

Waste Rock Geochemical Management Practices at Teck Coal's Operations in the Elk Valley

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Outline

- Geological and paleo-geographical setting of coal-hosting strata in the Elk Valley, BC.
- Acid rock drainage potential of waste rock.
- Mining methods and resultant exposure of potentially acid generating (PAG) rock.
- Approach to management of PAG rock.
- Operational monitoring.
- Post-depositional monitoring.

This is not a talk about selenium.

Location

- The Elk Valley is in southeastern British Columbia.
- Coal mining has occurred in the Valley since the 1900s and open pit mining since the 1970s.
- Teck currently operates four steelmaking coal mines and one mine in closure (Coal Mountain).

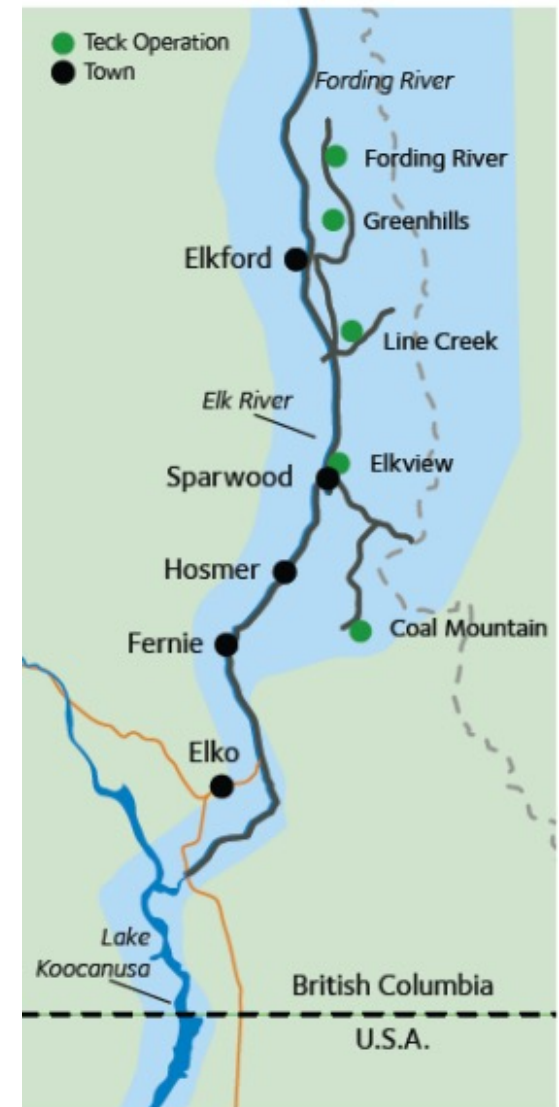


Image source: 2017 EMC Public report

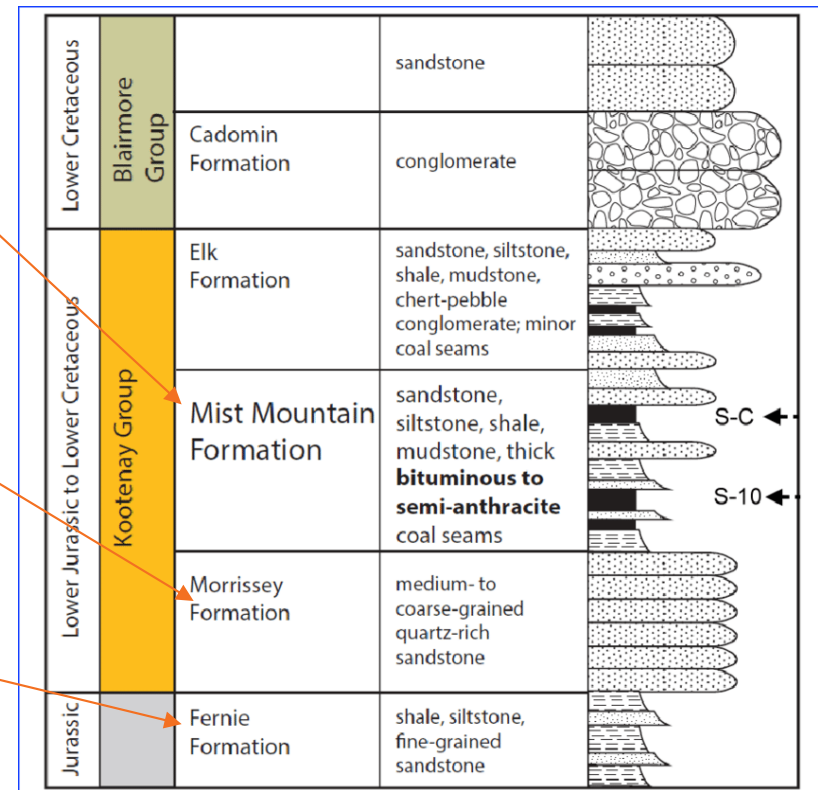
Geological Setting

Coal was formed in freshwater deltaic swamps west of the inland saline Fernie Sea.

Dolomitic coal-hosting Mist Mountain Formation.

Sands dunes between the delta and sea formed the underlying Morrissey Formation.

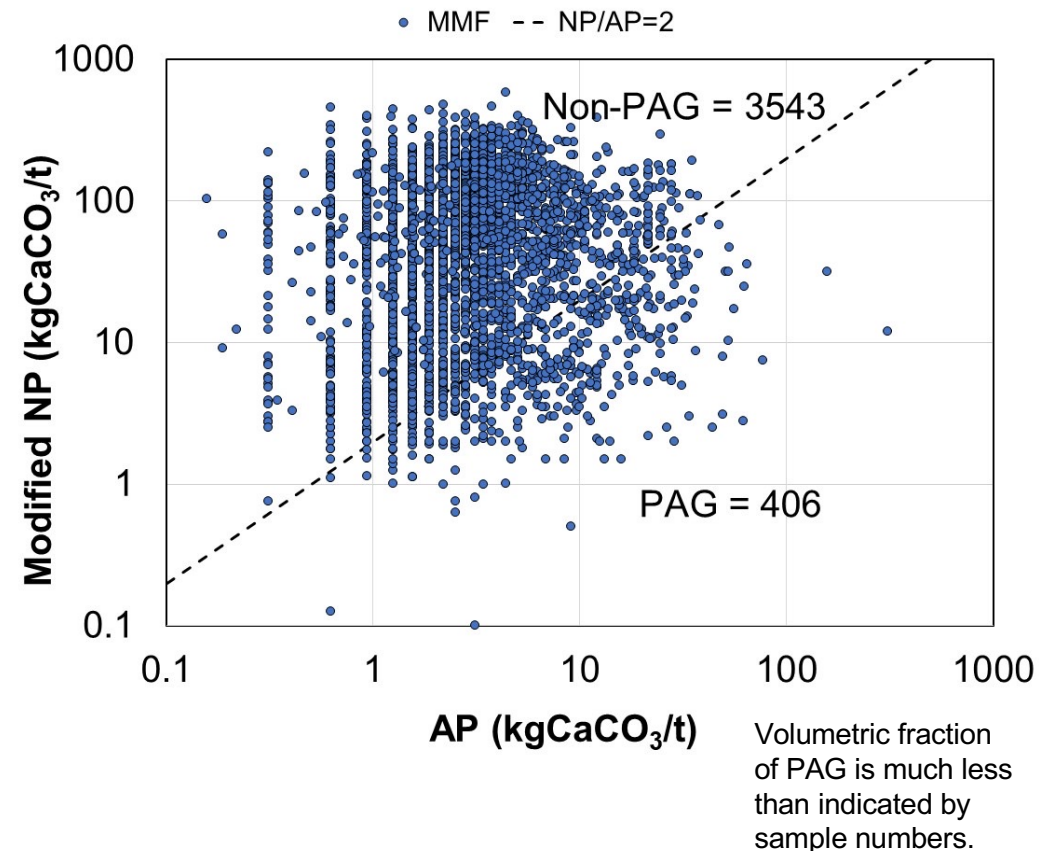
The Fernie Formation is the sediments deposited in the Fernie Sea



