Australian Government Initiative

WATER QUALITY AUSTRALIA

National Acid Sulfate Soils Guidance

A synthesis

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Foreword

The management of acid sulfate soils in Australia has shown large advances since the 1990s when the disturbance of soils containing sulfide minerals caused large fish kills in rivers in northern New South Wales. These incidents led to the development of a National Strategy for managing acid sulfate soils in coastal areas and the formation of the National Committee for Acid Sulfate Soils, (NatCASS) which was responsible for promoting and supporting the implementation of the national strategy by state and territory jurisdictions.

Since its inception in 2000, NatCASS continues to provide expert guidance on recurrent and emerging acid sulfate soil management issues to government, the community and industry. NatCASS has served to highlight that the disturbance of acid sulfate soils is a significant natural resource management issue and has been instrumental in developing approaches and strategies designed to avoid, minimise and mitigate costly damage to aquatic ecosystems, agriculture and fisheries, and to built infrastructure.

Although most states and territories have developed guidelines for assessing and managing environmental problems associated with acid sulfate soils, due to significant advances in science, knowledge and understanding of acid sulfate soils, some of the guidance is now dated and does not adequately address a number of specific management issues associated with the disturbance of sulfidic materials.

Consequently, NatCASS, in collaboration with the Commonwealth Government and state and territory governments, has developed new and revised national guidance to fill critical information gaps and provide expert advice based on current scientific knowledge. Specifically, the current suite of guidance documents provides updated information on the field assessment and chemical analysis of sulfidic and sulfuric soil materials (that is, potential and actual acid sulfate soils). Additionally, for the first time guidance is being provided on:

- the management of groundwater abstraction for construction dewatering in areas with sulfidic soil materials;
- the management of sulfidic dredge soil; and
- the management of accumulations of monosulfidic blacks oozes (MBOs).

On behalf of NatCASS, I encourage you to make full use of this comprehensive, integrated suite of national acid sulfate soils guidance to guide the management of sulfidic material in the natural resource landscape, particularly where development works on land or in waterways underlain by sulfidic soils and sediments is likely to occur.

NatCASS welcomes feedback on these guidance documents and on any other acid sulfate soil management issue via www.waterquality.gov.au/contact.

Dr Steve Appleyard

NatCASS Chair

1 The purpose of this synthesis

Acid sulfate soil (ASS) science in Australia, apart from a few notable reports and papers, started in earnest in the late 1980's in northern New South Wales (NSW). It is thus less than 30 years since the environmental hazards and risks associated with ASS have been recognised broadly by the scientific and regulatory community. Given this relatively short history of the recognition of the importance of ASS science in Australia, the quantity and range of guidance and other reports and papers concerning ASS is perhaps surprisingly high to land managers.

The purpose of this synthesis is to provide a review of the range of ASS guidance materials both past and present and to examine the coverage provided by them for a range of main issues of current concern associated with ASS. This report aims to clearly identify the past, and the current primary sources of ASS guidance material and introduces new national guidance for ASS as well as a decision support tool to assist users to navigate the range of guidance available.

It should be noted that national guidance is by its very nature broad in context and will need to be augmented, and in many cases underpinned, by local and regional guidance. Consequently, as well as accessing national guidance for ASS, there will be a need to contact relevant state or territory government departments for specific local and regional information and advice on ASS-related issues.

This synthesis is divided into the following five sections:

1 ASS guidance and other materials relating to understanding or managing ASS,

2 Current primary sources of guidance and 'historic' guidance materials considered to have been superseded by other more recent guidance,

3 A division of the guidance from a national level, that from state and territory governments, that from local governments, and that from other agencies,

4 National guidance comprising of

- 4.1 The National Strategy for the Management of Coastal Acid Sulfate Soils
- 4.2 National Guidance for the Management of Acid Sulfate Soils in Inland Aquatic Environments
- 4.3 National Acid Sulfate Soils Sampling and Identification Manual
- 4.4 National Acid Sulfate Soils Identification and Laboratory Methods Manual
- 4.5 Guidance for the Dredging of Acid Sulfate Soil Sediments and Associated Dredge Spoil Management
- 4.6 Guidance for the Dewatering of Acid Sulfate Soils in Shallow Groundwater Environments
- 4.7 Overview and Management of Monosulfidic Black Ooze (MBO) Accumulation in Waterways and Wetlands

5 A Decision Support Tool to assist in the use of guidance relating to ASS.

2 Acid Sulfate Soil guidance

2.1 Definition of guidance

A guideline, according to the Oxford Dictionary is “a general rule, principle, or piece of advice”. There are many documents relating to acid sulfate soil (ASS) management that fit into the definition of being guidelines. The term ‘guidance’ can also be used in a broad sense. In general, the term ‘guidance’ appears to be used mainly to assist compliance with regulations and policies. In providing such assistance, guidance materials often cover a range of publication types including: interpretive guidelines, guides, fact sheets, and information sheets.

For the purpose of this synthesis, we will use the term ‘guidance’ to strictly refer to “information from a regulatory authority that instructs readers on how to assess or manage ASS to ensure compliance”. We realise that this strict interpretation of the term will exclude other very useful and authoritative information that provide guidance relevant to ASS assessment and management, but not to do so would mean that much of even the scientific literature - whose general aim is usually to assist readers to a better understanding of ASS properties and behaviour - would be included in this report. To do so would be beyond the intended scope of this synthesis.

2.2 Organisation of guidance

In Table 1, Table 2 and Table 3, the various guidance materials relating directly to ASS that have been brought to our attention by literature searches, and recommendation by experts in the field, have been organised at several levels both between and within the tables:

1 The first level comprises what are considered “guidance” by the definition used in this report (Table 1 and Table 2), and other useful sources of material relating to understanding or managing ASS (Table 3).

2 The second level comprises current primary sources of guidance (Table 1), and ‘historic’ guidance material that can be considered to have been superseded by other more recent guidance materials (Table 2).

3 The third level, within each of the tables, is the division of the guidance at a national level, that from state and territory governments, that from local governments, and that from other agencies.

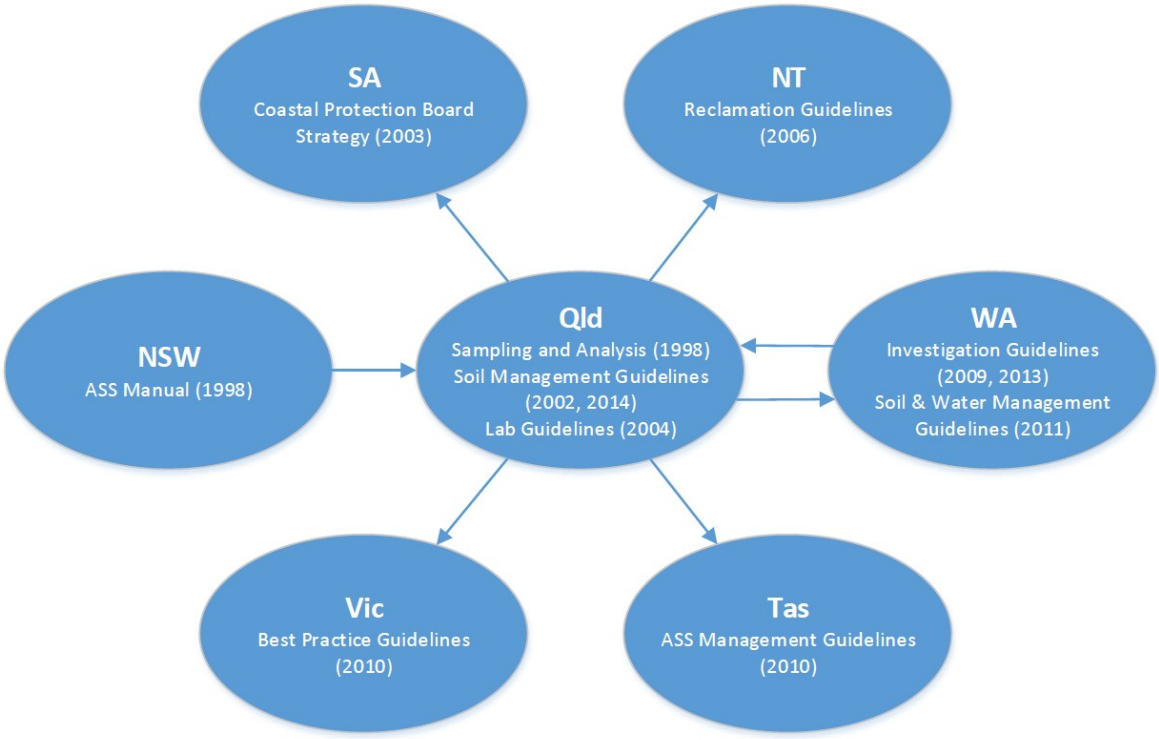
2.3 Derivation of ASS guidance

Acid sulfate soil science and management in Australia have only really become mainstream issues since the late 1980’s. Guidance on ASS issues soon appeared in the form of a two page fact sheet “Acid Sulfate Soils. Soilnote 22/90” in (Veness and Thompson, 1990, Table 2). Over the following decade, much additional effort was focussed on developing our understanding of the assessment, management and regulation of ASS.

