APPENDIX B11

Construction Acid Sulfate Materials Management Plan

Early Works – Wave 1 & 3 (part)

Woolgoolga to Ballina

Pacific Highway Upgrade

SEPTEMBER 2015

Document control

File name	RMS00031-125 B11 CASMMP_2.0.docx
Report name	W2B Early Works – Wave 1&3(part): Construction Acid Sulfate Materials Management Plan
Version	2.0 (Greenhill Cutting addition)

Plan approved by:

[signed]	*[signed]*	*[signed]*
Rob Blyth	*Doug Caldwell*	*Jeff Boylan*
Golding Contractors Pty Ltd Project Manager	Golding Contractors Pty Ltd Environmental Manager	Roads and Maritime Authorised Delegate

Revision history

Revision	Date	Description	Approval
This document supersedes *'RMS00031-2429-1016 Appendix B11 CASMMP'*			
1.0	17/08/2015	First controlled issue.	Rob Blyth
2.0	13/10/2015	Greenhill Cutting addition	Rob Blyth

Distribution of controlled copies

Copy no.	Issued to	Version
1	Dean Gregory	1.0
2	Jeff Boylan	2.0
3		
4		
5		

Contents

Tables

Appendices

Glossary/Abbreviations

ASS	Acid Sulfate Soils
CASMMP	Construction Acid Sulfate Materials Management Plan
CEMP	Construction Environmental Management Plan
CoA	Condition of approval
DP&E	Department of Planning and Environment
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPA	NSW Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EWMS	Environmental Work Method Statements
Golding	Golding Contractors Pty Ltd
Minister, the	Minister for Planning
NPW Act	*National Parks and Wildlife Act 1974*
OEH	Office of Environment and Heritage
PASS	Potential Acid Sulfate Soils
Project, the	Early Works – Wave 1 & 3 (part), Woolgoolga to Ballina, Pacific Highway Upgrade
RMS	NSW Roads and Maritime Services
Secretary	Secretary of the Department of Planning and Environment (formerly known as the Director General)
Submissions/PIR	Submissions/Preferred Infrastructure Report November 2013

1 Introduction

1.1 Context

This Construction Acid Sulfate Materials Management Plan (CASMMP or Plan) forms part of the Construction Environmental Management Plan (CEMP) for the Early Works - Wave 1 and part of Wave 3 Project, which is part of the upgrade of the Pacific Highway between Woolgoolga and Ballina.

This CASMMP has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), the mitigation measures listed in the Pacific Highway Upgrade Woolgoolga to Ballina Environmental Impact Statement (EIS), the requirements of the Project Specifications, and applicable legislation.

This Plan has been prepared for Wave 1 and 3 (part) of the Project which broadly includes:

- Ground treatment and preparatory earthworks (soft soils treatments) between STN 83400 and 91200.
- Excavation of material taken from a highway cutting at Tyndale (at approximate STN 69000 to 69500) for the soft soil treatments.
- Excavation of material taken from highway cuttings North of McIntyres Lane, Gulmarrad (at approximate STN 77500 to 78400) for the soft soil treatments.
- Excavation of material south of McIntyres Lane, Gulmarrad - Greenhills cutting (at approximate STN 76000 to 77075) for the soft soil treatments. McIntyres Lane would be widened to support truck movements from this cutting.
- Relocation of utility services at various locations throughout STN 67200 to 95100.

These works would be located within Sections 4 and 5 of the Approved Project.

1.2 Background

The Pacific Highway Upgrade Woolgoolga to Ballina EIS (RMS 2012) assessed potential acid sulfate soils impacts from construction of the Project.

The EIS identified areas of potential acid sulfate soils (PASS) within or near the Project boundary within Sections 4 and 5; largely consisting of land with a high probability of occurrence of acid sulfate soils (ASS), ranging from three metres below the ground surface to near ground surface level. The EIS also identified potential impacts during construction; primarily relating to oxidisation of ASS when exposed to air, potentially resulting in soil acidification and dissolved acid runoff, which can result in detrimental impacts on sensitive environments. For the EIS, information on acid sulfate soil issues was primarily obtained from existing acid sulfate soil risk maps.

Additional management measures were provided within the *Woolgoolga to Ballina Submissions/Preferred Infrastructure Report Nov 2013*, with applicable management measures from that report included as part of this CASMMP.

Acid Sulfate Soils (ASS) have formed naturally, commonly in estuarine areas along the east coast of Australia as well as other parts of the continent and throughout the world. If permanently deprived of oxygen, the sulphide minerals in ASS cause no environmental harm and the materials are referred to as Potential Acid Sulfate Soils (PASS). PASS occur predominantly in soils which sit below 5 metres Australian Height Datum (AHD). If exposed to

oxygen, the sulphide minerals in the soil oxidise and can produce excess sulphuric acid. Such soils are referred to as actual acid sulfate soils.

Field characteristics of acid sulfate materials is addressed in Attachment B, Acid Sulfate Material Unexpected Find.

1.3 Environmental management systems overview

The overall Environmental Management System for the Project is described in the Construction Environmental Management Plan (CEMP).

The CASMMP is part of the environmental management framework for the Project, as described in *Section 4.1 of the CEMP*.

Management measures identified in this Plan will be incorporated into site or activity specific Environmental Work Method Statements (EWMS). EWMS will be developed and signed off by environment and management representatives prior to associated works and construction personnel will be required to undertake works in accordance with the identified requirements and associated mitigation measures.

Used together, the CEMP, strategies, procedures and EWMS form management guides that clearly identify required environmental management actions for reference by Golding personnel and contractors.

The review and document control processes for this Plan are described in *Section 1.6 and Section 10 of the CEMP*.

2 Purpose and objectives

2.1 Purpose

The purpose of this Plan is to describe how Golding proposes to manage ASS impacts during construction of the Project.

2.2 Objectives

The key objective of the CASMMP is to ensure that ASS impacts from the construction of the Project are minimised. Specific objectives include:

- Minimise the duration of exposure of disturbed ASS/PASS materials and excavations to minimise oxidation and resultant acid production.
- Ensure that soils identified as ASS or PASS are treated to ensure adequate neutralisation and prevent adverse environmental impacts.
- Ensure appropriate measures are implemented to comply with relevant legislation, CoA, the Environment Protection Licence (EPL) for the Project and the Project Specifications.
- Provide effective mitigation measure to prevent adverse environmental impacts.
- Minimise pubic complaints associated with ASS/PASS issues associated with the Project.

The process for achieving these objectives is documented through mitigation measures detailed in Table 6-1.

2.3 Targets

The following targets have been established for the management of acid sulfate soils during the project:

- Ensure full compliance with the relevant legislative requirements and CoA D26(c) (v).
- Ensure training on acid sulfate soil management is provided to all construction personnel through site inductions.

