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Nature and Extent of Contamination at the Abandoned Wheal Ellen Mine and Implications for Rehabilitation

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ABSTRACT

The Wheal Ellen Mine, South Australia, was mined sporadically between 1860 and 1911 for Pb, Ag, Au and pyrite. The mining process exposed sulphidic material to oxygen and water, with the inevitable creation of acid mine drainage (AMD), and a resultant increase in the mobility of potentially toxic heavy metals. Since closure of the mine, AMD has continued unchecked, causing acid scouring, devegetation and erosion on the surrounding hillslopes, with fears of manifestations in the nearby Rodwell Creek, a tributary of the agriculturally important Bremer River. Following complaints, a MESA inspection in late 1995 identified Wheal Ellen as an environmental threat and safety hazard requiring rehabilitative action. Preliminary work saw the abandoned mine shafts infilled with surface dumped mine wastes, and "clean" clay dumped in readiness for spreading over the mine area as topsoil. The need for further work is acknowledged, but no plans are confirmed.

Investigations show that whole rock sulphidic wastes (up to about 98% sulphide content) constitute major acid producing potential at the mine. Tailings, containing highly reactive fine-grained sulphides also comprise a potential for acid production, even though total sulphide content (about 2%) is significantly lower. The abundant secondary mineral jarosite, formed from dissolution products of sulphides and aluminosilicates, generates acid during precipitation and again on dissolution. The background water-extracted pH of soils is approximately neutral compared to 2.5-4.0 in soil surrounding the mine. This enhanced acidity would primarily result from the downslope transportation of acid-producing materials (sulphide grains and/or jarosite) from the mine area.

Mine-related heavy metal contamination in soil surrounding the mine, particularly in major erosion features, is substantial for Pb, Zn, and Cu with minor increases in As levels. Rodwell Creek appears to be receiving groundwaters of mine origin, but current environmental impact is negligible through dilution, neutralisation by carbonates and possible natural filtering in a wetland system.

In retrospect, the relatively small volume of mine wastes involved may have best been treated by physical removal and relocation at a more appropriate treatment site. This option is no longer viable however, as surface remediation has already commenced (shaft infilling and clay dumping). MESA now needs to address the resultant potential threat to groundwater, and consequently Rodwell Creek, as well as the problems associated with surface contamination. An impermeable shaft capping (e.g. concrete) would minimise water infiltration into the shafts, although the potential for shaft subsidence may create complications. Compacted clay should create an adequate semi-impermeable cover for remaining surface wastes. Water diversion techniques (surface contouring and channel creation) would further reduce water infiltration and therefore AMD generation and transportation. Finally, importation of further clay as a topsoil cover is required, after which, rehabilitation of degraded surface soils ought to be satisfactorily addressed by MESA's revegetation plans. Monitoring of Rodwell Creek water quality and the evaluation of long-term revegetation success will need to be an integral part of rehabilitation.