

**AML Site 1820  
Buttermilk Highwalls  
Patoka Township, Pike County, Indiana**

**Submitted By**

Indiana Department of Natural Resources, Division of Reclamation, Abandoned Mine Land  
Program

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**Project Information**

Construction Start Date: February 1, 2018  
Construction Completion Date: October 8, 2018  
Design Estimate: \$1,814,159.44  
Construction Costs: \$1,191,086.62

**Organizations Responsible for Reclamation**

Indiana Department of Natural Resources, Division of Reclamation, Abandoned Mine Land  
Program

Indiana Department of Natural Resources, Division of Fish and Wildlife  
U.S. Department of the Interior, Office of Surface Mining, Reclamation and Enforcement  
Aigner Construction, Inc.

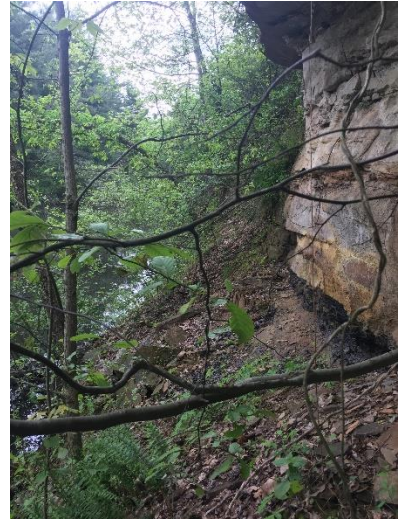
**Date Submitted**

June 15, 2020

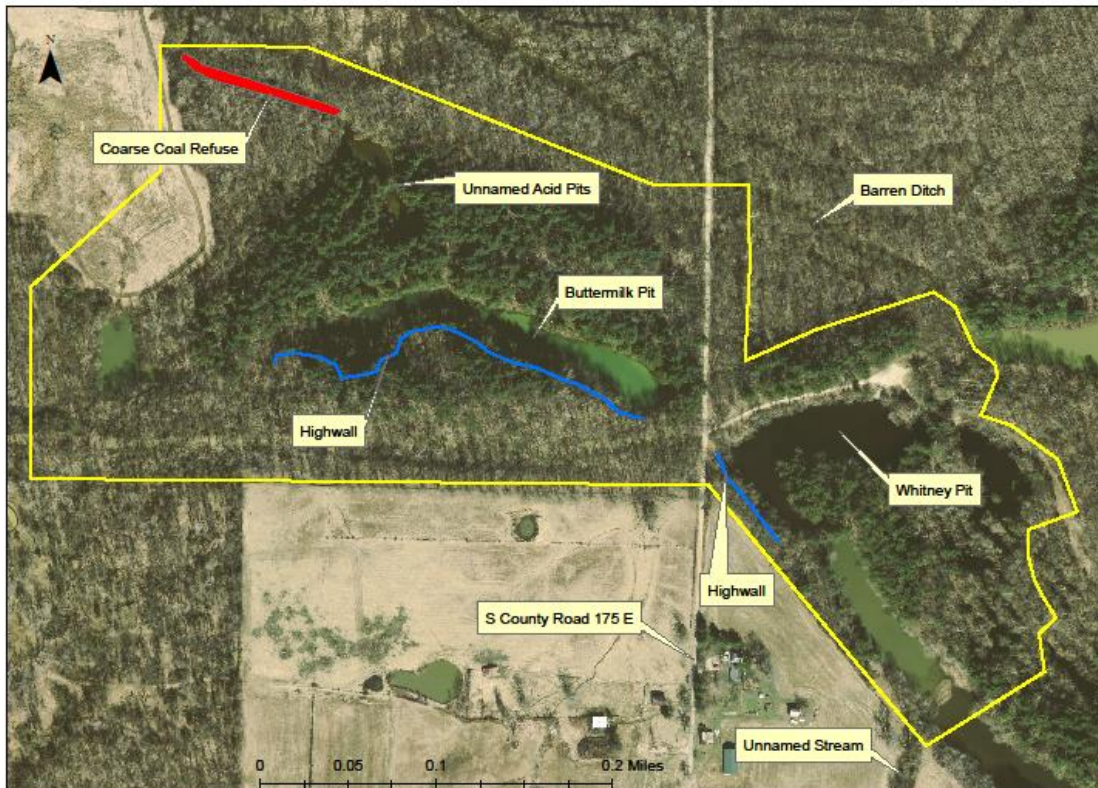


## AML Site 1820, Buttermilk Highwalls

The Buttermilk Highwalls project addressed public safety concerns posed by two dangerous highwalls at the site adjacent to two mine pit lakes, Buttermilk Pit and Whitney Pit. The highwall along the southern shore of Buttermilk Pit was 1,295 linear feet in length, 15-38 feet high and exacerbated by a 30-foot high pile of mine and railroad grade spoil on top of the highwall. The highwall along the southwest shore of Whitney Pit was 320 linear feet in length and 15-25 feet high. The highwalls were created during the operation of the Ayrshire #7400 surface mine, which operated from 1953 to 1955. Both highwalls were nearby a public roadway and posed a danger to visitors to the site, which is situated within the Sugar Ridge Fish and Wildlife Area. Geomorphic design and standard construction procedures were used to backfill the highwalls to a safe 4:1 slope. Additionally, the project stabilized the pool level of an underground mine that was hydrologically connected to a pit lake in another reclamation project finished in 2016. Finally, coarse coal refuse on the property was identified and buried below grade and potentially acidic spoil at the site was amended with limestone in order to eliminate a potential source of acid mine drainage at the site.



The western highwall of Whitney Pit prior to construction.



Map of AML Site 1820, Buttermilk Highwalls prior to construction showing the location of the highwalls, pit lakes, receiving stream and coal refuse at the site.



Buttermilk Pit prior to construction. Water in the pit lake had low alkalinity concentrations and was visibly discolored by suspended iron oxides.

## Significant Safety Hazards in a Complex Post-Mining Environment

The highwalls created during the operation of the Ayrshire #7400 mine were eroding, unstable and within easy access to visitors to the Sugar Ridge Fish and Wildlife Area, who utilize the site primarily for hunting and fishing. The highwalls and associated pits formed part of a multi-layer mining complex situated in the greater vicinity of the site due to the immediate proximity of the Ayrshire #7 underground mine (1912-1926), which operated within the same coal seam as the Ayrshire #7400 mine and created a hydraulic connection with other mine pits in the area.