3 Environmental requirements

3.1 Relevant legislation and guidelines

3.1.1 Legislation

Legislation relevant to the management of contaminated land for the Project includes:

- *Environmental Planning and Assessment Act 1979.*
- *Protection of the Environment Operations Act 1997*.
- Protection of the Environment Operations (General) Regulation 2009.
- Protection of the Environment Operations (Waste) Regulation 2005.
- *Contaminated Land Management Act 1997*.
- *Fisheries Management Act 1994.*

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the CEMP.

3.1.2 Guidelines

The main guidelines, specifications and policy documents relevant to this Plan include:

- *Acid Sulfate Soil Manual*, NSW Acid Sulfate Soil Management Advisory Committee, 1998.
- *Acid Sulfate Soils Assessment Guideline*, NSW Acid Sulfate Soil Management Advisory Committee, 1998.
- *Guidelines for the Management of Acid Sulfate Material, Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze*, RTA, 2005.
- *Queensland Acid Sulfate Soil Technical Manual,* Department of Natural Resources and Mines, 2002.
- *Waste Classification Guidelines Part 1: Classifying waste*, EPA, 2014
- *EPA Waste classification guidelines Part 4: Acid sulfate soils*, EPA, 2014

3.2 Minister's Conditions of Approval

The CoA relevant to this Plan are listed in Table 3-1. A cross reference is also included to indicate where the condition is addressed in this Plan or other project management documents.

Table 3-1 Conditions of Approval relevant to acid sulfate soils

CoA No.	Condition requirements	Document reference
D26 (c) (v)	As part of the Construction Environmental Management Plan for the SSI, the Applicant shall prepare and implement: (c) a Construction Soil and Water Quality Management Plan to manage surface and groundwater impacts during construction of the SSI.	This plan including Appendix A and B,

CoA No.	Condition requirements	Document reference
	The Plan shall be developed in consultation with the EPA, DPI (Fisheries), NOW, Rous Water (in relation to the Woodburn borefield), DoE and the relevant council and include, but not necessarily be limited to: (v) an Acid Sulfate Soils contingency plan, consistent with the Acid Sulfate Soils Manual, to deal with the unexpected discovery of actual or potential acid sulfate soils, including procedures for the investigation, handling, treatment and management of such soils and water seepage.	and CEMP Appendix B4

4 Existing environment

4.1 Potential areas of acid sulfate soils

Information on acid sulfate soils as presented in the EIS was obtained from existing acid sulfate soil risk maps. The Early Works – Wave 1 and 3 (part) project is located within Sections 4 and 5 of the Project, predominantly in low lying areas of the Clarence River floodplain.

Acid sulfate soil risks for Sections 4 and 5 of the Project are detailed in Table 9-4 and Figures 9-15 and 9-16 of the EIS. Additional mapping information is maintained in the AECOM Woolgoolga to Ballina GIS Portal. Table 4-1 below provides a summary of the acid sulfate soil risks for Sections 4 and 5 of the Project, as detailed within the EIS.

Table 4-2 Acid sulfate soil risks within Sections 4 and 5

Section	Predominant ASS risk level	Portion of section with predominant risk level (%)	Details
4	High probability	65	A large part of this section is mapped as having a high probability of occurrence of acid sulfate soils. Isolated areas of no known occurrence are found near Maclean.
5	High probability	100	The entire section is mapped as having a high probability of occurrence of acid sulfate soils.

The specific location of the Wave 1 and 3 (part) works within Section 4 and Section 5 of the Project are shown in the CEMP Appendix A5 – Sensitive Area Plans.

5 Environmental aspects and impacts

5.1 Construction activities

Key aspects of the Project that could cause ASS related impacts include:

- Shallow excavations
- Deep excavations
- Dewatering
- Diverting small open drainage lines.

Refer also to the Aspects and Impacts Register included in Appendix A2 of the CEMP.

5.2 Potential impacts

Potential acid sulfate soils (PASS) are soils rich in iron sulfides (pyrite). If these soils are dried and the pyrite is brought into contact with oxygen, oxidisation occurs and they become acid sulfate soils (ASS). Soil acidification and dissolved acid runoff can adversely impact on the health of land and aquatic plants and animals.

Potential ASS/PASS impacts from construction activities include:

- Uncontrolled surface runoff in areas of exposed ASS, causing the release of acid into the environment.
- Changes to surface run-off patterns promoting the release of acid into the environment;
- Leaching of acid into the environment at ASS treatment sites.
- Exposing ASS at/near new excavations, thus causing the release of acid into the environment in the short and long term.
- Exposure of PASS to the air thus causing oxidisation and conversion to ASS.
- Uncontrolled runoff from acidic water discharging from wick drains.

6 Environmental mitigation and management measures

A range of environmental requirements and control measures are identified in the various environmental documents, including the EIS, supplementary assessments, Conditions of Approval and RMS documents, and from recent experience on similar road projects. Specific measures and requirements to address acid sulfate soil impacts are outlined in Table 6-1.

Table 6-3 Acid sulfate soil management and mitigation measures

ID	Measure/Requirement	Resources needed	When to implement	Responsibility	Reference
GENERAL					
ASS1	Training will be provided to all project personnel, including relevant sub-contractors, on the significance and potential locations of ASS within the Project. This information will be updated during the course of construction as unexpected ASS/PASS is encountered.	RMS Guidelines for the Management of Acid Sulfate Materials, April 2005	Pre-construction/ Construction	Construction Manager/Environmental Site Representative	G36, Good practice
ASS2	All relevant construction personnel and contractors will be trained in the requirements of the Acid Sulfate Materials Management Procedure (Appendix A) and the Acid Sulfate Material Unexpected Find procedure (Appendix B), be aware of the location of the ASS treatment areas and their personal obligations to report excavated ASS or PASS material to their supervisor.		Pre-construction/ Construction	Construction Manager/Environmental Site Representative	G36, Good practice
ASS3	Works in any areas identified as potentially having ASS shall apply the following basic principles: • Aim to divert surface runoff away from acid sulfate material. • Appropriately manage surface runoff contaminated by exposure to acid sulfate material. • Remediate and validate excavated acid sulfate material. • Water from wick drains and preloading areas must be tested for pH and appropriately treated (if required) prior to discharge.		Pre-construction/ Construction	Construction Manager/Environmental Site Representative	G1, G36, Good practice

