Susquehanna River Basin Commission

West Branch Susquehanna Subbasin Year-1 Survey

Publication 268
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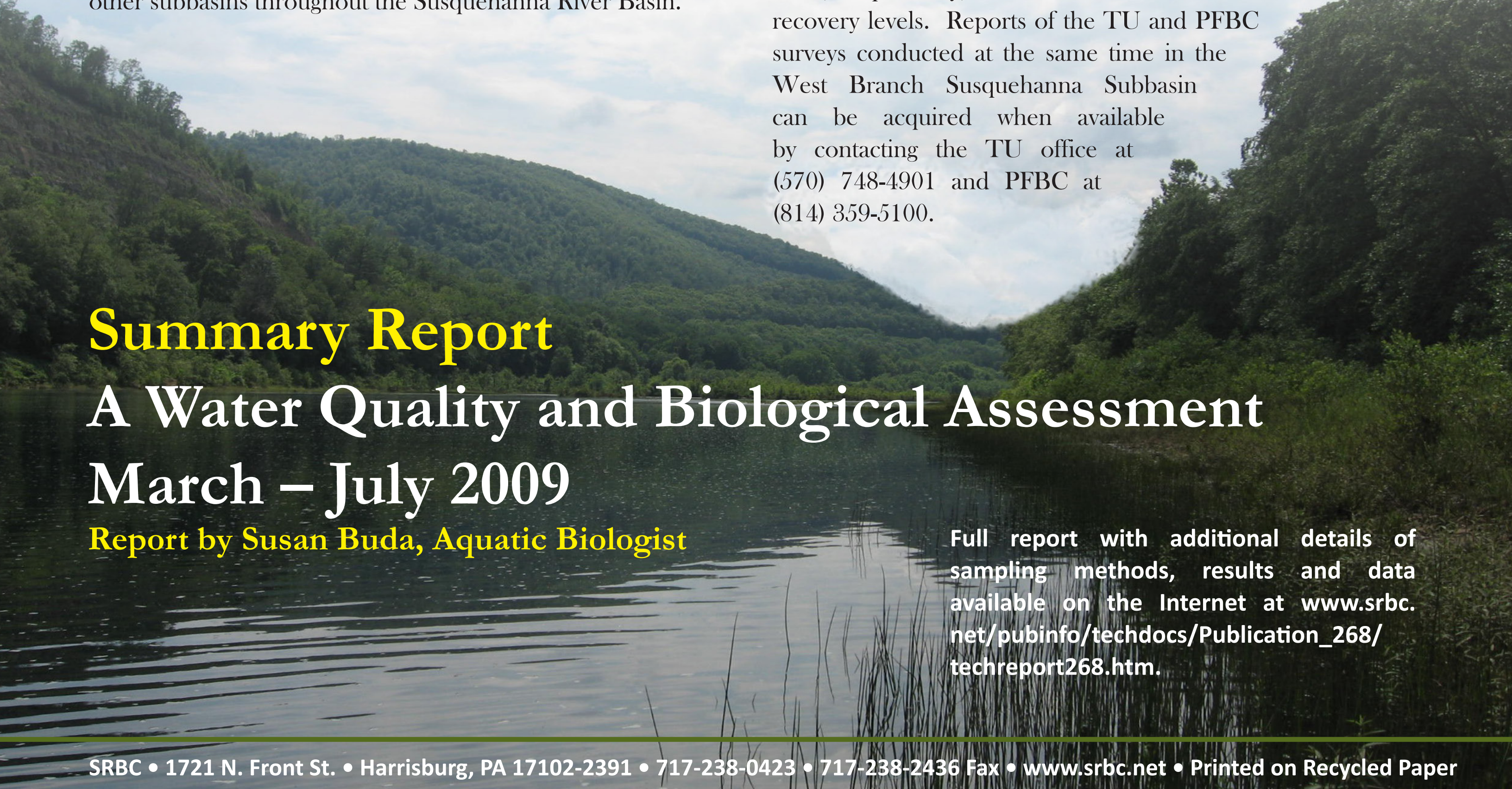
Executive Summary

The West Branch Susquehanna Subbasin Year-1 Survey is a stream quality assessment based on one-time sampling of water chemistry, biological, and habitat conditions throughout the West Branch Subbasin from March to July 2009. Pollution concerns in this subbasin are mostly due to resource extraction activities as land use is mostly forested. Abandoned mine drainage (AMD) was the most prevalent pollution issue in addition to concern about impacts from atmospheric deposition. The 141 tributary and mainstem river sites that were sampled are listed in the appendix of the report along with location description information. These sites have a corresponding site number displayed on maps and tables in the report providing site specific information including water quality, biological, and habitat condition categories. Historical data from previous subbasin surveys at these sites in the West Branch Subbasin were compared to current conditions and improvement was noted. Approximately 46 percent of AMD-impacted sites had improved in the percentage of Ephemeroptera (mayflies) from 1994 to 2009. In particular, improvement in Ephemeroptera was observed in the West Branch mainstem from 2002 to 2009 in the section from Clearfield to Jersey Shore, Pa. Despite these improvements, the streams in the West Branch Subbasin continue to be more impaired than other subbasins throughout the Susquehanna River Basin.

Introduction

The Susquehanna River Basin Commission (SRBC) conducted a water quality and biological survey of the West Branch Susquehanna Subbasin from March to July 2009. This survey is part of SRBC's Subbasin Survey Program, which is funded in part by the United States Environmental Protection Agency (USEPA). The Subbasin Survey Program consists of two-year assessments in each of the six major subbasins (Figure 1) on a rotating schedule. This report summarizes the Year-1 survey, which consists of point-in-time water chemistry, macroinvertebrate, and habitat data collection and assessment of the major tributaries and areas of interest throughout the West Branch Susquehanna Subbasin. The Year-2 survey is being conducted in the Drury Run and Birch Island Run Watersheds from March to November 2010, focusing on abandoned mine drainage (AMD) impacts and restoration needs, particularly with regard to brook trout habitat. Previous SRBC surveys of the West Branch Susquehanna Subbasin were conducted in 1983 (McMorran, 1985), 1994 (data summarized in LeFevre, 2003), and 2002 (LeFevre, 2003). The 2009 survey was conducted in partnership with Trout Unlimited (TU) and the Pennsylvania Fish and Boat Commission (PFBC), which repeated methods and sites from historical surveys on the West Branch Susquehanna River previously done by U.S. Geological Survey (USGS) in 1984 (Hanley and Barker, 1993) and PFBC in 1998-1999, respectively, in order to determine AMD recovery levels. Reports of the TU and PFBC surveys conducted at the same time in the West Branch Susquehanna Subbasin can be acquired when available by contacting the TU office at (570) 748-4901 and PFBC at (814) 359-5100.



Summary Report

A Water Quality and Biological Assessment March – July 2009

Report by Susan Buda, Aquatic Biologist

Full report with additional details of sampling methods, results and data available on the Internet at www.srbc.net/pubinfo/techdocs/Publication_268/techreport268.htm.

The West Branch Susquehanna Subbasin

The West Branch Susquehanna Subbasin drains an area of approximately 6,982 square miles from Carrolltown to Northumberland, Pennsylvania. Counties located primarily in the subbasin include Cambria, Clearfield, Elk, Cameron, Potter, Clinton, Centre, Tioga, Sullivan, Lycoming, Union, Northumberland, and Montour, all located in Pennsylvania. The subbasin boundaries include three different ecoregions:

- Northern Appalachian Plateau and Uplands,
- North Central Appalachians, and
- Central Appalachian Ridges and Valleys (Omernick, 1987; USEPA, 2007).

All the sites sampled in the subbasin, however, were located in the North Central Appalachians and the Central Appalachian Ridges and Valleys. The West Branch Subbasin contains some of the most scenic forestland in Pennsylvania and a large portion of the subbasin is located in the Pennsylvania Wilds (http://www.pawilds.com/index.aspx), an area of Northcentral Pennsylvania comprised of more than one million acres of public land with numerous recreational and tourism opportunities. Figure 2 shows the land use in the West Branch Susquehanna Subbasin, which is mostly forested with numerous state forests and gamelands.

Figure 1. Six Major Subbasins of the Susquehanna River

Agricultural lands are located mostly in the southeastern portion of the subbasin and urban areas are mostly small and scarce, especially in the central and northwestern areas. The largest urban centers in the subbasin are Williamsport, State College, Lock Haven, and Clearfield. A prominent industry in the subbasin is resource extraction. Coal extraction activity prior to current regulations left numerous abandoned mine lands and problems with AMD severely impacting streams (Figure 2). Natural gas extraction activities also are growing in this region, with recent interest in areas underlain by the Marcellus Shale formation. Concern over the natural gas extraction activities, which include technologies and methods new to Pennsylvania and New York, has prompted SRBC to initiate a Remote Water Quality Monitoring Network program. This program concentrates on smaller rivers and streams where the gas extraction activities occur and where only minimal data and monitoring exist due to the remote location. More information on this program is available at http://www.srbc.net/programs/remotenetwork.htm.

The West Branch Susquehanna Subbasin had the most extensive impact from AMD than any other subbasin in the Susquehanna River Basin. AMD impacts water quality by increasing acidity (decreasing pH and alkalinity), and increasing metals, especially iron, aluminum, and manganese. Sulfate is often elevated in AMD-impacted streams also. These water quality conditions are detrimental to the aquatic biota living in these streams. Low pH conditions (approximately less than 5.5) can cause respiratory or osmoregulatory failure depending on individual species tolerance levels (Kimmel, 1983; Potts and McWilliams, 1989). Mayflies, in general, are detrimentally impacted by low pH conditions, whereas some stoneflies and caddisflies can tolerate low pH conditions (Sutcliffe and Hildrew, 1989; Earle and Callaghan, 1998; Kimmel, 1999). Heavy metals, such as aluminum, can be toxic to aquatic life, especially in low pH conditions (Baker and Schofield, 1982; Earle and Callaghan, 1998). Also, elevated metals can cause habitat problems due to precipitation onto surfaces, which disrupts habitat niches, coats gills, smothers eggs, and can increase turbidity (Hoehn and Sizemore, 1977).

