RACCOON CREEK WATERSHED REPORT

2017–2018 NPS Report - Raccoon Creek Watershed

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

Reductions

Total acid load reduction = 2,645 lbs/day
Total metal load reduction = 573 lbs/day

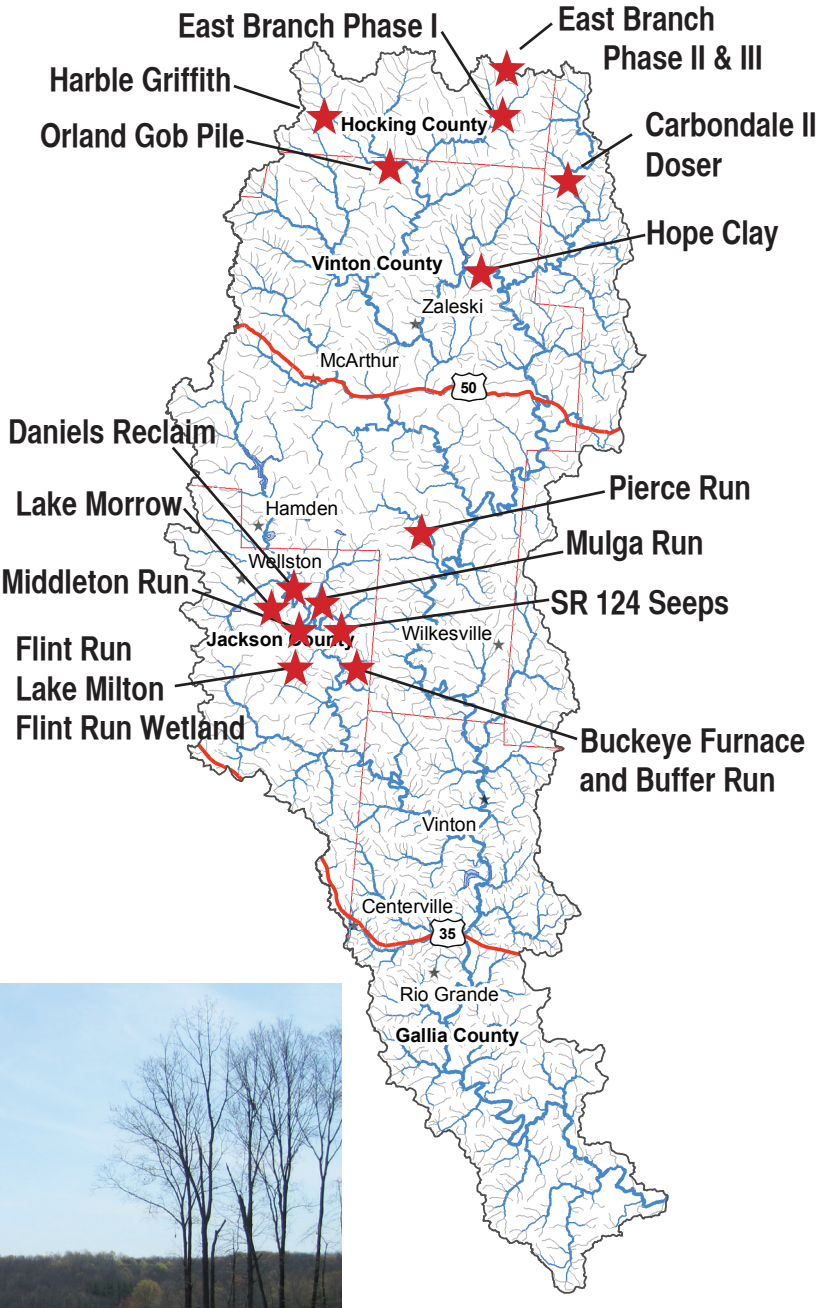
Data derived using the Stoertz Water Quality Evaluation Method (Kruse et al., 2014)

Acid and metal load reductions based on projects monitored during 2018 listed here: Carbondale Doser, Mulga Run, Flint Run, Lake Milton, East Branch I, II, & III, and Middleton Run II.

Cost

Design = $1,905,243
Construction = $13,317,412

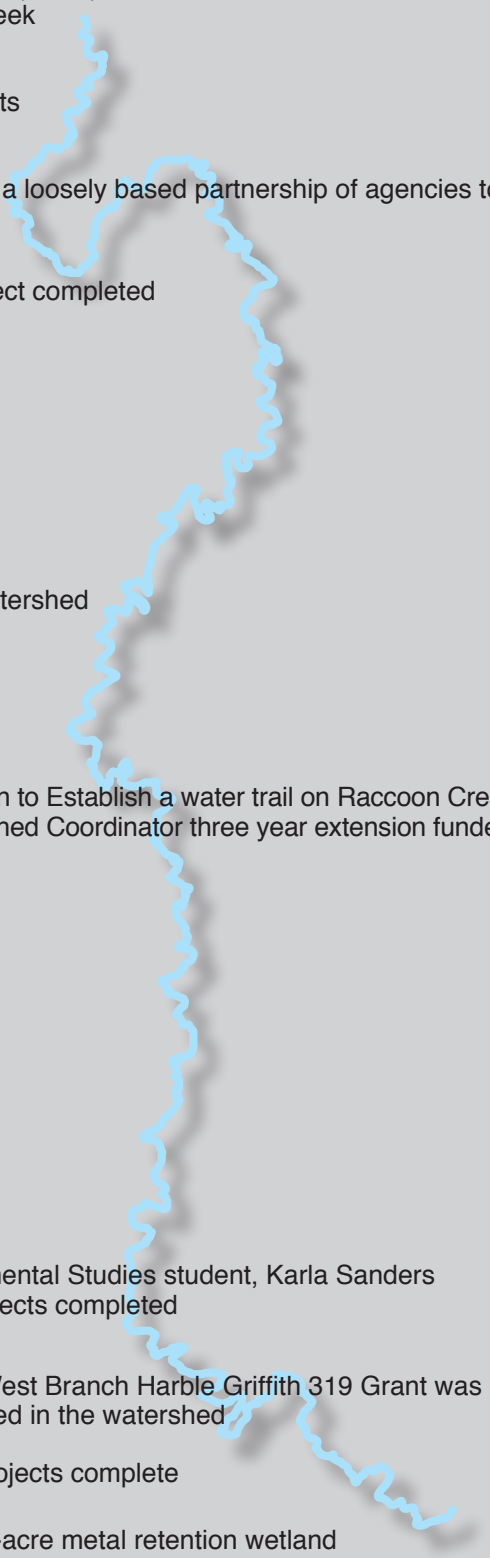
Total Costs through 2018 = $15,222,655



Lake Milton treatment ponds in Little Raccoon Creek, Photo by Sarah Cornwell

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
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
2015	• Flint Run Wetland Enhancement Project complete; 4-acre metal retention wetland
2016	• OH EPA conducted watershed-wide TMDL monitoring
2017	• 2017 Lake Milton, Flint Run, and Carbondale, maintenance projects completed
2018	• Daniels Reclamation Project completed



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

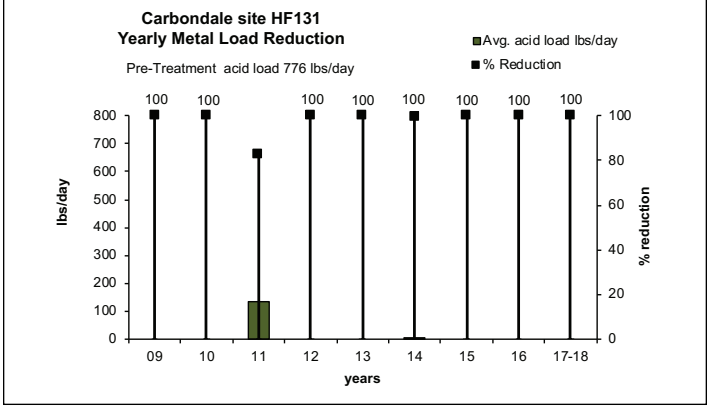
1999	*Buckeye Furnace/Buffer Run (BR0010) – Passive SAPS and gob pile reclamation*
2001	*State Route 124 Seeps (OTF0010) – Surface reclamation and limestone drains*
2004	Carbondale II Doser (HF131) – Active calcium oxide doser
	Mulga Run (MR0010) – 2 Steel slag beds and wetland enhancement
2005	*Hope 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 (FR0210) – reclaiming strip pit lakes and spoil*
	Middleton Run Reclamation II (MiR0110, MiR0045, MiR0119) – surface reclamation
2015	*Flint Run Wetland (FR095) – Wetland Enhancement with limestone berms across the Flint Run Valley*
2018	Daniels Reclaimation Project (DaR0051, DaR0052, DaR0053, DaR0054, DaR0055, DaR0056) - Drained and filled strip pits on 10 acre spoil, reconnected positive drainage, mitigated toxic spoil, resoiled and revegetated.

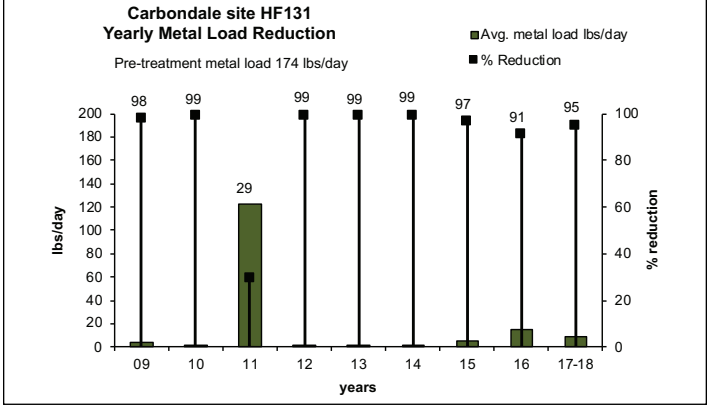
Italicized indicated projects are not actively monitored for acid mine drainage and metal load reduction purposes

Yearly acid and metal load reduction trends per project

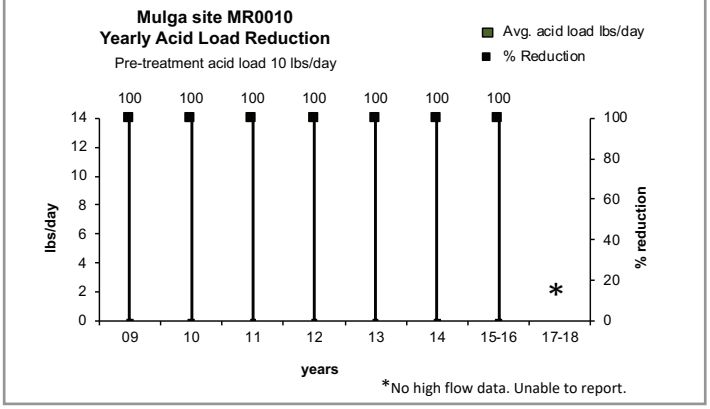
Similar to other environmental best management practices (BMPs), performance of passive acid mine drainage reclamation projects are also expected to decline with time. Active treatment systems are not expected to decline with time but sometimes need to be maintained to perform adequately. Operation and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