ID	Measure/Requirement	Resources needed	When to implement	Responsibility	Reference
ASS4	An EWMS will be prepared and implemented to manage ASS. The EWMS will undergo a period of consultation with relevant agencies.		Construction	Superintendent/Environmental Site Representative	G36 and G40
ASS5	All ASS or PASS disturbed during the construction process will be managed in accordance with the Acid Sulfate Soil Management procedure attached at Appendix A and the Acid Sulfate Material Unexpected Find procedure (Appendix B). The requirements will be incorporated into the EWMS referred to in ASS4.		Pre-construction/ Construction	Superintendent/Environmental Site Representative	Submissions / PIR (SSW25) CoA D26(c) v
ASS6	All ASS or PASS disturbed during the construction process will be managed in accordance with the Acid Sulfate Material Management procedure attached at Appendix A. Specific controls to be implemented will include: • Capping of exposed surfaces with clean fill to prevent oxidation where possible. • Placing excavated acid sulfate soils separately in a lined, bunded area. • Neutralising acid sulfate soils for reuse (where appropriate) by using additives such as lime. • Disposing of acid sulfate soils where necessary in accordance with the relevant guidelines set out in EPA (2014). The requirements will be incorporated into the EWMS referred to in ASS4.		Construction	Foreman/Superintendent/ Environmental Site Representative	G1, EIS (SSW31, SSW32)
ASS7	Strategies to remove/reduce risks associated with acid sulfate soils will be identified.		Pre-construction and Construction	Environmental Site Representative/Superintendent/ Foreman	Submissions / PIR (SSW24)

ID	Measure/Requirement	Resources needed	When to implement	Responsibility	Reference
ASS8	An acid sulfate soils management plan will be implemented in accordance with Guidelines for the Management of Acid Sulfate Materials (Roads and Maritime 2005) and Waste Classification Guidelines Part 4: Acid Sulfate Soils (EPA 2014), where there is a probability of encountering acid sulfate soils during construction.		Construction	Environment Site Representative /Superintendent/ Foreman	Submissions / PIR (SSW25)
IDENTIFICATION OF ASS					
ASS9	Testing for the presence of ASS shall be undertaken in locations as directed by the Principal and shall apply the following methodology: • Bore/dig holes 2.0 m deep, conduct four ASS screen tests on material from each bore at 0.5, 1.0, 1.5 and 2.0 m depths, then conduct 2 SPOCAS plus suites of tests on the two most acidic ASS screen test samples. • Testing and sampling to be undertaken in accordance with ASSMAC Guidelines. • Engage a specialist Subcontractor acceptable to the Principal for this testing.	Acid Sulfate Soil Manual, NSW Acid Sulfate Soil Management Advisory Committee, 1998.	Pre-construction /Construction	Construction Manager/Environmental Site Representative	G1, G36, Good Practice
STOCKPILING OF ASS					
ASS10	The location of stockpiles of acid sulfate material will be identified in consultation with RMS and in accordance with the Acid Sulfate Materials Management procedure (Appendix A).		Pre-construction/ Construction	Construction Manager/ Environmental Site Representative	G36, Good Practice
ASS11	Acid sulfate materials shall be segregated from non-acidic producing materials.		Pre-construction/ Construction	Construction Manager/ Environmental Site Representative	G1, G36, Good Practice

ID	Measure/Requirement	Resources needed	When to implement	Responsibility	Reference
ASS12	Stockpiles of acid sulfate material shall be located in a low permeability bunded area. Divert runoff from the stockpile via collector drains to a basin for monitoring and treatment of acid runoff.		Pre-construction/ Construction	Construction Manager/ Environmental Site Representative	G1, G36, Good Practice
TREATMENT OF ASS					
ASS13	Treatment of ASS material shall be done with Agricultural Lime (neutraliser) at a dosage rate agreed by RMS. The requirement for this process is detailed within the Acid Sulfate Materials Management procedure (Appendix A).		Pre-construction/ Construction	Construction Manager/ Environmental Site Representative	G1, G36, Good Practice
ASS14	Water from wick drains and runoff from ASS material to be tested and treated		Pre-construction/ Construction	Construction Manager/ Environmental Site Representative	G1, Good Practice
REUSE OF TREATED ASS					

ID	Measure/Requirement	Resources needed	When to implement	Responsibility	Reference
ASS15	Treated acid sulfate soil (neutralised) may be incorporated into the works except in the following locations: • Verges • Drainage layers • Rip Rap • Rock linings in drains. • Abutment batter treatments. • Within the upper zone of formation. • Within the top 400 mm of general fill. • Within 0.5 m of a median drawn invert or within 0.5 m of the top of a drainage layer. Prior to placement of the treated material, RMS must receive certification stating the material complies with requirements of RMS R44.		Pre-construction/ Construction	Construction Manager/ Environmental Site Representative	G1, G36, Good Practice
DISPOSAL OF ASS					
ASS 16	Spoiling of acid sulfate material will only be approved if it can be demonstrated that the material is surplus to the work. It must be appropriately treated prior to spoiling or spoiled to a suitable legal source.		Construction	Construction Manager / Environmental Site Representative	G1

7 Compliance management

7.1 Roles and responsibilities

The Project Team's organisational structure and overall roles and responsibilities are outlined in *Section 4.2 of the CEMP*. Specific responsibilities for the implementation of environmental controls are detailed in Section 6 of this Plan.

7.2 Training

All employees, contractors and utility staff working on site will undergo site induction training relating to acid sulfate management. The induction training will address elements related to acid sulfate management including:

- Existence and requirements of this sub-plan.
- Relevant legislation.
- Roles and responsibilities for acid sulfate material management.
- Procedure to be implemented in the event of an unexpected discovery of acid sulfate material.

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in acid sulfate soil management. Examples of training topics include:

- Acid sulfate material stockpile locations and control methods.
- Working near or in drainage lines and creeks.
- Identification of acid sulfate material including:
    - Soil pH of <4.
    - A sulphurous smell following disturbance of soils.
    - Pale yellow surface encrustations.
    - Excessive iron staining on drain surfaces or stream banks; iron stained drain water; orange red ochre deposits around water bodies.
    - Excessive corrosion of concrete and/or steel structures exposed to ground or drainage waters.
    - Blue-grey, blue-green or grey waterlogged soils which smell of rotten egg gas.
- Treatment and validation of acid sulfate materials.

Further details regarding staff induction and training are outlined in *Section 5 of the CEMP*.

7.3 Monitoring and inspection

Regular monitoring and inspections will be undertaken during construction.

Additional requirements and responsibilities in relation to inspections, in addition to those in Table 6-1, are documented in *Section 8.2 of the CEMP* and the Acid Sulfate Materials Management procedure in Attachment A.

7.4 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental mitigation and management measures, compliance with this plan, CoA and other relevant approvals, licenses and guidelines.

Audit requirements are detailed in *Section 8.4 of the CEMP*.

7.5 Reporting

Reporting requirements and responsibilities are documented in *Sections 8.4 and 8.5 of the CEMP*.

Appendix A
Acid Sulfate Materials Management
- Construction Procedure

CONSTRUCTION PROCEDURE
ACID SULFATE MATERIALS MANAGEMENT

Purpose: To define the method of testing, treatment and management to be used for Acid Sulfate Material (ASM).