The hydraulic connection was established by previous observations of pit lakes in the area, including coordinated pool levels between Whitney Pit, Buttermilk Pit and Pigeon Pit, the latter which was reclaimed in 2016. Hydrologic conductivity between the pit lakes was further corroborated by the observation of iron-rich subsurface discharges into the pit lakes during periods of wet weather. Fluctuations in the mine pool were likely a contributing factor for the prevalence of mine subsidences in the area.

The site was also plagued by acid mine drainage (AMD) issues. Buttermilk Pit contained net-acid water with visible suspended iron oxides and a low alkalinity concentration of 7 mg/L as  $\text{CaCO}_3$ . Two smaller ponds north of Buttermilk Pit contained stronger acid mine drainage with pH values between 3 and 4.

The AMD problems at the site were likely sourced in part by the presence of acidic spoil. Several tested spoil samples had low soil and buffer pH values in addition to high cation exchange capacity (CEC) values. An old haul road on the site built from coarse coal refuse also likely attributed to AMD issues.



Map of Whitney and Pigeon Pits superimposed with a map of the Ayrshire #7 underground mine. The mine void created a direct connection between the two pits, which created a substantial challenge during the reclamation of Pigeon Pit in 2016 as part of the Sugar Ridge #2 project. Buttermilk Pit (unmarked, upper center right of map) was also hydrologically connected to the mine, although the response to that pit to pool level changes in the mine was not as abrupt.

### Innovative Design Solution to a Difficult Hydrological Problem

The flooded underground mine workings to the west and south of the site and the hydrologic connection they created between pits in the area posed a unique challenge to Indiana Abandoned Mine Land Program (Indiana AML) engineers. In order to address this problem, a reclamation design emphasis was placed on stabilizing the mine pool within the Ayrshire #7 flooded workings and preventing directional flow from one pit to another. To accomplish this goal, the design coordinated final drain elevations of Whitney Pit and Pigeon Pit, which was reclaimed in 2016 as part of the Sugar Ridge #2 project, by setting both outlets at an elevation of 427 feet above sea level in order to stagnate the mine pool and limit variability of its elevation. Furthermore, the design eliminated Buttermilk Pit and the two smaller ponds north of it. This minimized the flow of water from the mine pool through acid producing materials downstream of Buttermilk pit and into proximate water bodies.

## Collaboration with Indiana Fish and Wildlife

Buttermilk and Whitney Pits were located within Sugar Ridge Fish and Wildlife Area, which is operated by Indiana Fish and Wildlife (Indiana F&W), a sister division of the Indiana Department of Natural Resources. Indiana AML consulted with Indiana F&W personnel throughout the design and construction phases of the project to ensure that the execution of the project did not interfere with the operations of Sugar Ridge Fish and Wildlife Area and that the finished project conformed with or enhanced Indiana F&W's vision for the site.

