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Revised Acid Sulfate Soils Management Plan

240202

1 Kendall Street, Byron Bay NSW 2481

For:
The Kollective Life
By:
ENV Services
Date:
March 2024

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Background

The Kollective Life (the client) engaged ENV Services Pty Ltd (ENV) to undertake an Acid Sulfate Soils Management Plan at 1 Kendall Street, Byron Bay, NSW (SP 96105, previously Lot 235, DP755695; the 'site'). ENV understands an Acid Sulfate Soil Management plan is required as part of the development application for the proposed development. The regional location of the site is presented as Figure 1, Attachment 1. The site is mapped as Class 3 with respect to acid Sulfate Soils and as such requires an Acid Sulfate Soil Management Plan.

The proposed development at 1 Kendall Street, Byron Bay - SP 96105 seeks consent for alterations and additions to an existing multi dwelling housing development. The existing development, approved in accordance with DA 10.2015.398.1 on 19 October 2015, comprises 12 dwellings. The proposal seeks consent for an additional 8 dwellings comprising 6 x 1 bedroom dwellings and 2 x 2 bedroom dwellings. Resident and visitor car parking for an additional 13 vehicles is also provided. The proposed strata subdivision of the new dwellings is also proposed.

The proposal responds to the well documented need for long term key worker rental accommodation in Byron Shire. The subject lot is well serviced by the existing water, sewer, NBN and electricity grid infrastructure.

Review of Previous Reports

There is an existing Acid Sulfate Soil Management Plan for the site – *7848 2016_01_21 Acid Sulfate Soil Management Plan (ASSMP)* (APP 2016) (Attachment 2). APP 2016 pertains to the Acid Sulfate Soil Assessment (ASSA) undertaken by APP in June 2011 for the development of the existing infrastructure. The assessment concluded that no actual acid sulfate soils were present at the site, however potential acid sulfate soils were identified in the top 1.5 m.

Recommendations

Treatment of Acid Sulfate Soils

A summary of APP 2016 results and laboratory calculated liming rates are presented in table 1 below. To ensure consistency, the highest liming rate of 5.4 kg/tonne has been applied for all material.

Table 1: Acid Sulfate Soil results

Sample Location	Depth (m)	Texture	pH_{KCl}	Net Acidity (Non-Treated Soil) (mole H^+/tonne)	Net Acidity (Non-Treated Soil) Action Criterion* (mole H^+/tonne)	Potential Sulfidic Acidity (CRS) ($\%S_{cr}$)*	Potential Sulfidic Acidity (C_{RS}) Action Criterion ($\%S_{cr}$)*	Liming Rate (kg $CaCO_3$/tonne DW)
BH3	0-0.5	Coarse	6.01	3.8	18	0.10	0.03	5.4
	0.5-1		5.29	2.4		0.09		
	1-1.5		5.58	5.7		0.04		
	1.5-2		5.75	2.4		0.02		

Liming Pad

Prior to the (potential) commencement of excavation of soils below the existing ground level, a liming pad (treatment area) should be constructed in an area that is not to be disturbed during the excavation and filling processes. If this is not possible, the treatment area may need to be relocated as excavation works progress. A graphical representation of a treatment pad is provided as Attachment 3.

Basic Design

The liming pad should be constructed so the base of the pad is composed of compacted fine-grained material, so as to produce as impermeable foundation as possible. Ideally a clay liner, no less than 300 mm thick, should be placed on the base of the pad. The base of the pad should slope gently (2 – 5%) so as to allow water/leachate to drain to a designated collection point. A leachate collection system, as described above, should be constructed.

Guard Layer

The base of the liming pad should be dusted with AgLime at a rate determined using the following equation:

Guard layer (kg/m2) = 0.2 x thickness of layer to be treated (m) x average liming rate (kg/tonne).

For (potential) excavations greater than 2.5 – 3.0 mBGL at the proposed development, the guard-layer liming rate was calculated to be 0.15 kg/m2 for a 0.30 m thick layer.

The AgLime for the guard layer should be spread using a lime/fertilizer spreader (tractor-towed) to ensure the base of the pad is evenly covered, prior to the placement of the material requiring treatment.

Validation of treated soils

The principal contractor will be responsible for ensuring that any validation sampling and analysis of lime treated soil undertaken is conducted by a suitably qualified person, and in a manner that will demonstrate, with acceptable confidence, that sufficient AgLime has been mixed into the ASS, to provide an adequate buffer, such that the material meets the criteria set out in Table 2.

Validation sampling locations will be selected, as approved by the Site Supervisor/Foreman, such that a representative distribution for sample locations is achieved for the treated soil.

Validation sampling and analysis will be undertaken at a frequency that will demonstrate that satisfactory neutralisation has taken place. The frequency of soil validation sampling and analysis will be:

- 1 sample per 100 m3 of remediated soil.

Sampling Technique

A suitably qualified Engineer/Scientist shall collect ten representative sub-samples to produce one (1) representative (composite) sample from each 100 m^3 of treated soil, in accordance with the following requirements:

- approximately 250 g of soil must be collected from 10 representative locations, evenly distributed through the 100 m3 of treated spoil; and
- where the soil is cohesive, the sample must be homogenised in a large stainless bowl or similar, and a representative sample taken from the homogenised material.

Laboratory Analysis

Suspension peroxide oxidation combined acidity and sulfur (SPOCAS) testing must be undertaken by a third-party laboratory accredited by the National Association of Testing Authorities (NATA) for the required testing on all material that has been treated. Southern Cross University's Environmental Analysis Laboratory (EAL) can perform the required testing.

Validation Reporting

The principal contractor is responsible for ensuring that a suitably qualified Engineer/Scientist prepares two (2) copies of an ASS Neutralisation Certification Report ("ASSNCR") suitable for submission to Ballina Shire Council and the NSW EPA. The report will demonstrate that the excavated and treated soil has been sufficiently neutralised and meets the criteria presented in Table 2.

The ASSNCR will include, but not be limited to, the following information:

- Summary table of analytical results for each soil stockpile and the results of validation analysis;
- Plan of earthworks stockpile locations, showing:
- Sample identification numbers
- Location of validation sampling.

By submitting the ASSNCR to the Superintendent for review, the contractor is deemed to be stating to the Superintendent that all information presented in the ASSNCR is true and accurate and that the remediation and validation of the ASS soils is of sufficient quality that the contractor is certifying that remediation, as defined under the contract, has been satisfactorily completed.

If the Superintendent considers that the ASSNCR does not provide sufficient evidence to demonstrate that satisfactory remediation has been achieved, or is of unsatisfactory quality, the Superintendent shall notify the contractor in writing, outlining the deficiencies in the ASSNCR and any corrective actions to be undertaken before approval by the Superintendent will be further considered. The contractor must immediately undertake such corrective action to the ASSNCR. The cost of such corrective action will be borne by the contractor.

Neutralisation Criteria

The criteria presented in Table 2 will be used to ensure that the excavated material has been sufficiently neutralised. The criteria have been drawn from the ASSMAC (1998) and NASSIMM (2018) Guidelines.