Edress and Attia (2021)

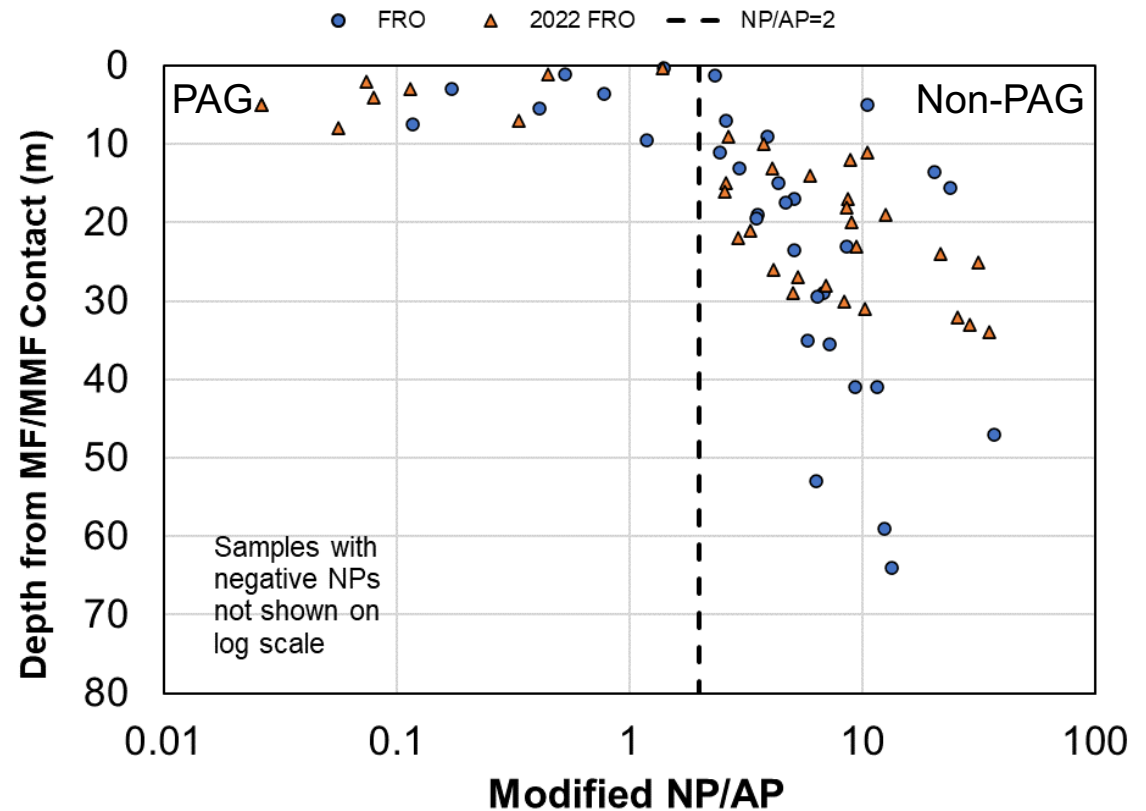
ARD Potential

- The Mist Mountain Formation typically contains around 0.1% sulphur as sulphide (acid potential of 3 kg CaCO_3/t).
- Carbonate minerals are abundant resulting in average neutralization potential of 80 kg CaCO_3/t .
- The MMF is dominantly non-PAG except in isolated thin strata



