Darby Creek Watershed River Conservation Plan

Darby Creek Valley Association

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Executive Summary

EXECUTIVE SUMMARY

A. Darby Creek Watershed River Conservation Plan

Introduction and Purpose

This River Conservation Plan is intended "…to foster development of locally initiated river conservation plans which restore, maintain or enhance the river resources throughout the Commonwealth; to provide financial and technical assistance for local river conservation planning activities; to establish a Pennsylvania Rivers Conservation Registry to recognize rivers or river segments which have an approved river conservation plan; and to encourage state and local organizations to take actions that are consistent with local river conservation plans." (Pennsylvania Department of Conservation and Natural Resources) Generally, River Conservation Plans are intended to inventory significant river resources, identify potential threats to these resources, and recommend restoration, maintenance, or enhancement options in the form of a set of management strategies, all based on a vision of the watershed's future.

The Darby Creek Valley Association applied to the Pennsylvania Department of Conservation and Natural Resources in 1998 and was awarded a grant to prepare this RCP for the Darby Creek Watershed, including Cobbs Creek. DCVA and its consultants have spent approximately the last two years developing this Draft Plan in conjunction with many other Watershed stakeholders in this highly urbanized, extremely complex watershed which includes 31 municipalities and four counties. The Watershed is a watershed of great challenge, where remarkable opportunities are balanced by an intimidating array of problems. Challenges notwithstanding, it is the vision of this Draft RCP to unify the energies and resources of this complex watershed of contrasting elements and build programs that will restore the Darby Creek Watershed with its rich history and culture, its wonderful landscape from the Piedmont Hills of the Waterloo Mills Preserve down to the Tinicum Marsh, and its valuable life forms, including the approximately 500,000 persons who call the Watershed home.

Draft Recommendations developed during the course of this RCP process take the form of a Goal-Based Action Plan (Section VII), summarized in this Executive Summary. Goals and Program Actions follow a summary of findings based on the different substantive sections of the Plan.

Draft RCP Recommendations

A variety of resource inventories have been developed for this Draft RCP; these resource inventories are critical when taken and understood individually, constituting important independent resource elements in the Watershed. However, their significance is even greater when these resources are linked and viewed together, forming a kind of "***ribbon of green***." This "ribbon of green" is the core of the Darby Creek Greenway vision (Figure i-1) at the heart of this Draft RCP. These resources together create a critical lineal system of those remaining cultural and ecological resources in this heavily developed-altered-impacted Watershed. The ultimate vision of the Greenway would come to be full implementation of the Goal-Based Action Plan, as set forth below, to the maximum degree, integrating conservation of critical ecological values with the remarkable historical and archaeological features present here, all linked through a complex of active and passive recreational elements. The potential user benefits of the Darby Creek Greenway Vision, given the large Watershed populations involved here, would be enormous, especially when understood in the context of the many community needs characterizing so many of the existing municipalities. The potential benefits could even reinforce economic revitalization efforts underway in the Watershed.

Implementing the Darby Creek Greenway Vision concept borders on the utopian and in any case can be expected to be extremely challenging. Nevertheless, this unifying concept can serve as a guide for step-by-step implementation, as Municipality A puts in place a mile of streambank and riparian zone restoration, as Municipality B develops a walking/biking trail, as Municipality C mounts preservation efforts for valuable historical mills and other floodplain structures, as authorities begin to plan for streamside interceptor sewer reconstruction. Ultimately, the puzzle will begin to fill in and take shape. And the Vision will become real.

B. Summary of Watershed Resources

Watershed Population and Land Use

The Watershed is home to approximately 500,000 persons, with as many as 150,000 residents in the Philadelphia portion of the Watershed. Across a large number of socioeconomic and demographic indicators, the Watershed reveals a wide variation from top (upstream) to bottom (downstream), from total population and population density to median household income to median housing values/land values to land development activity. Lower Watershed communities are generally older and economically challenged; upper communities are newer, less dense, and rank as some of the richest communities in the region, if not the State. Land use statistics reflect this Watershed variation as well, though at this point virtually the entire Watershed is developed. Upper communities are characterized by substantially more lower density residential development. Open space, public or private, is scarce, with the Heinz Refuge (public) at the bottom of the Watershed and the Waterloo Mills Preserve (private) substantially upstream being notable exceptions, as well as Philadelphia's very significant Cobbs Creek Park in the Cobbs Creek Sub-Watershed. Planning and zoning tend to be comparably disparate, ranging from sophisticated and progressive programs in upper Watershed communities to dated plans and ordinances which characterize lower communities.

Earth Resources and Water Resources

Geology and soils of the Watershed are relatively non-notable. Obviously building constraints can be overcome, though sometimes at environmental cost. The Watershed has experienced substantial development in floodplains, loss and disturbance of natural riparian areas, encroachment on wetlands, development on slopes, with increased development pressures threatening remaining sensitive areas more and more. Impacts have been greatest in the lower portions of the Watershed where development often has pre-dated many environmental regulations. Water resources, both quantity and quality, have been equally affected by land development of the Watershed. The water cycle has been altered, not so much by wastewater and water supply infrastructure as one might find in other watersheds, but especially by the proliferation of paved and other impervious surfaces throughout the Watershed, at extremely high levels in lower Watershed communities and still remarkably high in the upper part of the Watershed. The Watershed's natural hydrology has been dramatically impacted, with runoff and flood flows increasing dramatically with severe effects on streambanks and stream morphology, and with dry weather baseflows greatly diminished. Water quality has been impacted as well, with substantial loads of nonpoint source pollutants contributed throughout most reaches of the Watershed, plus pollution from combined sewer overflows, from leaking sanitary sewers, and other sources. A large number of Watershed streams have been listed on PADEP's List of Impaired Streams.

Biological Resources

Both terrestrial and aquatic biota reflect the changes made to the land and water realms. Woodland areas and zones of native vegetation are scarce in the Watershed, though somewhat less so in upper Watershed communities. Surprises of "islands" of vegetation remain, particularly along the often steeply sloped stream valleys where development has been deemed too problematic in the past. In terms of aquatic biota, values reflect water quality. Fish species, macroinvertebrates, and other biota typically indicate a degraded to severely degraded environment.

Recreational and Cultural Resources

As is so often the case, recreational needs are greatest in those areas least able to provide for them. Municipal park and recreation offerings not surprisingly vary substantially from the more affluent municipalities in the upper portions of the Watershed to the financially strapped communities in the lower portions of the Watershed. The disparities reflect the history of development as well, where older development simply lacked the community service standards later put in place to help guide the emergence of the more recent suburban communities. There are exceptions, not the least of which is the significant Cobbs Creek Park and Parkway created by perceptive Philadelphians many years ago. Historically, the Watershed is replete with historical values, from the Lenni Lenape through post-Colonialization. Some of the earliest settlement in the nation occurred here. Although some municipalities have developed management programs to conserve and protect these resources, the majority have not. Many cultural resources have already been lost; it is imperative that no more follow in their wake.

The Goal-Based Action Plan is designed to conserve this Watershed wealth. It will take time and patience as the determined commitment of Watershed stakeholders propels the implementation of this ambitious RCP program, one step at a time.

Draft Goal-Based Action Plan for Darby Creek Watershed River Conservation Plan

Goal A Restore Stream and Tributary Corridors, Provide Riparian Buffers, and Protect and Restore Wetlands

Program Actions

Stream Protection/Restoration

- Municipalities must adopt improved/more rigorous Floodplain, Riparian, Wetlands regulations as described below.
- Based on the stream morphology analysis being conducted as part of the Darby Creek Act 167 Stormwater Management Plan, the Munro report, the Heritage Conservancy, and other appropriate sources, government groups (Delaware County and Chester County Conservation Districts as well as municipal groups) and environmental organizations such as the DCVA should apply for grants and work to identify those most highly impacted stream segments where restoration is of greatest concern (issues include bank stabilization and restoration, canopy restoration, removal of abandoned/dysfunctional bridges and other structures, re-vegetation, etc.).
- Municipal groups and others such as the DCVA should apply for state and other grants to restore high priority stream segments, as identified above; restoration may include a variety of streambank stabilization techniques, re-vegetation and planting with appropriate native species, and more complex and costly removal of deteriorated instream structures deemed to be harmful to stream and overall Watershed health.
- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should canvass funding/grant sources such as Federal 319 program, Federal USDA-NRCS CRP and other programs, Pennsylvania's Growing Greener, Stream Releaf, the North American Wetlands Conservation Council, and others for application for all projects under Goal A.
- Environmental/watershed groups such as the DCVA must work to educate municipalities, other government groups and Watershed stakeholders regarding the functional importance of stream corridors, floodplains, riparian buffer zones, and wetlands (all of the targeted elements of Goal A).
- Lead by example: Municipalities/counties/other government agencies should integrate state-of-the-art floodplain, riparian buffer, and wetlands protection and restoration techniques into all of their programs and at all of their facilities (e.g., municipal maintenance crews could immediately start to refrain from mowing to streambanks, allowing taller meadows to emerge.

Riparian Buffer Protection/Restoration

- Protection of Existing Buffers on Existing Developed Sites as well as New
- Developing/Re-Developing Sites: Municipalities must adopt riparian buffer ordinances in their respective zoning ordinances.

Figure i-1 Conceptual Greenway, draft

Figure i-1 Conceptual Greenway, draft

- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for grants to study in detail the riparian corridor extant throughout the Watershed and prioritize zones of riparian need, building on Heritage Conservancy work.
- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for grants to implement specific riparian buffer projects (i.e., re-vegetation) based on priorities established by the study described above.
- Restoration of Lost Riparian Buffer: Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA must educate site owners and encourage them to establish riparian buffers with proper re-vegetation where these buffers have been removed; this can be done with assistance of state and other grants to cover direct/indirect costs (see above).

Wetlands Protection/Restoration

- Protection of Existing Wetlands on Existing Developed Sites as well as Developing/Re-Developing Sites: Regulation of wetlands is a function of State and Federal government. Municipal programs should reinforce these programs.
- Restoration of Lost Wetlands/Protection of Existing Wetlands: Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA must initiate projects to replace lost wetlands and acquire existing wetlands with assistance of state and other grants to cover direct/indirect costs.
- Promote the recharge of groundwater and overall maintenance of the water table in order to protect the hydrologic connection so critical to wetlands formation; see the stormwater discussion below.

Goal B   Restore Floodplain Where Feasible – Remove fill and abandoned structures. Prevent future filling and encroachment.

Program Actions

- New Development and Re-Development of Developed Sites: Municipalities must regulate floodplain encroachment more thoroughly, prohibiting structural encroachment and even disturbance of the natural floodplain vegetation/soil mantle. These restrictions go beyond the minimum FEMA requirements adopted by Watershed municipalities.
- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for grants to remove abandoned structures in the floodplain.
- Existing Development in the Floodplain: Educate existing owners to seek alternative locations for their land uses, residential and other. Explore non-financial incentives, positive and negative, for discontinuation of existing uses in floodplains.

- Municipalities should use special grant programs (e.g., FEMA's Hazard Mitigation Grants, Repetitive Loss Buyouts, etc.) to buy out existing uses, remove structures, and fill.

Goal C Improve Stormwater Management – Manage Quantity and Quality for both new development and re-development.

Program Actions

- New Development and Re-Development of Developed Sites: Municipalities must adopt more rigorous municipal stormwater management regulations which regulate total quantity/volume as well as water quality; see model ordinance. Pursuant to this, the RCP advocates model stormwater management ordinance requirements consistent with the model ordinance being developed pursuant to the Act 167 Stormwater Management Plan for the Darby Creek.
- Existing Development: For all those existing sites with either no stormwater management or partial/ineffective management (i.e., detention basins), the RCP advocates a program of education to make basin owners understand the need for corrective action. The RCP recommends that municipalities, watershed organizations such as DCVA, and other private entities use state/federal/other grants in the future to retrofit any existing basins for better quality/quantity functioning. Municipalities and/or groups of municipalities should consider undertaking special stormwater flooding mitigation projects with areawide benefit for the most serious problem areas. These projects might include specific structures as well as more nonstructural basin-wide actions.
    - Radnor Township is currently undertaking a variety of projects to remediate existing stormwater problems, both at specific sites (structural) and in broader sub-basins (non-structural)
    - Springfield Township also is exploring retrofit strategies for various problem areas.
- In those situations where no stormwater management exists, special studies and use of state/federal/other grants will be necessary for structural measures to mitigate existing stormwater/flooding problems, possibly to be accomplished through multi-municipal planning efforts. See Floodplain above.

Goal D Improve Development Patterns, Including Re-Development Practices, to Protect or Restore Stream Corridors, Maintain Open Space, and Protect/Promote Ecological Resources.

Program Actions

- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for state and other grants for open space acquisition and related projects, with focus on stream corridor greenway locations; all existing and future open space opportunities (e.g., the Haverford State Hospital site) should be given the highest priority for open space acquisition.

- Municipalities should revise municipal codes to require/promote open space, including protection of existing open spaces and creation of new open spaces, in the land development and re-development process; open space standards will varying by Watershed context; incentives, such as density bonuses, can be added to promote open space protection/creation.
- Municipalities should revise municipal codes to require/promote: cluster development and open space design, low impact development which includes reduction in impervious areas through setback reduction, reduced parking requirements where appropriate (or sharing of parking and other techniques to "green" parking lots), reduction in street widths, reduction in unnecessary, costly, and environmentally unfriendly systems such as inlets and storm sewer systems when vegetated swales and other environmentally friendly systems are viable options, and all other techniques to concentrate development in the least Watershed area.
- Educate all Watershed stakeholders, including municipal officials, regarding the importance and overall cost-effectiveness of open space conservation. See below.

Goal E Increase Open Space and Recreation – Restore access to the stream corridors. Protect existing open space and create new open space.

Program Actions

- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for state and other grants to study stream access needs and to prioritize access opportunities.
- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for state and other grants (PADCNR and others) for open space acquisition and related projects, with focus on stream corridor greenway locations.
- Municipalities should revise municipal codes to require/promote open space, including protection of existing open spaces and creation of new open spaces, as well as recreational facilities and "fee in lieu" requirements.
- Municipalities and other public and private Watershed groups should intensify work with land trusts/conservation groups in order to maximize use of conservation easements and related land stewardship techniques.
- Municipalities, individually and together, must work to promote the importance of trails and trail development along streams, using both paid and volunteer labor.
- Municipalities should strive to acquire conservation easements, both donated and purchased, for trail development on privately held parcels along streams or which provide access to streams.
- Municipalities and all Watershed organizations directly and indirectly should promote the work of land trusts and conservancies (i.e., conservation easements), such as the Brandywine Conservancy and Natural Lands Trust; indirect support can be provided by making sure that assessments reflect donated easements, removal of development rights, etc.

- Utilize the resource of Pennsylvania's *Growing Smarter* program to improve comprehensive planning, plus the resources of the Governor's Office of Local Government Services

Goal F Identify and Protect Historic, Cultural, and Ecological Resources.

Program Actions

- Municipalities should revise municipal ordinances to require/promote inventorying and conservation of natural/ecological resources; in conjunction with this effort, municipalities should consider formation of Environmental Advisory Councils (EACs) to assist in this significant effort..
- Watershed groups, from municipal agencies to private non-profit organizations, should mount an intensified campaign to combat the proliferation of invasive species with their increased adverse ecological impacts, with particular focus on deer and Canadian geese as problem species. This issue should be an important element in overall educational programming; for example, instructive materials should be readily available for municipal officials and others explaining how to eliminate Canadian geese habitat so that populations are not further increased.
- Municipalities and other governments groups should prepare an inventory of stream segments which are either buried or channelized and prioritize segments for remediation.
- Municipalities/other government groups should undertake to expand the inventory of cultural resources in the Watershed and work to prioritize these resources.
- Municipalities should revise municipal ordinances to require/promote inventorying and conservation of cultural resources.
- Watershed educational institutions (e.g., the Delaware County Community College) should expand their programs involving local history and environmental issues.
- Municipalities should directly support the DCVA Stream Clean-Up Day and should consider expanding this program; other specific cleanup programs should be considered.
- Educate. See below.

Goal G Foster Inter-Municipal Cooperation and Involvement - Coordinate efforts to encourage municipal interaction and planning on a watershed basis.

Program Actions

- Coordinate with and support the on-going efforts of the Darby-Cobbs Watershed Partnership and its members, the DCVA, and other watershed-related groups and programs.
- Encourage continuing watershed-based planning by municipalities and groupings of municipalities through inter-municipal planning strategies, as facilitated by Acts 67 and 68 of 2000, amending the Municipalities Planning Code, and creating inter-municipal planning. This planning could be Watershed-wide or be sub-Watershed-wide; agencies such as the Delaware County Planning Department should work to promote the

advantages of such planning for the benefit of potentially affected municipalities (i.e., the potential benefits of unification of the very small municipalities comprising the lower portions of the Watershed in Delaware County, in terms of environmental planning, municipal services planning, legal requirements for provision of all land use types, and so forth).

- Prioritize comprehensive planning on a county-wide basis, with the Chester County award-winning *Landscapes* as a model, now reinforced by the new *Watersheds* plan and *Linking Landscapes* plan for open space planning; the emerging comprehensive plan for Delaware County should be a top priority and should feature the watershed principles set forth in this Draft RCP.

Goal H Educate – Educate residents, municipal officials, teachers and others, and increase awareness of the stream, the watershed, and its resources and problems.

Program Actions

- DCVA and other Watershed organizations should develop and implement a Watershed Education Campaign, including all elements below.
- DCVA and other watershed organizations should work to increase watershed curriculum in public/private schools.
- DCVA and other Watershed organizations should work to increase Watershed resources available in public library system, in the Intermediate Unit, and other locations, including the electronic GIS database developed for this RCP.
- DCVA and other Watershed organizations should work to increase Watershed awareness of municipal/other government officials.
    - Highlight stormwater management (e.g., storm drain labeling for nonpoint control)
    - Highlight floodplain management
    - Highlight riparian buffer management
    - Highlight wetlands
    - Highlight all aspects of better Watershed planning (see above).
    - Highlight benefits of joint municipal planning on a Watershed level.
- DCVA and other Watershed organizations should develop program strategies for better use of EACs in the Education Campaign.
- DCVA and other Watershed organizations should consider short-term public relations strategies to promote all of the above, including a Darby Creek Week, intensifying Clean Up Day, and so forth.

Goal I Manage Land Development-Related Activities that Affect Water Quality to Reduce Pollutants - Malfunctioning wastewater systems, fertilizer and lawn maintenance, animal waste (including geese), and hazardous waste degrade water quality and create nonpoint source pollution.

Program Actions

- Support recommendations of Delaware County Sewage Facilities Plan Update (Eastern Plan of Study); attach high priority to remediation of leaking sanitary sewers and any other untreated wastewater sources.
- Support the combined sewer overflow (CSO) abatement program of the Philadelphia Water Department
- Support and closely follow planning processes for toxic/hazardous waste sites in the Watershed.
- Municipalities should revise municipal ordinances to minimize creation of artificial landscape and promote naturalized areas, use of native species, and so forth.
- Municipalities should promote use of minimum disturbance/minimum maintenance site development techniques, including reducing lawn area and promoting meadow and reforested zones with native species, especially to prevent/reduce creation of Canadian geese habitat.
- Educate. See above.

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I. Introduction & Background

I. INTRODUCTION AND BACKGROUND

A. THE RIVER CONSERVATION PLAN FRAMEWORK

The Darby Creek Valley Association (DCVA) and its technical consultants, Cahill Associates, have prepared this River Conservation Plan (RCP) for Darby Creek under a grant provided by the Pennsylvania Department of Conservation and Natural Resources (PADCNR). Additional funding support has been provided by the Delaware County Council directly, with matching in-kind labor and services provided by DCVA itself and Watershed municipalities. The Darby Creek RCP builds on a variety of previous studies of Darby Creek and its tributaries.

PADCNR has several purposes in mind for all river conservation plans:

- To foster development of locally initiated river conservation plans which restore, maintain or enhance the river resources throughout the Commonwealth;

- To provide financial and technical assistance for local river conservation planning activities;

- To establish a Pennsylvania Rivers Conservation Registry to recognize rivers or river segments which have an approved river conservation plan; and

- To encourage state and local organizations to take actions that are consistent with local river conservation plans.

Generally, River Conservation Plans are intended to inventory significant river resources, identify potential threats to these resources, and recommend restoration, maintenance, or enhancement options in the form of a set of management strategies, all based on a vision of the watershed's future. To the extent possible, River Conservation Plans also are encouraged to identify *specific projects* that will be eligible for funding from other PADCNR grant programs in the future, as well as from Pennsylvania Department of Environmental Protection (PADEP) *Growing Greener* grants.

PADCNR has established a four step planning process to guide this planning, which is being followed for this Darby Creek Watershed planning, which includes:

- Step 1 Determine public interest
- Step 2 Collect and analyze resource data
- Step 3 Prepare draft plan
- Step 4 Prepare final plan

In order to accomplish these River Conservation Plan goals in general - and especially in the case for the highly diverse Darby Creek Watershed, public participation and involvement is critical. Because there are so many different municipalities in this Watershed (31) and because these municipalities play such an important role in so many elements of watershed life and decision making, municipal involvement and cooperation early on has been recognized as essential to the success of this Darby Creek Watershed RCP. First, the Plan consultants needed input from the municipalities to identify the key natural, historic, and recreational features and facilities within each municipality, as well as to provide land use and land use management information. Identification of Watershed issues and problems has relied heavily on municipal input, as has the process of establishing Watershed goals and undertaking the visioning that is so important for this Plan. Ultimately, identification of general types of restoration and conservation projects, as well as specific project listings, is also very much influenced by municipal participation, though not exclusively.

The public participation process developed for this Darby Creek Watershed Plan has included a series of public meetings (evening) strategically located throughout the Watershed, as well as municipal meetings typically held during daytime hours for municipal staff and officials. Special Watershed posters have been prepared and distributed for display in each municipal building to help engender Plan interest and momentum. Building on the resources (and relationships) of an already well-established Watershed organization, DCVA's quarterly newsletter and other regularly scheduled events also have been used to promote the RCP process. In some cases, special individual municipal meetings have also been arranged. The Watershed Study Advisory Committee (Municipal and Non-Municipal; see Appendix A for a listing of all those invited to participate in the Municipal and Non-Municipal Watershed Study Advisory Committee) has been formed, including municipal representatives as well as a special list of priority Watershed professionals, and has been especially instrumental in the difficult work of defining Watershed projects and prioritization of Watershed projects.

All of these efforts notwithstanding, all participants fully acknowledge that so much remains to be done. The hope is that this RCP, reinforced by continuing efforts of the DCVA as well as the Darby-Cobbs Partnership (see below), will serve as the impetus for truly meaningful Watershed conservation.

B. THE DARBY CREEK WATERSHED STUDY AREA

The Darby Creek is an especially ambitious River Conservation Plan, given the Watershed's complexity and high degree of urbanization. Darby Creek is located within southeastern Pennsylvania and flows into the Delaware River, south of the Schuylkill River and the City of Philadelphia (Figure 1-1). The Watershed straddles the Fall Line, the imaginary physiographic line separating the Coastal Plain, vividly exemplified by the John Heinz National Wildlife Refuge at Tinicum, from the rolling hills of the Piedmont. The Darby Creek Watershed includes more than 77 square miles and includes portions of Chester, Delaware, Montgomery, and Philadelphia Counties, with all or parts of 31 municipalities. Most of the Watershed is located within Delaware County. Major tributaries of the Darby Creek include Cobbs Creek, Naylors Run, Indian Creek, Langford Run, Little Darby Creek, Julip Run, Ithan Creek, Meadowbrook Run, Wigwam Run, Foxes Run, , Muckinipattis Creek, Hermesprota Run, Stony Creek, and Whetstone Run, all of which combine to flow into the tidal Darby at the John Heinz National Wildlife Refuge at the Darby's juncture with the Delaware River, south of Little Tinicum Island. The Refuge is the largest remaining freshwater tidal wetland in Pennsylvania. Tidal influence exists throughout this lower portion of the Darby and its tributaries, extending varying distances upstream on tributaries like the Muckinipattis, Stony, and Hermesprota, and also to old impoundment such as on the mainstem and the Cobbs.

Historically, the Watershed has developed from the lower downstream portions in Delaware County, which were some of the earliest settlements in the nation, as well as outward from the City of Philadelphia. This older development tends to be very dense; most of it pre-dates any sort of stormwater management and other site development regulations. At the other extreme are the upper portions of the Darby Creek Watershed in Chester County, where development is much more recent and where development continues to compete for a rapidly dwindling supply of developable land, though this newer development tends to benefit from somewhat improved stormwater management and other site development regulations. Although an exact count has not yet been done, the Watershed, though not large by watershed standards, is home to a population that approaches 500,000 people (484,000 estimated by the Darby-Cobbs Watershed Partnership), for an average density of nearly 10 persons per acre. Its many businesses and economic enterprises provide many thousands of jobs, ranging from the robust high tech office parks at the top of the Watershed (e.g., the Radnor Corporate Park including the former Wyeth Ayerst complex) to the many aged and declining heavier industries in the lower part of the Watershed (Folcroft Industrial Park).

Urbanization of this Watershed with the resulting changes to the natural landscape has taken its toll, especially upon water resources. These changes have often substantially altered the natural characteristics and flow patterns of streams. Both direct human intervention as well as natural forces associated with surging flows from increased stormwater runoff have straightened once slowly meandering streams, scouring streambeds, and eroding stream banks, making it difficult for aquatic life continue, let alone thrive. With so much encroachment onto the natural floodplain by development, flooding has worsened, extending to adjacent homes and properties not previously subject to flooding. In multiple cases, Watershed development, particularly in the floodplains, has exposed homes and businesses to more frequent flooding (Darby-Cobbs Partnership Status Report 2001)

As we know, the human relationship with watersheds has not always been a healthy one. Land development—progress—has often meant filling in of wetlands. Wetlands act as natural filters, cleaning stormwater runoff and protecting our streams, and further act to mitigate flooding. The streams' natural floodplains, the land adjoining the streams, were paved in many places, destroying their natural buffers. Factories and homes were built, and sewers were constructed in the stream corridors to drain away wastewater.

Until recently, the impact of these changes to the land and streams—to watersheds—has not been fully understood. The landfills, tank farms, and industrial facilities which once operated along the Darby and Cobbs Creeks, have leached chemicals into the streams over the years. Aging interceptor sewer lines paralleling the streams have heaved and cracked over the years and now appear to be leaking. Portions of the Watershed built with combined sewers (where storm sewers are connected to sanitary sewers) invariably discharge untreated wastewater into streams during storm flows (and sometimes even after the storm surge has passed, if the combined sewer overflow regulators malfunction). Sediment from land disturbed by development upstream has been transported by stormwater runoff into the stream system. Urbanization increases the volume and velocity of stormwater runoff, so that contaminants deposited in the streets and on paved areas, such as oil, gasoline, metals, and other substances are washed away and then deposited in the stream system. We are only beginning to address the problems caused by shortsighted land use and development practices.

In fact, as much as this is a watershed of commonalities, this is a watershed of contrasts. It is a watershed of many personalities, often divergent in nature. It is a watershed of considerable wealth. It is a watershed of perplexing poverty. In short, unity of watershed planning comes to be a most challenging goal, where the goals and objectives of the stakeholders in one portion of the Watershed can be widely divergent from the goals and objectives of stakeholders in another part. The contrasts between low income realities in dilapidated row housing found in lower Watershed neighborhoods to the plush fox hunt “Philadelphia Story” estates at the top of the Watershed could not be more stark! As a consequence, Darby Creek RCP preparers have realized early on that the inventorying and analysis of the Darby Creek Watershed must respect these many distinctions—as well as acknowledge the commonalities and Watershed linkages where they exist—in order for the Plan to be properly focused, accurate, and ultimately successful. Therefore, although the Plan would be too cumbersome to discuss data from each of the thirty-one municipalities on an individual basis, from time to time groupings have been developed which highlight these important Watershed distinctions.

C. THE DARBY CREEK VALLEY ASSOCIATION (DCVA) AND THE STUDY ADVISORY COMMITTEE

Darby Creek Valley Association is a nonprofit watershed organization dedicated to the protection and enhancement of the Darby Creek Watershed and its resources, including water, wildlife, historical sites, floodplains, wetlands, and riparian zones. A major goal is the immediate prevention of all forms of pollution in the Darby Creek and its tributaries, including prohibition of all forms of dumping and construction within floodplain zones and maintenance of a debris-free stream through clean-ups and expanded public education programs. DCVA has worked energetically to support protection of historic properties, such as the Swedish Cabin and Blue Bell Inn, and has as its ultimate goal the development of a 30-mile greenway system to serve this Watershed's many highly urbanized communities. DCVA, with assistance from the US Environmental Protection Agency (USEPA), also supports a volunteer water quality monitoring program. DCVA continues to work energetically with public schools, the Delaware County library system, the Delaware County Environmental Network, the Philadelphia Water Department and the Darby-Cobbs Partnership, the Partnership for the Delaware Estuary (formerly Delaware Estuary Program), the Delaware County Historical Society, the Stroud Water Research Center, the Philadelphia Water Department, and Philadelphia Suburban Water Company.

DCVA is committed to preparing a River Conservation Plan for the Darby Creek that provides a vision for the restoration and protection of the Darby Creek Watershed, one that considers all residents and interest groups, all neighborhoods, and all municipalities. As such this plan must be actualized through the cooperative efforts of the many diverse stakeholders in this Darby Creek Watershed. In a watershed where resources are so often rigorously competed for, this cooperative vision is no simple matter.

D. OTHER IMPORTANT PLANNING IN THE WATERSHED

In addition to this River Conservation Plan, several other very important planning and management processes are ongoing in the Darby Creek Watershed. Given the seriousness of the Watershed challenges, it is of paramount importance that these major efforts be effectively coordinated and they work together successfully. The good news is that solving this Watershed's special problems can benefit greatly from these united efforts. The downside risk is that keeping all of these efforts straight is far from simple and at times can be frustrating.

The Darby-Cobbs Watershed Partnership

Partnerships are essential. Several years ago, the Philadelphia Water Department, realizing its critical role in the Cobbs Creek and other portions of the Darby system, initiated the Darby-Cobbs Partnership, with the support and endorsement of the State. PWD continues to financially support this important effort to unite Watershed stakeholders in a variety of ways. PADEP generally encourages the development of watershed partnerships as a mechanism to improve water quality and meet federal and state requirements. The Darby-Cobbs is one of several watersheds in the Southeast (others include the Wissahickon, the Tacony, etc.) where partnerships are being established with PADEP assistance. The mission of the Partnership is to improve the environmental health and safe enjoyment of the Watershed by sharing resources through cooperation of residents and other stakeholders in the Watershed. Partnership goals are to protect, enhance, and restore the beneficial uses of the waterways and riparian areas through improved watershed management. This management should seek to mitigate the adverse physical, biological, and chemical impacts of land uses as surface and groundwater moves through the landscape to waterways.

The Partnership is currently developing a Watershed Management Plan which will assist Watershed stakeholders in simultaneously meeting State and Federal regulatory requirements while defining and tackling local priorities for restoration and protection of waterways. Ideally, this Plan will also allow the Partnership stakeholders to apply for available funding for operation and maintenance of the Partnership as a consortium represented by the Watershed's stewards. The Watershed Management Plan is intended to include components that enable stakeholders to meet State required technical and public involvement requirements while at the same time, enable stakeholders to jointly develop goals and objectives for the Watershed. This will include the prioritization of problems, the evaluation of alternatives, followed by the overall Plan with recommendations targeted on a sub-watershed level. Partnership stakeholders will reevaluate the success of this Plan on a periodic basis to measure performance and to assess the need for Plan modifications.

A series of interrelated activities makes the Darby an especially good candidate for productive partnering. These activities include:

- **State List of Impaired Streams, 303d List, TMDLs:** Many sections of the Darby have been listed on the State's list of "impaired streams," as a result of PADEP's statewide assessment of streams (PADEP has conducted and continues to conduct an assessment of all waterbodies in the State as required by the Clean Water Act); "impairment" means that the waterway is not achieving its State-designated stream standards. One portion of the Darby Creek, the Hermesprota Creek, has been further listed on the State's 303(d) List. The CWA requires the development of Total Maximum Daily Loads (TMDLs) to be developed for both point (wastewater treatment plants) and nonpoint pollutant sources for these impaired waters which are listed on this "303d List." PADEP may decide in the future to list additional portions of the Darby system on the "303d List." Because all of the Cobbs Creek as well as several other sections of the lower Darby Creek and a few sections in the upper portion of the Watershed have been designated as "impaired" by the State, clearly water quality problems exist. Given the fact that the Darby has no significant point sources of pollution (e.g., wastewater treatment plants) as such, water quality improvement efforts are likely to focus primarily on nonpoint sources and their equitable allocation in order to meet CWA water quality standards in the Watershed.

- **PWDs Combined Sewer Abatement Program:** The PWD has undertaken a major pollution abatement program to reduce the impacts of combined sewer overflows (CSO's) on the Cobbs Creek. Combined sewers are often found in older cities where one pipe is used to convey sanitary sewage and storm water runoff. During wet weather, flows of stormwater and wastewater which exceed the wastewater treatment plant capacity are conveyed untreated to local waterbodies. In response to national policy addressing this issue and as part of a PADEP-approved plan, PWD is implementing a series of capital programs to increase the amount of combined flow that receives treatment. In addition, and in recognition that total CSO removal will still not allow the stream to attain water quality standards, PWD is developing a watershed-based control plan that will recommend controls for CSO discharges along with other point and nonpoint source pollution reductions necessary for the stream to attain beneficial use standards. Benefits of this work are substantial and an ambitious water quality sampling program has being undertaken by the City, extending beyond the Cobbs Creek portion of the Watershed. This data will be used to further confirm the nature and extent of the water quality impacts in the Watershed and will be used to begin the development of water quality solutions for the Watershed. This water quality intelligence is discussed further in Section IV.

- **NPDES Phase II:** All of the municipalities in the Watershed will be affected by the National Pollution Discharge Elimination System (NPDES) Phase II stormwater plan and permit requirements for Municipal Separate Storm Sewer Systems (all municipalities over a certain population and/or with a certain threshold population density must be permitted under the requirements of this new program; in order to obtain these permits, detailed Phase II plans will have to be prepared and submitted by each affected municipality. These permit requirements are being phased in the future under the administration of both PADEP and the US Environmental Protection Agency.

- **River Conservation Plan:** And of course DCVA is developing the River Conservation Plan.

Given the variety and level of activity, the development of a partnership on the Darby-Cobbs makes good sense. In addition to the PWD, the Darby-Cobbs Watershed Partnership includes a consortium of environmental groups, community groups, government agencies, residents, and other Watershed stakeholders. Specifically, the Partnership coordinates all of the various study and planning efforts ongoing and being planned for the future to maximize their positive effect on the Watershed. The Pennsylvania Environmental Council acts as Partnership coordinator. In addition to the PWD, partners at the present time include: DCVA, the Cobbs Creek Community Environmental Education Center, DCPD, the Montgomery County Planning Commission (MCPC), the John Heinz National Wildlife Refuge at Tinicum, the City of Philadelphia Fairmount Park Commission, USEPA, US Fish and Wildlife Service, Delaware River Basin Commission (DRBC), PADEP, PEC, Drexel University, and the Sunoco Corporation, and the list is growing. The Partnership is supported by the PWD and by various grants and will continue to function in important ways in future months.

Act 167 Stormwater Management Plan

The Delaware County Planning Department (DCPD), in cooperation with adjoining Watershed counties (Chester, Montgomery, and Philadelphia), is preparing an Act 167 Stormwater Management Plan for Darby Creek, funded in part through a PADEP grant. Preparation of this watershed-level study involves a complex planning process, with detailed inventorying and complex hydrologic modeling. The 167 Plan will identify stormwater problems and include development of new regulatory requirements which Watershed municipalities will be asked to adopt. It should be noted that Act 167 plans are designed to address future stormwater impacts from new development, not correct problems resulting existing development. Therefore, given the mostly developed status of the Darby Creek watershed, effectiveness of the plan will be limited to its ability to control runoff from future development. Although Act 167 plans have historically focused only on water quantity issues, recent re-interpretation of the Act now requires water quality considerations to be taken into account when managing future runoff. Because the 167 Plan is not on the same schedule as this RCP, various 167 outputs such as the model stormwater management ordinance cannot be provided as this document goes to press.

It should be noted here that Watershed issues (see below) for many Watershed stakeholders have been heavily targeted on a history of severe flooding which has occurred in selected portions of the Watershed, particularly in the lower portions of the Watershed (Upper Darby Township, Darby Borough and Township, and other municipalities). For those residents and stakeholders directly impacted by this flooding as well as for those municipal officials most severely impacted by this flooding, the expectation has been that the Act 167 Stormwater Management Plan, and even the River Conservation Plan, would solve these problems. Explaining how and why this is not the case has been challenging.

Act 537 Sewage Facilities Plan Update for Eastern Delaware County
Act 537 is a State-mandated program, requiring individual municipalities to undertake sewage facilities planning, establishing existing and future needs. In this case, Delaware County (Delaware County Planning Department) has volunteered to prepare a 537 plan update for the many different municipalities within the Darby Creek Watershed (eastern Delaware County), virtually all of which (excepting Newtown Township) also rely on the County's 1971 Sewage Facilities Plan. This planning is being undertaken with the Delaware County Regional Water Quality Control Authority (DELCORA), the regional authority created by the County to implement the 1971 Plan. With the exception of Tinicum Township which has its own municipal treatment plant, all of the Watershed wastewater is treated through the elaborate system of interceptor collection sewers plus large pump stations and force mains developed as part of this system; wastewater is ultimately treated at the City of Philadelphia Southwest Water Pollution Control Plant. The system is complicated by the existence of a variety of smaller authorities which own and operate localized collection facilities, including the Radnor-Haverford-Marple Authority, the Darby Creek Joint Authority, the Central Delaware County Authority, and the Muckinipates Sewer Authority, in addition to individual municipal authorities. In terms of remedying existing and future problems and planning for future needs, this 537 Plan is critical.

Many other individual projects, public and private, are occurring throughout the Watershed. A variety of specific projects are being undertaken by Watershed municipalities (see Section VII). Perhaps the most significant individual project is the ongoing analysis of the re-use of the former Haverford State Hospital site in the central portion of the Watershed (the site is expected to be conveyed from the State to Haverford Township). Although a portion of the large wooded tract was previously developed for mental hospital facilities, the bulk of this keystone Watershed site remains undeveloped and offers a tremendous conservation and recreation opportunity in this heavily developed Watershed. It is a wonderful opportunity for furthering the goals of this Plan.

In sum, each of these different projects and planning processes involves a series of actions which DCVA is striving to coordinate with this River Conservation Plan.

E. A BRIEF HISTORY OF WATERSHED PROBLEMS AND ISSUES

As a substantially developed watershed where development has often occurred at high densities predating even the most basic stormwater management regulations, the Darby Creek Watershed suffers from a variety of water resource, general environmental, and other Watershed problems. The significant change in the natural landscape with the tremendous addition of impervious cover undoubtedly has produced dramatic changes in the overall hydrology of the Watershed, if patterns existing in pre-colonial times were to be compared with the current day. First, stormwater runoff has increased such that serious flooding occurs in many different parts of the Watershed. This increased runoff means at the same time that far less water infiltrates naturally into the ground to replenish the groundwater, resulting in significant declines in stream baseflow. Stream flow quickly “flashes” into out of bank flooding during rains and then quickly sinks to a trickle after the rain stops. The flashy flood flows erode stream banks, scour away the natural pools and riffles so critical to the aquatic biota, and ultimately change the whole nature of the stream, its geomorphology in today’s terms. Flooding problems were demonstrated vividly in Springfield Township, Drexel Hill, Upper Darby (Naylor’s Run), Colwyn, Eastwick, and other Watershed communities during Hurricane Floyd. Flooding remains a serious issue in this Watershed.

On the water quality side, substantial nonpoint source pollutant loads, including sediment, are washed into the streams during and after rain events; this pollution combines with virtually constant (dry weather and wet weather) leakage from aging sanitary sewer interceptors which thread up and down Watershed stream valleys for many miles, as well as pollutant inputs from combined sewer overflows (CSOs) in the Cobbs Creek. Nonpoint loadings combine with various other hazardous waste site discharges, private wastewater treatment plant discharges, and miscellaneous sources such as a proliferating Canadian geese population to make overall water quality significantly degraded.

One of the most serious problems in the Watershed has been the direct impact of development on the stream system itself, from extensive channelizing and relocation of the stream to outright total piping, enclosure, and burial. Burial of the stream may solve one problem (though even this is questionable), but many more problems have been created! Indeed, as the result of this environmentally shortsighted and practically ineffective practice, many flooding problems have been exacerbated (burial of Naylor’s Run being a case in point). Water quality problems have worsened as well.

To make matters worse, land uses historically have encroached into the floodplain (many uses built before floodplain regulations). Still, floodplain encroachment continues even today as developers search out vacant parcels even with serious environmental constraints (many municipalities maintain minimum floodplain regulations which allow substantial disturbance of sensitive floodplain zones, provided that new uses are floodproofed). Frequent bridge abutments and old dam structures interfere with freeflow of the stream. Dumping has occurred and continues in many locations. Riparian buffers have been removed. Streambanks are often heavily eroded. Aquatic habitat has been seriously impacted. In short, the stream has been substantially impacted by human action.

The issues much transcend water resources. Most of the older development in the lower portions of the Watershed was constructed well before current environmental regulations and community service standards were put in place. These communities, so many built in the 19th century and early part of the 20th century, lack the recreational facilities, active and passive, which we now define as appropriate for healthy communities. Housing stock has aged and, as employment opportunities have radiated ever outward (and upward in terms of the Darby Creek Watershed), people have followed jobs. The lower communities have declined. Once prosperous neighborhoods have fallen into serious decline and suffer increasingly from the host of human-scale problems which are so often associated with this cycle of decline. Older neighborhoods are disposed of and cast aside by all those households or businesses having the economic mobility to keep moving. Meanwhile, infill development rapidly consumes what little vacant land remains in the Watershed, even as other properties go abandoned.

In many ways, the dilemma of the Darby Creek Watershed mirrors the dilemma facing so much of Pennsylvania and other older developed areas throughout the country. The end result becomes one of inefficient decay of older communities and rapid-fire destruction in zones of sprawling new development, all of it auguring watershed disaster as the “islands” of Penn’s Woods in watershed headwaters quickly vanish. The goal of this RCP is to reverse some of these trends and restore these Watershed values.

Figure 1-1, Study Area FOLDOUT

II.
Population & Land Use Characteristics

II. WATERSHED POPULATION AND LAND USE CHARACTERISTICS

A. POPULATION PROFILE

Population in the Watershed

Indisputably, the Darby Creek Watershed is home to many people. An exact count is difficult to develop, due to the fact that so many different counties and municipalities are involved and that Watershed boundaries cut through so many different municipalities, including some portions, omitting other portions. Table II-1 presents population statistics for the municipalities comprising the Watershed, omitting the very small portions of both Tredyffrin Township in Chester County at the top of the Watershed and relatively small portions of Lower Merion Township in Montgomery County. It is important to note here that these statistics are for entire municipalities. In some cases, sizable portions of a municipality extend beyond the Darby Creek Watershed boundary such that these statistics would overcount or overestimate the true Watershed counts. In the case of Philadelphia, US Census census tract boundaries were used to develop data; thirty-three census tracts have been aggregated, all or parts of which are contained within the Darby Creek Watershed. Again, because portions of these census tracts extend beyond the Watershed boundary, these statistics also overcount to some extent.

Notable from the table are the sheer size of the population numbers. Declines notwithstanding, Philadelphia population tops the list at 155,447 persons (probably closer to about 140,000 persons if the extra-Watershed census tract portions are removed). Upper Darby Township has approximately 80,000 persons, with Haverford Township at nearly 50,000, Radnor and Ridley Townships at 30,000 or more, and Marple and Springfield at about 25,000. At the same time, another reality emerges from the table—the large number of relatively small municipalities which also are found in the Watershed, such as Colwyn and East Lansdowne and Morton and Rutledge, right down to the tiny Millbourne Borough (810 persons in 2000). These municipalities are both very small in total population and are also very small in physical size, reflecting the historical high density development patterns which characterized Watershed communities as they were developing many years ago. Although there undoubtedly are advantages in having so many small municipalities comprise a Watershed, there is a clear downside when so many different sets of municipal officials, so many different planning commissions, so many different zoning ordinances and land development ordinances, and so many different comprehensive plans must be integrated when attempting to orchestrate a watershed-wide effort of any type. The tiny municipalities, such as Millbourne, Morton, Colwyn and Collingdale, have just as much land use authority and planning control as the much larger ones like Upper Darby, with its professional staffing and much larger budgets. Mounting effective action and covering all of the municipal bases (i.e., duties and responsibilities) that need to be covered, however, has been and will continue to be an enormous obstacle to be overcome. This reality features prominently in this River Conservation Plan.

Table II-1 Census Population Statistics for the Watershed Municipalities

Darby Creek Watershed Population Trends and Projections
(U.S. Census and Delaware Valley Regional Planning Commission)

Darby Watershed Municipalities	1990 Population	2000 Population	1990-2000 Change	2025 Projection
Aldan	4,549	4,313	-236	4,240
Clifton Heights	7,111	6,779	-332	6,160
Collingdale	9,175	8,664	-511	7,690
Colwyn	2,613	2,453	-160	2,110
Darby Boro	11,140	10,299	-841	9,300
Darby Twp.	10,955	9,622	-1,333	8,960
East Lansdowne	2,691	2,586	-105	2,220
Easttown Twp.	9,570	10,270	700	9,950
Folcroft	7,506	6,978	-528	6,330
Glenolden	7,260	7,476	216	6,370
Haverford	49,848	48,498	-1,350	48,040
Lansdowne	11,712	11,044	-668	9,890
Marple	23,123	23,737	614	23,110
Millbourne	831	943	112	830
Morton	2,851	2,715	-136	2,950
Narberth Boro	4,278	4,233	-45	4,100
Newtown	11,366	11,700	334	11,880
Norwood	6,162	5,985	-177	5,820
Philadelphia*	166,143	155,447	-10,696	n/a
Prospect Park	6,764	6,594	-170	6,200
Radnor	28,703	30,878	2,175	30,640
Ridley	31,169	30,791	-378	27,530
Ridley Park	7,592	7,196	-396	6,870
Rutledge	843	860	17	750
Sharon Hill	5,771	5,468	-303	4,830
Springfield	24,160	23,677	-483	22,320
Tinicum	4,440	4,353	-87	4,140
Upper Darby Twp.	81,177	81,821	644	69,300
Yeadon	11,980	11,762	-218	10,470
Delaware County	547,651	550,864	3,218	540,460

** data for Philadelphia in this table is based on the 33 Philadelphia Census Tracts which lie at least partially in the Darby Creek Watershed*

Also notable from the table are the frequent declines in total population from 1990 to 2000. The Philadelphia census tracts declined by almost 11,000 persons. Darby Borough, Darby Township, Lansdowne Borough, and Haverford Township all lost significant population, close to and even over 1,000 persons, 1990 to 2000. Many of the other smaller municipalities in the lower and middle portions of the Watershed also lost population, with smaller losses pro-rated on smaller sizes and population bases. These declines reflect a variety of population dynamics, including an aging population with increases in deaths, a reduction in average household size reflecting reduction in births, out-migration in general, out-migration of young people in particular, decline of employment opportunities, and other trends. These population losses were balanced to some extent by modest population increases in the upper Watershed municipalities, such as Marple, Newtown, and Radnor and Easttown, though growth even in these municipalities was not large. In many ways, the population story of the Darby Creek Watershed is reflected in that of Delaware County as a whole, where total County population remained nearly static, 1990 to 2000, obscuring the significant decreases occurring in the older "close in" municipalities being balanced by the growth still occurring in the "outer" municipalities. Perhaps the most surprising municipality was Upper Darby Township which increased population from 81,177 in 1990 to 81,821 in 2000, apparently successfully battling the trends which have so marked neighboring middle and lower Watershed municipalities which have been developed for many years.

Population projections also are provided on Table II-1. These projections have been developed by the Delaware Valley Regional Planning Commission for their Year 2025 regional planning activities; they are the "official" projections which are used by DVRPC for transportation and other official planning purposes and have been adopted by DVRPC as well as the regional counties, including Delaware County. Almost without exception, these projections demonstrate a very real continuation of the trends of population decline in Watershed municipalities. As a matter of fact, the population declines have been extended to municipalities such as Radnor and Marple and Easttown, which are also projected to lose small numbers of people. On the other hand much larger declines are projected for some of the larger municipalities in the middle and lower portions of the Watershed. For example, Upper Darby declines from 81,821 in 2000 to 69,300 in 2025, a loss of over 12,000 persons. Though not nearly as large in an absolute sense, losses are also relatively large in Ridley, Yeadon, Springfield, and Lansdowne, as well as the other middle and lower municipalities. Again, these losses can be explained by factors such as an aging population with increases in deaths, a reduction in average household size reflecting reduction in births, out-migration in general, out-migration of young people in particular, decline of employment opportunities, and other trends.

It should be noted that the Philadelphia portion of the Watershed is omitted from these projections. Although DVRPC prepares population for the City in toto, projections are not available for the more detailed census tracts. Given the substantial decline in these 33 census tracts between 1990 and 2000, it is likely that this decline will continue into 2025 as is projected for the City as a whole (these particular tracts are not characterized as a particular growth node or zone of intensive redevelopment efforts which would induce population growth).

Decline in population need not necessarily be negative, especially when the population base is so large as is the case in the Darby Creek Watershed. The modest declines in Radnor or Marple or Easttown in particular may be understood as balance or stasis in the community's development. Unfortunately, in most of the cases of decline in middle and lower Watershed municipalities, population declines are in fact reflective of overall economic decline and a variety of negative forces impinging upon these Watershed communities, and very much at odds with the concept of balance.

Population Density in the Watershed

Another important aspect of population is population density, especially in this particular Watershed where population density is so great. Table II-2 indicates persons per square mile, a more useful measure of development intensity than simple population counts, based on the 2000 US Census. Densities range from the 5-digit levels of Philadelphia, Upper Darby, Darby Borough, Millbourne, Clifton Heights, East Lansdowne to the greatly reduced density in Newtown (1,157 persons per square mile) or Easttown (1,805) or Radnor (2,233) or Marple (2,276) where the densities are literally only one-tenth to one-fifth as great as the middle and lower Watershed municipalities. Not surprisingly, density in the City of Philadelphia is nearly twice as great as that of any other municipality. At the same time, the point also should be made that densities even in the least dense portions of the Watershed, such as the Radnors and Easttowns, are reasonably high. Development is omnipresent! This is clearly a highly developed watershed.

A note should be quickly added here that density itself is not necessarily a negative concept in terms of overall planning and watershed management. Far from it! In this reality of low density sprawling growth consuming valuable watershed resources, density concentrations are something to be advocated. However, because higher density development has typically not been undertaken in an environmentally sensitive and in a manner which protects watershed values in this Watershed, density has historically come at a high environmental cost. Such is the case in the Darby Creek Watershed. At the same time, it is clear that, if these environmental impacts were to be effectively mitigated and if watershed values were to be restored, much of the dense development existing in middle and lower Watershed municipalities with its mixture of uses bears stark resemblance to the new urbanist/neo-traditional patterns which are being touted as "cutting-edge" by planners farther out in suburbs and exurbs, where rural watersheds are sprawling out with low density development at alarming rates. It remains a cruel irony that dense development patterns are being forsaken in the Darby even as large areas of relatively pristine watersheds only a few miles away are being rapidly consumed.

Table II-2 Population Density in the Darby Creek Watershed Municipalities

Darby Creek Watershed Population Density
(U.S. Census 2000)

Darby Watershed Municipalities	Persons/Square Mile
Aldan	7,310
Clifton Heights	10,934
Collingdale	9,959
Colwyn	9,812
Darby Boro	12,715
Darby Twp.	5,867
East Lansdowne	12,314
Easttown Twp.	1,805
Folcroft	5,057
Glenolden	8,693
Haverford	4,874
Lansdowne	9,203
Marple	2,226
Millbourne	13,471
Morton	7,542
Narberth Boro	10,583
Newtown	1,157
Norwood	7,389
Philadelphia*	24,138
Prospect Park	9,033
Radnor	2,233
Ridley	5,944
Ridley Park	6,919
Rutledge	5,733
Sharon Hill	7,101
Springfield	3,764
Tinicum	787
Upper Darby Twp.	10,738
Yeadon	7,351

** data for Philadelphia in this table is based on the 33 Philadelphia Census Tracts which lie at least partially in the Darby Creek Watershed, and had a total population of 155,447 in an area of 6.44 square miles*

Age Characteristics in the Watershed

Table II-3 provides information relating to age, with two categories, "17 and under" and "over 65," highlighted, using 2000 US Census data. These two categories are especially relevant in terms of this Darby Creek Watershed River Conservation Plan, especially in terms of addressing special recreational needs and opportunities. Though absolute numbers are of interest, of particular interest are the percentage calculations and where these percentages depart significantly from the County averages, especially in the municipalities with the larger base populations. Obviously, an especially large number of youth translates into particular recreational needs and demands. At the same time, especially large numbers of the elderly in the "over 65" age group also implies particular types of recreational needs and demands. Additionally, large groups of the elderly also can translate into special socioeconomic constraints such as larger portions of the population on fixed incomes and with special financial limitations, as is the case here.

Perhaps most telling is the "over 65" category. Watershed municipalities are significantly "older" than Delaware County at large with 9.5 percent of its total population in the "over 65" age group. Curiously, the large municipalities at the top of Watershed, such as Radnor, Newtown, Marple and moving down to Haverford and Springfield, have remarkably large percentages in this "over 65" age group (13.4 percent, 21.9 percent, 22.0 percent, 17.5 percent, and 20.3 percent respectively). The total of these age cohorts in absolute terms is surprisingly large. Moving downstream, the percentages in the "over 65" age group remain much higher than the Delaware County average, with Upper Darby Township at 13.7 percent having 11,201 persons in this category alone. Especially large percentages are also found in Ridley and Darby Townships but the percentages are uniformly large in virtually all of these middle and lower Watersheds municipalities. Curiously, although the absolute number of the aged in Philadelphia is large (21,440 for these 33 census tracts; the Plan for West Philadelphia reports an especially large population of elderly in the Wynnefield neighborhood), the percentage of 13.8 percent is not especially large. In sum, the Darby Creek Watershed includes an aging population. Many more elderly can be found in Watershed municipalities when contrasted with all of Delaware County and the region at large.

In terms of the "17 and under" category, the Delaware County average calculates to 24.7 percent and most of the Watershed municipalities appear to be relatively close to this County average. Patterns up and down the Watershed are difficult to detect. For example, the very suburban Radnor, where we might expect an especially large group of youth, offers the smallest percentage in the Watershed, only 19.5 percent, with the dense Colwyn offering the highest percentage of youth at 33.2 percent. The other large municipalities in the middle and lower Watershed also have large percentages in the "17 and under category" (Upper Darby at 25.2 percent, Yeadon at 24.4 percent, Ridley at 24.4 percent, Springfield at 24.0 percent, Haverford at 24.9 percent, Darby Borough at 26.5 percent). Perhaps the most interesting statistic is the very large 28.4 percent for Philadelphia, yielding a whopping 44,251 individuals; in combination with the aged count, Philadelphia emerges as a focus of youth. In sum, at the same time that there are a lot of elderly, there are a lot of children in the Watershed.

Table II-3 Age Characteristics of the Darby Creek Watershed

Darby Creek Watershed Demographic Characteristics: Age
(U.S. Census 2000)

Darby Watershed Municipalities	Age 0-17	(% of Total)	Age Over 65	(% of Total)
Aldan	982	22.8	684	15.9
Clifton Heights	1,748	25.8	1,009	14.9
Collingdale	2,477	28.0	1,127	13.0
Colwyn	814	33.2	241	9.8
Darby Boro	2,731	26.5	1,402	13.6
Darby Twp.	2,525	26.1	1,693	17.6
East Lansdowne	667	25.8	362	14.0
Easttown Twp.	2,260	25.9	1,821	17.7
Folcroft	1,872	26.8	935	13.4
Glenolden	1,781	23.8	1,103	14.8
Haverford	12,097	24.9	8,471	17.5
Lansdowne	2,535	23.0	1,537	13.9
Marple	5,178	21.8	5,234	22.0
Millbourne	222	23.5	70	7.4
Morton	628	23.1	418	15.4
Narberth Boro	944	22.3	537	12.7
Newtown	2,704	232.1	2,564	21.9
Norwood	1,574	26.3	717	12.0
Philadelphia*	44,251	28.4	21,440	13.8
Prospect Park	1,689	25.6	910	13.8
Radnor	6,012	19.5	4,143	13.4
Ridley	7,506	24.4	5,290	17.2
Ridley Park	1,542	21.4	1,397	19.4
Rutledge	261	30.3	99	11.5
Sharon Hill	1,523	27.8	693	12.7
Springfield	5,680	24.0	4,815	20.3
Tinicum	1,014	23.3	670	15.4
Upper Darby Twp.	20,635	25.2	11,201	13.7
Yeadon	2,876	24.4	1,814	15.4
Delaware County		24.7		9.5

** data for Philadelphia in this table is based on the 33 Philadelphia Census Tracts which lie at least partially in the Darby Creek Watershed*

Income Characteristics

Table II-4 provides data on median household income, based on the 1990 US Census (unfortunately, 2000 US Census data has not been made available for this RCP). Although the absolute values of the median household income numbers will be off (i.e., lower due to cost of living increases in the decade), many of the important relationships in Watershed municipalities will be evident in the 1990 data as well. For example, not surprisingly, Radnor, Newtown, Springfield, Haverford and Marple Townships have the highest median incomes ($51,762, $49,713, $49,541, $48,210, and $47,917 respectively, all of which form a fairly tight cluster). At the other end of the spectrum are Millbourne,Philadelphia, Darby Borough, Sharon Hill, Colwyn, Clifton Heights, and Darby Township ($21,759, $24,603, $26,705, $30,351, $30,482, $30,587, $30, 734 respectively). These municipalities as well as a considerable number of additional middle and lower Watershed municipalities (Upper Darby and Ridley Townships, for example) all have median household incomes which are seriously below the Delaware County median and where that Delaware County median is relatively low in contrast to the region at large.

It should be noted here that the Philadelphia income is the median for the entire City; it was not statistically possible to average or merge the different median values for the 33 census tracts in a meaningful way; it should be noted that many of the median values for the individual census tracts were below the $24,000 level. The Plan for West Philadelphia reports that income data for the West Philadelphia portion of the City (see discussion on this Plan below and the area designated as West Philadelphia) indicates a relative loss of ground, when compared with the total City ("The census shows that between 1960 and 1990, the median family income for West Philadelphia decreased from 92% of the citywide median family income to 86%."). The Plan reported that almost one in five West Philadelphia residents lived below the Federal poverty line as of 1990.

It also should be noted that although the absolute range of median household incomes, from Radnor's $51,762 to Millbourne's $21,759, may not seem to be all that great a gap (Radnor roughly twice that of Millbourne), the nature of statistics and of the computation of medians serves to reduce and normalize contrast. In fact, the Watershed range for median income is quite dramatic. Incomes in municipalities at the top of the Watershed are dramatically different than incomes in municipalities in middle and lower Watershed municipalities.

Table II-4 Income Characteristics of the Darby Creek Watershed

Darby Creek Watershed Income Statistics
(U.S. Census 1990)

Darby Watershed Municipalities	1989 Median Household Income
Aldan	$ 40,453.00
Clifton Heights	$ 30,587.00
Collingdale	$ 31,853.00
Colwyn	$ 30,482.00
Darby Boro	$ 26,705.00
Darby Twp.	$ 30,734.00
East Lansdowne	$ 31,321.00
Easttown Twp.	$ 66,723.00
Folcroft	$ 35,292.00
Glenolden	$ 31,796.00
Haverford	$ 48,210.00
Lansdowne	$ 35,795.00
Marple	$ 47,917.00
Millbourne	$ 21,759.00
Morton	$ 33,600.00
Narberth Boro	$ 41,823.00
Newtown	$ 49,713.00
Norwood	$ 37,113.00
Philadelphia*	$ 24,603.00
Prospect Park	$ 33,886.00
Radnor	$ 51,762.00
Ridley	$ 34,810.00
Ridley Park	$ 36,529.00
Rutledge	$ 40,208.00
Sharon Hill	$ 30,351.00
Springfield	$ 49,541.00
Tinicum	$ 32,390.00
Upper Darby Twp.	$ 32,356.00
Yeadon	$ 35,951.00
Delaware County	$ 37,337.00

** This figure applies to the entire City of Philadelphia; available data was insufficient to provide a median household income specific to the 33 Philadelphia Census Tracts which lie at least partially in the Darby Creek Watershed*

B. HOUSING PROFILE

Housing Units in the Watershed

Housing units in Watershed municipalities can be expected to reflect population statistics to a large extent, at least in terms of gross counts and densities. Table II-5 provides counts of units in both 1990 and 2000, based on the US Census. Obviously because the count of resident population in Watershed municipalities is high, the count of residences in Watershed municipalities is high, although some variation is introduced into this relationship due to

Table II-5 Housing Data in the Darby Creek Watershed Municipalities

Darby Creek Watershed Housing Data

(U.S. Census 2000)

Darby Watershed Municipalities	1990 Housing Units	2000 Housing Units	1990-2000 Unit change	% Owner Occupied
Aldan	1,816	1,817	1	73.3
Clifton Heights	2,836	2,883	47	60.5
Collingdale	3,483	3,404	-79	65.9
Colwyn	970	954	-16	60.0
Darby Boro	4,042	3,999	-43	54.1
Darby Twp.	3,941	3,868	-73	75.5
East Lansdowne	999	1,012	13	62.9
Easttown Twp.	3,491	3,862	371	85.4
Folcroft	2,623	2,629	6	74.8
Glenolden	3,055	3,198	143	61.5
Haverford	18,210	18,378	168	83.8
Lansdowne	5,115	4,999	-116	60.5
Marple	8,433	8,797	364	82.1
Millbourne	418	420	2	23.6
Morton	1,219	1,209	-10	52.1
Narberth Boro	2,044	1,904	-140	60.3
Newtown	4,433	4,690	257	78.4
Norwood	2,267	2,363	96	72.2
Philadelphia*	68,288	67,233	-1,055	66.1
Prospect Park	2,712	2,683	-29	59.2
Radnor	10,580	10,731	151	61.0
Ridley	12,276	12,544	268	73.3
Ridley Park	3,152	3,167	15	63.6
Rutledge	326	305	-21	82.6
Sharon Hill	2,251	2,246	-5	67.9
Springfield	8,604	8,800	196	90.4
Tinicum	1,796	1,876	80	64.0
Upper Darby Twp.	34,115	34,322	207	59.1
Yeadon	5,019	4,958	-61	59.4
Delaware County	211,024	216,978	5954	68.4

** data for Philadelphia in this table is based on the 33 Philadelphia Census Tracts which lie at least partially in the Darby Creek Watershed*

differences in average household size. Change in housing unit counts is interesting and demonstrates both a loss in existing housing units due to fire, demolitions, and other sources of loss as well as development and re-development activity. Municipalities with the largest housing unit absolute increases during the decade included Easttown, Marple, Ridley, Newtown, and Upper Darby Townships, with Springfield, Haverford and Radnor Townships next in line. Ridley and Upper Darby Townships are surprises, demonstrating that development and re-development is occurring to some extent in middle and lower Watershed municipalities. At the same time, the absolute number of units involved in any of these municipalities must be fully appreciated, especially when understood as the cumulative total of dwelling units gained over a 10-year period (1,561 unit increase on a 1990 total base of 144,691 dwelling units in the Darby Creek municipalities). For example, although Radnor is included in the list above, only 151 dwelling units were added during the entire decade, which is a very small number especially when viewed in terms of the total number of dwelling units in these largely populated and developed municipalities (a very important point in municipalities such as Upper Darby with 34,322 dwelling units, increasing only by about 20 units per year in the last decade). It should be noted that total dwelling units for all of Delaware County increased by only 5,954 units on a 1990 base of 211,024 units—a very small increase over 10 years, with development in the more rural municipalities being offset by losses in the City of Chester and other older high density communities.

Almost as many municipalities lost total dwelling units as gained total dwelling units in the Watershed, with Philadelphia, Collingdale, Darby Township, Darby Borough, Yeadon, and Prospect Park being the major dwelling unit losers. The large loss of 1,055 units in Philadelphia reflects its large population decline, although decline also undoubtedly resulted from reduction in average household size as well. Losses occurred generally in the middle and lower Watershed municipalities and though totaling only 1,648 dwelling units out of a total of 371,901 units in 1990 (again, with the exception of Philadelphia, all statistics are for total municipalities, as opposed to Watershed portions of these municipalities), these net losses still indicate a lack of strength in the real estate market in the Watershed and are a reflection of overall socioeconomic weaknesses in portions of the Darby Creek Watershed.

Table II-5 also provides data on residency status, namely percentage of dwelling units which are owner occupied. Owner-occupancy historically has been viewed as positive factor in community development. Delaware County's 2000 owner occupancy rate is at 68.4 percent, in contrast to the higher rates for Springfield, Easttown, Haverford, Marple, and Newtown (90.4 %, 85.4%, 83.8 %, 82.1 %, and 78.4 % respectively). Radnor flies in the face of the trend with its 61.0 percent owner occupancy, seemingly inconsistent with the reality of Radnor as one of the most upscale residential communities in the County, in the region, in the State. The surprisingly low owner occupancy can be explained by the large number of older high density apartment complexes which have been developed along Lancaster Avenue. Owner occupancy declines as one moves down the Watershed (Millbourne is at an aberrant 23.6 %), with most of these municipalities in the 50 and 60 percentile ranges, well below the Delaware County average. The Philadelphia census tracts are at a reasonably high 66.1 %.

Development Activity in the Watershed

Table II-6 includes a tally of dwelling units proposed for development or re-development in Watershed municipalities (Philadelphia data for these census tracts was not available at this time, though is discussed in more detail below). This data has been compiled from records at the Delaware County Planning Department (DCPD) and other sources and includes all developments which have been formally submitted to DCPD for review, regardless of the outcome of the review; developments may or may not have been constructed to date; if not already constructed, they may be constructed in the future. Developments include only residential units and exclude non-residential development. As with recent development statistics from the US Census, this data suggests a predominance of development activity in the upper portions of the Watershed, with Newtown being the focus of development (959 dwelling units), followed by Marple, Springfield, Easttown, and Radnor Townships. A total of 2,323 units were reviewed in the total of Watershed municipalities (excepting Philadelphia), almost half of which were in Newtown alone (81.6 percent were in the four municipalities listed above). Darby, Ridley, and Upper Darby Townships also had residential activity, though had less than 100 units in each case, during this 5-year period. Many of the middle and lower Watershed municipalities had either no residential proposals or very small numbers of residential proposals (often less than 10 units), indicating a very low level of demand for building activity over the 5-year period. There were 13,163 units reviewed during this period for all Delaware County municipalities, not a large number when contrasted with the other suburban counties in the region.

In Philadelphia, data as presented in the Plan for West Philadelphia indicate that "…the pace of residential construction has slowed." That appears to be true of all types of new land development in this part of the City, although re-devleopment projects using some form of public re-development assistance were more prevalent.

It should also be noted that at this point, most of the developable sites in upper Watershed municipalities have already been developed, so development activity in the current decade may actually drop significantly in this part of the Watershed as well.

Housing Values in the Watershed

Median values of housing units for Watershed municipalities are also given in Table II-6, again based on 1990 US Census due to the lack of availability of 2000 US Census data. As with household income data, the numbers can be expected to be uniformly low, in contrast to 2001 housing values; nevertheless, many if not most of the relationships in housing values existing today should be reflected in the older data as well.

This housing value data mimics the trends apparent in median household income, though the trends are considerably more pronounced. Median values range from Radnor's extremely high $266,700 and Easttown's $262,400 (keep in mind that this is a median and that these numbers are ten years old!) to Darby Borough's $48,100, which is dramatically lower than the County median and only 18.0 percent of the Radnor value. Philadelphia's value at $49,400 is

Table II-6 Development Activity in the Darby Creek Watershed

Darby Creek Watershed Housing Data
(U.S. Census and Delaware County Planing Department)

Darby Watershed Municipalities	1990 Median Housing Value	Proposed Housing Units, 1995-2000
Aldan	n/a*	1
Clifton Heights	$ 113,300.00	9
Collingdale	$ 85,900.00	0
Colwyn	$ 72,300.00	0
Darby Boro	$ 57,400.00	9
Darby Twp.	$ 48,100.00	92
East Lansdowne	$ 81,100.00	0
Easttown Twp.	$ 262,400.00	232
Folcroft	$ 74,900.00	0
Glenolden	$ 90,400.00	8
Haverford	$ 148,700.00	52
Lansdowne	$ 106,500.00	3
Marple	$ 164,200.00	319
Millbourne	$ 69,500.00	0
Morton	$ 103,300.00	12
Narberth Boro	$ 166,200.00	1
Newtown	$ 185,700.00	959
Norwood	$ 89,400.00	9
Philadelphia	$ 49,400.00	n/a*
Prospect Park	$ 92,100.00	21
Radnor	$ 266,700.00	204
Ridley	$ 103,000.00	85
Ridley Park	$ 115,600.00	12
Rutledge	$ 126,800.00	0
Sharon Hill	$ 73,400.00	3
Springfield	$ 152,400.00	226
Tinicum	$ 83,400.00	9
Upper Darby Twp.	$ 92,600.00	57
Yeadon	$ 79,300.00	0
Delaware County	$ 113,200.00	13,163

** "n/a" is used where data was not available; this does not necessarily mean that the value is zero* comparably low (again, this value is the median value for the entire City, averaging values for Society High and Chestnut Hill with those of North Philadelphia and South Philadelphia; it's hard to say whether the median for the Watershed portion of the City would be higher or lower than $49,400). This gap in median housing values is very important in terms of describing the Watershed and its many differences. Other upper Watershed municipalities also have higher median housing values with Newtown at $185,700, Narberth at $166,200, Marple at $164,200, Springfield at $152,400, and Haverford at $148,700, all well above the Delaware County median value at $113,200. There is then a dramatic drop in housing values to a level clustering crudely around $100,000 (Ridley Park at $115,600, Aldan at $113,300, Lansdowne at $106,500, Morton at $103,300, Ridley Township at $103,000, Upper Darby at $92,600, Prospect Park at $92,100, Glenolden at $90,400) with the remaining municipalities considerably below that level. These depressed housing values are good indicators of the extent of economic deterioration and stress that is being experienced by many municipalities in the middle and lower portions of the Darby Creek Watershed.

Some additional detailed housing value data can be gleaned form the Plan for West Philadelphia, which highlights the substantial variation in housing values even within the City portion of the Watershed. For example, the Plan reports that housing values for the row homes of the Cobbs Creek neighborhood averaged between $20,000 and $30,000 in 1990, versus the median sales prices of Green Hill Farms at over $150,000. In general, however, values have been losing ground in West Philadelphia neighborhoods, when compared with the remainder of the City. Vacancy data also indicate an increase in housing stock vacancies, again when compared with the remainder of the City.

Total Assessed Valuation and Municipal Millages in the Watershed

Table II-7 is based on median housing value data and further reinforces the trends apparent in housing. Obviously, a municipality's total assessed valuation is a very good measure of its fiscal health and overall economic health. In a state such as Pennsylvania where so much of the taxing authority and revenue potential is linked to the real estate tax, total assessed valuation is particularly important, especially where projects that require local revenues are concerned.

Table II-7 demonstrates an enormous range in total assessed values. Although as total assessments will increase as size of municipality increases, the variations that emerge from the data go well beyond variation in municipal size. For example, Radnor (13.8 square miles) has the highest valuation in the Watershed at $3,322,408,519 (10.6 percent of all of Delaware County, even though Radnor is only one of 49 County municipalities). Haverford ($3,053,167,386) is a close second, though with 10.0 square miles, Haverford is actually "more valuable" on a unit area basis. Marple ($1,787,774,175), Springfield ($1,688,465,909), Ridley ($1,417,999,088) and Newtown ($1,318,580,739) are next in a relatively close grouping, though again, Marple and Newtown are about twice the size of Ridley and Springfield. Curiously, there is then an enormous gap in assessments, down to Tinicum ($619,764,150) and Yeadon ($403,169,395) and Lansdowne ($403,180,222). Most municipalities fall in the less than

Table II-7 Housing Value and Millage Rates in the Darby Creek Watershed Municipalities

Darby Creek Watershed Municipality Assessed Values and Millage Rates (2000)

Darby Watershed Municipalities	Total Assessed Value 2001	Mun. Millage	Total Millage
Aldan	$ 172,811,030	3.91	32.20
Clifton Heights	$ 232,950,021	5.46	30.40
Collingdale	$ 234,108,184	5.53	30.20
Colwyn	$ 49,697,930	12.00	40.30
Darby Boro	$ 238,662,432	9.58	37.90
Darby Twp.	$ 327,681,640	5.69	30.30
East Lansdowne	$ 67,924,960	6.70	35.00
Folcroft	$ 268,863,230	4.64	29.30
Glenolden	$ 283,569,410	4.90	31.10
Haverford	$ 3,053,167,386	3.98	22.00
Lansdowne	$ 403,180,122	6.77	35.10
Marple	$ 1,787,774,175	2.44	16.60
Millbourne	$ 21,561,630	11.05	36.00
Morton	$ 129,231,090	4.65	24.10
Newtown	$ 1,318,580,739	1.63	15.80
Norwood	$ 218,302,530	5.85	32.10
Prospect Park	$ 253,799,240	5.04	31.30
Radnor	$ 3,322,408,519	2.55	22.30
Ridley	$ 1,417,999,088	4.34	27.20
Ridley Park	$ 378,093,900	4.12	27.00
Rutledge	$ 34,975,290	3.33	30.50
Sharon Hill	$ 196,570,580	5.56	30.20
Springfield	$ 1,688,465,909	3.70	23.20
Tinicum	$ 619,764,150	2.65	28.90
Upper Darby Twp.	$ 2,975,890,422	7.30	32.20
Yeadon	$ 403,169,395	6.60	34.90
Delaware County	$ 31,438,769,130	n/a*	n/a*

** "n/a" is used where data was not available or not applicable*

$400,000,000 category, with four less than $100,000,000 (Millbourne at $21,561,630). The point here is that trying to maintain a full range of municipal functions with such minimal resources becomes a tremendous challenge. Greatly complicating matters is the fact that the poorest municipalities typically are the ones with the greatest needs and expenses.