Project No.:	RMS 00031	**Project Description:**	Pacific Highway Upgrade - Woolgoolga to Ballina Early Works – Wave 1 and Wave 3 (part)
Scope of Procedure	This procedure is applicable to activities conducted by Golding personnel and subcontractors that have the potential to uncover/encounter Acid Sulfate Soils (ASS) and Potential Acid Sulfate Soils(PASS) such as excavations, earthworks and drainage. This Construction Procedure details the requirements to manage ASS/PASS in accordance with the Construction Acid Sulfate Materials Management Subplan, Environmental Protection Licence and Ministers Conditions of Approval. The procedure details the process involved in the following elements of managing ASS/PASS: **Training & Identification of ASM** → **ASM Handling & Storage** → **ASM Treatment** → **Monitoring** Refer to attached Figure for ASS/PASS procedure flowchart.		

Procedure

1. Acid sulfate material encountered during excavation / construction activities
If ASS/PASS is encountered by chance during excavation / construction activities: ***STOP ALL WORK*** *in the immediate / affected area and follow the steps detailed in the Acid Sulfate Material Unexpected Find procedure.* If ASS/PASS is expected during excavation and test results are available to determine treatment rates, then proceed to **Step 4 of this procedure.**

2. Identification of Acid Sulfate Material

The identification of ASS/PASS shall be performed as detailed in Acid Sulfate Material Unexpected Find procedure.

3. Personnel Protective Equipment (PPE)

Prior to any PASS / ASS management, appropriate personal protective equipment (PPE) is to be worn as per relevant MSDSs (e.g. for Lime). This may include:

- Eye protection and/or face masks
- Hard Hat
- Rubber boots, gloves
- Appropriate clothing (e.g. long sleeved shirts).

4. Acid Sulfate Material Storage and Handling

Organising the storage and handling of ASS/PASS is the responsibility of the Supervisor.

Storage

Acid sulfate material will be stored in a designated Acid Sulfate Treatment Area (ASTA).

Transport of ASS/PASS material

Transport of ASS / PASS material will be made via haulage trucks with adequate tailgates to prevent spillage of material onto public or construction access roads.

Haulage routes will be monitored routinely for ASS material and any spills cleaned up appropriately.

Acid Sulfate Treatment Area

The ASS / PASS treatment area will be constructed as per the treatment pad design guideline included at the end of this procedure. The location of treatment pads will identified on erosion and sediment control plans and included on sensitive area maps as identified. The Stockpile Location Checklist is to be completed and approval obtained from the Environmental Representative (ER) prior to stockpile establishment in accordance with CoA D21.

Treatment pads are considered Ancillary Facilities under the CoA Definitions and sites that have not been identified and assessed in the documents listed in CoA A2 shall meet the requirements in clause B73. A checklist of these conditions is included in the Stockpile Location Checklist.

5. Acid Sulfate Material Treatment

Testing requirements

Sampling and testing for acid sulfate material shall be in accordance with ASSMAC Guidelines and undertaken by an appropriately qualified subcontractor acceptable to the Principal.

Acid sulfate material screen testing to identify acid sulfate soils shall be by pH_{FOX} (oxidised using 30 per cent H_2O_2 solution) testing as materials are excavated, then determine the level of acid sulfate content and treatment measures by undertaking SPOCAS Plus analysis testing. Preliminary assessment results for the soils shall be reported to the Principal in accordance with Table 2.4 and Clause 2.3 of the ASSMAC Guidelines, including recommendations for the proposed treatment of soil.

Neutralising Agent

Aglime (or alternative) material will be stored at the ASTA in sufficient quantities to enable the treatment of acid sulfate material expected for the work activities being undertaken. The management of onsite treatment is the responsibility of the Supervisor, with assistance from the ESR.

Aglime will be covered with tarpaulin and stored in 'dry areas' such as an elevated holding bin or within a bunded ASTA to prevent runoff leaching into the surrounding area and to minimise dust.

Agricultural lime must comply with the following (minimum frequency of testing 1 per 1000 tonne):

(a) Fertilisers Act NSW 1985

(b) have a particle size distribution as follows as determined by AS 4489.2.1:

- *Passing 4.75mm sieve – minimum 95%*
- *Passing 1.18mm sieve – minimum 50%*
- *Passing 0.075mm sieve – minimum 10% and maximum 90%*

(c) have a minimum Neutralising Value of 85% in any standard particle size range as determined by AS 4489.6.1

(d) have a maximum moisture content of 10% as determined by AS 4489.8.1.

Prior to the establishment of aglime stockpiles outside the ASS treatment area, Stockpile Location Checklist (in accordance with CoA B73-B78) is to be completed and approval obtained from the Environmental Representative.

***In situ* treatment of acid sulfate material**

In situ treatment of acid sulfate material will be undertaken for exposed surfaces (batters/trenches) and works where the disturbed material will be used as backfill material after treatment, for example during excavation.

- Runoff shall be diverted away from exposed acid sulfate material.
- Cut batters and/or trenches shall be coated with fine aglime at a rate determined by the SPOCAS Plus test and the lime checked and re-limed as required on the advice of the 'appropriately qualified subcontractor'. Re-liming may be required on a daily basis during heavy rain or dewater activities
- Lime will be added over the top of the pre-disturbed soil in the appropriate quantities as determined by the SPOCAS Plus test results and thoroughly mixed.

Treatment within an ASTA

- Mixing lime through the acid sulfate material is undertaken using the following methodology. 1/3 of the total aglime required for the excavated material (determined from lab testing) will be placed as a bed over the proposed treatment location.
- ASS or PASS material is to be placed on top of the lime in a layer no greater than 350mm and allowed to dry sufficiently.
- When the material is dry (expected 1-2 days in dry weather), another 1/3 of the total lime shall be added to the top and sides of the stockpile and thoroughly mixed, using either small or large mechanical equipment such as a disc plough or rotary hoe attached to a tractor or other suitable equipment.
- The partially treated stockpile shall then be allowed to dry further if required.
- The remaining 1/3 of lime shall be added to the top and sides of the stockpile.
- Thoroughly mix the stockpile using a rotary hoe (either on a tractor or as an excavator attachment). Where an excavator is to be used increase the safety factor to 2-2.5 dependent on the difficulty of mixing lime into the material.
- Sample the treated material and test by laboratory analysis using the SPOCAS Plus method to confirm the neutralisation of the material (see Section 6)

- When the treated soil is confirmed as being neutral then it may be incorporated in the Work in accordance with the limitations identified in QA Specification G1, clause 15.2.2.
- In addition to the requirements of RMS R44, prior to placement of treated acid sulfate materials the Principal must be provided with certification that the material is suitable for reincorporation including original TS% test results, details of treatment(s) and confirmation of where the material is to be re-used. Submission under this clause constitutes a HOLD POINT.
- The final location of the neutral soil shall then be tracked and recorded using the Treated ASS Tracking Register.

