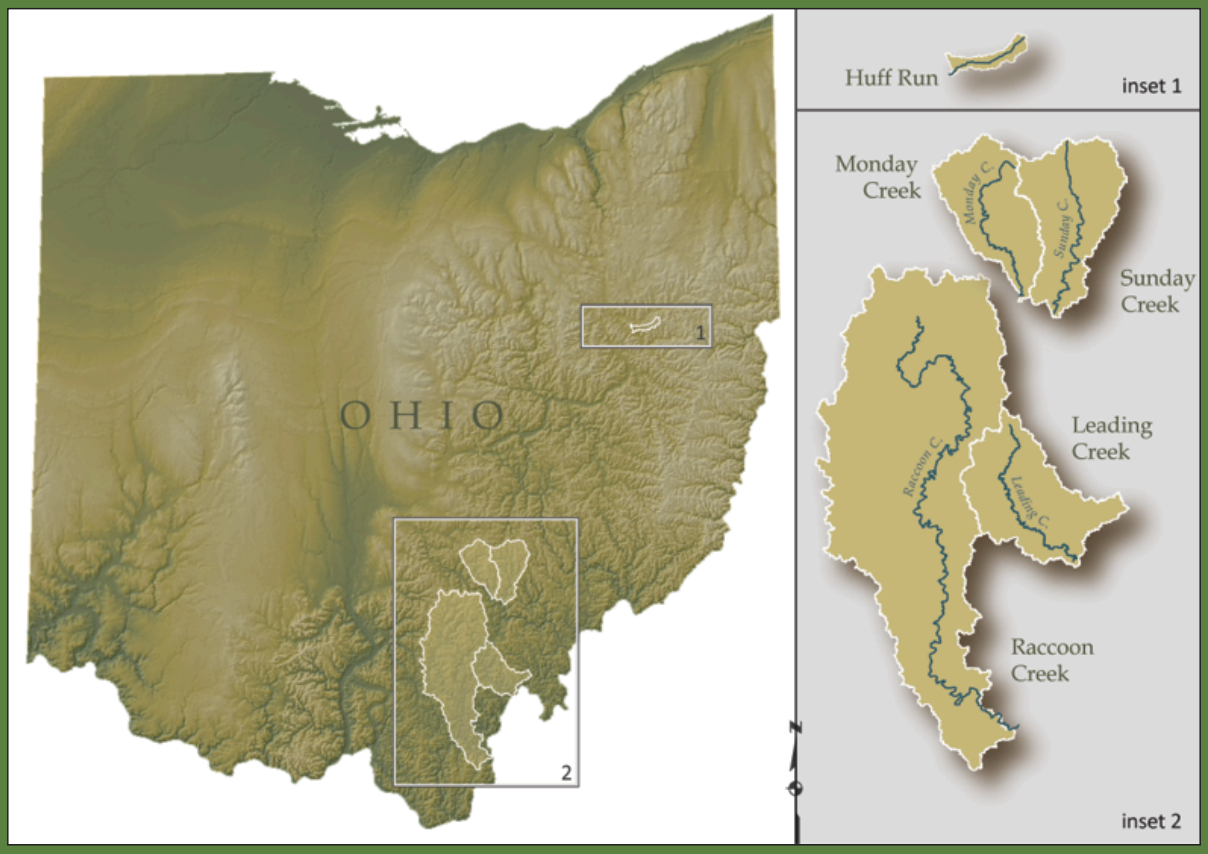
2014 STREAM HEALTH REPORT

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

JENNIFER BOWMAN AND KELLY JOHNSON

7-2-2015

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Specific AMD project entry forms used for 2014 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:

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Monday Creek: Nate Schlater and Tim Ferrell
Sunday Creek: Michelle Shaw
Huff Run: Marissa Lautzenheiser
Leading Creek: Jim Freeman
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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 (GIS and data analysis), Taeil Kim (program designer), Lindsey Siegrist (communications), Kyoung Lim (assistant programmer), and Natalie Kruse (research).

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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 1994-2001 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 Warmwater Habitat 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 198.5 miles of the 210.5 miles monitored met the pH 6.5 water quality standard in 2014.

Net alkalinity, iron, aluminum, pH, and macroinvertebrates were evaluated annually from 2006-2014. Incremental changes from year to year can be tracked using these indicators. Net alkalinity and pH values have improved from 2006 to 2014. The family-level biological indicator, Macroinvertebrate Aggregated Index for Streams (MAIS), were measured annually from 2006 to 2014, there have been slight fluctuations seen within each watershed, detailed in the biology section for each watershed. Macroinvertebrate data across all watersheds in 2014 indicated good results, most notable are the continued improvements seen in the West Branch of Sunday Creek, and mainsteam of Raccoon Creek. There was a dip in macroinvertebrate scores just downstream of Lost Run in Monday Creek, but overall throughout Monday Creek scores showed continued improvement.

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-MRM). 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 projects 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

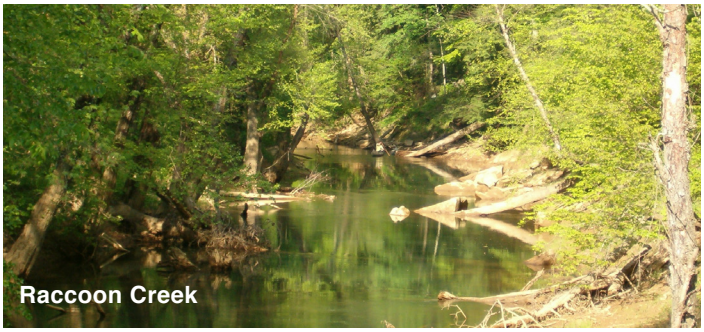
All AMD project descriptions are compiled in a separate document containing pertinent static information describing the AMD project, titled "Collection of Acid Mine Drainage (AMD) Reclamation Projects in the Coal-Bearing Region of Ohio". This will eliminate redundancy in printing static project specific 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 in chronological order 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 dynamic yearly chemical and biological data that changes 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 discharges 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. These data were 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.

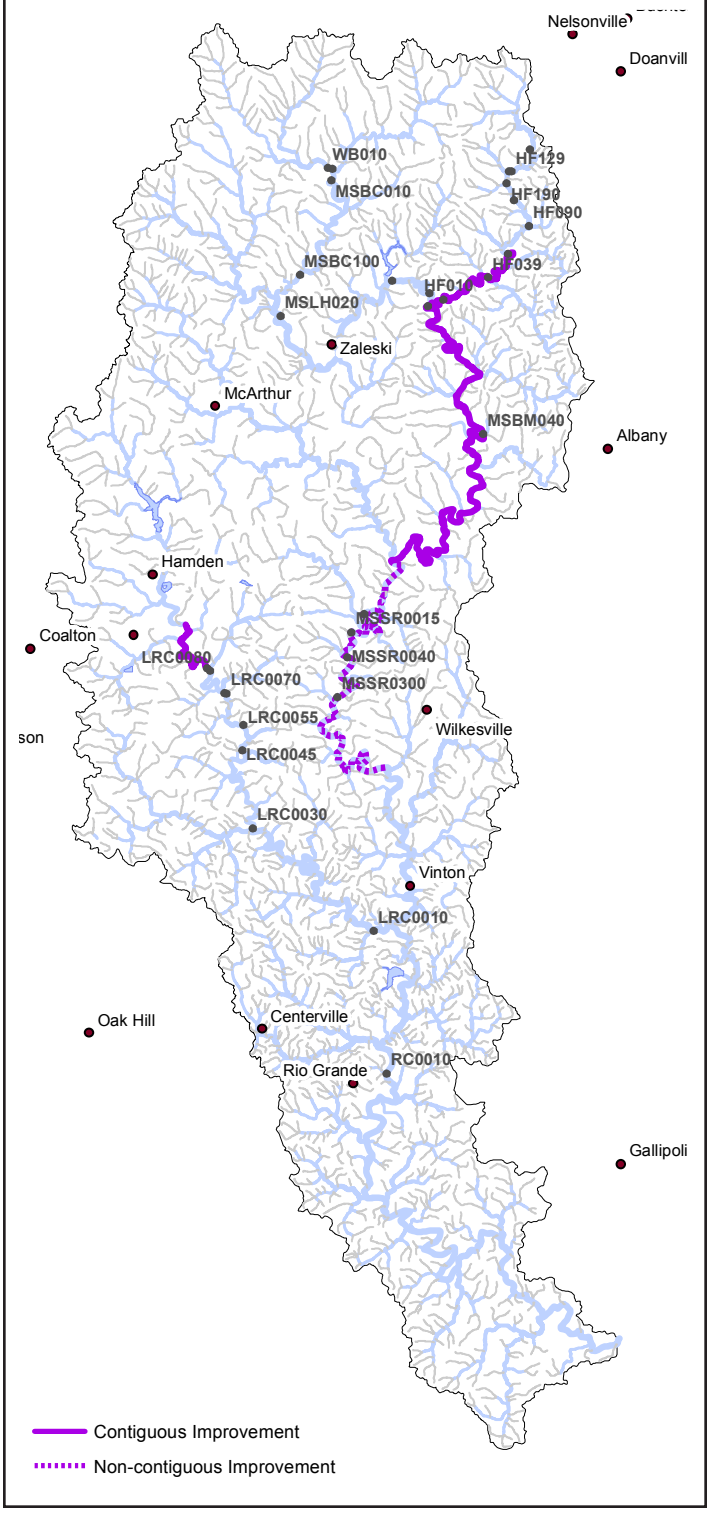


Figure 2: Biological health improvements in Raccoon Creek from 2005 to 2010.

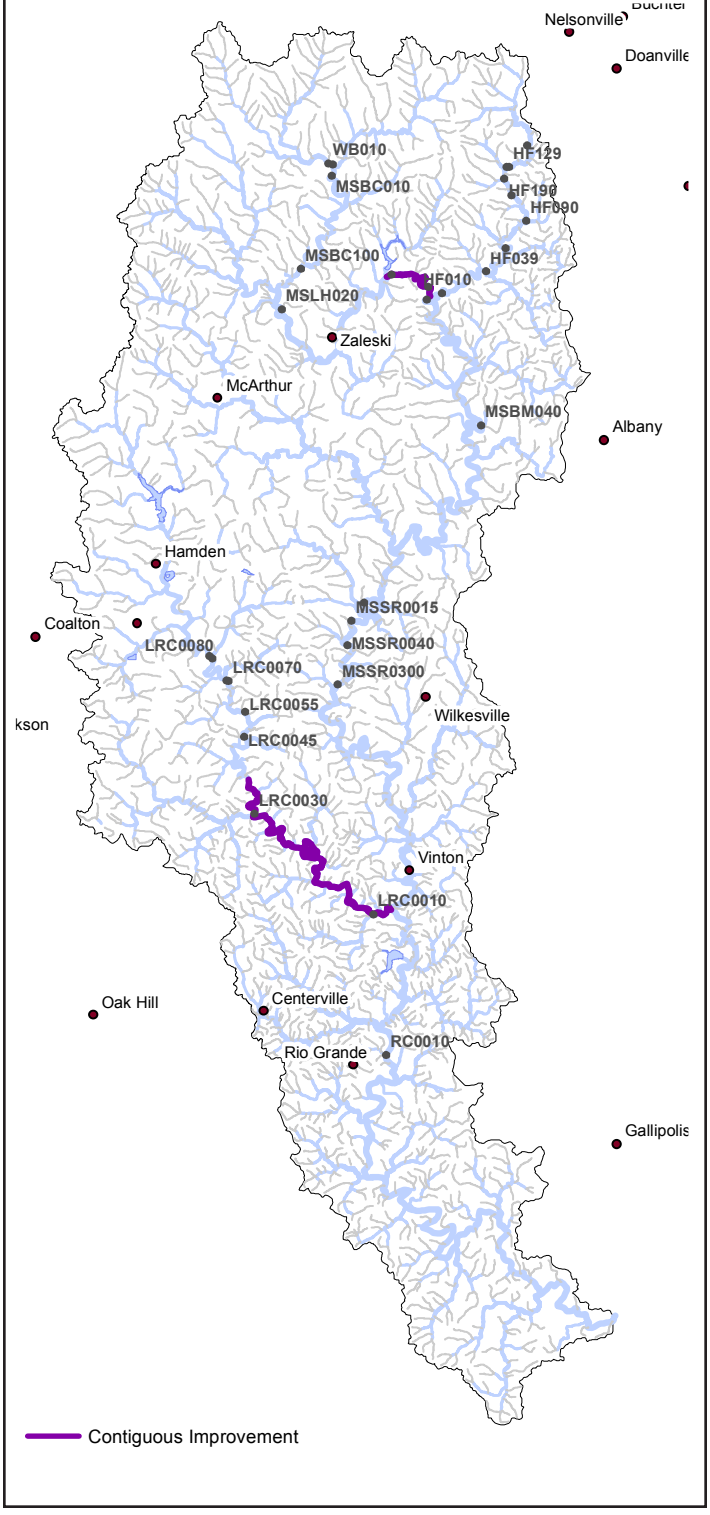


Figure 3: Biological health improvement in Sunday Creek West Branch from 2005 to 2010.

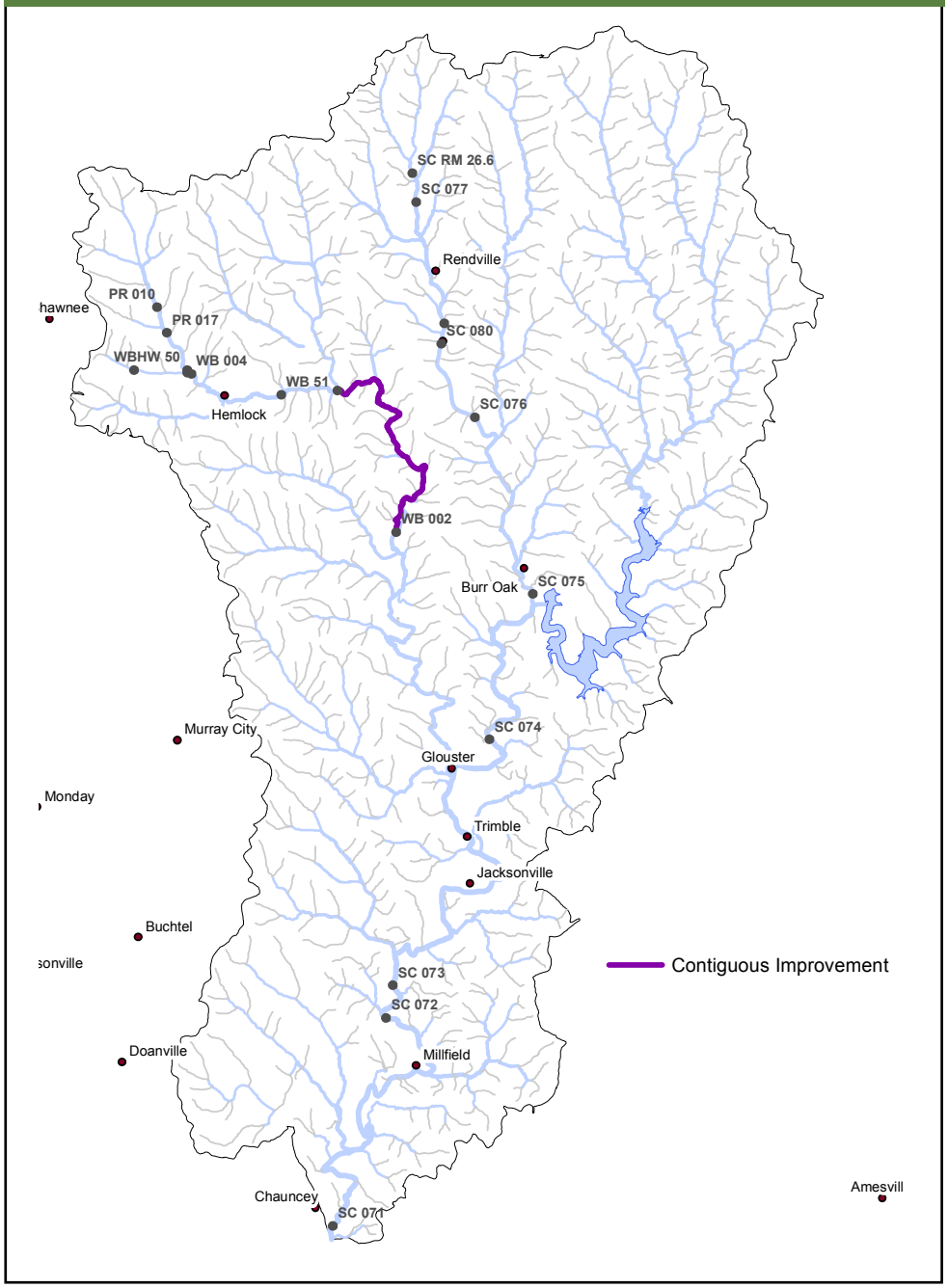


Table 1. Summary of results for each of the five watersheds evaluated in 2005 to 2014: Raccoon Creek, Monday Creek, Sunday Creek, Huff Run, and Leading Creek.

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	19	$14,292,679	5,018	23.3/18.42 (41.7)	117	117
Monday Creek	16 (plus 5 subsidence projects, costs are not included)	$6,569,422	3,035	0/0	23	32
Sunday Creek	12 (7 of 10 are sub-sidence projects)	$2,582,945	352	0/5.26 (5.26)	42	43
Huff Run	13	$5,017,262	1,063	0/0	10	10
Leading Creek	1	$415,437	661	NA/0	6.5	8.5
Total	61	$28,877,746	10,126	23.3/23.7 (47.0)	198.5	210.5

Reductions

Total to date acid load reductions = 10,126 lbs/day

Costs

Total to date reclamation costs = $28,877,746

RACCOON CREEK WATERSHED REPORT

Reductions

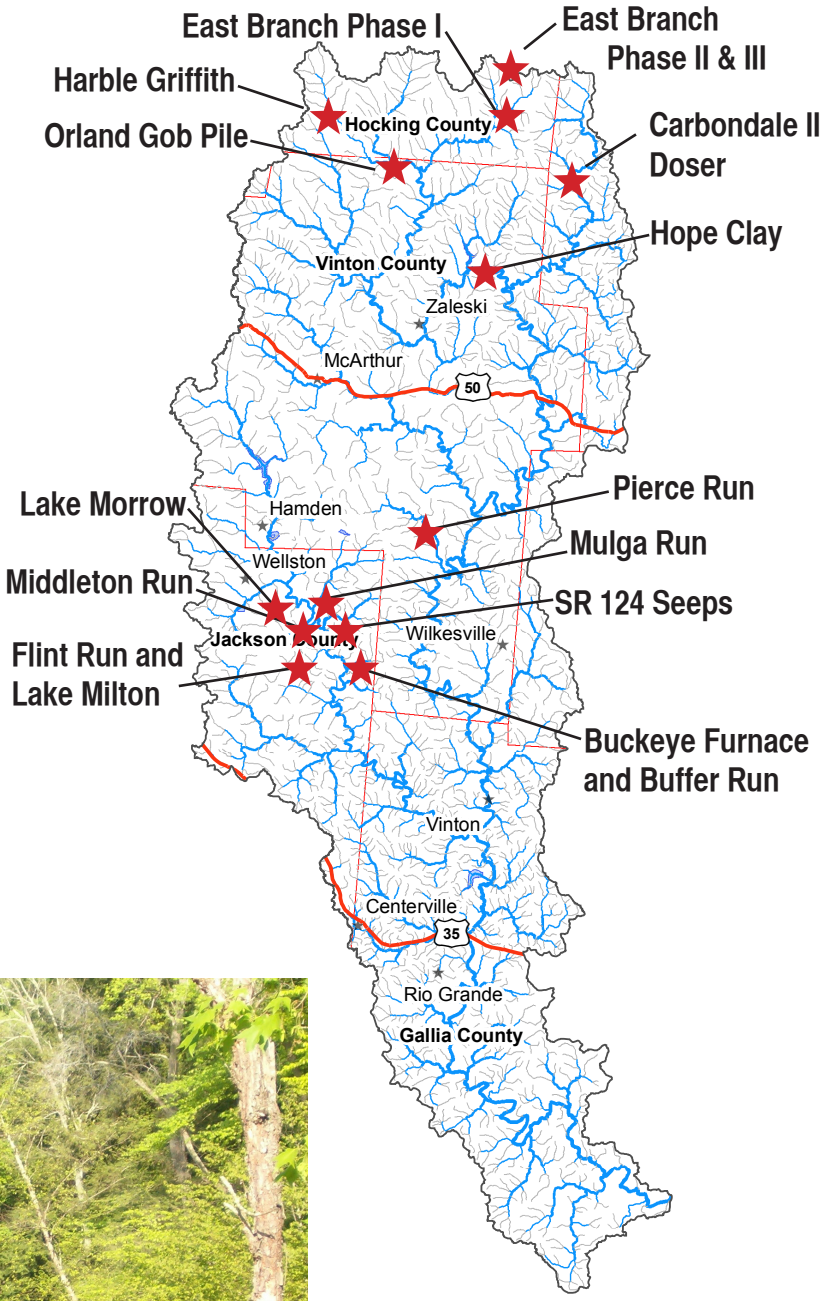
Total acid load reduction = 5,018 lbs/day
Total metal load reduction = 915 lbs/day

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

Cost

Design = $1,819,615
Construction = $12,473,064

Total Costs through 2014 = $14,292,679



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
2014	• Middleton Run II – Reclamation and Lake Morrow Projects complete

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

1999	Buckeye Furnace/Buffer Run (BR0010) – Passive SAPS and gob pile reclamation
2001	State Route 124 Seeps (OTF0010) – Surface reclamation and limestone drains
2004	Carbondale II Doser (HF131) – Active calcium oxide doser
	Mulga Run (MR0010) – 2 Steel slag beds and wetland enhancement
2005	*Hope Clay (HC001) – surface reclamation and limestone channels*
	Salem Road/Middleton Run (MiR0021, MiR0032, MiR0090) - limestone channels, steel slag leach beds, J-trenches, surface reclamation, and limestone leach bed
2006	Flint Run East (FR0126) – dewatering strip pits with multiple passive treatments
	Lake Milton (FR0120) – SAPS and steel slag bed
2007	East Branch Phase I (EB210 and EB 160) – 8 steel slags beds, limestone channels, gob pile reclamation, and passive settling ponds
2010-2011	East Branch Phase II & III (EB190) – 4 steel slag beds
2012	East Branch Phase I Maintenance – Valves replace, under drains extended, and new steel slag installed
	Jackson Area AMD Maintenance (Flint Run and Lake Milton) – Under drains extended, new steel slag installed, valves replaced, weir installed, and SAPS intake pipe relocated
2013	Orland Gob Pile (WB050) – Gob pile reclamation with limestone channels
	Harble Griffith (WB094, WB084, WB086) – Surface reclamation, limestone channels, and passive wetland
	Pierce Run (PR0010) – Steel slag bed
2014	Lake Morrow (FR0110) – reclaiming strip pit lakes and spoil
	Middleton Run Reclamation II (MiR0110) – surface reclamation

Italicized indicated projects are not actively monitored for acid mine drainage and metal load reduction purposes

2014 NPS Report - Raccoon Creek Watershed

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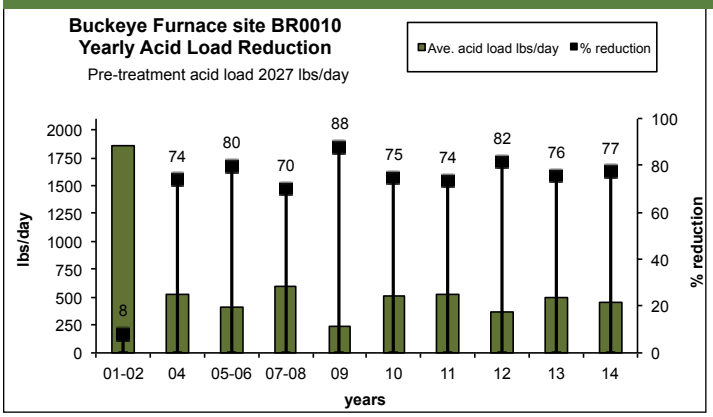
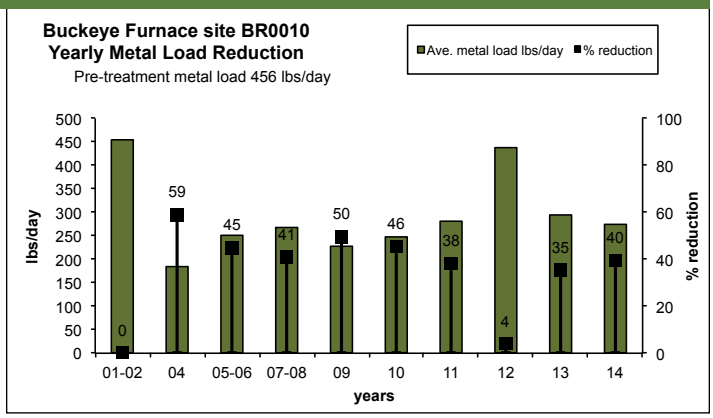
Yearly acid and metal load reduction trends per project

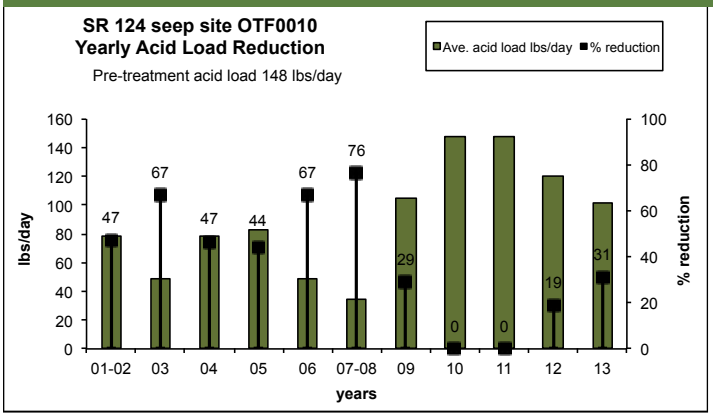
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, 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.

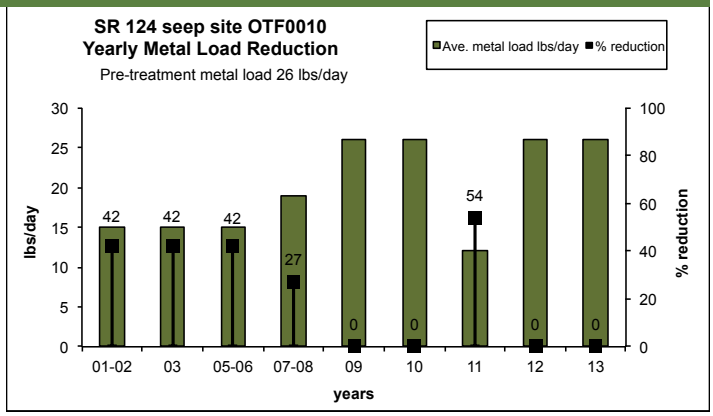
Buckeye Furnace site BR0010



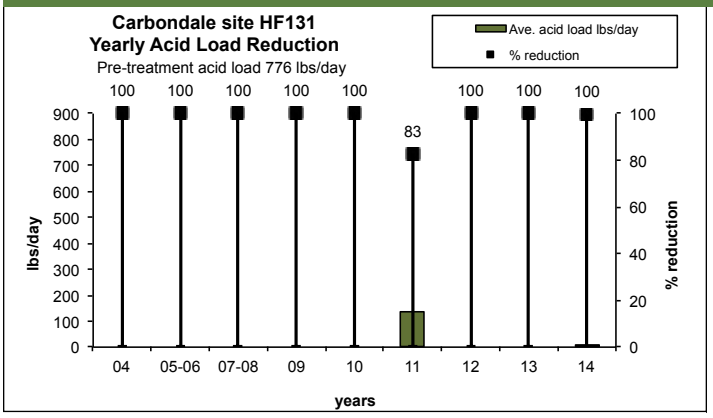


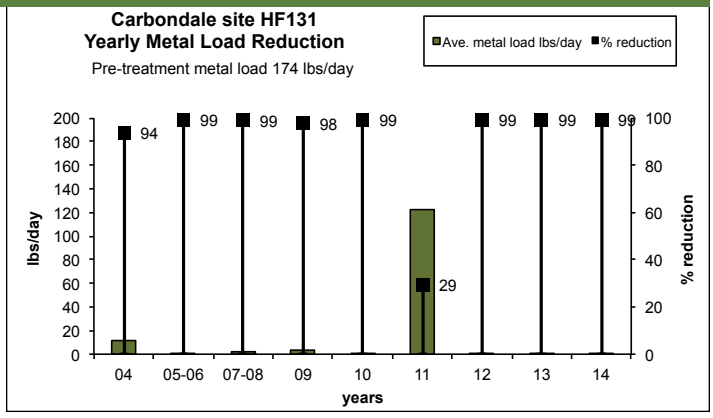
State Route 124 seep site OTF0010





Carbondale site HF131





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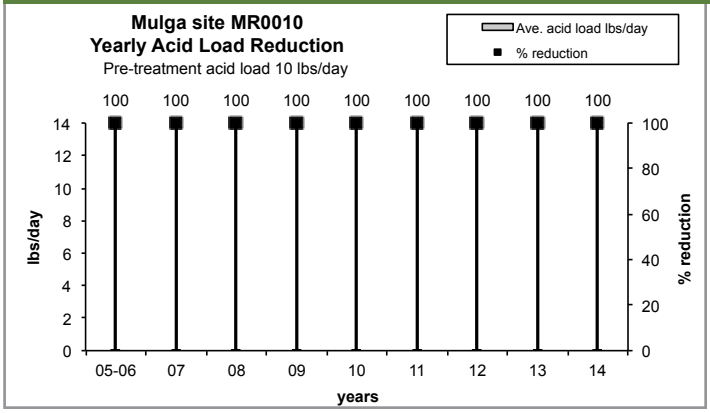
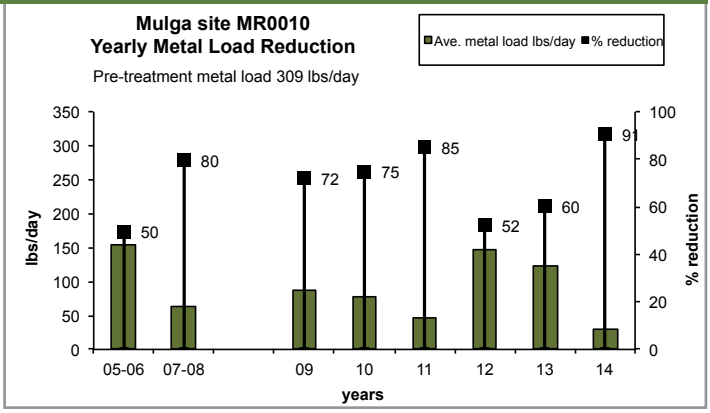
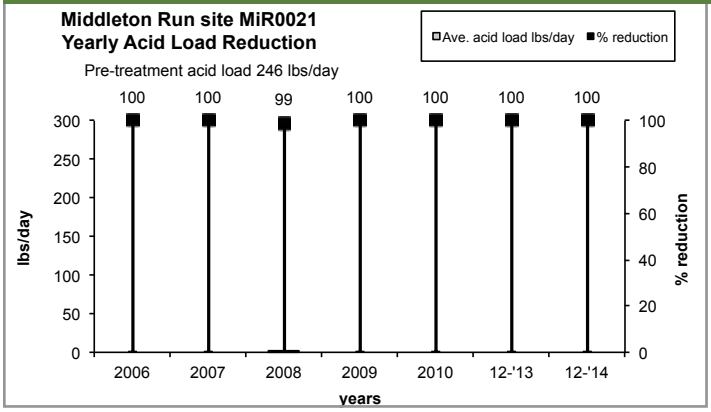
Yearly acid and metal load reduction trends per project

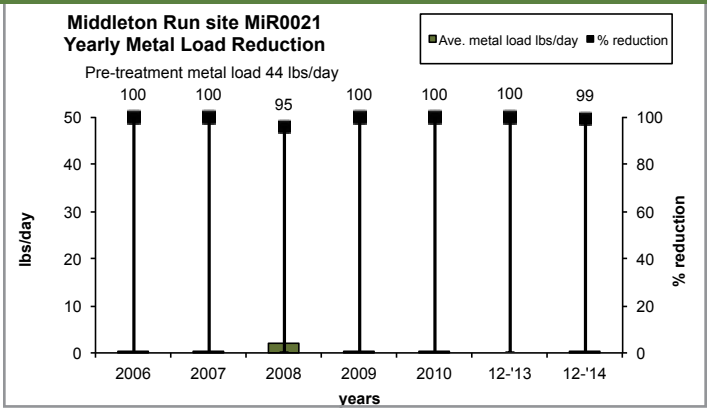
Mulga site MR0010



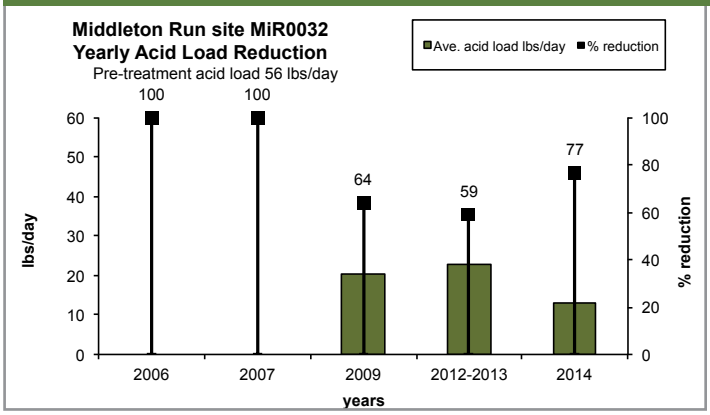


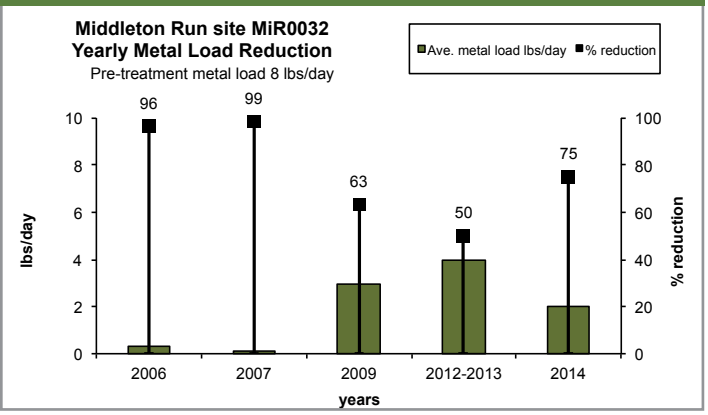
Middleton Run site MiR0021





Middleton Run site MiR0032





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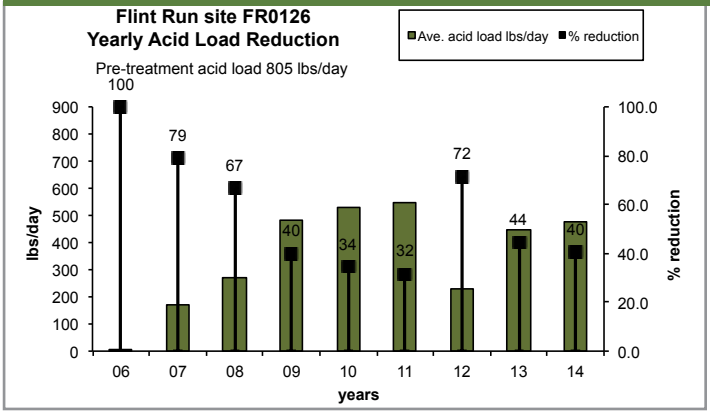
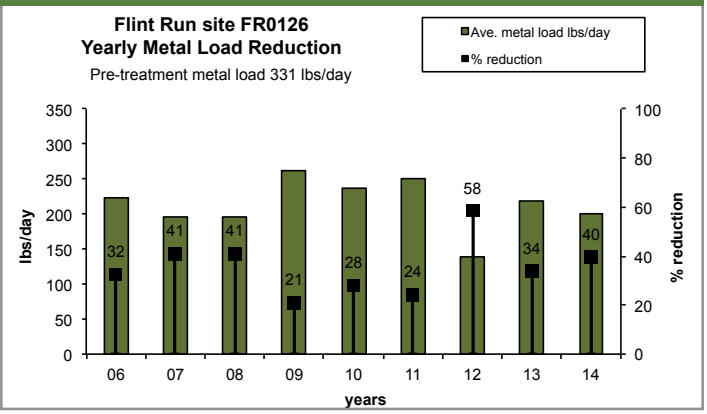
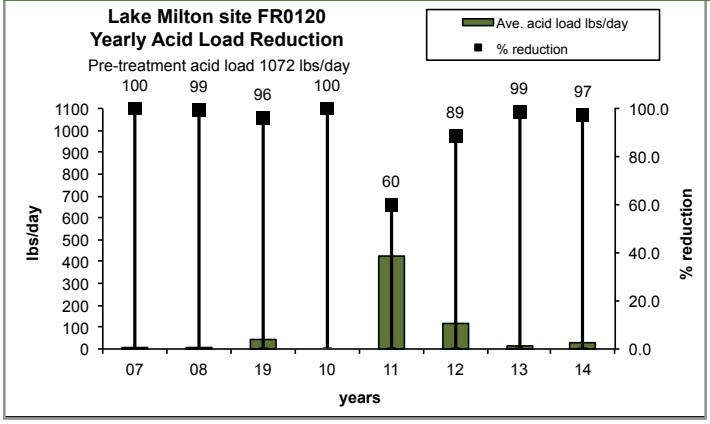
Yearly acid and metal load reduction trends per project

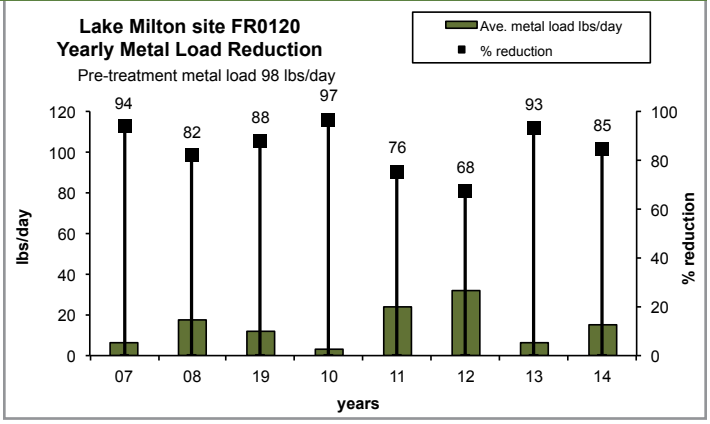
Flint Run site FR0126



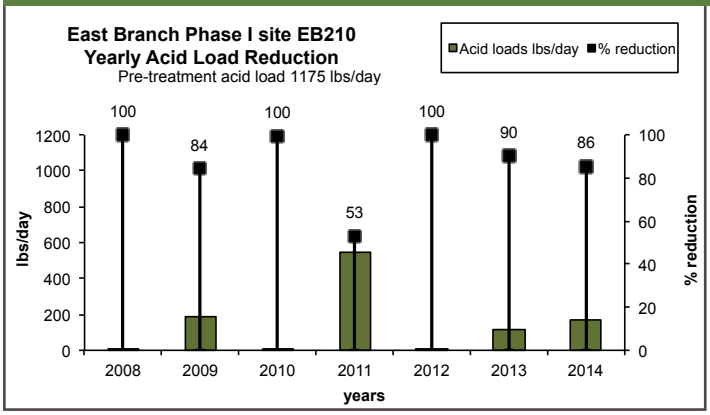


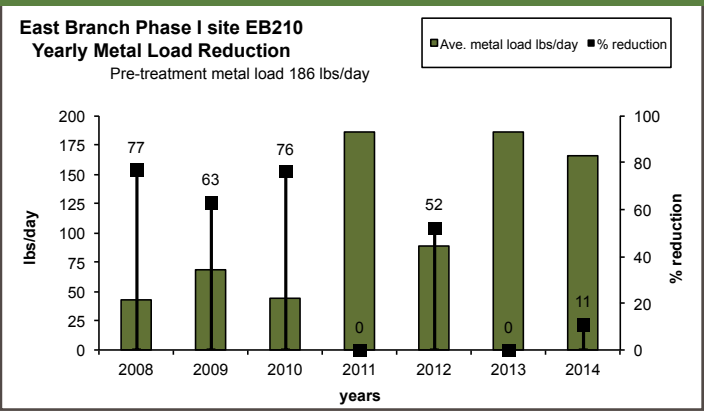
Lake Milton site FR0120





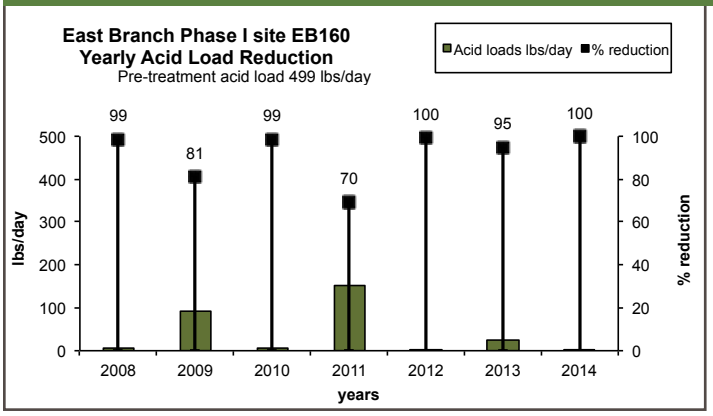
East Branch Phase I site EB210

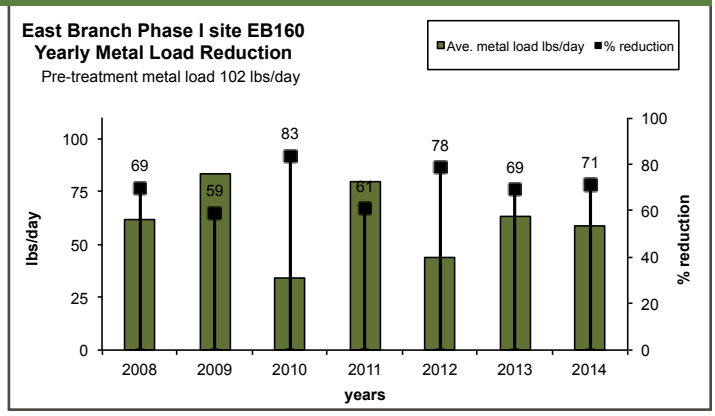




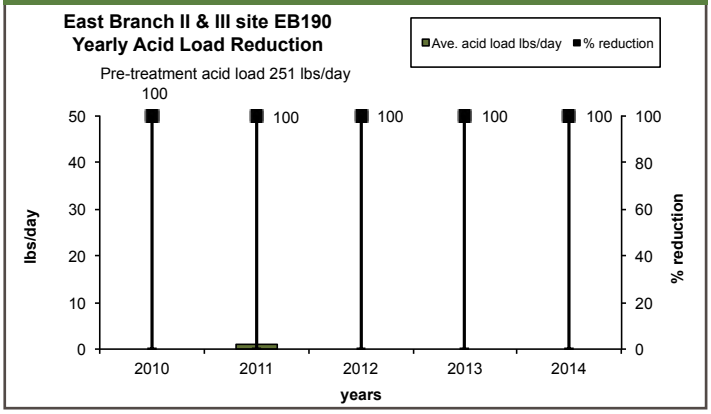
Yearly acid and metal load reduction trends per project