Table 2: Action Limits for Treatment

ASS Soil Texture	Clay Content %	< 1000 Tonnes Disturbed		> 1000 Tonnes Disturbed	
		Sulfur Content % w/w	Acid Trail mol H^+ /tonne	Sulfur Content % w/w	Acid Trail mol H^+ /tonne
Coarse (sand & gravel)	< 5	0.03	18	0.03	18
Medium (sandy loam - light clay)	5 - 40	0.06	36		
Fine (medium to heavy clays, silty clays)	> 40	0.10	62		

Where the laboratory results meet the action criteria presented in Table 2, the material will be considered to have been sufficiently neutralised.

Where the laboratory results do not meet the action, criteria presented in Table 2, additional neutralisation and validation testing of the soil will be required.

Conclusions

A review of the existing ASSMP and ASSA was undertaken by ENV to determine the suitability of these documents in relation to the proposed development at the site. The review determined no additional on-site assessment is required as previous investigations outlined in APP 2016 encompassed the proposed development area. Additionally, proposed works do not exceed the depths specified in APP 2016 and overall disturbance at the site is to be minimal. As such, APP 2016 is relevant for the management excavated material at site.

In consideration of the above, any soils excavated as part of the proposed development at the site at are to be managed under the existing ASSMP for the site (APP 2016).

In addition, construction of a liming rate is required for treatment of excavated material which is to be treated at the adopted liming rate of 5.4 kg CaCO3/tonne, following which validation sampling of treated material will be required.

Should there be any questions regarding the findings of this report, please do not hesitate to contact the undersigned.

Yours sincerely,

Jemma Attkins
Environmental Scientist

Attachment 1

Figures

Legend

Site Location (Approximate)

0 100 200 m

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Figure 1 – Site Location
1 Kendall Street, Byron Bay 2481 NSW

Project: 240202
Client: The Kollective Life
Date Drawn: 25/05/2024

Image source: SIXMaps (2015)

Legend

Site Location (Approximate)

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Figure 2 – Acid Sulfate Soils Map
1 Kendall Street, Byron Bay 2481 NSW

Project: 240202
Client: The Kollective Life
Date Drawn: 25/05/2024

Image source: SIXMaps (2015)

Attachment 2

7848 2016_01_21 Acid Sulfate Soil Management Plan (ASSMP)

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ACID SULFATE SOIL MANAGEMENT PLAN

Submission to Byron Shire Council

Proposed Multi Dwelling Housing
Ewingsdale Road, Byron Bay
Lot 235 DP 755695

for:
Koho Properties

January 2016

Engineers | Planners | Surveyors | Environmental | Project Management

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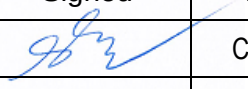
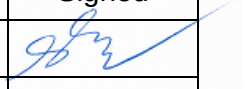
0	21/01/2016	C. Mulder		C. Mulder	
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1 Executive Summary

Ardill Payne and Partners (APP) have been engaged to provide an Acid Sulfate Soil Management Plan (ASSMP) for a proposed development at Lot 235 DP 755695 Ewingsdale Road, Byron Bay to satisfy Condition 13 of Development Application No. 10.2015.398.1.

An Acid Sulfate Soil Assessment (ASSA) was undertaken in June 2011 for the subject site. The assessment indicated that no actual acid sulfate soil (AASS) exists on the site but potential acid sulfate soil (PASS) is present in the top 1.5m. ASS management will be required during the installation of civil services. Groundwater was identified between 0.5m bgl and 0.7m bgl on the site. Dewatering is not proposed to be required during the excavation of service trenches. During the installation of the pump station on site dewatering is to occur with pumped water being recharged back into the groundwater at a nominated point on site.

The proposal involves the construction of a multi dwelling housing comprising twelve dwellings. The slab is a concrete slab on ground and the building is two storey. It is assumed that installation of the pump station will cause the greatest issue with regards to ASS.

2 Site Details

2.1 Site Location

The site is located on the western skirts of the Byron Bay CBD, on the southwestern corner of Kendall Street and Ewingsdale Road. A site locality plan is shown as Figure 1 below.

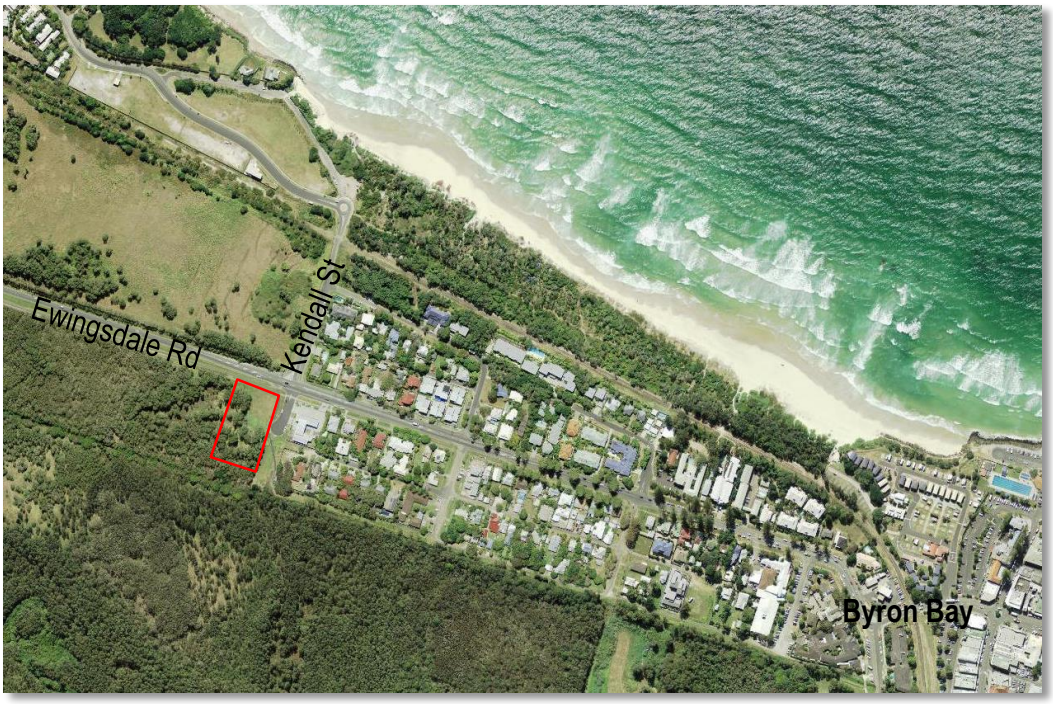

Figure 1: Site Locality Plan

2.2 Proposed Development

It is proposed that the redevelopment of the land at Lot 235 DP 755695 Ewingsdale Road involves the erection of a two storey, multi dwelling housing comprising twelve dwellings. The ground floor comprises car parking and yard space while the first floor comprises all living spaces.

It is estimated that a maximum of 25m^3 of soil will be excavated for the installation of services. It is assumed that all soil will be reused as backfill.

2.3 Site Conditions

Surface and sub-surface conditions have been described in APP's *Acid Sulphate Soil Assessment* dated June 2011 (Attachment 1).

The soil at the site generally consists of silty top soil underlain by silty sand overlaying sand.

