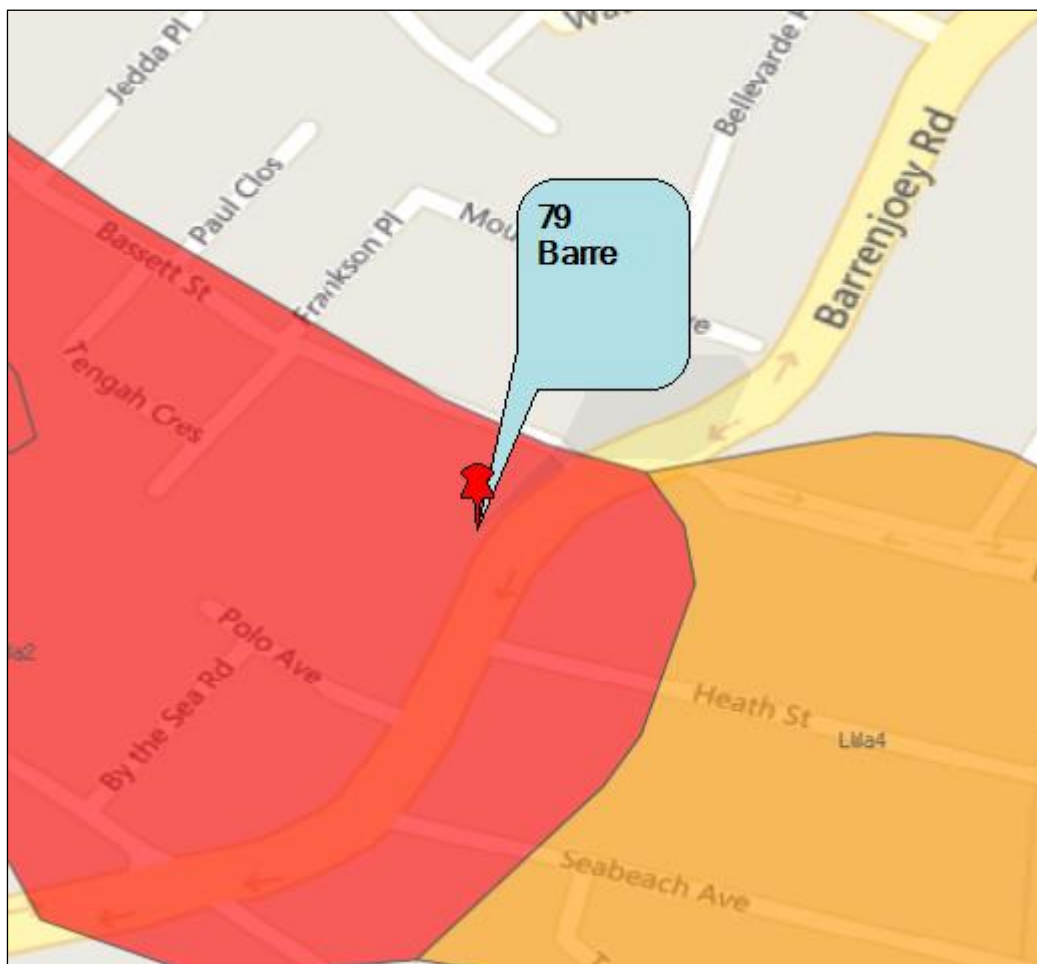


Figure 2: ASS map indicating site location (red marker), low probability of ASS (orange) and high probability of ASS (red)

The nearest sensitive receptor is considered to be Bongin Bongin Bay located approximately 580 m east-south-east of the site. Groundwater flow is likely to be in an easterly to south-easterly direction towards Bongin Bongin Bay. It is noted, however, that previous assessment by others at the site suggested groundwater flow in a south-westerly direction.

3. Background

3.1 EIS 2015

Preliminary ASS assessment has been conducted by others (EIS 2015) as part of the preliminary contamination screening assessment at the site for a former proposed development

The results of the subsurface investigation and preliminary ASS assessment are summarised below:

- The former proposed development comprised a commercial development with a two-level basement;
- Subsurface investigation was conducted across the proposed area of development, comprising the drilling of five boreholes;
- Subsurface conditions generally comprised filling (silty clay, silty sandy clay and silty sand filling) to 1.5 m to 5.8 m below ground level, underlain by natural silty sand and sandy silty clay soils;
- Groundwater seepage was encountered in four of five boreholes during drilling;
- Acid sulfate soil testing indicated potential acid sulfate soil conditions in natural sandy clay soils from a depth of approximately 3.8 m below ground level at the locations tested;
- A liming rate of up to 4.5 kg per tonne was recommended for treatment of ASS;
- The report recommended the preparation of an acid sulfate soil management plan.

