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Acid Sulphate Management Plan

Prepared for: Warringah Golf Club

Address: 433 Pittwater Road, North Manly

Job No: 60025A-IDF

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1.0 INTRODUCTION

Ideal Geotech was commissioned to undertake an acid sulfate soils management plan for the proposed works at Warringah Golf Club, 433 Pittwater Road, North Manly.

An acid sulphate soil investigation was undertaken previously by Ideal Geotech (refer to report number 60025). The report indicated that a management plan would be required for excavation and disposal of soil from the site.

Following field tests, two soil samples were submitted to ALS Environmental for SPOCAS testing. The soil was assessed against the guidelines set out in the Acid Sulfate Soils Management Advisory Committee (ASSMAC) (1998).

The results of the laboratory analysis show signs of actual acid sulfate soils within the samples taken at 1.0m and 2.0m below existing surface level at the location of BH2.

Excavation of soils will require treatment prior to disposal.

2.0 OBJECTIVES OF THE ACID SULFATE MANAGEMENT PLAN

The objectives of this ASSMP is to consider both the existing and potential future environmental impacts relating to PASS material in and around the project site and to detail mitigation measures to minimise the potential impacts within the surrounding areas.

The control measures in this ASSMP to mitigate the environmental impacts of the proposed excavations to acceptable levels have been developed to achieve the following objectives:

- Control and, where possible, minimisation of acid sulphate soils;
- Confirming the success of impact control measures by the means of validation monitoring;
- Compliance with statutory requirements
- Preserving the water quality on an ongoing basis

Each environmental protection measure is based on proven and industry best practice methodology.

The ASSMP is designed for the excavation phase of the project. It is based on tabulated checklists for management measures, maintenance, reporting, failure identification and corrective action for each identified use.

The control measures proposed in this ASSMP are for:

- Assessment procedures for AASS/PASS utilising a sampling protocol, set criteria to measure and agreed standards for those criteria to evaluate acid potential;
- Ongoing monitoring program (if required);

- Treatment of potential acid sulphate soils if encountered and control structures to prevent leachate discharge offsite without meeting specific soil quality criteria

3.0 SITE IDENTIFICATION

The subject site is roughly rectangular in shape and approximately 1550m^2 in area and is bound by Pittwater Road to the north east, Kentwell Road to the south, Brookvale Creek to the west and by Warringah Golf Course on all remaining sides.

The site is currently occupied by tennis courts and sports facilities. The site is relatively flat with no notable slopes that will impact construction with a line of large mature trees along the western, northern and eastern boundaries.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Profile

Reference to the Sydney 1:100,000 geological map (Geological Series Sheet 9130) indicates that the site is underlain by Quaternary Deposits consisting of silty to peaty quartz sand, silt and clay along with Ferruginous and humic cementation in places with common shell layers.

Two boreholes (BH1 & BH2) were drilled using a 4wd mounted drill rig to a maximum depth of 2.0m. The sub-surface soil profile encountered at the site generally comprised;

- Silty sand up to at least 3.0m.

Groundwater was not observed at the time of investigation. It should be noted that groundwater levels are likely to fluctuate with variations in climatic and site conditions.

4.2 Acid Sulphate Soils

Acid Sulphate Soils (ASS) are naturally occurring and usually form in low lying coastal areas, creeks, rivers and flood plains. The sulphates present in the soil are stable when in the saturated/waterlogged state, but react to form sulphuric acid when disturbed and exposed to oxygen.

Maps showing the areas identified as being affected by ASS have been prepared by the Department of Land and Water Conservation. These maps identify the probability of acid sulphate soils occurring in these areas and as such any areas should be specifically investigated before a particular site is classified.

Disturbance of these soil materials will result in an environmental risk that will vary with elevation and depth of disturbance. Any works below natural ground surface or affecting the water table has a risk of being contaminated with acid sulphate soils.

Reference to the Acid Sulphate Soils Map of Sydney Heads indicates that the site is located on the border between disturbed terrain and no known occurrence of acid sulphate soil materials.

5.0 SAMPLING & ANALYSIS PLAN

Sampling and analysis was undertaken in order to assess the presence or absence, location and likely distribution of any AASS or PASS present at the subject site in the area of the proposed development.

