THE 2008 SUSQUEHANNA RIVER BASIN WATER QUALITY ASSESSMENT REPORT

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The Susquehanna River Basin Commission was created as an independent agency by a federal-interstate compact* among the states of Maryland, New York, Commonwealth of Pennsylvania, and the federal government. In creating the Commission, the Congress and state legislatures formally recognized the water resources of the Susquehanna River Basin as a regional asset vested with local, state, and national interests for which all the parties share responsibility. As the single federal-interstate water resources agency with basinwide authority, the Commission's goal is to coordinate the planning, conservation, management, utilization, development and control of basin water resources among the public and private sectors.

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INTRODUCTION

This 2008 water quality assessment report provides a summary of the Susquehanna River Basin Commission's (Commission's) assessment of the water quality, physical habitat, and biological status of its basin's rivers and streams. These assessments are based on monitoring activities from subbasin surveys and interstate stream projects. This report was prepared to meet the requirements of Section 305(b) of the Clean Water Act.

In accordance with the guidelines, this report involves the use of water quality, biological, and physical habitat evaluations to determine the degree of use support. The assessments made in this water quality assessment report provide updates to the previous assessments: "The 2004 Susquehanna River Basin Water Quality Assessment 305(b) Report," "The 2006 Susquehanna River Basin Water Quality Assessment 305(b) Report," and the 2005 and 2007 305(b) Electronic Updates.

PART I: EXECUTIVE SUMMARY

The Susquehanna River drains 27,510 square miles in parts of New York, Pennsylvania, and Maryland and has one of the largest river basins on the East Coast of the United States. It originates at Otsego Lake in New York State and flows 444 miles to the Chesapeake Bay (Bay) at Havre de Grace, Maryland, where it contributes over half of the freshwater inflow to the Bay. Of the basin's 31,193 total stream miles (USEPA, 1993), 5,015.26 are assessed in this report. Over 81 percent of the assessed streams (4,084.31 stream miles) fully support designated uses.

The major causes of stream impairment for this water quality assessment report are elevated metals and sulfate concentrations and depressed pH due to abandoned mine drainage (AMD). Excess sediment and nutrient enrichment also are important causes of stream impairment in the Susquehanna River Basin. Other sources of impairment include habitat alteration, loss of riparian habitat, channelization, and increased nutrients due to agricultural and urban runoff problems, as well as some limited impacts from sewage treatment plants.

The Commission developed its monitoring program in order to fulfill its responsibilities and jurisdiction in interstate and Susquehanna River basinwide issues. To support the goals of the Chesapeake Bay Program (CBP), the Commission monitors nitrogen, phosphorus, sediment, and total suspended solids in the mainstem Susquehanna River and its major tributaries. The Commission established an interstate water quality network in 1986 to assess compliance with water quality standards for streams that cross state lines. Regional water quality, physical habitat, and biological conditions throughout the basin are addressed through subbasin surveys. Additionally, the Commission undertakes small scale studies as the need warrants. Commission staff also has developed a Large River Assessment program. These monitoring networks not only help Commission staff meet program objectives, but also provide information to assess streams for the water quality assessment report.

PART II: BACKGROUND

The Susquehanna River drains the largest basin on the Atlantic Coast of the United States and is the nation's 16th largest river. It originates at Otsego Lake, New York, and flows 444 miles to the Bay at Havre de Grace, Maryland. The 27,510-square-mile Susquehanna River Basin drains portions of New York, Pennsylvania, and Maryland and provides over half of the freshwater inflow to the Bay. Although relatively undeveloped, some of the basin's water resources have experienced degradation and overuse.

Total Waters

The information presented in Table 1 and Figure 1 provides a general perspective of the Susquehanna River Basin's water and land resources.

Summary of Classified Uses

The streams in the Susquehanna River Basin are classified (Appendix A) separately for the three basin states, since each state has its own classification system. Stream classifications are based on a combination of aquatic life, water supply, and recreational uses.

PART III: SURFACE WATER QUALITY ASSESSMENT

Surface Water Monitoring Program

The Commission operates under the general authority of the Susquehanna River Basin Compact, the broad objectives of the Commission's Comprehensive Plan, which the Commission currently is revising. The Commission's Watershed Assessment and Protection Division has developed its own strategic plan (http://www.srbc.net/programs/docs/WAPStrategicPlan.pdf) to complement the overall strategy and focus on specific goals, objectives, and actions to help the Commission more effectively manage water quality in the Susquehanna River Basin. Additionally, staff developed a monitoring strategy document, which was reviewed and approved by the U.S. Environmental Protection Agency (USEPA) (http://www.srbc.net/programs/docs/Monitoring%20Strategy1204.pdf).

Commission staff obtains stream assessment information through a variety of water quality programs. The Commission's monitoring program supports the Commission's responsibilities and jurisdiction in interstate and regional issues. To support the goals of the CBP, staff monitors nitrogen, phosphorus, and suspended sediment in the mainstem Susquehanna River and its major tributaries. The Commission also established an interstate water quality network to assess compliance with state water quality standards for streams that cross state lines. Regional water quality and biological conditions in the basin are addressed through six subbasin surveys. The Commission also has implemented a large river assessment program. These monitoring networks not only help the Commission meet each program objective, but also provide information to assess streams for the water quality assessment report and for local interests. The stream assessments provided in this 2008 305(b) report were obtained from the FY-2005 Interstate Streams Water Quality Network survey; the Middle Susquehanna Subbasin Survey, Year 1; the Middle Susquehanna Subbasin Survey, Year 2; the West Branch Susquehanna Subbasin Survey, Year 1; the West Branch Susquehanna Subbasin Survey, Year 2; the Juniata Subbasin Survey, Year 1; the Juniata Subbasin Survey, Year 2; the Lower Susquehanna Subbasin Survey, Year 1; the Chemung Subbasin Survey, Year 1; the 2002 River Assessment Pilot Project; and the 2005 Large River Assessment Project.

Table 1. Susquehanna River Basin Geographic Statistics

Basin Population[1]	4.2 million
Basin Surface Area[2]	27,510 sq. mi.
- New York	6,327 sq. mi.
- Pennsylvania	20,908 sq. mi.
- Maryland	275 sq. mi.
Water Subbasins[3]	
- Chemung	2,604 sq. mi.
- Upper Susquehanna	4,944 sq. mi.
- Middle Susquehanna	3,755 sq. mi.
- West Branch Susquehanna	6,992 sq. mi.
- Juniata	3,406 sq. mi.
- Lower Susquehanna	5,809 sq. mi.
Total miles of rivers and streams[4]	31,193.0 mi.
- Miles of perennial rivers/streams	26,064.0 mi.
- Miles of intermittent streams	5,500.7 mi.
- Miles of ditches and canals	45.3 mi.
- Border miles of shared rivers/streams	0.0 mi.
Numbers of lakes/reservoirs/ponds[4]	2,293
Acres of lakes/reservoirs/ponds[4]	79,687 acres
Square miles of estuaries/harbors/bays[4]	0 sq. mi.
Miles of ocean coast[4]	0 mi.
Miles of Great Lake shores[4]	0 mi.
Acres of freshwater wetlands[4]	Unknown
Acres of tidal wetlands[4]	0 acres
Land Use[5]	
- Forested	(63.1%) or 17,362 sq. mi.
- Urban	(9.3%) or 2,560 sq. mi.
- Pasture	(6.7%) or 1,845 sq. mi.
- Cropland	(19.4%) or 5,338 sq. mi.
- Water	(1.5%) or 405 sq. mi.

Sources of information:

[1]U.S. Bureau of the Census, 2000

[2,3]Susquehanna River Basin Study Coordination Committee, 1970

[4]U.S. Environmental Protection Agency, 1993

[5]Ott and others, 1991

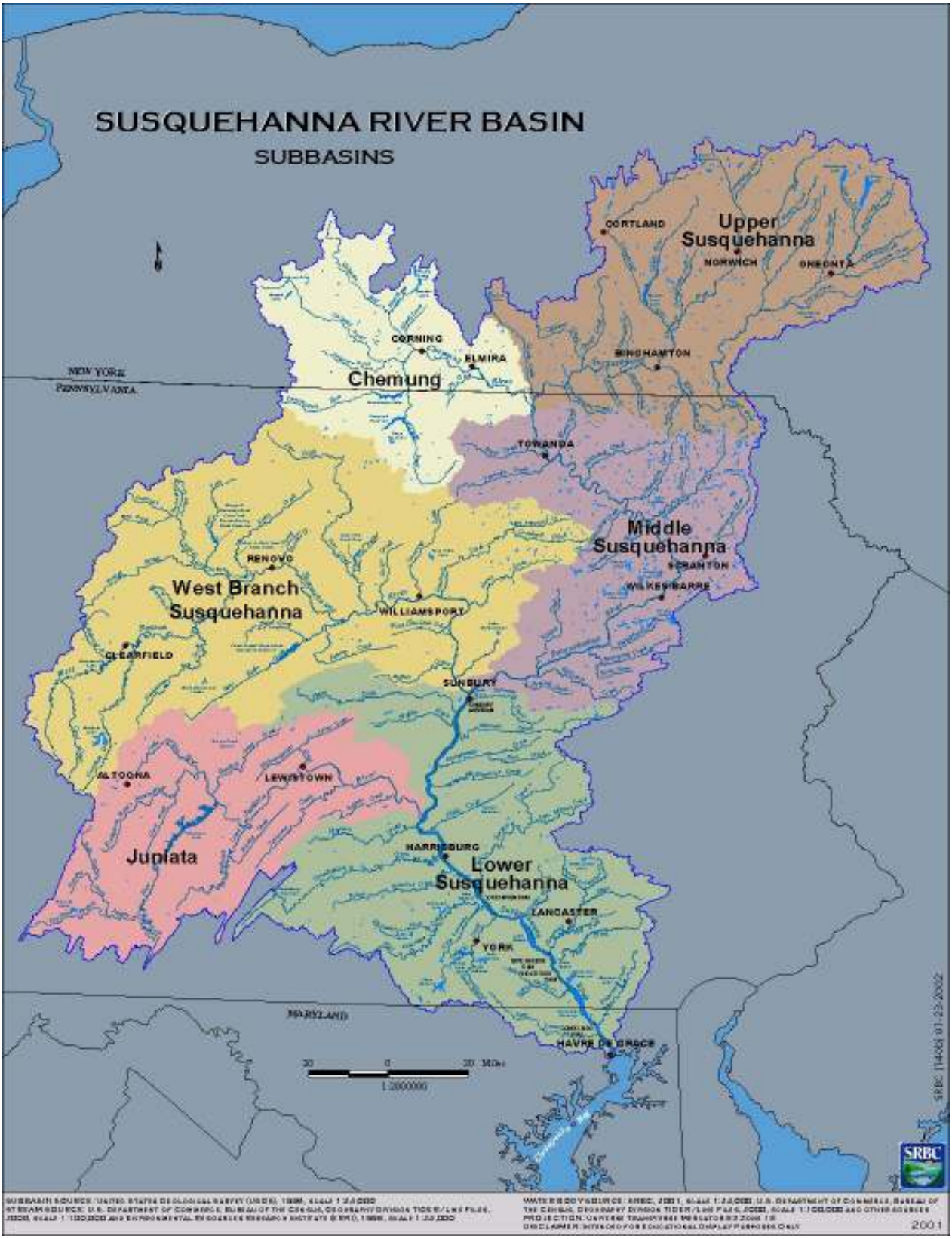

Figure 1. The Susquehanna River Basin Subbasins

Subbasin surveys

Commission staff has been conducting water quality and biological surveys on selected streams within each of the major subbasins since the early 1980s. The first round of subbasin surveys began in 1982; a second round began in 1993, and a third round began in 1998. Chemical and biological investigations are conducted to assess the condition of streams in the basin, identify impaired stream reaches and sources of impairment, provide a screening tool for many streams for possible further investigations, compare the most current assessments with historical data, and provide data for the water quality assessment reports.

The subbasin surveys are designed to rotate among six major subbasins, with sampling being performed in any one subbasin approximately once every six years. Sampling is conducted from mid-summer to early fall, when streamflows are maintained primarily by base flow. The sampling objective is to collect a single sample at each site over a relatively short time period to provide a "snapshot" of stream characteristics. Station locations on the main subbasin river are located so that the effects of major tributaries on the river can be evaluated, and water quality variations along the river due to point and nonpoint source changes can be documented. On tributary streams, stations are usually located near the mouth, at some mid-watershed point, and at a point near the headwaters. Several sites are used because of the potential differences in geologic setting and sources of pollution within the watershed. During a subbasin survey, 70 to 110 stations are sampled, depending on the size and characteristics of the subbasin and the overall goals of the survey.

Field and laboratory water quality analyses are performed on water quality samples collected at each site. Water quality parameters measured in the field include water temperature, conductivity, pH, dissolved oxygen, alkalinity, and acidity. The results are compared to the water quality standards to assess stream health and potential causes where stream quality is impaired. Water quality samples are collected with a depth-integrating sampler and sent to the Pennsylvania Department of Environmental Protection (PADEP) Laboratory (Lab) in Harrisburg, Pa., for analysis.

Habitat conditions are evaluated using a modified version of Rapid Bioassessment Protocol (RBP III) (Plafkin and others, 1989; Barbour and others, 1999). Eleven habitat features of substrate, instream cover, channel morphology, and riparian and bank structure are field evaluated at each site and used to calculate a site-specific habitat assessment score. Habitat assessment scores are used to assess habitat conditions of study sites relative to those of reference sites.

Benthic macroinvertebrate community integrity is assessed using procedures described by Plafkin and others (1989) and Barbour and others (1999). Using this method, staff calculates a series of biological indexes for a stream and compares them to a nonimpaired reference station in the same region to determine the degree of impairment. Metrics vary based on the needs of the survey, but always include taxa richness, EPT (Ephemeroptera/Plecoptera/Trichoptera) Index, Hilsenhoff Biotic Index, and Shannon Diversity Index. The 200-organism subsample data are used to generate scores for each of the metrics. 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.

Beginning in 1999, the subbasin survey program included a second year of a more focused sampling effort targeted to specific watersheds within the subbasin. Selection of targeted watersheds is based on assessments made during Year 1 of the subbasin survey and input from stakeholders in the respective subbasin. Data gathered from a targeted watershed sampling effort, in cooperation with input from stakeholders, provide fundamental information needed to plan for restoration and protection activities.

This report includes information collected during Year 1 from the Middle Susquehanna Subbasin Survey, the West Branch Susquehanna Subbasin Survey, the Juniata Subbasin Survey, the Lower Susquehanna Subbasin Survey, and the Chemung Subbasin Survey (LeFevre, 2002; LeFevre, 2003; LeFevre, 2005a; Buda, 2006; Buda, 2007). The report also includes data from the Commission's Year 2 surveys in Wyalusing Creek watershed in the Middle Susquehanna Subbasin (LeFevre, 2004); in the Morgan Run watershed (a tributary of Clearfield Creek) in the West Branch Susquehanna Subbasin (LeFevre, 2005b); and in the Morrison Cove area of the Juniata Subbasin (Steffy and Buda, 2006).

All water quality, physical habitat, and biological data collected from the subbasin surveys are stored in the Commission's computer system. Staff has been transferring water quality and station information data to USEPA's STORET and will transfer data to the Water Quality Exchange (WQX) when WQX is available. Reports are published following each survey and are available on the Commission's website (http://www.srbc.net). A one-page report announcement is published and widely distributed. Beginning in 2008, all of the Commission's data collected since 1998 will be available on the Commission's website.

Interstate stream water quality network

The Commission began the interstate stream water quality monitoring network (ISWQN) in April 1986 to monitor the water quality and biological conditions of streams that cross state borders in the Susquehanna River Basin. The ISWQN was established because monitoring programs conducted by New York, Pennsylvania, and Maryland do not produce comparable data and do not assess all the interstate streams.

The original 36 stations were sampled annually, and some of those streams judged to have a high potential for degradation were sampled once each month. Benthic macroinvertebrates were monitored annually at all stations. In October 1989, the ISWQN was modified to eliminate some of the streams and to increase the sampling frequency at the remaining stations. The streams removed from the network were small, first-order streams with good water quality and little potential for degradation. Thirty-one streams remained in the network. Fifteen of the streams were sampled once every other month, with the exclusion of January and February. The other 16 streams were sampled annually during July and August. In July 1996, the ISWQN was reduced from 31 streams to 29, with modifications to the sampling frequency. Fifteen stations were sampled quarterly, while the remaining 14 stations were sampled annually in July and August.

In November 1997, the program was modified to sample on a quarterly basis and to improve the quality of the data being collected. Laboratory analyses were added for the dissolved fractions of most water quality parameters. Also, analyses of total and dissolved solids were included to help describe how storm runoff and sediment loads affect water chemistry.

The interstate streams are divided into three groups, according to the degree of water quality impairment, historical water quality impacts, and potential for degradation. These groupings are determined based on historical water quality and land use.

Streams with impaired water quality or judged to have a high potential for degradation due to large drainage areas or historical pollution are assigned to Group 1. Group 1 streams are sampled quarterly for benthic macroinvertebrates and annually for benthic macroinvertebrates and habitat information.

Streams judged to have a moderate potential for impacts are assigned to Group 2. Water quality samples, benthic macroinvertebrate samples, and physical habitat information are obtained from Group 2 streams annually, preferably during base flow conditions in the summer months.

Streams judged to have a low potential for impacts are assigned to Group 3. Benthic macroinvertebrate samples and physical habitat information are assessed yearly, in the spring. Water quality samples are not collected on these streams, but stream field chemistry parameters are measured at the time of biological sampling.

The monitoring program includes periodic collection of water and biological samples from, as well as physical habitat assessments of, interstate streams. Water quality data are used 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 (TMDL) development; and (6) identify areas for restoration and protection. Biological conditions are assessed using benthic macroinvertebrate populations, which provide an indication of the biological health of a stream and serve as indicators of water quality. Habitat assessments provide information concerning potential stream impairment from erosion and sedimentation, as well as indicating the stream's ability to support a healthy biological community.

Temperature, dissolved oxygen, conductivity, pH, alkalinity, and acidity are measured at all sites in the field. Water samples are collected using a depth-integrating sampler at each of the Group 1 and 2 sites to measure nutrient, metal, and ion concentrations. Staff obtains composite samples by collecting four to eight (depending on stream width) depth-integrated samples across the stream channel and combining them in a churn splitter. The samples are then sent to PADEP Lab in Harrisburg, Pa., for analysis.