In addition to the above, a number of contamination assessments have been conducted on the site. It is understood that impact from previous site use (service station) and contaminated filling has been encountered on the site.

3.2 Site Audit Statement (Kohlrusch, 2012)

A Site Audit Statement (SAS) (No. 004 – 2120401, Former Caltex Service Station - 79 Barrenjoey Road, Mona Vale, NSW by Andrew Kohlrusch, GHD, 3 Aug 2012) has been prepared for the site, based on a number of assessments of soil, groundwater and vapour as a result of previously identified contamination at the site. The purpose of Site Audit was to determine land use suitability. A brief summary of the site audit statement is provided below:

- The Auditor stated that the site is **SUITABLE** for commercial/industrial use subject to compliance with Environmental Management Plan – Former Caltex Service Station, 79 Barrenjoey Road, Mona Vale NSW Site No. 22353 July 2012, in light of contamination remaining on the site;
- The site was a former service station which has undergone remediation through the removal of the former tanks and infrastructure, contaminated soil removal, soil bioremediation and biosparging of groundwater;

- Soil validation results demonstrated that some soils (the majority of which were below the water table) and groundwater within the site had concentrations of total petroleum hydrocarbons and benzene, ethyl benzene, toluene and xylenes (BTEX) in excess of the nominated investigation levels;
- Soil vapour (as a consequence of the contaminated soil and groundwater) was deemed (through measurement in soil vapour monitoring wells) to present an unacceptable risk to site users;
- An environmental management plan (EMP) was prepared documenting the hazards associated with the soil vapour and how they should be mitigated during future site development;
- Off-site sampling of groundwater and passive vapour sampling did not identify unacceptable risks to off-site receptors in the current off site building configuration;
- It was stated that off-site intrusive workers may be exposed to an unacceptable risk through dermal contact and ingestion of impacted soil or groundwater (at depths greater than 1.5 metres) as well as vapour inhalation;
- On the basis of the information reviewed as part of the audit, the auditor considers that the site is suitable for commercial/industrial land use provided the site specific site EMP is implemented and maintained and adhered to at all times.

3.3 Environmental Management Plan (PB, 2012)

An Environmental Management Plan (EMP) for the site was prepared in July 2012 by Parsons Brinckerhoff. A brief summary is provided below:

- The purpose of the EMP is to provide a plan for management of residual petroleum hydrocarbon impacts in soil and groundwater beneath the site in a manner which protects human health during redevelopment works and occupation of the site after redevelopment, in accordance with the National Environment Protection Council (NEPC 1999) National Environment Protection (Assessment of Site Contamination) Measure.
- Protection of human health will be achieved by the application of controls to future site excavation or maintenance works that involves contact with impacted soil or groundwater at the site, and the incorporation of soil vapour barriers into building foundations;
- Implementation of the controls outlined in the EMP will be the responsibility of the owner of the property, or the owner's agent;
- The site has been subjected to environmental investigations, remediation works, monitoring of residual groundwater and soil vapour impacts, and a human health risk assessment. At the completion of investigations, remediation and risk assessment, a site validation report, summarising the condition and residual risks was prepared;
- Some residual petroleum hydrocarbon soil impacts remain on the site (benzene, ethylbenzene, xylene and the hydrocarbon fractions, C6-C9 and C10-C36), generally in soils beneath clean imported backfill soils;
- The mass of contamination was detected in the saturated zone (i.e. beneath the water table) between 3.0 and 5.0 m below ground level (mBGL) in the central forecourt area;

