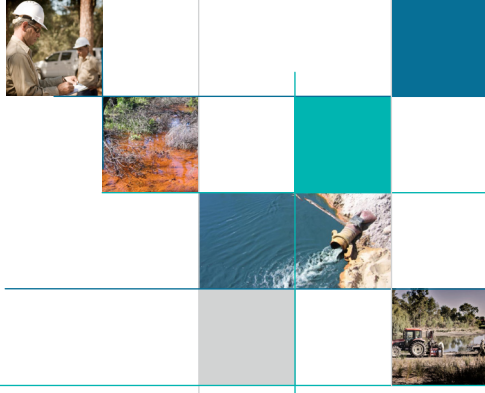
Government of **Western Australia**
Department of **Water and Environmental Regulation**



Acid sulfate soils fact sheet 1

What are acid sulfate soils?

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Purpose

Acid sulfate soils (ASS) are naturally occurring soils and sediments containing iron sulfides, most commonly pyrite. When ASS are exposed to air, the iron sulfides in the soil react with oxygen and water to produce a variety of iron compounds and sulfuric acid.

Initially a chemical reaction, the process is accelerated by soil bacteria. The resulting acid can release other substances, including heavy metals, from the soil into groundwater and the surrounding environment.

How are acid sulfate soils formed?

The ASS of most concern in many parts of WA were formed after the last major sea level rise within the past 10,000 years (i.e. during the Holocene period).

When the sea level rose and flooded the land, sulfate in the seawater mixed with land sediments containing iron oxides and organic matter.

On the Swan Coastal Plain between Geraldton and Busselton, ASS have also formed in sandy soils below the watertable through microbially enhanced chemical reactions between marine salts that have been deposited in rainfall and iron minerals in the soil. These sandy soils are acidifying in some areas where the watertable is falling because of decreasing annual rainfall and increasing groundwater use.

Potential acid sulfate soils (hypersulfidic soil materials)

ASS that have not been oxidised by exposure to air are known as potential acid sulfate soils (PASS) or hypersulfidic soil materials. While contained in a layer of waterlogged soil, the iron sulfides in the soil are stable and the surrounding soil pH is often weakly acid to weakly alkaline.

Potential ASS:

- often have a pH close to neutral (6.5 – 7.5)
- contain unoxidised iron sulfides
- are usually soft, sticky and saturated with water
- are usually gel-like muds but can include wet sands and gravels
- have the potential to produce acid if exposed to oxygen.

Actual acid sulfate soils (sulfuric soil materials)

When PASS are disturbed or exposed to oxygen, the iron sulfides are oxidised to produce sulfuric acid and the soil becomes strongly acidic (usually below pH 4). These soils are then called actual acid sulfate soils (AASS) or sulfuric soil materials.

AASS:

- have a pH of less than 4
- contain oxidised iron sulfides
- vary in texture
- often contain jarosite (a yellow mineral produced as a byproduct of the oxidation process) or schwertmannite (an orange mineral produced as a byproduct of the oxidation process).

If possible, DO NOT DISTURB ASS.

They are benign when left in a waterlogged, undisturbed environment. Avoiding disturbance is often the most environmentally sustainable and economic option.

Where are acid sulfate soils found?

ASS commonly occur in coastal wetlands as layers of marine muds and sands which are deposited in protected, low-energy environments such as barrier estuaries and coastal lakes. In similar environments, they are still being formed. They also occur below the watertable in some sandy soils on the Swan Coastal Plain.

ASS are a natural component of the landscape and may be found in a variety of waterlogged soil types.

These include:

- dark, organic rich soils and muds
- peaty wetland soils
- some pale grey sands (Bassendean sands and Spearwood sands)
- 'coffee rock' (cemented iron and/or organic rich sands) found below the watertable.

ASS in WA frequently occur in low-lying wetlands, backswamps, estuaries, salt marshes and tidal flats, although they are not limited to coastal regions.

