Crum Creek

Watershed Conservation Plan

CHESTER · RIDLEY · CRUM
CRC
WATERSHEDS ASSOCIATION

NATURAL LANDS TRUST

2005

FOREWORD

Human actions upon the land have direct impacts on the water which supports all life on Earth. If we hope to preserve the water resources that are so vital to our existence, then we must also preserve the resources of the land. The goal of this plan is to preserve and enhance the quality and quantity of ground and surface water in the Crum Creek watershed. To do so, we must also address the use and management of the land that surrounds and feeds these important waterways.

The Crum Creek Watershed Conservation Plan is designed to serve as a guidebook for landowners, municipalities, conservation groups, and citizens interested in taking concrete steps to enhance the long-term health of the Crum Creek watershed. A major portion of the Plan is devoted to an Action Plan which includes management recommendations for municipalities and landowners in the watershed. It also includes a summary of findings on existing physical conditions and regulatory restrictions in the watershed, and a summary of the input of municipal and county officials, landowners, and private citizens solicited through public workshops, questionnaires and interviews. The Plan provides a comprehensive geographic information system (GIS) database of computer map information dedicated to the watershed and available for environmental planning, conservation and restoration efforts and public use.

The Crum Creek Watershed Conservation Plan is a collaborative effort among the Chester-Ridley-Crum Watersheds Association, Natural Lands Trust, and Willistown Conservation Trust. Technical assistance is provided by Mitrofan Josan of Princeton Hydro (GIS mapping), Jim Schmid of Schmid and Company, Inc., ConsultingEcologists (wetland inventory), and by volunteers Sid Baglini (community surveys), and Bill Brainerd (history).

The Chester-Ridley-Crum Watersheds Association (CRC) is a non-profit 501(c) (3) citizens organization that was formed in 1970 to protect the resources of the Crum Creek watershed. Since then, its mission has been expanded to promote the enjoyment, restoration, protection, and prudent management of the natural resources of the Chester, Ridley, and Crum Creek watersheds. CRC's vision is to ensure that the creeks are flowing and filled with fish, stream banks have trails and are lined with parks, lush native landscapes, and no invasive species. This vision includes promoting awareness such that individuals know and love their creeks and do what it takes to keep them healthy. CRC's goals are to create and support public awareness for the stewardship of our watersheds, and foster and facilitate the development of policies and programs which promote the restoration and protection of their creeks. CRC works in partnership with municipalities and community groups on projects and programs which implement these goals.

Natural Lands Trust works proactively to protect significant open lands in the Philadelphia region by acquiring and protecting natural lands, optimizing the use and composition of its system of 45 nature preserves, and by working with landowners, municipalities, agencies, institutions and conservation organizations to promote and implement ecologically-sound land use policies and practices. The Trust's parent organization, the Philadelphia Conservationists, began its pioneering work in 1953.

Willistown Conservation Trust preserves the open land, rural character, scenic, historic and ecologically significant resources of the Willistown area and nearby communities, with particular emphasis on the Crum, Ridley and Darby Creek watersheds.

The Crum Creek Watershed Partnership serves as the Steering Committee for the Plan. Its regular meetings serve as a forum for discussion of key watershed issues and implementation actions to be included in the Plan. The mission of the Crum Creek Watershed Partnership is to improve and protect the Crum Creek watershed including its tributaries, groundwater, and forested valleys to assure the longevity of this precious and vital natural resource for the enjoyment and benefit of current and future generations. The Partnership is a collaborative framework for representatives from 25 organizations who share responsibility as stewards of the stream's water quality, supply, and ability to function as a healthy ecosystem.

CCWP Members: Chester-Ridley-Crum Watersheds Association, Delaware County Community College, Easttown Township, Eddystone Borough, Edgemont Township, Lyondell Chemical Company, Malvern Borough, Malvern Preparatory School, Marple Township, Natural Lands Trust, Nether Providence Township, Newtown Township, Aqua Pennsylvania, Ridley Park Borough, Ridley School District, Ridley Township, Rutledge Borough, Springfield Township, Swarthmore Borough, Swarthmore College, Tredyffrin Township, Upper Providence Township, Willistown Township, Willistown Conservation Trust.

CCWP Affiliates: Chester County Conservation District, Chester County Planning Commission, Chester County Water Resources Authority, Delaware County Conservation District, Delaware County Planning Department, PA DCNR, PA DEP, Pennsylvania Environmental Council.

The Conservation Plan was produced with the financial assistance of a grant to the Chester-Ridley-Crum Watersheds Association from the Pennsylvania Rivers Conservation Program administered by the Pennsylvania Department of Conservation and Natural Resources (DCNR). Major matching funds were contributed by the Delaware County Council, Lyondell Chemical, Aqua Pennsylvania and a grant to Natural Lands Trust from the William Penn Foundation. When DCNR approves the final Conservation Plan, Crum Creek will be proposed for inclusion on the "Pennsylvania Rivers Conservation Registry", providing the grounds for DCNR matching grants to municipalities that have adopted the Plan by resolution. These

municipalities, and other non-profit organizations working in the watershed, will be eligible to apply annually to DCNR for grants to implement the recommendations in the report. Therefore, the incorporation of the Crum Creek on the Rivers Conservation Registry can provide monetary benefit to participating municipalities and environmental organizations.

The *Crum Creek Watershed Conservation Plan* was prepared for the Chester-Ridley-Crum Watersheds Association by Natural Lands Trust

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I. The Case for Conservation in the Crum Creek Watershed

Much of the watershed can be considered a desirable place to live and work for thousands of people, yet the associated land use pattern has caused serious impacts to its streams and groundwater. One third of the watershed (33% of total stream miles) is listed as Impaired on the Pennsylvania Department of Environmental Protection (PA DEP) Integrated List of All Waters as required under the Federal Clean Water Act. The primary causes of this impairment include urban runoff, storm sewers, habitat alteration and flow alterations. Tributaries such as Trout Run, and Little Crum Creek are particularly impacted by development. The Crum Creek watershed encompasses approximately 72 miles of streams. Over half of those miles are First Order or headwater tributaries. Over half of the watershed land area drains to these small streams, which are especially vulnerable to pollution from various sources and enclosures in pipes due to their narrow, shallow nature and widespread distribution.

The streams, wetlands and groundwater of the Crum Creek watershed provide multiple benefits to the community and the environment. The Creek is a vital source of drinking water for over 200,000 households and businesses; a recreational, scenic and educational resource enjoyed by adults and children; habitat for a rich variety of native plants and wildlife; and a conveyance area for treated effluent from wastewater treatment plants.

The Crum Creek and its tributaries meander through the communities of southeastern Chester County and central Delaware County, connecting places and people, and telling a story of ecology, agriculture, industry and change. The living history of the Crum Creek valley can be read in the mature woods that dot its knolls, slopes and floodplains, the bucolic farms of Willistown Township, historic towns such as Malvern and Swarthmore , new corporate campuses, shopping centers and residential developments expanding out from the I-476 Blue Route corridor. The Springton and Crum Reservoirs and a number of private wells draw surface and ground water to meet the various needs of growing communities. Although growth continues to impact the integrity of the watershed, the stewardship ethic of local residents is evident in many well-maintained farmsteads, livable towns, and rich natural areas that define the landscape. It is also evident in the growing awareness among local residents, businesses, municipalities, and organizations that the quality and quantity of ground water and surface water are important and integral to a healthy and sustainable living environment. This awareness is reflected in the support given to local organizations such as the Chester-Ridley-Crum Watersheds Association, Natural Lands Trust, and Willistown Conservation Trust.

The previous 300 years of land use in the Crum Creek valley left a legacy of serious degradation to wetlands, groundwater and certain streams – a legacy in which the quality and quantity of water were compromised and the health of the creek diminished as a living environment for people, plants and animals. Wetlands have been drained, filled or flooded to support agriculture, development and water supply, while sedimentation of ponds and reservoirs and more recently, storm water management and mitigation, have formed new types of wetlands. Wetlands and floodplains in their natural state serve vital natural functions as water purifiers, flood storage areas, and rich habitat for flora and fauna. Tree clearing along streambanks, floodplains and steep slopes has reduced stream quality and wildlife habitat in parts of the watershed, while in other areas forest regrowth has helped to buffer streams and enhance habitat. Roads, parking lots, fertilized lawns, streamside crop fields and pastures, construction sites, wastewater discharges, and failing septic systems all contribute pollutants to surface and ground water. Impervious surfaces in certain parts of the watershed reduce stream baseflows and increase stormwater runoff and erosion. There are no Superfund sites listed by the US Environmental Protection Agency (EPA) in the Crum Creek watershed at present.

Wildlife populations have also changed with the increasingly urban land use pattern. Breeding populations of native brook trout and American shad, both important indicators of stream health once common throughout the Crum Creek stream network, are no longer found today in the watershed. Common backyard species such as gray squirrels and American robins can be found nearly everywhere in the watershed, while native species such as bobcats and hooded warblers that require larger natural habitats are not found in areas they once inhabited. Passenger pigeons, now extinct, can only be seen in the exhibits of the Delaware County Institute of Science; conversely, white-tailed deer are so abundant they frequently collide with automobiles and overbrowse native and cultivated vegetation.

Freshwater is a vital resource but it is not infinitely available and it is vulnerable to pollution. Trends in the ownership of land and land use, the pattern and density of development, demands for water supply, wastewater treatment discharges, stormwater management, and the natural cycles of flooding and drought all influence the quality and quantity of the water resources of the Crum Creek watershed. The quality of the local environment is also critical to supporting the current quality of life and economic stability that is enjoyed throughout the region.

As population growth in the region continues and as inner-ring suburbs expand outward, the increasing infill development and re-development of urban and suburban areas present threats and opportunities to alter the health and integrity of the watershed for better or worse. Along with the increasing population and consumption of land, our lifestyles are demanding more water per person. Between 1900 and 2000, the human

population of Pennsylvania more than doubled, while its consumption of water increased over 1,000%, from 5 gallons per person per day to 62 gallons per day (PA DEP 2000). However, the trend has leveled off and even declined in the past 20 years as water conservation practices have been implemented and the efficiency of water use has increased.

Communities all along the Crum Creek are making land use and water use decisions now that will decide the fate of the land and water resources that make up the watershed throughout the twenty-first century. The *Major Issues for the Crum Creek Watershed Conservation Plan* (pp. 91 – 93) represent an effort by residents, municipal officials, local watershed organizations, local and regional land trusts, and County agencies to identify major issues affecting water quality and quantity, and the living environment for local human residents, plants, and other animals. These issues, ranging from land development to the need for environmental education, are accompanied by a series of Implementation Recommendations contained in the Action Plan.

The *Crum Creek Watershed Conservation Plan* provides an overview of the key natural and manmade features that are currently recognized as impacting water quality and quantity here. The Plan also provides recommendations aimed at preserving the health of the watershed and the quality of life of its residents.

The concluding Action Plan section of this Conservation Plan recognizes that the communities of the Crum Creek watershed have reached an important crossroads – now is the time to address the impacts of development that have degraded streams, wetlands and aquifers of the watershed. This Action Plan offers a valuable road map for guiding growth and redevelopment in a way that preserves, restores and maintains key land areas and the waters that sustain life for the people, plants and animals that inhabit the watershed. It also provides an important avenue for funding specific watershed conservation and restoration projects.

As the watershed continues to experience an ongoing "building boom" in the Upper and Middle Watersheds, the issues and strategies raised here increase in urgency. This Plan is an important step toward addressing the following challenge: to understand the water quality and quantity of the Crum Creek watershed – the "water budget" -- so we may guide future growth, development, land use and conservation in a way that respects the hydrologic cycle – the "water balance" for the long term benefit of all its inhabitants. **(Figure 1 – Location)**

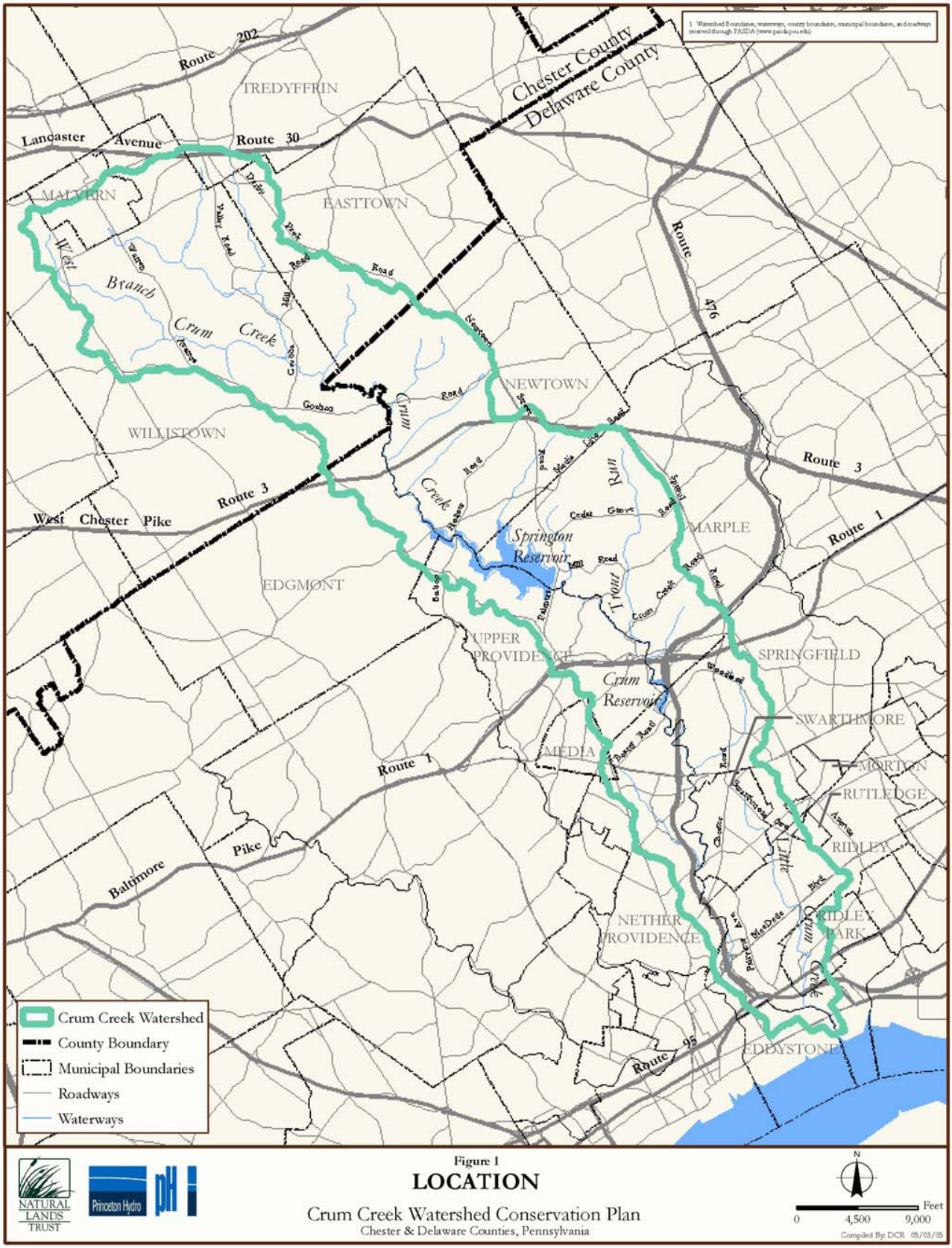

Figure 1

LOCATION

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

II. Principles of the Watershed Conservation Plan

The general principles for the Crum Creek Watershed Conservation Plan provide the basis for specific goals, objectives and recommendations found in the Action Plan.

- **Raise General Awareness About Watershed Issues.** The Crum Creek Watershed should come to be widely understood by those who live and work here as an interrelated natural system of land and water on which humans, plants, and animals depend. This awareness should include the recognition that the decisions affecting water quality and quantity in the Creek also affect the ability of the watershed to support all forms of life and commerce.

- **Coordinate Action within the Watershed.** Through the coordinated actions of all stakeholders – municipalities, government agencies, landowners, citizens, institutions, businesses, environmental organizations, developers, and private groups – the ecology and scenic beauty of the Crum Creek, its tributaries, and its watershed should be preserved and, where possible, enhanced. Consistent and coordinated implementation of various plans and initiatives is essential to the success of these efforts.

- **Coordinate Action with Other Watersheds.** Groups and individuals involved with the planning and implementation of the *Ridley Creek Conservation Plan*, the *Chester Creek Conservation Plan,* the *Darby Creek Conservation Plan (draft), Chester County's Watersheds* plan, and the *Comprehensive Conservation and Management Plan for the Delaware Estuary* should be cognizant of the importance of coordination between each plan and the resources, issues and implementation strategies they identify.

- **Promote Central Role of Municipalities.** Municipalities and organizations active in watershed planning and conservation should pursue the implementation recommendations found in the Action Plan section of this Watershed Conservation Plan, through their ability to regulate land use, stormwater management, environmental protection, and plan for open space, trails and greenways, and by using matching funding sources such as the Pennsylvania Rivers Conservation Program and other state, county, local, and private funding sources.

III. Integration with Other Plans and Initiatives for the Crum Creek

One of the primary emphases of this Plan is to create an integrated Action Plan based on a unified understanding of the issues and priority recommendations made by the various existing plans and initiatives prepared for the Crum Creek watershed.

Seven (7) plans and initiatives have been developed for all or part of the Crum Creek watershed in addition to this one. They are summarized below in chronological order.

1) Crum Creek Source Water Assessment
Prepared by: *Schnabel Engineering/Aqua Pennsylvania*
Completion: *2001*
Purpose and Project Summary: *Delineate Zone A and Zone B source protection areas and identify significant potential sources of contamination to the water supplying the Crum Creek water treatment plant. Provide report and Geographic Information System (GIS) data for municipalities, agencies, water suppliers, and watershed organizations working together to address potential threats of contamination. Reservoir and watershed studies showed high loadings of sediment and phosphorus from non-point sources and some from creek erosion and sediments. Threats from wastewater conveyance pipes and lift stations, transportation spills, and non-native wildlife were identified. Some methods of controlling sediment and nutrients are included in the Action Plan of the Crum Creek Watershed Conservation Plan.*

2) Crum Creek Watershed Action Plan – Chester County Watersheds
Prepared by: *Chester County Water Resources Authority (CCWRA)*
Completion: *2002*
Purpose and Project Summary: *Identify watershed management needs and priorities for the Crum Creek as part of the overall watersheds mission "to protect, sustain and enhance the quality and quantity of all water resources to insure the health, safety, and welfare of the citizens, and preserve the diverse natural resources and aesthetic and recreational assets of Chester County and its watersheds." CCWRA generated a Rivers Conservation Plan (RCP) for the Crum Creek as part of its Chester County-wide RCP process. The resulting document is a specific Crum Creek Watershed Individual Action Plan. This plan lists specific issues facing the Crum Creek and recommends a detailed series of strategies for addressing those issues. The CCWRA Plan makes the following Priority Management Objectives for the Crum watershed:*

1) *Reduce Stormwater Runoff and flooding throughout the watershed.*
2) *Restore water quality of "impaired" streams and protect unimpaired streams from further degradation.*

3) *Protect and enhance vegetated riparian corridors, particularly for first order streams.*
4) *Increase public access to and recreational use of streams.*
5) *Protect and enhance water-based historic and cultural resources.*
6) *Implement other source water protection measures for public water supply intakes, reservoirs, and wells.*
7) *Coordinate implementation of watershed management actions and public participation.*

(Crum Creek Watershed Action Plan, 2002, pg. 20)

A detailed series of issues and recommendations from the CCWRA Plan are included in the Action Plan section of this document.

3) Crum Creek Riparian Buffer Assessment

Prepared by: *Heritage Conservancy*
Completion: *2002*
Purpose and Project Summary: *Identify existing stream miles in the watershed having full riparian forest buffers (50 feet on both sides of stream), partial buffers (less than 50 feet on both sides of stream or 50 feet on only one side of stream), or missing buffers (no forest on either side of stream). Outline key opportunities for riparian buffer protection and restoration projects. The Riparian Buffer Assessment was conducted with the use of a helicopter with a mounted gyrocam to take video footage up and down the Crum Creek. This allowed project planners to identify riparian corridor vegetation in much greater detail, accuracy, and efficiency than would be possible on foot or by car. This information was correlated with aerial photographs and some ground-truthing to provide the most accurate estimates possible regarding streambank conditions.*

4) Upper Crum Restoration Plan

Prepared by: *Willistown Conservation Trust/Willistown Township*
Completion: *2005*
Purpose and Project Summary: *Identify key restoration needs in the Upper Crum watershed, and provide a watershed management database incorporating GIS mapping with field sampling of physical, biological and chemical stream conditions.*

5) Watershed Assessment of Crum Creek: Decision Support for a Community-Based Partnership

Prepared by: *Swarthmore College, Department of Engineering*
Completion: *2001*
Purpose and Project Summary: *This project provided monitoring data and an assessment of water quality conditions on the Lower Crum Creek, and identified a series of restoration monitoring sites. The project resulted in the founding of the Crum Creek Watershed Partnership that serves as the steering committee for this Plan.*

6) Crum Creek Landscape Conservation and Greenway Plan

Prepared by: *Natural Lands Trust*
Completion: *2004*
Purpose and Project Summary: *Identify and prioritize remaining open space parcels that are candidates for conservation and restoration to form a network of protected riparian land supporting and enhancing water quality, biodiversity, and greenway linkages. Stream corridors provide one of the few remaining conservation opportunities in Delaware County and eastern Chester County, where rapid development and infrastructure expansion have consumed most open land previously in forest or agricultural use. The Plan focuses on identification of specific undeveloped parcels along the creek corridor and tributaries and linkages between them that could become the basis for a network of protected riparian land. Prioritization of these parcels for land protection and, to a lesser extent, stewardship are major foci of this effort, with protection of water quality and quantity the primary goals. A secondary goal is to identify potential greenway corridors for use as routes for travel and migration by plants and animals and as possible recreational trails by people in the watershed. The Plan represents Phase I of a conservation strategy for the watershed. In Phase II recommended land will be eased and stewardship projects will be completed. A key conclusion of the analysis of the pattern, size and location of remaining open space parcels is that the overall goal of protecting watershed health and biodiversity can be achieved by establishing a protected greenway along Crum Creek in all sections of the watershed.*

7) Crum Creek Stormwater Management Plan (Act 167)

Prepared by: *Delaware County Planning Department*
Completion*: (pending 2005)*
Purpose and Project Summary: *Prepare GIS maps and databases and model ordinances for all municipalities in the watershed. Ordinance standards will reflect watershed-wide management needs, with varying release rates for stormwater systems in different subwatersheds. Best Management Practices (BMP's) will be required for new projects. Delaware County has completed Phase I of its watershed-wide plan to address stormwater management needs throughout the Crum Creek watershed. Phase I assesses key watershed characteristics and land use patterns, and promotes awareness of the Plan and process among municipalities in the watershed. Phase II will provide a model ordinance tailored for different sections of the watershed, which municipalities will be required to adopt as minimum guidelines to use in regulating stormwater management in land development projects.*

Other related Initiatives:

1) Crum Woods Stewardship Plan

Prepared by: *Natural Lands Trust and Continental Conservation (Roger Latham)*
Completion: *2004*
Purpose and Project Summary: *Prepare a stewardship plan and GIS maps and databases for one of the largest, most mature woodlands in single ownership in the Crum Creek watershed.*

The land and biota of the 220-acre Crum Woods of Swarthmore College have been thoroughly inventoried, and stewardship recommendations have been made for issues such as stormwater runoff, invasive species, and deer browse. The area is primarily upland forest but also includes 29.7 acres of swamps, marshes and floodplains along the Crum. The report enumerates both programmatic (directly related to educational programs) and ecosystem function priorities in this plan for the Crum Woods. The College, as an educational institution, has chosen to set an example of responsible stewardship for the Crum Woods. Correct action in protecting these threatened natural areas is crucial to nurturing ethical and social concern in students. The Crum Woods provide unparalleled opportunities for students to take pleasure from nature, such as hiking or bird watching, and supports them in their pursuit of full, balanced lives.

2) Delaware County Natural Areas Inventory

Prepared by: *PA Science Office of the Nature Conservancy*

Completion: *1992*

Purpose and Project Summary: *Provide an inventory and mapping of the best natural areas and the locations of all known animal and plant species of special concern (endangered, threatened, rare) to aid in making informed decisions regarding land conservation and guiding development. As part of a statewide initiative to catalogue ecologically important natural areas and species in each county, the report includes a series of maps depicting critical habitats and sites using USGS topographic sheets as a base. It includes a written description and a summary table of the sites that contain these elements, including quality, degree of rarity, and last-observed date. Other important areas such as large open space tracts, diverse habitats, and relatively mature woods are also included, as are certain water supply buffer areas and protected lands. Finally, an overall summary of the highest quality sites suggest protection and conservation options – unfortunately, some of these sites have been lost to development since only Federally listed endangered species (such as bog turtle) are granted protection under the Endangered Species Act.*

3) Delaware County Open Space Mapping Project

Prepared by: *Natural Lands Trust, Delaware County*

Completion: *2004*

Purpose and Project Summary: *Prepare Geographic Information Systems (GIS) maps and databases for participating municipalities in central and western Delaware County. Identify and categorize all remaining open space parcels by owner type. Mapping projects have been completed for most Crum Creek municipalities with remaining open space. As part of the Delaware County Renaissance Initiative, Natural Lands Trust is collaborating with the Delaware County Planning Department to provide detailed, GIS-based open space mapping for municipalities throughout the western part of the County, including the Crum Creek watershed. The purpose of this project is to assist communities in evaluating their remaining open space networks, and to determine priorities and strategies for protecting important lands. Roughly 60% of the Delaware County municipalities in the Crum participated in the Open Space Mapping Project. Some of these data were used in preparation of the Crum Creek Watershed Conservation Plan.*

4) Multi-municipal Comprehensive Plan for Swarthmore, Nether Providence, Rose Valley, Rutledge. *"The Comprehensive Plan will examine existing conditions in the planning area with the intent of determining future goals and objectives for land use, transportation, community facilities, economic development, housing, open space and recreation, natural resources, municipal services and historic preservation. The Plan will become a guide for decision-making in each community, and will include tools to help implement final recommendations."*

5) Crum-Ridley-Chester Volunteer Water Monitors. *Founded in 1990 by a partnership of local colleges and high schools, this citizen-based volunteer group has collected data on chemical and biological indicators of water quality in the Crum, Ridley, and Chester Creeks. It has since been incorporated into CRC, although some data is still collected by students. Monitoring continues on the Lower Crum in Smedley Park and, with the help of Swarthmore College, Whiskey Run.*

6) Chester-Ridley-Crum Watershed Association projects*. CRC's projects include: an Annual Streams Cleanup; presentations and training to homeowners and municipal employees; assisting municipalities with public outreach; streambank restorations, invasive plant species controls, and riparian buffer plantings; assistance to streamside landowners; special water quality studies; and working with local groups in the promotion of sustainable development practices.*

7) Delaware County Natural Areas Inventory. *Prepared by the Pennsylvania Science Office of The Nature Conservancy. Provides a relatively thorough overview of key natural areas in the county, including state and federal listed Species of Special Concern (plants and animals) and identification of uncommon or high quality habitats.*

8) Crum Creek Watershed Partnership.

Nether Providence *– stormdrain stenciling project*
Springfield Township *– stormdrain stenciling project, stormwater Best Management Practices (BMP) Site Selection Study (with Swarthmore College)*
Swarthmore Borough *– stormdrain stenciling project, Little Crum Park Wetland and stream buffers*
Swarthmore College *– stormwater, wetland and riparian restoration projects*

9) Pennsylvania DEP – Watershed Restoration Action Strategy (WRAS).
Pennsylvania DEP has prepared a web-based Watershed Restoration Action Strategy for the Darby, Crum, Ridley, Chester and Cobbs Creeks Watersheds (Subbasin 03G). The Strategy highlights stream quality concerns and includes an overview of environmental features, land use patterns,Restoration and Protection Initiatives, Citizen/Conservation Groups, and identifies restoration needs. For the Crum Creek, the WRAS calls for measures to reduce impairment to the lower 7.62 miles of the main stem and 3.3 miles of UNT's and the entire 3.68 miles of Little Crum Creek. The WRAS can be viewed on-line at:
http://www.dep.state.pa.us/dep/deputate/watermgt/Wc/Subjects/WSNoteBks/WRAS-03G.htm

IV. Crum Creek Overview

The Crum Creek watershed is a 38-square mile suburban area west of Philadelphia that drains a network of streams, wetlands and groundwater aquifers from its headwaters at Malvern to its confluence with the Delaware River at Eddystone. Early Dutch settlers in southeastern Pennsylvania named the stream Crum to mean Crooked Creek in Dutch. **(Figure 1 – Location)**

The Crum Creek watershed drains a portion of southeastern Chester County and central Delaware County. The main stem of Crum Creek originates along the Main Line of the historic Pennsylvania Railroad in the Borough of Malvern and flows in a southerly direction for over 25 miles before reaching its confluence with the Delaware River between Ridley Park and Eddystone, passing through a wide range of landscapes that represent a cross-section of land use in the Philadelphia region. These include: broad areas of preserved farms and woodlands in the Willistown area; the rapidly suburbanizing landscape and the Springton Reservoir water supply near Newtown Square; densely developed early- to mid-20th century suburbs such as Swarthmore and Springfield; and, the urban and industrial environment along the Delaware River. The Crum Creek watershed features late 17th century historic resources that testify to its significance as a location for early European settlement. The stream also suffers from the impacts of modern society, such as the late 20th-century superhighway known as the Blue Route (I-476), which carries thousands of unknowing drivers each day along a meandering, substantially walled-in route above the lower portion of Crum Creek. **(Figure 1 – Location).** Along this and other major roads, wetlands were filled in and streams were channelized and moved into culverts, and adjacent areas continue to be intensively developed.

The ecological integrity of the Crum Creek watershed is still sustained in a number of remnant natural areas. However, several important wetlands recently succumbed to development, including the Hunter Run Seeps, identified in the Delaware County Natural Areas Inventory as having suitable habitat conditions for a number of wetland plant and wildlife species, including bog turtle (*Clemmys muhlenbergii*), a federally-listed endangered species. A densely wooded stream corridor along Crum Creek south of Route 3 and upstream from Springton Reservoir is noted for the rich diversity of bird species it supports, including species associated with wooded stream corridors such as scarlet tanager and wood duck. The Crum Woods at Swarthmore College is one of the largest remaining mature woodlands in Delaware County, and includes a variety of oaks, beech, tulip poplar, and hemlock – an uncommon wild species in the County

The stream network serves multiple functions – supplying water, providing recreational opportunities and scenic benefits, and handling wastewater and stormwater runoff – for the thousands of residents, businesses and institutions that call the Crum Creek watershed home. Opportunities abound for the conservation and restoration of critical lands, including current and future projects and initiatives to address the sustainability of ground and surface water quality and quantity. For example, old industrial sites located where the Crum Creek reaches the Delaware River offer long-term potential for restoration of former tidal marsh habitat and riparian zones in the narrow portion of Atlantic Coastal Plain in Pennsylvania. **(Figure 2 – Aerial Photograph)**

The watershed includes a variety of land uses and stream quality conditions that represent the best and worst characteristics of streams in urbanizing areas. The Upper, Middle and Lower sections of the watershed each have their own unique landscape characteristics and associated water quality and quantity concerns, as summarized on the following pages:

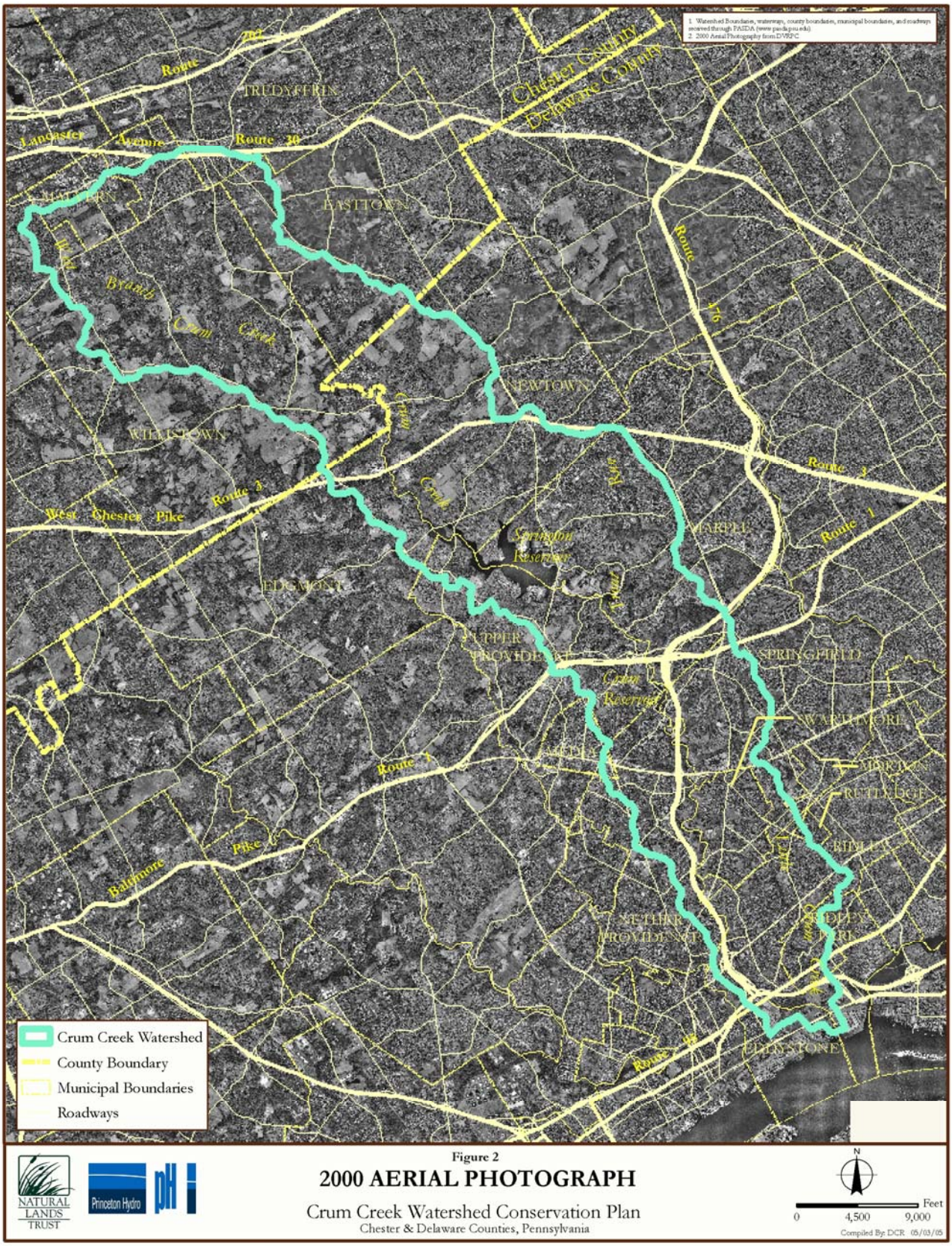

Figure 2

2000 AERIAL PHOTOGRAPH

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

Upper Watershed -- Rural/Suburban

The state-designated High Quality – Cold Water Fishery headwaters area includes the watershed lands north of West Chester Pike (Route 3). Streams here flow through a Rural/Suburban landscape with a relatively small amount of paved area and rooftops, and a sizeable network of protected open space and streamside forests and wetlands.

Figure 2a: **Representative Example of Upper Watershed.** *The Suburban/Rural Landscape within the upper Crum Creek watershed includes a relatively large network of protected open space in the critical headwaters area of the watershed. The ongoing efforts to protect and restore riparian forest buffers and wetlands in this area contributes greatly to sustaining water quality and quantity and providing habitat for native plants and wildlife.*

Middle Watershed -- Suburban

The Suburban portion of the watershed – the area between West Chester Pike and Baltimore Pike around Newtown Square and Media – contains the Springton Reservoir and Crum Reservoir, which store water from Crum Creek to supply over 200,000 households with drinking water. According to PA DEP, this system is the largest public drinking water supply in Delaware County (DEP-WRAS,). This area has experienced significant growth in the last decade and remains under significant development pressure – a trend which raises concerns over associated impacts to water quality and quantity. A portion of the streams in the Middle watershed are listed by PA DEP as Impaired.

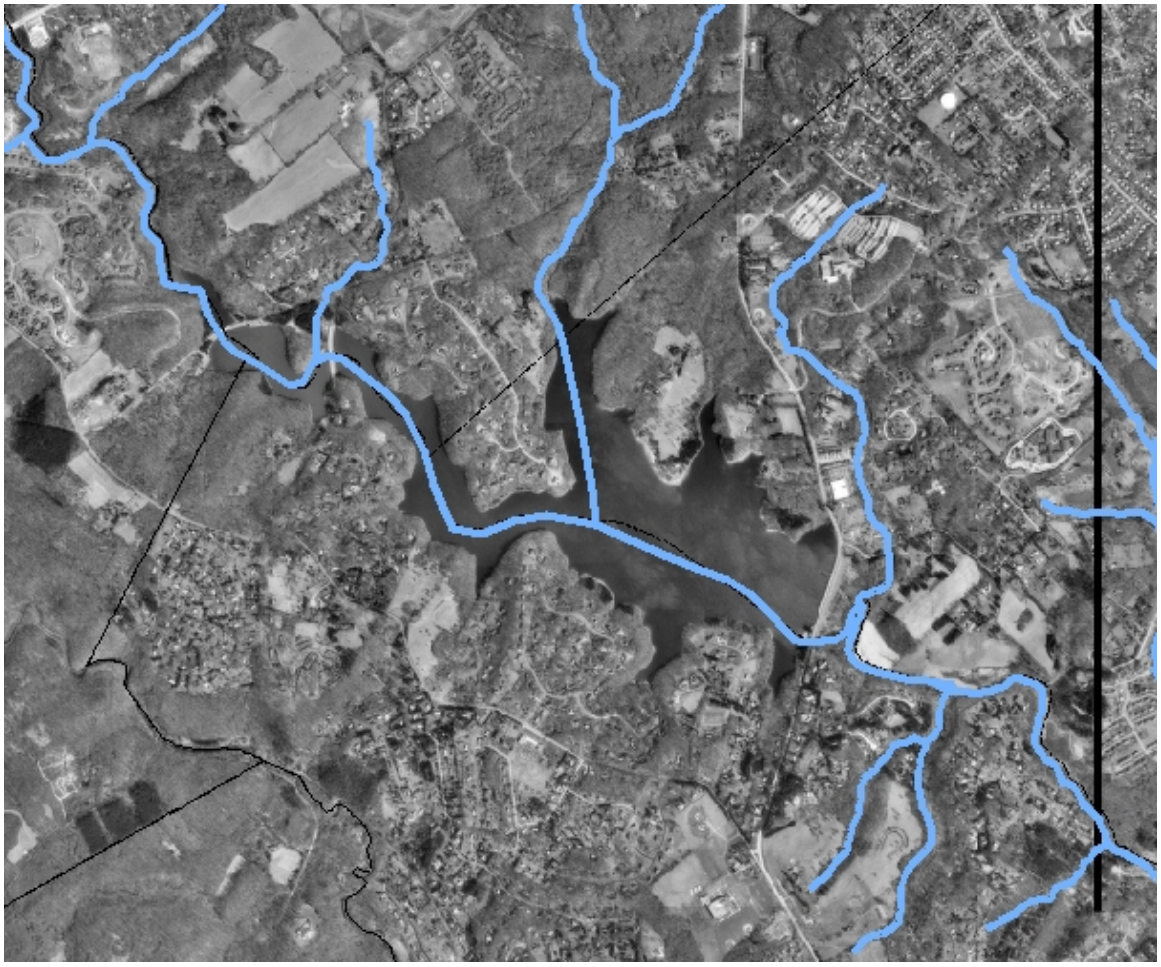

Figure 2b: Representative Example of Middle Watershed. *The Suburban Landscape within the middle Crum Creek watershed includes the rapidly developing low to medium density residential development centered around the Springton Reservoir, an impoundment on Crum Creek dating to 1934. One of the last remaining open spaces in this area is Natural Lands Trust's Hildacy Farm Preserve and adjacent Greenbank Farm below the dam. 1995 aerial photograph does not show new development around the reservoir*

Lower Watershed -- Urban

As Crum Creek flows south toward the Delaware River, it enters the Urban area south of Baltimore Pike with densely developed neighborhoods and industrial areas near the Blue Route (I-476) and I-95. Here, cumulative impacts from the area and upstream have created conditions that have resulted in the PA DEP listing nearly 19 stream miles of the Crum Creek and its tributaries as Impaired. This impairment is caused by suburban and urban stormwater runoff from roads, failing septic systems, parking lots and rooftops, lack of groundwater recharge, wastewater treatment plants, and dams.

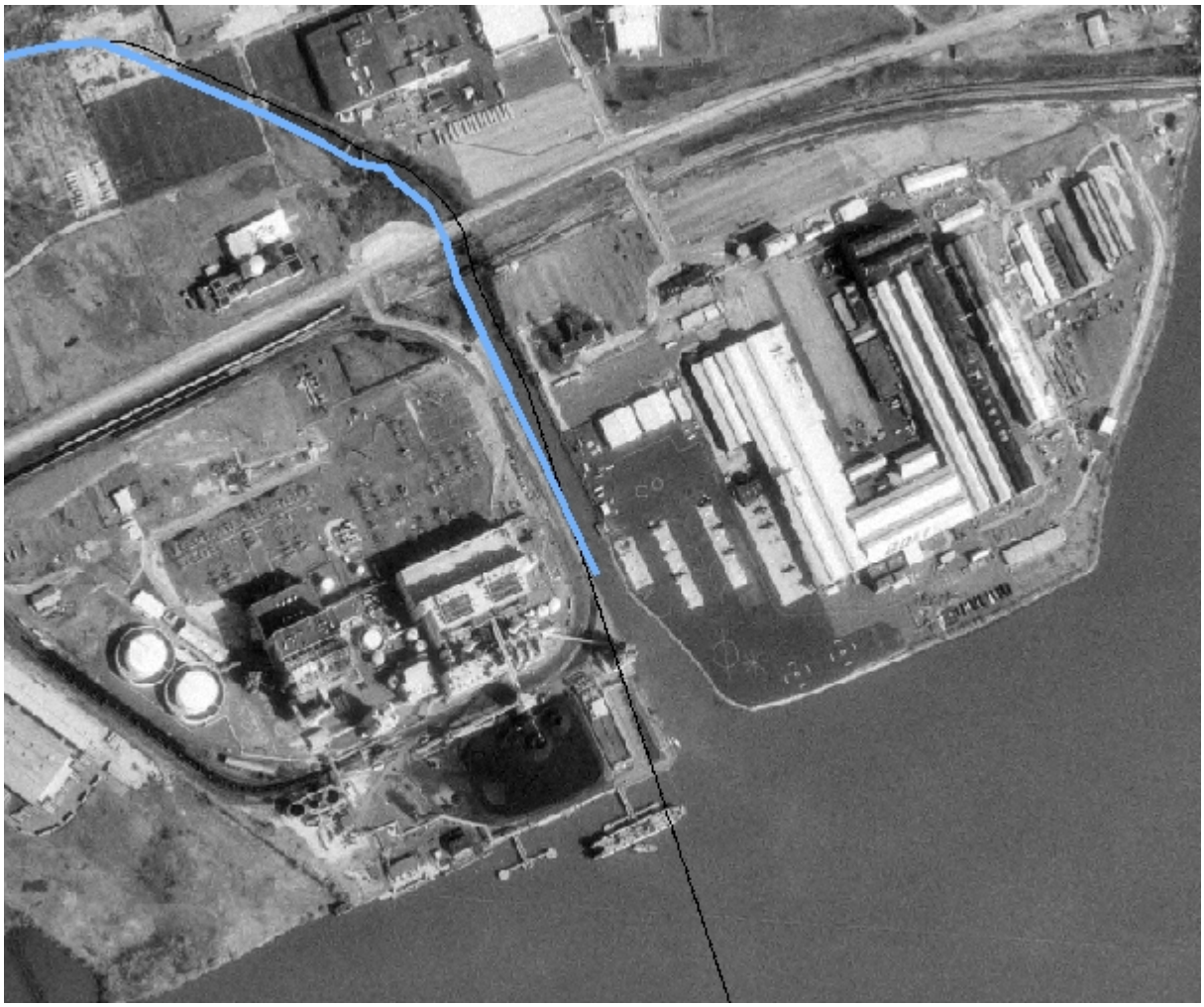

Figure 2c: Representative Example of Lower Watershed. *The Urban Landscape within the lower Crum Creek watershed includes the heavily industrialized and channelized mouth of the Crum Creek as it flows into the Delaware River at Eddystone (left) and Ridley Park (Right). The Excelon/PECO Eddystone Generating Plant is on the left (with a dark mound of coal) and the Boeing helicopter plant is on the right. This area historically supported plants and soils typical of the Atlantic Coastal Plain.*

The Crum Creek landscape system includes a small amount of farmland remaining in the Upper portion of the watershed above Route 3 (West Chester Pike). A substantial percentage of these properties in Willistown are protected by conservation easements held by the Willistown Conservation Trust and the Brandywine Conservancy. These areas hold great potential for restoration of riparian woodlands and wetland habitats. The most ecologically valuable lands throughout the watershed are the networks of contiguous remaining woodlands and wetlands along streams, particularly where they are owned in large holdings (as opposed to individual house lots). The majority of such areas in the Middle and Lower watershed are unprotected and increasingly are subject to infill development as parcels are subdivided, forest cover is removed, and grading is permitted on steep slopes. Natural lands and open space buffering the Springton Reservoir and the Crum Reservoir and upstream waterways are especially critical to retaining clean, plentiful water supplies, but many of these were sold for development in the late 20th century.

Another noteworthy aspect of the Crum Creek watershed is its lower portion, which is influenced by tidal flows and estuarine aquatic life, and also by soils and geology based on alluvial and coastal plain deposits, rather than by the hard bedrock and dense clay soils typical of the middle and upper watershed.

A number of large institutional properties hold promise for long-term protection and stewardship of key natural areas in the Crum Creek watershed. These include lands owned by several private schools and camp facilities, Aqua Pennsylvania, Delaware County Community College, a series of golf courses, the Archdiocese of Philadelphia, Boeing, and other private landowners and homeowners' associations. The linear nature of these tracts points to a natural greenway opportunity that could allow people, plants, and animals to move through the valley along the floodplain areas. Hildacy Farm, Greenbank Farm, and Smedley Park already serve as potential anchors for this type of system.

V. Natural Features

PHYSIOGRAPHIC SETTING

The Crum Creek is situated in the Delaware River Basin, a 13,500-square mile drainage area encompassing parts of 4 states. The streams of the Lower Delaware drain much of the southeastern Pennsylvania portion of the Northern Piedmont. The Northern Piedmont extends from northern Virginia to southwestern Maine (The Nature Conservancy 1996), and represents a gently to steeply rolling landscape of temperate deciduous forest underlain by crystalline bedrock and clayey soils between the eastern foothills of the Appalachian Mountains and the Atlantic Coastal Plain. The term Piedmont comes from the Italian "Piedmonte", meaning "foot of the mountain" (Godfrey 1980). The forested portions of the Middle Crum Creek valley such as Crum Woods are a limited representation of the pre-settlement (pre-1700) Northern Piedmont landscape within the Delaware River drainage, while the upper Crum watershed is characterized by the agricultural landscape typical of much of Northern Piedmont for the last 300 years.

