Hamptons Property Services

ACID SULPHATE SOIL MANAGEMENT PLAN

24 Coronation Road, Macksville

111183

November 2013

Prepared For:

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REV	DATE	Written	Reviewed	Approved	Approved Signature
B	2 MAY 2014	DC	SR	SR	

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1 Introduction

Meinhardt has been commissioned by the Hamptons Property Services to prepare this Acid Sulphate Soil Management Plan *(ASSMP),* which relates to the proposed development site located at 24 Coronation Road, Congarinni North. The land is legally described as Lots 155 and 188 in Deposited Plan 755537.

This ASSMP is designed to be utilised as part of the planning and development activities. Previous work conducted by others *(Planning Proposal)* indicated the presence of potential and actual acid sulphate soils *(PASS and AASS, respectively)* at the site. If impacted as part of construction and development works, these PASS and AASS soils will require appropriate treatment/management in accordance with regulatory requirements. This ASSMP provides the control measures for management of PASS and AASS during the proposed earthworks that give rise to potential disturbance of acid sulphate soils, including deep foundation excavation *(up to 12 m below ground surface),* trenching for installation of services, and cut and fill activity.

The location of the site is presented on **Figure 1,** and the layout of the site is presented in **Figure 2.**

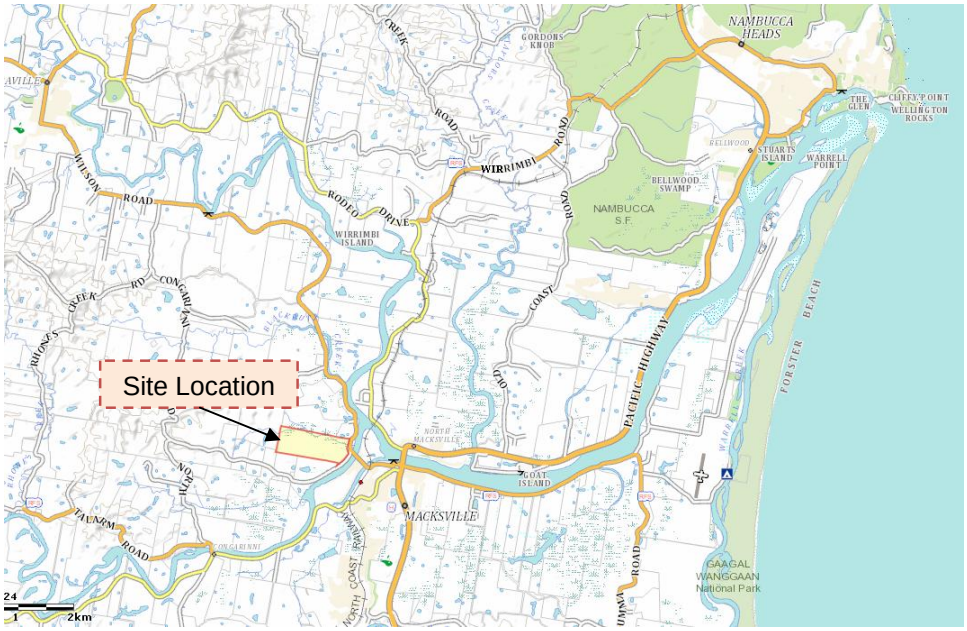

Figure 1: Site Location

Figure 2: Site Layout

1.1 What are Acid Sulphate Soils

Acid sulphate soil is the common name given to a range of soil types containing iron sulphides and/or their oxidation products.

As the sea level rose and inundated land, sulphate in the sea water mixed with land sediments containing iron oxides and organic matter. The resulting chemical reaction produced large quantities of iron sulphides in the waterlogged sediments. When exposed to air, these sulphides oxidise to produce sulphuric acid, hence the name acid sulphate soils.

Acid sulphate soils are generally found in:

- Coastal lowlands, embayment's and estuarine floodplains;
- Areas where the level of land is below 5 m Australian Height Datum *(AHD; and*
- Holocene sediments (~10,000 years old or younger).

The sulphuric acid produced by oxidation of iron sulphides affects soil and water and can severely damage the environment. As sulphuric acid moves through the soil, it mobilises iron, aluminium, manganese and other heavy metals from mineral structures. Acidic and metal-rich waters can be highly detrimental to flora and fauna.

Aquatic life, such as fish and crustaceans are extremely sensitive to acid drainage. In some situations, brought about by a combination of weather and hydrology, fish and crustaceans are not able to avoid the effluent and large kills over entire estuaries may result.

Acid waters can also corrode engineering works and infrastructure such as culverts, bridges and weirs, which are in contact with these waters. The precipitation of iron hydroxide/oxide flocs from acidic, iron rich waters can cause the blocking of drains, wells and the reduction of aquifer recharge.

1.2 Objectives of the ASSMP

The objective 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 both within and surrounding the subject site. The control measures in this ASSMP aim to mitigate the environmental impacts of the proposed site works to acceptable levels.

The ASSMP has been developed to achieve the following objectives:

- *Control (where possible) and minimisation of disturbance of acid sulphate soils;*
- *Confirmation of the success of impact control measures by the means of validation monitoring;*
- *Compliance with statutory requirements; and*
- *Preservation of water quality on an ongoing basis.*

Each environmental protection measure is based upon a proven and Industry Best Practice methodology. The ASSMP is designed for the planning and excavation phase of the development. It is based on tabulated checklists for management measures, maintenance, reporting, failure identification and corrective action for each identified issue.

The control measures proposed in this ASSMP are for:

- Assessment Procedures for PASS utilising a sampling protocol, set criteria to measure and agreed standards for those criteria to evaluate acid potential;
- Treatment of water accumulating within the site to an acceptable water quality for discharge;
- Ongoing Monitoring Programme *(if required);* and
- Treatment of potential acid sulphate soils if encountered and control structures to prevent leachate discharge off-site without meeting specified target water quality criteria.

1.3 Supporting Documents

The following investigation reports provided the basis for the assessment requirement for the presence of PASS and AASS at the site:

- Letter to Mr. Michael Coulter from the Planning Proposal to amend Nambucca Local Environmental plan 2010, dated 10.07.13.
- Planning Amendment No:14 to the Nambucca Shire Local Government Plan 2010 (the LEP), dated 05 June 2013;
- Hamptons Property Services, Planning Proposal for 24 Coronation Road, Congarinni North; and
- Dept. of Land & Water Conservation, Acid Sulphate Soil Risk Map – Edition Two, Macksville.

1.4 Changing the ASSMP Provision

This ASSMP contains provisions that may be changed. If any of the provisions are considered impractical, too costly or not thorough enough, then they should be changed to reflect the conditions on site.

This ASSMP has been prepared with consultation of the NSW Acid Sulfate Soils Manual (Stone et al., 1998).

- In addition and in line with best practice more recent guidelines were also consulted in formulating this ASMP including publications by QASSIT ASS Guidelines (Ahern et al., 1998), Laboratory Methods Guidelines (Ahern et al., 2004) and Management Guidelines (Dear et al., 2002), and EPA Vic Acid Sulphate Soil & Rock (Publication 655.1), July 2009.

1.5 Management

Starberg Investments Pty. Ltd., have clearly defined responsibilities under the Protection of Environment Operations Act, 1997[1] , to report any incidents likely to cause environmental harm. If there is any doubt over any particular incident, advice should be sought from the statutory authorities.

[1] *http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N*

2 Site Description

2.1 Site Identification

Table 2-1 Site Details

Item	Description
Site Owner/Relevant Agent	Starberg Investments Pty. Ltd.
Site Address	24 Coronation Road, Congarinni North.
Legal Description	Lots 155 & 188 in Deposited Plan 755537
Site Survey	Rural Property, predominantly agricultural pastureland with a homestead and ancillary farm buildings located in the eastern section of the site.
County and Parish	Congarinni North
Local Government Authority	Nambucca Shire
Current Zoning	• Part RU1 Primary Production • Part E2 Environmental Conservation; • Part E3 Environmental Management (pursuant to Nambucca Shire Local Environmental Plan 2010 (the LEP)
Proposed Land Use	Houses for Seniors and/or persons with Disability
Approx: Site Elevation Range (m AHD)	2m AHD to 30m AHD
Site Area	56 ha
Site Location	Figure 1
Site Layout	Figure 2

2.2 Site Conditions and Surrounding Environment

2.2.1 Current Land Use

At the time that this ASSMP was prepared *(November 2013)* the site comprised predominantly agricultural pastureland with a homestead and ancillary farm buildings located in the eastern section of the site.