Benthic macroinvertebrates are collected annually from Group 1 and 2 stations during July and August and from Group 3 stations in May. Macroinvertebrates are sampled to provide an indication of the ecological condition of the stream. Macroinvertebrates are defined as aquatic insects and other invertebrates too large to pass through a No. 30 sieve. Benthic macroinvertebrate samples are analyzed using field and laboratory methods described in RBP III (Plafkin and others, 1989; Barbour and others, 1999). Sampling is performed using a 1-meter-square kick screen with size No. 30 mesh. The kick screen is stretched across the current to collect organisms dislodged from riffle/run areas by physical agitation of the stream substrate. Two kick screen samples are collected from a representative riffle/run at each station. The two samples are composited and preserved in ethanol for later laboratory analysis, where the sample is sorted into a 200-organism subsample. Organisms in the subsample are identified to genus, where possible. For each of the sampling stations, the 200-organism subsample data set is used to calculate numerical values for several metrics.

Physical habitat conditions at each station are assessed using a slightly modified version of the habitat assessment procedure outlined by Plafkin and others, 1989; and Barbour and others, 1999. Eleven habitat parameters are field evaluated at each site and used to calculate a site-specific habitat assessment score, which is compared to the habitat assessment score of a reference site.

Stream discharge is measured at all Group 1 and 2 stations unless high streamflows make access impossible. Several stations are located near United States Geological Survey (USGS) stream gages. Recorded stages from USGS gaging stations and rating curves are used to determine instantaneous discharges in cubic feet per second (cfs). Instantaneous discharges for stations not located near USGS gaging stations are measured at the time of sampling, using standard USGS procedures (Buchanan and Somers, 1969).

Analysis methods of biological and physical habitat conditions are similar to those used in the subbasin surveys. Trends analysis also is performed every five years using Seasonal Kendal Tests and Locally Weighted Scatterplot Smoothing (LOWESS), as described in *Trends in Nitrogen, Phosphorus, and Suspended Sediment in the Susquehanna River Basin, 1974-93* (Edwards, 1995).

This report includes information collected during 2005 interstate streams sampling (Steffy, 2007). All water quality and biological data are stored in the Commission's computer system and transferred to USEPA's STORET (and eventually to WQX). Reports are published on the internet annually and are available on the Commission's website (http://www.srbc.net/interstate_streams/index.asp).

Large River Assessment Project

The Commission has been assessing streams biologically throughout the basin since the late 1970s. When the USEPA introduced the first version of the RBP manual (Plafkin and others, 1989), the Commission adopted those methods for use in its interstate stream monitoring program and its rotating subbasin surveys. However, neither the previous nor current RBP methods (Barbour and others, 1999) used by the Commission in the aforementioned surveys accurately depict the biological integrity of the basin's large rivers: the mainstem Susquehanna; Chemung; West Branch; and Juniata Rivers. Thus, in 2002, the Commission initiated a pilot project to determine proper methods of biologically assessing the large rivers in the basin. The information collected will be used in future years to select and calculate metrics for a benthic macroinvertebrate index of biotic integrity (IBI) to assess the biological conditions in the rivers of the basin. The data also will be used in the Commission's water quality assessments and to complement state assessment efforts.

The Commission conducted a pilot study to determine appropriate methods of biologically assessing the large rivers of the Susquehanna River Basin. Data were collected at eight of ten original sites along the New York–Pennsylvania border during September 2002. To biologically assess the river, staff used four methods: vacuum benthic sampler, rock basket sampler, multi-plate sampler, and a traditional RBP III kick net. Additionally, water quality and physical habitat data were collected at the time of sampling.

Staff conducted the pilot project on the Susquehanna River between Windsor, N.Y., and Sayre, Pa., during September 2002. This stretch of river was chosen because background biological information from SRBC's interstate streams monitoring program (LeFevre and Sitlinger, 2003) is available for a 13-year period from three stations (Windsor and Conklin, N.Y., and Sayre, Pa.). Biological and habitat data are collected annually at these sites, while water quality information is collected quarterly. The 10 sampling sites on this 76-mile stretch of river were selected so that data collected during this survey could be compared with past data collected by the Commission and to document the possible changes in the riverine biota throughout this stretch of river.

Water samples were collected at each sampling site to measure nutrient and metal concentrations in the river. Field water quality measurements included water temperature, dissolved oxygen, conductivity, pH, alkalinity, and acidity. Samples were iced and shipped to PADEP Lab in Harrisburg, Pa., for analysis.

The physical habitat conditions were evaluated at each site using a modified version of RBP III (Plafkin and others, 1989; Barbour and others, 1999). A total of 11 physical stream characteristics relating to substrate, pool and riffle composition, channel morphology, streambank condition, and the riparian area were rated on a scale of 0-20, with 20 considered optimal and used to calculate a site-specific habitat score. Physical habitat assessments were performed for riffle/run or glide/pool areas, depending on stream type. Other characteristics, such as stream type, weather conditions, substrate material, land use, and other important stream features also were noted at the time of sampling.

Staff collected benthic macroinvertebrate samples using four separate methodologies to determine the proper methods of biologically assessing the large rivers of the basin. Each methodology is described in detail below. Based on the results of the study, staff determined that a combination of rock baskets and the modified RBP were the best sampling methodologies. These resulting two methodologies were used at 25 stations in the subsequent Large River Assessment Project in 2005.

Benthic Vacuum Sampler (VBS)

A benthic vacuum sampler, operated by a SCUBA diver, can be very useful in sampling large rivers and can be used on a variety of substrates (Brown and others, 1987). With this collecting method, five riffle/run areas were targeted at each site where available. If riffle/run areas were not present, samples were taken in a transect across the stream bottom. The sampler was lowered to the river bottom by a helper in a boat, and the diver positioned the sampler in the appropriate sampling area. The diver settled the sampler on the bottom, the helper activated the pump, and the diver vacuumed the substrate into a net bag. Substrate was removed to a depth of approximately five centimeters over a time period of five minutes. Large organisms, such as crayfish and hellgrammites, also were hand-collected in a separate net bag for inclusion in the total sample.

Rock Basket (RS)

The second method was a rock substrate basket sampler. Rock basket samplers are useful in assessing areas that are too deep to sample with traditional RBP methods (Merritt and others, 1996). A wire basket filled with natural river rocks from the sampling area was placed in a run area, where possible, to ensure a constant flow of water running through the sampler. Before the baskets were placed in the river, they were attached to a concrete block for stabilization and a float for marking the sampler location. Five such baskets were located on a transect across the river and left in place for six weeks to allow colonization. Sites were chosen across the transect based on depth, velocity, substrate, and cover within the transect. To retrieve the substrates, the baskets were separated from the concrete blocks and placed in a collecting bag while still under water, usually by a SCUBA diver.

Multiplate Sampler (HD)

Additionally, at the request of PADEP, multiplate samplers were placed in conjunction with the rock baskets mentioned above at each of the sites to produce information regarding colonization of each type of artificial substrate sampler and their comparability. Three multi-plate samplers were deployed at each of the sampling stations (at the right and left banks and in the middle of the river). The multiplate samplers were retrieved and processed in the same manner as the rock baskets.

Modified Rapid Bioassessment Protocol (RBP)

The Commission has used this procedure for sampling throughout the basin since 1992. Including this methodology provides a link to past assessments in the river. The USEPA RBP III methodology (Barbour and others, 1999) was used in riffle areas, where present. When no riffle/run area was present,

this methodology was used along the banks of the river and around the edges of islands. In riffle/run areas, samples were collected at both sides of the river and at three internal sites for a total of five sites across the riffle/run area, where possible.

Sampling was conducted by placing a 1-meter-square kick screen perpendicular to the current and disrupting the substrate so dislodged macroinvertebrates are carried into the screen. All collected specimens were preserved in 95 percent ethanol and returned to Commission offices for identification and enumeration.

Subsampling and analysis procedures were consistent with those used in the subbasin surveys and interstate streams projects. Reports on both the pilot project and the 2005 Large River Assessment Project were produced (Hoffman, 2003 and Hoffman, 2006, respectively) and can be found on the Commission's website at http://www.srbc.net/pubinfo/techdocs/Publication_228/techreport228.htm and http://www.srbc.net/pubinfo/techdocs/Publication_245/techreport245.htm, respectively.

Monitoring/data management needs

The Commission is continuing to work on a protocol to assess the larger rivers in the Susquehanna River Basin, including the mainstem of the Susquehanna River, West Branch Susquehanna, Chemung, and Juniata Rivers. The pilot project is described in the section above, and the resulting protocol was used in 2005 to assess the mainstem Susquehanna River and its major tributaries.

In late 2006, USEPA began a conversation with the States, Tribes, and Interstate River Basin Commissions regarding sampling of large river systems. Commission staff attended a Large Rivers Planning Conference in January 2007 and engaged in conference calls with USEPA, States, Tribes, and other River Basin Commissions. In summer 2007, Commission staff utilized the USEPA's proposed large river sampling protocols at the 25 stations in the Commission's Large River Assessment project. A report detailing this monitoring effort and results will be available September 2008. The Commission hopes to develop an additional protocol for assessing the reservoir system at the mouth and approximately the last 40 miles of the Susquehanna River.

