A Guide to Preventing and Suppressing Bushfires on Organic and Acid Sulfate Soils

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Fire and Emergency Services**

Department of **Biodiversity, Conservation and Attractions**

Organic Soils

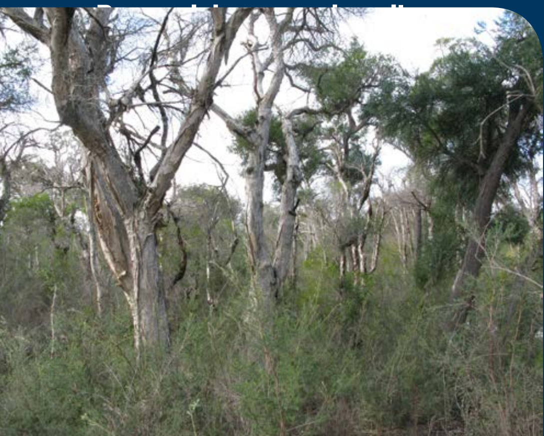
What are organic soils?

Soil is composed of a combination of minerals (sand, silt and clay) and organic material (partly decomposed plants and animals). Organic soils can contain up to 90% organic material, and those with very high organic content are also known as peats.

Organic material helps soils to store moisture and nutrients and improves soil structure. For this reason, organic soils are highly valued for agricultural land, and areas of native bush growing on organic soil are becoming rare. Organic soils are also important to the natural environment because they support a unique biodiversity. Their environmental significance means that areas of organic soil may be protected under legislation, including the Western Australian *Environmental Protection Act 1986* and the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999.*

The appearance of organic soils varies, depending on the amount of organic material they contain and how much it has decomposed. Plant roots, leaves and bark are clearly visible in some soils, giving them a spongy texture similar to potting mix. If the organic material has decomposed and broken down, it may only be evident as a dark brown, grey or black staining of the soil.

Organic soils usually form in wet environments such as swamps, marshes and coastal wetlands. These areas may be recognised by the plants that grow there: paperbark, swamp sheoak, flooded gum, samphire, mangrove, salt water couch, reeds and rushes all indicate wet areas where organic soils may be found. These plants often remain even when surface water is no longer present, indicating the presence of dry organic soils.



Cover Image: Organic soils form in wet environments such as this mound spring in the Northern Agricultural Region. Photo by Stephen Kern.

Left: Paperbarks indicating a wetland area where organic soils are likely to occur. Photo by V. Densmore.

Above: An organic soil profile. Photo by Jackson Parker

Above: Soils with organic material that has not broken down (left), partly broken down (centre) and mostly broken down (right). Photo by Jim Stratford.

Acid Sulfate Soils

What are acid sulfate soils?

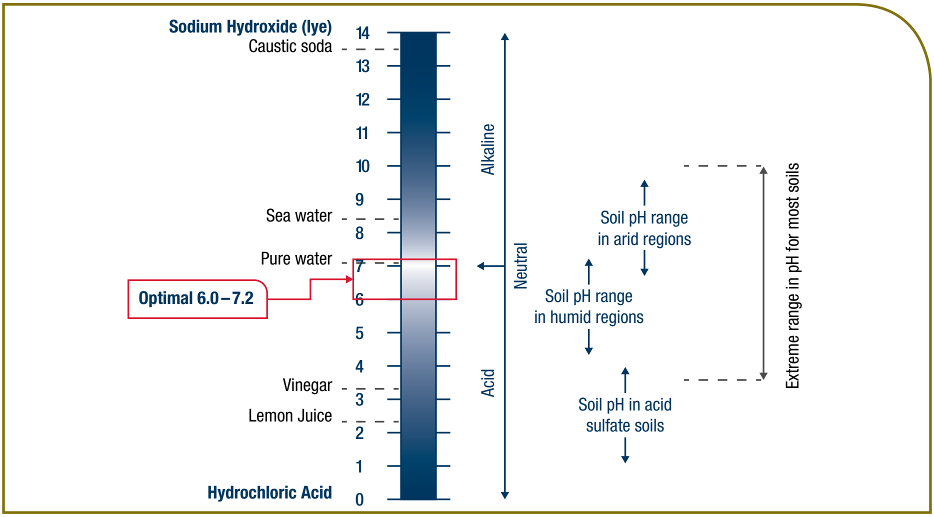
Acid sulfate soils contain chemical compounds called iron sulfides, most commonly as a mineral called pyrite. These soils are harmless when undisturbed, but react when exposed to air to form sulfuric acid.