2.2.2 Surrounding Land Use

Current land uses observed surrounding the Site are as follows:

- **North** – Agricultural landuse, with scattered rural homesteads and outbuildings;
- **South** – Agricultural landuse, with scattered rural homesteads and outbuildings;
- **East** – Taylors Arm Road, and the Taylors Arm / Nambucca River; and
- **West** – Agricultural landuse, with scattered rural homesteads and outbuildings.

2.2.3 Topography

The Site is elevated at approximately 30m AHD in the western section of the Site to approximately <5m AHD in the eastern section of the Site and has a general fall from the central high point in all directions, with adjacent creeks observed to follow localised contours in a northeast direction toward the river.

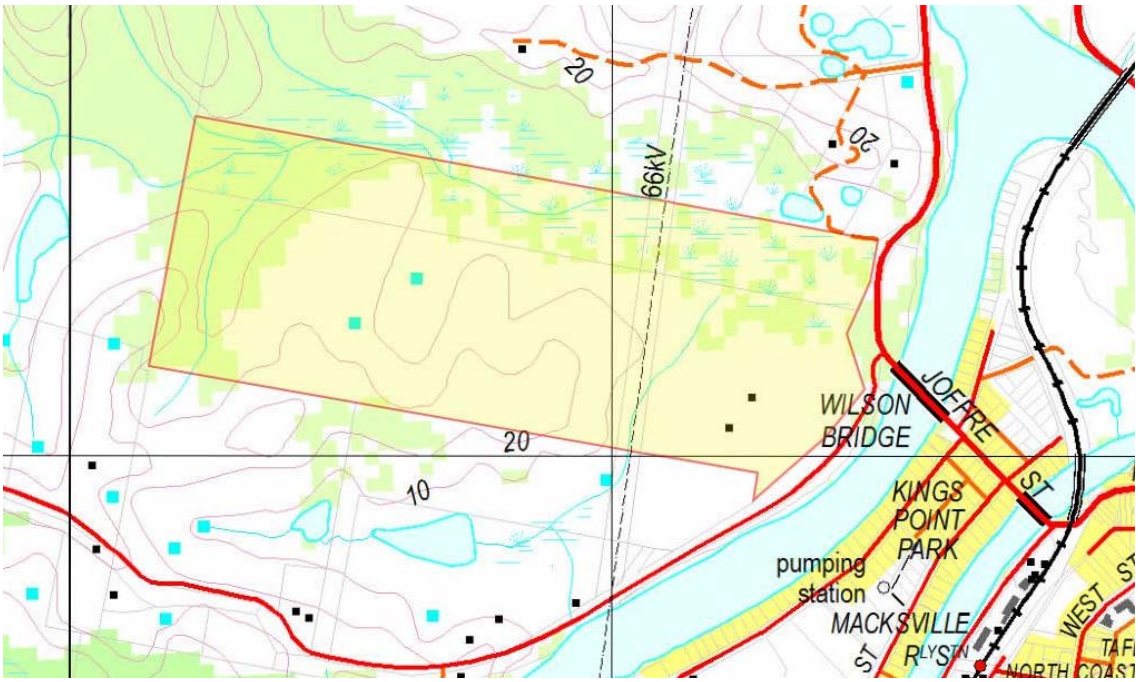

Figure 3: Localised Topography

2.2.4 Hydrology

No data relating to groundwater currently exists for the site. However, given the site's coastal location, relatively low AHD siting, and proximity to the Nambucca River, groundwater is expected to be relatively shallow in the northern and eastern sections of the site.

Localised hydrology comprises several creeks transecting the site, with several dams located to the south and west of the site. There is also evidence of a wetland area prone to flooding located in the low lying area in the north of the site.

Within the site the creek in the western section flows in a northerly direction, prior to its confluence with the northern site creek. This northern creek flows east through the low lying wetland area, where it confluences with the eastern creek (which flows northerly across the site) prior to its discharge into the Nambucca River at Taylors Arm.

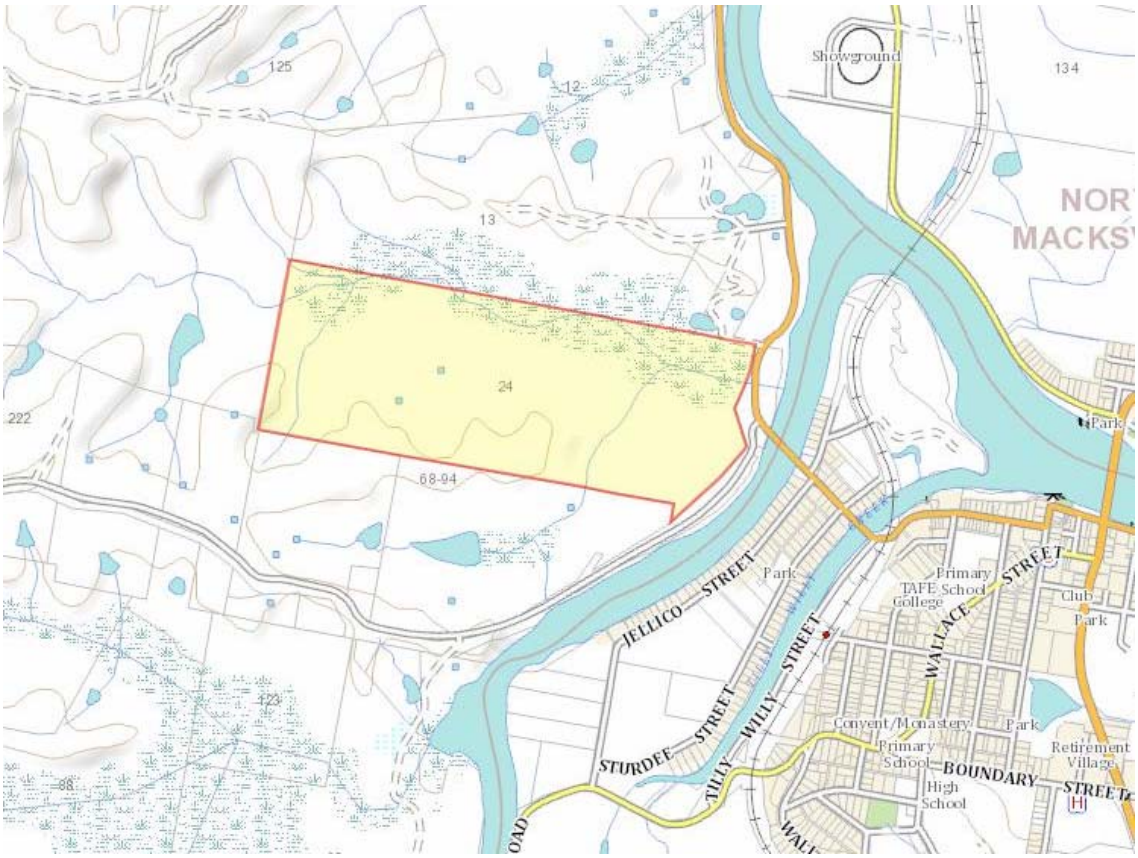

Figure 4: Localised Hydrology

2.2.5 Geology

According to the Dorrigo-Coffs Harbour 1:250,000 Geology Map (1992) the site is partially underlain by:

- Qa – Alluvial Mud, Silt, Sand, and Gravel Deposits; Coastal Sand beaches/Dunes and Swamp Deposits: and,
- Pn – Nambucca Beds
    - Pnfm – Unnamed Phyllite; Phyllite, Schist, & Rare Metabasalt

The presence of the Qa geology identified at the site indicates the site was previously influenced by a marine environment. Therefore, given the sites proximity to the Nambucca River, and coastline the potential for PASS & ASS soil conditions increases significantly.