Table II-7 also presents data relating to municipal tax bills and millage rates in Watershed municipalities (Delaware County only). The municipal millage rate is given, indicating the amount of tax revenue raised from the real estate tax for municipal use only (other revenue sources are allowed); the total millage rate is given as well, indicating the constant County millage rate of 3.802 mills, plus a variable rate of school district millage (usually much higher).

Theoretically, these millage rates are levied on an assessed value which has been determined by the County and which is reflective of market values. In truth, however, the relationship between assessed value and market value is worthy of much discussion; many critics have alleged the existence of all types of biases across Watershed municipalities. In short, the municipal millages and total millages indicate that millages decrease dramatically in the Upper Watershed communities, with total millage for Newtown at 15.8, Marple at 16.6, Haverford at 22.0, Radnor at 22.3, and Springfield at 23.2. Contrast these rates with 40.3 for Colwyn, 37.9 for the Darby Borough, 36.0 for Millbourne, 35.0 for East Lansdowne, 35.1 for Lansdowne, and 34.9 for Yeadon. In sum, both municipal and school district budgets are extremely hard pressed to provide adequate levels of service where service needs are greatest, given the tremendous disparity in real estate assessed values and the heavy reliance on the real estate tax to support budgets.

C. LAND USE AND TRANSPORTATION

Historical Development Trends
As discussed in the Cultural Resources section of this Plan, development trends in the Darby Creek Watershed have radiated both outward, east to west, from the City of Philadelphia as well as upward, south to north, from the Delaware River and upstream. Some of the earliest settlements in the United States occurred in the lower portions of the Darby Creek Watershed, as embodied in the Watershed's Swedish Cabin (Creek Road in Clifton Heights), and Morton Homestead in Prospect Park, as well as the many early historical values just outside of the Watershed in and around the early settlement's of New Sweden on Tinicum Island (Tinicum Township). As these early colonial settlements continued, developments also followed, especially along the trails and the roadways that emerged.

Transportation Facilities
As a densely developed watershed, the Darby Creek Watershed has many different transportation facilities. Most of the highways have been in place for many years. Only the two "Interstate" highways are relatively recent, with the highly controversial Blue Route, completed in the early 1990's, being the most significant new highway in the Watershed. In fact, its decades of planning notwithstanding, the impacts of Blue Route development are still being defined.

Major highways include Interstate 476 (the Blue Route, Figure II-1), US 30, US 1 (Bypass) and Baltimore Pike, US 13 (Chester Pike) and Interstate 95 at the bottom of the Watershed (Figure II-2). All of these arteries are important as regional arteries and carry significant percentages of non-local or non-Watershed focused traffic through the Watershed. All of these arteries suffer from significant congestion problems. Additionally, major Pennsylvania routes in the Watershed include PA 3, 320, 420, and 252, which are more locally oriented in terms of their traffic loads but which are also seriously congested in most cases. Of course, there are many different state roads/legislative routes such as MacDade Boulevard, Lawrence Road, Springfield Road, and many others which carry heavy traffic loads in the Watershed.

Rail and bus facilities are notable in the Watershed (Figure II-3). The Watershed's distinguished transportation history is embodied in the 69th Street Terminal in Upper Darby, where subway and subway surface car systems extend outward from the City of Philadelphia and interchange with fixed rail (trolley) and bus routes radiating outward into the suburbs. Of major importance are the trolley lines to Media and the trolley line to Norristown, as well as the many bus lines which exist. Of special importance are the SEPTA Regional Rail Lines (Figure II-3), including the R-5 which cuts through the northern portion of the Watershed (stops in Wayne, St. Davids, Radnor, Villanova), the R-3 which runs to Media/Elwyn (stops in Fernwood, Lansdowne, Gladstone, Clifton-Aldan, Primos, Secane, Morton), and the R-2 which parallels the main AMTRAK line south (stops in Darby, Curtis Park, Sharon Hill, Folcroft, Glenolden, Norwood, Prospect Park, Ridley Park, Crum Lynne).

The Philadelphia International Airport (PIA) runway lies within the Darby Creek Watershed at its downstream southern terminus. Airport-related development is beginning to extend along I-95 in a southerly direction within the Tinicum Township portion of the watershed. Given the desirability of airport locations, it is likely that future airport-related development will continue.

Major Sources of Employment

Historically, major sources of employment for Watershed residents have been the City of Philadelphia and the industrialized waterfront of Delaware County, from the City of Chester down to Marcus Hook, where manufacturing, refinery, and other heavy industry has been located (also extending up the Watershed into Folcroft and other Lower Watershed municipalities). A

Figure II-1 Interstate 476, the "Blue Route", is a Major Transportation Feature in the Darby Creek Watershed

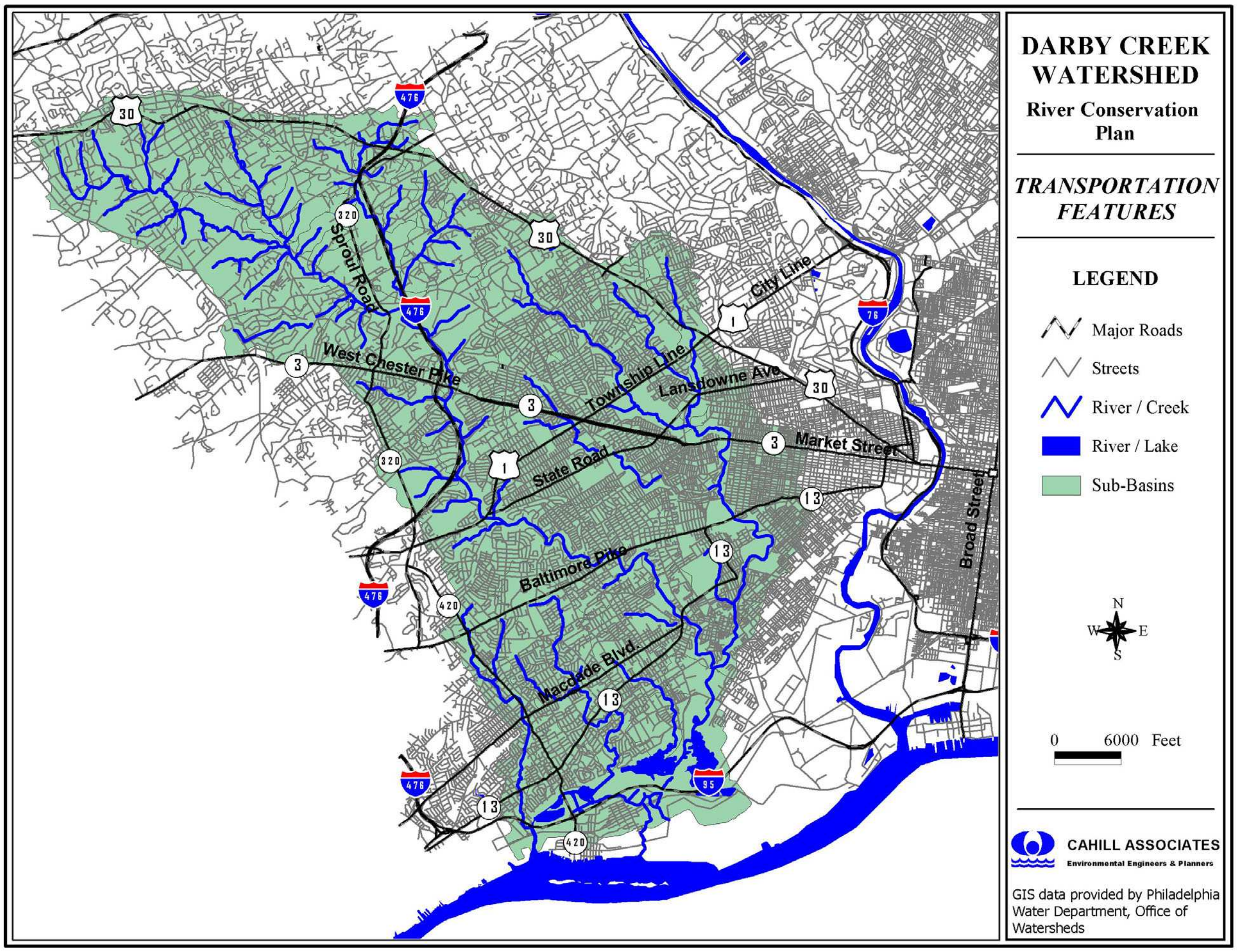

Figure II-2 Major highways and local roads within the Darby Creek Watershed

considerable number of manufacturing firms, making all types of products, also grew up within the Watershed itself. Commercial centers such as the 69th Street Terminal complex in Upper Darby emerged in time, in conjunction with transportation system developments (see above), providing many service sector jobs. Commercial strips proliferated along major highways such as old US 1 (Baltimore Pike) and PA 3 (West Chester Pike), and of course had always been present along the US 30 corridor where the Wayne Business District emerged, to some extent an extension of the Mainline development out of Center City. Post-World War II suburbanization, with its residential subdivisions and continued road building, created new commercial centers in places like Lawrence Park and St. David's, the vibrancy of which has now overshadowed the older employment centers farther down in the Watershed. Development of the Blue Route more recently has reinforced these commercial centers, and although its effects have probably been most pronounced to date in the northern (Upper) portions of the Watershed, some commercial intensification and job growth may still occur at interchanges to the south (MacDade Boulevard and others).

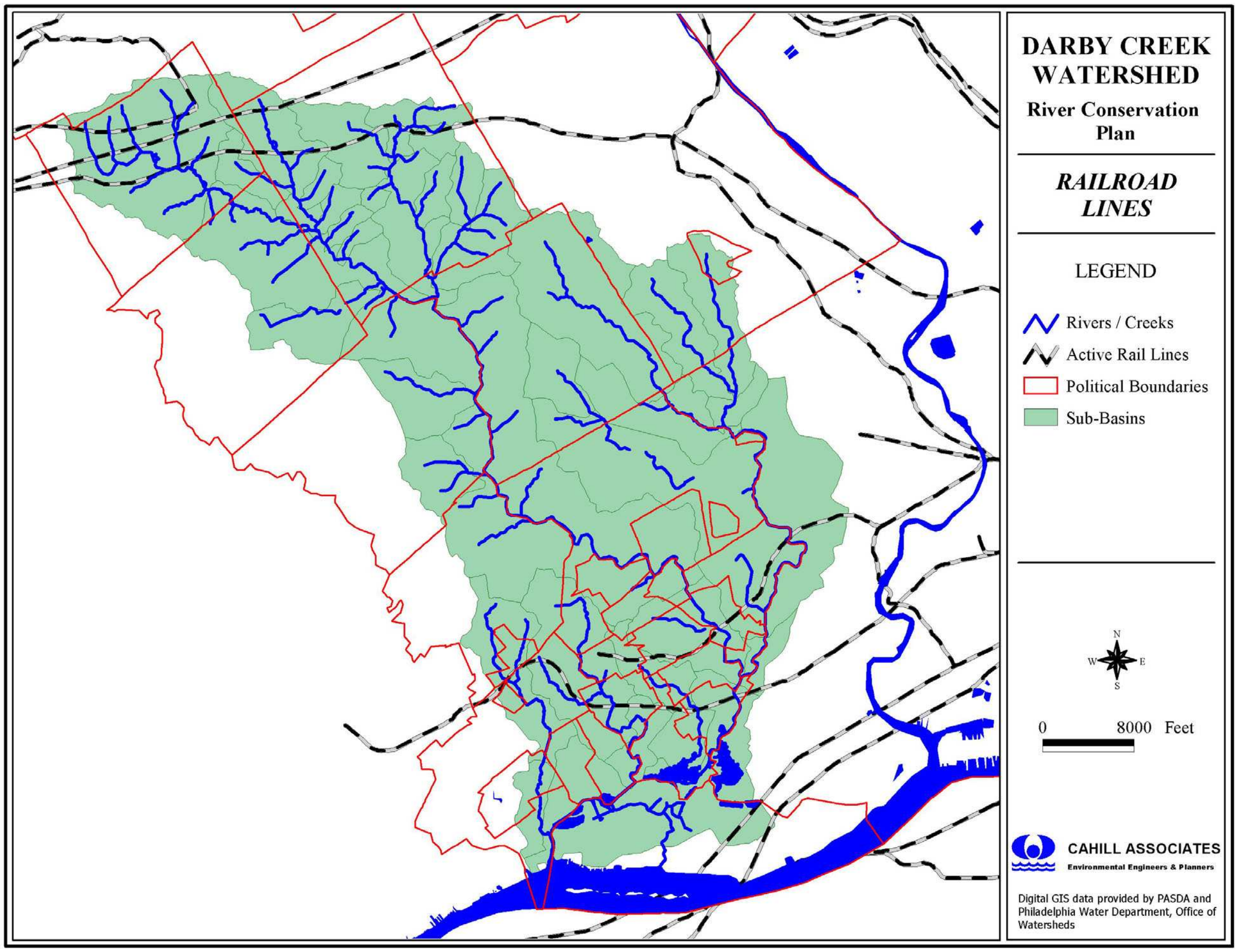

Figure II-3 Railroad lines within the Darby Creek Watershed

In the last half of the 20th century, this Watershed employment base has declined considerably. Clearly jobs have moved up the Watershed; far fewer jobs exist in the lower portions of the Watershed than have existed in the past. Alternatively, far more jobs now exist in Upper Watershed municipalities, such as Radnor with its burgeoning office parks; however, a considerable number of these jobs are held by non-Watershed residents. At the same time, the proliferation of employment in and around King of Prussia and along the US 202 corridor also offers employment to Watershed residents, though relatively few residents of the Lower Watershed appear to be able to participate in these employment opportunities for one reason or another.

Most recently, the construction of the Blue Route (I-476) has served as a stimulus for economic growth. Interchanges in the Watershed at Lancaster Avenue (US 30) and West Chester Pike (PA 3) and near the Watershed at US 1 are serving as magnets for new employment growth of various types as exemplified by Marple Township's Lawrence Park area.

Existing Land Use Patterns
Existing land use data has been developed by the Delaware Valley Regional Planning Commission, using a variety of categories as explained below and is presented in Figure II-4. The categorization has been based on interpretation of 1995 air photos. DVRPC uses standard land use categories, though some amplification is useful. For example, Low Density Residential includes all single-family detached dwelling units, even on small lots (in some parts of the Watershed that density could increase to 4 to 6 units per acre). High Density includes all other categories, from single-family attached units (townhouses) to apartments. Community Service includes hospitals, government buildings, churches, schools, and cemeteries. Transportation includes parking lots in this analysis; however, streets in residential subdivisions are categorized as Residential. Utility includes power generation, transmission lines, and all types of transmission towers, water and wastewater treatment, and landfills. Recreation includes parks, playgrounds, amusement parks, resorts and camps, golf course, and public assembly areas (i.e, both public and private facilities). Wooded includes those areas with a continuous tree canopy or solid tree cover, natural lands, marshes, and swamps; Wooded does not include hedgerows or wooded areas related to residences or other uses, to the extent that that can be interpreted. Vacant includes land that is not Wooded, not Agriculture, and not categorized as any other use. Because parcel boundaries were not used to classify uses in this process, clearly some error has been introduced in the classification. For example, it is likely that some Wooded areas are in fact included in parcels which are active developed land uses and therefore should be understood as part of these uses. A variety of other similar “confusions” may exist. However, the overall picture presented by this data is an accurate one and certainly appropriate for this River Conservation Plan.

Land use for the Darby Creek Watershed is given in Table II-8 using 24 land use categories as developed by the DVRPC. Due to the overwhelming amount of data resulting from recording 24 categories across 31 municipalities, the land use data has been grouped into the Upper, Middle, and Lower sections of the Watershed as shown in Table II-9; data for each municipality is available in Appendix B. There is no great significance to be accorded these Upper-Middle-Lower groupings other than the groupings provide a simplified way to perceive and compare land use patterns and the changes in land use patterns as one moves from the bottom or “mouth” of the Watershed to the top or headwaters. It should also be noted that although the major variable being used for the grouping process was intensity/density of land uses, liberties were taken in several instances (note that because of the intensity of land use in Philadelphia, the City was logically included in the Lower Watershed grouping). Municipalities included in these groupings are as follows:

Based on Table II-10 data, Residential land use, divided into Low and High categories, varies dramatically across the Watershed. Low Density ranges from a very high 61.8 percent in the Upper Watershed to only 19.8 percent in the Lower Watershed, averaging out to a very high 48.4 percent for the Watershed in total. High Density conversely varies from a very low 3.6 percent in the Upper to ten times that or 30.1 percent in the Lower Watershed, for a Watershed total of 12.9 percent. Recreation acreages, including all public and private uses, are modest across the

Figure 2-4, Land Use FOLDOUT

Figure 2-4, Land Use FOLDOUT

Table II-8 DVRPC Land Use Categories within the Darby Creek Watershed

Land Use Categories and Area for the Entire Darby Creek Watershed

DVRPC Land Use Category	Area, sq ft.	Area, acres	Area, sq. mi.	Percentage of watershed
Agriculture	44646247	1025	2	2.1%
Commercial /services	120335737	2763	4	5.6%
Community service	117458983	2696	4	5.5%
Manufacturing-heavy	1306500	30	0	0.1%
Manufacturing-light	28978065	665	1	1.3%
Military	248419	6	0	0.0%
Mining	1264390	29	0	0.1%
Parking-commercial/services	32561861	748	1	1.5%
Parking-community service	7931592	182	0	0.4%
Parking-manufacturing	4254792	98	0	0.2%
Parking-military	63206	1	0	<1%
Parking-multi family housing	2694444	62	0	0.1%
Parking-recreation	1044268	24	0	0.0%
Parking-transportation	1177366	27	0	0.1%
Parking-utility	97723	2	0	<1%
Recreation	166344433	3819	6	7.7%
Residential-multi family	107122381	2459	4	5.0%
Residential-row homes	170336456	3910	6	7.9%
Residential-single family detached	1042440460	23931	37	48.4%
Transportation	44041186	1011	2	2.0%
Utility	5291236	121	0	0.2%
Vacant	20969582	481	1	1.0%
Water	31479724	723	1	1.5%
Wooded	200051128	4593	7	9.3%

Table II-9 Watershed Municipalities by Sub-Region

Upper	Middle	Lower
Easttown	Aldan	Collingdale
Tredyffrin	Clifton Heights	Colwyn
Lower Merion	Darby Bor.	Darby Twp.
Narberth	East Lansdowne	Folcroft
Radnor	Lansdowne	Glenolden
Haverford	Millbourne	Norwood
Marple	Morton	Philadelphia
Newtown	Springfield	Prospect Park
	Upper Darby	Ridley
	Yeadon	Ridley Park
		Rutledge
		Sharon Hill
		Tinicum

Table II-10 Land Use Area by Watershed Subregion

Land Use Area for the Darby Creek Watershed Subregions, in Acres

CATEGORY	UPPER	MIDDLE	LOWER	TOTAL
Agriculture	1016	---	9	1025
Commercial/Services	1133	759	870	2763
Community Service	1266	734	697	2696
Manufacturing-Heavy	---	---	30	30
Manufacturing-Light	---	116	550	665
Military	---	---	6	6
Mining	29	0	---	29
Transportation	809	85	590	1484
Recreation	1504	515	1800	3819
Single Family Detached	16139	5250	2542	23931
Medium to High Density Resd.	939	1560	3871	6370
Utility	15	36	71	121
Vacant	57	41	384	481
Water	46	47	631	723
Wooded	3172	966	455	4593
TOTAL	26123	10107	12505	48736

board; though do show a modest increase from 4.7 percent to 5.8 percent from the Lower to the Upper Watershed. Utility acreage is extremely insignificant; Water is straightforward with the large acreage in the Lower Watershed largely explained by the extensive open water areas related to the Tinicum National Wildlife Refuge.

In terms of the more intensive land uses, Commercial/Services indicates a considerable area in the Lower Watershed, with considerable acreage in the Middle and Upper Watersheds, where the acreage is largest though percent is somewhat lower. This large accounting can be explained to some extent by the large corporate parks in Radnor as well as the Wayne Business District and other commercial and office development which is proliferating along Blue Route interchanges and along major Watershed arteries. In Montgomery County portion of the upper Watershed, there is the densely commercialized Ardmore business district as well as Narbeth shopping area. This is the heart of the area known as the "Main Line," extending from Merion, Narbeth, Wynnewood, Ardmore, Haverford, Bryn Mawr, Rosemont, Villanova, St. Davids, and Wayne (the originally defining rail line approximately followed the ridgeline and therefore the Watershed boundary, as does Lancaster Avenue/US 30; the exact Watershed boundary actually moves north and south to some extent), which remains a very vibrant zone much in demand; and where intensification of all land uses is likely. Community Services (see below) are surprisingly similar in absolute and percent ranges to Commercial Services. Manufacturing-Heavy is virtually nonexistent in any portions of the Watershed with Manufacturing Light a substantial contender in the Lower Watershed and less so in the Middle Watershed communities. Military and Mining are virtually nonexistent. Transportation has considerable acreage in all parts of the Watershed, though relatively is more present in the Lower Watershed where major rights-of-way for I-95 and other highways increase the numbers.

Community Service is distributed throughout the Watershed. This includes public and private schools, colleges and universities, and other institutions. There are some distinct uses located in the Upper Watershed, such as the large Haverford College campus, as well as notable institutions such as Lankenau Hospital, Eastern Theological Seminary, St Charles Seminary, Friends Central School, and a host of others all located along City Line Avenue.

Three land use categories, Vacant, Wooded, and Agriculture, are of special interest. These categories are often associated with designation of "vacant developable land" as an indication of future development potential, though of course Agriculture at the same time can and should be viewed as an active use of the land (i.e., not "undeveloped" as is sometimes assumed). Complicating the question of future development potential in this Watershed case is also the question of re-development which can and is occurring through demolition and intensification of land uses at previously developed sites. Though statistics are difficult to generate, it may well be that because the strength of the market for so many different uses is so strong in the Upper Watershed municipalities, such as at Blue Route interchanges, re-development has greater potential here than in the Lower Watershed municipalities, even though uses are often older and in greater "need" of re-development from a variety of perspectives. In so many areas, uses may be either actually abandoned or very marginally active, with existing sites substantially underutilized. In many cases, site contamination may be a problem or at least perceived as a problem. Though Pennsylvania has some of the nation's most effective award-winning "brownfields" re-development programs, these programs have not provided incentives adequate to generate developer interest. It's not clear that this situation will change in the forseeable future.

Looking at the data in Table II-10, Vacant land is almost nonexistent in both the Upper and Middle Watersheds. This is not surprising. The large offering in the lower Watershed appears to be an error, based on special analysis conducted for this RCP. In fact, much of these 1,031 acres happens to be the John Heinz National Wildlife Refuge (a better categorization would have been either Recreation or Community Service). Additionally, some lands appearing to be Vacant in these Lower municipalities are suspected to be the "brownfields" where development constraints can be considerable. In reality, "brownfields" typically suffer from significant contamination problems; categorization as Vacant implies a ready availability which is hardly the case. This type of situation may be especially problematic in the Lower municipalities (though not exclusively Lower) where a considerable amount of demolition and structural removal has created sites which appear to be vacant but which have numerous constraints which must be solved before redevelopment can occur. In fact, there is very little "vacant developable land" remaining in the Lower Watershed which has not already been developed and which is not characterized by contamination problems and/or severe environmental constraints of some sort.

Agriculture is also virtually nonexistent in the Watershed, although there remains over 1,000 acres in the Upper Watershed (to be adjusted when the 2000 data are available; some of this Agricultural use has probably been lost to other uses at this point). Finally, the Wooded category shows an increase from the Lower to Upper Watershed. Although Wooded values and percentages are not large, they are larger than one might expect in this densely developed Watershed, with much of the Wooded polygons following stream valleys where significant environmental constraints such as floodplains are also delineated (i.e., it would be ill-advised to equate Wooded with "vacant developable" in many cases). Vegetated portions of the John Heinz National Wildlife Refuge have been mapped as Wooded, increasing the Lower Watershed acreage artificially.

Developable Land is shown in Figure II-5, including all that land area as classified by the DVRPC into the following land use categories: Vacant, Wooded, Agriculture. These categories can be roughly construed as lands that are not already developed and that therefore can be reasonably developed without special difficulty (i.e., demolition and re-development), though certainly subject to the caveats discussed above.

Table II-11 presents additional data which translates land uses into levels of imperviousness, an especially important factor when understanding overall watershed health and more specific water

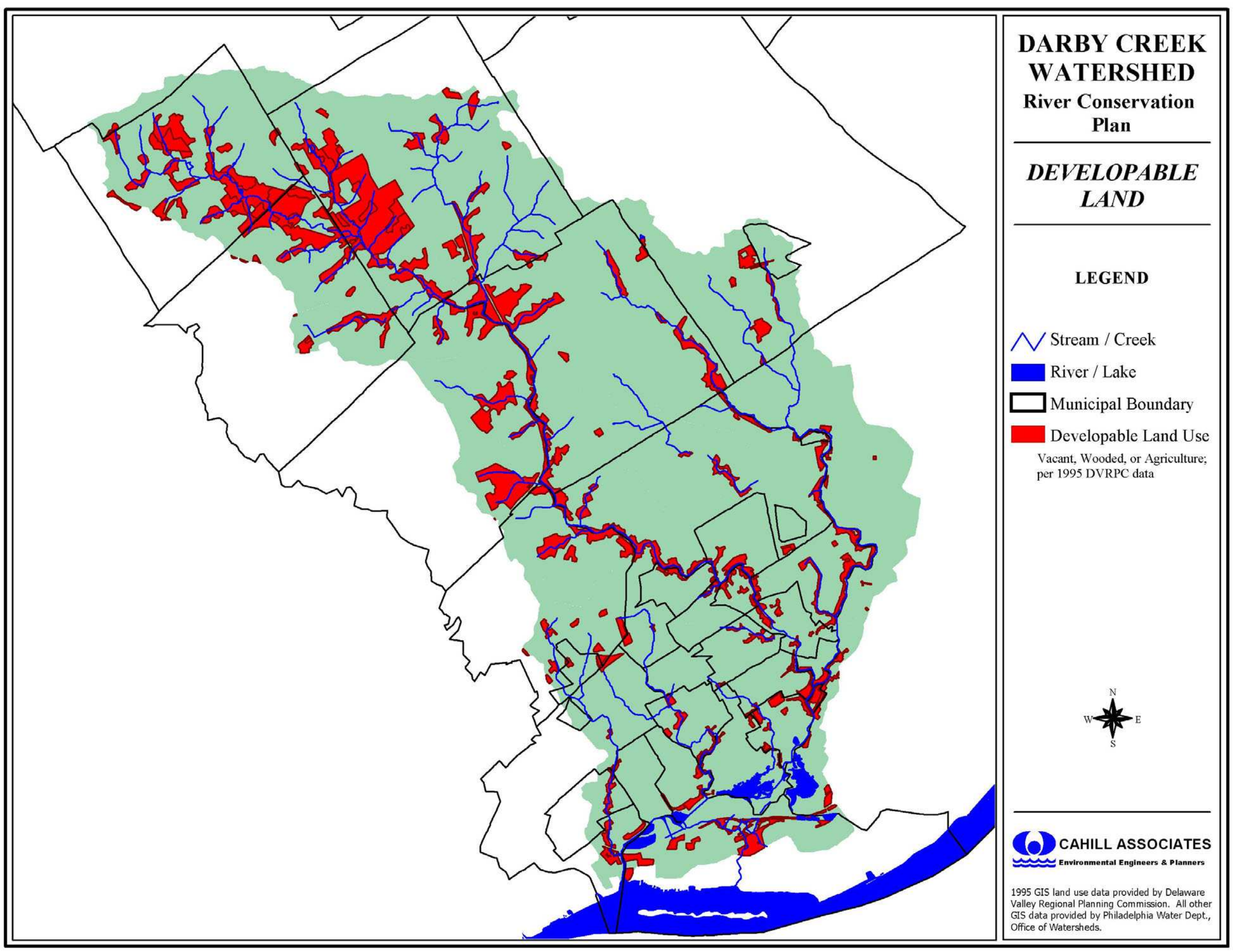

Figure II-5 Developable Land in the Darby Creek Watershed, (1995 Land Use, DVRPC) quality and water quantity issues. Using assumed levels of imperviousness for different land uses, which have been used by the Philadelphia Water Department in its studies as well as many other agencies; land uses have been translated into impervious acreages (again, these are not actual measurements of impervious area). Imperviousness ranges from 51.4 percent in the

Table II-11 Municipal Acreage and Impervious Acreage in the Darby Creek Watershed

Percentage of Impervious Acres Based on Land Use Categories for the Darby Creek Watershed Municipalities

Municipality	Percentage of Municipality Located Within Watershed	Percentage of Imperviousness PWD calc*	Impervious Area Within Watershed, (Acres)
UPPER			
EASTTOWN	70%	21.3%	781
HAVERFORD	100%	34.3%	2197
LOWER MERION	16%	36.7%	897
MARPLE	45%	30.2%	923
NARBERTH	85%	44.4%	119
NEWTOWN	40%	21.7%	563
RADNOR	82%	25.0%	1801
TREDYFFRIN	4%	42.1%	231
MIDDLE			
ALDAN	100%	43.0%	164
CLIFTON HEIGHTS	100%	54.4%	217
DARBY BORO	100%	51.3%	268
EAST LANSDOWNE	100%	56.3%	74
LANSDOWNE	100%	47.2%	356
MILLBOURNE	100%	52.3%	23
MORTON	95%	44.1%	97
SPRINGFIELD	62%	31.3%	779
UPPER DARBY TWP	100%	45.6%	2296
YEADON	100%	35.9%	370
LOWER			
COLLINGDALE	100%	46.5%	257
COLWYN	100%	57.3%	94
DARBY TWP.	100%	51.2%	470
FOLCROFT	100%	75.3%	679
GLENOLDEN	100%	43.3%	271
NORWOOD	100%	55.7%	295
PHILADELPHIA	5%	55.8%	2299
PROSPECT PARK	100%	53.3%	256
RIDLEY	41%	48.0%	661
RIDLEY PARK	43%	44.5%	131
RUTLEDGE	76%	39.1%	26
SHARON HILL	100%	50.0%	244
TINICUM	30%	54.9%	931

** Source: PWD, Technical Memorandum #2*

Lower Watershed to 44.6 percent in the Middle to 28.8 percent in the Upper Watershed. Even assuming that these numbers are approximated values and may be somewhat high or low, the numbers in total are extremely high and are further testament to the extremely high level of development which exists from the Lower to the Middle to the Upper portions of the Watershed. Even in the Upper Watershed, Radnor and Haverford Townships comprise very large portions of the Upper Watershed; their impervious percentages are 25.0 and 34.3, respectively, which are actually very high impervious percentages when based on total gross watershed areas. It should be noted that the Act 167 study will contain an analysis of actual current land uses and associated impervious cover and will address this issue in more depth.

City of Philadelphia: The Philadelphia portion of the Watershed (Cobbs Creek) is something of a special case in terms of land use patterns, notwithstanding the fact that it has been grouped somewhat artificially into the Lower Watershed category. Land use patterns in fact change tremendously as one moves form the downstream to the upstream portions of the City. For example, in the lower portions are commercial and industrial uses, increasingly related to airport-focused activity, as well as the John Heinz National Wildlife Refuge and the relatively newer residential neighborhoods of Eastwick. As one move upstream and into the general area of "West Philadelphia," densities and urban challenges increase. In stark contrast to this high density and highly impervious mix of older residential and commercial areas is the Cobbs Creek Park and adjacent Morris Park (all part of the Fairmount Park system) all of which provides a substantial "green belt" through the City, paralleling the Cobbs Creek Parkway. Moving farther upstream in the City, the nature of the residential and commercial development changes significantly as the Overbrook area is entered, as well as the more affluent and lower density neighborhoods adjacent to City Line Avenue. City neighborhoods which are at least partially located in the Watershed include: Wynnefield, Overbrook, Overbrook Park, Overbrook Farms, Green Hill Farms, Haddington, and Cobbs Creek.

Land Ownership (Public and Private)

The vast majority of lands within the Darby Creek Watershed are privately owned. Additional discussion of public lands is provided in the Plan's discussion of Recreation (Section VI). Public lands tend to be recreational lands which increase as one moves "up" the Watershed. Historically, the older communities have provided less in the way of public recreational and open space area than the more recently developed communities for a variety of reasons. A major exception to this, at least in several important respects, would be the City of Philadelphia and its Fairmount Park system, including the very significant Cobbs Creek Park and related Morris Park areas, which provides a significant greenway opportunity zone in the midst of densely developed neighborhoods, buffering Cobbs Creek and its tributaries. There are the very significant public recreational facilities sich as the The Willows in Radnor Township and Sharp's Woods Nature Preserve in Easttown Township. Additionally, there are significant masses of private institutional open space; the largest is probably the several hundred acres of Haverford College (which straddles the boundaries between Lower Merion and Haverford Townships, in Montgomery and Delaware Counties), as well as large institutional uses adjacent to City Line

Avenue. Although there is often intensive development associated with these uses, at the same time they also provide masses of undisturbed open space, wonderful scenic vistas, and undisturbed zones of wooded habitat. Some institutions provide exceptional recreational amenities; for example, Haverford College's campus is an arboretum, and provides public access to its perimeter nature trail.

Some "open" lands, such as the Waterloo Mills Preserve, are not publicly owned per se, but are owned by organizations such as the Brandywine Conservancy and function to some extent as public open space, although complete public access is not provided. Ultimately, the Conservancy intends to further "develop" this Preserve as a special environmental education center where limited public access will be provided. Other "open" lands would include large land holdings related to the Ardrossan Estate (Scott Family Farm), primarily in Radnor Township, where major portions of the estate have been protected by conservation easement and by limited development (mini-estates). Some of this land remains in agriculture use (leased to farmers), just about the last remaining agriculture in the Watershed. Not all of this Ardrossan Estate has been protected. Few other parcels in the Watershed are protected privately through the conservation easement mechanism.

Haverford State Hospital: Since the essential closure of the large nearly 200-acre Haverford State Hospital facility some years ago in Haverford Township, this site probably constitutes the most important land use issue in the Watershed. The site is centrally located in the Watershed and boasts one of the largest—if not the largest—remaining masses of natural vegetation remaining in this heavily developed Watershed. The site is currently owned by the State Department of General services, which will prepare a final request for site development. The State is expected to convey the site to Haverford Township in the relatively near future. Although there has been a considerable amount of development already at the site related to its institutional functioning, there remains a considerable amount of area—in fact, the bulk of the site—which is relatively undisturbed and wooded. A consultant, Carter Van Dyke Associates of Bucks County, was hired to develop alternative re-use concepts, which featured an office complex, an age-restricted housing, and an intensive recreational focus (all alternatives include a 135-acre nature preserve, a site for a municipal office building including banquet hall, and a community recreation center). Alternatives involved from 37 to 46 acres of buildings and parking area with from 7 to 9 acres of stormwater management basins. The Final Master Plan is patterned after the age-restricted housing alternative with the nature preserve and municipal and community complex included.

Obviously, the ideal re-use of the Haverford State Hospital site would be conversion to its natural Watershed landscape and vegetative cover. Such a re-use, necessitating extensive building demolition and removal, is simply economically nonviable. In fact, the re-use alternatives including the Final Master Plan maximize conservation objectives of the Watershed and this RCP even as reasonable economic re-use is accommodated. Even so, considerable additional development can be anticipated at the site. Re-development can be a wonderful

Watershed opportunity to apply state-of-the-art stormwater and overall site development principles, consistent with this RCP, at this keystone site. This can and should be a model of how to do it the right way!

John Heinz National Wildlife Refuge: The largest single public land holding in the Watershed is the approximately 1,200-acre John Heinz National Wildlife Refuge, most of which lies within the Darby Creek Watershed (the Refuge is located in both Delaware County and Philadelphia; given the subtlety of the drainage patterns in this part of the Watershed, coupled with extensive alteration of these patterns to date, precise determination of drainage is difficult). The Refuge, owned by the federal government, is of relatively recent origin (see more detailed discussion in Section VI). Most other public holdings, with the exception of road and highway rights-of-way, are recreational facilities of one sort or another and are discussed elsewhere in this document.

Public Land Management: Comprehensive Planning, Functional Planning, Zoning, Subdivision/Land Development Regulations

Land is managed publicly through municipal zoning ordinances; all Watershed municipalities have zoning ordinances, although some of these ordinances are extremely outdated. Most municipalities also have subdivision/land development regulations which are to work in conjunction with the zoning ordinance. Delaware County municipalities that do not have their own subdivision ordinance use the County's subdivision/land development ordinance. Appendix C provides an inventory of the many different ordinances which have been inventoried in Watershed municipalities. Copies of all municipal plans and ordinances have been requested on multiple occasions during the preparation of this RCP; however, some municipalities failed to respond to this request for information. The inventory in Appendix C is also evaluative and quickly assesses the extent to which a municipality's plans and regulations are consistent with the overall recommendations of this Draft RCP. Areas that need improvement are highlighted.

Trying to document comprehensive planning and land use planning in essentially four different counties and 31 different municipalities is no simple matter. To begin with, it must be recognized that comprehensive planning and land use planning is most directly accomplished on the local municipal level in Pennsylvania. In a Watershed with 31 municipalities, the challenge of developing a unifying Watershed-wide "vision" becomes extremely difficult, notwithstanding the fact that there is also planning occurring on the countywide and regionwide levels (i.e., Chester County, Delaware County, Montgomery County, Philadelphia and the Delaware Valley Regional Planning Commission). To complicate matters, municipal jurisdictions rarely do not conform to natural boundaries, such as watersheds, so that plans often emerge like patchwork quilts. Of course, each municipality also has its own zoning ordinance, providing for a full array of land uses to satisfy the Pennsylvania Constitution. The end result can be chaotic.

Overall, the majority of the comprehensive plans, as well as the majority of zoning ordinances and land development regulations, are substantially deficient in terms of promoting many of the goals of this Draft RCP. First and foremost, most municipalities in the Watershed fail to recognize the multiple values of the stream system, the floodplains, riparian zones, and related wetlands which link the many Watershed neighborhoods. Many municipalities acknowledge floodplains and wetlands (although even this basic level of understanding is sometimes not present), but the vast majority have simply not brought to the table the understanding of watershed systems, why they are important, and how they connect—one way or the other—to those upstream and downstream. This lack of appreciation for watershed values is further reflected in the accompanying regulations, both zoning and subdivision/land development ordinances. That is the bad news. The good news is that through the municipal planning process, and through the development of the comprehensive plan and the implementation of zoning ordinances and related land development regulations, each municipality has the power to attack Watershed problems and cooperate to make Watershed opportunities a reality.

We should also add here that some municipalities are moving forward, and are working to develop innovative plans with better regulations and overall management programs. Unfortunately, this tends to be most true of the municipalities in the upper portions of the Watershed, the municipalities where resources are far more plentiful, and the municipalities where the problems are far fewer. The watershed vision embodied in the Draft RCP goals must be communicated to all thirty-one municipalities—especially those most in need downstream.

City of Philadelphia Planning

The Philadelphia City Planning Commission published the Plan for West Philadelphia in 1994. And, although the study area designated as West Philadelphia in this Plan includes considerable area not included in the Darby Creek Watershed (extends to the Schuylkill River on the east) and omits some South Philadelphia area which is within the Watershed, this Plan is significant in terms of establishing a vision for this very important portion of the Watershed. Goals are established early on, including, but not limited to:

Maintain and Revitalize West Philadelphia Neighborhoods
Expand and Strengthen the Diverse Economic Base that Exist in West Philadelphia
Accommodate the Growth of Institutions
Plan for Quality and Compatibility of New Construction
Create a More Attractive Urban Environment in the Neighborhoods and Public Areas
Promote Programs that Encourage a Healthy Lifestyle
Provide Improved Recreation Opportunities

The Plan argues for renewal of commercial properties along Market Street and 52nd Street in order to reinforce the Cobbs Creek, Haddington, Carroll Park, and Overbrook neighborhoods. Projects include refurbishing of the Market-Frankford Elevated structure, improved lighting, and general upgrading of the streetscape, facilitated through home and business improvement loans and grants, plus strategically located new development projects. The City Line area (Wynnefield Heights and Wynnefield) is targeted for historic preservation programming, improved zoning initiatives, and traffic flow projects. Area-wide recommendations generally define a Neighborhood Conservation Strategy, including housing rehabilitation especially of vacant housing stock which are "problem properties," special programs to assist seniors in home maintenance projects, imposition of special development controls such as along the 63rd Street corridor, projects in the Cobbs Creek Park (several now completed), and selected site improvement projects. Specific projects have been identified and listed for the Cobbs Creek, Haddington, Carroll Park, and Overbrook neighborhoods as well as for the neighborhoods comprising the City Line area (Overbrook Park, Green Hill Farms, Overbrook Farms, and Wynnefield).

The City of Philadelphia has a distinguished tradition of planning. The detailed and comprehensive Plan for West Philadelphia embodies this impressive record and, difficult challenges notwithstanding, sets forth a program of action to conserve this important urban area and move it forward.

Special Philadelphia Planning: The Fairmount Park System's Natural Lands Restoration and Environmental Education Program (NLREEP): Although the Fairmount Park system, which includes the Cobbs Creek Park and Morris Park complexes, has undertaken system-wide comprehensive park master planning in the past (notably the 1983 comprehensive planning undertaken by Wallace Roberts and Todd), the NLREEP effort, initiated in 1996 through a $26.6 million grant from the William Penn Foundation, has been by far the most significant effort. NLREEP includes a series of interrelated activities which encompass restoration of vegetation and streams, trail repair and improvement, construction of environmental education centers, development of education and volunteer restoration programs, securing additional adjacent lands which are undeveloped, and protecting programs for Watershed protection beyond park boundaries. Some of the City's foremost experts such as scientists at the Academy of Natural Sciences were contracted to perform related planning work. The planning process started with identification of goals, compilation of existing data on park conditions, taking of biological specimens, development of field survey protocols, survey implementation, development of a database for historical and assessment data plus a Geographic information system. "While the primary goal of this process has been the development of recommendations for restoration to be done as part of the 5-year NLREEP program, it is anticipated that this plan will provide the basis for ongoing restoration and maintenance activities in the natural lands of the park system. (p. I-4) Obviously the NLREEP is closely related to the Darby Creek Watershed RCP in terms of substance, though the geographic focus of the two efforts does not exactly coincide.

Specific planning for facilities such as Cobbs Creek has generated specific parks plans, in this case the Cobbs Creek Master Plan, 1999. As part of this planning, the Plan recommends that 68 "high priority" sites be restored in Cobbs Creek Park; these sites are located throughout the Park, including Morris Park (wetland creation, control of invasives, and forest replanting on high quality floodplain and sloping hillsides), Cobbs Creek Golf Course (bank stabilization, invasive control, replanting and trash removal), the 63rd Street Area (removal/modification of Millbourne Dam, channel modification and bank stabilization, wetland enhancement, trash removal, invasive control, and replanting). Additional recommendations include:

> "Wetland creation and improvement of flood plain forests is recommended in the area around the stable, which will house a new environmental education center. Coordination with the Philadelphia Water Department to control erosion which has exposed a sewer line south of Marshall Road is also recommended. Several restoration projects to control water runoff and repair gullies and slopes are recommended in the area around Whitby Avenue. The area north and south of 65th Street contains a variety of woods, tributaries, wetlands and flood plain habitats. Recommended restoration work in this area include invasive control, replanting, repair of gullies and eroded slopes, and wetland enlargement. At the southern end of the park, removal or modification of the dam above Woodland Avenue is recommended to improve conditions in the creek. In addition to these projects, control of invasive vegetation, especially Japanese knotweed, is recommended along much of the banks of Cobbs Creek. Vehicle use, including ATVs, motorcycles and cars, and associated dumping of trash, are major problems in much of the park. Control of vehicular access is vital to enhancing the park. Trail erosion is a problem in many areas of the park, and this should be addressed in the trail master plan. In addition to the activities at specific sites, general recommendations are made which will reduce impacts of management of the designed landscape on natural lands. These recommendations would help control runoff on slopes and in tributaries, improve the border between the designed and natural lands, and reduce the potential for invasion by exotic plants." (p. II-6)

The Cobbs Creek Master Plan is discussed in more detail in Sections V and VI, as well as Section IV.

Delaware County and Other Areawide Planning

Although both the Chester County Planning Commission and Montgomery County Planning Commission have very active countywide planning programs (e.g., Chester County's countywide policy plan, *Landscapes*, recently won the county level planning award for the entire United States) which would require an entire chapter to properly document, the major focus here is the bulk of the Watershed in Delaware County and the planning ongoing at the Delaware County Planning Department. Some of the activities of the DCPD, such as the preparation of the Act 167 Stormwater Management Plan for the Darby Creek and the Act 537 Sewage Facilities Plan Update, have been described above and are further detailed in the sections below. Additionally, the DCPD has begun an update of the County's comprehensive plan, is especially active in preservation planning and provides staff assistance to the Delaware County Heritage Commission and to the Brandywine Battlefield Task Force, provides a variety of transportation planning services, and undertakes ongoing reviews of land development projects throughout all 49 Delaware County municipalities.

The Delaware Valley Regional Planning Commission (DVRPC) is the designated regional planning commission (the Metropolitan Planning Organization or MPO) which encompasses the Darby Creek Watershed. DVRPC is currently preparing a new comprehensive plan for the region, generally promoting conservation of existing communities and minimization of sprawl. The Darby Creek RCP couldn't be more compatible with this regional planning.

The Special Role of Environmental Advisory Councils

This RCP directs considerable attention to the municipal level of government. Many RCP recommendations in Section 7 involve either directly or indirectly municipal government actionsm , either by the elected governing body or the planning commission or some other arm of municipal government. These additional RCP recommended actions and initiatives come at a time when many municipalities are already overwhelmed by mounting responsibilities, with municipal officials searching for ways to shorten lists, rather than add to them.

An answer can be the municipal environmental advisory council or EAC. In 1973 the State passed Act 148 which allows a municipality or group of municplaities to establish EACs by ordinance. EACs are intended to advise the elected officials, the municipal planning commission, and other relevant boards on matters relating to natural resources and their conservation, protection, management, promotion, and use. Unfortunately only a few municipalities in the Watershed (e.g., Radnor, Haverford, Marple, Lower Merion) have used this useful tool so far. Creation of EACs could be very useful in spearheading the municipal-level recommendations being made in this RCP. Activities typically include development of natural resource inventories, park and recreation system improvements, and development plan reviews, in addition to a variety of special studies and reports. A challenging agenda for any EAC, new or old, would be to undertake to implement the multiple recommendations directed toward municipalities made in this RCP!

The Pennsylvania Environmental Council (215-563-0250) has established the EAC Network, which will explain how to get started, how to organize your efforts, and how to start to take the critical steps toward RCP implementation.

Private Land Management and Private Land Stewardship for Watershed Conservation

In addition to the conventional public acquisition and purchase of lands for overall conservation and recreation purposes, lands may be set aside through private mechanisms, including outright donation, donation of conservation easement, partial donation (bargain sales), and other mechanisms other than the straightforward fee simple transfer of title. Unfortunately, very little land in the Darby Creek Watershed has been privately set aside for conservation. Typically, a private land trust organization such as the Brandywine Conservancy or Natural Lands Trust manage these "conservation interests" in some manner, although local municipal land trusts can be created; if there has been a donation involved with possible Federal tax credit/benefit being provided to the donor, the land trust organization typically is required to inspect whatever has been donated to make sure that the public interest is being maintained (note that public interest does not equate to public access, according to the law; typically donated conservation easements do not include rights of public access).

Probably the most significant focus of private conservation in the Watershed is Waterloo Mills, a large estate recently donated to the Brandywine Conservancy by the Haas Family. This conservation area in both Easttown and Newtown Townships was donated outright (fee simple) rather than by donation of conservation easement. The area overlaps with the Waterloo Mills National Historic District. The Brandywine Conservancy is currently developing a facility plan and program for Waterloo Mills; public access is not guaranteed though is likely to be provided for specialized uses such as education. A few other private conservation areas, including donated conservation easements, do exist in the Watershed, though typically in the upper Watershed municipalities.

There are a variety of mechanisms or techniques which can be applied creatively to accomplish watershed conservation objectives privately, without public or municipal outlay of funds or without municipal regulatory action of some sort. These mechanisms include, but are not limited to:

Conservation Easements: A conservation easement transfers certain rights for use of a property, such as the right to develop and subdivide the property, while allowing the original property owner to retain ownership and occupancy of the property. A conservation easement may be donated or purchased, though usually are donated in exchange for Federal tax forgiveness (possibly also reduced local real estsate taxes) as well as for an overall conservation intent.

Bargain Sales: A conventional fee simple transfer of a property though accomplished at significant reduction of fair market value, as determined by a fair and equitable appraisal process. Owners bargain-selling to a government may enjoy some direct financial reward from the purchase, but may also enjoy a Federally recognized donation which can be used to offset the unpleasant taxes often linked to hugely appreciated properties (i.e., not only are the capital gains from the transaction substantially reduced, but the donation further offsets the taxes due).

Limited Development: Property owners intentionally reduce a development program for a program well below the maximum zoned density allowed by the respective zoning ordinance, I order to maximize conservation values at the property. A wonderful example of this concept in the Watershed is the Ardrossan I and II developments in Radnor Township, part of the Montgomery Scott Estate. Working with the Brandywine Conservancy, the Scott Family devised a program of mini-estates, each in excess of 10 acres, with structures carefully placed to be screened from viewpoints and with other environmental management controls imposed. Ironically, rather than lower values, this limited development approach has come to be viewed as extremely beneficial and desirable from the market's perspective (i.e., by purchasers), with values and prices inflating tremendously. Some experts would argue that there may be more money to be made from limited development, than from conventional development!

Open Space/Conservation Development: Also called clustering, a conventionally gridded subdivision plan with large lots (e.g., 1 or 2 acres) is allowed to be tightly concentrated on considerably smaller lots (e.g., ½ to ¼ acre), thereby allowing large portions of the site to remain undeveloped, undisturbed. If the cluster is properly and thoroughly developed, this open space area will be deed restricted or could be conveyed in some manner to a local conservation organization or the municipality itself, depending upon the context. PADCNR's Growing Greener program further advocates the strategic linking of these zones of open space, development by development, so that greenways are created. Because this open space being protected clearly should include, though not be limited to, sensitive zones such as floodplains, riparian areas, and wetlands, ideally a greenway eventually is created which protects the stream system. The important objective in clustering is to make sure that open spaces being provided are meaningful and not simply isolated and residual pockets of land where environmental functions have been substantially impacted and depleted.

Estate Planning: In many instances, property owners have held properties for many years and are horribly impacted by federal and state taxes through the estate taxation process. Poor estate planning often results in heirs having to sell off the family farm or subdivide it, all of which is unnecessary. The sheer act of proper and effective estate planning, utilizing some of the tools described above, can produce results which are financially more beneficial to the heirs and achieve many conservation objectives.

There are still properties remaining in the Watershed where all of the above mentioned mechanisms can be useful.

D. CRITICAL AREAS IN THE WATERSHED

Until recent years, most people were less aware of and less concerned about chemical wastes and how these chemicals affect public health and the environment. On properties where such chemical production and handling practices occurred, the result unfortunately has too often come to be a legacy of abandoned hazardous waste sites, such as abandoned warehouses and landfills. The US Environmental Protection Agency (USEPA) directs many federally funded programs that inventory, evaluate, and mitigate the adverse effects of these hazardous waste sites. Of most importance for the Darby Creek Watershed is the "Superfund" program, technically including both the **National Priorities List** (NPL), and the **Toxic Release Inventory** (TRI) program.

Superfund Program

Citizen concern over the extent of unregulated hazardous waste sites prompted Congress to establish the Superfund Program in 1980; this program is intended to locate, investigate, and remediate (i.e., clean up) the worst inactive hazardous waste sites nationwide. The USEPA administers the Superfund program in cooperation with individual states and tribal governments. Once a site is discovered and USEPA is notified, the site is entered into the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) Database, which contains information on hazardous waste sites, site inspections, preliminary

Table II-12 CERCLIS Sites in the Darby Creek Watershed, (EPA 2001)

LABEL	EPA SITE ID	SITE NAME	STREET ADDRESS
1	PA0000379669	ROUTE 30 & E.CONESTOGA RD.DIESEL SPILL E R	TAYLOR GIFTS, 355 E. CONESTOGA ROAD
2	PASFN0305403	HAVERTOWN RESIDENTIAL OIL SPILL	105 ROCKLAND ROAD
3	PASFN0305548	UPPER DARBY H.S. MERCURY SPILL	501 LANSDOWNE AVENUE
4	PASFN0305565	HILLTOP RESIDENTIAL LAB SITE	7110 HILLTOP
5	PA0002326460	HORTEN STREET SITE	234 HORTEN STREET
6	PASFN0305546	HOFFMAN PARK SITE	SCOTTDALE ROAD
7	PA0002349090	SECANE OIL SPILL	2339 SECANE RD.
8	PA0002195253	BIG MARTY TRANSFORMER ER	MAIN AND POWELL STREETS
9	PAD981736747	LANSDOWNE SITE #2	LANSDOWNE AVE
10	PASFN0305551	WINDSOR STREET OIL SPILL E.R.	5441 WINDSOR STREET
11	PA0001909522	OIL TANK LINES. INC.	2 INDUSTRIAL DRIVE
12	PA0002374395	MARITANK OIL SPILL	67TH STREET AT SCHUYLKILL RIVER
13	PAD987332848	70TH AND KINGSESSIN TRAILER	70TH AND KINGSESSIN BLVD.
14	PAD980693162	CLEARVIEW LANDFILL	83RD & BUIST AVE
15	PA6143515447	TINICUM NATIONAL ENVIRONMENTAL CTR	OFF DARBY CREEK

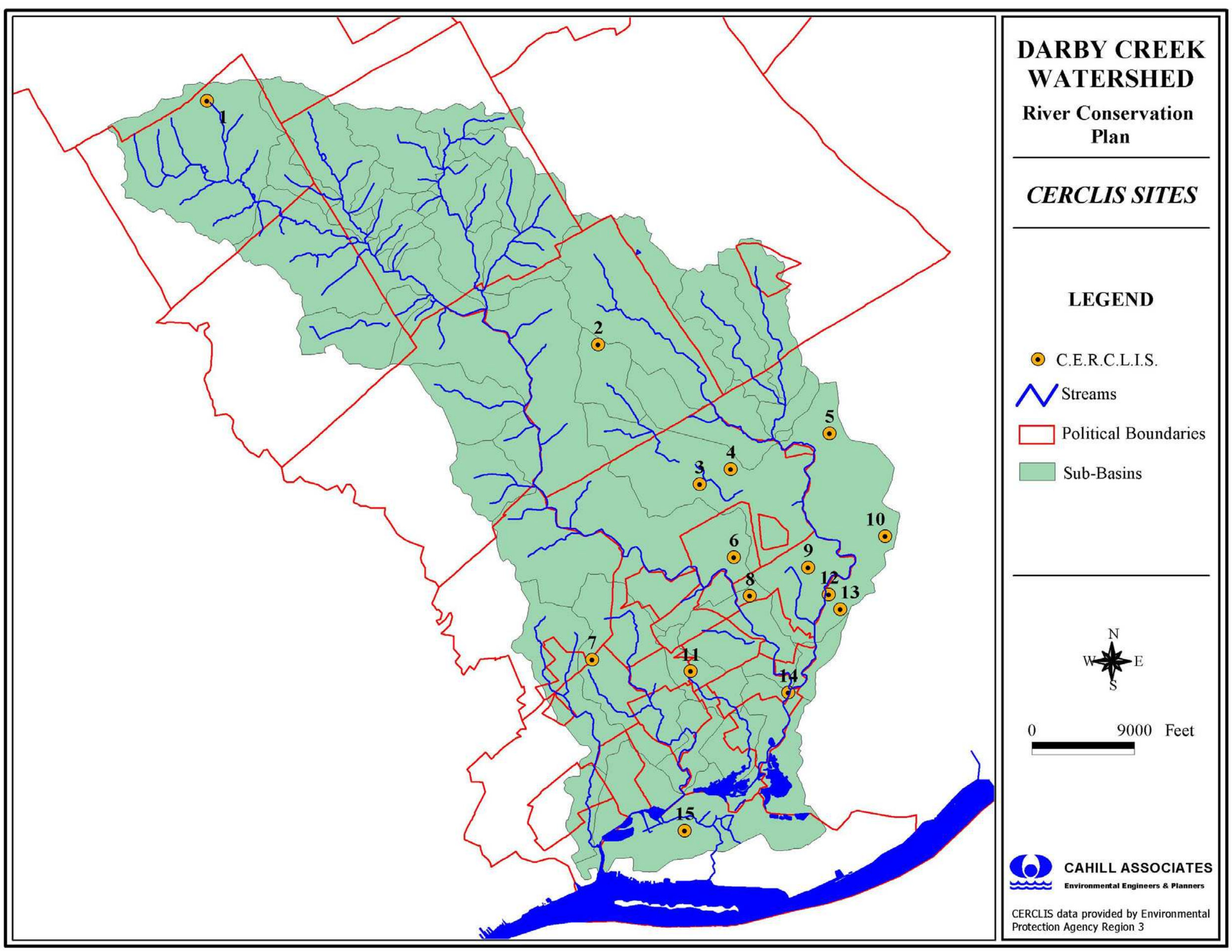

Figure II-6 EPA identified CERCLIS sites in the Darby Creek Watershed

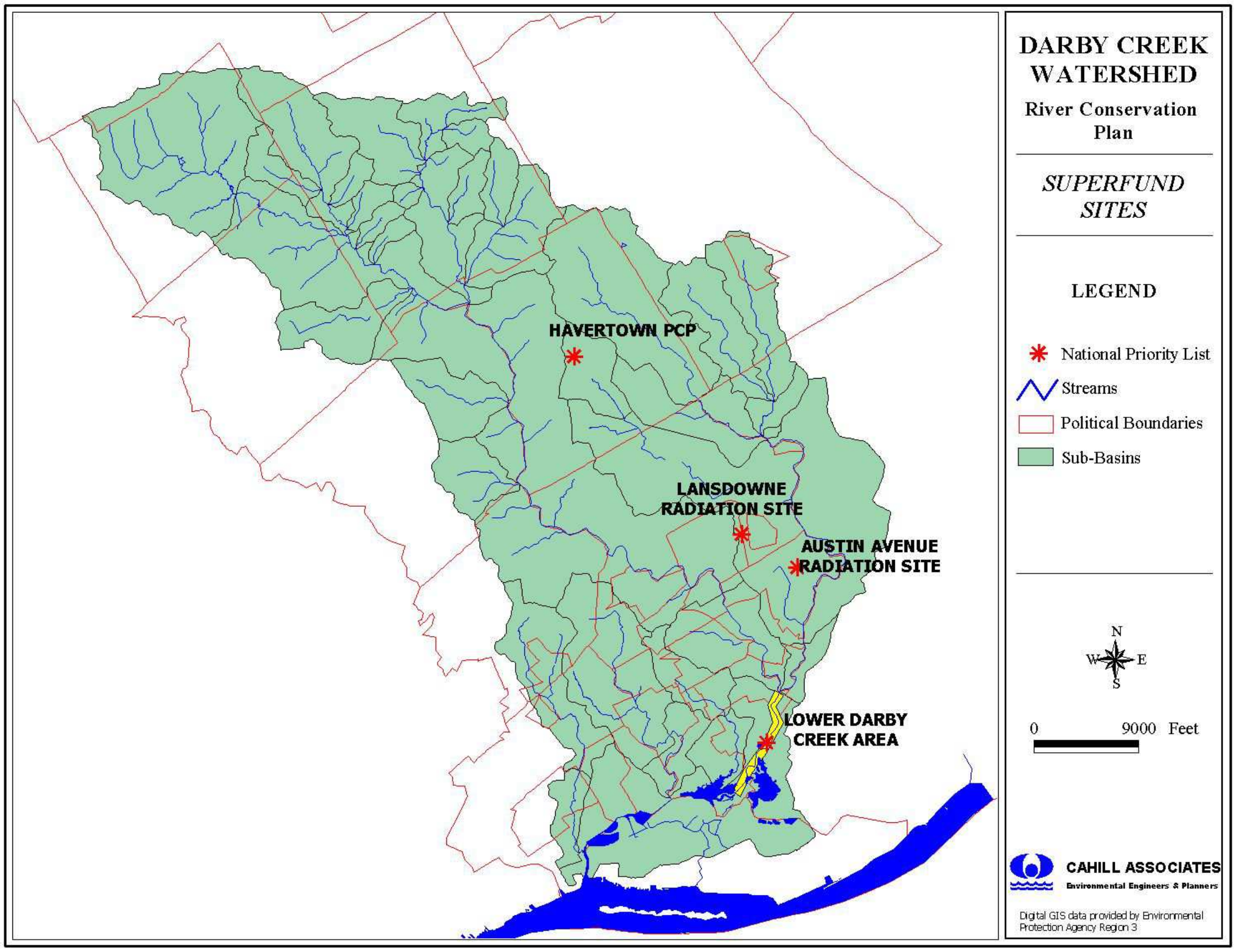

Figure II-7 USEPA identified Superfund sites in the Darby Creek Watershed

assessments, and remediation of hazardous waste sites. A limited-scope, Preliminary Assessment is performed on every CERCLIS site to determine the nature of the threat to human health and the environment. If the threat is deemed to be serious, a Site Inspection is performed to determine what hazardous substances are present at a site and what substances have been/are being released into the environment. Information from the Preliminary Assessment and/or Site Inspection is used to calculate a Hazard Ranking System score. The HRS system is the main mechanism USEPA uses to list sites on the NPL. Sites with an HRS score of 28.50 or greater are eligible for listing on the NPL.

Approximately 15 CERCLIS and 4 Superfund sites are listed in the Darby Creek Watershed (Figures II-6, II-7, and Table II-12), primarily located in the lower, more industrial portion of the Watershed. The hazardous wastes site data was provided to RCP consultants early on in the data-gathering phase, before the Lower Darby Creek Area (LDCA) was officially put on the NPL list. The newest Superfund site in the Watershed is located on a 2-mile stretch of the Darby Creek and includes six contiguous properties. From north to south, they include the Clearview

Table II-13 Toxic Release Inventory (TRI) sites in the Darby Watershed (EPA 2001)

LABEL	TRI ID	FACILITY ID	FACILITY NAME	STREET ADDRESS	CITY
1	19010CHMLL996RA	PAD987325321	CHEMALLOY CO. INC.	996 RAILROAD AVE.	BRYN MAWR
2	19008THDMRPOBOX	PAD987325552	EDMAR ABRASIVE CO.	1107 SUSSEX BLVD.	BROOMALL
3	19008MCHNS400RE	PAD987352507	M. COHEN & SONS INC.	400 REED RD.	BROOMALL
4	19091FRNKLUSRTE	PAD002487247	FRANKLIN MINT	U.S. RTE. 1	MEDIA
5	19032CRKND500KA	PAD987380714	CORK IND. INC.	500 KAISER DR.	FOLCROFT
6	19018BCHNNPENNJ	PAD002351450	BUCHAN IND.	415 S. PENN ST.	CLIFTON HEIGHTS
7	19018LTTNSMARPL	PAD987320165	CLIFTON PRECISION	MARPLE AT BROADWAY AVE.	CLIFTON HEIGHTS
8	19050JLNBS300EB	PAD002325777	JULIAN B. SLEVIN CO. INC.	300 E. BALTIMORE AVE.	LANSDOWNE
9	19050HYDRL520CO	PAD002261907	HYDROL CHEMICAL CO.	520 COMMERCE DR.	YEADON
10	19023SNTRY237MI	PAD002480002	SENTRY PAINT TECH. INC.	237 MILL ST.	DARBY
11	19032THBLL1640D	PAD987325222	BULLEN COS.	1640 DELMAR DR.	FOLCROFT
12	19032MZRCH1830C	PAD002313294	BASF CORP.	1830 COLUMBIA AVE.	FOLCROFT
13	19029SSCHM48POW	PAD987380128	ESSCHEM CO.	48 POWHATTAN AVE.	ESSINGTON

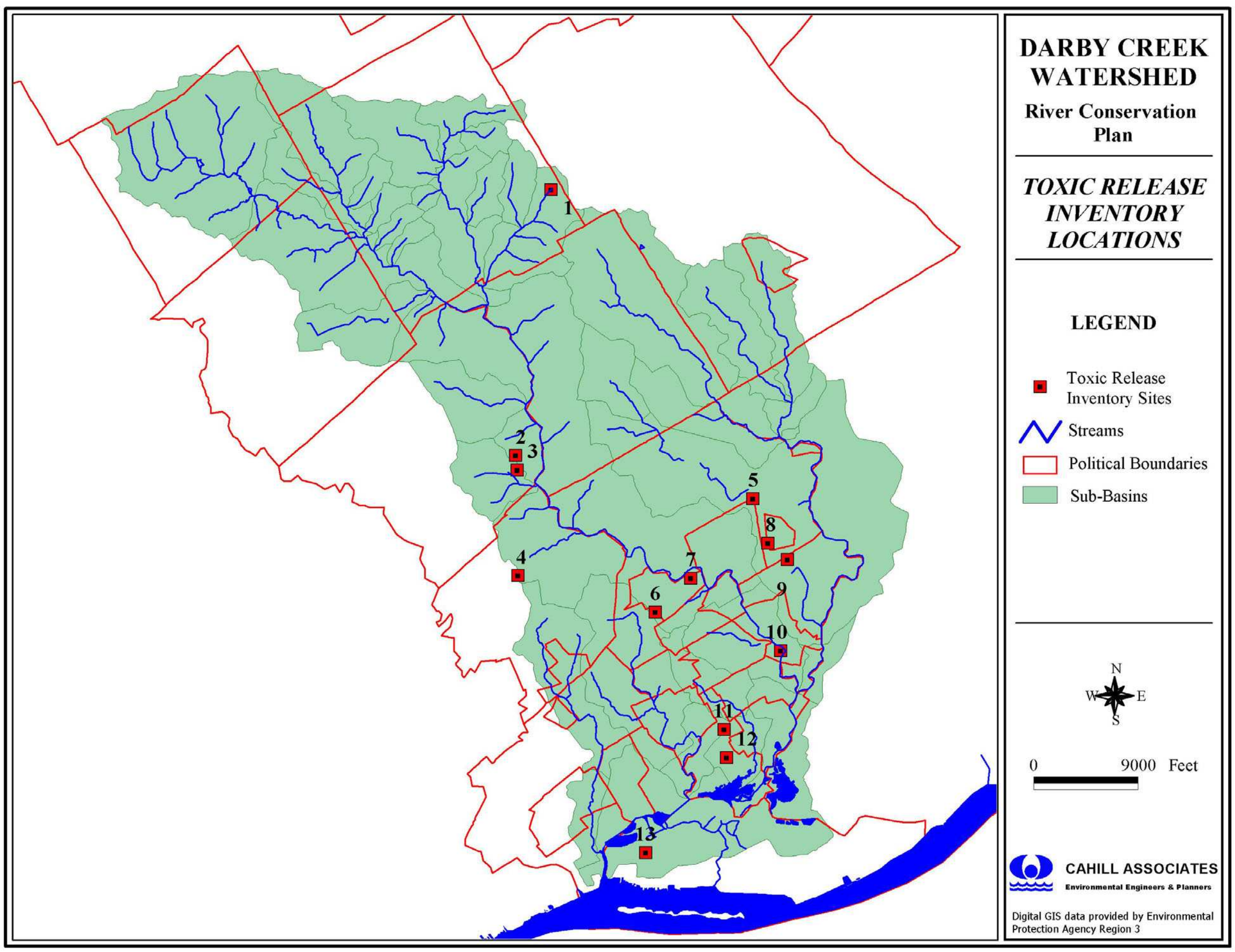

Figure II-8 Toxic Release Inventory (TRI) sites in the Watershed (EPA 2001)

Landfill, the Industrial Drive Properties, the Sun Oil Darby Creek Tank Farm, the former Delaware County Sewage Treatment Plant, the former Delaware County Incinerator, and the Folcroft Landfill and Annex. From the early 1950s to the late 1970s, the above properties disposed of sewage sludge, municipal waste, refinery waste, ash residue, and other hazardous substances into the air, water, and ground environment. Both the Austin Avenue Radiation Site and the Lansdowne Radiation Site have received remedial action to restore the sites, while the Havertown PCP Site is currently in the final phase of remediation. (EPA Envirofacts Data Warehouse, www.epa.gov/enviro/index_java.html). In sum, although the Darby Creek Watershed has had its share of environmental pollution, the good news is that three out of four Superfund sites have been remediated and restored. Action can and is being taken!

Toxic Release Inventory

Currently over 600 chemicals nationally have been determined to be toxic, and certain industries must report to USEPA if they use or handle these chemicals. Two federal statutes, Section 313 of the Emergency Planning and Community Right-To-Know Act and Section 6607 of the Pollution Prevention Act, mandate that a publicly accessible toxic chemical database be developed and maintained by US EPA. This database, the Toxic Release Inventory (TRI), maintains information concerning waste management activities and the release of toxic chemicals by facilities that manufacture, process, or otherwise use them (Figure II-8 and Table II-13). Manufacturer facilities are required to report the locations and quantities of chemicals to both state and local governments. Approximately 13 TRI facilities are located in the Darby Creek Watershed, again with the majority of the sites located south of Route 3 in the lower portion of the study area (EPA, TRI Query Form, www.epa.gov/enviro/html/tris/tris_query.html).

Quarries, Abandoned Mines, and Landfills

The PA DEP has developed a comprehensive environmental compliance online information reporting system to provide public access to facility information (http://www.dep.state.pa.us/efacts/). For residents interested in permitted activities and compliance information of facilities in their neighborhood, the DEP **eFACTS** system is a user-friendly source of public information, searchable by geographic location. Both eFACTS and DEP officials were consulted in order to inventory the quarry, mining, and landfill resources of the watershed.

No actively functioning (permitted) quarries or mines are located within the Darby Creek Watershed, (per.conv. with Dan Koury, PADEP). Though many local quarries historically supplied the watershed region with Wissahickon schist for early construction activities, most quarries in the watershed are currently inactive and/or closed. An economically beneficial alternative for the empty quarry is to function as a “reclamation” site whereby certain, nontoxic substances are buried in the empty hole in the ground. This activity – if unregulated – can obviously lead to dangerous and harmful effects on groundwater if the quarry is close to the water table. PADEP Bureau of Waste Management permits and inspects only those “cleanfills” that are potential threats to water resources.

Llanerch Reclamation Quarry, located in Haverford Township near Route 3 and Township Line Road, is one such former-quarry-turned-cleanfill in the watershed inspected regularly by PADEP. Llanerch Reclamation Quarry currently accepts construction residue such as brick, block, stone, concrete, old asphalt, and dirt for disposal. According to eFACTS, Llanerch Quarry is a repeating violator, with violations issued in 9 out of 19 inspections since 1997. The Llanerch Reclamation Quarry sits near the headwaters of Naylor's Run, in a critical location for influencing water quality and quantity effects.

It is important to downstream residents and watershed community members, that permitted waste management activities are regularly inspected, and dumpers are held accountable for any degradation to the watershed system. Unfortunately, many permitted dumpers get away with their illegal activities because inspectors are uninformed or unaware of the reality of the situation. In addition, many illicit and illegal dumping activities are occurring throughout the watershed, usually in the floodplain. Groups like DCVA, as organized stakeholders in the watershed, should play the role of "watchdog" whereby complaints are filtered through a special "Dumping Task Force" group which takes action and lodges the complaint (both locally with the municipality, and federally with PA DEP) and follows up with the compliance actions. A combination of regulation and community awareness will be the most influential method to combat dumpers in the Darby Creek Watershed.

III. Earth Resources

III. EARTH RESOURCES

A. GEOLOGY

Geologic Overview: Age and History

The upper portions (headwaters) of the Darby Creek Watershed are comprised primarily of older rock from the Precambrian era (older than 570 million years) and Lower Paleozoic era (430 to 570 mya). The lower portion of the Watershed consists of "younger" rock from the Tertiary and Quaternary periods (up to 67 million years in age). Weathering and erosion of these various rock types (Figure III-1) has produced the rolling topography of the upper Watershed and the gently undulating and relatively even landscape of the lower Watershed.

During much of Paleozoic era (570 to 245 mya), the earth's plate tectonic movements forced land masses together several times. One of the most significant of these "collisions" occurred 300 million years ago as the eastern margin of North America collided with South America and

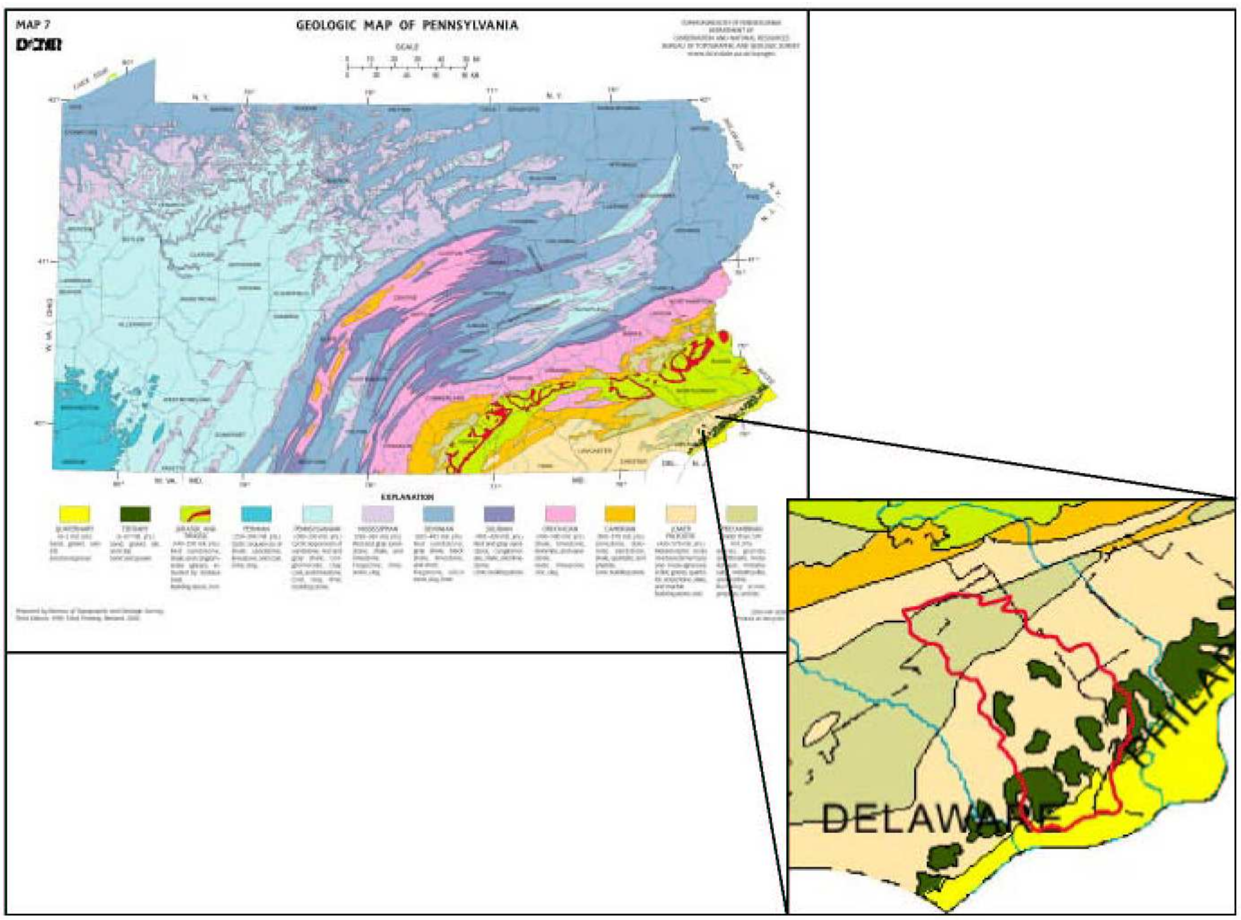

Figure 1II-1 Geologic map of Pennsylvania showing the Darby Creek Watershed, (DCNR)

Africa. The impact lifted the land and produced the Appalachia mountain range with elevations well over 15,000 feet, rivaling today's Alps and Himalayan ranges. Pangaea, the supercontinent created from the impact, subsequently began to break up and rift during the Triassic period (245 to 208 mya) to create the modern day Atlantic Ocean. To put this historic activity into watershed perspective, the Darby basin is the eroded remnant of what once was a massive mountain range. Watershed residents are currently residing on the weathered and eroded geologic material of this historic mountain range – the Appalachian range.

