0120-FM-PY0004 Rev. 3/2003

COMMONWEALTH OF PENNSYLVANIA
ENVIRONMENTAL QUALITY BOARD

PETITION FORM

I. PETITIONER INFORMATION

Name: Brodhead Watershed Association, Tobyhanna Creek Tunkhannock Creek Watershed Association, Brodhead Chapter of Trout Unlimited, Swiftwater Preserve, Buck Hill Conservancy

Mailing Address: c/o Brodhead Watershed Association
PO Box 339
Henryville, PA 18332

Telephone Number: 570-839-1120

Date: June 25, 2007

II. PETITION INFORMATION

A. The petitioner requests the Environmental Quality Board to (check one of the following):

☐ Adopt a regulation

☒ Amend a regulation (Citation 25 Pa. Code 93.9c)

☐ Repeal a regulation (Citation)

Please attach suggested regulatory language if request is to adopt or amend a regulation.

B. Why is the petitioner requesting this action from the Board? (Describe problems encountered under current regulations and the changes being recommended to address the problems. State factual and legal contentions and include supporting documentation that establishes a clear justification for the requested action.)

See attached petition pages 1 - 2

C. Describe the types of persons, businesses and organizations likely to be impacted by this proposal.

See attached petition pages 3- 4

D. Does the action requested in the petition concern a matter currently in litigation? If yes, please explain.

For section D, see attached petition page 4

For section E, numbers 1 - 9 see attached petition pages 4 - 10.

E. For stream redesignation petitions, the following information must be included for the petition to be considered complete. Attach supporting material as necessary.

1. A clear delineation of the watershed or stream segment to be redesignated, both in narrative form and on a map.
2. The current designated use(s) of the watershed or segment.
3. The requested designated use(s) of the watershed or segment.
4. Available technical data on instream conditions for the following: water chemistry, the aquatic community (benthic macroinvertebrates and/or fishes), or instream habitat. If such data are not included, provide a description of the data sources investigated.
5. A description of existing and proposed point and nonpoint source discharges and their impact on water quality and/or the aquatic community. The names, locations, and permit numbers of point source discharges and a description of the types and locations of nonpoint source discharges should be listed.
6. Information regarding any of the qualifiers for designation as high quality waters (HQ) or exceptional value waters (EV) in §93.4b (relating to qualifying as High Quality or Exceptional Value waters) used as a basis for the requested designation.
7. A general description of land use and development patterns in the watershed. Examples include the amount or percentage of public lands (including ownership) and the amount or percentage of various land use types (such as residential, commercial, industrial, agricultural and the like).
8. The names of all municipalities through which the watershed or segment flows, including an official contact name and address.
9. Locational information relevant to items 4-8 (except for contact names and addresses) displayed on a map or maps, if possible.

All petitions should be submitted to the
Secretary of the Department of Environmental Protection
P.O. Box 2063
Harrisburg, PA 17105-2063

A. The petitioner requests the Environmental Quality Board to
☒ **Amend a regulation** **(Citation** 25 Pa. Code § 93.9c.)

B. Why is the petitioner requesting this action from the Board?

The petitioners are requesting an amendment to the regulation that designates the upper Swiftwater Creek and all of its tributaries, including the Indian Run, as a High Quality Cold Water Fishery (HQ-CWF). This current designation does not accurately reflect the exceptional quality of the waters within this pristine watershed. Although the current designation affords special protection to the Swiftwater Creek, it may allow for discharges to degrade the quality of the water if a social or economic justification can be provided by a permit applicant. The redesignation of this watershed to Exceptional Value (EV) will allow only non-degrading discharges into its waters, thus protecting the existing water quality with no exceptions.

Increases in development are anticipated to occur within the upper Swiftwater Creek watershed. The redesignation of the upper Swiftwater Creek to EV will not prevent or hinder development from occurring in the watershed. Rather, it will encourage better planning of future developments, thus protecting the ecology of the stream and maintaining water quality.

The upper Swiftwater Creek and Indian Run are headwater tributaries in the Paradise watershed, a sub-watershed of the Brodhead watershed that drains into the Delaware River (Drainage List C.) The Delaware Water Gap formed at the exact point where the Brodhead watershed drains into the Delaware River.

Like the nearby Buck Hill Creek, which was redesignated from HQ to EV, Indian Run and Swiftwater Creek emanate from acidic swamps and bogs in the Glaciated Pocono Plateau region. The Pocono Plateau is 1300 feet in elevation higher than the elevation of the Delaware Water Gap, and the Plateau has a history of flooding the lowlands near the Delaware Water Gap dating back to the melting of the Wisconsin Glacier 12,000 years ago. Geologically, the Pocono Plateau is considered an upland that is a part of the Catskill formation of mountains extending into New York State, while the nearby Kittatiny Ridge at the Delaware Water Gap is considered part of the Appalachian Ridge and Valley system of mountains.

There is a substantial body of data and studies indicating that the upper Swiftwater Creek and Indian Run qualify for EV protection. Physical, chemical, and biological data sampled annually by the Monroe County Planning Commission demonstrate that these two streams maintain optimal to nearly optimal water quality. Indian Run, having optimal water quality, is the coldest stream in Monroe County based on this county-wide study. According to the a letter to DEP written by the former owner of Pocono Manor, James Ireland, Kettle Spring on Indian Run, has been a source of drinking water for the Pocono Manor community since its establishment in 1902. (**See AppendixY for 1930 era map with location of Kettle Spring and Ireland letter.)**

In the 2005 and 2006 County Water Quality studies, Indian Run (INDIRU01) scored 33 and 29 respectively. The two Swiftwater Creek stations in the stream segment of interest (SWIFCR03 and SWIFCR07) scored 27 and 29 in 2005 and both scored 27 in 2006. A score of 31 to 35 is considered optimal. It is important to note that the County does not test the Swiftwater Creek from its headwaters to the Pocono Manor Sewage Treatment plant; the County only tests downstream from the plant. **(See Figure E-9 Appendix D for site locations.)**

Another study of the same region, the Brodhead Watershed River Conservation Plan, completed in 2002 with funding from the Department of Conservation and Natural Resources identified as a primary goal, "maintain and improve water quality and quantity throughout the watershed and insure that an adequate quantity of surface water and groundwater is maintained." And an action item under this goal is to "protect headwaters areas."

As a next step beyond the River Conservation Plan, the Brodhead Watershed Association obtained a Growing Greener grant from the Department of Environmental Protection to conduct a study of the Paradise Watershed – the recently completed Paradise Watershed Restoration and Protection Project. This study compiled all existing water quality and quantity data in the Paradise watershed and, for over a year, conducted additional water quality monitoring. The data compiled and collected for the Paradise WRPP are included with, and form the basis for our presenting this petition. **(See Appendix H.)**

The Paradise Watershed Management Plan included in its Action Plan, "sustain existing water quality where it is better than state standards," (i.e. where the water quality is actually better than the stream's designated use as defined in 25 Pa. Code §93.9c.)

The Brodhead Watershed Association has conducted volunteer monitoring of Swiftwater Creek and Indian Run since 1991 as part of its watershed-wide volunteer Streamwatch program. **A summary of the BWA data for the upper Swiftwater Creek and Indian Run is included in Appendix V.**

The Monroe County Planning Commission and Conservation District have jointly conducted annual water quality monitoring for more than ten years. **The data collected in the 2005 and 2006 studies are included in Appendices E and F.**

The studies enumerated above show that water quality in the upper Swiftwater Creek and Indian Run meet or exceed the standards required for EV designation. In order to assure that existing water quality is maintained, the petitioners are requesting that the streams be redesignated as EV.

Furthermore, the entire Brodhead Watershed has a long history as a fly fishing mecca. Ultimately, the Swiftwater Creek flows into the Paradise Creek just upstream of the village of Henryville. In 1880, according to "Remembrance of Rivers Past," by Ernest Schweibert (1972), Grover Cleveland and Benjamin Harrison were simultaneously registered at the Henryville House, a fly fishing hotel on the Paradise Creek, during the week before their election campaign. Theodore Roosevelt and his friend and advisor Gifford Pinchot were also

registered to fish at the Henryville House. Schweibert writes in his book that Paradise Creek deserves to share credit with the Catskills as the "birthplace of American fly-fishing." Petitioners believe this historic watershed should be preserved for current and future generations of fly fishers.

C. Describe the types of persons, businesses and organizations likely to be impacted by this proposal.

The largest landowner in the stream segment of interest is the Pocono Manor Golf Resort and Spa, purchased in 2005 by Pocono Manor Investors, LLC. Pocono Manor is an historic resort that was originally founded by Quakers from Philadelphia in 1902. The resort is located on 3,500 acres, offering fishing, sporting clays and golf. The entire Pocono Manor property was named a National Historic District in 1997 by the U.S. Department of the Interior. **Historical information and marketing materials from the Pocono Manor property are included in Appendix X.**

Pocono Manor's marketing material boasts of its 2 ½ miles of classic mountain trout stream with "deep runs, free-running riffles, mossy banks and small pools with a consistent cool seasonal flow. A heavy canopy of hemlock provides an abundance of cover for the bountiful hatches and a healthy population of rowdy native brown trout." Pocono Manor will be positively impacted by this proposal because of the overwhelming public support for the protection of clean streams in the Poconos, and because of the importance of clean streams to Pocono Manor's business.

Pocono Manor Investors, LLC is proposing to build a casino on the Pocono Manor property. Pocono Manor Investors, LLC was not awarded a license in 2007 and has appealed the decision of the Gaming Commission. If it is awarded a license in the future and if the casino is developed, an increased discharge to the upper Swiftwater Creek may be proposed, although the current plan is to use a non-discharge alternative. If an increased discharge is proposed, Pocono Manor Investors LLC will be impacted by the proposed EV classification because any increased discharge would have to meet or exceed existing water quality.

The Sanofi Pasteur manufacturing facility, the largest manufacturer of vaccines in the United States, is located on the Swiftwater Creek immediately downstream of the stream segment of interest. Sanofi Pasteur will be positively impacted by this proposal in that it will continue to have a beautiful, unpolluted stream flowing through its several hundred acre campus if the stream is redesignated EV. Indeed, Sanofi stocks the stream with trout and allows employees to participate in fishing contests on the campus. Sanofi also is constantly improving and monitoring the quality of the fish habitat of the stream segment it abuts.

Monroe County's largest school district, Pocono Mountain, currently discharges effluent from its sewage treatment facility into the Swiftwater Creek below the stream segment of interest. Petitioners believe it is in the best interest of the school district, from a public relations standpoint, to be concerned about the water quality of a stream into which it discharges.

The Indian Run Fishing Club, a private fishing club with exclusive rights to fish Indian Run, will be greatly impacted in a positive way, in that it will be able to continue to rely on the excellent quality of that stream for its recreational use, as will residents of Pocono Manor who have been fly fishing in the upper Swiftwater Creek since Pocono Manor's inception in 1902.

The Swiftwater Preserve fishing club is located immediately downstream of Sanofi Pasteur. The Lake Swiftwater Club, farther downstream, uses the Swiftwater Creek as a source of water for a small man-made lake. Petitioners believe that members of these two clubs who swim in that lake or fish in the stream will be positively impacted by any and all efforts by their upstream neighbors to maintain the exceptional water quality in the Swiftwater Creek. The Henryville Flyfishers are another fishing club on the Paradise Creek below the Swiftwater confluence that will also benefit from stronger headwater protection.

D. Does the action requested in the petition concern a matter currently in litigation?

The requested action does not concern a matter currently in litigation to the petitioners' knowledge. The appeal of the decision of the Gaming Commission by Pocono Manor Investors, LLC, is unrelated to the issue of stream designation.

E. Supporting material

1) <u>Description of upper Swiftwater Creek Watershed including Indian Run</u>

The upper Swiftwater Creek watershed is located on USGS 7.5 minute Quadrangles for Pocono Pines and Mount Pocono and the watershed spans parts of the municipalities of Tobyhanna Township, Pocono Township, Paradise Township, and Mount Pocono Borough. **(See Figure E-1 Appendix A.)**

The Swiftwater Creek is a 13.5 km (8.4 mile) tributary to Forest Hills Run, which is a tributary to Paradise Creek near Henryville, Pennsylvania, which is a tributary to Brodhead Creek and ultimately the Delaware River Watershed, Drainage List C. It is a part of the Paradise Creek sub-watershed which drains an area of 44.5 square miles as part of the larger Brodhead Watershed. **(See Appendix W Paradise Creek Subwatershed.)**

Swiftwater Creek originates on the Pocono Plateau near the Interstate 380 and Route 940 interchange west of Mount Pocono. The Swiftwater Creek begins at an elevation of 1820 feet above sea level. It is a high gradient stream that descends 680 feet in elevation in approximately 4.5 miles from its source to its intersection with Route 611, an elevation of 1140 feet above sea level.

Indian Run, a tributary of approximately two miles, originates on the Pocono Plateau at elevation 1760 feet near the railroad line in Pocono Summit. Indian Run joins the upper Swiftwater Creek just upstream of Swiftwater, Pennsylvania, west of the Route 314 and Route 611 intersection.

