QUALITY ASSURANCE/WORK PLAN

WATER QUALITY MONITORING NETWORK OF INTERSTATE STREAMS

IN THE SUSQUEHANNA RIVER BASIN

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I. PROJECT NAME

Water Quality Monitoring Network of Interstate Streams in the Susquehanna River Basin

II. PROJECT OFFICER:

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III. QUALITY ASSURANCE OFFICER

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IV. DATE OF PROJECT INITIATION

October 1989

V. PROJECT DESCRIPTION

A. Goals

The Regulations and Procedures for Review of Projects in the Susquehanna River Basin state that the Susquehanna River Basin Commission (Commission) is responsible for reviewing projects for potential interstate impacts on water resources in the basin. Commission staff needs current data for interstate streams to meet this responsibility. The Commission conducts a monitoring program to assess the water quality of interstate streams and to support project and policy review tasks.

B. Scope

The Susquehanna River Basin spans three states: New York, Pennsylvania, and Maryland. This program includes the named perennial streams that flow across the borders between these states within the basin. The streams are divided into three groups: Group 1—streams with impacted water quality or where a high potential for impacts are judged to exist; Group 2—streams judged to have a moderate potential for impacts; and Group 3—streams judged to have a low potential for impacts.

C. Objectives

1. Monitor interstate streams

Tasks include quarterly collection of water samples from Group 1 streams, and annual water quality sampling from Group 2 streams; annual collection of macroinvertebrates from Group 1, Group 2, and Group 3 streams; analysis and interpretation of water quality and macroinvertebrate data; comparison of data with prior data; and storage of water quality data in STORET and Commission databases.

2. Collect data for trend assessment

Trend analysis is dependent upon large amounts of data. Tasks are to collect data in a consistent manner relative to collection and analytical procedures to improve suitability for trend analysis.

D. Data Usage

The data collected are used by Commission staff to: (1) assess compliance with water quality standards; (2) characterize stream quality and seasonal variations; (3) build a database for assessment of water quality trends; (4) identify streams for reporting to USEPA under Section 305(b) of the Clean Water Act; (5) provide information to signatory states for 303(d) listing and possible Total Maximum Daily Load development; and (6) identify areas for restoration and protection. The data are published annually by the Commission, as well as entered into STORET, thus being available to states and other parties for use in updating 305(b) reports (water quality inventory), 205(j) priorities (sewage construction grants) and other water quality management plans.

E. Monitoring Network Design and Rationale

All named interstate streams in the Susquehanna River Basin were assigned a group number according to the degree of impairment and the potential for degradation and are listed in Tables 1 and 2. The criteria for each group are as follows.

Table 1. Interstate Streams along the New York –Pennsylvania Border

Stream	Group	Stream	Group
Apalachin Creek	2	Little Wappasening Creek	3
Babcock Run	3	North Brook	3
Bentley Creek	1	North Fork Cowanesque River	2
Bill Hess Creek	3	Parks Creek	3
Bird Creek	3	Prince Hollow Run	3
Biscuit Hollow Run	3	Red House/Beagle Hollow Run	3
Briggs Hollow Run	3	Russell Run	3
Bulkley Brook	3	Sackett Creek	3
Camp Brook	3	Seeley Creek	1
Cascade Creek	1	Snake Creek	2
Cayuta Creek	1	South Creek	2
Chemung River	1	Strait Creek	3
Choconut Creek	2	Susquehanna River	1
Cook Hollow Run	3	Tioga River	1
Cowanesque River	1	Troups Creek	1
Deep Hollow Run	3	Trowbridge Creek	2
Denton Creek	3	Wappasening Creek	2
Dry Brook	3	White Branch Cowanesque River	2
Holden Creek	2	White Hollow Run	3
Little Snake Creek	1		

Table 2 Interstate Streams along the Pennsylvania-Maryland Border

Stream	Group	Stream	Group
Big Branch Deer Creek	2	Long Arm Creek	1
Conowingo Creek	1	Octoraro Creek	1
Deer Creek	1	Scott Creek	1
Ebaughs Creek	1	South Branch Conewago Creek	2
Falling Branch Deer Creek	2	Susquehanna River	1
Island Branch Deer Creek	3		

Group 1 streams: (1) receive point-source discharges; (2) have large areas of nonpoint sources influencing water quality; (3) have histories of degradation; or (4) are of some special interest. The rationale for selecting each Group 1 stream is discussed below. These streams were monitored five times a year on a bimonthly schedule. Streams between Pennsylvania and Maryland were sampled in even numbered months (except February), while streams between New York and Pennsylvania were sampled in odd numbered months (except January). The exclusion of midwinter sampling was based on budgetary limits that allow for five samples per year; January and February were skipped because of the adverse weather conditions typical of these months. A database spanning 12 years has been established; therefore, due to budgetary constraints, water quality sampling has been reduced to quarterly at these sites.

Group 2 streams have small watersheds and low flows, even in wet summers having above average rainfall. These streams are sampled once a year in July or August. Macroinvertebrate samples and physical habitat information are collected from all Group 1 and Group 2 streams once a year in July or August.

Group 3 streams have small watersheds and low flows, even in wet summers having above average rainfall. Initially, these streams were visually inspected annually. The biological condition and physical habitat of these streams will be assessed yearly in April or May.

Figure 1 shows the general location of the monitoring sites. A monitoring network of 48 streams was established according to the group criteria and is shown in Tables 3 and 4 and Figures 2-5.

<u>Group 1 Streams</u>

Five stations are located on the Susquehanna River. Three stations are near where the Susquehanna River crosses the New York-Pennsylvania border. A station at Windsor, N.Y., allows the Commission to monitor water quality from the headwaters of the Susquehanna River as it flows into Pennsylvania (Figure 2). Municipal discharges from Sidney and Oneonta, and an industrial discharge near Afton are the major point sources upstream of Windsor. However, due to the rural character of the watershed, water quality at Windsor is largely influenced by nonpoint sources.

Downstream of Windsor, the Susquehanna River makes a 25-mile bend through Pennsylvania. Degradation was reported in this reach during the 1960s. Improved conditions have been observed since the construction of sewage treatment plants (STP) serving Lanesboro, Susquehanna, Oakland, Great Bend, and Hallstead. Changes in the river's quality in this reach are monitored at Kirkwood, N.Y. (Figure 2).

