2026 West Virginia Envirothon

5th Topic Special Environmental Issue

Nonpoint Source Pollution Mitigation

Special thanks to the West Virginia Envirothon Committee and to West Virginia Envirothon Participants

The Clean Water Act (CWA) relies on the following logic to protect water quality in rivers (and streams):

1. Waterways have certain designated uses. The law doesn't protect a river for its own sake. Instead, it protects the qualities that support how humans use it. The most common designated uses of rivers are Category A: water supply, public; Category B: propagation and maintenance of fish and other aquatic life; Category C: water contact recreation; Category D: Agriculture and wildlife uses; and Category E: Water supply industrial, water transport, cooling and power. Waste assimilation and transport are not recognized as designated uses.

   Not all stream reaches have all designated uses. In West Virginia, streams have Category B and Category C designated uses by default. See the legislative rule, 47CSR02 (section 6), for more information. Scroll through this document to the landscape oriented pages to find the list of numerical standards.

2. After reviewing extensive research, a state sets numerical standards to protect a designated use. For example, nitrate in drinking water can cause methemoglobinemia, also known as "blue baby syndrome." Therefore, there is a standard for those waterways with a Category A designated use: the threshold is 10 mg nitrate-N/L. If the concentration is less than 10 mg nitrate-N/L, the water quality meets the standard. If the concentration exceeds 10 mg nitrate-N/L, it violates the standard, and the water body is impaired. If the threshold of sensitivity is different for different designated uses, the most stringent standard applies.

3. The CWA requires states to monitor their streams and report their condition to the EPA. The Integrated Report that they submit should contain a list of streams that have been found to violate standards. This list is known as the "303(d) list."

4. The state must also report to the EPA what they are going to do about streams that violate water quality standards. They satisfy this requirement by writing Total Maximum Daily Loads (TMDL) analyses. In this context, "load" means the amount of a pollutant, for example, in pounds per day, that flows past a particular point in a river. Loads are usually calculated by multiplying the discharge (flow) of a river by the concentration of a pollutant. In the metric system, if you multiply the flow, X liters/second, by the concentration Y milligrams of pollutant/liter, you would get the load X*Y milligrams of pollutant/second. For streams that violate the standard for a particular pollutant, the TMDL estimates how much the various sources of the pollutant have to cut back (usually in pounds per day or pounds per year) in order for the waterway to meet the standard.

   The most important decision made in the TMDL analysis is what proportion of a pollutant load is point source pollution, and what proportion is nonpoint source (NPS) pollution. This decision is important because of how each kind of pollution is controlled. Point source pollution comes into rivers through permitted discharges. (Watch for signs near outfall pipes that say "NPDES." Those are permitted discharges.) If point source pollution is causing the stream to violate standards, then the state must revise the permits so that less pollution comes out of those discharges.

The CWA does not have a way to force action to reduce nonpoint source pollution loads. Instead, EPA provides money to states for the purpose of decreasing NPS pollution. The money supports the installation of best management practices (BMPs) that will decrease NPS pollution loads.

EPA explains that NPS pollution is

> caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters, and ground waters.

Any kind of land use carries some risk of shedding NPS pollution to nearby waterways. In a construction project, for example, vegetation might be removed and soil exposed to the wind and rain, which can move it into a stream. In a neighborhood not served by a sanitary waste system, some houses may not have working septic systems that eliminate all the bacteria from the waste stream. You wouldn't want to swim downstream from a dog park right after a storm!

Examples of nonpoint source pollution and the BMPs used to reduce it

BMPs to control sediment moving to streams during logging operations

BMPs for agricultural lands

West Virginia Department of Environmental Protection lists of BMPs for various land uses.

As you read the scenario below, note what land uses are in the watershed of Left Fork of Sandy Creek, and whether there are BMPs to control any nonpoint source pollution from them.

Notes on polluted coal mine drainage:

If pyrite is present in a coal seam or in the adjacent rock, it often reacts with water and air to form acid mine drainage, which has a low pH as well as high concentrations of iron (Fe), aluminum (Al), and manganese (Mn). Sometimes, a nearby rock layer can contribute enough acid neutralizing capacity that pH is neutral or higher and aluminum concentrations are low, but iron concentrations are still high..

