Grazing and dairy industries in acid sulfate soils

In recent years there has been increased recognition of the need for grazing and dairy industry to actively manage acid sulfate soils both to increase the productivity of the land and to reduce the impacts on the waterways. These guidelines have been prepared to alert and inform pastoralists and dairy farmers of the issue and to provide advice on how to minimise the impacts of drainage works in acid sulfate soil areas. It is important that the industry acts responsibly to minimise any possible contribution by their drainage works on water quality and the productivity of the catchment.

What are acid sulfate soils

Acid sulfate soils contain iron sulfides. Iron sulfides are found underneath the watertable or in a waterlogged condition. While under water, these soils are stable and the sulfides do not cause a problem. When the sulfides are exposed to air as a result of drainage, the earth works or deep cultivation, they form sulfuric acid. In addition to reducing the productivity of the land the acid leachate can acidify adjoining drains, wetlands, creeks and estuaries leading to severe environmental damage as well as loss of fisheries productivity.

The pH is a measure of acidity. Each unit of pH represents a 10 fold change in the concentration of acidity. For example, pH 5 is 10 times more acid than pH 6. The pH of water is usually around neutral approximately pH 7-8. When water has a pH of 5.5 or below, it can kill fish, restrict plant growth and reduce agricultural productivity, and corrode metal and damaging concrete foundations and engineering structures.

Where do acid sulfate soils occur?

Acid sulfate soils occur naturally in low-lying areas generally less than five metres above the high tide level. These soils are common on coastlines throughout the world, including the coastline of Australia associated with coastal river, estuarine or marine sediments laid down generally in the past 10,000 years.

What do you need to do if acid sulfate soils are present

For the sustainable management of grazing or dairy properties in coastal areas, a preliminary assessment should be undertaken to determine if acid sulfate soils are likely to be disturbed by drainage, dams, levees and other earthworks. If likely, an acid sulfate soils management plan should be developed. This information sheet outlines how

- to recognise and confirm the presence of acid sulfate soils
- to minimise the impact on the environment from drainage and other works
- to improve the productivity of the farm.

The acid sulfate soil planning and risk maps for coastal areas in NSW (Department of Land and Water Conservation) should be the first step in the investigation. These maps can provide a useful indicator as to the likely presence or absence of acid sulfate soil by identify areas of high, low or no probability of finding acid sulfate soils in the landscape. The maps do not describe the actual severity of acid sulfate soils (ie the percentage of iron sulfides).

Are approvals required?

Prior to undertaking any works which are likely to affect acid sulfate soils, you should consult with the local council to determine what approvals may be required. If the works affect wetlands protected under SEPP 14 – Coastal Wetlands, development consent will be required from council and an environmental impact statement (EIS) must be prepared.
This document does not attempt to fully describe the soil sampling, testing and assessment required to develop an acid sulfate soils management strategy. If acid sulfate soils are identified on dairy or grazing properties, obtain a copy of the ASS Manual, engage a consultant with an understanding of soil science, and seek advice from the appropriate government agencies.
Preliminary assessment to identify acid sulfate soils

Many of the locations on coastal floodplains where used for grazing and dairying are likely to contain acid sulfate material. You can identify the presence and approximate distribution of acid sulfate soils by using existing mapping information, on-site indicators and field surveys. This information is necessary as a first step in developing sustainable management strategies for acid sulfate soils.

Desktop assessment
Desktop assessments of Acid Sulfate Soil Risk Maps, topographical maps and aerial photographs can help determine the likely presence of acid sulfate soils. Other indicators for the presence of acid sulfate soils include:

- soils deposited in river and estuary floodplains below approximately 5-10 m
- coastal wetlands or back swamp areas; waterlogged or scalded areas; interdune swales or coastal sand dunes
- area where the dominant vegetation is mangroves, reeds, rushes and other swamp-tolerant or marine vegetation such as swamp mahogany, paper bark and swamp oak

Surface inspection
Actual acid sulfate soils occur where the sulfides in the soils have been exposed to the air and acid is currently being generated. A field inspection for indicators of actual acid sulfate conditions can confirm that acid sulfate material is present on the site. The indicators include soils with pH less than 4; unusually clear or milky green drain water with a pH of less than 5.5; extensive rust-coloured iron stains on any drain surfaces, or iron-stained drain water and ochre deposits; butter-coloured jarosite present in surface spoil, on any material excavated and left exposed or in augered material showing yellow jarositic horizons or red, iron oxide mottling or corrosion of concrete and/or steel structures.

