Water Quality and Biological Assessment of the Wiconisco Creek Watershed

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**Statutory Citations: Federal - Pub. L. 91-575, 84 Stat. 1509 (December 1970); Maryland - Natural Resources Sec. 8-301 (Michie 1974); New York - ECL Sec. 21-1301 (McKinney 1973); and Pennsylvania - 32 P.S. 820.1 (Supp. 1976).*

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PREFACE

This report was prepared for the Pennsylvania Department of Environmental Protection, Bureau of Watershed Conservation. This project was designed to conduct a comprehensive, integrated assessment of the water quality conditions and develop a strategy for water quality restoration and protection in the Wiconisco Creek Watershed, Dauphin and Schuylkill Counties, Pennsylvania. The information generated from this report will be valuable for developing a comprehensive watershed-scale database that can serve as a baseline for comparison in future water quality studies. This first report will be a comprehensive evaluation of current conditions of the Wiconisco Creek Watershed. In 1998, the Susquehanna River Basin Commission will complete a restoration plan that will address problem areas identified in this report and potential treatment methods. Multivariate statistical analysis and the U.S. Environmental Protection Agency's Rapid Bioassessment Protocol III were used to assess the chemical water quality, physical habitat, and biological conditions of the Wiconisco Creek and its tributaries.

The author would like to acknowledge those who made significant contributions to the completion of this report. Charles McGarrell wrote the proposal for funding, and computed biological and principal component analysis data. Scott Bollinger managed this project until the author assumed project manager responsibilities in June 1997. Darryl Sitlinger, Duane Peters, Scott Bollinger, and Charles Takita collected field data and water quality and macroinvertabrate samples. Bob Edwards provided valuable insight into chemical analyses. Carrie Traver entered chemical and habitat data into a database. Donna Fiscus provided GIS support. JoAnn Painter edited, and Susan Obleski, Jennifer Rowles, and David Heicher provided helpful reviews of this report. The Pennsylvania Department of Environmental Protection, Bureau of Laboratories in Harrisburg, Pa., conducted all laboratory analyses of chemical water quality. Ed Wytovich, teacher at Williams Valley High School and president of the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR), provided information used in this report. A special thanks to John Orr, Dauphin County Conservation District, Craig Morgan, Schuylkill County Conservation District and Robert Hughes, EPCAMR, who have shown a special interest in this project.

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ABSTRACT

Multivariate statistical analysis and the U.S. Environmental Protection Agency's Rapid Bioassessment Protocol III were used to assess the chemical water quality, physical habitat, and biological conditions of 24 sample sites in the Wiconisco Creek Watershed in southcentral Pennsylvania. Assessment results indicate that approximately 10 percent of the assessed sites support nonimpaired biological communities. The primary source of impacts in the headwaters of Wiconisco Creek and Bear Creek are related to historical mining. Impairments in the lower half of the watershed are due to agricultural activities.

INTRODUCTION

Location

Wiconisco Creek is a 42-mile stream located approximately 20 miles north of Harrisburg, Pennsylvania (Plate 1). The Wiconisco Creek Watershed consists of 116 square miles (74,418 acres) of the Appalachian Mountain section of the Valley and Ridge Physiographic Province in northern Dauphin and western Schuylkill Counties. The creek has its headwaters in western Schuylkill County and flows westward to its terminus, emptying into the Susquehanna River at Millersburg, northern Dauphin County. All or portions of the municipalities in the listed in Table 1 are within the Wiconisco Creek Watershed.

Table 1. Municipalities in the Wiconisco Creek Watershed

County	Townships	Boroughs
Dauphin	Upper Paxton Jefferson Williams Rush Lykens Wiconisco Jackson Washington Mifflin	Millersburg Berrysburg Elizabethville Gratz Lykens Williamstown
Schuylkill	Porter Tremont	Tower City

The watershed is distributed over the following U.S. Geological Survey (USGS) 7.5 Minute Topographic Quadrangle Maps: Millersburg, Elizabethville, Lykens, Tower City, and Pine Grove.

Historical Problems

Past studies indicate that a diversity of nonpoint pollutants occurs within the Wiconisco Creek Watershed, including acid and alkaline mine drainage, coal fines, urban runoff, and nutrient and sediment loads from agricultural operations. The Pennsylvania Department of Environmental Resources (Pa. DER), presently Pennsylvania Department of Environmental Protection, conducted the most comprehensive studies of water quality and biological conditions in the Wiconisco Creek Watershed in 1977 and 1983 (Hughey, 1977; Gilligan, 1983). Pa. DER indicated that water quality and substrate conditions of the headwaters were severely degraded and nearly devoid of aquatic life (Pa. DER, 1973; SRBC, 1973; Hughey, 1974; Hughey, 1977; Schott, 1982a, 1982b; Gilligan, 1983), largely due to nonpoint source (NPS) pollutant loading from mine drainage and sedimentation from mining activities. Wiconisco

Creek has been impacted by raw sewage discharges, near urban areas (Hughey, 1974; Schott, 1982b), and nutrient runoff, erosion, and sedimentation in the agricultural areas in the watershed (Dauphin-Schuylkill Counties, 1986). Since these studies were conducted, a variety of NPS abatement and restoration projects has been completed, and others have been initiated within the watershed.

General Characteristics

In Pennsylvania, the basis for delineating watersheds is found in the State Water Plan (SWP). There are 104 watersheds in the state, comprising 20 major basins and 104 subbasins. Each major basin may contain anywhere from five to ten smaller subbasins. The Wiconisco Creek is located in the 6C watershed. The State Water Plan also provides for the development of a degraded watershed list (DWL). The Pennsylvania Department of Environmental Protection (Pa. DEP) has developed the list, which breaks the 104 watersheds into high, medium, and low priority. The top 25 percent of the scores are in the high priority (scores equal 9.5 or higher). The medium priority watersheds score from 9.0 to 6.0, and low priority watersheds score 5.5 or lower. Wiconisco Creek, with a DWL score of 10.0, is a high priority watershed. The main stem of Wiconisco Creek, all unnamed tributaries downstream of Loyalton, Pa., and the Little Wiconisco Creek Basin are all designated as Warm Water Fisheries. Cold Water Fisheries within the Wiconisco Creek Watershed include all unnamed tributaries above Loyalton, Bear Creek, and Rattling Creek. Rattling Creek is included in the commonwealth's Special Protection Program, and is designated as a High Quality-Cold Water Fishery. The Pennsylvania Fish and Boat Commission stocks the lower 16 miles of Wiconisco Creek with trout.

Topography

The headwaters (Upper Basin) of the Wiconisco Creek Watershed are located between Big Lick Mountain to the north and Broad Mountain to the south (Figures 1 and 2). The middle reach (Bear Creek Basin, Rattling Creek Basin, Middle Basin, Gratz Creek Basin) of the creek is bounded to the north by both Bear and Short Mountains, while Berry, Broad, and Peters Mountains serve as the southern border. Berry Mountain continues as the southern boundary for the lower reach (Lower Basin, Little Wiconisco Creek Basin), and Mahantango Mountain borders the northwestern edge of the basin.

Elevation within the watershed ranges from 380 feet at the mouth of Wiconisco Creek to 1,785 feet at the top of Big Lick Mountain. The upper section of the main stem of Wiconisco Creek is generally straight and fairly flat, and is characterized by wetlands and slow pool/run habitats. Two main tributaries enter Wiconisco Creek near the western end of the Upper Basin at the borough of Lykens. Bear Creek drains southward through Bear Valley from its beginnings in Bear Swamp, and Rattling Creek enters Wiconisco Creek from its beginnings in Broad and Peters Mountains. Wiconisco Creek passes between Short Mountain and Berry Mountain just east of the borough of Lykens. At this point, the characteristics of the stream change. The stream is still relatively flat, but without the confinements of the mountains, the stream becomes highly sinuous. There are many small, unnamed tributaries that add to the flow of Wiconisco Creek between Lykens and the mouth at Millersburg. The largest of these streams drains the area to the west of Short Mountain near the borough of Gratz. The last major tributary, Little Wiconisco Creek, drains a large area southeast of Mahantango Mountain, and enters Wiconisco Creek near Millersburg.

Soils

Based on the U.S. Department of Agriculture, Soil Conservation Service 1:250,000 scale State Soil Geographic (also known as STATSGO) data, four soil associations are found in the Wiconisco Creek Watershed (U.S. Department of Agriculture, 1994) (Figure 3, Table 2).

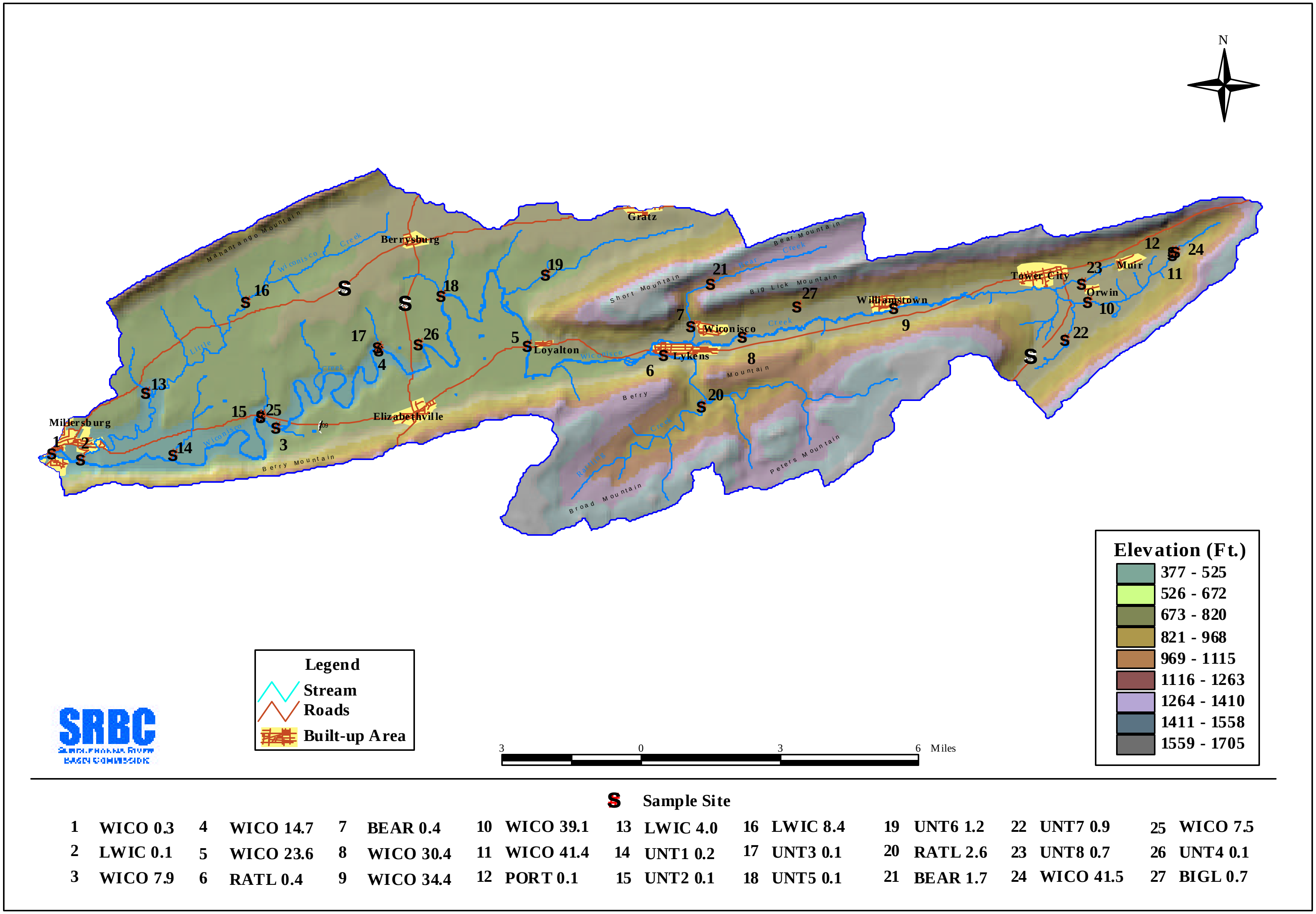

Figure 1. Map Showing Topography in the Wiconisco Creek Watershed

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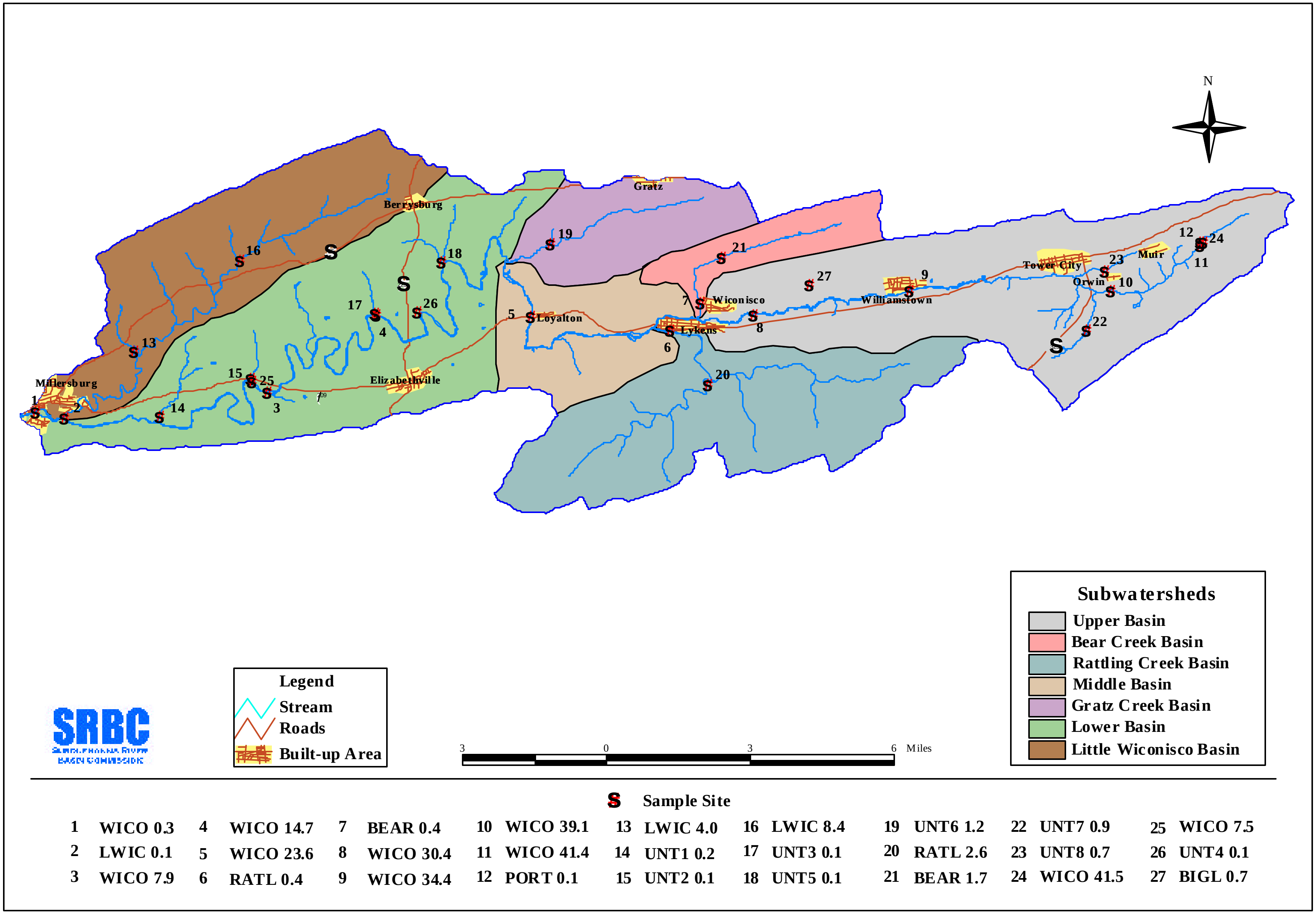

Figure 2. Map Showing Subwatersheds in the Wiconisco Creek Watershed

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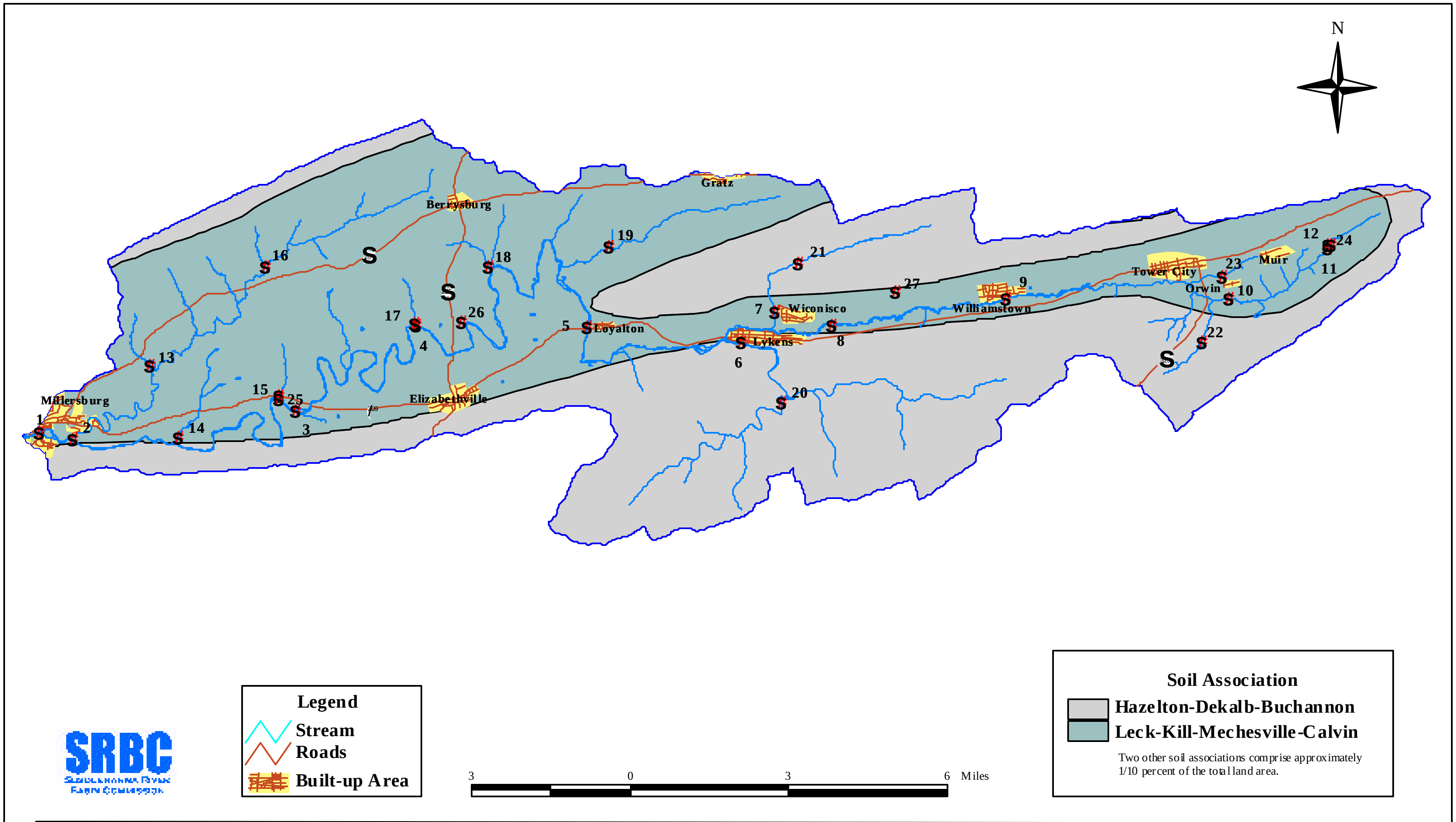


S Sample Site

1	WICO 0.3	4	WICO 14.7	7	BEAR 0.4	10	WICO 39.1	13	LWIC 4.0	16	LWIC 8.4	19	UNT6 1.2	22	UNT7 0.9	25	WICO 7.5
2	LWIC 0.1	5	WICO 23.6	8	WICO 30.4	11	WICO 41.4	14	UNT1 0.2	17	UNT3 0.1	20	RATL 2.6	23	UNT8 0.7	26	UNT4 0.1
3	WICO 7.9	6	RATL 0.4	9	WICO 34.4	12	PORT 0.1	15	UNT2 0.1	18	UNT5 0.1	21	BEAR 1.7	24	WICO 41.5	27	BIGL 0.7

Figure 3. Map Showing Soil Associations in the Wiconisco Creek Watershed

Table 2. Soil Associations and Acreage in the Wiconisco Creek Watershed

Soil Association	Acres in Watershed
Duncannon-Urban Land-Chavies	49.29
Hazelton-Dekalb-Buchannon	34,128.84
Leck-Kill-Meckesville-Calvin	35.21
Uderthents-Dekalb-Hazelton	40,205.42

The main stem of Wiconisco Creek, and most of the developed areas of the watershed, lie in the Uderthents-Dekalb-Hazelton Association. These soils are characterized as deep to shallow, dominantly well drained, gently sloping, and having a shaly, silt loam subsoil in upland areas between mountains. Mountainous areas on the outskirts of the basin are composed of the Hazelton-Dekalb-Buchannon Association. This Association has moderately deep, gently sloping to very steep soils that have a channery sandy loam to channery loam subsoil on upper mountain slopes and ridges. The following two associations are present in such insignificant proportions (less than 1 percent of the watershed per association) that the influence from these soils is negligible. The Duncannon-Urban Land-Chavies Soil Associations are composed of moderately deep, mixed sediments soils from glacial deposits with high available moisture capacity. This Association covers the gently sloping terraces along the Susquehanna River. The Leck-Kill-Meckesville-Calvin Association consists of nearly level to gently sloping, well-drained soils on upland areas and ridgetops.

Erosion

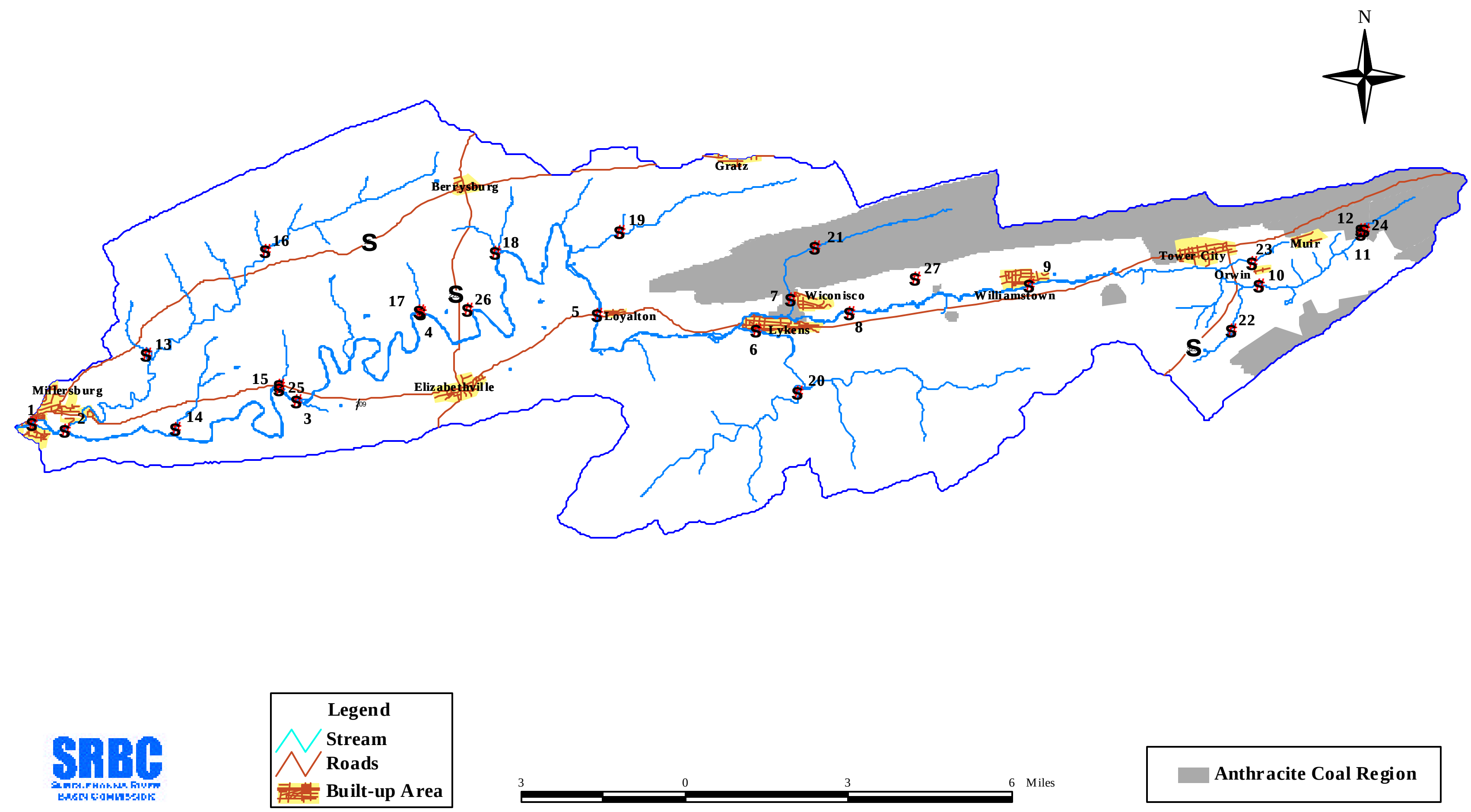
Soil erosion and siltation have been long-standing problem in the Wiconisco Creek Watershed (Hughey, 1977; Gilligan, 1983). Coal silt sedimentation present in the stream channel of the Upper Basin is the result of numerous unreclaimed strip mines and slag piles in the area between Loyalton and Muir. The coal mining area shown in Figure 4 displays the extent and concentration of disturbed land that causes the Upper Basin to be plagued by sedimentation problems. The area west of Loyalton also has erosion and sedimentation problems as a result of agricultural operations. Areas with high gradient (Figure 5) are of greatest concern, due to the increased potential for erosion. The area with highest erosion is the eastern part of the watershed, and is of special concern because of past mining activities.

Ecoregion

Ecoregions are areas of relative homogeneity based on environmental factors such as soils, vegetative cover, climate, geology, physiography, land use, wildlife, and hydrology. Ecoregions have been used as a tool for assessing the best attainable biological and water quality conditions on a regional basis (Wood and others, 1996).

Three subecoregions are in the Wiconisco Creek Watershed (Figure 6). Subecoregion 67b (Northern Shale Valleys) covers the lowland areas, including the valley floor in the headwaters of the Upper Basin and most of the basin to the west of Loyalton. Subecoregion 67b is characterized by rolling valleys and low hills that are underlain mostly by shale, siltstone, and fine-grained sandstone. The underlying bedrock is impermeable, and the resulting surface streams are large and have a high drainage density. Streams in this ecoregion are susceptible to soil erosion. Turbidity is relatively high and habitat is commonly degraded. The most common natural vegetation on steep sites in this region is Appalachian oak forests. Farming is the dominant land use on most of this subecoregion today.

Subecoregion 67c (Northern Sandstone Ridges) encompasses the mountain areas in the Wiconisco Creek drainage basin. These areas are characterized by high, steep, forested ridges with narrow crests. The streams in these areas have high gradients and flow through narrow valleys. Mountain streams in this area have low buffering capacity and are subject to acidification. Today this subecoregion is dominated by Appalachian oak forest.



S Sample Site

1	WICO 0.3	4	WICO 14.7	7	BEAR 0.4	10	WICO 39.1	13	LWIC 4.0	16	LWIC 8.4	19	UNT6 1.2
2	LWIC 0.1	5	WICO 23.6	8	WICO 30.4	11	WICO 41.4	14	UNT1 0.2	17	UNT3 0.1	20	RATL 2.6
3	WICO 7.9	6	RATL 0.4	9	WICO 34.4	12	PORT 0.1	15	UNT2 0.1	18	UNT5 0.1	21	BEAR 1.7

22	UNT7 0.9	25	WICO 7.5
23	UNT8 0.7	26	UNT4 0.1
24	WICO 41.5	27	BIGL 0.7

Figure 4. Map Showing Anthracite Coal Region in the Wiconisco Creek Watershed

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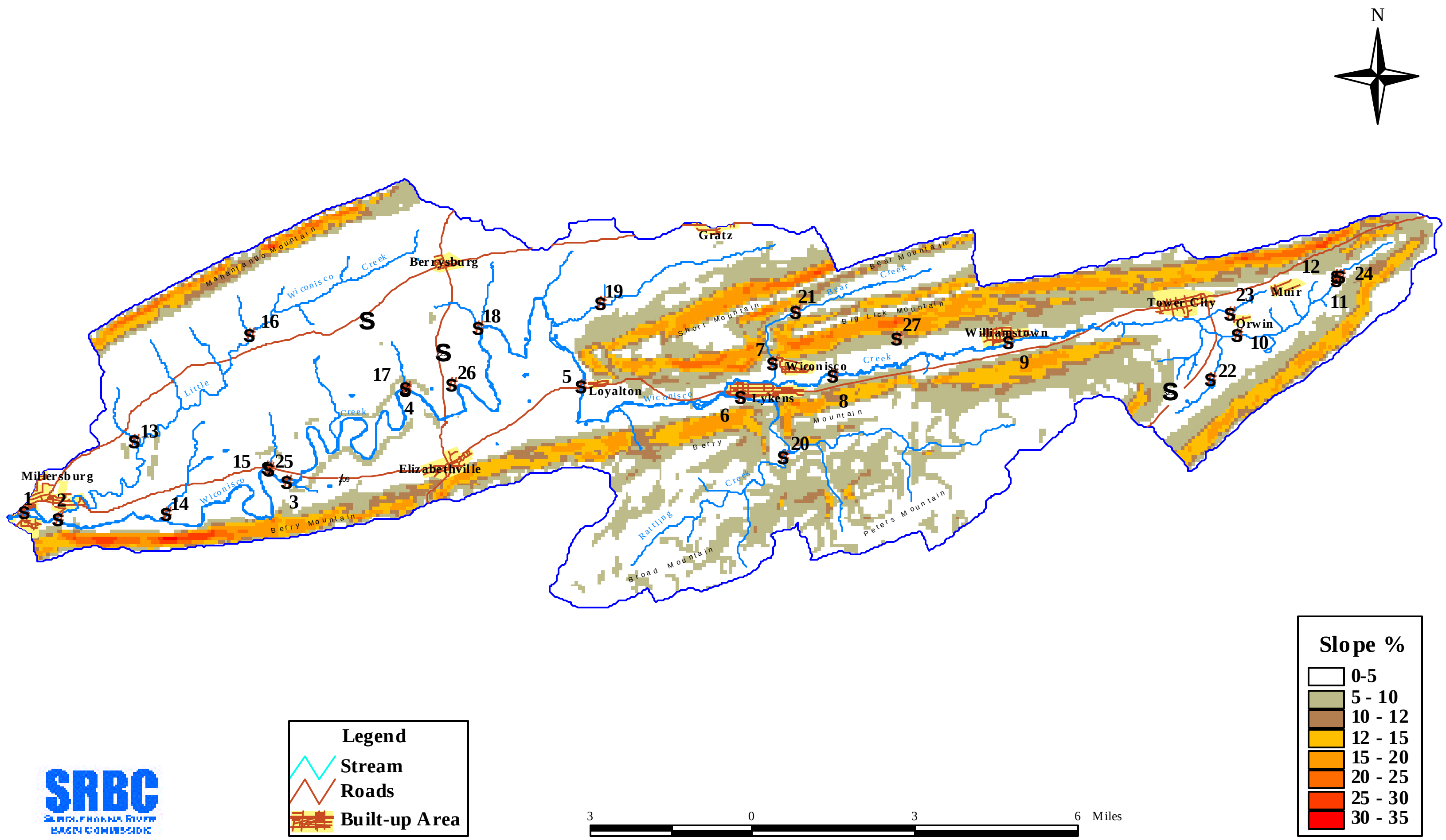

Sample Site

1	WICO 0.3	4	WICO 14.7	7	BEAR 0.4	10	WICO 39.1	13	LWIC 4.0	16	LWIC 8.4	19	UNT6 1.2	22	UNT7 0.9	25	WICO 7.5
2	LWIC 0.1	5	WICO 23.6	8	WICO 30.4	11	WICO 41.4	14	UNT1 0.2	17	UNT3 0.1	20	RATL 2.6	23	UNT8 0.7	26	UNT4 0.1
3	WICO 7.9	6	RATL 0.4	9	WICO 34.4	12	PORT 0.1	15	UNT2 0.1	18	UNT5 0.1	21	BEAR 1.7	24	WICO 41.5	27	BIGL 0.7

Figure 5. Map Showing High Gradient Areas in the Wiconisco Creek Watershed

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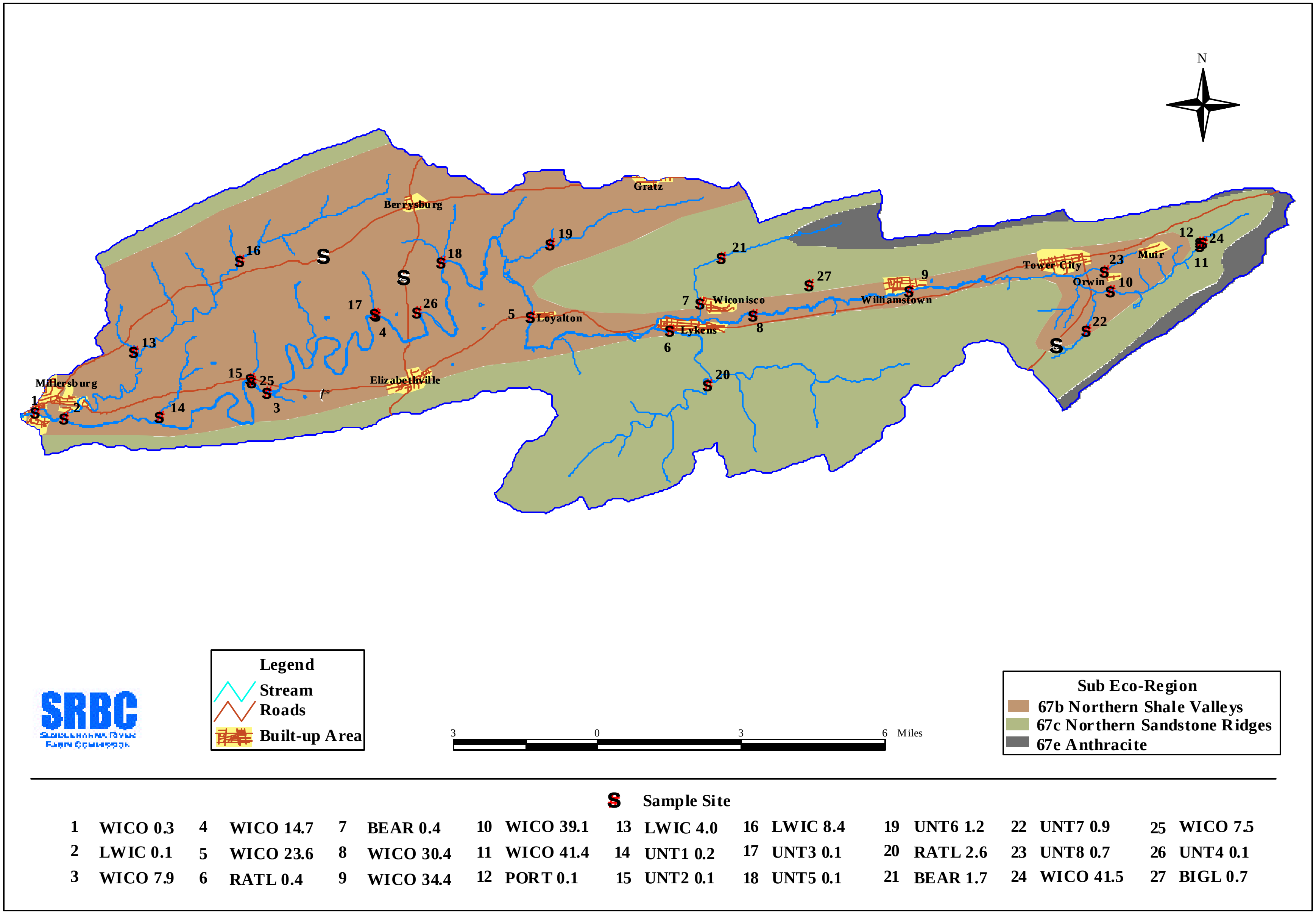

Figure 6. Map Showing Subecoregion Designations in the Wiconisco Creek Watershed

Subecoregion 67e (Anthracite) is an area that has been extensively disturbed by anthracite coal mining and urban-industrial development. Landforms, soils, and vegetation have all been impacted by mining operations and subsequent runoff. Streams tend to be very acidic and have high turbidity. The natural forest in this area was Appalachian oak forest and hardwood forest. Now, cherry and birch are recolonizing some of the mined areas.

