Mill Creek Watershed Coldwater Conservation Plan

Prepared by the Delaware Riverkeeper Network

December 2007

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The Delaware Riverkeeper Network (DRN) **The Delaware Riverkeeper Network (DRN)** is the only advocacy organization working throughout the entire Delaware River Watershed. The Delaware Riverkeeper is an individual who is the voice of the River, championing the rights of the River and its streams as members of our community. The Delaware Riverkeeper is assisted by seasoned professionals and a network of members, volunteers and supporters. Together they form DRN, and together they stand as vigilant protectors and defenders of the River, its tributaries and watershed. DRN is committed to restoring the watershed's natural balance where it has been lost and ensuring its preservation where it still exists.

Cover photo: James Hartman/Barry Pounder

Foreword

The goal of a coldwater conservation plan is ultimately to improve the health of the coldwater ecosystem for which the plan is prepared. Although the Mill Creek watershed is currently designated a Trout Stocking Fishery, anecdotal information had suggested that Mill Creek might qualify as a Cold Water Fishery, thereby gaining a greater degree of protection under Pennsylvania regulations. Under this plan, the Delaware Riverkeeper Network set as objectives:

- Gathering and reviewing existing Mill Creek watershed data,
- Conducting an Integrated Assessment of the Mill Creek watershed,
- Determining the appropriateness of pursuing a stream upgrade for the Mill Creek watershed.

Existing data has been reviewed and the Integrated Assessment completed, but the suitability of the Mill Creek watershed for an upgraded designation remains unclear. This effort does illustrate the important role that streamside vegetative buffers play in protecting water quality. The Stroud Water Research Center recently conducted an analysis of stream categories and conditions drawing on its 11-year study of the Schuylkill River basin. In this analysis, the primary factor governing macroinvertebrate quality, an important factor in determining stream designation in Pennsylvania, was found to be forest cover. The Mill Creek's forest coverage is projected to be less than 33%. The Stroud Center found that a reduction in forest cover, relative to Cold Water Fisheries, was an important factor distinguishing Trout Stocking Fisheries. The Mill Creek watershed's reduced forest may then be a factor in the overall health of this system. Conversely, an increase in forest cover could result in improvements in water quality and ecosystem health.

Establishment of streamside vegetative buffers in the Mill Creek watershed is an important recommendation of this plan. It is critical for the health of our streams and rivers that we provide and protect forested buffers that are a minimum of 100 feet wide, and greater where we have more sensitive streams such as in the headwaters of the Mill Creek. Buffers of a minimum 100-foot width are essential to protect our communities from flooding, drought and pollution, if we are to provide our communities with high quality drinking water, recreation, and growing businesses.

We must also increase awareness of the importance of riparian buffers. A 2004 Berks County Planning Commission survey of county residents' preferences for recreation, parks, heritage, and ecological issues found that water quality and streams/other water bodies were deemed the top two ecological/natural resources deserving preservation or conservation, but "riparian buffers" ranked near the bottom of the list. Streamside buffers help protect water quality by absorbing nutrients and pollutants, slowing rainwater runoff and filtering out sediments, but Berks County residents don't appear to be making the connection between healthy buffers and healthy streams.

This Mill Creek watershed coldwater conservation plan is offered as a guidebook for landowners, municipalities, conservation groups, and citizens interested in taking concrete steps to enhance the long-term health of the Mill Creek watershed and identify priorities for protection and restoration of streamside lands.

Maya K. van Rossum,
the Delaware Riverkeeper

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General Recommendations

- *Formally organize a Mill Creek Watershed Association.*

  Citizen groups have formed across Berks County to provide vehicles through which projects to protect and restore local streams can be implemented. An organized effort to protect the Mill Creek watershed could help to improve the health of this waterway.

Potential Mill Creek Watershed Stakeholders

Watershed residents
Watershed businesses
Landowners (public, private, and corporate)
Hamburg Area School District
Berks County Conservation District
Farmers and farm organizations
Scouting, 4-H and other youth groups
Service organizations (e.g., Rotary, Lions Clubs)
Conservation and sporting groups (e.g., Blue Mountain Wildlife and Federated Sportsmen's Clubs of Berks County)
Hiking Clubs (e.g., the Appalachian Trail Club)
Berks County Conservancy
Berks County Planning Commission
Audubon Pennsylvania's Kittatinny Ridge Project
Albright College
Consulting firms/Environmental professionals
Penn State Cooperative Extension
Pennsylvania Department of Conservation & Natural Resources (PA DCNR) Rivers Conservation Program
PA DCNR Bureau of Forestry
Pennsylvania Department of Environmental Protection, (PA DEP) Bureau of Watershed Conservation
PA DEP's Reading District Office
PA DEP's Southcentral Regional Office
Pennsylvania Department of Transportation
Pennsylvania Fish and Boat Commission
Pennsylvania Game Commission
United States Geological Survey

- *Increase opportunities for students in the Hamburg Area School District to participate in watershed education and hands-on riparian restoration.*

  The Mill Creek watershed takes in portions of the Hamburg Area School District. Limited environmental studies classes area offered for high school students. Such classes present students with opportunities to begin answering questions about impacts to water quality in the Mill Creek watershed. In addition, students can gain hands-on experience in watershed monitoring and stream restoration and protection methods that they may also pass along to other member of their communities. Experiential watershed protection training would result in on-the-ground streamside improvements to protect the Mill Creek watershed now, and would also influence land management practices of the next generation of landowners.

- *Increase awareness of the essential role that streamside plant buffers play in protecting the health of streams.*

  Streamside plantings, or riparian buffers, help protect water quality by absorbing nutrients and pollutants, slowing rainwater runoff and filtering out sediments, but Berks County residents to not appear to be making the connection between the need to protect riparian buffers in order to protect water quality and stream health. In 2004, the Berks County Planning Commission surveyed County residents about recreation, parks, heritage, and ecological issues in order to guide development of the County's Greenway, Park, and Recreation Plan. Water quality and streams/other water bodies were the top two ecological/natural resources selected as deserving preservation or conservation. However, riparian buffers were considered among the least important ecological/natural resources to be preserved or conserved.

- *Establish a continuous riparian corridor along the Mill Creek and its tributaries.*

  The establishment of streamside buffers would also help to prevent soil erosion in this largely agricultural watershed, reduce the energy of floodwaters, and, through shading, lower water temperatures which would improve fish habitat. Greater public education about buffer benefits coupled with an incentive-based approach for buffer establishment is needed.

- *Preserve Open Space*

  Large areas in the Mill Creek watershed are still at risk because they are zoned for development. Build out of the watershed could significantly increase the amount of developed, impervious areas. More work needs to be done to protect farmland in the watershed, especially contiguous and core forests on these farms.

  In 2006, the Berks County Commissioners established a Conservation Zoning Incentive Program to preserve natural areas, farmland and open space in Berks County by providing funding to local government for the purchase of land or conservation easements. $12,000,000 will be allocated to projects throughout the County through the end of 2009. Upper Bern Township is participating in this program. However, as of this printing, funding for this program is in doubt.

  In addition to state and county farmland preservation programs, two funds for open space and farmland preservation exist at the Berks County Community Foundation: The Conservation Equity Funds which support the preservation and/or conservation of open space, environmentally sensitive land; and the Fund for Farmland Preservation which was established in conjunction with the Berks County Conservancy to ensure the preservation of farmland and open space within Berks County.

- *Increase coordination between Tilden and Upper Bern Township to protect and restore the Mill Creek watershed.*

  Environmental Advisory Councils (EACs) are empowered to provide guidance to township supervisors and other township boards regarding environmental concerns. In the Mill Creek watershed, EACs could promote community environmental programs focusing on improving watershed health which would benefit quality of life in both communities. EACs can undertake community outreach, but they are not intended to compete with the efforts of a local watershed group (the formal organization of such a group is also recommended). EACs can serve as a point of contact for these and other community groups working to protect natural resources.

  Upper Bern Township established an Environmental and Agricultural Advisory Council (EAAC) in 2005. Tilden Township recently established an EAC as well. These two groups, working together, could better address watershed-based planning that will help ensure long-term protection of a shared resource. These two Advisory Councils have expressed interest in combining efforts for preserving the Mill Creek. They have specifically expressed increasing awareness of the importance of riparian buffers as well as undertaking a more complete stream assessment to include those areas that were not accessible for the report.

The Benefits of Protecting and Restoring Headwater Streams

Where do rivers begin? Headwaters streams, referred to as first or second order streams, mark the beginnings of our waterways. The smallest streams, or first order streams, are those intermittent or perennial streams that have no other streams flowing into them. When two first order streams come together, they form a second order stream. In the Schuylkill River system, first and second order streams comprise nearly 60% of the watershed's more than 2,000 stream miles. Much of the Mill Creek watershed's stream miles would be counted among that 60%. The health of small streams like the Mill Creek has significant implications for the health of the Schuylkill River itself. There is an increasing recognition of the need for more research to better understand the influence of headwater streams on the health of watersheds even as recent Supreme Court rulings and decisions by regulators have narrowed the federal authority to protect many upstream and wetland areas.

The benefits we receive from healthy and functioning headwater streams and associated wetlands, or ecosystem services, include natural flood control, groundwater recharge, sediment and pollution trapping, and nutrient recycling. They help to sustain biological diversity and the biological productivity of the larger rivers they feed. Ecosystem services have real economic benefits associated with them although placing a precise dollar value on them may be difficult. However, we can predict that actions that enhance the health of headwaters streams, such as protecting and restoring vegetative buffers along streams, will positively impact income from fishing and property values while reducing flood control costs, stormwater quality and quantity treatment costs, and restoration costs.

Assigning dollar values to benefits generated by recreational opportunities is more readily done for healthy and functioning streams, like Mill Creek, that have long been regarded as a popular fishing stream. The Pennsylvania Fish and Boat Commission reports that angling on stocked trout streams contributed over $65.7 million to the state's economy during the first eight weeks of the regular 2005 trout season. In addition, angling on stocked trout streams supported 1,119 jobs in Pennsylvania. In West Virginia, it has been estimated that each mile of trout stream provides over $40,000 in economic benefit to that state annually.
Trout fishing has economic benefit for many local businesses: motels, restaurants, gas stations, local bait and tackle shops, sporting goods stores, and guide services. The presence of a Cabela's store in Tilden Township attests to the value of healthy streams and the potential for recreational opportunities in the region. This outfitting store, built in 2003 just out of the Mill Creek watershed, is promoted as one of the largest tourist attractions on the East Coast and targets outdoorsmen of the Poconos, Central and Eastern Pennsylvania and even New York City.