3 Service Installations

The ASSMAC *Acid Sulfate Soils Management Guidelines* (1998) state:

> *Projects that involve the short-term disturbance of acid sulfate soils (eg pipe laying) should be staged to minimise the cost of mitigation and the risk to the environment. In these situations, the sulfidic material can be reburied back into the anaerobic conditions as quickly as possible prior to the generation of acid (for example, in sandy soils within a day and in clay soils within a couple of days). Neutralising agents should be incorporated with the excavated material to neutralise any acid that may have been or will be produced because of aeration. Analysis should be undertaken to determine the quantity of lime plus a safety factor. In circumstances where the material is returned immediately into an anaerobic environment, the additional lime safety factor may not be required.*

It's proposed that the installation of services should be staged to minimise the cost of mitigation and the risk to the environment. Soil excavated for service installation shall be stockpiled adjacent to the service trench and mixed with lime at a rate of **5.4 kg/tonne** as per lab results in the ASSA. Excavated material is to be used as trench backfill within 24 hours of initial excavation.

The installation of the pump station requires a larger volume of material to be excavated but can be completed within the 24 hour time period of oxidation. It is proposed that the installation of the pump station would be undertaken under the same principals as the other linear services on site.

It is proposed that the bulk of the material excavated for the installation of the pump station be stored and treated adjacent to the excavation and used as backfill within 24 hours of initial excavation. Only material that will be not reinterred within 24 hours will require storage in a bunded area.

Refer to Section 4.1 for soil treatment measures.

4 Treatment Measures

4.1 Soil Treatment Measures

It is estimated that a maximum of 25m^3 of soil will be excavated for the installation of the pump station. The majority of this will be PASS that comprises gravelly sandy fill and silty sand. As acid sulfate materials have been identified, measures must be taken to neutralise acid generated due to oxidation of PASS. Two distinct horizons of liming ratios have been identified, therefore the soil to be excavated is to be divided into the first metre below ground level and material below the first metre of excavation. The procedure to be employed is as follows:

- Excavated material from the first metre below ground level spread within the nominated stockpile area* in layers of workable depth (typically no more than 0.3m loose thickness);
    1. Lime applied to the excavated PASS material at a rate of **5.4 kg** of $CaCO_3$ per tonne of disturbed soil to neutralise potential acidity;
    2. Lime thoroughly mixed with soil materials through use of a rotary hoe, pilvi-mixer or some similar mechanical process nominated by the contractor to achieve a thorough mix. The liming should be confined to areas of manageable size;
- Excavated material from below 1m below ground level spread within the nominated stockpile area* in layers of workable depth (typically no more than 0.3m loose thickness);
    3. Lime applied to the excavated PASS material at a rate of **2.5 kg** of $CaCO_3$ per tonne of disturbed soil to neutralise potential acidity;
    4. Lime thoroughly mixed with soil materials through use of a rotary hoe, pilvi-mixer or some similar mechanical process nominated by the contractor to achieve a thorough mix. The liming should be confined to areas of manageable size;
    5. Once soil and lime is appropriately mixed the soil will be suitable for backfill. Excess soil shall be treated as specified above and disposed of on-site.

* nominated stockpile areas shall be either;
- appropriate areas adjacent to the workings for material to be reinterred within 24 hours, or
- a bunded area for material to be exposed to the atmosphere for longer than 24 hours

Receipts for the agricultural lime should be kept with other site records to demonstrate that adequate neutralizing agent was used on-site.

4.2 Water Treatment Measures

It is not proposed to undertake any dewatering during excavations for the service trenches. However, dewatering will be required during the installation of the pump station on site. The ASSA found groundwater to be between 0.5m bgl and 0.7m bgl on the site. Dewatering will consist of pumping water from the excavation and groundwater recharge at a nominated point on site.

Surface waters are not expected on site. Due to the nature of the soil, it is assumed that any surface water will infiltrate.

5 Liming Ratios

Laboratory results from the ASSA suggest that pure lime should be applied at a rate of;

- 5.4 kg/tonne of lime for 0.0 – 1.0m bgl; and
- 2.5 kg/tonne of lime for 1.0 – 2.0m bgl.

This rate includes a 1.5 factor of safety recommended in the ASSMAC Manual. Good quality, fine agricultural lime, with a neutralizing value of 100 will be used. Lime will be applied using the 'common method' described in the Acid Sulfate Soil Manual (i.e. spreading out excavated soils in 0.3m layers over a thin bed of lime, air drying and mechanically breaking up clods). When soil is sufficiently dry, appropriate lime quantity will be applied and thoroughly mixed.

The time required for applied lime to neutralize ASS is widely variable and depends on the specific properties of the neutralised soil, although the lime will begin to neutralise the acid soils from the time of application.

6 Classification & Disposal of Acid Sulfate Soil Waste

It is assumed that all excavated material is to be reused on site however, no excavated soils are to be disposed of off-site until the following activities are completed. The activities described below principally relate to soil classification and legal disposal thereof. They are derived from the *NSW EPA Waste Classification Guidelines (Parts 1 & 4)* (NSW EPA, 2014).

- Following neutralization, the generator of the waste must chemically assess the soil in accordance with Step 5 of Part1 of the Waste Classification Guidelines. This will determine whether there are any other contaminants that may affect how the waste is classified for disposal.
- Once classified, the waste must be taken to a landfill licensed to accept that class of waste.
- Prior arrangements should be made with the occupier of the landfill to ensure that it is licensed to accept the waste. The landfill should be informed that the ASS has been treated in accordance with neutralizing technique outlined in the ASS Manual and that the waste has also been classified in accordance with Part 1 of the Waste Classification Guidelines.
- Records of who transported the waste and waste dockets/receipts for the waste facility should be kept by the responsible party.

The waste regulatory framework is established under the principal legislation of the *Protection of the Environment Operations (POEO) Act 1997*. Under Chapter 1, Section 6 of the POEO Act, the EPA is the appropriate regulatory authority for scheduled activities, where scheduled activities are those described in Schedule 1 of the POEO Act. This particular activity is described in clause 49 of Schedule 1.

7 Contingency Measures

Soil from excavations is not expected to be stockpiled out of the excavation for longer than 24 hours, therefore no analysis is proposed for this material. If material is stockpiled out of an excavation for longer than 24 hours soil acidity in disturbed materials should be monitored. Should the field pH tests show that the soil acidity has not been neutralised, then the material must be reworked and additional lime treatment carried out until it is verified that the soil meets the required standard.

No water is proposed to be discharged off site. However, in the event that water is required to be discharged off site, if monitoring of collected water at the point of discharge indicates the pH is below acceptable discharge limits then discharge must immediately cease and further treatment be carried out. Agricultural lime may only be applied following directions by the ASS Consultant who shall direct the Contractor in mixing procedures such that lime is added in small increments so as not to cause unduly high water pH levels (ie. above 8.5). The agricultural lime shall be stored in a covered and bunded area to prevent accidental release to waters.

In the event that pH measurement of exposed soils in excavations does not meet required levels, lime shall be spread over the affected area and the pH levels further monitored.