The upper Swiftwater Creek watershed, for which the petitioners are requesting redesignation, is the 4.5 mile stream segment from its source in Pocono Summit to where it crosses under Route 611, just upstream from the Sanofi Pasteur manufacturing plant in Swiftwater, and the approximately two mile long Indian Run from its source in Pocono Summit to where it joins the Swiftwater Creek north of Route 314. The segment of the Swiftwater Creek that flows through the Sanofi Pasteur property is not included in this request for redesignation.

Regarding habitat, the Swiftwater Creek originates amongst forested wetlands perched on the topographically flat Pocono Plateau in Tobyhanna Township. These wetlands contain tree species including red oak, eastern hemlock, red maple, white pine, and ash. Highbush blueberry shrubs are also found in this swamp. From the point at which a defined channel for the Swiftwater Creek can be identified to downstream stretches of this watercourse, the steep banks and surrounding steep slopes prevent the collection of surface waters. Therefore, water drains quickly to the Swiftwater Creek via overland and underground flow.

The cold temperature of the waters within this watershed is maintained by the year-round shade of evergreens such as the eastern hemlock and rhododendron. A constant inflow of cold clean groundwater from the high water table of the Pocono Plateau adds to the stream flow. The cold temperature, ground water inputs and mixing of oxygen into the water as it tumbles down the escarpment of the Pocono Plateau, allows the sensitive stream macroinvertebrates to thrive in these waters.

2) Current Designated Uses

The upper Swiftwater Creek and Indian Run are listed on Drainage List C in 25 Pa. Code §93.9c. Both are designated as High Quality Cold Water Fisheries. The current HQ-CWF designation would allow degradation of the existing exceptional quality.

3) Requested Designated Uses

The requested designation for the upper Swiftwater Creek and Indian Run watershed is Exceptional Value. This designation would protect the existing water quality which is important to both the economy and the ecology of the area. **See Figure E-3 Appendix A.**

4) Available Technical Data: Water Chemistry, Benthic Macroinvertebrates and/or Fishes

The Swiftwater Creek/Indian Run watershed is part of the larger Paradise Watershed. This area has been studied extensively by the County and Paradise Township. The required technical data is found in the volumes below submitted with this petition. **See Map E-9 Appendix D for a map of the sampling stations.**

Monroe County Annual Water Quality Study (2005) conducted by the Monroe County Planning Commission and the Monroe County Conservation District.

Year 2005: Volume I, Executive Summary**:** See page 10 for SWIFCR03, page 11 for SWIFCRO7 and page 13 for INDIRU01, for site locations and habitat descriptions. **(See Appendix E)**

Volume II, Technical Appendices**:** see page 26 for all biological metric scores. See page 39 for INDIRU01, page 49 for SWIFCR07 and page 51 for SWIFCR03 for lists of macroinvertebrates. See pages 96, 98 and 99 for water chemistry. **(See Appendix E)**

Monroe County Annual Water Quality Study (2006) conducted by the Monroe County Planning Commission and the Monroe County Conservation District.

Year 2006: Volume I, Executive Summary**:** See page 10 for SWIFCR03, page 11 for SWIFCRO7 and page 14 for INDIRU01, for site locations and habitat descriptions. **(See Appendix F)**

Volume II, Technical Appendices**:** see page 29 for all biological metric scores. See page 39 for INDIRU01, page 49 for SWIFCR07 and page 51 for SWIFCR03 for lists of macroinvertebrates. See pages 99, 100 and 101 for water chemistry **(See Appendix F)**

Spreadsheet, Benthic Macroinvertebrate Metric Scores 1996 – 2005 Collected from the Monroe County Water Quality Studies. **(See Appendix G)**

Paradise Creek Watershed Management Plan (2005) sponsored by the Brodhead Watershed Association and funded through a Growing Greener grant from the Pennsylvania Department of Environmental Protection. **(See Appendix H)**

See page 29: Upper Swiftwater Creek Management Area Chemistry, and page 39 for Macroinvertebrate Trending Results.

Spreadsheet, Paradise Creek Watershed Study Field Water Chemistry for various sites along Indian Run and Swiftwater Creek. Sampling dates 2003 – 2004. **(See Appendix I)**

Paradise Watershed Historical Biological Data (1999 – 2003) Benthic macroinvertebrates and fish populations. **(See Appendix J)**

Stream Morphology and Water Quality Based Restoration Plan for the Paradise Creek Watershed (2005) prepared by Robert Limbeck, Watershed Sceintist, Delaware River Basin Commission. **(See Appendix K)**

See page 17 for Upper Swiftwater sub-watershed potential restoration sites.

Biological & Fish Data Gap Analysis. Paradise Watershed Historical Biological Data, Benthic Macroinvertebrates (undated) prepared by Don Baylor, Aquatic Resource Consulting for the Brodhead Watershed Association. **(See Appendix L)**

See page 2 for fish populations and page 4 for historical macroinvertebrate data.

Fish Inventory of Paradise Creek and Tributaries (2003) prepared by Jim Hartzler, Aquatic Biologist for Paradise Township. **(See Appendix M)**

See page 5 for fish species and page 11 for stream characterization for Indian Run.

Land Use and Impervious Cover in the Paradise Creek Watershed: An Initial Assessment (2003) prepared by James Sheehan **(See Appendix N)**

See page 6 for Upper Swiftwater Management Area

Benthic Macroinvertebrates of Swiftwater Creek above and below the Pocono Manor Sewage Treatment Plant Discharge (2001) prepared by Don Baylor for Paradise Township Supervisors. **(See Appendix O)**

See page 7 for summary.

Electrofishing Survey of Swiftwater Creek (2000) prepared by Jim Hartzler, Aquatic Resource Consulting, for Paradise Township Supervisors. **(See Appendix P)**

This study was conducted below the stream segment of interest and is included for purposes of evaluating sensitivity of downstream habitat to changes in the upstream habitat.

Benthic Macroinvertebrates of Swiftwater Creek (2000) prepared by Donald Baylor, Aquatic Resource Consulting, for Paradise Township. **(See Appendix Q)**

Station 1 is located in the stream segment of interest. Station 2 is located downstream of Sanofi Pasteur.

See page 6 for macroinvertebrate scores, page 7 for habitat and page 8 for taxa.

Benthic Macroinvertebrates of Swiftwater Creek (1997) prepared by Don Baylor, Aquatic Resource Consulting for Lake Swiftwater Association. **(See Appendix R)**

Benthic Invertebrates of Swiftwater (1986) prepared by Don Baylor, Aquatic Resource Consulting. **(See Appendix S)**

Memo, Department of Environmental Protection, October 25, 2000 authored by Sherrill R. Wills, Water Pollution Biologist. Subject: Phosphorous Criteria, Swiftwater Creek. **(See Appendix T)**

Included as historical data. As of 2000, according to the author, "water chemistry and macrobenthic results do not indicate any impairment of Swiftwater Creek."

Memo, Department of Environmental Resources, August 3, 1992 authored by Edward P. Kupsky, Water Pollution Biologist. Subject: Aquatic Chemical and Biological Investigation, Swiftwater Creek. **(See Appendix U)**

Included as historical data.

Brodhead Watershed Association, (1991 - 2005) containing data collected by volunteers at several sites along Indian Run and Swiftwater Creek. **(See Appendix V)**

BWA site 223 (INDIRU01 from County study) above Fairview Avenue in Pocono Township, near the headwaters.

BWA site 225 is Indian Run above the Swiftwater Confluence. County does not collect data for this site.

BWA site 224 is Swiftwater Creek above the Falls (SWIFCR08 in the Paradise Creek Watershed Management Plan.)

BWA site 226 is Swiftwater Creek above the Indian Run Confluence (SWIFCR07 from County study.)

BWA site 227 is Swiftwater Creek above Route 611 (SWIFCR03 from County study.)

USGS gage, located on the Sanofi property. The gage has provided real-time and statistical discharge amounts for the Swiftwater Creek since April of 2001. Following is a link to the data on the internet: http://waterdata.usgs.gov/pa/nwis/uv?01440485

5) Description of Discharges

The sole existing point source discharge in the upper Swiftwater watershed is the Pocono Manor Sewage Treatment Plant (NPDES permit # 0029149 under the name "Ireland Hotels/Pocono Manor.") **(See Figure E-5 Appendix B.)** The current facility is permitted to discharge 0.14 mgd. A proposal exists for the replacement of this facility and is contingent upon the appeal by Pocono Manor Investors, LLC of the recent decision by the Pennsylvania Gaming Board not to award a casino license to the owners of Pocono Manor LLC. Pocono Manor LLC has submitted and received approval for a Sewage Facilities Planning Module dated October 16, 2006 which provides for development of the property using land application of effluent from a new, enlarged wastewater treatment plant. Plans include spray irrigation of golf courses in the summer and snow making in the winter. The Brodhead Watershed Association supports the concept of spray irrigation and snowmaking.

The current potential non-point source pollution sources include Interstate 380, Route 314, Route 940, a grain mill, railroad, minor roadways, parking lots, golf courses, a decaying pump house on Indian Run, and a farm.

If not managed properly, the wastewater and stormwater generated by future developments within the watershed will degrade the exceptional quality of the upper Swiftwater Creek.

6) EV Qualifiers

Biological assessment qualifier.

Existing data indicates that the streams are optimal due to the existence of pollution intolerant mayflies, caddisflies and stoneflies. Petitioners have not chosen a reference stream for comparison.

Surveys of aquatic fauna have indicated exceptional water quality in Swiftwater Creek and Indian Run. Benthic macroinvertebrate surveys in the segment of Swiftwater Creek

proposed for EV designation and downstream have documented diverse, well balanced benthic communities consisting predominantly of very pollution-sensitive taxa (Baylor 1997, 2000, and 2001). Benthic samples from Indian Run in 1986 were indicative of exceptional water quality (Baylor 1986).

The fish population of Indian Run was surveyed in 2003. The fish community of Indian Run consisted primarily of trout and sculpins, indicating excellent cold water habitat. Brook and brown trout were about equally represented in a total trout biomass of approximately 48 pounds per acre – well above the Pennsylvania Fish & Boat Commission's standard for Class A Wild Trout Streams for combined brook and brown trout (Hartzler 2003). Excellent trout reproduction was indicated in the survey by abundant young-of-year.

Electrofishing surveys were conducted in 2000 and 2002 at five sites on Swiftwater Creek (Hartzler 2000 and 2002). One site below Swiftwater Lake and four above were sampled. The uppermost site was above the Route 611 crossing of Swiftwater Creek in the stream segment of interest. Trout populations in Swiftwater Creek consisted primarily of brown trout with a few brook and rainbow. Biomass estimates ranged from 70 to 220 pounds per acre among the five sites. All sites had trout biomass well above the requirements for Class A Wild Trout, with one site having several times the minimum requirement – an exceptional biomass for an infertile freestone stream. The four sites above Swiftwater Lake had abundant young-of-year brown trout, indicating excellent reproduction. There was some indication of natural reproduction of rainbow trout at the uppermost site.

Surface water of exceptional ecological significance.
Petitioners believe the upper Swiftwater Creek watershed qualifies for EV protection because it is a surface water of exceptional ecological significance. The wetlands draining into the headwaters likely represent the water source for numerous private wells adjacent to the wetlands. Older homes on Long Pond Road in Tobyhanna Township with shallow wells, built in the 1950's and 1960's, as well as two newer subdivisions adjacent to the Swiftwater Creek headwaters in the commercially zoned parcel along Route 380 likely rely upon these wetlands for their drinking water. Those subdivisions are named White Birches and Emerald Lakes. As mentioned on page one, Kettle Spring on Indian Run is a drinking water source for the Pocono Manor community.

A "surface water of exceptional ecological significance" is defined "as a surface water which is important, unique or sensitive ecologically, but whose water quality as measured by traditional parameters (for example chemical, physical or biological) may not be particularly high, or whose character cannot be adequately described by these parameters. These waters include wetlands that are exceptional value wetlands under § 105.17(1) (relating to wetlands)." 25 Pa. Code § 93.1. Exceptional value wetlands include wetlands that are located along an existing pubic or private drinking water supply, including both surface and groundwater sources, that maintain the quality or quantity of the drinking water supply. See 25 Pa. Code § 105.17(1).

7) Land Use and Development Patterns in the Watershed

The upper Swiftwater Creek watershed, in the area pertaining to the requested amendment, is primarily forested and contains wetlands, ponds, and waterfalls. This entire watershed is privately owned. The watershed area is zoned for recreational, residential, commercial, and industrial uses. The Indian Run, the County's coldest stream, begins in an undeveloped industrial zone adjacent to a railroad line. Swiftwater Creek's headwaters are adjacent to Interstate 380 and PA Route 940 in an undeveloped commercially zoned parcel. The developed areas of the watershed contain residential structures, Pocono Manor Resort buildings and golf courses, a horseback riding facility, a trap-shooting course, the Amber Tavern, and the Swiftwater Inn. The vast majority of the Pocono Manor property is located in Pocono Township, zoned RD for Recreational District. **(See Figure E-7 Appendix C.)**

The rate of growth in the upper Swiftwater Creek Watershed is anticipated to increase in the near future due to the following factors:

- Monroe County has the second fastest growing population in comparison to all counties in the Commonwealth of Pennsylvania based on year 2000 census data.

