

Friendship Hill National Historic Site Ice Pond Run Acid Mine Drainage (AMD) Assessment

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Report prepared by Hedin Environmental for National Parks of Western
Pennsylvania



AMD flows through a weir on the southern part of the Friendship Hill property.

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Summary

Ice Pond Run, Fayette County, Pennsylvania, is almost entirely inside the Friendship Hill National Historic Site and is severely polluted by acid mine drainage (AMD). In this report, one AMD discharge on Friendship Hill property was identified. This discharge flows from <10 gpm to ~200 gpm and contains on average 640 mg/L CaCO₃ net acidity, 91 mg/L Fe, and 37 mg/L Al. This discharge is responsible for approximately 50% of the AMD pollution in Ice Pond Run. To attain biological restoration, additional AMD sources must be identified and characterized. Friendship Hill should engage with local landowners for permission to identify and sample AMD discharges, prioritize AMD discharges for treatment to attain biological restoration, and engage with the US Department of Interior Office of Surface Mining Reclamation and Enforcement on treatment strategies.

Background

Ice Pond Run is a small tributary to the Monongahela River near the town of New Geneva in Fayette County, Pennsylvania, USA. Ice Pond Run has a 326 acre watershed area which is almost entirely contained within the Friendship Hill National Historic Site. Ice Pond Run is approximately 1.5 miles long.

The attached maps show the geology, National Park Service (NPS) property, abandoned mine lands (AML), topography, and sampling locations around Ice Pond Run.

Ice Pond Run is severely polluted with AMD. The Pittsburgh Coal seam is in the hilltops above the Monongahela River and outcrops in the hilltops in the headwaters of Ice Pond Run. There is an island of coal in the hilltops above Ice Pond Run. The Fayette Anticline splits this island approximately in half with the western half dipping northwest and the eastern half dipping southeast.

The Pennsylvania Mine Map Atlas contains two maps with mine workings in the area: a 1920 map that shows Winstead Coal Co. room and pillar workings in the headwaters of Ice Pond Run and Works Progress Administration (WPA) maps from the 1930s that show room and pillar workings owned by the American Manganese and Fuel Co. These maps suggest that AMD in Ice Pond Run is from mining that predates the Surface Mining Control and Reclamation Act (SMCRA) of 1977 and therefore is considered “abandoned”. There are many AML polygons and point features in Ice Pond Run in the AMLIS database.

The US Department of the Interior Bureau of Mines (BOM) constructed an experimental passive treatment system in the early 1990’s along Ice Pond Run on National Park Service property. A portion of Ice Pond Run was diverted into wetlands. These wetlands still exist but they do not treat the AMD in Ice Pond Run. The US Department of the Interior United States Geologic Survey (USGS) installed and operated a pilot scale treatment system in the headwaters of Ice Pond Run in summer 2000. This project also installed a weir at the largest AMD discharge in the headwaters. The pilot scale treatment system was operated through fall 2021 and is described in Sibrell et al. 2003. The system is no longer operational.

Hedin Environmental assessed the current AMD impacts to Ice Pond Run. This report includes the results of that assessment and conceptual treatment options.

Methods

Stream Assessment

Hedin Environmental staff walked Ice Pond Run from the Rt 166 culvert to the headwaters on 7/12/2023. Conductivity and pH were measured at instream locations at the mouth of major tributaries that entered Ice Pond Run.

Discharge Sampling

Hedin Environmental rehabilitated the USGS weir at the largest AMD discharge in the headwaters of Ice Pond Run and installed a data logging pressure transducer in the weir pool to measure flow rate on. Flow rates were logged at 30-minute intervals from 10/24/2023 to 5/30/2024. Hedin Environmental sampled the discharge for flow rate and chemistry on 7/12/2023, 10/24/2023, 1/12/2024, and 5/30/2024.

Mass Balances

To determine the fraction of AMD pollution from the USG weir, Hedin Environmental sampled a downstream location of Ice Pond Run. On 7/12/2023 and 10/24/2023, the downstream location was the Rt 166 culvert. On 1/12/2024 and 5/30/2024, the downstream location was a culvert by the BOM passive treatment system (about 1,100 ft downstream of Rt 166). This location is indicated on the sampling map.