East Branch Phase I site EB160

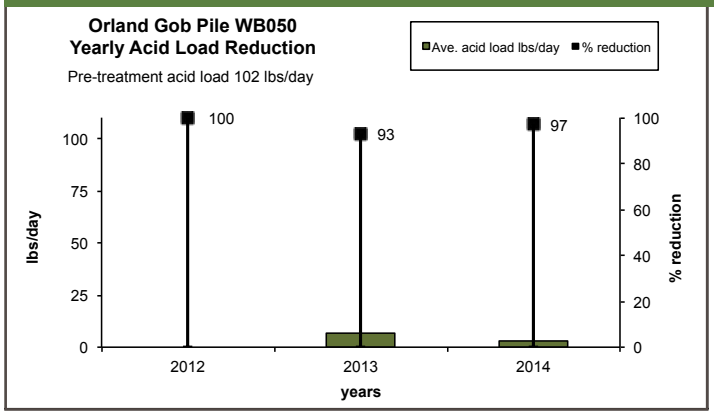


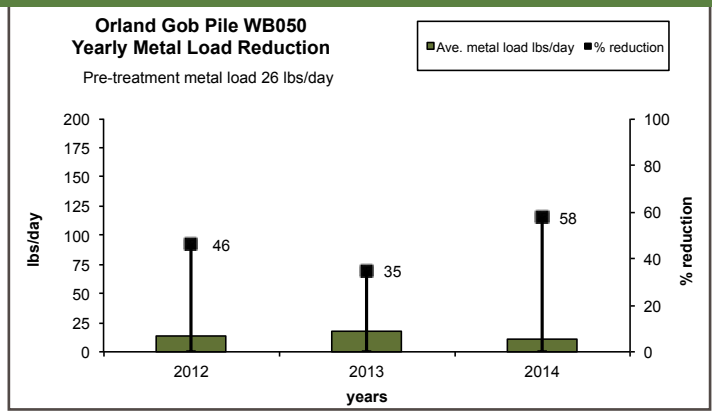


East Branch Phase II & III site EB190



Orland Gob Pile site WB050





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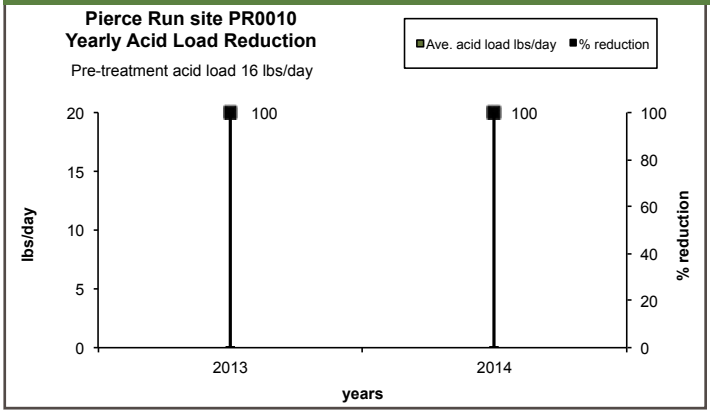
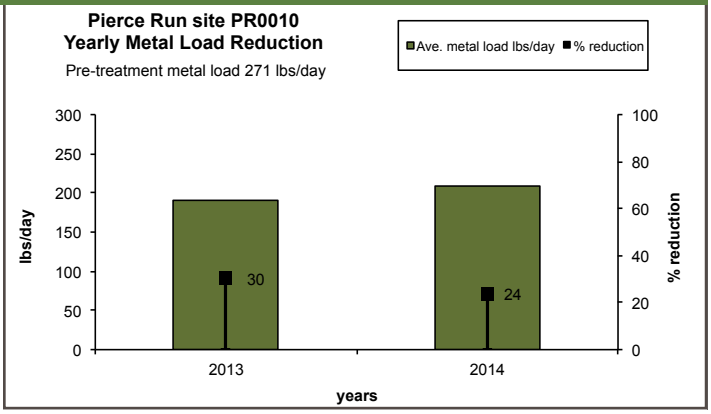
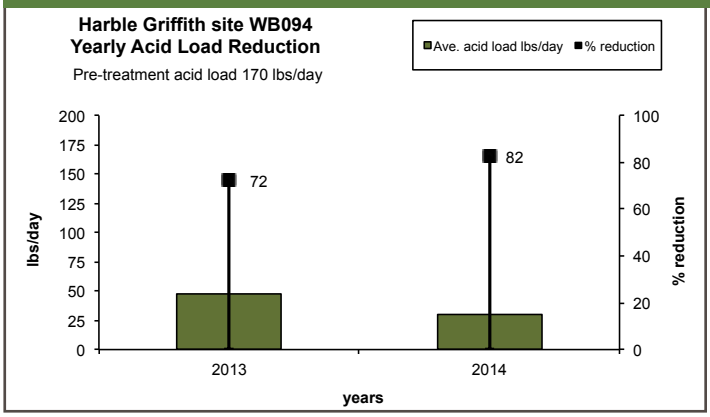
Yearly acid and metal load reduction trends per project

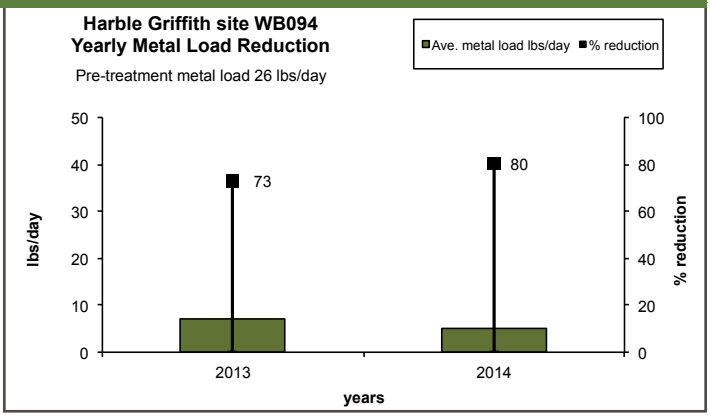
Pierce Run site PR0010



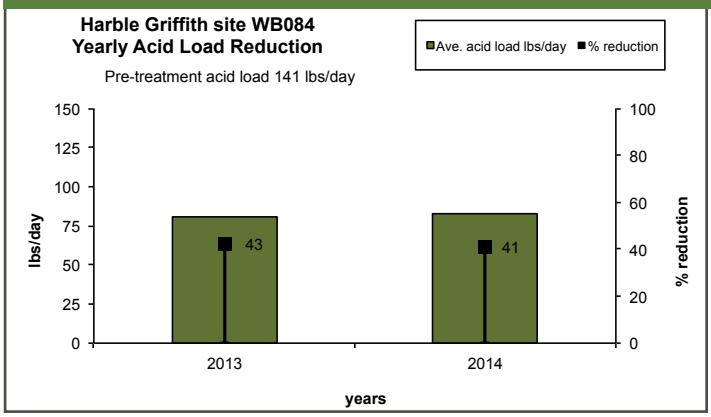


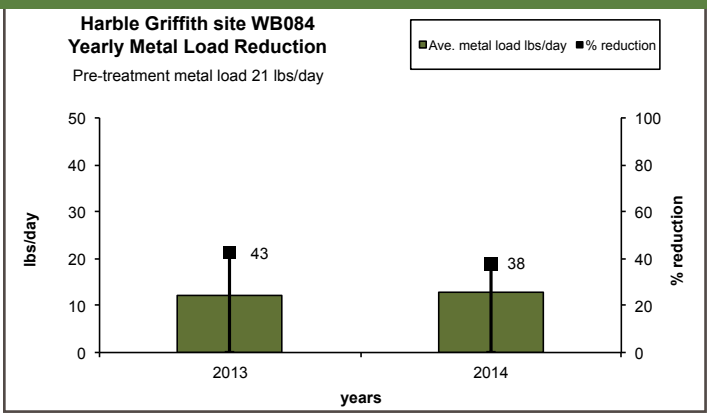
Harble Griffith site WB094





Harble Griffith site WB084





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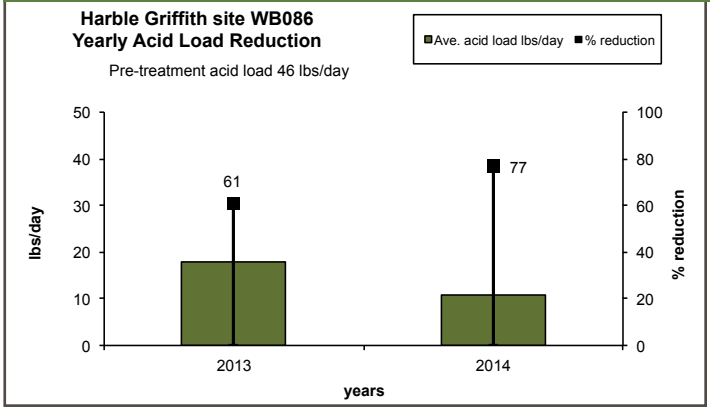
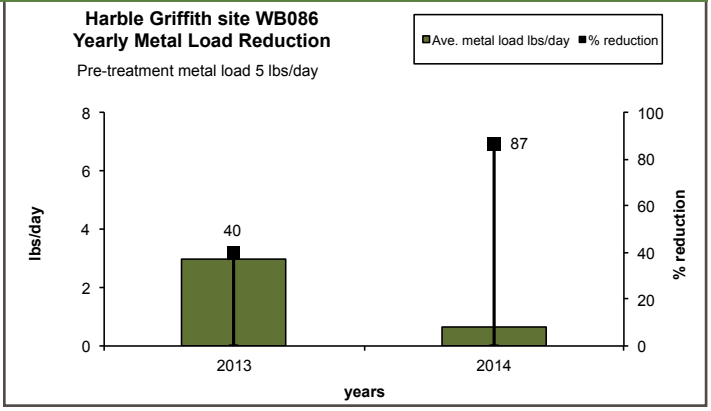
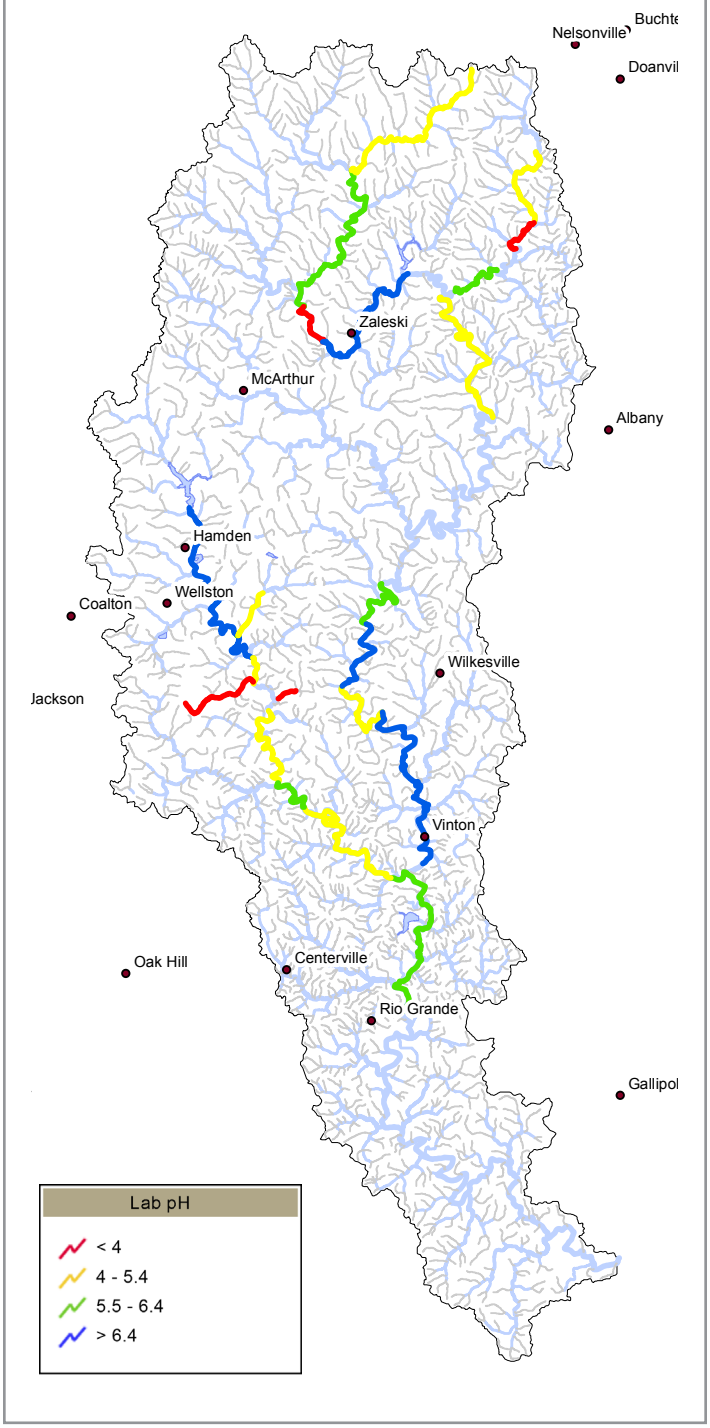
Yearly acid and metal load reduction trends per project

Harble Griffith site WB086

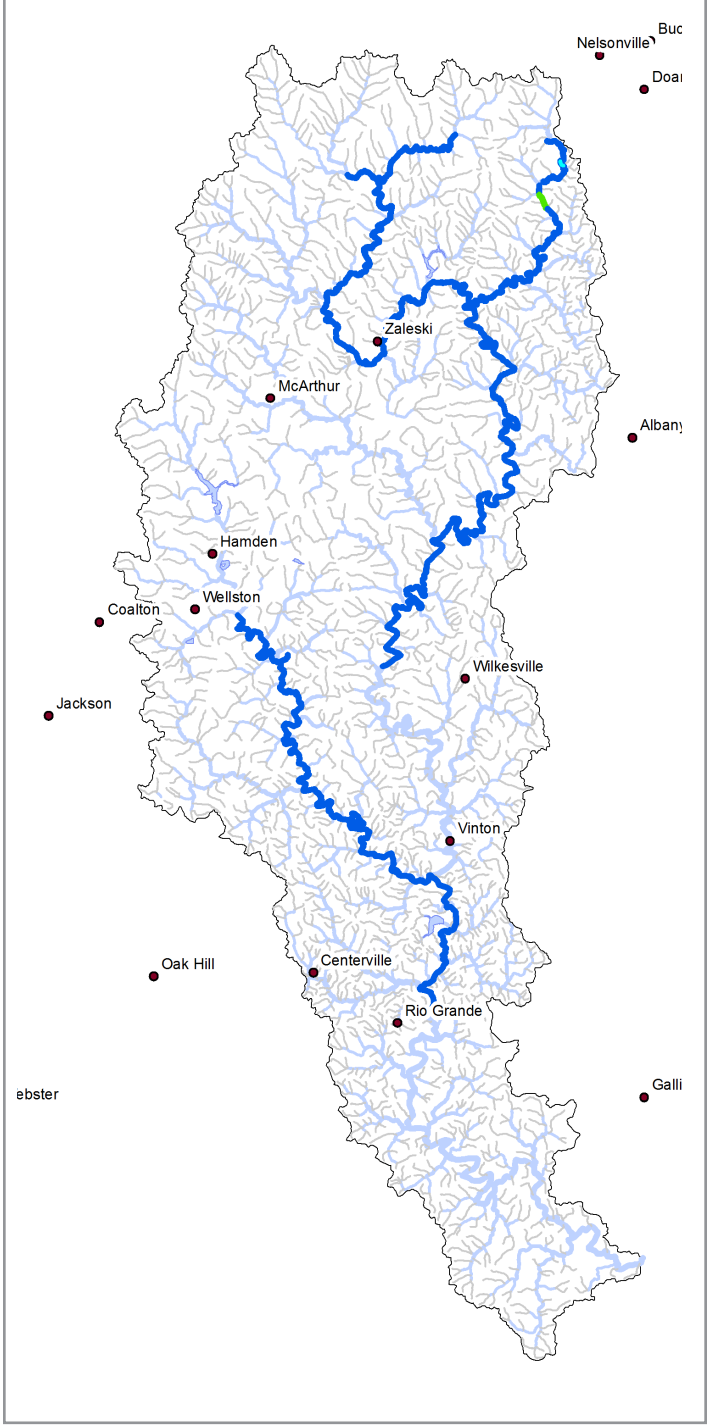




Raccoon Creek baseline pH



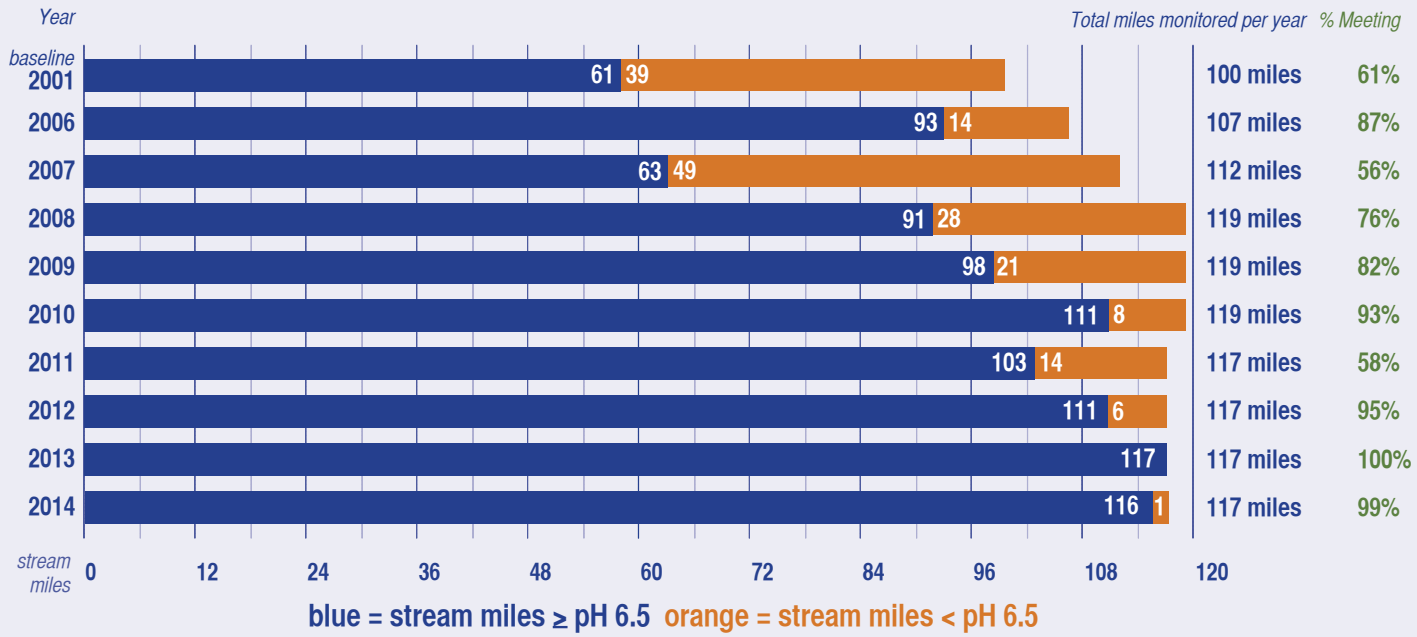
Raccoon Creek 2014 pH



In Raccoon Creek pH values have improved throughout the watershed from baseline conditions (1994-2001) to 2014. 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 2014, except for a short section of stream directly downstream of the Carbondale doser. Of the miles of stream monitored in 2014, 14.2 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).

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 2014, all but about one half mile 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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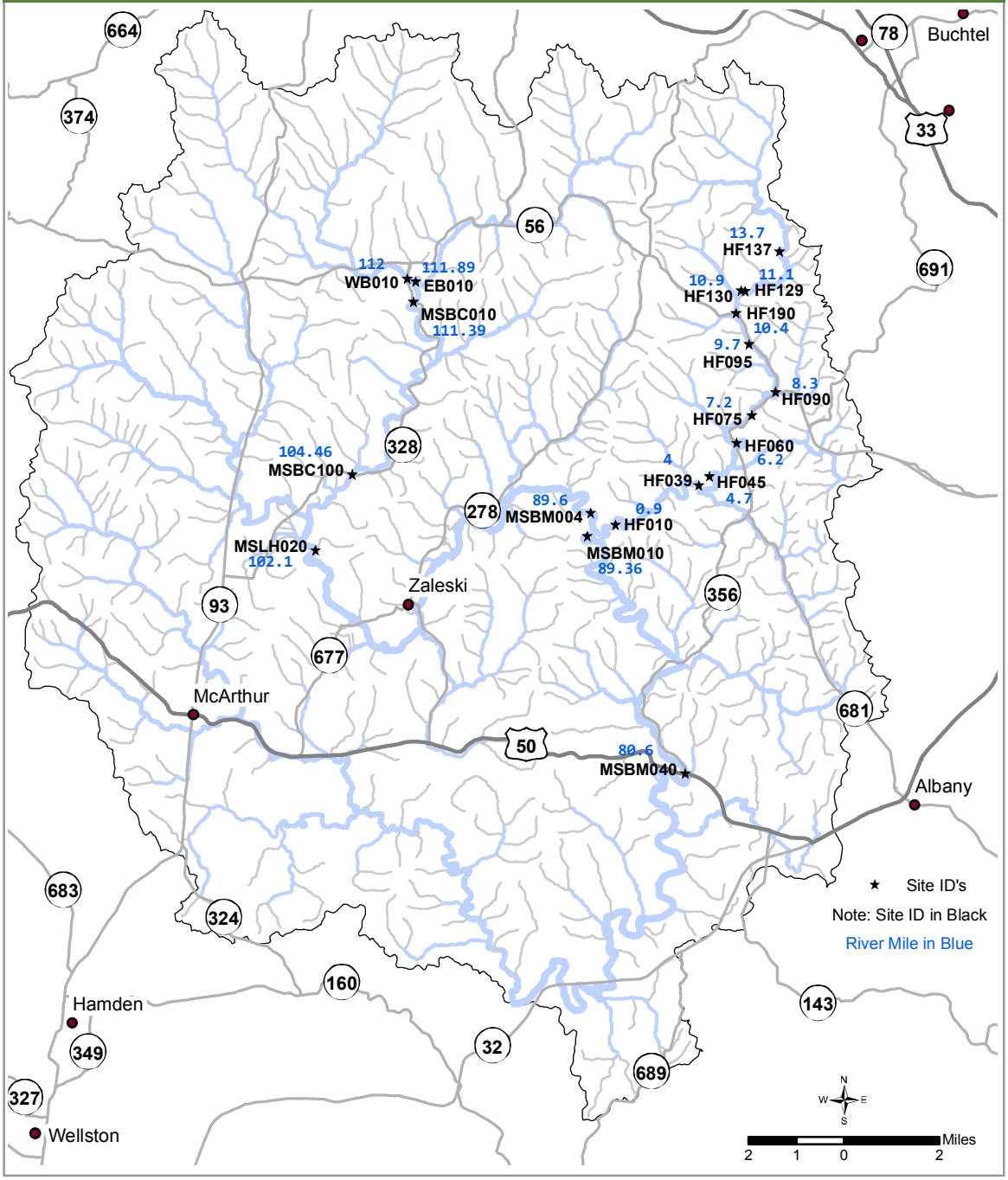
Chemical water quality analysis per stream reach

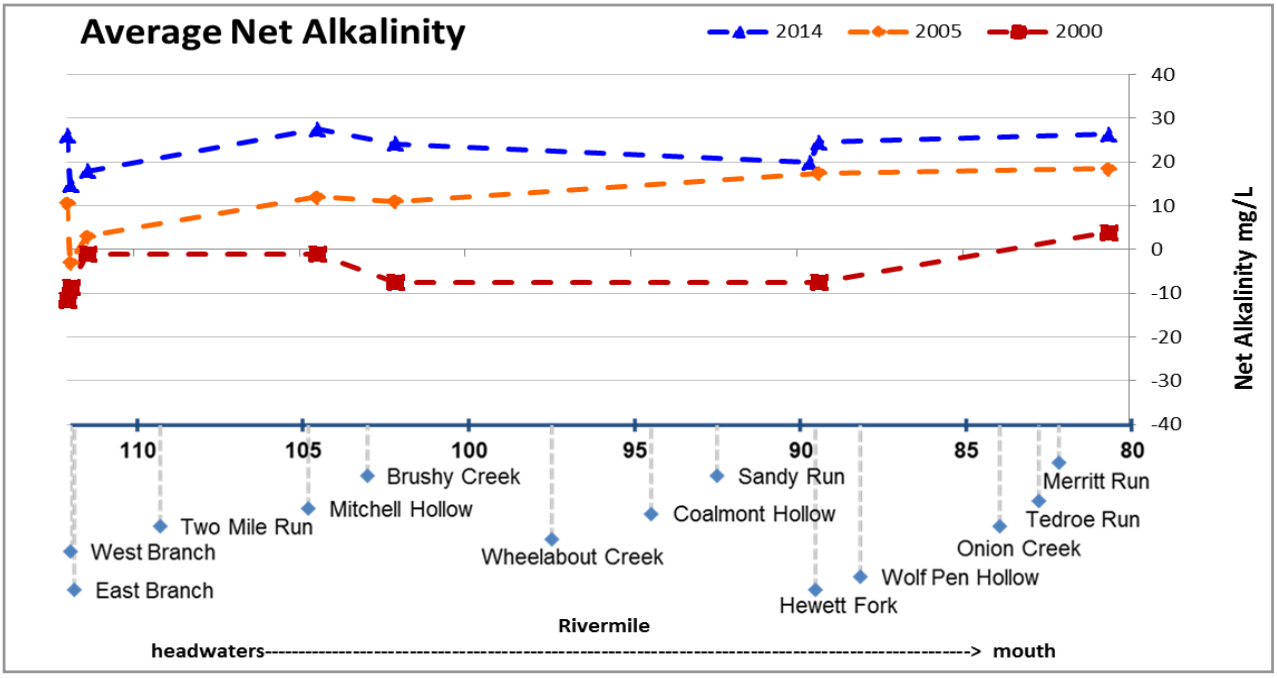
For purposes of analyzing chemical water quality changes along the mainstem of receiving stream where AMD reclamation projects have been completed, Raccoon Creek has been divided into the following stream segments: Raccoon Creek Mainstem, Little Raccoon Creek, and Hewett Fork. Within these stream reaches, 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.

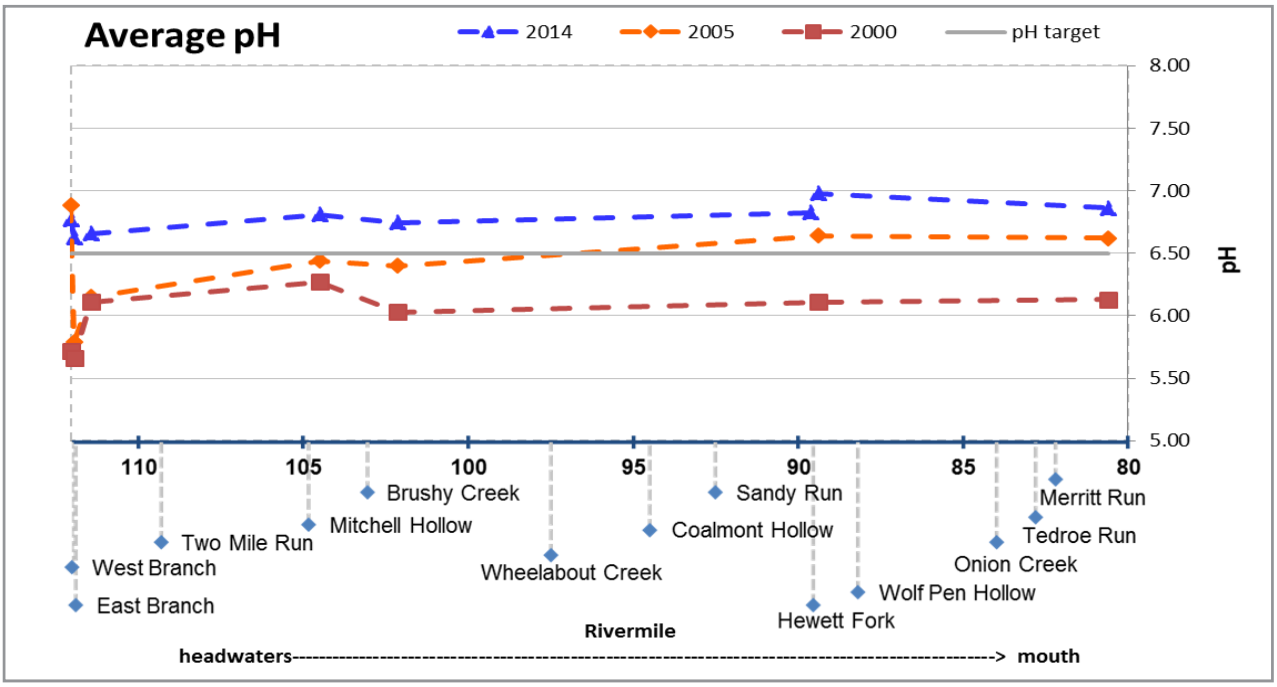
Raccoon Creek Mainstem



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

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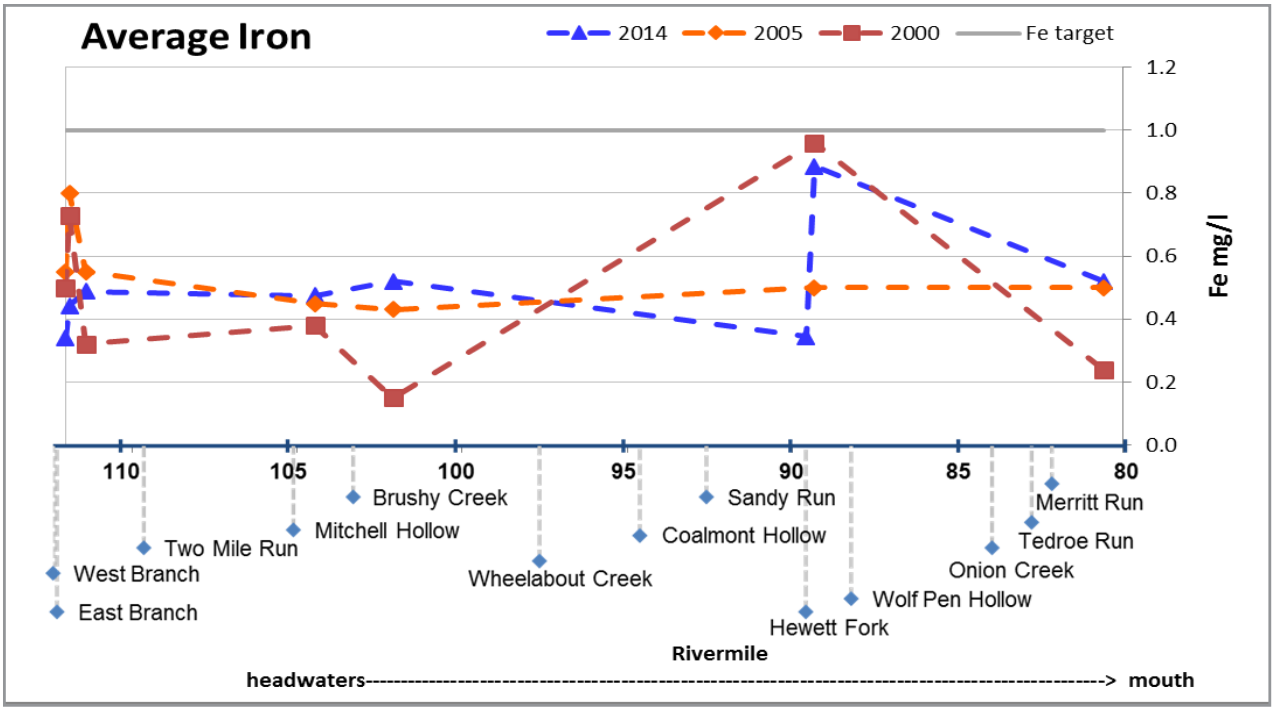

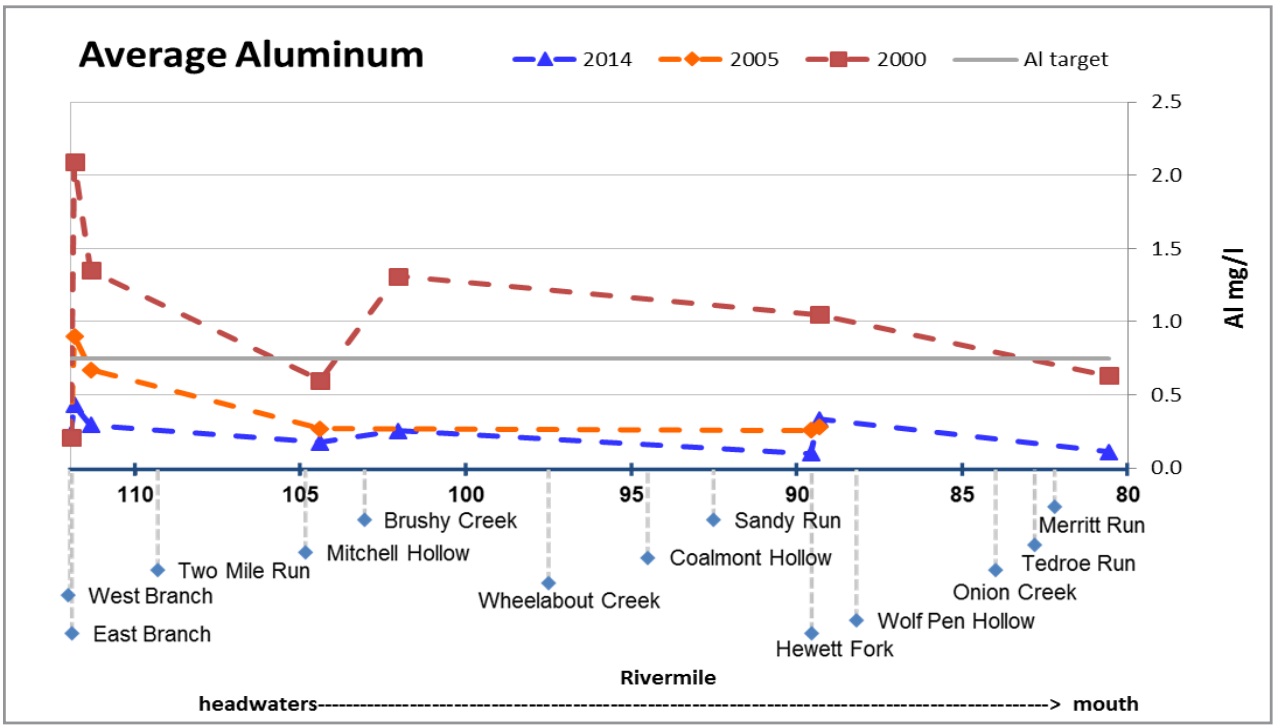

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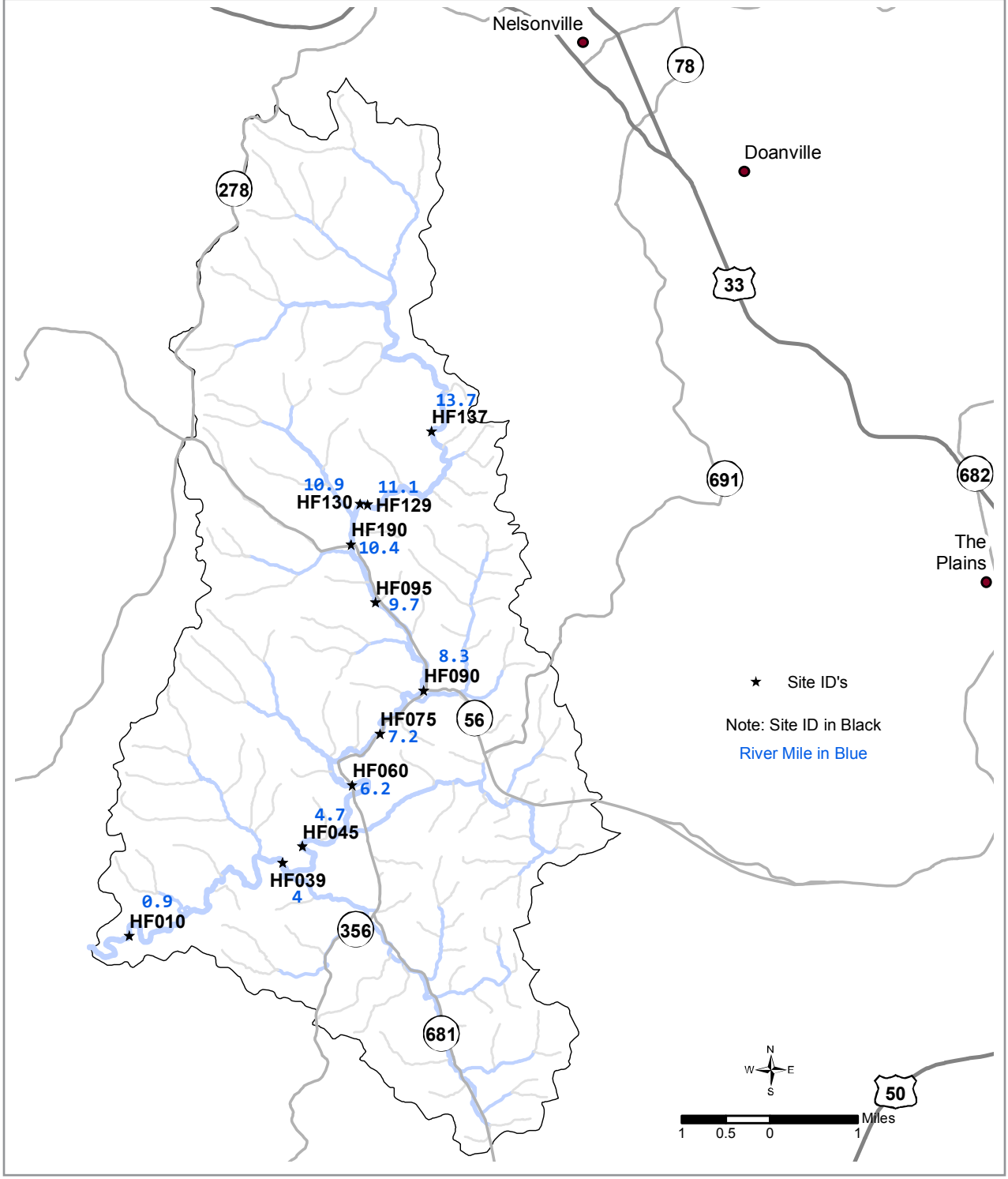
Chemical water quality analysis per stream reach

