2015 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
6-30-2016
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Stream Health Report contains an evaluation of five watersheds:
Raccoon Creek, Monday Creek, Sunday Creek, Huff Run, and Leading Creek.

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Watershed Reports contains five NPS reports, one for each watershed, detailing
the chemical and biological data trends from baseline condition to 2015.

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Specific AMD project entry forms used for report 2015 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 dedicated watershed professionals. This project would not have come together without the dedication and support of our watershed partnership. I would like to thank and acknowledge the following people for their input and contributions towards this project:

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

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

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

Voinovich School – Steve Porter (GIS and data analysis), Elkan Kim (watersheddata.com), Lindsey Siegrist (graphic design), Kyoung Lim (assistant programmer), Natalie Kruse (research) and Ryan Kline (Voinovich School Scholar).
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. 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 for this study, 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

172 miles of the 183 miles monitored met the pH 6.5 water quality standard in 2015.

Net alkalinity, iron, aluminum, pH, and macroinvertebrates were evaluated annually from 2006-2015. Incremental changes from year to year can be tracked using these indicators. Net alkalinity and pH values have improved from 2006 to 2015. The family-level biological indicator, Macroinvertebrate Aggregated Index for Streams (MAIS), were measured annually from 2006 to 2015, there have been slight fluctuations seen within each watershed, detailed in the biology section for each watershed. Macroinvertebrate data across all watersheds in 2015 indicated good results, most notable are the continued improvements seen in the West Branch of Sunday Creek, and mainstem of Monday Creek.

INTRODUCTION

The Nonpoint Source (NPS) Monitoring Project was created by the Voinovich School of Leadership and Public Affairs at Ohio University in 2005 and funded by the Ohio Department of Natural Resources Division of Mineral Resources Management (ODNR-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 watersheddata.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.

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. However, 2015’s annual health report does not contain yearly chemical or macroinvertebrate trend data for Sunday Creek mainstem or West Branch, due to a lack of water quality data. Similarly, Little Raccoon Creek was not evaluated for macroinvertebrate yearly trends in 2015.
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 2010 are shown in Figure 1. 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.

Biological fish data collected from 2010 to 2015 suggest the following areas highlighted in green (Figure 1) may meet warm water habitat (30 miles in Raccoon Creek and 5 miles in Sunday Creek). These green highlighted areas are conditional and will be evaluated after more biological data is collected as part of the OEPA TMDL being conducted in Raccoon Creek 2016-2017. Additional macroinvertebrate and fish data in the West Branch of Sunday Creek will be collected to confirm the warm water habitat condition (Figure 2).

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.
Figure 1: Biological health improvements in Raccoon Creek from baseline (1997) to 2015.

Conditional improvement 2010-2015 in green highlight.
Figure 2: Biological health improvement in Sunday Creek West Branch from 2005 to 2015.

Table 1. Summary of results for each of the five watersheds evaluated in 2005 to 2015: Raccoon Creek, Monday Creek, Sunday Creek, Huff Run, and Leading Creek.

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Total number of completed projects</th>
<th>Total costs</th>
<th>Total acid load reduction lbs/day</th>
<th>Total stream miles improved in 2005/2010 to meet IBI &amp; MAIS Biological stream health targets</th>
<th>Stream miles that met the pH target</th>
<th>Total stream miles monitored</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raccoon Creek</td>
<td>20</td>
<td>$14,521,361</td>
<td>5,866</td>
<td>23.3/18.42 (41.7)</td>
<td>115</td>
<td>117</td>
</tr>
<tr>
<td>Monday Creek</td>
<td>18</td>
<td>$7,197,808</td>
<td>2,551</td>
<td>0/0</td>
<td>23</td>
<td>32</td>
</tr>
<tr>
<td>Sunday Creek</td>
<td>12 (7 of 10 are subsidence projects)</td>
<td>$2,618,273</td>
<td>352</td>
<td>0/5.26 (5.26)</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Huff Run</td>
<td>14</td>
<td>$5,308,353</td>
<td>1,095</td>
<td>0/0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Leading Creek</td>
<td>2</td>
<td>$728,481</td>
<td>661</td>
<td>NA/0</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>66</td>
<td><strong>$30,374,277</strong></td>
<td>10,173</td>
<td>23.3/23.7 (47.0)</td>
<td>172</td>
<td>183</td>
</tr>
</tbody>
</table>

**Reductions**

Total to date acid load reductions = 10,173 lbs/day

**Costs**

Total to date reclamation costs = $30,374,277
**Reductions**

Total acid load reduction = 5,866 lbs/day  
Total metal load reduction = 962 lbs/day  

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

**Cost**

Design = $1,905,243  
Construction = $12,616,118  
Total Costs through 2015 = $14,521,361
### Timeline of the Raccoon Creek Watershed Project Milestones and AMD Projects

<table>
<thead>
<tr>
<th>Year</th>
<th>Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980s</td>
<td>- Formation of Raccoon Creek Improvement Committee (RCIC): Grassroots citizen group to address water quality issues in Raccoon Creek</td>
</tr>
<tr>
<td>Early 1990s</td>
<td>- RCIC invites citizens from all six counties to join efforts</td>
</tr>
<tr>
<td>Late 1990s</td>
<td>- Formation of Raccoon Creek Watershed Partnership, a loosely based partnership of agencies to address technical AMD issues</td>
</tr>
<tr>
<td>1999</td>
<td>- State Route 124 Strip Pit and Buckeye Furnace Project completed</td>
</tr>
</tbody>
</table>
| 2000 | - Little Raccoon Creek AMDAT completed  
- Watershed Coordinator position funded for six years |
| 2001 | - Headwaters AMDAT completed  
- State Route 124 seeps project completed |
| 2002 | - Mulga Run project completed  
- Middle Basin AMDAT completed  
- Completed management plan for Raccoon Creek Watershed |
| 2003 | - Carbondale II project completed |
| 2004 | - Middleton Run-Salem Road project completed |
| 2005 | - 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 |
| 2006 | - Raccoon Creek Partnership formed 501 (c) 3  
- Waterloo Aquatic Education Center opened |
| 2007 | - East Branch Phase I AMD Project |
| 2008 | - Pierce Run AMD Project began  
- East Branch Phase II Project began |
| 2009 | - East Branch Phase II completed |
| 2010 | - East Branch Phase III completed |
| 2011 | - 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 |
| 2012 | - 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 |
| 2013 | - Middle Basin AMDAT completed |
| 2014 | - Flint Run Wetland Enhancement Project complete; 4-acre metal retention wetland |
| 2015 | - Flint Run Wetland Enhancement Project complete; 4-acre metal retention wetland |