Mines with a current mining permit are required to treat the water they discharge so that it will not cause a receiving stream to violate water quality standards, like any other NPDES permittee. If a mining company got out of the mining business, often through bankruptcy, after 1977 (because it was losing too much money treating water, for example), then it forfeits a bond to the state, and the state is responsible to make sure any water discharge meets the requirements of the NPDES permit. That drainage is point source drainage. If a mining company got out of the mining business before 1977, then the mine is an abandoned mine land (AML), and its pollution is considered nonpoint source pollution.

The mines in the Left Fork of Sandy Creek watershed are bond forfeitures, so any pollution they discharge is point source pollution.

Scenario

Left Fork of Sandy Creek

Several of your neighbors, some of whom drive hundreds of miles to fish every weekend, say that the stream through your rural part of the county does not have many fish. The land is beautiful. In many places, you can look from the road through the valley across green pastures on one side of the creek far up the hill across more pastures on the far side of the creek to the forest that starts where the hill becomes steep. The creek has deep, vertical banks, so the cattle grazing nearby don't climb into it, except in some of the shallower tributaries. If you carefully climb down to the stream during low flows, maybe using the roots of one of the solitary trees along the bank, the water is mostly clear after the grey-brown cloud disperses from the place where your feet land. During high flows you wouldn't dare climb into the rapid brown current, too opaque to gauge the depth for your next step.

Some of the neighbors recount their parents' stories of the fish they once caught there. They also remember fish stocking efforts 15 years ago, but say they didn't seem to change the fish community.

At the very headwaters of the creek there is a bond-forfeited coal mine. State agencies have been working there for years, first bringing in ammonium hydroxide and then lime, to neutralize the acid in the water. They say they have the mine drainage mostly under control, but there are events when the machinery goes off line or when a lime delivery is late.

In contrast to the bucolic scene in the rest of the watershed, there are approximately 15 acres of junked cars in a salvage yard along the creek.

Why does such a beautiful stream not have more fish and what can be done about it? A few of the neighbors have smart, hard-working kids in high school who went through 4-H and now participate in an environmental science club at the high school. The parents are tired of hearing them talk about climate change and suggest they try to figure out what's going on with the creek. The students enlist their club's advisor and start gathering information for a presentation. They plan to host a meeting at the local Community Center. The advisor sends them off with two pieces of advice: First, science progresses not by proving that a hypothesis is correct, but by proving that alternative hypotheses are false. Second, the state Department of Environmental Protection and the state Division of Natural Resources may know a lot about the creek already. The club might save some time by finding out what they already know.

The Task

As an environmental science club, work together to generate two or more hypotheses about what might be preventing the fish community from becoming more numerous and more exciting to fish. Explain whether each hypothesis connects to nonpoint source pollution, then work your way down through the following steps:

1. For each hypothesis about what is harming the stream community, identify what land use is responsible, what substance does it add to the water, what is the water quality standard for that substance, and what BMPs should help the stream meet standards.

2. Describe data that would rule out each of the hypotheses that you identify. For example, if you have a hypothesis that the problem is a population of crocodiles that are eating all the fish, what data would you collect to completely rule out the presence of crocodiles?

3. Review the data collected by the Water Quality Standards and Assessment Section, which is part of the West Virginia Department of Environmental Protection. Do these data rule out any of your hypotheses?