These efforts soon resulted in a series of state-government based guidance. The first such document “Assessing and managing ASS: Guidelines for land management in NSW Coastal areas”, by the NSW Environment Protection Authority appeared in 1995. A range of other guidance materials soon followed culminating in comprehensive guidance documents in both NSW and Queensland (Qld) in 1998 (that is the NSW “Acid Sulfate Soil Manual”, and the “Guidelines for sampling and analysis of lowland acid sulfate soils (ASS) in Queensland”).

The activities of the National Committee for Acid Sulfate Soils (NatCASS) were instrumental in these initial ASS guidance subsequently being adopted / adapted by other state and territory governments. Figure 1 diagrammatically represents the progression of these guidance materials at the state and territory government level. Table 1 lists many of these current, primary sources of ASS guidance.

Figure 1 Development of state government-derived ASS guidance material in Australia



The progress made in ASS guidance materials can also be viewed in the context of the guidance literature that has been either replaced or has been superseded by other guidance material.

Table 2 lists 16 such guidance materials that fit into this category. This 'maturing' of guidance literature reflects the progress that has been made over the last two decades in particular in developing and enhancing our understanding of the assessment and behaviour of ASS, as well as on the management and regulatory approaches for ASS.

Table 1 Current primary sources of ASS guidance.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
National	Nation wide	Overarching National strategy	National strategy for the management of coastal acid sulfate soils.	2000	National Working Party on Acid Sulfate Soils (predecessor of NatCASS), NSW Agriculture, Wollongbar, NSW.	Agriculture and Resource Management Council of Australia and New Zealand, Australia and New Zealand Environment and Conservation Council and Ministerial Council on Forestry, Fisheries and Aquaculture	Current National Strategy for managing ASS. Is limited in its scope, that is it doesn't recognise acidified groundwater, inland ASS or MBOs.
National	Nation wide	Inland acid sulfate soils	National Guidance for the management of acid sulfate soils in inland aquatic ecosystems	2010	Environmental Protection and Heritage Council and the Natural Resource Management Ministerial Council, Canberra.	-	Current National Guidelines for the management of inland ASS.
New South Wales	State wide	Managing contemporary disturbance	NSW Acid Sulfate Soil Manual	1998	Published by the Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia.	Ahern CR, Stone Y, Blunden B	Guidelines currently referred to by NSW regulations. Is significantly out of date – refers to past laboratory analysis. Not available on-line or for purchase.
New South Wales	State wide	Distribution	Guidelines for the Use of Acid Sulfate Soil Risk Maps	1998	NSW Department of Land and Water Conservation	Naylor S, Chapman G, Atkinson G, Murphy C, Tulau M, Flewin T, Milford H, Morand D	Guidance on how to use and interpret NSW ASS risk maps.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Acid Sulfate Soil Remediation Guidelines for Coastal Floodplains in NSW	2007	NSW Department of Environment and Climate Change	Tulau M	Guidance on remediating broad acre, historical disturbance. Includes technical details from Restoring the Balance along with project management and legal aspects.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
New South Wales	State wide	Waste management	EPA Waste Classification Guidelines	2008	NSW EPA	-	Has section that refers to ASS.
Northern Territory	Territory wide	Managing contemporary disturbance	Environmental guidelines: reclamation in coastal areas.	2006	Environment and Heritage Division, Department of Natural Resources, Environment and the Arts, Darwin.	-	Advice document to developers who are undertaking reclamation work in coastal areas of NT. Mentions ASS as an issue to consider and provides basic advice on management.
Queensland	State wide	Laboratory Assessment	Queensland acid sulfate soils technical manual: laboratory methods guidelines	2004	Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland.	Ahern C, McElnea A, Sullivan LA	Guidance on analytical assessment of ASS. Since adopted as National Standards and International Standards.
Queensland	State wide	Regulatory	Queensland acid sulfate soils technical manual: legislation and policy guide	2004	Queensland Department of Natural Resources, Mines and Energy, Indooroopilly, Queensland.	Dear SE, Moore NG, Watling KM, Fahl D, Dobos SK	Provides an overview of Queensland and Commonwealth legislation and policies that regulate the disturbance of ASS.
Queensland	State wide	Managing contemporary disturbance	Queensland acid sulfate soil technical Manual – soil management guidelines	2014	Qld Department of Science, Information, Technology, Innovation and the Arts.	Dear SE, Ahern CR, O'Brien LE, Dobos SK, McElnea AE, Moore NG, Watling KM	Updated version which supersedes 2002 version. Widely accepted as national best practice of contemporary disturbance. Now includes section on closure reports and groundwater impacts based on WA experience.
South Australia	State wide	Managing contemporary disturbance	A strategy for implementing CPB policies on Coastal Acid Sulfate Soils in South Australia.	2003	South Australian (SA) Coastal Protection Board No.33	-	Only state-wide guidelines that provide advice on assessment and management of contemporary disturbance. Refers to outdated laboratory methods.
South Australia	State wide	Waste and contamination	Site contamination - acid sulfate soil materials.	2007	SA EPA 638/07	-	Brief guidance on the assessment and management of ASS – refers to current laboratory methods.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
Tasmania	State wide	Managing contemporary disturbance	Tasmanian Acid Sulfate Soil Management Guidelines.	2009	Department of Primary Industries, Parks, Water and the Environment.	-	Current state guidance document for assessment and management of ASS. Draws heavily on the Queensland guidelines.
Victoria	State wide	Strategic planning	Victorian Coastal Acid Sulfate Soils Strategy	2009	Department of Sustainability and Environment.	-	Awareness raising document that sets the direction of how the issue of ASS will be addressed in Victoria.
Victoria	State wide	Managing contemporary disturbance	Victorian best practice guidelines for assessing and managing coastal acid sulfate soils.	2010	Department of Sustainability and Environment.	-	Current state guidance document for assessment and management of ASS. Draws heavily on the Queensland guidelines.
Victoria	State wide	Waste and contamination	Acid Sulfate Soil and Rock. Information Bulletin	2009	Vic EPA Publication 655.1.	-	Advice on identifying and classifying ASS materials and management as a waste material.
Western Australia	State wide	Managing contemporary disturbance	Treatment and management of soils and water in acid sulfate soil landscapes.	2011	WA Department of Environment and Conservation	-	Current management guidelines for WA. Provides information on managing groundwater impacts. Includes lengthy section on managing impacts on groundwater.
Western Australia	State wide	Assessment	Identification and investigation of acid sulfate soils and acidic landscapes.	2013	WA Department of Environment and Conservation	-	Detailed, state specific information related to the assessment of ASS. Refers briefly to assessment of risks from dredging and dewatering of groundwater.
Western Australia	State wide	Regulatory	Planning Bulletin 64/2009 ASS	2009	WA Department of Planning	-	This planning bulletin introduces a set of revised Acid Sulfate Soils Planning Guidelines.
New South Wales	Agency only	Managing contemporary disturbance	Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze.	2005	NSW Roads and Traffic Authority	-	RMS internal guidelines on how to manage ASS. Refers to inland ASS and MBO.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
South Australia	Agency only	Managing contemporary disturbance	Guideline for the Assessment of Acid Sulfate Soils.	2012	Department of Planning, Transport and Infrastructure, Government of South Australia.	-	Provides guidance to Departmental staff and contractors on the assessment and management of ASS which may be disturbed during construction of infrastructure projects or maintenance activities.
New South Wales	Council only	Managing contemporary disturbance	Floodgate and drain management guidelines	2002	Kempsey Shire Council	Kemsley R	Council guidelines for cleaning drainage systems in ASS areas. Presents information included in the NSW Manual.
New South Wales	Local Government Area only	Managing contemporary disturbance	Developing on ASS	>2008	Sutherland Shire Council	-	Information sheet explaining regulation of contemporary disturbance. Presents information included in the NSW Manual.
New South Wales	Local Government Area only	Managing contemporary disturbance	ASS and planning requirements	>2008	Fairfield City Council	-	On-line fact sheet, outlining how ASS are regulated. Presents information included in the NSW Manual.
New South Wales	Local Government Area only	Managing contemporary disturbance	ASS Guidance for Construction Activities	2007	Richmond Valley Council	-	Council providing advice on how ASS disturbance is regulated. Refers heavily to the NSW acid sulfate soil Manual.
New South Wales	Local Government Area only	Managing contemporary disturbance	Landowners Seeking to Excavate Guidelines- For works in areas of actual or potential acid sulfate soils in the Richmond Catchment NSW	2011	Richmond River County Council	Owers G, Storer A	Council advice on how the disturbance of ASS is regulated during excavation. Presents information included in the NSW Manual.
New South Wales	Local Government Area only	Managing contemporary disturbance	Earthmoving Contractors: Guidelines - for works in actual or potential acid sulfate soils in the Richmond River Catchment NSW.	2011	Richmond River County Council	Owers G, Storer A	Council advice on how the disturbance of ASS is regulated during excavation. Presents information included in the NSW Manual.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
Western Australia	Local Government Area only	General information	Is my house built on acid sulfate soils?	2004	WA Department of Environment and Conservation	-	A brochure for homeowners in areas affected by ASS in the suburb of Stirling.