5.1 Sampling

Soil sampling was undertaken in general accordance with the Acid Sulphate Soil Guidelines. Test results were compared to the relevant New South Wales Environment Protection Authority (NSW EPA) criteria.

BH1 was terminated at a depth of approximately 3.0m below ground level with samples collected at 0.5m and 1.5m below ground level. BH2 was terminated at a depth of approximately 3.0m below ground level with samples collected at 1.0m and 2.0m below ground level. The samples were placed directly into labelled clean zip lock bags and placed on ice until delivery to the laboratory for testing. All analyses were performed by a NATA registered laboratory using NATA accredited methods.

6.0 ACID SULPHATE SOILS ASSESSMENT

6.1 Field Screening

The field screening involved the testing of the samples for field pH and peroxide pH, using 30% hydrogen peroxide to oxidise the soil, and comparing both results.

A positive peroxide test, indicating the potential presence of acid sulphate soil, may include one or more of the following.

- Change in colour from grey tones to brown tones.
- Effervescence.
- Release of sulphurous odours.
- pH following oxidation with H_2O_2 (pH_{fox}) <3.
- Lowering of the pH (pH_f - pH_{fox}) by 1 or greater.
- Field pH (pH_f) <4.

The results of the field and peroxide tests are provided in Table 1 below.

Table 1: Results of Field Screening Tests

Location/Depth	Field pH	Peroxide pH	Reaction to 30% h_2O_2
BH1/0.5m	6.8	3.2	Strong
BH1/1.5m	6.1	3.0	Strong
BH2/1.0m	6.2	2.6	Strong
BH2/2.0m	6.0	3.6	Slight

Based on findings of the field screenings, indications of PASS were observed. Two samples were tested by quantitative laboratory analysis to confirm the presence or absence of acid sulphate soil.

6.2 Laboratory Test Results

Two samples were analysed for SPOCAS to confirm the presence or absence of AASS or PASS in the soil. The sample was dispatched to ALS Environmental services for the quantitative analysis for Suspension Peroxide Oxidation Combined Acidity & Sulphate (SPOCAS).

6.3 Assessment Criteria for Acid Sulphate Soils (Laboratory)

The results of analysis for the soils are compared to the below ASSMAC assessment criteria. It is assumed that <1000 tonnes of material would be disturbed hence the action criteria for less than 1000 tonnes have been applied.

6.4 NSW ASSMAC Action Criteria

The NSW ASSMAC action criteria is detailed in Table 2 below for less than 1000 tonnes of disturbance.

Table 2: NSW ASSMAC Action Criteria

Type of Material Texture	Approx Clay Content (% <0.002mm)	Action Criteria <1000 tonnes Sulfur Trail Spos or Stos%	Action Criteria <1000 tonnes Acid Trail TPA or TSA mole H+/t
Coarse e.g. sands	**< 5**	**0.03**	**18**
Loams/light clays	5 – 40	0.06	36
Fine clays/silts	≥ 40	0.1	62

Note: The assessment values chosen are based on fine sands which are in bold

6.5 SPOCAS Test Results

The SPOCAS testing identified exceedances of the threshold criteria at 1.0m and 2.0m below ground surface in BH2 which suggests there is a presence of acid sulphate soils. Refer to Table 3 below.

Table 3: Results of SPOCAS Testing

Sample	pH_{ox}	TAA pH 6.5 moles H+/tonne	TPA pH 6.5 moles H+/tonne	TSA pH 6.5 moles H+/tonne	Spos %w/w
BH2/1.0m	3.0	**34**	**214**	**179**	**0.069**
BH2/2.0m	3.9	**27**	**80**	**52**	<0.020

6.6 Aggressiveness to Steel and Concrete

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of pH and types of salts present. In order to determine the degree of aggressiveness, the test values obtained are compared to tables 6.4.2 (C) and 6.5.2 (C) in AS2159 Piling - Design and Installation and tables 5.1 to 5.4 in AS2870-2011 “Residential Slabs and Footings”. The following testing suite was undertaken with results summarised within table 4 below;

- pH
- Electrical Conductivity (EC µS/cm)
- Chloride (Cl)
- Resistivity (ohm.cm)
- Sulphate

Table 4: Results of Aggressivity Testing

Location/Depth	pH	EC_e dS/m	Resistivity Ohm.cm	Cl mg/kg	Sulfate mg/kg
BH1/0.5m	5.9	0.578	5880	<10	20
BH1/1.5m	5.4	0.782	7040	<10	170

Based on test results detailed in Table 4 the soil conditions are mildly aggressive to concrete and non-aggressive to steel in high permeability soils. An exposure classification of A2 for concrete has been determined.