Land Use

Agriculture and forest land are the dominant land uses in the Wiconisco Creek Watershed. The predominant areas for agriculture are in the Lower Basin and the Little Wiconisco Creek Basin, although there is some agricultural land in the Upper Basin. Woodlands dominate mountainous areas on the edge of the drainage, with some coal mining in headwater areas. Urban or built-up land is concentrated in the upper half of the basin between the mountains (Figure 7).

Point Sources

The Wiconisco Creek Watershed has a number of point source discharges that could potentially influence water quality and aquatic life. Permitted point source discharges are listed in Table 3 and the locations are identified in Figure 8.

Table 3. Permitted Point Source Discharges in Wiconisco Creek Watershed

Facility	NPDES	Type	Latitude	Longitude
AMP Inc./Williamstown	PA0010294	IW	40°34’42”	76°37’16”
Bendar, Connie	PA0087203	SN	40°33’58”	76°48’53”
Berrysburg Municipal Authority	PA0080900	SP	40°36’15”	76°48’42”
Dauphin Meadows, Inc.	PA0080187	IW	40°32’52”	76°52’30”
Elizabethville Boro Authority	PA0037737	SP	40°33’38”	76°48’50”
Metal Industries Inc. of California	PA0086495	IW	40°36’27”	76°43’49”
Millersburg Area Authority	PA0085570	IW	40°32’10”	76°55’23”
Porter-Tower Jt. Authority	PA0046272	SP	40°34’59”	76°34’46”
Thompson, Fred	NO PM REC	IW	40°34’10”	76°41’04”
Upper Dauphin Area School Authority	PA0035301	SN	40°34’00”	76°45’50”
Washington Twp. Sewer Authority	PA0086185	SP	40°34’01”	76°05’57”
Wiconisco Township	PA0084697	SP	4034’17”	76°41’59”
Williams Valley School Authority	PA0083062	SN	40°34’56”	76°35’03”
Williamstown Boro Sewer Authority	PA0021491	SP	40°34’40”	76°37’35”

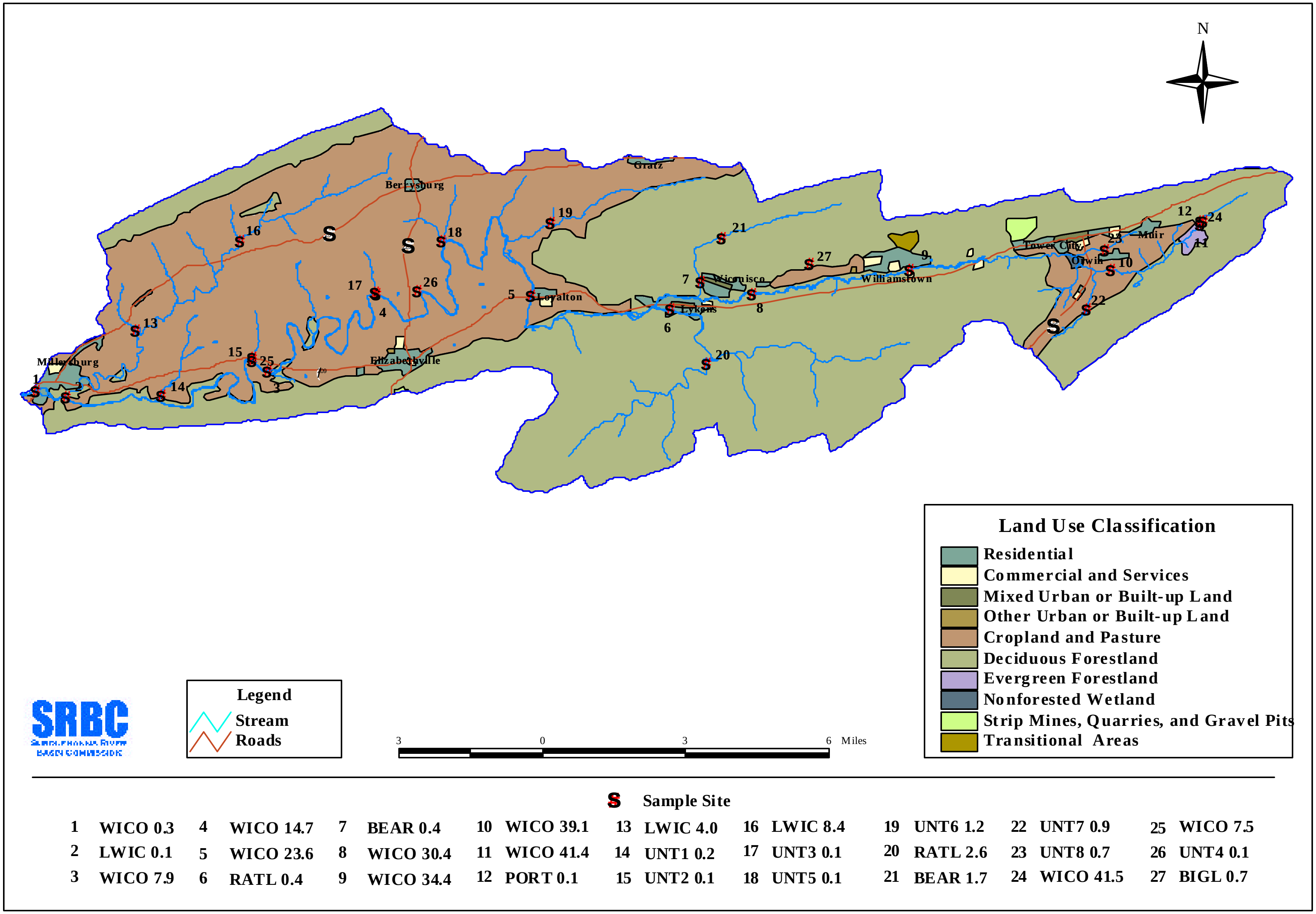

Figure 7. Map Showing Land Use in the Wiconisco Creek Watershed

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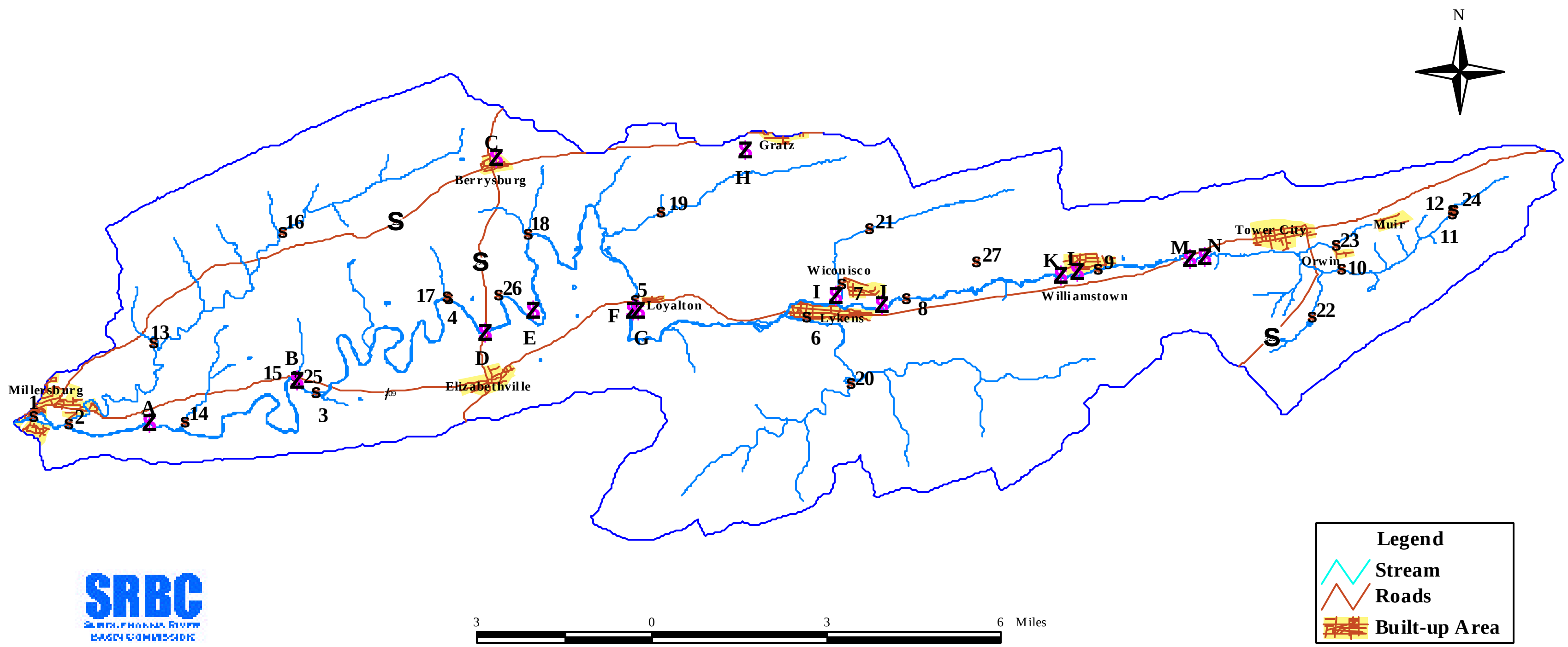

Point Sources

- A Millersburg Area Authority
- B Dauphin Meadows, Inc.
- C Berrysburg Municipal Authority
- D Elizabethville Boro Authority
- E Bendar, Connie
- F Upper Dauphin Area School Authority
- G Wash. Twp. Sewer Authority
- H Metal Ind. Inc. of California
- I Wiconisco Township
- J Thompson, Fred
- K Williamstown Boro Sewer Authority
- L AMP Inc. / Williamstown
- M Williams Valley School Authority
- N Porter-Tower Jt. Authority

Sample Site

- 1 WICO 0.3
- 2 LWIC 0.1
- 3 WICO 7.9
- 4 WICO 14.7
- 5 WICO 23.6
- 6 RATL 0.4
- 7 BEAR 0.4
- 8 WICO 30.4
- 9 WICO 34.4
- 10 WICO 39.1
- 11 WICO 41.4
- 12 PORT 0.1
- 13 LWIC 4.0
- 14 UNT1 0.2
- 15 UNT2 0.1
- 16 LWIC 8.4
- 17 UNT3 0.1
- 18 UNT5 0.1
- 19 UNT6 1.2
- 20 RATL 2.6
- 21 BEAR 1.7
- 22 UNT7 0.9
- 23 UNT8 0.7
- 24 WICO 41.5
- 25 WICO 7.5
- 26 UNT4 0.1
- 27 BIGL 0.7

Figure 8. Map Showing Permitted Point Source Discharges and Sample Sites in the Wiconisco Creek Watershed

METHODS

Field and Laboratory Methods

Field data were collected during periods of little or no precipitation when streamflows were maintained primarily by base flow. Twenty-four sites were sampled in the Wiconisco Creek Watershed in September 1996 and May 1997 (Plate 1). Nine sites were located on the main stem of Wiconisco Creek, and 15 sites were distributed among Wiconisco Creek tributaries (Table 4). Physical habitat and chemical water quality conditions were documented at each sample site, and benthic macroinvertebrate and chemical water quality samples were collected for analysis in the laboratory.

Chemical water quality

Field water quality measurements included water temperature, dissolved oxygen, conductivity, pH, alkalinity, and acidity. Dissolved oxygen was measured using a YSI dissolved oxygen meter or by the Winkler titration method. Conductivity was measured using a Beckman Solubridge meter. An

Table 4. Description of Wiconisco Creek Watershed Sampling Sites and Reference Categories

Collection ID	Sample Site	Description	Latitude	Longitude
		Sample Sites		
WICO 01	WICO 0.3	Wiconisco Creek at the mouth (Rt. 147 bridge)	40°32’14”	76°57’39”
WICO 02	LWIC 0.1	Little Wiconisco Creek at the mouth	40°32’08”	76°56’57”
WICO 03	WICO 7.9	Wiconisco Creek near Rife, Pa.	40°32’40”	76°52’08”
WICO 04	WICO 14.7	Wiconisco Creek near Elizabethville, Pa.	40°34’07”	76°49’35”
WICO 05	WICO 23.6	Wiconisco Creek at Loyalton (Rt. 209 bridge)	40°34’09”	76°45’54”
WICO 06	RATL 0.4	Rattling Creek near the mouth in Lykens, Pa.	40°33’57”	76°42’33”
WICO 07	BEAR 0.4	Bear Creek near the mouth	40°34’28”	76°41’52”
WICO 08	WICO 30.4	Wiconisco Creek near Wiconisco, Pa.	40°34’16”	76°40’36”
WICO 09	WICO 34.4	Wiconisco Creek near Williamstown, Pa. (Railroad St.)	40°34’45”	76°36’52”
WICO 10	WICO 39.1	Wiconisco Creek near Orwin, Pa.	40°34’49”	76°32’04”
WICO 11	WICO 41.4	Wiconisco Creek below the Porter Tunnel discharge	40°35’40”	76°29’57”
WICO 12	PORT 0.1	Porter Tunnel acid mine discharge	40°35’44”	76°29’57”
WICO 13	LWIC 4.0	Little Wiconisco Creek near Killinger	40°33’22”	76°55’19”
WICO 14	UNT1 0.2	Tributary to Wiconisco Creek near Reservoir Heights, Pa.	40°32’11”	76°54’40”
WICO 15	UNT2 0.1	Tributary to Wiconisco Creek near Rife, Pa.	40°32’55”	76°52’31”
WICO 16	LWIC 8.4	Little Wiconisco Creek in the headwaters	40°35’03”	76°52’51”
WICO 17	UNT3 0.1	Tributary to Wiconisco Creek near Reservoir Heights, Pa.	40°34’09”	76°49’36”
WICO 18	UNT5 0.1	Tributary to Wiconisco Creek near Berrysburg, Pa.	40°35’07”	76°48’02”
WICO 19	UNT6 1.2	Tributary to Wiconisco Creek near Gratz, Pa.	40°35’29”	76°45’27”
WICO 20	RATL 2.6	West Branch of Rattling Creek above the reservoir	40°32’58”	76°41’39”
WICO 21	BEAR 1.7	Bear Creek below Bear Swamp	40°35’17”	76°41’21”
WICO 22	UNT7 0.9	Tributary to Wiconisco Creek near Gold Mine Road	40°34’06”	76°32’38”
WICO 23	UNT8 0.7	Tributary to Wiconisco Creek near Muir, Pa.	40°35’10”	76°32’13”
WICO 24	WICO 41.5	Wiconisco Creek above the Porter Tunnel discharge	40°35’44”	76°29’53”
		Reference Sites		
Reference Category	**Sample Site**	**Description**	**Latitude**	**Longitude**
67bs	LSHM 0.8	Little Shamokin Creek near Sunbury	40°51’30”	76°46’00”
67lb	WMHT 2.2	West Mahantango Creek at Rte. 104 bridge	40°38’48”	76°57’59”
67c	STON 0.4	Stony Creek upstream of dam at Dauphin	40°22’31”	76°54’57”

Orion Model 399A meter was used to measure pH. Alkalinity was measured by titrating a known volume of sample water to pH 4.5 with 0.2N H_2SO_4. Acidity was measured by titrating a known volume of sample water to pH 8.3 with 0.02N NaOH. Approximately 2 liters of water from each site were collected for laboratory analysis. Laboratory samples consisted of two 500 mL bottles for nutrient analysis (one filtered and one unfiltered), and two 500 mL bottles for metal analysis (also one filtered and one unfiltered). Sample water was filtered through a cellulose nitrate filter with a 0.45 um pore size. The samples for metal analyses were acidified to pH 2 or less with nitric acid. All samples were chilled on ice and shipped within 24 hours to the Pa. DEP, Bureau of Laboratories in Harrisburg, Pa.

Physical habitat and biological conditions

Physical habitat conditions at each sample site were assessed using a slightly modified version of the habitat assessment procedure outlined by Plafkin and others (1989). Eleven habitat parameters were field-evaluated at each site and used to calculate a site-specific Habitat Assessment Score. Habitat parameters were identified as primary, secondary, or tertiary, based on their contribution to habitat quality. Primary parameters, stream habitat features that have the greatest direct influence on the structure of aquatic communities, were evaluated on a scale of 0-20 and included characterization of the stream bottom substrate, instream cover, embeddedness, and velocity/depth diversity. Secondary parameters included stream channel morphology character-istics and were scored on a scale of 0-15. Tertiary parameters characterized riparian and bank conditions and were scored on a scale of 0-10. The criteria used to evaluate habitat parameters are summarized in Table 5.

Benthic macroinvertebrate samples were analyzed using field and laboratory methods described by Plafkin and others (1989). Macroinvertebrate communities were sampled using 1-meter square kick nets to collect organisms dislodged from riffle areas by physical agitation of the streambed. Two areas of the streambed, each approximately 1-meter square, were sampled at each site: one area of high velocity and one of lower velocity. The two samples were composited and preserved in a solution of isopropyl alcohol and glycerin for laboratory analysis. In the laboratory, composite samples were sorted into 100-organism subsamples using a gridded pan and a random numbers table. The organisms contained in the subsamples were identified to genus (except for Chironomidae and Simuliidae) and enumerated. Each taxon was assigned an organic pollution tolerance value and a functional feeding category as outlined in Appendix A.

Data Analysis Methods

Reference category designation

Sample sites were grouped into reference categories based on subecoregion designation and drainage area size. Sites within subecoregion 67b (Northern Shale Valleys) were divided into two reference categories (small and large) based on drainage area. Sites with drainage areas less than 30 square miles were considered small. For each reference category, one site that represented a combination of the "least disturbed or best attainable" habitat and biological conditions was identified and used as the reference site for the reference category. Due to the lack of unimpaired sites, the reference sites were chosen from outside the Wiconisco Creek Watershed. These sites were chosen based on subecoregion, proximity to Wiconisco Creek, and comparable drainage area. They were sampled using the same methods at the same time of year. Reference category delineation criteria are summarized in Table 6.

Chemical water quality

Principal components analysis (PCA) and hierarchical cluster analysis were used to group sample sites into water quality classes based on base flow concentrations of water quality parameters. These analyses condense the water quality data into a manageable format to reveal

Table 5. Criteria Used to Evaluate Physical Habitat Parameters

Habitat Parameter	Excellent	Good	Fair	Poor
1. Bottom Substrate	Greater than 50% cobble, gravel, submerged logs, undercut banks, or other stable habitat **(16-20)**	30-50% cobble, gravel, or other stable habitat. Adequate habitat. **(11-15)**	10-30% cobble, gravel, or other stable habitat. Habitat availability is less than desirable. **(6-10)**	Less than 10% cobble, gravel, or other stable habitat. Lack of habitat is obvious. **(0-5)**
2. Embeddedness (a)	Larger substrate particles (e.g., gravel, cobble, boulders) are between 0 and 25% surrounded by fine sediment. **(16-20)**	Larger substrate particles (e.g., gravel, cobble, boulders) are between 25 and 50% surrounded by fine sediment. **(11-15)**	Larger substrate particles (e.g., gravel, cobble, boulders) are between 50 and 75% surrounded by fine sediment. **(6-10)**	Larger substrate particles (e.g., gravel, cobble, boulders) are over 75% surrounded by fine sediment. **(0-5)**
3. Velocity/Depth Diversity	Four habitat categories consisting of slow (<1.0 ft/s), deep (>1.5 ft); slow, shallow (<1.5 ft); fast (> 1.0 ft/s), deep; fast, shallow habitats are all present. **(16-20)**	Only 3 of the 4 habitat categories are present. **(11-15)**	Only 2 of the 4 habitat categories are present. **(6-10)**	Dominated by 1 velocity/depth category (usually pools). **(0-5)**
4. Pool/Riffle Ratio (or Run/Bend)	Distance between riffles divided by mean wetted width equals 5-7. Stream contains a variety of habitats including deep riffles and pools. **(12-15)**	Distance between riffles divided by mean wetted width equals 7-15. Adequate depth in pools and riffles. **(8-11)**	Distance between riffles divided by mean wetted width equals 15-25. Stream contains occasional riffles. **(4-7)**	Distance between riffles divided by mean wetted width >25. Stream is essentially straight with all flat water or shallow riffle. Poor habitat. **(0-3)**
5. Pool Quality (b)	Pool habitat contains both deep (>1.5 ft) and shallow areas (<1.5 ft) with complex cover and/or depth greater than 5 ft. **(12-15)**	Pool habitat contains both deep (>1.5 ft) and shallow (<1.5 ft) areas with some cover present. **(8-11)**	Pool habitat consists primarily of shallow (<1.5 ft) areas with little cover. **(4-7)**	Pool habitat rare with maximum depth <0.5 ft, or pool habitat absent completely. **(0-3)**

Table 5. Criteria Used to Evaluate Physical Habitat Parameters—Continued

Habitat Parameter	Excellent	Good	Fair	Poor
6. Riffle/Run Quality (c)	Riffle/run depth generally >8 in. and consisting of stable substrate materials and a variety of current velocities. **(12-15)**	Riffle/run depth generally 4-8 in. and with a variety of current velocities. **(8-11)**	Riffle/run depth generally 1-4 in.; primarily a single current velocity. **(4-7)**	Riffle/run depth <1 in.; or riffle/run substrates concreted. **(0-3)**
7. Channel Alteration (d)	Little or no enlargement of islands or point bars, and/or no channelization. **(12-15)**	Some new increase in bar formation, mostly from coarse gravel; and/or some channelization present. **(8-11)**	Moderate deposition of new gravel, coarse sand on old and new bars; pools partially filled with silt; and/or embankments on both banks. **(4-7)**	Heavy deposits of fine material, increased bar development; most pools filled with silt; and/or extensive channelization. **(0-3)**
8. Upper and Lower Streambank Erosion (e)	Stable. No evidence of erosion or bank failure. Side slopes generally <30%. Little potential for future problems. **(9-10)**	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods. **(6-8)**	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% in some areas. High erosion potential during extreme high flow. **(3-5)**	Unstable. Many eroded areas. Side slopes >60% common. "Raw" areas frequent along straight sections and bends. **(0-2)**
9 Upper and Lower Streambank Stability (e)	Over 80% of the streambank surface is covered by vegetation or boulders and cobble. **(9-10)**	50-79% of the streambank surface is covered by vegetation, gravel, or larger material. **(6-8)**	25-49% of the streambank surface is covered by vegetation, gravel, or larger material. **(3-5)**	Less than 25% of the streambank surface is covered by vegetation, gravel, or larger material. **(0-2)**
10. Streamside Vegetative Cover *(Both Banks)*	Dominant vegetation that provides stream-shading, escape cover, and/or refuge for fish within the bankfull stream channel is shrub. **(9-10)**	Dominant vegetation that provides stream-shading, escape cover, and/or refuge for fish within the bankfull stream channel is trees **(6-8)**	Dominant vegetation that provides stream-shading, escape cover, and/or refuge for fish within the bankfull stream channel is forbs and grasses. **(3-5)**	Over 50% of the streambank has no vegetation and dominant material is soil, rock, bridge materials, culverts, or mine tailings. **(0-2)**

Table 5. Criteria Used to Evaluate Physical Habitat Parameters—Continued

Habitat Parameter	Excellent	Good	Fair	Poor
11. Forested Riparian Buffer Zone Width (f) ***(Least Forested Bank)***	Riparian area consists of all three zones of vegetation, Zones 1-3. (see zone descriptions (e))	Riparian area consists of Zones1 and 2.	Riparian area is limited primarily to Zone 1. Zone 2 may be forested but is subject to disturbance (e.g. grazing, intensive forestry practices, roads).	Riparian area lacks Zone 1 with or without Zones 2 and/or 3.
	(9-10)	**(6-8)**	**(3-5)**	**(0-2)**

(a) Embeddedness — The degree to which the substrate materials that serve as habitat for benthic macroinvertebrates and for fish spawning and egg incubation (predominantly cobble and/or gravel) are surrounded by fine sediment. Embeddedness is evaluated with respect to the suitability of these substrate materials as habitat for macroinvertebrates and fish by providing shelter from the current and predators, and by providing egg deposition and incubation sites.

(b) Pool Quality — Rated based on the variety and spatial complexity of slow- or still-water habitat within the sample segment. It should be noted that even in high- gradient segments, functionally important slow-water habitat may exist in the form of plunge-pools and/or larger eddies. Within a category, higher scores are assigned to segments that have undercut banks, woody debris, or other types of cover for fish.

(c) Riffle/Run Quality — Rated based on the depth, complexity, and functional importance of riffle/run habitat in the segment, with highest scores assigned to segments dominated by deeper riffle/run areas, stable substrates, and a variety of current velocities.

(d) Channel Alteration — A measure of large-scale changes in the shape of the stream channel. Channel alteration includes: concrete channels, artificial embankments, obvious straightening of the natural channel, rip-rap, or other structures, as well as recent sediment bar development. Sediment bars typically form on the inside of bends, below channel constrictions, and where stream gradient decreases. Bars tend to increase in depth and length with continued watershed disturbance. Ratings for this metric are based on the presence of artificial structures as well as the existence, extent, and coarseness of sediment bars, which indicate the degree of flow fluctuations and substrate stability.

(e) Upper and Lower Streambank Erosion and Stability — These parameters include the concurrent assessment of both the upper and lower banks. The upper bank is the land area from the break in the general slope of the surrounding land to the top of the bankfull channel. The lower bank is the intermittently submerged portion of the stream cross section from the top of the bankfull channel to the existing water-line.

(f) Forested Riparian Buffer Zone Width —
Zone 1: a 15-ft-wide buffer of essentially undisturbed forest located immediately adjacent to the stream.
Zone 2: a 100-ft-wide buffer of forest, located adjacent to Zone 1, which may be subject to non-intensive forest management practices.
Zone 3: a 20-ft-wide buffer of vegetation, located adjacent to Zone 2, that provides sediment filtering and promotes the formation of sheet flow of runoff into Zone 2. Zone 3 may be composed of trees, shrubs, and/or dense grasses and forbs, which are subject to haying and grazing, as long as vegetation is maintained in vigorous condition.

Source: Modified from Plafkin and others, 1989.

Table 6. Summary of Reference Category Delineation Criteria

Ecoregion Designation (1)	Ecoregion 67 Central Appalachian Ridges and Valleys		
Drainage Area Size (2)	**< 30 sq. mi.**		**> 30 sq. mi.**
Subecoregion Designation (3)	67b Northern Shale Valleys	67c Northern Sandstone Ridges	67b Northern Shale Valleys
Reference Category	**67b**	**67c**	**67b**
Sample Sites	LWIC 0.1 LWIC 0.4 LWIC 8.4 UNT1 0.2 UNT2 0.1 UNT3 0.1 UNT5 0.1 UNT6 1.2 UNT7 0.9 UNT8 0.7 WICO 30.4 WICO 34.4 WICO 39.1	BEAR 0.4 BEAR 1.7 PORT 0.1 RATL 0.4 RATL 2.6 WICO 41.4 WICO 41.5	WICO 0.3 WICO 7.9 WICO 14.7 WICO 23.6
Reference Site	LSHM 0.8	STON 0.4	WMHT 2.2

(1) Omernik (1987)
(2) Pa. DER (1989)
(3) Pa. DEP (unpublished)

patterns in the water quality characteristics of the sample sites. PCA was used to identify a subset, consisting of 16 of the 33 parameters measured during base flow water quality sampling, which accounted for most of the variation in the data. In this study, 7 of these 17 parameters were combined into three indexes listed in Table 7.

Table 7. Description of Indexes Used in Principal Components Analysis

Index	Calculation
{Nutrients}	[DOP] * [Diss. NO_3]
{Ions}	[Mn] * [Ca]
{Diss. Metals}	[Diss. Fe] * [Diss. Mn] * [Diss. Al]

Next, three indexes and the nine remaining parameters identified by PCA were used in a hierarchical, agglomerative cluster analysis to produce a dendrogram, a tree-like graph, which shows the relative similarity of sample sites. PCA and cluster analyses were performed using software developed by Kovach (1993) and Minitab Inc. (1996), respectively. Both of these analyses were conducted using methods discussed in Gauch (1982). The same procedure was used to summarize the 1997 base flow water quality data.

Physical habitat and biological conditions

Habitat assessment scores of sample sites were compared to those of reference sites to classify each sample site into a Habitat Condition Category (Table 8). The biological integrity of each sample site was assessed using a modified version of RBP III, as described by Plafkin and others (1989). This modification included the substitution of several of the indexes ("metrics") used to evaluate the overall integrity of the site's benthic macroinvertebrate community. These substitutions included: (1) Shannon Diversity (log base 2) for the Percent Contribution of Dominant Taxa Metric, (2) Percent Taxonomic Similarity for the EPT/Chironomidae Abundances and Community Loss Metrics, and (3) Percent Trophic Similarity for the Scrapers/Filtering Collectors and Shredders/Total Metrics. The metrics used in this survey are summarized in Table 9.

The 100-organism subsample data were used to generate scores for each of the six metrics. Each metric score was then converted to a Biological Condition Score based on the percent similarity of the metric score, relative to the metric score of the appropriate 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 (Table 10).