Table 2 Historical guidance material

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
New South Wales	State wide	Assessment	Acid Sulphate Soils. Soilnote 22/90	1990	NSW Department of Primary Industry	Veness R, Thompson D	This two-page fact sheet was the first guidance material produced in NSW on ASS.
New South Wales	State wide	Assessment	Assessing and managing ASS: Guidelines for land management in NSW Coastal areas.	1995	NSW EPA	Blunden B, Naylor SD	Very early guidance on assessing ASS.
National	Nation wide	Management	Treatment and Containment of Potential Acid Sulphate Soils: Formation, Distribution, Properties and Management of Potential Acid Sulphate Soils.	1993	CSIRO Division of Environmental Mechanics Tech. Report No. 53	White I, Melville M	Early national guidance on understanding and managing ASS.
New South Wales	State wide	Strategic planning	1996/97 Strategic Plan for the Management of ASS in NSW	1996	Acid Sulfate Soils Management Advisory Committee (ASSMAC)	-	First strategic document on how to address the issue of ASS in NSW.
Queesland	State wide	Strategic Planning	Queensland Acid Sulfate Soils Management Advisory Committee (QASSMAC) ASS Management Strategy for Queensland	1999	QASSMAC	Powell B, Ahern C	Strategic plan for managing the issue of ASS in Queensland.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
Queensland	State wide	Managing contemporary disturbance	Sampling and Analysis Procedure for lowland ASS in Queensland	1996	Queensland Acid Sulfate Soils Investigation Team (QASSIT), Department of Natural Resources	-	Early versions and drafts, outlining procedures for assessing ASS. Superseded by 1998 guidelines.
Queensland	State wide	Managing contemporary disturbance	Guidelines for sampling and analysis of lowland acid sulfate soils (ASS) in Queensland.	1998	QASSIT, Department of Natural Resources,	Ahern C, Ahern M, Powell B	Guidance on sampling and assessment of ASS – includes reference to outdated laboratory methods.
Queensland	State wide	Managing contemporary disturbance	Instructions for the Treatment and Management of Acid Sulfate Soils	2001	Qld EPA	-	Early guidelines on managing ASS as a waste product.
Queensland	State wide	Regulatory	State Planning Policy 2/02 guideline – Planning and Managing Development involving ASS	2002	Queensland Government	-	Provides advice and information on interpreting Queensland ASS regulation.
Queensland	State wide	Managing contemporary disturbance	Queensland acid sulfate soils technical manual: soil management guidelines	2002	Department of Natural Resources and Mines	Dear SE, Moore NG, Dobos SK, Watling KM & Ahern CR	Guidance on management principles and practices for contemporary disturbance.
Queensland	State wide	Managing contemporary disturbance	Field testing, sampling and safety for ASS	2002	QASSIT, Department of Natural Resources and Mines	Hey K	Guidance for field operators.
Victoria	State wide	Managing contemporary disturbance	Managing Waste ASS	2000	Victorian EPA	-	Early guidelines on handling ASS as a waste product. Superseded by 2009 information bulletin.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
Western Australia	State wide	Managing contemporary disturbance	Draft Department of Environment Water and Catchment Protection and EPA guidance on managing acid sulfate soils	2002	WA Department of Environmental Protection Water and Rivers Commission (amalgamating to form Department of Environment, Water and Catchment Protection) and WA EPA.	-	Earliest management guidelines in WA.
Western Australia	State wide	Strategic Planning	Proposed framework for managing ASS	2004	WA Department of Environment	-	Early strategic document proposing how the issue of ASS will be addressed in WA. Based on outcomes of ASS Workshop held in 2003.
Western Australia	State wide	Regulatory	ASS Planning Guidelines	2008	WA Department of Planning and Department of Environment and Conservation	-	The Acid Sulfate Soils Planning Guidelines outline a range of matters that need to be addressed at various stages of the planning process to mitigate and manage the disturbance of ASS.
Western Australia	State wide	Assessment	Identification and investigation of ASS and acidic landscapes.	2009	WA Department of Environment and Conservation	-	Superseded by 2013 investigation guidelines.

Table 3 Other sources of information on ASS, their assessment, and their management

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
National	Nation wide	Distribution	National Atlas of acid sulfate soils	2008	-	Fitzpatrick RW	On-line information on distribution of ASS, uploaded to Australian Soil Resource Information System website (ASRIS)

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
National	Nation wide	Distribution	Safeguarding Dangerous Shores. A national atlas of acid sulfate soils.	2006	CSIRO article in ECOS, 133, 28-31.	Fitzpatrick RW	Article introducing the National acid sulfate soils Atlas
National	Nation wide	Distribution	Atlas of Australian Acid Sulfate Soils.	2008	In Fitzpatrick R and Shand P (eds.), Inland acid sulfate soil systems across Australia, 63–77. Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME) Open File Report 249 (thematic volume). CRC LEME, Perth.	Fitzpatrick R, Powell B, Marvanek S	Article on the National acid sulfate soils Atlas
National	Nation wide	Distribution	Information Sheet - Atlas of Australian Acid Sulfate Soils.	2008	CSIRO Land and Water	Fitzpatrick RW	Provides information on using the National acid sulfate soils Atlas.
New South Wales	Industry only	Managing contemporary disturbance	Best Practice Guidelines for acid sulfate soils (sugar industry)	2000	The NSW sugar industry	-	Guidance for sugar cane farmers on complying with industry self-regulation for ASS. Advice provided on managing disturbance of ASS. Initial sampling wouldn't meet today's guidelines.
National	Nation wide	Identification	The Australian Soil Classification	2002	CSIRO	Isbell R	A framework for organising knowledge about Australian soils and provides a means of communication amongst scientists and those who use the land.
International	Nation wide	Understanding	Acid Sulphate Soils: a Baseline for Research and Development.	1986	International Institute for Land Reclamation and Imp. Wageningen. I.RI Pub. No. 39.	Dent DL	One of the earliest documents providing guidance on understanding ASS