Another pollution problem in this region is acidic atmospheric deposition. This includes wet and dry deposition of sulfur, nitrogen, and other compounds in air pollution, often due to the burning of fossil fuels. The impacts of acidic deposition are usually noticed in the higher elevations or ridgetops that receive more deposition due to the orographic effect, and also have geologic formations that are unable to buffer acidic conditions (Sharpe et al., 1984; Kimmel, 1999). Also, the impacts of acidic deposition are usually more severe at higher flow conditions (Sharpe et al., 1984; Kimmel, 1999). Streams impaired from atmospheric deposition have low alkalinity and elevated aluminum during high flows (Sharpe et al, 1984; Kimmel, 1999).

The aluminum is leached from the soil when other minerals such as calcium and magnesium are not available or already depleted (Swistock et al., 1989). Macroinvertebrate community impairment can be difficult to determine since many stoneflies sensitive to other kinds of pollution are tolerant of acidic conditions. A large increase in Diptera (true flies) and a decrease in Ephemeroptera (mayflies) is often an indication of atmospheric deposition impairment (Earle and Callaghan, 1998; Kimmel, 1999). Detrimental impacts to fish populations can occur with atmospheric deposition as aluminum is toxic at levels higher than 200 µg/l when pH values are lower than 5.0 for sustained periods (Baker and Schofield, 1982; Gagen et al., 1993). More information on atmospheric deposition and data from deposition across the United States is available at the National Atmospheric Deposition Program's web site at http://nadp.sws.uiuc.edu/.

The West Branch Susquehanna Subbasin had the most extensive impact from AMD than any other subbasin in the Susquehanna River Basin.

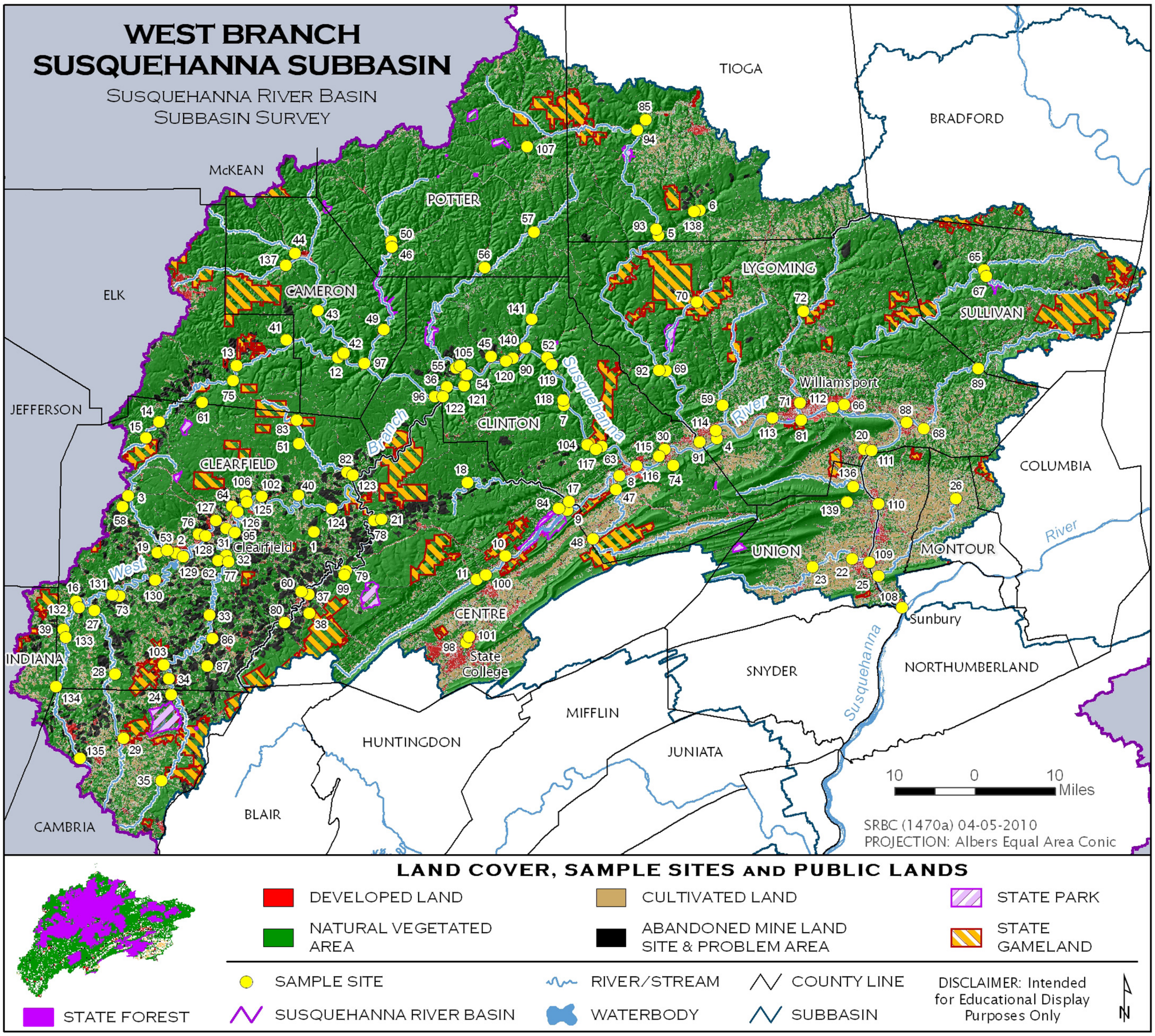


Figure 2. Land Cover, Sample Sites, and Public Lands in the West Branch Susquehanna Subbasin

Methods

From March to July 2009, SRBC and TU staff collected samples from 141 stream sites throughout the West Branch Susquehanna Subbasin. The appendix contains a sample site list with the sample site number, station name (designated by approximate stream mile), sample location description, county, latitude and longitude, ecoregion, and drainage size. The drainage size designation was based on drainage areas, which were divided into small (<100 square miles), medium (100–500 square miles), and large (>500 square miles). Many of the stations listed were sampled in the historical surveys of 2002 and 1994. Stations that were not sampled in 1994 are marked with an asterisk. Stations that were only sampled in 2009 (not sampled in 1994 and 2002) are marked with two asterisks.

Staff sampled the West Branch Susquehanna Subbasin Survey sites once during the Year-1 effort to provide a point-in-time picture of stream characteristics throughout the whole subbasin. Water quality was assessed by examining field and laboratory parameters that included nutrients, major ions, and metals. A list of field and laboratory parameters and their units is found in Table 1.

Table 1. Water Quality Parameters Sampled in the West Branch Susquehanna Subbasin Survey

Field Parameters	
Flow, instantaneous cfs[a]	Conductivity, µmhos/cm[c]
Temperature, °C	Alkalinity, mg/l
pH	Acidity, mg/l
Dissolved Oxygen (DO), mg/l[b]	
Laboratory Analysis	
Alkalinity, mg/l	Total Magnesium, mg/l
Total Suspended Solids (TSS), mg/l	Total Sodium, mg/l
Total Nitrogen, mg/l	Chloride, mg/l
Nitrite - N, mg/l	Sulfate - IC, mg/l
Nitrate - N, mg/l	Total Iron, µg/l[e]
Turbidity, NTU[d]	Total Manganese, µg/l
Total Organic Carbon (TOC), mg/l	Total Aluminum, µg/l
Total Hardness, mg/l	Total Phosphorus, mg/l
Total Calcium, mg/l	Total Orthophosphate, mg/l
Total Dissolved Solids (TDS), mg/l	

[a] cfs = cubic feet per second
[b] mg/l = milligram per liter
[c] µmhos/cm = micromhos per centimeter
[d] NTU = nephelometric turbidity units
[e] µg/l = micrograms per liter

Table 2. Water Quality Levels of Concern and References

Parameters	Limits	Reference Code
Temperature	>25 °C	a,f
D.O.	<5 mg/l	a,g,i
Conductivity	>800 µmhos/cm	d
pH	<5.0	c,f,g
Acidity	>20 mg/l	m
Alkalinity	<20 mg/l	a,g
TSS	>25 mg/l	h
Nitrogen*	>1.0 mg/l	j
Nitrite-N	>0.5 mg/l	f,i
Nitrate-N*	>0.6 mg/l	j,k
Turbidity	>150 NTU	h
Phosphorus	>0.1 mg/l	e,j,k
Orthophosphate	>0.05 mg/l	l,j,k
TOC	>10 mg/l	b
Hardness	>300 mg/l	e
Calcium	>100 mg/l	m
Magnesium	>35 mg/l	l,i
Sodium	>20 mg/l	i
Chloride	>250 mg/l	a,i
Sulfate	>250 mg/l	a,i
Iron	>1,500 µg/l	a
Manganese	>1,000 µg/l	a
Aluminum	>750 µg/l >200 µg/l, pH <5.0	n,c
TDS	>500 mg/l	a

Reference Code & References	
a	http://www.pacode.com/secure/data/025/chapter93/s93.7.html
b	Hem (1970) - http://water.usgs.gov/pubs/wsp/wsp2254/
c	Gagen and Sharpe (1987) and Baker and Schofield (1982)
d	http://www.uky.edu/WaterResources/Watershed/KRB_AR/wq_standards.htm
e	http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm
f	http://www.hach.com/h2ou/h2wtrqual.htm
g	http://sites.state.pa.us/PA_Exec/Fish_Boat/education/catalog/pondstream.pdf
h	http://www.epa.gov/waterscience/criteria/sediment/appendix3.pdf
i	http://www.dec.ny.gov/regs/4590.html
j*	http://water.usgs.gov/pubs/circ/circ1225/images/table.html
k	http://pubs.usgs.gov/circ/circ1136/
l	http://www.epa.gov/waterscience/criteria/goldbook.pdf
m	based on archived data at SRBC
n	http://www.epa.gov/waterscience/criteria/wqctable/

* Background levels for natural streams

SRBC staff member processes the macroinvertebrate sample on the West Branch Susquehanna River.

