Steel Slag Leach Bed Longevity

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Exploring New Frontiers in Reclamation

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Raccoon Creek Watershed

- 683.5 square miles
- 112 mile Ohio River Tributary
- Flows through 6 rural counties





Reclamation & Treatment Projects

Active 1 Calcium Oxide Doser

Passive

3 Successive Alkalinity Producing Systems 15 Steel Slag Leach Beds Limestone Leach Bed Limestone Channels Steel Slag Channels J-trenches Settling Ponds with Limestone Berms Wetland Creation/Enhancement

Reclamation Projects

Water Quality Improvements

Raccoon Creek mainstem and Little Raccoon Creek set as goals for recovery

15 years OVER \$11 million dollars 14 reclamation and treatment projects (with more on the way)

42 stream miles

Now meet water quality standards for Warm Water Habitat designation

Projects have resulted in <u>acid load reduction of 6,030 lbs/day</u> and <u>metal</u> <u>load reduction of 775 lbs/day (2012)</u>

Seeing biological recovery downstream of projects

Consistent net alkaline conditions near the mouth of Raccoon Creek and Little Raccoon Creek

Extending the Life...

Objectives:

Determine target alkalinity loads for steel slag leach bed (SSLB) discharges Estimate the useful lifespan of slag in SSLB's and evaluate treatment targets

Initial Questions:

Which AMD tributaries are being treated by each bed? How much data do we have on the AMD tributaries? What is the acid load of the receiving tributary? What are the alkaline loads coming out of the beds? What are the treatment goals for each SSLB?



Little Raccoon Creek Watershed

38.5 miles long

Encompasses 155 square miles

Accounts for 22% of the drainage in Raccoon Creek Watershed



Little Raccoon Creek Abandoned Coal Mines



Coal mining occurred in 22% of the LRC basin



Little Raccoon Creek Project Sites



Tributary Impacts on Little Raccoon Creek



Flint Run Tributary Mouth

Flint Run Acid Load



Flint Run Tributary Mouth

Flint Run Metal Load





Flint Run Projects

Flint Run East

Completed: August 2006 Size: 56 Acres Phase I of Flint Run Project Design Cost: \$241,702 Construction Cost: \$1,456,106

Lake Milton

Completed: September 2006 Size: 155 Acres (Lake is 15 acres) Phase II of Flint Run Project Design cost: \$416,000 Construction cost: \$961,536

1992 Aerial Photo Preconstruction Flint Run East

2013 Arial Photo



Steel Slag Leach Bed Technology

TEREX

1/15/2010

Steel Slag Leach Bed Technology

What is Steel Slag?

Byproduct of steel making

A highly alkaline material formed when limestone, dolomite or lime is added to the molten iron ore.

The alkaline material and impurities in the iron form slag, which float up to the top of the melt and are disposed of.

Most recent cost 2012: \$23/ton (Slag: \$19/ton, Labor:\$4/ton)

Beds typically have 4 feet of slag on top of the piping

Sourced from either Stein, Inc. from Ashland, Kentucky or Steel Slag fines as supplied by IMS from Mingo Junction, Ohio



Lake Milton SSLB



Lake Milton Project





Lake Milton SSLB mixing with AMD discharge

Flint Run East

- Storage pond check
- intakes for clogging
- Storage pond overflow
- SAPS inlet valve
 - Exercise/Flush valve
- SAPS inlet weir
 - Actual Reading
 - CFS

- Condition of channel
- SAPS outlet valves (3)
 - Exercise/Flush valves
- Wetland ditch condition
 - Horizontal LLB
 - Horizontal LLB valve
 - Exercise/Flush valve •
 - Storage pond condition
- Storage pond discharge

valves (2)

- Exercise/Flush
- valves SSLB inlet weir
 - o Actual Reading
 - o CFS
 - o Condition of channel
- SSLB condition
 - o Water level
 - o Algae

- Debris/Vegetation
- o Liner
- SSLB outlet valves (3)
 - Exercise/Flush valves
- SSLB discharge pipes (3 at top; 1 at bottom)
- Parshall Flume o Actual Reading o CFS

Project Maintenance

Lake Milton

- Storage pond (Upper Lake Milton)
- Storage pond overflow channel (Upper Lake Milton)
- SAPS condition
- SAPS discharge pipes
- SAPS discharge valves (2)
 - Exercise/Flush valves

- SAPS overflow dam Storage pond condition (Lake Milton)
 - Water level
- Intake structures
 - Syphon
 - o 18' pipe
- Lake Milton Valves
 - 6" valve exercised
 - 18" valve exercised
 - o 6" valve amt. open
- Sediment pond condition