For this cycle's assessment, the Commission's geographic information systems (GIS) section linked the data contained in Assessment Database (ADB) to specific stream reaches using the National Hydrologic Dataset (NHD). GIS is a powerful tool that can be used to link the water quality database with geographic data, such as land use, point source discharge sites, and ecoregional information to determine possible sources of contamination. The Commission plans to continue linking the data contained within the ADB to specific stream reaches using the NHD for future listing cycles, as funding permits.

Assessment Methodology and Summary Data

Assessment methodology

The Commission's water quality assessment program is designed to determine if the waters of the Susquehanna River Basin meet the water quality standards of the state through which the stream flows. The program also coordinates standards between states to avoid conflicts on interstate streams. The standards are based on protected uses and water quality criteria to prevent stream degradation, as determined by each of the Commission's member states (New York, Pennsylvania, and Maryland).

All surface waters in the basin have multiple use designations for aquatic life, water supply, and recreation. Water quality criteria for a specific waterbody are set to protect the most sensitive use, which is generally aquatic life.

Maryland classifies all of its waters for basic water uses that include swimming, supporting a balanced population of fish and other aquatic life, supporting wildlife, and providing for water supply (agricultural, industrial). In Pennsylvania, all surface waters must meet protected uses for aquatic life (warm water fishes), water supply (potable, industrial, livestock, and wildlife), and recreation (boating, fishing, water contact sports, and aesthetics). New York State has a minimum use requirement that stipulates water quality shall be suitable for primary (swimming) and secondary (fishing) contact recreation. These waters must be suitable for fish survival, but not necessarily for fish propagation. Each state's water classification and best use definitions are presented in Appendix A.

The Commission focuses on determining the degree to which the waters of the Susquehanna River Basin support aquatic life because aquatic life use support can be easily and economically assessed using biological sampling techniques and because aquatic life is one of the most sensitive of the national use support categories. The Commission does not sample routinely for bacteria (to determine if the contact recreation use is being met) or collect fish tissue (for fish consumption impairments); thus, these assessments are not included in the assessment report. However, the Commission did sample bacteria (fecal coliform, enterococci, and *Escherichia coli*) as part of its Year 2 subbasin survey of the Yellow Breeches Watershed in the Lower Susquehanna subbasin. A limited number of parameters, such as chloride, iron, manganese, nitrite + nitrate, sulfate, and total dissolved solids, are examined for the ISWQN program with regard to drinking water. However, as samples are collected only quarterly and not in targeted water supply areas, the Commission considers the aquatic life use support as the best indicator of the health of the basin's waters.

The Commission's water quality assessment program involves the collection of physical habitat, chemical water quality, and biological (macroinvertebrate) data primarily obtained through the interstate streams water quality monitoring network and the subbasin surveys, described previously. These data are analyzed relative to the designated use and associated criteria of the waterbody being assessed. Other information such as land use, location of point sources, and habitat characteristics are incorporated into the assessment as a guide to the possible causes and sources of impairment of a waterbody. An overall use-support classification for a waterbody is based on an integrated assessment of the available biological data and, when available, the professional judgment of scientists who planned and conducted the field investigations.

The degree of use support of designated uses is fully supporting, not supporting, and insufficient information. Assessments are based on biological data collected from the Commission's monitoring programs. The biological conditions of a stream segment are assessed using procedures described in Barbour and others (1999). Using this method, staff calculates a series of biological indexes for each stream and compares them to indexes for a nonimpaired reference station in the same region to determine the degree of impairment. The metrics used in Commission projects are: Taxonomic Richness, Shannon Diversity Index, Hilsenhoff Biotic Index, Ephemeroptera/Plecoptera/Trichoptera (EPT) Index, percent Ephemeroptera, percent contribution of dominant taxon, and percent Chironomidae.

The 200-organism subsample data were used to generate scores for each of the metrics. Each metric score was then converted to a biological score, based on the percent similarity of the metric score, relative to the metric score for the reference site. The sum of the biological condition scores constituted the total biological score for the sample site, and total biological scores were used to assign each site to a biological condition category. A score of 54 percent or greater constitutes full support while 53 percent or less characterizes nonsupporting conditions. Due to the differences in the Commission's monitoring

techniques and assessments and the assessments of its member states, the Commission, New York, Pennsylvania, and Maryland jointly decided that all of the Commission's nonsupporting assessments would be characterized as "Category 3 - insufficient information." This will allow the member states to address the possible issues concerning these streams without the streams automatically requiring a TMDL.

Biological

Fully Supporting = 54 percent or greater of the reference condition
Not Supporting = 53 percent or less of the reference condition

Data gathered to assess the status of the basin's streams are stored in the Commission's water quality database. Assessment decisions are stored in USEPA's Assessment Database. Sources and causes are determined for each impaired reach.

Water quality summary

There are approximately 31,193 miles of named streams in the Susquehanna River Basin (USEPA, 1993), of which 5,015.26 stream miles, or 16 percent, are assessed in this report. Reach-specific data are provided in each of the following summary sections. Over 81 percent of the assessed stream miles meet the aquatic life designated use (Table 2). This represents 4,084.31 miles of assessed streams.

Nineteen percent of the assessed stream miles do not have sufficient information to characterize them as impaired. The Commission has determined that these streams do suffer from a degree of impairment; however, the states will need to review the data and the assessment to determine if the streams belong on the state list of impaired waters.

Of the streams surveyed, the primary causes of steam impairment are metals, sulfates, nitrates, and low pH (Table 3). The primary sources of impairment are AMD, agriculture, and unknown sources (Table 4). In Appendices C and D, individual streams with associated sources and causes are detailed.

Table 2. Susquehanna River Basin Overall Use Support Summary for Rivers and Streams

Degree of Use Support	Waterbody Type		Total Miles Assessed
	Rivers	Streams	
Fully Supporting	901.37	3,182.94	4,084.31
Insufficient Information	253.4	677.55	930.95

Table 3. Susquehanna River Basin Total Stream Miles with Insufficient Information for Aquatic Life Use Impairment Designation by Various Causes of Suspected Impairment

Suspected Cause of Impairment	Total Length of Waters Affected (in miles)		Total Miles
	Rivers	Streams	
Manganese	160.8	425.1	585.9
Sulfates	132.0	234.4	366.4
Aluminum	39.1	298.6	337.7
pH	39.1	273.7	312.8
Iron	48.8	250.2	299.0
Nitrogen, Nitrate	13.6	144.4	158.0
Zinc		149.0	149.0
Macroinvertebrates	67.0	75.1	142.1
Acidity	19.1	93.8	112.9
Nickel		108.5	108.5
Sedimentation/Siltation	12.0	94.35	106.35
Alkalinity	19.1	78.1	97.2
Phosphorus		85.9	85.9
Habitat Assessment	13.1	54.6	67.7
Sodium		57.5	57.5
Orthophosphate		36.1	36.1
Temperature		5.6	5.6
Dissolved Oxygen		1.75	1.75
Copper		1.2	1.2

Table 4. Susquehanna River Basin Total Stream Miles with Insufficient Information for Aquatic Life Use Impairment by Various Sources of Impairment

Suspected Source of Impairment	Total Length of Waters Affected (in miles)		Totals
	Rivers	Streams	
Abandoned Mine Drainage	160.8	497.8	658.6
Agriculture	14.7	132.85	147.55
Unknown	63.4	69.5	132.9
Highway/Road/Bridge Runoff		82.8	82.8
Loss of Riparian Habitat	12	51.2	63.2
Channelization		3	3
Upstream Impoundment	2.5	0.8	3.3
Municipal Point Source Discharge		1.5	1.5

Lake Water Quality Assessment

According to USEPA's (1993) Total Waters Database and Reporting Program, the Susquehanna River Basin has a total of 2,293 lakes, reservoirs, and ponds totaling 79,687 acres.

During past 305(b) reporting cycles, the Commission conducted a 2-year project, funded by USEPA and PADEP through the Section 314(a) Clean Lakes Program. The purpose of the project was to: (1) update the PADEP's database for lakes and water quality of lakes; (2) enhance the water quality assessment reporting activities under Section 305(b); and (3) help evaluate and prioritize projects funded under the Section 314 Clean Lakes Program. The Commission's inventory of lakes in the Pennsylvania part of the Susquehanna River Basin identified 135 lakes with public access, of which 70 were considered significant (Ballaron and others, 1996). The trophic state of 10 lakes in the Susquehanna River Basin was reported in the 1996 305(b) report (Edwards, 1996).

Estuary and Coastal Assessment

Not applicable.

Wetlands Assessment

The Commission has not conducted any water quality assessment work on wetlands in the basin.

Public Health/Aquatic Life Concerns

Toxics in the nation's waters and their impact on human and aquatic health have been of increasing concern to federal and state agencies. These pollutants enter the water environment from point sources such as industrial facilities and sewage treatment plants and nonpoint sources such as agricultural and urban runoff, atmospheric deposition, rock and soil weathering, and erosion. Additionally, in recent years, the impacts of personal care products on human health and aquatic life have received both increased press and concern from the scientific community.

The Commission's role in addressing toxic pollution is to support state and federal programs. The Commission assists other agencies in data collection for the overall goals of its member jurisdictions and the CBP.

