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Creating Anaerobic Environments to Control Acid Generation in Pyritic Material

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For Those Too Young (or Too Old) to Remember: A Brief History of Passive Treatment

AND

My Projection of Our Next Step Forward

A Brief History of Passive Treatment

"A WEED IS A PLANT WHOSE VIRTUE HAS NOT YET BEEN DETERMINED"

HENRY THOREAU

Aerobic Wetlands and Ponds

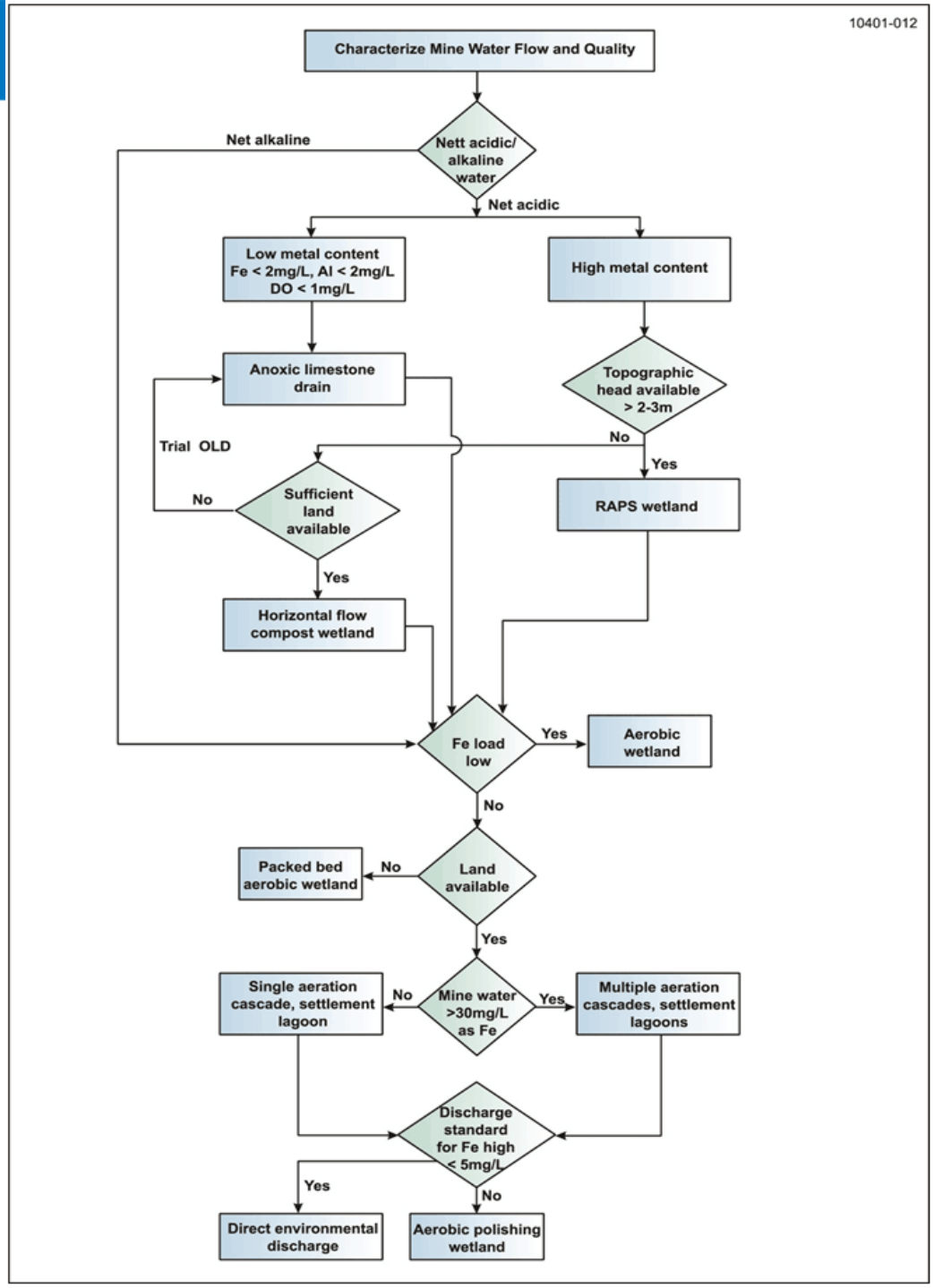
- Net Alkaline Mine Drainage
- Oxidize Fe and Mn
- Precipitate Metal Hydroxides
- Settle Solids
- Removal Rates:
  - Fe: 10 – 20 $gd^{-1}m^{-2}$
  - Mn: 0.5 – 1 $gd^{-1}m^{-2}$

Compost Wetlands => Anaerobic Wetlands => Sulfate Reducing Bioreactors

- Net Acidic Mine Drainage
- Ferric Iron or Aluminum
- Adds Bicarbonate Alkalinity
- Sulfate Reduction:
  - Metal sulfides (Cu, Pb, Zn, Cd) less soluble than hydroxides
  - Acidity removal rate: 3.5 to 7 $gd^{-1}m^{-2}$
  - Large land areas

Passive Treatment Flow Chart

- Soon new technology was being developed: ALDs , OLDs, SAPS, and RAPS, etc.
- But there were no guidelines and many passive treatment systems were failing, giving passive treatment a bad reputation.
- Bob Hedin saw the need for some common guidance and so we developed a flow chart like this one that was the heart of the report whose anniversary we are now commemorating.
- And so the technology thrived and continued, and continues to evolve.