- An Act 537 Plan for Pocono Township has recently been approved by Pocono Township and submitted to the DEP and the Delaware River Basin Commission. This Plan allows for a sewage treatment facility and sewage line to be constructed along the Route 611 corridor, servicing customers in the vicinity of the Swiftwater Creek, including Sanofi Pasteur. As stated in the Department's Water Quality Antidegradation Implementation Guidance book, traditional sewage disposal systems, without carefully developed land use planning, could contribute to the problems of urban sprawl and unplanned development (see Chapter 7 § 14.a of the Antidegradation Guidance book). It is likely that, with the development pressures this area faces and with the addition of this new sewer line and treatment plant, the undeveloped areas may soon be developed.

- The 3,500-acre Pocono Manor Resort is divided into recreationally, commercially, and industrially zoned parcels. This resort has plans to expand with the addition of a casino, pending the outcome of an appeal of the Pennsylvania Gaming Commission's decision not to award Pocono Manor Investors, LLC a license.

Protecting the existing exceptional quality of the upper Swiftwater Creek and its tributaries as development occurs is important for the sustainability of recreational activities and private wells in the watershed, as well as to water users downstream.

8) Municipalities in Watershed

Lori Yocum Secretary/Treasurer
Mount Pocono Borough
303 Pocono Boulevard
Mount Pocono, PA 18344
570-839-8436
www.borough.mountpocono.pa.us

Reda Briglia, Secretary/Treasurer
Paradise Township
RR 1 Box 1226
Cresco, PA 18326
570-595-9880
www.paradisetownship.com

Jane Cilurso Secretary/Treasurer
Pocono Township
PO Box 197
Tannersville, PA 18372
570-629-1922
www.poconotownship.org

John Kerrick, Chair
Board of Supervisors
Tobyhanna Township
HC 89 Box 289
Pocono Pines, PA 18350
570-646-1212
www.tobyhannatownship.org

9) Locational information relevant to items E-4 through E-8

Figure E-9 Map of Sampling Stations for Chemical and Biological Data used by Monroe County Water Quality Study

Appendices

A.	**Figure E-1**	Upper Swiftwater Indian Run Watershed
	Figure E-3	USGS Map of Area to be Redesignated
B.	**Figure E-5**	Point and Non-Point Source Discharges
C.	**Figure E-7**	Land Use and Zoning/Development
D.	**Figure E-9**	Map of Sampling Stations for Chemical and Biological Data used by Monroe County Water Quality Study

E. Monroe County Annual Water Quality Study (2005)

F. Monroe County Annual Water Quality Study (2006)

G. Spreadsheet, Benthic Macroinvertebrate Metric Scores 1996 – 2005

H. Paradise Creek Watershed Management Plan (2005)

I. Spreadsheet, Paradise Creek Watershed Study Field Water Chemistry (2003 – 2004)

J. Paradise Watershed Historical Biological Data (1999 – 2003)

K. Stream Morphology and Water Quality Based Restoration Plan for the Paradise Creek Watershed (2005)

L. Biological & Fish Data Gap Analysis. Paradise Watershed Historical Biological Data, Benthic Macroinvertebrates (undated) prepared by Don Baylor, Aquatic Resource Consulting

M. Fish Inventory of Paradise Creek and Tributaries (2003) prepared by Jim Hartzler, Aquatic Biologist for Paradise Township

N. Land Use and Impervious Cover in the Paradise Creek Watershed An Initial Assessment (2003) prepared by James Sheehan

O. Benthic Macroinvertebrates of Swiftwater Creek above and below the Pocono Manor Sewage Treatment Plant Discharge (2001) by Don Baylor for Paradise Township Supervisors

P. Electrofishing Survey of Swiftwater Creek (2000) prepared by Jim Hartzler, Aquatic Resource Consulting, for Paradise Township Supervisors.

Q. Benthic Macroinvertebrates of Swiftwater Creek (2000) prepared by Donald Baylor, Aquatic Resource Consulting, for Paradise Township

R. Benthic Macroinvertebrates of Swiftwater Creek (1997) prepared by Don Baylor, Aquatic Resource Consulting for Lake Swiftwater Association.

S. Benthic Invertebrates of Swiftwater (1986) prepared by Don Baylor, Aquatic Resource Consulting.

T. Memo, Department of Environmental Protection, October 25, 2000 written by Sherrill R. Wills, Water Pollution Biologist. Subject: Phosphorous Criteria, Swiftwater Creek.

U. Memo, Department of Environmental Resources, August 3, 1992 written by Edward P. Kupsky, Water Pollution Biologist.

V. Brodhead Watershed Association, (1991 - 2005) Data collected by volunteers at several sites along Indian Run and Swiftwater Creek.

W. Paradise Creek Subwatershed. (2000) Description and relevant facts, Brodhead Watershed Association.

X. Pocono Manor: Historical information, marketing materials.

Y. Map circa 1930 showing location of Kettle Springs and letter from former owner of Pocono Manor, Jim Ireland, regarding water quality of Indian Run.