The lower portion of the watershed, closest to the Delaware River, occupies the Atlantic Coastal Plain, an area strongly influenced by a long history as a marine environment. This area is also heavily urbanized, and has been for hundreds of years, so it is difficult to tell the native vegetation and soil types. The sandy soils and pine barren or oak-pine forests typical of southern New Jersey are absent from this landscape, but the relatively flat topography, tidal waters, and sand found in soil borings in the area are indicators that the southernmost portion of the Crum watershed is a naturally distinct environment from the Piedmont landscape that defines the majority of the upstream areas. **(Figure 3 – Physiographic Region)**

GEOLOGY

The geologic formations of the Upper and Middle Crum Creek watershed are largely dense, crystalline, metamorphic bedrock, with Gneiss and Schist as dominant types. These formations are known for tight fissures and faults with relatively low groundwater yields and a strong capacity to form ridges and clay soils. The Lower portion of the watershed closest to the Delaware River supports the Pensauken and Bridgeton formation of the Atlantic Coastal Plain environment dominated by sediments and sands deposited over time when the Delaware River and the Atlantic Ocean were much broader in their influence. This area, being further inland along a large river, is more heavily influenced by ancient river deposits than areas of the Outer Coastal Plain

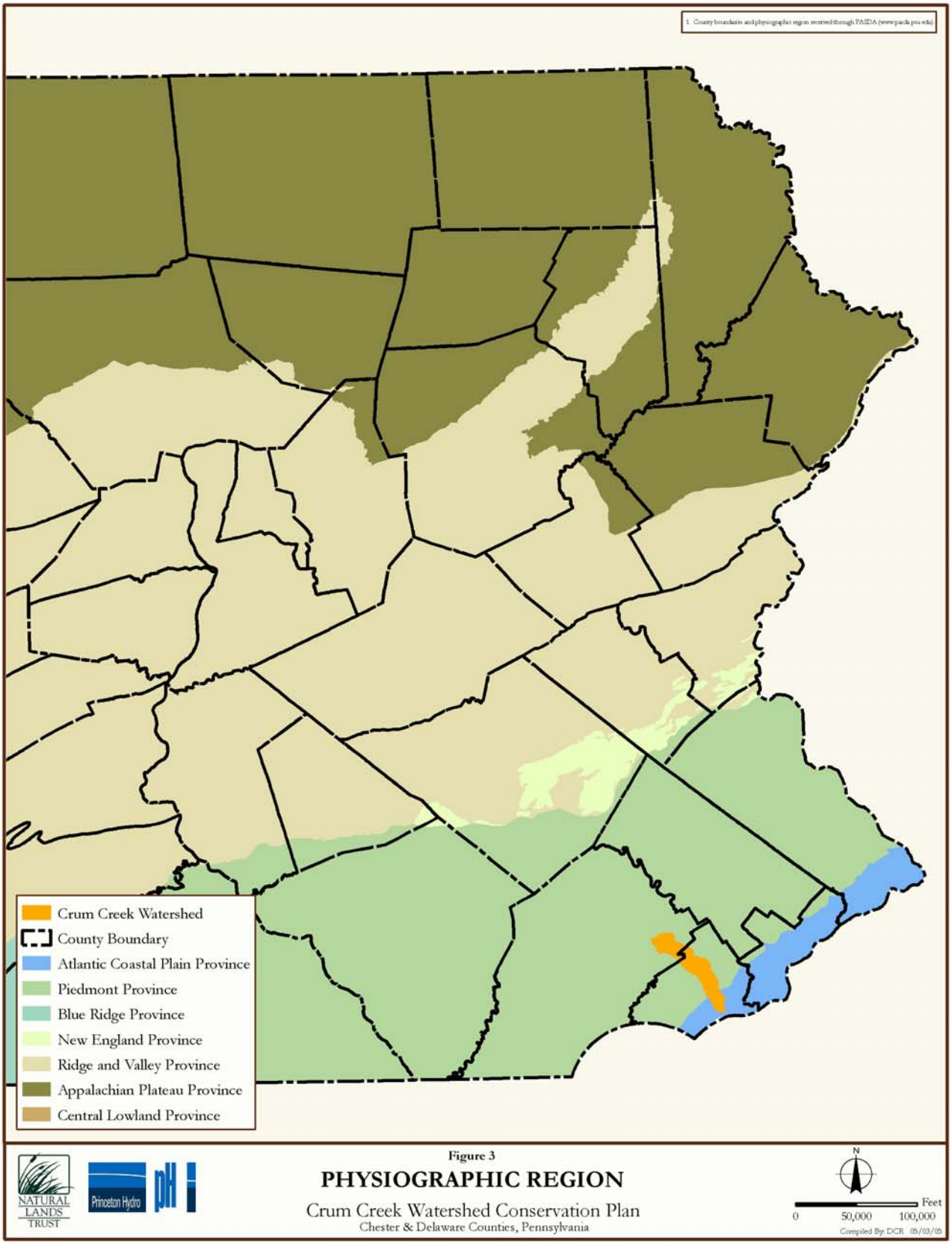

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Figure 3

PHYSIOGRAPHIC REGION

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

closer to the Atlantic Ocean. A small band of Serpentinite in the upper watershed supports unique, globally rare plant communities at the Sugartown Barrens and Crum Creek Barrens. **(Figure 4 – Geology)**

Geologic Formations and Generalized Locations in the Crum Creek Watershed:

- Bryn Mawr Formation (lower half of watershed)
- Diabase (small pockets near northern watershed boundary)
- Felsic Gneiss (large portion of upper watershed)
- Granitic Gneiss (found in lower watershed)
- Mafic Gneiss (scattered through watershed)
- Pegmatite (found in lower watershed)
- Pensauken and Bridgeton Formations (band near mouth of watershed)
- Serpentine (bands in upper and middle of watershed)
- Wissahickon Schist Formation (large portion of lower watershed, narrow band near northern watershed boundary)

Sources: Chester County Geology; The Geology of Pennsylvania; Pennsylvania Spatial Data Access.

Radon Gas

Radon gas accumulation in houses is also a potential hazard in the geologic formations of the Crum Creek valley, particularly Precambrian granitic gneisses commonly containing 10 to 20 ppm (parts per million) of uranium, but locally containing hundreds of parts per million. Radon gas is a naturally occurring product of radioactivity in certain rock types, and has been linked to human health problems and lung cancer. This problem occurs in localized "hot spots" throughout southeastern Pennsylvania.

TOPOGRAPHY AND LANDFORMS

The upheaval and gradual weathering and erosion of the Gneiss and Schist geology over millions of years largely shaped the topography of the Crum Creek watershed and helps to explain its unusually narrow, linear form. **[Figure 5 – Regional Topographic Map – Digital Elevation Model (DEM)]** These events have produced a landscape with two narrow stream valleys draining to the south (Ridley and Crum). Steeply sloping areas characterize the lower valleys. The greatest concentrations of moderately steep (15 to 25%) and steep slopes (>25%) in the Crum Creek watershed are found along the sides of the valley walls downstream from the Springton Reservoir, with other steep sites located along Trout Run in the eastern section of the watershed. **(Figure 6 – Slope Map)**

The highest points in the Crum Creek valley are in the northwestern headwaters areas close to Malvern and Route 30, with erosion-resistant schist ridges reaching elevations of 600 feet above sea level, some of the highest points in Delaware County. The study area upland reaches its lowest point at roughly 10 feet above sea level near the intertidal

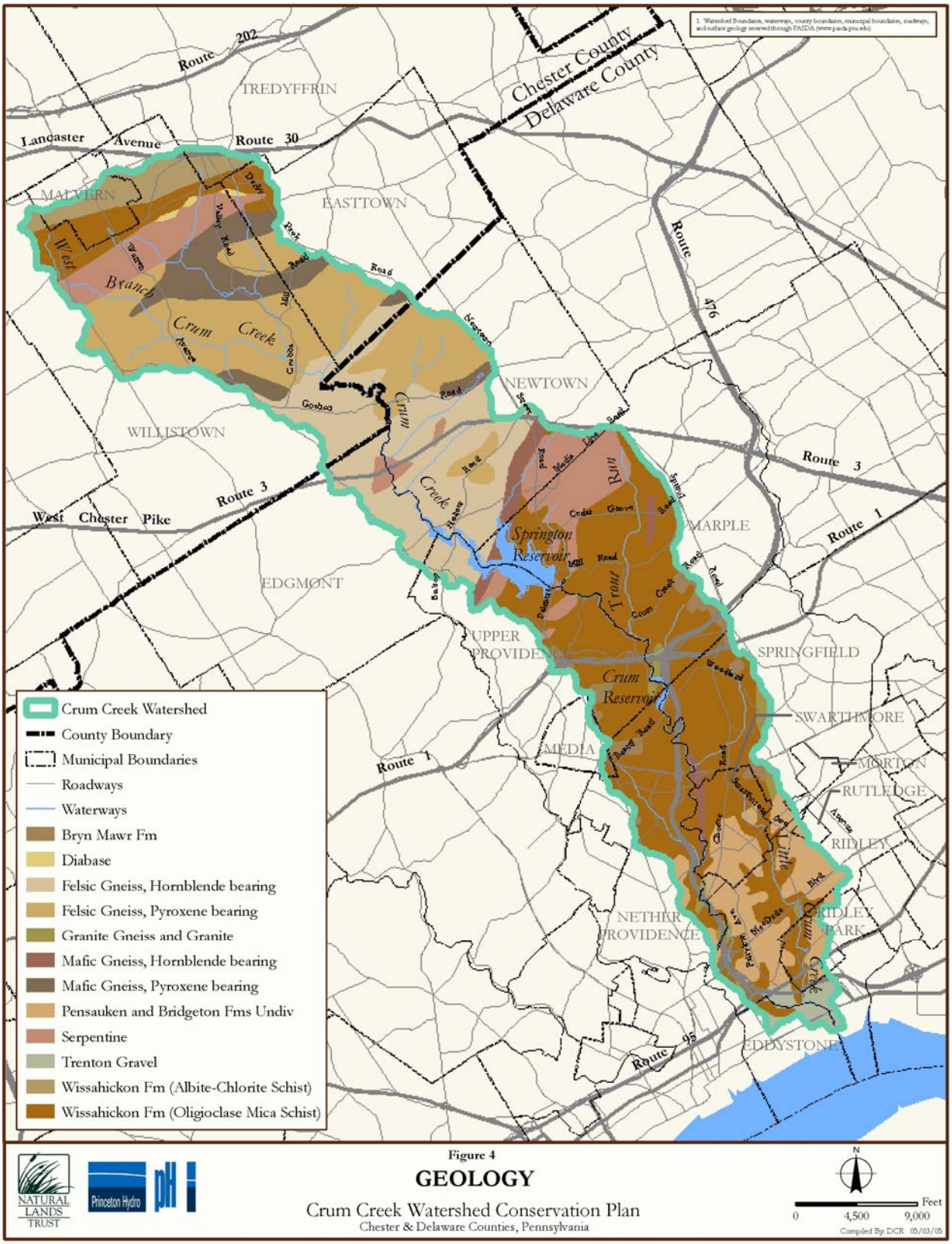

Figure 4

GEOLOGY

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

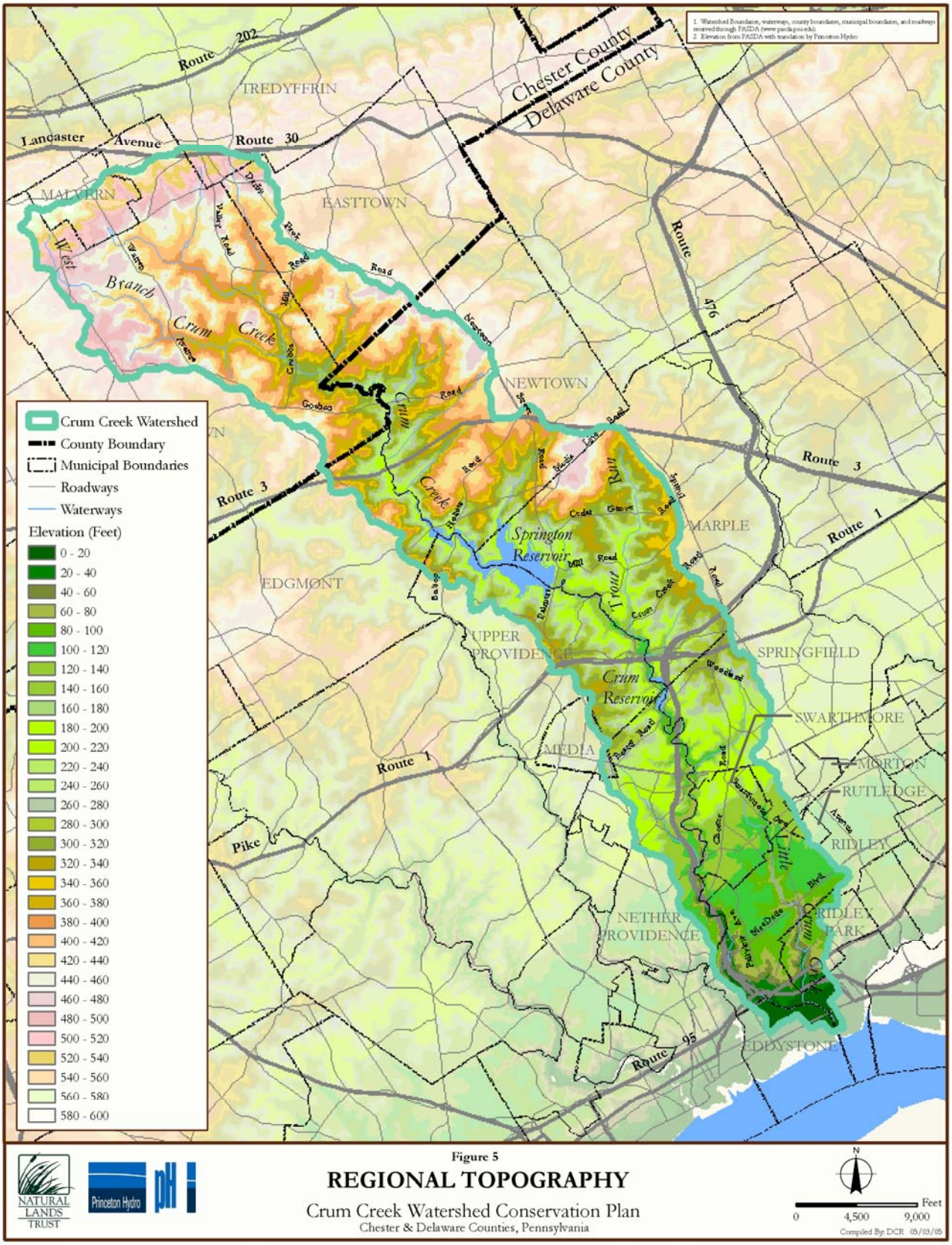

Figure 5

REGIONAL TOPOGRAPHY

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

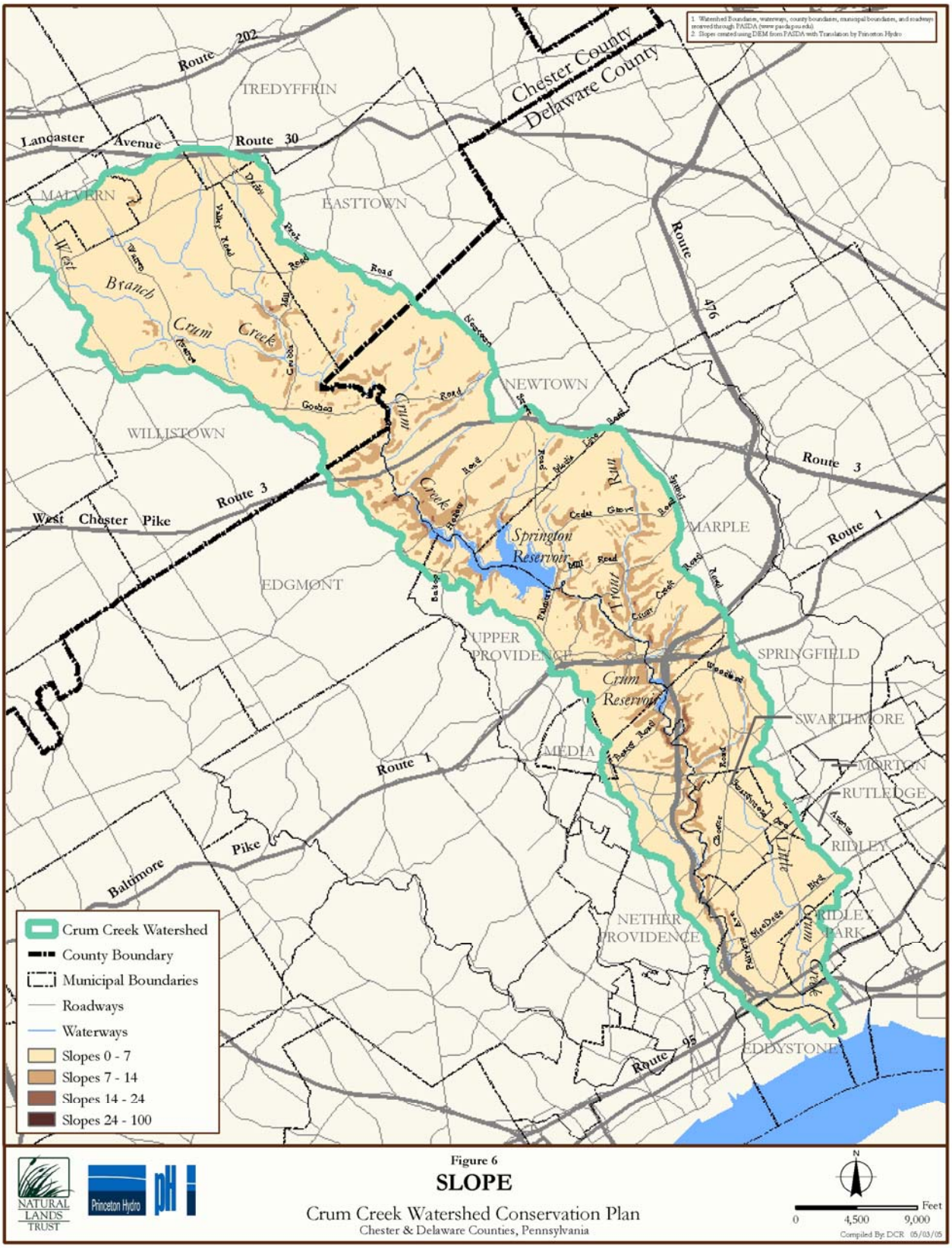

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Figure 6

SLOPE

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

mouth of the Crum Creek in the Delaware River floodplain, a drop of nearly 600 feet over a distance of approximately 25 miles. The streams of the steeper portions of the valley had much more rapid drops in elevation (100 feet or more over 1 mile) and were used to power early mills in the area. The "Fall Line" marking the boundary between Piedmont and Coastal Plan crosses through the Crum Creek watershed somewhere in the vicinity of I-95, where land elevations drops from approximately 50 feet above sea level down to an average of 0 to 20 feet. The Hillshade Map depicts the topographic features of the watershed in a shaded relief image that highlights the pattern of ridges and valleys. **(Figure 7 – Hillshade Map)**

The floodplain of the Crum Creek is never really more than 50 or 100 feet wide, owing to the erosion-resistant underlying bedrock. The linear nature of the stream channel and lower third of the Crum Creek floodplain were chosen as an advantageous location for part of the Blue Route (I-476). The alluvial sediment deposits in the lower areas once formed extensive floodplain forest and marsh near the Delaware River.

Planning Implications of Geology and Topography

The underlying geology and topography have influenced much of the land use in the Crum Creek valley, and will continue to play an important role in the future. The density and location of development has historically been influenced by these landforms and these trends have implications for land use planning today:

- the relatively level, accessible areas of the Lower watershed below the Fall Line attracted a higher concentration of early settlement for small grist and sawmills and scattered sheep farms, and 19th and 20th century industries and associated worker housing that remain today. Major highways and rail lines have also been planned and constructed to take advantage of these conditions.
- the ridges, slopes and narrow valleys of the Middle and Lower watershed today are largely developed with various densities of residential housing in less steep or wet areas. The location of the Springton Reservoir was most likely chosen in part to flood a deep section of the main Crum Creek valley.
- the northern portion of the study area is known for its gently rolling agricultural landscape of horse farms, where the broad, level topography favors pasture and cropland.
- road networks in the area are local, indirect, and winding, and are often narrow. Only Route 1, Route 3, Route 252 and the Blue Route provide direct routes through the watershed, and these largely follow historic Native American paths and early settler routes along ridges and high points.

The presence of steep slopes, narrow valleys, rock outcrops, ridges and areas with bedrock close to the surface are all factors that must influence decisions regarding the zoning of land and regulation of land development. Development in these areas must

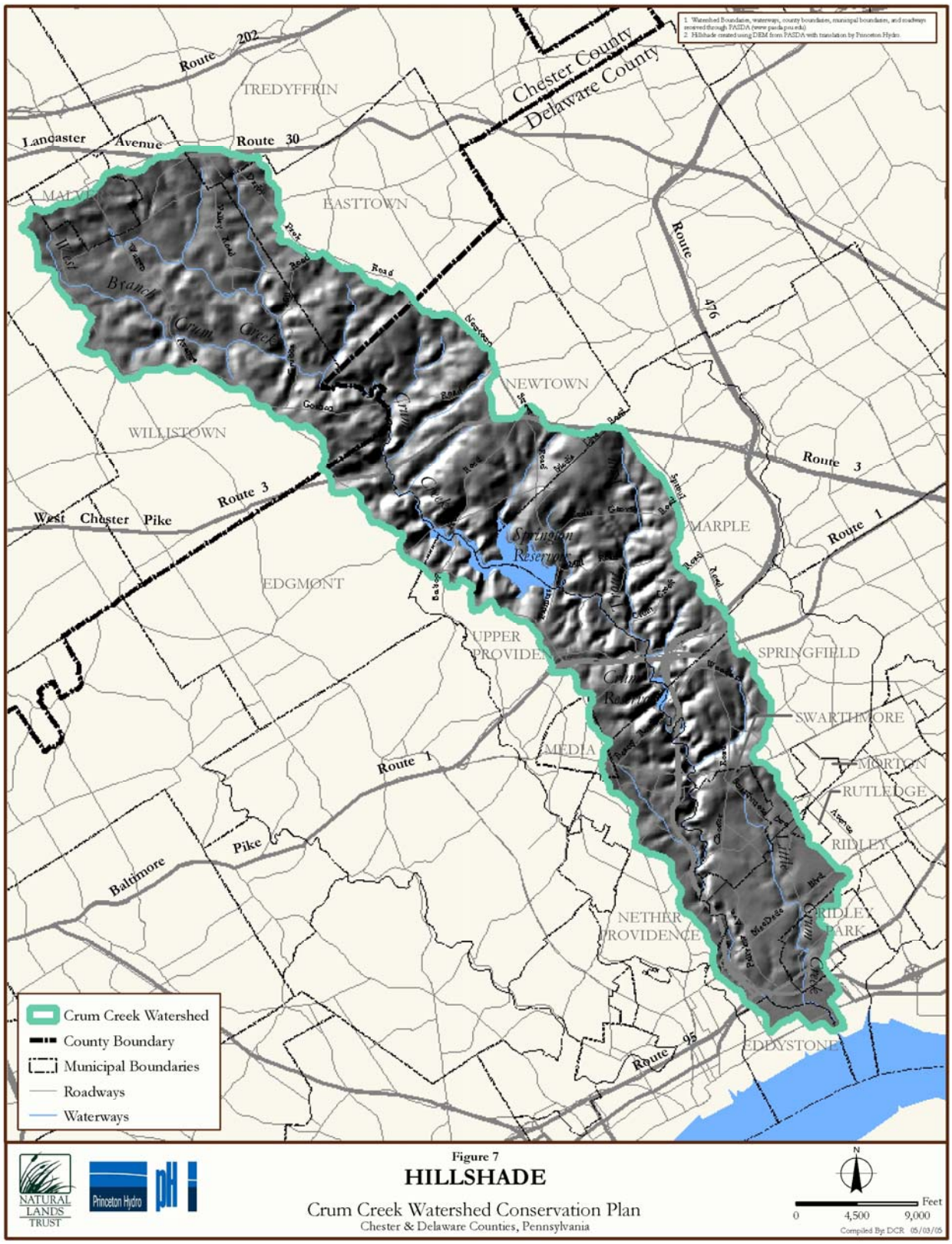

Figure 7

HILLSHADE

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

be at densities, locations and scales to limit the amount of land clearing, regarding of slopes and ridges, and blasting of bedrock.

To alleviate concerns regarding radon gas contamination, new and existing homes in the watershed should be fitted with radon gas monitoring systems and, when levels are determined to be higher than safety thresholds set in state or county health standards, ventilation systems should be installed. Certain "hotspots" may exist where gas levels are too high for safe construction of residences.

SOILS

Major soil associations in the Crum Creek watershed reflect the influence of parent material weathered from geologic formations. These groupings of soils also coincide with various topographic features such as floodplains, seeps and springs, and headwaters ridges. There are four main associations **(Figure 8 – Generalized Soils Map)**, each with numerous subcategories of soil types **(Figure 9 – Soil Series Map)**:

Manor -- Neshaminy-Chrome-Conowingo
These soils are present in a narrow east-west band in the Malvern area at the upper limits of the watershed, and are underlain by Granitic Gneiss Wissahickon schist and some serpentine geology. They are also present in and around the Springton Reservoir and the Delaware County Community College campus , where some serpentine outcrops are also found.

Hatboro -- Neshaminy-Glenelg
This soil group covers a relatively large section of the Upper Crum watershed over the Felsic Gneiss formation. It includes soils that are generally deep, productive, and well-drained.

Manor -- Glenelg-Manor-Chester
These deep, well drained soils are common in the Middle and parts of Lower Crum over Wissahickon Schist.

Othello -- Beltsville-Sassafras-Butlertown
These soils are concentrated in the Lower Crum, and are considered to be formed in part from remnant deposition from heavier flows from the Delaware River such as glacial outwash.

A narrow band of Opequon soils can be found along the eastern watershed boundary just north of Paxon Hollow Road and Route 320.

More detailed soil descriptions are available from the *Soil Survey of Chester and Delaware Counties, Pennsylvania*, prepared by the U.S. Dept. of Agriculture, Soil Conservation Service.

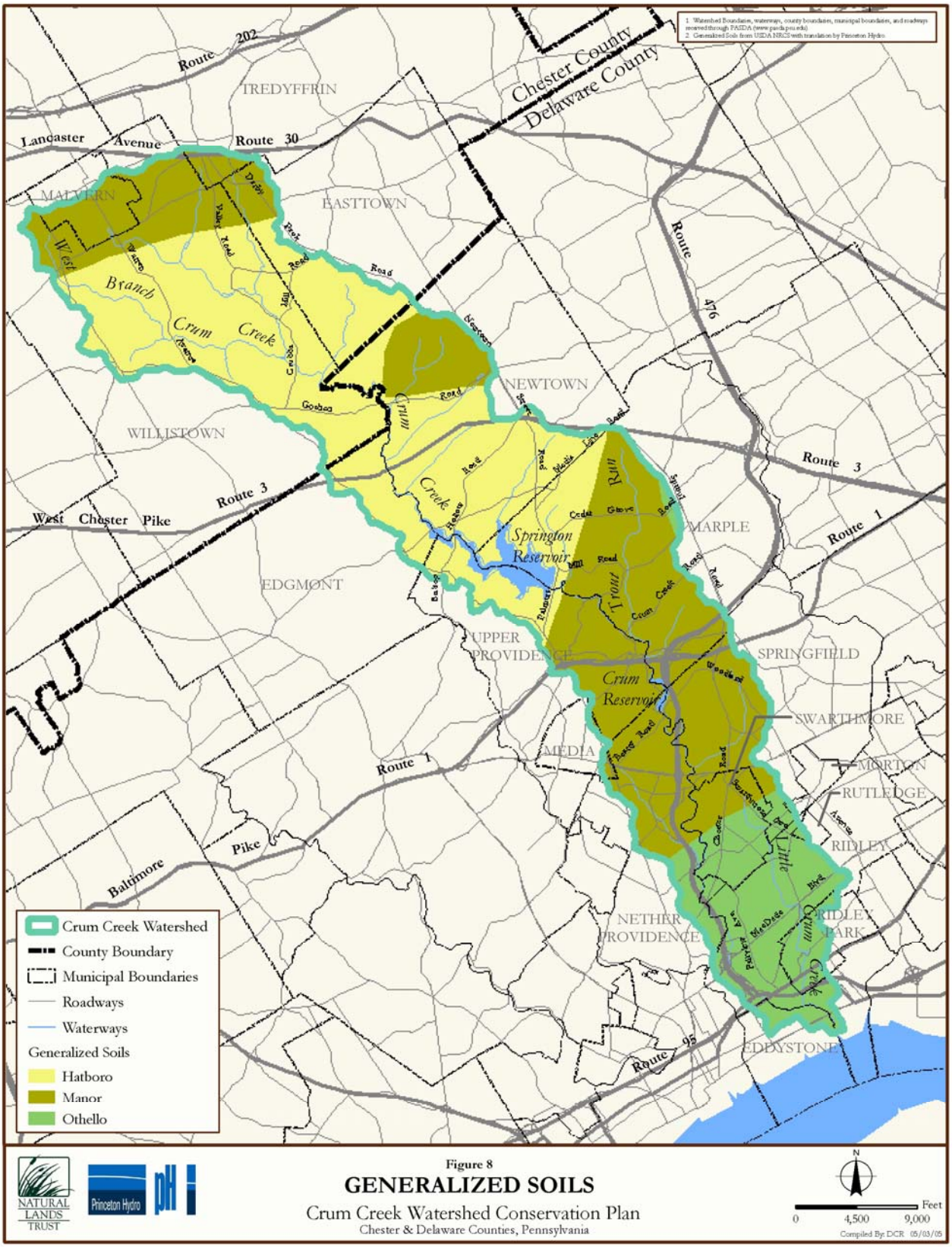

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Figure 8

GENERALIZED SOILS

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

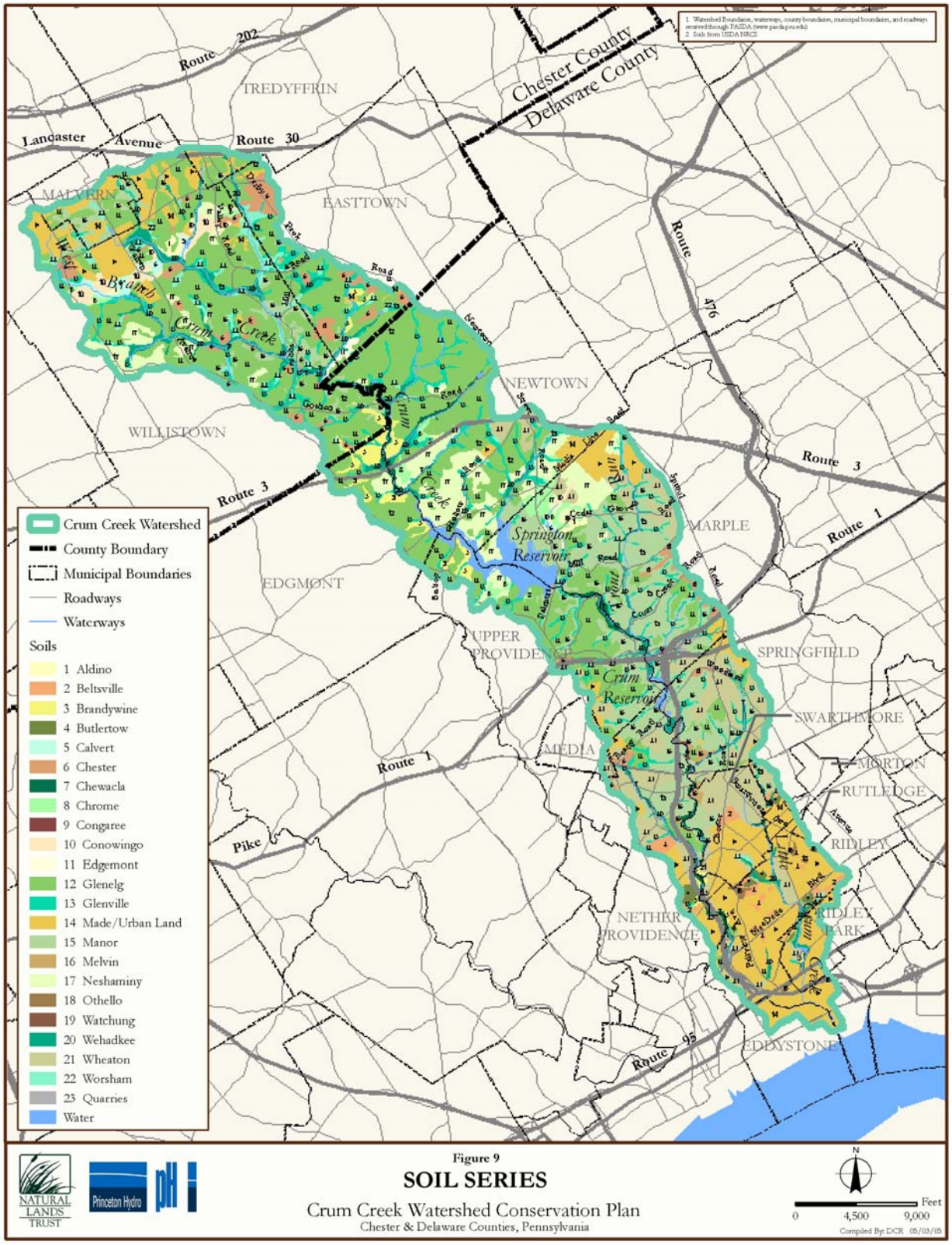

Figure 9

SOIL SERIES

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

Planning Implications of Soils

For several reasons, the Crum Creek watershed and adjoining areas have been a target for widespread single-family home development. First, most of the local soil types do not have the poor recharge, high groundwater table, shallow depth to bedrock, or rocky outcrops that often constrain development. Broad agricultural areas of the Middle and Upper watershed have deep, well-drained soils and are fairly level, so they can be used for on-lot septic systems. Exceptions to this pattern are the rocky ridges in the Upper watershed and steep slopes in the Middle and Lower watershed having thin, rocky soils not useful for percolation and subject to erosion. Second, public water and sewer systems are available in most areas. Development in some areas is constrained by institutional strategies (such as conservation easements) rather than engineering constraints or costs of overcoming unfavorable soil conditions. The capacity of the land to supply clean groundwater for the private wells used by some residents currently is a minor concern, since most new homes rely on public water. Well yields from relatively tight bedrock formations limit the use of large community wells in the watershed.

Even though only about 7% of local residents still rely on private wells for drinking water, careful consideration should be given to the groundwater impacts that may result with each new proposed land development plan in the area (CCWRA, 2002). Where construction of new septic systems is permitted, protection of existing wells and ground water quality in the area should be guaranteed with accurate hydrologic documentation and escrow funds to cover the cost of replacing failed wells.

Figure 10 – Hydric Soils Map shows limited areas of hydric and alluvial soils in the project area, again owing to the tight, dense geology which did not erode to form broad floodplains and did not produce broad areas of seeps, springs, and high water table. A small amount of hydric soils has been recorded and mapped by the USDA-NRCS Soil Survey for Delaware County, but there are extensive areas known to include potential hydric inclusions where seeps, springs, and rivulets emerge along the bases of slopes in the area. These hydric soils of greatest concern and interest for conservation planning, indicating preservation opportunities. (The final draft of the Crum Creek Watershed Conservation Plan will include a more detailed Wetland Map based on these criteria).

Only a small percentage of the project area supports important agricultural soils, with the greatest concentrations found along the upper Crum areas of Neshaminy-Glenelg soils. Since these areas are relatively limited and are substantially protected by permanent easement, they have not been mapped here or recognized as a key resource for additional future protection in the Action Plan section of this report. Typically, properties over 50 acres in size would be mapped as candidates for agricultural preservation through Pennsylvania's Agricultural Easement program, as administered locally by Chester County and, in some cases, with the assistance of municipal open space funding. The critical mass areas (several hundred acres) of contiguous Class 1, 2 or 3 soils (undeveloped) that are required for strong participation in these programs do not occur in this study area, even in the Upper watershed.

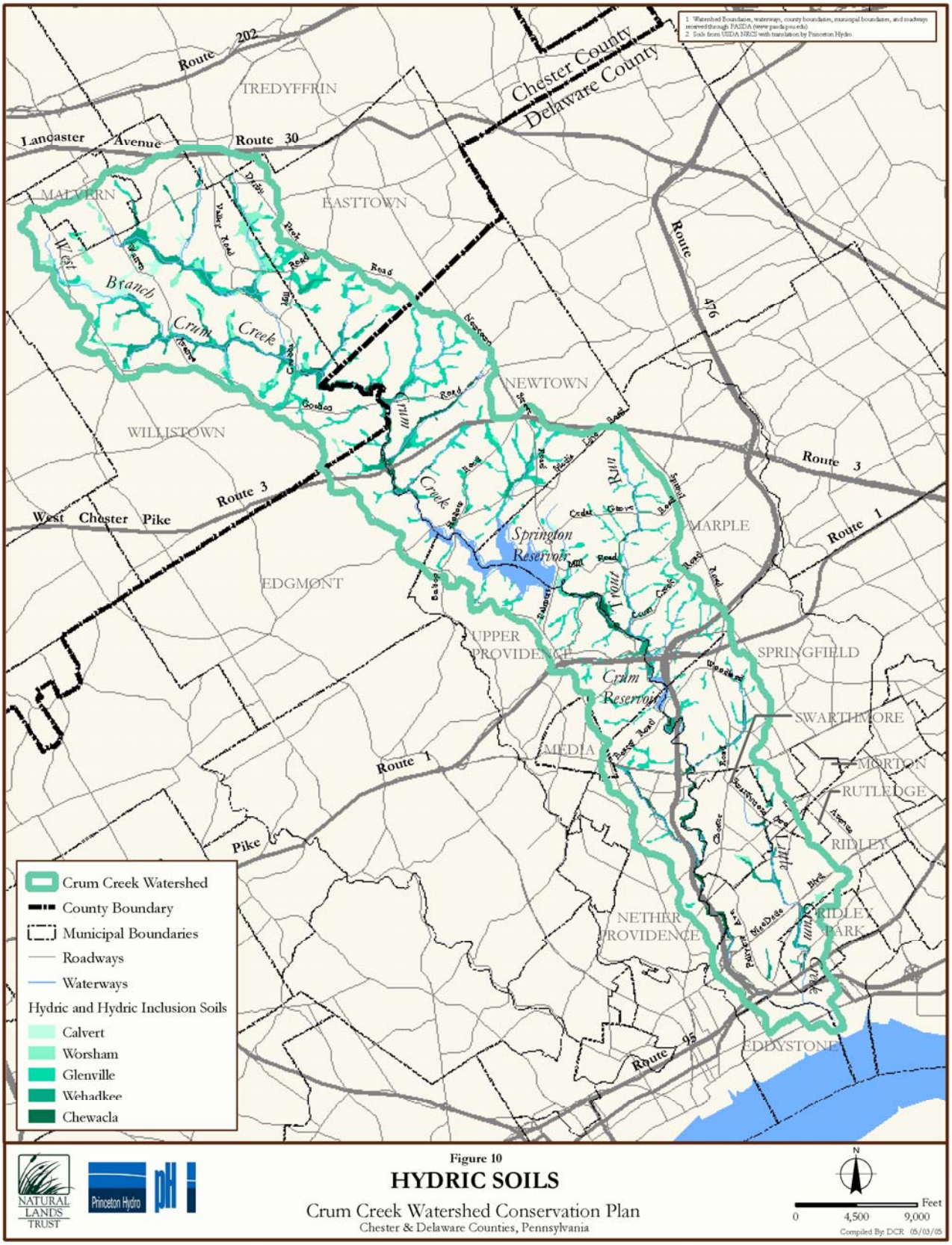

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Figure 10

HYDRIC SOILS

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

VI. Water Resources

Overview

The greatest concerns for water quality in the study area are pollutants and sediments carried by runoff from roadside culverts along public and private roads and driveways, the prevalence of failed or poorly functioning septic systems, and increased clearing of woodlands and steep slope areas, construction of impervious rooftops and driveways, and resulting erosion along steep slopes. As development continues to increase the scope and severity of these impacts, the need for protected and restored open space, clearing and grading standards, and innovative stormwater management approaches (both new standards and retrofits of old systems) will become increasingly important to the health and viability of local streams, wetlands and groundwater.

An understanding of the issues affecting the Crum Creek and the actions needed to maintain its health and function must begin with an understanding of the quality and quantity of ground and surface water, dependent on the processes of the hydrologic cycle. In this complex interrelated natural system, surface water (runoff, streams, wetlands) and groundwater (recharge, soil storage, aquifers) move from precipitation through the soil mantle for filtering and into and out of the local water table. Surface vegetation draws from near-surface aquifers, as do local wells. Ground water provides the baseflow for streams and for some wetlands, even during periods of drought. This cycle is governed by climate and precipitation, and is frequently altered by human activity. All life in the watershed depends on this natural cycle. **(see Figure 10a -- Hydrologic Cycle)**

The 1994 report *Geology, Hydrology, and Ground-Water Quality of Chester County, Pennsylvania*, the United States Geologic Survey (USGS) and the Chester County Water Resources Authority includes an average water budget for the Crum Creek watershed, prepared by the United States Geologic Survey (USGS). Based on recent land use conditions in the watershed, of the 45.8 inches of precipitation recorded in an average year:

- Runoff: 6.7 inches (15 % of total) flow over the land surface and into surface water bodies, primarily into streams;
- Evapotranspiration: 27.1 inches (59 % of total) either evaporate to the atmosphere from soils, open water surfaces, leaves, pavement, and rooftops, or are taken up by the roots of plants and returned to the atmosphere via photosynthesis ;

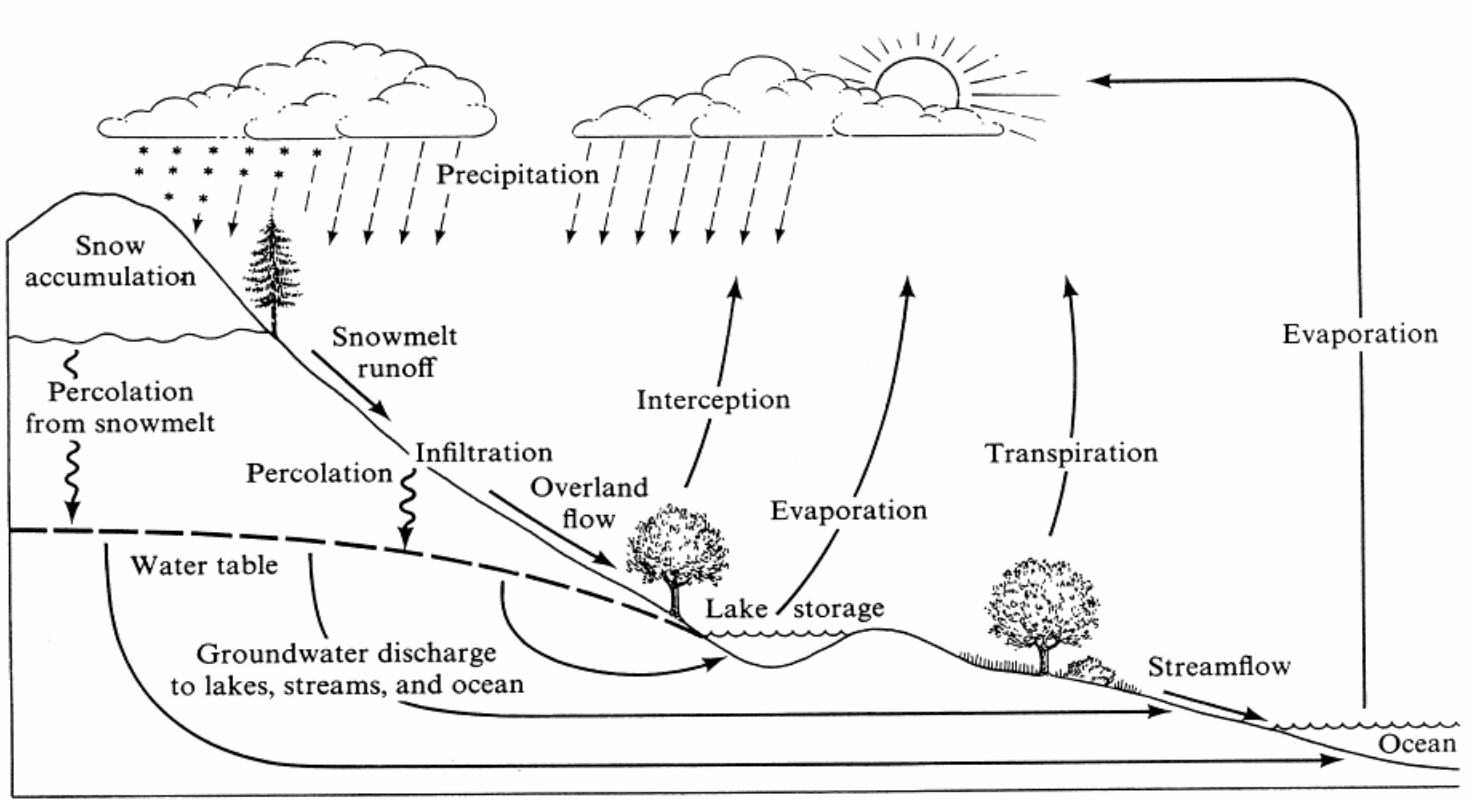


Figure 7a Schematic diagram of the hydrologic cycle.

Source: Dunne, Thomas and Leopold, Luna, 1978. *Water in Environmental Planning*. W.H. Freeman and Company, New York.

- Recharge: 12 inches (26 % of total) infiltrate the soil and underlying geology as groundwater supplying wells and baseflow for streams.

An adjusted version of this breakdown is shown in **Figure 10b -- Hydrologic Cycle of the Crum Creek**. Although the overall percentage of forested land in southeastern Pennsylvania has gradually increased in the region over the past 70 years as more marginal farmland has been abandoned, what remains is increasingly more fragmented by development, thereby decreasing the percentage of recharge. As the percentage of impervious surfaces associated with development increases, surface run-off and evapotranspiration also increase. The Springton and Crum Reservoirs, with hundreds of acres of surface area, surely contribute to the evaporation of water. One of the most obvious gaps in this type of water budget is the export of water out of the watershed and import of water into the watershed attributed to public water systems. These interbasin transfers must be considered to gain a full picture of how much future growth and water consumption can be sustained in the Crum Creek watershed without overtaxing its ability to provide clean, plentiful water for people, plants and wildlife.