Too often, the health and function of our headwater streams is sacrificed to the supposed economic opportunity associated with development. The potential economic benefits from ecosystem services are not fully presented, preventing decision-makers from making informed decisions about opportunities associated with not developing. When the potential economic benefits from ecosystem services are fully presented, decision-makers often see that protecting and restoring headwater streams have benefits meriting investment in this work.

The Mill Creek Watershed

Study Area

The Mill Creek study area is located in Berks County and extends from the creek's headwaters east of Shartlesville to its confluence with the Schuylkill River below Hamburg. The Mill Creek watershed includes portions of Upper Bern and Tilden Townships. There are no incorporated municipalities in the Mill Creek watershed.

Hydrology

The Mill Creek rises along the Blue Mountain in Upper Bern Township, Berks County, and flows approximately 8 miles east and south to its confluence with the Schuylkill River in Tilden Township. The creek's drainage area covers over 17 square miles. Mill Creek tributaries include Hassler Run, which has a drainage area of over 3 square miles, and several unnamed streams. Prior to 2006, Hassler Run was Mill Creek's only officially named tributary. In June 2006, unanimous approval was given by the United States Board on Geographic Names Domestic Names Committee to apply the new commemorative name Wolfe Run to an unnamed, 2-mile long tributary of Mill Creek.

Geologic and Topography

The major ridges of the Mill Creek watershed run along Blue Mountain and are underlain by sandstone and quartz-rich rock of Shawangunk formation. The narrow band of the Appalachian Mountain section of the Ridge and Valley province that runs across the northernmost part of Berks County, and the Mill Creek watershed, rises in elevation to over 1,500 feet. In the valleys below Blue Mountain, the Great Valley section of the Ridge and Valley province, Hamburg sequence shales and greywacke, a quartz sandstone, comprise the bedrock. In the valley section of the Mill Creek watershed, elevations range from 340 feet to about 600 feet.

A stream's buffering capacity indicates its ability to neutralize acidic pollution and depends largely on the underlying bedrock. The better the buffering capacity of the bedrock, the greater the likelihood that negative impacts to the stream from acidic precipitation and associated runoff can be neutralized and effects on aquatic life reduced. None of the Mill Creek watershed's underlying rock types affords significant buffering capacity. As a result, air pollution and careless actions on the land can have serious implications for the long-term health of the watershed and the aquatic organisms that depend on it. Some studies have shown that streams with low buffering capacity also have low fish species richness.

The type of bedrock in a watershed also affects water quantity. The water-bearing properties of the Mill Creek watershed's bedrock are somewhat limited. Areas underlain by shale typically produce only small amounts of water. This limitation must be considered when planning for land use and density of residential development. If these groundwater limitations are not considered, domestic water supplies will be diminished or exhausted, especially during a drought. With stream baseflow inextricably linked to groundwater, diminished groundwater levels can have serious implications for aquatic life.

Soils

Weathering of shale and siltstone form the basis of the soils of the Mill Creek watershed. These soils can be grouped into two associations: the Hazleton-Dekalb-Buchanan Association, found along the upper slopes and crest of the Blue Mountain, and the Berks-Weikert-Bedington Association, which extend across the Great Valley section of the Ridge and Valley province. The majority of the Mill Creek watershed's prime agricultural soils are located within this Great Valley section.

- *Hazleton-Dekalb-Buchanan Association* consists of deep and moderately deep soils formed in material weathered from acid sandstone, quartzite, and conglomerate. These soils can be marked by instability and stoniness. They have low natural fertility and are poorly suited to crops. Buchanan soils tend to have a seasonally high water table and standing surface water can present management problems.
- *Berks-Weikert-Bedington Association* consists of shallow to deep, well-drained soils formed in material weathered from slightly acid shale and siltstone. These soils have a tendency to be droughty and erosion can be a problem. With slopes of 8% or more, runoff is medium to rapid and the hazard for erosion is moderate to high. Berks and Weikert soils have moderate to low natural fertility. With Weikert soils, which tend to be steeper and shallower than the other soils in the association, depth to bedrock (1 1/2 to 3 feet) can limit use.

Weather

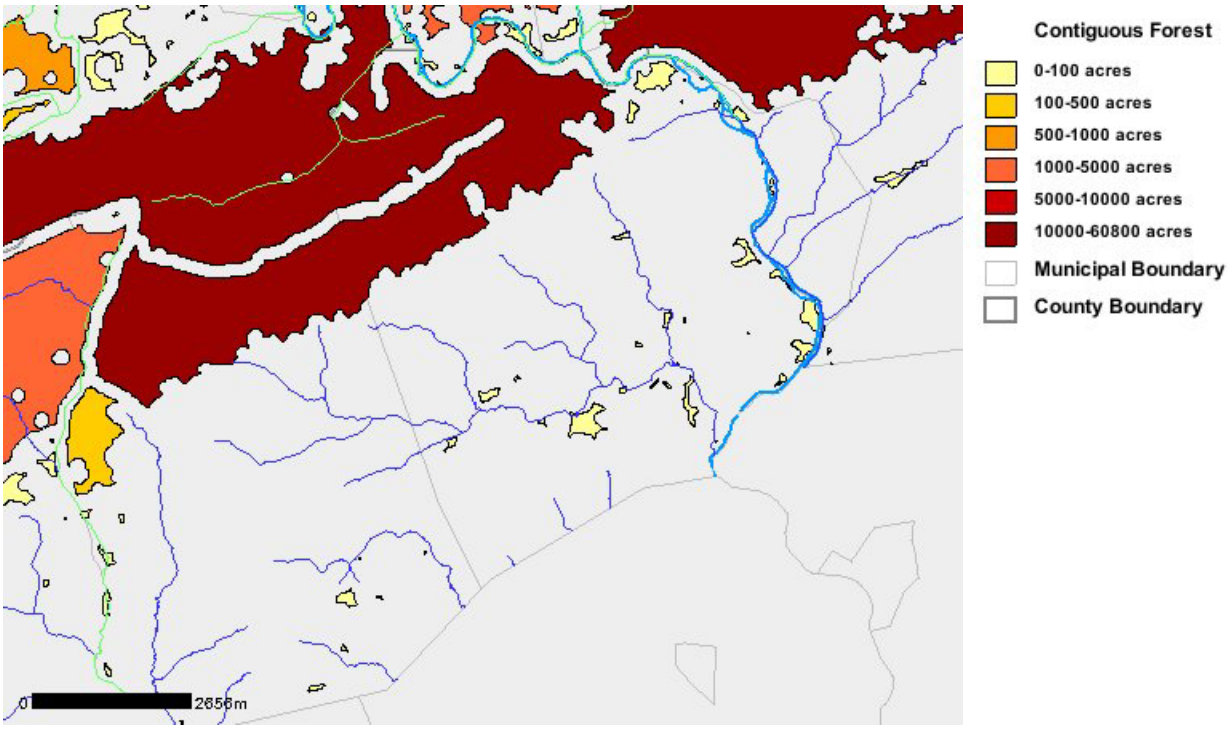
The climate of Berks County is fairly mild, with warm humid summers and mild winters. Average monthly temperatures range from 30° F in January to 77° F in July. Local variations result primarily from differences in elevation.

Near Blue Mountain, average winter temperatures are lower than in the southern part of the county and snow accumulation can be greater. Total precipitation near Blue Mountain averages 44 inches annually, however rainfall can be slightly less over lower parts of the watershed.

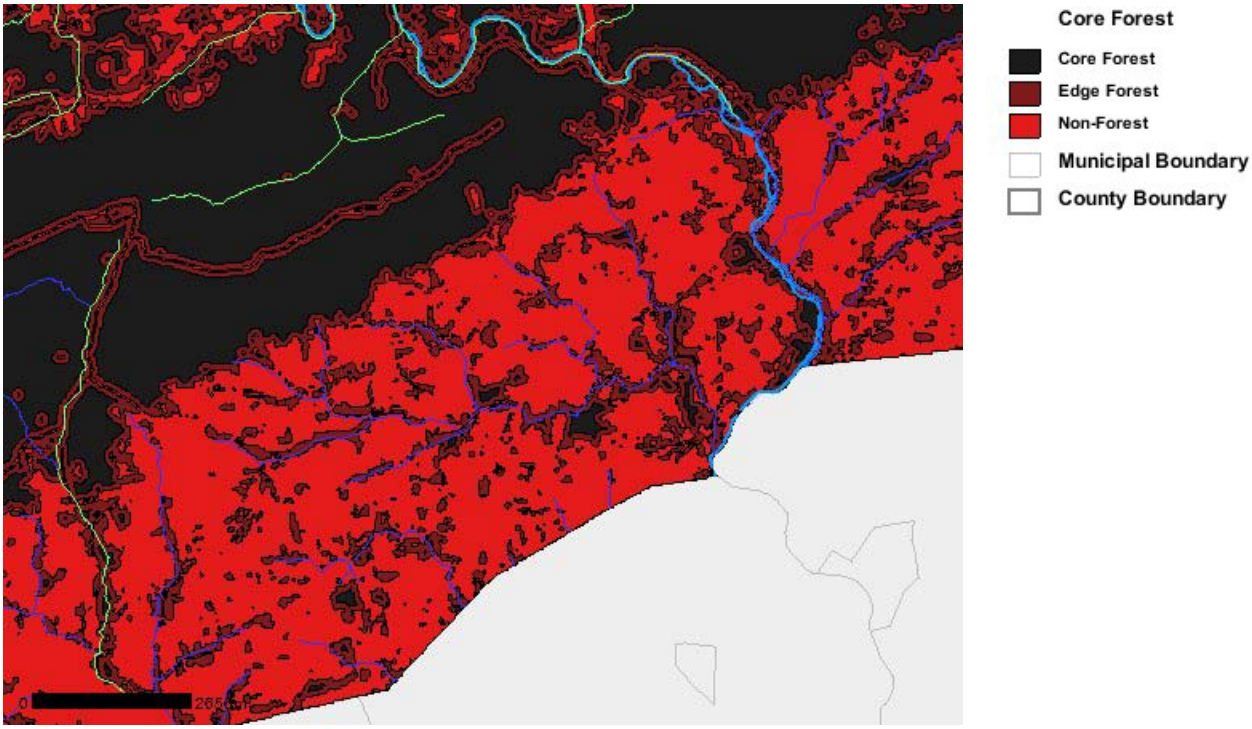
Land Use

State protected lands (State Game Lands 110) extend into the headwaters of the Mill Creek watershed. Although the preserved nature of state game lands affords some measure of protection to the Mill Creek's headwaters, the Pennsylvania Game Commission has conducted a series of timber sales in Game Lands 110 and plans to do more in the future. The forests along Blue Mountain, the largest forested area in Berks County, have been identified as being among sites of statewide significance for the protection of biological diversity (*A Natural Areas Inventory of Berks County, Pennsylvania*).

