Sydney Environmental & Soil Laboratory

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Acid Sulphate Soils

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Question:

Objectors have raised the issue of acid sulphate soils in a coastal development we are planning. Can you explain what acid sulphate is and would the presence of acid sulphate soils prevent the development?

Answer:

The term "Acid Sulphate Soil" (ASS) applies to estuarine sediment deposits laid down in the late Pleistocene epoch by rising sea levels caused by the melting of the polar ice caps at the end of the last ice age, about 20,000 years BP. As such they occur only within a zone about 8 metres of AHD or below AHD and they usually only occur in warmer climates above the latitude of about Eden in NSW in river deltas and estuaries.

After deposition the organic matter and iron in the sediments, and sulphate in sea water react together in the absence of oxygen to form iron sulphide, a black mineral that smells like rotten egg gas (sulphide). Thus they are never associated with freshwater deposits (no sulphate present), and they are characterised by a poorly drained low lying swampy condition, silty texture, black or grey colouration, and characteristic smell of swamps (sulphides). A mangrove mud is the best example with its grey or black colour, and characteristic smell.

Iron sulphide is not stable when exposed to oxygen in the air and fairly rapidly oxidises to form iron oxides (rust) and sulphuric acid. This sulphuric acid dissolves aluminium minerals and soluble aluminium can be very dangerous to living things, particularly gilled organisms. A big "slug" of acid sulphate affected drainage water can cause widespread fish kills in the adjacent estuary. The sulphuric acid also corrodes concrete and steel, and landscape plants will find it hard to grow on the acidified sediments.

If left alone so that they remain wet and anoxic they do not oxidise (or do so only very slowly) and are rarely a problem. If drained, for example for agriculture but also by natural processes, they can oxidise and cause problems related to the ecology of the area but as well to the buildings and footings present. Natural release of such acids is usually slow enough for the estuary to absorb any problems but man made changes can be too rapid for the waterway.

The amount of acidity potentially developing depends on how much iron sulphide is present but also on the presence of minerals such as calcium carbonate shell grit that could neutralise the resulting acidity (acid neutralising capacity).

There are two types of acid sulphate soils**, Actual Acid Sulphate soil (AAS)** where drainage and oxidation has already occurred, and **Potential Acid Sulphate soils (PAS**) which are still wet and not oxidised but which will potentially oxidise if drained. AAS soils are identified by acidic pHs (below4.0), rusty red colours, and the presence of a buttery yellow mineral called Jarosite which is a complex sulphate of iron and aluminium minerals. PAS soils are usually wet, grey or black in colour, and smell of sulphides. A single soil profile next to an estuary can show AAS conditions in the surface (where air enters) and PAS conditions at depth where the soils remains reduced (anoxic).

The first step in identifying the likelihood of encountering acid sulphate problems is to obtain the relevant "Acid Sulphate Risk Map" from the NSW Department of Land and Water Conservation. All state soil conservation organisations have such maps available. You will note from the maps that the risk of encountering ASS decreases with elevation above the sea and is highest on flat inundated plains associated with estuaries.

Once it is decided that a risk may occur in the location of the development a sampling and testing program by qualified consultants needs to be established. This will quantify the problem and help to guide management decisions. Do not establish the bulk earthworks plan before conducting ASS analysis as the presence of AAS or PAS soils can radically alter the earthworks requirements.

Yes, both PAS and AAS soils can be managed. In fact, allowing development of the land may be the only way to remediate a soil acidified by careless agricultural development that occurred in the past. In some cases land can need prodigious amounts of lime to remediate the acid being generated. Farmers cannot usually afford such amounts of lime but developers may.

The simple presence of acid sulphate soil should not preclude development as some misguided local council planning policies dictate.

Managing potential and actual acid sulphate soil involves-

a. **Avoidance**. If there is any way the development can be rearranged or modified to avoid disturbing the PAS soil on site then this is nearly always the cheapest option.
b. **Reburial** or encapsulation. Where PAS soil needs to be removed for the development it is best if it can be placed back into a waterlogged situation so that it does not oxidise in the post development landscape.
c. **Treatment**. Treatment can involve a number of approaches-
    I. **Liming** to neutralise acidity. This involves adding enough lime (calcium carbonate) to just get the final pH of the post oxidised soil up to about 5.5. This is easy enough to measure and to do but can sometimes involve large amounts of lime. A material we measured (a heavy silty black clay) required 50kg of lime per tonne. The development was to produce about 100,000 tonnes of the material so the cost of the lime alone came to about $ 350,000 (remember what I said about testing before designing the earthworks).
    II. **Extracting the pyrite**. Using a cyclonic separator in a sandy material the pyrite can be separated from the sand and much smaller volumes of PAS soil reburied or treated.
    III. **Managed oxidation**. The PAS material is removed and stockpiled in a controlled area such that acidified leachate resulting from the oxidation can all be captured and treated with lime before release back to the river.

The presence of acid sulphate soil does not preclude development but such an occurrence will require a careful testing program, and a management plan which includes monitoring requirements to be developed. A cost/benefit analysis on the different management options should be performed by the developer once the management report is available. Any management plan will need to be approved by the relevant authorities (usually the state EPA) before going to the planning approval stage. Careful science and good planning resulting in a convincing case is the only way to get around alarmist objections.

Further Reading

NSW Dept of Land and Water Conservation. Acid Sulphate Soil Risk Maps and Guide to the use of Acid sulphate Soil Risk Maps. phone (02) 9228 6315

Sammut Jesmond 1997 An Introduction to Acid Sulphate Soil. Department of Environment, Sport and Territories and Australian Seafood Industry Council.

List of Consultants: ASSIST (Acid Sulphate Soils Public Database). Phone: Jon Woodworth, acid sulphate soils information officer 02 66 261 344. or email: woodwoj@agric.nsw.gov.au

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