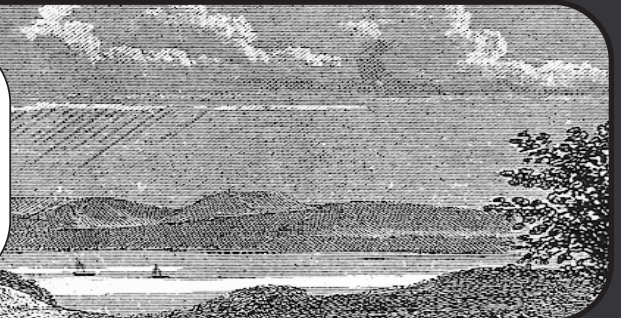


SURVEY OF ACIDIC AND EPISODICALLY ACIDIC STREAMS IN WESTERN MARYLAND



**CHESAPEAKE BAY AND
WATERSHED PROGRAMS
MONITORING AND
NON-TIDAL ASSESSMENT
CBWP-MANTA- EA-01-1**





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Survey of Acidic and Episodically Acidic Streams in Western Maryland

Prepared for:

**Paul Kazyak
Maryland Department of Natural Resources
Monitoring and Non-Tidal Assessment Division
Resource Assessment Service
Annapolis, MD 21401**

Prepared by:

**Matthew J. Kline
Raymond P. Morgan II**

**University of Maryland
Center for Environmental Science
Appalachian Laboratory
Frostburg, MD 21532**

**Report Completed
January 2000**

FOREWORD

This report, *Survey of Acidic and Episodically Acidic Streams in Western Maryland*, is submitted to Paul Kazyak, Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources (DNR) in partial fulfillment of contract #: MA98-002-003 to Dr. Raymond P. Morgan II, Appalachian Laboratory (AL), University of Maryland, Center for Environmental Science, Frostburg, Maryland. The purpose of the project was to determine the extent of streams in Western Maryland that are or may be acidic or episodically acidic due to atmospheric deposition in 1999.

INTRODUCTION

The Maryland Department of Natural Resources (DNR) has been studying the extent and effects of atmospheric deposition in Maryland for more than ten years (Roth et al. 1999). In 1987, the Maryland Synoptic Stream Chemistry Survey (MSSCS) (Knapp et al. 1988) was conducted to estimate the extent of acidified and acid sensitive streams in Maryland. The MSSCS determined that the South Coastal Plain and the Appalachian Plateau sampling strata in Maryland had the highest proportions of stream reaches and stream kilometers with acid neutralizing capacity (ANC) values less than 50 $\mu\text{eq/L}$ (Figure 1) and pH values less than 6.0. When ANC is less than 50 $\mu\text{eq/L}$ biological assemblages tend to be impaired (Roth et al. 1999). The MSSCS also determined that nearly one third of all headwater streams in Maryland have ANC values less than 200 $\mu\text{eq/L}$, levels that may indicate potential sensitivity to acid deposition. However, for this report we chose to use a primary threshold of 50 $\mu\text{eq/L}$ ANC because of the widespread and consistent biological impacts below this level.

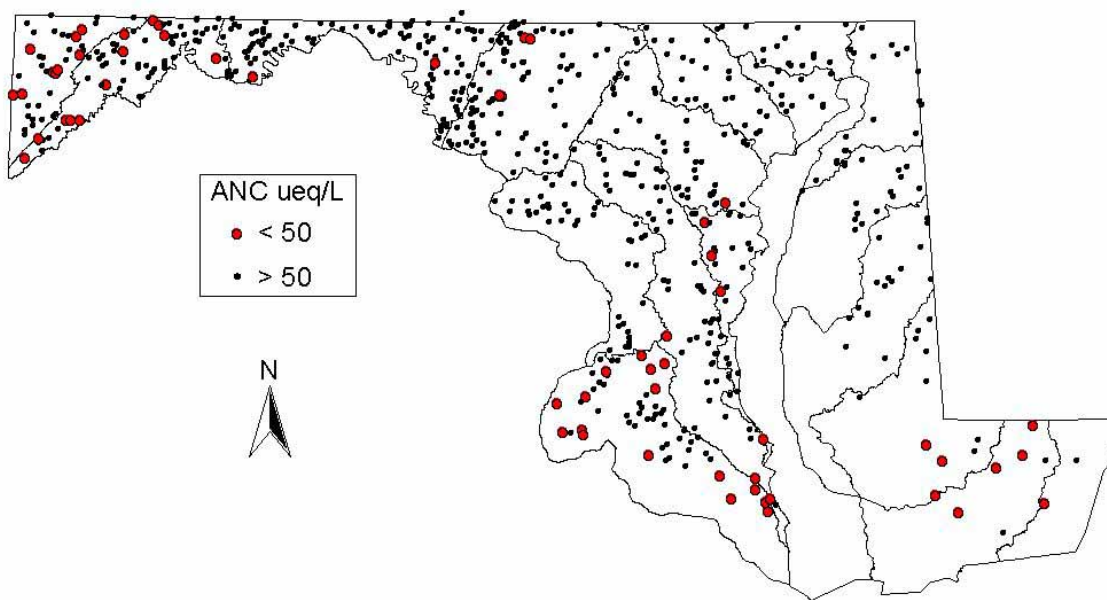


Figure 1. ANC values at 1987 MSSCS sample sites in Maryland.

The Maryland Biological Stream Survey (MBSS) was created in 1993 to provide information on the effects of acid deposition and other anthropogenic stresses on the biota and physical habitat of Maryland streams. During 1995-1997, 955 randomly selected 75-meter stream segments were sampled in the spring as part of the MBSS. Spring sampling for the MBSS included water chemistry sampling. The MBSS found similar results as the MSSCS; the highest percentage of streams with low pH and low ANC values were found within the Coastal Plain and Appalachian Plateau sampling strata in Maryland (Figure 2) They also concluded that acid-base chemistry in Maryland had improved since 1987 (Roth et al. 1999).

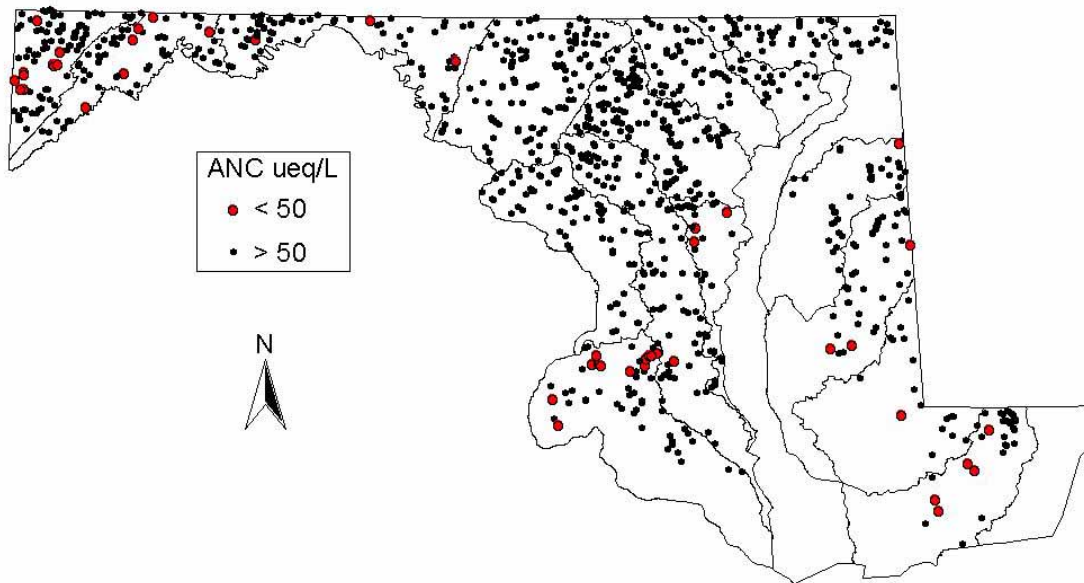


Figure 2. ANC values at 1995-1997 MBSS randomly-selected sample sites.

This project was conducted to determine: (1) the present status of specific stream reaches within the Appalachian Plateau that were determined to be acidic (ANC < 0 $\mu\text{eq/L}$) or highly acid sensitive (ANC 0-50 $\mu\text{eq/L}$) in 1987 by the MSSCS and in 1995-1997 by the MBSS; and (2) how far upstream and downstream acidic or highly acid sensitive conditions exist within the sampled watersheds. Although information about the percentage of stream miles affected by acid deposition is important, it is also important to have site-specific information about acid impacts to aid in restoration and protection activities. This information can be used to rank streams and help determine the sources of impairment.

