PA DEP-BAMR Active Mine Drainage Treatment Facilities

Wildwood
Lancashire 15
Brandy Camp
Swamp Creek
B & T Mine 20
Hollywood
Little Toby and Coal Hollow
Rausch Creek
## PA DEP-BAMR Active Mine Drainage Treatment Facilities

<table>
<thead>
<tr>
<th>Facility</th>
<th>Stream Miles improved</th>
<th>Avg. Flow Treated (MGD)</th>
<th>Operation &amp; Maintenance Cost 2017</th>
<th>Cost Benefit Raito</th>
<th>Cost per 1000 gallons treated 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildwood</td>
<td>8</td>
<td>1.44</td>
<td>$10,848</td>
<td>63:1</td>
<td>$0.021</td>
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<tr>
<td>Lancashire</td>
<td>30</td>
<td>6.48</td>
<td>$468,400</td>
<td>2.9:1</td>
<td>$0.198</td>
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<td>Swamp Creek</td>
<td>na*</td>
<td>2.88</td>
<td>$8,675</td>
<td>87:1</td>
<td>$0.008</td>
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<tr>
<td>Hollywood</td>
<td>33</td>
<td>2.88</td>
<td>$670,248</td>
<td>4.2:1</td>
<td>$0.637</td>
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<tr>
<td>Little Toby</td>
<td>6</td>
<td>1.44</td>
<td>$265,060</td>
<td>1.9:1</td>
<td>$0.504</td>
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<tr>
<td>Brandy Camp</td>
<td>3.5</td>
<td>1.44</td>
<td>$263,499</td>
<td>1.1:1</td>
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<td>Rausch Creek</td>
<td>31</td>
<td>8.64</td>
<td>$420,204</td>
<td>6.3:1</td>
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<tr>
<td><strong>Total</strong></td>
<td>111.5</td>
<td>24.7</td>
<td>$2,106,934</td>
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<td>$0.234</td>
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</table>

* Treated effluent discharges to East Branch Clarion River ACOE Dam
<table>
<thead>
<tr>
<th>Facility</th>
<th>Year Constructed</th>
<th>Treatment Process</th>
<th>Capital Construction Cost</th>
<th>Capital Cost Adjusted to 2017 Cost*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildwood</td>
<td>1974</td>
<td>Hydrogen Peroxide / Pond Clarification</td>
<td>$214,884</td>
<td>$1,108,677</td>
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<tr>
<td>Lancashire</td>
<td>2011</td>
<td>Hydrogen Peroxide / HDS Clarifier</td>
<td>$12,887,512</td>
<td>$14,397,346</td>
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<tr>
<td>Swamp Creek</td>
<td>1970</td>
<td>Lime (CaOH²) Doser</td>
<td>$70,729</td>
<td>$526,401</td>
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<tr>
<td>Hollywood</td>
<td>2013</td>
<td>Lime (CaOH²) / HDS Clarifier</td>
<td>$14,608,912</td>
<td>$15,509,262</td>
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<tr>
<td>Little Toby</td>
<td>1996</td>
<td>Lime Slurry / Pond Clarification</td>
<td>$2,735,374</td>
<td>$5,301,959</td>
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<tr>
<td>Brandy Camp</td>
<td>2001</td>
<td>Hydrogen Peroxide, Lime Slurry / Pond Clarification</td>
<td>$2,481,339</td>
<td>$4,236,722</td>
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<td>Rausch Creek</td>
<td>1974</td>
<td>Lime (CaO) / Clarifier</td>
<td>$3,555,297</td>
<td>$18,343,274</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$36,554,047</strong></td>
<td><strong>$59,423,641</strong></td>
</tr>
</tbody>
</table>

* Capital cost adjusted to 2017 dollars using R.S. Means Construction cost indexes
Wildwood Treatment Facility

- Located in Harmar Township, Allegheny County (AML Problem Area, PA 4324)

- Facility constructed in 1974 by the Commonwealth under Operation Scarlift
  - Project Number SL 192-2
  - Capital Cost: $214,884

- Receiving Stream Sequence:
  - Willow Run to Pine Creek to Allegheny River

- Pine Creek is one of the few remaining Trout Stocked Fisheries in Allegheny County.
Wildwood Treatment Facility