Once out of the forested, steep slopes of Blue Mountain, the Mill Creek watershed's land use is largely agricultural. The Mill Creek watershed is estimated to be less than 33% forested (*Schuylkill Watershed Conservation Plan*). The Berks County Conservancy's *Upper Schuylkill River Watershed Protection Plan* lists problems in the Mill Creek watershed associated with cattle in streams, degradation associated with livestock access to creeks, agricultural runoff, and stream bank erosion as well as the need to protect wetland areas.

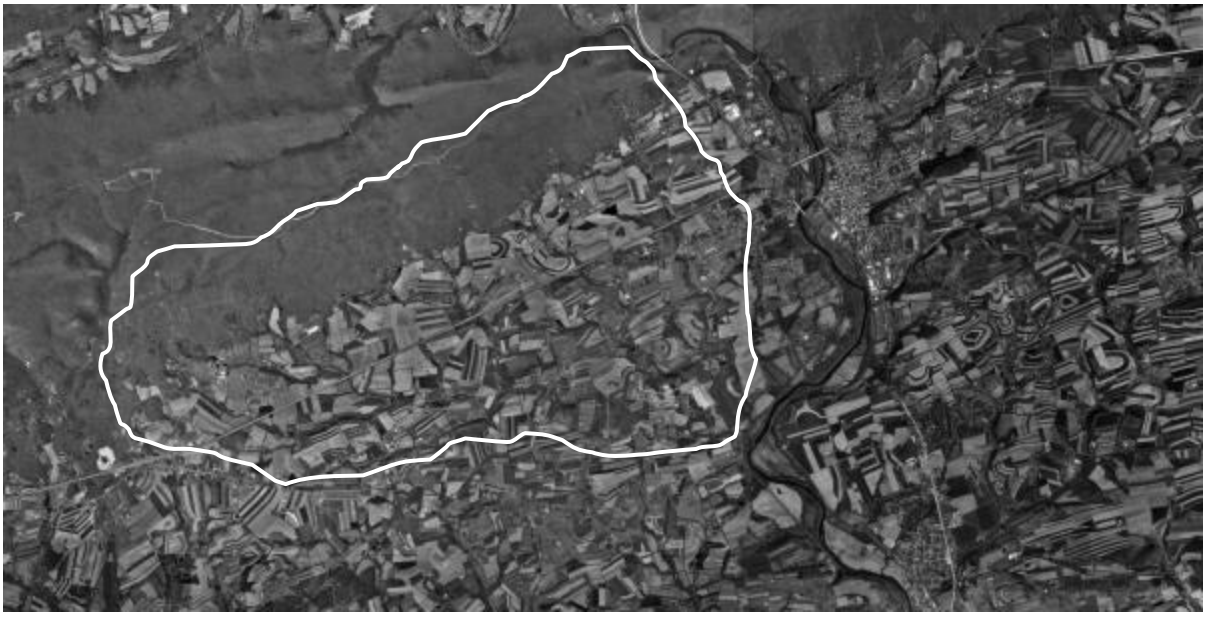


Map 1: Contiguous Forest in the Mill Creek Watershed. Prepared online at http://pa.audubon.org/kittatinny/. *Copyright 2007 by National Audubon Society, Inc., 700 Broadway, New York, NY 10003, USA. All rights reserved.*



Map 2: Core Forest in the Mill Creek Watershed. Prepared online at http://pa.audubon.org/kittatinny/. *Copyright 2007 by National Audubon Society, Inc., 700 Broadway, New York, NY 10003, USA. All rights reserved.*

The Digital Ortho Quadrangle aerial image below, with the Mill Creek watershed roughly outlined in white, illustrates predominant agricultural land use. Just as the forested headwaters can be clearly discerned, only small areas of streamside vegetation are present to protect water quality throughout the lower parts of the watershed.



Map 3: The Mill Creek Watershed Digital Ortho Quadrangle. Image compiled online from Terraserver-USA, courtesy of USGS.

Agriculture may be the predominant land use in the Mill Creek watershed at this time, but sprawling development poses a threat to stream health. A look at housing development and population growth (*Berks County Data Book*) shows that the agricultural character of the watershed is changing more rapidly than anticipated. The pace of this development is even more obvious in Tilden Township.

Table A: Mill Creek Townships - Municipal Population Density in 2000

Municipality	**Land Area (square miles)**	**Population (2000 Census)**	**Population Density (persons per square mile)**
Tilden Twp.	18.99	3,553	187.1
Upper Bern Twp.	18.25	1,479	81.1

Table B: Mill Creek Townships - Municipal Housing Units 1980, 1990, 2000 and beyond

				Change 1990 - 2000		**2000 to 2004**
Municipality	**1980**	**1990**	**2000**	**Number**	**Percent**	**Units Added**
Tilden Twp.	739	887	1,357	470	53.0%	185
Upper Bern Twp.	431	577	611	34	5.9%	58

Table C: Mill Creek Townships - Municipal Population Projections

Municipality	Population (2000 Census)	Based on PPH* info, units added, 2000-2004	Units Added, 2005	Units Added, 2006	2010	2020	2030
Tilden Twp.	3,553	2.73 x 185 = 505.5	22	20	3,764	3,989	4,228
Upper Bern Twp.	1,479	2.66 x 58 = 154.28	14	3	1,567	1,660	1,760

* *PPH: People per housing unit*

In Tilden, build out of its Rural Conservation areas, as designated in the county comprehensive plan, *Berks Vision 2020*, coupled with build out of the Designated or Future Growth Areas, would more than double the developed areas in the township. Moreover, only 122 acres, or 0.26% of Tilden Township's land area, has been protected under one Agricultural Conservation Easement.

In Upper Bern, build out of the *Berks Vision 2020* Rural Conservation areas, coupled with build out of the Designated or Future Growth Areas, would nearly triple the developed area in the township. In Upper Bern, 933.5 acres, or 2.04% of the township's land area has been protected under eight Agricultural Conservation Easements.

Table D: Mill Creek Townships - *Berks Vision 202*0 Designated Land Use

Municipality	Agricultural Preservation	Developed	Environmental Hazards	Designated Growth	Future Growth	Open Space	Rural Conser-vation
Tilden	3,748	2,316	762	70	568	2,278	2,552
Upper Bern	5,797	1,128	261	69	260	2,192	1,813

Sprawling development is accompanied by an increase in the amount of impervious surfaces -- roads, parking lots, driveways, and rooftops. As impervious surfaces increase, the amount of precipitation that is allowed to filter into the soil is decreased and the amount of runoff is increased. Stormwater runoff enters streams in greater volume and with greater velocity, scouring stream banks and beds and damaging stream ecosystems.

Stormwater runoff can begin to cause degradation when the total area of impervious surfaces reaches 10% of the total watershed area. For the Mill Creek watershed, that means that degradation of stream health begins at less than 2.5 square miles, or 1,600 acres, of impervious surface area. A stormwater management plan has been prepared for the Berks County portion of the Schuylkill River watershed that includes the Mill Creek and its tributaries. This plan supports maintaining the existing hydrologic regime in the watershed as the best means to accomplish stormwater management. The plan recommends: Maintaining groundwater recharge; Implementing non-point source pollution removal methodologies; Reducing channel erosion; Managing overbank flood events, and Managing extreme flood events. The mechanisms will help maintain the existing hydrologic regime and address stream bank erosion, flooding, water quality, groundwater recharge, and stormwater management measures on development sites.

Tilden Township also falls under the federal National Pollutant Discharge Elimination System Phase II requirements for stormwater. The intent of the NPDES Phase II requirements is to improve waterways by reducing the quantity of pollutants picked up by stormwater and carried

into storm sewer systems during storm events. NPDES Phase II permitting covers discharges from municipal separate storm sewer systems in municipalities located within an urbanized area as defined by the 1990 Census and the 2000 Census, and construction sites over 1 acre. As such, Tilden Township is required to implement a stormwater management program that includes Best Management Practices, or BMPs, for six minimum control measures which include:

1. Public education
2. Public participation and involvement
3. Illicit discharge detection
4. Construction site stormwater runoff control
5. Post-construction stormwater management
6. Pollution prevention/good housekeeping for municipal operations maintenance.

Municipalities have until 2008 to enact the six minimum control measures. Upper Bern Township does not fall under the NPDES Phase II requirements.

Water quality in the Mill Creek watershed appears to be at greater risk from nonpoint source pollution (pollution sources without a single point of origin which are generally carried off the land by stormwater) than from point source pollution (a single identifiable source of pollution such as a discharge pipe). There only two permitted discharges to the Mill Creek watershed: Mountain Springs Mobile Home Park (NPDES Permit No. PA0070378), and Blue Mountain Academy (NPDES Permit No. PA0070378) which has extended aeration as of 2004. A third discharge to Hassler Run was permitted at one time, but that permit was terminated in 2003.

Sprawling development also decreases groundwater recharge capabilities as a result of the increase in impervious surfaces. Land use planning must consider how much water is available and what limits there may be to meet future demands. A water budget study for the Mill Creek watershed would provide local municipal officials with information on the extent of available water resources, identify those areas where the demand for water may exceed available supplies, and present management recommendations to safeguard water resources.

Planning

Berks Vision 2020, the County's comprehensive plan, supports Smart Growth, the American Planning Association concept that encourages a more efficient and environmentally sensitive use of land. *Berks Vision 2020* places relatively small portions of the Tilden and Upper Bern landscape in Designated or Future Growth Area and significant portions of these townships in Agricultural Preservation and Rural Conservation. The Agricultural Preservation designation is intended to protect the agricultural land resource base. The Rural Conservation designation allows for suitably sited low-density development.

Tilden and Upper Bern Townships together with Hamburg and Strausstown Boroughs and Upper Tulpehocken and Winsdor Townships undertook a joint planning effort that was completed in 2005, *The Joint Comprehensive Plan for Northern Berks County.* This joint planning effort was initiated by the municipalities involved in recognition of the development trends and pressures in the region. The plan presents common goals for land use and provides more specific, relatively short-term policy guidelines, or objectives, for the participating municipalities to follow. Many of the goals presented in the joint plan are relevant to efforts to protect Mill Creek and include protection and preservation of Natural and Scenic Resources, Agricultural Resources, Open Space, Land Use and Housing, and Planning. Both Tilden and

Upper Bern Townships have approved the joint plan. However, the plan is only a guide and not a zoning map. Each township must adopt a zoning map and a recommended zoning map is included in the joint plan (see Map 4, following page). Although Upper Bern has approved the recommended map and included it in the Township's ordinance, Tilden Township has not.

