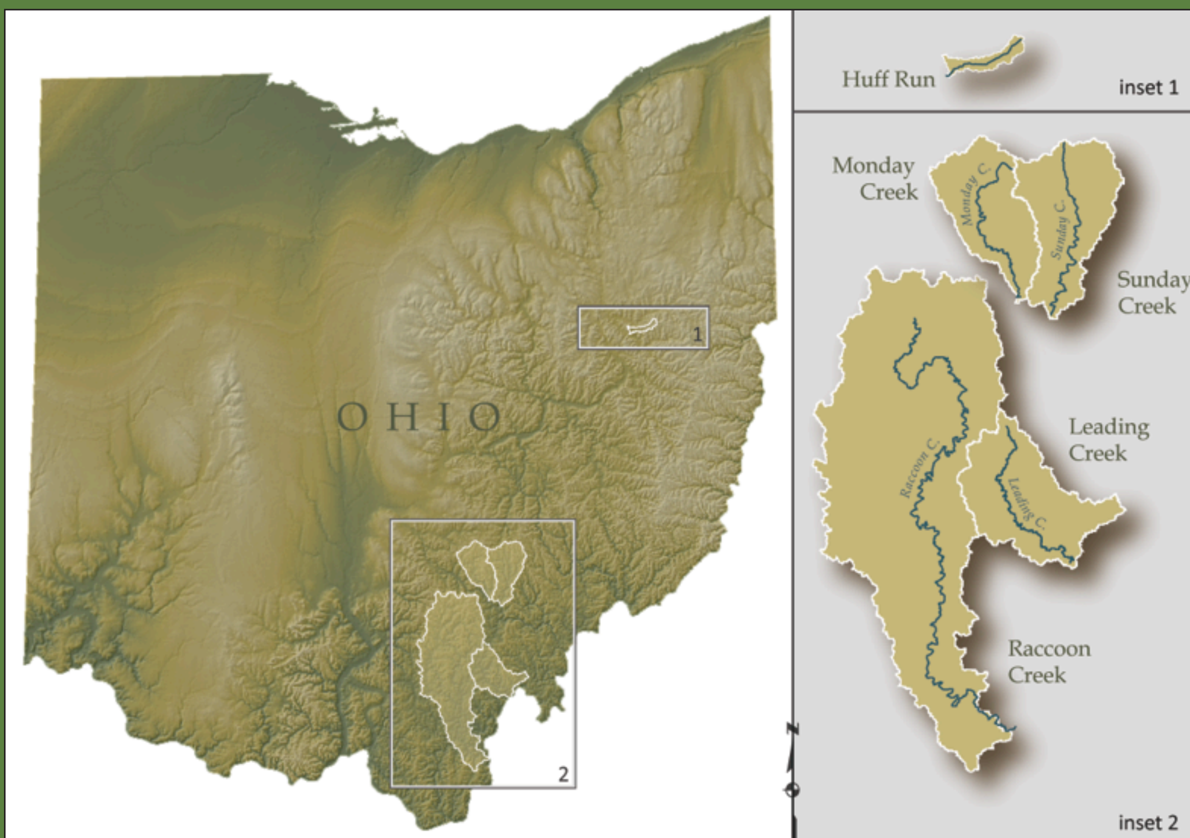
2013 STREAM HEALTH REPORT

AN EVALUATION OF WATER QUALITY, BIOLOGY, AND ACID MINE DRAINAGE RECLAMATION IN FIVE WATERSHEDS: RACCOON CREEK, MONDAY CREEK, SUNDAY CREEK, HUFF RUN, AND LEADING CREEK.



CREATED BY:
VOINOVICH SCHOOL OF LEADERSHIP AND PUBLIC AFFAIRS
AT OHIO UNIVERSITY
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9-10-2014

Table of Contents

Stream Health Report contains an evaluation of five watersheds: Raccoon Creek, Monday Creek, Sunday Creek, Huff Run, and Leading Creek.

Watershed Reports contains five NPS reports, one for each watershed, detailing the chemical and biological data trends from baseline condition to 2013.

Specific AMD project entry forms used for 2013 NPS report can be found at (watersheddata.com)

Section IV on the website shows the completed NPS data entry form for each individual AMD project in pdf format. These reports include all information gathered about the site description, contact, monitoring plan, design and reclamation information, average water quality data (pH, net acidity, and discharge) at long-term monitoring stations, complete list of pre and post reclamation water quality and biology data, and if applicable; photos, water quality and biology reports, and site map. These reports are available to download as pdf reports from the NPS monitoring website www.watersheddata.com under the ‘Reports Tab’.

Acknowledgements

The Stream Health Report is a collective effort by many people. This project would not have come together without the dedication and support of our watershed partnership. I would like to thank and acknowledge the following people for their input and contributions towards this project:

Ohio Department of Natural Resources – Division of Mineral Resources Management (ODNR-DMRM) - Ben McCament, Kaabe Shaw, Bill Jonard, Tammy Richards, Chad Kinney, Jeff Calhoun and Mary Ann Borch for funding, data collection, guidance, and being a supporter and partner in this project.

Watershed Groups –
Raccoon Creek: Amy Mackey and Sarah Landers
Monday Creek: Nate Schlater and Tim Ferrell
Sunday Creek: Michelle Shively
Huff Run: Marissa Lautzenheiser
Leading Creek: Jim Freeman
I would like to thank the watershed groups for their cooperation and patience in this project for doing everything from data collection, participation in trainings, gathering historical data, data validation and verification, and data entry on top of their busy work schedules.

Rural Action's AmeriCorps Watershed Crew – 2013 field crews for MAIS data collection and chemical water sampling

ODNR-DMRM summer interns – 2013 field crews for data collection and data entry

Ohio University Biological Sciences - Kelly Johnson – conducting the MAIS training, macroinvertebrate laboratory identification, data analysis, macroinvertebrate data collection, method development, and guidance.

Voinovich School – Steve Porter and Matt Trainer (GIS and data analysis), Taeil Kim (program designer), Lindsey Siegrist (communications), Kyoung Lim (assistant programmer), and Natalie Kruse (research).

Ohio University students – Bruce Underwood, Nora Sullivan, Caleb Hawkins, Sarah Hayley Shaw and Kalen Robeson

Abstract

The Voinovich School of Leadership and Public Affairs at Ohio University created an evaluation system to track changes in chemical and biological data for the following watersheds: Monday Creek, Sunday Creek, Raccoon Creek, Huff Run and Leading Creek. The annual monitoring and reporting system was developed for the Ohio Department of Natural Resources Division of Mineral Resources Management (ODNR-DMRM) in 2005 to track progress towards the targets of the state's 2005 Non Point Source (NPS) management plan for acid mine drainage (AMD) on an annual basis. The state's Nonpoint Source Management plan is no longer active. However, the ODNR-DMRM is committed to tracking chemical and biological changes in the watersheds where active AMD abatement and treatment reclamation is planned and implemented.

The NPS annual reporting website (www.watersheddata.com) integrates water quality and biology data from watershed groups with project status details including: maps, graphs, charts, photos, and printable reports to address the progress with respect to AMD treatment and reclamation. Water-quality and biological trends are compared through time at long-term monitoring stations and acid load reductions are measured at AMD reclamation project discharges. Incremental changes in pH, net alkalinity, iron, and aluminum are reported along stream reaches within key restoration areas, identified by river mile and sample site IDs.

Total number of stream miles impaired by acid mine drainage were evaluated during 1997-2001 and are considered the baseline conditions, 341 stream miles were impacted at that time. Each year the number of stream miles surveyed that suggest they are meeting Warmwater Habitat (WWH), based on their fish and macroinvertebrate index scores, are recorded. As of 2010, 47 stream miles of the 175 miles assessed suggest they meet full attainment of the WWH Status. In addition to tracking the number of stream miles meeting their fish and macroinvertebrate target levels, incremental water-quality changes are also tracked, pH values show 199.8 miles of the 210.5 miles monitored met the pH 6.5 water quality standard in 2013.

Net alkalinity, iron, aluminum, pH, and macroinvertebrates were evaluated annually from 2006-2013. Incremental changes from year to year can be tracked using these indicators. Net alkalinity and pH values have improved from 2006 to 2013. The family-level biological indicator, Macroinvertebrate Aggregated Index for Streams (MAIS), was measured annually from 2006 to 2013, there have been slight fluctuations seen within each watershed. Macroinvertebrate data across all watersheds in 2013 indicated good results, most notable are the improvements seen in the West Branch of Sunday Creek. There has been a steady improvement in the biological community that correlates to the improvements in water quality due to reclamation projects constructed in the headwaters of the West Branch of Sunday Creek.

Introduction

The Nonpoint Source (NPS) Monitoring Project was created by the Voinovich School of Leadership and Public Affairs at Ohio University in 2005 and funded by the Ohio Department of Natural Resources Division of Mineral Resources Management (ODNR-DMRM). This project was developed to address the targets set forth for Abandoned Mine Drainage in the State of Ohio's Non Point Source (NPS) Management Plan 2005-2010 (www.epa.state.oh.us/dsw/nps/NPSMP/ET/amdjumppage.html). Abandoned Mine Drainage is one of the six NPS pollutants listed as a key issue to address in Ohio to improve water quality. This plan is no longer active, however the ODNR-DMRM, watershed partners, and university researchers continue to monitor the effects of acid mine drainage and reclamation in the region. This report reflects the works of this partnership at the federal, state, and local level working together to improve water quality in the Appalachian coal region of Ohio.

As a result of the NPS Monitoring Project, an on-line reporting system, www.watersheddata.com, has been created to track environmental changes in five watersheds: Raccoon Creek, Monday Creek, Sunday Creek, Huff Run and Leading Creek. These five watersheds represent where active AMD reclamation are being constructed. Chemical water quality and biological data trends have been evaluated at the project level, watershed level, and collectively to monitor the changes in water quality as a result of AMD reclamation. The website provides a repository of information related to acid mine drainage reclamation and water quality including reports of: AMD reclamation projects and watersheds' water quality trends. All water quality data can be viewed, entered, edited, mapped and downloaded for each watershed.

Reports

All AMD project descriptions are compiled in a separate document containing pertinent static information describing the AMD project, titled "Collection of Acid Mine Drainage (AMD) Reclamation Projects in the Coal-Bearing Region of Ohio". This will eliminate redundancy in printing static project specific information each year. This report is available online at watershedata.com as well as with all partner organizations.

The "AMD project collection" report includes: a chronological collection of all projects completed since late 1990s. The 'AMD project collection' report displays general information about the AMD issues prior to reclamation and the AMD project description. Specifically the 'AMD project collection' report includes: pre and post construction photos, description of AMD problem, design and construction information, costs, contractors, dates of construction, identification of project discharge, map of site (optional), and pre-water quality data at project discharge. 'AMD project collection' report is a compilation of all projects completed since the late 1990s including all past archived reports. This report is a stand-alone document. Each year, the newly completed project reports are simply added to the collection.

The "Annual Stream Health" report contains the yearly chemical and biological data that change each year. This report includes the chemical and biological water quality data analysis for all target stream reaches within the five key watersheds. Stream reaches are identified as: Raccoon Creek Mainstem, Hewett Fork, Little Raccoon Creek, Monday Creek Mainstem, Sunday Creek Mainstem, West Branch of Sunday Creek, Huff Run, and Thomas Fork (Leading Creek). Data from these stream reaches are analyzed each year for changes and trends in pH, net alkalinity, iron, aluminum, and macroinvertebrates. Yearly trends of acid loading and metal loading reduction from each AMD project discharge are also displayed in this report. Long-term monitoring data, family-level macroinvertebrate data, and pre/post project discharge data collected by watershed groups and DMRM staff are utilized to generate the graphs of water quality trends along the stream reaches.

To track the overall health of Raccoon Creek, Monday Creek, Sunday Creek, Leading Creek and Huff Run, the watersheds where acid mine drainage reclamation is active, chemical data were collected annually since 2005 (2009 in Leading Creek). Biological data are collected annually for family–level macroinvertebrates (MAIS) and every 3-5 years for fish (IBI, Index of Biotic Integrity). Baseline conditions were established during the time period of 1997-2001 with historic data. 2010 fish and macroinvertebrate data suggest a total of 47 miles of stream meet the use attainment criteria for WWH, with 51 stream miles evaluated. Over 158 miles were evaluated for MAIS and 54 miles for IBI. This data was collected to compare these indices to the biological health targets of 12 for MAIS and IBI scores of 44/40 for wadable/boatable streams. Stream miles that improved in biological health from baseline to 2005 are shown in Figure 1. Figures 2 and 3 show 18.4 miles were improved in the Raccoon Creek watershed and 5.3 miles improved in West Branch of Sunday Creek from 2005 to 2010. Year 2015 will mark the next full biological evaluation across watershed sites.

Other significant incremental water changes are also tracked and described in this report; for example, acid and metal loading reductions, pH and net alkalinity improvements. These incremental changes track progress toward the overarching goal of meeting targets. Incremental changes are tracked in the acid mine drainage project level reports and in the watershed level reports.


Raccoon Creek


Sunday Creek


Huff Run


Monday Creek


Leading Creek

Figure 1: Biological health improvements in Raccoon Creek from baseline (1997) to 2005.

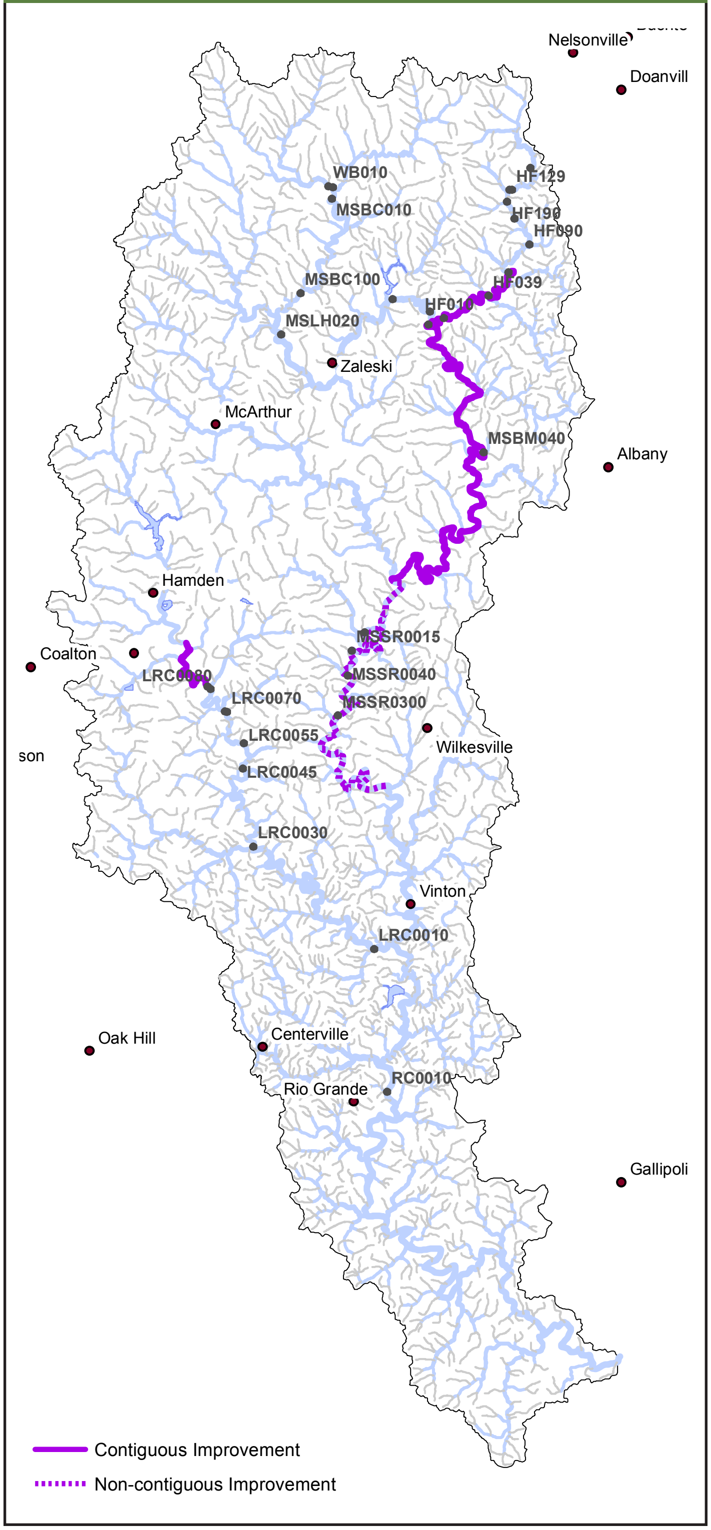


Figure 2: Biological health improvements in Raccoon Creek from 2005 to 2010.

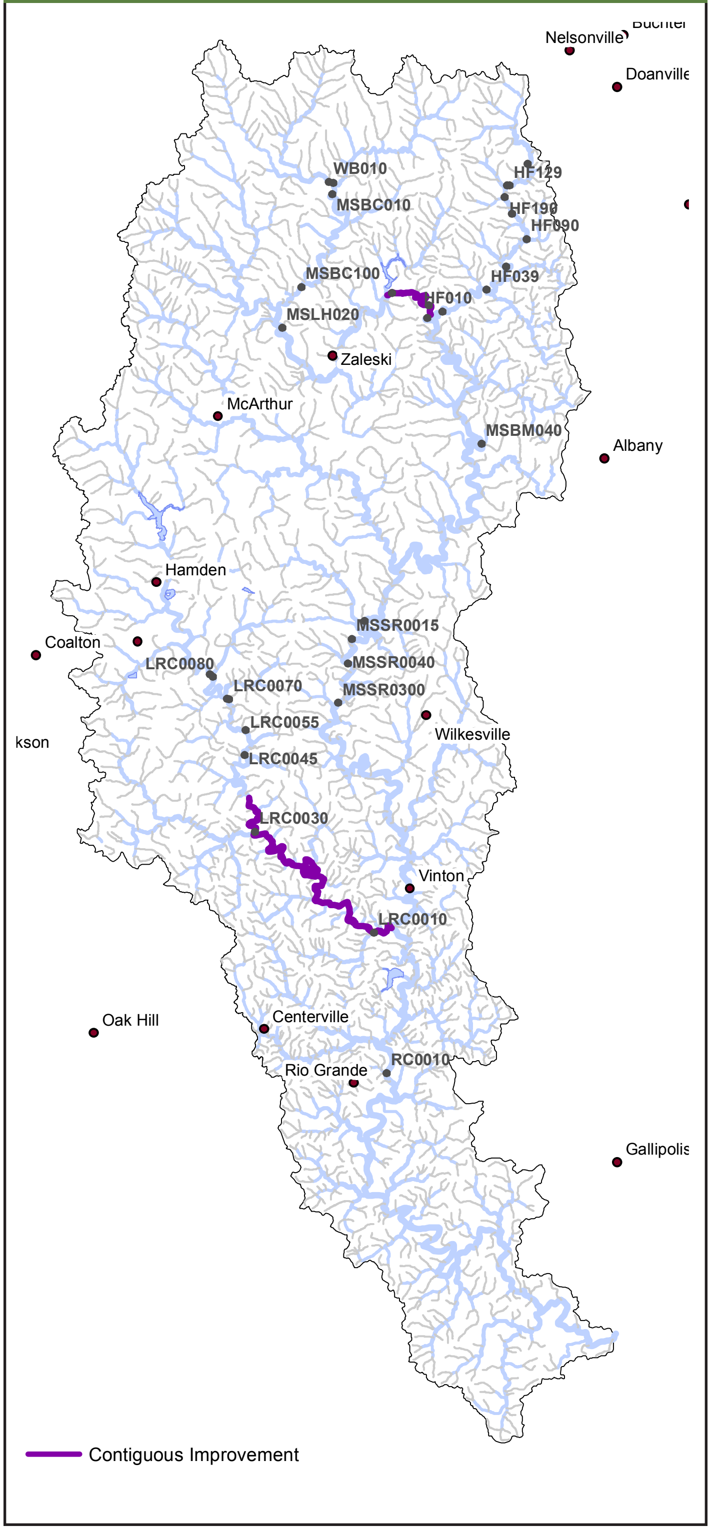


Figure 3: Biological health improvement in Sunday Creek West Branch from 2005 to 2010.

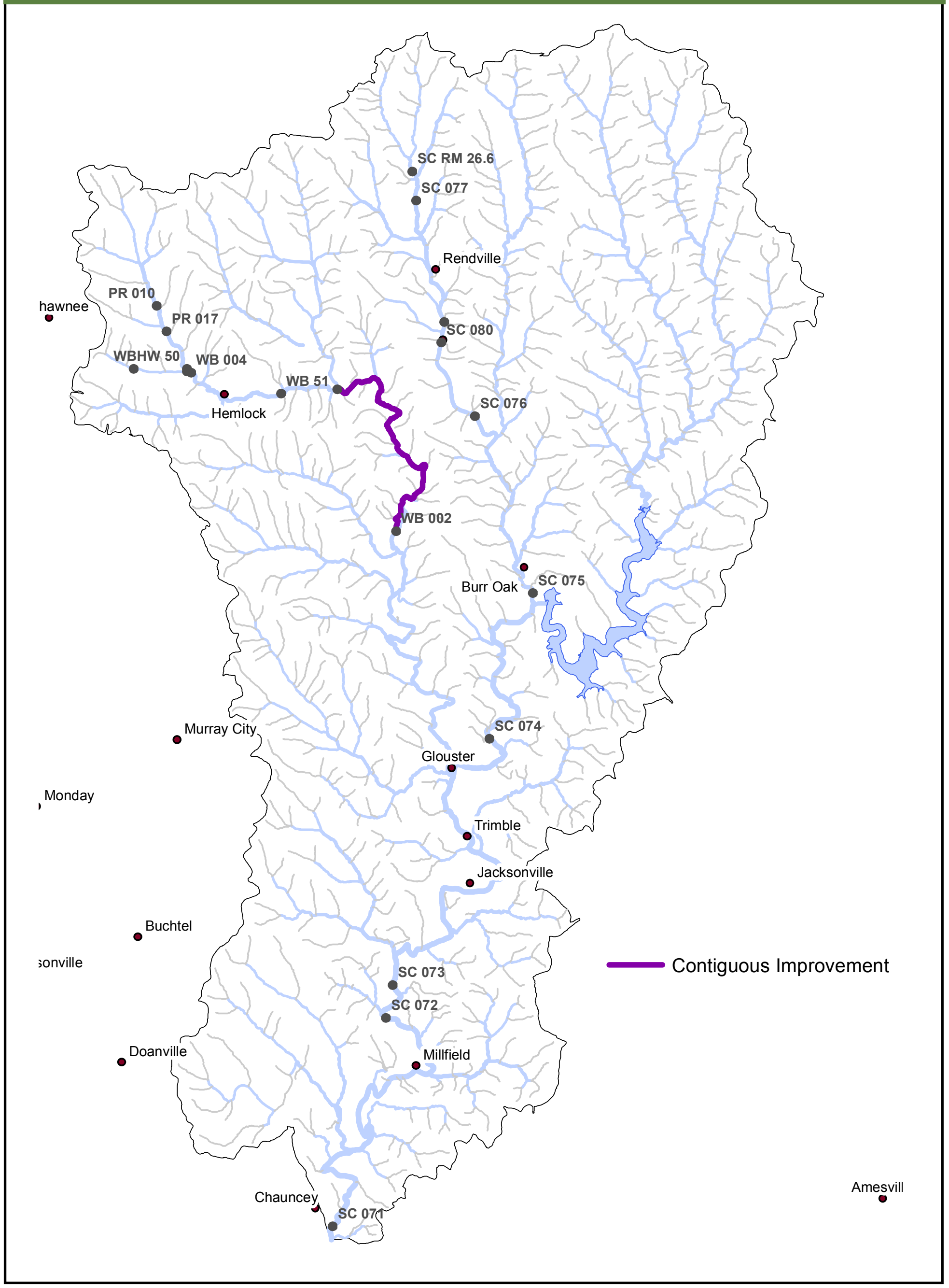


Table 1. Summary of results for each of the five watersheds evaluated in 2005 to 2013: Raccoon Creek, Monday Creek, Sunday Creek, Huff Run, and Leading Creek.

Watershed	Total number of completed projects	Total costs	Total acid load reduction lbs/day	Total stream miles improved in 2005/2010 to meet IBI & MAIS Biological stream health targets	Stream miles that met the pH target	Total stream miles monitored
Raccoon Creek	17	$11,986,204	5,629	23.3/18.42 (41.7)	117	117
Monday Creek	16 (plus 5 subsidence projects, costs are not included)	$6,569,422	4,178	0/0	24	32
Sunday Creek	11 (7 of 10 are subsidence projects)	$2,455,445	369	0/5.26 (5.26)	42.8	43
Huff Run	13	$5,016,487	1,075	0/0	10	10
Leading Creek	1	$415,437	661	NA/0	6	8.5
Total	58	$26,442,995	11,912	23.3/23.7 (47.0)	199.8	210.5

Reductions

2013 total acid load reductions = 11,912 lbs/day

Costs

2013 total reclamation costs = $26,442,995

RACCOON CREEK WATERSHED REPORT

2013 NPS Report - Raccoon Creek Watershed

Generated by Non-Point Source Monitoring System
www.watersheddata.com

Reductions

Total acid load reduction = 5,629 lbs/day

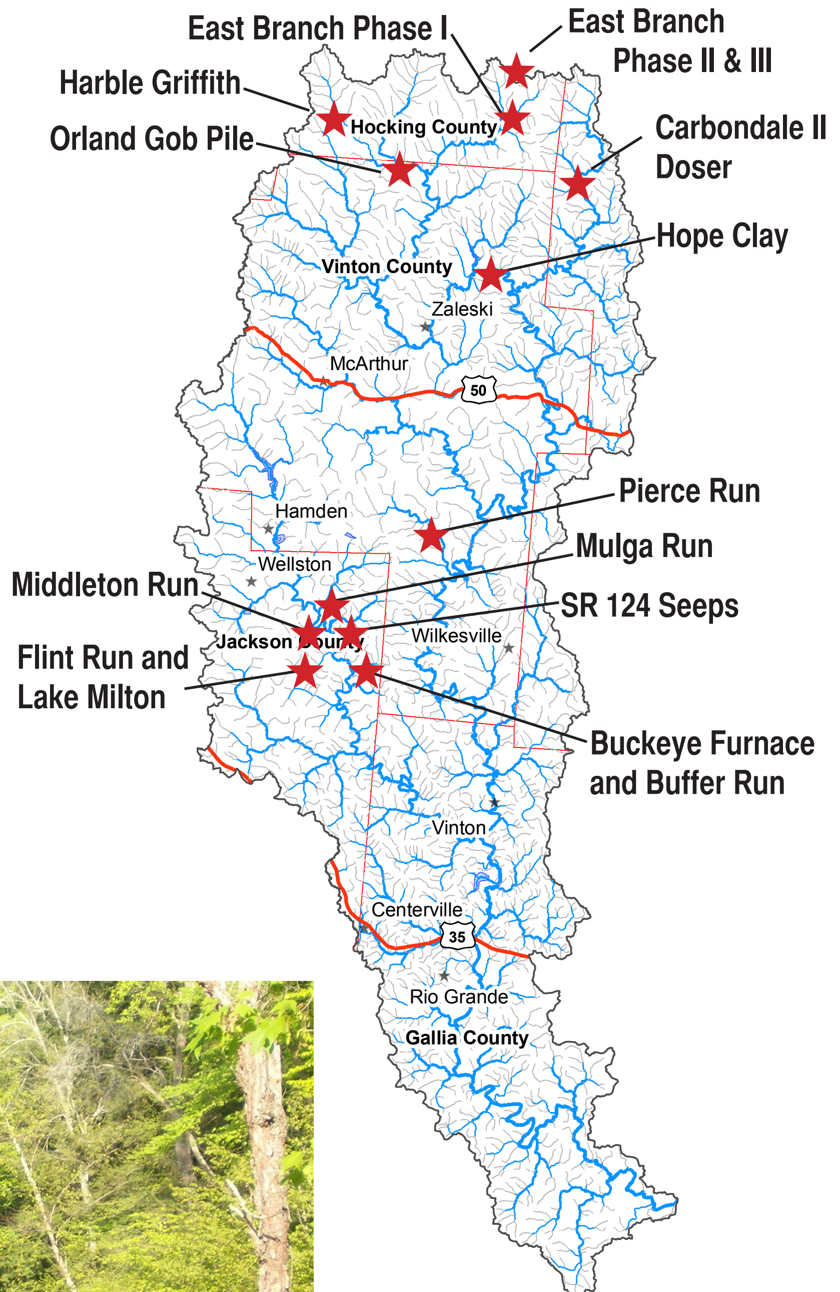
Total metal load reduction = 888 lbs/day

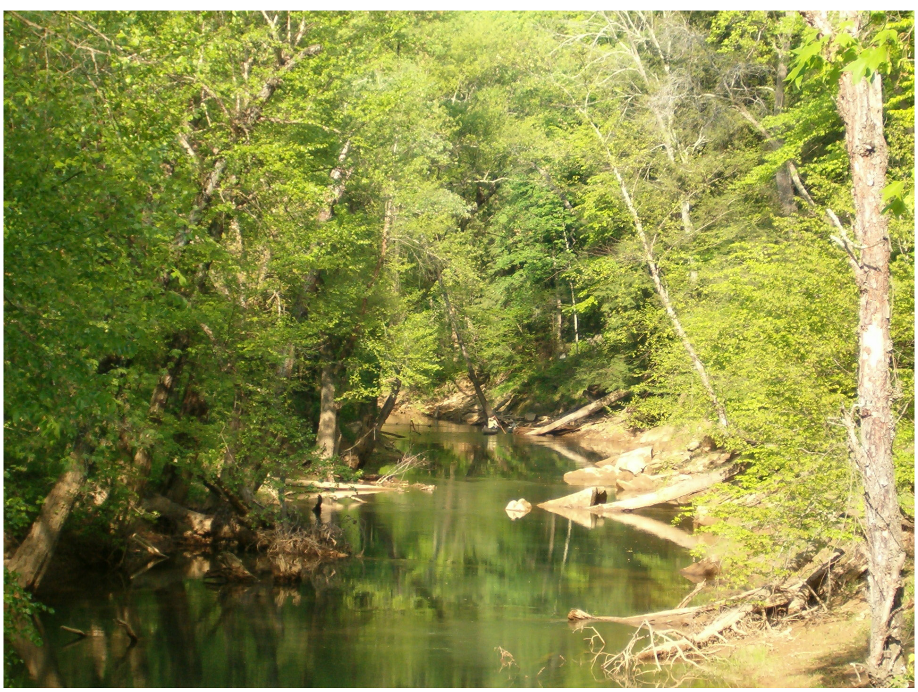
Data derived using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014)

Cost

Design = $1,819,615
Construction = $10,166,589

Total Costs through 2013 = $11,986,204





Raccoon Creek near Moonville, Photo by Ben McCament

Timeline of the Raccoon Creek Watershed Project Milestones and AMD Projects

1980s	• Formation of Raccoon Creek Improvement Commitee (RCIC): Grassroots citizen group to address water quality issues in Raccoon Creek
Early 1990s	• RCIC invites citizens from all six counties to join efforts
Late 1990s	• Formation of Raccoon Creek Watershed Partnership,a loosely based partnership of agencies to address technical AMD issues
1999	• State Route 124 Strip Pit and Buckeye Furnace Project completed
2000	• Little Raccoon Creek AMDAT completed • Watershed Coordinator position funded for six years
2001	• Headwaters AMDAT completed • State Route 124 seeps project completed
2002	
2003	• Mulga Run project completed • Middle Basin AMDAT completed • Completed management plan for Raccoon Creek Watershed
2004	• Carbondale II project completed
2005	• Middleton Run-Salem Road project completed
2006	• Raccoon Creek Water Trail Association formed Mission to Establish a water trail on Raccoon Creek • Flint Run and Lake Milton Projects completed, Watershed Coordinator three year extension funded
2007	• Raccoon Creek Partnership formed 501 (c) 3 • Waterloo Aquatic Education Center opened
2008	• East Branch Phase I AMD Project
2009	• Pierce Run AMD Project began • East Branch Phase II Project began
2010	• East Branch Phase II completed
2011	• East Branch Phase III completed
2012	• Water Trail map created by Ohio University Environmental Studies student, Karla Sanders • Orland Gob Pile and Harble Griffith Reclamation Projects completed • Pierce Run AMD treatment project completed
2013	• Raccoon Creek Water Trail maps were distributed, West Branch Harble Griffith 319 Grant was completed, and 2 new families of mayflies documented in the watershed

Raccoon Creek Projects

Acid mine drainage reclamation projects completed in the Raccoon Creek Watershed:

1999	Buckeye Furnace/Buffer Run
2001	State Route 124 Seeps
2004	Carbondale II Doser
	Mulga Run
2005	*Hope Clay*
	Salem Road/Middleton Run
2006	Flint Run East
	Lake Milton
2007	East Branch Phase I
2010-2011	East Branch Phase II & III
2012	East Branch Phase I Maintenance
	Jackson Area AMD Maintenance-Flint Run and Lake Milton
2013	Orland Gob Pile
	Harble Griffith
	Pierce Run

Italicized projects indicates not actively monitored

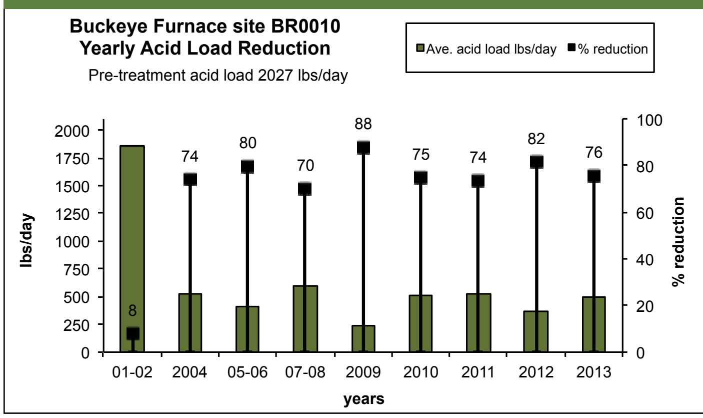
2013 NPS Report - Raccoon Creek Watershed

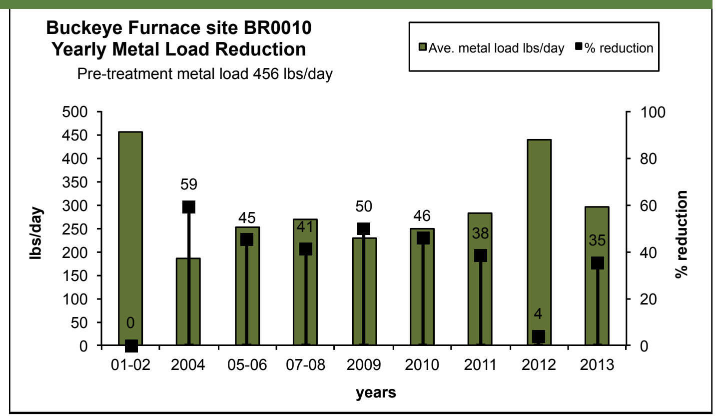
Generated by Non-Point Source Monitoring System
www.watersheddata.com

Yearly acid and metal load reduction trends per project

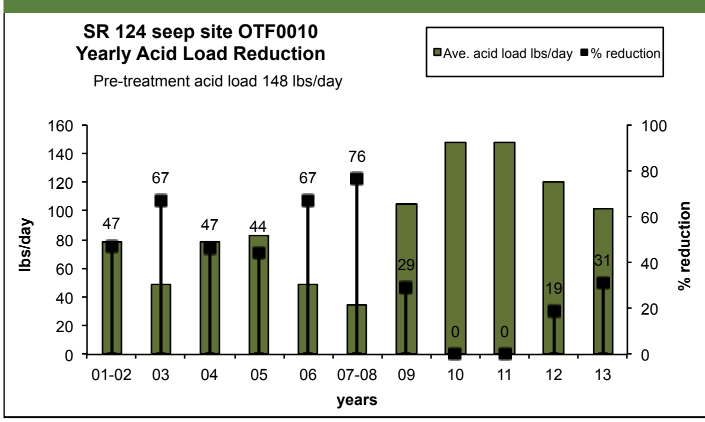
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, operation and maintenance plans are being designed for each existing system and are planned for future projects. The graphs below show the mean annual acid and metal load reduction using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014) for each year (or group of years) during post-reclamation from the project effluent. From these graphs the rate of decline (and/or improvement) with time of the treatment system is implied. Knowing the rate of decline will aid in the implementation of operation and maintenance plans.

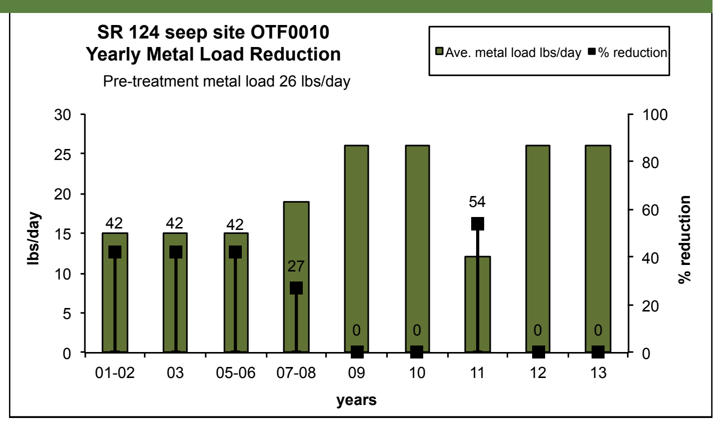
Buckeye Furnace site BR0010



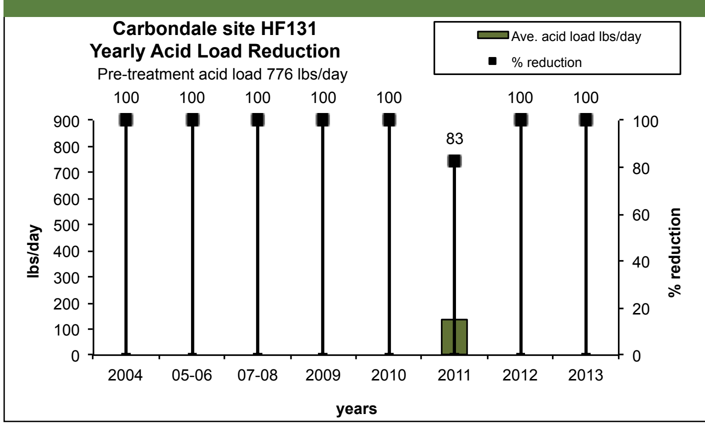


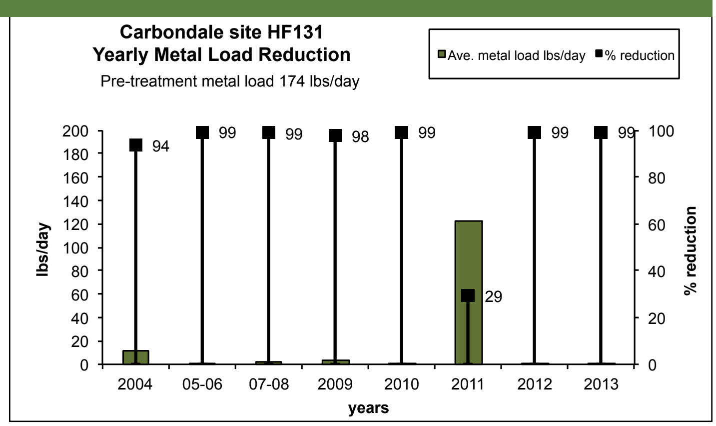
State Route 124 seep site OTF0010





Carbondale site HF131





2013 NPS Report - Raccoon Creek Watershed

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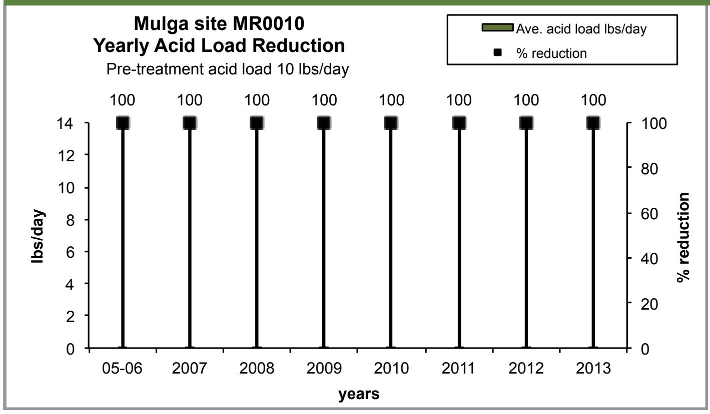
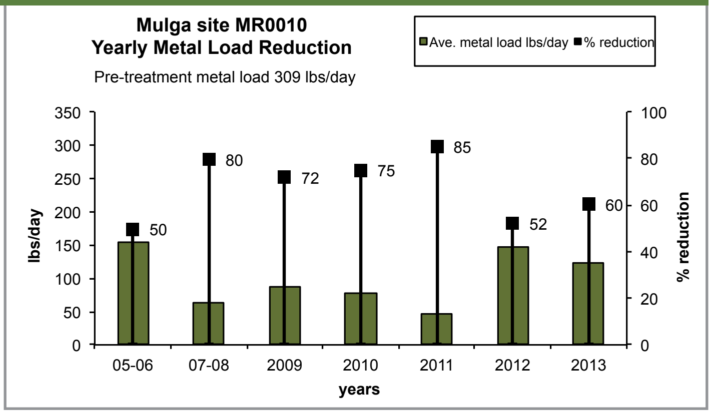
www.watersheddata.com

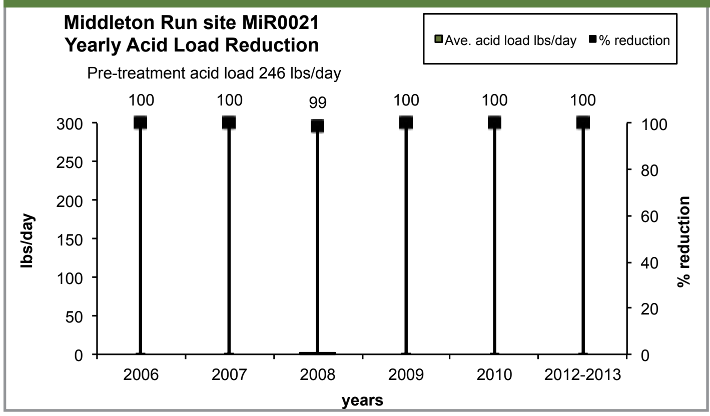
Yearly acid and metal load reduction trends per project