ASS may be found in:

- **low-lying land adjacent to estuaries** – typically grey silty or sandy sediments of alluvial origin
- **groundwater-dependent wetlands** – typically peaty and sandy sediments associated with some wetlands on the Swan Coastal Plain. Pyrite in the sediments can acidify the wetland if the watertable falls well below the base of the wetland due to dry weather or excessive groundwater pumping
- **former seashores** – pyrite often occurs with heavy-mineral accumulations associated with former seashores. These seashores may occur several kilometres inland from the current seashore
- **sandy soils** – leached sandy soils (Bassendean and Spearwood sands) in areas of high watertable along the Swan and Scott coastal plains
- **inland ASS** – there are inland forms of ASS occurring in agricultural areas well away from the coast. These soils appear to be acidifying in response to rising watertable and land salinisation in southern WA.

The impact of disturbing acid sulfate soils

Without proper management, disturbing ASS can have serious environmental, economic, engineering and health impacts and can constrain development, construction and other activities in affected areas. Detrimental effects can include:

- ecological damage to aquatic and wetland ecosystems
- harmful effects on estuarine fisheries and aquaculture projects
- contamination of groundwater with arsenic, aluminium and heavy metals
- reduction in agricultural productivity due to soil degradation
- damage to infrastructure through the corrosion of concrete and steel pipes, bridges and other subsurface assets
- potential threat to human and animal health.

Activities that may generate acid in certain areas

These can include:

- major earthworks – large-scale excavations for canal developments and estates
- infrastructure earthworks – digging for bridges, roads, tunnels and railways
- excavating for sewerage pipes, pump stations, basements and installation of underground services
- construction and maintenance of drainage channels (including digging channels to manage waterlogging in agricultural areas)
- maintenance dredging – boating channels and canal estates
- lowering of the watertable because of declining rainfall, groundwater abstraction and dewatering activities.

Possible indicators of acid sulfate soil disturbance on land – what to look for

They can include:

- acid scalds – bare patches appear where the topsoil is salty or acidic
- iron monosulfides – 'sulfurous smelling' black sediments and muds found in low-oxygen environments
- jarosite – yellow mineral indicative of iron sulfides in ASS oxidising and forming sulfuric acid
- stunted, dead vegetation.

Acid scald—bare patches appear where the top soil is salty or acidic

Possible indicators of acid sulfate soil disturbance in water—what to look for

These can include:

- crystal clear water – high levels of aluminium can cause soil particles to drop to the bottom of a waterway leaving the water clear
- yellow-brown water – indicates iron
- iron flocs – usually a red-brown or brown-yellow colour present throughout the water
- blue-green water – indicates soluble aluminium and iron
- milky-white water – also an indication of aluminium particles.

Iron flocs—ususally a red-brown or yellow-brown colour present throughout the water

Blue green water—indicates soluble aluminium and iron

Other possible indicators of acid sulfate soils

These can include:

- fish kills – acidic water and metals can kill fish and increase their susceptibility to disease
- damage to infrastructure – sulfuric acid can degrade concrete and steel
- iron staining – rust-coloured iron stains on footpaths, fences and walls
- oily looking water – iron bacteria floating on affected water.

Management options for acid sulfate soils

Where ASS disturbance is unavoidable, successful management can be derived from a suitable investigation of the nature of soils and groundwater. Mitigation management measures may include:

- minimising radial drawdown of groundwater associated with dewatering
- treatment of soils – mixing adequate qualities of lime into exposed ASS to neutralise any produced acidity
- building wide, shallow drains – shallow drains allow removal of surface water while maintaining watertable height.

More information

For advice on ASS, or related matters, please contact your Local Government Authority. Additional resources, including National Guidelines on the investigation and management of ASS, can be found at Water Quality Australia.

This document is available in alternative formats and other languages on request.

Related documents

Related fact sheets and further technical documents about ASS are available from the Department of Water and Environmental Regulation (the department).

Legislation

This document is provided for guidance only. It should not be relied upon to address every aspect of relevant legislation. Please refer to the Department of Justice for copies of the relevant legislation.