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**2015 NPS Report - Raccoon Creek Watershed**  
*Generated by Non-Point Source Monitoring System*  
*www.watersheddata.com*
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

2015  Flint Run Wetland (FR095) – Wetland Enhancement with limestone berms across the Flint Run Valley

*Italicized indicated projects are not actively monitored for acid mine drainage and metal load reduction purposes*
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.
Yearly acid and metal load reduction trends per project

Mulga site MR0010

Mulga site MR0010 Yearly Acid Load Reduction
Pre-treatment acid load 10 lbs/day

Yearly Metal Load Reduction
Pre-treatment metal load 309 lbs/day

Middleton Run site MiR0021

Middleton Run site MiR0021 Yearly Acid Load Reduction
Pre-treatment acid load 246 lbs/day

Yearly Metal Load Reduction
Pre-treatment metal load 44 lbs/day

Middleton Run site MiR0032

Middleton Run site MiR0032 Yearly Acid Load Reduction
Pre-treatment acid load 56 lbs/day

Yearly Metal Load Reduction
Pre-treatment metal load 8 lbs/day
**Flint Run site FR0126**

Yearly Acid Load Reduction

- Pre-treatment acid load: 805 lbs/day
- % reduction:
  - 2006: 79%
  - 2007: 67%
  - 2008: 72%
  - 2009: 44%
  - 2010: 52%
  - 2011: 60%
  - 2012: 72%
  - 2013: 97%
  - 2014: 80%
  - 2015: 93%

Yearly Metal Load Reduction

- Pre-treatment metal load: 331 lbs/day
- % reduction:
  - 2006: 97%
  - 2007: 76%
  - 2008: 68%
  - 2009: 93%
  - 2010: 80%
  - 2011: 76%
  - 2012: 88%
  - 2013: 99%
  - 2014: 99%
  - 2015: 96%

**Lake Milton site FR0120**

Yearly Acid Load Reduction

- Pre-treatment acid load: 1072 lbs/day
- % reduction:
  - 2007: 94%
  - 2008: 89%
  - 2009: 99%
  - 2010: 99%
  - 2011: 96%
  - 2012: 96%
  - 2013: 100%
  - 2014: 76%
  - 2015: 80%

Yearly Metal Load Reduction

- Pre-treatment metal load: 98 lbs/day
- % reduction:
  - 2007: 84%
  - 2008: 93%
  - 2009: 76%
  - 2010: 80%
  - 2011: 76%
  - 2012: 88%
  - 2013: 97%
  - 2014: 97%
  - 2015: 93%

**East Branch Phase I site EB210**

Yearly Acid Load Reduction

- Pre-treatment acid load: 1175 lbs/day
- % reduction:
  - 2008: 98%
  - 2009: 73%
  - 2010: 86%
  - 2011: 98%
  - 2012: 100%
  - 2013: 98%
  - 2014: 75%
  - 2015: 86%

Yearly Metal Load Reduction

- Pre-treatment metal load: 186 lbs/day
- % reduction:
  - 2008: 77%
  - 2009: 63%
  - 2010: 52%
  - 2011: 52%
  - 2012: 52%
  - 2013: 38%
  - 2014: 38%
  - 2015: 38%
Yearly acid and metal load reduction trends per project

**East Branch Phase I site EB160**

**Yearly Acid Load Reduction**
- Pre-treatment acid load: 499 lbs/day
- Average acid load (lbs/day) and % reduction:
  - 2008: 99
  - 2009: 81
  - 2010: 70
  - 2011: 100
  - 2012: 95
  - 2013: 100
  - 2014: 81
  - 2015: 80

**Yearly Metal Load Reduction**
- Pre-treatment metal load: 102 lbs/day
- Percentage reduction:
  - 2008: 69%
  - 2009: 83%
  - 2010: 78%
  - 2011: 69%
  - 2012: 71%
  - 2013: 65%
  - 2014: 95%
  - 2015: 100%

---

**East Branch Phase II & III site EB190**

**Yearly Acid Load Reduction**
- Pre-treatment acid load: 251 lbs/day
  - 2012: 100
  - 2013: 100
  - 2014: 100

**Yearly Metal Load Reduction**
- Pre-treatment metal load: 26 lbs/day

---

**Orland Gob Pile site WB050**

**Yearly Acid Load Reduction**
- Pre-treatment acid load: 102 lbs/day
  - 2012: 100
  - 2013: 97
  - 2014: 93

**Yearly Metal Load Reduction**
- Pre-treatment metal load: 26 lbs/day
  - 2012: 46
  - 2013: 35
  - 2014: 58
Pierce Run site PR0010*

Yearly Acid Load Reduction

Avg. acid load lbs/day | % reduction
-- | --
16 | 0

Yearly Metal Load Reduction

Avg. metal load lbs/day | % reduction
-- | --
271 | 0

Harble Griffith site WB094

Yearly Acid Load Reduction

Avg. acid load lbs/day | % reduction
-- | --
170 | 73

Yearly Metal Load Reduction

Avg. metal load lbs/day | % reduction
-- | --
26 | 43

Harble Griffith site WB084

Yearly Acid Load Reduction

Avg. acid load lbs/day | % reduction
-- | --
141 | 43

Yearly Metal Load Reduction

Avg. metal load lbs/day | % reduction
-- | --
21 | 43

* Waterloo draining alkaline water into Pierce Run, Pierce Run slag bed is clogged.
Harble Griffith site WB086