- On account of remaining soil impacted by hydrocarbons, a potential risk exists for underground maintenance workers and excavation workers at the site through ingestion and dermal contact if hydrocarbon impacted soils are intercepted;
- Shallow soil vapour testing showed that at four of the soil vapour bores installed to depths of 1 m, vapour concentrations exceeded vapour screening levels and may represent a risk for occupants of future buildings should vapour barriers or equivalent controls on vapour intrusion not be implemented. Testing results, however, showed no unacceptable health risk, from vapour inhalation, for maintenance workers trenching to depths of 1 m or less;
- Soil vapour concentrations deeper in the profile were greater than in the shallow soil;
- Concentrations of hydrocarbon vapours in several of the 3 m deep bores exceeded vapour screening levels and thus indicated a potential vapour intrusion risk for occupiers of future buildings if vapour barriers were not incorporated into foundation designs;
- The vapours measured in the soil at both the shallow 1 m bores and in the deeper 3 m bores originated from the residual contamination in the soil profile and from the impacted groundwater, generally at depths of between 3 m and 5 m at the time of the vapour testing;
- Residual impacts to soil and groundwater consist of volatile (petrol fraction) and semi-volatile (diesel fraction) hydrocarbons;
- The highest concentrations were located in the central portion of the site coinciding with former location of the underground fuel infrastructure and the bowisers;
- The hydrocarbon impacted groundwater flows to the south-west and extends beyond the site boundary by a distance of approximately 100 m;
- Health risk evaluation has determined that there is an unacceptable risk, arising from vapour intrusion into buildings if constructed on the site without vapour mitigating measures such as the incorporation of vapour membrane barriers into the foundation slabs;
- A potential risk exists to intrusive maintenance workers and excavation workers at the site through ingestion and dermal contact in the event that impacted groundwater is intercepted;
- Impacts are more likely to occur at approximately 5 mBGL the saturated zone;
- Work procedures must incorporate controls to minimise dermal contact with hydrocarbon impacted groundwater and soils as a precaution measure;
- An unacceptable vapour inhalation risk may exist for workers in trenches where depths exceed 1 m;
- Task specific safety precautions would need to be implemented as part of work permitting for any trenching works, and work methods must take into consideration the potential for exposure to hydrocarbon vapours in deep trenches;
- The EMP outlines risk management and environmental management measures for works to be conducted at the site (i.e. handling of soils, excavations, work health and safety);
- Vapour mitigating measures such as foundation vapour barriers must be incorporated in to the construction of any buildings.

Reference should be made to the EMP for details.

4. Potential for Oxidising ASS

It is anticipated that localised excavations will be required for construction activities including pavement construction, service trenches, fuel lines/vents, underground fuel storage tanks and foundations.

ASS may also be exposed during dewatering, if required (i.e. if excavation beneath the groundwater table and subsequent dewatering of ASS is required).

It is likely that natural soils will be encountered during construction works for the proposed development.

The recommended management option for excavated ASS is neutralisation by full lime treatment and oxidation, subject to confirmation of ASS and groundwater conditions within proposed excavation areas.

It is noted that limited site-specific ASS assessment has been conducted at the site. Additional ASS assessment is recommended to further assess the depth and extent of ASS and groundwater conditions within proposed excavation areas prior to development. We also recommend that the contamination status of soils and groundwater within excavation areas are confirmed to assist with site management.

Residual soil and groundwater contamination is present within the site due to former site activities as discussed in Section 3 of this report. The proposed development is likely to disturb contaminated soils in addition to underlying ASS. The management of ASS should be conducted with due regard to site contamination conditions.

5. Management Strategy

5.1 Soil Treatment Strategy

Neutralisation of ASS, where disturbed, will be required and should be undertaken with reference to the ASSMAC and QASSIT guidelines, as discussed below.

ASS should be segregated during excavations and treated within a suitable contained and bunded area prior to re-use on-site in approved locations.

The location of the bunded area should be selected in order to minimise the potential for impact on nearby sensitive receptors, including nearby water bodies. Any leachate produced in the bunded area should be contained for monitoring and treatment as discussed below.

If a suitable located bunded area is not available on-site, consideration could be given to progressive treatment of soils immediately adjacent to the excavation as the material is excavated (i.e. treated within 4 hours of excavation).

The contamination status of soils should be considered in the location and design of bunded areas (i.e. it is likely that bunded areas will require a low permeability liner).

Suitable neutralising agents for actual or potential ASS include agricultural lime (CaCO_3), calcined magnesite (MgO or $\text{Mg}(\text{OH})_2$) and dolomite ($\text{MgCO}_3 \cdot \text{CaCO}_3$).

An assessment of the dosing rate for lime treatment can be calculated from the results of detailed laboratory testing, using the following equation, which includes a factor of safety.