Sufficient lime is to be stored in a dry location on-site to permit the immediate implementation of the above contingency measures.

8 Responsible Parties

The construction manager (or any person or agent duly authorized by the construction manager) is to be responsible for undertaking all monitoring, testing and maintenance requirements detailed in this plan.

Position	Name	Contact Number
Construction Manager	Phil Agnew	04 2213 1613
Environmental Scientist	to be announced	

9 Conclusion

The Acid Sulfate Soil Management Plan provided in this report adequately addresses Condition 13 of Council's DA number 10.2015.398.1 dated 19 October 2015.

The preliminary ASS/PASS investigation undertaken by Ardill Payne and Partners indicated the presence of PASS material in the top 1.5m. Proposed service trenches and pump station installation will therefore require the excavation of PASS material. An Acid Sulphate Soil Management Plan has been provided in this report to ensure the PASS material is treated, managed and disposed of appropriately so as to prevent any detrimental effects on the environment. All excavated materials shall meet Local and State Government ASS/PASS discharge/disposal requirements and approvals prior to removal from the site. It is assumed that all excavated material will be reused on site.

10 General Notes

General

Geotechnical and environmental reports present the results of investigations carried out for a specific project and usually for a specific phase of the project (e.g. preliminary design). The report is based specific criteria, such as the nature of the project, underground utilities or scope of service limitations imposed by the Client. The report may not be relevant for other phases of the project (e.g. construction), after some time or where project details and clients change.

Soil and Rock Description

Soil and rock descriptions are based on AS1726-1993 using visual and tactile assessment except at discrete locations where field and/or laboratory tests have been carried out. Refer to the terms and symbols sheet for definitions.

Groundwater

The water levels indicated are taken at the time of measurement and depending on material permeability may not reflect the actual groundwater level at those specified locations. Also groundwater levels can vary with time due to seasonal or tidal fluctuation, construction activities and other external factors.

Interpretation of Results

The discussion and recommendations in the accompanying report are based on extrapolation/interpolation from data obtained at discrete locations and other external sources and guidelines. The actual interface between the materials may be far more gradual or abrupt than indicated. Also actual conditions in areas not sampled may differ from those predicted.

The report is based on significant background details that only the authors can be aware off, and therefore implementation of the recommendations by others may lead to misinterpretation and complications. Therefore this company should be consulted to explain the reports implications to other involved parties.

Reporting relies on interpretation of often limited factual information based on judgement and opinion which has a level of uncertainty and ambiguity attached to it, and is far less exact than other design disciplines. This should be considered by users of the report when assessing the implications of the recommendations.

Change in Conditions

Subsurface conditions can change with time and can vary between test locations. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions.

11 Scope of Engagement

This report has been prepared by Ardill Payne & Partners (APP) at the request of Koho Properties for the purpose of an Acid Sulfate Soils Management Plan and is not to be used for any other purpose or by any other person or corporation.

This report has been prepared from the information provided to us and from other information obtained as a result of enquiries made by us. APP accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

APP declares that it does not have, nor expects to have, a beneficial interest in the subject project.

To avoid this advice being used inappropriately it is recommended that you consult with APP before conveying the information to another who may not fully understand the objectives of the report. This report is meant only for the subject site/project and should not be applied to any other.

12 Attachments

Attachment 1 APP's Acid Sulfate Soil Assessment (June 2011)

ATTACHMENT 1

Attachment 1: APP's Acid Sulfate Soil Assessment (June 2011)

ARDILL PAYNE & PARTNERS

Civil & Structural Engineers – Project Managers – Town Planners – Surveyors

ACID SULPHATE SOIL ASSESSMENT

Submission to Byron Shire Council

PROPOSED RESIDENCE
Lot 235 DP 755695 Ewingsdale Road,
Byron Bay

for:
Peter Croke

June 2011

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(PO Box 20)
BALLINA NSW 2478

Ph: (02) 6686 3280
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Document Control Sheet

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Job Captain:	Bill Payne
Author:	Madeleine Payne
Client:	Mr. Peter Croke
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		Name	Signed	Name	Signed
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1					
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Table of Contents

1 Executive Summary

Ardill Payne and Partners (APP) have been commissioned by Mr. Peter Croke to carry out an Acid Sulphate Soil (ASS) Assessment to accompany the development application for a residential development at Lot 235 DP 755695, Ewingsdale Road, Byron Bay, NSW.

Field work was carried out in May 2011 to assess the presence and extent of ASS below ground level. Three boreholes were excavated to a maximum depth of 2.0 mbgl and 12 samples were collected. Four samples were analysed for Chromium Reducible Sulphur and existing acidity (Total Titratable Acidity, TAA). None of the four samples submitted for laboratory testing contained TAA in excess of the ASSMAC action criteria values. Three of the four samples (BH3 at 0-0.5, 0.5-1 and 1-1.5 mbgl) contained $\%S_{CR}$ in excess of the ASSMAC action criteria values. These results suggest that no AASS exists on site but PASS is present in the top 1.5 m. Basic ASS management will be required during the installation of civil services.

This assessment has been conducted in accordance with the NSW Acid Sulphate Soils Manual (Acid Sulphate Soils Management Advisory Committee, 1998).

2 Introduction

2.1 Acid Sulphate Soils

Acid Sulphate Soil (ASS) is the common name given to soils containing iron sulphides. When exposed to oxygen (or some other oxidizing agent), these soils produce sulphuric acid, iron and aluminium.

ASS typically occur in low-lying coastal areas. Runoff from exposed ASS areas may find its way to stormwater, groundwater and eventually into natural aquatic environments. The acidic runoff may lower the pH of receiving waters, increase the concentration of metals and reduce the natural buffering capacity of the receiving waters.

There are two basic types of ASS: Actual Acid Sulphate Soils (AASS) and Potential Acid Sulphate Soils (PASS). AASS are soils that have already been oxidized. Hence AASS environments may be acidic, but have low potential for further acid generation. PASS are soils that have not yet been oxidized (i.e. they contain oxidisable sulphur). AASS and PASS can coexist. In anaerobic conditions, PASS do not pose an environmental threat, however if conditions change (e.g. water table lowering, excavation, drought), the sulphides will oxidise and form sulphuric acid. Developments involving excavation or dewatering must establish the presence and extent of ASS down the soil profile, as works may intercept ASS horizons and pose risks to both human and ecological health.

2.2 Scope

The scope of work for the Acid Sulphate Soil Assessment included:

- Drilling of three boreholes to maximum 2.0 m depth;
- Obtaining soil samples from the boreholes at 0.5 m intervals;
- Analysis of all samples for field pH (pH_F) and field peroxide pH (pH_{fox}) to provide initial indication of PASS/AASS;
- Laboratory analysis of four samples to determine Total Actual Acidity (TAA) and % Chromium Reducible Sulphur ($\%S_{CR}$);
- Summary of ASS assessment results with calculated liming rates; and
- Recommendations for ASS Management.

3 Proposed Excavation Works

The development is at the DA stage and excavation details are limited. To the best of APP's knowledge, the maximum depth excavated will be 1 mbgl for the installation of civil services.

