

Strata Geoscience

Peer Review for Oceana Gold
Of
Macraes Mine Phase 4.3: Environmental
Geochemistry Assessment



Mixed Tails 2017

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Reference: 2023 00012

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Macraes Mine

Additional recipients: none

Reviewer: na

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Review:			
27/10/23	Final Report issued		JP

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1 Introduction

Strata Geoscience has been contracted to peer review Macraes Mine Phase 4.3: Environmental Geochemistry Assessment and related documents (Appendix 1). The purpose is to provide a succinct, plain English review of a technical report provided to Oceana Gold by expert geochemists, Mine Waste Management for resource consent purposes.

This review focusses on the approach taken by the consultant and technical content of the documents provided but does not review breadth or scope work that has been contracted to Mine Waste Management by Oceana Gold with respect to the adequacy of this work for resource consent. The author is familiar with the requirements of geochemistry reporting to meet resource consent applications but has only brief knowledge of the Macraes Mine Phase 4.3 work programme and consent process. The data supplied pertain to activities and operations within the mine footprint and no assessment of the impact of on-site geochemical processes on the downstream environment can be made from the data supplied.

The author is familiar with the geochemistry of the Macraes ore deposit and has completed consultancy work related to processing plant chemistry and mine drainage geochemistry previously and has co-authored and reviewed several scientific papers and conference papers related to the Macraes site. The author is familiar with the geology and broad scale operations at Macraes but is not familiar with all available data or the details of the monitoring datasets collected by Oceana Gold.

In addition to this report, tracked changes have been made throughout the documents provided. Some of the comments included in tracked changes will overlap with the comments in this report, several common themes are present in the tracked changes that will be more completely explained by this report.

2 Comments

2.1 Approach

Mine Waste Management have taken an analogue modelling approach to provision of information for current resource consent purposes at Macraes Mine Phase 4.3. This is the appropriate approach given the 30-year operating history at Macraes and has strengths and weaknesses. A major finding of this review is that the approach that has been taken for this work should be explained clearly by the consultant for the mining company and regulator.

Mine Waste Management use available monitoring data from many aspects of large scale mining at Macraes to inform planning for future operations at the site. The current operations are an 'analogue' for planned operations.

For the purposes of completing geochemical interpretations at Macraes, the analogue modelling approach will deliver more certain and accurate outputs than other approaches. At other sites where long-term monitoring data are not available, geochemical predictions have additional assumptions and sources of uncertainty related to scale-up of geochemical tests, variability of waste and projections of geochemical trends into the future. These assumptions and uncertainties are avoided or minimised in the approach taken by Mine Waste Management because monitoring data is interpreted for the purpose of geochemical projections.

An analogue modelling approach has several strengths or benefits:

- Less new geochemical information is collected because geological and geochemical continuity is assumed,
- Monitoring datasets built up over years are integrated into prediction outputs,
- Assumptions related to scale up from laboratory test work or field trials are avoided,
- The evolution of geochemistry with time is naturally integrated into modelling outputs
- Seasonal variations are naturally captured.

However, there are risks as well:

- Changes in geology, mineralisation or mining practise in proposed mining areas might occur that are not reflected in monitoring data,
- Monitoring data collected for compliance purposes might not be optimal for geochemical predictions,
- Assumptions made in previous assessments related to geochemistry or environmental monitoring are carried forward,
- Variability related to low recurrence events (eg drought or flood) might not be present in the available monitoring data,
- Climate change information might not present in monitoring data.

Overall, the reports provided utilise the benefits of the analogue modelling at Macraes and risks have been minimised with adequate additional geochemical testing. I have not reviewed the water balance model but assume that this document is written to include risk mitigation of low recurrence weather events and climate change.

Recommendation 1: The scope, limitations and risk mitigations within the approach that has been adopted should be stated in the report.

2.2 Datasets and methods.

Overall, the methods applied and datasets collected are fit for purpose, the collection of source terms for modelling is an appropriate approach and the conceptual models developed are geochemically sensible. Mine Waste Management have collected additional new data for waste geochemistry (eg, acid base accounting, shake flask testing, portable XRF). This data collection mitigates the risk implicit in analogue modelling that there is an unrecognised change in geology/mineralisation that might produce a different result compared to monitoring data.

Acid base accounting data

The acid base accounting (ABA) dataset contains 70 samples which is low compared to standards, however, when put in context of 30-years of operation these sample numbers are adequate. The data indicate that there will not be any change from circum-neutral pH, SO₄ rich seepages from waste rock. There is a comment in the report that some of the anomalous geochemistry results fall outside the most recent iteration of the mine plan. If a significant number of samples collected for this study are now outside the most current mine plan, consider adjusting the data presented to reflect only relevant data.

Recommendation 2: Include a plot of recent ABA data over previously collected ABA data.

Shake flask data

The shake flask test work is interpreted conservatively and fit for purpose although sample numbers are low. The data indicate that metal release from submerged material will be low.

P-XRF data

The portable XRF data are appropriate and are conservatively interpreted. There are slight elevations of Sb and Cd above the thresholds that Mine Waste Management have set for interpretation. These elevated concentrations should be addressed with the analogue model data set or interpreted further if required.

Recommendation 3: Address elevated Cd and Sb values in P-XRF data more thoroughly.

Pit lake models

Overall the pit lake models are well thought out and appear to be comprehensive. The modelling process is that Mine Waste Management derive geochemical characteristics for different inputs into the pit lake, another consultant (GHD) provide mass flows in and out of the pit based on hydrological and climate data, then Mine Waste Management complete a geochemical model of the pit through time.

