wington I (also called Blue Waters) void

# Controlling Acidity in Flooded Collie (WA) Coal Voids

## – Is it necessary and how can it be achieved?

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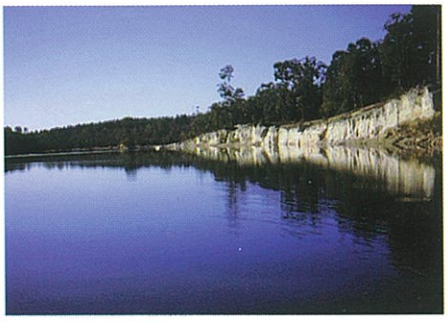
In Australia, the voids created by open cut mining are set to become some of the country's largest and deepest lakes. Muja coal pit in Collie (Western Australia) will eventually create a lake that is 200 m deep and about 400 ha in area. In Western Australia, there are no natural lakes of this depth that could be used for comparison with these new artificial lakes. There are however several smaller voids in Collie that have been flooded for over 40 years. Collie is the centre of coal mining and power generation for Western Australia, with two mining companies Wesfarmers Collieries Ltd and Griffin Coal Ltd extracting coal primarily for Western Power's two coal fired Power Stations.

In the 1950's there were three mining companies, but Amalgamated Collieries Ltd ceased operations in 1960, following a dispute with the Government. Their open cut mines subsequently flooded creating six lakes. As at the time there was no requirement for rehabilitation, the voids were left as is, complete with old mine equipment and telegraph poles still in place. One void (Wallsend) has since been converted to a landfill site, two (Stockton and Black Diamond A) are actively used for public recreation and the remainder (Black Diamond B, Ewington I and II) are on private property. These voids provide a unique insight into the fate of voids after 40 years with little to no rehabilitation undertaken.

The Western Australian Department of Conservation and Land Management manages the largest void (Stockton), and has rehabilitated much of the surrounding land. Stockton is a popular area for water skiing and boating. In the summer of 1994/95 the lake was closed to the public as pH had dropped below 4.5. Treatment of the void with additions of sodium hydroxide and lime to increase the pH proved unsuccessful. In winter 1995, pH levels had increased sufficiently to allow the void to be reopened. This event stimulated both industry and agency interest in conducting research into the voids. Dr Mark Lund and his research team (Scott Thompson and Sarah Brown) at the Centre for Ecosystem Management at Edith Cowan University (ECU) joined a collaborative Australian Coal Association Research Program Grant funded project with mining companies, government agencies and Curtin University to examine final void water quality enhancement.

Dr Lund's research focussed on understanding some of the physical and chemical processes occurring within three of the voids (Stockton, Ewington I and II) and examining strategies to reduce acidity inside the void using a biological approach. The aim was to encourage the range of biological processes normally found in natural lakes and use this to both reduce acidity and stabilise the voids. Evidence from



Eroding cliffs at Ewington I (also called Blue Waters) void

Macroinvertebrate Sampling at Stockton Lake (Alan Lyons)

overseas suggest that voids in the pH range 3-5 will start to become less acidic over time as they accumulate organic material which supports normal biological processes. This approach has the potential to offer a long-term and cost-effective solution to the acidity problem in voids. To aid in the establishment of suitable biological processes, controlling acidity generation and possibly short-term neutralisation may still be required to speed up the process.

Water quality in the voids is exceptionally good, with very low concentrations of heavy metals, sulphate and nutrients. The main cause for concern is pH levels, which can drop to just below 3 in some voids. Although pH varies seasonally, it does not appear to be changing over the years. The low nutrient concentrations ensure that biodiversity within the voids is extremely low.

**Where is the acidity coming from?**

The groundwater in Collie tends to be mildly acidic (pH 5-6), but the main source of acidity in the voids is from surface and subsurface runoff from the surrounding land. Evidence suggests that pyrite oxidation in the overburden produces the acidity. Acidity generation is typically accompanied by high concentrations of iron and sulphate in the void, but in Collie it appears that they rapidly mineralise in the lake sediment. There is also evidence that acidity from the voids is effecting groundwater in the vicinity of the voids. Fortunately heavy metals and nutrients contamination of groundwater is unlikely given the low concentrations in the voids.