Table 8. Summary of Criteria Used to Classify the Habitat Conditions of Sample Sites

DETERMINATION OF HABITAT ASSESSMENT SCORES				
	Habitat Parameter Scoring Criteria			
Parameter	**Excellent**	**Good**	**Fair**	**Poor**
Bottom Substrate	20-16	15-11	10-6	5-0
Embeddedness	20-16	15-11	10-6	5-0
Velocity/Depth Diversity	20-16	15-11	10-6	5-0
Pool-Riffle (Run-Bend) Ratio	15-12	11-8	7-4	3-0
Pool Quality	15-12	11-8	7-4	3-0
Riffle/Run Quality	15-12	11-8	7-4	3-0
Channel Alteration	15-12	11-8	7-4	3-0
Upper and Lower Streambank Erosion	10-9	8-6	5-3	2-0
Upper and Lower Streambank Stability	10-9	8-6	5-3	2-0
Streamside Vegetative Cover	10-9	8-6	5-3	2-0
Forested Riparian Buffer Zone Width	10-9	8-6	5-3	2-0
Habitat Assessment Score (a)				

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↓
↓

HABITAT ASSESSMENT	
Percent Comparability of Study and Reference Site Habitat Assessment Scores	**Habitat Condition Category**
>90%	Excellent (comparable to reference)
89-75%	Supporting
74-60%	Partially Supporting
<60%	Nonsupporting

(a) Habitat Assessment Score = Sum of Habitat Parameter Scores

Table 9. Summary of Metrics Used to Evaluate the Overall Biological Integrity of Stream and River Benthic Macroinvertebrate Communities

Metric	Description
1. Taxonomic Richness (1)	The total number of taxa present in the 100 organism subsample
2. Shannon Diversity Index (2)	A measure of biological community complexity based on the number of equally or nearly equally abundant taxa in the community
3. Modified Hilsenhoff Biotic Index (1)	A measure of the overall pollution tolerance of a benthic macroinvertebrate community
4. EPT Index (1)	The total number of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa present in the 100 organism subsample
5. Percent Taxonomic Similarity (2)	A measure of the similarity between the taxonomic composition of the sample site and its appropriate reference community
6. Percent Trophic Similarity (2)	A measure of the similarity between the functional feeding group composition of a sample site and its appropriate reference community

Sources: (1) Plafkin and others (1989); and
(2) calculated using software developed by Kovach (1993).

Table 10. Summary of Criteria Used to Classify the Biological Conditions of Sample Sites

SAMPLING AND ANALYSIS

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TOTAL BIOLOGICAL SCORE DETERMINATION

Metric	Biological Condition Scoring Criteria 6	4	2	0
1. Taxonomic Richness (a)	>80%	79 - 60%	59 - 40%	<40%
2. Shannon Diversity Index (a)	>75%	74 - 50%	49 - 25%	<25%
3. Modified Hilsenhoff Biotic Index (b)	>85%	84 - 70%	69 - 50%	<50%
4. EPT Index (a)	>90%	89 - 80%	79 - 70%	<70%
5. Percent Taxonomic Similarity (c)	>45%	44 - 33%	32 - 20%	<20%
6. Percent Trophic Similarity (c, d)	>75%	74 - 50%	49 - 25%	<25%
Total Biological Score (e)				

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↓

BIOASSESSMENT

Percent Comparability of Study and Reference Site Total Biological Scores	Biological Condition Category
>81%	Nonimpaired
81-53%	Slightly Impaired
52-20%	Moderately Impaired
<20%	Severely Impaired

(a) Score is study site value/reference site value X 100.
(b) Score is reference site value/study site value X 100.
(c) Range of values obtained. A comparison to the reference site is incorporated in this index.
(d) Functional Feeding Group Designations are summarized in Appendix A.
(e) Total Biological Score = the sum of Biological Condition Scores assigned to each metric.

RESULTS

Cluster analysis of the 1996 base flow water quality data revealed that ten water quality groupings represent the streams within the Wiconisco Creek Watershed. Analysis of the 1997 base flow water quality data reinforced the grouping into ten groups, although the composition of the groups has variation from the 1996 groupings. Habitat data from 1996 to 1997 were comparable, so the assessment is based on the 1996 data. Due to an oversight in data collection, the 1997 base flow biological data were not analyzed using the RBP III procedure. The 1997 base flow aquatic macroinvertebrate data were used only to address concerns and conclusions that were made based on the 1996 base flow biological data.

A summary of the RBP III evaluation of macroinvertebrate data is presented by reference category in Table 11. Habitat data are presented for 1996 and 1997 in Tables 12 and 13, respectively. Figure 9 shows the relationship between biology and instream habitat, as seen at the main stem sites on Wiconisco Creek. The 1996 and 1997 dendrograms, as produced by PCA of chemistry data, are represented in Figures 10 and 11, and relative chemical concentrations at each water quality grouping are shown in Table 14. A spatial relationship among water quality groupings is shown in the map (Figure 12). Figure 13 displays the relationship among biological, habitat, and relative chemistry data from the 1996 base flow data set.

Chemical loads increased at all sites from September 1996 to May 1997, due to higher flows at the time of sampling in May 1997. Concentrations were generally comparable, but loads (lb/day) and yields (lb/ac/day) were higher, due to higher flow.

Table 11. Summary of Reference Categories 67bs, 67bl, and 67c RBP III Biological Data, 1996

	Reference Category 67bs										
	LSHM 0.8*	**LWIC 0.1**	**LWIC 4.0**	**LWIC 8.4**	**UNT1 0.2**	**UNT2 0.1**	**UNT3 0.1**	**UNT6 1.2**	**WICO 30.4**	**WICO 34.4**	**WICO 39.1**
Raw Data Summary											
Number of Individuals	144.0	125.0	135.0	163.0	132.0	143.0	120.0	241.0	131.0	114.0	114.0
Percent Shredders	0.7	0.0	0.0	0.6	0.0	0.0	1.7	0.0	0.8	0.9	0.0
Percent Collector-Gatherers	13.2	13.6	20.0	53.4	20.5	22.4	23.3	16.2	67.9	22.8	57.0
Percent Filterer-Collectors	45.8	69.6	56.3	10.4	47.0	58.7	53.3	29.9	28.2	72.8	0.9
Percent Scrapers	18.8	6.4	20.7	29.4	21.2	12.6	14.2	35.7	0.0	0.0	0.9
Percent Predators	21.5	10.4	3.0	6.1	11.4	6.3	7.5	18.3	3.1	3.5	41.2
Number of EPT Taxa	9.0	8.0	8.0	5.0	8.0	6.0	9.0	9.0	2.0	2.0	1.0
Metric Scores											
Taxonomic Richness	16.0	15.0	16.0	15.0	17.0	15.0	17.0	17.0	9.0	8.0	7.0
Diversity Index	3.2	2.8	3.1	2.6	3.2	3.1	3.0	3.6	1.6	1.6	1.5
Hilsenhoff Biotic Index	3.5	4.4	4.8	5.9	4.9	4.8	4.8	4.1	6.2	4.8	5.8
EPT Index	9.0	8.0	8.0	5.0	8.0	6.0	9.0	9.0	2.0	2.0	1.0
Percent Taxonomic Similarity	100.0	24.5	24.4	20.8	26.1	31.4	22.7	41.6	8.7	7.0	6.2
Percent Trophic Similarity	100.0	75.8	80.7	49.1	89.1	77.9	81.4	80.1	45.2	63.2	38.6
Percent of Reference											
Taxonomic Richness	100	93.8	100.0	93.8	106.3	93.8	106.3	106.3	56.3	50.0	43.8
Diversity Index	100	89.0	95.9	80.3	98.6	95.7	93.5	111.5	51.0	48.9	47.8
Hilsenhoff Biotic Index	100	80.1	73.2	59.6	70.9	72.1	72.3	84.5	56.4	73.3	60.5
EPT Index	100	88.9	88.9	55.6	88.9	66.7	100.0	100.0	22.2	22.2	11.1
Percent Taxonomic Similarity	100	24.5	24.4	20.8	26.1	31.4	22.7	41.6	8.7	7.0	6.2
Percent Trophic Similarity	100	75.8	80.7	49.1	89.1	77.9	81.4	80.1	45.2	63.2	38.6
Biological Condition Scores											
Taxonomic Richness	6	6	6	6	6	6	6	6	2	2	2
Diversity Index	6	6	6	6	6	6	6	6	4	2	2
Hilsenhoff Biotic Index	6	4	4	2	4	4	4	4	2	4	2
EPT Index	6	4	4	0	4	0	6	6	0	0	0
Percent Taxonomic Similarity	6	2	2	2	2	2	2	4	0	0	0
Percent Trophic Similarity	6	6	6	2	6	6	6	6	2	4	2
Total Biological Score											
Total Biological Score	**36.0**	**28.0**	**28.0**	**18.0**	**28.0**	**24.0**	**30.0**	**32.0**	**10.0**	**12.0**	**8.0**
Biological % of Reference	**100.0**	**77.8**	**77.8**	**50.0**	**77.8**	**66.7**	**83.3**	**88.9**	**27.8**	**33.3**	**22.2**

*Reference Site

Table 11. Summary of Reference Categories 67bs, 67bl, and 67c RBP III Biological Data, 1996—Continued

	Reference Category 67 bl					Reference Category 67c				
	WMHT 2.2*	WICO 0.3	WICO 7.9	WICO 14.7	WICO 23.6	STON 0.4*	RATL 0.4	RATL 2.6	UNT8 0.7	WICO 41.5
Raw Data Summary										
Number of Individuals	116.0	121.0	161.0	152.0	87.0	117.0	144.0	121.0	139.0	133.0
Percent Shredders	0.9	0.0	0.0	0.0	0.0	6.0	0.7	9.9	0.0	3.0
Percent Collector-Gatherers	6.9	18.2	21.1	12.5	18.4	28.2	16.7	1.7	59.7	32.3
Percent Filterer-Collectors	36.2	66.1	65.8	61.2	71.3	42.7	71.5	57.0	35.3	54.1
Percent Scrapers	34.5	5.8	6.8	4.6	5.7	5.1	3.5	2.5	1.4	0.0
Percent Predators	21.6	9.9	6.2	21.7	4.6	17.9	7.6	28.9	3.6	10.5
Number of EPT Taxa	9.0	11.0	10.0	7.0	4.0	10.0	9.0	7.0	4.0	4.0
Metric Scores										
Taxonomic Richness	24.0	18.0	18.0	13.0	10.0	19.0	13.0	15.0	11.0	12.0
Diversity Index	3.7	3.1	2.8	3.1	2.9	3.6	3.1	2.4	2.0	3.7
Hilsenhoff Biotic Index	3.9	4.0	3.3	3.9	4.8	3.8	2.0	3.6	5.7	3.5
EPT Index	9.0	11.0	10.0	7.0	4.0	10.0	9.0	7.0	4.0	4.0
Percent Taxonomic Similarity	100.0	17.7	24.5	26.1	16.7	100.0	22.2	17.6	7.8	24.8
Percent Trophic Similarity	100.0	58.8	56.1	69.3	53.4	100.0	71.2	70.8	53.5	84.5
Percent of Reference										
Taxonomic Richness	100	75.0	75.0	54.2	41.7	100	68.4	78.9	68.8	63.2
Diversity Index	100	82.9	76.6	83.3	77.0	100	84.5	65.3	61.6	102.8
Hilsenhoff Biotic Index	100	97.8	117.0	100.1	81.1	100	195.3	105.1	61.5	109.7
EPT Index	100	122.2	111.1	77.8	44.4	100	90.0	70.0	44.4	40.0
Percent Taxonomic Similarity	100	17.7	24.5	26.1	16.7	100	22.2	17.6	7.8	24.8
Percent Trophic Similarity	100	58.8	56.1	69.3	53.4	100	71.2	70.8	53.5	84.5
Biological Condition Scores										
Taxonomic Richness	6	4	4	2	2	6	4	4	4	4
Diversity Index	6	6	6	6	6	6	6	4	4	6
Hilsenhoff Biotic Index	6	6	6	6	4	6	6	6	2	6
EPT Index	6	6	6	2	0	6	6	2	0	0
Percent Taxonomic Similarity	6	0	2	2	0	6	2	0	0	2
Percent Trophic Similarity	6	4	4	4	4	6	4	4	4	6
Total Biological Score										
Total Biological Score	**36.0**	**26.0**	**28.0**	**22.0**	**16.0**	**36.0**	**28.0**	**20.0**	**14.0**	**24.0**
Biological % of Reference	**100.0**	**72.2**	**77.8**	**61.1**	**44.4**	**100.0**	**77.8**	**55.6**	**38.9**	**66.7**

*Reference Site

Table 12. Summary of Reference Categories 67bs, 67bl, and 67c RBP III Habitat Data, 1996

	Reference Category 67bs												
	LSHM 0.8*	**LWIC 0.1**	**LWIC 4.0**	**LWIC 8.4**	**UNT1 0.2**	**UNT2 0.1**	**UNT3 0.1**	**UNT5 0.1**	**UNT6 1.2**	**UNT7 0.9**	**WICO 30.4**	**WICO 34.4**	**WICO 39.1**
Primary Parameters													
Substrate	**16**	14	17	7	17	17	11	9	16	12	4	8	9
Embeddedness	**16**	17	17	8	16	14	12	11	12	13	3	5	6
Velocity/Depth Diversity	**14**	8	8	12	6	13	11	12	15	13	12	16	10
Total	**46**	39	42	27	39	44	34	32	43	38	19	29	25
Percent of Reference	**100**	85	91	59	85	96	74	70	93	83	41	63	54
Secondary Parameters													
Pool/Riffle Ratio	**14**	9	9	10	12	14	13	12	11	10	3	5	3
Pool Quality	**11**	6	7	11	3	9	9	7	13	9	13	12	12
Riffle/Run Quality	**14**	7	7	6	5	12	8	9	10	7	3	6	4
Channel Alteration	**13**	13	13	6	12	11	11	10	9	8	6	7	11
Total	**52**	35	36	33	32	46	41	38	43	34	25	30	30
Percent of Reference	**100**	67	69	63	62	88	79	73	83	65	48	58	58
Tertiary Parameters													
U/L Streambank Erosion	**7**	7	9	6	7	8	8	8	7	7	7	7	5
U/L Streambank Stability	**9**	9	9	5	9	9	9	7	8	6	7	8	6
Vegetative Cover	**9**	7	5	5	5	8	9	5	9	5	8	9	8
FRB Zone Width	**8**	4	2	4	7	8	8	3	6	4	9	5	5
Total	**33**	27	25	20	28	33	34	23	30	22	31	29	24
Percent of Reference	**100**	82	76	61	85	100	103	70	91	67	94	88	73
Total Habitat Score													
Total Habitat Score	**131**	**101**	**103**	**80**	**99**	**123**	**109**	**93**	**116**	**94**	**75**	**88**	**79**
Habitat % of Reference	**100**	**77**	**79**	**61**	**76**	**94**	**83**	**71**	**89**	**72**	**57**	**67**	**60**

*Reference site

Table 12. Summary of Reference Categories 67bs, 67bl, and 67c RBP III Habitat Data, 1996—Continued

	Reference Category 67bl					Reference Category 67c								
	WMHT 2.2*	WICO 0.3	WICO 7.9	WICO 14.7	WICO 23.6	STON 0.4*	BEAR 0.4	BEAR 1.7	PORT 0.1	RATL 0.4	RATL 2.6	UNT8 0.7	WICO 41.4	WICO 41.5
Primary Parameters														
Substrate	**18**	7	17	17	11	**19**	18	10	17	17	18	18	18	18
Embeddedness	**18**	17	17	17	6	**15**	6	6	7	18	17	14	7	14
Velocity/Depth Diversity	**16**	15	17	18	17	**18**	13	10	7	16	16	18	16	18
Total	**52**	39	51	52	34	**52**	37	26	31	51	51	50	41	50
Percent of Reference	**100**	75	98	100	65	**100**	71	50	60	98	98	96	79	96
Secondary Parameters														
Pool/Riffle Ratio	**13**	13	13	11	13	**14**	13	4	9	12	14	14	13	14
Pool Quality	**12**	12	11	13	14	**14**	7	12	1	10	12	13	14	13
Riffle/Run Quality	**11**	11	12	12	12	**13**	12	5	9	14	13	14	13	13
Channel Alteration	**12**	12	12	12	11	**10**	13	8	12	12	12	12	11	12
Total	**48**	48	48	48	50	**51**	45	29	31	48	51	53	51	52
Percent of Reference	**100**	100	100	100	104	**100**	88	57	61	94	100	104	100	102
Tertiary Parameters														
U/L Streambank Erosion	**2**	6	7	7	8	**8**	9	9	5	9	8	8	6	8
U/L Streambank Stability	**5**	8	9	8	8	**9**	9	9	5	9	9	8	5	8
Vegetative Cover	**7**	6	8	7	8	**8**	9	8	7	4	8	9	9	9
FRB Zone Width	**7**	4	5	5	5	**4**	6	8	8	2	8	9	8	9
Total	**21**	24	29	27	29	**29**	33	34	25	24	33	34	28	34
Percent of Reference	**100**	114	138	129	138	**100**	114	117	86	83	114	117	97	117
Total Habitat Score														
Total Habitat Score	**121**	**111**	**128**	**127**	**113**	**132**	**115**	**89**	**87**	**123**	**135**	**137**	**120**	**136**
Habitat % of Reference	**100**	**92**	**106**	**105**	**93**	**100**	**87**	**67**	**66**	**93**	**102**	**104**	**91**	**103**

*Reference site

Table 13. Summary of Reference Categories 67bs, 67bl, and 67c RBP III Habitat Data, 1997

	Reference Category 67bs											
	LWIC 0.1	**LWIC 4.0**	**LWIC 8.4**	**UNT1 0.2**	**UNT2 0.1**	**UNT3 0.1**	**UNT5 0.1**	**UNT6 1.2**	**UNT7 0.9**	**WICO 30.4**	**WICO 34.4**	**WICO 39.1**
Primary Parameters												
Substrate	14	17	7	16	18	11	8	15	10	4	8	9
Embeddedness	16	16	7	17	13	12	11	13	6	3	5	6
Velocity/Depth Diversity	8	9	12	6	13	12	12	14	9	12	15	10
Total	38	42	26	39	44	35	31	42	25	19	28	25
Secondary Parameters												
Pool/Riffle Ratio	9	9	11	11	14	12	12	12	4	3	5	3
Pool Quality	6	7	10	3	9	9	7	13	12	13	11	11
Riffle/Run Quality	6	7	6	5	11	8	9	10	5	3	6	4
Channel Alteration	14	12	6	11	12	11	9	9	8	5	6	10
Total	26	26	22	19	32	28	25	32	25	21	23	25
Tertiary Parameters												
U/L Streambank Erosion	7	9	5	7	8	9	8	7	9	7	7	5
U/L Streambank Stability	9	8	5	9	8	8	7	8	9	6	8	5
Vegetative Cover	8	5	5	5	8	9	5	8	9	7	9	8
FRB Zone Width	4	2	4	7	8	8	3	7	8	9	5	5
Total	21	15	14	21	24	25	15	23	26	22	22	18
Total Habitat Score												
Total Habitat Score	**85**	**83**	**62**	**79**	**100**	**88**	**71**	**97**	**76**	**62**	**73**	**68**

Table 13. Summary of Reference Categories 67bs, 67bl, and 67c RBP III Habitat Data, 1997—Continued

	Reference Category 67bl				Reference Category 67c							
	WICO 0.3	WICO 7.9	WICO 14.7	WICO 23.6	BEAR 0.4	BEAR 1.7	UNT8 0.7	PORT 0.1	RATL 0.4	RATL 2.6	WICO 41.4	WICO 41.5
Primary Parameters												
Substrate	7	17	17	10	18	16	12	17	17	18	18	17
Embeddedness	16	16	16	7	6	16	12	7	18	17	7	14
Velocity/Depth Diversity	15	17	17	16	12	8	13	7	17	17	15	17
Total	38	50	50	33	36	40	37	31	52	52	40	48
Secondary Parameters												
Pool/Riffle Ratio	13	12	10	13	12	11	10	9	12	13	13	14
Pool Quality	12	11	13	12	7	6	8	1	11	12	14	13
Riffle/Run Quality	11	12	11	12	12	7	7	9	15	13	13	14
Channel Alteration	11	12	12	10	13	12	9	11	12	12	11	12
Total	34	35	36	34	32	25	24	21	38	37	38	39
Tertiary Parameters												
U/L Streambank Erosion	5	7	7	8	9	9	7	4	9	8	5	8
U/L Streambank Stability	8	8	7	7	9	9	6	5	9	9	5	8
Vegetative Cover	7	8	7	8	9	7	5	7	4	7	9	8
FRB Zone Width	4	5	5	5	5	10	4	8	2	8	7	9
Total	19	21	19	20	23	26	15	20	15	24	21	25
Total Habitat Score												
Total Habitat Score	**91**	**106**	**105**	**87**	**91**	**91**	**76**	**72**	**105**	**113**	**99**	**112**

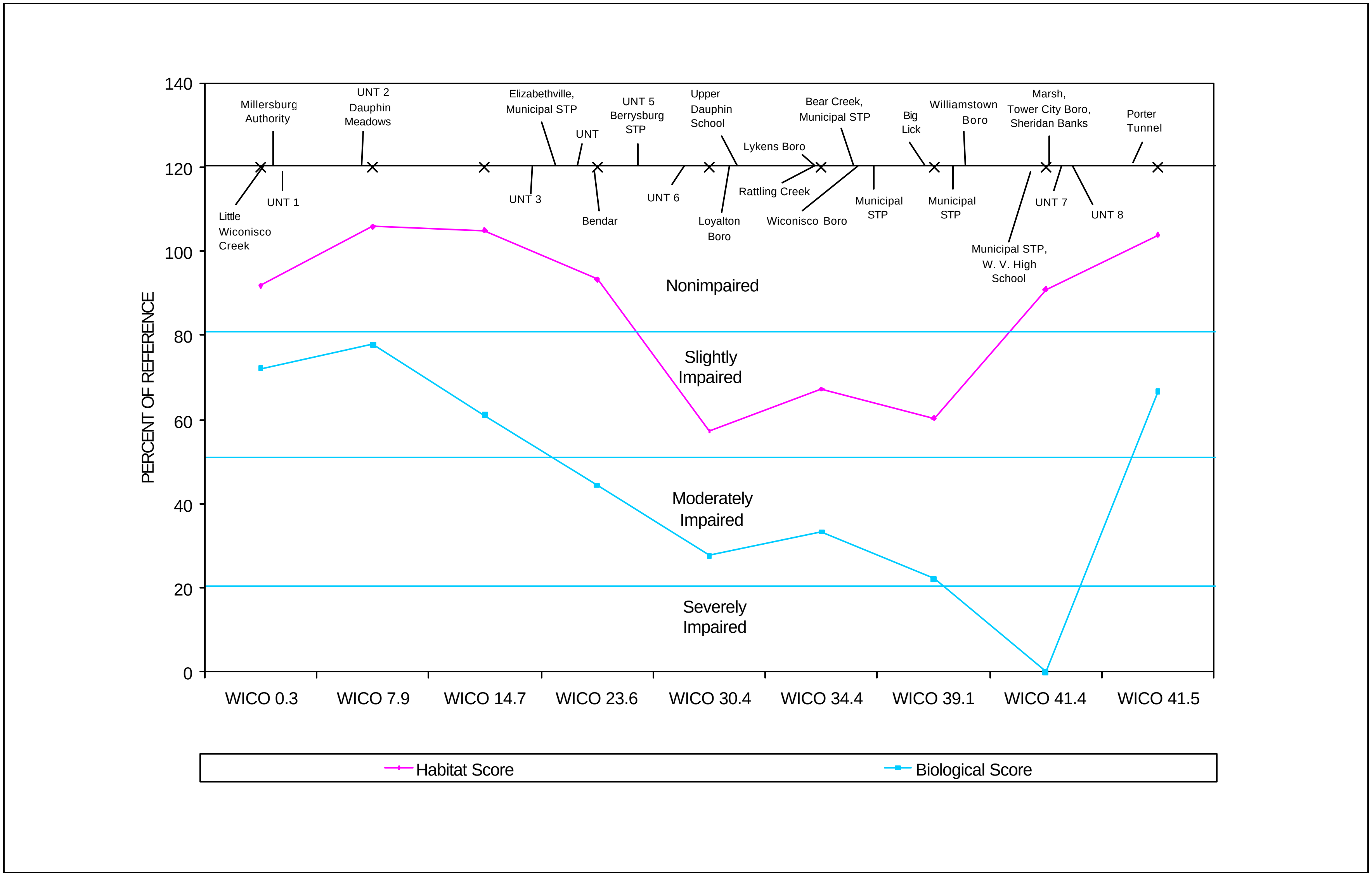
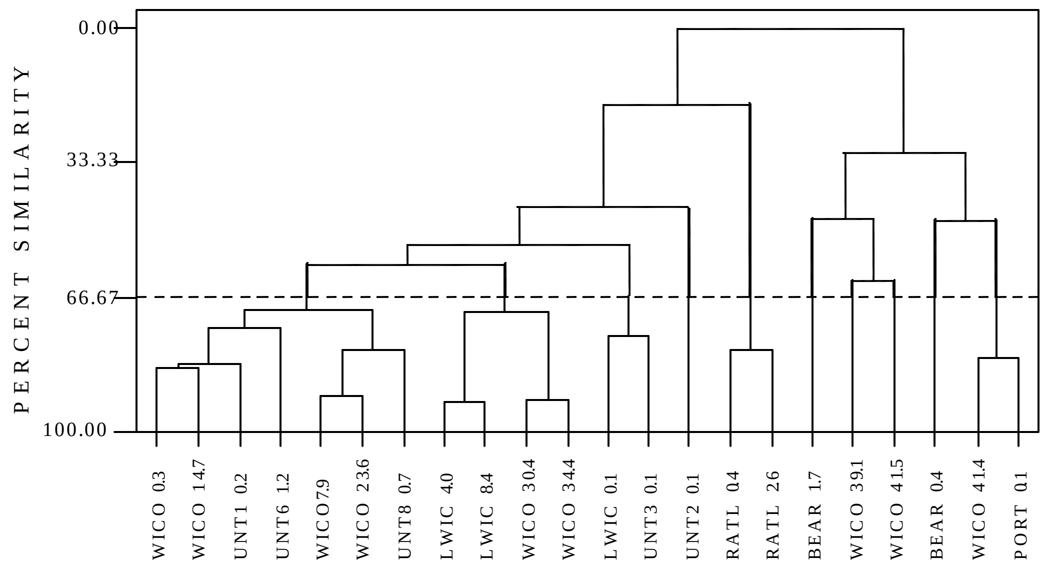


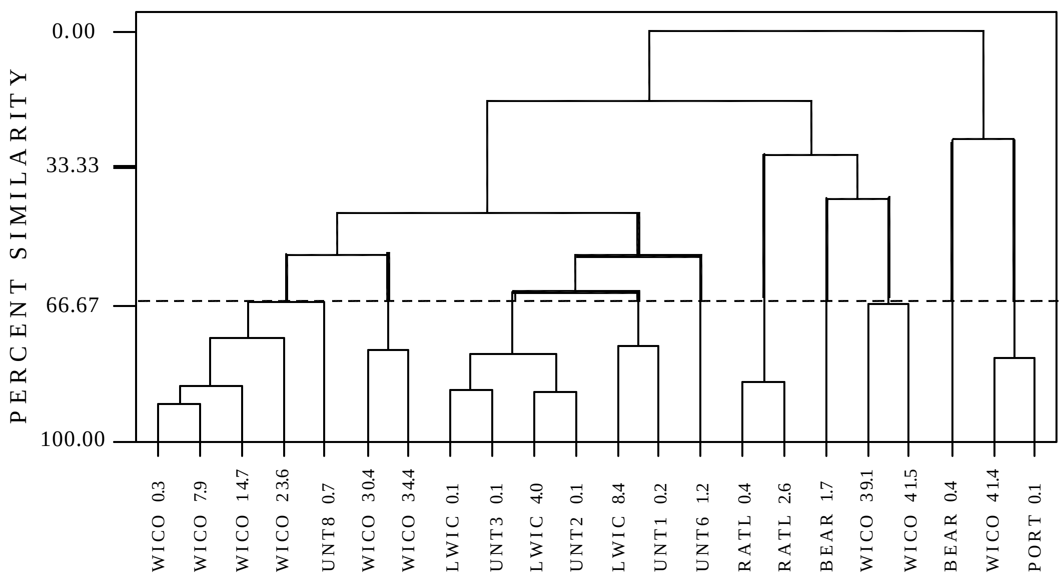
Figure 9. Habitat and Biological Condition Scores of Main Stem Wiconisco Creek Sample Sites, as Related to Potential Sources of Impacts, 1996



Water Quality Variables Identified by PCA and Used to Generate Dendrogram

General Variables	Nutrients	Organic Matter	Major Ions	Metals
Turbidity	{Nutrients}	TOC	{Ions}	{Dis. Metals}
Spec. Cond.	NH_3 Total		Cl	Al Total
Alkalinity (field)	NO_2 Total		SO_4	
Acidity (field)				

Figure 10. Dendrogram Generated by Cluster Analysis of Water Quality Parameters That Account for Most of Variability in the 1996 Wiconisco Creek Water Quality Data, as Identified by PCA



Water Quality Variables Identified by PCA and Used to Generate Dendrogram

General Variables	Nutrients	Organic Matter	Major Ions	Metals
Turbidity	{Nutrients}	TOC	{Ions}	{Dis. Metals}
Spec. Cond.	NH_3 Total		Cl	Al Total
Alkalinity (field)	NO_2 Total		SO_4	
Acidity (field)				

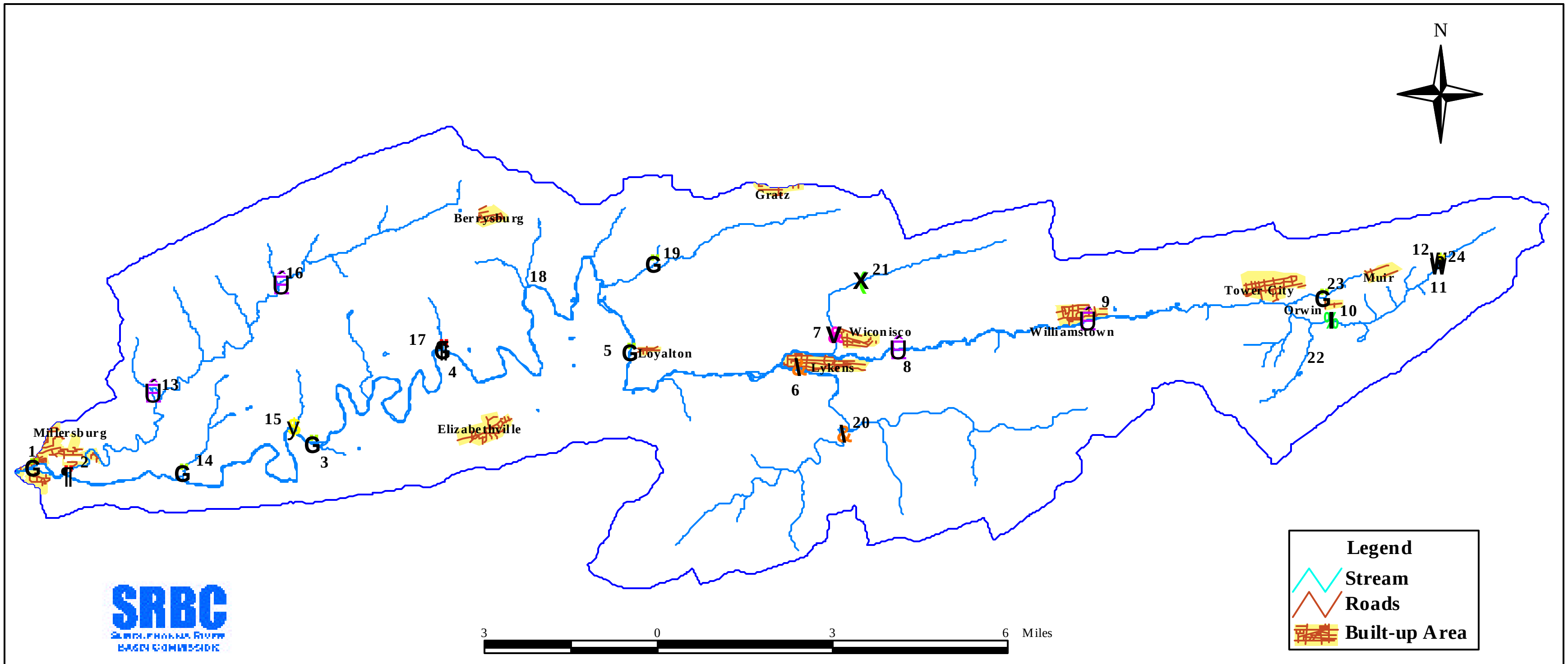
Figure 11. Dendrogram Generated by Cluster Analysis of Water Quality Parameters That Account for Most of Variability in the 1997 Wiconisco Creek Water Quality Data, as Identified by PCA

Table 14. Water Quality Groupings and Relative Chemical Concentrations in the Wiconisco Creek Watershed

WQ Class	1	2	3	4	5	6	7	8	9	10
	RATL 0.4 RATL 2.6	WICO 41.5	WICO 39.1	WICO 0.3 UNT1 0.2 WICO 7.9 WICO 14.7 UNT6 1.2 WICO 23.6 UNT8 0.7	LWIC 4.0 LWIC 8.4 WICO 30.4 WICO 34.4	LWIC 0.1 UNT3 0.1	UNT2 0.1	BEAR 0.4	WICO 41.4 PORT 0.1	BEAR 1.7
Temp	M	L	L	M	M	M	M	VL	VL	M
DO	M	M	M	M	M	M	M	M	M	VL
TOC	VL	L	L	L	L	L	M	VL	VL	VH
Cl	VL	L	L	L	M	M	VH	VL	VL	L
TN	VL	VL	L	L	M	H	VH	L	VL	M
NO2, Total	VL	VL	VL	VL	L	VL	VL	VL	VL	VL
NO3, Total	VL	VL	VL	L	M	M	VH	VL	VL	VL
P, Total	VL	VL	VL	VL	L	L	VH	VL	VL	L
NH3, Total	L	VL	M	L	M	L	L	VH	H	H
Turb	L	L	L	L	L	L	L	VH	H	M
Cond	VL	L	M	M	M	M	VH	M	VH	VL
pH	L	L	VL	M	M	M	M	M	VL	VL
Alk	VL	VL	VL	L	L	M	H	M	VL	VL
Acid	L	M	H	L	M	L	L	M	VH	H
Ca	VL	L	M	M	M	H	H	H	VH	VL
Mg	VL	L	M	L	M	L	M	M	VH	VL
SO4	VL	L	M	L	M	L	H	M	H	L
Fe, Total	VL	M	H	L	M	M	L	VH	VH	VH
Mn, Total	VL	M	H	L	M	L	L	VH	VH	L
Al, Total	VL	L	H	VL	M	VH	VL	VL	VH	H