Staff compared the data collected to water chemistry levels of concern based on current state and federal regulations, background levels of stream chemistry, or references for approximate tolerances of aquatic life (Table 2). For this 2009 survey, SRBC added Total Dissolved Solids (TDS) to the water quality parameters analyzed in the laboratory in order to obtain baseline data in the West Branch Susquehanna Subbasin, which is a significant location for recent natural gas drilling and potential waterways for drilling wastewater disposal or accidental spills. Also, this parameter was added in order to detect any impacts that may already have occurred. Flowback and produced water from natural gas drilling has very high TDS concentrations.

Staff collected macroinvertebrate samples and conducted habitat assessments using a slightly modified version of USEPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (RBP III) (Barbour and others, 1999). Detailed sampling methods, more detailed results for individual watersheds, and a link to the raw data can be found on SRBC's web site at http://www.srbc.net/pubinfo/techdocs/publication_268/techreport268.htm.

Results/Discussion

Water quality, biological (macroinvertebrate) community, and habitat site conditions for each sampling site in 2009 throughout the West Branch Susquehanna Subbasin are depicted in Figure 3. Almost half of the sites (46 percent) had moderately or severely impaired biological conditions and 78 percent exceeded at least one water quality level of concern. This was largely due to AMD pollution problems in this subbasin. The habitat, however, was mostly excellent (43 percent) or supporting (46 percent) due to the remote and forested nature of a large portion of this subbasin. The best quality sites were located in the headwaters of Sinnemahoning Creek Watershed, Pine Creek Watershed, headwaters of Kettle Creek, Bucktail State Park Natural Area (from Renovo to Lock Haven, Pa.), and around Williamsport, Pa. The worst quality sites were located in the headwaters area of the West Branch Susquehanna Subbasin around Clearfield County and in Clinton County, with the largest impaired watershed areas being Clearfield Creek and Moshannon Creek.

Thirty-one sites had the highest water quality rating (higher quality), 32 sites scored the highest biological rating (nonimpaired), and 59 sites had the highest habitat rating (excellent); however, there were no sites that had the highest level of conditions for all three categories. Nineteen of the sites that had nonimpaired biological conditions and excellent habitat had middle water quality due to exceeding alkalinity standards. In fact, alkalinity was the parameter that exceeded levels of concern at the highest number of sites (78) (Table 3). This parameter was exceeded at 55 percent of the sites throughout the West Branch Susquehanna Subbasin. The second highest number of sites to exceed levels of concern was 23 for aluminum. Also, manganese, nitrogen, and nitrate-n had around 20 sites that exceeded the levels of concern for these parameters. The highest number of levels of concern exceeded at a single site was nine for Roaring Run (ROAR 0.9). Muddy Run (MUDR 4.5) had eight parameters that exceeded levels of concern.

The highest or lowest value for each parameter is printed in bold in Table 3. The metals associated with AMD (aluminum, iron, and manganese) had the highest levels at Alder Run (ALDR 4.7) of 8,370 µg/l, 10,400 µg/l, and 5,890 µg/l, respectively. This site also had the lowest pH (2.9), the lowest alkalinity (zero), and the highest acidity (112 mg/l). Many sites (11) had the lowest alkalinity value of zero. The highest values for nitrogen and nitrate-n were 3.23 mg/l and 3.17 mg/l, respectively, at Slab Cabin Run (SLAB 0.2). The highest level of orthophosphate was 0.065 mg/l at Montgomery Creek (MONT 0.2). The highest level of sulfate (352 mg/l) and TDS (608 mg/l) were at MUDR 4.5 (Table 3). For more information on the particular levels of concern and the effects to water quality and aquatic life, please see the references listed in Table 2. A more detailed discussion of the results is available in the long version of the report on SRBC's web site at http://www.srbc.net/pubinfo/techdocs/publication_268/techreport268.htm.

Table 3. West Branch Susquehanna Subbasin Sites with Water Quality Values Exceeding Levels of Concern

Site #	Station ID	Date	Time	Alkalinity < 20 mg/l	Al > 750 ug/l*	Hardness > 300 mg/l	Iron >1,500 ug/l	Mg > 35 mg/l	Mn >1,000ug/l	Nitrate > 0.6 mg/l	Nitrogen > 1.0 mg/l	OrthoP >0.05 mg/l	Sodium > 20 mg/l	Sulfate > 250 mg/l	TSS > 25 mg/l	TDS > 500 mg/l	Acidity > 20 mg/l	D.O. < 5.0 mg/l	pH < 5.0	# Exceeds
1	ALDR 4.7	06-02-2009	11:00:00	**0**	**8370**		**10400**		**5890**					263			**112**		**2.9**	**7**
2	ANDR 0.4	06-02-2009	15:00:00	4																**1**
3	ANDR 12.3	06-02-2009	10:45:00	5.2																**1**
4	ANTE 0.1	06-03-2009	13:30:00							1.2	1.33									**2**
5	BABB 0.1	06-02-2009	15:30:00	17.4																**1**
6	BABB 7.2	06-02-2009	14:30:00	4.6																**1**
7	BAKR 0.1	06-17-2009	14:45:00	3.8																**1**
8	BALD 4.5	06-30-2009	13:30:00							0.99	1.33									**2**
9	BALD 14.0	06-30-2009	11:20:00							1.1	1.57									**2**
10	BALD 24.7	06-24-2009	09:55:00							1.94	2									**2**
12	BBSC 3.8	06-08-2009	14:50:00	4																**1**
13	BBSC 17.6	06-08-2009	12:50:00	2.2																**1**
16	BEAR 0.1	03-26-2009	10:00:00	0.8	850		2520		1680											**4**
17	BECH 1.7	05-01-2009	08:30:00	0.2	536														4.7	**3**
18	BECH 20.3	06-15-2009	12:30:00	0	1660		4190		2900								30		3.7	**6**
19	BILG 0.1	06-02-2009	13:15:00	8.6																**1**
21	BLMO 0.1	06-02-2009	13:25:00	2																**1**
22	BUFF 0.2	06-08-2009	12:00:00							1.68	1.95									**2**
23	BUFF 10.4	06-08-2009	11:00:00							1.66	1.83									**2**
25	CHLL 0.9	06-08-2009	08:00:00							1.52	1.76									**2**
26	CHLL 19.3	06-08-2009	09:30:00							0.95	1.15									**2**
28	CHST 13.2	06-04-2009	07:00:00							0.78										**1**
29	CHST 24.5	06-04-2009	14:50:00							0.92	1.12									**2**
30	CHTM 0.1	06-03-2009	16:00:00		1025		1844								38					**3**
31	CLFD 0.9	06-03-2009	07:00:00						1819											**1**
32	CLFD 8.2	04-07-2009	13:30:00								1.46									**1**
33	CLFD 22.8	06-03-2009	12:51:00				1531		1553											**2**
34	CLFD 42.2	06-04-2009	12:00:00						1360											**1**
35	CLFD 60.5	06-04-2009	14:00:00							0.77										**1**
36	COKR 0.1	05-01-2009	12:49:00	0	1790		2250										32		3.1	**5**
37	COLD 1.1	06-01-2009	10:40:00	1			1630													**2**
38	COLD 3.6	06-01-2009	14:35:00	7.4																**1**
40	DEER 0.2	05-04-2009	15:00:00	0	735				1500										4.65	**4**
41	DENT 0.6	06-08-2009	14:00:00		1200				2230										4.2	**3**
42	DRFT 0.1	06-10-2009	08:40:00	14.8																**1**
43	DRFT 9.9	06-10-2009	07:20:00	15																**1**
44	DRFT 21.2	06-09-2009	13:45:00	11.6																**1**
45	DRUR 0.7	06-16-2009	17:25:00	0.2	836															**2**
46	EAST 0.1	06-09-2009	09:20:00	13.4																**1**
47	FISH 2.1	06-18-2009	09:15:00							2.15	2.29									**2**
48	FISH 13.3	06-18-2009	11:40:00							1.3	1.48									**2**
49	FRST 5.3	06-10-2009	10:00:00	13.8																**1**
50	FRST 19.1	06-09-2009	07:30:00	17.4																**1**
51	GIFF 1.6	06-03-2009	11:45:00	2.2															4.9	**2**
52	HYNR 0.1	06-15-2009	18:45:00	9.4																**1**
54	KTTL 0.2	06-16-2009	15:20:00	11																**1**
55	KTTL 2.1	06-16-2009	14:05:00	11.8																**1**
56	KTTL 25.3	06-16-2009	11:15:00	13.2																**1**
57	KTTL 34.1	06-16-2009	09:00:00	11.8																**1**
58	LAND 1.7	06-02-2009	12:00:00	0	4150		3470		3710								60		3.1	**6**
59	LARR 2.9	06-03-2009	10:00:00	13.6																**1**
60	LAUR 0.1	06-01-2009	16:15:00	7.4		307		39.4	3980					302						**5**
61	LAUR 3.2	06-08-2009	10:40:00	3.8																**1**
63	LICK 0.2	06-22-2009	17:05:00	7.4																**1**
64	LICK 0.3	04-23-2009	14:30:00	0.6																**1**