Yearly Acid Load Reduction

- Pre-treatment acid load 46 lbs/day
- % reduction 61% in 2013
- % reduction 80% in 2014-2015

Yearly Metal Load Reduction

- Pre-treatment metal load 5 lbs/day
- % reduction 40% in 2013
- % reduction 88% in 2014-2015

Lake Morrow site FR0110

Yearly Acid Load Reduction

- Pre-treatment acid load 138 lbs/day
- % reduction 0% in 2015

Yearly Metal Load Reduction

- Pre-treatment metal load 17 lbs/day
- % reduction 0% in 2015

Middleton Run II site MiR0110

Yearly Acid Load Reduction

- Pre-treatment acid load 141 lbs/day
- % reduction 0% in 2015

Yearly Metal Load Reduction

- Pre-treatment metal load 22 lbs/day
- % reduction 0% in 2015
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 2015, except for a section (1.57 miles HF137) upstream of the input to Hewitt Fork from the Carbondale doser. Of the miles of stream monitored in 2015, 13.2 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 2015, all but 1.5 of 117 miles of stream miles monitored met the pH target (pH > 6.5).
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.
Chemical water quality analysis per stream reach

### Raccoon Creek Mainstem

<table>
<thead>
<tr>
<th>Site ID</th>
<th>Rivermile</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB010</td>
<td>112</td>
</tr>
<tr>
<td>EB010</td>
<td>111.89</td>
</tr>
<tr>
<td>MSBC010</td>
<td>111.39</td>
</tr>
<tr>
<td>MSBC100</td>
<td>104.46</td>
</tr>
<tr>
<td>MSLH020</td>
<td>102.1</td>
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<tr>
<td>MSBM004</td>
<td>89.6</td>
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<tr>
<td>MSBM010</td>
<td>89.36</td>
</tr>
<tr>
<td>MSBM040</td>
<td>80.6</td>
</tr>
</tbody>
</table>

#### Average Net Alkalinity

- 2015
- 2005
- 2000

#### Average pH

- 2015
- 2005
- 2000
- pH target
## Chemical water quality analysis per stream reach

<table>
<thead>
<tr>
<th>Site ID</th>
<th>WB010</th>
<th>EB010</th>
<th>MSBC010</th>
<th>MSBC100</th>
<th>MSLH020</th>
<th>MSBM004</th>
<th>MSBM010</th>
<th>MSBM040</th>
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<tbody>
<tr>
<td>Rivermile</td>
<td>112</td>
<td>111.89</td>
<td>111.39</td>
<td>104.46</td>
<td>102.1</td>
<td>89.6</td>
<td>89.36</td>
<td>80.6</td>
</tr>
</tbody>
</table>

### Average Iron

![Graph showing average iron levels across different river miles and locations.](image)

### Average Aluminum

![Graph showing average aluminum levels across different river miles and locations.](image)
Hewett Fork

<table>
<thead>
<tr>
<th>Site ID</th>
<th>HF137</th>
<th>HF129</th>
<th>HF130</th>
<th>HF190</th>
<th>HF095</th>
<th>HF090</th>
<th>HF075</th>
<th>HF060</th>
<th>HF045</th>
<th>HF039</th>
<th>HF010</th>
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</thead>
<tbody>
<tr>
<td>Rivermile</td>
<td>13.7</td>
<td>11.1</td>
<td>10.9</td>
<td>10.4</td>
<td>9.7</td>
<td>8.3</td>
<td>7.2</td>
<td>6.2</td>
<td>4.7</td>
<td>4</td>
<td>0.9</td>
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</table>

Note: Lime Doser installed in 2004 at RM 11
Chemical water quality analysis per stream reach

Hewett Fork

<table>
<thead>
<tr>
<th>Site ID</th>
<th>HF137</th>
<th>HF129</th>
<th>HF130</th>
<th>HF190</th>
<th>HF095</th>
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<th>HF075</th>
<th>HF060</th>
<th>HF045</th>
<th>HF039</th>
<th>HF010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivermile</td>
<td>13.7</td>
<td>11.1</td>
<td>10.9</td>
<td>10.4</td>
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</table>

Note: Lime Doser installed in 2004 at RM 11
Chemical water quality analysis per stream reach

2015 NPS Report - Raccoon Creek Watershed
Generated by Non-Point Source Monitoring System
www.watersheddata.com

Little Raccoon Creek

Map of Little Raccoon Creek with site IDs and river miles marked.

Note: Site ID in Black
River Mile in Blue
Little Raccoon Creek

<table>
<thead>
<tr>
<th>Site ID</th>
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<th>LRC0080</th>
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<td>19.5</td>
<td>18.7</td>
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Average Net Alkalinity

Average pH

Rivermile

headwaters---------mouth

pH target
Little Raccoon Creek

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<tr>
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<td>19.5</td>
<td>18.7</td>
<td>12.7</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**Average Iron**

- 2015
- 2005
- 2001
- Fe target

**Average Aluminum**

- 2015
- 2005
- 2001
- Al target
MAIS samples were collected throughout Raccoon Creek in 2015 (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, with a total of 9 river miles fitting the category of ‘statistically improved’. There was an unusually low MAIS score this year at RM 92.3 (“11” when it is usually >“14”), but sites immediately upstream and downstream met or exceeded previous years’ high scores, suggesting that the decline in quality was not widespread.

**Figure 1. Area of Degradation**

**Figure 2. Raccoon Creek - Mainstem - MAIS Regressions**

*Indicates a score graphed as the mean of sites immediately upstream and downstream that year*
Raccoon Creek - Hewett Fork

In 2015, the biological quality of the eleven mile reach below the Carbondale doser was relatively unchanged 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. Two of the sites in the downstream recovered zone (HF060 and HF045) scored a little lower than usual but it is unknown whether this is an annual variation or a new trend.