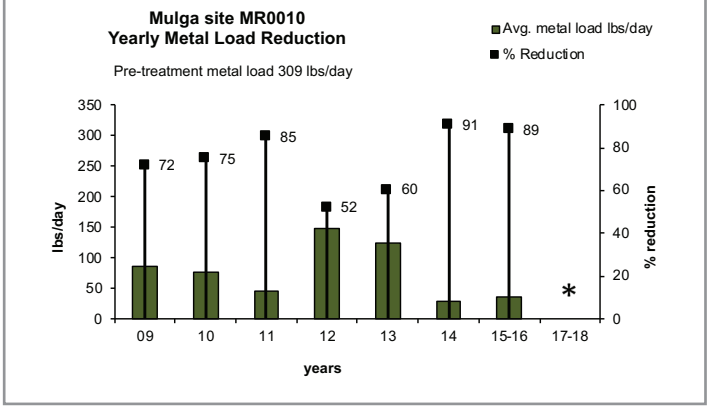
Carbondale site HF131



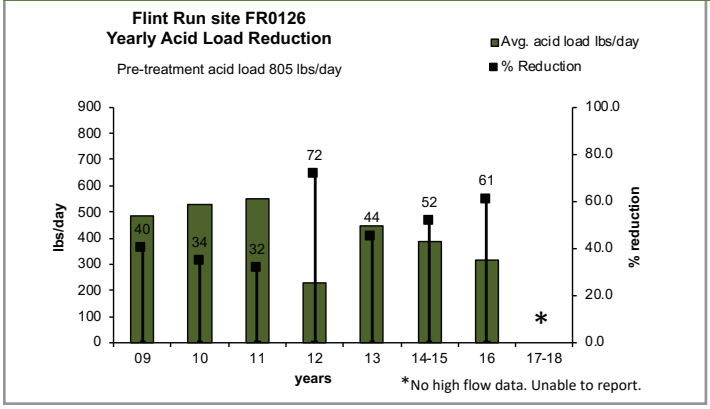


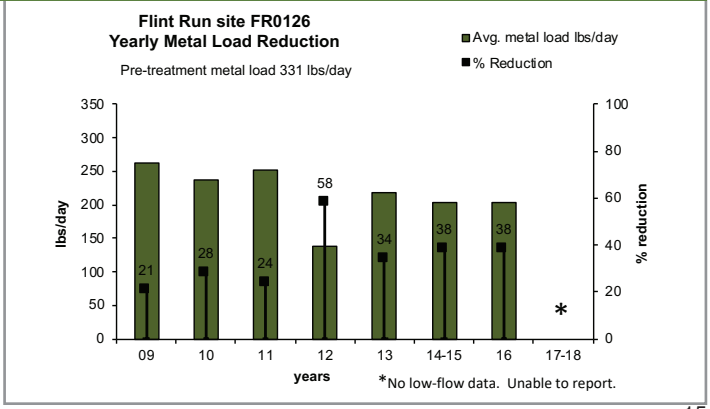
Mulga site MR0010





Flint Run site FR0126





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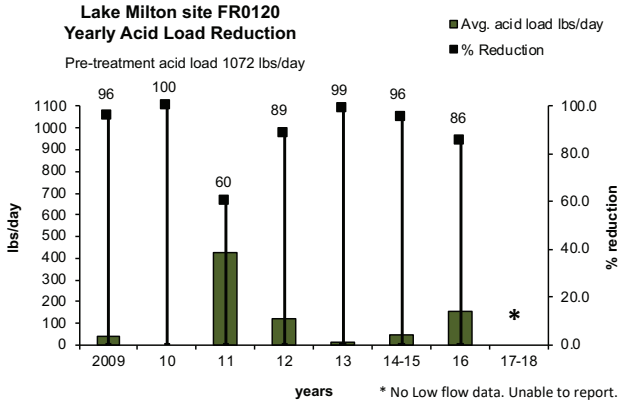
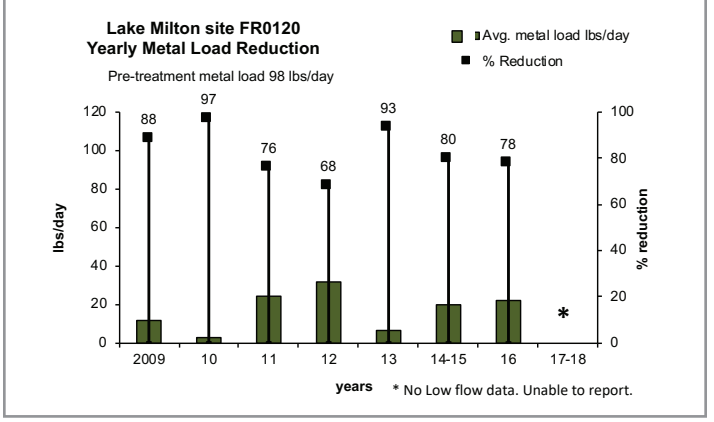
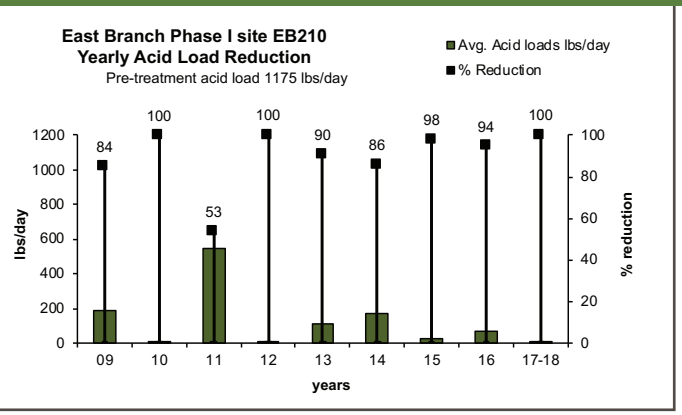
Yearly acid and metal load reduction trends per project

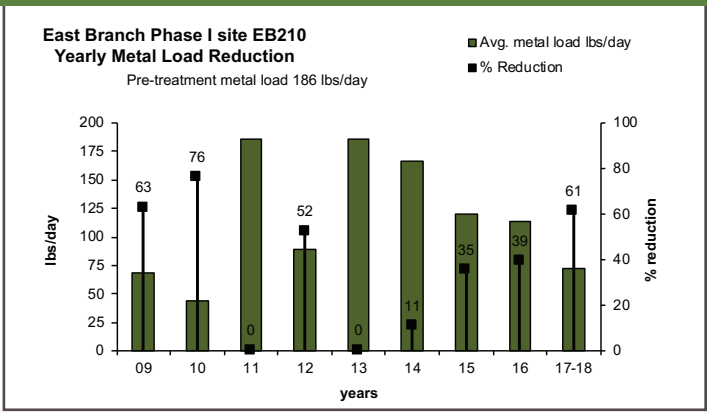
Lake Milton site FR0120



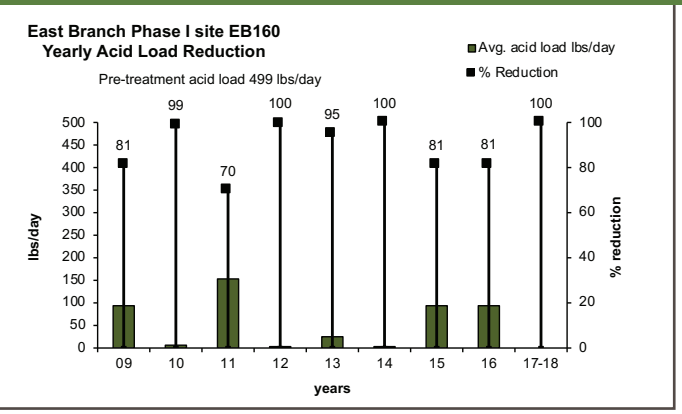


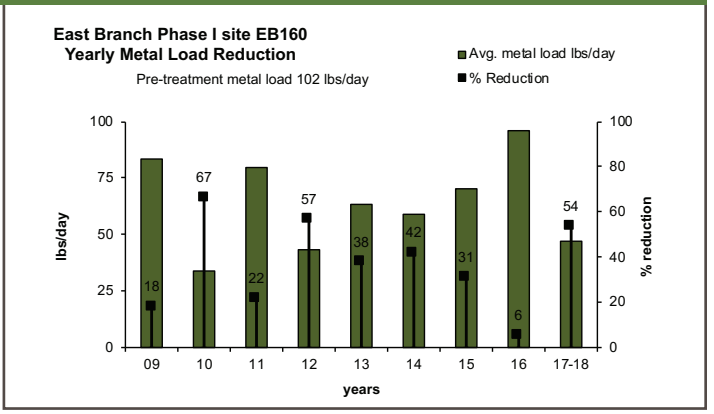
East Branch Phase I site EB210





East Branch Phase I site EB160





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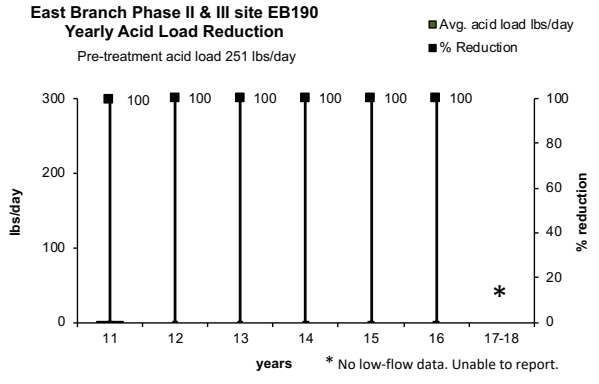
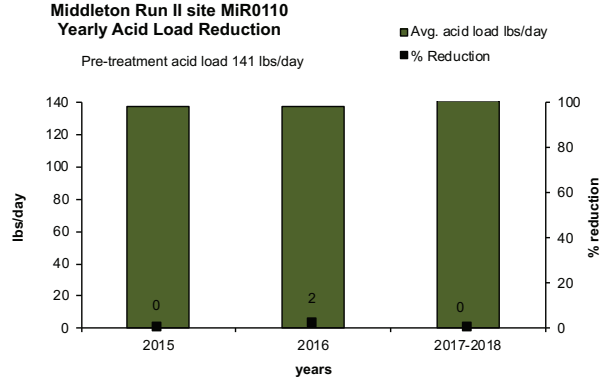
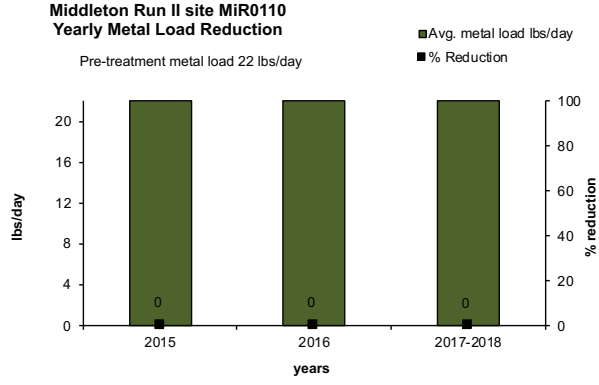
Yearly acid and metal load reduction trends per project