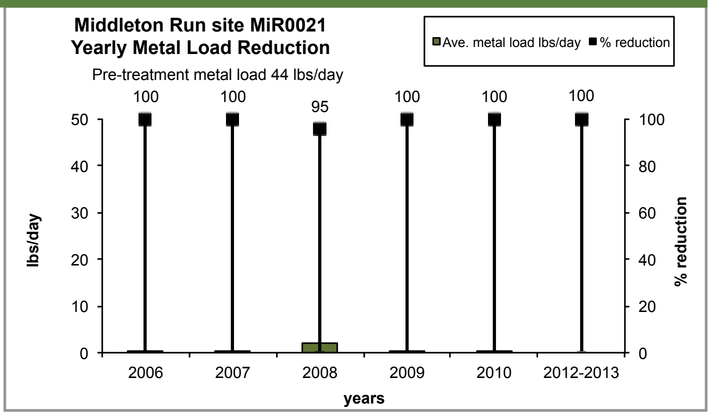
Mulga site MR0010



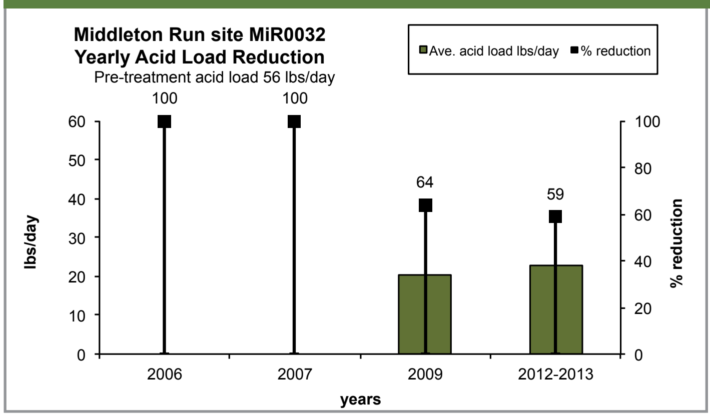


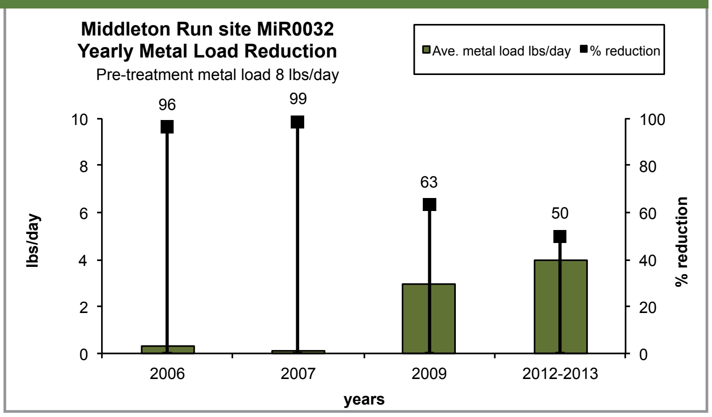
Middleton Run site MiR0021





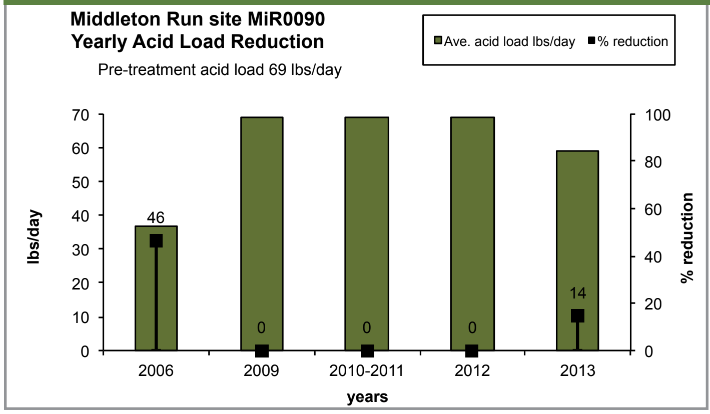
Middleton Run site MiR0032

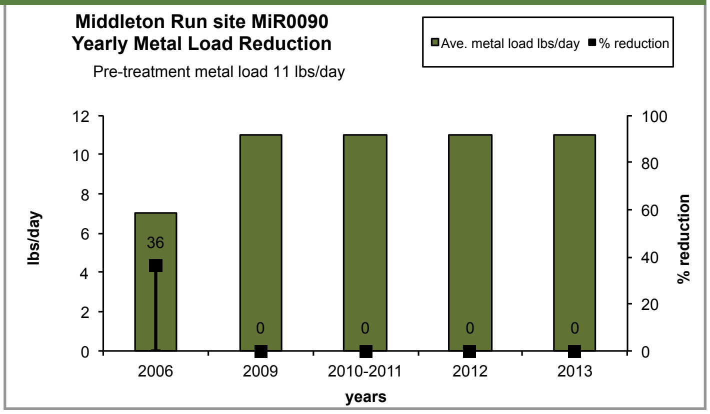




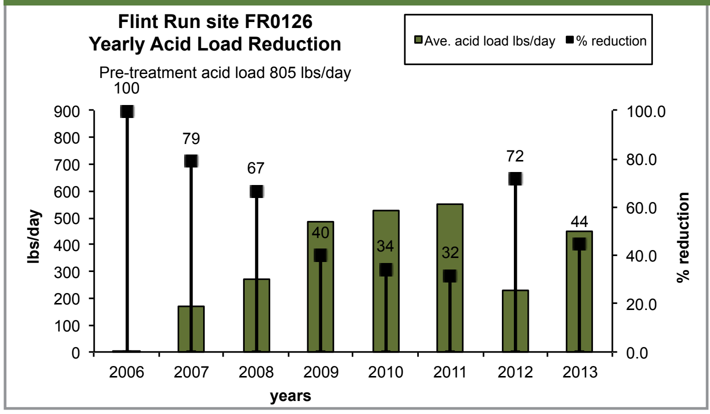
Yearly acid and metal load reduction trends per project

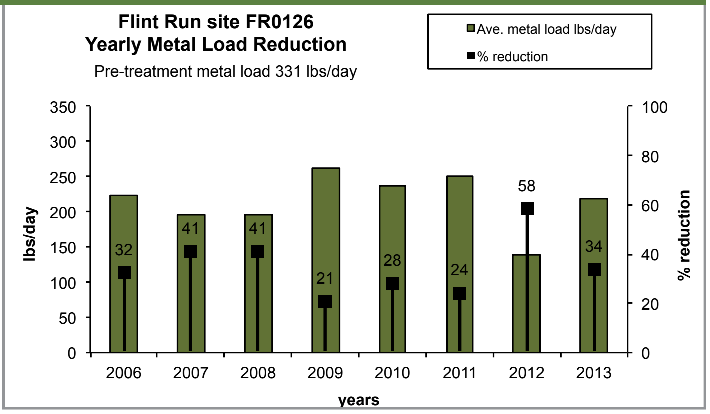
Middleton Run site MiR0090



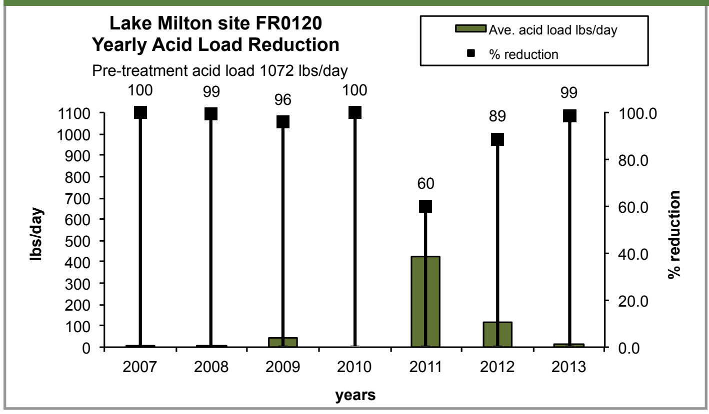


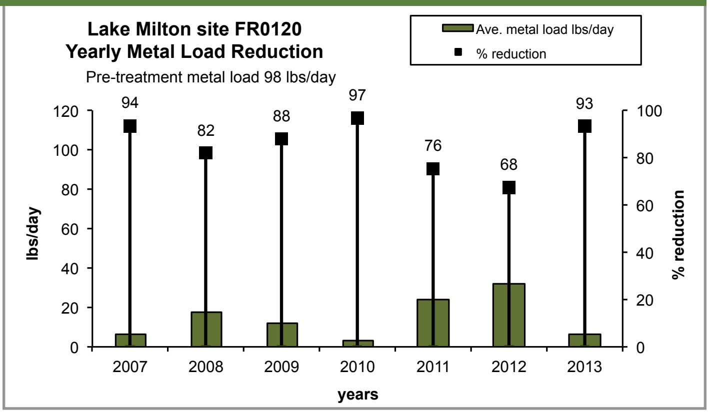
Flint Run site FR0126





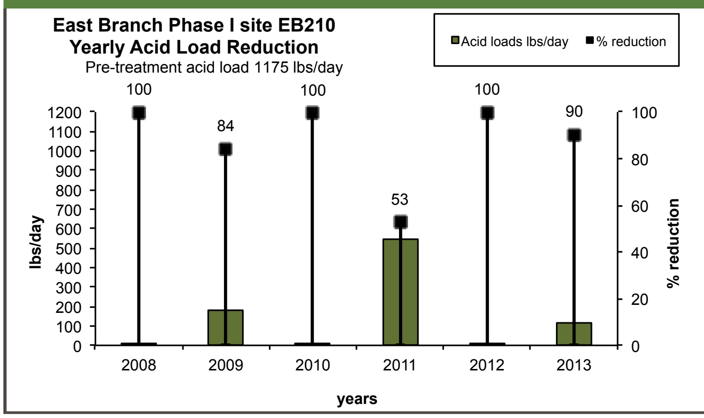
Lake Milton site FR0120

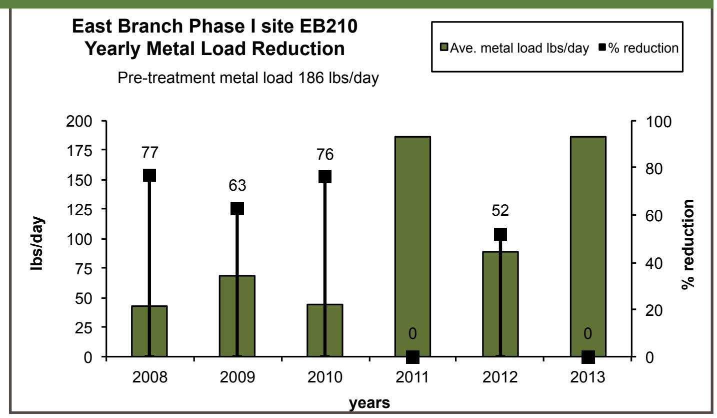




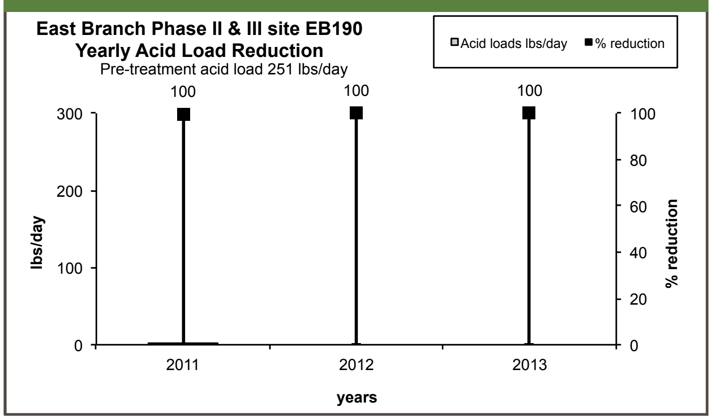
Yearly acid and metal load reduction trends per project

East Branch Phase I site EB210

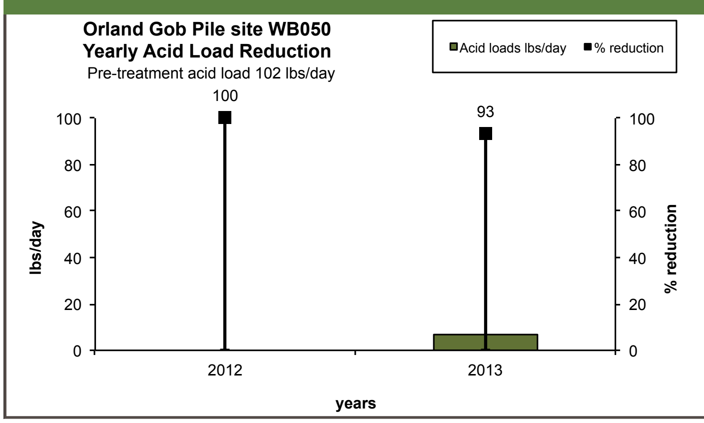


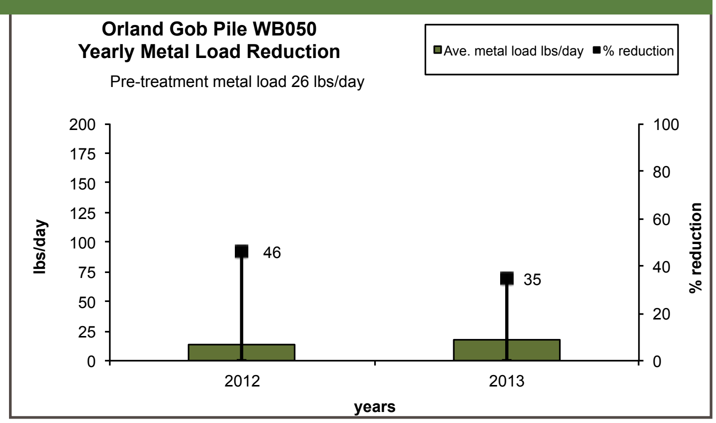


East Branch Phase II & III site EB190



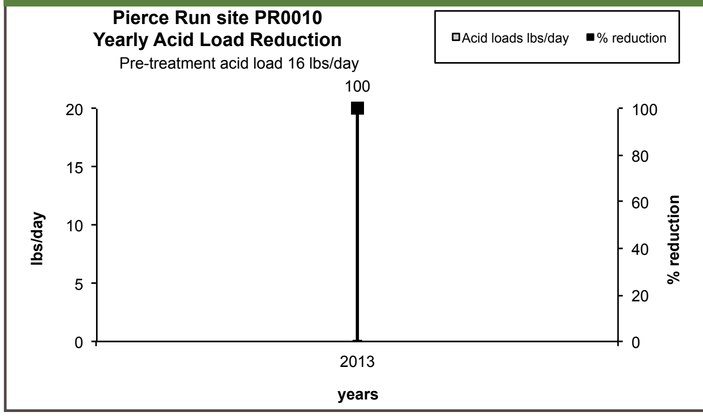
Orland Gob Pile site WB050

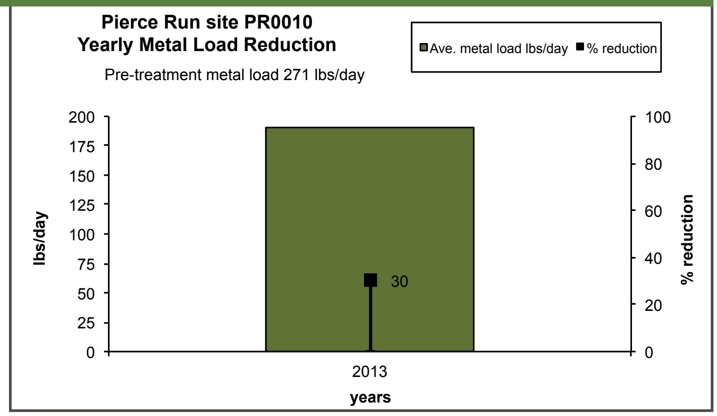




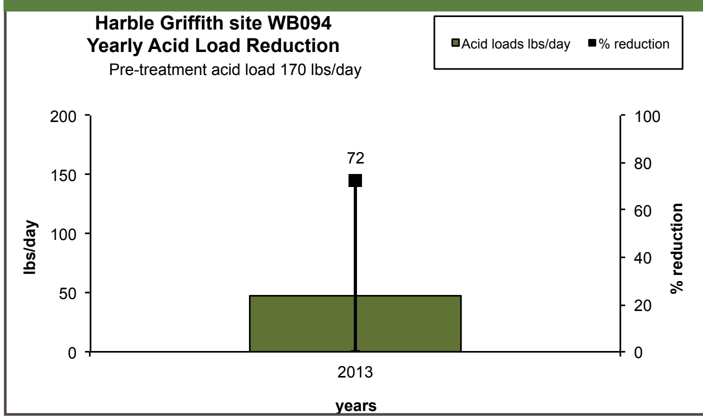
Yearly acid and metal load reduction trends per project

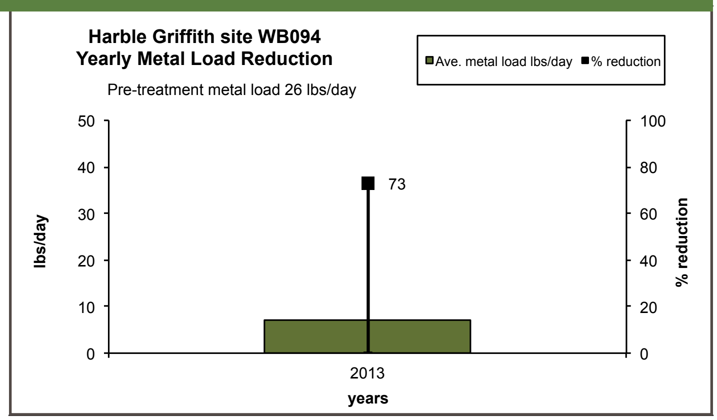
Pierce Run site PR0010





Harble Griffith site WB094





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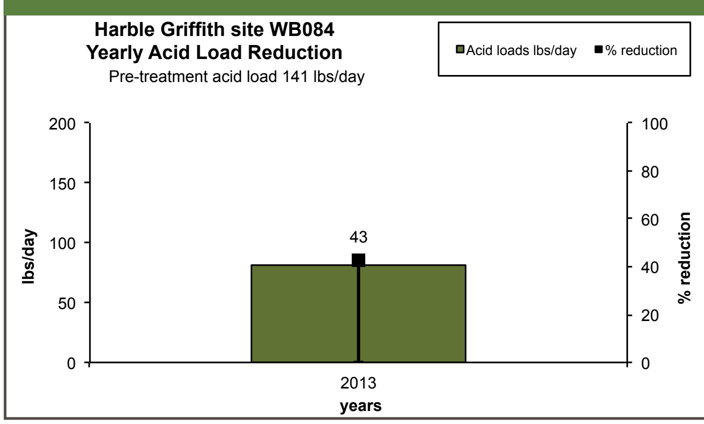
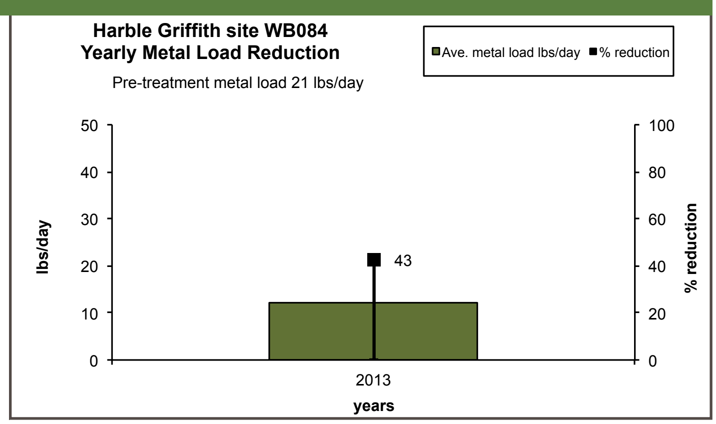
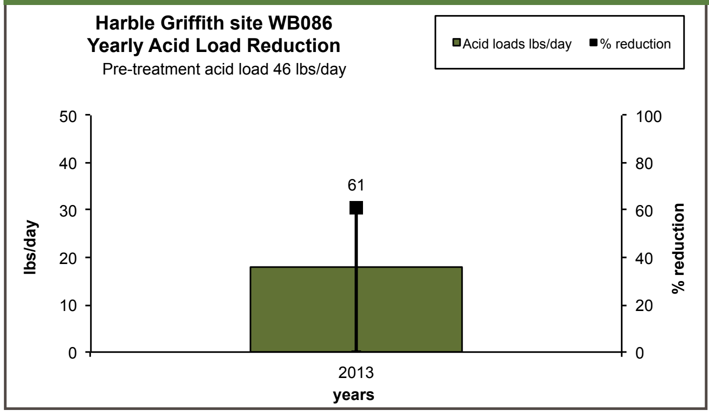
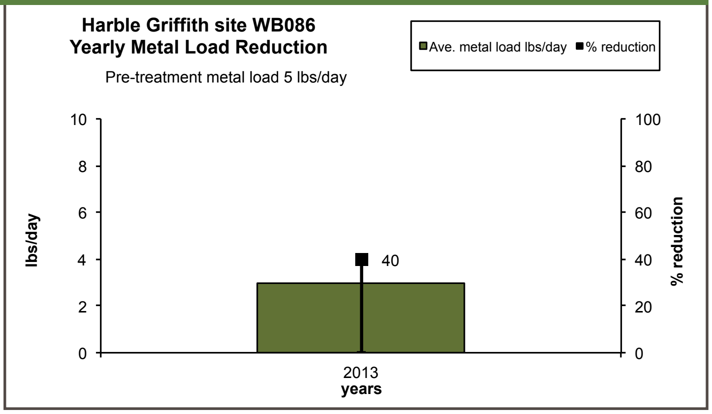




Yearly acid and metal load reduction trends per project

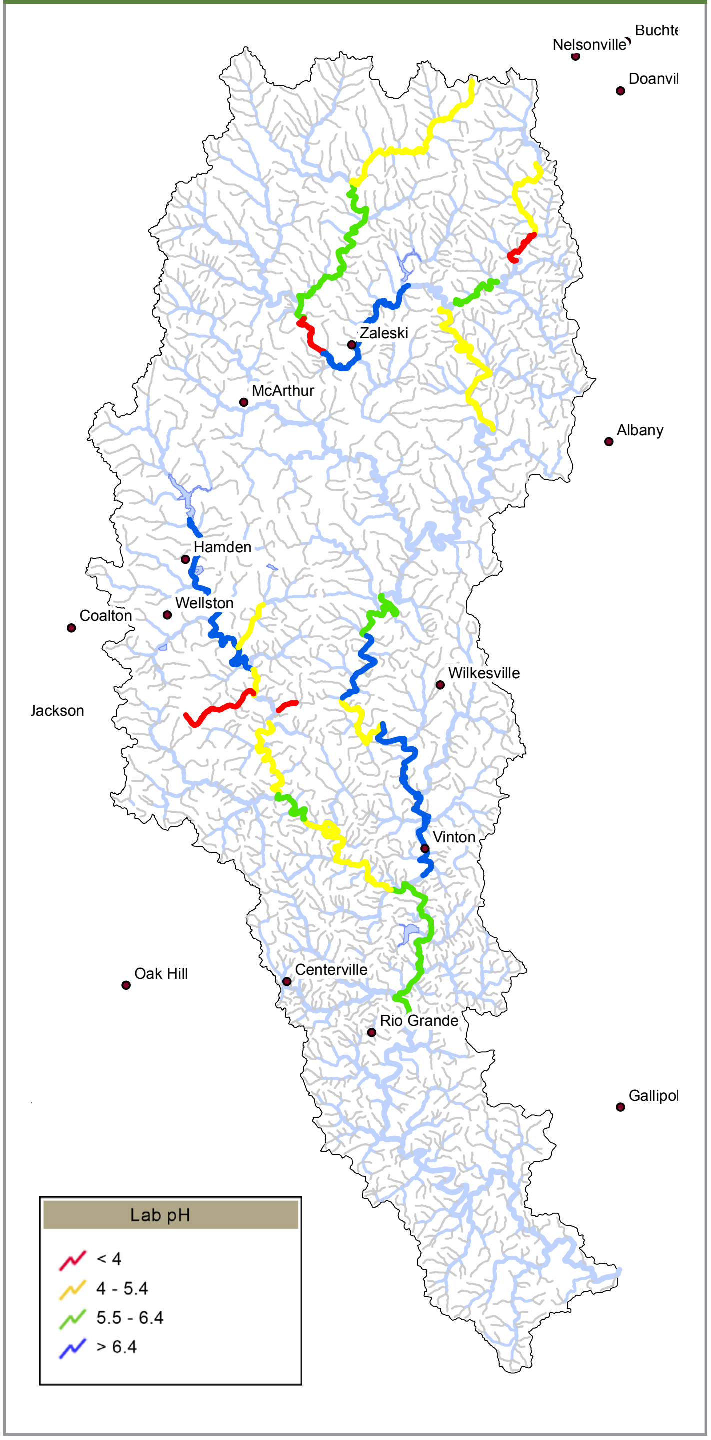
Harble Griffith site WB086



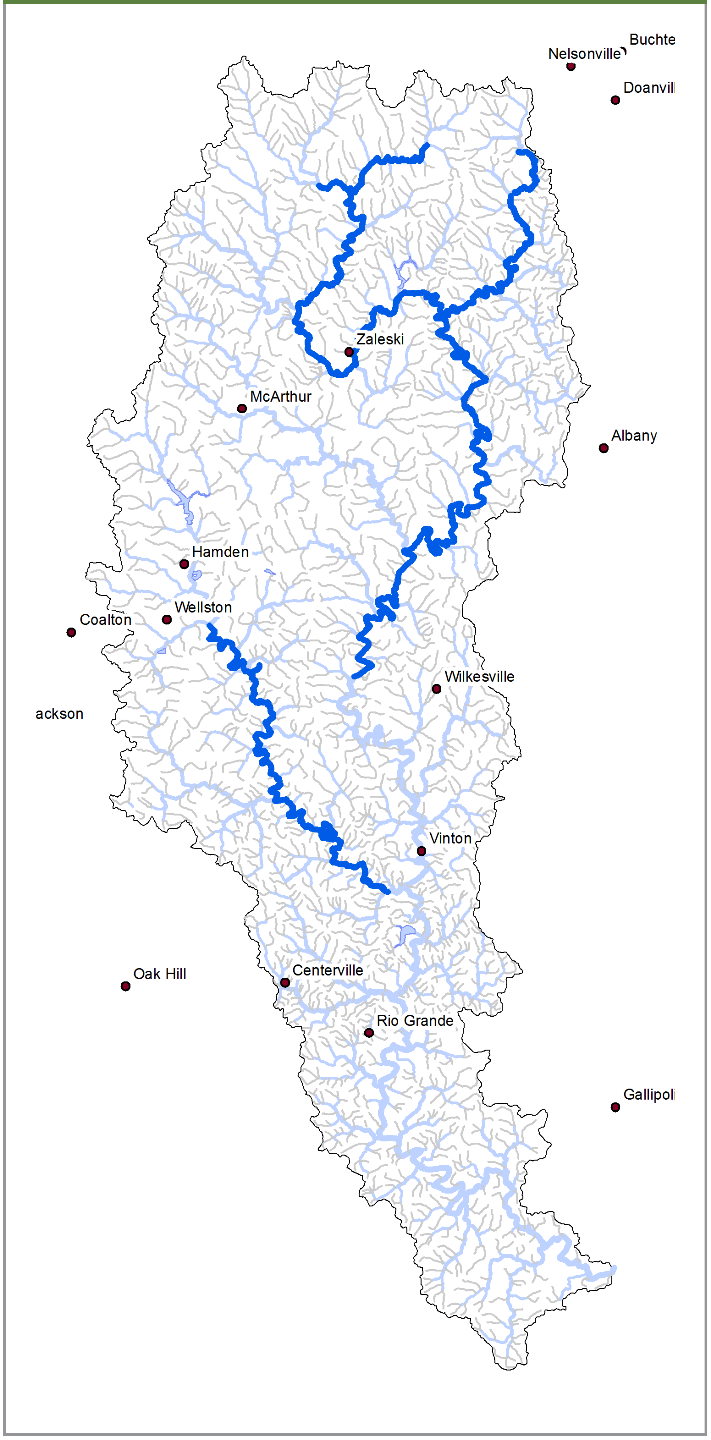


Chemical Water Quality

Raccoon Creek baseline pH



Raccoon Creek 2013 pH



In Raccoon Creek pH values have improved throughout the watershed from baseline conditions (1994-2001) to 2013. Raccoon Creek mainstem, Hewett Fork and Little Raccoon Creek average pH values have increased from a range of 4.0-5.4 during baseline to all meeting the pH target of 6.5 in 2013. Of the miles of stream monitored in 2013, 14.8 river miles in Hewett Fork, 1.6 miles in West Branch, 6 miles in East Branch, all 27 river miles in Little Raccoon Creek (LRC), and all 68 miles along the mainstem of Raccoon Creek met the pH standard (pH >6.5).

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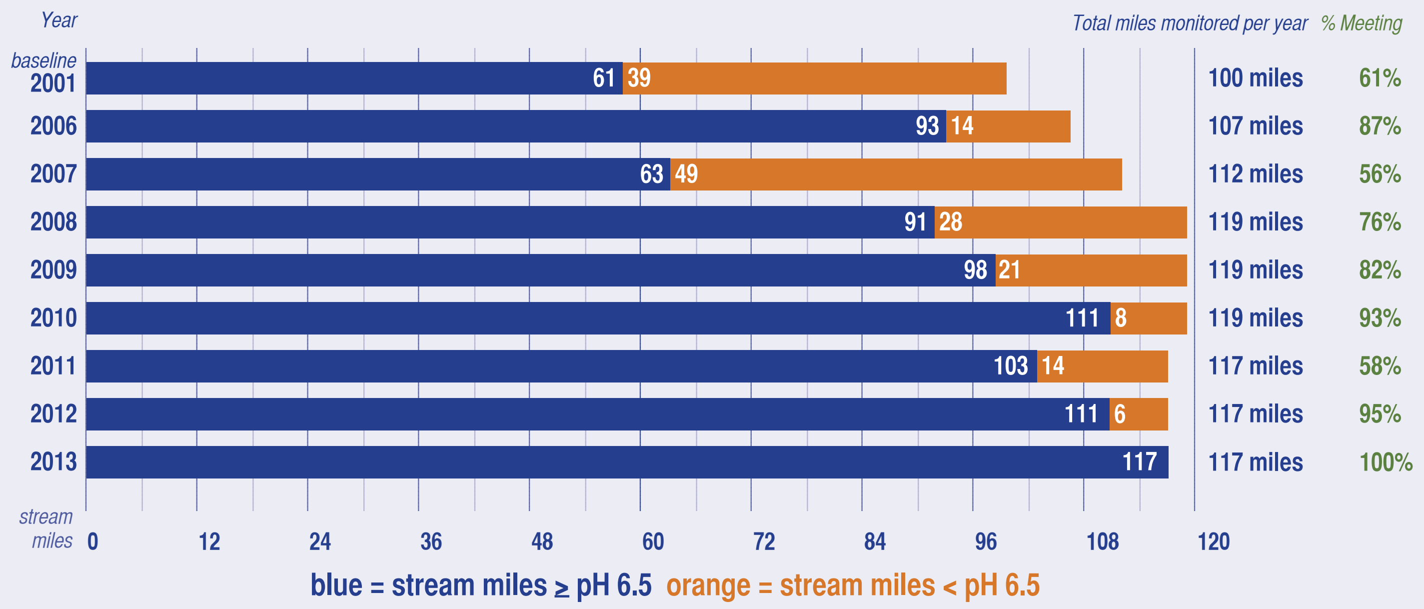
Chemical Water Quality

There are approximately 117 stream miles monitored each year along the mainstem of Raccoon Creek (downstream to Rio Grande), Little Raccoon Creek, Hewett Fork, and East and West Branch. Each year the number of miles that meet this target fluctuates. Currently in 2013, all of 117 miles of stream miles monitored met the pH target.

Raccoon Creek total stream miles monitored for pH through time from 2001-2013.



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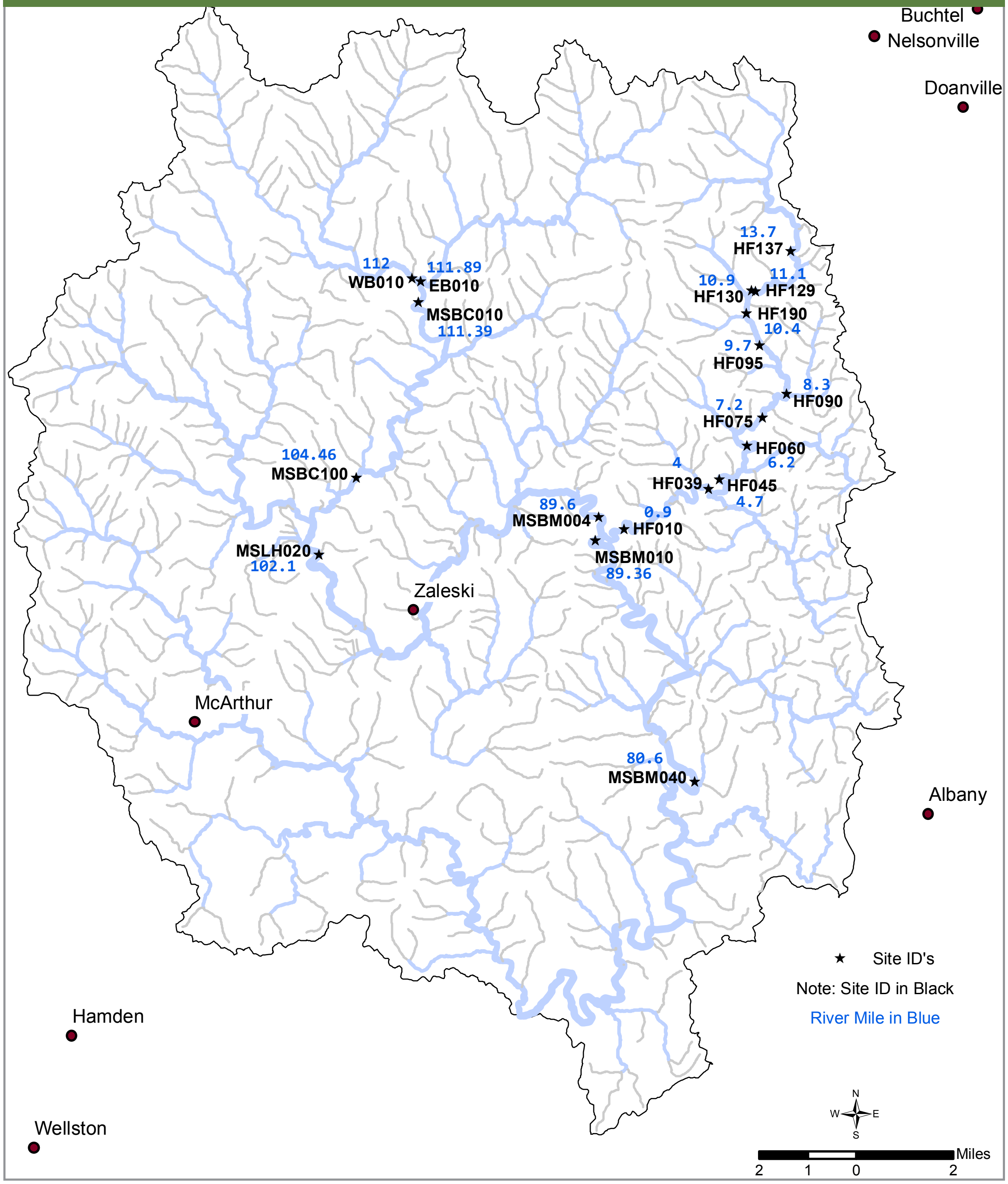
Chemical water quality analysis per stream reach

For purposes of analyzing chemical water quality changes along the mainstem of receiving stream where AMD reclamation projects have been completed, Raccoon Creek has been divided into the following stream segments: Raccoon Creek Mainstem, Little Raccoon Creek, and Hewett Fork. Within these stream reaches, chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate new sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown before each set of stream reach graphs.

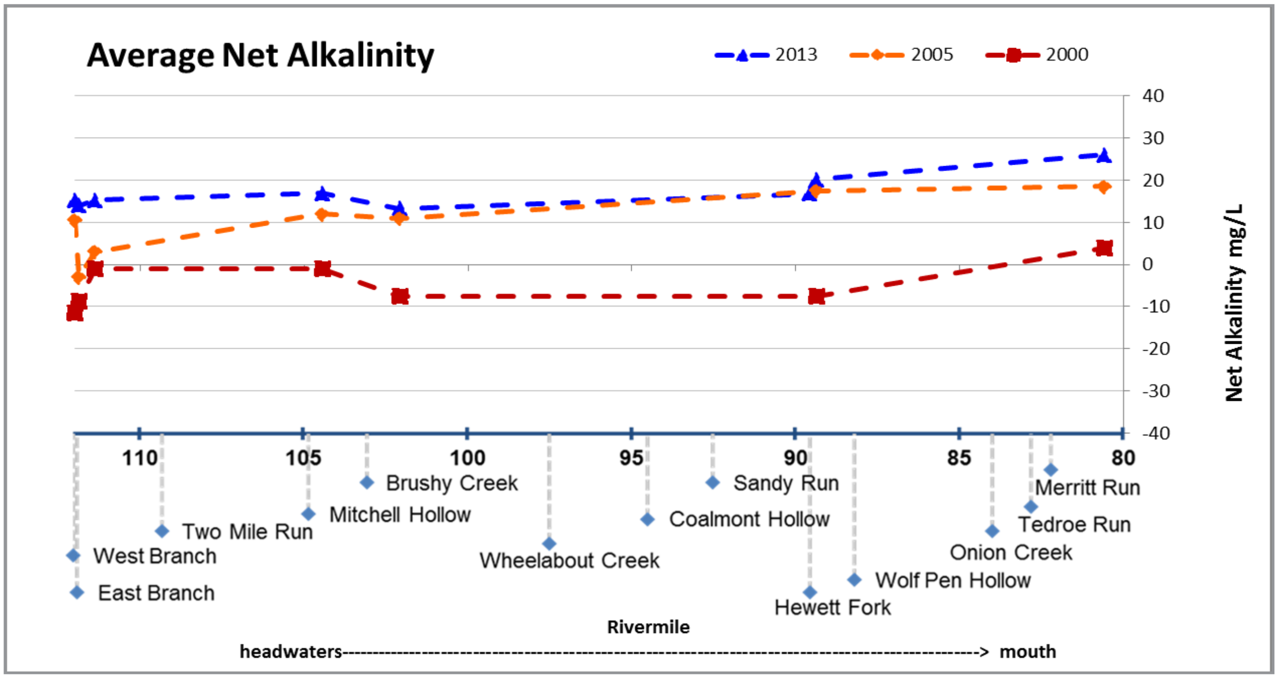
Raccoon Creek Mainstem

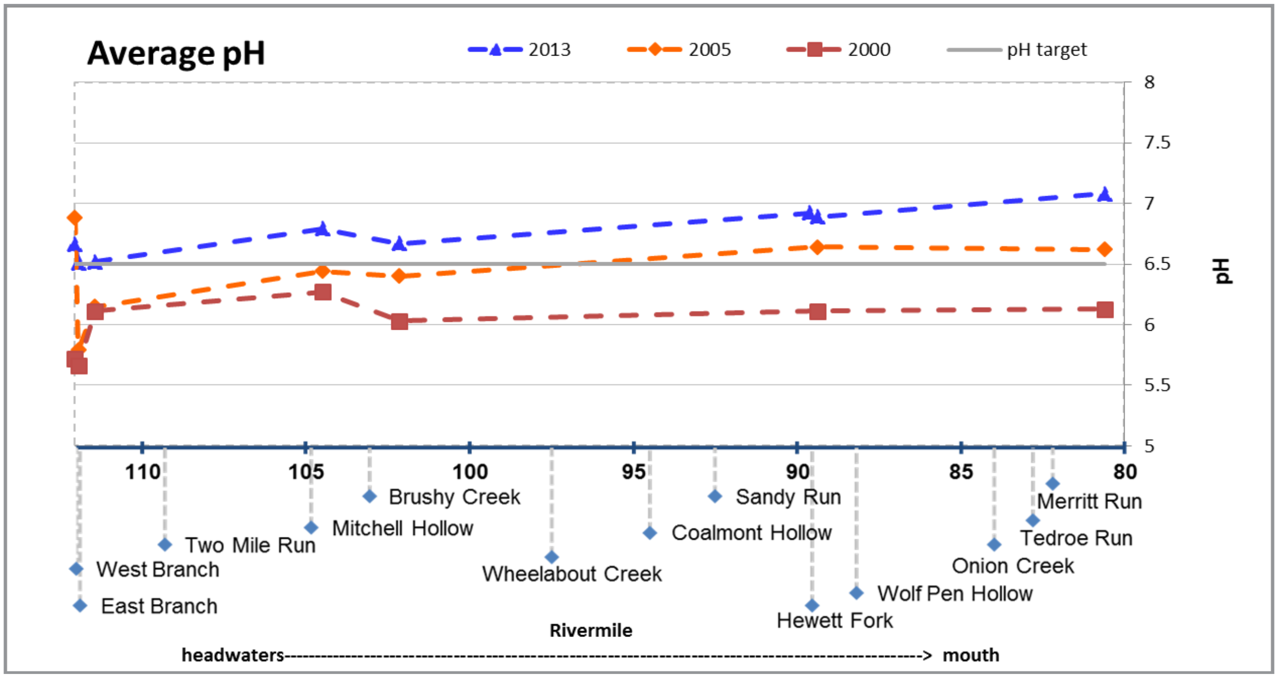


Chemical water quality analysis per stream reach

Raccoon Creek Mainstem

Site ID	WB010	EB010	MSBC010	MSBC100	MSLH020	MSBM004	MSBM010	MSBM040
Rivermile	112	111.89	111.39	104.46	102.1	89.6	89.36	80.6