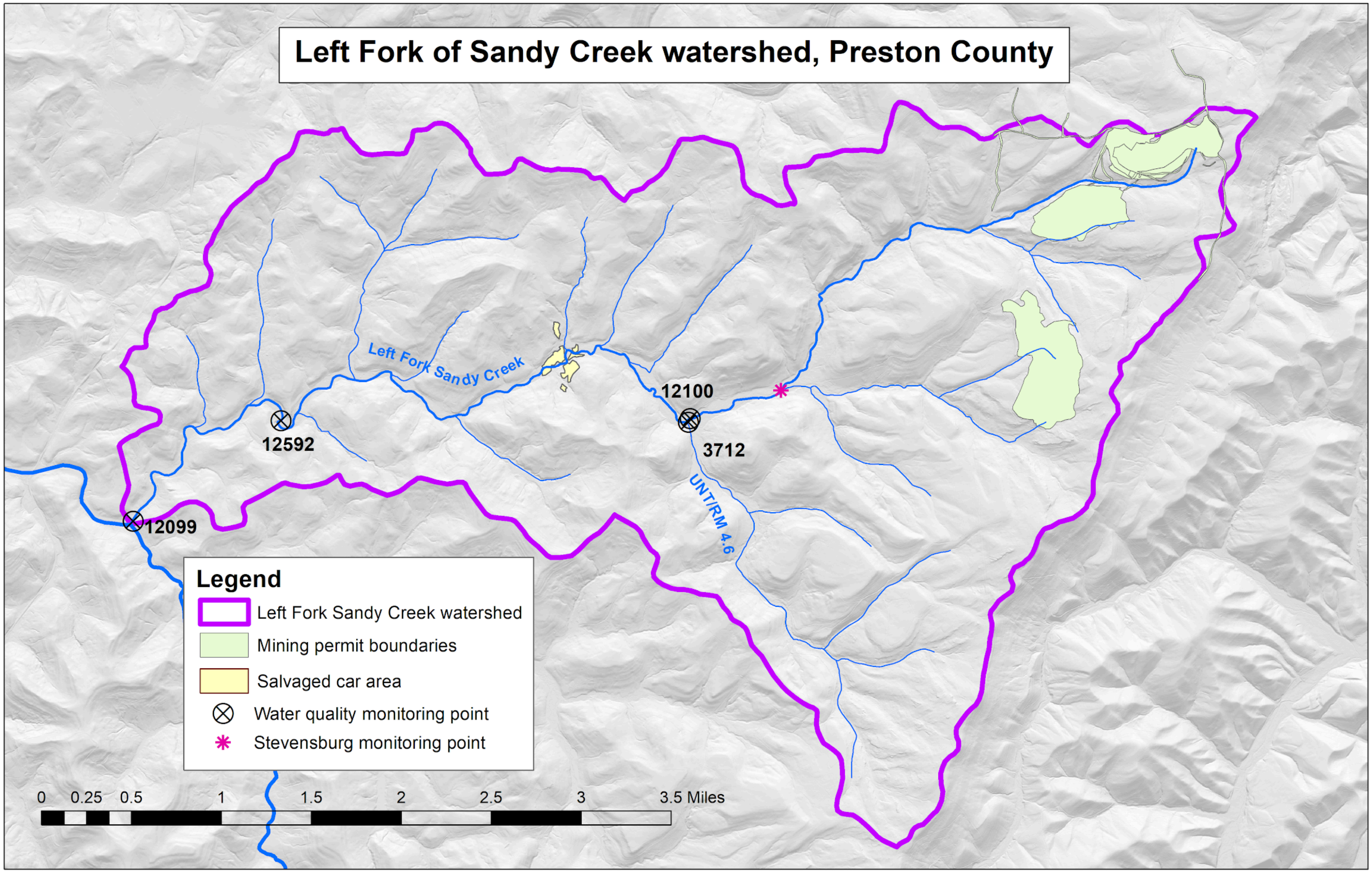
4. Present a water monitoring plan to collect your own data that may help you rule out a hypothesis. For example, what water quality parameters should your club test for, how often, and where at?

5. Describe a plan for gathering information from the neighbors. Which neighbors should your club prioritize for interviews? What would you ask them?

6. Suggest actions that the neighbors might take to improve the creek.

7. Outline how your club can use data to gather support for your plan of action from the community.

8. Outline a presentation that you will make for the neighbors. Suggest other people and professionals you might invite to the event.



Four- and five- digit numbers correspond to monitoring sites in the watershed of the Left Fork of Sandy Creek.
See first table on page 9.

Water Quality data for the Left Fork of Little Sandy Creek

The West Virginia Department of Environmental Protection (WVDEP) has collected water quality on the Left Fork of Sandy Creek for a couple of different reasons.

WVDEP gathered watershed assessment data for a TMDL in 2012 and 2013. The stream had been known to violate water quality standards for some time. One TMDL had already been written, but WVDEP did a new one. The tables below summarize results of the measurements likely to show impairment.

WVDEP also collects data at the former coal mine. This mine is a bond forfeiture site, so WVDEP is obligated to make sure that its discharge does not impair water quality. WVDEP installed a datalogger in the creek, which recorded pH, temperature, dissolved oxygen, and specific conductance. The data are graphed below.