Hewett Fork

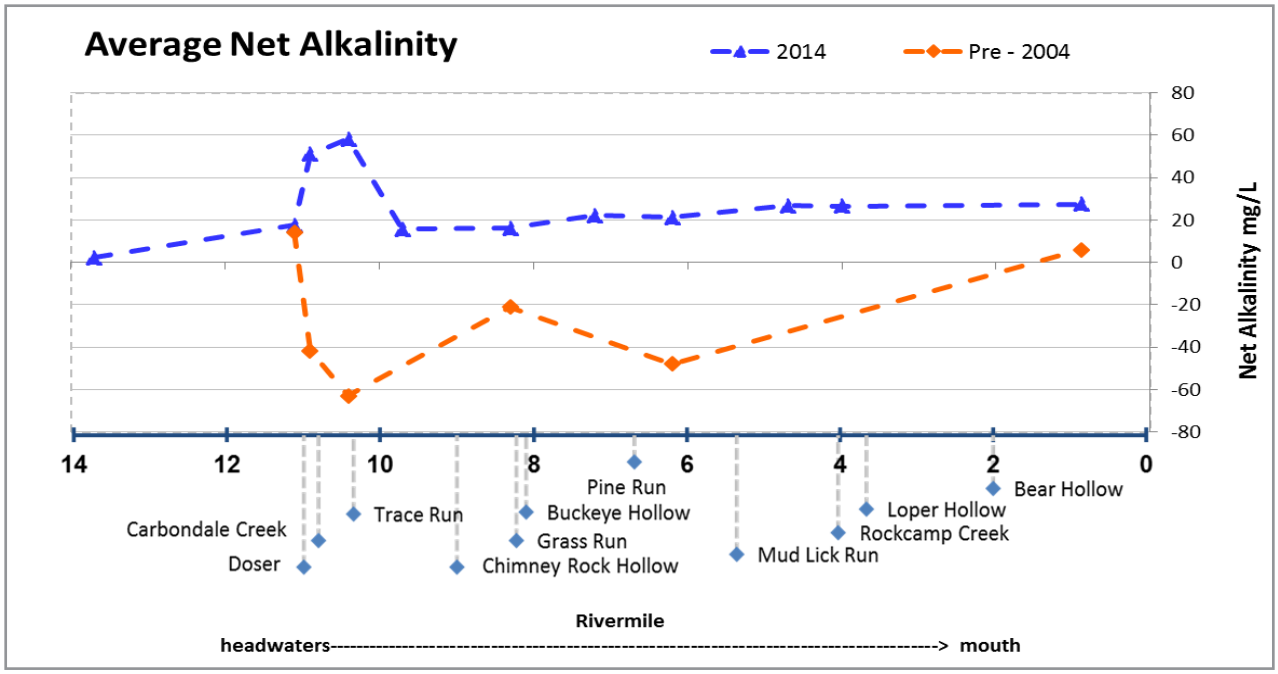


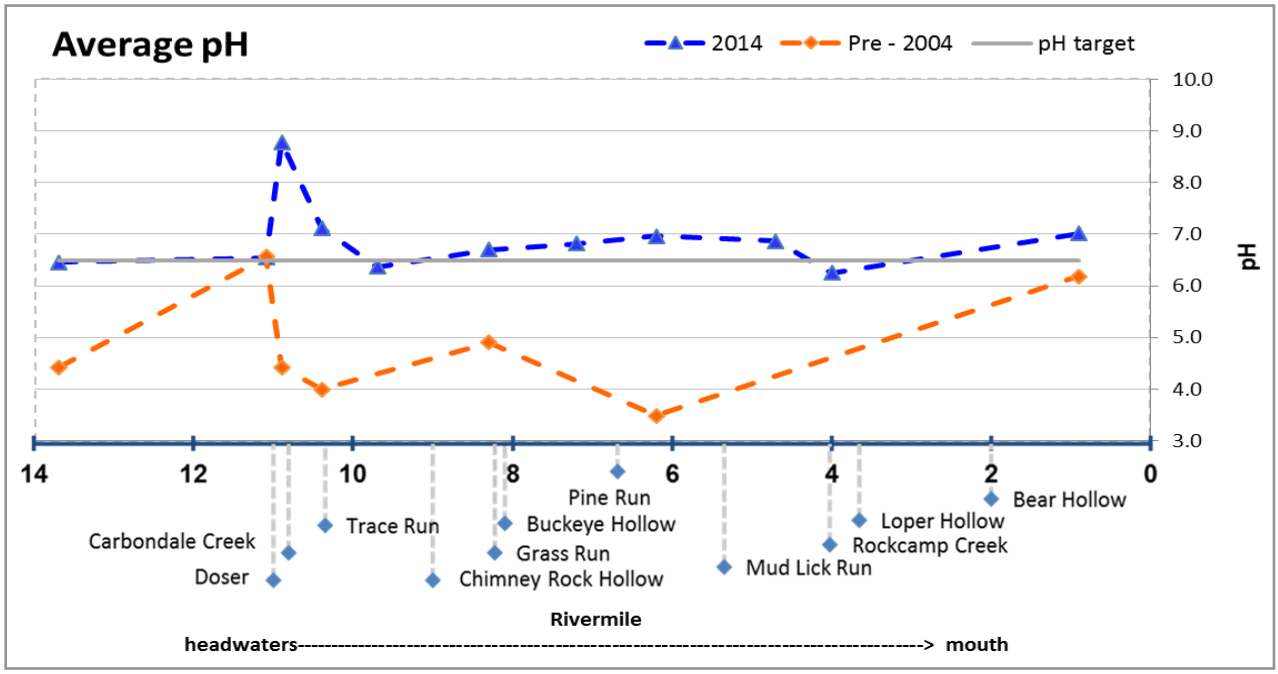
Chemical water quality analysis per stream reach

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

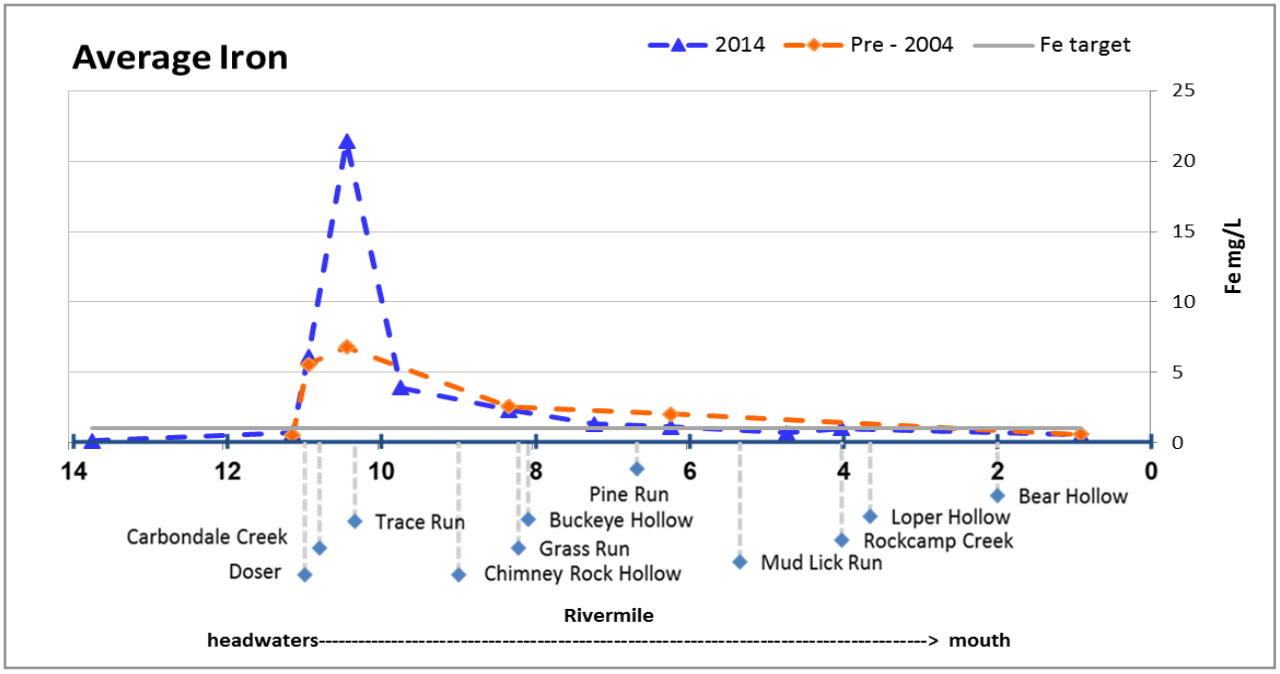


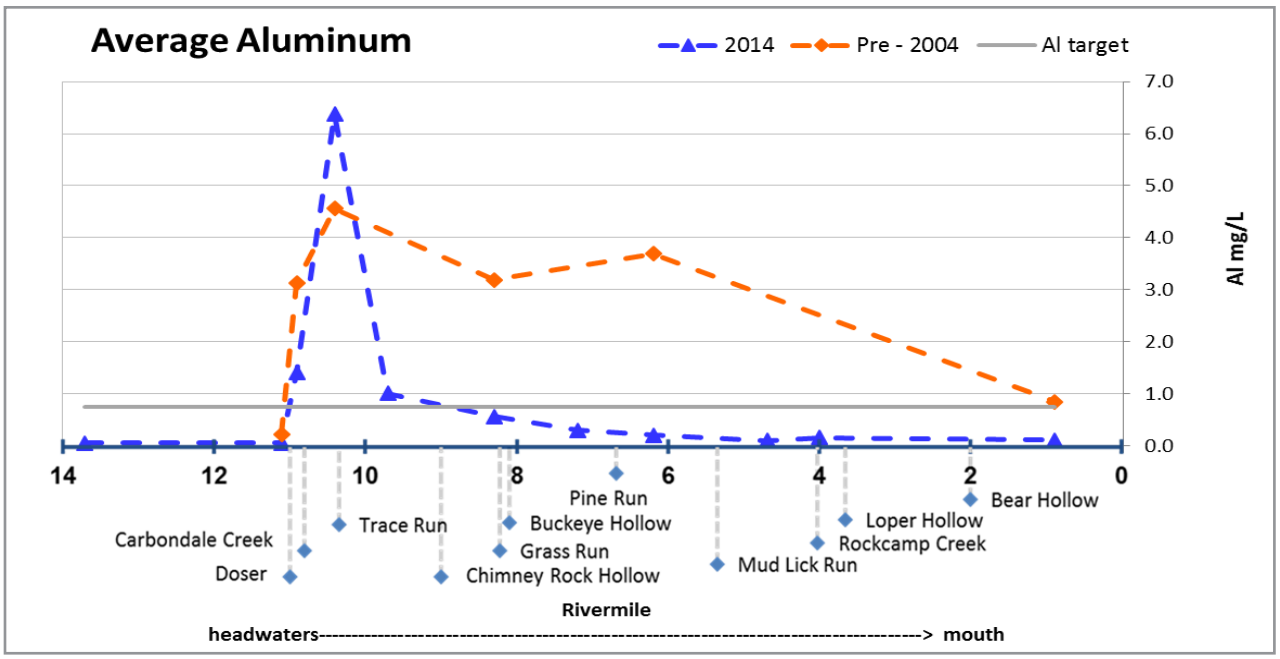


Chemical water quality analysis per stream reach

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





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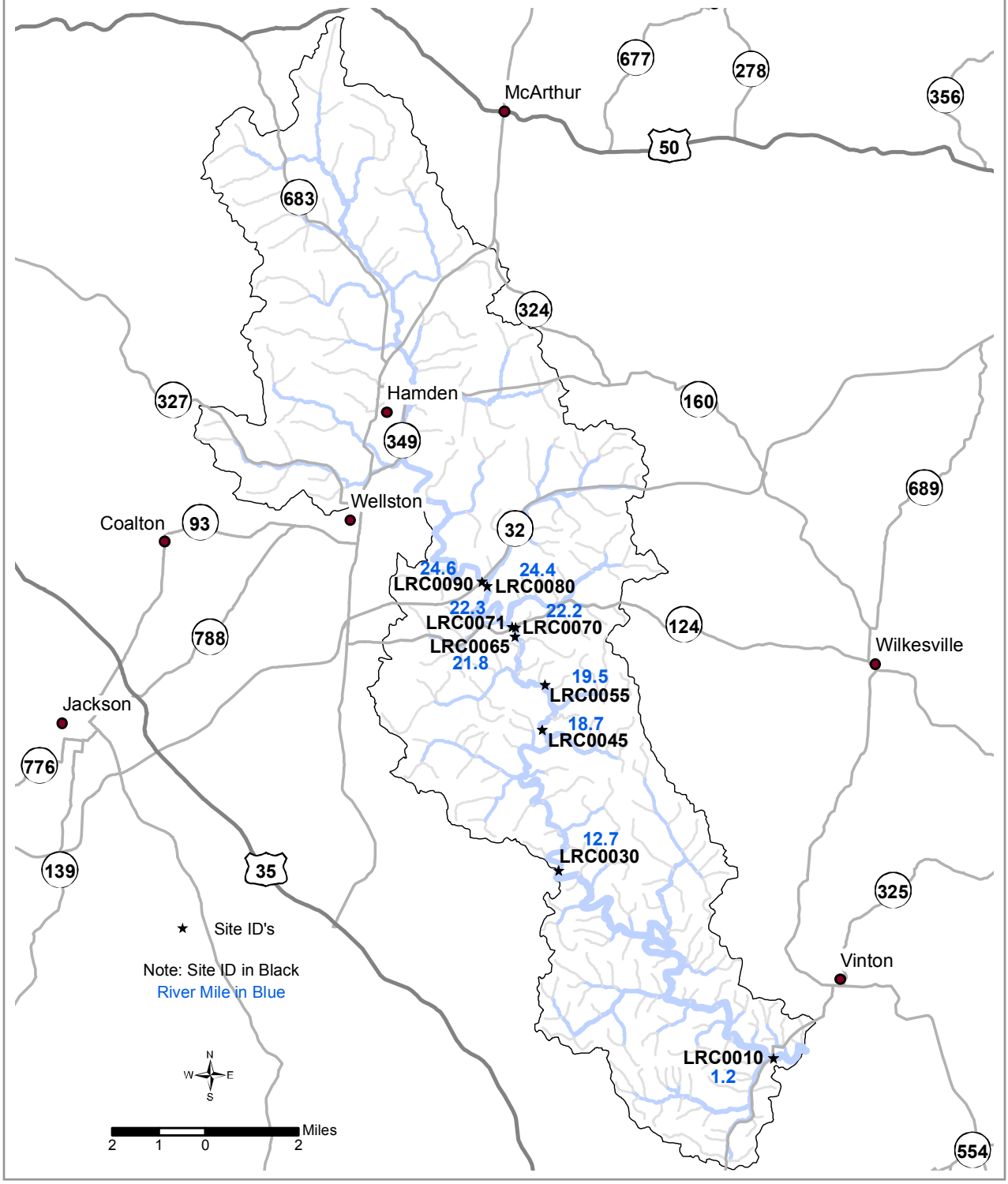
Chemical water quality analysis per stream reach

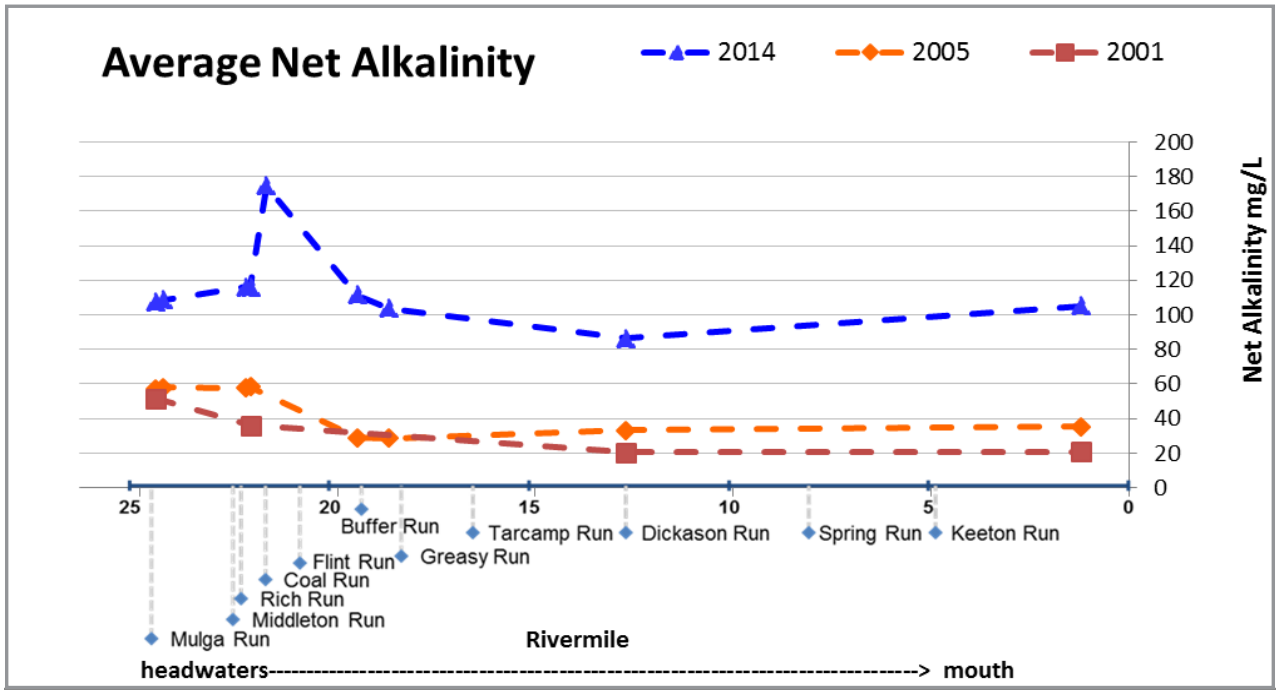
Little Raccoon Creek

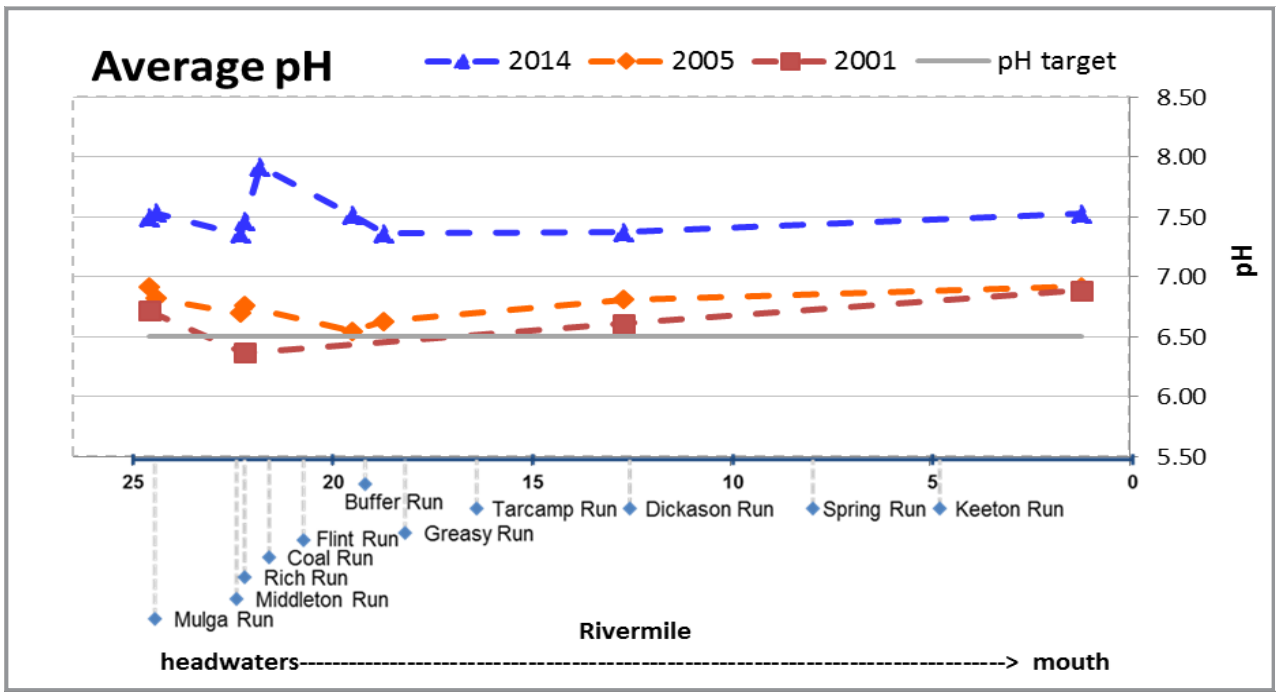


Chemical water quality analysis per stream reach

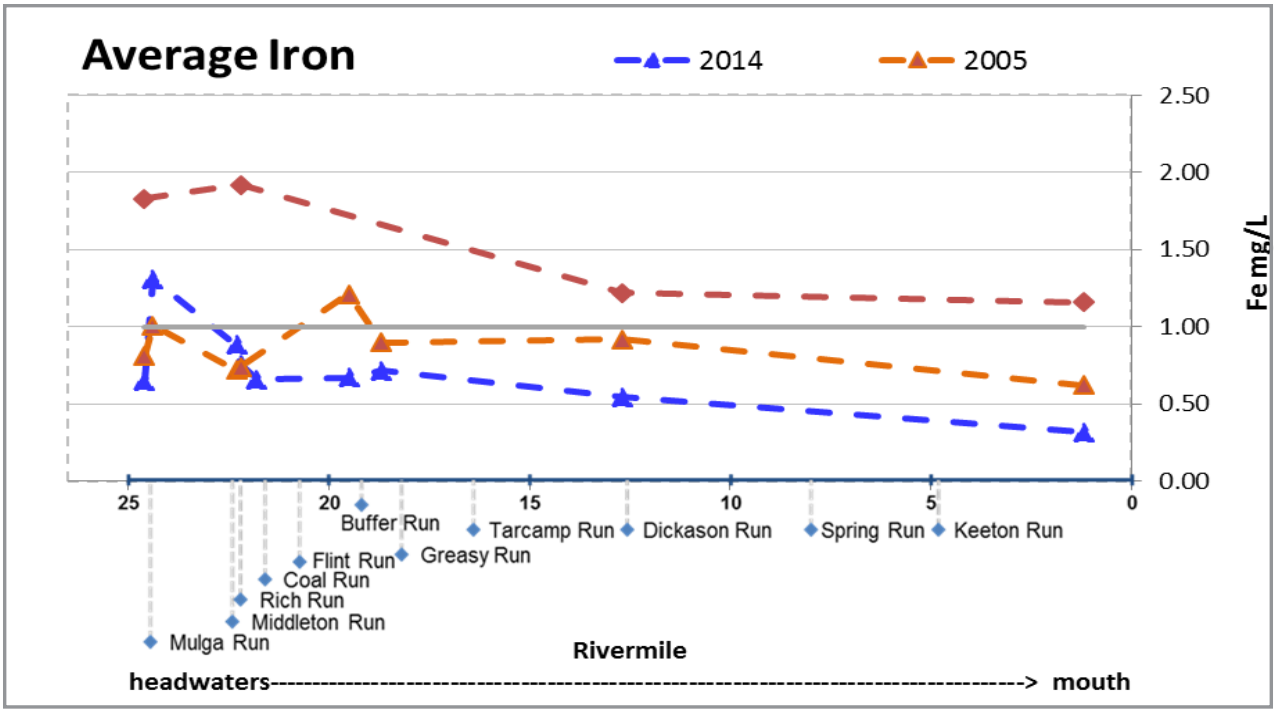
Little Raccoon Creek

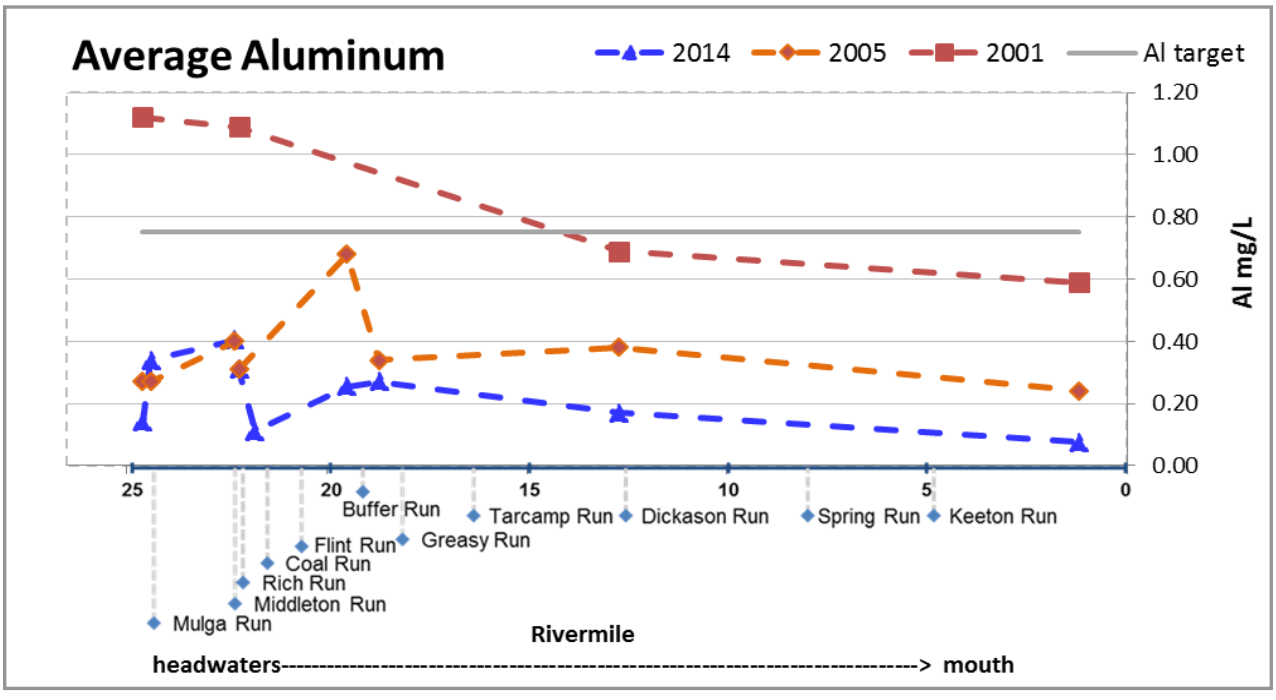
Site ID	LRC0090	LRC0080	LRC0071	LRC0070	LRC0065	LRC0055	LRC0045	LRC0030	LRC0010
Rivermile	24.6	24.4	22.3	22.2	21.8	19.5	18.7	12.7	1.2



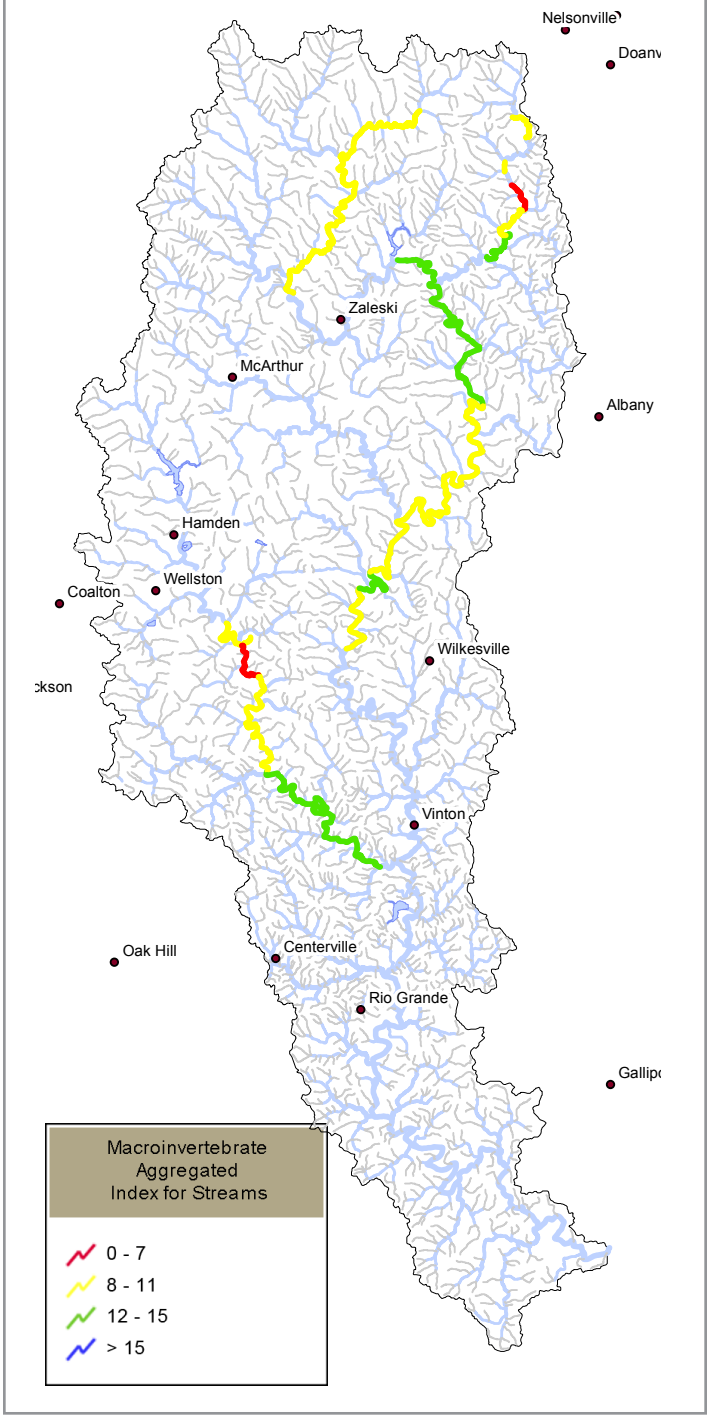


Little Raccoon Creek									
Site ID	LRC0090	LRC0080	LRC0071	LRC0070	LRC0065	LRC0055	LRC0045	LRC0030	LRC0010
Rivermile	24.6	24.4	22.3	22.2	21.8	19.5	18.7	12.7	1.2

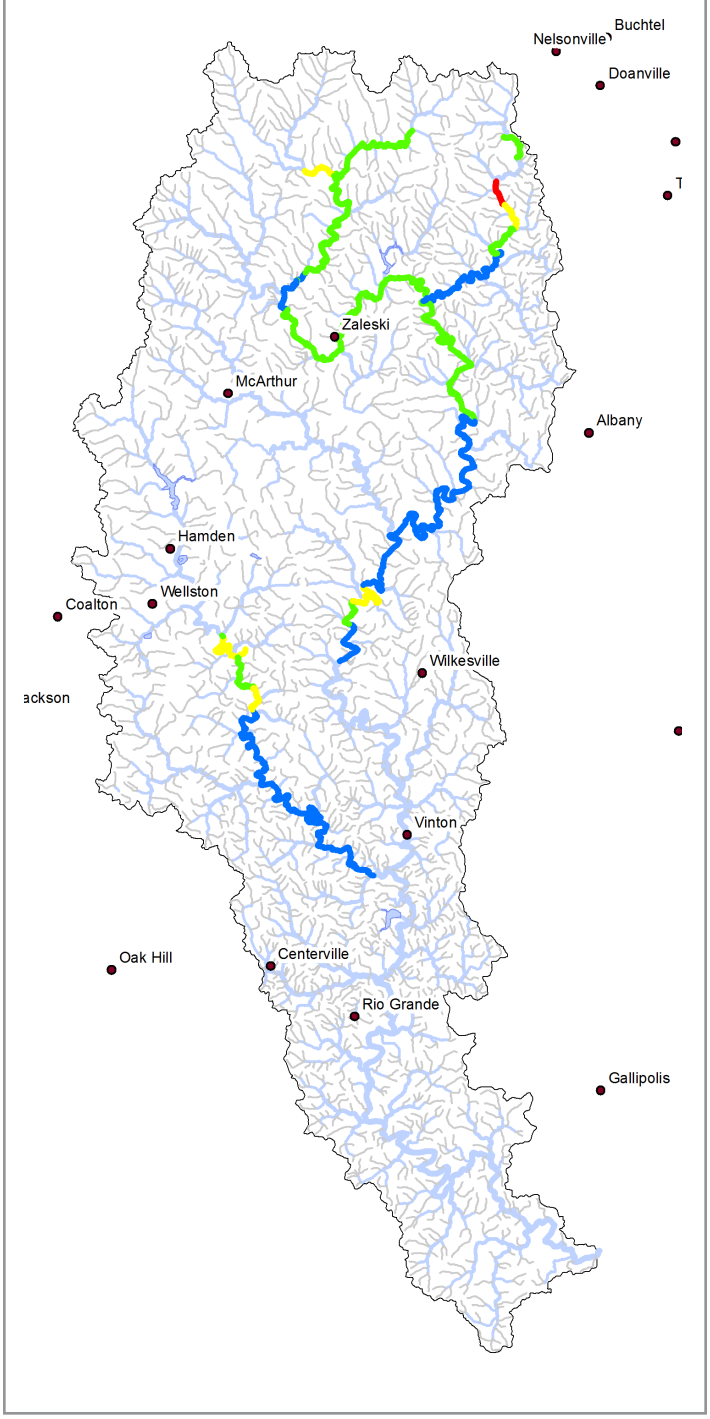




Raccoon Creek baseline MAIS



Raccoon Creek 2014 MAIS

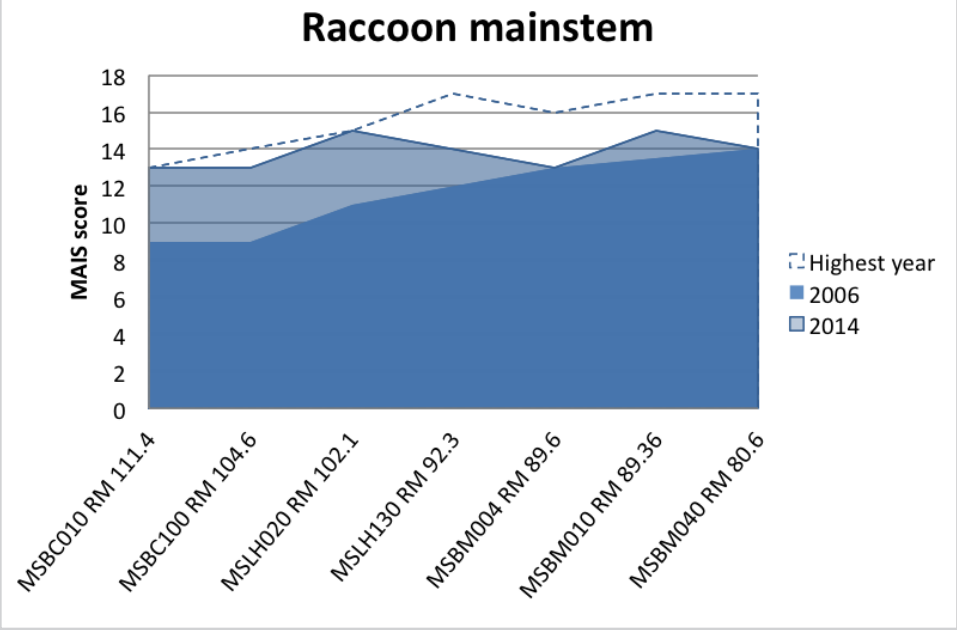


MAIS samples were collected throughout Raccoon Creek in 2014 (excluding Middle Basin sites). These stations have been established as annual monitoring stations for macroinvertebrates. The sites are used to track incremental changes each year.

Raccoon Creek - Mainstem

The thirty or more miles of the Raccoon Creek Mainstem are generally of uniformly high quality, with all having met or exceeded the target MAIS score of "12" in recent years (2012, 2013). The upstream sites, which were historically the worst impaired, have improved the most and another high score at RM 102 in 2014 elevated this site and a total of 9 river miles to the category of 'statistically improved'. The lower section of the mainstem (below RM 102.1), has generally met the MAIS target of "12" but often does not meet its full biological potential.

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

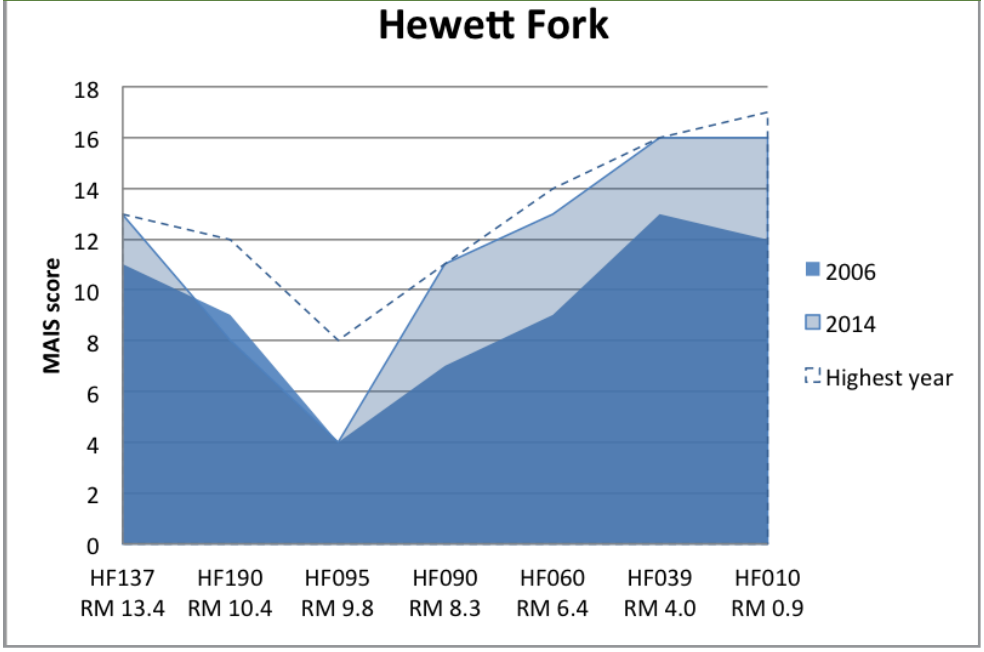
Rivermile	2005	2006	2007	2008	2009	20t10	2011	2012	2013	2014	Linear trends	R sq.	P-value	No. of years
MSBC010 RM 111.4	8	9	12	9	10	12	13	12	13	13	**improved**	0.697154	0.002646	10
MSBC100 RM 104.6		9	11	12	9	11	10	14	14	13	**improved**	0.496324	0.034092	9
MSLH020 RM 102.1		11	11	10	13	10	11	12	15	15	**improved**	0.500000	0.033146	9
MSLH130 RM 92.3		*	*	10	10	17	11	14	13	14	no change	0.203804	0.309249	7
MSBM004 RM 89.6		13	14	11	16	12	16	15	14	13	no change	0.045283	0.582519	9
MSBM010 RM 89.36		*	12	16	14	17	13	13	13	15	no change	0.226891	0.232779	8
MSBM040 RM 80.6		14	14	17	16	12	14	15	14	14	no change	0.036986	0.620088	9

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

Raccoon Creek - Hewett Fork

In 2014, the biological quality of the eleven mile reach below the Carbondale doser showed a similar pattern of improvement relative to previous years. A well-defined 2.5 mile 'mixing zone' downstream of the doser remains impaired but the remainder of the downstream sites show steadily increasing MAIS scores with increasing distance from the doser and mixing zone. A new high score at RM 8.3 suggests that biological recovery since installation of the doser in 2004 is still progressing. Two sites, RM 6.4 (upstream King Hollow Rd.) and RM 4.0 (Rockcamp) that achieved new high scores of "14" and "16" in 2013 remained high. The biological improvement of more than 8 river miles downstream the doser (RM 8.3 to 4.0) since 2006 appears to be relatively stable.