- Intake pipes (2)
- Overflow channel condition
- Weir reading (for overflow)
- SSLB inlet

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- SSLB Condition
 - Water level
 - Algae/veg/debris
 - o Liner
- Agridrains (2)
 - Exercise
 - Change stop logs
- Overflow for SSLB

- Weir at SSLB outlet
 - Weir reading (GPM)
 - CFS
 - Discharge pipes (2)
 - Parshall flume (amd)
 - Reading (inches)
 - Reading CFS
 - Condition of channel
- Hothouse Lake
 - Beaver activity

Challenges: East Branch



Graphic source: Caleb Hawkins, Ohio University MSES Candidate

AMD Data Analysis

					conductiv			
			measured_discharge		ity_lab_u	acidity_lab_	alkalinity	Acid Load
site_id	sample_date	sample_id	_cfs	PH_field	Scm	mgl	_lab_mgl	(lbs/day)
FR0170	11/7/2006 0:00	LRC-BM-139	0.073	3.15	9060	2139	0	841.63
FR0170	2/26/2007 0:00	LRC-BM-152	0.167	6.4	3770	540	0	486.07
FR0170	8/19/2008 0:00	LRC-BM-203	0.029	2.85	4690	2523	0	394.37
FR0170	3/22/2011 0:00	LRC-BB-337/338	0.0827	3.06	4030	2287	0	1019.44
FR0170	1/4/2012 0:00	LRC-SL-176/177	0.1546	3.43	2560	891	0	742.46
FR0170	5/9/2012 0:00	LRC-SL-315/316	0.2781	4.54	1760	360	0	539.63
FR0170	8/15/2012 0:00	LRC-SL-419/420	0.02	2.5	2760	489	0	52.71
FR0170	11/13/2012 0:00	LRC-SL-545/546	0.064	3.33	2340	474	0	163.51
FR0170	5/21/2013 0:00	LRC-SL-836/837	0.089	3.03	2700	553	0	265.28
					Av	erage Acid Lo	ad	500.57

FR0170: Lake Milton AMD

Calculated Acid Load

Concentration (mg/L) X Discharge (cfs) X 5.39 = Load (lbs/day)

Average Acid Load: 500 lbs/day



Treatment Data Analysis

					conductiv			
			measured_discharge		ity_lab_u	acidity_lab_	alkalinity	Alkalinity Load
site_id	sample_date	sample_id	_cfs	PH_field	Scm	mgl	_lab_mgl	(lbs/day)
FR0180	11/7/2006 0:00	LRC-BM-138	0.156	12.07	9570	0	2352	1977.66
FR0180	2/26/2007 0:00	LRC-BM-151	0.2228	12.33	9240	0	1921	2306.91
FR0180	8/19/2008 0:00	LRC-BM-201	0.22	11.9	2800	0	514	609.50
FR0180	5/5/2009 0:00	LRC-AM-053/054	0.18	11.75	2090	0	363	352.18
FR0180	4/12/2010 0:00	LRC-BB-004	0.2	11.9	2130	0	299	322.32
FR0180	6/21/2010 0:00	LRC-BB-048	0.2674	11.64	1850	0	289	416.53
FR0180	3/21/2011 0:00	LRC-BB-334	0.1248	12.26	1750	0	295	198.44
FR0180	8/23/2011 0:00	LRC-SL-008	0.08	11.48	1930	0	268	115.56
FR0180	11/1/2011 0:00	LRC-SL-096	0.0156	12.02	1800	0	320	26.91
Project Maintenance Complete and Slag Replaced								
FR0180	1/4/2012 0:00	LRC-SL-175	0.29	11.39	1100	0	66.9	104.57
FR0180	1/16/2012 0:00	LRC-SL-212	0.691	11.66	1120	0	67.1	249.91
FR0180	5/9/2012 0:00	LRC-SL-313	0.234	12.29	6280	0	1400	1765.76
FR0180	8/15/2012 0:00	LRC-SL-421	0.0334	12.58	4840	0	1000	180.03
FR0180	11/13/2012 0:00	LRC-SL-547	0.0668	11.79	5300	0	1200	432.06
					Average Alkalinity Load		647.03	

Average Alkalinity Load over entire lifetime: 647 lbs/day *decrease in alkalinity from 2006-2011*

increase then decrease in alkalinity in 2012 post maintenance

Developing Treatment Targets

Average Acid Load 2006-2013	500.57
Average Alkalinity Load Total 2006-2012	647.03
Average Alkalinity Load 2006-2011	702.89
Total load over lifetime 2006-2011	1,282,774.94
Total load if 500 lbs/day average	2565.55
Expected lifetime of bed at 500 lbs.day	7.03