For small quantities of ASS / PASS material, such as an individual truck load, lime will be mixed using an excavator bucket.

Note: the ratios of aglime to be added may be varied on approval by the ESR.

6. Treated Acid Sulfate Material Monitoring

Following mixing and additional drying, if required, the treated soil, including exposed batters, is to be tested by laboratory analysis using the SPOCAS Plus method to determine if the Action Criteria for determining the neutralisation of treated material has been met (Action Criteria shown in Table 1).

Treated acid sulfate material will be determined to be neutral if results for the acid and/or sulphur trails are below the criteria detailed in Table 1. Consideration must be given to the amount of treated soil and the soil texture. If any doubt exists over either factor, the lowest criteria of 0.03% oxidisable sulphur or 18 Mol H+ per tonne shall be used.

If testing shows the criteria are met, and the pH of the soils and leachate pond does not fall below pH 6.5 no further treatment is required and the material may be reused on site. A record of where this treated material is transported to must be kept via Treated ASS Tracking Register.

If these acid and sulphur criteria are not met, further mixing with additional treatment product is required on the relevant material until targets are met. The amount of additional treatment product can be determined from results of the sulphur and acid trails.

Verification testing rates

Minimum volumetric rates (depending on existing plus potential acidity) are:

- <0.5% S-equivalent (<312 mol H+/tonne) – 1 per 1000 m^3
- 0.5–2% S-equivalent (312–1247 mol H+/tonne) – 1 per 500 m^3
- >2% S-equivalent (>1247 mol H+/tonne) – 1 per 250 m^3.

The specialist Subcontractor acceptable to the Principal shall conduct composite sampling taken according to a random or stratified-random protocol. Sampling and testing frequency may be modified by the specialist Subcontractor in accordance with site conditions and industry best practice. Sampling will include verification testing following decommissioning of ASTA.

7. Treatment of water

Where wick drains are used to speed up settlement, water quality of drained water will be assessed and contained in drains and holding ponds, and treated prior to surface discharge.

When the pH of the leachate pond falls below 6.5 the water must be treated prior to discharge using hydrated lime in the ratio detailed in Table 2.

Discharge from leachate capture ponds shall be in accordance with procedures within Appendix B4 – Construction Soil and Water Quality Management Plan and the EWMS – Dewatering Activities.

Training

Site Specific Induction

Environmental Awareness Training – Acid Sulfate Soils Module.

Toolbox Talk – Acid Sulfate Soil Impacts.

Table 1: Action Criteria (for determining neutralisation of treated soil)

TYPE OF MATERIAL		ACTION CRITERIA 1-1000 TONNES DISTURBED		ACTION CRITERIA >1000 TONNES DISTURBED	
Texture	Approx Clay Content %	Equivalent Sulphur % S Oxidisable	Equivalent Acid Mol H+ / tonne TPA	Equivalent Sulphur % S Oxidisable	Equivalent Acid Mol H+ / tonne TPA
Coarse Texture (sands to loamy sands)	<5	0.03	18	0.03	18
Medium Texture (sandy loams to light clays)	5-40	0.06	36	0.03	18
Fine Texture (medium to heavy clays and silty clays)	>40	1	62	0.03	18

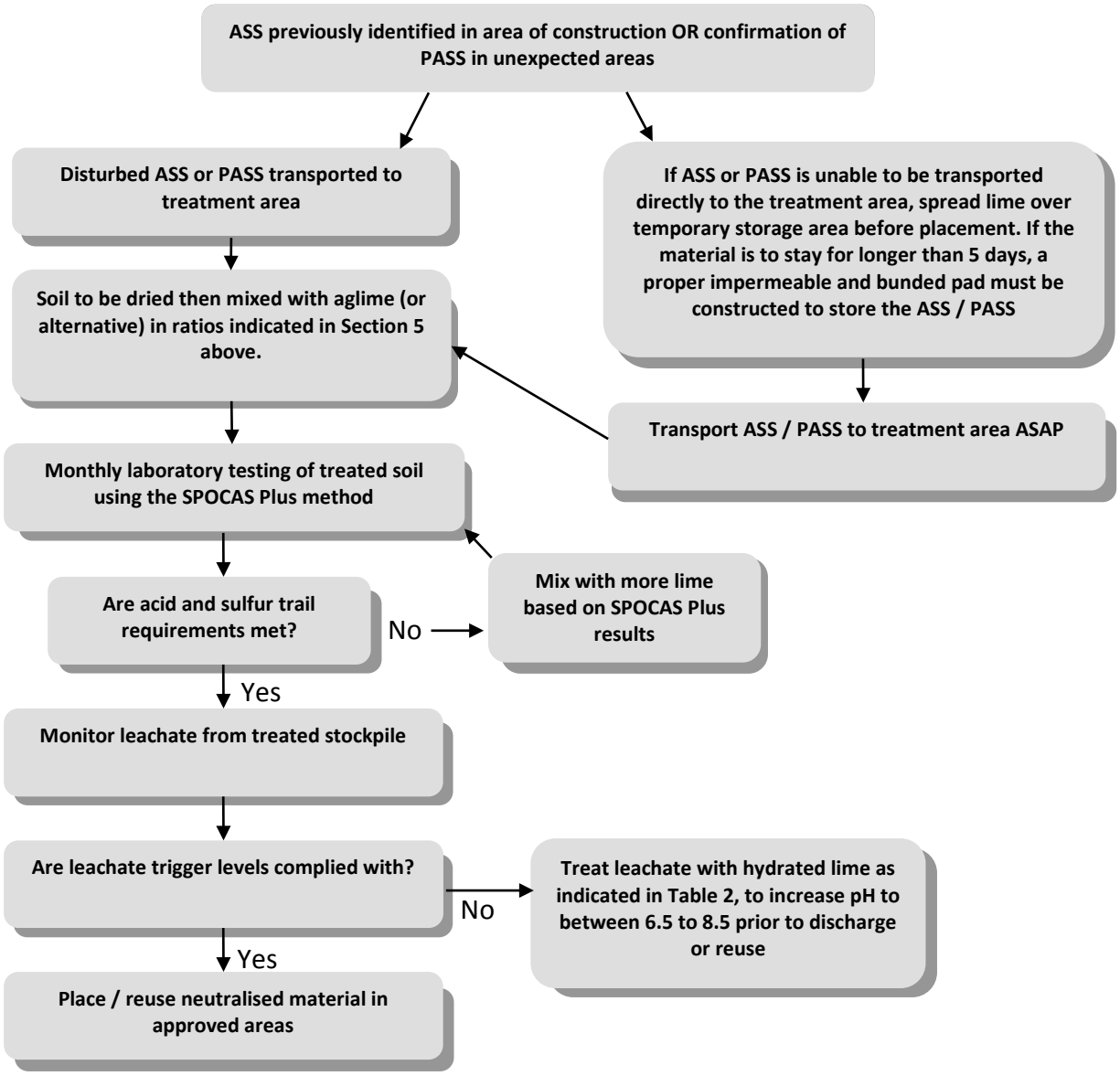
Table 2: Leachate Pond Hydrated Lime Treatment Ratios

Table 7.1 Quantity of pure neutralising agent required to raise from existing pH to pH 7 for 1 megalitre of low salinity acid water.