Upper Swiftwater/Indian Run Watershed
Headwaters to Route 611 in Pocono Township

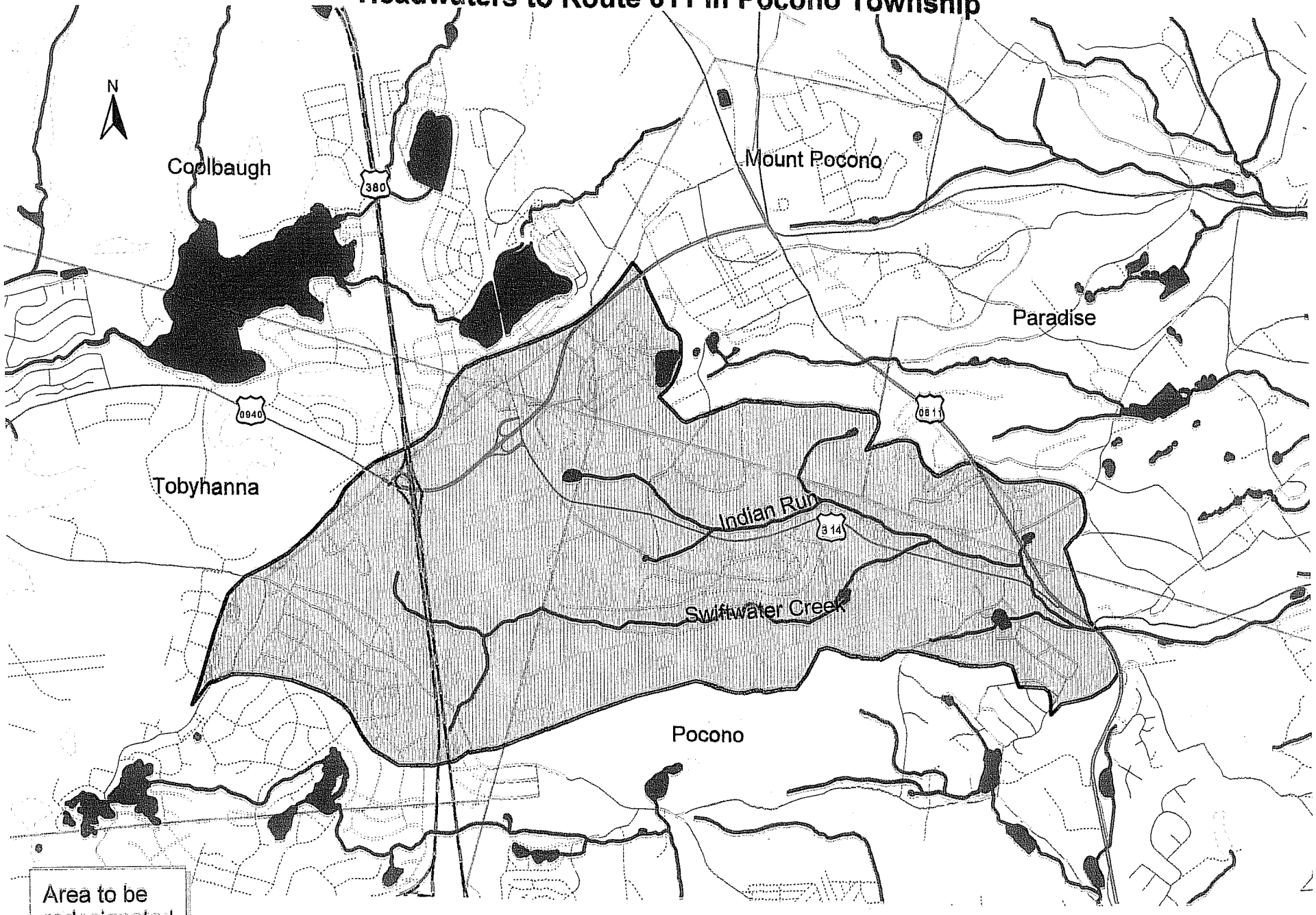


Fig. E-1

Upper Swiftwater/Indian Run Watershed
Requested Use Exceptional Value Waters

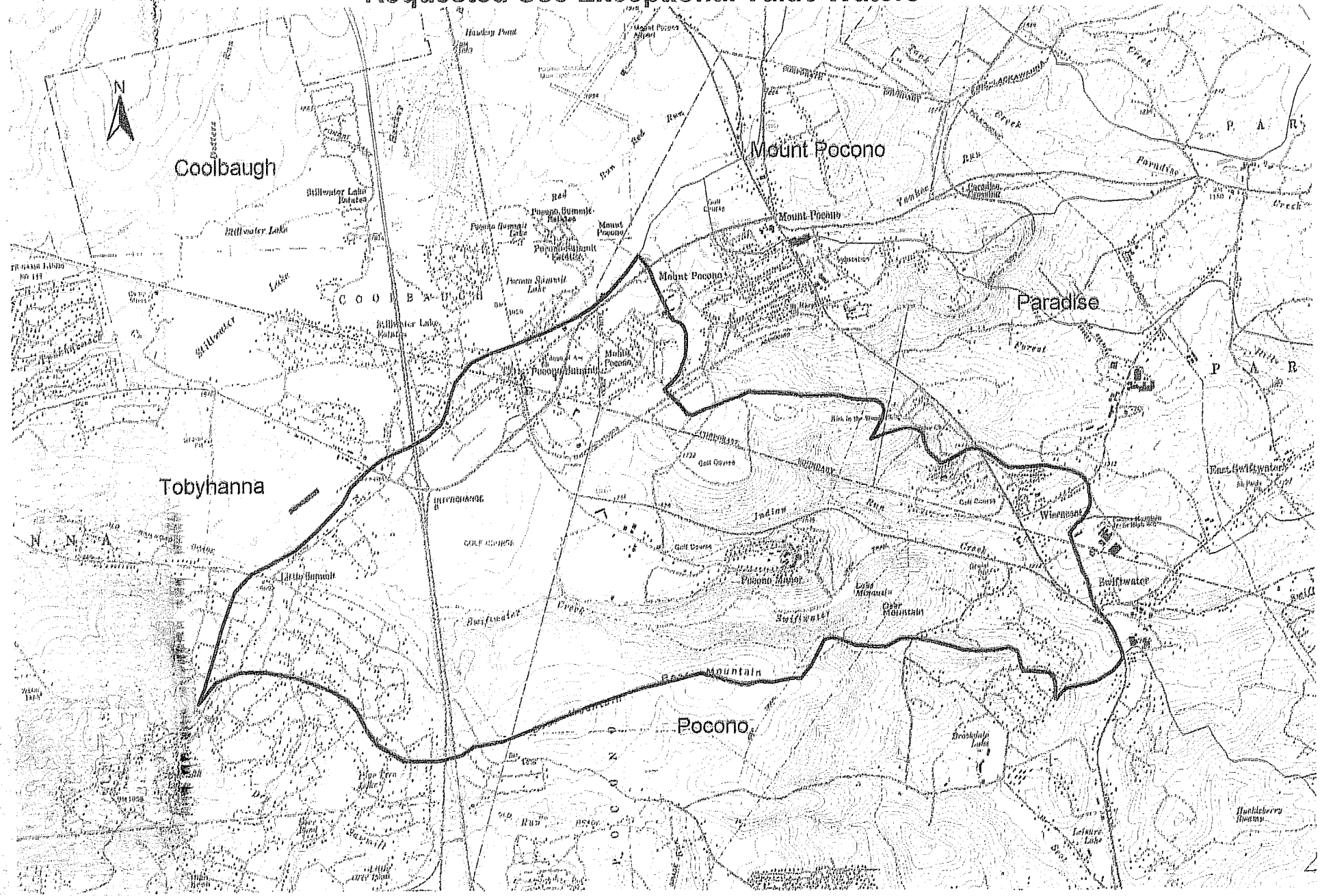


Fig. E-3

Upper Swiftwater/Indian Run Watershed
Point and Non Point Source Discharges

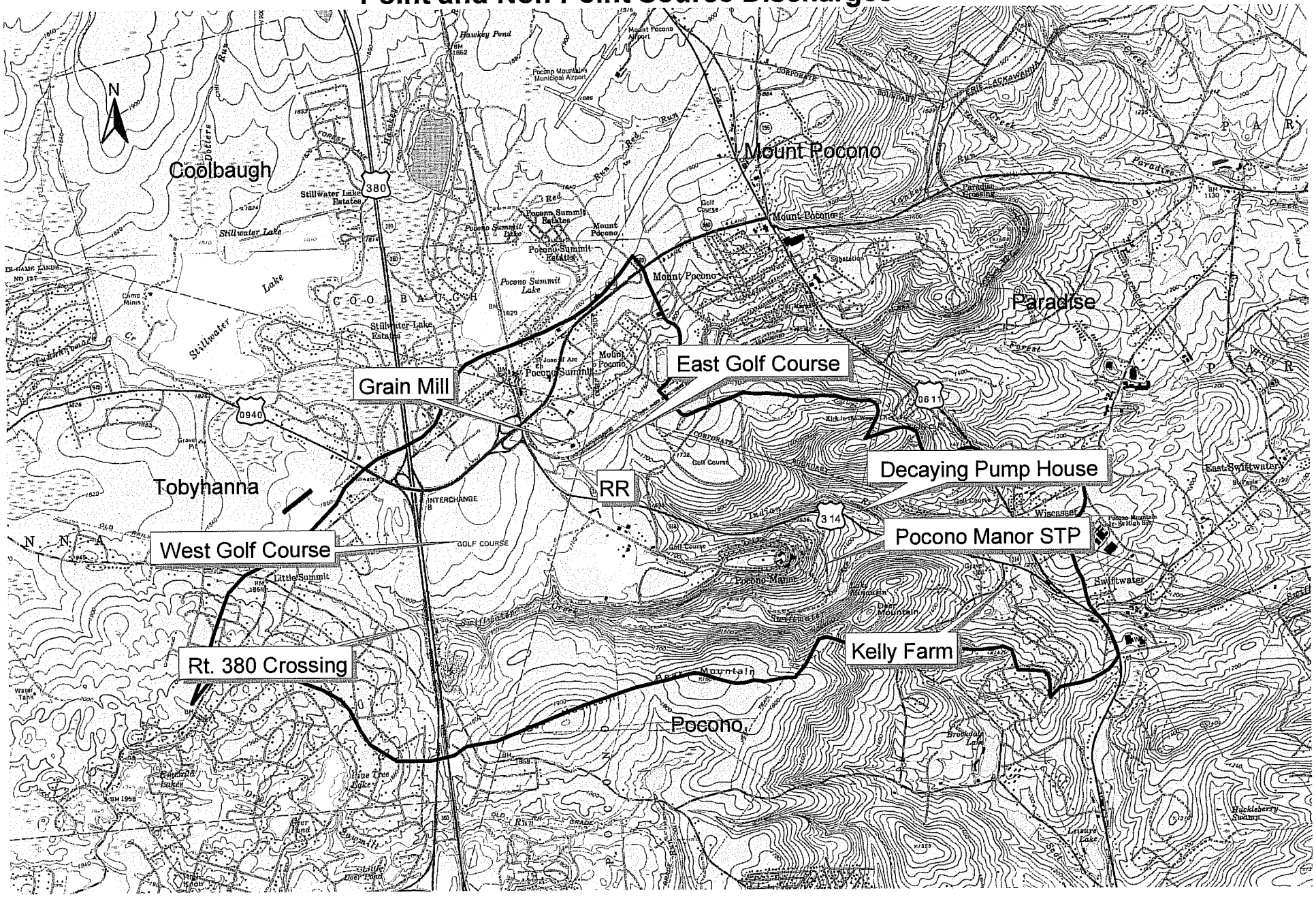
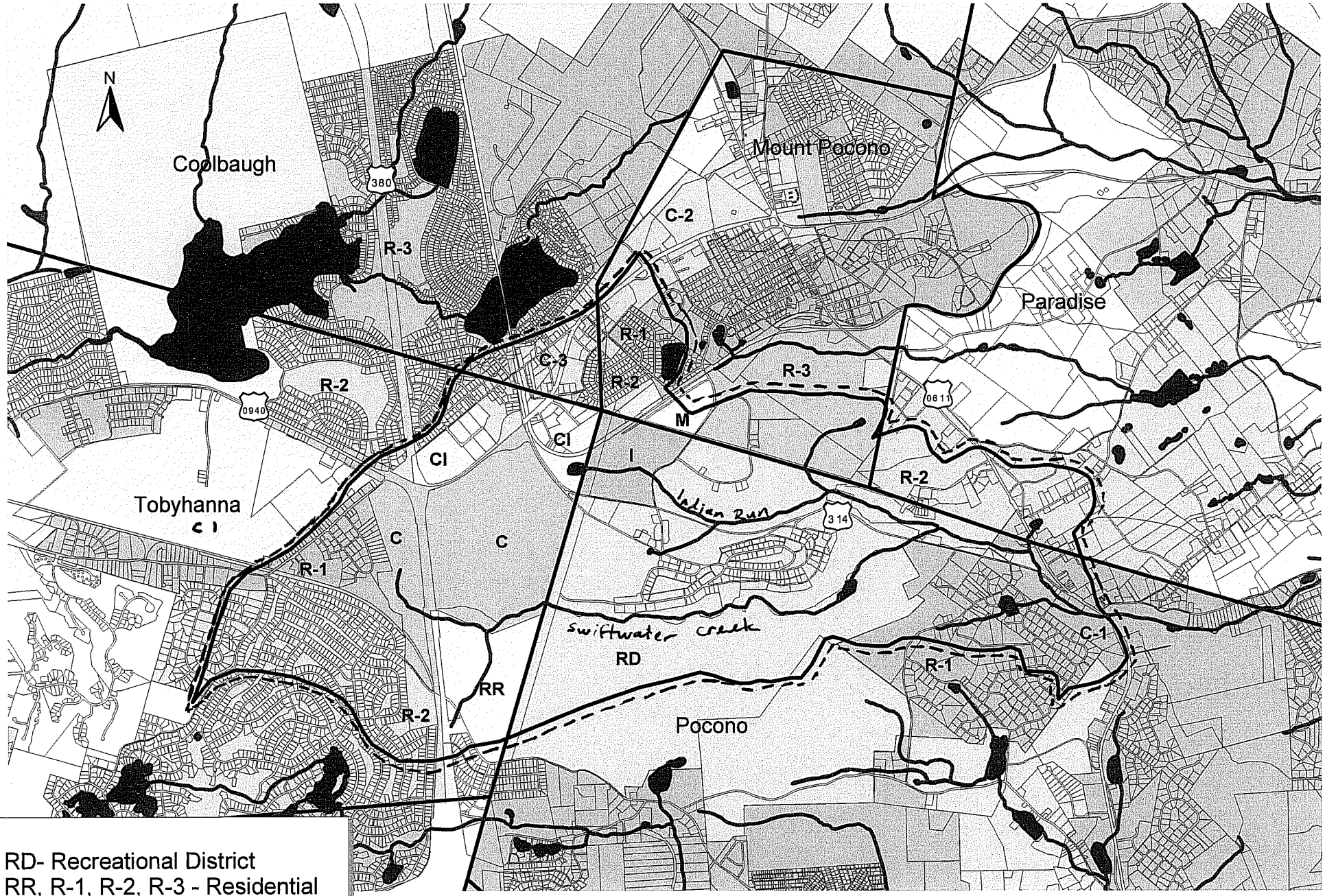


Fig. E-5

Upper Swiftwater/Indian Run Watershed
Zoning and Land Use Patterns



RD- Recreational District
RR, R-1, R-2, R-3 - Residential
C, C1 - Commercial
I, M - Industrial
--- watershed boundary

1 0 1 2 Miles

Fig. E-7

Upper Swiftwater/Indian Run Watershed
Sampling Point Locations

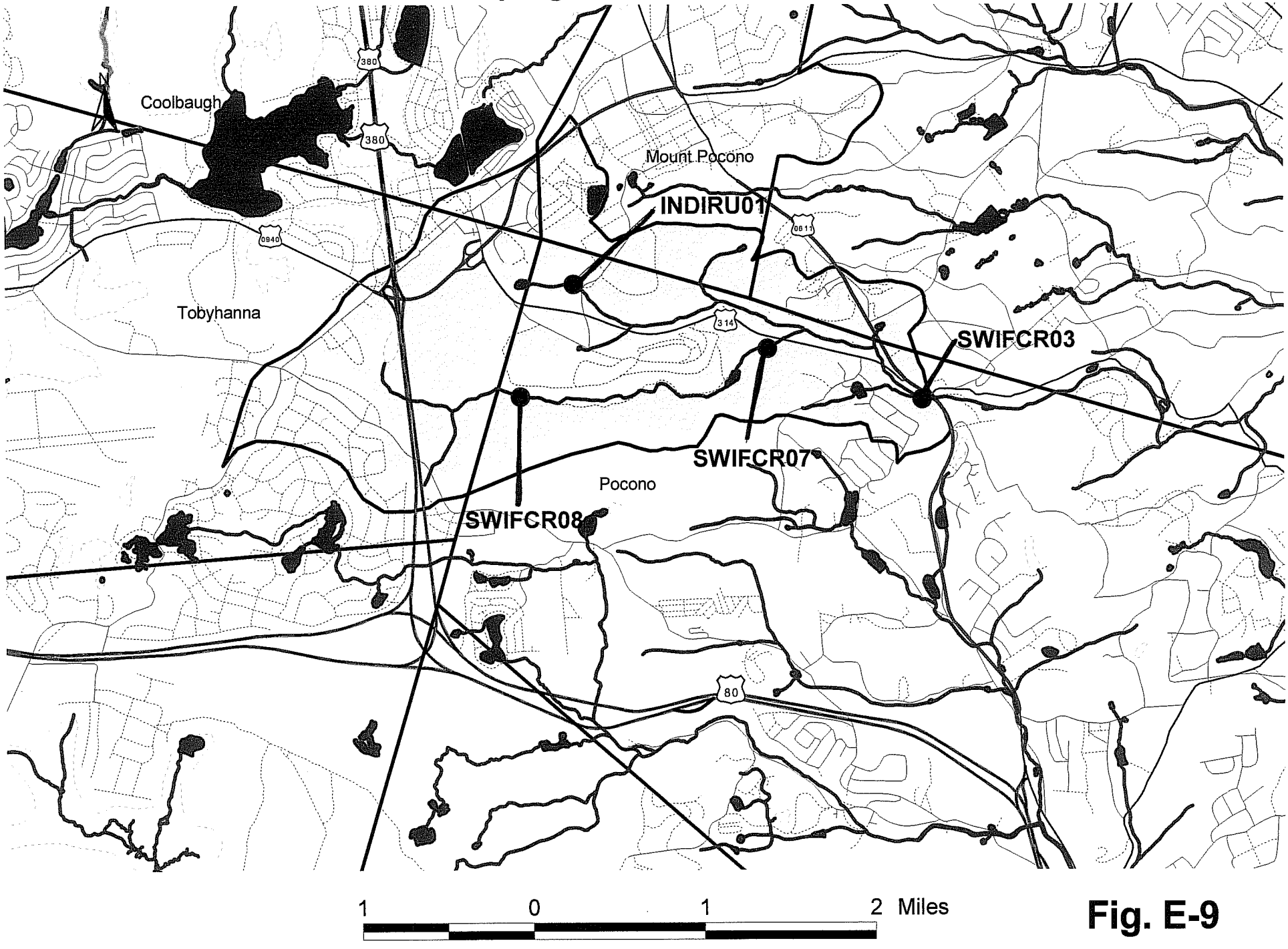


Fig. E-9

Site #	Site Name	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996
POCOCR15	Pocono Creek	33	35	29	31	35	31	27			
POCOCR16	Pocono Creek	27	27	25	31	23	29	29			
POCOCR17	Pocono Creek	31	21	23	33	29	33				
POCOCR18	Pocono Creek	28	33	33	31	31	27				
POCOCR19	Pocono Creek	31	31	27	35	33					
POCOCR20	Pocono Creek	35	27	23	29	27					
POCOCR22	Pocono Creek	35	33								
POHOCR06	Pohopoco Creek	31	33	35	33	31	33	33	33	31	33
POHOCR07	Pohopoco Creek	27									
PRINRU01	Princess Run	25									
REDRU03	Red Run	22	24	22	24						
SAMBCR10	Sambo Creek	25	31								
SCOTCR04	Scotrun Creek	23	27	27	31	29					
SCOTCR05	Scotrun Creek	17									
SWIFCR02	Swiftwater Creek	27	25	27							
SWIFCR03	Swiftwater Creek	27	29	29	25	29	29	17	27	19	27
SWIFCR05	Swiftwater Creek	33	33	23	25	29	27	25	29	21	25
SWIFCR06	Swiftwater Creek	25	21	23							
SWIFCR07	Swiftwater Creek	29	29	25	29	33					
TOBYCR01	Tobyhanna Creek	28	22	26	26	22	24	20	14	18	26
TOBYCR17	Tobyhanna Creek	29							26		
TOBYCR17	Tobyhanna Creek	20									
TOBYCR18	Tobyhanna Creek	26									
TROUCR02	Trout Creek	24									
TUNKCR03	Tunkhannock Creek		28	28	30	28	26	26	28	30	30
TUNKCR06	Tunkhannock Creek		22	24	20	28	24	20	18	18	
WEIRCR01	Weir Creek	23				21	19				

The following tables compare trending results of the EPA/County scoring schemes for repeat sites (1995 through 2003).