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

<table>
<thead>
<tr>
<th></th>
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</table>

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

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Milestones</th>
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</thead>
<tbody>
<tr>
<td>1994</td>
<td>• Formation of Monday Creek Restoration Project</td>
</tr>
</tbody>
</table>
| 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  
|      | • “Monday Creek Watershed AMDAT Acid Mine Drainage Abatement and Treatment Plan I” published |
| 1997 | • 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 |
|      | • 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 | • Jobs 13 gob pile capping is underway. |
| 2003 | • Video about Monday Creek entitled “Cool Waters” is released |
| 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 |

*continued on next page*
Timeline of the Monday Creek Watershed Project Milestones & AMD Projects (continued)

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)
- 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

2006
- 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 authorized $21 million for ecological restoration of Monday Creek

2007
- 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
- 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

2008
- U.S. Forest Service closed subsidences along Snow Fork, Rock Run, and New Straitsville South
- 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

2009
- 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

2010
- Five new fish species found in Monday Creek and the first annual Monday Creek Canoe Float with 54 people in 27 boats!

2011
- 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.

2012
- The Smallmouth Bass (Micropterus dolomieu) was found for the first time in Monday Creek since restoration project. Two other native species were also found, greenside darter (Etheostoma blennioides) and spotted sucker (Minytrema melanops).

2015
- Monkey Hollow Doser began operating August 26, 2015. This project will help improve 6.5 miles of Monday Creek.
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

2015  Monkey Hollow Doser (MH00100) – Active calcium oxide doser

*Italicized indicated projects are not actively monitored for acid mine drainage and metal load reduction purposes*
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.
Yearly acid and metal load reduction trends per project

Lost Run Phase I and II site LR00020

Lost Run Phase I and II site LR00020
Yearly Acid Load Reduction
Pre-treatment acid load 2138 lbs/day

Lost Run Phase I and II site LR00020
Yearly Metal Load Reduction
Pre-treatment metal load 316 lbs/day

Coe Hollow site CH00100

Coe Hollow site CH00100
Yearly Acid Load Reduction
Pre-treatment acid load 335 lbs/day

Coe Hollow CH00100
Yearly Metal Load Reduction
Pre-treatment metal load 65 lbs/day

Big Four Hollow LLB site BF00400

Big Four Hollow LLB site BF00400
Yearly Acid Load Reduction
Pre-treatment acid load 468 lbs/day

Big Four Hollow LLB site BF00400
Yearly Metal Load Reduction
Pre-treatment metal load 65 lbs/day

Monkey Hollow Doser site MH00100

Monkey Hollow Doser site MH00100
Yearly Acid Load Reduction
Pre-treatment acid load 478 lbs/day

Monkey Hollow Doser site MH00100
Yearly Metal Load Reduction
Pre-treatment metal load 70 lbs/day
In Monday Creek pH values have improved throughout the watershed from baseline conditions (2001) to 2015. In 2015, 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. From 2012 -2015, stream miles meeting the pH target have remained constant. 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](image-url)
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.

<table>
<thead>
<tr>
<th>Monday Creek Mainstem</th>
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<th>Rivermile</th>
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### Chemical water quality analysis per stream reach

#### Average Iron

- **2015**: Various levels across different rivermiles, showing a trend from higher levels at the headwaters to lower levels as you move downstream.
- **2005**: Similar trend as 2015, with slightly different values.
- **2000**: Lower levels compared to 2015 and 2005, indicating a decrease in iron content over time.

#### Average Aluminum

- **2015**: Shows an increase in aluminum levels as you move downstream, particularly noticeable in the middle rivermiles.
- **2005**: Similar pattern to 2015, with slight variations.
- **2000**: Shows a decrease in aluminum levels compared to 2015 and 2005, indicating improvements in water quality.

Both graphs display the chemical water quality analysis per stream reach, with specific sites marked along the rivermiles.
MAIS samples were collected throughout Monday Creek at established annual monitoring stations from 2001 through 2015.
Long-term monitoring of biological quality along the Monday Creek mainstem has shown steady improvements in biological quality over the last ten years and this year saw continued improvement across all sites. In 2014 two sites that had previously been showing improvement declined. After two years of exceeding MAIS score targets and appearing to be well into recovery, RM 15.9, downstream of Lost Run, declined to “9” and RM 9.35, at Carbon Hill downstream of Monkey Hollow dropped from “15” in 2013 to “11” and disrupted what had been a statistically significant trend in biological recovery. In 2015, the biological scores at these two sites were back up to “13” and “14” respectively, indicating that the 2014 low scores were unusual. This year the statistical trend of recovery at both sites was re-established, as was the recovery trend for the final two other long term sites previously categorized as ‘unchanged’. All long term sites are now categorized as ‘improved’ and only two sites this year did not exceed the MAIS target of “12” for biological quality, JH0500 at the site of the doser and MC0240 at Snake Hollow. In addition, there was overall continued improvement as indicated by sustained or new high scores at six of the eleven long term sites: MC0950, MC0900, MC0800, MC0580, MC0510, and MC0300 at Carbon Hill. The latter site earned an outstanding “18” in biological quality, which is unusual for our study watersheds in southeast Ohio.

### Figure 3. Monday Creek MAIS Regressions

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<td>15</td>
<td></td>
<td></td>
<td></td>
<td>improved</td>
<td>0.58144</td>
<td>0.01032</td>
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<tr>
<td>MC00800</td>
<td>RM 23.5</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>7</td>
<td>9</td>
<td>12</td>
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<td>13</td>
<td>11</td>
<td>13</td>
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<td>14</td>
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<td>16</td>
<td>14</td>
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<td>12</td>
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<td></td>
<td></td>
<td>improved</td>
<td>0.55877</td>
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<td>12</td>
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<td>MC00500</td>
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<td>7</td>
<td>8</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>improved</td>
<td>0.47498</td>
<td>0.02748</td>
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<tr>
<td>MC00300</td>
<td>RM 10.5</td>
<td>5</td>
<td>10</td>
<td>13</td>
<td>13</td>
<td>12</td>
<td>14</td>
<td>12</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>16</td>
<td>16</td>
<td>18</td>
<td></td>
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<td>0.68552</td>
<td>0.00189</td>
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<tr>
<td>MC00280</td>
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<td>9</td>
<td>14</td>
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<td>10</td>
<td>15</td>
<td>11</td>
<td>14</td>
<td></td>
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<td>0.49954</td>
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<tr>
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<td>7</td>
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<td>8</td>
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<td>MC00180</td>
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<td>6</td>
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<td>8</td>
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<td>9</td>
<td>7</td>
<td>4</td>
<td>13</td>
<td>9</td>
<td>9</td>
<td>15</td>
<td>11</td>
<td>13</td>
<td>improved</td>
<td>0.46662</td>
<td>0.02946</td>
<td>14</td>
</tr>
</tbody>
</table>