Current Water pH	*$[H^+]$ {mol/L}*	*H^+ in 1 Megalitre {mol}*	*Lime to neutralise 1 Megalitre {kg pure $CaCO_3$}*	*Hydr. lime to neutralise 1 Megalitre {kg pure $Ca(OH)_2$}*	*Pure $NaHCO_3$/ 1 Megalitre {kg }*
0.5	.316	316,228	15,824	11,716	26,563
1.0	.1	100,000	5,004	3705	8390
1.5	.032	32,000	1,600	1185	2686
2.0	.01	10,000	500	370	839
2.5	.0032	3,200	160	118	269
3.0	.001	1,000	50	37	84
3.5	.00032	320	16	12	27
4.0	.0001	100	5	4	8.4
4.5	.000032	32	1.6	1.18	2.69
5.0	.00001	10	0.5	0.37	0.84
5.5	.0000032	3.2	0.16	0.12	0.27
6.0	.000001	1	0.05	0.037	0.08
6.5	.00000032	.32	0.016	0.12	0.027

CONSTRUCTION PROCEDURE
ACID SULFATE MATERIALS MANAGEMENT

The following flow chart details the summary of the steps required to effectively treat ASS / PASS



CONSTRUCTION PROCEDURE
ACID SULFATE MATERIALS MANAGEMENT
Treatment pad design guideline

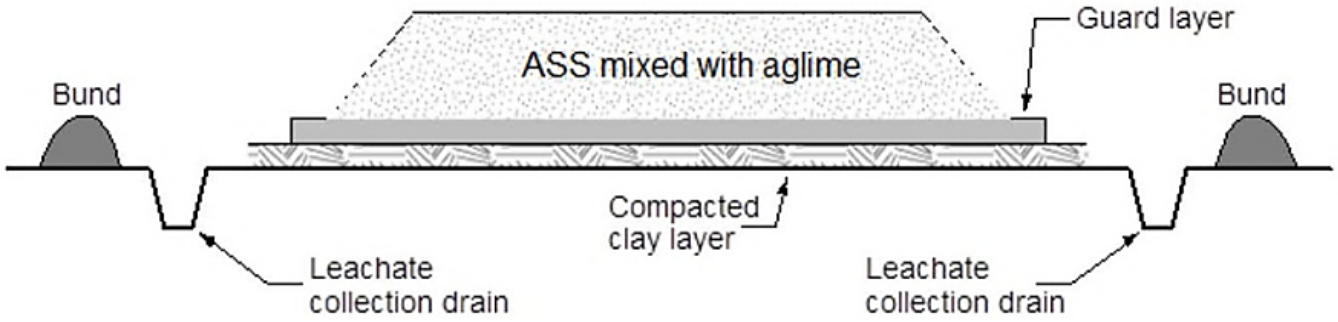
1 Impervious base

A layer of compacted non-ASS clayey material (>0.1 metres thick) placed on the surface of the treatment pad can reduce the infiltration of leachate to the soil and groundwater. An impervious base is particularly beneficial if the treatment pad is situated in a sandy area. The base layer should be slightly domed or sloped to prevent leachate from pooling in the treatment pad area.

2 Guard layers

For situations where treated ASS will remain permanently in its treatment location, a guard layer of neutralising agent should be spread onto the soil surface of the treatment pad before the placement of soils (see Figure 1 below). 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 ASS that is placed for treatment before application of the neutralising agent. The guard layer will help protect groundwater quality.

Figure 1: Schematic cross-section of a treatment pad, including a compacted clay layer, guard layer, leachate collection system and containment with bunding.



The guard layer should be employed as a precaution to neutralise acidity that has not been adequately treated during the soil neutralisation process.

The minimum guard layer rate beneath any treated-in-place ASS will be 5 kilograms fine aglime per m^2 per vertical metre of fill. Where the highest detected sum of existing and potential acidity is more than 1.0% S-equivalent, the rate will be at minimum 10 kilograms fine aglime per m^2 per vertical metre of fill.

Note: Reapplication of the guard layer will be necessary under temporary treatment pads, as the guard layer is likely to be removed with the treated soil. Guard layers may need to be applied between each compacted ASS layer as a precaution in environmentally sensitive areas, areas with high levels of sulfides or where soils are difficult to mix.

Stockpiling of acid sulfate material

When stockpiling acid sulfate materials within the treatment pad is unavoidable, the following additional requirements shall apply:

- Line the bund with a clay lining mixed with neutralising agent (50kg/m3) and a minimum of 500mm thick
- The stockpile site must be above the 1 in 20 ARI flood level.

3 Containment

Stormwater runoff and leachates should be contained within treatment pads by suitable bunds and may be collected in a sump or retention pond. Diversion drains should be installed to prevent stormwater run-on into the treatment pad. Surface liming of earth bunds and diversion drains can help neutralise any acidic stormwater. Bunds and diversion drains should not be constructed out of untreated ASS or other materials that may be a source of contaminants to the environment. The materials used should have low permeability to avoid leakage. Waters should be monitored and if necessary treated before reuse or release.

4 Treatment pad location and dimensions

Treatment pads should be located on stable ground above the 1 in 20 ARI flood level, away from overland flow paths and preferably in a location where bund and leachate collection pond construction does not disturb in situ ASS.

Treatment pads should be set up to allow maximum treatment batch sizes of 500 m^3, as it is difficult to representatively sample larger batches, and re-treatment of large failed batches is expensive.

5 Decommissioning

Decommissioning will include verification testing to ensure no residual effect for acid sulfate material and restoration of the acid sulfate material treatment area to an agreed final landform.

Appendix B
Acid Sulfate Material Unexpected Find - Construction Procedure

CONSTRUCTION PROCEDURE
ACID SULFATE MATERIAL UNEXPECTED FIND

Purpose: Acid Sulfate Soils (ASS) are the common name given to sediment and soils containing iron sulphides which when exposed to oxygen generate sulphuric acid. If untreated, runoff from ASS could cause the release of acid into the environment. Potential Acid Sulfate Soils (PASS) are rich in iron sulphides (pyrite) which if brought into contact with oxygen, oxidisation occurs and they become ASS. This procedure details the actions to be taken when acid sulfate materials are unexpectedly encountered during excavation / construction activities. Consequences of not following this procedure could lead to significant impacts on built infrastructure, the natural environment and conservation of biodiversity

Project No.:	RMS 00031	**Project Description:**	Pacific Highway Upgrade - Woolgoolga to Ballina Early Works – Wave 1 and Wave 3 (part)
Scope of Procedure	This procedure is applicable to all activities conducted by personnel that have the potential to uncover/disturb ASS/PASS. Refer to the attached figure for ASS/PASS Unexpected Find Procedure flow chart.		