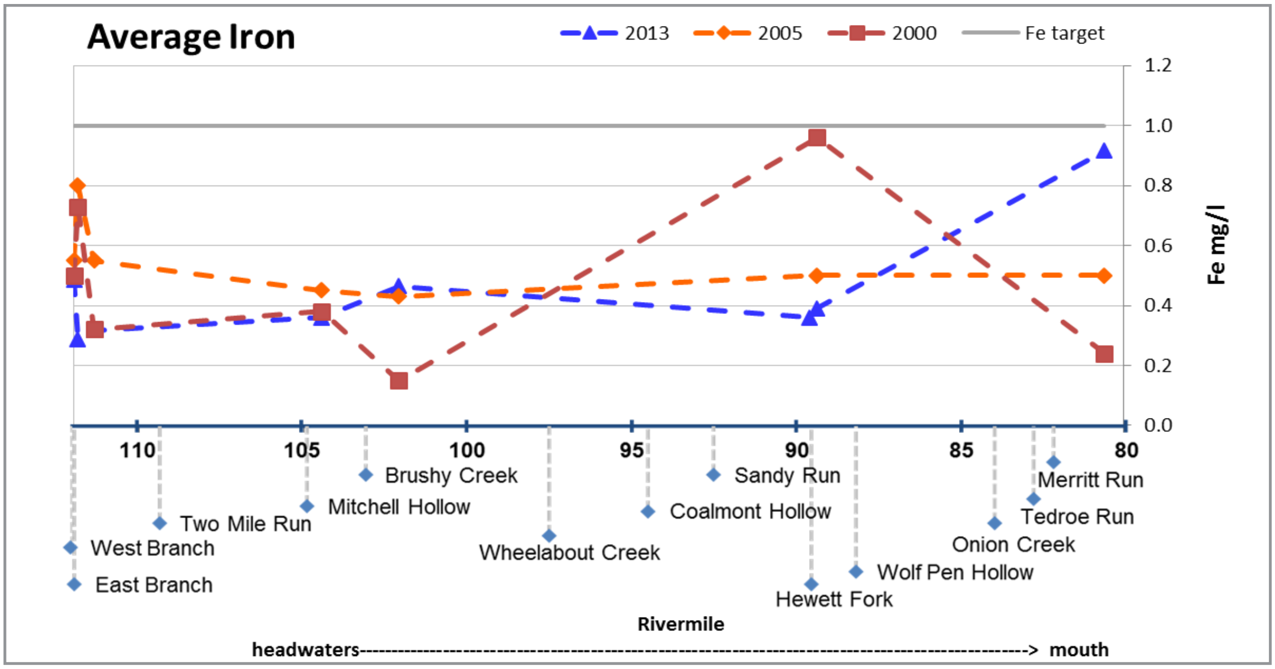


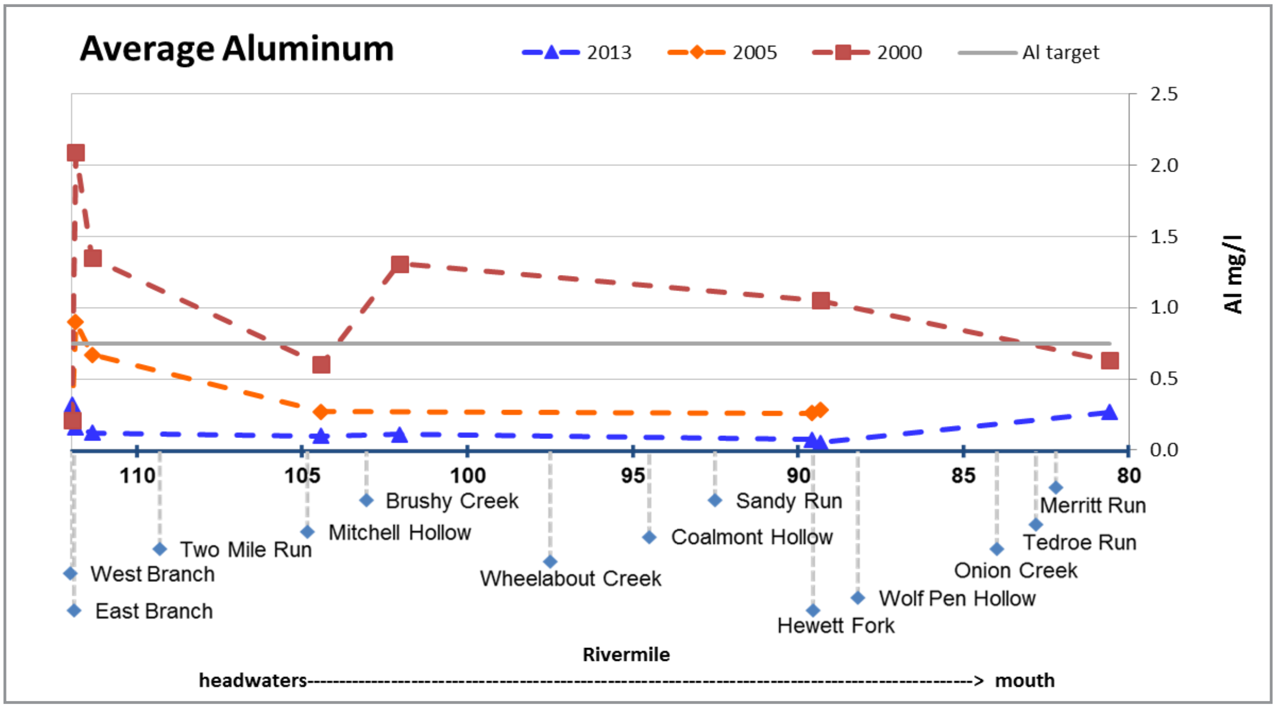


Chemical water quality analysis per stream reach

Raccoon Creek Mainstem

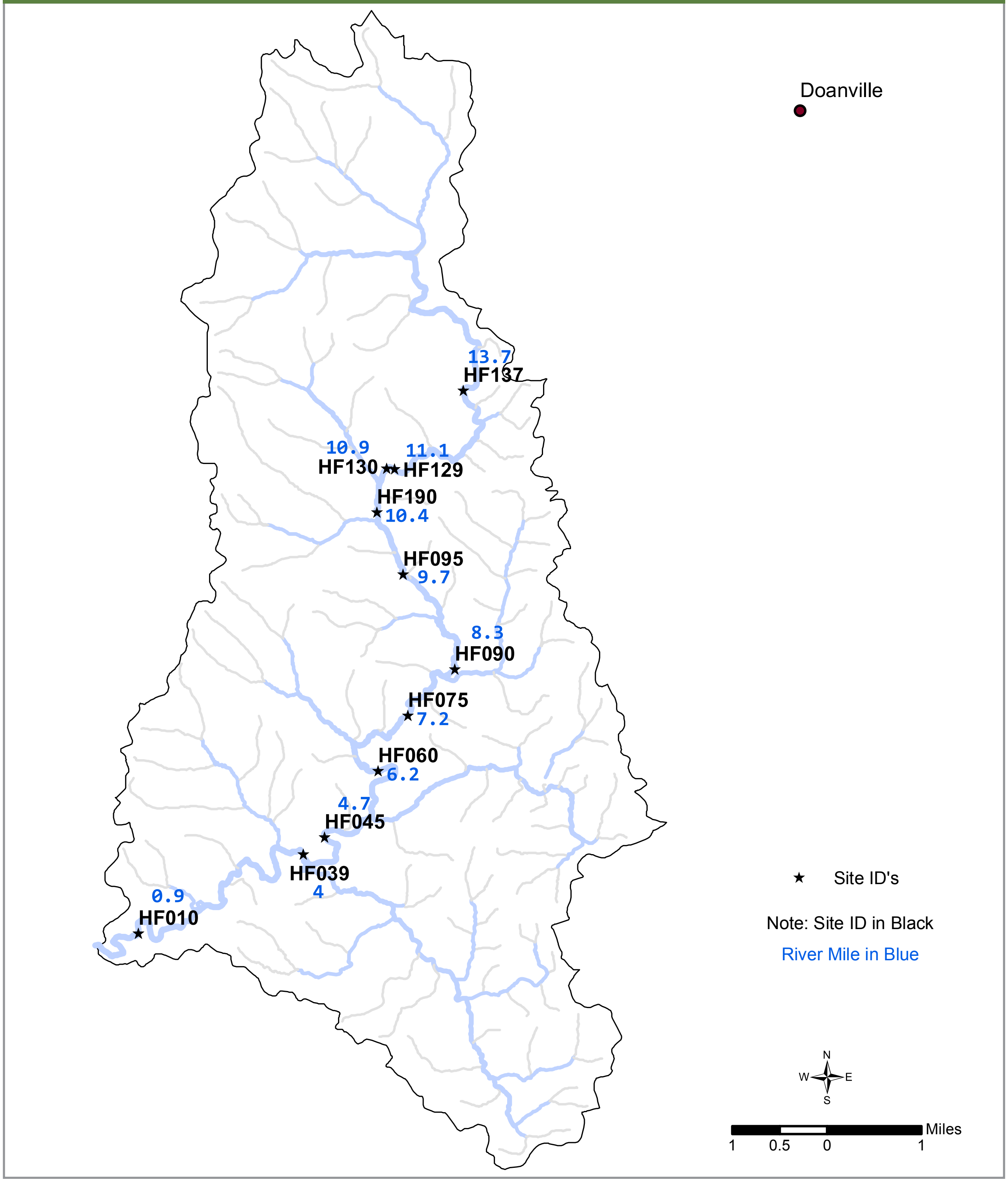
Site ID	WB010	EB010	MSBC010	MSBC100	MSLH020	MSBM004	MSBM010	MSBM040
Rivermile	112	111.89	111.39	104.46	102.1	89.6	89.36	80.6





Chemical water quality analysis per stream reach

Hewett Fork

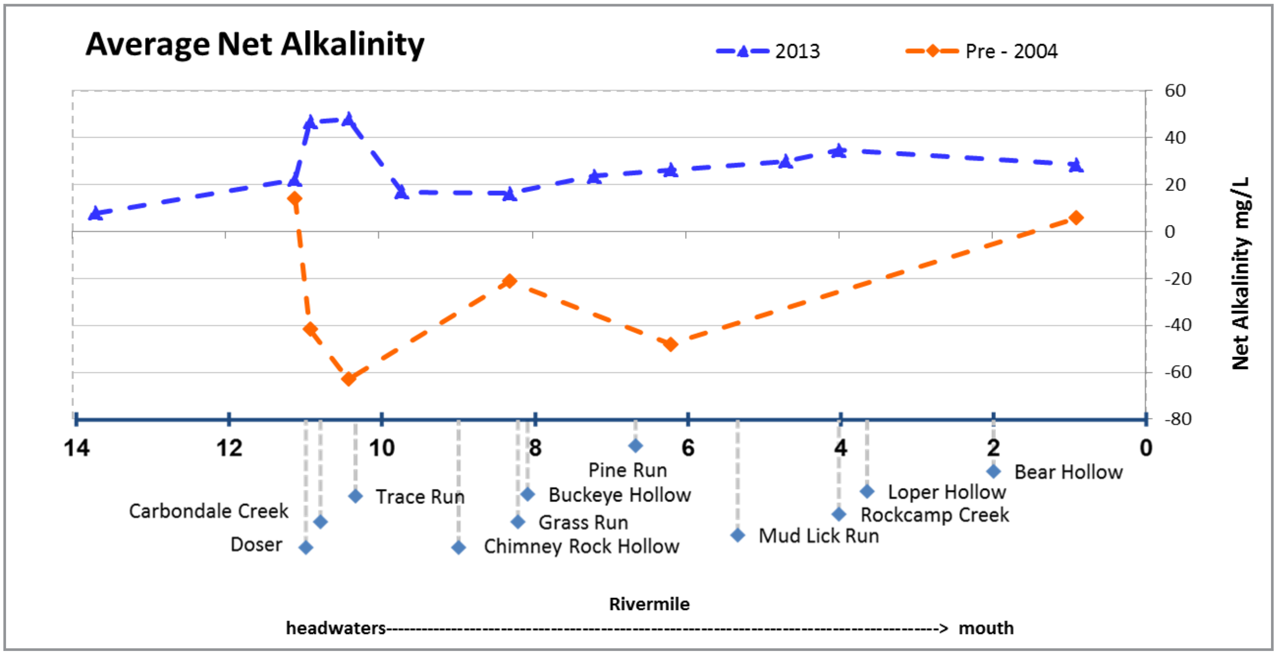


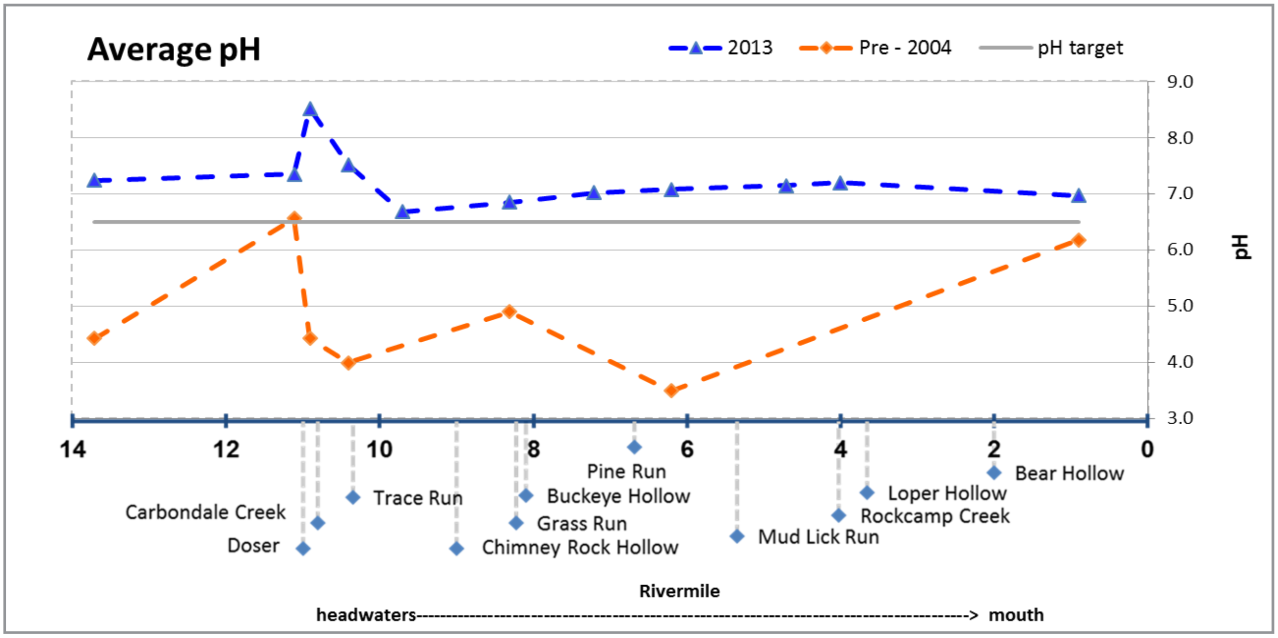
Chemical water quality analysis per stream reach

Hewett Fork

Site ID	HF137	HF129	HF130	HF190	HF095	HF090	HF075	HF060	HF045	HF039	HF010
Rivermile	13.7	11.1	10.9	10.4	9.7	8.3	7.2	6.2	4.7	4	0.9

Note: Lime Doser installed in 2004 at RM 11



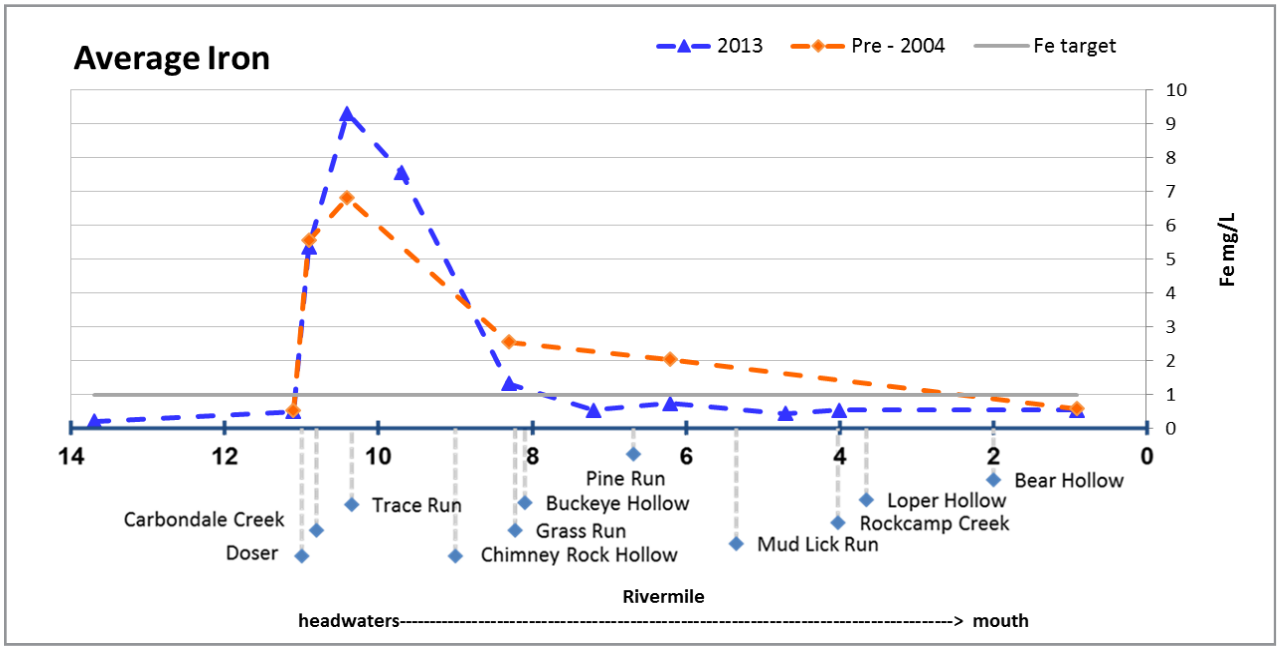


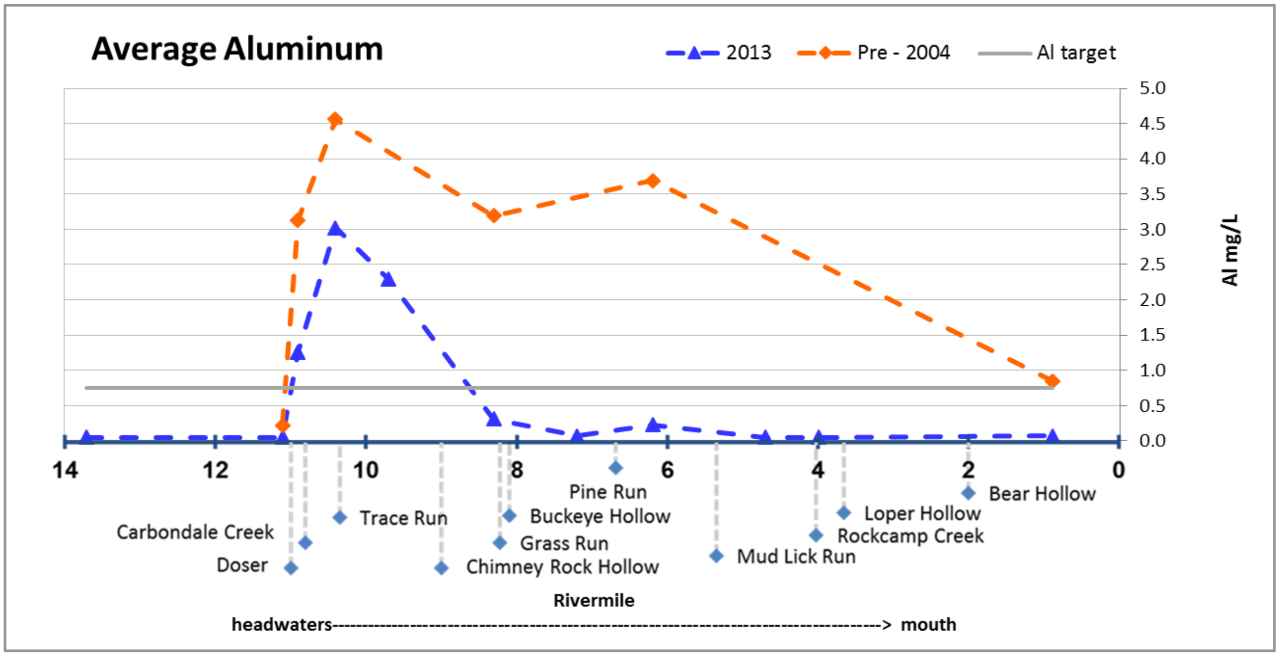
Chemical water quality analysis per stream reach

Hewett Fork

Site ID	HF137	HF129	HF130	HF190	HF095	HF090	HF075	HF060	HF045	HF039	HF010
Rivermile	13.7	11.1	10.9	10.4	9.7	8.3	7.2	6.2	4.7	4	0.9

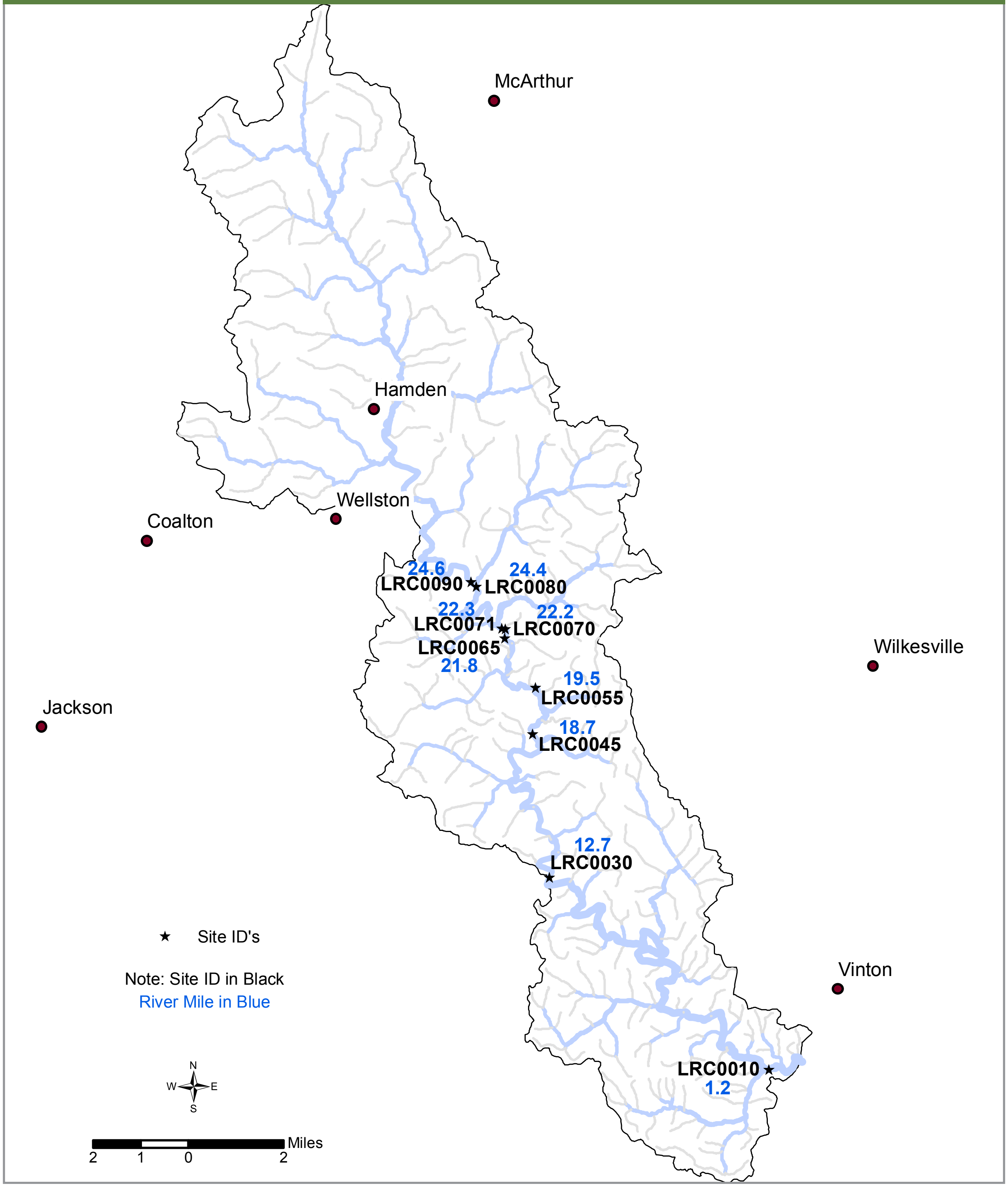
Note: Lime Doser installed in 2004 at RM 11





Chemical water quality analysis per stream reach

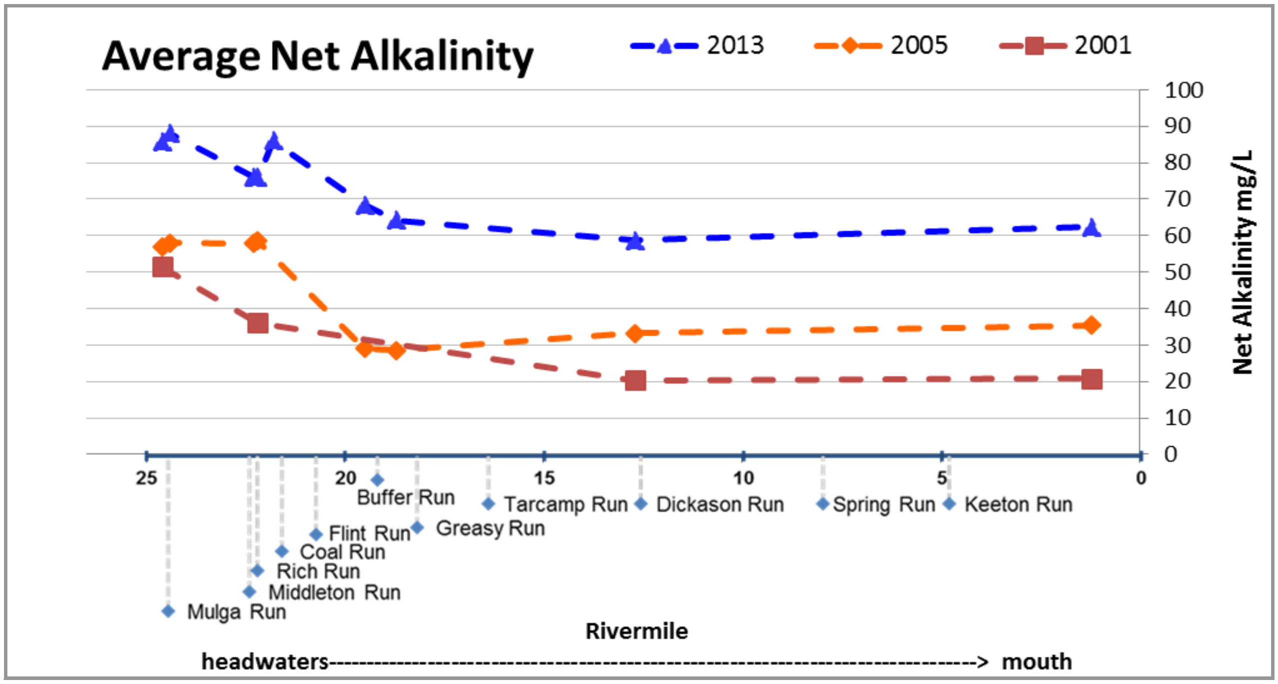
Little Raccoon Creek

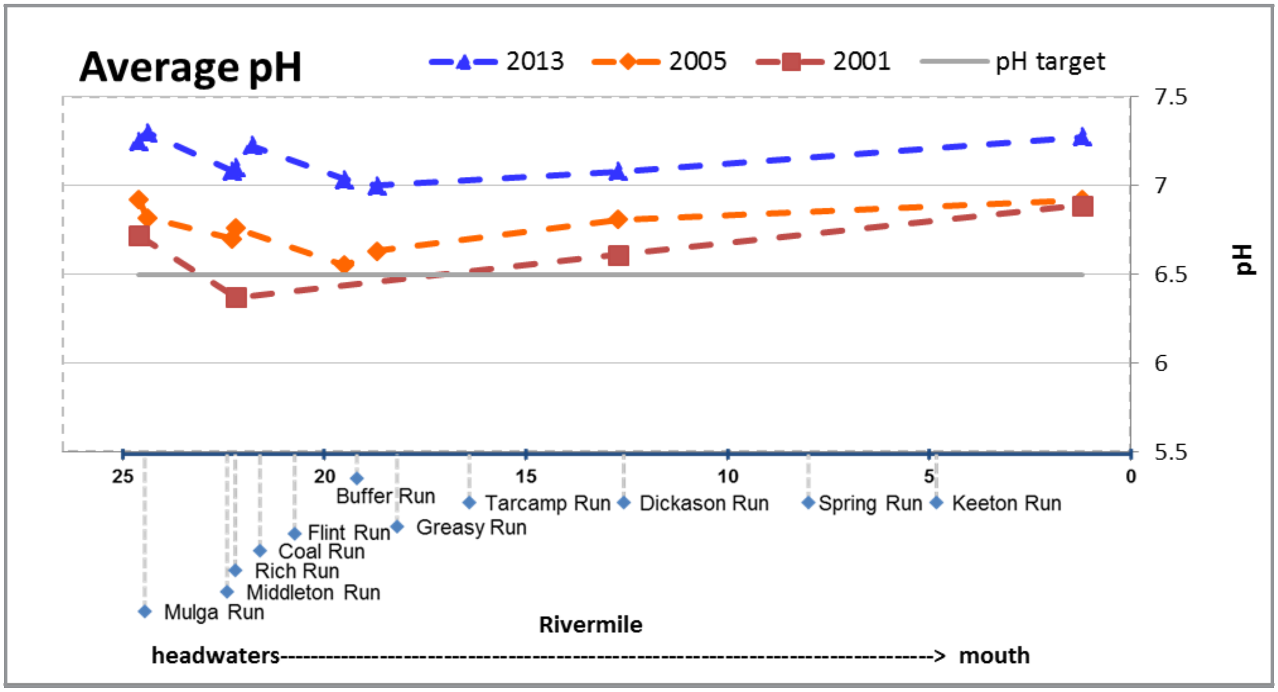


Chemical water quality analysis per stream reach

Little Raccoon Creek

Site ID	LRC0090	LRC0080	LRC0071	LRC0070	LRC0065	LRC0055	LRC0045	LRC0030	LRC0010
Rivermile	24.6	24.4	22.3	22.2	21.8	19.5	18.7	12.7	1.2





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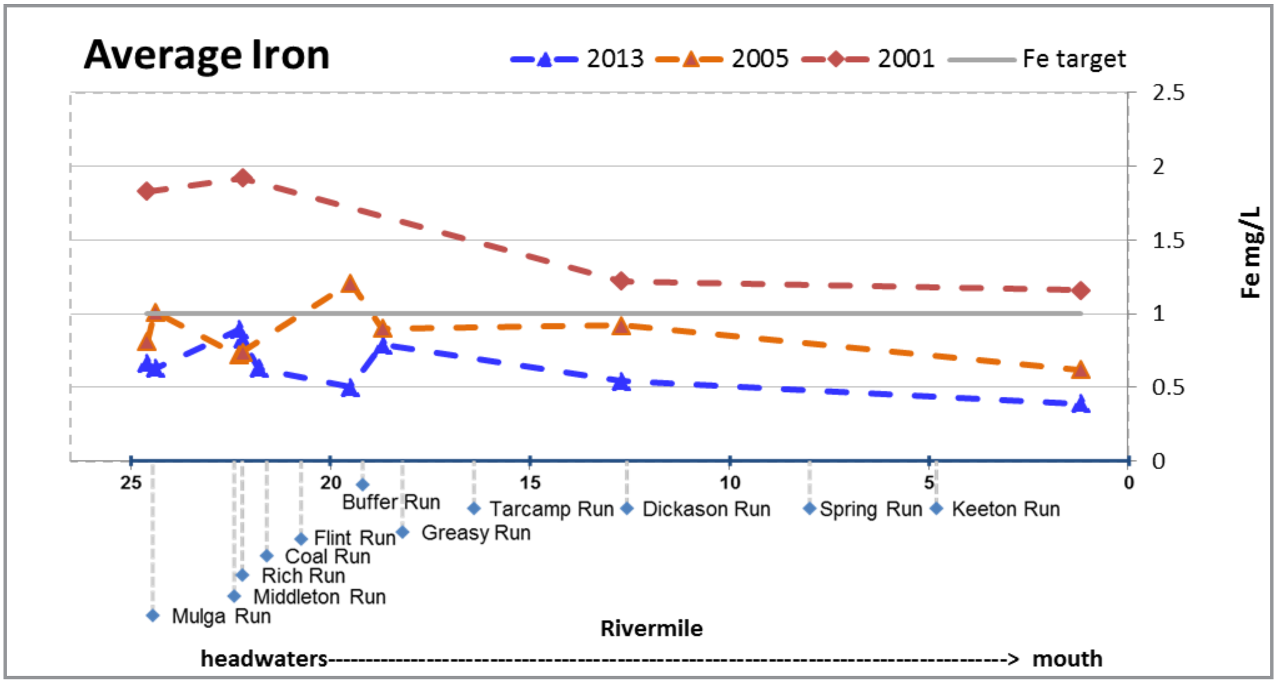
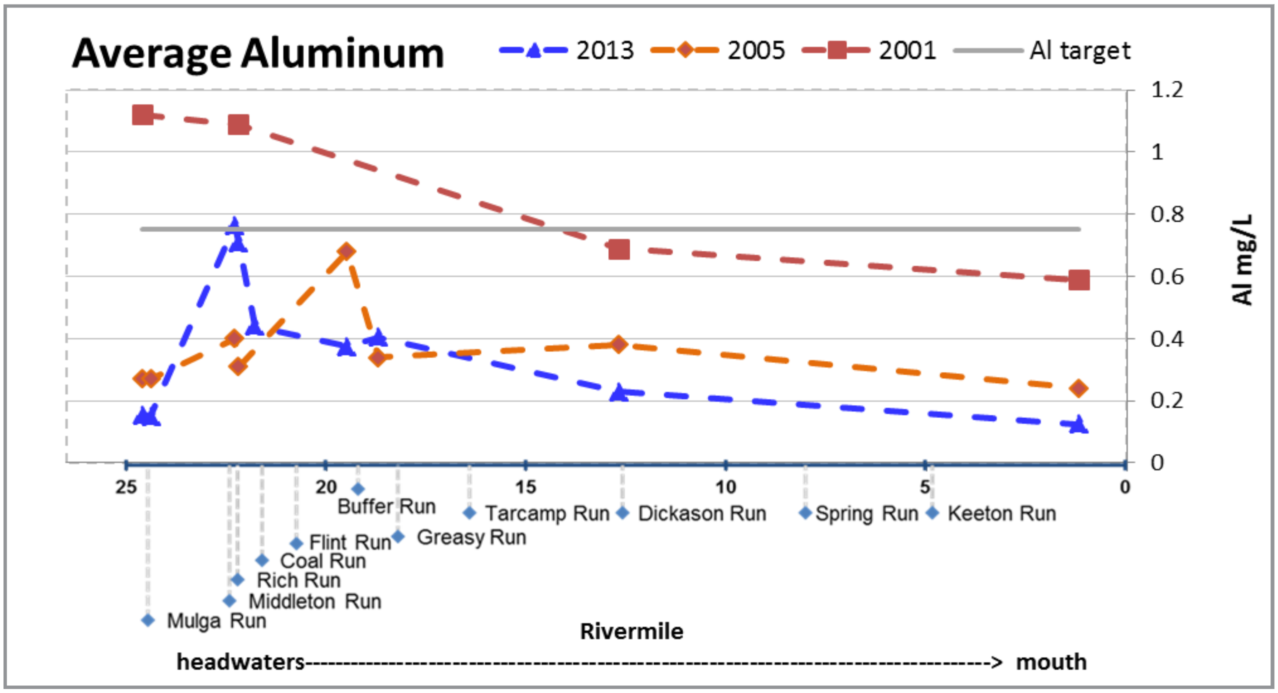
Chemical water quality analysis per stream reach

Little Raccoon Creek									
Site ID	LRC0090	LRC0080	LRC0071	LRC0070	LRC0065	LRC0055	LRC0045	LRC0030	LRC0010
Rivermile	24.6	24.4	22.3	22.2	21.8	19.5	18.7	12.7	1.2





2013 NPS Report - Raccoon Creek Watershed

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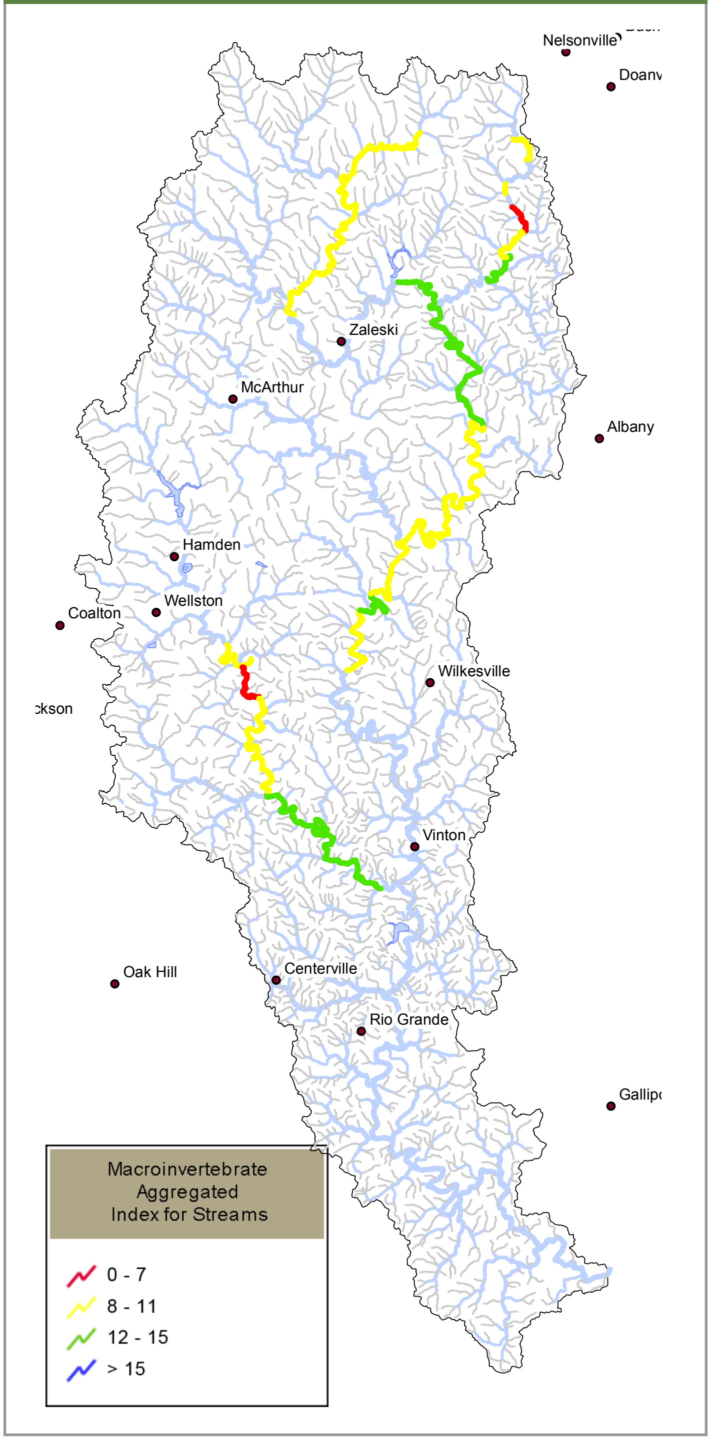
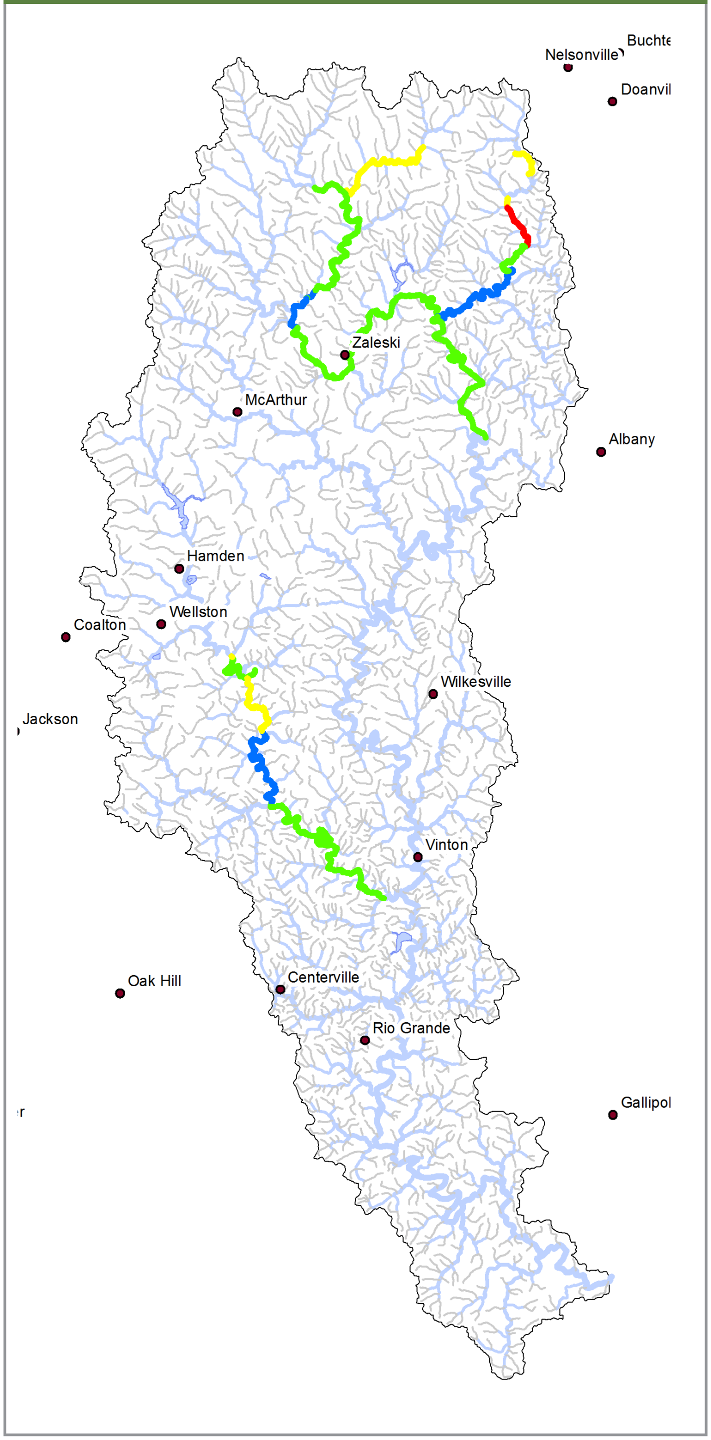
Biological Water Quality

Raccoon Creek baseline MAIS



Raccoon Creek 2013 MAIS

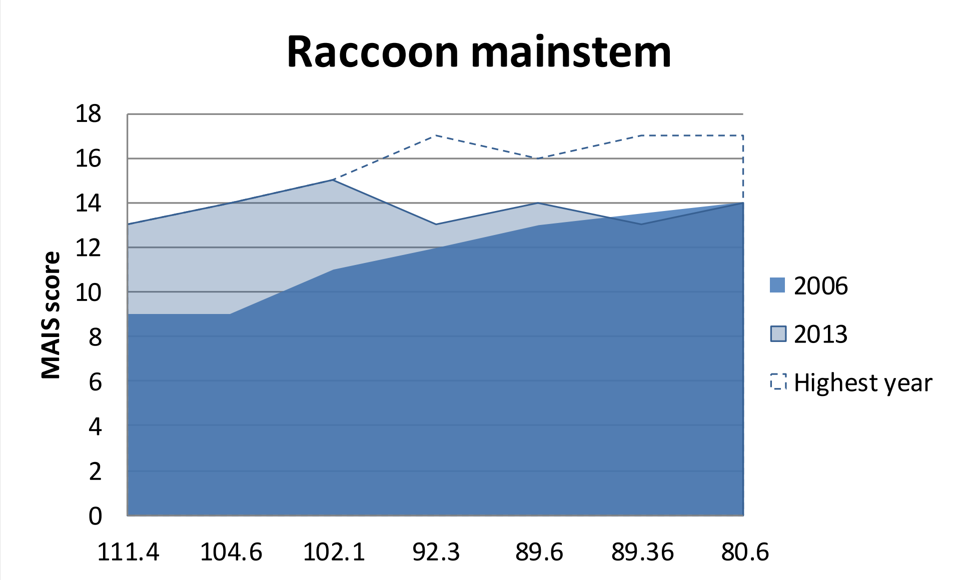


MAIS samples were collected throughout Raccoon Creek in 2013 (excluding Middle Basin sites). These stations have been established as annual monitoring stations for macroinvertebrates. The sites are used to track incremental changes each year.

Raccoon Creek - Mainstem

All seven of the long term monitoring sites along the thirty or more miles of the Raccoon Creek Mainstem scored a “12” or higher on the macroinvertebrate (MAIS) index, for the second year in a row (Figure 1). Sites in the upper sections scored as well as they ever have (met highest scores attained in past years) but in the lower section of the mainstem (below RM 102.1), MAIS scores fell below their highest potential, as they did in 2012. These sites had better biological quality in previous years, especially in 2009 and 2012 when several sites scored 16-17 (Very Good quality). However, the high scores have not recurred consistently every year. In 2012, only one site met statistical criteria for improvement (RM 111.4) over the 7 year monitoring period; this year a second site also met the criteria (the site immediately downstream, RM 104.6) (Figure 2).

Figure 1. Area of Degradation



The blue dashed line identifies the highest MAIS score achieved at that site throughout the monitoring time period.