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
National	Nation wide	Assessment	Quick, quantitative assessment of the acid sulphate hazard.	1996	CSIRO Division of Soils, Divisional Report No. 128.	Dent D Bowman G	Early national guidance on assessment
National	Nation wide	Assessment	Acid sulfate soil drain ooze: distribution, behaviour and implications for acidification and deoxygenation of waterways.	2002	In: Lin C, Melville M and Sullivan L (eds.), Acid sulfate soils in Australia and China. Science Press, Beijing,91–99.	Sullivan LA, Bush RT, Fyfe D	The first technical paper written on MBOs.
National	Nation wide	Assessment	Acid Sulfate Soil: A Review of Methods, An Interpretation of Chemistry and Derivation of Hazard Assessment.	2004	The Centre for Contaminant Geoscience, Technical Paper 17.	Mulvey P	Early technical paper on assessment methods.
National	Nation wide	Management	From conflict to industry – regulated best practice guidelines: a case study of estuarine flood plain management of the Tweed River, eastern Australia.	2006	In: Hoanh, C.T., Tuong, T.P., Gowing, J.W. and Hardy, B. (eds). Environment and Livelihoods in Tropical Coastal Zones.	White, I, Melville, M, Macdonald, BCT, Quirk, R, Hawken, R, Tunks, M Buckley, D, Beattie, R, Heath, L Williams, J	A case study looking at approaches used in northern NSW to address ASS issues.
National	Nation wide	Inland	Development of a protocol for recognising sulfidic sediments (potential acid sulfate soils) in inland wetlands.	2007	Journal article in Ecological Management and Restoration	Baldwin D, Hall K, Rees G Richardson A	Early inland guidance. Predecessor to 2010 guidelines.
National	MDBA	Inland	Fact Sheet – Assessing the risk of acid sulfate soils in Murray-Darling Basin Wetlands	2008	Murray-Darling Basin Commission	-	Information sheet on the MDBA ASS assessment project.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
National	Nation wide	Inland	Rehabilitation options for inland waterways impacted by sulfidic sediments.	2009	Journal article in Journal of Environmental Management	Baldwin D Fraser M	Early inland guidance. Predecessor to 2010 guidelines.
National	MDBA	Inland	Detailed assessment of acid sulfate soils in the Murray–Darling Basin: protocols for sampling, field characterisation, laboratory analysis and data presentation.	2010	Murray–Darling Basin Authority (MDBA) Publication 57/10.	-	Further detailed information on the assessment of inland ASS, following the publication of the National Guidelines.
National	Nation wide	Inland	Technical Guidelines for Assessment and Management of Inland Freshwater Areas Impacted by Acid Sulfate Soils	2010	CSIRO Land and Water Science Report 5/11.	Fitzpatrick RW, Shand P, Hicks WS	Further detailed information on the management of inland waterbodies impacted by ASS, following the publication of the National Guidelines.
National	MDBA	Inland	Sulfidic sediments in inland waterways.	2011	Waterlines report, National Water Commission, Canberra.	Baldwin DS Capon SJ	Presents a summary of key findings and management recommendations from the Minimising environmental damage from water recovery in inland wetlands project that determined appropriate wetting and drying strategies in inland wetlands to minimise the formation of sulfidic sediments.
National	MDBA	Inland	Acid Sulfate Soils in the Murray-Darling Basin.	2011	MDBA Publication 147/11	Baldwin DS	Contains the results of the Murray–Darling Basin Acid Sulfate Soils Risk Assessment Project, which determined the spatial occurrence of, and risk posed by, ASS at priority wetlands in the River Murray system.
New South Wales	District only	Distribution	A reconnaissance of soils in the Kempsey District, NSW	1963	CSIRO	Walker, P	The very first technical reference to ASS in NSW discusses the catclays of the Macleay Floodplain.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
New South Wales	State wide	General information	An illustrated guide to acid sulfate soils and groundwater	1996	NSW Department Land & Water Conservation, NSW Agriculture	Schmidt J, Lines-Kelly R	Series of illustrations showing the effects of drainage, cropping and excavations on ASS.
New South Wales	Nation wide	General information	An Introduction to acid sulfate soils	1997 Revised 2000	NSW Agriculture	1st edition Sammut J, Lines-Kelly R 2nd edition Woodworth A	The first general awareness publication on ASS. Very wide distribution, but is primarily focussed on NSW and Qld and is now outdated.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Guidelines for operation of Local Action Committees for improved management of acid sulfate soils	1995	ASSMAC	Williams J	Early guidelines for local communities wanting to form Action Committees
New South Wales	State wide	Broad acre remediation (historical disturbance)	Floodgates and farmlands	1996	NSW Department of Land & Water Conservation	Haskins P	Early information sheet on actively managing floodgates for improved ASS outcomes.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
New South Wales	State wide	Broad acre remediation (historical disturbance)	Hotspot Reports (8) ASS Priority Management Areas on the Tweed Floodplain Byron-Brunswick Floodplain Lower Richmond Floodplain Lower Clarence Floodplain Lower Macleay Floodplain Lower Hastings-Camden Haven Floodplains Lower Manning Floodplain Shoalhaven Floodplain	1999	NSW Department of Land and Water Conservation	Tulau MJ	Series of reports that provided early information on priority areas for remediation of broad acre, historical disturbance.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Policy, strategies and processes for the remediation of ASS Management Priority Areas in NSW.	1999	NSW Department of Land and Water Conservation	Tulau MJ	Guidance document accompanying the regional Hotspot Reports providing early advice on management strategies.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Remediation of acid sulfate soils in NSW	1999	ASSMAC report to Water CEOs	Porter M, Williams J	Government report outlining preliminary assessment and remediation strategies for ASS 'hotspots' in NSW and a discussion on financial incentives to assist private landowners remediate ASS.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Remediation of broad acre acid sulfate soils	1999	ASSMAC. Proceedings of workshop on remediation and assessment of broadacre ASS.	Slavich PG (ed)	Early discussions and information on broad acre remediation of coastal floodplains.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
New South Wales	State wide	Broad acre remediation (historical disturbance)	Acid Sulfate Soils – farming community ideas about the way forward	1999	NSW Agriculture and ASSMAC	Woodhead A	Results of an early benchmarking study of landowners knowledge, skills and attitude towards ASS.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Acid sulfate soils: Keys to Success.	2000	SSMAC and NSW Agriculture.	Woodhead A, Jenkins A, Wood M	Landowner extension document that demonstrates how to conduct a preliminary assessment.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Acid Sulfate Soils Program – design improvements for rural drainage systems	2000	SSMAC and NSW Agriculture.	Smith R Patterson	First technical details on how to retrofit or modify historical drainage systems for improved ASS outcomes.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Acid sulfate soil scalds: How they occur and best management practices for their revegetation.	2002	NSW Agriculture and ASSMAC, Wollongbar.	Rosicky MAJ, Slavich PG Sullivan L	Only document that provides guidance on remediating ASS scalds. Hasn't been superseded, information still current.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Water quality monitoring in acid sulfate soils areas	2002	NSW Agriculture	Collins C, Henderson S	Brief fact sheet on monitoring water quality.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Coastal Backswamps – restoring their values	2002	Wetland Care Australia	Smith B	An early landowner extension document discussing the importance and management of North Coast backswamps.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Restoring the balance: Guidelines for managing floodgates and drainage systems on coastal floodplains. (includes series of 6 information sheets conveying major points from guidelines)	2003	NSW Agriculture: Wollongbar, Australia.	Johnstone S, Kroon F, Slavich P, Cibilic A, Bruce A	Technical guidelines on managing historical drainage systems for improved ASS outcomes. S