The joint plan suggests two zoning districts that offer opportunities for preserving open space and protecting water resources: Blue Mountain Preservation and Agricultural Preservation. The Blue Mountain Preservation district includes the forested headwaters of Mill Creek. In order to protect waterways, water supplies, vulnerable steep slopes and woodlands and to minimize erosion and sedimentation, the joint plan recommends that only limited development be permitted on privately held land in this area. Recommended densities would be one dwelling per 3 to 5 acres. Development in the Agricultural Preservation district would be on allowed on a sliding scale, with the number of residential units permitted varying depending upon the size of the farm. Recommended densities would use a formula of one dwelling per 20 acres.

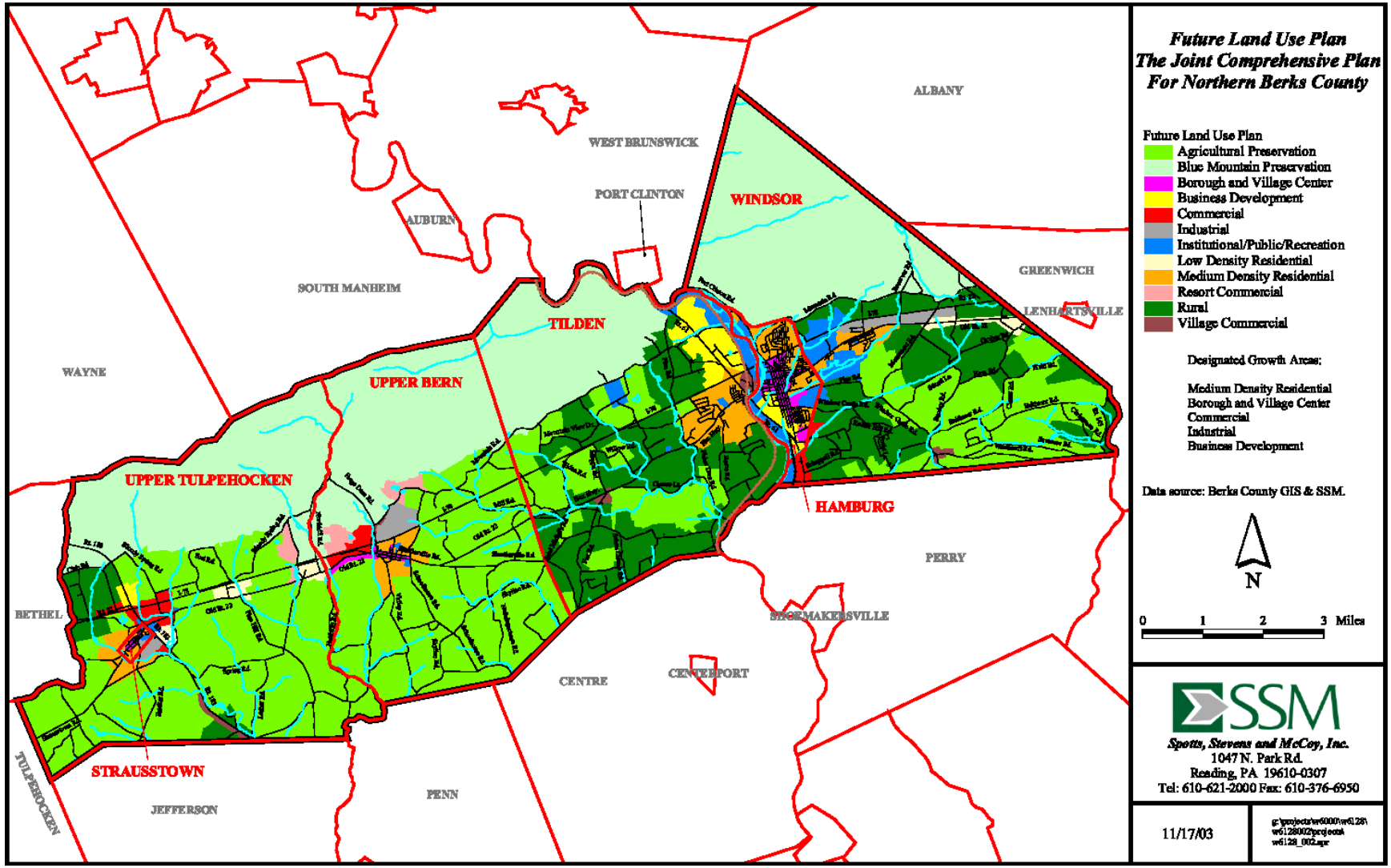
Upper Bern had placed 3,761 acres, or 32% of the Township, in the Blue Mountain Preservation district (*P. Mogel, personal communication*). This includes much of the forested headwaters of the Mill Creek watershed. Over 50% of the Township area is in the Agricultural Preservation district, which includes a significant part of that portion of the Mill Creek watershed in upper Bern Township, but existing campgrounds and related activities that currently exist along the main stem of the Mill Creek rises are grand-fathered.

In addition, the joint plan recommends another zoning tool that could be used to protect streams in the Mill Creek watershed, the Stream Corridor Preservation Overlay district. The first objective in *The Joint Comprehensive Plan for Northern Berks County* under Natural and Scenic Resources calls for the protection of:

> water resources within the Region to assure the quantity and quality of surface and groundwater for recreational use, wildlife habitats, and water supply. Of particular concern will be the water courses, such as the Schuylkill River; Hassler, Lesher and Rattling Runs; and Maiden, Northkill, Little Northkill, Wolf, Mill, Little Swatara, Jackson, Mollhead, Birch, Spring, Stony, Pigeon, Furnace and Kaercher Creeks; tributaries to these creeks; wetlands and floodplains along the creeks; and steep slopes draining to the creeks.

However, the protection and restoration of forested buffer areas along the region's waterways is not listed as an objective under any goal in this plan.

The protection of streams through the establishment of Stream Corridor Preservation Overlay Districts in municipal zoning ordinances does appear as a recommended action under a number of the goals of the joint plan. Townships can create these districts individually, but the Mill Creek watershed would benefit best from some cooperative planning between Upper Bern and Tilden Townships to secure extensive vegetated riparian buffers throughout the entire watershed. Tilden and Upper Bern Townships are experiencing population growth that can bring with it an increase in the demand for water and increased pressure on local water supplies. How development and the population growth that comes with it will impact the Mill Creek watershed depends on action at the township level.



Map 4: Future Land Use Plan, *Northern Berks Joint Comprehensive Plan*

Stream Health

The Pennsylvania Fish and Boat Commission lists Mill Creek as "Approved Trout Waters," which means that large sections of Mill Creek are open to public fishing and are stocked with trout. In April 2007, Mill Creek was stocked with both brown and rainbow trout from the Tylersville Hatchery in the main stem reach from the Creamery Road Bridge/Mill Road intersection downstream to the confluence with Hassler Run.

Mill Creek has long been regarded as a popular stream for fishing even earning a listing on the ESPN Outdoors website in 2006 for recommended Pennsylvania fishing destinations. Available records show that Mill Creek, which has also been known locally as Fisher's Creek, has long been stocked for the benefit of local anglers. Records show stocking beginning as early as 1931 with native trout repeatedly listed as the species most fished for and the species most stocked. Board of Fish Commissioners' correspondence indicates that in the late 1940's and into the early 1950's, Mill Creek was stocked with at a minimum, several hundred trout annually.

A 1938 stream survey does note that the lower end of Mill Creek, that reach below Fisher's or Naftzinger Dam, should not be stocked as these waters were not suitable for trout.[1] These early stream surveys frequently report that Schuylkill River, into which the Mill Creek flows, was polluted likely referring to acid mine drainage and coal silt, negative impacts that would continue to affect the health of the Schuylkill River for years to come. The first indication of concerns for the health of the Mill Creek itself appear in a 1958 stream survey in which an investigator notes that the stream was of poor quality. No causes of degradation were indicated.

The Pennsylvania Department of Environmental Protection conducted an Aquatic Biology Investigation of Hassler Run in1997 to evaluate the impact of a permitted discharge on this tributary. It was found that the discharge was having a negative impact on the creek. This discharge permit was terminated in 2003.

Today, the entire Mill Creek basin's designated use[2] is Trout Stocking Fishery, or TSF, for the "[m]aintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat." The TSF designation affords a lower level of protection than the Cold Water Fishery, or CWF, designation, but greater protection than the Warm Water Fishery, or WWF, designation.

In 2002, during unassessed waters screening in which streams are determined to be "Impaired" or "Not Impaired," the Pennsylvania Department of Environmental Protection found the Mill Creek to be "Not impaired." This assessment included:

- Surveys of aquatic organisms (relative abundance),
- Visual habitat assessments (Instream Fish Cover, Epifaunal Substrate, Embeddedness, and Velocity/Depth Regime),

[1] Land use in the area downstream from Fisher's or Nafziger Dam has included a battery recycling and lead recovery facility, located on a 14-acre site bordered by Mill Creek and the Schuylkill River; that operated from 1961 to 1971. The site was formally added to the National Priorities List (Superfund) in 1986. Cleanup of contaminated soil and battery casings was completed in the summer of 2003.

[2] A stream's designated use is determined by evaluating historical data, biological information and current/existing activities, or "uses," that can occur in or on the water within a particular stream segment. The designated use determines the level of regulatory protection a stream is afforded.

- Channel Alteration (Sediment Deposition, Riffle Frequency, and Channel Flow Status),
- Condition of Banks (Bank Vegetative Protection, Grazing or Other Disruptive Pressures, Riparian Vegetative Zone Width) and
- Field chemistry (temperature, dissolved oxygen, pH, and specific conductance).

These parameters are evaluated and scored and the scores then totaled to determine a habitat score for each site evaluated. The "optimal" category scores range from 240-192; "suboptimal" from 180-132; "marginal" from 120-72; and "poor" is 60 or less. When a stream scores between categories, the assignment of a category is left to the discretion of the investigator's best professional judgment. During the 2002 screening, three Mill Creek tributaries, Wolfe Run, Hassler Run and an unnamed tributary scored 190 or 191, just shy of the optimal designation. The main stem of Mill Creek and another unnamed tributary scored in the high suboptimal range, 177.

Tributary streams that feed Mill Creek originate along the Blue Mountain, and are characterized by similar soils, topography and underlying geology as the adjacent Northkill Creek watershed. By contrast, the Northkill's headwaters are among Berks County's highest quality streams and the Northkill Creek basin, from its source to Interstate 78, is designated an Exceptional Value stream, receiving the highest level of protection afforded to streams in Pennsylvania.

Anecdotal information collected in 2005 for Mill Creek's Wolfe Run tributary streams suggested the watershed may deserve greater protection than that afforded by the TSF designation. During macroinvertebrate sampling of two sites along Wolfe Run, undertaken by DRN staff with students from the Hamburg Area School District (HASD), the percentage of Mayflies+Stoneflies+Most Caddisflies was found to exceed 50%, indicating good water quality. However, subsequent sampling of Wolfe Run conducted by DRN staff with HASD in 2006 and 2007 showed declining percentages of sensitive taxa and increasing percentages of tolerant taxa.

