Monitoring experimental valley fills engineered for reduction of TDS generation

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Mine Construction Objectives:

 Build VF with reduced TDS levels relative to conventional fills

 Improve hydrologic function of mined watersheds and VFs compared to conventional fills

Research Objectives:

 Evaluate effectiveness of proposed low TDS engineering methods for VFs and associated mined landforms

Presentation Outline

- VF construction methods
- Monitoring methods
- Preliminary results
 - Water Quality
 - TDS, Specific Conductance
 - Discharge
 - Discharge and water quality relationships
 - Total Dissolved Solids (TDS) loading

Natural flow paths in Central Appalachian Mountain coal field





Example of spoil leaching test of drill core



Photo and chart: Lee Daniels





Site 1: Experimental Fill 1 (under construction)

- Low-TDS rock drains to carry groundwater (old mine works; old, small hollow fill) to daylight
- Build haul road into fill using low-TDS rock
- Construct most of fill in lifts 25-50' (compact at surface)
- Exaggerate crown to limit infiltration
- Follow FRA guidelines for surface spoil







SITE 1 WATERSHEDS



Site 2: Experimental Fill 2 (starting 2014)

- Low-TDS rock drains to carry groundwater
- Isolate high TDS materials
- Loose dump bulk fill
- Compact surface of bulk fill to limit infiltration, then cover w/ loose low TDS spoil
- Build drainage channels on natural ground where possible and pitch to minimize infiltration
- Follow FRA guidelines for surface spoils

SITE 2 WATERSHEDS

445

890

Water Quality Monitoring Point
Pre-Mining Watershed
NHD Streams

Experimental Fill 2 Filled 2014+

1,780 Meters

Conventional Fill 3 Filled 2007

SC Monitoring Methods



-15 Minute Intervals

Discharge Monitoring Methods



Precipitation



-tipping bucket-2mm increments-one at each site

Data Screening

- SC and discharge corrected using point measures
- Remove data that cannot be corrected
 - Sediment or debris on probe or flume
 - Probe out of water
 - Equipment malfunction
 - Ants in precipitation gauge
 - Ice/Snow

Water Chemistry

- Seasonal grab samples (monthly until 7/13)
- Field filtered to 0.04 μm
- Bicarbonate,
- Sulfate,
- Major ions,
- TDS by weight

Installation Dates

	<u>Site 1</u>			<u>Site 2</u>	
	Exp.	Conv.	Conv.	Exp.	Conv.
	Fill 1	Fill 1	Fill 2	Fill 2	Fill 3
Area (ha)	76	66	47	42	12
Year Filled	~2014	2008	1997	~2015	2006
SC	4/12	4/12	4/13	7/12	8/12
Discharge	11/12		12/13	12/12	12/12
Water	9/12	9/12	10/13	9/12	9/12
Chemistry					
Precipitation	7/12			7/12	

*Un-mined reference stream 1 is 128 ha and 2 is 326 ha

Site 1 Specific Conductance



Site 1 Mean Monthly SC



Site 2 Specific Conductance



Site 2 Mean Monthly SC



Total Dissolved Solids



Site 1 Discharge Rate



Site 2 Discharge Rate







Discharge vs. SC

TDS Loading

- TDS concentrations or SC may not capture the impact of a mined stream on receiving water bodies
- Loading incorporates TDS concentration, the contributing area, and the discharge rate
- Quantifies the contribution of TDS from headwater watershed to receiving water body
- Need more data to estimate load rates
- Need accurate measure of watershed area

Calculating TDS loads



Calculating TDS loads



2013 Mean Monthly TDS Loads



Note. Months with less than 5 days of data were removed from figure

Annual TDS Load

Conventional Valley Fill (yr. 6)= 1360 ± 331 Mg km⁻² yr⁻¹

Exp. Fill 1 (during disturbance)= 203.5 ± 58 Mg km⁻² yr⁻¹

Exp. Fill 2 (pre-mining)= 107.2± 4.8 Mg km⁻² yr⁻¹





SC vs TDS Loading Rate





Discharge vs TDS Loading Rate

Preliminary Conclusions

- TDS and SC at conventional VFs an order of magnitude higher than un-mined streams.
- Experimental VF 1 has stayed below ~1000 μS cm $^{-1}$ during construction of 6 out of 8 lifts.
- Experimental VF 2 has stayed below 300 μS $cm^{\text{-1}}$ during logging operation.
- Hydrology appears to have a role in driving TDS loading rates for streams and rivers.

Hydrology Questions

- Do the experimental VFs have hydrologic regimes that differ from conventional fills?
- Do the experimental VFs have lower peak flows, higher baseflows, longer or shorter lag times compared to conventional fills?
- Can we improve post-mining watershed delineations?

Future Research Questions

- If experimental VF method works, can it be scaled up to a whole mine site?
- What are the role of ponds on SC and TDS?



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Questions?



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