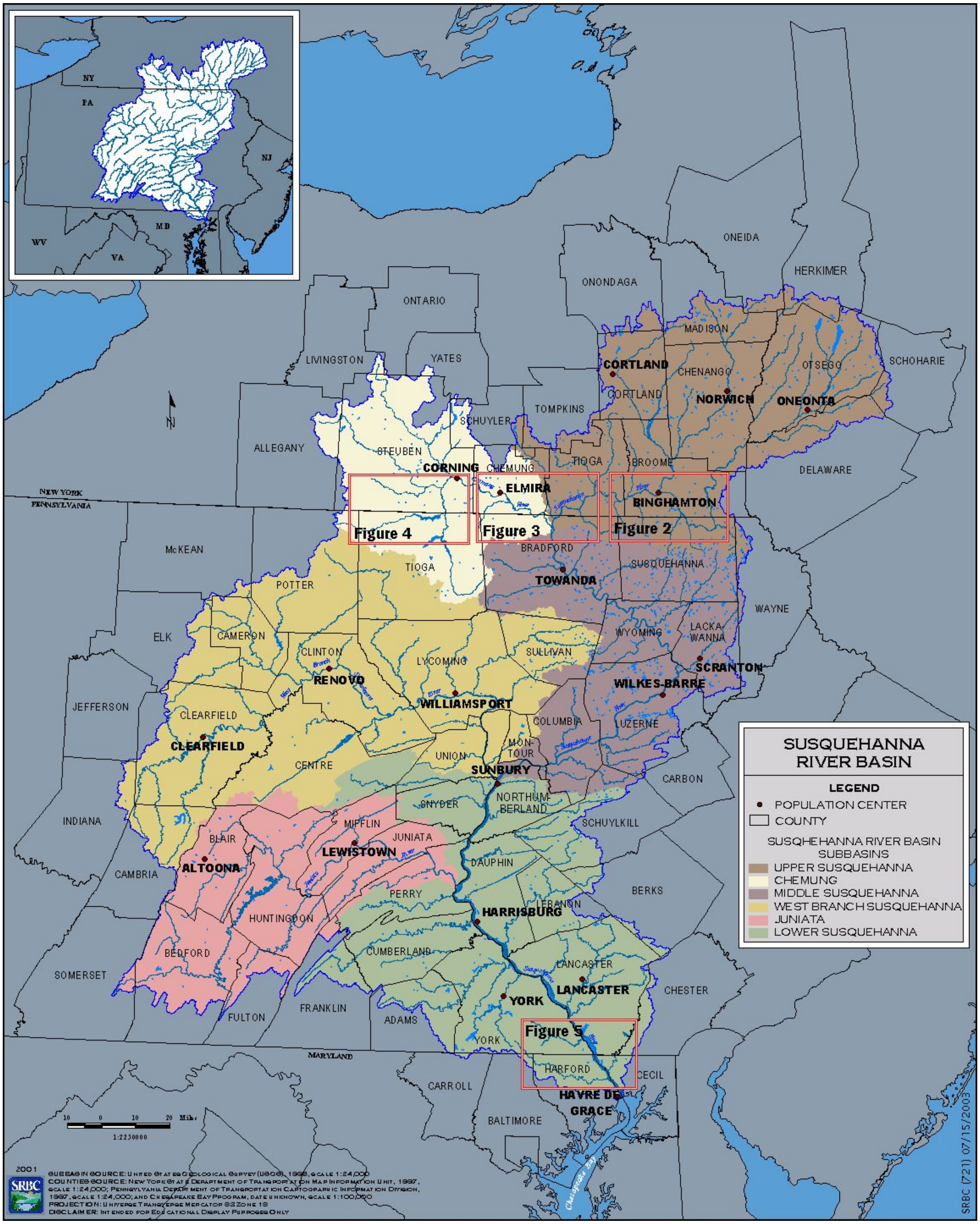


Figure 1.   General Location of the Monitoring Sites

Table 3. Sampling Stations on the New York-Pennsylvania Border

Station	Stream	Location	Group
APAL 6.9	Apalachin Creek	Little Meadows, Pa.	2
BABC	Babcock Run	Cadis, Pa.	3
BILL	Bill Hess Creek	Nelson, Pa.	3
BIRD	Bird Creek	Webb Mills, N.Y.	3
BISC	Biscuit Hollow	Austinburg, Pa.	3
BNTY 0.9	Bentley Creek	Wellsburg, N.Y.	1
BRIG	Briggs Hollow	Nichols, N.Y.	3
BULK	Bulkley Brook	Knoxville, Pa.	3
CAMP	Camp Brook	Osceola, Pa.	3
CASC 1.6	Cascade Creek	Lanesboro, Pa.	1
CAYT 1.7	Cayuta Creek	Waverly, N.Y.	1
CHEM 12.0	Chemung River	Chemung, N.Y.	1
CHOC 9.1	Choconut Creek	Vestal Center, N.Y.	2
COOK	Cook Hollow	Austinburg, Pa.	3
COWN 5.0	Cowanesque River	Knoxville, Pa.	1
COWN 2.2	Cowanesque River	Lawrenceville, Pa.	1
COWN 1.0	Cowanesque River	Lawrenceville, Pa.	1
DEEP	Deep Hollow Brook	Danville, N.Y.	3
DENT	Denton Creek	Hickory Grove, Pa.	3
DRYB	Dry Brook	Waverly, N.Y.	3
HLDN 3.5	Holden Creek	Woodhull, N.Y.	2
LSNK 7.6	Little Snake Creek	Brackney, Pa.	1
LWAP	Little Wappasening Creek	Brackney, Pa.	3
NFCR 7.6	North Fork Cowanesque River	North Fork, Pa.	2
PARK	Parks Creek	Litchfield, N.Y.	3
PRIN	Prince Hollow Run	Cadis, Pa.	3
REDH	Red House/Beagle Hollow Run	Osceola, Pa.	3
RUSS	Russell Run	Windham, Pa.	3
SACK	Sackett Creek	Nichols, N.Y.	3
SEEL 10.3	Seeley Creek	State Line, Pa.	1
SMIT	Smith Creek	East Lawrence, Pa.	3
SNAK 2.3	Snake Creek	Brookdale, Pa.	2
SOUT 7.8	South Creek	Fassett, Pa.	2
STRA	Strait Creek	Nelson, Pa.	3
SUSQ 365.0	Susquehanna River	Windsor, N.Y.	1
SUSQ 340.0	Susquehanna River	Kirkwood, N.Y.	1
SUSQ 289.1	Susquehanna River	Sayre, Pa.	1
TIOG 10.8	Tioga River	Lindley, N.Y.	1
TRUP 4.5	Troups Creek	Austinburg,Pa.	1
TROW 1.8	Trowbridge Creek	Great Bend, Pa.	2
WAPP 2.6	Wappasening Creek	Windham, Pa.	2
WBCO	White Branch Cowanesque River	North Fork, Pa.	3
WHIT	White Hollow	Wellsburg, N.Y.	3

Table 4. Sampling Stations on the Pennsylvania-Maryland Border

Station	Stream	Location	Group
BBDC 4.1	Big Branch Deer Creek	Fawn Grove, Pa.	2
CNWG 4.4	Conowingo Creek	Pleasant Grove, Pa.	1
DEER 44.2	Deer Creek	Gorsuch Mills, Md.	1
EBAU 1.5	Ebaughs Creek	Stewartstown, Pa.	1
FBDC 4.1	Falling Branch Deer Creek	Fawn Grove, Pa.	2
LNGA 2.5	Long Arm Creek	Bandanna, Pa.	1
OCTO 6.6	Octoraro Creek	New Bridge, Md.	1
SCTT 3.0	Scott Creek	Delta, Pa.	1
SBCC 20.4	South Branch Conewago Creek	Bandanna, Pa.	2
SUSQ 44.5	Susquehanna River	Columbia, Pa.	1
SUSQ 10.0	Susquehanna River	Conowingo Dam, Md.	1

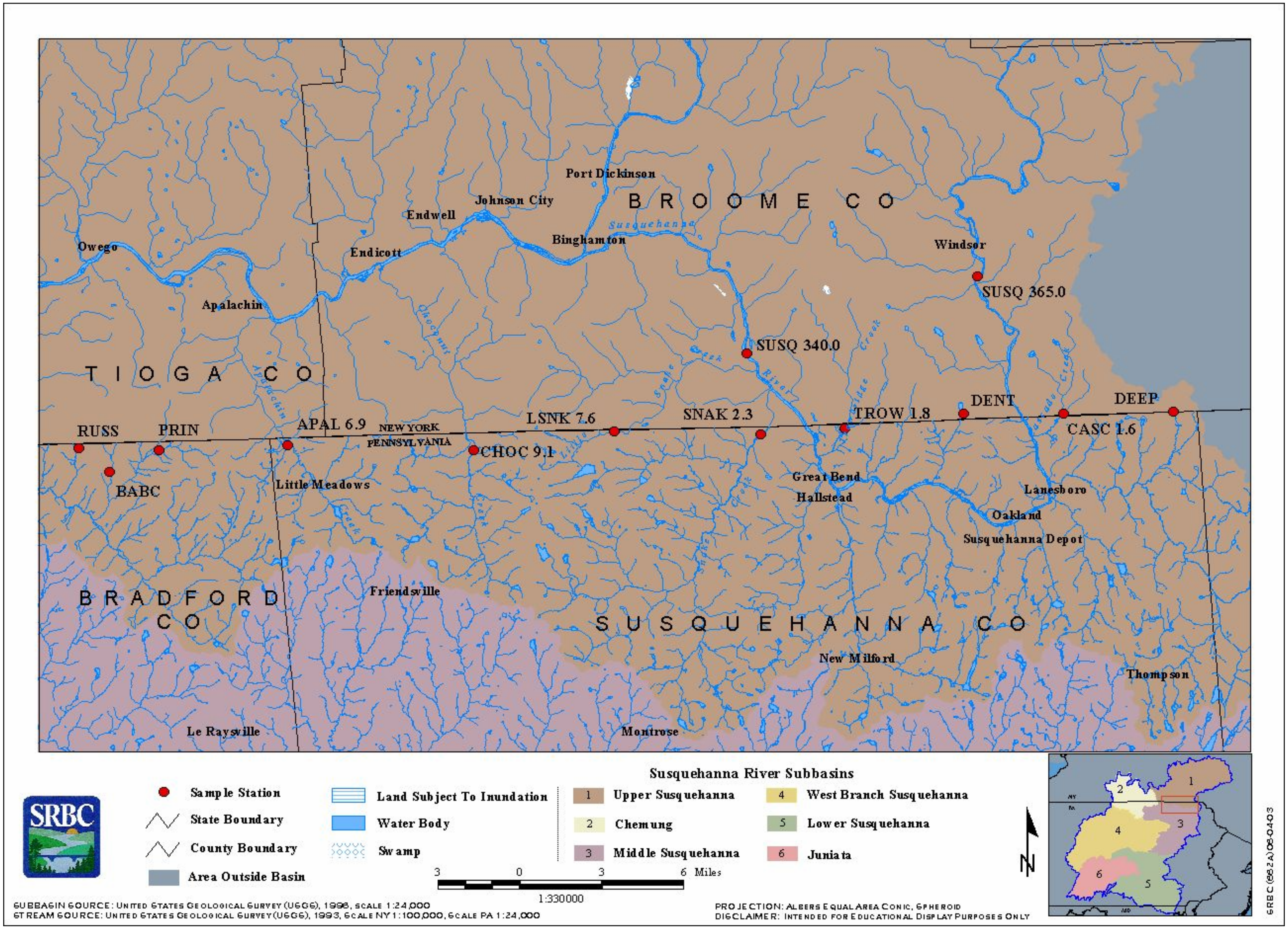


Figure 2. Interstate Streams along the New York-Pennsylvania Border between Russell Run and Deep Hollow Brook