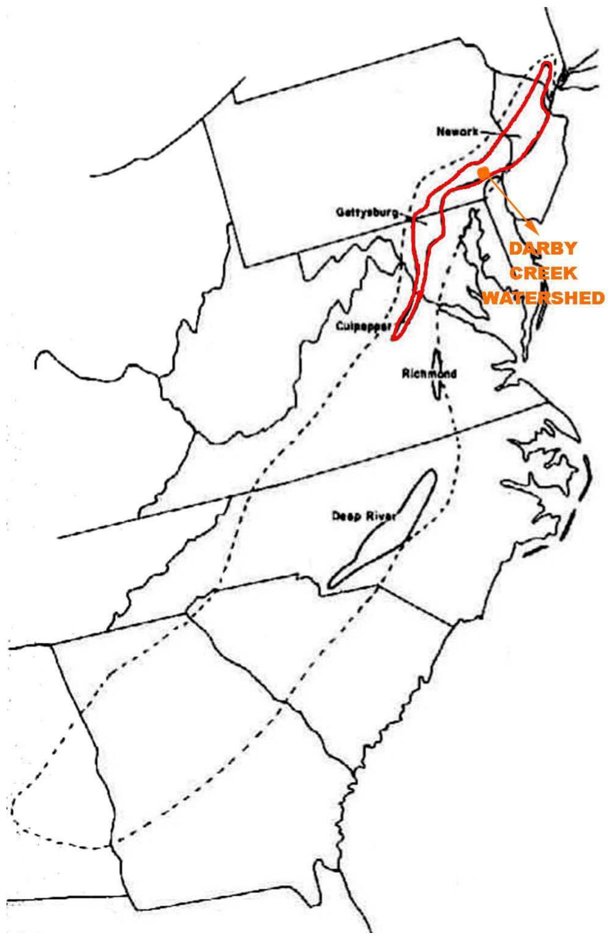

Figure III-2 Triassic Basin Deposits in Delaware County Region, (Godfrey 1997)

Remnants of this historical rifting activity occur in areas where younger rock was downfaulted into the older rock, creating Triassic Basins (Figure III-2). Triassic basins are modern day remnants of a geologic transition period. Through the subsequent millions of years of intense geologic activity, the Appalachian range underwent vigorous erosion by wind and water, as well as cycles of uplifting and rifting, to create the present geology and landform within the Darby Creek Watershed region.

Physiography
The Darby Creek Watershed straddles two physiographic provinces: the Piedmont Uplands Province in the north and the Atlantic Coastal Plain Province in the south (see Figure III-3). A physiographic province is the expression of bedrock at the surface of the land. All the land in the Piedmont and the Coastal Plain provinces have undergone geological processes in the past, which have produced a characteristic topography. The northern portion of the Darby Creek Watershed, situated in the Piedmont Uplands, is characterized by generally very old and hard upland rocks, resulting from the erosion of the Appalachian Mountains. The Piedmont, meaning "foot of the mountains," is a region of gently rolling hills, fertile valleys, and well-drained soils. Weathering and erosion over the years has produced the rolling topography, often more deeply cut by streams with deeply incised stream valleys traversing the landscape.

The Coastal Plain portion of the Watershed in the south contains soft, unconsolidated sediments that were deposited by water and glacial erosion relatively recently (1.6 million years ago). This Coastal Plain land is generally low, gently rolling to flat and poorly drained, consisting of

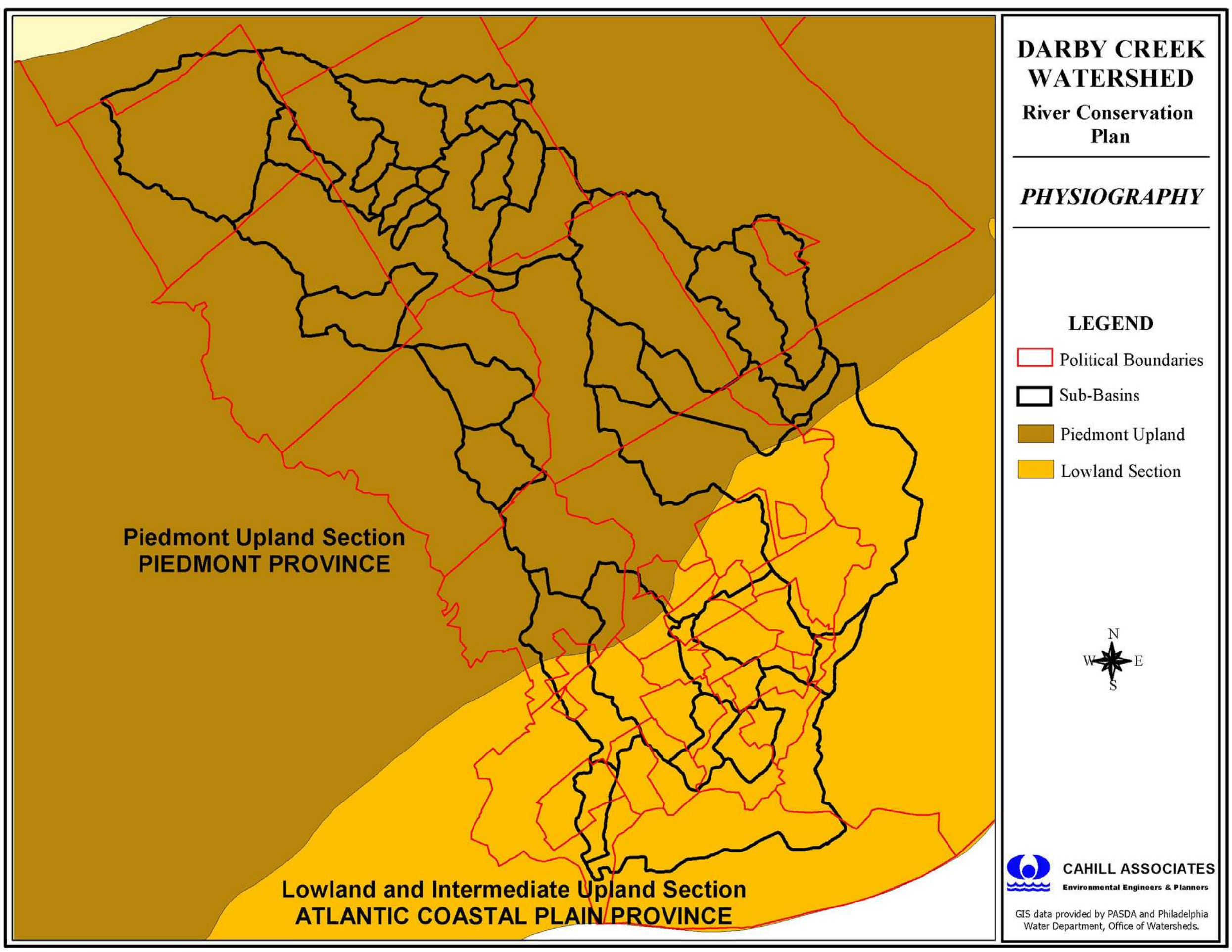

Figure III-3 Physiographic Provinces within the Darby Creek Watershed unconsolidated and poorly consolidated layers of Quaternary-age sand, gavel, and clay dipping gently to the east. In the Darby Creek Watershed, the Coastal Plain has primarily been used for industrial and residential use, and the John Heinz National Wildlife Refuge at Tinicum is one of the few remaining Coastal Plain natural communities in Pennsylvania.

The boundary between the Piedmont and the Coastal Plain Provinces is marked by what is known as the "fall line". The fall line is a conceptual geologic break marked by waterfalls and rapids which form where the hard rock of Piedmont Upland region meets the softer rock of the Coastal Plain. Falls and rapids develop as erosion by streams wears away some of the softer rock, creating a ledge over which the water flows. In the Darby Creek Watershed, the falls and rapids historically provided sufficient energy for development of numerous mills located adjacent to rivers and streams, remnants of which are still with us today as reminders of this important phase in the Watershed's historical development.

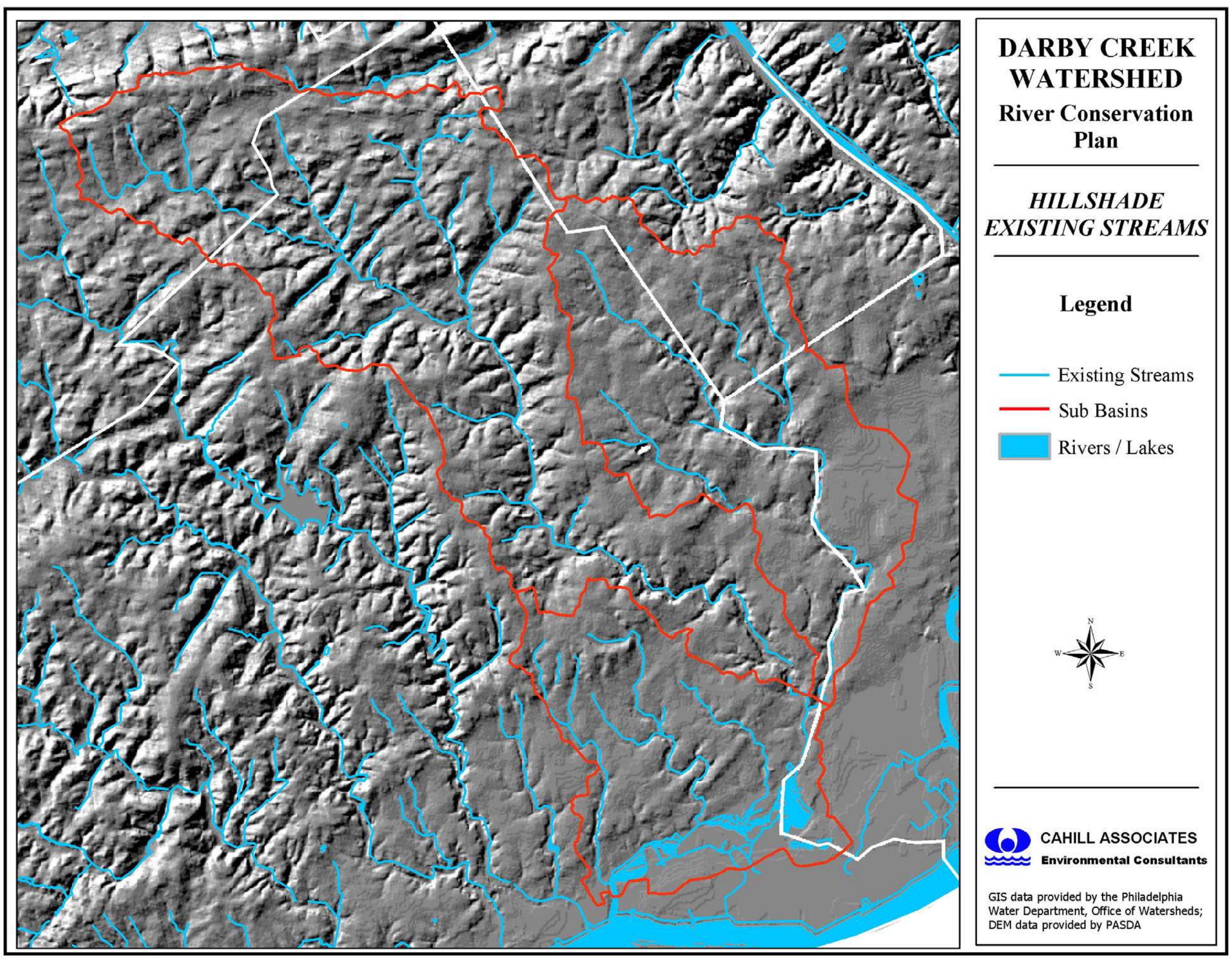

Figure III-4 Hillshade Showing the Fall Line between the Piedmont and Coastal Plain

Digitally, this physiographic transition is represented through the manipulation of a digital elevation models (DEM) using a GIS. A DEM is transformed into a “hillshade” image in order to show the change in elevations at the land surface. When the hillshade is overlain with the existing stream network (Figure III-4), one can more easily visualize how the existing land surface is the direct result of historic geologic activity.

Topography and Land Form
The topography of the Watershed was shaped by the great tectonic forces of the earth’s shifting crustal plates, combined with hundreds of millions of years of erosion by wind and water. Present day topography is based on the physiographic region in which the Watershed lies, as discussed above. In the rolling hills of the Piedmont portion of the Watershed, elevations generally range from 100 to 200 feet above sea level. The range of elevations in the gently rolling and relatively flat Coastal Plain portion of the Watershed is 0 to 100 feet above sea level.

Steep slopes are rare in the Coastal Plain. Although elevations are not great in the Piedmont, change in elevation, and therefore steeply sloped areas, can occur in the more northern portions of the Watershed. Slopes can be especially steep in the sometimes deeply incised stream valleys which have been cut over the years. The geological history and variability is often revealed in the attractive, even dramatic rock outcroppings which are exposed in the Darby Creek’s stream valleys.

Specific Geologic Description
The Darby Creek Watershed consists primarily of ancient crystalline bedrock, along with metamorphic and igneous rocks from the Precambrian period (430 to 570 million years ago). Figure III-5 depicts the surficial geologic units of the Watershed and surrounding region, though only geologic units found within the Watershed boundaries will be discussed here. Each rock formation has important properties that influence the local hydrology, topography, vegetative composition and structure, and landform of the Darby Creek Watershed. Geology tends to be related to Watershed soils as well.

The Wissahickon Formation, a mica schist derived from sandstones and mudstones, is predominant in the Watershed as well throughout the Piedmont Plateau region of the Delaware Valley (see Figure III-5). The Wissahickon Formation is a consolidated rock aquifer and is the highest yielding crystalline aquifer in Delaware County (Balmer and Davis, 1996). Felsic gneiss and mafic gneiss are metamorphic rock units, located in the northern portion of the Darby Creek Watershed. These formations yield smaller quantities of water due to the smallness of the cracks, joints, and other openings within the rock. The Bryn Mawr formation and the Bridgeton formation are unconsolidated deposits that overlay the tighter and denser crystalline bedrock. These geologic formations are important in that they provide additional hydrologic recharge and groundwater volume for the crystalline rocks beneath them.

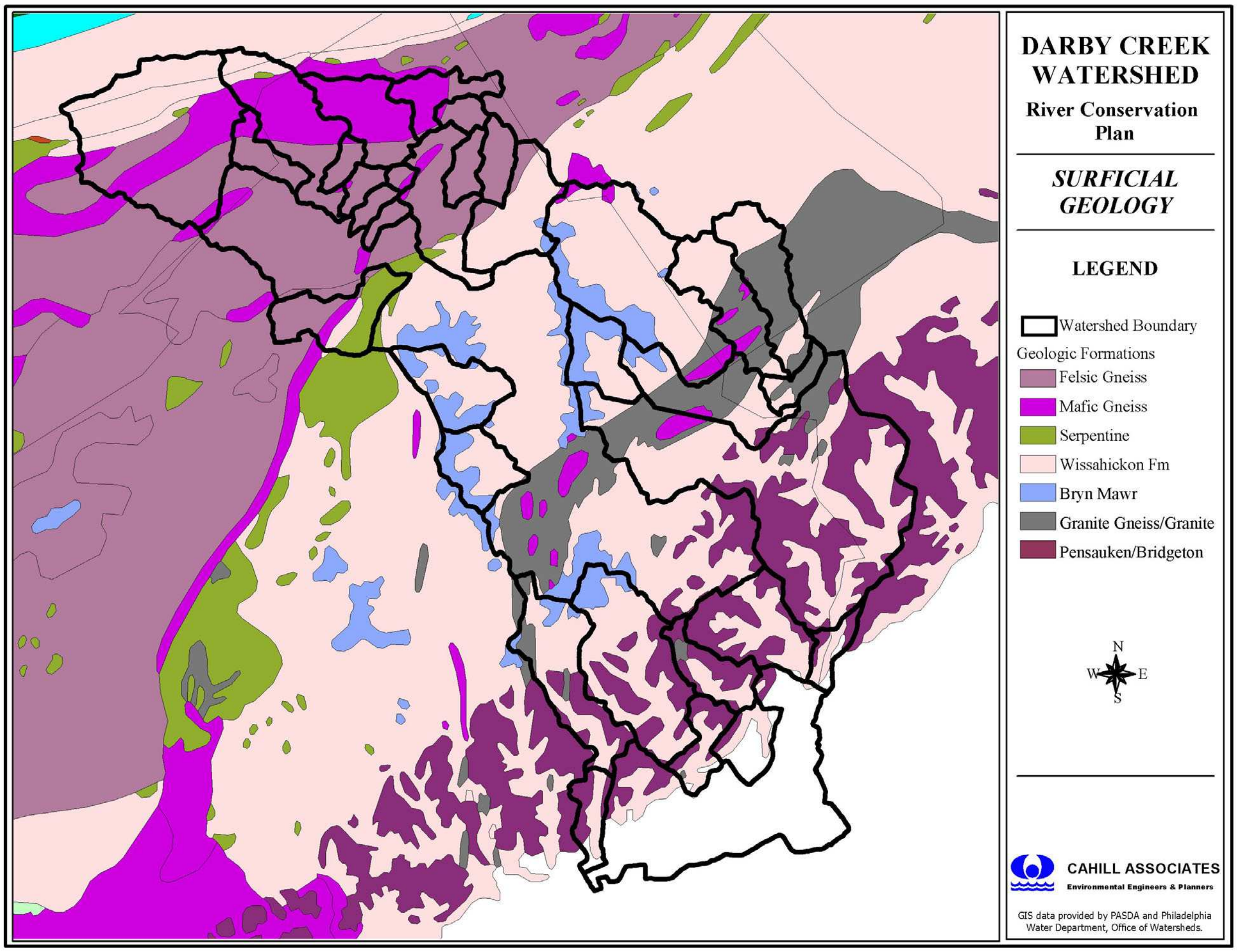

Figure III-5 USGS Geologic Composition of Darby Creek Watershed

Within the Watershed, small areas of serpentine rock are shown only in southern Radnor and Newtown Townships. Early in the 19th century, the Watershed and surrounding region was famous for its serpentine rock quarries. Serpentine stone was easily extracted from the earth and provided building material for many local structures and homes in earlier periods. Serpentine and the minerals associated with this formation produce a sterile and toxic growing environment for crops and plants, hence the name "serpentine barrens." Serpentine barrens are rare on the east coast and provide habitat for many rare, threatened, and endangered species. These areas, however, are currently being threatened by human behavior. Mining and quarrying have destroyed much of the barrens. Development spurred by suburban sprawl has led to the conversion and consumption of much barrens habitat.

In terms of hydrogeology, groundwater is present in and moves in different degrees through cracks, fractures, and voids within the bedrock material in virtually all of these rock formations in the Watershed. Because these cracks, fissures, and voids have been caused by weathering over the millennia and are therefore most common closer to the surface, most of this groundwater is present relatively close to the earth's surface as well, typically less than 500 feet in depth (as depth increases, weathering and water "opportunities" generally decrease). Although small wells have been developed over the years, none of the geologic formations in the Darby Creek Watershed yields enough water consistently for large industrial or public supplies because of the inherently low storage capacity of the rocks, both consolidated and unconsolidated (Balmer and Davis, 1996), a topic discussed in more detail in Section IV Water Resources.

Streams in Delaware County generally act as "drains" for the groundwater aquifers, as they are called, with the groundwater continuously discharging by gravity to the surface streams through systems of springs, seeps, wetlands, and other points of discharge (more discussion in Section IV). The Darby Creek is one of five creeks (Darby, Crum, Ridley, Chester, Brandywine) that flow northwest to southeast (see Figure III-6 below) across Delaware County, all discharging into the Delaware River. These five creeks all flow in remarkably parallel routes through the hard rock and deeply cut Piedmont valleys and the subdued hills of the Coastal Plain.

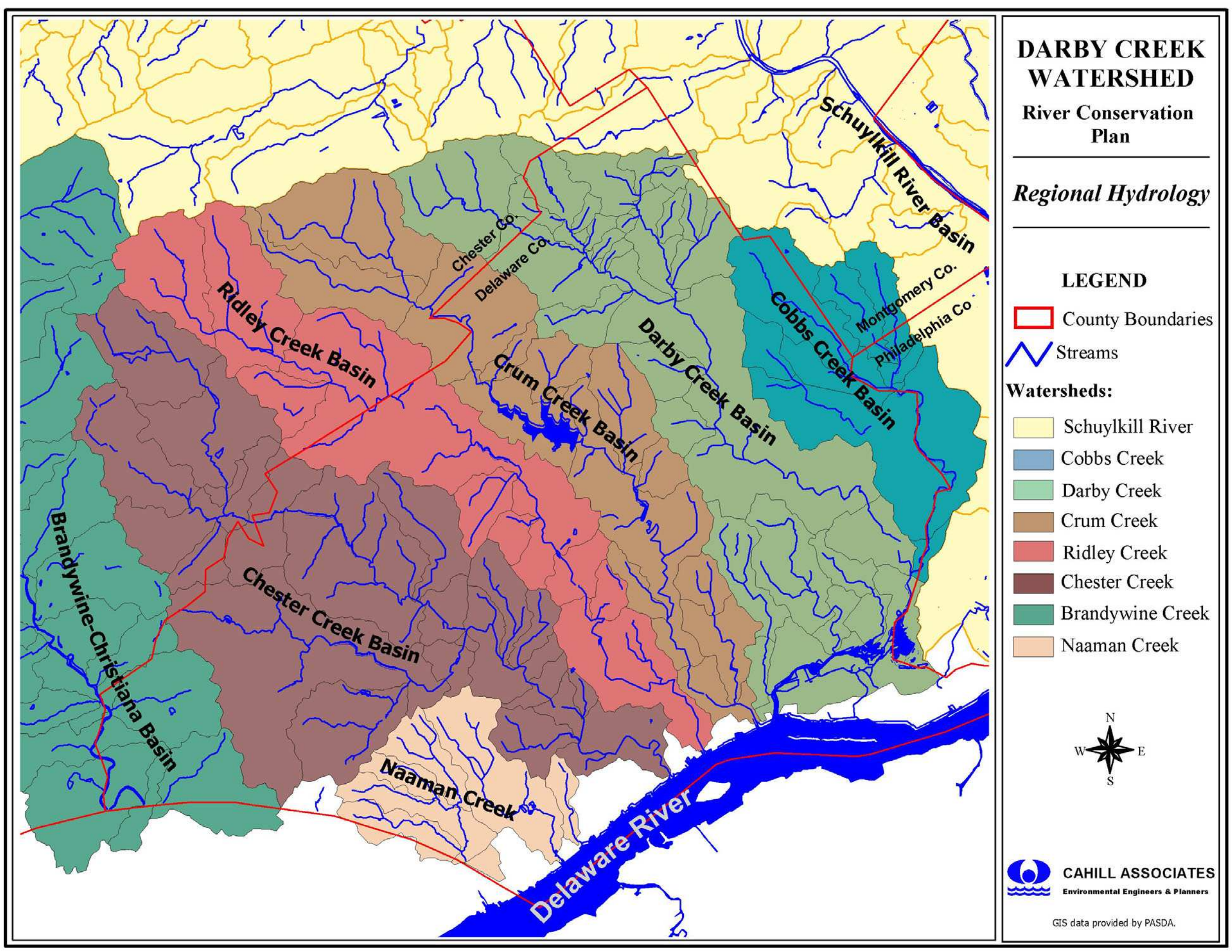

Figure III-6 Parallel Stream Networks Flowing to the Delaware River

B. SOIL CHARACTERISTICS

Major Soil Series & Characteristics

The soils in the Watershed (Figure III-7) reflect the weathering process of the parent bedrock geology. In the Piedmont region schist, gneiss, and crystalline rock are the predominant bedrock material. These upland areas of the Darby Creek Watershed consist of well-drained silt loam soils including Glenelg, Manor, and Wheaton. Both Glenelg and Manor formed in materials weathered from micaceous schist, and support native oak and red maple vegetation. The Wheaton soil series is the product of human alteration of the land (including Glenelg and Chester soils) and is predominately used for human dwellings. Wehadkee, Chewacla, and Congaree series are floodplain soils that are moderately to poorly drained, and occur in low-lying areas around headwaters of streams. Urban soil predominates in the southern coastal plain and Philadelphia portion of the Watershed, reflecting the residential land cover of this area. Found scattered throughout the southern coastal plain portion of the Watershed are Butlertown,

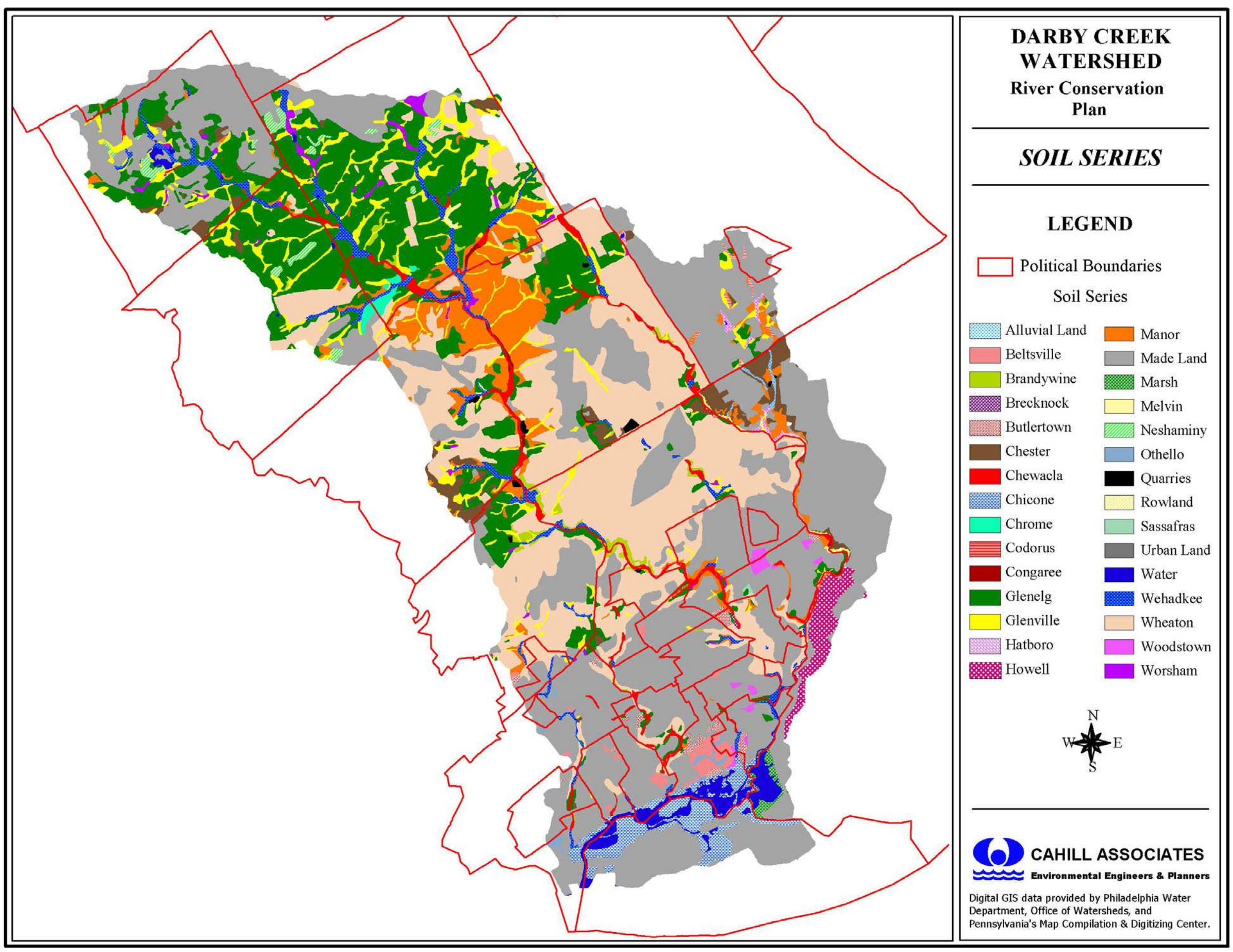

Figure III-7 Soil Composition within the Darby Creek Watershed

Chewacla, and Woodstown, all fine-loamy soils that were deposited from sandy marine and alluvial sediments along streams that drain from the Piedmont (USDA, 1959).

Hydrologic Soil Groups

The relationship between water resources and land development impacts can be expressed by the Hydrologic Soil Group (HSG) classification of the soil series (USDA, 1979; Figure III-8). HSG is given a rating, A through D. These HSG ratings describe the physical drainage properties of each soil series, including texture and permeability, as well as certain physiographic properties, such as depth to bedrock and water table. HSG Group A is well drained and highly permeable, in contrast to HSG Group D which is poorly drained and which produces much greater runoff. The HSG classification is of importance in determining the feasibility of using infiltration or recharge-oriented Best Management Practices (BMPs) for stormwater management, as well as for determining feasibility of land-based wastewater treatment technologies that recycle wastewater effluent. The Watershed within the Piedmont region contains mostly B soils.

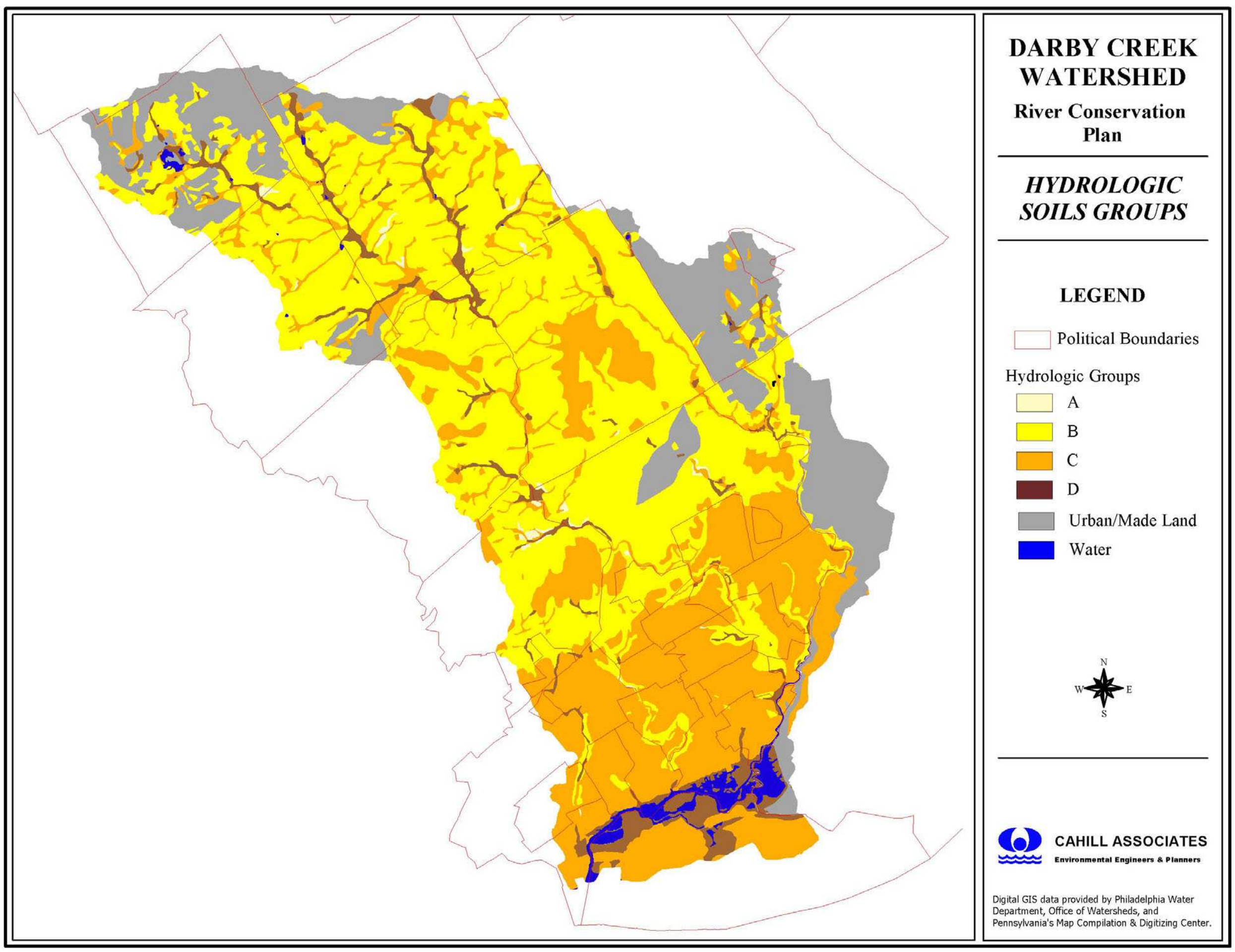

Figure III-8 Hydrologic Soil Groups within the Darby Creek Watershed

Watershed lowlands along stream valleys typically consist of HSG Groups C and D soils, reflecting an almost constant saturation/poor drainage condition. The lower portion of the Watershed is almost entirely C soils, while the Tinicum Marsh area is poorly drained with D soils.

Soils that have been altered or disrupted during construction and development tend to be limited in their drainage capabilities. These soils are classified as “Urban Land” or “ Made Land” and require site-specific investigations in order to determine whether they might be suitable for recharge or infiltration BMPs, and therefore, have no HSG rating. Much of the land in the Darby Creek Watershed has been developed, redeveloped, or altered from its original state. According to data provided by the Pennsylvania USDA – Natural Resources Conservation Service’s Map Compilation & Digitizing Center (http://mcdc.cas.psu.edu/), 13% of the watershed area is made up of Urban or Made Land.

Sinkholes

Sinkholes are depressions in the land surface that occur as a natural process of erosion of limestone or carbonate formations by water. In pre-development times, sinkholes were usually triggered by heavy rains or a flood that made the soil “roof” so heavy that it eventually collapsed. Presently, droughts can also lower the groundwater levels, which reduce the buoyant support of a cavity roof and cause a collapse. Once sinkholes form, they provide a direct flow channel to groundwater and can carry pollutants and thus affect groundwater quality. Sinkholes can be found in any area in which soils are formed in materials weathered from carbonate sedimentary rock.

Fortunately for the Darby Creek Watershed communities, limestone rock is not present in the Watershed. According to the PADCNR Geologic Survey’s Sinkhole Inventory, no sinkholes exist in Delaware County or Philadelphia County, or in the small portions of Chester and Montgomery Counties which exist in the upper portions of the Watershed. (http://www2.dcnr.state.pa.us/sinkhole/).

C. OUTSTANDING OR UNIQUE FEATURES

In this watershed, the transition between the Piedmont Plateau and Coastal Plain physiographic regions is a unique attribute of watershed location. Outstanding characteristics in the upper and middle portion of the watershed include the deeply incised stream valleys, the steeply sloping ridgeline, the softly undulating hills; the topography itself is unique to this region. In the lower portion, the tributaries that drain directly to main stem Darby Creek flow through a more subtle and delicate - yet sturdy and determined - landscape. Unique earth resource features are also included in the discussion of the Pennsylvania Natural Diversity Inventory in the Biotic Resources section of this RCP (Section V).

D. ISSUES, THREATS, OPPORTUNITIES

The Darby Creek Watershed is blessed with a relative lack of geological and soil-related constraints. The extensive development which has proliferated throughout the Watershed is excellent testament to its general developability, enjoying the good rock foundations and the good soil which exist. With a few exceptions, even the lesser desirable soils in the southern Watershed portions tolerated extensive building, provided that certain accommodations were made.

At this point, vacant land is not easily found anywhere in the Watershed, though scattered parcels with added building constraints, such as wet soils and steep slopes and floodproneness, may still remain, especially in the northern portions of the Watershed. Unfortunately, as development pressures mount, the pressures to develop these especially sensitive and highly constrained sites also mounts, with local officials sometimes yielding to developers' persistent applications and approving developments which are especially destructive from a Watershed perspective. Threats still exist. And of course these threats to sensitive lands must be viewed together with the already extensive alterations made to vast areas of the Watershed, discussed in the Water Resources and Biotic Resources sections of this RCP.

The good news is that the stream system itself provides a critical framework upon which to build a region-wide Watershed conservation strategy. The hillshade image (see Figure III-4) shows the overall Watershed physiography with elevation and topography; the stream system provides a clear pattern and overall structure and, as sections below will document, a way to link the remaining natural and important human values characterizing the Darby Creek Watershed. Ever more threatened with encroaching development, we must protect what remains and expand conservation of this stream system framework.

When that same hillshade image is overlain with the Delaware County 1870's stream network (Figure III-9), the linkage between the landform and the water system is underscored. Historical streams, many of which are now "lost," very carefully conform to the existing system of ridges and valleys of the Watershed—the foundation upon which our conservation efforts should be focused. Though many of the natural functions have been sacrificed and compromised, these critical natural functions are still operating. The Darby's stream valleys, though encroached upon, still cut through a virtual sea of development and aging impervious surfaces with a surprising degree of "naturalness." After driving through miles of high-density development, they constitute a remarkable surprise. Watershed visionaries have realized the tremendous potential of organizing more green spaces, more recreational facilities (active and passive) along these stream valley spines in order to achieve multiple benefits. In fact, this natural greenway system could even be the key to the economic stimulation that is so desperately needed in so many Watershed communities.

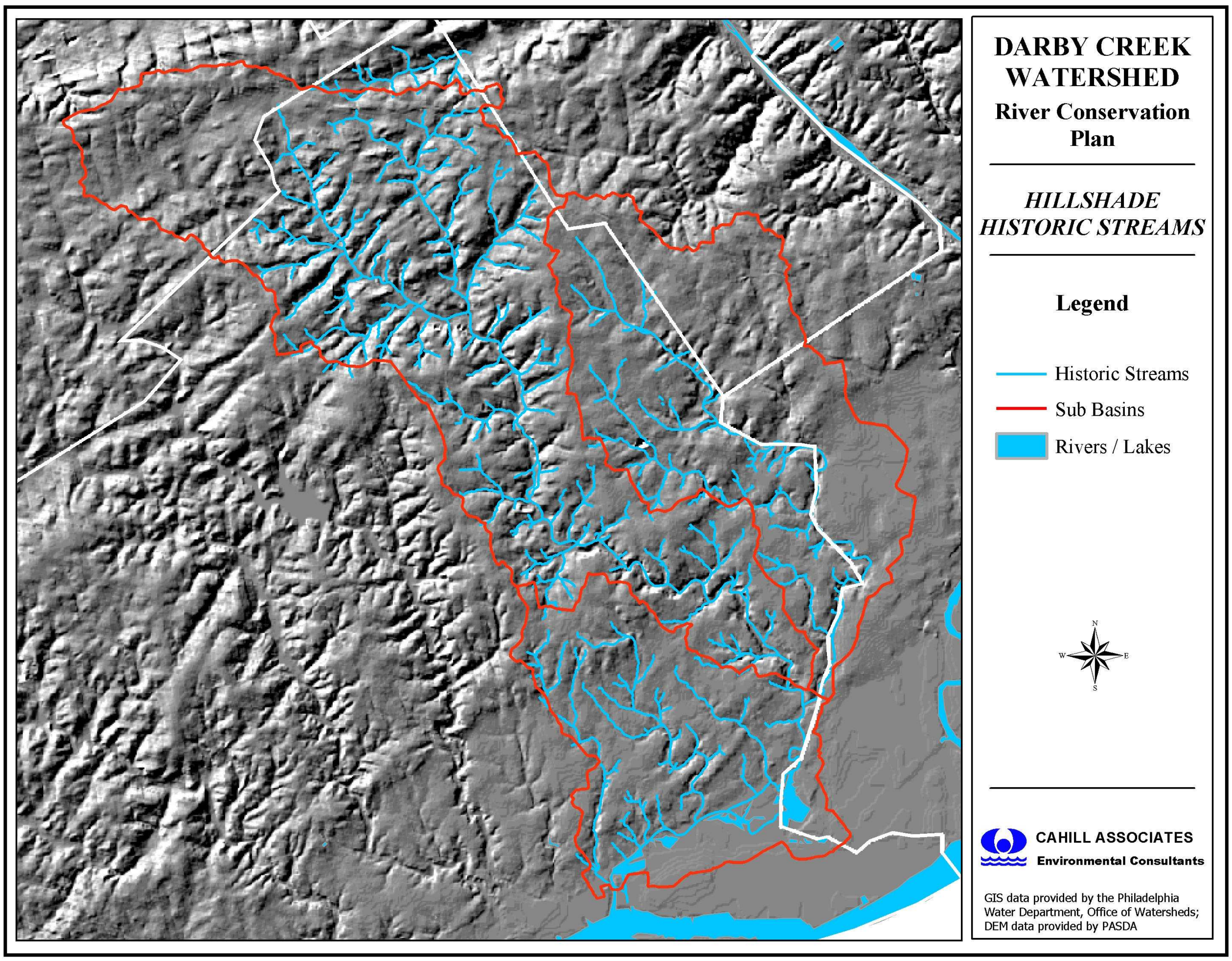

Figure III-9 Delaware County 1870 Stream Network for the Darby Creek Watershed overlaid on Hillshade

IV. Water Resources

IV. WATER RESOURCES

A. SURFACE WATERS: STREAMS AND MAJOR TRIBUTARIES

The Darby Creek Watershed streams and stream sub-basins are shown in Figure IV-1. Sub-basin areas are listed in Table IV-1 for a total of 77 square miles; stream lengths by sub-basin and in total are listed in Table IV-1 as well for a total of 123 miles (data developed from GIS files). The Cobbs Creek is the largest tributary of the Darby and has often been treated as a major stream itself, given its size and juncture with the Darby Creek so close to the Delaware River; the Cobbs sub-basin includes about 18.7 square miles or 24.2 percent of the total Darby Creek Watershed.

There are no natural lakes in the Watershed. Several ponds exist in the upper northern portions of the Watershed, typically artificially created. These small bodies of water often have been created as part of landscape master planning for older estates, and have varying, though usually limited, functional benefit for the overall aquatic life and water resources of the Watershed. In fact, many of these small constructed impoundments suffer from water quality problems; for example, the ponds at the Willows recreational center (Radnor Twp.) attract a vast goose population, and the water quality suffers as a result of nutrient loading due to excessive goose droppings.

Historic Streams
Figure IV-2 shows the location of historic perennial streams, based on a stream inventory from the mid-19th century (1870 Delaware County Historic Streams Map from the Delaware County Historical Society). Quick perusal indicates a substantial reduction in the total stream system extent; many first order tributaries (see discussion below) no longer appear on current maps. Although there may be a variety of explanations for the disparity between this historic stream network and the currently existing streams, certainly one plausible explanation for the loss of headwater streams is that substantial development has interfered with the natural water cycle. This has reduced infiltration of precipitation into the groundwater aquifers, thereby lowering the water table and reducing stream baseflow. Reduction in baseflow, in turn, means that streams cease flowing, and the extent of perennial streams is reduced over time.

Buried Streams
Though not at all the same issue, another important reality of the stream system in the Darby Creek Watershed is "buried" streams. Burial of the stream, though considered to be a viable development practice years ago, is now recognized as largely ineffective and environmentally destructive. Burial deprives stream water of essential sunlight, exposure to the atmosphere, and vegetation, all of which transform, bind up, and neutralize pollutants. Aquatic habitat, including feeding and spawning areas, is virtually eliminated. Furthermore, in most cases, increased runoff velocities and quantities have overtaxed "buried" streams. The Naylors Run flooding situation in Upper Darby Township and other problem areas vividly illustrate the results of burying streams. In a surprising number of locations in the Darby Creek Watershed, development has translated into the total enclosure and literal burying of the stream system in pipes, sometimes for

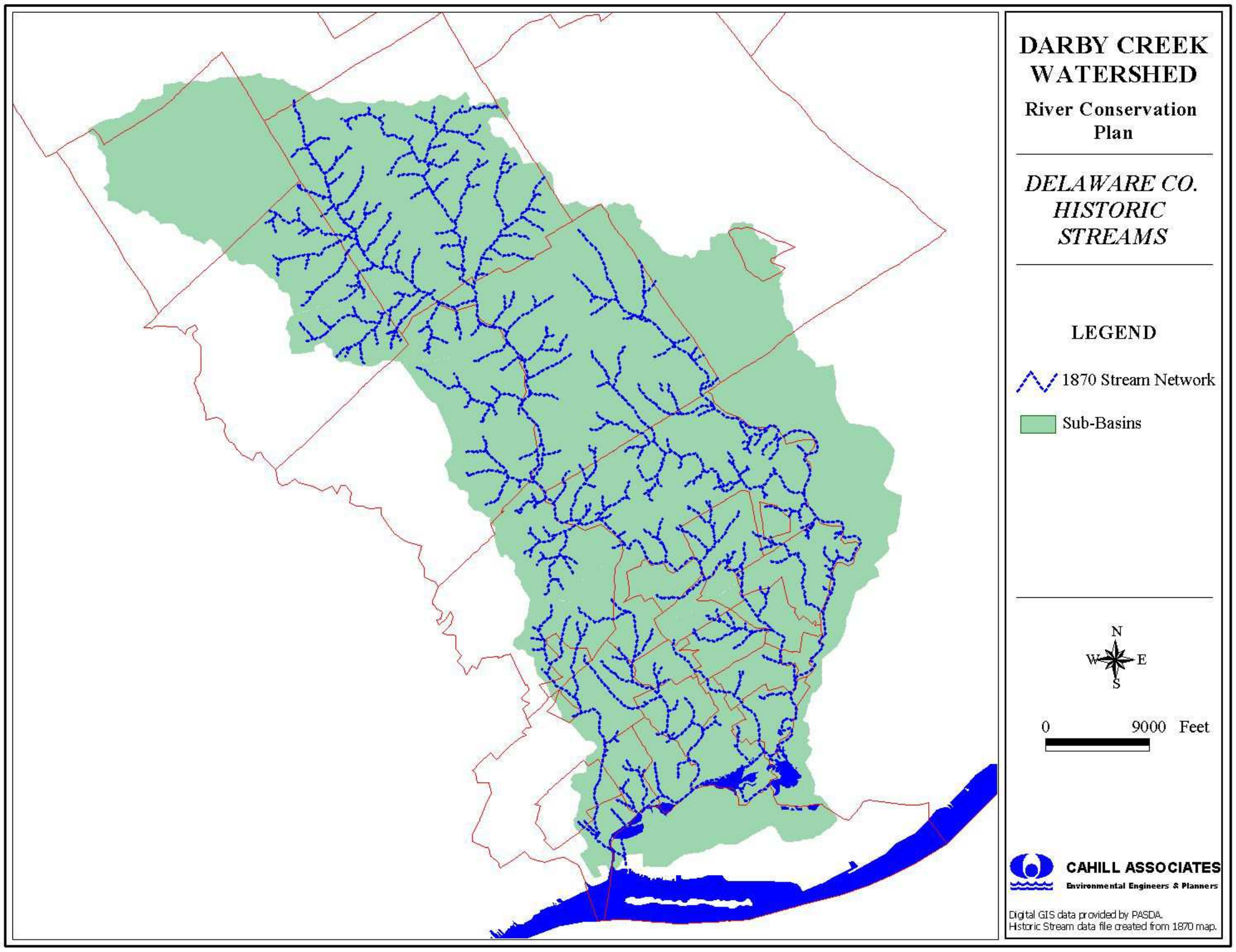

Figure IV-2 Delaware County 1870 Historic Streams

Figure IV-3 Stony Run Tributary totally buried under Springfield Township Strip Center

Figure 4-1 Sub Basins and Tributaries foldout

Figure 4-1 Sub Basins and Tributaries foldout

Figure IV-4 The Little Darby Creek off Sugartown Road in Radnor Township

considerable distances. Probably the longest section of such piping is in the Naylors Run in Upper Darby Township (Figure IV-3), a section of stream which has experienced considerable flooding problems, and where the stream is buried for several thousand feet. This piping and culverting exists in Springfield Township, Radnor Township (Figure IV-4), and many other locations to varying degrees and distances. We should note here that Richard Pinkham's *Daylighting: New Life for Buried Streams* (Rocky Mountain Institute, 2000) provides a useful discussion of the problems relating to burial and channelizing of streams, and the benefits resulting from their "liberation" through various daylighting techniques. Where feasible, daylighting strategies should be explored in all those areas in the Darby Creek Watershed where streams have been buried (see discussions below).

Stream Order

Another important characteristic of the Watershed relates to the ordering of the stream system. First order streams are especially important to watershed life because they comprise the largest percentage of the total stream system on a lineal percentage basis. Headwaters are the locations of critical ecological functioning where exchange of energy from land to water occurs most directly and is most ecologically vital. Because flows in these small headwaters are especially small, these first order streams are extremely sensitive and are the first streams to dry up when water levels decline. Figure IV-5 is a map of first order streams in the Darby Creek Watershed. One can imagine that a mapping of historical first order streams would show considerably more first order streams. Figure IV-5 is consistent with the scenario of an overall decline in water quantity and aquatic biota habitat in the Watershed as the result of increased development.

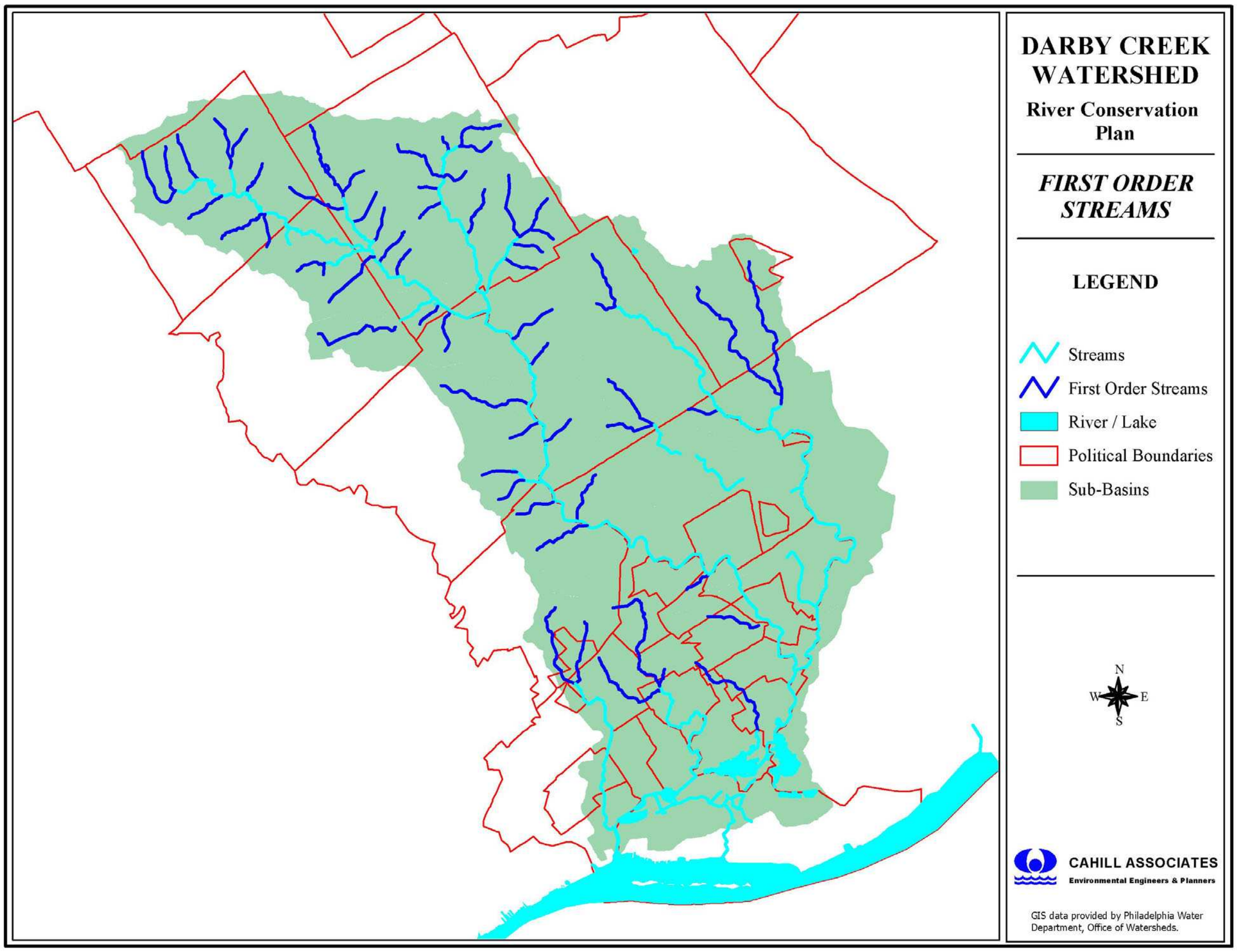

Figure IV-5 First Order Streams in the Darby Creek Watershed

B. FLOODPLAINS, RIPARIAN ZONES, RIPARIAN BUFFERS

Floodplains and the riparian areas buffering streams, rivers, lakes, and other water bodies are especially sensitive watershed zones. In their naturally vegetated and undisturbed state, floodplains and riparian areas provide critical stormwater management and flood control functions, both in terms of water quantity and water quality. For example, floodplains intercept and reduce unmanaged sheet flow runoff and absorb/contain out-of-bank flows as storms increase in intensity. Flood flows are slowed, infiltrated into the vegetated floodplain zone, and actually "stored" when the entire watershed system is taken into account. Substantial physical filtering of nonpoint pollutants, especially particulates, occurs as stormwater and flood flows move across and through the vegetated floodplain, and a host of chemical and biological actions are at work both on the surface and in the sub-surface to reduce and convert nonpoint source pollutant loadings. The naturally vegetated floodplain and riparian zone typically provides substantial 40

Table IV-1 Watershed Sub-Basin Areas and Stream Length

SUB-BASIN	Basin Area, square miles	Stream Length, linear miles
COBBS CREEK SUB-BASIN	**18.68**	**24.80**
Cobbs Creek A	0.50	1.15
Cobbs Creek B	10.01	10.26
Cobbs Creek C	1.91	2.15
Cobbs Creek D	1.10	0.86
Cobbs Creek E	0.26	4.29
East Branch Indian Creek	1.74	2.57
Indian Creek Main Stem	1.41	0.72
West Branch Indian Creek	1.75	2.80
DARBY CREEK SUB-BASIN	**43.40**	**65.39**
Abrahams Run	0.32	0.65
Browns Run	0.34	0.75
Camp Run	4.79	0.72
Darby Creek B	2.29	3.30
Darby Creek C	16.89	25.11
Darby Creek D	5.19	10.02
Foxes Run	1.50	2.37
Hardings Run	0.83	1.95
Ithan Creek A	1.70	3.44
Ithan Creek B	1.49	1.49
Julip Run	0.65	1.09
Kirks Run	0.49	0.93
Langford Run	0.46	1.77
Little Darby Creek	2.30	3.45
Meadowbrook Run	1.76	3.68
Miles Run	0.23	0.54
Ramsey Run	0.15	0.49
Valley Run	0.60	1.14
Whetstone Run	1.10	1.81
Wigwam Run	0.33	0.70
DIRECT DRAINAGE SUB-BASINS	**15.32**	**32.88**
Darby Creek A	6.24	15.92
Hermesprota Creek	1.82	3.54
Muckinipattis Creek A	0.79	1.73
Muckinipattis Creek B	3.51	5.67
Stony Creek	2.96	6.02

stream shading through the tree and shrub canopy, which reduces overheating of waters in the summer; aquatic species are often sensitive to water temperature. The vegetation also provides a balanced level of detrital matter, such as leaves and twigs, which serves as an important food source for aquatic biota. Floodplain vegetation anchors the stream bank and prevents scouring, undercutting, and overall erosion. This helps maintain the stream's morphology, its system of meanders and riffles, and the aquatic habitats they support. When floodplains are conserved as an area is developed, they provide a system of greenways linking larger open space areas that provide habitat for wildlife. In short, undisturbed floodplains and riparian areas are essential watershed elements.

It should be noted that these positive floodplain functions are closely interrelated to the positive functions of the riparian buffer. In many cases, assuming a riparian buffer width of 65 to 100 feet, the floodplain and recommended riparian buffer may be virtually one and the same, although certainly the floodplain may extend beyond the riparian buffer limit and vice versa, depending upon the upstream-to-downstream watershed location. In this discussion, floodplain and riparian buffer functions and benefits are treated as one. Floodplains are shown in Figure IV-6. If we hypothesize an average floodplain/riparian zone width of 100 feet (extending on both sides of the stream) and apply this buffer to the entire stream system of the Darby Creek Watershed, floodplains/riparian zones potentially comprise 2,984 acres (about 6 percent of the total Watershed area).

Over the years, development has encroached substantially into floodplains of the Darby Creek Watershed. In many places, this development has resulted in total stream enclosure/burial with virtual elimination of any semblance of the floodplain. Elsewhere, streams have been substantially channelized with structures that are built into and on the floodplain. Fill has been placed within floodplain areas to accommodate parking, roads, and other development elements, resulting in a broad array of impacts on natural floodplain functions. Even the relatively inoffensive clearing of floodplain areas with replacement as lawn and other landscaped areas takes its toll on the important water quality and water quantity functions of the natural floodplain. Figure IV-7 illustrates recent floodplain encroachment in the Drexelbrook area.

Conversely, an excellent example of floodplain and riparian zone conservation and protection is the Cobbs Creek Park itself, with the adjacent Morris Creek Park facility. Philadelphia had the foresight years ago to establish greenways along the Cobbs and its tributaries, both for conservation and recreational purposes. With the exception of the Heinz National Wildlife Refuge, the Cobbs Creek Park and related facilities constitutes the most significant conservation and recreation zone in the Watershed.

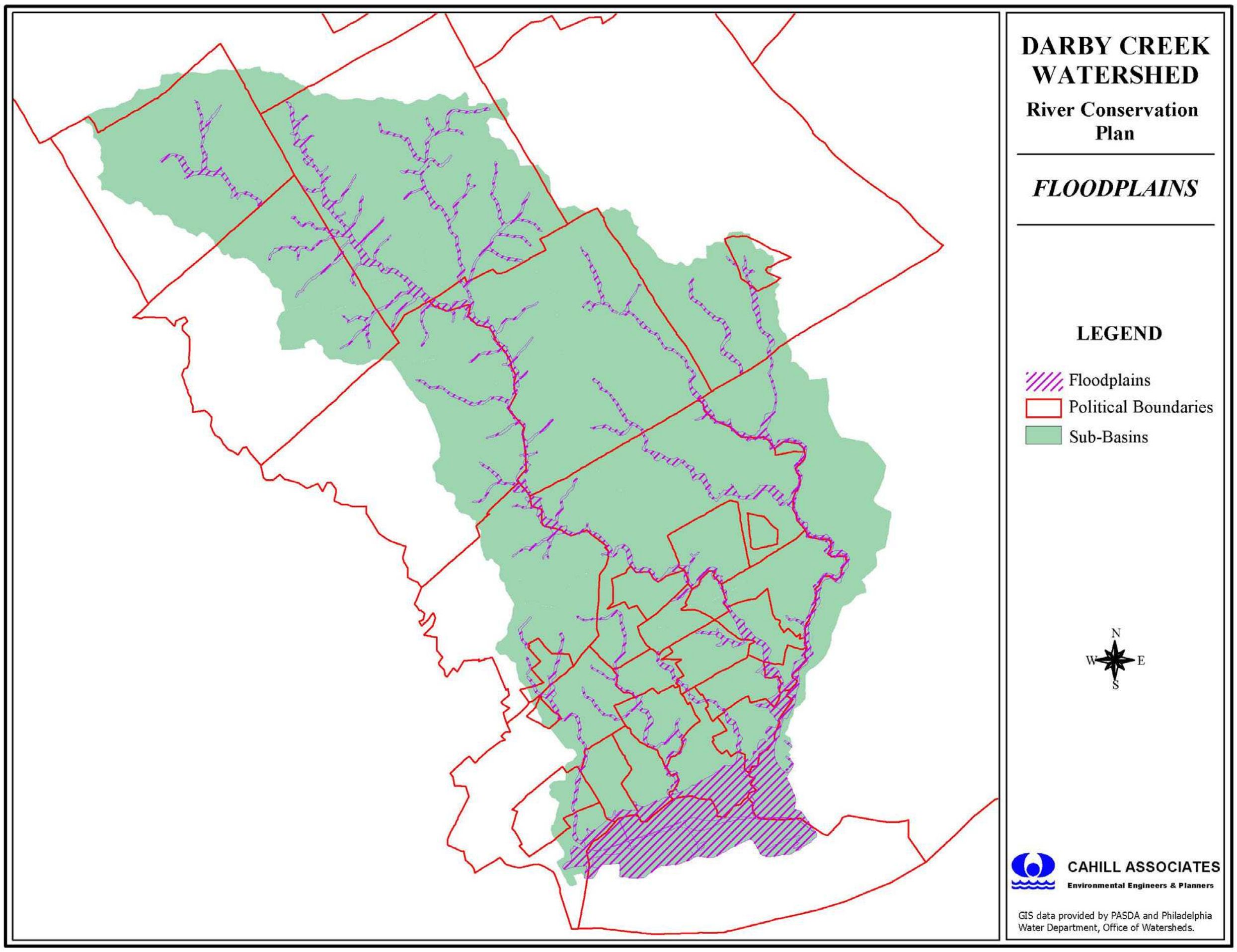

Figure IV-6 Floodplain Areas in the Darby Creek Watershed

Figure IV-7 Floodplain Encroachment near Drexelbrook, main stem Darby Creek

PWD's Cobbs Creek Restoration Project - A Sustainable Approach to Restoring an Impaired Urban Stream

This special effort by PWD focuses on the critical natural functions of the stream system, its floodplains and riparian buffer zones. This project will implement a sustainable approach to stream habitat restoration that will mitigate the impacts of urban development and related hydrologic and hydraulic modifications. By enlisting the members of the Darby-Cobbs Watershed Partnership and national experts, this local Watershed restoration effort will restore 1,000 linear feet of the Cobbs Creek stream corridor between Pine Street and Cedar Avenue using natural restoration techniques. The primary goal of this project is to identify and document existing stream conditions, develop conceptual alternatives, prepare final design and construction drawings, and stabilize a reach of Cobbs Creek using fluvial geomorphologic principals and natural channel design techniques. The most appropriate restoration techniques will be selected based upon a comprehensive, Cobbs Creek-wide, fluvial geomorphologic characterization completed by the PWD project team using Rosgen methodologies.

PWD is applying an holistic approach in this work, recognizing that a stable stream channel is a function of the balance of in-stream morphological features as well as the many interconnections with the surrounding riparian ecosystem. Restoration encompasses the replication of natural hydrologic and ecological cycles, sustainability, enhancement to riparian and in-stream aquatic habitat, improved aesthetics, all with significant cost savings over structural solutions. The results of this approach include not just a stable stream bank geometry, but also long term ecological stability. This approach to stream bank stabilization combines the disciplines of fluvial geomorphology, hydraulics, hydrology, and applied ecology and requires an accurate identification of stream classification type, an understanding of hydrologic actions within the watershed and their effects on a stream channel, and clearly defined restoration goals. Sound fluvial geomorphologic principles and an understanding of the natural stream system are integral to creating a stable stream channel that facilitates the restoration of the riparian ecosystem. The objective is to create a stream system that is stable, requires little maintenance, and is self-sustaining.

Floodplain/Riparian Zone Encroached Area Analysis

Although detailed inventory and analysis of the existing floodplain and riparian zone has not been undertaken for the preparation of this RCP, an approximate evaluation of the floodplain and riparian zone condition has been developed by combining the land use data file with the mapping of the Watershed stream system (Figure IV-8). Land use/land cover categories including Vacant, Wooded, Recreation, Agriculture, and Water, which bounded the stream were assumed to be natural or relatively natural (a very forgiving and generous assumption; in truth, significant portions of these land use categories also could have been altered from their natural riparian condition). They were assumed to have some existing riparian buffer and/or undeveloped floodplain condition. All other land use categories were assumed to constitute some floodplain/riparian zone encroachment condition. Based on this combination of data layers, the resultant statistics indicate that 1,168 acres of the Darby's total 2,984 floodplain/riparian zone acres (about percent) have experienced encroachment by development, and are likely to have substantially reduced floodplain and riparian zone functions. This could well be a substantial underestimate, given the amount of clearing and disturbance which could occur in both the Recreation and Vacant categories; the situation could be worse than suggested by these numbers and may well approach 50 percent encroachment. In summary, substantial portions of the most sensitive and critical riparian zones in the Watershed have been adversely impacted by development. Clearly, restoration of these areas already impacted is important, and better management of the floodplain and riparian zones should be an important goal for the Darby Creek Watershed in the future.

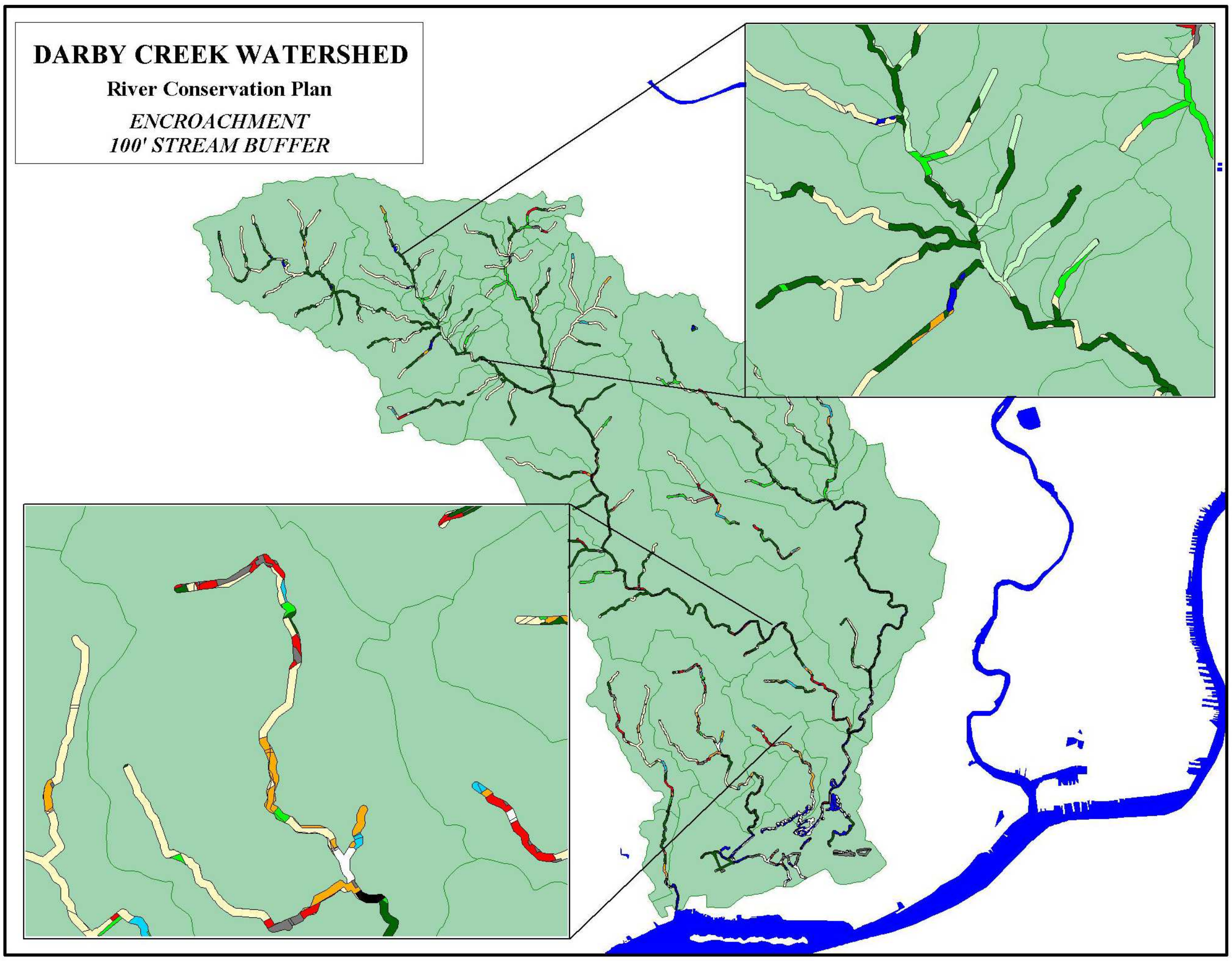

Figure IV-8 Stream Encroachment Analysis using 1995 DVRPC Land Use (Colors relate to Figure II-3)

Federal Emergency Management Agency (FEMA)
Floodplain management in an undeveloped watershed is important, but effective management is especially important in a highly developed watershed where the benefits of the floodplain and riparian zone take on heightened importance. A major problem, as the data indicate, is that so

much of the Darby Creek Watershed has been developed before the emergence of any floodplain regulations, the most notable of which are the Federal Emergency Management Agency (FEMA) set of minimum floodplain standards, which were modified and made more rigorous in the mid-1990's. At this time, virtually all of the 31 municipalities of the Darby Creek Watershed participate in the FEMA floodplain program; East Lansdowne is the one municipality in Delaware County which is not required to participate in the FEMA program. Most municipalities have incorporated minimum FEMA standards into their respective codes and ordinances, although some municipalities in Delaware County may not be in strict compliance with the FEMA program, especially given the FEMA program changes which occurred in the mid 1990's. (According to William Gothier at the Delaware County Conservation District, several municipalities may be in violation of FEMA program requirements; in cases of non-compliance with elements of the National Flood Insurance Program, municipalities could be suspended from the FEMA program and held responsible if flooding damages were to occur; in these cases, homeowners would be deprived of flood protection as part of the NFIP). In any case, a cursory review of the municipal ordinances requested from and made available by the municipalities for this RCP indicates that most municipalities have not gone beyond FEMA minimum requirements, although they are constitutionally enabled to enact more rigorous floodplain and riparian zone controls.

Important points need to be made here regarding floodplain management and the FEMA program in the Darby Creek Watershed. Of course, all new development projects and redevelopment projects must comply with these minimum floodplain standards, as part of municipal regulation. However, the number of new development projects and redevelopment projects is not great, especially in the middle and lower portions of the Watershed where the problems and Watershed impacts tend to be most serious. It is true that as available land has dwindled and availability of developable sites has declined, pressure to develop less desirable sites such as floodplain sites has intensified. A scarcity of land has led to more development in the floodplain and to filling, legally and illegally, of floodplain and even floodway areas for building foundations, parking lots, and other ancillary facilities. Nevertheless, new development and redevelopment are relatively limited, especially in the lower portions of the Watershed. Consequently, regulations for new land development projects in the respective subdivision and land development regulations of the 31 municipalities, though important, have limited effectiveness, whatever these regulations might require. In fact, a substantial amount of land on the floodplain was developed prior to the existence of any floodplain management program, whether it was the FEMA program or any other more local initiative. As is discussed elsewhere in this RCP, the very history of the Watershed itself is steeped in mills and waterpower, the construction of which meant direct encroachment into the floodplain.

Secondly and perhaps most importantly, the minimum FEMA standards themselves are inadequate and allow for substantial floodplain and riparian zone impacts to continue to occur, even when fully and completely implemented and enforced. FEMA standards focus primarily on the protection of life, limb, and property. Although standards have improved in the mid-1990's, FEMA standards are not intended statutorily to be a program of floodplain protection and watershed management. Filling and even structural construction may occur even within the highest risk floodway zone, provided that hydraulic and floodway impacts are not substantial and first floor areas are properly flood-proofed. Even more extensive clearing, filling and paving are possible in the "flood fringe" portion of the floodplain. These very generous allowances in the existing local and Federal regulations explain why development projects continue to be approved within the floodplain and riparian zone in the Darby Creek Watershed, and why Watershed impacts especially in terms of flooding may grow even more serious in the years ahead, unless something is done to curb this type of development. As this Watershed has developed and the overall hydrology has been altered so dramatically (see discussion below), the floodplain is being required to accommodate and mitigate flood events which impinge upon it with greater and greater frequency and with more intensity. To add insult to injury, at the same time, the floodplain itself is paved, filled, and otherwise impacted by innumerable land development projects, even further reducing and compromising its critical natural functions—a devastating "double whammy".

As challenging and difficult as this might be, Watershed municipalities must realize that rigorous floodplain and riparian zone protection is cost effective and ultimately the wisest course of action. Development and redevelopment projects must avoid floodplains and riparian zones in order to prevent disastrous future flooding. To protect intensive development in adjacent areas, the floodplain itself must be kept as fully and densely vegetated as possible, so that it can provide maximum flow reduction and retention. Strict ordinances must be enacted so that natural floodplain/riparian zone functions are preserved and restored. Though this restoration will take many years and comes at a cost, given the current level of impact, benefits will begin to accrue to Watershed residents, who will also benefit in so many other ways from this floodplain and riparian zone restoration.