Site #	Site Name	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996
AQUACR09	Aquashicola Creek	35	29	27	29	33	31	33	29	35	35
AQUACR10	Aquashicola Creek	33	33								
BRODCR01	Brodhead Creek	33	35	33/31	35	35	33	35	35	33	35
BRODCR12	Brodhead Creek	33	29	29	29	29	29	29	29	27	29
BRODCR13	Brodhead Creek	19	---	23/25	29	27	21	29	27	27	11
BUCKCR01	Buckwha Creek	31									
BULGRU01	Bulgers Run	23									
BUSHCR07	Bushkill Creek	31	27	29	29	31	27	29	27	33	29
BUTZRU01	Butz Run	23	29	23							
CRCRPA01	Cranberry Creek (Paradise)	29	29								
DEHOCR04	Devils Hole Creek	33	31	31							
DRSARU01	Dry Sawmill Run	19	21	27	31	21	23			29	
FOHIRU01	Forest Hills Run	29	29	25							
FOHIRU04	Forest Hills Run	21	25	19	25	29	25	27	27	23	31
FOHIRU09	Forest Hills Run	21	15	17							
HAWKRU01	Hawkey Run	24						28			
INDIRU01	Indian Run	33		31					31	31	
MARSCR08	Marshalls Creek	33	27	23	23	27	25	19	27	19	23
MARSCR09	Marshalls Creek	25/25	25	23	31	29	25	31	25	21	25
MCMICR21	McMichael Creek	23	25	25	31	33	25	29	27	25	31
MCMICR28	McMichaels Creek	25	21	23							
MCMICR30	McMichaels Creek	21	27								
PARACR01	Paradise Creek	33	29	29							
PARACR03	Paradise Creek	35	33	31							
PARACR04	Paradise Creek	33	33	31							
POCOCR14	Pocono Creek	29	23	27	29	25	21	29			

Paradise Creek Watershed Study
Indian Run Field Water Chemistry

WSHED_ID	SAMP_DATE	TEMP_C	SP_COND	DO_MG_L	F_PH	ORP_MV	DO__	COND	TDS_MG_L	WIDTH_FT	GUAGE_FT	FLOW_CFS
INDIRU01	4/13/2003	9.53	297	10.06	5.90	357	88.20	209	193		1.12	
INDIRU01	5/18/2003	9.43	226	9.04	5.47	368	79.10	158	147	10.0	0.92	2.57
INDIRU01	6/15/2003	12.74	254	9.59	6.11	321	90.60	195	165	10.1	1.14	6.23
INDIRU01	7/20/2003	9.97	219	10.23	5.56	370	90.60	156	142	9.4	0.92	2.29
INDIRU01	8/14/2003	11.31	235	9.17	5.85	327	83.80	173	153	9.6	0.96	1.96
INDIRU01	9/29/2003	11.43	235	9.75	6.28	457	89.30	1	153	10.0	1.07	6.11
INDIRU01	11/30/2003	7.34	213	10.72	6.74	308	89.10	141	139	10.1	1.11	6.02
INDIRU01	1/29/2004	7.48	208	9.54	7.03	323	79.60	139	135		0.85	
INDIRU01	2/25/2004	8.32	214	9.51	5.91	289	81.00	146	139		0.81	
INDIRU01	3/15/2004	8.36	227	10.13	5.91	308	86.30	155	148		0.86	

I

Paradise Creek Watershed Study
SWIFCR03 (above Rt. 611) Field Water Chemistry

WSHED_ID	SAMP_DATE	TEMP_C	SP_COND	DO_MG_L	F_PH	ORP_MV	DO__	COND	TDS_MG_L	WIDTH_FT	GUAGE_FT	FLOW_CFS
SWIFCR03	4/4/2003	6.21	148	11.65	7.13	312	94.10	95	96		0.88	
SWIFCR03	5/3/2003	12.04	143	10.36	7.39	283	96.30	101	87	23.5	0.70	29.31
SWIFCR03	6/17/2003	11.38	112	10.61	7.14	286	97.00	83	73	25.4	0.94	59.71
SWIFCR03	7/9/2003	14.05	121	10.15	7.47	273	98.60	96	79	23.3	0.80	26.63
SWIFCR03	8/14/2003	15.74	122	10.12	7.45	325	102.00	101	80	23.8		26.93
SWIFCR03	9/10/2003	13.17	122	9.15	7.62	365	87.20	94	79	22.4	0.54	15.24
SWIFCR03	10/29/2003	9.95	94	11.50	7.58	372	101.80	67	61		1.15	
SWIFCR03	12/13/2003	4.49	92	12.42	7.37	295	96.00	56	60			
SWIFCR03	1/24/2004	0.56	114	12.86	8.21	267	89.40	61	74			
SWIFCR03	2/21/2004	4.24	130	12.31	8.04	273	94.60	79	85			
SWIFCR03	3/27/2004	8.73	163	12.08	7.71	289	103.90	113	106	24.4		25.09

Paradise Creek Watershed Study
SWIFCR07 (75 yards west of Rt. 314) Field Water Chemistry

WSHED_ID	SAMP_DATE	TEMP_C	SP_COND	DO_MG_L	F_PH	ORP_MV	DO__	COND	TDS_MG_L	WIDTH_FT	GUAGE_FT	FLOW_CFS
SWIFCR07	4/13/2003	7.60	147	11.44	7.20	300	95.70	98	96		0.66	
SWIFCR07	5/18/2003	11.87	96	10.12	6.77	321	93.60	72	62	19.8	0.58	15.51
SWIFCR07	6/15/2003	12.58	74	10.62	6.96	298	99.90	56	48	19.8	0.82	29.42
SWIFCR07	7/20/2003	13.92	92	10.97	7.34	297	106.30	73	60	19.3	0.54	12.15
SWIFCR07	8/14/2003	13.35	92	10.34	7.09	352	98.90	71	60	19.6	0.67	17.10
SWIFCR07	9/29/2003	11.16	73	10.85	7.11	406	98.80	54	48	19.8	0.80	25.30
SWIFCR07	11/30/2003	6.10	67	12.10	6.87	283	97.40	43	43	19.6	0.95	31.70
SWIFCR07	1/31/2004	0.97	88	13.49	7.90	285	94.80	48	57			
SWIFCR07	2/29/2004	5.05	191	12.68	7.91	299	99.50	118	124			
SWIFCR07	3/15/2004	6.80	103	12.06	6.81	292	98.90	67	67			

Paradise Creek Watershed Study

SWIFCR08 (upstream of Pocono Manor falls) Field Water Chemistry

WSHED_ID	SAMP_DATE	TEMP_C	SP_COND	DO_MG_L	F_PH	ORP_MV	DO__	COND	TDS_MG_L	WIDTH_FT	GUAGE_FT	FLOW_CFS
SWIFCR08	4/13/2003	8.71	149	10.77	6.22	561	92.60	103	97		1.16	
SWIFCR08	5/23/2003	9.09	127	10.48	6.18	360	90.90	88	82	14.5	0.98	8.29
SWIFCR08	7/26/2003	11.18	121	10.41	6.56	292	94.80	89	79	14.1	1.09	5.68
SWIFCR08	8/14/2003	10.91	123	10.52	6.37	356	95.20	90	80	13.8	1.10	5.41
SWIFCR08	9/29/2003	10.36	121	10.51	6.45	451	93.90	87	79	15.2	1.12	13.85

Paradise Creek Watershed Study
SWIFCR03 (above Rt. 611) Laboratory Chemistry

WSHED_ID	SAMP_DATE	PH_LAB	NITRATE_N	NITRITE_N	TSS	TOTAL_PHOS	ALKALINITY	HARDNESS	AMMONIA_N	CHLORIDE
SWIFCR03	4/4/2003	6.39	0.12	<0.005	<1.0	0.06				
SWIFCR03	5/3/2003	7.11	0.22	0.01	1.9	0.11				
SWIFCR03	6/17/2003	6.86	0.32	<0.005	<1.0	0.06				
SWIFCR03	7/9/2003	7.44	0.43	0.02	<1.0	0.10				
SWIFCR03	8/14/2003	6.94	0.33	<0.005	<1.0	0.10	12	29.9	<0.1	35
SWIFCR03	10/29/2003	6.91	<0.10	0.011	1.2	0.08				
SWIFCR03	11/22/2003	6.86	0.86	0.02	1.2	0.03				
SWIFCR03	12/13/2003	6.69	0.60	0.01	<1.0	0.11				
SWIFCR03	1/24/2004	6.64	<0.1	0.01	<1.0	0.06				
SWIFCR03	2/21/2004	6.98	0.40	0.04	1.0	0.03				
SWIFCR03	3/27/2004	6.86	0.37	<0.01	1.0	<0.02				
SWIFCR03	9/10/2003	6.88	0.59	0.01	1.4	0.03				

Paradise Creek Watershed Study
SWIFCR03 (above Rt. 611) Laboratory Chemistry

WSHED_ID	SAMP_DATE	FECAL_COLI	ALUMINUM	ANTIMONY	ARSENIC	BARIUM	BERYLLIUM	CADMIUM	CALCIUM	CHROMIUM	COBALT
SWIFCR03	4/4/2003	1									
SWIFCR03	5/3/2003	0									
SWIFCR03	6/17/2003	12									
SWIFCR03	7/9/2003	6									
SWIFCR03	8/14/2003	10	<0.1	<0.1	<0.005	<0.1	<0.02	<0.02	9.5	<0.02	<0.02
SWIFCR03	10/29/2003	305									
SWIFCR03	11/22/2003	0									
SWIFCR03	12/13/2003	12									
SWIFCR03	1/24/2004	1									
SWIFCR03	2/21/2004	17									
SWIFCR03	3/27/2004	2									
SWIFCR03	9/10/2003	5									

Paradise Creek Watershed Study
SWIFCR03 (above Rt. 611) Laboratory Chemistry

WSHED_ID	SAMP_DATE	COPPER	IRON	LEAD	MERCURY	MAGNESIUM	MANGANESE	NICKEL	POTASSIUM	SELENIUM	SODIUM
SWIFCR03	4/4/2003										
SWIFCR03	5/3/2003										
SWIFCR03	6/17/2003										
SWIFCR03	7/9/2003										
SWIFCR03	8/14/2003	<0.02	0.04	<0.01	<0.0005	1.5	<0.02	<0.02	0.55	<0.005	
SWIFCR03	10/29/2003										
SWIFCR03	11/22/2003										
SWIFCR03	12/13/2003										
SWIFCR03	1/24/2004										
SWIFCR03	2/21/2004										
SWIFCR03	3/27/2004										
SWIFCR03	9/10/2003										

Paradise Creek Watershed Study
SWIFCR03 (above Rt. 611) Laboratory Chemistry

WSHED_ID	SAMP_DATE	SILVER	THALLIUM	VANADIUM	ZINC
SWIFCR03	4/4/2003				
SWIFCR03	5/3/2003				
SWIFCR03	6/17/2003				
SWIFCR03	7/9/2003				
SWIFCR03	8/14/2003	<0.02	<0.1	<1	<0.02
SWIFCR03	10/29/2003				
SWIFCR03	11/22/2003				
SWIFCR03	12/13/2003				
SWIFCR03	1/24/2004				
SWIFCR03	2/21/2004				
SWIFCR03	3/27/2004				
SWIFCR03	9/10/2003				

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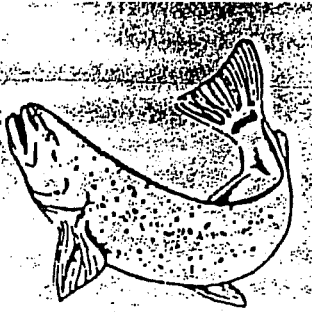

Fish Inventory of Paradise Creek and Tributaries

September 2003

Prepared for

Paradise Township

Jim Hartzler
Aquatic Biologist
February 2004

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BACKGROUND

On September 11 and 12, 2003, Aquatic Resource Consulting (ARC) sampled the fish communities of Paradise Creek and four tributary streams – Butz Run, Indian Run, Forest Hill Run, and Cranberry Creek. The objective was to establish a database to identify the fish species composition of the streams, one important measure of water quality. Paradise Township has developed a comprehensive monitoring program for streams that includes periodic measurements of physical, chemical, and biotic parameters. The information from this electrofishing survey will assist the Township in evaluating each stream's present condition and in assessing possible changes in water quality related to residential, commercial, and industrial development in the Paradise Creek watershed.