LEGEND

Condition		Concentration	
Good		VL	Very Low
		L	Low
		M	Moderate
		H	High
Poor		VH	Very High



Sample Site

G	1	WICO 0.3		10	WICO 39.1	G	19	UNT6 1.2
¶	2	LWIC 0.1	W	11	WICO 41.4		20	RATL 2.6
G	3	WICO 7.9	W	12	PORT 0.1	X	21	BEAR 1.7
G	4	WICO 14.7		13	LWIC 4.0		22	UNT7 0.9
G	5	WICO 23.6	G	14	UNT1 0.2	G	23	UNT8 0.7
	6	RATL 0.4	y	15	UNT2 0.1	8	24	WICO 41.5
	7	BEAR 0.4		16	LWIC 8.4		25	WICO 7.5
	8	WICO 30.4	¶	17	UNT3 0.1		26	UNT4 0.1
	9	WICO 34.4		18	UNT5 0.1		27	BIGL 0.7

Figure 12. Map Showing Water Quality Groupings in the Wiconisco Creek Watershed

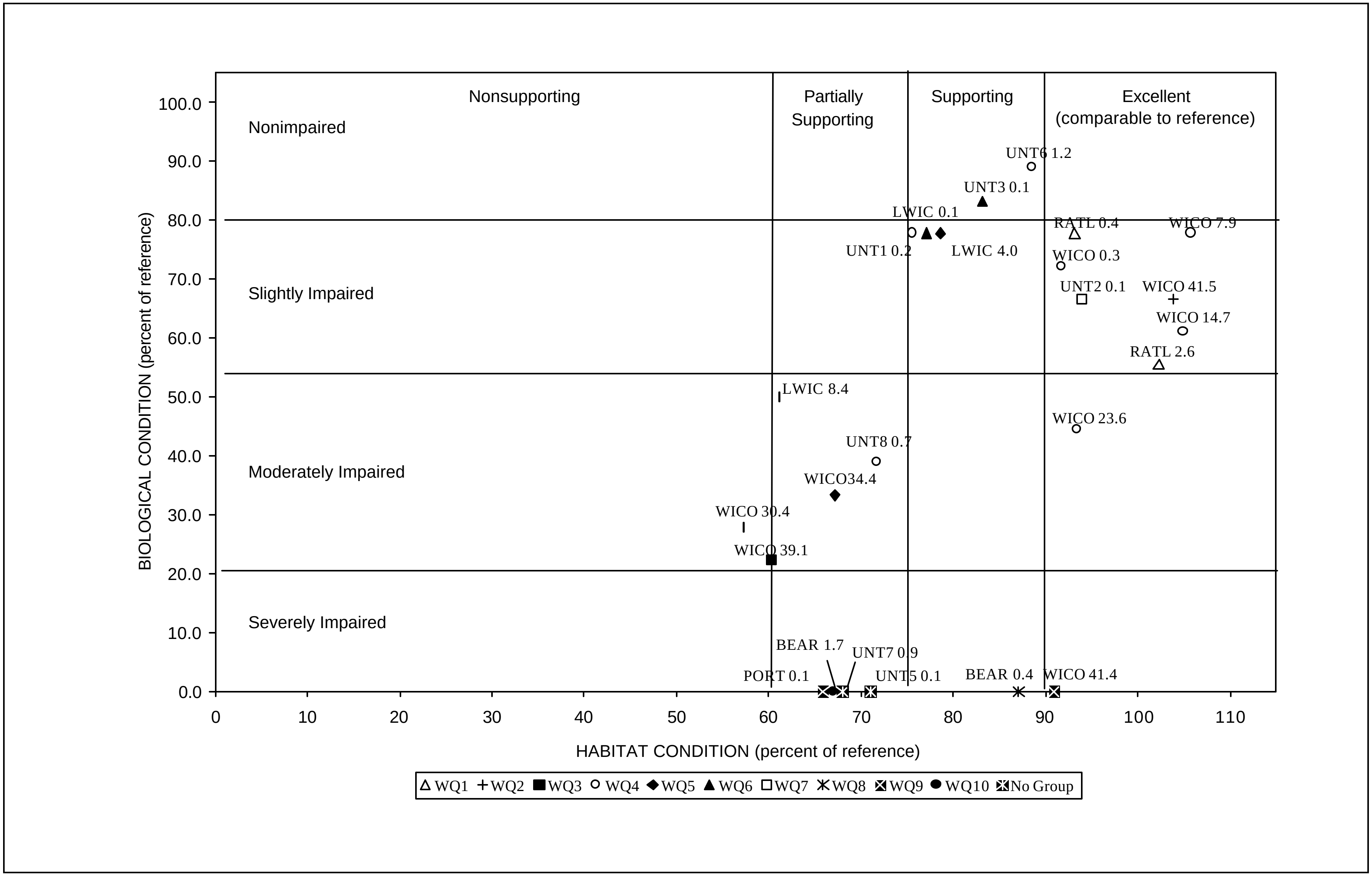


Figure 13. Habitat and Biological Condition Scores and Water Quality Groupings of Wiconisco Creek Watershed Sample Sites, 1996

BIOASSESSMENT OF WICONISCO CREEK AND ITS TRIBUTARIES

The focus of this assessment is on the biological integrity of the site; habitat and water quality data are used as ancillary information. This assessment is discussed site by site, starting with the headwaters of the Upper Basin and working down the main stem toward the mouth, presenting the tributary assessments in the order in which they enter Wiconisco Creek.

Upper Wiconisco Basin

Bioassessment (RBP III) data indicate that habitat conditions of Wiconisco Creek immediately upstream of the Porter Tunnel discharge (WICO 41.5) are excellent. The biological community at this site is slightly impaired due to a low EPT index score and differences in the taxonomic composition of the benthic macroinvertebrate community relative to that of the reference category 67c reference site (STON 0.4). Taxonomic richness is somewhat low at WICO 41.5, and the macroinvertebrate community consists primarily of the net-spinning caddisfly *Diplectrona* (Trichoptera: Hydropsychidae) and midge larvae (Diptera: Chironomidae). Taxonomic diversity, Hilsenhoff biotic index, and percent trophic similarity metric scores at WICO 41.5 support the conclusion that the degree of impairment to the biological community at this site is slight. No substantial changes were observed in the macroinvertebrate community at this site between September 1996 and May 1997. Water quality data at WICO 41.5 has slightly elevated concentrations of metals, but this is expected due to the historical mining activities above this site.

Benthic macroinvertebrate sampling conducted in the Porter Tunnel discharge channel (PORT 0.1) and in Wiconisco Creek immediately downstream of its confluence with the tunnel discharge (WICO 41.4) produced no organisms in September 1996 or May 1997. Although the habitat condition score of WICO 41.4 is comparable to that of the reference site, channel substrate conditions are degraded below the Porter Tunnel discharge due to increased embeddedness associated with the formation of ferric hydroxide precipitate (yellow-boy). Thus, the Porter Tunnel discharge alters the physical habitat and chemical water quality conditions of Wiconisco Creek to the point that the creek is unable to support a viable benthic macroinvertebrate community.

The Porter Tunnel discharge has a deleterious influence on the headwaters of Wiconisco Creek, the affects of which can be seen for miles downstream. The highest metal and ion loads in the Wiconisco Creek Watershed were observed entering the creek from the Porter Tunnel discharge. The Porter Tunnel discharge, based on the 1996 and 1997 base flow water quality samples, showed an iron load of approximately 170 pounds per day, and an acid load of approximately 1,340 pounds per day. PORT 0.1 has the highest concentrations of acid, total nitrogen, total NH_3, TOC, Ca, Mg, Cl, SO_4, Mn, Al, and TOP. Loads (lb/day) entering Wiconisco Creek from the Porter Tunnel Discharge at the time of sampling in 1996 and 1997 are listed in Table 15.

Table 15. Loading Rates for Chemical Parameters From the Porter Tunnel Discharge, September 1996 and May 1997

Parameter	September 1996	May 1997
	pounds per day	
Acid	1,253.39	1,422.96
Al, Total	39.66	44.94
Ca	372.44	441.12
Cl	17.91	47.43
Fe, Total	147.72	186.17
Mg	480.76	641.52
Mn, Total	39.84	46.36
NH_3-N, Total	2.78	1.66
Nitrogen, Total	1.09	3.20
NO_3-N, Total	0.18	0.24
P, Total	0.09	0.12
SO_4	2,900.70	1,909.14
TOC	0.45	5.93
TOP	0.11	0.07

The effects of the influx of metals and ions are still present at the site on the main stem of Wiconisco Creek below the Porter Tunnel discharge (WICO 41.4). Loads (lb/day) at WICO 41.4 at the time of sampling in 1996 and 1997 are listed in the Table 16.

Table 16. Loading Rates for Chemical Parameters at WICO 41.4, September 1996 and May 1997

Parameter	September 1996	May 1997
	pounds per day	
Acid	1,203.21	3,169.32
Al, Total	41.25	102.34
Ca	379.87	1,096.06
Cl	51.57	330.14
Fe, Total	168.11	364.47
Mg	488.16	1,386.58
Mn, Total	40.74	112.91
NH_3-N, Total	1.72	3.96
Nitrogen, Total	2.96	15.85
NO_3-N, Total	1.20	1.32
P, Total	0.34	1.32
SO_4	2,784.57	6,932.89
TOC	0.86	33.01
TOP	0.34	0.33

Approximately 2.3 miles downstream of the confluence of the Porter Tunnel discharge, Wiconisco Creek (WICO 39.1) shows signs of biological recovery from the influence of the Porter Tunnel discharge. However, the physical habitat conditions of the creek are substantially degraded at WICO 39.1, due to degraded channel substrate composition, embeddedness, and channel morphology characteristics. The benthic macroinvertebrate community at WICO 39.1 borders between severely and moderately impaired, and consists primarily of midge and alderfly (Megaloptera: Sialidae) larvae. No substantial changes were observed in the macroinvertebrate community at this site between September 1996 and May 1997.

The influence of the Porter Tunnel discharge is diluted noticeably by the time it reaches WICO 39.1. The concentrations and loads of metals and ions at this site are significantly lower than those sites upstream. Total nitrogen and nitrate concentrations are slightly higher at WICO 39.1 than at WICO 41.4; this may be due to the impact of small farming operations between the two sites.

Between WICO 39.1 and Tower City, Pa., an unnamed tributary flows westward from Muir, Pa., into Wiconisco Creek. The physical habitat conditions of this stream (UNT8 0.7) are only partially supporting, due primarily to degraded stream channel substrate and morphology characteristics. The macroinvertebrate community at UNT8 0.7 is moderately impaired, due to low taxonomic similarity and EPT index metric scores and an elevated Hilsenhoff index metric score. No substantial changes were observed in the macroinvertebrate community at this site between September 1996 and May 1997. Nitrogen concentrations are elevated slightly at this site.

Downstream of the intersection of UNT8 0.7 with Wiconisco Creek, the biological conditions of Wiconisco Creek continue to improve at WICO 34.4 near Williamstown, Pa., despite stormwater runoff from the Tower City/Sheridan Banks area, municipal and non-municipal sewage treatment discharges, and degraded physical habitat. The macroinvertebrate community at WICO 34.4 consists primarily of the net-spinning caddisfly *Hydropsyche* (Trichoptera: Hydropsychidae) and midges. Although RBP III results indicate that the macroinvertebrate communities of both WICO 39.1 and WICO 34.4 are moderately impaired, the Hilsenhoff index and trophic similarity metric scores of WICO 34.4 suggest that additional biological recovery occurs between WICO 39.1 and WICO 34.4. The most noticeable difference in the biological conditions of these two sites pertains to the trophic or feeding structure of their macroinvertebrate communities (Figure 14).

The proportional composition of functional feeding groups in a benthic macroinvertebrate community reflects the food resources that are available to these organisms, and provides insight

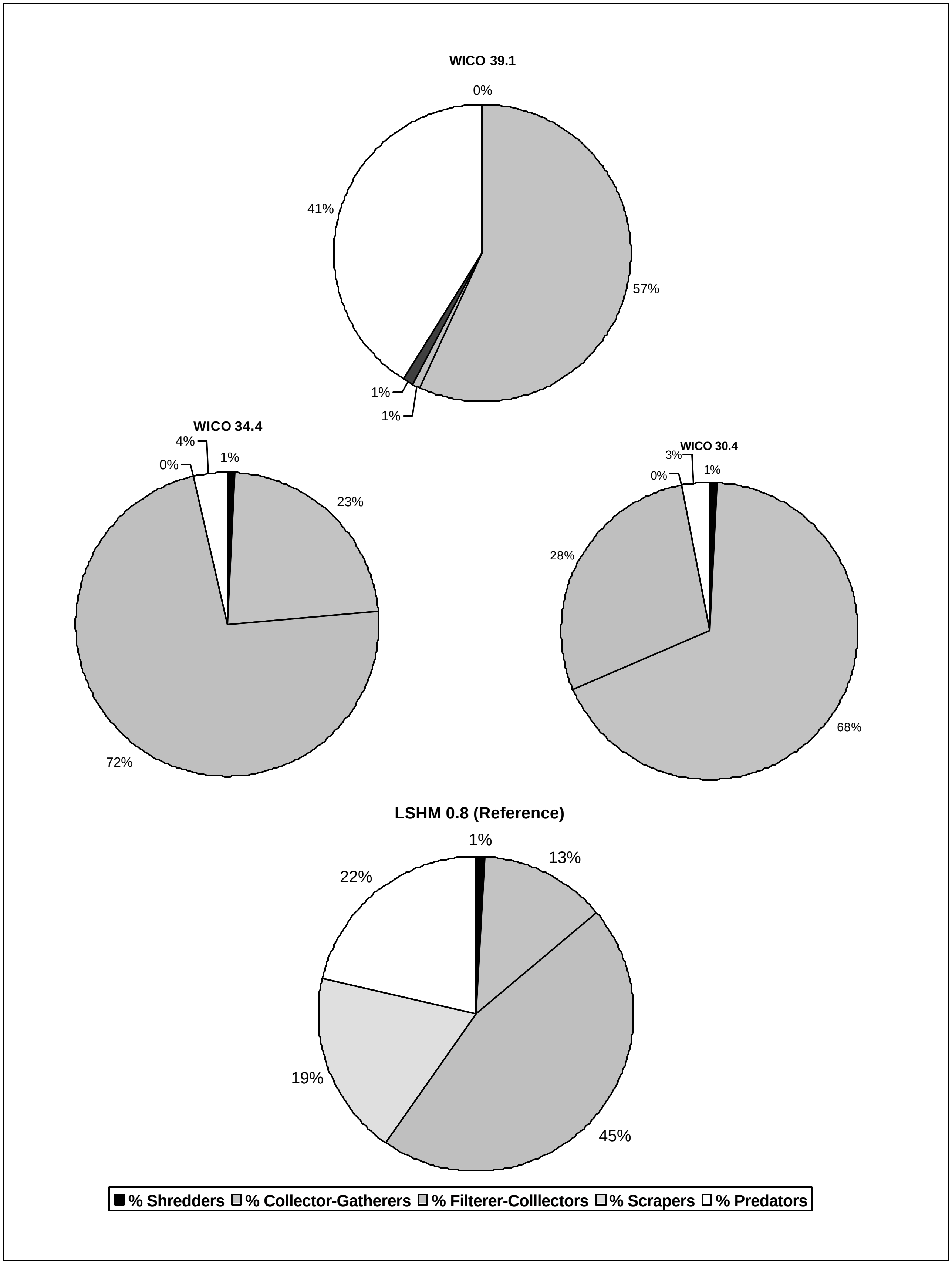


Figure 14. Trophic Structure of Selected Sites in the Upper Basin of Wiconisco Creek

into the way energy, in the form of organic matter, is distributed throughout a given aquatic ecosystem. The macroinvertebrate community at WICO 39.1 consists primarily of collector-gatherers and predators and is quite different from the filterer-collector-dominated communities of WICO 34.4 and the reference category 67bs reference site (LSHM 0.8) (Figure 14). This change in the proportional composition of functional feeding groups between WICO 39.1 and WICO 34.4 indicates that the food resource and energy distribution characteristics of Wiconisco Creek improve between WICO 39.1 and WICO 34.4. No substantial changes in the macroinvertebrate community of WICO 34.4 were observed between September 1996 and May 1997.

Water quality data show that metal concentrations and loads are lower at WICO 34.4 than at WICO 39.1, but the nutrient loads continue to be elevated at this site. Between WICO 39.1 and WICO 34.4, there is an increase in what seems to be urban-related influences. The increases in NH_3, Ca, SO_4, P, and TOC suggest that impacts in this area are not due to acid mine drainage (AMD), but rather, the impacts are more related to urban runoff and treatment facility discharges in this stretch of the stream.

September 1996 RBP III data indicate that downstream of WICO 34.4 the biological conditions of Wiconisco Creek remain moderately impaired. Furthermore, these data indicate that both physical habitat and biological conditions worsen between WICO 34.4 and WICO 30.4 at Wiconisco, Pa. Stream channel substrate and morphology deteriorate from fair to poor through this section of the creek. The macroinvertebrate community consists primarily of midges, and to a much lesser extent, the net-spinning caddisflies *Hydropsyche* and *Cheumatopsyche* (Trichoptera: Hydropsychidae) and blackflies (Diptera: Simuliidae). In conjunction with this shift in taxonomic composition, the trophic structure of the macroinvertebrate community at WICO 30.4 deviates from the diverse, filterer-collector dominated structure of the reference site to a more homogenous, collector-gatherer dominated structure (Figure 14).

Field data collected at WICO 30.4 in May 1997 indicate that biological conditions at this site continued to deteriorate between the collection of macroinvertebrate samples in September 1996 and May 1997. Although these samples were collected at different times of the year, not all of the changes observed in the macroinvertebrate community of this site can be attributed to natural, temporal changes in the community. Figure 15 shows the September 1996 and May 1997 metric scores of main stem Wiconisco Creek sample sites. These figures indicate that the changes observed in the taxonomic richness and taxonomic diversity metric scores of WICO 30.4 between September 1996 and May 1997 are of substantially greater magnitude than those observed at all other main stem sample sites.

In addition to the decrease in taxonomic richness and diversity at WICO 30.4 between September 1996 and May 1997, the trophic structure of this site changed substantially during this time (Figure 16). None of the filtering-collectors present in September 1996 (*Hydropsyche*, *Cheumatopsyche*, and Simuliidae) appeared in the May 1997 macroinvertebrate samples. However, larvae of the genus *Hydropsyche* were present in samples collected from all main stem sites except WICO 30.4 and WICO 7.9, *Cheumatopsyche* were present at all main stem sites downstream of WICO 30.4, and Simuliidae were present in samples collected at sites upstream and downstream of WICO 30.4 during May of 1997. Filtering-collectors are susceptible to uptake of toxicants that readily bind to dissolved organic matter, forming fine particulate organic matter (FPOM), that is a food source for the filtering-collectors (Plafkin, 1989). The loss of filtering-collectors at this site may be a result of an increase in flow from 1996 to 1997. It was observed that the flow entering Wiconisco Creek from the Big Lick Tunnel discharge was substantially higher in 1997 than in 1996. The Big Lick Tunnel discharge is mine drainage that could potentially impact the macroinvertebrate community below its confluence with Wiconisco Creek.

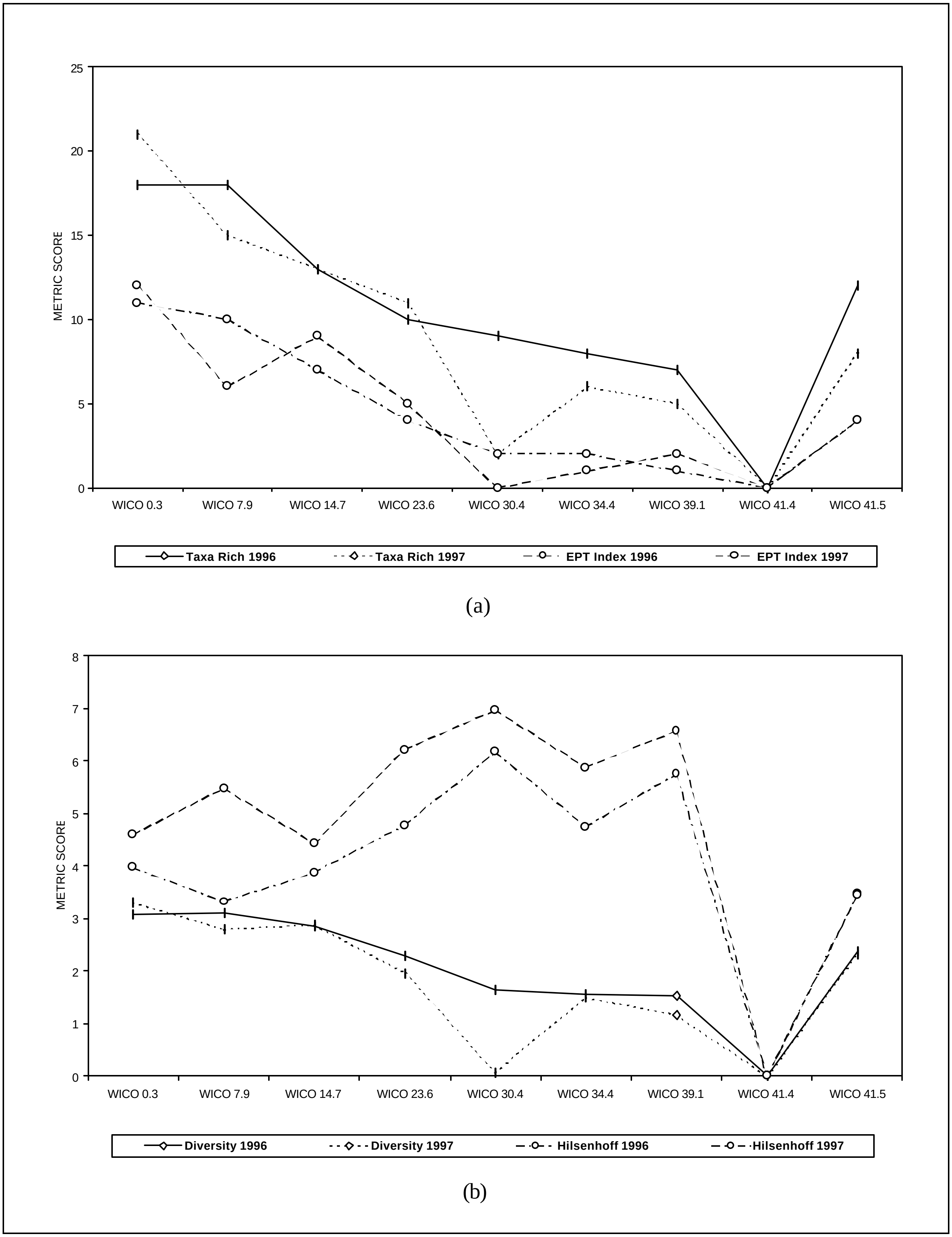


Figure 15. Comparison of 1996 and 1997 Metric Scores of Main Stem Wiconisco Creek Sample Sites During Base flow Sampling *(Taxonomic Richness and EPT Index (a), and Diversity Index and Hilsenhoff Biotic Index (b)*

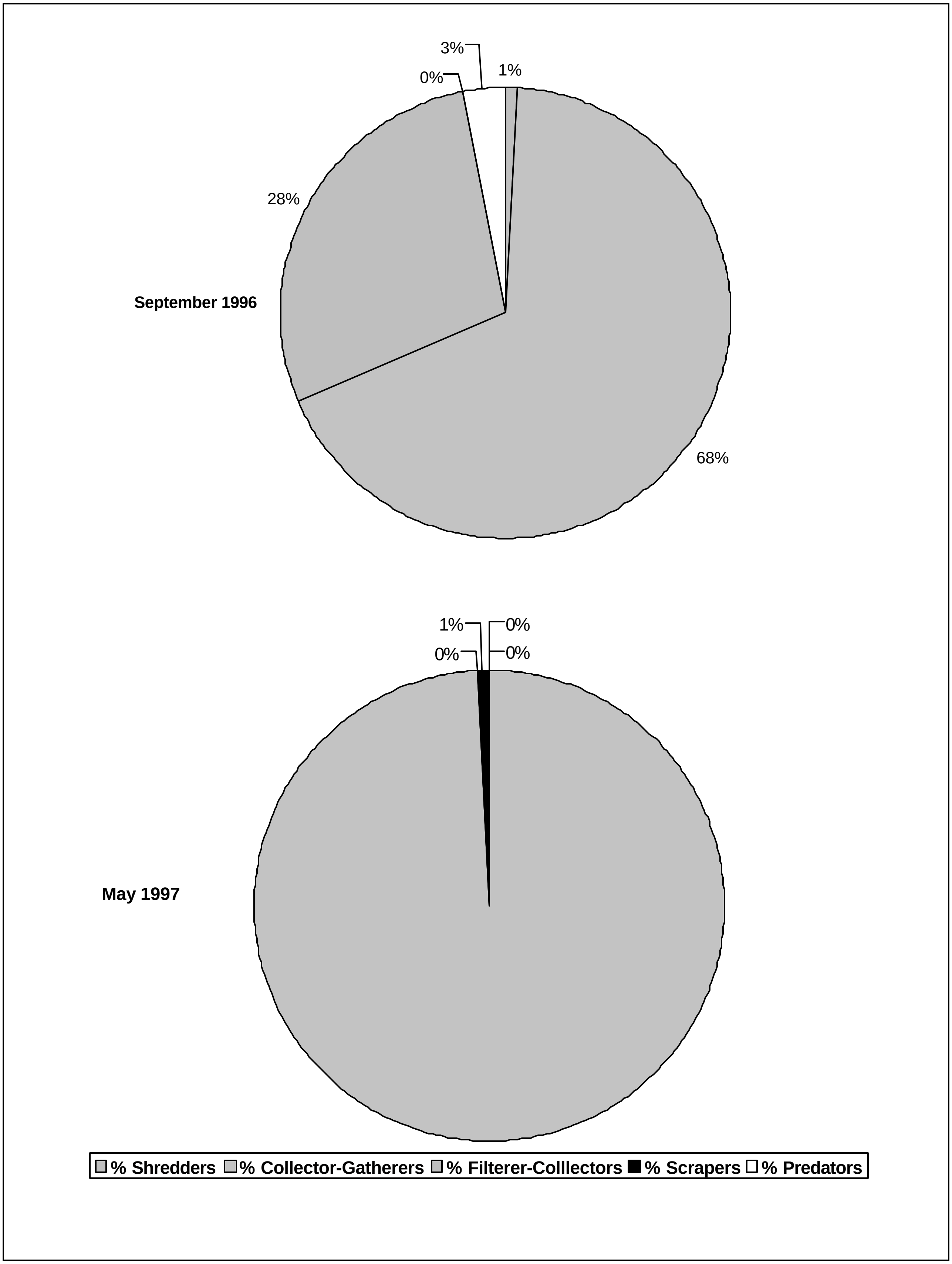


Figure 16. Comparison of Trophic Structure of WICO 30.4 From September 1996 to May 1997

Base flow water quality data for 1996 indicate concentrations and loads of nitrogenous and ionic parameters increased from WICO 34.4 to WICO 30.4, while metal loads decreased. Water quality data from 1996 and 1997 support the suggestion that the loss of biological diversity at this site is related to the increase in flow, resulting in an increase of mine drainage influence of Big Lick Tunnel discharge. Chemical loading at each site increased from 1996 to 1997, due to a higher flow at the time of sampling, but proportionally, relationships between sites in the Upper Basin remained the same. The exception to this generalization is from WICO 34.4 to WICO 30.4 in 1997. Loads of Fe, Mn, Al, and SO_4 at WICO 30.4 are higher than at WICO 34.4, while at low flows in 1996, the loads at WICO 34.4 are higher than those found at WICO 30.4.

Bear Creek Basin

Macroinvertebrates are absent in Bear Creek (BEAR 1.7 and BEAR 0.4) in both 1996 and 1997. Habitat conditions at BEAR 1.7 are partially supporting. The lack of macroinvertebrates at this site can be attributed to poor water quality at this site. This site is located at the outflow of Bear Swamp; the water in this section is tea-colored and stagnant. Water quality data indicate pH at this site was between 4.35 and 4.5 during base flow sampling in 1996 and 1997. Total organic carbon is the highest at this site for both base flow sampling, and metal concentrations are elevated. This is expected, due to the fact that the creek is influenced by past mining operations in Bear Swamp drainage area.

Downstream of BEAR 1.7, Bear Creek flows through Bear Valley toward the borough of Lykens. Operation Scarlift identified four drift openings in the east side of Short Mountain that contribute mine drainage to Bear Creek (Sanders and Thomas, Inc., 1973). At the mouth of Bear Creek (BEAR 0.4), pH is approximately neutral (7.0). Mining influences contributed by Bear Creek to Wiconisco Creek include an increase in the load of Fe, Residues, Mn, Al, and SO_4. Bear Creek is a major contributor of alkalinity to Wiconisco Creek (72 mg/L). The increase in alkalinity causes the pH of Wiconisco Creek to increase, thus metals in solution precipitate out of the water column at this point. Precipitation of metals causes degradation of physical habitat at this point, but this precipitation is necessary for improvement of water quality downstream. Loads (lb/day) calculated for 1996 and 1997 base flows from Bear Creek are listed in Table 17.

Table 17. Loading Rates for Chemical Parameters From Bear Creek, September 1996 and May 1997

Parameter	September 1996	May 1997
	pounds per day	
Acid	566.60	666.84
Al, Total	2.39	3.22
Ca	867.60	1,138.39
Cl	35.41	47.63
Fe, Total	154.40	595.39
Mg	715.33	971.68
Mn, Total	66.22	110.03
NH_3-N, Total	9.92	12.86
Nitrogen, Total	11.54	19.53
NO_3-N, Total	0.71	0.95
P, Total	0.35	0.48
SO_4	3,116.28	4,334.46
TOC	1.77	23.82
TOP	0.99	0.29

Rattling Creek Basin

The Rattling Creek Basin is classified as a high-quality, cold-water fishery (HQCWF). Land use in this basin is primarily deciduous forestland; therefore, the physical habitat conditions at RATL 2.6 are excellent. Biological scores indicate that this site is slightly impaired, due to a low EPT index and taxonomic similarity. Sterility at this site causes the diversity of the biological community to be depressed. The pH at this site also is somewhat low at 5.75, which can be attributed to the lack of alkalinity in the soil, which lowers buffering capacity. Alkalinity at this site was an average of 5 mg/L over the sampling period.

RATL 0.4 is located below the reservoirs on Rattling Creek, and the biological community is slightly impaired. The primary reason for impairment is the homogeneity of the biological community. Macroinvertebrates at this site consist primarily of pollution-intollerant, net-spinning caddisflies *Dolophilodes* (Trichoptera: Philopotamidae.). These filtering-collectors utilize the abundance of organic matter being released into the stream from the reservoirs. The habitat at RATL 0.4 is excellent, with cobble substrate and very low embeddedness. Water quality data indicate that nutrient levels increase slightly from upstream conditions, but this site is still sterile. Flow contributed to Wiconisco Creek by Rattling Creek improves overall quality of Wiconisco Creek by diluting the mine drainage. No substantial differences are observed in the samples at this site between 1996 and 1997.

Middle Basin

WICO 23.6 is situated downstream of the confluence of both Bear and Rattling Creeks with the main stem of Wiconisco Creek. At WICO 23.6, mine drainage impacts (increased metal loads) from Bear Creek are eased by the precipitation of metals, due to high alkalinity and the influx of high quality water from Rattling Creek. The macroinvertebrate community at WICO 23.6 is moderately impaired, due to low EPT, taxonomic richness, and taxonomic similarity scores. Filtering-collectors predominate at this site. Lack of mayflies (Ephemeroptera) is the most significant difference from the reference site (WMHT 2.2). Although habitat is classified as excellent, siltation is a problem at this site.

The Middle Basin is a transition area within the Wiconisco Creek Watershed. In this area, land use (Figure 7) changes from primarily deciduous forest to cropland and other agricultural uses. Types of impacts also change, from mining activities and urban development in the Upper Basin to agricultural influences in the lower half of the Wiconisco Creek Watershed. The water quality data show this transition. Although iron levels continue to be elevated at this site, Mn and Al concentrations drop significantly. Nutrients such as NO_3 and total nitrogen, as well as ions, including Ca and Mg, are high at this site.