Figure 2. Raccoon Creek - Mainstem - MAIS Regressions

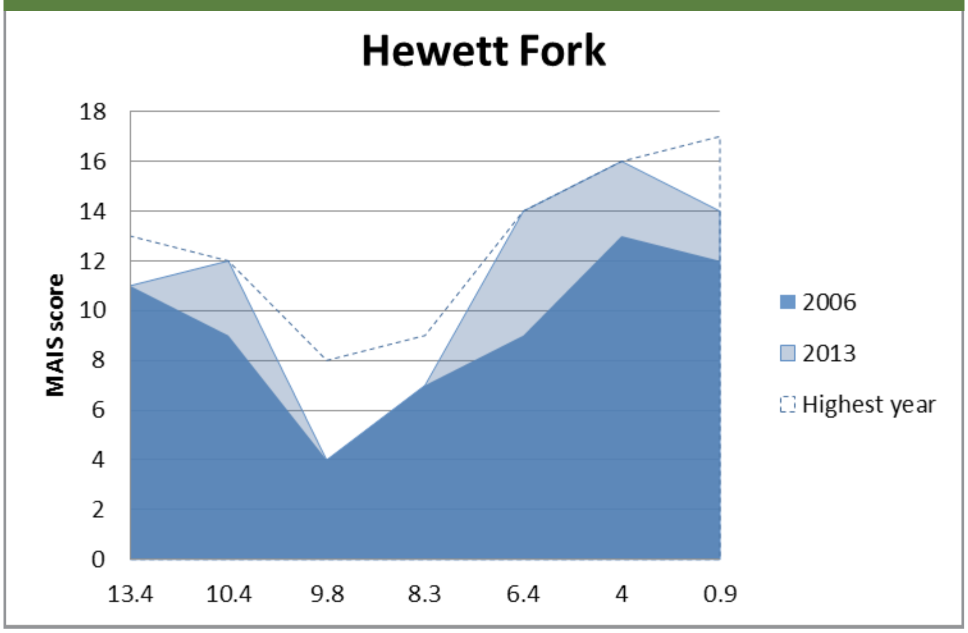
RM	2005	2006	2007	2008	2009	2010	2011	2012	2013	Linear trends	R sq.	P-value	No. of years
111.4	8	9	12	9	10	12	13	12	13	**improved**	0.667	0.007	9
104.6		9	11	12	9	11	10	14	14	**improved**	0.458	0.066	8
102.1		11	11	10	13	10	11	12	15	no change	0.326	0.139	8
92.3		*	*	10	10	17	11	14	13	no change	0.168	0.420	6
89.6		13	14	11	16	12	16	15	14	no change	0.138	0.366	8
89.4		*	12	16	14	17	13	13	13	no change	0.029	0.717	7
80.6		14	14	17	16	12	14	15	14	no change	0.024	0.715	8

*scores illustrated in the figure were estimated as the mean of sites immediately upstream and downstream that year

Raccoon Creek - Hewett Fork

In 2013, the biological quality of the eleven mile reach below the Carbondale doser showed continued improvement, with the exception of a well-defined 2.5 mile 'mixing zone' downstream of the doser, which remains impaired even as other sections of the stream recover. One site immediately downstream of the doser produced a new high score of "12" compared to its usual "5-9", which was somewhat surprising given that it lies within the mixing zone and is not generally expected to show strong recovery (Figure 3). Several sites further downstream in the 'recovery zone' (RM 8.3-4.0) showed steady numerical improvement compared to last year, suggesting that biological recovery since installation of the doser in 2004 is still progressing. Two of these sites, RM 6.4 (upstream King Hollow Rd.) and RM 4.0 (Rockcamp), achieved new high scores this season of "14" and "16", compared to last year's scores of "11" and "14", which helped confirm that biological improvement of more than 8 river miles downstream the doser (RM 8.3 to 4.0) since 2006 has reached statistical significance (Figure 4).

Figure 3. Area of Degradation



The blue dashed line identifies the highest MAIS score achieved at that site throughout the monitoring time period.

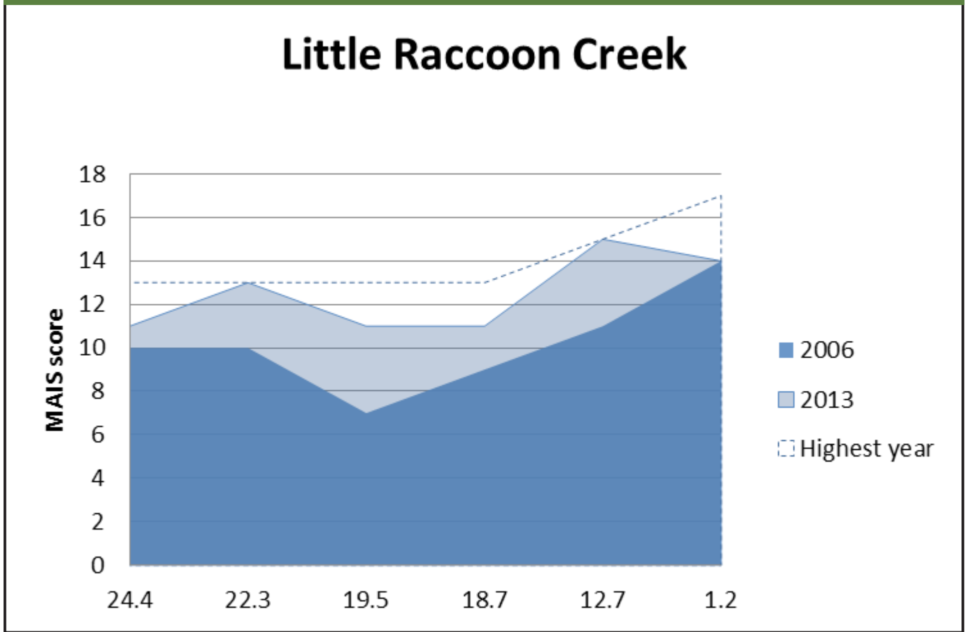
Figure 4. Raccoon Creek - Hewett Fork MAIS Regressions

RM	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	Linear trends	R sq.	P-value	No. of Yrs.
13.4					11	8	9	12	13	11	11	11	no change	0.164	0.319	8
10.4					9	3	7	6	6	5	8	12	no change	0.183	0.290	8
9.8					4	3	6	3	3	8	4	4	no change	0.032	0.667	8
8.3	2	3	3	5	7	3	5	6	3	6	9	7	**improved**	0.500	0.010	12
6.4					9	9	8	10	10	13	11	14	**improved**	0.714	0.008	8
4					13	13	14	13	13	14	14	16	**improved**	0.536	0.038	8
0.9					12	12	15	17	13	16	16	14	no change	0.250	0.206	8

Raccoon Creek - Little Raccoon Creek

Little Raccoon Creek biological quality in 2013 was similar to 2012, with most sites showing stable improvement since 2006, after completion of the six major reclamation projects upstream of RM 19.5 (Mulga Run, Salem Road/Middleton Run, State Rte. 124 seeps, Flint Run East, Lake Milton, and Buckeye Furnace) (Figure 5). The macroinvertebrate community at the long term site at RM 12.7 has shown the greatest and most consistent improvement, and is now consistently attaining a MAIS score of “14-15” from a low of “3” in 2005. This year it attained a new high score of “15”. As in the past, sites from approximately RM 18 to 1.2 (more than 16 river miles) achieved target macroinvertebrate scores of ‘12’, indicating that the macroinvertebrate community is probably at or near attainment of WWH status. Upstream sites have also improved since 2006, with RM 22.3 showing continued improvement. It surpassed the MAIS target of “12” this year, attaining a new highest score of 13 and a statistically significant improvement since monitoring began (Figure 6).

Figure 5. Area of Degradation



The blue dashed line identifies the highest MAIS score achieved at that site throughout the monitoring time period.

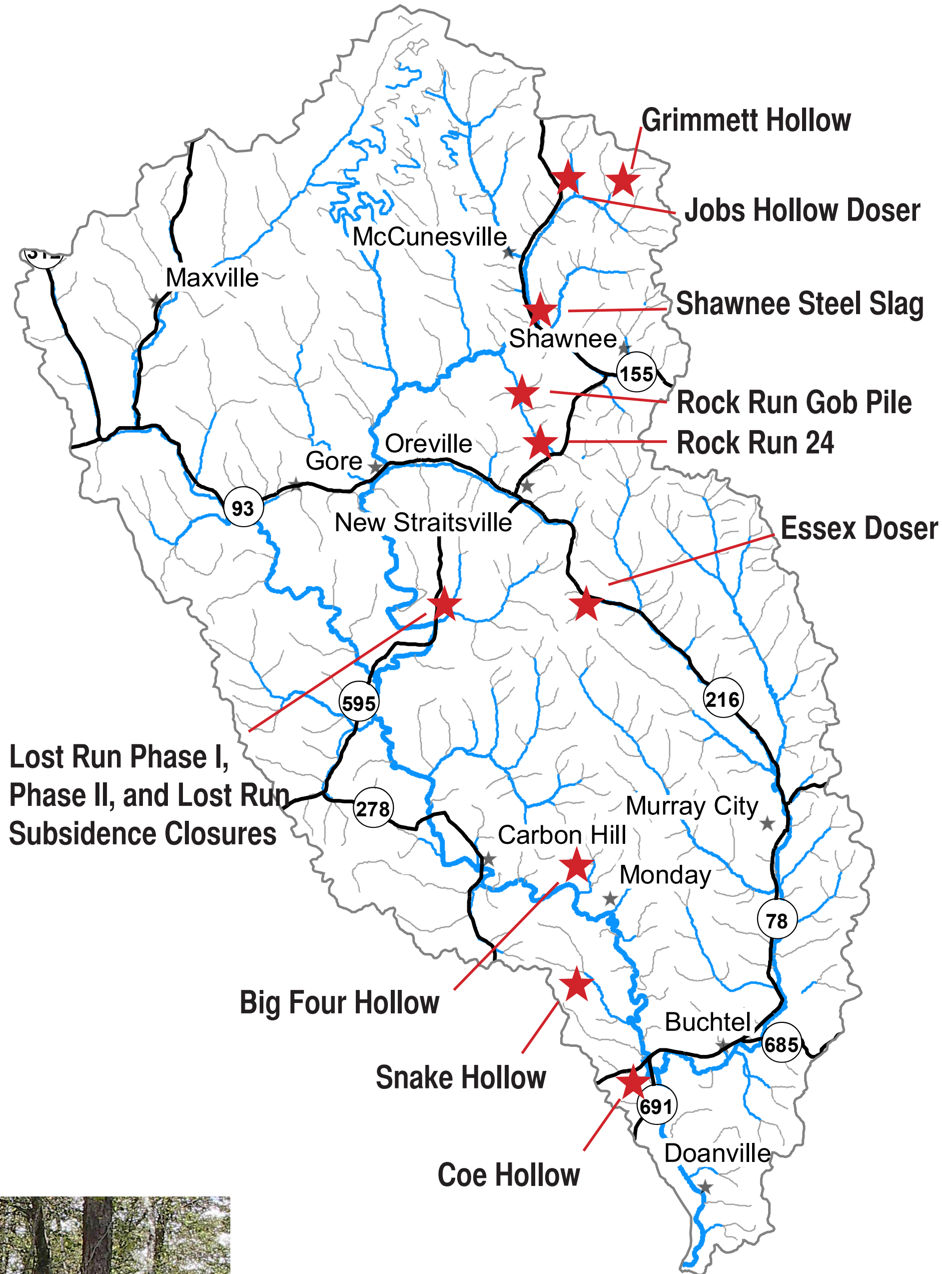
Figure 6. Little Raccoon Creek - MAIS Regressions

RM	2005	2006	2007	2008	2009	2010	2011	2012	2013	Linear trends	R sq.	P-value	No. of years
24.4	8	10	11	11	9	9	13	11	11	no change	0.268	0.154	9
22.3	8	10	10	9	10	10	10	10	13	**improved**	0.525	0.027	9
19.5		7	*	9	11	12	13	10	11	no change	0.536	0.038	8
18.7	14	9	12	9	13	11	11	12	11	no change	0.007	0.832	9
12.7	3	11	13	13	14	14	14	14	15	***improved***	0.556	0.021	9
1.2	14	14	13	15	17	16	16	16	14	no change	0.201	0.226	9

**Indicates a score illustrated as the mean of sites immediately upstream and downstream that year*

MONDAY CREEK
WATERSHED REPORT

Monday Creek Restoration Project



Reductions

Total acid load reduction 2013 = 4,178 lbs/day

Total metal load reduction 2013 = 526 lbs/day

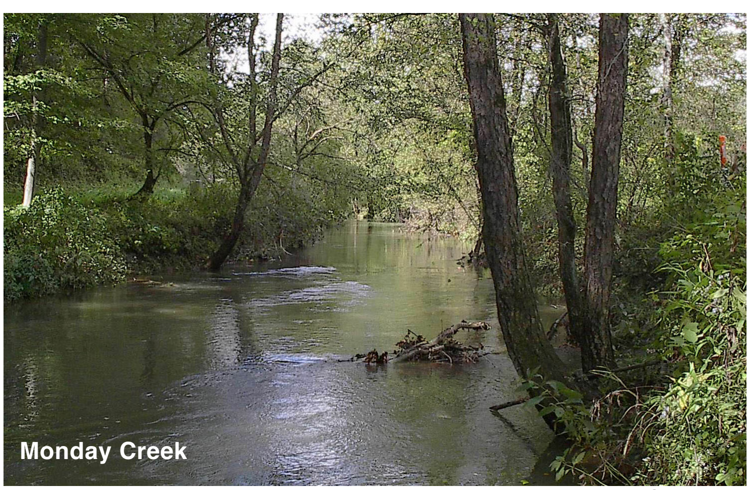
Data derived using the Stoertz Water Quality Evaluation Method (Kruse et al. 2014) (excludes Rock Run Gob Pile Project)

Cost

Design $374,593
(excluding Jobs Doser & Lost Run maintenance and Snake Hollow)

Construction $6,194,830

Total costs through 2013 = $6,569,422


Monday Creek

363,425,000 gallons of stream water per year eliminated from entering into the deep mines as the result of conducting seven stream capture closure projects in Monday creek.

Timeline of the Monday Creek Watershed Project Milestones & AMD Projects

1994	• Formation of Monday Creek Restoration Project
1995	• First stream water quality study on Monday Creek (USFS, CURSML, and USGS) • OSM awarded MCRP an Appalachian Clean Stream Initiative (ACSI) grant for Rock Run
1996	• Ohio EPA awards Monday Creek with a 319 grant for Rock Run
1997	• "Monday Creek Watershed AMDAT Acid Mine Drainage Abatement and Treatment Plan I" published • Ohio EPA awards Ohio University with a 319 to treat mine drainage at Rock Run, Brush Fork and seal a subsidence on Goose Run and at Majestic Mine site • Monday Creek video "Silent Waters: The Story of Monday Creek" is produced
1998	• Grant from CURSML for capping Jobs 13 gob pile
1999	• First Management Plan, "A Comprehensive Plan for the Monday Creek Watershed", published • MCRP Office opened in New Straitsville • OSM awarded ACSI grant for Jobs Hollow doser, Snake Hollow, and Salem Hollow • Mitigation funds from ODOT awarded to MCRP for reclamation in Big Four Hollow • "Monday Creek Watershed Acid Mine Drainage Abatement and Treatment Plan II" published • OSM awarded a Cooperative Agreement for treatment at Rock Run 24
2000	• Ohio EPA awarded a 319 grant for work at Jobs Hollow (Grimmett Site) and Monkey Hollow • MCRP receives Watershed Coordinator Grant
2001	• Wayne National Forest closed subsidences at Orbiston North, Long Hollow, and Essex Mine
2002	
2003	• Jobs 13 gob pile capping is underway. • Video about Monday Creek entitled "Cool Waters" is released

continued on next page

Timeline of the Monday Creek Watershed Project Milestones & AMD Projects (continued)

2004	• Volunteers planted nearly 7,000 Pine on Sunday Creek Coal Company land • Jobs active alkaline doser installed • U.S. Forest Service constructed a series of limestone leach beds and channels in Snake Hollow • Ohio EPA awarded MCRP a 319 grant for work at Lost Run
2005	• U.S. Army Corps of Engineers Civil Works Review Board approves the Monday Creek Feasibility Study for a favorable Chief of Engineers' Report and inclusion in Water Resources Development Act of 2005 (WRDA '05)
2006	• Acid Mine Drainage Abatement and Treatment (AMDAT) Plan III approved • Essex Doser (319 grant) is operational • U.S. Forest Service constructed open limestone channels, closed subsidence and established positive drainage at New Straitsville North area, Monkey Hollow, and Elm Rock area • The MCRP Watershed Management Plan was fully endorsed by the Ohio DNR and Ohio EPA • Lost Run Phase I reclamation and OEPA 319 grant was completed
2007	• Ohio EPA awarded MCRP a 319 grant for construction of a steel slag leach bed at Shawnee • U.S. Forest Service closed subsidences near State Route 216 and Snake Hollow • The Water Resources Development Act of 2007 is approved, Congress authorizied $21 million for ecological restoration of Monday Creek
2008	• U.S. Forest Service completes reclamation in Valley Junk area • ODOT mitigation funds in the amount of $200,000 secured for work at Lost Run Phase 2
2009	• ODOT mitigation funds are in place for work in Big Four Hollow and at Rock Run • U.S. Forest Service completed reclamation work along State Route 278, New Straitsville South area, Lost Run headwaters, Brush Fork, and Coe Hollow. • Ohio DNR completes phase II of Shawnee steel slag leach bed
2010	• U.S. Forest Service closed subsidences along Snow Fork, Rock Run, and New Straitsville South
2011	• U.S. Forest Service closed subsidences in the Cawthorn area • Ohio DNR conducted reclamation and needed maintenance at Rock Run • U.S. Forest Service and ODNR completed reclamation in Sand Run • Ohio DNR completes construction to minimize sediment transport at Big Four Hollow
2012	• 3 limestone leach beds installed in Big Four Hollow. • MCRP, Perry Co. Health Department, Village of New Straitsville and watershed residents installed a community garden in New Straitsville. • Major AMD maintenance projects completed in Lost Run and Jobs Hollow
2013	• Five new fish species found in Monday Creek and the first annual Monday Creek Canoe Float with 54 people in 27 boats!

Monday Creek Projects

Acid mine drainage reclamation projects completed in Monday Creek Watershed:

1999 Rock Run Gob Pile (revamped 2011)

2001 *Rock Run 24*

2003 Grimmett Hollow

2004 Jobs Hollow Doser
Big Four Hollow
Snake Hollow

2006 *Essex Doser*
Lost Run Phase I

2007 Lost Run Phase II
Lost Run Subsidence and Portal Closures

2008 *Shawnee Steel Slag Leach Bed*

2010 Jobs Hollow Doser Maintenance II
Coe Hollow

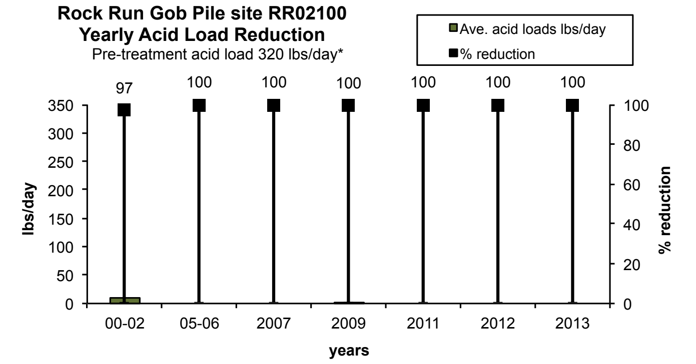
2012 Lost Run II Maintenance
Big Four Hollow LLB

Italicized indicates projects are not actively monitored for acid and metal load reduction purposes

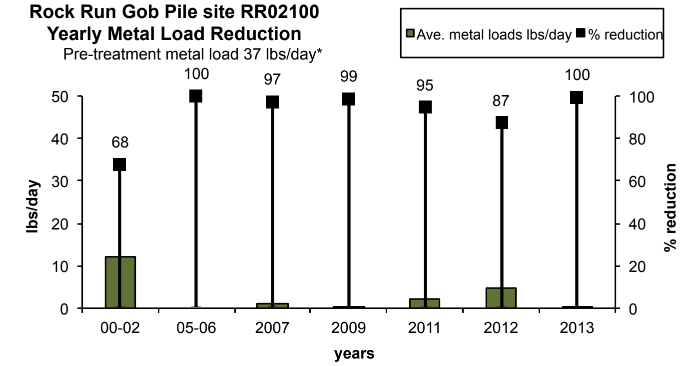
Yearly acid and metal load reduction trends per project

Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, operation and maintenance plans are being designed for each existing system and are planned for future projects. The graphs below show the mean annual acid and metal load reduction using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014) for each year (or group of years) during post-reclamation from the project effluent. From these graphs the rate of decline (and/or improvement) with time of the treatment system is implied. Knowing the rate of decline will aid in the implementation of operation and maintenance plans.

Rock Run Gob Pile site RR02100

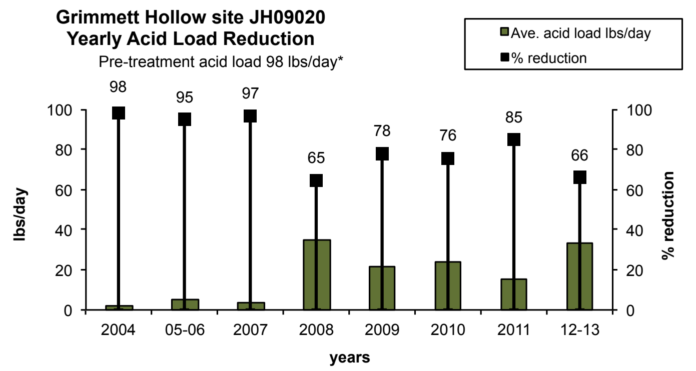


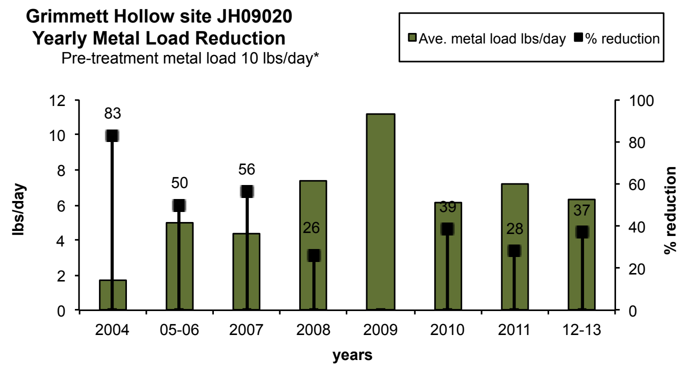
* pre-treatment value based on one sample taken 3/30/1998



* pre-treatment value based on one sample taken 3/30/1998

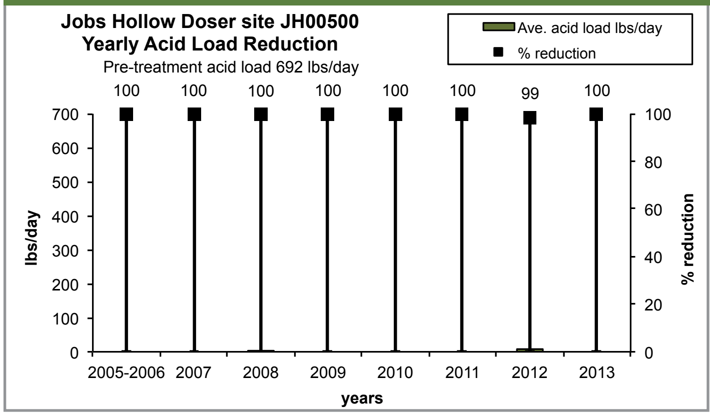
Grimmett Hollow site JH09020

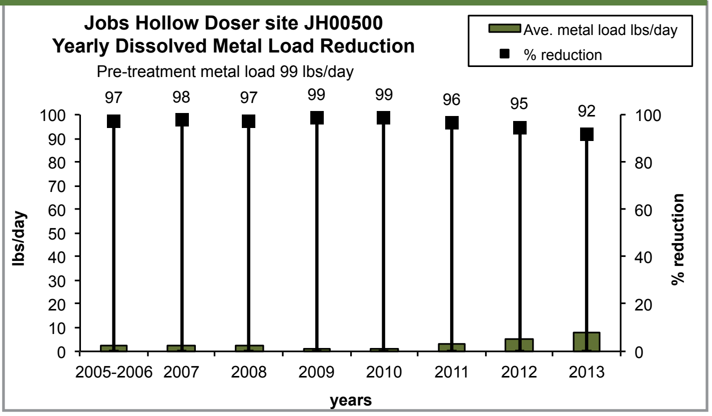




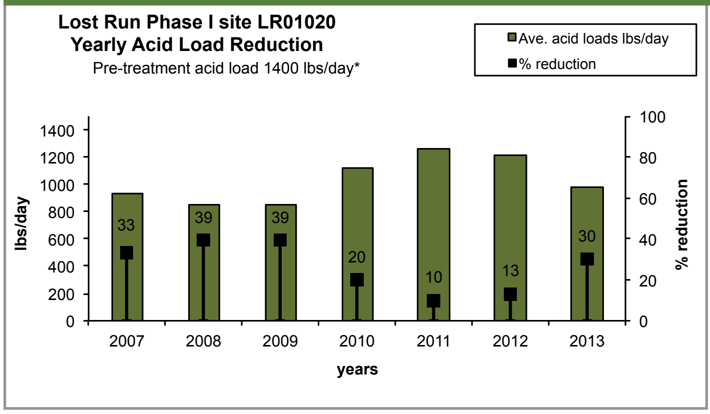
Yearly acid and metal load reduction trends per project

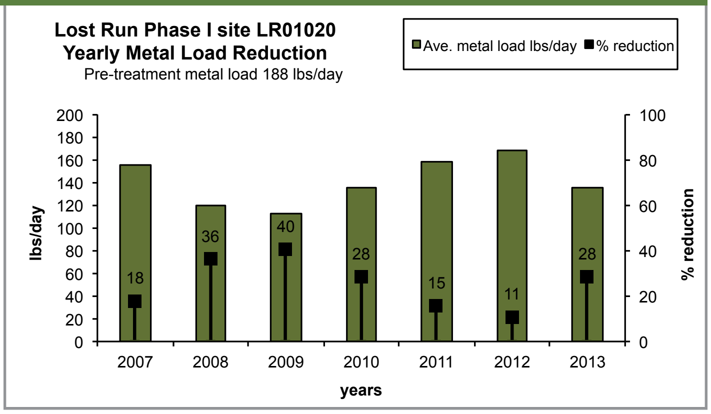
Jobs Hollow Doser site JH00500



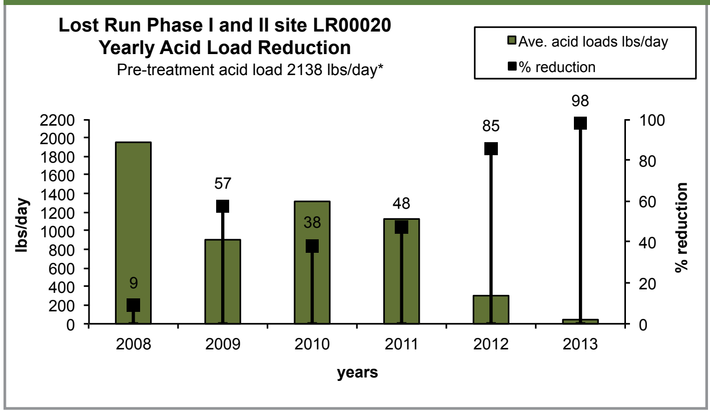


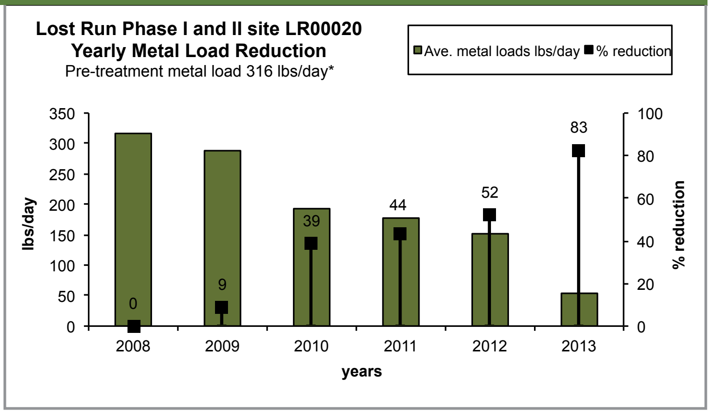
Lost Run Phase I site LR01020





Lost Run Phase I and II site LR00020





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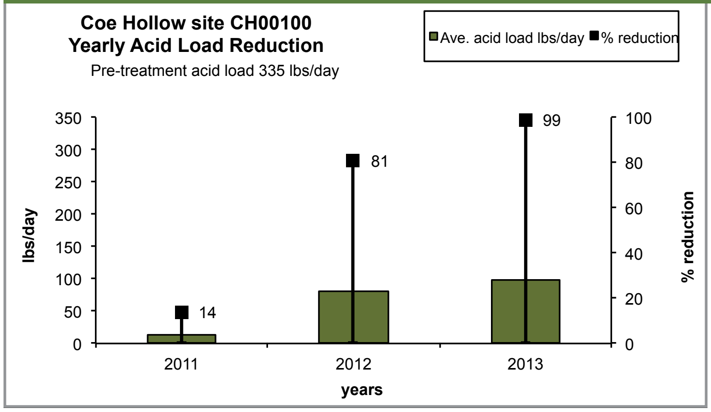
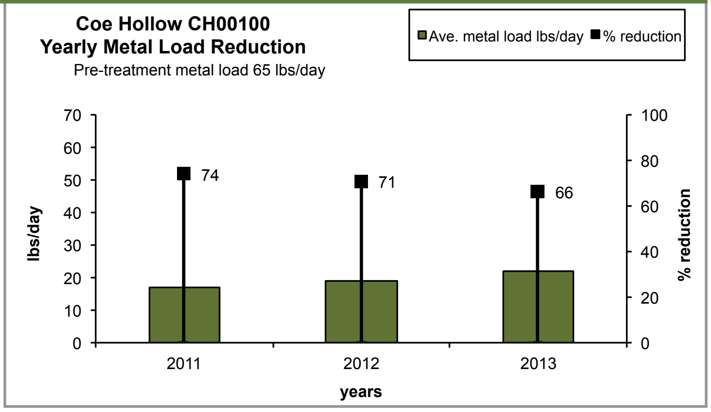
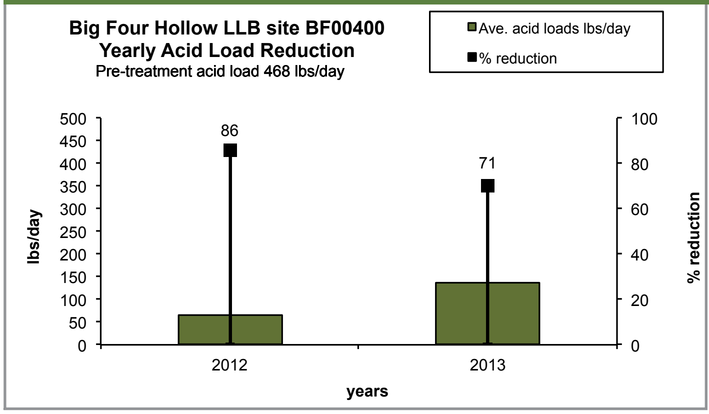
Yearly acid and metal load reduction trends per project

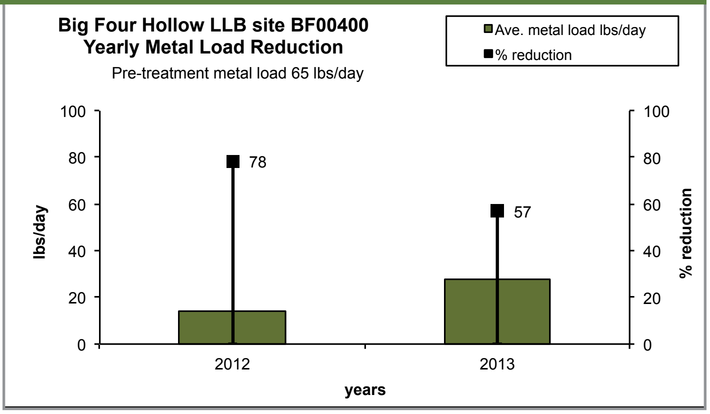
Coe Hollow site CH00100





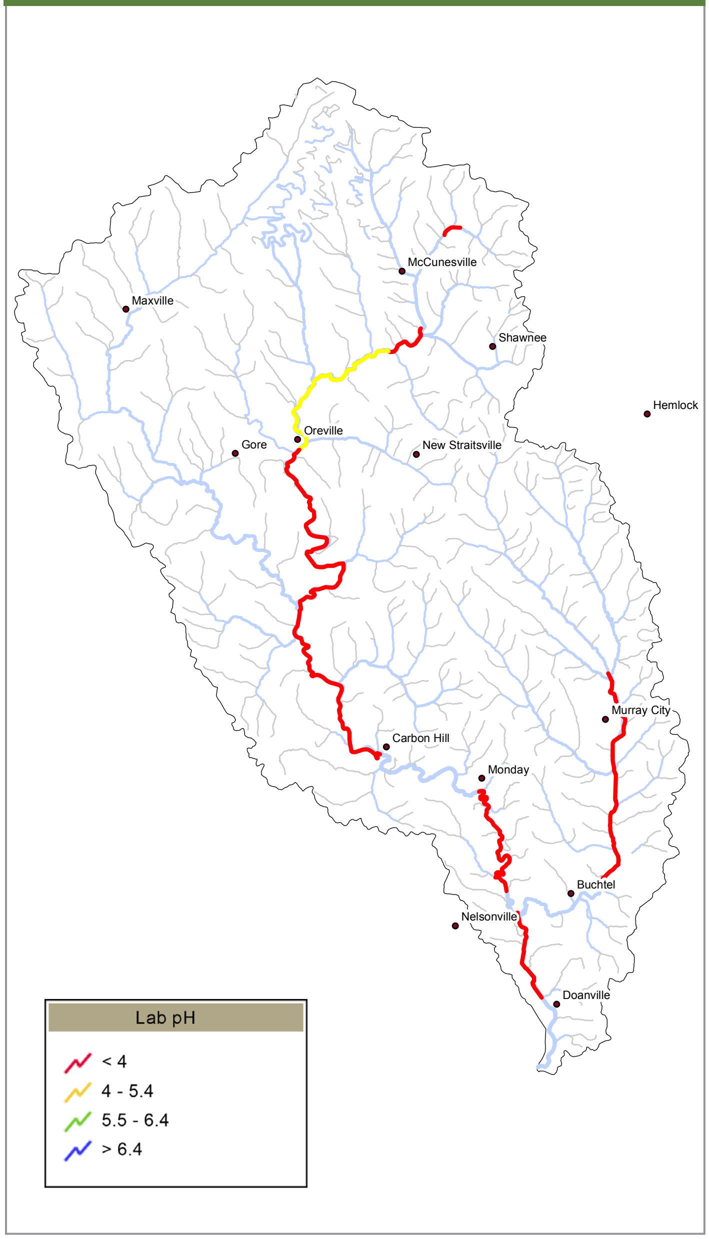
Big Four Hollow LLB site BF00400



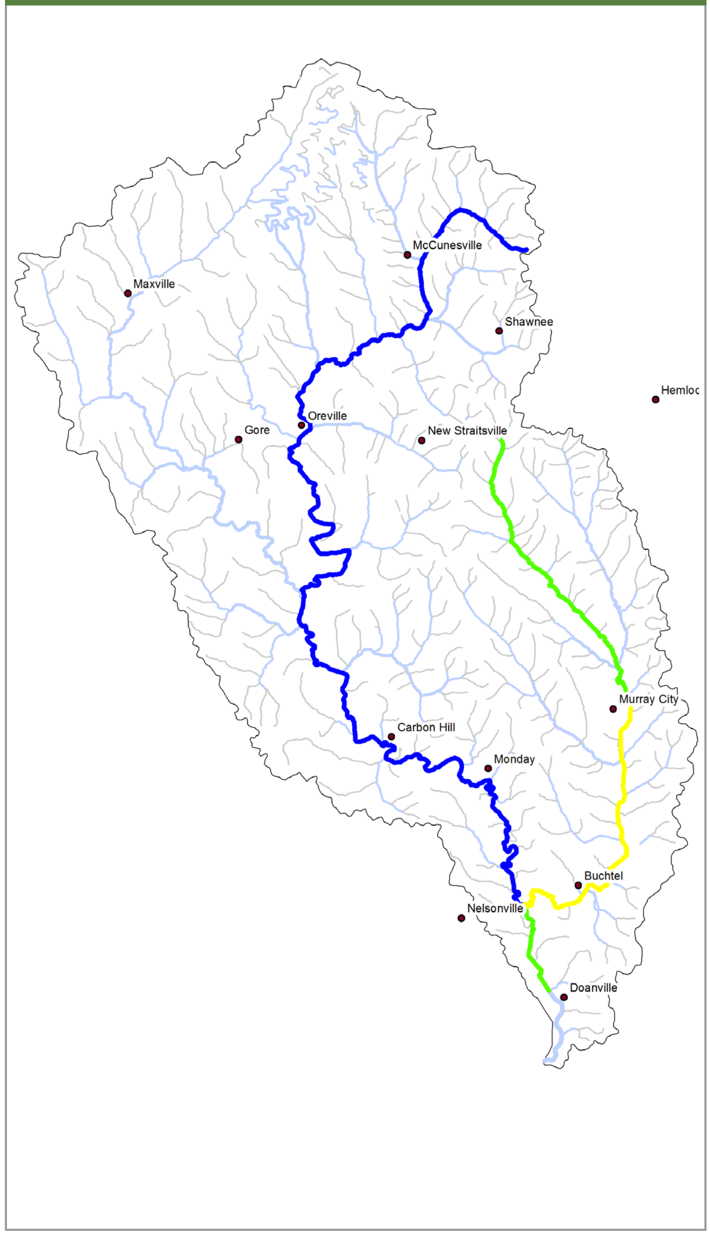


Chemical Water Quality

Monday Creek baseline pH



Monday Creek 2013 pH



In Monday Creek pH values have improved throughout the watershed from baseline conditions (2001) to 2013. From 2001 (32%) to 2013 (75%) there has been 43% increase in the number of stream miles that meet the pH target of 6.5.

2013 NPS Report - Monday Creek Watershed

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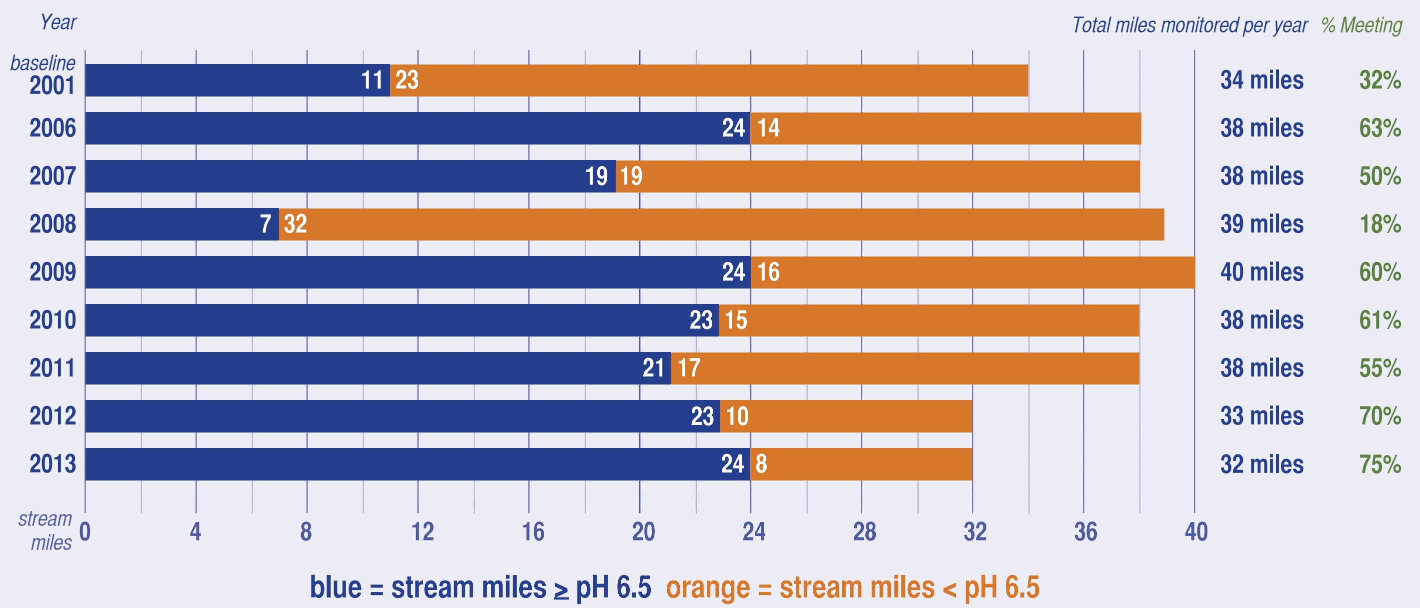
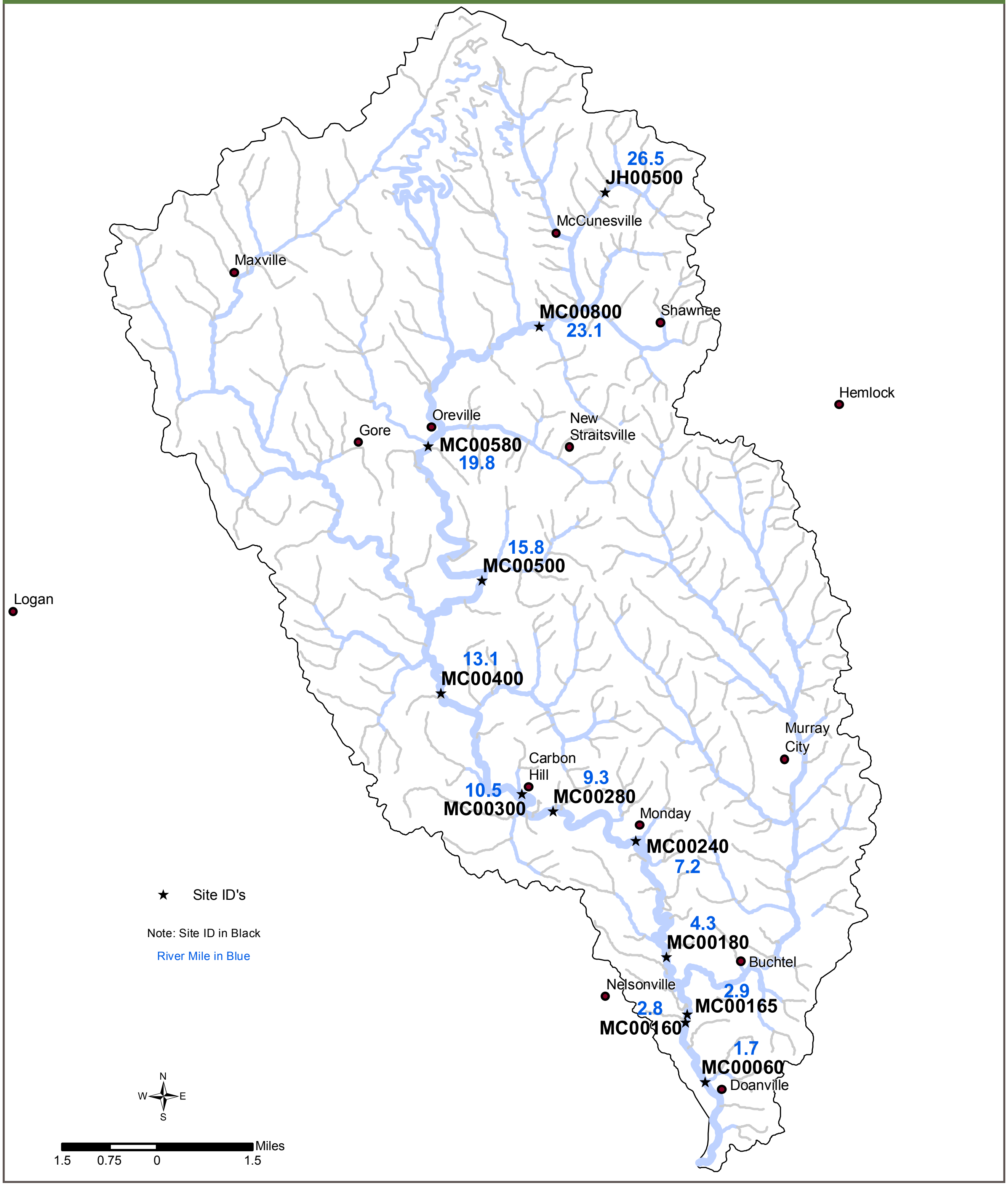
Chemical Water Quality

There are approximately 32 stream miles monitored each year along the mainstem of Monday Creek, 38 when major tributary Snow Fork is included. The restoration target for pH is 6.5. In 2007, 19 stream miles of the 38 monitored met the pH target of 6.5. However in 2008 only 7 miles of the 39 miles monitored met this target. In 2009 and 2010 data shows an increase again with approximately 24 of the 39 miles monitored meeting the pH target. In 2011, the site near Lost Run MC00500 dropped below the pH target with an average pH value of 6.24. In 2012, stream miles meeting the pH target match 2010. The mainstem of Snow Fork, downstream of Essex Doser has been discontinued for monitoring. Site SF00940 represents the five miles missing from the total miles monitored in past years 38 down to 33 (Figure 1). Snow Fork fails to meet the pH target of 6.5 and treatment in this basin is unlikely.