Potential acid sulfate soils contain iron sulfides that have not been exposed to air. They occur naturally and have a neutral pH of between 6 to 8. Most organic soils are potential acid sulfate soils.

Actual acid sulfate soils have been exposed to air, triggering the reaction that produces acid and reducing the soil pH to less than 4. Actual acid sulfate soils can be formed when potential acid sulfate soils are disturbed by earthworks, lowering of the water table or fire.

This acidity releases elements such as metals and nutrients from the soil profile which can then be transported to waterways, wetlands and groundwater systems, often with harmful environmental and economic impacts.
These include the acidification of waterways and groundwater, death of plants and animals, and corrosion of concrete structures and sub-surface utilities.

It is very difficult to restore soils once they become acidic. The most effective management is prevention, by avoiding any unnecessary disturbance of potential acid sulfate soils.



Above: The pH of normal and acid sulfate soils compared with some common substances.

Recognising acid sulfate soils

Potential acid sulfate soils form where the soil has been saturated with water, usually near the coast and in estuaries, rivers, streams or wetlands. In Western Australia, they are usually dark-coloured organic soils, pale grey sands or hardened sands known as ‘coffee rock’.

Some indicators of potential acid sulfate soils are:

- Dark grey-coloured subsurface soil
- A smell of rotten eggs (hydrogen sulfide gas) when the soil is disturbed
- Rust-coloured staining in soils exposed to air.

Actual acid sulfate soils are usually soft, sticky, blue-grey muds or fine grey sands. Black ooze may be visible at the sides and bottom of drains, cuttings or boreholes and there may be oily, rust-coloured bacterial scum floating on the water. Soil scalding may also occur, leaving bare patches of ground where plants have died. Any plants that remain will be salt and acid resistant, such as samphire, salt water couch, phragmites (a group of tall grasses), reeds, rushes, paperbark and swamp sheoak.

Left: Black ooze or yellow staining in exposed soil indicates actual acid sulfate soil.

Acid sulfate soil risk maps are available on the *Shared Land Information Portal* at: https://www2.landgate.wa.gov.au and on *FESMaps*. Note that these maps only provide an overview of where these soils may occur and are not highly detailed. Chemical tests can be used to identify conclusively potential and actual acid sulfate soils.
The DFES Bushfire Technical Services Branch are available to assist DFES Operations in testing for acid sulfate soils upon request through the State Situation Officer (SAO), during normal business hours. Assistance outside of business hours or the Metropolitan Region will be by exception and determined by need and availability.

Left: Red staining of soil exposed to the air indicates actual acid sulfate soil.

Left: Rust-coloured bacterial scum floating on water indicates actual acid sulfate soil. The surrounding area has been treated with agricultural lime to neutralise the acid.

Left: Scalding – vegetation killed by acid in soil and water. Photo by Mike Coote.

Fire management on organic and potential acid sulfate soils

Organic soils can become flammable when dry, owing to the large amount of plant material they contain. Declines in rainfall and groundwater levels in the south-west of Western Australia are making it more likely that organic soils will dry out for prolonged periods. This has resulted in an increased frequency of organic soil fires.

Burning organic soil can be difficult to detect and suppress because it may:

- Burn underground
- Burn for a long time
- Re-ignite or escape from containment lines.

Organic soils smoulder because their compact nature limits the oxygen available to the fire. This means they produce far more smoke, and for a longer period of time, than a vegetation fire of the same size. The smoke from an organic soil fire also contains chemicals and fine particulates that may cause irritation or more serious health effects for firefighters and nearby residents.

Fires in organic soils may also cause serious environmental harm. Organic soils are very slow to form, and deep organic soil layers may take many thousands of years to develop. This material can be lost in a single fire, with long-lasting effects on the biodiversity of the area.

Any fire or earthworks in areas of organic soil will allow oxygen to enter the soil and may trigger the reactions that create actual acid sulfate soils. Works that should be undertaken with care in these areas include back burning, the creation of fire containment lines and and any excavation to reach or isolate subterranean fires.

Above: An area where organic soil has burnt away in a bushfire.

Fires in organic soils may have health effects and can damage the environment

Fire operations in organic soils

Fire management operations must be undertaken with care in areas of organic soil, in order to ensure the safety of firefighters, protect biodiversity and prevent the formation of actual acid sulfate soils. The three most important principles for managing fire in organic soils are:

1. Exclude bushfire wherever possible
2. Attack bushfires quickly using large quantities of water
3. Minimise ground-disturbing activities.