PART IV: WATER POLLUTION CONTROL PROGRAM

The Commission recognizes that the states shall have the primary responsibility for water quality management and control. The Commission coordinates local, state, and federal water quality management efforts, promotes uniform enforcement of, and compliance with, established standards and classifications, and encourages amendment and modification of standards and classifications within the basin, as deemed in the public interest.

The Commission's program objective is to control water pollution sufficiently to maintain and establish water quality capable of supporting multiple uses, such as: public water supply after treatment; recreation, fish, and wildlife; agriculture; industry; and other such uses. To meet that objective, the overall goal is to achieve compliance with water quality standards and criteria for intrastate and interstate waters of the basin, as established by the member jurisdictions.

Point Source Control Program

The Commission's point source control program goal is to encourage continued upgrading and development of needed public and private waste treatment facilities.

Nonpoint Source Control Program

The Commission's nonpoint source program goal is the increased control of stormwater runoff and nonpoint source pollution through the fulfillment of the CBP's objectives. These objectives are related to monitoring and research recommendations, and baywide toxicant recommendations.

Cost/Benefit Analysis

Not performed.

Special State Concerns and Recommendations

Abandoned mine drainage

Degradation of streams due to AMD from past coal mining activities is one of the most prevalent water quality problems in the basin. These discharges occur when coal and sulfur-bearing minerals (pyrite) are exposed to oxidizing conditions to form sulfuric acid. The low pH of the water also dissolves metals (iron, manganese, and aluminum) from the rock strata. These dissolved metals can enter nearby streams.

State and federal agencies are pursuing remedial action for this problem, but progress is slow due to the magnitude of the problem and the significant costs to clean up the degradation. Successful abatement projects have been implemented in small areas, but the scope of the problem is so large, it will take many years before streams affected by AMD meet designated uses.

The current round of assessments indicates that AMD remains a significant source of pollution in the Susquehanna River Basin.

Chesapeake Bay

CBP findings indicate the Susquehanna River Basin contributes a significant portion of nutrients to the Bay. To create a water quality condition necessary to support the living resources of the Bay, the CBP states have agreed to reduce or control point and nonpoint sources of pollution. Programs and policies implemented by the Bay states to reduce nutrient and toxic transport to the Bay have produced water quality benefits in the Susquehanna River Basin. Future efforts should focus on a continued commitment to the reduction of nutrients and an expanded commitment to reducing toxics from AMD and conventional pollutants.

Currently, the Commission participates in several CBP activities, including monitoring for sediment and nutrients in the Susquehanna River Basin, participating in a CBP workgroup focused on enhanced monitoring throughout the Bay watershed, and participating on the Chesapeake Bay Water Quality Steering Committee.

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APPENDIX A
WATER CLASSIFICATION AND BEST USAGE RELATIONSHIPS

New York:

The New York State water quality classifications are summarized from Water Quality Regulations for Surface Waters and Groundwaters, 6NYCRR Parts 700-705, effective September 1, 1991, NYSDEC Division of Water, Albany, N.Y.

Class AA - The best usages of Class AA waters are a source of water supply for drinking, culinary, or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival. This classification may be given to those waters that, if subjected to approved disinfection treatment, with additional treatment necessary to remove naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes.

Class A - The best usages of Class A waters are a source of water supply for drinking, culinary, or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival. This classification may be given to those waters that, if subjected to approved treatment equal to coagulation, sedimentation, filtration, and disinfection, with additional treatment necessary to remove naturally present impurities, meet or will meet New York State Department of health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes.

Class B - The best usages of Class B waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.

Class C - The best usage of Class C waters is fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

Class D - The best usage of these waters is fishing. Due to natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery, or streambed conditions, the waters will not support fish propagation. These waters shall be suitable for fish survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

(T) - Suffix added to Classes AA, A, B, and C waters where trout survival is an additional best use to the classification.

(TS) - Suffix added to Classes AA, A, B, and C waters where trout propagation is an additional best use to the use classification.

Pennsylvania:

The Pennsylvania State water quality classifications are summarized from Water Quality Standards of the Department's Rules and Regulations, 25 Pa. Code, Chapter 93.3-5, effective August 1989, Pa. DER, Division of Water Quality, Harrisburg, Pa. All surface waters must meet protected water uses for aquatic life (warm water fishes), water supply (potable, industrial, livestock, and wildlife), and recreation (boating, fishing, water contact sports, and aesthetics). The designated use classifications are as follows:

EV - Exceptional Value Waters: These waters must meet the statewide list, and are protected at their existing water quality. These streams constitute outstanding national, state, regional, or local resources. The water quality in these streams shall not be lowered.

HQ-TSF - High Quality Trout Stocking Fishery: The water quality can only be lowered if a discharge is the result of necessary social or economic development, the water quality criteria are met, and all existing uses are protected. Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna, which are indigenous to a warm water habitat.

HQ-CWF - High Quality Cold Water Fishery: The water quality can only be lowered if a discharge is the result of necessary social or economic development, the water quality criteria are met, and all existing uses are protected. Maintenance and/or propagation of fish species, including the family of Salmonidae and additional flora and fauna, which are indigenous to a cold water habitat.

HQ-WWF - High Quality Warm Water Fishery: The water quality can only be lowered if a discharge is the result of necessary social or economic development, the water quality criteria are met, and all existing uses are protected. Maintenance and propagation of fish species and additional flora and fauna, which are indigenous to a warm water habitat.

TSF - Trout Stocked Fishery: Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna that are indigenous to a warm water habitat.

CWF - Cold Water Fishery: Maintenance and/or propagation of fish species, including the family Salmonidae and additional flora and fauna, which are indigenous to a cold water habitat.

WWF - Warm Water Fishery: Maintenance and propagation of fish species and additional flora and fauna that are indigenous to a warm water habitat.

MF - Migratory Fishes: Passage, maintenance and propagation of anadromous and catadromous fishes and other fishes that ascend to flowing waters to complete their life cycle. The MF designation is in addition to other designations when appropriate.

Maryland

The Maryland State water quality classifications are summarized from Water Quality Regulations for Designated Uses, COMAR 26.08.02, effective November 1, 1993, Maryland Department of the Environment, Annapolis, Md. All surface waters must protect public health or welfare, enhance the quality of water, protect aquatic resources, and serve the purposes of the Federal Act. The designated uses are:

Use I - Water Contact Recreation and Protection of Aquatic Life. This use designation includes waters that are suitable for water contact sports; play and leisure time activities where individuals may come in direct contact with surface water; fishing; the growth and propagation of fish (other than trout), other aquatic life, and wildlife; and industrial supply.

Use I-P - Water Contact Recreation, Protection of Aquatic Life, and Public Water Supply. This use includes all uses identified in Use I and use as a public water supply.

Use II - Shellfish Harvesting Waters. This use designation includes waters where shellfish are propagated, stored, or gathered for marketing purposes; and actual or potential areas for the harvesting of oysters, softshell clams, hardshell clams, and brackish water clams.

Use III - Natural Trout Waters. This use designation includes waters that have the potential for or are suitable for the growth and propagation of trout; and capable of supporting self-sustaining trout populations and their food organisms.

Use III-P - Natural Trout Waters and Public Water Supply. This use includes all uses identified in Use III; and use as a public water supply.

Use IV - Recreational Trout Waters. This use designation includes cold or warm waters which have the potential for or are capable of holding or supporting adult trout for put-and-take fishing; and managed as a special fishery by periodic shocking and seasonal catching.

Use IV-P - Recreational Trout Waters and Public Water Supply. This use includes all uses identified in Use IV; and use as a public water supply.

Appendix B
Assessed Stream Reaches in the Susquehanna River Basin

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
Abrahams Creek		3.1	2004
Alberts Run	0.5		2006
Alder Run	4.8		2004
Anderson Creek	10.3		2004
Antes Creek	0.4		2004
Apalachin Creek		3.3	2004
Armstrong Creek	0.9		2007
Aughwick Creek		17.3	2006
Babb Creek		9	2004
Babcock Run		3.6	2004
Baker Run		2.7	2004
Bald Eagle Creek	1		2004
Bald Eagle Creek		10.3	2004
Bald Eagle Creek		2.5	2004
Baldwin Creek		14.8	2008
Bear Run	3.2		2004
Beaver Creek		11.6	2007
Beaver Creek		8.89	2006
Beaverdam Branch	6.1		2006
Beaverdam Run		1.7	2004
Beech Creek	27.2		2004
Bells Gap Run		2.1	2006
Bennett Branch Sinnemahoning Creek	35.2		2004
Bennett Creek		1.6	2008
Bennett Creek	0.5		2008
Bentley Creek		9.6	2008
Bermudian Creek		13.7	2007
Big Beaver Creek		4.2	2007
Big Branch Deer Creek		6	2004
Big Fill Run		7.43	2006
Bilger Run	1.1		2004
Bill Hess Creek		3.9	2004
Billings Creek		1.5	2005
Bird Creek		3.3	2004
Biscuit Hollow		2.4	2004
Black Creek	21.8		2004
Black Moshannon Creek	6.4		2004
Blacklog Creek		28.11	2006
Blair Gap Run		3.85	2006
Bobs Creek		22.57	2006
Bowmans Creek		25.2	2004
Brewer Creek	0.8		2005
Briggs Hollow Run		3.3	2004
Brush Creek		24.37	2006
Buffalo Creek		30.17	2006
Buffalo Creek		10.3	2004