- Upper Freeport Underground Mine operated by the Rochester and Pittsburgh Coal Company (R&P) - Abandoned in 1972

- Artesian alkaline - Iron discharge degraded ~ 8 miles of the receiving stream, Pine Run, a trout stocked fishery

Original system design:
- Atmospheric aeration using aeration trays
- 256'(l)x46'(w)x10'(d) sedimentation basin
- Design flow – 800 gpm
## Wildwood Treatment Facility

### Initial system performance

<table>
<thead>
<tr>
<th>Date: 1/16/1976</th>
<th>Influent</th>
<th>Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.80</td>
<td>7.10</td>
</tr>
<tr>
<td>Alkalinity (mg/l)</td>
<td>460</td>
<td>460</td>
</tr>
<tr>
<td>Total Iron (mg/l)</td>
<td>37.4</td>
<td>29.5</td>
</tr>
<tr>
<td>Dissolved Iron (mg/l)</td>
<td>35.8</td>
<td>22.6</td>
</tr>
<tr>
<td>Sulfate (mg/l)</td>
<td>619</td>
<td>619</td>
</tr>
<tr>
<td>Flow Rate (gpm)</td>
<td></td>
<td>2,800</td>
</tr>
</tbody>
</table>

- In 1977 the system was retrofitted to include a chemical oxidant.
- 50% hydrogen peroxide has been used at the site since that time.
Results of the peroxide addition redesign were published in July 1977 in WPCF Journal:

**Peroxoide oxidation of iron in coal mine drainage**

C. A. Cole  
The Pennsylvania State University, Middletown  
A. E. Molinski, N. Rieg  
Pennsylvania Department of Environmental Resources, Harrisburg  
F. Backus  
E. I. DuPont DeNemours & Co., Wilmington, Del.
## Current system performance

<table>
<thead>
<tr>
<th>Date</th>
<th>Influent</th>
<th>Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Alkalinity (mg/l)</td>
<td>390</td>
<td>371</td>
</tr>
<tr>
<td>Total Iron (mg/l)</td>
<td>9.9</td>
<td>1.52</td>
</tr>
<tr>
<td>Dissolved Iron (mg/l)</td>
<td>9.8</td>
<td>0.04</td>
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<tr>
<td>Sulfate (mg/l)</td>
<td>159</td>
<td>158</td>
</tr>
<tr>
<td>Flow Rate (gpm)</td>
<td></td>
<td>1,200</td>
</tr>
</tbody>
</table>

- Peroxide addition rate = 8.5 gal/day
- Annual cost @ $2.85/gal = $8,850
- Electrical cost 110v Peroxide pump = ~ $500/year

The treated mine discharge provides an additional benefit in that the constant temperature of the mine discharge (52°F) has allowed for the establishment of a 1.4 mile section of delayed harvest trout fishery on Pine Creek.
### Cost Benefit Analysis

<table>
<thead>
<tr>
<th>Receiving Stream</th>
<th>Miles Improved</th>
<th>Use Rate (1) Trips/mile/year</th>
<th>Value (2) $/trip</th>
<th>Economic Benefit (3)</th>
<th>Annual (4) Operation Cost</th>
<th>Benefit Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willow Run/ Pine Creek</td>
<td>8</td>
<td>1,100</td>
<td>$78.02</td>
<td>$686,576</td>
<td>$10,848</td>
<td>63 : 1</td>
</tr>
</tbody>
</table>

(1) Source: PA Fish & Boat Commission (PAFBC) internal Biologist interviews  
(2) Source: Recreational Use Loss Estimates for Pennsylvania Streams Degraded by AMD 2006 (PAFBC)  
(3) Economic Benefit = miles improved x use rate x valuation  
(4) 2017 Cost (Includes treatment chemical, electric, labor and sludge disposal costs)

- The treated mine discharge provides an additional benefit in that has allowed for the establishment of a 1.4 mile section of delayed harvest trout fishery on Pine Creek. The stream flows through North Park, a heavily visited Allegheny County recreational facility.
Lancashire 15 Site Background

• Located in Barr and West Carroll Townships, Cambria County and Pine Township, Indiana County.