However, more needed to be known about the Mill Creek watershed and its habitats to determine appropriate stream designation, increase awareness and ensure the necessary protection. In its 2003 *Upper Schuylkill River Watershed Protection Plan*, the Berks County Conservancy suggested that upgrading qualifying streams to Exceptional Value and High Quality classifications would be valuable to ensuring adequate protection for both surface and groundwater resources in the region. A targeted study of the Mill Creek watershed could provide the data necessary to pursue an upgrade to provide long-term protection as well as identify restoration projects that could result in improvements in habitat and water quality.

In the Spring of 2007, Stroud Water Research Center conducted macroinvertebrate sampling at two sites the Mill Creek watershed: Hassler Run at Fisher Dam Road and Cheese Lane, and the Mill Creek man stem at Saint Michaels Road off of Hex Highway. An overview of the sampling methods used during the Stroud Center's Schuylkill River watershed study as well as at these Mill Creek sites can be found at http://www.stroudcenter.org/schuylkill/methods.htm. The Stroud Center's initial analysis of the Mill Creek data places the stream on par with other TSF streams (*J. Jackson, personal communication*).

The Stroud Center recently conducted an analysis of stream categories and conditions drawing on its 11-year study of the Schuylkill River basin. In this analysis, it was found that the primary factor governing macroinvertebrate quality was forest cover. With the Mill Creek's forest coverage less than 33%, the results of the Stroud Center macroinvertebrate sampling at two sites that are located lower in the watershed are not unexpected. DRN's macroinvertebrate sampling that found more sensitive taxa were conducted primarily along more forested headwaters streams.

The Stroud Center analysis of stream categories and conditions found that water quality in:

> Cold and Warm Water Fisheries designations were distinct with little overlap while Trout Stocking Fisheries overlapped markedly with both Cold and Warm Water Fisheries. These results suggest that the structure of the macroinvertebrate assemblages in Cold and Warm Water Fisheries are distinctly different, but that macroinvertebrate assemblages in Trout Stocking Fisheries are not consistently distinct from Cold or Warm Water Fisheries. Instead, some Trout Stocking Fisheries support macroinvertebrate assemblages that resemble Cold Water Fisheries while others support macroinvertebrate assemblages that resemble Warm Water Fisheries.

Furthermore, the Stroud Center found that a reduction in forest cover, relative to Cold Water Fisheries (mean = 30% forest), to be an important factor distinguishing Trout Stocking Fisheries. The Mill Creek watershed's reduced forest may then be a factor in the overall health of this system. The Stroud Center's analysis suggests that an increase in forest cover could result in improvements in water quality.

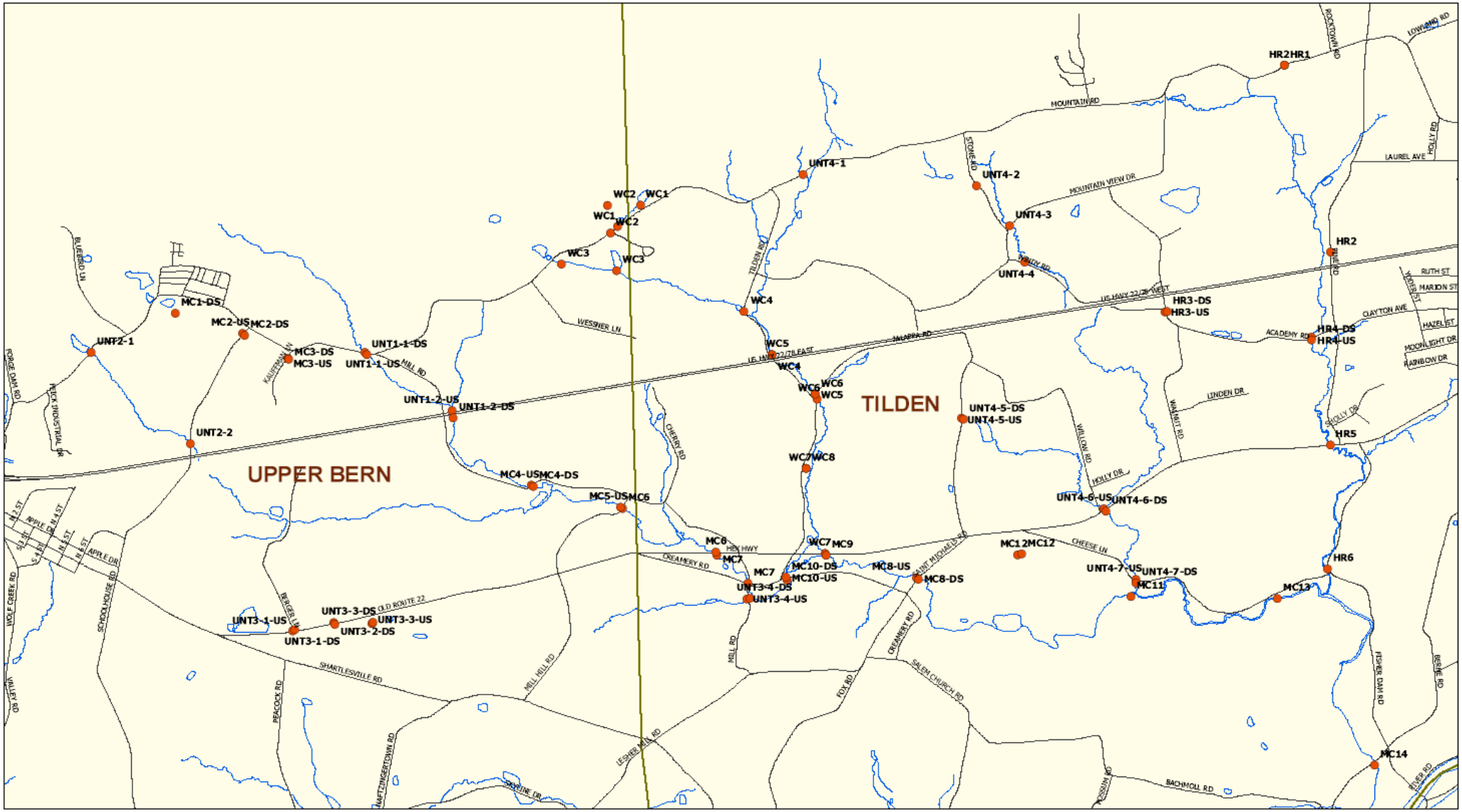
Integrated Stream Assessment

To identify and prioritize sites for protection and restoration, DRN undertook an Integrated Stream Assessment conducted by 11 volunteers from October to December 2006. Volunteers assessed, rated, and photographed physical stream conditions and streamside vegetation at 69 different locations, completing 59 assessments (see Map 5, following page).

Volunteers used DRN's Integrated Assessment (provided in Appendix B) to assess and rank habitat and stream stability (or riparian condition) at each site. Habitat conditions were photo-documented (see Appendix C) and given a score from 1 to 10 in five categories including: riparian width, riparian condition, available cover, fish barriers, and pool variability. Stability conditions were evaluated by scoring (1 to 10): bank erosion, bank vegetation protection, bank angle, trees leaning or slumping bank, and channel alteration. Each stream reach assessed was given a Habitat Score and a Stability Score, which were combined for a Total Score.

The field data were then compiled and added to the Geographic Information System (GIS) database, and the Total Scores for the 59 stream reaches were classified and assessment maps prepared by Ryan Zerbe, Berks County Watershed Specialist, and Brad Shirey, Berks County GIS coordinator. Assessments conducted at road crossings were mapped as points while assessments conducted by walking a stream reach were mapped as lines.

The total score for habitat and stability were compiled and all assessment sites were ranked as having "Excellent", "Good", "Fair", or "Poor" ecological conditions (see Appendix D) and plotted (see Appendices E and F). Scores for Available Cover, Fish Barriers, and Pool Variability were totaled to describe Fish Habitat conditions and sites were ranked accordingly. Tables depicting the rank for the highest and lowest scoring sites for Fish Habitat are included in Appendices G and H.



Mill Creek Habitat Observation Information Overview Map

Map 5: Mill Creek Habitat Observation Information

Streamside land use and management directly affect stability and habitat values for each stream reach. In general, better scores corresponded with more extensive streamside woodlands and wetlands, while lower scores were often associated erosion from developed areas, roads, or where lawn or agriculture extended right up to the streambank with no natural buffer.

Mill Creek Restoration Projects

DRN reviewed Habitat and Stability scores from the Mill Creek Integrated Assessment to identify the top priority candidates for restoration. Integrated Assessment scores for the top ten priority candidates for restoration are shown in Appendix D .The Mill Creek watershed's land use is largely agricultural, with many of the top ten priority candidates consisting of pasture with cattle actively grazing in or adjacent to streams.

Among these lowest scoring sites, two are located on one farm along the Mill Creek main stem (MC-6, MC-7). At the time of the assessment, a project was underway on this farm to: 1) Relocate 60 lineal feet of channel; 2) Place fill and rock stabilization within the left bank's 100-year floodway; 3) Construct and maintain a 42-inch pipe culvert; and 4) Install two 6 inch outfalls at the channel of a unnamed tributary of Mill Creek as part of a barnyard improvement project. This project was undertaken by the landowner with the assistance of the USDA- Natural Resources Conservation Service. Future work on the MC-6 reach on this farm is to include the installation of 2,350 feet of stream bank fencing. In addition, DRN has received funding to undertake channel restoration, bank stabilization, and riparian buffer planting that will be coupled with the installation of over 1,000 feet of streambank fencing and 3 - 4 stream crossings on the MC-7 reach of this farm. Taken together these projects should result in an improvement of water quality and fish habitat in Mill Creek.