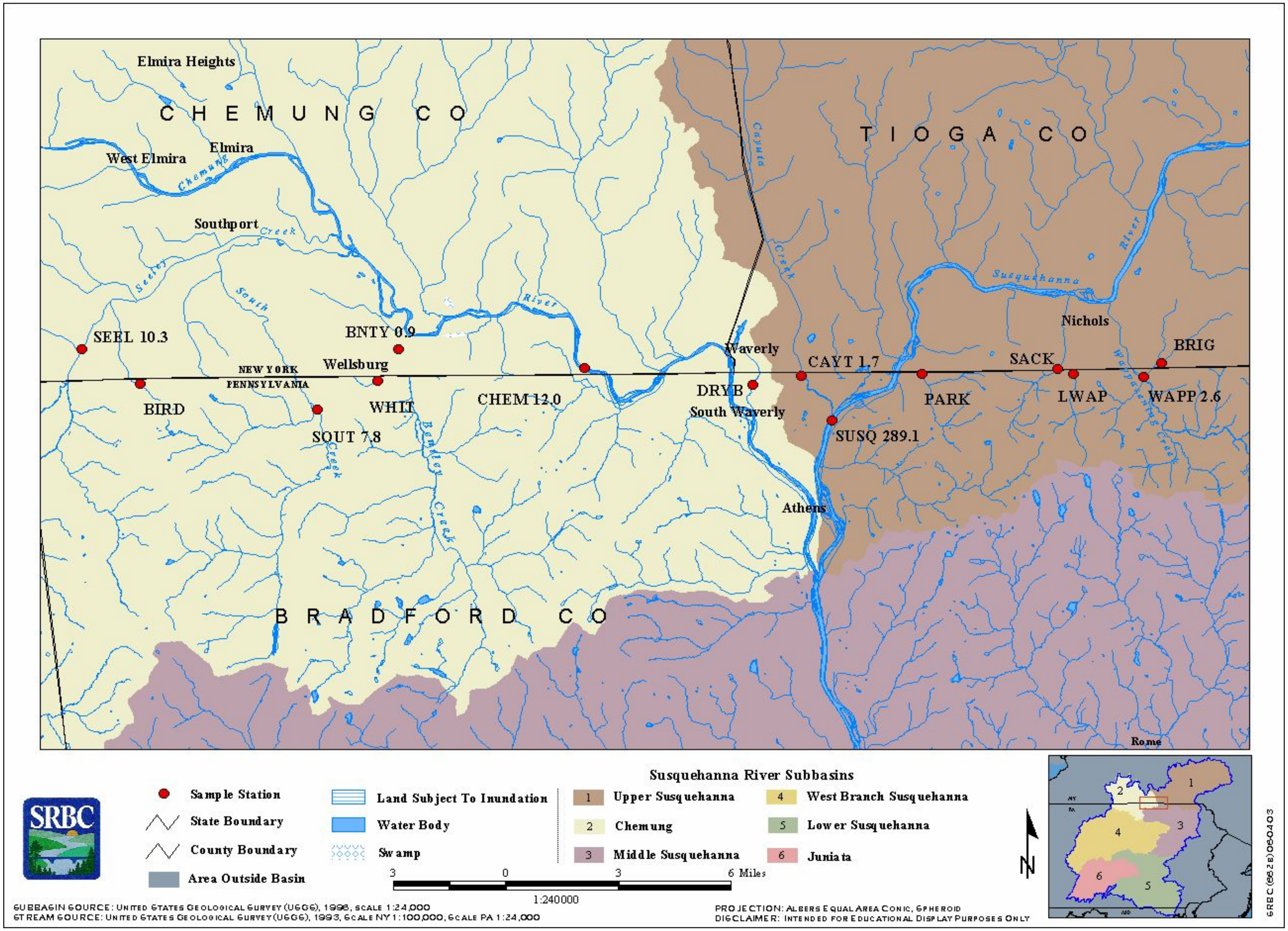


Figure 3. Interstate Streams along the New York-Pennsylvania Border between Seeley Creek and Briggs Hollow

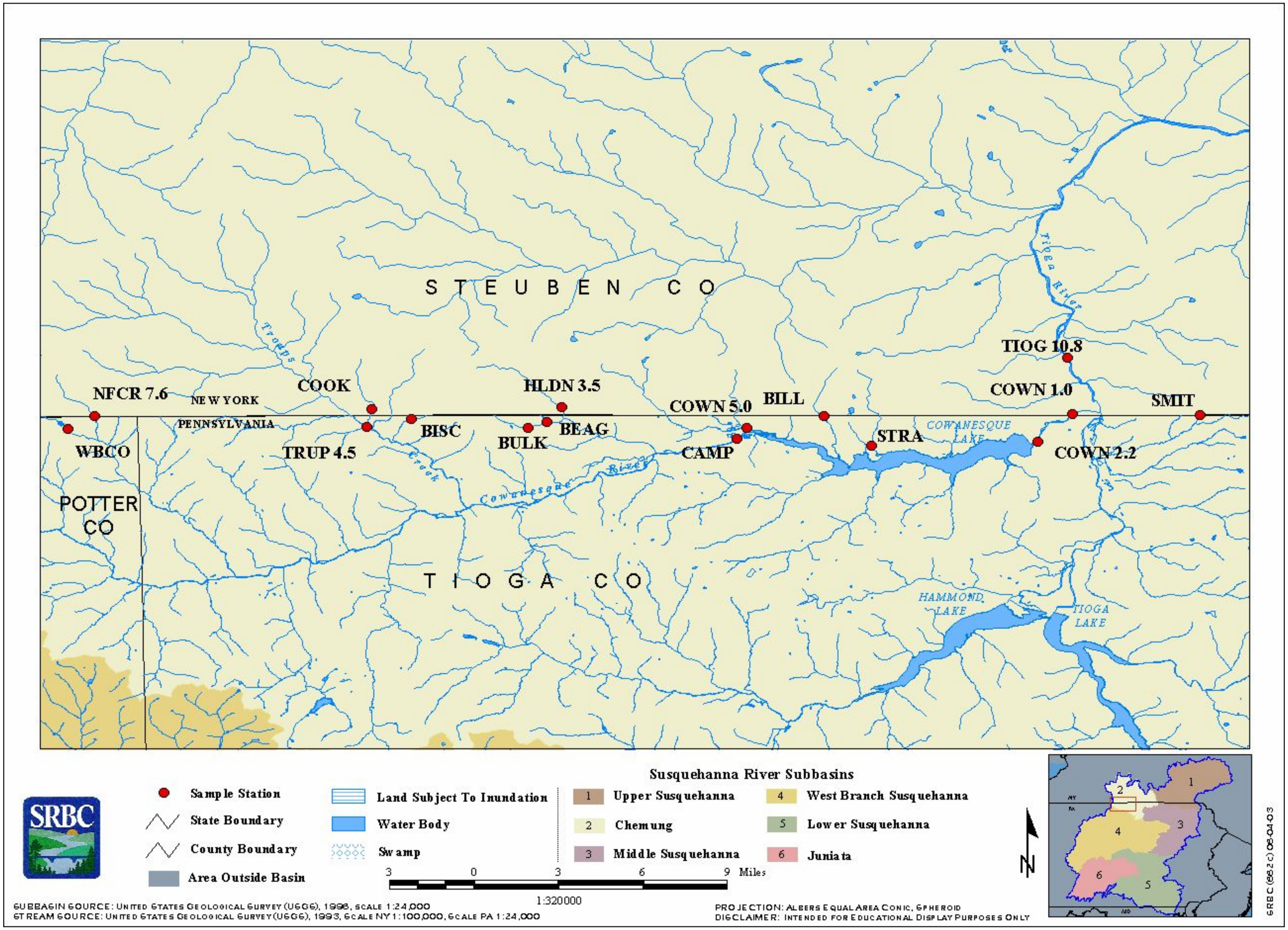


Figure 4. Interstate Streams along the New York-Pennsylvania Border between White Branch Cowanesque River and Smith Creek

Figure 5. Interstate Streams along the Pennsylvania-Maryland Border

Downstream of Kirkwood, the Susquehanna River flows through a densely-populated area between Binghamton and Owego, N.Y. This area is heavily developed and many municipal and industrial discharges enter the river. Impacts from these discharges and other factors are monitored downstream near Sayre, Pa. (Figure 3).

Sampling was increased at Cascade Creek (Figure 2) due to poor water quality conditions during the winter months. Additionally, the biological community recently has shown slight impairment.

Little Snake Creek (Figure 2) recently has shown some water quality and biological impacts, due to unknown causes. Monitoring also was increased to complement Year 2 monitoring in the Upper Susquehanna Subbasin Survey, completed in 2000.

The Chemung River is monitored because of degradation originating from Elmira, N.Y. Samples are collected at Chemung, N.Y. (Figure 3).

Bentley Creek and Seeley Creek (Figure 3) are degraded by poor habitat conditions for most of their lengths. Water quality conditions in these streams are generally good; however, the macroinvertebrate communities and physical habitat are degraded due to rechannelization activities and poor instream habitat conditions.