Procedure

1. Unexpected Disturbance of ASS / PASS

If on-site personnel suspect that ASS or PASS has been unexpectedly disturbed, stop work in the immediate vicinity, notify the Environmental Site Representative (ESR). The ESR is responsible for undertaking field pH testing of ASS/PASS.

ASS Characteristics:

Any of the following characteristics y indicate the presence of ASS:

- Soil pH of <4;
- A sulphurous smell following soil disturbance;
- Pale yellow surface encrustations;
- Excessive iron staining on drain surfaces or stream banks, or iron stained drain water and orange red ochre deposits around water bodies;
- Excessive corrosion of concrete and / or steel structures exposed to ground or drainage waters, or rapid corrosion of fresh steel in the soil; and
- Blue-grey, blue-green or grey waterlogged soils which smell of rotten egg gas.

High risk indicators for PASS could include:

- Low position in the landscape;
- Soil from beneath the water table;
- Heavy textures;
- Dark colours; and
- Sulphur odour (rotten egg odour).

The ESR will undertake testing to determine the acidity (field pH test) and potential for acidity (field 30% peroxide test). The procedure for conducting the 30% field peroxide test and indicators of positive results are included at the end of this procedure.

If it is shown conclusively that the material is not ASS or PASS, construction can proceed as normal. If results are positive or inconclusive proceed to Step 2.

2. Positive or Inconclusive Field Test Result for ASS / PASS

If field tests are positive or inconclusive, laboratory analysis using the SPOCAS Plus test will be required to determine if the material is in fact acid sulfate material and/or the required treatment rates based on the net acidity. In this event all disturbed undetermined material must be taken to an Acid Sulfate Treatment Area (ASTA) in accordance with the Acid Sulfate Sub Management Plan and Acid Sulfate Material Management procedure.

If the SPOCAS Plus laboratory testing results confirm the presence of acid sulfate material, the material will be treated in accordance with the above procedure with appropriate liming rates based on SPOCAS Plus analysis results.

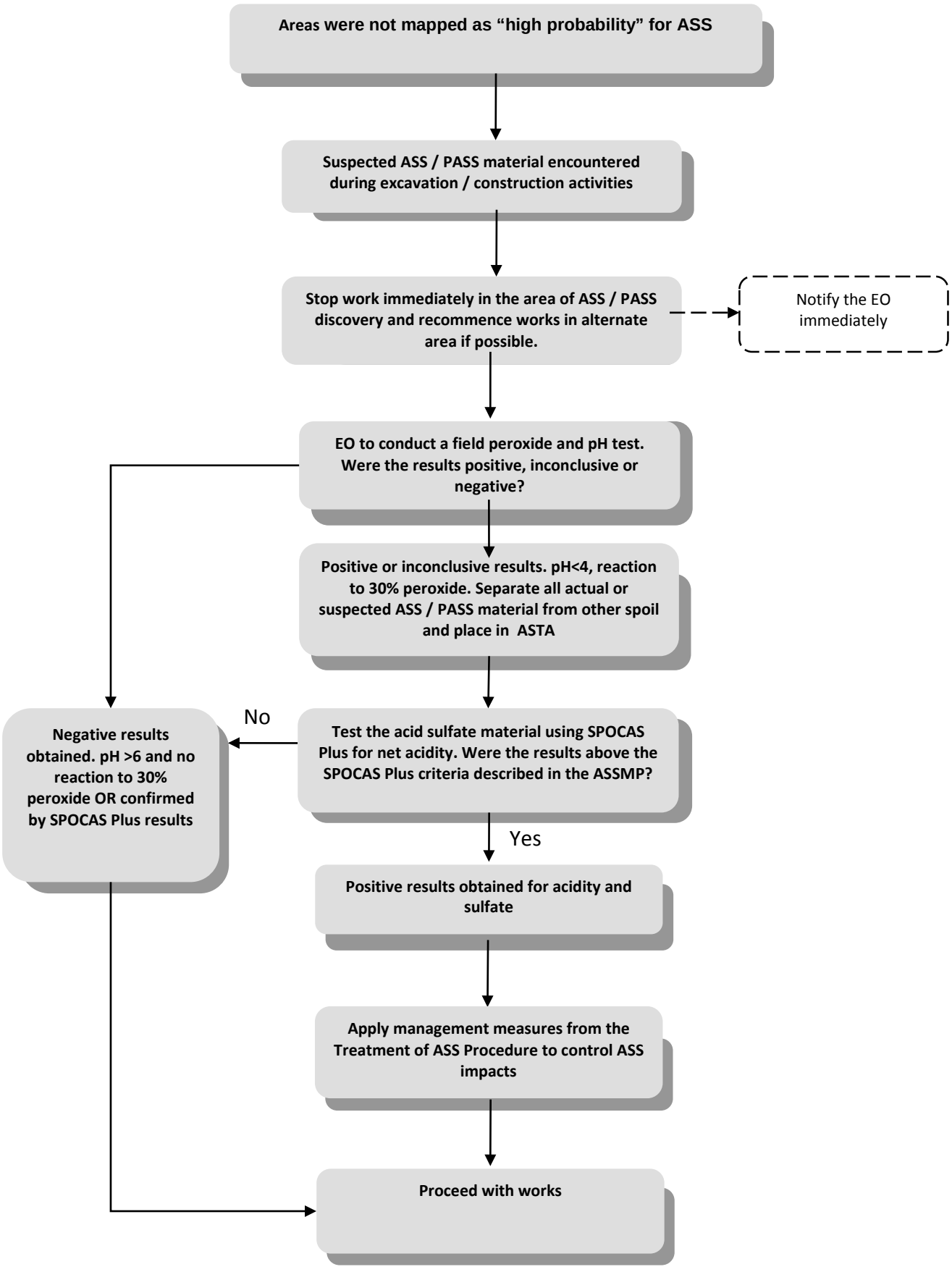
3. Personal Protective Equipment (PPE)

Prior to any PASS / ASS treatment, appropriate personal protective equipment (PPE) is to be worn as per the MSDS (e.g. for Lime)

This may include:

- Eye protection;
- Hard hat;
- Face mask;
- Rubber boots, gloves; and
- Appropriate clothing (e.g. long sleeved pants and shirts).