• Surface and Underground Mining primarily on two coal seams – the Lower Kittanning “B” seam and the Lower Freeport “D” seam.

• Underground mining has been ongoing in the area for the past 100+ years.

• The shaded outlines on the map indicate “B” and “D” seam underground mines in the area.
There are 20 to 30 known mines and many more smaller mines.

Closures have been occurring since the 1920s.

The Lancashire 15 Mine opened in 1915 near the location of the current mine water treatment facility.

The Lancashire 15 Mine alone is approximately 6,600 acres or 10 square miles.

Mines that may contribute to the discharge encompass over 14,000 acres or more than 22 square miles.
Barnes & Tucker closed Lancashire 15 on July 14, 1969, (pumps shut off) and it began to flood.

A mine pool blowout occurred in late June 1970. The mine water breakout originated near the sealed entries of the Lancashire 15 mine and resulted in a major pollution event and fish kill on the West Branch Susquehanna River.

During the summer of 1970 the Commonwealth conducted emergency treatment operations.

- The upper right photo shows lime being end dumped into the West Branch to raise pH and neutralize acidity in the river.
- The lower right photo indicates tank trucks delivering sodium hydroxide (NaOH) which was used to adjust pH at the outlet of the Curwensville USACOE dam.
Upon remand from this Court, the Commonwealth Court made additional findings of fact and entered a final decree, which reads in pertinent part:

"2. For the purpose of avoiding repetition of such a breakout or the discharge of untreated acid mine water *122 from Mine No. 15 into the waters of the Commonwealth, a public nuisance; and until such time as the likelihood of a reoccurrence of another breakout is past, Barnes & Tucker Company shall cause to be pumped from Mine No. 15 sufficient quantities of mine water to avoid any such breakout and shall maintain a treatment program of the mine water discharge to achieve minimum water quality standards as prescribed by law pertaining to the discharge of acid mine water into the waters of the Commonwealth.

3. Expenses incurred by the Commonwealth in the operation and maintenance of the Duman Dam pumping and treatment facility or sums paid by the Commonwealth to Barnes & Tucker incident to the operation of said pumping and treatment facility by Barnes & Tucker during the course of this litigation as prescribed in our prior Orders of April 13, 1971, June 7, 1973 and September 20, 1974, shall be entered as a money judgment in favor of the Commonwealth and against Barnes & Tucker Company."
Lancashire 15 Site Background

- Original treatment facility, known as the Duman Plant, was located in Barr Township, Cambria County (AML Problem Area, PA 4090).

- Facility constructed by Barnes and Tucker Coal Company (B&T) in 1966.

- B&T pumped and treated the mine water until bankruptcy (September 2001). The Commonwealth then took over treatment.
The Duman Facility was located in the deepest portion of the Lancashire 15 Mine. Very high pumping and electrical costs.

Pumped and treated about 9.4 million gallons per day (mgd) (6,500 gallons per minute) in order to control the mine pool.

Discharged water (7 - 8 mgd) to tributaries of Blacklick Creek (Elk Creek).

Water quality:
- pH ~ 6.5
- Alkalinity ~ 130 mg/L
- Dissolved Iron ~ 40 mg/L (mainly ferrous)
- Manganese < 1.0 mg/L
- Sulfate ~ 378 mg/L
Lancashire 15 Site Background

Rationale for moving the Treatment Plant

• The pumps, Plant and entire system were ~ 40 years old and antiquated.

• A new plant at the selected location would not have to pump from such a great depth (capital cost and energy savings) and would employ newer more efficient technology (VFDs, HDS design, etc.).

• The Susquehanna River Basin Commission (SRBC) expressed interest in having the treated effluent discharged to the West Branch for flow augmentation and consumptive use needs and provided funding which would provide partial coverage of the treatment costs.
Lancashire 15 Treatment Facility

• In 2011 a new hydrated lime treatment facility was constructed to replace the original Barnes and Tucker system.

• The treatment process includes:
  • Pre-aeration to exsolve $\text{CO}_2^{(aq)}$ from raw mine water
  • Dense sludge recirculation
  • Polymer addition

• Tradeoff was that net acidic water would be encountered for at least a period of time at the new plant location given that pumping would occur in more shallow portions of the mine pool.
Location: Barr Township, Cambria County

Official Start Date: October 30, 2009

Completion Date: June 17, 2012

Treatment Start Date: November 2011

Contractor: HRI, Inc.