C. WETLANDS

Wetlands are transitional lands between terrestrial and aquatic environments, and include lands commonly known as swamps, marshes, bogs, springs, and seeps; wetlands can also include areas which may not always have standing water. Wetlands are unique environments which provide critical ecological and overall environmental functions, which ultimately have natural, economic, and even social benefits. These wetland functions include water storage, flood water abatement, water quality improvement, provision of vital plant and wildlife habitat (including an inordinate proportion of Pennsylvania's rare, threatened, and endangered species), groundwater discharge that maintains stream base flow, and groundwater recharge in some cases. In terms of the Darby Creek Watershed, all of these benefits are of importance, though given the Darby's problems of both water quality and stormwater flooding, these wetland benefits undoubtedly top the list. Because an unknown quantity of wetlands have been lost to development (i.e., filled) over the years in the Watershed (it can be surmised that a considerable quantity of wetlands located adjacent to the Watershed's major streams and tributaries have been filled as development has encroached across the floodplain and overall riparian zone), those wetlands which remain are of particular importance and are deserving of special protection.

National Wetlands Inventory Program

Wetlands within the Darby Creek Watershed have been identified and mapped (Figure IV-9) based on National Wetland Inventory (NWI) data. The NWI wetland classification system is hierarchal, with habitats divided among five major systems at the broadest level. Three major systems are represented in the Watershed; the other two classes, Marine and Estuarine, are not. Lacustrine (lakes and ponds), Palustrine (marshes and swamps), and Riverine (rivers, creeks, and streams) systems only comprise 3% of the total Watershed area (2.1 square miles) with the remaining 97% of the Watershed classified as Upland. While few Palustrine fragments dot the northern Watershed landscape, the majority of the wetlands in the Watershed which remain are located at or near the John Heinz Wildlife Refuge at Tinicum, the largest remaining freshwater tidal wetland in

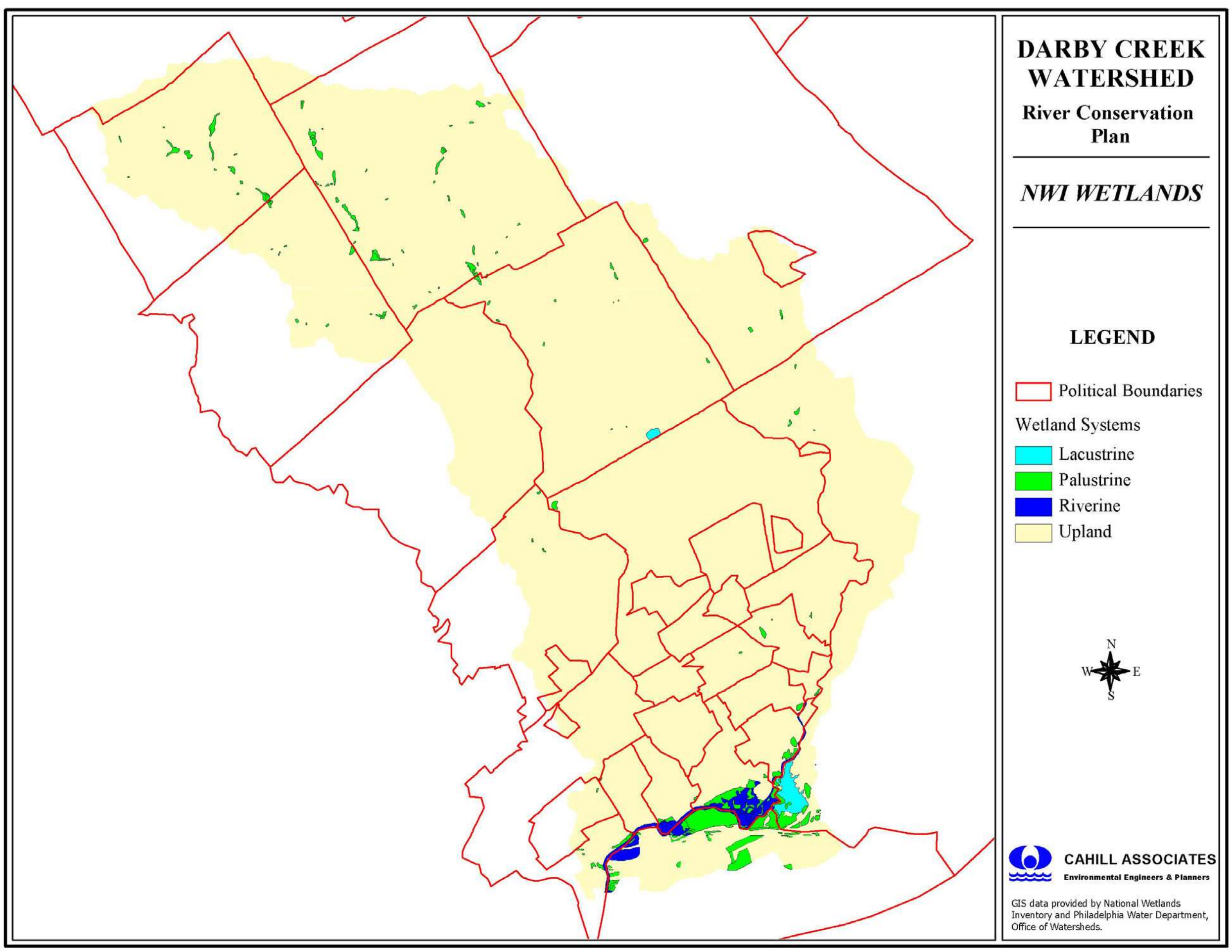

Figure IV-9 Wetland Systems in the Darby Creek Watershed

Pennsylvania. The NWI data source provides an approximate mapping of wetlands and is appropriate for use in this Plan. NWI wetlands delineation is based on interpretation of high altitude aerial photography and should not be used for regulatory purposes. Many small wetlands typically are omitted from NWI mapping.

Wetland Construction

Wetlands can be recreated. Special wetland studies by the City of Philadelphia with USEPA support have indicated the potential for creating wetlands between the Darby and Cobbs, immediately above their confluence. The City has also recently reconstructed approximately 2 acres of wetlands adjacent to Naylor's Run in Delaware County, through the Natural Lands Restoration and Environmental Education Program. Though opportunities are limited, additional wetlands creation potential exists throughout the Watershed and would be beneficial from a water quality, flood reduction, and habitat perspective.

Special PWD/USEPA Wetlands Program

The Philadelphia Water Department'' (PWD) Office of Watersheds (OOW), in conjunction with other Watershed stakeholders, has undertaken a comprehensive watershed-based planning initiative to characterize and develop solutions to regional urban water pollution problems. An important component of this initiative is to define appropriate water quality improvement approaches for abatement of point and nonpoint source pollution impacts pursuant to achieving the goals of USEPA's Total Maximum Daily Load Program (TMDL). This PWD/USEPA wetlands project is intended to help illuminate the vital role that wetlands play in contributing to Watershed health and to further support the protection and enhancement of their inherent water quality improvement function. The goal of this project is to *expand* PWDs existing wetland inventory and assessment program to define opportunities for wetland protection and enhancement for four watersheds in the Southeast Region of the Commonwealth of Pennsylvania.

This project will both provide and receive information from other ongoing projects in the Watershed, including a fluvial geomorphologic master plan under development for the Cobbs Creek portion of the Watershed. In an effort to identify and reduce major wetland stressors, assessment efforts will be focused around existing stormwater discharge infrastructure - especially those areas that are presently targeted for renewal. The data collected from this project will provide a foundation for continued wetland protection efforts and support future wetland preservation, enhancement, and creation activities. This project will also promote the integration of floodplain management, runoff pollution source management, and water quality management in priority Watershed areas through the identification and assessment of wetland habitats. Finally, the project will identify the best approaches to implement water quality improvements through construction of stormwater treatment wetlands that appropriately integrate with existing wetland systems, and that do not intrude on existing wetlands, consistent with the guidance provided in EPA 843-B-00-003 *Guiding Principles for Constructed Treatment Wetlands.*

D. THE WATER CYCLE

Understanding the water cycle and how human development actions have affected this cycle is especially important in understanding the Darby Creek Watershed. Figure IV-10 illustrates the essential dynamics of the water cycle (or hydrologic cycle, a term which can be used interchangeably). The water cycle arrows illustrate continuous movement. Of all the aspects of the water cycle which must be emphasized, its dynamic quality—the never-ending cycling from atmosphere to the land and then to surface and groundwater pathways and back to the atmosphere—is most critical to appreciate. The often-heard observation that we drink the same water today that the Indians drank hundreds of years ago is a function of this continuous cycling and recycling.

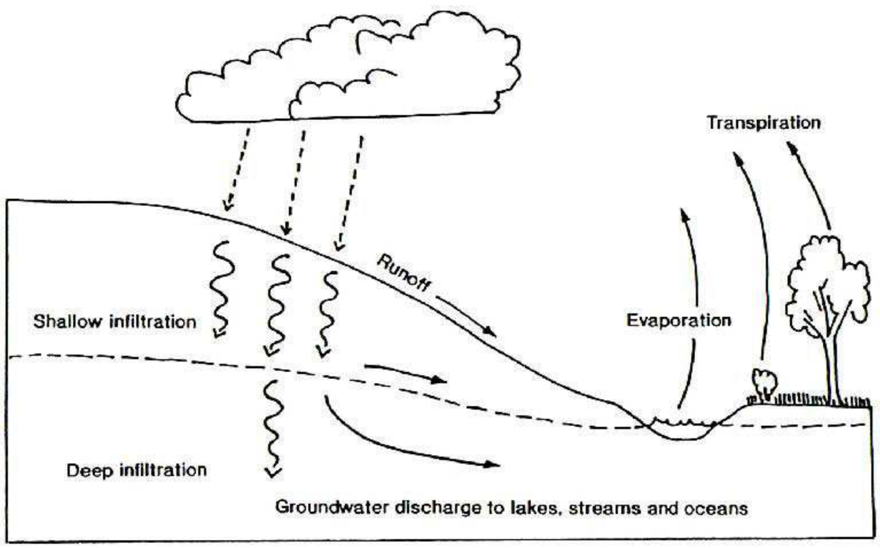

Figure IV-10 The Hydrologic Cycle

The water cycle for an average year in our general climate zone includes a variety of components which can be displayed in the form of a relatively simple system flow chart (Figure IV-11). Precipitation data is based on rain gauges and includes data recorded over many years at many different stations (the closest official National Oceanic Atmospheric Administration rain gauge is located at the Philadelphia International Airport, relatively close to the Darby Creek Watershed). The PWD has instituted a system of rain gauges, several of which are located in the Cobbs Creek Watershed. Total stream flow data, where available, similarly is obtained from stream gage data, typically recorded by the US Geological Survey, over as many years as possible, with special procedures applied to distinguish stormwater runoff from stream baseflow occurring during non-storm periods or dry weather (i.e., baseflow separation). USGS stream gauge locations within the Watershed are shown in Figure IV-12. Different watersheds with different land covers and different geology and aquifer characteristics will demonstrate some variation in stormwater runoff and stream baseflow volumes in average precipitation years, although the general relationships between the two are remarkably consistent in this Piedmont and Coastal region.

Before delving into any one of the water cycle elements in greater detail, it is important to stand back and appreciate that the system is a closed loop. What goes in must come out. Impacts on one part of the cycle by definition create comparable impacts elsewhere in the cycle. If inputs to infiltration are decreased by 10 inches, then inputs to surface runoff and/or depression storage must be increased by the same amount to balance the cycle. Further along in the cycle, infiltration outputs will have to be reduced by the same 10 inches. Following along on the flow diagram, the groundwater reservoir, evapotranspiration and soil moisture elements together would be reduced by 10 inches, which would be reflected in stream baseflow reductions.

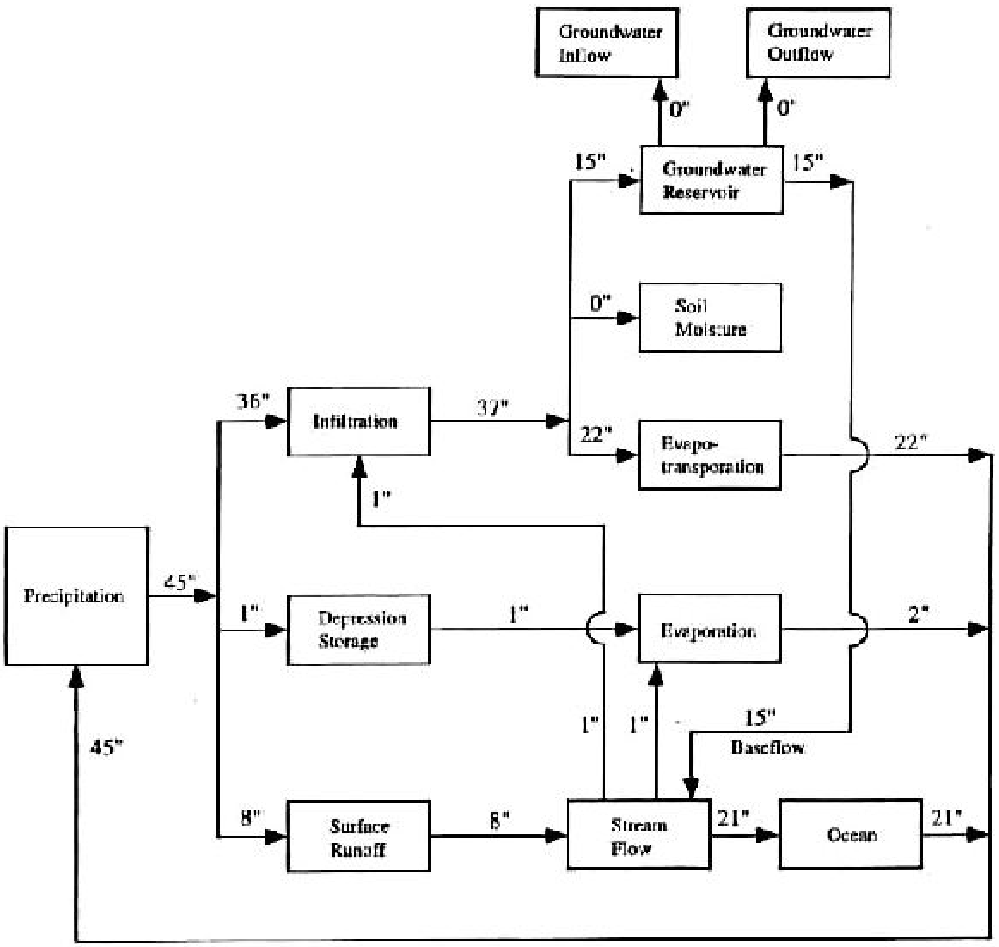

Figure IV-11 The Hydrologic Cycle Quantified for the Piedmont Region

To repeat, the point here is that impacting one part of the water cycle invariably affects the entire system. This action/reaction system sensitivity has important ramifications for any attempt to manipulate and manage individual elements within the water cycle. Management programs which purport to focus exclusively on one aspect of the water cycle—for example, controlling only for peak rates of stormwater runoff as we have done so often, without paying attention to the total water cycle volume impacts—produce all sorts of "surprises" elsewhere in the cycle and typically are doomed to failure.

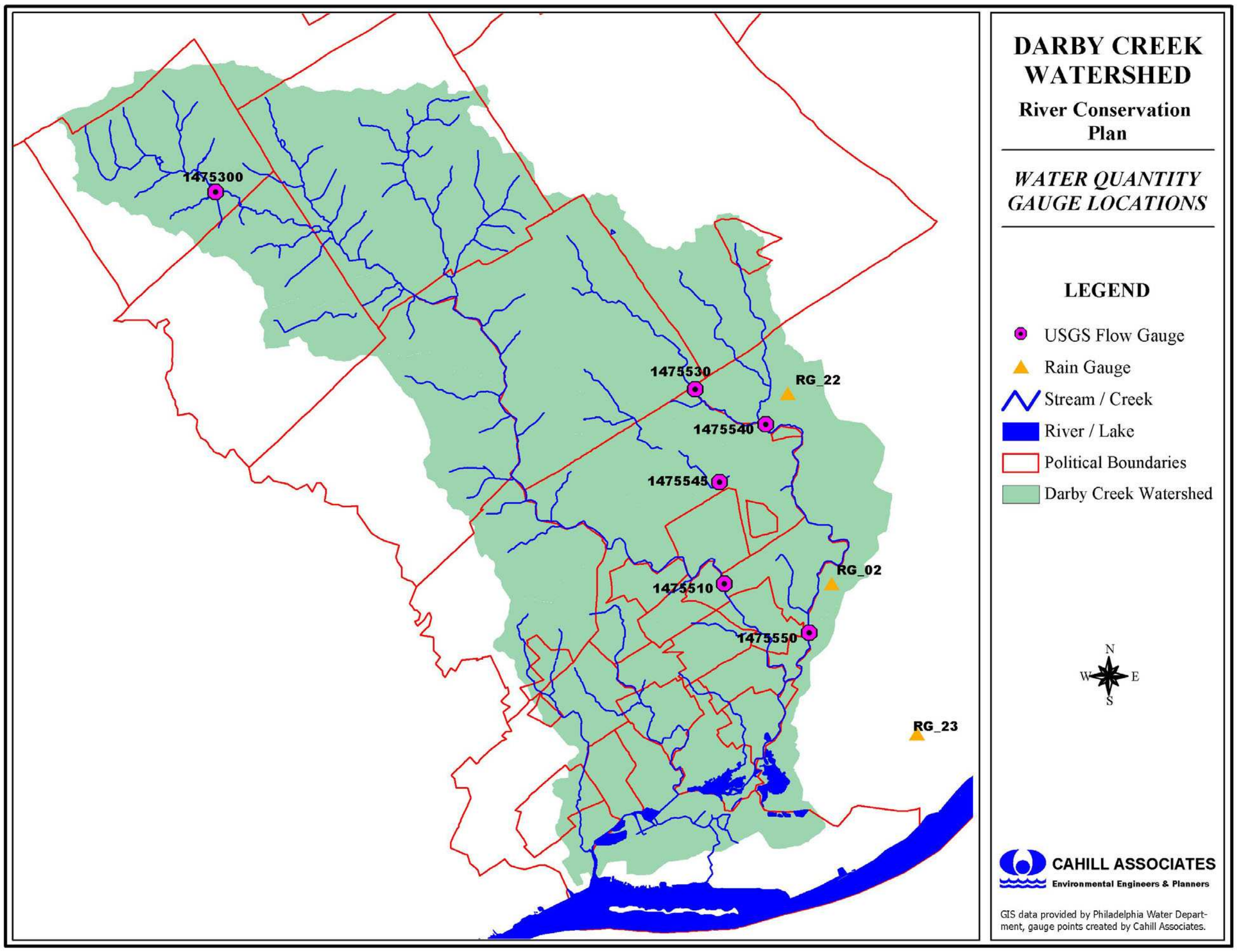

Figure IV-12 USGS Water Flow Gauges in the Darby Creek Watershed

Land development has come to mean a significant change in the natural landscape, including creation of vast areas of impervious surfaces. When we pave over and create impervious surfaces, we increase surface runoff. Figure IV-13 illustrates the effects if increased impervious surfaces. The arrows in the illustration are drawn to suggest size or extent of impact (in this case, total quantities of water involved year after year). Note that when we move from the pre-development to post-development site, the 3 medium-sized arrows become one large surface runoff arrow with both evapotranspiration and infiltration substantially decreased in size. Figure IV-14 carries the comparison several steps further, contrasting a Natural Ground Cover scenario with 10-20 percent impervious, 35-50 percent impervious, and 75-100 percent impervious scenarios. Again, the point to be made is that increasing surface water runoff total volumes translates into significantly reduced total volumes of infiltration, with significant consequences elsewhere in the water cycle. This issue is of paramount importance given the tremendous amount of development which has already occurred in this Watershed.

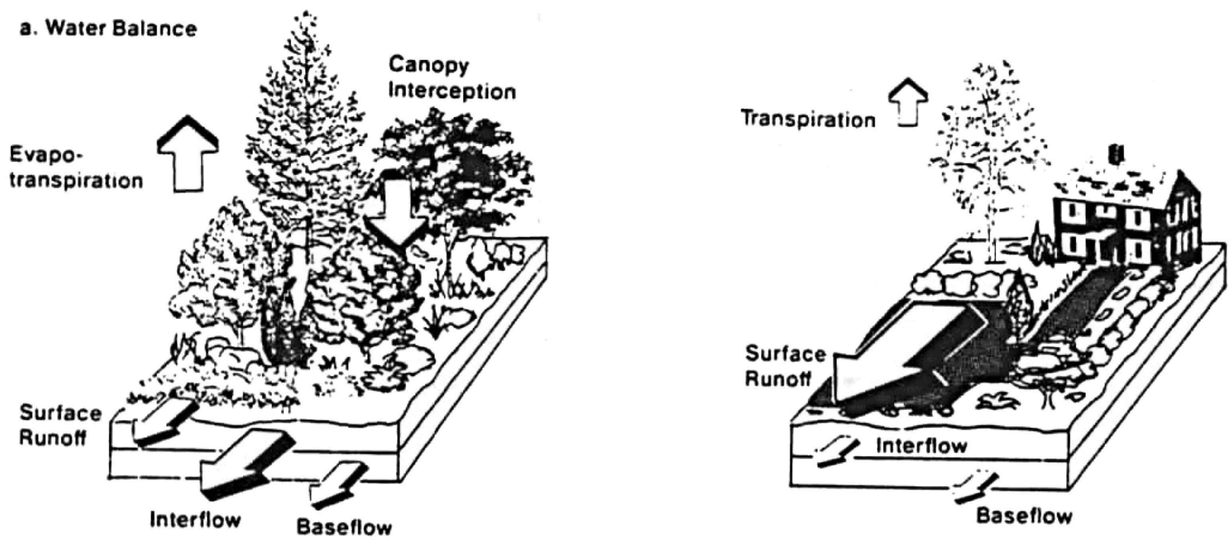

Figure IV-13 The Effects of Development on the Hydrologic Cycle

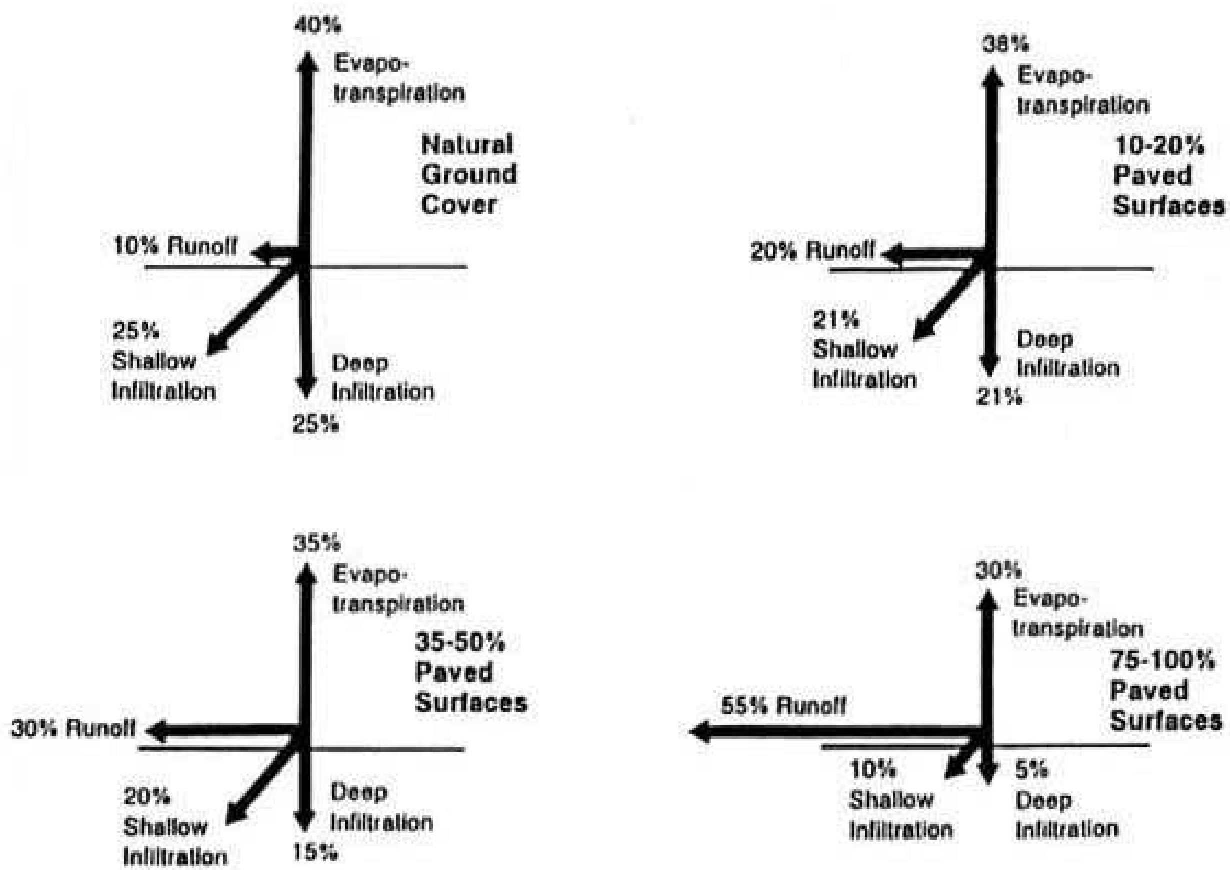

Figure IV-14 Typical changes in runoff resulting from paved surfaces

In the recent past, most municipal stormwater management regulations have focused on peak rate stormwater management. In fact, in many areas of the Darby Creek Watershed (especially the lower and middle portions), much of the existing development occurred prior to any stormwater management regulations. The only stormwater provisions put in place often are stormwater collection systems which directly discharge any and all stormwater runoff into the nearest stream without any type of peak rate control, volume control, or water quality control. More recently, detention basins have been engineered for land development plans to satisfy adopted municipal regulations which have focused on the single stormwater management need of peak rate control in order to prevent flooding on adjacent parcels downstream. According to these municipal regulations, peak rates of runoff at a site, pre- to post-development, are to be held constant, although large increases in total runoff volumes are allowed. As these increased volumes combine downstream, flooding typically gets worse, detention basins notwithstanding. Because such peak rate control management efforts are so partial in concept, and because this approach to stormwater management fails to acknowledge and plan for critical system-wide water cycle impacts, the existing stormwater management system itself has become a problem, rather than a solution.

Precipitation

Obviously precipitation is fundamental to the concept of the water cycle. In southeastern Pennsylvania, average annual precipitation does vary to some extent from location to location, but long-term rain gauge data generally indicates average annual precipitation to be about 45 inches (the PWD lists the Philadelphia International Airport gauge as 41.5 inches per year)—in other words, a relatively humid climate pattern, the relatively recent droughts notwithstanding. Overall, this water cycle is distinguished by substantial precipitation which tends to be distributed throughout the year in frequent events of modest size. The long-term charting of precipitation month-by-month confirms this relatively even distribution. No one specific month or season tends to be excessively wet or dry, though certainly times of precipitation extremes have occurred (especially hurricanes).

Also important is the distribution of rainfall by size of event. Data records indicate that precipitation occurs mostly during small events. Based on previous analyses of southeastern Pennsylvania data for various rain gauges, over 95 percent of the total number of precipitation events occurring during the last several decades were classified in the "less than 2 inches in 24-hours" (approximately the 1-year storm) categories. Even more important from a water cycle perspective, over 95 percent of the average annual rainfall **total volume** occurred in storms or "events" of less than 3 inches (less than the 2-year storm); 85 percent of the average annual rainfall **volume** occurred in storms or "events" of less than 2 inches. Over half of the total volume of the average annual precipitation occurs in "less than 1-inch" precipitation events. In short, the vast bulk of precipitation occurs in the smaller and more frequent storm events. Surface water management strategies, especially stormwater and flooding management programs, have historically dwelled on only the largest catastrophic events, such as the 100-year storm, but these smaller storms are actually more critical when most water cycle questions are being asked (and answered). If our concern is keeping the water cycle in balance, storm size distribution data suggests that using the 1- or 2-year storm as the basis of design for stormwater Best

Management Practices, rather than the larger 100-year storm, will serve to capture the vast bulk of stormwater runoff and provide adequate water cycle balance.

Precipitation events for our region have been classified in storm events as below:

1-year storm	2.4 inches in 24 hours
2-year storm	3.2 inches in 24 hours
10-year storm	5.6 inches in 24 hours
100-year storm	7.2 inches in 24 hours

Note that these events are to be understood as statistical probabilities. The 1-year storm has a 100 percent chance of occurring during any one year. A 2-year storm has a 50 percent chance of occurring in any one year, and so forth. The largest storms, certainly the 100-year storm, tend to be hurricane-related events, although not all storms fit the hurricane pattern.

Stormwater and the Groundwater Reservoir/ Stream Baseflow
Precipitation can take several routes after reaching the land surface. One possibility, depression storage, consists of small quantities of precipitation which are intercepted and temporarily ponded or pooled on the land surface, later to be evaporated. Depression storage tends to be relatively insignificant and not subject to significant change, pre-to post-development.

The focus of interest for stormwater management lies with both infiltration and surface runoff. As discussed above, increased surface runoff by definition means decreased infiltration. Land development creates both impervious surfaces and altered pervious surfaces such as lawns, both of which result in reduced quantities of infiltration when compared with the pre-development natural condition. Important here is the pre-development vegetative cover condition of the site; existing stands of forest or meadow or even scrub vegetation allow for considerably more infiltration than will occur with a post-development lawn on a disturbed and at least partially compacted soil base.

A critical water cycle impact here focuses on the groundwater reservoir component, also commonly referred to as groundwater or aquifer recharge. Decreases in infiltration mean decreases in the groundwater reservoir volume. Subtract from infiltration and you subtract from the groundwater reservoir. As these subtractions continue acre-by-acre, development-by-development, their cumulative effect grows larger. As the effects accumulate, groundwater reservoir depletion grows more serious, and the water table, the uppermost surface of this groundwater reservoir, declines as well. Figure IV-15 illustrates a simplified pre-development situation in cross-section, where normal precipitation patterns combine with natural vegetation to produce a particular groundwater reservoir or aquifer condition. In the post-development condition (Figure IV-16), water well development and withdrawal and impervious surfaces have been added, resulting in reduced inputs to the groundwater reservoir. The water table declines. If we add in the effect of drought further reducing groundwater reservoir inputs and further lowering the water table, the cumulative effects of development and drought become quite significant. Springs and streams—especially first order headwater streams—are jeopardized and may even dry up. Wells, especially older shallow wells, may fail, and Piedmont wetlands, typically fed by groundwater discharge, will be adversely impacted. Depending upon location, salinity levels in both ground and surface water systems may actually increase.

Most wells can be re-drilled at greater depths, though at considerable expense. Not so, for headwater streams and springs—the lifeblood of the stream system. The illustrations in Figures IV-15 and IV-16, though simplified, clearly establish the dynamic and critical relationship between the groundwater reservoir and stream baseflow. If the water table declines, stream baseflow declines by definition. The groundwater reservoir might be thought of as a saturated sponge where precipitation inputs are added from time to time on the surface. In the consolidated aquifers of the Piedmont, groundwater then moves gradually through a myriad of pathways down and through the nooks and crannies of the sponge, ultimately flowing gradually out of the groundwater reservoir in the form of stream baseflow. However slow the movement and indirect the pathways might be for this continuous flow, however distant the point of stream discharge might be, the point here is that when subtractions are made from this groundwater reservoir flow, at some point the impact will be seen in the form of a lowered water table and reduced stream baseflow discharge.

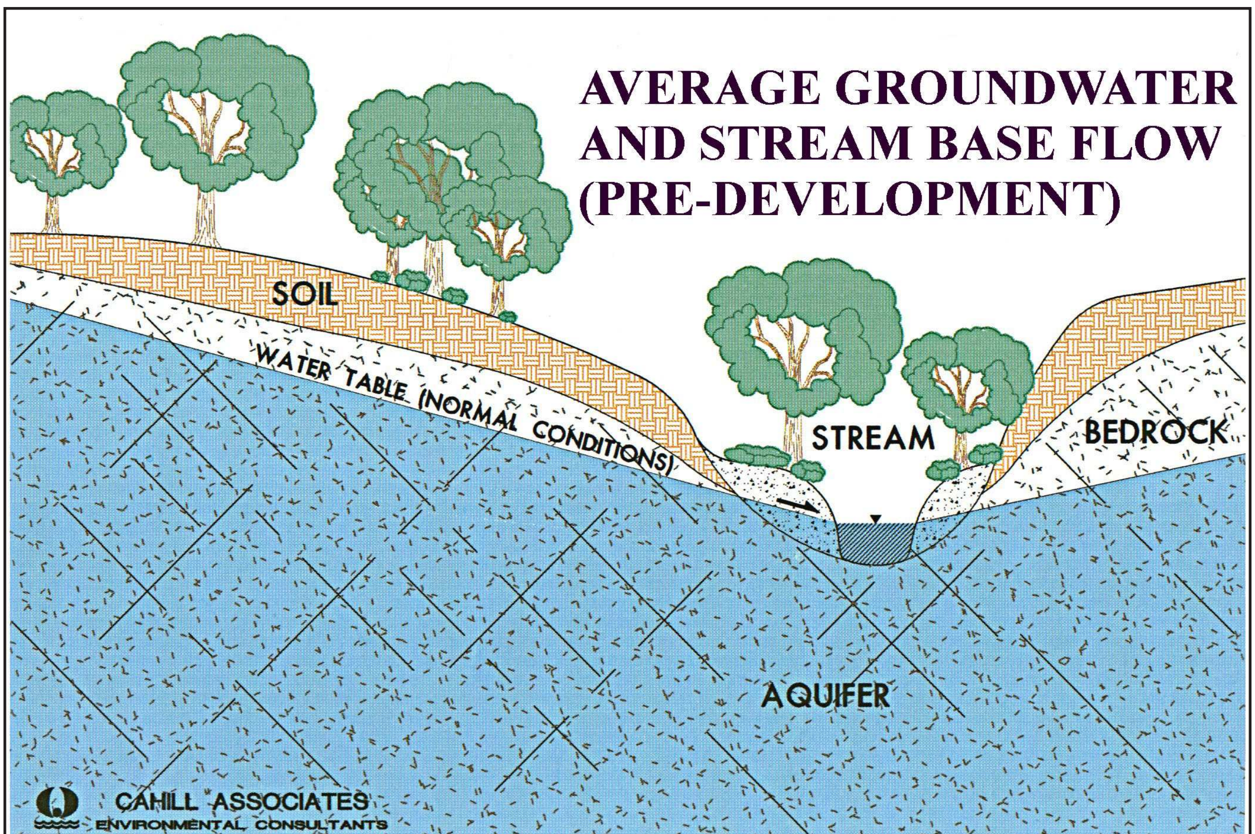

Figure IV-15 Groundwater and stream flow with pre-development activities

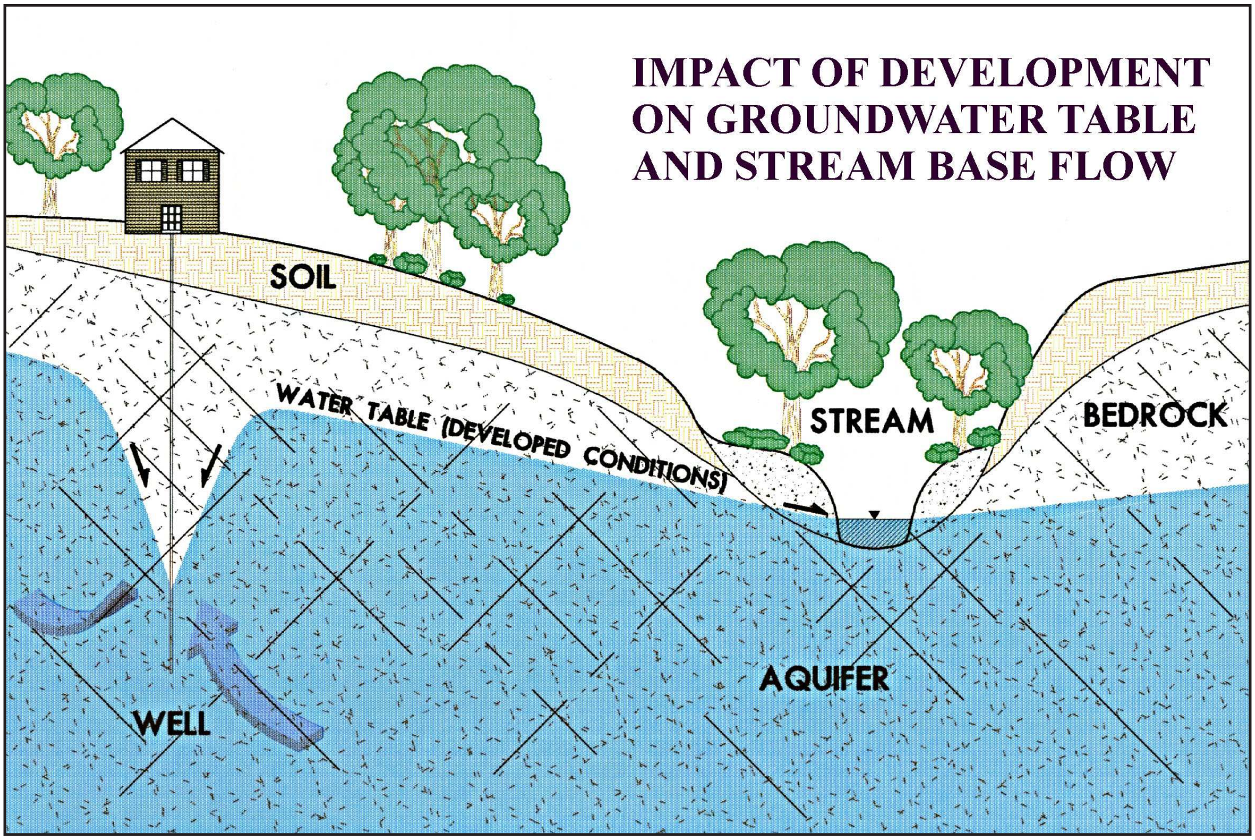

Figure IV-16 Groundwater and stream flow affected by development activities

In Piedmont physiographic contexts, stormwater runoff comprises stream flow for a small fraction of the time, perhaps less than 20 percent of the time in first order headwater streams. The vast bulk of the time, stream flow consists of stream baseflow discharged from the groundwater reservoir. This stream baseflow discharge occurs continuously, a reflection of the continuous movement occurring within the groundwater, which is such a distinguishing characteristic of the water cycle.

It should be noted that this presentation of the water cycle and the groundwater phase of this cycle has been highly simplified for this discussion. In fact, the hydrogeologic context can be quite complex. Rock types may vary from high capacity carbonate formations to tighter and less water-yielding rock. These variations and complexities notwithstanding, the basic dynamics of the simplified hydrogeologic model described above remain valid.

Of course during dry periods, both the water table and stream baseflow decline as well. When the effects of drought and development are combined, the groundwater reservoir and water table may be so reduced that flows ultimately are virtually eliminated from the stream, and the stream dries up with catastrophic ecological consequences. Even if stream baseflow is not entirely eliminated, reductions in flow occur which also adversely stress the aquatic community in a variety of ways, well before total dry up results. In addition to potential loss of base flow, adding to the gravity of the problem is the fact that these stormwater-related impacts are magnified in the smallest streams—the headwaters zones—of the total stream system.

Headwaters are defined here as 1st-order perennial streams, where the stream system with its aquatic community literally begins. In headwaters, stream baseflow by definition is modest even in pre-development and non-drought conditions. Therefore, any subtraction from flows in these small streams proportionally has greatest adverse impact. The potential for actual dry up is greatest in this most vulnerable, most sensitive headwaters zone. Furthermore, headwaters zones comprise the largest percentage of the total stream system on a lineal percentage basis. Headwaters are the locations of critical ecological functioning where exchange of energy from land to water occurs most directly and is most ecologically vital. Headwaters zones therefore are both most sensitive and of special value.

In some cases, the groundwater reservoir does not discharge to a stream, but rather to a wetland. Frequently, wetlands are zones of groundwater discharge and are in fact "fed" and kept alive by the groundwater reservoir. In these instances, reduced infiltration and a lowered water table ultimately translates into loss of wetlands themselves, reduced wetland extent, reduced wetland vibrancy and richness, and other wetland functional losses.

In sum, reduction of groundwater recharge and stream baseflow due to impervious cover has serious and far-reaching consequences. Comprehensive stormwater management must strive to recognize the full range of functional impacts occurring when new land development generates increased stormwater runoff. Comprehensive stormwater management strategies must maintain as many of these critical water cycle-linked functions as possible. Because the balance in the Darby Creek Watershed has already been so impacted by existing development, it is especially critical that new development projects do not make the problems even worse.

Stormwater and Surface Runoff

Because land development alters the water cycle by increasing stormwater runoff, stormwater management has historically focused on handling excess water to prevent flooding. In fact, flood prevention continues to be the focus of most conventional stormwater management programs, and generally focuses on moving a stormwater flood peak through the stream system and downstream as fast as possible. This practice is fraught with problems.

Understanding stormwater runoff means understanding the concept of a hydrograph, a graphical comparison of runoff being discharged from any particular site (measured in cubic feet per second) on the vertical axis, versus time (measured as time into the storm event such as Hour 1, 2, 3, and so forth) on the horizontal axis. Hydrographs can be developed for sites of any size—one acre, 100 acres, or 1,000 acres—and for all different sized storm events. Hydrographs can actually be measured in the field (no simple matter) or can be estimated through a variety of mathematical modeling methodologies (the most typical approach). Figure IV-17 presents a hydrograph for a typical site showing both pre- and post-development conditions (note that the actual discharge values, site sizes, etc. are largely

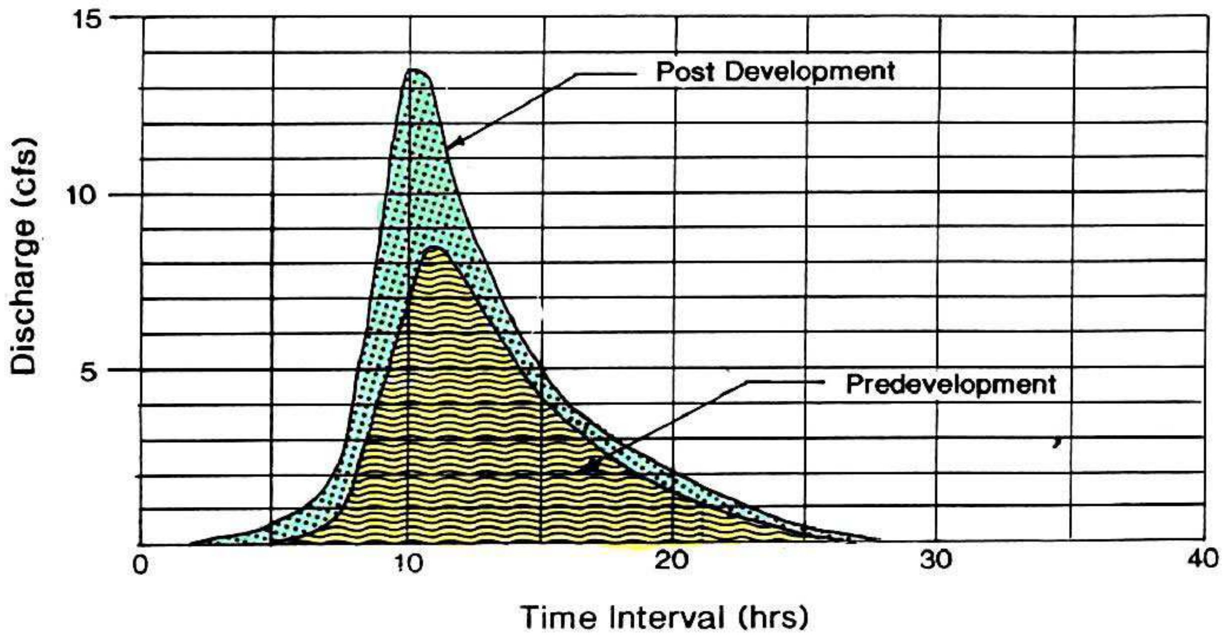

Figure IV-17 Pre-development and post-development stormwater hydrograph (no controls)

irrelevant for the sake of the comparison developed here). A storm—hypothetically, the 100-year storm—commences. As can be seen from the pre-development hydrograph, runoff from the site does not begin for a while, until Hour 2 or so, at which point the site soils have become saturated (when rate of precipitation exceeds the rate of permeability of the soils). At this time, the rate of precipitation is assumed to increase such that the rate of runoff increases rapidly. As precipitation rates decline, runoff rates decline as well.

Note that the hydrograph is a graph of the rate of runoff. Rate must be carefully distinguished from volume of runoff. The area beneath the hydrograph curve in Figure IV-17 constitutes the total volume of runoff discharged from the site. A second point to be stressed is that the pattern of runoff even in the pre-development or natural site condition is very much dictated by the assumed precipitation rates defining the storm event. If these assumed rates of precipitation were to be modified, then runoff rates would be modified as well. Lastly, note that there is runoff occurring even in pre-development conditions for large storm events. Because the assumed rate of precipitation increases so dramatically in the 100-year storm event illustrated here, maximum infiltration rates are exceeded even without development. Even in forests, a considerable amount of runoff results during the 100-year storm, given the assumed storm distribution.

Figure IV-17 shows the changes that result from development at the hypothetical site and presents a Post-Development hydrograph without any stormwater management controls in place. Several observations relating to the two hydrographs can be made. First, the Post-Development hydrograph rises or increases earlier in time when compared with Pre-Development. Runoff starts occurring earlier in a Post-Development scenario because portions of the site have been made impervious and immediately start to discharge as rain begins to occur. More importantly, Post-Development runoff rapidly increases and peaks at a runoff rate which is considerably higher than the peak rate of runoff for Pre-Development. The extent of this peak rate increase is very much linked to the amount of impervious surface and other land cover changes involved in the development process. If only 10 percent or so of the site were to be made impervious, then increase in peak rate would not be so great. If 50 percent of the site were made impervious, extent of increase in peak rate would be dramatic.

The Post-Development hydrograph encompasses the entire Pre-Development hydrograph. The area under the Post-Development Uncontrolled curve is considerably larger than the area under the Pre-Development curve, meaning that the Post-Development volume discharge is larger as well.

Now let's introduce stormwater management to the picture. Figure IV-18 adds a Post-Development with Detention hydrograph to the comparison, where management is in the form of a detention basin which functions to keep the rate of runoff at pre-development levels by engineering design (via a notched weir, perforated riser, or some other technique to regulate discharge rate). However, because the detention basin simply collects and detains the added runoff, discharging this increased volume at the maximum pre-development rate over an extended period of time, the end result is that the total area under the Post-Development with Detention hydrograph is considerably larger than the Pre-Development hydrograph. Total volume of stormwater being discharged by Post-Development with Detention is significantly increased. By design, detention facilities control runoff rates, but do not reduce post-development runoff volumes.

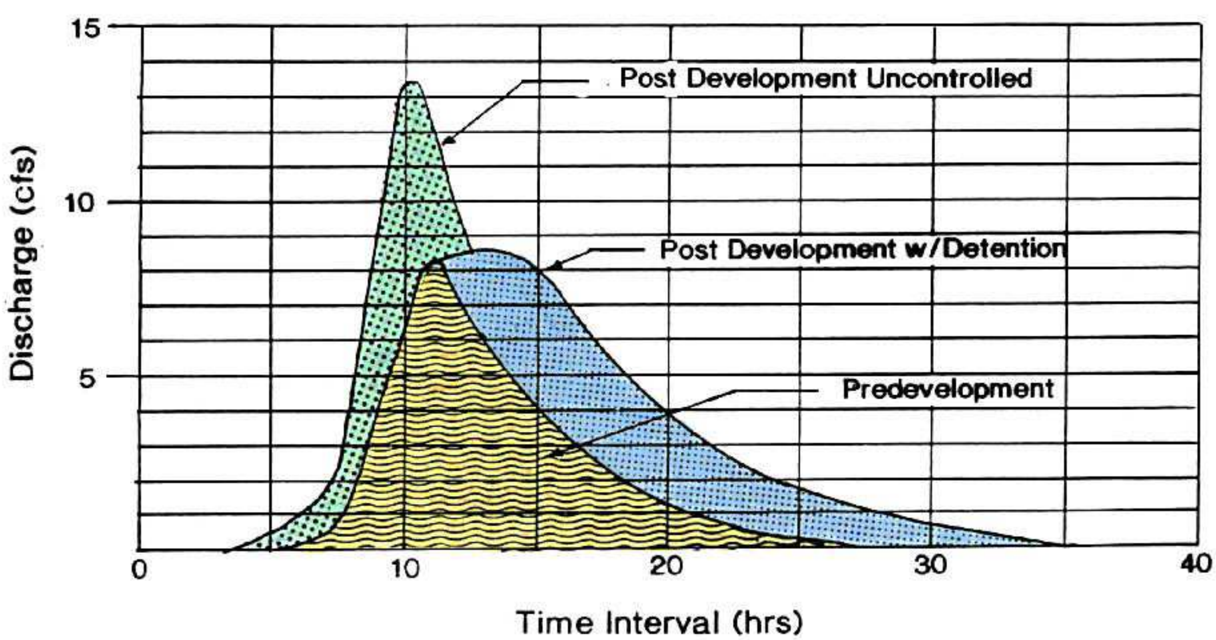

Figure IV-18 Comparison of pre- and post-development stormwater hydrographs

Peak rate control is a stormwater management strategy in large part designed to protect the adjacent downstream property from flooding, ignoring properties farther downstream. That limited objective is usually achieved. If the studied area is extended to the broader sub-watershed or watershed area, the effect of this increased volume of runoff can be seen farther downstream. What happens when many different sites throughout the watershed are developed with many different detention facilities discharging these increased volumes site-by-site? What is the cumulative watershed impact of widespread development? Real-world examples of such development show that even if detention basins are employed to limit peak rate, flooding has worsened nonetheless.

Figure IV-19 illustrates the possible flooding impacts (depending upon the location within the watershed) which can result when a peak rate control philosophy is used watershed-wide. The illustration shows a hypothetical watershed comprised of five sub-basin development sites, or Sub-Basins 1 through 5, each of which undergoes development and relies on a peak rate control/ detention basin approach to stormwater management. Pre-Development, when the hypothetical storm occurs, five different hydrographs result for each Sub-Basin, and combine to create a resultant Pre-Development hydrograph for the watershed, shown in blue (note that the vertical y-axis value for the total watershed hydrograph is simply the addition of the 5 y-values for the 5 sub-basins at any one time).

Figure IV-19 assumes that all five developments utilize detention basins. The five hydrographs are modified as shown, with Pre-Development peak rates not being exceeded, but being extended over time. What is the impact at the base of the watershed? As these extended peak rates are added up, the resultant watershed hydrograph grows taller. Not surprisingly, the resultant Post-Development with

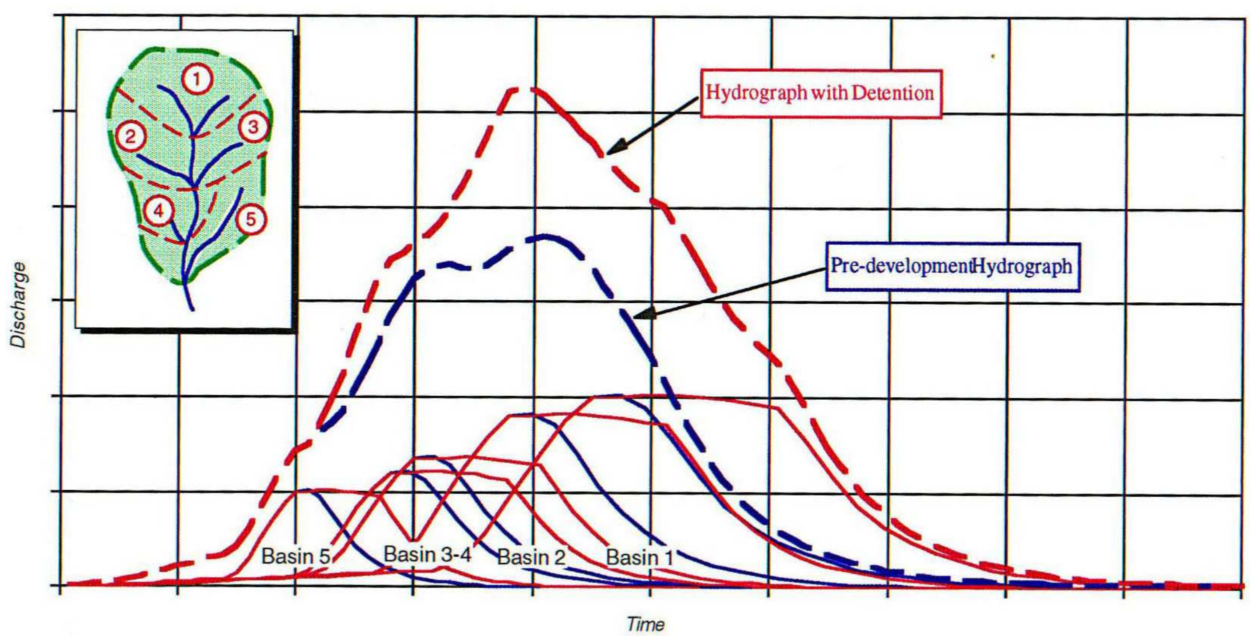

Figure IV-19 Effects of stormwater detention in a hypothetical watershed

Detention hydrograph for the watershed not only exceeds the Pre-Development hydrograph in terms of total area under the respective curves (i.e., more volume clearly is discharged Post-Development, which would be anticipated), but peak rate of runoff for the watershed increases considerably, because these increased volumes compound as they are routed down the watershed system. In short, flooding worsens considerably downstream, even though elaborate and costly detention facilities have been installed at each individual development. The floodplain limit by definition will be expanded. Property loss, possible loss of life and limb—all the costs associated with flooding—can be expected to worsen.

Based on Figure IV-19, the peak rate increases significantly, as does the duration of flood flows. In the Pre-Development condition, the peak runoff rate may last for an hour or so. In the Post-Development with Detention condition, the peak rate or near peak rate may last for 11 or 12 hours. Although the hypothetical nature of all of these hydrographs must be kept in mind, the point here is that the time of peak flooding can be expected to increase, as well as the rate at which these flood waters move through the lower watershed. This increased flooding results in serious impacts to the stream system, including but not limited to:

- significant stream bank erosion
- bank undercutting
- elimination of meanders
- channel widening and straightening
- increased sedimentation and deposition
- elimination of pools and riffles
- reduced aquatic life

Over time, these impacts can transform a stream from a high quality waterway, with excellent species diversity and richness, literally to a functional storm sewer.

E. IMPERVIOUS COVER ANALYSIS AND WATER CYCLE IMPACTS IN THE DARBY CREEK

Using the existing land use mapping as a base, the Philadelphia Water Department has applied appropriate impervious cover assumptions to these land use categories (see Section II and Table II-11). Figure IV-20 illustrates the mapping of this impervious cover in the Darby Creek Watershed.

Table IV-2 Impervious Area within the Darby Creek Watershed (PWD)

	Acres	% Impervious
Lower Watershed	6,613	51.4
Middle Watershed	4,644	44.6
Upper Watershed	7,513	28.8
Total Watershed	18,769	38.0

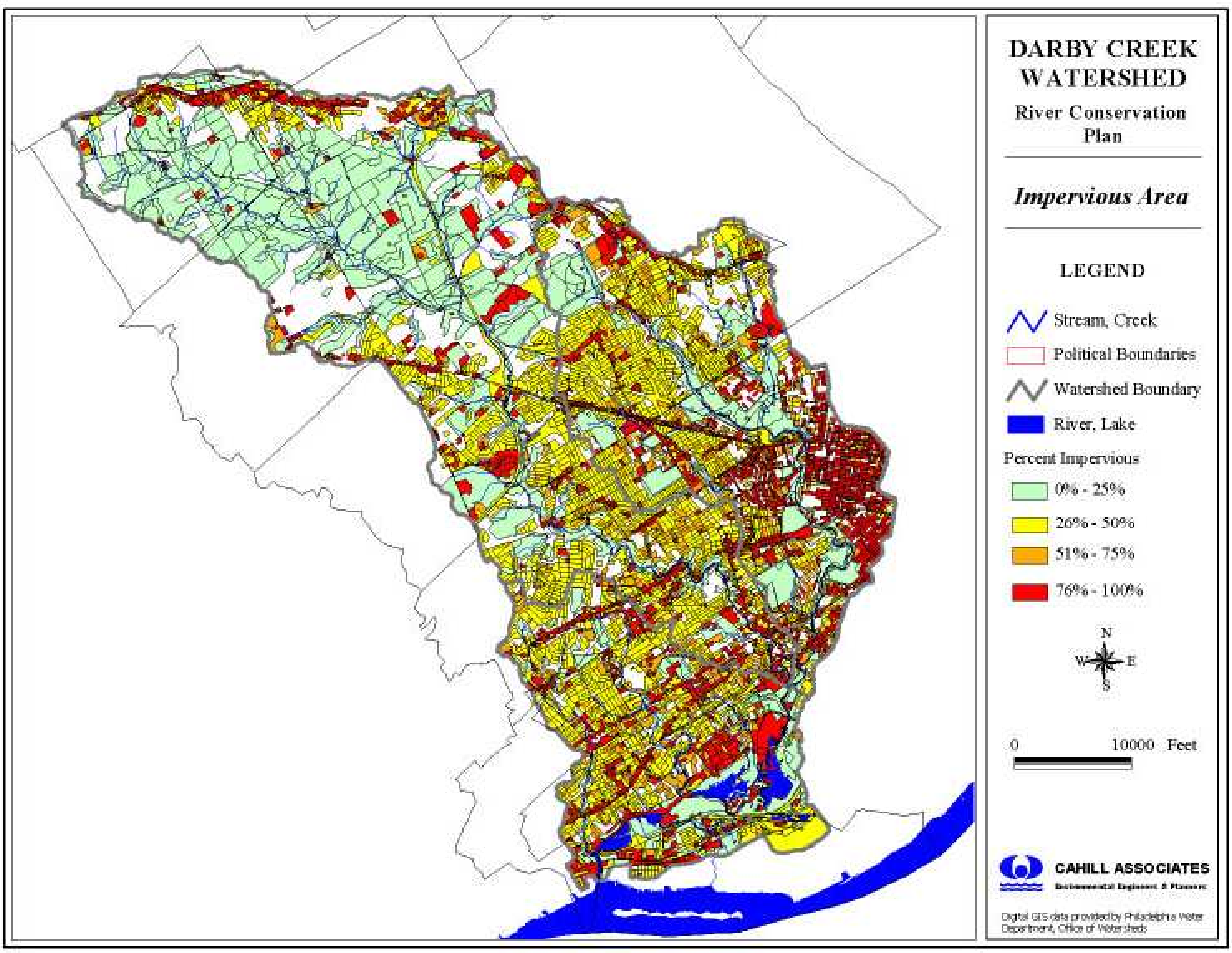

Figure IV-20 Impervious Area Percentages based on land uses (PWD)

Table IV-2 provides a summary of PWD's statistics for impervious cover in the Lower, Middle, and Upper portions of the Watershed. The summary reveals that the total impervious area for the Watershed is a very high 38 percent; even the least developed Upper Watershed is 28.8 percent, and the Lower Watershed is an extremely high 51.4 percent. Table IV-3 and Figure IV-21 translate impervious cover into a water cycle reality. Figure IV-21 shows the increased runoff created by impervious surfaces on a hydrologic sub-basin basis. Table IV-3 conversely shows the loss or reduction in natural infiltration into the ground, caused by impervious surfaces in the three Watershed sub-areas. The loss in recharge is many billions of gallons each year. Any way you choose to look at it, development has had a tremendous detrimental impact on the natural water cycle in the Darby Creek Watershed.

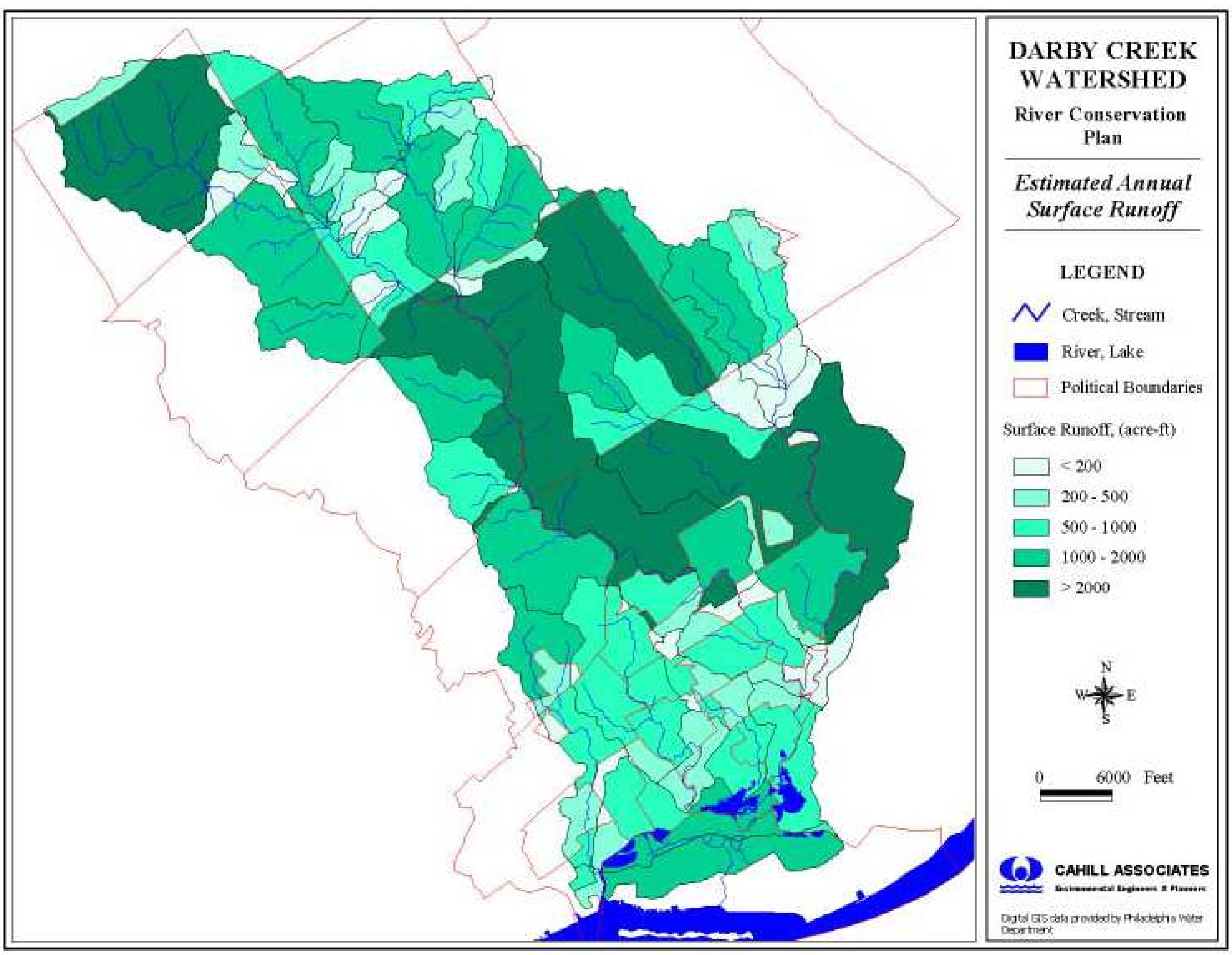

Figure IV-21 Estimated annual surface runoff in the Watershed sub-basins

Table IV-3. Average Annual "Lost" Recharge in the Darby Creek Watershed (CA 2001)

Watershed Area	Gallons
Lower Watershed	2,693,363,772
Middle Watershed	1,891,511,325
Upper Watershed	3,060,024,903
Total Watershed	7,644,900,000

F. GENERAL WATER QUALITY ISSUES

The importance of water quantity issues notwithstanding, important changes in water quality result from development. We sometimes make this distinction between water quality and water quantity, as though the two issues were separate and unrelated. But the truth is that both aspects of water management are inextricably linked, and many management strategies that effectively address water quantity will in many cases address quality as well. Runoff from impervious surfaces both increases volume and rate of runoff. This means that pollutants are scoured and swept into the sensitive aquatic ecosystem. Strategies that reduce this impervious surface and/or redirect runoff into natural swales directly reduce the stormwater runoff source and indirectly reduce the transport of stormwater-linked pollutants. If we eliminate runoff quantitatively, erosion by definition will be eliminated. Once in the stream, increased volumes and rates of runoff mean streambank erosion, undercutting, flattening and straightening of the channel, re-suspension of sediment, all of which become serious quality problems. Even if flooding is not worst case, full or near full bank flooding has serious water quality ramifications. Therefore, although the focus of this chapter has been on water quantity and the water cycle, both quantity and quality are very much at issue.

Even so, not all quality pollutant loads can be eliminated through quantity reduction techniques. Roads and highways are necessary, and will generate vehicle use and pollution by definition (i.e., there is some proportion of these pollutant loads which are not variable and will be generated even if maximum reduction in quantity can be achieved). At the other end of the quantity spectrum—reductions in stream baseflow—water quality and water quantity issues emerge as well. To the extent that any fixed or constant source of pollution—for example, point source discharges or malfunctioning onsite septic systems—continues to generate pollution loads as infiltration and stream baseflow decline, this reduced stream baseflow translates into increased concentrations of instream pollutants, and pollution-related problems grow more severe.

Nonpoint Source Pollution

Water quality aspects of stormwater management have become a major concern nationwide. In fact, stormwater-linked nonpoint source pollution—the mix of pollutants that is washed off the earth's surface with each precipitation event—is often cited as the primary water quality problem in the nation today. As a result, numerous manuals such as the new *Pennsylvania Handbook of Best Management Practices for Developing Areas* have been produced setting forth management programs designed to minimize stormwater-linked water quality problems.

Stormwater-linked pollutants vary with type of land use and intensity of land use and have been shown to include bacteria, suspended solids, nutrients, hydrocarbons, metals, herbicides and pesticides, other toxics, organic matter, and others. Pollutant loads are generated both from impervious areas ("hot spots" such as gas stations, fast food parking lots, and heavily traveled roadways are primary culprits) as well as from pervious zones, such as the chemically-maintained lawns and landscaped areas where chemical maintenance can be considerable. Some nonpoint pollutants are even air-borne, deposited onto the land surface and then washed into receiving water bodies.

Sources of this pollution include:

- vehicles
- vegetative decay (leaves, grass, etc.)
- direct atmospheric deposition
- general litter, including pet litter
- soil erosion
- road surface applications (salt, sand, etc.)
- fertilizers
- pesticides/herbicides

Point Source Pollution

Additionally, an important source of pollutant loading in selected portions of the Darby Creek Watershed (Cobbs Creek) is combined sewer overflow (Figure IV-22), where due to the physical interconnection of sanitary and stormwater collection systems and the tendency of these interconnected systems to malfunction, there is released significant amounts of untreated sanitary wastes into the stream, in addition to the load of nonpoint source pollutants. Furthermore, there also appear to be serious problems of inflow and infiltration, or "I/I" as it is commonly called, throughout many portions of the Watershed which are sewered. As discussed in more detail below, elevated pollutant loadings in both wet weather and dry weather in those stream reaches where large sanitary collection and conveyance systems parallel the stream (sometimes on both sides of the stream) suggest that these sewers are leaking their sanitary wastes directly into the streams. In such a highly developed watershed, point source wastewater treatment plants would be expected to be a pollutant source, but are not significant pollutant sources in the Darby Creek Watershed, given the export of wastewater to Philadelphia's Southwest Treatment Plant.

Physical Types of Pollutants: Soluble vs. Particulate

The physical form of the pollutant has major bearing on all aspects of water quality management. One very important way of differentiating pollutants is the extent to which pollutants are particulate vs. soluble in nature. Good examples of this comparison are the nutrients phosphorus and nitrogen. Phosphorus typically occurs in particulate form, often bound to soil particles. Because of this physical form, stormwater management practices which rely on physical filtering and/or settling out can be largely successful for phosphorus removal. In stark contrast is nitrogen, which tends to exist in highly soluble forms where any sort of attempt at physical filtering has little if any effect. As a consequence, management approaches for nitrogen must be quite different in approach (wetlands/wet ponds and

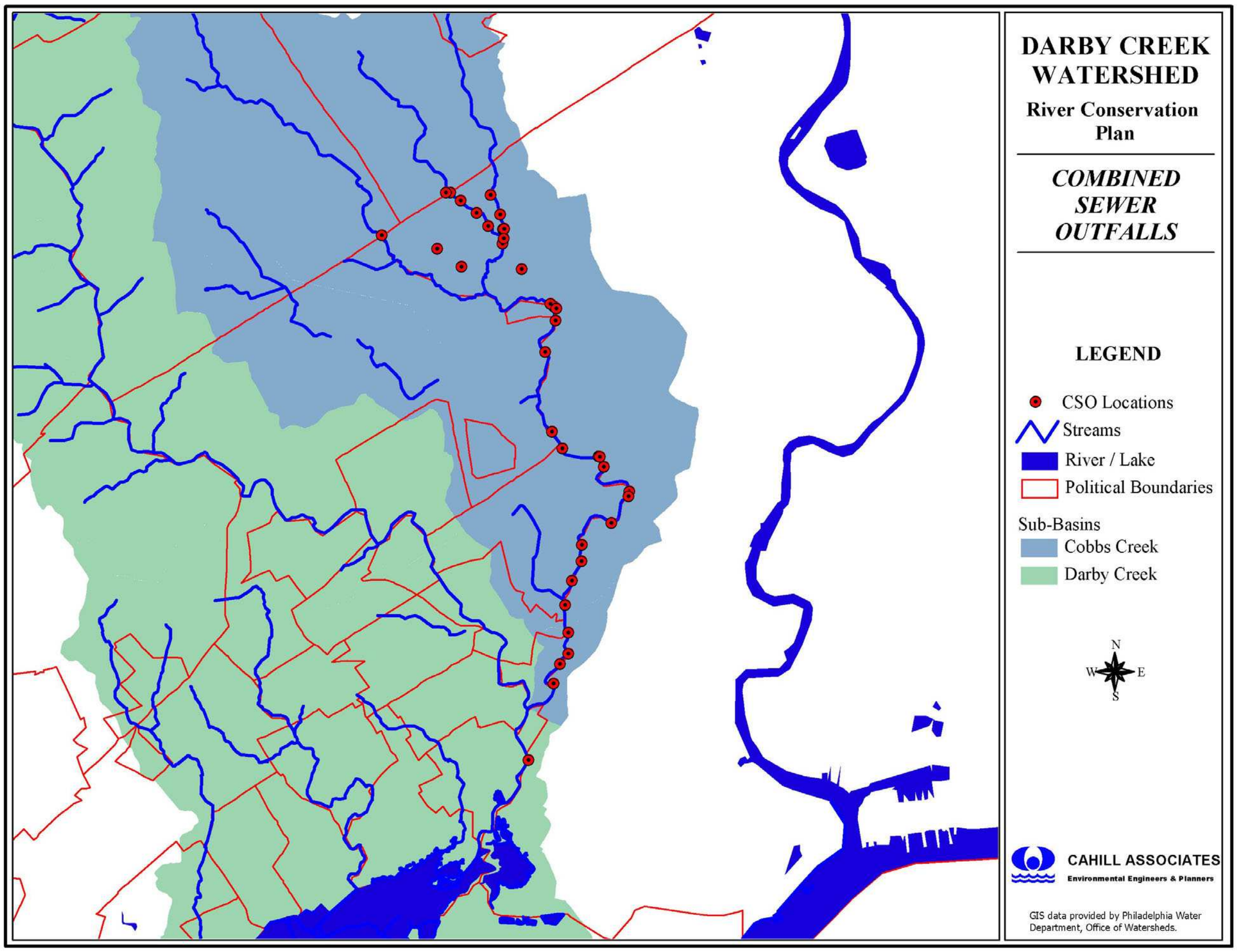

Figure IV-22 Combined sewer overflow locations in the Cobbs Creek Sub-watershed

other approaches where anaerobic conditions are promoted and where denitrification can occur are preferable).

Natural Mechanisms for Stormwater Pollutant Reduction/ Mitigation

Although stormwater-related pollution often can be reduced if not eliminated through preventive Best Management Practices (BMPs) driven by quantity reduction objectives, not all stormwater pollution can be avoided. In such cases, an array of natural pollutant removal processes is available for use and should be exploited to the maximum. Because these processes tend to be associated with, even reliant upon both the vegetation and soil realms, they can be readily incorporated into many BMPs. Such natural pollutant removal processes include:

Settling As discussed above, the kinetic energy of stormwater washes all types of matter; particulate form and other, from land cover surfaces. Particles remain suspended in stormwater flows as long as the energy level is maintained. Larger particles require more kinetic energy in order to remain in suspension. As the energy level declines—as the storm flow slows, these suspended particles begin to settle out by gravity, with larger, heavier particles settling out most quickly and the smallest colloidal particles requiring considerably more time for settling. To the extent that time can be maximized, more settling can be expected to occur, holding all other factors constant. Therefore, approaches which delay stormwater movement or approaches that reduce kinetic energy in some manner (e.g., energy dissipaters) serve to maximize settling and deposition.

Filtering Another natural process is physical filtration. As pollutants pass through the surface vegetative layer and then down through the soil, larger particles are literally physically filtered from stormwater. Vegetation on the surface ranging from grass blades to underbrush removes larger pollutant particles. Stormwater sheet flow through a relatively narrow natural riparian buffer of trees and understory herbaceous growth has been demonstrated to physically filter surprisingly large proportions of larger particulate-form stormwater pollutants from stormwater flows. Both filter strip and grassed swale BMPs rely very much on this filtration process. Filtration may also occur in stormwater which is infiltrated and then gradually moves downward through the various soil layers, although once this infiltration process begins, a variety of other pollutant removal processes (see below) are set into motion as well.

Biological Transformation and Uptake/ Utilization Though grouped as one type, this category includes a complex array of different processes that reflect the remarkable complexity of different vegetative types, their varying root systems, and their different needs and rates of uptake of different "pollutants" (in this case, clearly "resources out of place"). An equally vast and complex community of microorganisms exists within the soil mantle, and though more micro in scale, the myriad of natural processes occurring within this realm is just as remarkable. Certainly both nutrients phosphorus and nitrogen are essential to plant growth and therefore are taken up typically through the root systems of the various vegetative types, from grass to trees. Nitrogen processing is quite complex, a function of nitrate/nitrite and ammonia/ammonium forms. The important process of denitrification occurs through the action of widely present facultative heterotrophs, which function to facilitate the exchange of ions in the absence of oxygen and ultimately convert nitrates for release in gaseous form. These processes ultimately become chemical in nature, as discussed in the next section). As wetland species are introduced, all of this processing becomes more chemically complex.