METHODS

Study Area

The Appalachian Plateau is the westernmost physiographic province in Maryland and is located throughout Garrett County and into western Allegany County. The plateau is characterized by broad upland areas with ranges of mountains that extend in northeast-southwest directions. Elevations range from around 600 to 3000 feet above sea level. Surface waters in the region flow east into the Potomac River as part of the Chesapeake Bay drainage basin or west into the Youghiogheny River as part of the Mississippi drainage basin. Vegetation is mostly oak and mixed hardwoods. Landuse is mostly forest with some cropland and pasture. Precipitation in this region ranges from about 100 to 140 cm/year, with May-July being the wettest months (Kauffman et al. 1988, Staubitz and Sobashinski 1983).

The Appalachian Plateau province of Maryland experiences chronic acid deposition with sulfate wet deposition rates that are some of the highest in North America (PPRP 1988). The yearly average precipitation pH over this area is approximately 4.3 and there have been depressions reported as low as 2.8 (Baker et al. 1990). The effects of

acid precipitation on aquatic systems can vary considerably depending upon the vegetation, soil composition, bedrock geology, hydrologic characteristics, distribution and amounts of precipitation, type of precipitation, and landuse (Hendrey et al. 1980, Sharpe et al. 1987, Newton et al. 1987, Bricker and Rice 1989, Rice and Bricker 1991).

Meagher (1995) found that the sensitivity of headwater streams to acid precipitation within the Appalachian Plateau could be predicted to some degree using the geology-based, stream reach method developed by Bricker and Rice (1993). This geology-based, stream reach method predicts a stream's response to acidification based on the bedrock upon which the stream flows. Meagher (1995) also assigned sensitivities to the geologic formations present within the Appalachian Plateau in Maryland that were based on the mineralogic descriptions of each formation. Formations that were made up of very few weatherable materials were designated as highly sensitive to acid inputs, while formations that contain highly weatherable materials such as calcareous shales and/or limestones were designated as low or moderately sensitive to acid inputs. Figure 3 shows the geographic distribution of the geologic formations within the Appalachian Plateau province and Figure 4 shows the same formations with the assigned sensitivities of each.

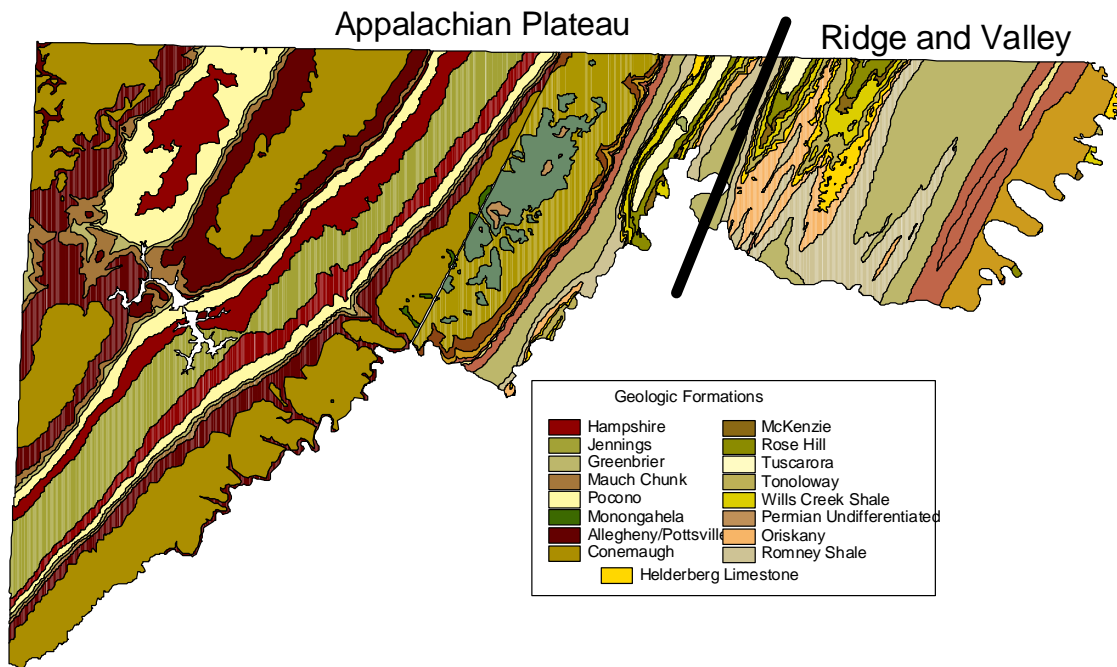


Figure 3. Geologic formations within the Appalachian Plateau province of Maryland (Amsden 1953, Berryhill et al. 1956).

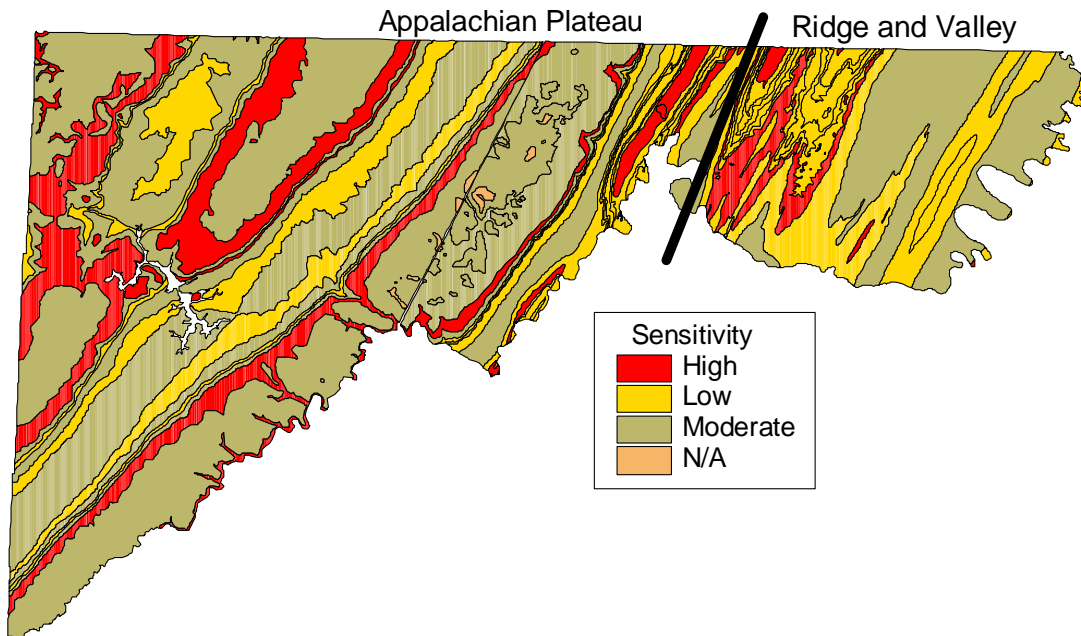


Figure 4. Sensitivities of geologic formations as estimated by Meagher (1995) using mineralogic information from Vokes (1961) N/A – Geologic formations that are limited to small outcrop areas with no permanent streams.

Approach

Eighteen stream reaches within the Appalachian Plateau that were sampled by the MBSS had ANC values that were less than 50 $\mu\text{eq/L}$ (Figure 2). Twenty-two stream reaches that were sampled by the MSSCS within the Appalachian Plateau had ANC values that were less than 50 $\mu\text{eq/L}$ (Figure 1). Twelve of the stream reaches were sampled by both the MBSS and the MSSCS. Each of the 28 stream reaches determined to have low ANC by the MBSS and MSSCS was revisited during March 1999. Water samples were analyzed for open pH, ANC, and conductance. Conductance was measured and to determine if acid mine drainage (AMD) could possibly be affecting the sampled stream reaches. Visual signs of AMD, including white and yellow precipitates of aluminum ($\text{Al}(\text{OH})_3$) and iron ($\text{Fe}(\text{OH})_3$), were also noted.

Sampling was then conducted throughout the watersheds to determine how far upstream and downstream the acidic or highly acid sensitive condition persisted. In general, stream reaches immediately upstream and downstream and adjacent streams were sampled. In most cases, every stream reach upstream of the MBSS or MSSCS site was sampled.

Additional sample sites were selected in streams flowing across highly sensitive geologic formations. A total of 180 water samples were taken throughout the Appalachian Plateau from 11 March to 2 April, 1999 while streams were at spring baseflow. Water samples were also taken from 31 stream reaches sampled within 6

MBSS reference watersheds and from 40 stream reaches sampled as part of a separate project (Hypio 1999). Water samples were collected at the most accessible points along each sampled stream reach and the chemistry of each water sample was assumed representative of the entire stream reach. No sampling was conducted within 3 days of significant rainfall. Figure 5 shows the locations of the 251 sample sites and the stream network within the Youghiogheny River and North Branch Potomac River basins.