Figure 1. Monday Creek pH



Monday Creek

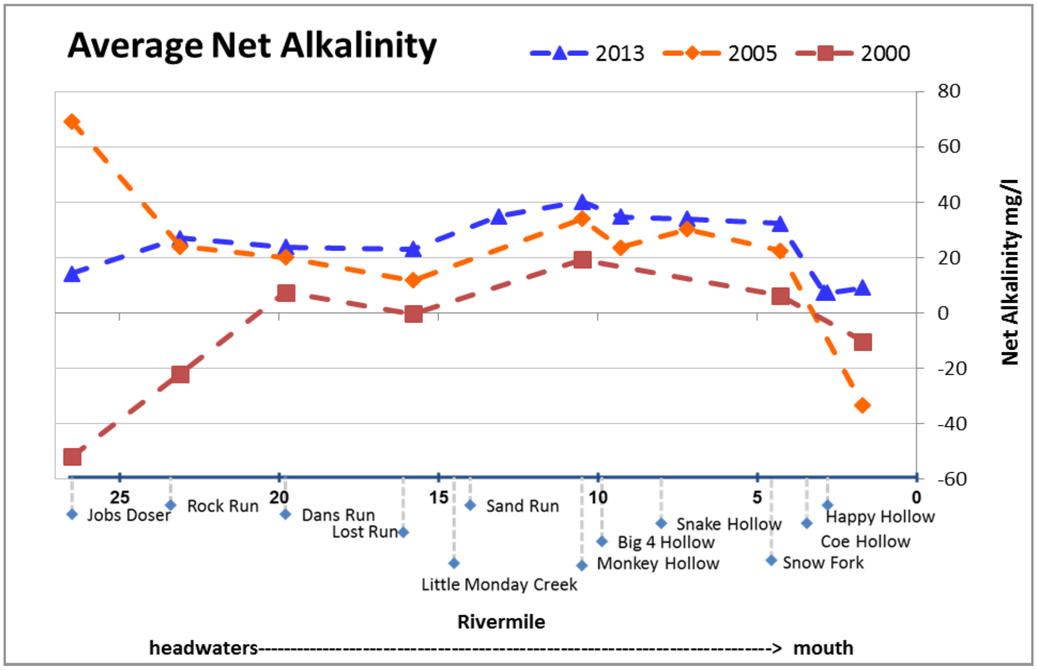


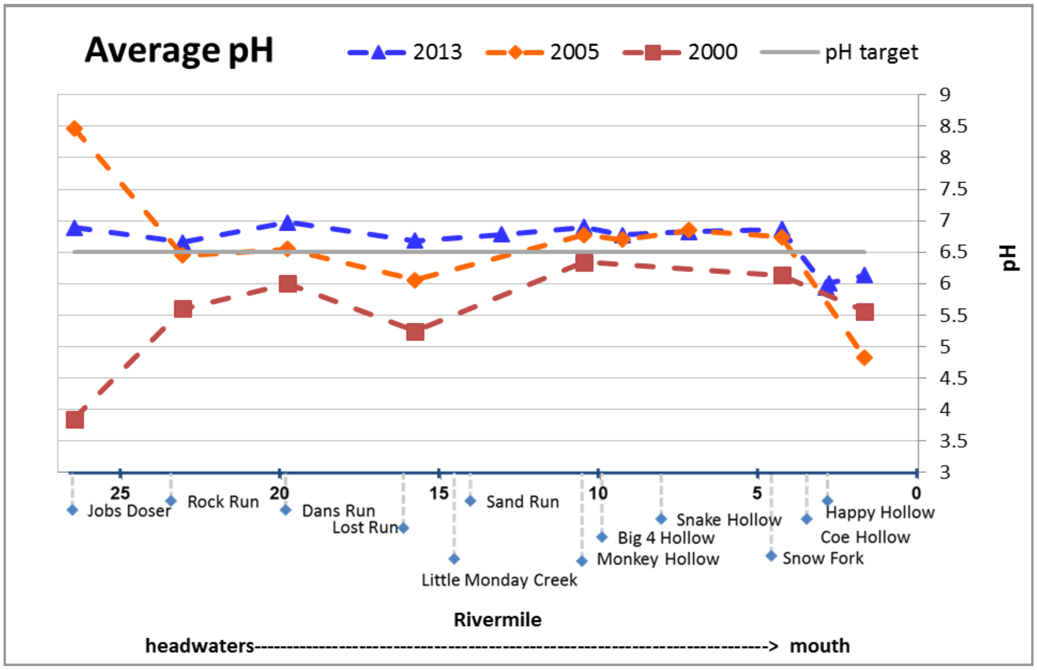
Chemical water quality analysis per stream reach

Chemical water quality changes along the mainstem of Monday Creek are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown below.

Monday Creek Mainstem

Site ID	JH00500	MC00800	MC00580	MC00500	MC00400	MC00300	MC00280	MC00240	MC00180	MC00165	MC00160	MC00060
Rivermile	26.5	23.1	19.8	15.8	13.1	10.5	9.3	7.2	4.3	2.9	2.8	1.7





2013 NPS Report - Monday Creek Watershed

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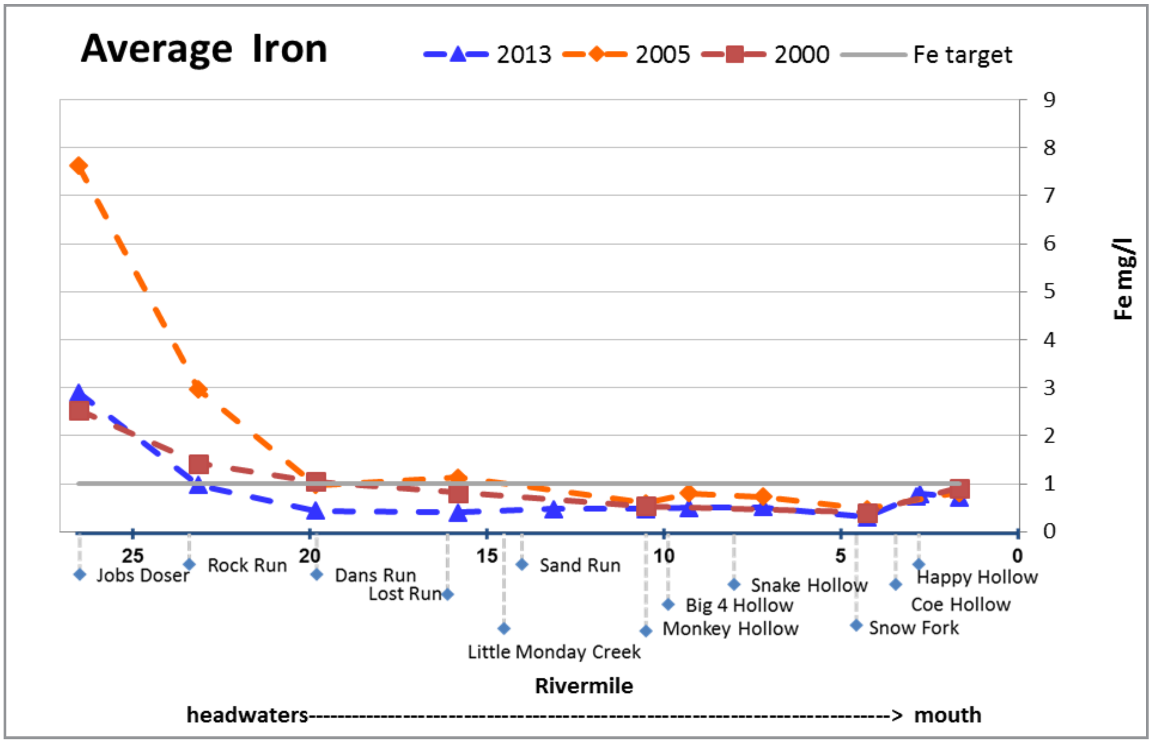
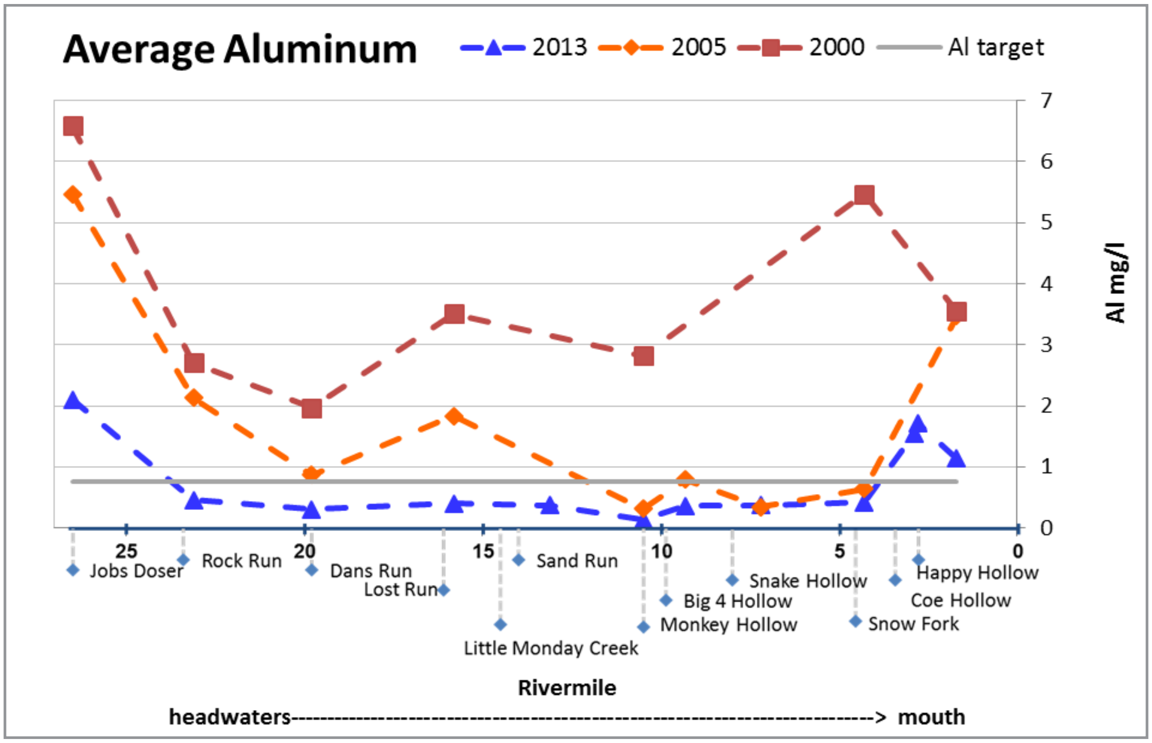
Chemical water quality analysis per stream reach

Monday Creek Mainstem

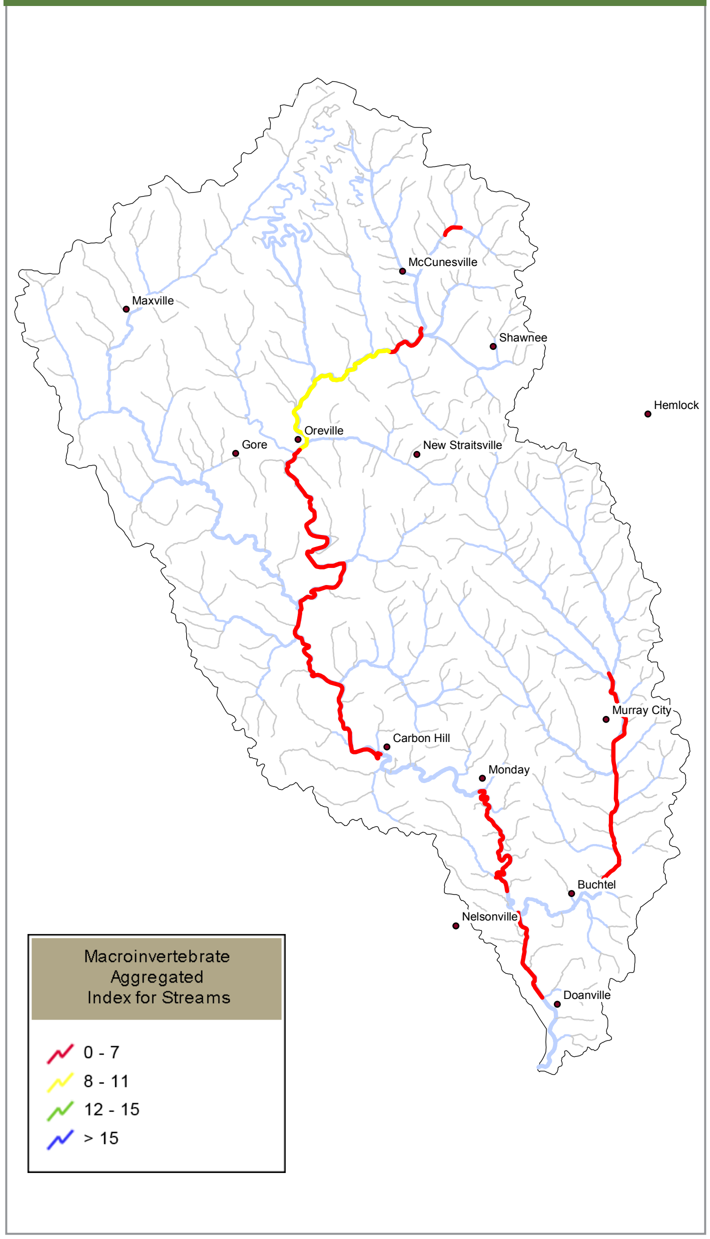
Site ID	JH00500	MC00800	MC00580	MC00500	MC00400	MC00300	MC00280	MC00240	MC00180	MC00165	MC00160	MC00060
Rivermile	26.5	23.1	19.8	15.8	13.1	10.5	9.3	7.2	4.3	2.9	2.8	1.7



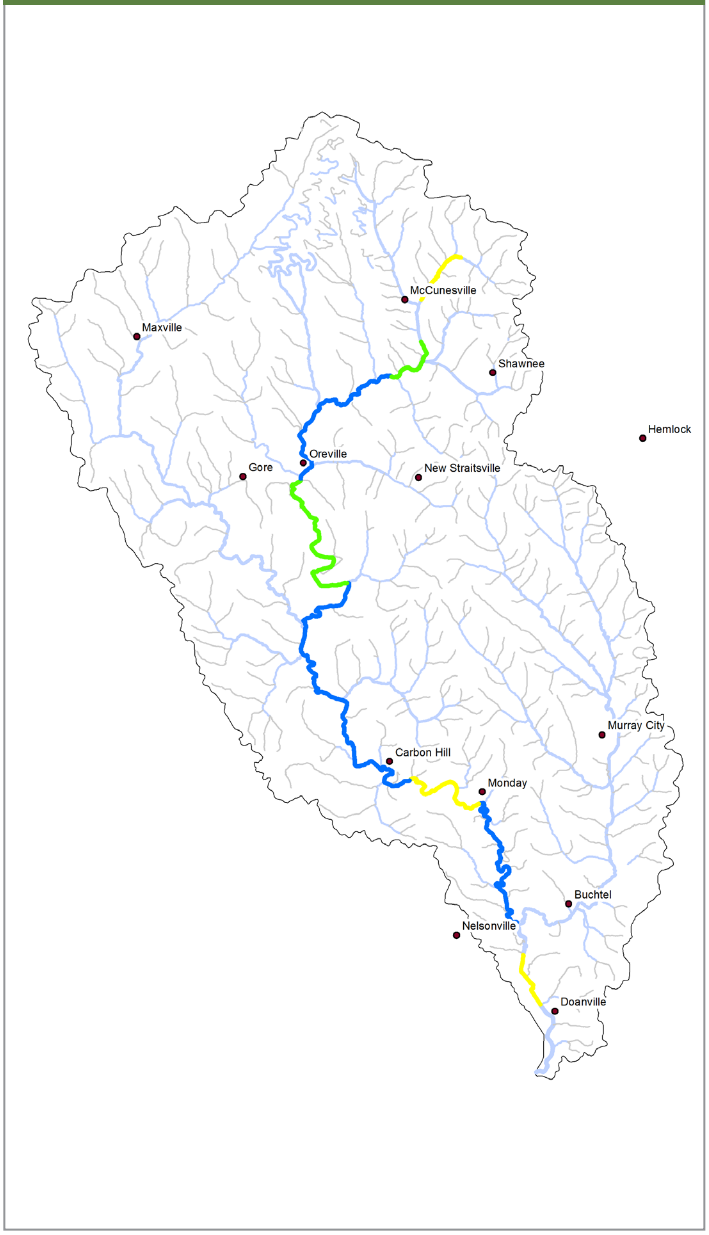


Biological Water Quality

Monday Creek baseline MAIS



Monday Creek 2013 MAIS

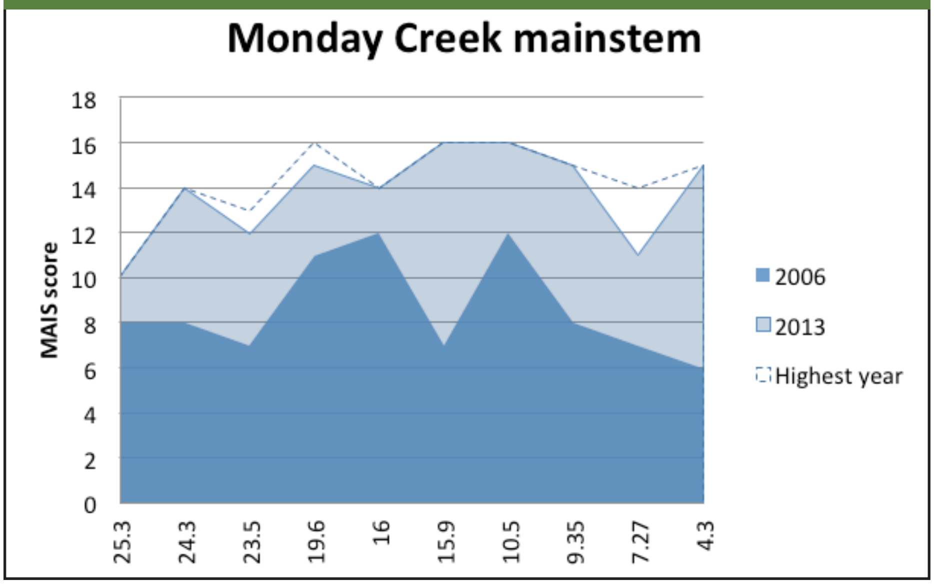


MAIS samples were collected throughout Monday Creek at established annual monitoring stations from 2001 through 2013.

Biological Water Quality

The majority of long-term monitoring sites along the Monday Creek mainstem have shown steady improvements in biological quality over the last ten years (Figures 2 and 3). By 2013, nine of ten sites show statistically significant ($P < 0.05$) improvements in biological scores since 2006. Sites in the upper most half of the watershed (RM 25.3 to 16) have consistently achieved their highest scores over the past few years. This was another good year for Monday Creek, with four sites in the watershed earning new high scores and notable improvements in the lower portion (downstream for RM 9.35). The two lowermost sites on the mainstem showed particularly strong improvement in 2013 compared to 2012, perhaps from cumulative improvements in water quality upstream and a good flow year.

Figure 2. Area of Degradation

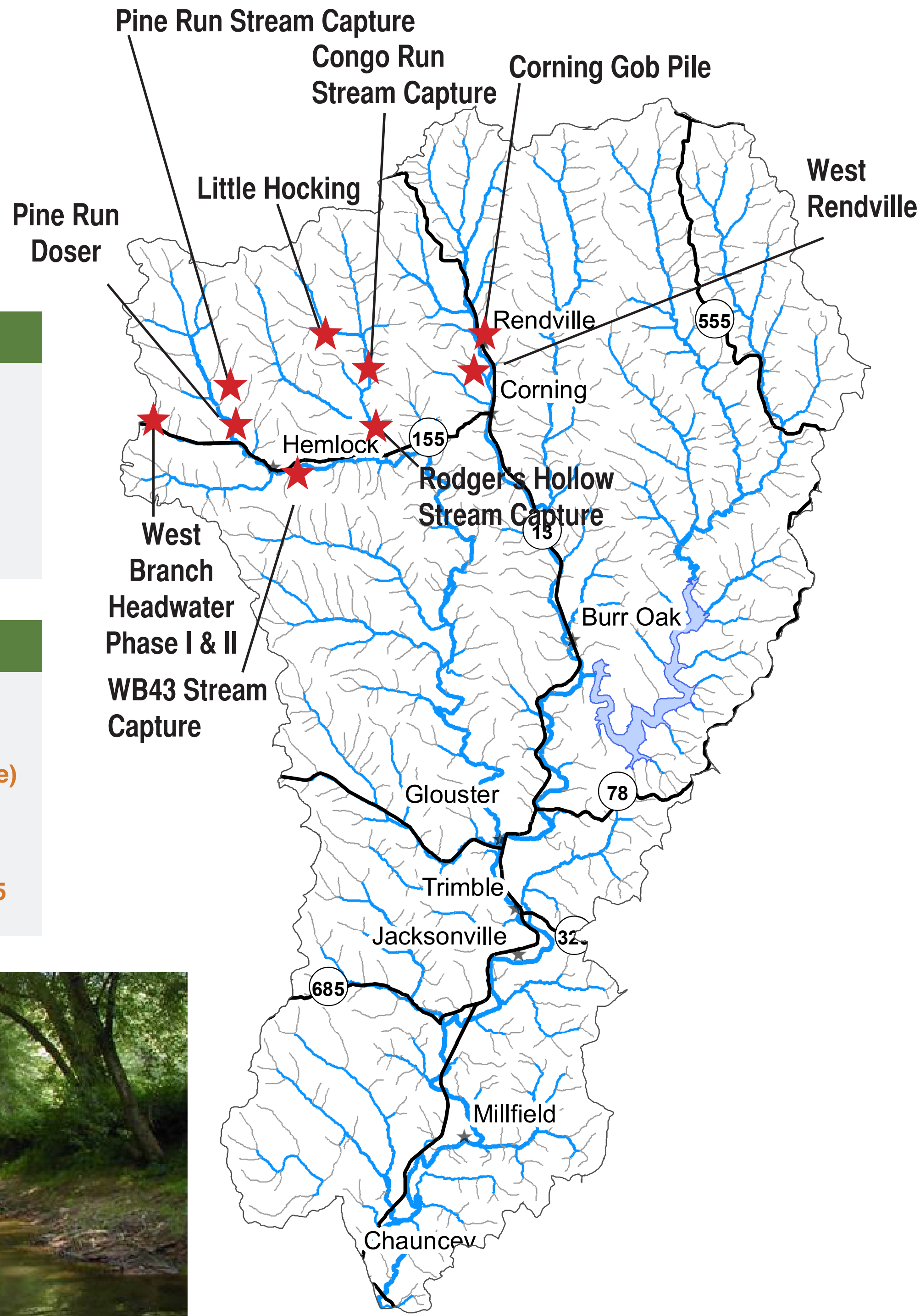


The blue dashed line identifies the highest MAIS score ever achieved at that site throughout the monitoring time period.

Figure 3. Monday Creek MAIS Regressions

RM	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	Linear trend	R square	p-value	No. of years
JH00500	4	6	4	7	6	5	4	7	8	9	11	10	**improved**	0.600	0.014	12
25.3				7	8	7	4	9	6	10	10	10	no change	0.323	0.110	9
24.3				6	8	12	12	11	11	12	12	14	**improved**	0.657	0.008	9
23.5	5	3	1	11	7	9	12	7	13	11	13	12	**improved**	0.647	0.002	12
19.6	8	9	10	13	11	12	12	13	16	14	16	15	**improved**	0.850	0.0001	12
16	2	6	6		12	11	10	10	10		14	14	**improved**	0.802	0.0005	12
15.8					7	8		5			15	16	**somewhat imp.**	0.724	0.067	8
10.5	5	10	13	13	12	14		12	16	16	15	16	**improved**	0.674	0.001	12
9.4					8	9	10	9	14	12	10	15	**improved**	0.560	0.033	8
7.3				8	7	7	8	10	14	10	8	11	no change	0.292	0.133	9
4.3	2	6	2	8	6	9	7	4	13	9	9	15	**improved**	0.578	0.004	12

SUNDAY CREEK
WATERSHED REPORT



Reductions

Total acid load reduction 2013 = 369

Total metal load reduction 2013 = 96

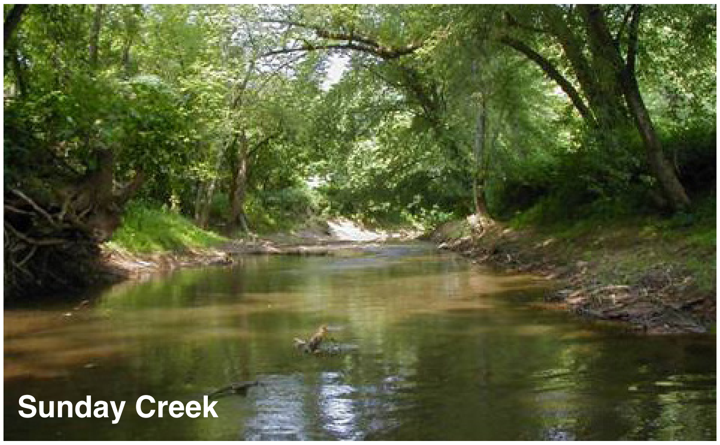
Data derived using the Stoertz Water Quality Evaluation Method (Kruse et al. 2014)

Costs

Design = $491,759
(excluding Congo Run CR-15 & Pine Run Stream Capture maintenance)

Construction = $1,963,686

Total costs through 2013 = $2,455,445


Sunday Creek

Six stream captures located in the Sunday Creek Watershed were closed and completed from 2004-2011. A total of 2,401 acres surface drainage area drained year round into the deep mines and, as a result of closing these subsidence holes, 884,021,000 gallons per year were diverted from entering into the deep mine, thus abating the generation of acid mine drainage. Expected additional alkaline loading from these closures returning clean water to the receiving streams is 986 lbs/day. As result of the Rodgers Hollow Subsidence closure, the deep mine discharge in Drakes has seen a reduction in acidity load by 18 lbs/day.

Timeline of the Sunday Creek Watershed Project Milestones and AMD Projects

1999	• Sunday Creek Watershed Group (SCWG) Founded
2000	
2001	• Rural Action adds VISTA volunteer to SCWG staff
2002	• SCWG Hired First Watershed Coordinator, funded for six years
2003	• Sunday Creek Watershed AMDAT Completed • SCWG Watershed Action Plan Conditionally Endorsed by the State of Ohio
2004	• Congo Subsidence/ Stream Capture Project Completed
2005	• Sunday Creek Watershed TMDL Study Completed
2006	• SCWG Coordinator funded three more years
2007	• Pine Run Stream Capture Project Completed • Rodger's Hollow Stream Capture Project Completed • Corning Gob Pile Reclamation Project Completed
2008	
2009	• Congo Run (CR-11/ Little Hocking) Stream Capture Project Completed • SCWG Coordinator funded for three more years • Rural Action adds AmeriCorps member to SCWG staff
2010	• West Branch Headwaters Phase I Project Completed • West Branch 43 Stream Capture Project Completed
2011	• SCWG Watershed Action Plan Officially Endorsed by the State of Ohio • West Branch Headwaters Phase II Project Completed • West Rendville Stream Capture Project Completed
2012	
2013	• Pine Run Doser installed

Sunday Creek Projects

Acid mine drainage reclamation projects completed in Sunday Creek Watershed:

2004 *Congo Stream Capture*

2007 *Pine Run Stream Capture*

Corning Gob Floodplain

Rodger's Hollow Stream Capture

2009 *Little Hocking Stream Capture CR 11*

2010 *West Branch 43 Stream Capture*

Pine Run Stream Capture Maintenance

West Branch Sunday Creek Headwaters Phase I & II

2011 *West Rendville Stream Capture*

2013 Pine Run Doser

Italicized indicates projects are not actively monitored for acid and metal load reduction purposes

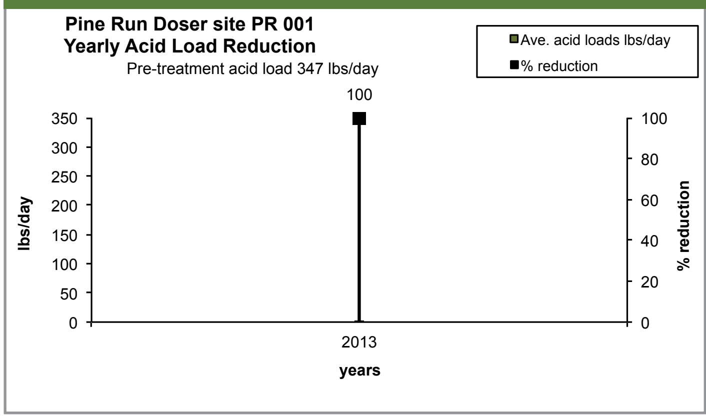
Most of the remediation in Sunday Creek consists of source control (i.e. stream capture, gob pile capping, etc…) and aren't actively monitored for acid and metal load reductions. Therefore target restoration sites along the West Branch of Sunday Creek mainstem have been selected to analyze the acid and metal load reductions, these sites include:

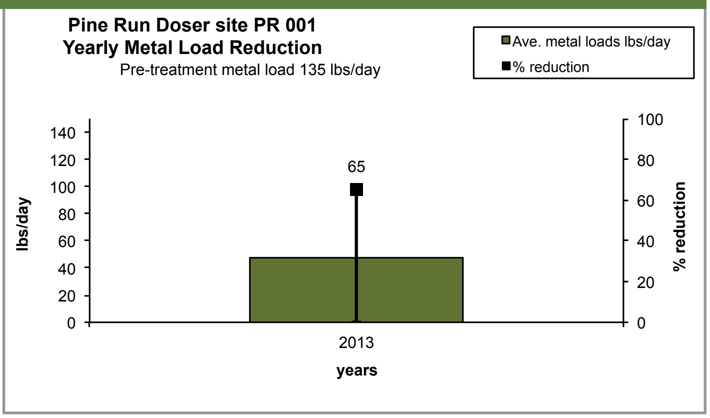
WBHW 03, WB 51, and WB 002. Yearly load reductions for these mainstem sites are shown on the next few pages.

Yearly acid and metal load reduction trends per project

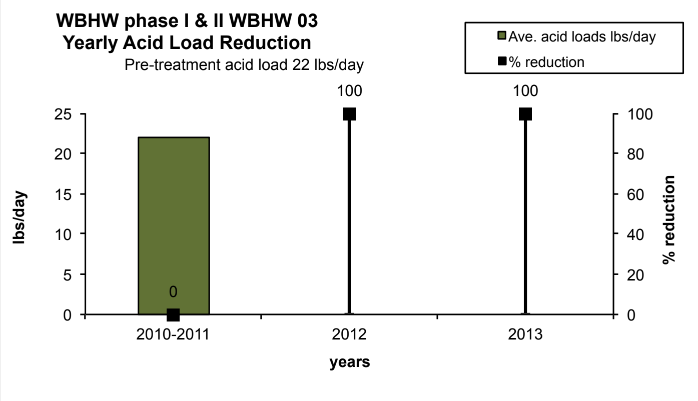
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, operation and maintenance plans are being designed for each existing system and are planned for future projects. The graphs below show the mean annual acid and metal load reduction using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014) for each year (or group of years) during post-reclamation from the project effluent. From these graphs the rate of decline (and/or improvement) with time of the treatment system is implied. Knowing the rate of decline will aid in the implementation of operation and maintenance plans.

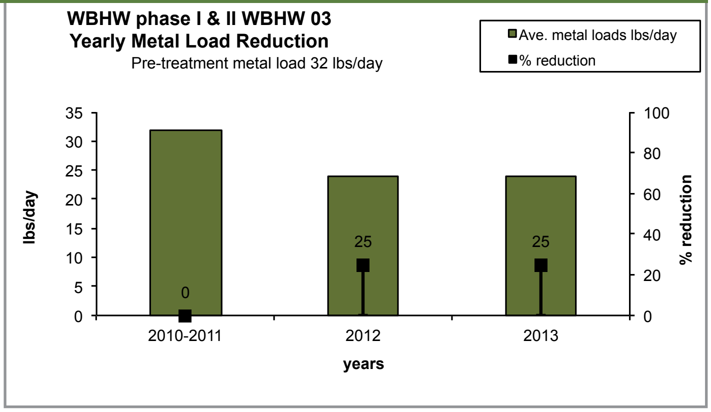
Pine Run Doser site PR001





WBHW phase I & II site WBHW 03





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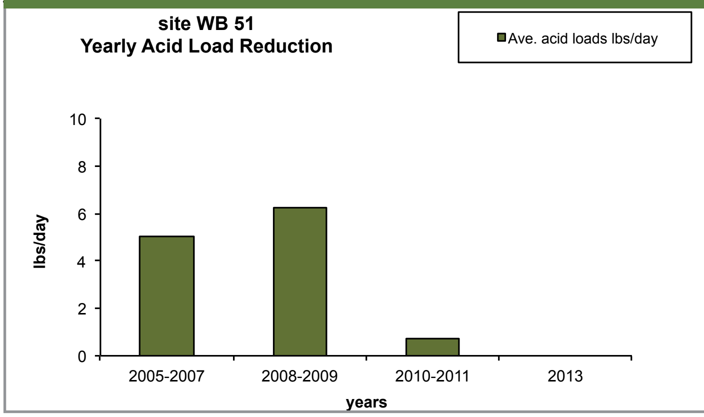
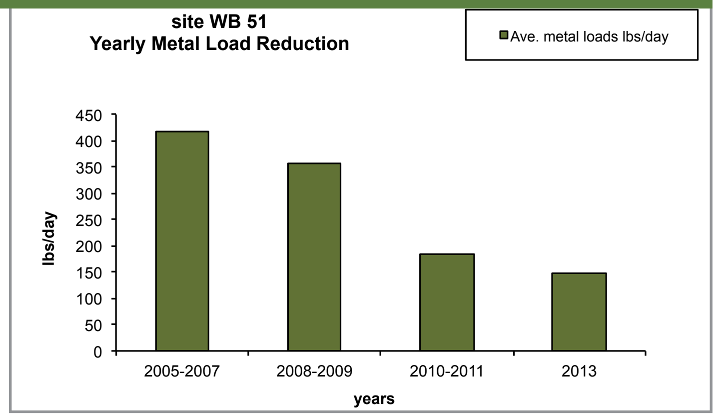
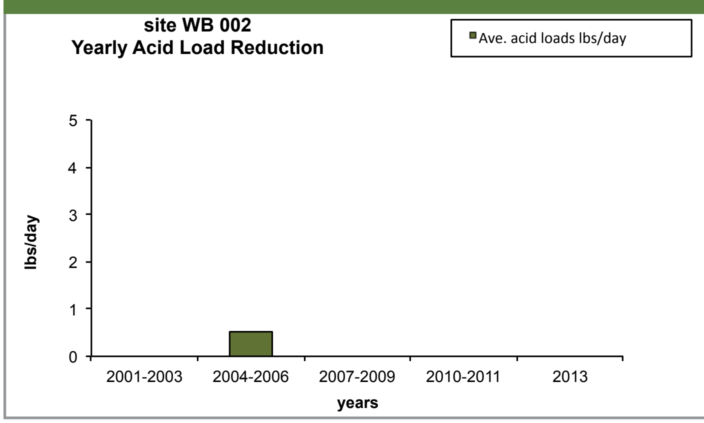
Yearly acid and metal load reduction trends per project

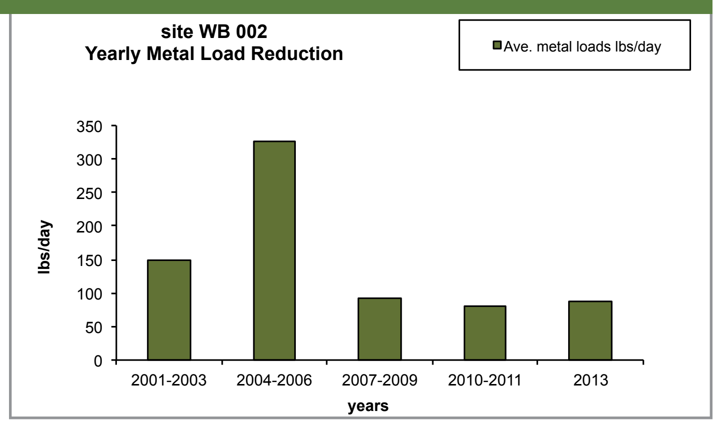
Site WB 51





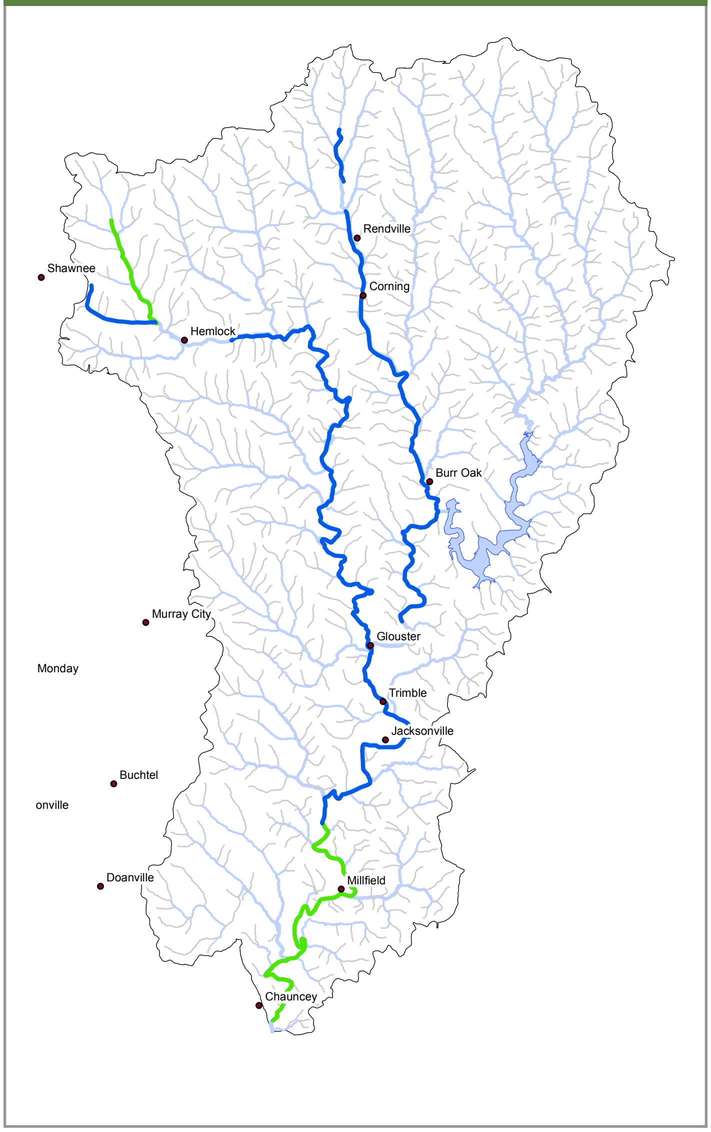
Site WB 002



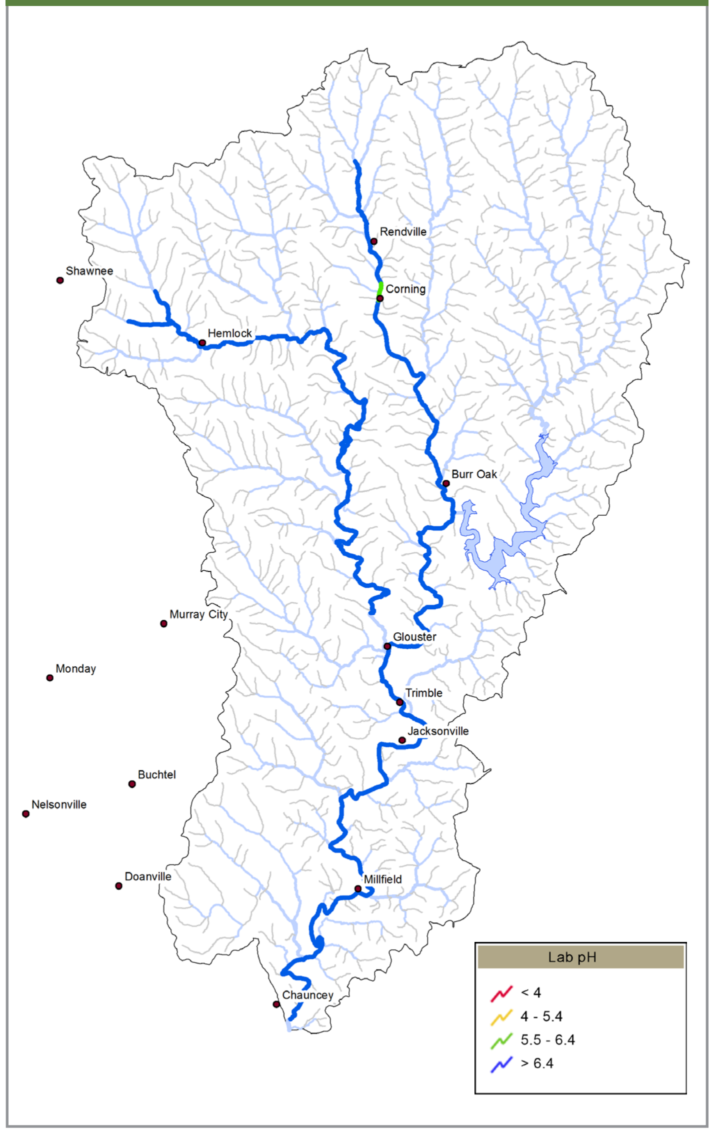


Chemical Water Quality

Sunday Creek baseline pH



Sunday Creek 2013 pH

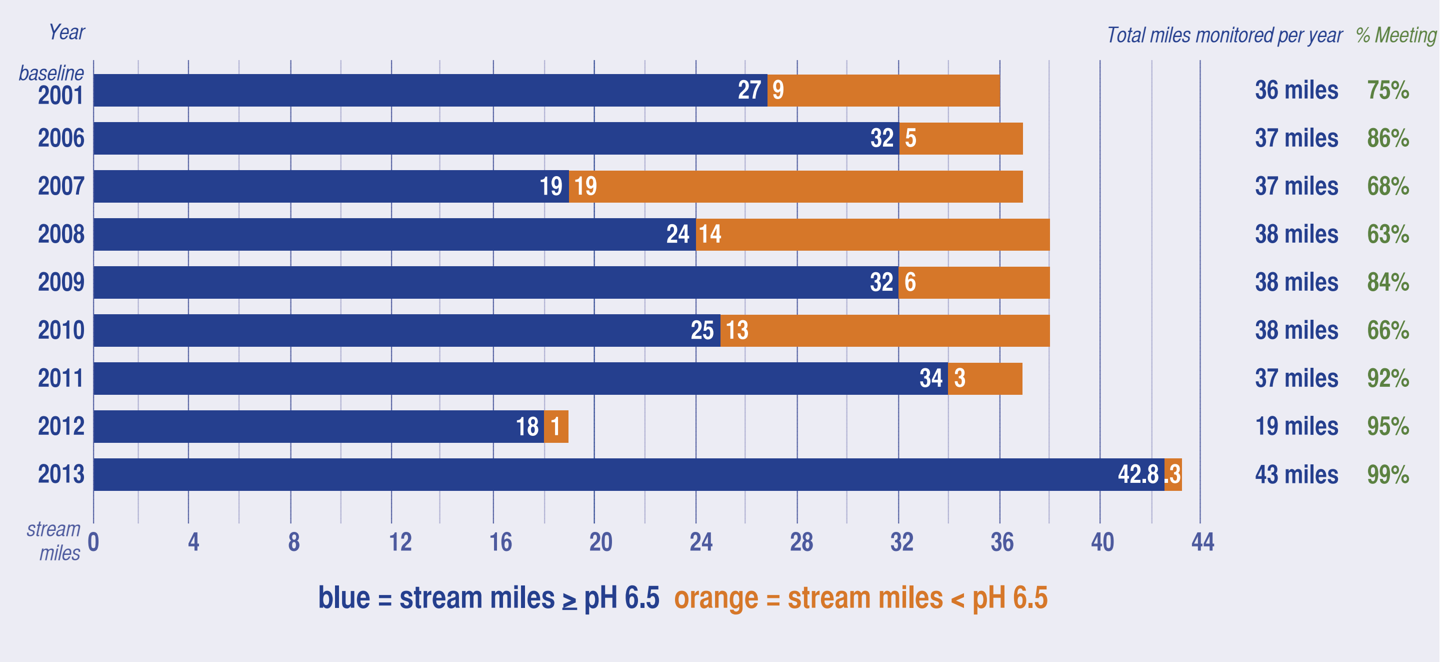


Water quality along the West Branch of Sunday Creek was degraded from baseline conditions in 2001 to 2007. Values of average pH dropped from >6.4 to 4.0-5.4 range in 2005 to 2006 and remained constant in 2007. When the subsidence features increased in Rodger's Hollow, funneling more water into the mine that generated AMD and discharged it into West Branch of Sunday Creek, the water quality decreased. However, after the subsidence closure in Rodger's Hollow in late 2007, in 2008 data for the first time shows an increase in pH along this stream segment. As of 2013 all sites met the pH target of 6.5 except for a small section of a stream directly downstream of the Corning discharge.