ARC conducted electrofishing surveys in 1999, 2000, and 2002 on Paradise Creek and other tributaries, including Swiftwater Creek, Devils Hole Creek, Yankee Run, and Tank Creek. These inventories revealed that most of these streams support reproducing populations of brown trout and often brook trout, two "coldwater" species classified as intolerant to environmental perturbation, such as high water temperatures, sedimentation, pollutants, and habitat degradation. Wild rainbow trout, another salmonid that has a limited distribution in Pennsylvania, were also collected at several locations on Swiftwater Creek.

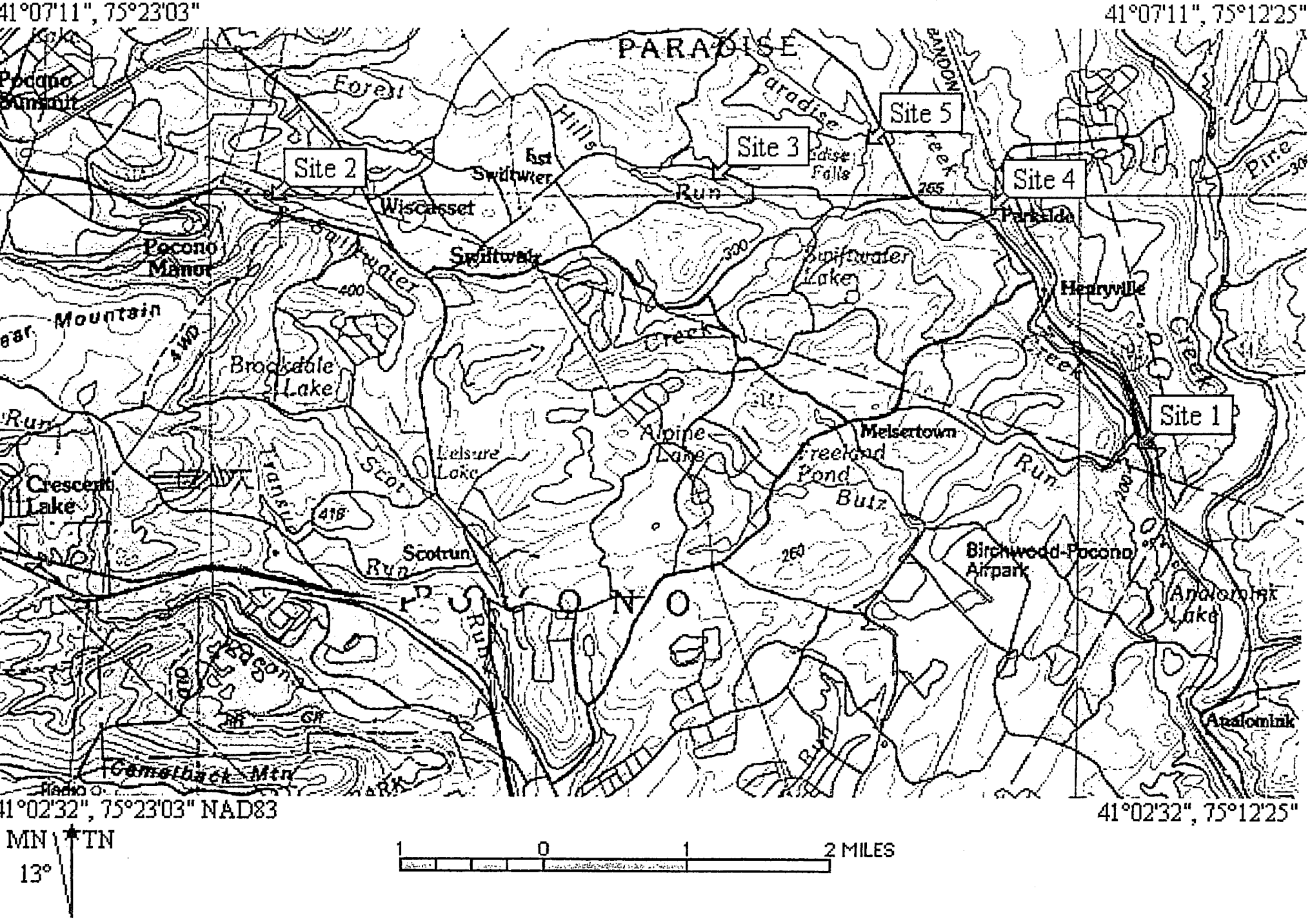
METHODS

Fish communities were sampled by electrofishing with a Coffelt BP1C 300 watt backpack variable voltage (0-600 V) unit with handheld electrodes and nets. Collections were made in an upstream direction, and two or three consecutive runs were made at each station to permit statistical estimates of total abundance (numbers) and biomass (weight per unit area) of wild trout. All trout were netted, anesthetized, weighed and measured. Relative abundance of other fish species was estimated.

Sampling locations (see Figure 1) were as follows (GPS coordinates of starting point in parentheses).

(1) Butz Run – begin at old logging road just upstream from juncture with Paradise Creek, off Sylvan Cascade Rd. (41 04.683N, 75 13.733W).

Figure 1. Location of electrofishing stations, 2003.



(2) Indian Run – begin approximately 100 yards upstream from juncture with Swifwater Creek, just off Rt. 314 near power line (41 06.133N, 75 20.842W).
(3) Forest Hill Run – begin approximately 50 yards below footbridge on Steven's property, off Donaldson Rd. (41 06.262N, 75 17.189W).
(4) Cranberry Creek – begin approximately 150 yards upstream from Browns Hill Rd., off Rt. 191 (41 06.140N, 75 14.985W).
(5) Paradise Creek – begin approximately 150 yards downstream from Paradise Lutheran Falls Road bridge (41 06.544N, 75 16.021W).

RESULTS AND DISCUSSION

Fish Species Composition

Brown trout was the predominant fish species at the Paradise Creek station and in all four tributaries (Table 1). This salmonid is the most adaptable of the three species with reproducing populations in Pennsylvania – brook, brown, and rainbow trout – because of its higher temperature tolerance and less demanding spawning requirements. The total weight of wild brown trout exceeded that of any other species at all the sampling locations except perhaps on Paradise Creek, where white suckers were abundant. Numerically, brown trout also ranked first except on Indian Run where both wild brook trout and slimy sculpin were more numerous.

American eel were found at all stations but on Indian Run. This catadromous species ascends most streams tributary to the Delaware River as young-of-year (0+ age) "elvers" after migrating from spawning areas in the Sargasso Sea near Bermuda. After reaching adulthood in 3-5 years, the mature eels migrate downstream in the fall months. Although classified as a "warmwater" species, American eels can be found in many trout streams in the Pocono region, including some higher elevation headwater brook trout streams.

Two small, closely related minnow species – longnose and blacknose dace – were collected at most of the electrofishing sites (Table 1). Cutlips minnow, another member of the Cyprinidae (minnow) family that prefers slightly higher temperatures, was found in Butz Run and Paradise Creek. All these fish require water temperatures in the 70's to spawn and have a widespread distribution in Pocono area streams. Blacknose dace are probably the most numerous minnow in the region because of their broad tolerance to temperature and generalist feeding habits (Table 2). Whereas blacknose dace commonly school in quiet pools and backwater areas of streams, longnose dace are solitary and prefer torrential flows (riffles and runs). Both species were absent on Indian Run, and blacknose dace were not found at the Forest Hills Run site.

Table 1. Relative abundance of fish species collected in tributaries of Paradise Creek in September, 2003.

Occurrence: A = Abundant (>20 individuals); C = Common (5-20); R = Rare (<5); (--) = Absent.

SPECIES	Butz Run	Indian Run	Forest Hill Run	Cranberry Creek	Paradise Creek
Brown trout *Salmo trutta*	A	A	A	A	A
American eel *Anguilla rostrata*	C	--	C	R	C
Longnose dace *Rhinichthys cataractae*	R	--	R	C	R
Blacknose dace *Rhinichthys atratulus*	C	--	--	C	C
Cutlips minnow *Exoglossum maxillingua*	C	--	--	--	C
Slimy sculpin *Cottus cognatus*	--	A	--	C	--
Brook trout *Salvelinus fontinalis*	--	A	--	R	--
White sucker *Catostomus commersoni*	--	--	--	--	A
Margined madtom *Noturus insignus*	R	--	--	--	--
Brown bullhead *Ameiurus nebulosus*	--	--	--	--	R
Bluegill *Lepomis macrochirus*	--	R	--	--	--

Table 2. Classification of fish species collected in tributaries to the Paradise Creek in September, 2003.

SPECIES	Distribution	Temp.	Trophic Class	Tolerance
Brown trout *Salmo trutta*	S	C	TC	I
American eel *Anguilla rostrata*	S,L	W	TC	T
Longnose dace *Rhinichthys cataractae*	B,S	CW	BI	M
Blacknose dace *Rhinichthys atratulus*	B,S	CW	GF	T
Cutlips minnow *Exoglossum maxillingua*	S,L	W	BI	I
Slimy sculpin *Cottus cognatus*	B,S	C	BI	I
Brook trout *Salvelinus fontinalis*	B,S,L	C	TC	I
White sucker *Catostomus commersoni*	S,L	CW	GF	T
Margined madtom *Noturus insignus*	S	W	BI	M
Brown bullhead *Ameiurus nebulosus*	S,L	W	GF	T
Bluegill *Lepomis macrochirus*	S,L	W	GF	M,T

KEY

Distribution: B = brooks (flowing waters <5 m wide); S = streams (flowing waters 5-10 m wide); R = rivers (flowing waters >10 m wide); L = lakes (ponds & reservoirs).

Temp. class : C = coldwater (<22 C); W = warmwater (>24 C); CW = coolwater (inhabits both types).

Trophic Class: TC = top carnivore (feeds on fish and insects); BI = benthic invertivore (feeds on aquatic insects); GF = generalist feeder (omnivore, i.e., feeds on available plants and animals).

Tolerance (to environmental perturbation): I = Intolerant; T = Tolerant: M = Intermediate.

Slimy sculpin and brook trout, two "coldwater" species with very demanding spawning requirements, were collected only in Indian Run and Cranberry Creek. Spawning females of sculpin deposit adhesive eggs on the underside of boulders and large cobble in early spring. Brook trout require upwelling groundwater (springs) where a nest is excavated in suitable sized silt-free gravel and cobble in late fall; fry hatch the following spring after a four-month incubation period. Both species are benthic invertivores, i.e., feed primarily on aquatic macroinvertebrates.

Four other fish species were sampled, each at only one stream location: White sucker and brown bullhead in Paradise Creek, margined madtom in Butz Run, and bluegill in Indian Run. Both white sucker and brown bullhead are bottom feeders that prefer deep pools with a silty substrate, features more commonly found in warmer, low gradient streams. However, suckers spawn in early spring when temperatures approach 40 degrees F and are often associated with trout in cold, undegraded streams. Distribution of margined madtom, like bullhead a member of the catfish family, is limited to warmer Pocono streams. The presence of bluegill (sunfish) in cooler Pocono streams can often be attributed to individual fish that have escaped from upstream impoundments. Distribution of most members of the sunfish group is restricted to lakes and ponds; spawning in streams is rare.

Salmonids

Numbers and biomass (weight per unit area of stream) of wild brown trout varied widely in the five waterways sampled. These differences, along with the fish species composition, were useful in characterizing the water quality and habitat features of each stream (see next section). Brown trout, although adaptable to a wide range of temperatures and stream conditions, cannot tolerate high water temperatures (>75 degrees F) for extended periods and have very specific requirements in order to survive, grow, and reproduce. Hence, there is a greater focus on this species because their presence is indicative of fairly high water quality and habitat in the resident stream.

Successful reproduction defines whether a wild trout population exists. Young-of-year (0+ age) brown trout were present in Paradise Creek and all four tributaries, evidence for successful spawning in the fall of 2002 (Table 3). These fingerlings measured less than 110 mm (4.3 inches) and were most abundant at the Cranberry Creek and Butz Run electrofishing sites and least numerous in Paradise Creek. [Bear in mind that the total area sampled differed among sites, with the Cranberry and Paradise Creek areas being much larger than the other three]. Adult brown trout apparently found suitable spawning substrate, generally a mix of gravel and cobble at the tails of pools or heads of riffle areas, in all the streams. High natural mortality of eggs, fry and

Table 3. Summary of electrofishing data for wild brown trout in tributaries of Paradise Creek in September, 2003.