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
New South Wales	State wide	Broad acre remediation (historical disturbance)	Hydraulic conductivity – a simple field test for shallow coastal acid sulfate soils	2003	NSW Agriculture: Wollongbar, Australia.	Johnston S, Slavich P	Early information sheet on assessing hydraulic conductivity
New South Wales	State wide	Broad acre remediation (historical disturbance)	Acid Sulfate Soils – 4 years on, what changed?	2003	NSW Agriculture and ASSMAC	Woodhead A	A follow up benchmarking survey (from 1998) of landowner's knowledge, skills and attitude towards ASS.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Grazing the coastal floodplain: meet the graziers who are farming the floodplain sustainably.	2008	NSW Department Primary Industries: Wollongbar, Australia.	Andersen L, Baker E, Clay C, Rose H	Landowner extension document highlighting sustainable practises for grazing low-lying ASS floodplain areas.
New South Wales	State wide	Broad acre remediation (historical disturbance)	Assessment of hydraulic conductivity in coastal floodplain acid sulfate soils on the North Coast of NSW.	2009	NSW Department of Primary Industries	Hirst P, Slavich P, Johnston S, Walsh S	Provides details on how to assess hydrological conductivity and results of survey and assessment of different North Coast wetlands.
Northern Territory	Region only	Distribution	Acid Sulfate Soils of the Darwin Region.	2008	Land and Water Division Department of Natural Resources, Environment the Arts and Sport, NT.	Hill JV, Edmeades BFJ	Technical report on the distribution and assessment of ASS in the Darwin region. Identifies management principles.
Queensland	State wide	General information	Fact sheet series (x4): Acid sulfate soils in Queensland Identifying acid sulfate soils Managing acid sulfate soils Using acid sulfate soils maps	2002	Qld Department of Environment and Resource Management	-	Early general information sheet series

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
Queensland	State wide	Regulatory	Implications of the State Planning Policy on ASS. What does it all mean?	2000	Department of Natural Resources and Queensland Environmental Law Association Inc.	-	Series of papers presented the Queensland Environmental Law Association seminar.
South Australia	State wide	Broad acre remediation (historical disturbance)	Acid sulfate soil technical manual: coastal acid sulfate soils management guidelines, Barker Inlet, SA.	2003	CSIRO Land and Water.	Thomas B, Fitzpatrick R, Merry R Hicks W	Technical guidelines for management of ASS at Barker Inlet.
South Australia	Region only	Inland	Information Sheet - Acid sulfate soils along the Lower Murray	2007	SA Government	-	Information sheet on drought conditions and ASS.
South Australia	Region only	Inland	Acid sulfate soils and dust.	2009	Public Health Fact Sheet - Department of Health SA	-	Fact sheet on health concerns during drought conditions.
South Australia	Region only	Managing contemporary disturbance	Guidelines for the Lower Murray Reclaimed Irrigation Area (LMRIA)	2014	SA EPA	-	Guidelines mention ASS as an issue that needs to be addressed.
Tasmania	State wide	Managing contemporary disturbance	Fact sheet series from guidelines Acid Sulfate Soils: Indicators for Field Operators Acid Sulfate Soils: Information for Planners & Developers Acid Sulfate Soils in Agricultural & Aquacultural Environments	2009	Department of Primary Industries, Parks, Water and the Environment.	-	-
Victoria	State wide	Assessment	ASS Hazards Maps – guidelines for coastal Victoria	2003	Vic Department of Primary Industries	Rampant P	Advice on how to use and interpret Victoria's ASS mapping.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
Victoria	State wide	General awareness	Identification and management of acid sulfate soils. Corangamite CMA Soil Health Strategy.	2012	Vic Department Primary Industries	-	General awareness brochure produced by Vic Department of Primary Industries for Corangamite Catchment Management Authority.
Western Australia	State wide	Health guidelines	Groundwater domestic use guideline	2006	WA Department of Health	-	Information sheet on domestic groundwater use.
Western Australia	Region only	Historic disturbance, inland agricultural landscapes	A synopsis of potential amendments and remediation techniques for the neutralization of acidic drainage waters in the Western Australian Wheatbelt.	2006	CSIRO Land and Water Science Report No. 46/06 and CRC LEME Open File Report 209. CSIRO, Perth.	Douglas G Degens B	Technical report on ASS in the inland WA Wheat belt area.
Western Australia	State wide	General information	Acid Sulfate Soils and Acidic Drainage. Impacts on Coastal Waterways of South West Western Australia.	<2008	WA Department of Water	-	Early WA information booklet.
Western Australia	Region only	Historic disturbance, inland agricultural landscapes	Proposed guidelines for treating acidic drain water in the Avon catchment: adapting acid mine drainage treatment systems for saline acidic drains, Western Australia	2009	WA Department of Water Salinity and land use impacts series, report no. SLUI 54	Degens, B	Technical report on managing ASS in the WA Wheatbelt area.
Western Australia	Region only	Historic disturbance, inland agricultural landscapes	Introduction to acidic saline groundwater in the WA Wheatbelt - characteristics, distribution, risks and management.	2009	Department of Water	Degens, B Shand, P	Technical report provides advice and information on managing inland ASS in the WA Wheatbelt area.

Coverage	Focus	Area of guidance covered	Title	Year	Publishing organisation	Authors	Commentary
Western Australia	State wide	General information	Acid sulfate soils fact sheet series (x4) *What are acid sulfate soils? *Recognising disturbed acid sulfate soils *Acid sulfate soils Risk Maps *Managing urban development in acid sulfate soils areas	2008	WA Department of Environment and Conservation	-	Fact sheet series providing general, introductory information on different aspects of managing ASS.
Western Australia	Region only	Assessment	Mineralogy and chemistry of sandy acid sulfate soils in the Perth metropolitan area of the Swan Coastal Plain	2011	University of WA and WA Department of Environment and Conservation	Prakongkep N, Gilkes R, Singh B, Wong S	Technical report on the findings of a study into the sandy ASS sediments surrounding Perth.
Western Australia	Region only	Assessment	Experimental oxidation of Bassendean sands in soil columns.	2012	WA Department of Environment and Conservation	Singh B, Pal Y, Wong S	Technical report determining the adequacy of the current action criteria for sandy soils. Includes the results of an experimental study to determine the acid generation from sandy sediments.

3 Coverage of our existing acid sulfate soil guidance materials

3.1 National Level

As shown in Table 1, there are two current primary sources of acid sulfate soil (ASS) guidance material existing at a national level. The first, the "National strategy for the management of coastal acid sulfate soils" was published in 2000 by the Working Party on Acid Sulfate Soils, the predecessor of NatCASS. This seminal document provided an overarching national strategy at a high level, for the management of ASS. Although a landmark document in ASS guidance literature in Australia, it does not (nor was it intended to) provide detailed guidance on the assessment and management of ASS.

The second ASS guidance material at a national level is the "National Guidance for the management of acid sulfate soils in inland aquatic ecosystems" published in 2010 to address the urgent need for national guidelines on the management of inland ASS exposed by a particularly severe drought experienced especially in the Murray-Darling Basin from 2007 to 2010. As for the other national ASS guidance documents, this document does not (nor was it intended to) provide detailed guidance on the assessment and management of inland ASS.

3.2 State and territory government level

Table 4 shows an outline of the coverage of current primary ASS guidance material provided at the state and territory government level within Australia. For each jurisdiction, Table 4 summarises the completeness of coverage of their guidance materials according to nine fundamental aspects of ASS assessment and management. These are:

- Field and preliminary assessment
- Mapping
- Analytical assessment
- General management principles
- Detailed management plan requirements
- Closure reports
- Management of ground water
- Management of Monosulfidic Black Ooze (MBO)
- Management of dredge material.

Coverage of the guidance materials has been simplified to the following three categories in Table 4: c) covered, n) not covered or r) referred to but not in a comprehensive fashion or based on relatively out-dated information.

Table 4 Coverage of current ASS guidance material at state and territory government level

Jurisdiction	Field and preliminary assessment	Mapping	Analytical assessment	General management principles	Detailed management plan requirements	Closure reports	Assessment and management of ground water	Assessment and management of MBO	Assessment and management of dredge material
New South Wales	c	c	r	c	n	n	n	n	n
Northern Territory	n	c	n	n	n	n	n	n	n
Queensland	c	c	c	c	c	c	r	n	n
South Australia	r	c	r	r	n	n	n	n	n
Tasmania	c	c	c	c	n	n	n	n	n
Victoria	c	c	c	c	n	n	n	n	n
Western Australia	c	c	c	c	c	c	c	n	n

c Covered,

n Not covered,

r Referred to, or information is outdated.