The pit lake models are based on calibration of a geochemical model to monitoring data collected on pit lakes. Relatively good fits are derived between modelled results and monitoring data providing confidence that the modelling process is accurate.

There is little data available for stratification assessment of the pit lakes with time. Stratification is likely though and lake turn over events can be seasonal or irregular (prompted by extreme weather, algal bloom, instability in the thermocline or other factors). A brief discussion of stratification should be included in monitoring and adaptive management regime.

There is little sense of the uncertainty associated with the pit lake models. A sensitivity analysis with max and min values for concentrated vs dilute sources and max and min values for concentrations

should be completed. Maybe this is a good example of where your model delivers an 'expected case' and sensitivity analysis provides an idea of 'variance' that is referred to in the adaptive management section of the report.

Source terms

The approach taken to deliver source terms for the input into the water balance model are robust and conservative where appropriate. This is where the power of the analogue model approach becomes clear and relatively tight values or distributions of values can be made for different input sources and these can be stated with confidence. There is insufficient data for me to review the values that are supplied in the reports, but the descriptions provided for the methods that have been used indicate that a robust process has been followed.

There are possibly two missing source terms:

1. There is no source term for mining impacted groundwater, it seems like all groundwater in the areas modelled is relatively pristine. Possibly this is the correct approach but the geography of where mine impacted groundwater might occur vs the areas modelled is not clear.
2. For the Frasers Pit tailings dam storage area, a source term will need to be developed for process water entrained with tailings deposition.

Recommendation 4 : Run a sensitivity analysis on pit lake models with at 25th and 75th percentiles to deliver most dilute or concentrated contributions of flow and chemistry, include new source term for mine impacted groundwater if appropriate. Stratification risks and mitigations should be discussed in the report within an adaptive management framework and an appropriate monitoring regime.

Reports and appendices

The report and supporting documents are at an advanced draft stage. There are updates to the main text of the report required, there are additional models to complete and additional appendices to compile. I have made some comments related to some of this future work but cannot provide detailed comments at this stage. The incomplete work includes the most complex pit lake model for tailings disposal in Frasers pit.

Detailed comments have been made throughout the reports.

Recommendation 5: Overall the approach and quality of work is robust and appropriate for Macraes Mine Phase 4.3 Environmental Geochemistry Assessment. External reviews of additional work and documents related to Phase 4.3 environmental geochemistry should be completed once the documents are released with a view to recommendations fitting with adaptive management and monitoring regimes as required.

3 Summary

Analogue modelling delivers a relatively accurate set of predictions, because the monitoring data that has been collected is suitable for this purpose. Additional interpretation of monitoring data is high quality, for example:

- The history matching/calibration approach taken for matching pit lake monitoring to geochemical predictions is innovative and thorough.
- The derivation of seepage chemistry based on waste rock stack thickness is well developed.

Adequate additional geochemical datasets have been collected and indicate continuity of geochemical conditions at the site for the Mine Phase 4.3 compared to the mines operational history and monitoring period.

Draft reports and appendices completed to date by Mine Waste Management have been reviewed, and detailed comments have been provided. These reports are incomplete, and the most complex pit lake model had not been provided for review to date.

Five recommendations have been made to improve the material supplied to date in addition to the comments in the reports.

4 Appendix 1 – Scope Document

Strata Geoscience

Peer Review Proposal:
Macraes Mine Phase 4.3:
Environmental Geochemistry Assessment













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Proposal

Strata Geoscience has been provided a data package by RARL Ltd for the purpose of providing a quote for peer review of environmental geochemistry services provided Mine Waste Management to Oceana Gold Ltd.

The data package includes

 61130-031-RevA - WRS Seepage Assessment - June 2022.pdf	2/10/2023 1:56 pm	7,061 KB
 J-NZ0205-003-M-Rev1 Macraes WRS Seepage Water Quality.pdf	2/10/2023 1:56 pm	808 KB
 J-NZ0229-002-M-Rev1 Appendix D.pdf	2/10/2023 1:56 pm	336 KB
 J-NZ0229-004-R-RevB Macraes Mine Phase 4.3 Geochemistry Assessment 2-10-23.docx	2/10/2023 1:56 pm	12,390 KB
 J-NZ0284-001-M-Rev0 Macraes Phase 4.3 Golden Bar Pit Analogue Model.pdf	2/10/2023 1:56 pm	1,724 KB
 J-NZ0284-002-M-Rev1 Macraes Phase 4.3 Golden Bar Pit Stage 2 Pit Lake Model.pdf	2/10/2023 1:56 pm	1,358 KB
 J-NZ0285-001-M-Rev2-Macraes Phase 4.3 Coronation Stage 6 Pit Lake Model.pdf	2/10/2023 1:56 pm	1,183 KB
 Mine Pit Extension ABA results.pdf	2/10/2023 1:56 pm	254 KB
 Mine Pit Extension pXRF results.pdf	2/10/2023 1:56 pm	399 KB
 Shake flask extractions.pdf	2/10/2023 1:56 pm	66 KB

Deliverables will include

- A concise ~ 3 page plain English report
- Tracked changes/notes on reports as review is completed
- a video conference meeting prior to finalising report
- early indication of any major issues or risks

It is estimated that the review, report and meeting will take just under one week.

Completion date is 17/10/2023

The cost estimate for this work is (*Redacted*)

All work will be completed by an expert geochemist with >20 years minerals sector experience with a good understanding of Macraes geology, geochemistry and environment.

Geochemical consultancy or interpretation related to any major issues or risks will be additional to the review work included in the cost estimate. Review work on any follow-up or extra information will be additional to the review work in the cost estimate. Additional work might not be completed by the 17/10/23. No disbursements or travel included in the cost estimate.