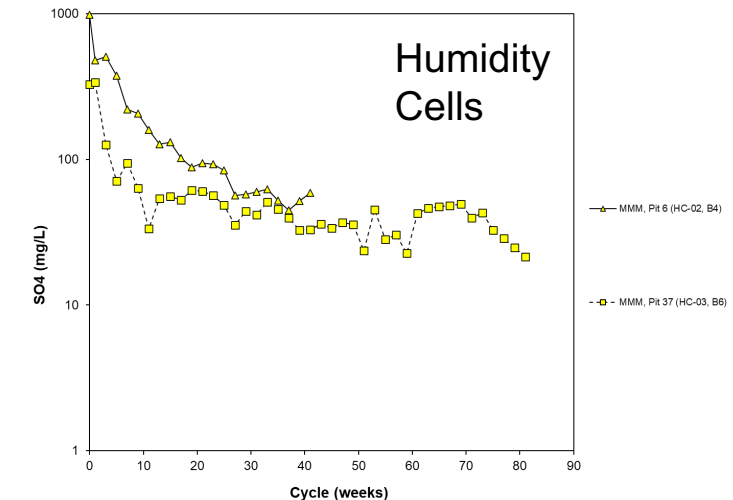
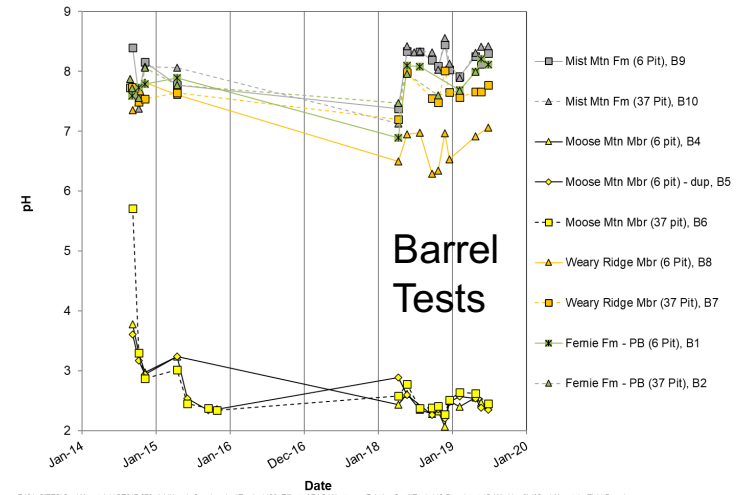
ARD Potential

- The upper 10 to 20 m of the Morrissey Formation contains more sulphur as sulphide but negligible carbonate.
- This section is PAG.
- Carbonate content increases with depth, becoming non-PAG.
- Fernie is non-PAG.