WVDEP also got involved with the salvage yard, and required it to be cleaned up. However, no water quality samples were collected in that process.

WVDEP WATERSHED ASSESSMENT DATA

Water quality data for watershed assessment were gathered at these sites:

Label	ID on Map	NHD Code	Mile point	Lat/Long	WVSCI	Description
1	12099	WV-MT-34-L	0	39.2905 -79.8669	Too deep to sample	This is the point where the Left Fork of Sandy joins the Right Fork of Sandy
2	12592	WV-MT-34-L	1.4	39.29842 -79.8514	56.57	1.4 miles, (as the fish swims) from the confluence of the Left and Right Forks.
3	12100	WV-MT-34-L	4.6	39.29817 -79.8090	64.05	4.6 miles from the confluence. Just upstream from an unnamed tributary
4	3712	WV-MT-34-L-10	0	39.29788 -79.8092	72.43	Unnamed tributary to Left Fork of Sandy at river mile 4.6, at the confluence.

Dates for data collection

Label	How many monitoring trips	Date of first sample	Date of last sample
1	11	8/7/2012	7/30/2013
2	4	10/2/2002	8/22/2013
3	12	8/7/2012	8/19/2013
4	12	9/3/1997	7/30/2013

pH values

Label	Number of measurements	Minimum	Average	Maximum
1	11	5.7	6.7	7.2
2	4	6.7	7.1	7.9
3	12	6.1	6.5	7.0
4	12	5.7	6.4	6.9

Total iron concentrations (mg/L)

Label	Number of measurements	Minimum	Average	Maximum
1	11	0.1	0.5	2.3
2	3	0.1	0.2	0.4
3	12	0.0	0.2	0.5
4	12	0.0	0.3	1.3

Dissolved aluminum concentration (mg/L)

Label	Number of measurements	Minimum	Average	Maximum
1	11	0.02	0.04	0.08
2	3	0.02	0.04	0.05
3	12	0.03	0.05	0.08
4	12	0.02	0.05	0.10

Dissolved oxygen concentration (mg/L)

Label	Number of measurements	Minimum	Average	Maximum
1	11	6.6	10.4	14.0
2	4	8.6	9.9	12.5
3	12	7.4	9.8	12.8
4	12	7.8	10.0	12.9

Fecal coliform counts (cfu/100 mL)

Label	Number of measurements	Minimum	Average	Maximum
1	11	7	1499	8000
2	3	54	211	500
3	11	4	175	1400
4	13	2	1168	12000

Total suspended solids (mg/L)

Label	Number of measurements	Minimum	Average	Maximum
1	11	2.0	14.1	79.0
2	3	2.0	5.0	10.0
3	12	2.0	8.2	25.0
4	12	2.0	14.8	60.0

Embeddedness (Figure 3 shows scoring scale)

Label	Embeddedness scores (average ± standard deviation)
1	4.4 ± 1.3
2	9.8 ± 2.9
3	9.7 ± 2.1
4	10.8 ± 1.4