Site #	Station ID	Date	Time	Alkalinity <20 mg/l	Al >750 ug/l*	Hardness >300 mg/l	Iron >1,500 ug/l	Mg >35 mg/l	Mn >1,000 ug/l	Nitrate >0.6 mg/l	Nitrogen >1.0 mg/l	Ortho P >0.05 mg/l	Sodium >20 mg/l	Sulfate >250 mg/l	TSS > 25 mg/l	TDS > 500 mg/l	Acidity > 20 mg/l	D.O. < 5.0 mg/l	pH < 5.0	# Exceeds
66	LLSK 1.2	06-01-2009	17:00:00	13.4																**1**
67	LLSK 37.2	06-01-2009	11:15:00	4.8																**1**
68	LMUN 0.1	06-01-2009	14:00:00							1.46	1.61									**2**
69	LPIN 0.2	06-02-2009	18:00:00	15																**1**
71	LYCO 2.0	06-03-2009	08:30:00	15.8																**1**
72	LYCO 17.7	06-03-2009	07:30:00	11.6																**1**
74	MCEL 2.0	06-03-2009	14:30:00	7.4																**1**
75	MEDX 0.1	06-08-2009	11:50:00	8.2																**1**
76	MONT 0.2	04-07-2009	14:10:00	0.2	529						1.3	**0.065**								**4**
77	MORG 0.2	06-03-2009	11:15:00	0	2081				5145								24		3.4	**5**
78	MOSH 5.1	06-02-2009	13:30:00	0	2490				2230										3.2	**4**
79	MOSH 19.1	06-04-2009	13:15:00	0	2000	301	2880		2580								28		3.9	**7**
80	MOSH 39.9	05-07-2009	10:43:00		2019		4778		2218										4.6	**4**
82	MOSQ 1.0	06-03-2009	14:30:00	2																**1**
83	MOSQ 13.8	06-03-2009	09:50:00	0.8	207														4.2	**3**
85	MRSH 1.6	06-02-2009	11:30:00									0.055								**1**
86	MUDR 0.3	04-07-2009	10:50:00		1137		2915		2533		1.13			256						**5**
87	MUDR 4.5	06-03-2009	14:00:00		985	**362**	1783	38.4	5271					**352**		**608**	22			**8**
88	MUNC 1.1	06-01-2009	16:00:00							0.92	1.06									**2**
89	MUNC 18.8	06-01-2009	12:30:00	16.2																**1**
90	PADY 0.1	06-17-2009	07:40:00	8.2																**1**
92	PINE 14.2	06-03-2009	11:30:00	17.8																**1**
94	PINE 57.5	06-02-2009	11:00:00	15.6																**1**
95	ROAR 0.9	06-03-2009	08:10:00	**0**	2516		1708	35.7	5604					306		534	38		3.5	**9**
96	SINN 0.2	06-10-2009	11:15:00	10.4														**4.79**		**2**
97	SINN 11.9	06-10-2009	09:30:00	9.8																**1**
98	SLAB 0.2	06-18-2009	17:30:00							**3.17**	**3.23**		**27.7**							**3**
99	SMIL 0.1	06-04-2009	10:25:00	7.8																**1**
100	SPRG 0.2	06-18-2009	14:00:00							3.03	3.21									**2**
101	SPRG 14.8	06-18-2009	16:05:00							3.04	3.18									**2**
102	SURV 0.3	04-23-2009	11:15:00	0	2427				3041					322						**4**
104	TANG 0.2	06-22-2009	13:15:00	4.8																**1**
105	TMIL 0.1	05-01-2009	14:51:00	**0**	2710		1870		2180								36		3.3	**6**
106	TROT 0.1	06-02-2009	09:00:00	1.6																**1**
107	WBPC 3.5	06-02-2009	09:30:00	10.6																**1**
111	WBSR 23.0	07-07-2009	10:20:00												**52**					**1**
115	WBSR 64.0	07-06-2009	14:05:00	12																**1**
116	WBSR 69.0	07-06-2009	12:15:00	11.8																**1**
117	WBSR 75.0	07-01-2009	15:40:00	8.6																**1**
118	WBSR 83.0	07-01-2009	13:20:00	9																**1**
119	WBSR 91.0	07-01-2009	11:30:00	8.6																**1**
120	WBSR 97.0	07-01-2009	09:40:00	9.2																**1**
121	WBSR 103.8	06-30-2009	17:00:00	9.2																**1**
122	WBSR 110.0	06-29-2009	11:00:00	10.6																**1**
123	WBSR 131.0	06-29-2009	12:45:00	10																**1**
124	WBSR 142.0	06-29-2009	13:45:00	13																**1**
132	WBSR 208.0	06-30-2009	16:45:00										20.6							**1**
133	WBSR 214.0	07-01-2009	08:20:00										25.4							**1**
134	WBSR 224.0	07-01-2009	11:45:00										25.9							**1**
135	WBSR 235.0	07-01-2009	14:47:00	8.6	2603		2557			0.68			25.8							**5**
137	WEST 2.0	06-09-2009	12:10:00	13.4																**1**
138	WILS 0.5	06-02-2009	13:00:00	17.2	1208				2034											**3**
139	WTDR 3.7	06-04-2009	11:00:00	9.4																**1**
140	YGWO 0.5	06-17-2009	11:30:00	10.8																**1**
141	YGWO 4.5	06-17-2009	09:55:00	10																**1**
	# Exceeds			**78**	**23**	**3**	**15**	**3**	**20**	**19**	**19**	**2**	**5**	**6**	**2**	**2**	**9**	**1**	**15**	

Bold numbers are highest or lowest value exceeding levels of concern

* Aluminum >750 ug/l for all waters and >200 ug/l for waters with pH < 5.2.

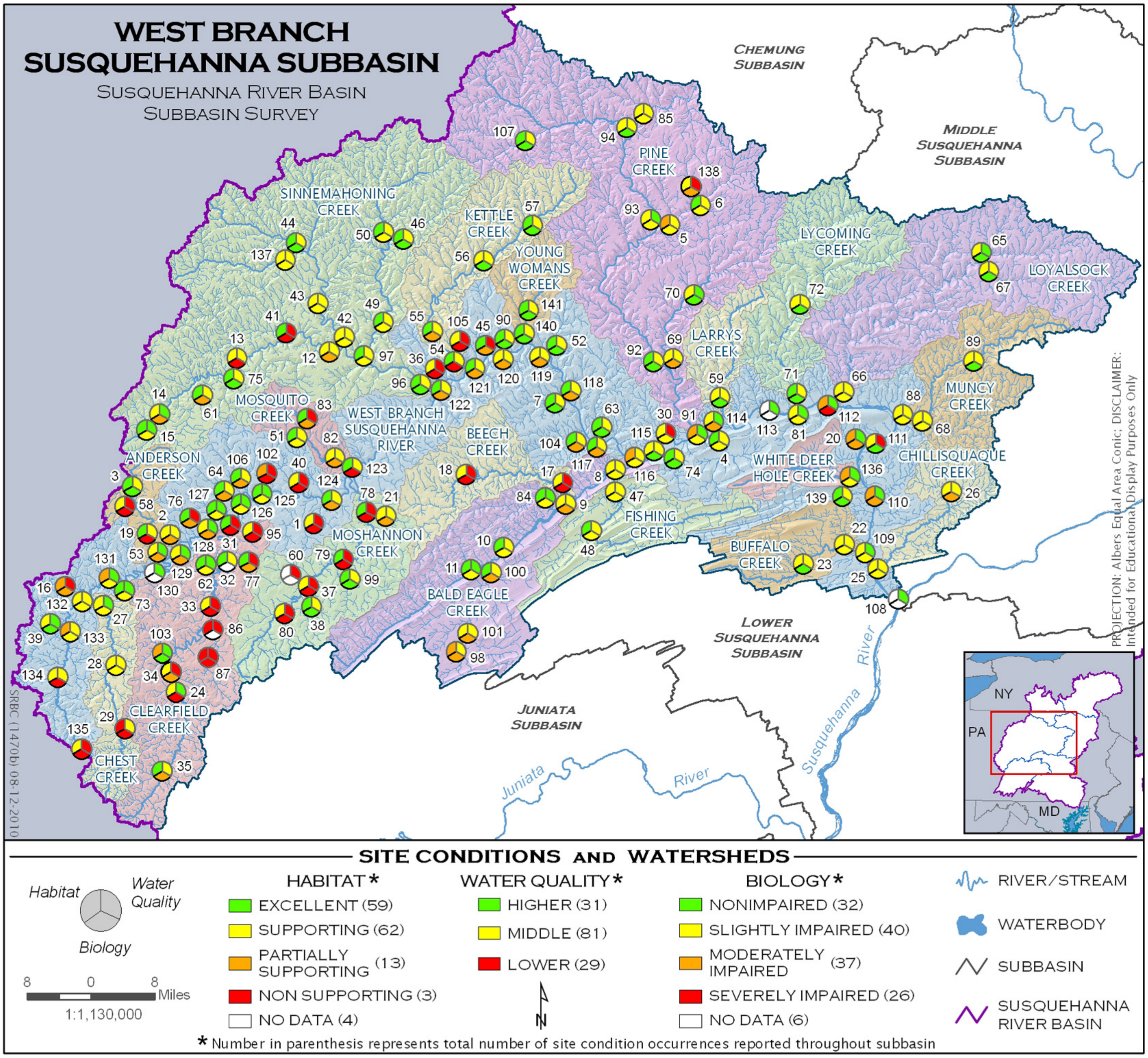


Figure 3. Water Quality, Biological, and Habitat Conditions in the West Branch Susquehanna Subbasin in 2009

Historical Data Comparison

A comparison of the current 2009 data to historical data indicates that overall conditions in the West Branch Susquehanna Subbasin have improved over the years from the first time SRBC sampled in 1983. In particular, the AMD conditions appear to have improved, which may have been due to natural processes, but also was most likely facilitated by the numerous remediation efforts happening in many of the watersheds. The historical data comparison includes assessment of overall condition categories, water quality values exceeding levels of concern, and metric values able to detect AMD conditions.

Biological, water quality, and habitat conditions from the subbasin survey in 2002 (LeFevre, 2003) are depicted in Figure 4. The distribution of conditions was similar to that in 2009 (Figure 3) with the red colors (severely impaired, “lower”, and nonsupporting conditions) located in the abandoned mine land areas in the western portion of the subbasin and the green colors (nonimpaired, “higher”, and excellent) located in the northern and eastern portions of the subbasin. The watersheds that were higher quality and reference watersheds in 2002 continued to be higher quality in 2009. Some individual watersheds showed improvement, such as Babb Creek, Cush Creek, and Sinnemahoning Creek, and many sites on the West Branch Susquehanna River mainstem showed marked improvement from 2002 to 2009.