Chemical Processes For that stormwater which has infiltrated into the soil mantle and then moved vertically toward groundwater aquifers, various chemical processes also occur within the soil. Important processes occurring include adsorption through ion exchange and chemical precipitation. Cation Exchange Capacity (CEC) is a rating given to soil which relates to a particular soils ability to remove pollutants as stormwater infiltrates through the soil mantle (i.e., through the process of adsorption). Adsorption will increase as the total surface area of soil particles increases; this surface area increases as soil particles become smaller, as soil becomes tighter and denser (in other words, large particle sandy soils end up having considerably lower total surface areas per unit volume measure than a heavy clayey soil. CEC values typically range from 2 to 60 milliequivalents (meq) per 100 grams of soil. Coarse sandy soils have low CEC values and therefore are not especially good stormwater pollutant removers (a value of 10 meq is often considered to be the minimum necessary to accomplish a reasonable degree of adsorption-related pollutant removal). Conversely, "tighter" soils such as clayey types have much higher CEC values.

Through reliance on these processes, management practices can be applied which substantially increase pollutant removal potential above and beyond any mitigation being provided by the detention basins currently utilized by most municipalities in the Watershed. Through a combination of vegetative-linked removal combined with a host of processes occurring within the soil mantle, pollutants entrained in stormwater runoff can be removed and even eliminated.

G. WATER QUALITY ISSUES: INTERACTION BETWEEN WATER QUANTITY AND QUALITY

Water quantity and water quality typically are closely interrelated. As the natural flow patterns of a watershed undergo change, water quality and the aquatic biota present in the stream system typically change as well. Usually these changes are not for the best. This is certainly true of the Darby Creek Watershed.

The Philadelphia Water Department's Technical Memorandum No. 4 provides an excellent discussion of how impacts to water quantity have in turn caused significant impacts to water quality, especially the aquatic biota which comprise the Darby Creek Watershed. The considerable urbanization which has occurred in the Cobbs and Darby Creeks has translated into dramatic encroachment into the floodplain and directly into the stream channel itself (in the most extreme, completely burying the stream underground in some cases). Changes in the natural hydrology—in the patterns of infiltration and runoff—have resulted in extreme stream channelization, creating a system which is not in dynamic equilibrium. Time to peak has been decreased, sometimes dramatically; peak flow rates are increased equally dramatically. Smaller rainfall events produce more and more bankfull and out-of bank flooding, unable to be accommodated by the existing stream channels, floodplains, and wetlands. More erosion occurs; more sediment is deposited. Increased flood flows scour stream banks, fill pools and cover riffles with sediment. A more short-lived, homogeneous, and unstable species system is created with increased sediment deposition and decreased habitat diversity. The aquatic ecosystem has lost much of its critical energy linkage in first order streams and wetlands, as these valuable areas are disturbed and paved over and their ecological functions destroyed.

Benthic Macroinvertebrates
The bottom dwellers of the stream, benthic macroinvertebrates are critical links in the food chain and are crucial for the support of the high order icythyfaunal (fish) community. Animals in this group include a variety of aquatic insects and insect larvae, as well as worms and crustaceans. Unfortunately, the impacts of urbanization have hit the benthic macroinvertebrate community especially hard. Because these organisms rely heavily on the stream's system of natural riffles as primary habitat for most of their life cycle activities, the increased flows, plus sediment deposition and scouring that have resulted in the Darby Creek system, have adversely impacted the reproductive and feeding activities of many macroinvertebrates. Eggs are either scoured downstream or covered with sediment. Many species have been eliminated; others tremendously reduced in terms of richness and abundance. Organisms adapted to hydrologic extremes proliferate.

Fish
As with the benthic macroinvertebrates, habitat change means fish species change. Those species reliant on riffles, rocks and vegetation for egg depositing, or those where egg nests located in larger constant pools are guarded by parents, are seriously impacted. Sudden changes in flow regimes physically destroy eggs which have been deposited and kill the fry. At the other end of the spectrum, sudden stream flow reductions and reduced stream baseflows means that biotic life in pools can be killed off quickly as these pools literally dry up.

Further, stormwater outfalls and combined sewer overflows worsen the overall stream condition for the aquatic community by increasing flood flows, increasing sedimentation and erosion, and then reducing water quality (e.g., fecal coliform releases ultimately result in increased biological oxygen demand with reduced dissolved oxygen levels as flows decrease, ultimately depriving fish life of oxygen).

H. WATER QUALITY SAMPLING DATA AND WATER QUALITY PROBLEMS IN THE WATERSHED

Although water quality in the Darby Creek Watershed is not as well-documented as we might like, our understanding has benefited tremendously by recent sampling and analysis work performed by the Philadelphia Water Department (PWD) and other agencies such as PADEP and the Fairmount Park Commission as part of their Natural Lands Restoration Master Plan. There have been a variety of special study efforts conducted during recent years, which have increased our understanding of Darby system water quality. PWD, jointly with the USGS, undertook special water quality work in the 1970's, which included two sampling stations in the Darby (both in the Cobbs Creek; Station 12 Cobbs at US 1 and Station 15 Cobbs just upstream of Darby Creek). Monthly sampling for a variety of parameters was performed for about 10 years, demonstrating significantly higher loadings of BOD, ammonia, phosphate and fecal coliform upstream and during wet weather storm events. PWD's consultant Camp Dresser & McKee reported that the quality problems "…were attributed to malfunctioning regulators and higher pollutant loading rates during storm events." (CDM Technical Memo 1, November 16, 1999)

Philadelphia Water Department
PWD has recently undertaken a watershed-based planning initiative, to a large degree triggered by the combined sewer overflow problems being experienced in the Cobbs Creek portion of the Darby Creek Watershed which is within the City's jurisdiction. In Technical Memorandum No. 1, PWD undertook special analysis and loading estimates of its 1970-1980- sampling data for two Cobbs Creek stations (12 and 15) and compared results with another study by Radziul et. al (American Water Resources Association, 1975) to establish baseline data for Cobbs Creek only. Based on this analysis, notable results included: "DO concentrations at the upstream range seasonally from about 8 mg/l to 14 mg/L. DO concentrations at the downstream location are almost always lower and drop as low as 0 mg/L during the summers….Suspended solids are greatest in the downstream location, ranging as high as 60 mg/L, except for two peaks in the upstream concentration….Fecal coliform counts appear to increase by a factor of approximately ten from the upstream to downstream locations."

The most interesting and reliable water quality data undoubtedly has been developed recently by the Philadelphia Water Department; this data fortunately extends to both the Cobbs Creek and non-Cobbs Creek portions of the Darby Creek system. In 1999, the PWD undertook special water quality sampling which included both actual sampling and computer model simulations of water quality. Ten additional sampling stations were selected, five in the Cobbs Creek and five in the remainder of the Darby Creek system, based on varying rationales. Sampling generally was performed weekly during the late Spring and early Summer, 1999, with 4 of the 10 samples occurring during what considered to be "wet weather." Parameters include Statewide Specific Criteria as well as a variety of basic water quality parameters to be later used by the PWD in its analysis of water quality problems and their respective sources. In addition, it should be noted that PWD also added to this individual sampling program data from 2 shallow depth continuous samplers (Sondes) that were deployed three times at Station 6 and once at Stations 3, 7, 8, and 10. Due to the variability and limited nature of these sampling results, they are not reported here (see Technical Memorandum No. 2, November 30, 1999).

Results indicate a remarkable degree of PADEP standards violations for fecal coliform; exceedances were greatest in the Cobbs (160,000/100 mL at Station 6 on 6/15/99) but were also remarkably high on the Stony (73,000) and the Muckinipattis (31,000) and were quite high farther up the Darby mainstem (7,000 and 6,000 stations 4 and 5 respectively). Exceedances were much higher during the wet weather samples, yet were definitely present during dry weather flows, again both in the Cobbs and throughout the Darby Creek system stations. The second parameter of interest is dissolved oxygen where two stations on the Cobbs and three stations on both the Stony and Muckinipattis violated the State standard of 5.0 mg/L on several individual sampling occasions (averages for all sampling were not in violation). Iron also exceeded State standards (five times at four stations during three individual sampling events). Metals toxicity does not appear to be a significant problem, although metals and other toxics buried in sediments and re-suspended may be a problem. Ammonium-nitrogen may be a possible concern due to the violations of standards reported by the continuous sampling from the Sondes devices. In sum, the PWD concludes, "…the pollutants of concern for the Darby and Cobbs Creek Watershed are dissolved oxygen, fecal coliform, and dissolved iron."

Fairmount Park Commission

As part of the Fairmount Park Commission's work for the Cobbs Creek Park Master Plan, special water quality and habitat analysis have been undertaken:

> "In addition to the physical, water quantity-related problems, parts of Cobbs Creek and its tributaries have severely degraded water quality. Although water quality is not specifically addressed by this restoration plan, it did arise as an issue for this park. A known source of pollution comes from combined sewer overflows (CSOs), which contribute untreated wastewater to the creek during storm events (Marengo, 1992). Undoubtedly, other impairments to Cobbs Creek's water quality include typical urban pollutants such as vehicle fluids (oils, antifreeze), and household and lawn chemicals (detergents, fertilizers, pesticides). Still other impacts to some streams of Cobbs Creek Park come from Cobbs Creek and Karakung Golf courses. Those streams running through and adjacent to the golf course are at high risk of having water quality and water quantity related problems. Pesticides and fertilizers used on the courses may drain into the streams causing poor water quality. Furthermore, many of the streams within the golf course lack a forested riparian buffer, and in some cases the maintained grass is mowed to the edge of a stream bank. This practice does not allow beneficial stream-side vegetation to take root, and consequently stream banks can be very unstable."

"A stream quality index (SQI) was developed to rate habitat quality of tributaries in Cobbs Creek Park. The SQI combines information on channel morphology, aquatic habitat (as indicated by macroinvertebrates) and riparian condition. Based on the SQIs, the majority of Cobbs tributary reaches were impaired, with several severely impaired reaches and no slightly or nonimpaired reaches. In comparison, over the entire Fairmount Park system, the majority of reaches were classified as moderately impaired." (p. II-6)

Table IV-4 summarizes this Stream quality Index data for the stream system contained within the Cobbs Creek Park system and studied as part of the Master Plan process. The Cobbs Creek Master Plan also includes specific recommendations for mitigating existing water quality problems in these particular streams and waterways (see additional discussions in Sections II and VII).

Table IV-4 Steam Quality Index Categories and Results in the Stream System of theCobbs Creek Park (Cobbs Creek Master Plan, 1999)

Stream Quality	Stream Quality Index Range	Number and % of Reaches - Fairmount Park System	Number and % of Reaches - Cobbs Creek Park
Severely Impaired	0 to 75	11 (3%)	3 (7%)
Impaired	76 to 150	164 (38%)	27 (60%)
Moderately Impaired	150 to 225	248 (58%)	15 (33%)
Slightly or Non-impaired	226 to 300	3 (1%)	0 (0%)
Totals	0 to 300	426 (100%)	45 (100%)

Note: This index and the number of stream reaches does not include FDR Park.

I. WATER QUALITY AND AQUATIC BIOTA (SEE SECTION V)

PA Department of Environmental Protection, 1995-1996

The abundance and diversity of the aquatic biota, of course, are excellent indicators of water quality. In 1995 and 1996, Pennsylvania Department of Environmental Protection performed special investigations of the Darby Creek Watershed, sampling for water quality, fish, and benthic invertebrates at a variety of stations. As reported in PWD's Technical Memorandum No. 1, the benthic was rated as "fair" at upper Watershed Stations 1 and 2 with both benthic and fish rated as "very good" and "good" respectively farther downstream at stations 3 and 4 (Radnor Township). Ratings generally declined to "poor" and "fair" for benthic and fish immediately downstream, from Radnor down through Springfield Township (sampling for benthic and fish does not appear to have been performed below Station 9). In terms of water quality sampling results, PWD reports that this same PADEP sampling generally indicated levels above detection limits for iron, aluminum, total suspended solids, and fecal coliform, with low dissolved oxygen and elevated ammonia, phosphorus, iron, lead and manganese on the Cobbs Creek. Although PWD concludes that "…the overall water quality in the Darby Creek was good…," it would appear that pollution and pollution impacts on the aquatic biota are present in much of the Darby Creek system, especially as one moves downstream.

Normandeau Associates, 1997

In 1997, a special study by Normandeau Associates was conducted on the Cobbs Creek for the Philadelphia Water Department, triggered by a fish mortality incident resulting from a water main break. Stations were all within Cobbs Creek Park from just above Manoa Road down to below City Line Avenue. Although the habitat was rated as "good" to "excellent," the data itself indicated "…poor taxonomy, domination by pollution tolerant species, and low diversity. The fisheries data indicated that although numerically dense, the fish community was species poor, containing a preponderance of blacknose dace and white suckers."

PA Department of Environmental Protection, 1998

Finally, and perhaps most significantly, PADEP has performed biological assessment of the Darby Creek system in 1998, including 28 stations using EPA's Rapid Bio-Assessment Protocol and habitat assessment methods. The purpose of this special study was to determine stream impairment, based on quality and quantity of habitat and the macroinvertebrate community data. This work also was to be used as the basis for the 303(d) list that PADEP is required to develop under the Federal Clean Water Act. Figure IV-23 indicates the findings based on this sampling. Substantial portions of the Darby Creek system (52 percent of the stations) are classified as "impaired," with the bulk of the impairment being located below PA Route 3. Curiously, impairment also has been classified in the upper tributaries of the Cobbs Creek system in Lower Merion Township, Narberth, and Haverford Township, as well as in the Little Darby in Radnor. The PWD, summarizing this work, reports that "…Stormwater, CSOs, and habitat modification

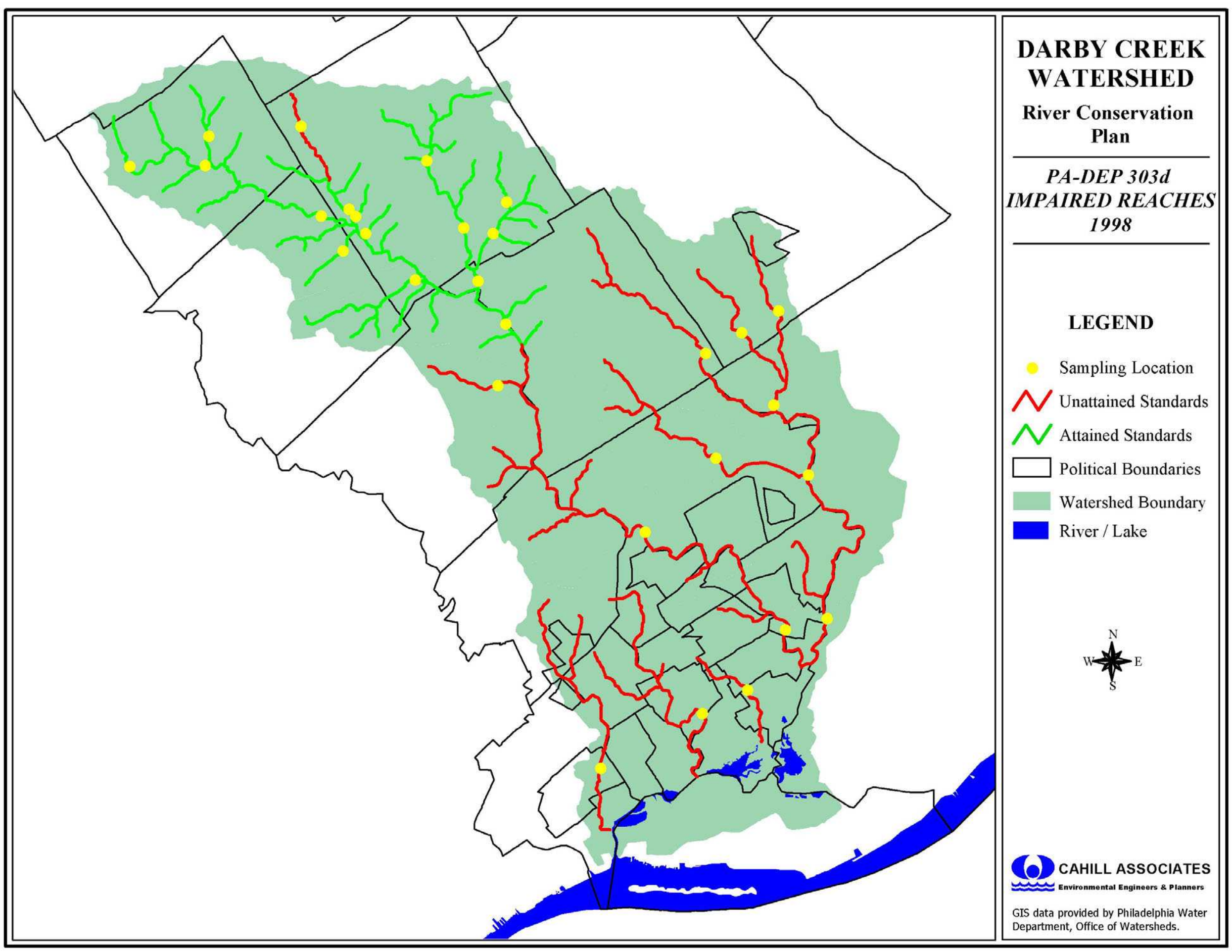

Figure IV-23 PADEP sampling locations and results from TMDL assessment were surmised as the primary and secondary causes of impairment. As a result, TMDLs will need to be developed for pollutants causing stream impairment, once those pollutants are determined." (Technical Memorandum No. 1, November 16, 1999)

Philadelphia Water Department Bioassessment, 1999

The PWD, with the Academy of Natural Sciences and PADEP, has performed additional evaluations of fish species, macroinvertebrates, and overall habitat in the Cobbs Creek specifically (see PWD's Technical Memorandum No. 4). In terms of fish sampling (undated), results indicate wide variation of fish in the Cobbs Creek, with the station at Woodland Avenue offering the highest species richness and species diversity (relatively diverse and relatively evenly distributed, although several of the species were pollution tolerant); other stations offered poorer richness and diversity. No "pollution intolerant" species were counted in any samples. In terms of macroinvertebrate sampling conducted in December 1999, results indicate moderate to severe impairment, reflective of episodes of poor water quality (organic enrichment) and habitat degradation (substantial sediment deposition, heavily imbedded substrate, lack of riparian vegetation, etc.).

Natural Lands Restoration and Environmental Education Programs, 1999

Extensive discussion of aquatic biota and macroinvertebrates is included in the Cobbs Creek Master Plan (1999); much of this work was conducted by the Academy of Natural Sciences. Based on their analysis of existing data plus sampling and analysis conducted for the Plan itself, the biota in the stream system within the Cobbs Creek Park system generally appeared to be impaired, reflective of the water quality and overall habitat conditions (see pp. II-14 through II-19 for data by stream reach and tributary). Restoration recommendations in the Master Plan have been limited for biota due to the need for first remedying the causal water quality and habitat degradation factors which are so significant.

J. POINT AND INTERMITTENT POINT SOURCES OF POLLUTION

Wastewater Treatment

In general, the Darby Creek Watershed is quite different from most highly developed watersheds. Although virtually the entire Watershed has public or centralized sewer systems, there are hardly any significant wastewater treatment plants, or point sources of pollution as they are called, discharging treated sewage effluent into the Darby or any of its tributaries—at least intentionally discharging. This atypical situation has resulted from the fact that over the years, a massive system of sewer mains was constructed in and along the Darby Creek valley in Delaware County, conveying sewage flows by gravity to large pumps (pump stations) located at the bottom of the Watershed. Sewage was/is then pumped over to the large wastewater treatment plants in Philadelphia (Southwest Treatment Plant). Figure IV-24 illustrates the array of wastewater treatment authorities which exist locally in the Darby Creek Watershed. These authorities typically own and manage the local collection systems in the Watershed. Additionally, DELCORA

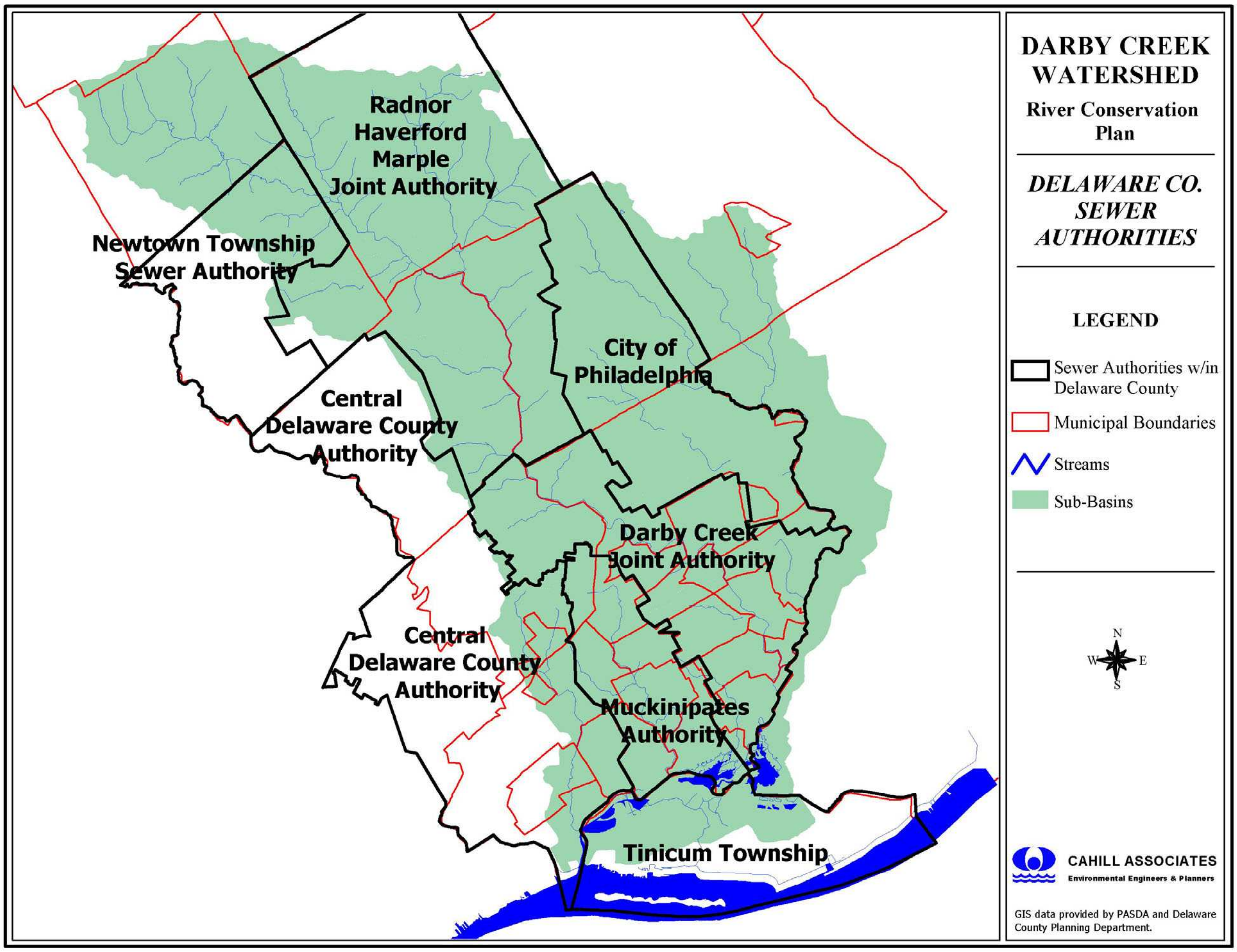

Figure IV-24 Wastewater Treatment Authorities in the Darby Creek Watershed (also DELCORA)

exists as the regional authority which provides the link, physically through pumping stations/force mains and administratively, to the treatment function in Philadelphia.

Point sources of pollution also may include private wastewater treatment plants, including industrial processing facilities. The Philadelphia Water Department reports that PADEP records indicate the existence of eight permitted point source dischargers in the Darby Creek Watershed (Figure IV-25), none of which is especially significant in terms of quantity of flow and severity of pollutant load (at least according to volunteer reporting provided by the point sources themselves). These plants, only one of which treats sanitary or non-industrial wastes (Tinicum Township), are listed in Table IV-5. Obviously these treatment plant discharges themselves are not the cause of the water quality problems in the Darby and its tributaries discussed here, although to the extent that these treatment plant effluents are discharged into the stream, water quality is negatively affected to some extent. The relatively small (1.4 million gallons per day) Tinicum Township wastewater treatment plant, which discharges into the Darby relatively close to

Table IV-5 Point Source Dischargers in the Darby Creek Watershed (Facilities Permitted under the National Pollution Discharge Elimination System, Data from PADEP; see Figure IV-25)

Permit No. Name of Facility	Pollutant Discharged
PA0056839 Sun Oil Co	Benzene,BTEX, ethylbenzene, toluene, xylene, pH
PA0011541 Sun Oil Co	Oil, grease, TOC, pH
PA0056685 SEPTA Victory Terminal	None
PA0056642 Meenham Oil Co	None
PA0052752 Mobil Oil Co	Benzene, toluene, xylene, pH
PA0013323 Boeing Defense/Space Group	TDS, TSS, oil, grease, CN Asg, Cd, Cr, Cu, Ni, Pb, Zn
PA0028380 Tinicum Twp Sewerage Auth	Settled solids, TSS, BOD, chlorine, Fecal coliform, pH
PA0057002 Haverford Twp Public Works (Landfill)	TSS, TDS, Mn, Mg, Color, Fe, barium, specific conductance, pH

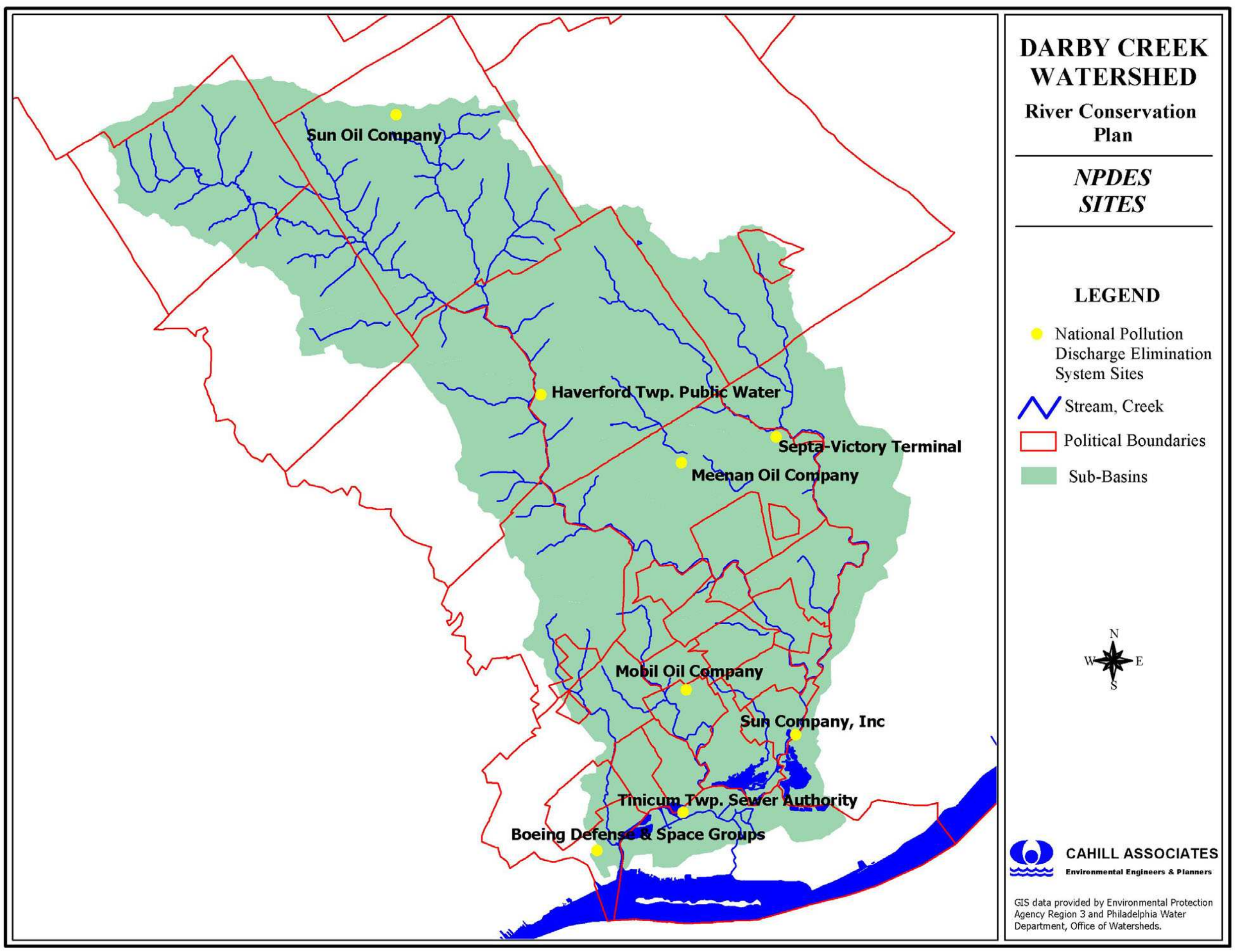

Figure IV-25 NPDES permitted dischargers in the Darby Creek Watershed its mouth, is having difficulty complying with its NPDES permit limits and is exceeding its maximum allowable pollution discharge limits. The Pennsylvania Public Interest Research Group (PennPIRG) and the Widener University Environmental Law Center have advised the Tinicum Township Authority that this situation must be remedied in the near future or legal action will be taken. The Authority has indicated that it is fast-tracking development of a solution which will solve this problem, subject to PADEP approval.

Wastewater from some source traditionally is a source of pollution in most watersheds, though given the relative lack of onsite septic systems and the relative lack of large wastewater treatment plants discharging into the streams, wastewater-linked pollution should be minimal. Given the water quality data as discussed above and the remarkably high evidence of fecal coliform reported in recent sampling, wastewater-related pollution is surprisingly great. Although there are undoubtedly scattered pockets of onsite septic systems some of which probably do malfunction, the vast majority of land uses in the Watershed are connected to centralized sewers; most wastewater generated in the Watershed is directed into a collection system and piped and exported to a centralized wastewater treatment plant beyond the Watershed. With virtually no wastewater treatment plants present, what is the source of the wastewater problem?

The apparent answer, being corroborated by other study efforts such as the Draft Eastern Delaware County Act 537 Sewage Facilities Plan Update (Eastern Plan of Study Draft 2001), indicates that the wastewater collection system is leaking. For much of its length, sewer interceptors run up and down the Darby Creek valley, sometimes on both sides of the Creek, in the floodplain and sometimes quite close to the stream itself. In some cases, this piping system is quite old, and over the years, erosion and settling and other forces have served to weaken the system, expose piping in some highly eroded places, and clearly jeopardize its integrity. During precipitation events, inflow occurs through defective manholes and other parts of the system, increasing sanitary flows and sometimes overtaxing the pump stations at the bottom of the system; overflows may be released. Analysis has indicated that the general problem is serious. In its discussion of the Darby Creek Joint Authority System, the 2001 Draft states, "The I&I Summary Report indicated that flow metering confirms the presence of severe I&I." (p. 3-22, 2001 Draft). The pollutant readings are also quite elevated during dry weather, the implication being that pollutants are being released (i.e., are leaking) even when it's not raining and quite possibly in numerous locations. Again, the data suggest that the problems exist along the Darby mainstem as well as many tributaries such as the Muckinipattis and Stony. Because remediation of these types of problems involves a complex array of different local and regional authorities and would be quite costly, remedies cannot be expected to be quickly forthcoming. Nevertheless, if significant money must be spent on these interceptor sewers along the stream, on these lineal features, the question emerges as to whether this might present an opportunity for conservation efforts, perhaps greenway efforts, perhaps passive recreational trails, as the remediation project unfolds.

Combined Sewer Overflows
Although combined sewer overflows are not specifically a point source of pollution (they are really intermittent point sources), they are present in the Watershed in the Cobbs Creek portion and are a significant source of pollution. Combined sewers are both a water quality blessing and a curse, in that combined wastewater and stormwater runoff flows are directed into wastewater treatment facilities up to a point at which treatment capacity is exceeded. At this point in order to protect the treatment plant, the system is designed to deflect overflows directly into a receiving stream without treatment, meaning that raw sewage plus runoff is discharged into the stream. Conversely, the good news is that before this overflow occurs, both sanitary wastewater as well as some amount of stormwater runoff (and this typically is the initial flush most laden with nonpoint source pollutants) is being treated at the wastewater treatment plant, in contrast to other conventional stormwater systems which discharge directly into streams.

The PWD has undertaken a major pollution abatement program to reduce the impacts of combined sewer overflows (CSOs) on the Cobbs Creek. Combined sewers are often found in older cities where one pipe is used to convey sanitary sewage and storm water runoff. During wet weather, flows of stormwater and wastewater which exceed the wastewater treatment plant capacity are conveyed untreated to local waterbodies. In response to national policy addressing this issue and as part of a PADEP-approved plan, PWD is implementing a series of capital programs to increase the amount of combined flow that receives treatment. In addition, and in recognition that total CSO removal will still not allow the stream to attain water quality standards, PWD is developing a watershed-based control plan that will recommend controls for CSO discharges along with other point and nonpoint source pollution reductions necessary for the stream to attain beneficial use standards. Benefits of this work are substantial and an ambitious water quality sampling program has being undertaken by the City, extending beyond the Cobbs Creek portion of the Watershed. This data will be used to further confirm the nature and extent of the water quality impacts in the Watershed and will be used to begin the development of water quality solutions for the Watershed

Act 537 Sewage Facilities Plan Update: Eastern Plan of Study (Draft for Discussion)
This new wastewater facilities planning, being undertaken jointly by the Delaware County Planning Department and DELCORA, continues a long tradition of joint planning begun in 1971 with the Delaware County Sewerage Facilities Plan, adopted by all 49 Delaware County municipalities and used as their respective officially State-mandated 537 Sewage Facilities Plans. Wastewater and wastewater planning is complex in Delaware County, reflecting the complexities of the physical systems which are in place and are being planned, as well as the complex of institutions which have been created to accommodate these physical systems. DELCORA, the Delaware County Regional Authority has been created as a regional authority to mange certain functions, in addition to several sub-regional authorities and local authorities, all managing different aspects of collection of wastewater, conveyance, and then treatment of wastewater (it should be noted that the eastern portion of the County, which includes all of the Darby creek Watershed lying in Delaware County, is considered to be virtually all sewered, though a small

number of onsite systems are scattered about, and differs substantially from the western portion of the County; the eastern portion is the focus of this discussion).

There are a variety of issues facing the aging wastewater treatment system in eastern Delaware County. One extremely important issue, possibly the most important issue, involves the extensive amount of inflow and infiltration which has now been documented generally throughout this complex collection and conveyance system. Inflow and infiltration relates to all that extraneous water, especially runoff and precipitation during wet weather, which manages to make its way into the sanitary sewer system, possibly through leaking and defective manholes and other direct ports of entry, as well as the day-by-day infiltration of groundwater into the collection and conveyance system that is cracked and generally compromised. A series of studies undertaken by the different authorities as well as for this 537 Update has documented the substantial amount of I&I which exists (see *Act 537: Sewage Facilities Plan, Municipal and Authority Inflow and Infiltration Study, Summary Report Revised July 2000*). This *Summary Report* process included flow monitoring, field investigations (including visual inspection, smoke testing, televising of sewer lines in some cases), data analysis, and preparation of a corrective action plan. The *Summary Report* concludes that there is a tremendous amount of I&I occurring throughout the wastewater system; the *Plan Update* reports:

1. It is estimated that DELCORA's member municipalities and authorities are paying to treat over 14 MGD of I&I. Removal of this I&I could equate to significant conveyance and treatment capacity as well as significant cost savings to member municipalities.
2. .Both CDCA (Central Delaware County Authority) and DCJA (Darby Creek Joint Authority) are currently under modified sewer bans ("restrictions") with respect to new connections. This is due to problems with wet weather capacity issues associated with the systems
3. The various authority-owned pump stations have received numerous Notices of Violation for wet weather overflows. Such incidences can lead to health problems." (*Plan Update*, p. 3-25)

Remediation of these serious I&I problems, the *Summary Report* further concludes, would increase sewer infrastructure capacity for other uses, reduce treatment and O&M costs related to wastewater disposal, and would reduce or eliminate public health hazards associated with sewage overflows such as at pump stations and other overtaxed facilities. Recommendations for remediation include regular sewer cleaning, implementation of an I&I monitoring program, better sewage facilities documentation, and implementation of a sewage facility management system. An array of specific corrective actions were identified and analyzed in terms of cost-effectiveness, as follows (*Plan Update*, p. 6-2):

1. Manhole inserts
2. Public education/information
3. Roof leader/sump pump disconnects
4. Manhole frame repairs
5. Slip lining of stream crossings
6. Chemical grouting
7. Manhole repairs
8. Slip lining of other segments
9. Disconnect inlets
10. Sewer replacement

The I&I problems as documented clearly are related to some level of water quality problem in the Watershed. Overflows at pump stations are essentially the same type of problem as combined sewer overflows, contributing some amount of raw sewage into receiving streams. To the extent that sewers are not "tight" and are receiving substantial infiltration during wet as well as dry weather, it is also possible that untreated raw sewage is also making its way out of the collection and conveyance system during both wet and dry periods (this would help explain the sampling results and fecal coliform exceedances during both wet and dry periods, as discussed above in this Section). Unfortunately, this 537 planning does not seem to address these water quality and overall environmental issues and the extent of pollution which these I&I-plagued sewers are having on the Darby Creek Watershed. The water quality issue is not identified as a major problem; the potential water quality benefit of removal of this pollution source is not addressed in this I&I discussion. Given water quality sampling results, the question must be raised whether the potential water quality impacts of the I&I-plagued sewer system are being adequately addressed in this 537 planning process.

This facilities planning process is still in progress; outcomes are not certain. If I&I recommendations are adopted and implemented as the result of this 537 Plan Update, clearly reduction of I&I problems will have a beneficial impact on water quality in the Darby Creek Watershed. If the water quality impacts of the sewer system are included in the analysis, remediating actions are even more critical—and will yield even greater benefit.

V. Biological Resources

V. BIOLOGICAL RESOURCES

A. INTRODUCTION

In 1681, King Charles II of England gave William Penn the charter to a territory of almost 48,000 square miles (30 million acres) to repay a debt owed to Penn's father. "*The soil is good, air serene and sweet from the cedar, pine and sassafras, with wild myrtle of great fragrance"* wrote Penn in an early description of Penn's Woods. Pennsylvania was largely forested – though the Leni Lenape burned and actively farmed the land – upon Penn's arrival, and he recommended, "*…care to be taken to leave one acre of trees for every five acres cleared*." Philadelphia, built strategically on the banks of the Delaware River, rapidly evolved into the dominant city of both Pennsylvania and the new American nation directly because of Penn's Quaker ideals and comprehensive planning approach.

The metropolitan population of Philadelphia quickly outgrew the city boundaries and numerous villages sprang up around its periphery. Connected to the villages was a regional network of plantations which supplied agricultural resources to support the growing population and economy (Fairmont Park Natural Lands Restoration Master Plan, 1999).

The natural physical characteristics of the watershed region had much to do with shaping its density. Its geographic location, natural resources, and soil and climate influenced the development of industry, agriculture, and commerce. The floodplain, the land adjacent to the streambed, as a naturally level surface, typically developed into the principal route of transportation for horses, carriages, automobiles, railroads, and trolleys. Consequently, suburban population – many European immigrants to the New World – distributed itself along the natural routes of transportation. Major traffic highways – Route 30, Route 1, Interstate-95, and Interstate-476 – along with numerous smaller arteries criss-cross the Watershed, providing easy access between the City of Philadelphia and adjacent towns.

The intense historic development impacted and diminished much of the original natural ecological landscape in eastern Delaware County and the Darby Creek Watershed. Poor land use planning, irresponsible development, lack of regional cooperation, and migration of people out of the cities and into the suburbs have and continue to play larger roles than net population growth in driving development in our Watershed. Unfortunately, the cost of unplanned and uncontrolled development was and is the environment – the land, the water, the natural system.

Poor planning did not eat up all of the ecological resources of this watershed. Early Philadelphia planners established the Fairmont Park system in 1855 in an effort to protect the city's water resources. This important foresight left Cobbs Creek watershed residents a valuable wooded recreation feature that mitigates the effects of surrounding dense development (Fairmont Park Natural Lands Restoration Master Plan, 1999).

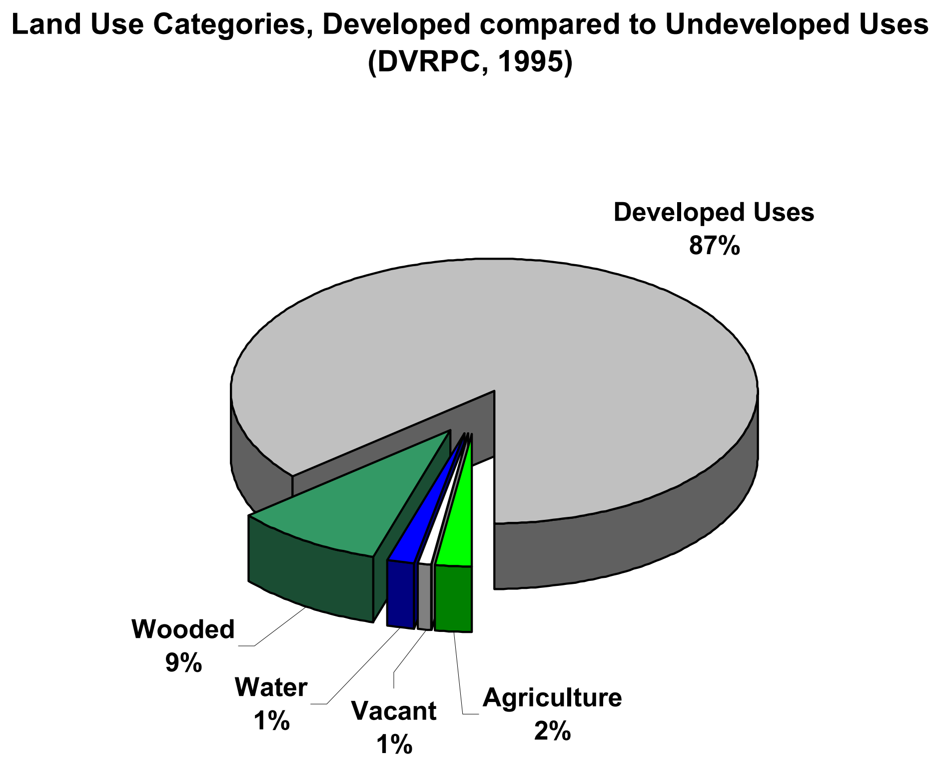

Figure V-1 Summary Land Use Within the Darby Creek Watershed (DVRPC, 1995)

Undeveloped uses of the entire Darby Creek watershed (agriculture, wooded, vacant and water) total a mere 13% of land area, while all other uses (corresponding to the developed uses) cover 87% of land area (DVRPC, 1995, Figure V-1). The wooded area that remains in the watershed (7 sq. miles) distinctly follows the stream valley of main stem Darby Creek and Cobbs Creek (Figure V-2). [Note: portions of Cobbs Creek Park are covered by forest, though the land use is actually recreation]. Some of the lower direct drainage tributaries (Stony Creek, Muckinipattis Creek, and Hermesprota Creek) are lacking this natural wooded greenway as small slivers of forested islands lie between larger tracts of residential, commercial, transportation, and other land uses.

The stream valley greenway that currently exists in the watershed is the primary natural resource feature in our urban watershed, though it survives as a fragmented, disconnected resource. A patchy natural habitat has damaging implications for the ecological system including reduced species diversity, increased rates of species extinction, and establishment of invasive species. The existing greenway should be supplemented and restored with more and more "green" islands, in order to connect and link the environmental natural features. Section VII takes this linkage discussion a step further and describes the vision for a Conceptual Darby Creek Greenway that links the remaining natural resources of the watershed with the existing cultural, historical, and recreational resources.

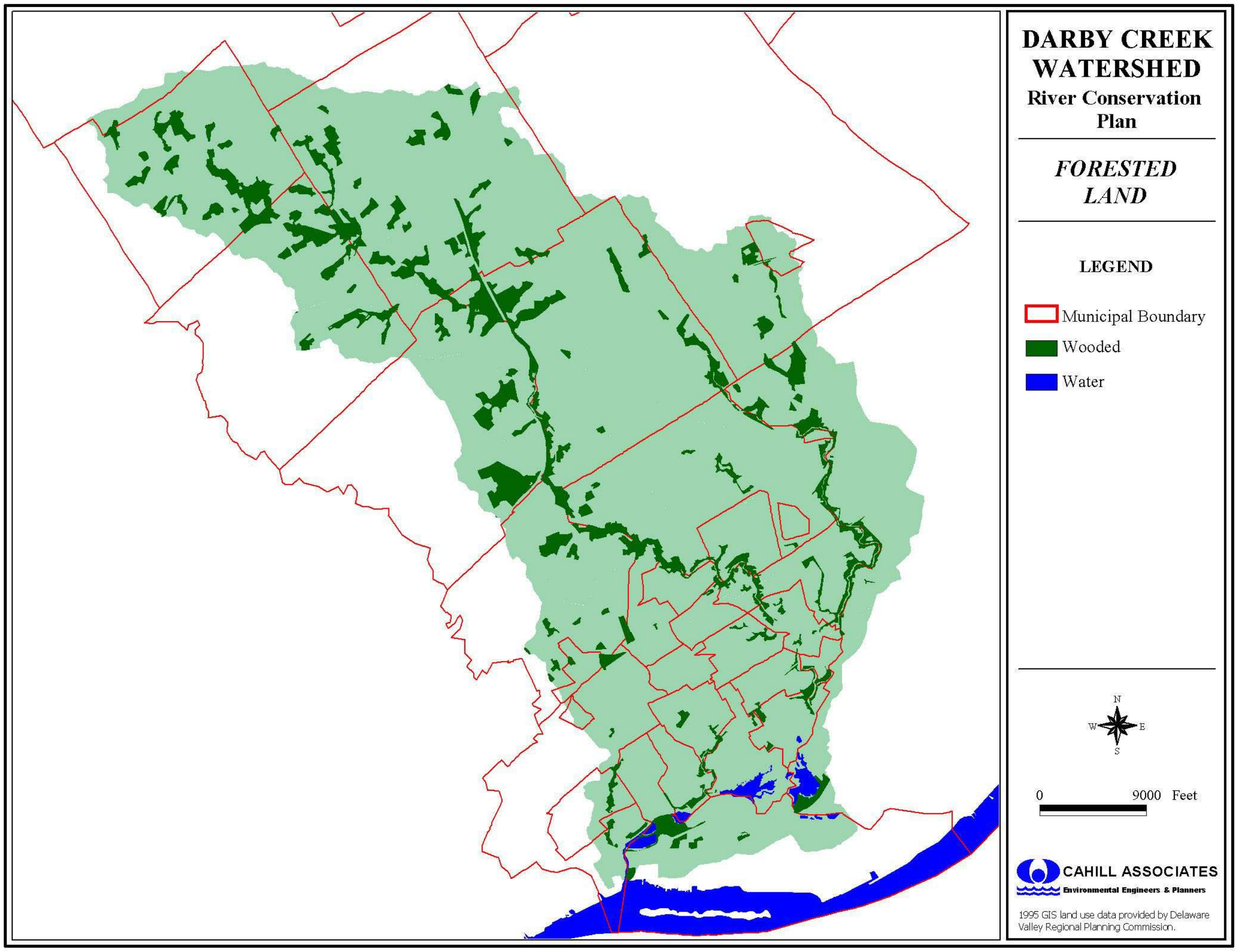

Figure V-2 Forested area within the watershed (DVRPC, 1995 land use data)

B. ENDANGERED SPECIES AT THE FEDERAL LEVEL AND THE COMMONWEALTH LEVEL

The Federal Endangered Species Act (ESA) passed in 1973 has been the primary mechanism of protection for plant and animal species that are in danger of extinction. The purpose of the ESA is to conserve and recover listed species and the ecosystems upon which listed species depend for survival. Under the law, species may be listed as endangered, where a species is in danger of extinction throughout all or a significant portion of its range; or threatened, where a species is likely to become endangered within the near future. All plant and animal species (except pest insects) are eligible for listing. An obvious challenge facing an endangered or threatened species is that by the time they make the list, they are already on the verge of extinction. The process of listing a species is quite complex but is the only legal means of long-term protection for the species at the federal level. Pennsylvania has 17 species on the federal list as endangered or threatened (Table V-1, Nov. 1, 2001).

The protection of species is also achieved through federal partnership with the Commonwealth. In Pennsylvania, the responsibility for protecting vulnerable species lies with three separate agencies. The Bureau of Forestry within the Department of Conservation and Natural Resources (DCNR, http://www.dcnr.state.pa.us/wrcf/contents.htm) is responsible for protecting all plant species. The Pennsylvania Game Commission (PGC, http://sites.state.pa.us/PA_Exec/PGC/endangered/) is responsible for bird and mammal protection and the Pennsylvania Fish and Boat Commission (FBC, http://sites.state.pa.us/PA_Exec/Fish_Boat/etspecis.htm) has jurisdiction over fish, reptiles, and amphibians. DCNR hosts a web site (http://www.dcnr.state.pa.us/wrcf/contents.htm) that describes Pennsylvania-listed species, their native habitat, and provides maps of historic and present species distributions. A total of 67 species are listed as threatened or endangered in Pennsylvania (Table V-2). One species - the passenger pigeon – is listed as *extinct* statewide, though it was historically a migrant throughout the Darby Creek Watershed region. During the colonial period, species populations were estimated to include approximately two billion individuals nationwide. According to PADCNR records, ten birds, two fish, two reptiles, one amphibian, and two plants (8 endangered, 9 threatened) have habitat within the Watershed region.

Table V-1 Federally listed species in Pennsylvania (USFWS Threatened and Endangered Species System, 11/01/01)

ANIMALS		
Status	**Common Name**	**Scientific Name**
E	Plover, piping	*Charadrius melodus*
E	bat, Indiana	*Myotis sodalis*
E	clubshell	*Pleurobema clava*
T	eagle, bald	*Haliaeetus leucocephalus*
T	lynx, Canada	*Lynx canadensis*
E	mucket, pink (pearlymussel)	*Lampsilis abrupta*
E	pearlymussel, cracking	*Hemistena lata*
E	pigtoe, rough	*Pleurobema plenum*
E	pimpleback, orangefoot (pearlymusse	*Plethobasus cooperianus*
E	puma (=cougar), eastern	*Puma (=Felis) concolor couguar*
E	riffleshell, northern	*Epioblasma torulosa rangiana*
E	ring pink (mussel)	*Obovaria retusa*
T	turtle, bog (=Muhlenberg)	*Clemmys muhlenbergii*
E	wedgemussel, dwarf	*Alasmidonta heterodon*
PLANTS		
E	bulrush, Northeastern	*Scirpus ancistrochaetus*
T	pogonia, small whorled	*Isotria medeoloides*
T	spiraea, Virginia	*Spiraea virginiana*

Table V-2 Pennsylvania listed species from PADCNR, PAGC, PAFBC; 11-01-01

Status	Common Name
BIRDS AND MAMMELS	
T	American Bittern *
E	Bald Eagle
E	Black Tern
E	Delmarva Fox Squirrel
T	Eastern Woodrat
T	Great Egret *
E	Indiana bat
E	King Rail *
T	Least Bittern *
E	Least Shrew
E	Loggerhead Shrike
E	Osprey *
E	Peregrine Falcon *
T	Sedge Wren *
E	Short-Eared Owl *
T	Small-Footed Myotis
T	Upland Sandpiper *
T	West Virginia Water Shrew
T	Yellow-Bellied Flycatcher
T	Yellow Crowned Night Heron *
PLANTS	
T	Box Huckelberry
E	Canby's Mountain-lover
E	Eared False-Foxglove
E	Glade Spurge
E	Hispid Gromwell
E	Jacob's Ladder
T	Jeweled Shooting-Star
E	Large-Flowered Marshillia
E	Northeastern Bulrush
T	Serpentine Aster *
T	Shale-Barren Evening Primrose
T	Showy Lady's Slipper
E	Small Whorled Pogonia
E	Spreading Globeflower
E	Swamp Pink
E	Tall Larkspur
E	Variable Sedge *
E	White Monkshood

** Historically or presently found in study area*

Status	Common Name
FISH	
T	Atlantic sturgeon *
T	Bluebreast darter
T	Burbot
T	Channel darter
E	Eastern sand darter
T	Gilt darter
E	Gravel chub
E	Lake sturgeon
E	Longhead darter
E	Longnose sucker
T	Mountain brook lamprey
T	Mountain madtom
E	Northern brook lamprey
T	Northern madtom
T	Ohio lamprey
E	Shortnose sturgeon *
E	Spotted darter
E	Tippecanoe darter
REPTILES	
E	Bog turtle *
E	Kirtland's snake
E	Massasauga rattlesnake
T	Red-bellied turtle *
T	Rough green snake
AMPHIBIANS	
E	Coastal plain leopard frog *
E	Eastern mud salamander
T	Green salamander
E	New Jersey chorus frog
MUSSELS	
E	Clubshell
E	Northern riffleshell

** Historically or presently found in study area*

C. PENNSYLVANIA NATURAL DIVERSITY INVENTORY

Pennsylvania Natural Diversity Inventory (PNDI, http://www.dcnr.state.pa.us/forestry/pndi/pndiweb.htm) was established in 1980 as a cooperative project with the PADCNR Bureau of Forestry, The Nature Conservancy (TNC, http://nature.org/), and Western Pennsylvania Conservancy (http://www.paconserve.org/). PNDI partners collect data and conduct inventories to describe and identify Pennsylvania's endangered, threatened and rare species ("special concern" species), storing this information in a computerized data management system. In addition to species, PNDI provides for the most outstanding examples of Pennsylvania's natural communities and geologic features ("Critical Sites" or "Priority Areas"). After surveying the ecological resources of a county and identifying the outstanding species and areas, each site is ranked from 1 to 5 (1 being the highest priority) in order to prioritize conservation of these areas. The goal of the PNDI program is "…to provide accurate and accessible ecological information needed for conservation, development planning, and natural resource management."

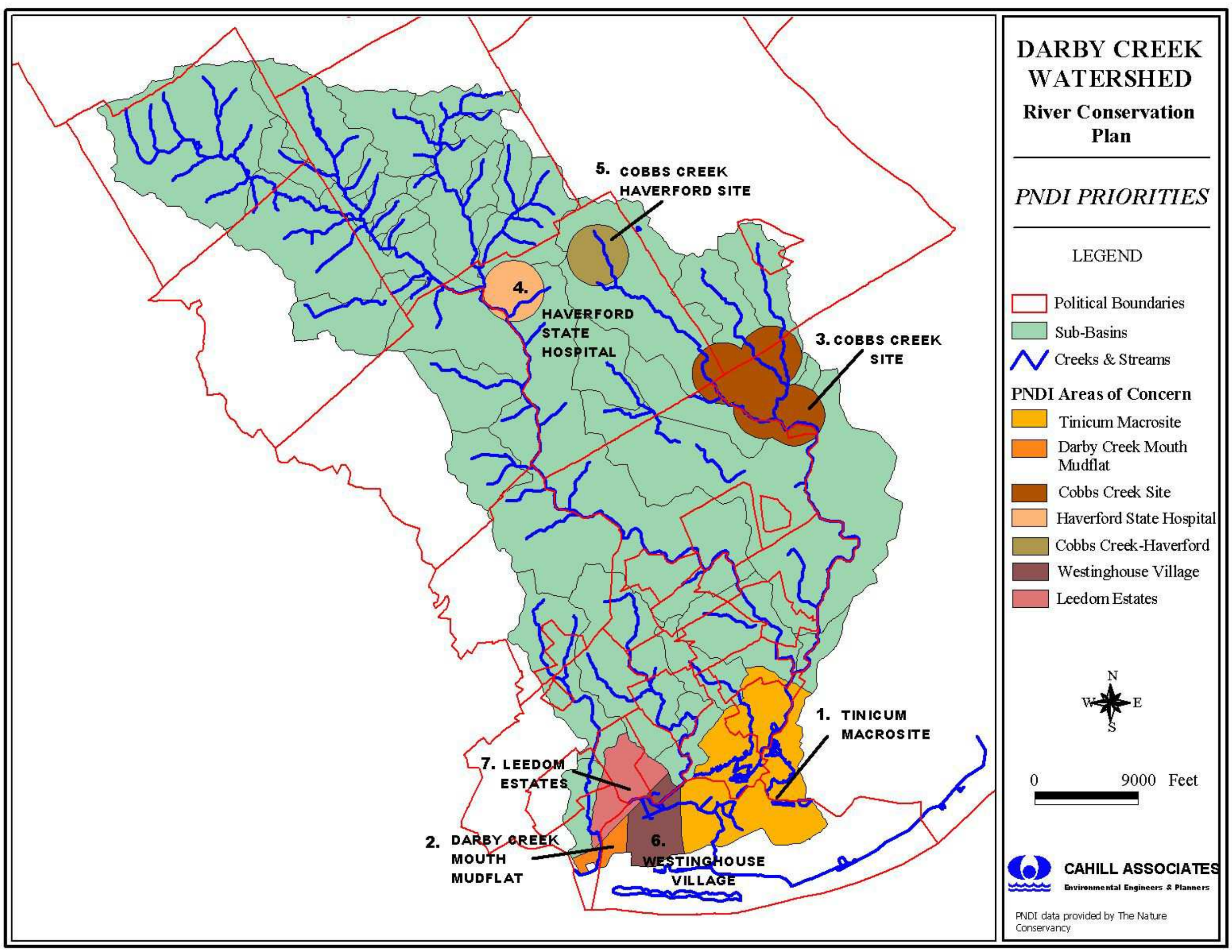

Figure V-3 PNDI Priority Areas within the Darby Creek Watershed (TNC)

In line with their goals, countywide reports are published to document results of the inventory. In the Darby Creek watershed, Chester, Montgomery, and Delaware Counties have PNDI reports available from the respective county planning entities. An inventory for the City of Philadelphia has not been conducted, though the Fairmont Park Commission (along with the Academy of Natural Sciences) is active in scientific collection and inventory cataloging the species and sites within Philadelphia urban parks.

TNC provided plan preparers an updated list of species of concern found in the Darby Creek watershed (Table V-3) and GIS datasets to map the PNDI priority sites in the watershed (Figure V-3 and Table V-4). The species list and the priority area map characterize the current ecological information in the watershed monitored by PNDI partners. The information and maps presented both here and in the PNDI reports should be and hopefully are being used by municipalities as a guide for planning development and redevelopment, as well as a supplement to municipal open space plans.

Table V-3 PNDI / TNC Priority Sites within the Darby Creek Watershed

PRIORITY	SITE NAME	HABITAT
1	TINICUM MACROSITE	FRESHWATER INTERTIDAL MARSH
2	DARBY CREEK MOUTH MUDFLAT	FRESHWATER INTERTIDAL MARSH
3	COBBS CREEK SITE	TULIPTREE-BEECH-MAPLE FOREST
4	HAVERFORD STATE HOSPITAL	OLD FIELD/DISTURBED FOREST
5	COBBS CREEK HAVERFORD SITE	COASTAL PLAIN FOREST
6	WESTINGHOUSE VILLAGE	FRESHWATER INTERTIDAL MARSH AND COASTAL PLAIN FOREST
7	LEEDOM ESTATES	FRESHWATER TIDAL MARSH

Table V-4 PNDI / TNC Species and Habitats of Concern in the Darby Creek Watershed

Species and Ecological Communities Tracked by PNDI within the Darby Creek Watershed			
SCIENTIFIC NAME	COMMON NAME	STATE RANK	STATE STATUS
FRESHWATER INTERTIDAL MARSH	FRESHWATER INTERTIDAL MARSH	S1	
POANES VIATOR ZIZANIAE	BROAD-WINGED SKIPPER	S1	
INCISALIA IRUS	FROSTED ELFIN	S2	
LYCAENA HYLLUS	BRONZE COPPER	S2	
CISTOTHORUS PALUSTRIS	MARSH WREN	S2S3B	
NYCTICORAX NYCTICORAX	BLACK-CROWNED NIGHT-HERON	S2S3B	
EUPHYES CONSPICUUS	BLACK DASH	S3	
RALLUS LIMICOLA	VIRGINIA RAIL	S3B	
TYTO ALBA	BARN-OWL	S3B,S3N	
CIRCUS CYANEUS	NORTHERN HARRIER	S3B,S4N	
PONTIA PROTODICE	CHECKERED WHITE	SH	
KINOSTERNON SUBRUBRUM	EASTERN MUD TURTLE	SH	
PANOQUINA PANOQUIN	SALT-MARSH SKIPPER	SH	
ATRYTONE AROGOS AROGOS	AROGOS SKIPPER	SX	
DRYOPTERIS CLINTONIANA	CLINTON'S WOOD FERN	S2	N
HETERANTHERA MULTIFLORA	MULTIFLOWERED MUD-PLANTAIN	S1	PE
ECHINOCHLOA WALTERI	WALTER'S BARNYARD-GRASS	S1	PE
ELEOCHARIS PARVULA	LITTLE-SPIKE SPIKE-RUSH	S1	PE
ELEPHANTOPUS CAROLINIANUS	ELEPHANT'S FOOT	S1	PE
LYONIA MARIANA	STAGGER-BUSH	S1	PE
QUERCUS FALCATA	SOUTHERN RED OAK	S1	PE
VERNONIA GLAUCA	TAWNY IRONWEED	S1	PE
ELEOCHARIS OBTUSA VAR PEASEI	WRIGHTS SPIKE RUSH	S1	PE
BOTAURUS LENTIGINOSUS	AMERICAN BITTERN	S1B	PE
RALLUS ELEGANS	KING RAIL	S1B	PE
CASMERODIUS ALBUS	GREAT EGRET	S1B	PE
IXOBRYCHUS EXILIS	LEAST BITTERN	S1B	PE
NYCTANASSA VIOLACEA	YELLOW-CROWNED NIGHT-HERON	S1B	PE
ASIO FLAMMEUS	SHORT-EARED OWL	S1B,S3N	PE
QUERCUS PHELLOS	WILLOW OAK	S2	PE
RANA SPHENOCEPHALA	COASTAL PLAIN LEOPARD FROG	S2	PE
SAGITTARIA SUBULATA	SUBULATE ARROWHEAD	S3	PR
AMARANTHUS CANNABINUS	WATERHEMP RAGWEED	S3	PR
SCHOENOPLECTUS FLUVIATILIS	RIVER BULLRUSH	S3	PR
ZIZANIA AQUATICA	INDIAN WILD RICE	S3	PR
BIDENS BIDENTOIDES	SWAMP BEGGAR-TICKS	S1	PT
ELLISIA NYCTELEA	ELLISIA	S2	PT
PSEUDEMYS RUBRIVENTRIS	REDBELLY TURTLE	S2	PT
SPIRANTHES TUBEROSA	LITTLE LADIES'-TRESSES	S1	TU
TRADESCANTIA OHIENSIS	OHIO SPIDERWORT	S1	TU
EUPATORIUM ROTUNDIFOLIUM	A EUPATORIUM	S3	TU

John Heinz National Wildlife Refuge at Tinicum

John Heinz National Wildlife Refuge at Tinicum (labeled *Tinicum Macrosite* in Figure V-3) and *Little Tinicum Island* are ranked #1 and #2 respectively, as critical sites for maintaining biological diversity in the Darby Creek watershed, according to the *Delaware County Natural Areas Inventory* (TNC, 1992). Currently under federal protection within the Refuge system, both sites are well protected. Though Tinicum Island is just outside of the watershed in the Delaware River, the largest Freshwater Intertidal Marsh natural community in Pennsylvania (Tinicum Marsh) is located in the Heinz Refuge (Figure V-4) within the Darby Watershed. The refuge is nesting habitat for waterfowl and songbirds, as well as a wide variety of migrating birds. Appendix D includes a detailed species list of animals, birds, reptiles, amphibians, and plants, provided by the Heinz Refuge.

According to the *1992 Delaware Count Natural Areas Inventory*, eleven animal species and three plant species of special concern have been documented within the Heinz Refuge. Three state rare intertidal plant species are scattered within the marsh, yet are threatened by purple loosestrife and common reed (phragmites), two highly aggressive plants that grow throughout the marsh. Two pairs of bird species considered rare at the state level and several nesting pairs of a state-threatened bird species utilize the marsh area and impoundment. In addition, a state-endangered animal species occurs in the Heinz Refuge. Although the Refuge is protected by the USFWS, upstream activities threaten the health and integrity of the marsh fauna and flora. Water pollution – in the form of sewage effluent, plastic debris, and contaminated stormwater runoff – as well as the spread of exotic plants are the primary threats to this significant source of biologic diversity (TNC, 1992).

Figure V-4 The "Impoundment" at the John Heinz National Wildlife Refuge at Tinicum

Cobbs Creek Park, City of Philadelphia

The Cobbs Creek Site (Figure V-5), listed as the third priority area by PNDI partners, is noted for the occurrence of plant and animal species of special concern, as well as areas of significant natural vegetative communities. The Pennsylvania endangered plant species *Elephantopus caroliniaius* (elephant's foot) has habitat in the Cobbs Creek Park (Figure V-6 below, From David Smith's "Delaware Wildflowers" web site, http://www.delawarewildflowers.org/).

Figure V-5 The Cobbs Creek Park in Philadelphia, (photo provided by NLREEP)

Figure V-6 Elephantopus caroliniaius *(Elephant's foot) is a state-endangered plant found in the Cobbs Creek Watershed*

The Cobbs Creek Park is valuable to the local Cobbs Creek watershed as a wildlife corridor and recreational greenway in the midst of a highly urbanized environment. Though many areas of the park were logged for timber to support the growing population in the 18th and 19th centuries, the forest within the Cobbs Creek Park is moderately mature. Numerous and varied habitats can be found in Cobbs Creek Park, including wetlands, floodplains, disturbed streambanks and riparian zones, and small, fragmented woods. Exotic species like Norway maple, Japanese honeysuckle, multiflora rose, garlic mustard, and Japanese knotweed threaten the native diversity of flora found in the park. Human disturbances are negatively affecting areas surrounding the dense forest, where ATVs, dumping of waste and large appliances, and disposal of stolen vehicles are commonly found (Cobbs Creek Park Master Plan, 1999). NLREEP staff and volunteers are currently implementing an urban ecological restoration plan to restore the natural landscape found in Cobbs Creek Park.

Haverford State Hospital, Haverford Township

The Haverford State Hospital tract (PNDI/TNC Priority #4) sits in the headwaters of a first order tributary to the main stem of Darby Creek (Figure V-7). This site is listed as a PNDI priority for conservation based the hydrologic value of this large mostly undeveloped tract of open space. Current plans for the 212-acre site include the development an assisted-living facility along with a municipal recreation facility, and preservation of some acreage as open space and an arboretum (Figure V-8). The proposed development of the Haverford State Hospital site is an intense issue in both the township and watershed community**.**

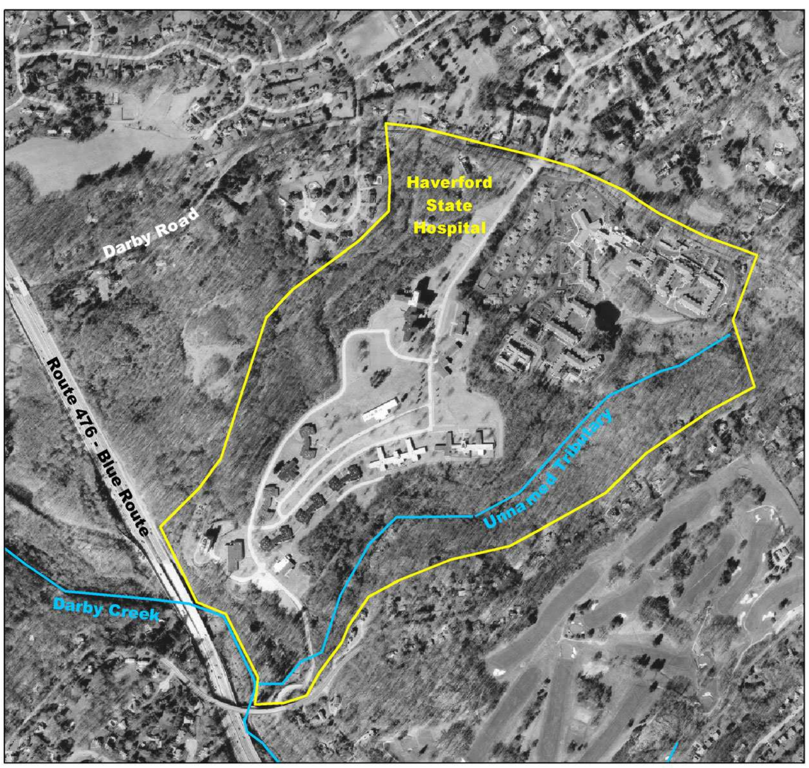

Figure V-7 The Haverford State Hospital Area according to 2000 DVRPC Aerials

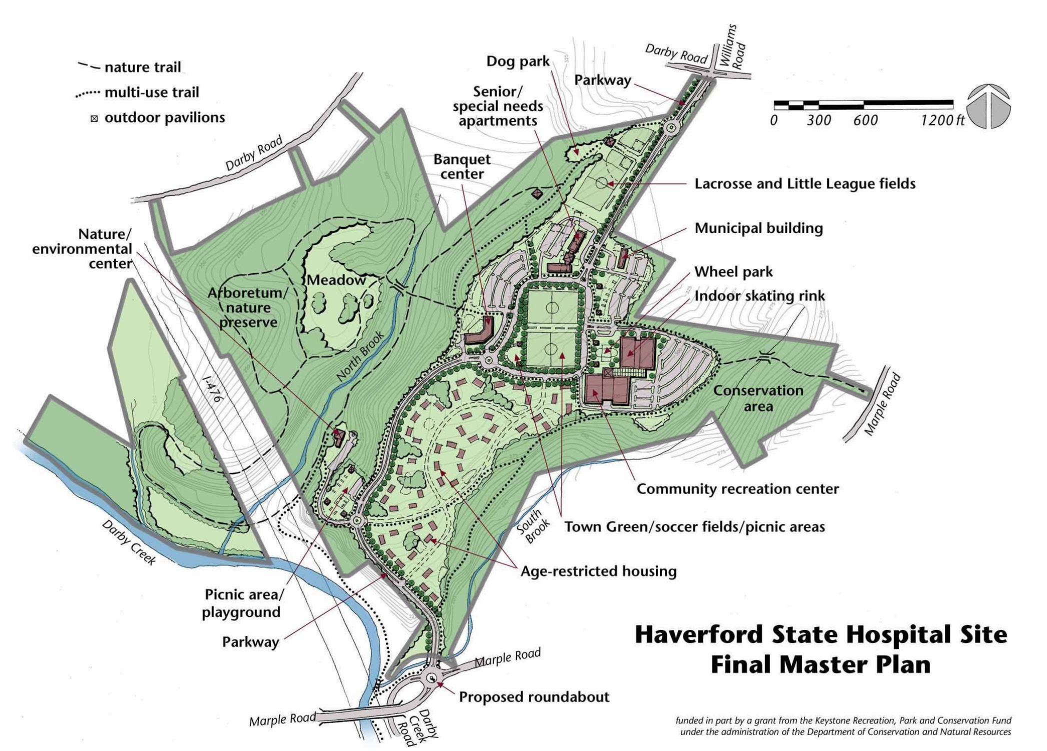

Figure V-8 Haverford State Hospital Site Final Master Plan,
(www.pahouse.com/vitali/haverford/)

D. LOCAL SPECIES INTERACTIONS

All forms of life evolve in close interaction with their immediate environment. Native plant and animal species co-evolved under a variety of local pressures to fit the conditions of today's environment. Species develop individual mechanisms to protect themselves from predators. Native plants have built-in capacities to handle stress and meet the nutrient requirements of native wildlife. However, when a new species is introduced - accidentally or not - it can have disastrous impacts on native flora and fauna that have no defenses against such invaders.

Non-native species - also known as introduced species, invasive species, exotics, or aliens – cause substantial harm to existing ecosystems, second only to habitat destruction and fragmentation. Introduced into an environment in which they did not evolve, exotic species usually have fewer predators or diseases and thus their populations may grow uncontrolled by local biological factors. Prey organisms may not have evolved defense mechanisms and native species may not compete successfully for space or food, and so are often pushed to extinction. Since exotic species are often self-perpetuating, they can become a permanent threat to biodiversity, equal to overexploitation and habitat loss. Invasive species are considered as a factor contributing to the endangered or threatened status of 42% of animals and plants on the U.S. Federal endangered species list, according to USFWS.

The Darby Creek watershed sits in the *Eastern Broadleaf Coastal Forest Ecological Province* (Figure V-9). Historically this area was characterized as an oak-chestnut forest, named for the dominant native tree species the American chestnut (*Castanea dentata)*. Up until the early 1900's, the chestnut was a major tree co-dominating forests in the region, reaching over 100 feet in height and outnumbering all other tree species. Ecologically and commercially, this species was important throughout much of Eastern North America. By 1940, three and a half billion American chestnuts perished from blight, a Chinese fungus brought into America accidentally on a shipment of Asian nursery stock. The lethal fungus spread rapidly throughout the eastern forests, dispersed by wind, rain, birds and other animals, creating an ecological disaster to occur in North America. The chestnut (Figure V-10) is considered biologically extinct throughout the region, and serves to show the harmful impact of exotic species in a healthy ecosystem.

