

## 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 <sup>a</sup>	Conductivity, $\mu\text{mhos}/\text{cm}^c$
Temperature, °C	Alkalinity, mg/l
pH	Acidity, mg/l
Dissolved Oxygen (DO), mg/l <sup>b</sup>	
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, $\mu\text{g}/\text{l}^e$
Turbidity, NTU <sup>d</sup>	Total Manganese, $\mu\text{g}/\text{l}$
Total Organic Carbon (TOC), mg/l	Total Aluminum, $\mu\text{g}/\text{l}$
Total Hardness, mg/l	Total Phosphorus, mg/l
Total Calcium, mg/l	Total Orthophosphate, mg/l
Total Dissolved Solids (TDS), mg/l	

<sup>a</sup> cfs = cubic feet per second      <sup>d</sup>NTU = nephelometric turbidity units

<sup>b</sup> mg/l = milligram per liter      <sup>e</sup>  $\mu\text{g}/\text{l}$  = micrograms per liter

<sup>c</sup>  $\mu\text{mhos}/\text{cm}$  = micromhos per centimeter

**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 $\mu\text{mhos}/\text{cm}$	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 $\mu\text{g}/\text{l}$	a
Manganese	>1,000 $\mu\text{g}/\text{l}$	a
Aluminum	>750 $\mu\text{g}/\text{l}$ >200 $\mu\text{g}/\text{l}$ , pH <5.0	n,c
TDS	>500 mg/l	a
Reference Code & References		
a	<a href="http://www.pacode.com/secure/data/025/chapter93/s93.7.html">http://www.pacode.com/secure/data/025/chapter93/s93.7.html</a>	
b	Hem (1970) - <a href="http://water.usgs.gov/pubs/wsp/wsp2254/">http://water.usgs.gov/pubs/wsp/wsp2254/</a>	
c	Gagen and Sharpe (1987) and Baker and Schofield (1982)	
d	<a href="http://www.uky.edu/WaterResources/Watershed/KRB_AR/wq_standards.htm">http://www.uky.edu/WaterResources/Watershed/KRB_AR/wq_standards.htm</a>	
e	<a href="http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm">http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm</a>	
f	<a href="http://www.hach.com/h2ou/h2wtrqual.htm">http://www.hach.com/h2ou/h2wtrqual.htm</a>	
g	<a href="http://sites.state.pa.us/PA_Exec/Fish_Boat/education/catalog/pondstream.pdf">http://sites.state.pa.us/PA_Exec/Fish_Boat/education/catalog/pondstream.pdf</a>	
h	<a href="http://www.epa.gov/waterscience/criteria/sediment/appendix3.pdf">http://www.epa.gov/waterscience/criteria/sediment/appendix3.pdf</a>	
i	<a href="http://www.dec.ny.gov/regs/4590.html">http://www.dec.ny.gov/regs/4590.html</a>	
j*	<a href="http://water.usgs.gov/pubs/circ/circ1225/images/table.html">http://water.usgs.gov/pubs/circ/circ1225/images/table.html</a>	
k	<a href="http://pubs.usgs.gov/circ/circ1136/">http://pubs.usgs.gov/circ/circ1136/</a>	
l	<a href="http://www.epa.gov/waterscience/criteria/goldbook.pdf">http://www.epa.gov/waterscience/criteria/goldbook.pdf</a>	
m	based on archived data at SRBC	
n	<a href="http://www.epa.gov/waterscience/criteria/wqctable/">http://www.epa.gov/waterscience/criteria/wqctable/</a>	

\* 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](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](http://www.srbc.net/pubinfo/techdocs/publication_268/techreport268.htm).