East Branch Phase II & III site EB190

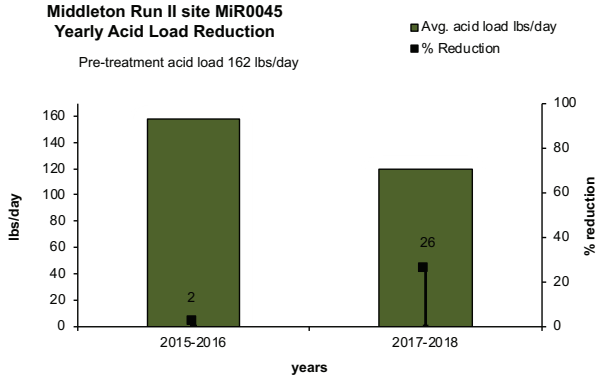


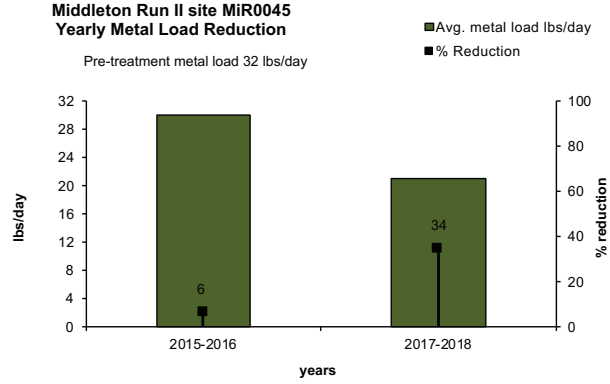
Middleton Run II site MiR0110





Middleton Run II site MiR0045





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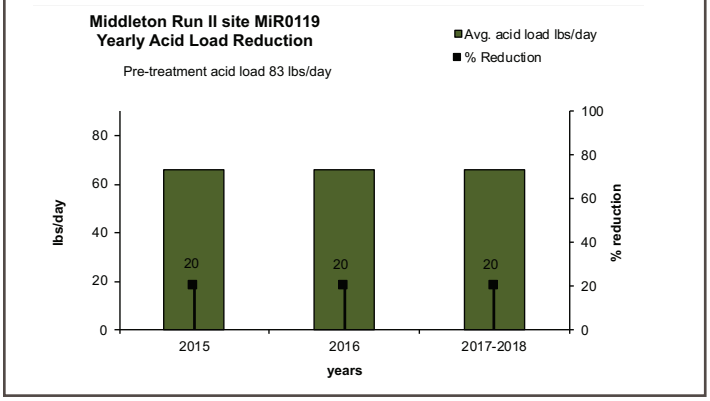
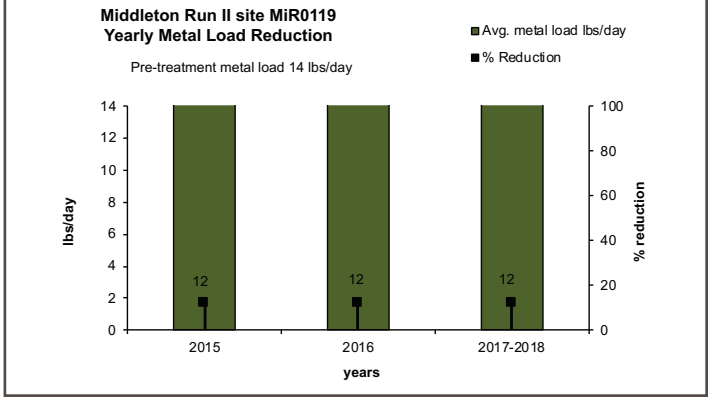
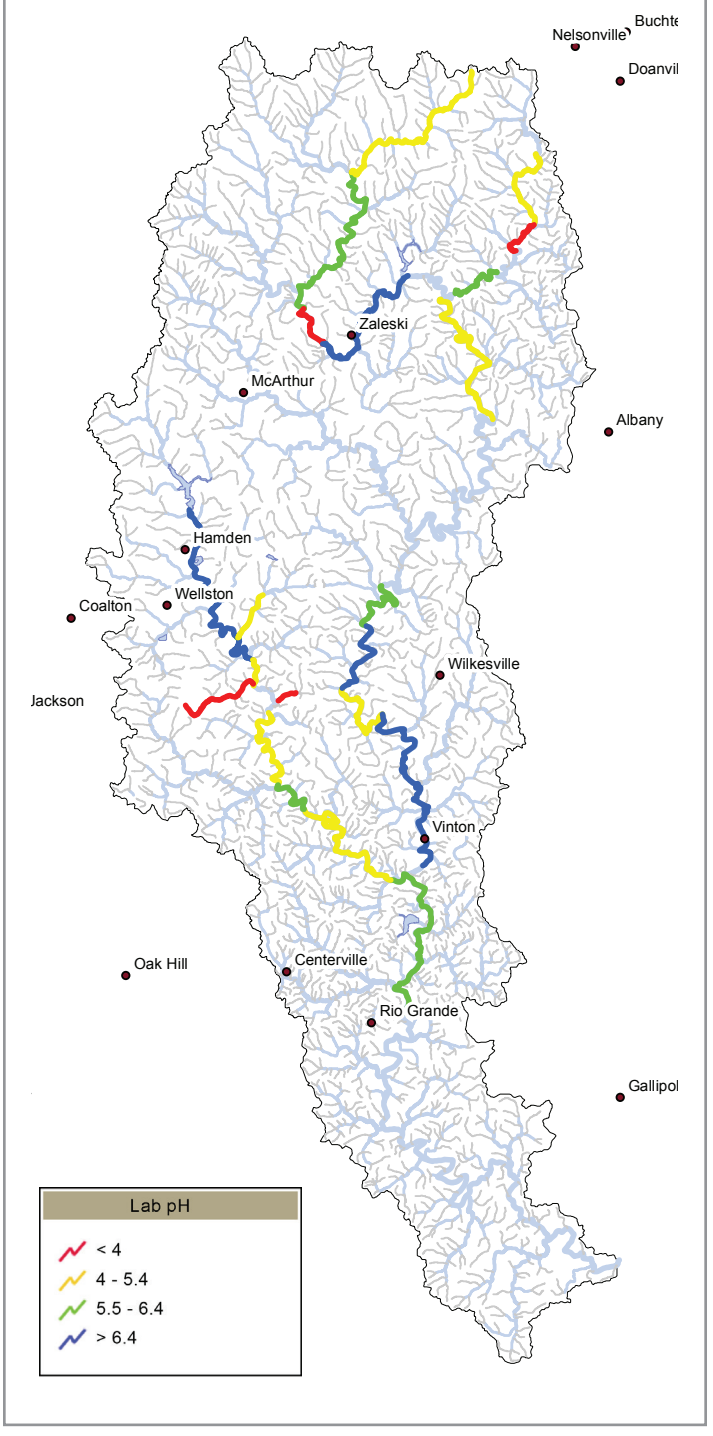
Yearly acid and metal load reduction trends per project

Middleton Run II site MiR0119

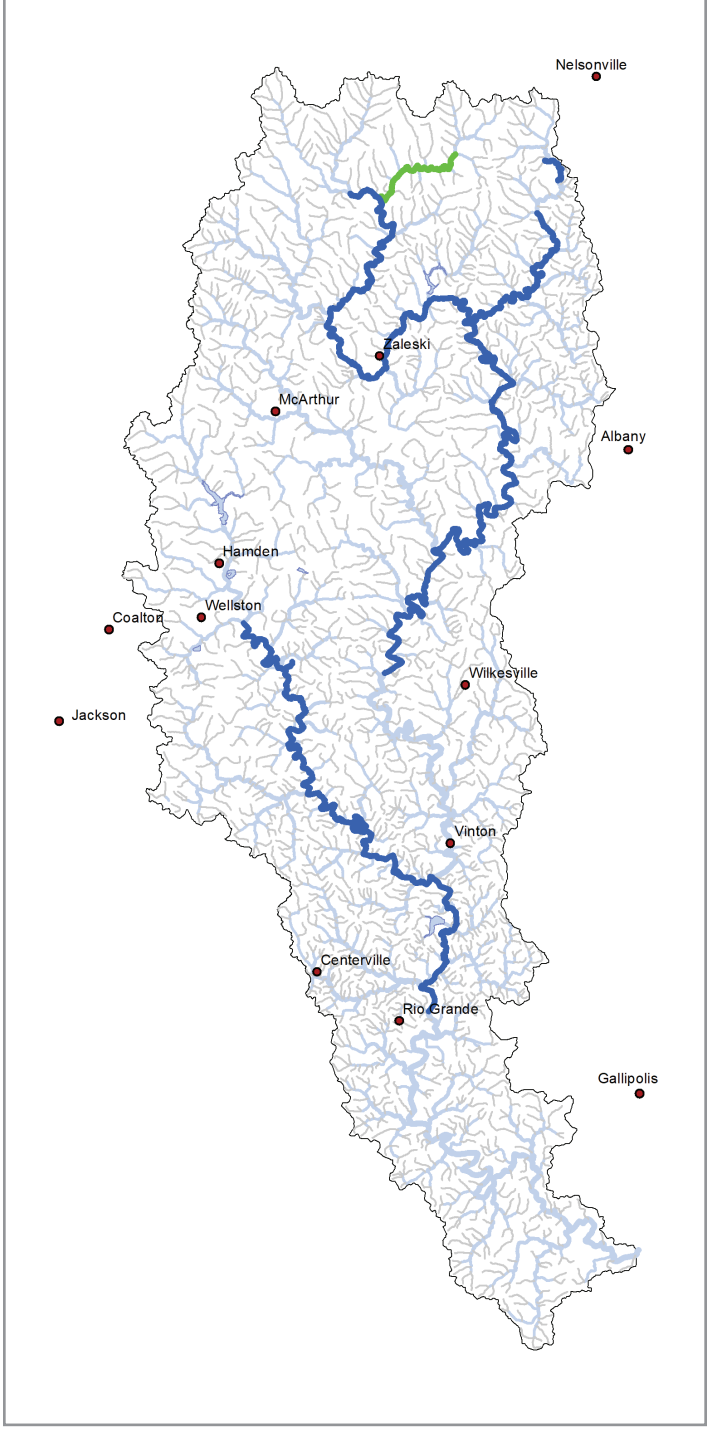




Raccoon Creek baseline pH



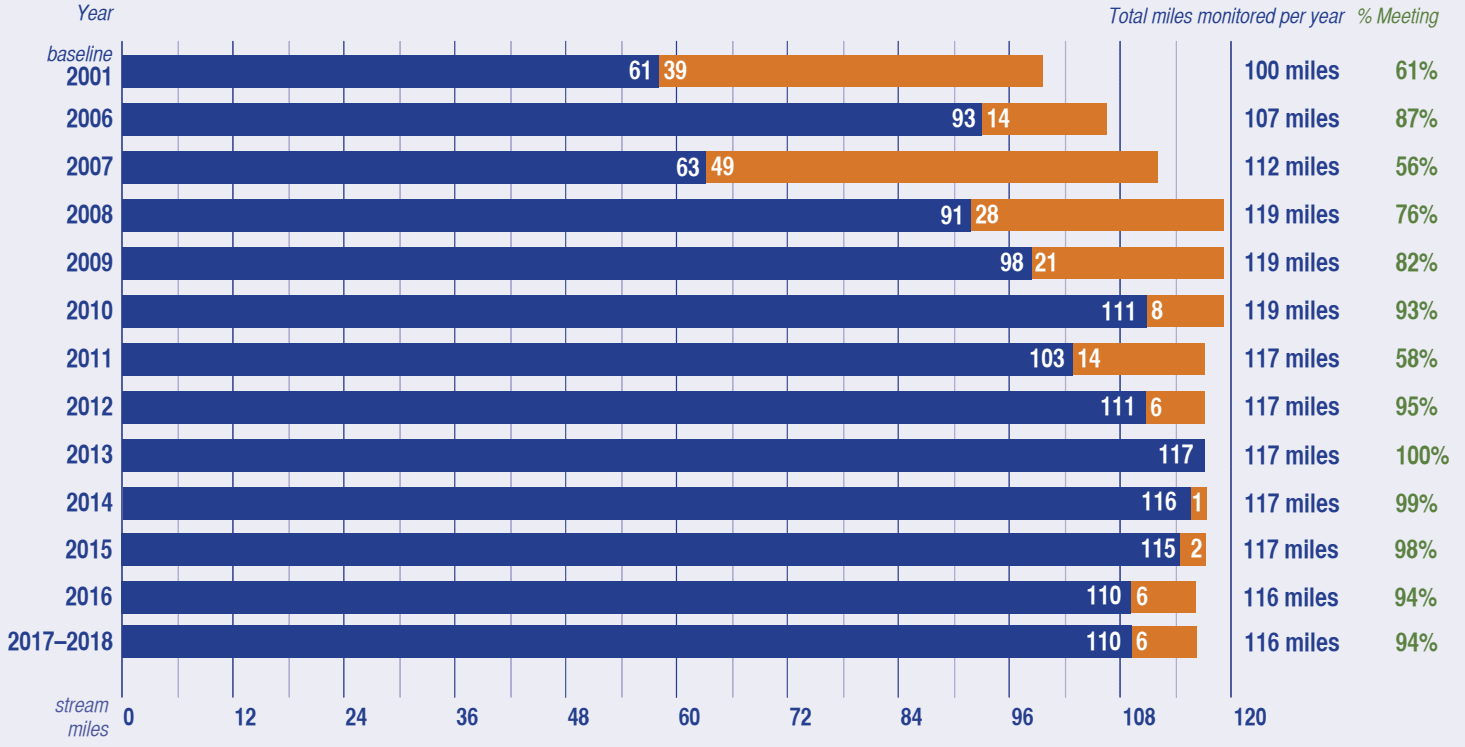
Raccoon Creek 2017–2018 pH



In Raccoon Creek pH values have improved throughout the watershed from baseline conditions (1994-2001) to 2018. 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 2018, except for a 6.0 stream mile section at the mouth of East Branch. Of the miles of stream monitored in 2017–2018, 14.8 river miles in Hewett Fork (Site HF190 was not monitored during 2017-2018, but field testing in early 2019 indicated the site met pH targets), 1.6 miles in West Branch, all 27 river miles in Little Raccoon Creek (LRC), and 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 Crteek, Hewett Fork, and East and West Branch. Each year the number of miles that meet this target fluctuates. Currently in 2018, all but 6.0 of 117 miles of stream miles monitored met the pH target (pH > 6.5).

Raccoon Creek total stream miles monitored for pH through time from 2001-2018.



