The role of a subsurface lime-fly ash barrier in the mitigation of acid sulphate soils

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By

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DECLARATION

I, Laura J. Banasiak, declare that this thesis, submitted in fulfilment of the requirements for the award of Masters of Civil Engineering, in the Faculty of Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for any qualifications at any other academic institution.

Laura B. Banasiak
21 December 2004
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The effectiveness of using a sub-surface lime-fly ash barrier to reduce the oxidation of a pyritic soil layer and to improve groundwater and surface water quality was investigated for land affected by acid sulphate soils near Berry in southeastern NSW, Australia. Prior to the installation of the lime-fly ash barrier, groundwater and surface water analyses indicated a highly acidic environment. High concentrations of dissolved aluminium, total iron and sulphate in the groundwater were a result of falling groundwater tables and biotic oxidation. Traditional management techniques of groundwater manipulation, via floodgates or weirs, would be rendered ineffective in arresting biotic oxidation where the pyrite layer is submerged.

The study combined field and laboratory analysis in order to determine the feasibility of the lime-fly ash barrier at the study site. A comprehensive field study incorporated the installation of piezometers and observation wells to determine the level of the phreatic surface along with the monitoring of water quality parameters at the site of the lime-fly ash barrier, and also floodgate sites and the site of the self-regulating tilting weir. The installation of the lime-fly ash barrier was undertaken by the pumping of a slurry through boreholes via pressure pumping.

The subsurface lime-fly ash barrier, as an acid sulphate soil remediation technique, was shown to significantly improve groundwater quality. Groundwater pH increased to values between 4.5 and 5.5. The concentration of the pyritic oxidation products, acidic cations $\text{Al}^{3+}$ and $\text{Fe}_{\text{total}}$, basic cations $\text{Ca}^{2+}$ and $\text{Mg}^{2+}$ and anions $\text{Cl}^-$ and $\text{SO}_4^{2-}$, also, on average decreased in the groundwater after the installation of the lime-fly ash barrier. A comparison between the average groundwater table elevations before and after the installation of the barrier also indicated a perched water table, which would reduce the exposure of pyritic soil to oxygen, and in turn reduce pyritic oxidation and the generation of acidic products.

The Lime-fly ash barrier is effective in remediating acid sulphate soils in areas in which floodgates and weirs cannot be installed. A comparison of the result shows that the lime-fly ash barrier had greater success in increasing the groundwater pH than the self-regulating tilting weir. The lime-fly ash barrier treats acid sulphate soils and...
the related environmental problems before they occur, whereas, the floodgates treat the pyrite oxidation products generated after they have been discharged into the flood mitigation drains. Significantly greater concentrations of $\text{Al}^{3+}$, $\text{Fe}_{\text{total}}$ and $\text{SO}_4^{2-}$ were found in the groundwater at the floodgate sites.
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