4 Field Investigation and Sampling

Fieldwork was carried out on the 19th May, 2011 and included three boreholes excavated to a maximum depth of 2.0 m. Borehole locations are indicated on Figure 2 (Attachment 1). BH1 & BH2 were excavated primarily for the purpose of piezometer installation. They are outside the building envelope and ASS conditions are not relevant to this investigation which seeks only to determine ASS conditions in areas which may be disturbed during construction.

Samples for acid sulphate testing were recovered at 0.5 m intervals to 2.0 m depth from all boreholes. Soil samples were placed in plastic bags and placed under cold storage conditions to minimise oxidation. Field pH and field peroxide pH tests were carried out on all samples. Samples that showed signs of ASS (from BH3 only) were submitted to the NATA Accredited Environmental Analysis Laboratory at Southern Cross University (Lismore campus) and were analysed using both the SPOCAS method and the Chromium Reducible Sulphur technique.

Fieldwork was carried out by

- Australian Soils & Concrete Testing: excavation, sample collection and prepared engineering logs of the excavation; and
- Ardill Payne & Partners: carried out field pH and peroxide testing on samples and submitted suspected ASS samples to the EAL. The laboratory results are attached to this report (Attachment 3).

5 Site Conditions

5.1 Surface

The site is located on the corner of Ewingsdale Road and Kendall Street and is bordered by a service station to the east and bushland to the south and west. A locality plan is provided in Attachment 1 (Figure 1). The site is generally flat with a slight slope towards the rear south-eastern corner. The rear of the site is covered in reasonably dense native bush and scrub; the front north-eastern corner is cleared and grassed.

5.2 Sub-surface

Morand maps the site as Tyagarah, which typically consists of black, loamy sands, overlying bleached sand and then brown organic pan (coffee rock).

Site geotechnical investigations (AS&CT, May 2010) found that the proposed building envelope is underlain by gravelly, sandy fill to between 0.5 and 0.9 m depth. The fill is underlain by silty sand (0.7-1.2 mbgl) and sand (1.2 -2.0 mbgl). Geotechnical observations were made during the installation of the groundwater monitoring piezometers (BH1 & BH2). These had the same soil profile as one another: silty top soil, silty sand to 0.7 mbgl and sand below. Groundwater inflow was observed at 0.5 mbgl at BH1 & BH3, and at 0.7 mbgl in BH2. Engineering logs are attached (Attachment 2).

The site is mapped as Class 3 – Acid Sulphate Soil (ASS) on the Byron Shire Council's *Acid Sulphate Soil Classes (West Byron area)* map (Figure 3, Attachment 1). Areas defined as class 3 soil are those where:

- Works beyond 1 m below the natural ground surface; and
- Works by which the water table is likely to be lowered beyond 1 m below the natural ground surface

are likely to have ASS impact.

6 Laboratory Testing

6.1 Techniques and Criteria

Twelve soil samples were obtained from the investigation. Although only the results from BH3 were pertinent to this investigation, field pH and peroxide tests were carried out on all 12 samples. These are simple qualitative techniques used to gauge the likely presence and severity of AASS and PASS. Field test results are displayed below:

Table 1: ASS Field Testing Outcomes

Sample location	Sample Depth (mbgl)	pH_F	pH_{Fox}	pH Drop	Effervescence Rating	Further Testing Undertaken
BH1	0-0.5	6.8	4.73	**2.07**		**No**
	0.5-1	6.44	1.27	**5.17**	**	**No**
	1-1.5	6.55	1.41	**5.14**	**	**No**
	1.5-2	6.3	1.34	**4.96**	**	**No**
BH2	0-0.5	5.28	1.68	**3.6**		**No**
	0.5-1	5.42	1.34	**4.08**	**	**No**
	1-1.5	5.81	1.34	**4.47**	**	**No**
	1.5-2	5.95	1.33	**4.62**	**	**No**
BH3	0-0.5	6.01	3.11	**2.9**		**Yes**
	0.5-1	5.29	2.05	**3.24**	**	**Yes**
	1-1.5	5.58	1.3	**4.28**	**	**Yes**
	1.5-2	5.75	1.21	**4.54**	**	**Yes**

Samples were generally mildly acidic (pH_F). Peroxide field testing indicated that oxidisable material was present in each sample from BH3. Consequently, all samples from BH3 were submitted to the EAL for analysis.

The ASSMAC action criteria (threshold values) for AASS and PASS soils are as follows:

Table 2: Acid Sulphate Soil Action Criteria

Soil Category (Texture)	Action Criteria (<1000 tonnes to be disturbed)		Action Criteria (>1000 tonnes to be disturbed)	
	Oxidisable Sulphur (% S_{cr}) (Strong indicator of PASS/AASS)	**Titratable Actual Acidity (TAA) (moleH^+/tonne)** (Indicator of AASS)	**% S_{cr}** (Strong indicator of PASS/AASS)	**TAA (moleH^+/tonne)** (Indicator of AASS)
Coarse: sands - loamy sands	0.03	18	0.03	18
Medium: sandy loams - light clays	0.06	36	0.03	18
Fine: medium - heavy/silty clays	0.1	62	0.03	18

The *<1000 tonnes disturbed* action criteria are relevant for this investigation.

6.2 Results and Discussion

A summary of the laboratory results are displayed in Table 3. Laboratory certificates are included in Attachment 3.

Table 3: Summary of Laboratory Results

Sample Location	Sample Depth (mbgl)	Oxidisable Sulphur (%S_{CR}) (mole H^+/tonne)	Titratable Actual Acidity (TAA) (mole H^+/tonne)	Liming Rate (kg/tonne)
BH3	0-0.5	**0.1**	3.8	5.4
	0.5-1	**0.09**	2.4	4.4
	1-1.5	**0.04**	5.7	2.3
	1.5-2	0.02	2.4	1.1

Total Actual Acidity (TAA) was below ASSMAC action criteria in all samples. Samples from 0-0.5, 0.5-1 & 1-1.5 mbgl had levels of oxidisable sulphur above ASSMAC action criteria. Curiously, the highest concentration of oxidisable sulphur occurred in the fill near the surface (0-0.5 mbgl). Typically, concentrations of oxidisable sulphur increase with depth as ASS nearer the surface has greater opportunity to oxidise.

Lime calculations were included in the laboratory analysis and are displayed in Table 3. These lime calculations are based on both TAA and %S_{CR}.

These results suggest ASS management (liming) will be required during any excavations on site.

7 Conclusion

Ardill Payne & Partners (APP) has been commissioned by Mr. Peter Croke to complete an Acid Sulphate Soil Assessment to accompany the development application for a residential development at Lot 235 DP 755695, Ewingsdale Road, Byron Bay, NSW.

Field and laboratory testing suggested the site was mildly acidic and contains levels of PASS greater than ASSMAC action criteria. As such, ASS management will be required during construction. An Acid Sulphate Soils Management Plan should be prepared once civil design has been undertaken.

8 General Notes

General

Geotechnical and environmental reports present the results of investigations carried out for a specific project and usually for a specific phase of the project (e.g. preliminary design). The report is based on specific criteria, such as the nature of the project, underground utilities or scope of service limitations imposed by the Client. The report may not be relevant for other phases of the project (e.g. construction), after some time, or where project details and clients change.