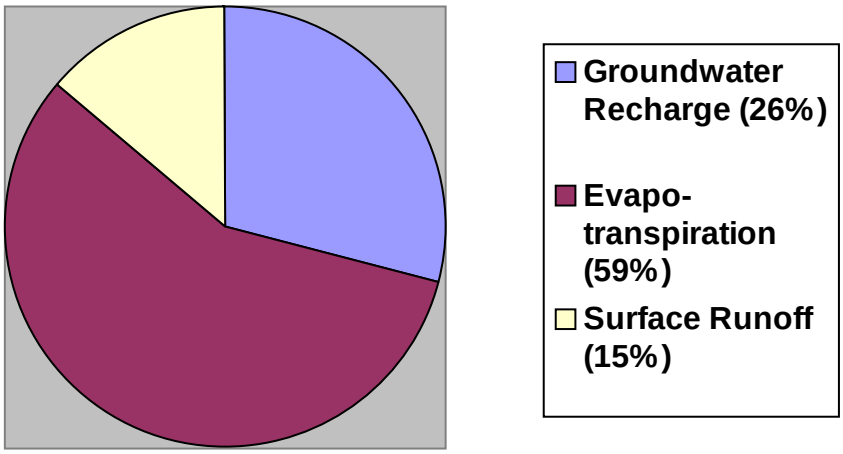


Figure 10b. *Hydrologic Cycle of the Crum Creek watershed (estimated) based on USGS data (CCWRA 2002).*

Estimated Impervious Cover in each subwatershed is shown by township in **Figure 11b** and by sub-watershed in **Figure 11c**. The greatest percentage of impervious cover can be found in the Little Crum Creek watershed, which has at least 35% of its land area devoted to impervious surfaces. The West Branch has the lowest percentage, with 12% impervious cover. These figures are discussed later in this section.

Human interventions with the hydrologic cycle often result in significant alterations of groundwater recharge and stream flows over the course of the year. In the Crum Creek watershed, these interventions span over 300 years and particularly affect water

quantity. They include clearing of woodlands, plowing of soil, construction of dams for mills, ponds and reservoirs, digging and drilling of wells, construction of impervious surfaces and stormwater management systems, construction of water supply systems and construction of wastewater treatment systems.

Groundwater

Fractures in local bedrock and seasonal high water table in many parts of the study area provide for a direct connection between land surfaces and groundwater. Thus, the potential for groundwater contamination exists, and is aggravated by the potential for direct interchange between surface and groundwater as groundwater seeps and springs feed the local stream network.

Public water today is available to new development throughout nearly all of the Crum Creek valley. The design, source, service area, and capacity of the Aqua Pennsylvania public water supply systems impact groundwater and stream levels, and they potentially serve as a catalyst for development, particularly in areas with poor groundwater yields. The Chester Water Authority supplies water to homes, institutions and businesses to a relatively small section of the Lower watershed.

The Delaware River Basin Commission (DRBC) regulates groundwater withdrawals of 10,000 gallons per day (gpd) or more in a Groundwater Protected Area that includes the majority of the Upper Crum Creek watershed. This Area was established by DRBC in 1980 at the request of the Commonwealth of Pennsylvania when it became evident that development was negatively impacting ground water levels. A significant number of the approximately 7% of residences in the Crum Creek watershed relying on private wells are connected to public wastewater treatment systems, but a firm number has not been prepared as part of this study.

In 1999, the Delaware River Basin Commission (DRBC) amended its Ground Water Protected Area Regulations for Southeastern Pennsylvania by the establishment of numerical withdrawal limits for 62 subbasins entirely or partially within the Protected Area. The Upper Crum watershed in Malvern, Willistown, and Easttown falls within this area. The amendment rated the Upper Crum as Potentially Stressed at 1290 million gallons per year (MGY) with a Withdrawal limit of 1721 MGY. (DRBC , 2005)

There are currently no EPA Superfund sites listed for the Crum Creek watershed. The presence of numerous sources of hazardous materials in the watershed raises concern that ground and surface water are vulnerable to oil spills, chemical spills, and other industrial hazards. The nearest Superfund site is located in Paoli, just to the north of the watershed, where an ongoing cleanup of PCB's has been underway at the SEPTA Rail Yard. The PA DEP Watershed Restoration Action Strategy for the Crum Creek includes

a note that the remediation and clean up of a contaminated abandoned paper products manufacturing plant and waste lagoons in the lower part of the Crum Creek watershed (near the current location of Smedley Park) was completed in 1994." (PA DEP, 2005)

Planning Implications for Groundwater

Where public water supply and wastewater treatment are not used, the dense crystalline nature of bedrock places a natural limit on the development potential of the land. Large-scale community wells or large community septic systems are not likely in the watershed. The trends toward increased public distribution of surface water parallels a trend toward construction of package treatment plants discharge increasing amounts of wastewater to streams and, possibly, to the land as drip or spray irrigation systems. There are several interrelated concerns regarding groundwater quantity, including: balancing of water transferred out of the watershed; and potential reduction of recharge. An Integrated Water Resources Plan (as outlined in Goal 7 of the Action Plan) could be considered to provide municipalities and utilities with information on long-term, sustainable water supply. The State Water Resources Plan for Pennsylvania is developing water use and water balance calculations for all watersheds across the state, which should provide an updated water balance for Crum Creek by its publication date of 2008.

Public water and sewer systems are undermining the natural carrying capacity of the Crum Creek watershed to provide sustainable water supply for its residents.

Groundwater recharge in the area results from precipitation, though some recharge from reservoirs and ponds is likely. A five-foot depth of permeable soil overburden is recommended to cleanse most ordinary suspended and dissolved contaminants. Hence, there should be at least 5-feet of soil between the *bottom* of a septic system and the *top* of the water table. In the Crum Creek area, where certain soils are thin and poorly drained, public sewerage is a common way to avoid limitations from soils unable to absorb septic system effluent. In areas along the streams where the water table is high, slopes are steep, and small headwaters streams are common, contaminants from septic systems may not have a chance to be removed by the soil before entering the water supply, with or without sand mounds. Shallow wells in these areas are likely to become contaminated by septic effluent more easily than deep wells. Fecal coliform bacteria from failing septic systems can also show up as a contaminant in streams, particularly when these systems are close to streams. This problem can also occur with bacteria from animal wastes including livestock and pets. These concerns are all important considerations for municipalities in determining zoning densities for land development. To provide reasonable assurances that septic leachate does not contaminate streams and domestic water supply wells where local sewer and public water are not supplied, residential densities should be carefully evaluated in relation to soil types, and the use of low-impact community disposal systems should be considered.

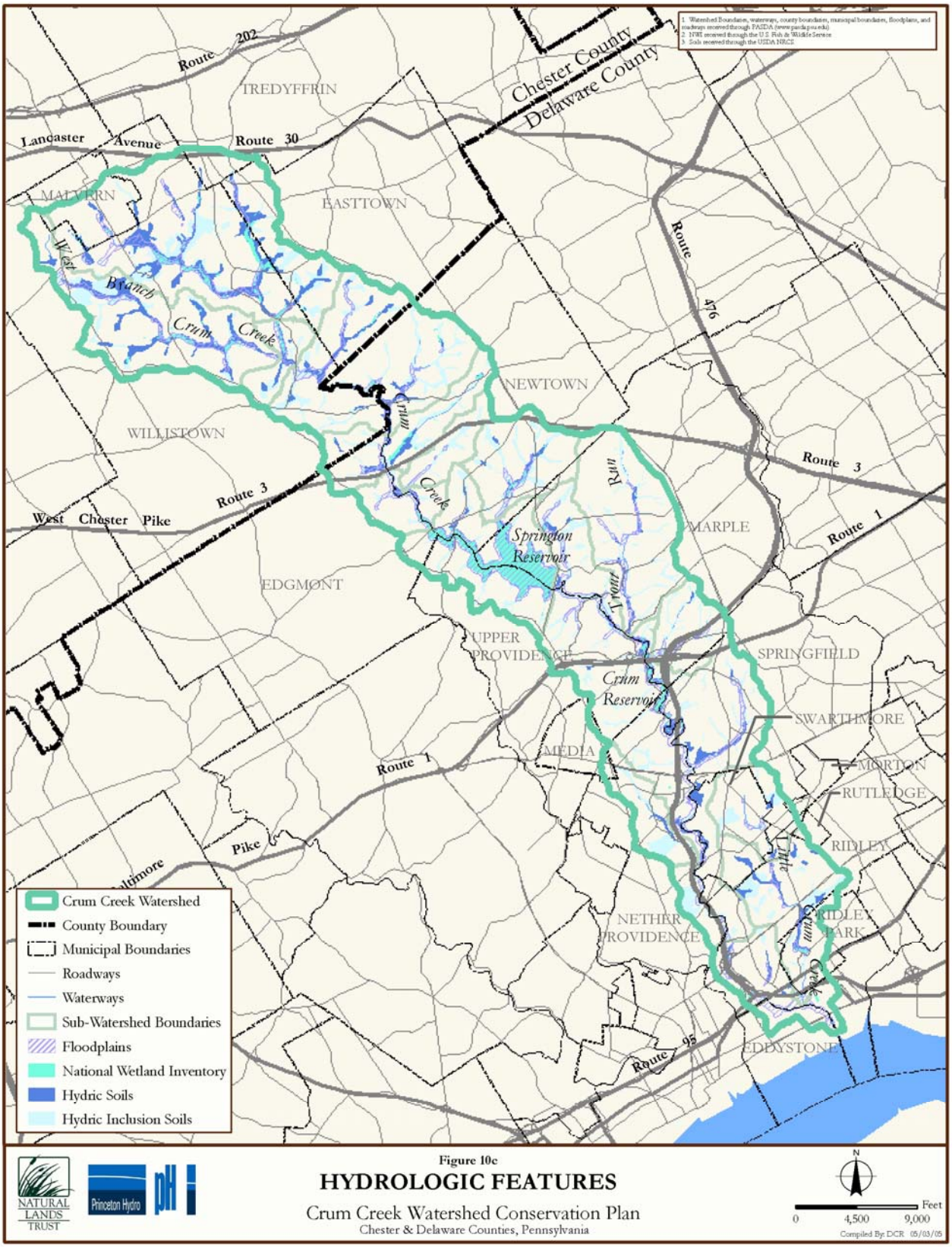
Surface water

The project area for the *Crum Creek Watershed Conservation Plan* includes major sections of Crum Creek and tributaries such as West Branch, Trout Run, Little Crum Creek, and numerous other small tributaries that have local names or are unnamed. **(Figure 10c – Hydrologic Features)** The total size of the Crum Creek basin is 38 square miles, with roughly 22 square miles in the middle/lower portion (Delaware County) and about 16 miles in the upper portion (Chester County). The Crum Creek watershed supports approximately 72 miles of streams, with 41 miles (57%) in First Order headwater tributaries. The areas draining to those First Order streams total over 22 square miles, well over half of the watershed area. The linear nature of the watershed, based on its geology, means that its tributaries are often too short to accumulate broader drainages, or extensive networks of tributaries, seeps, and springs. Compared to more broad, dendritic (tree-like) drainage networks, there is less opportunity for dilution of contaminated waters and more direct opportunities for pollution of the entire system. The land use pattern adjacent to these stream corridors is largely dominated by single family residential development, and a substantial portion is still wooded, supporting some form of riparian forest buffer.

Streams in the watershed are generally influenced by natural conditions such as the underlying gneiss or schist geology, the topography of steep ravines, a broad, level headwater areas, combined with the long history of human influence – with the initial forest clearing, agricultural use, construction of mills, dams, and ponds, road and building construction, and modern development, conservation, and restoration. The physical characteristics of the stream channel, the quality of the water (chemical, biological, and physical), and the quantity of water during periods of average flow, drought, and flooding are all influenced by these natural and cultural forces. The streams of the Upper watershed north of Route 3 are generally ranked by PA DEP as among the highest quality for the Crum Creek, yet they still suffer from nonpoint source pollution and some sections ranked by DEP as Impaired from the various suburban and urban land uses in the watershed **(Appendix F).**

The Springton Reservoir is perhaps the most tangible symbol of the quantity of surface water in the Crum and its use by humans. The Geist dam was constructed in 1931 of rock and earth, measuring 70 feet high above the natural grade of the floodplain and spanning 2,000 feet across. This impoundment of the waters of the Crum Creek holds 3.5 billion gallons over a 391 acre surface area. The watershed area draining to the reservoir is approximately 21.5 square miles (CRC, 1988).

As land in the watersheds continues to face increasing pressure for subdivision and land development, the need to maintain and restore the quality and quantity of the streams of the Crum Creek must be central to the decision-making process. Conservation and restoration of land along streams are perhaps the most important steps that can be taken to balance the impacts of future development.


1. Watershed Boundaries, waterways, county boundaries, municipal boundaries, floodplains, and roadways received through PASDA (www.pasda.psu.edu)
2. NWI received through the U.S. Fish & Wildlife Service
3. Soils received through the USDA NRCS
Route 202
Chester County
Delaware County
IREDYFFRIN
Lancaster Avenue
Route 30
MALVERN
EASTTOWN
West Branch Crum Creek
Route 476
NEWTOWN
WILLISTOWN
Route 3
West Chester Pike
Springton Reservoir
Ran Creek
MARPLE
Route 1
EDGMONT
Trout Run
UPPER PROVIDENCE
SPRINGFIELD
Crum Reservoir
SWARTHMORE
MEDIA
MORTON
RUTLEDGE
Pike
RIDLEY
NETHER PROVIDENCE
RIDLEY PARK
Crum Creek
Route 95
EDDYSTONE
Crum Creek Watershed
County Boundary
Municipal Boundaries
Roadways
Waterways
Sub-Watershed Boundaries
Floodplains
National Wetland Inventory
Hydric Soils
Hydric Inclusion Soils
NATURAL LANDS TRUST
Princeton Hydro
pH
Figure 10c
HYDROLOGIC FEATURES
Crum Creek Watershed Conservation Plan
Chester & Delaware Counties, Pennsylvania
N
0
4,500
9,000
Feet
Compiled By: DCR 05/03/05

Name	Length (mi.)	Drainage Area (sq.mi.)	Stream Order	Protected Use Designation	Discharges (NPDES)	Intakes
Main Stem Crum Creek (above and including Springton Reservoir)	30	12	5th	HQ-CWF (Basin, Source to Junction of Newtown, Edgemont, Willistown borders) CWF (Basin, Junction of Newtown, Edgemont, Willistown borders to Springton Reservoir) WWF (below Springton Reservoir)	1	0
West Branch Crum Creek	7.5	3	2nd	EV	0	0
Main Stem and Other tributaries (below Springton Reservoir)	21.5	23	5th	WWF	1	1
Trout Run	5.5		3rd	WWF	0	0
Little Crum Creek	7.5		3rd	WWF	0	0

Table 1. Sub-watershed Data. This table provides an overview of the range of sub-watershed sizes, the lengths of stream in each, stream quality designations and point-source discharges/intakes. Subwatershed drainage areas to be calculated.. (Source: PA Code, Title 25, Chapter 93 Water Quality Standards (www.pacode.com)

Surface Water Quality
Nonpoint Source Pollution (NPS)

Water quality is a major consideration in the Crum Creek watershed. The natural forest cover that defined the watershed for much of the last 10,000 years provided a living filter and sponge to regulate the quality of water in aquifers, streams and wetlands. The relatively pure air and precipitation, the level and dispersion of animal and human waste, the rich leaf litter and humus of the forest soils, and the biological diversity of plants and organisms in the pre-settlement ecosystem functioned as the best possible water purifier. Over the last three centuries, humans have steadily altered the landscape and reduced the quality of water it provides. Surface and ground water are now susceptible to various levels of contaminants ranging from nutrients to sediment, and heavy metals to toxic chemicals.

Water quality in the Crum watershed is impacted by point source pollution, such as discharges from sewage treatment plants and industrial facilities, and non-point source pollution such as runoff from agricultural fields, parking lots, and chemically treated lawns.. Contamination from septic systems is also an ongoing concern. Potential hazardous waste sites represent one of the most serious threats to ground water quality and the well supplies on which many residents depend, and can be a direct source of contaminants to streams. Sites suspected of having contaminated materials should be reported to PA DEP or the U.S. EPA.

Causes of NPS in the Crum Creek

- sediment from construction sites and agricultural fields.
- chemical nutrients and pesticides from agricultural fields, golf courses, and other public and private lawns.
- bacteria from failing septic systems, livestock operations, and Canada geese.
- oils and heavy metals from roads, parking lots, and driveways.
- runoff from contaminated sites.

Phase II of the National Pollution Discharge Elimination System (NPDES) permitting system of the Clean Water Act focuses on nonpoint source pollution, which has the most significant impact to stream quality in the Crum Creek watershed. Nonpoint source pollution is less easily defined than point source pollution from a pipe, and is often tied to broad areas influenced by a certain land use pattern or land management approach. This type of pollution is closely tied to both agricultural or to suburban/urban landscapes and the behavior patterns of residents throughout the watershed. Nonpoint source pollution is often carried as stormwater runoff in these forms:

Source	Sediment (soil/gravel)	Nutrients (nitrogen/ phosphorus)	Biocides (insecticides/ herbicides)	Heavy metals (lead/zinc)	Bacteria (fecal coliform)	Road salt
Roads/ parking lots	√	√		√		√
Lawns	√	√	√			
Cultivated Fields	√	√	√		√	
Livestock Pastures	√	√	√		√	
Construction Sites	√					
On-lot septic systems		√			√	

Table 2. Nonpoint Source Pollutants. T*he nonpoint source pollutants affecting streams in the Crum Creek watershed originate in a variety of rural and suburban land uses and land management approaches.*

Point Source Discharges

The known point-source discharge permits on the Crum Creek are:

- Boeing Defense Systems plant, which discharges approximately one-half mile upstream of the confluence with the Delaware River.
- Aqua Pennsylvania Crum Reservoir treatment plant.

A number of smaller package treatment systems in Edgmont and Newtown Townships utilize subsurface discharge. In addition, approximately 6 single residence package treatment systems are situated in the Upper portion of the watershed. The Newtown and Edgmont package treatment plants are subsurface disposal.

Effluent from these discharges varies according to the type of use, the volume of discharge, and the type of treatment system and permit requirements set by PA DEP. The Boeing Defense Systems plant includes discharges of metals and other contaminants associated with industrial manufacturing. The Aqua Pennsylvania plant discharges water associated with its filtration system for a public water supply. The sewage treatment system for a shopping center handles human waste and other wastewater associated with retail businesses.

Stream Classification

Following a petition by the Willistown Conservation Trust, the Pennsylvania Department of Environmental Protection (DEP) and the Environmental Quality Board (EQB) recently upgraded the protected use designation for the West Branch

subwatershed from High Quality-Cold Water Fishery (HQ-CWF) to Exceptional Value (EV), the highest ranking category in Pennsylvania (PA Code, Ch. 93). This ranking is based on stream monitoring that found a good diversity of aquatic life and balanced water chemistry, attributable in part to the relatively undeveloped agricultural, low density residential and natural landscapes that form its drainage area. The remaining Upper watershed above Route 3 is HQ – CWF. EV streams are offered the highest level of protection by DEP, and any new permitted activities must demonstrate no degradation of water quality. Still, the streams in the West Branch suffer from non-point source pollution such as runoff and sedimentation from inadequately protected construction sites, effluent from failed on-lot septic systems, and runoff from agricultural lands lacking Best Management Practices (BMP's). Below Route 3 but above the Springton Reservoir, the Crum is rated as a Cold Water Fishery. The rest of the basin from the Springton Reservoir to the mouth is Warm Water Fishery due to the degradation associated with thermal pollution, flow alteration, and urban runoff.

Stream Water Quality -- Impaired Streams Assessment

The DEP assessment of impaired streams reveals that numerous sections of the Crum Creek and its tributaries do not meet EPA standards under Section 303(d) requirements. Dicks Run is impaired by flow alterations and siltation, Holland Run (aka "Hotland" Run) is impaired due to the same causes, some unnamed tributaries of the Crum in upper, middle and lower segments of the watershed are impaired due to other habitat alterations and excessive algal growth, and siltation and flow alterations (dams). Trout Run faces some of the most serious impacts due to road runoff and urbanization with storm sewers. **(Figure 11 -- Water Quality)**

The Pennsylvania Integrated List of All Waters (formerly the Section 303(d) report) outlines the various categories into which the streams and lakes of the Crum Creek have been classified. The Department of Environmental Protection (DEP) has adopted an integrated format for Clean Water Act Section 305(b) reporting and Section 303(d) listing. This new report is entitled the "2004 Pennsylvania Integrated Water Quality Monitoring and Assessment Report" and satisfies the requirements of both Sections 305(b) and 303(d). The narrative report contains summaries of various water quality management programs including water quality standards, point source control and nonpoint source control. It also includes descriptions of programs to protect lakes, wetlands and groundwater quality.

Approximately 24 miles of Crum Creek and its tributaries are listed as impaired – roughly 33% of the entire stream network. A series of stream segments along the Crum and the Springton Reservoir are listed as "attaining at least one designated use but all uses not assessed."

The PA DEP Watershed Restoration Action Strategy reports that "The subbasin (03-G – includes Chester, Ridley, Crum, Darby) was assessed under the Department's

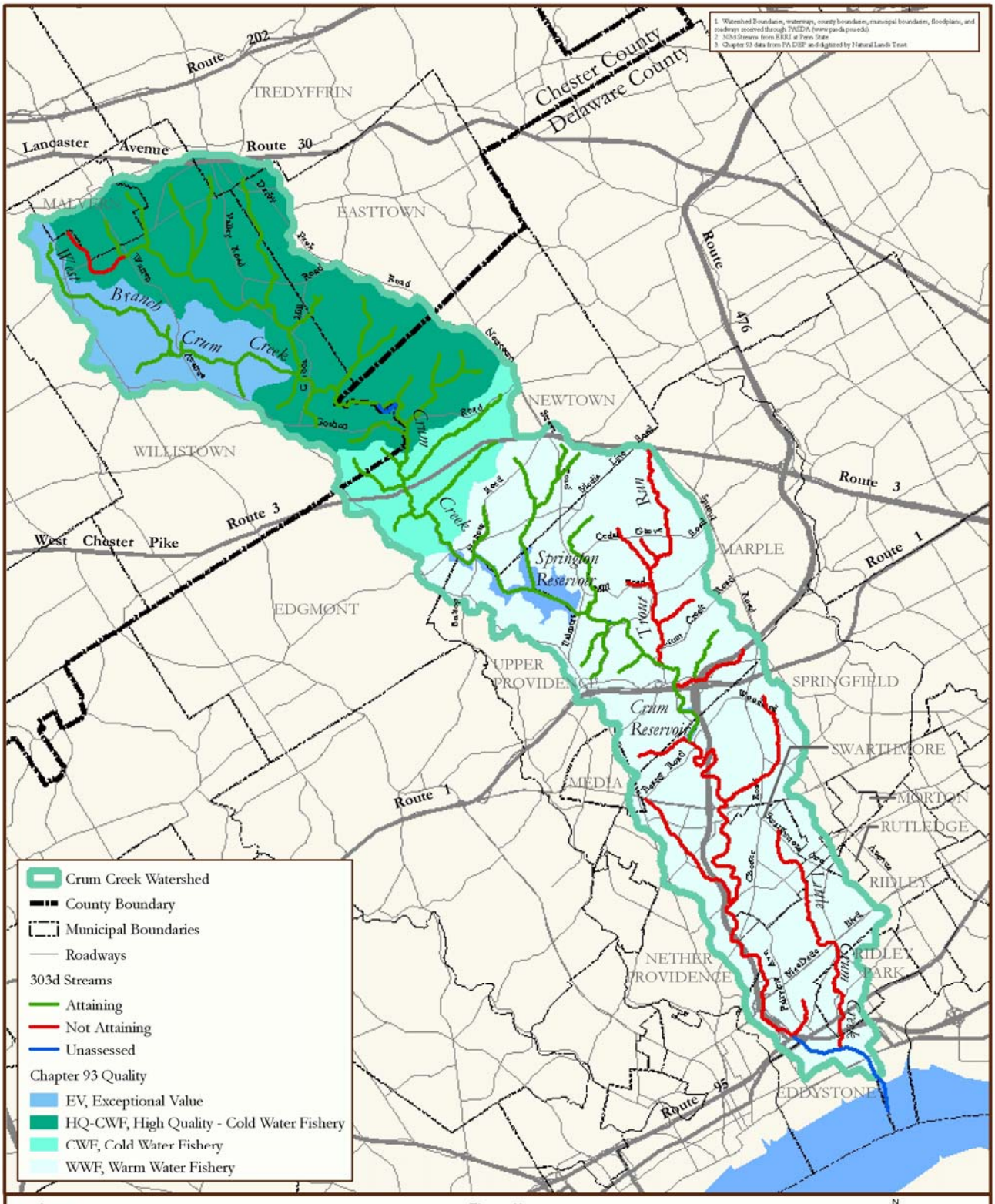
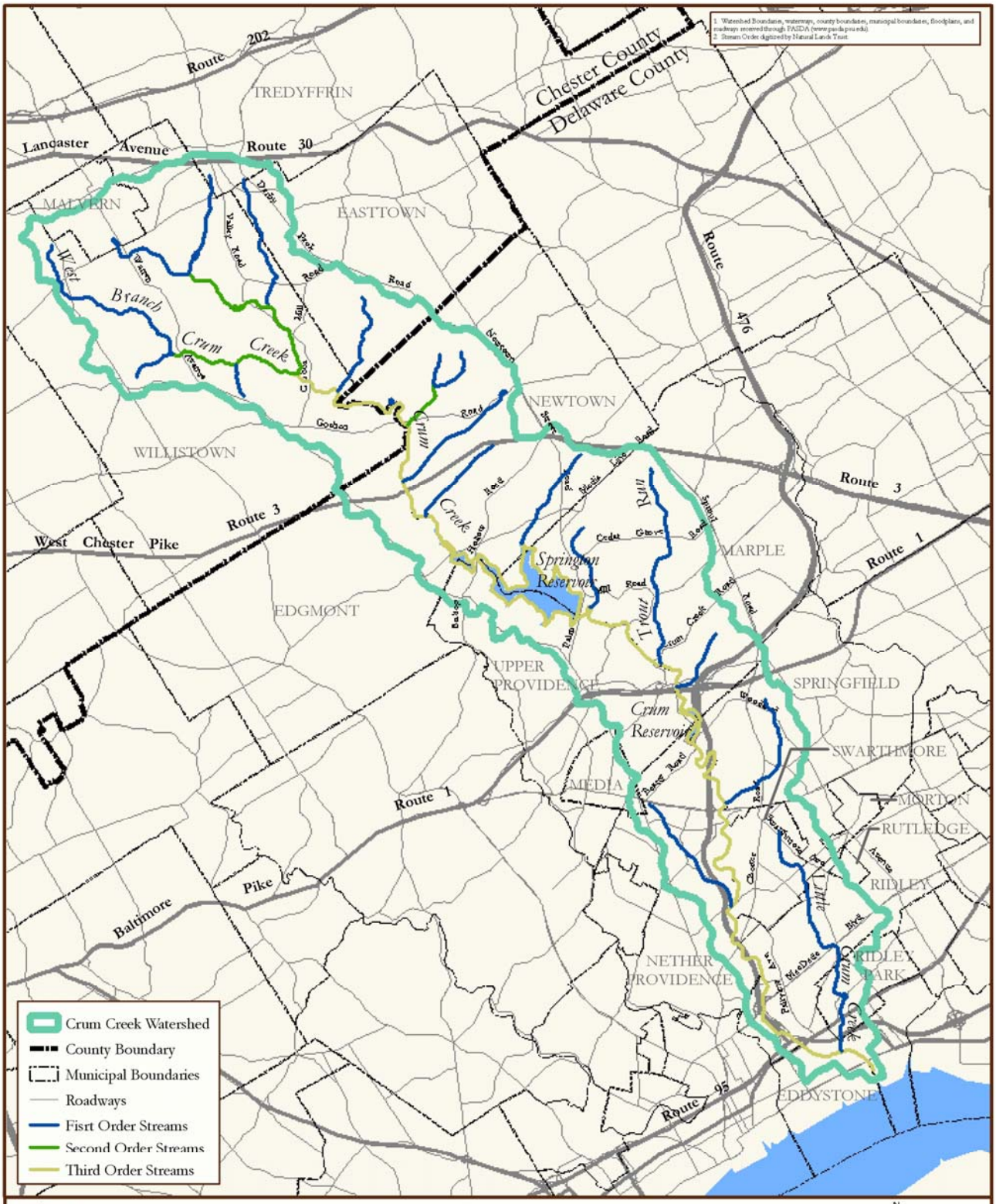


Figure 11

WATER QUALITY

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania



NATURAL LANDS TRUST

Princeton Hydro

Figure 11a

STREAM ORDER

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

Unassessed Waters Program in 1998 and 1999. Out of 404.5 miles assessed, 127.6 miles or 32% are impaired and 276.9 miles are unimpaired and support their protected uses for aquatic life. Most of the impaired stream segments are in the lower portions of the individual watersheds." (DEP 2004) Smaller streams like Dicks Run (2.1 miles Impaired) have large portions of their total length listed as Impaired. The most common sources of impairment are habitat modification and urban runoff/storm sewers that cause water and flow variability and sedimentation. Municipal point sources also cause impairment.

The program assesses representative sites along various stream segments by taking kick-screen samples of benthic macroinvertebrates. These are organisms (primarily aquatic insects) that live on the stream bottom. The assessment takes into account the diversity of species present, and the presence of pollution sensitive species relative to those that can tolerate pollution. Habitat assessments are also done to determine how much erosion, sedimentation, and riparian vegetation is present. Unimpaired streams tend to be those with a high number of pollution-sensitive species, a low amount of streambank erosion and sedimentation, and healthy streamside forests and wetlands. Impaired streams are more likely to have a higher number of pollution-tolerant species, severe erosion and sediment deposits, and parking lots and lawns next to the stream.

Lakes such as the Springton Reservoir are assessed under PA DEP's Lake Water Quality Assessment Program. While the reservoir is not listed as impaired, it has "trophic status impairments" associated with eutrophic conditions (based on an index of nutrient enrichment, transparency and phytoplankton standing crop (Chl-a).

A complete Crum Creek excerpt from the Pennsylvania Integrated List of All Waters is included as **APPENDIX F** of this report.

Stream	**Impaired Stream Miles**	**% of Total Impaired Stream Miles**	**Cause of Impairment to Aquatic Life Uses**	**Unassessed or Partially Assessed**
Main Stem	7.6	27	Hydromodification/Flow alterations/Urban Runoff/ Storm Sewers/Flow Variability/Thermal Modifications	1.9 miles (unassessed) 46.52 miles (partially assessed)
Dicks Run	2 (TMDL)	8.3	Urban Runoff/ Storm Sewers/Siltation	
Hotland Run	1.2 (TMDL)	5	Urban Runoff/ Storm Sewers/Siltation	
Little Crum Creek	3.7 (TMDL)	15.4	Urban Runoff/Storm Sewers/Siltation	
Unnamed Tributaries	3.3 (TMDL)	13.8	Urban Runoff/Storm Sewers/Siltation	
TOTAL	17.8			48.42

Table 3 – Summary List of Impaired Streams.

According to the Pennsylvania Integrated List of All Waters, "The watershed approach requires selection or definition of watershed size and begins with a comprehensive assessment of water quality in the watershed. After water quality impairments are identified, a planning process occurs to develop strategies that can successfully address and correct water pollution in the watershed. Pennsylvania is using this process together with federal Clean Water Act requirements for establishing total maximum pollutant loadings or TMDLs to restore polluted streams so that they meet water quality standards. Water quality standards are the combination of water uses, such as water supply, recreation, and aquatic life, to be protected and the water quality criteria necessary to protect them.

TMDLs can be considered to be a watershed budget for pollutants, representing the total amount of pollutants that can be assimilated by a stream without causing water quality standards to be exceeded. The pollutant allocations resulting from the TMDL process represent the amount of pollutants that can be discharged into a waterway from each source. The TMDL does not specify how dischargers must attain particular load reduction. In an April 7, 1997 Memorandum Of Understanding with EPA, the Department agreed to a 12-year schedule to develop TMDLs for impaired streams listed on the 1996 CWA Section 303(d) list. Over the years the Department has met those TMDL goals. The Department is also developing methodologies, processes, and computer models to establish TMDLs on a broader scale. In addition, several contracted TMDL initiatives have been undertaken in various parts of the Commonwealth."

Volunteer Monitoring

In the 1990's, the Crum-Chester-Ridley Volunteer Water Monitors collected physical, biological and chemical data for streams in the Lower, Middle and Upper watershed. These data samples were taken at several locations, including:

- Yale Avenue dam (Swarthmore)
- Pumphouse Run
- Hildacy Farm (NLT preserve)
- Mill Hollow (north side of Route 3)

Data for these sites and other sampling stations in the Lower watershed have been compiled as part of the Swarthmore College project entitled "Watershed Assessment of Crum Creek: Decision Support for a Community-Based Partnership." In recent years, students from Swarthmore have collected and analyzed data on the Lower Crum and have found impairments consistent with PA DEP's assessments.

A cursory review of several criteria in these data as posted on the Widener University website (http://www.science.widener.edu/~grant/crc/crc_main.html) reveal an overall pattern for the watershed:

- a relatively high pH (between 6 and 9) for most of the watershed, indicating alkaline/basic water (not acidic);
- water temperatures that can reach excessively high levels in any part of the watershed during summer months, rendering conditions unfit for reproduction of wild trout (which require temperatures below 65 degrees Farenheit).
- Turbidity that can fluctuate wildly in all parts of the watershed due to severe erosion and sedimentation during heavy storm events.
- Dissolved oxygen levels (critical for aquatic life) that tend to be higher in the less urbanized Middle and Upper watershed areas.
- Biological samples taken between 1994 and 1996 below the Springton Reservoir dam reveal the presence of aquatic insects such as caddisflies, water pennies, mayflies, craneflies and hellgrammites, all indicators of good water quality. (it should be noted that significant development has taken place in the areas around the reservoir over the last decade, and these sampling stations should be reassessed to determine the presence of these indicator species).

Stormwater sampling in December 2002 at 4 sites along Trout Run showed progressive increases in Total Suspended Solids, phosphate, turbidity, organic nitrogen, and TKN as the sample sites progress downstream.

Taxa: Organisms Indicating Good Water Quality:

- Mayfly larvae (*Phylum Arthropoda, Class Insecta, Order Ephemeroptera*)
- Stonefly larvae (*Phylum Arthropoda, Class Insecta, Order Plecoptera*)
- Caddisfly larvae (*Phylum Arthropoda, Class Insecta, Order Trichoptera*)
- Water Penny/ Riffle Beetle (*Phylum Arthropoda, Class Insecta, Order Coleoptera, Families Psephenidae/ Elmidae*)
- Gilled Snail (*Phylum Mollusca, Class Gastropoda*)
- Dobsonfly larvae "Hellgrammite" (*Phylum Arthropoda, Class Insecta, Order Neuroptera, Family Corydalidae*)

The lack of consistent water quality data highlights the need for establishing a watershed-wide volunteer stream monitoring program.

Planning Implications for Stream Quality

The streams in the area are vulnerable to ongoing non-point source pollution impacts and erosion and flooding problems. On the quality side, pollutants such as road salt, hydrocarbons, and sediments carried by runoff channels along the ditches of paved and dirt roads drain directly into these streams through culverts, swales, and sheet flow. Runoff from farm fields and lawns in the Crum Creek watershed carry nutrients, pesticides and sediments. *Where the stream is buffered by a wooded strip of 50 feet or more, these pollutants are less likely to reach the stream as sheet flow is intercepted by natural vegetation and pollutant-laden sediments settle out and are filtered by plants and soils. A greater width of buffers is essential in areas of steep and very steep slopes – a formula of 10 additional feet*

for every 4-degree increase in slope is suggested to account for increased runoff impacts associated with clearing of vegetation and grading of soil on steep slopes. (USDA Forest Service, 1992)

Those involved with land use planning along the Crum should look to the natural hydrologic cycle as a model, with optimum water quality and quantity benefits achieved in a forested condition, where groundwater recharge and filtration are the key characteristics. The worst case scenario is one that bleeds groundwater by linking homes on well water to public sewage treatment systems discharging directly to streams, combined with impervious coverage and stormwater management that reduces recharge and maximize stream discharge.

Streambank erosion is a direct contributor of nutrients (bound to soil particles) that contribute to growth in algal populations in the Lower Crum Reservoir. Certain algae are a source of the taste and odor compounds, a recent problem in drinking water supplied from the Crum Reservoir.

The stream channels below the two dams on the Crum are altered by varying and unnatural flow rates, They lack the natural pool-and-riffle pattern formed as a stream meanders between rock outcrops, soils, and forested corridors. Deposits and islands of alluvial silts, sediments, sands, and gravels are in some places concentrated by heavy stormwater runoff and erosion. The benefits of these major dams for drinking water, flood control, scenic and recreational values, and habitat for wildlife such as ducks and warm water fish must be considered in relation to their impacts to natural stream hydrology and ecology. Historic resources, recreational areas, and unique open water habitats along Crum Creek each can be understood as having effects on the overall health and viability of the stream ecosystems. Maintaining steady releases from large dams during low-flow periods is critical to sustaining stream life. The permits for these dams should be revisited by PA DEP to guarantee aquatic life is given proper weight in decisions about dam releases. Removal of minor dams should be assessed as a stewardship option that could greatly increase the quality of both streams and suitability for diverse aquatic life and plants.

Monitoring Stream Flows

The public can monitor stream flows and water levels in the Crum Creek over the Internet with real-time data from a gage upsteam from the Springton Reservoir, part of the United States Geological Survey (USGS) gauging station network. The following listing from the USGS website http://waterdata.usgs.gov describes the gage.

USGS Gage 01475850 - Lat: 39° - 58' - 35" Long: 75° - 26' - 13" - Hydrologic Unit 02040202 - Castle Rock Bridge on State Highway 3, 0.6 miles upstream from Preston Run confluence with Crum Creek, 0.8 miles upstream from Geist Reservoir, 2.0 miles west of Newtown Square - 15.8 square miles drainage area upstream of gage - 21 years of records - Datum at gage is 225.75 feet above sea level.

Station	Low Flow	Peak Flow and Date	Lowest Annual Mean Streamflow and Date	Highest Annual Mean Streamflow and Date
01475850	2.30 cfs (7/27/99)	4,250 cfs (9/16/99)	13.7 cfs (1985)	43.3 cfs (1996)

Table 4. Stream Gage Data. *The low, peak and average flow rates (in cubic feet per second, or cfs) for the USGS stream gage in the Crum Creek watershed over the last 20 years.*

Between 1981 and 2002, the Annual Mean Streamflow at the gage ranged from a low of 13.7 cfs in 1985 to a high of 43.3 cfs in 1996, but it is the highs and lows that illustrate how precarious the balance may be between too much water during floods and too little during droughts. The peak flow of record (highest velocity/volume) at the gage was 4,250 cfs during Hurricane Floyd on September 16, 1999. The gage height (depth) on that day at that location reached nearly 12 feet. One of the lowest flows of recent record was less than 2 months earlier, on July 27, 1999 when the stream was only flowing at 2.30 cfs and the gage height of only 1.79 feet. Recently, on August 15, 2002, the stream reached its record low flow with 1.41 cfs (at a depth of 1.91 feet). Droughts are perhaps most evident to the public when reservoir levels are low, exposing large mudflats in areas normally under water.

This information for Crum Creek stresses the wide fluctuations possible between flooding and droughts – fluctuations that are heightened by the dense crystalline geology which generates relatively "flashy" flood conditions experienced in different parts of the watershed.

It should be noted that USGS maintained a stream gage on the Crum Creek at Woodlyn in the Lower watershed from 1932 to 1936. Dams and impoundments were present along the Crum Creek and its tributaries at this time, including the largest impoundment, Springton Reservoir, which was under construction. This gage (#01476000) reported the following Annual Mean Streamflow in cubic feet per second during that period:

1932 – 9.75 (lower than recent record low in 1985)
1933 – 48.0 (higher than recent record high in 1996)
1934 – 30.0
1935 – 36.9
1936 – 39.2

In many watersheds, including the Crum Creek, the amount of runoff (as measured in stream flow) is influenced by factors in addition to total precipitation in the watershed, including:

- pattern of precipitation. Some parts of the watershed receive more rain or snow in different parts of the watershed;
- soil moisture. Dry soils reduce runoff, whereas saturated or frozen soils generate more runoff;
- land cover. Parking lots, roads, roofs and lawns generate many times more runoff than forests;
- land forms (such as slopes); (Cahill 1994).

Natural cycles of drought and flooding characterize the climate of the northern Piedmont region in general and the long-term hydrology of the Crum watershed in particular. These cycles of drought and flooding have historically influenced stream channel characteristics, the diversity of aquatic life, and groundwater levels. With the introduction of human land use patterns over the last three centuries, the impacts of drought and flooding cycles have in many ways been exacerbated – such as the accelerated erosion of streambanks devoid of woodland cover, and reduced stream baseflow (and reservoir levels) in areas with extensive impervious surface coverage.

Flooding

The Crum Creek watershed is subject to varying levels of development and impervious surface coverage, which contribute significant amounts of stormwater runoff to streams. Flooding is a serious and increasing problem in parts of the watershed -- property damage, severe erosion and stream degradation, and the safety of residents are among the top concerns, particularly the more urbanized Lower portion of the watershed as noted in the Watershed Restoration Action Strategy developed by PA DEP. Flood problems have been noted in a number of municipal and landowner survey responses. While localized flooding is common throughout the watershed, areas highlighted as having serious problems include Trout Run above the confluence with Crum Creek, Little Crum Creek near the main stem, and several tributaries in Newtown Township.

Floodplains are mapped on **Figure 10c – Hydrologic Features**. Stream corridors and floodplains are still relatively undeveloped in the Upper section of the watershed (with a mix of equal parts agriculture, woodland, and single family residential developer), allowing streams to spread out of their banks during high flows. The Middle and Lower watershed includes much more residential development along streams and less woodland. Impervious surface coverage in the watershed is relatively high compared to other parts of southeastern Pennsylvania. According to the Chester County Water Resources Authority, the Upper watershed supports approximately 11.1% impervious cover as of 1998, whereas the Middle and Lower sections had over double that amount, with 24.6%. (CCWRA, 2002) Coverage of 10 to 15% is considered by the Center for Watershed Protection to be a critical threshold for streams in terms of flood damage and degradation. (CWP, 2005) The watershed is impacted by the typical flood problems associated with conventional stormwater management systems in suburban areas –

basins throughout each subwatershed, collecting, concentrating, and discharging increased volumes of water directly to wetlands and streams over extended periods of time. *With proper plannin, the cumulative flooding impacts of conventional stormwater management systems can be reduced and avoided as development continues.*

The Pennsylvania Floodplain Management Act of 1978 (Act 166), requires all municipalities in the state to adopt floodplain ordinances that meet minimum standards. Municipalities must comply with the Act in order for their citizens to be eligible for federal flood insurance and for the municipalities to continue to receive state funding. Thirteen respondents to the municipal survey reported that they had adopted floodplain regulations in accordance with Act 166, however, it is believed that all municipalities in the watershed meet minimum standards. As flood problem areas have shown throughout the urbanizing Crum and adjacent watersheds like the Darby, minimum standards do not always keep people and property safe or allow streams to flow freely during floods. More progressive floodplain ordinances should be enacted to gradually shift toward fewer structures in floodplains and re-greening of these areas.

Impervious Cover Assessment

Hard surfaces such as rooftops, roads, parking lots, driveways, and sidewalks that are impermeable to precipitation are collectively known as impervious cover. These surfaces are considered among the greatest stressors of watershed health, due to the fact that they generate much higher levels of contaminated runoff much lower levels of groundwater recharge than more natural conditions such as woodland or meadow. The highest quality streams in our region and in the Crum Creek watershed are almost always situated in watersheds very low amounts of impervious surfaces (less than 5% of the land area) and relatively high amounts of woodland (50% or greater), while the most degraded typically have more impervious cover and less woodland.

Impervious cover in the Crum Creek watershed varies widely, from a low of 12% in more rural parts of the upper watershed to over 45% in the most urbanized sections of the lower watershed. Because so much of the Middle and Lower watershed is impervious. The total percentage is approximately 40.84. An analysis prepared by Princeton Hydro, summarized in the table below, confirms one of the most telling findings for the current and future health of the watershed: all of the 17 municipalities in the Crum Creek watershed have impervious cover of at least 12%. According to the Center for Watershed Protection (www.cwp.org), in its report entitled "The Importance of Imperviousness", research in numerous sites reveals that "stream degradation occurs at relatively low levels of imperviousness (~10%). Indicators show SEVERE degradation beyond 25%". This means that, in the Crum, most streams in most townships are at the threshold between moderate to severe degradation unless something can be done to reverse the impacts of impervious cover. **(Figure 11b Pervious-Impervious by Township)**

Figure 11b

PERVIOUS-IMPERVIOUS BY TOWNSHIP

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

The breakdown of impervious cover by subwatersheds tells a similar story: The West Branch fares best with 12.22% (still a relatively high number considering its Exceptional Value designation); the Main Stem is listed as 21.04% impervious, including the widest range from the Upper to Lower watershed; Trout Run is 24.35% impervious, and Little Crum Creek is 35.63%. **(Figure 11c Pervious-Impervious by Subwatershed)**

According to DEP WRAS, "Studies by the Maryland Department of Natural Resources stated that a reduction in stream aquatic species diversity may begin with as little as 2% impervious cover. Species hardest hit include fish (such as trout), stoneflies and other insects eaten by fish, and a variety of reptiles and amphibians. The problems associated with impervious cover result from the lack of groundwater recharge (i.e. less baseflow for streams, wetlands, seeps and springs), increase in flooding and erosion, increased stream temperatures, and washing of oil, grease and other pollutants into streams. Extreme and unnatural fluctuations in stream flow alter and scour streambeds in a way that undermines the bottom dwelling organisms that are critical to the food web.

The Center for Watershed Protection report points out the amount of paved area devoted to automobiles and other transportation can often exceed 50% of the total imperviousness of suburban watersheds. More importantly, all levels of impervious cover can be quantified and controlled in new development through more careful planning and design. Impervious cover impacts in existing developed areas can be reduced through stormwater BMP's promoting ground water recharge, and redesign of existing paved areas and structures.

Municipality	*Acres*	*% Impervious*	*Impervious Acres*	*Category*
Edgmont	238.64	12.05	82.77	Low
Easttown	574.7	12.52	186.98	Low
Willistown	2362.2	13.7	805.53	Low
Newtown	1256.8	13.87	532.19	Low
Malvern Borough	170.19	16.75	80.09	Medium
Upper Providence	1246.5	21.08	410.2	Medium
Marple	2113.8	23.7	868.23	Medium
Eddystone Borough	37.17	27.75	28.85	High
Rutledge Borough	21.96	30.16	6.63	High
Springfield Township	1088.5	31.89	502.83	High
Ridley Park Borough	321.31	33.19	125.85	High
Swarthmore Borough	738.82	33.75	303.39	High
Nether Providence	1122	34	491.03	High
Morton Borough	10.32	40	5.39	High
Ridley Township	1517.3	45.04	770.34	High
Media Borough	41.95	47.59	19.96	High
Tredyffrin	183.19	56.34	107.254	High
TOTAL	13,045.35	40.84	5,327.514	

Table 5 -- Summary of Impervious Cover by Municipality.