Table 4 clearly shows that the coverage of these nine aspects of ASS assessment and management is not uniform across the various state and territory jurisdictions. Although it is clear that some aspects have received more uniform coverage (that is mapping, field and preliminary assessment, analytical assessment, and general management principles), the other aspects have received far more patchy coverage at this level of government.

3.3 Need for additional national ASS guidance

It is clear from the preceding analysis that some critical aspects of ASS assessment and management are either not well covered across Australia by the provision of guidance materials (that is detailed management plan requirements, closure reporting, and groundwater) or not covered at all (that is the assessment and management of both MBO and dredge materials).

The gaps in coverage of current ASS guidance materials apparent in Table 4 and in the existing national ASS guidance literature both highlight the pressing need to provide national coverage of ASS guidance materials in a range of aspects of importance to the optimal assessment and management of ASS materials. The guidance provided here aims to address the most pressing of these needs.

4 National ASS guidance

4.1 The National Strategy for the Management of Coastal Acid Sulfate Soils (2000)

This seminal national ASS guidance:

- Introduces the problem of ASS, identified the nature of past and future impacts, and outlines the benefits of a national strategy. The National Strategy does not provide in depth technical material, however it does provide a list of references for further reading.
- Provides a flexible, broad based Australia-wide strategy and a hierarchy of national objectives and management options for implementation. The document does not provide action plans for states, territories, regions or specific sites.
- Recognised a pressing need to address problems in coastal areas. The National Strategy does not address ASS of inland Australia or acid drainage from acid mine spoils.
- Recognised the importance of the environment and ecologically sustainable management of land and water resources by all stakeholders.
- The National Strategy has been framed within a number of major natural resource management policies, including:
  - the National Strategy for Ecologically Sustainable Development,
  - the National Water Quality Management Strategy,
  - the National Strategy for the Conservation of Australia's Biological Diversity,
  - the Intergovernmental Agreement on the Environment,
  - the Decade of Landcare Plan,
  - the Wetlands Policy of the Federal Government of Australia and more recently, and
  - the Australia's Oceans Policy.

The National Strategy can be accessed at waterquality.gov.au/issues/acid-sulfate-soils/coastal.

4.2 National guidance for the management of acid sulfate soils in inland aquatic ecosystems (2011)

This guidance is designed to guide the identification and management of inland ASS to reduce or eliminate the risks they pose to the Australian environment and its economy.

Initially it was assumed that ASS in Australia were largely restricted to the coastal regions. However, ASS have been identified in a wide range of inland aquatic ecosystems, include lakes, wetlands, creeks and rivers, and in drainage channels.

This guidance was been developed in the context of the National Water Quality Management Strategy (NWQMS). The main objective of the NWQMS is to achieve sustainable use of the nation's water resources by protecting and enhancing water quality while maintaining economic and social development.

This guidance can be used as an authoritative reference for natural resource managers, planners, policy makers and other practitioners.

The guidance aims to help understand the complexities associated with managing ASS, and describes how to manage ASS in a range of aquatic environments in a drying climate.

The document should be considered in conjunction with relevant Commonwealth, state and territory legislation, policies and guidance.

The National guidance for the management of ASS in inland aquatic ecosystems can be accessed at waterquality.gov.au/issues/acid-sulfate-soils/inland-aquatic-systems.

4.3 National Acid Sulfate Soils Sampling and Identification Methods Manual

This guidance provides the current best practice management for ASS investigations and sampling for management purposes.

The purpose of this guidance is to provide technical and practical advice on the identification and sampling of ASS materials both prior to field investigations and when in the field.

Guidance is also provided on the sampling requirements necessary to define the extent of ASS materials in the landscape.

This guidance document is divided into six sections:

1 An introduction to ASS and outlines the scope of the document.

2 A background on ASS formation and impacts that may occur arising from the disturbance of these soil materials.

3 A description of the conditions under which sites will require investigations for the presence or absence of ASS materials.

4 A description of the utility of desktop assessment of sites prior to field investigations.

5 A description of the requirements of inspections of sites reasonably suspected to contain ASS materials, including an examination of the field indicators of ASS materials and useful preliminary soil and water assessments that need to be undertaken, and

6 A description of the minimum requirements for soil sampling and field testing including the location and number of sampling points, depth of sampling, sampling procedures including handling, transport and storage and soil field tests.

The guidance also provides information on soil field tests and their interpretation and recommendations on the most suitable sampling equipment for different field conditions.

The National Acid Sulfate Soils Sampling and Identification Methods Manual can be accessed at waterqulity.gov.au/issues/acid-sulfate-soils/sampling-and-identification-methods-manual.

4.4 National Acid Sulfate Soils Identification and Laboratory Methods Manual

The purpose of this guidance is to provide the current best practice ASS laboratory analytical methods for ASS samples to both:

1 conclusively identify the presence or absence of ASS, and

2 to quantitatively assess the associated hazards.

These include methods to quantify the Net Acidity of a soil sample using an Acid Base Accounting (ABA) approach to assess the acidity hazard of soil materials.

The deoxygenation and the metals and metalloid mobilisation hazards of ASS materials are also becoming routine assessments in the development of ASS management plans. The current best practice laboratory analytical methods for their assessment are also included.

The National Acid Sulfate Soils Sampling and Identification Manual referred to in the previous section outlines the first three stages of an ASS investigation process – desktop assessment (Stage 1), site inspection (Stage 2) and soil sampling (Stage 3).

This National Acid Sulfate Soils Identification and Laboratory Methods Manual covers the two final stages of an ASS investigation process: the laboratory analysis (Stage 4) and the reporting of results (Stage 5).

This manual contains three parts:

- Part 1 - Identification and analysis of acid sulfate soils
- Part 2 - Laboratory methods
- Part 3 – Interpretation of laboratory results.

It should be noted that this guidance is designed to help identify ASS, and to quantify some of the hazards posed by ASS. If these methods are used for soil materials that are not ASS, they may result in spurious identification of acidity hazards for those soil materials.

The National Acid Sulfate Soils Identification and Laboratory Methods Manual can be accessed at waterquality.gov.au/issues/acid-sulfate-soils/identification-and-laboratory-methods-manual.

4.5 Guidance for the Dredging of Acid Sulfate Soil Sediments and Associated Dredge Spoil Management

The purpose of this guidance is to provide technical and procedural advice to avoid environmental harm from ASS encountered during dredging projects. It addresses both the risks posed during dredging operations and during disposal of dredged spoil materials.

The guidance describes a technical framework for evaluating the environmental acceptability of dredged material, management alternatives and means to minimise and manage potential impacts. Because this framework provides national guidance over a wide range of dredging scenarios and management options, flexibility and discretion is necessary. As a consequence, not all of the considerations will apply, or relative importance will vary, depending on the specifics of the dredging project being proposed.

The guidance document is divided into four sections:

1 Introduction to dredging activities and need for specific consideration of ASS

2 Overview of the extent, risks, legacies and potential liabilities posed by ASS, and existing policy and regulatory environment with respect to dredging

3 Guide to assessing risks and management principles and procedures for disposal of dredged spoil within water bodies and on land, including site selection, preparation, remediation and monitoring.

4 Development of management strategies and plans, including the development of an ASS Management Plan.

The guidance is intended to provide greater certainty about the assessment and permitting process for dredging activities. The intent is to provide guidance that is 'fit for purpose'.

This report does not review, describe or evaluate methods for dredging (for example appropriate equipment or operation techniques). It also does not review or describe and evaluate methods for collection of sediment samples for assessment, which are adequately described elsewhere.

The Guidance for the Dredging of Acid Sulfate Soil Sediments and Associated Dredge Spoil Management can be accessed at waterquality.gov.au/issues/acid-sulfate-soils/dredge-spoil-management.

4.6 Guidance for the Dewatering of Acid Sulfate Soils in Shallow Groundwater Environments

This guidance provides technical and practical advice on dewatering ASS in shallow groundwater environments to help prevent or minimise harm to the environment.

This guidance has been designed to help in the decision making process when groundwater dewatering or removal of overburden, that may expose ASS present below the water table, is required. This guidance complements existing ASS guidance.