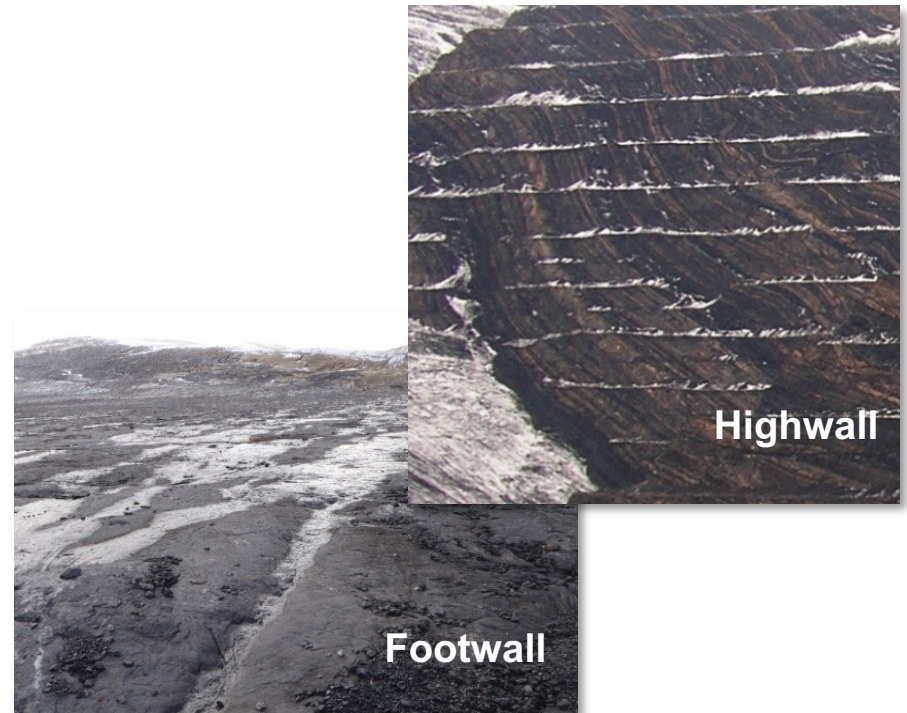
ARD Potential

- Acidification has been demonstrated at the scale of laboratory and field (barrel) kinetics and observed in highly localized footwall seeps.
- Acidification can occur within weeks of exposure under site conditions.
- Leachate pHs are between 2 and 4.
- Metal concentrations can be in the 10s mg/L.
- At small scale, rapid depletion of sulphide occurs resulting in observable decrease in acid generation rates.



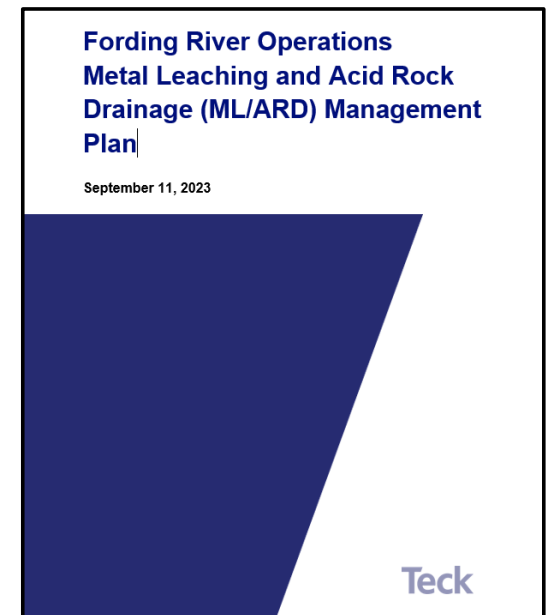
Mining Methods and Exposure of PAG

- The dipping MMF is mined down to the footwall leaving a smooth surface in the top surface of the Morrissey Formation (MF).
- Some circumstances require mining of the MF:
 - Benching to stabilize the footwall slope.
 - Access to pit (notch through footwall).
 - Pit wall pushbacks due to steeply dipping strata.
 - MF thrust over MMF.
- At the current operating mines, the overall average proportion of MF PAG is a few percent of the total waste rock volume.



Approach to Management of PAG Waste Rock

- Historically, the coal mines in the Elk Valley did not recognize the presence of PAG waste rock.
- Due to the low proportion of PAG rock, acid rock drainage has not been observed.
- Awareness increased due to acidic pit water at Coal Mountain Operations and waste rock characterization for a Mines Act Permit amendment at Greenhills Operations.
- Now, each operation has an ML/ARD Management Plan.



Approach to Management of PAG Waste Rock

- PAG waste rock is managed by blending with non-PAG waste rock due to the high excess neutralization potential available in the MMF.
- The objective of blending is to produce a mixture in which PAG does not acidify *in situ*. Acid neutralization occurs at the grain scale by dissolved alkalinity rather than reaction of acid with carbonates.
- The principle was presented by Day and Hockley (1998, 5th BC MEND workshop) and quantified recently by Day (2022).

Approach to Management of PAG Waste Rock

- Blending is implemented by end dumping.
- The proportion of PAG blended is not allowed to exceed 50% at any time.
- PAG rock is always dumped on non-PAG and over-dumped by non-PAG.
- The height of end-dumping lifts is specified to result in thin layers on dump faces.
- PAG rock is required to be blended before it acidifies (usually 10 weeks). This requirement is relaxed when temperatures are below 0°C.
- Specifications vary slightly by site based on findings on reactivity of PAG rock.