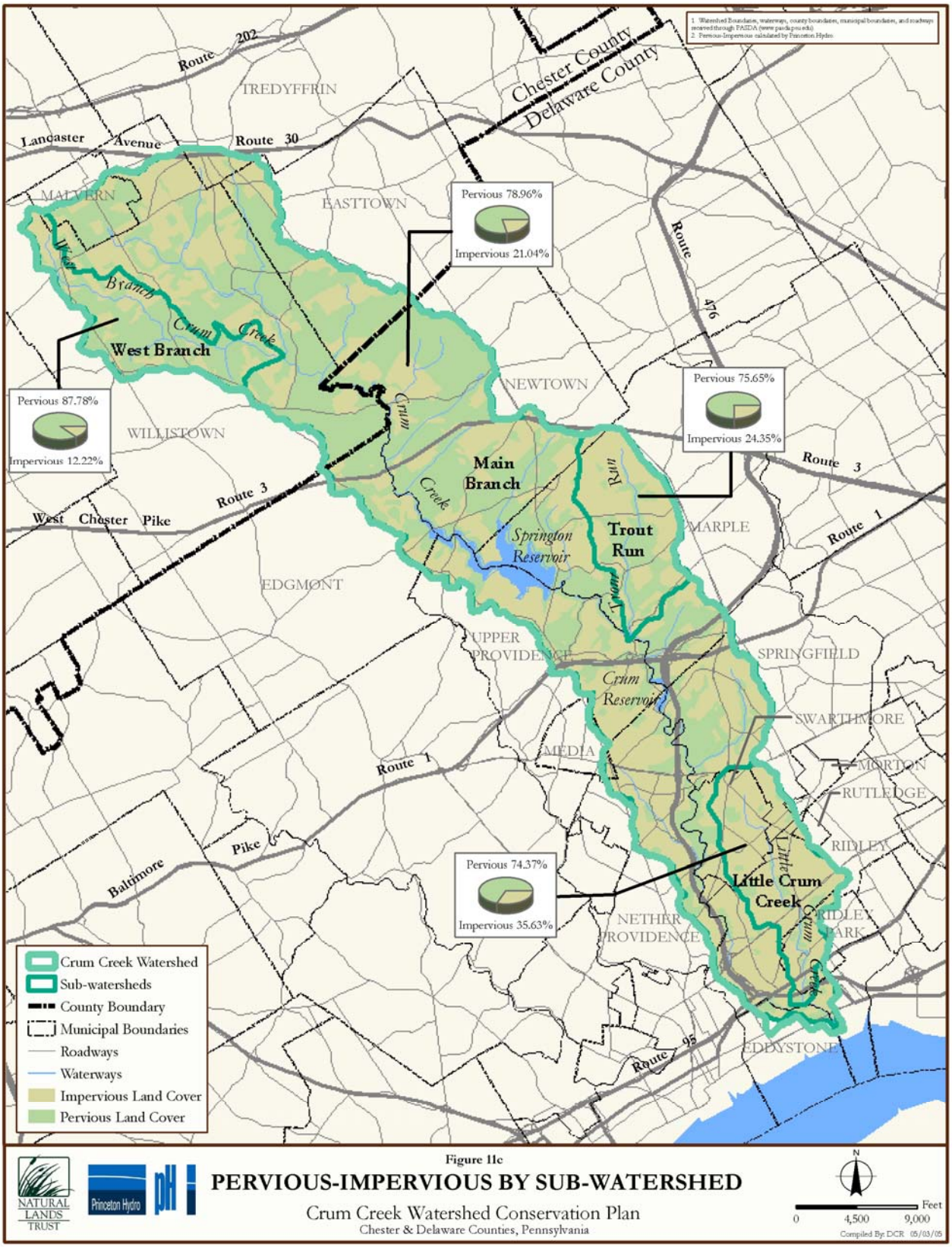


Figure 11c

PERVIOUS-IMPERVIOUS BY SUB-WATERSHED

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

Wetlands and Vernal Pools

Wetlands are not a major natural feature of the Crum Creek study area. They are probably an underrepresented habitat type compared to the historic condition of the region, with aerial photography confirming the strong probability that many formerly wet headwaters areas were drained and/or filled for agricultural and development purposes, including reservoirs and manmade ponds. A study of wetlands in the watershed conducted by wetland ecologists from Schmid and Company generated the Potential Wetlands map (**Figure 12**). This wetland mapping should be incorporated into future prioritization of conservation and restoration projects in the Crum Creek watershed, and provides a guide for municipalities to use in verifying the accuracy of wetland delineations submitted for land development plans. Section 105.17(1)(iv) of the Pennsylvania Code designates wetlands on drinking water streams as "exceptional value", thereby restricting projects that directly impact them and allowing a public hearing process. Appendix E of this report includes a summary of wetland law and regulations, including a case study of how local municipal regulations may not adequately protect wetlands.

The Crum Creek watershed does contain Exceptional Value Wetlands as defined in Section 105.17.(1)(iv) of the Pennsylvania Code. The code defines *Exceptional Value Wetlands* as those that are "located along an existing public or private drinking water supply, including both surface water and groundwater sources, that maintain the quality or quantity of the drinking water supply". This definition is somewhat vague in that it does not provide guidance as to where a drinking water supply begins and ends. However, it is clear that wetlands meeting this definition are afforded similar water quality protections as those given to Exceptional Value streams under the Antidegradation Requirements section of the code. The PA Environmental Hearing Board has ruled in favor of protecting Exceptional Value Wetlands in a case where a proposed corporate water project was granted permits by PA DEP, yet the agency "failed to consider the effects of the project on the wetlands and adjacent exceptional value creek, and failed to determine whether the proposed activity was environmentally inconsequential." *Oley Township v. Department of Environmental Protection, 1996 EHB 1098*.

Vernal Pools are important conservation features at a local level, since they are the focus of most amphibian and some reptile reproductive viability. These ephemeral pools that appear as the spring high water table and spring rains saturate the soils, may only be present for a few months of the year. Vernal Pools most commonly occur along forested floodplains in the area where floodwaters deposit sediments that form natural "levees" along the tops of stream banks, thereby impeding direct runoff to streams.[1] Certain poorly drained upland soils along fairly level, forested diabase ridgetops also exhibit ponding effects that may serve to support Vernal Pools. They are usually so small that

[1] Godfrey, 1980.

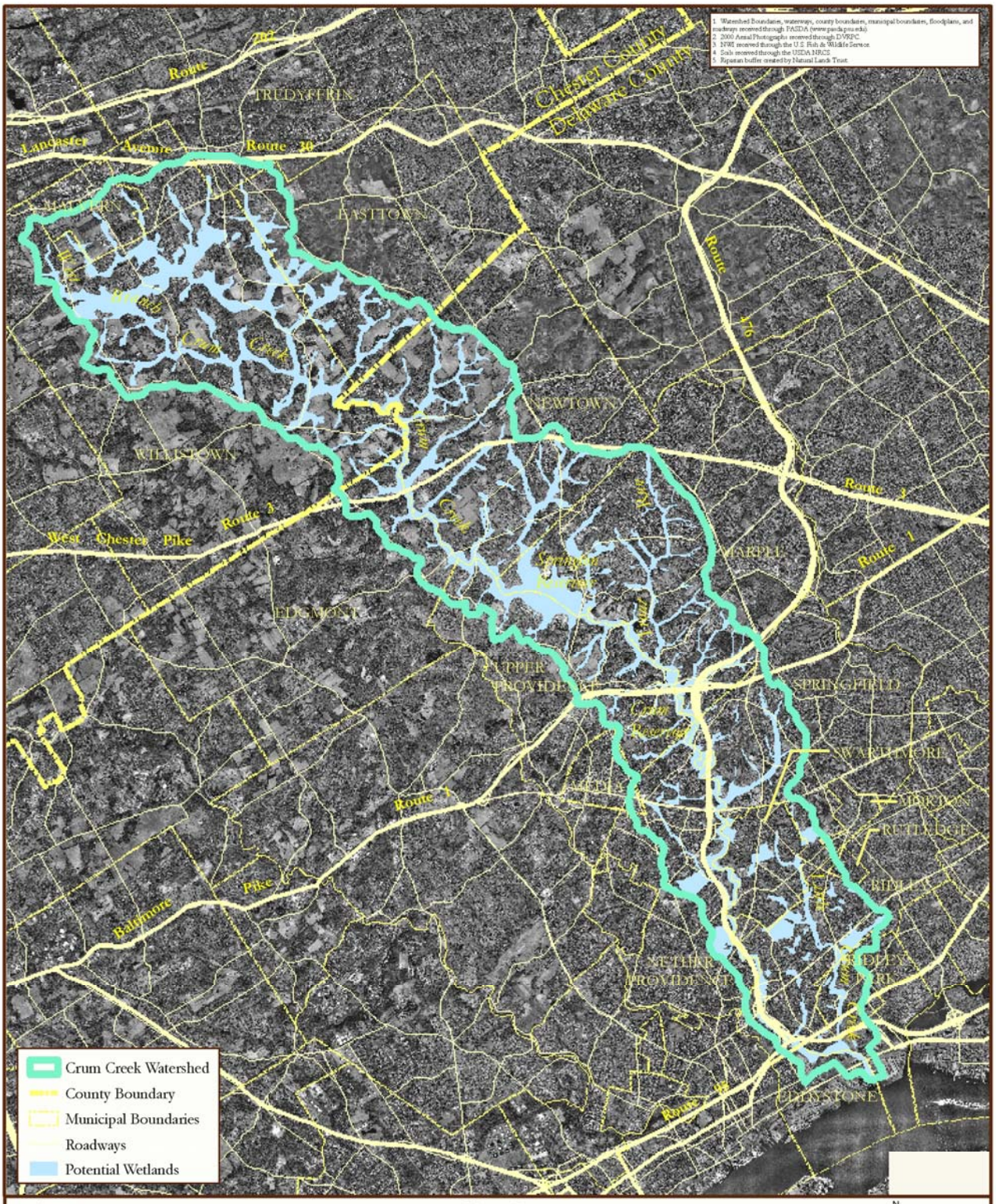


Figure 12

POTENTIAL WETLANDS

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

they are easily overlooked. None of the GIS mapping completed for this project is detailed enough to capture the locations, if any, of these critical conservation features. If they are locally known of, every effort should be made to protect them, and their immediate upstream watershed and buffer areas. The list of reptiles and amphibians in the watershed suggests that some such pools exist and support breeding frogs and salamanders. Unless specifically protected during the review of a site development plan, vernal pools are not typically recognized as wetlands and are virtually certain to be lost.

Wetlands are one subset of Waters of the United States and Waters of the Commonwealth of Pennsylvania. Crum Creek wetlands include areas such as swamp forests, swamp scrubs, tidal and non-tidal freshwater marshes, shallow ponds, and wet meadows. Because of their limited extent, unusual characteristics, diverse functional values, and general unsuitability for developed uses (in the absence of drastic alteration), wetlands today are recognized as fragile environmental resources deserving of protection under Federal and State laws. Like certain other aquatic features (such as mudflats and the riffle-pool-riffle reaches of streams) wetlands are defined as "special aquatic sites" that warrant stringent protection to an even greater extent than typical open waters. Some Pennsylvania municipalities seek to protect wetlands and even to limit construction in adjacent upland buffers that surround them.

In the Crum Creek watershed, NWI wetlands occupy a tiny fraction of the landscape (3%, see **Figure 10c, Hydrologic Features**). These wetlands consist of scattered, small ponds and of riparian corridors of palustrine deciduous forest, deciduous scrub, and emergent herbaceous marsh. Upper perennial, lower perennial, and tidal riverine deepwater systems also are present in this watershed, along with several lacustrine areas where streams were impounded to form reservoirs.

Table 6. Classes of wetlands and deepwater habitats (lakes and rivers) reported in the Crum Creek watershed by the National Wetland Inventory of the US Fish and Wildlife Service, based on 1970s aerial photographs. (Source: GIS-derived data produced for this report.)

Symbol Interpretation

Lacustrine System (403 acres, 2% of the Crum Creek Watershed; 62% of Watershed NWI wetlands)

L1OWHh	Lacustrine limnetic, impounded, permanent open water
L1OWKHh	Lacustrine limnetic, artificial, impounded, permanent open water
L2BBA	Lacustrine littoral temporary beach
L2UBKGh	Lacustrine littoral, artificial, impounded, unconsolidated bottom, intermittently exposed

Palustrine System (243 acres, <1% of the Crum Ck. Watershed; 38% of Watershed NWI wetlands)

PEM	Palustrine emergent (marsh)

PEM5A	Palustrine emergent, narrow-leaved persistent (marsh), temporary water regime
PEM5C	Palustrine emergent, narrow-leaved persistent (marsh), seasonal water regime
PEM5E	Palustrine emergent, narrow-leaved persistent (marsh), seasonal saturated water regime
PEM5Eh	Palustrine emer. narrow-leaved pers. (marsh), impounded, seasonal saturated water regime
P EM5/FL C	Palustrine emergent, narrow-leaved persistent (marsh)/seasonal flat
PFLAh	Palustrine flat, impounded, temporary water regime
PFO1	Palustrine broad-leaved deciduous forest
PFO1A	Palustrine broad-leaved deciduous forest, temporary water regime
POWFh	Palustrine impounded, semi-permanent open water
POWFx	Palustrine excavated, semi-permanent open water
POWH	Palustrine permanent open water
POWHh	Palustrine impounded, permanent open water
POWKZx	Palustrine artificial, excavated, intermittently exposed, permanent open water
POWZh	Palustrine impounded, intermittently exposed, permanent open water
POWZx	Palustrine excavated, intermittently exposed, permanent open water
PSS1A	Palustrine broad-leaved deciduous scrub, temporary water regime
P SS1/EM	Palustrine broad-leaved deciduous scrub/emergent (marsh)
P SS/EM 1A.	Palustrine deciduous scrub/persistent emergent (marsh), temporary water regime
P SS1/EM5 A	Palustrine broad-leaved deciduous scrub, narrow-leaved persistent emergent (marsh), temporary water regime
P SS1/EM5 E	Palustrine broad-leaved deciduous scrub, narrow-leaved persistent emergent (marsh), seasonal saturated water regime
PUBKGh	Palustrine artificial, impounded, unconsolidated bottom, intermittently exposed

Riverine System (no acreages calculated for these linear features)

R1OW	Riverine tidal open water, unknown bottom
R2OW	Riverine lower perennial open water, unknown bottom
R2OWh	Riverine impounded, lower perennial open water, unknown bottom
R3OWH	Riverine upper perennial, permanent open water, unknown bottom

If wetlands are to be protected by regulation of any kind, their limits must be identified and respected when construction projects are planned. The NWI maps are not adequate for site-specific regulatory purposes. Instead, identifying regulated wetlands is a responsibility of landowners planning fill or other development. Wetlands must be identified in the field on a site-by-site basis. The smaller any parcel of land under review, the less accurate NWI and USGS maps are likely to be for that particular parcel. Thus little reliance can be placed on the GIS mapping of NWI-reported wetlands, except for the illustrative purposes of regional planning, in part because of the inherent locational inaccuracies introduced by the GIS but primarily because of the fragmentary base data from NWI. These inaccuracies may not be obvious to the casual user of NWI information, given the complex and detailed classification system and apparent detail of

the mapping. But on any specific tract of land, the difference between NWI maps and reality can be dramatic.

Landscape features can serve as clues signaling the potential presence of wetlands. Streamcourses often have wetlands associated with them, although wetlands are not confined to floodplains and not all floodplains are wetlands. Thus all stream margins should be checked for potential wetlands. Certain soil map units identified by the Natural Resources Conservation Service (US Department of Agriculture) in county soil surveys are classed as "hydric" map units, within which most soil samples are likely to exhibit one or more of the defining field characteristics of hydric soil. Other map units are identified as having known "hydric inclusions" within the county, but the locations of such inclusions are not shown separately on published survey maps. In the Crum Creek watershed these two classes of soil map units typically run alongside watercourses and extend outward into more extensive, relatively flat areas, especially in the Upper and Lower sections. As might be expected from the relatively steep topography in the Middle Section of the watershed along the Fall Line, hydric and potentially hydric soil map units are least extensive here.

Table 7. Soil survey map units (1) deemed hydric and (2) reported by NRCS to have unmapped hydric inclusions in the Crum Creek watershed.

Map Symbol	**Name**
Map Units Principally Consisting of Hydric Soils (6.8% of Delaware County; 9.0% of Chester County; 7.4% of Crum Creek watershed)	
Bo	Bowmansville silt loam
CaA	Calvert silt loam, 0-3% slopes
CaB	Calvert silt loam, 3-8% slopes
CaB2	Calvert silt loam, 3-8% slopes, moderately eroded
CrA	Croton silt loam, 0-3% slopes
CrB	Croton silt loam, 3-8% slopes
Gu	Guthrie silt loam
Mn	Melvin silt loam
OtA	Othello silt loam
Tm	Tidal marsh
W	Water
WaA	Watchung silt loam, 0-3% slopes
WaB2	Watchung silt loam, 3-8% slopes, moderately eroded
WcB	Watchung very stony silt loam, 0-8% slopes
We	Wehadkee silt loam
WoA	Worsham silt loam, 0-3% slopes
WoB	Worsham silt loam, 3-8% slopes
WoB2	Worsham silt loam, 3-8% slopes, moderately eroded
WoC2	Worsham silt loam, 8-15% slopes, moderately eroded
WsB	Worsham very stony silt loam, 0-8% slopes

Map Units with Unmapped Hydric Inclusions

(11.4% each in Delaware and Chester Counties; 10.3 % of Crum Creek watershed)

AgA	Aldino silt loam, 0-3% slopes
AgB2	Aldino silt loam, 3-8% slopes
AsB2	Aldino very stony silt loam, 0-8% slopes
BdA	Bedford silt loam, 0-3% slopes
BdB	Bedford silt loam, 3-8% slopes
BdB2	Bedford silt loam, 3-8% slopes, moderately eroded
BeA	Beltsville silt loam, 0-3% slopes
BeB2	Beltsville silt loam, 3-8% slopes
ByA	Butlertown silt loam, 0-3% slopes
ByB2	Butlertown silt loam, 3-8% slopes
Ch	Chewacla silt loam
Cn	Congaree silt loam
CoA	Conowingo silt loam, 0-3% slopes
CoB2	Conowingo silt loam, 3-8% slopes
GnA	Glenville silt loam, 0-3% slopes
GnB	Glenville silt loam, 3-8% slopes
GnB2	Glenville silt loam, 3-8 % slopes, moderately eroded
GnC2	Glenville silt loam, 8-15% slopes
GsB	Glenville very stony silt loam, 0-8% slopes
LaA	Lawrence silt loam, 0-3% slopes
LaB	Lawrence silt loam, 3-8% slopes
LeB	Lehigh silt loam, 3-8% slopes
LeB2	Lehigh silt loam, 3-8% slopes, moderately eroded
LeC3	Lehigh silt loam, 8-15% slopes
LhB	Lehigh very stony silt loam, 0-8% slopes
LhD	Lehigh very stony silt loam, 8-25% slopes
Ls	Lindside silt loam
MoB2	Montalto channery silt loam, 3-8% slopes, mod. eroded
MoC2	Montalto channery silt loam, 8-15% slopes, mod.eroded
MoC3	Montalto channery silt loam, 8-15% slopes,severely ero.
MrB	Montalto very stony silt loam, 8-15% slopes
MrD	Montalto very stony silt loam, 8-25% slopes
MsB	Mount Lucas very stony silt loam, 0-8% slopes
RdA	Readington silt loam, 0-3% slopes
RdB	Readington silt loam, 3-8% slopes
RdB2	Readington silt loam, 3-8% slopes, mod. eroded
Ro	Rowland silt loam
Rp	Rowland silt loam, dark surface
WnA	Woodstown loam, 0-3% slopes

Soil survey mapping at the published scale of 1:20,000 (1 inch = 1,667 feet), like NWI mapping, is not considered adequate for the planning of specific parcels of land, even though it is provided for the Crum Creek watershed on airphoto basemaps at a 20% larger scale than USGS topographic quadrangles. Some generalization of landscape features is included in county soil maps, so considerable areas within a particular hydric soil map unit may in fact be found not to be hydric when a specific property is

examined. The same is even more applicable to generally non-hydric map units reported merely as having unmapped hydric "inclusions".

Despite these limitations, soil mapping is greatly influenced by landscape topography and benefits from a much more intensive level of fieldwork (especially in cultivated lands) than was used when preparing NWI wetland maps. Consequently, it is worthwhile to focus on areas mapped as hydric soils and as "potential hydric inclusions" soils when looking for wetlands.

In the Crum Creek watershed, the published soil maps provide an excellent screening tool readily available to the landowners, engineers, municipalities, and conservation groups considering land development. Soil map units labeled as hydric or as known to contain hydric inclusions, and any low-lying areas adjacent to them, always should be inspected in the field for wetlands. Areas already deemed urbanized by the 1950s in the Crum Creek watershed were subject to greater generalization by the soil survey than less densely developed areas. Thus, particular scrutiny should be applied to lowlying areas along watercourses in the various "Made land" map units, even though these are not identified as hydric-inclusion map units (Ma through Mf; 34.4% of Delaware County as a whole in the 1950s, 0.3% of Chester County; xx% of the Crum Creek watershed).

As can be seen in **Figure 10c, Hydrologic Features**, the NWI wetlands in the watershed (aside from a very few of the small, artificial ponds) are everywhere associated with mapped hydric soils. Throughout this watershed the hydric and hydric-inclusion soil map units encompass substantially larger areas than the NWI wetlands. To the extent that such areas have been drained and farmed, filled, or otherwise developed to more intensive uses, they may no longer exhibit wetland hydrology or qualify for regulation. One would expect, however, that most hydric and many hydric-inclusion map units in this watershed even today are likely to contain wetlands. In addition to regulatory considerations, a very practical consequence of new construction in these areas is wet basements, unless special drainage is designed and installed. Field inspection throughout the watershed confirms that the expectation of likely wetlands in hydric and hydric-inclusion soil map units is justified and should be addressed thoroughly in each development proposal for all lands so mapped.

Proposed construction in wetlands and other waters requires State and/or Federal permit approval. The landowner is expected to avoid wetlands insofar as possible and to minimize unavoidable incursions, even if this means a reduced development from that which would have been allowed by municipal zoning in the absence of wetlands. The siting of new private or public development in wetlands may be denied, if there are alternative upland sites available. Approval of unavoidable encroachments may be conditioned upon compensatory mitigation through the creation of new or restored wetlands elsewhere. A few municipalities have ordinances regarding wetlands, and municipalities may impose conditions of approval beyond those required by State or

Federal permits including the preservation of undeveloped upland buffers adjacent to the remaining wetlands.

Planning Implications for Wetlands

Wetlands are important habitats, and also act as the valve, sponge and filter of the hydrological system, holding floodwaters after a storm, cleaning them naturally through biofiltration, and then letting the water out slowly. The most intact wetland areas have been identified in this Plan as either Priority Conservation Areas. These are typically forested and scrub-shrub wetlands in headwaters seeps and floodplains, or wet meadows along streams in agricultural landscapes at the north end of the study area.

In the Crum Creek study area, more natural wetlands may have existed in the area before dams and ponds were constructed and wider floodplain areas were converted to limited agricultural or suburban uses. Although visual expressions of wetlands along open floodplains are limited where large ponds, pastures and crop fields exist, the soils in these areas may still exhibit the hydric characteristics of wetlands. There could be many opportunities to recreate and/or restore wetland habitats on mapped hydric soils in the Crum Creek area, even as part of the development and re-development process.

Riparian Buffers

Riparian buffers are defined in this Plan as wooded corridors paralleling streams. They provide numerous community benefits, including:

- serving as the first line of defense for non-point source surface water quality concerns such as sediment, erosion, nutrients, and other water pollutants;
- anchoring streamside soils with the roots of trees, shrubs, and herbaceous vegetation;
- reducing flooding by providing a living sponge for stormwater and physical barriers to reduce the velocity of floodwaters;
- providing food and habitat in the form of leaves, twigs, branches, and logs of trees on which the entire food web of a healthy stream ecosystem is based; and
- shading streams with tree canopies to maintain cooler water temperatures necessary for many native aquatic organisms, including native brook trout.

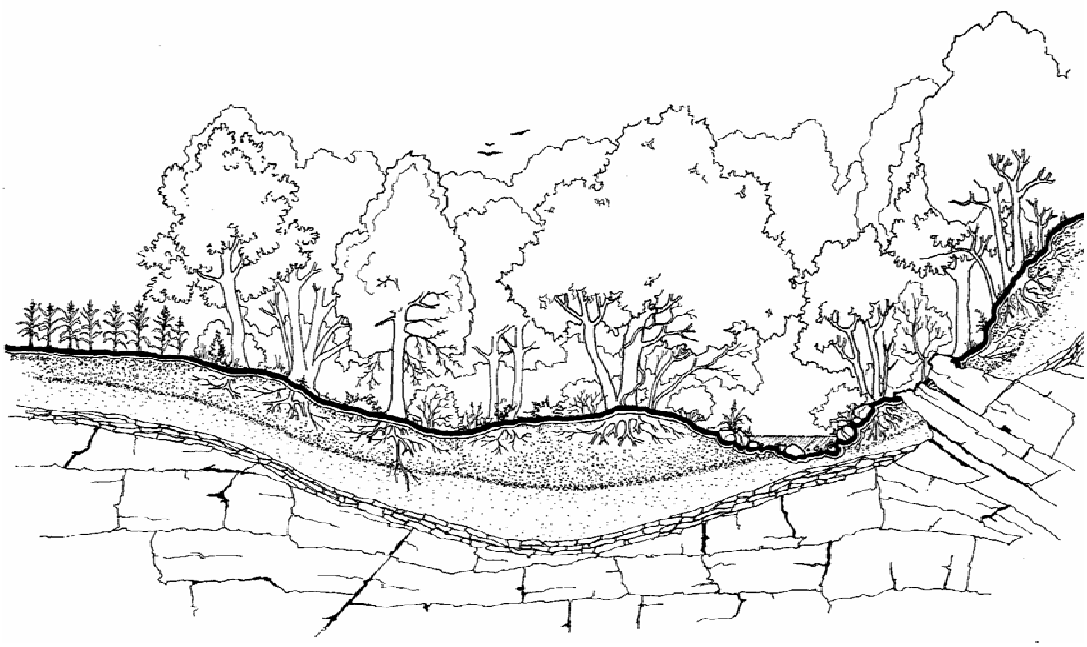
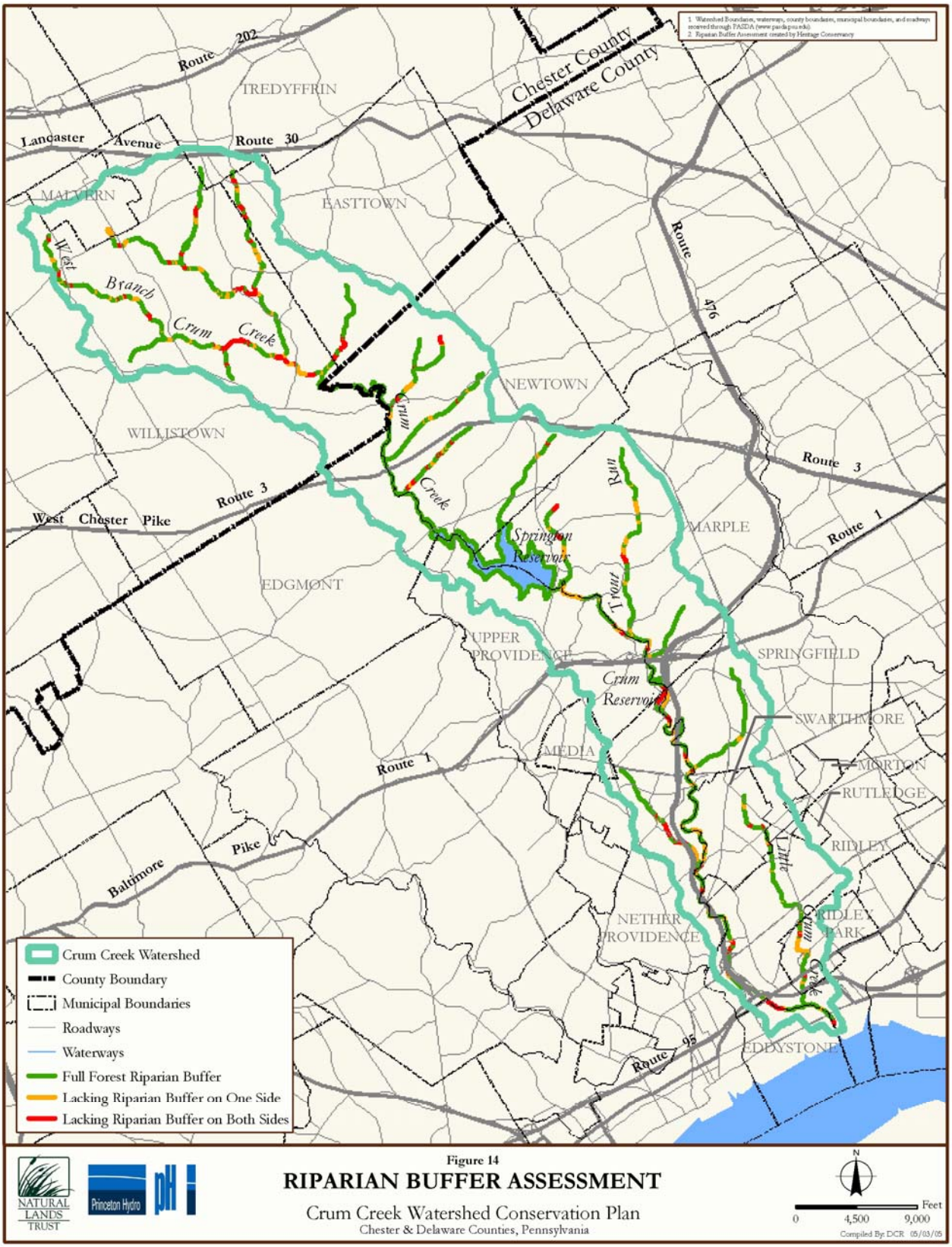


Figure 13 -- Riparian Forest Buffer Crossection. *Riparian forest buffers include a complex natural system of canopy and subcanopy trees, understory trees and shrubs, herbaceous plants, forest humus and soils, root systems and geologic formations that all serve as a living filter and support system for streams in the Crum Creek watershed.*

The vast majority of the streambanks in the southern half of the Crum Creek watershed are lacking forest; however, the northern half includes numerous stream reaches with significant riparian forest buffer coverage, partial coverage (on one or both sides) and gaps in riparian buffer coverage due to clearing for agriculture, development and other uses. A minimum of 75 feet of forest cover on each side of a stream is recommended by the Stroud Water Research Center and the US Forest Service for most of southeastern Pennsylvania, with increased buffers for steeply sloping areas. The US Forest Service recommends at least 10 additional feet of forested buffer for every 4-degree increase in slope. the Crum area municipalities need to protect significantly wider buffers to benefit the stream ecosystem due to the intensity of development in much of the watershed. The Chester County *Watersheds* Plan recommends protection of at least 100 feet of forest on each side of a stream (CCWRA, 2002).

This Plan references the *Riparian Buffer Assessment of Southeastern Pennsylvania* (the Assessment) prepared by the Heritage Conservancy, one version of which includes a detailed analysis of riparian buffer coverage and gaps in the Crum Creek watershed. The goal of the Assessment is "to promote non-point source (NPS) pollution prevention and mitigation." This study involved helicopter flights and video assessments of riparian corridors along the main stem Crum Creek, and aerial photograph evaluation and field verification of riparian corridors throughout the watershed. **(Figure 14 -- Riparian Buffer Assessment)**



NATURAL LANDS TRUST

Princeton Hydro

pH

Figure 14

RIPARIAN BUFFER ASSESSMENT

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

The results include documentation of 4 categories:

1) "full" riparian forest buffers (at least 50 feet of woodland on each side of a stream);.
2) "partial" riparian forest buffers (less than 50 feet of woodland on one or both sides of a stream);
3) streams "lacking buffer on one side" but not the other; and
4) stream segments "lacking buffers on both sides", where riparian forest buffers are missing.

This information is scheduled to be posted on the Internet at the Pennsylvania Spatial Data Access (PASDA) website.

At face value, the Assessment appears to tell a different story – with the largest gaps in full riparian buffer coverage appearing in the Upper watershed, including over a full half-mile on the West Branch (designated as Exceptional Value) and over 2 miles on the main stem of the Crum Creek and its tributaries above the Springton Reservoir. These gaps can largely be attributed to the presence of farmland, golf courses and residential developments in this area. The Middle and Lower sections of the watershed appear to have fewer gaps in full coverage. However, the presence of steep slopes and intensive urbanization in these areas means that those riparian buffers that do exist are too narrow to function very well in maintaining healthy stream ecosystems. In addition, numerous small streams in these areas were difficult to locate and therefore not covered in the Assessment, and some are not mapped because they are in culverts and storm sewers.

The results of the Assessment and subsequent analysis provide important guidance for ongoing riparian buffer conservation and restoration activities in the Crum watershed. Perhaps the most important factor is that none of the subwatersheds had less than 50% Full Forest Buffer coverage (for mapped streams). This is a similar or even better amount of stream buffering relative to other neighboring watersheds, but the fact that significant gaps in full coverage remain points to the need to increase riparian buffer coverage standards for new land development plans in every community.

The location and contiguous nature of full buffers along streams is also important. For example, headwaters streams (1st and 2nd Order) and streams draining to water supply sources such as the Aqua Pennsylvania intakes near at the Crum Reservoir are among the most important locations for reducing NPS pollution through riparian buffer protection.

Subwatershed (Area - acres)	Total Stream Length (miles)	Lacking Buffer Both Sides (miles)	Lacking Buffer One Side (miles)	Full Forest Buffer (miles)	% Total in Full Forest Buffer
Main Stem	22.3	3	4.5	14.8	--
West Branch	5.56	1.5	.5	3.5	--
Trout Run	3.1	.5	.8	1.8	--
Little Crum	3.8	.3	1.5	2	--
Other Tributaries	17.8	3.3	1.8	22.2	--
Totals	72	8.6	9.1	54.3	75%

Table 8. *Riparian Buffer Coverage by Subwatershed. The subwatersheds are listed in descending order of Full Forest Buffer coverage, with the main stem providing the greatest amount and therefore ranking as a prime candidate for* ***conservation.*** *Other t ibutaries have the greatest amount of stream Lacking Buffer – Both Sides, particularly in the headwaters areas, and therefore are a prime candidate for* ***restoration****.*

Conservation Priorities

An estimated total of 54 (75%) of the 72 miles of waterways in the Crum Creek watershed benefit from Full Forest Buffers. This number is relatively high for the region, and may be attributed in part to the relatively large amount of protected land in the Upper watershed, and the fact that many residential subdivisions in the Upper and Middle watershed have been built in communities requiring lower densities near steep slopes and floodplains. Still, the majority of forested cover in these corridors is *unprotected* from clearing for other uses. This fact points to the importance of *conservation efforts* to keep these buffers in place and provide their vital functions amidst shifting patterns of ownership, logging, development and other activities. Riparian Buffer Ordinances must be adopted in municipalities throughout the Crum Creek watershed in order to maintain these vital corridors in new subdivision applications and to reduce clearing of vegetation along streams. Models for such ordinances can be found in North Coventry and Easttown Townships, Chester County, and the Montgomery County Planning Commission. In addition, Part 8 of the CCWRA *Watersheds* plan includes an extensive listing of strategies for riparian buffer protection that are supported by technical literature. In cases where such clearing is unavoidable, compensatory mitigation must be required, either on-site or off-site. Conservation easements, parks, nature preserves, and conservation-oriented development plans must be looked at as vital tools to protect these stream buffers.

Restoration Priorities

A total of 8.6 stream miles (12%) of the 72 miles of waterways in the Crum Creek watershed listed in the Assessment as Lacking Buffer on Both Sides are fully exposed to

erosion, pollutants and sunlight. The location and extent of these gaps is critically important in terms of impacts to otherwise healthy stream segments and valuable community water supplies. Many of these "gaps" occur along small, First Order headwater streams in the Upper and Middle watershed above the two main reservoirs, raising concern about the widespread lack of these living filters in critically important locations. These areas are prime candidates for *restoration efforts* such as those that have been underway in the watershed, including tree planting projects sponsored by the Chester-Ridley-Crum Watersheds Association and other groups. A relatively minor effort to reforest this small percentage of stream miles through voluntary tree planting projects and regulatory means (i.e. stormwater and open space management requirements for new developments) can produce major benefits for stream quality and result in major cost savings by reducing future flood damage, dredging frequency, and water treatment. The Chester County Water Resources Authority consistently stresses the importance of buffering first order streams (CCWRA, 2002).

In addition, the Assessment noted 9.1 stream miles (12.6% of the total in the watershed) as Lacking Buffer on One Side but having a full 50′ buffer on the other side.

Planning Implications for Riparian Buffers

Creative and innovative ways should be pursued to encourage landowners to maintain and restore sizeable riparian buffers – particularly where large "missing links" are evident between substantial sections of otherwise well buffered stream. In many cases, the use of conservation easements or "riparian buffer easements" is the most effective approach. These voluntary agreements help to ensure that stream corridors remain natural without future clearing or construction of improvements within the riparian zone. Municipalities may want to consider financial incentives, such as property tax rebates, for landowners who are willing to install and maintain high quality riparian buffers on their property. Riparian buffer ordinances are used in many municipalities to ensure that future development does not unnecessarily intrude on these valuable natural areas. A model Riparian Buffer ordinance is available through the Montgomery County Planning Commission. Other good models are in place in North Coventry and Easttown Townships, Chester County. A program should be developed and goals set for the next 10 years – such as achieving stream bank fencing in all parts of the Upper watershed with livestock and reforesting 50% of the corridors where riparian buffers are missing in ten years.

Stormwater Management

Many conservation concerns arise from poor stormwater management. Surface water non-point pollution (particularly sedimentation), erosion, and lack of groundwater recharge are perhaps the biggest concerns in the Crum Creek watershed, as evidenced by the PA DEP listing of impaired streams.

The Crum Creek watershed, along with other watersheds throughout the region, is undergoing a Comprehensive Stormwater Management Plan process led by the Delaware County Planning Department under the Pennsylvania DEP's Act 167 Program. This process will result in a watershed-wide plan and GIS database for dealing with stormwater issues, and will generate a model ordinance to be applied in communities throughout the watershed. The standards in this ordinance will reflect innovative approaches to reducing runoff, promoting infiltration of groundwater, and enhancing filtration of runoff. A minimum amount of stormwater recharge should be required in all future proposed development projects, with incentives offered for complete on-site recharge of stormwater (i.e. no discharges to streams, storm sewers, or neighboring properties).

By and large, the uncontrolled small storms (2 year storm = 3.2 inches in 24 hours) cause most stormwater problems and stream degradation in the region, and runoff from these storms is generally not well managed.

Older developed areas often include large amounts of impervious cover discharging directly to streams , either with overland flow or storm sewers. Most roads drain to storm sewers or culverts with direct stream discharge. Most developments constructed after the 1960's have some form of runoff control, but these are often simply basins designed to reduce peak discharge to prevent exacerbation of flash flooding. The combined effects of these unmanaged runoff areas and conventionally managed runoff areas is evident at the very root of stream impairments in the Crum Creek watershed. We are essentially managing land in a way that discharges greater amounts of more polluted runoff over longer periods of time than would ever occur naturally. The net effects to watershed health are devastating -- severe erosion and sedimentation, exacerbated flooding, unnaturally low stream flows during droughts, impoverished aquatic life, and degraded water quality. Communities throughout the Crum must work together to find a way to undo this damage and prevent it from worsening.

Although no site-specific analysis of stormwater conditions have been conducted for this report, some general guidelines can be recommended. Some of these are listed below, and in the Action Plan section.

Planning Implications for Stormwater Management

The Crum Creek Act 167 Plan being developed by Delaware County Planning Department will include a model ordinance with important variations in release rates for different parts of the watershed. Municipal stormwater management ordinances should be consistent with this model ordinance, and should include innovative approaches such as those presented in *Pennsylvania Handbook of Best Management Practices for Developing Areas* (1998), and in the Draft *Pennsylvania Stormwater Management Manual* for which DEP is currently holding focus group meetings.

In addition, by planning the intensity and location of site disturbance and impervious cover with stormwater recharge in mind, developers can greatly reduce the impacts of their projects on the watershed. Numerous opportunities exist throughout the watershed to perform vital retrofit projects that upgrade existing stormwater facilities to do a better job of recharging groundwater and enhancing water quality. Opportunities also exist to establish stormwater controls in areas where none exist. Natural Lands Trust is currently working with Newtown Township and Cahill Associates to develop an innovative ordinance that achieves important goals for recharge and filtration of runoff. In Section 8 of its *Watersheds* plan, the Chester County Water Resources Authority has produced an excellent brochure, "Reducing Stormwater and Flooding: the Ten Principles of Effective Stormwater Management." The principles are generally incorporated in the Action Plan section of this document, however the reader is encouraged to obtain the brochure with more detailed information, available on the CCWRA website (www.chesco.org/water).

In general, comprehensive ordinances should require land development projects to: minimize the volume of stormwater generated; design and locate stormwater systems first rather than at the end of the planning process; use appropriate storm designs (e.g. detention and recharge of the 1 and 2-yr storms); promote infiltration to protect groundwater recharge and reduce runoff; and protect water quality by removing pollutants prior to discharge to streams. Municipalities should also work with applicants to retrofit grandfathered properties with up to date stormwater management levels as they are redeveloped, or when applying for permits to expand impervious surface area.

Municipalities should have policies and ordinances that incorporate provisions to reward developers and homeowners (by relaxing some permitting requirements or shortening review cycles), for using low-impact site design principles. For example, permit requirements can be relaxed when applicants recharge all of the 2-year storm. Tangible financial incentives are justified where voluntary measures will substantially reduce the costs that would otherwise be incurred by municipalities for water treatment, maintenance, repairs or improvements to publicly owned facilities. *This could include financial payments to local landowners, - compensating them if they agree to set-aside ideally 100-foot riparian buffers along each side of a stream or along hydric soils for riparian buffer and wetland restoration.*

At the same time, Stormwater Utilities (SWU) (a mechanism to fund stormwater facilities and services) are being implemented with greater frequency in the United States. Tax payments can be made to the municipality on the basis on some index of stormwater impact created by the property – such as total impervious area or contiguous impervious area. The revenues from these taxes should be used to fund watershed studies, GIS databases, and direct subsidies to landowners who install BMPs on their properties.

DAMS IN THE CRUM CREEK WATERSHED

According the Environmental Protection Agency, dams are relatively abundant in the mid-Atlantic region, with a surprising number occurring on the nearly level topography of the coastal plain. More than 3,200 permitted dams exist along waterways in the Commonwealth of Pennsylvania, and during the course of this study, a small number of unpermitted dams and at least 2 permitted dams were verified by field study and aerial photography to currently exist in the Crum watershed. One of the recommendations of the Action Plan is to provide a comprehensive inventory and GIS database of dams along Crum Creek and its tributaries.

According the DEP-WRAS, "Flow regulation impairments within the (03-G) subbasin are primarily associated with flow diminution in Crum Creek below the Philadelphia Suburban Water Company (Aqua Pennsylvania) lower reservoir and water intake. The Springton Reservoir outlet works regulates flow in the lower Crum Creek. (Aqua Pennsylvania) is not required to maintain a conservation flow. Depending on water release from Springton Reservoir and water intake at (Aqua Pennsylvania's) Crum Creek Filtration Plant, the lack of a conservation release during low-flow periods creates dry riffle areas and stagnant pools in the 3rd order stream directly downstream from the intake. Additionally, lack of flushing flows below a dam may cause a buildup of fine silts and clays in the streambed. Baseflow diminution can also be caused by reduced groundwater recharge associated with impervious surfaces in suburban/urban land uses. Flow diminution reduces or eliminates riffle habitat by exposing subtrates that would typically be utilized by macroinvertebrates, peripyton (algae and organisms in the streambed), and fish. Stagnant pool habitats can create unacceptable temperature levels or dissolved oxygen concentrations that limit fish populations.

Reflecting a pattern found on waterways across Pennsylvania, the majority of these dams are privately owned, small dams, less than 15 feet high. A number of dams were constructed to impound water for irrigation and to create large ponds for recreational fishing, boating, and swimming. A 12' dam exists on the Crum near Strath Haven. Some local dams are former mill dams (such as Victoria Mills or the Franklin Paper Mill) constructed in the 19th century to impound or divert water to power numerous saw mills and grist mills and to provide industrial water supplies. In most cases, the mills are long gone and the dams remain. Dams were also constructed for ice production, and to draw drinking water supplies.

Dams are constructed features of the Crum Creek Valley and are a complex part of the human history of the watershed. They stand as a meaningful part of past and present human connection to the stream, yet have also generated serious impacts to stream health and have taken human lives. A balanced assessment of each dam in the watershed is warranted to evaluate the true socioeconomic benefits it offers in relation to the very real ecological impacts and safety concerns it may present. The knowledge

gained from this kind of assessment can then be used to inform decisions about dam permit renewal, maintenance, reconstruction, and removal.

How Small Dams Affect Creeks

Despite their classification as "small," dams along the streams and creeks of the Crum watershed affect the ecological health and natural hydrology of the watershed, primarily by negatively impacting the quality of waterways and altering the habitat they provide for aquatic species.

Healthy streams are free flowing systems that support a diversity of aquatic life which depends upon that free-flow. Reproducing fish populations, freshwater mollusks, aquatic insects and plants native to the Crum Creek are all adapted to the naturally forested, free-flowing streams that characterized the watershed for most of its history. Small dams fragment waterways into smaller, isolated, slower moving segments — reducing the ability of the complex, dynamic system to support aquatic life. Rivers are, by definition, moving water, and dams interfere with that flow — and with river ecology. It should be noted that constructed dams have a much different effect on streams than beaver dams. Streams in this region actually adapted to beaver dams because they were constructed of impermanent, organic materials that created temporary wetlands before eventually failing as the beavers moved on to alter another stream segment in the watershed. Beaver dams enhance biodiversity in a watershed by creating a shifting mosaic of successional wetland conditions suitable for a variety of plants and wildlife such as river otter, osprey, muskrat and red-bellied turtles.