Active pasture at site of the planned DRN restoration project. Photo: R. Zerbe

Pasture steep slopes at site of the planned DRN restoration project. Photo: R. Zerbe

For the remaining lowest ranked sites, specific recommendations for restoration projects include:

Map ID	Description	Potential Restoration Projects
WC6	Wolfe Run downstream of Jalappa Rd.	Streambank Fencing, Buffer Planting, Removal of Concrete Structure Restricting Creek
UNT3-2-US	Road crossing at Old Route 22; Yellow/black reflector, bridge, farmstead	Streambank Fencing, Buffer Planting
MC1-DS	Road crossing. Public road at camp/rodeo ground	Streambank Fencing, Buffer Planting, Dam Removal
HR1	Road crossing. Mountain Rd just west of Pine Rd	Streambank Fencing, Buffer Planting
HR2	Farm at intersection of Mountain & Pine Rd to bridge on Mountain Rd, just past intersection with Pine Rd	Streambank Fencing, Buffer Planting
UNT3-1-DS	Road crossing at Old Route 22; Berger Ln, North side	Buffer Planting, Reduce Road Runoff
UNT4-6-US	Road crossing at Old Route 22 (Hex Hwy)	Buffer Planting
MC10-US	Bridge crossing. St. Michaels Rd.; 0.25 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	Buffer Planting, Reduce Road Runoff

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Appendix A

DRN's Wolfe Run Macroinvertebrate Sampling

	Now Wolfe Run (US)			*Now Wolfe Run (DS)*		
Common and Scientific Names	**UNT-MiCr1-05**	**UNT-MiCr1-06**	**WoCr-MiCr1-07**	**UNT-MiCr2-05**	**UNT-MiCr2-06**	**WoCr-MiCr2-07**
Water penny larvae, *Psephenidae*	0	0	1	0	0	0
Mayfly nymphs, *Ephemeroptera*	100	100	100	100	100	37
Stonefly nymphs, *Plecoptera*	61	15	20	13	12	10
Non-netspinning caddisfly, *Trichoptera*	100	7	19	13	6	3
Fingernet caddisfly larvae, *Philopotamidae*	4	0	5	0	0	2
Free-living caddisfly larvae, *Rhyacophilidae*	2	0	1	0	0	1
Watersnipe fly larvae, *Athericidae*	0	3	1	0	0	0
Dobsonfly larvae (hellgrammites), *Corydalidae*	0	0	0	0	0	0
Fishing spiders, *Pisauridae*	0	0	0	0	0	1
Gilled snails, *Gastropoda: Prosobranchia*	0	0	1	0	0	0
Other beetle larvae, *Coleoptera*	2	4	6	6	5	3
Riffle beetle adult, *Elmidae*	1	10	4	4	1	6
Other beetle adult, *Coleoptera*	0	0	0	0	0	3
Cranefly larvae, *Tipulidae*	4	2	4	6	4	0
Damselfly larvae, *Odonata: Zygoptera)*	3	0	0	0	1	0
Dragonfly larvae, *Odonata: Anisoptera)*	1	0	0	0	0	0
Scuds, *Amphipoda*	0	0	4	3	0	0
Aquatic sowbugs, *Isopoda: Asellidae*	4	0	0	0	0	0
Alderfly larvae, *Sialidae*	0	0	0	0	0	0
Net-spinning caddisfly larvae, *Hydropsychidae*	26	30	15	12	18	4
Crayfish, *Decapoda*	6	0	2	0	1	0
Water Mites, *Acariformes*	0	1	0	0	0	0
Clams, *Bivalvia*	0	0	0	0	0	0
Aquatic worms, *Oligocheta*	0	3	2	3	2	1
Blackfly larvae, *Simuliidae*	0	0	3	5	1	0
Leeches, *Hirudinea*	0	0	0	0	0	0
Other Midge larvae, *Diptera: Chironomidae*	6	20	9	18	23	6
Pouched/Lunged snails, *Gastropoda: Pulmonata*	0	0	0	0	0	0
Rat-tailed maggots, *Diptera: Syrphidae*	0	0	0	4	0	0
Horsefly larvae, *Diptera: Tabanidae*	0	1	0	0	0	0
Flat worms, *Turbellaria*	0	1	0	0	0	0
Water striders, *Gerridae*	0	0	0	0	0	0
Giant water bugs, *Belostomatidae*	0	0	0	0	0	0
Water boatmen, *Corixidae*	0	0	0	0	0	0
Total Number of Individuals	320	197	197	187	174	77
Mayflies+Stoneflies+Most Caddisflies	267	122	145	126	118	53
% Mayflies+Stoneflies+Most Caddisflies*	83.4375	61.92893401	73.60406091	67.37967914	67.81609195	68.83116883
Total Number of EPT Individuals	293	152	160	138	136	57
% Common Netspinners	8.125	15.2284264	7.614213198	6.417112299	10.34482759	5.194805195
% Lunged Snails	0	0	0	0	0	0
Total Number of Beetles	3	14	11	10	6	12
% Beetles	0.9375	7.106598985	5.583756345	5.347593583	3.448275862	15.58441558
Total Number of Tolerant	14	24	18	29	27	7
% Tolerant	4.375	12.18274112	9.137055838	15.50802139	15.51724138	9.090909091
Total Number of Non-Insects	10	4	9	6	3	1
% Non-Insects	3.125	2.030456853	4.568527919	3.20855615	1.724137931	1.298701299
Total Number of True Flies (Diptera)	10	23	16	33	28	6
% True Flies (Diptera)**	3.125	11.6751269	8.121827411	17.64705882	16.09195402	7.792207792
EPT/Diptera Ratio***	29.3	6.608695652	10	4.181818182	4.857142857	9.5
Total Caddisflies (Tricoptera)	132	37	40	25	24	10
% Hydropsychidae to Tricoptera	19.6969697	81.08108108	37.5	48	75	40
% Plecoptera	19.0625	7.614213198	10.15228426	6.951871658	6.896551724	12.98701299
% Chironomidae	1.875	10.15228426	4.568527919	9.625668449	13.2183908	7.792207792

* Ratios of 50% or greater are good. Values between 50% and 25% are moderate. Values below 25% are poor

** If the value is greater than 40%, then conditions are poor. If the value is between 20 and 40%, then conditions are moderate. If the value is less than 20%, then conditions are good.

*** The higher the number, the healthier the stream

Appendix B

DRN's Integrated Assessment

Return completed datasheets, photos, GPS Units, etc., by December 1st. It is important you complete the survey on time so results can be used. Contact the Delaware Riverkeeper Network at 610-469-6005 with questions.

Date (mm/dd/yy): _____ Segment ID: _____ Reach No: _____

START Time: _____ AM/PM Start GPS: N ____° ____'____" W_____° ____'____"

Description: _____

END Time: _____ AM/PM End GPS: N ____° ____'____" W_____° ____'____"

Description: _____

Stream Reach Order (from map): _____

Starting Point: Downstream to upstream ❒ Upstream to downstream ❒

Monitor Name(s): _____

Part I: Habitat Assessment

A. Riparian Buffer Width (USDA, related EPA)

If widths differ from greatly from side to side, average the final score (i.e., banks comparatively scoring a "1" and "7" would equal a final score of 4)

Natural vegetation extends at least two active channel widths on each side.	**10**		
Natural vegetation extends one active channel width on each side, or at least the entire flood plain.	**7**		
Natural vegetation extends 1/3rd to half of the active channel width.	**3**		
Natural vegetation is <1/3 of the active channel width.	**1**	**L**	**R**
SCORE			

B. Riparian Buffer Condition (DRN, related USDA)

If conditions differ from greatly from side to side, average the final score (i.e., banks comparatively scoring a "1" and "7" would equal a final score of 4)

"Three habitat layers" refers to the presence of forest canopy, understory shrubs, and grass/wildflower groundlayer.

If possible, indicate invasive species present in reach and their relative abundance (L-local, S-scattered, W-widespread) on the attached "Invasive Plant Survey."

All three habitat layers present and abundant. Mostly native species with low numbers of invasive plants. Undisturbed.	**10**		
One habitat layer impaired or not present. Scattered presence of invasive plants, but community mostly intact. Minimal disturbance.	**7**		
Two habitat layers impaired or not present. Invasive species present throughout. Degraded.	**3**		
Two or more habitat layers missing. Low diversity of species, mostly invasive plants. Severely degraded.	**1**	**L**	**R**
SCORE			

C. Available Cover (USDA)

Fine woody debris, large woody debris; submerged logs, overhanging vegetation, dense aquatic vegetation (not algae), leaf packs, thick root mats, boulders, cobble, coarse gravel, deep pools, isolate or backwater pools, and undercut banks.

Each type of habitat cover must be in appreciable amounts.

>7 types available.	**10**
At least 7 types available.	**7**
3 to 4 types available.	**3**
1 to 2 types available.	**1**
SCORE	

Part I: Habitat Assessment (cont.)

D. Fish Barriers (USDA)

No barriers.	**10**
Drop structures, culverts or diversions (<1' drop) in reach.	**7**
Drop structures, culverts or diversions (>1' drop) in reach.	**3**
Drop structures, culverts or diversions (>3' drop) in reach.	**1**

SCORE ☐

E. Pool Variability (EPA, related USDA)·

Even mix of large-shallow, large-deep, small-shallow, small-deep pools present	**10**
Majority of pools large-deep; very few shallow.	**7**
Shallow pools much more prevalent than deep pools.	**3**
Majority of pools small-shallow or pools absent	**1**

SCORE ☐

Total Habitat Score ☐

Habitat Restoration Potential

Circle all that apply	
Scope	**Examples**
Minor	Riparian buffer planting Manual invasive species control
Intermediate	Stream fencing Create no-mow buffer Mechanical/chemical invasive control
Intensive	In-stream habitat enhancement Dam removal Other _____

Your Completed Assessment

Once you have completed your assessment, you may choose to return assessment supplies and completed paperwork by mail to:
Chari Towne, Delaware Riverkeeper Network, 300 Pond Street, 2nd Floor, Bristol, PA 19007

Or you may return these materials to **Berks County Conservation District** offices (1238 County Welfare Road, Suite 200, Leesport, PA 19533) during business hours 8 AM to 4 PM.

Part II: Stability Assessment

A. Bank Erosion (EPA & Pfankuch, relate USDA)

Banks stable; infrequent and minor erosion (up to 25% of bank height) along banks. <5% of reach affected	**10**
Moderately stable; some erosion intermittently at outcurves & constrictions. Raw banks between 25 - 50% of total bank height. Less than 30% of reach has erosion.	**7**
Moderately unstable; Significant erosion consisting of 50-75% of total bank height. Root mat overhangs & sloughing. 30 - 60% of bank has areas of erosion.	**3**
Unstable with almost continuous cuts, some 100% of bank height. Overhangs common. 60 - 100% of bank has erosion scars.	**1**
SCORE	

B. Bank Vegetation Protection (EPA & Pfankuch, relate USDA)·

More than 90% of the bank surfaces (from top of bank to low water line) and immediate riparian area covered by native vegetation, including trees, understory shrubs, or non-woody species; disturbance is not present (or minimal).	**10**
Fewer individual plants/or less dense root masses. 70 - 90% of the bank surfaces covered by native vegetation, but one layer of plants is not well-present; disturbance evident but not affecting full potential.	**7**
Still fewer species, somewhat shallow & discontinuous root mass. 50-70% of the bank surfaces covered by vegetation; patches of bare soil or disturbed vegetation common.	**3**
Less than 50% of the streambank surfaces covered by vegetation; disturbance of bank vegetation is very high.	**1**
SCORE	

C. Bank Angle (related Rosgen, Leopold)

Bank angles in reach average slope of 20 degrees or less. Nice slope, easy to walk down.	**10**
Bank angles in reach average slope of 60 degrees. Steep, but walkable, slope.	**7**
Bank angles in reach average slope of 80 degrees. Relatively vertical banks.	**3**
Bank angles in reach average 90 degrees or more. Dangerous overhangs.	**1**
SCORE	

D. Trees Leaning of Slumping Bank (R2)

No leaning trees. No evidence of slumping.	**10**
Trees leaning, but not threatened. Curved trunks suggest older impacts. Old slumps.	**7**
Severely leaning or suspended trees. Occasional slumping.	**3**
Severely leaning, suspended, fallen and "missing" trees. Fresh evidence of actively slumping banks.	**1**
SCORE	

E. Channel Alteration (USDA, related Rosgen)·

Alterations can consist of natural or man-made causes. Consider both in scoring.

