



Muddy Creek Watershed, West Virginia

Permitted-In-Stream Approach

Overview

The Muddy Creek watershed, located in Preston County, West Virginia, has been historically impacted by acid mine drainage. Although the West Virginia Department of Environmental Protection (DEP) Office of Special Reclamation (OSR) has treated individual point sources of acid mine drainage in the past, this approach has proved unsuccessful at improving water quality. As a result, OSR is implementing an approach to treat all sources of acid mine drainage in the watershed simultaneously using an in-stream treatment system.

West Virginia DEP’s Division of Mining and Reclamation has facilitated this approach by adopting a water quality standards variance and establishing a watershed-based National Pollutant Discharge Elimination System (NPDES) permit, which superseded four individual NPDES permits for bond forfeiture mining facilities. Through this unique approach, OSR is restoring the Muddy Creek watershed and tributary waters downstream.

This case study focuses on the watershed-based approach to address acid mine drainage in the Muddy Creek watershed, as well as the Muddy Creek Watershed NPDES Permit (Permit No. WV1029380), which authorizes OSR to operate an in-stream system and discharge treated wastewater and stormwater runoff from multiple mines sites to surface waters in the Muddy Creek watershed.

Watershed

Muddy Creek, West Virginia

Key Water Quality Concerns

Total Nitrogen

Stakeholder Involvement Techniques

- Formed work group with federal and state agencies
- Collaborated with Friends of the Cheat, West Virginia Water Research Institute, and Office of Abandoned Mine Lands and Reclamation to obtain data and perform pilot studies

Case Study Issues of Interest

Type of Point Sources



Industrial Process Wastewater Discharges

Type of Watershed-Based Permit or Approach



Multisource Watershed-Based Permit

Highlighted Approach(es)



Coordinated Watershed Monitoring

Background

West Virginia has nearly 2,500 miles of streams that are polluted by acid mine drainage. The Muddy Creek watershed encompasses 21,487 acres in northern West Virginia. Impairments in the watershed include iron, aluminum, and pH, primarily resulting from contamination from coal mines and acid mine drainage. Contamination can come from both historically abandoned (pre-1977) mines and mines that had their permits revoked and bonds forfeited since enactment of the Surface Mining Control and Reclamation Act of 1977. Muddy Creek is a healthy trout fishery upstream of its confluence with Martin Creek, and also supports sensitive macroinvertebrates. However, partially due to two large mine blowouts in the mid-1990s, the lower 3.4 miles of Muddy Creek have remained uninhabitable for aquatic life.

OSR is responsible for treating acid mine drainage resulting from bond forfeiture sites and is required to obtain NPDES permits for surface water discharges from those sites. Traditionally, OSR has obtained individual permits for each mine site to treat pollution at the source. However, this approach has been less effective and more expensive than anticipated. As OSR treated the acid mine drainage water from the forfeiture sites, pollution from pre-1977 abandoned mines continued to enter the watershed, negating any progress made toward restoring the water quality.

To improve the effectiveness and efficiency of the state's acid mine drainage treatment and help restore the watershed, OSR developed an alternative strategy to remediate pollution from these sites using in-stream treatment methods. As part of this "permitted-in-stream" strategy, the Division of Mining and Reclamation issued a watershed-based permit that established one compliance point located at the mouth of Martin Creek. The watershed-based permit, in conjunction with a water quality standards variance, allows OSR to address both pre- and post-1977 acid mine drainage at the same time, thereby increasing the potential for meaningful water quality restoration in the watershed.

West Virginia DEP first presented the strategy to EPA in 2014, and representatives from West Virginia DEP's Division of Mining and Reclamation and Division of Water and Waste Management, EPA Region 3, and EPA Headquarters formed a work group. The primary role of the work group was to determine an approach for making significant water quality improvements within the NPDES permitting program framework.

In addition to forming the work group, West Virginia DEP collaborated with the Friends of the Cheat watershed group and the Office of Abandoned Mine Lands and Reclamation to obtain water quality data from the watershed. West Virginia DEP also worked with the West Virginia Water Research Institute to conduct a pilot study to determine the most efficient placement for instream dosers within the watershed.