The Tioga River (Figure 3) is degraded by acid mine drainage (AMD) from Fall Brook to Tioga, Pa. The Tioga-Hammond flood control project has improved water quality downstream of Tioga, but AMD impacts and sedimentation are observable at the monitoring station at Lindley, N.Y.

Cayuta Creek (Figure 3) is a high-quality stream for most of its length. Prior to the construction of a sewage treatment plant at Waverly, the downstream reach of Cayuta Creek was severely degraded. Improved conditions have been observed in Cayuta Creek during the last eight years.

The Cowanesque River (Figure 4) receives discharges from Knoxville, Westfield, and Elkland, Pa.; has a large nonpoint source area; and is impacted by Cowanesque Lake. Most of the stream and its drainage area are in Pennsylvania, but 20 tributaries cross the state line from New York State, and the Cowanesque River crosses back into New York about one mile from its confluence with the Tioga River. The Cowanesque River is sampled at three sites: one upstream of Cowanesque Lake, one immediately downstream of the lake, and one site at the mouth of the Cowanesque River.

Troups Creek (Figure 4) is the largest tributary from New York to the Cowanesque River. High turbidity levels have been observed that suggest sources other than storm runoff. The stream also receives a municipal wastewater discharge from Troupsburg, N.Y.

Two stations on the lower Susquehanna River (at Columbia, Pa., and Port Deposit, Md.) bracket hydroelectric impoundments (Figure 5). Upstream of Columbia, the river is considered to be free-flowing. Low head dams at Sunbury, Harrisburg, and York Haven do not have significant impacts on the flow of the Susquehanna River. Downstream, the river is impounded behind Safe Harbor Dam (Lake Clarke), Holtwood Dam (Lake Aldred), and Conowingo Dam (Conowingo Reservoir).

Deer Creek and Ebaughs Creek experienced degradation due to domestic waste from Stewartstown, Pa. (Figure 5). Construction of an STP has improved water quality, but concerns remain regarding residual effects of chlorine in Ebaughs Creek. Deer Creek also is of special interest, due to its potential nutrient contributions to the Chesapeake Bay.

Scott Creek is degraded near Delta, Pa., and Cardiff, Md. (Figure 5). The stream is characterized by a severely depressed biological community, a sludge- and algae-covered substrate, and a sewage odor.

Conowingo Creek and Octoraro Creek have elevated nutrient levels due to agricultural runoff (Figure 5). Concerns exist regarding water quality and instream flow impacts resulting from a water supply diversion from Octoraro Lake.

F. Monitoring Parameters

Parameters of interest are listed in Table 5. Discharge is measured manually at most stations, using standard U.S. Geological Survey (USGS) equipment and methods (Buchanan and Somers, 1969). Discharge at sites adjacent to USGS gaging stations will be obtained from USGS rating tables. Macroinvertebrate data will be comprised of a list of the different genera collected and an estimate of the population density.

G. Frequency of Collection

Water samples are collected quarterly from Group 1 streams. Water samples are collected annually from Group 2 streams. Macroinvertebrate samples and physical habitat information will be collected annually from Group 1 and 2 streams during July and August and from Group 3 streams in April or May.

Table 5. Parameters

Parameter	Number of Samples	Analytical Sample Matrix	Method Reference	Sample Preservation	Holding Time
Flow	NA	NA	Buchanan and Somers, 1969	NA	NA
Temperature	120	aq.	Field measurement on grab sample[3]	none	0
Dissolved Oxygen	120	aq.	Field measurement on grab sample[3]	none	0
Conductivity	120	aq.	Field measurement on grab sample[3]	none	0
pH	120	aq.	Field measurement on grab sample[3]	none	0
Alkalinity	120	aq.	Field measurement on grab sample[3]	none	0
Acidity	120	aq.	Field measurement on grab sample[3]	none	0
Turbidity	98	aq.	EPA 180.1	cooling to 4^o C	7 days
Total Residue	98	aq.	EPA 160.3	cooling to 4^o C	24 hours
Total Organic Carbon	98	aq.	EPA 415.2	cooling to 4^o C H_2SO_4 to pH <2	24 hours
Total NH_3-N	98	aq.	EPA 350.1	cooling to 4^o C H_2SO_4 to pH <2	24 hours
Total NO_2-N	98	aq.	EPA 353.2	cooling to 4^o C	24 hours
Total NO_3-N	98	aq.	EPA 353.2	cooling to 4^o C	24 hours
Total Nitrogen	98	aq.	Std. Methods[2] 4500-N-D	cooling to 4^o C	24 hours
Total Phosphorus	98	aq.	EPA 365.3	cooling to 4^o C H_2SO_4 to pH <2	24 hours
Total Orthophosphate	98	aq.	EPA 365.1	cooling to 4^o C	24 hours
Total Magnesium	98	aq.	EPA 200.7	preserve w/HNO_3 to a pH <2	6 months
Total Calcium	98	aq.	EPA 200.7	HNO_3 to pH <2	6 months
Total Chloride	98	aq.	EPA 325.2	cooling to 4^oC	24 hours
Total Sulfate	98	aq.	EPA 375.2	cooling to 4^oC	24 hours
Total Iron	98	aq.	EPA 200.7	preserve w/HNO_3 to a pH <2	6 months
Total Manganese	98	aq.	EPA 200.7	preserve w/HNO_3 to a pH <2	6 months
Total Aluminum	98	aq.	EPA 200.7	preserve w/HNO_3 to a pH <2	6 months
Macroinvertebrates	53		Barbour and others, 1999	Preserve in denatured alcohol	1 year

1. Standard Methods, 13th Edition.
2. Standard Methods, 19th Edition.
3. See Section X.C.

VI. PROJECT FISCAL INFORMATION

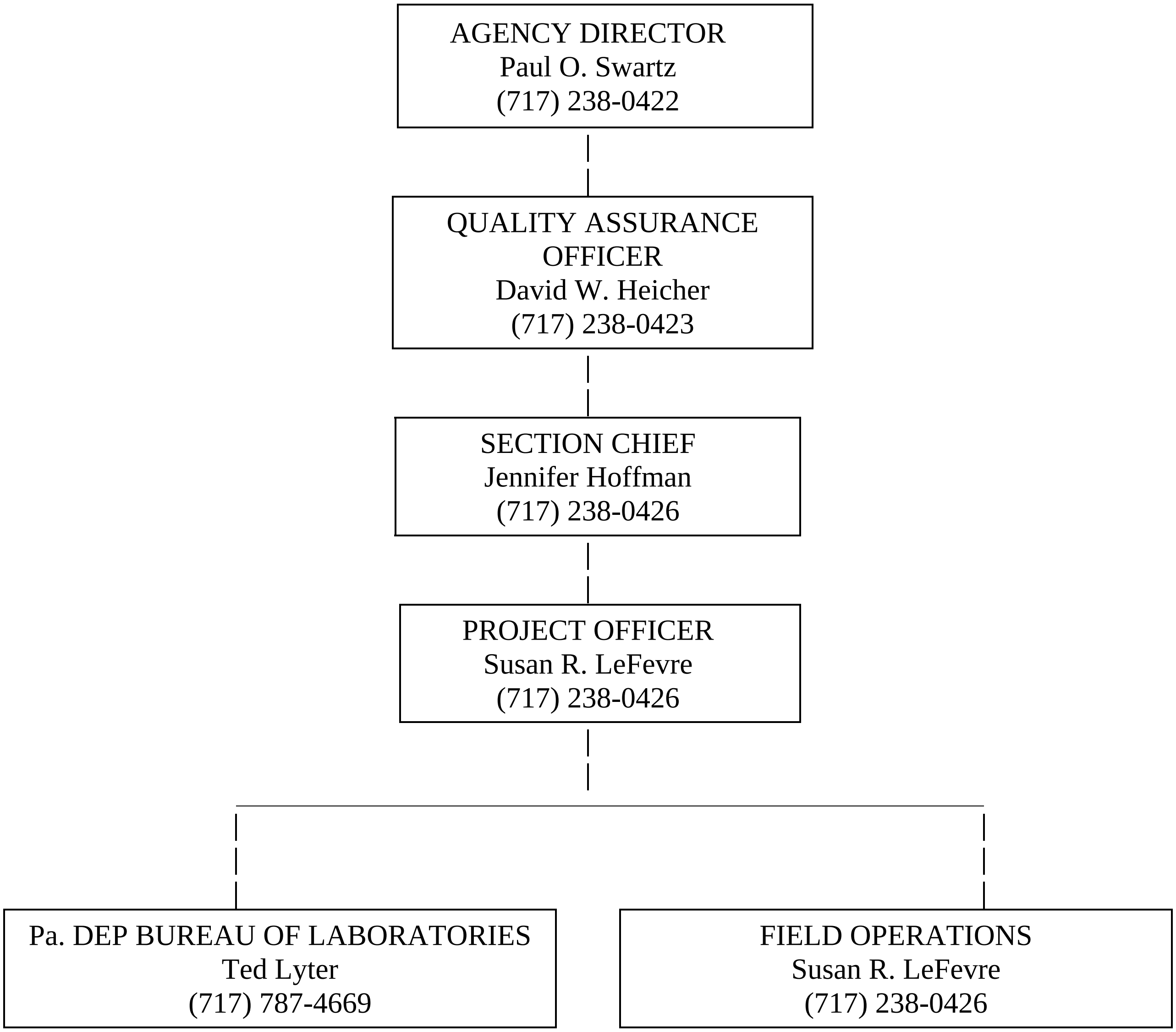
See USEPA grant application.