Alkali Material Required (kg)

$$\text{per unit volume of soil (m}^3\text{)} = \left(\frac{\%S \times 623.7}{19.98} \right) \times \frac{100}{\text{ENV}(\%)} \times D \times \text{FOS}$$

Where: $\%S$ = existing and potential acidity ($\% S$ units);
 623.7 = $\% S$ to $\text{mol H}^+ / \text{t}$;
 19.98 = $\text{mol H}^+ / \text{t}$ to $\text{kg CaCO}_3 / \text{t}$;
 D = Bulk density of soil (t/m^3);
 FOS = safety factor (usually 1.5);
 ENV = Effective Neutralising Value (e.g. 80% for Grade 1 Agricultural lime).

Note: The ENV is calculated based on the molecular weight, particle size and purity of the neutralising agent and should be assessed for proposed materials in accordance with QASSIT 2014.

It is recommended that Grade 1 agricultural lime is used for the neutralisation of ASS excavated during the construction.

Treatment of ASS should be conducted with due regard to the contamination status of the site and requirements of the EMP.

5.2 Liming and Monitoring Procedure

The liming and monitoring procedure for the treatment of ASS is as follows:

- The surface of the bunded soil treatment area/stockpile area adjacent to the excavation should be dosed with approximately 1 kg/m^2 of agricultural lime as a precautionary measure;
- All identified and segregated ASS should be contained within a suitably bunded area and kept moist to minimise oxidation, prior to treatment with lime. Progressive neutralisation will minimise the area required for bunding;
- The base of excavations within ASS should be treated with approximately 1 kg/m^2 of agricultural lime.

Based on the mapped geology, possibly variable soil types and the results of investigations at the site, lime application rates for ASS may vary significantly. Generally higher liming rates are required for clay soils. It is recommended that a rate of 5 kg of lime per tonne of clayey soil (i.e. $\sim 9 \text{ kg/m}^3$) is initially considered (i.e. in the absence of additional development-specific investigation) to minimise the risk of over-liming. Lime treatment should be conducted as follows:

- Soils should be neutralised as soon as practicable (and within 24 hours for bunded treatment areas or 4 hours for stockpiles adjacent to trenches) following excavation;
- The neutralising agent and ASS should be thoroughly mixed and aerated. The soil should be treated in layers up to 300 mm thick to encourage aeration;

- Thorough mixing of lime may be difficult where clayey soils are encountered. Improved mixing may be achieved by reducing the thickness of treatment layers, and using a rotary hoe or similar;
- It should be noted that the actual lime rate required will also depend on the results of monitoring during neutralisation. Additional lime will be required if monitoring results indicate that appropriate neutralisation has not been achieved. Conversely the liming rate may decrease if monitoring suggests over-liming is occurring;
- Sampling and testing should be undertaken in accordance with Section 5.5 to confirm the neutralisation treatment. The acceptance criteria are discussed in Section 5.5.2. Depending on the results of testing, re-application of lime may be necessary to gain adequate neutralisation;
- Upon confirmation of treatment, the neutralised ASS would be suitable for re-use on-site subject to contamination and geotechnical suitability. Alternatively, appropriately treated ASS soils could be disposed to a licenced landfill following waste classification or subject to further assessment for specific exemption classification with reference to the relevant NSW EPA guidelines (NSW EPA 2018).

Additional investigation should be conducted prior to development to confirm ASS and groundwater conditions within proposed excavation areas.

The liming and monitoring procedures should be conducted with due regard to the contamination status of the site and EMP requirements.

5.3 Neutralising Leachate

Leachate water collected from the bunded area (if any) should be neutralised as necessary before release. Calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) is the recommended neutralising agent as it produces a two-step reaction, which proceeds rapidly at acidic pH and slows down as higher pH is approached, and hence reduces the potential for over neutralisation to occur.

The amount of neutraliser required to be added to the leachate can be calculated from the equation below:

$$\text{Alkali Material Required (kg)} = \frac{M_{\text{Alkali}} \times 10^{-\text{pH}_{\text{initial}}}}{2 \times 10^3} \times V$$

Where: $\text{pH}_{\text{initial}}$ = initial pH of leachate
 V = volume of leachate (litres)
 M_{Alkali} = molecular weight of alkali material (g/mole)

Note: molecular weight of calcined magnesia (M_{MgO}) = 40 g/mole.

