

# **DEVELOPING SITE SPECIFIC GUIDELINES IN SUPPORT OF WOODCUTTERS LEAD-ZINC MINE COMPLETION CRITERIA**

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## **INTRODUCTION**

Developing closure criteria for Woodcutters Mine in Northern Australia has involved multiple investigations to support site specific thresholds for a number of key indicators including available metals concentrations in soils. In Australia “Enduring Value” of the Mineral Council of Australia promotes the need to have rigorous mine closure programs well in advance of mining completion and identifies the need to have quantitative indicators of rehabilitation success.

Base metal mining is accompanied with requirements to ensure that effects of heavy metals and metalloids do not impact on human health and the environment as part of the closure process. Australia has national guidelines for soil called National Environment Protection Measures (NEPMs) (NEPC 1999) to give an indicative protective measure of from contamination of heavy metals and metalloids. When the designated soil guidelines are exceeded, a tier 2 health risk (or ecological risk) study is required to measure bioavailability and determine the % total concentration that is available to human or other biota uptake. Bioavailability (BA) is measured by animal uptake experiments using rats but is an expensive process. An alternative is to measure the bioaccessibility (BAc) using a physiologically-based extraction test or PBET (Bruce et al. 2007). Rat bioavailability is used to calibrate and confirm the wider use of the PBET method.

## **OBJECTIVES OF REPORT**

- Identify key hazards to map extent of contamination from mining
- Undertake studies of PBET to map contamination
- Confirm reliability of bioaccessibility through bioavailability measurement (rats)
- Establish site specific guidelines based on bioaccessibility and bioavailability assessments
- Undertake further remedial works and confirm if mine closure is satisfactory

## **DESCRIPTION OF THE STUDY SITE**

The Woodcutters soil anomaly was discovered in 1966 and mining commenced in 1984. The Woodcutters Mine was operational from 1985 until March 1999, producing 539,000 tonnes of zinc; 245,000 tonnes of lead; 16 million ounces of silver for export; and 3,650,000 tonnes of ore. Ore production commenced from the open pit in 1985 and became an underground operation in 1986. Mining ceased in March 1999 when economic ore was depleted. Newmont Asia Pacific took over the Woodcutters site in February 2002 and have progressed the mine closure program for the site.

## RESULTS

Historical investigations into the distribution and concentrations of metals at the Woodcutters mine site indicate that there was an elevated natural background of various minerals. Accordingly, in 2006 site specific remediation guidelines were developed by EnTox following bioaccessibility studies. The approach adopted follows the procedure established by the NEPC (1999) and led to the further refinement of the proposed remediation guidelines (Table 1). Consequently this approach and the site specific remediation guidelines (Table 1) were utilised for the development of revised 2006 remediation guidelines. Bioavailability is normally measured by animal uptake experiments including rats which are expensive. An alternative estimate of bioavailability is to measure the bioaccessibility (%BAc) using the physiologically-based extraction test or PBET (Bruce et al. 2007). The measure of %BAc using PBET and confirmed by rat bioavailability (%BA) on key soil types led to the development of site specific guidelines and indicated that the extent of contamination was limited to a number of small discrete locations.

**Table 1 Summary of guidelines for Woodcutters mine site remediation**

<b>Metal/metalloid</b>	<b>% BAc 2005</b>	<b>% BA 2005</b>	<b>%BAc 2006</b>	<b>NEPM Level E</b>	<b>EnTox 2006 Remediation Guideline</b>
Arsenic	3-10	1.6-8.9	2-22	200	1000
Cadmium	17-30	-	1-46	40	80
Cobalt	6-18	-	6-18	200	1,000
Copper	5-13	-	4-22	2000	10,000
Lead	10-18	0.6-1.4	11-38	600	1,500
Nickel	4-17	-	4-17	200	2,000
Zinc	23-27	-	10-36	14,000	40,000

Although the EnTox 2005 soil survey results for total Pb and As were relatively high in the rehabilitated areas, the results for % BAc indicated that the contamination was not a significant health risk (Table 1). Only Cd at one site and Pb at 4 sites were considered to be contaminated and significant compared to the EnTox 2006 remediation criteria.

## CONCLUSIONS

The investigation and development of site specific thresholds demonstrates that careful examination of specific source characteristics and receiving context can greatly improve the focusing and application of resources in closure processes. This had a significant bearing on the focus and extent of remediation activities and success of this mine closure process.

## REFERENCES

Bruce, S. Noller, B., Matanitobua, V. and Ng, J. (2007) In Vitro Physiologically-based Extraction test (PBET) and Bioaccessibility of Arsenic and lead from Various Mine Waste Materials. *Journal of Toxicology and Environmental Health, Part A* 70 1700-1711.

NEPC (1999) National Environmental Protection (Assessment of Site Contamination) Measures, National Environment Protection Council, Adelaide.