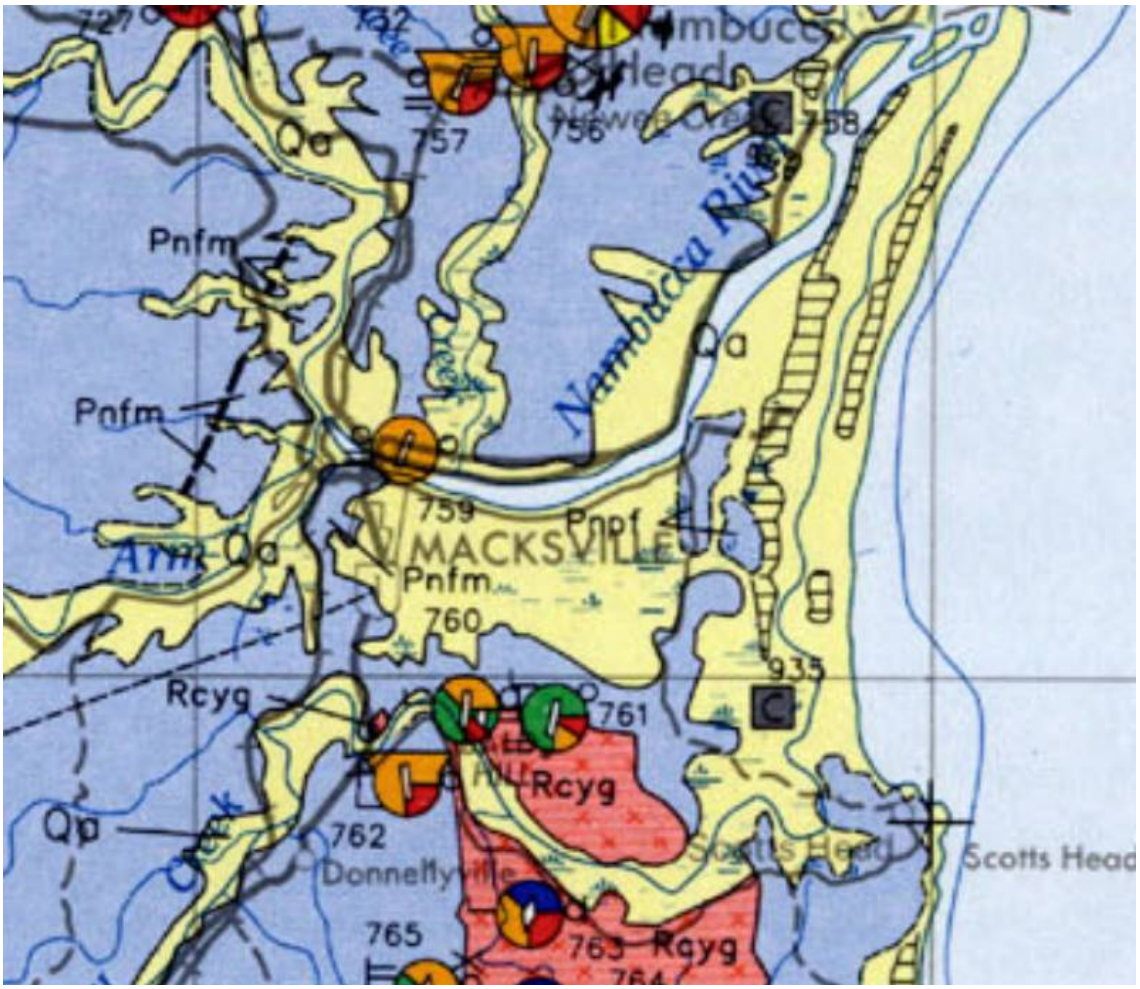

Figure 5: Localised Geology *(See Attachment A for Detailed Geology)*

2.3 Acid Sulphate Soil Risk Map

PASS areas at the Site have been identified by the Department of Land and Water Conservation in the Macksville Acid Sulphate Soil Risk Map – Edition 2, see *Attachment A*. Areas to the north and east of the site are described as having High Probability for contamination.

Northern and eastern site areas are described as Eu1, which is likely to have PASS within 1m of the natural ground surface. Areas to the south and southeast are described as As2 and Ap2, which are likely to have PASS between 1m and 3m below the natural ground surface. Details of these Landform Codes are summarised in Table 2-2 below.

Table 2-2 ASS Landform Codes

Landform Code	Landform Process Class	Landform Element	Elevation [Note1]
Eu1	*Estuarine*	*Supratidal Flat*	*1 – 2m*
As2	*Alluvial*	*Swamp*	*2 – 4m*
Ap2	*Alluvial*	*Plain*	*2 – 4m*

Note 1: *Approximate AHD*

Figure 6: Assumed ASS & PASS Locations Across the Site

3 Management Strategies

As per the site Master Plan no development involving excavations into the potential PASS or ASS areas in the eastern or northern sections of the site will take place. Development with excavations to depth below 4m AHD will only take place to the west of the existing eastern creek *(if required),* which has not been identified as having potential for PASS or ASS in the Risk Map.

Therefore, as per the site master plan *(see Figure 7)* the area identified as Eu1 on the risk map will remain as a preserved wetland, and will not facilitate any development works requiring excavation.

The areas identified as As2 and Ap2 on the risk map will not facilitate development requiring excavations below 4m AHD. However, if excavations below this depth are required then the soils will be managed as per Section 3.1 to 3.4 of this report.

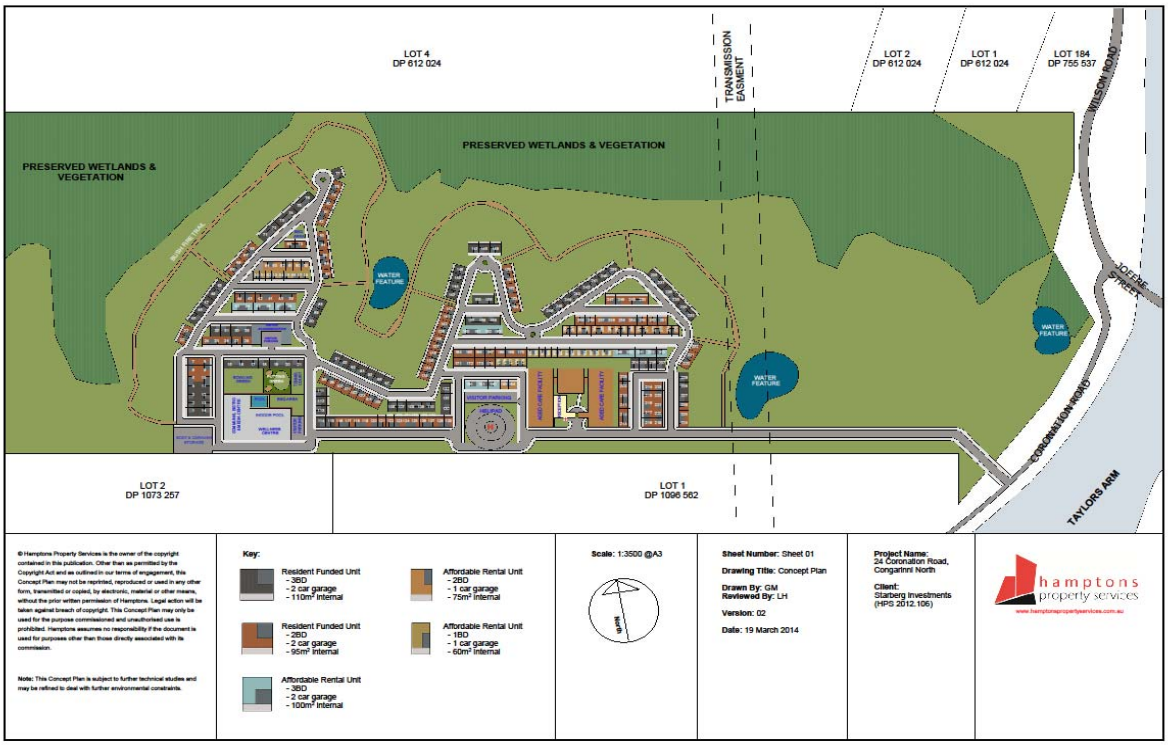

Figure 7: Site Master Plan - As per Hamptons Property Services Planning Proposal

3.1 Site Management

As per the site master plan, excavations into the PASS material is not expected, however, if site conditions are not as expected or changes to the master plan result in infractions into these areas then the following plan should be implemented.

PASS materials should be kept separate from non-PASS materials at all times. Acid is transported by water; therefore, excavation works in PASS should be conducted during dry periods *(where practical)* to minimise the risk of overflow associated with sudden or heavy rain and to allow better control of treated waters for discharge.

In general the PASS material is to be placed into an appropriately bunded treatment area *(pads)* and treated with a neutralising agent *(eg. lime).* The treatment pad design details are presented in Section 4.1.

Leachate water from the ASS material would also need to be managed and treated to ensure no acid is released to the environment.

3.2 Leachate Control

Leachate should be managed as per Procedure 1 & 2 detailed in Table 4.1 and Table 4.2 of this management plan.

Based on the information provided to Meinhardt at the time of preparation of this ASSMP, during proposed excavation works, groundwater and surface runoff during storm events will not accumulate within excavations within the PASS areas of the Site, including water generated from any ASS treatment. However, if this occurs, then this water will require collection and management.