VII. SCHEDULE

	2004												2005											
Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Coordination	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Group I Water Samples											X				X		X		X	X				
Group II Water Samples																			X	X				
Macroinvertebrate Samples (Groups 1 and 2)																			X	X				
Group 3 Macroinvertebrate Samples																	X							
Process Data										X	X	X	X	X	X			X			X			
Entry into STORET												X			X			X			X			
Report Writing												X	X	X	X	X	X	X	X					
Finalization																		X	X					

VIII. PROJECT ORGANIZATION AND RESPONSIBILITY

A. Project Organization



B. Project Responsibility

1. Sampling operations—S. LeFevre, SRBC
2. Sampling QC—S. LeFevre, SRBC
3. Laboratory analysis—T. Lyter, Pa. DEP
4. Laboratory QC—T. Lyter, Pa. DEP
5. Data processing activities—S. LeFevre, SRBC
6. Data processing QC—S. LeFevre, SRBC
7. Data quality review—S. LeFevre, SRBC
8. Performance auditing— J. Hoffman, SRBC
9. Systems auditing—S. LeFevre, SRBC
10. Overall QA—D. Heicher, SRBC
11. Overall project coordination—D. Heicher, SRBC

IX. DATA QUALITY REQUIREMENTS AND ASSESSMENTS

Table 6. Data Quality Requirements and Assessments

Parameter	Detection Limit (mg/l)	Accuracy[1]	Precision[2]
Turbidity	1 NTU	**+/-10%**	+/- 10%
Total Organic Carbon	1	**+/-10%**	+/- 10%
Total Solids	2.0	**+/-10%**	+/- 10%
Total Ammonia	0.02	**+/-10%**	+/- 10%
Total Nitrite	0.04	**+/-10%**	+/- 10%
Total Nitrate	0.04	**+/-10%**	+/- 10%
Total Nitrogen	0.04	**+/-10%**	+/- 10%
Total Phosphorus	0.01	**+/-10%**	+/- 10%
Total Orthophosphate	0.01	**+/-10%**	+/- 10%
Total Magnesium	0.01	**+/-10%**	+/- 10%
Total Chloride	0.001	**+/-10%**	+/- 10%
Total Sulfate	20.0	**+/-10%**	+/- 10%
Total Iron	0.02	**+/-10%**	+/- 10%
Total Manganese	0.01	**+/-10%**	+/- 10%
Total Aluminum	0.2	**+/-10%**	+/- 10%
Macroinvertebrates	NA	**NA**	+/- 10%

1 Calculate Accuracy using the formulas:

For matrix spikes: $\%R = 100 \times \frac{S - U}{C_{sa}}$

%R = percent recovery
S = measured concentration in spiked aliquot
U = measured concentration in unspiked aliquot
C_{sa} = actual concentration of spike added

For standard reference material: $\%R = 100 \times \frac{C_m}{C_{rm}}$

%R = percent recovery
C_m = measured concentration of standard reference material
C_{rm} = actual concentration of standard reference material

2 Calculate precision using the formula: $RPD = \frac{(C_1-C_2)}{(C_1+C_2)/2} \times 100$

RPD = relative percent difference
C_1 = larger of two observed values
C_2 = smaller of two observed values

A. Data Representatives

Water samples are collected at five points along a transect across the stream with depth-integrating samplers. The depth-integrating sampler provides a composite of the whole water column. Vertical samples are then composited in a churn, where the final sample is withdrawn. This provides a composite sample representing average stream quality.

Sampling stations are placed on or near state borders to monitor the water quality leaving one state and entering another. Macroinvertebrate sampling will occur in riffle/run habitat to help ensure that the samples are representative of the best available habitat conditions.

B. Data Comparability

The purpose of this QA plan is to eliminate factors in sampling and analysis that reduce the comparability of data collected at different points in space and time. All sampling, analysis, and processing procedures are standardized to ensure comparability. One field crew is used to collect samples at all sties to reduce variability in sampling.

C. Data Completeness

Collection of 95 percent of the total programmed samples will be deemed as fulfilling the project objectives.

Completeness can be calculated using the formula: $\%C = 100 \times \frac{V}{N}$

%C = percent completeness
V = number of measurements judged valid
N = total number of measurements necessary to achieve a specific statistical level of confidence in decision making

X. SAMPLING PROCEDURES

A. Sample Collection

Water samples are collected using depth-integrating samplers. Samples are collected using a hand sampler by wading or from a bridge when the transect area is not wadeable due to high flows. The sampler is faced upstream into the current to prevent collection of sediments kicked up by the sampler or field personnel. At each station, five vertical samples are collected, composited in a churn splitter and churned while the sample bottle is filled.

B. Water Samples

One liter of water is collected at each station for laboratory analysis. Nalgene bottles will be used. The samples consist of a 500-ml bottle and two 250-ml bottles. The 500-ml bottle is a raw sample. One of the 250-ml bottles consists of a whole water sample fixed with concentrated nitric acid (HNO_3) for metal analysis and the other 250-ml bottle consists of a whole water sample fixed with concentrated sulfuric acid (H_2SO_4) for nutrient analysis. The samples are chilled on ice and sent to the Pennsylvania Department of Environmental Protection (PADEP), Bureau of Laboratories in Harrisburg, Pa., within 24 hours of collection.

C. Field Chemistry

Temperature and dissolved oxygen are measured using a YSI dissolved oxygen meter. Conductivity is measured using a VWR conductivity meter. A Cole-Parmer meter is used to measure pH. Alkalinity and acidity are measured using field titrations. Alkalinity is measured in the field by titrating a known volume of sample water to pH 4.5 with 0.02N H_2SO_4 (Attachment A). Acidity is measured in the field by titrating a known volume of sample water to pH 8.3 with 0.02N NaOH (Attachment B).

Titrations are performed using syringes. Separate syringes will be used for sulfuric acid and for sodium hydroxide. Magnetic stirring bars and beakers will be thoroughly rinsed with distilled water and with sample water to be tested before titrations are conducted. Personnel conducting field titrations will be required to undergo six months of on-the-job training with an experienced field person. Total chlorine is measured at Cayuta and Ebaughs Creeks and the downstream site on Cowanesque River since CAYT 1.7, EBAU 1.5, and COWN 1.0 are located downstream of wastewater treatment plant discharges. A HACH Datalogging Colorimeter model DR/890 is used with the DPD Test and Tube method (10101).

D. Discharge Measurements

Nine stations are at or near USGS gaging stations. At other stations, flow measurements are made by field personnel using pygmy or AA meters and standard USGS procedures (Buchanan and Somers, 1969). All staff are required to participate in computer-assisted training provided by USGS entitled "Measurement of Stream Discharge by Wading Water, Resources Investigations Report 00-4036, by K. M. Nolan and R. R. Shields" and undergo six-months of on-the-job training with an experienced staff member, as well as a yearly field check.

E. Macroinvertebrates

Macroinvertebrate assessments are adapted from Rapid Bioassessment Protocol III (RBP III), described by Barbour and others (1999). Macroinvertebrate sampling is conducted in riffle/run habitats at each station, except SUSQ 10.0, where riffle/run habitats do not exist. Sampling is conducted by placing a kick screen perpendicular to the current and raking the substrate so dislodged macroinvertebrates are carried into the screen. All collected specimens are preserved in 95 percent ethanol and returned to the Commission office for identification and enumeration. Subsampling and sorting procedures are based on the 1999 RBP document (Barbour and others, 1999). In the laboratory, composite samples are sorted into 200-organism subsamples using a gridded pan and a random numbers table. The organisms contained in the subsamples are identified to genus (except Chironomidae and Oligochaeta), when possible, and enumerated. Benthic macroinvertebrates are identified by professional biologists**,** with a minimum of a B.S. degree in biology, skilled at recognizing most benthos to the family level by sight, and to the genus level with appropriate keys. Biologists also attend the annual Mid-Atlantic Water Pollution Biology Workshop in Berkley Springs, WV, and the annual Pennsylvania State Biologist Workshop. Work is supervised by Mr. David Heicher, who was formerly Assistant Benthos Section Leader for Ichthyological Associates, Inc. in Stamford, N.Y. Mr. Heicher has 15 graduate level credits in courses related to macroinvertebrate identification, including Entomology, Aquatic Insect Ecology, Identification and Quantification of Invertebrates, and his M.S. thesis research.

After sampling has been completed at a given site, all equipment that has come in contact with the sample will be rinsed thoroughly, examined carefully and picked free of algae or debris before sampling at the next site. Additional organisms that are found on examination are placed into the sample containers.