The alkali should be added to the leachate as a slurry. Mixing of the slurry is best achieved using an agitator.

Any discharge / disposal of water (if required) should be conducted in accordance with statutory and regulatory requirements.

5.4 Dewatering

The following procedure is recommended in order to minimise potential adverse impacts resulting from localised dewatering of ASS (where required) during construction:

- Minimise the dewatering depth required for construction (i.e. as close as practicable to the invert level of the excavation);
- Minimise the time and volume of exposed ASS (i.e. stage excavation and dewatering);
- Appropriate management of extracted waters to allow monitoring and treatment (if required) prior to discharge/disposal;
- The extracted groundwater could then be discharged/disposed, subject to regulatory requirements;
- The pH of the extracted water should be monitored prior to discharge. Neutralisation should be undertaken as per the leachate neutralisation procedures, as discussed in Section 5.3;
- Extracted waters will require monitoring and possible treatment/neutralisation with due regard to ASS and contamination conditions in accordance with regulatory requirements prior to discharge/disposal;
- Dose the base of the excavation at a rate of approximately 1 kg/m² of Agricultural lime in order to counteract the possible generation of acidic leachate following groundwater recovery;
- Segregate and treat the ASS excavated during construction as discussed in Section 5.2;
- Undertake ASS monitoring as recommended in Section 5.5 below.

Development-specific investigation should be conducted prior to development to confirm groundwater conditions and options for discharge/disposal during dewatering.

Dewatering should be conducted with due regard to the contamination status of the site and the requirements of the EMP.

5.5 Acid Sulfate Monitoring Strategies

5.5.1 Procedures

Soil Neutralisation / Management

The following inspections and monitoring should be undertaken when excavating ASS materials, based on guidelines presented in the ASSMAC 1998 and QASSIT (Dear et al 2014) manuals:

- Daily inspection of liming operations during excavation;
- Sampling and screening testing after lime treatment (i.e. measurements of soil pH in distilled water and pH following oxidation with peroxide) should be undertaken at a frequency of at least one sample per 10 m³ excavated soil, or daily (whichever is greater), to assist in confirming the neutralisation treatment;
- Analysis of one soil sample per 50 m³ for Chromium Suite analysis by a NATA accredited laboratory to confirm appropriate neutralisation;

- The frequency of testing could be reduced depending on the results of monitoring and consistency of excavated ASS.

It is anticipated that ASS monitoring will be conducted in conjunction with monitoring for site contamination in accordance with the site EMP.

Leachate Management

Leachate collected within the bunded area should be temporarily stored and neutralised as necessary. The pH of the leachate should be monitored daily, and prior to any discharge to the environment. The neutralised leachate could be discharged/disposed, subject to regulatory requirements and licences.

Treatment/neutralisation should be undertaken where required subject to regulatory requirements.

Dewatering

Extracted waters should be managed to allow ASS monitoring and treatment (if required) prior to release/discharge. The pH of extracted water associated with areas of ASS should be monitored twice daily (am and pm). If variable results are detected a higher frequency of monitoring may be required. Monitoring of waters during dewatering for ASS purposes should be conducted in conjunction with the required monitoring for site contamination conditions.

Appropriate treatment/neutralisation should be conducted subject to regulatory and licensing requirements prior to discharge/disposal of waters.

Site management procedures for ASS should allow for lime / calcined magnesia dosing and monitoring and confirm appropriate neutralisation prior to appropriate discharge/disposal, subject to regulatory requirements. Monitoring is also recommended in nearby surface water bodies/drains and sensitive receptors.

Reporting

A record of treatment of ASS and leachate should be maintained by the contractor and should include the following details:

- Date;
- Location;
- Time stockpile has been exposed prior to treatment;
- Neutralisation process undertaken;
- Lime rate utilised;
- Results of soil, leachate and groundwater monitoring;
- Record of location, level placement and capping details where treated ASS has been re-used on-site.

A record should also be maintained confirming contingency measures and additional treatment if undertaken.

A final report should be issued upon completion of the works presenting the monitoring regime and results, and confirming that appropriate management of ASS has occurred during the works.

5.5.2 Acceptance Criteria

Water

Discharge of waters should be conducted in accordance with statutory and regulatory requirements, and the ANZECC 2000 and ANZG 2018.