If on-site treatment is occurring then any leachate generated during the treatment operations must be directed to collection ponds and treated to a prescribed discharge water quality (refer to Procedure 2 – Performance Criteria). In addition, a truck washdown area comprising a hardstand of base course with drainage should be constructed adjacent to a leachate pond so that truck washdown water can be collected for treatment also.

Leachate collection ponds must be constructed to accommodate the leachate and storm runoff water that would be generated in a 1 year ARI, 72-hour duration storm event as well as groundwater accumulated in potential PASS/ASS excavations during construction.

Disposal of water should be undertaken in accordance with a Water discharge licence. Prior to disposal of water off site to a creek, stormwater, or sewerage system, discharge water should be tested for the parameters/analytes required by the licensing authority.

Likely analytes that will require testing on a regular basis will comprise:

- pH;
- Total Suspended Solids (mg/L);
- Turbidity (NTU)
- Dissolved Oxygen
- Oil/ grease;

Prior to disposal of water, appropriate treatment should be undertaken in accordance with any licences/relevant regulation.

Treatment measures may include but not limited to the following:

- pH adjustment of the ponded water with a calcium hydroxide solution (e.g. hydrated/ slaked lime); and
- Removal through flocculation.

3.3 Liming Rates

A technique commonly used in ASS management is neutralisation where alkaline materials are physically incorporated into the soil. Sufficient neutralising agent(s) needs to be used to ensure that there is the capacity to neutralise all existing acidity that may be present and all potential acidity that could be generated from complete oxidation of the sulphides over time.

Note: If there is existing acidity, no effective natural buffering capacity remains. Finely crushed limestone or Aglime is commonly used as the neutralisation agent.

Note: *Aglime is calcium carbonate and should not be confused with hydrated lime or calcium hydroxide.*

The liming rate is the amount of Aglime required to neutralise existing and potential acidity in the soil material that has been disturbed by the development activity.

The formula to calculate liming rates is:

$$\%S \times 30.59 \times 1.02 \times 1.5 = kg\ CaCO_3/tonne\ of\ soil$$

Note: *30.59 converts S% to kg of H_2SO_4 per tonne; 1.02 converts kg of H_2SO_4 per tonne to kg of $CaCO_3$ per tonne; and 1.5 is the safety factor*

To convert units from tonnes to cubic metres, multiply the kg $CaCO_3$/tonne of soil by the bulk density of the soil material being tested.

3.3.1 PASS/ASS Sampling

Where excavations are to occur within the PASS areas then sampling should occur to identify the presence and concentrations of ASS.

Samples should be analysed for PASS/AASS constituents prior to excavation, these results should be then inputted into the below table for liming rates assessment.

Samples should be tested for:

- Texture;
- Moisture content (%);
- Dry bulk density (t/m_3);
- Titratable Actual Acidity – *TAA* pH;
- TAA (mole H_+/t);
- Chromium reducible sulphur (%S_{CR});
- Chromium reducible sulphur (mole H^+/t);
- Percentage Acid Neutralizing Capacity - % ANC;
- a-ANC (mole H^+/t); and
- Net acidity – chromium suite (mole H^+/t)

The oxidisable sulphur concentration, based on %S_{CR}, recorded from the samples collected during the preliminary testing for ASS can be classified into a specific maximum and minimum range, with an associated liming rate range.

Table 3-1 Example - Liming Rates Calculation Table

Sample Id	Elevation (m AHD)	Depth Interval (m)	Reduced Level (m AHD)	pH (KCL)	TAA (m H* / t)	S_{Cr} (%)	Lime Calculation Kg $CaCO^3/m^3$

3.4 Limestone Neutralisation

The following management protocols should be followed:

- Soils selected for this method of treatment will be treated with limestone or neutralising agent to neutralise the net acidity based on Total Potential Acidity (TPA) or equivalent oxidisable sulphur (S_{CR}), TAA, and retained acidity, if present (derived from S_{NAS});
- Treatment will be verified using field pH after oxidation, ANC by C_{IN} or ANC_{BT} and Lab TPA or oxidisable sulphur based on verification sample testing at a specified rate *(usually one sample per 1000m^3 of excavated material);*
- Lime *(finely crushed limestone or suitable and approved alternative)* application rate will include a safety factor for mixing of 1.5, unless it can be demonstrated that this factor can be reduced to the satisfaction of the local governing authority;
- Excavated PASS material will be placed in spatially tracked, prepared lots *(i.e. bunded using non-PASS material)* and limed;
- Suitable quantities of treatment additives will be stockpiled on site for emergency treatment;
- Stockpiles of lime will be “dampened down” or covered to minimise dust emission;
- Utilisation of safe handling and storage procedures for alkaline treatment substances, including training of project staff in health and safety procedures relating to their use;
- The treatment areas will be constructed with a guard layer base and fully bunded to contain any runoff during rain events; the bund should be constructed from non-acid sulphate soil material;
- The guard layer installed will have a surface treatment of lime disked in at a minimum rate of 5kg/m^2/metre depth of material *(or part thereof)* to be placed. This is to provide a layer of neutralising treatment for any acidic runoff or leachate from the treatment areas.

4 PASS/ASS Treatment

Handling of excavated PASS material should use Industry best practice to mitigate acid generation. The proposed option for treatment of PASS material on site will be by lime treatment using finely crushed limestone as the neutralisation agent.

Other options that might be employed may include:

- Over-excavation and burial below water table; and
- Preloading and burial below water table.

Treatment should be undertaken progressively in designated treatment areas in accordance with the excavation program.

The action levels for excavations larger than 1000 tonnes is 0.03 % oxidisable sulphur. Treatment areas should be bunded and the bund walls lined with an anchored geotextile or plastic sheeting liner, so as to minimise erosion and direct impact by the PASS. The bunds will also minimize surface water runoff entering or leaving the treatment areas.

A guard layer of aglime as described in Section 4.4.1 should be placed over the underlying soil at the base of each treatment area, so as to provide further safeguard against any acidic leachate generated during treatment which is not fully neutralised by the aglime treatment. The division of each treatment area into cells may expedite the treatment process as material can be allocated to different cells as excavation works progress, resulting in a staged treatment process.

Once PASS material has been placed in the treatment areas it should be allowed to drain *(with leachate directed into the leachate management pond)* and then dosed with a neutralising agent (e.g. aglime) in accordance with the required dosing rate *(calculated based on assessment findings, as per Section 3.3.1).*

The application rate for the neutralising agent *(liming rate)* will depend on the agent used. It is recommended that fine grained aglime with a neutralising value (NV) of at least 95% is used.

It is noted, however, that in-situ testing is intrinsically limited in nature, and the required liming rate may differ due to natural variations in the material.

The lime should be thoroughly mixed through the soil with suitable site machinery. Additional quantities of aglime above the calculated dosing rate may be required to allow for difficulties in mixing and to act as a back-up buffer under such circumstances. The effectiveness of the adopted dosing rate should be confirmed by the regular sample screening of the treated material using pH and peroxide pH field tests, with additional lime added as required.

It should be noted that as a precautionary measure, treatment works involving aglime should not be conducted during windy conditions, unless the material can be appropriately conditioned to prevent dust generation. When the field screening indicates that the material has been suitably treated, the PASS should be disposed of as “General Solid Waste” to an appropriately licensed landfill.

4.1 Treatment Pad Design

For treatment of large volumes of material, neutralisation should be carried out on a treatment or liming pad. The following issues should be considered in the treatment pad design.

4.1.1 Guard Layers

A guard layer of neutralising agent should be spread onto the soil surface of the treatment pad prior to the placement of soils. This will reduce risk by neutralising acidic leachate generated in the treatment pile and not neutralised during the treatment process. This is especially relevant to the first layer of PASS that is placed for treatment prior to application of the neutralising agent. The guard layer will assist in protecting groundwater quality.

To further reduce risk, a layer of compacted non-ASS clayey material (0.3–0.5 m thick) might be placed on the surface of the treatment pad and below the guard layer to restrict infiltration from the material being treated. In fully contained situations a physical barrier may be used as an alternative to a guard layer of neutralising agent as a means of protecting groundwater quality and preventing infiltration of acidic water; e.g. a bunded concrete slab, paved area or layer of bitumen may be placed under a temporary treatment pad.

4.2 Monitoring of Treatment

Treated layers will be monitored regularly for success using a combination of field based tests *(ASS Laboratory Methods Guidelines for pH before and after peroxide oxidation, Ahern et al, 2004)* and acid neutralising capacity or equivalent parameter on representative samples of material being treated, before placement of subsequent layers upon the same site with reference to the action levels listed in Table 4.1 and Table 4.2, with verification sampling will be tested at a rate of one sample per 1000m^3;

Monitoring of surface water around the treatment site to detect any temporary failures.