Soil and Rock Description

Soil and rock descriptions are based on AS1726-1993 using visual and tactile assessment except at discrete locations where field and/or laboratory tests have been carried out.

Groundwater

The water levels indicated are taken at the time of measurement and depending on material permeability may not reflect the actual groundwater level at those specified locations. Also groundwater levels can vary with time due to seasonal or tidal fluctuation, construction activities and other external factors.

Interpretation of Results

The discussion and recommendations in the accompanying report are based on extrapolation/interpolation from data obtained at discrete locations and other external sources and guidelines. The actual interface between the materials may be far more gradual or abrupt than indicated. Also actual conditions in areas not sampled may differ from those predicted.

The report is based on significant background details that only the authors can be aware off, and therefore implementation of the recommendations by others may lead to misinterpretation and complications. Therefore this company should be consulted to explain the reports implications to other involved parties.

Reporting relies on interpretation of often limited factual information based on judgement and opinion which has a level of uncertainty and ambiguity attached to it, and is far less exact than other design disciplines. This should be considered by users of the report when assessing the implications of the recommendations.

Change in Conditions

Subsurface conditions can change with time and can vary between test locations. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions.

9 Scope of Engagement

This report has been prepared by Ardill Payne & Partners (APP) at the request of Mr. Peter Croke for the purpose of assessing the presence and extent of Acid Sulphate Soils on the subject site, and is not to be used for any other purpose or by any other person or corporation.

This report has been prepared from the information provided to us and from other information obtained as a result of enquiries made by us. APP accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

APP declares that it does not have, nor expects to have, a beneficial interest in the subject project.

To avoid this advice being used inappropriately it is recommended that you consult with APP before conveying the information to another who may not fully understand the objectives of the report. This report is meant only for the subject site/project and should not be applied to any other.

10 References

Acid Sulphate Soils Management Advisory Committee (ASSMAC). August 1998. *Acid Sulphate Soil Manual.*

Australian Soils & Concrete Testing (AS&CT) (May 2011). *Geotechnical Site Investigation for Proposed Commercial Development At Lot 235 Ewingsdale Road BYRON BAY.*

Byron Shire Council. *Acid Sulphate Soil Classes (West Byron area).*

Morand, D.T. 1994. *Soil Landscapes of the Lismore-Ballina 1:100 000 Sheet Map*. Soil Conservation Service of NSW, Sydney.

11 Attachments

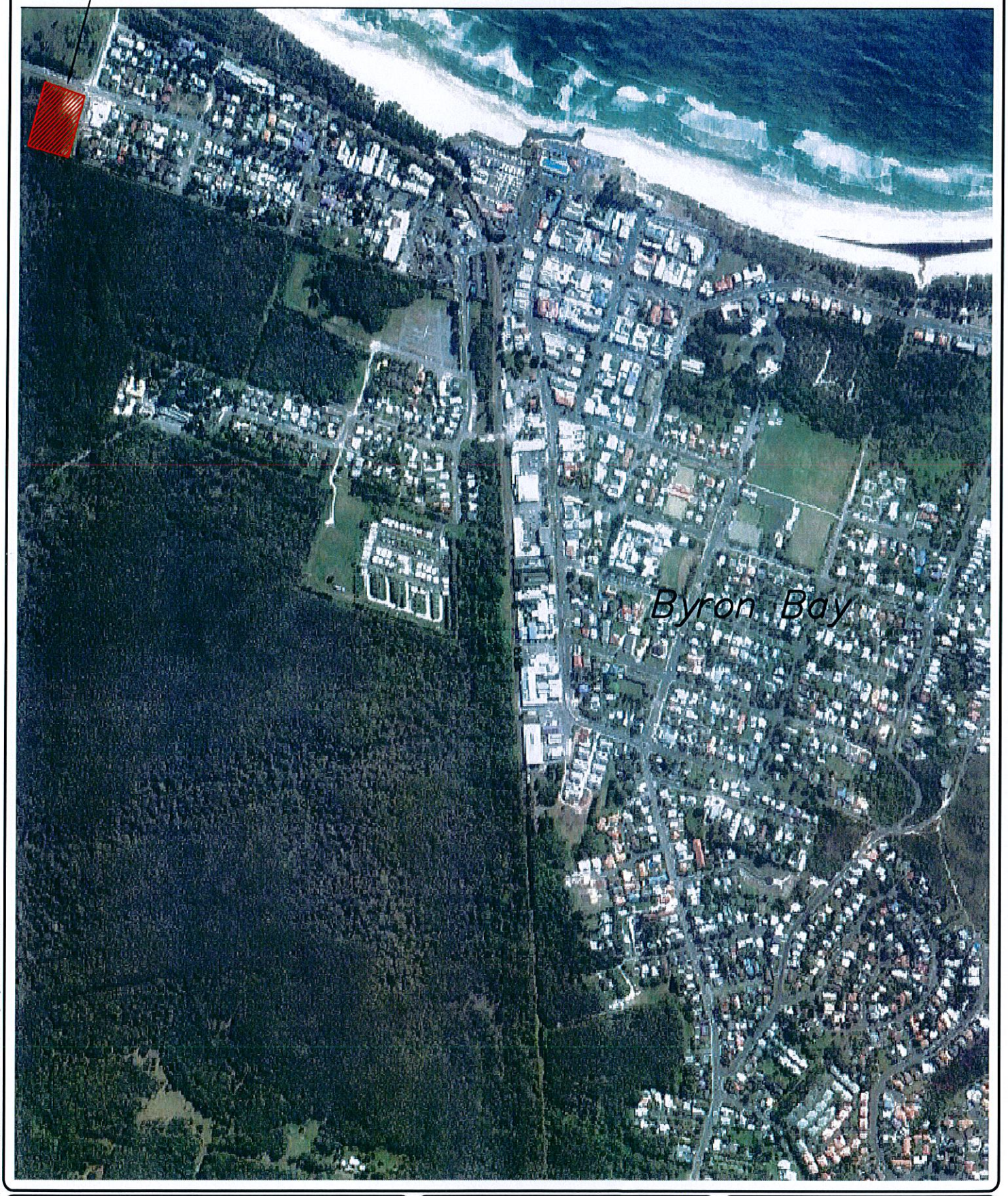
Attachment 1 Figures

Attachment 2 Engineering Borelogs

Attachment 3 Laboratory Certificates

ATTACHMENT 1

Attachment 1
Figures



Client: Peter Croke

Title: Site Locality Plan

ARDILL PAYNE & PARTNERS
Consulting Civil and Structural Engineers
Project Managers Town Planners & Surveyors
79 Tamar Street
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BALLINA NSW 2478
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Email: info@ardillpayne.com.au
Website: www.ardillpayne.com.au

Scale at A4	NTS	Datum	N/A
Design	RMcG	Date	01-06-11
Drawn	RMcG	File	7134-Fig1
Dwg No.	Fig 1	Job No.	7134