Figure 3. Area of Degradation



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

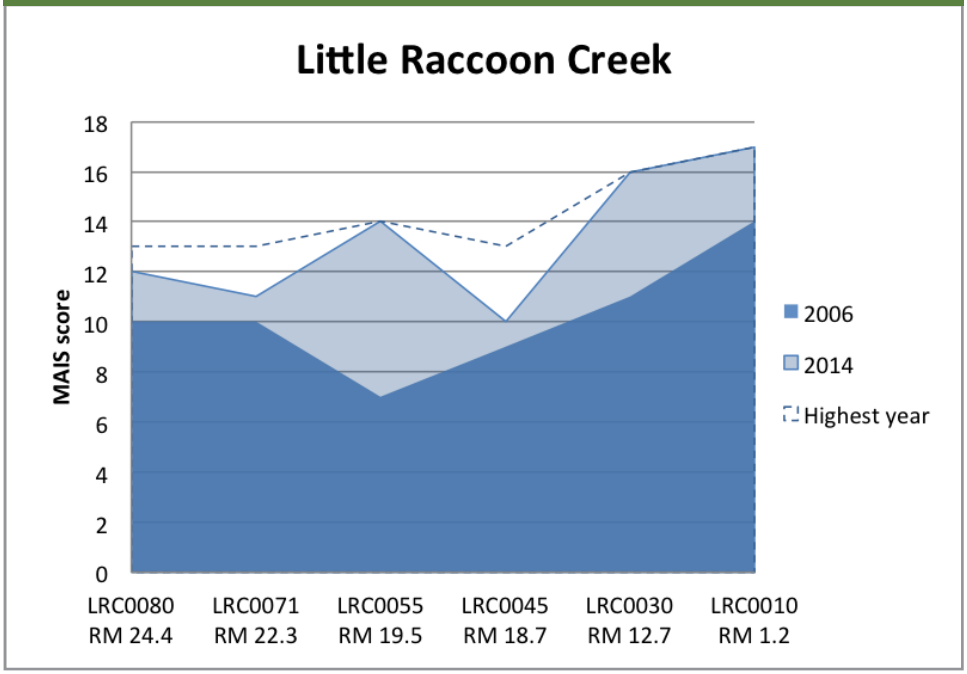
Figure 4. Raccoon Creek - Hewett Fork MAIS Regressions

Rivermile	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Linear trends	R sq.	P-value	Yrs.
HF137 RM 13.4					11	8	9	12	13	11	11	11	13	no change	0.30303	0.124578	9
HF190 RM 10.4					9	3	7	6	6	5	8	12	8	no change	0.181513	1.552361	9
HF095 RM 9.8					4	3	6	3	3	8	4	4	4	no change	0.012121	0.777967	9
HF090 RM 8.3	2	3	3	5	7	3	5	6	3	6	9	7	11	**improved**	0.594978	0.002017	13
HF060 RM 6.4					9	9	8	10	10	13	11	14	13	**improved**	0.7500	0.002536	9
HF039 RM 4.0					13	13	14	13	13	14	14	16	16	**improved**	0.672222	0.006812	9
HF010 RM 0.9					12	12	15	17	13	16	16	14	16	no change	0.312402	0.117716	9

Raccoon Creek - Little Raccoon Creek

Little Raccoon Creek biological quality in 2014 was similar to that recorded in previous years. Most sites have improved 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), but the trend is statistically significant at only two of the six long term sites. Two sites earned new high scores in 2014 (RM 19.5 and 12.7), suggesting that the macroinvertebrate communities are still improving. As in the past, sections of the Little Raccoon 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.

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

Rivermile	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Linear trends	R sq.	P-value	No. of years
LRC0080 RM 24.4	8	10	11	11	9	9	13	11	11	12	no change	0.354915	0.069156	10
LRC0071 RM 22.3	8	10	10	9	10	10	10	10	13	11	**improved**	0.528981	0.017139	10
LRC0055 RM 19.5		7	*	9	11	12	13	10	11	14	no change	0.340726	0.168853	9
LRC0045 RM 18.7	14	9	12	9	13	11	11	12	11	10	no change	0.041602	0.571926	10
LRC0030 RM 12.7		11	13	13	14	14	14	14	15	16	**improved**	0.590644	0.009395	10
LRC0010 RM 1.2	14	14	13	15	17	16	16	16	14	17	no change	0.333333	0.080516	10

**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 2014 = 3,035 lbs/day

Total metal load reduction 2014 = 260 lbs/day

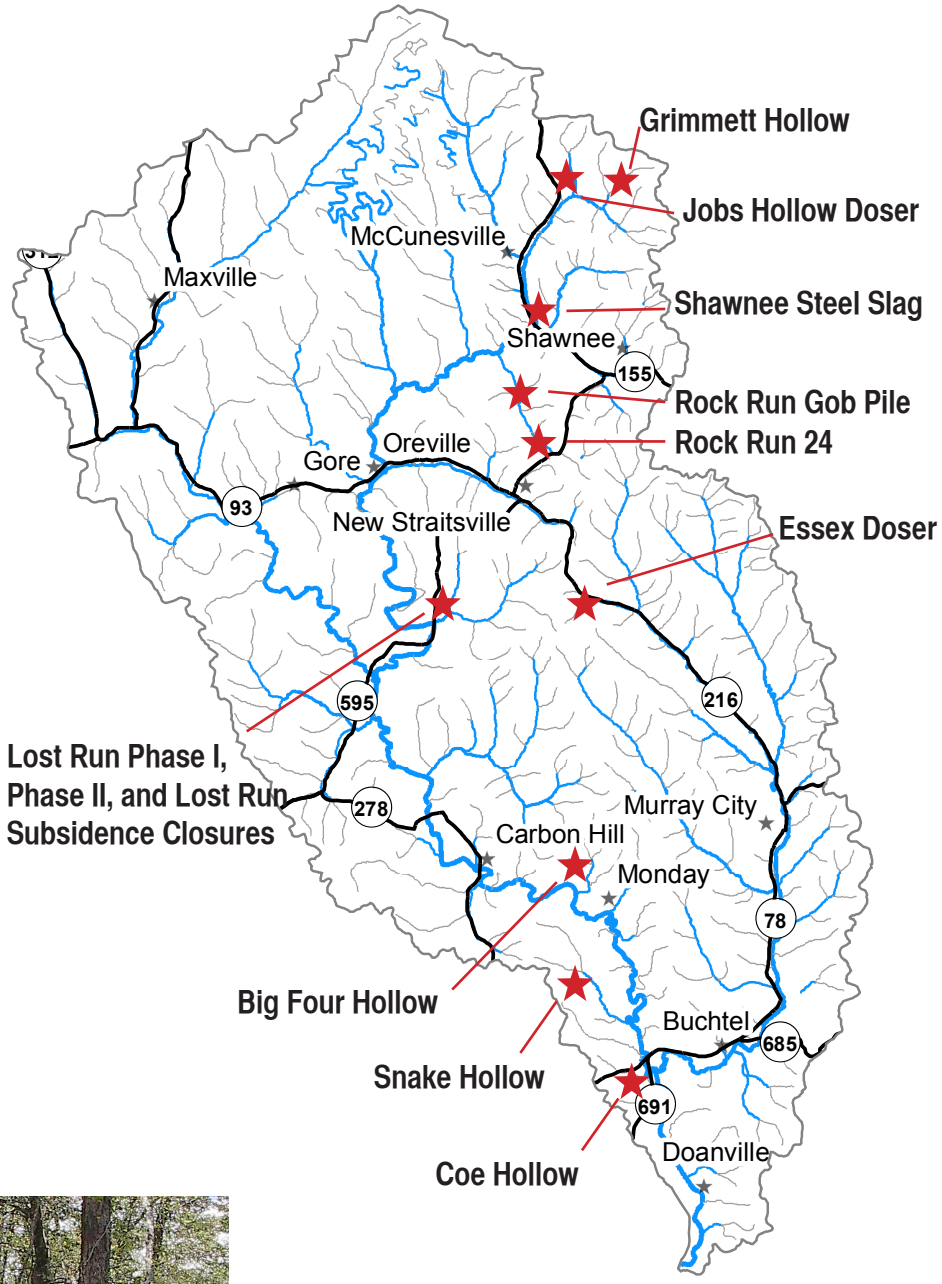
Data derived using the Stoertz Water Quality Evaluation Method (Kruse et al. 2014) (excludes Rock Run Gob Pile Project)

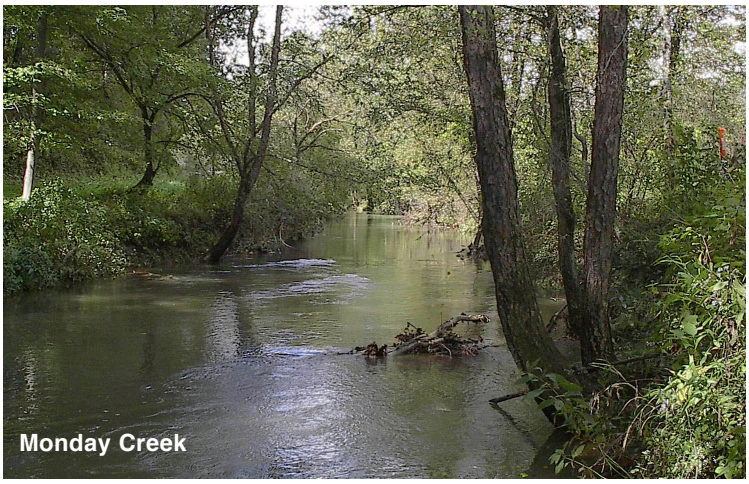
Cost

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

Construction $6,194,830

Total costs through 2014 = $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!

2014
- The Essex Doser moved to Monkey Hollow and two new species of fish found in the Carbon Hill area: Brown Bullhead and the Banded Darter.

Monday Creek Projects

Acid mine drainage reclamation projects completed in Monday Creek Watershed:

1999 Rock Run Gob Pile revamped 2011 (RR02100) – Gob pile reclamation

2001 *Rock Run 24 (RR00820) – Limestone channel*

2003 *Grimmett Hollow (JH09020) – Enhanced wetland with lime and limestone channels*

2004 Jobs Hollow Doser (JH00500) – Active calcium oxide doser

Big Four Hollow (BF00100) – 2 limestone beds and limestone channels

Snake Hollow (SH00100) – Close 9 subsidence features, 2 steel slag beds, enhance wetland, and limestone channels

2006 *Essex Doser (SY00706) – Active calcium oxide doser shutdown in 2008*

Lost Run Phase I (LR01020) – limestone leach beds and limestone channels

2007 Lost Run Phase II (LR00020) – Steel slag beds, limestone leach beds, and limestone channels

Lost Run Subsidence and Portal Closures – closed ten subsidence features

2008 *Shawnee Steel Slag Bed (MC00900) – Steel slag bed, limestone channels, and sand filter*

2010 Jobs Hollow Doser Maintenance II – Clean out of source pond, supply lines, and installed safety cage to hatch and ladder

Coe Hollow (CH00100) – Limestone leach ponds, passive wetlands,, steel slag leach bed, and 2 subsidence features closed

2012 Lost Run II Maintenance – New steel slag installed, additional piping in the underdrain, and improve water delivery to SSLB.

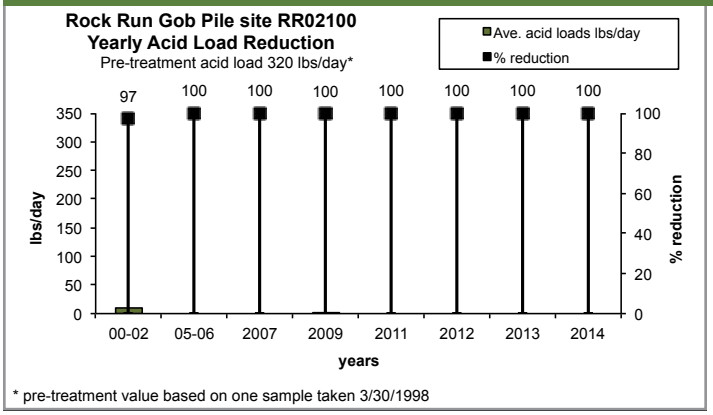
Big Four Hollow LLB (BF00400) – 3 limestone leach beds

Italicized indicated projects are not actively monitored for acid mine drainage and metal load reduction purposes

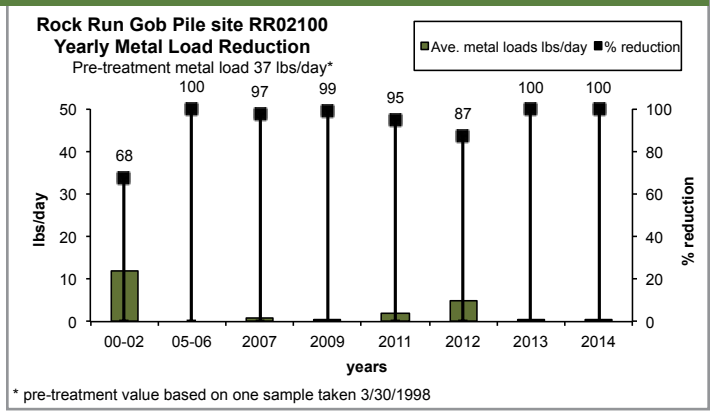
Yearly acid and metal load reduction trends per project

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

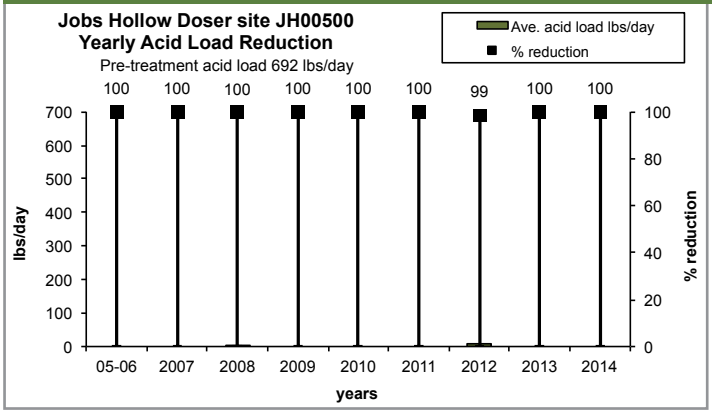


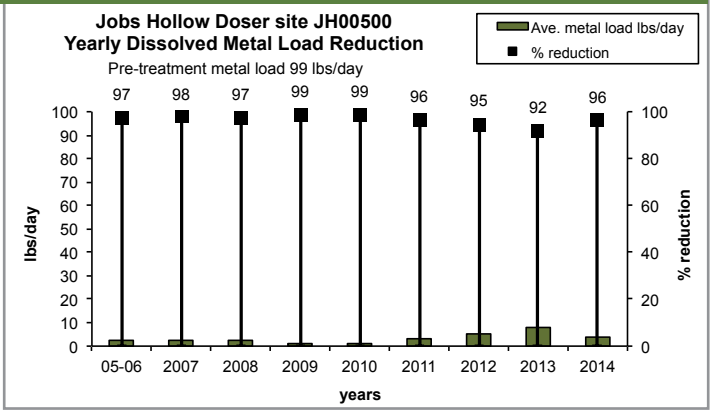
* pre-treatment value based on one sample taken 3/30/1998



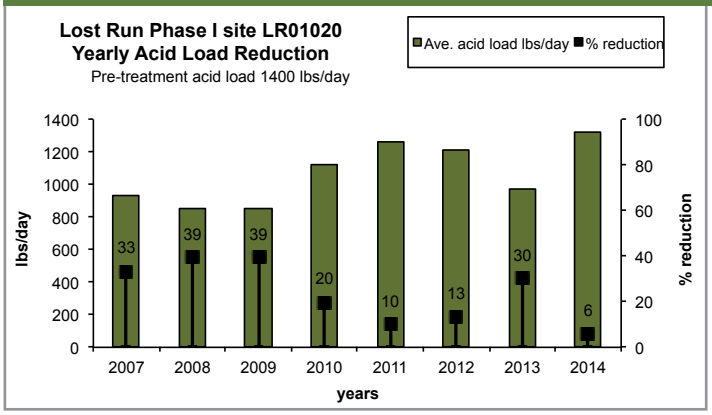
* pre-treatment value based on one sample taken 3/30/1998

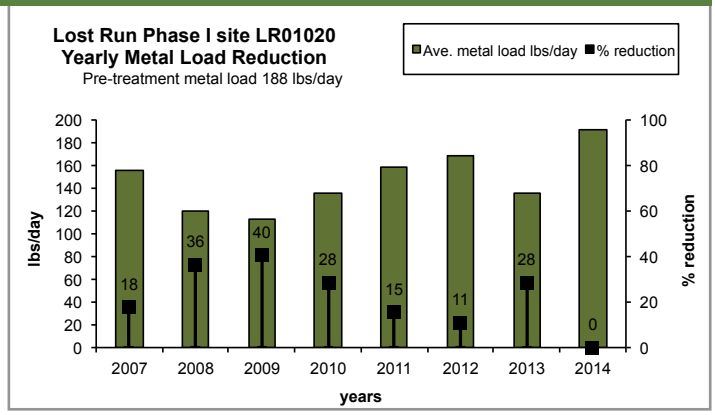
Jobs Hollow Doser site JH00500





Lost Run Phase I site LR01020





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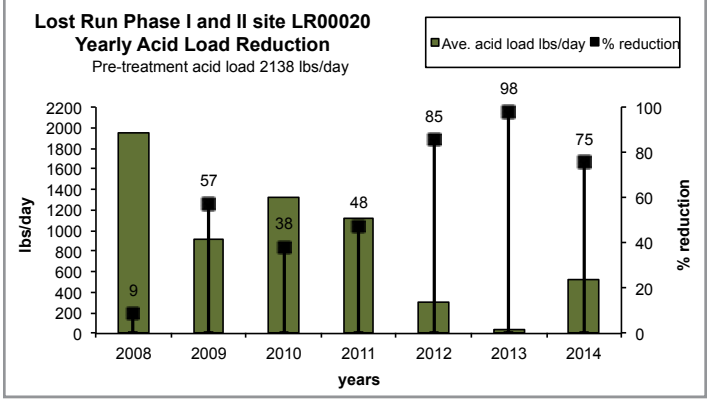
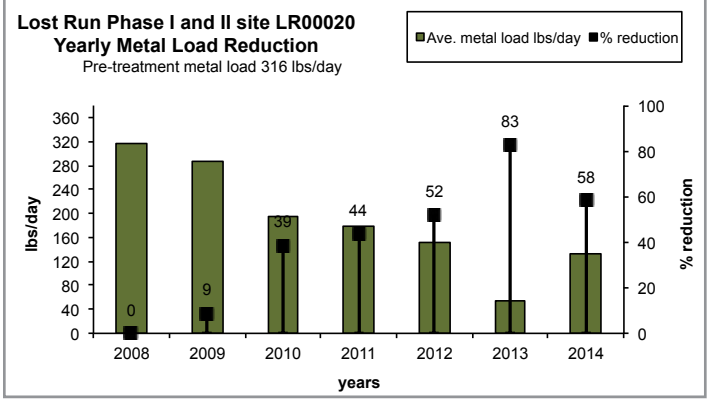
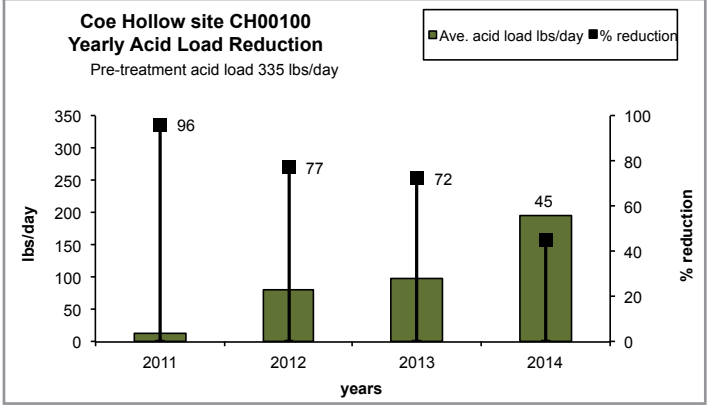
Yearly acid and metal load reduction trends per project

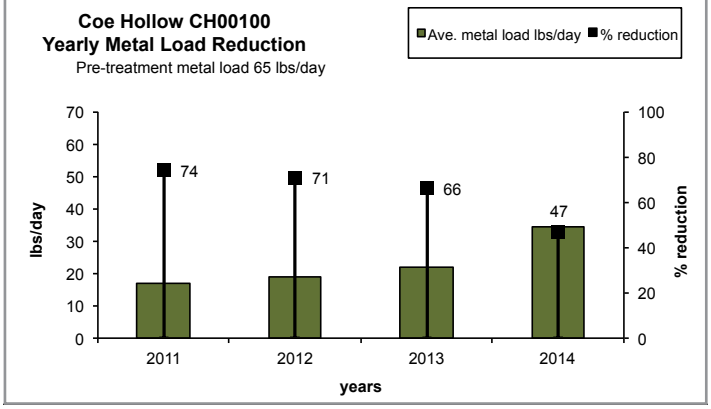
Lost Run Phase I and II site LR00020



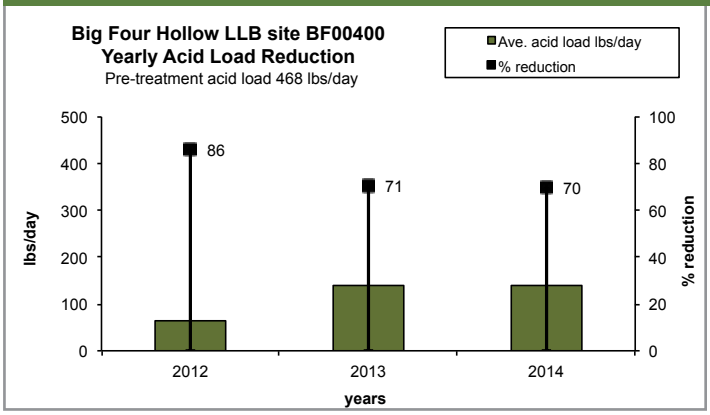


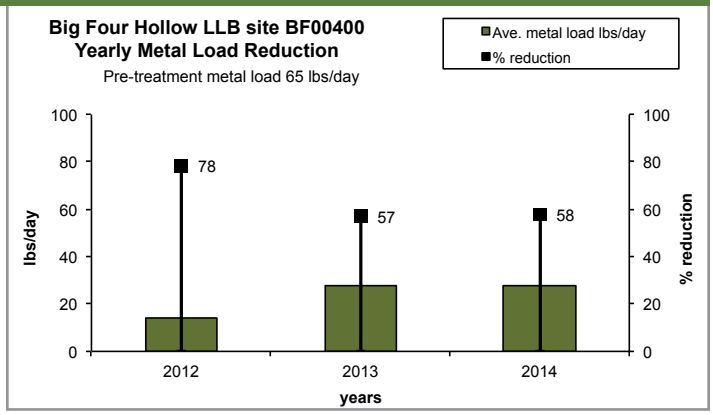
Coe Hollow site CH00100



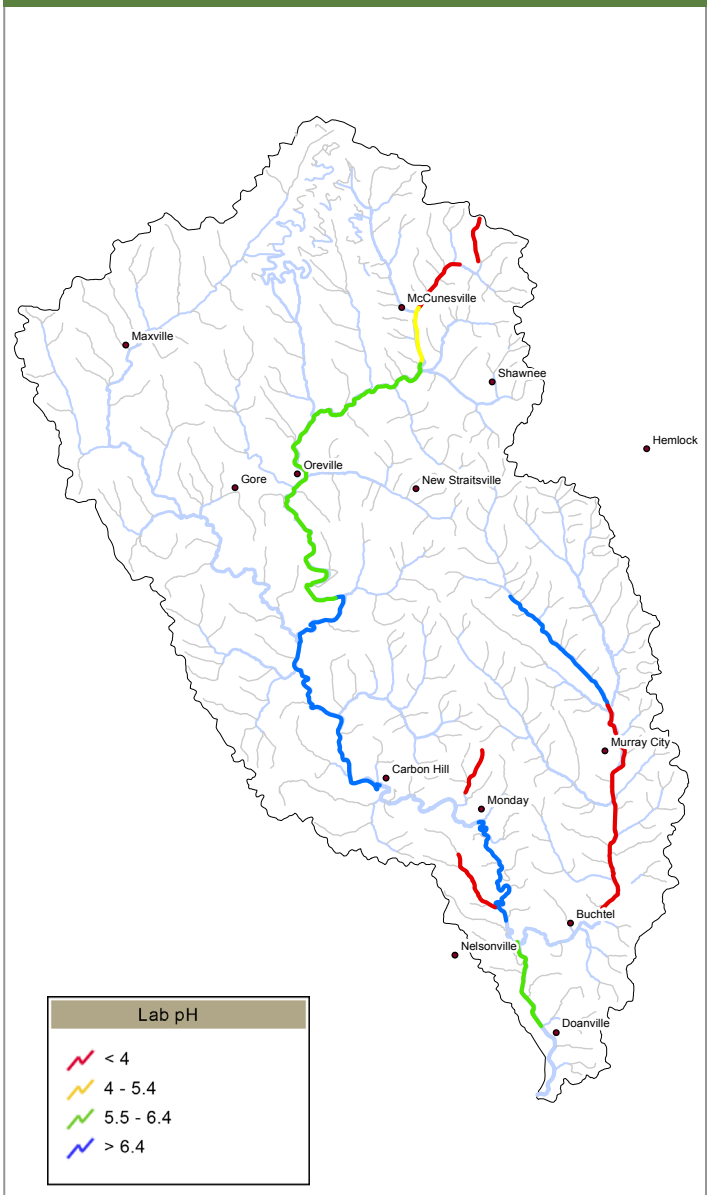


Big Four Hollow LLB site BF00400

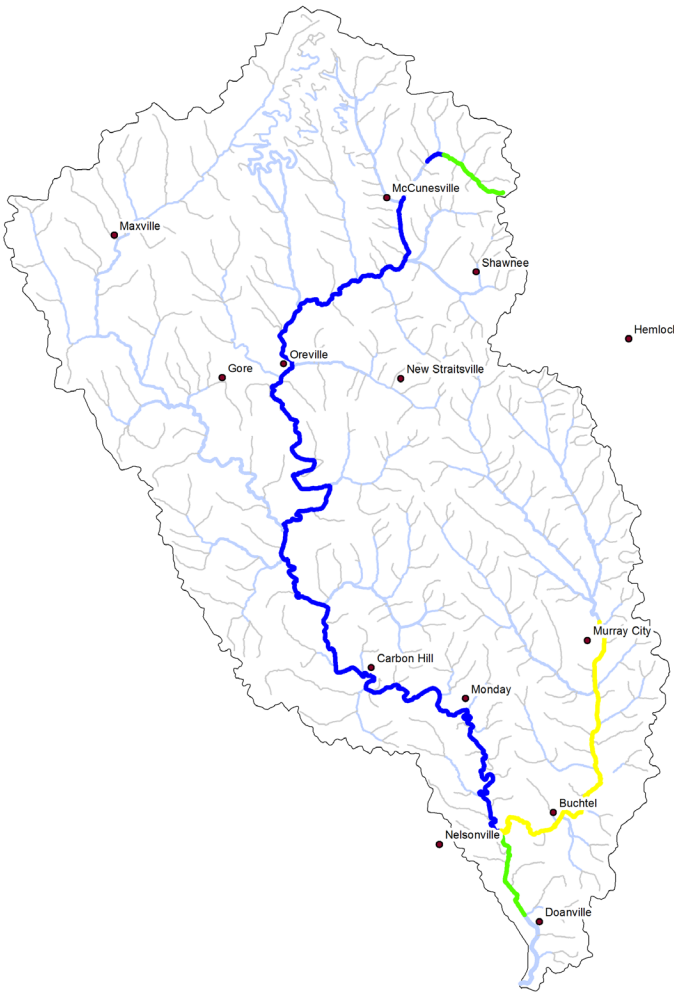




Monday Creek baseline pH



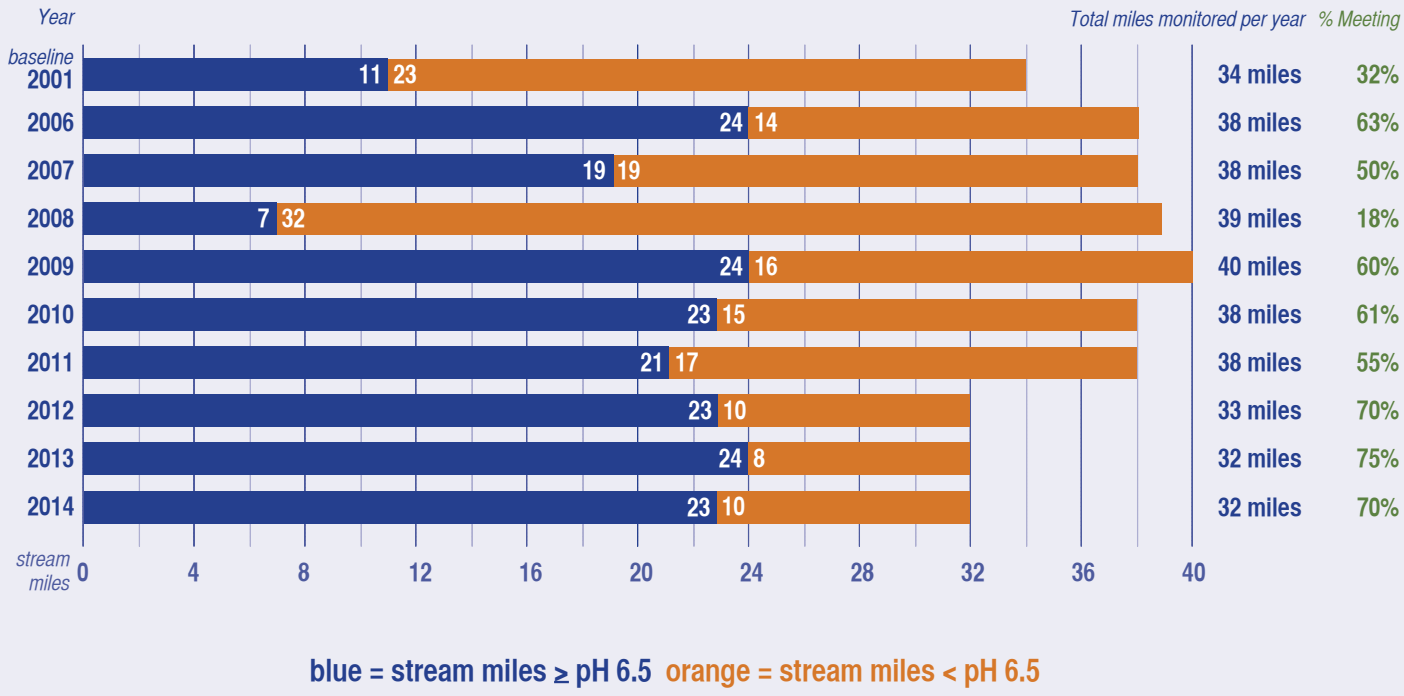
Monday Creek 2014 pH



In Monday Creek pH values have improved throughout the watershed from baseline conditions (2001) to 2014. In 2014, stream miles meeting pH target of 6.5 is approximately 23 miles of the 32 miles monitored (72%).

There are approximately 32 stream miles monitored each year along the mainstem of Monday Creek, 38 miles 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 2014, the stream miles meeting the pH target are consistent with past 3-5 years 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 (SF00100) fails to meet the pH target of 6.5 and treatment in this basin is unlikely.

Figure 1. Monday Creek pH



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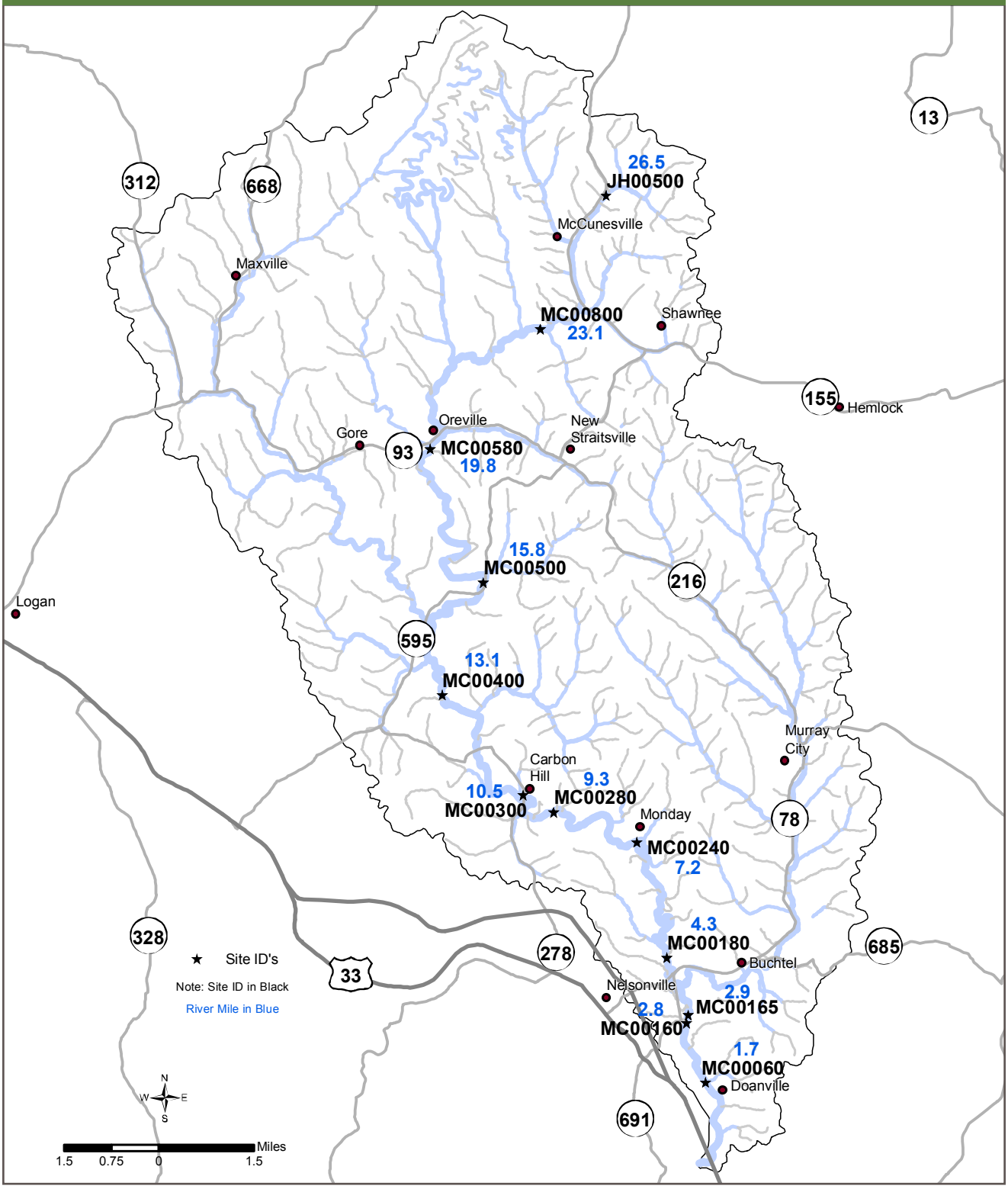
Chemical Water Quality

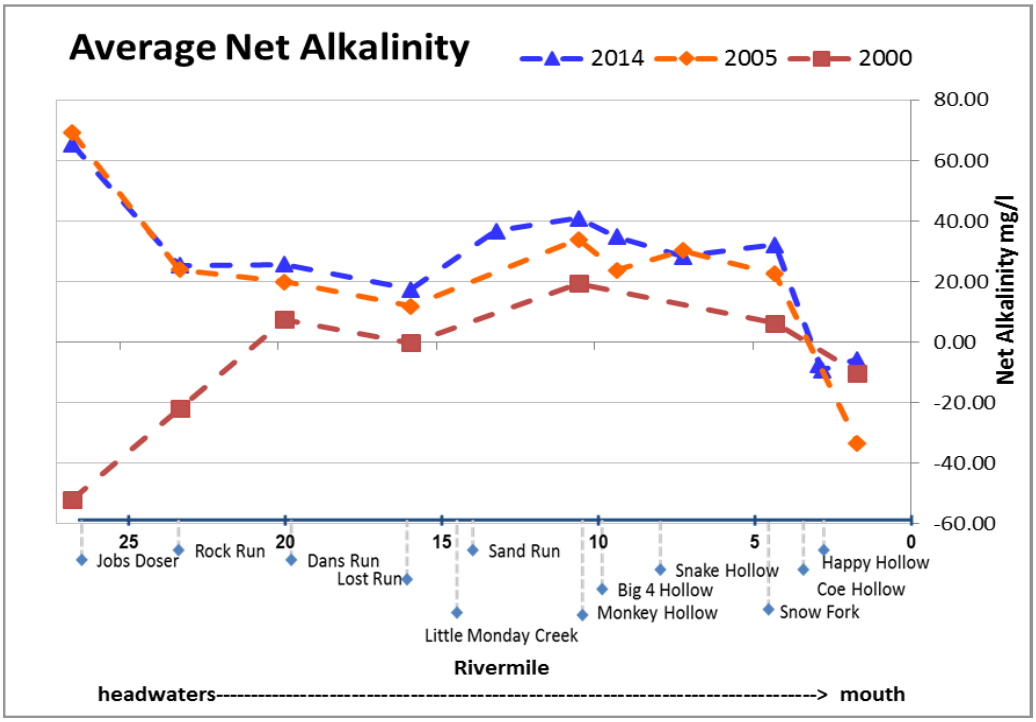
Monday Creek

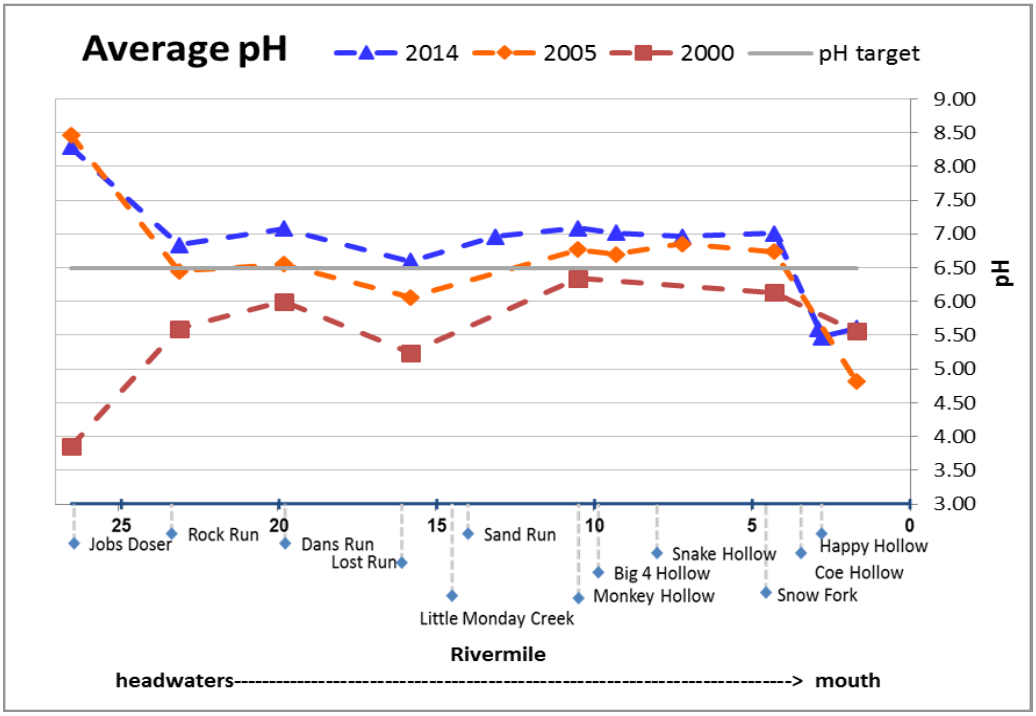


Chemical water quality changes along the mainstem of Monday Creek are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources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

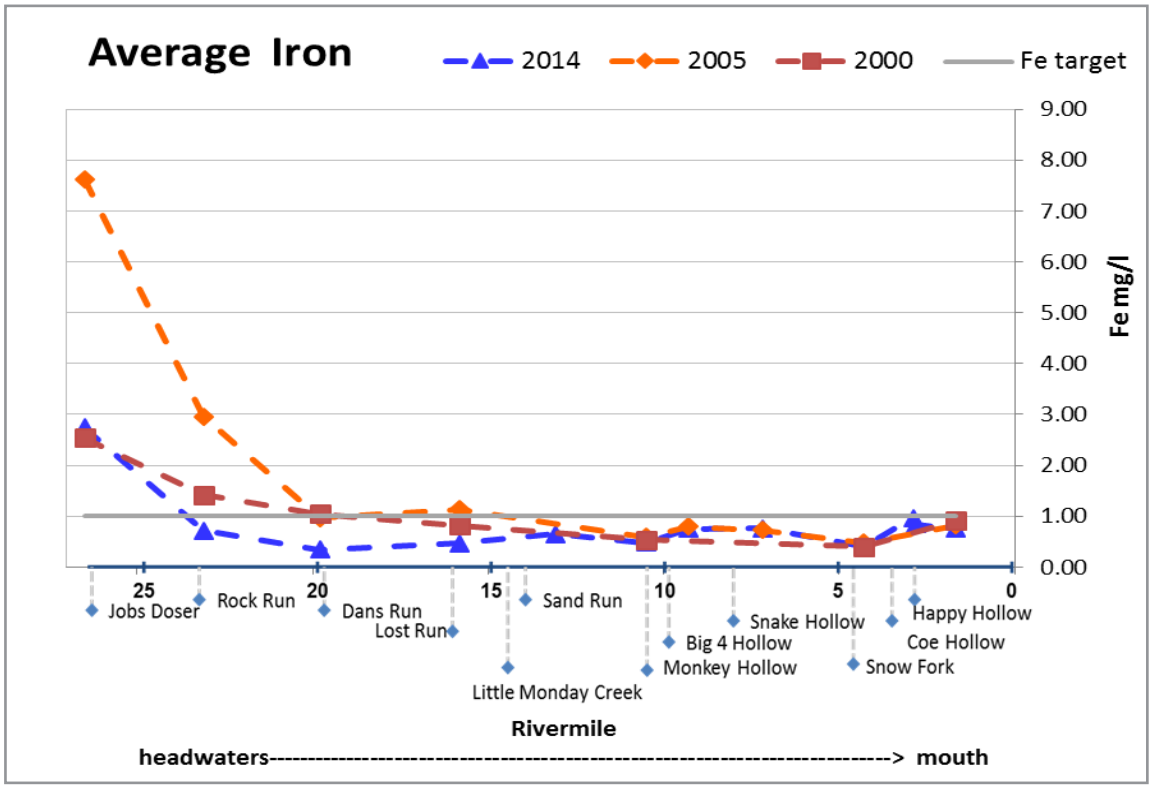
Site ID	JH00500	MC00800	MC00580	MC00500	MC00400	MC00300	MC00280	MC00240	MC00180	MC00165	MC00160	MC00060
Rivermile	26.5	23.1	19.8	15.8	13.1	10.5	9.3	7.2	4.3	2.9	2.8	1.7