Property Owner: Clean Streams Foundation, Inc.

Project Cost: $12,887,517.42

Project Area: 22.4 Acres
By the summer of 2013, the initial net acidic influent became net alkaline. The hydrated lime ($\text{Ca(OH)}_2$) treatment process was still effective at meeting effluent goals. However;

- Under normal flow conditions (4,000 to 5,000 gallons per minute)
  - 5 tons/day of $\text{Ca(OH)}_2$ were needed to meet plant effluent goals
  - Current hydrated lime cost is $160/ton
  - Lime product costs have risen significantly over the past 5 years and are likely to continue to do so

- Evaluation showed that only 36% of the lime added was being consumed by pH and mineral (iron) acidity reactions

- Remaining lime consumed by nuisance reactions
  - Calcite formation – 29%
  - CO2 and hydroxylation acidity – 35%
Alternative treatment: Hydrogen Peroxide ($\text{H}_2\text{O}_2$)

- Near instantaneous iron oxidation without pH adjustment
- No nuisance reactions
- Only minor plant modifications required
- Additional electrical and sludge disposal savings
U.S. Peroxide “Turn Key” System

- All capital equipment and installation provided
- 90 day trial period with option to extend 1 year at current cost
Lancashire 15 Alternative Treatment Strategies

- Site testing began September 9, 2013. Operated at 4,000 gpm under varied polymer and sludge return rates
- October 23 to November 6 operated at plant design capacity 7,000 gpm
- Currently operating at 4-5,000 gpm
# Lancashire 15 Site Effluent

<table>
<thead>
<tr>
<th>CaOH$_2$</th>
<th>H$_2$O$_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH 8.1 – 8.5</td>
<td>pH 7.0 – 7.6</td>
</tr>
<tr>
<td>Total Fe 1.0 – 1.6 mg/l</td>
<td>Total Fe 0.3 – 1.5 mg/l</td>
</tr>
<tr>
<td>TDS 650 – 700 mg/l</td>
<td>TDS 600 – 640 mg/l</td>
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</tbody>
</table>
Lancashire 15 Site Summary

Hydrogen peroxide re-design

• Superior performance under all tested conditions

• Reduced plant maintenance

• Significant sludge volume reduction

• Likely need to use lime under extended drawdown conditions
Lancashire Site Summary

Annual Operation and Maintenance Cost 2017:

- Electrical*: $280,000
- Chemical: $100,500
- Labor: $ 88,000

* Sludge disposal included in electrical cost

Peroxide Treatment Cost Savings

- Annual Chemical Cost Savings - $182,500
- Annual Electrical Cost Savings - $30,000
- Total Cost Reduction - $212,500/year
Lancashire 15 Treatment Facility

Cost Benefit Analysis

<table>
<thead>
<tr>
<th>Receiving Stream</th>
<th>Miles Improved</th>
<th>Use Rate (1)</th>
<th>Value (2) $/trip</th>
<th>Economic (3) Benefit</th>
<th>Annual (4) Operation Cost</th>
<th>Benefit Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB Susquehanna River</td>
<td>18</td>
<td>306</td>
<td>$58.61</td>
<td>$1,352,688</td>
<td>$468,400</td>
<td>2.9 : 1</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1,100</td>
<td>$78.02</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

(1) Source: PA Fish & Boat Commission (PAFBC) internal Biologist interviews
(2) Source: Recreational Use Loss Estimates for Pennsylvania Streams Degraded by AMD 2006 (PAFBC)
(3) Economic Benefit = miles improved x use rate x valuation
(4) 2017 Cost (Includes treatment chemical, electric, labor and sludge disposal costs)