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
Buffalo Run		6.79	2006
Bulkley Brook		3.1	2004
Burgoon Run	3.2		2006
Camp Brook		5.8	2004
Camp Creek	0.5		2005
Canacadea Creek	3.5		2008
Canacadea Creek	3.8		2008
Canisteo River		5.7	2008
Canisteo River		12.3	2008
Canisteo River	7		2008
Cascade Creek		3.8	2004
Catawissa Creek	40.5		2004
Cayuta Creek		4.7	2004
Cedar Run	5.2		2007
Chatham Run		1.5	2004
Chemung River		45	2008
Chest Creek	0.8		2004
Chest Creek		4.4	2004
Chest Creek	0.8		2004
Chillisquaque Creek	1.75		2004
Chillisquaque Creek		5.1	2004
Chiques Creek	21.8		2007
Choconut Creek		2.7	2004
Clarks Creek		29.7	2007
Clearfield Creek	60.5		2004
Clover Creek		23.44	2006
Cocalico Creek	22.4		2007
Cocolamus Creek		19.62	2006
Codorus Creek		3.1	2007
Codorus Creek		13.1	2007
Cohocton River		44.6	2008
Cohocton River	13.6		2008
Cold Creek		2.7	2005
Cold Stream	1.1		2004
Cold Stream		3.6	2004
Colonel Bill's Creek	0.7		2008
Conestoga River		21.6	2007
Conestoga River		8.1	2007
Conodoguinet Creek	4.7		2007
Conodoguinet Creek		94.3	2007
Conowingo Creek		4	2007
Cook Hollow		2.9	2004
Cooks Run	1.2		2004
Corey Creek		9.9	2008
Cove Creek		19.53	2006
Cowanesque River		34.4	2008
Cowanesque River	2.5		2004

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
Crooked Creek		15.5	2008
Crooked Creek		10.56	2006
Crooked Sewer Run		1.7	2006
Cush Creek		2.3	2004
Deep Creek		22.5	2007
Deep Hollow Brook		2.5	2004
Deer Creek		51.8	2007
Deer Creek	4.3		2004
Deer Creek		6.6	2004
Deer Lick Creek		2.2	2005
Delaware Creek		6.73	2006
Denton Creek	0.8		2004
Dents Run	5.3		2004
Doe Run		8.75	2006
Driftwood Branch Sinnemahoning Creek		35.8	2004
Drury Run	1		2004
Dry Brook	2.2		2004
Dunning Creek		22.79	2006
East Branch Fishing Creek		5.3	2004
East Branch Lackawanna River		3	2004
East Branch Octoraro Creek		16	2007
East Branch Standing Stone Creek		13.24	2006
East Branch Tunkhannock Creek		18.6	2004
East Branch Wyalusing Creek	2.1		2005
East Branch Wyalusing Creek		2.4	2005
East Branch Wyalusing Creek		4.3	2005
East Conewago Creek		2.5	2007
East Fork Harveys Creek		2.2	2004
East Fork Sinnemahoning Creek		16.6	2004
East Licking Creek		23.03	2006
Ebaughs Creek		2.6	2004
Elk Creek	1.7		2007
Falling Branch Deer Creek		6.4	2004
Fellows Creek	2.4		2008
First Fork Sinnemahoning Creek		25.1	2004
Fishing Creek		30	2004
Fishing Creek		3.7	2004
Fishing Creek	1.9		2004
Fivemile Creek		7.1	2008
Forest Lake Creek		2.8	2005
Frankstown Branch Juniata River		44.72	2006
Gardner Creek		4.1	2004
Gaylord Creek		5.7	2005
Gifford Run		3.2	2004
Goff Creek		10	2008
Great Trough Creek		10.16	2006
Green Creek		3.2	2004

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
Halter Creek		8.7	2006
Hammer Creek		18.2	2007
Harveys Creek		10	2004
Hickory Bottom Creek		5.22	2006
Hills Creek		6.5	2008
Holden Creek		7	2008
Honey Creek		19.75	2006
Horse Valley Run		8.94	2006
Hunlock Creek		2.1	2004
Huntington Creek		28.8	2004
Hyner Run		4.3	2004
Jacks Creek		20.19	2006
James Run	0.9		2006
Jemison Creek		7.1	2008
Johnson Creek		0.9	2008
Juniata River		12.4	2007
Juniata River		101.95	2006
Karr Valley Creek		8	2008
Kettle Creek	3.2		2004
Kettle Creek		34	2004
Kishacoquillas Creek		15.6	2006
Kratzer Run		1.7	2004
Kreutz Creek		9	2007
Lackawanna River	9.7		2004
Lackawanna River		22.4	2004
Lake Stream		3.6	2005
Larry's Creek		4.3	2004
Laurel Run		7.4	2007
Laurel Run		5.1	2007
Laurel Run	3.5		2004
Laurel Run		8.1	2004
Leggetts Creek	1		2004
Letort Spring Run	0.9		2007
Lick Run		16.9	2004
Lick Run	2.8		2004
Little Anderson Creek	6.4		2004
Little Aughwick Creek		10.7	2006
Little Buffalo Creek		3.2	2006
Little Chiques Creek	8.9		2007
Little Clearfield Creek		1.7	2004
Little Conestoga Creek		1.6	2007
Little Conewago Creek		11.6	2007
Little Fishing Creek		23.4	2004
Little Juniata River		31.1	2006
Little Lost Creek		7.1	2006
Little Loyalsock Creek		4.4	2004
Little Muncy Creek		1.9	2004

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
Little Nescopeck Creek	4.9		2004
Little Pine Creek		11.5	2004
Little Shamokin Creek		1.6	2007
Little Shickshinny Creek		9.2	2004
Little Snake Creek		5	2004
Little Swatara Creek		26.2	2007
Little Trough Creek		13.8	2006
Little Wappasening Creek		3.4	2004
Little Wapwallopen Creek		16.7	2004
Long Arm Creek	1.7		2005
Lost Creek		17.44	2006
Loyalsock Creek		37.9	2004
Lycoming Creek		19.7	2004
Mahanoy Creek	53.8		2007
Mahantango Creek		17.2	2007
Mahantango Creek	5.8		2007
Mahoning Creek		10.5	2004
Manada Creek		6.3	2007
Marsh Creek		8.5	2004
Marsh Creek		2.7	2004
McElhattan Run		3.1	2004
Meads Creek		17.7	2008
Medix Run		9.8	2004
Mehoopany Creek		10.7	2004
Meshoppen Creek		29.1	2004
Middle Branch Wyalusing Creek		10.9	2005
Middle Creek		14.6	2007
Middle Creek		7.7	2007
Middle Creek	4		2007
Middle Spring Run	4.7		2007
Mill Creek		9.8	2007
Mill Creek		9.4	2006
Mill Creek		12.4	2008
Montgomery Creek	2.1		2004
Morgan Run	8.8		2006
Morris Run	6.5		2008
Moshannon Creek	46		2004
Mosquito Creek		7.4	2004
Mosquito Creek		21.1	2004
Mountain Creek		11	2007
Mud Creek		13.7	2008
Muddy Creek		17	2007
Muddy Creek		11.6	2007
Muddy Run	8.6		2004
Muncy Creek		19.4	2004
Nanticoke Creek	3.9		2004
Narrows Branch Tuscarora Creek		5.3	2006

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
Nescopeck Creek	18.5		2004
Nescopeck Creek		17.3	2004
Newport Creek	5		2004
Newtown Creek	8.9		2008
Newtown Creek		13.2	2008
North Branch Little Aughwick Creek		8.3	2006
North Branch Mahantango Creek		6.3	2007
North Branch Mehoopany Creek		3.9	2004
North Branch Middle Creek	2.3		2007
North Branch Muddy Creek		11	2007
North Branch Newtown Creek	2.3		2008
North Branch Tuscarora Creek		14	2008
North Branch Wyalusing Creek		1.9	2005
North Branch Wyalusing Creek		2.5	2005
North Branch Wyalusing Creek	0.8		2005
North Fork Cowanesque River		10.8	2008
Octoraro Creek		21.8	2007
Paddy Run		9.7	2004
Parks Creek		3.1	2004
Paxton Creek	11.4		2007
Penns Creek		50	2007
Pequea Creek		16.6	2007
Pettis Creek	2.5		2005
Pine Creek	8.2		2007
Pine Creek		1.5	2007
Pine Creek		7.8	2007
Pine Creek		62	2004
Piney Creek	2.3		2006
Post Creek		14.9	2008
Potter Creek		5.8	2006
Powell Creek		11.4	2007
Prince Hollow Run		2.2	2005
Purdy Creek	0.9		2008
Quittapahilla Creek	4.8		2007
Raccoon Creek		12.6	2006
Raystown Branch Juniata River		124.7	2006
Redhouse/Beagle Hollow Run		1.8	2008
Roaring Brook		3.8	2004
Roaring Creek		21.1	2004
Rockwell Creek	0.9		2005
Rockwell Creek		2.9	2005
Russell Run		4.1	2004
Sackett Creek		5.2	2004
Schrader Creek		23.5	2004
Scott Creek	3.1		2005
Seeley Creek		7.1	2008
Seeley Creek	8.4		2008