Any leachate generated within the site will be collected and treated within a bunded area and, if high acidities persist, then the collected leachate will be treated using hydrated lime or equivalent to:

- Raise pH within the range 6.5 to 9.0; and keep
- Suspended Solids to <50 mg/l.

These parameters should be tested on a daily basis; Records will be kept of lime dosing rate and water quality monitoring results.

During treatment of PASS, soil pH should be regularly measured. Soil pH will be used as a measure of the effectiveness of neutralisation, and the material will only be considered to have been suitably treated when a pH value in excess of 6.5 and a peroxide pH value in excess of 6 have been attained consistently throughout the batch of material being treated.

If treated soils are to be stockpiled on-site prior to disposal, the field pH and peroxide pH of the stockpiled materials should be determined immediately prior to disposal. If material fails the pH and peroxide pH testing, further dosing with aglime should be conducted as required prior to disposal.

During PASS treatment, if soil sampling for POCAS[2] analysis is required, soil sampling, transport and laboratory analysis should be undertaken.

[2] POCAS - Peroxide Oxidation-Combined Acidity and Sulphate

4.5.2 Preloading Option

This option may be utilised where sufficient non-PASS material is available for use. Non-PASS material is placed over compressible PASS material and compresses the PASS material to below the permanent water table.

4.6 Water Quality Management

The quality of water within the construction site will be maintained according to the procedures outlined in the site Dewatering Plan, or Construction Environmental Management Plan *(CEMP)* – to be utilised for treatment of acid leachate generated from exposure of PASS material and stormwater runoff:

- Direct drainage within the site to a collection and treatment point;
- All external drainage will be directed away from the excavated site to minimise the volume of water within the site that may require treatment;
- Any water collecting within the excavation will be treated with hydrated lime or equivalent prior to discharge. Conditioned water will not be discharged until it meets acceptable water quality standards outlined in the Dewatering Plan, or CEMP; and
- Discharge from the water treatment point will be undertaken once the pH of the water has reached 6.5-9.0, has low suspended solids <50 mg/l and is in compliance with water quality limits detailed in the Dewatering Plan, or CEMP.

4.7 ASS/PASS Management Procedures

The following tables provide a detailed checklist of procedures for management of potential acid sulphate soils and mitigation of their potential impacts.

4.7.1 Procedure 1: PASS/ASS Assessment and Treatment

Table 4-1 Procedure 1: PASS/ASS Treatment

Issue	Procedure
Operational Policy	• To prevent, mitigate or manage potential impacts from acid sulphate forming material; and • To minimise impacts of acid sulphate soils on the surrounding watercourses and ecology.
Performance Criteria	Final placement of soils will not be carried out until validation sampling ensures compliance with governing Guidelines for action levels for oxidisable sulphur.

Issue	Procedure
Implementation Strategy/Mitigation Measures	Assessment and Management of acid sulphate material will be conducted in accordance with Industry best practice and will incorporate the following procedures; • Excavations within the Eu1, AS2 & Ap2 areas will be kept above the PASS material; • Any soils excavated within the site area identified for acid sulphate soil potential will be tested for acid sulphate potential and classified; • If ASS is identified then suitable methods of treatment based on the testing classification will be designed, including calculation of liming rates using a safety factor of 1.5 and bulk densities (where applicable) of the material to be treated; • Within the designated Eu1, AS2 & Ap2 areas exposure of PASS material within an excavated trench site will be minimised to reduce the potential for oxidation and acid leachate generation; • Excavation for construction will be done under dry conditions, where possible using a truck and shovel *(tracked excavator)* operation. • No lowering of the water table will occur within the Eu1, AS2 & Ap2 areas. o Excavated fill will be monitored for colour and leachate quality; o No PASS material will be placed and left at surface untreated; o Stockpiled material will be monitored for colour and leachate quality; o Stockpiling of PASS material will be minimised where possible.
Monitoring/Validation Sampling of Liming Rates	• Treated material will be monitored regularly for success using fieldbased tests and lab. TPA or equivalent on representative samples of material being treated at a rate of one sample per 1000 m^3; • No samples to have a pH <6.5 after peroxide oxidation. • Monitoring of surface water around the treatment site will be undertaken to detect temporary failures. • Any leachate generated within the site will be collected and treated within a bunded area if high acidities persist; the collected leachate will be treated using alkaline additives to pH of 6.5; and • Records will be kept of lime dosing rates and monitoring results.
Identification of Incident or Failure to Comply	• Acid sulphate field test and lab; and • TPA results indicate PASS materials found in the treated excavated material.
Corrective Action	• Further testing of materials in vicinity of the excavation using Chromium Suite method (S_{CR} and TAA) or equivalent; and • Reprocessing of materials and treatment with lime.

4.7.2 Procedure 2: Surface Water Quality

Table 4-2 Procedure 2: Surface Water Quality Management

<table>
<tr><th>Issue</th><th colspan="3">Procedure</th></tr>
<tr><td>Operational policy</td><td colspan="3">Treatment and management of surface water flows from areas containing acid sulphate soils to prevent leaching of acidic waters and metal contaminants into the environment, maintaining present surface water quality wherever practicably possible.</td></tr>
<tr><td rowspan="8">Performance Criteria</td><td colspan="3">All water discharged from site to comply with the following criteria:</td></tr>
<tr><td>Indicator</td><td>Freshwater</td><td>Marine Water</td></tr>
<tr><td>pH</td><td>6.5 – 8.0</td><td>8.0 – 8.4 and <0.2 unit change</td></tr>
<tr><td>Suspended Solids</td><td colspan="2">Not Defined</td></tr>
<tr><td>Turbidity</td><td>1 - 20</td><td>0.5 – 10</td></tr>
<tr><td>Dissolved Oxygen
(Field measurement %)</td><td colspan="2">110</td></tr>
<tr><td>Oil & Grease</td><td colspan="2">None visible</td></tr>
<tr><td>Iron Floc & Scum</td><td colspan="2">None visible or detected in discharge water</td></tr>
<tr><td colspan="3">Testing parameters should contain aluminium and iron when the pH falls below 6.0.</td></tr>
</table>

4.3 Soil Sampling

Soil samples of 250-500grams to be collected from each designated sample interval. Soil samples handling and transport should be undertaken as detailed below:

- Samples will be placed in a labelled plastic bag that is then sealed and refrigerated for transport to a registered laboratory for analysis;
- Samples will be despatched to Laboratory within 24 hours of sample collection under chain-of-custody protocol; and
- Samples will be stored under cool (4°C) conditions in the Laboratory prior to analysing.

4.3.1 Analysis

All soil samples collected for ASS assessment are to be analysed by a NATA registered laboratory. The methods specified are based on Chromium Suite methods for acid sulphate soil assessment as outlined in the *Acid Sulphate Soils Laboratory Methods Guidelines*. (Ahern *et. al*. 2004).

The Chromium suite can also be used for verification testing to validate whether the required neutralising agent has been added to the ASS material.

The samples are to be screened for:

- pH *(KCL)* and either a combination of:
  - Total Actual Acidity (TAA);
  - Chromium Reducible Sulphur (S_{CR});
  - Acid Neutralisation Capacity (optional); and
  - Net acid soluble sulphur, or retained acidity (S_{NAS}) *(where appropriate).*

The method of analysis will be regularly reviewed and adapted to tried and proven new technology in line with Industry Standards.

4.4 Transportation of PASS/ASS

PASS material requiring transport should be loaded into sealed trucks and immediately transferred to a regulated landfill. All vehicles must be covered and sealed where practical to prevent the loss/leakage of PASS material, including leachate, during transport. Similarly, wheels and external surface of all trucks will require appropriate cleaning prior to leaving the subject site to remove any PASS material that may be clinging to exterior surfaces.

4.4.1 PASS/ASS Off-site Disposal

Treated PASS should be disposed off-site at a landfill facility as “General Solid Waste” in accordance with the NSW DECC Waste Guidelines: Part 1 – Classifying Waste.

4.5 Alternative Treatment Options

4.5.1 Over Excavation Option

This option may be utilised where low or non-PASS material is located at depth in the excavated site below the water table. The process involves placing high PASS material below the water table and treating the lower PASS material if necessary.

Stockpiling of high PASS material should be minimised where practical and located in temporary treated sites (bunded and limed).