- Additionally, the treated mine discharge provides for Q 7/10 low flow augmentation and consumptive use needs in the Susquehanna River Basin
We conducted fish surveys on the upper West Branch Susquehanna River as well as on several tributaries over the past week. We documented considerably more wild trout in the West Branch as compared to our 2012 surveys, including both wild brook and brown trout populations. The extent of the wild trout appear to be from the Lancashire 15 AMD treatment plant outflow downstream to Shryock Run. This represents a significant increase in length as compared to our 2012 surveys. No trout were collected above the treatment plant; we did pick up a couple white suckers and creek chubs which was similar to 2012. We also sampled several tributaries to the West Branch, three of which exceeded Class A biomass criteria. Pretty amazing given the historic land use and impacts these streams have endured. We have several more tributaries to sample this year and will provide an update upon completion. Please extend my thanks to BAMR staff as the AMD treatment plant has successfully improved water quality in the West Branch to the point that it is supporting wild brook and brown trout. Of particular note is the cold water temperatures the plant is providing. Our sample site located about one mile downstream of the treatment plant had a water temperature of 59F yesterday; this cold water is undoubtedly responsible for the river’s ability to support wild trout downstream to the Shryok Run area.

Thanks,
Jason

Jason Detar
Area 3 Fisheries Manager
Pennsylvania Fish and Boat Commission
Lancashire 15 Treatment Facility

WT AJ TV Our Town Video
• Located in West Carroll Township Cambria County (AML Problem Area, PA 0824)

• Facility constructed by Barnes and Tucker Coal Company in 1966 in response to amendments to PA Clean Streams Law

• Receiving Stream Sequence:
  • Headwaters West Branch Susquehanna River
• DEP assumed treatment obligation as part of the Barnes & Tucker Coal Co. Bankruptcy (2001)

• Plant influent quality and quantity varies seasonally; 30 to 250 gpm; net acidic at low flow, net alkaline at normal and high flow conditions
• Current treatment system uses calcium oxide (quicklime CaO) in an antiquated silo mix tank configuration

• System upgrades are currently being implemented to increase retention time and treat the discharge passively during the periods of the year that the influent is net alkaline
Swamp Creek Treatment Facility

- Located in Jones Township, Elk County (AML Problem Area, PA 0418)

- Facility constructed by the Commonwealth of PA under Operation Scarlift in 1970
  - Project No. SL 106-3
  - Capital Cost: $70,729.50

- Treating AMD from several AML problem areas in the headwaters of Swamp Creek, which then flows directly to the USACOE East Branch Flood Control Dam and the East Branch of the Clarion River
The Swamp Creek Treatment Facility consists of a hydrated lime silo with an automatic feed control. The Plant doses Swamp Creek with hydrated lime.

The lime silo was updated with a new electrical unit, auger and automation in 2007.

Capable of treating an average flow rate of up to 2,000 gallons per minute (gpm) and a maximum flow of 7,000 gpm.

The acidity neutralization rate for the system is approximately 315 pounds per day.

Upstream of the Plant, Swamp Creek has a pH of 4.0, acidity of 30 to 50 mg/L and approximately 1 mg/L to 5 mg/L iron.
Swamp Creek Treatment Facility

Prior to the 1970 construction of this facility most of the East Branch Lake was lifeless, particularly the Swamp Creek lobe, which received the most direct input from Swamp Creek.

The Swamp Creek Treatment Plant allows aquatic life to exist in a large portion of the East Branch Dam. A tourist and recreational fishing industry flourishes around the lake.
## Cost Benefit Analysis

<table>
<thead>
<tr>
<th>Receiving Stream</th>
<th>Miles Improved</th>
<th>Use Rate (1) Trips/year</th>
<th>Value (2) $/trip</th>
<th>Economic (3) Benefit</th>
<th>Annual (4) Operation Cost</th>
<th>Benefit Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swamp Creek / East Branch Dam</td>
<td>n/a</td>
<td>240,000</td>
<td>n/a</td>
<td>$750,000</td>
<td>$8,675</td>
<td>87 : 1</td>
</tr>
</tbody>
</table>

(1) Source: USACOE reporting  
(2) Source: American Fisheries Society Report (1992)  
(3) ACOE studies have attributed 75 – 80% of the iron loading occurring in the Lake to Swamp Creek prior to installation of the Plant. ACOE estimates that the annual economic benefit from the dam and recreational facilities is 3 million dollars, of which 1 million dollars is attributed to fishing. Therefore, the annual economic benefit of the Swamp Creek Treatment Plant is $750,000  
(4) 2017 Cost (Includes treatment chemical, electric and labor costs)
Hollywood Treatment Facility