Bushfire may be excluded from organic soils by maintaining fire-breaks, and prescribed burning of the surrounding vegetation when the soil is saturated. Bushfires should be prevented from igniting organic soils by aggressive direct attack suppression tactics, using large amounts of water. Foams, retardants and wetting agents should be used with caution because they may be toxic to plants and animals in wetland systems. If their use cannot be avoided, they should not be allowed to enter waterways or wetlands (refer to DFES SOP 3.5.5 - Use of A Class Foam at Incidents).

Organic soils are unstable, especially when burnt, and may collapse beneath people or vehicles. Their thin surface crust may give way with little pressure, exposing the soft and extremely hot soil beneath. Firefighters should check the stability and temperature of organic soils before travelling on them, and should remember that subterranean fire could have spread to affect previously used tracks and control lines. Subterranean fires often burn tree roots, destabilising trunks and increasing the risk of falling trees. Areas of wet organic soil also pose a hazard as they are likely to be soft. Machines with wide wheels or tracks (good flotation) should be used to construct fire-breaks if they are required in these areas.

Above: A firetruck stuck in organic soil.

Above: Tree roots exposed after the surrounding soil has burnt away in a bushfire.

Burning organic soils should be isolated, and thoroughly extinguished, including any subterranean fire. Earthworks should be kept to a minimum, and should be as narrow as possible when created to isolate organic soils. A tracked skid-steer loader or similar small machine is preferred for fire-break construction because they are lighter and cause less soil disturbance than larger machines. The use of rakes, rather than buckets, to create fire-breaks will further reduce ground disturbance.

Sprinklers or water tankers should be used to drench any burning organic soils, but water may need to be applied slowly. Organic soils are water-repellent when dry, and water applied to the surface will take a long time to penetrate. As a guide, two litres of water should be applied per square metre of soil, and then allowed to be absorbed before applying more. Water applied more rapidly may run-off and be ineffective.

If fire occurs beneath the surface, it may be necessary to dig a narrow trench to isolate the burning area. A small excavator or backhoe should be used to dig trenches, to minimise the width and ensure sufficient depth to isolate the burning area. Trenches do not need to extend to the water table, only deep enough to reach moist soil. If possible, the trench should be filled with water or mineral soil because that will help suppress the fire and may reduce the likelihood of forming actual acid sulfate.

Two litres of water should be applied per square metre of burning soil, and then allowed to be absorbed before applying more.

Above: A sprinkler being used to drench an area of smouldering organic soil.

Above: A narrow trench used to isolate an area of organic soil.

Organic soils can smoulder beneath the surface for weeks or months unless the soil is saturated by firefighters or heavy rain. Handheld infrared detectors or thermal imaging cameras can be used to check for hotspots that indicate surface or subterranean fire. Airborne or satellite-based infrared scans may be required if large areas of organic soil are affected by fire. Preferably, water should continue to be applied to the burnt area until hotspots cannot be found, areas left smouldering will spread, risking a fire escape and further damage.

Ground-disturbing earthworks to create fire-breaks or access subterranean fire can expose sulfides and cause actual acid sulfate soils to form.
Such works should be undertaken carefully, and soils rehabilitated after the fire. Disturbed areas should be tested for acidity and any areas found to be above background levels should be neutralised with agricultural lime. The amount of agricultural lime and application techniques required to neutralise actual acid sulfate soils depends upon the quantity of soil disturbed and its composition. Seek advice from the Department of Water and Environmental Regulation before attempting to restore a disturbed site.

Below: A handheld thermal imaging camera is being used to detect smouldering organic soil.

Assistance

Contact the DFES Bushfire Technical Services Branch, during business hours, for more information on fire management in areas with organic soils. The Department of Water and Environmental Regulation can assist with identifying and managing potential and actual acid sulfate soils.

DFES Bushfire Technical Services Branch

Phone: (08) 9395 9300

Email: environment@dfes.wa.gov.au

Department of Water and Environmental Regulation

Phone: (08) 6364 7000

Email: Atrium.Reception@dwer.wa.gov.au

A Guide to Preventing and Suppressing Bushfires on Organic and Acid Sulfate Soils

Bushfire Technical Services Branch,
Department of Fire and Emergency Services, Western Australia
20 Stockton Bend, Cockburn Central, Western Australia 6164

Phone: (08) 9395 9300

Email: environment@dfes.wa.gov.au

Web: www.dfes.wa.gov.au

Disclaimer

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Fire and Emergency Services**

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Fire and Emergency Services**

Department of **Biodiversity, Conservation and Attractions**