Natural channel; no structures, dikes, mid-channel gravel bars; No signs of channelization.	**10**
Evidence of past channel alteration or transition, but w/ significant recovery.	**7**
Altered channel; <50% of reach w/riprap, channelization, or mid channel gravel bars. Stream cannot access floodplain (i.e., cannot flood).	**3**
Channel is actively downcutting or widening. >50% of reach is riprapped, channelized, or gravel bars. Access to floodplain is restricted.	**1**
SCORE	

Total Stability Score

Stability Restoration Potential

Circle all that apply	
Scope	Examples
Minor	Riparian buffer planting Stream fencing Create no-mow buffer Live staking Other
Intermediate	Small bank stabilization (<200 ft) Stormwater outfall stabilization Other
Intensive	Large bank stabilization (>200 ft) In-stream flow deflectors Other

Appendix C

Integrated Assessment Photographs

MC1-DS, Mill Creek looking downstream from Mountain Road. Photo J. and G. Seidel.

UNT1-1-US, Unnamed tributary, looking upstream from Mountain Road. Photo: J. Caves

WC3, Wolfe Run, looking upstream, below pond south of Mountain Road. Photo. J. Freymoyer.

WC6, Wolfe Run, looking downstream, below Jalappa Road. Photo. J. Freymoyer.

MC10-DS, Route 22 bridge crossing at the confluence of Wolfe Run and Mill Creek, looking downstream on Mill Creek. Photo. E. Stohrer.

UNT4-2, Unnamed tributary looking upstream (may be intermitant). Photo: J. Hartman and B. Pounder.

MC13, Mill Creek looking upstream from Cheese Lane crossing. Photo. S. Lyons and M. Feeg.

HR2, Hassler Run looking upstream on a reach between Mountain Road and I-78. Photo. L. Rowe.

HR6, Hassler Run, looking downstream, from the intersection of Fisher Dam Road and Cheese Lane. Photo: L Rowe.

MC14, Mill Creek looking downstream from Berne Road crossing. Photo: K. Shellington

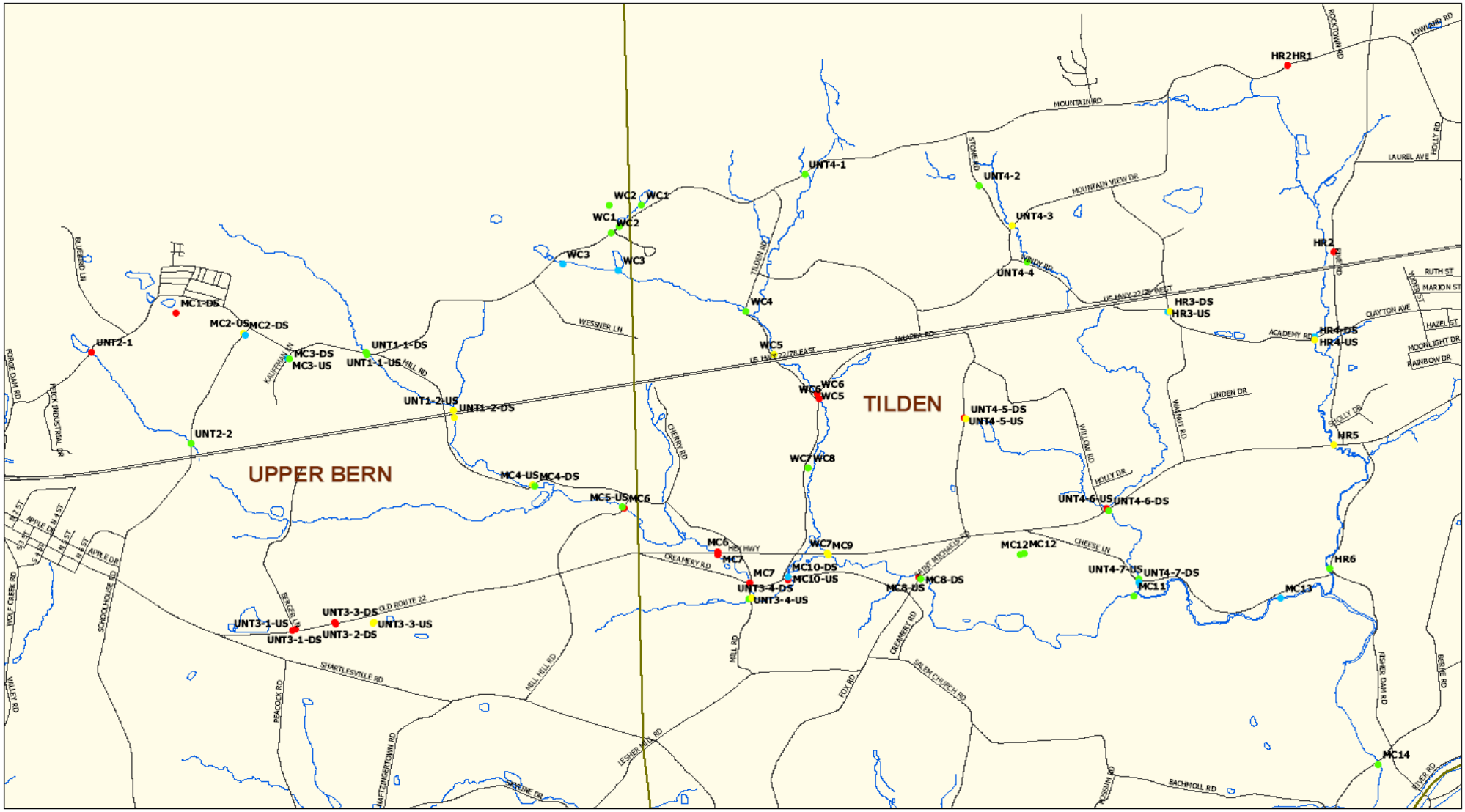
Appendix D

Mill Creek Integrated Assessment Scores

Map ID Code	Assess-ment Date	Reach No.	Direction	Description	Stream Reach Order	Total Habitat Score	Total Stability Score	Total Score	Rank
HR3-US	10/15/2006	Looking Upstream		Bridge on Academy Rd	1	50	50	100	E
MC2-DS	11/12/2006	Looking Down stream		Road crossing in valley near School House & Kaufman Rd		50	48	98	E
UNT4-7-DS	10/29/2006	Looking Down stream		Road crossing at Cheese Ln bridge	2	45	50	95	E
HR4-US	10/15/2006	Looking Upstream		Road crossing on Academy Rd		46	47	93	E
MC13	11/12/2006	N/A		Done from bridge crossing (not labeled Duck Farm)		47.5	44	91.5	E
MC10-DS	11/3/2006	Looking Down stream		Bridge crossing. St. Michaels Rd.; 0.25 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	3	45	45	90	E
MC3-US	11/12/2006	Looking Upstream		Road crossing. Valley near Kauffman & Mountain Rd		47	43	90	E
WC3	12/1/2006		U-D	Wolfe Run at Mountain Rd to below pond		48	42	90	E
MC11	11/12/2006	-1		Done from bridge crossing on Cheese Ln (Duck Farm)	3	43	44	87	G
UNT2-2	11/15/2006	N/A		Road crossing - Small but probably runs all year		45	42	87	G
MC14	10/15/2006			Standing on the bridge at the intersection of Berne Road and Mill Creek	3	43	44	87	G
WC8	12/1/2006			Wolfe Run confluence with Mill Creek		46	41	87	G
MC5-US	11/3/2006	Looking Upstream		Bridge crossing near Mill Road & Mill Hill Rd; 1.5 miles west of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	1	36.5	50	86.5	G
UNT4-2	11/15/2006	N/A		Road crossing. Small, but probably runs all year		44	42	86	G
UNT1-1-US	10/29/2006	Looking Upstream		Road crossing	1	38	47	85	G
WC1	12/1/2006		U-D	Downstream of neighbor's pond to Freymoyer farm barn pond		39	45	84	G
UNT3-4-US	11/3/2006	Looking Upstream		Bridge crossing near Creamery; 1.1 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	1,2	40	44	84	G
WC4	12/1/2006		U-D	Wolfe Run at I78 to Jalappa Rd		42	42	84	G
MC3-DS	11/12/2006	Looking Down stream		Road crossing. Valley near Kauffman & Mountain Rd		46	38	84	G
UNT4-6-DS	10/29/2006	Looking Down stream		Road crossing at Old Route 22 (Hex Hwy)	2	39	44	83	G
UNT4-7-US	10/29/2006	Looking Upstream		Road crossing at Cheese Ln bridge	2	42	41	83	G
MC8-DS	11/3/2006	Looking Down stream		Bridge crossing. Creamery and Tilden; 0.8 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	2	46	37	83	G