If this option is selected, actual acid sulphate value of the soil to be excavated will be assessed as per ASS Laboratory Methods Guidelines *(Ahern et al., 2004)* and any actual acid sulphate soil identified will be treated using a pre-determined lime application rate *(including the 1.5 factor)* as described previously.

Issue	Procedure
Implementation Strategy/Mitigation Measures	• Surface water monitoring locations will be detailed and provided to regulatory authority *(e.g. local Council)* for approval prior to commencement of construction. • Leachate collection ponds will be constructed to accommodate the leachate and runoff water that would be generated in a 1 year ARI, 72-hour duration storm event. • All leachate from acid sulphate soil treatment areas and areas of disturbed acid sulphate soils including areas where groundwater levels are lowered due to dewatering will be collected and directed to a centralised polishing pond for treatment of acidity *(if required).* • Ponded water within the site will be minimised wherever possible, unless part of the treatment process. • Stormwater control will rely on the maintenance of directed drains to the excavations or a centralised settlement pond. • All stormwater runoff from undisturbed areas and areas not affected by the development will be directed away from development disturbed areas, and existing surface water conditions shall be maintained wherever possible. • Where sediment problems are identified settling in the excavations shall be aided by dosing with flocculation agents. • If increasing acidity is encountered, the waters within the excavations will be treated until a minimum pH of 6.5 has been achieved prior to discharge. • Acidity will be treated with a suitable neutralising agent such as hydrated lime to the prescribed pH in the Performance Criteria of this Procedure prior to discharge. • Suitable OHS standards for storage and handling alkaline substances such as hydrated lime must be strictly maintained during operation, in accordance with the registered MSDS. Sufficient quantities of hydrated lime must be maintained on site to treat any acidic runoff water or leachate.

<table>
<tr><th>Issue</th><th>Procedure</th></tr>
<tr><td>Monitoring</td><td>

Weekly monitoring in water bodies with hand held pH and EC meter during construction.
Daily monitoring of water within the settlement/polishing pond/tank with hand held pH meter and Secchi disk during period of treatment.
Monthly laboratory analyses at a NATA registered laboratory for:
Sulphate, Chloride, Alkalinity and Acidity for the polishing pond and adjoining the point of discharge.
Determination of Chloride:Sulfate ratios (it should be ~7 for marine waters).
Analysis of settlement pond water for Chloride and Sulfate (if EC < 10 μ S/cm), Alkalinity and Acidity, NFR (true colour) and DO prior to discharge.
During flood events, samples of stormwater runoff will be collected and analysed for Colour, NFR (true colour) where access permits.
Visual inspection will be undertaken following each rainfall event and on a regular basis during dry periods to determine the presence or absence of oil, grease and iron floc/precipitate.

<table>
<tr><th>Indicator</th><th>Freshwater</th><th>Marine Water</th></tr>
<tr><td>pH, EC, Secchi disc</td><td>Settlement / Polishing pond All Sites</td><td>Daily during period of water treatment
Weekly in nontreatment period</td></tr>
<tr><td>Suspended Solids</td><td>All Sites</td><td>Weekly</td></tr>
<tr><td>Dissolved Oxygen Field Measured</td><td>All Sites</td><td>Prior to discharge</td></tr>
<tr><td>Oil and Grease</td><td>All Sites</td><td>Weekly</td></tr>
<tr><td>Iron Floc & Scum</td><td>All Sites</td><td>Weekly</td></tr>
<tr><td>Sulphate,
Chloride,
Alkalinity, Acidity</td><td>All Sites</td><td>• Weekly – prior to discharge during water treatment periods;
• Monthly - in non-treatment periods</td></tr>
</table>
</td></tr>
<tr><td>Auditing</td><td>Auditing to ensure assessment and treatment procedures according to the performance criteria prior to discharge of surface water from the site.</td></tr>
<tr><td>Reporting</td><td>Weekly result sheets will be compiled for monitoring results relating to water quality of water bodies. Results will be available at all times.</td></tr>
<tr><td>Identification of Incident or Failure to Comply</td><td>Fall in surface water quality as per water quality criteria, at the environmental monitoring points to below background level.</td></tr>
</table>

Issue	Procedure
Corrective Action	• Identify reason for deterioration in surface water quality and determine if it is linked to the construction operations. • Review of construction operation. • View and upgrade neutralisation treatment procedure.

5 Conclusions and Recommendations

5.1 Conclusions

The following conclusions can be made based upon the findings of the preliminary desktop environmental site assessment:

- The Site is elevated at approximately 30m AHD in the western section of the Site to approximately <5m AHD in the eastern section of the Site and has general fall from the central high point in all directions;
- Localised hydrology comprises several creeks transecting the site; with several dams located to the south and west of the site. Adjacent creeks follow localised contours in a northeast direction prior to its discharge into the Nambucca River at Taylors Arm;
- There is also evidence of a wetland area prone to flooding located in the low lying area in the north of the site.
- No data relating to groundwater currently exists for the site, however, given the sites coastal location, relatively low AHD siting, and proximity to the Nambucca River, groundwater is expected to be relatively shallow in the northern and eastern sections of the site.
- A*ccording to the Dorrigo-Coffs Harbour 1:250,000 Geology Map (1992) the site is partially underlain by:*
    - **Qa** – Alluvial Mud, Silt, Sand, and Gravel Deposits; Coastal Sand beaches/Dunes and Swamp Deposits;
    - **Pn** – Nambucca Beds; and
    - **Pnfm –** Unnamed Phyllite; Phyllite, Schist, & Rare Metabasalt
- The presence of the Qa geology identified at the site indicates the site was previously influenced by a marine environment. Therefore, given the sites proximity to the Nambucca River, and coastline, the potential for PASS & ASS soil conditions increases significantly.
- Areas to the north and east of the site are described in the Macksville Acid Sulphate Soil Risk Map – Edition 2 (Dept. LWC) as having High Probability for PASS;
- Northern and eastern site areas are described as Eu1, which is likely to have PASS within 1m of the natural ground surface. The area identified as Eu1 on the risk map will remain as a preserved wetland, and will not facilitate any development works requiring excavation.
- Areas to the south and southeast are described as As2 and Ap2, which are likely to have PASS between 1m and 3m below the natural ground surface. The areas identified as As2 and Ap2 on the risk map will not facilitate development requiring excavations below 4m AHD. However, if excavations below this depth are required, then the soils will be managed as per Section 3.1 to 3.4 of this report.
- As per the site Master Plan no development involving excavations into the potential PASS or ASS areas in the eastern or northern sections of the site will take place. Development with excavations to depth below 4m AHD will only take place to the west of the existing eastern creek *(if required),* which has not been identified as having potential for PASS or ASS in the Risk Map.

5.2 Recommendations

- As per the site master plan, excavations into the PASS material is not expected; however, if site conditions are not as expected or changes to the master plan result in infractions into these areas then the following plan should be implemented;
  - PASS materials should be kept separate from non-PASS materials at all times;
  - Excavation works in PASS should be conducted during dry periods *(where practical)* to minimise the risk of overflow associated with sudden or heavy rain and to allow better control of treated waters for discharge;
  - In general, the PASS material is to be placed into an appropriately bunded treatment area *(pads)* and treated with a neutralising agent *(eg. lime).* The treatment pad design details are presented in Section 4.1; and
  - Leachate water from the ASS material would also need to be managed and treated to ensure no acid is released to the environment.

6 References

- Stone (et al. 1998). NSW Acid Sulphate Soil Management Advisory Committee – Acid Sulphate Soil Manual;
- Ahern CR (et al. 2004). Acid Sulfate Soils Laboratory Methods Guidelines. Queensland Department of Natural Resources, Mines and Energy, Queensland.
- Ahern, C.R et al. 1998. Guidelines for Sampling and Analysis of Lowland Acid Sulphate Soils (ASS) in Queensland. QASSIT, Department of Natural Resources, Queensland.
- Australian Government Department of Industry Tourism and Resources, 1995–8. Best Practice Environmental Management in Mining (series).
- Dear SE et al., 2002. Soil Management Guidelines. In Queensland Acid Sulphate Soil Technical Manual. Department of Natural Resources and Mines, Queensland.
- Department of Environment and Conservation 2009, Identification and Investigation of Acid Sulphate Soils and Acidic Landscapes: Acidic Sulphate Soils Guidelines Series. West Australia.
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- EPA 2007, Soils sampling guideline (Off-site management and acceptance to landfill), EPA publication 1178.
- EPA 2009. Sampling and analysis of waters, wastewaters, soils and wastes. EPA publication IWRG701.
- Miller S, Robertson A, Donahue T 1997, Advances in Acid Drainage Prediction using the Net Acid Generation (NAG) Test, 4th International Conference on Acid Rock Drainage, Vancouver, BC.
- Sobek AA, Schuller WA, Freeman JR, Smith RM 1978, Field and Laboratory Methods Applicable to Overburdens and Minesoils, USEPA Publication EPA-600/2-78-054.
- Standards Australia series AS 4969, 2008/9, Analysis of acid sulfate soil — Dried samples — Methods of test.