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
Shade Creek	1.9		2006
Shamokin Creek	32.9		2007
Shaver Creek		19.8	2006
Shawnee Branch Juniata River		10.3	2006
Sherman Creek		53.3	2007
Shickshinny Creek		4.9	2004
Shobers Run		12.2	2006
Shoups Run	8.1		2006
Sideling Hill Creek		21.9	2006
Sing Sing Creek		14.3	2008
Sinking Run		14.4	2006
Sinnemahoning Creek		12.7	2004
Six Mile Run		9.7	2004
Sixmile Run	3.4		2006
Slab Cabin Run	3.3		2004
Snake Creek		6.4	2004
Solomons Creek	4.4		2004
South Bald Eagle Creek		9.4	2006
South Branch Codorus Creek		8.6	2007
South Branch Conewago Creek		10	2007
South Branch Conewago Creek		3.2	2004
South Branch Little Aughwick Creek		14.8	2006
South Branch Muddy Creek		10.2	2007
South Branch Roaring Creek		16.8	2004
South Branch Towanda Creek		16.1	2004
South Branch Tunkhannock Creek		6.3	2004
South Branch Wyalusing Creek		2.6	2005
South Creek		16	2008
South Whitmer Run		7	2004
Spring Brook		4	2004
Spring Creek	2.2		2007
Spring Creek	3.9		2004
Spring Creek	1		2004
Spring Run		4.5	2006
Spruce Creek		16.5	2006
Standing Stone Creek		34.2	2006
Stocking Creek		12.3	2008
Stonestreet Creek		1.3	2005
Stony Creek		23.1	2007
Strait Creek		4.3	2008
Strait Creek		4.1	2005
Sugar Creek	1.1		2004
Sugar Creek		13.2	2004
Sugar Creek	0.5		2004
Sugar Run		2.2	2004
Surveyor Run	2.1		2004
Susquehanna River	8.6		2007

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
Susquehanna River		29.4	2007
Susquehanna River	22.2		2007
Susquehanna River		53.2	2007
Susquehanna River	22.2		2007
Susquehanna River		76.5	2007
Susquehanna River	10.4		2007
Susquehanna River		60.3	2007
Susquehanna River		70.3	2007
Swatara Creek		52.5	2007
Swatara Creek	15.4		2007
Tangascootack Creek		1.8	2004
Tea Creek		4.2	2006
Tenmile Creek		10.1	2008
Three Springs Creek		4	2006
Three Springs Run	3.6		2006
Tioga River	19.1		2008
Tioga River		10.7	2008
Tioga River		12.5	2008
Tipton Creek		9.4	2006
Tobehanna Creek		7.1	2008
Toby Creek	1.4		2004
Toby Creek		3.5	2004
Tomhickon Creek	10.8		2004
Towanda Creek		31.1	2004
Trindle Spring Run	0.7		2007
Troups Creek		15	2008
Trout Run	0.2		2004
Trowbridge Creek		3.7	2004
Tunkhannock Creek		26.3	2004
Tuscarora Creek		24.3	2008
Tuscarora Creek		49.2	2006
Twelvemile Creek		13.3	2008
Two Mile Run	1.9		2004
Unnamed tributary to Hunlock Creek		5.3	2004
UNT to Smith Creek		1	2005
Wappasening Creek		4.3	2005
Wapwallopen Creek		22.5	2004
West Branch Fishing Creek		12.6	2004
West Branch Little Fishing Creek		7.1	2004
West Branch Mahantango Creek		15	2007
West Branch Meshoppen Creek		1.2	2004
West Branch Octoraro Creek		13	2007
West Branch Pine Creek		5.8	2004
West Branch Susquehanna River	112		2004
West Branch Susquehanna River	5		2004
West Branch Susquehanna River		42	2004
West Branch Susquehanna River		58	2004

Stream Name	Impacted Miles	Nonimpacted Miles	Listing Cycle (year)
West Branch Susquehanna River	20		2004
West Conewago Creek		83.6	2007
West Creek		16.2	2004
White Branch Cowanesque River	1.1		2004
White Deer Creek		27.7	2004
White Deer Hole Creek		2.27	2004
White Hollow		2	2004
Wiconisco Creek		23.9	2007
Willow Run		9.4	2006
Wilson Creek	2.4		2004
Wolf Creek		2.9	2005
Wyalusing Creek		19.2	2004
Wynkoop Creek		14.5	2008
Wysox Creek		9.9	2004
Yellow Breeches Creek		41.8	2007
Yellow Creek		13.2	2006
Yellow Creek	3.3		2006
Young Womans Creek		10.4	2004
TOTALS	**930.95**	**4084.31**	

Appendix C
Impacted Stream Reaches and Causes in the Susquehanna River Basin

Stream Name	Miles Impacted	Causes																		
		ACID	ALK	Al	MACRO	Cu	DO	HAB	Fe	Mn	Na	Ni	NO3	pH	P	PO4	SED	SO4	TEMP	Zn
Alberts Run	0.5	0.5	0.5							0.5										
Alder Run	4.8	4.8		4.8					4.8	4.8		4.8		4.8				4.8		4.8
Anderson Creek	10.3									10.3										
Antes Creek	0.4												0.4							
Armstrong Creek	0.9							0.9					0.9		0.9		0.9			
Bald Eagle Creek	1												1							
Bear Run	3.2			3.2					3.2	3.2		3.2		3.2						3.2
Beaverdam Branch	6.1			6.1	6.1				6.1	6.1			6.1							
Beech Creek	27.2			27.2						27.2				27.2				27.2		
Bennett Branch Sinnemahoning	35.2			35.2						35.2				35.2				35.2		
Bennett Creek	0.5																0.5			
Bigler Run	1.1								1.1											
Black Creek	21.8			21.8										21.8						
Black Moshannon Creek	6.4			6.4					6.4			6.4		6.4						6.4
Brewer Creek	0.8				0.8															
Burgoon Run	3.2	3.2	3.2	3.2	3.2				3.2	3.2										
Camp Creek	0.5				0.5			0.5												
Canacadea Creek	3.5				3.5												3.5			
Canacadea Creek	3.8				3.8								3.8		3.8		3.8			
Canisteo River	7							7									7			
Catawissa Creek	40.5			40.5						40.5				40.5						40.5
Cedar Run	5.2										5.2		5.2							
Chest Creek	0.8							0.8												
Chest Creek	0.8							0.8												
Chillisquaque Creek	1.75						1.75										1.75			
Chiques Creek	21.8												21.8		21.8					
Clearfield Creek	60.5								60.5	60.5										
Cocalico Creek	22.4							22.4			22.4		22.4		22.4	22.4	22.4			
Cohocton River	13.6												13.6							
Cold Stream	1.1			1.1					1.1	1.1				1.1						

Stream Name	Miles Impacted	Causes																		
		ACID	ALK	Al	MACRO	Cu	DO	HAB	Fe	Mn	Na	Ni	NO3	pH	P	PO4	SED	SO4	TEMP	Zn
Colonel Bill's Creek	0.7							0.7									0.7			
Conodoguinet Creek	4.7												4.7						4.7	
Cooks Run	1.2	1.2		1.2		1.2			1.2	1.2		1.2		1.2				1.2		1.2
Cowanesque River	2.5				2.5															
Deer Creek	4.3			4.3					4.3	4.3		4.3		4.3						4.3
Denton Creek	0.8				0.8															
Dents Run	5.3	5.3		5.3						5.3		5.3		5.3				5.3		5.3
Drury Run	1			1						1				1						
Dry Brook	2.2				2.2			2.2												
East Branch Wyalusing	2.1												2.1		2.1					
Elk Creek	1.7												1.7							
Fellows Creek	2.4		2.4	2.4										2.4						
Fishing Creek	1.9												1.9							
James Run	0.9	0.9	0.9	0.9	0.9					0.9										
Kettle Creek	3.2		3.2											3.2						
Lackawanna River	9.7								9.7	9.7										
Laurel Run	3.5			3.5						3.5		3.5		3.5				3.5		3.5
Leggetts Creek	1												1		1					
Letort Spring Run	0.9												0.9				0.9			
Lick Run	2.8																			
Little Anderson Creek	6.4	6.4		6.4					6.4	6.4		6.4		6.4				6.4		6.4
Little Chiques Creek	8.9										8.9		8.9		8.9	8.9	8.9			
Little Nescopeck Creek	4.9	4.9		4.9					4.9	4.9		4.9		4.9						4.9
Long Arm Creek	1.7							1.7					1.7							
Mahanoy Creek	53.8								53.8	53.8								53.8		
Mahantango Creek	5.8												5.8				5.8			
Middle Creek	4														4					
Middle Spring Run	4.7												4.7				4.7			
Montgomery Creek	2.1			2.1						2.1		2.1		2.1				2.1		2.1
Morgan Run	8.8	8.8	8.8	8.8	8.8				8.8	8.8				8.8						
Morris Run	6.5	6.5	6.5	6.5	6.5				6.5	6.5				6.5				6.5		