Chemical Water Quality

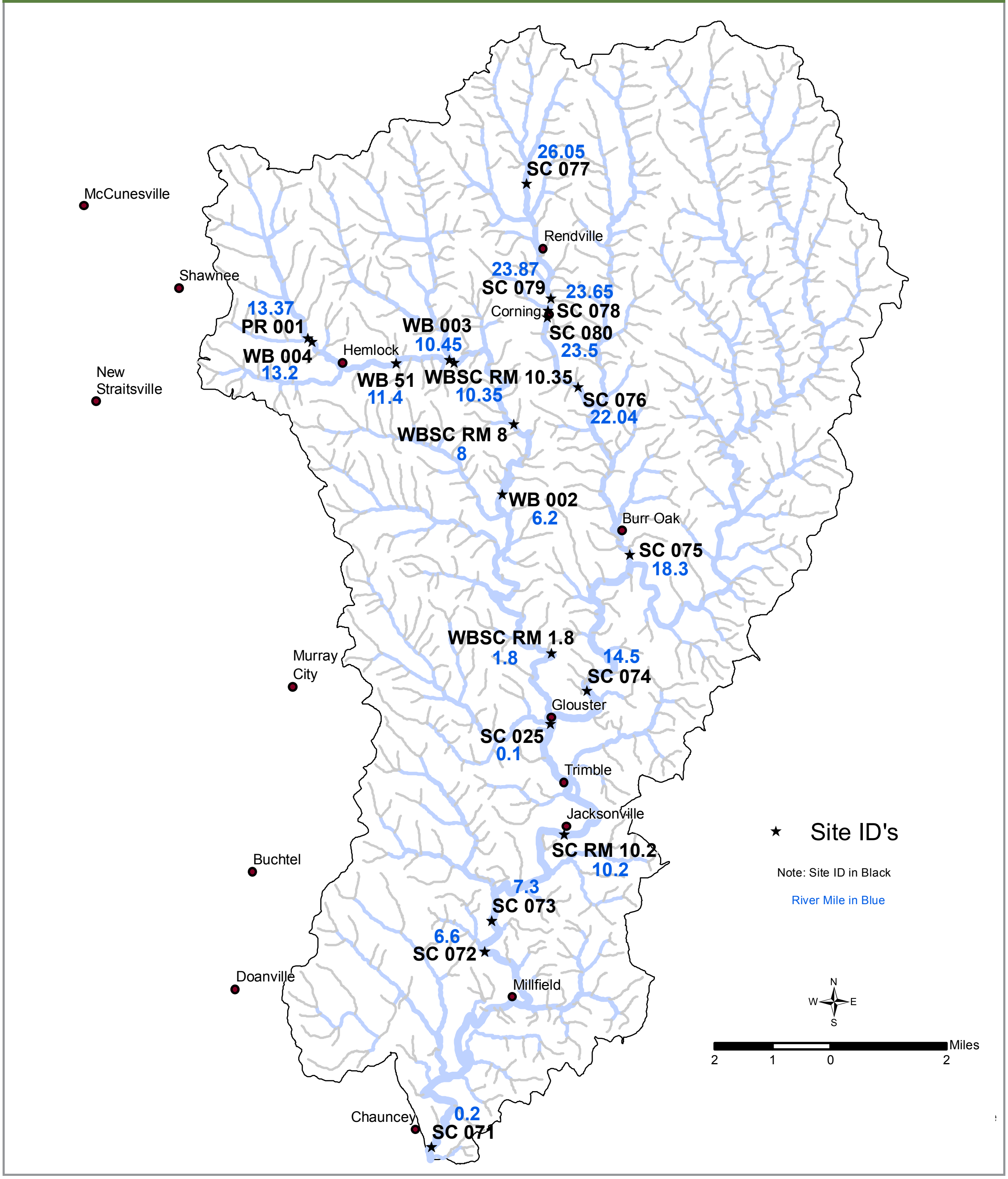
There are approximately 38 stream miles monitored each year along the mainstem of Sunday Creek and major tributary West Branch. A restoration target for pH has been set to 6.5. Since 2001 there have been fluctuations in the number of stream miles that meet this target. Currently, in 2013 all 42 miles of stream miles monitored meet the pH target.

Sunday Creek pH



Chemical water quality analysis per stream reach

Sunday Creek

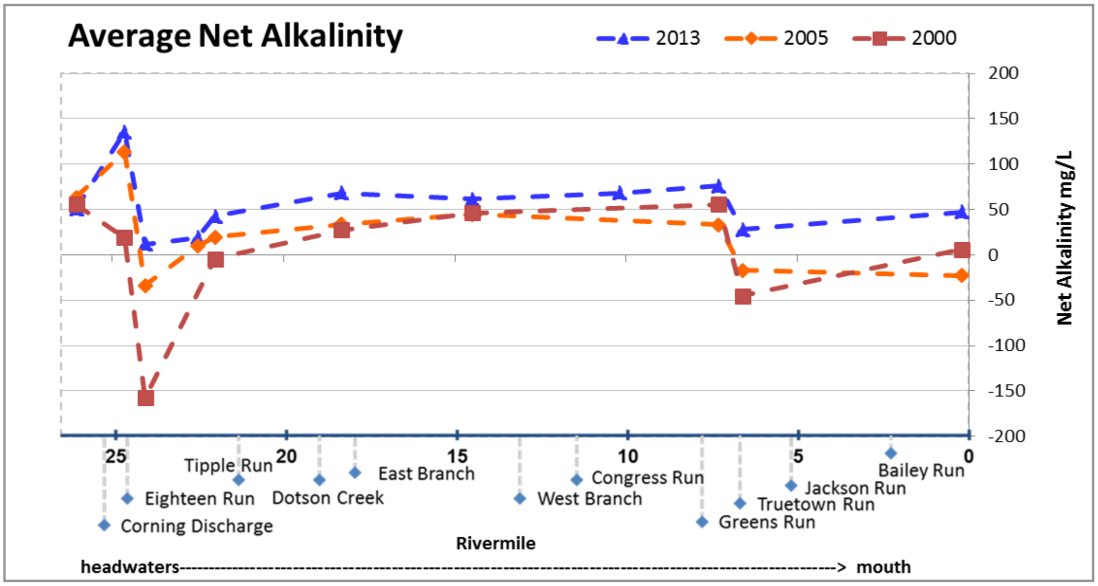


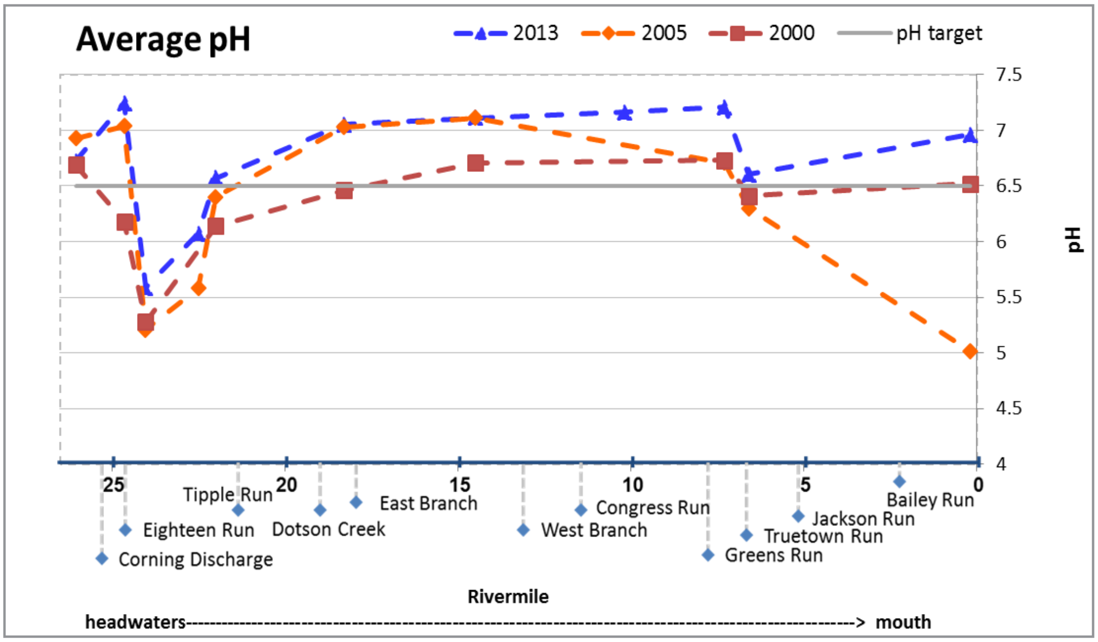
Chemical water quality analysis per stream reach

For purposes of analyzing chemical water quality changes along the mainstem of receiving stream where AMD reclamation projects have been completed, Sunday Creek has been divided into the following stream segments: Sunday Creek Mainstem and West Branch of Sunday Creek. Within these stream reaches, chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown before each set of stream reach graphs.

Sunday Creek Mainstem

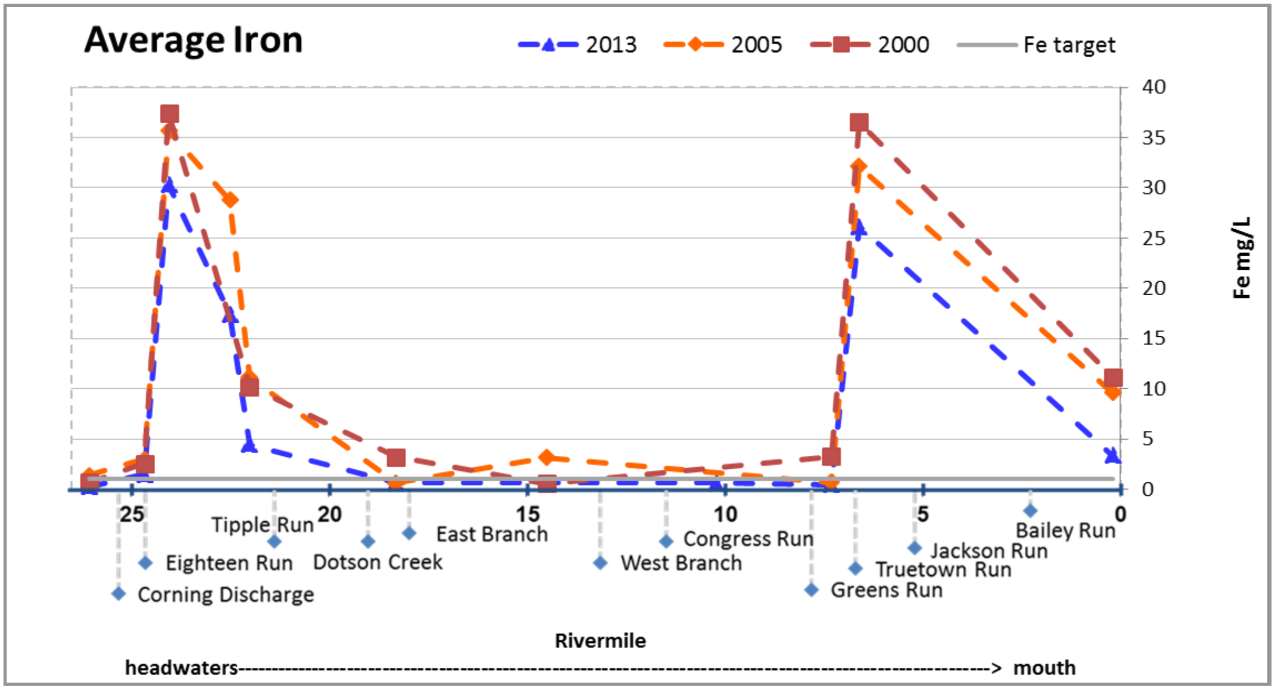
Site ID	SC 077	SC 079	SC 078	SC 080	SC 076	SC 075	SC 075	SC 074	SC 073	SC 072	SC 071
Rivermile	26.05	23.87	23.65	23.5	22.04	18.3	18.3	14.5	7.3	6.6	0.2

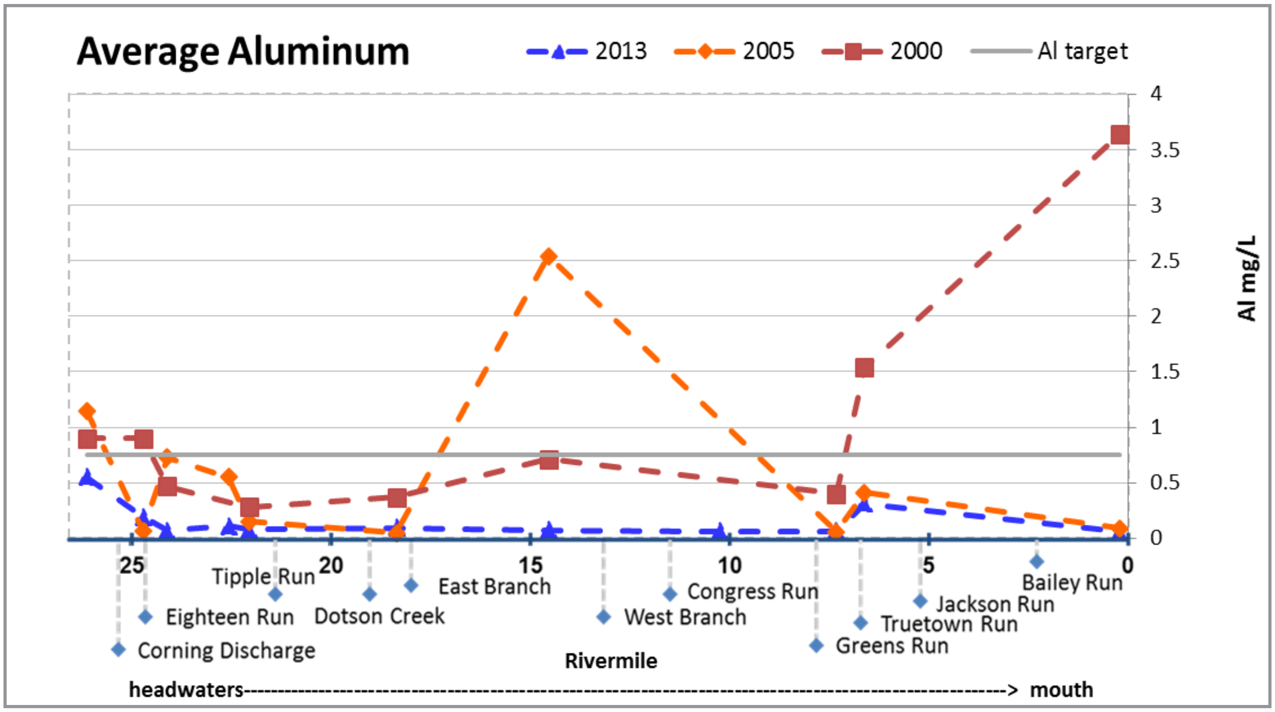




Chemical water quality analysis per stream reach

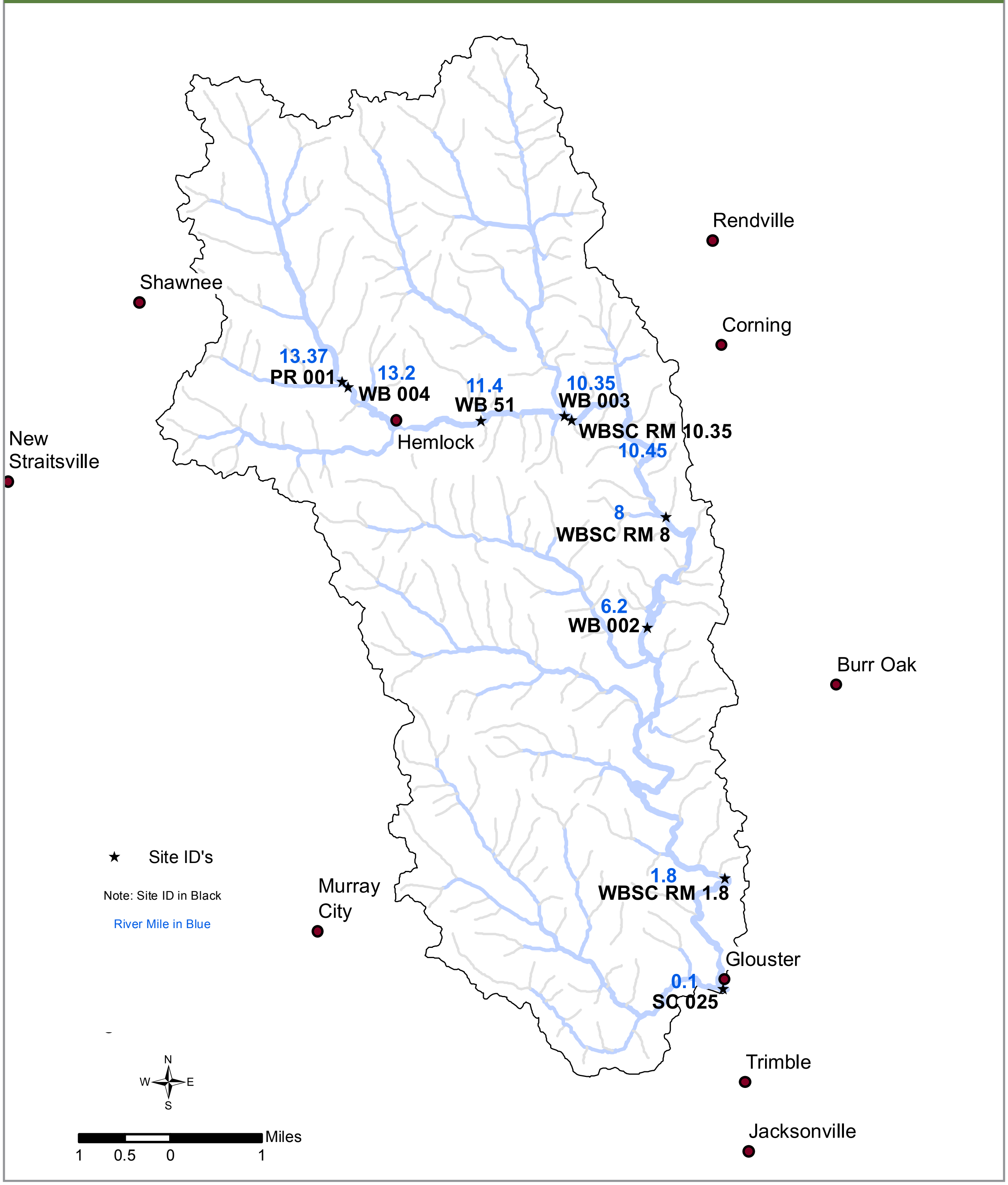
Sunday Creek Mainstem										
Site ID	SC 077	SC 079	SC 078	SC 080	SC 076	SC 075	SC 074	SC 073	SC 072	SC 071
Rivermile	26.05	24.65	24.04	22.5	22	18.3	14.5	7.3	6.6	0.2





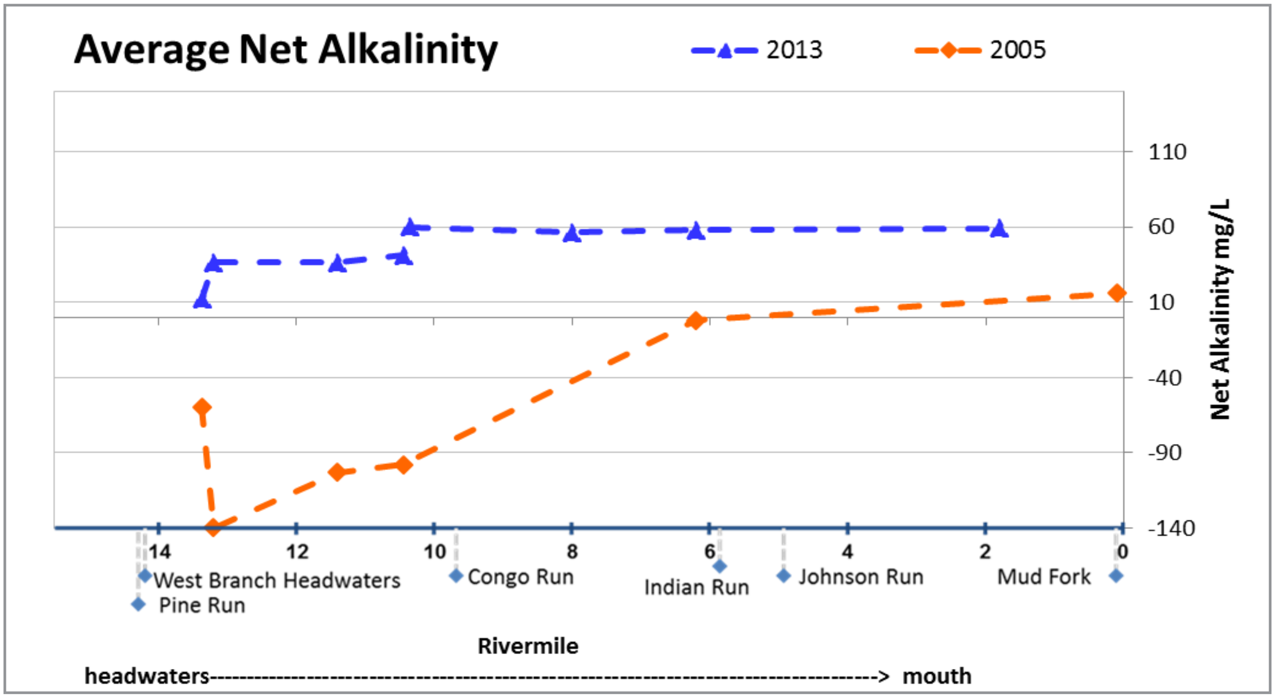
Chemical water quality analysis per stream reach

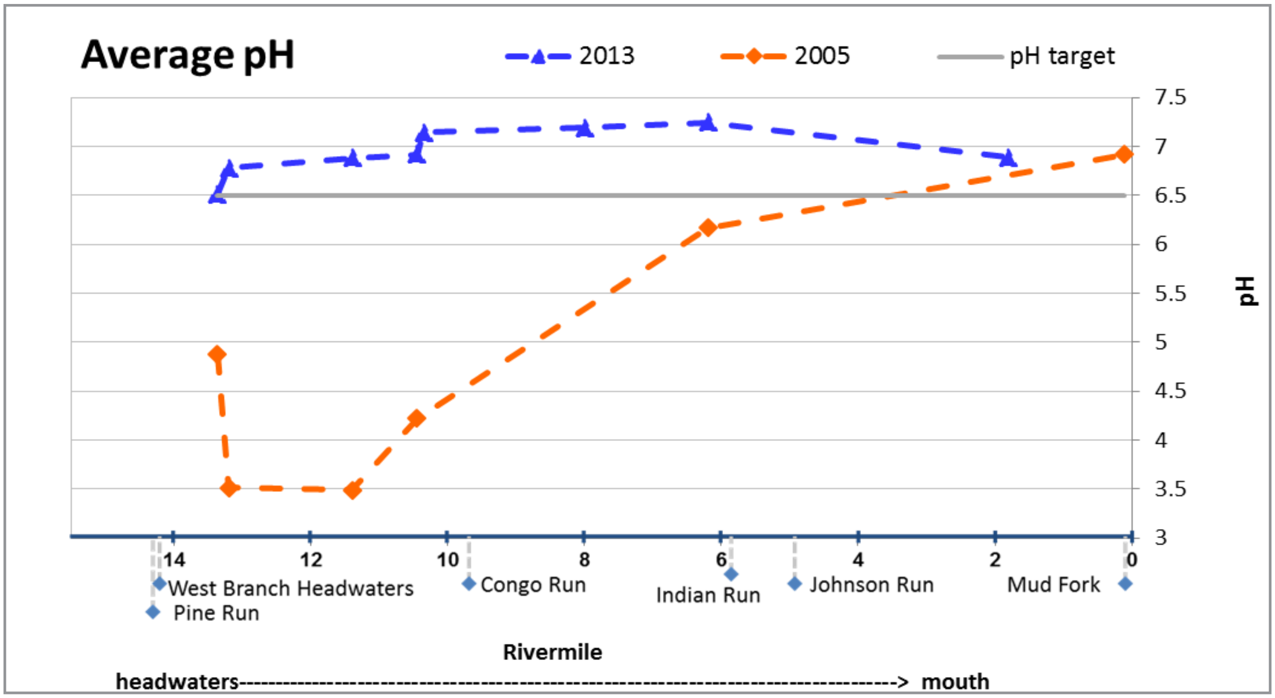
West Branch of Sunday Creek



Chemical water quality analysis per stream reach

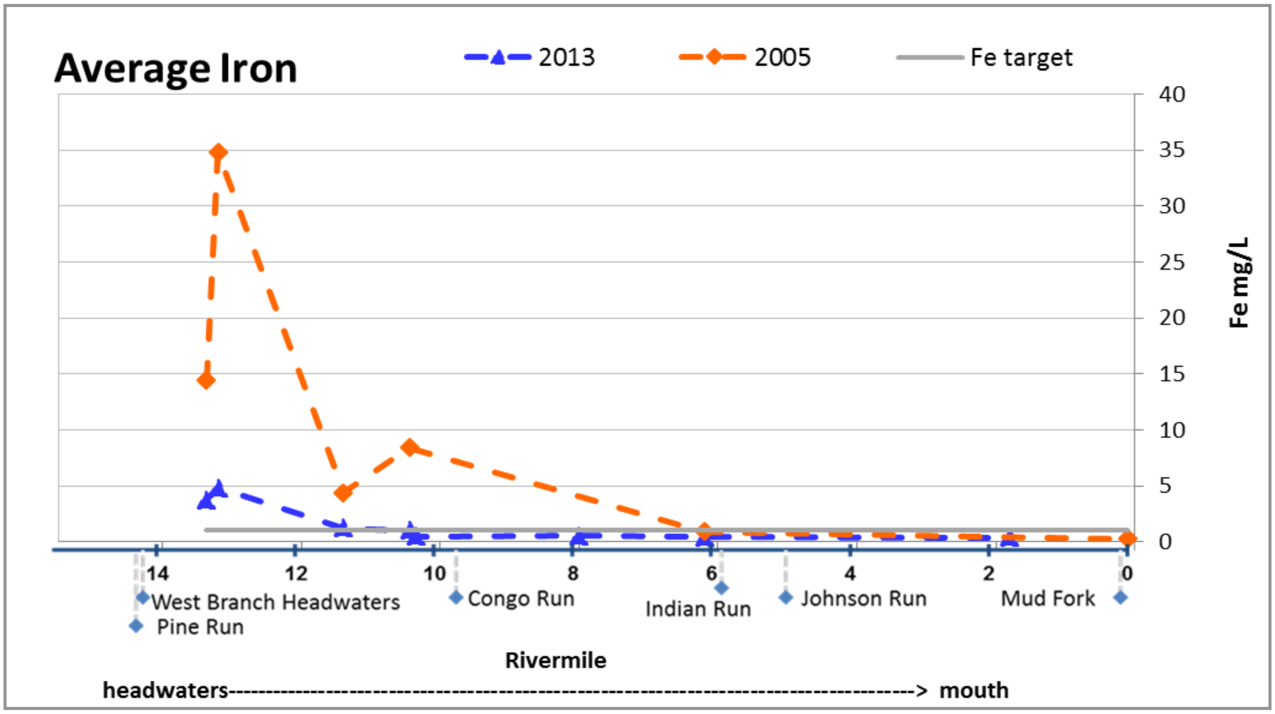
West Branch of Sunday Creek									
Site ID	PR 001	WB 004	WB 51	WB 003	WBSC RM 10.35	WBSC RM 8	WB 002	WBSC RM 1.8	SC 025
Rivermile	13.37	13.2	11.4	10.45	10.35	8	6.2	1.8	0.1

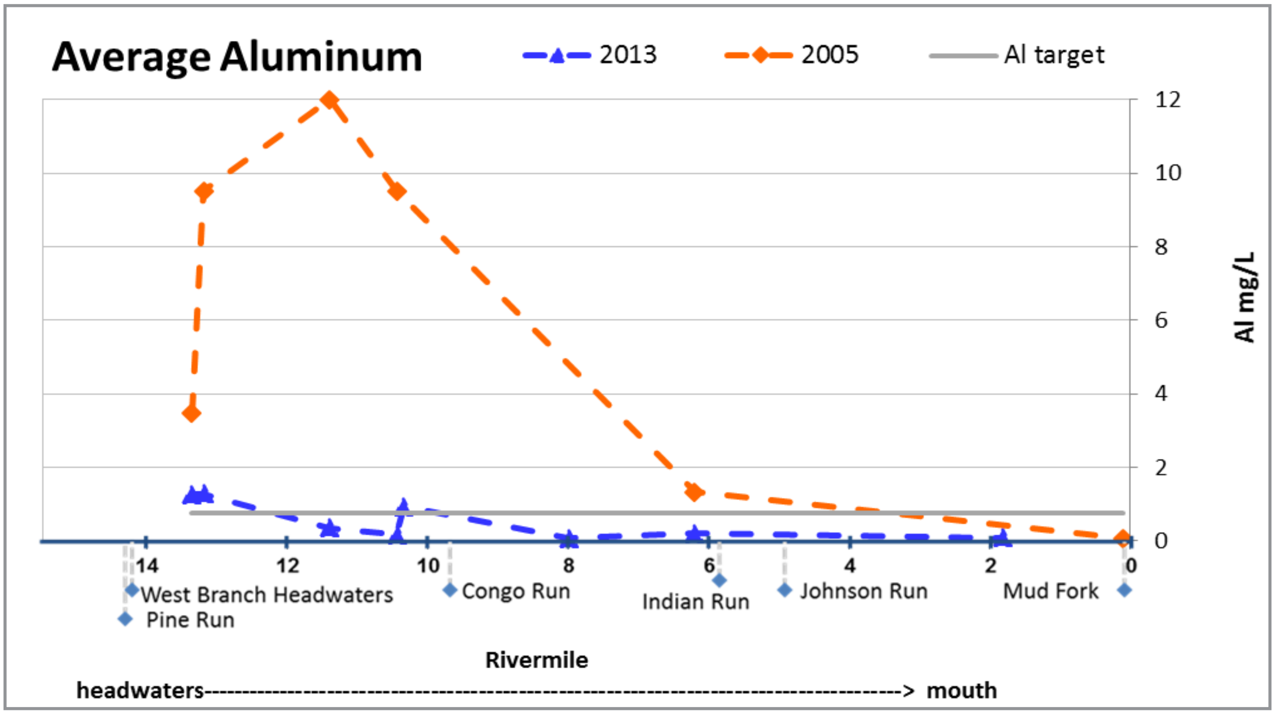




Chemical water quality analysis per stream reach

West Branch of Sunday Creek									
Site ID	PR 001	WB 004	WB 51	WB 003	WBSC RM 10.35	WBSC RM 8	WB 002	WBSC RM 1.8	SC 025
Rivermile	13.37	13.2	11.4	10.45	10.35	8	6.2	1.8	0.1





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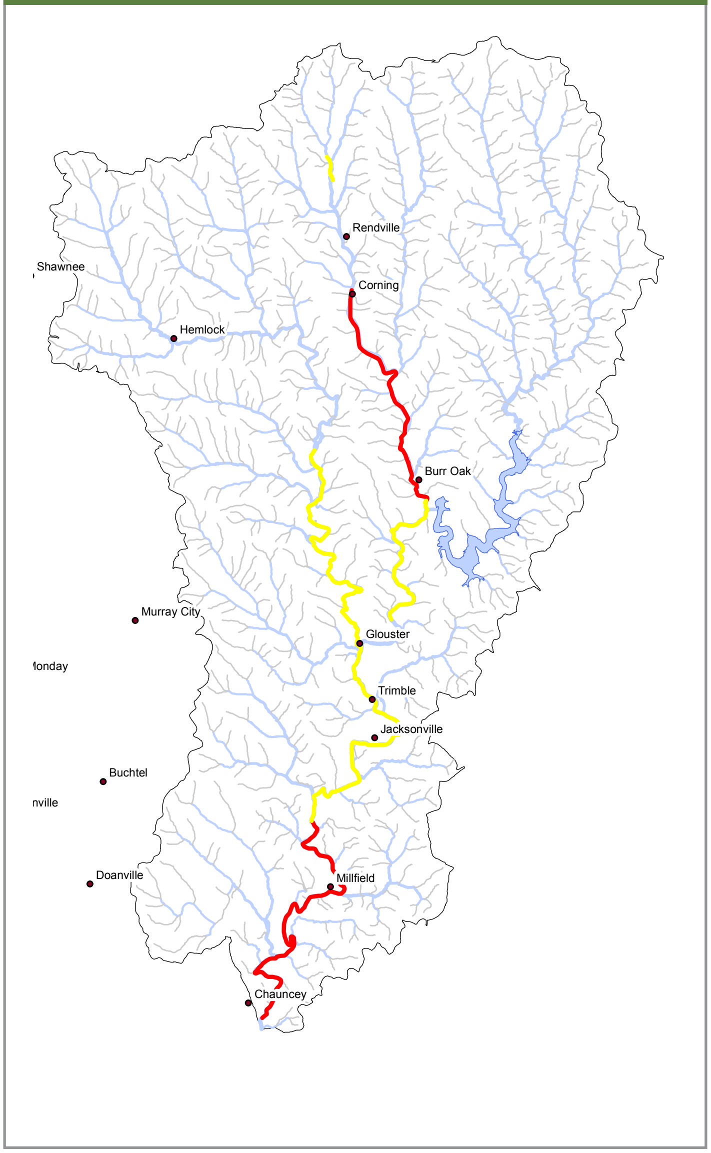
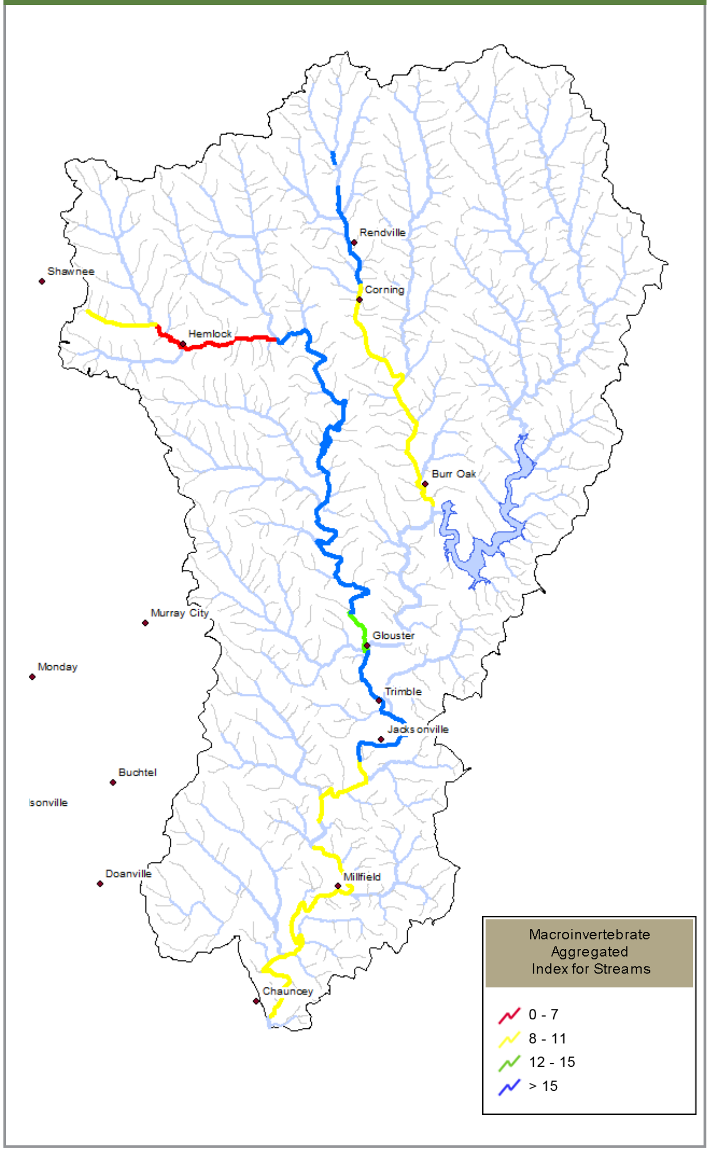
Biological Water Quality

Sunday Creek baseline MAIS



Sunday Creek 2013 MAIS



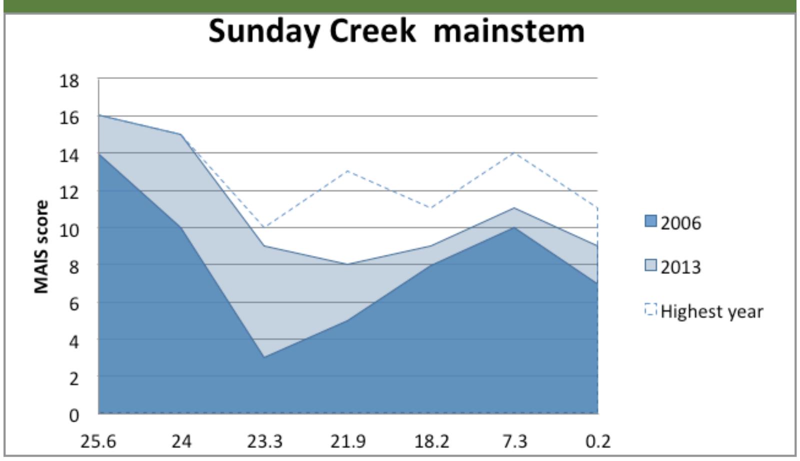
MAIS samples were collected throughout Sunday Creek at established annual monitoring stations from 2001 through 2013.

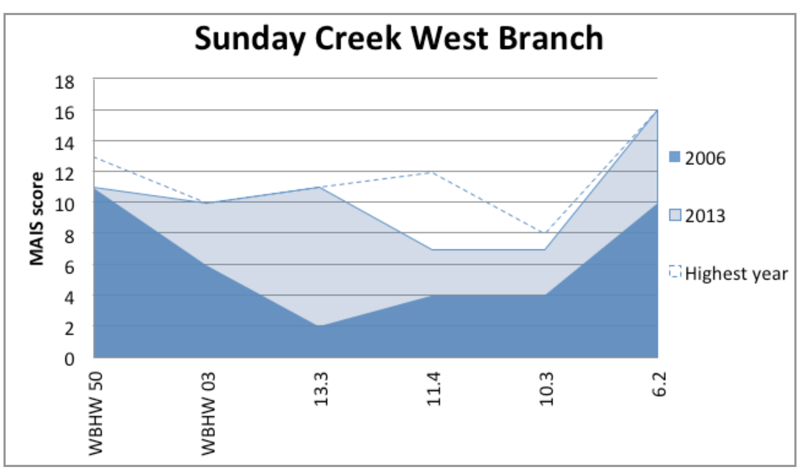
Biological Water Quality

The biological quality along the upper portion of the Sunday Creek mainstem improved this year compared to 2012, when most sites fell uniformly below their potential, as indicated by previously achieved high scores (Figure 1). In 2013, the two uppermost sites (RM 25.6 and 24.0) achieved their highest scores and the next two downstream sites (RM 23.3 and 21.9) also showed improvement compared to previous years. The five mile stream section from RM 23.3, just downstream of the Corning discharge at Corning Park, to RM 18.1 (across from the entrance to Tom Jenkins Dam) has relatively high year-to-year variability in biological quality, because they occasionally support high MAIS scores even though the water quality is generally impaired by the Corning discharge. This section does not consistently reach its full recovery potential, perhaps because of episodic pulses of acidity and/or metal precipitates, which are often observed during the summer. This section of stream has not shown a statistical improvement since 2006. However, further down, the mainstem continues to improve and the site just above the Truetown discharge (RM 7.3) consistently supports a high quality biological community (MAIS score 11 in 2013, sometimes as high as 14). While the furthest downstream section of Sunday Creek is badly impaired by the Truetown discharge and cumulative upstream impairments, it is still the only mainstem site that has shown consistent and significant improvement in MAIS scores since 2006.

In contrast, improvements in the West Branch are more evident. Three sites in the West Branch continue to exhibit significant long-term improvement in macroinvertebrate scores: the headwaters site WBHW 03, the site at RM 13.3 (WB 004), and the most downstream West Branch monitoring site (WB 002 at RM 6.2). RM 13.3, which supported almost no macroinvertebrates in 2005 (MAIS score of "1"), earned a new high score of "11" this year. The most downstream West Branch monitoring site at RM 6.2 surpassed its high score of "15" in 2012 with a score of "16" in 2013, indicating the presence of a high quality macroinvertebrate community (Figure 2).