7 Statement of Limitations

The assessment in this report was restricted to the agreed scope of works and is subject to the limitations set out below or elsewhere within this report.

The assessment has been undertaken and performed in a professional manner consistent with the skill and care ordinarily exercised by reputable consultants under similar circumstances. No other warranty, expressed or implied, is given.

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APPENDIX A FIGURES

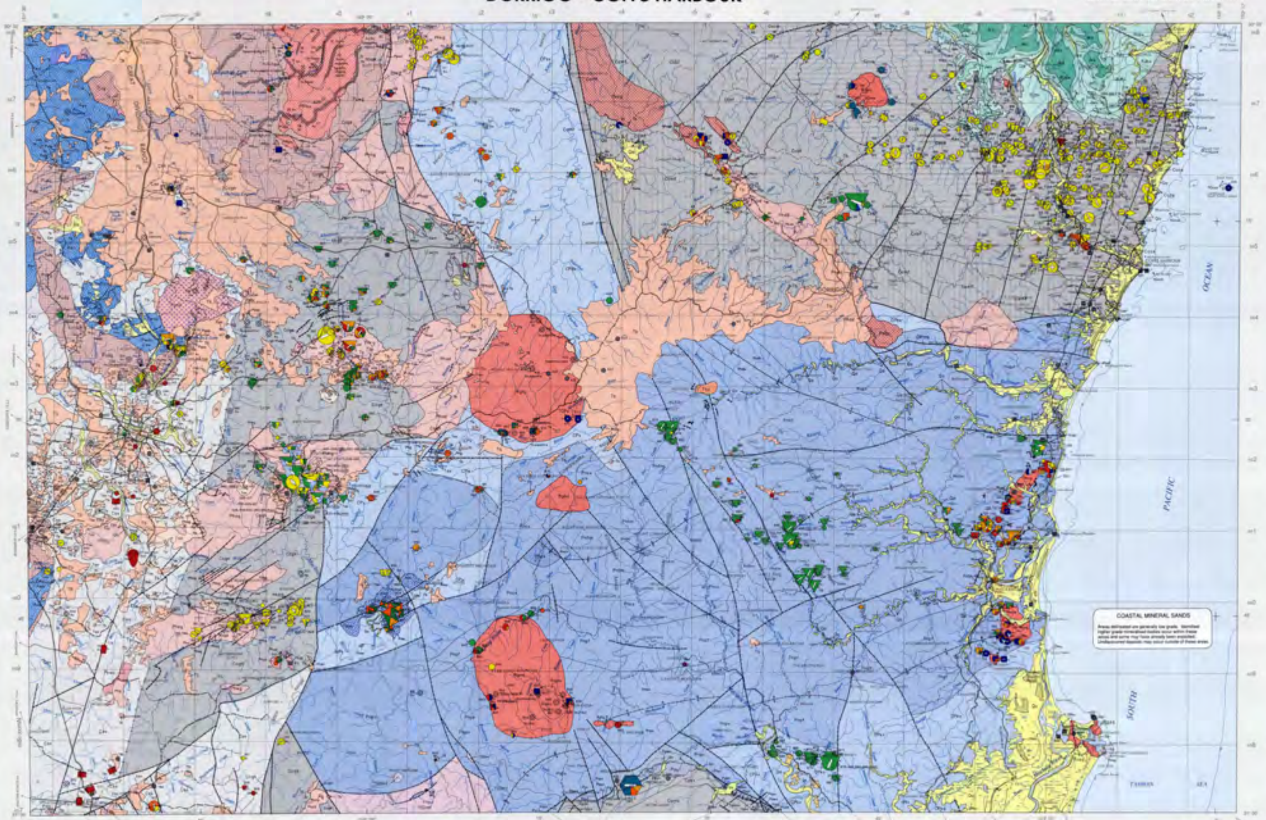
AUSTRALIA 1:250 000

DORRIGO - COFFS HARBOUR

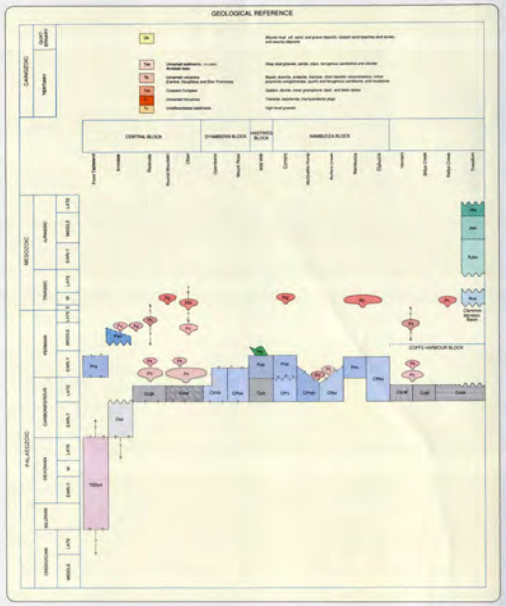
METALLOGENIC SERIES SHEET SH/56 10-11

FIRST EDITION 1992

DEPOSIT REFERENCE



GEOLOGICAL REFERENCE



PRE-TERTIARY SEDIMENTS AND VOLCANICS

GRANITOIDS

MINERALISATION REFERENCE

SIZE CATEGORIES

HOST ROCK

GANGUE

RELATIVE IMPORTANCE OF COMMODITIES

GEOLOGICAL SYMBOL REFERENCE

TOPOGRAPHIC REFERENCE

Scale 1:250 000

GEOLOGICAL FRAMEWORK

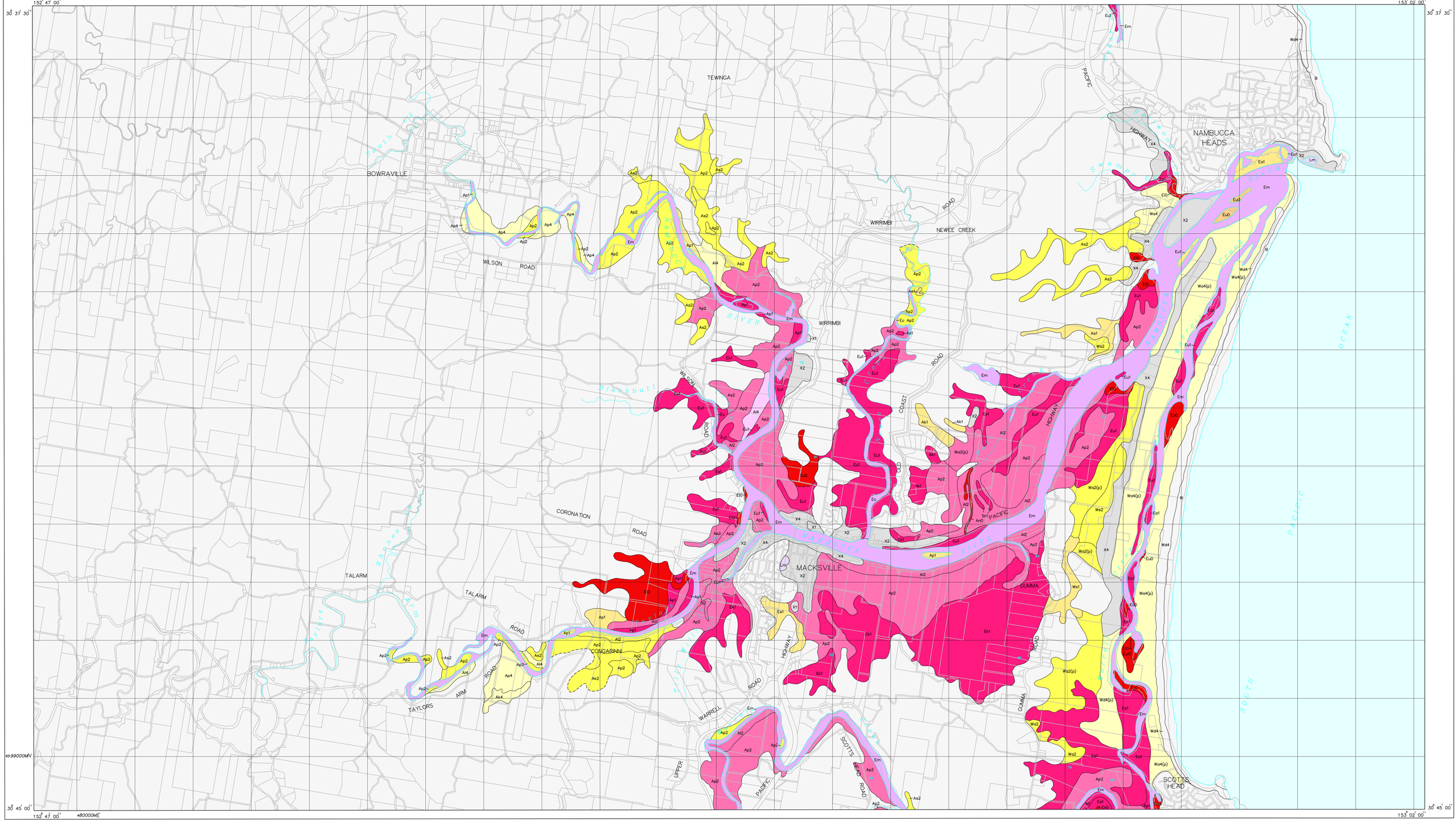
REFERENCE

DORRIGO-COFFS HARBOUR METALLOGENIC MAP

DEPARTMENT OF LAND AND WATER CONSERVATION

MACKSVILLE

ACID SULFATE SOIL RISK MAP – EDITION TWO



KEY

Map Class Description	Depth to Acid Sulfate Soil Materials		Environmental Risk	Typical Landform Types
HIGH PROBABILITY High probability of occurrence of acid sulfate soil materials within the soil profile. The environment of deposition has been suitable for the formation of acid sulfate soil materials. Acid sulfate soil materials are widespread or sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.	Severe environmental risk if bottom sediments are disturbed by activities such as dredging.	Bottom sediments of lakes, lagoons, tidal creeks, rivers and estuaries.
		At or near the ground surface.	Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.	Estuarine swamps, intertidal flats and supratidal flats.
		Within 1 metre of the ground surface.	Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.	Low alluvial plains, estuarine sandplains, estuarine swamps, backswamps and supratidal flats.
		Between 1 and 3 metres below the ground surface.	Environmental risk if acid sulfate soil materials are disturbed by activities such as deep excavation for pipelines, dams or deep drains.	Alluvial plains, alluvial swamps, alluvial levees and sandplains.
		Greater than 3 metres below the ground surface.*	Environmental risk if acid sulfate soil materials are disturbed by activities such as deep excavations, –e.g., large structure foundations or deep dams.	Elevated levees and sandplains, alluvial plains and alluvial swamps in estuarine reaches of catchments.
LOW PROBABILITY Low probability of occurrence of acid sulfate soil materials within the soil profile. The environment of deposition has generally not been suitable for the formation of acid sulfate soil materials. Soil materials are often Pleistocene in age. Acid sulfate soil materials, if present, are sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.	The majority of these landforms are not expected to contain acid sulfate soil materials. Therefore, land management is generally not affected by acid sulfate soils. However, highly localised occurrences may be found, especially near boundaries with environments with a high probability of occurrence. Disturbance of these soil materials will result in an environmental risk that will vary with elevation and depth of disturbance.	Elevated alluvial plains and levees dominated by fluvial sediments. Plains and dunes dominated by aeolian soils. Pleistocene plains. Lacustrine and alluvial bottom sediments.
		At or near the ground surface.		
		Within 1 metre of the ground surface.		
		Between 1 and 3 metres below the ground surface.		
		Greater than 3 metres below the ground surface.*		