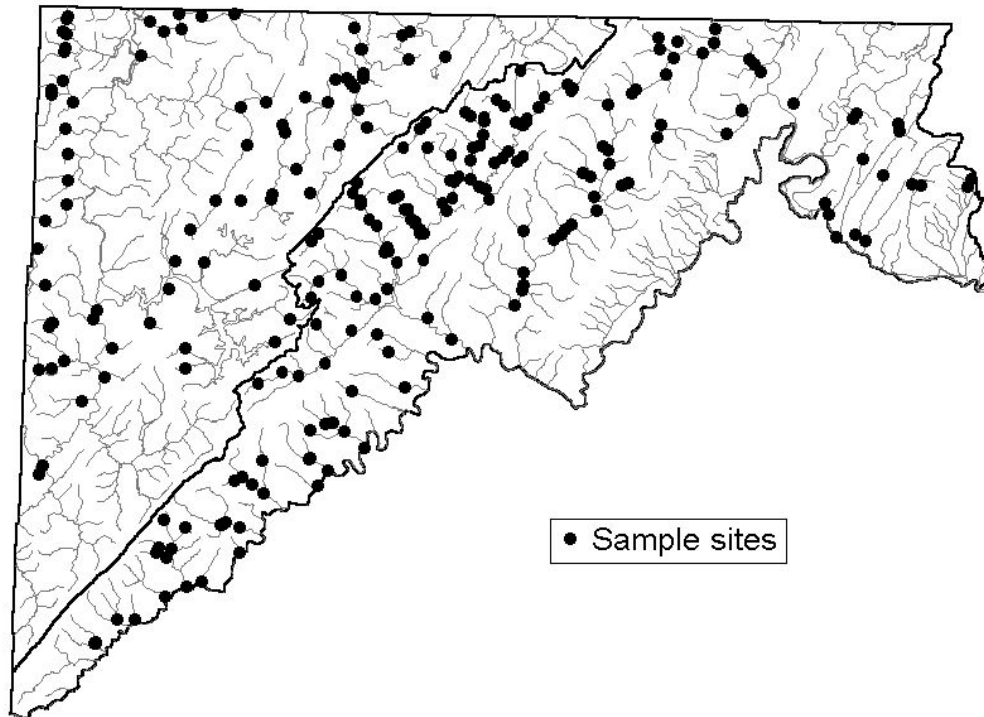


Figure 5. Sample sites and stream network within the Youghiogheny and North Branch Potomac River basins, 1999. Stream network is based on a 1:250,000 map scale.

Quality Control

Acid neutralizing capacity (ANC) was measured using the acidimetric Gran titration technique with electrometric pH detection. The pH meter used for the titration was calibrated using a set of two pH buffers that bracketed sample pH. A QCCS with a theoretical value of 5.00 was used to verify calibration. Any time that the QCCS was outside of the acceptable limits, the meter was re-calibrated and the QCCS was subsequently re-analyzed. The normality of the acid titrant was also cross-checked on a routine basis to verify method accuracy.

Prior to sample analysis a deionized water lab blank and sodium carbonate standard with a calculated ANC of 50 $\mu\text{eq/L}$ were analyzed to verify method and analyst accuracy. A standard with an ANC of 50 $\mu\text{eq/L}$ was chosen because it most closely reflected the expected median ANC value of the samples.

RESULTS

Data from the 251 sample sites can be found in the appendix. One hundred and sixty-six of the sample sites were from 1st order stream reaches, 65 were from 2nd order stream reaches, and 20 were from 3rd order stream reaches (Table 1).

Conductance

Conductance values ranged from 26.7 to 1901 $\mu\text{S}/\text{cm}$. Twenty-nine sample sites had conductance levels greater than 300 $\mu\text{S}/\text{cm}$ but only two of these sites had pH levels that were less than 6.0. Thirty-five sites were suspected to be affected by AMD, based on conductance values and/or visual signs (Appendix).

ANC

ANC values ranged from $-61.8 \mu\text{eq}/\text{L}$ to $3120.1 \mu\text{eq}/\text{L}$. Thirty-four of the sample sites (14%) had ANC values that were less than $0 \mu\text{eq}/\text{L}$. Sixty-seven of the sample sites (27%) had ANC values that were less than $50 \mu\text{eq}/\text{L}$ (Figure 6). Fifty-two of the sample sites (78%) that had ANC values were less than $50 \mu\text{eq}/\text{L}$ were located on 1st order stream reaches (Table 1). One hundred and twenty-three of the sample sites (49%) had ANC values less than $100 \mu\text{eq}/\text{L}$ (Table 1).

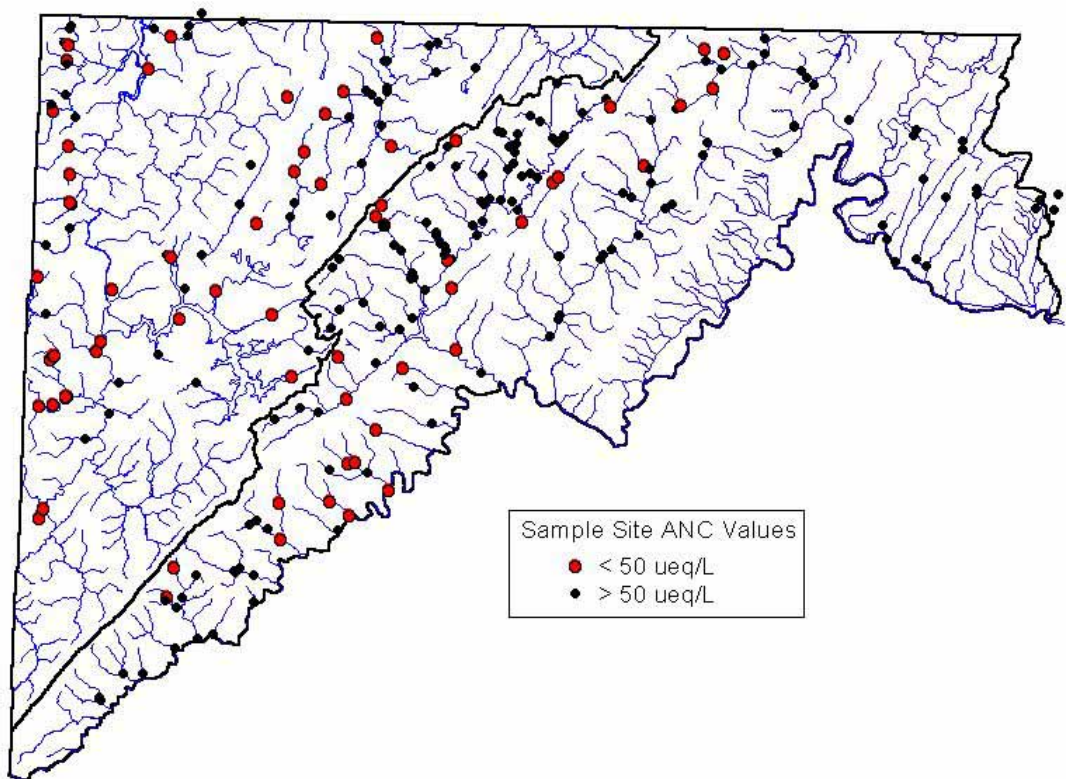


Figure 6. Sample sites that had ANC values less than $50 \mu\text{eq}/\text{L}$, 1999.

pH

Only 3 sample sites had pH values less than 4.5 and 41 sample sites had pH values less than 5.5. Thirty-two of the 41 sample sites that had pH values less than 5.5 were 1st order streams (Table 2). The pH data from Hypio (1999) was not available for this report.

Table 1. ANC data by stream order for all 1999 sample sites.

Order	ANC ($\mu\text{eq/L}$)					Total
	< 0	0.01-49.99	50-99.99	100-200	> 200	
1 st	27	25	32	32	50	166
2 nd	5	4	20	20	16	65
3 rd	2	4	4	8	2	20
Total	34	33	56	60	68	251

Table 2. pH data by stream order for all 1999 sample sites except for Hypio et al. (1999).

Order	pH				Total
	< 4.5	4.51-5.50	5.51-6.50	> 6.50	
1 st	4	26	30	82	142
2 nd	0	6	12	37	55
3 rd	0	4	5	8	17
Total	4	36	47	127	214

Twenty-eight stream reaches were determined by the MSSCS and MBSS to be acidic or highly acid sensitive in the Appalachian Plateau (Figure 7). All of these stream reaches were re-sampled during Spring 1999. Of these 28 stream reaches, 14 of these stream reaches were each located within the Youghiogheny River and North Branch Potomac River basins.

Figure 8 displays the stream reaches within the study area that were sampled. The stream reaches that had ANC values that were less than 50 $\mu\text{eq/L}$ are colored in red. The orange stream reaches are those stream reaches that had ANC values between 50 $\mu\text{eq/L}$ and 200 $\mu\text{eq/L}$. All black stream reaches had ANC values greater than 200 $\mu\text{eq/L}$. Blue stream reaches were not sampled for this project.

Of the 28 stream reaches that were determined to be acidic or highly acid sensitive (< 50 $\mu\text{eq/L}$) by the MSSCS and the MBSS, 17 still had ANC values that were less than 50 $\mu\text{eq/L}$, 9 had an ANC value between 50 and 200 $\mu\text{eq/L}$, and 2 had ANC values that were greater than 200 $\mu\text{eq/L}$. None of the eleven stream reaches that had ANC values > 50 $\mu\text{eq/L}$ were AMD mitigation streams. An additional 52 stream reaches were found by this project to have ANC values that were less than 50 $\mu\text{eq/L}$ (Figure 8).