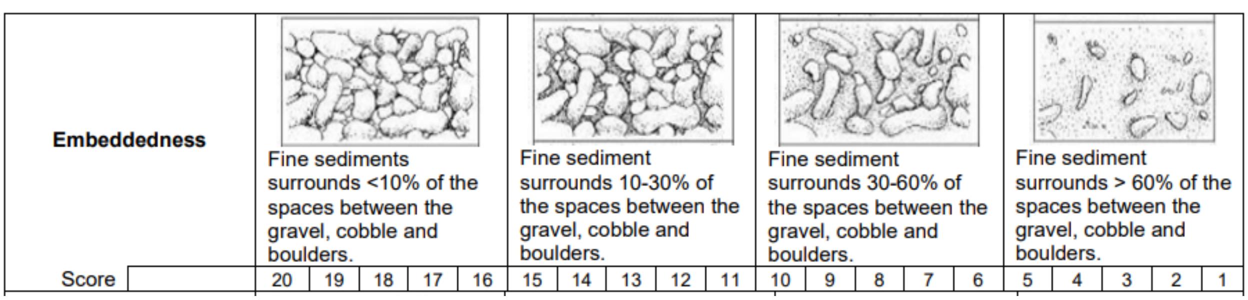


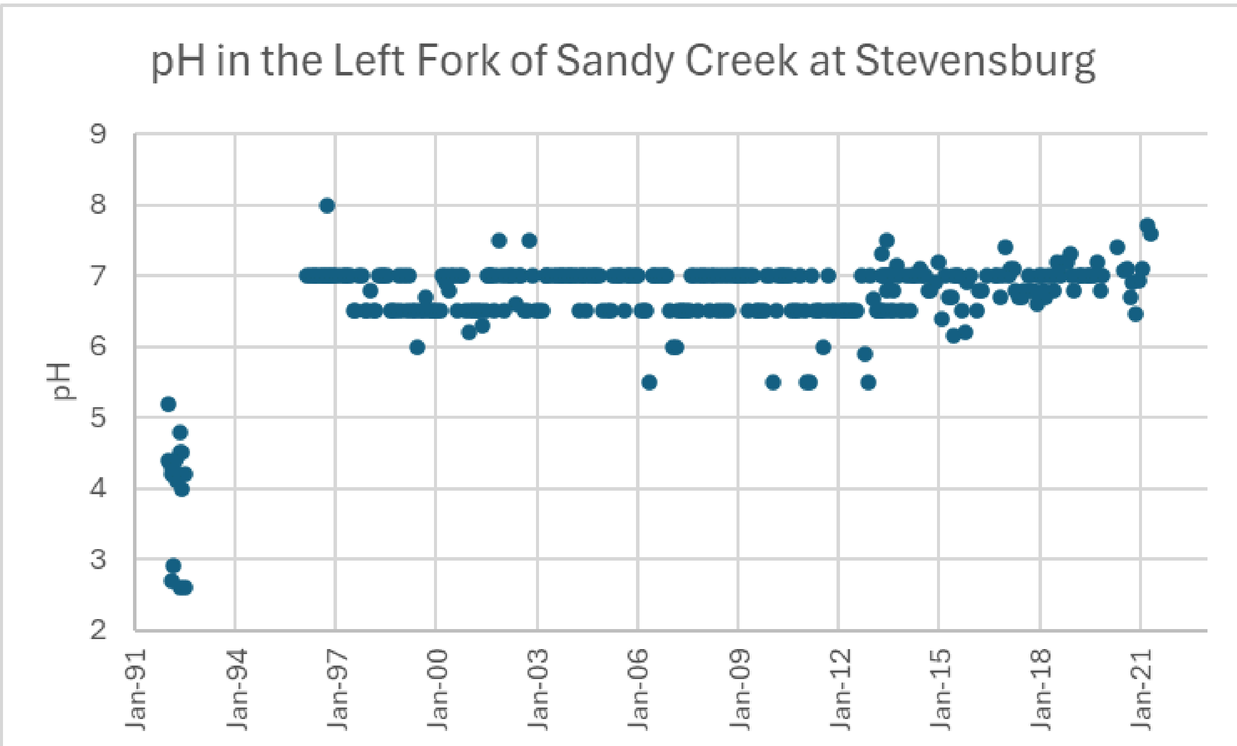
Figure 3: Scoring rubric for embeddedness.