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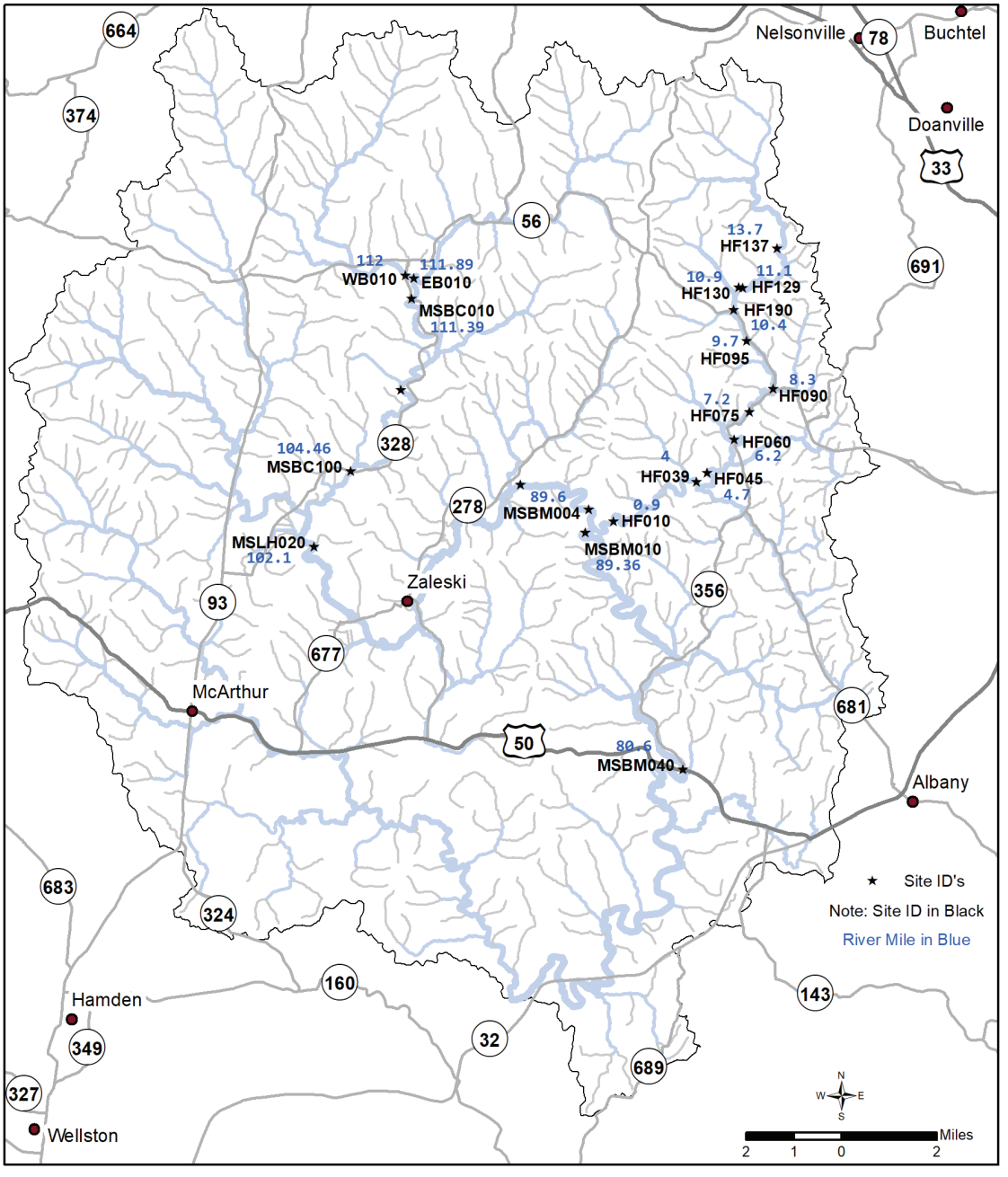
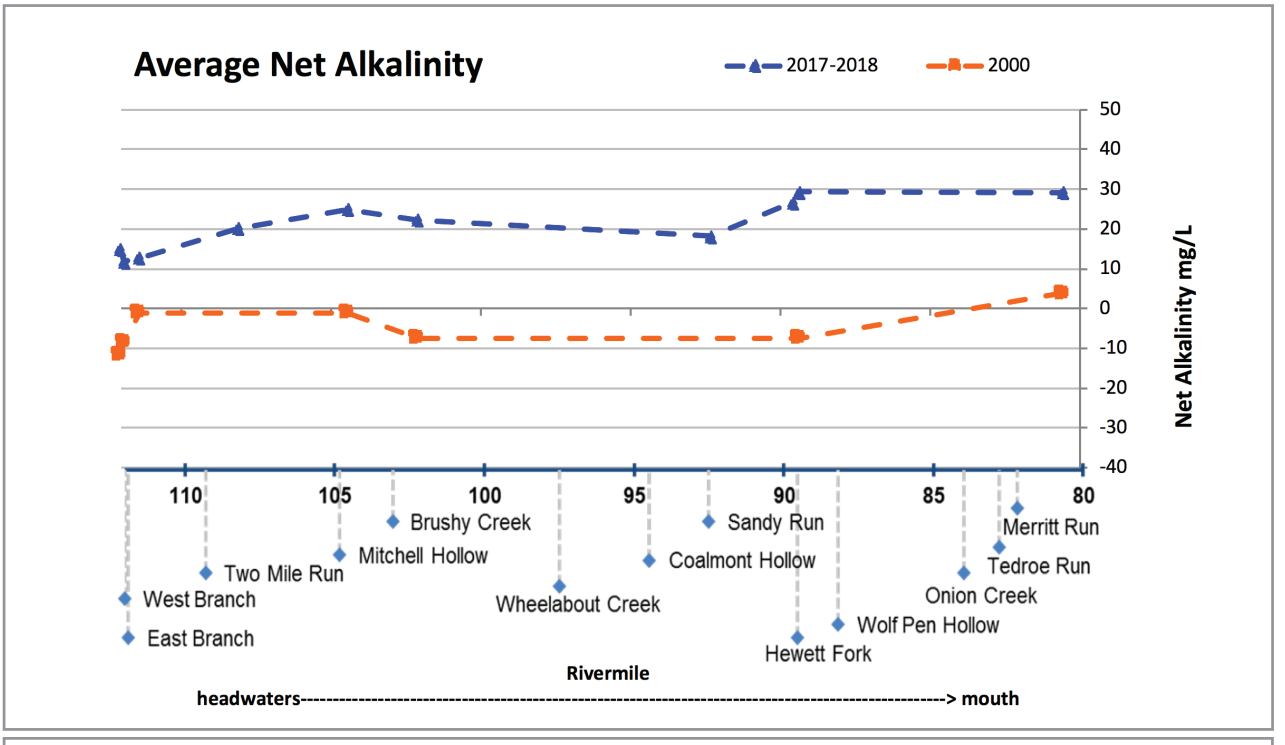
Chemical water quality analysis per stream reach

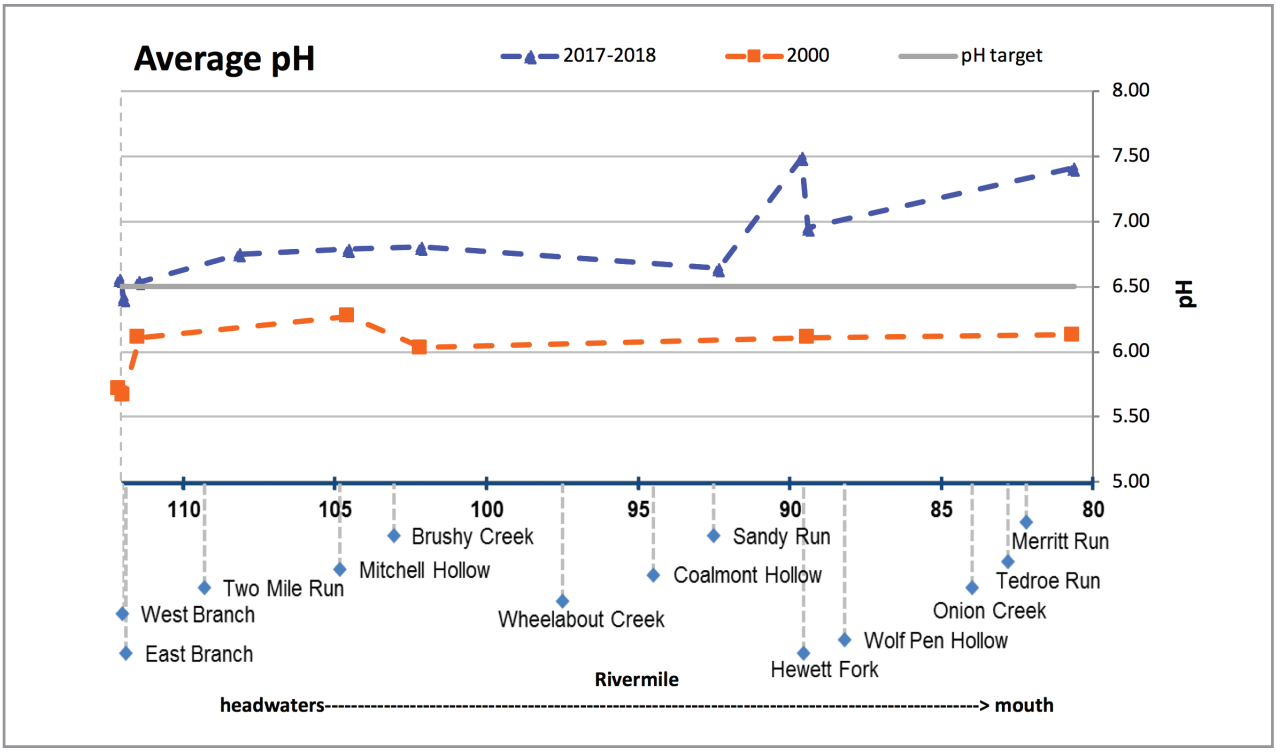
For purposes of analyzing chemical water quality changes along the mainstem of receiving stream where AMD reclamation projects have been completed, Raccoon Creek has been divided into the following stream segments: Raccoon Creek Mainstem, Little Raccoon Creek, and Hewett Fork. Within these stream reaches,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



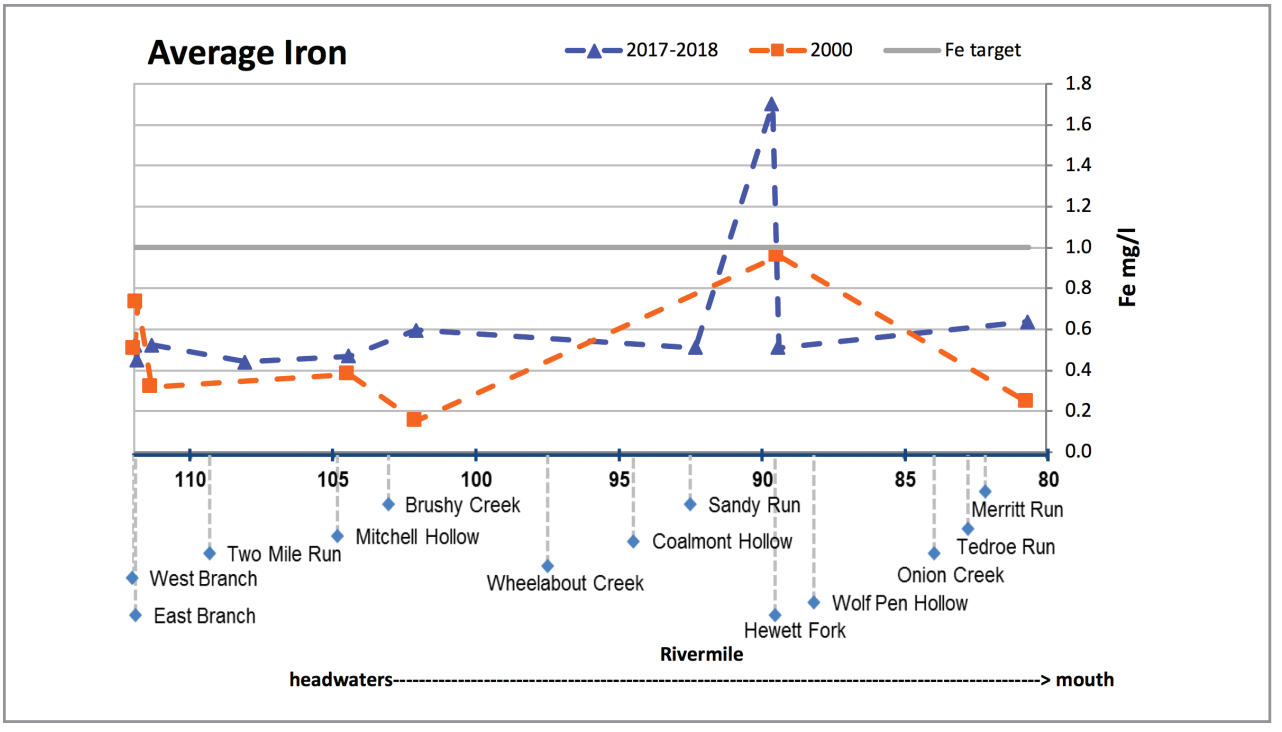
Raccoon Creek Mainstem										
Site ID	WB010	EB010	MSBC010	MSBC015	MSBC100	MSLH020	MSLH130	MSBM004	MSBM010	MSBM040
Rivermile	112	111.89	111.39	108.1	104.46	102.1	92.3	89.6	89.36	80.6