The blue dashed line identifies the highest MAIS score ever achieved at that site throughout the monitoring time period.
HUFF RUN
WATERSHED REPORT
Total acid load reduction 2015 = 1,095 lbs/day
Total metal load reduction 2015 = 25 lbs/day excluding Mineral Zoar and Farr

Design $724,181 (excluding Linden Bioremediation and Lyons II)
Construction $4,584,172
Total cost through 2015 = $5,308,353
### Timeline of the Huff Run Watershed Project Milestones & AMD Projects

<table>
<thead>
<tr>
<th>Year</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>Study funded by ODNR conducted by Benatec Associates to identify acid problems in Huff Run Watershed</td>
</tr>
<tr>
<td>1988</td>
<td>First abandoned mine land project, Jobes, completed in the watershed</td>
</tr>
<tr>
<td>1996</td>
<td>Huff Run Watershed Restoration Partnership founded</td>
</tr>
<tr>
<td>2000</td>
<td>Huff Run AMDAT completed</td>
</tr>
<tr>
<td></td>
<td>Huff Run Watershed Coordinator funded for six years</td>
</tr>
<tr>
<td></td>
<td>First acid mine drainage restoration project, Farr, completed in watershed</td>
</tr>
<tr>
<td>2001</td>
<td>First draft of Huff Run Watershed Plan completed</td>
</tr>
<tr>
<td>2002</td>
<td>Linden Bioremediation Project constructed</td>
</tr>
<tr>
<td>2003</td>
<td>Acid Pit Restoration Project completed</td>
</tr>
<tr>
<td>2004</td>
<td>Lindentree Restoration Project completed</td>
</tr>
<tr>
<td>2005</td>
<td>Rural Action and Huff Run awarded US EPA Targeted Watershed Grant</td>
</tr>
<tr>
<td></td>
<td>Rural Action adds VISTA volunteer to Huff Run staff</td>
</tr>
<tr>
<td></td>
<td>Second draft of Huff Run Watershed Plan authored, endorsed by the State of Ohio</td>
</tr>
<tr>
<td></td>
<td>Lyons Restoration Project constructed</td>
</tr>
<tr>
<td>2006</td>
<td>Harsha North Restoration project completed</td>
</tr>
<tr>
<td>2007</td>
<td>Belden Restoration Project constructed</td>
</tr>
<tr>
<td></td>
<td>Fern Hill (HR-42) Phase II Project constructed</td>
</tr>
<tr>
<td>2009</td>
<td>Huff Run Watershed Coordinator funded for three years</td>
</tr>
<tr>
<td></td>
<td>Mineral Zoar Project completed</td>
</tr>
<tr>
<td></td>
<td>Rural Action adds AmeriCorps member to Huff Run staff</td>
</tr>
<tr>
<td>2010</td>
<td>Thomas Project, Fern Hill Pond A &amp; Belden Gob pile constructed</td>
</tr>
<tr>
<td>2011</td>
<td>Lyons II constructed</td>
</tr>
<tr>
<td>2012</td>
<td>Hilltop Restoration Project started</td>
</tr>
<tr>
<td>2013</td>
<td>Completed Hilltop Restoration Project</td>
</tr>
<tr>
<td></td>
<td>MWCD Partners in Watershed Management Grant awarded for environmental education and community outreach</td>
</tr>
<tr>
<td>2014</td>
<td>Project development for JS&amp;L AMD Reclamation Project and the Farr Phase II</td>
</tr>
<tr>
<td>2015</td>
<td>Constructed JS&amp;L AMD Restoration Project, funded by ODNR-DMRM and OEPA</td>
</tr>
<tr>
<td></td>
<td>Received $1.7M ODOT Mitigation</td>
</tr>
</tbody>
</table>
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

2015  
- JS&L AMD Reclamation (HR25) – Limestone channels, limestone leach bed and precipitation basin.

*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*
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.
Yearly acid and metal load reduction trends per project

**Lindentree site LNT01**

- **Pre-treatment acid load**: 85 lbs/day
- **% reduction**: 100%

**Harsha North site HAN05**

- **Pre-treatment acid load**: 110 lbs/day
- **% reduction**: 14%

**Fern Hill site FRN01**

- **Pre-treatment acid load**: 634 lbs/day
- **% reduction**: 85%
2015 NPS Report - Huff Run Watershed
Generated by Non-Point Source Monitoring System
www.watersheddata.com

Yearly acid and metal load reduction trends per project

**Belden site BLD01**

**Yearly Acid Load Reduction**
- Pre-treatment acid load 119 lbs/day
- % reduction

**Yearly Metal Load Reduction**
- Pre-treatment metal load 11 lbs/day
- % reduction

**Thomas site THM01/THM06**

**Yearly Acid Load Reduction**
- Pre-treatment acid load 31 lbs/day
- % reduction

**Yearly Metal Load Reduction**
- Pre-treatment metal load 6 lbs/day
- % reduction

**Hilltop Energy (HRT21/HR37A)**

**Yearly Acid Load Reduction**
- Pre-treatment acid load 55 lbs/day
- % reduction

**Yearly Metal Load Reduction**
- Pre-treatment metal load 8 lbs/day
- % reduction
Huff Run pH values have improved from baseline conditions (1985-1998) to 2015. The entire length of Huff Run has met the pH target (6.5) for the last six 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. From 2010 to 2015, all 10 miles met the pH target.