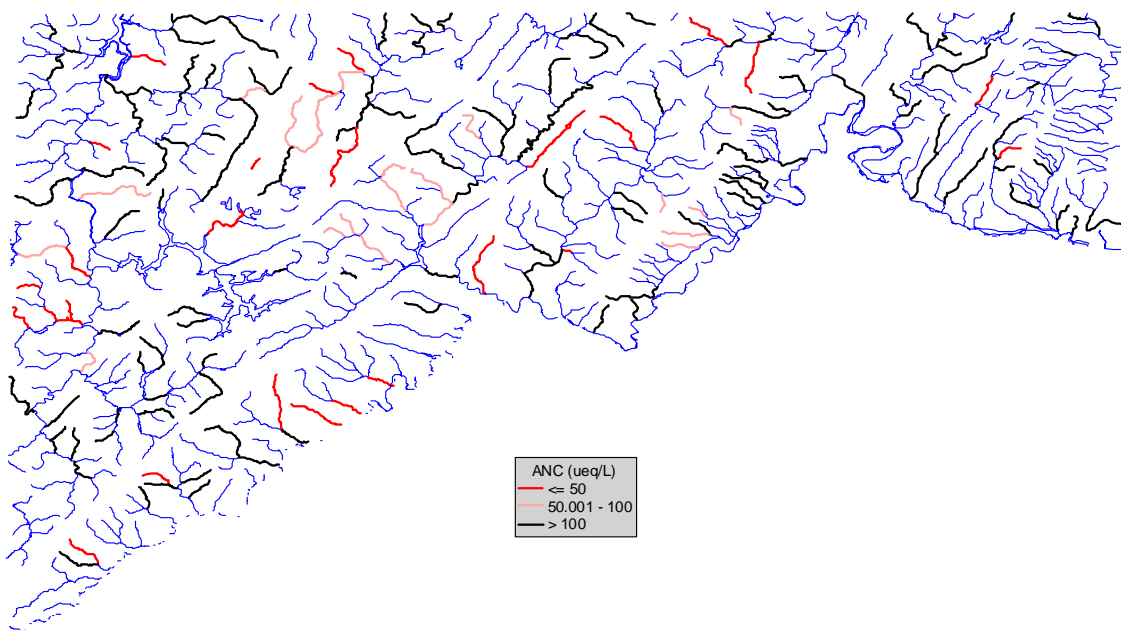


Figure 7. Stream reaches sampled by the MSSCS and MBSS. The stream reaches colored in red were determined to be acidic or highly acid sensitive (ANC <50µeq/L) and were re-sampled during Spring 1999.

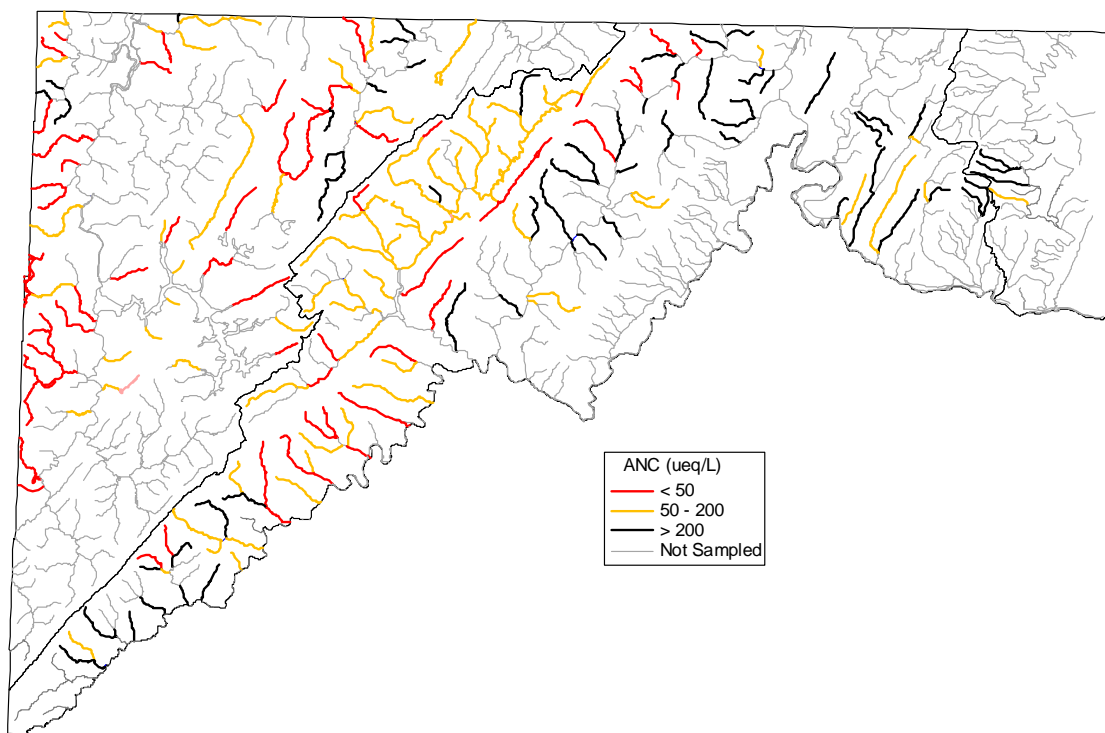


Figure 8. Stream reaches sampled in 1999. Colored in red had ANC values less than 50 µeq/L; orange stream reaches had ANC values between 50 µeq/L and 200µeq/L; and the black stream reaches had ANC values that were greater than 200 µeq/L. Gray stream reaches were not sampled.

Quality Control

The average ANC of the QCCS measured during the spring of 1999 was 49.3 $\mu\text{eq/L}$. The accuracy goal for analysis of the QCCS for ANC is $\pm 5\%$, resulting in an acceptable range of 47.5 to 52.5. All QCCS values were well within the accepted limits. The mean ANC for all blanks analyzed was 0.2 $\mu\text{eq/L}$, which is well below the acceptable limit of 10 $\mu\text{eq/L}$, and indicates an overall lack of contamination. Laboratory duplicate analysis also yielded excellent precision results for ANC. Laboratory duplicates were analyzed once every 10 samples and resulted in an average calculated percent relative standard deviation of 1.6%.

DISCUSSION

A stream cutting through highly weatherable calcareous materials will have high buffering capacity conferred upon downstream stream reaches. A stream will therefore gain buffering capacity as it moves downstream in the watershed. Stream will not however, lose buffering capacity. This allows us to predict an ANC class for unsampled stream reaches. For example, upstream unsampled tributaries to a poorly buffered stream may be predicted to be poorly buffered and downstream unsampled reaches to a well buffered stream may be predicted to at least be in the same ANC class.

Figure 9 shows additional, unsampled stream reaches for which an ANC class can be predicted. Two unsampled stream reaches can be predicted to have ANC values less than 50 $\mu\text{eq/L}$, 29 can be predicted to have ANC values between 50 and 200 $\mu\text{eq/L}$, and an additional 31 unsampled stream reaches can be predicted to have ANC values that are greater than 200 $\mu\text{eq/L}$.

Twenty-eight stream reaches in the Appalachian Plateau were determined by the MSSCS and MBSS to be acidic ($< 0 \mu\text{eq/L}$) or highly acid sensitive ($< 50 \mu\text{eq/L}$) in the Appalachian Plateau (Figure 7). Of the 28 stream reaches that were determined to be acidic or highly acid sensitive by the MSSCS and the MBSS, 17 still had ANC values that were less than 50 $\mu\text{eq/L}$, 9 had an ANC value between 50 and 200 $\mu\text{eq/L}$, and 2 had ANC values that were greater than 200 $\mu\text{eq/L}$ in 1999. An additional 52 stream reaches were found by this project to have ANC values that were less than 50 $\mu\text{eq/L}$. Figure 10 shows the ANC condition of most of the streams in close vicinity of the 28 stream reaches.

One possible explanation for the higher ANC values at 11 of the 28 stream reaches identified by the MBSS and MSSCS is that no water samples were collected in 1999 within 72 hours of a precipitation event. MBSS and MSSCS sampling was conducted regardless of precipitation amounts and regardless of discharge levels. Eshleman et al. (2000) showed that ANC concentrations can decline by more than 100 $\mu\text{eq/L}$ during a precipitation event. Natural fluctuations of ANC concentrations could explain differences between the results of this project and the results of the MBSS and MSSCS.