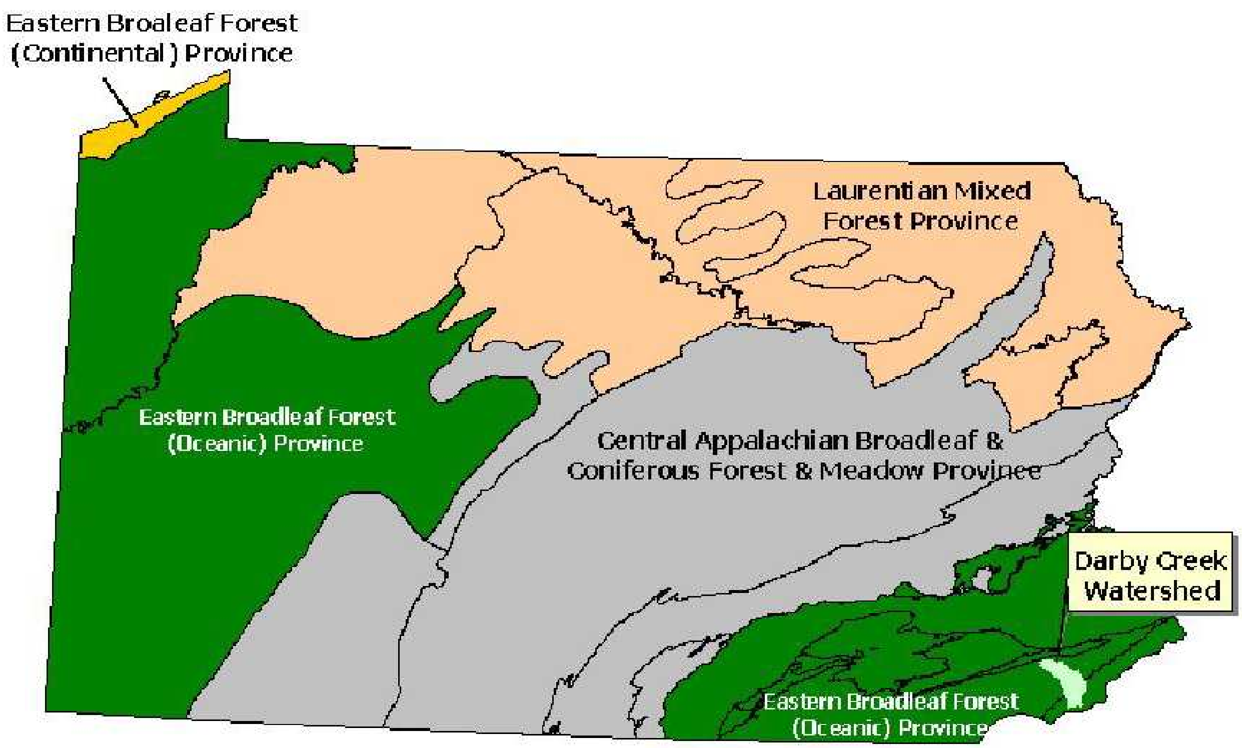

Figure V-9 The Darby Creek Watershed is located within the Eastern Broadleaf Oceanic Forest Ecoregion

Figure V-10 The American chestnut tree was once common in Eastern North America

Vegetation– Native and Introduced

The Pennsylvania Flora Project, Botany Department, Morris Arboretum of the University of Pennsylvania (http://www.upenn.edu/paflora/index.htm) provides an online database of plant species found in Pennsylvania, searchable by many attributes, including native/introduced, federal/state status, growth habit, wetland status, or federal/state noxious weed status.

The ecoregion is dominated by Appalachian oak forests, characterized by white oak (*Quercus alba)* and northern red oak (*Q. rubra)*. Other deciduous or evergreen trees that are native to Pennsylvania and found within the watershed region include eastern hemlock, pitch pine, elm, sycamore, pin oak, red and silver maple, white ash, black birch, sassafras, tulip tree, hickory, and flowering dogwood. Introduced deciduous or evergreen trees common throughout the Darby Creek Watershed include Norway, blue and white spruce, jack pine, tree-of-heaven, bald cypress, ginkgo, Japanese maple, and Norway maple.

Other than the chestnut, the only tree species listed as extirpated in Pennsylvania is the Atlantic white cedar, a wetland species occupying swamps in the coastal plain. Dramatic decline of the once common Atlantic white cedar is attributed to harvesting without replanting, hydrologic alteration, and extensive development of coastal areas. Additionally, the American elm population has been severely impacted due to the introduction of Dutch elm disease into the watershed region (www.na.fs.fed.us/spfo/pubs/howtos/ht_ded/ht_ded.htm).

Typical native shrubs found in the Darby Creek Watershed include witch hazel, mountain laurel, high-and low-bush blueberry, viburnum and spicebush. Native vines found in the area include dewberry, purple clematis, Virginia creeper, and trumpet creeper. Non-native shrubs and vines that may dominate the shrub layer include Japanese and bush honeysuckle, multiflora rose, and autumn olive. In this watershed, several invasive vines that are a substantial problem to the local ecosystem include wild grape, oriental bittersweet, English ivy, poison ivy, kudzu, and Japanese knotweed.

Kudzu, a high-climbing perennial vine from eastern Asia, is severe example of a highly invasive exotic vine species. In the 1930s, the Soil Conservation Service promoted kudzu as a soil builder and erosion control aid. Although the vines are killed each year by frost, the deep fleshy roots survive through winters and resprout with vigor each spring. Kudzu is abundant throughout the southeastern United States and is now encroaching northward, with disastrous effects. Kudzu grows on roadsides and railroad embankments, in vacant lots, in timberlands, and in fields. Figure V-11 shows an area within the Darby Creek Watershed where kudzu has overtaken the landscape.

Figure V-11 Kudzu vine over a stream bank on the Little Darby Creek in Radnor Township

Typical native wildflowers found in the watershed region include jack-in-the-pulpit, mayapple, dog-tooth violet, spring beauty, phlox, purple coneflower, eastern columbine, brown-eyed susan, and milkweed. Many cultivated flower species are used in landscaping and may escape to the wild environment, causing substantial harm to the native population. Over browsing by deer also worsens problems with invasive exotic species of plants as deer feed preferentially on native species allowing non-native invaders to expand and prosper. Due to the combined impact of deer over browsing and invasive species, native forest wild flowers have been replaced by stands of invasive wildflower, like stiltgrass, garlic mustard, lesser celandine, and crown vetch.

Deliberate removal of invasive shrubs, vines, and wildflowers on both public and private land should be implemented immediately in accordance with RCP goals (see Section VII).

Wildlife

Inherently connected to the flora within the oak-chestnut forest (or oak-hickory forest as it is also known) are the associated faunal species. A healthy vegetative community is an assemblage of plants and animals coexisting and interacting. Here in the Darby Creek Watershed, little to no formal documentation exists on the type and distribution of wildlife species. Sources of information are out there, including:

- species checklists and observations at Heinz Refuge
- species lists from birding clubs such as the Audubon Society
- existing flora and fauna inventory from the Cobbs Creek Master Plan, 1999

Assumptions can be made, but more information – in terms of detailed scientific studies – must be documented in order to accurately characterize existing wildlife. In an urban setting like the Darby, most animals are nocturnal, excluding most bird species of course, and are therefore not nearly as easy to observe. The Cobbs Creek Master Plan provides the most thorough assessment to date for the Cobbs Creek sub-basin, as very little faunal information existed before the inventory. Readers should consult the Appendices of the Cobbs Creek Master Plan (available from NLREEP) if interested in specific species observed during the inventory.

Mammals

White-tailed deer, chipmunk, woodchuck (groundhog), opossum, skunk, red fox, eastern cottontail, gray squirrel, raccoon, flying squirrel, muskrat, eastern mole, rat, and mice are common animal species currently found throughout the Watershed region. These species are typically found in most of the state as well. This may appear to be somewhat non-notable, but the lack of observed species diversity is directly based on the elimination of the all-important species habitat. Few animals, other than those listed above, are willing or even able to co-exist with humankind when faced with the enormous impacts of urban development on their habitat.

Deer (Figure V-12) are a normal component of the forests of Pennsylvania; however, deer numbers have grown to unnaturally high levels because of the elimination of large predators and the availability of abundant habitat and food sources such as agricultural fields, suburban landscaping, and edge habitat resulting from suburban development and sprawl. High deer populations can alter the diversity and structure of forests through browsing of the understory vegetation. The ability of a forest to regenerate is threatened when seedling and sapling trees are over browsed, along with forest floor plants such as wild flowers, grasses, and sedges. Deer also feed preferentially on native species, allowing exotic invaders to flourish. Interestingly, the Cobbs Creek Park has a low density of deer, based on little evidence of understory damage by plan preparers (Cobbs Creek Master Plan, 1999).

Birds

Habitat loss and fragmentation are the most serious threats facing populations of birds across America and locally within the Darby Creek Watershed. Unless rapid destruction and degradation of habitat can be slowed, populations of many birds may decline to dangerously low levels. Of the

*Figure V-12 White-tailed deer (*Odocoileus virginianus) *is a common sight in urban watersheds*

world's 9,700 bird species, almost 4,300 occur in the Americas. Of most concern to scientists is that 353 of these are classified as threatened with extinction, and many more are suffering from long-term population declines. Pennsylvania harbors a significant portion of the world breeding population for many forest bird species as well as over-wintering and migration habitat. Local organizations, including the Pennsylvania Audubon Society, Valley Forge Audubon Society, Birding Club of Delaware County, and others are promoting conservation, education, and habitat restoration for bird species within the Watershed area.

The John Heinz NWR is the premiere birding spot in the watershed, especially during migration season. Appendix D provides a list of bird species seen at the Refuge, totaling over 300 species. This list represents the official Refuge "check-list" for visitors; about half of the species listed are migrants or accidentals, while the remainders are known to nest on or near the refuge.

The Important Bird Area (IBA) Program (managed by the National Audubon Society http://www.audubon.org/bird/iba/state_coords.html and coordinated through state offices) is a worldwide effort to identify and protect outstanding habitats for birds and is pivotal to a continent-wide bird conservation strategy. Pennsylvania was the first state to develop an IBA program in the United States. Based on strict scientific criteria, a group of scientific advisors (known as the Ornithological Technical Committee) selected 73 Important Bird Areas encompassing over one million acres of public and private lands within the state. The John Heinz NWR at Tinicum is the only IBA in the Darby Creek Watershed, and contains migratory staging areas, winter-feeding and roost areas, and prime breeding areas for over 280 species of songbirds, wading birds, and other species. The technical committee, on an ongoing basis, selects additional IBA sites in Pennsylvania. Future work of the IBA program will include the development of volunteer bird monitoring efforts, public education, conservation and management plans, and identification of additional IBAs. Important Birding Areas are a PADCNR conservation priority, and funding is available to help plan or acquire potential areas.

E. PHILADELPHIA WATER DEPARTMENT BIOLOGICAL ASSESSMENT OF COBBS CREEK

Philadelphia Water Department's Office of Watersheds and Bureau of Laboratory Services, along with the Academy of Natural Sciences and the PA Department of Environmental Protection, have been developing a biological database to assess the aquatic integrity of Cobbs Creek. Macroinvertebrate, ichthyfauna, and habitat evaluations were conducted at different locations within the Cobbs Creek portion of the Darby Creek Watershed. Basic methodology and sampling results are summarized here in order to characterize the biological resources of the Cobbs Creek, a major sub-watershed that has dramatic influence in the Darby Watershed system. Appendix E contains location maps and data tables extracted from Technical Memorandum #4 (TM-4). See www.darby-cobbs.org, the Watershed Partnership's website, to download all four Technical Memorandums.

Fish (Ichthyfaunal) Sampling
Five sampling stations were chosen for the fish sampling - three on main stem Cobbs Creek, one on Naylor's Run, and one on West Branch Indian Creek. Six metrics were used to assess the quality of the fish assemblages, including: (1) Species Richness, (2) Species Diversity, (3) Trophic Composition Relationships, (4) Pollution Tolerance Levels, (5) Disease and Parasite Abundance/ Severity, and (6) Introduced (exotic) Species. According to PWD TM #4, page 14, "…the data provided by this sampling effort were used to assess the general condition of the resident fish population as a function of abundance and diversity."

In general, sampling results show that fish abundance (number), richness (number of taxa) and species diversity (variety) varied greatly among the five locations (see Appendix E). The highest number of individuals were found at the most upstream sampling site (CCF) along main stem Cobbs Creek. Throughout the Watershed, dominant fish species found were blacknose dace, swallowtail shiner, common shiner, white sucker, and mummichog. Cobbs Creek at Woodland Avenue (CC2) displayed the highest species richness, with 13 total taxa sampled, and the highest species diversity value of all monitoring locations. Though results indicate a relatively diverse community, four of the dominant species are classified as *pollution tolerant*. In fact, all five sites were dominated by pollution *tolerant* or *moderately tolerant* fish assemblages. No sampling sites "…contained individuals classified as *pollution intolerant*, indicating the probability of episodic periods of impaired water quality or habitat degradation." Two out of the five sampling sites (Naylors Run and mid-stream Cobbs Creek) contained the introduced species green sunfish and fathead minnows, though these species were not dominant within the community.

Benthic (Macroinvertebrate) Sampling
Seven sites were chosen for the benthic sampling, where EPA Rapid Bioassessment Protocols III and PADEP Modified Rapid Biological Assessments were performed. After completion of the total biological scoring criteria, each site was compared to a site-specific control/regional reference station in an attempt to create a baseline for monitoring trends in benthic community structure. Based on the percent comparison to reference score, each site was classified into four

categories of biologic condition: Nonimpaired, Slightly Impaired, Moderately Impaired, and Severely Impaired.

Six sampling sites were scored Moderately Impaired and one site received a Severely Impaired score. Dominant species in the sampling effort include filter-feeding caddisfly, net spinning caddisfly, and aquatic sowbug species. The abundance of caddisfly species points to an unbalanced community responding to an overabundance the food resource, Fine Particulate Organic Matter (FPOM). Results from all seven sampling locations indicate a moderately high pollution tolerant benthic community. The lack or absence of genera belonging to the sensitive families Ephemeroptera, Plecoptera, or Trichoptera is indicative of a biologically impaired stream reach.

Habitat Assessment

Habitat assessments were completed at the seven benthic-sampling sites, prior to benthic procedures. Using 12 different habitat parameters, each site was graded between 0 – 20 per parameter. Each parameter was summed and then compared to two reference sites and given a rating from Comparable to Reference, Supporting, or Partially Supporting.

Five out of seven sampling sites were designated as Partially Supporting when compared to reference stations. Reasons for the low habitat assessment scores include lack of riparian buffer; anthropogenically disturbed riparian zone, sediment deposition, heavily embedded substrate, low channel flow, and low riffle frequency. Only one sampling site received a habitat assessment score Comparable to Reference, and one site was evaluated as Supporting. Site 3 (see Appendix E) received the highest habitat assessment values attributed to adequate instream cover, a well-defined channel with little evidence of accelerated sedimentation processes, ample vegetative cover along the streambanks and a considerable riparian buffer along the stream reach.

Bioassessment Summary

The Cobbs Creek sub-basin is a highly urbanized area and any first order tributaries have been lost or altered from development and impervious surfaces. Significant alteration in the biologic community of the stream is therefore not surprising in this sub-basin. Results from the PWD study show that the benthic community is moderately impaired and the fish assemblages are pollution tolerant. Main reasons for impairment include “habitat deterioration and episodic water quality degradation” throughout the Watershed. Organisms well adapted to hydrologic extremes and pollution currently dominate the assessed areas, yet species diversity is diminished. The bioassessment report recommends further biological, chemical, and physical studies continue on Cobbs Creek, as well as the Darby, coupled with wetland and streambank restoration projects, fluvial geomorphological studies, and stream modeling for the purpose of increasing habitat heterogeneity within the aquatic system. Recent communication with PWD officials indicates that in 2002 the Darby Creek portion, along with the Cobbs Creek, will be assessed for benthic macroinvertebrate community structure.

F. DCVA BIOMONITORING PROJECT

Darby Creek Valley Association, as the local grassroots stewards of the Watershed, received USEPA funding for a stream biomonitoring program in 1996. Benthic macroinvertebrate samples were collected at five sample locations on the main stem of Darby Creek. USEPA staff assisted in the identification of the macros to the family level, and taxa richness, EPT richness, and Hilsenhoff Biotic Index (HBI) metrics were calculated by DCVA volunteers to assess the health of the stream system. Both taxa richness and EPT richness values decreased downstream, indicating decreasing water quality and increasing habitat degradation. The HBI values were lower upstream, indicating little organic pollution, with downstream site results showing higher HBI values and increasing organic pollution. No significant water quality sampling programs followed the 1996 program. DCVA has just resumed (summer 2001) benthic monitoring at a single site on Darby Creek, and hopes to have the remaining sections sampled in the summer of 2002.

G. OUTSTANDING OR UNIQUE FEATURES

Indian Rock Park, Springfield Township
This park is a steeply wooded slope above Darby Creek, notable for the maturity of its canopy trees. The woodland provides significant habitat for wildlife, recreational opportunities (hiking, fishing, and rock climbing) as well as protection in the stream system. Significant rock outcroppings occur along the hiking trails (Figure V-13)

Figure V-13 Outcropping of rock along the banks of the Darby Creek

Ithan Creek Wetland, Radnor Township
This area was identified by the PNDI report as an area of local significance. The wetland, bordered by the Blue Route, Bryn Mawr Avenue, Ithan Creek and a residential neighborhood, offers wildlife habitat and local landscape diversity, in addition to wetland functions for water quantity and quality.

Jenkins Arboretum, Radnor Township
Serving multiple benefits to the Watershed, Jenkins Arboretum was developed as a public garden in 1976. Its woodland ecosystem, large pond, and stream preserve the diverse displays of native trees, wildflowers, ferns and over 1,000 varieties and species of azaleas and rhododendrons.

Chanticleer, Radnor Township
Chanticleer is a 30-acre pleasure garden, which includes thousands of spring bulbs, orchards of flowering trees, and native wildflowers blooming in the woods. It is open to the public; a fee is charged.

Villanova Arboretum, Radnor Township
The campus of Villanova has contributed to the conservation of the Watershed area for over 150 years. Its landscape includes rolling hills, 1500 trees, and some historic and abundant flora including 35,000 daffodils each spring.

H. ISSUES, THREATS, OPPORTUNITIES

The primary threat to remaining biological and ecological resources of the Darby Creek Watershed is habitat fragmentation produced by development. The islands of land that are “protected” – be it through a township park, a county park, eased open space, or any other means – are scattered about the landscape, although generally follow the stream valley foundation. These islands are vulnerable to invasion by non-native species, extinction of local species, and reduction of biological diversity. With careful planning and coordination of existing and future conservation activities, watershed stakeholders can witness the success of the urban greenway which protects biological resources.

VI.
Recreation & Cultural Resources

VI. RECREATIONAL AND CULTURAL RESOURCES

A. RECREATIONAL RESOURCES

The Darby Creek Watershed contains an abundance of recreation sites and facilities. Their locations have been mapped using municipal Open Space Plans and municipal Environmental and Recreation Plans if they were available (Figure VI-1). Other sources of information include DCNR's database of Recreation Sites by Municipality, Delaware County Planning Department trail records, and Philadelphia Department of Recreation facilities map. Appendix F provides detailed facility information, extracted from the GIS, by municipality. A trend within this watershed shows that the majority of recreation activity is taking place near stream and water features. Almost 2,700 acres of land are classified as Recreation, according to DVRPC 1995 land

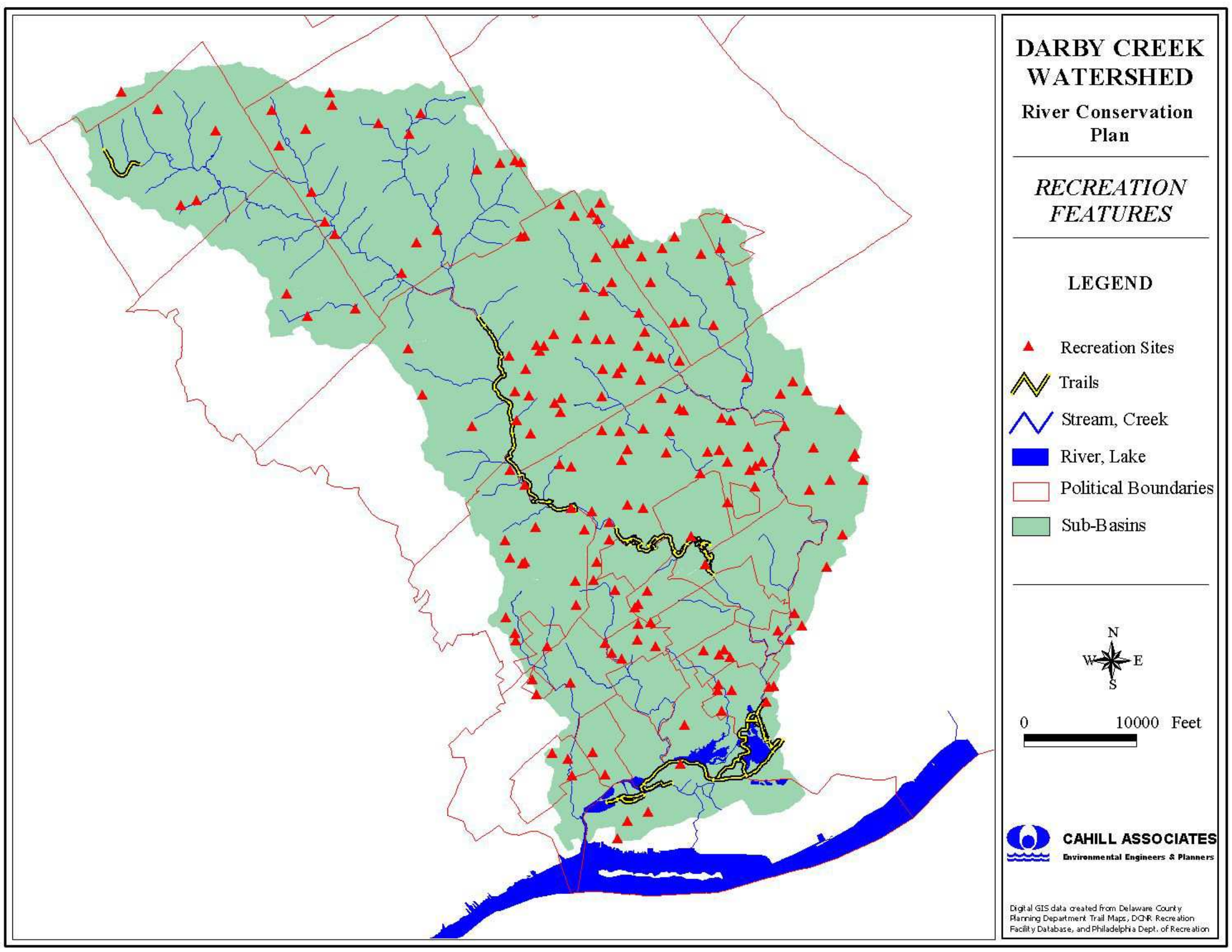

Figure VI-1 Recreation Facilities and Trails in the Darby Creek Watershed use files (Figure VI-2). 5,000 acres of the watershed are wooded, a category which could be included in the recreation summary, since wooded areas provide many forms of active and passive recreation. Again, these areas usually coincide with the stream valley and water entities in the watershed. Walking along the Darby Creek on a beautiful spring day, one can find families playing in the water (Figure VI-3), fishermen casting their lines (Figure VI-4), and hikers strolling through the cool forest (Figure VI-5).

An interesting feature of the Darby watershed is that although many small to medium sized facilities exist, no large regional or county parks exist to serve watershed residents, except the Fairmont Park System and the John Heinz Refuge. Areas of the Haverford State Hospital site are wooded and could serve as additional recreational space within the watershed, though the future use of the parcel is currently still in planning stages. The designation of some of the Hospital property as a recreational area would benefit residents of the entire watershed as it is centrally located and a source of local activity. The Haverford site is also an ideal location to serve residents of the more urban areas in the watershed and could be characterized like a small version

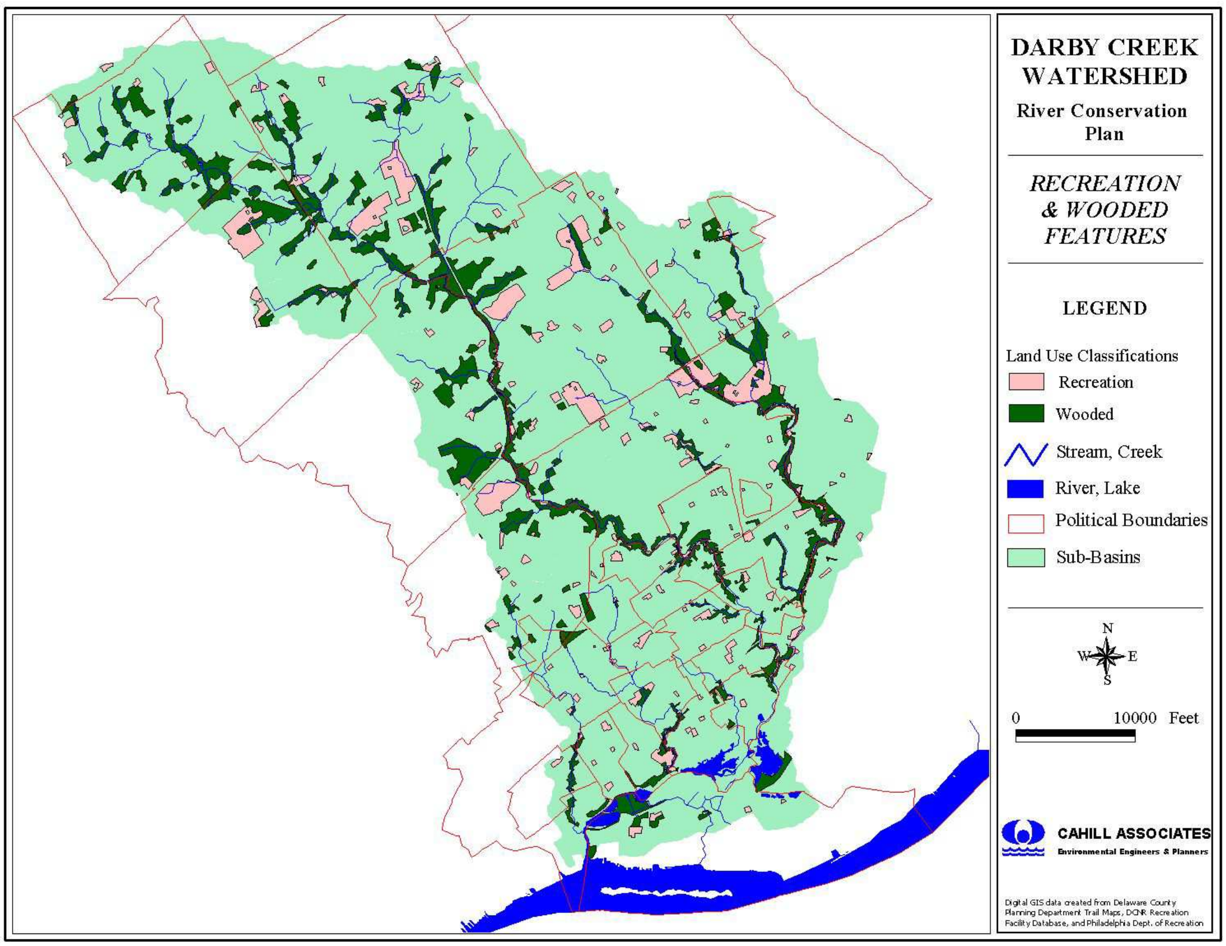

Figure VI-2 Recreation and Wooded Land Use Categories, DVRPC 1995 of the Fairmount Park System in Philadelphia. A park in this area provides a place for those residents who crave solitude in the "wilderness," or a bit of peace and quite amidst the urban hubbub. The Hospital tract should be conserved as one of the last bits of pristine land in the watershed for its recreational benefits and for its water quality benefits.

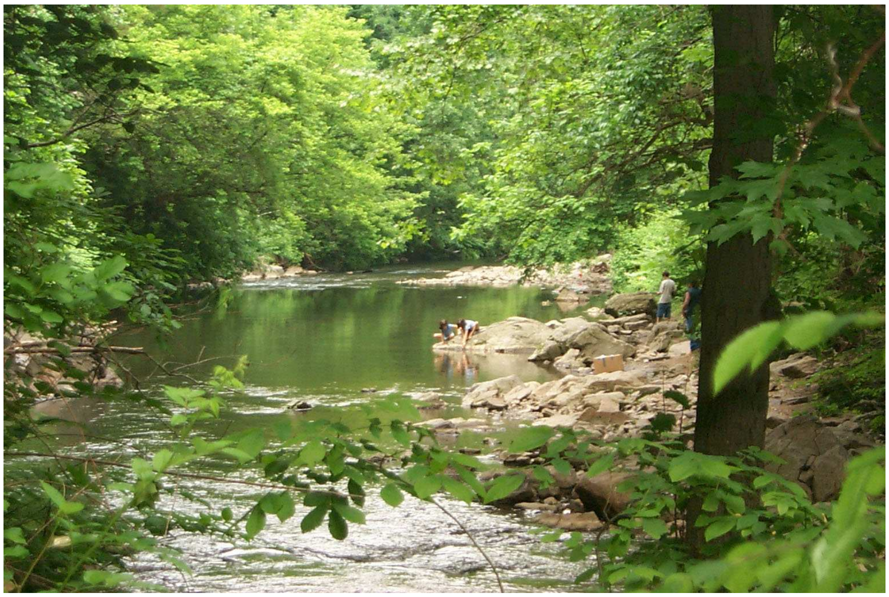

Figure VI-3 The Darby Creek in Upper Darby Township near Creek Avenue

Figure VI-4 A fisherman along the Darby Creek in Upper Darby Township, Creek Avenue

Figure VI-5 A Hiker along Darby Creek in Upper Darby Township, near Creek Avenue

Cobbs Creek Park

Cobbs Creek Park (Figure VI-6) drains nearly 13 miles of stream – approximately 6% of the Cobbs Creek Sub-Basin – and includes Morris Park (1911) and Carroll Park (1929), Cobbs Creek Golf Course, and Karakung Golf Course. The Olde Course at Cobbs Creek Golf Club has been nationally recognized as the Sixth Best Municipal Golf Course in the U.S. by *Golfweek* magazine. The historic course is named after George Cobb, the owner and operator of a Grist Mill that was located on the present day site (www.cobbscreek.com/). There is a network of paths in the park, though the paths do not form a well-defined trail system. Figure VI-7 depicts the park land and trails, provided by the Philadelphia Water Department, Office of Watersheds.

Many parts of Cobbs Creek Park are considered unsafe by community members and are not used for walking, biking, observing nature, or other passive recreation activities. Many areas in the park are used as disposal sites for trash and stolen cars. In addition, many motorcycles and all terrain vehicles (ATVs) use areas in the park as a practice track. Restriction of unauthorized vehicle access is necessary to maintain the natural integrity of the park, as well as the positive atmosphere for recreation.

Stream Stocking Program

The Pennsylvania Fish and Boat Commission (PFBC) undertakes an annual fish-stocking program in various stream throughout the Commonwealth each year. Fish stocking includes trout (3.8 million per year) as well as 100 million fry, fingerling, and adult warmwater fish. Last fiscal year (9 July 2000 through June 2001), PFBC maintained a Fall Trout Stocking Program (146,000 legal

Figure VI-6 Cobbs Creek Park in Philadelphia

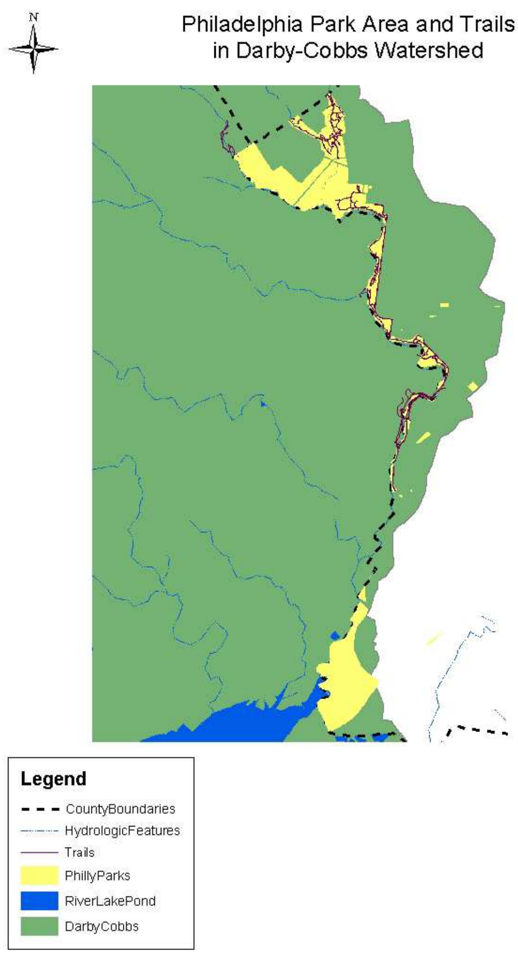

Figure VI-7 Parkland and Trails in the Cobbs Creek Park, Philadelphia (PWD, 2001) size trout in 161 waterways), a Winter Trout Stocking program (95,000 adult trout in 61 lakes), and a Late Winter Program (90,000 adult trout in 58 waterways). In the coming season, PFBC has designated seven segments in the Darby Creek Watershed for stocking, as outlined below. Clearly, this stocking program has tremendous recreational value for the Watershed, although this value is difficult to quantify.

Darby Creek	4/15/02	Fr where SR 1006 joins Darby Cr dwnstrm fr SR 0003; upstrm to 804 meters upstrm of confl with Ltl Darby Cr
Darby Creek	5/6/02	Above location
Darby Creek	5/6/02	Fr SR 1006 (Glendale Rd) dwnstrm to Hilldale Rd Bridge
Darby Creek	4/15/02	Above location
Darby Creek	4/29/02	Fr SR 1006 dwnstrm to Hilldale Rd Bridge
Ltl Darby Cr	5/6/02	Fr uppermost bridge in Willows Pk dwnstrm 0.8 mi to mouth
Ithan Creek	5/6/02	Fr I-476 dwnstrm to mouth

According to the PFBC, a total of 5,390 brown trout and 4,910 rainbow trout will be stocked in the Darby Creek Watershed at the above locations.

B. TRAIL RESOURCES

Overview of Trail in the Darby Creek Valley

In spite of over three hundred years of development along the Darby Creek, a journey from the headwaters in Chester County to the mouth at the Delaware River still brings the visitor to a range of landscapes — agricultural, suburban, commercial, industrial, urban, parkland and tidewater. In some places, trails exist, linking communities, historic sites, and even occasional vistas.

Of course, poor planning, and now abandonment in places, has resulted in a pattern of fragmented open space, and often limited opportunities for a fully-fledged trail system along the Darby Creek. However, it is impressive how much of a system is already in place, and how its elements could be connected to each other and to the communities along the creek valley.

Since in many places there is no “creek road” such as the Wissahickon’s Forbidden Drive, or Washington’s Rock Creek Parkway, there is little awareness in many parts of the watershed of Darby Creek. Cobbs Creek Parkway is notable as it parallels the park’s eastern edge within Philadelphia. The improvement of existing trails, and the linking with new trail sections, and the promotion of a stream-based greenway trail network would help immeasurably to increase the public’s awareness of the Creek and its watershed, and hopefully to its protection and enhancement.

The Upper Valley from the Trail Point of View

The Darby Creek and many of its principal tributaries arise in Easttown Township in Chester County and in adjacent Radnor Township in Delaware County. Of course, the Creek then remains entirely in Delaware County for the rest of its length, except where it forms the Boundary with Philadelphia County in the vicinity of the John Heinz National Wildlife Refuge.

Lancaster Pike and the Main Line of the Pennsylvania Railroad (Amtrak/SEPTA) follow a ridge separating the Great Valley from the Darby Creek Valley. Trail linkages to key town centers on the Main Line such as Daylesford and Berwyn will probably be limited to sidepaths, if that, owing to the current pattern of land ownership and development. See Figures VI-8 and VI-9.

Owners with large properties that back up to the Creek would probably be unwilling to grant easements for trail use. See Figure VI-10. Nevertheless, in this Piedmont section of the trail, there are still attractive back roads suitable for cycling — and often there are interesting historic buildings at the stream crossings, some even open to the public. See Figures VI-11 and VI-12.

Figure VI-8 Waterloo Road in Berwyn

Figure VI-9 Sugertown Road bridge

Figure VI-10 Private estate on Church Road

Figure VI-11 Waterloo Mills Historic District

Figure VI-12 Paper Mill House at St. David's Road

As the Darby Creek enters Radnor Township, it encounters a series of Township parks and trails including The Willows (Figure VI-13) and Skunk Hollow (Figure VI-14). Following existing Township Trails along the Little Darby and Darby Creeks, one may enjoy several miles of scenic walks. See Figure VI-15. Even where there are no trails below the Township Parks, the Darby-Paoli Road parallels the Creek and makes for enjoyable cycling with its still rural vistas. See Figures VI-16 and VI-17.

However, land development patterns again bring back yards right up to the Creek, making trail development unlikely in this lower section of Radnor Township. See Figure VI-18.

Figure VI-13 The Willows in Radnor Twp.

Figure VI-14 Skunk Hollow Park in Radnor

Figure VI-15 Old Paper Mill Road

Figure VI-16 Pasture along the Darby Creek

Figure VI-17 One-room Radnor School (1882)

Figure VI-18 Upstream from Bryn Mawr Ave

Along the last portion of the Valley in Radnor Township and for about two miles in Haverford Township, the former Pennsylvania RR Newtown Square Branch tracks followed the Creek. However, the line was abandoned in this vicinity many years ago, and it appears that the right-of-way is neither intact nor available for a section of "rail-trail." See Figure VI-19.

Figure VI-19 Old railroad grade removed for new development

At this point, nearing Marple Road, much work is under way with plans for the reuse of the grounds of the Haverford State Hospital. Trails are included in this plan, and any trail development along Darby Creek should take linkages into account. At this point on Marple Road and existing trail, following a sewer right of way begins and can be followed, with few small breaks, all the way to State Road (US 1) in Upper Darby Township.

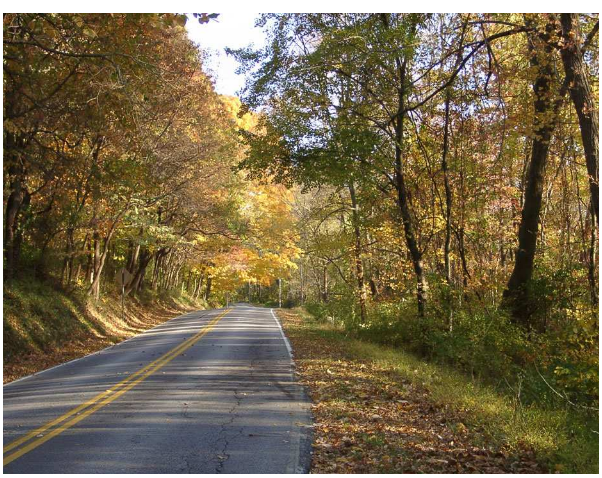

Figure VI-20 Darby Creek Road

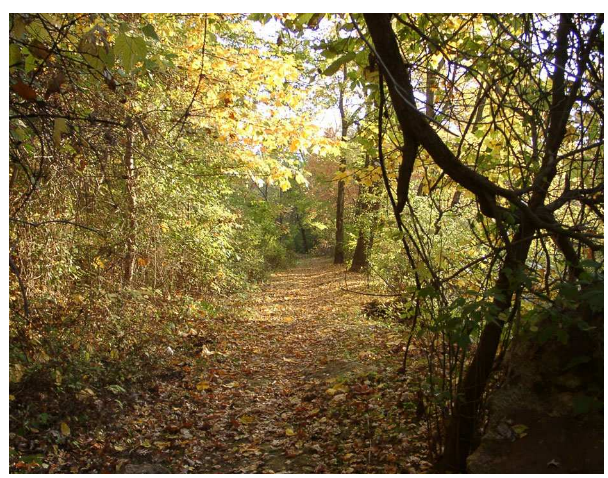

Figure VI-21 Existing trail below Marple Road

Figure VI-22 Trail exit at Robindale Apts.

Figure VI-23 Development at West Chester Pike

As the stream leaves Marple Road, the Valley narrows, and is cut much more into the landscape. See Figures VI-20 and VI-21. At West Chester Pike, there is a good connection to existing apartments. See Figure VI-22. However, crossing West Chester Pike and Old West Chester Pike, one must contend with a highly developed commercial area. See Figure VI-23. Amazingly, one soon returns to an isolated streamside trail. If not for the traffic noise from Interstate 476 the ambiance is little changed from long ago.

As the existing trail follows the Creek it links to existing parks (Figure VI-24) and Burmont Road (Figure VI-25). It appears that the sewer authority has fenced off the access road and trail to discourage dumping or other illegal activities. This writer saw little trash or dumping along the existing trail, but also no signs warning against trespass.

Figure VI-24 Parks could be linked by a trail

Figure VI-25 Trail exit at Burmont Road

Figure VI-26 Public transit access

Figure VI-27 Entrance to Indian Rock Park

Figure VI-28 Trail link below Rosemont Ave

Figure VI-29 Restored Lindbergh Bridge

A Darby Creek Trail system would have excellent connections to public transit. Both the SEPTA trolley lines to Media and Sharon Hill already have stations on or near the Creek. See Figure VI-26.

In Springfield Township, much development backs onto the deep creek valley, but gives no access to other than the individual residents. Occasional a right-of-way does link to riparian parkland, such as at Indian Rock Park (Figure VI-27). Of course, good connections are possible at roadway bridges across the Creek, such as at Rosemont Avenue (Figure VI-28).

In the entire section between Springfield, Clifton Heights, and Darby, the Creek is in a deep valley, sometimes with a most attractive trail, but often not. At Clifton Heights the Lindbergh Bridge spans the valley in a dramatic leap (Figure VI-29); as the valley approaches Lansdowne, a trail

Figure VI-30 View at Hilldale Road

Figure VI-31 Historic Lansdowne Station

exists, or could be developed, linking small sections of what appear to be public parkland. See Figure VI-30. An easy connection is possible to the center of Lansdowne, and the historic SEPTA Station there. See Figure VI-31.

As the Valley enters Yeadon and Darby, there is evidence of an earlier trail behind Fitzgerald Mercy Hospital. See Figure VI-32. There are also sections of beautiful trail along the Creek. See Figure VI-33.

Figure VI-32 Fitzgerald Mercy Hospital

Figure VI-33 A beautiful section of existing trail

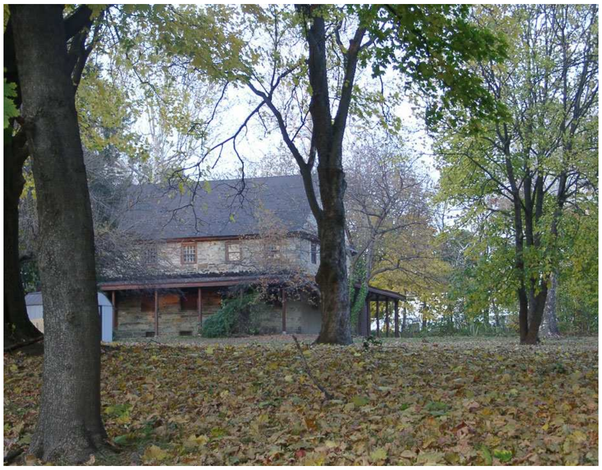

Figure VI-34 The Darby Friends Meeting House

Figure VI-35 Old trolley bridge in Darby

Above the Creek in Darby are numerous historic buildings such as the Darby Friends Meeting House (Figure VI-34). However, at the Creek itself, there is often little streamside land available for trail development. See Figure VI-35. Yet, there are stretches of parkland, such as that below 9th St., which appear to be part of an earlier plan to create a continuous linear park.

Parts of Darby have been subject to frequent flooding, and some homes are now slated for removal (Figure VI-36). In these riparian lands, the opportunity to develop a trail should not be missed. As the Darby Creek leaves the Piedmont for the Coastal Plain, it joins the Cobbs Creek in Colwyn. Development patterns here give both individual and common access to open areas along the Creek. See Figure VI-37. Trail development linking this area with the John Heinz National Wildlife Refuge appears physically possible if a right-of-way could be obtained.

Figure VI-36 Homes to be removed from the flood plain

Figure VI-37 Open space along the Darby Creek

Once 84^{th} Street is reached, the John Heinz National Wildlife Refuge at Tinicum provides one of the largest areas of public open space in Delaware County, and the largest freshwater marsh in Pennsylvania. Fortunately, existing trails follow an old dike along the east side of the creek with excellent vistas and views of wildlife. See Figures VI-38 and VI-39. Fort Mifflin on the Delaware has undertaken a trail development study in this area, and future crossings of Route 420 and I-95 are being planned to link the Creek Trails to the surrounding communities in Prospect Park, Lester and Essington.

Figure VI-38 Philadelphia viewed from Tinicum Marsh

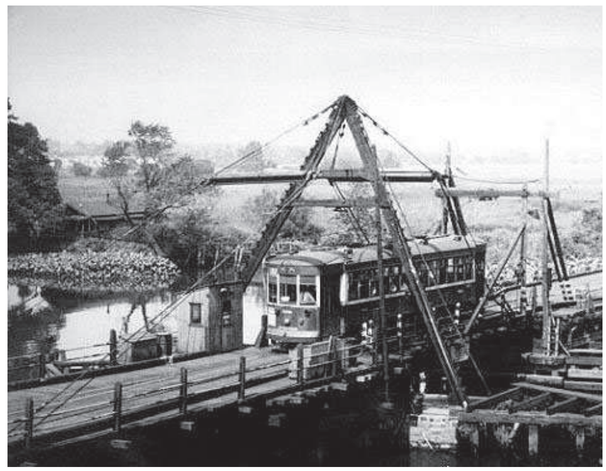

Figure VI-39 Historic view at the mouth of Darby Creek

Near the mouth of the creek is Route 291. Delaware County is currently performing an enhancement study along the Route 13/291 here which includes the East Coast Greenway. Thus, the Darby/Cobbs Creek trails will be linked to an important interstate trail here in Tinicum Township.

All the above has focused on foot and bicycle routes. One must not forget that the tidal portion of the Darby Creek is navigable by canoe most of the time, and docks already exist in the National Wildlife Refuge. The maze of channels offers several hours of adventure, and a chance to learn to work with the tides. The full development of a trail system should include all the canoeing and other boating opportunities possible along the lower Darby Creek.

C. HISTORICAL RESOURCES

Brief History of the Darby Creek Watershed
The Watershed has had a rich history, both before and after European settlement. It is believed that the Lenni Lenape were the first Native Americans to cultivate the Darby Creek Watershed area. Its fertile floodplains supported abundant crops of maize and tobacco. The Creek and the surrounding land were used for fishing, hunting, and for transportation, which facilitated trade.

The Pre-European landscape was not virgin, primeval forests; it had been altered to some extent by Native Americans living in the Watershed for many thousands of years. The Lenni Lenape farmed clearings in forests, hunted in the woods, and fished in the streams and rivers. Forests were closed canopy with oaks, maples and other species, often 300 to 400 years old. Forests were interrupted by open areas, sometimes created by burning and then used for farming by Native Americans. Burning was also used to control the forest understory, promoting forage for deer, forest access and open vistas for security and protection. (Fairmount Park System Natural Lands Restoration Master Plan, 1999)

The hunting/trapping of beavers and other fur-bearing animals led to the beaver skin and fur trade business with the Dutch in the early 17th century. Although the Indians sold some of their land in the Watershed to the Dutch before 1635, the Dutch did not make any settlements on the Darby Creek. In 1655, the Indians executed a treaty with the Dutch that reserved their hunting and fishing rights. The Swedes were first to establish a permanent colony in the Watershed during the 1640's, and by the 18th century, the Indians realized that their way of life, their fishing, hunting, and agriculture practices, could no longer coexist with the Swedish farming communities. As a result, the Darby Creek no longer served as a "bounty" off which to live. Not until the 1920's did the Creek's "bounty" prove beneficial when the "Crickers," shipyard workers who had been laid off, formed a tight knit community of hunters and fishermen living in stilt houses opposite the Tinicum marshes. All that remains of the original Lenni Lenape settlements are the names of places such as Tinicum, Muckinipattis Creek (a tributary of Darby Creek) and Indian Rock Park. Remaining physical evidence of the pre-European history includes some trail routes and the occasional re-surfacing of Indian arrowheads.

The first European to arrive in the area was the Dutch explorer Henry Hudson, who first explored the waterways of Delaware County in 1609. The Dutch coexisted with Indians while primarily focusing on the fur trade (beaver) business. The Swedes were interested in establishing the first European settlements and creating relatively self-sufficient agrarian communities. They settled and established a treaty with the Indians despite the Netherlands' prior claim to the area. The Swedish settlements were located along the flat land bordering the Darby Creek and extended no more than two miles inland. Although settlement was slow, Swedish communities eventually became so successful that by the late 17th century, they were able to sell their surplus products of grain, meat, and dairy products to the arriving English colonists. With the Dutch recapturing Fort Casmir and conquering Ft. Christina in Delaware and Fort Gottenburg and Printz Hall in Tinicum, the Swedish settlers dutifully took their oaths to the Netherlands in 1655. The Dutch surrendered to the English in 1664 and the Darby Creek area became English. Like the Indians, the Dutch left little physical evidence of their occupation in the Darby Creek Watershed, with the exception of a few names of places such as the Schuylkill River, Hook Road, and Calcon Hook Road (derived from "*Kalkoen Hoek*"). The Swedes on the other hand, had a greater impact. Physical evidence along the Creek can be noted at the John Morton Cabin, the Morton Mortenson Homestead, and the Swedish Cabin.

This European development had devastating consequences for the Watershed:

> "By 1720, plantations, the common term for farmsteads, dotted the countryside in and around Philadelphia. As people entered the city, a greater demand was placed on the nearby resources. As forests were cut for the plantation fields, there was a ready market in nearby Philadelphia for the wood. Houses needed to be built and heated. Local forest wood was needed for shipping crates, furniture, shingles, beams, floor boards, window sashes and doors. Clay was removed from fields, molded into brick and fired. Marshes were drained for agriculture and health reasons… The closer to the city, the more pressures on the local resources, and the less one would see patches of forests. Streams in and around the city were rerouted, covered or drained. Housing expanded westward. The huge appetite for lumber began to exhaust the local supply. The need for food and shelter put huge demands on the natural resources of the area, creating the need to clear more land, and plant more crops for the growing markets of the city."
>
> "Indeed most of our curious native plants, shrubs and trees is destroyed for 80, 90, 100 miles back this year. I went up scukil toward ye mountain to gather ye shugar maple seeds were grew a fine grove of them whose fallen tops lay so thick upon ye ground that I took another course 30 miles to gather some particular forest seeds I gathered there but ye trees was cut down and ye land cleared and clouthed with green corn…" (John Bartram 1741 Letter to Peter Collinson, Academy of Natural Sciences Archives)
>
> "The land clearing had tremendous effects on streams and rivers. The change in flow regime with clearing was noticed early. For example, Kalm (a Swedish traveler who spent time in the area; note added) noted the decrease in stream flows following clearing. Clearing also increased erosion, and there was a tremendous amount of sediment entering streams and rivers. This sediment was deposited in the flood plains and in the stream channel raising stream elevations. The soil horizon marking the presettlement soil surface and several feet of post-settlement deposition can be seen in many stream banks in the Piedmont…." (Fairmount Park System Natural Lands Restoration Master Plan,1999, p. I-39)

The Creek's fish supply was no longer used for sustenance by those settling along it; the English settlers instead focused on a livelihood from Darby Creek's water as a power source. The Welsh

Quakers, the earliest English to arrive on Darby Creek, established themselves within Penn's 40,000-acre grant. This grant tract included the east side of the Darby Creek to Newtown Township and easterly to the Schuylkill River. Names still prominent in the Darby Creek area are derived from the early settlers such as John Blunston, William Wood, John Bartram, and Henry Lawrence. In 1685, William Wood established the first mills on the Creek, just below the present 1006 Main Street in Darby. The Creek provided power for a variety of mills, including lumber, grist, and textiles. Although many of the Mills have deteriorated or have been demolished, many present day names of roads originate from the once thriving collection of mills along the Creek, such as Saw Mill Road and Paper Mill Road. However, still existing are some of the tenement structures that the mill owners commonly provided for their workers. These tenements are still used today as housing. The Cobbs Creek Master Plan summarizes this era succinctly:

> "Cobbs Creek was one of the early areas of settlement in the region, with a Swedish mill in 1646. Early estates were developed along the watershed, such as the Grange (built in 1682 with a number of subsequent additions), which is located across from parklands in Delaware County. Over the next several generations, much of the watershed was farmed and a number of industrial mills were built in the valley. A number of textile mills were built in Darby and Cobbs creeks to provide textiles for the War of 1812 (Barrett 1975), including several in the park, such as the Clinton textile mill in Carroll Park. Grist mills, saw mills and gunpowder mills were also located in the valley (Eckfeldt n.d., Barrett 1975). These used local wood for lumber or for fuel and depletion of wood eventually caused closing of some mills (Barrett, 1975). Willows were planted around the gunpowder mills as a source of fuel (Barrett 1975). Mills typically involved construction of a dam and mill race, and creation of an impoundment, generating channel changes which may affect the flood plain and channel long after disappearance of the buildings or dam." (Fairmount Park System Natural Lands Restoration Master Plan, p. II-8)

During the American Revolution, those living along the Darby Creek were forced to take up arms against the British. Guard boats were moored in the Creek and a fort was improvised at the mouth of Darby Creek in 1777. Because both sides depended on the countryside for supplies, the Darby Creek Watershed underwent devastating raids conducted by Britain's General Cornwallis. Once the war was over, Quaker dominance of the area diminished, and more immigrants arrived who earned a living off of the Creek's mills. Unfortunately, the late 18th and early 19th century floods made the milling livelihood difficult for mill owners and workers to sustain a profitable living. Many bridges, dams, mills, dwellings and lives were swept away as a result of this flooding. In the late 1800's, the production of engine-driven machinery began to force water-driven mills out of the market. The manufacturing industry, as a result, moved into the industrial centers along the Delaware River and flourished. These centers offered new and cheaper power sources such as steam and electrical energy.

As developments were moving from the mouth of the Watershed and northward, a second major development prong was moving westward, expanding outward from the City of Philadelphia. Though the early development of Philadelphia focused on the lands between the Delaware and Schuylkill Rivers, the rapid development of the Pennsylvania Railroad and the development of the trolley and other fixed rail-related technologies resulted in a tremendous growth of Philadelphia (and Pennsylvania) westward. "Suburban" developments rapidly grew around each Pennsylvania Railroad station stop, from the especially large commercial nodes in Ardmore (Lower Merion Township) and Narbeth, to locales farther west, such as Wayne, all in the Darby Creek Watershed. Other rail lines were being built, radiating outward from Philadelphia. In relatively short order as the trolley system expanded, the famous "streetcar suburbs" of Philadelphia mushroomed across West Philadelphia and extended into the Darby Creek Watershed, out to Cobbs Creek. By the turn of the century, an enormous number of residences had been built out across this part of the Watershed, a testament to the new middle class emerging from rapid post-Civil War industrialization.

By 1935, most of the early mills had left the lower Darby Creek Watershed. Although its industrial base was in decline, industry was replaced by the development of housing in these lower portions of the Watershed. Railroads, trolleys, and new roads offered city folk easy access to the Darby countryside. New housing proliferated, starting with the southern and eastern portions of the Watershed. As a result, large portions of the Darby Creek Watershed area are now occupied by dense housing developments, many of which were constructed before the emergence of zoning controls and other environmental and land management methods. As a further result, the natural resources of the Darby Creek were negatively impacted by inadequate and polluted stormwater run-off and drainage systems, leaking and inadequate septic tanks, lack of open space and adequate recreation, illegal dumping, and an array of other urban ills.

Residential developments continued, especially in municipalities like Springfield and Haverford after World War II as the industrialized Delaware River waterfront industries (manufacturing, oil refining, etc.) grew ever larger. Auto-oriented suburban development became popular, and upper Watershed municipalities like Marple and Newtown and Radnor began to develop rapidly, though at considerably lower densities. In so many ways, the Darby Creek Watershed story embodies the remarkable story of growth and development across the nation.

The Commonwealth's Role in Protecting Historic Resources

The Pennsylvania Historical and Museum Commission's Bureau for Historic Preservation (http://www.phmc.state.pa.us/) is the official agency in the Commonwealth for the conservation of Pennsylvania's historic heritage. The Bureau manages the National Register of Historic Places for the state through the National Historic Preservation Act of 1966. Properties listed in the Register include sites, buildings, structures, objects and districts that are significant in American history, architecture, archaeology, engineering, and culture. Properties considered potentially eligible for the National Register are generally more than 50 years old, and follow some general guiding criteria:

- are associated with events that have made a significant contribution to the broad patterns of our history;
- are associated with the lives of persons significant in our past;
- embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction;
- may be likely to yield or have yielded, information important in prehistory or history.

The process of listing a property in the National Register is thorough and complex, yet it encourages public participation in the protection of local historic resources. To be considered for the Register, an individual (or local government, or local historical society) must first submit a *resource inventory form* to the Bureau. Once the property information is processed through the Bureau's database system, the state's review board – composed of professionals in the fields of American history, architectural history, architecture, prehistoric and historic archaeology, and other related disciplines – provides a Determination of Eligibility (DOE) for each resource. The board (through the DOE assignment process) assigns a status of Eligible, Ineligible, or Contributing to a historic district. Assuming enough supporting information has been provided for the property, the nomination (only for Eligible or Contributing properties) is then submitted to the National Park Service to determine whether the property actually becomes Listed on the National Register. Properties that have been submitted to the Bureau but do not have a completed Determination of Eligibility are included in the historic property database and classified as Undetermined.

Listing in the National Register does not interfere with a private property owner's right to alter, manage or dispose of property (see discussion on State Road property in Springfield Township, below). 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.

Important Historic Sites in the Darby Creek Watershed

A variety of important historic sites remain within the Darby Creek Watershed area and its 31 municipalities in Delaware, Chester, Montgomery, and Philadelphia Counties. Some of these sites are documented; many are not. Some are protected; most are not. The challenge of this RCP is to both recognize those historic and archaeological values which have been documented, as well as work to better catalog those values which have not been adequately inventoried.

Plan preparers consulted with PAHMC officials in order to create a watershed map of historic sites that are "listed" on the National Register of Historic Places and "eligible" for listing on the

National Register. In the Darby Creek Watershed, 50 properties are eligible for listing, while 33 are listed on the National Register (Figure VI-40 and Table VI-1). Many other sites and properties have historical importance (in the sense that someone submitted a resource inventory form) but are not legally protected. These Undetermined sites are vulnerable to demolition and redevelopment. The Philadelphia portion of the Cobbs Creek Watershed has the largest number of vulnerable sites based on PAHMC database.

Many municipalities have their own Historical Societies, which provide a means of increased local support and management (Table VI-2). The Darby Creek Valley Association has paid special attention to the historic structures in the Watershed through their Historical Sub-Committee. The Committee is composed of representatives from Historical Societies in the Watershed and meets quarterly for planning purposes. The greater challenge is then to develop better management mechanisms which will protect these important cultural resources in the future. As has been documented so often with environmental resources, careful management can be a key to economic stimulation, rather than a hindrance.

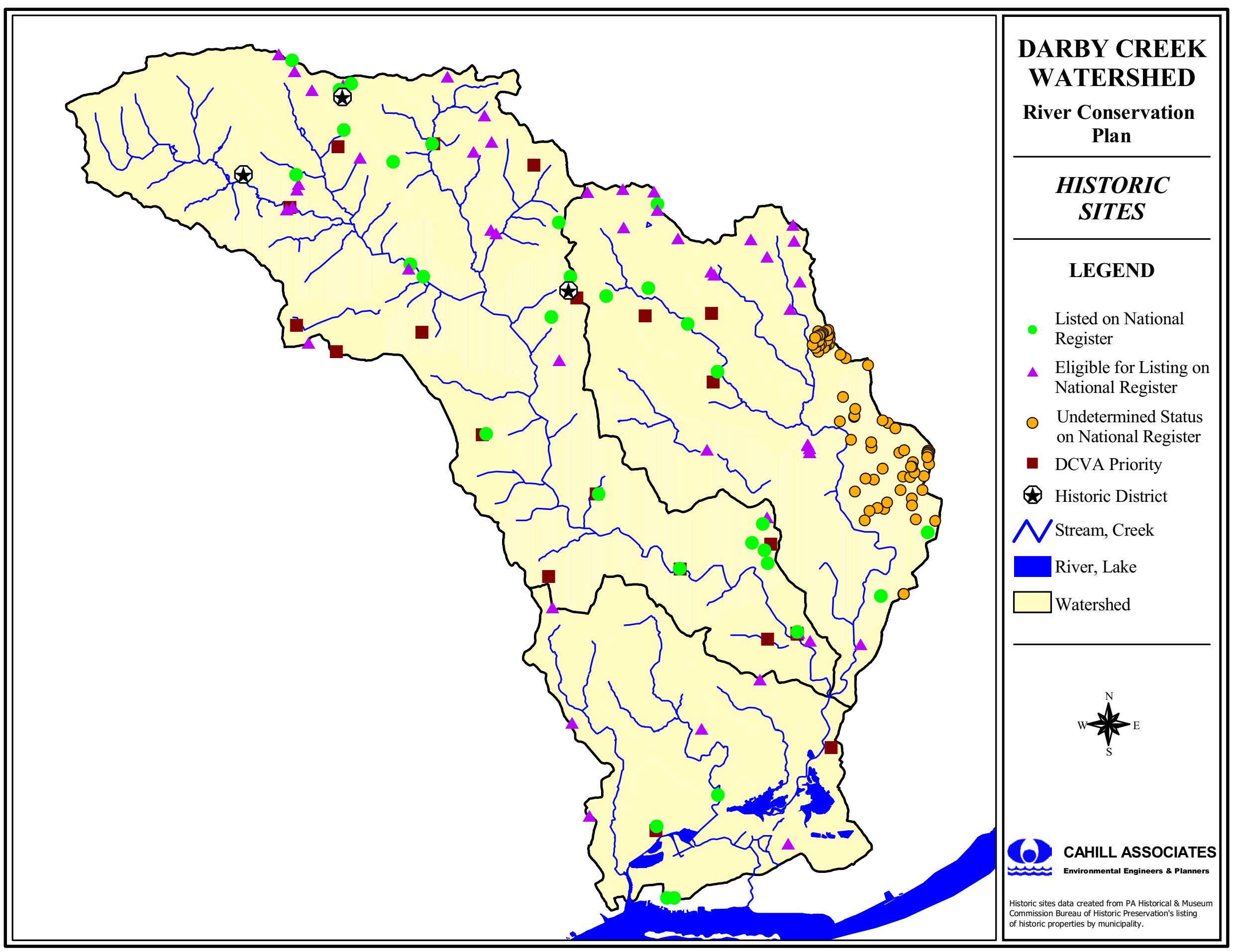

Figure VI-40 National Register Listed and Eligible Sites, and DCVA Priority Sites

Specific Historic Sites located in the Darby Creek Watershed
Sites are discussed below in a Watershed sequence, moving from downstream to upstream.

Tinicum Township

Lazaretto
On the Delaware River at Essington, PA

The Lazaretto was constructed as a result of people's fear of the Yellow Fever, which was rampant in Philadelphia during the end of the eighteenth century. The original Lazaretto stood behind the Old Fort Mifflin but was relocated to 10 acres of land on Tinicum Island in 1799. Completed in 1800, the Lazaretto served as a quarantine station until 1893 when the station was relocated to Marcus Hook. At this time, the Tinicum Island Lazaretto became a popular picnic ground for Philadelphia politicians, City employees and councilmen. At the turn of the century, the City leased the Lazaretto to the Orchard Club, a private club, and the area became a lavish pleasure resort. In 1915, it was transformed into the Philadelphia Seaplane base, and was temporarily used as a US Army aviation-training base at the outbreak of WWI. The Lazaretto,

Table VI-1 National Register Historic Sites, by Municipality

Municipality	Listed	Eligible	Undetermined	Total
Darby Boro	1	2		3
Easttown	1			1
Glenolden		1		1
Haverford	6	3		9
Lansdowne	4	1		5
Lower Merion	1	10		11
Marple	1			1
Narberth		3		3
Newtown	1	5		6
Norwood	1			1
Philadelphia ***	3	1	89	93
Prospect Park	1			1
Radnor	9	10		19
Ridley Park		1		1
Rutledge		1		1
Sharon Hill		1		1
Springfield		1		1
Tinicum	2	1		3
Tredyffrin	1	2		3
Upper Darby Twp.	2	5		7
TOTAL	**34**	**48**	**89**	**171**

Only sites found within Watershed are shown in table
Information based on data received July 2001, PAHMC
*** Information based on data received January 2002, PAHMC

Table VI-2 Historical Societies in the Watershed

Local Historic Societies and Commissions	**Address**			**ZIP**	**Phone**
Darby Borough Historical & Preservation Society	P.O. Box 108	Darby	PA	19023	(610) 583-4386
Glenolden Historical Commission					(610) 585-3305
Greater Lansdowne Civic Association	P.O. Box 366	Lansdowne	PA	19050	(610) 622-6643
Haverford Township Historical Society	P.O. Box 825	Havertown	PA	19083	(610) 446-7988
Lower Merion Historical Society	P.O. Box 51	Ardmore	PA	19003	
Marple Newtown Historical Society	P.O. Box 755	Broomall	PA	19008	(610) 353-4967
Morton Historical Society					(610) 328-3152
Norwood Historical Society	10 West Cleveland Avenue	Norwood	PA	19074	
Radnor Historical Society	113 West Beech Tree Ln	Wayne	PA	19087	(610) 688-2668
Ridley Park Historical Society					(610) 521-1333
Sharon Hill Historical Society					(610) 583-2757
Springfield Historical Society	P.O. Box 211	Springfield	PA	19064	(610) 938-6299
Tinicum Township Historical Society					(610) 521-1698
Upper Darby Historical Society of Pennsylvania					(610) 924-0222

County Historic Societies and Commissions	**Address**			**ZIP**	**Phone**
Chester County Historical Society	225 N. High St.	West Chester	PA	19380	(610) 692-4066
Delaware County Historical Society	85 N. Malin Rd, Room 208	Broomall	PA	19008	(610) 359-1148
Historic Commission of Delaware County	322 N. Edgmont Street	Media	PA	19063	(610) 566-2503
Montgomery Co. Dept. of History & Cultural Arts					(610) 278-3553

Philadelphia Historic Societies and Commissions	**Address**			**ZIP**	**Phone**
Historical Society of Pennsylvania	1300 Locust St.	Philadelphia	PA	19107	(215) 732-6200
National Trust for Historical Preservation	6401 Germantown Avenue	Philadelphia	PA	19144	(215) 848-8033
Pennsylvania Historical & Museum Commission	400 North St, 2nd Floor	Harrisburg	PA	17120	(717) 787-4368

Tinicum Township's oldest landmark, is listed on the National Register of Historic Places. Presently, the three-story Georgian administration building and the Physicians House are in danger of demolition by the current owner to make way for a riverside parking lot. The buildings are on private property and not open to the public.

Governor Printz Park
2nd St. & Wanamaker Ave., Essington, PA
610-583-7221
www.biderman.net/parks.htm

In 1643 the new governor of New Sweden, Johan Printz moved his capital from Fort Christina to Tinicum Island. At this time Fort Gottenburg was established in addition to Printz's dwelling and headquarters. Two years later a fire swept over the newly established settlement. Printzhoff, the governor's home and headquarters, was reconstructed more solidly and lavishly thereafter. This two-story log structure contained lumber sent from Sweden, glass windows, and lavish draperies. In 1653 Governor Printz relinquished his command and returned to Sweden. In 1655 Peter Stuyvesant, governor of New Netherlands, vanquished Printz's successor and gained control of the Swedish colony. Printzhoff is no longer standing, but there are self-guided tours available for visitors to tour the grounds of what is the site of the first European government in Pennsylvania.

John Heinz National Wildlife Refuge at Tinicum
86th St. & Lindbergh Blvd., Philadelphia, PA
215-365-3118

Presently host to over 280 species of birds, the recently-created Refuge offers an idyllic location for birdwatching. Recent sightings have included the Tennessee Warbler, the Immature Bald Eagle or Golden Eagle, the Scarlet Tanager, and the Baltimore Oriole. Along with birdwatching, fishing is another recreational activity available to visitors. Fishing is allowed here along the banks of the Darby Creek with rewarding catches such as carp, catfish, and large-mouth bass. Another favorite spot is the fishing pier that accesses the lagoon areas of the Refuge. The pier is located near Tinicum and Prospect Park on the west side of PA 420. The Refuge does have a catch and release policy effective throughout the entire grounds. Activities such as hiking and biking throughout the Refuge offer hours of peaceful observation of wildlife in its natural habitat. There are six major hiking trails in the Refuge and a direct cycling trail around the perimeter of the Refuge. Bicycles are permitted on only a few of the hiking trails. Canoeing also provides yet another perspective to observe the wildlife, nature and an historic site within the Refuge. There are canoeing maps labeling important habitats and sites to visit available at the Visitors Contact Station and on the Refuge web site at www.fws.gov.

The 4.5-mile segment of Darby Creek that flows through the Refuge is quite scenic and allows canoeists to see a variety of unique plants and animals. Located on Darby Creek's northern side is Hermesprota Creek, one of the larger tributaries of the Darby. Past the marsh, Darby Creek is bordered by the Refuge to the south and the Boroughs of Folcroft and Norwood to the north. Another large Darby Creek tributary, Muckinipatis Creek, also enters Darby Creek in this segment. On the shores of the confluence of the Darby and Muckinipatis sits the historic Morton Morton House in Norwood's Winona Park. There is a canoe launch on the grounds; however, visitors must remember that the Refuge waters are tidal and navigable only within 2 hours before and after high tide.

Prospect Park Borough.

Morton Homestead
100 Lincoln Ave., Prospect Park, PA
610-583-7221

The Morton Homestead is significant for its architecture as a surviving link to the first Swedish settlement and for its association with the politically prominent Morton family of colonial times. Morton Mortonson constructed the Morton Homestead in several stages starting in about 1654. Morton Mortonson was the great grandfather of John Morton, a signer of the Declaration of Independence, and he originally owned all of what is now Norwood, south of Chester Pike, a total of about 700 acres. Some type of "blockhouse" or some other type of structure partially below ground was constructed on the banks of the Darby Creek in the Borough of Prospect Park; however, this earlier structure was likely demolished after 1666. Later in 1698, a one-story log cabin was constructed for Morton's son, Mathias, and his family, and in the mid-1700s a second structure was built. At this time, the two buildings served as the Darby Creek Ferry House; the ferry across Darby Creek was located nearby. In the late 1790s, these cabins were connected by stone walls and re-roofed, forming a second story. Morton Mortonson's property remained within the family for quite some time. John Morton constructed his home in 1764 in what is now Ridley Park Borough. Currently owned by the Pennsylvania Historical and Museum Commission, the exterior of the cabin has been restored and the interior has been furnished with period furniture. In 1970, the state nominated the building for inclusion in the National Register of Historic Places. The cabin is located one mile north of Governor Printz Park and is open to the public for guided tours. It is presently surrounded by three acres of parkland, which includes a picnic area. See Figure VI-41.

Norwood Borough

Morton Mortonson House
515-½ Winona Avenue, Norwood, PA

Morton Morton of Ridley, grandson of Morton Mortonson, constructed this two story brick house probably sometime between 1720 and 1760 on the property near Darby and Muckinipatis

Creeks about a mile north of what was once known as "Great Tinicum Island." In 1654 Morton Mortonson, Senior, owned this land, which was included as part of New Sweden, the first European settlement in Pennsylvania. Lydia Boon, the granddaughter of Morton Morton, inherited some 300 acres of her grandfather's land, and it is on this property that the existing House stands. The House was passed on to family members until the mid to late nineteenth century.

In 1840 the wing, which was originally constructed for Morton Morton's mother-in-law, was rebuilt and a third floor added. Owned by Norwood Borough since 1954, the Borough restored the Morton Mortonson house to its original construction in 1969. At the time of the restoration, only the chimney and partial foundation of the wing remained standing, while the main portion of the building was severely dilapidated. During the renovations, the third floor was removed, the exterior and interior of the main building were painstakingly rehabilitated, and the wing was completely reconstructed, with the existing fireplace and chimney incorporated into the new structure. Recently added to the National Register of Historic Places, the Morton Mortonson house is the oldest surviving building in Norwood Borough and one of the oldest buildings in Delaware County. The building is open to the public for guided tours.

Figure VI-41 The Morton Homestead in Prospect Park, PA

Sharon Hill Borough

Sharon Hill Railroad Station
Sharon Ave., Sharon Hill, PA
610-583-2757

This 1872 railroad station is the only serpentine stone station in the country. Additionally, the station is important because of its influence on the development of the Sharon Hill community. The Philadelphia, Wilmington & Baltimore rail line was developed here in 1873, and as a result spurred development within this moderately settled area, which included the Sharon Hill Academy (later known as Sisters of Holy Child Jesus Catholic Seminary). This modest thirteen-structure community along Chester Pike grew to accommodate industry such as the Knowlton Machine Works, and then a considerable amount of "suburban" residential development in the late 1800's.

Collingdale Borough

Mount Zion Methodist Meeting House
1400 block of Springfield Road, Collingdale, PA
610-583-4386

The first building on this site was a school built around 1725. It became one of the first "subscription" schools in Pennsylvania. In 1808 the Methodist Meeting House was built. The building later evolved into the Home Protection Society of Darby, which is believed to have held in 1818 the first temperance meeting in Pennsylvania and possibly the United States. Many of the area's first settlers and original church members were buried in the adjacent cemetery. Additionally, more than 30 Darby area Civil War veterans were buried here. The site has been abandoned for fifty years and is now being restored by the Friends of Darby Methodist Meeting Cemetery.

Darby Borough

Darby Free Library
1001 Main Street, Darby, PA
610-586-7310

Established in 1743, the Darby Free Library is the oldest public library in continuous operation in the United States. The present building, erected in 1873, is an example of Romanesque Revival architecture, designed by Benjamin Price. The Library presently houses an open history room with information on local history, books, pictures and artifacts.

Darby Friends Meeting House
1017 Main Street, Darby, PA
215-247-3729

Established in 1687, the present building was erected in 1805. It was used as a hospital during the War of 1812 and was the site of the first school in Darby. John Bartram, noted American botanist, is buried in the nearby burial ground, which is the oldest burial ground in continuous use in the United States. The Meeting House is in its original state and is listed on the National Register of Historic Places.

Darby Creek Mills Site
Below 1006 Main Street, Darby, PA

It was below 1006 Main Street in Darby Borough that William Wood built the first mills of the area in 1685. Later known as the Darby Mills, these mills changed hands and milling functions many times until the 19th century. A cluster of approximately 15 mills developed upstream of Darby Mills, up to Garrett Road.