However, just because there are no indicators for actual acid sulfate soils, it does not mean that acid sulfate soils are not present and have the potential to generate acid in the future. Where the iron sulfides have not been exposed to oxygen, then visual identification may prove difficult. Potential acid sulfate soils are typically waterlogged estuarine sands or silty sands; mid to dark grey to dark greenish grey in colour; soft, buttery consistency of a clay; or pH neutral. These “potential” acid sulfate soils will generate acid if they are disturbed and exposed to air.

Sub-surface inspection and sampling
The next step is to examine the soil profile by using an auger or backhoe pit. (Caution: take care when digging backhoe pits to ensure they do not slump - see ASS Manual).

Sample the soil to at least the depth of the proposed earthworks (e.g. drainage, dams or land formation works). Due to the uneven distribution of iron sulfides in the soil, take at least five samples in any one area to understand the likely distribution. The pH of the samples should be tested in the field using a pH meter. If the pH is less than 4, it confirms the presence of actual acid sulfate soils. The Peroxide Test (described in the ASS Manual) provides a field test for potential acid sulfate soils. If any of the preliminary assessment indicates that acid sulfate soils could be present, engage a consultant to undertake a more rigorous soil survey and sampling program.

Laboratory Analysis
The conclusions drawn from the desktop assessment or field inspection should always be confirmed by laboratory analysis. Representative samples should be sent for laboratory analysis, to confirm if acid sulfate soils are present and at what concentrations. It is recommended that qualified consultants do the sampling and a laboratory using methods in the ASS Manual undertake the analysis. Further information for determining the concentration of acid sulfate soil, its potential acid generation potential and management options can be found in the ASS Manual.
Sustainable management of acid sulfate soils

Acid sulfate soils are manageable. It is important to recognise the constraints they pose to sustainable pasture management at the outset. The most sensible way to manage these soils is to incorporate their management into the farm management plan.

Grazing or Dairy Properties

The best way to minimise the impacts of acid sulfate soil both on and off-site is to responsibly manage the soils from the outset. You need to know whether acid sulfate soils are present, and if they are, where they occur in relation to proposed earthworks (drains, dams, laser levelling, and levees). You can then plan the layout of the works so that you do not disturb acid sulfate soils. In developing the design and layout of any new works or the redesign of any existing, you need to consider:

- the depth and fluctuation of the watertable
- surface water hydrology – storm and flood patterns.
- acid sulfate soils characteristics – location, depths and concentrations - the depth from the ground surface to the acid sulfate soil layer
- any existing scalded or degraded areas
- the likely change in watertable resulting from pastures compared with the existing vegetation.

Drainage Principles

The following “rules of thumb” should apply when considering drainage of new areas or reviewing the performance of existing cane land drains:

1. Where areas are “scalded” or degraded and devoid of vegetation, no further drainage should be undertaken. Remediation strategies should be developed which may include alternative drainage management including the removal of existing drains.
2. Where the sulfidic layers is at a depth below the soil surface of less than 0.5 metres, these areas should be left undrained as any drainage will produce acid. Generally these areas are best left waterlogged and planted with species such as swamp grass or managed as irrigated pastures.
3. Where the sulfidic layer is between 0.5 and 2.0 m from the surface, drainage should only be attempted with properly designed drains and treatment of any acidic discharge.
   - if the sulfidic layer is 0.5 to 1 metre below the soil surface, surface drainage and landgrading should be limited to cuts less than 30 mm. Irrigated pastures or crops should be considered
   - if the sulfidic layer is 1 metre to 1.5 metres below the soil surface, surface drainage and landgrading should be limited to cuts no greater than 1 metre.

Deciding on a Management Strategies

Once you understand the characteristics of acid sulfate and hydrology, you can make informed management decisions to improve the productivity of the land and to reduce the risks to the environment and your liability. Options include:

- avoid disturbing locations where acid sulfate soils occur
- if acid sulfate soils areas cannot be avoided, design the drains, dams or earthworks to avoid disturbing the material or lowering the watertable
- if acid sulfate soils are to be disturbed, treat any extracted soil, neutralise any acid produced and prevent any acid leaving the site
- if acid sulfate soils have previously been disturbed, manage any acid already being produced and minimise further production
- ensure that the ongoing management of the farm will minimise the disturbance of acid sulfate soils and will manage any acid generated.