### Huff Run pH

<table>
<thead>
<tr>
<th>Year</th>
<th>Stream miles</th>
<th>Total miles monitored per year</th>
<th>% Meeting</th>
</tr>
</thead>
<tbody>
<tr>
<td>baseline</td>
<td>2 5</td>
<td>7 miles</td>
<td>29%</td>
</tr>
<tr>
<td>2006</td>
<td>7 3</td>
<td>10 miles</td>
<td>100%</td>
</tr>
<tr>
<td>2007</td>
<td>8 2</td>
<td>10 miles</td>
<td>100%</td>
</tr>
<tr>
<td>2008</td>
<td>8 2</td>
<td>10 miles</td>
<td>100%</td>
</tr>
<tr>
<td>2009</td>
<td>8 2</td>
<td>10 miles</td>
<td>100%</td>
</tr>
<tr>
<td>2010</td>
<td>8 2</td>
<td>10 miles</td>
<td>100%</td>
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<tr>
<td>2011</td>
<td>8 2</td>
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<td>2012</td>
<td>8 2</td>
<td>10 miles</td>
<td>100%</td>
</tr>
<tr>
<td>2013</td>
<td>8 2</td>
<td>10 miles</td>
<td>100%</td>
</tr>
<tr>
<td>2014</td>
<td>8 2</td>
<td>10 miles</td>
<td>100%</td>
</tr>
<tr>
<td>2015</td>
<td>8 2</td>
<td>10 miles</td>
<td>100%</td>
</tr>
</tbody>
</table>

*blue = stream miles > pH 6.5  orange = stream miles < pH 6.5*
Chemical water quality analysis per stream reach

2015 NPS Report - Huff Run Watershed
Generated by Non-Point Source Monitoring System
www.watersheddata.com
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.

<table>
<thead>
<tr>
<th>Site ID</th>
<th>HRR01</th>
<th>HRR02</th>
<th>HRR03</th>
<th>HRR04</th>
<th>HRR05</th>
<th>HRR06</th>
<th>HRR07</th>
<th>HRR08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivermile</td>
<td>7.7</td>
<td>6.7</td>
<td>5.4</td>
<td>4.8</td>
<td>4.1</td>
<td>2.7</td>
<td>1.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

**Average Net Alkalinity**

**Average pH**
### 2015 NPS Report - Huff Run Watershed

**Generated by Non-Point Source Monitoring System**

[www.watersheddata.com](http://www.watersheddata.com)

#### Chemical water quality analysis per stream reach

<table>
<thead>
<tr>
<th>Site ID</th>
<th>HRR01</th>
<th>HRR02</th>
<th>HRR03</th>
<th>HRR04</th>
<th>HRR05</th>
<th>HRR06</th>
<th>HRR07</th>
<th>HRR08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivermile</td>
<td>7.7</td>
<td>6.7</td>
<td>5.4</td>
<td>4.8</td>
<td>4.1</td>
<td>2.7</td>
<td>1.4</td>
<td>0.4</td>
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</tbody>
</table>

#### Average Iron

![Average Iron Graph](image)

#### Average Aluminum

![Average Aluminum Graph](image)
Biological quality in Huff Run decreases from headwaters to the mouth.
Biological quality in Huff Run (based on macroinvertebrate data) improved modestly along the length of the mainstem. In 2014 for the first time since monitoring began in 2005 one of the eight monitoring sites (RM 5.4), improved enough to be categorized as sustained and statistically significant and four sites (RM 7.7, 5.4, 4.8 and 2.7) achieved new high scores that year. In 2015, RM 5.4 became the first site to reach its biological restoration target, earning a MAIS score “13”. RM 2.7 also earned a new high score of “11” and became the second site along the mainstem to show sustained biological recovery. These improvements, however, do not extend further downstream; biological quality at the two lowermost sites continues to be relatively poor. Scores at the upper two sites were also unusually low this year.

Figure 2. Huff Run MAIS Regressions

<table>
<thead>
<tr>
<th>Site</th>
<th>RM</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>Linear trends</th>
<th>R square</th>
<th>P-value</th>
<th>No. of years</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRR01</td>
<td>7.7</td>
<td>14</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>13</td>
<td>9</td>
<td>13</td>
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<td>no change</td>
<td>0.0972</td>
<td>0.350655</td>
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<tr>
<td>HRR02</td>
<td>6.7</td>
<td>12</td>
<td>8</td>
<td>8</td>
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<td>9</td>
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<td>9</td>
<td>7</td>
<td>no change</td>
<td>0.016667</td>
<td>0.705201</td>
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</tr>
<tr>
<td>HRR03</td>
<td>5.4</td>
<td>8</td>
<td>6</td>
<td>7</td>
<td>6</td>
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<td>9</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>improved</td>
<td>0.677237</td>
<td>0.001862</td>
<td>11</td>
</tr>
<tr>
<td>HRR04</td>
<td>4.8</td>
<td>6</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>9</td>
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<td>9</td>
<td>no change</td>
<td>0.26</td>
<td>0.109078</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>HRR06</td>
<td>2.7</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5.5</td>
<td>7</td>
<td>11</td>
<td>improved</td>
<td>0.352671</td>
<td>0.054061</td>
<td>11</td>
</tr>
<tr>
<td>HRR07</td>
<td>1.4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>no change</td>
<td>0.063035</td>
<td>0.456462</td>
<td>11</td>
</tr>
<tr>
<td>HRR08</td>
<td>0.4</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>no change</td>
<td>0.203521</td>
<td>0.163704</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>
Total acid load reduction = 661 lbs/day
Total metal load reduction = 154 lbs/day

Design $36,132
Construction $692,349
Total Costs through 2015 = $728,481
### Timeline of the Leading Creek Watershed Project Milestones & AMD Projects