- Located in Huston Township, Clearfield County and Jay Township, Elk County (Main AML Problem Area, PA 1416)

- Facility constructed by the Commonwealth of PA in 2013
  - Project No. AMD 17(1416)202.1
  - Capital Cost: $14,608,912.68

- Receiving Stream Sequence:
  - Bennett Branch Sinnemahoning Creek
  - Sinnemahoning Creek
  - West Branch Susquehanna River

- Treating AMD from 20 mine seals, 2 seeps and 2 horizontal boreholes
Location: Village of Hollywood, Huston Township, Clearfield County and Jay Township, Elk County (South side of State Route 255)

Official Start Date: July 1, 2010

Completion Date: August 27, 2013

Treatment Start Date: March 2013

Contractor: Kukurin Contracting, Inc.

Project Cost: $14,608,912.68

Project Area: 41 Acres
The Bennett Branch is a wild and scenic river that was significantly degraded as a result of the adverse impacts of acid mine drainage.

Mine drainage problems are localized to three distinct areas of the watershed.

The Hollywood Treatment Facility in combination with AML Reclamation and AMD Source Remediation Projects have resulted in the restoration of over 33 miles of the main stem of the Bennett Branch.
• The facility treats an average of 4,000 gpm of mine drainage from 20 separate discharges originating in 4 different underground mine complexes

• Collection system major components:
  • 19,836 feet of conveyance pipelines
  • Horizontal directional boreholes (HDD) to control and direct mine pool water from the Proctor No. 2 Mine to the treatment facility
  • 2 mine dewatering pumps
  • 3 mine water pump stations
  • 20 wet mine seals
Hollywood Treatment Facility

• The facility has a treatment capacity of up to 10 million gallons per day (7,000 gallons per minute) utilizing a hydrated lime high density slurry system that includes sludge recirculation technology (HDS)

• Major Treatment Components
  • 2 Ferrous oxidation reactors
  • 180-foot diameter clarifier
  • 2 Sludge conditioning reactors
  • 4.5-Acre polishing pond
Cost Benefit Analysis

<table>
<thead>
<tr>
<th>Receiving Stream</th>
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</thead>
<tbody>
<tr>
<td>Bennett Branch</td>
<td>33</td>
<td>1100</td>
<td>$78.02</td>
<td>$2,832,126</td>
<td>$670,248</td>
<td>4.2: 1</td>
</tr>
</tbody>
</table>

(1) Source: PA Fish & Boat Commission internal Biologist interviews  
(2) Source: Recreational Use Loss Estimates for Pennsylvania Streams Degraded by AMD 2006  
(3) Economic Benefit = miles improved x use rate x valuation  
(4) 2017 Cost (Includes treatment chemical, electric, labor and sludge disposal costs)

- Additionally AML Remediation and AMD Source abatement projects have improved water quality in a number of tributaries in the Bennett Branch Watershed (Mill Run, Tyler Run, Caledonia Run, Dents Run, etc.)
Hollywood Treatment Facility

BENNETT BRANCH RESTORATION VIDEO
Little Toby/Coal Hollow Treatment Facilities

- Located in Fox Township, Elk County (Little Toby AML Problem Area, PA 0964, Coal Hollow AML Problem Area, PA 0968)

- Both facilities constructed by the Commonwealth in 1996
  - Project Nos. SL 132-5-106.11,12,13,14, 107.1 and 108.1
  - Capital Cost: $2,735,374.24

- Receiving Stream Sequence:
  - Little Toby Creek
  - Clarion River

- The Bureau of Abandoned Mine Reclamation has been an active partner in restoring water quality within the Toby Creek and Clarion River Watersheds for more than 50 years.
Work began in the late 1960s with a comprehensive study of the Little Toby Creek watershed identifying major sources of pollution within the watershed. This study was funded under “OPERATION SCARLIFT,” a $200 million state bond issue that was initiated in 1968 and which was a first of its kind program in the nation.

Nearly $4 million worth of studies and reclamation projects designed to eliminate past mining problems and improve the water quality in the local watersheds were implemented during the first 15 years of the program.

Construction of the Little Toby Creek Limestone Run Treatment Plant was completed in 1996 and was funded with Scarlift monies.