7.0 MANAGEMENT METHOD

Neutralising with agricultural lime is a widely accepted method to minimise the generation of acid and acid products associated with the disturbance of ASS. Agricultural lime is readily available, relatively easy to handle and less hazardous than some other agents.

To be conservative and adopt the precautionary principle it would seem appropriate to adopt a lime application rate to treat the soil that is adequate to neutralise the existing acidity and the potential acid generation due to future oxidisation of sulfidic sediments. It is recognised that the calculated lime application rate includes a 50% safety factor to cater for the inefficient mixing and isolated “hotspots”.

Using the worst case scenario (TPA moles H+/tonne 214) for samples collected within the potential excavation zone, calculations for proposed agricultural lime application rates are shown in Table 5 below.

Table 5: Lime Application Rates

Site	%S	TPA mol H+/T	Min. Kg lime/m^3 soil (assume BD = 1.6g/cm^3)	Min. Kg lime/m^2/300mm layer
Excavation of batter and footings	0.069	214	10	3.5

A bunded treatment pad would be required for the site. Excavated material would be placed into a maximum 300mm deep layer and the appropriate agricultural lime applied and mechanically incorporated into the soil. The layer ensures proper aeration of excavated material when mixing with the lime agent.

7.1 ASS Treatment Area and Procedure

- Provide a non-ASS bunded soil treatment area. The rate of excavated material should be in accordance with appropriate mixing rates on the bunded treatment as stated in Table 5 above.
- Apply a guard layer (5kg/m^2) of agricultural lime to the base of the treatment area.
- Apply lime at adopted application rate and mechanically incorporate into the excavated material.
- Repeat the process until manageable volume of treated material is available for validation testing.
- Undertake soil validation testing at a rate of 1/50m^3 of excavated soil or once per day (whichever is greater). The soil pH should be measured in distilled water as well as in peroxide. This will verify if neutralisation treatment is succeeding as well as confirm that oxidation of acid sulfate soils is not occurring.
- If validation testing indicates excavation material below action criteria remove soil from site as required for final disposal otherwise incorporate required lime and repeat validation testing.

7.2 Dewatering

From investigation of the site, groundwater was not encountered. If groundwater is encountered during excavation, a management plan is included below;

- Should the water table be encountered during excavation attempt to minimise dewatering depth required for the installation.
- Time and volume of exposure to acid sulfate soils should be minimised during excavation and dewatering
- Should any discharged water pH levels be below natural groundwater levels then neutralisation via Magnesium calcite (Magnesium hydroxide) should be employed.

- Following any neutralisation the groundwater can be discharged to a bunded area away from the excavation or to stormwater/sewer, subject to regulation.

7.3 Contingency Plan

Remedial action will be required if the agreed standards or acceptance criteria are not being achieved. Remedial action shall comprise mixing of additional lime through the excavated material and neutralisation of leachate. The required mixing rate to remediate the soil or leachate should be confirmed by monitoring tests.

If overland discharge of groundwater is proposed, a contingency plan should be in place to allow neutralisation and confirmation monitoring prior to injection if pH levels are low or fall below natural background levels.

During periods of heavy or prolonged rainfall, stockpiling of acid sulphate soils should be appropriately contained/bunded to collect leachate for testing and neutralisation (if required) prior to disposal. Alternatively backfilling of acid sulphate soils could be undertaken to prevent the migration of leachate.

Sufficient lime should be stored on site during construction for the neutralisation of acid sulphate soils and contingency measures along with access to appropriate application equipment.

8.0 RECOMMENDATIONS

1. All excavated material on site is to be managed to minimise and ameliorate the existing and potential acidity. Grade 1 agricultural lime (80% ENV) shall be thoroughly incorporated into the material at the application rate shown in Table 5 of this report.