F. Physical Habitat Assessment

Physical habitat conditions at each station are assessed using a slightly modified version of the habitat assessment procedure outlined by Barbour and others (1999). Eleven habitat parameters are field-evaluated at each site and used to calculate a site-specific habitat assessment score. Physical habitat assessments are performed for riffle/run or glide/pool areas, depending on stream type. Figure 6 and Table 7 show habitat assessment forms and the criteria used to evaluate habitat in riffle/run streams and Figure 7 and Table 8 show forms and criteria used to evaluate habitat in glide/pool stream types.

Figure 6. Rifle/Run Habitat Assessment Sheet

Riffle/ Run Habitat Assessment Sheet

Stream	**Date**
Station ID	**Time**
Sample #	**Crew**
Location Description:	

Stream type: Limestone Sandstone Valley Headwater Large River Glacial Other ___________

Habitat Assessment	
Parameter	Score
1. Epifaunal Substrate	
2. Instream Cover	
3. Embeddedness	
4. Velocity/ Depth Regimes	
5.Sediment Deposition	
6. Channel Flow Status	
7. Channel Alteration	
8. Frequency of Riffles	
9. Condition of Banks (Score each bank)	
Left Bank	
Right Bank	
10. Vegetative Protective Cover (score each bank)	
Left Bank	
Right Bank	
11. Riparian Vegetative Zone Width (score each bank)	
Left Bank	
Right Bank	

Weather Conditions	
Air Temperature ©	____________________
Current Conditions: Sunny Cloudy Partly Cloudy	
Present Precipitation: None Rain Snow Mixed Precip.	
Heavy? (> 1 inch) Yes No	
Precip. Within last 24 hours: None Rain Snow Mixed Precip.	
Heavy? (> 1 inch) Yes No	
Ice Present at Site? Yes No	

Functionally Important Stream Characteristics

Predominant Substrate Material (circle one)

Bedrock (> 160 inches in diameter)
Boulder (10 – 160 inches in diameter)
Cobble (2.5 – 10 inches in diameter)
Gravel (0.1 – 2.5 inches in diameter)
Sand/Silt/Clay (< 0.1 inches in diameter)

Residential		Commercial	
Industrial		Cropland	
Nursery		Pasture	
Abd. Mining		Old Fields	
Forest		Other	

Comments:

Temp.	**Cond.**	**D.O.**
pH	**Acid.**	**Alk.**

Table 7. Riffle/Run Habitat Assessment Criteria

HABITAT PARAMETER	CATEGORY			
	OPTIMAL (20-16)	**SUBOPTIMAL (15-11)**	**MARGINAL (10-6)**	**POOR (5-0)**
1. Epifaunal Substrate	Well-developed riffle/run; riffle is as wide as stream and length extends 2 times the width of stream; abundance of cobble	Riffle is as wide as stream but length is less than 2 times width; abundance of cobble; boulders and gravel common	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; some cobble present	Riffle or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking
2. Instream Cover	> 50% mix of boulders, cobble, submerged logs, undercut banks or other stable habitat	30–50% mix of boulder, cobble, or other stable habitat; adequate habitat	10–30% mix of boulder, cobble, or other stable habitat; habitat availability less than desirable	<10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious
3. Embeddedness	Gravel, cobble, and boulder particles are 0–25% surrounded by fine sediments	Gravel, cobble, and boulder particles are 25–50% surrounded by fine sediments	Gravel, cobble, and boulder particles are 50–75% surrounded by fine sediments	Gravel, cobble, and boulder particles are >75% surrounded by fine sediments
4. Velocity/Depth Regimes	All 4 velocity/depth regimes present (slow/deep, slow/shallow, fast/deep, fast/shallow)	Only 3 of 4 regimes present (if fast/shallow is missing, score lower than if missing other regimes)	Only 2 of 4 regimes present (if fast/shallow or slow/shallow are missing, score low)	Dominated by 1 velocity/depth regime
5. Sediment Deposition	Little or no enlargement of islands or point bars and <5% of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from coarse gravel; 5–30% of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, coarse sand on old and new bars; 30–50% of the bottom affected; sediment deposits at obstructions; moderate deposition of pools prevalent	Heavy deposits of fine material, increased bar development; >50% of the bottom changing frequently; pools almost absent due to sediment deposition
6. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed	Water fills >75% of the available channel; or <25% of channel substrate exposed	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed	Very little water in channel and mostly present as standing pools
7. Channel Alteration	No channelization or dredging present	Some channelization present, usually in areas of bridge abutments; evidence of past channelization (>20 yr) may be present, but not recent	New embankments present on both banks; and 40-80% of stream reach channelized and disrupted	Banks shored with gabion or cement; >80% of the reach channelized and disrupted

Table 7. ***Riffle/Run Habitat Assessment Criteria*** *(continued)*

HABITAT PARAMETER	CATEGORY			
	OPTIMAL (20-16)	SUBOPTIMAL (15-11)	MARGINAL (10-6)	POOR (5-0)
8. Frequency of Riffles	Occurrence of riffles relatively frequent; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 7 to 15	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the stream width is between 15-25	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is >25
9. Condition of Banks (score each bank 0-10)	Banks stable; no evidence of erosion or bank failure; little potential for future problems; <5% of bank affected	Moderately stable; infrequent, small areas of erosion mostly healed over; 5-30% of bank in reach has areas of erosion	Moderately unstable, 30-60% of banks in reach have areas of erosion; high erosion potential during floods	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars
10. Vegetative Protective Cover (score each bank 0-10)	>90% of the streambank surfaces covered by vegetation; vegetative disruption through grazing or mowing minimal	70-90% of the streambank surfaces covered by vegetation; disruption evident but not affecting full plant growth potential to any great extent	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation	<50% of the steambank surfaces covered by vegetation; disruption is very high; vegetation removed to 5 cm or less
11. Riparian Vegetative Zone Width (score each bank 0-10)	Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clearcuts, lawns, or crops) have not impacted zone	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally	Width of riparian zone 6-12 meters; human activities have impacted zone only minimally	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities

Figure 7. Glide/Pool Habitat Assessment

Glide/Pool Habitat Assessment Sheet

Stream	**Date**
Station ID	**Time**
Sample #	**Crew**
Location Description:	
Stream Type: Limestone Sandstone Valley Headwater Large River Glacial Other __	

Habitat Assessment		**Weather Conditions**	
Parameter	Score	Air Temperature (^{o}C)	
1. Epifaunal Substrate		Current Conditions: Sunny Cloudy Partly Cloudy	
		Present Precipitation: None Rain Snow Mixed Precip.	
		Heavy? (> 1 inch) Yes No	
2. Instream Cover		Precip. within last 24 Hours: None Rain Snow Mixed Precip.	
		Heavy? (>1 inch) Yes No	
		Ice Present at Site? Yes No	
3. Pool Substrate Characterization		**Functionally Important Stream Characteristics**	
4. Pool Variability			
5. Sediment Deposition			
6. Channel Flow Status			
7. Channel Alteration		**Predominant Substrate Material (circle one)**	
8. Channel Sinuosity		Bedrock (>160 inches in diameter) Boulder (10-160 inches in diameter) Cobble (2.5 – 10 inches in diameter) Gravel (0.1 – 2.5 inches in diameter) Sand/Silt/Clay (<0.1 inches in diameter)	
9. Condition of Banks (Score each bank)			

Parameter	Score				
Left Bank		Residential	%	Commercial	%
		Industrial	%	Cropland	%
Right Bank		Nursery	%	Pasture	%
		Abd. Mining	%	Old Fields	%
10. Vegetative Protective Cover (score each bank)		Forest	%	Other	%
Left Bank		**Comments:**			
Right Bank					
11. Riparian Vegetative Zone Width (score each bank)					
Left Bank		**Temp.**	**Cond.**	**D.O.**	
Right Bank		**pH**	**Acid.**	**Alk.**	

Table 8. Glide/Pool Habitat Assessment Criteria

HABITAT PARAMETER	CATEGORY			
	OPTIMAL (20-16)	SUBOPTIMAL (15-11)	MARGINAL (10-6)	POOR (5-0)
1. Epifaunal Substrate	Preferred benthic substrate abundant throughout stream site and at stage to allow full colonization (i.e. log/snags that are not new fall and not transient)	Substrate common but not prevalent or well suited for full colonization potential	Substrate frequently disturbed or removed	Substrate unstable or lacking
2. Instream Cover	> 50% mix of snags, submerged logs, undercut banks or other stable habitat; rubble, gravel may be present	30-50% mix of stable habitat; adequate habitat for maintenance of populations	10-30% mix of stable habitat; habitat availability less than desirable	Less than 10% stable habitat; lack of habitat obvious
3. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present	All mud or clay or sand bottom; little or no root mat; no submerged vegetation	Hard-pan clay or bedrock; no root mat or vegetation
4. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present	Majority of pools large-deep; very few shallow	Shallow pools much more prevalent than deep pools	Majority of pools small-shallow or pools absent
5. Sediment Deposition	Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of island or point bars	20-50% affected; moderate accumulation; substantial sediment movement only during major storm event; some new increase in bar formation	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial movement during storm events	Channelized; mud, silt, and/or sand in braided or non-braided channels; pools almost absent due to substantial sediment deposition
6. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed	Water fills >75% of the available channel; or <25% of channel substrate exposed	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed	Very little water in channel and mostly present as standing pools
7. Channel Alteration	No channelization or dredging present	Some channelization present, usually in areas of bridge abutments; evidence of past channelization (>20 yr) may be present, but not recent	New embankments present on both banks; and 40-80% of stream reach channelized and disrupted	Banks shored with gabion or cement; >80% of the reach channelized and disrupted