This Plant has greatly improved the water quality within Toby Creek and the Clarion River. Fish are stocked in waters that were previously lifeless due to the devastating effects of acid mine drainage.
• At Toby an average of 500 gallons per minute (gpm) of mine drainage from three separate source locations is treated. The Coal Hollow facility treats an additional average 500 gpm flow from an upstream AMD source.

• Both facilities originally employed a treatment approach that utilized high calcium limestone fines.

• The initial design involved the use of water-powered rotating drums to pulverize limestone fines and mix with the mine water influent. In addition flushable beds of limestone fines were also used at the Toby Plant.
Little Toby/Coal Hollow Treatment Facilities

• Both technologies, rotating drums and static downflow limestone beds, proved to be problematic in terms of sludge generation and mechanical reliability.

• Within five years the treatment process was changed. Bagged hydrated lime (CaOH$_2$) was used exclusively as the treatment reagent at the Toby Plant.

• The Coal Hollow facility was converted to use liquid sodium hydroxide (NaOH).

• In 2010 premix hydrated lime slurry product replaced the use of bagged hydrated lime at the Toby Plant.
• A trial study had been conducted at the Plant using a calcium hydroxide premix slurry product from December 11, 2009, through January 28, 2010.

• The trial results have shown several advantages over bagged lime:
  • A more consistent slurry feed rate resulted in improved water quality results.
  • The premixed lime slurry proved to be 25 percent more efficient than the existing bagged lime.

• A 7,000 gallon slurry tank equipped with mixer and pump was installed at the Plant.
### Little Toby/Coal Hollow Treatment Facilities

#### Cost Benefit Analysis

<table>
<thead>
<tr>
<th>Receiving Stream</th>
<th>Miles Improved</th>
<th>Use Rate (1) Trips/miles/year</th>
<th>Value (2) $/trip</th>
<th>Economic Benefit (3)</th>
<th>Annual (4) Operation Cost</th>
<th>Benefit Cost Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Toby Creek</td>
<td>6 *</td>
<td>1,100</td>
<td>$78.02</td>
<td>$514,932</td>
<td>$265,060</td>
<td>1.9 : 1</td>
</tr>
</tbody>
</table>

(1) Source: PA Fish & Boat Commission internal Biologist interviews  
(2) Source: Recreational Use Loss Estimates for Pennsylvania Streams Degraded by AMD 2006  
(3) Economic Benefit = miles improved x use rate x valuation  
(4) Includes treatment chemical, electric, labor and sludge disposal costs

* In conjunction with the Brandy Camp Treatment facility, over 24 miles of the downstream portions of Little Toby Creek have been improved to support a recreational fishery.
• Located in Horton Township, Elk County (AML Problem Area, PA 6134)

• Constructed by the Commonwealth in 2001
  • Project Nos. OSM 24(6134)101.1 thru 104.1
  • Capital Cost: $2,481,339.98

• Receiving Stream Sequence:
  • Brandy Camp Creek
  • Little Toby Creek
  • Clarion River

• A number of treatment process modifications have occurred at the facility since its initial construction.
Brandy Camp’s original configuration was a lime silo, settling pond and polishing wetland. It was designed to treat up to 700 gallons per minute.

There were problems with the settling pond filling with sludge much quicker than anticipated. Contributing factors included:
  • Inherent lime treatment inefficiencies
  • Higher than expected flows
  • Sludge density less than anticipated

A belt filter press was added to help dispose of the sludge. These presses mechanically dewater the sludge facilitating transport and disposal.
• Additional Plant upgrades including inclined plate settlers, polymer mixers, storage tank, etc. were introduced with the purpose of facilitating sludge handling and disposal.

• Ironically, the belt filter press and other components of the operation worked best when more lime than chemically needed was added to the front end of the treatment system.

• The amount of time the press was operated was limited to about 1/4 of the total Plant operating hours in a day; the increased lime addition to make better sludge more than offset the sludge volume taken out of the system by the press.
In 2008 and 2009 BAMR and OSM conducted hydrogeologic investigations of underground and surface mines that are hydrologically connected to the discharge.

The purpose was twofold:
- Investigate the potential to reduce surface and unaffected groundwater inflow to the mine complex.
- Determine potential locations within the hydrologically-connected underground mines for the injection of iron sludge.