2. Any encounter with the water table and or water below that of natural groundwater pH levels should follow the management plan as in 7.2 above.

3. The management strategy and monitoring schedule is provided as an attachment in appendix A.

9.0 CONCLUSION

Acid sulphate soils have been identified as being a constraint to development at Warringah Golf Club, 433 Pittwater Road, North Manly. An acid sulfate management plan has been prepared to address treatment of the actual acidity and minimizing the potential generation of acidity during the proposed earthworks.

Should you have any queries, please do not hesitate to contact the undersigned.

For and on behalf of Ideal Geotech

D. Dwyer

Dane Dwyer
Geotechnical Engineer

REFERENCES:

Stone, Y, and Hopkins G (1998). *Acid Sulfate Soils Planning Guidelines.* Published by the Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia.

Ahern C R, Stone, Y, and Blunden B (1998). *Acid Sulfate Soils Assessment Guidelines* Published by the Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia

Appendix A – Management Strategy

Appendix A ***Management Strategy***

ELEMENT ASS1 **Acid Sulfate Soil Treatment**

Why:

- To minimise acid generation and acid products due to oxidation of ASS
- To treat the acid generated by excavation of material.

Performance Objective:

- Compliance with the *Protection of the Environment and Operations Act 1997, NSW Acid Sulfate Soil Manual 1998* and other relevant statutes, policy and guidelines
- Implement best practice environmental management of ASS

Responsible Person:

- Site Manager/representative.

Control Actions:

- Minimise disturbance of acid sulfate soils
- Identify treatment area on site or off-site. Note minimal area available on site unless excavation staged. If off-site approval to be sought from statutory authorities prior to commencement of earthworks.
- Prior to disturbance of ASS install non – ASS bunds to stockpile/treatment areas
- Any stockpiling/treatment pad will require the placement of an agricultural lime guard layer under the stockpile/treatment pad. The guard layer shall be 0.3 times the average liming rate/m^2 for each vertical metre of the stockpile/treatment pad. Maximum stockpiling period = 14 days
- Place all excavated material in bunded area. Wet material will require spreading to allow dewatering to occur prior to further treatment
- Place excavated material in maximum 0.3m deep layers and incorporate agricultural lime at the following rates

Site	**%S**	**TPA mol H+/T**	**Min. Kg lime/m3 soil (assume BD = 1.6g/cm^3)**	**Min. Kg lime/m^2/300mm layer**
Any excavation	0.069	214	10	3.5

Monitoring

- Mechanical mixing methods eg rotary hoeing/disc ploughing shall be used.
- Site Manager or representative shall monitor the works daily for evidence of
    1. Yellow efflorescence on soil surface
    2. Iron staining
    3. Sulphurous odour.
- Regular monitoring of any leachate (see ELEMENT ASS2)
- Lime delivery dockets to be collected and checked against calculated lime application rate

Reporting:	• Records to be kept by the Site Manager on the monitoring activities, complaints received, and control actions subsequently taken. Records to be made available to Council, OEH, and OW if requested.

ELEMENT ASS2 ASS Leachate Treatment

Why:	• To avoid negative off-site impacts on water quality from acid generation or acid products
Performance Objective:	• Compliance with the *Protection of the Environment and Operations Act 1997, NSW Acid Sulfate Soil Manual 1998* and other relevant statutes, policy and guidelines • Implement best practice environmental management of ASS
Responsibe Person:	• Site Manager
Control Actions:	• Provide surface water controls to divert surface water run-on • Isolate soil treatment areas in non-ASS bunded areas. • All water discharged from the site to be contained, collected and treated to meet adopted water quality criteria. • Treatment of water within bunded areas may include dosing with hydrated lime at appropriate rates to ensure discharge pH 6.5 – 8.5. (Note extreme care required with hydrated lime to avoid “overshooting” target pH.)
Monitoring: (if leachate evident)	• Daily monitor leachate pH and Electrical Conductivity in treatment and stockpile areas
Action Criteria	• pH < 6.5 or >8.5
Reporting:	• Records to be kept by the Site Manager on the monitoring activities, complaints received, and control actions subsequently taken. Records to be made available to Council, OEH, and OW as requested. • Event = >25mm rainfall in 24hr