Figure 1. Area of Degradation 2006-2013



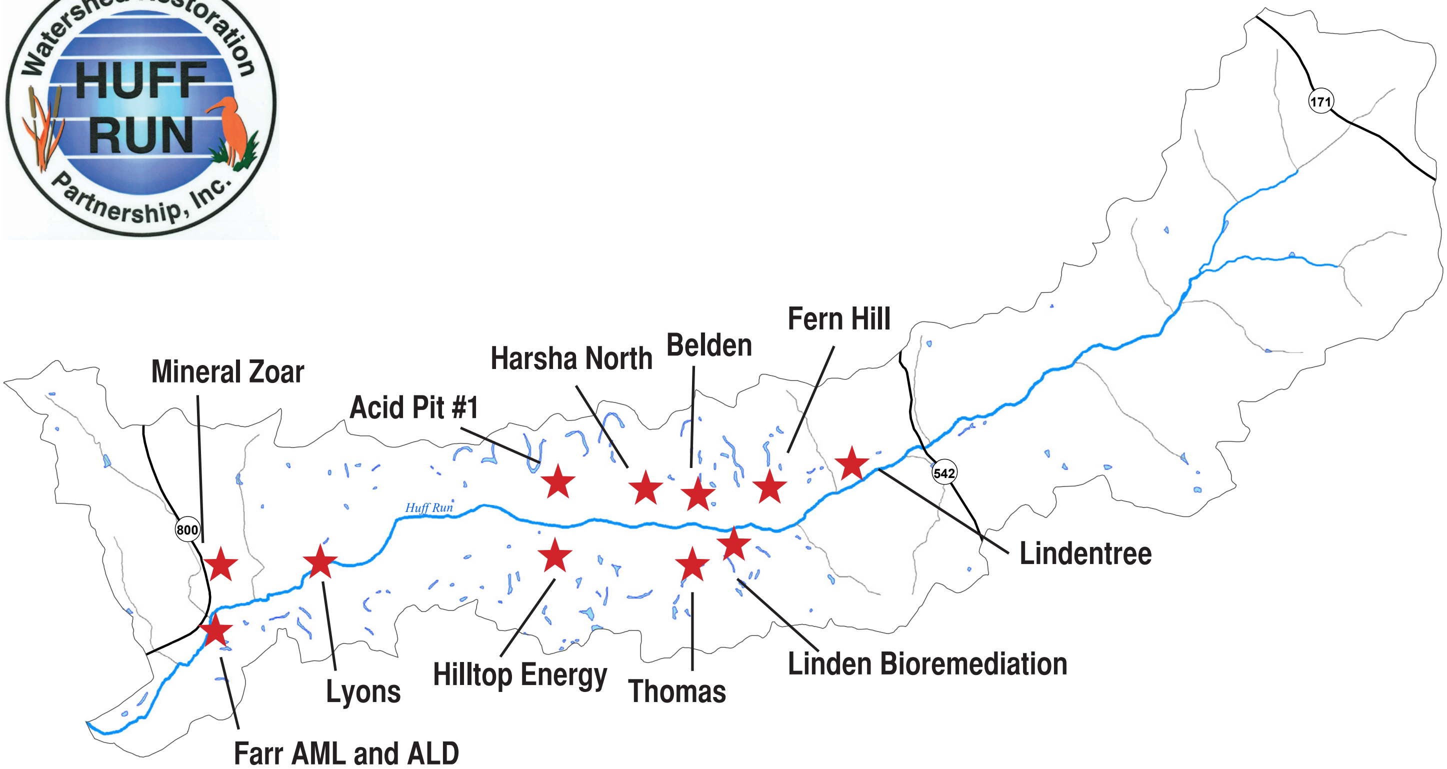


The blue dashed line identifies the highest MAIS score ever achieved at that site throughout the monitoring time period.

Figure 2. Sunday Creek MAIS Regressions

RM	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	*Linear trends*	*R square*	*P-value*	*No. of Yrs*
Mainstem																
24				12	10	10	14	12	13	12	11	15	no change	0.235	0.185	9
23.3				5	3	2	7	12	5	10	4	9	no change	0.197	0.231	9
21.9	2	1	2	11	5	5	9	2	3	7	5	8	no change	0.162	0.194	12
18.2	5	9	8	10	8	10	5	7	8	11	10	9	no change	0.137	0.236	12
7.3	10	11	11	11	10	10	10	12	11	14	9	11	no change	0.036	0.553	12
0.2	4	2	3	8	7	3	6	11	8	10	7	9	**improved**	0.523	0.008	12
West Branch																
WBHW50					11	10	11	8	12	13	11	11	no change	0.090	0.470	8
WBHW03				5	6	4	8	6	8	10	8	10	**improved**	0.677	0.006	9
13.3				1	2	2	5	5	7	7	5	11	**improved**	0.795	0.001	9
11.4				8	4	2	7	9	5	12	10	7	no change	0.222	0.200	9
10.3				8	4	3	4	8	4	7	7	7	no change	0.089	0.435	9
6.2				7	10	8	10	10	13	13	15	16	**improved**	0.898	0.0001	9

HUFF RUN
WATERSHED REPORT



Reductions

Total acid load reduction = 83 lbs/day at site HRR08

Total acid load reduction at all project sites = 1075 lbs/day

excluding Mineral Zoar and Farr

Costs

Design $667,412
(excluding Linden Bioremediation and Lyons II)

Construction $4,349,075

Total cost through 2013 =$5,016,487

Timeline of the Huff Run Watershed Project Milestones & AMD Projects

1985	• Study funded by ODNR conducted by Benatec Associates to identify acid problems in Huff Run Watershed
1988	• First abandoned mine land project, Jobes, completed in the watershed
1996	• Huff Run Watershed Restoration Partnership founded
2000	• Huff Run AMDAT completed • Huff Run Watershed Coordinator funded for six years • First acid mine drainage restoration project, Farr, completed in watershed
2001	• First draft of Huff Run Watershed Plan completed
2002	• Linden Bioremediation Project constructed
2003	• Acid Pit Restoration Project completed
2004	• Lindentree Restoration Project completed
2005	• Rural Action and Huff Run awarded US EPA Targeted Watershed Grant • Rural Action adds VISTA volunteer to Huff Run staff • Second draft of Huff Run Watershed Plan authored, endorsed by the State of Ohio • Lyons Restoration Project constructed
2006	• Harsha North Restoration project completed
2007	
2008	• Belden Restoration Project constructed • Fern Hill (HR-42) Phase II Project constructed
2009	• Huff Run Watershed Coordinator funded for three years • Mineral Zoar Project completed • Rural Action adds AmeriCorps member to Huff Run staff
2010	• Thomas Project, Fern Hill Pond A & Belden Gob pile constructed
2011	• Lyons II constructed
2012	• Hilltop Restoration Project started
2013	• Completed Hilltop Restoration Project • MWCD Partners in Watershed Management Grant awarded for environmental education and community outreach

Huff Run Projects

Acid mine drainage reclamation projects completed in Huff Run Watershed:

2003 *Farr Project*
Linden Bioremediation Project
2004 Acid Pit #1 Project
2005 Lyons Project
Lindentree Project
2006 Harsha North Project
2008 Fern Hill HR-42 Pits A, B, & C
Belden and Belden Gob Pile Project
2009 *Mineral Zoar*
2010 Thomas Project
2011 Lyons II
2013 Hilltop Energy Project* no high flow

Italicized indicates projects are not actively monitored for acid and metal load reduction purposes

**Indicates no post yearly trend graphs due to lack of data*

2013 NPS Report - Huff Run Watershed

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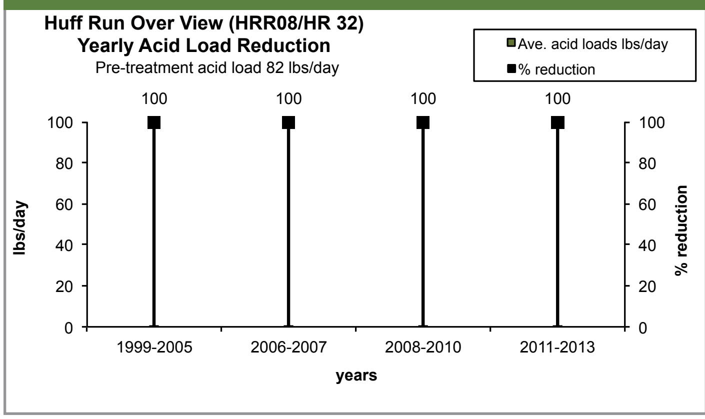
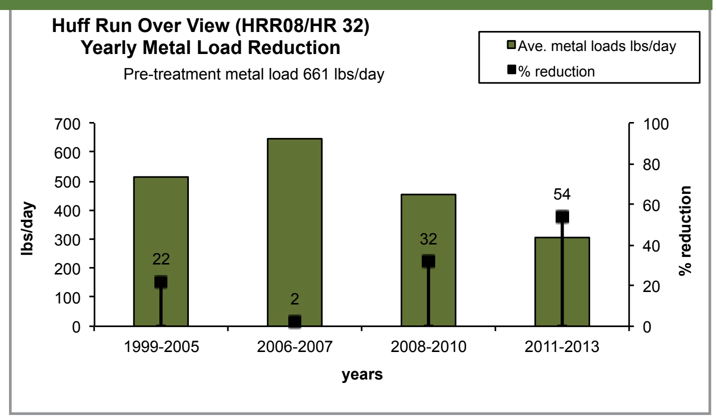
Yearly acid and metal load reduction trends per project

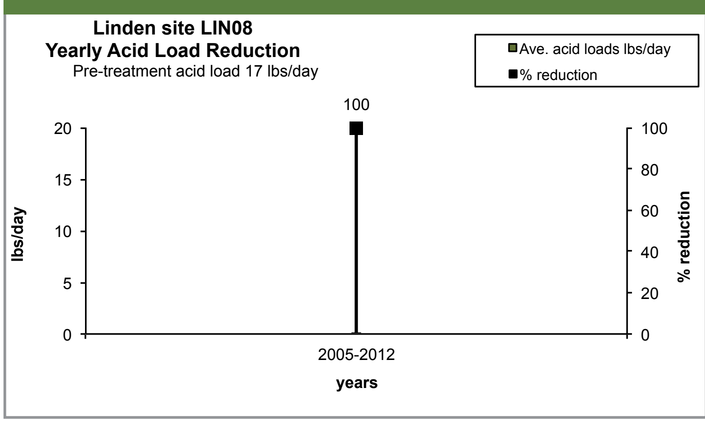
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, operation and maintenance plans are being designed for each existing system and are planned for future projects. The graphs below show the mean annual acid and metal load reduction using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014) for each year (or group of years) during post-reclamation from the project effluent. From these graphs the rate of decline (and/or improvement) with time of the treatment system is implied. Knowing the rate of decline will aid in the implementation of operation and maintenance plans.

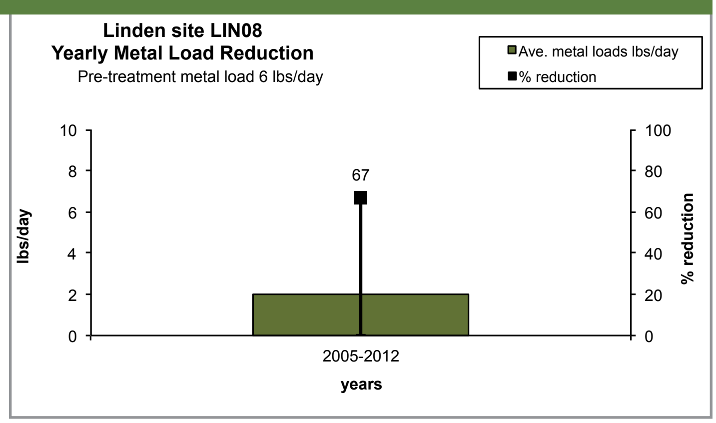
Huff Run Overview (HRR08/HR 32)



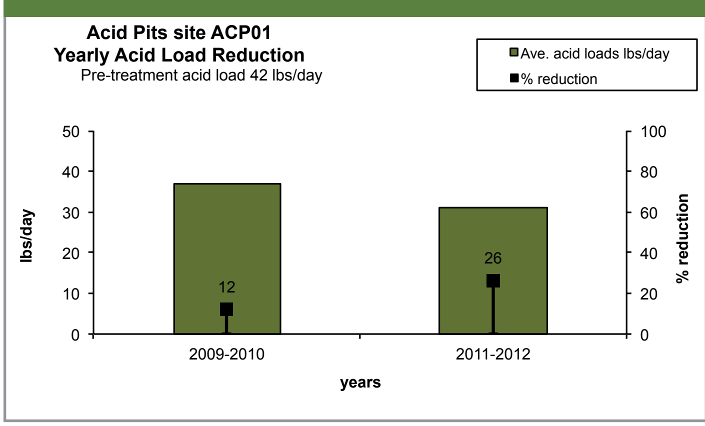


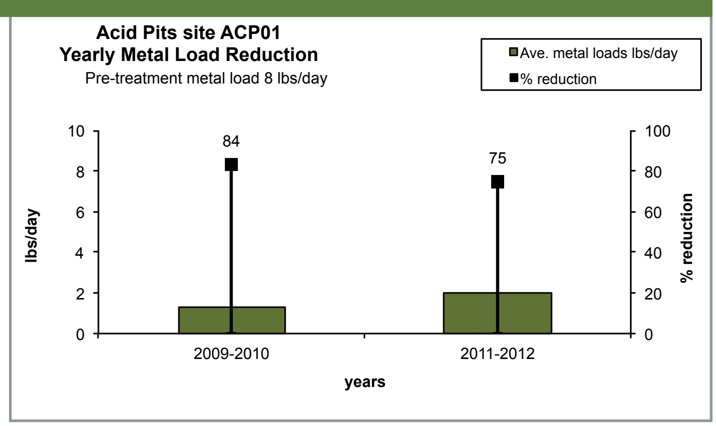
Linden site LIN08





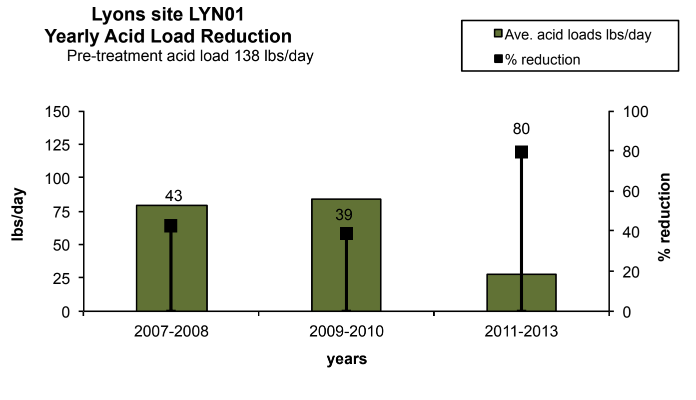
Acid Pits site ACP01

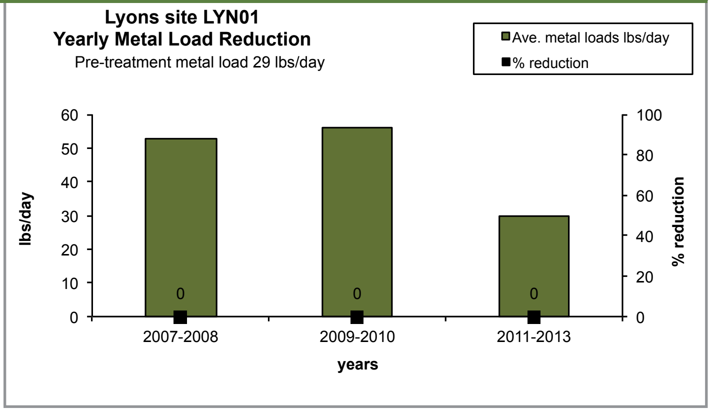




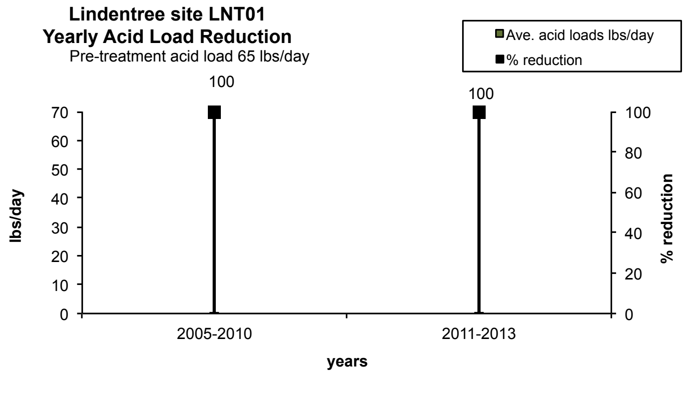
Yearly acid and metal load reduction trends per project

Lyons site LYN01

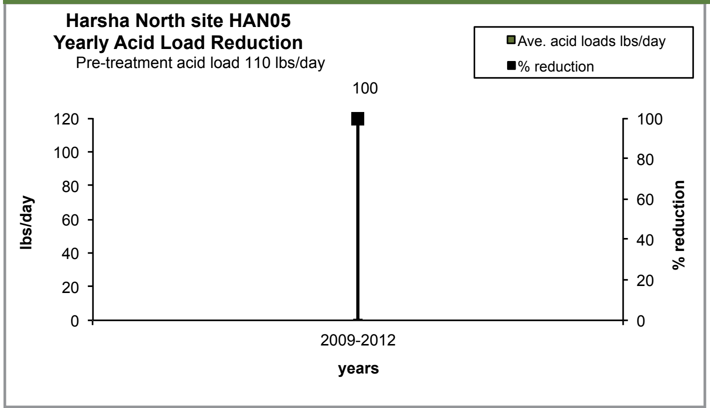


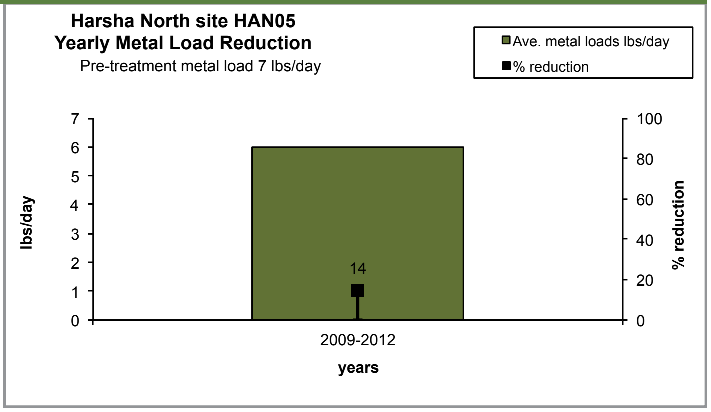


Lindentree site LNT01



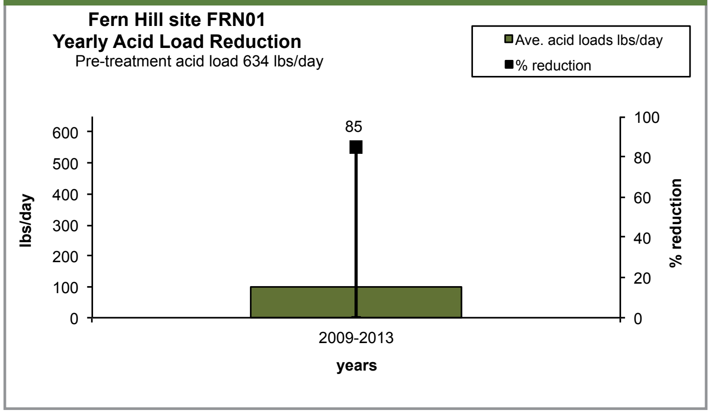
Harsha North site HAN05



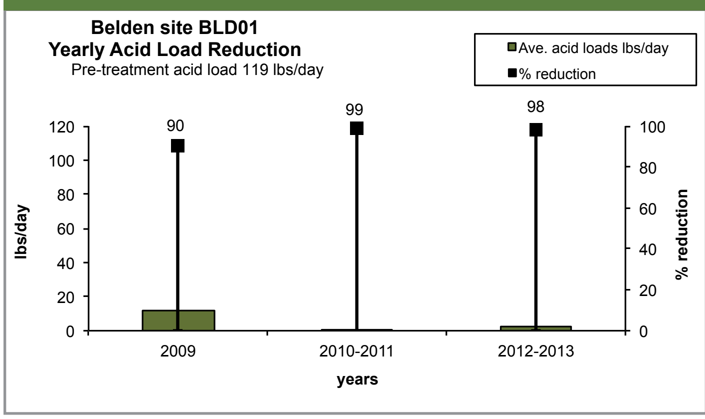


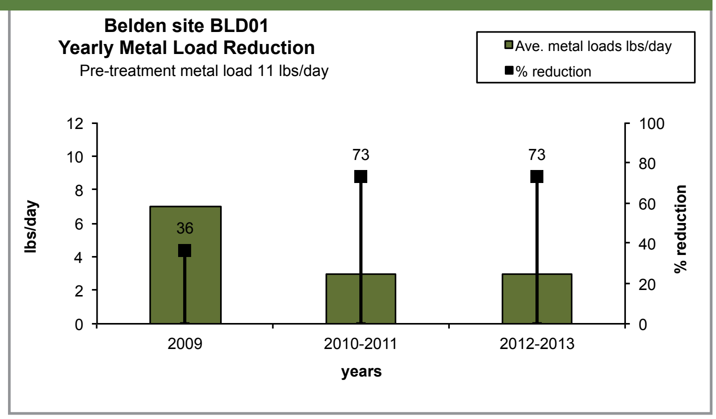
Yearly acid and metal load reduction trends per project

Fern Hill site FRN01

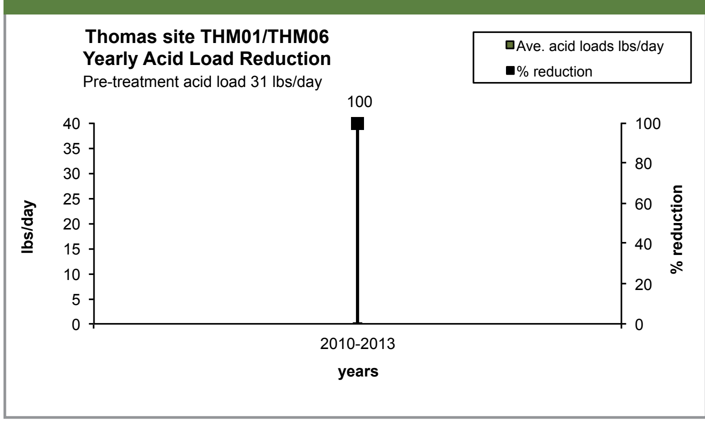


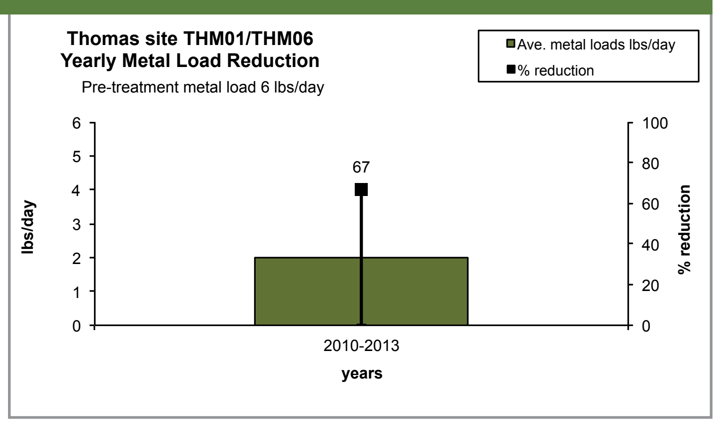
Belden site BLD01





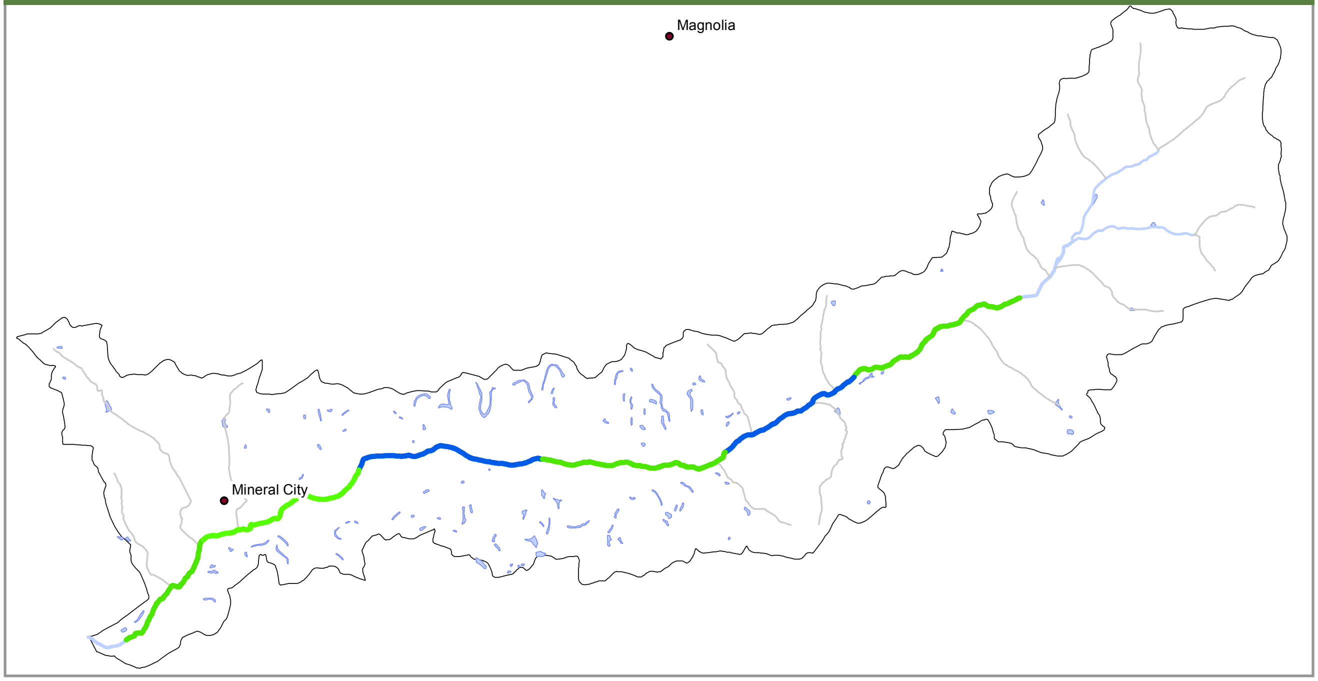
Thomas site THM01/THM06



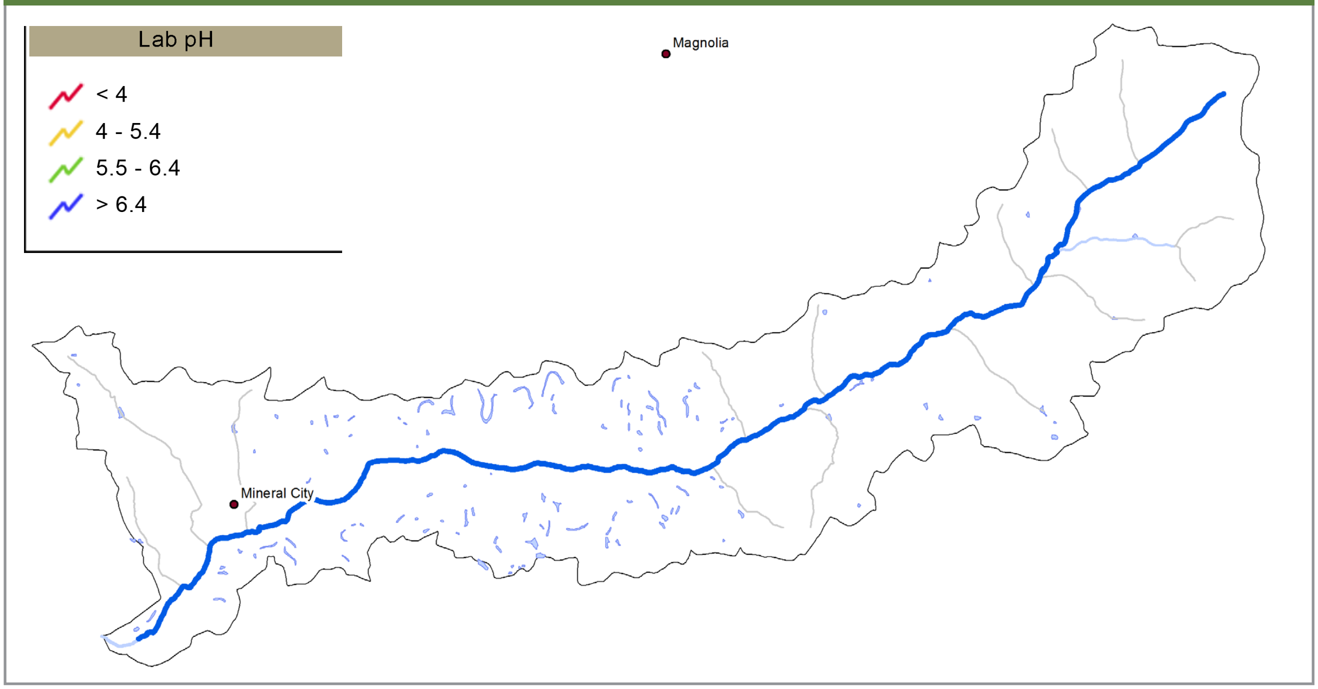


Chemical Water Quality

Huff Run baseline pH



Huff Run 2013 pH

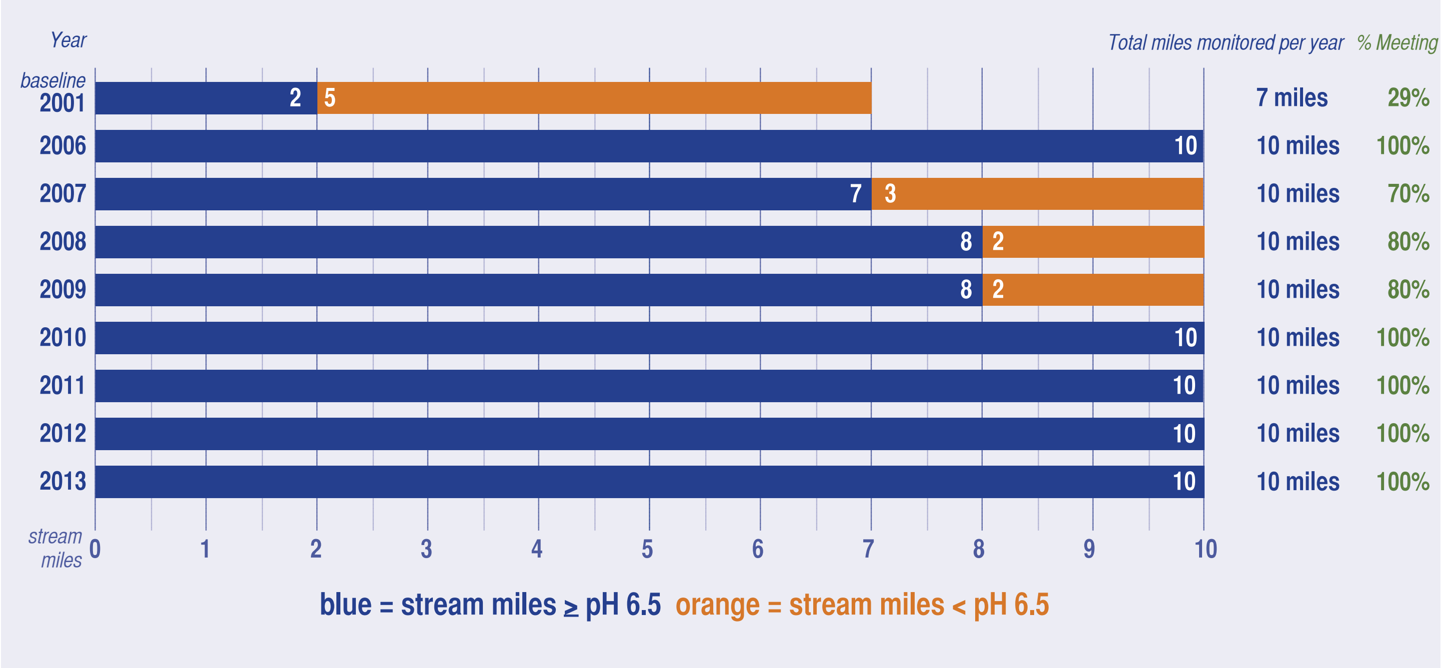


Huff Run pH values have improved from baseline conditions (1985-1998) to 2013. The entire length of Huff Run has met the pH target (6.5) for the last four years.

Chemical Water Quality

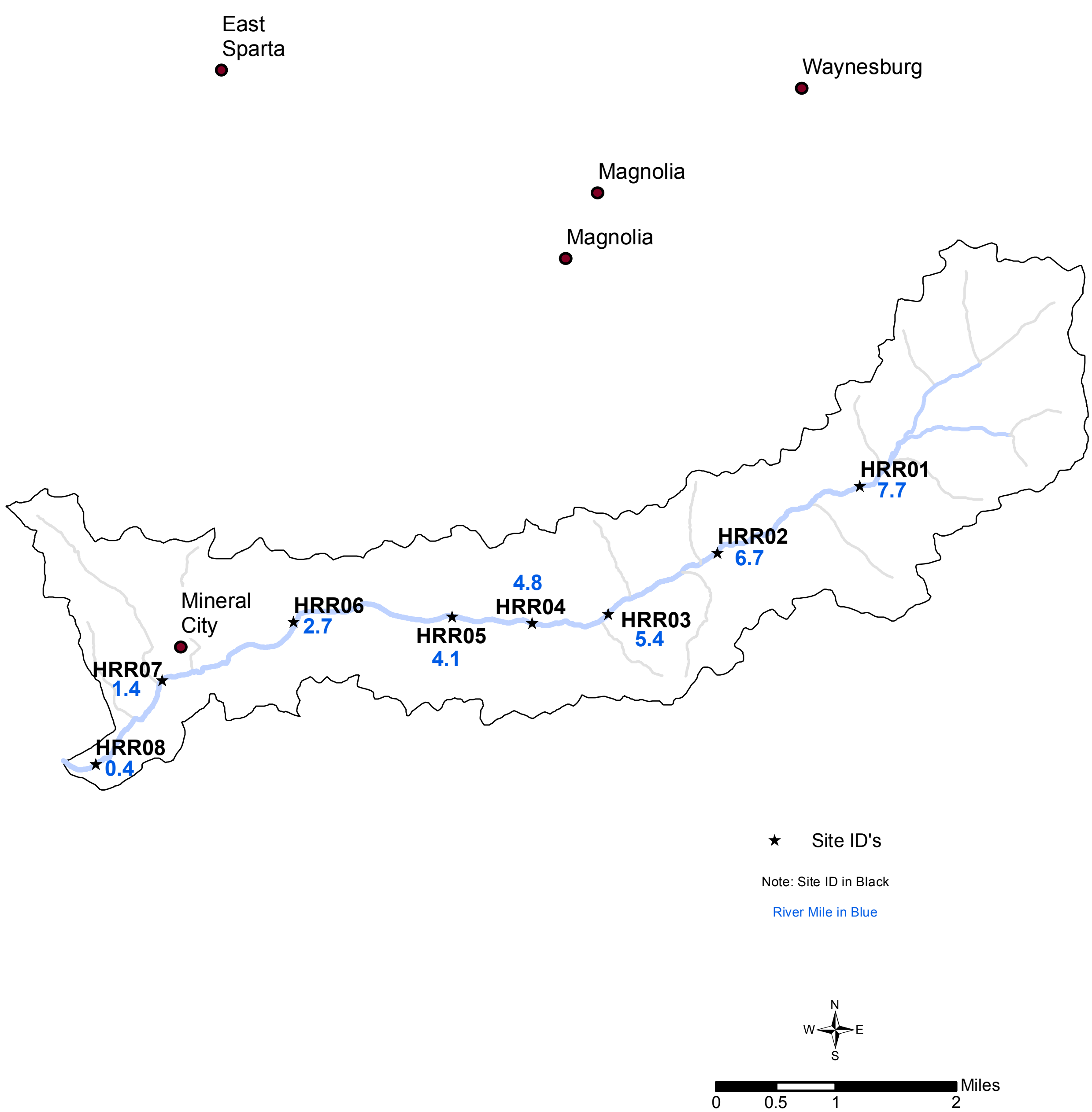
The mainstem of Huff Run is approximately 10 miles in length with monitoring occurring year round. In 2009, 8 miles met the pH target of 6.5 while the two downstream stream reaches (HRR08 and HRR07) fell slightly below the target with an average pH of 6.4. Since 2010 to 2013, all 10 miles met the pH target.

Huff Run pH



Chemical water quality analysis per stream reach

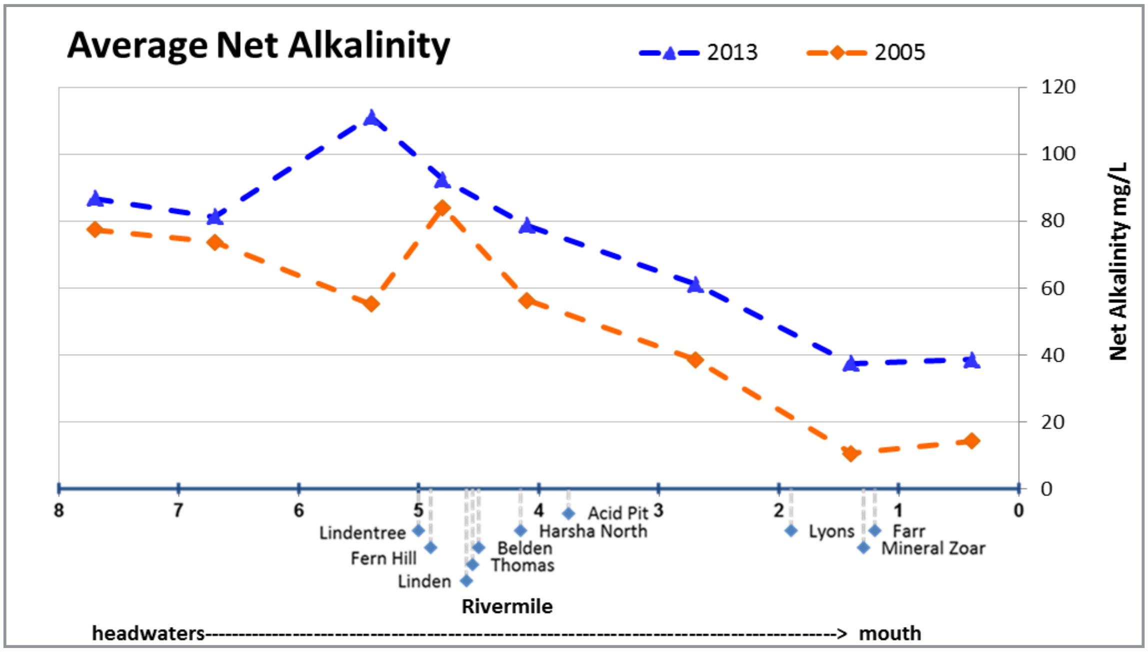
Huff Run

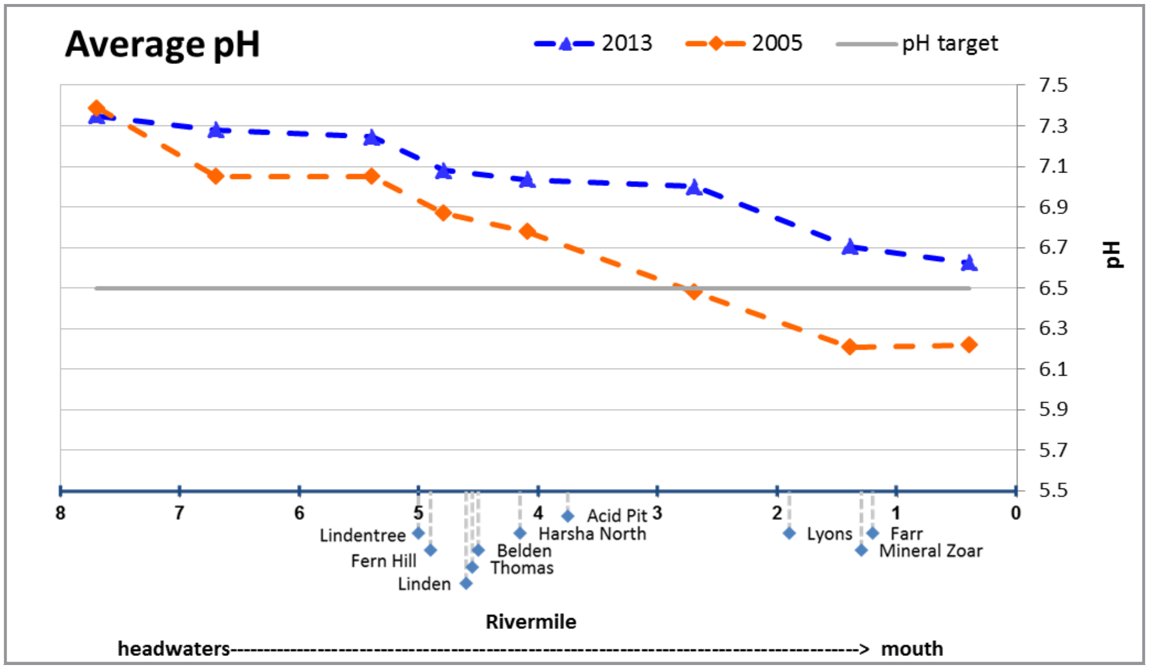


Chemical water quality analysis per stream reach

Chemical water quality changes along the mainstem of Huff Run are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown below.