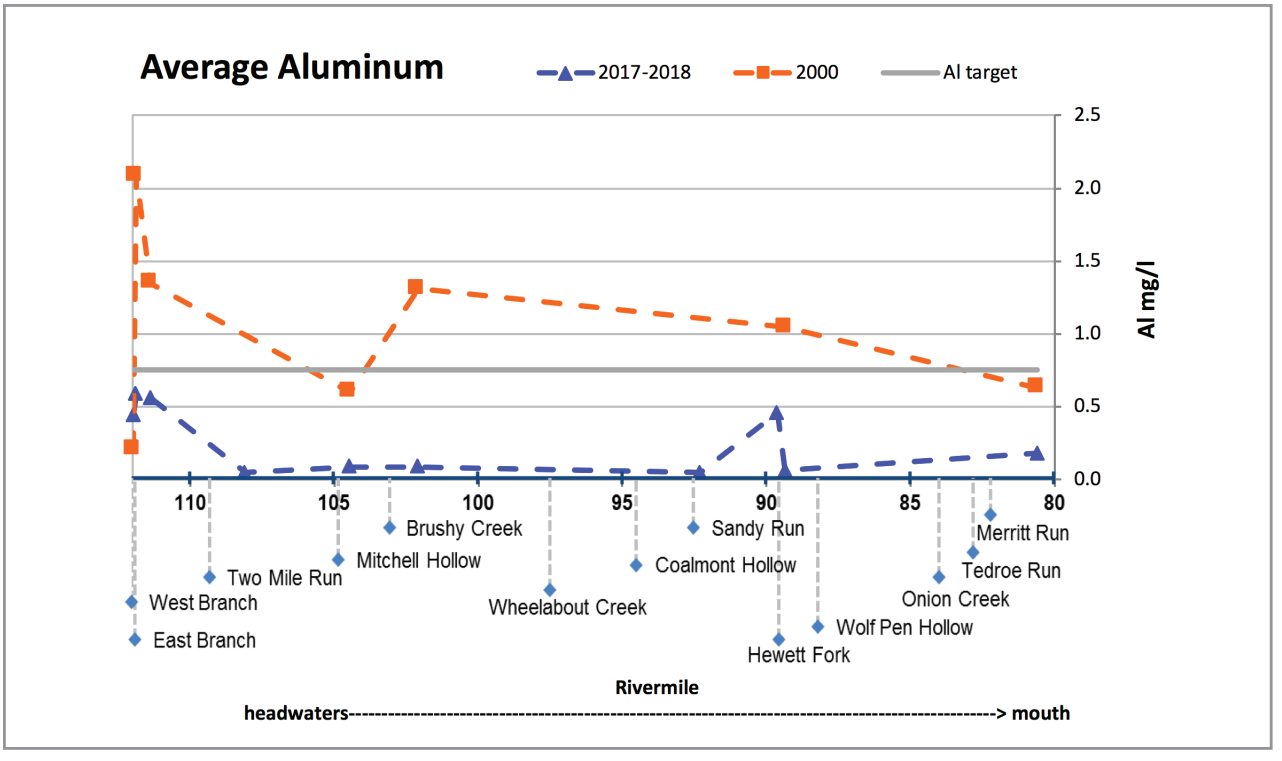




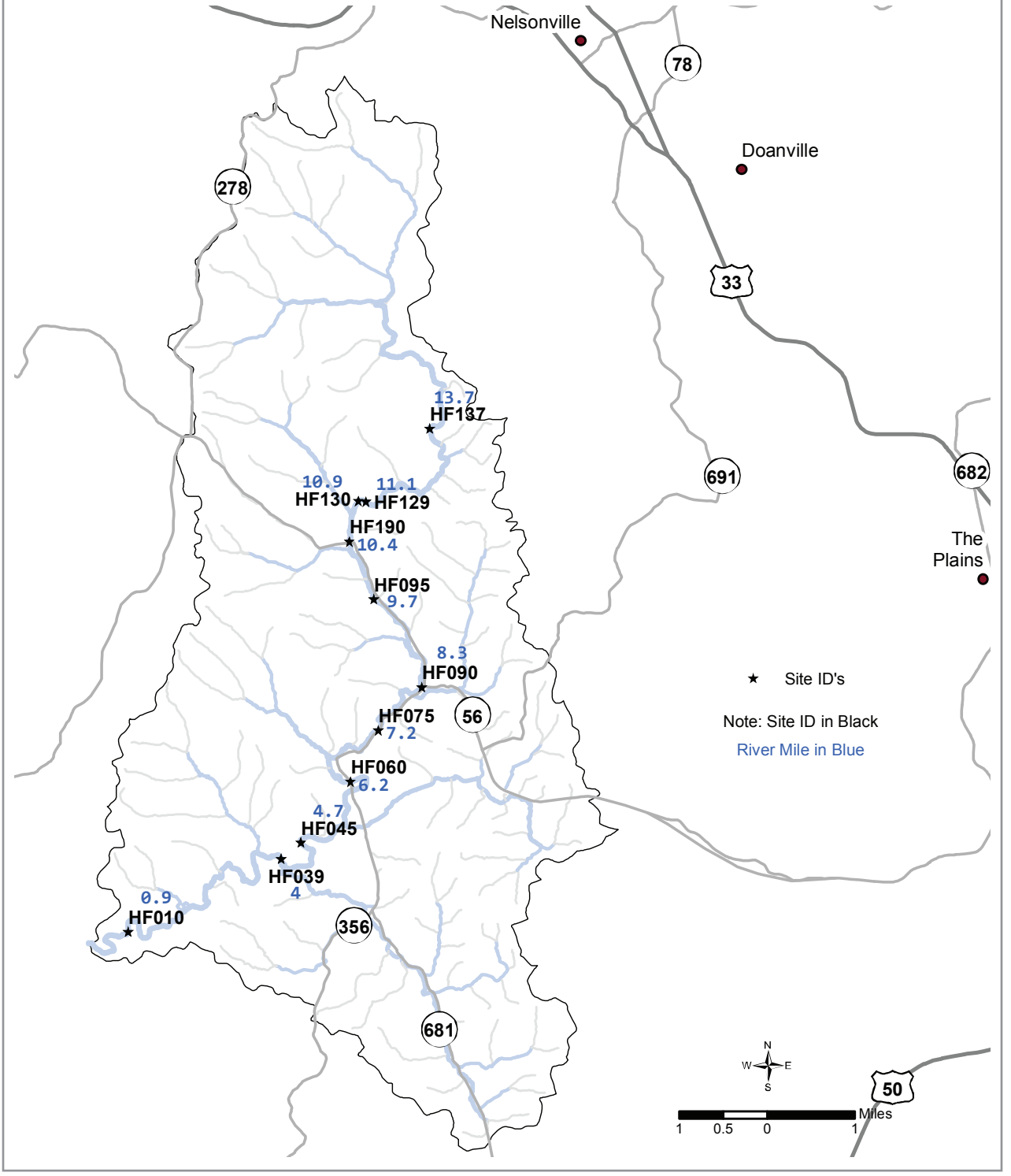
Raccoon Creek Mainstem

Site ID	WB010	EB010	MSBC010	MSBC015	MSBC100	MSLH020	MSLH130	MSBM004	MSBM010	MSBM040
Rivermile	112	111.89	111.39	108.1	104.46	102.1	92.3	89.6	89.36	80.6





Hewett Fork


Nelsonville
78
Doanville
278
33
13.7
HF137
10.9
HF130
11.1
HF129
HF190
10.4
HF095
9.7
691
682
The Plains
8.3
HF090
HF075
7.2
56
HF060
6.2
4.7
HF045
HF039
4
0.9
HF010
356
681
50
Site ID's
Note: Site ID in Black
River Mile in Blue
N
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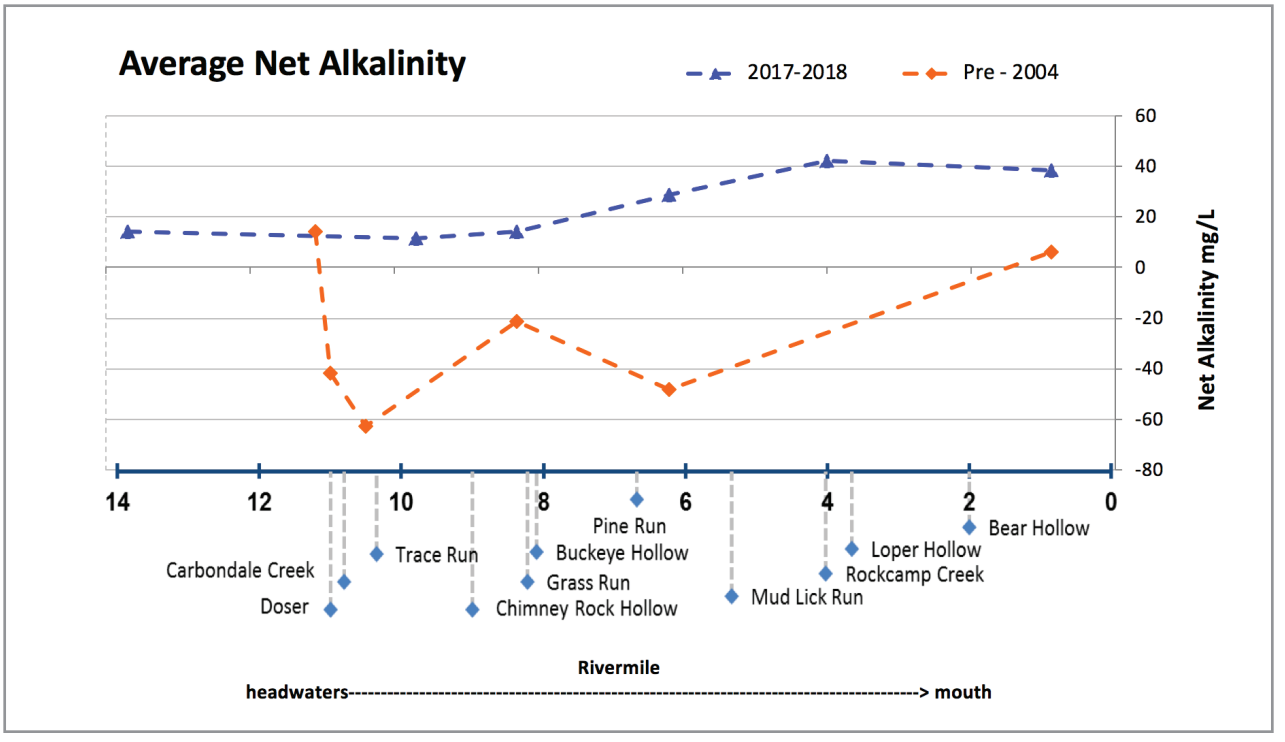
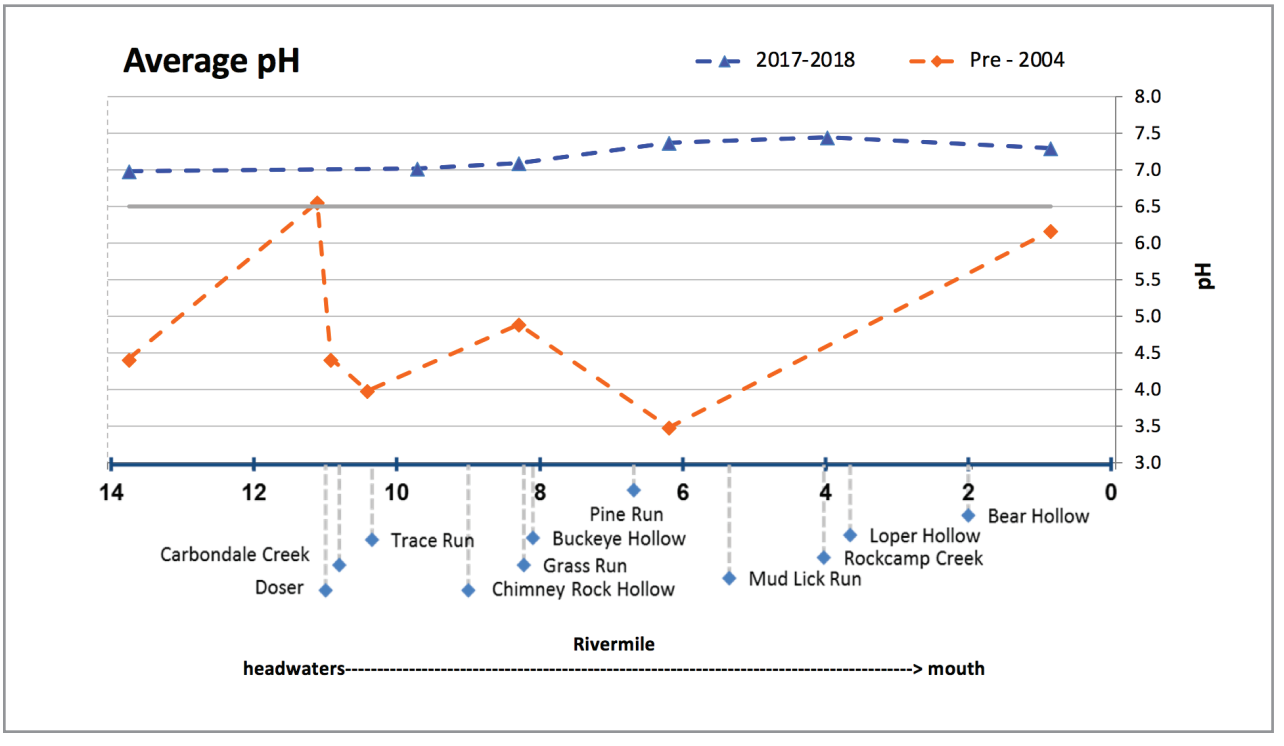
Miles