CONSTRUCTION PROCEDURE
ACID SULFATE MATERIAL UNEXPECTED FIND



Field pH and the 30% Peroxide Test

ASSMAC Assessment Guidelines

1 Field pH Test

The field pH (pHF) of actual ASS tends to be ≤ 4 while the field pH of PASS tends to be neutral. Field pH provides a useful quick indication of the likely presence and severity of "actual" acid sulfate soils. The field pH is a qualitative method only that cannot be used as a substitute for laboratory analysis in the identification of acid sulfate soils for assessment purposes.

Field pH readings should be taken at regular intervals down the soil profile. It is recommended this test be done every 0.25m down the profile but at least every 0.5m interval or horizon whichever is the lesser.

pH Indications:

- pH readings of pH ≤4, indicates that actual acid sulfate soil are present with the sulphides having been oxidised in the past, resulting in acid soil (and soil pore water) conditions.
- pH values >4 and <5.5 are acid and may be the result of some previous or limited oxidation of sulphides, but is not a definite confirmation of actual ASS. Substantial exchangeable / soluble aluminium and hydrogen ions usually exist at these pH values. Other factors such as excessive fertiliser use, organic acids or strong leaching can cause pH >4 - <5.5. Field pH alone cannot indicate potential ASS as they may be neutral to slightly alkaline when unoxidised.

In order to test for potential acid sulfate soils that contain unoxidised sulphides, peroxide is used to rapidly oxidise the iron sulphides (usually pyrite), resulting in the production of acid with a corresponding drop in pH.

Notes on pH equipment
Preferably a battery powered, field pH meter with a robust, spear point, double reference pH electrode should be used. The probe can be inserted directly into soft wet soils or soil mixed up into a paste with deionised water. Care must be exercised not to scratch the electrode on sandy or gravely soils. The probe should be standardised prior to use and regularly during use against standard solutions according to the manufacturer's instructions. Alternatively, an approximate 1:5 ratio of soil:deionised water suspension can be made up in small tubes, hand shaken and pH of the solution measured. pH test strips can be used to give an approximate value (pH +/- 0.25). Raupach soil pH test kits should be used with caution as they can give erroneous results. Both these latter methods are based on mixed indicator solutions that give a pH dependant colour and are subject to interferences.

2 Field Peroxide pH Test

To test for the presence of unoxidised sulphides and therefore PASS, the oxidation of the soil with 30% (100 volume) hydrogen peroxide can be performed in the field. The most common method is:

A small sample of soil (approx. 5 g) is placed in a small glass container (e.g. short clear centrifuge tubes, clear tissue culture clusters or sample jar) and a small volume of peroxide is dropped onto the soil (20 mL).

Note: Allow the digested solution to cool after the reaction.

A pH probe will only measure to 60℃.

The reaction should be observed and rated. In some cases, the reaction may be instantaneous; in others, it may take 10 minutes or more. Heating over hot water or in the sun may be necessary to start the reaction on cool days, particularly if the peroxide is cold.

Potentially positive reactions for PASS includes one or more of the following:

- change in colour of the soil from grey tones to brown tones
- effervescence
- the release of sulphurous odours
- final pH of <3.5 and preferably < 3
- lowering of soil pH by at least one pH unit

The strength of the reaction is a useful indicator. The peroxide test is most useful and reliable with clays and loams containing low levels of organic matter. It is least useful on coffee rock, sands or gravels, particularly dredged sands with low levels of sulphuric material (e.g. <0.05 % S). With soils containing high organic matter (such as surface soils, peats, mangrove / estuarine muds, and marine clays), care must be exercised when interpreting the reaction as high levels of organic matter and other soil constituents particularly manganese oxides can also cause a reaction.

Note of caution with the use of peroxide
30 % hydrogen peroxide is a strong oxidising agent and should be handled carefully with appropriate eye and skin protection. This test should be only undertaken by trained personnel. The pH of analytical grade peroxide may be as low as 3 as manufacturers stabilise technical grade peroxide with acid, The peroxide pH should be checked on every new container and regularly before taking to the field and adjusted to 4.5 - 5.5 with a few drops of 0.1M NaOH if necessary. False field pH_{FOX} readings could result if this step is not undertaken.

3 pH After Oxidation

The measurement of the change in the pH_{FOX} following oxidation can give a useful indication of the presence of sulphuric material and can give an early indication of the distribution of sulphide down a core/ profile or across the site. The pH after oxidation test is not a substitute for analytical test results.

If the pH_{FOX} value is at least one unit below field pH_F, it may indicate potential acid sulfate soils. The greater the difference between the two measurements, the more indicative the value is of a potential acid sulfate soils. The lower the final pH_{FOX} value is, the better the indication of a positive result.

- If the pH_{FOX} < 3 and there was a strong reaction to the peroxide, there is a high level of certainty of a potential acid sulfate soils. The more the pH_{FOX} drops below 3, the more positive the presence of sulphides.
- A pH_{FOX} 3-4 is less positive and laboratory analyses are needed to confirm if sulphides are present. Sands particularly may give confusing field test results and must be confirmed by laboratory analysis.
- For pH_{FOX} 4-5 the test is neither positive nor negative. Sulphides may be present either in small quantities and be poorly reactive under quick test field conditions. In some cases, the sample may contain shell / carbonate that neutralises some or all acid produced by oxidation. In other cases, the pH_{FOX} value may be due to the production of organic acids and there may be no sulphides present. In these cases, analysis for sulphur using the POCAS method would be the best to check for the presence of oxidisable sulphides.
- For pH >5 and little or no drop in pH from the field value, little net acid generating ability is indicated. Again, the sulphur trail of the POCAS method should be used to check some samples to confirm the absence of oxidisable sulphides.

Care is needed with interpretation of the result on highly reactive soils. Some soil minerals other than pyrite react vigorously with peroxide, particularly manganese but may only show small pH changes.

Note of caution with testing of soil with high organic content
Note: When selecting soil for testing it is advisable to avoid material high in organic matter as the oxidation of organic matter can lead to the generation of acid. However pH of soils containing organic matter and no pyrite do not generally stay below 4 on extended oxidation. In general positive tests on 'apparently well drained' surface soils should always be treated with caution and followed up with laboratory confirmation.

The field peroxide tests can be made more consistent if a fixed volume of soil (using a small scoop) is used, a consistent volume of peroxide is added and left to react for an hour, and the sample is made up to a fixed volume with deionised water before reading. However, such procedures take time in the field and are more suited to a 'field shed' situation. When effervescence (sometimes violent) has ceased, a few additional mL of peroxide should be added until the reaction appears complete. If the reaction is violent, it is recommended that deionised water be added to cool and dilute the reaction. The test may have to be repeated with a small amount of water added to the soil prior to peroxide addition. The pH^{FOX} of the resultant mixture is then measured.