Measurement of pH and EC of groundwater at the commencement of construction should be conducted to determine baseline conditions for the monitoring of ASS and waters at the site.

Soil

Further ASS treatment may be required if monitoring of the material reveals any of the following properties:

- pH of soil in water is less than background values. Applicable background values are those present within the area proposed for re-use of treated ASS (i.e. background pH of soils within re-use areas). At the commencement of ASS construction activities, the background soil pH should be determined within the nominated re-use areas (where required);
- pH in water minus pH in hydrogen peroxide (i.e. $pH_F - pH_{FOX}$) is greater than 1, and pH in water is less than background values;
- existing plus potential acidity results are greater than zero.

Depending on the results of testing, re-application of lime may be necessary to gain adequate neutralisation, or additional mixing with ASS may be required if over-liming has occurred. Care should be taken to ensure over-liming does not occur.

5.6 Acid Sulfate Contingency Plan

Remedial action will be required if the standards or acceptance criteria outlined above are not being achieved. Remedial action shall comprise mixing of additional lime through the excavated material and neutralisation of leachate (if under liming has occurred). If monitoring indicates that over-liming has occurred, additional ASS or leachate should be mixed to reduce pH to acceptable levels. The required mixing rate to remediate the soil or leachate should be confirmed by monitoring tests.

During periods of heavy or prolonged rainfall, stockpiled soils should be appropriately contained/covered or temporarily backfilled to minimise leachate generation and runoff.

Sufficient lime should be stored on site during construction for the neutralisation of ASS and contingency measures.

The development should be conducted with due regard to erosion and sediment controls to minimise potential impacts to nearby sensitive receptors, including stormwater drains.

Management of ASS during construction should be conducted by an experienced contractor and qualified environmental consultant.

6. Site Contamination

It is noted that residual soil and groundwater contamination is present within the site as indicated in the previous site investigations, SAS and EMP for the site. The proposed site development is likely to disturb contaminated soils and groundwater within the site in addition to ASS. The site development and management of ASS and groundwater should be conducted with due regard to site contamination conditions, ASS conditions and the requirements of the EMP.

7. References

ANZECC 2000, "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", October 2000.

ANZG 2018, "Australian and New Zealand Guidelines for Fresh and Marine Water Quality", Canberra, Australia: Australian and New Zealand Governments and Australian state and territory governments, 2018.

ASSMAC 1998, Stone, Y, Ahern CR, and Blunden B (1998), "Acid Sulfate Soil Manual, 1998", New South Wales Acid Sulfate Soil Management Advisory Committee, August 1998.

Dear et al 2014, Dear SE, Ahern CR 2014, O'Brien LE, Dobos SK, McElnea AE, Moore NG and Watling KM "Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines", Department of Science, Information Technology, Innovation and the Arts, Queensland Government, June 2014.

EIS 2015, "Report to Macarthur Projects Pty Ltd on Preliminary Contamination Screening for Proposed Commercial Development at 79 Barrenjoey Road Mona Vale 2103" ref E28476KGrpt-R1 dated 8 October 2015.

Kohlrusch 2012, "Site Audit Statement No. 004 – 2120401, Former Caltex Service Station - 79 Barrenjoey Road, Mona Vale, NSW", 3 Aug 2012.

NSW EPA 2018, "Guidelines on Resource Recovery Orders and Exemptions for the Land application of waste materials as fill", January 2018.

PB 2012, "Environmental Management Plan (EMP) – Former Caltex Service Station, 79 Barrenjoey Road, Mona Vale NSW Site No. 22353" July 2012.

8. Limitations

Douglas Partners (DP) has prepared this report for this project at 79 Barrenjoey Road Mona Vale with reference to DP's proposal NCL190167 dated 18 March 2019 and acceptance received from Brown Commercial Building dated 19 March 2019. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Brown Commercial Building for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations (by others), and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences.

DP's advice is based upon the conditions encountered during investigation by others. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

It is noted that residual soil and groundwater contamination is present within the site due to former site activities. Site development and management of ASS should be conducted with due regard to the contamination status of the site and the requirements of the EMP.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the environmental components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

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

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

Patrick Heads
Associate

Chris Bozinovski
Principal

Attachments: About this Report

About this Report

Douglas Partners



Introduction

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

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

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

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

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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