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

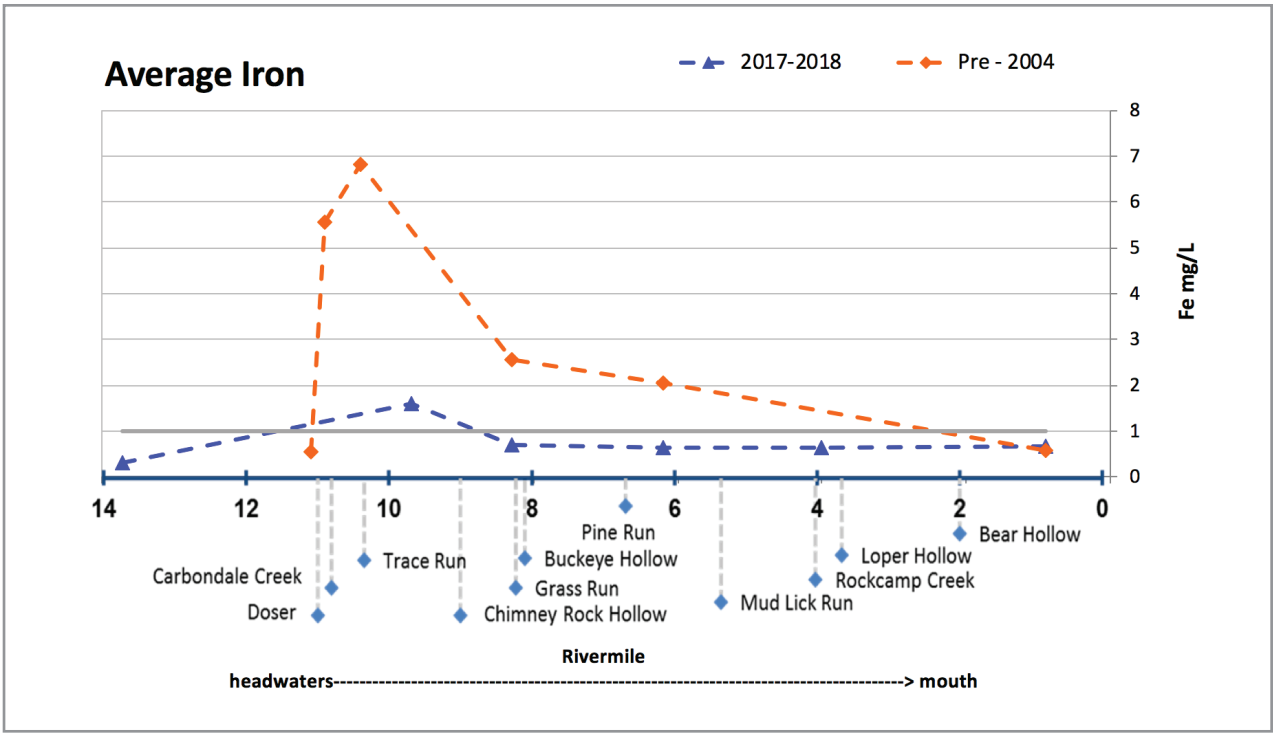


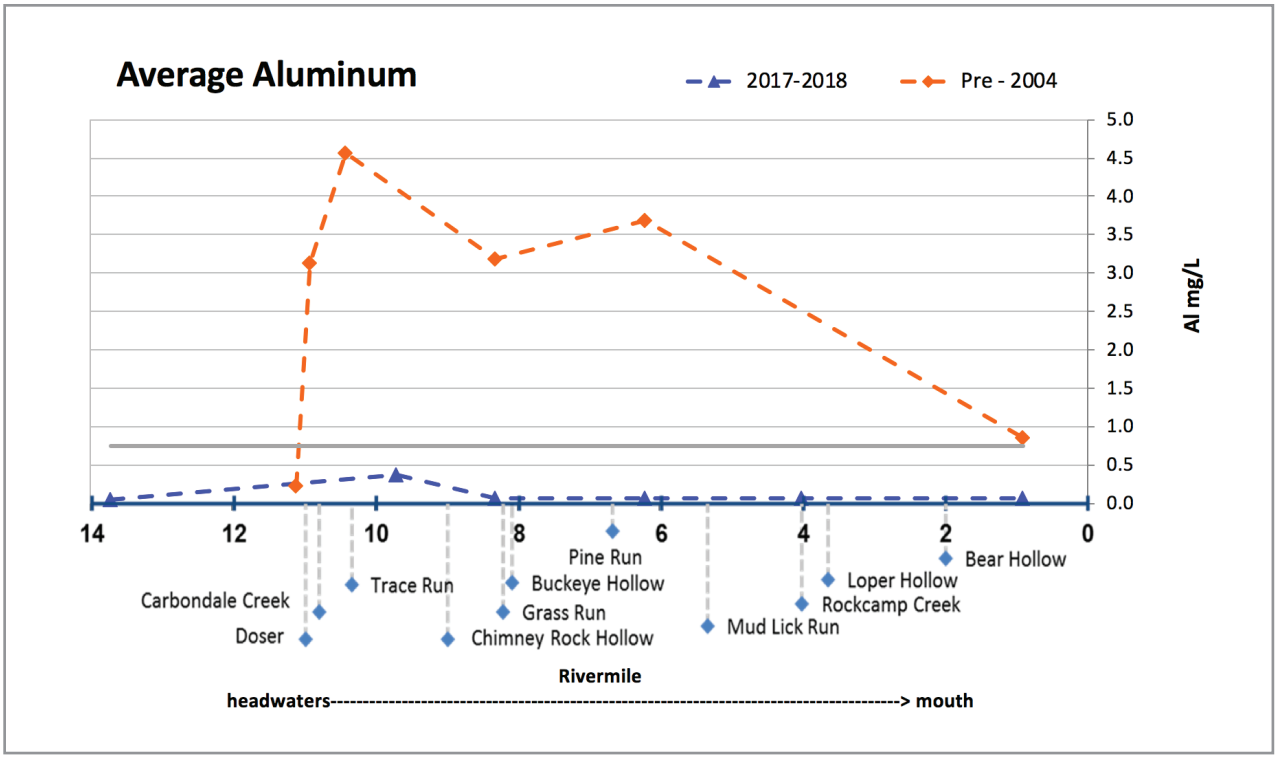


Chemical water quality analysis per stream reach

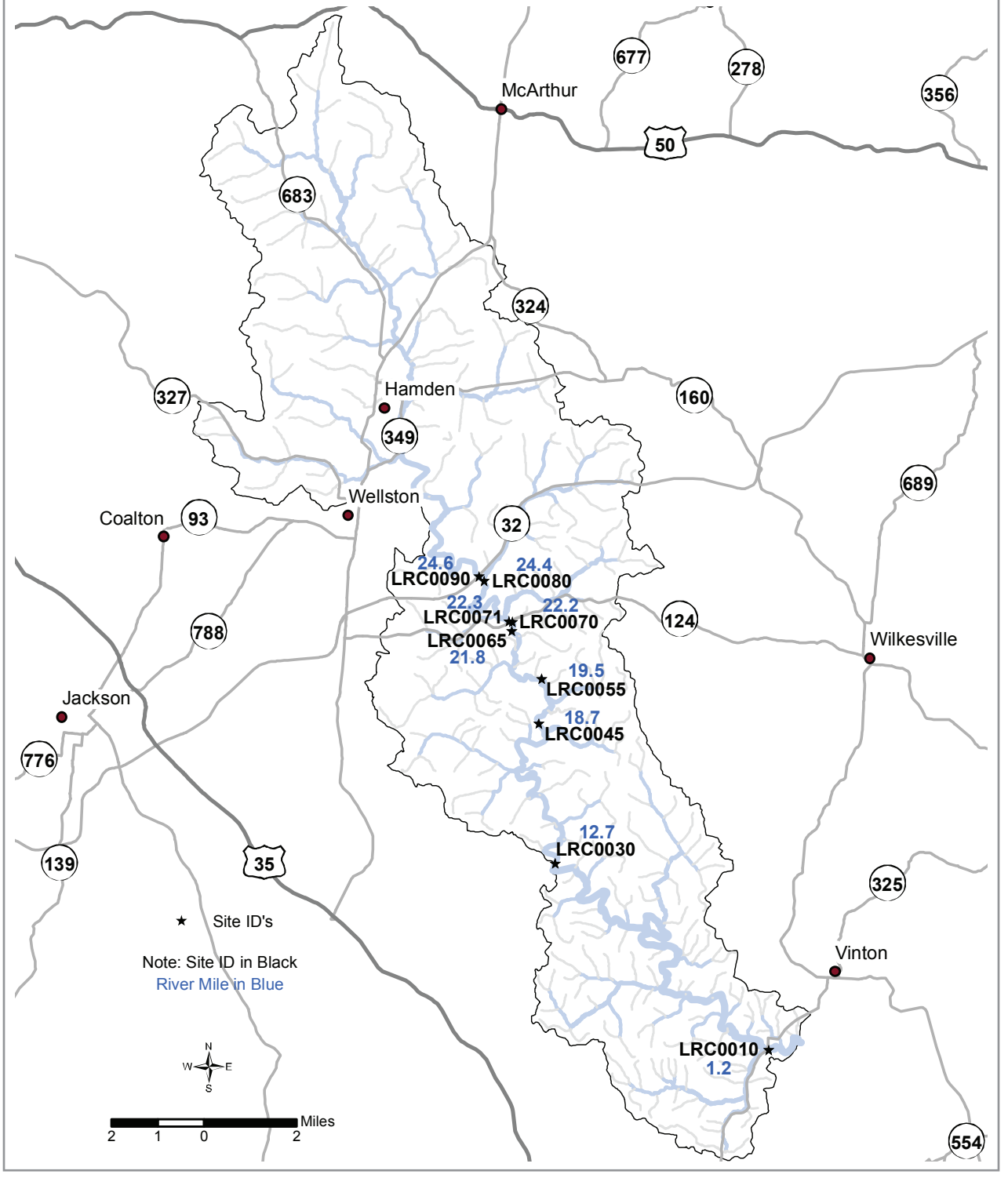
Hewett Fork											
Site ID	HF137	HF129	HF130	HF190	HF095	HF090	HF075	HF060	HF045	HF039	HF010
Rivermile	13.7	11.1	10.9	10.4	9.7	8.3	7.2	6.2	4.7	4	0.9