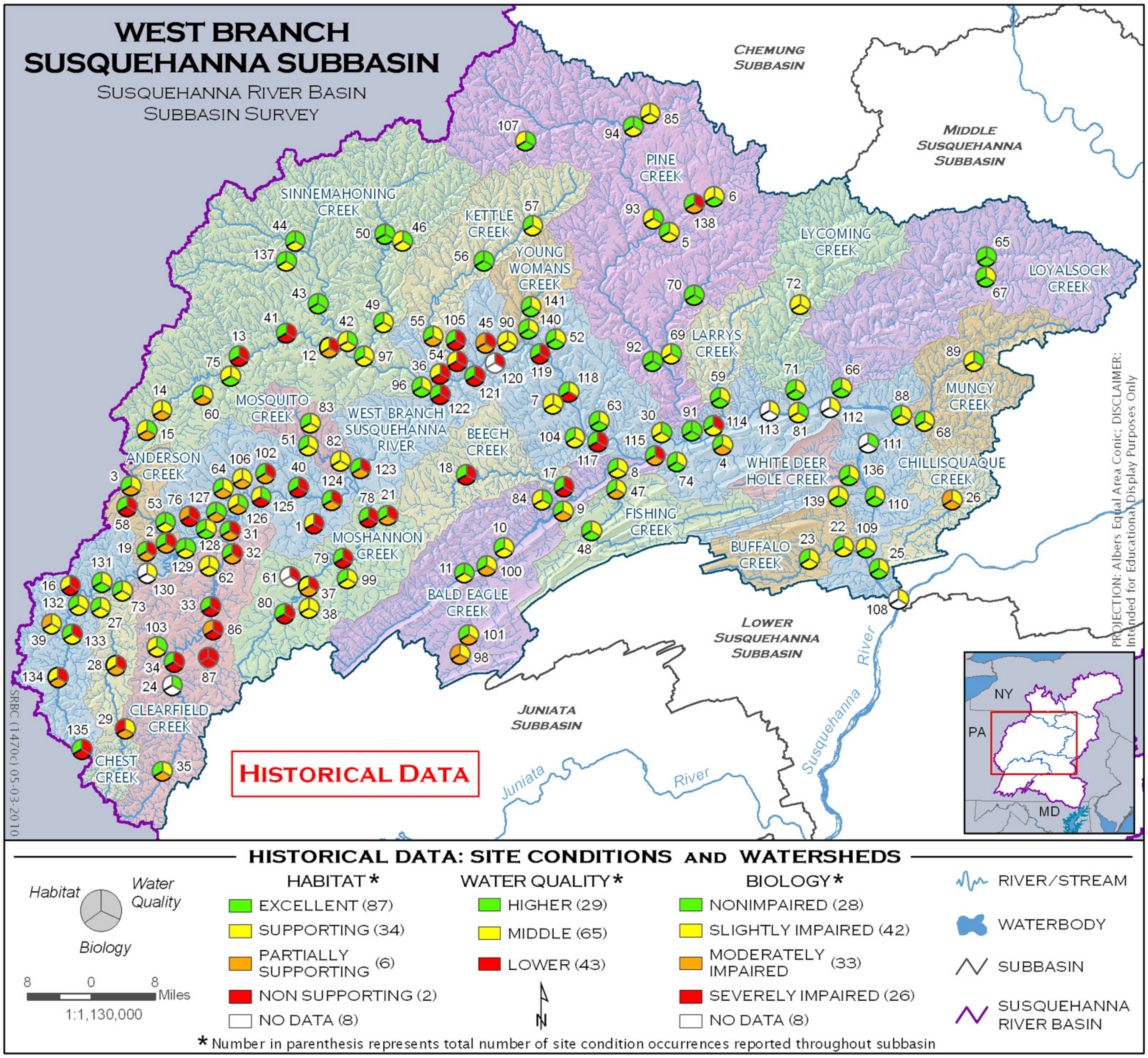


Figure 4. Water Quality, Biological, and Habitat Conditions in the West Branch Susquehanna Subbasin in 2002

Figures 5–8 show the percentage of biological condition categories in the different subbasin surveys in 1983, 1994, 2002, and 2009 for the sites that were sampled in all four surveys. These pie charts indicate that biological condition has improved from 1983 to 2009. The percentage of severely impaired stream sites has decreased from 38 percent in 1983 and 1994 to 18 and 15 percent in 2002 and 2009, respectively. The percentage of moderately and severely impaired sites has decreased from 52 percent and 54 percent in 1983 and 1994, respectively, to 43 percent and 45 percent in 2002 and 2009, respectively.

Table 4 shows the number of sites with water quality values exceeding levels of concern for sites sampled in both 2009 and 2002. This table indicates that alkalinity was the parameter that was exceeded at the highest number of sites for both years. In fact, the number of sites exceeding alkalinity increased slightly from 2002 to 2009, whereas all other parameters had a decrease or similar number of sites exceeding levels of concern. The decrease in the number of sites exceeding levels of concern from 2002 to 2009 may indicate improvement, or may be the result of dilution during higher flow conditions. All the sites had higher flows at the time of sampling in 2009 than in 2002, except for seven tributary and six mainstem river sites.

Table 4. Number of Sites with Water Quality Values Exceeding Levels of Concern for Sites Sampled in 2002 and 2009

Parameter	2002	2009
Acidity	40	9
Alkalinity	64	78
Aluminum T	25	23
Calcium T	9	0
DO	0	1
Hardness T	24	3
Iron T	18	15
Magnesium T	18	3
Manganese T	32	20
Nitrate-N	30	19
Nitrogen T	28	19
pH	20	15
Phosphorus T	1	0
Phos T Ortho	1	2
Sodium T	7	5
Sp. Cond	17	0
Sulfate-IC	23	6
Temp	4	0
TSS	3	2

Insects of the order Ephemeroptera are commonly known as Upwinged Flies or Mayflies. Mayflies are one of the most sensitive orders to AMD conditions.

Image Credit: R.W. Holzenthal

Alkalinity was exceeded at many sites in 2009 that did not have any parameters exceeding levels of concern in 2002, such as on Driftwood Branch Sinnemahoning, headwaters of First Fork Sinnemahoning, headwaters of Kettle Creek, Larrys Creek, headwaters of Muncy Creek, and headwaters of Pine Creek. These headwater sites that had low alkalinity values at elevated flows may indicate influence of acidic atmospheric deposition.

Alkalinity was the parameter that exceeded levels of concern at the highest number of sites — 55 percent of the sites throughout the West Branch Susquehanna Subbasin.

AMD impairment was extensive in this watershed and many tributaries and the mainstem river have been mostly void of healthy macroinvertebrate populations and fish for decades. Numerous efforts have been made to remediate AMD conditions in this watershed, and assessment of the historical data from SRBC's subbasin surveys conducted since 1994 indicates that conditions are improving. Due to different data collection and recording in 1983, the data from that survey were not used for the assessment of changing AMD conditions.

The percent Ephemeroptera metric was used to assess improvement, since Ephemeroptera (mayflies) are one of the most sensitive orders to AMD conditions. As AMD streams improve, mayflies are once again able to inhabit them. Also, percent Ephemeroptera is a metric that most likely remained correct throughout the years as taxonomists and taxonomies changed. Approximately 46 percent of AMD-impacted sites (including the mainstem sites) improved in percent Ephemeroptera from 1994 to 2009. This increase in mayflies in AMD-impacted areas indicates improvement in conditions conducive to their survival, such as lower acidity and less metal precipitate embedding the substrate.

Summary of Biological Conditions in the West Branch Susquehanna Subbasin

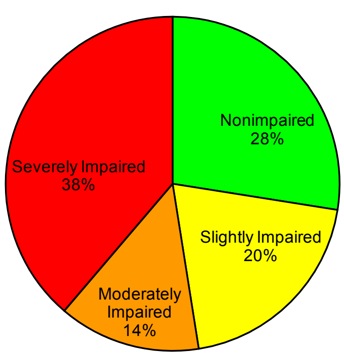


Figure 5. 1983 Biological Conditions

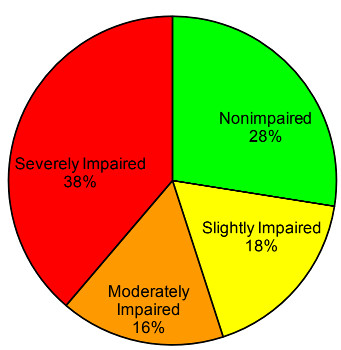


Figure 6. 1994 Biological Conditions

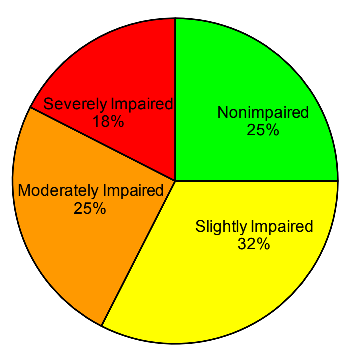


Figure 7. 2002 Biological Conditions

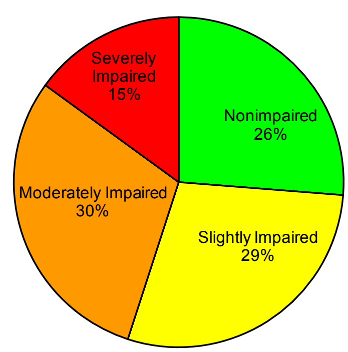


Figure 8. 2009 Biological Conditions

Figure 9 shows percent Ephemeroptera at the sites on the mainstem river (in river miles upstream from mouth) in 1994, 2002, and 2009. Arrows and letters "ND" indicate that no data were taken during that year. All other places without a bar line indicate that no mayflies were found at that site. The percentage of mayflies inhabiting the mainstem river improved mostly between the 2002 and 2009 surveys. The stretch of river from WBSR 172.3 (just upstream of Clearfield Creek in Clearfield) to WBSR 64 (just upstream of Jersey Shore) had large increases in percent mayflies in 2009. Many of the sites did not have mayflies in the 1994 and 2002 samples. The highest percentage of mayflies was found at the sites around McGees Mills. These sites had almost 70 percent Ephemeroptera. Some of the sites downstream of Jersey Shore had decreases in the percent Ephemeroptera metric in 2009. This may be due to sediment embedding the substrate and impacting macroinvertebrate habitat.