Lake Milton Slag Bed Discharge						
Proposed Treatment Guidelines						
Flow (GPM)	Load					
30	1400	504				
50	830	498				
75	555	499.5				
100	420	504				
125	330	495				
Target load of 500 ll						

Calculating Treatment Target

Concentration (mg/L) X Discharge (gpm) X 0.012 = Load (lbs/day)

> (X) gpm X 1400 mg/l X 0.012 = 500 lbs/day

> > X = 29.76 gpm

Challenges: East Branch

	Average Alkalinity load (Ibs/dav)	Average SSLB Discharge (gpm)	Average Acid load (Ibs/day) of targeted tributary	Expected Lifetime (vrs)
East Branch I Beds				
Site 1: EB201	23	1.85	184	0.64
Site 3: EB221	43	3.49	255	0.87
Site 5: EB247	47	3.27	277	0.86
Site 7: EB293	48	9.85	957	0.26
Site 8: EB169	39	7.46	691	0.3
East Branch II Beds				
Kern Hollow: EB450	104	4.8	188	2.9
Forrest: EB570	146	7.33	176	4.15
Northwoods: EB550	196	10.7	64	15
East Branch III Beds				
EB451 & EB452	47	2.28	13	16

Data Analysis: Sarah Maj, Ohio University

Additional Challenges

□ Is there sufficient historical data available? □ Has the project performed consistently since completed? □ Is there sufficient water quality data for the SSLB discharge? Can project discharge be regulated in the system? □ Are there other SSLB's near by? □ What AMD sources are downstream of the project? □ Staffing available to conduct project maintenance? Funding availability for project maintenance ?

Recommendations

□ Adequate pre-construction chemical water quality monitoring

Consistent annual data collection per monitoring plan

□ Analyze data at project discharge & tributary mouths

□ Regular project component maintenance



Thank you! ~ Questions?

For more information visit <u>www.watersheddata.com</u> <u>www.raccooncreek.org</u>

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Little Raccoon Creek Mouth



Little Raccoon Creek Mouth

Fish Community Recovery







#1 Watershed Issue

Historic (pre-law) Coal Mining

- •Acid Mine Drainage (AMD)
- Sedimentation
- Erosion
- Lack of species diversity
- 190 stream miles affected by AMD







Surface Mines (21,550 acres) Underground Mines (25,610 acres)

Reclamation and Treatment Projects are located in the most impacted watershed areas: Headwaters & Little Raccoon Creek



Flint Run Tributary Mouth



Little Raccoon Creek Mouth



Tributary Impacts on Little Raccoon Creek



Projected Maintenance Costs

Subwatershed	Project Name	Date	Capital Cost (Design & Construction)	O&M 2012- 2032 Adjusted for Inflation	Total Projected Cost 1998-2032 (Capital + O&M)
Implemented Projects					
Mulga Run	Mulga Run Reclamation	8/30/2004	\$687,910	\$590,274	\$1,278,184
Middleton Run	Middleton Run Reclamation (Salem Rd.)	11/15/2005	\$881,196	\$0	\$881,196
State Route 124 Tributary	State Route 124 Seeps Reclamation	6/18/2001	\$395,490	\$0	\$395,490
Flint Run	Flint Run East Reclamation	8/1/2006	\$1,697,808	\$1,713,636	\$3,411,444
Flint Run	Lake Milton Reclamation	9/5/2006	\$1,377,536	\$1,258,776	\$2,636,312
Buffer Run	Buckeye Furnace	6/20/1998	\$1,215,530	\$472,504	\$1,688,034
Total for Existing Projects			\$6,255,470	\$4,035,190	\$10,290,660
Proposed Projects (costs estimated)					
Middleton Run	Middleton Run Reclamation II	2013/2014	\$1,237,820	\$19,352	\$1,257,172
Middleton Run	Middleton Run Treatment Project(s)	2016 if needed	\$500,000	TBD	\$500,000
Flint Run	Flint Run Wetland Enhancement	2014	\$325,000	TBD	\$325,000
Flint Run	Lake Morrow AMD Reclamation Project	2013/2014	\$368,614	TBD	\$368,614
Daniels Run	Daniels Run Reclamation	2014	\$400,000	TBD	\$400,000
Total for Proposed Projects			\$2,831,434	TBD	\$2,850,786
Total Existing & Proposed			\$9,086,904	TBD	\$13,141,446

On Site Improvement

Flint Run East directly downstream of project



Lake Milton site FR0120



2012 Stream Health Report Source: 2012 NPS Report, www.watersheddata.com

Lake Milton **directly downstream** of project

100

80

60

40

20

0

reduction

2

68