Operational Monitoring

- An early finding was that PAG rock in the MF could be identified by the absence of hydrochloric acid “fizz” due to the lack of carbonate minerals.
- This provided a rapid alternative to acid-base accounting.
- Blast hole chips from the upper MF are tested for fizz and used to set dig limits for segregating PAG.
- Samples are sent to off-site labs for formal acid-base accounting to evaluate the performance of the fizz test.



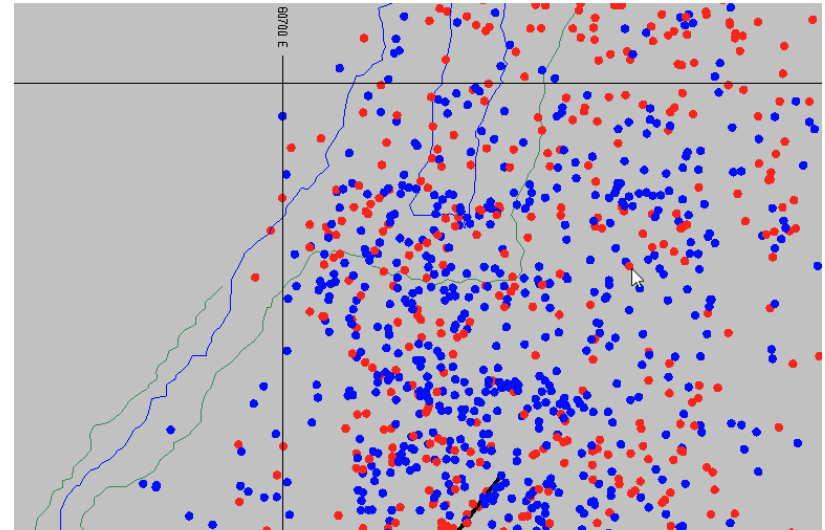
<http://academic.brooklyn.cuny.edu/geology/grocha/mineral/acid.html>

Operational Monitoring

- The fizz procedure very rarely misclassifies PAG as non-PAG but can misclassify non-PAG as PAG leading to over-handling of PAG.
- These outcomes are acceptable from an environmental standpoint.
- However, Teck is evaluating methods to reduce the misclassification of non-PAG as PAG due to the impacts on haulage requirements and dump capacities.

Operational Monitoring

- Placement of PAG is managed and tracked by Wenco.
- Loads are coded (PAG, non-PAG) prior to placement.
- The GPS location of each dumped load is recorded and can be used to ensure that specifications are being met.



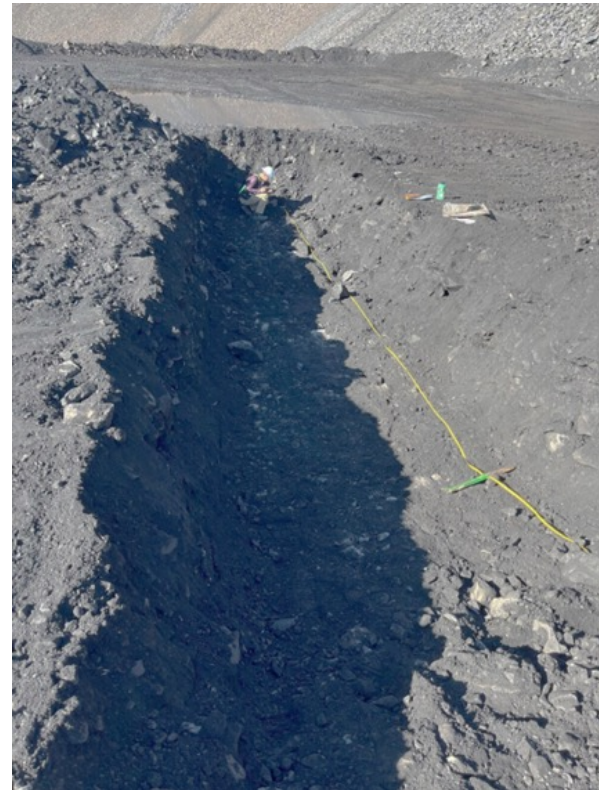
Post-Depositional Monitoring

- Post-depositional monitoring is performed at locations where PAG waste rock was placed to confirm that blending was successful:
 - PAG rock not detectable.
 - Acidification has not occurred.



