REHABILITATION OF ANTIMONY MINE WASTES

AT HILLGROVE, NEW SOUTH WALES

BY

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DECLARATION OF ORIGINALITY

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

[redacted]

Warwick Arthur Watkins.

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SUMMARY

The tailings disposal systems of the New England Antimony Mines N. L. Company were investigated and a plan for future tailings disposal prepared. This was a two stage process, the first resulting from the capacity of the existing tailings dump having been reached, the second from a decision to reprocess the tailings due to a rise in the price of gold and a decline in the grade of antimony in the mined rock. The tailings disposal systems involved the creation of a closed system in which both solid and liquid wastes could be managed.

The sands and slimes tailings fractions were collected from the freshly hydrocycloned material and four mixtures prepared; 100% sands, 75% sands:25% slimes, 50% sands:50% slimes, and 100% slimes. Chemical analyses revealed the tailings to be low in organic matter and nitrogen, other necessary nutrients being in adequate supply for plant growth. The levels of potentially phytotoxic heavy metals, which are often associated with metalliferous mine wastes and arsenic and antimony were low. The monitoring of pH during a number of oxidation and reduction cycles showed that the oxidation of pyrite and subsequent generation of acidity would not be a problem.

The milling and processing operation produces tailings with a particle shape and size distribution which predisposes them to dense packing. The bulk densities, as determined by the Saran resin technique were 1.58 g cm^{-3} for the 100% sands and 1.43 g cm^{-3} for the 100% slimes tailings fractions. The moisture characteristics revealed a good range of available moisture for the four mixtures. Air filled pore space at field capacity (pF 2.4) was <10% for all mixtures.

Effect of different levels of phosphorus on the growth of couch grass (*Cynodon dactylon*) and Japanese millet (*Echinochloa utilis*) in the tailings mixtures was investigated. The couch grass died 10 days after emergence and the Japanese millet withered at the two leaf stage of growth. Examination of the roots revealed gross morphological effects. No interaction between phosphorus and antimony and no toxicity effects due to antimony were detected during pot trials with a chocolate soil. Further investigations with different levels of antimony on a sandy loam soil found it not to be toxic up to the highest application rate of 320 kg ha^{-1}.

The root morphology of plants grown in the tailings mixtures reflected the aeration and mechanical impedence effects over the range of moisture tensions created under glass house conditions and regular watering to maintain field capacity. Roots were stunted with limited lateral development. Root tips were clubbed with many roots displaying swollen sections. An abundance of root hairs were evident together with noticeable changes in direction of root members.

Because of the poor root growth in the tailings mixtures the physical characteristics of the tailings were investigated further. A study of the inter-relationship between aeration and mechanical resistance at different matric suctions showed the very limited suction range which was favourable to growth (100% sands: pF 2.3-3.0 and 100% slimes: pF 2.8-3.0) assuming the critical values to be <10% air filled pore space and a mechanical resistance of 3,000 kPa as measured by a penetrometer. The use of topsoil and a number of organic and inorganic amendments failed to increase plant growth to an acceptable level and roots displayed gross deformations.

It was concluded that the establishment of vegetation in the tailings was not practicable due to the effects of poor aeration and mechanical impedence. The most suitable rehabilitation method would be to apply a topsoil covering and establish a self sustaining cover of vegetation.