Permit Strategy

To be effective, the permitted-in-stream approach requires a water quality standards variance and novel acid mine drainage treatment methods. OSR developed and is implementing a watershed monitoring and assessment plan to determine the efficacy of the in-stream treatment methods and overall health of the watershed.

Water Quality Standards Variance

In June 2016, the West Virginia Legislature approved revisions to the state's water quality standards rule in Title 47 Series 2 of the Code of State Rules (47CSR2), which included a water quality standards variance for Martin Creek in the Muddy Creek watershed.

The variance, which EPA approved in 2017, establishes in-stream interim criteria for Martin Creek, including a pH range of 3.2 to 9.0 standard units, 10 milligrams per liter (mg/L) of total iron, and 15 mg/L of dissolved aluminum. The variance also requires OSR to implement alternative restoration measures to achieve significant improvements to existing conditions in these waters during the variance period. Throughout the variance period, West Virginia DEP is required to evaluate conditions within Martin Creek during each triennial review. The variance will remain in effect until the West Virginia DEP secretary acts to revise the variance or July 1, 2025, whichever comes first.

During the variance period, water quality at the mouth of Martin Creek is expected to meet the interim water quality criteria for iron, aluminum, and pH due to the in-stream treatment at the headwaters. Once fully implemented, the in-stream treatment and other restoration measures implemented during the variance term are expected to restore the designated use of the lower 3.4 miles of Muddy Creek.

In-Stream Treatment Methods

OSR's alternative approach includes new methods of acid mine drainage treatment. These methods involve collecting and treating pre- and post-1977 mine water at a new treatment facility, the T&T Treatment Facility, while simultaneously treating in-stream.

The T&T Treatment Facility, constructed along Muddy Creek past the confluence of Martin Creek, began operation in March 2018. The facility treats multiple sources of acid mine drainage, including 300 gallons per minute from large bond forfeiture sources (i.e., T&T Fuels, Viking Coal, Rockville Mining, Preston Energy, Mary Ruth Coal) and 250 gallons per minute from the headwaters of Fickey Run. The facility is a high-density lime slurry system and consists of two 80-foot clarifiers, a lime slurry feed system, and a mixing tank for treating contaminated water. During the treatment process, the 100-ton lime slurry system feeds dry hydrated lime into a mix tank where a 35 percent lime slurry solution is mixed and pumped to the application point. The water then enters the two clarifiers, where metal precipitates become insoluble and fall to the bottom. The treated water from the clarifiers is discharged to Muddy Creek. The facility can treat up to 6 million gallons per day and allows for remote operation and control.

The lime-laden sediment, or sludge, from the clarifiers is pumped to the T&T 3 Mine. The alkaline sludge treats the water within the mine by making the initial discharge from the mine less acidic. The deep mine void also provides retention during storm events, allowing OSR to treat and retain stormwater until water flow returns to normal levels.

In October 2018, OSR began operating two in-stream lime dosers upstream of the permit compliance point to treat acid mine drainage in-stream, one in Martin Creek and the other in Glade Run, a tributary to Martin Creek. The dosers disperse a 35 percent lime slurry directly into the stream, neutralizing the acidity and improving water quality downstream. When selecting the locations for the dosers, OSR considered 1) accessibility to bring in new lime and perform maintenance, 2) sufficient flows to allow for mixing of the lime, 3) cooperation of landowners, and 4) the location of the acid mine drainage to ensure maximum obtainable treatment efficiency

Permit Components

Effluent Limitations and Monitoring Requirements

The permit includes effluent limitations for pH, iron, and aluminum consistent with the interim water quality criteria established in the water quality standards variance. The effluent limitations must be achieved at Outlet 001, located at the mouth of Martin Creek.

The permit requires monthly monitoring for flow, pH, iron, and aluminum at Outlet 001. OSR must report monitoring results in quarterly discharge monitoring reports.

Special Conditions

The permit requires OSR to conduct benthic macroinvertebrate and fish surveys in the Muddy Creek watershed at the tributary mouths, in accordance with the monitoring and assessment plan submitted with the water quality standards variance. Following the startup of the permanent in-stream dosers and the T&T Treatment Facility, OSR must conduct benthic macroinvertebrate surveys every six months for a period of two years. After two years, benthic macroinvertebrate surveys must be conducted on an annual basis. OSR must conduct fish surveys six months and 18 months after the startup of the permanent in-stream dosers and the T&T Treatment Facility, and every two years thereafter. The Division of Water and Waste Management compiles the results of the benthic macroinvertebrate and fish surveys and provides them to Water Quality Standards program staff for use in the triennial review of the variance.