Note: Lime Doser installed in 2004 at RM 11





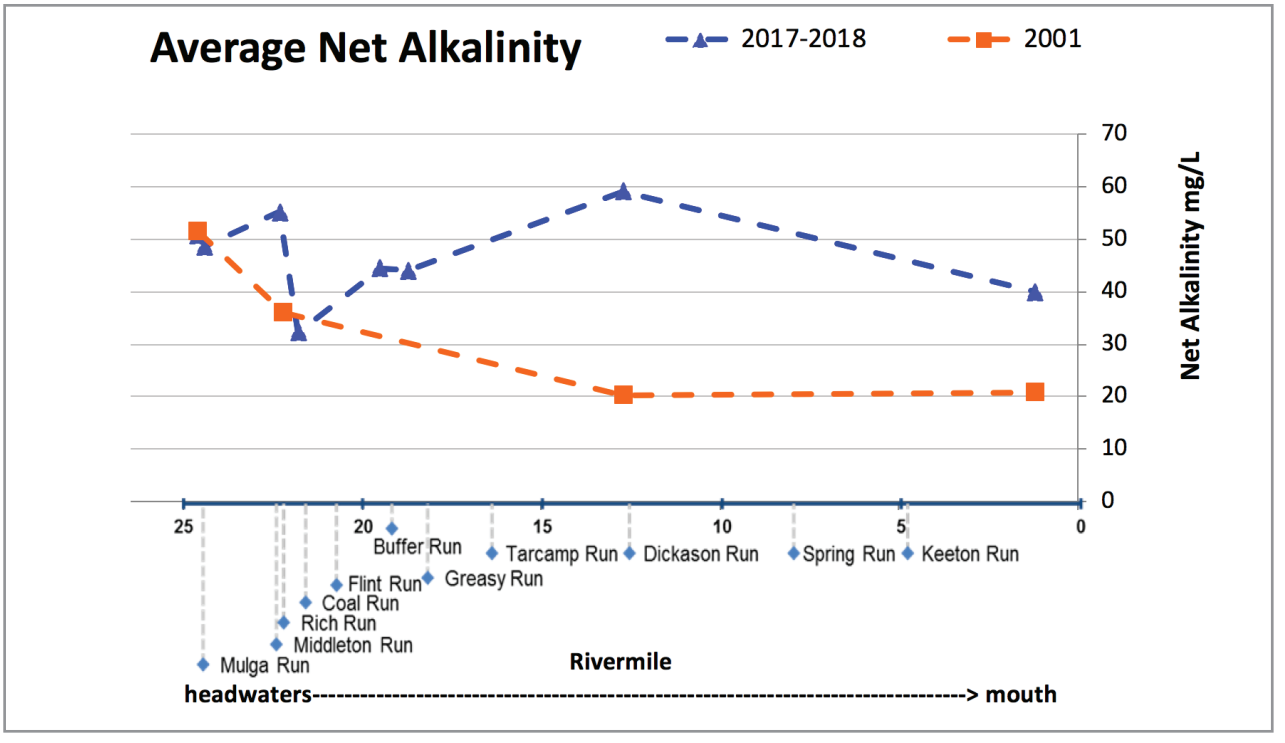
Little Raccoon Creek

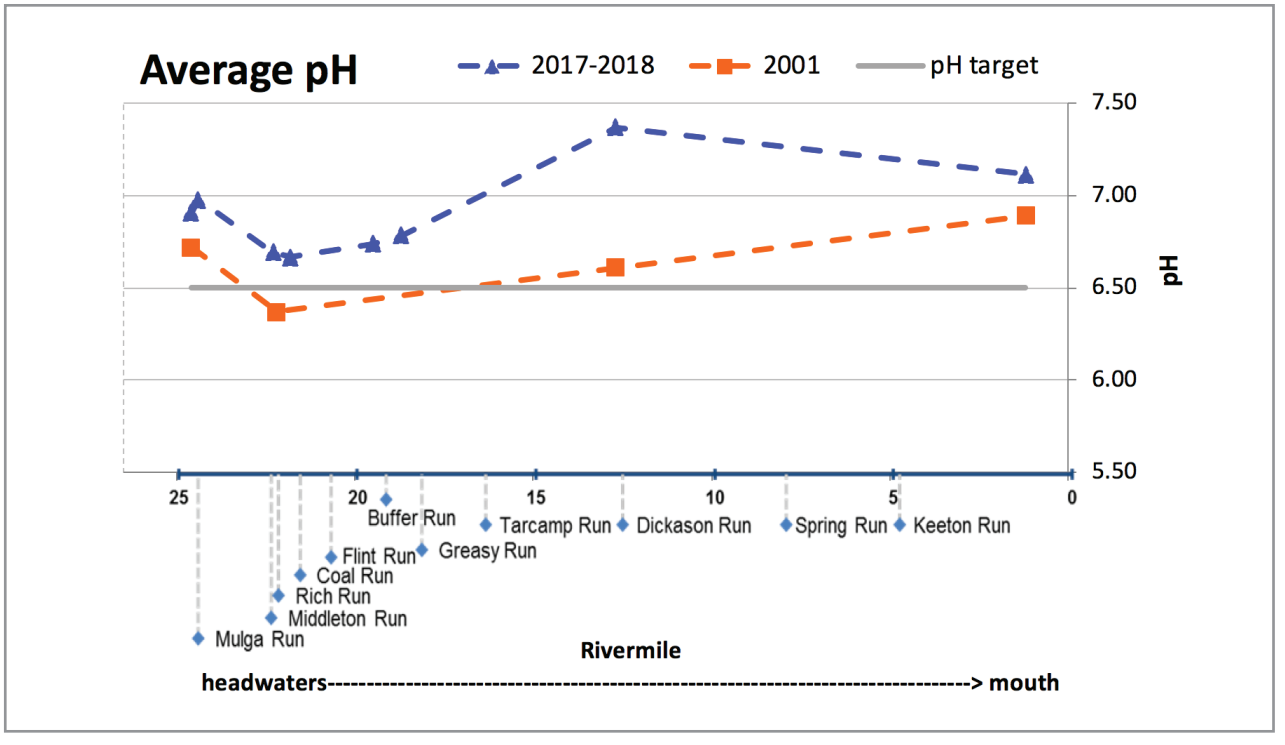


Chemical water quality analysis per stream reach

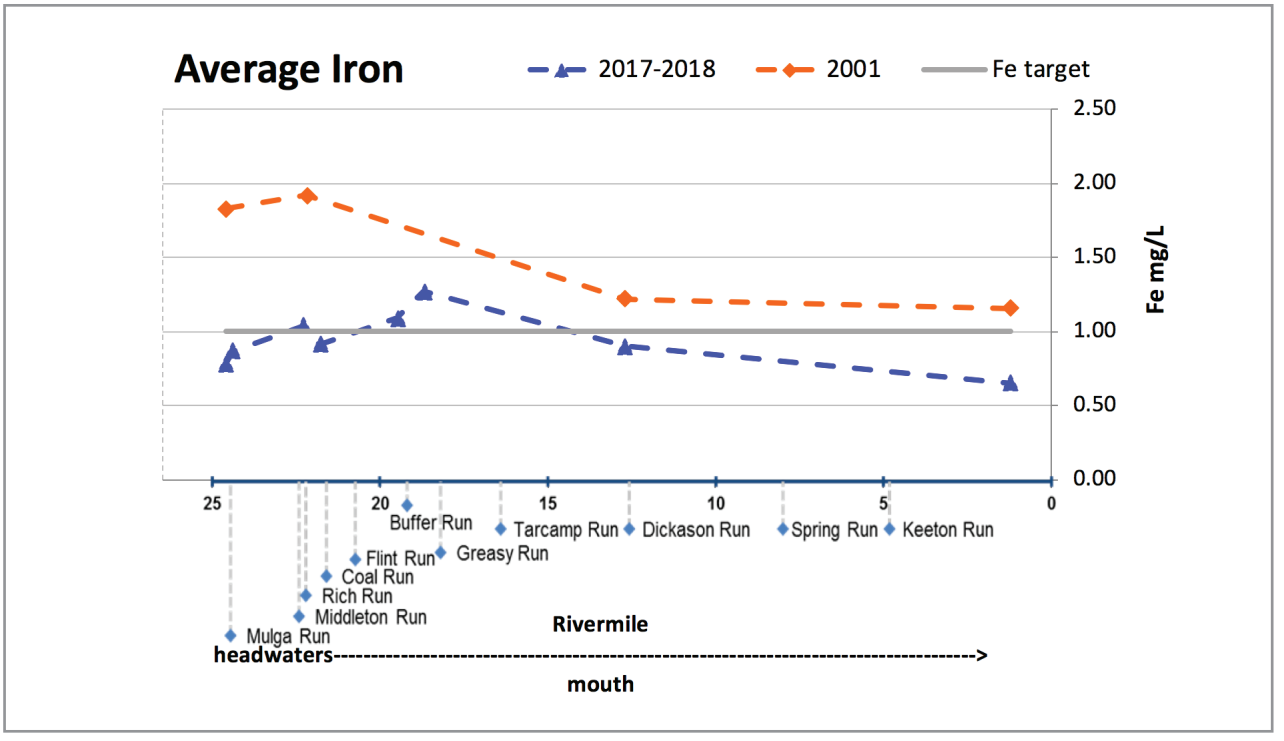
Little Raccoon Creek

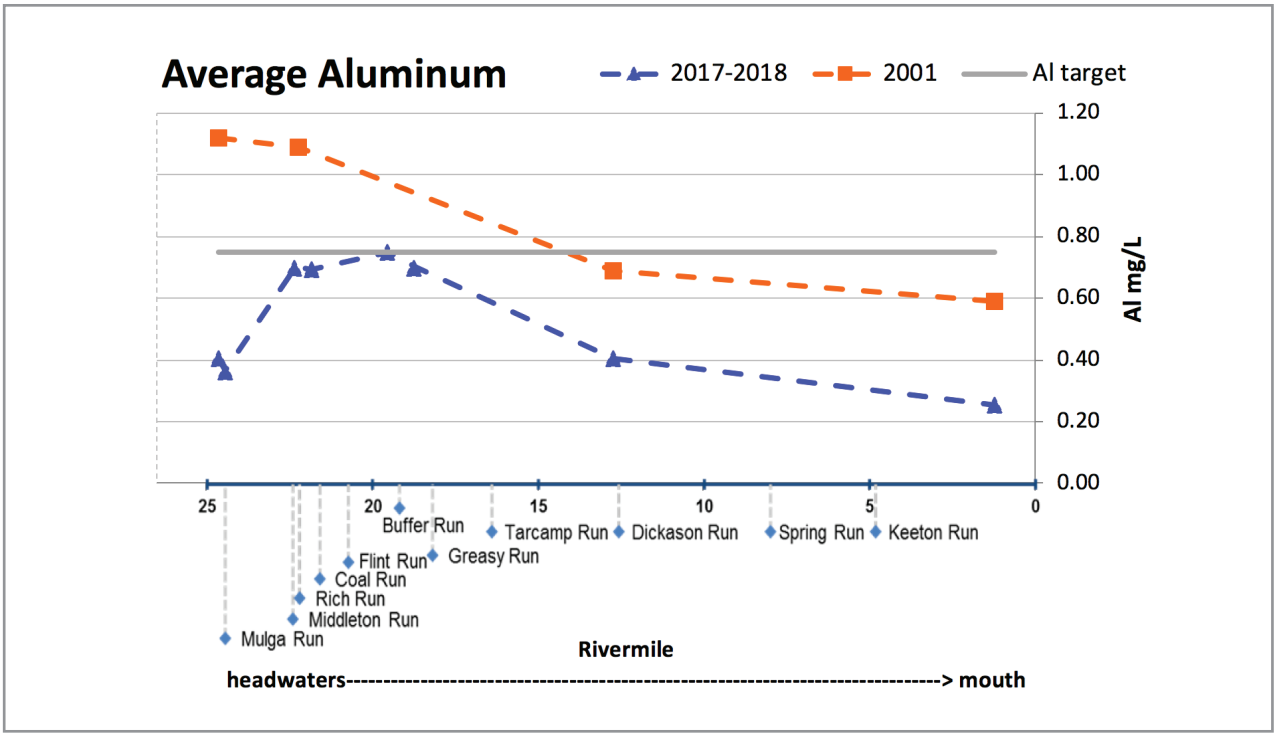
Site ID	LRC0090	LRC0080	LRC0071	LRC0070	LRC0065	LRC0055	LRC0045	LRC0030	LRC0010
Rivermile	24.6	24.4	22.3	22.2	21.8	19.5	18.7	12.7	1.2



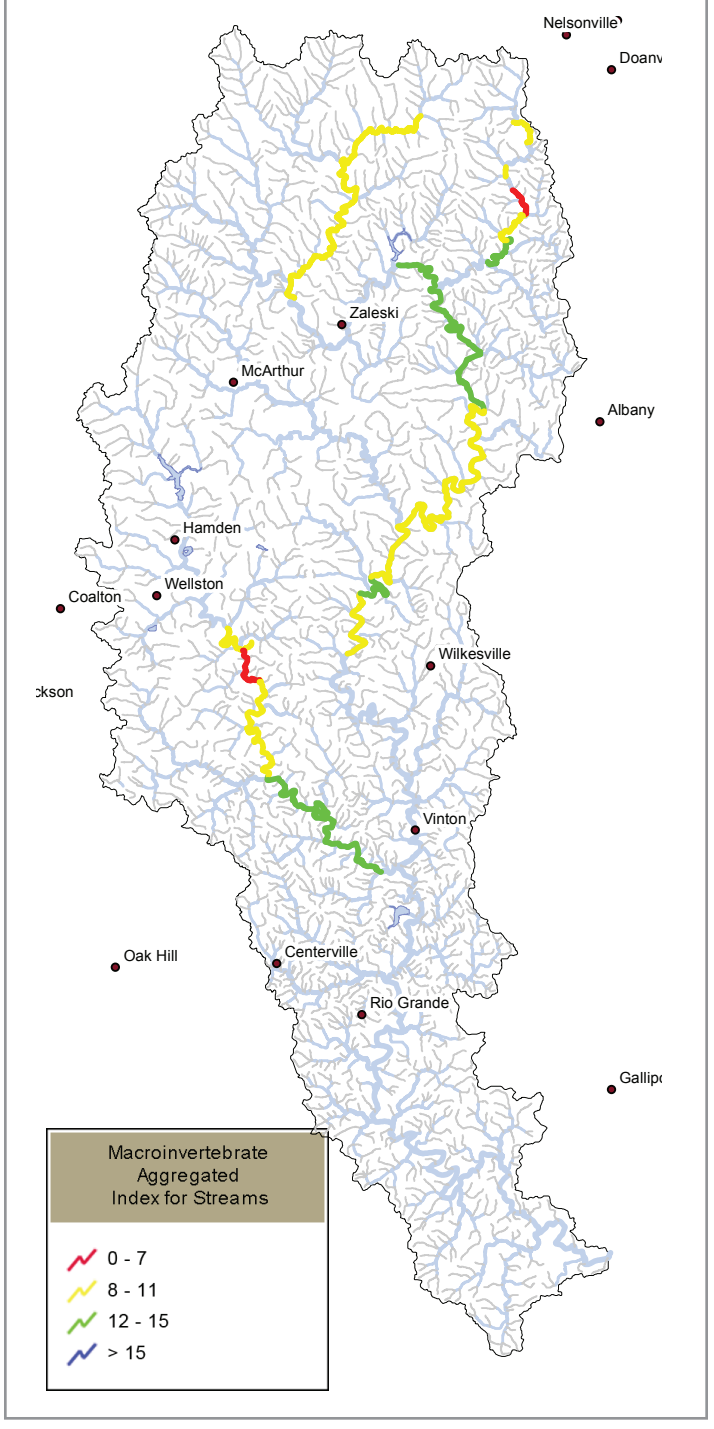


Little Raccoon Creek									
Site ID	LRC0090	LRC0080	LRC0071	LRC0070	LRC0065	LRC0055	LRC0045	LRC0030	LRC0010
Rivermile	24.6	24.4	22.3	22.2	21.8	19.5	18.7	12.7	1.2