The guidance document is divided into five sections:

1 Introduction to ASS, the scope of the document, and coverage of sub-surface ASS

2 The extent of, and risks associated with, groundwater dewatering or exposure and current management strategies

3 Recommended management strategies for dealing with ASSin shallow groundwater environments based on current best practices

4 Framework, including different levels of management, for inclusion within a site ASS management plan for groundwater ASS

5 Data gaps in terms of knowledge or techniques which are needed to underpin effective management practices.

It should be emphasized that this guidance does not replace the need for a site ASS management plan which is generally required by local or state and territory regulatory authorities.

This guidance builds upon and aims to be consistent with current ASS guidelines at the national, state and territory level.

The Guidance for the Dewatering of Acid Sulfate Soils in Shallow Groundwater Environments can be accessed at waterquality.gov.au/issues/acid-sulfate-soils/dewatering-groundwater-environments.

4.7 Overview and Management of Monosulfidic Black Ooze (MBO) Accumulation in Waterways and Wetlands

This guidance provides technical and procedural advice to assess and manage Monosulfidic Black Ooze (MBO) in waterways and wetlands. It provides best management practices to deal with MBO accumulations in waterways.

The assessment and management of MBOs in the landscape are less developed than other areas relating to ASS. Consequently this guidance provides details on the nature of MBOs including their hazards as well as examples of best management practices to deal with MBO accumulations in waterways and wetlands.

The guidance document is divided into four sections:

1 Introduction to MBO in waterways and wetlands

2 Examination of literature available on the extent, risks, legacies and potential liabilities of MBOs

3 Outline of the policy and regulatory environment of acid sulfate soil materials including MBOs

4 Current best management practices for MBO.

This guidance is aimed as an authoritative reference for natural resource managers, planners, policy makers and other practitioners. The guidance aims to help understand the complexities associated with MBOS, and provides examples of the assessment and management of MBOs in a range of landscape situations.

The document should be considered in conjunction with relevant Commonwealth, state and territory legislation, policies and guidance.

The Overview and Management of Monosulfidic Black Ooze (MBO) Accumulation in Waterways and Wetlands can be accessed at waterquality.gov.au/issues/acid-sulfate-soils/monosulfidic-black-ooze-accumulation.

5 Selecting the right guidance for managing acid sulfate soils

We have produced eight documents on acid sulfate soils to help you find the right advice for your needs. Always use our guidance alongside relevant state and territory guidelines and requirements.

The information on this page is illustrated in Figure 2.

Overview of past and present guidance

National Acid Sulfate Soils Guidance: a Synthesis reviews current and past primary sources of acid sulfate soils guidance and covers the main issues in assessment and management.

Geographical setting

Coastal

National Strategy for the Management of Coastal Acid Sulfate Soils is a holistic and comprehensive approach to mitigating the acid sulfate soil problem and reducing existing acid water run-off.

Inland

National Guidance for the Management of Acid Sulfate Soils in Inland Aquatic Ecosystems advises on identifying and managing these soils to reduce risks to the Australian environment and economy.

Field and laboratory methods

Field

National Acid Sulfate Soils Sampling and Identification Methods Manual advises provides advice on procedures necessary before conducting field investigations. Also lists sampling requirements for defining the extent of acid sulfate soil materials in the landscape.

Laboratory methods

National Acid Sulfate Soils Identification and Laboratory Methods Manual covers best-practice methods for analysing these soils. Use this manual to confirm whether acid sulfate soil is present and to quantitatively assess associated hazards.

Soil and contamination management

Dewatering

Guidance for the Dewatering of Acid Sulfate Soils in Shallow Groundwater Environments provides technical and practical advice on managing these soils to minimise harm to the environment.

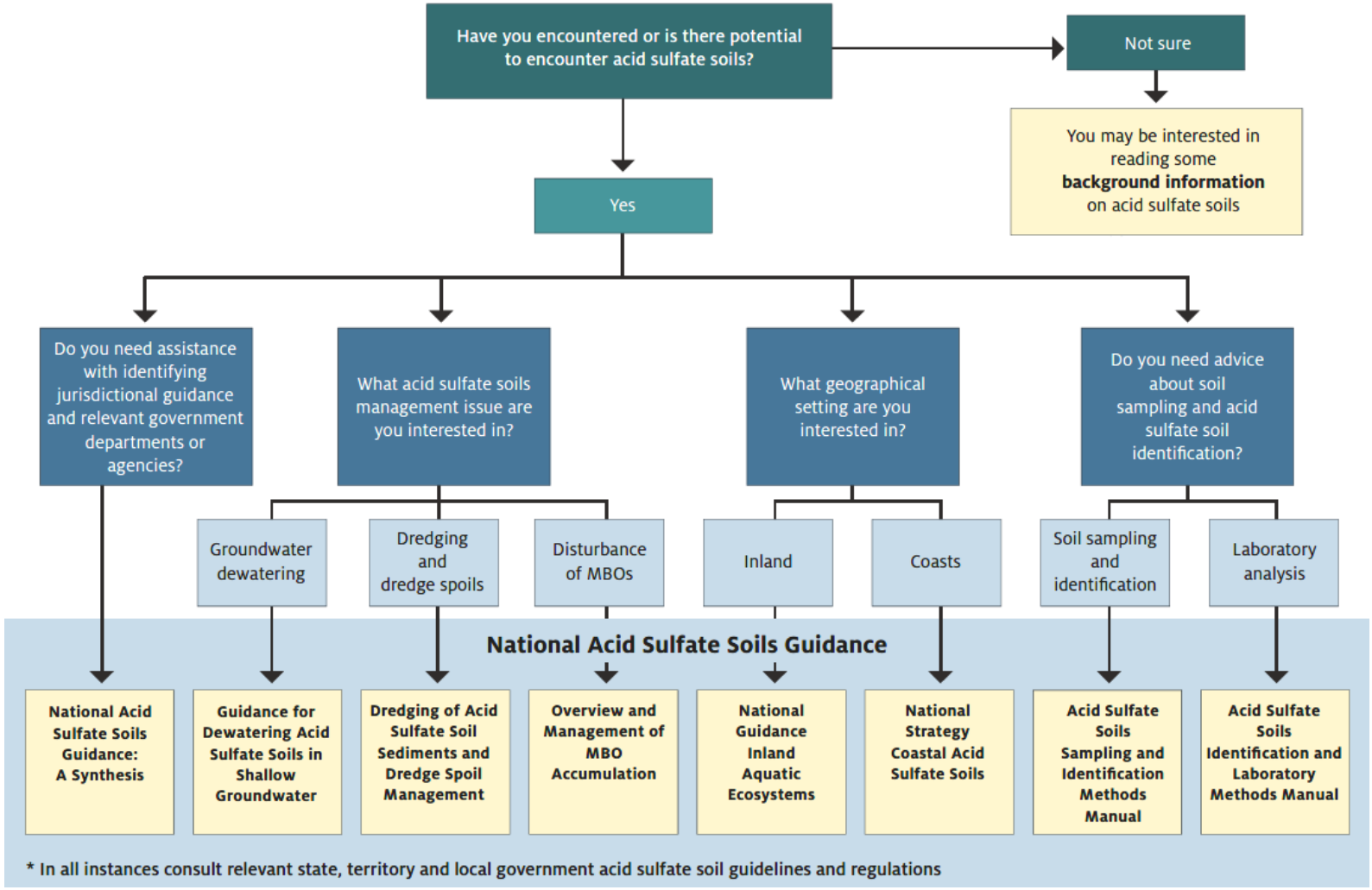
Dredging

Guidelines for the Dredging of Acid Sulfate Soil Sediments and Associated Dredge Spoil Management provides technical and procedural advice to avoid environmental harm during dredging operations.

Disturbance of monosulfidic black ooze

Overview and Management of Monosulfidic Black Ooze (MBO) Accumulations in Waterways and Wetlands covers technical and procedural advice on assessing and managing MBOs in water systems.

Figure 2 Selecting the right guidance on acid sulfate soils



Note: Always consult relevant state and territory acid sulfate soil guidelines and regulations. This diagram can be downloaded as a decision support tool.