Dams alter creek ecology in three ways: physically, chemically, and biologically, all of which are interrelated. Physically, dams greatly reduce the natural flow of silt and gravel downstream, and water slowed by a dam drops its natural load of sediment. In some cases sediments are contaminated with point-source and non-point source pollutants such as nutrients, pesticides, heavy metals and fecal coliform bacteria, This sediment covers gravel areas, smothering bottom-dwelling insects and fish nursery habitat. By contrast, silt-free gravel areas are favorable insect-producing areas, and prime nursery habitat for fish that lay their eggs on streambeds. Dams also impede the movement of organic debris, ranging from masses of leaves to pieces of wood, which benefit aquatic life by providing food and creating debris snags that offer places to hide and rest.

Dams not only impede the flow of water, but affect water temperature and chemistry as well. Water stilled behind dams is unnaturally warmer. Sediments trapped behind dams contribute to raising water temperatures because cloudy water traps more heat from the sun than clear water. When dams increase water temperature, the water's chemical composition is also affected as oxygen content decreases. Cooler water is more favorable as it holds more oxygen and thus supports more aquatic life. Many aquatic species such as trout and the aquatic insects they rely on as a food source are sensitive to changes in

water temperature and will avoid warmer areas. Dams also tend to collect silts laden with chemical contaminants associated with runoff and discharges from upstream sources.

These detrimental physical changes affect the aquatic food chain. Algae, invertebrates such as snails, and insects are good indicators of the health of a stream and its ability to support larger species such as fish. Caddisflies, stoneflies, and crane flies — the favored food of stream-dwelling fish such as trout — prefer well-aerated, oxygenated water. Aquatic insects further prefer shallow streambeds free of silt and dominated by stone and gravel riffles.

Biologically, dams affect the habitat and movement of native fish populations. Dams without fish ladders completely halt upstream fish migration, blocking fish from their historic spawning and nursery grounds. Resident species that do not migrate are also affected. Breeding populations of native brook trout, once common throughout the Crum stream network, are no longer present. Brown trout, though introduced from Europe, are considered naturalized indicators of stream health by aquatic biologists. In the Crum, reproducing brown trout are limited to a small number of tributaries in the West Branch that offer favorable conditions.

There are likely to be migratory fish species present in the lower Crum, including American shad, striped bass, and American eel. Only the eel is likely to extend further upstream in the watershed because of its ability to circumnavigate dams. It is thought that in the future, if fish passages are completed at some dams, that alewife and blueback herring might use drainages such as the Crum to spawn. In one local example in the spring of 2004, DEP broke ground for a vertical slot fish passageway at the Flat Rock Dam on the Schuylkill River in Lower Merion Township in hopes of allowing American shad to migrate upriver for the first time in nearly 200 years. Additional fish passageways are planned for dams on the Schuylkill River in Norristown and Phoenixville. The Delaware River is considered the longest un-dammed stream in the eastern United States.

Socioeconomic Values of Dams

Compared to the last three hundred years, a relatively small number of dams in the Crum watershed currently serve economic functions. Drinking water supply and recreational uses are the main examples. The vast majority of dams provide scenic, recreational and historic values to many residents. Residents may look at dams and impounded waterways as symbols of the long history of settlement in the Crum Valley.

Dam Ownership and Maintenance

The Pennsylvania Department of Environmental Protection (DEP) regulates and permits dams in the Commonwealth and maintains thorough files and inspection reports of all

permitted dams in the Office of Dams and Waterways in Harrisburg. DEP classifies many dams in the region as either "Category 2" or "Category 3". These are "low-hazard" dams, meaning that, if the dam were to fail, the potential for loss of life down stream is low.

DEP issues a permit to dam owners (permittees) to maintain a run-of-river dam, and dam ownership carries significant legal responsibilities. While DEP inspects low-hazard dams every two or five years depending on the category, all permitees of low-hazard dams are required to inspect their dams at least once every three months. A manual, "The Inspection, Maintenance, and Operation of Dams in Pennsylvania," is available upon request from the Division of Dam Safety.

If a permitee has decided upon dam removal, DEP's Division of Dam Safety has adopted a procedure to facilitate the breaching and removal. The procedure makes it easier and more affordable for a dam owner to remove an unwanted and/or unsafe dam. DEP also has an expedited process for dam owners if they are interested in removing run-of-river dams. For more information, contact DEP's Division of Dam Safety at 717 787-8568 or visit DEP's website at www.dep.state.pa.us.

VII. Ecology

This section provides an overview of the rich diversity of plants, animals, and habitats of the Crum Creek watershed and their interactions is a key component of sound environmental planning, protection and restoration.

VEGETATION

Plant communities do not generally occur at random across the landscape, but form patterns based on environmental conditions. The division of plant cover into discrete communities is an artificial process, simplifying the complexity of nature to convey the character of a site. There are no hard divisions between plant community types – boundaries dissolve slowly as rich mosaics of plant associations and community patches respond to changing environmental conditions – from dry to moist to wet, and by aspect (i.e. direction of a slope), topography, depth of soil, and elevation.

Most forests in the Crum watershed are heavily impacted by human disturbance and its side effects such as heavy deer browse and invasion by non-native exotic plant species. They have lost the American chestnut and elms that our grandfathers probably would have expected to see.

Common forest types (and dominant trees wihin each) that may occur in the Crum Creek watershed are included in the following list, based on the statewide plant classification system (Fike, 1999):

Successional Red Maple Forest

This forest type is typically found in uplands, particularly those that have been logged or that haven't been farmed within the last 40 to 100 years. These forest types may be found throughout the Upper and Middle watershed.

Eastern redcedar	*Juniperus virginiana*
Red maple	*Acer rubrum*
Tuliptree	*Liriodendron tulipifera*
White ash	*Fraxinus americana*

Bottomland Oak-Hardwood Palustrine Forest

Forested areas along broader floodplains bordering Crum Creek may mature to this forest type.

Black walnut	*Juglans nigra*
Box elder	*Acer negundo*
Hop hornbeam	*Ostrya virginiana*

Pin oak	*Quercus palustris*
River birch	*Betula nigra*
Shagbark hickory	*Carya ovata*
Silver maple	*Acer saccharinum*
Sycamore	*Platanus occidentalis*

Sycamore-River Birch-Box Elder Flood Plain Forest

Flood plains may also support a forest type with greater representation of silver maple or sycamore and river birch. These forest types are most likely to be found in the broader floodplains of the Middle watershed.

Conifer Plantations

Planted stands of evergreen species such as Norway spruce (*Picea abies*) and white pine (*Pinus strobes)* can be found in certain parts of the program area. These plantations are not a native forest type, but often date back 50 to 75 years when seedlings were widely distributed. These tree groupings can be found scattered in the Upper and Middle watershed areas.

Buttonbush Wetland

Alder-Ninebark Wetland

Shrubby wetland communities in the study area are generally found in areas adjoining the Crum Reservoir, and may support the following species:

Alder	*Alnus spp.*
Arrowwood	*Viburnum dentatum*
Buttonbush	*Cephalanthus occidentalis*
Elderberry	*Sambucus canadensis*
Red-osier dogwood	*Cornus amomum*
Silky dogwood	*Cornus racemosa*
Spicebush	*Lindera benzoin*
Swamp Rose	*Rosa palustris*
Willow	*Salix spp.*
Winterberry holly	*Ilex verticillata*

Tussock Sedge Marsh

Mixed forb Marsh

Openings in shrubby wetlands, and broader wet meadow areas support these communities, including species such as tussock sedge, sweet flag iris, sensitive fern and skunk cabbage.

The *Crum Woods Stewardship Plan* prepared by Natural Lands Trust and Roger Latham for Swarthmore College includes a survey of woodland trees and plants along the Crum Creek that provides insight into what species can be expected to occur elsewhere.

Planning Implications for Vegetation

At the end of the last ice age (Pleistocene), the area forests probably consisted primarily of spruce, pine, birch and alder, which gave way to chestnut-oak forests as the climate warmed. Indians likely burned the forest periodically to promote production of game and forage foods, while subsequent Eurocolonials cleared and plowed many forests and introduced new species, both intentionally (e.g. Norway maples) and unintentionally (e.g. chestnut blight). While chestnut, elm, and hemlock have declined locally due to disease, and oaks, beech and hickories are now probably *underrepresented* due to "high-grade" lumbering (over harvesting the high value woods), ash, maple, sycamore, and tulip poplar are probably more common than they once were in the landscape. The forest composition in the Crum watershed is also surely influenced by deer browse, elevated nitrogen levels in soils due to acid rain, and even the rise and fall of squirrel populations.

Any future restoration activities involving forests and/or riparian buffers should consider *emphasizing* the underrepresented native species to reinstate biological balance. This will also ensure that appropriate seed-sources are reintroduced to the region, which will in turn provide for long-term viability and balance of the common plant communities.

A final note about *local provenance* is applicable at this point: Efforts should be made to ensure that, where possible, any plants used for restoration (or even for horticultural use – at least by the governments and institutions if not by residents) should be obtained from local growers. Much discussion in the ecological and native plant communities in recent years has promoted the concept of purchasing plants grown within, ideally, less than 50 miles of the planting site – and certainly no more than 100 miles. This is an important strategy for promoting the long-term genetic diversity and survival of species in local ecoregions, particularly as plants are stressed by increasing pollution and forced to shift their current ranges northward due to global warming.

Invasive Exotic Plant Species

Infestations of invasive exotic plants pose a major threat to the ecological integrity of natural communities throughout southeastern Pennsylvania; the Crum Creek watershed is no exception. The primary concern with these invasive species is their ability to out-compete and dominate native plants, thereby reducing plant species diversity and providing degraded habitat and food sources for native wildlife. Invasive species are prevalent in disturbed areas, such as successional old fields and abandoned

pastures, along woodland edges and hedgerows, forest gaps or clear-cuts, roads and railroads, and may disseminate from the disturbed areas into higher quality, interior forests and woodlands, particularly in response to browse pressure from deer. Even rivers can act as highways for invasive species carrying seeds from upstream invasive populations downstream, thus initiating and continually recharging new infestations along downstream banks and floodplains.

Invasive exotic plant species of particular concern in the area typically include, but are not limited to the species listed in Table 7:

Table 9: Common Southeastern Pennsylvania Invasive Species and the Impacted Habitats

Trees	**Impacted Habitats**
Norway maple (*Acer platanoides*)	DW
Tree of heaven (*Ailanthus altissima*)	DW, Hr, Rd, RR, vacant l
Japanese angelica-tree (*Aralia elata*)	DW
Empress tree / Princess tree (*Paulownia tomentosa*)	DW, Rd, RR, WG
Corktree (*Phellodendron japonicum, P. lavallei, P. sachaliner*	DW, Rd
Shrubs	**Impacted Habitats**
Japanese & European barberry (*Berberis thunbergii, Berbe vulgaris*)	DW, Hr, OF, Rd
Autumn & Russian olive (*Elaeagnus umbellata, Elaeagnus angustifolia*)	OF, WG,
Burning bush / Winged euonymus (*Euonymus alatus*)	DW, Hr, SB
Privet (*Ligustrum amurense, L. obtusifolium, L. ovalifolium, vulgare*)	DW, Hr, OF, Rd, T
Shrub honeysuckles (*Lonicera* x *bella, L. maackii, L. morrou tatarica*)	DW, Fp, Hr, OF, Rd, SB,
Buckthorn (*Rhamnus cathartica, R. frangula*)	OF, OW, Hr, Rd, T
Multiflora rose (*Rosa multiflora*)	DW, T, Hr, OF, Rd
Vines	**Impacted Habitats**
Five-leaf akebia (*Akebia quinata*)	DW
Porcelain berry (*Ampelopsis brevipedunculata*)	DW, OF, Fp, Rd, T
Oriental bittersweet (*Celastrus orbiculatus*)	DW, Hr, OF
English ivy (*Hedera helix*)	DW
Japanese hops (*Humulus japonicus*)	M, Rd, WG
Japanese honeysuckle (*Lonicera japonica*)	DW, T, OF, RD
Mile-a-minute polygonum (*Polygonum perfoliatum*)	T, OW, M, Of, Rd
Kudzu (*Pueraria lobata*)	WG, edge habitat
Wisteria (*Wisteria floribunda, W.a sinensis*)	DW, Rd, abandoned nur
Herbs	**Impacted Habitats**
Garlic mustard (*Alliaria petiolata*)	DW, Fp, WG
Purple loosestrife (*Lythrum salicaria*)	S, wM, and Sh

Japanese Knotweed & Giant knotweed (*Polygonum cuspidatum, P. sachalinense*)	Dt, Rd, RR, SB, WG
Lesser celandine (*Ranunculus ficaria*)	Low OW, Fp, M, WG
Goutweed (*Aegopodium podagraria*)	
Moneywort (*Lysimachia nummularia*)	
Grasses	**Impacted Habitats**
Japanese stilt grass *Microstegium vimineum*	Low OW, T, M, paths
Miscanthus grasses (*Miscanthus sinensis*)	Rd, WG
Reed canary grass (*Phalaris arundinacea*)	Dt, aM, Mr, Sh
Phragmites (*Phragmites australis*)	Dt, Mr, moist disturbed s

Habitat Codes: Dt= Ditch, DW = disturbed woods, Fp= floodplains, Hr= hedgerows, M=meadows, aM= alluvial meadow, wM= wet meadow, Mr= marshes, OF= open fields, OW = open woodlands, Rd = roadsides, RR= railroad right of ways, S= swamps, Sh=shores, SB= stream banks, T= thickets

This list represents only some of the most infamous species. More extensive lists are available through the Pennsylvania Department of Conservation and Natural Resources, which consider potentially harmful species that are still being evaluated locally for detrimental impacts. Japanese knotweed (*Polyganum cuspidatum*) is one of the most problematic species that is starting to invade southeastern Pennsylvania along streams, disturbed areas and roadsides. Because of its extensive root systems (up to 15 meters long) it is very difficult to remove, requiring up to 3 years of water-safe herbicide applications. Japanese knotweed is considered an actionable invasive – meaning that action now can reap great rewards before this species becomes more pervasive and destructive. Species such as Japanese knotweed and Purple loosestrife, which spread by dispersal of seeds and live fragments along streams, are best addressed on a watershed-wide basis rather than site-by-site. Eliminating these species from a floodplain area without addressing the upstream sources can result in rapid re-infestation.

At the same time, there is also a general overabundance of native ruderal[1] species that prefer 'edge' or disturbed environments. More recent human impacts have created many more of these habitat areas through development patterns that fragment the landscape. The imbalance toward aggressive invasive species caused by fragmentation can be addressed through public awareness and encouraging underrepresented native species that provide food and cover for wildlife.

[1] ruderal definition

This list represents only some of the most infamous species. More extensive lists are available[2], which also consider potentially harmful species that are still being evaluated locally for detrimental impacts.

For example, fox grape is an over-abundant native species in the area that thrives in disturbed edge habitat conditions. Although it provides good wildlife food, its extent should be monitored carefully. If it becomes overabundant, it should be carefully controlled - but not necessarily eradicated. If there are local concerns about loss of wildlife food sources, encouraging natural regeneration or planting native shrubs that produce high-lipid berries and nuts (e.g. viburnums) is a good alternative.

Planning Implications for Invasive Vegetation

Invasive exotic plant species spread typically by bird droppings (for berry-or seed reproducing species) or wind. Since most invasives were introduced by man, either by accident or purposefully, their distribution is typically highest around urban areas, with concentric rings of decreasing density moving into the countryside. It is no longer sufficient to conveniently assume that nature is maintaining a self-perpetuating balance. With the invasion of aggressive, non-native species, many native plant populations can be severely impacted. Highly disturbed forests can lose their naturally high biodiversity in the face of these alien invasions – surprisingly quickly.

It is recommended that local conservation groups undertake annual monitoring of the natural habitats throughout the Crum Creek watershed, particularly those that house rare plant species and in protected parks and nature preserves. At the first signs of invasion by exotics, volunteers should be solicited to manually remove the invasive plants, paying particular attention to removing all roots and seed-heads to avoid resprouting or new germination. If necessary, a skilled, qualified and certified professional can be hired to spot-spray herbicide (typically in the late summer with Roundup,) to control patches of invasive exotic plants that don't respond to manual removal. A public education campaign should be initiated to inform local landowners of the issue and concerns. Natural Lands Trust's Hildacy Farm Preserve provides a valuable local demonstration site to learn invasive species management techniques.

As a complement to a native plant species local provenance ordinance, the local townships should also consider implementing an Invasive Exotic Plant ordinance to ensure that future plantings do not use known invasive species. Again, institutions and corporations could be *required* to adhere to the guidelines, while residential landowners might be *encouraged*, perhaps through property tax rebate incentives, to follow the recommendations. Numerous counties and municipalities in southeast Pennsylvania have such ordinances that could serve as models.

[2] Pennsylvania Department of Conservation and Natural Resources has recently published [4/00] an excellent pamphlet called 'Invasive Plants in Pennsylvania' [#8100-pa-dcnr3077]explaining this problem and listing plant species in the region which are considered current threats.

WILDLIFE

The Crum study area includes a limited network of more-or-less wild forest-interior habitat, forested stream corridors, and wetlands, upland meadows and old fields, and herbaceous and shrub wetlands that supports a considerable number of native wildlife species. This value is further confirmed by the designation of 5 priority natural areas in the Delaware County Natural Areas Inventory.

Contiguous forests and wetlands along streams provide the most ecologically valuable habitat networks for supporting native wildlife. More intensively used agricultural and developed areas generally support only the most common species of wildlife. Agricultural and developed areas that maintain connected networks of natural habitat have greater wildlife value.

The distinction between wildlife species that are *habitat specialists* and those that are *habitat generalists* is important to consider in prioritizing natural areas for protection. Habitat *specialists* depend on specific habitat types (e.g. grasslands, forest-interior, cold-water streams), whereas habitat *generalists* are more adaptable to a variety of human-influenced environments. Habitat generalists such as gray squirrels, white-tailed deer and blue jays are commonly found in the suburban landscapes of residential areas, woodland edges and woodlots, and small fields that are becoming more ubiquitous throughout the region. Habitat specialists such as bald eagles, wood frogs and luna moths rely on larger, undisturbed blocks of interconnected natural areas. These areas are being replaced by suburban landscapes favoring habitat generalists.

Wildlife resources in the Crum Creek watershed were analyzed using the Natural Lands Trust's *SmartConservation*™ resource assessment tool, which helps determine the distribution and relative quality of wildlife resources. It uses the concepts of contiguous, high quality, interconnected habitat networks to identify and prioritize the conservation value of both aquatic and terrestrial wildlife resources throughout the expanded Piedmont Ecoregion of Pennsylvania. The *Smart Conservation*™ analysis results in a 1 – 10 ranking of wildlife values.

The *Crum Creek Landscape Conservation and Greenway Plan*, completed by Natural Lands Trust includes a Potential Habitat Map that demonstrates the suitability of the habitat networks in the study area for supporting biodiversity for each of the major taxa groups: plants; aquatic species (invertebrates and vertebrates); birds; mammals; herpetofauna (reptiles and amphibians); and invertebrates (terrestrial). **Figure 15 – Smart Conservation, Interim Conservation Resources** consolidates these individual suitability maps into one comprehensive overview of the Crum Creek area that rates blocks of land based on their potential for supporting biodiversity. This map reveals that, as can be expected, the largest blocks of land containing the broadest networks of

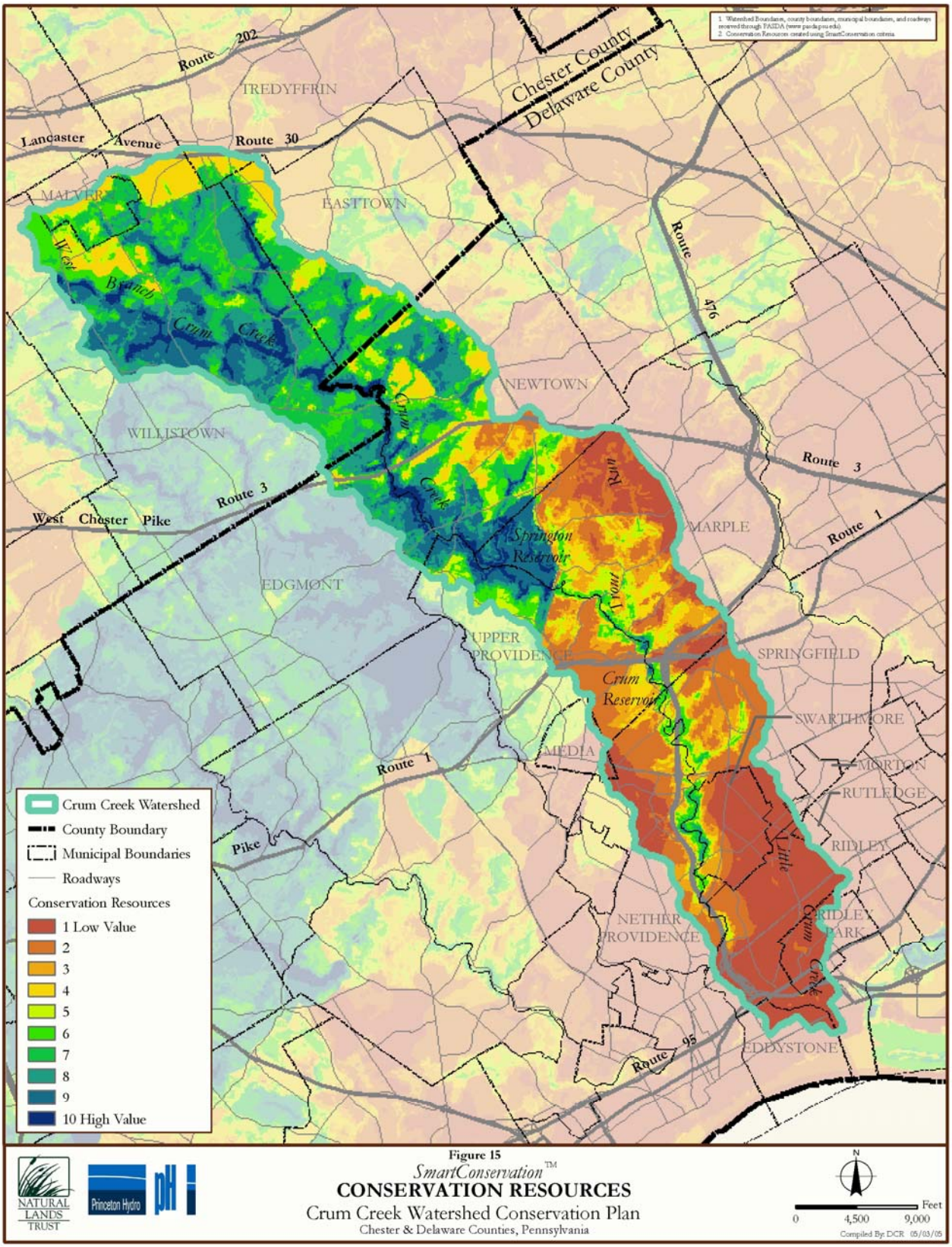


Figure 15

SmartConservation™

CONSERVATION RESOURCES

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

forest, wetland, and stream habitat are those with the greatest potential habitat value for biodiversity conservation. The larger woods and wooded corridors along the Upper and Middle Crum Creek are all rated as the High Value tracts of land for supporting biodiversity spread across the greatest number of taxa groups. The Middle and Lower Crum are somewhat less important due to their denser development pattern and resulting lack of habitat networks. Some seemingly high-ranking areas appear to be forested residential communities which may lack true forest habitat.

SmartConservation™ Conservation Resources Assessment	
Resource Group	Resource Values Assessed
Subgroup A. Potential Vertebrate (Animal) Habitat	- Potential Fish Conservation Value (CV)
	- Potential Birds CV
	- Potential Herps CV
	- Potential Mammals CV
Subgroup B. Aquatic Habitat Resources	- Water Quality (DEP Unassessed Waters 303[d] List
	- National Wetland Inventory
	- Hydric Soils
	- Floodplains
	- Forested Water Quality
	- Riparian Buffer Quality
	- Headwaters Protection
	- Impervious Cover 2000
	- Impervious Cover Change 1985-2000
Subgroup C. Terrestrial Habitat Resources	- Steep Slopes
	- Interior Forest Habitat
	- Natural Vegetation Blocks
	- Contiguous Grassland Habitat
	- Contiguous Barren- Transitional (Scrub-Shrub) Habitat

Table 10 – Smart Conservation Conservation Resources Assessment.

The *SmartConservation*™ composite Conservation Resources Assessment identifies the northern section of the Crum Watershed as one of the most important wildlife areas in the watershed, as well as throughout southeastern PA. The intact, relatively unfragmented, forests and open spaces around the headwaters area is a major contributing factor in its high wildlife value SC score of 10. Other regional hotspots for wildlife resources include the riparian corridors along the main branch and its major tributaries. Low valued areas surround pockets of highly developed lands in urban area. **(Figure 15 – Smart Conservation, Interim Conservation Resources).**

The diversity of aquatic species, birds, herpetofauna[3], invertebrates, and mammals and the suitability of their habitat resources in the Crum watershed are examined in the

[3] herpetofauna definition

sections below. The criteria predict the potential occurrence of species in the region using known information about a species range and habitat preferences that was collated by the Pennsylvania Gap Analysis Project. In addition, *SmartConservation* taxonomic advisory committees applied boosts to species known to be of great conservation value (e.g. habitat specialists, rare and endangered species, keystone species that help to support ecosystems, etc). This assessment has not been completed for invertebrates due to limited data availability. Too little is known about the diversity and distribution of insect populations to make accurate predictions.

Birds of the Crum Creek Watershed

The size, diversity and quality of habitats in the Crum Creek valley indicate that the number of overwintering, migratory and breeding bird species utilizing the area should be high, particularly for forest dwelling and edge dwelling species. The Delaware River valley and its adjacent woodlands, wetlands and grasslands, including those in the Crum Creek valley, are critical stopover points for migratory birds along the Atlantic Flyway, the major migratory corridor for birds in eastern North America. In addition to migratory functions, local habitats support breeding grounds and overwintering areas for numerous bird species. The deep woods habitats and wooded riparian corridors of the ridges and valleys in the watershed attract numerous species of woodland warblers and other habitat specialists such as woodpeckers, owls and small hawks and wood ducks. Even shrubbier successional old field habitats attract less-common edge species such as American woodcock, yellow-breasted chat, and indigo bunting.

One of the benefits of farm ponds and reservoirs in the watershed is the habitat diversity they add for bird species. Larger bodies of open water attract a variety of wading birds, shorebirds and waterfowl, particularly during migration and in winter, however the large resident Canada goose population is a source of concern for water quality and human health due to their significant contributions of nutrients and bacteria. Canada geese populations today result in part from re-introduction of non-migratory flocks in the 1950's and 1960's, and wildlife management practices that have favored geese and discouraged hunting in populated areas. These birds have since thrived in the combinations of lawns, ponds and lakes, and remnant agricultural fields that dot the watershed. Shorelines, wetlands and mudflats along the perimeter of the reservoirs provide habitat for a variety of wading birds, shorebirds and other species.

These woodland/stream/wetland/river habitat networks are critical for supporting bird species diversity in the Crum Creek valley. Some lower density developed areas and agricultural lands with hedgerows, woodlands, stream corridors and less intensively maintained hayfields have significant habitat value for birds. Intensively farmed agricultural lands and developments dominated by lawns and paved areas and the historic villages of the area are generally less important for most bird species, owing to the lack of food and cover opportunities for many of the habitat specialists of the area.

A list of bird species known or likely to occur in the Crum Creek area is included in **Appendix G – Wildlife**.

Terrestrial habitat resources were evaluated using the five criteria listed as Subgroup C in the *SmartConservation*™ Composite Conservation Resources Assessment Chart. These criteria are not specific to bird habitat but rather rate the terrestrial habitat resources.

Audubon Important Bird Area (IBA) and other Habitats:
The section of Crum Creek above Route 3 has been designated by the Pennsylvania Audubon Society as the "Upper Ridley/Crum Important Bird Area" (IBA) as an extension of the Ridley Creek State Park/Tyler Arboretum IBA. The Important Bird Area (IBA) program was established to reverse declining trends in bird population. An IBA is a site that is part of a global network of places recognized for their outstanding value to bird conservation. The Upper Ridley/Crum area was chosen because of the amount of diverse habitat protected by landowners and conservation groups such as Willistown Conservation Trust. The Trust sponsors a grassland bird restoration project to work with landowners on mowing schedules and native grass plantings to support breeding populations of species such as meadowlarks, bobolinks, and savannah sparrows. The area was also selected because of the number of habitat restoration projects in which local residents are involved, including riparian buffer plantings and native grassland management. **(see flyer in Appendix G – Wildlife)**

Other areas suggested by Doris McGovern (personal communication, 4/03), local birder, Birding Club of Delaware County include:

Crum Reservoir/Springton Reservoir The reservoirs provide excellent habitat for overwintering waterfowl such as ruddy duck, common and hooded mergansers, buffleheads, canvasbacks, and ring-necked ducks. Red necked and horned grebes, common loons, cormorants, gulls, Canada and snow geese are other water birds that use these water bodies in the winter (Canada geese are noted in the *Source Water Assessment* as a problem species contributing excessive nutrients and bacteria to these water bodies). Bald eagles and osprey hunt and perch there in summer but are not known to nest locally. They nest on the Delaware River not far from the mouth of the Crum. Osprey nesting platforms should be tried, but predation from Great Horned Owls may be a problem. Girdling a tree to create a large snag at the water's edge is an easier option than building a platform. Saw-whet owls overwinter in the older white pine plantations along the shorelines of the reservoirs.

Winter Run Woods This is a narrow wooded ravine just west of the dam at the Crum Creek Reservoir in Nether Providence. It supports a beech-oak forest with toad trillium, salamanders, nesting broad-winged hawks, scarlet tanager, ovenbird, winter wren and northern goshawk as visitors. This natural area connects to a broader habitat network

including Smedley Park and eventually the large woods at Baltimore Pike, and could be an excellent trail network. 14 homes on large lots are proposed in this area.

Crystal Forest Crum Creek Road near Dog Kennel Road, northwest of Archdiocese land. Nice woods, inaccessible, some larger parcels.

Archdiocese Woods West of Blue Route, north of Route 1. Large, some mature and less disturbed, beech-oak, trout lily, dutchman's breeches, nesting broad-winged hawks. Has ATV problems, invasives, Cardinal O'Hara uses it for cross country trails. This area has a potential linkage to Smedley Park if trails are established. A large, high density residential subdivision is currently proposed in the western portion of this woodland above Hotland Run and the Crum Creek.

Route 1 Marsh South of Route 1, east of Blue Route. Some natural, some constructed (Blue Route mitigation). Had Virginia and Sora rails in recent years. Silting in steadily. Historical society photo from 1910 shows barren landscape, cleared for dairy farming.

Blue Route Ponds, Marple Township Potential habitat for waterbirds, frogs, salamanders, turtles.

Delaware County Community College Supports a variety of wooded, meadow, edge and pond habitat, with 105 species documented on campus by Kevin Diggins and Chris Sims.

Mammals

The habitats of the Crum may support as many as 50 different species of mammals. Some of the more more common habitat generalists are woodland edge species found in many backyards. White-tailed deer, gray squirrel, red fox, groundhog, white-footed mouse, raccoon, opossum, moles, shrews, and eastern cottontail rabbit are included in this category. A list of mammal species known or likely to occur in the Crum Creek area is included in **Appendix G – Wildlife**.

The white-tailed deer population has boomed in recent decades across the state. Pennsylvania Audubon reports that the natural deer herd in pre-settlement forest conditions (including top predators) was as low as 8 to 11 deer per square mile. Today, it is well over 20 deer per square mile, and in some cases as high as 70 deer per square mile. This change is due to a combination of factors, including the ability of deer to adapt to human environments with increased fragmentation and loss of natural habitats (deer thrive in edge conditions), the long absence of historic top predators such as gray wolf and mountain lion, and the cultural shift away from hunting as rural populations become more suburbanized. Major impacts of white-tailed deer overpopulation in the Crum are the overbrowsing of the forest understory resulting in a loss of plant diversity

and future canopy trees; the loss of farm crops; and the hazard of collisions between deer and automobiles.

The potential list of less common, habitat-specialist mammals in the area includes several types of weasels (including mink), gray fox, up to 10 species of bats, eastern coyote and red squirrel. Several larger mammal species that are indicators of large, healthy habitat networks may pass through the area, or could be reestablished in the future. These include bobcat, river otter and beaver.

As with so many other forms of wildlife, the interconnected woodland/stream/ wetland/river networks are critically important for mammals. Conventional agricultural and residential landscapes tend to support only the more generalist species of mammals. The buffering and linking value of farmland adjoining woodlands, hedgerows, and natural stream corridors is certainly an important factor in maintaining the diversity of mammals in the Crum. Residential subdivisions designed to maintain interconnected habitat networks will have a greater likelihood of supporting native wildlife species than those dominated by lawn.

The general quality of terrestrial habitat resources were evaluated with *Smart Conservation* using the five criteria listed in Table 7. These habitat types include**:** Interior Forest Habitat, Natural Vegetation Blocks, Contiguous Grassland Habitat, and Contiguous Barren-Transitional (Scrub- Shrub) Habitat.

Herpetofauna (Reptiles and Amphibians)

The same habitat networks that support aquatic and bird species diversity are also critical for the reptiles and amphibians of the Crum Creek area – but riparian and wetland habitats are most important. Amphibians such as frogs, toads, and salamanders are examples of habitat specialists, often reproducing in small vernal pools and shallow wetlands during the spring breeding season, then dispersing to streamside and upland woodlands and meadows. Reptiles including turtles and snakes are also found more commonly in natural areas rather than residential or agricultural landscapes. The stream, pond, and various wetland habitats in the valley are most important for these species, while the majority of woodlands in the area rank as moderately important. Agricultural and residential landscapes are less important habitats for reptiles and amphibians. A checklist for these species is included in **Appendix G -- Wildlife**, compiled by local herpetologist Skip Conant for this Plan.

Invertebrates (Terrestrial)

Invertebrates are perhaps the most diverse yet least understood and appreciated of the wildlife taxa groups. The myriad ants, beetles, worms, and larvae that live in the forest leaf litter and upper soil layers in the region are the "decomposers" that play a crucial role in maintaining healthy ecosystems and stream quality. The more charismatic butterflies, moths, dragonflies, damselflies, and the less popular bees, wasps, flies, and

mosquitoes play crucial roles as pollinators and/or decomposers, and are often *plant specific* in their habitat requirements, in addition to being habitat specific. These species are most dependent on forested habitats in the Crum Creek watershed for their survival, due to the combination of high plant diversity and accumulation of organic matter they provide. Agricultural and residential landscapes are less beneficial.

Aquatic Species (fish, invertebrates) The major streams, tributary streams, wetlands and ponds that constitute the aquatic ecosystems of the Crum Creek watershed provide food and habitat conditions suitable for a rich diversity of aquatic life. These include an array of benthic macroinvertebrates (insects and larvae found in stream beds) such as caddisfly nymphs, stonefly nymphs, and mayfly nymphs. Freshwater mussels, snails and crayfish also fall into this category. These species form the base of the food web in stream ecosystems, and are important indicators of stream health or degradation. A list of fish species known or likely to occur in the Crum Creek watershed is included in **Appendix G – Wildlife**.

The stream, pond, and wetland habitats that support aquatic species are generally associated with forested areas. The forests provide important filtration and recharge benefits that maintain the quality and quantity of water on which aquatic organisms depend. The richness and viability of the streams are inherently connected to the presence of healthy streamside and upland forest networks. Developed areas and agricultural land are less important for aquatic species unless they retain significant natural buffers along streams and wetlands.

Aquatic habitat resources were evaluated using the nine criteria listed as Subgroup B in the *SmartConservation*™ Composite Conservation Resources Assessment Chart in Appendix G. Small watersheds within the Crum watershed identified as having the highest aquatic habitat resources conservation value (score = 10) include the headwater reaches north of Route 3. Good water quality exists in these areas due to the amount and quality of the forests and the limited impervious cover. Areas below the dams and in more urbanized areas had the lowest aquatic habitat resources conservation value (score = 1)

Planning Implications

Habitat destruction, fragmentation, and disturbance are the primary causes of loss of flora and fauna diversity across the region, and in the Crum Creek landscape. However, studies show that the introduction or invasion of exotic species now has the second largest impact in reducing wild plant and animal species diversity across the nation. Deer browse is also a major concern for plant species diversity and the wildlife diversity that depends on native vegetation. A recent study published by Pennsylvania Audubon calls for a complete shift in Pennsylvania Game Commission policies to favor ecological management of the deer herd rather than management based on promoting hunting

(Audubon Pennsylvania 2005). Locally, gypsy moth invasions are a good invasive exotic wildlife example, but there are many others – the newest of which are Asian longhorn beetle and Asian and European earthworms in natural woodlands. No sustainable solutions to these problems have yet been developed.[4]

As in many other areas in the region, some wildlife species are bouncing back from human impacts – such as white-tailed deer, beaver and red fox – while others continue to decline. Typically invertebrates, amphibians and reptiles continue to be disproportionately impacted by our modern world, while other vertebrates, and mammals in particular, seem better able to adapt. Species of all taxonomic groups that have difficulty adapting to disturbance, or those that *require* specific disturbance regimes (such as forest plants adapted to natural fires) or that are area-sensitive and affected by habitat fragmentation, continue to decline in the region. Many bird species – neotropical migrants and grassland species in particular, are showing marked population declines on the east coast of the United States. Many amphibians and reptiles suffer as wetlands, vernal pools, and other surface waters are 'improved' for higher-value land use or compromised by pollution. Water habitats are essential for breeding, but many of these species also need an undisturbed upland habitat buffer adjacent to their breeding habitats for foraging and hibernation in non-breeding season.

It is, of course, costly and time consuming to obtain accurate wildlife survey information - and even when we do obtain it, we must acknowledge that it is always over-representative of charismatic megafauna and under-representative of the lower orders of faunal life forms.

Unlike flora, it is difficult to know where wildlife is located at any given time – since it moves around over both the short and long term. Seasonal migrations are particularly difficult to provide for in conservation planning, especially when the migrations are of large geographic extent, particularly international. Neotropical migratory birds are perhaps the best example of this scale. *Successful land preservation efforts to support viable wildlife therefore needs to focus more on providing a suitable regional habitat network, rather than just focusing on site-specific parcels where species have been seen and are presumed to reside. Local land use ordinances must also consider the importance of wildlife habitats in guiding development. In addition, more detailed surveys of local fauna are needed to better assess the health or crises facing wildlife communities in the area.*

While the *Crum Creek Landscape Conservation Plan* has identified numerous Habitat Conservation Networks **(see Smart Conservation Interim Conservation Resources map, Figure 15**) as part of the prioritization process for Conservation Priorities, very little is known about the actual populations of native wildlife species that are sustained by those habitat networks. To do a better job of protecting the most ecologically

[4] Contact Natural Lands Trust for more information on this developing issue.

valuable natural areas, we need a better understanding of how wildlife are using those areas. Where do we find the greatest concentrations of amphibians such as frogs and salamanders -- are they found around the vernal pools and the seeps and springs along small rivulets in the area? Are top-predator mammals such as coyote or bobcat found in the area (Coyote have been reported in nearby Ridley Creek State Park)? Do mink utilize all of the stream corridors or just the densely forested ones? Where are the greatest concentrations of forest-nesting warblers and bats in the area?

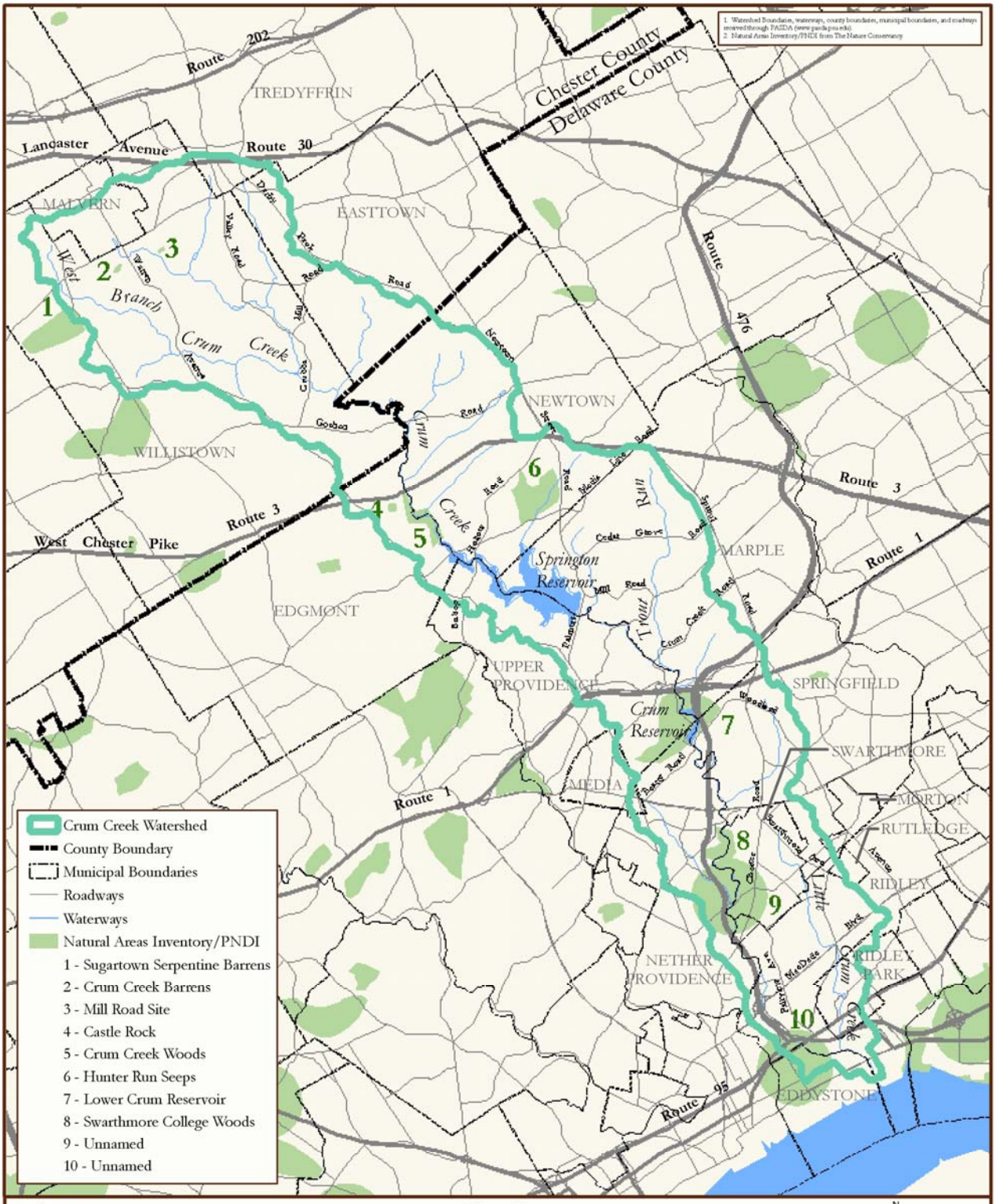
These are extremely important questions for honing-in on the "hotspots" of biodiversity in the Crum Creek valley. So far, they have only been addressed based on educated assumptions, the plant survey for Crum Woods, bird lists of local bird clubs, and the limited surveys of the Delaware County and Chester County Natural Areas Inventories. The best way to answer questions about patterns of wildlife occurrence and diversity is to enlist the assistance of ornithologists, zoologists, herpetologists, etymologists and other wildlife experts in conducting field surveys of the area. Local bird clubs and local sportsmen's clubs are also good sources of information regarding wildlife and local habitats. Natural Lands Trust should develop a *wildlife inventory initiative* for the entire Crum Creek watershed to establish baseline data on species diversity and habitat use.

Natural Areas Inventories

Both Delaware and Chester Counties have participated in the Natural Areas Inventory program sponsored by the Pennsylvania Science Office of the Nature Conservancy and funded in part through the Pennsylvania Department of Conservation and Natural Resources. The purpose of these inventories is to assess the biological importance of various natural areas throughout each county, and to confirm historic or new records of state or federally listed rare, threatened or endangered plant or wildlife species. In most counties, these inventories represent the most complete compilation of data on native flora and fauna available, yet they are typically not done in a great level of detail and should be considered a foundation for much needed detailed surveys. Species codes are used to protect these plants and animals from those who would do them harm either as collectors or as vandals.

The Delaware County and Chester County Natural Areas Inventories, prepared by the Pennsylvania Science Office of The Nature Conservancy and the Pennsylvania Natural Diversity Index include five (5) Priority Sites of Local Significance within the Crum Creek as priorities for biodiversity conservation. **(Figure 16 – Natural Areas Inventory/PNDI)** These include:

Crum Creek Barrens (SP 551 and SP 552) – Willistown Township, poor populations of a PT and a PR plant species occur on small serpentine outcrop; no recommendations.



NATURAL LANDS TRUST

Princeton Hydro

pH

Figure 16

NATURAL AREAS INVENTORY / PNDI

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

Mill Road Site (SP 551) – Willistown Township, PA Threatened wildflower, with minimal management (removing weeds and woody invasives), this species may survive here indefinitely.

Sugartown Serpentine Barrens (NC511) – Willistown Township (partially in watershed). Nine plant species of special concern; under easement to NLT; management will be needed to maintain serpentine elements.

Dutton Mill Road Woods (SP567, SP569) – East Goshen and Willistown Townships (partially in watershed). Two separate habitats near Dutton Mill are home to plant species of concern. Habitats are red maple swamp and grass on edge of forested seeps, small streams.

In addition to these sites, a number of other sites are mapped and noted for supporting Species of Special Concern. These include a number of globally rare plants adapted to serpentine rock outcrops in Willistown Township, with the following species codes (SP501, SP502, SP520, SP529, SP547, SP503, SP534, SP543, and SP544).

Planning Implications - Ecology
Overall chestnut, elm and hemlock have declined locally due to disease, and oaks, beech, and hickories have been reduced by development and lumbering over time. Ash, maples, sycamore, and tulip poplar are now more common than they once were in the landscape.

Recommendation: Future forests and/or riparian buffer restoration activities should emphasize the underrepresented native species to reinstate biological balance. Reintroduction of native species will ensure that appropriate seed-sources are reintroduced which will in turn increase long-term viability and balance of the common plant communities.

Recommendation: Efforts should be made to ensure that, where possible, any plants used for restoration (or even for horticultural use – at least by the local institutions if not by residents) should be obtained from local growers. Ecological and native plant communities promote the concept of purchasing plants grown within a *local provenance*, ideally less than 50 miles of the planting site and no more than 100 miles, to promote a strong, diverse gene pool reflecting long-term adaptation to local conditions. Local nurseries that specialize in native plants include Redbud Nursery in Glenn Mills.

Highly disturbed forests can quickly lose their natural biodiversity as aggressive non-native species become dominant in the understory. Invasive plant species spread typically by bird droppings (for berry or seed reproducing species) or wind. Since most invasives were introduced by man, either by accident or purposefully, their distribution is typically highest around urban areas, with concentric rings of decreasing density

moving into the countryside. In this area, if the seed-source for many of these species is not yet evident – they will probably be arriving soon.