	LOCATION				
	Butz Run	Indian Run	Forest Hill Run	Cranberry Creek	Paradise Creek
Sampling - length (feet)	285	260	215	300	330
width (feet)	13	13	15	28	32
area (hectares)	0.035	0.031	0.031	0.079	0.097
(acres)	0.086	0.077	0.076	0.195	0.238
Number of trout collected					
<110 mm (4.3 in.)	32	18	16	50	4
110-199 mm (4.3-7.9 in.)	4	12	24	25	18
>=200 mm (>=7.9 in.)	2	4	22	27	41
Total	38	34	62	102	63
Population estimate					
<110 mm (4.3 in.)	50	21	16	65	4
>=110 mm (>=4.3 in.)	6	17	46	59	62
Total estimated biomass					
kg./hectare	18.5	26.6	139.4	83.5	74.0
pounds/acre	16.5	23.8	124.5	74.6	66.0
Coefficient of condition (k)					
<110 mm (<4.3 in.)	0.86	0.90	0.96	0.93	1.03
110-199 mm (4.3-7.9 in.)	0.95	0.94	0.99	0.98	0.97
>=200 mm (>=7.9 in.)	1.01	1.07	0.97	1.01	0.93

fingerlings may explain the lower numbers on some streams. Since no previous data are available for comparison, the abundance or scarcity of young-of-year trout may represent normal conditions. Additional sampling on other areas of the same stream or in other years would give a more precise picture of reproduction and mortality.

Abundance of adult, legal-size (>200 mm, or >7.9 inches) brown trout also varied among the streams. Larger fish were most numerous in Paradise Creek, Cranberry Creek, and Forest Hill Run, while Butz Run and Indian Run, the smallest (narrowest) waterways, held the least. Larger trout require suitable refuge areas provided by undercut banks, boulders, overhanging roots, and deep pools, where they can escape predators and swift currents, particularly during storm events. Total area provided by these features is generally more limited in small tributaries.

Numbers of fish in balanced populations normally declines as fish grow due to mortality, and on most of the streams sampled this was the case (Table 3). Each size group (<110 mm, 110-199 mm, >200 mm) represents a specific age class, e.g., 0+, 1+, 2+ years, etc. Mortality thins the ranks, so that fingerlings are usually much more numerous than yearlings, which in turn are more abundant than legal-size trout. Paradise Creek displayed the worst balance, with numbers of young-of-year fish depleted while catchable-size trout were very abundant. These proportions can change yearly depending upon a myriad of factors – spawning success, stream discharge, and mortality (both natural and fishing, even cannibalism. However, streams with stable trout populations show the least year-to-year fluctuation.

Estimated biomass of wild trout on four of the five stream areas sampled exceeded 40 kg/hectare, the PA Fish & Boat Commission's standard for Class A waterways (Table 3). Only the weight of trout on Butz Run fell below this level. [The biomass of trout in Indian Run totaled 47.6 kg/hectare when the weight of wild brook trout was included.] Forest Hill Run clearly supported the highest weight per unit area of stream – almost 140 kg/hectare. Large numbers of legal-size trout in Cranberry and Paradise Creeks also sent biomass levels far above the standard. Indian Run was unique because the stream ecosystem supported an almost equal number and weight of both wild brook and brown trout – sympatric populations.

Growth rates of wild brown trout, based upon the length-frequency distribution (LFD) of fish, were similar among four of the streams sampled. Only Indian Run deviated somewhat with lower values than in Paradise Creek and the other tributaries. The LFD plots the number of trout collected in each size group; peaks in the graph represent the average size of a specific age group. For example, for Cranberry Creek these peaks occur at 80-90 mm, 170 mm, and 260 mm, corresponding to 0+, 1+, and 2+

year-old brown trout (Figure 2). Columns (points) to the left or right of the average represent fish of that age group that are smaller or larger, respectively. Cranberry Creek was chosen for graphing because more trout were collected there. If only a few larger trout are collected, such as in Butz Run, there aren't adequate numbers to create peaks, and estimation of growth using the LFD method is not recommended. More accurate aging of trout is possible by the microscopic examination of boney parts (scales, otoliths, fin rays) for annuli (annual rings).

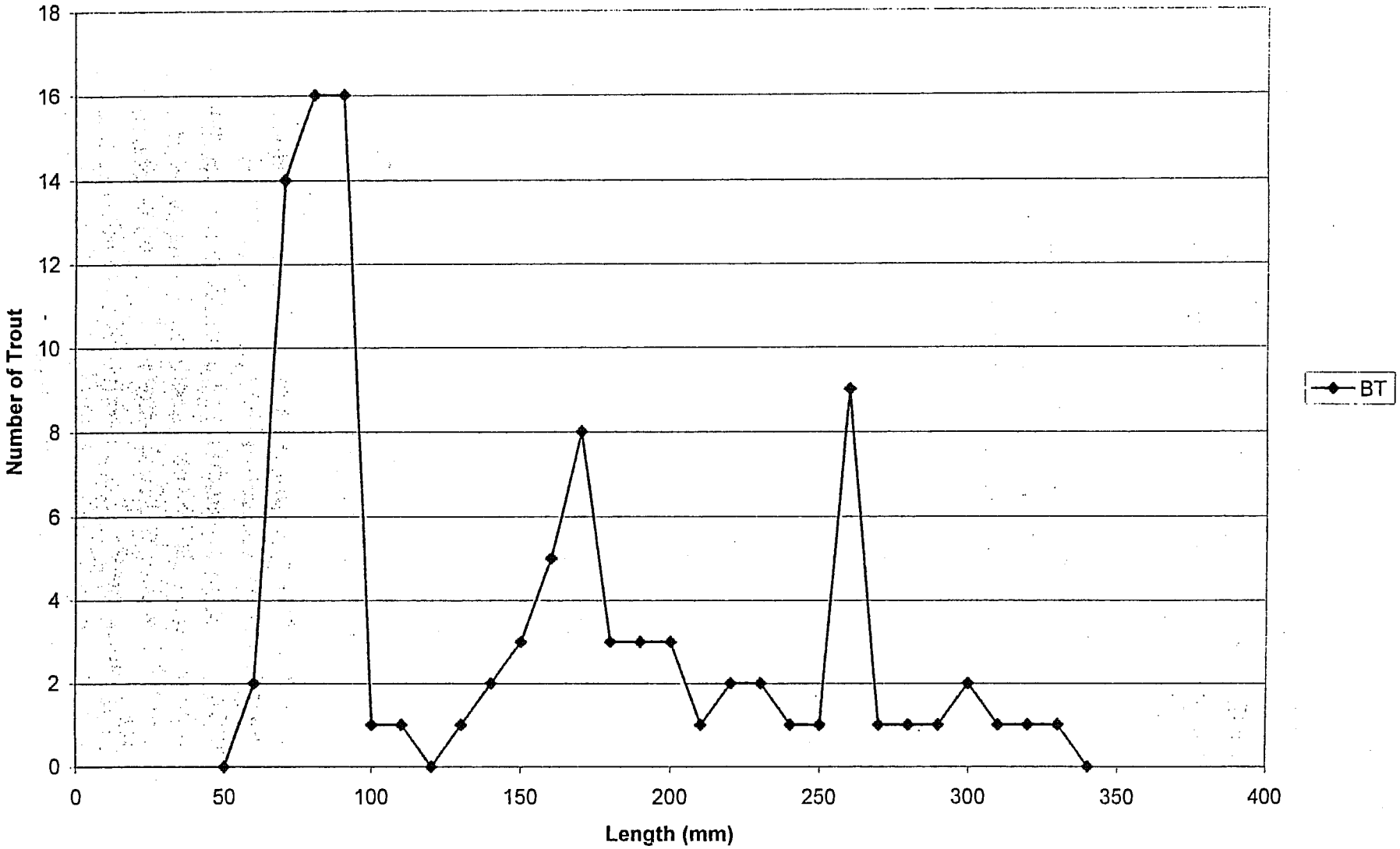
The condition of individual trout at the five locations sampled was generally good. Condition factor (K) is a statistical measure of a fish's weight in relative to its length; more robust fish have a higher condition. K for wild trout usually falls within the 0.90-1.10 range. Almost all size groups of wild brown trout on the five stream electrofished had values in this range (Table 3). Diseased or starving fish can exhibit low K values, and competition among fish for food and space can affect condition as well as high metabolism caused by elevated water temperatures. The lowest coefficient of condition recorded was for fingerling (mostly young-of-year) trout in Butz Run. Condition of the same size group in Indian Run was below the average K value calculated for trout in the other streams.

Stream Characterization

Each stream ecosystem, and stream area within that waterway, has a host of physical, chemical, and biotic features that regulates the number and species of fish found there. Water analysis is often used to measure water quality. However, water chemistry can change momentarily, whereas fish species composition usually remains fairly stable. Furthermore, each taxa can be classified using a number of criteria, including preferred temperature regime, habitat requirements, foraging strategy, and tolerance to environmental disturbance (Table 2). Hence, an assessment of the fish community can be used as a benchmark to measure and monitor changes in water quality. Following is a brief description or characterization of the five stream areas on the Paradise Creek watershed sampled in 2003 based upon the electrofishing results.

Paradise Creek – The "main stream" had the highest species diversity as expected since three of the other streams electrofished are smaller tributaries. This finding can be attributed to the more complex and diverse habitat features – variable depth, width, velocity, substrate, instream debris, etc. – offered by this larger stream. Paradise Creek supports a mix of cold, warm, and coolwater taxa with wide tolerances to environmental stress and feeding habits ranging from carnivores to omnivores to exploit the available forage. Wild brown trout predominated in collections, which had an abundance of legal-size fish (>200 mm) but few young-of-year (0+ age).

Figure 2. **Length-frequency Distribution of Brown Trout in Cranberry Creek, 2003**



Cranberry Creek – Biomass estimates for wild brown trout in this large tributary to the Paradise Creek were slightly higher than in the main stream. More fingerling trout were found here than at any other electrofishing station, indicative of excellent spawning conditions – suitable substrate, stable temperatures and flows. In addition, the wild trout population in this stream displayed the best balance among size (age) groups. The presence of brook trout and slimy sculpin and absence of several warmwater species found in the main stream suggests slightly cooler temperatures in summer.

Butz Run – Clearly, the fish species composition in this tributary that discharges into the lower Paradise Creek reflected the warmer temperature regime. Upstream impoundments may have a significant effect on water temperature and quality. Most taxa collected are classified as warm or coolwater, with brown trout the only coldwater species. The presence of numerous young-of-year indicated excellent reproductive success but adult trout were rare. Due to the sampling site's close proximity to the main stream, it's possible resident adults in Paradise Creek ascend Butz Run to spawn, then return to the main stream.

Indian Run – Located at the highest elevation in the watershed of the five electrofishing sites, this small tributary had only four fish species but probably the highest quality habitat and coolest summer temperatures. All taxa except the single bluegill, which probably escaped from a pond at the source, were coldwater species. Biomass estimates for wild brook trout (21.0 kg/hectare) were comparable to weight of brown trout (26.6 kg/hectare). Slimy sculpin, whose distribution is limited to only the coldest, least-degraded, sediment-free Pocono streams, were abundant.

Forest Hills Run – With its relatively steep gradient and boulder strewn, silt-free channel, this stream was a study in contrasts. Only three fish species were collected – one classified as coldwater, one warmwater, and one coolwater. Yet the wild brown trout biomass, almost 140 kg/hectare, far exceeded the estimated weight at the other stations and was well above the state standard for Class A wild trout waterways. The high productivity may be attributable to excellent habitat features, such as refuge provided larger trout by boulders and plunge pools, or possibly are a consequence of nutrient enrichment from upstream sewage discharges that "feed" the food chain (algae, aquatic macroinvertebrates).

SUMMARY

Electrofishing surveys of Paradise Creek and four tributaries revealed a diverse mix of fish species, reflecting the influence of water temperature, width, depth, sediment load, substrate composition, and habitat features on relative abundance. Eleven taxa were collected at the five stations, with the highest number taken on Paradise Creek (7) and the least on Indian Run (4) and Forest Hill Run (3). Wild brown trout predominated at each sampling site. American eel, longnose dace, and blacknose dace were the next most common species collected. Distribution of wild brook trout and slimy sculpin, two other "coldwater" species with demanding spawning requirements and an even lower tolerance to environmental degradation than brown trout, was limited to Indian Run and Cranberry Creek. Butz Run had the highest number of warmwater species.

Water quality at the five stream areas can be characterized as very good/excellent, based upon the abundance and biomass of brown trout. Fingerling (0+ years) brown trout were found at all five stations, indicative of successful reproduction in the fall of 2002. Total estimated biomass of trout on each stream showed extreme variation as did the relative number of fish in size groups that corresponded to age classes. Forest Hill Run had the highest weight per unit area, nearly 140 kg/hectare (125 pounds/acre), while Butz Run displayed the lowest – 18+ kg/hectare (17 pounds/acre). All the streams except Butz Run had values exceeding the Pa Fish & Boat Commission's standard for Class A Wild Trout Waters. On Indian Run, weight of wild brook trout nearly equaled that of brown trout. Legal-size brown trout (>200 mm, or 7.8 inches) were abundant on the largest streams – Paradise Creek, Cranberry Creek, and Forest Hill Run – but relatively scarce on the smallest, Butz Run and Indian Run. Average condition factors of different size (age) groups of brown trout were generally within normal ranges.