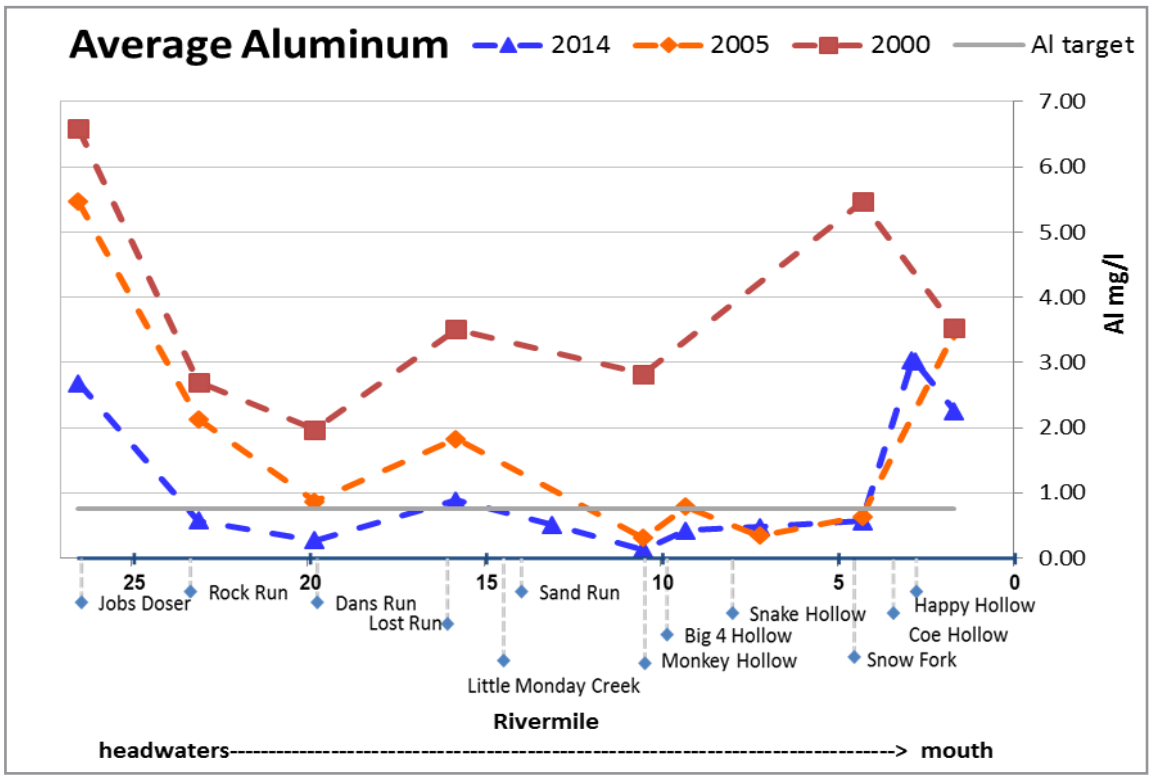




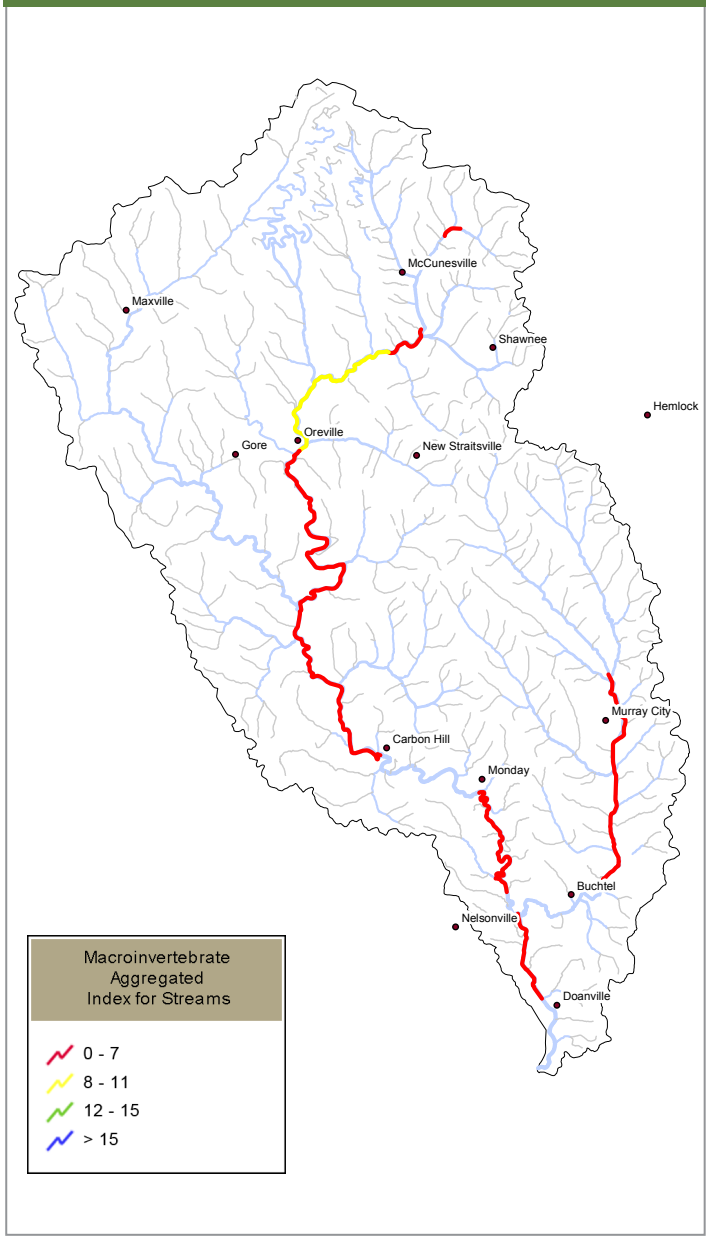
Chemical water quality analysis per stream reach

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

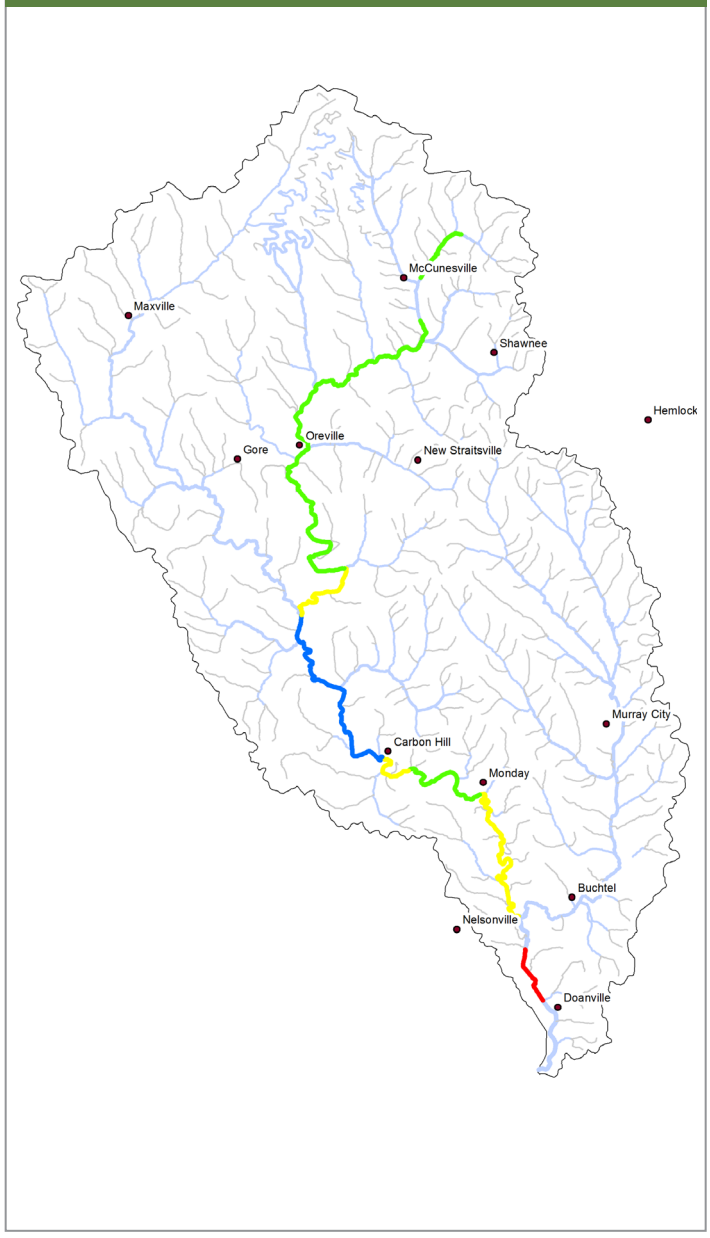




Monday Creek baseline MAIS



Monday Creek 2014 MAIS

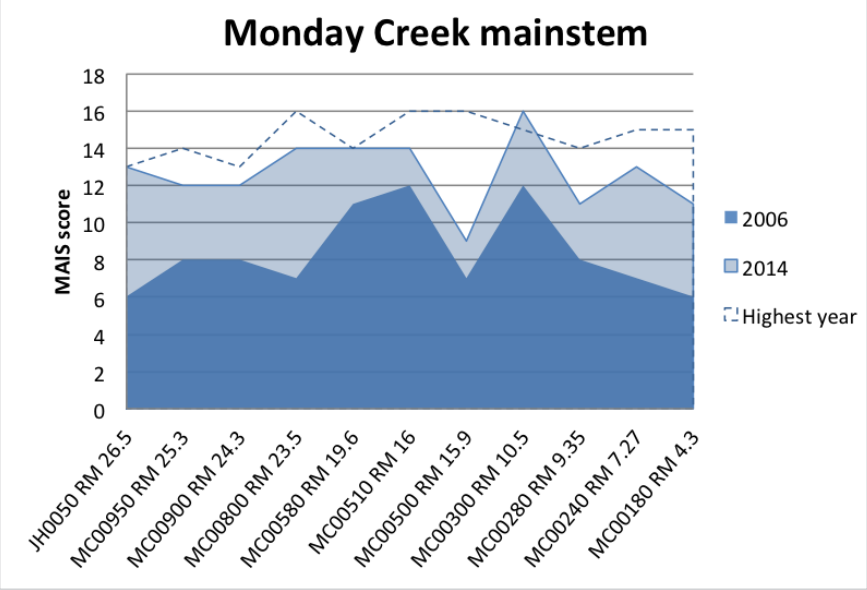


MAIS samples were collected throughout Monday Creek at established annual monitoring stations from 2001 through 2014.

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, with sites in the upper half of the watershed (RM 25.3 to 16) achieving their highest scores over the past few years. This year there are two notably lower scores at sites that had previously been showing improvement. After two years of exceeding MAIS score targets and appearing to be well on its way to recovery, RM 15.9, downstream of Lost Run, declined to "9", well below the target of "12". This was enough to disrupt the "moderately significant" trend of improvement recorded last year since 2006. Macroinvertebrate scores upstream of the Lost Run confluence (at RM 16) remained high. Scores at RM 9.35, at Carbon Hill downstream of Monkey Hollow also dropped enough this year to disrupt what had been a statistically significant trend in biological recovery. Its status changed from 'improved' to 'moderately improved' (less statistical significance).

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

Rivermile	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Linear trend	R square	P-value	No. of years
JH09020 RM 27.4				8	6	6	4	4	4	4				declined			7
JH00500 RM 26.5	4	6	4	7	6	5	4	7	8	9	11	10	13	**improved**	0.702912	0.000343	13
MC00950 RM 25.3				7	8	7	4	9	6	10	10	10	12	no change	0.479102	0.026552	10
MC00900 RM 24.3				6	8	12	12	11	11	12	12	14	12	**improved**	0.581818	0.010289	10
MC00800 RM 23.5	5	3	1	11	7	9	12	7	13	11	13	12	14	**improved**	0.692427	0.000418	13
MC00580 RM 19.6	8	9	10	13	11	12	12	13	16	14	16	15	14	**improved**	0.793702	4.39E-05	13
MC00510 RM 16	2	6	6		12	11	10	10	10		14	14	14	**improved**	0.819509	0.000126	13
MC00500 RM 15.9					7	8		5			15	16	9	no change	0.402857	0.175783	9
MC00300 RM 10.5	5	10	13	13	12	14		12	16	16	15	16	16	**improved**	0.687214	0.000858	13
MC00280 RM 9.4					8	9	10	9	14	12	10	15	11	somewhat improved	0.404332	0.065661	9
MC00240 RM 7.3				8	7	7	8	10	14	10	8	11	13	**improved**	0.431373	0.039103	10
MC00180 RM 4.3	2	6	2	8	6	9	7	4	13	9	9	15	**11**	improved	0.593746	0.002052	13

SUNDAY CREEK WATERSHED REPORT

2014 NPS Report - Sunday Creek Watershed

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Sunday Creek Watershed Group

Reductions

Total acid load reduction 2014 = 352 lbs/day

Total metal load reduction 2014 = 110 lbs/day

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

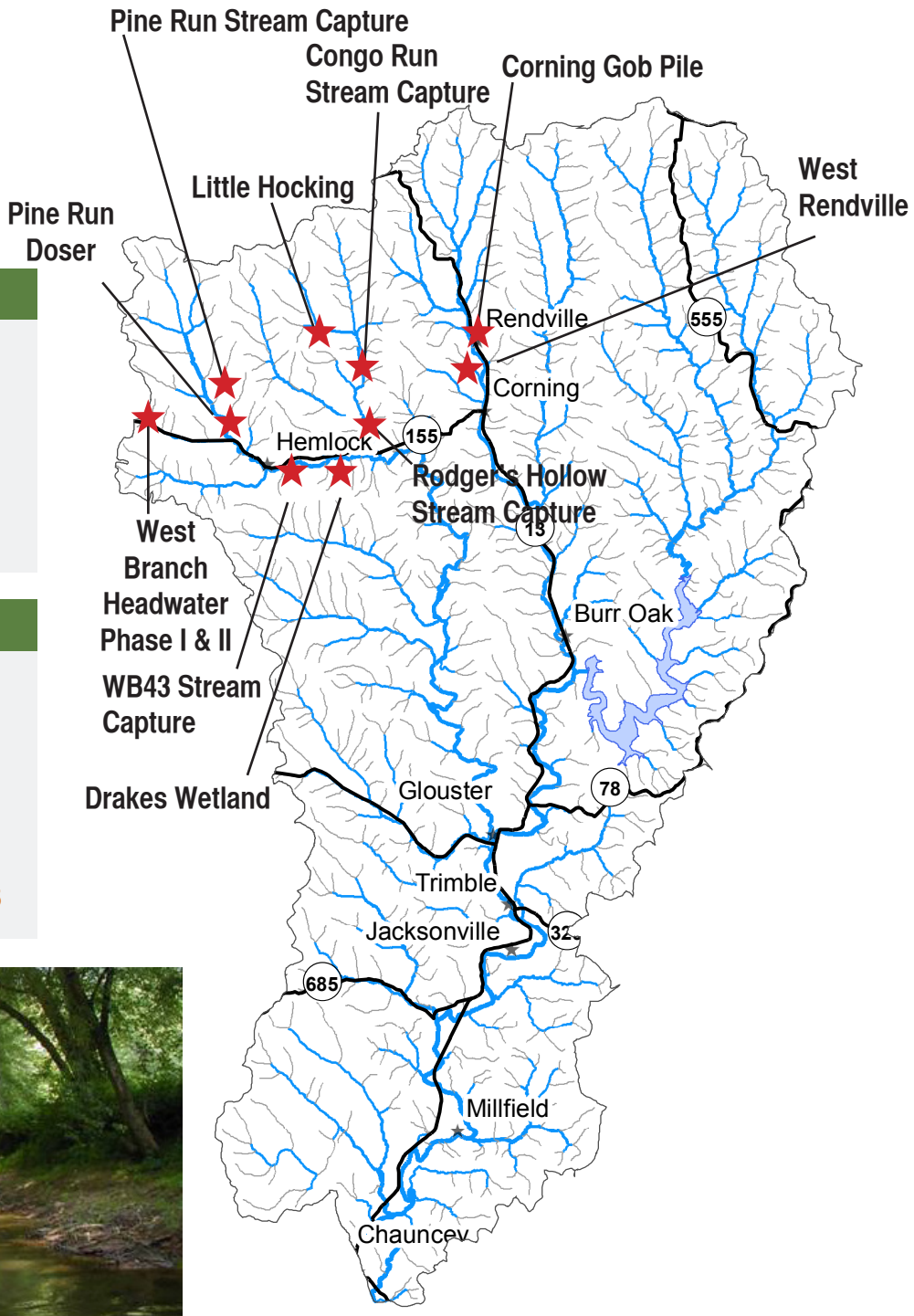
Costs

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

Construction = $2,091,186

Total costs through 2014 = $2,582,945


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

2014
- Drakes Wetland project in the West Branch of Sunday Creek completed

Sunday Creek Projects

Acid mine drainage reclamation projects completed in Sunday Creek Watershed:

2004 *Congo Stream Capture (CR-15) –Fill subsidence feature*

2007 *Pine Run Stream Capture (PR-20 and PR-21) – Fill subsidence feature and restore positive drainage in stream*

Corning Gob Floodplain (CG 02) – Remove gob from floodplain, gob pile reclamation on hillslope

Rodger's Hollow Stream Capture (RH 001) – Close multiple subsidence features and install natural channel

2009 *Little Hocking Stream Capture (CR 11) – Close subsidence feature and reconnect stream channel*

2010 *West Branch 43 Stream Capture (WB 43) – Close subsidence feature and create positive drainage*

Pine Run Stream Capture Maintenance – installed 4 limestone berms in channel

West Branch Sunday Creek Headwaters Phase I & II (WBHW 03) – Limestone channels, closed 4 subsidence features, reclaimed gob pile, surface reclamation, limestone leach bed, and passive wetland

2011 *West Rendville Stream Capture – Close 2 subsidence features and create positive drainage*

2013 Pine Run Doser (PR001) – Active calcium oxide doser

2014 Drakes Wetland Enhancement (WB 36) – Wetland enhancement, metals removal

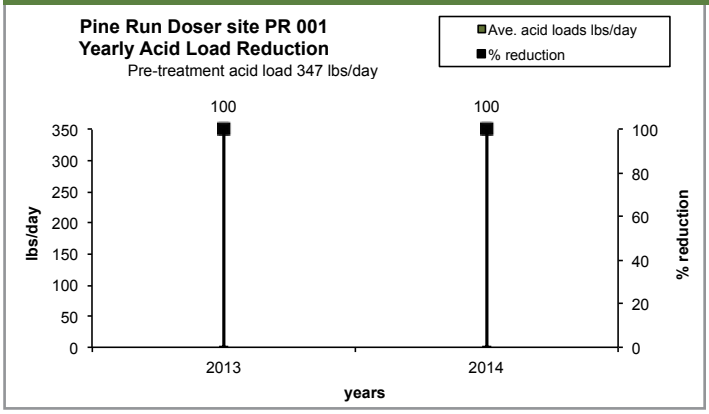
Italicized indicates projects are not actively monitored for acid and metal load reductions purposes

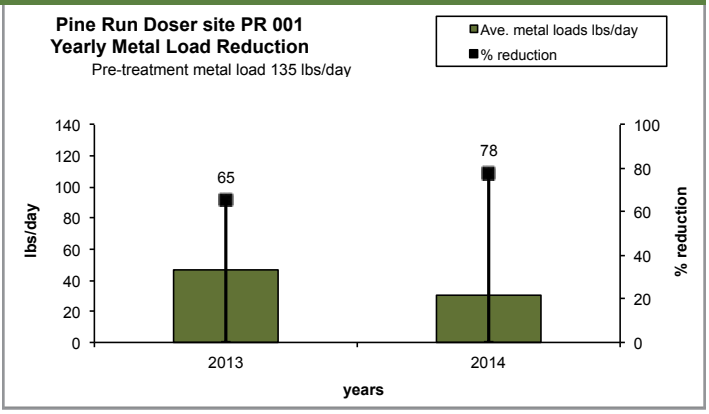
Most of the remediation in Sunday Creek consists of source control (i.e. stream capture, gob pile capping, etc….) and aren't actively monitored for acid and metal load reductions. Therefore target restoration sites along West Branch of Sunday Creek mainstem have been selected to analyze the acid and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

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

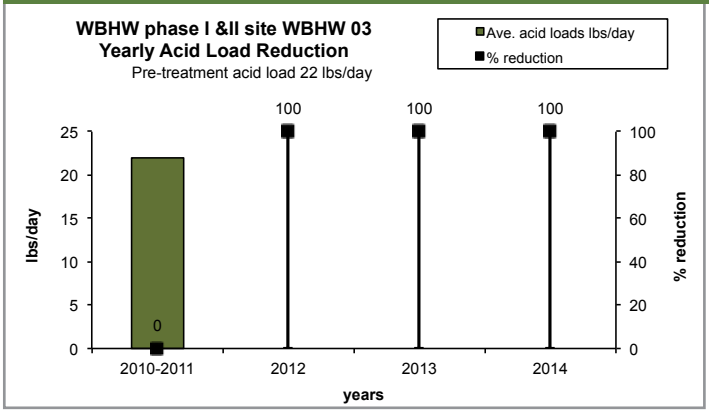
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, 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.

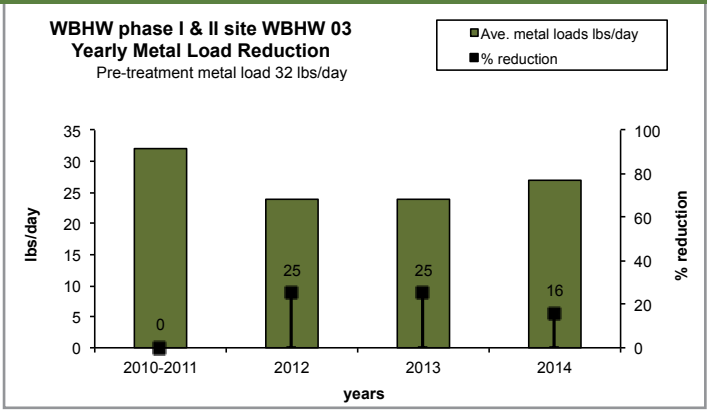
Pine Run Doser site PR 001





WBHW phase I & II site WBHW 03





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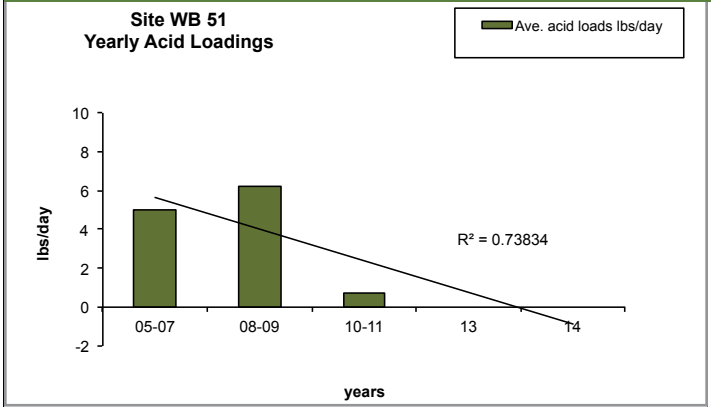
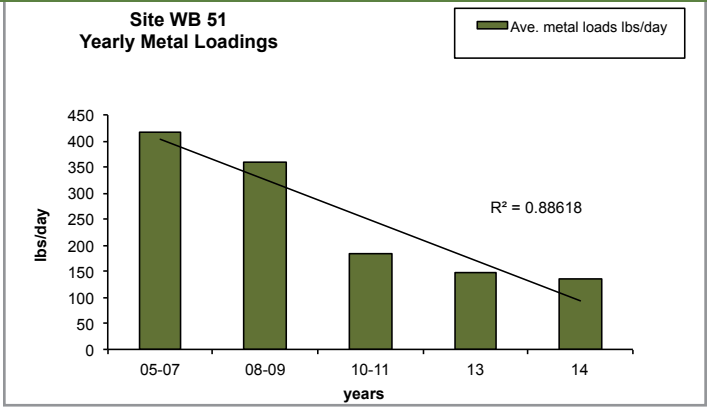
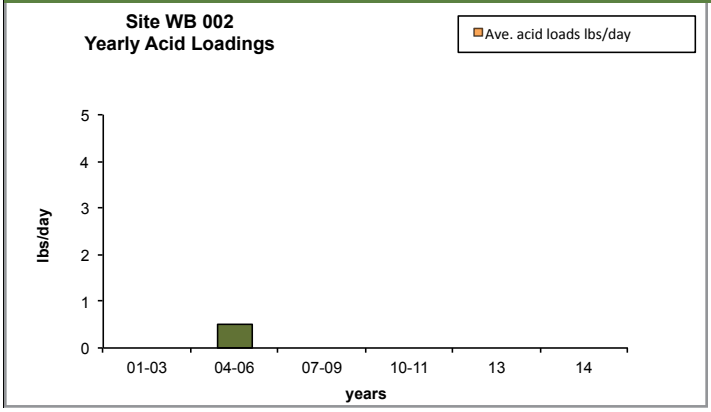
Yearly acid and metal load reduction trends per project

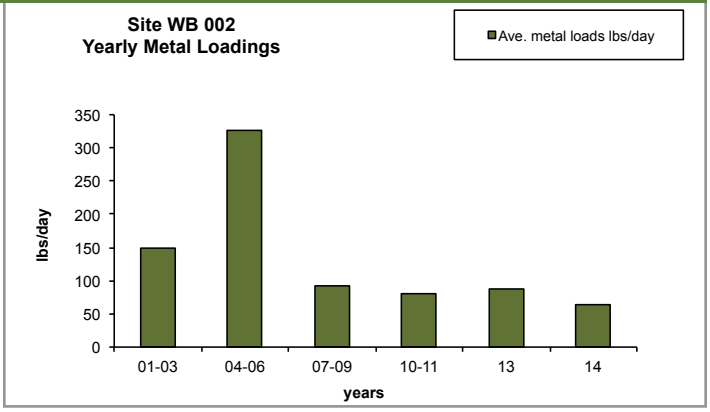
Site WB 51



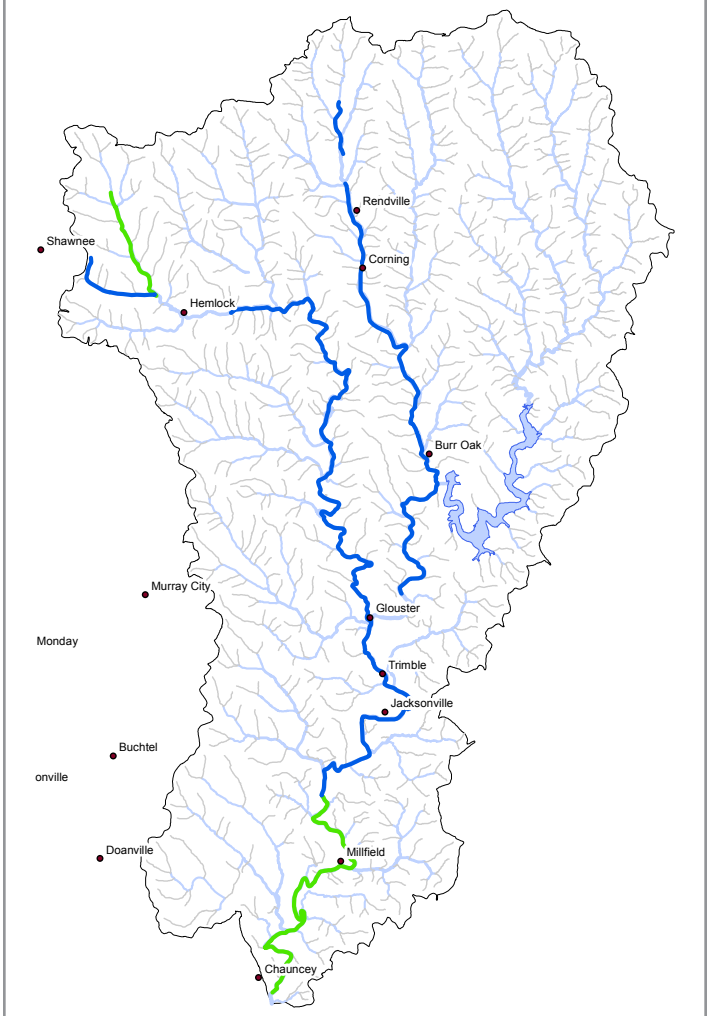


Site WB 002

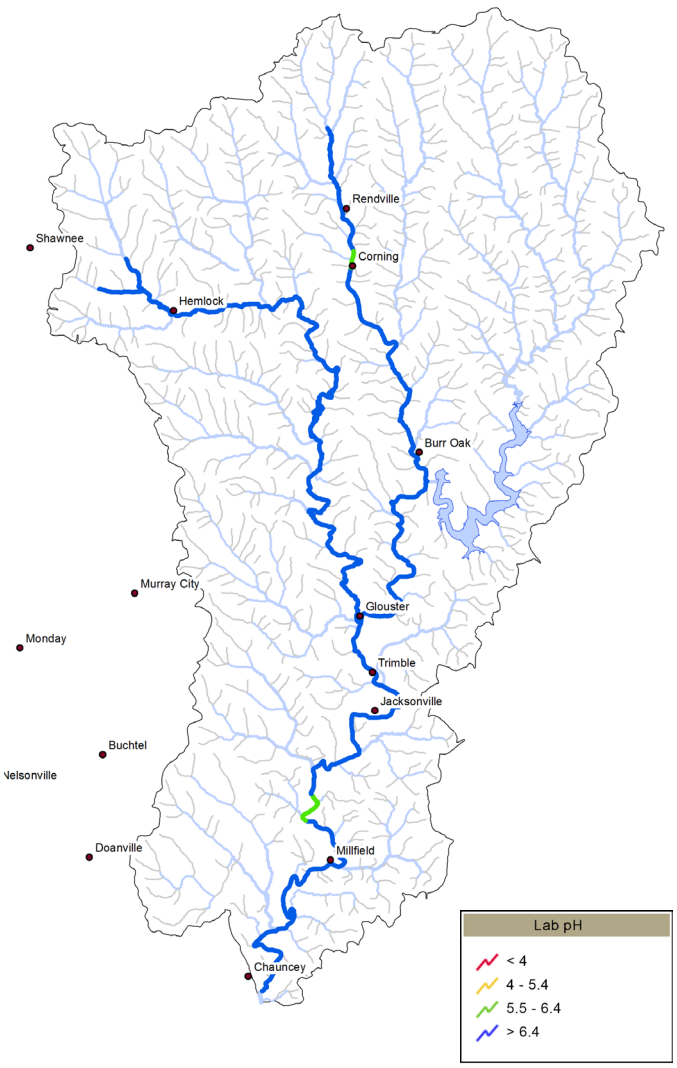




Sunday Creek baseline pH



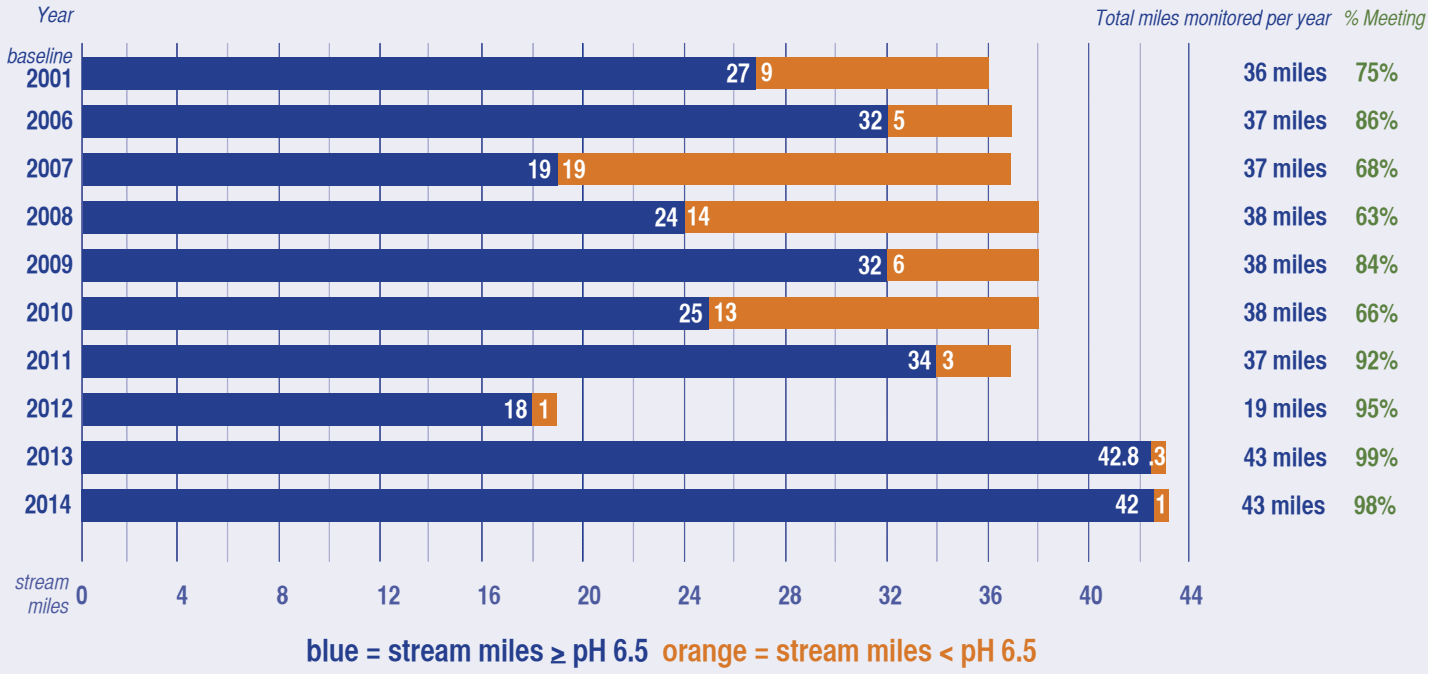
Sunday Creek 2014 pH



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 2014 all sites met the pH target of 6.5 except for a small section of a stream directly downstream of the Corning discharge, and a small section at Truetown, a total of only slightly more than one mile of the 43 miles monitored.

There are approximately 43 miles monitored for the past two years along the mainstem of Sunday Creek and major tributary West Branch, up from 38 stream miles monitored in 2010 and early. 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 2014, 42 of 43 miles of stream monitored meet the pH target.