Table 8. Glide/Pool Habitat Assessment Criteria (continued)

HABITAT PARAMETER	CATEGORY			
	OPTIMAL (20-16)	SUBOPTIMAL (15-11)	MARGINAL (10-6)	POOR (5-0)
8. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line	Channel straight; waterway has been channelized for a long time
9. Condition of Banks (score each bank 0-10)	Banks stable; no evidence of erosion or bank failure; side slopes generally <30%; little potential for future problems; <5% of bank affected	Moderately stable; infrequent, small areas of erosion mostly healed over; side slopes up to 40% on one bank; slight erosion potential in extreme floods; 5-30% of bank in reach has areas of erosion	Moderately unstable; moderate frequency and size of erosional areas; side slopes up to 60% on some banks; high erosion potential during extremely high flow; 30-60% of bank in reach has areas of erosion	Unstable; many eroded areas; “raw” areas frequent along straight sections and bends; on side slopes; side slopes >60% common; 60-100% of bank has erosional scars
10. Vegetative Protective Cover (score each bank 0-10)	>90% of the streambank surfaces covered by vegetation; vegetative disruption through grazing or mowing minimal	70-90% of the streambank surfaces covered by vegetation; disruption evident but not affecting full plant growth potential to any great extent	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation	<50% of the steambank surfaces covered by vegetation; disruption is very high; vegetation removed to 5 cm or less
11. Riparian Vegetative Zone Width (score each bank 0-10)	Width of riparian zone >18 meters; human activities (i.e. parking lots, roadbeds, clearcuts, lawns, or crops) have not impacted zone	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally	Width of riparian zone 6-12 meters; human activities have impacted zone only minimally	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities

G. Training Records

Training records will be maintained in the Watershed Assessment and Protection Division files by the Quality Assurance Coordinator.

XI. SAMPLE CUSTODY PROCEDURES

Water quality samples are delivered to the laboratory by the collectors or shipped to the PADEP Lab by overnight courier service. Sample numbers, as well as field chemistry and flow data, are stored in a field logbook and checked against sample numbers received from PADEP Lab. For macroinvertebrate samples, a logbook is kept containing information regarding the collection, preservation, subsampling, and identification of the macroinvertebrates. The station identification data is recorded on each macroinvertebrate sample and entered into a logbook in the field. This logbook is used to track the macroinvertebrate sample through the laboratory process. Staff members are responsible for entering the date and their initials for each sample during processing and identification of the sample.

XII. CALIBRATION PROCEDURES AND PREVENTATIVE MAINTENANCE

A. Dissolved Oxygen (DO) Meter

A YSI dissolved oxygen meter is calibrated using the air-saturated chamber technique prior to use each day. This calibration test is repeated in the event of a membrane replacement or other maintenance that may affect the accuracy of the meter.

B. Specific Conductance Meter

The VWR conductivity meter is calibrated prior to sampling by checking the meter readings against three fresh specific conductance standards. Results are recorded in the calibration log, and new rating curves are generated as necessary.

Acceptable Criteria	
Standards (<1000 µmhos/cm)	± 4%
(>1000 µmhos/cm)	± 3%

C. pH Meters

The meter is calibrated against three buffers daily, before and after use. Calibration checks will be made after every 10 samples. These checks are recorded in the calibration log.

D. Flow Meter

Current meters are sent to the manufacturer for calibration, as necessary. Spin tests are performed before and after each day of use.

XIII. DOCUMENTATION

Water and macroinvertebrate sample bottles are labeled at the time of collection. Water samples are labeled with a seven-digit identification number, the station, date, and time, whether the sample is filtered or raw, and whether any fixatives were added to the sample. This information is recorded on laboratory analysis forms. One copy is submitted to the laboratory with the sample, while another is retained as a record. Results of field chemistry are recorded on this form.

Results of laboratory analyses are entered into a computer database. Data entries are verified, and reductions are performed using computer files to eliminate transcription errors. Field chemistry and laboratory analysis sheets are retained for a period of two years and subsequently archived. Excel spreadsheets containing all information are retained on the Commission's server for ready access.

Databases for all water quality, physical habitat, field chemistry, and macroinvertebrate data consist of Excel spreadsheets developed for in-house needs. The databases are located on the Commission's server. Back-up copies are retained by the project manager in addition to a copy kept in the filing system with hard copies of the data sheets. Currently, staff are developing an Access database for data storage and to assist in transferring data to USEPA's STORET.

Macroinvertebrate bottles are labeled with the station and date. A logbook is kept for all sites, containing information on the macroinvertebrate sample collection, such as station number, stream name, date, the number of bottles, and the person who collected the sample. Identification is conducted by staff biologists at the Commission office, where additional information such as dates of subsampling, identification, and the personnel associated with each activity also is recorded. Log sheets (Figure 8) are used to record the number of specimens for each genus identified. This information is transcribed onto electronic files and verified. All data also will be entered into STORET.

XIV. DATA REDUCTION

Water quality data are formatted into tables by station. The data are compared to state standards. A simple water quality index is computed by averaging the percentile rank of the observations for each station. Only the data collected during this monitoring program are used to determine percentile. This index gives a simple comparison of overall water quality between monitoring stations.

Data reduction procedures are similar to those described in Rapid Bioassessment Protocol III (Barbour and others, 1999). The data for each station are reduced to the following metrics: (1) taxa richness; (2) modified Hilsenhoff Biotic Index; (3) percent Ephemeroptera; (4) percent contribution of dominant taxon; (5) number of Ephemeroptera/Plecoptera/Trichoptera taxa; (6) percent Chironomidae; and (7) Shannon Weiner diversity index. These metrics are quantified and compared to a reference station with the best available conditions based on physical habitat, water quality, and macroinvertebrate information.

The subsample data are used to generate scores for each of the seven macroinvertebrate metrics listed above. Each metric score is then converted to a biological condition score, based on the percent similarity of the metric score, relative to the metric score of the reference site. The sum of the biological condition scores constitutes the total biological score for the sample site, and total biological scores are used to assign each site to a biological condition category. A sampling site that scores 83 percent or greater as compared to the reference site is designated nonimpaired. A score of 79 to 54 percent is termed slightly impaired; moderately impaired conditions are characterized as 50 to 21 percent of the reference site; and a score of less than 17 percent is designated severely impaired.

Habitat assessment scores of sample sites are compared to those of the reference sites to classify each sample site into a habitat condition category. Habitat parameters for riffle/run and glide/pool habitat types are listed in Tables 4 and 5, respectively. A site that scores 90 percent or greater as compared to the reference score is designated excellent (comparable to reference). A habitat score of 75 to 89 percent is designated supporting; partially supporting conditions are characterized as 60 to 74 percent of the reference score; and a score of less than 60 percent is determined to be nonsupporting.

Figure 8. Benthic Macroinvertebrate Enumeration Sheet

MACROINVERTEBRATE ENUMERATION LIST

SITE: __________________________ **DATE SAMPLED: ______________**
IDENTIFIED BY: ________________ **DATE IDENTIFIED: _____________**

FAMILY/GENUS	NUMBER OF INDIVIDUALS
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	
25.	
26.	

XV. DATA VALIDATION

Primary responsibility for data validation lies with the project officer. The collector may assist the project officer in determining the acceptability of the data, based on his knowledge of the stream conditions. Field collections are conducted according to the above methodology to insure accurate data. The use of duplicates, reviewed by the project officer, also validates the water quality analyses. Additionally, the data go through a series of validations as they are entered into the database.

Five percent of the macroinvertebrate samples identified by one biologist are validated by a second biologist and recorded in the logbook. A biologist also spot-checks five percent of the samples picked by laboratory personnel during subsampling and records the samples in the logbook.

XVI. PERFORMANCE AND SYSTEMS AUDITS

A. Laboratory Analyses

Analytical and quality assurance procedures for the PADEP laboratory are detailed in the QA plan submitted by the laboratory. The laboratory analyzes a matrix spike/matrix spike duplicate at a frequency of one per 10 samples per matrix. Duplicate samples will be submitted to the laboratory (at least one per 10 samples). PADEP Lab is certified by USEPA for drinking water parameters; the laboratory ID number is PA00001.

B. Field Procedures

Yearly, field operator techniques are tested for pH, specific conductance, and alkalinity with USGS standard samples. The project officer is responsible for insuring that all field personnel are competent in measurement and collection techniques prior to fieldwork. The project officer also is responsible for insuring the quality of all equipment and reagents.

Duplicate tests are performed on alkalinity and acidity in the same proportion as other duplicate analyses and results with a relative percent difference of 10 is acceptable. Temperature readings from the dissolved oxygen meter are checked against a standard laboratory thermometer. These checks are performed prior to fieldwork.