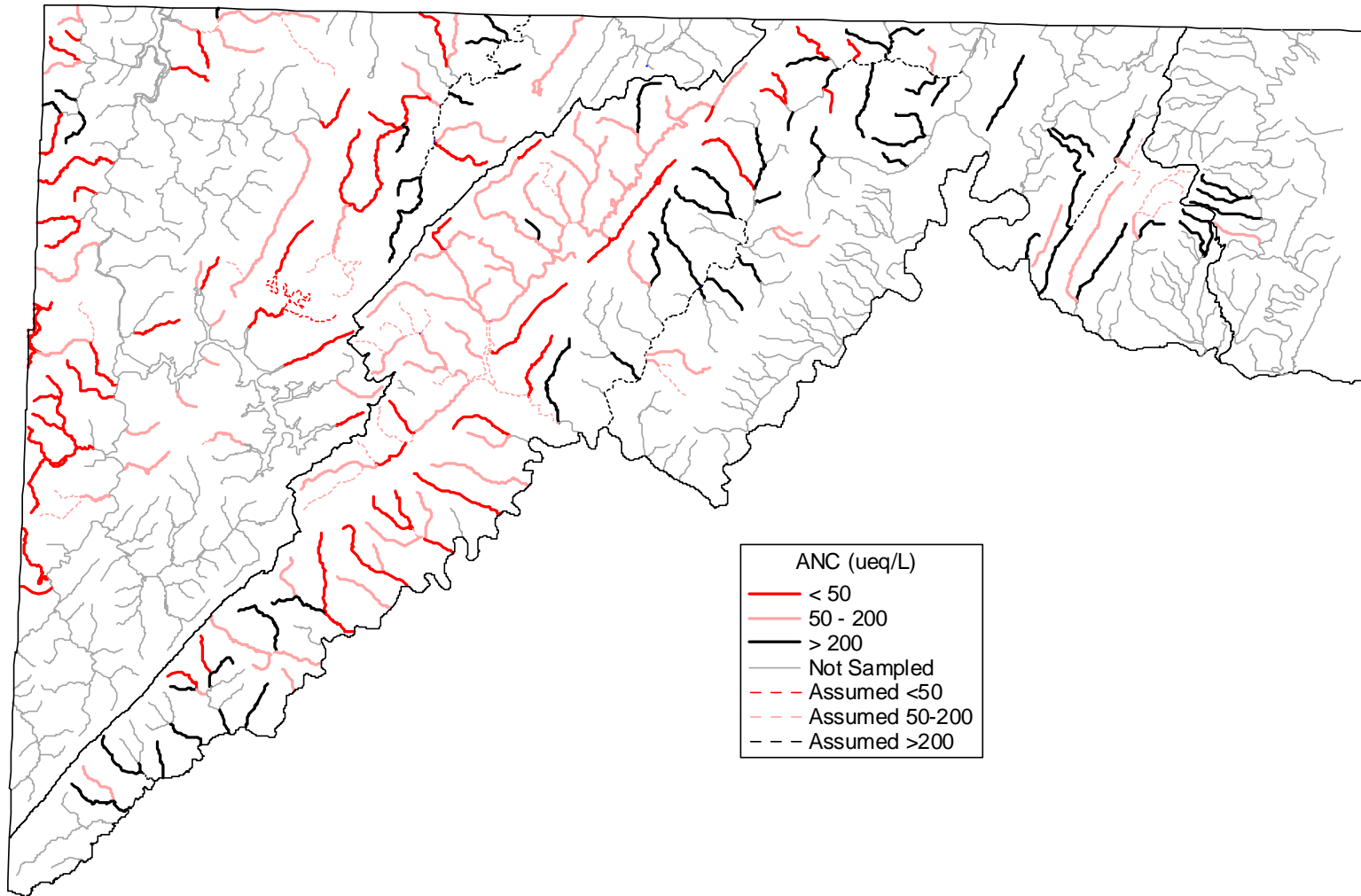


Figure 9. Stream reaches sampled during Spring 1999 (solid lines) and stream reaches for which an ANC class was predicted (dashed lines).

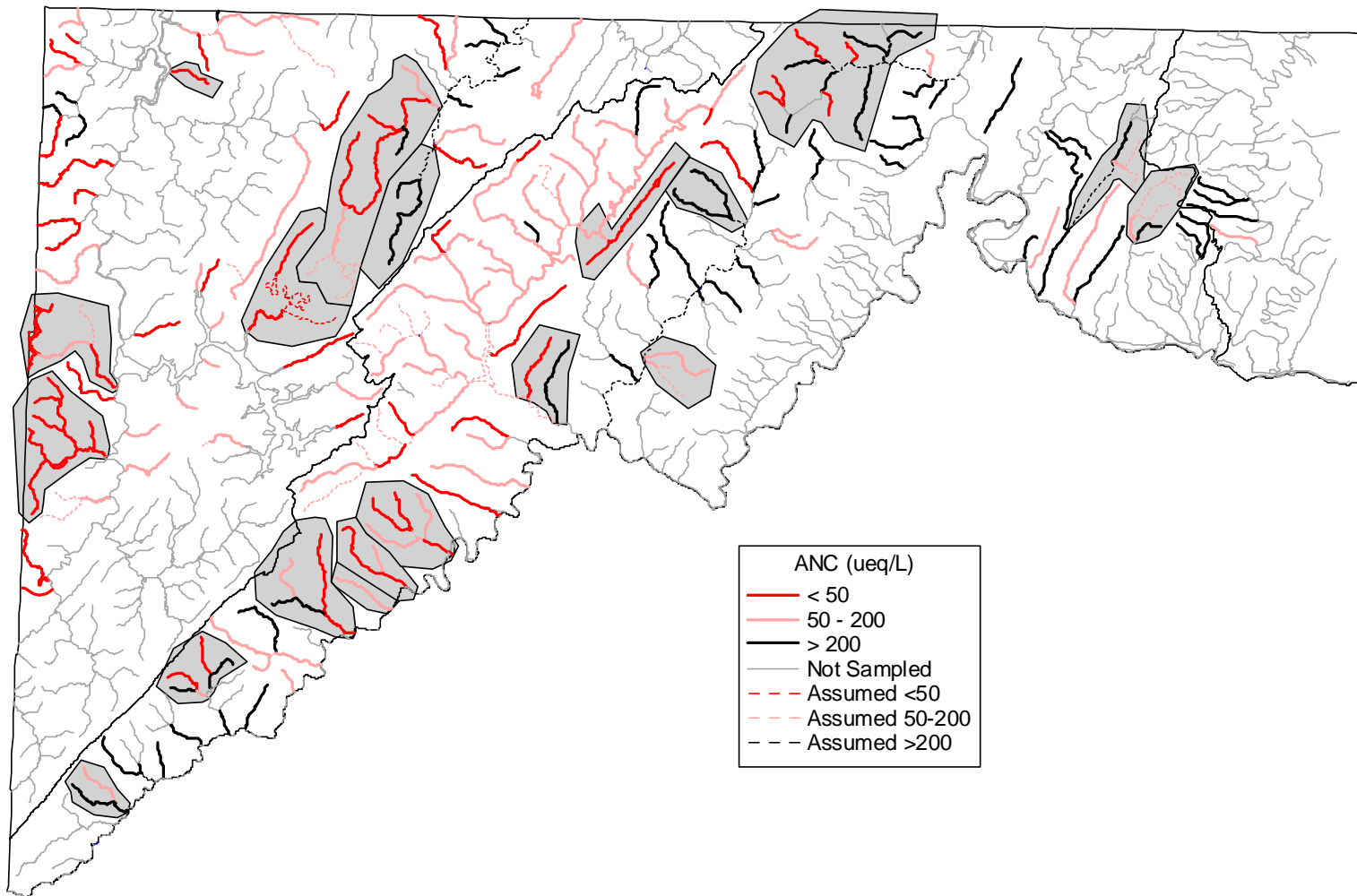


Figure 10. Current condition (1999) of areas determined by the MBSS (1995-1997) and MSSCS (1987) to be susceptible to acid deposition.

Another possible explanation for the higher ANC values at 11 of the 28 stream reaches identified by the MBSS and MSSCS is acid mine drainage (AMD) mitigation. Many of the streams identified as being chronically acidic or highly sensitive to acidification are tributaries to Georges Creek, Jennings Run, the North Branch of the Casselman River and the North Branch of the Potomac River. Numerous AMD mitigation projects have been conducted within these four watersheds. While it is not within the scope of this project to determine where every mitigation project was located, it is worth noting that these projects could be the reason for higher ANC values being measured at some of these stream reaches.

While it was the intent of this 1999 project to determine the status of most (if not all) of the acid sensitive stream reaches in the study area, time and funding limited us to sampling within those watersheds that had been previously determined to have acidic or acid sensitive stream reaches. Streams flowing across or in the vicinity of highly acid sensitive geologic formations were sampled, while streams flowing across low sensitivity geologic formations were not sampled. While the streams in these low acid sensitivity areas (e.g. Little Youghiogheny River and tributaries, South Branch of Bear Creek and tributaries, and Lower Bear Creek and tributaries) are suspected to have moderate to high buffering capacities, the current ANC and pH conditions in these streams were not determined by this project.