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>SOCCO mine release into Leading Creek</td>
</tr>
<tr>
<td>1994</td>
<td>Mother’s Day Flood</td>
</tr>
<tr>
<td>1995</td>
<td>Leading Creek Improvement Plan by Dr. Cherry completed</td>
</tr>
<tr>
<td>1996</td>
<td>USFWS began working with Meigs SWCD on watershed projects</td>
</tr>
<tr>
<td>1997</td>
<td>First Leading Creek Stream Sweep conducted</td>
</tr>
<tr>
<td>1998</td>
<td>Meigs SWCD Conservation Area purchased along Little Leading Creek</td>
</tr>
<tr>
<td>1999</td>
<td>Meigs SWCD obtained first watershed coordinator grant</td>
</tr>
<tr>
<td>2000</td>
<td>Leading Creek Watershed Management Plan completed</td>
</tr>
<tr>
<td>2001</td>
<td>Pauline Atkins Memorial Trail completed</td>
</tr>
<tr>
<td>2002</td>
<td>Leading Creek AMDAT Plan completed</td>
</tr>
<tr>
<td>2003</td>
<td>First Americorps member dedicated to the Leading Creek Watershed</td>
</tr>
<tr>
<td>2004</td>
<td>Leading Creek TDML Report completed</td>
</tr>
<tr>
<td>2005</td>
<td>Biological observations along Thomas Fork indicate an increase in diversity of fish and macroinvertebrate species since 2010</td>
</tr>
<tr>
<td>2006</td>
<td>Project development for Casto Doser reclamation scheduled for 2015</td>
</tr>
<tr>
<td>2007</td>
<td>Freshwater mussels reintroduced</td>
</tr>
<tr>
<td>2008</td>
<td>Thomas Fork Doser Project completed</td>
</tr>
<tr>
<td>2009</td>
<td>Leading ‘From the Past’ book completed</td>
</tr>
<tr>
<td>2010</td>
<td>Leading Creek Volunteer Monitor Program begun</td>
</tr>
<tr>
<td>2011</td>
<td>Casto Doser began operating October 2015, adding alkalinity to Thomas Fork to supplement low flow conditions</td>
</tr>
</tbody>
</table>
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

2015  Casto Doser (TF0030) – 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

<table>
<thead>
<tr>
<th>Year</th>
<th>Ave. acid load lbs/day</th>
<th>% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>661</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>88</td>
<td>96</td>
</tr>
<tr>
<td>2014</td>
<td>89</td>
<td>99</td>
</tr>
<tr>
<td>2015</td>
<td>88</td>
<td>99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Ave. metal load lbs/day</th>
<th>% reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>155</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>88</td>
<td>96</td>
</tr>
<tr>
<td>2014</td>
<td>89</td>
<td>99</td>
</tr>
<tr>
<td>2015</td>
<td>88</td>
<td>99</td>
</tr>
</tbody>
</table>
Thomas Fork in 2015, show 8.7 stream miles meeting the pH target of (6.5) of the 8.7 miles monitored (100%). The 2.5 miles of streams that didn’t meet the pH target last year are now on average meeting the pH target.

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

blue = stream miles > pH 6.5  orange = stream miles < pH 6.5
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

<table>
<thead>
<tr>
<th>site ID</th>
<th>TF0071</th>
<th>TF0068</th>
<th>TF0064</th>
<th>TF0058</th>
<th>TF0050</th>
<th>TF0030</th>
<th>TF0020</th>
<th>TF0015</th>
<th>TF0010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivermile</td>
<td>7.6</td>
<td>7.1</td>
<td>6.85</td>
<td>6</td>
<td>5.8</td>
<td>4.3</td>
<td>3.15</td>
<td>2.8</td>
<td>1.2</td>
</tr>
</tbody>
</table>

### Average Net Alkalinity

![Average Net Alkalinity Graph](image)

### Average pH

![Average pH Graph](image)
### Average Iron

<table>
<thead>
<tr>
<th>Rivermile</th>
<th>Fe mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>headwaters</td>
<td>0.0</td>
</tr>
<tr>
<td>7.6</td>
<td>7.1</td>
</tr>
<tr>
<td>6.85</td>
<td>6</td>
</tr>
<tr>
<td>5.8</td>
<td>4.3</td>
</tr>
<tr>
<td>3.15</td>
<td>2.8</td>
</tr>
<tr>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>

**2015**

**2009-2011**

**Target Recovery Reach**

### Average Aluminum

<table>
<thead>
<tr>
<th>Rivermile</th>
<th>Al mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>headwaters</td>
<td>0.0</td>
</tr>
<tr>
<td>7.6</td>
<td>7.1</td>
</tr>
<tr>
<td>6.85</td>
<td>6</td>
</tr>
<tr>
<td>5.8</td>
<td>4.3</td>
</tr>
<tr>
<td>3.15</td>
<td>2.8</td>
</tr>
<tr>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>

**2015**

**2009-2011**

**Target Recovery Reach**
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 2015.
Thomas Fork

This year was the seventh year of biological monitoring in Thomas Fork of Leading Creek, and macroinvertebrate scores at most sites were similar to those recorded for the past three years. Overall biological quality has been higher for the past three years than the “5’s” scored at most of the sites in 2009, 2011 and 2012. Improvements still have not attained statistical significance yet, but two sites, TF0050 and TF0015 earned new high scores of “10” and “11” this year.

Figure 2. Area of degradation 2009-2015

<table>
<thead>
<tr>
<th>Site</th>
<th>RM</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>Linear trends</th>
<th>R square</th>
<th>P-value</th>
<th>No. of years</th>
</tr>
</thead>
<tbody>
<tr>
<td>TF0090</td>
<td>7.9</td>
<td>9</td>
<td>13</td>
<td>12</td>
<td>11</td>
<td>14</td>
<td>14</td>
<td>12</td>
<td>no change</td>
<td>0.320076</td>
<td>0.185566</td>
<td>7</td>
</tr>
<tr>
<td>TF0050</td>
<td>5.5</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>6</td>
<td>10</td>
<td>no change</td>
<td>0.182857</td>
<td>0.338563</td>
<td>7</td>
</tr>
<tr>
<td>TF0038</td>
<td>5.0</td>
<td>5</td>
<td>11</td>
<td>7</td>
<td>5</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>no change</td>
<td>0.189922</td>
<td>0.328368</td>
<td>7</td>
</tr>
<tr>
<td>TF0030</td>
<td>4.3</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>5</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>no change</td>
<td>0.056882</td>
<td>0.606527</td>
<td>7</td>
</tr>
<tr>
<td>TF0015</td>
<td>2.56</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>no change</td>
<td>0.511624</td>
<td>0.110059</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>TF0010</td>
<td>1.2</td>
<td>5</td>
<td>12</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>no change</td>
<td>0.048193</td>
<td>0.636232</td>
<td>7</td>
</tr>
</tbody>
</table>
References