Both objectives were realized and recommendations that were provided have resulted in significant improvement in Plant performance that have lowered operational costs.
- An upper seam mine pool containing good quality water was daylighted thus eliminating the former contribution to the discharge.
- Areas of this same upper seam mine complex conducive for treatment sludge injection were found and developed.
• In 2012 Brandy Camp was operated using a combination of bulk hydrated lime, hydrogen peroxide and hydrated lime slurry in order to help determine the most efficient and cost effective mode of operation.

• The trial study indicated:
  • Hydrogen peroxide efficiently utilized the limited alkalinity that is present in the raw AMD oxidizing the majority of the iron without raising the pH of the solution.
  • As the peroxide oxidizes the ferrous iron to ferric, the mineral acidity liberated lowers the pH of the solution making the dissolution of lime after peroxide addition more efficient.
  • Premanufactured hydrated lime slurry offered significant operational advantages over the existing bulk lime slurry system.

• In 2015 Brandy Camp was upgraded to include hydrogen peroxide pretreatment and premanufactured lime slurry systems.
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<th>Economic Benefit (3)</th>
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<th>Benefit Cost Ratio</th>
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<tbody>
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<td>$300,377</td>
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</tbody>
</table>

(1) Source: PA Fish & Boat Commission internal Biologist interviews  
(2) Source: Recreational Use Loss Estimates for Pennsylvania Streams Degraded by AMD 2006  
(3) Economic Benefit = miles improved x use rate x valuation  
(4) 2017 Cost (Includes treatment chemical, electric, labor and sludge disposal costs)

* In conjunction with the Little Toby Creek Treatment facilities, over 24 miles of the downstream portions of Little Toby Creek have been improved to support a recreational fishery.
Rausch Creek Treatment Facility

• Located in Hegins Township, Schuylkill County (AML Problem Area, PA 4124)

• Facility constructed by the Commonwealth of PA in 1974
  • Project No. SL 112-1
  • Capital Cost: $3,555,297.63

• Receiving Stream Sequence:
  • Rausch Creek
  • Pine Creek
  • Mahantango Creek
  • Susquehanna River

• The Rausch Creek facility is an on-stream plant. Rausch Creek is intercepted and diverted into the treatment plant.
• There are large abandoned mine pools in the Watershed of Rausch Creek. They are known as Brookside, Good Spring No. 1, Good Spring No. 3, Markson and Williamstown-Lykens. Abandoned mine drainage discharges provide the bulk of the base flow in the headwaters of Rausch Creek.

• The Rausch Creek Treatment Facility was placed in operation during April 1974 and has been in continuous operation since that time.

• The Facility is capable of treating a maximum flow of 16 million gallons per day. Excess streamflow is by-passed around the plant and neutralized with lime slurry.
The acidic waters taken into the plant flow into a 17 x 17 foot flash mixer where the water is mixed with lime slurry made from calcium oxide (CaO).

The neutralized water then flows into two aeration tanks where it is aerated for 30 minutes in order to oxidize the iron. At the effluent of the aeration tanks, a polymer is added.

The aerated water then passes into two 90-foot diameter clarifiers where the solids settle out.
• The clear water flows into two large polishing lagoons for further settling and then back into Rausch Creek.

• Sludge from the clarifiers is pumped into a thickener where it is dewatered to approximately 2.5% solids. It is then pumped to drying beds and periodically hauled from the beds to an offsite disposal area.

• The Facility provides for restoration of a total of 31 miles of streams from the Susquehanna River eastward to Rausch Creek.
### Rausch Creek Treatment Facility

#### Cost Benefit Analysis

<table>
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<tr>
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<tbody>
<tr>
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</table>

(1) Source: PA Fish & Boat Commission internal Biologist interviews  
(2) Source: Recreational Use Loss Estimates for Pennsylvania Streams Degraded by AMD 2006  
(3) Economic Benefit = miles improved x use rate x valuation  
(4) 2017 Cost (Includes treatment chemical, electric, labor and sludge disposal costs)

- The 31 miles include eight miles of Pine Creek and 23 miles of Mahantongo Creek, which are periodically stocked with trout and provide two of the best recreational fishing streams in the area.