Glossary

Term	Definition
Acid base account (ABA)	A simple equation used to combine the results of several laboratory soil tests to produce a consistent and comparable measure of net soil acidity. The accounting system includes measures of freely available (actual) acidity, acidity released from low solubility chemical compounds (retained acidity) and sulfides vulnerable to oxidation (potential acidity), balanced against any acid-neutralising capacity (ANC) if present in the soil. Except where the neutralising material in the soil is very fine, ANC on fine-ground laboratory samples is usually an overestimate of effective ANC compared to its field reactions and kinetics. Hence a compensating 'fineness factor' is employed in the equation.
Acid-neutralising capacity (ANC)	The ability of a soil to counteract acidity and resist the lowering of the soil pH. In an ASS context, acid-neutralising capacity is considered negligible if the soil's pH_{KCl} after processing (according to the latest Laboratory Methods Guidelines) is less than 6.5. Above pH 6.5, ANC is defined and measured according to the latest Laboratory Methods Guidelines (or AS 4969).
Acid sulfate soils (ASS)	Soils, sediments or other materials containing iron sulfides and/or acidity generated by their breakdown. These materials are environmentally benign when left undisturbed in an aqueous, anoxic environment but when exposed to oxygen the iron sulfides break down, releasing large quantities of sulfuric acid and soluble iron.
Acid Volatile Sulfide	Sulfur released as H_2S from RIS by reaction with strong acids.
Action criteria	For ASS, the measured level of potential plus existing acidity beyond which management action is required if a soil or sediment is to be disturbed. The trigger levels vary for texture categories and the amount of disturbance. The extent of management required will vary with the level of acidity and the volume of the disturbance, among other factors.
Anoxic	An environment where oxygen is intrinsically rare or absent.
Aquatic ecosystem	Any water environment, from an ephemeral pond to the ocean, in which plants and animals interact with the chemical and physical features of the environment.
Aqueous	Composed of or pertaining to water.
Aquatic environment	The geochemical environment in which dredged material is submerged under water and remains water saturated after disposal is completed.
Coastal zone	Includes coastal waters and the adjacent shorelands designated by a State as being included within its approved coastal zone management program. The coastal zone may include open waters, estuaries, bays, inlets, lagoons, marshes, swamps, mangroves, beaches, dunes, bluffs, and coastal uplands. Coastal-zone uses can include housing, recreation, wildlife habitat, resource extraction, fishing, aquaculture, transportation, energy generation, commercial development, and waste disposal.
Dewatering	The process of extracting water from a saturated soil or sediment.
Dredged material	Material which has been dredged from a water body, while the term sediment refers to material in a water body prior to the dredging process.
Dredging	An excavation activity or operation usually carried out at least partly underwater (generally in shallow water areas) with the purpose of removing bottom sediments and relocating them.
Environmental harm	Any adverse effect or potential adverse effect (whether temporary or permanent and of whatever magnitude, frequency or duration) on an environmental value, and includes environmental nuisance.
Existing acidity	In acid base accounting, a collective term that includes actual acidity and retained acidity.

Term	Definition
Groundwater	Subsurface water in the zone of saturation, including water below the watertable and water occupying cavities, pores and openings in underlying soil and rock.
Habitat	The specific area or environment in which a particular type of plant or animal lives. An organism's habitat provides all of the basic requirements for the maintenance of life. Typical coastal habitats include beaches, marshes, rocky shores, bottom sediments, mudflats, and the water itself.
Impact	Environmental change (usually biological) that has occurred as a result of dredging activity. The extent of the change may be considered unacceptable and may require some intervention by regulatory authorities.
Indicator	Measurement parameter or combination of parameters that can be used to assess the quality of water.
Infrastructure	The basic facilities and support systems underpinning urban areas, for instance water, power, sewerage and transport networks. Infrastructure can include services and institutional arrangements, but in the context of this document only refers to physical structures like roads and pipelines.
Measurement parameter	Any parameter or variable that is measured to find something out about an environment or ecosystem.
Monosulfides	The term given to highly reactive RIS compounds with the approximate cation:sulfur ratio of one. In ASS materials RIS includes iron monosulfide minerals, such as greigite and mackinawite, as well as aqueous FeS ad HS^-. Monosulfides are operationally measured as Acid Volatile Sulfide (AVS).
Monosulfidic	In relation to ASS, refers to soil material containing ≥ 0.01% acid volatile sulfide (AVS).
Monosulfidic black ooze (MBO)	Amorphous gels that contain high concentrations of iron monosulfide minerals (general formula FeS). These minerals form in the base of low-flow surface water bodies in acid sulfate soil–influenced environments. MBOs are highly reactive in the presence of oxygen, breaking down in a matter of minutes to produce free iron and acidity. The reactions are controlled by the presence of oxygen in the water, and their disturbance can cause significant deoxygenation events in natural waters, killing aquatic life. MBOs may sometimes be referred to as iron monosulfides, monosulfides or acid volatile sulfides. MBO formation is considered a precursor to biogenic pyrite formation, and thus formation of ASS.
Net Acidity	The measure of the acidity hazard of ASS materials. Determined from laboratory analysis, it is the result obtained when the values for various components of soil acidity and acid neutralising capacity (but only after corroboration of the ANC's effectiveness) are substituted into the Acid Base Accounting equation.
Neutralising	The process whereby acid produced (by the oxidation of iron sulfides) is counteracted by the addition of an ameliorant such as lime ($CaCO_3$); there are formulae for calculating the amount of ameliorant needed.
NWQMS	National Water Quality Management Strategy.
Organism	Any living animal or plant; anything capable of carrying on life processes.
Oxidation	The combination of oxygen with a substance, or the removal of hydrogen from it; or, more generally, any reaction in which an atom loses electrons.
Potential acidity	Acidity associated with the complete oxidation of sulfides (mainly pyrite) – that is, the maximum theoretical amount of acidity that could be produced if all the pyrite in the soil oxidised. In an acid sulfate soils context, potential acidity is operationally defined by either the chromium-reducible sulfur method or the peroxide-oxidisable sulfur method.
Pyrite	pale-bronze or brass-yellow, isometric mineral: FeS_2; the most widespread and abundant of the sulfide minerals.
Retained Acidity	The 'less available' fraction of the existing acidity (not measured by the TAA) that may be released slowly into the environment by hydrolysis of relatively insoluble

Term	Definition
	sulfate salts (such as jarosite, natrojarosite, schwertmannite and other iron and aluminium hydroxy sulfate minerals).
Risk	A statistical concept defined as the expected frequency or probability of undesirable effects resulting from a specified exposure to known or potential environmental concentrations of a material, organism or condition. A material is considered safe if the risks associated with its exposure are judged to be acceptable. Estimates of risk may be expressed in absolute or relative terms. Absolute risk is the excess risk due to exposure. Relative risk is the ratio of the risk in the exposed population to the risk in the unexposed population.
Sediment	Unconsolidated mineral and organic particulate material that has settled to the bottom of aquatic environments. The term dredged material refers to material which has been dredged from a water body, while the term sediment refers to material in a water body prior to the dredging process.
Soil materials	The term soil material refers to both soil materials and sediments in this guideline.
Solubility	In chemistry, how easily a substance will dissolve into a homogeneous solution, and also how much of a substance can dissolve into a solvent before saturation is reached. Solubility in water is the most common measurement, and the most relevant to ASS management.
Spoil	Material obtained by dredging.
Sulfide	A compound containing the –S functional group, or the S^{2-} anion itself. The terms 'sulfides' and 'sulfidic' are used more generally throughout this document to refer to all the inorganic sulfur-containing minerals and precipitates involved in acid sulfate soils chemistry.
Sulfidic	In relation to ASS, refers to soils containing detectable sulfide, with the following sub-division.
Sulfuric	In relation to ASS, refers to soil material that has a pH less than 4 (1:1 by weight in water, or in a minimum of water to permit measurement) when measured in dry season conditions as a result of the oxidation of sulfidic materials. Materials were previously referred to as actual acid sulfate soils (AASS).
Wetlands	Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and that, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated-soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.