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


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

<table>
<thead>
<tr>
<th>Collection Period</th>
<th>Samples Collected</th>
<th>Duplicate Samples Collected</th>
<th>Blanks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/21/15-12/8/15</td>
<td>66</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

**Percent of Samples**
- Percent of Samples: 7.6%
- 7.6%
- 1.5%

**Percent Difference from Lab and Field**

<table>
<thead>
<tr>
<th>% Difference pH</th>
<th>% Difference Conductivity</th>
<th>Duplicate Samples Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0-59.2</td>
<td>0.1-55.0</td>
</tr>
<tr>
<td>Median</td>
<td>4.7</td>
<td>3.7</td>
</tr>
</tbody>
</table>

**Percent Difference of Duplicate Samples (5)**

<table>
<thead>
<tr>
<th>% Difference pH</th>
<th>% Difference Conductivity</th>
<th>% Difference Iron</th>
<th>% Difference Aluminum</th>
<th>% Difference Acidity</th>
<th>% Difference Alkalinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0.3-1.0</td>
<td>0-3.9</td>
<td>0.5-22.5</td>
<td>0-76.3</td>
<td>0.8-21.1</td>
</tr>
<tr>
<td>Median</td>
<td>0.3</td>
<td>0.3</td>
<td>2.3</td>
<td>2.5</td>
<td>5.1</td>
</tr>
</tbody>
</table>

Blanks (1)

Percent difference in the blank sample is 1.52%, showing little carryover.
## LEADING CREEK

<table>
<thead>
<tr>
<th>Collection Period</th>
<th>Samples Collected</th>
<th>Duplicates</th>
<th>Blanks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/20/15-12/4/15</td>
<td>27</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Percent of Samples

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Samples</td>
<td>14.8%</td>
</tr>
<tr>
<td></td>
<td>3.7%</td>
</tr>
</tbody>
</table>

#### Percent Difference from Lab and Field

<table>
<thead>
<tr>
<th>Leading Creek</th>
<th>% Difference pH</th>
<th>% Difference Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0.8-6.9</td>
<td>0.4-67.8</td>
</tr>
<tr>
<td>Median</td>
<td>3.5</td>
<td>4.5</td>
</tr>
</tbody>
</table>

#### Percent Difference of Duplicate Samples (3)

<table>
<thead>
<tr>
<th></th>
<th>% Difference pH</th>
<th>% Difference Conductivity</th>
<th>% Difference Iron</th>
<th>% Difference Aluminum</th>
<th>% Difference Acidity</th>
<th>% Difference Alkalinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0-3.2</td>
<td>0-71</td>
<td>3.7-166</td>
<td>3.9-172</td>
<td>7-102</td>
<td>0.28-46</td>
</tr>
<tr>
<td>Median</td>
<td>1.6</td>
<td>35.5</td>
<td>84.9</td>
<td>80</td>
<td>54.5</td>
<td>23.1</td>
</tr>
</tbody>
</table>

**Blanks (1)**

The one blank sample tested showed little carryover.
MONDAY CREEK

<table>
<thead>
<tr>
<th>Monday Creek</th>
<th>Collection Period</th>
<th>Samples Collected</th>
<th>Duplicate Samples</th>
<th>Blanks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/18/15 – 11/16/15</td>
<td>194</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Percent of Samples</td>
<td>-</td>
<td>-</td>
<td>4%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Percent Difference from Lab and Field

<table>
<thead>
<tr>
<th></th>
<th>% Difference pH</th>
<th>% Difference Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0-17.7</td>
<td>0-161.9</td>
</tr>
<tr>
<td>Median</td>
<td>2.1</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Percent Difference of Duplicate Samples (7)

<table>
<thead>
<tr>
<th></th>
<th>% Difference pH</th>
<th>% Difference Conductivity</th>
<th>% Difference Iron</th>
<th>% Difference Aluminum</th>
<th>% Difference Acidity</th>
<th>% Difference Alkalinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0-8.2</td>
<td>0-2.5</td>
<td>0-30.5</td>
<td>0-17.0</td>
<td>1.0-28.6</td>
<td>0-4.2</td>
</tr>
<tr>
<td>Median</td>
<td>0.5</td>
<td>0.3</td>
<td>2.7</td>
<td>2.7</td>
<td>4.9</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Blanks (3)

When one of the blank samples showed evidence of carryover, equipment was cleaned using the methods outlined in the QAQC manual.
RACCOON CREEK

<table>
<thead>
<tr>
<th>Raccoon Creek</th>
<th>Collection Period</th>
<th>Samples Collected</th>
<th>Duplicates</th>
<th>Blanks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/27/15 - 12/15/15</td>
<td>318</td>
<td>17</td>
<td>8</td>
</tr>
</tbody>
</table>

Percent of Samples

<table>
<thead>
<tr>
<th>Percent Difference from Lab and Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Difference pH</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Range</td>
</tr>
<tr>
<td>Median</td>
</tr>
</tbody>
</table>

Percent Difference of Duplicate Samples (17)

<table>
<thead>
<tr>
<th>% Difference pH</th>
<th>% Difference Conductivity</th>
<th>% Difference Iron</th>
<th>% Difference Aluminum</th>
<th>% Difference Acidity</th>
<th>% Difference Alkalinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0-2.4</td>
<td>0-4.0</td>
<td>0-3.2</td>
<td>0-10.4</td>
<td>0.5-26.4</td>
</tr>
<tr>
<td>Median</td>
<td>0.3</td>
<td>0.4</td>
<td>1.0</td>
<td>0.9</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Blanks (8)

Based on the data provided in the QAQC report, there appears to be little carryover.