Gratz Creek Basin

UNT 6 1.2 is located on an unnamed tributary that drains the northern side of Short Mountain from Gratz, Pa., towards Lykens, Pa. This site sustains a nonimpaired biological community, and habitat is supporting. The 1996 base flow sample contained a sparse population of the pollution-intolerant genera of stoneflies, *Capnia* (Plecoptera:Capniidae) and mayflies, *Attenella* (Ephemeroptera:Ephemerellidae) and *Ephemera* (Ephemeroptera:Ephereridae), which are not present at any other site within the study area. Habitat is slightly degraded due to lack of streambank stability, which causes the stream to be highly embedded.

Water quality data at this site show concentrations of most parameters are among the lowest in the Wiconisco watershed in both the 1996 and 1997 base flow samples. Thus, this small tributary contributes high quality water into Wiconisco Creek to further increase the biological recovery in the Lower Basin.

Lower Basin

The predominant land use adjacent to WICO 14.7 is cropland and pasture. This site possesses a biological community that is slightly impaired due to low EPT index, taxonomic richness, and trophic similarity scores. Habitat at this site is classified as excellent. The most noticeable changes at this site, as compared to the upstream sites, are the values for substrate and embeddedness. Improvement of habitat, as well as the precipitation of metals upstream of the site, improves the overall quality at this site. The recovery of the biological community can be seen by the emergence of more pollution-intolerant genera from one site to the next (toward the mouth). Pollution-intolerant genera present at WICO 14.7 in 1996 include *Atherix* (Diptera:Athericidae), *Isonychia*

(Ephemeroptera:Isonychiidae), *Paraleptophlebia* (Ephemeroptera:Leptophlebiidae), *Nigronia* (Megaloptera:Corydalidae) and *Isoperla* (Plecoptera:Perlodidae). Although some of these genera are not present in great abundance, the above listed genera comprise 31 percent of the population at this site.

Immediately downstream of WICO 14.7 an unnamed tributary flows southward to enter Wiconisco Creek. Habitat conditions at UNT3 0.1 are comparable to the reference site, although substrate and embeddedness scores are low. The biological community at this site is nonimpaired and appeared to have a diverse heterogeneous trophic structure. Nitrogen in the form of NO_3 and total nitrogen are slightly elevated, and concentrations of both metals and ions are low at this site. Agricultural activities in the drainage area seem to be a factor contributing to the slight degradation of physical habitat and water quality.

Approximately 7 miles downstream, WICO 7.9 has a biological community that borders between nonimpaired and slightly impaired. Macroinvertebrates at this site include somewhat pollution-tolerant *Hydropsyche*, and pollution-intolerant genera, including *Centroptilum* (Ephemeroptera:Baetidae), *Isonychia*, *Nigronia*, and *Acroneuria* (Plecoptera:Perlidae). Trophic structure at this site differs from the reference site. Filtering-collectors predominate, comprising 66 percent of the population. Habitat at this site is excellent, with high scores for all primary parameters (Table 12).

Water quality data, collected at this site in 1996, indicate that concentrations of metals are lower at this site than those upstream, but ions and nitrogenous species, excluding ammonia, are slightly higher at this site. A shift in the water quality data is noticeable from 1996 to 1997. Concentrations and loads of SO_4 are anomalous at this site in 1997.

Directly downstream of this site, an unnamed tributary enters Wiconisco Creek near the borough of Rife, Pa. Biological sampling in 1996 shows that UNT2 0.1 possessed a slightly impaired biological community, although habitat is excellent. The population is supported by pollution-tolerant genera including *Microvelia* (Hemiptera:Veliidae) and *Ragovelia* (Hemiptera:Veliidae). Though the biological community is classified as slightly impaired, it is worth noting that this site has an EPT index of zero in 1996. There is a noticeable change in composition of the biological community from 1996 to 1997. In 1997, though still dominated by pollution-tolerant genera, this site supported a population of pollution-intolerant genera that were not present in 1996. Present are *Ephemerella*, *Amphinemura* (Plecoptera:Nemouridae), and *Dolophiloides*. Habitat is comparable for the two years, but the shift in the biological community appears to be due to a change in water quality.

Near the borough of Reservoir Heights, an unnamed tributary drains 1.6 square miles of agriculture and sparse forest land. Habitat at UNT1 0.1 borders between partially supporting and supporting. The low habitat score can be attributed to an unstable gravel substrate, with little vegetative cover. Impacts at this site are due to agricultural practices within the drainage basin.

Biological conditions at this site border between nonimpaired and slightly impaired. Hilsenhoff biotic index and EPT scores are low at this site in 1996. Few pollution-intolerant genera are represented in the biological sample in 1996, including *Isonychia*, *Nigronia*, *Acroneuria*, and *Glossosoma* (Trichoptera:Glossosomatidae). Biological samples are similar from 1996 to 1997.

Water quality parameters at this site are among the lowest of the entire watershed. No measured chemistry parameters are conspicuous. There are no point source discharges within this drainage area.

Below the point where Little Wiconisco Creek drains into Wiconisco Creek, WICO 0.3 is located near the mouth of Wiconisco Creek at the Rt. 147 bridge crossing in Millersburg, Pa. Physical habitat and biological scores are both reduced at this site, as compared to the sites located upstream of the mouth. Physical habitat at WICO 0.3 is supporting of the reference site, but this site is somewhat degraded due to a bedrock substrate and the lack of vegetative cover and stream bank stability. The presence of residential and commercial/industrial land uses adjacent to this site leaves the stream without a forested buffer zone.

The biological community at this site is slightly impaired. Taxanomic richness is 18, which is lower than the 24 of the reference site, but the quality of macroinvertabrates at this site is comparable to the reference site. There are more EPT taxa at this site, and the Hilsenhoff index is only slightly higher at this site. The major cause of the slightly impaired status of this site is due to values for taxonomic richness, diversity, and trophic similarity. Pollution-tolerant genera present at this site include *Centroptilum*, *Rhithrogena* (Ephemeroptera:Heptageniidae), *Isonychia*, *Acroneuria*, and *Paragnetina* (Plectoptera:Perlidae). There is no noticeable change in the biological community from 1996 to 1997.

Water quality data show that WICO 0.3 is similar to WICO 7.9. Concentrations of nitrogenous chemicals are similar to those of the upstream sites. Ion concentrations also are very similar to those at WICO 7.9. As with all the other sites in the Lower Basin, metal loads and concentrations are negligible. Loads (lb/day) entering the Susquehanna River from Wiconisco Creek at the time of sampling in 1996 and 1997 are described in the Table 18.

Table 18. Loading Rates for Chemical Parameters From the Main Stem Wiconisco Creek to the Susquehanna River, September 1996 and May 1997

Parameter	September 1996	May 1997
	pounds per day	
Acid	947.35	2,950.49
Al, Total	15.99	49.79
Ca	3,007.82	9,441.56
Cl	1,894.69	4,425.73
Fe, Total	38.37	187.36
Mg	1,529.96	4,027.41
Mn, Total	12.79	86.30
NH_3-NTotal	11.84	14.75
Nitrogen, Total	252.47	767.13
NO_3-N, Total	184.73	435.20
P, Total	7.11	7.38
SO_4	11,841.83	24,341.51
TOC	426.31	1,180.19
TOP	10.18	4.43

Little Wiconisco Creek Basin

Land use in the Little Wiconisco Creek Basin is dominated by pasture and cropland, with scattered woodland areas. Influence of drainage from Mahatango Mountain is masked by agriculture in the valley as well as an urban influence near the mouth at Millersburg, Pa.

Near the headwaters of Little Wiconisco Creek at LWIC 8.4, habitat borders between partially supporting and nonsupporting. Physical habitat degradation at this site is due to lack of suitable substrate, high embeddedness, evident streambank erosion, and lack of a forested buffer zone to protect the stream.

The biological community reflects the lack of suitable habitat at this site, and data indicate that this site is moderately impaired. The 1996 data indicate that only five EPT genera are present. In comparison, other streams in the same reference category with comparable drainage area are represented by eight to nine EPT genera. The lack of EPT genera and a low Hilsenhoff Biotic Index score indicate that this site is disturbed.

At this site in 1996, elevated water quality parameters measured included total nitrogen, nitrate, TOC, and a few ions. The concentrations and loads of these chemicals are not as important as degraded physical habitat in contributing to the depressed biological community.

Approximately 4.5 miles downstream of this site both physical habitat and biological scores improve at site LWIC 4.0. At LWIC 4.0, improvement in substrate, embeddedness, streambank stability, and streambank erosion have led to a habitat score supporting the reference site.

According to RBP III evaluation and scoring criteria, biological conditions at WICO 4.0 are between nonimpaired and slightly impaired. Trophic structure vastly improved from LWIC 8.4 to LWIC 4.0. The most noticeable difference in the biological community is a reduction in number of chironomids (Diptera:Chiromomidae) present. Biological scoring of this site may be artificially inflated due to the presence of single individuals representing an EPT genus, which elevates the EPT index score.

Loads of nitrogenous chemical parameters are elevated at this site. TOC and ion concentrations are only slightly higher than those found upstream. The only land use types in this drainage area are agricultural and forested land.

LWIC 0.1 possesses a biological community that is classified as slightly impaired, bordering on nonimpaired. Habitat is supporting of the reference site. Substrate at LWIC 0.1 is bedrock, and embeddedness is low. Streamside vegetative cover is lacking at this site, and therefore, streambank stability and erosion received low scores.

Biological recovery at this site is evident by the presence pollution-tolerant genera present at this site, which include *Atherix, Acentrella* (Ephemeroptera:Baetidae), *Centroptilum*, *Isonychia*, *Acroneuria*, and *Paragnetina*.

Water quality at this site is characterized by relatively low concentrations of most chemical parameters. Aluminum is an outstanding exception at this site. Concentration of aluminum at this site is much higher than any other site in the lower part of the Wiconisco Creek Watershed in 1996. The cause of this increase in aluminum is not evident. Loads (lb/day) entering Wiconisco Creek from Little Wiconisco Creek at the time of sampling in 1996 and 1997 are summarized in the Table 19.

Table 19. Loading Rates for Chemical Parameters From Little Wiconisco Creek, September 1996 and May 1997

Parameter	1996	1997
	Pounds per day	
Acid	39.67	164.29
Al, Total	172.57	2.77
Ca	238.02	772.15
Cl	158.68	410.72
Fe, Total	1.74	9.49
Mg	60.60	195.50
Mn, Total	0.40	1.85
NH3-N, Total	0.60	0.41
Nitrogen, Total	32.01	134.72
NO3-N, Total	26.08	121.98
P, Total	0.60	0.82
SO4	188.43	821.44
TOC	34.71	123.22
TOP	0.55	0.49

CONCLUSIONS

Sampling in 1996 revealed that, according to RBP III methods, no sites on the main stem of Wiconisco Creek possessed nonimpaired biological communities. Approximately 44 percent of these sites possessed slightly impaired biological communities, while the remaining sites (56 percent) possessed moderately or severely impaired biological communities (Figure 17). There seems to be a direct correlation between biological scores and habitat scores on main stem sites, as shown in Figure 17.

In the Upper Basin, mine drainage is the major source of impacts. Increased metal loads and a low pH, as well as the associated precipitation of these metals, render portions of the headwaters of Wiconisco Creek devoid of life. Water quality improves with the addition of flow contributed by lesser-impacted tributaries in the area; also, a wetland near Tower City improves water quality by allowing precipitation of metals and uptake of nutrients by aquatic plants. The wetland is acting as a retention and settling basin for much of the iron and sulfate present in water passing through the wetland.

Sedimentation is a problem throughout the Wiconisco Creek Watershed, but the impacts can be seen easily in the Upper Basin from the headwaters to the confluence of Bear and Rattling Creeks at Lykens. The impact of Big Lick Tunnel Discharge can be seen clearly in water quality data from May 1997. Higher flows at the time of sampling, due to seasonal variations in flow, result in greater influence from this discharge.

Bear Creek is a major contributor of metals to the middle portion of Wiconisco Creek. Water in Bear Creek has high concentrations of metals, and it also has high alkalinity and pH. Metals from Bear Creek precipitate out of solution after mixing with water from Wiconisco Creek, resulting in precipitate-covered substrate immediately downstream of Bear Creek. Biological conditions directly downstream of the confluence of Bear Creek with Wiconisco Creek would be improved by removal of metals from Bear Creek.

The Rattling Creek Basin is of one of the most pristine areas in the Wiconisco Creek Watershed. Diversity and taxanomic richness of the biological community are hampered by the sterility of water, and lack of buffering capacity in the headwaters results in slightly acidic conditions. Organic materials are utilized by filter feeders immediately downstream of reservoirs near Lykens.

The Middle Basin of Wiconisco Creek near Loyalton is a transition zone in the Wiconisco Creek Watershed. The transition between mining/forest land and agricultural land is reflected in the biological conditions, physical habitat, and water quality of samples collected in this area during September 1996 and May 1997. Water quality and biological conditions improve from this site downstream, and are better than conditions in upstream areas affected by mining.

The Gratz Creek Basin is unimpaired and possesses high quality water, as well as a diverse biological community. The biological community at this site supports several pollution-intolerant genera. Water contributed to Wiconisco Creek by this tributary aids the biological recovery downstream.

The Lower Basin of Wiconisco Creek is an area of biological recovery. Buffering of impacts from the headwaters by tributaries results in healthy biological communities at the majority of Lower Basin sites, though habitat values are reduced slightly due to sedimentation from agricultural activities.

Little Wiconisco Creek is stressed by agricultural impacts such as streambank destruction in pasture areas and soil erosion in poorly managed crop areas. The addition of streambank stabilization methods and channel restoration could vastly improve the overall physical habitat, biological conditions, and water quality of the Little Wiconisco Creek Watershed.

Chemical Loading

Figure 18 (a) compares the loading of acid and alkalinity on the main stem sites in September 1996 and May 1997. Although flows are lower at headwater sites, concentrations of acid are so high that loads are comparable to sites near the mouth (with nearly 14 times the flow). The same relationship existed in September 1996 and May 1997; loads are higher in 1997 because, at the time of sampling, flows are greater. There is a noticeable increase in alkalinity between WICO 30.4 and WICO 23.6, and the most significant contributor in that section is Bear Creek. The influence of Bear Creek also can be seen in Figure 18 (b). It appears that Bear Creek has a much larger effect at higher flows (1997).

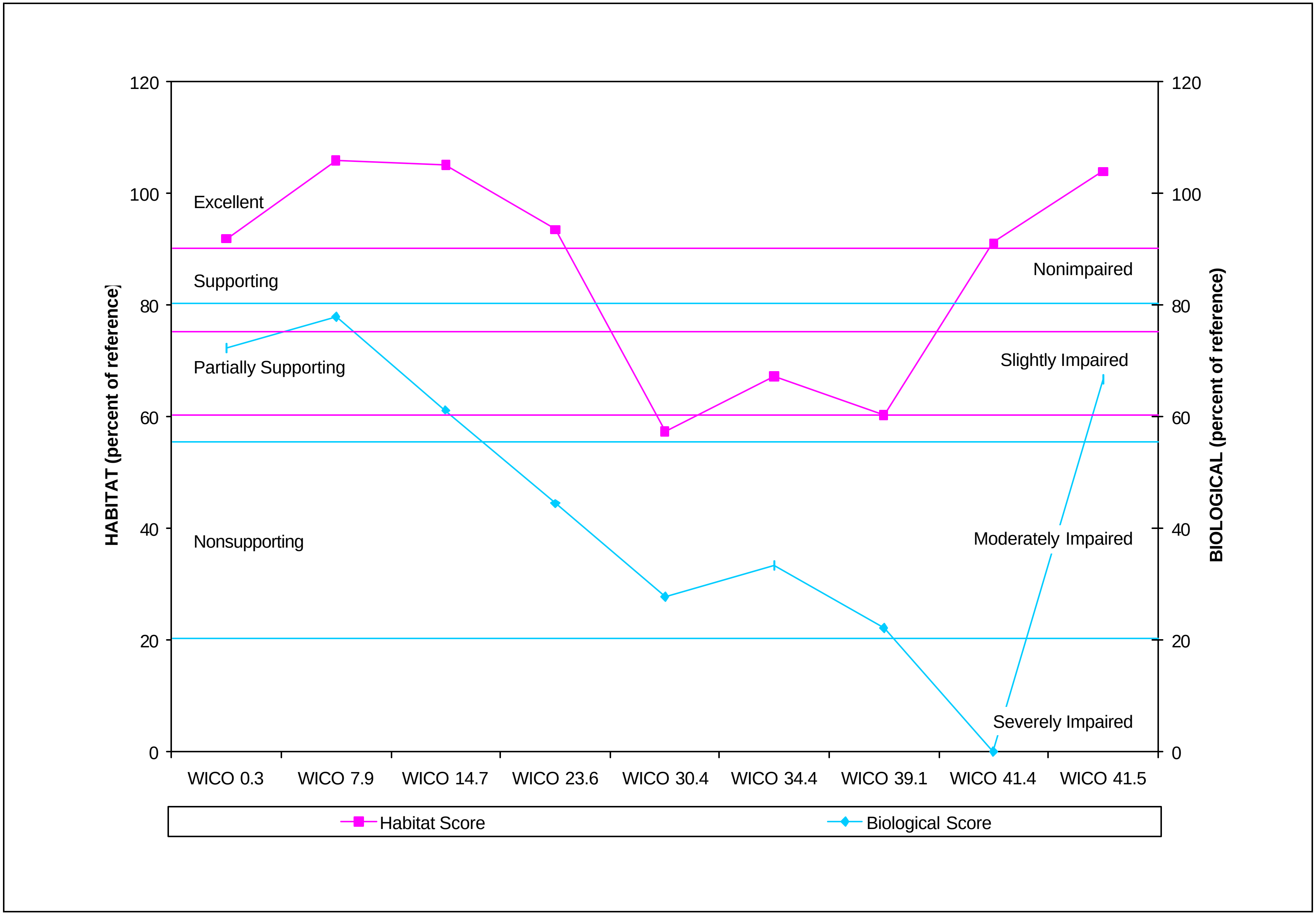


Figure 17. Habitat and Biological Scores of Main Stem Wiconisco Creek Sample Sites, 1996

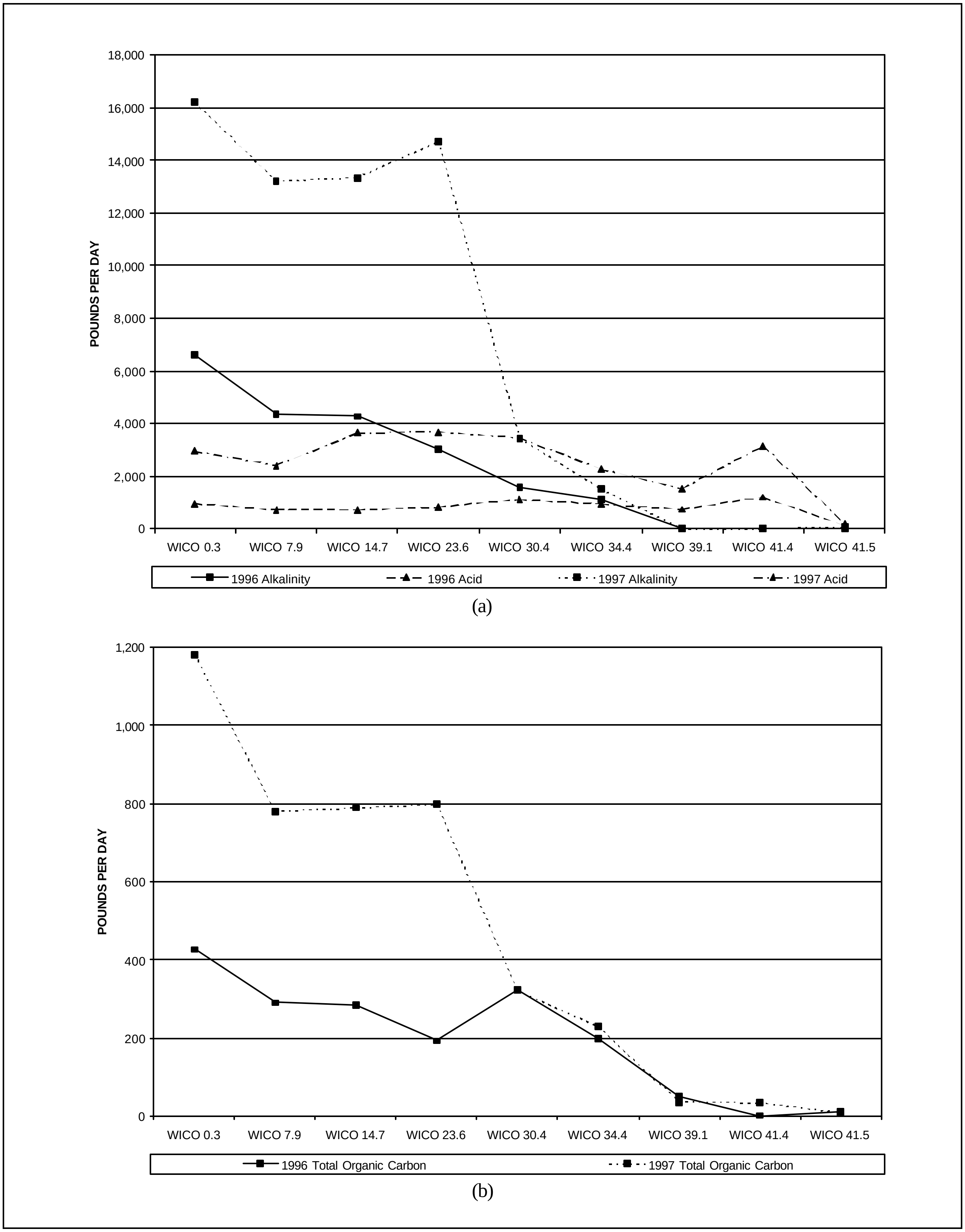


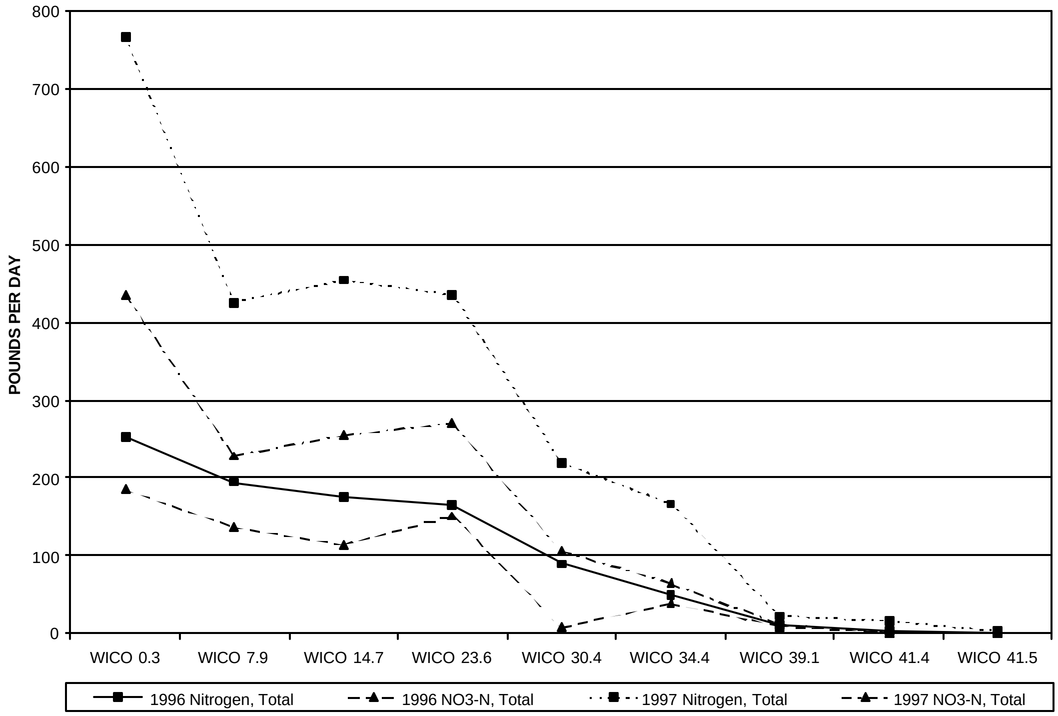
Figure 18. Comparison of Alkalinity, Acid, and Total Organic Carbon Loads at Main Stem Wiconisco Creek Sample Sites at Time of Sampling, 1996 and 1997 *(Alkalinity, as Calcium Carbonate and Acid (a) and Total Organic Carbon (b))*

The influence of Little Wiconisco Creek, entering between WICO 7.9 and WICO 0.3, is evident in Figure 18 (a and b).

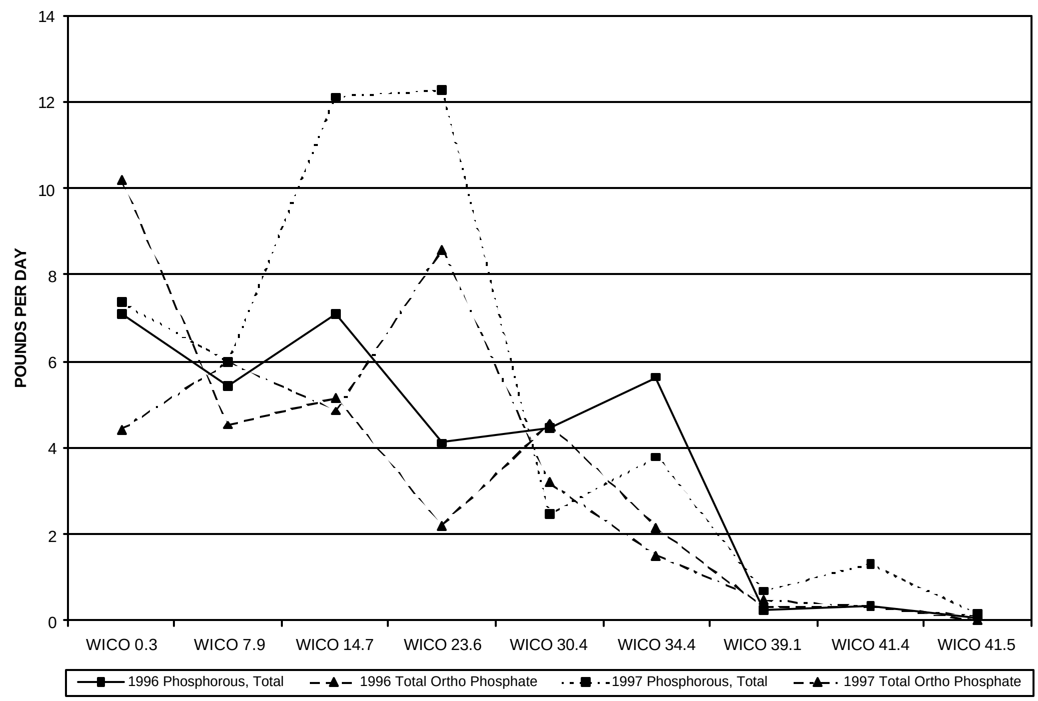
Nutrient loads, at the time of sampling in 1996 and 1997, are shown in Figure 19 (a and b). Wiconisco Creek total nitrogen and total nitrate showed an increasing trend in 1996 and 1997 (Figure 19). The most noticeable increases occur at intersections of Bear Creek and Little Wiconisco Creek with Wiconisco Creek.

Ion loads are shown in Figure 20 (a). Loads of Ca and Mg increase toward the mouth of Wiconisco Creek. Loads of ions increase most significantly in the area of land use transition (WICO 23.6). The use of fertilizers may be the cause of increased loading. Metal loads (Figure 20 (b)) indicate that Porter Tunnel discharge has the greatest impact to the stream, as revealed by the spike shown for aluminum and iron. The severity of the spikes is amplified by the fact that flow in the headwaters is much less than that at the mouth. The influx of metals from Bear Creek can be seen clearly in Figure 20 (b). Big Lick Tunnel discharges between WICO 34.4 and WICO 30.4, and the influence due to higher flow, can be seen in 1997 iron loads.

The Susquehanna River Basin Commission will conduct a full evaluation of potential remediation activities in the Wiconisco Creek Watershed as a part of year two (1998) activities under the existing Pa. DEP grant. This investigation will include an evaluation of the validity of remediation projects using Geographic Information System (GIS) based modeling.

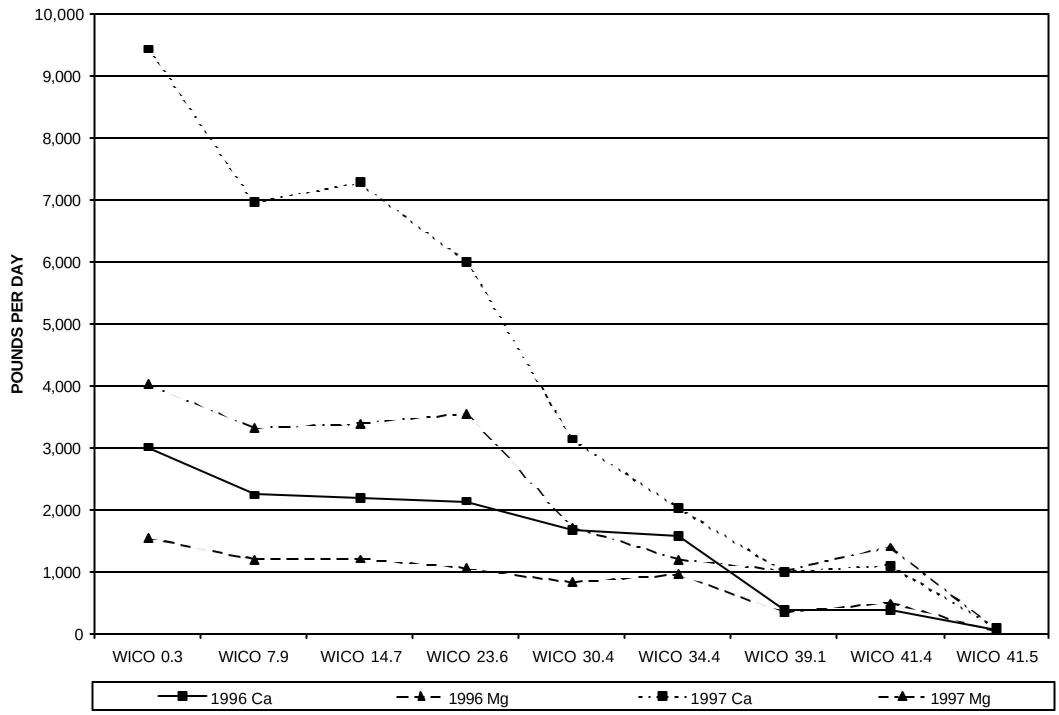


(a)

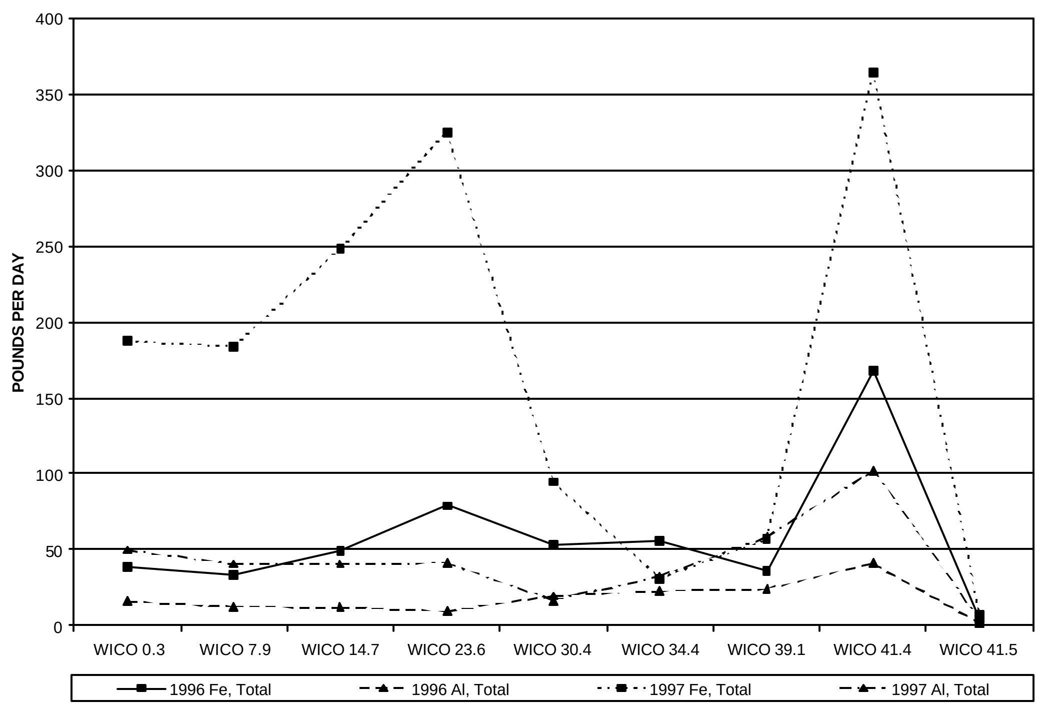


(b)

Figure 19. Comparison of Total Nitrogen, Total Nitrate, Total Phosphorus and Total Ortho Phosphate Loads at Main Stem Wiconisco Creek Sample Sites at Time of Sampling, 1996 and 1997 *(Total Nitrogen and Total Nitrate (a) and Total Phosphorus and Ortho Posphate (b))*



(a)



(b)

Figure 20. Comparison of Calcium, Magnesium, Iron, and Aluminum Loads at Main Stem Wiconisco Creek Sample Sites at Time of Sampling, 1996 and 1997 *(Calcium and Magnesium (a) and Iron and Aluminum (b))*