C. Biological Sampling

A second biologist verifies the identifications on five percent of the sorted samples.

XVII. CORRECTIVE ACTION

Implementation of corrective action involving any sampling procedures, equipment, or data reduction and processing is the responsibility of the project officer. The QA officer is responsible for seeing that such corrective action is performed. Implementation of corrective action involving laboratory analyses is the responsibility of the laboratory analysis officer, with oversight by the laboratory quality control officer.

The results of any corrective actions will be documented by the individual(s) taking the necessary actions.

XVIII. REPORTS

A report describing the results of the monitoring program will cover the year from July 1 to June 30. This report will be published by the following July 31. This report will include the data and the results of data analysis. Conclusions and recommendations will be made, as appropriate. In addition, the data are utilized by staff for project review and by outside agencies and interested parties as background information. The report and data will be available on the Commission's website (www.srbc.net).

XIX. DATA QUALTY OBJECTIVES

Parameters with New York State Department of Environmental Conservation (NYSDEC), PADEP, and Maryland Department of Environment (MDE) standards are listed in Table 9 below (NYSDEC, 1992; Commonwealth of Pa., 2003; MDE, 1993). Data collected during the project will be compared against New York, Pennsylvania, and Maryland state standards.

Table 9. Applicable New York, Pennsylvania, and Maryland State Water Quality Standards

Parameter	State	Criteria	Critical Use
Alkalinity	PA	Minimum 20 mg/l as CaCO3, except where natural conditions are less.	Aquatic Life
Aluminum	NY	100 ug/l	Aquatic Life (chronic)
Chlorine	PA	1-hour average 0.019 mg/l	Aquatic Life
	NY	0.019 mg/l	Aquatic Life (acute)
	MD	0.019 mg/l	Aquatic Life
Dissolved oxygen	PA	5.0 mg/l (Cold Water Fisheries); 4.0 mg/l (Warm Water Fisheries); 5.0 mg/l February 15 – July 31, otherwise 4.0 mg/l (Trout Stocked Fishery)	Aquatic Life
	NY	5.0 mg/l (trout); 4.0 (non-trout)	Trout Waters
	MD	5.0 mg/l	Aquatic Life
Dissolved Solids	PA	750 mg/l	Public Water Supply
	NY	500 mg/l	General
Iron	PA	30-day average 1.5 mg/l as total recoverable	Aquatic Life
	NY	300 ug/l	Aquatic Life (chronic)
Magnesium	NY	35,000 ug/l (Class A)	Health (Water Source)
Manganese	PA	Maximum 1.0 mg/l, as total recoverable.	Aquatic Life and Public Water Supply
	NY	300 ug/l (Class A)	Aesthetic
Nitrate + Nitrite	PA	10 mg/l	Public Water Supply
	NY	10,000 ug/l (Class A)	Health (Water Source)
Nitrate	NY	10,000 ug/l (Class A)	Health (Water Source)
Nitrite	NY	1,000 ug/l (Class A) 100 ug/l (warm water fishery), 20 ug/l (cold water fishery)	Health (Water Source) Aquatic (chronic)
pH	PA	From 6.0 to 9.0 inclusive.	Aquatic Life
	NY	From 6.5 to 8.5 inclusive	General
	MD	From 6.5 to 8.5 inclusive	Aquatic Life
Sulfate	PA	Maximum 250 mg/l.	Public Water Supply
	NY	250,000 ug/l (Class A)	Health (Water Source)
Turbidity	MD	Maximum 150 NTU	Aquatic Life

REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Buchanan, T.J. and W.P. Somers. 1969. Discharge Measurements at Gaging Stations. USGS Techniques of Water-Resources Investigations, Book 3, Chapter A8.

Commonwealth of Pennsylvania. 2003. Pennsylvania Code, Title 25. Environmental Protection, Department of Environmental Protection, Chapter 93. Water Quality Standards.

Maryland Department of the Environment. 1993. Water Quality Regulations for Designated Uses, COMAR 26.08.02. Annapolis, Maryland.

New York State Department of Environmental Conservation. 1992. Water Quality Regulations for Surface Waters and Groundwaters, 6NYCRR, Parts 700-705. Division of Water, Albany, New York.

Nolan, K.M. and R.R. Shields. Measurement of Stream Discharge by Wading Water. USGS Resources Investigations Report 00-4036.

ATTACHMENT A

SUSQUEHANNA RIVER BASIN COMMISSION

STANDARD OPERATION PROCEDURE (SOP)
FOR DETERMINATION OF ALKALINITY

Prepared by: Charles S. Takita Date: September 15, 2000
WQ Program Specialist

Reviewed by: David W. Heicher Date: September 18, 2000
Quality Assurance Coordinator

Procedural Section

1.0 Scope & application

- 1.1 This method is applicable to surface waters, sewage and industrial wastes.
- 1.2 The method is applicable for all ranges of alkalinity.

2.0 Summary of method

- 2.1 The alkalinity of a sample is its quantitative capacity to react with a strong acid to a certain pH. The pH of the unaltered sample is determined and a measured amount of standard acid is added to lower the pH to an endpoint of 4.5..

3.0 Interference

- 3.1 The sample must be analyzed as soon as practical; preferably, within a few hours.
- 3.2 Substances, such as salts of weak organic and inorganic acids present in large amounts, may cause interference in the electrometric pH measurements.
- 3.3 Oil and grease, by coating the pH electrode, may also interfere, causing sluggish response.

4.0 Apparatus

- 4.1 Analog field pH meter
- 4.2 Syringe with 0.2 ml graduation
- 4.3 Magnetic stirrer
- 4.4 Stirring bars
- 4.5 Glass beaker, 100 ml
- 4.6 Graduated cylinder, 50 ml

5.0 Reagent

- 5.1 0.02N H_2SO_4

6.0 Procedure

- 6.1 Measure 50 ml of sample with graduated cylinder and pour into the 100 ml beaker.
- 6.2 Measure the pH of the sample.
- 6.3 Using the syringe, drop 0.02N H_2SO_4 into sample in increments of 0.5 ml or less until the pH in the sample approaches 4.5 then add H_2SO_4, dropwise, pausing between drops to allow the pH to stabilize until a pH of 4.5 is reached.
- 6.4 Determine the amount of 0.02N H_2SO_4 added to sample.

7.0 Calculation

- 7.1 Calculate alkalinity, as mg/l, using the following formula:

$$\text{Alkalinity, mg/l as } CaCO_3 = \frac{A \times N \times 50{,}000}{\text{ml of sample}}$$

where:

A = ml of H_2SO_4used
N = normality of H_2SO_4

Quality Control and Quality Assurance

1.0 Choose one sample from the set of analyses and run a duplicate. Results should be within 10%.

Reference

1.0 Standard Methods for Examination of Water and Wastewater, 17th Edition

SUSQUEHANNA RIVER BASIN COMMISSION

STANDARD OPERATION PROCEDURE (SOP) FOR DETERMINATION OF ACIDITY

Prepared by: Charles S. Takita Date: September 15, 2000
WQ Program Specialist

Reviewed by: David W. Heicher Date: September 18, 2000
Quality Assurance Coordinator

Procedural Section

1.0 Scope & application

1.1 This method is applicable to surface waters, sewage and industrial wastes, particularly mine drainage and receiving streams, and other wastes containing ferrous iron and other polyvalent ions in a reduced state.
1.2 The method is applicable for samples with acidities less than 1,000 mg/l using a 50 ml sample.

2.0 Summary of method

2.1 The acidity of a sample is its quantitative capacity to react with a strong base to a certain pH. The pH of the sample is determined and a measured amount of standard alkali is added to raise the pH to 8.3.

3.0 Interference

3.1 Suspended matter present in the sample or precipitates formed during the titration may cause a sluggish electrode response. This may be offset by allowing a 15-20 second pause between additions of titrant or by slow dropwise addition of titrant as the endpoint is approached.

4.0 Apparatus

4.1 Analog field pH meter
4.2 Syringe with 0.2 ml graduation
4.3 Magnetic stirrer
4.4 Stirring bars
4.5 Glass beaker, 100 ml
4.6 Graduated cylinder, 50 ml

5.0 Reagent

5.1 0.02N NaOH

6.0 Procedure

6.1 Measure 50 ml of sample with graduated cylinder and pour into the 100 ml beaker.
6.2 Measure the pH of the sample.
6.3 Using the syringe, drop 0.02N NaOH into sample in increments of 0.5 ml or less until the pH in the sample approaches 8.3 then add NaOH, dropwise, pausing between drops to allow the pH to stabilize until a pH of 8.3 is reached.
6.4 Determine the amount of 0.02N NaOH added to sample.

7.0 Calculation

7.1 Calculate acidity, as mg/l, using the following formula:

$$\text{Acidity, mg/l as } CaCO_3 = \frac{A \times N \times 50{,}000}{\text{ml of sample}}$$

where:
A = ml of NaOH used
N = normality of NaOH

Quality Control and Quality Assurance

1.0 Choose one sample from the set of analyses and run a duplicate. Results should be within 10%.

Reference

1.0 Standard Methods for Examination of Water and Wastewater, 17th Edition