Recommendation: Natural habitats throughout the Crum watershed should be monitored annually by local environmental organizations and land managers, particularly in areas that currently support rare plant species and are in protected parks and nature preserves. One method for removing invasive plants is manual, paying particular attention to removing all roots and seed-heads to avoid re-sprouting or new germination or spot spraying with a herbicide by a certified professional. A public education campaigns can inform local landowners of the issue and concerns and provide information about local demonstration sites.

Recommendation: Municipalities may also enact a native plant species local provenance ordinance or an Invasive Exotic Plant ordinance to ensure that future plantings do not use known invasive species. New ordinances would legally affect only developments and site plan modifications proposed after the enactment of the ordinance but could provide guidance to existing residential landowners and businesses.

Planning Implications – Natural Areas Inventory

The Natural Area Inventories highlight conservation sites that are highly valued throughout the watershed for habitat and water quality impacts. The next challenge is to ensure the protection of these sites, as well as any remaining blocks of contiguous forests in the watershed, and build linkages between these sites.

Recommendation: Selective harvesting can occur without causing too much harm to forest and aquatic systems; however, local controls need to ensure that over-harvesting and clear-cuts are avoided, especially within riparian zones and on the steepest slopes, which have the most erodible soils. Municipalities are advised to adopt Forest Management Ordinances requiring permits for commercial timber harvests (including clearing for development) based on a forest management plan prepared by a registered forester and submitted to the municipality for review by a consulting forester. Such plans should demonstrate protection of environmentally sensitive areas, use of Best Management Practices including soil stabilization and replanting.

VIII. Cultural and Historic Resources

Knowledge of past human experience in the Crum Creek Watershed is essential to aid planners and local officials in molding the future. A detailed history of the Crum Creek watershed prepared by William R. Brainerd is included as **Appendix H** of this report. As stated in the document *Crum Creek: Past Present & Future*, prepared by the Chester-Ridley-Crum Watersheds Association in 1988,

"Historical importance of the creek to the local economy as a source of power for mills engaged in a variety of manufactures. That era is past and the remaining economic value of the creek is as a source of water for human consumption…recreational and esthetic values to an increasingly crowded populace."

The interplay between the natural features of the Crum Creek and the requirements for human survival shaped the unique identity of this landscape. The earliest of these inhabitants, was the Algonquin tribe of Lenni Lenape, who inhabited the woodlands for thousands of years. Dutch and Swedish traders were present in the area during the 17th century, but never settled in great numbers. An influx of Northern European settlers led by English and Welsh Quakers seeking religious freedoms lived peacefully with the Native Americans in the late 17th and early 18th centuries. Their growing presence changed the character of the land and culture after it was peacefully transferred from Lenape ownership to William Penn in 1684 and renamed Penn's Woods.

From that point in history, the landscape of the Crum Creek watershed grew more complex, and a rich cultural legacy remains to this day. Through necessity and labor, those European settlers created a rural heritage still visible today in the gently rolling farmland, hedgerows, historic trees, woodlots and wooded ridges. Likewise, the churches, bridges, mills, and villages that helped sustain them remain as a visual record of the historic and cultural importance of this region. The earliest transformation of the Crum Creek Watershed was dictated by settlement patterns of this European migration. The settlements brought enormous change and innovations in agriculture and industry. They shape the roads we travel, the sights we are inspired by, and the resources we value.

Lenni Lenape/Late Woodland Period (to 1680)

Lenni Lenape, the oldest of the Algonquin tribes in the northeast, means "the original people, those who live along streams." They were a part of the Algonquin language group, and were under the political influence of the Iroquois Confederation. The Lenape were a truly woodland people who lived within the

native hardwood forest by harvesting most of their foods, medicines and materials from the diversity of plants and animals of the area. By and large they were a peaceful people. They were typical hunters and gatherers, although they also practiced farming, raising corn, beans, and squash as staples of their diet. By the mid-17th Centuy, the Lenape became involved in the fur trade in conjunction with Dutch and Swedish settlers.

Because the earliest European settlers had established good relations with the Lenape, William Penn had little difficulty negotiating the sale of the land in 1684. Although the Lenape did not view the land as a commodity, the lands in this area were gradually sold off to Penn for a nominal exchange of goods. Many Lenape died from diseases inadvertently introduced by the settlers – diseases for which they had no immunities or cures. The former 3,000 acre Okehocking Reservation in the Ridley Creek watershed to the west of the Crum was used as a temporary holding area before the remaining Lenape were forcibly moved to Oklahoma in the 19th century. The Okehocking Preserve stands today along the north side of Route 3 as a legacy of the gradual removal of the Lenape from their native land.

Early European Settlement Period (1680—1800)

The majority of the land in the Crum Creek valley was conveyed to European settlers in the mid-18th Century by patent by the heirs of William Penn or later by the Commonwealth of Pennsylvania. Across the Atlantic Ocean, the early seventeenth century witnessed the Reformation in Europe in the Thirty Years' War, which ultimately led to persecutions of Protestants in Germany, England, and other states. These events stimulated the migration of Quakers and other "peace" sects to the New World and to Penn's Woods.

These European settlers brought with them skills and ways of life that would change the landscape of the Crum Creek valley. For instance, they introduced the practice of crop rotation whereby agricultural lands were replenished with nutrients from alternating corn, oats, wheat, and clover crops. This technique exponentially increased agriculture yields and was a major factor in the success and prosperity of the region. Numerous small hamlets and villages were founded during the early development of the Crum Creek valley, including Newtown Square (Penn's "Green Country Towne" experiment), Malvern, Swarthmore, and other settlements.

The Historic Preservation program of the Delaware County Planning Department has on record survey cards for over 600 resources it deems as having historic significance in the Crum Creek watershed. The Historic Resources map **(Figure 17)** shows locations of water-related historic resources and sites listed on the National Register of Historic Places.

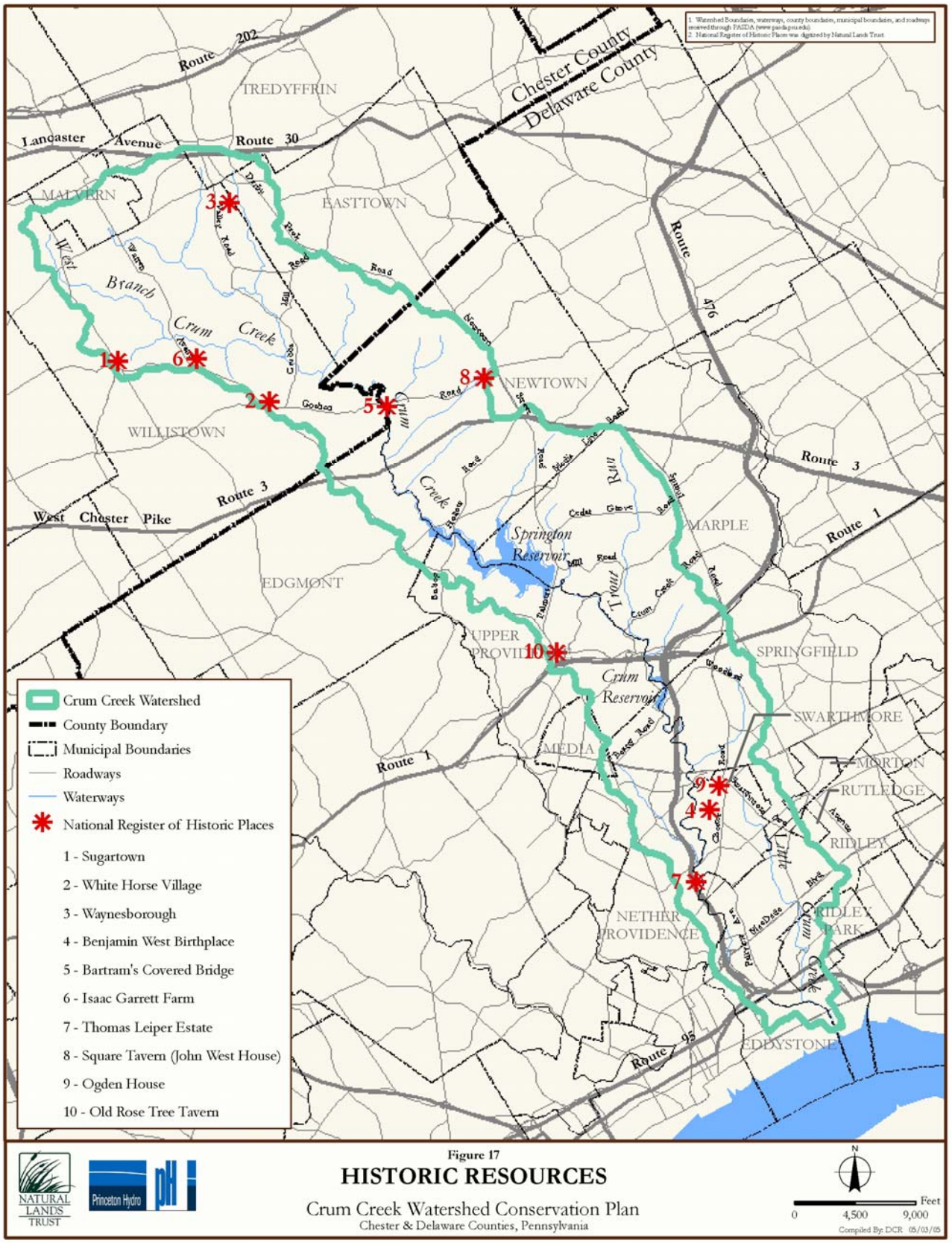


Figure 17

HISTORIC RESOURCES

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

Key #	Type	Name	Address	Municipality	County
067763	District	Sugartown	Sugartown Road	Willistown	Chester
097020	District	White Horse Village	Goshen and Providence Rds.	Willistown	Chester
001599	Landmark	Waynesborough	Waynesborough Road	Easttown	Chester
000693	Landmark	Benjamin West Birthplace	Swarthmore College Campus	Swarthmore	Delaware
050747	Property	Bartram's Covered Bridge	Goshen Road	Willistown and Easttown	Chester and Delaware
118746	Property	Issac Garrett Farm	Providence Road and Warren Ave.	Willistown	Chester
000714	Property	Thomas Leiper Estate	Avondale Road	Nether Providence	Delaware
067762	Property	Square Tavern (John West House)	Goshen Road and Rt. 252	Newtown	Chester
000707	Property	Ogden House	Cedar Lane	Swarthmore	Delaware
000699	Property	Old Rose Tree Tavern	Rose Tree Road and Rt. 252	Upper Providence	Delaware

Table 11: Resources Listed on the National Register of Historic Places in the Crum Creek Watershed (keyed to Historic Resources map, Figure 17)

At least 10 resources in the Crum Creek watershed are listed on the National Register of Historic Places. These include buildings, bridges and village districts dating to the 18th and 19th centuries. Larger areas with multiple resources are listed as Districts. Individual resources of exceptional significance and deemed of importance to all Americans by the Secretary of the Interior are listed as Landmarks. Other resources are listed as Properties.

The National Register of Historic Places is the Nation's official list of cultural resources worthy of preservation. It is authorized under the National Historic Preservation Act of 1966, and administered by the National Park Service -- part of the U.S. Department of the Interior. National Register properties are distinguished by having been documented and evaluated according to uniform standards. These criteria recognize the accomplishments of all peoples who have contributed to the history and heritage of the United States and are designed to help state and local governments, Federal agencies, and others identify important historic and archeological properties worthy of preservation and of consideration in planning and development decisions.

Listing in the National Register contributes to preserving historic properties in a number of ways:

- Recognition that a property is of significance to the Nation, the State, or the community.
- Consideration in the planning for Federal or federally assisted projects.
- Eligibility for Federal tax benefits.
- Qualification for Federal assistance for historic preservation, when funds are available.

It should be noted that the Crum Creek supports a wide variety of historic resources that could be eligible for the National Register but have not been nominated at this time.

Delaware County Comprehensive Historic Resources Survey

A number of watershed-related historic resources are also catalogued in a series of reports prepared by the Delaware County Planning Department for most of the municipalities along Crum Creek. The Comprehensive Historic Resources Survey, prepared during the 1980's and 1990's, included extensive documentation of a over 600 resources in the Crum Creek watershed. The resources are listed below by the municipality and survey document from which they were derived:

Chester County

Malvern Borough

Paoli Massacre site – origin of main branch, Monument Ave. Malvern just above dam at Warren Ave and Paoli Pike.

Waynesborough

Report of the Findings of the Delaware County Historic Resources Survey for Newtown Township, Delaware County Planning Department, 1984

25, Bartram's Bridge – built in 1860, 80' long, 18' wide, 60'span (owned by Marple-Newtown Historical Society)

26. Springhouse – Goshen Rd. east of Partridge Lane, early 18th century. Part of complex serving as American outpost for intelligence officers during the Revolutionary War.

Report of the Findings of the Delaware County Historic Resources Survey for Marple Township, Delaware County Planning Department, 1984

1, 14, 15, 16, 24, 25, 28, 29, 30, 31, 32, 46, 47, 81

Report of the Findings of the Delaware County Historic Resources Survey for Edgmont Township, Delaware County Planning Department, 1994

65 Mill Hollow mill complex (1799)

Report of the Findings of the Delaware County Historic Resources Survey for Upper Providence Township, Delaware County Planning Department, 1989

110, 132, 133

Report of the Findings of the Delaware County Historic Resources Survey for Swarthmore Borough, Delaware County Planning Department.

1, 2, 4, 5, 6, 10, 27, 28, 29, 47, 48, 49

Report of the Findings of the Delaware County Historic Resources Survey for Nether Providence Township, Delaware County Planning Department, 1983.

1. Springton Dam, off Oak Valley and Beatty Roads

5, Media Quarry Co. (18th century)

18, 20, 21, 22, Plush Mills (Baltimore Pike, 1750's to 1947)

29 – 115 Plush Mill Rd. Confusion Hill

102 Strath Haven Mill ruins, race, dam. Strath Haven Dam (lake), meadows were part of lake bed, 18th century (Yale Ave, Swarthmore)

103 Leiper grist mill - Residence and remains of 1776 powder mill for Continental Army (w. bank Crum Creek just e. of Dicks Run, just above Yale Ave. bridge)

104 Thomas Leiper Estate 521 Avondale Road (mill and quarry owner)

105 Leiper Springhouse, Avondale Road

106 Springwater bottling plant, Avondale Road

107 federal style mill foreman's house,

108 Leiper Quarry Railroad and Sproul Viaduct

111 Leiper canal bed 1828, former granite locks and lockhouse. Crum Creek at Bullens Lane.

Report of the Findings of the Delaware County Historic Resources Survey for Ridley Park Borough, Delaware County Planning Department.

Ridley park lake within "historic district"

2, 9, 10, 15, 4

Report of the Findings of the Delaware County Historic Resources Survey for Ridley Township, Delaware County Planning Department (1994).

4 McIlvain House – 1800, former tanyard, bark mill, saw mill along Crum Creek.

32 Chester Pike Bridge over Crum Creek, 1926.

23 Peter Hill House (1790) – sawmill and gristmill during Revolution across Haverford Ave. along Little Crum.

24 Jacob Simcock House

25 18th century, part of former mill complex along Little Crum.

Historic Trees

There are many historic trees within the watershed that are vulnerable and warrant protection. A number of these were documented in the 1981 publication by the Green Valleys Association, *Penns Woods* (1682-1982). Several of these were listed as located in or near the Crum Creek watershed. Their existence today, 23 years later, has not been confirmed. These include

American Beech at Pendle Hill, Wallingford.
White Ash, Timber Lane off Saw Mill Road, Newtown Township.
White Oak, Springfield Western School, Springfield.
White Oak, Springfield Friends Meeting, Springfield.
White Oak, Walnut Lane and Hillborn Avenue, Swarthmore.
White Oak, Crum Creek Road at Berry Lane, Upper Providence.

2 historic White Oaks at Hildacy Farm (Natural Lands Trust preserve on Palmers Mill Road) – one near headquarters, one along Crum Creek

Swarthmore College campus – large beech

Because of their unique ability to blend natural and cultural history, an ongoing GIS database of historic trees in the Crum Creek watershed should be prepared and maintained.

Historic Sites of Importance

Spring house on Swarthmore Avenue, Swarthmore Borough.
This structure is privately owned. A tree recently fell on it and demolished the roof and part of two walls. The owners say they will try to restore it. This spring house may cover the origin of the main branch of Little Crum Creek

Historic Sugartown

One unique historic destination in the Upper Crum Creek Watershed is Historic Sugartown, a historic enclave of homes and shop dating from the 1780s.
The "off the beaten path" Quaker village of homes, stores, a one room schoolhouse, and a book bindery, straddles Sugartown Road in Willistown, and therefore also the watershed boundary with the Ridley Creek Watershed. Eleven of these buildings have been beautifully restored by the nonprofit group Historic Sugartown, Inc. The 1800s saw the village as a stop for wagon trains carting lime to the kilns of Great Valley and cattle drivers, as well as the focus for the surrounding farms, many of which have been preserved in a rural state today through the efforts of Willistown Conservation Trust.

IX. Land Use Patterns and Trends

The **Subbasins and Land Use Map (Figure 18)** depicts the land use pattern which influences the water quality and quantity of the Crum Creek. These uses are regulated by the 17 municipalities that govern land use and determine zoning districts under the Pennsylvania Municipalities Planning Code (**Figure 19 – Municipalities)** The single greatest land use category, Residential - Single Family Detached occurs at increasing densities from the upper watershed to the lower watershed. Many of the homes constructed in the watershed over the last 30 years are in lower-density developments designed to meet demand from people migrating outward from Philadelphia and older inner-ring suburbs of eastern Delaware County.

Much of the developed land in the middle watershed, some of which served as an important buffer for drinking water supply reservoirs and intakes, was only developed over the last 10 to 15 years. The greatest concentrations of manufacturing can be found at the mouth of the Crum where it reaches the Delaware River. Commercial centers can be seen at major crossroads and along major arteries.

The network of remaining agricultural lands and woodlands in the Upper Watershed is truly a testimony to conservation-minded landowners and the work of conservation organizations.

The frequency of Parking as a land use category is an indicator of impacts to watershed health – for the sheer fact that it is large enough to appear on a map of this scale. These areas cover soils, remove vegetation and wildlife habitat, inhibit recharge of groundwater, and generate excessive amounts of polluted (and heated) runoff into streams. They are habitat for automobiles, and nothing else.

Golf Courses

The growing popularity of golf in recent years has led to an increase in the number of public and private golf courses in the Crum Creek watershed. Of the 6 courses documented in the watershed, all of them retain at least some open (unbuffered) stream frontage as a feature of play. Golf courses present both benefits and challenges to the health of the watershed as a living environment for people, plants and animals. Golf courses can average 100 to 150 acres in size, providing an open space use that keeps land relatively free of impervious surfaces or more intensive uses such as quarries, and allowing golfers the chance to enjoy local open spaces. A golf course can also cause serious environmental impacts, including extensive clearing of native vegetation and

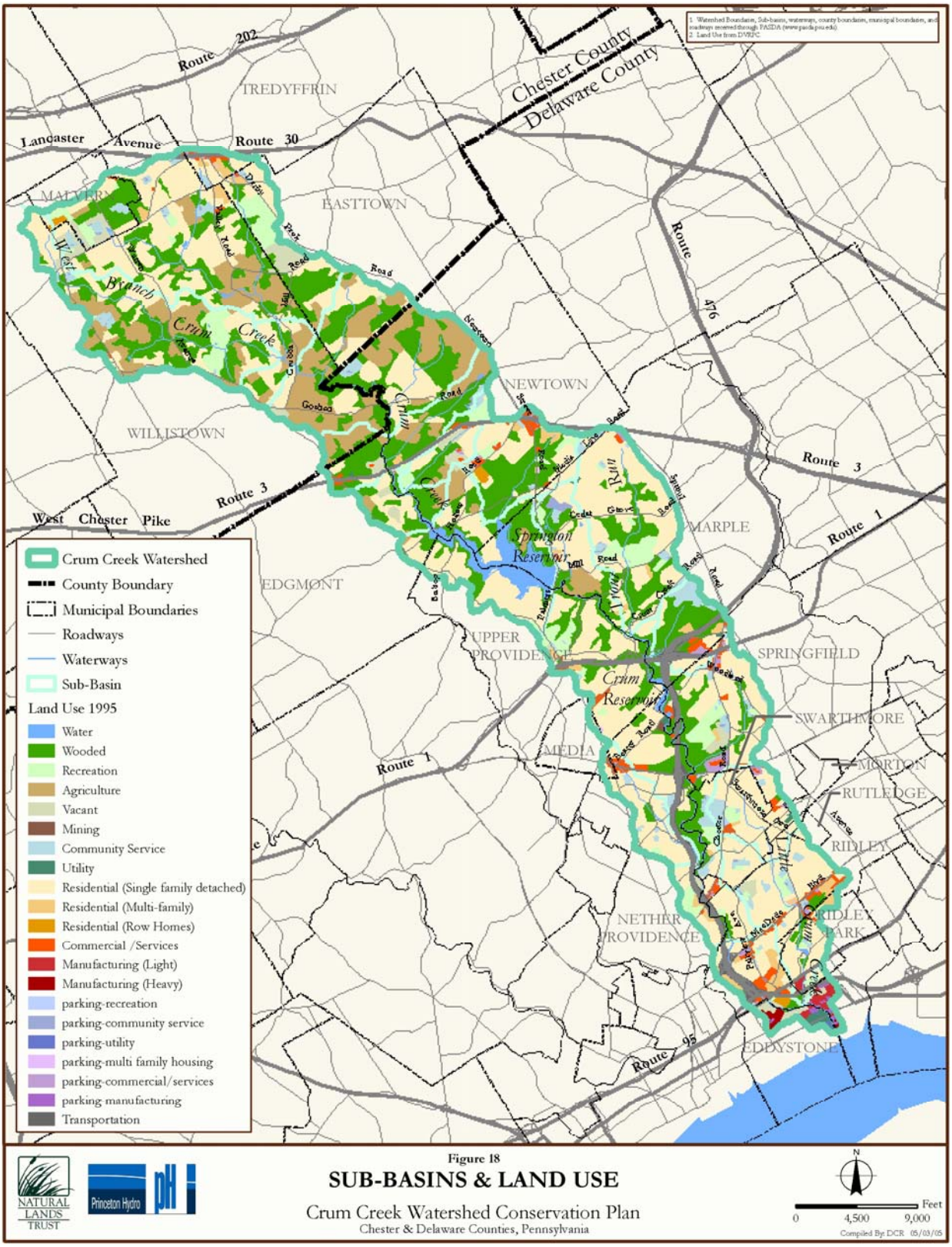


Figure 18

SUB-BASINS & LAND USE

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

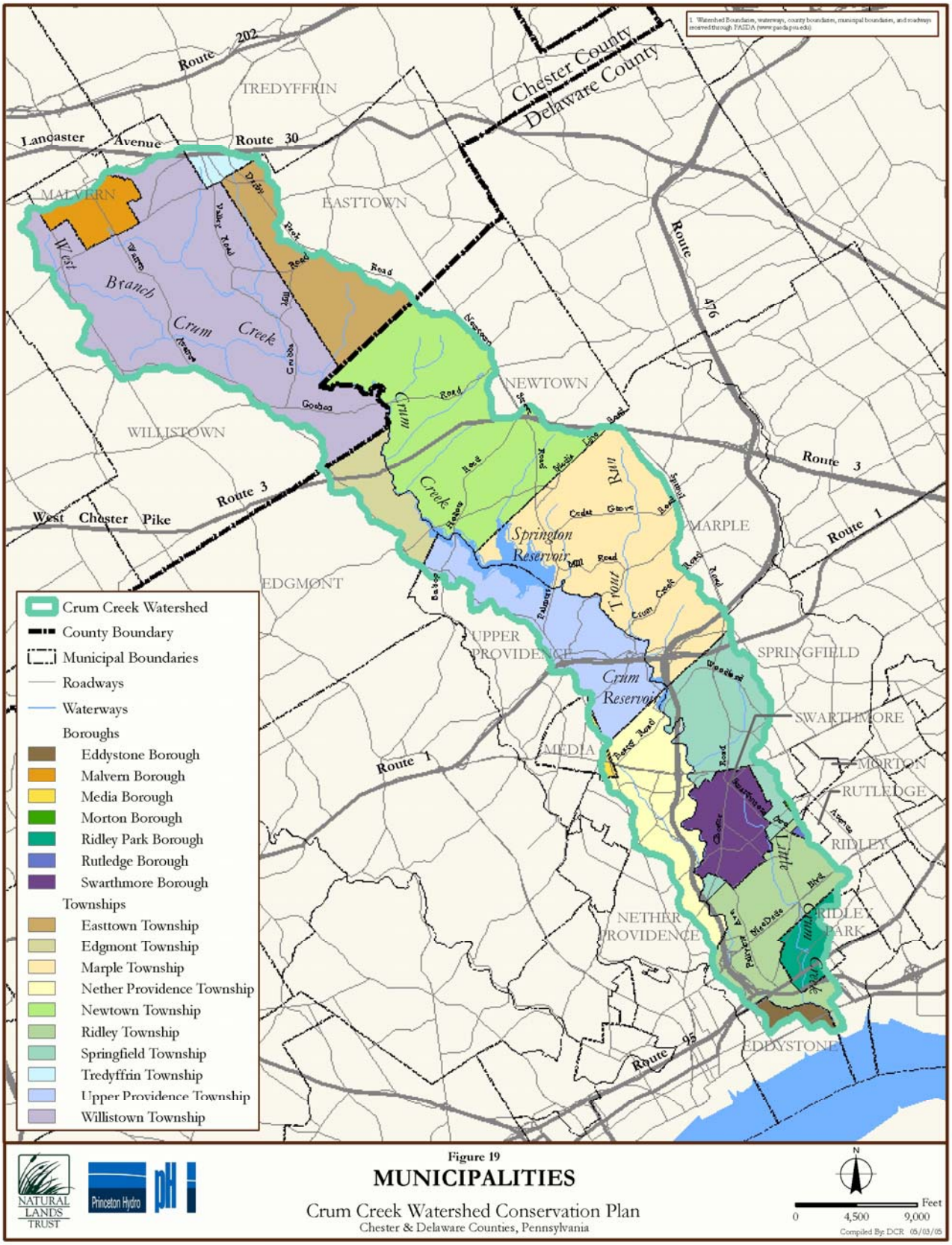


Figure 19

MUNICIPALITIES

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

wildlife habitat, grading of soil, conversion of diverse plant communities to monocultures of turfgrass, use of chemical fertilizers and biocides, and excessive consumption of ground and/or surface water.

Audubon International (not affiliated with the National Audubon Society) is a widely-recognized Cooperative Sanctuary Program that certifies golf courses with comprehensive environmental management plans and practices in place. Participants must adhere to standards for wildlife habitat enhancement and Integrated Pest Management (IPM). While these practices are critically important, they do not preclude the need for local communities to seriously evaluate the impacts of each new and existing golf course in terms of its location, design, management and water consumption. In addition, achieving permanent protection status for the hundreds of acres of land devoted to golf is an important goal for the Crum Creek Valley. Conservation easements have been used to protect a number of golf courses in southeastern Pennsylvania, including nearby Applebrook, and in some cases have been required by municipalities as part of the land development approval process.

Golf Course	Location	Subwatershed/Stream
Waynesborough	Route 252	Main Stem/unnamed tributary
White Manor	Providence Road	West Branch
Old Masters	Route 3	Main Stem/Preston Run
Paxon Hollow	Paxon Hollow Road	Trout Run
Springfield	Paper Mill Road	Main Stem
Springhaven	Route 252 and Route 320	Main Stem

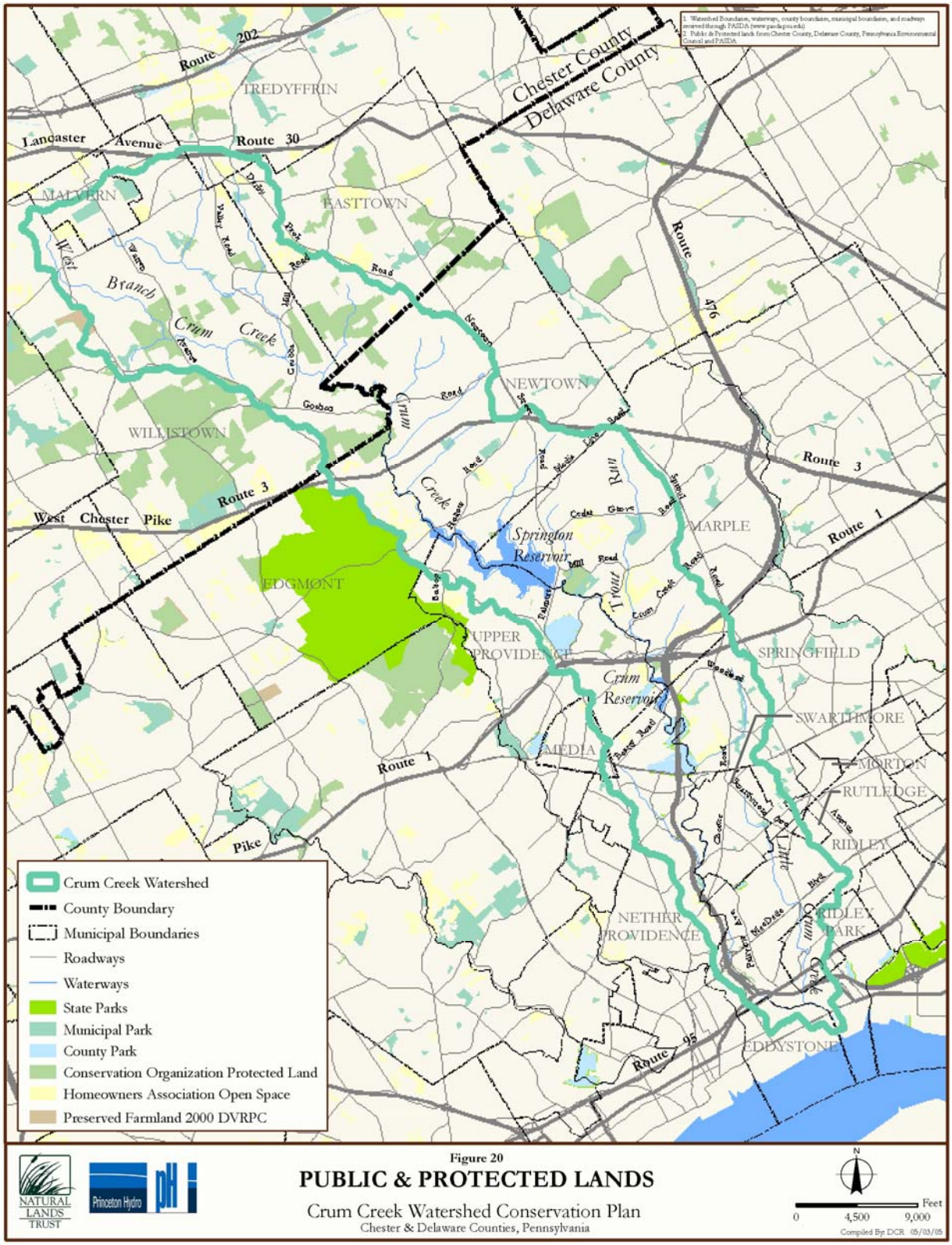
Table 12 -- Golf Courses of the Crum Creek watershed

Protected Open Space

The Crum Creek watershed supports a limited but growing network of protected open space, a slow trend given the relatively fragmented parcel sizes and the presence of the largest block of protected public access land in Delaware County just outside the watershed to the west at Ridley Creek State Park and the Tyler Arboretum. The amount of land protected by land trusts in the watershed is steadily growing, however these areas tend to be smaller (parcels of less than 100 acres) and more scattered. **(Figure 20 Public and Protected Lands)**

Planning Implications and Recommendations

What will the land use pattern of the Crum Creek valley be like 20 years from now? Will the underlying aquifers produce water as clean and plentiful as it is now? Will streams and wetlands in the watershed teem with life and maintain a constant flow of high quality water? Many municipalities that make up the Crum Creek watershed will continue to experience infill development pressure on increasingly constrained and environmentally-sensitive lands. Current and future residents of the watershed will require increasing densities of residences, businesses, industries, public services, and



NATURAL LANDS TRUST

Princeton Hydro

Figure 20

PUBLIC & PROTECTED LANDS

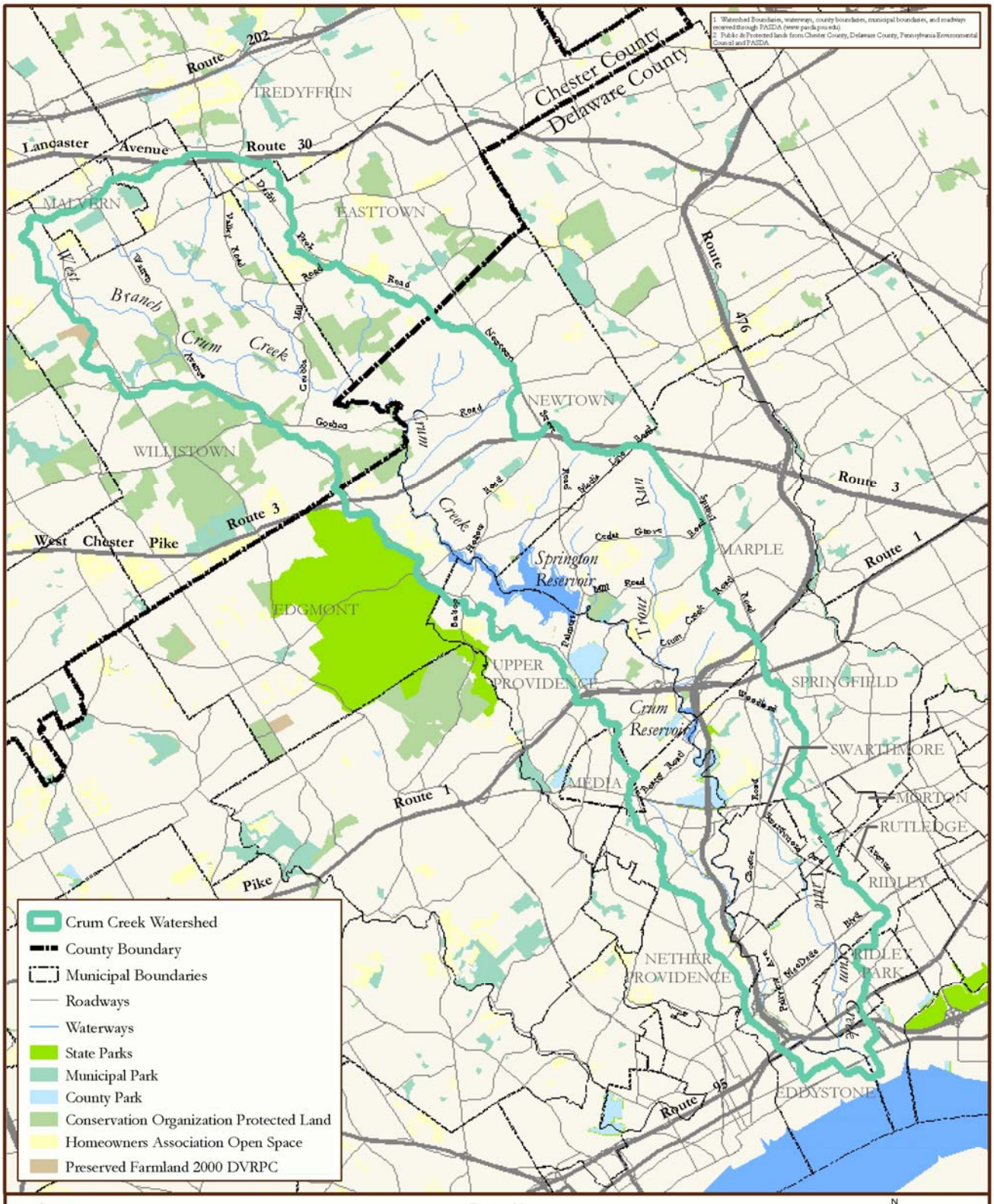
Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

roads, and will increase demands for water supply, wastewater treatment, and stormwater management. The pattern and intensity of this land use will determine the future health and sustainability of the Crum Creek watershed. If that pattern is sprawling and converts critical remaining open space areas into conventional suburban landscapes of lawns and paved area, then the streams, wetlands and aquifers of the Crum can be expected to become drier and more degraded (just as they have begun to be in the more "built-out" communities in the watershed).

For these reasons, municipalities along Crum Creek should carefully craft land use regulations – including Comprehensive Plans, Zoning Ordinances, and Subdivision and Land Development Ordinances – with the goal of generating a pattern of development that calls for sustainable development practices and stormwater management, avoids infill development on constrained lands, and promotes restoration of urban and suburban stream corridors to the healthiest state possible. All of these steps are necessary and vital to sustaining the quality and quantity of ground and surface water in the Crum Creek watershed.

In addition to paying taxes and voting, municipal residents are empowered by the Pennsylvania Municipalities Planning Code and by municipal ordinances to participate in the land development plan review process. Residents concerned with a proposed development project may attend Board of Supervisors meetings and Planning Commission meetings, and may question elected officials and applicants and, in some cases, offer expert testimony regarding specific issues or legally challenge decisions. Key points for this participation are included as **Appendix L** of this report.



NATURAL LANDS TRUST

Princeton Hydro

Figure 20

PUBLIC & PROTECTED LANDS

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

X. Recreation

The Crum Creek watershed supports a variety of recreation sites and facilities, and those for which GIS map information is available are shown in **Figure 20 – Public and Protected Lands**. Much of the information presented here was made available through the Delaware County Planning Department as part of its Parks, Recreation and Open Space Plan (draft), supplemented by responses to municipal surveys. At least 606 acres of land in the watershed are maintained as public parks. This figure is far below the 2,606 acres of Ridley Creek State Park situated just to the west of the Crum Creek watershed. The State Park helps to fulfill a growing regional demand for large-scale recreation areas with wooded trails, open meadows and picnic areas, however, sections of the watershed may be underserved in terms of publicly accessible open space and stream access.

A number of recreation areas are situated along streams in the watershed, and feature views and access to the stream as an amenity. These areas vary from active recreation facilities such as ball fields, playgrounds, tennis and basketball courts, swimming pools, golf courses, tot-lots, and paved-trails for biking and rollerblading, to passive recreation areas such as trails, nature preserves, fishing areas, and picnic areas. While a number of public recreation areas are situated along streams, the amount and location of public access points to streams in the watershed is relatively limited.

The Upper watershed supports a total of approximately 152 acres of park land spread out among only 16 properties. These figures account for the relatively large sizes of individual parks afforded by a less dense land development pattern, with several municipal parks in the 40 to 60 acre range. The Middle watershed has the greatest acreage devoted to public parks, with over 377 acres on 21 sites. Larger county parks such as Smedley Park and Rose Tree Park account for these sizes, and this area also has the most interconnected trail network in the watershed, the Leiper-Smedley Trail, connecting to the Springfield Trail for a loop over 6.5 miles in length. Parks in the Upper and Middle watersheds tend to be multiple use parks, with combinations of passive recreation such as trails and picnic areas, and active recreation in the form of ball fields, tennis courts and basketball courts.The Lower watershed, with the greatest concentration of people, has the lowest acreage devoted to park land, with approximately 77 acres spread out among 23 facilities. The majority of these are small neighborhood parks under 5 acres in size and are generally devoted to active recreation only.

In addition to parks, the largest land area devoted to one type of recreation is for golf courses, with 6 courses totaling over 700 acres in the Upper, Middle and Lower watershed areas. These are summarized in the Land Use Patterns and Trends, and are

generally private facilities for which a fee must be paid, even those such as Springfield Country Club and Paxon Hollow Golf Club, both of which are municipally-owned.

The largest parklands within the watershed are those associated with two parks owned by Delaware County: Smedley Park, totaling over 116 acres; and Rose Tree Park, with 69.5 acres. Of the two, Smedley Park is more natural, with a network of trails through extensive woodlands and stream frontage along Crum Creek, and also ballfields. A new Environmental Center in the park provides facilities for Delaware County Cooperative Extension programs such as 4-H, Master Gardeners, and Horticultural Agents. Rose Tree Park features larger open fields with picnic areas, a music pavilion, woodlands, nature trails, and community gardens. It's historic structures house offices of agencies such as the Delaware County Conservation District. These County parks generally serve the public from a broader area beyond the watershed. Other County parks in the watershed include Martin Park near the Crum Reservoir, and Willow Park below I-476 in Ridley Township.

The next level of recreation areas are municipal parks, which are generally situated and designed to handle the recreational needs of residents within the community. The largest of these is the 40-acre Randolph Woods and 40 acre Paoli Batttlefield sites in Malvern Borough. The greatest concentrations of municipal parks are within the more urbanized Middle and Lower watershed communities, where neighborhood parks abound and back yards tend to be smaller than less-densely developed parts of the Middle and Upper watersheds. These are generally devoted to active recreational uses, and most do not include stream frontage.

Trails and Greenways

The Crum Creek watershed features several important trail networks with potential for interconnection as a broader, watershed wide system. The Leiper-Smedley Trail is over 2 miles in length and includes extensive frontage along Crum Creek, providing one of the only significant public stream access areas in the watershed. This trail links to the Springfield Trail, which loops for 4.5 miles through a series of parks and open spaces in Springfield Township. These interconnected trails form a core area in the central part of the watershed, with over 6.5 miles of outdoor recreation and open spaces for people to enjoy. Trails within Rose Tree Park and numerous smaller parks provide potential for future linkages. A network of equestrian trails in the Willistown area is maintained by a private association, the Willistown Area Trails Association, for use by local residents. Crum Woods on the Swarthmore College campus hosts a trail network used by local residents and students.

The overall pattern of the size, type, number and location of parks points to a deficit of larger, passive-recreation areas in the Lower watershed, and an overall pattern of parks situated as "islands" surrounded by development or private lands, rather than interconnected by trails and greenways. The natural of the topography along the Crum

Creek provides opportunities for greenways protecting natural corridors of woodlands, streams, and wetlands, some of which could also support trail corridors. The ownership pattern, often broken by numerous smaller lots and residences, makes public trail access difficult in some locations, while other areas could support trails without infringing upon residences. These areas should be looked at carefully as part of an overall greenways and trails assessment.