Huff Run								
Site ID	HRR01	HRR02	HRR03	HRR04	HRR05	HRR06	HRR07	HRR08
Rivermile	7.7	6.7	5.4	4.8	4.1	2.7	1.4	0.4





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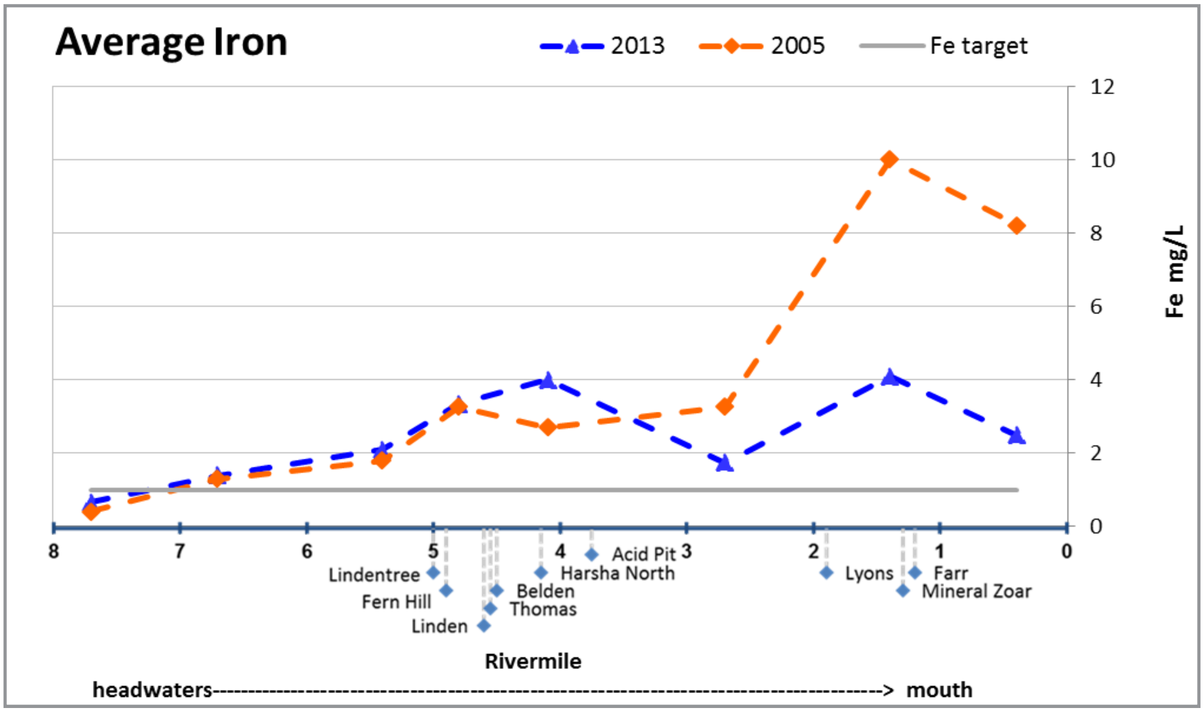
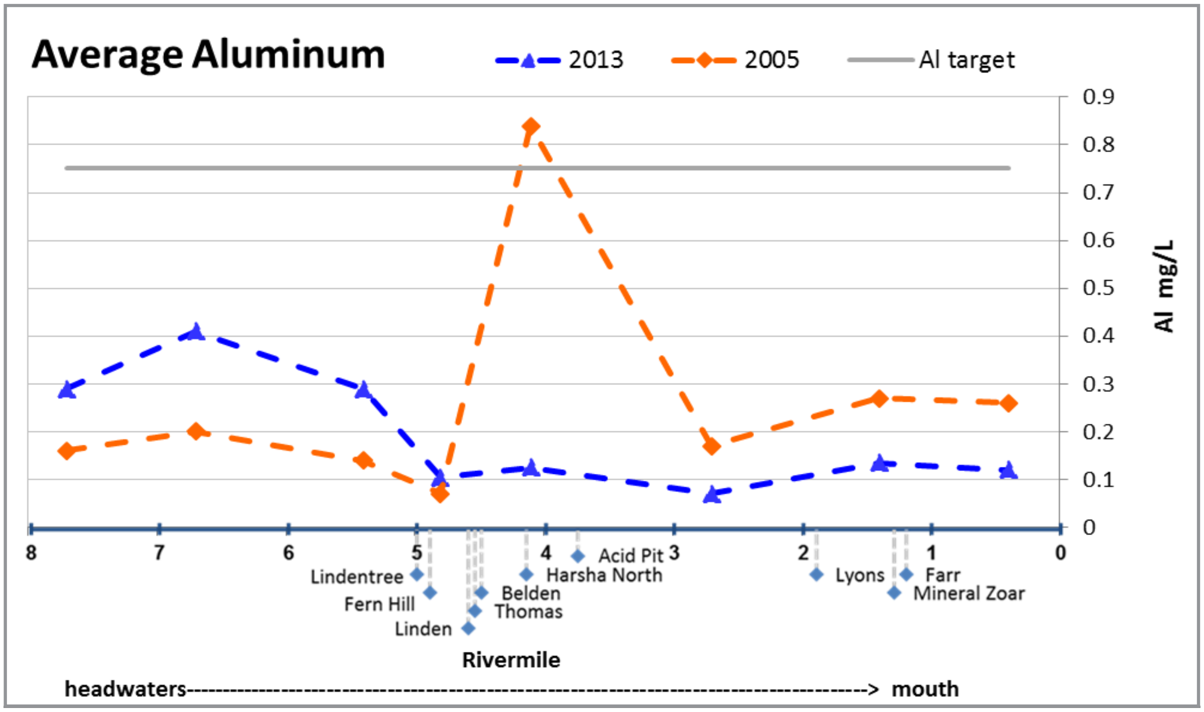
Chemical water quality analysis per stream reach

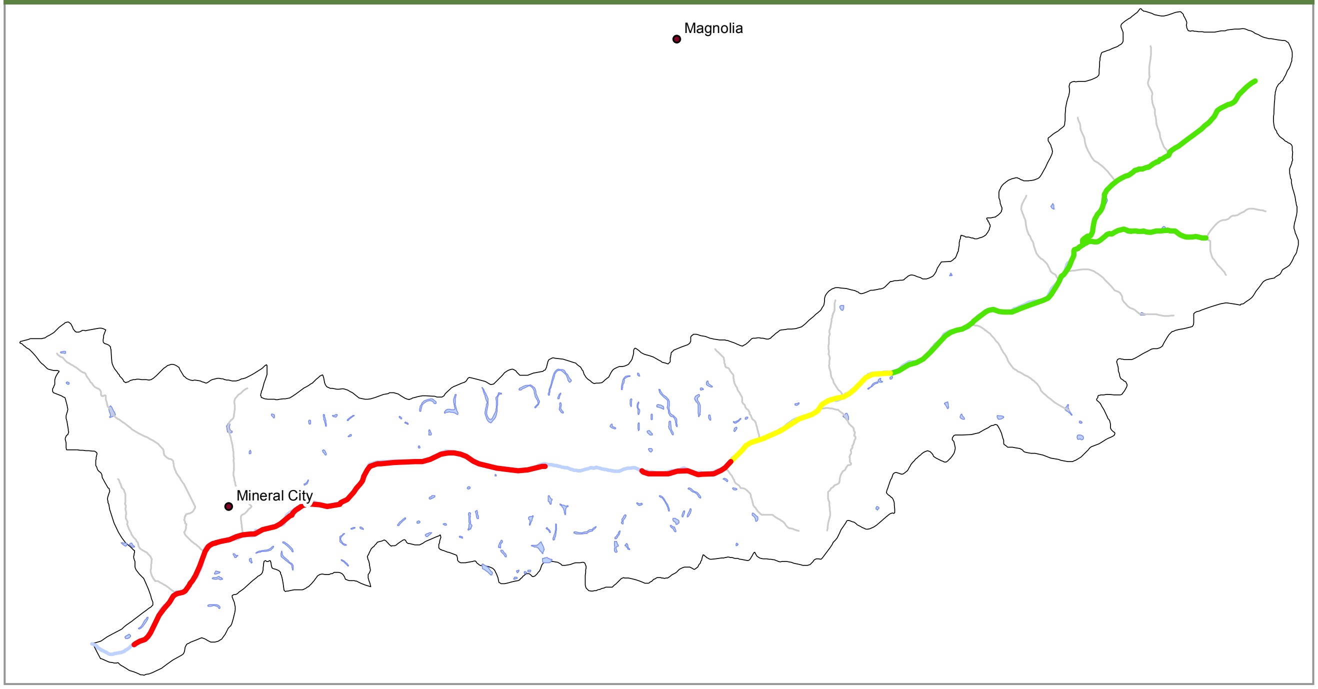
Huff Run								
Site ID	HRR01	HRR02	HRR03	HRR04	HRR05	HRR06	HRR07	HRR08
Rivermile	7.7	6.7	5.4	4.8	4.1	2.7	1.4	0.4



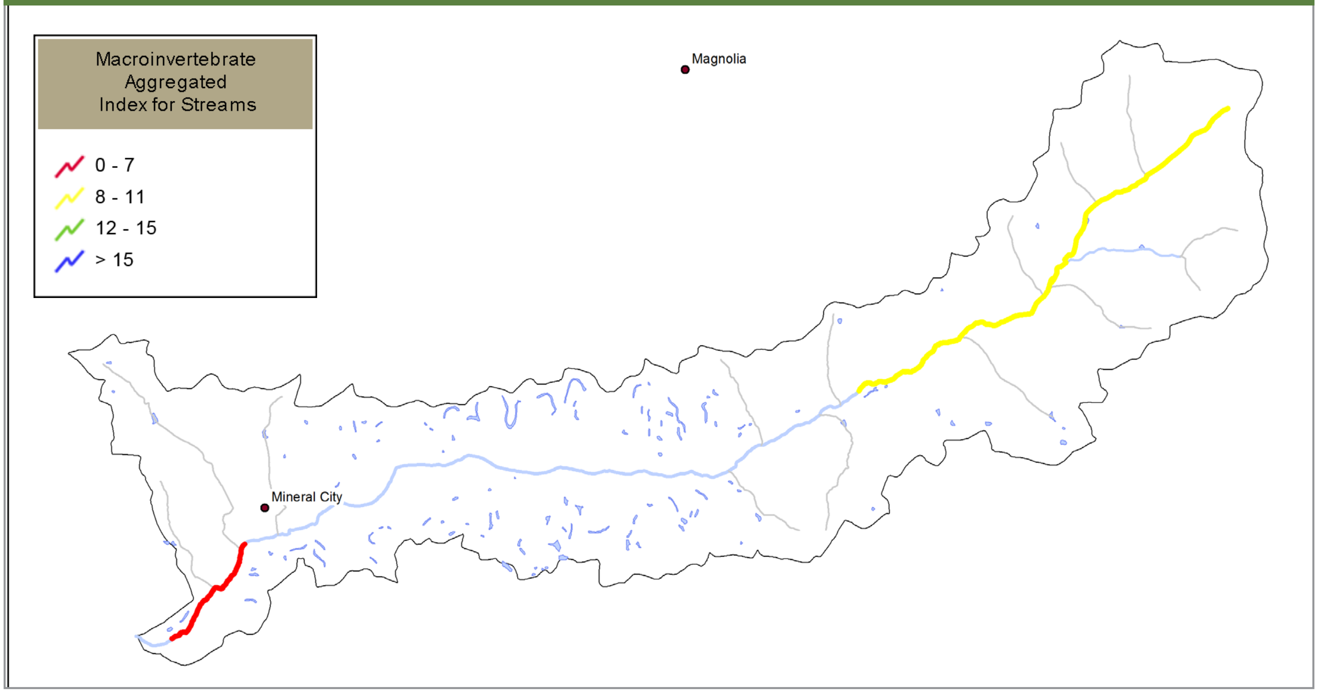


Biological Water Quality

Huff Run baseline MAIS



Huff Run 2013 MAIS



Biological quality in Huff Run decreases from headwaters to the mouth. Only 3 sites along the mainstem were monitored in 2013.

Biological Water Quality

Biological data results presented here are from 2012, limited biological data was collected in Huff Run in 2013. A full set of biological data is scheduled for collection in 2014. Biological quality in Huff Run (based on macroinvertebrate data from 2012) declines from the headwaters to the mouth (Figure 1). Although several stations have shown transient improvements since 2006, these trends have not been sustained long enough to reach statistical significance in 2012 (Figure 2). Based on past highest year scores, virtually all sites have potential for additional improvement, but only the two uppermost headwater sites have achieved the target MAIS score of "12" in the past 8 years of monitoring. In 2012, the uppermost headwater site (RM 8.4) had an unusually low score of "6", compared to its usual average score of 12-13, because a key section of forested habitat at one end of the designated reach was inadvertently not sampled in 2012.

Figure 1. Area of Degradation 2006-2012

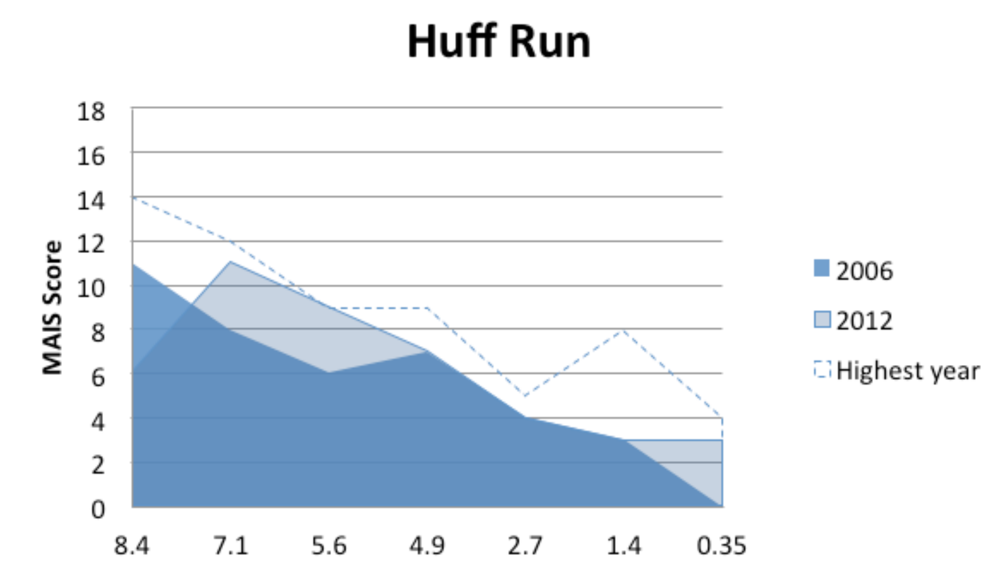


Figure 2. Huff Run MAIS Regressions

RM	2005	2006	2007	2008	2009	2010	2011	2012	Linear trends	R square	P-value	No. of Years
8.4	14	11	12	12	13	9	13	6	no change	0.365	0.112	8
7.1	12	8	8	8	9	11	11	11	no change	0.099	0.448	8
5.6	8	6	7	6	8	9	7	9	no change	0.238	0.220	8
4.9	6	7	9	8	9	9	6	7	no change	0.004	0.874	8
2.7	5	4	5	3	4	5	3	4	no change	0.148	0.347	8
1.4	2	3	3	2	8	2	2	3	no change	0.005	0.866	8
0.35	3	0	4	3	4	3	3	3	no change	0.093	0.464	8

LEADING CREEK WATERSHED REPORT

2013 NPS Report - Leading Creek Watershed

Generated by Non-Point Source Monitoring System
www.watersheddata.com

Reductions

Total acid load reduction = 661 lbs/day

Costs

Design $8,201

Construction $407,23

Total Costs through 2013 = $415,437

Timeline of the Leading Creek Watershed Project Milestones & AMD Projects

1993	• SOCCO mine release into Leading Creek
1994	
1995	• Mother's Day Flood
1996	
1997	
1998	• Leading Creek Improvement Plan by Dr. Cherry completed
1999	• USFWS began working with Meigs SWCD on watershed projects
2000	
2001	• First Leading Creek Stream Sweep conducted
2002	
2003	• Meigs SWCD Conservation Area purchased along Little Leading Creek • Meigs SWCD obtained first watershed coordinator grant
2004	
2005	• Leading Creek Watershed Management Plan completed
2006	• Pauline Atkins Memorial Trail completed • Leading Creek AMDAT Plan completed
2007	
2008	• Leading Creek TDML Report completed
2009	• Leading Creek Water Trail established • First AmeriCorps member dedicated to the Leading Creek Watershed
2010	• Leading 'From the Past' book completed • Leading Creek Volunteer Monitor Program begun
2011	• Freshwater mussels reintroduced
2012	• Thomas Fork Doser Project completed
2013	• Biological observations along Thomas Fork indicate an increase in diversity of fish and macroinvertebrate species since 2010

Leading Creek Projects

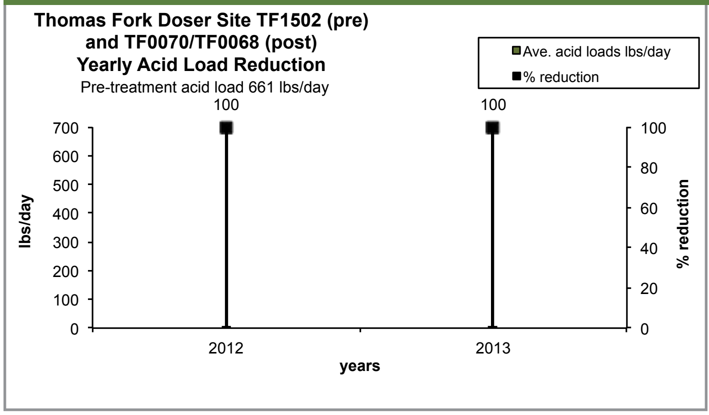
Acid mine drainage reclamation projects completed in Leading Creek Watershed:

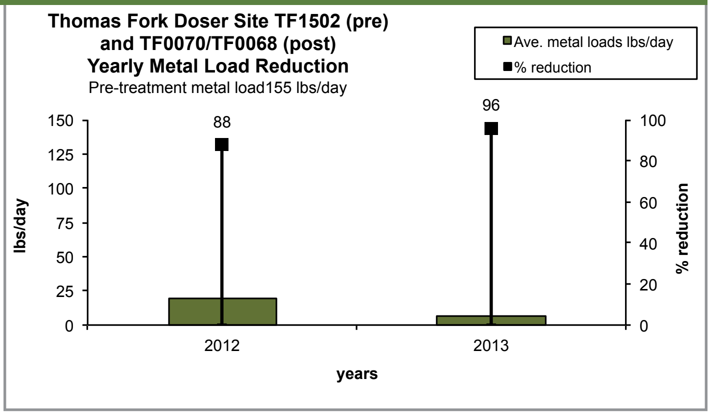
2012 Thomas Fork Doser

Yearly acid and metal load reduction trends per project

Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, operation and maintenance plans are being designed for each existing system and are planned for future projects. The graphs below show the mean annual acid and metal load reduction using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014) for each year (or group of years) during post-reclamation from the project effluent. From these graphs the rate of decline (and/or improvement) with time of the treatment system is implied. Knowing the rate of decline will aid in the implementation of operation and maintenance plans.

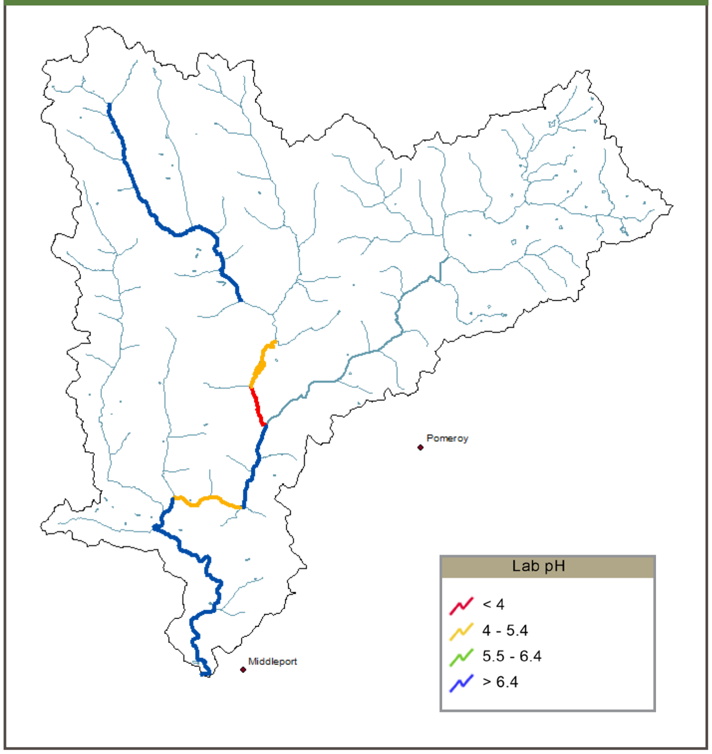
Thomas Fork Doser Site TF1502 and TF0070/TF0068



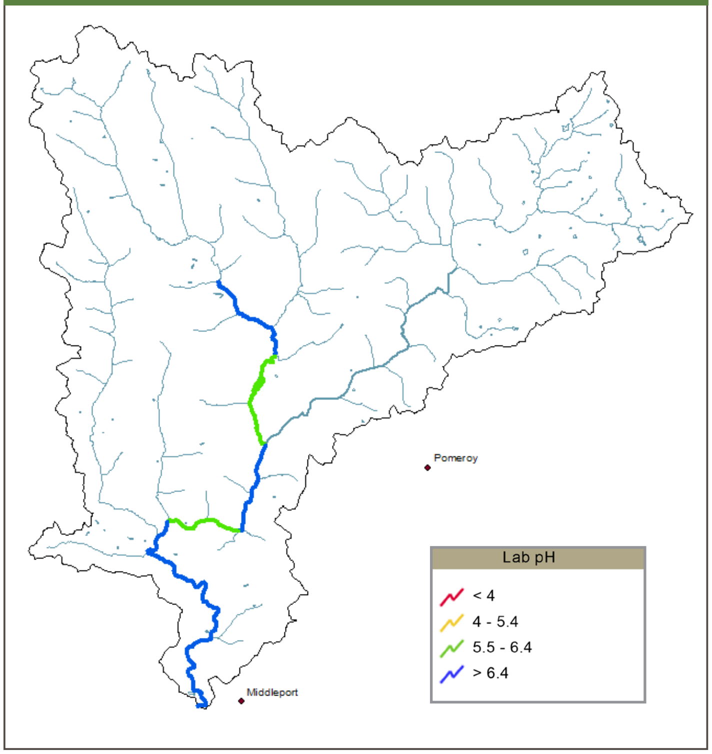


Chemical Water Quality

Thomas Fork baseline (2009) pH

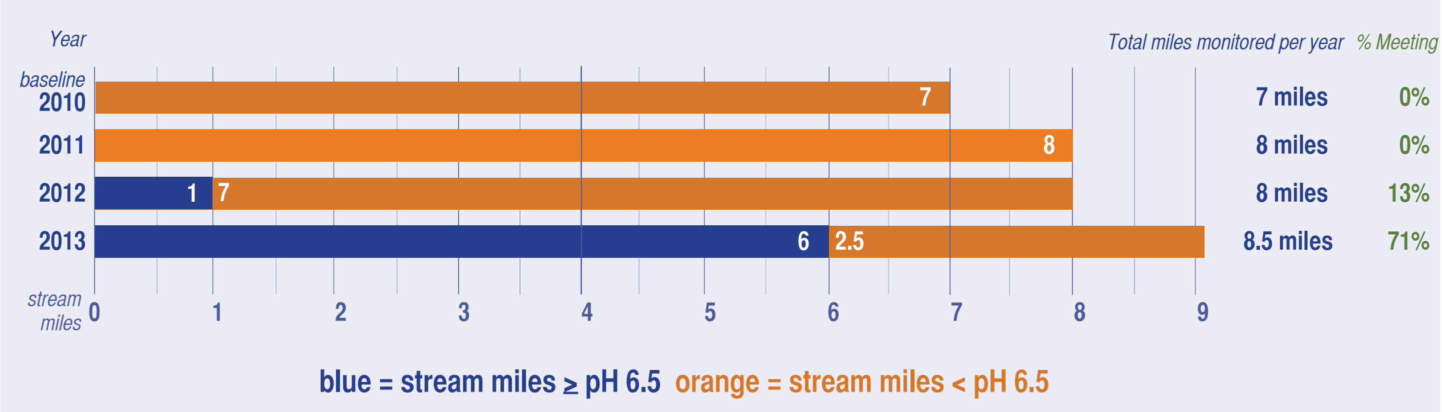


Thomas Fork 2013 pH

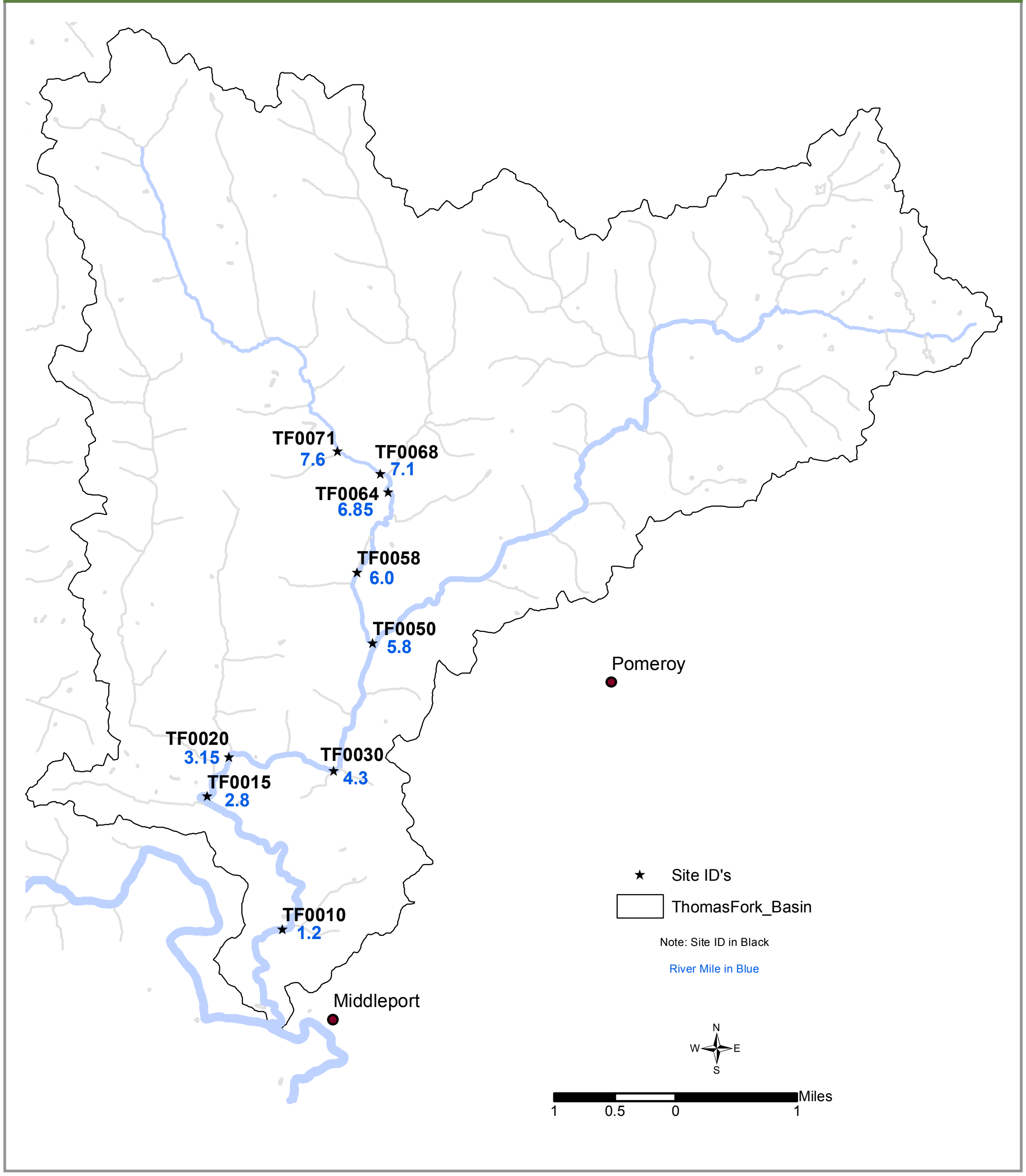


In Thomas Fork pH values on average along the mainstem do not meet the pH target of 6.5 from the ‘unnamed tributary’ downstream to the mouth (Figure 1).

Figure 1. Thomas Fork total stream miles monitored for pH through time



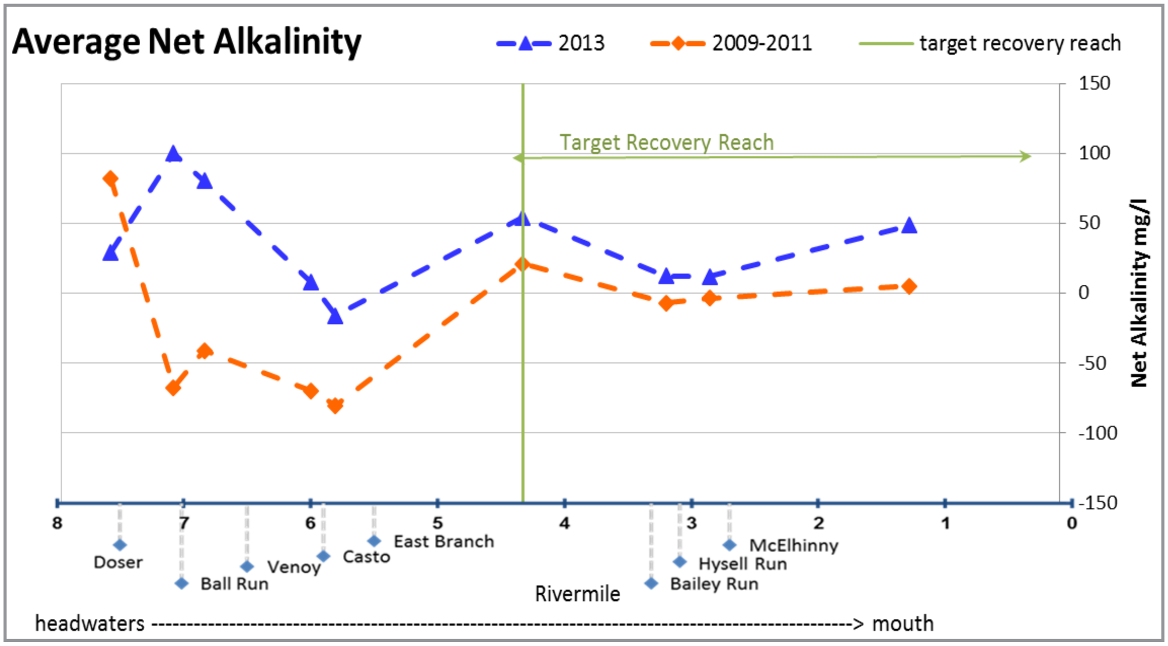
Thomas Fork

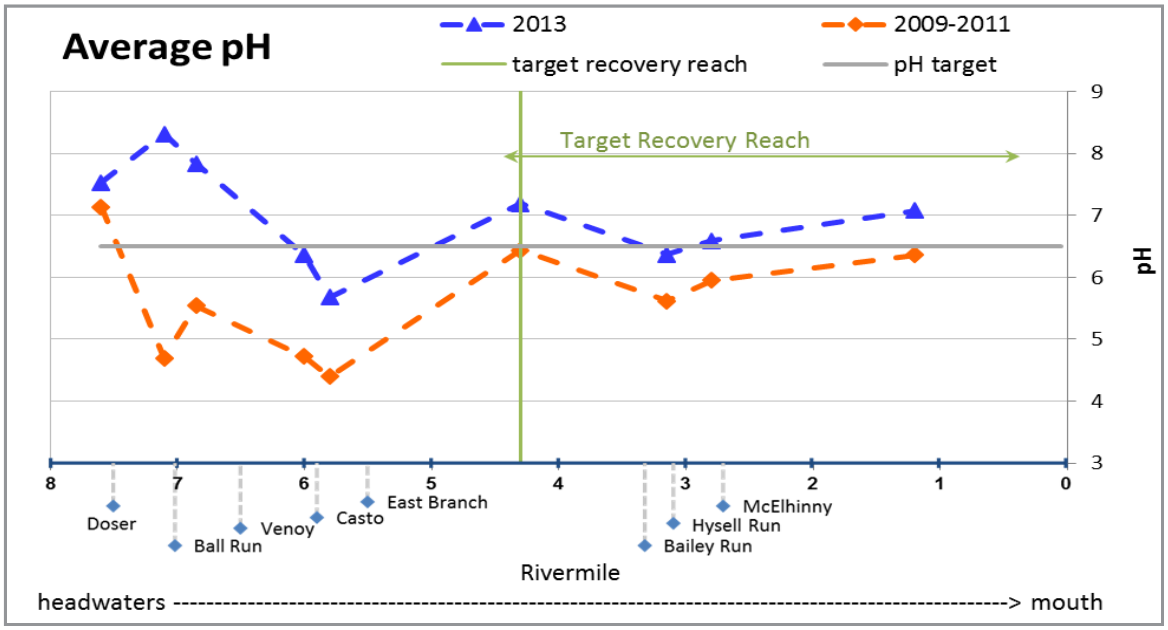

TF0071
7.6
TF0068
7.1
TF0064
6.85
TF0058
6.0
TF0050
5.8
Pomeroy
TF0020
3.15
TF0030
4.3
TF0015
2.8
TF0010
1.2
Middleport
Site ID's
ThomasFork_Basin
Note: Site ID in Black
River Mile in Blue
N
W
E
S
Miles
1
0.5
0
1

Chemical Water Quality

Chemical water quality changes along the mainstem of Thomas Fork are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources of water entering the mainstem. A list of long-term monitoring sites utilized to generate the graphs with their river miles are shown below.

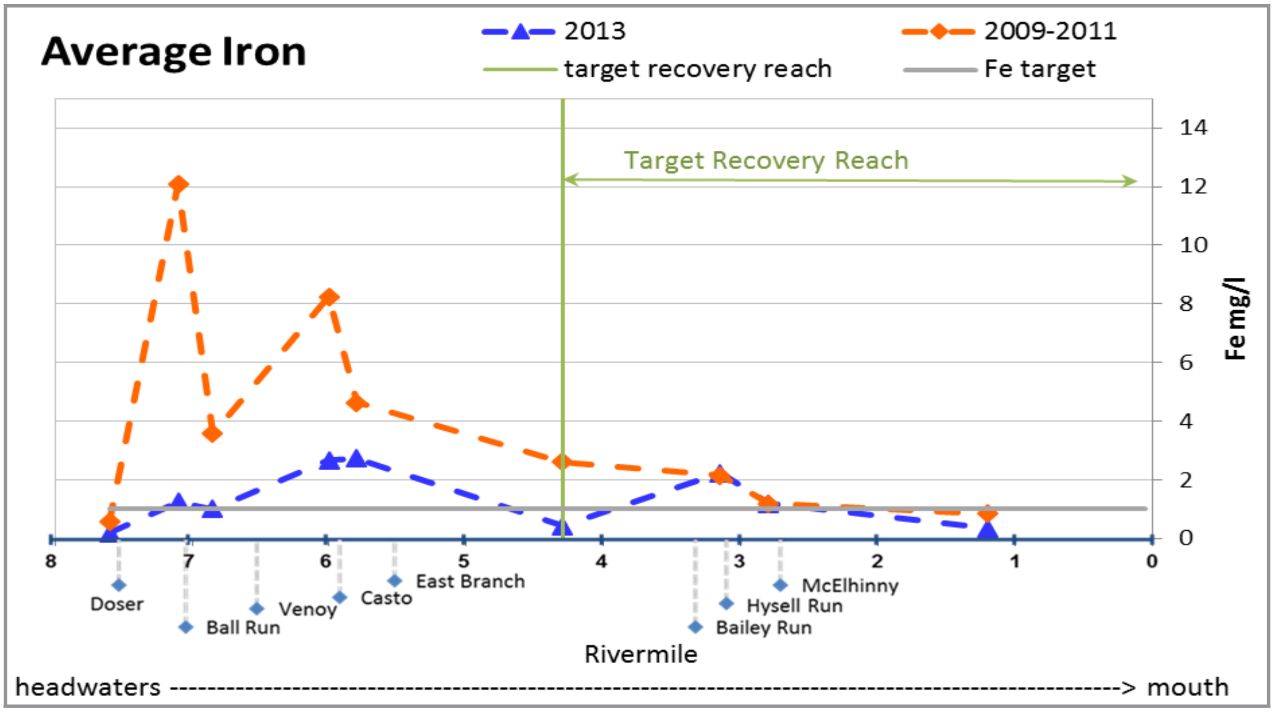
Leading Creek Watershed									
site ID	TF0071	TF0068	TF0064	TF0058	TF0050	TF0030	TF0020	TF0015	TF0010
Rivermile	7.6	7.1	6.85	6	5.8	4.3	3.15	2.8	1.2

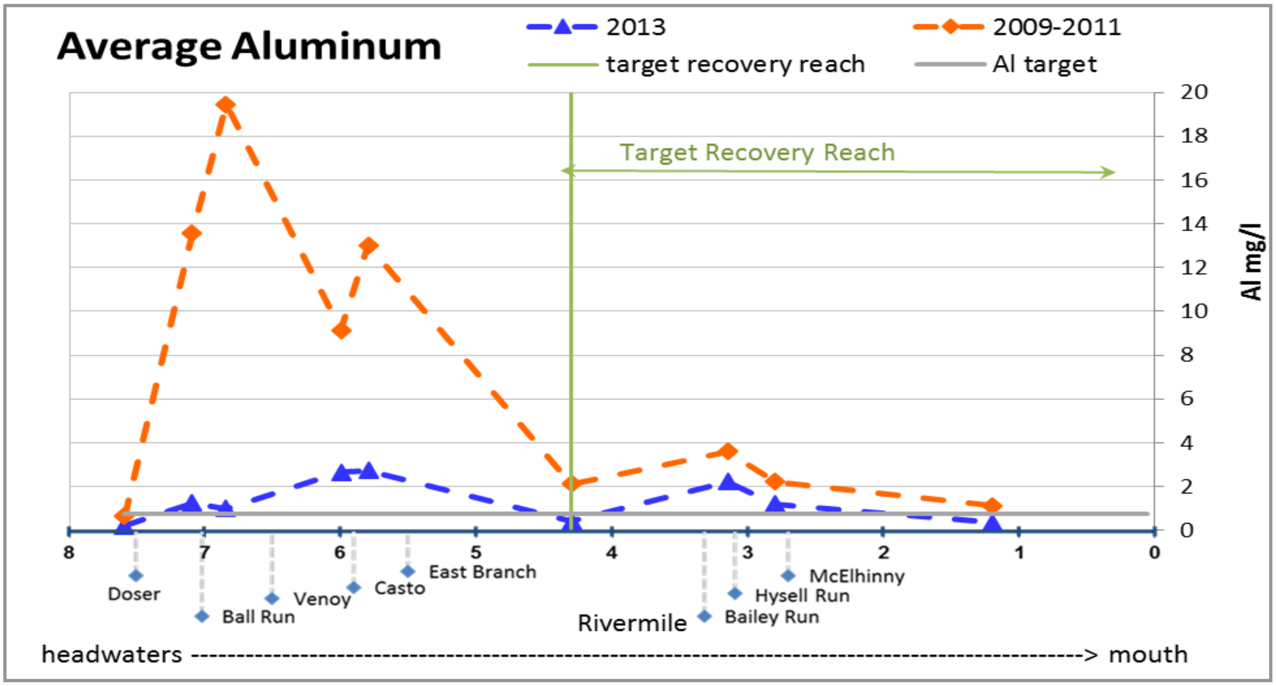




Chemical Water Quality

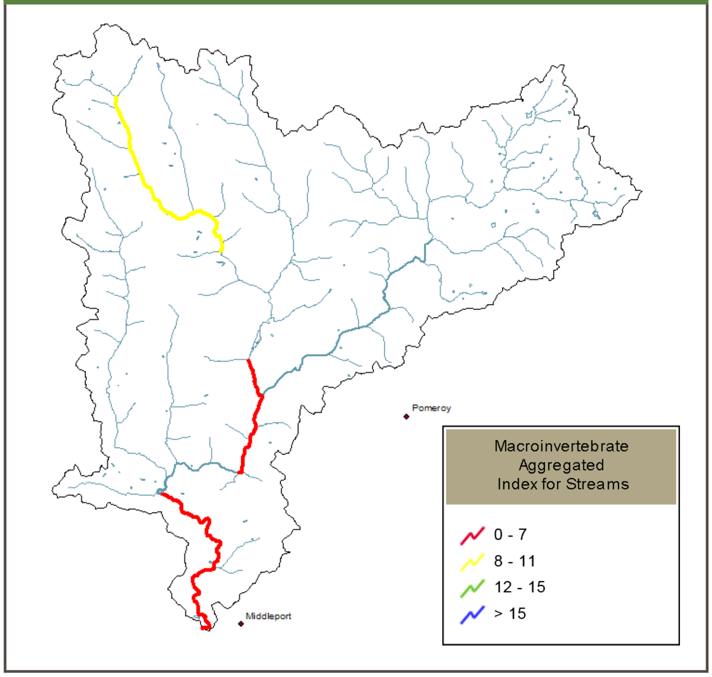
Leading Creek Watershed									
site ID	TF0071	TF0068	TF0064	TF0058	TF0050	TF0030	TF0020	TF0015	TF0010
Rivermile	7.6	7.1	6.85	6	5.8	4.3	3.15	2.8	1.2



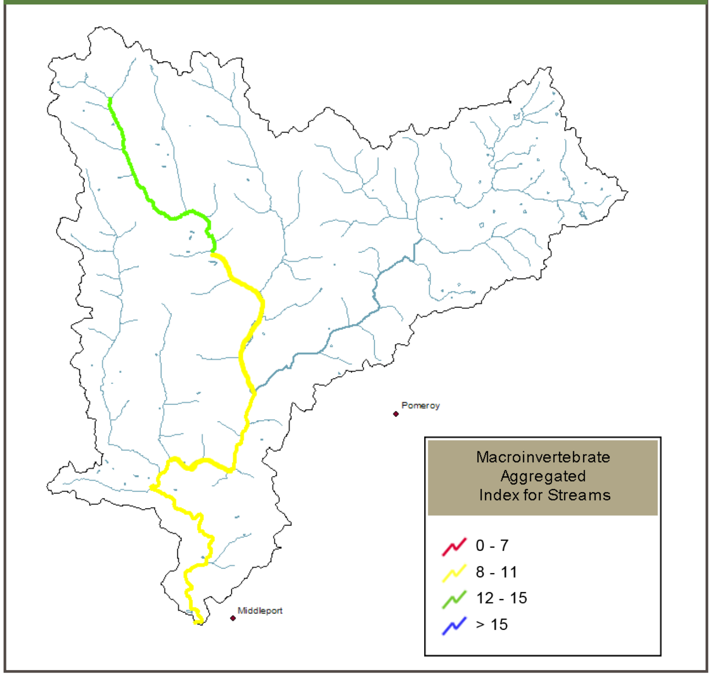


Biological Water Quality

Thomas Fork baseline MAIS



Thomas Fork 2013 MAIS



MAIS samples were collected along Thomas Fork a tributary to Leading Creek. These sites are along the mainstem at established long-term monitoring stations, collected from 2009 through 2013.

Thomas Fork

This year was the fifth year of biological monitoring in Thomas Fork of Leading Creek and our first opportunity to statistically test for trends in biological improvement. MAIS scores for the last several years have not been much higher than the "5" scored at most of the sites in 2009, but this year (2013) all scores increased by 4-6 points, a dramatic improvement (Figures 2 and 3). It is too soon to determine whether this reflects a temporary gain or permanent recovery, and too sudden to produce a statistically significant trend. However, it is encouraging and hopefully will continue in the future.

Figure 2. Area of degradation 2009-2013

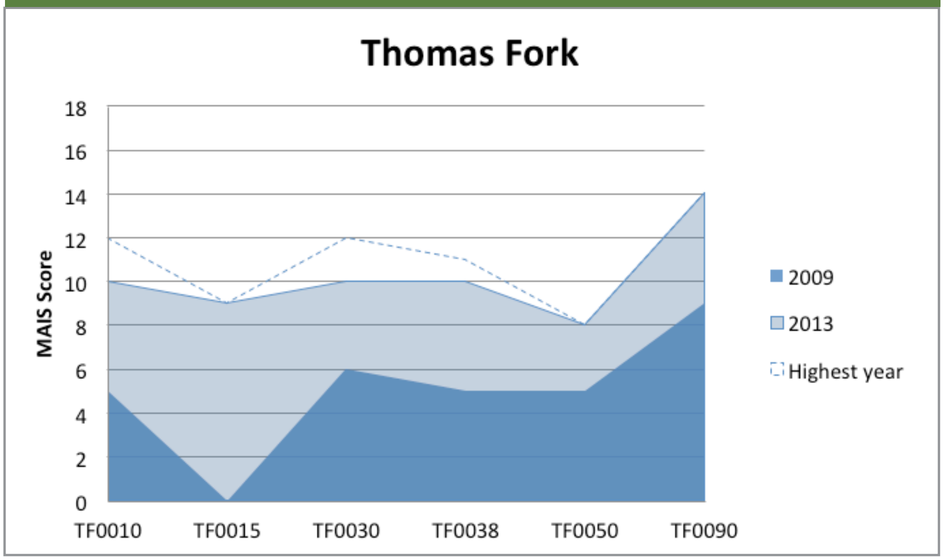


Figure 3. Thomas Fork MAIS Regressions

Site	2009	2010	2011	2012	2013	Linear trends	R square	P-value	No. of years
TF0010	5	12	5	5	10	no change	0.0199	0.8209	5
TF0015		8	6	5	9				
TF0030	6	12	4	5	10	no change	0.0021	0.9414	5
TF0038	5	11	7	5	10	no change	0.0021	0.9414	5
TF0050	5	8	3	2	8	no change	1.15E-16	1	5
TF0090	9	13	12	11	14	no change	0.4324	0.2277	5

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http://water.usgs.gov/osw/streamstats version 2