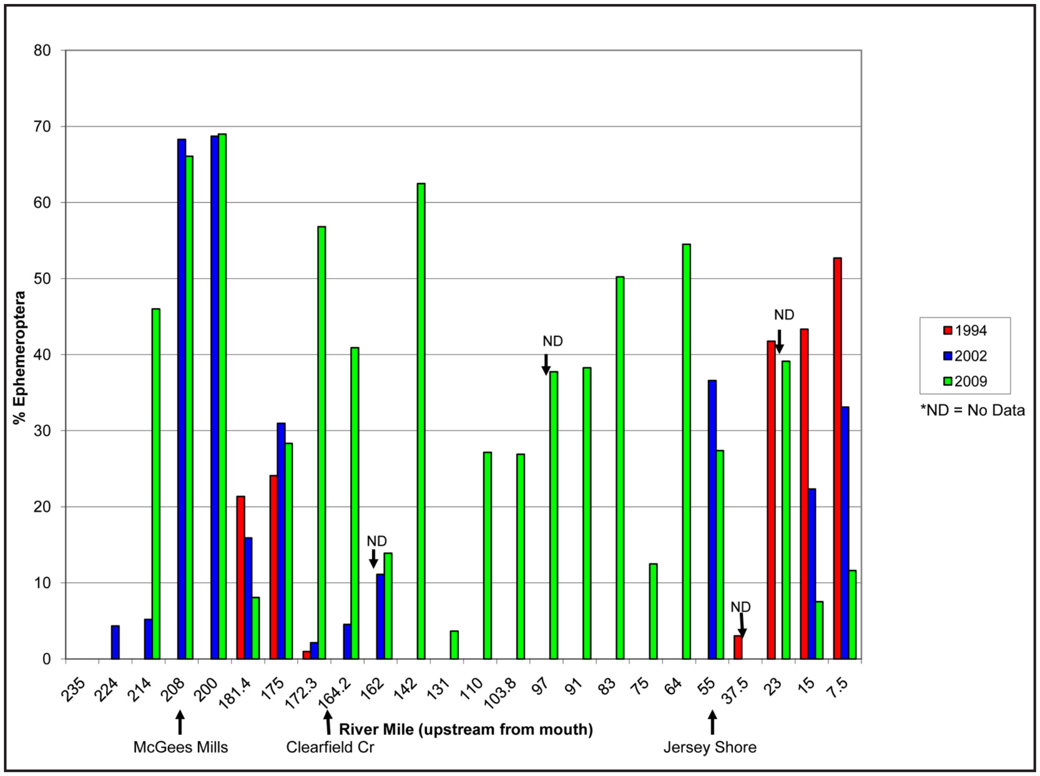


Figure 9. Percent Ephemeroptera at Mainstem Susquehanna River Sites during 1994, 2002, and 2009

Tributary watersheds that had increases of percent Ephemeroptera indicating improvements in AMD condition were Babb Creek, Chest Creek, Cush Creek, Kettle Creek, Mosquito Creek, Bennett Branch Sinnemahoning Creek, and Sinnemahoning Creek (Figure 10). Babb Creek had a large increase in mayflies in 2002 and a decrease in 2009, although the percentage of mayflies is larger than 20 percent (higher than 25 percent mayflies in the sample indicates healthy conditions). Remediation of Babb Creek began in 1990. In 2009, 14 miles of Babb Creek were removed from the 303(d) list of impaired waters. Chest Creek, Cush Creek, and Sinnemahoning Creek showed significant improvement throughout the years and all have percent Ephemeroptera values higher than 25 percent. Kettle Creek, Mosquito Creek, and Bennett Branch Sinnemahoning Creek appear to have started improving, but need additional restoration.

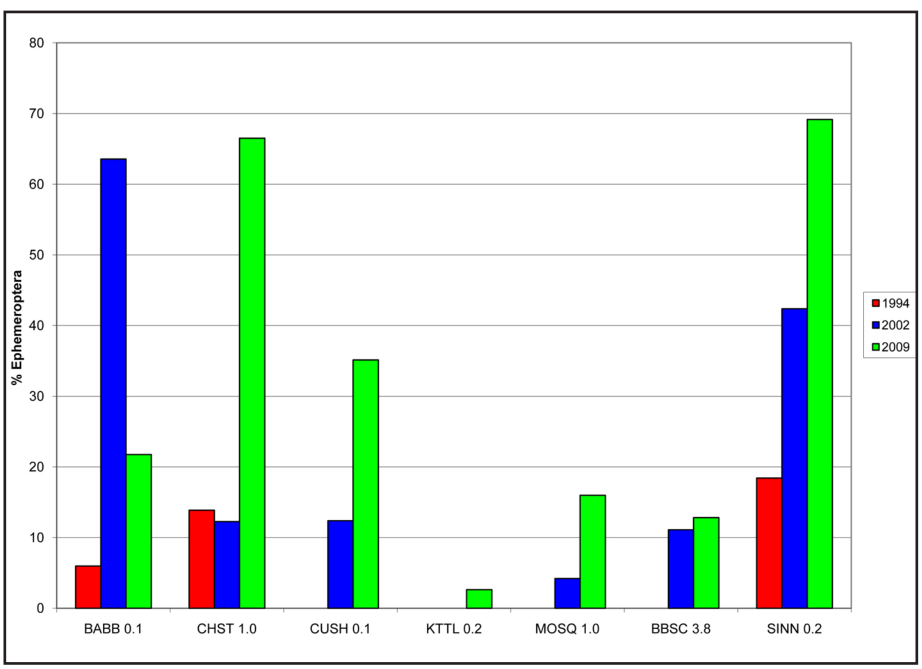


Figure 10. Sample Sites Showing Increased Percent Ephemeroptera Indicating Improved AMD Conditions

Photo Credit: NCSU

Conclusions

SRBC staff member measures flow along Mosquito Creek, one of the seven tributaries showing improvements in AMD condition.

The West Branch Susquehanna Subbasin continues to be largely impaired by AMD; however, improvements have been noted throughout the years of conducting subbasin surveys in this watershed. Improvement occurred in individual watersheds, where remediation work was conducted, and in the mainstem West Branch Susquehanna River from 2002 to 2009, where large increases in mayfly populations were noted. Some of this improvement on the mainstem may be due to the removal of the Barnes-Watkins pile in 2007, which was a large AMD source.

The AMD impairment was mostly located in the western (headwater) portion of the West Branch Susquehanna Subbasin. Agricultural and urban impacts are more prevalent in the eastern and southern portion of the subbasin. The habitat in this subbasin is mostly forested with numerous state forest lands and state gamelands, so there is not a lot of urban or agricultural impact; however, resource extraction continues to be a threat to the health of this subbasin. Natural gas drilling in the Marcellus Shale formation presents new challenges for this recovering watershed, and continued monitoring and assessment will be imperative.

Approximately 46 percent of the sites that were sampled in 2009 had moderately or severely impaired biological conditions. Of those sites that had moderately and severely impaired conditions, approximately 80 percent were due to AMD. Some of the most degraded watersheds within this subbasin were Muddy Run, Roaring Run, Moshannon Creek, Beech Creek, Two Mile Run, Dents Run, Cooks Run, Alder Run, Deer Creek, Little Anderson Creek, Surveyor Run, and Montgomery Creek. Some of the highest quality watersheds in this subbasin were Pine Creek, First Fork Sinnemahoning Creek, Driftwood Branch Sinnemahoning Creek, Young Womans Creek, Hyner Run, Paddy Run, Lick Run, Larrys Creek, Lycoming Creek, McElhattan Run, and White Deer Creek.

Numerous stream sites had low alkalinity values that exceeded levels of concern. Many of these sites were headwater streams on elevated areas that otherwise had nonimpaired or slightly impaired macroinvertebrate conditions. These low alkalinity values may have been temporary due to acidic atmospheric deposition during high flow conditions that occurred throughout the subbasin during sampling. The 2009 sampling season occurred after a wet spring and had frequent rains in early summer. There may have been more sites that were impacted by atmospheric deposition; however, since they were already acidic due to AMD, the impact may have been masked. Furthermore, the higher flows possibly resulted in some of the streams impacted by AMD to have lower levels of metals than expected.

A second year of more intensive sampling is being conducted in the West Branch Subbasin Survey from March to November 2010. Drury Run and Birch Island Run are being assessed for AMD impacts and restoration needs, with a focus on wild trout habitat and populations. Water quality, flows, macroinvertebrates, and fish population data are being collected. These watersheds have healthy biological conditions in the headwaters, but are impaired by AMD conditions toward the mouth, so fish are not able to pass through this stream from the mainstem West Branch Susquehanna River.

Acidic Deposition Treatment System on Gifford Run north of Karthaus, Pa.