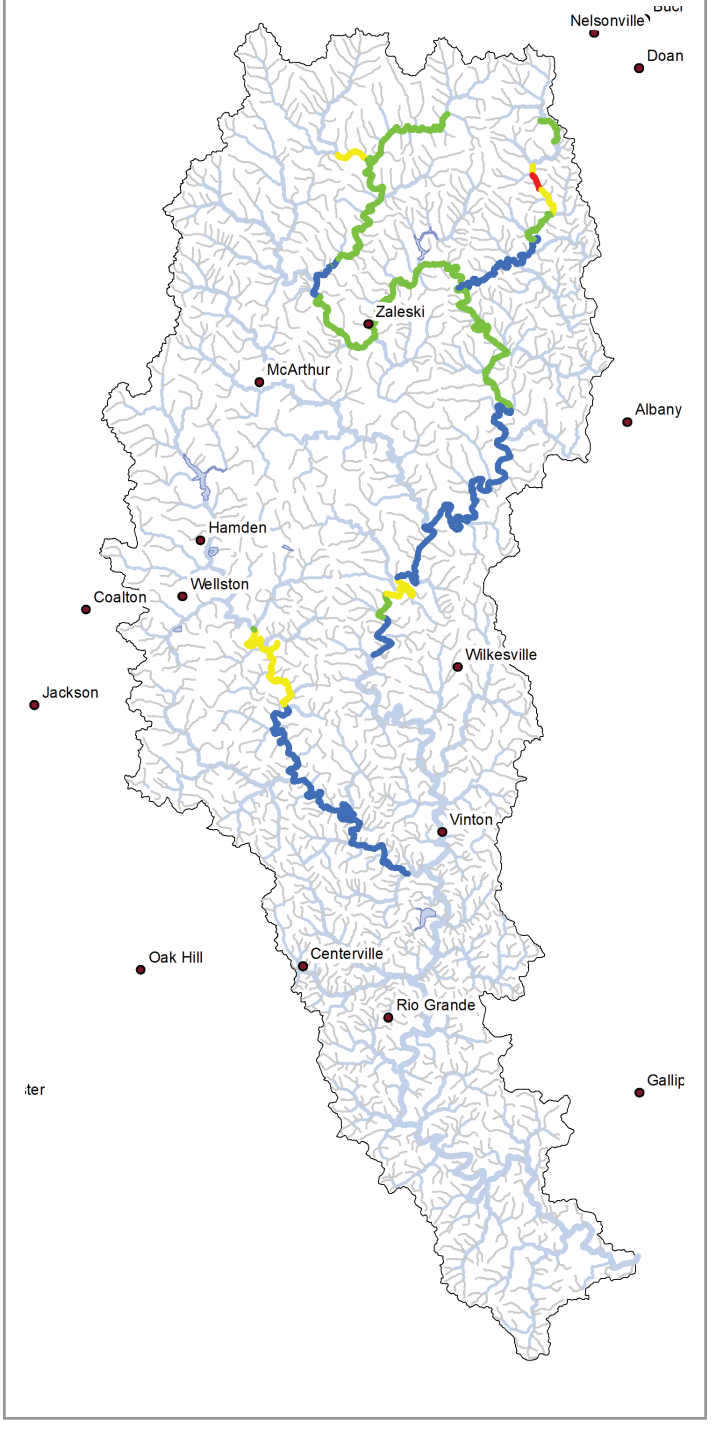




Raccoon Creek baseline MAIS



Raccoon Creek 2017–2018 MAIS

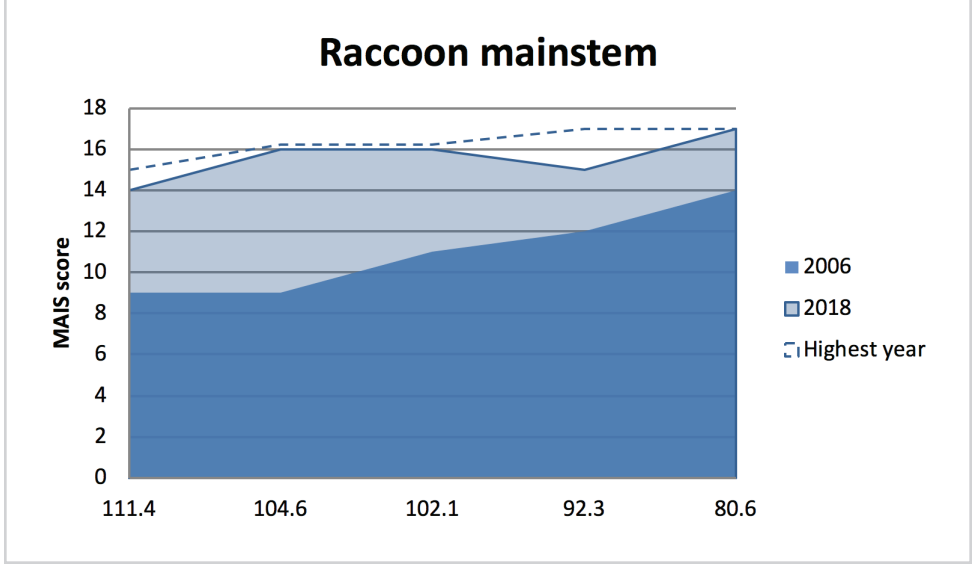


MAIS samples were collected throughout Raccoon Creek in 2017-2018 (excluding Middle Basin sites). These stations have been established as annual monitoring stations for macroinvertebrates. The sites are used to track incremental changes each year.

Raccoon Creek - Mainstem

The mainstem of Raccoon Creek is of high biological quality overall. Most sites are meeting or exceeding the target MAIS score of '12'. The sites furthest upstream between RM 111.4 and 102.1 were historically the most impaired in 2006, so the three sites in this nine mile section have shown the greatest improvement since then. By 2012 all three had scores well above '12' and continued to improve. In 2018, MCBC100 at RM104.6 earned a new high score of '16'.

Biological Recovery



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

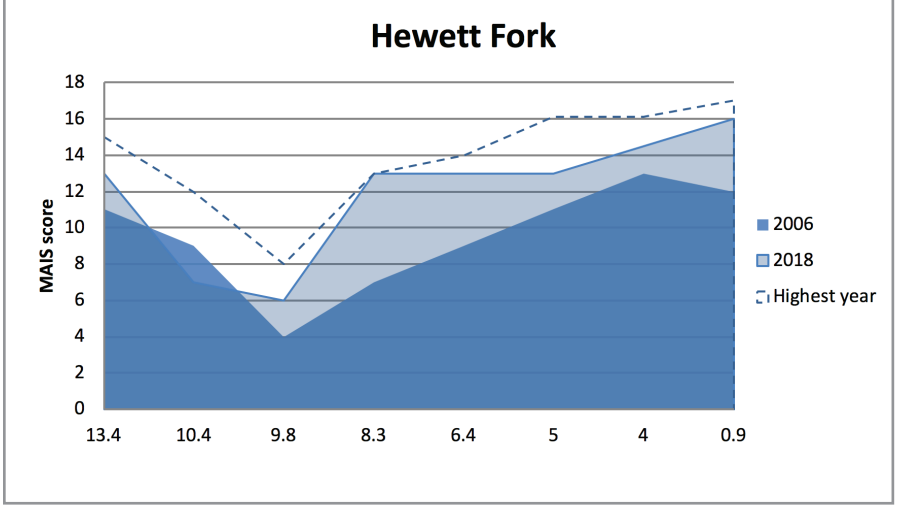
Raccoon Creek - Mainstem - MAIS Regressions

Raccoon Mainstem		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2018	Linear trends	R square	P-value	No. of observations
MSBC010	111.4	8	9	12	9	10	12	13	12	13	13	15	13	14	**improved**	0.735386	0.000178	13
MSBC100	104.6		9	11	12	9	11	10	14	14	13	13	12	16	**improved**	0.579537	0.004024	12
MSLH020	102.1		11	11	10	13	10	11	12	15	15	16	12	16	**improved**	0.547593	0.005930	12
MSLH130	92.3				10	10	17	11	14	13	14	11	13	15	no change	0.133153	0.299841	10
MSBM004	89.6		13	14	11	16	12	16	15	14	13	16	12					
MSBM010	89.36			12	16	14	17	13	13	13	10	14	13					
MSBM040	80.6		14	14	17	16	12	14	15	14	14	16	12					
MSPR0085	65.8				16	16	14	14			15			17				

Raccoon Creek - Hewett Fork

The biological quality of Hewett Fork downstream of the Carbondale doser continues to be maintained, along with the 2.5 mile 'mixing zone' where the water chemistry is still poor and precipitated metals coat the streambed. By 2016, HF090 at the downstream end of the mixing zone exceeded the target MAIS score of '12'. In 2018, all sites downstream of HF090 scored above a 12, indicating that over 8 miles of Hewett Fork continue to meet macroinvertebrate targets for Warm Water Habitat, although most were not meeting their highest scores.

Biological Recovery



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

***River miles 10.4 and 9.8 not sampled in 2018. Last known scores (from 2016) used in graph.**

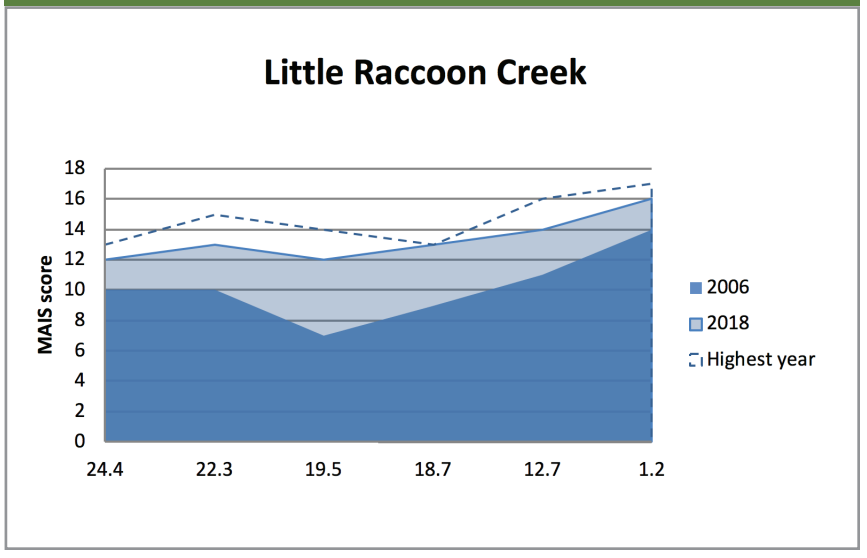
Raccoon Creek - Hewett Fork MAIS Regressions

	RM	'01	'02	'03	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'18	Linear trends	R square	P-value	No. of observations
HF 137	13.4					11	8	9	12	13	11	11	11	13	15	13	13	**improved**	0.541108	0.00987	12
HF 190	10.4					9	3	7	6	6	5	8	12	8	9	7					
HF095	9.8					4	3	6	3	3	8	4	4	4	5	6					
HF 090	8.3	2	3	3	5	7	3	5	6	3	6	9	7	11	11	13	13	**improved**	0.750333	2.96913	16
HF075	7.3									12	11	12	13	11	13						
HF 060	6.4					9	9	8	10	10	13	11	14	13	11	12	13	**improved**	0.520695	0.012183	12
HF045	5									14	15	12	13	16	14	14					
HF 039	4					13	13	14	13	13	14	14	16	16	15	15	16	**improved**	0.670194	0.002060	12
HF 010	0.9					12	12	15	17	13	16	16	14	16	14	10	16	no change	0.002206	0.890911	12

Raccoon Creek - Little Raccoon Creek

Little Raccoon Creek has shown slow but steady improvement in biological quality since monitoring began, especially in the upstream sections between RM 24.4 and 19.5 that scored poorly in 2006. By 2014, half of the sites along the creek's 24 mile length were meeting the target MAIS score of '12'; in 2018 all of the sampled sites met or exceeded this target.

Biological Recovery



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

Little Raccoon Creek - MAIS Regressions

	RM	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2018	Linear trends	R square	P-value	No. of observations
LRC0080	24.4	8	10	11	11	9	9	13	11	11	12		11	12	**improved**	0.357396254	0.040067	12
LRC0071	22.3	8	10	10	9	10	10	10	10	13	11		15	13	**improved**	0.693137588	0.000777	12
LRC0055	19.5		7		9	11	12	13	10	11	14		12					
LRC0045	18.7	14	9	12	9	13	11	11	12	11	10		12	13	no change	0.014185906	0.712364	12
LRC0030	12.7	3	11	13	13	14	14	14	14	15	16		13	14	**improved**	0.353032719	0.041624	12
LRC0010	1.2	14	14	13	15	17	16	16	16	14	17		16	16	no change	0.307753957	0.061197	12