NO KNOWN OCCURRENCE Acid sulfate soils are not known or expected to occur in these environments.		No known occurrences of acid sulfate soil materials.	Land management activities not likely to be affected by acid sulfate soil materials.	Bedrock slopes, elevated Pleistocene and Holocene dunes, and elevated alluvial plains.
DISTURBED TERRAIN		Disturbed terrain may include filled areas, which often occur during reclamation of low lying swamps for urban development. Other disturbed terrain includes areas which have been mined or dredged, or have undergone heavy ground disturbance through general urban development or construction of dams or levees. Soil investigations are required to assess these areas for acid sulfate potential.		

*Deep occurrences of acid sulfate soil materials not able to be confirmed by field inspection and sampling.

LAND & WATER CONSERVATION

SCALE 1:25000

metres 500 0 1 2 kilometres

G N

TRANSVERSE MERCATOR PROJECTION
Numbered grid lines are 1000 metre intervals of the Australian Map Grid, Zone 56. Grid values are shown in full only at the south–west corner of the map.

Cadastral information based on the Digital Cadastral Data Base courtesy of the Surveyor Generals Department of N.S.W. Waterbody boundaries are dynamic and show slight differences between cadastral and topographic information.

THIS MAP IS TO BE USED AS A GENERAL GUIDE FOR REGIONAL AND LOCAL SCALE LAND USE PLANNING AND LAND MANAGEMENT ONLY AND NOT FOR THE ASSESSMENT OF SPECIFIC SITES WHICH CAN ONLY BE ASSESSED BY A SITE SPECIFIC SOIL INVESTIGATION. THIS MAP HAS BEEN PREPARED ON THE BASIS OF CURRENT INDICATORS WHICH MAY VARY AS THE PROCESS OF DETECTING THE OCCURRENCE OF ACID SULFATE SOILS IS FURTHER DEVELOPED. ACID SULFATE SOILS MAY OCCUR IN AREAS SPECIFICALLY IDENTIFIED ON THE MAP AS NO KNOWN OCCURRENCE.

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THIS MAP IS ONLY RELIABLE AT THE PUBLISHED SCALE OF 1:25000

LANDFORM CODES

Landform Process Class	Landform Element		Elevation#
W..... Aeolian	b..... Backplain	t..... Levee Toe	0..... 0–1 m
A..... Alluvial	k..... Backswamp	o..... Ox–bow	1..... 1–2 m
B..... Beach	m..... Bottom Sediments	p..... Plain	2..... 2–4 m
E..... Estuarine	n..... Channel	q..... Sandplain	4..... >4 m
L..... Lacustrine	d..... Dune	s..... Swamp	
S..... Swamp	r..... Interbarrier Swamp	y..... Spivy	Additional Descriptive Codes
	i..... Intertidal Flat	u..... Supratidal Flat	(p)..... Pleistocene
X..... Disturbed Terrain*	g..... Lagoon	w..... Swale	(s)..... Acidic Scald
	l..... Levee	c..... Tidal Creek	

*Elevation levels given on the map refer to the elevation of the ground surface at the time of mapping. Depending on the nature of the disturbance, these elevation levels may or may not represent the original ground surface elevation.

Approximate AHD

MAP PREPARED BY S.D. NAYLOR. REVIEWED BY M. EDDIE

MAP COMPILED BY GIS. OPERATIONS FROM DIGITISED FIELD INFORMATION AND DATA HELD IN THE DEPARTMENT OF LAND AND WATER CONSERVATION'S GEOGRAPHIC INFORMATION SYSTEM.

THIS MAP SHOULD BE USED IN CONJUNCTION WITH THE *GUIDELINES FOR THE USE OF ACID SULFATE SOIL RISK MAPS* S.D. NAYLOR et.al. (1995) DEPARTMENT OF LAND AND WATER CONSERVATION

THIS MAP IS PART OF A SERIES OF ACID SULFATE SOIL RISK MAPS ALONG THE ENTIRE NEW SOUTH WALES COAST. THE MAPPING HAS BEEN UNDERTAKEN BY A TEAM OF EXPERIENCED AND QUALIFIED SOIL SURVEYORS. THE MAPPING IS BASED ON THE ASSESSMENT OF GEOMORPHIC PROCESSES AND ENVIRONMENTS. ASSESSMENT METHODS INCLUDE, INTERPRETATION OF AERIAL PHOTOGRAPHY AND SATELLITE IMAGERY, EXTENSIVE FIELD WORK AND LABORATORY SOIL TESTING.

EDITION TWO

KEY TO ADJOINING MAPS IN THIS SERIES

		MISSABOTTI/ WENONAH HEAD 9436N1
	MACKSVILLE 9436S1	
		EUNGAI 9436N2

LEGEND

LANDFORM BOUNDARY.....

APPROXIMATE LANDFORM BOUNDARY.....

SOIL PROFILE DESCRIPTION SITE.....27

RIVER or CREEK.....

CADASTRE .....