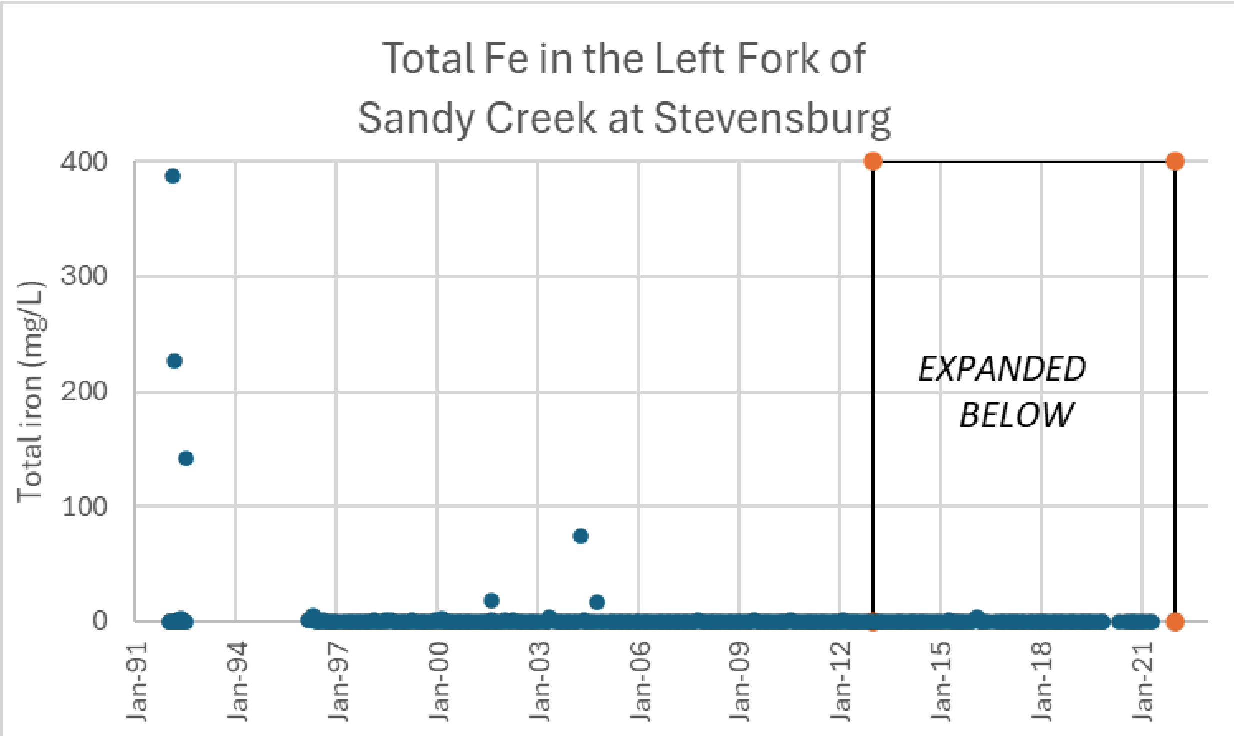
WATER QUALITY MONITORING FOR MINE RECLAMATION

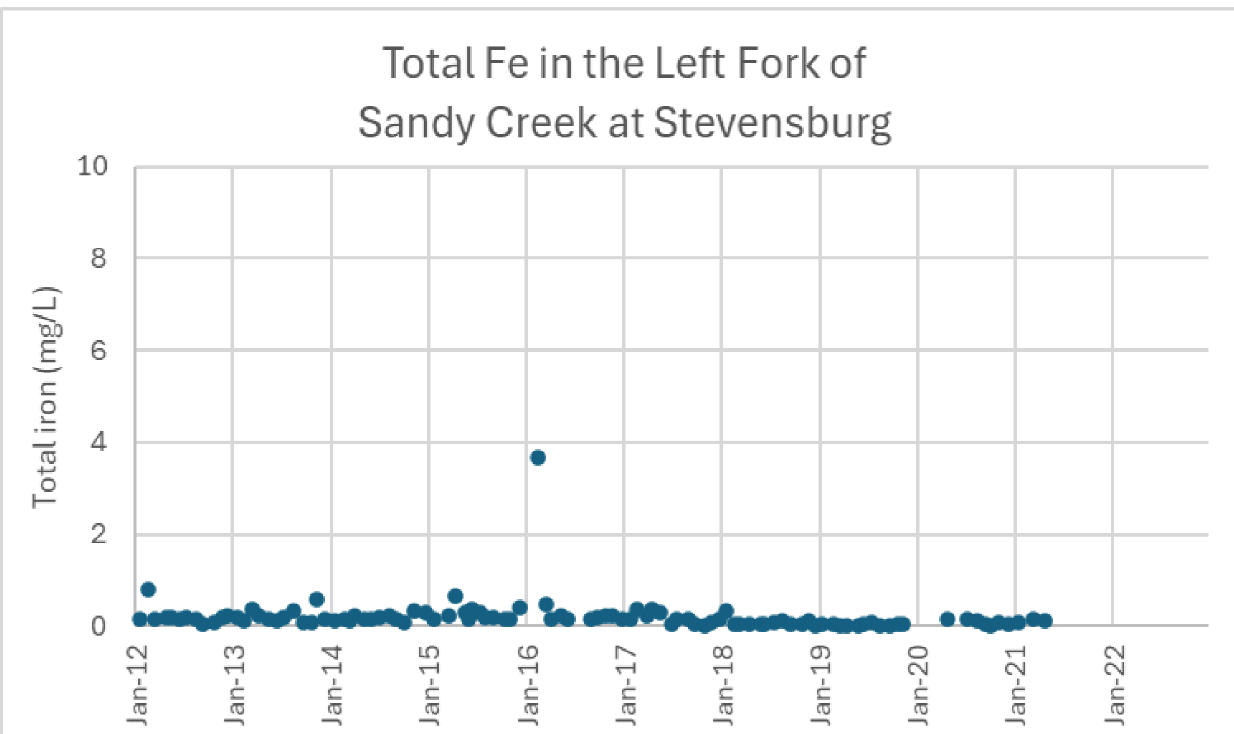
To make sure a permitted mine is not causing a receiving stream to violate standards, WVDEP often requires a mine to monitor the receiving stream. The following graphs plot data measured just downstream of Stevensburg, where streams draining the two permitted areas come together.

