

MEMO

TO:	Justin Robbins	COMPANY:	ABM Resources NL
FROM:	SWC Personnel	PROJECT TITLE:	Twin Bonanza Geochemical Characterisation Review
DATE:	29 November 2013	PROJECT & DOCUMENT NO:	PABM-003-01-08 002
SUBJECT:	Review of the Tailings and Waste Material Geochemical Characterisation		

Justin,

Soilwater Consultants (SWC) were commissioned by ABM Resource NL (ABM) to carry out a review of the geochemical classification of the tailings and mining wastes completed as part of the Twin Bonanza Environmental Impact Statement (EIS).

A total of five key geological units were identified within the proposed pit shells (sandstone, siltstone, intercalated siltstones and sandstones, intercalated anomalous arsenic and quartz veins as ore) and these were further sub-divided into fresh, intermediate and oxidised to improve clarity. Both characterisation of the materials and the recommendation were based on these groupings.

Characterisation of the materials was carried out the Geochemical Characterisation method as defined by AMIRA¹ as well as an Acid Potential Ratio (APR) approach. In addition x-ray diffraction and x-ray fluorescence were carried out with XRF to determine the Geochemical Abundance Index (GAI) of the materials. Leaching potential of the materials was determined by applying the Australian Standard Leaching Procedure (ASLP) with pH, EC, major cations and anions as well as trace elements determined on the leachates.

Waste Characterisation

The geochemical review found that the bulk of the waste was classified as NAF (using the ABA/NAG approach), containing sulfides from within vein systems. The samples were therefore deemed to have limited potential for Acid Mine Drainage (AMD). Using the APR approach found that a number of intercalated and intercalated anomalous arsenic rock unit samples returned potential for neutral or alkaline drainage. The presence of arsenopyrite, pyrite and galena minerals in some of the materials indicated that there was some potential for leaching of As and Pb.

¹ AMIRA 2002. *ARD Test Handbook. Project 387A. Prediction and Kinetic Control of Acid Mine Drainage.* . Melbourne, Australia: AMIRA International.

Management of the materials will primarily focus on isolating the adverse waste materials from oxidation thereby limiting the potential for leaching of elements in the environment. ABM's proposed waste rock design will involve isolating the potential material with arsenopyrite, pyrite and galena, in the centre of the waste dump, with the benign and stable waste (NAF) used as the outer embankment walls

Tailings Characterisation

The bulk of the tailings were classified as NAF (ABA/NAG) with minimal potential for AMD. Some minerals in the materials were found to have the potential to leach elements into the environment.

Management of the tailings will involve locating the tailings dam on existing mineralised soils so as to reduce the adverse effects on the environment, recycling of process waters to reduce leachates entering the water cycle and installation of monitoring boreholes downstream of the TSF to monitor any leaching into the environment.

Conclusions

The review carried out by SWC concluded the following:

- The assessment of the materials based on their geology and subclass provided a detailed understanding of the materials in the proposed project area.
- The wide ranging methodology employed by ABM for the geochemical characterisation was extensive and as a result the findings allowed for a thorough assessment of the risk of Acid Metalliferous Drainage (AMD).
- Findings of the reports showed a good understanding of the materials and the hazards posed during mining operations.
- Recommendations for disposal of material with arsenopyrite, pyrite and galena has considered all possible pathways and targets and satisfied all requirements for reducing the impact on the environment.

Following an extensive review, SWC agreed with the findings of the assessments for both tailings and waste characterisation and concur with the recommendations for the safe handling and disposal of the adverse waste as proposed by ABM resources.

Should you have any queries regarding this report, please do not hesitate to contact us.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Hayley Castlehouse".

Hayley Castlehouse

Senior Geochemist

m: +61 (0)401 308 462

t: +61 8 9228 3060

e: Hayley.Castlehouse@soilwatergroup.com