Integrating Geochemical Characterization and Field Methods

Mitigating Potentially Acid-Generating Construction Materials in Northern MN

Mehgan Blair, Irvin Mossberger – Barr Engineering Company
Jason Richter – MN Department of Transportation
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Outline

• Project and site background
• PAG rock mitigation plan elements and basis
• Implementation –
  – Comparing plan versus implementation
• Project challenges and status
MnDOT
Hwy 169/1
• Many serious and fatal accidents
• 2005: federal funding authorized
• 2010-16: NEPA review/EAW
  – technical panels, 18 alternatives vetted, studies
  – acid rock drainage concern
• 2016: potentially acid generating (PAG) mitigation plan completed
Site geology

Severson & Heine, 2012
Mitigation Plan

Methods

• Acid-base accounting:
  – total sulfur and carbon; speciated forms of sulfur
  – neutralization potential (by titration)
• Whole rock geochemistry
• Identified a design criteria for PAG rock of neutralization = 3x acid potential
• Preliminary lime demand for the project
Plan Protocols →

- Designated PAG/non-PAG
- Placed limits on crushing
- Consolidation plan, specs on neutralizing agents to prevent ARD
  - ID dosing rates limestone/ag lime
  - lining ditches with limestone
  - repository designs
- monitoring for 10 years

Construction Monitoring Needs

- confirmatory testing for sulfur
- adjustment of lime dose rates based on PAG rock and lime characteristics
- Screening aggregate sources
plans: pre-blast testing; planning for PAG fill

LEGEND

X-1, X-2, X-3
DENOTES SUB-SECTION AREA TEXT

DENOTES FIELD SAMPLE LOCATION LIMITS

DENOTES PREVIOUS SAMPLE LOCATIONS / SUB-SECTION AREAS

① REQUIRED "PAG" ROCK FILL AREA.
Lime “Mitigation”/Dosing; design criteria = NPR ≥ 3

- Net Potential Ratio = Neutralization Potential/Acid Potential
- “3” is a safety factor and is repository design criteria
- AP and NP were pre-determined to provide estimate of “mitigation” (augmentation of NP), to achieve NPR = 3

\[ 3 = \frac{NP}{AP} \]

- NP comes from rock AND from added lime “mitigation”
Dosing; design criteria = \( \text{NPR} \geq 3 \)

- **Revise AP** with additional sampling during construction, “on the fly”

- \( \text{NPR} \geq 3 \), Remembering \( 3 = \frac{NP}{AP} \), so the “dosing equation” =

\[
\text{NP}_{\text{mitigation}} = (3 \cdot \text{AP}_{\text{revised}}) - \text{NP}_{\text{rock}}
\]

- NP expressed in tons \( \text{CaCO}_3/\text{kt rock} \), so tell the contractor how many tons of lime (ag lime/limestone) to add.
Blasting the highs
Filling the lows
- rock-cored highway
- 65’ high PAG rock landfill

monitoring well installation
Hauling, dosing, placing, grading
Building successive benches
Lots of equipment
- 20 side dumps
- 14 articulators
- 3 dozers
- 2 rollers
- 1 backhoe

Fast, intense pace, in restricted work area
• Adjustments to preliminary dose rate on the fly:
  – Incorporate new sulfur values
  – Lime quality, moisture, CEC, etc.
  – Estimated volume of the trucks and of backhoe bucket, etc.
Ideal blending
Fabrics and covers
Plan versus execution

- TAT too long
  - Confirmatory testing “on the fly”/another pre-construction program
- Blending impractical at low dose rates
  - Combined blending and layering
- “Examination of saturated hydric soils”- PAG/non-PAG?
  - Reactive secondary sulfides
  - Field leach test, odor after HCl,
Many arrows in our geochemical methods quiver!

Consider suitability for use in

- plan development:
  - Comprehensive for risk assessment
  - Customized to rock type
  - Versus

- construction monitoring:
  - Quick turn-around
  - Cost-efficient
  - Interpretable
  - Executable
additional project challenges

- Rain
- Snow
- Hurricane
Project stats

>200 sulfur samples added

6.5 miles of new road

60,000 cy PAG rock managed
Project status

- Final bituminous – summer 2018
- Ongoing groundwater monitoring
- Development of MnDOT guidance
Questions?