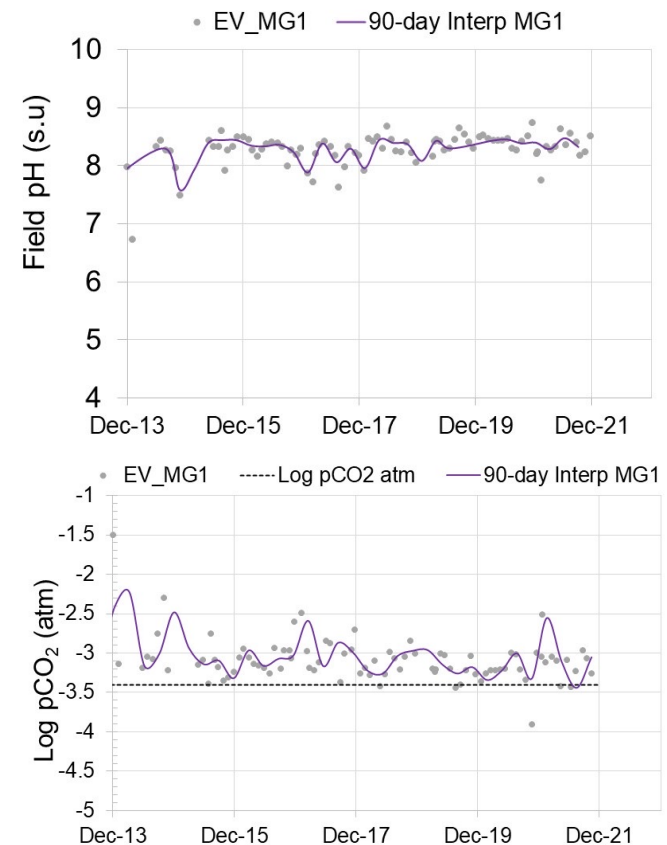
Post-Depositional Monitoring

- Long shallow trenches are excavated through the traffic surface.
- Fizz tests and visual observations are used in the field to identify PAG rock and possible acidification.
- Samples are submitted to off-site labs for formal ABA analysis.
- Blending is continuously well implemented.



Post-Depositional Monitoring

- Drainage water chemistry data are interpreted for evidence of acidification where PAG rock has been spoiled.
- Key indicators include:
 - pH depression.
 - Increasing p_{CO_2} (modelled).
 - Increasing metal-to-sulphate ratios.



Summary

- Potentially acid generating rock is found in the immediate footwall of the coal-bearing strata. It generates acid within weeks of exposure due to negligible carbonate content.
- This rock is managed by blending using specifications defined in ML/ARD Management Plans specific to each of the operations.
- Blending with non-PAG waste rock by end-dumping has been shown to be effective.

References

- Day, S. Hockley, D., 1998. Risk Assessment and Management Associated with Blending Waste Rock. 5th Annual BC MEND ML/ARD Annual Workshop.
- Day, S. 2022. Small-Scale Field Evaluation of Geochemical Blending of Waste Rock to Mitigate Acid Rock Drainage Potential. Geochemistry: Exploration, Environment, Analysis, Vol 22.
- Edress, Nader & Abdel-Fatah, A.R. & Attia, G. 2021. Construct a Paleo-Limnological Environment Based on Coal Petrography; Case Study, Two Selected Coal Seams, North Crowsnest Open-Pit Mine, Canada. 54. 1-14. 10.46717/igj.54.2D.1Ms-2021-10-20.