Acid Mine Drainage (AMD) Sources in Ice Pond Run

USGS Discharge

Ice Pond Run is polluted by acidic mine water discharges emanating near the coal crop in the stream's headwaters. One of the discharges occurs on NPS property and flows through a weir that was installed by USGS in 2000. The AMD discharge is located in AML area PA 2741. There is not an AML point feature associated with the discharge but there are many nearby AML points indicating entries and impacted water sources.

Table 1 shows the chemistry of samples collected at the USGS weir by USGS in 2000-2001 and by Hedin Environmental in 2023-2024. The discharge has improved in the last 20 years, but it is still highly contaminated. The recent sampling found water with pH less than 3, 600-700 mg/L acidity, 50-135 mg/L Fe and 20-45 mg/L Al. This is severe AMD. There was only modest improvement in discharge chemistry under higher flow conditions. The highest loadings of contaminants (pounds per day or ppd) occurred at high flow.

Table 1. Ice Pond Run headwaters at the USGS weir. Average data is 2023-2024 data only. Total metal concentrations and loadings are shown. pH is field measured and net acidity is lab measured in units of mg/L CaCO ₃ or ppd CaCO ₃ .													
Date	Flow	pH	Sp. Cond.	Acidity	Fe	Al	Mn	SO ₄	Acidity	Fe	Al	Mn	SO ₄
	gpm		uS/cm	mg/L				ppd					
2000-2001		2.50		1,100	200	61	11						
7/12/2023	14	2.56	2,294	560	80	38	6	1,360	93	13	6	1	225
10/24/2023	8	2.79	2,416	710	135	44	7	1,444	67	13	4	1	137
1/12/2024	73	2.69	1,965	660	54	23	3	729	579	48	20	3	639
5/30/2024	50	2.51	2,386	640	94	46	6	1,550	384	56	27	4	931
2023-2024 Average	36	2.64	2,265	643	91	37	6	1,271	281	33	15	2	483

Flow rate at the USGS weir was logged between October 2023 and May 2024. Figure 1 shows flow rates at the weir along with daily rainfall totals. Precipitation between 10/24/23 and 3/31/24 was typical, averaging 0.10 inches per day (annualized value 36.5 inches/yr). During the first 5 days of April rainfall totaled 5.0 inches and regional flooding occurred. Flow rate peaked at 410 gpm on the morning of 4/3/2024 and rapidly decreased to a steady ~200 gpm by early morning 4/4/2024. After April 5, precipitation returned to typical conditions (average 0.10 inch between April 6 and May 30). Discharge at the USGS weir increased substantially during the early April rains and then gradually decreased over the next 6 weeks, reaching pre-April levels in late May.

Table 2 shows statistical summaries for the flow measurements at the USGS weir. A common treatment target for mine water treatment systems is the 75th – 90th percentile flow and loadings. The 90% flow rate was 146 gpm. Assuming average chemical conditions (Table 1), the 90th percentile loadings for the discharge were: 1,127 ppd acidity, 159 ppd Fe, and 65 ppd Al.