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APPENDIX

Water chemistry data and site location information for all 251 sample sites in 1999. (N - No signs of AMD, P - Possibly impacted by AMD, Y - Definitely impacted by AMD, ND - No Data)

Site ID#	Stream Name	Stream Reach ID#	Latitude	Longitude	Open pH	ANC (µeq/L)	Conductance (µS/cm)	AMD
001	UT Casselman River	GA-A-306	39.7089	79.1286	7.00	551.8	220.0	N
002	UT Casselman River	GA-A-327	39.7064	79.1355	7.69	1130.4	518.2	P
003	Big Shade Run	GA-A-236	39.6958	79.1732	6.78	173.4	301.3	Y
004	Little Shade Run	GA-A-530	39.6958	79.1749	6.55	154.3	165.6	N
005	Little Shade Run	GA-A-530	39.7113	79.1813	4.79	-11.1	37.3	N
006	UT Casselman River	GA-A-118	39.6889	79.1293	6.74	407.4	618.3	P
007	Spiker Run	GA-A-338	39.6779	79.1723	6.60	253.8	366.3	Y
008	N. Branch Casselman River	GA-A-398	39.6679	79.1798	6.28	74.2	128.2	N
009	UT Casselman River	GA-A-052	39.6725	79.1854	6.68	356.2	301.3	P
010	UT Casselman River	GA-A-153	39.6743	79.1717	7.00	518.3	149.2	N
011	Big Laurel Run	GA-A-382	39.6515	79.1761	6.62	90.4	74.3	N
012	Little Laural Run	GA-A-493	39.6387	79.1676	5.33	-1.4	32.5	N
013	UT Casselman River	GA-A-544	39.6570	79.2049	6.81	257.5	176.5	N
014	Alexander Run	GA-A-077	39.6595	79.2257	4.54	-30.5	44.6	N
015	UT Casselman River	GA-A-461	39.6336	79.2437	4.15	-61.8	51.3	N
016	N. Branch Casselman River	GA-A-477	39.5884	79.2542	6.17	59.2	124.2	N
017	S. Branch Casselman River	GA-A-439	39.5903	79.2185	6.76	213.7	150.8	N
018	UT Big Run	GA-A-312	39.5523	79.1456	6.51	86.0	57.3	N
019	UT S. Branch Casselman River	GA-A-075	39.6257	79.1928	6.80	235.6	194.4	N
020	Big Run	GA-A-145	39.5986	79.1748	6.23	24.5	34.5	N
021	Big Run	GA-A-090	39.5833	79.1709	6.60	91.5	48.0	N
022	UT Big Run	GA-A-057	39.5852	79.1719	6.46	47.5	48.6	N
023	UT Big Run	GA-A-508	39.5842	79.1715	6.49	61.8	46.6	N
024	Monroe Run	GA-A-303	39.5494	79.1447	6.70	136.1	98.5	N
025	Dry Run	GA-A-084	39.5222	79.1449	5.10	149.4	71.5	N
026	Bear Pen Run	GA-A-525	39.5626	79.1117	6.51	71.2	52.8	N
027	Meadow Run	GA-A-998	39.6919	79.0947	6.36	138.6	345.3	P
028	Elk Lick	GA-A-171	39.6006	79.0844	6.64	128.2	62.8	N
029	UT Savage River	GA-A-999	39.5796	79.0908	6.32	82.6	98.3	N
030	Poplar Lick Run	GA-A-162	39.6385	79.1177	6.16	54.2	39.8	N
031	Elk Lick Run	GA-A-171	39.6255	79.1096	6.64	100.5	62.5	N
033	Christley Run	GA-A-042	39.6572	79.0378	6.44	111.8	69.5	N
034	Mudlick Run	GA-A-412	39.6433	79.0216	6.38	128.2	250.1	N
035	Savage River	GA-A-558	39.6432	79.0205	6.41	120.3	367.9	P
036	Savage River	GA-A-313	39.6732	78.9799	6.56	92.4	320.5	P
037	Little Savage River	GA-A-074	39.6169	79.0249	5.17	-4.4	39.8	N
038	Kootz Run	AL-A-342	39.5679	78.9792	7.10	479.0	378.3	Y
040	Jennings Run	AL-A-997	39.6678	78.9187	6.85	598.4	0.0	P
041	Moore's Run	AL-A-462	39.5266	79.0167	6.56	197.6	778.4	Y
042	UT Georges Creek	AL-A-221	39.5232	79.0173	6.67	176.6	1062.0	Y
043	Mill Run	AL-A-075	39.5122	79.0245	6.83	206.2	344.0	Y
044	Jackson Run	AL-A-252	39.5644	78.9819	6.98	463.7	277.9	P
045	Hill Run	AL-A-084	39.5719	78.9727	8.25	2322.8	484.0	P
046	Elklick Run	AL-A-228	39.5819	78.9496	7.02	600.8	120.5	N

APPENDIX (cont.)

Site ID#	Stream Name	Stream Reach ID#	Latitude	Longitude	Open pH	ANC (µeq/L)	Conductance (µS/cm)	AMD
048	Neff Run	AL-A-998	39.6031	78.9206	6.47	91.9	211.8	Y
050	Woodland Creek	AL-A-112	39.6096	78.9629	6.64	213.0	80.1	N
051	Staub Run	AL-A-712	39.6071	78.9561	6.72	247.9	86.0	P
052	UT Georges Creek	AL-A-432	39.6165	78.9384	8.04	1764.8	1479.0	Y
053	Winebrenner Run	AL-A-144	39.6290	78.9453	4.43	-28.1	532.9	Y
054	Sand Spring Run	AL-A-299	39.6265	78.9400	6.98	544.6	1414.0	Y
055	UT Jennings Run	AL-A-149	39.6826	78.8867	4.99	-1.0	55.9	Y
056	UT Sand Spring Run	AL-A-652	39.6593	78.9407	6.59	214.0	1270.0	Y
057	UT Jennings Run	AL-A-296	39.7087	78.8945	4.57	-18.1	57.8	N
058	UT Jennings Run	AL-A-516	39.7004	78.8930	6.68	295.9	55.8	N
059	Jennings Run	AL-A-435	39.6946	78.8799	6.95	511.4	79.1	P
060	UT Jennings Run	AL-A-453	39.7062	78.8768	5.19	2.1	36.2	P
061	Aaron Run	AL-A-012	39.4864	79.0837	6.61	206.3	631.5	Y
062	UT Savage River	AL-A-317	39.5014	79.1063	5.23	-0.3	50.3	N
063	UT Jennings Run	AL-A-520	39.6984	78.8531	7.00	392.5	29.6	N
064	UT N. Br. Jennings Run	AL-A-715	39.7062	78.8421	7.25	625.2	220.0	N
065	UT N. Branch Jennings Run	AL-A-164	39.7161	78.8415	6.85	378.8	149.2	N
066	UT Jennings Run	AL-A-579	39.6947	78.8094	6.74	142.8	518.2	Y
067	UT Jennings Run	AL-A-314	39.6904	78.8038	6.75	313.0	164.9	N
068	UT Jennings Run	AL-A-678	39.6857	78.7979	7.03	552.6	165.6	N
069	UT Braddock Run	AL-A-050	39.6576	78.8147	7.19	593.6	37.3	N
070	UT Braddock Run	AL-A-513	39.6572	78.8150	7.00	488.6	618.3	Y
071	UT Braddock Run	AL-A-030	39.6400	78.8283	6.95	598.9	366.3	Y
072	Preston Run	AL-A-278	39.6366	78.8937	7.11	406.3	128.2	Y
073	UT Wills Creek	AL-A-175	39.6627	78.7667	7.31	656.2	301.3	P
074	Laurel Run	AL-A-260	39.5662	79.0181	6.98	437.2	250.9	P
075	UT Laurel Run	AL-A-038	39.5662	79.0181	6.61	180.5	136.6	N
076	Matthew Run	AL-A-515	39.6004	78.9261	6.38	74.2	122.3	Y
077	Porter Run	AL-A-101	39.6451	78.8908	7.67	996.2		ND
078	UT Evitts Creek	AL-A-137	39.6526	78.7103	8.24	3120.1		ND
080	UT Brice Hollow Run	AL-A-550	39.5643	78.6966	6.83	416.1	74.3	N
081	Brice Hollow Run	AL-A-290	39.5687	78.7056	6.84	333.9	32.5	N
082	Mill Run	AL-A-480	39.6140	78.6533	6.80	284.8	176.5	N
083	UT Mill Run	AL-A-607	39.6173	78.6532	6.73	178.6	44.6	N
084	Collier Run	AL-A-465	39.5666	78.7233	7.10	497.9	51.3	N
085	UT Potomac River	AL-A-099	39.5911	78.7352	7.11	822.0		ND
086	UT Potomac River	AL-A-564	39.5824	78.7314	6.60	161.2	124.2	N
087	Collier Run	AL-A-257	39.6236	78.7000	6.72	608.5	150.8	N
088	Collier Run	AL-A-706	39.6494	78.6672	6.59	205.2	57.3	N
089	UT Collier Run	AL-A-198	39.6443	78.6666	6.47	111.1	194.4	N
090	Upper Brice Hollow Run	AL-A-290	39.6117	78.6804	6.50	158.0	34.5	N
091	Lick Run	AL-A-224	39.6238	78.5696	6.80	234.7	48.0	N
092	Gerlock Hollow Run	AL-A-606	39.6148	78.5818	6.74	200.2	48.6	N
093	Sugar Hollow Run	AL-A-407	39.6044	78.5862	6.57	128.7	46.6	N
094	UT Trading Run	AL-A-717	39.6102	78.5977	7.03	516.8	98.5	N
095	UT Trading Run	AL-A-393	39.6048	78.6019	6.65	255.0	71.5	N
096	Jennings Run	AL-A-999	39.6705	78.9150	5.20	-2.3	52.8	Y

APPENDIX (cont.)