Factors Considered During Permit Development

Improved Efficiency

Before implementing the watershed-based approach, OSR had constructed nine active treatment sites and one passive treatment system within the Muddy Creek watershed. OSR still needed to construct three additional sites. The total capital cost for water treatment construction was approximately \$3.4 million. OSR also spent more than \$10 million in operation and maintenance costs using the at-source treatment approach.

In addition, OSR had to maintain and monitor 10 NPDES outlets in Muddy Creek. Without an alternative treatment approach, OSR was scheduled to spend an additional \$1.6 million to retrofit seven existing treatment sites and construct two new sites within Martin Creek and its tributaries. By addressing treatment in-stream instead of at the source, OSR is able to use funds more efficiently while also reducing the number of NPDES permits.

Increased Effectiveness

One of the primary issues with treating acid mine drainage at the source was that it only treated water from bond forfeiture sites, neglecting water from pre-1977 abandoned mines. Discharges from bond forfeiture sites only account for approximately 16 percent of the acid mine drainage loads to Martin Creek. Therefore, the majority (84 percent) of acid mine drainage from the pre-1977 abandoned mines continued to pollute Martin Creek, negating any progress made by treating the bond forfeiture sites individually. By treating in-stream, OSR is able to treat both the pre-1977 abandoned mine water and the bond forfeiture mine water. This has improved the effectiveness of treatment while simultaneously allowing OSR to more efficiently utilize its funds.

Permit Effectiveness

Since the October 2018 startup of the in-stream dosers and the T&T Treatment Facility, water quality in Muddy Creek has been improved. Biological connectivity has been reestablished throughout its 15.6-mile length, with freshwater trout and early signs of aquatic life beginning to emerge. In addition, West Virginia DEP staff reports there has been an increase in the amount of people using Muddy Creek for recreational activities, such as kayaking and canoeing.

As reported in the 2020 *Muddy Creek Watershed Biological Monitoring Status Report*, concentrations of iron and aluminum have decreased dramatically since treatment began, and pH is now within the optimal range. Water quality data from before and after commencement of treatment through the permitted-in-stream approach showed a roughly 90 percent reduction in total iron and a 43 percent reduction in total aluminum at the mouth of Fickey Run. The average pH has also increased from 3.75 standard units to 7.08 standard units at the mouth of Muddy Creek.

The watershed-based permit has enabled OSR to spend state funds for demonstrated improvements in water quality throughout the watershed instead of treating at the point source with no net gains in water quality.

Lessons Learned

According to West Virginia DEP staff, the most challenging aspect of the permitting approach was explaining the reasoning for the variance to the public and educating people who were not familiar with abandoned mine drainage treatment.

When asked if the watershed-based permitting approach in the Muddy Creek watershed could be applicable to other watersheds, West Virginia DEP staff indicated that it could be, depending on the severity of abandoned mine drainage in the watershed and the watershed's specific characteristics. All watersheds are different and present their own complexities. Improving the aquatic ecology of a particular stream segment or reach must be at the forefront of strategizing and goal setting. Other candidate watersheds for in-stream treatment would receive significant drainage from pre-1977 abandoned mine lands; have ideal in-stream levels for pH (4–6 standard units), iron (<5 mg/L), aluminum (<3 mg/L), and acidity (<100 mg/L); and have a total in-stream treatment length greater than 18 miles.

Resources

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Sheehan, M. and P. Ziemkiewicz. 2017. *Assessing the Benefits of At-Source vs. In-Stream Treatment: Implications for Managing Water Liabilities Under the WVDEP's Bond Forfeiture Program*. Joint Conference of the American Society of Mining and Reclamation and Appalachian Regional Reforestation Initiative. https://wvmdtaskforce.files.wordpress.com/2017/05/2017-sheehan_mon-230.pdf.

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Permit Information:

Permit: NPDES No. WV1029380

Pollutants of Concern in Watershed:

Iron, aluminum, and pH

Pollutants Addressed in Permit:

Iron, aluminum, and pH

Permit Issued:

July 29, 2019