Sunday Creek pH



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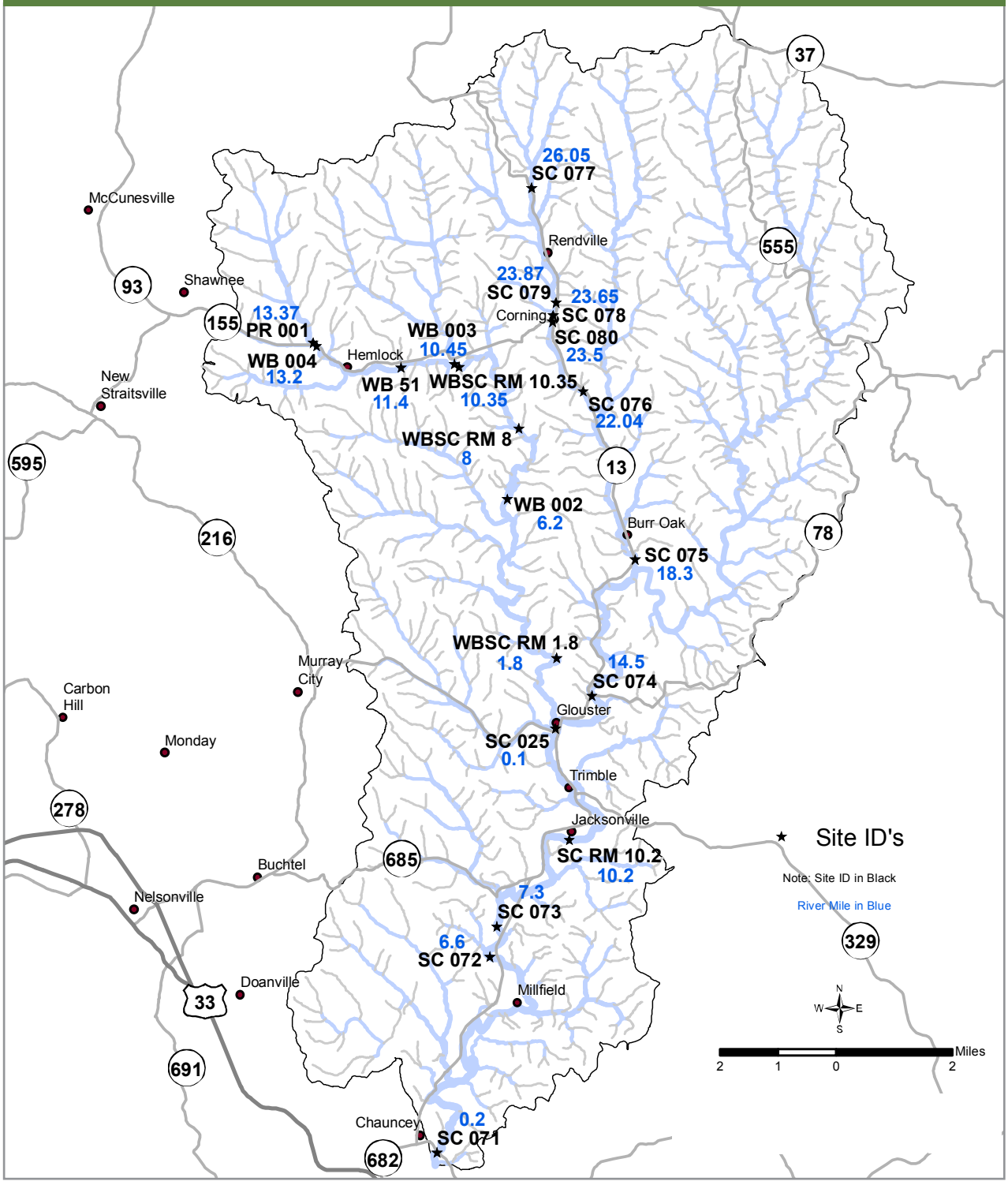
Chemical water quality analysis per stream reach

Sunday Creek



2014 NPS Report - Sunday Creek Watershed

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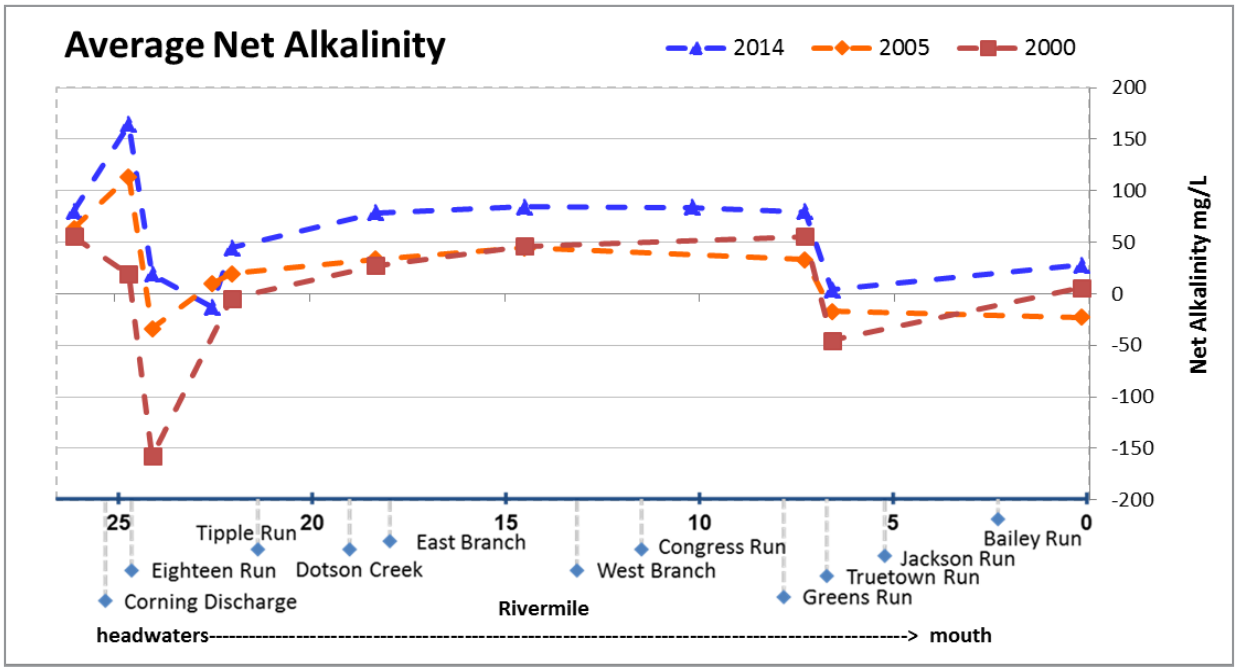
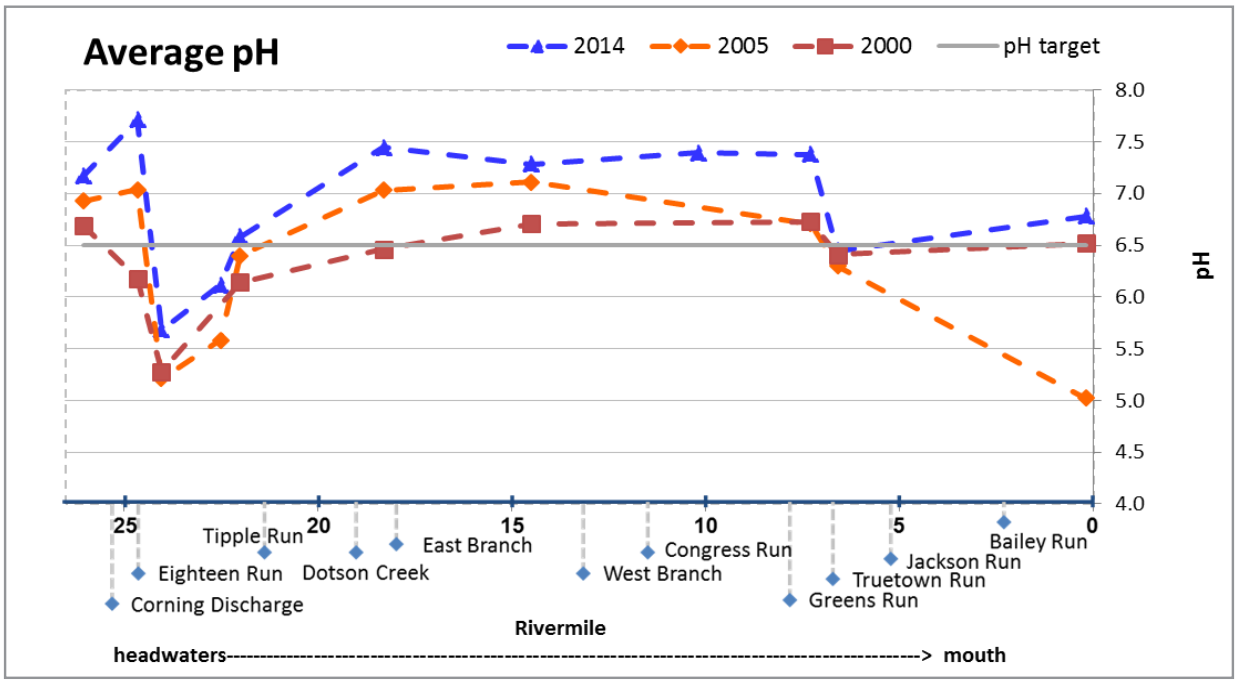
Chemical water quality analysis per stream reach

For purposes of analyzing chemical water quality changes along the mainstem of receiving stream where AMD reclamation projects have been completed, 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 074	SCRM 10.2	SC 073	SC 072	SC 071
Rivermile	26.05	23.87	23.65	23.5	22.04	18.3	14.5	10.2	7.3	6.6	0.2





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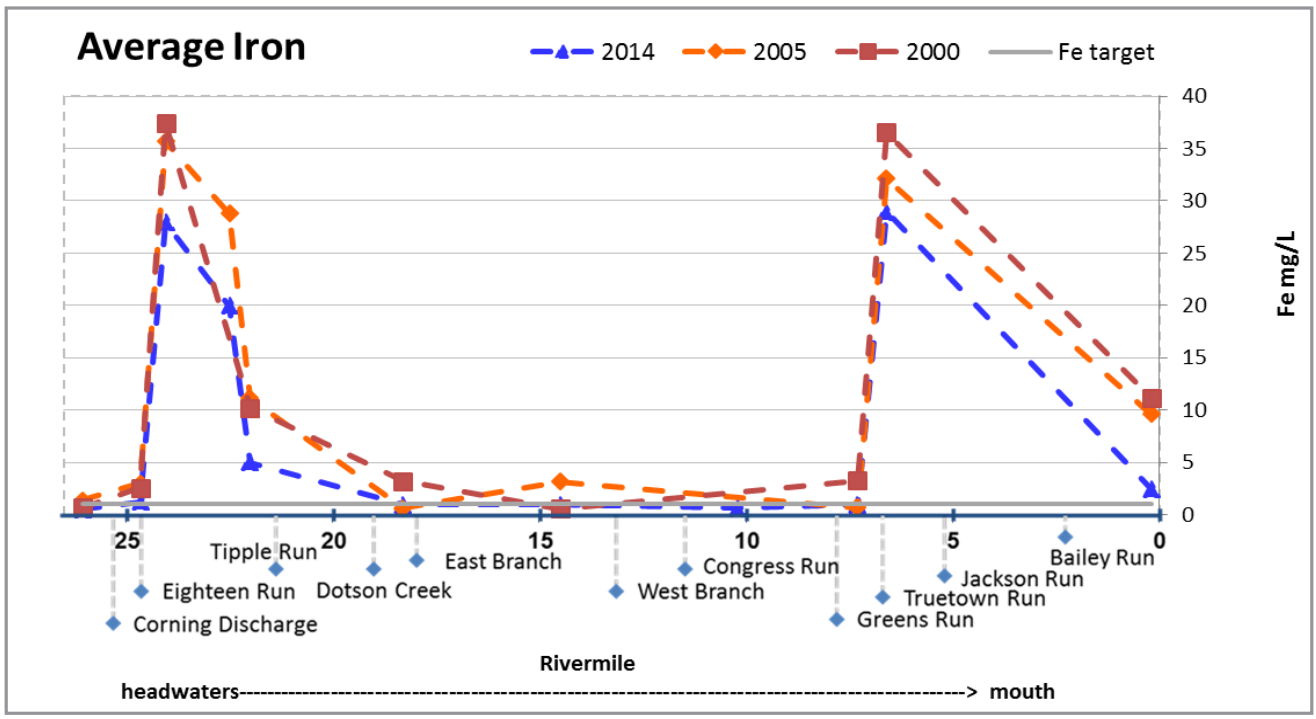

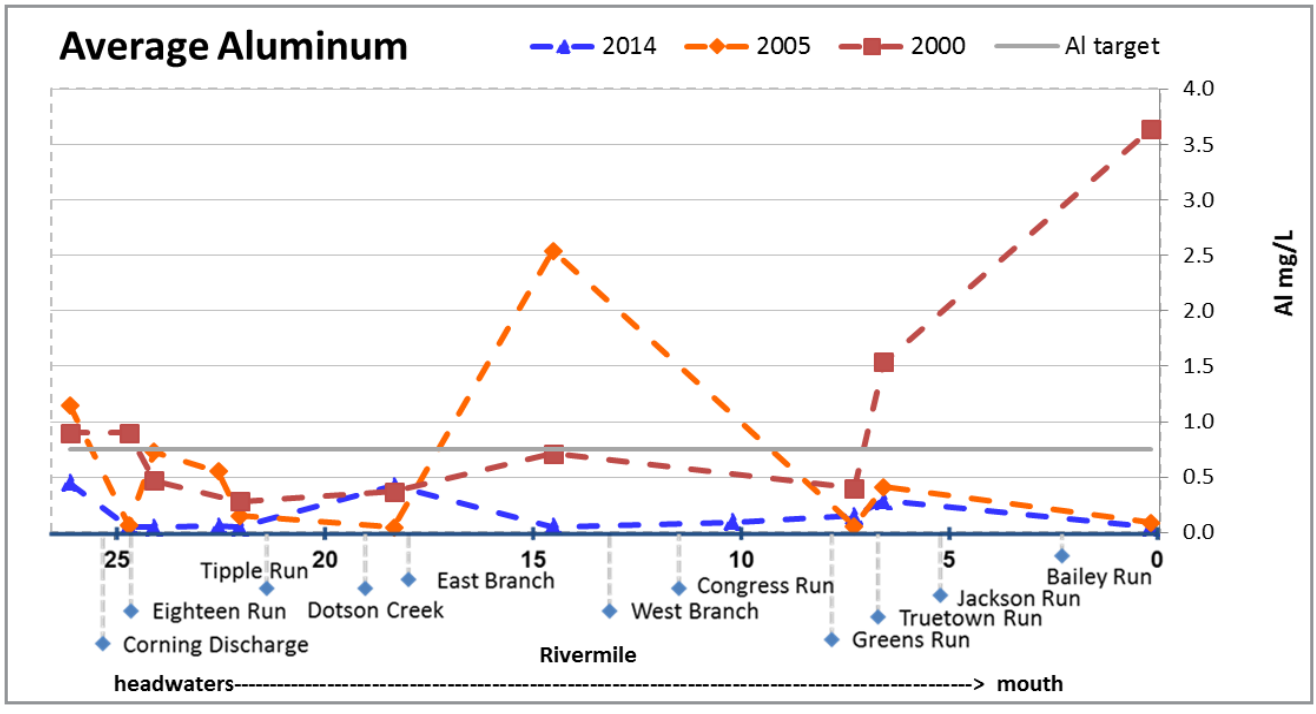

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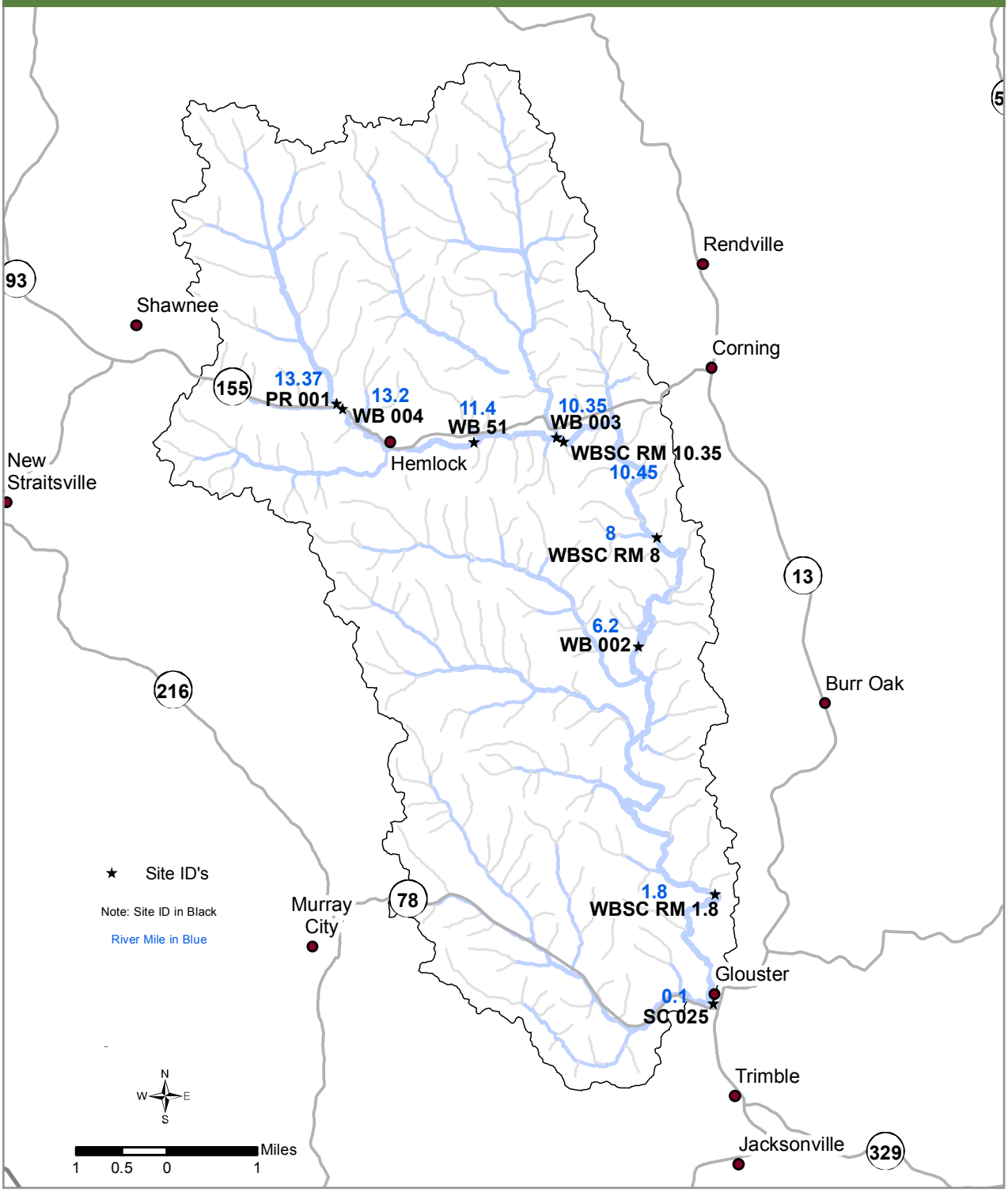
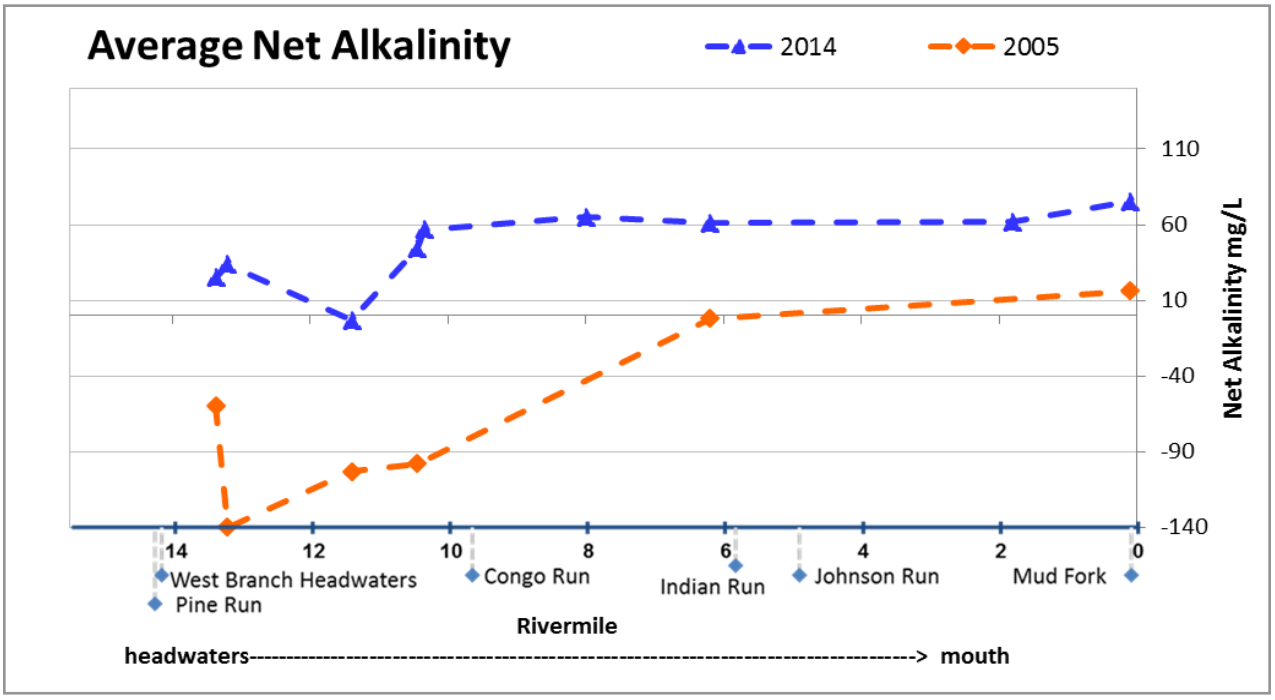
Chemical water quality analysis per stream reach

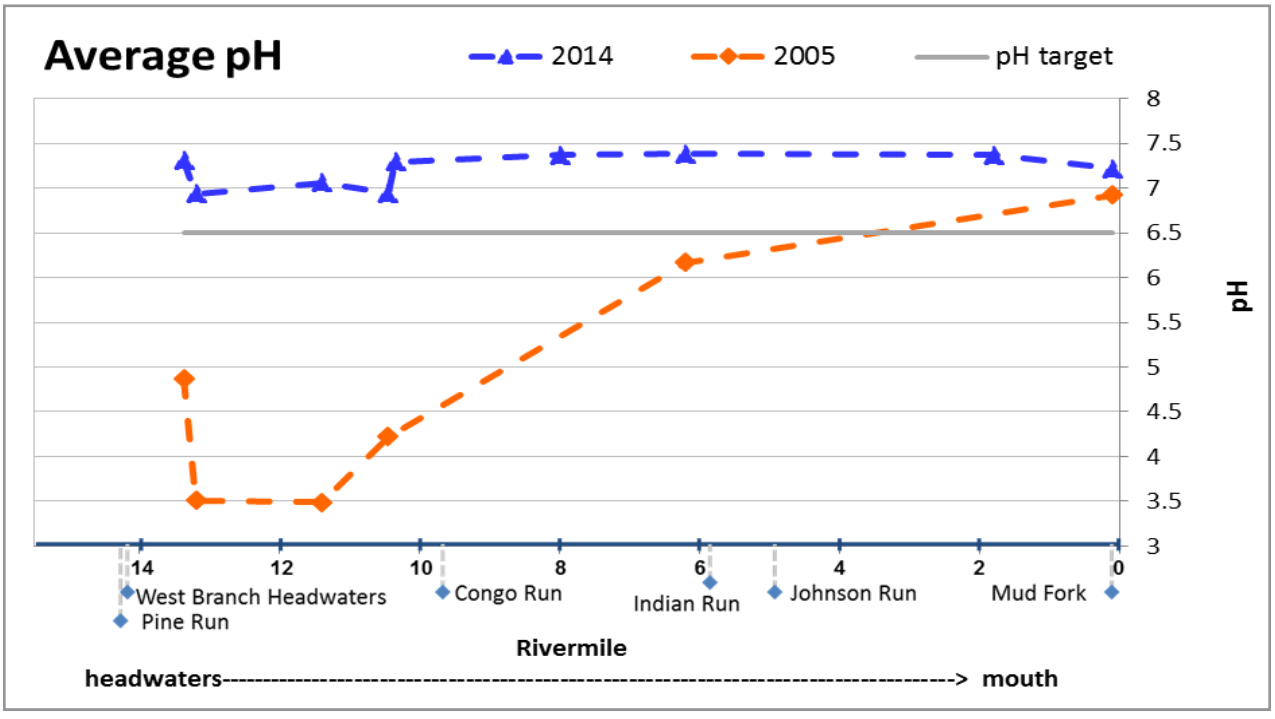
West Branch of Sunday Creek



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

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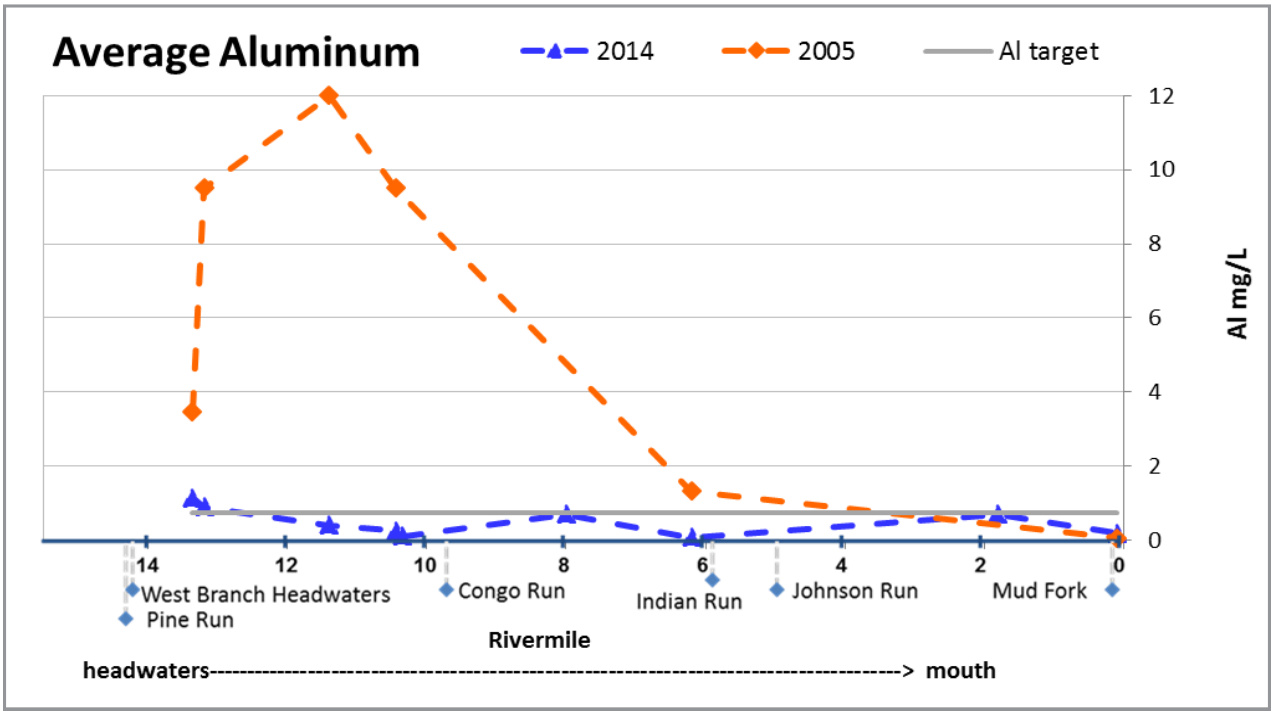
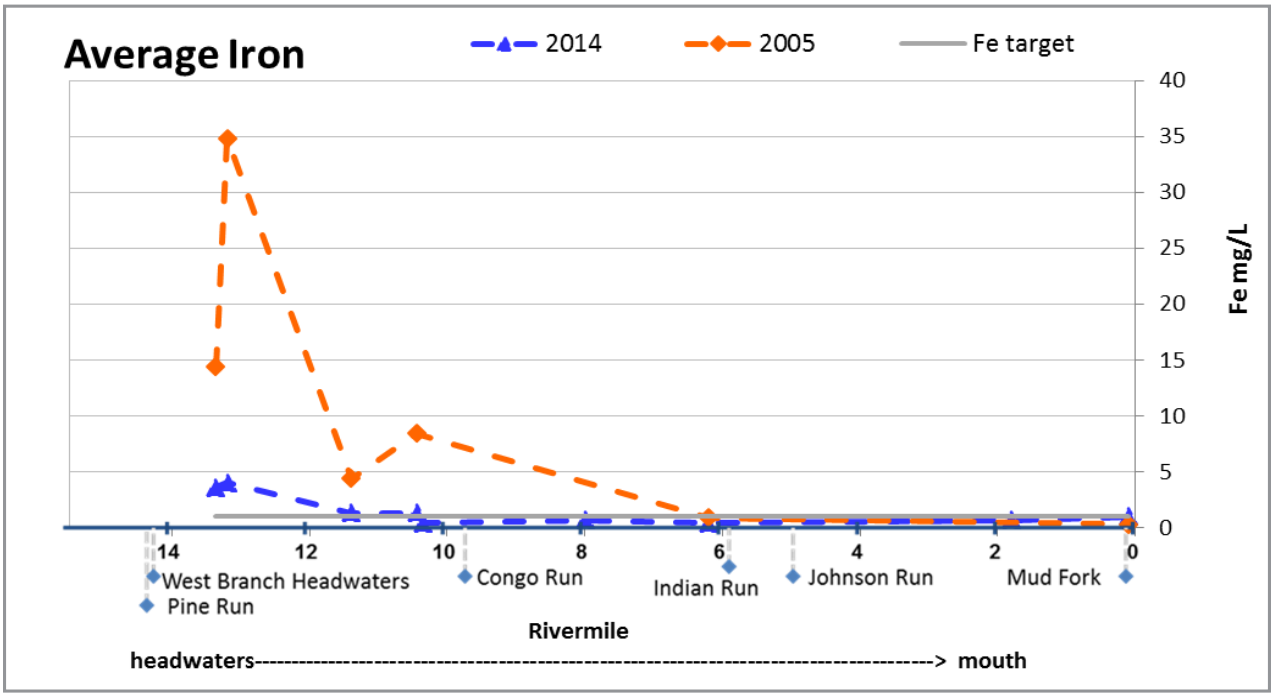
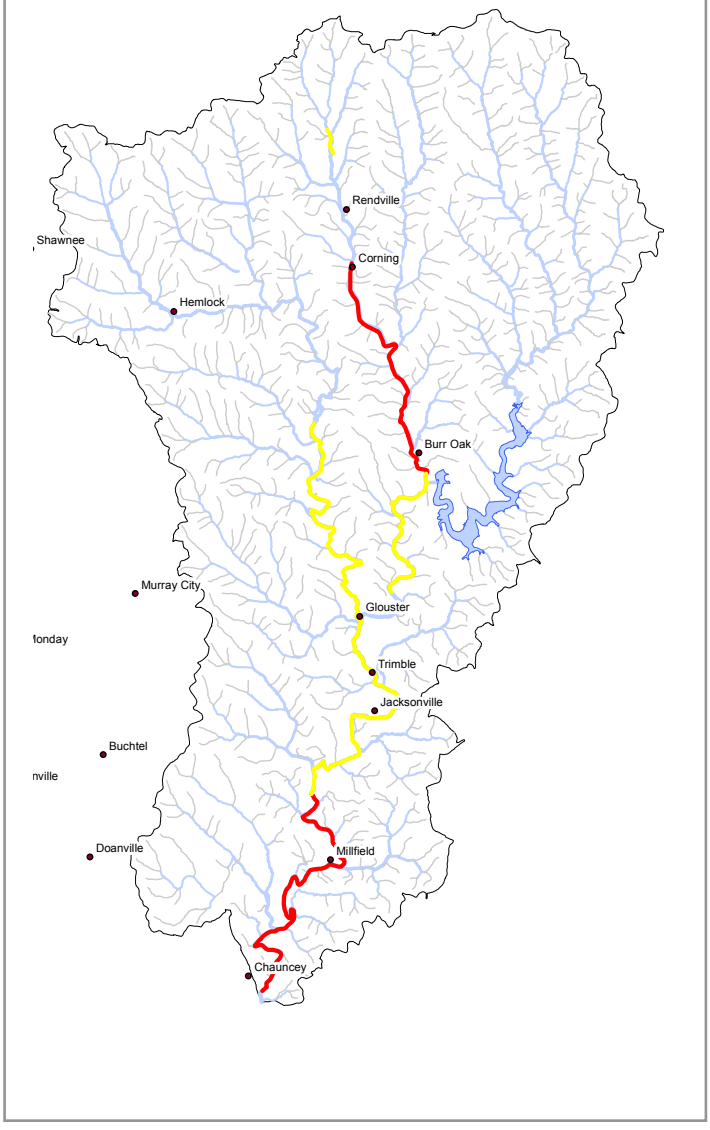
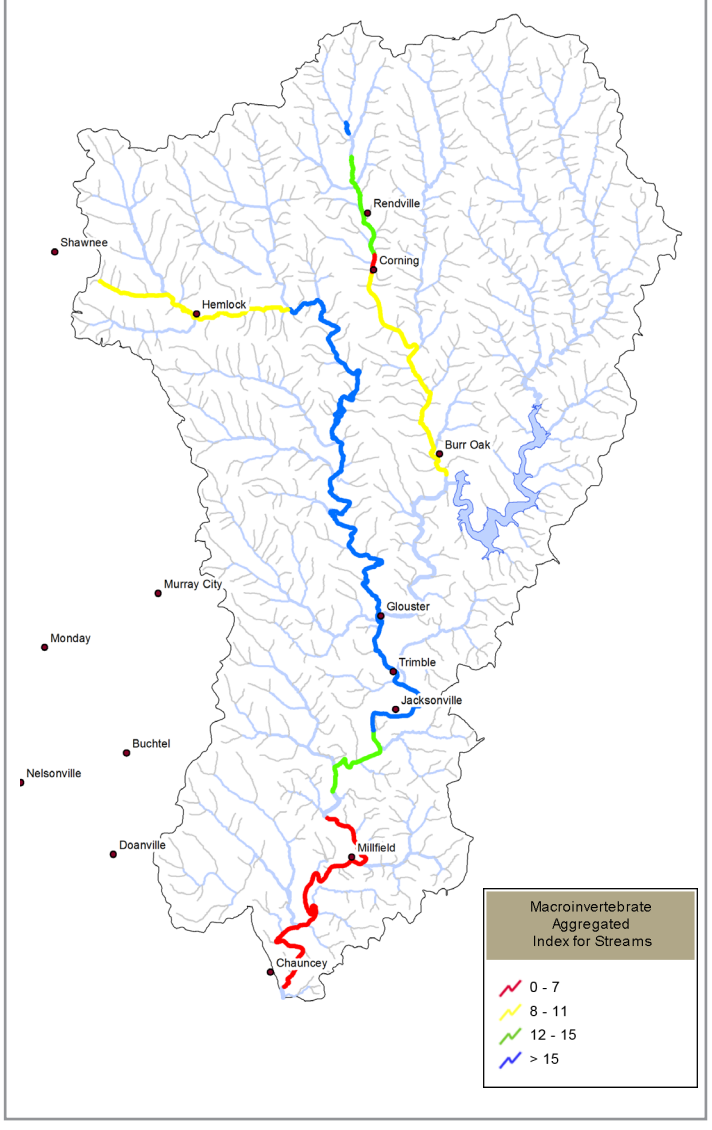




Sunday Creek baseline MAIS



Sunday Creek 2014 MAIS



MAIS samples were collected throughout Sunday Creek at established annual monitoring stations from 2001 through 2014.

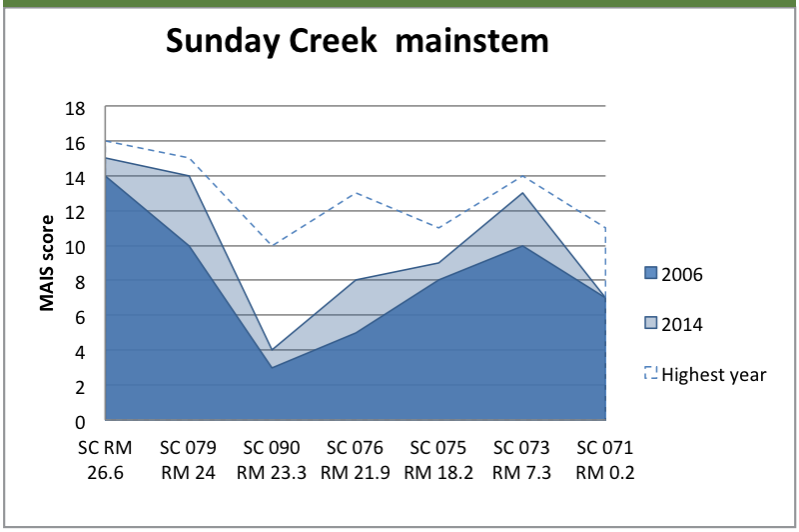
Biological Water Quality

Overall, the biological quality of the Sunday Creek mainstem remained similar to that recorded in 2013. The long term mainstem sites have improved since 2006 but no new gains in macroinvertebrate scores were seen in 2014 compared to 2013. 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) continues to be of the worst quality and although sites in this section have occasionally supported high MAIS scores, the section is not reaching its full recovery potential. RM 23.3 consistently has large amounts of metal precipitates, and metal precipitates are sporadically observed at RM 21.9, especially during low flow in summer. This section of stream has not shown statistical improvement since 2006.

Further downstream, however, biological quality is better and the site just above the Truetown discharge (RM 7.3) supports a biological community of moderately high quality, although it does not always attain the target of a MAIS score of "12". A high score of "14" recorded in 2011indicates that the site has good recovery potential. The furthest downstream section of Sunday Creek is badly impaired by the Truetown discharge and cumulative upstream impairments. The site at the dog shelter (RM 0.2) is still the only mainstem site that has shown significant improvement in MAIS scores since 2006. They still fall well below the target of "12".

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" last year and RM 10.3 earned a new high of "11" this year, suggesting that the section is improving slowly. The most downstream West Branch monitoring site at RM 6.2 continues to earn high scores, indicating the presence of a high quality macroinvertebrate community. This year marks the fifth year of monitoring at RM 8.0 (data added to table and figure), a site with similarly high quality macroinvertebrate community since monitoring began in 2010.

Figure 1. Area of Degradation 2006-2014



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

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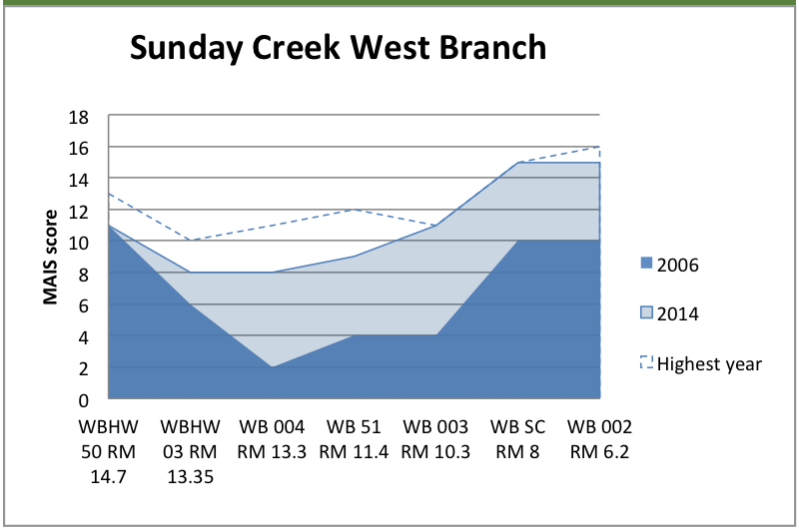
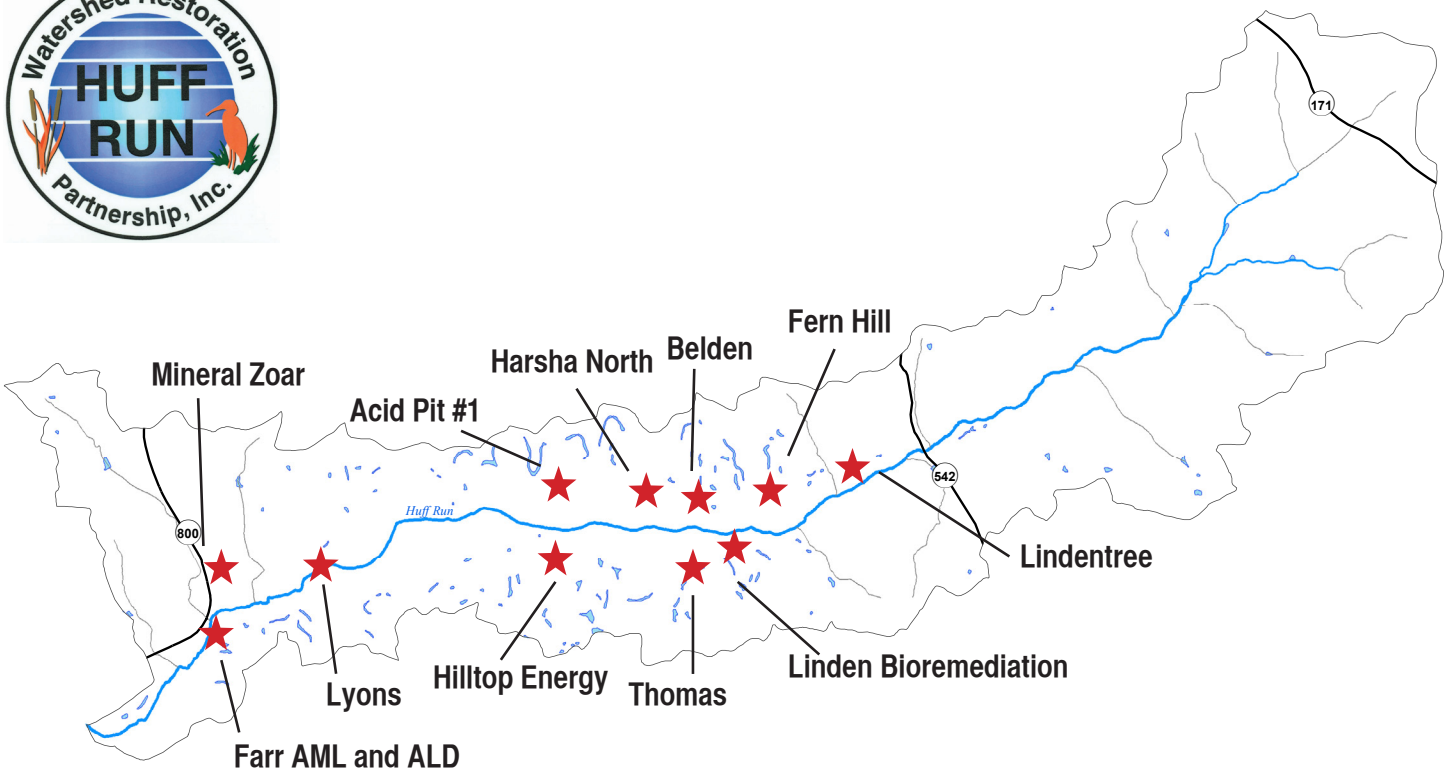


The blue dashed line identifies the highest MAIS score ever achieved at that site throughout the monitoring time period.