Appendix: Sample Site List

Sample Site #	Station	Location Description	Latitude	Longitude	Ecoregion	Drainage Size
1	ALDR 4.7	Alder Run about 0.25 mile downstream of SR 1014 (Schoonover Rd.) bridge near Palestine, Clearfield Co.	41.014	78.199	67	Small
2	ANDR 0.4	Anderson Creek at Rt. 453 (Filbert St.) bridge in Curwensville, Clearfield Co.	40.972	78.528	67	Medium
3	ANDR 12.3*	Anderson Creek at Rt. 322 bridge near Rockton, Clearfield Co.	41.073	78.643	67	Small
4	ANTE 0.1	Antes Creek at mouth near Antes Fort, Lycoming Co.	41.189	77.240	67	Medium
5	BABB 0.1	Babb Creek at mouth in Blackwell, Tioga Co.	41.554	77.381	62	Medium
6	BABB 7.2*	Babb Creek along Landrus Rd. upstream of Long Run near Morris, Tioga Co.	41.599	77.282	62	Small
7	BAKR 0.1	Baker Run at Rt. 120 bridge near Bucktail State Park Natural Area, Clinton Co.	41.247	77.607	62	Small
8	BALD 4.5	Bald Eagle Creek at Rt. 150 bridge in Flemington, Clinton Co.	41.121	77.472	67	Large
9	BALD 14.0	Bald Eagle Creek at T496 (Eagleville Rd.) bridge upstream of Marsh Creek near Eagleville, Centre Co.	41.058	77.596	67	Medium
10	BALD 24.7*	Bald Eagle Creek at Curtain Rd. bridge in Curtain, Centre Co.	40.975	77.743	67	Medium
11	BALD 30.0	Bald Eagle Creek at T435 bridge in Wingate, Centre Co.	40.932	77.811	67	Medium
12	BBSC 3.8	Bennett Branch Sinnemahoning Creek upstream of confluence with Driftwood Branch near Tom Mix Park, Cameron Co.	41.336	78.134	62	Medium
13	BBSC 17.6*	Bennett Branch Sinnemahoning Creek upstream of Trout Run in Benezette, Elk Co.	41.312	78.390	62	Medium
14	BBSC 35.2	Bennett Branch Sinnemahoning Creek at Rt. 153 bridge in Penfield, Clearfield Co.	41.208	78.573	62	Small
15	BBSC 38.2*	Bennett Branch Sinnemahoning Creek at T512 bridge (Ontario St.) in Winterburn, Clearfield Co.	41.179	78.603	62	Small
16	BEAR 0.1	Bear Run at SR 36 bridge near McGees Station, Clearfield Co.	40.882	78.763	67	Small
17	BECH 1.7	Beech Creek at Rt. 150 bridge in Beech Creek at Centre Co./Clinton Co. line	41.074	77.592	67	Medium
18	BECH 20.3*	Beech Creek at Panther in Sproul State Forest, Centre Co.	41.106	77.835	62	Medium
19	BILG 0.1*	Bilger Run at Rt. 879 bridge near Bridgeport, Clearfield Co.	40.973	78.571	67	Small
20	BLHC 1.0**	Black Hole Creek downstream of bridge in Montgomery, Lycoming Co.	41.168	76.876	67	Small
21	BLMO 0.1	Black Moshannon Creek near mouth upstream of Rt 53 bridge near Moshannon, Centre Co.	41.036	78.057	62	Medium
22	BUFF 0.2	Buffalo Creek beside T379 (Campbell Mill Rd.) near Lewisburg, Union Co.	40.972	76.917	67	Medium
23	BUFF 10.4	Buffalo Creek at Rt. 192 bridge in Cowan, Union Co.	40.957	77.012	67	Medium
24	BVDR 0.2*	Beaver Dam Run at SR 1021 bridge in Beaver Valley, Cambria Co.	40.717	78.532	67	Small
25	CHLL 0.9	Chillisquaque Creek at Rt. 405 bridge in Chillisquaque, Northumberland Co.	40.941	76.855	67	Medium
26	CHLL 19.3	Chillisquaque Creek at T411 bridge upstream of PPL Montour near Dieffenbach, Montour Co.	41.080	76.669	67	Small
27	CHST 1.0	Chest Creek at SR 3001/T324 bridge near Ostend, Clearfield Co.	40.866	78.718	67	Medium
28	CHST 13.2*	Chest Creek at SR 3006 bridge at Westover, Clearfield Co.	40.751	78.667	67	Medium
29	CHST 24.5	Chest Creek end of 2nd Ave. in Patton, Cambria Co.	40.637	78.643	67	Small
30	CHTM 0.1	Chatham Run at SR 1002 (River Rd.) bridge near Chatham Run, Clinton Co.	41.168	77.365	67	Small
31	CLFD 0.9	Clearfield Creek at Rt. 322 bridge near Clearfield, Clearfield Co.	41.018	78.408	67	Medium
32	CLFD 8.2	Clearfield Creek upstream of Little Clearfield Creek near Dimeling, Clearfield Co.	40.970	78.407	67	Medium
33	CLFD 22.8*	Clearfield Creek upstream of Lost Run near Belsena Mills, Clearfield Co.	40.861	78.444	67	Medium
34	CLFD 42.2	Clearfield Creek at Beechwood Park in Coalport, Clearfield Co.	40.746	78.538	67	Medium
35	CLFD 60.5	Clearfield Creek at Rt. 36 bridge in Ashville, Cambria Co.	40.561	78.552	67	Small
36	COKR 0.1*	Cooks Run at Rt. 120 bridge in Cooks Run, Clinton Co.	41.279	77.885	62	Small
37	COLD 1.1	Cold Stream at Rt. 322 bridge, downstream of the reservoir in Philipsburg, Centre Co.	40.901	78.210	67	Small
38	COLD 3.6	Cold Stream upstream of Game Reserve Rd. upstream of Tomtit Run near Philipsburg, Centre Co.	40.868	78.207	67	Small
39	CUSH 0.1	Cush Creek at Rt. 219 bridge in Dowler Junction Station, Clearfield Co.	40.831	78.791	67	Small
40	DEER 0.2	Deer Creek upstream of rip-rap at T 637 bridge near Frenchville Station, Clearfield Co.	41.080	78.237	67	Small
41	DNTS 0.6*	Dents Run at bridge off Dents Run Road in Dents Run, Elk Co.	41.359	78.272	62	Small
42	DRFT 0.1	Driftwood Branch Sinnemahoning Creek at the mouth in Driftwood, Cameron Co.	41.337	78.134	62	Medium
43	DRFT 9.9	Driftwood Branch Sinnemahoning Creek at SR 3002 bridge near Sterling Run, Cameron Co.	41.414	78.197	62	Medium
44	DRFT 21.2	Driftwood Branch Sinnemahoning Creek upstream of high school at H.W. Zimmer Memorial Park in Emporium, Cameron Co.	41.516	78.254	62	Medium
45	DRUR 0.7	Drury Run beside Rt. 144 about 1 mile upstream at abandoned factory near Renovo, Clinton Co.	41.334	77.781	62	Small
46	EAST 0.1*	East Fork Sinnemahoning Creek at Rt. 872 bridge in Wharton, Potter Co.	41.530	78.022	62	Medium
47	FISH 2.1	Fishing Creek at parking area along Rt. 64 upstream of Mill Hall, Clinton Co.	41.096	77.480	67	Medium
48	FISH 13.3*	Fishing Creek at SR 2004 bridge downstream of Lamar National Fish Hatchery, Clinton Co.	41.007	77.534	67	Medium
49	FRST 5.3	First Fork Sinnemahoning Creek along Rt. 872 upstream of Lick Island Run in Elk State Forest, Cameron Co.	41.381	78.038	62	Medium
50	FRST 19.1*	First Fork Sinnemahoning Creek upstream of confluence with East Fork Sinnemahoning in Wharton, Potter Co.	41.530	78.022	62	Medium
51	GIFF 1.6*	Gifford Run at Lost Run Road bridge in Moshannon State Forest, Clearfield Co.	41.173	78.238	62	Small
52	HYNR 0.1	Hyner Run at Rt. 120 bridge in Hyner, Clinton Co.	41.332	77.647	62	Small
53	KRAT 0.1*	Kratzer Run beside Rt. 879 at mouth at Bridgeport, Clearfield Co.	40.977	78.548	67	Small
54	KTTL 0.2	Kettle Creek at Rt. 120 bridge in Westport, Clinton Co.	41.300	77.841	62	Medium
55	KTTL 2.1*	Kettle Creek along SR 4001 upstream of Two Mile Run near Westport, Clinton Co.	41.313	77.865	62	Medium
56	KTTL 25.3	Kettle Creek along Rt. 144 upstream of Cross Forks, Potter Co.	41.494	77.798	62	Medium
57	KTTL 34.1*	Kettle Creek upstream of Long Run upstream of Rt. 44 bridge near Oleona, Potter Co.	41.559	77.680	62	Small