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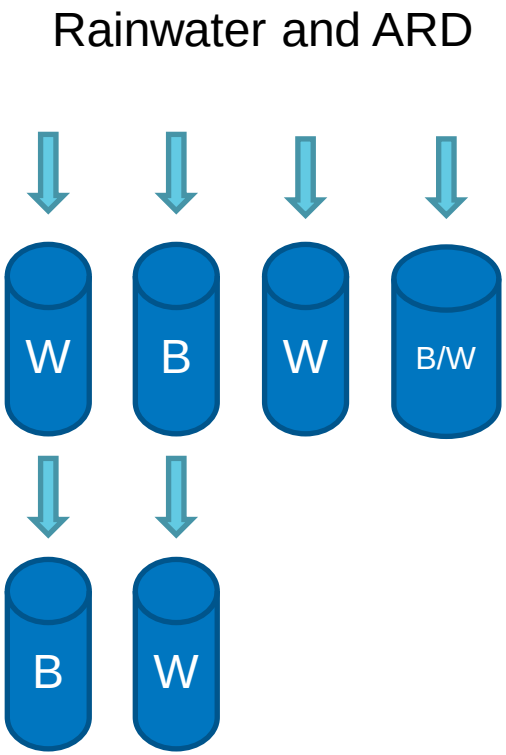
The Concept

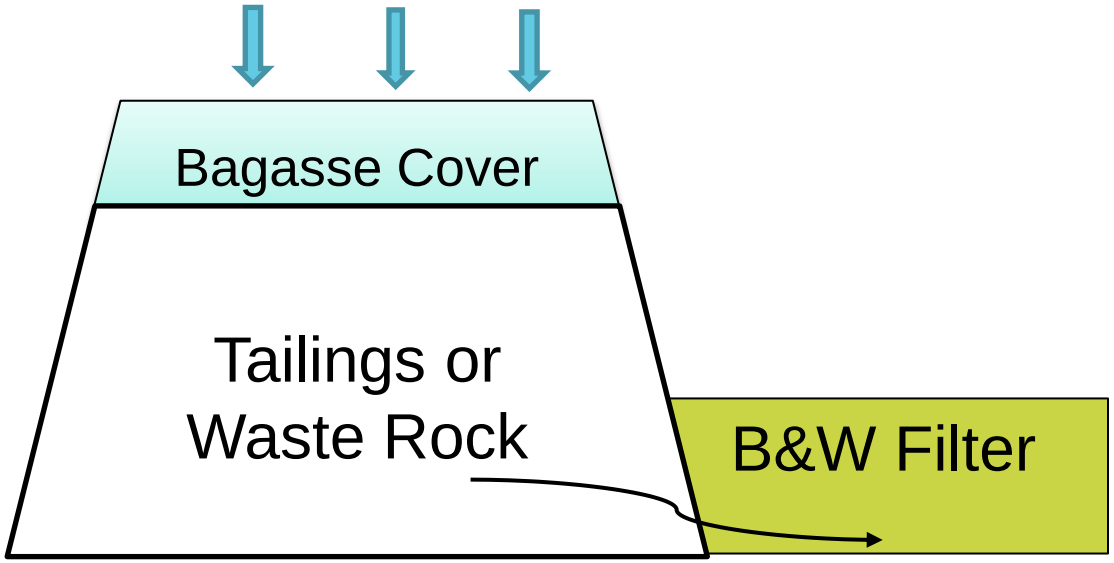
- Before effective sulfate reduction is possible,
  - first the dissolved oxygen has to be consumed
  - then the nitrate and the ferric iron has to be reduced.

- To combat the limited area available for treatment in a sulfate-reducing bioreactor, let's move the reducing reaction up-gradient. Ideally, organic material can be added during construction, but if it's too late for that, it can be injected into the tailings, waste rock, or coal refuse.

- The further up-gradient in the tailings you move it, the more you have replaced pyrite oxidation, acid generation, and contaminant dissolution with pyrite formation, alkalinity generation, and contaminant precipitation, and replaced passive treatment with at-source control.

Field Demonstration





Bagasse & Waste Rock Drum Tests:
- W+B in sequence
- B+W in sequence
- Waste rock control
- B/W mixture
  V/V ratios: 20/80, 40/60, 50/50, 60/40, 80/20

Caveats

1. Contaminants that have already precipitated as oxides and hydroxides in the zone that will become reducing will be remobilized.
   - For example, if iron hydroxide has precipitated, it will be converted to ferrous iron. If arsenic has co-precipitated with the iron or is adsorbed on it, it will also be mobilized. These, along with most metals, should both reprecipitate as sulfides once sulfate reduction is in full swing.
2. If too much hydrogen sulfide is created, more than can be removed by the metals, you could be generating odiferous emissions and, if you have a confined space, a toxic gas.

Caveats

3. Pyrite is being formed and contaminants precipitated. So care must be taken to prevent subsequent reoxidation and remobilization.
   - In other words, either oxygen has to be excluded during reclamation (as it always should be) or else organic waste injection will be a perpetual requirement.

4. Because each site, and its organic waste, is different, pilot-scale tests should be conducted at every site before implementation.

Summary

1. We hope to test this concept later this year in South America.

   But if you have a site closer to home where you would like to see this concept tested…
   please talk to me.

2. Passive treatment has evolved and will continue to evolve. Don’t accept the status quo as a limitation.

Summary

3. Take full advantage of your interactions here. Ask the folks you meet your tough questions.

After all, sometimes you can learn some really useful tidbits in the hallways... between presentations.

Thank you

Questions and Discussion