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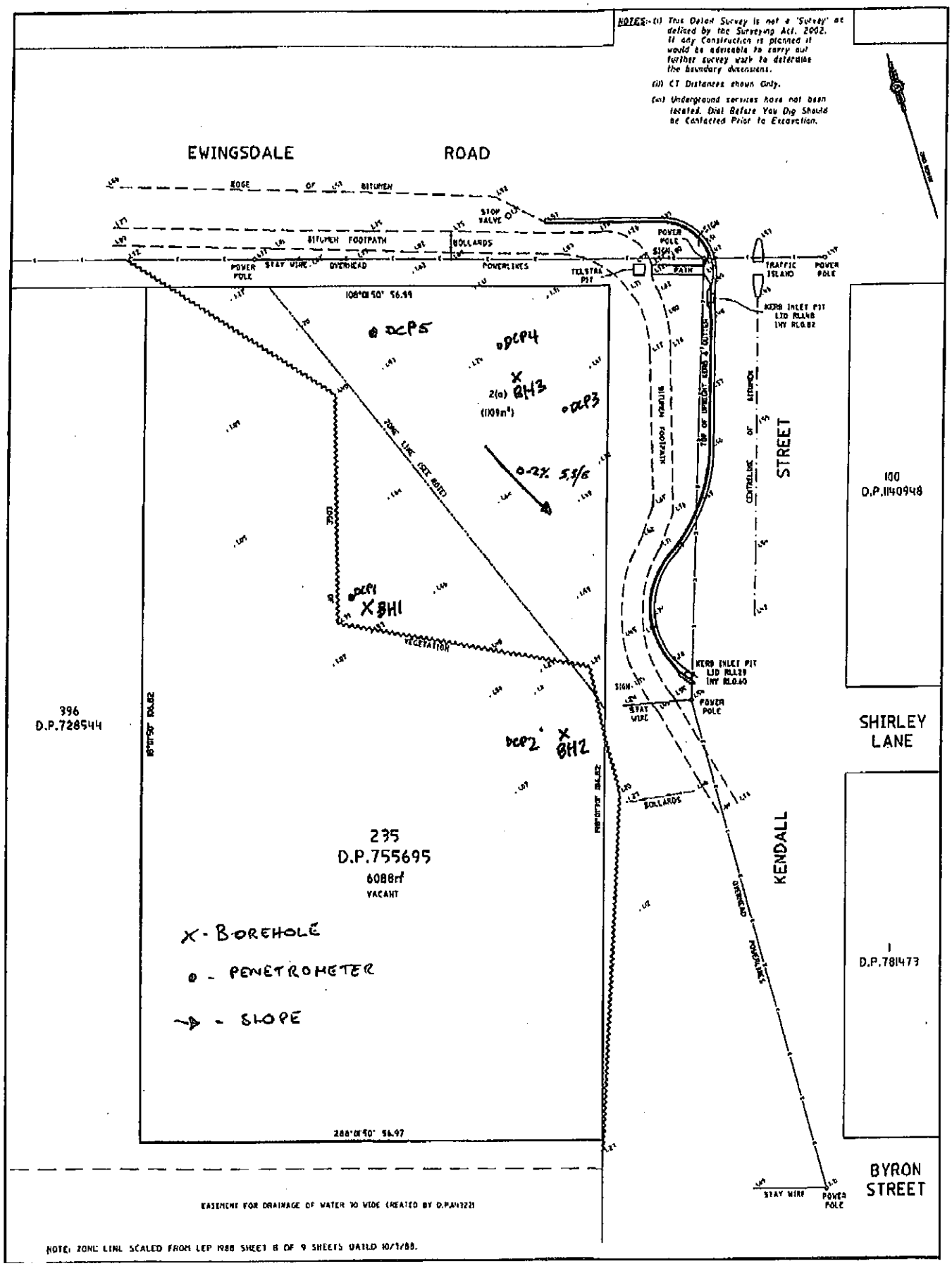

Client: Peter Croke

Title: Site plan with borehole locations

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Scale at A4	NTS	Datum	N/A
Design	RMcG	Date	01-06-11
Drawn	RMcG	File	7134-Fig2
Dwg No.	Fig 2	Job No.	7134

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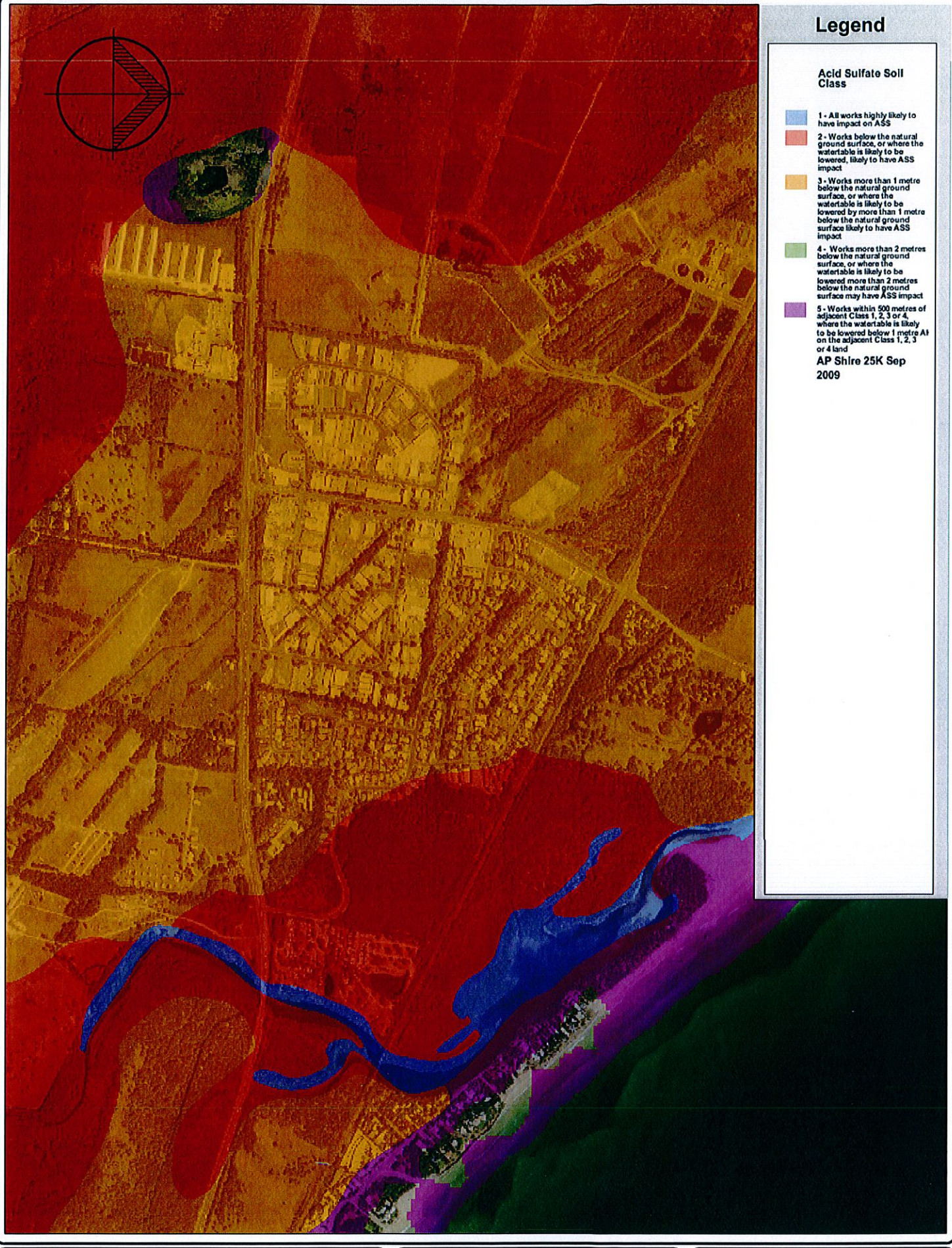

