APPENDIX 6: ACID SULFATE SOILS

Summarised and paraphrased from Sammut J & Lines-Kelly R, *An Introduction to Acid Sulfate Soils,* Department of Environment, Sport & Territories [Commonwealth], no date; White I & others, *Acid Sulfate Soils - facing the challenges,* Earth Foundation Australia monograph 1, 1996.

What are acid sulfate soils?

Acid sulfate soils are soils which contain iron sulfide. Under natural conditions the iron sulfide layer usually lies below the watertable, where it is waterlogged and inert ('potential acid sulfate soil'). However, if the iron sulfide layer is exposed to air (for example, from lowering the watertable, or when disturbed by earthworks), it reacts with oxygen from the air to produce sulfuric acid ('actual acid sulfate soil'). The soil itself may be able to neutralise the acid, or some of it. The remaining acid moves through the soil, acidifying soil water, groundwater and, eventually, surface waters.

Acid sulfate soils are found in low-lying coastal areas, generally less than five metres above mean sea level. It is estimated that in Australia there are more than two million hectares of acid sulfate soil containing about one billion tonnes of iron sulfide. One tonne of iron sulfide, if oxidised, produces about 1.5 tonnes of sulfuric acid. Depending on the conditions (for example, how easily air can percolate through the soil) the soil may release acid for one year or hundreds of years. In some areas of Australia, acid sulfate soils drained 100 years ago are still releasing acid.

Acid is sometimes produced naturally (for example, when the watertable lowers in time of drought, allowing air to reach the iron sulfide layer). It is usually neutralised by tidal flows of alkaline sea water. But when waterlogged soils are drained or excavated it greatly increases the rate of oxidation. The released acid can overwhelm the stream's capacity to neutralise it.

Environmental impacts of acid on land

The acid can damage the environment in various ways:

Mobilisation of toxic heavy metals: The acid strips iron, aluminium and sometimes manganese from the soil. In some cases it also dissolves heavy metals such as cadmium. This can make the soil so acid and toxic that few plants can survive.

Reduced farm productivity: Acid conditions make several soil nutrients less available to plants. The acid dissolves iron and aluminium from the soil so that they become available to plants in toxic quantities in soil water. These conditions reduce plant growth and only acid-tolerant plants can survive. Animals may take in too much aluminium and iron by feeding on acid-tolerant plants and drinking acidic water.

Corrosion: The acid corrodes metal and concrete structures.

Landfill: Using acid soils as landfill can prevent establishment of lawns and gardens.

Environmental impacts of acid on fish and aquatic life

Acidic water may kill fish, crustaceans and sea plants, or trigger diseases like 'red spot' disease. Some 70% of our commercial fish species spend part of their life cycles in estuaries, so the impacts of acid water raise major concerns for the future of commercial and recreational fishing industries and the ecosystem.

Massive fish kills can occur when drought-breaking rains wash large amounts of acid and aluminium into waterways. More common are the chronic, less visible effects, such as reduced hatching and reduced growth rates. Mosquitoes may multiply because the fish which eat their larvae have declined.

Neutralisation of acid water by less acid stream water or sea water can make dissolved metals precipitate out. The metal can smother plants and damage fish gills, and may enter the food chain.

Only a few acid-tolerant water plants can survive in acid water. They can take over the drain or stream, so that even when pH returns to normal other species cannot re-establish.

Management of acid sulfate soils

Avoidance: The best way to manage acid sulfate soils is to avoid disturbing the iron sulfide layer in the first place. Iron sulfides are harmless when waterlogged.

Liming: Sulfuric acid can be neutralised with agricultural lime but this is too costly for large areas of badly affected land. Drains can be limed so that the acid produced in the drain walls is neutralised as it is washed out.

*Covering with water**:*** This may be a solution for badly affected areas where the land is scalded. The water cover encourages the growth of acid tolerant grasses such as water couch and provides drought pasture for stock. However, it is important that the water remains on the affected area: if it evaporates the soil will oxidise again.

Shallow drainage: Shallow drains allow surface water to drain quickly from low-lying land without exposing the deeper iron sulfide layer beneath the soil. Deep, narrow drains are more likely to expose the iron sulfide layer.

Burial beneath the water table: Potential acid sulfate spoil may be buried beneath the water table to prevent oxidation. An option for high-value land uses.

Capping: Has been used to control drainage from mine dumps. Spoil may be capped with a relatively impermeable layer to reduce the entry of oxygen and water. This slows down the production of acid and the rate at which acidic water is released.