**Why have the Collie voids remained acidic for 40 years?**

No rehabilitation of overburden dumps has ensured that there is a constant inflow of acidic runoff. In addition, very little organic matter washes into the voids from rushes or fringing vegetation. The low pH also ensures that levels of nutrients remain low, preventing algae from producing organic matter within the void. The low sulphate concentrations and low availability of organic matter prevent sulphate reducing bacteria from converting the sulphate back to sulphide removing the acid in the process. At the moment the voids appear to have established equilibrium between acid coming and acid leaving keeping the pH relatively constant.

**What is a suitable endpoint for Collie voids in terms of mine closure?**

As a minimum Dr Lund suggests that the pH of these voids should be raised to that of the surrounding groundwater. He believes that this is an achievable target, as it will only require changes in pH in the order of 1-2 pH units. Above this pH, the groundwater will actually be working against your solution.

Sampling at Ewington I (also called Blue Waters) void

Ewington II void

The eroding cliffs at Ewington I (also called Blue Waters) void, showing the limited development of rushes in the void. Alan Lyons in the foreground

**Do current mining practices ensure that the problems are over?**

Modern voids are better shaped, and overburden is layered and vegetated to reduce acid mine drainage. Despite all efforts sufficient acid producing overburden will remain on the surface and together with the void walls will ensure that there is some acid generation.

**What did the research find?**

The ECU research team initially looked at adding organic matter to create a suitable environment for sulphate reducing bacteria in the voids. This approach has been successfully used in wetlands to treat acid mine drainage discharges. The aim was to test its effectiveness within a void receiving diffuse sources of acidity rather than point sources. Laboratory and field trials found that there was an initial reduction in acidity but this was due to neutralisation by the material rather than through bacterial activity. In Collie, the low sulphate concentrations in the voids work against a bacterial mediated solution. The use of cow manure resulted in a prolonged increase (over a year) in pH of1-2 units. This was attributed to the high concentrations of phosphorus in the manure. Phosphorus is found in the voids at extremely low concentrations and adding it in conjunction with organic matter stimulates algal growth, which in turn provides food for fauna. Increased biodiversity and production all help to stabilise the lake and reduce acidity.

**How can this research be used to aid in mine closure?**

The ECU team recommends that as much organic material as possible be left in the shallow areas of the final lake. The type of organic material is probably not too important. One possibility is that the upper slopes (which are usually contoured for safety reasons) are planted prior to flooding to 'grow' the organic matter. Other possible sources of organic matter include mulch, sawdust, hay, wine lees, manures and sewage. Naturally, consideration would have to be given to the proposed end use of the void and possible health and safety issues associated with some of these materials. The team suggests that consideration be given to use fertilisers to encourage algal growth, in voids low in nutrients.

To reduce the contribution made by runoff to acidity within the voids, the team hopes in the future to trial a narrow wetland trench around the wetted perimeter of the lake that would intercept and treat runoff. Another promising alternative is to make use of the discharge from aquaculture trials currently being undertaken at Curtin University to add nutrients and dissolved organic material to the voids.

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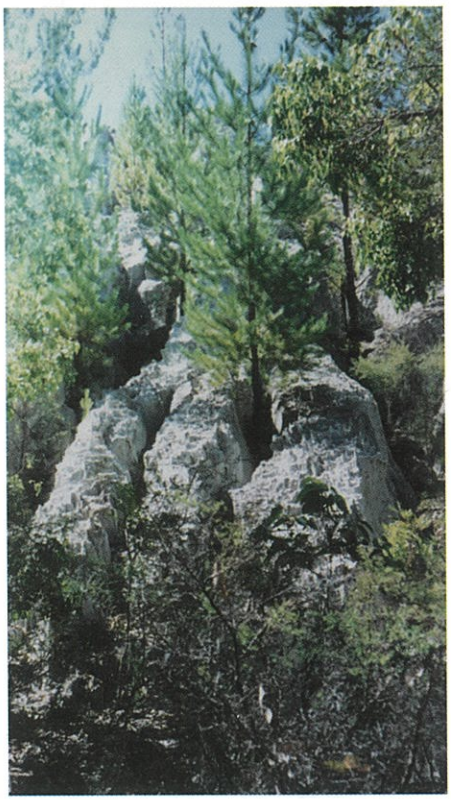

Eroding overburden dump at Black Diamond void