Figure 2. Sunday Creek MAIS Regressions

Rivermile	2001	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Linear trend	R square	P-value	Yrs
Mainstem																	
SC RM 26.6									14	14	13	16	15	no change	0.307692	0.331841	5
SC 079 RM 24				12	10	10	14	12	13	12	11	15	14	no change	0.326135	0.084645	10
SC 080 RM 23.3				5	3	2	7	12	5	10	4	9	4	no change	0.063327	0.483075	10
SC 076 RM 21.9	2	1	2	11	5	5	9	2	3	7	5	8	8	no change	0.216382	0.109211	13
SC 075 RM 18.2	5	9	8	10	8	10	5	7	8	11	10	9	**9**	no change	0.140382	0.207178	13
SC 073 RM 7.3	10	11	11	11	10	10	10	12	11	14	9	11	13	no change	0.122169	0.241741	13
SC 071 RM 0.2	4	2	3	8	7	3	6	11	8	10	7	9	7	improved	0.447961	0.012349	13
West Branch																	
WBHW 50 RM 14.7					11	10	11	8	12	13	11	11	**11**	no change	0.071642	0.486241	9
WBHW 03 RM 13.35				5	6	4	8	6	8	10	8	10	8	improved	0.578276	0.010665	10
WB 004 RM 13.3				1	2	2	5	5	7	7	5	11	8	improved	0.781368	0.000688	10
WB 51 RM 11.4				8	4	2	7	9	5	12	10	7	**9**	no change	0.248212	0.142772	10
WB 003 RM 10.3				8	4	3	4	8	4	7	7	7	**11**	no change	0.287852	0.10985	10
WB SC RM 8.0									14	13	15	14	**15**	no change	0.321429	0.318932	5
WB 002 RM 6.2				7	10	8	10	10	13	13	15	16	**15**	improved	0.891583	3.95E-05	10

HUFF RUN
WATERSHED REPORT



Reductions

Total acid load reduction at all project sites = 1063 lbs/day

Total metal load reduction at all projects sites = 33 lbs/day

excluding Mineral Zoar and Farr

Costs

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

Construction $4,349,850

Total cost through 2014 =$5,017,262

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

2014
- Project development for JS&L AMD Reclamation Project and the Farr Phase II

Huff Run Projects

Acid mine drainage reclamation projects completed in Huff Run Watershed:

2003 *Farr Project* (FAR01/02) – Surface reclamation, limestone channels, anoxic limestone drains, and passive wetland*
Linden Bioremediation Project (LIN08) – Pyrolusite limestone bioremediation bed

2004 Acid Pit #1 Project (ACP01) – Drain impoundments and surface reclamation

2005 Lyons Project (LYN01) – Steel slag bed, limestone channels, drain impoundments, and surface reclamation

Lindentree Project (LNT01) – Steel slag bed, limestone channels, and fill acid pits

2006 Harsha North Project (HAN05) – Surface reclamation, limestone trenches, and reclaimed gob pile

2008 Fern Hill HR-42 Pits A, B, & C (FRN01) – Surface reclamation, limestone Channels and reclaim 3 acidic pits

Belden and Belden Gob Pile Project (BLD01) – Surface reclamation, steel slag beds, reclaim gob pile, and passive settling ponds

2009 *Mineral Zoar (MZR08) – Reverse alkaline producing systems (RAPS)*

2010 Thomas Project (LIN01/THM06) – Surface reclamation and passive settling ponds

2011 Lyons II maintenance Project (LYN01) – Additional steel slag installed, pipe clean-outs, and added limestone berms to settling pond

2013 Hilltop Energy Project (HRT21/HR37) – Reclaimed gob pile, surface reclamation, limestone channels, and settling pond

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

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

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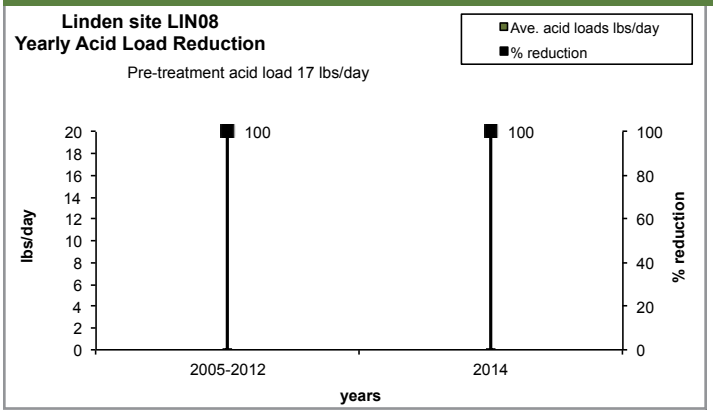
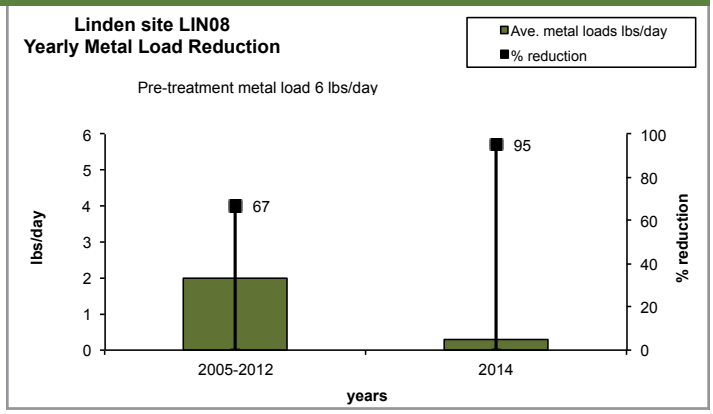
Yearly acid and metal load reduction trends per project

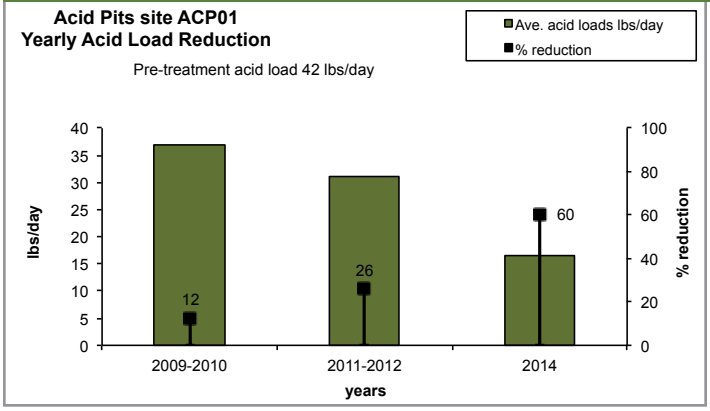
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, 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.

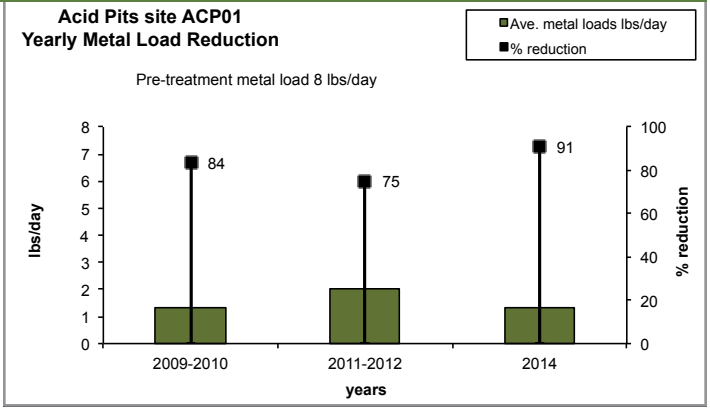
Linden site LIN08



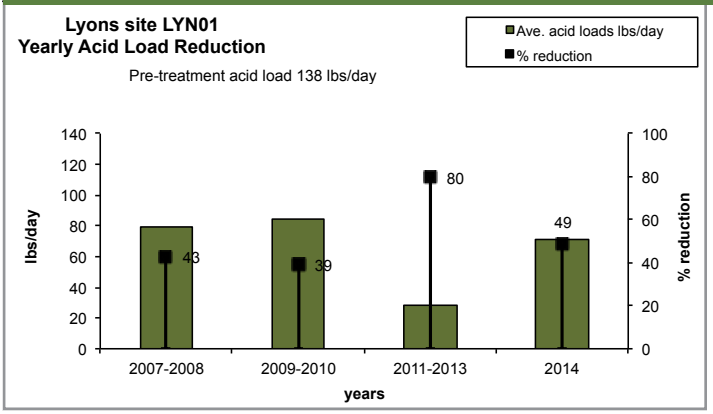


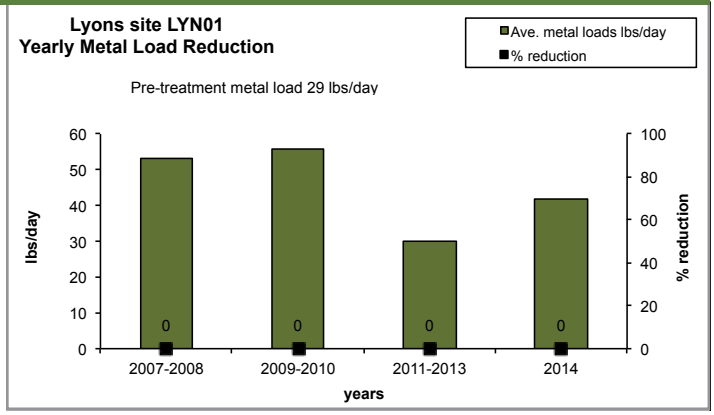
Acid Pits site ACP01





Lyons site LYN01





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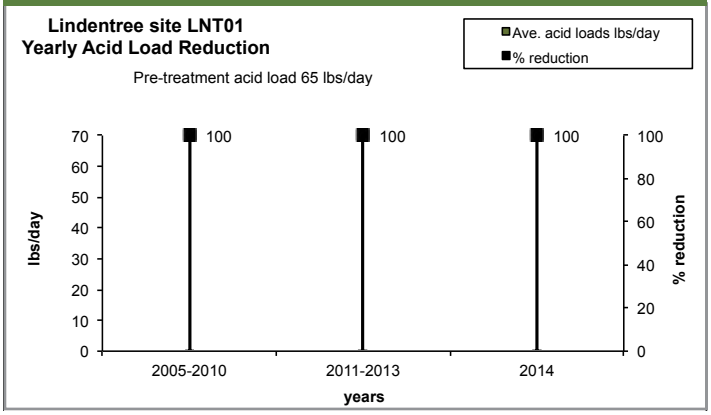
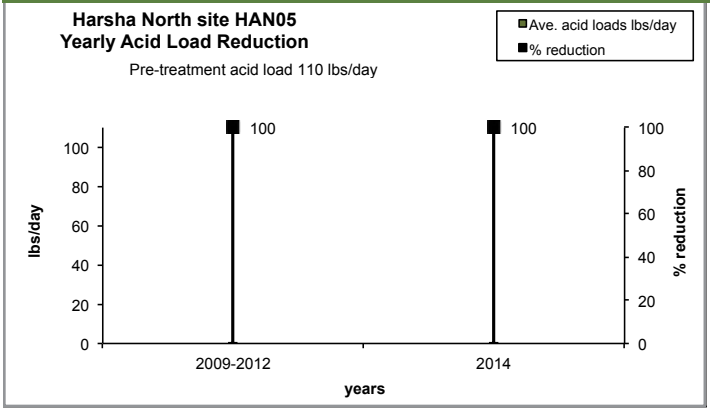
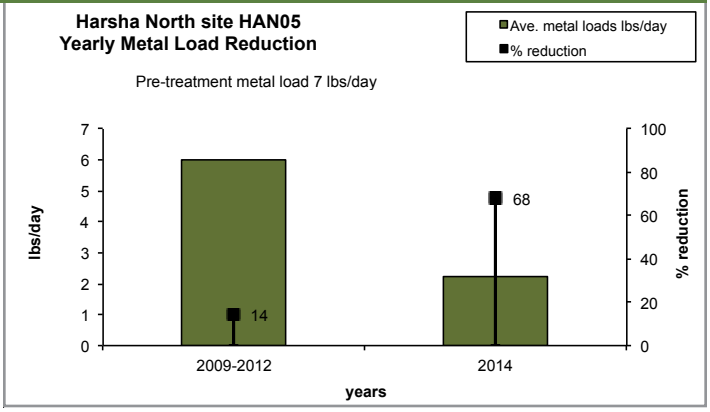
Yearly acid and metal load reduction trends per project

Lindentree site LNT01

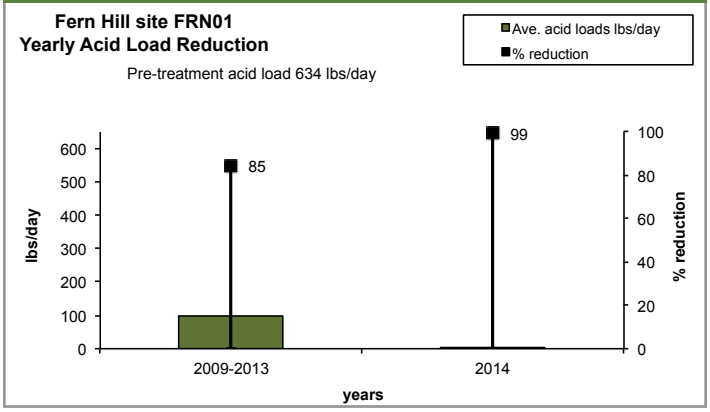


Harsha North site HAN05





Fern Hill site FRN01



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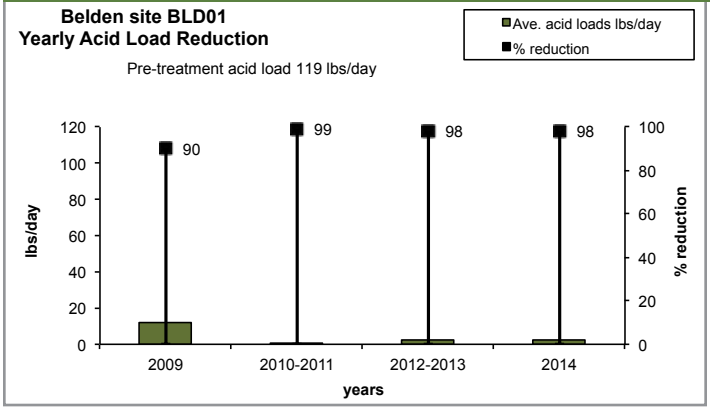
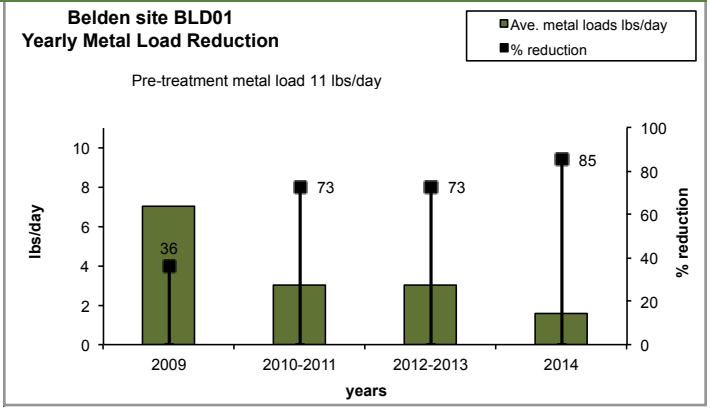
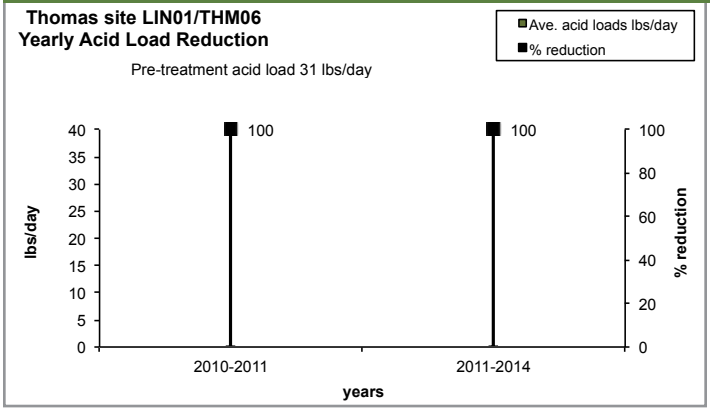
Yearly acid and metal load reduction trends per project

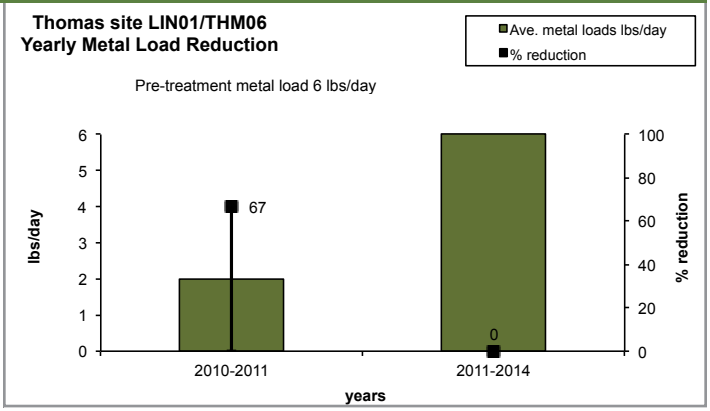
Belden site BLD01



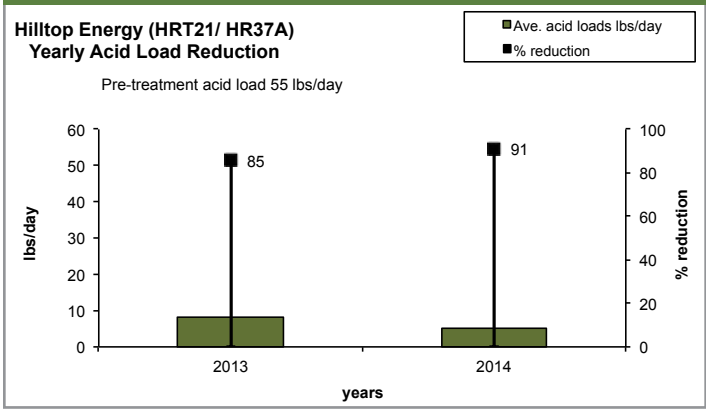


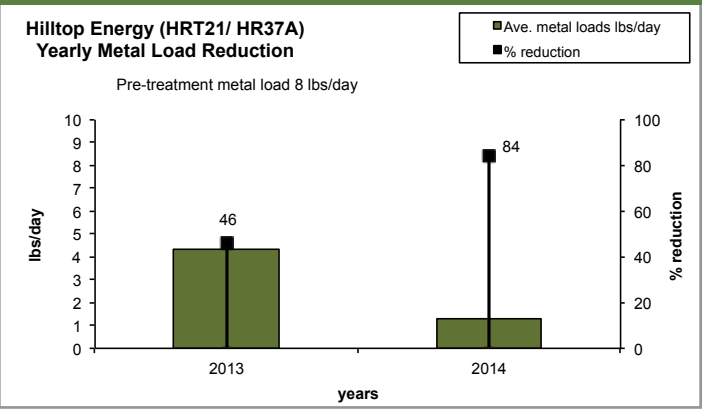
Thomas site LIN01/THM06



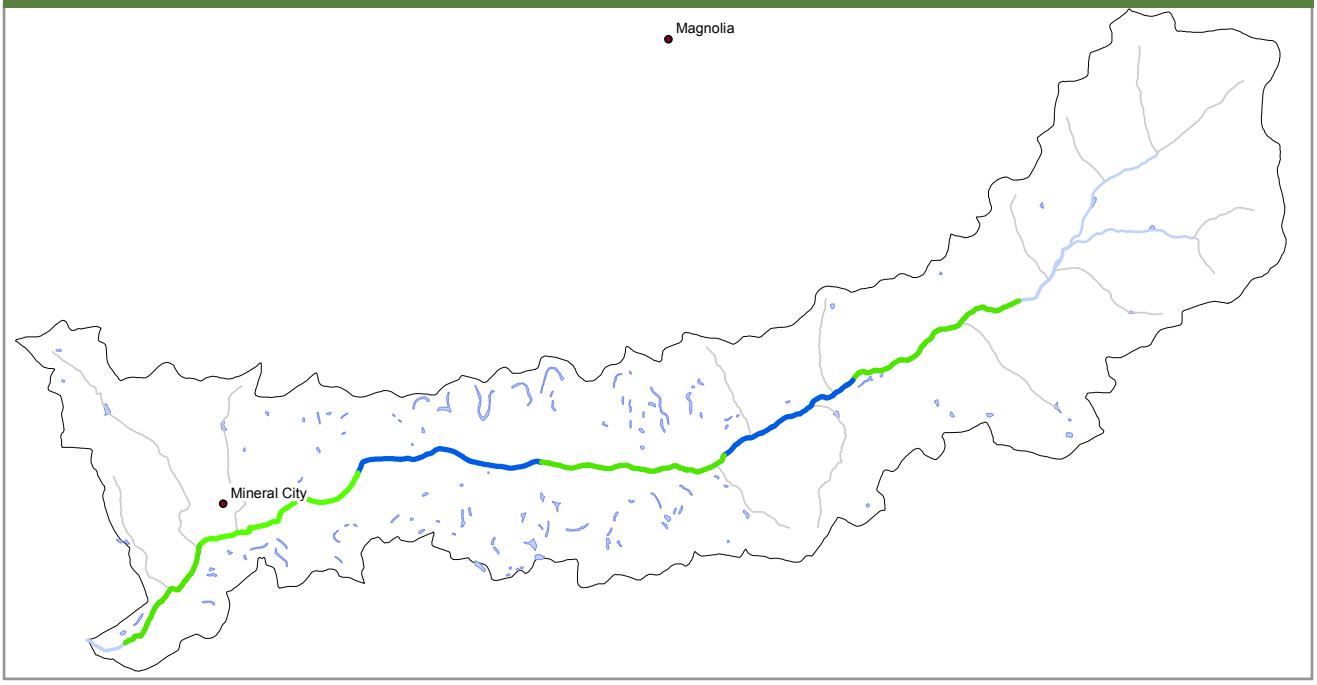


Hilltop Energy (HRT21/HR37A)

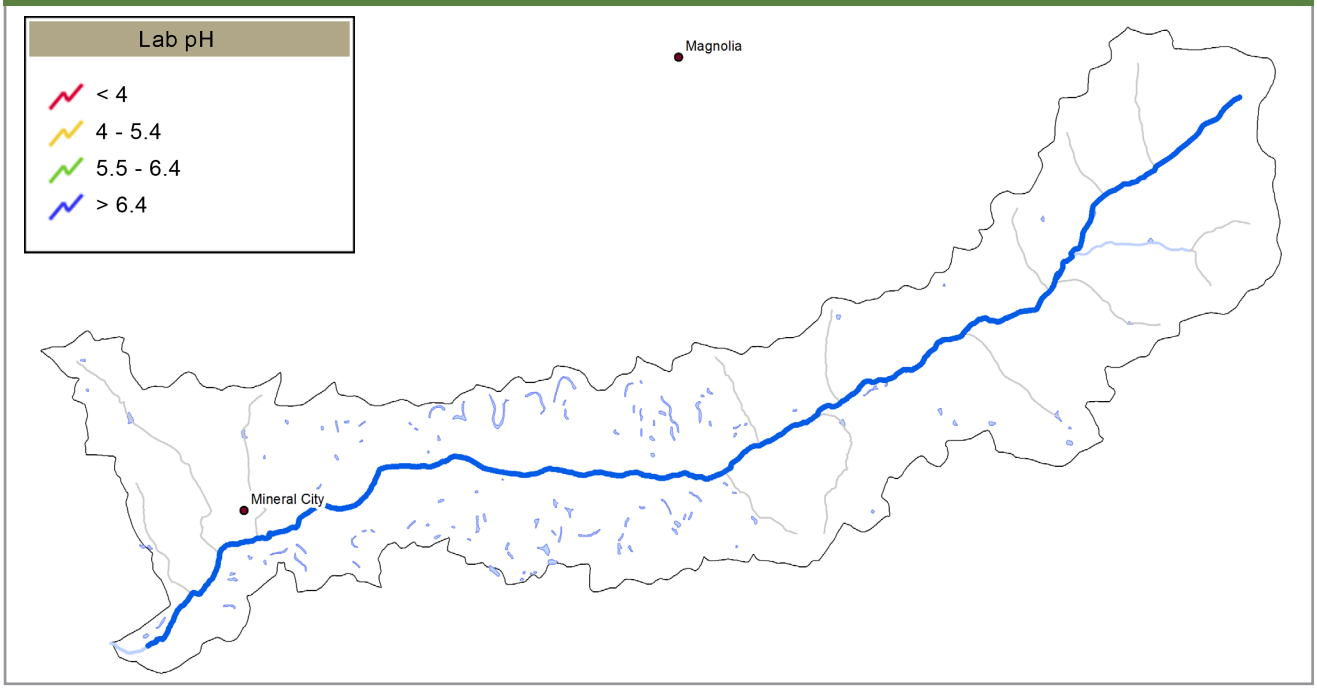




Huff Run baseline pH



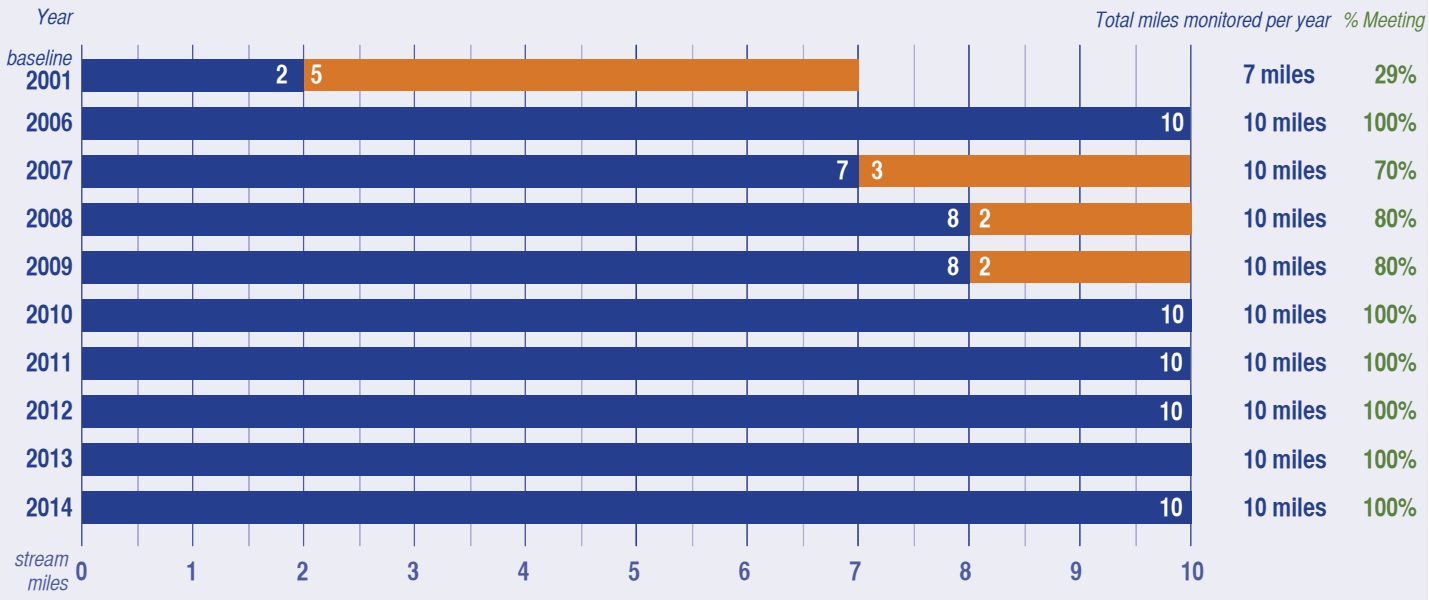
Huff Run 2014 pH



Huff Run pH values have improved from baseline conditions (1985-1998) to 2014. The entire length of Huff Run has met the pH target (6.5) for the last five years.

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 2014, all 10 miles met the pH target.

Huff Run pH



2014 NPS Report - Huff Run Watershed

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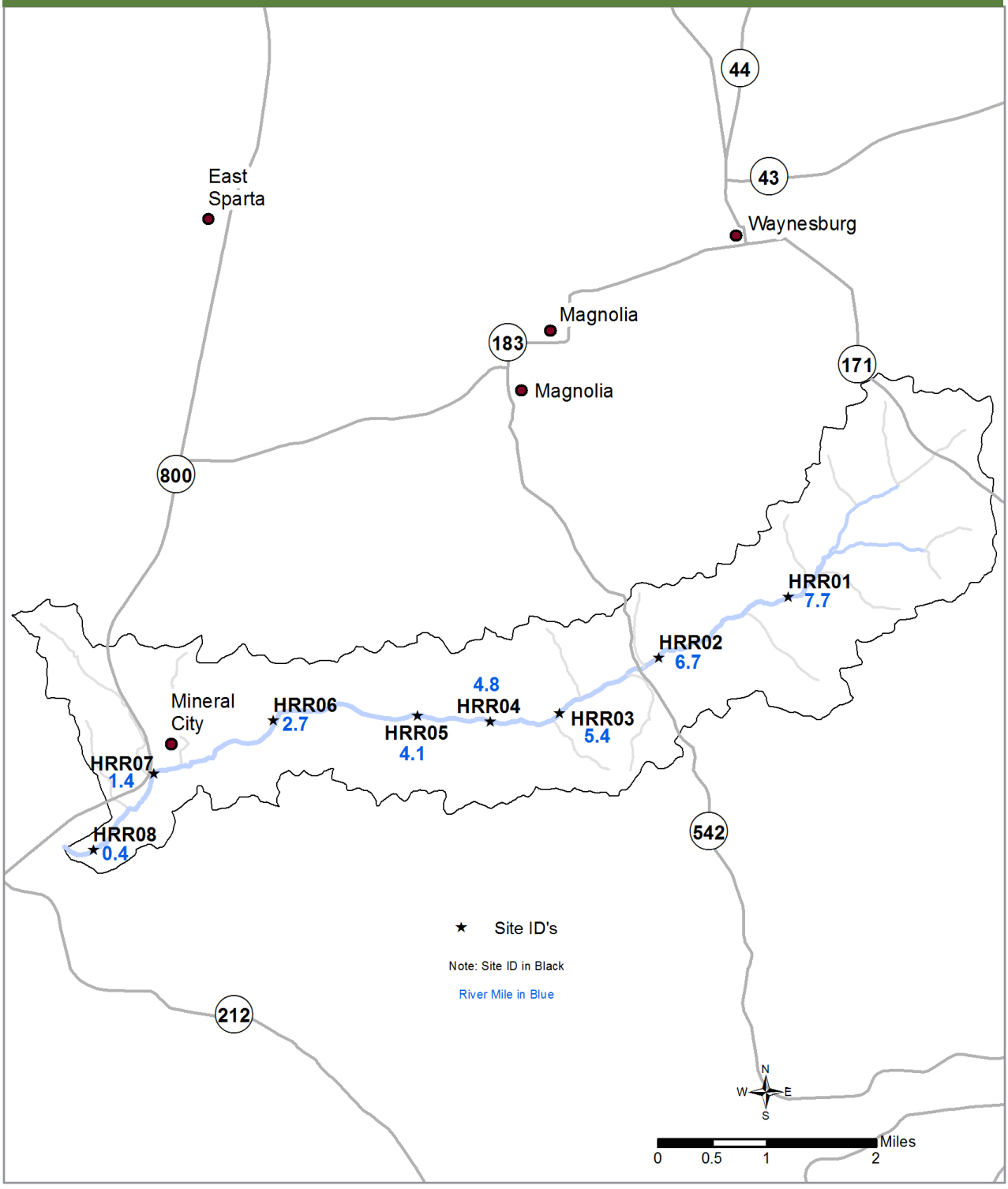
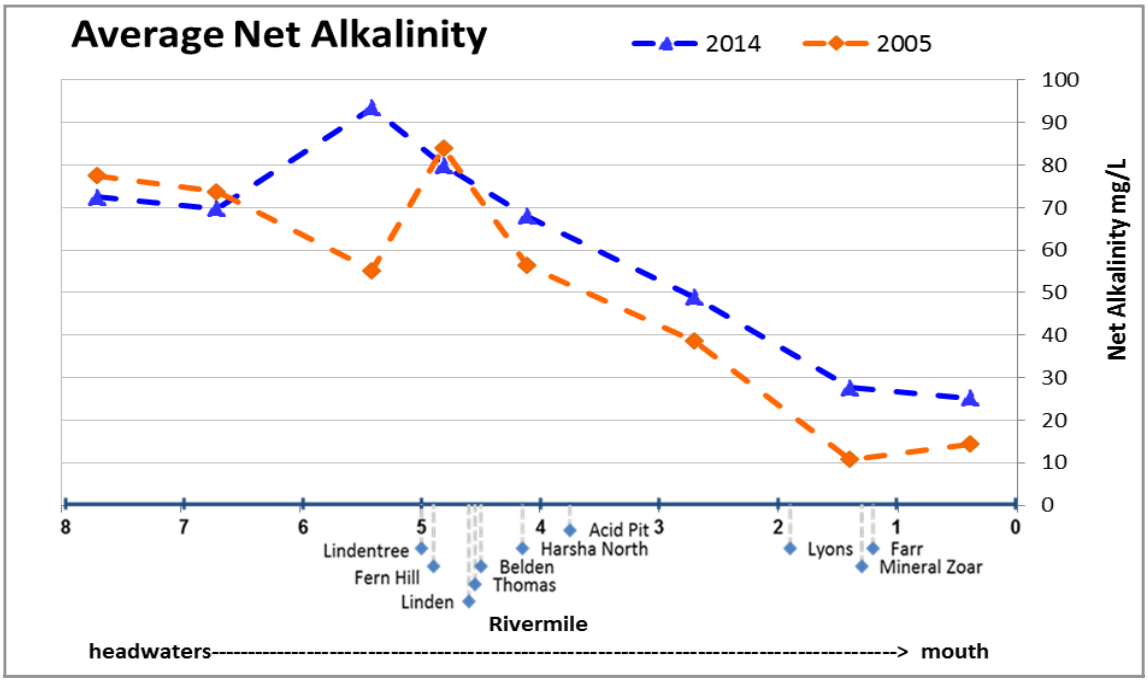
Chemical water quality analysis per stream reach

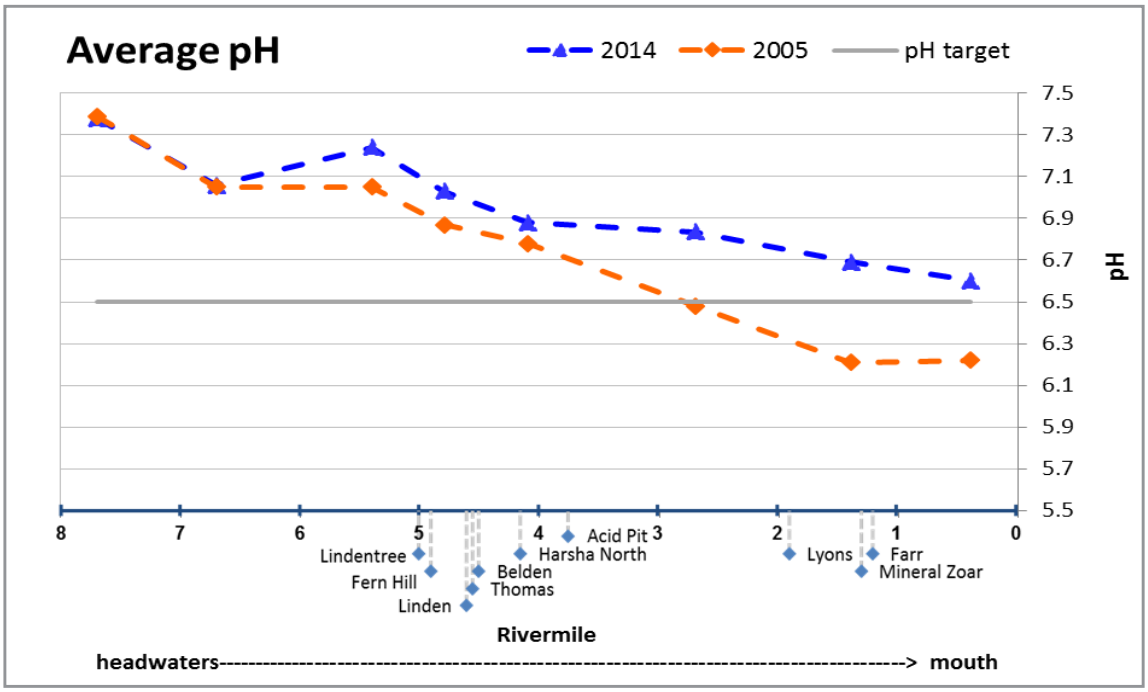
Huff Run



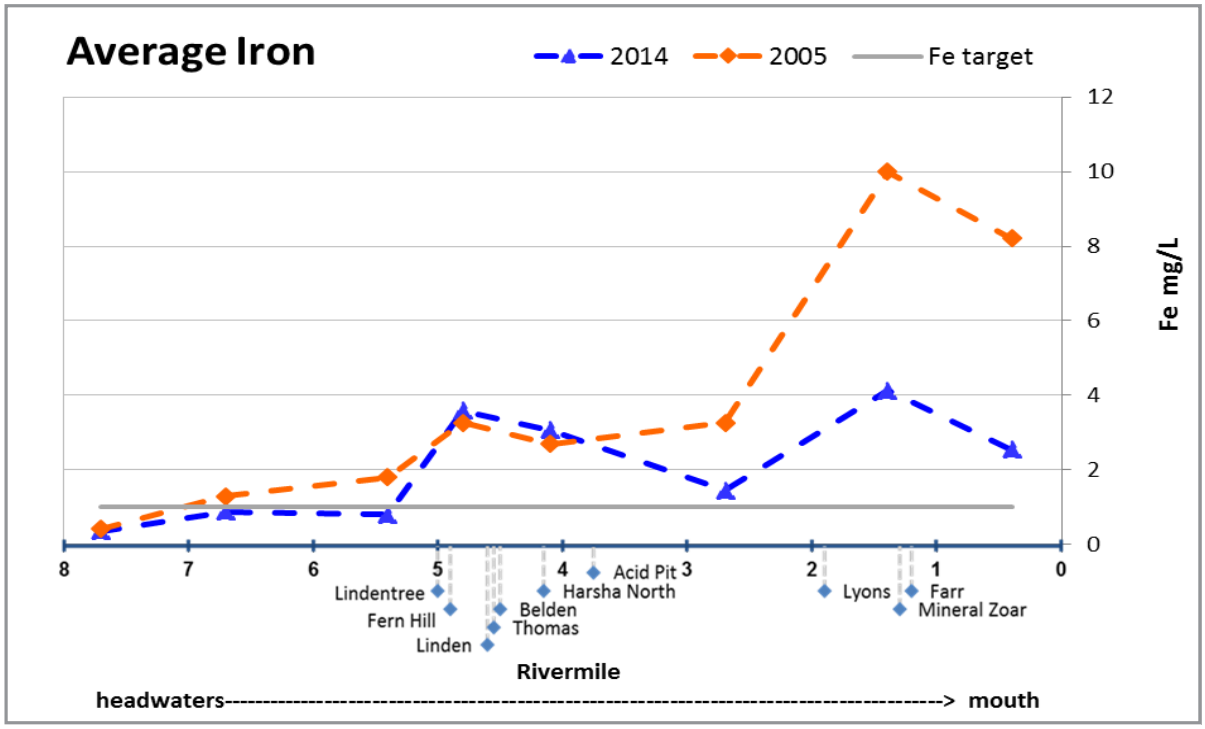
Chemical water quality changes along the mainstem of Huff Run are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources of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

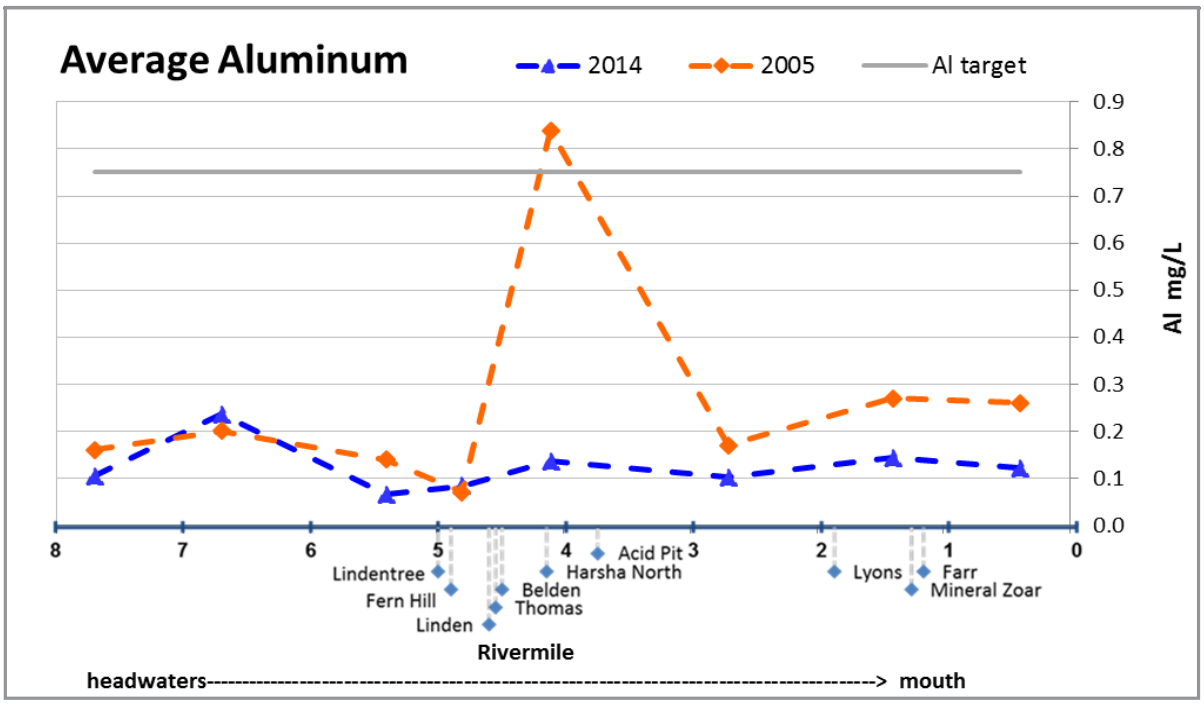
Huff Run								
Site ID	HRR01	HRR02	HRR03	HRR04	HRR05	HRR06	HRR07	HRR08
Rivermile	7.7	6.7	5.4	4.8	4.1	2.7	1.4	0.4



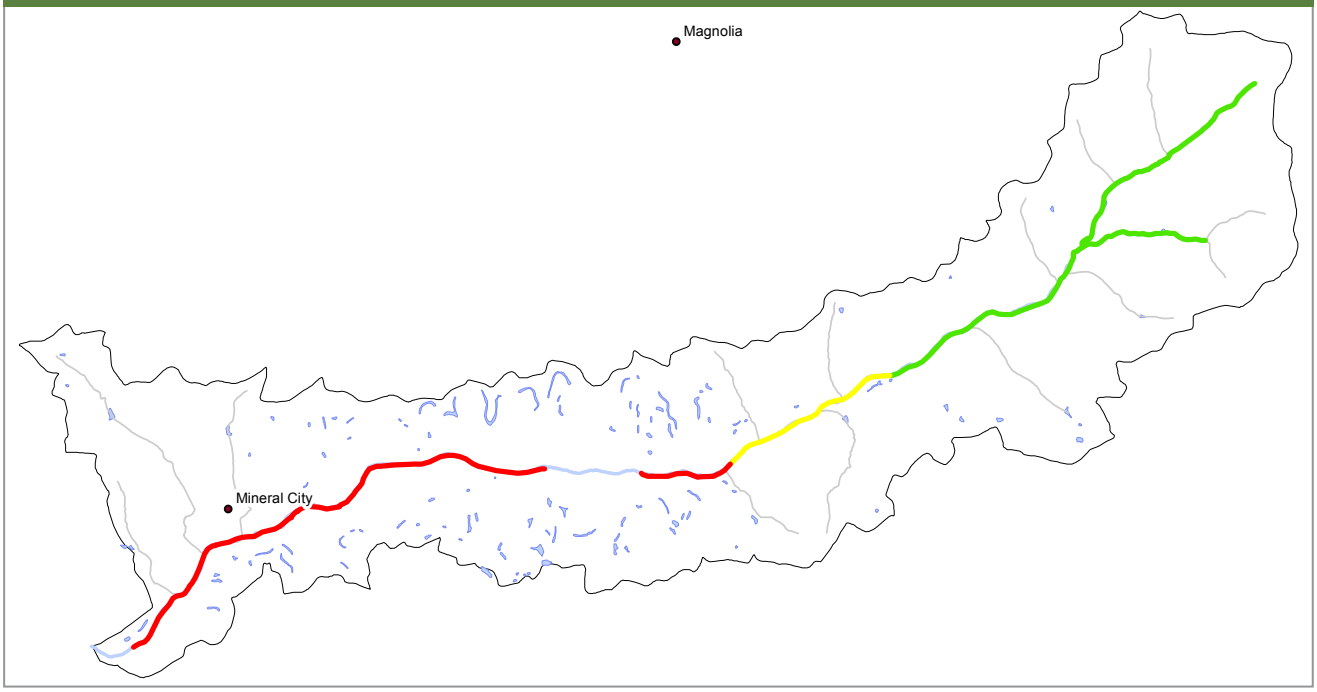


Huff Run								
Site ID	HRR01	HRR02	HRR03	HRR04	HRR05	HRR06	HRR07	HRR08
Rivermile	7.7	6.7	5.4	4.8	4.1	2.7	1.4	0.4

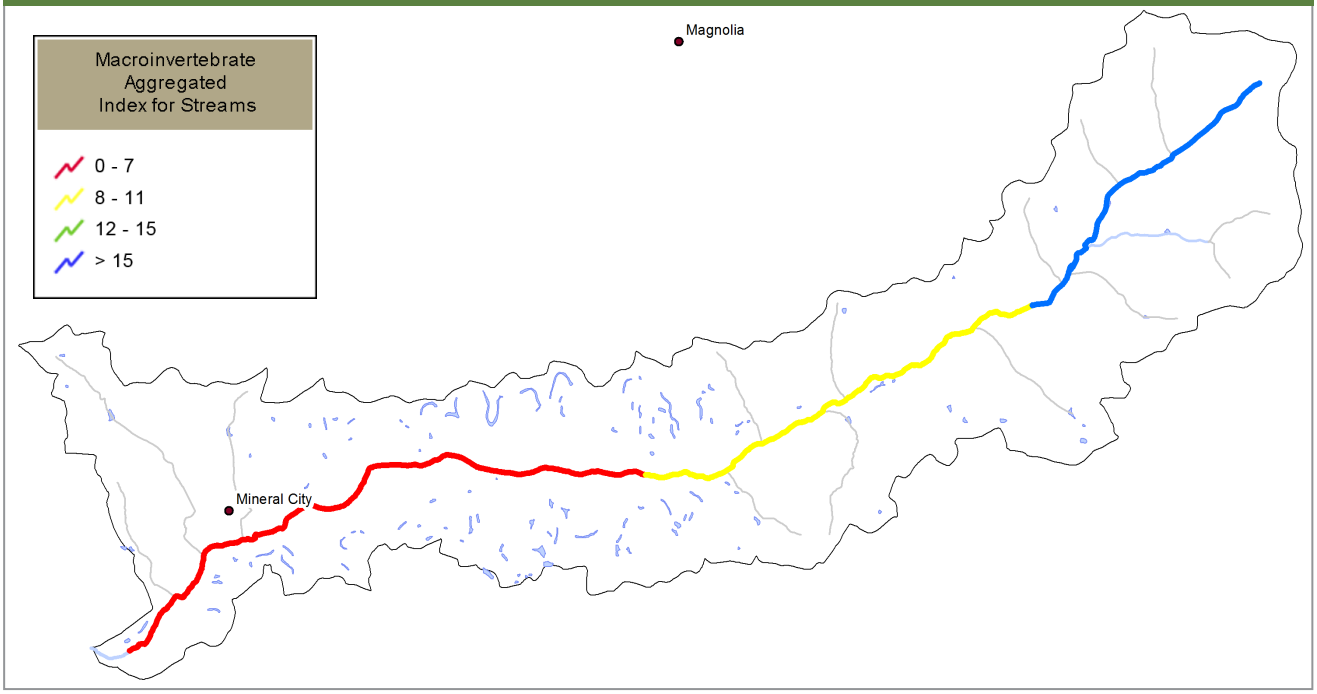




Huff Run baseline MAIS



Huff Run 2014 MAIS



Biological quality in Huff Run decreases from headwaters to the mouth.