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Appendix A

Organic Pollution Tolerance Values and Functional Feeding Group Designations of Bethic Macroinvertebrate Taxa

Class: Order	Family	Family/*Genus*	Tolera	Trophic
Insecta: Coleoptera	**Dytiscidae**	*Agabus*	5	P
	Elmidae	*Ancyronyx variegata*	2	CG
		Dubiraphia	6	SC
		Optioservus	4	SC
		Ordobrevia	5	SC
		Stenelmis	5	SC
	Hydrophilidae	*Hydrobius*	5	P
		Laccobius	5	P
	Psephenidae	*Psephenus*	4	SC
Collembola	**Poduridae**	*Podura*	9	CG
Diptera	**Athericidae**	*Atherix*	2	P
	Ceratopogonidae	*Alluaudomyia*	6	P
	Chironomidae	**Chironomidae**	7	CG
	Empididae	*Hemerodromia*	6	P
	Simuliidae	**Simuliidae**	6	FC
	Tabanidae	*Tabanus*	5	P
	Tipulidae	*Antocha*	3	CG
		Dicranota	3	P
		Hexatoma	2	P
		Limonia	6	SH
		Limnophila	3	P
		Tipula	4	SH
Ephemeroptera	**Ameletidae**	*Ameletus*	0	CG
	Baetidae	*Acentrella*	4	CG
		Baetis	6	CG
		Centroptilum	2	CG
		Cloeon	4	CG
	Ephemerellidae	*Attenella*	2	CG
		Ephemerella	1	CG
		Serratella	2	CG
	Ephemeridae	*Ephemera*	2	CG
		Hexagenia	6	CG
	Heptageniidae	*Epeorus*	0	CG
		Leucrocuta	1	SC
		Macdunnoa	3	SC
		Nixe	2	SC
		Rhithrogena	0	CG
		Stenacron	4	CG
		Stenonema	3	SC
	Isonychiidae	*Isonychia*	2	FC
	Leptophlebiidae	*Leptophlebia*	4	CG
		Paraleptophlebia	1	CG
Hemiptera	**Veliidae**	*Microvelia*	8	P
		Rhagovelia	8	P
	Tricorythidae	*Leptohypes*	4	CG
Megaloptera	**Corydalidae**	*Corydalus*	4	P
		Nigronia	2	P
	Sialidae	*Sialis*	4	P
Odonata	**Aeshnidae**	*Boyeria*	2	P
	Calopterygidae	*Hataerina*	6	P
	Coenagrionidae	*Argia*	6	P
	Cordulegastridae	*Cordulegaster*	3	P
	Gomphidae	*Gomphus*	5	P

Class: Order	Family	Family/*Genus*	*Tolera*	Trophic
Plecoptera	**Capniidae**	*Capnia*	1	SH
		Paracapnia	1	SH
	Leuctridae	*Leuctra*	0	SH
	Nemouridae	*Amphinemura*	2	SH
	Peltoperlidae	*Peltoperla*	2	SH
	Perlidae	*Acroneuria*	0	P
		Agnetina	2	P
		Eccoptura	2	P
		Paragnetina	1	P
		Perlesta	4	P
	Perlodidae	*Isoperla*	2	P
Trichoptera	**Glossosomatidae**	*Glossosoma*	0	SC
	Hydropsychidae	*Ceratopsyche*	4	FC
		Cheumatopsyche	5	FC
		Diplectrona	0	FC
		Hydropsyche	4	FC
		Macrostemum	3	FC
		Potamyia flava	5	FC
	Philopotamidae	*Chimarra*	4	FC
		Dolophilodes	0	FC
	Phryganeidae	*Oligostomis*	2	P
	Polycentropodidae	*Neureclipsis*	7	FC
		Polycentropus	6	FC
	Psychomyiidae	*Lype diversa*	2	CG
	Rhyacophilidae	*Rhyacophila*	1	P
Oligochaeta: Haplotaxida	**Naididae**	**Naididae**	8	CG
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**	8	P
	Lymnaeidae	*Lymnaea stagnalis*	7	SC
Hirudinea: Gnathobdellida	**Hirudinidae**	**Hirudinidae**	8	P
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*	6	SH
Decapoda	**Cambaridae**	*Cambarus*	6	CG
		Orconectes	6	SH
Gastropoda: Gastropoda	**Physidae**	*Physa*	8	SC
		Physella	8	SC
	Planorbidae	*Planorbella*	6	SC
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*	8	FC

APPENDIX B

RAW BENTHIC MACROINVERTEBRATE DATA FOR 1996

Class: Order	Family	Family/*Genus*	Reference Category 67bl				
			WMHT 2.2*	WICO 0.3	WICO 7.9	WICO 14.7	WICO 23.6
Insecta: Coleoptera	**Elmidae**	*Optioservus*	2	1	2	3	
		Ordobrevia	2				
		Stenelmis	7	3	2		5
	Hydrophilidae	*Hydrobius*					
		Laccobius					
	Psephenidae	*Psephenus*	27	2	1	3	
Collembola	**Poduridae**	*Podura*					1
Diptera	**Athericidae**	*Atherix*				6	
	Ceratopogonidae	*Alluaudomyia*					
	Chironomidae	**Chironomidae**	4	13	4	18	13
	Empididae	*Hemerodromia*	7				2
	Simuliidae	**Simuliidae**		3	3		
	Tabanidae	*Tabanus*	1				
	Tipulidae	*Antocha*		1	1		
		Dicranota					
		Hexatoma	2				
		Limonia					
		Tipula					
Ephemeroptera	**Baetidae**	*Acentrella*		3	2		
		Baetis	2				
		Centroptilum		4	16		2
		Cloeon			11		
	Ephemerellidae	*Attenella*					
	Ephemeridae	*Ephemera*					
	Heptageniidae	*Epeorus*	2				
		Macdunnoa			2		
		Nixe					
		Rhithrogena		1			
		Stenacron					
		Stenonema	1	1	4	1	
	Isonychiidae	*Isonychia*	19	3	44	20	
	Leptophlebiidae	*Paraleptophlebia*				1	
Hemiptera	**Veliidae**	*Microvelia*					
		Rhagovelia	1				1
Megaloptera	**Corydalidae**	*Corydalus*		1	6	7	
		Nigronia	4		1	19	1
	Sialidae	*Sialis*	1				
Odonata	**Aeshnidae**	*Boyeria*					
	Coenagrionidae	*Argia*					
	Cordulegastridae	*Cordulegaster*					
	Gomphidae	*Gomphus*					
Plecoptera	**Capniidae**	*Capnia*					
		Paracapnia					
	Perlidae	*Acroneuria*	7	3	3		
		Agnetina	1				
		Eccoptura					
		Paragnetina		8			
	Perlodidae	*Isoperla*				1	
Trichoptera	**Glossosomatidae**	*Glossosoma*					

*Reference Site

Class: Order	Family	Family/*Genus*	Reference Category 67bl				
			WMHT 2.2*	WICO 0.3	WICO 7.9	WICO 14.7	WICO 23.6
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	14				
		Cheumatopsyche	1	6	13	23	17
		Diplectrona					
		Hydropsyche		46	44	49	41
		Macrostemum		2	2		
		Potamyia flava					
	Philopotamidae	*Chimarra*	3	20		1	4
		Dolophilodes					
	Phryganeidae	*Oligostomis*					
	Polycentropodidae	*Polycentropus*					
	Rhyacophilidae	*Rhyacophila*					
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**					
Hirudinea: Gnathobdellida	**Hirudinidae**	**Hirudinidae**	1				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*					
Decapoda	**Cambaridae**	*Cambarus*					
		Orconectes	1				
Gastropoda: Gastropoda	**Physidae**	*Physa*	1				
		Physella					
	Planorbidae	*Planorbella*					
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*	5				

*Reference Site

Class: Order	Family	Family/*Genus*	Reference Category 67bs			
			LSHM 0.8*	LWIC 0.1	LWIC 4.0	LWIC 8.4
Insecta: Coleoptera	**Elmidae**	*Optioservus*				
		Ordobrevia				
		Stenelmis	4	6	16	44
	Hydrophilidae	*Hydrobius*				3
		Laccobius				
	Psephenidae	*Psephenus*	23	2	11	4
Collembola	**Poduridae**	*Podura*				
Diptera	**Athericidae**	*Atherix*	25	2		
	Ceratopogonidae	*Alluaudomyia*				
	Chironomidae	**Chironomidae**	7	15	19	58
	Empididae	*Hemerodromia*				2
	Simuliidae	**Simuliidae**		2	4	1
	Tabanidae	*Tabanus*				
	Tipulidae	*Antocha*				
		Dicranota				
		Hexatoma				
		Limonia				
		Tipula	1			
Ephemeroptera	**Baetidae**	*Acentrella*		1		
		Baetis	11			29
		Centroptilum		1	6	
		Cloeon			2	
	Ephemerellidae	*Attenella*				
	Ephemeridae	*Ephemera*				
	Heptageniidae	*Epeorus*	1			
		Macdunnoa				
		Nixe				
		Rhithrogena				
		Stenacron				
		Stenonema			1	
	Isonychiidae	*Isonychia*	28	6	4	1
	Leptophlebiidae	*Paraleptophlebia*				
Hemiptera	**Veliidae**	*Microvelia*				
		Rhagovelia			1	2
Megaloptera	**Corydalidae**	*Corydalus*	1	2		
		Nigronia	1		1	1
	Sialidae	*Sialis*		2	1	
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*			1	2
	Cordulegastridae	*Cordulegaster*				
	Gomphidae	*Gomphus*				
Plecoptera	**Capniidae**	*Capnia*				
		Paracapnia				
	Perlidae	*Acroneuria*	2	1		
		Agnetina				
		Eccoptura				
		Paragnetina	2	6		
	Perlodidae	*Isoperla*				
Trichoptera	**Glossosomatidae**	*Glossosoma*				

*Reference Site

Class: Order	Family	Family/*Genus*	Reference Category 67bs			
			LSHM 0.8*	LWIC 0.1	LWIC 4.0	LWIC 8.4
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	25			
		Cheumatopsyche	3	29	40	7
		Diplectrona				
		Hydropsyche		45	23	7
		Macrostemum			1	
		Potamyia flava	2			
	Philopotamidae	*Chimarra*	8	5	4	1
		Dolophilodes				
	Phryganeidae	*Oligostomis*				
	Polycentropodidae	*Polycentropus*				
	Rhyacophilidae	*Rhyacophila*				
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**				
Hirudinea: Gnathobdellida	**Hirudinidae**	**Hirudinidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
Decapoda	**Cambaridae**	*Cambarus*				
		Orconectes				1
Gastropoda: Gastropoda	**Physidae**	*Physa*				
		Physella				
	Planorbidae	*Planorbella*				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

*Reference Site

Class: Order	Family	Family/*Genus*	Reference Category 67bs UNT1 0.2	UNT2 0.1	UNT3 0.1	UNT6 1.2
Insecta: Coleoptera	**Elmidae**	*Optioservus*				
		Ordobrevia				
		Stenelmis	17	3	6	47
	Hydrophilidae	*Hydrobius*				
		Laccobius				
	Psephenidae	*Psephenus*	9	15	9	20
Collembola	**Poduridae**	*Podura*				
Diptera	**Athericidae**	*Atherix*				25
	Ceratopogonidae	*Alluaudomyia*				
	Chironomidae	**Chironomidae**	23	24	25	27
	Empididae	*Hemerodromia*				
	Simuliidae	**Simuliidae**			3	3
	Tabanidae	*Tabanus*				
	Tipulidae	*Antocha*		1		
		Dicranota	2	4	1	10
		Hexatoma	1			
		Limonia				
		Tipula			1	
Ephemeroptera	**Baetidae**	*Acentrella*				
		Baetis	4	6	3	3
		Centroptilum				
		Cloeon				
	Ephemerellidae	*Attenella*				6
	Ephemeridae	*Ephemera*				2
	Heptageniidae	*Epeorus*				
		Macdunnoa				
		Nixe	1		1	
		Rhithrogena				
		Stenacron				
		Stenonema			1	19
	Isonychiidae	*Isonychia*	3		1	8
	Leptophlebiidae	*Paraleptophlebia*				1
Hemiptera	**Veliidae**	*Microvelia*	4	1		
		Rhagovelia	1	2		
Megaloptera	**Corydalidae**	*Corydalus*				1
		Nigronia	5	2	6	8
	Sialidae	*Sialis*			2	
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Cordulegastridae	*Cordulegaster*	1			
	Gomphidae	*Gomphus*				
Plecoptera	**Capniidae**	*Capnia*			1	
		Paracapnia				
	Perlidae	*Acroneuria*	1			
		Agnetina				
		Eccoptura				
		Paragnetina				
	Perlodidae	*Isoperla*				
Trichoptera	**Glossosomatidae**	*Glossosoma*	1			

NOTE: Reference site is LSHM 0.8

Class: Order	**Family**	**Family/*Genus***	Reference Category 67bs			
			UNT1 0.2	**UNT2 0.1**	**UNT3 0.1**	**UNT6 1.2**
Trichoptera	**Hydropsychidae**	*Ceratopsyche*				
		Cheumatopsyche	38	21	25	20
		Diplectrona				
		Hydropsyche	17	25	33	25
		Macrostemum				
		Potamyia flava		2		
	Philopotamidae	*Chimarra*	4	34	1	16
		Dolophilodes				
	Phryganeidae	*Oligostomis*				
	Polycentropodidae	*Polycentropus*		2	1	
	Rhyacophilidae	*Rhyacophila*				
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**				
Hirudinea: Gnathobdellida	**Hirudinidae**	**Hirudinidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
Decapoda	**Cambaridae**	*Cambarus*		1		
		Orconectes				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
		Physella				
	Planorbidae	*Planorbella*				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

NOTE: Reference site is LSHM 0.8

Class: Order	Family	Family/*Genus*	Reference Category 67bs			
			UNT8 0.7	WICO 30.4	WICO 34.4	WICO 39.1
Insecta: Coleoptera	**Elmidae**	*Optioservus*				1
		Ordobrevia				
		Stenelmis				
	Hydrophilidae	*Hydrobius*				
		Laccobius				
	Psephenidae	*Psephenus*				
Collembola	**Poduridae**	*Podura*				
Diptera	**Athericidae**	*Atherix*				
	Ceratopogonidae	*Alluaudomyia*			1	6
	Chironomidae	**Chironomidae**	81	88	26	65
	Empididae	*Hemerodromia*				
	Simuliidae	**Simuliidae**	4	7	7	1
	Tabanidae	*Tabanus*				
	Tipulidae	*Antocha*	1			
		Dicranota		1	1	
		Hexatoma		1		
		Limonia				
		Tipula		1	1	
Ephemeroptera	**Baetidae**	*Acentrella*				
		Baetis				
		Centroptilum				
		Cloeon				
	Ephemerellidae	*Attenella*				
	Ephemeridae	*Ephemera*				
	Heptageniidae	*Epeorus*				
		Macdunnoa				
		Nixe				
		Rhithrogena				
		Stenacron				
		Stenonema				
	Isonychiidae	*Isonychia*				
	Leptophlebiidae	*Paraleptophlebia*	1			
Hemiptera	**Veliidae**	*Microvelia*	2			
		Rhagovelia				
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia	3	2	2	1
	Sialidae	*Sialis*				37
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Cordulegastridae	*Cordulegaster*				
	Gomphidae	*Gomphus*				
Plecoptera	**Capniidae**	*Capnia*				
		Paracapnia				
	Perlidae	*Acroneuria*				
		Agnetina				
		Eccoptura				
		Paragnetina				
	Perlodidae	*Isoperla*				
Trichoptera	**Glossosomatidae**	*Glossosoma*				

NOTE: Reference site is LSHM 0.8

Class: Order	Family	Family/*Genus*	Reference Category 67bs			
			UNT8 0.7	WICO 30.4	WICO 34.4	WICO 39.1
Trichoptera	**Hydropsychidae**	*Ceratopsyche*				
		Cheumatopsyche	9	13		
		Diplectrona	8			
		Hydropsyche	28	17	73	
		Macrostemum			3	
		Potamyia flava				
	Philopotamidae	*Chimarra*				
		Dolophilodes				
	Phryganeidae	*Oligostomis*				3
	Polycentropodidae	*Polycentropus*				
	Rhyacophilidae	*Rhyacophila*				
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**				
Hirudinea: Gnathobdellida	**Hirudinidae**	**Hirudinidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
Decapoda	**Cambaridae**	*Cambarus*		1		
		Orconectes				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
		Physella	1			
	Planorbidae	*Planorbella*	1			
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

NOTE: Reference site is LSHM 0.8

Class: Order	Family	Family/*Genus*	Reference Category 67c			
			STON0.4*	RATL 0.4	RATL 2.6	WICO 41.5
Insecta: Coleoptera	**Elmidae**	*Optioservus*	1			
		Ordobrevia				
		Stenelmis	4		3	
	Hydrophilidae	*Hydrobius*				
		Laccobius				
	Psephenidae	*Psephenus*		4		
Collembola	**Poduridae**	*Podura*				1
Diptera	**Athericidae**	*Atherix*				
	Ceratopogonidae	*Alluaudomyia*				8
	Chironomidae	**Chironomidae**	14	16	2	41
	Empididae	*Hemerodromia*				
	Simuliidae	**Simuliidae**	6	1	1	11
	Tabanidae	*Tabanus*				
	Tipulidae	*Antocha*				1
		Dicranota			6	1
		Hexatoma		3	1	
		Limonia	1			
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*	6	3		
		Baetis	12			
		Centroptilum				
		Cloeon				
	Ephemerellidae	*Attenella*				
	Ephemeridae	*Ephemera*				
	Heptageniidae	*Epeorus*				
		Macdunnoa				
		Nixe				
		Rhithrogena		5		
		Stenacron	1			
		Stenonema	1	1		
	Isonychiidae	*Isonychia*	18			
	Leptophlebiidae	*Paraleptophlebia*				
Hemiptera	**Veliidae**	*Microvelia*				
		Rhagovelia				
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia	3		5	4
	Sialidae	*Sialis*	1			1
Odonata	**Aeshnidae**	*Boyeria*			5	
	Coenagrionidae	*Argia*				
	Cordulegastridae	*Cordulegaster*				
	Gomphidae	*Gomphus*	1			
Plecoptera	**Capniidae**	*Capnia*		1	12	4
		Paracapnia	4			
	Perlidae	*Acroneuria*	16	6		
		Agnetina				
		Eccoptura			10	
		Paragnetina				
	Perlodidae	*Isoperla*				
Trichoptera	**Glossosomatidae**	*Glossosoma*				

*Reference Site

Class: Order	Family	Family/*Genus*	Reference Category 67c			
			STON0.4*	RATL 0.4	RATL 2.6	WICO 41.5
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	13			
		Cheumatopsyche	12	3	43	6
		Diplectrona				54
		Hydropsyche		27	19	
		Macrostemum				
		Potamyia flava				
	Philopotamidae	*Chimarra*			5	
		Dolophilodes	1	72		1
	Phryganeidae	*Oligostomis*				
	Polycentropodidae	*Polycentropus*			1	
	Rhyacophilidae	*Rhyacophila*		2	7	
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**			1	
Hirudinea: Gnathobdellida	**Hirudinidae**	**Hirudinidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*	2			
Decapoda	**Cambaridae**	*Cambarus*				
		Orconectes				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
		Physella				
	Planorbidae	*Planorbella*				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

*Reference Site

Appendix C

Raw Benthic Macroinvertebrate Data for 1997

Class: Order	Family	Family/*Genus*	Reference Category 67bl			
			WICO 0.3	WICO 7.9	WICO 14.7	WICO 23.6
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Ancyronyx variegata*	1			
		Dubiraphia				
		Optioservus	2	3	21	1
		Stenelmis	3	4	2	1
	Psephenidae	*Psephenus*	2	3		
Diptera	**Athericidae**	*Atherix*		1		
	Ceratopogonidae	*Alluaudomyia*		6		
	Chironomidae	**Chironomidae**	51	51	24	61
	Empididae	*Hemerodromia*	2	4		9
	Simuliidae	**Simuliidae**	1	9		1
	Tipulidae	*Antocha*	2			
		Hexatoma				
		Limnophila				
		Tipula	2			
Ephemeroptera	**Ameletidae**	*Ameletus*				
	Baetidae	*Acentrella*				
		Baetis	3		2	
	Ephemerellidae	*Attenella*			3	
		Ephemerella	2	9		2
		Serratella				
	Ephemeridae	*Ephemera*	7			
		Hexagenia			1	
	Heptageniidae	*Epeorus*			3	1
		Leucrocuta				
		Stenacron	1			
		Stenonema	9	6	14	
	Isonychiidae	*Isonychia*	8	1		
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia				
	Tricorythidae	*Leptohypes*		1		
Megaloptera	**Corydalidae**	*Corydalus*		1		
		Nigronia			1	
	Sialidae	*Sialis*				
Odonata	**Calopterygidae**	*Hataerina*				
	Coenagrionidae	*Argia*				
Plecoptera	**Capniidae**	*Paracapnia*				
	Leuctridae	*Leuctra*				
	Nemouridae	*Amphinemura*	8			1
	Peltoperlidae	*Peltoperla*				
	Perlidae	*Acroneuria*	9			
		Agnetina				
		Perlesta				
	Perlodidae	*Isoperla*			1	
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	2	7	6	
		Cheumatopsyche	9	1	7	18
		Hydropsyche	1		34	3
	Philopotamidae	*Chimarra*	2			
		Dolophilodes				
	Polycentropodidae	*Neureclipsis*				
		Polycentropus				
	Psychomyiidae	*Lype diversa*				
	Rhyacophilidae	*Rhyacophila*				
Oligochaeta: Haplotaxida	**Naididae**	**Naididae**				4
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**				
	Lymnaeidae	*Lymnaea stagnalis*				

Class: Order	Family	Family/*Genus*	Reference Category 67bs			
			LWIC 0.1	LWIC 4.0	LWIC 8.4	UNT1 0.2
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Ancyronyx variegata*				
		Dubiraphia			1	
		Optioservus	4			1
		Stenelmis	20	2	18	3
	Psephenidae	*Psephenus*	2	8		4
Diptera	**Athericidae**	*Atherix*				
	Ceratopogonidae	*Alluaudomyia*			1	
	Chironomidae	**Chironomidae**	45	60	55	38
	Empididae	*Hemerodromia*	4		5	1
	Simuliidae	**Simuliidae**		4	9	1
	Tipulidae	*Antocha*				1
		Hexatoma				
		Limnophila				
		Tipula	1			
Ephemeroptera	**Ameletidae**	*Ameletus*				1
	Baetidae	*Acentrella*	1			
		Baetis	4	9	8	12
	Ephemerellidae	*Attenella*				
		Ephemerella			10	34
		Serratella		2		
	Ephemeridae	*Ephemera*	1			
		Hexagenia				1
	Heptageniidae	*Epeorus*				
		Leucrocuta		1		1
		Stenacron				
		Stenonema		1		
	Isonychiidae	*Isonychia*	10	1		
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia				
	Tricorythidae	*Leptohypes*				
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia	1			
	Sialidae	*Sialis*	1			
Odonata	**Calopterygidae**	*Hataerina*				1
	Coenagrionidae	*Argia*		1		
Plecoptera	**Capniidae**	*Paracapnia*				
	Leuctridae	*Leuctra*				
	Nemouridae	*Amphinemura*	1	1	7	1
	Peltoperlidae	*Peltoperla*				
	Perlidae	*Acroneuria*				1
		Agnetina	4	10		
		Perlesta				
	Perlodidae	*Isoperla*		1	1	1
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	2		2	1
		Cheumatopsyche	14	5	10	3
		Hydropsyche	1	3	1	3
	Philopotamidae	*Chimarra*	3	2		
		Dolophilodes			1	
	Polycentropodidae	*Neureclipsis*				
		Polycentropus				
	Psychomyiidae	*Lype diversa*				
	Rhyacophilidae	*Rhyacophila*				
Oligochaeta: Haplotaxida	**Naididae**	**Naididae**				
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**				
	Lymnaeidae	*Lymnaea stagnalis*				

Class: Order	Family	Family/*Genus*	Reference Category 67bs			
			UNT2 0.1	UNT3 0.1	UNT6 1.2	UNT8 0.7
Insecta: Coleoptera	**Dytiscidae**	*Agabus*		1		
	Elmidae	*Ancyronyx variegata*				
		Dubiraphia				
		Optioservus				5
		Stenelmis	1		22	
	Psephenidae	*Psephenus*	2		3	
Diptera	**Athericidae**	*Atherix*			2	
	Ceratopogonidae	*Alluaudomyia*	1	1		
	Chironomidae	**Chironomidae**	63	52	49	69
	Empididae	*Hemerodromia*			4	4
	Simuliidae	**Simuliidae**		3	1	2
	Tipulidae	*Antocha*				
		Hexatoma				
		Limnophila				1
		Tipula				4
Ephemeroptera	**Ameletidae**	*Ameletus*				
	Baetidae	*Acentrella*	1			
		Baetis	36	7		
	Ephemerellidae	*Attenella*				
		Ephemerella	1		23	
		Serratella				
	Ephemeridae	*Ephemera*				
		Hexagenia				
	Heptageniidae	*Epeorus*				
		Leucrocuta				
		Stenacron				
		Stenonema			3	
	Isonychiidae	*Isonychia*			1	
	Leptophlebiidae	*Leptophlebia*			1	
		Paraleptophlebia		2		
	Tricorythidae	*Leptohypes*				
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia				1
	Sialidae	*Sialis*				
Odonata	**Calopterygidae**	*Hataerina*				
	Coenagrionidae	*Argia*				
Plecoptera	**Capniidae**	*Paracapnia*				1
	Leuctridae	*Leuctra*			1	
	Nemouridae	*Amphinemura*	4	12		1
	Peltoperlidae	*Peltoperla*				
	Perlidae	*Acroneuria*				
		Agnetina				
		Perlesta		2		
	Perlodidae	*Isoperla*				2
Trichoptera	**Hydropsychidae**	*Ceratopsyche*			1	13
		Cheumatopsyche	1		2	
		Hydropsyche	1		2	
	Philopotamidae	*Chimarra*	2			
		Dolophilodes	6	41	6	
	Polycentropodidae	*Neureclipsis*				
		Polycentropus				
	Psychomyiidae	*Lype diversa*				
	Rhyacophilidae	*Rhyacophila*		1		
Oligochaeta: Haplotaxida	**Naididae**	**Naididae**				
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**				
	Lymnaeidae	*Lymnaea stagnalis*				

Class: Order	Family	Family/*Genus*	Reference Category 67bs		
			WICO 30.4	WICO 34.4	WICO 39.1
Insecta: Coleoptera	**Dytiscidae**	*Agabus*			
	Elmidae	*Ancyronyx variegata*			
		Dubiraphia			
		Optioservus	1		
		Stenelmis			
	Psephenidae	*Psephenus*			
Diptera	**Athericidae**	*Atherix*			
	Ceratopogonidae	*Alluaudomyia*			
	Chironomidae	**Chironomidae**	120	15	15
	Empididae	*Hemerodromia*			1
	Simuliidae	**Simuliidae**		65	
	Tipulidae	*Antocha*			
		Hexatoma			
		Limnophila		1	
		Tipula		1	
Ephemeroptera	**Ameletidae**	*Ameletus*			
	Baetidae	*Acentrella*			
		Baetis			
	Ephemerellidae	*Attenella*			
		Ephemerella			
		Serratella			
	Ephemeridae	*Ephemera*			
		Hexagenia			
	Heptageniidae	*Epeorus*			
		Leucrocuta			
		Stenacron			
		Stenonema			
	Isonychiidae	*Isonychia*			
	Leptophlebiidae	*Leptophlebia*			
		Paraleptophlebia			
	Tricorythidae	*Leptohypes*			
Megaloptera	**Corydalidae**	*Corydalus*			
		Nigronia			
	Sialidae	*Sialis*			1
Odonata	**Calopterygidae**	*Hataerina*			
	Coenagrionidae	*Argia*			
Plecoptera	**Capniidae**	*Paracapnia*			
	Leuctridae	*Leuctra*			
	Nemouridae	*Amphinemura*			
	Peltoperlidae	*Peltoperla*			
	Perlidae	*Acroneuria*			
		Agnetina			
		Perlesta			
	Perlodidae	*Isoperla*			
Trichoptera	**Hydropsychidae**	*Ceratopsyche*			
		Cheumatopsyche			
		Hydropsyche		14	1
	Philopotamidae	*Chimarra*			
		Dolophilodes			
	Polycentropodidae	*Neureclipsis*			
		Polycentropus			1
	Psychomyiidae	*Lype diversa*			
	Rhyacophilidae	*Rhyacophila*			
Oligochaeta: Haplotaxida	**Naididae**	**Naididae**		3	
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**			
	Lymnaeidae	*Lymnaea stagnalis*			

Class: Order	Family	Family/*Genus*	Reference Category 67c		
			RATL 0.4	RATL 2.6	WICO 41.5
Insecta: Coleoptera	**Dytiscidae**	*Agabus*			
	Elmidae	*Ancyronyx variegata*			
		Dubiraphia			
		Optioservus		13	
		Stenelmis			
	Psephenidae	*Psephenus*	1		
Diptera	**Athericidae**	*Atherix*			
	Ceratopogonidae	*Alluaudomyia*			
	Chironomidae	**Chironomidae**	44	8	7
	Empididae	*Hemerodromia*	1	1	1
	Simuliidae	**Simuliidae**	1	9	22
	Tipulidae	*Antocha*		1	
		Hexatoma	1		
		Limnophila			
		Tipula			
Ephemeroptera	**Ameletidae**	*Ameletus*			
	Baetidae	*Acentrella*			
		Baetis	1		
	Ephemerellidae	*Attenella*			
		Ephemerella	1		
		Serratella			
	Ephemeridae	*Ephemera*			
		Hexagenia			
	Heptageniidae	*Epeorus*	3	1	
		Leucrocuta			
		Stenacron			
		Stenonema			
	Isonychiidae	*Isonychia*			
	Leptophlebiidae	*Leptophlebia*			
		Paraleptophlebia			
	Tricorythidae	*Leptohypes*			
Megaloptera	**Corydalidae**	*Corydalus*			
		Nigronia			2
	Sialidae	*Sialis*			
Odonata	**Calopterygidae**	*Hataerina*			
	Coenagrionidae	*Argia*			
Plecoptera	**Capniidae**	*Paracapnia*			
	Leuctridae	*Leuctra*		11	
	Nemouridae	*Amphinemura*	10	44	35
	Peltoperlidae	*Peltoperla*		2	
	Perlidae	*Acroneuria*	2	2	
		Agnetina	3		
		Perlesta			
	Perlodidae	*Isoperla*			19
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	1	9	
		Cheumatopsyche			
		Hydropsyche	1		6
	Philopotamidae	*Chimarra*		1	
		Dolophilodes	35		2
	Polycentropodidae	*Neureclipsis*		1	
		Polycentropus			
	Psychomyiidae	*Lype diversa*	7	3	
	Rhyacophilidae	*Rhyacophila*		2	
Oligochaeta: Haplotaxida	**Naididae**	**Naididae**			
Hirudinea: Rhynchobdellida	**Glossiphoniidae**	**Glossiphoniidae**		1	
	Lymnaeidae	*Lymnaea stagnalis*			

Appendix D
Raw Water Quality Data From Sample Sites in the Wiconisco Creek Watershed

Sample Site	WICO 01	WICO 02	WICO 03	WICO 04	WICO 13	WICO 14	WICO 15	WICO 16
New ID	WICO 0.3	LWIC 0.1	WICO 7.9	WICO 14.7	LWIC 4.0	UNT1 0.2	UNT2 0.1	LWIC 8.4
Date	960903	960903	960903	960903	960903	960903	960903	960903
Flow (cfs)	43.94	1.84	33.647	32.97	1.668	0.149	0.375	0.558
Sed (mg/L)	1	9	2	6				
Temp (C)	19.3	18.3	19.6	20.6	20	17.9	18.8	21.4
pH (SU)	7.3	7.65	7.35	7.1	7.5	7.65	7.8	7.55
DO (umhos/cm)	7.69	7.47	8.49	7.55	7.47	8.29	8.2	7.67
Cond (mg/L)	184	229	196	175	210	209	982	211
Alk (mg/L)	28	68	24	24	56	58	110	64
Acid (mg/L)	4	4	4	4	6	6	4	4
Residue Total (mg/L)	158	176	136	164	184	182	718	198
Residue Diss (mg/L)	134	166	133	150	166	174	718	194
Nitrogen Total (mg/L)	1.066	3.228	1.074	0.994	4.19	2.226	15.428	4.198
Nitrogen Diss (mg/L)	0.826	3.206	1.024	0.844	3.532	2.186	14.138	3.972
NH3N Diss (mg/L)	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
NH3N Total (mg/L)	0.05	0.06	< 0.02	0.05	0.1	0.04	0.02	0.1
NO2N Diss (mg/L)	0.016	0.006	0.004	0.004	0.032	0.006	0.008	0.032
NO2N Total (mg/L)	0.016	0.008	0.004	0.004	0.04	0.006	0.008	0.038
NO3N Diss (mg/L)	0.71	2.63	0.75	0.62	3.4	2.08	14.03	3.4
NO3N Total (mg/L)	0.78	2.63	0.75	0.64	3.39	2.12	14.27	3.4
P Total (mg/L)	0.03	0.06	0.03	0.04	0.12	0.04	0.98	0.08
P Diss (mg/L)	0.032	0.03	0.011	0.02	0.052	0.023	0.94	0.025
DOP (mg/L)	0.043	0.032	0.012	0.016	0.056	0.025	0.9	0.022
TOC (mg/L)	1.8	3.5	1.6	1.6	3.8	2.7	5.6	3.7
Ca (mg/L)	12.7	24	12.3	12.2	20.3	22.1	26.6	21.9
Mg (mg/L)	6.46	6.11	6.53	6.73	5.68	5.54	11.2	5.89
Chl (mg/L)	8	16	7	6	14	14	69	12
SO4 (mg/L)	50	19	38	47	16	18	234	16
Fe Total (ug/L)	162	175	185	277	373	110	107	378
Fe Diss (ug/L)	16	38	18	28	55	14	19	50
Mn Total (ug/L)	54	40	44	52	108	16	28	104
Mn Diss (ug/L)	41	32	39	46	81	13	28	94
Al Total (ug/L)	< 135	17400	< 135	< 135	275	< 135	< 135	144
Al Diss (ug/L)	< 135	< 135	< 135	< 135	< 135	< 135	< 135	< 135
TOP mg/L)	0.043	0.055	0.025	0.029	0.107	0.039	0.97	0.056
Turb (NTU)	1.6	1.9	1.8	1.3	5.9	1.3	1.2	5.2