### Construction: Challenges and Solutions



Buttermilk Pit highwall during construction.

for a bypass drainage way to be constructed through a spoil ridge immediately across from the mouth of the stream draining the watershed in order to allow storm water to flow away from active construction areas. The drainage way was built prior to other construction activities on the east side of the site.

The flooded Ayrshire #7 mine posed a serious challenge to drawing down the level of Whitney Pit, which was required in order to complete the project. The mine entrances were below the surface in Whitney Pit, and their exact locations had to be determined by careful observation of water movements at the highwall side of the pit lake during pumping. Once the locations of the mine entrances were established, fill was placed over the entrances in order to stop outflow from the mine workings so that the project could continue. This placement of fill into water created a large volume of mud that had to be displaced during the highwall backfill process.

Water management of two large watersheds, a 480-acre surface watershed flowing into Whitney Pit at the southeast end of the site and the subsurface watershed of the flooded Ayrshire #7 mine workings, was the principle challenge encountered by Indiana AML and its contractor, Aigner Construction, Inc. during construction at the Buttermilk Highwalls reclamation site. The surface watershed threatened to damage new construction features and equipment during storm events. In order to mitigate this risk, the reclamation design called



Whitney Pit highwall during construction.

Another challenge encountered during construction was a shortfall of fill material on the Whitney Pit side of the project, which required movement of additional fill from the Buttermilk Pit side of the project. Indiana AML had to seek permission from the Pike County government in order to move the fill across County Road 175, which was granted. Approximately 8,000 cubic yards of fill material was transported across the road in order to make up for the shortfall.

Despite these challenges, the Buttermilk Highwalls project was completed significantly under budget. The original design cost estimate of the project was \$1,814,159.44, the winning bid price from Aigner Construction, Inc. was \$1,248,850.00, and the final construction cost was \$1,191,086.82. Therefore, the total cost of the project was \$623,072.62 less than the design cost estimate and \$57,763.18 less than the bid price.

### Long-Term Improvement

As a result of the Buttermilk Highwalls project, two dangerous highwalls totaling 1,615 linear feet, both of which were in close proximity to a public roadway on a public property designated for recreational use, were eliminated, thus ensuring safe conditions for visitors to the site. The highwalls were both backfilled to a stable 4:1 slope. The grading conformed to geomorphic design to the best extent practicable in order to minimize erosion of the new grades by mimicking natural drainage topography.



Completed reclamation of Buttermilk Pit highwall. The pits on this side of the project, which were contaminated with AMD, were eliminated and replaced with new water bodies of good water quality on a one-to-one basis with respect to area.

This project, in conjunction with the Sugar Ridge #2 project (completed in 2016) that reclaimed Pigeon Pit, also improved conditions of the flooded Ayrshire #7



Completed reclamation of Whitney Pit western highwall. The highwall was backfilled to a 4:1 slope.

underground mine workings by establishing two well-defined outlets for the mine pool. The two outlets, both of which were set at 427 feet above sea level, discourage directional flow through the mine void and ensure that the mine void remains permanently flooded. As a result, oxygen input into the mine void is reduced, which will mitigate future problems with AMD. Stabilizing the mine pool is also expected to attenuate further subsidence of the mine void, thus mitigating a future source of public safety hazards on the surface.

Furthermore, the Buttermilk Highwalls project eliminated AMD-impacted pit lakes at the site by amending potentially acidic spoil with limestone and properly disposing of coarse coal refuse found at the site. These water bodies were replaced with an equivalent amount of water and wetland acreage with good water quality, thus providing better wildlife habitat at the site.

As a final touch, the revegetation section of the design was amended to include Illinois Bundleflower. This was done in order to provide habitat and forage for quail on the property, thus improving recreational opportunities at the site.

## Greater Impacts

The Buttermilk Highwalls project was made possible through funding provided by the Office of Surface Mining, Reclamation and Enforcement, a branch of the United States Department of the Interior, pursuant to Title IV of the Surface Mining Control and Reclamation Act of 1977. The main purpose of Title IV is to abate public safety hazards left behind by coal mining activities conducted prior to 1977. The Buttermilk Highwalls project, in conjunction with the Sugar Ridge #2 project completed in 2016, provides the local community with a long-term solution to stabilize the flooded Ayrshire #7 mine workings in addition to eliminating two dangerous highwalls at the surface. By adopting a long view strategy with a coordinated design process spanning multiple reclamation projects, Indiana AML gained useful experience in designing solutions for problematic underground mine workings that can be adapted to future reclamation project designs.



Completed reclamation of the Buttermilk Pit side of the project. The AMD-contaminated pits on this side of the project were replaced with water bodies of good water quality.