Biological quality in Huff Run (based on macroinvertebrate data) improved modestly, but notably, along the length of the mainstem. This year for the first time since monitoring began in 2005 one of the eight monitoring sites (HRR03 at RM 5.5), improved enough to be categorized as sustained and statistically significant. Although none of the downstream impaired sites are yet meeting the target MAIS score of "12", four sites (RM 7.7, 5.4, 4.8 and 2.7) achieved new high scores this year.

Figure 1. Area of Degradation 2006-2014

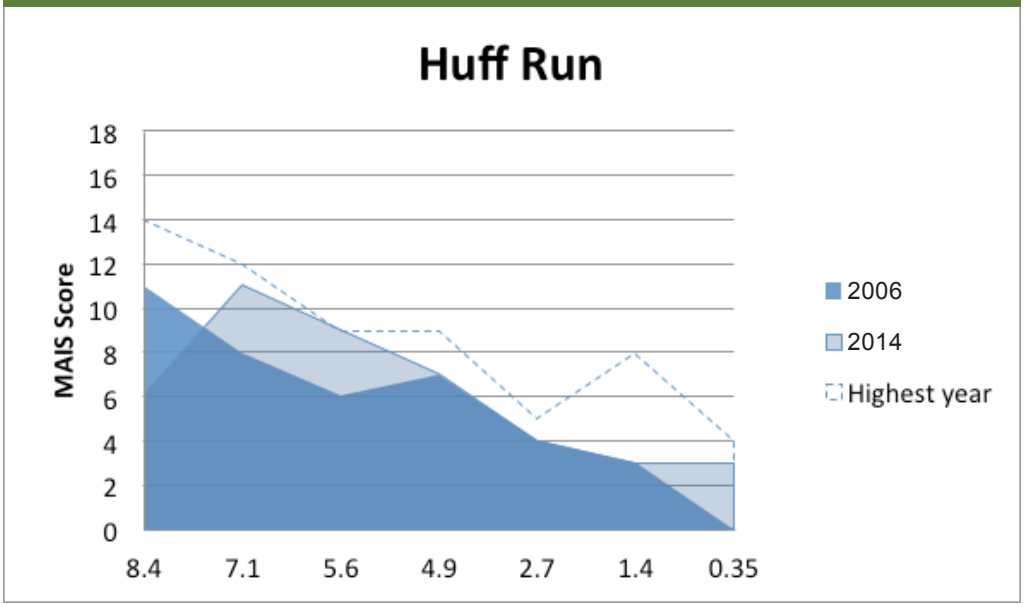


Figure 2. Huff Run MAIS Regressions

Site ID Rivermile	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Linear trends	R square	P-value	No. of years
HRR01 RM 8.0	14	11	12	12	13	9	13	6	10	15	no change	0.040776	0.575853	10
HRR02 RM 6.7	12	8	8	8	9	11	11	11	10	9	no change	0.025479	0.659592	10
HRR03 RM 5.5	8	6	7	6	8	9	7	9	10	11	improved	0.579409	0.010544	10
HRR04 RM 4.8	6	7	9	8	9	9	6	7	9	11	no change	0.244674	0.146108	10
HRR06 RM 2.7	5	4	5	3	4	5	3	4	5.5	7	no change	0.137538	0.291414	10
HRR07 RM 1.4	2	3	3	2	8	2	2	3	5	7	no change	0.193019	0.203952	10
HRR08 RM 0.4	3	0	4	3	4	3	3	3	3	4	no change	0.145455	0.276846	10

LEADING CREEK WATERSHED REPORT

2014 NPS Report - Leading Creek Watershed

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

Reductions

Total acid load reduction = 661 lbs/day

Total metal load reduction = 138 lbs/day

Costs

Design $8,201

Construction $407,23

Total Costs through 2014 = $415,437


Leading Creek

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
2014	• Project development for Casto Doser reclamation scheduled for 2015

Leading Creek Projects

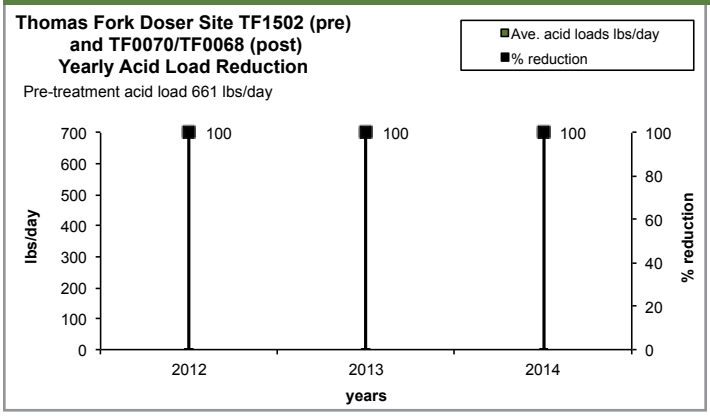
Acid mine drainage reclamation projects completed in Leading Creek Watershed:

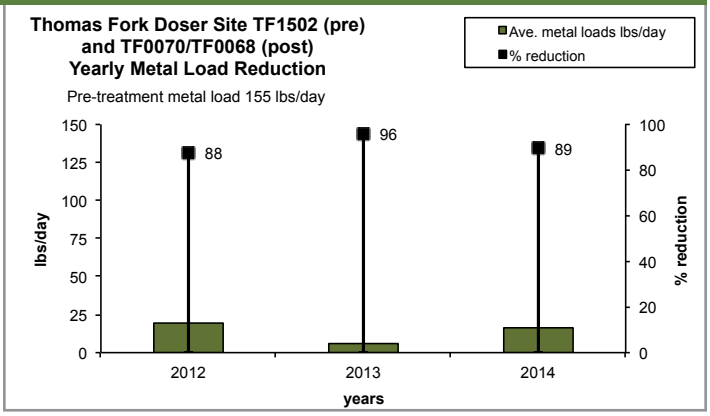
2012 Thomas Fork Doser (TF1502 pre/ TF0070 and TF0068 post) – Active calcium oxide doser

Yearly acid and metal load reduction trends per project

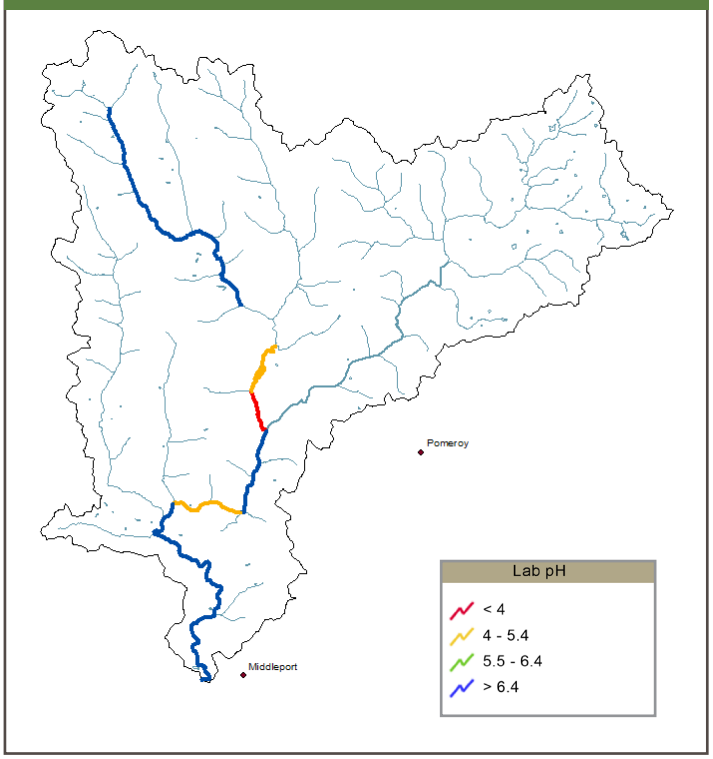
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Currently, 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

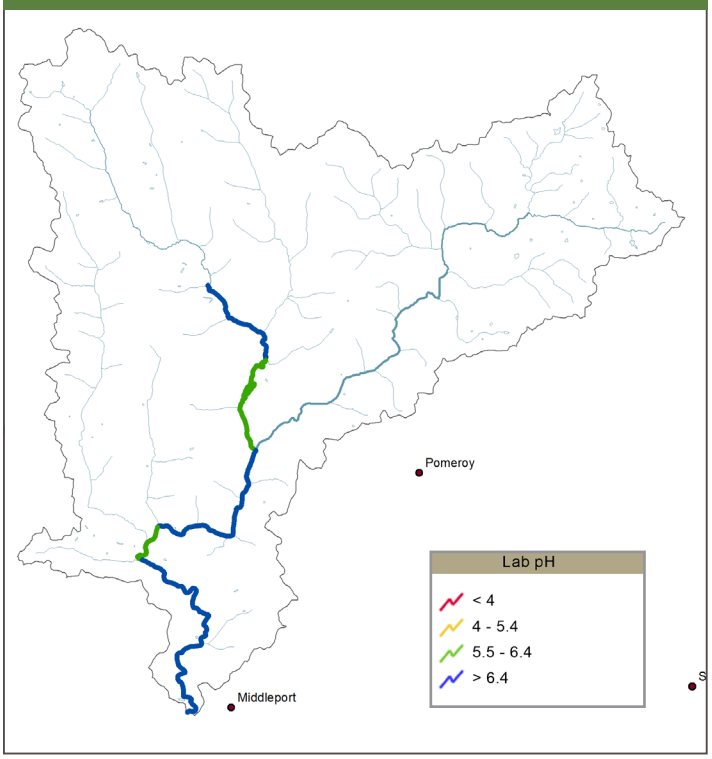




Thomas Fork baseline (2009) pH

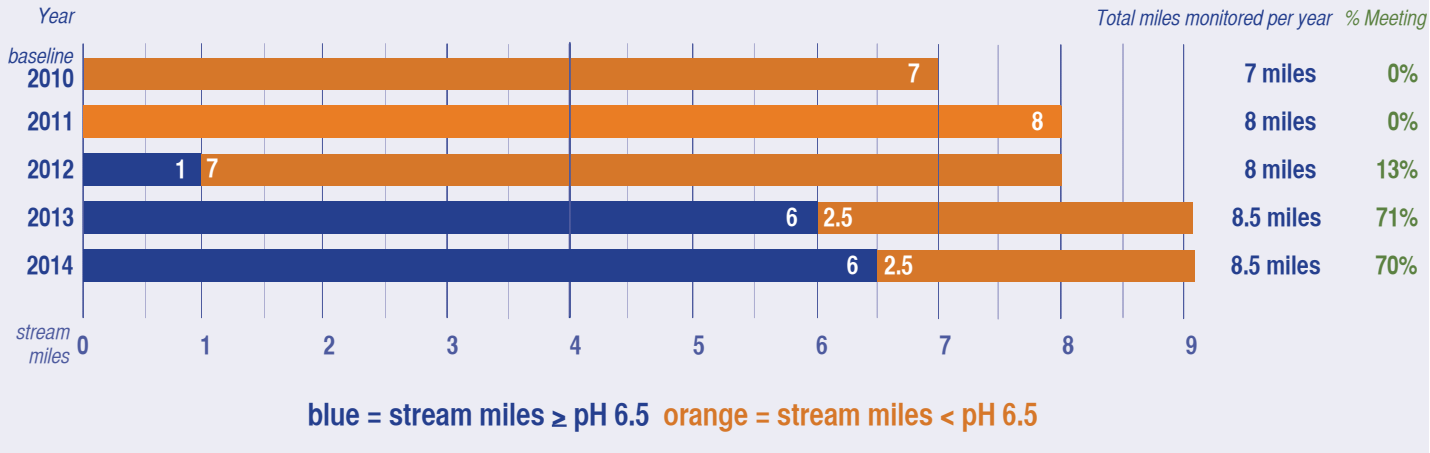


Thomas Fork 2014 pH

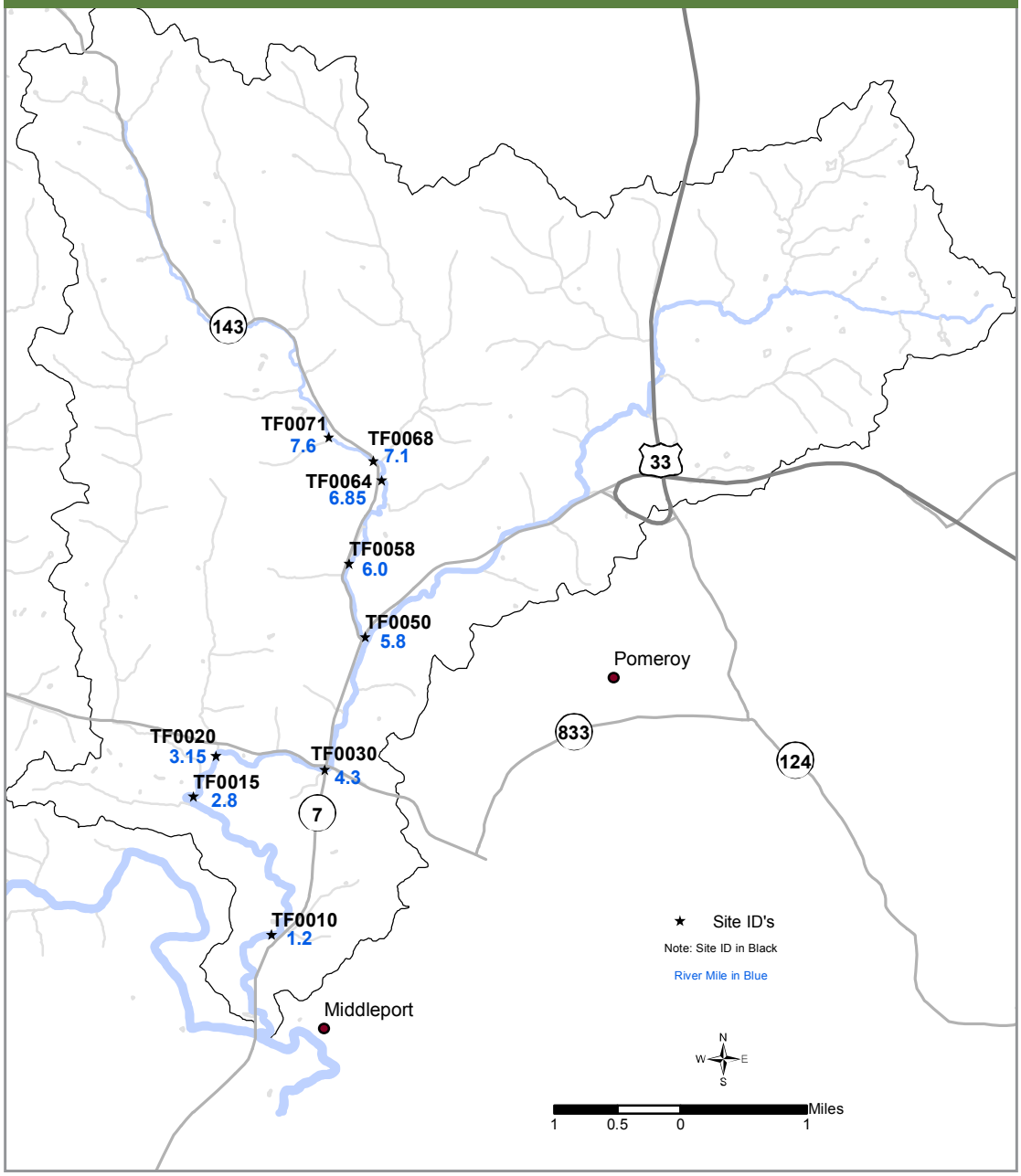


In Thomas Fork pH values on average along the mainstem do not meet the pH target of 6.5 from the 'unnamed tributary' downstream to the mouth (Figure 1).

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

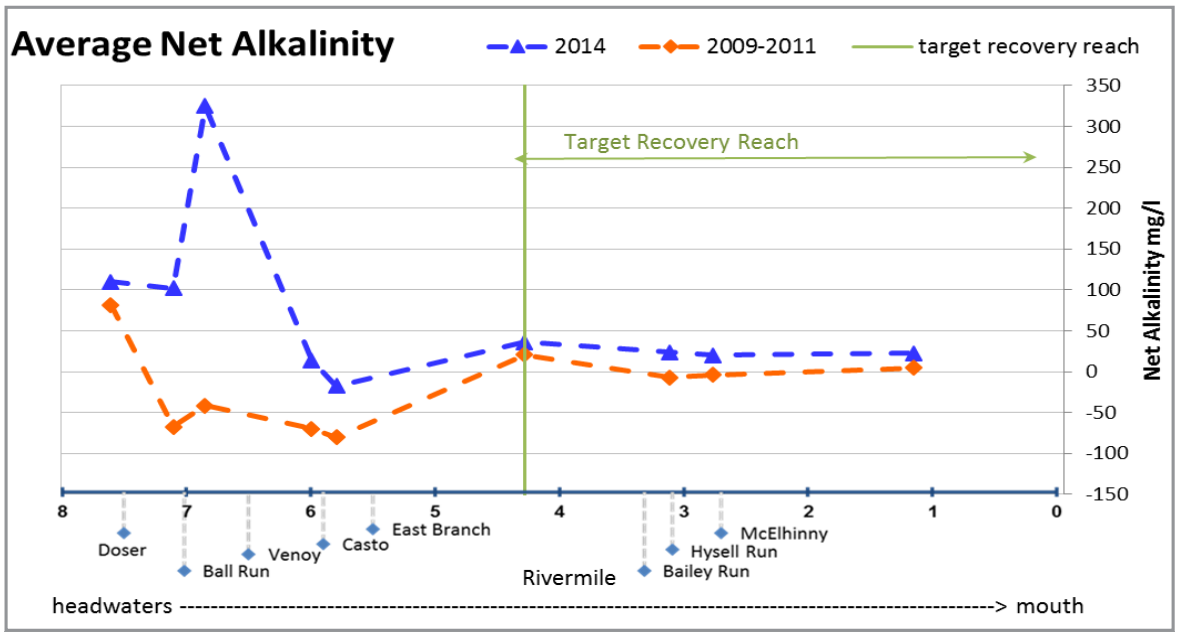


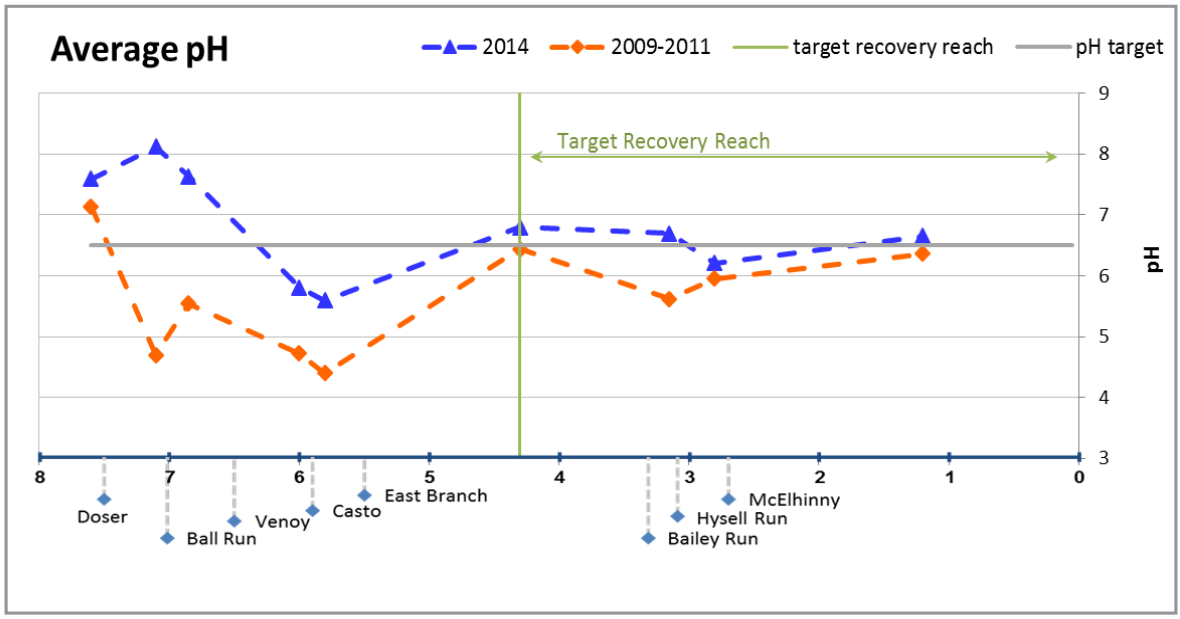
Thomas Fork


143
TF0071
7.6
TF0068
7.1
TF0064
6.85
33
TF0058
6.0
TF0050
5.8
Pomeroy
833
124
TF0020
3.15
TF0030
4.3
TF0015
2.8
7
TF0010
1.2
Middleport
Site ID's
Note: Site ID in Black
River Mile in Blue
N
W
E
S
Miles
1
0.5
0
1

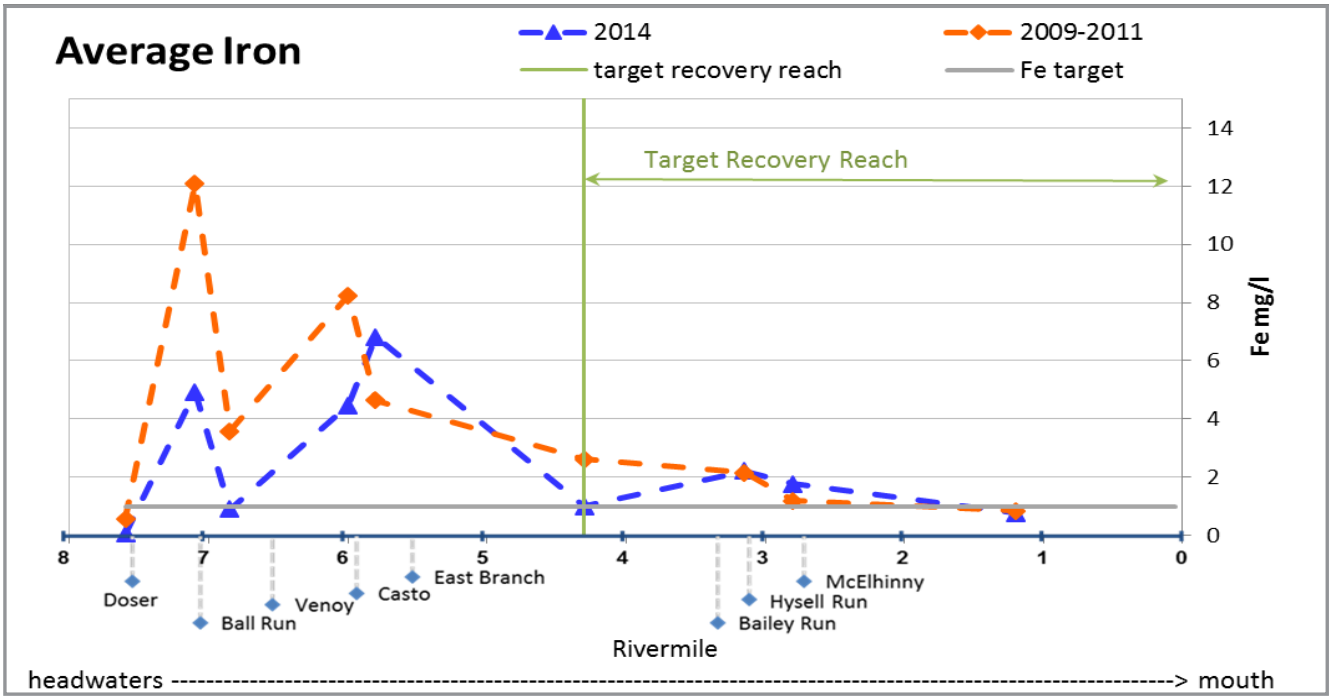
Chemical water quality changes along the mainstem of Thomas Fork are shown in the stream reach graphs below. Chemical long-term monitoring data is utilized to generate line graphs along the stream gradient from headwaters to the mouth. Along the x-axis named tributaries are shown to illustrate sources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

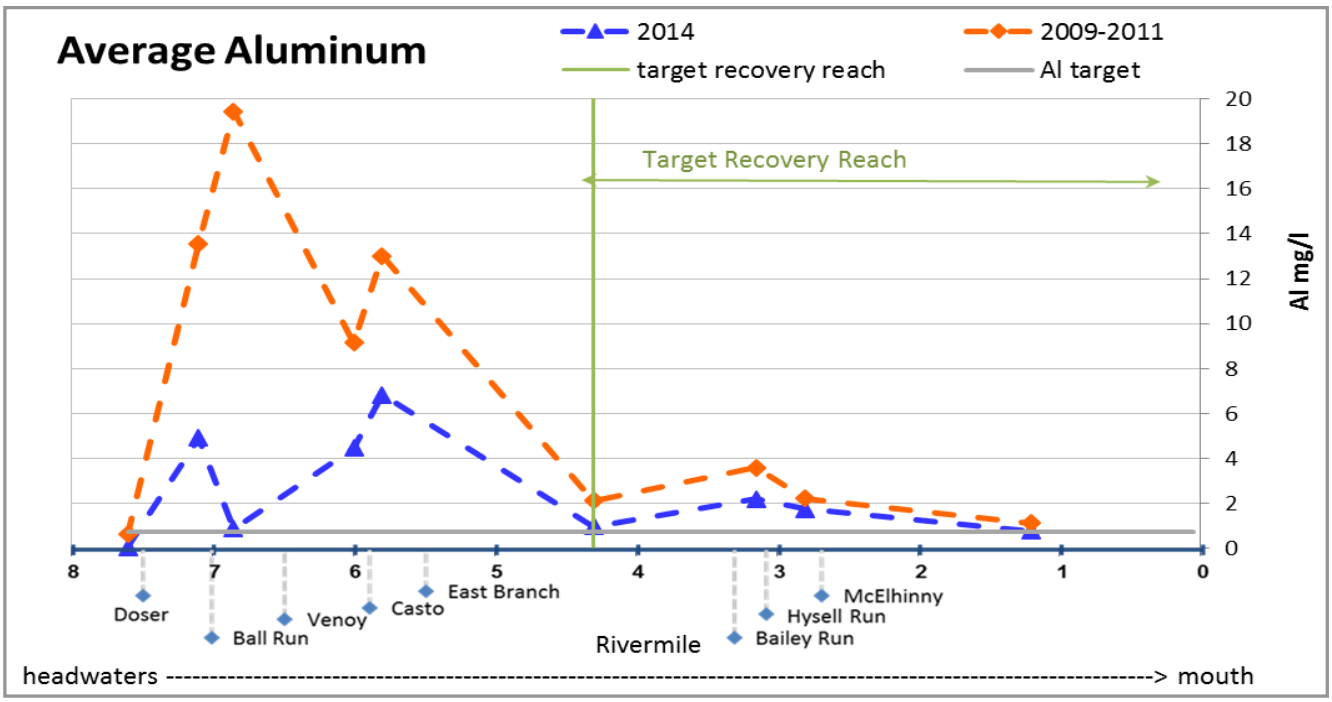
Leading Creek Watershed									
site ID	TF0071	TF0068	TF0064	TF0058	TF0050	TF0030	TF0020	TF0015	TF0010
Rivermile	7.6	7.1	6.85	6	5.8	4.3	3.15	2.8	1.2



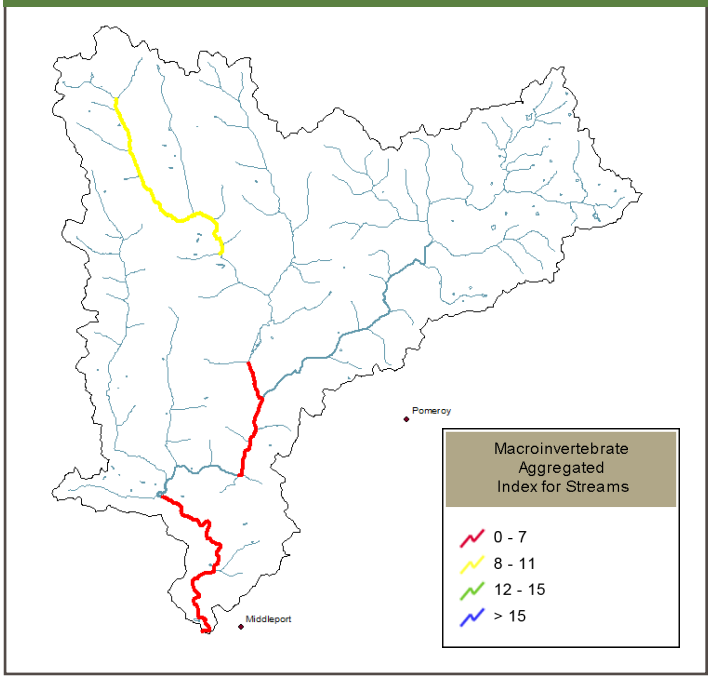


Leading Creek Watershed									
site ID	TF0071	TF0068	TF0064	TF0058	TF0050	TF0030	TF0020	TF0015	TF0010
Rivermile	7.6	7.1	6.85	6	5.8	4.3	3.15	2.8	1.2

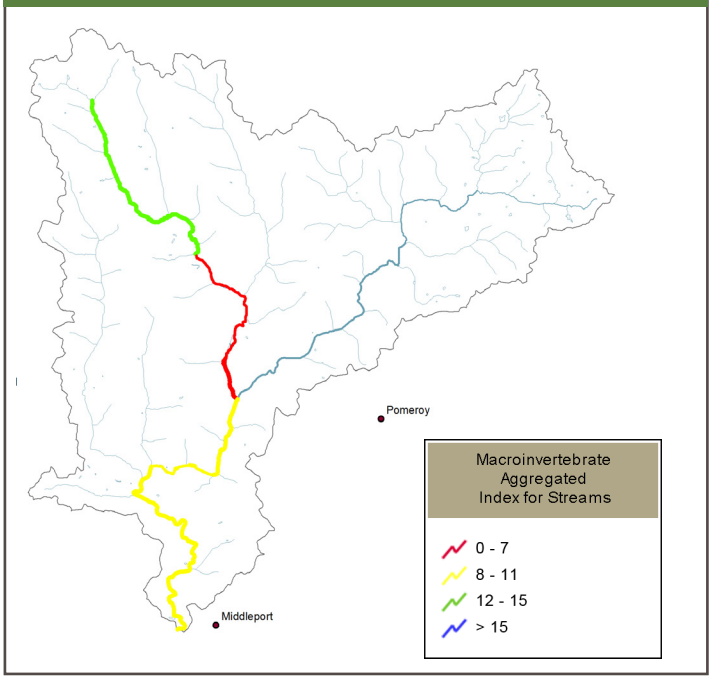




Thomas Fork baseline MAIS



Thomas Fork 2014 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 2014.

Thomas Fork

This year was the sixth year of biological monitoring in Thomas Fork of Leading Creek and macroinvertebrate scores at most sites were very similar to last year, and higher now for two years (2013 and 2014) than the "5" scored at most of the sites in 2009, 2011 and 2012. It is too soon to determine whether this reflects a permanent gain, and there is no statistical change yet, but the trends are encouraging.

Figure 2. Area of degradation 2009-2014

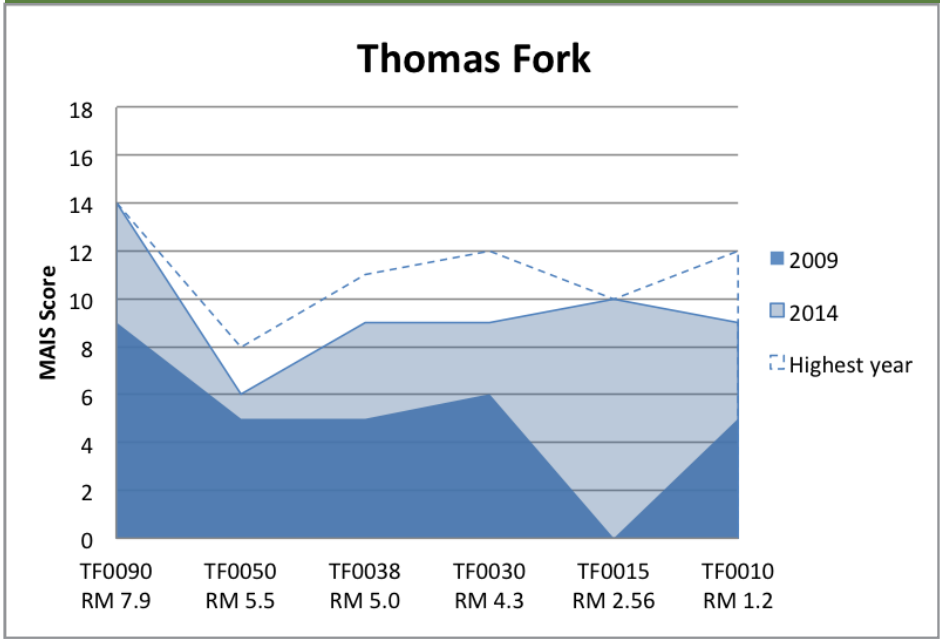


Figure 3. Thomas Fork MAIS Regressions

Site ID Rivermile	2009	2010	2011	2012	2013	2014	Linear trends	R square	P-value	No. of years
TF0090 RM 7.9	9	13	12	11	14	14	no change	0.552971	0.09017	6
TF0050 RM 5.5	5	8	3	2	8	6	no change	0.007295	0.872197	6
TF0038 RM 5.0	5	11	7	5	10	9	no change	0.097897	0.545988	6
TF0030 RM 4.3	6	12	4	5	10	9	no change	0.028958	0.74721	6
TF0015 RM 2.56		8	6	5	9	10	no change	0.284884	0.354224	5
TF0010 RM 1.2	5	12	5	5	10	9	no change	0.059155	0.642367	6

References

Johnson, Kelly, 2009. Personal Communications, Ohio University Biological Sciences

Kinney, Chad, 2006. A Comparison of Two Methods of Bioassessment in Streams. Master Thesis at Ohio University.

Kinney, Chad, and Ben McCament, 2010. Screening Guidelines for the Identification of Acid Mine Drainage (AMD) Impaired Watersheds and for Acid Mine Drainage Abatement and Treatment (AMDAT) Plan Selection and Prioritization. Ohio Department of Natural Resources – Division of Mineral Resources Management (ODNR-DMRM) Guidance Document

Kruse, Natalie, Mary W. Stoertz, Douglas H. Green, Jennifer R. Bowman, and Dina L. Lopez, 2014. *Acidity Loading Behavior in Coal-Mined Watersheds.* Mine Water and the Environment 33:177-186.

Stoertz, Mary W. and Douglas H. Green, 2004. Mean Annual Acidity Load: A Performance Measure to Evaluate Acid Mine Drainage Remediation. Ohio Department of Natural Resources Conservation and Restoration Innovations 2004 Applied Research Conference at Ohio University

US Geological Survey (USGS), 2001. *Techniques for estimating selected streamflow characteristics of Rural, unregulated streams in Ohio.* Water-resources investigation report 02-4068. Columbus Ohio.

US Geological Survey (USGS) Stream Stats website – flow characteristics
http://water.usgs.gov/osw/streamstats version 2