Table 13 - Crum Creek Watershed Park Inventory

Park Name	Municipality	Location	Acres	Ownership	Facilities	Watershed Location
Paoli Battlefield	Malvern	Warren and Monument Aves. And Sugartown Rd.	40	Borough	Lawns, ballfields	Upper
Samuel M. Burke Park	Malvern	off of 1st Ave.	1.4	Borough	Gazebo, landscaped area	Upper
Horace J. Quann Memorial Park	Malvern	1st and Warren Aves.	1.6	Borough	Baseball, basketball, open space	Upper
Randolph Woods	Malvern	Ruthland Ave. along headwaters tributary of Crum Creek	40	Borough	Woodland, stream	Upper
Greentree Park	Willistown	Woodland Ave., headwaters of Crum Creek	8	School District, leased to Township	Playset, pavilion, picnic, fields	Upper
Mill Road Park	Willistown	off of Grubb Rd., headwaters of Crum Creek	18.8	Township	Playset, ballfields, pavilion	Upper
Kirkwood Preserve	Willistown	Grubbs Mill Rd., along W. Branch	60	Land Trust -agreement with Township	Grassland, floodplain, riparian woods, wetlands	Upper
Spring Road Preserve	Willistown	Spring Rd. along W. Branch	18	Township	Woodland, stream, meadow	Upper
Aspen Lane	Newtown	Route 252 & Aspen Lane	1.5	Township	Wooded area	Upper

Park Name	Municipality	Location	Acres	Ownership	Facilities	Watershed Location
Bartram Covered Bridge	Newtown	Boot Rd. & Goshen Rd. on Crum Creek	0.33	Township	Covered bridge, stream	Upper
DeBotton Tract	Newtown	Boot Rd. near Crum Creek	2.95	Township	Meadow, woodland,	Upper
Larchmont Park	Marple	Cedar Grove Rd. near Trout Run	13	Township	Wooded area, baseball/softball diamond, tot lot, picnic area	Middle
Newtown/Edgmont Little League Fields	Newtown	Bishop Hollow Rd. & Campus Blvd.	9.45	Township	Baseball, community center, concession stand	Middle
Drexel Lodge Park	Newtown	4140 West Chester Pike & Campus Blvd. along Preston Run	20	Township	Stream/pond	Middle
Gable Park/Township Offices	Newtown	Bishop Hollow Rd. & Ellis Ave. E. of New Township Park, trib of Hunter Run	8.2	Township	Wooded area, stream, basketball court, baseball, tot lot	Middle
Troop Farm Petticoat Fields	Newtown	Bishop Hollow Rd. & Stone Dr. near trib of Hunter Run	4.16	Township	Ballfields	Middle
Greer Park	Newtown	Winding Way on Foxes Run	6.5	Township	Stream, pond, playground, picnic tables	Middle
Hatch's Lane	Newtown	West Chester Pike & Hatchers Lane near Crum Creek	15.45	Township	Wooded area, stream, wildflower meadow	Middle
New Township Field	Newtown	Bishop Hollow Rd. S. of Township Building	8.28	Township	Lawn- rough graded for ball field, Township mulch area	Middle

Park Name	Municipality	Location	Acres	Ownership	Facilities	Watershed Location
Rose Tree Park	Upper Providence	Rt. 252 and Rose Tree Lane, along tributaries of Crum Creek	69.52	County	picnic tables, amphitheater, community gardens	Middle
Martin Park	Upper Providence	Farnum Rd. & Crum Creek Rd., just W. of Crum Reservoir	19.93	County	Wooded area	Middle
Smedley Park, Penza Tract	Nether Providence	Pine Ridge Rd. and Baltimore Pike along Crum Creek	29.30	County	Open space, woodland	Middle
Conservation Area (Springfield)	Springfield	Along Crum Creek at Int. 476 near Rt. 320	4.5	County	Natural area	Middle
Smedley Park (main parcels)	Springfield	Paper Mill Road off of Baltimore Pike	50.34	County	Ballfields, tot lot, trails, picnic pavilions, woods, stream	Middle
Smedley Park, Lawton Tract	Springfield	South side of Beatty Road at Interstate 476	7.78	County	Wooded area	Middle
Jane Lownes Park	Springfield	Kennerly Road, adjoins Smedley Park and Springfield Trail	23.37	Township	Wooded area, stream, basketball court, baseball, hiking trail, tot lot, playground, picnic tables	Middle
Greenbriar Park	Springfield	Woodland Avenue	3	Township	Wooded area, stream, basketball court, hiking trail, picnic tables	Middle
Woodland Park	Springfield	Woodland Avenue along trib of Crum	26	Township	Wooded area, hiking trail	Middle

Park Name	Municipality	Location	Acres	Ownership	Facilities	Watershed Location
Thomson Park	Springfield	Thomson Avenue along trib of Crum	15.36	Township	Hiking trails	Middle
Spring Valley Park	Springfield	Leamy Ave.	5.4	Township	Wooded area, hiking trail	Middle
Kerr Park	Springfield	Woodland Ave.	2.1	Township	Wooded area, hiking trail	Middle
Meadowgreen Park	Springfield	State Rd.	3.78	Township	Basketball and tennis courts, baseball, tot lot, picnic tables	Middle
Smedley Park, Swarthmore College Land	Springfield	N. section of Smedley Park between main section and Lawton tract	29.10	Private/ leased to County	Wooded area	Middle
Maple Street Park	Springfield	Maple St.	0.49	Borough	Basketball court, tot lot, picnic tables	Lower
Lehigh Circle Park	Springfield	Lehigh Circle	1.7	Borough	Older children's playground	Lower
Church Road Park	Springfield	Church Rd.	14	Borough	Baseball/softball diamond, football and soccer fields, tot lot, picnic area	Lower
Gateway Park (temporary name)	Swarthmore	SW Corner of Cedar Lane and Baltimore Pike	0.5	Borough	Gateway park, lawn, garden, sign	Lower
Thatcher Park	Swarthmore	Cornell & Rutgers Aves.	0.5	Borough	Tot lot, historic	Lower

Park Name	Municipality	Location	Acres	Ownership	Facilities	Watershed Location
Centennial Park	Swarthmore	Dartmouth & Park Aves.	0.048	Borough	Sitting area, trees	Lower
Umoja Park	Swarthmore	Kenyon & Rutgers Aves.	1.5	Borough	Sitting area, historic	Lower
Little Crum Creek Park	Swarthmore	Swarthmore & Yale Aves.	4.74	Borough	Wooded area, stream, wetland area, picnic tables	Lower
Keystone Park	Swarthmore	North Chester Rd. & Riverview Ave.	0.5	Borough	Sitting area, historic	Lower
Rodney Island Park	Ridley Township	Rodney Road	1	Township	Wooded area	Lower
Black Rock Park	Ridley Township	Michigan Avenue	12	Township	Wooded area, stream, basketball court, ballfields, tot lot, picnic tables,	Lower
6th Avenue Park	Ridley Township	6th Avenue	0.4	Township	Wooded area, stream, tot lot	Lower
Clark Avenue Park	Ridley Township	6th & Edgewood	0.6	Township	Wooded area	Lower
Smiley Street Park	Ridley Township	Smiley Street	0.7	Township	Wooded area, basketball court, tot lot	Lower
West Road Park	Ridley Township	West Road & Gilbert Street	1.7	Township	Wooded area, baseball, volleyball court, tot lot	Lower

Park Name	Municipality	Location	Acres	Ownership	Facilities	Watershed Location
Bissinger Park	Ridley Township	MacDade Boulevard & Arlington Avenue	4.2	Township	Wooded area, baseball	Lower
Derwood Park and Gillespie Field	Ridley Township	Bullens Lane & Ridley Creek	6.8	Township	Wooded area, stream, baseball	Lower
Kinder Park	Ridley Township	MacDade Boulevard Delco Housing	14.9	Township	Ballfields	Lower
Nassan Field	Ridley Township	Swarthmore Avenue	1.5	Borough	Wooded area, stream, baseball, tot lot	Lower
Rutledge Triangle	Rutledge	Rutledge Avenue & Waverly Terrace	1.5	Borough	Basketball court, baseball, tot lot, picnic tables	Lower
Willow Park	Ridley Township	Under and around I-476, mostly to the N.	4.3	County	Wooded area	Lower
Ridley Township Park	Ridley Township	Woodland & Milmont Aves.	2	Township	Ballfields	Lower
Maplewood Park (Franklin Field)	Ridley Township	Whitney Road	1.3	Township	Wooded area, baseball, tot lot	Lower
Balignac Park	Ridley Township	Balignac Avenue	0.5	Township	Wooded area, tot lot	Lower
East Lake Park	Ridley Park	Constitution Ave.	12	Borough	Wooded area, lake, tennis court, tot lot,	Lower

XI. Landscape Ecology

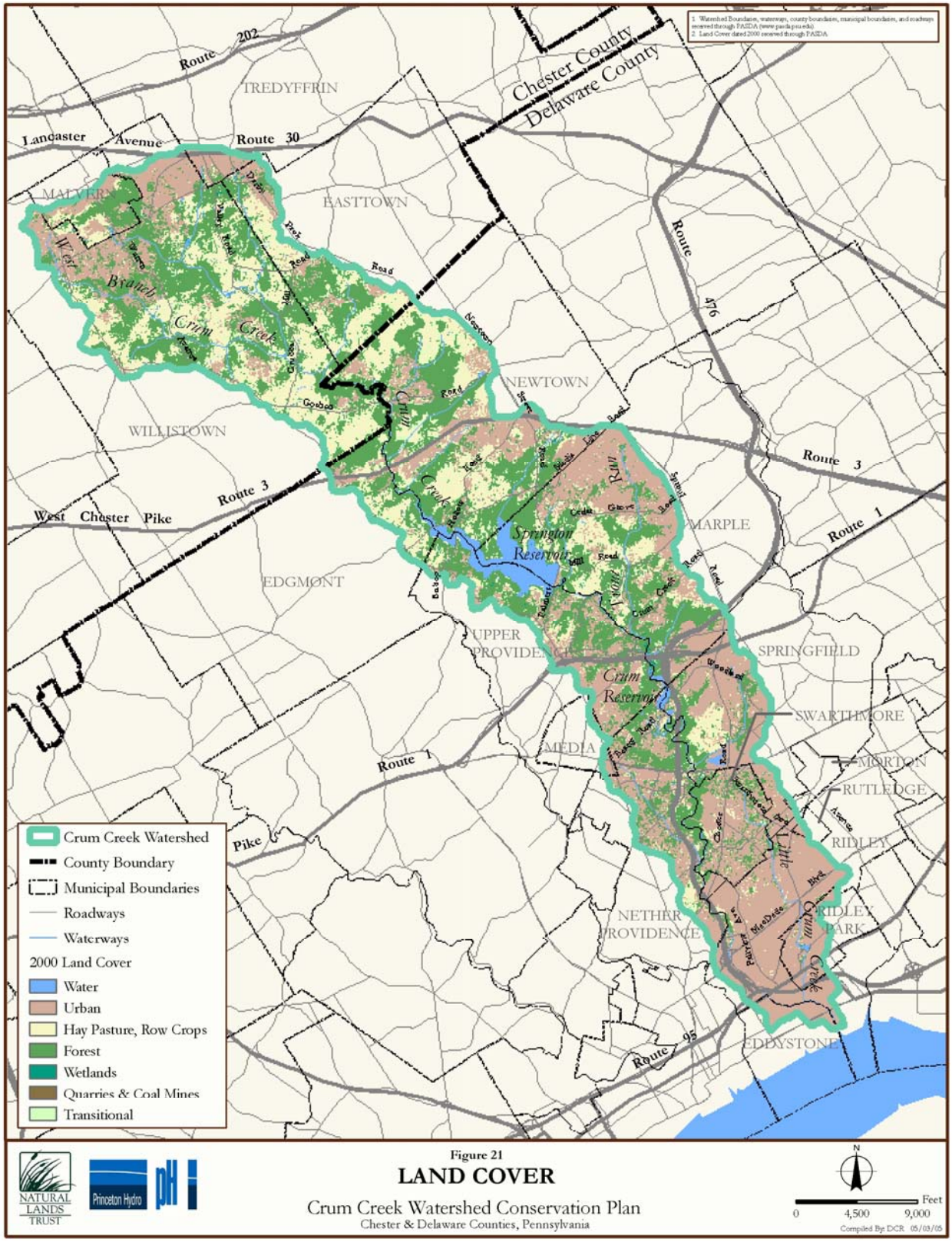
The Crum Creek program area includes ecologically-significant networks of habitat interspersed through the broader areas of farmland and residential development. These networks of both remnant and regenerating woodlands, wetlands, streams, ponds and successional areas (i.e. meadows, old fields and thickets) are the main habitats for the diversity of native vegetation and wildlife (e.g. biodiversity) that constitute the natural diversity (or biodiversity) of the area. As of the year 2004, approximately one-third of the watershed can be considered as supporting habitat networks. **(Figure 21 – Land Cover).** The following characteristics are important for maintaining local biodiversity:

1) relatively large habitats representing the full diversity of habitat types that are typical of the region, particularly large, contiguous woodlands;
2) habitats that are linked by undeveloped corridors such as streams, hedgerows, utility lines, and other open space linkages;
3) higher quality habitats that retain their ecological integrity and are not seriously degraded by disturbances such as exotic invasive vegetation, intensive logging, erosion, sedimentation, soil compaction, grazing, dumping, etc.
4) habitats that protect or feature plant or animal species or unique habitats listed in the Pennsylvania Natural Diversity Inventory or the Natural Areas Inventories for Delaware and Chester Counties.
5) habitats with existing open space buffers and potential for expansion through active restoration or natural succession.

These desirable features should be protected and enhanced.

This Plan evaluates the condition and interconnections between habitat networks in the Crum Creek landscape, and identifies those networks which best meet these characteristics as "Habitat Conservation Networks" which are of the highest priority for conservation, as depicted in the Smart Conservation map (**Figure 15**). Areas of open space such as active or abandoned farmland or large areas of pasture that are contiguous with these Habitat Conservation Networks can be considered as having Habitat Restoration Potential or Habitat Management Potential as meadows, reforestation areas, or wetland restoration sites. Finally, the Landscape Conservation Priorities section further evaluates these Habitat Conservation Networks and areas of Habitat Restoration or Management Potential in terms of their pattern of ownership and prioritizes specific parcels for conservation and restoration.

Individual Conservation Areas were identified, analyzed and prioritized as either Priority 1, 2, or 3 on the **Figure 22a, 22b, 22c Conservation Priorities maps** according to the following criteria:


1. Watershed Boundaries, waterways, county boundaries, municipal boundaries, and roadways sourced through PASDA (www.pasda.psu.edu)
2. Land Cover dated 2000 sourced through PASDA
Route 202
TREDYFFRIN
Chester County
Delaware County
Lancaster Avenue
Route 30
MALVERN
EASTTOWN
West Branch Crum Creek
NEWTOWN
Route 476
WILLISTOWN
Route 3
West Chester Pike
Springton Reservoir
MARPLE
Route 1
EDGMONT
UPPER PROVIDENCE
SPRINGFIELD
Crum Reservoir
SWARTHMORE
MORTON
MEDIA
RUTLEDGE
RIDLEY
NETHER PROVIDENCE
RIDLEY PARK
Route 95
EDDYSTONE
Crum Creek
Crum Creek Watershed
County Boundary
Municipal Boundaries
Roadways
Waterways
2000 Land Cover
Water
Urban
Hay Pasture, Row Crops
Forest
Wetlands
Quarries & Coal Mines
Transitional
NATURAL LANDS TRUST
Princeton Hydro
Figure 21
LAND COVER
Crum Creek Watershed Conservation Plan
Chester & Delaware Counties, Pennsylvania
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Compiled By DCR 05/03/05

Habitat Size:

The areas of contiguous habitat blocks were identified and ranked in descending order of size. Habitat blocks are areas not fragmented by major roads, utility lines, clearings, or wetland excavation or filling. Features that did not result in breaks in forest canopy (such as narrow roads, driveways or small structures) were not counted as having significant fragmentation effects. These blocks range in size from small (10 acres) to large (100+ acres), with the greatest concentration of blocks, (including contiguous woodlands and wetland/stream networks), falling in the 10 to 30 acre range.

Habitat Shape:

These habitat blocks were assessed and ranked in terms of their shape, as calculated by comparing the perimeter of each block to the area within each block. The most rounded or square shaped blocks have a relatively close ratio of edge-to-area, while the more irregular or elongated blocks have greater amounts of edge relative to area. This is an ecologically important criterion for supporting a diversity of forest-nesting birds and forest plants, since forest edge conditions generally support less-sensitive plant and wildlife species. Irregular or narrow wetlands and stream corridors are also more vulnerable to a variety of impacts from adjacent land uses, including pollutants, excessive runoff, erosion, and sedimentation, invasive species, alterations of water table, filling, and excavation. Perhaps the most unique quality of the Crum Creek landscape is its ability to provide nearly contiguous networks of habitat blocks along greenway corridors, providing relatively healthy riparian and wetland areas with great conservation and restoration potential. The urgency for addressing this potential is borne out by the fact that these networks are still intact at a time when the impacts of sprawling development is beginning to urbanize much of the watershed.

Forest-Interior Habitat Area:

To further refine the assessment of size and shape, the amount of forest-interior habitat area was estimated for each forested habitat block. Forest-edge conditions (warmer, drier soils, predatory wildlife, invasive exotic plants) were assumed to extend roughly 300 feet into the interior, based on numerous landscape ecology studies for the Piedmont region[1]. Woodlands beyond that distance can be considered as potential forest-interior habitat with a greater critical mass for supporting less-common flora and fauna. Given the fragmented nature of the area, most forests in the Crum are too small to reach this habitat category.

Habitat Connectivity:

The final criterion used to identify Habitat Conservation Networks is habitat connectivity – in this case the length of stream frontage in each woodland or connecting each Conservation Area. Natural areas that are interconnected by natural corridors have

[1] Forman and Godron, 1986.

greater potential to support a diversity of native plants and animals than those natural areas that are isolated and surrounded by more intensively managed land uses. Isolated populations are more vulnerable to extirpation due to disease, predation, disturbance, or inbreeding than those that are part of a habitat network. Once extirpated, the potential for a species to recolonize an isolated natural area is much lower.

The northern portion of the Crum Creek valley does include significant natural corridors, particularly riparian forests, wetlands and stream channels that allow plants, animals and people to move through the landscape. Therefore, the habitat connectivity assessment took into account the amount of stream frontage found in each larger habitat blocks and also the type and length of corridor linking smaller habitat blocks. This analysis assumes that streams are the major natural corridors for connecting large woodlands in the Crum landscape, and that greater amount of frontage along a stream means a healthier, more diverse stream and forest habitat with greater overall connectivity to other habitats in the landscape.

Conservation Areas Analysis:

The final GIS analysis combines these criteria for ranking the most ecologically valuable Conservation Areas within Habitat Conservation Networks. Equal weight is assigned to each criterion. *The Conservation Priorities maps reveal that the Priority 1 (most important) networks in the Crum Creek study area are the largest, most well-rounded or square blocks for woodland with the greatest area of forest-interior habitat and the most extensive amounts of stream frontage. Woodlands with these qualities are not only the most ecologically valuable habitats in the Crum Creek project area – given their context they are also among the most ecologically important habitats in southeastern Pennsylvania.*

Two additional criteria that have been factored-in are: the presence of PNDI-listed species or Natural Areas Inventory (NAI) priority sites; and the number of owners (fewer owners is more valuable for conservation potential).

XII. Summary of Land Conservation Priorities

The urgency of land protection in the Crum Creek watershed is emphasized by a recent building boom taking place particularly in the Upper and Middle Watershed communities. A number of large projects involving hundreds of units of residential housing, and large amounts of commercial square footage are under construction or have been proposed in these areas. It is essential that the remaining open space parcels in these communities be assessed for protection before they are built-out.

The Conservation Priorities are listed below as key open space parcels organized by municipality and watershed, with description of important features and potential conservation status where possible. These parcels are not listed in order of priority. Consideration has been given to rankings provided by municipalities, Willistown Conservation Trust, and Natural Lands Trust. These entities are the most likely, in addition to the state and county governments, to secure protection of land by working with landowners to establish nature preserves, parks, or conservation easements. The prioritization process in the *Crum Creek Landscape Conservation Plan* prepared by Natural Lands Trust in 2004 provides the basis for this summary. Certain properties are listed as a series of contiguous parcels under single ownership. Others are listed as proposed for subdivision, with potential protection of key resources. Lands that are already protected are listed and mapped as such based on current information. *Given the conservation importance of the Crum Creek, all parcels over 10 acres in size may be considered as priorities providing significant conservation benefit.*

Open Space Parcel Analysis

Conservation Priorities are mapped for the **Upper Watershed on Figure 22a**, the **Middle Watershed on Figure 22b**, and the **Lower Watershed on Figure 22c**. The purpose of the Open Space Parcel Analysis is to:

1) *Identify* a network of remaining open space parcels (> 10 acres) in the Crum Creek watershed;
2) *Prioritize* these parcels based on their importance for protection and restoration of water resources and biological diversity and, where possible, the level of development threat.
3) *Identify* linkages between these open space parcels that could become the basis for a greenway.

This has been accomplished through the following steps:

1) *Open Space Parcel Database* Create a database and map of specific open space parcels and associated owners
    - Coordinate tax parcel data and maps between GIS and on-line sources
    - Prepare Excel spreadsheet showing tax parcel number, acreage, owner name and address, protected status, and key resources.

2) *Open Space Analysis* Review, analyze and prepare a written summary descriptions of how these open space parcels are characterized by immediate and surrounding:
    - land use
    - land cover
    - natural areas (woodlands, wetlands, meadows)
    - stream frontage
    - protected lands

3) *Open Space Prioritization* Using ownership data and Classify parcel data according to High, Medium and Low Priority parcels for conservation. Highest priority parcels provide the greatest benefits to water resources and/or biological diversity, and would tend to be relatively large (50+ acres) properties with extensive woodlands, stream frontage and wetlands, and linking directly to protected lands. Lowest priority parcels provide the fewest benefits, and might include smaller, more isolated agricultural properties lacking significant stream frontage and surrounded by development.

A code system has been developed to aid in identifying priority parcels. The code for each priority parcel starts with the letter "U", "M", or "L" indicating whether it is located in the Upper, Middle, or Lower section of the watershed. The number that follows each letter indicates their priority rank (1, 2, or 3), with Priority 1 parcels being of greatest importance for protection. The number is followed by a letter indicating the sequence of each parcel in each priority category (generally from north to south) in that portion of the watershed. So, a parcel designated as "M2B", for example, is in the Middle watershed, ranks in importance as Priority 2, and is the second ("B") of the Priority 2 parcels when you scan the map from north to south.

The Plan represents Phase I of a conservation strategy for the watershed. Phase II will carry out recommended land and easement acquisitions and stewardship projects.

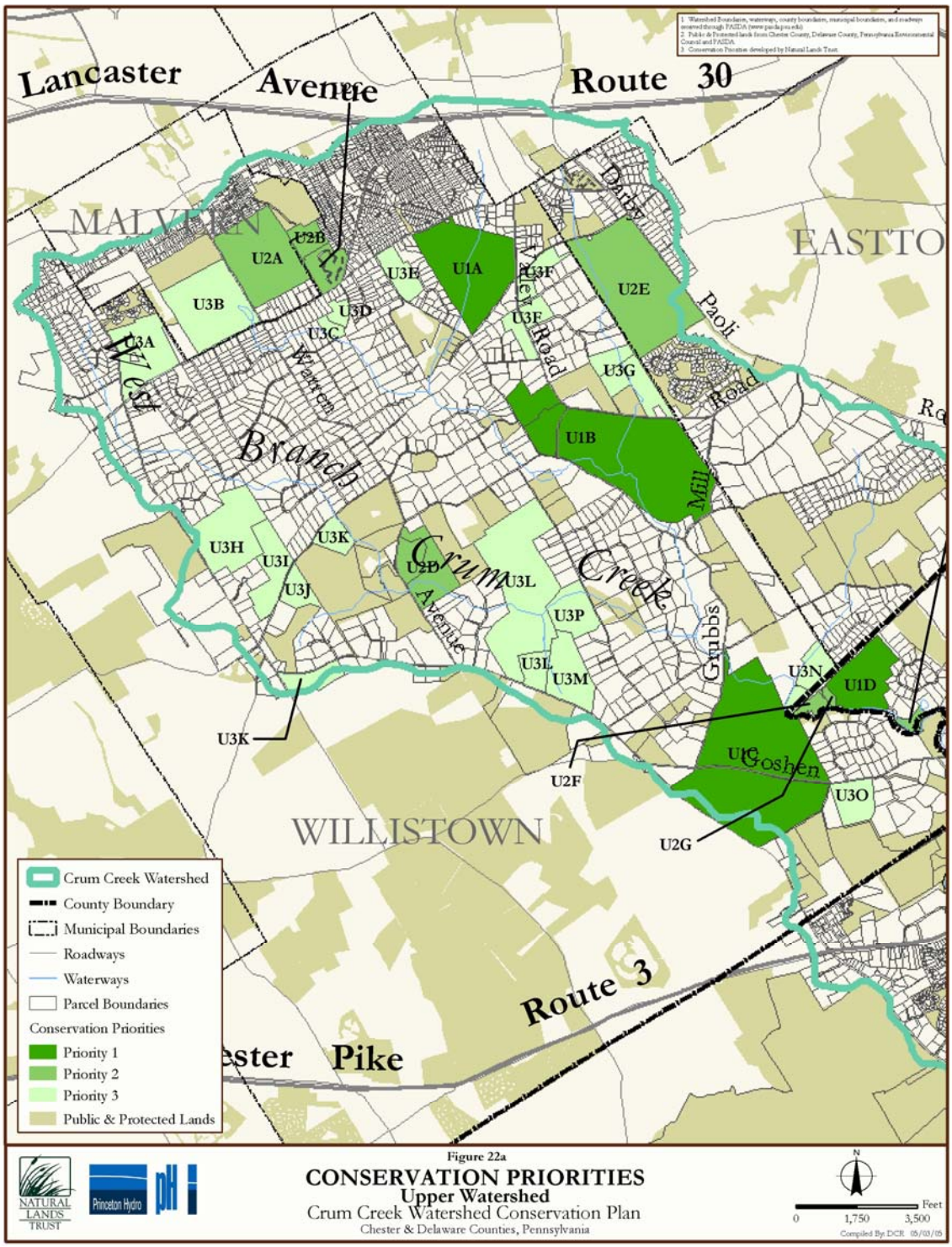

Figure 22a

CONSERVATION PRIORITIES

Upper Watershed

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

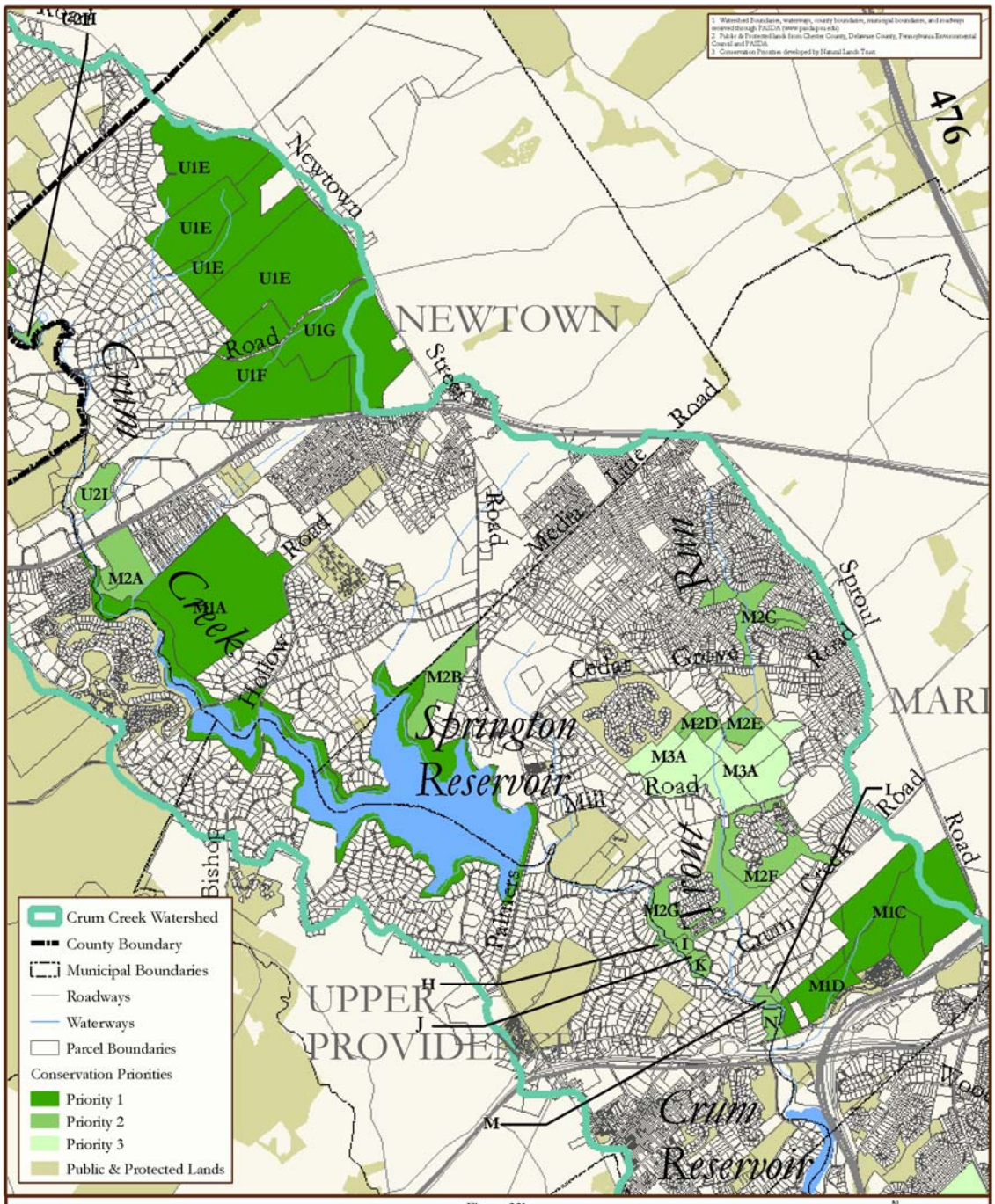

Figure 22b

CONSERVATION PRIORITIES

Middle Watershed

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

N

0 1,750 3,500 Feet

Compiled By: DCR 05/03/05

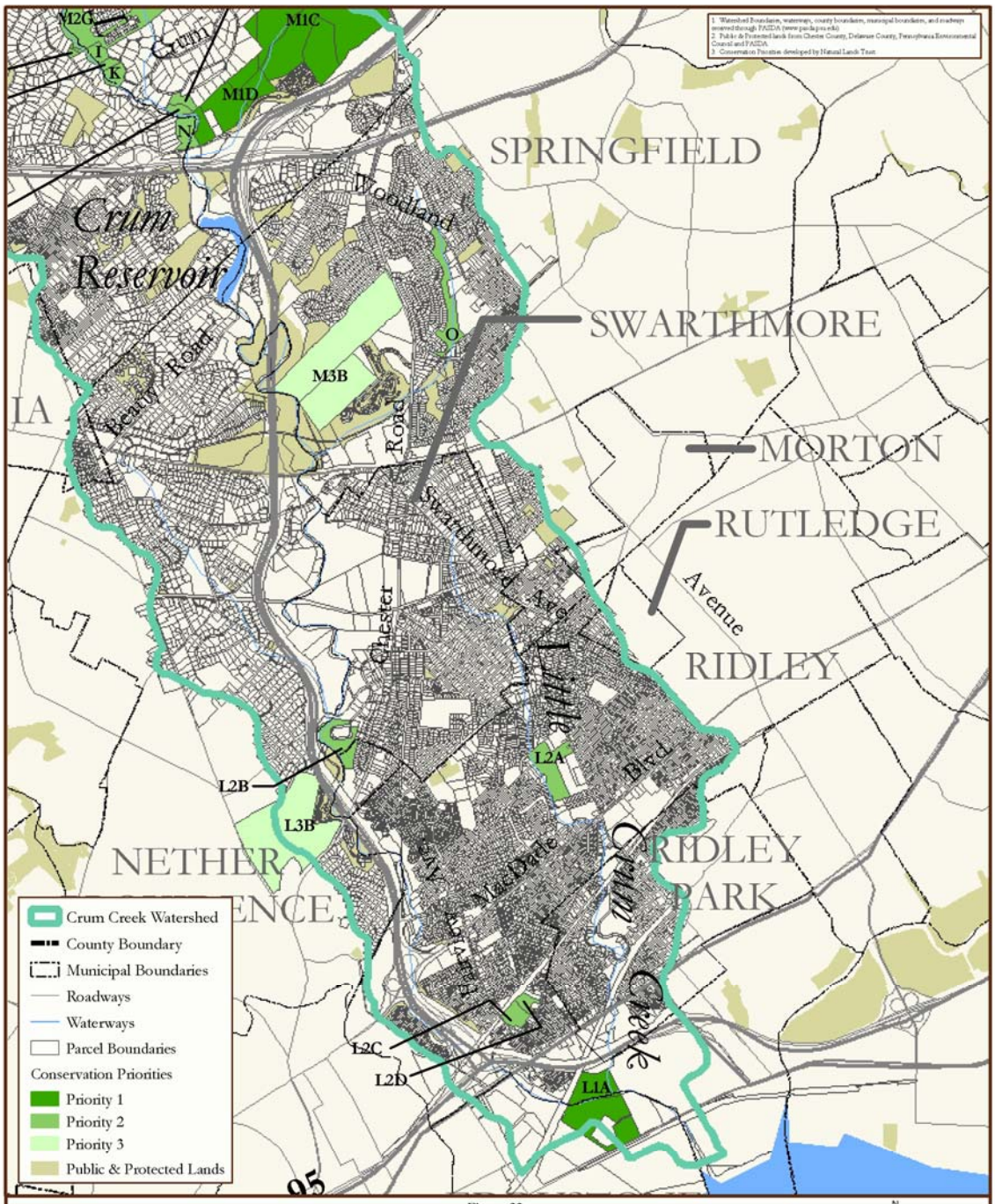

Figure 22c

CONSERVATION PRIORITIES

Lower Watershed

Crum Creek Watershed Conservation Plan

Chester & Delaware Counties, Pennsylvania

XIII. Major Issues for the Crum Creek Conservation Plan.

The following list includes local watershed concerns and issues raised at public meetings held for this Plan, at the Crum Creek Conference, and through interviews and surveys with various CCWP members and residents of the watershed. Municipal input is summarized in the tally of surveys in **Appendix C**. It also cross-references the other plans and studies recently completed for the Crum Creek watershed.

The Watershed Restoration Action Strategy (WRAS) developed by PA DEP lists "restoration needs", including: riparian buffers, streambank stabilization, and stormwater runoff controls. Crum Creek --- the lowest 7.62 miles of the main stem and 3.3 miles of 3 unnamed tributaries are impaired due to stormwater, water/flow variability and habitat modifications and excessive algae from agriculture. Little Crum Creek: the entire 3.68 miles is impaired by water/flow variability, urban runoff/storm sewers and habitat modification.

1. Land Use and Growth Management
   - A *building boom* is currently underway in much of the Upper and Middle Watershed. The cumulative impacts of these individual projects on watershed health are not being considered.
   - *Overdevelopment – sprawl* and *infill development* are continuing to impact the watershed in environmentally-sensitive areas.
   - *Redevelopment* – existing developed sites in the Crum watershed are being redeveloped, often a lost opportunity for implementing stormwater Best Management Practices, stream and wetland restoration, and historic preservation.
   - *Innovative strategies* – Most municipalities in the Crum have not adopted innovative standards or programs for conservation subdivision design, transfer of development rights (TDR), transit-oriented development, open space protection, riparian buffer or wetland restoration.
   - Some subwatersheds in the Middle and Lower Crum already exceed 20% impervious cover. This can seriously degrade streams. (CCWRA, 2002)

2. Open Space Protection and Restoration
   - *Prioritization* – open space parcels throughout the watershed need to be prioritized for land preservation and ecological restoration, particularly

where the building boom is permanently altering the land use pattern of the Middle Watershed.

- *Stewardship* – management of existing open space parcels does not always provide water quality benefits or habitat for native plants and wildlife.
- *Lawn* – new lawns are replacing former natural areas throughout the watershed, particularly along streams and in woodlands -- promote natural landscaping alternatives to lawn.
- *Accessibility of Crum Creek*— a number of municipalities identified lack of access to Crum Creek as among their top problems. In contrast to Ridley Creek, there are very few places where the main stem of Crum Creek is publicly accessible, other than Smedley Park, the Crum Woods portion of Swarthmore College, Ridley Park Lake, and the proposed Kirkwood tract in Willistown. Where it is accessible, it is a major asset.

3. Woodland Protection and Restoration
   - the health and quality of woodlands throughout the watershed are being impacted by fragmentation from development, excessive logging, overbrowsing by deer, and invasive vegetation.
   - a multi-pronged strategy is needed to avoid degradation and loss of woodlands.

4. Invasive Species (exotic and native)
   - excessive densities of white-tailed deer are degrading woodlands and gardens, and causing a safety hazard on roads.
   - large Canada goose populations are degrading water quality in ponds and reservoirs.
   - invasive plant species are outcompeting native plants and greatly reducing diversity.

5. Riparian Buffer and Wetland Protection and Restoration
   - streamside forests and wetlands are lacking in many parts of the watershed. These areas need to be protected and restored to support and enhance water quality, flood control and wildlife habitat.

6. Stormwater Management, Flooding and Erosion
   - Chester County Water Resources Authority and *Crum Creek Source Water Assessment* both note widespead lack of stormwater management in older developments – need for retrofitting of stormwater Best Management Practices where little or no runoff controls are in place. Some storm systems empty directly to streams. Stormwater problem areas are widespread (flooding, erosion, channelized and culverted streams) –prioritize areas for retrofits with Best Management Practices.

- High density of road crossings – uncontrolled runoff to streams. (CCWRA, 2002)
- Act 167 Plan and ordinance should be adopted by municipalities.
- Municipal ordinances must promote better filtration and recharge, handle small (1 year) storms
- Overcome fears of West Nile virus in wetland basins (allow ecosystem to support predators of mosquito larvae).
- Localized flooding areas in Little Crum, headwaters near Malvern, Newtown Heights, Trout Run headwaters/ Giant Shopping Center, and along Crum from State Road to Farnum Road. Flooding and streambank erosion on Crum Creek where it crosses Bullens Lane and on Little Crum Creek from Manor Circle upstream to the Ridley Township boundary.
- Severe erosion along all of Trout Run impacts stability of sanitary sewer interceptor in Marple Township.
- Erosion along Whiskey Run and Garnet Run sanitary sewer system and trail system in Springfield Township.
- Low clearance on Crum Creek Road bridge crossing in Marple Township, causes stream to back up.

7. Water Quality
   - Development impacts to drinking water
   - Better water quality data needed (ground and surface water) – expand volunteer monitoring
   - Expand Stream Clean-up participation
   - Impacts of roads and golf courses
   - Protection of 1 public water supply intake (CCWRA, 2002)
   - First Order streams (57% of all streams in the Crum Creek drainage are original headwaters tributaries and are highly vulnerable to pollution and degradation). (CCWRA, 2002)
   - Greater than 60% of the land area drains to these First Order streams (CCWRA, 2002)
   - Phosphorus loadings causing eutrophication in Springton Reservoir associated with urban runoff and streambank erosion from roads and developed areas. The lower Crum Creek, Little Crum Creek and Trout Run all suffer severely from these impacts. (CCWRA, 2002)
   - 33% of Total Stream Miles are listed as Impaired on the Pennsylvania Department of Environmental Protection (PA DEP) Section 303(d) list. (CCWRA, 2002)
   - Siltation (from erosion) and flow variability (from dams) are listed as key factors affecting impaired streams according to the Pennsylvania Integrated List of All Waters, prepared by PA DEP in 2005 and included as excerpts in Appendix F of this Plan).

- Naturally reproducing Brown Trout populations exist on healthier headwaters reaches of the Crum Creek and is tributaries.
- Radon naturally occurs in high levels in groundwater in some areas. (CCWRA, 2002)
- Impacts of golf courses on ground and surface water
- Need better data on groundwater recharge
- Need better data on water volume/well yields from different geologic types.
- Water budget – document and evaluate impact of Inter Basin Transfers – how much water is taken out of the watershed, how much is returned? Is enough water available for all future needs?
- 2 water supply reservoirs (Springton Reservoir and Crum Reservoir) and the impacts to stream baseflows caused by these impoundments (Chester County Water Resources Authority), particularly dewatering of the lower section of Crum Creek below the intake for Crum Reservoir. PA DEP permit governs release requirements from reservoirs.

8. Wastewater Treatment
   - New treatment plants are increasing – location, number and design should be carefully evaluated (promote land application alternatives to stream discharge, rethink gravity-fed locations)
   - Need to monitor and upgrade existing problems (on-lot septic and wastewater treatment plants) as sources of potential contamination to ground and surface water. Leaking sewer lines and sewer lines following and crossing streams. Combined sewer overflows in Lower watershed.
   - Failing and aging septic systems contribute bacteria and nutrients to streams and groundwater. (CCWRA, 2002)
   - Edgmont Township -- failing septic and small site violations at waste water treatment facilities along Crum Creek in Castle Rock area, high density old community along Crum Creek in northwest corner of township.

9. Dams
   - protect as a community resource
   - identify small dams and prioritize for removal to reduce impacts to stream health and hazards posed for humans.
   - Ensure that large dam release rates balance stream habitat value with drinking water needs, particularly during low flows.

10. Environmental Education
    - Environmental education efforts are growing but must be expanded to better educate children and adults about their living environment
    - County commissioners and municipal officials, engineers, and solicitors must be kept aware of watershed issues and solutions
    - Plan needs strong outreach to all involved with municipalities

11. Recreation, Greenways, Trails and Public Access
    - Lack of public stream access. Much of the Crum Creek is inaccessible to the general public. The few public access areas that do exist are generally associated with existing parks. Trespass on private property for fishing and nature enjoyment indicates the need for increased access.
    - Lack of protected greenways. While many of the protected open space parcels are situated along streams, the potential for protecting interconnected networks of habitat for wildlife, plants and people is often disrupted by developed parcels or privately owned, unprotected land.
    - Need for trails and trail networks. With a few exceptions outlined in the Recreation section, trails for hiking and nature enjoyment are limited in the Crum Creek watershed. More extensive, multi-municipal trail networks are also lacking.

XIV. Action Plan for the Crum Creek Watershed

The Action Plan topics that follow are organized according to the Major Issues , pp. 95-98,that affect the conservation of streams, wetlands, and ground water aquifers. Each section begins with one or more Goals specific to the Crum Creek, followed by a series of Implementation Actions that are based on the goals. These Implementation Actions identify ways to strengthen current regulations, land management, public education, etc., that would achieve the goal.

The identification of Major Issues, Goals and Implementation Actions in the Crum Creek watershed is based on a combination of input from public meetings, survey questionnaires, interviews with municipal officials, and research and analysis of data.

Participating parties capable of implementing this Action Plan range from individuals and non-profit organizations to municipalities and government agencies. Each may have a connection with a specific issue or project listed here. They may be able to provide support staff or funding (e.g. the County Planning Commissions or Pennsylvania Department of Environmental Protection), undertake the project as part of their mission (e.g. Chester-Ridley-Crum Waterheds Association), or simply be directly affected by the project (e.g. landowners).

It is important to realize that the issues that affect stream, wetland and aquifer protection tend to overlap, making their separation into these discrete topics at times artificial. Quite often an Implementation Strategy for one issue is also an objective for another. In fact, the most important objectives, for example a commitment to preserving and enhancing riparian buffers, are those that address most of the issues simultaneously. Rather than repeating similar information, the recommendations are placed under what issue seems to be the most fitting.

1

MUNICIPAL GUIDANCE OF LAND DEVELOPMENT

GOALS

The overall pattern and intensity of land uses in communities throughout the Crum Creek watershed should be planned in a manner that:

- *Accounts for and reduces the cumulative impacts of many small and large scale projects on overall watershed health.*
- *Permanently protects critical environmental features such as streams, wetlands, floodplains, riparian woodlands, major forest blocks, and steep slopes from clearing, excavation and development.*
- *Retains the historic, village pattern of development in the area, with homes and businesses on smaller lots in or near existing hamlets, villages and towns and crossroads (where major roads and utilities already exist), and rural lots and large properties in areas dominated by farmland and woodlands.*
- *Provides flexible standards for developers to design more compact communities adjoining substantial areas of protected open space and avoiding critical environmental features.*
- *Explicitly recognizes the value of regional planning among neighboring municipalities.*
- *Revitalizes existing developed communities with carefully-planned infill and redevelopment projects.*

IMPLEMENTATION ACTIONS

1. Assess recently built and proposed projects to determine the cumulative impacts to watershed health, particularly in Middle Watershed communities facing a building boom, and work with municipalities to reduce impacts.

2. Adopt flexible zoning and subdivision ordinances in each municipality. Enacting "*Conservation Design*" ordinances can strongly encourage a shift from conventional residential development on 1 or 2 acre lots to more *open space-oriented development* with residences on lots of less than 1 acre in size and substantial areas of protected open space encompassing sensitive natural features and historic resources and also otherwise "buildable" land. "*Traditional Neighborhood Design*" ordinances should be enacted to shift Highway Commercial development away from wide, extended, single-use strips along major roads and toward multiple-use "nodes" at crossroads and existing developed areas. Provide municipalities with model Conservation Design (i.e. Growing Greener, NLT) and Traditional Neighborhood Design ordinances that have been applied in other communities.

3. Review and consider establishing Transfer of Development Rights (TDR) programs in each municipality and among neighboring municipalities. This strategy includes identifying important "sending zones" (such as prime farmland and large forests) where important land areas should be protected and "receiving zones" (such as village extension areas or existing "nodes" of development) where higher densities of residential or mixed-use development can be accommodated in a creative and environmentally-sensitive manner. Model ordinances enacted by other communities to achieve this goal should be provided to municipalities for consideration. This approach is also compatible with strategies such as agricultural land preservation and joint municipal comprehensive planning.

4. Increase enrollment of Upper Crum Creek farms in County and State Agricultural Land Preservation programs. This effort can be made by a coalition of municipalities, county agencies and conservation groups. Important issues to address include: greater consistency between actual appraised easement values and the per-acre price "ceilings" for purchasing agricultural easements; consideration of municipal funds as a match for County and State funds.

5. Form municipal partnerships to work together toward adopting Joint-Municipal Comprehensive Plans, as allowed under the Pennsylvania Municipalities Planning Code. Since the scale and rate of development that is occurring in the Crum Creek valley and adjacent watersheds affects entire landscapes and subwatersheds, a coordinated, regional approach to land use planning among neighboring municipalities is essential for realistic growth management and resource protection, not the conventional mosaic of small, fragmented plans that currently exists. Regional comprehensive planning is being conducted in other parts of southeast Pennsylvania and should be undertaken in multi-municipal land use planning in and around the Crum.

6. Consider the use of environmental impact fees and requirements by municipalities for environmental impact mitigation for major energy generation facilities, landfills, and quarries, water use, water pollution, and large-scale developments that can have community-wide impacts.

7. Provide municipal residents with information to participate effectively in the land development review process. This may include training and materials relating to local ordinances and the Pennsylvania Municipalities Planning Code.

8. Enhance the livability of local Boroughs and towns through the promotion of revitalization programs and joint municipal planning with neighboring Townships. Reduction of traffic impacts and promotion of amenities and can go a long way in attracting residences and businesses to traditional population centers.

9. Ensure that municipalities throughout the watershed adopt the full range of environmental protection ordinances, including those dealing with wetlands, floodplains, riparian buffers, steep slopes, and grading.

10. Adopt stringent steep slope ordinances to address the growing problem of infill development on sensitive sites. Steep slope ordinances should be adopted and enforced by municipalities to protect steep slopes and limit development in these areas. Steep slopes are naturally constrained in that they often have shallow depth to bedrock and highly erodible soils. Construction on steep slopes generally require excessive amounts of grading that alters natural hydrology and generates accelerated erosion and sedimentation in areas adjacent to streams.

    Some townships in the watershed have steep slope ordinances in place to restrict development and excessive grading on inappropriate topographic areas. The increasing pattern of infill development on smaller, steeper wooded lots close to streams is a major threat to the ecological health of the watershed. To best protect the steep slopes and sensitive surface water resources in the Crum Creek area, municipalities should update steep slope ordinances periodically and strictly enforce them against violations. Steep slope ordinances limit, and sometimes prohibit, development on slopes considered too steep to be built upon without danger to public health and safety. Steep slopes erode rapidly if exposed, causing silt to enter streams. It is also difficult to build safe driveways and roads on steep slopes without excessive grading, disturbance to vegetation, erosion of soils and sediment, and salt impacts to streams in winter. Generally two categories of steep slope are defined in the municipalities of the Crum Creek watershed:

- Steep Slopes that fall one foot vertically for every 6.67 linear feet horizontally (15%) to one foot vertical for every four linear feet horizontally (25%),
- Very Steep Slopes greater than 25%.

Restrictions on the second category are greater, concomitant with their greater sensitivity. These are overlay zoning districts, like the floodplain districts.

In the Very Steep Slope areas (> 25%) , structures and septic fields are usually prohibited. In the Steep Slopes areas (15 – 25%), buildings and septic systems are often allowed as conditional uses requiring Zoning Hearing Board approval. In some ordinances a maximum percentage of each slope type on a specific tax parcel may be disturbed. *All such ordinances should include standards greatly limiting development and protecting vegetation, particularly on those steep and very steep slopes adjacent to the floodplain and small tributaries.*

11. As recommended in the *Crum Creek Source Water Assessment*: consider maintaining large lot size of potential developments in the upper watershed and allow construction on a small percentage of the lot.

12. The Chester County Water Resources Authority recommends a focus on open space land preservation in the drainage areas of First Order Streams in the headwaters of the watershed and headwaters tributaries discharging to reservoirs.

13. <u>Specific land conservation projects</u> <u>– Natural Lands Trust</u>
    - protection of Priority 1, 2 and 3 sites identified in *Crum Creek Landscape Conservation and Greenway Plan*.

14. <u>Specific land conservation projects – Willistown Conservation Trust</u>
    - protection of Kirkwood Property
    - protection of priority properties identified in *Willistown Conservation Trust Redline Report*

15. <u>Specific park improvement and trail projects</u> -- Rutgers Avenue School Playgrounds, Swarthmore Borough. This 7-acre site bordering both sides of a tributary of Little Crum Creek is in need of recreational improvements. A jogging trail should be constructed to link up to a proposed trail in an adjoining woodland.

2

RIPARIAN FOREST BUFFER PROTECTION AND RESTORATION

GOAL

Protection, restoration and management of a full riparian buffer extending 75 to 100 feet from each stream bank throughout the entire Crum Creek watershed (buffer widths should be greater in steeply sloping areas). Where this width cannot be achieved, a sliding scale of buffer widths should be considered. The majority of these buffers should consist of native floodplain forest vegetation, however, existing herbaceous wetland vegetation, meadow, and shrub vegetation should be considered as alternatives where forest buffers are not feasible. In addition, planting plans for buffers should be designed to respect scenic views of historic settings such as bridges and mills. One of the most important strategies to protect streams includes the preservation and restoration of sizeable natural open space networks along streams

IMPLEMENTATION ACTIONS

1. Establish a Crum Riparian Buffer Initiative. Protection, restoration and management of riparian forest buffers and, in some cases, vegetative buffers, should be established as the goal of a watershed-wide program such as a *Crum Riparian Buffer Initiative*. The initiative should be sponsored by a coalition of local watershed and conservation organizations and should promote this goal by encouraging the adoption of riparian buffer ordinances by municipalities. The Initiative should utilize the *Riparian Buffer* Assessment prepared by Heritage Conservancy as a basis, and should involve local volunteers in conducting a more detailed assessment of riparian corridor priorities. In addition, funding assistance should be encouraged and provided for private, institutional and government landowners to voluntarily protect and restore these areas on their lands through easements, fencing, and reforestation.