Site ID#	Stream Name	Stream Reach ID#	Latitude	Longitude	Open pH	ANC (µeq/L)	Conductance (µS/cm)	AMD
098	UT Evitts Creek	AL-A-609	39.6569	78.7071	8.20	2949.1		ND
099	Cherry Creek	GA-A-143	39.5837	79.2839	4.98	-6.0	56.9	Y
100	Cherry Creek	GA-A-011	39.5378	79.3172	5.05	-1.2	73.3	Y
101	Meadow Mountain Run	GA-A-209	39.5226	79.2686	5.43	10.3	43.2	N
102	North Glade Run	GA-A-557	39.4984	79.2349	6.46	104.8	67.5	N
103	Green Glade Run	GA-A-259	39.4812	79.2490	6.04	27.9	49.6	N
104	Pawn Run	GA-A-009	39.4751	79.3329	6.63	149.4	69.9	N
105	UT Deep Creek Lake	GA-A-336	39.4931	79.3664	6.35	79.4	80.5	N
106	UT Deep Creek Lake	GA-A-228	39.5610	79.3620	6.56	65.3	45.1	N
107	UT Deep Creek Lake	GA-A-152	39.5600	79.3581	5.10	-5.8	26.7	N
108	Bear Creek off of Margraff Place	GA-A-126	39.5610	79.3303	6.54	104.0	57.5	N
109	Gravelly Run	GA-A-065	39.5384	79.3446	6.68	147.3	43.0	N
110	Smith Run	GA-A-997	39.5181	79.3496	6.16	24.0	29.3	N
111	Fork Run	GA-A-160	39.5367	79.4081	5.29	0.8	35.1	N
112	UT Youghiogheny River	GA-A-428	39.4737	79.4008	6.50	111.8	49.9	N
113	Millers Run	GA-A-326	39.4521	79.4080	6.46	53.3	44.1	N
114	UT North Glade Run	GA-A-089	39.7026	79.4560	6.42	82.5	96.3	N
115	Herrington Creek	GA-A-563	39.4636	79.4456	5.05	-3.4	30.6	N
116	Herrington Creek	GA-A-203	39.4632	79.4463	5.84	12.2	28.4	N
117	Murley Run	GA-A-333	39.4636	79.4460	4.77	-12.4	30.2	N
118	Murley Run	GA-A-328	39.4878	79.4612	4.60	-26.1	35.1	N
119	Bull Glade Run	GA-A-443	39.4909	79.4583	4.63	-27.1	28.5	N
120	UT Bull Glade Run	GA-A-996	39.4912	79.4578	4.56	-31.4	35.2	N
121	Toliver Run	GA-A-088	39.4948	79.4204	4.80	-9.7	33.7	N
122	Muddy Creek	GA-A-542	39.5012	79.4169	5.95	15.6	35.4	N
123	Muddy Creek	GA-A-051	39.5183	79.4652	6.31	62.8	39.3	N
124	UT Muddy Creek	GA-A-995	39.5444	79.4735	5.87	16.1	33.8	N
125	Salt Block Run	GA-A-547	39.5653	79.4676	6.68	174.7	53.4	N
126	Salt Block Run	GA-A-547	39.5774	79.4471	6.57	82.0	40.4	N
127	White Rock Run	GA-A-037	39.5945	79.4467	4.68	-21.8	41.5	N
128	UT White Rock Run	GA-A-023	39.5953	79.4472	4.69	-18.5	43.5	N
129	UT Youghiogheny River	GA-A-340	39.6143	79.4481	5.16	-0.3	107.9	N
130	Laurel Run	GA-A-441	39.6329	79.4502	5.82	14.0	53.7	N
131	Buffalo Run	GA-A-168	39.6565	79.4649	6.30	41.3	50.1	N
132	UT Buffalo Run	GA-A-294	39.6522	79.4447	6.59	212.1	155.6	N
133	UT Buffalo Run	GA-A-452	39.6916	79.4529	5.72	8.6	53.7	N
134	UT Buffalo Run	GA-A-166	39.6887	79.4533	6.45	58.3	52.4	N
135	UT Glade Run	GA-A-444	39.7014	79.4524	4.70	-17.7	113.0	N
136	UT Glade Run	GA-A-230	39.7124	79.4519	6.50	86.1	128.6	N
137	Glade Run	GA-A-349	39.7139	79.4506	6.47	93.9	54.0	N
138	UT Youghiogheny River Lake	GA-A-409	39.6870	79.3814	6.41	42.9	136.2	N
139	UT Buffalo Run	GA-A-300	39.6603	79.4651	6.88	299.9	223.5	N
140	UT Buffalo Run	GA-A-248	39.6668	79.4542	6.82	318.1	79.9	N
141	UT Herrington Creek	GA-A-040	39.4582	79.4576	4.53	-29.1	35.2	N
142	UT Herrington Creek	GA-A-144	39.4563	79.4701	5.75	13.1	32.6	N
143	Dunkard Lick Run	GA-A-543	39.4344	79.4280	6.50	76.3	35.5	N
145	Monroe Run	GA-A-429	39.5553	79.2166	6.42	52.6	78.8	N

APPENDIX (cont.)

Site ID#	Stream Name	Stream Reach ID#	Latitude	Longitude	Open pH	ANC (µeq/L)	Conductance (µS/cm)	AMD
146	Blue Lick Run	GA-A-212	39.6488	79.0704	6.54	77.7	52.3	N
147	Blue Lick Run	GA-A-008	39.6355	79.0582	6.57	83.6	48.9	N
148	Laurel Run	GA-A-522	39.4882	79.1531	4.50	-32.1	123.2	N
149	UT Laurel Run	GA-A-523	39.4759	79.1422	6.71	188.5	96.3	N
150	Folly Run	GA-A-559	39.4505	79.1261	6.56	83.2	105.5	N
151	Elklick Run	GA-A-503	39.4466	79.1751	5.02	-1.1	258.6	N
152	UT Three Forks Run	GA-A-208	39.4170	79.1817	6.56	95.4	85.1	P
153	Three Forks Run	GA-A-455	39.4177	79.2141	6.63	122.3	137.2	Y
154	Three Forks Run	GA-A-205	39.4056	79.1622	5.75	18.9	302.9	Y
155	Three Forks Run	GA-A-350	39.4229	79.1991	4.94	-7.1	121.7	Y
156	Three Forks Run	GA-A-085	39.4239	79.1928	5.34	2.8	431.6	Y
157	Wolfden Run	GA-A-060	39.3883	79.1961	6.45	41.7	60.2	N
158	UT Wolfden Run	GA-A-556	39.3972	79.2132	6.75	140.8	157.4	N
159	Short Run	GA-A-131	39.3772	79.2058	6.74	150.6	109.2	N
160	Lostland Run	GA-A-305	39.3827	79.2769	6.39	59.8	136.9	Y
161	UT Lostland Run	GA-A-229	39.3795	79.2831	7.76	1506.5	467.4	Y
162	Lostland Run	GA-A-298	39.3709	79.2555	6.12	20.0	70.4	Y
163	Lostland Run	GA-A-502	39.3768	79.2671	6.90	260.6	203.3	Y
164	Trout Run	GA-A-101	39.3477	79.2951	6.66	117.2	68.8	N
165	UT Trout Run	GA-A-100	39.3473	79.2943	6.61	110.2	43.6	N
166	Laurel Run	GA-A-017	39.3496	79.2902	6.97	284.0	197.5	P
167	Laurel Run	GA-A-191	39.3454	79.2779	6.84	163.7	99.8	N
168	UT Potomac River	GA-A-415	39.3276	79.2775	6.68	114.6	46.6	N
170	Glade Run	GA-A-360	39.3225	79.3452	6.65	180.0	99.8	N
171	Glade Run	GA-A-332	39.3301	79.3533	5.77	14.2	66.6	N
172	Glade Run	GA-A-096	39.3263	79.3549	7.42	1270.7	345.7	P
173	UT Glade Run	GA-A-099	39.3290	79.3406	6.74	273.7	140.7	N
174	Nydegger Run	GA-A-515	39.2943	79.3458	7.07	289.9	120.1	N
175	UT Potomac River	GA-A-504	39.2771	79.3730	6.94	357.6	125.7	N
176	Shield Run	GA-A-189	39.2767	79.3900	7.10	639.7	183.3	P
178	McMillan Fork	GA-A-198	39.2763	79.3904	6.96	366.0	114.9	N
179	North Fork Sand Run	GA-A-269	39.2597	79.4096	6.59	119.3	228.7	Y
180	South Fork Sand Run	GA-A-165	39.2588	79.4104	7.56	683.9	1901.0	Y
181	Sand Run	GA-A-043	39.2583	79.4089	7.18	452.5	1281.0	Y
185	UT Youghigheny River	GA-A-215	39.3801	79.4664	6.31	45.6	38.0	N
186	Snowy Creek	GA-A-181	39.3873	79.4638	5.27	5.3	70.6	N
187	Wolfden Run	GA-A-169	39.3968	79.2136	5.03	-7.9	34.5	N
188	Lostland Run	GA-A-013	39.3949	79.2580	5.01	-2.7	49.1	Y
189	UT Glade Run	GA-A-087	39.3445	79.3285	6.73	209.5	70.7	N
190	UT Glade Run	GA-A-087	39.3500	79.3484	4.90	-10.8	31.0	N
191	Glade Run	GA-A-226	39.3020	79.3255	6.89	320.1	126.6	N
192	Steyer Run	GA-A-378	39.3052	79.3121	7.11	562.3	241.4	Y
H-01	UT Savage River	GA-A-219	39.6685	78.9760		12.92		ND
H-02	Carey Run	GA-A-007	39.6637	79.0007		56.23		ND
H-03	Upper Mudlick Run	GA-A-256	39.6832	79.0236		273.20		ND
H-04	Savage River	GA-A-558	39.6482	79.0167		104.62		ND
H-05	UT Savage River	GA-A-994	39.6460	79.0167		55.11		ND