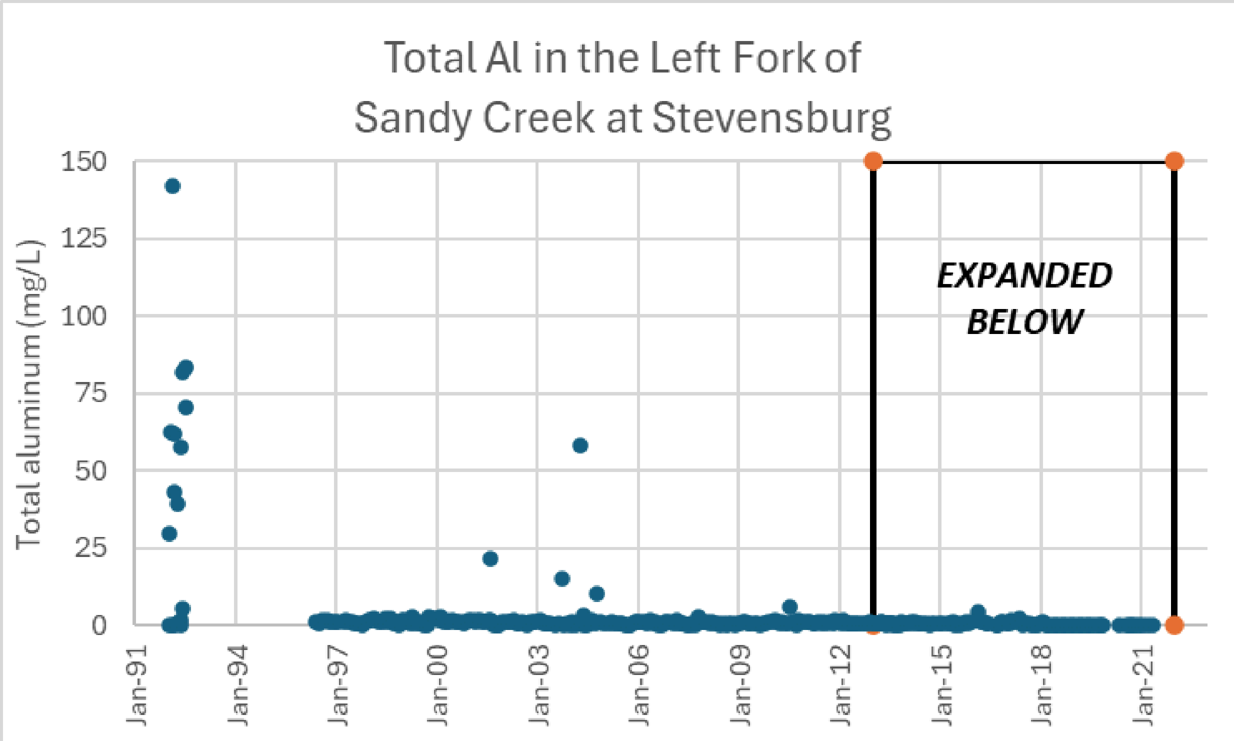
Occasionally, the water quality standards change. During the span of these data, the standard for aluminum changed. It used to be based on total aluminum concentration, but it was changed to dissolved aluminum in 2001.