Site of John Blunston Homestead
West of 1205 Main Street, Darby, PA

One of the earliest settlers along the Darby Creek in the Darby area, John Blunston arrived in 1682, naming Darby after his ancestral home. Blunston's house was located west of 1205 Main Street and his property abutted the Creek. Blunston cleared the forested land for farming and cattle grazing. He donated the land behind his house for a burial ground, which still exists. His house served as the Quaker meetinghouse until a log meetinghouse was constructed nearby in 1687. The present meetinghouse was built in 1805 and the tenant house in front of the meetinghouse was built in 1752. Surviving as a reminder of the Blunston family is the house, which stands at 1006 Main Street on a one-acre lot that backs to the old millrace. It was built for John Blunston's granddaughter in 1734 and is occasionally open on Darby festival days.

Lansdowne Borough

Woodburne
Lansdowne Court, Lansdowne, PA

Now divided into apartments in Lansdowne Court, Thomas Alexander Scott had this house designed by Frank Furness. Mr. Scott had acquired his wealth from railroads and other interests and purchased land on both sides of the Darby Creek in the Upper Darby and Lansdowne areas. His Victorian house with its wrap-around porch is situated on property that once extended from Lansdowne Avenue to the Darby Creek. In 1907 the development of Lansdowne Court incorporated Mr. Scott's house, at which time Scott's son, Edgar Scott, built the present Woodburne. This home sits high above the Creek and has been the home to the Daughters of the Divine Redeemer since 1936. Presently it serves as a retirement home for the Sisters of this order.

Kellyville Mill Complex
On Darby Creek at Baltimore Pike, Lansdowne, PA

Charles Kelly arrived in the Darby Creek area in 1822, and worked in a newly established textile mill on the Creek at Baltimore Pike. In 1839 Kelly leased the mill, and by 1845 he owned this mill, the D&C Kelly Cotton Factory, the largest cotton mill in Upper Darby. He also leased mills from the Garrett Family upstream, and owned 40 tenements. The housing for his managers and laborers developed into the neighborhood of Kellyville, which stretched along the Creek from Baltimore Pike to Garrett Road. His house stood above the mills at the southeast corner of Baltimore Pike and Scottdale Road. Said to be the grandest house with a farm and tannery in Lansdowne, it could be seen for miles. Kelly passed away in 1861 and a department store merchant in Philadelphia purchased the mansion and surrounding 52 acres. By the 1920's a developer surrounded the mansion with housing, and the mansion was used by the local civic association as a meeting place until it was torn down in 1935.

Lansdowne Historic Sycamore Park
47 East LaCrosse Avenue, Lansdowne, PA
610-623-7300

An over 350 year-old American sycamore tree is the centerpiece of this public park, which was created by the Greater Lansdowne Civic Association. Located within a National Register Historical District, the park consists of 3 acres of open space developed as passive parkland. The Sycamore Park is one of the Association's many efforts in preserving Lansdowne's rich history.

Clifton Heights Borough

Kent Mill
On Creek at Rockbourne Road, Clifton Heights, PA

Thomas Kent had worked in the textile mills of England since his childhood. He continued this trade when he moved to the Upper Darby area. It is believed that Kent worked with his sister's husband, James Wilde, who leased a textile mill from the Garrett family. The Garrett family owned, with the Levis family, 1000 acres along the Creek in what is now Upper Darby and Springfield Townships. One year after the flood of 1843, Thomas Kent purchased the Rockbourne Mill from the Thomas Garrett estate. Two years later he purchased the Union Mills across the Creek. Less flamboyant than his neighbor, mill complex owner Charles Kelly, Thomas Kent's mill complex prospered until the 1960's. A four-story fieldstone mill building still stands on Rockbourne Road and is presently home to a furniture warehouse. Vestiges of its steam power plant, which was used for auxiliary power, can still be seen.

Springfield Township

Old Central School
161 Saxer Avenue, Springfield, PA
610-328-5234

Located some distance from Darby Creek but within the Watershed area, the original Central School was built in 1752. The present building at this site was constructed in 1852. The Springfield Historical Society now uses the building as a community center and for special events.

Sexton Homestead
421 N. State Rd., Springfield, PA

This historic home is not listed on the National Register, but locally is extremely important to community members. The main part of the house dates to the early 1860s, and some believe the original portion was built in 1757. The original Quaker owners, the Maris family, may have contributed to the Underground Railroad, evidenced by the presence of an underground room and tunnels. In January of 2002, Claude de Botton purchased the 2.6-acre property and the building on it for $695,000 from Charles Sexton, Jr., in order to combine it with an adjacent undeveloped 64-acre parcel. De Botton has postponed the demolition of the building, giving township residents, county officials, and historic preservationists a chance to come up with a plan to save the house. This property serves as an example of how listing on the National Register, or even having a local Historic Preservation Board, can serve to preserve and protect the local cultural resources in a township.

Upper Darby Township

Swedish Cabin
9 Creek Road, Drexel Hill, PA
610-623-1650
http://biderman.net/log.htm

Swedish settlers constructed this one and one-half story log cabin in 1643-53, and it may have been used as an outpost for Indian trade. It is an outstanding example of early log construction by the Swedes and Finns who introduced this style of architecture to the New World. The cabin, one of very few log structures still standing in the area, represents the establishment and strong influence of the Swedes within Delaware County. The Friends of the Swedish Cabin currently maintain this cabin. See Figure VI-42.

Figure VI-42 The Swedish Log Cabin on Darby Creek in Upper Darby Township

Collen Brook Farm
Mansion & Marvine, Drexel Hill, PA
610-789-2324

In the 1690's Ralph Lewis purchased the land on which Collen Brook Farms stands. In 1829 Mary Lewis, the last relative of Ralph, married Dr. George Smith, a physician, educator, and state legislator. The remaining eight acres include a farmhouse, half of which dates back to 1794, a 300-year-old burr oak, a carriage house and springhouse.

City of Philadelphia

Overbrook Farms
Overbrook Ave, Philadelphia, PA
www.overbrookfarms.org

Overbrook Farms, situated at the headwaters of the Cobbs Creek sub-basin (Figure VI-44), is an extraordinarily intact example of late 19th and early 20th century planned suburban residential development, resulting from tremendous wealth generated by industrial growth and prosperity in Philadelphia after the Civil War. Roughly bounded by City Line Avenue, 58th Street, Woodbine Avenue, and 64th Street, the tracks of the Pennsylvania main line bisect the 168-acre community. The railroad station, built in 1858, predates Overbrook Farms. Drexel & Co., financers of the

Pennsylvania Railroad, purchased tracts of land surrounding the train station and commissioned architects and planners to design a model commuter suburb.

In 1985, Overbrook Farms was placed on the National Register of Historic Places through the effort of the Overbrook Farms Club, the oldest civic association in Philadelphia. Within the watershed, currently over 30 homes have a National Register Status of "Undetermined" though the individual homes (Figure VI-45) contribute to the Listed Historic District. A variety of architectural styles are represented in the Overbrook Farms neighborhood, including Colonial Revival, Tudor Revival, Gothic Revival, Arts and Crafts, Queen Anne, Italian Villa, and Federal Revival.

Figure VI-43 Historic homes within the Overbrook Farms Historic District of Philadelphia

La Blanche Apartments
5100 Walnut Street, Philadelphia, PA
http://uchs.net/HistoricDistricts/lablanche.html

The completion of the Market Street Elevated rail line in 1907 spurred a wave of residential construction in West Philadelphia. Built in 1910, the La Blanche Apartment building is one of the first large apartment buildings to come to Philadelphia, filling the need for new middle class housing. Presently, the neighborhood has somewhat deteriorated evidenced by the re-development of La Blanche's spacious apartments to provide cheaper housing.

Haddington Historic District
6000 Blocks of Market, Ludlow, and Chestnut Streets, Philadelphia, PA

The Haddington Historic District is another example of a West Philadelphia community developed out of a functional use of a stop on the Market-Frankford Elevated Line. The developer planned the neighborhood with a direct organizing intent to focus the commercial buildings at the immediate corner of the station, mixed commercial and residential one block down from the

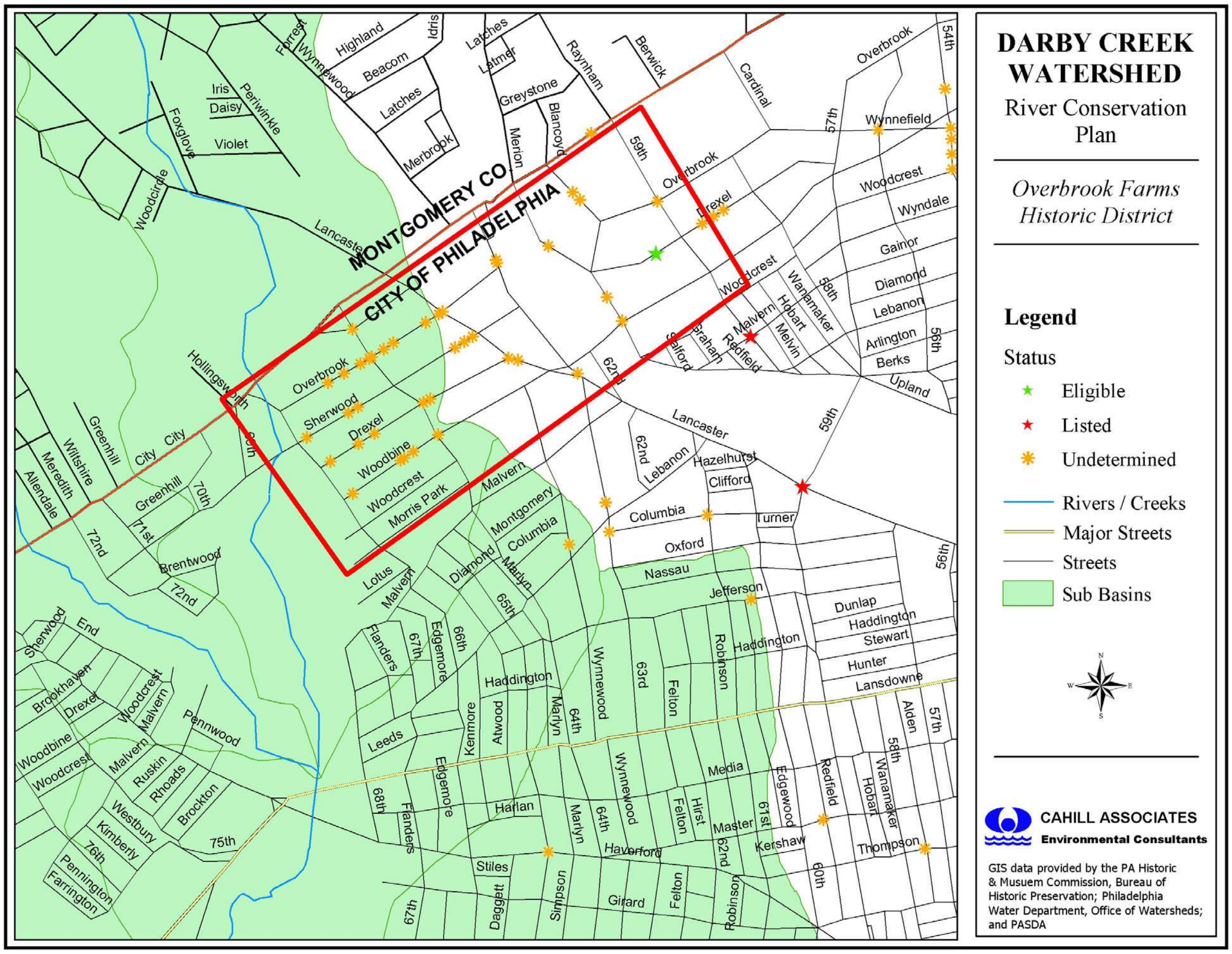

Figure VI-44 Overbrook Farms Historic District in the Cobbs Creek Watershed

station, and finally purely residential two blocks from the station. This logical functional hierarchy shelters residents from the noise and traffic of the commercial area. While other areas of West Philadelphia share the impact of the elevated subway, only the Haddington District is unique in maintaining its original distinctive architectural character. E. A. Wilson, responsible for much of the building architecture in West Philadelphia, developed the Haddington District between 1909 and 1915 in the then popular colonial and classical revival styles (http://uchs.net/HistoricDistricts/historicdistricts.html).

Lower Merion Township

The General Wayne Inn
625 Montgomery Avenue, Merion, PA

Originally called The Wayside Inn at its inception in 1704, the General Wayne Inn — renamed in 1793 — has remained a prominent feature of the main line in Lower Merion Township. The Inn was named for General "Mad Anthony" Wayne, a Revolutionary War hero who in 1775 led the 7th Pennsylvania Regiments of the Continental Army. Because of its location, the Inn played host to many American Patriots and British Redcoats. During the 1800's, many Philadelphians vacationed on the main line, and enjoyed fine dining at The General Wayne Inn. In addition to being an inn and a restaurant, the building has also been used as a post office, a general store, and a social center for newly arrived Welsh Immigrants. Local legend holds that the Inn is haunted by over 17 Revolutionary War period ghosts, including soldiers and barmaids (see www.HauntedHouses.com for more information).

Haverford Township

Nitre Hall and Lawrence Cabin
Powder Mill Valley, Karakung Road, Havertown, PA
610-446-7988

Israel Whelen built Nitre Hall, home of the powder master of Nitre Hall Powder Works, in 1810. The Powder Works was the second largest powder mill in the country during the 19th century. Nitre Hall is the only remaining building of the Powder Mill Valley which developed during the industrial era. The building is on the National Register of Historic Places and is the headquarters of the Haverford Township Historical Society. The Society's library and archives pertaining to the Township's history is housed here and is open to the public.

Two Lawrence cabins remain in the area. Built in 1710, the Lawrence cabin, next to Nitre Hall, is a one-room log home with a loft and large fireplace. Also known as the Three Generation House, it is typical of the early homes built in this area. The cabin was rebuilt on this site in 1961 and is furnished in a style representative of early settlers. The other cabin belonged to Henry Lawrence who arrived in the area and purchased 209 acres along the Creek, near what is now West Chester Pike and Lawrence Road. A late 17th century cabin already stood on this property and was incorporated into later additions in 1720 and 1823. Henry's house still stands at 1901 Lawrence Road. Along the Darby Creek the Lawrence family built a sawmill, which operated until the late 1980's. The site included a living quarters and a covered bridge. By early 1991 the sawmill had been demolished, arson had destroyed the living quarters, and the covered bridge had been blown over in high winds.

The Grange Estate
Myrtle Avenue at Warwick Road, Havertown, PA

Located some distance from Darby Creek, but within the Watershed area, the Grange remains a wonderful example of an 18th-19th century gentleman's countryseat. The property was deeded to William Penn in 1682 and then granted to a Welsh Quaker who created a compound including a 1700's mansion, carriage house, long barn, springhouses, necessary, formal gardens, and winding trails within acres of hardwood forest. During the Revolutionary War, many influential men of the time were entertained here, including Generals Lafayette and Washington. The total area of the Estate is now 9.9 acres and is owned by Haverford Township. The site is listed on the National Register of Historic Places.

Old Haverford Friends Meeting
East Eagle Road & St. Denis Lane, Haverford, PA
610-789-3340

Located within the Watershed area, the Meeting House was situated on a path, now Haverford Road, leading to Darby. The Haverford Friends Meeting is the oldest home of worship in Delaware County. The stone building was built in 1700 with additions in 1800, 1949, and the 1950's. Surrounded by a stone wall, there is a burial ground, dating as far back as the late 1600's, one-half block down East Eagle Road.

1797 Federal School
Darby Road at Coopertown Road, Haverford, PA
610-789-5169

Located up Darby Road from the Old Haverford Friends Meeting House, this one room schoolhouse began as a "subscription" school in 1797. In 1849 this stone building became the first public school in Haverford Township. In 1991 restoration was completed and the One Room School Day program was begun. The School is listed on the National Register of Historic Places.

Marple Township

Thomas Massey House
Lawrence & Springhouse Roads, Broomall, PA
610-353-3644

Thomas Massey, a follower of William Penn and an indentured servant, became a landowner and prominent citizen after settling in the Watershed. His house is one of the oldest English Quaker houses in Pennsylvania. With sections dating to about 1696, 1730 and 1840, the house encompasses three centuries of construction techniques. The interior features a walk-in fireplace and beehive oven. The grounds include herb and kitchen gardens and a mini-farm.

Newtown Township

Newtown Square Friends Meeting House
118 N. Newtown Street Road (Rte 252), Newtown Square, PA
610-356-6669

The Friends Meeting House was built in 1711 and redesigned and rebuilt in 1797 with additions in the 20th century. Adjoining the Meeting House is a burying ground older than the Meeting House. The Meeting House is still active with worship every Sunday.

Octagonal School
3500 West Chester Pike, Newtown Square, PA
610-359-4511

Built in 1798 of fieldstone, it is octagonal in shape and functioned as a school until the 19th century. Dunwoody Village has restored the building back to its original condition. The interior features a pot-bellied stove, schoolmaster's desk, and student benches. The School is one of three extant octagonal schools in its original condition in Delaware County.

Paper Mill House Museum
St. Davids & Paper Mill Roads, Newtown Square, PA
610-975-0290

At Paper Mill Road, a few mills were located along Darby Creek, including the Crossley Woolen Mill, which was constructed here in 1810. This milling community emerged from one of the three original settlements in the area. At the end of the 19th century, the Union Paper Mill took over the site and in 1891 C.C. Harrison used the mill race and water wheel of the Mill to power his hilltop house, until electricity was brought to it in 1900. The Paper Mill House was originally built to house the mill workers and their families. The oldest part, built in 1780, also housed a general store. The four family mill workers flats were added in 1820. The House presently serves as a museum, which includes a general store, tool room, parlor, bedroom and kitchen furnished in the style of the 1840's.

Old St. David's Episcopal Church
Valley Forge Road, Newtown Square, PA
610-688-7947

Built in 1715, Old St. David's Church retains many of its original features, such as the Queen Anne window and the steeply pitched roof. The Revolutionary War's General Anthony Wayne and many of his relatives are buried in the adjacent cemetery.

The Square Tavern
Goshen Road & N. Newtown Street Road, Newtown, PA
610-975-0290

William Penn laid out Old Newtown Square as a Greene Countrie Towne, of which the Square Tavern served as a hub. Built by Francis Elliot in 1742, the brick structure remained a tavern for well over a century. One of the tavern's many proprietors, John West, was the father of America's first internationally known painter, Benjamin West. Benjamin lived at the tavern from 1744 to 1748. In 1981, the ARCO Chemical Research Company completely restored the building.

Baptist Cemetery
Newtown Street Road (Rte 252), one block North of intersection with Goshen Rd., Newtown Square, PA

Many of the original settlers who established Old Newtown Square, the settlement at Goshen and Newtown Street Roads, are buried here, including Elizabeth Wayne, mother of General Anthony Wayne of Revolutionary War fame. Owned and maintained by the First Baptist Church of Newtown Township on West Chester Pike, the cemetery is in continuing use.

Radnor Township

Cassat Estate
Berwyn-Paoli Rd., Devon, PA

In 1906 Mr. and Mrs. Cassat hired Cope and Stewardson to design a house for use as a summer residence. The grounds included a swimming pool, which was fed by Darby Creek, and a small lake that was large enough for small boats. Although Mrs. Cassat did not enjoy their summer residence, her daughter adored the house. After Mr. Cassat's death in 1926, she moved in full-time with her family. The estate was sold in 1950 and immediately resold to a Catholic order of priests. Later the YMCA with the help of the Natural Lands Trust purchased the estate. The swimming pool is filled-in and overgrown, but the lake remains edged by a walking trail maintained by the Natural Lands Trust. A small bridge that spans the Creek still exists, as well. The barn is now an attractive house. The conservation of the Cassat estate is the beginning of the Natural Lands Trust's vision for creating a green walkway along the Darby Creek. By 1960, they had also purchased 15 acres of land adjacent to the Creek downstream from the Estate for conservation.

Old Eagle School
Old Eagle School Road, Strafford, PA
610-687-2939

The Old Eagle School, a one-room stone schoolhouse, was built in 1788, enlarged in 1842, and restored in 1900. The interior features benches, desks, and a display case of early 19th century schoolbooks, slates, quills, and other school related items. On the school grounds is a cemetery that contains graves of Revolutionary War veterans.

The Finley House
113 West Beech Tree Lane, Wayne, PA
610-688-2668

One of the oldest residences in Main Line Delaware County, the Victorian style Finley House dates back to 1840. The interior features a restored 1789 basement kitchen, an 1840's Victorian bedroom, and a late 1800's front and back parlor. On the site is a wagon house that contains a Conestoga wagon and several other 19th century vehicles. The Finley House is also the headquarters of the Radnor Historical Society. Its reference library contains a collection of maps, photographs, documents, and books on local history, architecture, and decorative arts.

Ardrossan
Acreage on the Creek near Saw Mill Rd., Radnor, PA

Originally belonging to Levis Lewis in the early 19th century, a gristmill and a sawmill occupied this Creek area near what is now Saw Mill Road. The gristmill, under Tryon Lewis' ownership, remained in operation until 1880. Just above the Creek, a one-room schoolhouse was built, commonly referred to as the Lewis Mills School. Constructed in 1887, the schoolhouse can still be seen from Darby-Paoli Road near Godrey Road. In 1912 Robert Montgomery purchased the mills and the surrounding farmland. He had Horace Trumbauer design his estate, Ardrossan, which sits in the middle of rolling farmland along with several early 19th century houses. The gristmill was torn down in 1920 and the millpond was filled in and turned into a cow pasture.

Radnor Friends Meeting House
Conestoga and Sproul Roads, Radnor, PA

The site has been used as a worship place since 1693. The present Welsh Tract Friends Meeting House was constructed in 1718 and was used as a hospital and piquet post by the Continental Army during the Revolutionary War. The Village of Ithan emerged around the site of this Meeting House. By 1848, the Village consisted of at least five structures that included the Meeting House and a Friend's school. The Village grew to 10 structures, including the Sorrell Horse Hotel, in 1875.

Radnor United Methodist Church
930 Conestoga Road, Rosemont, PA
610-525-9588

The Church and its cemetery were founded in 1780. The original log church building was replaced in 1833 with a stone structure. It is the oldest Methodist Church in Delaware County and is designated as United Methodist Church Historical site #95. Its interior features the original 1833 seats, as well as historical display cases. Several Methodist Bishops have visited the church over the years.

Easttown Township

Waynesborough
2049 Waynesborough Road, Paoli, PA
(610) 647-1779
www.madanthonywayne.org

Though situated *just* outside of the Darby Creek Watershed, the Waynesborough 1745 House is an important piece of history within Easttown Township, and the Darby Creek Watershed as well. Built by Captain Isaac Wayne in 1745, his son General Anthony Wayne inherited the house in 1774. Additions to the original stone cottage were made in 1765, 1810, and 1902. Currently Easttown Township owns Historic Waynesborough and the Philadelphia Society for the Preservation of Landmarks administers the house museum, which is available for tours, weddings, and parties. See Figure VI-45.

D. ARCHAEOLOGICAL RESOURCES IN THE DARBY CREEK WATERSHED

The Darby Creek Watershed is predominantly located in the Upland section of the Piedmont Province of southeastern Pennsylvania. The Piedmont separates the Appalachian Mountains from the Atlantic Coastal Plain. This area is dominated by the presence of granite gneiss. The aboriginal land provided a source of quartz, quartzite, and possibly steatite (soapstone), and jasper. The Pleistocene (15000 BP) climate of the area was likely to have encouraged a forest of spruce intermingled with dwarf birch. As the climate became warmer, fir, pine, and alder joined the forest growth. By 8000 BP, hemlock and chestnut had appeared.

Although evidence suggests that the Amerindian populations relating to the Paleo-Indian Period (15000 BC – 6500 BC) and the Archaic Period (6500 BC to 3000 BC) existed within Delaware County, archaeological investigations have not produced any similar evidence within the Watershed area. During the Late Woodland period (1000 BC to 1600 AD), prior to European settlement, the Amerindian populations, like the Lenni Lenape who settled the Watershed area, had cleared the forests for fuel, lumber, and agricultural purposes, thus beginning the destruction of the existing biotic community. Similarly, the existing animal life including the elk, deer, bear, wolf, fox, rabbit, hare, beaver, turkey, partridge, and other fowl were being exploited; however, their habitats were substantially destroyed by the European settlement, causing severe depletion. It was the settlements along the waterways, like Darby Creek, that increased the quantity of resources that could be exploited. These waterways supplied transportation, which in turn facilitated trade. Also serving the Lenape's agricultural and trade needs, the floodplains within the Watershed area offered fertile fields for the production of crops including maize, beans, squash, and pumpkins.

Following the Late Woodland period, the Contact Period (1600 AD to 1720 AD) marks the period of European contact, which appears in archaeological investigations as an intrusion of European artifacts into the Native American artifacts. The Europeans interacted with the Native American Indians, such as the Lenape, through trade and/or hostilities. As a result, the contact between these two different cultures ultimately led to the disintegration of the Lenape culture.

Delaware County Archaeological Resource Inventory and Management Plan

The Delaware County Archaeological Resource Inventory and Management Plan, completed in 1991, provides the County planning commission with township-based archaeological resource information in the form of Mylar map overlays and a computer database. The inventory – certainly outdated with recent increasing development – classifies endangered and sensitive areas that warrant further investigation, while keeping the location of potential and undisturbed sites confidential to protect them from thieves and pillaging. For this reason, archaeological resources in the Darby Creek Watershed are not mapped in this River Conservation Plan, though interested parties should contact the Delaware County Planning Commission for further discussion.

The majority of executed archaeological investigations in Delaware County have resulted in no data, lost data, or insufficient data that led to an inaccurate study of archaeological resources in the region. Much of the work was executed during the 1970's when archaeological standards were much lower. Fortunately, recent investigations are clarifying some areas of the archaeological resources in Delaware County. Those investigations pertaining to the Watershed area include the Printzhof and Morton Homestead sites.

In Marple and Newton, there are a total of three known prehistoric sites. The remaining municipalities either do not show signs of prehistoric settlements, or not enough investigations have taken place to provide an accurate account of prehistoric settlements. The two sites documented in Marple Township were both found on Langford Run in the late 1940's, one dating to the Late Woodland period and the other from the Contact period. Stone, bone, and ceramic artifacts were excavated from these Lenape Rock Shelters. The Contact Period site contained a burial ground.

As with existing historical sites, unidentified prehistoric sites are continuing to be lost and/or destroyed within the vast housing developments and unmanaged open space within the Watershed. Given the extent of existing development, this loss already has been extensive. Without the local protection of the resources which remain, the story of the prehistoric development of Darby Creek and Watershed area will be lost or permanently destroyed. Archaeological investigations should take precedence over subdivision and land development. Further archaeological investigations of the Watershed area will need to be executed especially around rock shelters or possible quarry sites. It should be noted that those areas with extensive disturbance already present, existing wetlands, and areas with slopes of greater than 15 percent are believed to have no potential, or very low potential of containing prehistoric archaeological sites.

E. ISSUES AND OPPORTUNITIES

The Darby Creek Watershed tells the story of how its natural resources continually attracted development, beginning with its first Swedish settlements. In this sense Darby is somewhat different from other watershed park and recreational areas, such as Philadelphia's Fairmount Park which focuses mostly on its Colonial community landscape. The Darby Creek story continues with the channeling of the Creek's power for the development of production mills, needed for the growth and the survival of the emerging nation, and later trade. This era was followed by the mills' demise, as the era of improved power efficiency opportunities in surrounding areas emerged. In parallel, were those who attempted to exploit the Watershed's natural beauty with the development of grand estates, especially in the upper portions of the Watershed. As more and more people gained access to the area with the construction of new roads and rail systems, middle class housing developments proliferated throughout the Watershed, devouring much of its natural beauty.

Presently, a large number of sites, specifically a cluster of historic mill sites (some including the mill owners' estates and/or the mill workers' tenements), surround the Creek within Upper Darby and Darby Townships, mostly between the area of Garrett Road and McDade Boulevard. A few of the established parks in this area are linked by informal trails that are not reliably detailed on maps, lack interpretation signage, and lack directions indicating parking and distances between historic structures and/or sites. Although Upper Darby and Darby Townships are rich with preserved historical sites and structures, there are many scattered sites and structures throughout the remaining municipalities of the Darby Creek Watershed area, immediately adjacent to stream valleys and beyond. Many of these sites, like the Bonsall House in Upper Darby and Lewis House in Springfield are privately owned; although they remain unprotected, they could become important additions to future conservation plans in the Watershed.

Many of these numerous sites go unrecognized, "lost" amidst vast housing developments or other development or unmanaged open space. Not only are these individual sites historically important, but as a group, these sites could tell the story of the historical development of the Darby Creek

Watershed, a story important to the nation, if they were properly linked. This linking can happen in several ways. A program (system) of interpretive signage throughout the Watershed could offer a comprehensive story about the settlement and growth of the Watershed area. With such a interpretive system, those visiting sites as a destination both from afar and from nearby would be welcomed and guided, in most cases pleasantly surprised to realize that their history lesson had just begun. The interpretive system could demonstrate how other historic Watershed sites and structures are accessible via walking/biking/hiking/driving along an historical story route, eventually evolving into a program like that of Boston's urban Liberty Trail.

This linking of historical sites and structures could increase the knowledge of and visitation of isolated sites and thus increase possible donations for the upkeep and maintenance of many of these nonprofit-owned sites. This linking could also lead to increased volunteer support of one or many sites. Although some of the isolated sites located at the northern end of the Watershed such as in Radnor Township may be interrupted from a continuous public right-of-way along the Creek due to privately owned land along the Creek, these sites could be linked with signage along an off-creek trail and thus continue the interconnected history story of the Watershed area. Not only would these connected sites and structures explain the history of the Watershed, but they would also help preserve the future of the Watershed. Where possible, a formal link via a proposed trail could prevent further development of this overdeveloped landscape, increasing the conservation awareness of those living in and outside of the area of the Watershed. In this way, support for the conservation of the Watershed from those not even aware of its existence should increase over time.

Valuable resources, historical and other, will not be saved and preserved unless they are first recognized. Awareness is key. With a system of interpretive signage linking the numerous sites and structures in the Watershed, Watershed visitors, both children and adults, would be able to experience a complete interactive history lesson focusing on this remarkable Watershed.

Municipal Actions for Better Inventorying and Analysis of Cultural Resources
In addition to the visions set forth above, municipalities have available to them a number of different tools which they should be using in the Watershed to better identify and manage cultural resources. Although selected Watershed municipalities and counties to some extent have inventoried and evaluated their cultural resources to date, there remains a substantial amount of work to do to more carefully document the resources that remain.

Historic Resource Surveys
The good news is that the Watershed is rich in history, notwithstanding the fact that a tremendous amount of development has already eliminated many of these historical values. The bad news is that many values remain undocumented or poorly documented. The first step for most municipalities is to develop better inventories of historic resources; in some cases, there are existing databases already compiled, sometimes residing in the Delaware County Planning Department's individual municipal files, sometimes in the municipal offices themselves. These

existing listings should be reviewed and organized, through preparation of a Historic Resources Survey, including both standing structures as well as archaeological resources. The Survey should be as comprehensive and complete as possible and include: resource descriptions (both written and photographic property descriptions, with a narrative or feature checklist describing the structure from the front façade, circling the structure and addressing major features such as style/period, building materials, building size and shape, roof material and shape with dormers, chimneys, cornices, other decorative features discussed, window treatment, porches/patios, doors and entrances, auxiliary buildings with an adequate photographic record of total facades plus individual details being documented); resource documentation (including written research from local histories, records of local historical societies, oral histories, paintings/etchings, old maps, legal records, interviews with existing and past owners); and archaeological data. Substantial guidance is available through the Brandywine Conservancy, through the Pennsylvania Historical and Museum Commission, through the Delaware County Planning Department, through the US Department of the Interior's *Guidelines for Local Surveys,* and other sources. The Pennsylvania Historical and Museum Commission maintains a program of matching grants, available to assist municipalities in this inventorying and evaluation effort (see discussion below).

Surveys require work. A municipality with substantial resources may choose to hire professionals to prepare its Survey. On the other hand, a large budget is not necessary if local labor is volunteered. A subcommittee including interested members of the municipal planning Commission, other interested officials and citizens committed to historical resource protection can be formed to undertake the Survey, including the necessary reviews of structures and sites I order to evaluate what is worthy of recognition and protection. The evaluative phase of the Survey process can be reinforced with professional consulting talent to the extent that this is possible.

Ultimately, the goal is often to list historic resources in the Survey on the National Register of Historic Places, created by the National Historic Preservation Act of 1966, administered cooperatively by the US Department of the Interior and the respective State Historic Preservation Offices. The process required to be listed on the National Register or deemed Eligible for Listing on the National Register guarantees that the historical resource is of value to the nation, state, or local community; that it will be considered when planning any federally-assisted or federally permitted project or action; that it will be eligible for various federal tax benefits and for other federal assistance when these programs are available. As with all historic resources, types of resources may include individual buildings, historic districts, sites, other structures (canals, bridges, etc.), objects (statues, fountains, monuments, etc.), and multiple "thematic resources" related to an historical person or event or development type and so forth. There are about 3,000 registered sites in Pennsylvania which is one of the top states in the nation for listings. It is important to note that although the overall significance of gaining National Register status can be great, many Register structures have been destroyed. Register status in no way guarantees protection. Private owners, and most Register structures are privately owned, are free to alter, even demolish their structures unless municipal regulation exists or unless some federal action or authority is involved.

Historic Resources Ordinances

In terms of regulation, the State adopted the Historical Architectural Review Act (Act 167 of 1961 as amended) which authorizes municipalities "…to create historic districts within their geographic boundaries; providing for the appointment of Boards of Historical Architectural Review: empowering governing bodies…to protect the distinctive historical character of these districts and to regulate the erection, reconstruction, alteration, restoration, demolition or razing of buildings within the historic districts." The Pennsylvania Historical and Museum Commission must certify the historical significance of each historical district designated by a municipality after an ordinance has been put in place. A Board of Historical Architectural Review (five members, including a registered architect, a licensed real estate broker, a building inspector, and two people with interests in historic preservation) must be appointed to advise the governing body. The governing body then has the power to "…certify the appropriateness of the erection, reconstruction, alteration, restoration, demolition or razing of any building, in whole or in part, within the historic district…and shall consider the effect which the proposed change will have upon the general historic and architectural nature of the district."

The Municipalities Planning Code also authorizes municipalities to enact zoning ordinances which take into account cultural resources. Historic preservation standards to accomplish these objectives are authorized. An historic resources overlay may be included as an overlay in the zoning ordinance. This overlay may divide historic resources into classes: Class I (resources already on the National Register or Eligible); Class II (resources important historically but which have been already altered); Class III (a broad class often just relating to age, such as anything over 100 years in age). Special ordinance provisions applying to this overlay may include demolition permits, delay of demolition, area and bulk waivers, special buffering requirements, expanded use opportunities and other special provisions. The municipality may establish a Municipal Historical Commission through this ordinance (in contrast to the HARB) to act in concert with its ordinance requirements and act to support its overall historic resource protection program. This Commission, appointed by the governing body, can act as a planning, advisory, and review body for both the local planning commission and governing body for all historic resource issues (beyond any Act 167 jurisdiction, if any). The Commission can manage all Survey work and oversee all ordinance development and actions related to such ordinances (e.g., reviewing all building and demolition permit applications which have the potential to threaten the municipality's historic resources). The Commission can process Act 167 districting and HARB formation and can oversee National Register nominations and other historic preservation-related activities, such as grant applications. Commissions may rely heavily on a wide variety of published resources to accomplish their work, such as the US Department of the Interior's *Standards for Rehabilitation* and *Guidelines for Rehabilitating Historic Buildings*.

There exists in the Watershed some good examples of municipal ordinances in the area of historic resource management. For example, Lower Merion Township has one of the most rigorous and advanced programs in the Southeastern Pennsylvania Region (if not the State), where a Historic Resource Overlay District is created in the zoning ordinance, based on a Historic Resource

Inventory that identifies Class I and II Historic Resources. Both a Historical Commission and a Board of Historical Architectural Review are created to administer the overall protection program, pursuant to State law requirements. A Historic Resource Impact Study is also established with content and application defined; impacts and mitigation measures are set forth in the ordinance.

Haverford Township also has an historic resources ordinance (Article IV in the Subdivision/Land Development Ordinance) which is considerably more "low profile" in nature. Though not as inclusive and comprehensive as that of Lower Merion, this ordinance allows the Township through the land development process to identify resource values through a set of explicit criteria and then requires the Township to apply specific standards for action. Most of these standards for action provide guidance for the development process, but are nevertheless flexible; however one specific provision ("The distinguishing original qualities or character of a building, structure or site and its environment shall not be destroyed.") is quite explicit. The point is that although municipal ordinances should be as rigorous as possible, there are many variations on the regulatory theme. Municipalities can start small and take "baby steps" as they proceed to better manage their historic resources.

Better Overall Management through Historic Resources Plans
Because there are multiple aspects to historic resource inventorying, evaluation, and management, municipalities in the Watershed should consider unifying all of this work into a local preservation plan, or Historic Resource Protection Plan, which integrates all of elements discussed above. This plan can be viewed as part of a municipality's Comprehensive Plan. Such a Plan establishes the community's general history and the nature and extent of its cultural resources, as well as consensus on the nature and extent of protection to be achieved. The Plan unifies both public sector and private sector initiatives. On the public sector side, the Plan integrates federal, state, county, and local resources. A critical step in this Plan process is the clear identification of goals, more explicit objectives related to these goals, and finally the implementing actions needed to make the Plan a reality. This framework provides essential guidance and structure as the many different challenges are confronted and surmounted.

Grants and Other Resources Available
Although volunteer support for cultural resources programming on the local level is tremendously important, money—grants—helps, too. There are a surprising number of programs which exist and which may be relevant to a Watershed municipality's program. For example, on the broadest of levels (federal or national;), the National Historic Preservation Fund has been created and it funds the Certified Local Government Program, all under the US Department of the Interior, National Park Service. This source is best accessed via the PHMC. The federal government also has a program of Technical Preservation Assistance, as well as the Archaeological Assistance Program. The Community Development Block Grant program also can be used for cultural resource programming. The National Trust for Historic Preservation has a Grant Program as well as a National Preservation Loan Fund, and there are a variety of private programs (Inner-City

Ventures Fund, Critical Issues Fund, Preservation Services Fund, Preservation Pennsylvania) and private foundations (Pew Charitable Trust, William Penn Foundation, Stockton Rush Bartol Foundation), all of which have supported cultural resources programming. In sum, it is never easy to get grants, but the programs do exist. Advice can be obtained locally, especially at county planning departments and commissions, and then at the Pennsylvania Historical and Museum Commission. The Brandywine Conservancy also has excellent information available; refer to their *Environmental Management Handbook*.

VII.
Goals & Recommended Actions

VII. RIVER CONSERVATION PLAN PRIORITIES: GOALS AND RECOMMENDED ACTIONS

A. RIVER CONSERVATION PLAN PRIORITIES: WATERSHED GOALS

During the course of the RCP planning process, considerable effort has been directed toward the development and refinement of Watershed goals. These goals establish the priorities for RCP-related actions now and in the future. Goals have been drafted by the Watershed Study Committee (Municipal and Non-Municipal) with the help of the RCP consultants and the DCVA and reviewed on multiple occasions, both at public meetings as well as with the Study Committee (Municipal and Non-Municipal). The revised goals appear in Table VII-1. These goals have emerged after a variety of public meetings where stakeholders were asked to identify both the Watershed's problems and opportunities (see Appendix A).

Goals in Table VII-1 are quite general, overarching, and extremely ambitious. The goals reflect the issues that are so prominent in the Watershed and the extent of impact that land development has had over the years in the Darby Creek Watershed. Clearly, accomplishing these goals will require concerted effort over many years. An important aspect of this listing of goals is that a

Figure VII-1 Existing Riparian Area along Darby Creek in the Upper Darby Area Greenway.

Table VII-1 Revised Goals for the River Conservation Plan

GOALS FOR DARBY CREEK WATERSHED RIVER CONSERVATION PLAN

A. Restore Stream and Tributary Corridors, Provide Riparian Buffers, and Protect and Restore Wetlands.

B. Restore Floodplain Where Feasible – Remove fill and abandoned structures. Prevent future filling and encroachment.

C. Improve Stormwater Management – Manage Quantity and Quality for both new development and re-development.

D. Improve Development Patterns, Including Re-Development Practices, to Protect and/or Restore Stream Corridors, Maintain Open Space, and Protect Ecological Resources.

E. Increase Open Space and Recreation Opportunities – Restore access to the stream corridors. Protect existing open space and create new open space.

F. Identify and Protect Historic, Cultural, and Ecological Resources.

G. Foster Intermunicipal Cooperation and Involvement – Coordinate efforts to encourage municipal interaction and planning on a watershed basis. Coordinate with and support the on-going efforts of the Darby-Cobbs Watershed Partnership and its members. Encourage watershed-based planning.

H. Educate – Educate residents, municipal officials, teachers and others, and increase awareness of the stream, the watershed, and its resources and problems.

I. Improve Management of Land Activities that Affect Water Quality – Fertilizer and lawn maintenance, animal waste, and hazardous waste degrade water quality and create non-point source pollution.

J. Identify both long-term and short-term projects and "action items" to meet these goals.

major focus of action in the future obviously must be the municipality, although there are many actions to be taken by county, state, and federal agencies, as well as citizen stakeholders, businesses, DCVA/other watershed organizations, other nonprofit public interest groups, utilities and authorities, politicians on all levels, and schools. Municipal action is key. From floodplains and riparian buffers to wetlands to stormwater management to development patterns to open space and recreation, the critical actor is the municipality—all 31 of them!

At the same time, actions must be taken by more than just the municipalities if the goals of the RCP are to be achieved. Vital roles are identified here for citizen stakeholders, businesses, DCVA/other watershed organizations, other nonprofit public interest groups, utilities and authorities, and schools—all of whom must work together closely, from one end of the Watershed to the other. Citizen stakeholders need to advocate and support the long list of actions needed on the municipal level; this work will never be accomplished unless strong citizen support emerges to "encourage" local officials to take the necessary actions. Support from the business community is critical, so that municipal decision makers become aware that the Watershed program is also an economic renewal program as well. Enhanced recreational facilities, improved water quality, restored stream systems—all of these goals have been demonstrated to have positive economic effects on the total community. Support from politicians on a variety of levels, from federal to local, will be essential if many of the high cost programs are to be implemented (such as the remediation of leaking sewer lines).

Working together is something that hasn't happened in the past and will not be easy to make happen now and in the future. Substantial socioeconomic and cultural differences have been hindrances. As documented in this RCP, for all of its commonality, this is also a Watershed of stark differences. Perhaps the compelling vision of this Watershed and its future health will engender the unity that is so crucial now. In most cases, the Darby Creek has not been uppermost in the minds of most Watershed citizens, except when floodwaters have created crisis. That must be changed.

Figure VII-2 Flooding in the Lower Watershed continues to be a serious problem.

B. RIVER CONSERVATION PLAN PRIORITIES: A GOAL-BASED ACTION PLAN

A goal-based action plan, derived from the goals developed for this RCP, has been developed below. As these goals are identified, generic program actions are identified. These are the actions essential to achieve Watershed goals. Although the resulting list is lengthy, it is quite possible that additional program actions can and will be identified as more thinking and imagination is given to solving these Watershed problems.

Some work has already started. Some progress is already being made. Specific actions and projects are also listed at the end of each goal discussion. This listing includes all projects which have occurred in the recent past, all active Watershed projects, including both PADEP's Growing Greener program and PADCNR projects which have been funded, as well as projects of merit which have been identified (and in some cases submitted to either PADEP or PADCNR in the past) and may be pending.

Some of these projects are especially notable and really relate to multiple Watershed goals, such as DCVA's (via Dr. John Furth) Upper Darby Area Greenway (mostly in Upper Darby Township, but also extending into the Boroughs of Clifton Heights, Aldan, Lansdowne, Darby, and Yeadon). This Upper Darby Area Greenway (Figure VII-3) project builds on a previous plan developed by the Delaware County Planning Department some years ago but never implemented (The Darby Creek Acquisition Project and the more formalized Darby Creek Stream Valley Park Master Plan, 1987). A special feature of the 4.25 mile Greenway plan is the linking together of multiple municipal and County recreational facilities and land holdings (some publicly owned but "undeveloped" at the present time); the large 15-acre creekside Thompson Tract (undeveloped but proposed for an assisted living facility; across Creek from Lansdowne's Hoffman Park) could be connected, as well as the Darby Borough riparian project promoted by DCVA's William Frasch. The Greenway would also connect important historical sites such as the very significant Lower Swedish Cabin in or adjacent to the Darby Creek valley as well. A hiking/nature trail would be included. Some limited rights-of-way and/or acquisition of small parcels would be required. The project would enhance the productivity and level of use of existing recreational facilities being linked, as well as enhance the desirability and livability of the neighborhoods being served. The proposed passive recreational facilities would have immediate benefits to the many residents being served in this very high density zone and would not require driving for access, given the excellent public transportation facilities serving the area. Although the Upper Darby Area Greenway is listed below under the Recreation/Open Space Goal E (more details are provided below), it is important to many of the other Watershed goals as well. Again, the project is the "poster child" for this RCP, simultaneously achieving multiple RCP goals.

Another ambitious linkage with tremendous greenway potential is located on the Cobbs Creek, extending from the Cobbs Creek Environmental Center in Philadelphia upstream to Haverford College several miles to the northwest (Figure VII-4; these end points are not absolute; in fact the Cobbs Creek Park extends farther downstream, connecting to the large Mount Moriah Cemetery complex; as discussed below, there is also very interesting potential to connect the Cobbs Creek to the Darby Creek main-stem through the Merion Golf Club and Haverford State Hospital Site). This segment, the Upper Cobbs Creek Area Greenway, bisects an area of very high residential density and parallels the SEPTA Red Arrow Trolley Line from the City Line and West Overbrook Station to Pennfield, Beechwood-Brookline, Wynnewood Road, Ardmore Junction, Ardmore Avenue, and Haverford SEPTA Stations. City park (Fairmount Park) ownership extends from the Cobbs Creek Environmental Center to City Line (also adjacent to the large Philadelphia Electric County Club at Highland Park in Delaware County). Existing parkland extends upstream in Haverford Township on both sides of the Cobbs Creek, including the very significant and very historic Grange Estate complex. Though not dedicated parkland, Karakung Drive then parallels the Creek and the SEPTA rail facility, extending almost to

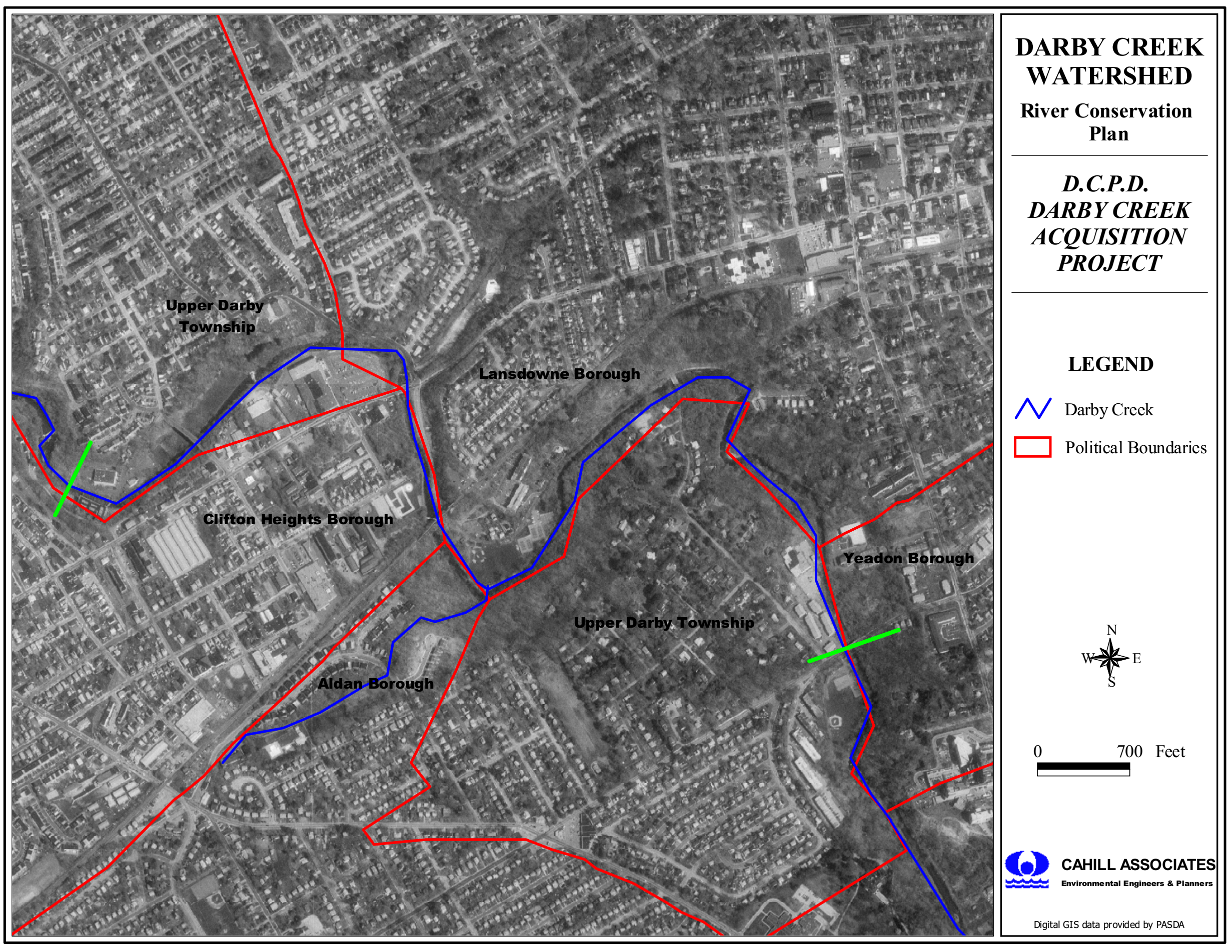

Figure VII-3 Upper Darby Creek Area Greenway (draft)

Wynnewood Road and presenting very real greenway potential. Special accommodations would have to be made in the next half-mile portion of the corridor due to encroachment of residential development, but then the corridor opens into the Merion Golf Course on the west and then to Haverford College on the east. The College already offers a lengthy nature trail around the perimeter of its large campus with public access; this facility would provide a wonderful greenway anchor and overall destination for the Upper Cobbs Creek Area Greenway. Extending into the Philadelphia portion of the Greenway, the Cobbs Creek Master Plan (see description in Section VI) includes a variety of projects which would reinforce and build on this Greenway concept, linking to major existing facilities such as the Cobbs Creek Golf Course, the Karakung Golf Course, Morris Park, and many other adjacent uses and facilities.

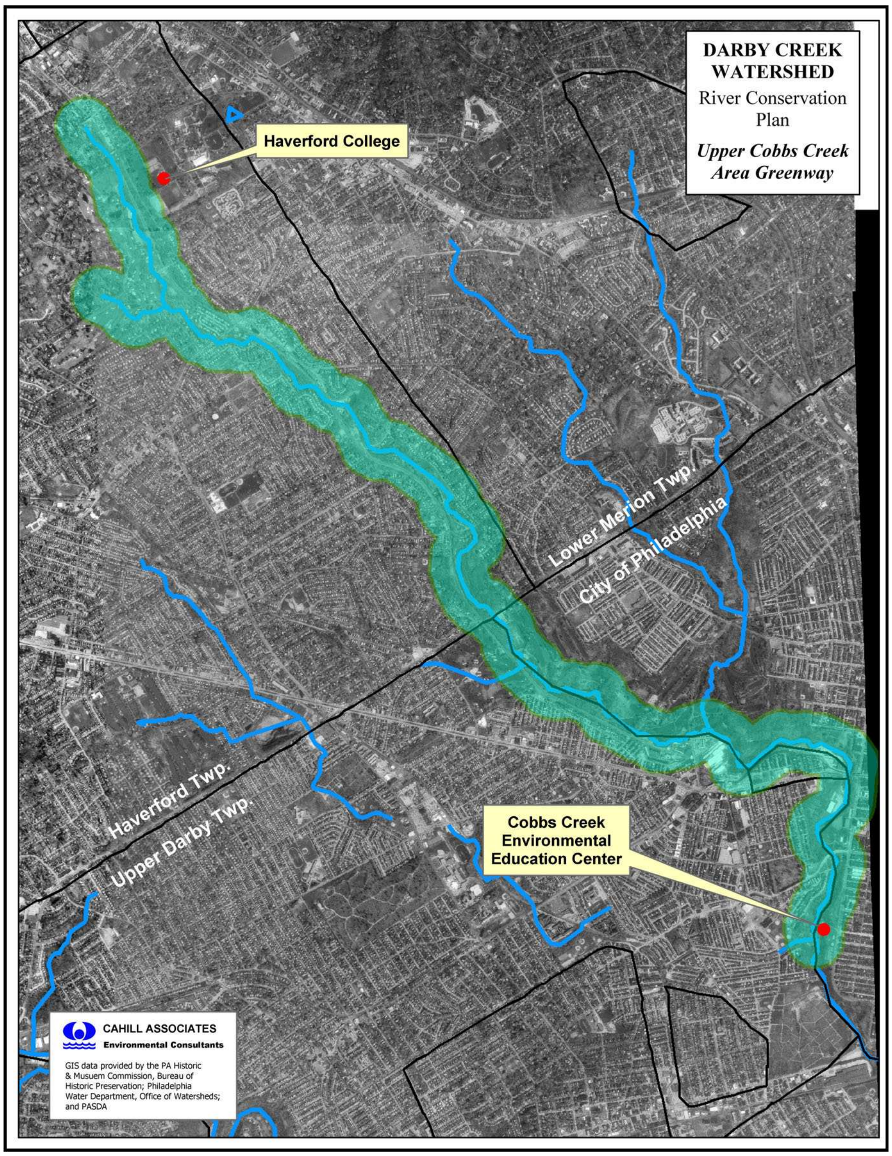

Figure VII-4 Upper Cobbs Creek Area Greenway

Another example of a zone of special greenway potential is much more limited and contained in scope and is located on the Muckinipattis Creek (the Muckinipattis/Glenolden Area Greenway; Figure VI-5). If developed, this greenway would link two Glenolden municipal park complexes (Glenolden Municipal Park/Glenolden Park with park headquarters, tennis courts, and other facilities as well as an unnamed open space/park facility upstream bisected by Hibbs Avenue and the Creek) with adjacent institutional uses (the Community Bible Church and Glenolden Elementary School) and the historic Glenolden Library (an architecturally important 1939 structure which has undergone several renovations/modernizations and is now part of the Delaware County Library System). In so doing the recreational use and value of these existing facilities could be significantly increased, with relatively little additional work. Ultimately, these

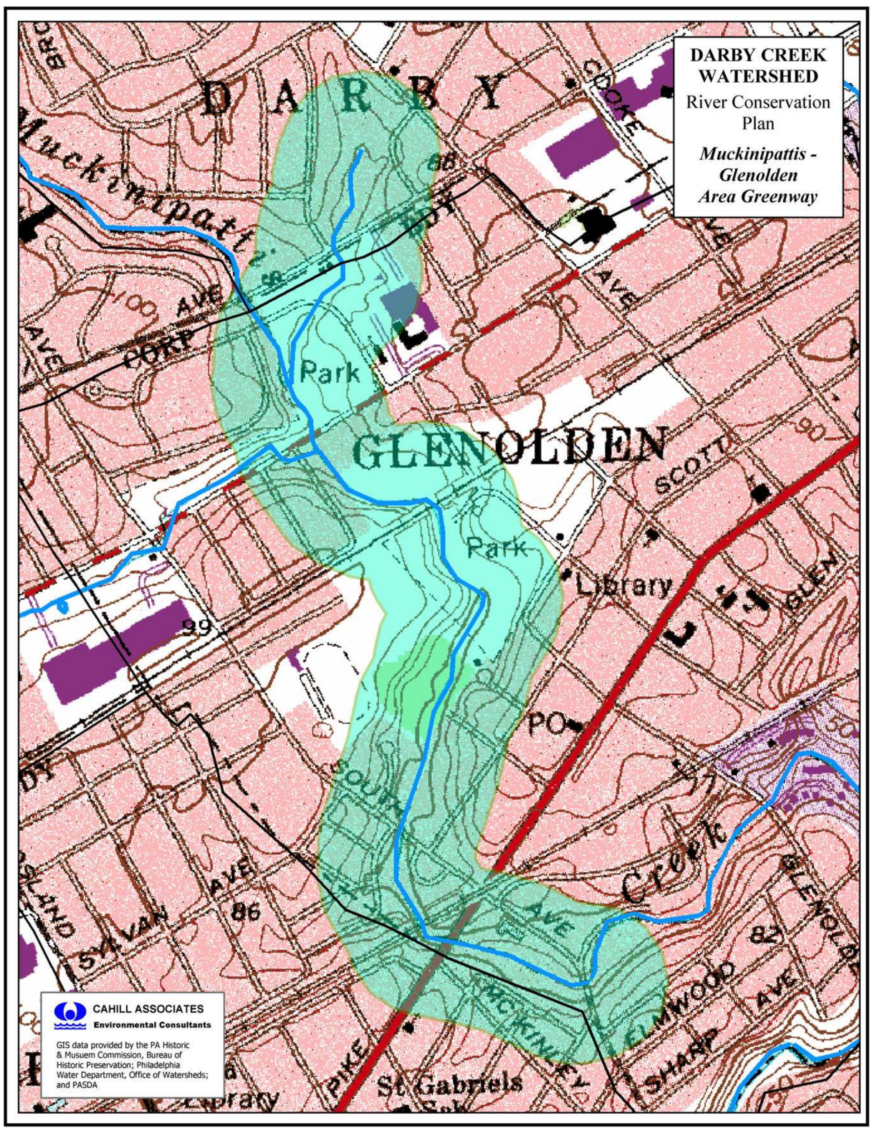

Figure VII-5 Muckinipattis / Glenolden Area Greenway enhanced facilities, with revitalization of facilities such as the library, can reasonably be expected to translate into a community anchor, providing economic stimulation for the broader Glenolden community and positively affecting adjacent land values, both residential and commercial.

Other Darby Creek-related projects are being considered and proposed in other communities. In Radnor Township, for example, the Township's existing open space plan already has identified Creek-related projects (also including important tributaries of the Darby Creek); a trail system is under consideration as well. The Township is in the midst of a new comprehensive plan preparation process and will be looking to expand these opportunities, hopefully building on the goals established in this RCP and the actions being recommended. The planning process also includes intensified efforts at cultural resource inventorying, evaluation, and management, consistent with the recommendations in this RCP. In Springfield Township, a variety of initiatives are being taken to remedy existing stormwater problems, exacerbated by the total burying of several sections of the stream system; in terms of land development, citizens united to argue for better, more environmentally sensitive land development concepts during the recent Coventry Woods development meetings. In Haverford Township, the re-use of the keystone Haverford State Hospital site (Figure VII-6), certainly the largest development (or re-development) site in the Watershed epitomizes virtually every issue discussed in this RCP. This RCP argues strongly for conservation-oriented planning concepts at this remaining ecological "island" in the Watershed.

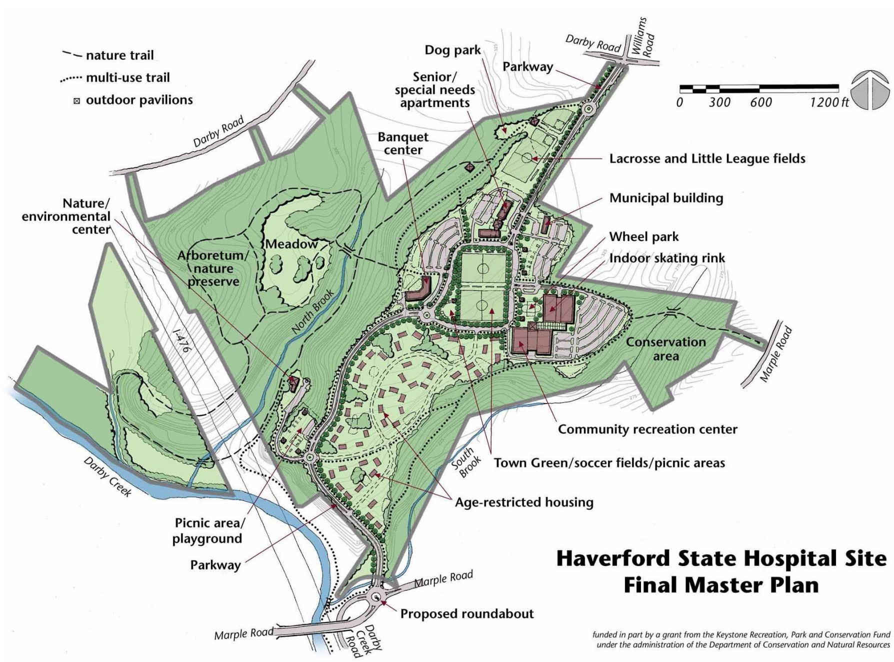

Figure VII-6 Haverford Hospital Master Plan (http://www.pahouse.com/vitali/haverford/)

One step at a time, it is possible to imagine each community or even groupings of communities coming together and establishing localized greenway systems. In time, as these more focused projects emerge, DCVA's ultimate vision of a total Darby Creek Greenway, as discussed in the next section, will then come to fruition.

Of course, major program efforts such as the Act 167 Stormwater Management Plan will be continuing months after this RCP is completed; elements of this effort will both directly and indirectly relate to RCP goals. In the case of the 167, model stormwater management ordinances will be drafted and must be adopted by the respective municipalities, for example. Other specific projects may also "spin off" from this 167 effort. Obviously, it is critical that the 167 be compatible with the RCP's Goal-Based Action Plan.

Similarly, the Darby-Cobbs Partnership work program, including a host of actions being taken by the Philadelphia Water Department (such as a possible TMDL), will continue. An important element here is the watershed management plan effort, which again hopefully will further reinforce efforts to implement the RCP's Goal-Based Action Plan.

We should also note that this RCP effort with its recommendations builds on a very important planning effort undertaken throughout Delaware County several years ago, the Delaware County Open Space Project. In fact, many of the specific goals, actions, and projects envisioned as part of this Darby Creek RCP are borne out of this effort. The Delaware County Open Space Project Recommended Strategy (1996), for example, identified Stream Corridor Acquisition, Protection, and Enhancement Grants and Natural Resource Protection Grants as of the highest priority in their overall recommended $100 million bond program. Unfortunately, this program was never approved.

C. THE DARBY CREEK GREENWAY VISION

In the course of assembling information for this RCP, a variety of resource inventories have been developed; these have been presented and discussed in previous sections. These resource inventories are critical when taken and understood individually, constituting important independent resource elements in the Watershed. But their significance is even greater – and constitutes a kind of synergy here – when these resources are linked and viewed together in a "ribbon of green." This synergy is the core of the Darby Creek Greenway vision. For example, Figures VII-7 through VII-10 recap existing wooded areas in the Watershed, existing wetlands and floodplains in the Watershed, existing recreational facilities and major recreational focal areas in the Watershed, and the most prominent historical/cultural resources in the Watershed (we have acknowledged that in virtually all cases, there are more resources existing than are shown on these maps, due to the limitations of our data sources). Additionally, Figure VII-11 represents a composite of projects, which have specific locations and therefore are mapable, as taken from the ever expanding lists of Specific Projects at the end of this section, presented goal

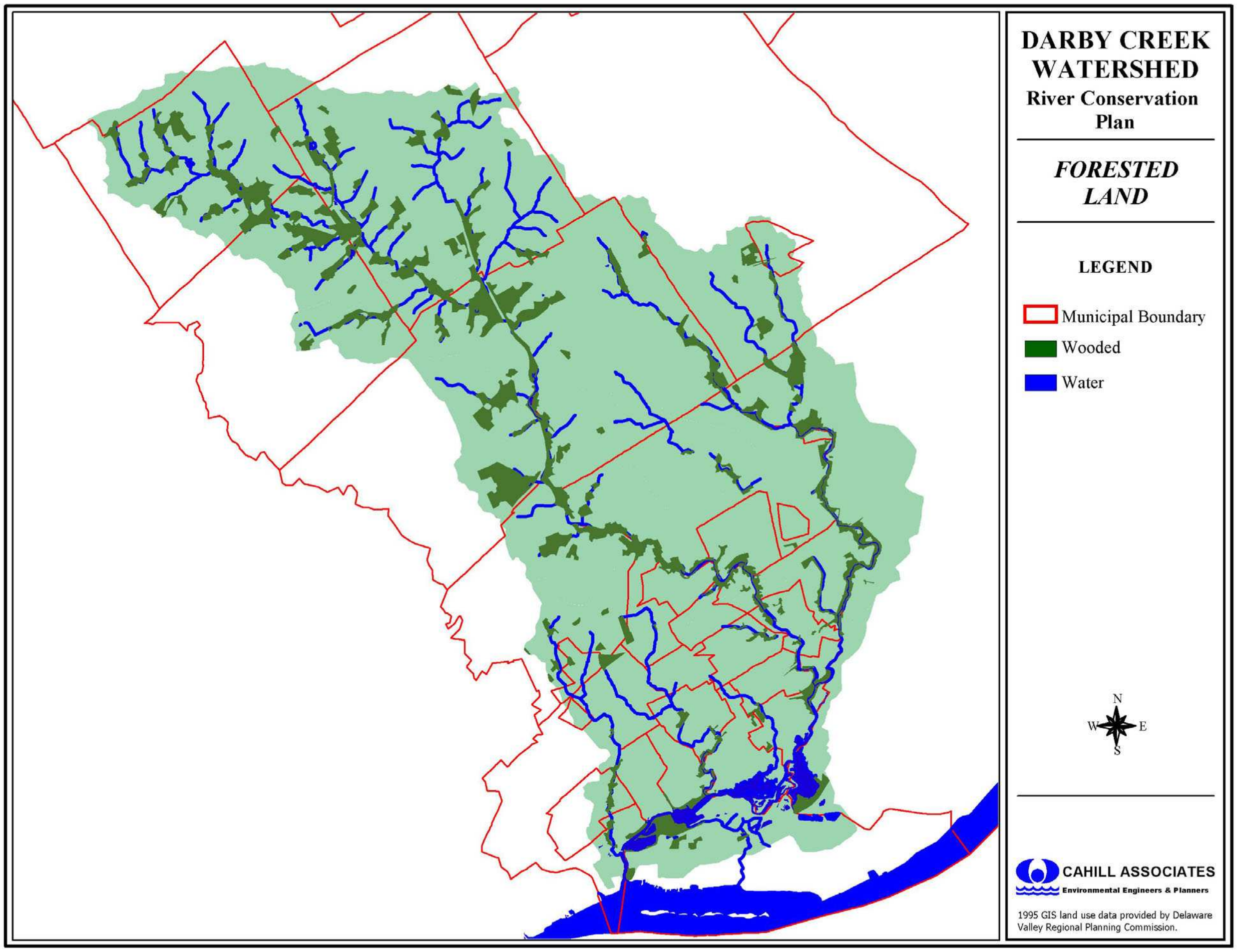

Figure VII-7 Wooded Areas in the Darby Creek Watershed, (DVRPC 1995)

by goal. Some of these projects are completed; some of these projects are approved and funded; some of these projects are still very much in the future tense and are not committed, however, have been given serious thought and attention by a wide variety of project sponsors. In any case, these projects represent levels of interest and levels of commitment already existing by a number of different Watershed municipalities, conservation groups, and other interested stakeholders.

Figure VII-12 represents a composite of these resources. A compelling "ribbon of green" pattern emerges in this Watershed, the vision for the Darby Creek Greenway. The resources together create a critical lineal system of those remaining cultural and ecological resources in this heavily developed-altered-impacted Watershed. The ultimate vision of the Greenway would come to be full implementation of the Goal-Based Action Plan, as set forth below, to the maximum degree, integrating conservation of critical ecological values with the remarkable historical and

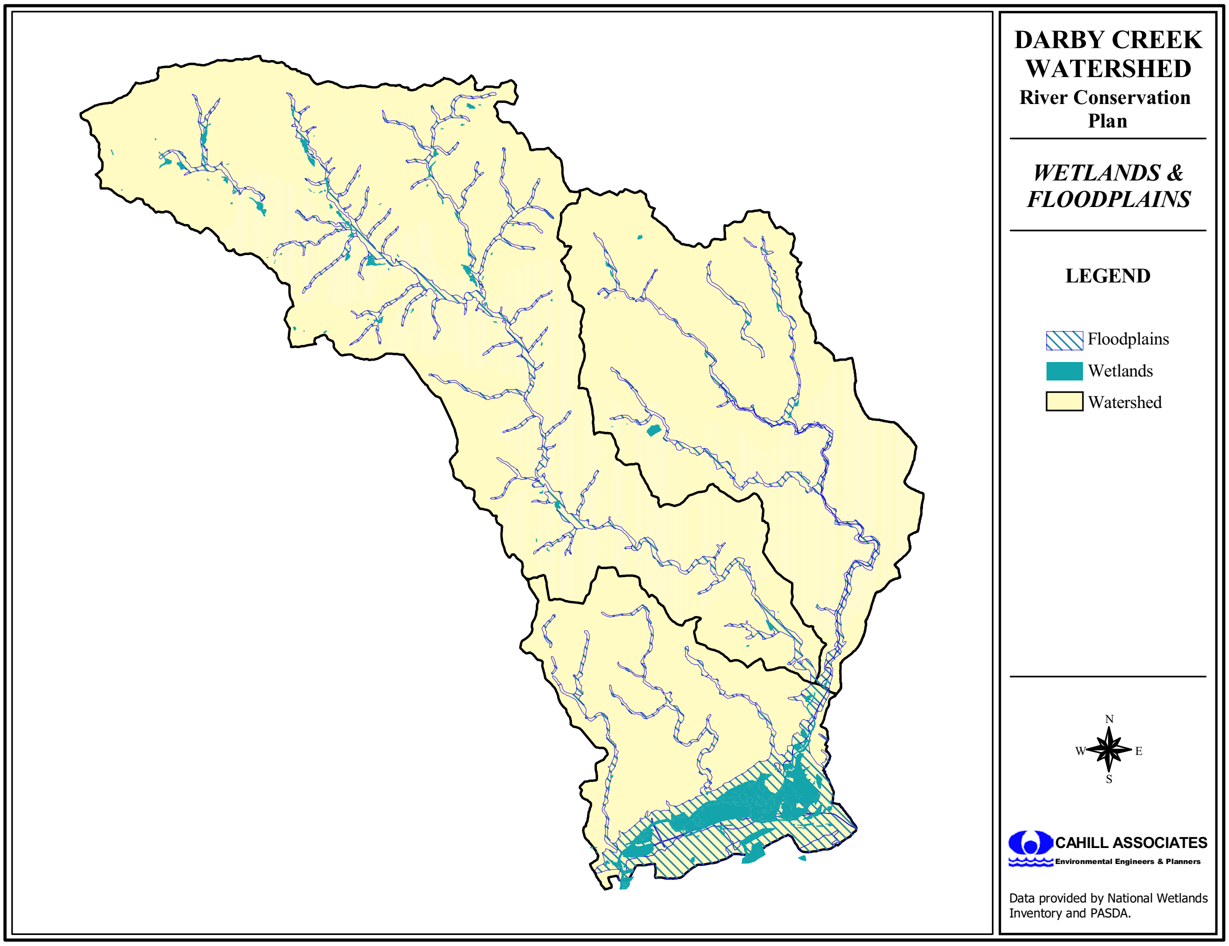

Figure VII-8 Wetlands & Floodplains in the Darby Creek Watershed (NWI, FEMA)

archaeological features present here, all linked through a complex of active and passive recreational elements. The potential user benefits of the Greenway, given the large Watershed populations involved here, would be enormous, especially when understood in the context of the many community needs characterizing so many of the existing municipalities. The potential benefits could even reinforce economic revitalization efforts underway in the Watershed.

The greenway vision offers exciting potential for linkages even within the Watershed. For example, at one point in Haverford Township, the Cobbs Creek and Darby creek main-stem are quite close. In fact their proximity is made the greater by the fact that two "green" and institutional or quasi institutional uses (the very large private Merion Golf Course East and West facilities that serendipitously extend in a largely east-west direction as well as the enormous Haverford State Hospital Site) happen to be strategically located between the Darby and the

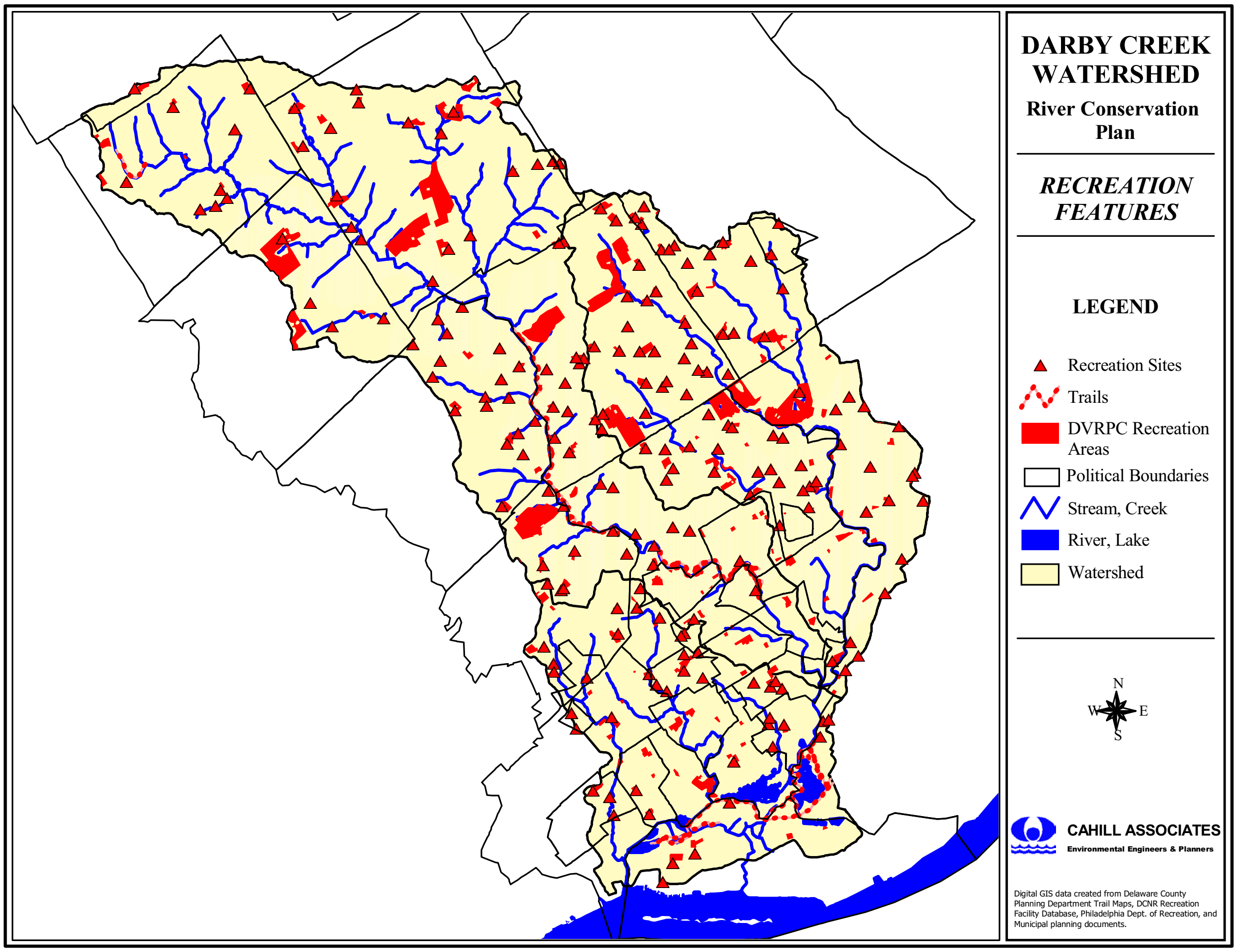

Figure VII-9 Recreation Features in the Darby Creek Watershed (DVRPC 1995, Municipal Documents, var.)