Sample Site	WICO 17	WICO 05	WICO 06	WICO 07	WICO 18	WICO 19	WICO 20
New ID	**UNT3 0.1**	**WICO 23.6**	**RATL 0.4**	**BEAR 0.4**	**UNT5 0.1**	**UNT6 1.2**	**RATL 2.6**
Date	**960903**	**960904**	**960904**	**960904**	**960904**	**960904**	**960904**
Flow (cfs)	0.107	25.498	7.212	6.57		0.357	3.574
Sed (mg/L)		1	1	27			
Temp (C)	20.6	18.5	19.3	15.1	19.7	20.4	17
pH (SU)	7.4	7.12	6.3	7.05	7.55	7.4	5.75
DO(umhos/cm)	7.24	8.11	7.91	8.72	7	6.93	8.22
Cond (mg/L)	225	175	18	298	358	103	17
Alk (mg/L)	52	22	6	72	72	38	4
Acid (mg/L)	6	6	6	16	6	4	6
Residue Total (mg/L)	250	166	24	240	272	104	34
Residue Diss (mg/L)	172	166	20	230	256	96	30
Nitrogen Total (mg/L)	5.646	1.204	0.212	0.326	5.256	0.956	0.122
Nitrogen Diss (mg/L)	5.346	0.734	0.212	0.126	4.316	0.906	0.122
NH3N Diss (mg/L)	0.03	< 0.02	0.04	0.18	<0.02	< 0.02	0.06
NH3N Total (mg/L)	0.03	< 0.02	0.04	0.28	< 0.02	0.04	0.06
NO2N Diss (mg/L)	0.006	0.004	< 0.004	0.006	0.016	0.006	< 0.004
NO2N Total (mg/L)	0.006	0.004	< 0.004	0.006	0.016	0.006	< 0.004
NO3N Diss (mg/L)	4.88	0.63	0.11	<0.04	4.2	0.7	< 0.04
NO3N Total (mg/L)	4.88	1.1	0.11	< 0.04	5.14	0.72	< 0.04
P Total (mg/L)	0.1	0.03	< 0.02	< 0.02	0.15	0.07	< 0.02
P Diss (mg/L)	0.037	0.009	0.006	0.004	0.111	0.04	0.006
DOP (mg/L)	0.035	0.009	0.006	0.02	0.094	0.038	0.007
TOC (mg/L)	2.4	1.4	< 1.0	< 1.0	2.8	2.9	1.1
Ca (mg/L)	23.2	15.5	0.878	24.5	33.8	11.2	0.42
Mg (mg/L)	6.03	7.62	0.6	20.2	6.99	2.26	0.53
Chl (mg/L)	14	5	2	1	39	4	2
SO4 (mg/L)	< 10	50	< 10	88	26	< 10	< 10
Fe Total (ug/L)	1000	575	24	4360	52	260	23
Fe Diss (ug/L)	16	44	< 50	4360	30	99	21
Mn Total (ug/L)	53	192	< 10	1870	31	38	23
Mn Diss (ug/L)	24	144	< 10	1870	29	30	22
Al Total (ug/L)	1230	< 135	< 135	< 135	< 135	< 135	< 135
Al Diss (ug/L)	< 135	< 135	< 135	< 135	< 135	< 135	< 135
TOP (mg/L)	0.066	0.016	0.008	0.028	0.155	0.065	0.007
Turb (NTU)	4.5	3.2	< 1.0	110	< 1.0	3.7	< 1.0

Sample Site	WICO 21	WICO 08	WICO 09	WICO 10	WICO 11	WICO 12	WICO 22
New ID	**BEAR 1.7**	**WICO 30.4**	**WICO 34.4**	**WICO 39.1**	**WICO 41.4**	**PORT 0.1**	**UNT7 0.9**
Date	**960904**	**960905**	**960905**	**960905**	**960905**	**960905**	**960905**
Flow (cfs)		20.716	17.417	4.881	3.189	1.661	
Sed (mg/L)		7	14	10	36	31	
Temp (C)	19.1	18.5	19.3	16.9	16.2	14.4	17.2
pH (SU)	4.35	6.55	6.45	3.9	2.7	2.5	6.05
DO (umhos/cm)	4.59	6.84	6.34	7.74	8.63	9.12	7.88
Cond (mg/L)	26	185	214	264	564	975	53
Alk (mg/L)	0	14	12	0	0	0	10
Acid (mg/L)	34	10	10	28	70	140	8
Residue Total (mg/L)	238	166	204	130	484	918	56
Residue Diss (mg/L)	226	150	188	226	490	828	36
Nitrogen Total (mg/L)	1.9	0.8	0.536	0.452	0.172	0.122	0.742
Nitrogen Diss (mg/L)	1.506	0.794	0.516	0.452	0.172	0.122	0.742
NH3N Diss (mg/L)	0.2	0.11	0.1	0.08	0.1	0.31	< 0.02
NH3N Total (mg/L)	0.2	0.11	0.12	0.08	0.1	0.31	< 0.02
NO2N Diss (mg/L)	0.006	0.014	0.026	< 0.004	< 0.004	< 0.004	< 0.004
NO2N Total (mg/L)	0.01	0.02	0.026	< 0.004	< 0.004	< 0.004	< 0.004
NO3N Diss (mg/L)	<0.04	0.68	0.39	0.35	0.07	< 0.04	0.64
NO3N Total (mg/L)	< 0.04	0.68	0.41	0.35	0.07	< 0.04	0.64
P Total (mg/L)	0.07	0.04	0.06	< 0.02	0.02	< 0.02	0.02
P Diss (mg/L)	0.01	0.02	0.012	0.007	0.006	0.009	0.02
DOP (mg/L)	0.013	0.022	< 0.002	0.007	0.003	0.005	0.011
TOC (mg/L)	67.3	2.9	2.1	1.9	< 1.0	< 1.0	2.6
Ca (mg/L)	1.85	14.8	16.8	14.5	22.1	41.6	4.2
Mg (mg/L)	0.87	7.31	10.1	12.7	28.4	53.7	1.36
Chl (mg/L)	5	7	6	4	3	2	6
SO4 (mg/L)	20	55	69	81	162	324	< 10.0
Fe Total (ug/L)	19100	481	596	1370	9780	16500	377
Fe Diss (ug/L)	5980	208	50	782	6540	13400	150
Mn Total (ug/L)	174	410	626	1080	2370	4450	34
Mn Diss (ug/L)	174	410	606	1080	2370	4150	44
Al Total (ug/L)	1230	177	241	915	2400	4430	190
Al Diss (ug/L)	583	< 135	< 135	762	2220	4040	< 135
TOP (mg/L)	0.056	0.041	0.023	0.012	0.02	0.012	0.019
Turb (NTU)	31	3.9	2.7	2.8	32	57	4.6

Sample Site	WICO 23	WICO 24	WICO 01	WICO 02	WICO 03	WICO 13	WICO 14
New ID	**UNT8 0.7**	**WICO 41.5**	**WICO 0.3**	**LWIC 0.1**	**WICO 7.9**	**LWIC 4.0**	**UNT1 0.2**
Date	**960905**	**960905**	**970512**	**970512**	**970512**	**970512**	**970512**
Flow (cfs)	0.272		136.85	7.62	111.28	3.96	0.25
Sed (mg/L)			3	7	3		
Temp (C)	19.3	16.7	13.2	13.1	13.1	16.5	14.9
pH (SU)	6.85	5.2	7.15	7.4	7.25	7.3	7.55
DO (umhos/cm)	7.51	8.26	9.05	9.27	9.83	9.62	9.27
Cond (mg/L)	186	84	135	161	132	147	208
Alk (mg/L)	30	4	22	42	22	30	52
Acid (mg/L)	10	14	4	4	4	8	8
Residue Total (mg/L)	154	84	130	116	132	114	154
Residue Diss (mg/L)	162	98	124	112	120	94	136
Nitrogen Total (mg/L)	1.38	0.192	1.04	3.28	0.71	3.6	2.99
Nitrogen Diss(mg/L)	1.376	0.172	0.89	3.12	0.57	3.41	2.93
NH3N Diss (mg/L)	< 0.02	< 0.02	<0.02	<0.02	<0.02	<0.02	<0.02
NH3N Total (mg/L)	< 0.02	< 0.02	0.02	<0.02	<0.02	0.04	0.03
NO2N Diss (mg/L)	0.006	< 0.004	0.02	0.04	0.02	0.05	0.03
NO2N Total (mg/L)	0.01	< 0.004	0.02	0.04	0.02	0.05	0.03
NO3N Diss (mg/L)	1.27	0.07	0.58	2.8	0.38	3.15	2.67
NO3N Total (mg/L)	1.27	0.09	0.59	2.97	0.38	3.28	2.67
P Total (mg/L)	0.03	< 0.02	<0.02	0.02	<0.02	0.02	0.02
P Diss (mg/L)	0.019	0.01	0.012	0.014	0.008	0.016	0.014
DOP (mg/L)	0.01	< 0.002	0.011	0.013	0.006	0.013	0.011
TOC (mg/L)	3.2	1.3	1.6	3	1.3	2.7	2.6
Ca (mg/L)	18.3	4.91	12.8	18.8	11.6	16.6	25.1
Mg (mg/L)	4.73	3.7	5.46	4.76	5.51	4.45	5.51
Chl (mg/L)	13	3	6	10	5	9	16
SO4 (mg/L)	36	15	33	20	35	14	23
Fe Total (ug/L)	319	465	254	231	306	194	187
Fe Diss (ug/L)	94	921	54	75	113	54	39
Mn Total (ug/L)	64	426	117	45	162	49	46
Mn Diss (ug/L)	64	779	91	37	162	38	34
Al Total (ug/L)	240	180	<135	<135	<135	<135	203
Al Diss (ug/L)	< 135	499	<135	<135	<135	<135	<135
TOP (mg/L)	0.01	< 0.002	0.006	0.012	0.01	0.014	0.017
Turb (NTU)	6.4	1.8	1.6	3.8	1.8	4.5	38

Sample Site	WICO 16	WICO 04	WICO 15	WICO 17	WICO 18	WICO 19	WICO 05
New ID	**LWIC 8.4**	**WICO 14.7**	**UNT2 0.1**	**UNT3 0.1**	**UNT5 0.1**	**UNT6 1.2**	**WICO 23.6**
Date	**970512**	**970513**	**970513**	**970513**	**970513**	**970513**	**970514**
Flow (cfs)	1.65	112.5	0.49		0.326	1.63	113.83
Sed (mg/L)		3					4
Temp (C)	18.6	13	12.3	12.1	12.6	12.5	10.3
pH (SU)	7.4	6.9	7.35	7.3	7.15	7.1	6.97
DO (umhos/cm)	9.24	8.13	8.01	9.02	7.68	9.27	9.03
Cond (mg/L)	143	135	223	212	344	80	130
Alk (mg/L)	26	22	68	44	56	24	24
Acid (mg/L)	4	6	8	6	4	6	6
Residue Total (mg/L)	118	88	158	156	262	90	116
Residue Diss (mg/L)	94	86	158	152	260	86	106
Nitrogen Total (mg/L)	4.45	0.75	4.59	5.93	8.64	1.23	0.71
Nitrogen Diss (mg/L)	4.21	0.67	4.52	5.93	8.08	1.19	0.63
NH3N Diss (mg/L)	<0.02	0.03	0.05	<0.02	0.06	<0.02	0.04
NH3N Total (mg/L)	0.07	0.03	0.05	<0.02	0.06	<0.02	0.04
NO2N Diss (mg/L)	0.06	0.02	0.05	0.03	0.1	0.02	0.01
NO2N Total (mg/L)	0.06	0.02	0.05	0.03	0.1	0.02	0.01
NO3N Diss (mg/L)	3.82	0.42	3.9	5.19	7.72	0.89	0.43
NO3N Total (mg/L)	3.83	0.42	4.05	5.24	7.73	0.9	0.44
P Total (mg/L)	0.03	0.02	0.04	0.03	0.14	0.03	0.02
P Diss (mg/L)	0.019	0.014	0.041	0.025	0.129	0.022	0.01
DOP (mg/L)	0.013	0.012	0.039	0.025	0.143	0.017	0.008
TOC (mg/L)	3.1	1.3	2.4	2.4	3.4	2	1.3
Ca (mg/L)	16.7	12	24.5	25.9	36.6	8.69	9.77
Mg (mg/L)	4.47	5.59	6.25	6.2	7.51	2.18	5.78
Chl (mg/L)	8	5	11	14	40	4	4
SO4 (mg/L)	13	34	24	21	22	<10	38
Fe Total (ug/L)	499	410	101	94	102	199	529
Fe Diss (ug/L)	67	50	27	25	24	65	28
Mn Total (ug/L)	87	264	30	18	19	32	282
Mn Diss(ug/L)	71	221	18	18	17	24	247
Al Total (ug/L)	425	<135	<135	<135	<135	150	<135
Al Diss (ug/L)	<135	<135	<135	<135	<135	<135	9770
TOP (mg/L)	0.021	0.008	0.061	0.033	0.158	0.022	0.014
Turb(NTU)	9.8	2.9	2.1	2.1	1.7	4	3.7

Sample Site	WICO 06	WICO 07	WICO 08	WICO 20	WICO 21	WICO 09	WICO 10
New ID	**RATL 0.4**	**BEAR 0.4**	**WICO 30.4**	**RATL 2.6**	**BEAR 1.7**	**WICO 34.4**	**WICO 39.1**
Date	**970514**	**970514**	**970514**	**970514**	**970514**	**970515**	**970515**
Flow (cfs)	43.96	8.837	45.79	10.26		35.18	12.83
Sed (mg/L)	1	25	4			4	1
Temp (C)	9.7	12.3	11.4	9.1	10.5	11.9	10.4
pH (SU)	6.5	6.65	6.65	6	4.5	6.35	3
DO (umhos/cm)	9.28	8.75	9.07	9.98	7.73	8.36	9.28
Cond (mg/L)	17	271	160	18	27	152	269
Alk (mg/L)	6	68	14	6	0	8	0
Acid (mg/L)	4	14	14	6	14	12	22
Residue Total (mg/L)	62	204	120	56	72	176	216
Residue Diss (mg/L)	60	172	130	54	60	174	214
Nitrogen Total (mg/L)	0.16	0.41	0.89	0.12	0.52	0.88	0.33
Nitrogen Diss (mg/L)	0.13	0.36	0.89	0.12	0.49	0.85	0.29
NH3N Diss (mg/L)	<0.02	0.26	0.29	<0.02	<0.02	0.27	<0.02
NH3N Total (mg/L)	<0.02	0.27	0.29	<0.02	0.02	0.29	0.02
NO2N Diss (mg/L)	<0.01	0.03	0.01	<0.01	<0.01	<0.01	<0.01
NO2N Total (mg/L)	<0.01	0.04	0.01	<0.01	<0.01	<0.01	<0.01
NO3N Diss (mg/L)	0.04	<0.04	0.43	<0.04	<0.04	0.33	0.17
NO3N Total (mg/L)	0.04	<0.04	0.43	<0.04	<0.04	0.34	0.17
P Total (mg/L)	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02
P Diss (mg/L)	0.006	0.005	0.006	0.007	0.011	0.006	0.006
DOP (mg/L)	0.006	0.003	0.004	0.004	0.004	0.002	0.002
TOC (mg/L)	<1	<1	1.3	<1	10.6	1.2	<1
Ca (mg/L)	1.15	23.9	12.7	0.671	2.26	10.7	14.2
Mg (mg/L)	0.832	20.4	6.94	0.624	1.36	6.29	14.5
Chl(mg/L)	2	1	6	2	<1	5	4
SO4 (mg/L)	<10	91	50	<10	38	44	67
Fe Total (ug/L)	38	12500	384	40	1300	165	820
Fe Diss (ug/L)	15	4300	85	40	593	109	653
Mn Total (ug/L)	20	2310	384	40	176	418	936
Mn Diss (ug/L)	20	1700	375	40	176	418	884
Al Total (ug/L)	<135	<135	<135	<135	310	171	844
Al Diss (ug/L)	1150	<135	<135	<135	210	<135	780
TOP (mg/L)	0.011	0.006	0.013	0.005	0.009	0.008	0.007
Turb (NTU)	<1	121.8	2	<1	1	1.5	<1

Sample Site	WICO 11	WICO 12	WICO 22	WICO 23	WICO 24	WICO 01	WICO 02
New ID	**WICO 41.4**	**PORT 0.1**	**UNT7 0.9**	**UNT8 0.7**	**WICO 41.5**	**WICO 0.3**	**LWIC 0.1**
Date	**970515**	**970515**	**970515**	**970515**	**970515**	**970602**	**970602**
Flow (cfs)	12.25	2.2		0.341	3.02		
Sed (mg/L)	8	15				61	240
Temp (C)	11.1	12.3	10.5	11	11.6	13.1	13
pH (SU)	2.6	2.25	6.25	6.8	6.15	6.2	6.97
DO (umhos/cm)	9.11	8.71	9.26	9.08	9.63	7.67	7.96
Cond (mg/L)	415	836	44	199	85	171	253
Alk (mg/L)	0	0	10	14	4	12	10
Acid (mg/L)	48	120	6	8	12	18	42
Residue Total (mg/L)	348	752	78	192	152	208	378
Residue Diss (mg/L)	336	752	78	192	152	144	144
Nitrogen Total (mg/L)	0.24	0.27	0.63	1.56	0.19	1.89	4.48
Nitrogen Diss (mg/L)	0.17	0.24	0.59	1.56	0.16	1.6	3.87
NH3N Diss (mg/L)	0.06	0.13	<0.02	<0.02	<0.02	0.04	0.06
NH3N Total (mg/L)	0.06	0.14	0.02	<0.02	<0.02	0.04	0.06
NO2N Diss (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.04
NO2N Total (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.05
NO3N Diss (mg/L)	<0.04	<0.04	0.41	1.3	<0.04	1.11	3.12
NO3N Total (mg/L)	<0.04	<0.04	0.42	1.3	<0.04	1.12	3.66
P Total (mg/L)	0.02	<0.02	<0.02	<0.02	<0.02	0.07	0.17
P Diss (mg/L)	0.006	0.006	0.016	0.009	0.005	0.014	0.024
DOP (mg/L)	0.004	0.002	0.01	0.009	0.002	0.01	0.028
TOC (mg/L)	<1	<1	1.2	1.1	<1	3.1	4.2
Ca (mg/L)	16.6	37.2	3.46	17.5	4.95	9.86	16.3
Mg (mg/L)	21	54.1	1.19	6.47	3.65	4	5.24
Chl (mg/L)	5	4	5	15	5	6	10
SO4 (mg/L)	105	161	<10	44	19	22	19
Fe Total (ug/L)	5520	15700	140	82	406	1760	4930
Fe Diss (ug/L)	4610	16000	71	37	175	129	100
Mn Total (ug/L)	1710	3910	48	204	328	280	392
Mn Diss (ug/L)	1680	3900	48	204	328	110	57
Al Total (ug/L)	1550	3790	<135	<135	250	1600	5570
Al Diss (ug/L)	1490	3790	<135	<135	148	<135	<135
TOP (mg/L)	0.005	0.006	0.01	0.008	0.007	0.032	0.064
Turb (NTU)	6.2	4.2	3.8	1	2.1	16.7	81.9

Sample Site	WICO 03	WICO 04	WICO 05	WICO 06	WICO 07	WICO 08	WICO 09
New ID	**WICO 7.9**	**WICO 14.7**	**WICO 23.6**	**RATL 0.4**	**BEAR 0.4**	**WICO 30.4**	**WICO 34.4**
Date	**970602**	**970602**	**970602**	**970602**	**970602**	**970602**	**970602**
Flow (cfs)							
Sed (mg/L)	43	21	31	2	24	41	40
Temp (C)	13	12.2	11.8	10.6	12.1	12.5	12
pH (SU)	6.85	6.28	6.41	6.25	6.2	6.25	6.2
DO (umhos/cm)	7.67	8.01	8.63	9.17	8.85	7.47	7.62
Cond (mg/L)	147	117	78	15	85	100	100
Alk (mg/L)	16	28	22	6	16	12	8
Acid (mg/L)	40	4	8	6	16	20	12
Residue Total (mg/L)	106	104	14	176	146	156	210
Residue Diss (mg/L)	70	94		166	116	110	160
Nitrogen Total (mg/L)	1.19	1.2	0.75	0.16	0.37	1.2	1.27
Nitrogen Diss (mg/L)	0.88	0.05	0.65	0.15	0.36	1.01	0.87
NH3N Diss (mg/L)	0.03	0.07	0.06	<0.02	0.21	0.23	0.27
NH3N Total (mg/L)	0.03	0.05	0.04	<0.02	0.21	0.21	0.28
NO2N Diss (mg/L)	<0.01	0.02	0.01	<0.01	0.02	0.02	<0.01
NO2N Total (mg/L)	0.01	0.03	0.01	<0.01	0.02	0.02	0.01
NO3N Diss (mg/L)	0.71	0.69	0.37	<0.04	<0.04	0.47	0.34
NO3N Total (mg/L)	0.71	0.7	0.37	<0.04	<0.04	0.48	0.34
P Total(mg/L)	0.05	0.05	0.04	<0.02	<0.02	0.11	0.12
P Diss (mg/L)	0.011	0.014	0.009	0.008	0.004	0.012	0.008
DOP (mg/L)	0.013	0.012	0.007	0.007	<0.002	0.004	0.004
TOC (mg/L)	2.2	1.7	1.9	1.2	1.3	2.3	2.3
Ca (mg/L)	8.43	9.18	7.28	0.75	18.1	10.24	10.9
Mg (mg/L)	4.07	4.47	3.56	0.588	15.9	4.78	5.3
Chl (mg/L)	5	6	4	2	1	5	6
SO4 (mg/L)	23	27	25	<10	74	43	42
Fe Total (ug/L)	1240	1290	2580	64	9890	2460	1140
Fe Diss (ug/L)	78	64	101	31	4070	93	102
Mn Total (ug/L)	251	256	252	27	1400	316	342
Mn Diss (ug/L)	157	186	170	27	1400	279	311
Al Total (ug/L)	608	477	561	<135	<135	1480	782
Al Diss (ug/L)	<135	<135	<135	<135	<135	<135	<135
TOP (mg/L)	0.02	0.022	0.024	0.011	0.022	0.036	0.035
Turb (NTU)	7.6	6.1	9.6	1.3	66	11.4	12.8

Sample Site	WICO 10	WICO 11	WICO 12	WICO 01	WICO 02	WICO 03	WICO 04
New ID	**WICO 39.1**	**WICO 41.4**	**PORT 0.1**	**WICO 0.3**	**LWIC 0.1**	**WICO 7.9**	**WICO 14.7**
Date	**970602**	**970602**	**970602**	**970603**	**970603**	**970603**	**970603**
Flow (cfs)							
Sed (mg/L)	85	19	15				89
Temp (C)	10.9	10.7	10.8	13.5	13.2	13.2	12.5
pH (SU)	6.05	3.2	2.2	6.4	7	7.1	6.5
DO (umhos/cm)	8.02	8.71	9.12	7.99	8.02	7.7	8.18
Cond (mg/L)	90	147	780	154	238	136	100
Alk (mg/L)	8	0	0	140	120	160	26
Acid (mg/L)	18	40	122	20	40	40	4
Residue Total (mg/L)	212	734	64	232	296	242	168
Residue Diss (mg/L)	118	716	42	78	194	108	84
Nitrogen Total (mg/L)	1.05	0.24	0.17	5.24	10.9	3.71	2.69
Nitrogen Diss (mg/L)	0.87	0.2	0.16	4.33	10.7	3.09	2.27
NH3N Diss (mg/L)	0.09	0.04	0.14	0.1	0.17	0.07	0.06
NH3N Total(mg/L)	0.09	0.04	0.14	0.08	0.18	0.07	0.04
NO2N Diss (mg/L)	<0.01	<0.01	<0.01	0.02	0.03	0.02	0.02
NO2N Total (mg/L)	0.01	<0.01	<0.01	0.03	0.05	0.02	0.03
NO3N Diss (mg/L)	0.29	0.06	<0.04	3.72	9.45	2.69	1.85
NO3N Total (mg/L)	0.29	0.08	<0.04	3.72	9.49	2.72	1.85
P Total (mg/L)	0.07	0.02	0.02	0.22	0.2	0.18	0.11
P Diss (mg/L)	0.007	0.011	0.012	0.023	0.08	0.013	0.012
DOP (mg/L)	0.004	<0.002	0.014	0.023	0.089	0.018	0.01
TOC (mg/L)	3.3	1.4	1	4.6	6.9	4.5	4.4
Ca (mg/L)	8.9	14.8	37.6	12	19.7	9.79	8.94
Mg (mg/L)	6.05	10.3	50.4	4.38	6.31	3.59	3.43
Chl (mg/L)	4	4	4	8	10	7	5
SO4 (mg/L)	53	94	213	16	24	20	19
Fe Total (ug/L)	7120	3230	16700	7390	2660	6560	7770
Fe Diss (ug/L)	152	1950	14300	173	125	188	227
Mn Total (ug/L)	561	944	3730	681	183	592	492
Mn Diss (ug/L)	504	944	3610	192	80	234	232
Al Total (ug/L)	1840	954	3700	3770	3270	2320	2070
Al Diss (ug/L)	163	815	3550	<135	<135	<135	<135
TOP (mg/L)	0.059	0.012	0.022	0.054	0.14	0.05	0.036
Turb (NTU)	525	6.7	12.2	54.6	29	48	60.9

Sample Site	WICO 05	WICO 06	WICO 07	WICO 08	WICO 09	WICO 10	WICO 11
New ID	**WICO 23.6**	**RATL 0.4**	**BEAR 0.4**	**WICO 30.4**	**WICO 34.4**	**WICO 39.1**	**WICO 41.4**
Date	**970603**	**970603**	**970603**	**970603**	**970603**	**970603**	**970603**
Flow (cfs)							
Sed (mg/L)	43	3	24	21	22	19	9
Temp (C)	12.3	10.9	12.3	12.6	12.3	11.2	11
pH (SU)	6.45		6.35	6.3	6.25	6.15	3.4
DO (umhos/cm)	8.58	9.12	8.79	7.54	7.71	8.23	8.82
Cond (mg/L)	75	17	89	104	102	98	158
Alk (mg/L)	20	6	18	14	8	12	0
Acid (mg/L)	8	6	16	20	16	22	52
Residue Total (mg/L)	86	18	110	100	98	110	126
Residue Diss (mg/L)	52	18	90	78	84	108	116
Nitrogen Total (mg/L)	0.81	0.17	0.51	0.97	1.03	1.28	0.4
Nitrogen Diss (mg/L)	0.61	0.15	0.4	0.92	0.96	1.11	0.29
NH3N Diss (mg/L)	0.04	<0.02	0.07	0.08	0.09	0.04	0.03
NH3N Total (mg/L)	0.04	<0.02	0.07	0.08	0.1	0.07	0.03
NO2N Diss (mg/L)	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NO2N Total (mg/L)	0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01
NO3N Diss (mg/L)	0.32	<0.04	<0.04	0.4	0.56	0.81	0.1
NO3N Total (mg/L)	0.35	<0.04	0.15	0.4	0.6	0.82	0.14
P Total (mg/L)	0.04	<0.02	0.02	0.04	0.04	0.02	0.02
P Diss (mg/L)	0.011	0.005	0.007	0.01	0.009	0.006	0.005
DOP (mg/L)	0.08	0.007	0.005	0.011	0.008	0.003	0.003
TOC (mg/L)	3.6	2	6.8	3.8	4.5	3.6	2.6
Ca (mg/L)	5.68	0.768	6	8.17	7.74	6.64	7.29
Mg (g/L)	2.47	0.609	4.25	3.12	3.03	3.4	5.98
Chl (mg/L)	4	2	1	5	6	4	5
SO4 (mg/L)	20	<10	30	37	39	14	50
Fe Total (ug/L)	4450	112	8910	1040	1120	2890	1950
Fe Diss (ug/L)	281	72	2580	188	230	329	1340
Mn Total (ug/L)	286	35	518	168	1690	258	621
Mn Diss (ug/L)	161	33	447	163	159	247	621
Al Total (ug/L)	866	182	430	443	573	546	633
Al Diss (ug/L)	<135	<135	173	<135	<135	177	613
TOP (mg/L)	0.03	0.015	0.013	0.037	0.029	0.024	0.016
Turb (NTU)	33	1.6	39	9.2	8.9	8.1	5.4

Sample Site	WICO 12	WICO 02	WICO 03	WICO 04	WICO 05	WICO 06	WICO 01
New ID	**PORT 0.1**	**LWIC 0.1**	**WICO 7.9**	**WICO 14.7**	**WICO 23.6**	**RATL 0.4**	**WICO 0.3**
Date	**970603**	**970604**	**970604**	**970604**	**970604**	**970604**	**970604**
Flow (cfs)							
Sed (mg/L)	15	43	46	33	15	1	55
Temp (C)	11.2	14.3	13.5	12.8	12.5	11.5	14.2
pH (SU)	2.35	7.05	7	6.7	6.55	6.2	6.65
DO (umhos/cm)	9.3	8.39	8.37	8.29	8.51	8.88	8.24
Cond (mg/L)	786	206	101	91	71	17	114
Alk (mg/L)	0	11	14	20	18	4	12
Acid (mg/L)	126	30	30	6	8	6	20
Residue Total (mg/L)	638	254	144	100	96	22	162
Residue Diss (mg/L)	616	220	124	84	78	12	102
Nitrogen Total (mg/L)	0.26	11.8	2.95	2.19	0.73	0.15	3.85
Nitrogen Diss (mg/L)	0.32	11.4	2.89	1.99	0.59	0.13	3.41
NH3N Diss (mg/L)	0.14	0.03	0.03	0.03	0.02	<0.02	0.03
NH3N Total (mg/L)	0.14	0.03	0.03	0.03	0.02	<0.02	0.03
NO2N Diss (mg/L)	<0.01	0.03	0.01	0.01	<0.01	<0.01	0.01
NO2N Total (mg/L)	<0.01	0.04	0.01	0.01	<0.01	<0.01	0.02
NO3N Diss (mg/L)	<0.04	10.1	2.21	1.65	0.39	<0.04	3
NO3N Total (mg/L)	<0.04	10.1	2.22	1.65	0.39	<0.04	3.04
P Total (mg/L)	0.02	0.06	0.05	0.03	0.02	<0.02	0.06
P Diss (mg/L)	0.008	0.025	0.007	0.009	0.007	0.006	0.013
DOP (mg/L)	0.004	0.022	0.004	0.007	0.002	0.003	0.013
TOC (mg/L)	<1	4.1	2.9	2.6	2.2	1.4	3.2
Ca (mg/L)	36.4	20.9	8.22	7.43	5.24	0.695	11.4
Mg (mg/L)	48.1	6.23	3.21	3.01	2.56	0.649	3.7
Chl (mg/L)	4	11	6	5	4	2	6
SO4 (mg/L)	345	38	31	17	15	32	19
Fe Total (ug/L)	15700	817	1840	2770	1280	75	4290
Fe Diss (ug/L)	14200	61	148	178	232	68	191
Mn Total (ug/L)	3570	96	271	249	172	31	328
Mn Diss (ug/L)	3580	53	143	139	132	31	128
Al Total (ug/L)	3560	760	500	764	277	<135	1840
Al Diss (ug/L)	3560	<135	<135	<135	<135	<135	<135
TOP (mg/L)	0.016	0.032	0.012	0.01	0.012	0.003	0.014
Turb (NTU)	11.2	10.3	18.2	22	6.2	<1	9.7