Animal health risks

Good water quality is an essential component of successful livestock production. There could be animal health implications if the principal water supply in drains or dams is acidic with high levels of aluminium, iron and other heavy metals. The maintenance of pH levels above pH 5.5 would reduce the risks to the stock and to the natural ecology of the waterbodies.

Outline of Management Options

- **Avoid acid sulfate soils**
  If a soil survey identifies areas containing acid sulfate soils, the most environmentally responsible approach is to avoid the disturbance of the area. Selecting alternative non-acid sulfate sites for drains or dams, in most cases is a preferable alternatives as it avoids the need for costly remediation measures.
  - **Take care when disturbing the soil**
    Avoid disturbing potential acid sulfate soils during laser levelling, drain or dam construction. Avoid extensive cut or fill operations. Make use of the natural contour of the land to assist surface drainage.
The deeper the potential acid sulfate soil layer is in the profile, the less likely it is to be disturbed.

- **Use shallow drains**
  Use shallow, wide spoon drains to remove surface water from the land. This type of drain can transport the same volume of water as deeper drains if properly designed. They also can be easily maintained. See the Drainage Principles.

- **Improve drainage efficiency**
  The drainage system should be reviewed to determine if all the drains are justified and if they can be reconfigured to achieve the required performance. Laser levelling of pasture improvement areas or areas to be irrigated should be considered.

- **Neutralise any acid produced**
  Lime any areas where acid sulfate soils were disturbed or have become acidic. These areas may include pasture country, spoil from drainage or dam works or the walls of drains and dams or levee banks.

- **Keep the watertable high**
  By maintaining high water levels in the drain, you keep air out of the potential acid sulfate soil layer, so the production of acid can be minimised. This can result in increased pasture productivity.

- **Consider irrigated pastures**
  Maintaining higher moisture levels can reduce the production of acid and improve the productivity of pasture country. In some cases, it may be possible to use effluent from near-by industry or wastewater treatment plants.

- **Don’t burn off near wetlands and prevent strategies bushfires reaching wetlands**
  If the peat layer burns, the natural buffering capacity important in reducing the impacts of acid sulfate soils in peaty areas, swamps or wetlands will be lost. As a result the area can become highly acidic and degraded and useless for grazing. Steps such as firebreaks around these areas and fuel reduction by slashing should be considered.

- **Monitoring the pH**
  It is important to measure the pH of water before it is discharged from drainage systems. To reduce the impact on the environment and agricultural productivity the pH of the water should be between 6.5 and 8.5. If you detect acid water in drains or collection ponds some form of treatment is necessary before it can be discharged safely.

- **Develop maintenance strategies**
  As part of the property management plan, develop maintenance strategies for the pasture and back swamp country, drains, dams and other works that involve the disturbance of acid sulfate soils.

**Include Acid Sulfate Soils in the Property Management Plan**

The management of acid sulfate soils should be included in the property management plan. It should include procedures for maintenance of all drains, dams and pastures in areas affecting acid sulfate soils. It should include contingency measures to deal with unpredicted occurrences and monitoring of water quality.

**For further information**

This information sheet outlines how to recognise and confirm the presence of acid sulfate soils. It also discusses management techniques to minimise the soils’ impact on the environment and farm productivity. For more details on the assessment and management of acid sulfate soils, see the ASS Manual.

**NSW Agriculture**

NSW Agriculture provides advice on agronomy, farm planning, drainage, irrigation and production systems important in the sustainable management of acid sulfate soils.

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**ACID SOIL ACTION** An initiative of the NSW Government.

For further information on the assessment and management of acid sulfate soils, consult the ASS Manual. This leaflet has been produced by NSW ASSMAC. Inquiries: Jon Woodworth, Acid Sulfate Soils Information Officer, Acid Sulfate Soils Management Advisory Committee, NSW Agriculture, Wollongbar Agricultural Institute, Bruxner Highway, WOLLONGBAR NSW 2477 Telephone 02 6626 1340, Fax 02 6628 1744

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