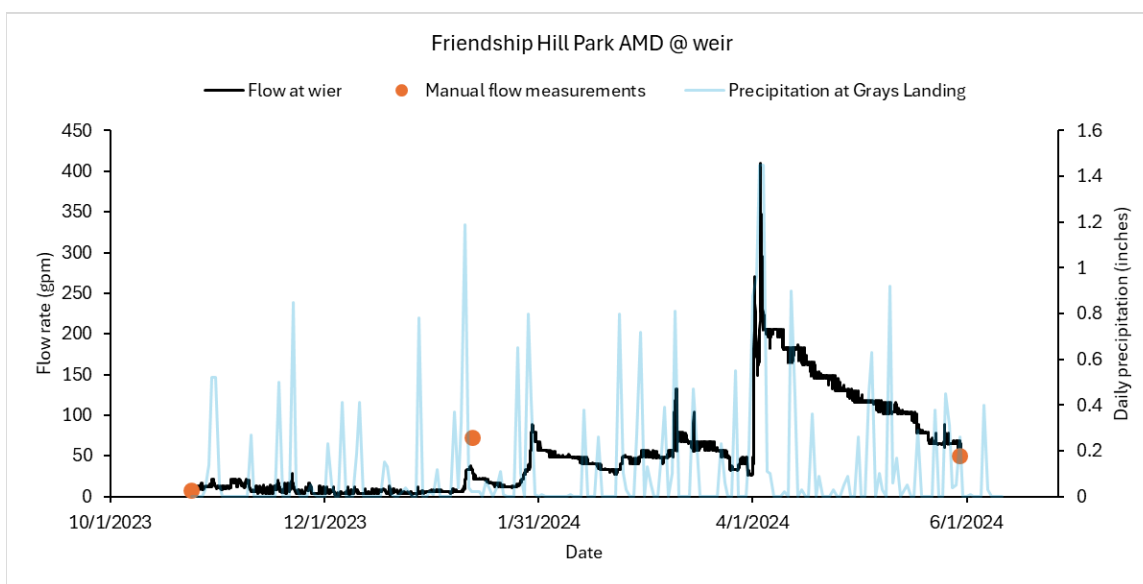


Figure 1. Flow at the USGS weir measured by pressure transducer and manually. Precipitation from Grays Landing Lock and Dam 4 miles away is shown.

Table 2. Flow statistics for the USGS weir at Friendship Hill From 10/24/23 – 5/30/24.						
	Average	Percentile				
		10%	25%	50%	75%	90%
Flow, gpm	55	6	9	40	69	146

Ice Pond Run

Ice Pond Run was sampled where it crosses New Geneva Road (Rt 166) and at the culvert below the BOM experimental system. These locations both appear to be downstream of all inputs of AMD and so

represent the total AMD loading to Ice Pond Run. Table 3 shows the sampling results. The table includes the average input to the 1994 BOM experimental system which was taken directly from Ice Pond Run. The chemistry in Ice Pond Run has improved since 1994, but it is still severely polluted. The sampling included a higher flow event in January 2024. While dilution is indicated (lower concentrations of acidity and metals), the highest loads of AMD pollutants were observed on this day.

Table 3. Ice Pond Run instream flow rates, chemistry, and loadings as it flows through Friendship Hill National Historic Site. Total metal concentrations and loadings are shown. pH is field measured and net acidity is lab measured in units of mg/L CaCO ₃ or ppd CaCO ₃ .													
Date	Flow	pH	Sp. Cond.	Acidity	Fe	Al	Mn	SO ₄	Acidity	Fe	Al	Mn	SO ₄
	gpm		uS/cm	mg/L				ppd					
1994				892	160	58	9						
7/12/2023	n/m	2.39	2,422										
10/24/2023	14	2.57	2,333	845	73	43	7	1,177	140	12	7	1	195
1/12/2024	370	2.66	1,492	492	45	19	3	562	2,189	200	86	13	2,496
5/30/2024	167	2.66	1,596	380	55	27	4	859	762	109	53	7	1,724

Table 4 shows the percentage of downstream pollution loadings from the USGS weir. Approximately 50% of pollution at the downstream Ice Pond Run location is from the USGS weir. This calculation indicates that an AMD-polluted tributary in the headwaters (West Trib) of Ice Pond Run is a significant source of pollution. During the July 2023 reconnaissance, the West Trib had pH 2.47 with 1706 uS/cm conductivity and was approximately 1/3 of the downstream flow. The West Trib and its AMD discharges are not on Friendship Hill property. Besides the West Trib, there may be additional undocumented AMD sources in the headwaters of Ice Pond Run.

Table 4. Ice Pond Run mass balance results showing the percentage of downstream pollution loadings from the USGS weir.						
Date	Flow	Acidity	Fe	Al	Mn	SO ₄
	%	%	%	%	%	%
10/24/2023	57%	48%	106%	58%	58%	70%
1/12/2024	20%	26%	24%	24%	24%	26%
5/30/2024	30%	50%	52%	51%	48%	54%
Average	36%	42%	61%	44%	44%	50%

Ice Pond Run Restoration

Ice Pond Run is polluted with AMD from abandoned underground coal mines in its headwaters. A primary source of AMD is located on Friendship Hill property at the USGS weir. However, a substantial inflow of AMD occurs from a tributary that drains private property. Restoration of Ice Pond Run will require treating both sources of AMD. Treatment of only the USGS discharge will not result in conditions in Ice Pond Run that would support biological restoration of the stream.

If NPS wishes to further consider restoration of Ice Pond Run, additional discharge(s) that pollute the Ice Pond Run (e.g. West Trib) must be identified and characterized. Contact should be made with the landowner(s) and agreements should be secured that allow access to install monitoring stations and collect samples every month for one year. After this monitoring effort, discharges can be prioritized for treatment that would restore Ice Pond Run.