Sample Site	WICO 07	WICO 08	WICO 09	WICO 10	WICO 11	WICO 12	WICO 01
New ID	**BEAR 0.4**	**WICO 30.4**	**WICO 34.4**	**WICO 39.1**	**WICO 41.4**	**PORT 0.1**	**WICO 0.3**
Date	**970604**	**970604**	**970604**	**970604**	**970604**	**970604**	**970605**
Flow (cfs)							
Sed (mg/L)	9	13	11	7	8	20	33
Temp (C)	12.7	12.3	12.1	11	11.2	12	15.5
pH (SU)	6.5	6.35	6.3	5.8	3.2	2.5	6.75
DO (umhos/cm)	8.45	7.7	7.72	8.38	8.71	8.39	8.27
Cond (mg/L)	128	101	104	125	219	800	107
Alk (mg/L)	28	10	8	14	0	0	16
Acid (mg/L)	14	20	18	30	56	140	12
Residue Total (mg/L)	112	98	112	128	194	742	142
Residue Diss (mg/L)	110	78	110	128	190	702	124
Nitrogen Total (mg/L)	0.36	1.12	1.27	1.41	0.25	0.24	3.29
Nitrogen Diss (mg/L)	0.31	1.03	1.08	1.23	0.21	0.24	3.16
NH3N Diss (mg/L)	0.09	0.07	0.07	0.03	0.03	0.13	<0.02
NH3N Total (mg/L)	0.1	0.07	0.07	0.04	0.03	0.13	<0.02
NO2N Diss (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NO2N Total (mg/L)	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.01
NO3N Diss (mg/L)	<0.04	0.69	0.87	1.04	0.1	<0.04	2.69
NO3N Total (mg/L)	<0.04	0.69	0.88	1.05	0.11	<0.04	2.69
P Total (mg/L)	<0.02	0.03	0.02	<0.02	<0.02	<0.02	0.04
P Diss (mg/L)	0.007	0.008	0.008	0.01	0.007	0.006	0.013
DOP (mg/L)	0.002	0.003	0.02	0.002	<0.002	0.004	0.012
TOC (mg/L)	4.7	2.6	2.6	1.7	1.1	<1	2.3
Ca (mg/L)	8.39	8.26	8.03	7.7	9.5	33.6	8.23
Mg (mg/L)	6.73	3.56	3.31	4.69	9.13	44.6	3.16
Chl (mg/L)	1	5	6	5	6	3	6
SO4 (mg/L)	59	41	48	48	70	247	17
Fe Total (ug/L)	5540	911	684	878	2590	14600	1680
Fe Diss (ug/L)	3620	136	129	244	1820	12900	163
Mn Total (ug/L)	705	157	152	340	823	3850	180
Mn Diss (ug/L)	650	139	150	340	773	3850	87
Al Total (ug/L)	259	334	342	360	813	3920	741
Al Diss (ug/L)	152	<135	<135	234	747	3920	<135
TOP (mg/L)	0.002	0.008	0.011	0.005	0.005	0.01	0.006
Turb (NTU)	8.3	5.3	4.1	3.2	4.8	12.5	8.3

Sample Site	WICO 02	WICO 03	WICO 04	WICO 05	WICO 06	WICO 07	WICO 08
New ID	**LWIC 0.1**	**WICO 7.9**	**WICO 14.7**	**WICO 23.6**	**RATL 0.4**	**BEAR 0.4**	**WICO 30.4**
Date	**970605**	**970605**	**970605**	**970605**	**970605**	**970605**	**970605**
Flow (cfs)							
Sed (mg/L)	34	28	23	12	2	17	14
Temp (C)	15.9	14.4	13.6	13.4	11.9	13.5	13.1
pH (SU)	6.8	6.65		6.5	6.3	6.6	6.5
DO (umhos/cm)	8	8.27	8.22	8.37	8.67	8.28	7.65
Cond (mg/L)	197	97	90	75	18	165	107
Alk (mg/L)	24	14	12	10	4	38	16
Acid (mg/L)	12	12	12	8	6	20	12
Residue Total (mg/L)	254	102	100	92	28	170	128
Residue Diss (mg/L)	244	90	92	90	26	170	112
Nitrogen Total (mg/L)	10.4	2.44	1.88	0.69	0.19	0.41	1.13
Nitrogen Diss (mg/L)	9.94	2.32	1.75	0.63	0.15	0.37	1.01
NH3N Diss (mg/L)	0.03	0.02	0.02	0.03	<0.02	0.13	0.07
NH3N Total (mg/L)	0.03	0.02	0.02	0.03	<0.02	0.13	0.07
NO2N Diss (mg/L)	0.02	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
NO2N Total (mg/L)	0.03	0.01	0.01	<0.01	<0.01	<0.01	<0.01
NO3N Diss (mg/L)	9.38	1.89	1.42	0.39	<0.04	<0.04	0.65
NO3N Total (mg/L)	9.52	1.9	1.44	0.39	<0.04	<0.04	0.67
P Total (mg/L)	0.04	0.04	0.03	0.02	<0.02	<0.02	0.03
P Diss (mg/L)	0.016	0.011	0.009	0.009	0.008	0.007	0.008
DOP (mg/L)	0.015	0.01	0.009	0.009	0.006	0.004	0.01
TOC (mg/L)	3.1	2.1	1.9	1.8	1.3	2.7	2
Ca (mg/L)	19.5	7.66	6.78	5.29	0.739	13.4	8.86
Mg (mg/L)	5.88	3.27	3	2.72	0.674	9.3	3.77
Chl (mg/L)	11	6	5	4	2	<1	5
SO4 (mg/L)	22	18	19	19	<10	56	26
Fe Total (ug/L)	699	1680	1130	1040	67	7590	582
Fe Diss (ug/L)	40	169	106	2720	54	3240	133
Mn Total (ug/L)	60	189	168	153	28	984	167
Mn Diss (ug/L)	35	106	131	134	43	950	157
Al Total (ug/L)	789	569	285	207	<135	195	232
Al Diss (ug/L)	<135	<135	<135	<135	<135	<135	<135
TOP (mg/L)	0.019	0.011	0.011	0.01	0.004	0.006	0.006
Turb (NTU)	9.2	5.6	4.9	3.8	<1	13.5	4.8

Sample Site	WICO 09	WICO 10	WICO 11	WICO 12	WICO 01	WICO 02	WICO 03
New ID	WICO 34.4	WICO 39.1	WICO 41.4	PORT 0.1	WICO 0.3	LWIC 0.1	WICO 7.9
Date	970605	970605	970605	970605	970715	970715	970715
Flow (cfs)							
Sed (mg/L)	9	4	5	14			
Temp (C)	12.9	10.9	11.4	12.4	23.3	21.6	22.6
pH (SU)	6.25	5.95	3.6	3	7.65	7.6	7.5
DO (umhos/cm)	7.59	8.56	8.81	8.6	7.12	7.3	7.87
Cond (mg/L)	107	141	255	790	193	193	193
Alk (mg/L)	12	4	0	0	36	56	26
Acid (mg/L)	14	20	36	124	2	4	2
Residue Total (mg/L)	96	128	184	692	156	152	148
Residue Diss (mg/L)	82	128	182	690	156	136	142
Nitrogen Total (mg/L)	1.28	1.16	0.24	0.27	1.07	2.07	0.85
Nitrogen Diss (mg/L)	1.16	1.12	0.2	0.27	0.92	1.95	0.79
NH3N Diss (mg/L)	0.09	0.03	0.04	0.13	0.03	0.02	<0.02
NH3N Total (mg/L)	0.09	0.04	0.04	0.13	0.03	0.02	<0.02
NO2N Diss (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NO2N Total (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
NO3N Diss (mg/L)	0.73	0.88	0.07	<0.04	0.55	1.33	0.52
NO3N Total (mg/L)	0.74	0.88	0.07	<0.04	0.56	1.34	0.52
P Total (mg/L)	0.02	<0.02	<0.02	<0.02	0.03	0.06	0.03
P Diss (mg/L)	0.007	0.006	0.008	0.009	0.012	0.035	0.009
DOP (mg/L)	0.003	0.002	0.007	0.006	0.01	0.027	0.006
TOC (mg/L)	2.3	1.3	1	<1	2.1	3.9	1.8
Ca (mg/L)	9.17	9.84	12.6	39.2	18.2	23.1	15.9
Mg (mg/L)	3.93	6.5	13.6	52.9	10.4	5.75	8.45
Chl (mg/L)	6	5	6	3	7	12	6
SO4 (mg/L)	33	53	73	232	36	14	33
Fe Total (ug/L)	446	954	3150	15700	329	364	337
Fe Diss (ug/L)	144	362	2640	14600	32	48	26
Mn Total (ug/L)	165	473	1010	3810	76	55	66
Mn Diss (ug/L)	165	455	1010	3670	49	32	40
Al Total (ug/L)	196	439	949	3940	<200	256	<200
Al Diss (ug/L)	<135	334	949	3950	<200	<200	<200
TOP (mg/L)	0.009	0.004	0.005	0.006	0.013	0.061	0.008
Turb (NTU)	3.2	1.8	12.1	10.1	<1	9.5	2.8

Sample Site	WICO 04	WICO 05	WICO 25	WICO 06	WICO 07	WICO 08	WICO 09
New ID	**WICO 14.7**	**WICO 23.6**	**WICO 7.5**	**RATL 0.4**	**BEAR 0.4**	**WICO 30.4**	**WICO 34.4**
Date	**970715**	**970715**	**970715**	**970716**	**970716**	**970716**	**970716**
Flow (cfs)							
Sed (mg/L)							
Temp (C)	22.3	21.3	22.3	22.6	15.3	19.9	23
PH (SU)	6.8	7.55	7.35	6.05	7.05	6.9	6.1
DO (umhos/cm)	7.59	8.64	7.24	7.22	8.74	6.46	5.54
Cond (mg/L)	196	198	194	21	281	223	221
Alk (mg/L)	24	26	28	2	64	20	6
Acid (mg/L)	4	2	2	2	14	6	6
Residue Total (mg/L)	156	140	166	16	246	152	238
Residue Diss (mg/L)	148	4	156	14	220	152	214
Nitrogen Total (mg/L)	0.85	0.83	0.95	0.17	0.43	1.28	1.09
Nitrogen Diss (mg/L)	0.75	0.83	0.81	0.27	0.43	1.24	1.05
NH3N Diss (mg/L)	0.02	<0.02	<0.02	<0.02	0.27	0.12	0.17
NH3N Total (mg/L)	0.02	<0.02	<0.02	<0.02	0.27	0.12	0.17
NO2N Diss (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02
NO2N Total (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02
NO3N Diss (mg/L)	0.51	0.48	0.53	0.11	<0.04	0.76	0.51
NO3N Total (mg/L)	0.52	0.49	0.55	0.12	<0.04	0.76	0.51
P Total (mg/L)	0.04	0.03	0.03	0.02	0.02	0.04	0.04
P Diss (mg/L)	0.013	0.006	0.011	0.005	0.008	0.01	0.009
DOP (mg/L)	0.012	0.005	0.006	0.004	0.013	0.005	0.005
TOC (mg/L)	1.6	1.4	2	<1	<1	1.6	1.8
Ca (mg/L)	16	80.5	17.4	1.21	24.2	19.5	19.1
Mg (mg/L)	8.69	36.5	9.23	0.748	20.8	12.1	12.8
Chl (mg/L)	6	5	7	2	1	8	7
SO4 (mg/L)	41	74	42	<10	68	49	56
Fe Total (ug/L)	556	16200	411	63	14700	768	682
Fe Diss (ug/L)	19	15	27	53	4710	105	62
Mn Total (ug/L)	90	6180	84	14	2000	528	779
Mn Diss (ug/L)	69	136	59	<10	1990	528	779
Al Total (ug/L)	<200	13100	<200	<200	<200	<200	281
Al Diss (ug/L)	<200	200	<200	<200	<200	<200	<200
TOP (mg/L)	0.014	0.011	0.009	0.005	0.007	0.009	0.016
Turb (NTU)	4.6	4.9	3.9	<1	122.5	5.4	3.4

Sample Site	WICO 10	WICO 11	WICO 12	WICO 26	WICO 27	WICO 01	WICO 02
New ID	**WICO 39.1**	**WICO 41.4**	**PORT 0.1**	**UNT4 0.1**	**BIGL 0.7**	**WICO 0.3**	**LWIC 0.1**
Date	**970716**	**970716**	**970716**	**970716**	**970716**	**970724**	**970724**
Flow (cfs)							
Sed (mg/L)						337	107
Temp (C)	17.6	16.5	14.3	21.7	15.6	19.1	19.4
pH (SU)	3.5	3.5	2.25	7.15	8.05	5.9	6
DO (umhos/cm)	7.64	8.56	8.9	6.89	8.81	7.21	7.73
Cond (mg/L)	325	445	858	199	296	185	225
Alk (mg/L)	0	0	0	28	92	28	40
Acid (mg/L)		36	112	4	6	12	8
Residue Total (mg/L)	326	492	864	188	270	458	272
Residue Diss (mg/L)	324	476	844	182	248	134	170
Nitrogen Total (mg/L)	0.4	0.12	0.27	0.92	0.57	3.53	4.08
Nitrogen Diss (mg/L)	0.39	0.23	0.29	0.87	0.63	2.16	3.45
NH3N Diss (mg/L)	0.07	0.08	0.16	<0.02	0.32	0.1	0.23
NH3N Total (mg/L)	0.07	0.09	0.16	<0.02	0.32	0.1	0.29
NO2N Diss (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.05
NO2N Total (mg/L)	<0.01	<0.01	<0.01	<0.01	0.01	0.03	0.05
NO3N Diss (mg/L)	0.18	<0.04	<0.04	0.55	0.08	1.43	2.42
NO3N Total (mg/L)	0.18	<0.04	<0.04	0.55	0.08	1.51	2.43
P Total (mg/L)	<0.02	<0.02	<0.02	0.02	0.02	0.54	0.4
P Diss (mg/L)	0.004	0.004	0.003	0.006	0.006	0.052	0.2
DOP (mg/L)	0.002	0.002	0.002	0.004	0.002	0.04	0.201
TOC (mg/L)	<1	<1	<1	1.6	<1	5.7	14.7
Ca (mg/L)	26.5	34.1	35	18.5	30.6	14.7	18.4
Mg (mg/L)	21.7	29.6	49.4	11.9	20.4	6.46	5.26
Chl (mg/L)	4	4	3	5	1	9	14
SO4 (mg/L)	99	142	260	48	41	35	24
Fe Total (ug/L)	352	7820	15500	547	9050	13100	2680
Fe Diss (ug/L)	263	1320	13600	28	24	93	217
Mn Total (ug/L)	1650	2130	3830	98	1430	1660	235
Mn Diss (ug/L)	1650	2120	3740	75	949	68	90
Al Total (ug/L)	1170	2050	3730	<200	353	5690	2200
Al Diss (ug/L)	1030	1720	3590	<200	<200	<200	<200
TOP (mg/L)	0.003	0.011	0.009	0.008	0.012	0.065	0.233
Turb (NTU)	<1	35	20	3.8	40	174.3	48.3

Sample Site	WICO 03	WICO 04	WICO 05	WICO 06	WICO 07	WICO 08	WICO 09
New ID	**WICO 7.9**	**WICO 14.7**	**WICO 23.6**	**RATL 0.4**	**BEAR 0.4**	**WICO 30.4**	**WICO 34.4**
Date	**970724**	**970724**	**970724**	**970724**	**970724**	**970724**	**970724**
Flow (cfs)							
Sed (mg/L)	278	166	84	6	35	319	104
Temp (C)	18.5	17.8	17.4	16	16.1	17.7	17.6
pH (SU)	5.4	7	6	6.8	5.9	6.2	6
DO (umhos/cm)	7.4	7.83	7.54	7.78	8.47	6.63	5.87
Cond (mg/L)	166	133	119	28	206	143	150
Alk (mg/L)	20	16	12	4	36	12	12
Acid (mg/L)	12	8	8	4	16	8	12
Residue Total (mg/L)	390	262	160	28	150	394	224
Residue Diss (mg/L)	116	228	80	22	118	62	102
Nitrogen Total (mg/L)	3.18	2.53	1.16	0.37	0.67	1.29	1.09
Nitrogen Diss (mg/L)	2.12	1.88	0.76	0.32	0.61	0.8	0.83
NH3N Diss (mg/L)	0.09	0.07	0.03	<0.02	0.14	0.04	0.04
NH3N Total (mg/L)	0.09	0.08	0.03	<0.02	0.14	0.05	0.04
NO2N Diss (mg/L)	0.02	0.01	<0.01	<0.01	<0.01	0.01	0.01
NO2N Total (mg/L)	0.02	0.02	<0.01	<0.01	<0.01	0.02	0.01
NO3N Diss (mg/L)	1.49	1.35	0.46	0.1	0.29	0.46	0.47
NO3N Total (mg/L)	1.5	1.55	0.47	0.1	0.3	0.49	0.52
P Total (mg/L)	0.41	0.25	0.14	<0.02	<0.02	0.19	0.25
P Diss (mg/L)	0.022	0.019	0.009	0.008	0.002	0.013	0.012
DOP (mg/L)	0.016	0.016	0.008	0.005	0.005	0.007	0.008
TOC (mg/L)	5	5.2	4	5.2	2	4.1	3.9
Ca (mg/L)	13.2	10.9	9.16	1.23	13.5	11.2	11.5
Mg (mg/L)	5.98	4.04	3.8	0.827	10.1	4.34	4.46
Chl (mg/L)	7	7	4	2	<1	6	5
SO4 (mg/L)	33	31	34	<10	54	35	41
Fe Total (ug/L)	16500	10200	6950	253	15100	14000	4550
Fe Diss (ug/L)	98	113	100	89	2150	114	157
Mn Total (ug/L)	1500	844	598	100	1230	401	314
Mn Diss(ug/L)	96	148	226	83	1180	215	255
Al Total (ug/L)	4240	3310	1420	359	252	5610	1810
Al Diss (ug/L)	<200	<200	<200	<200	<200	<200	<200
TOP (mg/L)	0.021	0.021	0.018	0.011	0.007	0.039	0.02
Turb (NTU)	152.5	<1	<1	6.9	52.5	270	<1

Sample Site	WICO 10	WICO 11	WICO 12	WICO 01	WICO 02	WICO 03	WICO 04
New ID	**WICO 39.1**	**WICO 41.4**	**PORT 0.1**	**WICO 0.3**	**LWIC 0.1**	**WICO 7.9**	**WICO 14.7**
Date	**970724**	**970724**	**970724**	**970725**	**970725**	**970725**	**970725**
Flow (cfs)							
Sed (mg/L)	101	25		78	14	53	48
Temp (C)	16.4	15.8	13.7	20.5	21.4	19.9	19.4
pH (SU)	5	4.7	2.8	5.7	6.2	5.9	5.9
DO (umhos/cm)	5.85	7.63		7.59	7.89	7.83	8
Cond (mg/L)	113	121	901	173	24.9	174	170
Alk (mg/L)	2	0	0	20	32	16	16
Acid (mg/L)	20	18	96	16	8	12	6
Residue Total (mg/L)	160	98	640	184	188	116	124
Residue Diss (mg/L)	60	64	626	118	175	72	80
Nitrogen Total (mg/L)	1.57	0.68	0.29	3.28	8.82	3	2.61
Nitrogen Diss (mg/L)	1.77	0.59	0.25	2.96	7.4	2.85	2.07
NH3N Diss (mg/L)	0.04	<0.02	0.13	0.04	0.05	0.04	0.03
NH3N Total (mg/L)	0.05	<0.02	0.13	0.06	0.05	0.04	0.04
NO2N Diss (mg/L)	<0.01	<0.01	<0.01	0.02	0.03	0.01	0.02
NO2N Total (mg/L)	<0.01	<0.01	<0.01	0.03	0.04	0.02	0.02
NO3N Diss (mg/L)	0.71	0.33	0.05	2.36	5.07	2.21	1.83
NO3N Total (mg/L)	0.72	0.34	0.05	2.36	5.23	2.23	1.84
P Total (mg/L)	0.07	0.03	0.02	0.12	0.15	0.08	0.08
P Diss (mg/L)	0.01	0.01	0.011	0.022	0.09	0.016	0.014
DOP (mg/L)	0.01	0.01	0.002	0.02	0.042	0.012	0.012
TOC (mg/L)	4.7	5.2	1.2	4.2	7.6	3.7	3.6
Ca (mg/L)	7.91	71.4	32	13.5	22.2	14.1	13.3
Mg (mg/L)	3.32	3.99	40.5	4.88	5.91	5.24	4.75
Chl (mg/L)	4	4	3	8	14	7	7
SO4 (mg/L)	45	23	291	32	35	39	45
Fe Total (ug/L)	11800	3810	12200	4210	608	3470	3920
Fe Diss (ug/L)	477	714	10700	120	110	110	188
Mn Total (ug/L)	304	386	3670	316	48	291	306
Mn Diss (ug/L)	282	386	3640	45	23	102	151
Al Total (ug/L)	1810	868	3270	2190	356	867	1100
Al Diss (ug/L)	<200	370	3180	<200	<200	<200	<200
TOP (mg/L)	0.014	0.011	0.013	0.013	0.114	0.011	0.012
Turb (NTU)	87.5	15.6	35	95	12.5	61.5	29

Sample Site	WICO 05	WICO 06	WICO 07	WICO 08	WICO 09	WICO 10	WICO 11
New ID	**WICO 23.6**	**RATL 0.4**	**BEAR 0.4**	**WICO 30.4**	**WICO 34.4**	**WICO 39.1**	**WICO 41.4**
Date	**970725**	**970725**	**970725**	**970725**	**970725**	**970725**	**970725**
Flow (cfs)							
Sed (mg/L)	37	3	60	32	22	7	8
Temp (C)	19.5	17.8	18.6	18.8	18.8	17.2	17.5
pH (SU)	5.8	5.8	5.8	5.9	5.9	5.5	3.5
DO (umhos/cm)	8.56	8.2	8.8	7.42	7.05	8.5	7.48
Cond (mg/L)	153	33	196	167	165	215	416
Alk (mg/L)		4	36	8	10	4	
Acid (mg/L)		4	22	14	4	14	46
Residue Total (mg/L)	96	4	142	130	122	134	336
Residue Diss (mg/L)	70	4	96	228	106	130	330
Nitrogen Total (mg/L)	1.19	0.31	0.4	1.47	1.61	2.64	0.32
Nitrogen Diss (mg/L)	1	0.29	0.37	1.39	1.52	2.57	0.29
NH3N Diss (mg/L)	0.02	<0.02	0.13	0.04	0.05	0.05	0.05
NH3N Total (mg/L)	0.03	<0.02	0.13	0.04	0.05	0.05	0.05
NO2N Diss (mg/L)	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
NO2N Total (mg/L)	0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01
NO3N Diss (mg/L)	0.72	0.11	0.08	0.87	1.1	2.19	0.15
NO3N Total (mg/L)	0.73	0.12	0.09	0.85	1.1	2.19	0.15
P Total (mg/L)	0.06	<0.02	<0.02	0.06	0.04	<0.02	<0.02
P Diss (mg/L)	0.01	0.004	0.01	0.012	0.012	0.003	0.006
DOP (mg/L)	0.007	0.004	0.008	0.012	0.013	<0.002	0.004
TOC (mg/L)	3.4	2.6	2.4	3.6	3.4	2	1.3
Ca (mg/L)	11.1	1.61	13.3	11.7	12.3	15	18.2
Mg (mg/L)	4.6	0.932	9.46	4.38	4.73	8.81	20.3
Chl (mg/L)	6	3	<1	6	7	6	4
SO4 (mg/L)	44	16	57	50	54	71	108
Fe Total (ug/L)	3200	158	23700	1760	1260	835	4800
Fe Diss (ug/L)	140	32	1160	147	122	327	3260
Mn Total (ug/L)	338	38	1200	263	267	633	1680
Mn Diss (ug/L)	188	26	1070	220	243	579	1630
Al Total (ug/L)	678	<200	231	843	538	330	1390
Al Diss (ug/L)	<200	<200	<200	<200	<200	<200	1290
TOP (mg/L)	0.008	0.004	0.009	0.014	0.014	0.006	0.009
Turb (NTU)	20	4.3	122.5	17.8	13.5	3	17.3

Sample Site	WICO 12	WICO 01	WICO 02	WICO 03	WICO 04	WICO 05	WICO 06
New ID	**PORT 0.1**	**WICO 0.3**	**LWIC 0.1**	**WICO 7.9**	**WICO 14.7**	**WICO 23.6**	**RATL 0.4**
Date	**970725**	**970728**	**970728**	**970728**	**970728**	**970728**	**970728**
Flow (cfs)							
Sed (mg/L)	21	5	8	4	6	4	0
Temp (C)	14.1	25.5	25.9	24.4	23.3	22.8	23
pH (SU)	3	5.8	6.1	6.1	6.1	7.1	5.9
DO (umhos/cm)	7.86	9.17	8.83	8.52	8.61	10.03	9.25
Cond (mg/L)	1031	213	266	200	221	216	29
Alk (mg/L)		22	40	20	40	20	4
Acid (mg/L)	116	4	10	8	8	4	4
Residue Total (mg/L)	768	110	154	114	114	104	20
Residue Diss (mg/L)	754	106	150	110	106	94	20
Nitrogen Total (mg/L)	0.31	4.45	8.52	3.05	2.43	1.19	0.24
Nitrogen Diss (mg/L)	0.27	4.45	7.22	2.97	2.37	1.19	0.23
NH3N Diss (mg/L)	0.15	<0.02	<0.02	0.02	<0.02	<0.02	<0.02
NH3N Total (mg/L)	0.15	<0.02	<0.02	0.02	<0.02	<0.02	<0.02
NO2N Diss (mg/L)	<0.01	<0.01	0.02	0.01	<0.01	<0.01	<0.01
NO2N Total (mg/L)	<0.01	<0.01	0.02	0.01	<0.01	<0.01	<0.01
NO3N Diss (mg/L)	0.04	2.77	6.01	2.48	1.96	0.88	0.07
NO3N Total(mg/L)	0.05	2.98	6.04	2.48	1.96	0.88	0.07
P Total (mg/L)	<0.02	0.03	0.06	0.03	0.04	0.02	<0.02
P Diss (mg/L)	0.011	0.016	0.04	0.013	0.015	0.006	0.008
DOP (mg/L)	0.012	0.013	0.04	0.012	0.014	0.01	0.009
TOC (mg/L)	<1	2.8	4.1	2.5	2.2	1.8	1.4
Ca (mg/L)	38.5	18.4	24.2	18.3	17.6	16	1.19
Mg (mg/L)	60	5.99	5.82	6.4	6.76	6.75	0.675
Chl (mg/L)	4	11	15	11	10	7	2
SO4 (mg/L)	262	43	23	37	41	48	<10
Fe Total (ug/L)	15700	12800	239	12500	660	751	50
Fe Diss (ug/L)	13500	41	32	20	42	33	22
Mn Total (ug/L)	4600	3170	26	1630	115	189	12
Mn Diss(ug/L)	4380	29	14	42	99	166	12
Al Total (ug/L)	4070	1050	<200	415	<200	<200	<200
Al Diss (ug/L)	3870	<200	<200	<200	<200	<200	<200
TOP (mg/L)	0.015	0.009	0.05	0.008	0.01	0.01	0.011
Turb (NTU)	38	2.6	8.4	5.7	6.2	5.8	<1

Sample Site	WICO 07	WICO 08	WICO 09	WICO 10	WICO 11	WICO 12
New ID	**BEAR 0.4**	**WICO 30.4**	**WICO 34.4**	**WICO 39.1**	**WICO 41.4**	**PORT 0.1**
Date	**970728**	**970728**	**970728**	**970728**	**970728**	**970728**
Flow (cfs)						
Sed (mg/L)	29	8	8	3	13	19
Temp(C)	18.9	21.9	22.3	19.2	18.5	18.5
pH (SU)	6.7	5.9	5.9	4.1	3.4	2.9
DO (umhos/cm)	10.18	7.54	7.79	9.43	9.81	10.78
Cond (mg/L)	310	233	232	320	576	1032
Alk (mg/L)	60	16	12		0	0
Acid (mg/L)	20	10	8	22	28	128
Residue Total (mg/L)	202	148	162	224	352	790
Residue Diss (mg/L)	176	138	156	224	344	788
Nitrogen Total (mg/L)	0.41	1.6	1.57	1.7	0.31	0.33
Nitrogen Diss (mg/L)	0.4	1.55	1.52	1.68	0.21	0.25
NH3N Diss mg/L)	0.24	0.08	0.14	0.07	0.08	0.16
NH3N Total (mg/L)	0.24	0.08	0.14	0.07	0.08	0.16
NO2N Diss (mg/L)	<0.01	0.02	0.01	<0.01	<0.01	<0.01
NO2N Total (mg/L)	<0.01	0.02	0.02	<0.01	<0.01	<0.01
NO3N Diss (mg/L)	0.04	1.15	1.09	1.35	0.05	<0.04
NO3N Total (mg/L)	0.04	1.16	1.09	1.35	0.05	<0.04
P Total (mg/L)	<0.02	0.04	0.04	<0.02	<0.02	<0.02
P Diss (mg/L)	0.006	0.012	0.012	0.011	0.008	0.008
DOP (mg/L)	0.01	0.011	0.013	0.004	0.004	0.003
TOC (mg/L)	1	2.2	2.3	1.5	1	<1
Ca (mg/L)	24.1	18.9	15	19.6	24.4	39.7
Mg (mg/L)	19.3	7.66	7.7	15.8	27.9	60.3
Chl (mg/L)	<1	9	9	6	4	4
SO4 (mg/L)	70	64	55	94	150	278
Fe Total (ug/L)	2300	1150	542	524	7140	16900
Fe Diss (ug/L)	3520	94	53	436	5940	15300
Mn Total (ug/L)	3180	269	320	1110	2220	4390
Mn Diss (ug/L)	1720	276	313	1070	2210	4250
Al Total (ug/L)	1180	225	<200	1050	2090	4460
Al Diss (ug/L)	<200	200	<135	946	2060	4280
TOP (mg/L)	0.008	0.016	0.011	0.004	0.005	0.007
Turb (NTU)	109.2	6.9	9.5	1.4	26	8.9

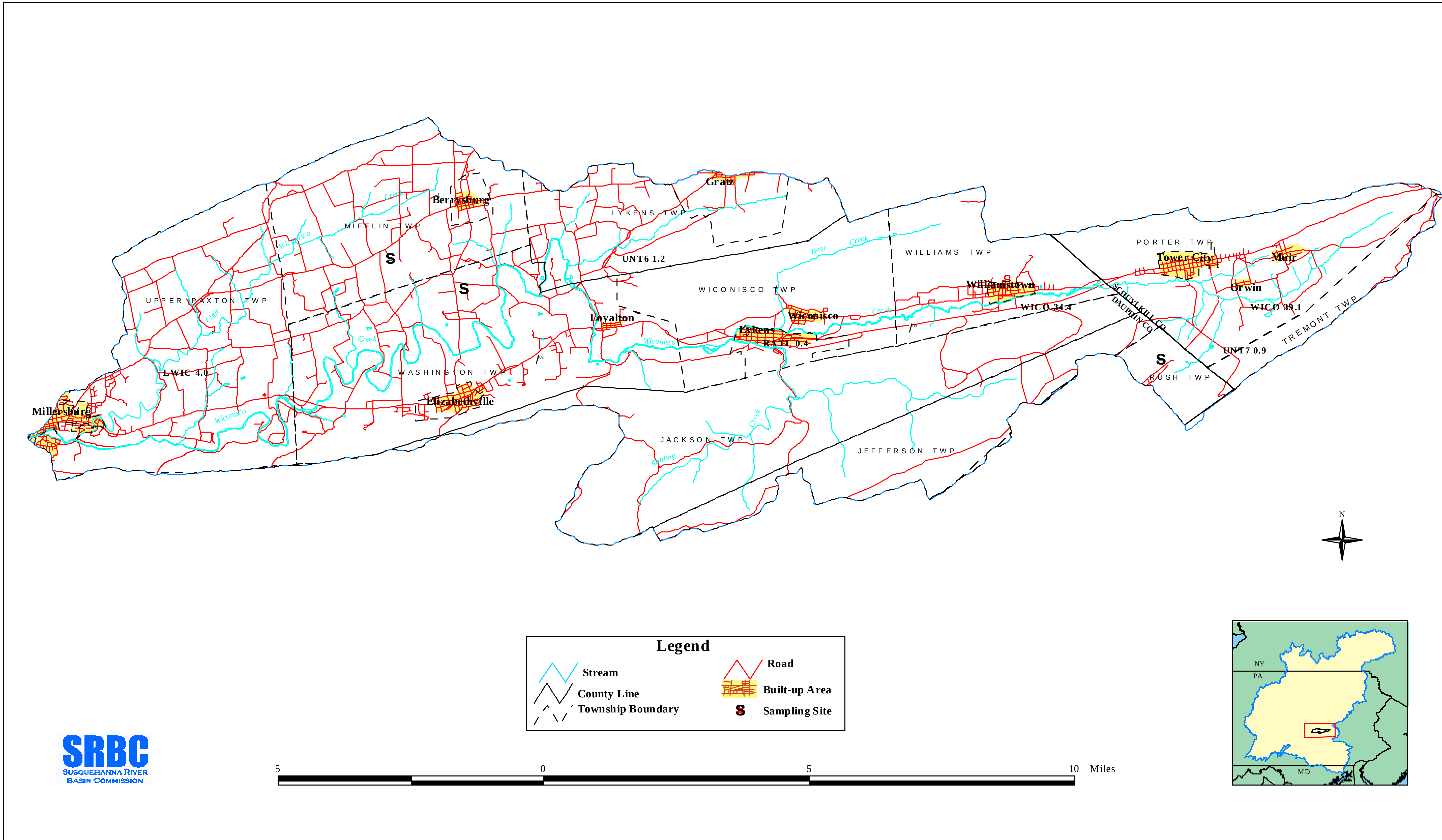

Plate 1. Map Showing Sample Site Locations in the Wiconisco Creek Watershed