Client: Peter Croke

Title: West Byron Bay ASS map

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Scale at A4	NTS	Datum	N/A
Design	RMcG	Date	01-06-11
Drawn	RMcG	File	7134-Fig3
Dwg No.	Fig 3	Job No.	7134

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ATTACHMENT 2

Attachment 2
Engineering Logs

AUSTRALIAN SOIL AND CONCRETE TESTING P/L A.B.N. 49 050 539 930
7/17 Southern Cross Drive, Ballina, NSW 2478. Telephone: (02) 66868 567, Fax: (02) 66868 396

BORHOLE LOG

Client: Ardill Payne & Partners	**Project No**: 044-514	**Project**: Lot 235 Ewingsdale Rd Byron Bay	
Lab No: 13734	**Borehole No**: 1 & 2	**Page**: 1	**of**: 2

Borehole Inclination: 90°	**Borehole Direction**: Vertical	**Date Drilled**: 19/5/11
Surface Elevation: Existing Surface Level	**Drilling Method**: Yanmar 35 Drill Rig	**Drill Type**: 100mm Auger
Borehole Location: Proposed Building Area (See Figure 1)		

TEST DATA

Soil Description	Depth (m)	Graphic Symbol	Group Symbol	Consistency/ Strength	Sample
SILTY CLAY TOPSOIL: dark brown black, high plastic, medium to high dry strength, some organic matter, very soft to soft, moist to very moist.	0.0		CH	VS-S	
SILTY SAND: brown grey, low to non plastic, low dry strength, fine sand, trace of medium to fine gravel, loose to medium dense, wet	0.2		SM	L-MD	
SAND: grey, non plastic, no dry strength, fine sand, medium dense, wet	0.7		SP	MD	
Stopped no change	2.0				

AUSTRALIAN SOIL AND CONCRETE TESTING P/L A.B.N. 49 050 539 930
7/17 Southern Cross Drive, Ballina, NSW 2478. Telephone: (02) 66868 567, Fax: (02) 66868 396

BORHOLE LOG

Client: Ardill Payne & Partners	**Project No**: 044-514	**Project**: Lot 235 Ewingsdale Rd Byron Bay	
Lab No: 13734	**Borehole No**: 3	**Page**: 2	**of**: 2

Borehole Inclination: 90°	**Borehole Direction**: Vertical	**Date Drilled**: 19/5/11
Surface Elevation: Existing Surface Level	**Drilling Method**: Yanmar 35 Drill Rig	**Drill Type**: 100mm Auger
Borehole Location: Proposed Building Area (See Figure 1)		

TEST DATA

Soil Description	Depth (m)	Graphic Symbol	Group Symbol	Consistency/ Strength	Sample
GRAVELLY SAND FILL: grey, non plastic, low dry strength, fine to coarse gravel, some organic matter in top 200mm, loose to medium dense, very moist to moist.	- 0.0		SP	L-MD	
SILTY SAND: brown grey, low to non plastic, low dry strength, fine sand, loose to medium dense, wet	- 0.7		SM	L-MD	
SAND: grey, non plastic, no dry strength, fine sand, medium dense, wet	-- 1.2		SP	MD	
Stopped no change	-- 2.0				

ATTACHMENT 3

Attachment 3
Laboratory Certificates

RESULTS OF ACID SULFATE SOIL ANALYSIS

4 samples supplied by Ardill Payne and Partners on 23rd May, 2011 - Lab. Job No. B4134

Analysis requested by Madeline Payne. **Your Project: 7134 Ewingsdale Rd**

PO Box 20 Ballina NSW 2478.

required if pH_{KCl} > 6.5

Sample Site	Depth (m)	EAL lab code	TEXTURE (note 6)	MOISTURE CONTENT (% moisture of total wet weight)	MOISTURE CONTENT (g moisture / g of oven dry soil)	TITRATABLE ACTUAL ACIDITY (TAA) pH_{KCl}	TAA (To pH 6.5) (mole H^+/tonne)	REDUCED INORGANIC SULFUR (% chromium reducible S) (%Scr)	Scr (mole H^+/tonne)	ACID NEUTRALISING CAPACITY (ANC_{BT}) (% $CaCO_3$)	ANC (mole H^+/tonne)	NET ACIDITY Chromium Suite mole H^+/tonne (based on %Scrs)	LIME CALCULATION Chromium Suite kg $CaCO_3$/tonne DW (includes 1.5 safety Factor when liming rate is $^+$ve)
Method No.												*note 5*	*note 4 and 6*
BH3	**0.5**	*B4134/1*	Coarse	21.4	0.27	5.55	3.80	0.10	62	..	0	66	5.0
BH3	**1.0**	*B4134/2*	Coarse	17.9	0.22	5.71	2.40	0.09	56	..	0	59	4.4
BH3	**1.5**	*B4134/3*	Coarse	24.2	0.32	5.50	5.70	0.04	25	..	0	31	2.3
BH3	**2.0**	*B4134/4*	Coarse	5.8	0.06	6.04	2.40	0.02	12	..	0	15	1.1

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & sulfate) and 'Chromium Reducible Sulfur' technique (Scr - Method 22B)

3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.

4 - Bulk Density is required for liming rate calculations per soil volume. Lab. Bulk Density is no longer applicable - field bulk density rings can be used and dried/ weighed in the laboratory.

5 - **ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF (with FF currently defaulted to 1.5)**

6 - The neutralising requirement, lime calculation, includes a 1.5 safety margin for acid neutralisation (an increased safety factor may be required in some cases)

7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays

8 - .. denotes not requested or required. '0' is used for ANC and Snag calcs if TAA pH <6.5 or >4.5

9 - SCREENING, CRS, TAA and ANC are NATA accredited but other SPOCAS segments are currently not NATA accredited

10- Results at or below detection limits are replaced with '0' for calculation purposes.

11 - Projects that disturb >1000 tonnes of soil, the ≥0.03% S classification guideline would apply (refer to acid sulfate management guidelines).

12 - Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.

NATA
WORLD RECOGNISED ACCREDITATION
Lab.Accred.No.:14960
This Document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IES 17025

(Classification of potential acid sulfate material if: coarse Scr≥0.03%S or 19mole H^+/t; medium Scr≥0.06%S or 37mole H^+/t; fine Scr≥0.1%S or 62mole H^+/t) - as per QUASSIT Guidelines

checked: .....
Graham Lancaster
Laboratory Manager

Attachment 3

Liming Pad Design