Land Use and Impervious Cover in the Paradise Creek Watershed: An Initial Assessment

Report To:

Paradise Creek Watershed Assessment and Protection Plan

Date: February 14, 2003

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Introduction

Land uses within the Paradise Creek Watershed, particularly those that create impervious surfaces such as asphalt, compacted earth, and rooftops are being increasingly monitored as concern over the integrity of this watershed grows. There is growing evidence that when impervious cover comprises more than 10% of a watershed, water quality and quantity begin to be affected[1]. Aside from an increase in imperviousness, land use such as residential development also causes fragmentation and destruction of habitats[2]. To assist in the Paradise Creek Watershed Assessment and Protection Plan, an estimate of impervious cover and an analysis of land use within this watershed are needed. Several types of data exist that allow land use classification and direct estimates of the amount of impervious cover including ground surveys, aerial photography, and satellite remote sensing; usually in conjunction with a Geographic Information System (GIS)[3]. This analysis attempts to quantify impervious cover and land use in this watershed using GIS to apply an existing land use classification based on aerial photography.

The Collaborative Environmental Monitoring and Assessment Program (CEMRI)[4] recently sponsored low-level aerial photography of the Delaware River Basin (including the Paradise Creek Watershed) to quantify land use, impervious cover and forest fragmentation. CEMRI provided their impervious estimation results and land use classification to the Pennsylvania Spatial Data Access (PASDA) website (http://www.pasda.psu.edu; Access Data, New Data Additions, September 2002) as a free GIS dataset available for download. A key advantage to this dataset is that the goal of the project was to overcome the limitations of existing satellite imagery and aerial photography complicated by the extensive forest canopy of this region. (see Appendix I).

Methods

The CEMRI land classification is a vector-based dataset, a commonly used image format in GIS that is comprised of contiguous geometric shapes (polygons), each containing information on such parameters as area and land use (Figure 1).

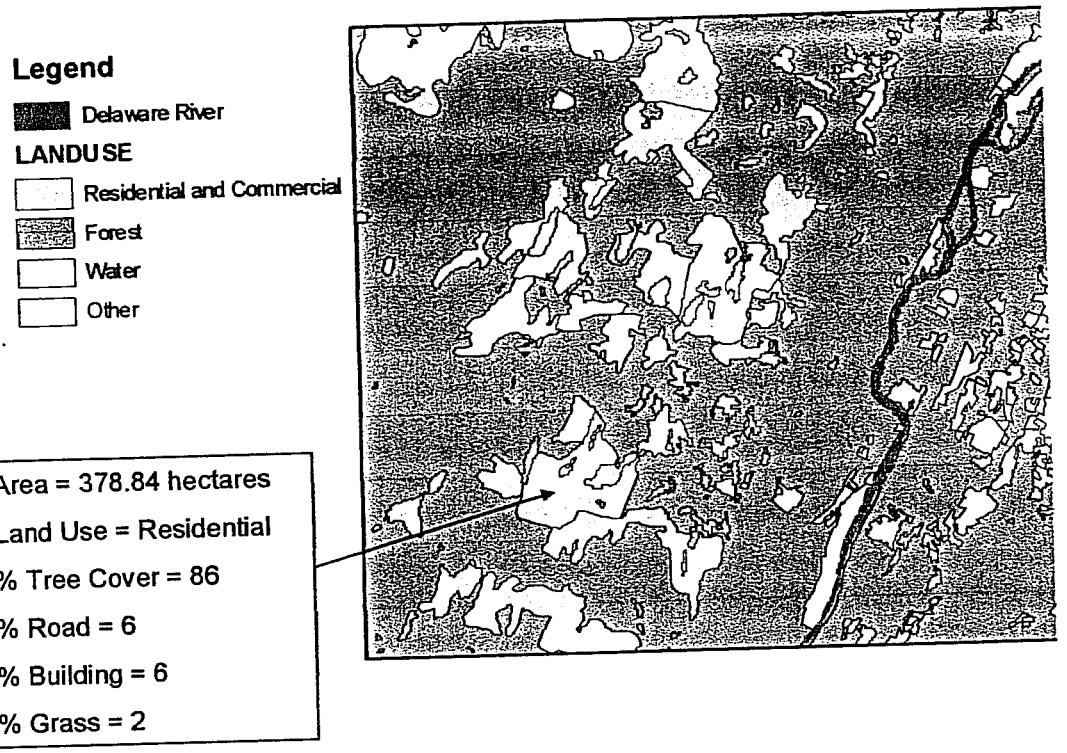

Figure 1. Portion Of CEMRI Land Use Polygons for the Delaware River Basin

Using a GIS, this image was clipped to the entire Paradise Creek Watershed and proposed management units within the watershed (Figure 2.).

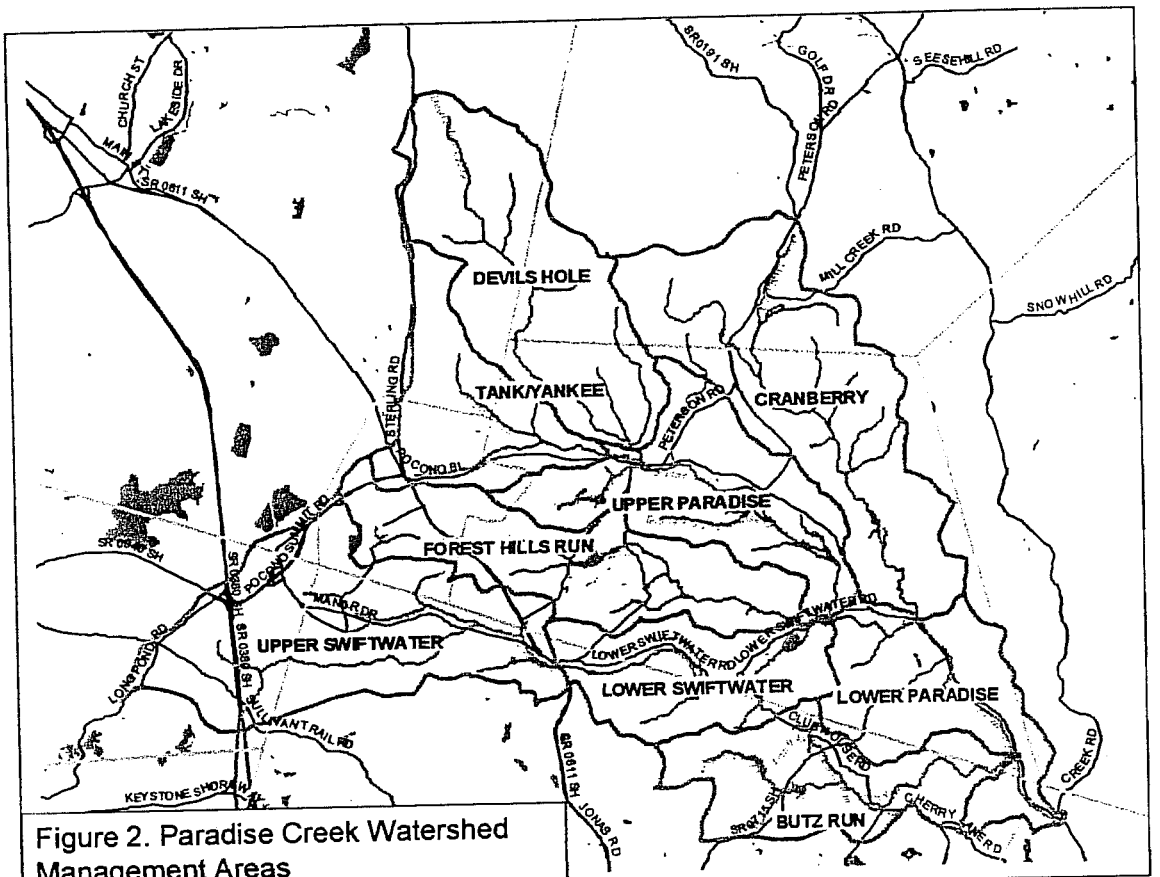

Figure 2. Paradise Creek Watershed Management Areas

The polygons within each clipped area were summarized according to the types and coverage of land use. CEMRI also estimated the percent area occupied by buildings and roads, forest, and grass cover for residential polygons. This allowed residential impervious surface area and forest cover to be calculated for each clipped area.

One problem with the CEMRI dataset needed to be overcome. Some polygons within the watershed were not classified due to occasional cloud cover obscuring the ground. These polygons were overlaid on 1999 flight file USGS digital orthophotos (available from PASDA) in the GIS, and classified according to their resemblance to CEMRI classified ones. For each of these polygons classified as residential, impervious percent cover values derived from averaging the entire CEMRI dataset were used (Table 1.). In order to determine impervious cover for other anthropogenic land use polygons (e.g. retail and industrial areas, roads) a value of 50% imperviousness was applied based on values described in the literature[1,5] and visual inspection of these polygons overlaid on the orthophotos. This value is conservative with regard to literature recommendations for some of these land uses but is considered more applicable to this analysis based on the visual assessment.

Table 1. Land Use Polygon Codes and Values Used For Impervious Cover Estimation.

CEMRI [1] Polygon Code	Description	CEMRI Impervious Cover Polygon Values (%) [2]	Impervious Cover Values Used For Unclassified Polygons (%) [3]
1101 1111 1112	Low Density Residential	Range: 4 – 18	CEMRI Mean: 10.597
1121 1122	Medium Density Residential	Range: 4 – 18	CEMRI Mean : 12.862
1130	High Density Residential	Range: 8 – 35	CEMRI Mean : 15.661
1140	Multi-family (apartments)	–	CEMRI Mean : 34.154
1210 1220	Commercial/industrial	–	50
1300	Urban open	–	50
1400	Transportation	–	50
1500	Powerlines	–	–
1600	Recreation	–	–
2100	Pasture	–	–
2200	Crop	–	–
4000	Forest	–	–
5200	Lake	–	–
5300	Pond	–	–
5500	Wetland	–	–
7200	Bare Soil/mining	–	–

1. Collaborative Environmental Monitoring and Research Initiative (CEMRI).
2. Impervious cover was provided for each residential class polygon by CEMRI except when photo interpretation was precluded by cloud cover.
3. For Commercial/industrial, Urban open, and Transportation polygons, values were based on visual inspection of 1-meter resolution 1999 digital orthophotos from the USGS and the literature. Means derived from the entire Delaware River Basin CEMRI classification were applied to residential class polygons with no data.

Results

Impervious cover for the Paradise Creek Watershed is estimated at 3.63% (Table 2).

Table 2. Summary of Results From Impervious Cover and Land Use Analysis

Watershed Management Unit	Area in Hectares	Land Cover Percentages		
		Impervious Cover	Other Land Use	Forest Cover
LOWER PARADISE	1010.97	0.85	4.14	95.01
CRANBERRY	1910.18	1.96	3.90	94.14
BUTZ	951.43	2.63	12.51	84.86
DEVILS HOLE	1590.97	2.93	1.85	95.22
FOREST HILLS	1233.65	3.68	16.21	80.11
LOWER SWIFTWATER	863.81	3.81	13.71	82.48
UPPER SWIFTWATER	1782.63	5.51	11.65	82.85
UPPER PARADISE	1172.80	5.54	11.48	82.98
TANK-YANKEE	828.30	6.31	4.22	89.46
Calculated for Entire Watershed:	**11344.78**	**3.63%**	**8.47%**	**87.91%**

The Tank-Yankee, Upper Paradise, and Upper Swiftwater management units had the highest impervious cover values (5.51 to 6.31%) and the Lower Paradise and Cranberry management units had the lowest (< 2%). In general, the opposite trend is observed for percent forest cover, although the proportion of other land uses is more variable, resulting in the unit with the most impervious cover, Tank-Yankee (6.31%), having the fourth highest forest cover (89.46%). Forest cover is notable in that it is consistently high, with a value of more than 87% for the entire watershed, and ranging from approximately 80% to 95% for the management units.

Figure 3 shows individual management unit maps summarizing the types of land uses present (see Table 1 for code descriptions) and graphically illustrating the proportion of land cover types. A detailed assessment of all land use present in these management units is beyond the scope of this research; however, some general trends are evident. Diversity and types of land use vary across management units. Forest Hills is diverse, with 12 land use categories while Lower Paradise has only four. Management units such as Devils Hole and Lower Paradise are largely contiguous forest; Butz Run and Upper Paradise have more agricultural use; and Tank-Yankee, Forest Hills, and Lower Swiftwater have the most area allocated to residential and commercial use. It is important to note that while Tank-Yankee is dominated by residential development, these areas contribute almost 25% to the overall forest cover of this unit. The distribution of land use relative to waterways is also varies. Most of the