Sample Site #	Station	Location Description	Latitude	Longitude	Ecoregion	Drainage Size
58	LAND 1.7*	Little Anderson Creek downstream of R.R. culvert downstream of T499 bridge at Anderson Station, Cleafield Co.	41.054	78.656	67	Small
59	LARR 2.9	Larrys Creek along Rt. 287 upstream of Old Forge Rd. near Larryville, Lycoming Co.	41.249	77.226	67	Medium
60	LAUR 0.1*	Laurel Run at Rt. 53 bridge near Pleasant Hill, Clearfield Co.	40.907	78.227	67	Small
61	LAUR 3.2*	Laurel Run at Saunders Rd./Blackwell Rd. crossing in Moshannon State Forest near Elk Co./Clearfield Co. line	41.244	78.471	62	Small
62	LCLF 0.1	Little Clearfield Creek at mouth near Dimeling, Clearfield Co.	40.970	78.407	67	Small
63	LICK 0.2	Lick Run at SR 1001 bridge at Farrandsville Community Park in Farrandsville, Clinton Co.	41.173	77.515	67	Small
64	LICK 0.3	Lick Run at Rt. 879 bridge near Gray Station, Clearfield Co.	41.051	78.386	67	Small
65	LITL 0.4*	Little Loyalsock Creek at Rt. 87 bridge in Forksville, Sullivan Co.	41.492	76.600	62	Medium
66	LLSK 1.2	Loyalsock Creek at SR 2014 bridge near Montoursville, Lycoming Co.	41.250	76.935	67	Medium
67	LLSK 37.2	Loyalsock Creek upstream of covered bridge upstream of Rt. 87 bridge near Forksville, Sullivan Co.	41.486	76.599	62	Medium
68	LMUN 0.1*	Little Muncy Creek at Rt. 442 bridge near Muncy, Lycoming Co.	41.206	76.745	67	Medium
69	LPIN 0.2	Little Pine Creek at Rt. 44 bridge in Waterville, Lycoming Co.	41.310	77.363	62	Medium
70	LPIN 11.5	Little Pine Creek upstream of English Run at English Center, Lycoming Co.	41.435	77.289	62	Medium
71	LYCO 2.0	Lycoming Creek adjacent to Weis Markets parking lot from Business Rt. 15 in Garden View, Lycoming Co.	41.253	77.042	67	Medium
72	LYCO 17.7	Lycoming Creek at Susque Rd. bridge near Gray, Lycoming Co.	41.418	77.034	62	Medium
73	MCCR 1.0*	McCracken Run at T324 bridge near Bower, Clearfield Co.	40.892	78.659	67	Small
74	MCEL 2.0	McElhattan Run along SR 1005 in Mt. Logan Natural Area, Clinton Co.	41.140	77.344	67	Small
75	MEDX 0.1*	Medix Run at the mouth near Medix Run, Elk Co.	41.284	78.397	62	Small
76	MONT 0.2*	Montgomery Creek at SR 1001 bridge in Hyde, Cleafield Co.	41.003	78.461	67	Small
77	MORG 0.2**	Morgan Run downstream of Rt. 153 bridge near Dimeling, Clearfield Co.	40.958	78.401	67	Small
78	MOSH 5.1	Moshannon Creek at Rt. 53 bridge upstream of Black Moshannon Creek near Moshannon, Clearfield/Centre Co.	41.036	78.059	62	Medium
79	MOSH 19.1*	Moshannon Creek upstream of Six Mile Run near Winburne Station, Clearfield/Centre Co.	40.945	78.121	62	Medium
80	MOSH 39.9	Moshannon Creek at Rt. 970 bridge in Osceola Mills, Clearfield Co.	40.850	78.266	67	Medium
81	MOSQ 0.2	Mosquito Creek at Rt. 654 bridge in Duboistown, Lycoming Co.	41.222	77.038	67	Small
82	MOSQ 1.0	Mosquito Creek upstream of unamed trib. out of Shingle Hollow in Karthaus, Clearfield Co.	41.123	78.122	62	Medium
83	MOSQ 13.8*	Mosquito Creek at Lost Run Road bridge in Moshannon State Forest, Clearfield Co.	41.216	78.244	62	Small
84	MRSH 1.2*	Marsh Creek at Rt. 150 bridge near Beech Creek, Centre Co.	41.061	77.616	67	Small
85	MRSH 1.6*	Marsh Creek along SR 3022 near Asaph, Tioga Co.	41.763	77.413	62	Medium
86	MUDR 0.3*	Muddy Run at T550 bridge near Madera, Clearfield Co.	40.819	78.437	67	Small
87	MUDR 4.5*	Muddy Run at SR 729 bridge near Beccaria, Clearfield Co.	40.769	78.447	67	Small
88	MUNC 1.1	Muncy Creek upstream Main St. bridge (SR 2014) near Muncy, Lycoming Co.	41.218	76.787	67	Medium
89	MUNC 18.8*	Muncy Creek at Edkin Hill Rd. bridge in Beech Glen, Sullivan Co.	41.314	76.616	62	Medium
90	PADY 0.1	Paddy Run at Rt. 120 bridge near Renovo, Clinton Co.	41.331	77.728	62	Small
91	PINE 1.1	Pine Creek upstream of Tiadaughton Dr. bridge near Jersey Shore, on Clinton Co./Lycoming Co. line	41.182	77.281	67	Large
92	PINE 14.2	Pine Creek at Rt. 44 bridge upstream of Little Pine Creek near Waterville, Lycoming Co.	41.311	77.379	62	Large
93	PINE 40.3	Pine Creek at Rt. 414 bridge in Blackwell, Tioga Co.	41.557	77.383	62	Medium
94	PINE 57.5*	Pine Creek upstream of Marsh Creek, upstream of Colton Rd. bridge, in Ansonia, Tioga Co.	41.744	77.434	62	Medium
95	ROAR 0.9**	Roaring Run near Barrett, Clearfield Co.	41.009	78.390	67	Small
96	SINN 0.2	Sinnemahoning Creek at SR 4002 bridge in Keating, Clinton Co.	41.261	77.907	62	Large
97	SINN 11.9*	Sinnemahoning Creek at SR 2001 (Wykoff Rd.) bridge upstream of First Fork in Sinnemahoning, Cameron Co.	41.319	78.084	62	Large
98	SLAB 0.2*	Slab Cabin Run at SR 3012 (Puddintown Rd.) bridge near Houserville, Centre Co.	40.818	77.834	67	Small
99	SMIL 0.1	Six Mile Run near mouth at SR 4006 (Munson Rd.) bridge near Winburne Station, Centre Co.	40.942	78.125	62	Small
100	SPRG 0.2	Spring Creek upstream of Commercial Rd. bridge in Milesburg, Centre Co.	40.940	77.788	67	Medium
101	SPRG 14.8*	Spring Creek at SR 3012 (Puddintown Rd.) bridge near Houserville, Centre Co.	40.821	77.832	67	Small
102	SURV 0.3*	Surveyor Run about 0.3 mile upstream of the mouth near Surveyor, Clearfield Co.	41.077	78.325	67	Small
103	SWIT 0.1	South Whitmer Run at SR 3005 bridge in Irvona, Clearfield Co.	40.770	78.551	62	Small
104	TANG 0.2	Tangascootack Creek at Rt. 120 bridge near Riverview, Clinton Co.	41.176	77.550	67	Small
105	TMIL 0.1*	Two Mile Run at SR 4001 bridge near mouth near Westport, Clinton Co.	41.316	77.859	62	Small
106	TROT 0.1	Trout Run at Rt. 879 bridge in Shawville, Clearfield Co.	41.070	78.359	67	Small
107	WBPC 3.5*	West Branch Pine Creek upstream of Right Branch Run in Germania Station, Potter Co.	41.713	77.699	62	Medium
108	WBSR 0.0*	West Branch Susquehanna River at Rt. 11 bridge in Northumberland, Northumberland Co.	40.884	76.798	67	Large
109	WBSR 7.5	West Branch Susquehanna River at Rt. 45 bridge in Lewisburg, Union Co./Northumberland Co. line	40.965	76.877	67	Large
110	WBSR 15.0	West Branch Susquehanna River along Rt. 405 between Rt. 80 and Watsontown near Watsontown, Northumberland Co.	41.071	76.854	67	Large
111	WBSR 23.0	West Branch Susquehanna River at Rt. 54 bridge and Montgomery Fish Access in Montgomery, Lycoming Co.	41.167	76.870	67	Large
112	WBSR 37.5	West Branch Susquehanna River at PA Fish and Boat Greevy Access and Riverfront Park in Williamsport, Lycoming Co.	41.245	76.963	67	Large
113	WBSR 45.3	West Branch Susquehanna River at Linden Boat Access off Fourth Ave. near Williamsport, Lycoming Co.	41.226	77.107	67	Large
114	WBSR 55.0	West Branch Susquehanna River at Rt. 44 bridge (right branch) in Jersey Shore, Lycoming Co.	41.204	77.242	67	Large
115	WBSR 64.0	West Branch Susquehanna River upstream SR 1003/SR 1005 bridge upstream Chatham Run near Chatham Run, Clinton Co.	41.165	77.368	67	Large
116	WBSR 69.0**	West Branch Susquehanna River downstream of the Grant Street Dam in Lock Haven, Clinton Co.	41.139	77.431	67	Large
117	WBSR 75.0	West Branch Susquehanna River upstream of Lick Run in Farrandsville, Clinton Co.	41.168	77.520	67	Large

Sample Site #	Station	Location Description	Latitude	Longitude	Ecoregion	Drainage Size
118	WBSR 83.0	West Branch Susquehanna River upstream of Baker Run in Glen Union, Clinton Co.	41.250	77.607	62	Large
119	WBSR 91.0	West Branch Susquehanna River upstream of Hyner Run in Hyner, Clinton Co.	41.33	77.647	62	Large
120	WBSR 97.0	West Branch Susquehanna River at Rt. 144 bridge in Renovo, Clinton Co.	41.326	77.746	62	Large
121	WBSR 103.8	West Branch Susquehanna River upstream Kettle Creek in Westport, Clinton Co.	41.300	77.838	62	Large
122	WBSR 110.0	West Branch Susquehanna River upstream of Sinnemahoning Creek in Keating, Clinton Co.	41.261	77.901	62	Large
123	WBSR 131.0	West Branch Susquehanna River at Rt. 879 bridge in Karthaus, Clearfield Co.	41.117	78.108	62	Large
124	WBSR 142.0	West Branch Susquehanna River at SR 1011 bridge in Rolling Stone, Clearfield Co.	41.057	78.157	67	Large
125	WBSR 162.0	West Branch Susquehanna River downstream of powerplant in Shawville, Clearfield Co.	41.066	78.360	67	Large
126	WBSR 164.2	West Branch Susquehanna River upstream of Lick Run near Gray Station, Clearfield Co.	41.048	78.382	67	Large
127	WBSR 172.3	West Branch Susquehanna River at railroad bridge in Clearfield, Clearfield Co.	41.033	78.434	67	Medium
128	WBSR 175.0	West Branch Susquehanna River at Rt. 879 bridge in Hyde, Clearfield Co.	41.004	78.457	67	Medium
129	WBSR 181.4	West Branch Susquehanna River at Bloomington Ave. bridge downstream of Anderson Creek in Curwensville, Clearfield Co.	40.974	78.520	67	Medium
130	WBSR 191.0	West Branch Susquehanna River at Rt. 729 bridge in Lumber City, Clearfield Co.	40.923	78.576	67	Medium
131	WBSR 200.0	West Branch Susquehanna River at T418 (Camp Corbley Rd.) in Bower, Cleafield Co.	40.895	78.676	67	Medium
132	WBSR 208.0	West Branch Susquehanna River along T327 downstream of Deer Run near McGees Mills, Clearfield Co.	40.871	78.755	67	Medium
133	WBSR 214.0	West Branch Susquehanna River at Rt. 219 bridge north of Burnside, Clearfield Co.	40.816	78.785	67	Medium
134	WBSR 224.0	West Branch Susquehanna River at Rt. 580 bridge in Cherry Tree, Indiana Co.	40.727	78.805	67	Medium
135	WBSR 235.0	West Branch Susquehanna River at Goodway Rd. bridge near Bakerton, Cambria Co.	40.598	78.745	67	Small
136	WDHC 1.9	White Deer Hole Creek at SR 1012 bridge near Allenwood, Union Co.	41.102	76.914	67	Medium
137	WEST 2.0*	West Creek at T345 bridge (Hercules Rd.) in West Creek, Cameron Co.	41.494	78.275	62	Medium
138	WILS 0.5*	Wilson Creek at Rt. 287 bridge in Morris, Tioga Co.	41.598	77.297	62	Small
139	WTDR 3.7	White Deer Creek along SR 1010 (White Deer Pike) upstream of Rt. 80 crossing near White Deer Furnace, Union Co.	41.074	76.929	67	Small
140	YGWO 0.5	Young Womans Creek upstream of Rt. 120 bridge at Fire Department Access in North Bend, Clinton Co.	41.350	77.698	62	Medium
141	YGWO 4.5*	Young Womans Creek 0.2 - 0.3 mile upstream of bridge upstream of Laurelly Fork in Sproul State Forest, Clinton Co.	41.401	77.685	62	Small
	* Stations not sampled in 1994					
	** Stations not sampled in 1994 and 2002					

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