2. Consider adoption of a Riparian Buffer Ordinance in all municipalities in the watershed. This ordinance would require anyone submitting a land development plan application or a building permit application to demonstrate that a full riparian buffer zone of 75 to 100 feet on either side of a stream or wetland has been protected as common open space as a condition of approval (as

recommended by the USDA Forest Service and the Stroud Water Research Center). For every 4% increase in slope, an additional 10 feet of buffer should be required. When larger-scale residential, industrial or commercial developments are proposed, reforestation of unforested riparian buffer zones or expansion of partial buffers (as identified in the Heritage Conservancy *Riparian Buffer Assessment*, summarized in this Plan) should be required as a mitigating measure and stormwater Best Management Practice to offset the impact of the development on streams running through or adjacent to the site. A sliding scale of alternative buffer widths (15-25 feet, 25-50 feet, 50-75 feet, based on stream size) should be provided where applicants can demonstrate that 75 feet or greater is not feasible. Riparian buffer ordinances can be freestanding, to apply to specific areas of degradation along streams. The Montgomery County Planning Commission has developed a model ordinance that has been adopted in numerous municipalities. Additional models are available through the Pennsylvania Stream ReLeaf manual prepared by DEP.

3. Provide Riparian Forest Buffer protection/restoration funding assistance to landowners. Landowners should be encouraged to consider implementing voluntary riparian buffer projects including streambank fencing, reforestation, and conservation easements. Riparian buffer projects have been instituted on a series of properties in the watershed by CRC, Aqua Pennsylvania, Willistown Conservation Trust, Natural Lands Trust, and other partners. Such projects should also follow the 75-100 foot standard for each side of the stream, with a sliding scale of reduced buffer widths where the full amount cannot be achieved.

4) Develop riparian habitat restoration and interpretive natural landscaping projects at locations throughout the watershed. Establish demonstration projects to promote riparian buffer awareness at public education facilities such as parks and schools. These projects should be developed as part of an overall restoration and management plan for each site.

5) The Chester County Water Resources Authority specifically lists among its Priorities for the Crum the protection of at least 30% of riparian buffers along first order streams, and restoration of up to 29 miles of first order streams lacking riparian buffers. *The CCWRA Crum Creek Watershed Action Plan includes among its Priority Management Objectives "protect and enhance vegetated riparian corridors, particularly for first order streams."*

6) As stated in the *Crum Creek Source Water Assessment*:
    - Reduce or eliminate riparian zone deforestation, and reforest riparian zones that have been destroyed, with any type of native, woody vegetation. Species should include those listed in the Ecology section of this plan for Bottomland Oak-Hardwood Palustrine Forest, Sycamore-

River Birch-Box Elder Floodplain Forest, Buttonbush Wetland, or Alder-Ninebark Wetland.

- Establish woody plant communities around Springton Reservoir shoreline, especially at incoming tributaries. Experiment with species, but start with Black Willow (*Salix nigra),* a species that has begun to grow on sediment deposits in the reservoirs, to trap sediment and to permanently incorporate nutrients, while providing large woody debris to the system.
- Establish woody vegetation on the deltas that have formed in the Lower Crum Reservoir, after removing phragmites.

7) Marple Township riparian restoration -- conducting a streambank stabilization and buffer management program at the Paxon Hollow Golf Course to protect the course property and to decrease sediment and nutrient loading to water supply.

8) Springfield Township streambank restoration/stabilization along Whiskey Run and Garnet Run.

9) Little Crum Creek Projects, Swarthmore Borough.
   - Little Crum Creek Park. This 4.74 acre site is in need of a stream bank restoration, relocation of a foot bridge and foot paths, erosion control, invasive species removal, and construction of an observation deck for use by local schools for education in overlooking a recently restored wetland. Three stabilization projects totally roughly 350 linear feet have been completed to date, with about 800 feet unrestored or needing further restoration.
   - Acquisition of streamside properties at 121 Dartmouth Avenue. This site, along a tributary of Little Crum Creek , adjoins a Borough property. Removal of invasive plants and stream bank stabilization are needed at the site. The borough has a shortage of parkland that is usable for active recreation.
   - Stream Bank Improvements on Private Properties (approximately 100). Provide design assistance and materials to encourage owners of private property along Little Crum Creek and its tributaries to encourage them to stabilize stream banks, remove invasive exotic species and install native flora.
   - Swarthmore Swim Club stream bank restoration and flood control. A 5.17 acre site in need of stream bank work along two tributaries of Little Crum Creek. Several culverts exacerbate flood problems on the property and can be removed and modified to restore a natural stream channel. An engineering and hydrologic analysis is needed to design an appropriate meandering stream channel. The block channel would be removed and the stream would be re-established within the new natural channel. Bank stabilization, streamside vegetation, and riparian zones would be created.

3

CONSERVATION OF MAJOR WOODLANDS

GOAL

Large, contiguous blocks of "deep woods" (or forest-interior habitat) should be identified and prioritized for conservation to limit impacts from clearing and development.

IMPLEMENTATION ACTIONS

1) Establish a Crum Woodland Conservation and Restoration Initiative. Partnerships between Pennsylvania DCNR, parks departments and planning departments in the four counties, municipalities, land trusts, local conservation and watershed organizations, and landowners should be established and maintained with the goal of permanent forest conservation in priority locations throughout the watershed. In addition, priority areas for expansion of existing forest networks should be identified, with the goal of increasing the size, shape, connectivity, and health of these networks through reforestation and restoration. (i.e. promoting native canopy, subcanopy and understory trees, and shrubs and herbaceous plants through planting, deer management and invasive species removal).

2) Strategies outlined in the *Conservation and Stewardship Plan for the Crum Woods of Swarthmore College* provide a valuable local model. These include identifying various Management Units based on land use, conservation priority, resources, surrounding influences, and existing and potential threats. A listing of these units is provided, followed by a ranked summary of recommendations for each (i.e. invasive species management, deer exclosures, trail management).

3) Prioritize the largest blocks of contiguous forest in the watershed for conservation. These include woodlands at the headwaters of Crum Creek and along wooded slopes and knolls in its lower reaches, particularly those Priority woodland parcels listed in this Plan , as defined in the *Crum Creek Landscape Conservation Plan prepared by Natural Lands Trust* (NLT, 2003).

4) Utilize the full range of conservation options for permanently protecting parcels containing key woodlands. Partnerships should tailor one or more options to each situation, including donation of land or conservation easements, bargain sale of land or conservation easements, purchase of land or conservation easements, transfer of development rights (TDR), and limited development with conservation of key wooded open space.

5) Consider adoption of woodland conservation ordinances in all municipalities to reduce the impacts of land development in priority woodlands. Such ordinances should address logging both for commercial timber/firewood harvests and clearing for development projects. In either case, a permit should be required based on an approved Forest Management Plan prepared by a consulting forester.

6) Encourage reforestation of farms and dormant fields, and replacement of lawns in residential areas with more natural vegetation. Investigate ordinance for new development to include large areas of replanted woody vegetation rather than expanses of turf grass. (Recommended in the *Crum Creek Source Water Assessment)*

7) Establish a deer management program to reduce the impacts of deer browse on current and future forests and associated wildlife. The findings and recommendations of the recent report prepared for Audubon Pennsylvania should be used as a guideline (Latham, et al, 2005).

8) As recommended in the *Crum Creek Source Water Assessment:* Strictly maintain and encourage a maximum width buffer zone around reservoir shoreline. Revegetate all areas that do not currently possess a dense woody growth.

9) Rutgers Avenue School Woods, Swarthmore Borough – conduct an environmental assessment for preservation of open space and a hiking/biking trail. This 7.7 acre wooded site behind a school along two sides of a tributary of Little Crum Creek is the only remaining publicly owned property in Swarthmore that is unimproved . A foot bridge across the creek connects a residential street with the school parking lot. Unsanctioned activities such as the removal of trees to create biking trails threaten the stability of this highly sensitive area. The area is used for dumping yard waste, and litter is a problem. The woods include invasive exotic species, especially Norway maples. Possible uses for this site include installation of trails for hiking and jogging. A professional study should be completed to determine the need for stream bank restoration, restoration of areas impacted by current use, and the appropriate location of trails which may require the construction of an additional foot bridge.

4

PROTECTION AND RESTORATION OF WETLANDS

GOALS

- *Permanently protect existing wetlands throughout the Crum Creek watershed from excavation, filling and clearing of native vegetation.*

- *Provide adequate open space buffers between all wetlands and adjacent land uses such as lawns, agricultural fields, and improvements such as roads, parking lots, stormwater basins and structures*

- *Restore previously drained, filled or cleared wetlands wherever possible.*

IMPLEMENTATION ACTIONS

1) Establish a watershed-wide initiative to accurately *identify and characterize* all existing wetlands. This can be achieved by expanding upon preliminary wetland mapping prepared in this Plan by Schmid and Company. A combination of aerial photo interpretation, Soil Survey and National Wetland Inventory (NWI) mapping, field verification, and wetland delineation should be used. Characterization should be based on general wetland types including forested, shrub, emergent, wet meadows, and other wet habitats such as vernal ponds. Existing wetland delineations on file with municipal offices can gradually be mapped to add accurate data to the wetland maps for each of the major subwatersheds. Data should be compiled and regularly updated on the *Crum GIS Database.*

2) Establish a Wetland Conservation Initiative in the watershed. Partnerships between Pennsylvania DEP, DCNR, parks departments, and planning departments in the two counties, municipalities, land trusts, local conservation and watershed organizations, and landowners should be established and maintained with the goal of permanent wetland protection throughout the watershed. Vernal ponds, often occurring in the springtime as shallow pools of water in floodplains, should also be protected as critical breeding areas for amphibians. Adoption of riparian buffer and wetland protection ordinances

should be promoted in municipalities throughout the watershed to avoid impacts from adjacent land development.

3) Protect and restore wetlands listed as high priority sites in county Natural Areas Inventories. These sites are described in the Ecology section of this Plan. The drainage areas helping to supply water to these wetlands should also be prioritized for conservation to minimize the impacts of adjacent land uses.

4) Establish a Wetland Restoration Initiative in the watershed. Public and private partnerships should be established and maintained with the goal of identifying degraded or destroyed wetlands altered by draining (tiling, ditching), excavation or filling, and areas with potential for reestablishment of wetland soil, vegetation and habitat conditions. Programs such as the *PA DEP Wetland Replacement Project* may provide funding for projects as a means of mitigating impacts from permitted development projects located elsewhere in the region. This requires willing landowners. Historic aerial photography, soils maps, and Soil Conservation Plans prepared for individual farms can provide clues about drained and filled areas.

5) Utilize the full range of conservation options for parcels containing important wetlands. Partnerships should work to educate landowners and tailor one or more conservation options to each situation, including donation of land or conservation easements, bargain sale of land or conservation easements, purchase of land or conservation easements, transfer of development rights (TDR), and limited development with protection of key wetlands and buffers.

6) Initiate a *wetland assessment service and fund* to provide pre-funded, professional wetland delineation expertise to local environmental groups, landowners or municipalities. It would provide additional detail for watershed-wide wetland inventory mapping, and allow additional evidence as a ("second opinion") for wetland delineations presented as part of any land development project.

7) Municipalities should adopt ordinances requiring wetlands to be buffered and tile drained lands along Crum Creek to be addressed during the land development process. Projects involving potentially drained floodplain wetlands along Crum Creek should provide an assessment of tile field locations and remove or crush drainage tiles to reestablish wetlands as a requirement of plan approval.

5

IMPLEMENT INNOVATIVE STORMWATER MANAGEMENT AND FLOODPLAIN MANAGEMENT STRATEGIES

GOALS

One of the most important strategies to protect streams includes the use of stormwater management systems that maximize filtration and recharge of stormwater runoff.

- Maintain natural hydrology of each subwatershed as closely as possible by reducing surface runoff and promoting groundwater recharge.
- Enhance the quality of ground and surface water by reducing sources of contaminated stormwater runoff and providing natural and constructed filters for stormwater runoff.
- Protect the health, safety, and welfare of residents in the watershed and downstream communities by reducing flood hazards and damage.
- Adopt Act 167 Stormwater Management ordinance as a minimum standard in all municipalities in the Crum Creek watershed.
- *These goals are consistent with the Priority Management Recommendations presented by the Chester County Water Resources Authority in its Crum Creek Watershed Action Plan, which states: "Reduce Stormwater Runoff and flooding throughout the watershed." (CCWRP, 2002)*

IMPLEMENTATION ACTIONS

1) Review and consider adoption of innovative stormwater management ordinances in each municipality. Such ordinances require innovative techniques or Best Management Practices (BMP's) to improve the quality of runoff by minimizing sediment and other pollutants contained in runoff from developed areas, and to maximize recharge of groundwater by directing runoff into the ground. Under DEP regulations, ordinances may exceed standards established in the Act 167 model ordinance. Variations of the model ordinance have been proposed in Marple and Newtown Townships, in some cases to include tighter controls, and may provide examples for other communities to follow. In anticipation of pending US EPA National Pollution Discharge Elimination System

(NPDES) Phase II requirements and potential Total Maximum Daily Load (TMDL) requirements developed by DEP to reduce impairments caused by urban runoff, municipalities in the Crum Creek must begin to address existing and future stormwater management needs. This recommendation is consistent with the findings of the Crum Creek Source Water Assessment, which recommends such measures for reducing or eliminating the stream erosion problem that causes sedimentation in water supply reservoirs.

2) Establish a Stormwater BMP Retrofit Initiative to identify existing problem areas as "BMP retrofit" priorities and seek funding to implement projects. These areas include poorly designed basins, gully erosion problems, paved surfaces draining directly to streams, flooding problems. The initiative should be launched by local watershed organizations and municipalities with technical and funding assistance from DEP and the county Conservation Districts and should include field surveys and GIS mapping. Identifying and addressing existing stormwater management problem areas through incorporation of current stormwater Best Management Practices can greatly improve the quality and quantity of water in streams, wetlands, and aquifers. The *Crum Creek Source Water Assessment* recommends including retrofitting older systems and purchasing property to install others. Included in retrofitting older systems should be the integration of water quality enhancement practices along with water quantity control. Also, integrate groundwater infiltration practices with stormwater management basins where feasible. Provide added incentives for properties contributing the greatest amounts of runoff in major problem areas.

3) Define appropriate infiltration areas in watershed. Work toward acquisition or conservation easement protection for groundwater infiltration land areas, including as sites for recharge beds.

4) Require proper stormwater management of all roadways, whether managed by PennDOT, municipalities, or homeowner associations. National Pollution Discharge Elimination System Phase II regulations will now require PennDOT to meet the municipal separate storm sewer system (MS4) protocols, and these requirements should be carefully monitored in the Crum Creek. . Replacement of narrow culverts with half-pipes and bridges should be a priority for flood reduction and maintaining natural stream corridors for wildlife.

5) Malvern Borough stormwater retrofits: Due to concerns of downstream flooding in Willistown, retrofits should be made to existing stormwater management basins (Malvern Preparatory School Property, Village of Pennywick Basin – HOA owned). Pond and stormwater facilities along

Crum tributary on Malvern Preparatory School property should be remediated.

6) Newtown Township stormwater retrofits: Stormwater management in Newtown Heights and other areas. Prepare an assessment of highest return on investment for retrofit project.

7) Marple Township stormwater retrofits: Construction of stormwater BMP(s) to infiltrate stormwater at the Trout Run headwaters (Giant shopping center), and work with Aqua Pennsylvania to address stormwater control and infiltration and stabilize stream banks all along Trout Run. Prepare an assessment of highest return on investment for retrofit projects.

8) Ridley Township streambank restoration: on Little Crum Creek from Swarthmore boundary; drainage improvements for Bullens Lane crossing of Crum Creek.

9) Rose Tree Park runoff control: Work with Rose Tree Park and downstream landowners along tributaries to the Crum Creek to reduce runoff volumes and velocities and restore stream channels and banks.

10) Consider adoption of stormwater utilities to tax impervious surfaces and give credits for reduction of impervious surfaces in development projects, and provide funds for retrofitting and maintaining stormwater BMP's.

11) Implement the stormwater management recommendations of the *Crum Creek Source Water Assessment* (Schnabel, 2002) and *Crum Creek Watershed Action Plan* (CCWRA, 2002), including:

- Minimize the volume of stormwater generated, including:
  - Minimize soil and vegetation disturbance.
  - Minimize impervious surfaces.
- Assess site to locate stormwater systems first (and in optimum soils for recharge), rather than last (and in poorest soils for recharge).
- Use appropriate storm designs (e.g. detention and recharge of the 1 and 2-yr storms).
- Promote infiltration to protect groundwater recharge and reduce runoff, including:
  - Retain first ¾ inch of rainfall on-site (rain barrels and rain gardens for individual homes).

- Preserve the same volume of infiltrated rainfall as in pre-development condition. Define "predevelopment condition" as "woodland, pasture, or meadow condition.")
- In High Quality or Exceptional Value watersheds, infiltrate net increase in runoff volume from a 2-year storm event, in other areas infiltrate first 1.5 inches.

- Protect water quality by removing pollutants prior to discharge to streams.

(use BMP's to capture the first one inch of rainfall)

- Protect instream channels and geomorphology conditions.

(use BMP's to temporarily attenuate runoff from a 1-year 24-hour storm event on-site for a period of 12 to 24 hours)

- Reduce impacts of development to flood flows.

(reduce post-development peak rate of runoff for the 2-year through the 100-year storm events to be equal to the corresponding peak rate for a "woodland, pasture or meadow condition.")

- Lists of recommended BMPs, including grassed swales and berms, vegetated filter strips, constructed wetlands, biofilters, pervious paving/paver blocks, and green roofs. Intensive uses such as convenience stores and gas stations should be treated as "hotspots" for water pollution, with special filtering systems required.

- Where possible, encourage stormwater runoff infiltration at each single residence. Subsidizing cost for materials and installation fees for rain barrels or dry well construction for treating roof drain runoff, and porous driveways, walkways and patios. Direct runoff from residences into vegetated bioretention gardens (rain gardens) rather than to driveways and streets.
- Encourage use of permeable driveways and parking lots, bioretention, stormwater pre-treatment in new and existing commercial, industrial, and government developments.

- Protect adjacent lands from direct stormwater discharge.

(utilize drainage easements and design systems to avoid erosion and flooding)

- Ensure long-term operation and maintenance of stormwater facilities.

(prepare operation and maintenance plan designating responsible party and funding source)

- Establish forested riparian buffer networks.

- Protect wetlands, floodplains and forested slopes.

The following measures are also encouraged:

- Reassess stormwater management objectives by municipalities
- Retrofitting grandfathered properties with up to date stormwater management levels as they are redeveloped, or when applying for permits to expand impervious surface area.
- Require management of roof runoff
- Reduce runoff associated with agricultural lands and large lawn areas.

Floodplain Actions:

12) Review and consider adopting the most current floodplain regulations in each municipality. These regulations should set limits on development and re-development in floodplains and floodways, promote retention of natural floodplain soils and vegetation, and provide detailed requirements regarding safe storage of hazardous materials.

13) Update FEMA floodplain mapping to more accurately reflect 100 year flood conditions.

6

PLAN FOR WATER SUPPLY NEEDS AND IMPROVEMENT OF WATER QUALITY

GOALS

- *Prepare a multi-municipal Integrated Water Resource Plan (IWRP) for the Crum Creek watershed to determine future (2020) water demand and wastewater needs in each subbasin. No comprehensive understanding of current and future water needs, availability, or levels of interbasin transfers exists for the Crum Creek. Both the Chester County Water Resources Authority and the Delaware River Basin Commission recommend this approach as a tool for managing growth and local water supply in a manner that is sustainable within the carrying capacity of the natural system of surface water and ground water (CCWRA, 2002). Factors such as reservoir storage and major historical importations and exportations should be assessed and may prove to be barriers to an accurate water budget analysis.*
- *Manage land use and water resources to protect and guarantee the availability of clean, plentiful water as a drinking water supply for the hundreds of thousands of residents who rely on the Crum Creek.*
- *Restore water quality of "impaired" streams and protect unimpaired streams from further degradation a Priority Management Recommendation of the CCWRA Crum Creek Watershed Action Plan)*

IMPLEMENTATION ACTIONS

Actions 1 through 7 as listed below are included as recommendations in the *Crum Creek Source Water Assessment* as strategies for protecting and enhancing the main water supply system on the Crum Creek (Schnabel, 2001).

1) Develop an Integrated Water Resources Plan for the Crum Creek watershed. As stated in the *Crum Creek Watershed Action Plan* component of Chester County *Watersheds*, " Municipalities, utilities, and other relevant stakeholders (including the Crum Creek Watershed Partnership) located within the Crum Creek watershed are encouraged to consider developing an IWRP to link land use and water resources needs and

management objectives together in a consistent planning framework. " In each subwatershed, an IWRP can include:

- estimated current water demand, projected increased water demand (based on estimated buildout over 20 years);
- available supply (surface, groundwater, interbasin transfers);
- determination of sustainable water supply based on maintaining quality and quantity of surface and groundwater;
- links of water budget calculations with land use planning and zoning densities in every municipality (without relying on excessive imports of water into the watershed from other areas); (CCWRP, 2002)

Models of this type of planning are available from the Green Valleys Association and Cahill Associates (Sustainable Watershed Management) and the Chester County Water Resources Authority's "Watersheds" plan. A watershed-wide initiative to raise awareness about the value of a community-based IWRP should be promoted by local watershed organizations and government agencies.

2) Provide hypolimnetic aeration in the Springton Reservoir to discourage sediment phosphorus recycling.

3) Enact ordinances within Zone A (closest to streams) that require basins or traps at every drainage pipe outlet before allowing entrance to tributaries to the Lower Crum Reservoir.

4) Install a sedimentation basin at the Riverine Zone of the reservoir in order to isolate this zone and settle out sediment in one area where maintenance dredging can take place, if needed. Establish aquatic bed wetlands in and near the sedimentation basin to trap sediment and provide some polishing of water quality.

5) Continue Resident Canada Goose (*Branta canadensis*) control, especially in the Lower Crum Reservoir.

6) Install subsurface sediment traps at all tributary inlets to the reservoir.

7) Eliminate soil loss caused by compaction of soils and destruction of vegetative cover at the shoreline of Springton Reservoir by controlling pedestrian use. This may be achieved by installing distinct wood chip or wooden plank walkways to fishing areas. Installation of a dock or wooden platform along the shoreline may help to direct users to only designated fishing areas (such as near Bishop Hollow Road and the dam) areas and not along the shoreline.

8) Establish a public-private initiative to restore the quality of "impaired" streams, as part of a Total Maximum Daily Load (TMDL) process, particularly by addressing specific sources of non-point source pollution and urban runoff. Establish a related public-private initiative to protect unimpaired streams from further degradation. Such Water Quality Initiatives must involve combinations of voluntary actions, funded projects, and regulatory approaches listed throughout this Action Plan.

9) Develop suggested spill emergency action plans at each Crum Creek road crossing above the water intake at Crum Reservoir and make these available to local emergency personnel.

10) Municipalities should review and consider adopting wellhead protection ordinances. Such ordinances ensure protection of public health, prevent groundwater contamination, lower the cost of treatment for compliance with drinking water standards, and promote sound land use planning. This would involve identifying existing community and private wells and "cones of depression" where ground and surface water is drawn into wells, and establishing buffer areas limiting land use impacts to wells. Establish overlay zones to strictly limit or eliminate hazardous waste and impervious cover in wellhead protection areas.

11) A watershed-wide assessment of hazardous materials storage practices, and locations should be conducted. Municipalities should coordinate with DEP, County Health Departments and water supply utilities to prepare and adopt ordinances that set detailed requirements for safe and proper storage, transport, disposal and cleanup of hazardous materials. In addition, adopt an Emergency Response Planning and early warning system (*Crum Creek Source Water Assessment).*

12) Avoid or minimize interbasin transfers of water out of the watershed wherever possible, and closely examine transfers between subwatersheds for their impact on the hydrologic balance of the watershed. Rather than serve development projects with artificially high densities or water consumption rates, the priority in maintaining hydrologic balance is to avoid negative impacts to the baseflows and ecology of streams, wetlands and groundwater levels supporting local wells.

13) Increase the use of water conservation measures in households and businesses throughout the watershed. Water-saving appliances, fixtures and habits should be encouraged among all watershed residents and businesses. The Rain Barrel Give-Away programs of the County Conservation Districts educate homeowners about "recycling" of

stormwater runoff for outdoor/garden applications to reduce water use and runoff. Municipalities and watershed organizations should promote DEP and DRBC water conservation programs among residents.

14) Stream restoration and designation upgrades: The Chester County Water Resource Authority recommends that the High Quality streams in the watershed be protected and restored, efforts which could warrant nominations to Exceptional Value designation (CCWRA, 2002).

15) Map all public sewer lines, especially those running along streams, crossing streams, and combined sewer overflows. Upgrade sewage systems (plants and lines) to reduce infiltration and leaking of sewer lines, separate any combined sewers, and reduce stream discharge of contaminants in effluent. Address these issues in Swarthmore and neighboring communities. Over time, stream-discharge of treated sewage effluent should be prohibited or discouraged, in favor of land application technologies such as drip irrigation, spray irrigation constructed wetland systems and Living Machines.

16) Extend sanitary sewer to eliminate failing septic systems and inadequate small waste water systems in Edgmont Township.

17) Municipalities can address the problem of failing on-lot septic systems by working with PA DEP or the Chester County Health Department to require regular monitoring and establish criteria for upgrades with homeowner assistance through improvement funds and low-interest loans.

18) Municipalities, PA DEP and Chester County Health Department can work together to monitor wastewater treatment plants and establish requirements for upgrades as needed to prevent potential sources of ground and surface water contamination.

19) Coordinate Act 537 Plans to promote multi-municipal wastewater management.

20) Promote land application alternatives to stream discharge, evaluate the environmental impacts of stream disposal areas for gravity-fed systems.

21) Establish water quality monitoring programs on various tributaries and the main stem to supplement DEP and USGS data, provide baseline conditions and an ongoing measurement of improvement or degradation of stream quality. Little Crum Creek should be looked at as a pilot

project for this effort. Areas above and below the reservoirs and water supply system intakes should be monitored carefully. Chester-Ridley-Crum Watersheds Association should consolidate and maintain a website for monitoring data on the Crum, Ridley and Chester watersheds. Expand CRC's monitoring efforts to the Source Water Protection areas in Marple.

22) Adopt municipal regulations to prevent draining of swimming pools into streets, streams and storm sewers instead of sanitary sewers (leading to a wastewater treatment plant). Direct discharges of pool water contain pool chemicals and/or decaying organic matter that have impacted small streams and have been responsible for fish kills in the watersheds.

23) Implement other source water protection measures for public water supply intakes, reservoirs, and wells (CCWRA, 2002).

7

ASSESS COSTS AND BENEFITS OF PONDS AND IMPOUNDMENTS

GOAL

Reduce impacts of current and future ponds and impoundments on the health of stream ecosystems throughout the watershed, specifically the effects of artificial heating of stream water, fragmentation of streambed and stream channel, and loss of wetlands.

IMPLEMENTATION ACTIONS

1) Establish a watershed-wide initiative to identify and characterize ponds, lakes dams and impoundments, evaluate costs/benefits, and prioritize removal candidates. This initiative should be led by a coalition of groups and agencies to identify ponds and lakes throughout each subwatershed and characterize by type of impoundment, function, ownership, ecological benefits (such as bird species diversity, associated wetlands, or fire control) and impacts (thermal pollution, stream fragmentation, wetland loss) and cultural benefits (such as fishing, boating or historic significance). A model of this type of Dam Inventory was recently completed by a student at the University of Pennsylvania, Natural Lands Trust, and the Perkiomen Watershed Conservancy for the *Lower Perkiomen Creek Watershed Conservation Plan*.

2) Establish a Crum Creek fund for pond and dam removal and encourage removal of priority candidates. Assess and prioritize ponds or lakes that may be candidates for removal to restore natural stream hydrology and reduce stream quality impacts and contact landowners to discuss options for each site. A fund for pond removal and breaching and/or removal of dams should be established. (Prior to recommendation of any dam removal project, environmental impact assessments should be considered to determine: potential gain or loss of habitat for plant and animal species; the potential for stream contamination from release of trapped sediments; potential loss of public recreational and cultural resource).

   An existing illegal dam has been identified on the main stem of Crum Creek about 50 yards downstream from Paxon Hollow Road, on the border of Upper

Providence and Marple Townships. The dam was constructed by a homeowneron Timber Jump Lane just east of Rose Tree Park. The dam is approximately 4 feet high, is constructed of medium-sized stones and has been in place for nearly 20 years. It appears to be breached in the middle, but continues to fragment the stream ecosystem by inhibiting passage of fish, mollusks, and aquatic insects, and creates slow moving water to exacerbate algae blooms. Request DEP action be taken to require removal.

3) Discourage new dam construction.

4) Establish and promote standards for restoration of existing ponds and construction of new ponds. These standards should be established due to the importance of stream water quality in the Crum Creek as a public water supply, recreational resource and high quality habitat for a rich diversity of aquatic life. These should include criteria for siting, design standards for minimizing solar exposure (i.e. orientation, shape and shade trees), the use of bottom-discharge outflow structures to discharge cooler water instead of heated water, and the use of native vegetation buffer areas to filter chemical pollutants from lawns and agricultural fields and discourage large Canada goose populations.

5) Identify a strategy for negotiating dam releases from the Springton Reservoir and Crum Reservoir to sustain minimum baseflows for downstream aquatic life during low flow periods.

6) Ridley Park Borough – Ridley Park Lake restoration as outlined in the Eastlake Park Master Plan Update (2001) for Ridley Park Lake. Improve water quality of Little Crum Creek and lake, including plantings for erosion control, invasive plant management, repairing shoreline erosion, planting trees, maintaining habitat for wildlife, improvements such as a boardwalk and trail, boat launch, bike racks, and preschool playground.

8

IMPROVE RECREATIONAL OPPORTUNITIES. INCLUDING TRAILS AND GREENWAYS

GOALS

- Increase enjoyment and appreciation of the Crum Creek watershed by residents and visitors through expansion of active and passive recreation facilities, including parks, trails and greenways.
- Expand the existing economic benefits of fishing, ecotourism (such as birdwatching), and recreational tourism.
- Establish a comprehensive greenway planning process for the watershed.
- Increase public access to and recreational use of streams on public and private lands (a Priority Management Action as recommended in the CCWRA *Crum Creek Watershed Action Plan*.

IMPLEMENTATION ACTIONS

1) State, County, and local governments should acquire, or otherwise make available to the public, selected open space properties and greenways. Preserve greenway parcels and create trails by working toward municipal protection of key parcels identified in Comprehensive Plans, Open Space Plans, Official Maps, and this Plan.

2) Prepare a comprehensive trails and greenways map and feasibility study for the watershed to identify opportunities and constraints for establishing a trail network and protected greenway corridors at the municipal and multi-municipal levels.

3) Adopt municipal trail master plan and ordinances requiring dedication of trails and/or greenways from developers (or fee-in-lieu), particularly along streams. Work to acquire trail corridors and trail easements from private landowners.

4) Establish new trails along streams and other open space corridors in the watershed (including road and utility rights-of-way). Such corridors may include links to parks in the watershed, nearby Tyler Arboretum and Ridley

Creek State Park, nature preserves, homeowners association open space, institutional properties, and other trails identified in the watershed or linking protected open space areas. To create an interconnected trail network, municipalities should establish Community Trail Networks with an ordinance requiring developers to set aside trails or a fee-in-lieu of a trail.

5) Improve public access to Crum Creek by constructing modest facilities for parking, wildlife observation, fishing, interpretive walks, and other passive activities on public streamside lands. Trail management plans should be adopted to manage public access and address existing trail management needs including those in local parks and nature preserves.

6) Educate public and private landowners about the liability protection offered by state law for opening their land to limited public use. (Recreational Use of Land and Water Act -- RULWA). Information on this act can be obtained through the *Community Trails Handbook* published by the Brandywine Conservancy in Chadds Ford, PA.

7) Local governments should encourage private landowners to provide reasonable public access to the stream in key locations, and assist in risk management.

8) Protect greenway corridors along streams throughout the watershed through conservation easements, ordinance standards, and dedicated lands from developers.

9) Provide technical assistance to non-profit institutions and private corporations with large land holdings in the watershed to develop public access where appropriate.

10) Consider strategies for marketing higher quality, publicly accessible sections of the Crum Creek watershed as a destination for fishermen, bird watchers, bikers, hikers, and hunters.

11) Willistown Township trail protection: Acquisition of trail easements including linking Kirkwood Preserve to adjacent trail systems, and in Daylesford Abbey. Acquisition of trail easements for passive recreation throughout the watershed from private landowners creating a trail network along the creek and linking to Ridley Creek watershed.

12) Newtown Township, Edgmont Township and Upper Providence Township trail and greenway protection: Acquisition of land or public access along the Springton Reservoir, Crum Creek, and its tributaries

9

PROVIDE LANDOWNERS WITH INFORMATION ON CONSERVATION AND MANAGEMENT OPTIONS

GOALS

- *Reduce the number of properties sold for development by raising awareness among large property owners throughout the watershed regarding the benefits of land conservation, and the many options and programs available.*

- *Improve restoration and management potential for large properties and streamside properties by educating landowners about available options and programs.*

- *Ensure that all homeowners have access to information on maintaining their properties in a manner that enhances watershed health.*

IMPLEMENTATION ACTIONS

1) Establish coordinated education and outreach programs to raise awareness among landowners of land conservation options. Land trusts, watershed associations, municipalities, and county and state agencies can coordinate efforts to reach landowners. These options may involve protection of part or all of a given property and may offer associated financial and tax benefits. Landowners throughout the watershed should also be made aware of the importance of conservation, restoration, and management of woodlands, wetlands, meadows, other successional lands, and streams, and the relationship of these practices to water quality and quantity, biodiversity, and human health.

2) Consider additional tax incentives (beyond Act 319) for landowners to avoid developing their land or selling their land for development (perpetually or in 10-year increments).

3) Establish education and outreach programs to raise awareness among landowners and developers of land restoration and management options. Landowners and developers should be educated about the wide range of restoration and management options available for their land. These options may include the importance of establishing and maintaining riparian forest buffers, removal of invasive exotic vegetation, establishment of native meadows, and

reforestation areas as alternatives to lawns and old fields. Outreach should be targeted specifically to streamside landowners.

4) Municipalities should review and consider adopting Natural Landscaping Ordinances as alternatives to Weed Laws. Such ordinances recognize the environmental and aesthetic value of meadows and naturally landscaped areas as alternatives to lawn, and encourage homeowners to pursue these approaches in a manner that avoids causing nuisances with neighboring properties.

5) Promote organic lawn care and natural landscaping among schools and other institutional properties. Use school properties and municipal properties as demonstration sites and living classrooms for sustainable landscaping practices.

6) Encourage all homeowners, particularly streamside homeowners, to employ practices that promote watershed stewardship, with programs similar to the Chesapeake Bay Program's "Bayscapes" and the National Wildlife Federation's "Backyard Habitat Program". Establish a "Watershed Stewards" recognition program to recognize good practices. Such practices include:

    - stop mowing within 25 feet of all streams and wetlands.
    - organic lawncare practices to reduce or eliminate chemical-based approaches,
    - on-lot stormwater management systems such as rain barrels, rain gardens.
    - creating backyard habitat areas with native landscaping, ornamental ponds, bird boxes, bat boxes, butterfly gardens.
    - avoid using and disposing of household chemical products.
    - employ water-saving devices and practices.
    - regularly monitor and maintain septic systems (if present) and upgrade older systems (15 to 20 years or older) to modern standards.
    - Promote planting of street trees and shade trees in residential areas throughout the watershed, and particularly in more urbanized Lower watershed to reduce stormwater runoff, add to energy savings attributed to the cooling effect of trees in summer, and enhance property values.

7) Develop and publicize models for good stewardship practices in the Crum Creek Watershed.

10

SUPPORT COOPERATIVE EFFORTS AND PARTNERSHIPS AMONG ENVIRONMENTAL ADVISORY COUNCILS AND OTHER STAKEHOLDERS THROUGHOUT THE WATERSHED

GOALS

Promote partnerships and cooperation among watershed stakeholders such as Chester-Ridley-Crum Watersheds Association, Delaware County Community College, Swarthmore College, Aqua Pennsylvania, Conservation Districts for Delaware County and Chester County, Delaware County Planning Department, Chester County Water Resources Authority, PA DEP, municipalities and land trusts.

In addition, since Environmental Advisory Councils (EAC's) are the main municipally-based environmental organizations permitted under the Pennsylvania Municipalities Planning Code, they should be encouraged throughout the watershed. EAC's are already in place in many Crum Creek communities, including: Ridley Township, Swarthmore Borough, Springfield Township, Nether Providence Township, Upper Providence Township, Marple Township, Newtown Township, Willistown Township, Easttown Township and Tredyffrin Township.

IMPLEMENTATION ACTIONS

1) Encourage Environmental Advisory Councils (EAC's) in every municipality in the watershed, or in multiple municipalities. These Councils can be considered as specialized volunteer bodies with the roles of monitoring and providing advocacy and information on key environmental issues affecting environmental resources in the municipality.

2) Support the continuation of and an expanded role for the Crum Creek Watershed Partnership. The Crum Creek Watershed Partnership provides an excellent forum for collaboration of municipalities, including EACS, with other watershed stakeholders.

3) Provide technical and financial support for establishing EAC training and capacity building**.** CRC and the Pennsylvania Environmental Council (PEC) should provide support and technical and financial assistance should be provided to develop training programs in water resource issues for EAC's in the watershed.

4) Organize a watershed-wide annual or biannual Crum Creek Conference to coordinate activities and share inspiration and support between volunteers throughout the entire Crum Creek watershed, including EAC's.

11

IDENTIFY AND PROTECT IMPORTANT CULTURAL AND HISTORIC FEATURES OF THE CRUM CREEK WATERSHED

GOAL

In addition to natural areas and water resources, the historic pattern of land use and settlements is the other main defining feature of the Crum Creek landscape. Farmland, historic farmsteads, mills, rail lines, bridges, archaeological sites, old trees, villages and towns tell the history of the Crum Creek valley and should be carefully understood and documented prior to the advance of suburban development.

IMPLEMENTATION ACTIONS

1) Organize a coalition of conservation and historic groups to prepare a cultural history of the Crum Creek watershed. A history of the cultural and historic features of the Crum Creek watershed should be prepared, highlighting the historic dependency on water resources. This could be done by a coalition of groups interested in the history of the area, including local historical societies. The history text prepared by Bill Brainerd as background for this report should be expanded, illustrated, and published as a *Crum Creek Watershed History*.

2) Historic and cultural resources should be documented and catalogued using the watershed-wide GIS system. Resources should be identified according to their status on the National Register of Historic Places, Pennsylvania list of Determination of Eligibility resources, local historic districts, and county and municipal lists. Coordinate with the historic preservation programs and historical societies of both Delaware County and Chester County to ensure that data is complete and compatible.

3) Share this history with the public through publishing and presentations. This information should be made widely available to residents and municipal officials throughout the watershed.

4) Preserve specific historic and archaelogical resources listed on the National Register of Historic Places and the Delaware County Historic Preservation survey, and also historic trees in the watershed.

5) Municipalities should adopt historic preservation ordinances forming historic architectural review boards (HARBS), and prohibiting demolition of such resources without approval of county historic commissions and municipalities. Setbacks for historic structures should be required, along with flexible standards for adaptive re-use.

6) Protect and enhance water-based historic and cultural resources (CCWRA, 2002)

7) Establish a GIS database of historic trees in the Crum Creek watershed with regular updates.

12

CONDUCT DETAILED INVENTORIES OF NATIVE FLORA AND FAUNA OF THE WATERSHED AND IDENTIFY STEWARDSHIP NEEDS

GOALS

Detailed surveys of wildlife should be conducted, including birds, mammals, reptiles, amphibians, invertebrates, fish, and aquatic invertebrates. These surveys are important for several reasons. Very little is known about the native plants and animals that inhabit the watershed and constitute its biodiversity. Natural areas are one of the main defining characteristics of the Crum Creek watershed, and are among the most vulnerable resources to be impacted by conventional land development practices.

IMPLEMENTATION ACTIONS

1) Detailed surveys of native plant and wildlife communities should be conducted. Such surveys can be done with the assistance of botanists, naturalists, ornithologists, bird clubs, and biology programs from nearby universities. Surveys should emphasize characterization of woodlands, wetlands, meadows and stream corridors, and assess species diversity, rare, threatened and endangered species. GIS and Global Positioning System (GPS) technology should be used for accurate mapping of key plant populations. The survey should include roadside locations, public access areas, and private properties in key locations (with landowner permission). The Ridley-Willistown Important Bird Area and the Crum Woods Stewardship Plan provides local models for this approach. Stewardship needs for individual species and habitat areas should be developed and implemented to sustain viable populations of all species.

2) The Natural Areas Inventories prepared for Delaware and Chester Counties should be updated and expanded every 3 to 5 years. Inventory recommendations for protection can be included in a GIS database for the watershed.

3) Establish a GIS-based Crum Creek Biodiversity Database. The survey information should be constantly updated and provided as a web-based GIS

Database accessible to local residents, groups and municipalities. Data on listed rare, threatened or endangered species should be kept general in terms of species and locations. This "living" database is ideally suited for the Smart Conservation interactive program established by Natural Lands Trust, which could be modified for this purpose specific to the Crum Creek watershed and adjacent watersheds.

4) Identify opportunities for reintroduction of locally extirpated wildlife species such as river otter, American beaver, native brook trout, and American shad. Provide breeding sites for species such as osprey, bald eagle, wood ducks, bats, purple martins, and barn owls.

5) Incorporate Big Tree Data from Historic Literature and from EAC Surveys into the GIS Database for the Crum Creek Watershed Conservation Plan.

13

ASSIST MUNICIPALITIES IN DEVELOPING GIS CAPABILITIES

GOAL

Develop Geographic Information System (GIS) capabilities in every municipality in the Crum Creek watershed, with a shared GIS database of information and maps based on this Crum Creek Watershed Conservation Plan.

IMPLEMENTATION ACTIONS

1) An assessment of current uses of and needs for GIS should be prepared. A Geographic Information System (GIS) is one of the most important tools for municipal governments throughout the Crum Creek watershed to use in guiding development and offsetting potential negative impacts of sprawl. To ensure that municipalities develop GIS capabilities, intermunicipal cooperation should address the need for technical and financial assistance in acquiring GIS software (and in some cases computer hardware), training for staff and volunteers, technical support from consultants, and sharing of data. The data from this Crum Creek Watershed Conservation Plan should be made available to all municipalities as a foundation for a GIS database. County Planning Commissions, CCWP and CRC can play important coordination roles for municipalities and groups in the watershed.

2) Assistance in writing and/or supporting applications for grants to acquire GIS systems should be provided.

3) Training programs for municipal staff and volunteers in the use of GIS should be provided. A recent GIS workshop for communities in the Perkiomen Valley was held by PEC and yielded good turnout and sharing of information. This type of forum should be organized for the Crum Creek and neighboring watersheds as a means of coordinating current and potential GIS efforts and data among municipalities and organizations.

14

ESTABLISH WATERSHED-WIDE ENVIRONMENTAL EDUCATION PROGRAMS

GOALS

- *Establish watershed-wide education programs and implementation projects to raise watershed awareness and promote better coordination and effectiveness in addressing watershed issues.*

- *Raise the awareness of local residents, businesses and groups about the importance of the watershed, their potential impact on water resources, and their potential involvement in watershed conservation activities.*

IMPLEMENTATION ACTIONS

1) Form an Alliance of conservation organizations to establish and coordinate education programs and implementation projects in communities throughout the Crum Creek Valley. The Crum Creek Watershed Partnership is a model for this type of coalition of government and non-profit groups, and regularly convenes to address watershed awareness and coordinate implementation projects. The recommendations of the *Crum Creek Source Water Assessment* highlight the need for this level of coordination.

2) Establish a Crum Creek Legal Defense Fund . This fund can provide local communities and organizations with a means of addressing major land development plans or land use activities that pose potential threats to the quality or quantity of surface water or ground water.

3) Expand Chester-Ridley-Crum Watersheds Association's Role in Organizing citizen groups to participate in watershed-related activities. These groups may include employees of professional organizations, corporations, and local businesses, volunteer service organizations, neighborhood associations, boy scout and girl scout groups, and students. They can be mobilized to assist in various environmental activities such as stream cleanups, riparian buffer plantings, water quality monitoring programs, and stream-naming initiatives (as

demonstrated in Edgmont Township). CRC has effective volunteer programs organized around numerous watershed events.

4) The Chester-Ridley-Crum Watersheds Association should work with partners to develop a traveling watershed educational/informational program to use in presentations to area schools and local groups. This type of program could use multi-media approaches such as slides, video, PowerPoint, watershed poster brochures, and large-scale maps, and could be scripted to allow numerous members of CRC and the Crum Creek Watershed Partnership to easily make the presentation.

5) Establish a "speakers bureau" of volunteers to provide "watershed updates" in public meetings. Volunteer speakers can regularly attend Board of Supervisors and Planning Commission meetings in local municipalities and provide talks that cover positive gains in water resource conservation and restoration efforts, and outline issues and concerns. Links between land use and water resources should be stressed. Some events can be coordinated with those held by the Delaware County Institute of Science.

6) Establish a watershed-based curriculum in local schools. This initiative should involve cooperation between local conservation groups, environmental educators, the school board, principles and teachers. A watershed-based curriculum , based in part on existing programs established by organizations in neighboring watersheds such as the Brandywine Valley Association, Green Valleys Association, and Delaware Nature Society, should be introduced to elementary and secondary schools in the watershed. This initiative should stress a holistic approach to watershed education involving field studies, identifying solutions to watershed problems, and student participation in hands-on restoration projects along streams and wetlands in the watershed. This type of curriculum should be considered a means of addressing current statewide environmental education requirements.

7) Make funding available for the Chester-Ridley-Crum Watersheds Association to promote quality watershed education to public and private schools in the watershed and to work with municipal EAC's to involve the watershed community in monitoring and reforestation programs. Name all un-named tributaries to Crum Creek to raise public awareness about streams; provide signage at all stream crossings to show the name of the tributaries (Schnabel, 2001).

8) A dedicated demonstration site should be established in the watershed for students to engage in long-term watershed restoration projects. This type of site should be located in an area where classes can regularly participate in soil

preparation, seeding and planting of native vegetation, and ongoing vegetation management and learn about the water quality and quantity benefits of their work. Restoration goals can include establishment of native forest, wetland, stream and meadow communities, and also establishment of sustainable food production systems such as edible landscaping and forest gardens with native fruits and nuts, and vegetable and fruit gardens. The Marple Environmental Advisory Board coordinates such efforts at schools.

9) Coordinate implementation of watershed management actions and public participation**.** *(Crum Creek Watershed Action Plan, 2002, pg. 20)*

10) Adopt municipal regulations to prevent draining of swimming pools into streams (or storm sewers draining to streams) instead of sanitary sewers (leading to a wastewater treatment plant).