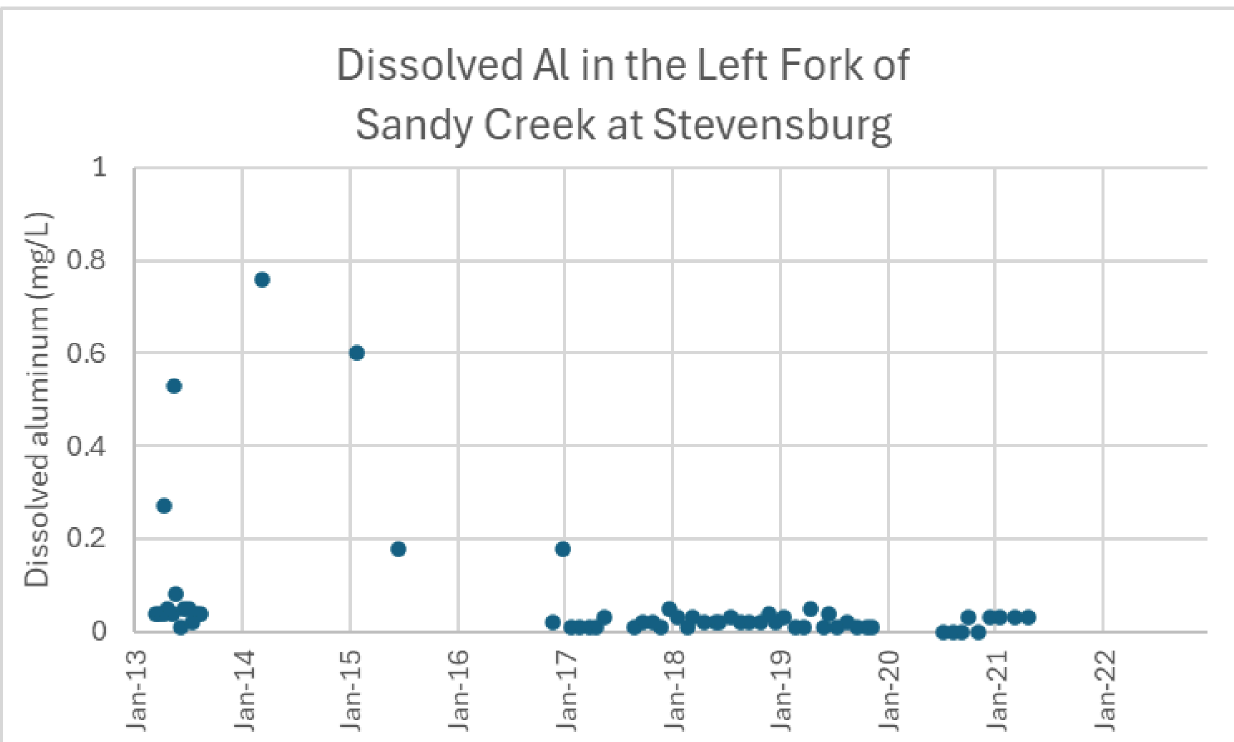
Current standards are set forth in 47CSR02 (link).




Total Fe in the Left Fork of
Sandy Creek at Stevensburg
Total iron (mg/L)
400
300
200
100
0
EXPANDED
BELOW
Jan-91
Jan-94
Jan-97
Jan-00
Jan-03
Jan-06
Jan-09
Jan-12
Jan-15
Jan-18
Jan-21


Total Fe in the Left Fork of
Sandy Creek at Stevensburg
Total iron (mg/L)
10
8
6
4
2
0
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22


Total Al in the Left Fork of
Sandy Creek at Stevensburg
Total aluminum (mg/L)
150
125
100
75
50
25
0
EXPANDED
BELOW
Jan-91
Jan-94
Jan-97
Jan-00
Jan-03
Jan-06
Jan-09
Jan-12
Jan-15
Jan-18
Jan-21


Dissolved Al in the Left Fork of
Sandy Creek at Stevensburg
Dissolved aluminum (mg/L)
1
0.8
0.6
0.4
0.2
0
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20
Jan-21
Jan-22