AMD Treatment

Ideally, AMD discharges are collected at their sources and conveyed to an AMD treatment system. Alternatively, a portion of Ice Pond Run downstream of the AMD discharges could be collected and conveyed to a treatment system. Instream collection is not preferred because unpolluted water is collected and treated and instream collection structures can wash out and/or clog.

Active Treatment

AMD is treated by either active or passive technologies. Active technologies involve the addition of alkaline chemicals and the precipitation of metals in ponds. The chemicals raise the pH of the mine water to 9-10 which neutralizes acidity and promotes the rapid precipitation of Fe and Al. The conventional chemicals used for AMD treatment are sodium hydroxide and lime. Chemical treatment produces a large amount of sludge which must be managed. Active treatment includes hazardous chemicals and treatment conditions that require that the system is isolated from public access.

The design of an active system requires flow and chemistry of the AMD inputs. Assistance in the design of an active treatment system could be obtained from the US Department of Interior Office of Surface Mining Reclamation and Enforcement.

An alternative, novel active system is to use the pulsed limestone bed reactor treatment technology developed by the USGS at Friendship Hill. This technology uses tanks of agitated limestone fines to neutralize acidity and generate alkalinity. USGS estimated annual costs of \$129,630 (includes maximum capacity of the plan and adjusted to 2024 costs).

Passive Treatment

Passive treatment of acid mine drainage is accomplished using limestone aggregate and organic substrates. The chemistry of the USGS discharge is severe and its treatment would be noteworthy. The most similar situation that HE is aware of is the Hunters Drift passive system located on Babb Creek in Tioga County (PA). For the last 20 years, this system has treated severe AMD with vertical flow ponds (a combination of limestone aggregate and organic substrate) and constructed wetlands. The final discharge has consistently been pH 7 with low metals, even under high flow conditions. Table 5 compares the characteristics of the USGS and Hunters Drift discharges. The Hunters Drift system treats mine water with greater flow, similar concentrations of Al, and lower concentrations of acidity and Fe. The Hunters Drift acidity loading is approximately 3X higher than the USGS discharge. The Hunters Drift system includes four, one-acre vertical flow ponds and two acres of wetlands. The footprint for the entire Hunters Drift system is approximately 10 acres. Assuming that the USGS discharge accounts for 50% of the AMD inflow to Ice Pond Run, then passive treatment of 100% of the AMD would likely require a system similar in size to Hunters Drift.

Passive systems do not require hazardous chemicals. The most hazardous feature is deep water (2-4 ft) in ponds. At many passive treatment systems, public access is encouraged. Pennsylvania's Mid-State Trail is adjacent to the Hunters Drift passive system.

Table 5. Average and maximum flow and chemistry for the Hunters Drift discharge and the Friendship Hill USGS discharge							
Site	period	Flow	pH	Acid	Fe	Al	Acid
		gpm	s.u.	mg/L	mg/L	mg/L	ppd
		ave (max)	ave (max)	ave (max)	ave (max)	ave (max)	ave (max)
FH USGS	2023-24	55 (400)	2.6 (2.5)	643 (710)	91 (135)	37 (46)	281 (579)
Hunters Drift in	2004 - 2022	266 (510)	2.8 (2.6)	266 (510)	31 (79)	30 (62)	862 (1823)
Hunters Drift out	2004 - 2022	na	7.5 (6.7)	-112 (-10)	0.5 (6.9)	0.2 (0.9)	na

Recommendations

If the NPS decides to further pursue the treatment of Ice Pond Run with a goal of its biological restoration, the following actions are recommended.

- Contact private landowner(s) of AML in the Ice Pond Run headwater and obtain permission to identify and access AMD discharges.
- Monitor the AMD discharges and a downstream location for at least one year collecting water samples monthly and flow rates at least daily via data logged flow measurement hardware (e.g. pressure transducer and weir).
- Identify discharges that, when treated, will result in biological restoration of Ice Pond Run. Determine if these discharges can be combined to a central treatment system.
- Contact OSMRE about assistance with AMD treatment, particularly an active treatment system.
- Determine if a 10 acre passive treatment system would be compatible with current and future activities at the Friendship Hill National Historic Site property.

References

Sibrell, P. L., Watten, B., Boone, T. 2003. Remediation of Acid Mine Drainage at the Friendship Hill National Historic Site with a Pulsed Limestone Bed Process. Presented at Hydrometallurgy 2003 – Fifth International Conference in Honor of Professor Ian Ritchie- Volume 2: Electrometallurgy and Environmental Hydrometallurgy.