APPENDIX (cont.)

Site ID#	Stream Name	Stream Reach ID#	Latitude	Longitude	Open pH	ANC (µeq/L)	Conductance (µS/cm)	AMD
H-06	Savage River	GA-A-528	39.6192	79.0383		114.76		ND
H-07	Christley Run	GA-A-042	39.6611	79.0456		121.15		ND
H-08	UT Blue Lick Run	GA-A-993	39.6486	79.0564		78.28		ND
H-09	Blue Lick Run	GA-A-008	39.6283	79.0595		89.34		ND
H-10	Little Savage River	GA-A-074	39.6205	79.0197		-4.91		ND
H-11	Swamp Run	GA-A-201	39.5889	79.0508		27.90		ND
H-12	Blacklick Run	GA-A-315	39.6045	79.0798		58.17		ND
H-13	UT Blacklick Run	GA-A-992	39.6201	79.0871		74.38		ND
H-14	Elklick Run	GA-A-171	39.6019	79.0876		129.59		ND
H-15	Savage River	GA-A-108	39.5889	79.0854		100.00		ND
H-16	Poplar Lick Run	GA-A-174	39.5855	79.0945		81.19		ND
H-17	Poplar Lick Run	GA-A-162	39.6253	79.1321		53.79		ND
H-18	Poplar Lick Run	GA-A-162	39.6434	79.1109		17.89		ND
H-19	UT Bear Pen Run	GA-A-991	39.5626	79.1152		47.97		ND
H-20	UT Bear Pen Run	GA-A-990	39.5708	79.1187		77.06		ND
H-21	Silver Bell Run	GA-A-045	39.5803	79.1256		67.64		ND
H-22	UT Savage River Reservoir	GA-A-989	39.5414	79.1351		79.17		ND
H-23	UT Monroe Run	GA-A-988	39.5483	79.1472		109.67		ND
H-24	Big Run	GA-A-154	39.5673	79.1559		76.80		ND
H-25	UT Big Run	GA-A-987	39.5716	79.1628		131.56		ND
H-26	Big Run	GA-A-145	39.5907	79.1788		16.96		ND
H-27	Monroe Run	GA-A-429	39.5608	79.2099		62.08		ND
H-28	Pine Swamp Run	GA-A-376	39.5431	79.1114		-3.87		ND
H-29	Pine Swamp Run	GA-A-376	39.5431	79.1114		-3.45		ND
H-30	Middle Fork Run	GA-A-159	39.5141	79.1555		85.94		ND
H-31	Toms Spring Run	GA-A-434	39.5159	79.1727		84.88		ND
H-32	UT Middle Fork Run	GA-A-372	39.5314	79.1879		72.97		ND
H-33	Middle Fork Run	GA-A-151	39.5262	79.2091		87.05		ND
H-34	Middle Fork Run	GA-A-197	39.5137	79.2160		76.01		ND
H-35	Spring Lick Run	GA-A-133	39.4912	79.1766		129.20		ND
H-36	Maple Lick Run	GA-A-337	39.4951	79.2099		28.76		ND
H-37	UT Hungry Hollow	GA-A-448	39.4670	79.2013		46.65		ND
H-38	Crabtree Creek	GA-A-266	39.4571	79.2251		185.65		ND
H-39	North Fork of Crabtree Creek	GA-A-262	39.4592	79.2411		152.67		ND
H-40	North Fork of Crabtree Creek	GA-A-262	39.4510	79.2627		109.58		ND
S-BC-2	Bear Creek	GA-A-141	39.6228	79.2900	7.00	143.5	49.7	N
S-BC-3	Little Bear Creek	GA-A-029	39.6700	79.2593	6.30	14.8	131.0	N
S-BC-4	Bear Creek	GA-A-141	39.5961	79.2990	6.78	126.9	53.2	N
S-BL-1	Blue Lick Run	GA-A-076	39.6033	79.0697	6.89	88.5	52.7	N
S-BL-2	Blue Lick Run	GA-A-076	39.6393	79.0638	6.94	75.7	50.5	N
S-BL-3	West Branch Blue Lick Run	GA-A-026	39.6245	79.0652	6.94	69.1	48.9	N
S-BL-4	UT Blue Lick Run	GA-A-173	39.6412	79.0577	7.04	104.2	78.4	N
S-BL-5	Blue Lick Run	GA-A-212	39.6500	79.0743	6.92	2322.8	57.5	N
S-BP-1	Bear Pen Run	GA-A-525	39.5681	79.1167	6.84	74.9	48.6	N
S-BP-2	Bear Pen Run	GA-A-121	39.5652	79.1184	6.63	74.9	51.0	N
S-BP-3	UT Bear Pen Run	GA-A-156	39.5728	79.1218	6.70	72.8	52.7	N
S-BP-4	UT Bear Pen Run	GA-A-045	39.5789	79.1255	6.53	67.8	48.2	N

APPENDIX (cont.)

Site ID#	Stream Name	Stream Reach ID#	Latitude	Longitude	Open pH	ANC (µeq/L)	Conductance (µS/cm)	AMD
S-BP-5	Bear Pen Run	GA-A-099	39.5869	79.1348	6.78	74.9	50.1	N
S-CS-2	Spiker Run	GA-A-052	39.6754	79.1900	6.70	52.1	142.2	N
S-CS-3	N.Branch Casselman River	GA-A-310	39.6748	79.2101	6.47	44.4	83.1	N
S-CS-4	N.Branch Casselman River	GA-A-407	39.6117	79.2284	6.39	41.7	77.6	N
S-CS-5	N.Branch Casselman River	GA-A-505	39.5979	79.2511	6.41	51.7	86.4	N
S-CS-6	UT N.Branch Casselman River	GA-A-461	39.6201	79.2511	4.45	-30.2	39.8	N
S-MR-1	Mill Run	GA-A-289	39.7135	79.3781	7.11	157.0	210.2	N
S-MR-2	UT Mill Run	GA-A-319	39.7091	79.3629	5.87	10.2	227.3	N
S-MR-3	Cove Run	GA-A-130	39.7094	79.3476	7.13	130.6	184.6	N
S-MR-4	Chub Run	GA-A-380	39.7163	79.3466	6.96	204.0	165.2	Y
S-MR-5	Mill Run	GA-A-062	39.7249	79.3366	7.08	142.4	197.1	N
S-MR-6	Mill Run	GA-A-462	39.7202	79.2997	7.16	151.7	157.6	N
S-SR-1	Upper Savage River	GA-A-313	39.6716	79.9767	6.82	101.7	210.1	N
S-SR-2	Savage River	GA-A-558	39.6466	79.0165	6.85	140.3	170.3	N
S-SR-3	Mudlick Run	GA-A-412	39.6461	79.0257	7.19	185.8	152.3	N
S-SR-4	Savage River	GA-A-528	39.6217	79.0443	6.95	105.9	113.4	N
S-SR-5	Savage River	GA-A-002	39.6200	79.0522	6.98	101.0	101.4	N
S-SR-6	Savage River	GA-A-225	39.5969	79.0554	7.03	124.4	110.7	N
S-SR-7	Little Savage River	GA-A-316	39.6029	79.0605	7.06	104.2	45.5	N