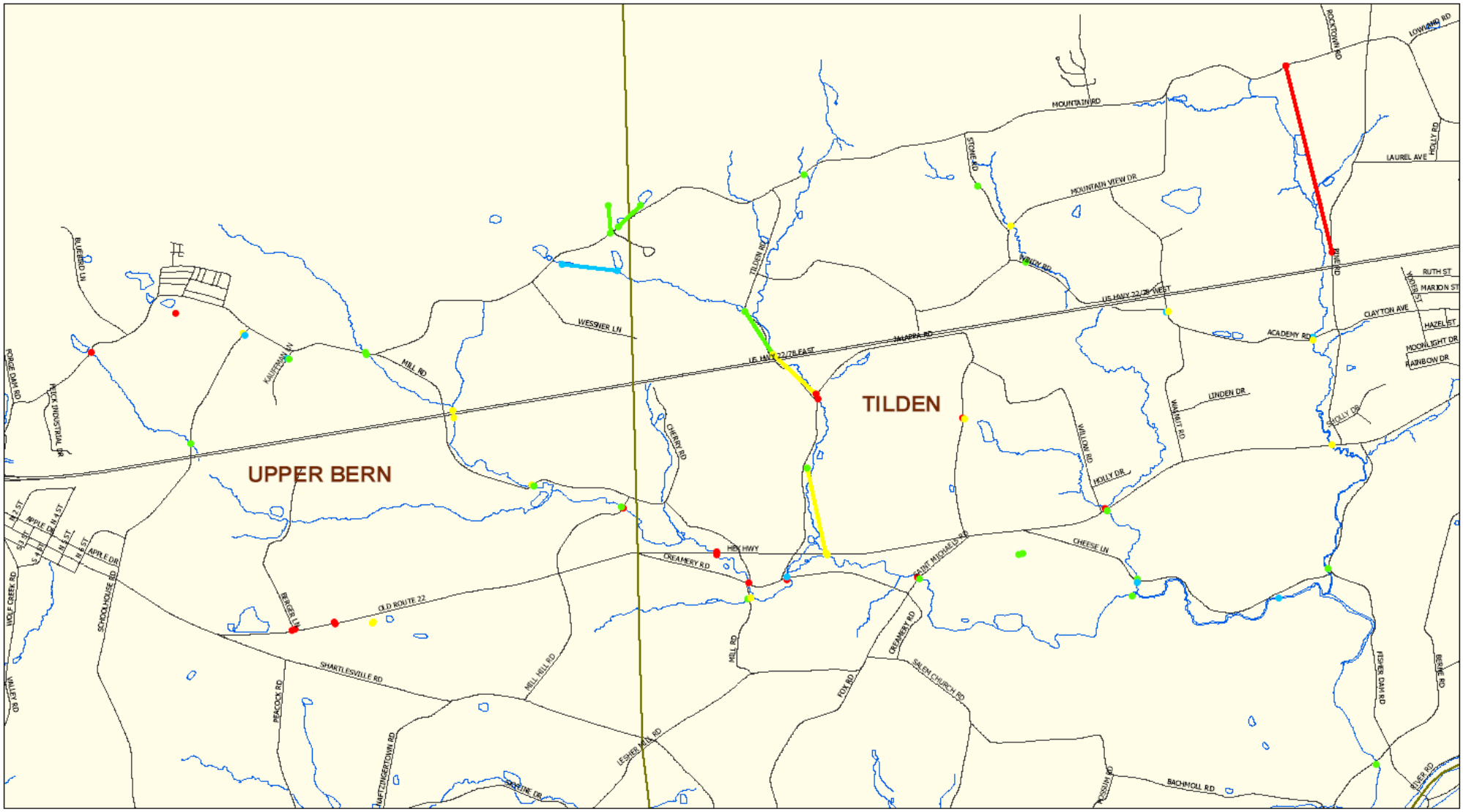
Map ID Code	Assess-ment Date	Reach No.	Direction	Description	Stream Reach Order	Total Habitat Score	Total Stability Score	Total Score	Rank
MC12	11/12/2006	-2	U-D	Walking along stream	3	47.5	35	82.5	G
WC2	12/1/2006		D-U	Wolfe Run source to Mountain Rd		39	43	82	G
HR6	11/5/2006			Intersection of Fisher Dam Rd & Cheese Ln		42	40	82	G
UNT4-1	11/15/2006	N/A	U-D	Road crossing. Very small, probably dry part of year		38	43	81	G
UNT1-1-DS	10/29/2006	Looking Down stream		Road crossing	1	39	41	80	G
MC4-DS	2/6/2007	Looking Down stream		Road Crossing - Mill Road		39	41	80	G
UNT4-4	11/15/2006	N/A		Road crossing.Small to medium. Runs all year		39	40	79	G
UNT4-5-DS	11/19/2006	Looking Down stream		Road crossing. Looking upstream from Jalappa Rd	1	27	50	77	F
WC7	12/1/2006		D-U	Wolfe Run pheasant farm to Mill Creek confluence		33	44	77	F
MC4-US	2/6/2007	Looking Upstream		Road Crossing - Mill Road		38	39	77	F
MC9	11/3/2006			Bridge crossing. Hex Highway; 0.5 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	1,2	40	37	77	F
UNT1-2-US	11/19/2006	Looking Upstream		Road crossing	2	40	34	74	F
UNT4-3	11/15/2006	N/A	U-D	Road crossing.Small to medium. Runs all year		32	37	69	F
WC5	12/1/2006		U-D	Wolfe Run at Tilden Rd to I78 Roadside. Intersection of Pine Rd and Old Route 22 (Hex Hwy)		30	37	67	F
HR5	11/5/2006			Road crossing on Academy Rd		33	33	66	F
HR4-DS	10/15/2006	Looking Down stream		Road crossing in valley near School House & Kaufman Rd		24	42	66	F
MC2-US	11/12/2006	Looking Upstream		Bridge crossing near Creamery; 1.1 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]		27	39	66	F
HR3-DS	10/15/2006	Looking Down stream		Bridge on Academy Rd	1	21	43	64	F
UNT3-3-US	11/12/2006	Looking Upstream		Old Route 22. Crossing is just East of barn,silos		16	45	61	F
UNT3-4-DS	11/3/2006	Looking Down stream			1,2	34	27	61	F
UNT1-2-DS	11/19/2006	Looking Down stream		Road crossing	2	25	35	60	F
UNT3-3-DS	11/12/2006	Looking Down stream		Old Route 22. Crossing is just East of barn,silos		19	40	59	F
UNT3-2-DS	11/12/2006	Looking Down stream		Road crossing at Old Route 22; Yellow/black reflector, bridge, farmstead		25	32	57	P
UNT3-1-US	11/12/2006	Looking Upstream		Road crossing at Old Route 22; Berger Ln, North side		17	38	55	P

Map ID Code	Assess-ment Date	Reach No.	Direction	Description	Stream Reach Order	Total Habitat Score	Total Stability Score	Total Score	Rank
UNT4-5-US	11/19/2006	Looking Upstream		Road crossing. Looking upstream from Jalappa Rd	1	23	30	53	P
UNT2-1	11/15/2006	N/A		Road crossing - Very small, probably dry part of the year		24	29	53	P
MC8-US	11/3/2006	Looking Upstream		Bridge crossing. Creamery and Tilden; 0.8 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	2	24	29	53	P
UNT4-6-US	10/29/2006	Looking Upstream		Road crossing at Old Route 22 (Hex Hwy)	2	14	32	46	P
MC10-US	11/3/2006	Looking Upstream		Bridge crossing. St. Michaels Rd.; 0.25 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	3	21	25	46	P
UNT3-1-DS	11/12/2006	Looking Down stream		Road crossing at Old Route 22; Berger Ln, North side		9.5	33	42.5	P
HR2	11/19/2006		D-U	Farm at intersection of Mountain & Pine Rd to bridge on Mountain Rd, just past intersection with Pine Rd	2	19	23	42	P
MC6	11/30/2006	2	D-U	Road crossing along Old Route 22 (Hex Hwy) to road crossing on Mill Hill Rd		21	18	39	P
HR1	11/5/2006			Road crossing. Mountain Rd just west of Pine Rd		14	22	36	P
MC7	11/30/2006	1	D-U	Intersection of Creamery & Mill Rds, following Mill Rd, to Old Route 22 (Hex Hwy)	2	17	17	34	P
MC1-DS	11/12/2006	Looking Down stream		Road crossing. Public road at camp/rodeo ground		15	15	30	P
UNT3-2-US	11/12/2006	Looking Upstream		Road crossing at Old Route 22; Yellow/black reflector, bridge, farmstead		13	15	28	P
WC6	12/1/2006		U-D	Wolfe Run downstream of Jalappa Rd.		12	15	27	P



Mill Creek Habitat Observation Information
Habitat Rank Map

Appendix E *Mill Creek Assessment: Points*



Mill Creek Habitat Observation Information
Habitat Rank Map

Map Produced by Berks County GIS
Coordinate System: State Plane Pennsylvania South
Datum: NAD 1927

Appendix F *Mill Creek Assessment: Lines*

Appendix G

Mill Creek Integrated Assessment: Highest Scoring Fish Habitat Sites

Map ID Code	Assess-ment Date	Reach No.	Direction	Description	Stream Reach Order	Fish Habitat Score	Fish Habitat Rank
MC9	11/3/2006			Bridge crossing. Hex Highway; 0.5 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	1,2	30	E
MC12	11/12/2006	-2	U-D	Walking along stream	3	30	E
MC13	11/12/2006	N/A		Done from bridge crossing (not labeled Duck Farm)		30	E
MC2-DS	11/12/2006	Looking Down stream		Road crossing in valley near School House & Kaufman Rd		30	E
HR3-US	10/15/2006	Looking Upstream		Bridge on Academy Rd	1	30	E
UNT3-4-DS	11/3/2006	Looking Down stream		Bridge crossing near Creamery; 1.1 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	1,2	28	G
MC8-DS	11/3/2006	Looking Down stream		Bridge crossing. Creamery and Tilden; 0.8 mile SW of [intersection of Hex Highway, Jalappa Rd, and St. Michaels Rd]	2	28	G
WC3	12/1/2006		U-D	Wolfe Run at Mountain Rd to below pond		28	G
WC8	12/1/2006			Wolfe Run confluence with Mill Creek		28	G

Appendix H

Mill Creek Integrated Assessment: Lowest Scoring Fish Habitat Sites

Map ID Code	Assess-ment Date	Reach No.	Direction	Description	Stream Reach Order	Fish Habitat Score	Fish Habitat Rank
UNT3-1-DS	11/12/2006	Looking Down stream		Road crossing at Old Route 22; Berger Ln, North side		4	P
WC6	12/1/2006		U-D	Wolfe Run downstream of Jalappa Rd.		5	P
UNT1-2-DS	11/19/2006	Looking Down stream		Road crossing	2	10	P
UNT4-5-US	11/19/2006	Looking Upstream		Road crossing. Looking upstream from Jalappa Rd	1	10	P
UNT3-2-US	11/12/2006	Looking Upstream		Road crossing at Old Route 22; Yellow/black reflector, bridge, farmstead		11	P
HR1	11/5/2006			Road crossing. Mountain Rd just west of Pine Rd		12	P
MC1-DS	11/12/2006	Looking Down stream		Road crossing. Public road at camp/rodeo ground		13	P
UNT3-1-US	11/12/2006	Looking Upstream		Road crossing at Old Route 22; Berger Ln, North side		13	P
UNT2-1	11/15/2006	N/A		Road crossing - Very small, probably dry part of the year		14	P
MC7	11/30/2006	1	D-U	Intersection of Creamery & Mill Rds, following Mill Rd, to Old Route 22 (Hex Hwy)	2	14	P
UNT4-6-US	10/29/2006	Looking Upstream		Road crossing at Old Route 22 (Hex Hwy)	2	14	P
UNT3-3-US	11/12/2006	Looking Upstream		Old Route 22. Crossing is just East of barn,silos		14	P

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