Stream Name	Miles Impacted	Causes																		
		ACID	ALK	Al	MACRO	Cu	DO	HAB	Fe	Mn	Na	Ni	NO3	pH	P	PO4	SED	SO4	TEMP	Zn
Moshannon Creek	46	46		46						46		46		46				46		46
Muddy Run	8.6			8.6					8.6	8.6								8.6		
Nanticoke Creek	3.9								3.9	3.9								3.9		
Nescopeck Creek	18.5			18.5						18.5		18.5		18.5				18.5		18.5
Newport Creek	5								5	5								5		
Newtown Creek	8.9				8.9						8.9		8.9							
North Branch Middle Creek	2.3												2.3		2.3					
North Branch Newtown Creek	2.3				2.3															
North Branch Wyalusing	0.8							0.8												
Paxton Creek	11.4										11.4		11.4		11.4		11.4			
Pettis Creek	2.5												2.5		2.5					
Pine Creek	8.2		8.2														8.2			
Piney Creek	2.3				2.3								2.3				2.3			
Purdy Creek	0.9				0.9			0.9											0.9	
Quittapahilla Creek	4.8												4.8		4.8	4.8				
Rockwell Creek	0.9							0.9					0.9							
Scott Creek	3.1				3.1			3.1												
Seeley Creek	8.4							8.4												
Shade Creek	1.9				1.9			1.9												
Shamokin Creek	32.9		32.9						32.9	32.9										
Shoups Run	8.1		8.1	8.1	8.1					8.1										
Sixmile Run	3.4	3.4	3.4	3.4	3.4				3.4											
Slab Cabin Run	3.3							3.3												
Solomons Creek	4.4								4.4	4.4										
Spring Creek	2.2												2.2				2.2			
Spring Creek	3.9							3.9					3.9							
Spring Creek	1												1				1			
Sugar Creek	1.1												1.1							
Sugar Creek	0.5												0.5							
Surveyor Run	2.1			2.1						2.1				2.1				2.1		
Susquehanna River	8.6				8.6															

Stream Name	Miles Impacted	Causes																		
		ACID	ALK	Al	MACRO	Cu	DO	HAB	Fe	Mn	Na	Ni	NO3	pH	P	PO4	SED	SO4	TEMP	Zn
Susquehanna River	22.2				22.2															
Susquehanna River	22.2				22.2															
Susquehanna River	10.4				10.4															
Swatara Creek	15.4								15.4					15.4			15.4			
Three Springs Run	3.6				3.6								3.6							
Tioga River	19.1	19.1	19.1	19.1					19.1	19.1				19.1						
Toby Creek	1.4							1.4												
Tomhickon Creek	10.8			10.8																
Trindle Spring Run	0.7										0.7		0.7							
Trout Run	0.2				0.2															
Two Mile Run	1.9	1.9		1.9					1.9	1.9		1.9		1.9				1.9		1.9
West Branch Susquehanna	112									112								112		
West Branch Susquehanna	5							5									5			
West Branch Susquehanna	20			20					20	20				20				20		
White Branch Cowanesque	1.1				1.1			1.1												
Wilson Creek	2.4			2.4					2.4	2.4								2.4		
Yellow Creek	3.3				3.3								3.3							
TOTALS	**930.95**	**112.9**	**97.2**	**337.7**	**142.1**	**1.2**	**1.75**	**67.7**	**299**	**585.9**	**57.5**	**108.5**	**158**	**312.8**	**85.9**	**36.1**	**106.35**	**366.4**	**5.6**	**149**

ACID = Acidity
ALK = Alkalinity
Al = Aluminum
MACRO = Macroinvertebrates
Cu = Copper
DO = Dissolved Oxygen
HAB = Habitat
Fe = Iron
Mn = Manganese
Na = Sodium
Ni = Nickel
NO3 = Nitrate
pH = pH
P = Phosphorus
PO4 = Orthophosphate
SED = Sediment
SO4 = Sulfate
TEMP = Temperature
Zn = Zinc

Appendix D
Impacted Stream Reaches and Sources in the Susquehanna River Basin

Stream Name	Miles impacted	Sources							
		AG	AMD	CHAN	HRRUN	MPS	LRH	UNK	UPIMP
Alberts Run	0.5		0.5						
Alder Run	4.8		4.8						
Anderson Creek	10.3		10.3						
Antes Creek	0.4	0.4							
Armstrong Creek	0.9	0.9							
Bald Eagle Creek	1	1							
Bear Run	3.2		3.2						
Beaverdam Branch	6.1		6.1		6.1		6.1		
Beech Creek	27.2		27.2						
Bennett Branch Sinnemahoning	35.2		35.2						
Bennett Creek	0.5				0.5				
Bigler Run	1.1		1.1						
Black Creek	21.8		21.8						
Black Moshannon Creek	6.4		6.4						
Brewer Creek	0.8							0.8	
Burgoon Run	3.2		3.2						
Camp Creek	0.5						0.5		
Canacadea Creek	3.5				3.5				
Canacadea Creek	3.8	3.8							
Canisteo River	7						7		
Catawissa Creek	40.5		40.5						
Cedar Run	5.2				5.2				
Chest Creek	0.8						0.8		
Chest Creek	0.8			0.8			0.8		
Chillisquaque Creek	1.75	1.75							
Chiques Creek	21.8	21.8							
Clearfield Creek	60.5		60.5						
Cocalico Creek	22.4	22.4			22.4				
Cohocton River	13.6	13.6							
Cold Stream	1.1		1.1						
Colonel Bill's Creek	0.7						0.7		
Conodoguinet Creek	4.7				4.7				
Cooks Run	1.2		1.2						
Cowanesque River	2.5								2.5
Deer Creek	4.3		4.3						
Denton Creek	0.8								0.8
Dents Run	5.3		5.3						
Drury Run	1		1						
Dry Brook	2.2			2.2	2.2		2.2		
East Branch Wyalusing	2.1	2.1							
Elk Creek	1.7	1.7							
Fellows Creek	2.4		2.4						
Fishing Creek	1.9	1.9							
James Run	0.9		0.9						
Kettle Creek	3.2		3.2						
Lackawanna River	9.7		9.7						
Laurel Run	3.5		3.5						
Leggetts Creek	1					1			
Letort Spring Run	0.9				0.9				
Lick Run	2.8							2.8	
Little Anderson Creek	6.4		6.4						
Little Chiques Creek	8.9	8.9							

Stream Name	Miles Impacted	Sources							
		AG	AMD	CHAN	HRRUN	MPS	LRH	UNK	UPIMP
Little Nescopeck Creek	4.9		4.9						
Long Arm Creek	1.7	1.7					1.7		
Mahanoy Creek	53.8		53.8						
Mahantango Creek	5.8	5.8							
Middle Creek	4	4							
Middle Spring Run	4.7	4.7							
Montgomery Creek	2.1		2.1						
Morgan Run	8.8		8.8						
Morris Run	6.5		6.5						
Moshannon Creek	46		46						
Muddy Run	8.6		8.6						
Nanticoke Creek	3.9		3.9						
Nescopeck Creek	18.5		18.5						
Newport Creek	5		5						
Newtown Creek	8.9				8.9				
North Branch Middle Creek	2.3							2.3	
North Branch Newtown Creek	2.3						2.3		
North Branch Wyalusing	0.8	0.8					0.8		
Paxton Creek	11.4				11.4		11.4		
Pettis Creek	2.5	2.5							
Pine Creek	8.2	8.2	8.2						
Piney Creek	2.3	2.3							
Purdy Creek	0.9						0.9		
Quittapahilla Creek	4.8	4.8							
Rockwell Creek	0.9	0.9							
Scott Creek	3.1				3.1		3.1		
Seeley Creek	8.4						8.4		
Shade Creek	1.9						1.9		
Shamokin Creek	32.9		32.9						
Shoups Run	8.1		8.1						
Sixmile Run	3.4		3.4						
Slab Cabin Run	3.3				3.3		3.3		
Solomons Creek	4.4		4.4						
Spring Creek	2.2	2.2							
Spring Creek	3.9	3.9			3.9		3.9		
Spring Creek	1	1			1		1		
Sugar Creek	1.1	1.1							
Sugar Creek	0.5					0.5			
Surveyor Run	2.1		2.1						
Susquehanna River	8.6							8.6	
Susquehanna River	22.2							22.2	
Susquehanna River	22.2							22.2	
Susquehanna River	10.4							10.4	
Swatara Creek	15.4	15.4	15.4						
Three Springs Run	3.6	3.6							
Tioga River	19.1		19.1						
Toby Creek	1.4						1.4		
Tomhickon Creek	10.8		10.8						
Trindle Spring Run	0.7				0.7				
Trout Run	0.2							0.2	
Two Mile Run	1.9		1.9						

Stream Name	Miles Impacted	Sources							
		AG	AMD	CHAN	HRRUN	MPS	LRH	UNK	UPIMP
West Branch Susquehanna	112		112						
West Branch Susquehanna	5				5		5		
West Branch Susquehanna	20		20						
White Branch Cowanesque	1.1	1.1							
Wilson Creek	2.4		2.4						
Yellow Creek	3.3	3.3							
TOTALS	**930.95**	**147.55**	**658.6**	**3**	**82.8**	**1.5**	**63.2**	**69.5**	**3.3**

AG = Agriculture
AMD = Abandoned Mine Drainage
CHAN = Channelization
HRRUN = Highway Runoff
MPS = Municipal Point Source
LRH = Loss of Riparian Habitat
UNK = Unknown
UPIMP = Upstream Impoundment