Cobbs in such a way that a potential link of some sort is likely to be possible. Linkage would extend to the large Haverford College site as well. If greenway facilities can be developed along the Darby and along the Cobbs, this connection between the two would increase their importance tremendously.

The greenway vision can even be extended to linkages with neighboring watersheds. For example, similar networks and nodes of potential greenway development exist in the adjacent Crum Creek Watershed, where potential linkages could be made over time. Ultimately, this kind of connection could serve to unite broader regional networks of greenways and provide enhanced recreational functions, as well as opportunities for habitat and other ecological values.

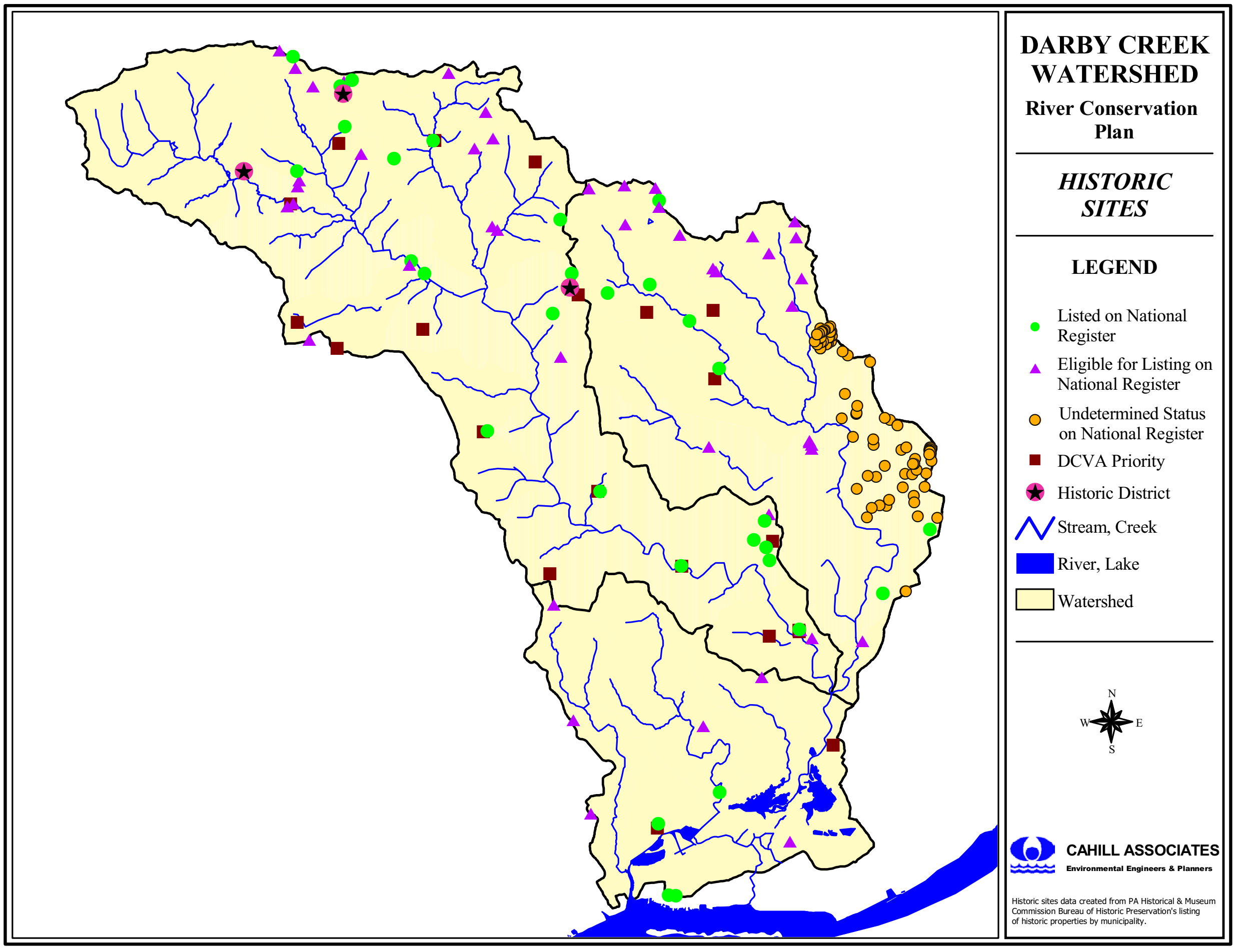

Figure VII-10 Historic Sites in the Darby Creek Watershed (PA H&MC, 2001)

The Darby Creek Greenway Vision is just that—a vision—for the moment. Implementing the concept, some might argue, borders on the utopian and in any case can be expected to be extremely challenging. Nevertheless, this unifying concept can be extremely useful in the shorter term as a guide to step-by-step implementation, as Municipality A puts in place a mile of streambank and riparian zone restoration, as Municipality B develops a walking/biking trail, as Municipality C mounts preservation efforts for valuable historical mills and other floodplain structures, as authorities begin to plan for streamside interceptor sewer reconstruction. Ultimately, the puzzle will begin to fill in and take shape. And the Vision will become real.

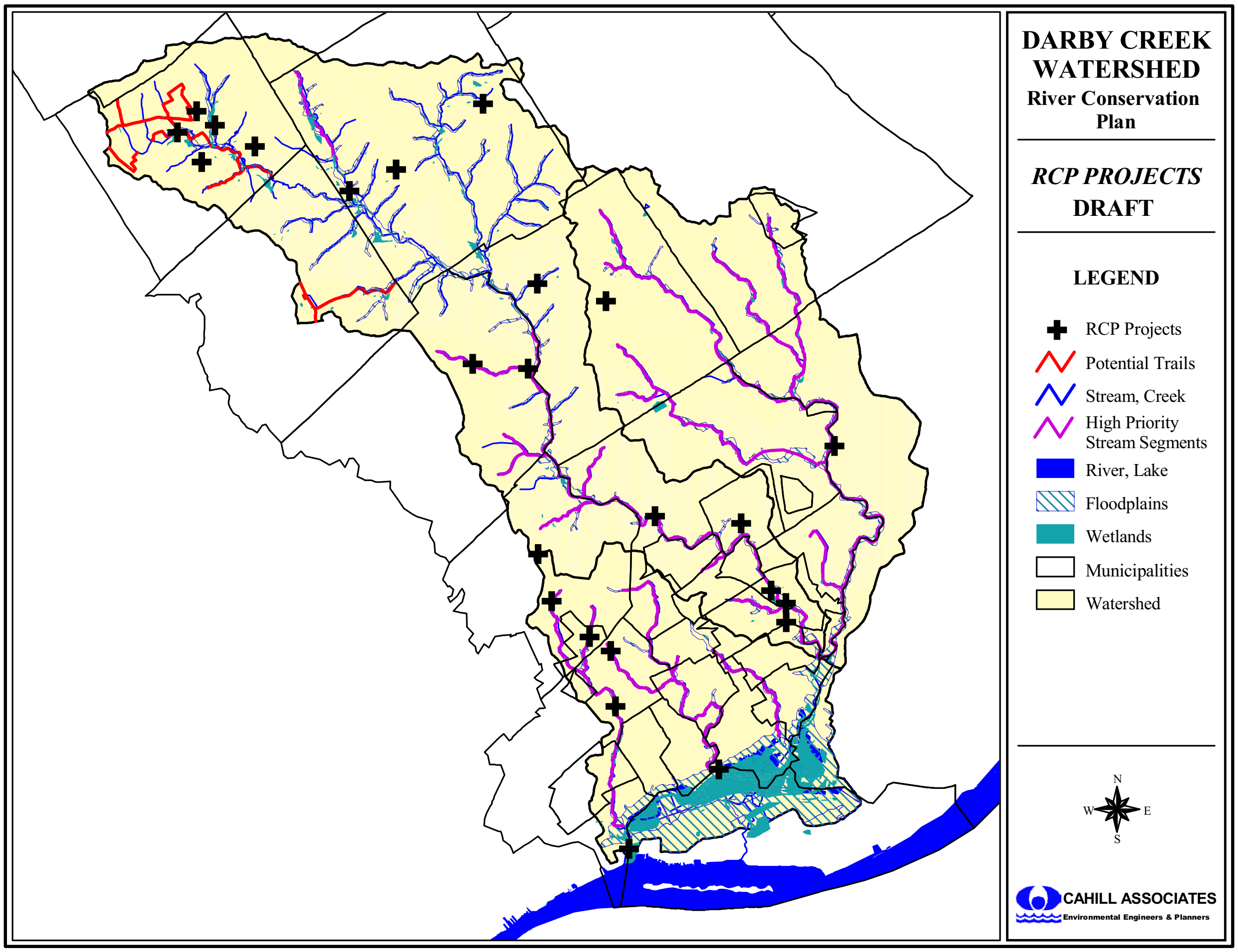

Figure VII-11 River Conservation Plan Project Recommendations (draft)

Figure 7-12 Natural and Cultural Resources Overlay pull-out

Figure 7-12 Natural and Cultural Resources Overlay pull-out

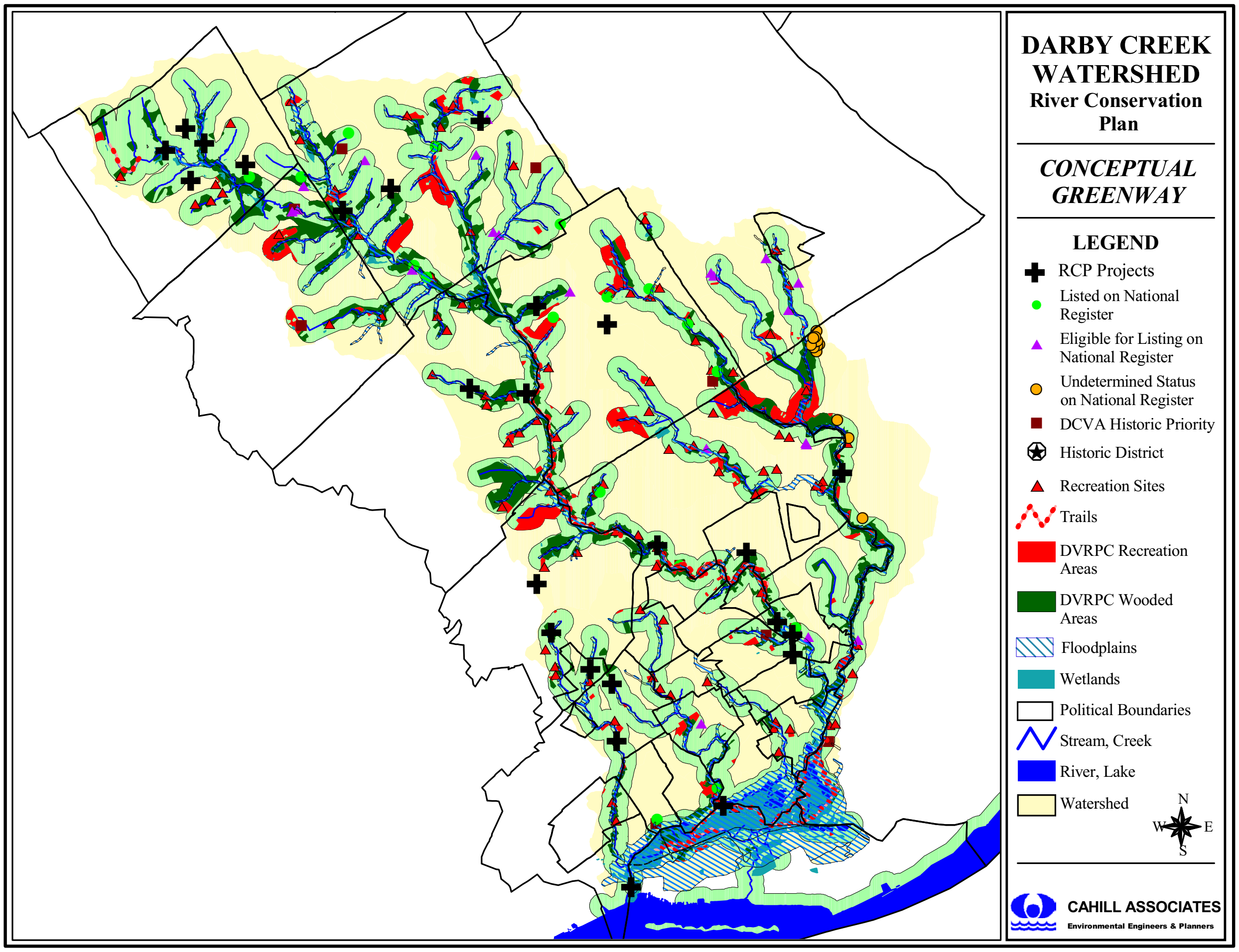

Figure VII-13 Darby Creek Watershed Greenway Analysis Results (see figure i-1 for more detail)

D. THE DRAFT GOAL-BASED ACTION PLAN

In the next section the Goal-Based Action Plan is presented. Goals are most fixed, Program Actions somewhat less so, with Specific Actions most open-ended. During the presentation of the Draft RCP, Program Actions may be modified and added, and certainly Specific Actions hopefully will be substantially expanded as more Watershed stakeholders understand the importance of RCP implementation. Following the Action Plan is a presentation of funding opportunities which can help stakeholders in their project development process.

DRAFT GOAL-BASED ACTION PLAN FOR DARBY CREEK WATERSHED RIVER CONSERVATION PLAN

GOAL A. RESTORE STREAM AND TRIBUTARY CORRIDORS, PROVIDE RIPARIAN BUFFERS, AND PROTECT AND RESTORE WETLANDS

Program Actions
Stream Protection/Restoration

- Municipalities must adopt improved/more rigorous Floodplain, Riparian, Wetlands regulations as described below.
- Based on the stream morphology analysis being conducted as part of the Darby Creek Act 167 Stormwater Management Plan, the Munro report, the Heritage Conservancy, and other appropriate sources, government groups (Delaware County and Chester County Conservation Districts as well as municipal groups) and environmental organizations such as the DCVA should apply for grants and work to identify those most highly impacted stream segments where restoration is of greatest concern (issues include bank stabilization and restoration, canopy restoration, removal of abandoned/dysfunctional bridges and other structures, re-vegetation, etc.).
- Municipal groups and others such as the DCVA should apply for state and other grants to restore high priority stream segments, as identified above; restoration may include a variety of streambank stabilization techniques, re-vegetation andplanting with appropriate native species, and more complex and costly removal of deteriorated instream structures deemed to be harmful to stream and overall Watershed health.
- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should canvass funding/grant sources such as Federal 319 program, Federal USDA-NRCS CRP and other programs, Pennsylvania's Growing Greener, Stream Releaf, the North American Wetlands Conservation Council, and others for application for all projects under Goal A.
- Environmental/watershed groups such as the DCVA must work to educate municipalities, other government groups and Watershed stakeholders regarding the functional

importance of stream corridors, floodplains, riparian buffer zones, and wetlands (all of the targeted elements of Goal A).

- Lead by example: Municipalities/counties/other government agencies should integrate state-of-the-art floodplain, riparian buffer, and wetlands protection and restoration techniques into all of their programs and at all of their facilities (e.g., municipal maintenance crews could immediately start to refrain from mowing to streambanks, allowing taller meadows to emerge.

Riparian Buffer Protection/Restoration

- Protection of Existing Buffers on Existing Developed Sites as well as New
- Developing/Re-Developing Sites: Municipalities must adopt riparian buffer ordinances in their respective zoning ordinances.
- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for grants to study in detail the riparian corridor extant throughout the Watershed and prioritize zones of riparian need, building on Heritage Conservancy work.
- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for grants to implement specific riparian buffer projects (i.e., re-vegetation) based on priorities established by the study described above.

Figure VII-14 Springfield Township Stony Creek Restoration Study Site

- Restoration of Lost Riparian Buffer: Municipalities/other government groups
- (e.g., Delaware and Chester County Conservation Districts) and other environmental/ watershed groups such as the DCVA must educate site owners and encourage them to establish riparian buffers with proper re-vegetation where these buffers have been removed; this can be done with assistance of state and other grants to cover direct/ indirect costs (see above).

Wetlands Protection/Restoration

- Protection of Existing Wetlands on Existing Developed Sites as well as Developing/Re-Developing Sites: Regulation of wetlands is a function of State and Federal government. Municipal programs should reinforce these programs.
- Restoration of Lost Wetlands/Protection of Existing Wetlands: Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA must initiate projects to replace lost wetlands and acquire existing wetlands with assistance of state and other grants to cover direct/indirect costs.
- Promote the recharge of groundwater and overall maintenance of the water table in order to protect the hydrologic connection so critical to wetlands formation; see the stormwater discussion below.

Specific Projects

Heritage Conservancy Riparian Project

The Heritage Conservancy of Bucks County is currently undertaking a detailed inventory of the riparian buffer in the Darby Creek Watershed, to result in prioritized analysis of riparian buffer needs.

City of Philadelphia Fairmount Park Commission Cobb Creek Park Master Plan 1999 see Section II)

This plan includes 68 high priority restoration projects with the Cobbs Creek systems of parks. Examples of projects include: Tributary 5: restoration through improvement of stormwater outfall, repair of stream banks, removal of Woodland Avenue dam); Middle Park Area (new environmental education center and creation of a floodplain wetland near the new environmental center), Upper Park Area (removal of Millbourne Dam, protect/ enhance scenic zone downstream of dam site and between Cobbs Creek and Karakung Golf Courses, riparian forest restoration and streambank stabilization near Hole 5 of Cobbs Creek Golf Course), trash removal/streambank stabilization/trail crossing improvement/exotic plant control on tributary upstream of Millbourne Dam, general restoration activities/wetlands enhancement in tributaries in Karakung Golf Course, scenic enhancement of waterfall on Indian Run, stream-side plantings of native vegetation along tributary in Cobbs Creek Golf Course. Also see project below.

City of Philadelphia Sustainable Approach to Stream Habitat in an Impaired Urban Stream
This $140,000 Growing Greener grant assists in the implementation of a sustainable approach to stream habitat restoration, including mitigation or urban impacts and related hydrologic and hydraulic modifications; the project includes restoration of 1,000 feet of Cobbs Creek between Pine Street and Cedar Avenue, using natural techniques, beginning 2002.
Marple Township
$68,225 for Lawrence Road/Darby Creek bank stabilization in PADEP Year 2 Growing Greener.
Darby Borough: two-$25,000 WRAP grants from PADEP (1999 and 2000) for streambank stabilization and riparian plantings above MacDade Avenue Bridge (in PennDOT redesign/reconstruction); see William Frasch of DCVA.
Easttown Township Comprehensive Plan
Specifically recommends that wetlands and riparian zone buffers be required/protected along all township streams, through new overlay district zoning provisions.
Munro Report Projects
See below.
Haverford Township Streambank Gabions
Several projects in recent years.
Morton Borough Stony Creek Tributary Streambank Restoration
Growing Greener application for area below Providence Road, including rip-rap, bio-logs, re-vegetation.
Radnor Township Willows/Streambank Restoration Projects
Several Growing Greener applications to reduce stormwater runoff and its pollutant loads, including geese problem.
Ridley Township Stream Restoration
Stream restoration through the Pennsylvania Conservation Corps applying bio-engineering techniques (native plantings, coconut fiber logs, rip-rap, willow shoots) to a small section of Stoney Creek (between MacDade and 4th) and Shipley Run (terminus of 6th).
Springfield Township Stony Creek Restoration
Growing Greener applications for various restoration works.
Springfield Township West Rolling Hills Park
Restoration/preservation of floodplain and riparian buffer at FEMA mitigation site.
Tinicum Township's Longhook Creek Project and Related Projects
Remove obstacles/construct a connection between the Delaware River and Darby Creek; create adjacent wetlands, all along the Long Hook Creek Corridor; objectives of the project are to reduce flooding in surrounding residential neighborhoods from existing sources and from new non-residential development in the area and to generally promote better stormwater management through provision of larger water storage areas.

Glenolden Borough
Streambank stabilization and riparian buffer restoration along 1,500 ft of the Muckinipattis Creek in Borough properties, at Glendale Heights at the intersection of MacDade Boulevard and South Avenue; not submitted to Growing Greener due to lack of sponsor.

Delaware County Open Space Project
This project was not approved but intended to provide stream, riparian, and wetland protection through a variety of land acquisition efforts.

Goal B. Restore Floodplain Where Feasible – Remove fill and abandoned structures. Prevent future filling and encroachment.

Program Actions

- New Development and Re-Development of Developed Sites: Municipalities must
- regulate floodplain encroachment more thoroughly, prohibiting structural encroachment and even disturbance of the natural floodplain vegetation/soil mantle. These restrictions go beyond the minimum FEMA requirements adopted by Watershed municipalities.
- Municipalities/other government groups (e.g.,Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for grants to remove abandoned structures in the floodplain.
- Existing Development in the Floodplain: Educate existing owners to seek alternative locations for their land uses, residential and other. Explore nonfinancial incentives, positive and negative, for discontinuation of existing uses in floodplains.
- Municipalities should use special grant programs (e.g., FEMA's Hazard Mitigation Grants, Repetitive Loss Buyouts, etc.) to buy out existing uses and remove structures and fill.

Specific Projects

FEMA Residential Removal
Removal of 6 homes at West Rolling Hills Road Park site in Springfield Township. Removal of 38 homes in floodplain from MacDade Avenue Bridge to Bartram Park in Darby.

Munro Study 1997
This special study, *Floodplain Study and Conceptual Plan for Colwyn, Sharon Hill, and Darby Boroughs*, analyzes flooding and other Creek problems and identifies a variety of solutions for this lower portion of the Creek; although the main focus of the study and study recommendations is the elimination of the flooding problems plaguing the area, water quality is also addressed extensively. This excellent report includes recommendations as follows: multiple offstream storm basins, oversizing storm basins elsewhere in the Watershed, retrofitting parking lot stormwater storage, roof runoff into dry wells, low-head temporary storage in parks, porous pavement and other infiltration

techniques, conversion of lawns to forest, sealing off sewers, and others. Recommendations are made for removal of abandoned and dysfuntional impoundment structures in the Creek in the Study Area.

City of Philadelphia Fairmount Park System's Cobbs Creek Park Master Plan

Includes projects which are designed to increase the integrity of the floodplain, including re-vegetation, removal of structures and impoundments such as the Millbourne Dam and Woodland Dam, and others.

Ridley Township Flood Project

Township constructed a detention facility in this generally developed area in 1997 at Shipley Farm, a naturally low lying area along an unnamed tributary of the Muckinipattis upstream of the SEPTA Railroad (near Dale Road and Secane Road), using a Pennvest loan. Some wooded area was disturbed; trees were replanted.

Tinicum Township's Longhook Creek Project and Related Projects

Remove obstacles/construct a connection between the Delaware River and Darby Creek; create adjacent wetlands, all along the Long Hook Creek Corridor; objectives of the project are to reduce flooding in surrounding residential neighborhoods from existing sources and from new non-residential development in the area and to generally promote better stormwater management through provision of larger water storage areas.

Colwyn Borough

Potential for removal of abandoned buildings with floodplain restoration.

Figure VII-15 WRAP grant project area in Darby Borough with homes removed

Goal C. Improve Stormwater Management – Manage Quantity and Quality for both new development and re-development.

Program Actions

- New Development and Re-Development of Developed Sites: Municipalities must adopt more rigorous municipal stormwater management regulations which regulate total quantity/volume as well as water quality; see model ordinance. Pursuant to this, the RCP advocates model stormwater management ordinance requirements consistent with the model ordinance being developed pursuant to the Act 167 Stormwater Management Plan for the Darby Creek.
- Existing Development: For all those existing sites with either no stormwater management or partial/ineffective management (i.e., detention basins), the RCP advocates a program of education to make basin owners understand the need for corrective action. The RCP recommends that municipalities, watershed organizations such as DCVA, and other private entities use state/federal/other grants in the future to retrofit any existing basins for better quality/quantity functioning. Municipalities and/or groups of municipalities should consider undertaking special stormwater flooding mitigation projects with areawide benefit for the most serious problem areas. These projects might include specific structures as well as more nonstructural basin-wide actions
    - Radnor Township is currently undertaking a variety of projects to remediate existing stormwater problems, both at specific sites (structural) and in broader sub-basins (non-structural)
    - Springfield Township also is exploring retrofit strategies for various problem areas.
- In those situations where no stormwater management exists, special studies and use of state/federal/other grants will be necessary for structural measures to mitigate existing stormwater/flooding problems, possibly to be accomplished through multi-municipal planning efforts. See Floodplain above.

Specific Projects

Villanova University

$59,112 for Villanova stormwater bioretention traffic island, parking lot expansion, and other demonstration projects to promote water quantity and water quality objectives. Villanova University sponsors the Pennsylvania Stormwater Conference every two years.

Springfield Township

Special studies to remediate existing stormwater problems, with Cahill Associates.

Munro Study 1997

This special study, *Floodplain Study and Conceptual Plan for Colwyn, Sharon Hill, and Darby Boroughs*, analyzes flooding and other Creek problems and identifies a variety of solutions for this lower portion of the Creek; although the main focus of the study and study recommendations is the elimination of the flooding problems plaguing the area, water quality

Figure VII-16 Waterfall Feature in Upper Darby Area Greenway

is also addressed extensively. This excellent report includes recommendations as follows: multiple offstream storm basins, oversizing storm basins elsewhere in the Watershed, retrofitting parking lot stormwater storage, roof runoff into dry wells, low-head temporary storage in parks, porous pavement and other infiltration techniques, conversion of lawns to forest, sealing off sewers, and others.

Radnor Township

Variety of stormwater retrofits at key sites to promote groundwater recharge and reduce runoff in the Ithan Creek sub-basin, including Wayne Art Center.

Easttown Township Comprehensive Plan

Specifically recommends use of BMPs for inclusion in the SLDO, including wet ponds, infiltrations systems, various types of filters, vegetated swales, and so forth.

GOAL D. IMPROVE DEVELOPMENT PATTERNS, INCLUDING RE-DEVELOPMENT PRACTICES, TO PROTECT OR RESTORE STREAM CORRIDORS, MAINTAIN OPEN SPACE, AND PROTECT/PROMOTE ECOLOGICAL RESOURCES.

Program Actions

- Municipalities/other government groups (e.g., Delaware and Chester County
- Conservation Districts) and other environmental/watershed groups such as the
- DCVA should apply for state and other grants for open space acquisition and

- related projects, with focus on stream corridor greenway locations; all existing and future open space opportunities (e.g., the Haverford State Hospital site) should be given the highest priority for open space acquisition.
- Municipalities should revise municipal codes to require/promote open space, including protection of existing open spaces and creation of new open spaces, in the land development and re-development process; open space standards will varying by Watershed context; incentives, such as density bonuses, can be added to promote open space protection/creation.
- Municipalities should revise municipal codes to require/promote: cluster development and open space design, low impact development which includes reduction in impervious areas through setback reduction, reduced parking requirements where appropriate (or sharing of parking and other techniques to "green" parking lots), reduction in street widths, reduction in unnecessary, costly, and environmentally unfriendly systems such as inlets and storm sewer systems when vegetated swales and other environmentally friendly systems are viable options, and all other techniques to concentrate development in the least Watershed area.
- Educate all Watershed stakeholders, including municipal officials, regarding the importance and overall cost-effectiveness of open space conservation. See below.

Specific Projects

Re-Use of Haverford State Hospital Site

In process, this project constitutes a tremendous opportunity for Watershed goal achievement. Although this incredibly valuable site is desired by many different interest groups for many different uses, the site constitutes one of the last remaining, relatively undeveloped "islands of open space in the Watershed. As such, it's open space functions and values, from water resources quantity and quality to biodiversity and habitat to air quality and aesthetics, are of tremendous importance and must be maximized. Obviously, from the Watershed's perspective, open space uses should be maximized (future of existing buildings is uncertain).

Easttown Township Comprehensive Plan

Specifically recommends improvement of clustering requirements with better design criteria in zoning ordinance.

Springfield Township Citizens for Responsible Land Use and **DCVA, Coventry Woods Residential Development Project**

These private conservation-minded groups took serious issue with a proposed land development plan on a tributary of the Darby Creek and hired consultants to critique and improve the proposed land development plan. The additional technical work helped the Township review the proposed plan more fully.

Goal E. Increase Open Space and Recreation – Restore access to the stream corridors. Protect existing open space and create new open space.

Program Actions

- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for state and other grants to study stream access needs and to prioritize access opportunities.
- Municipalities/other government groups (e.g., Delaware and Chester County Conservation Districts) and other environmental/watershed groups such as the DCVA should apply for state and other grants (PADCNR and others) for open space acquisition and related projects, with focus on stream corridor greenway locations.
- Municipalities should revise municipal codes to require/promote open space, including protection of existing open spaces and creation of new open spaces, as well as recreational facilities and "fee in lieu" requirements.
- Municipalities and other public and private Watershed groups should intensify work with land trusts/conservation groups in order to maximize use of conservation easements and related land stewardship techniques.
- Municipalities, individually and together, must work to promote the importance of trails and trail development along streams, using both paid and volunteer labor.
- Municipalities should strive to acquire conservation easements, both donated and purchased, for trail development on privately held parcels along streams or which provide access to streams.
- Municipalities and all Watershed organizations directly and indirectly should promote the work of land trusts and conservancies (i.e., conservation easements), such as the Brandywine Conservancy and Natural Lands Trust; indirect support can be provided by making sure that assessments reflect donated easements, removal of development rights, etc.
- Utilize the resource of Pennsylvania's *Growing Smarter* program to improve comprehensive planning, plus the resources of the Governor's Office of Local Government Services.

Specific Projects

Upper Darby Area Greenway

The proposed Greenway project, extending 4.25 miles for an overall width of 1500 feet, including many steep slopes and floodplain zones. The area includes the Indian Head on a high cliff overlooking the Indian Basin, the Lower Swedish Cabin (possibly the oldest surviving log cabin structure in the nation), an historic mill complex, SEPTA trolley stops, the County's underutilized Kent Park, Lansdowne's major Hoffman Park, the historic Bonsall House built in the 1700s, and Bartram Park. Connector trails would also be included in this project: Bloomfield Avenue to Kent Park; Baltimore Pike through

Figure VII-17 Historic Kent Mill Structure in Upper Darby Area Greenway

Hoffman Park; and Penn Pines Park to MacDade Boulevard. Off-road pedestrian and bicycle paths would be provided. Details of this project are included above.

Lansdowne Borough's Reconstruction of Hoffman Park through FEMA/Keystone funding Radnor Township Open Space Acquisition Program

Continuing program to implement the Township's adopted open space plan.

Easttown Township Comprehensive Plan

Specifically recommends that Township intensify efforts with land trusts/conservation groups to promote conservation easements on all remaining undeveloped tracts. The Plan also recommends that a "public greenway with hiking and/or riding trails" be established, that more community and neighborhood parks be established, that the SLDO be revised to increase dedication of open space, that a variety of specific zoning provisions be added to increase/improve trail and open space provisions, that the Township acquire through purchase or easement all unprotected lands along the Darby Creek (and Crum Creek).

Easttown Township Recreation, Open Space, and Environmental Resources Plan

Recommendations are generally consistent with the above Comprehensive Plan, although more detailed. For example, a specific recommendation is made to develop a walkway linking the YMCA to Leopard Lake through Sharps Woods and Waynesborough Woods (not quite 2 miles). Also develop a trail along Darby Creek for about 2 miles, linking several local recreation sites. Recommended bikeways typically follow roads, not streams.

Lower Merion Township

Master Plan for Penn Wynne Park, Master Plan for Wynnewood Valley Park, Master Plan for South Ardmore Park, Master Plan for Vernon Young Memorial Parks (all pending approval at PADCNR). Township Trail Feasibility Study.

Goal F. Identify and Protect Historic, Cultural, and Ecological Resources

Program Actions

- Municipalities should revise municipal ordinances to require/promote inventorying and conservation of natural/ecological resources; in conjunction with this effort, municipalities should consider formation of Environmental Advisory Councils (EACs) to assist in this significant effort.
- Watershed groups, from municipal agencies to private non-profit organizations, should mount an intensified campaign to combat the proliferation of invasive species with their increased adverse ecological impacts, with particular focus on deer and Canadian geese as problem species. This issue should be an important element in overall educational programming; for example, instructive materials should be readily available for municipal officials and others explaining how to eliminate Canadian geese habitat so that populations are not further increased.
- Municipalities and other governments groups should prepare an inventory of stream segments which are either buried or channelized and prioritize segments for remediation.
- Municipalities/other government groups should undertake to expand the inventory of cultural resources in the Watershed and work to prioritize these resources.
- Municipalities should revise municipal ordinances to require/promote inventorying and conservation of cultural resources.
- Watershed educational institutions (e.g., the Delaware County Community College) should expand their programs involving local history and environmental issues.
- Municipalities should directly support the DCVA Stream Clean Up Day and should consider expanding this program; other specific cleanup programs should be considered.
- Educate. See below.

Specific Projects

Easttown Township Comprehensive Plan

Specifically recommends that a Historic Preservation Plan be considered for development. The Plan recommends that historic resources be evaluated for inclusion in the National Register of Historic Places and develops very specific sub-plans for historic resource protection in Watershed portions of the Township. The new Easttown Plan also provides a good example of full treatment of natural resources.

Lower Merion Township Regulations for the Protection of Cultural Resources
See Lower Merion's Zoning and Subdivision/Land Development Regulations; this township has one of the most comprehensive regulatory programs for identifying and protecting historic resources, promoting re-use and minimizing demolition, etc.

Haverford Township
See existing Haverford Township cultural resources protection regulations.

Darby Township
Daylighting of a large section of the Muckinipattis Creek currently buried under a cemetery parallel to Oak Lane.

Brandywine Conservancy's Municipal Assistance Program and Environmental Management Handbook
This compendium of resources includes excellent guidance for municipalities, other governments, and Watershed stakeholders in general, setting forth steps essential for cultural resource management and protection. Contact the Conservancy at 610-388-2700; the Conservancy invites municipalities to become Subscribers in their Municipal Assistance Program for a relatively modest fee). Special emphasis is placed on legal aspects of state-of-the-art management techniques.

Goal G. Foster Inter-Municipal Cooperation and Involvement - Coordinate efforts to encourage municipal interaction and planning on a watershed basis.

Program Actions

- Coordinate with and support the on-going efforts of the Darby-Cobbs Watershed Partnership and its members, the DCVA, and other watershed-related groups and programs.
- Encourage continuing watershed-based planning by municipalities and groupings of municipalities through inter-municipal planning strategies, as facilitated by Acts 67 and 68 of 2000, amending the Municipalities Planning Code, and creating inter-municipal planning. This planning could be Watershed-wide or be sub-Watershed-wide; agencies such as the Delaware County Planning Department should work to promote the advantages of such planning for the benefit of potentially affected municipalities (i.e., the potential benefits of unification of the very small municipalities comprising the lower portions of the Watershed in Delaware County, in terms of environmental planning, municipal services planning, legal requirements for provision of all land use types, and so forth). A variation on this theme would be the formation of joint inter-municipal Environmental Advisory Councils.

- Prioritize comprehensive planning on a county-wide basis, with the Chester County award-winning *Landscapes* as a model, now reinforced by the new *Watersheds* plan and *Linking Landscapes* plan for open space planning; the emerging comprehensive plan for Delaware County should be a top priority and should feature the watershed principles set forth in this Draft RCP.

Specific Projects

Darby-Cobbs Watershed Partnership

$35,000 for Darby-Cobbs Watershed Partnership education and outreach.

GOAL H. EDUCATE – EDUCATE RESIDENTS, MUNICIPAL OFFICIALS, TEACHERS AND OTHERS, AND INCREASE AWARENESS OF THE STREAM, THE WATERSHED, AND ITS RESOURCES AND PROBLEMS.

Program Actions

- DCVA and other Watershed organizations should develop and implement a Watershed Education Campaign, including all elements below.
- DCVA and other watershed organizations should work to increase watershed curriculum in public/private schools.
- DCVA and other Watershed organizations should work to increase Watershed resources available in public library system, in the Intermediate Unit, and other locations, including the electronic GIS database developed for this RCP.
- DCVA and other Watershed organizations should work to increase Watershed awareness of municipal/other government officials.
    - Highlight stormwater management (e.g., stormdrain labeling for nonpoint
    - control).
    - Highlight floodplain management.
    - Highlight riparian buffer management.
    - Highlight wetlands.
    - Highlight all aspects of better Watershed planning (see above).
    - Highlight benefits of joint municipal planning on a Watershed level.
- DCVA and other Watershed organizations should develop program strategies for better use of EACs in the Education Campaign.
- DCVA and other Watershed organizations should consider short-term public relations strategies to promote all of the above, including a Darby Creek Week, intensifying Clean Up Day, and so forth.

Specific Projects

Friends' Central School

$75,913 for Cobbs Creek watershed monitoring and restoration.

Radnor Township

Middle School 7th grade watershed program.
City of Philadelphia's Cobbs Creek Community Environmental Education Center:
Various education projects.
City of Philadelphia's Fairmount Park Natural Lands Restoration Environmental Education Project or NLREEP
Various reports.
DCVA
Increase media coverage of existing DCVA work program to improve overall educational value of activities.

Goal I. Manage Land Development-Related Activities that Affect Water Quality to Reduce Pollutants - Malfunctioning wastewater systems, fertilizer and lawn maintenance, animal waste (including geese), and hazardous waste degrade water quality and create nonpoint source pollution.

Program Actions

- Support recommendations of Delaware County Sewage Facilities Plan Update (Eastern Plan of Study); attach high priority to remediation of leaking sanitary sewers and any other untreated wastewater sources.
- Support the combined sewer overflow (CSO) abatement program of the Philadelphia Water Department
- Support and closely follow planning processes for toxic/hazardous waste sites in the Watershed.
- Municipalities should revise municipal ordinances to minimize creation of artificial landscape and promote naturalized areas, use of native species, and so forth.
- Municipalities should promote use of minimum disturbance/minimum maintenance site development techniques, including reducing lawn area and promoting meadow and reforested zones with native species, especially to prevent/reduce creation of Canadian geese habitat.
- Educate. See above.

Specific Projects

Delaware County Act 537 Sewage Facilities Plan Update
Completion and implementation of this wastewater treatment plan for the Delaware County portion of the Watershed; this ongoing effort is critical for future Watershed water quality.

E. FUNDING OPTIONS FOR RCP IMPLEMENTATION

Implementing the Darby Creek Watershed RCP many different recommendations will not be cheap. Whether the actions be undertaken by the public or private or any other sectors, funding is critical (though funding by itself is by no means the single Watershed solution). In the section below, a variety of potential funding sources are listed and described. These programs are in a relative constant state of flux, especially given the rapidly changing landscape of public sector budgets. Some of this information may need to be updated. Nevertheless, these descriptions provide a good start.

Many of these programs are matching grant programs (the bad news). The good news is that it is possible to use one grant to match another grant in some, though not all cases. The matching requirement is often used by potential funding sources as a test of an applicant's determination and commitment. On the municipal level, matching funds can be raised in a variety of ways over and above the general fund through a dedicated income tax and municipal bonds. The point is that though grantsmanship is never easy and always takes time and energy, there is money out there. As has been pointed out several times by PADCNR spokespersons during the course of this RCP preparation, many other watersheds, many other areas are successfully garnering much larger shares of PADCNR monies for their projects (records indicate that municipalities in Delaware County have applied for and received significantly less in the way of PADCNR grants than neighbors in Chester, Bucks, and Montgomery Counties).

Federal Programs

TEA21: Stemming from the 1991 Intermodel Surface Transportation Efficiency Act (ISTEA), massive funding was made available for highway and mass transportation projects; funding also was available for bike and pedestrian trails. TEA 21, the 1998 renewal of the program, provides another $198 billion to fund the program through 2003. Special program [provisions include: the Transportation enhancements Program (TE), Congestions Mitigation and Air quality Improvement Program (CMAQ), and the Recreational Trails Program 9adminsitered by PADCNR). See www.fhwa.dot.gov/tea21 for more information.

Transportation Enhancements: Up to 10 percent of the total state grant to each state is authorized for TE projects. These projects include 12 different categories, two of which fund bicycle and pedestrian trails. Funding is provided for new facilities for bicycles and pedestrian use and for improvements to existing trails, though excludes sidewalks and required curb ramps; funding is also provided for the planning, acquisition, rehabilitation, and development of active and abandoned railway corridors for public uses including pedestrian and bicycle trails. Funding is provided up to a maximum of 80 percent of total project costs and provided as a reimbursement, not a grant, after project completion. See the National Transportation Enhancement Clearinghouse at 888-388-6832 or www.railtrails.org/ntec for additional information. The Pennsylvania Department of Transportation administers the TE program, collaboratively with the Delaware Valley Regional Planning Commission (along with the

Pennsylvania Transportation enhancements Advisory Committee). Applicants may be any government or non-profit entity; applications usually are submitted in the Fall and can be complex, requiring considerable time and assistance from PennDOT. Contact PennDOT's Engineering District 6 Transportation Enhancements Coordinator at 610-964-6534 for more information.

Congestion Mitigation and Air Quality Improvements: Grants here fund projects which reduce harmful emission related to transportation. Like the TE program, the program is a competitive reimbursement with a maximum of 80 percent share of a project's total cost funded. The PennDOT/DVRPC institutional structure is similar to that of the TE Program, although in this case the Federal Highway Administration is also involved. Sixteen different categories of projects are defined, including public education campaigns and construction of park and ride lots and development of bicycle and pedestrian trails (this category may include designation of bike lanes on roadways as well as construction/reconstruction of paths, tracks, or areas for pedestrian or other non-motorized transportation modes.). Eligibility is similar to that of the TE Program, although special emphasis is placed on coordination with the respective county and municipal governments in which the project is located. See the DVRPC's Transportation Planning Division Director at 215-238-2863 for more information.

State Programs

State programs include several different agencies. PADCNR programs are described first and include the grants known as Keystone Grants in the 1990's and renamed the Community conservation Partnership Program in 2000, using Growing Greener Funds provided by the Environmental Stewardship and Watershed Protection Act. The following funds and programs are included: Keystone Recreation, Park and Conservation Fund; Recreational Trails Program; Pennsylvania Heritage Parks Fund (limited to Schuylkill River Watershed); and the Environmental Stewardship and Watershed Protection Act (Growing Greener Fund). Contact www.dcnr.pa.state.us or 717-787-7672 for additional grant program information. One grant manual provides details for all of the PADCNR programs; go to www.dcnr.state.pa/grants.htm. Contact should be made with the SE Pennsylvania PADCNR Recreation and Park Advisor at 215-644-0609 to discuss grant programs, their details, specific project needs, and so forth

PADCNR's Community Recreation Grants: This annual municipal agency (also councils-of-government) grant program (mid-Fall deadline), established under the Keystone Recreation, Park and Conservation Funds (PA Act 1993-50), provides 50 percent matching grants for planning and technical assistance (comprehensive recreation and park planning, conservation plans, county natural areas inventories, feasibility studies, greenways and trails, master site development planning, circuit rider and peer-to-peer technical assistance grants), acquisition of land for park and recreation purposes, and development (rehabilitation and development of park and recreation facilities and grants for small communities with populations of 5,000 or below); small communities, circuit rider, and peer grants are not governed by the 50 percent limit.

Rails-to-Trails: This annual municipal and non-profit agency grant program (mid-Fall deadline), established under the Keystone Recreation, Park and Conservation Funds (PA Act 1993-50), provides 50 percent matching grants for planning and technical assistance (feasibility studies, master site development plans, special purpose studies of abandoned railroad right-of-way for trails and adjacent lands necessary for access and support facilities for trails), acquisition (acquisition of abandoned right-of-way for trails and adjacent land necessary for access and support facilities for trails), and renovation and development of abandoned railroad right-of-way for trails.

Land Trust Grants: Pre-qualified non-profit land trusts and conservancies may receive up to 50 percent of a project cost for use in acquisition and planning of open space and natural areas facing development; lands must have public use/access and get priority if they are habitat for threatened/endangered species.

River Conservation Grants: Up to 50 percent matching grants are provided to municipal agencies of all types and non-profit groups for planning and technical assistance (River Conservation Plans, special purpose projects such as preparing zoning and subdivision ordinances, river area access studies, water quality monitoring, other projects), for land acquisition, and for development of river conservation projects.

Recreational Trails Fund: TEA21 funds the Pennsylvania Recreation Trails Grant program, awarded each year (mid-Fall deadline) to municipal agencies and private entities. Grants up to 80 percent of total project cost (acquisition projects limited to 50 percent) are to be used for acquisition, development, and maintenance of motorized and non-motorized trails.

Other Programs

PADEP Grants: These Pennsylvania Department of Environmental Protection Growing Greener grants, funded under the Environmental Stewardship and Watershed Protection Act, include sewer and water infrastructure improvements, reclamation of abandoned mines and wells, and wetland and streambank restoration and protection. Applicants may include counties and municipalities, conservation districts, watershed organizations promoting watershed conservation efforts and recognized by PADEP, and other authorized organizations recognized by PADEP as promoting the protection, enhancement, conservation, preservation and/or enjoyment of Pennsylvania's environmental, conservation, recreation, and/or similar resources. Although a match is not required per se, applications, which have become much more competitive since recent funding cutbacks, are more likely to be funded if they include connection to other sources of funding or services and/or partnering in some manner with other agencies and programs. Contact www.dep.state.pa.us and the PADEP Grants Center at 717-705-5400 for more information, including grant manuals and updates on application deadlines. Locally contact the PADEP Southeastern Regional Office at 610-832-6259.

PADCED Grants: These programs, including the Shared Municipal service Program (funding regional recreation activities, public works operations, and municipal insurance pooling) and the Land Use Planning and Technical Assistance Program or LUPTAP (funding open space as part of a comprehensive plan with priority toward regional planning efforts), usually require a 50 percent match and are available throughout the year to counties, and municipalities (again with priority given to multi-municipal applications). Contact www.dced.state.pa.us or the Governor's Center for Local Government Services locally at 610-530-8223 or 215-560-2374.

County Grants
The four counties have substantially different funding programs available to Watershed municipalities and other stakeholders, with Chester County programs being most extensive; contacts should be made with the respective County, starting in most cases with the county planning commission or department.

Other Grants
Some additional sources of funding for conservation, recreation, and open space are available, usually fairly small in size (i.e., mini-grants from $2,000 to $10,000). These include but are not limited to:

Pennsylvania Urban and Community Forestry Council Grants: Community Improvement Grants are given to plant and maintain trees; they are funded by the PA Bureau of Forestry, the PA Urban and Community Forestry Council, and the USDA Forest Service. Municipal Challenge Grants provide $1,000 to $5,000 for projects in public spaces and rights-of-way, as well as street tree projects. Community Improvement Grants provide $500 to $3,000 for projects in parks, greenbelts, schools, and community public spaces. Grants can be given to municipalities, authorities, schools, youth groups, church groups, local business, and other like organizations and are dispensed typically twice a year. Contact the Pennsylvania Urban Forestry Coordinator at 717-783-0385 or the Southeast Urban Forester at 610-489-4315.

American Forest Global Releaf Grants: Projects here should include native tree planting on sites of 20 acres or more; the goal is planting diversity. Eligibility is broad, though projects must be located on land that is publicly owned or owned by a publicly assisted private entity. Applications are usually twice per year. Contact the American Forest website at www.amfor.org or 212-955-4500 for more information.

National Tree Trust Tree Planting Program: Created by the America the Beautiful Act of 1990 and endowed by a one-time grant from Congress, the National Tree Trust dispenses these grants to provide tree seedlings, tree planting materials, and a cash subsidy to cover cost of potting for projects that facilitate tree planting on public lands and along roadsides. Funds must be equally matched by the applicant with non-Federal funds. Volunteer organizations, school groups, municipal park and recreation departments, and other interested groups are eligible; the application process takes two years. Contact the National Tree Trust at 800-846-8733 or www.nationaltreetrust.org.

Kodak American Greenways Grants: Through a Kodak Corporation, Conservation Fund and National Geographic Society partnership, grants of up to $2,500 (most under $1,000) are awarded to develop and assist in the implementation of greenway projects. Grants may be used to map resources and greenways, undertake ecological assessments, perform design activities, hire consultants, plan bike paths, and perform other greenway tasks. Most awards have gone to local community, regional, and statewide non-profit organizations, although public agencies also may apply (e.g., recent awards have gone to the Wildlands Conservancy in Emmaus to construct a footbridge on a heavily used trail in Lehigh County; also to Delaware Greenways in Wilmington DE). Contact the American Greenways Programs at www.conservationfund.org or 703-525-6300 for more information.

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Ridley Township, 1974. Comprehensive Plan, by Buchart-Horn Associates, York, PA.

Ridley Park Borough, 1998. Comprehensive Plan, prepared by the Delaware County Planning Department, (excerpts).

Southeast Delaware County Comprehensive Plan for Collingdale, Colwyn, Darby, Glenolden, Sharon Hill, and Yeadon Boroughs; 1971, prepared by the Delaware County Planning Commission.

Springfield Township, 1983. Comprehensive Plan, prepared by the Delaware County Planning Department.

Tredyffrin Township, 1987. Comprehensive Plan, prepared by Waetzman Planning Group.

Tredyffrin Township, 1992 (2nd draft). Open Space, Recreation, and Environmental Resources Plan, prepared by the Environmental Management Center of the Brandywine Conservancy.

Yeadon Borough, 2001 (draft). Comprehensive Plan, prepared by the Delaware County Planning Department, (excerpts).

Municipal Ordinances:

Collingdale Borough, 1993. Zoning Ordinance, (excerpts).

Darby Township, 1965-1992 (amended). Zoning Ordinance, (excerpts).

Easttown Township, 1997, as amended. Zoning Ordinance.

Easttown Township, (undated). Subdivision and Land Development Ordinance.

Folcroft Borough, 1990. Zoning Ordinance, (excerpts).

Haverford Township, 1994. Subdivision and Land Development Ordinance.

Lansdowne Borough, 1987. Zoning Ordinance, (excerpts).

Lower Merion, 1998. Subdivision and Land Development Ordinance.

Lower Merion, 2000. Zoning Ordinance.

Marple Township, 1998. Zoning Ordinance, as amended.

Milbourne Borough, 2001. Zoning Ordinance, (excerpts).

Morton Borough, 1995. Zoning Ordinance, (excerpts).

Narberth Borough, 1982. Zoning Ordinance, as amended.

Narberth Borough, 1999. Stormwater Management Ordinance.

Newtown Township, 1995. Land Use Regulations (consisting of Flood Damage Prevention, Natural Features and Landscaping, Slope Conservation, Soil Erosion and Sediment Control, and Subdivision and Land Development Ordinances).

Radnor Township, 2000. Subdivision and Land Development Ordinance.

Radnor Township, 2001. Zoning Ordinance.

Ridley Township, 2001. Zoning Ordinance.

Ridley Township, 2001. Subdivision and Land Development Ordinance.

Ridley Park Borough, 1989 as amended. Zoning Ordinance, (excerpts).

Ridley Park Borough, 1989. Subdivision of Land Development Ordinance, (excerpts).

Ridley Park Borough, 1992, Shade Tree Ordinance, (excerpts).

Ridley Park Borough, 1995, Historic District Ordinance, (excerpts).

Sharon Hill, 1995. Zoning Ordinance.

Sharon Hill, (undated). Subdivision and Land Development Ordinance.

Springfield Township, 2000. Subdivision and Land Development Ordinance.

Springfield Township, 2001. Zoning Ordinance.

Tinicum Township, 2000. Zoning Ordinance.

Tredyffrin Township, 1979. Zoning Ordinance.

Tredyffrin Township, 1998. Subdivision and Land Development Ordinance.

Upper Darby Township, 2001. Zoning Ordinance.

Appendices

APPENDIX A

Municipal Meetings
Public Input Results

JUNE 7, 2001 MEETING NOTES

Lower Sub-Region

Problems/Negatives

- Inadequate wetlands identification
- Added road run off
- Trash/Debris; Better trash collections
- DEP obstacles to clean up
- Old landfills
- Chemical, fecal, tidal pollutants
- Inadequate state inspections
- Upstream development
- Flooding
- Darby Creek Joint Sewage Treatment Plant - overflow
- Bridges
- Split legislative representative
- Lack of caring
- Folcroft house
- Bumting house (see Bill Frasch); Penn trel?
- Invasive species/impacts on wetlands
- Lack of money on lower and smaller boroughs

Solutions/Positives

- Walking trails
- Foster cooperation/interconnecting trail system
- Norwood - Morton Mortonsen House
- Ecological restoration/revegetation strategies
- Reduced sewage related problems - inflow and infiltration-
- Street trees
- Team to target private sector on waste/other water quality issues
- Education - signs, etc.
- School programs
- Tax/ fiscal impacts – “What’s in it for me?”
- Community connections
- Responsive regulations agencies (Small community groups, liaisons)
- Improved municipal code enforcement
- Passive parks
- Property purchases in critical zones

Middle Sub-Region

Problems/Negatives

- DREDGING (UPPER DARBYTWP) CREEK, TREE REMOVAL "ROUTINE MAIN" NAYLOR'S RUN
- BARTRAM PARK – EROSION AND EXOTIC/INVASIVE AND STREAMBANK
- HOFFMAN PARK. – Bank erosion (Lansdowne) No trails/access
- New Construction (after Floyd hit it and flooded) Property owner removed trees UPPER DARBY (Hilldale Road)
- MILLBOURNE DAM – Cobbs Creek – Obstructing Flow
- LLANARCH QUARRY (Neighbors) Landfill for hazardous wastes/wood chips
- MR. KAY DREXEL BROOK (fill and floodplain encroachment and A.C.O. Eng./DEP Issues)
- BRIDGE (a) Marshall Road – Constricts flow prior to underground
- TRASH REMOVAL (?) – From Floyd aftermath
- PENNDOT in general
- KMART – No Riparian Buffer and bad basin
- LOSS OF NESTING – Habitat for Migrating Birds
- POTENTIAL AVAILABLE OPEN SPACE PROPERTY – For sale signs
- DEV (SW 167) – RE – INFIL-DEVELOPMENT (need SW Management)
- (PIXS) STONEY CREEK NEAR MORTON
- ICINERATOR #2 – Ash Pile and Leachate into Darby Creek
- HAVERFORD (ILLEGAL DUMP- Main stem septa trolley Drexel Line Shopping Center) SITE – onto creek bank off of West Chester Pike

Solutions/Positive

- BARTRAM PARK
- SWEDISH CABIN
- MODEL WATERSHED CURRICULUM – 9TH grade/stream Restoration, Tree Planting) Macro-invertebrates. Small grant WILLIAM PENN SCHOOL DISTRICT George Ambrose
- SPRINGFIELD TWP. – Remove Structures from flood planes (5 homes)
- HOUSES WILL BE REMOVED FOR PASSIVE PARK
- KENT PARK – Repairing Sewer lines and stream stabilization.
- WELCH PARK (SPRINGFIELD) – Upgrade to sewer line
- WETLAND MITIGATION (FAIRMOUNT PARK COMMISSION) – near 69th street park, Church Lane/Naylor's Run/Cobbs confluence
- COLLINGBROOK - Historic site
- STEVEN'S TRACT – Upper Darby Money for passive rec.
- THAYER – Open space now
- TROUT – Stocked below Darby
- NAYLOR'S RUN "GABIONS"
- 5 (NATIONAL) ACRES/RETENTION/INFILTRATION

- INFILTRATION AT HOME DEPOT LOT (MUCK CREEK)
- OUTDOOR CLASS RM (HS) (conservation district $) – Upper Darby High School
- SYCAMORE (LACROSSE STREET) AND FORMER HOUSE

Upper Sub-Region

Problems/Negatives

- FAILING DAMS
- CHANNELIZATION
- SOUTH OF BRYN MAWR AVENUE – Riparian Restoration
- 2 GROWING GREENER APPS. ON LANFORD
- GOOSE CONTROL
- POND RESTORATION AT WILLIAMS
- CAP ON IMPERVIOUSNESS

Solutions/Positives

- LAWN CARE – Education and ordinances require mowing
- STREAM BUFFERS - trees important to stream system
- INFILL DEVELOPMENT
- NO BUILDING IN FLOOD PLAIN
- BASIN RETROFIT

Upper Darby Township
Meeting #1 Beverly Hills Middle School
Fall 2001, Horner/Ackerman notes

What is a Watershed?
What is your Watershed Address?

Problems:

- Naylors Run off Garrett Rd. – water quality
- actively address the flooding problem
- Normandy Rd. – Veronica Rd.
- Springton and Grace
- need for upstream management
- question of hold back in Havertown
- Socio – economic (if problem were in Radner something would happen)
- purchase PECO Property at Marshall and long lane (possible flood control)
- flooding problems
- Marshall Rd. overflow
- PENN-DOT Bridge (at Naylors Run and Marshall Rd. – inadequate for flow of water at entrance of culvert)

- open space enough to alleviate the problem
- Penn-Dot Bridge

Concerns:

- Question of building in a floodplain
- FEMA- technical levels
- Perhaps-
- 2a. Contact for purchase of PECO property
- 2b. Could PECO get a tax deduction for an in perpetuity easement
- Congressman Weldon
- Act 167- new storm water standards (hopefully will help)
- better map (maps for presentation must be more definitive)
- 5a. We can get these or could get them. People have to know we know the area.
- have politicians
- legislative grouping – legislative coalition
- Haverford State Project (need to be an aware of project – how it can help downstream communities)
- Naylors Run Park
- Stormwater potential – can the park area absorb any more storm water in peak time
- Dumping/ Maintenance problems
- Citizens must participate – need to be part of the solution
- Stormwater backup by Cobbs – affects Veronica problem
- Bought Stevens property (Is this in this area? Need to clarify)
- Litter
- Veronica Road Day (Neighborhood Organization)
- School Curriculum Issues – students need to learn about this area
- Then they can
    - educate their parents
    - educate community via projects
- Two (2) clean up days
- Land acquisition (Nothing left)
- Public Education

Upper Darby Township
Meeting #2
Main Stem Western boundary of Upper Darby Township

Issues:

- Township Line Bridge at W. Rolling Road and Route 1 – level of the bridge
- Penn-Dot issue and cause excessive flooding
- Can create a catch basin at Township Line and Drexel Line Shopping Center
- Rosemont Bridge

  - "Absolute" but not to local residents
  - County has evaluated the bridge and deemed its safe
- Baltimore Pike Bridge
  - was there a streamside debris built?
- Causes excessive flooding condition at K-mart; buffer to have been part of K-mart development
- Kent Park
  - Adequate for local residents for passive recreation; part of county park system
- Thompson Tract (tract to watch) on Providence Road
- who prefer development to the rear of the site rather than adversely affect their properties
- Problem of roadway access to the tract
- Drexel Brook
  - Were proper permits for development obtained? Building in flood plain?
  - Question of removing riparian buffers
  - Question of altering course the stream
  - Example of visual blight parking lot designated spen. SP & CP; were any of these areas originally designated as open space when property was sold for Drexel Brook (need to check deed)?
  - Pollution
  - Problems of erosion
  - Effect on biological life – (fish, wildlife; concern for natural habitat; evidence of wildlife in spite of development; blue heron)
  - Litter
  - Noise Pollution
  - Access for trucks; with land fill – will cares use their access route – Tom Judge
  - Drexel Brook not to happen
  - Non-point pollution; runoff pesticides and fertilizers
- What is the Conservation District position? Concern for failure to obtain proper permits
- Correnti Property in Clifton Heights
  - with new owner, need to watch

Areas that need to be watched to protect from development, if at all possible
- Mozino Tract on State Road adjacent to Collenbrook; present zoning single family
- Whelan Tract on Creek Road
- Dayle property
- Clifton Heights - west of Boonies
- Positive move: need to identify recently donated land in Clifton Heights

Solutions - One Step at a time
- intermunicipality cooperation – mutual support for projects
- Education – need to educate public of the value to our quality of life; if we preserve our natural and cultural heritage

- Need to educate public as to cost or consequences of paving with impervious surfaces
- Taxpayer
- Education worth it – effect of consequence on property values
- Resources beyond municipal level should be shared equally between area of greater/ lesser wealth
- Why not funding for open space in Upper Darby? Question of representation in Eastern corridor of County; Open space task force planning commission; Need for inter-municipal support in eastern corridor
- Mozino Property – zoning single family
- Tract on Rt. 1

Upper Darby Township
Muckinipates Meeting #3
Fall 2001, Anne Ackerman Notes

- -Still flooding, back yards
- -Curb on development
    - Township is buying Stevens tract
- -Home Depot an example of controlling runoff; problem from Springfield runoff
- -Socioeconomic issues
- -People will work together (positive)
- -Need for education
- -Need for intermunicipal cooperation
- -Need for public input; leaks in sewer line – not line awareness
- -Preserve Morton Morton house in Norwood
- -? Of the Thompson tract on Providence Road, though not on Muck.

Upper Darby Township
Cobbs Creek Meeting #4
Fall 2001, Anne Ackerman Notes
(four people but good dialogue with councilman)

Concerns

- -More access from the park to Stonehurst short cut to Walnut Park Drive (?)
- -Erosion
- -Pollution
- -Public education most important
- -Environmental Center; need better public awareness and education of residents; Center as an asset
- -Especially for wetlands and non-invasive species
- -Concern for West Nile virus/mosquitos
- -Socioeocnomic concerns

- -Back up from Cobbs Creek into Upper Darby and Veronica Road; Army Corps dredging a possibility?
- -Maybe when Environmental Center opens, there could be some celebration for Upper Darby neighbors to create greater awareness
- -Cobbs Creek center just got a $167,000 grant for education

Municipalities (M)
County (C)
State/Federal (S/F)
Citizen Stakeholders (CS)
Businesses (B)
DCVA/other watershed organizations (DCVA)
Other nonprofit public interest groups (ON/PI)
Utilities/Authorities (U/A)
Schools/Educational (S/E)
Other (O)

GOAL-BASED ACTION PLAN FOR DARBY CREEK WATERSHED RIVER CONSERVATION PLAN

Summary: Draft Recommendations can be grouped roughly into several categories of actions:

- Municipal Regulation
  - Riparian
  - Wetlands
  - Floodplain
  - Stormwater
  - Open Space/Recreation
  - Ecological resource Protection
  - Cultural Resource Protection

- Specific Projects
  - Restoration
    - Floodplain, Riparian, Wetlands, Other
  - Stormwater
  - Recreation/Open Space

- Planning Process
  - Specific: Partnership
  - General: Watershed Planning

- Additional Detailed Study
  - See Detailed List.

- Education
  - Public Schools
  - Municipal Officials
  - Landowners
  - Libraries

APPENDIX B

Land use data by Municipality
DVRPC, 1995

Land Use Within the Darby Creek Watershed, by Municipality
(Data from DVRPC, 1995)

Darby Creek Watershed Municipality	Land Use Category	Area (sq. ft.) in Watershed	Acres in Watershed
Aldan Boro	commercial /services	1,242,070.67	28.51
	community service	260,050.69	5.97
	parking-commercial/services	286,265.28	6.57
	parking-community service	47,878.90	1.10
	recreation	411,377.03	9.44
	residential-row homes	586,369.80	13.46
	residential-single family detached	13,729,800.00	315.19
	water	19,414.60	0.45
	wooded	592,960.00	13.61
Clifton Heights Boro	commercial /services	3,668,085.07	84.21
	manufacturing-light	327,636.70	7.52
	parking-commercial/services	490,505.53	11.26
	parking-manufacturing	41,249.70	0.95
	recreation	872,379.54	20.03
	residential-multi family	416,793.73	9.57
	residential-row homes	5,187,083.40	119.08
	residential-single family detached	5,146,025.90	118.14
	utility	8,256.92	0.19
	water	183,569.80	4.21
	wooded	1,338,523.80	30.73
Collingdale Boro	commercial /services	2,816,760.10	64.66
	community service	4,180,986.07	95.98
	parking-commercial/services	185,161.33	4.25
	parking-community service	41,294.50	0.95
	recreation	1,121,232.30	25.74
	residential-multi family	8,853,086.60	203.24
	residential-row homes	2,170,189.50	49.82
	residential-single family detached	3,832,290.00	87.98
	vacant	130,640.00	3.00
	wooded	1,331,156.00	30.56
Colwyn Boro	commercial /services	661,548.00	15.19
	community service	367,161.30	8.43
	manufacturing-light	423,028.00	9.71
	parking-commercial/services	11,374.20	0.26
	parking-community service	14,835.70	0.34
	recreation	567,369.00	13.02
	residential-row homes	1,968,322.59	45.19
	residential-single family detached	1,244,486.91	28.57
	transportation	323,874.00	7.44
	utility	176,488.00	4.05
	water	473,054.10	10.86
	wooded	931,599.97	21.39

Darby Boro	commercial /services	2,785,149.15	63.94
	community service	4,233,128.00	97.18
	manufacturing-light	70,587.90	1.62
	parking-commercial/services	171,287.00	3.93
	parking-community service	197,468.70	4.53
	parking-multi family housing	23,122.14	0.53
	parking-recreation	26,029.00	0.60
	recreation	712,458.00	16.36
	residential-multi family	2,570,639.14	59.01
	residential-row homes	6,341,284.90	145.58
	residential-single family detached	3,048,620.80	69.99
	transportation	116,460.00	2.67
	water	467,573.57	10.73
	wooded	2,087,812.30	47.93
Darby Twp	commercial /services	2,976,020.50	68.32
	community service	4,904,438.10	112.59
	manufacturing-light	6,348,631.60	145.74
	parking-commercial/services	741,511.25	17.02
	parking-community service	101,163.10	2.32
	parking-manufacturing	108,468.19	2.49
	recreation	1,472,521.80	33.80
	residential-multi family	4,391,974.55	100.83
	residential-row homes	7,232,218.80	166.03
	residential-single family detached	4,652,151.41	106.80
	transportation	569,584.00	13.08
	utility	487,124.00	11.18
	vacant	2,626,616.90	60.30
	water	1,191,439.00	27.35
	wooded	1,842,398.00	42.30
East Lansdowne Boro	community service	244,701.90	5.62
	manufacturing-light	302,108.00	6.94
	recreation	28,427.30	0.65
	residential-row homes	1,713.31	0.04
	residential-single family detached	4,903,920.00	112.58
Easttown Twp	agriculture	11,130,394.60	255.52
	commercial /services	5,252,571.33	120.58
	community service	2,667,973.00	61.25
	parking-commercial/services	889,427.40	20.42
	parking-community service	341,819.00	7.85
	parking-multi family housing	132,288.68	3.04
	parking-recreation	19,159.66	0.44
	parking-transportation	144,238.00	3.31
	recreation	1,909,646.70	43.84
	residential-multi family	772,385.60	17.73
	residential-row homes	4,629,213.00	106.27
	residential-single family detached	105,953,134.90	2,432.35
	utility	121,137.00	2.78
	vacant	1,248,775.00	28.67
	water	330,495.80	7.59
	wooded	23,041,090.00	528.95

Folcroft Boro	commercial /services	1,858,263.00	42.66
	community service	429,363.40	9.86
	manufacturing-light	5,871,714.08	134.80
	parking-commercial/services	466,881.00	10.72
	parking-community service	61,679.10	1.42
	parking-manufacturing	1,000,134.70	22.96
	recreation	10,979,920.60	252.06
	residential-multi family	6,384,811.38	146.58
	residential-row homes	454,515.00	10.43
	residential-single family detached	3,762,746.00	86.38
	transportation	263,790.70	6.06
	vacant	63,091.50	1.45
	water	5,759,113.93	132.21
	wooded	1,485,107.70	34.09
Glenolden Boro	commercial /services	2,580,985.60	59.25
	community service	877,269.40	20.14
	parking-commercial/services	777,167.60	17.84
	parking-community service	107,483.00	2.47
	parking-multi family housing	32,743.10	0.75
	recreation	1,222,009.00	28.05
	residential-multi family	7,939,095.00	182.26
	residential-row homes	52,733.80	1.21
	residential-single family detached	10,409,059.50	238.96
	transportation	418,671.00	9.61
	utility	304,728.00	7.00
	vacant	838,796.00	19.26
	water	50,144.50	1.15
	wooded	1,612,240.70	37.01
Haverford Twp	commercial /services	8,817,694.99	202.43
	community service	14,445,147.80	331.62
	mining	1,259,040.00	28.90
	parking-commercial/services	1,734,980.29	39.83
	parking-community service	777,772.90	17.86
	parking-multi family housing	244,742.10	5.62
	parking-recreation	127,242.10	2.92
	recreation	25,084,163.00	575.85
	residential-multi family	7,078,279.70	162.49
	residential-single family detached	186,927,630.14	4,291.26
	transportation	2,283,362.25	52.42
	utility	374,636.40	8.60
	water	358,725.50	8.24
	wooded	28,729,257.00	659.53

Lansdowne Boro	commercial /services	2,755,722.50	63.26
	community service	593,626.00	13.63
	parking-commercial/services	439,865.80	10.10
	parking-community service	37,682.30	0.87
	parking-recreation	12,237.60	0.28
	recreation	1,088,280.30	24.98
	residential-multi family	346,426.00	7.95
	residential-row homes	3,191,645.40	73.27
	residential-single family detached	21,974,948.60	504.48
	water	269,637.00	6.19
	wooded	2,789,150.00	64.03
Lower Merion Twp	commercial /services	6,866,178.95	157.63
	community service	9,778,481.87	224.48
	parking-commercial/services	2,604,357.73	59.79
	parking-community service	1,049,661.02	24.10
	parking-multi family housing	264,004.95	6.06
	parking-recreation	91,380.80	2.10
	recreation	4,858,837.10	111.54
	residential-multi family	11,502,473.00	264.06
	residential-row homes	301,180.00	6.91
	residential-single family detached	64,474,975.92	1,480.14
	transportation	1,123,138.34	25.78
	vacant	27,937.30	0.64
	water	210,565.30	4.83
	wooded	5,295,476.60	121.57
Marple Twp	commercial /services	8,980,579.22	206.17
	community service	10,997,552.40	252.47
	parking-commercial/services	2,849,928.51	65.43
	parking-community service	686,995.60	15.77
	parking-multi family housing	24,966.10	0.57
	recreation	2,266,696.00	52.04
	residential-multi family	1,452,014.00	33.33
	residential-single family detached	72,909,785.00	1,673.78
	transportation	6,030,060.00	138.43
	utility	75,227.50	1.73
	water	293,570.90	6.74
	wooded	25,222,713.88	579.03
Millbourne Boro	commercial /services	436,751.90	10.03
	parking-commercial/services	385,890.30	8.86
	parking-transportation	23,959.40	0.55
	residential-multi family	617,446.00	14.17
	water	115,759.82	2.66
	wooded	312,922.00	7.18
Morton Boro	commercial /services	1,441,831.00	33.10
	parking-commercial/services	422,885.88	9.71
	parking-multi family housing	31,215.57	0.72
	residential-multi family	289,418.00	6.64
	residential-single family detached	6,996,855.10	160.63
	utility	48,013.60	1.10
	wooded	348,371.70	8.00

Narberth Boro	commercial /services	683,065.50	15.68
	community service	190,555.80	4.37
	parking-commercial/services	129,179.30	2.97
	parking-community service	34,004.30	0.78
	recreation	249,242.00	5.72
	residential-multi family	540,459.39	12.41
	residential-row homes	8,924.34	0.20
	residential-single family detached	9,023,590.00	207.15
	transportation	174,379.00	4.00
	wooded	273,869.30	6.29
Newtown Twp	agriculture	5,687,818.70	130.57
	commercial /services	2,061,839.32	47.33
	community service	2,189,822.04	50.27
	parking-commercial/services	179,110.10	4.11
	parking-community service	120,489.30	2.77
	parking-recreation	146,234.60	3.36
	parking-utility	30,263.30	0.69
	recreation	9,819,665.00	225.43
	residential-multi family	2,412,404.74	55.38
	residential-single family detached	68,732,240.18	1,577.88
	utility	66,133.60	1.52
	vacant	298,050.00	6.84
	water	315,768.80	7.25
	wooded	19,574,841.50	449.38
Norwood Boro	commercial /services	1,594,587.97	36.61
	community service	600,566.21	13.79
	parking-commercial/services	200,852.40	4.61
	parking-community service	42,685.30	0.98
	recreation	1,755,423.00	40.30
	residential-multi family	3,904,384.22	89.63
	residential-single family detached	10,893,024.81	250.07
	water	1,803,590.00	41.40
	wooded	1,867,731.00	42.88
Philadelphia	agriculture	378,129.00	8.68
	commercial /services	9,979,920.60	229.11
	community service	10,091,382.00	231.67
	manufacturing-light	1,004,739.20	23.07
	parking-commercial/services	858,804.40	19.72
	parking-community service	688,911.13	15.82
	parking-multi family housing	152,313.70	3.50
	parking-recreation	74,626.90	1.71
	parking-utility	48,030.30	1.10
	recreation	41,466,249.14	951.93
	residential-multi family	1,466,069.80	33.66
	residential-row homes	98,340,644.30	2,257.59
	residential-single family detached	2,394,551.90	54.97
	transportation	4,808,052.85	110.38
	utility	1,169,971.00	26.86
	vacant	4,195,501.65	96.32
	water	8,467,811.97	194.39
	wooded	222,736.20	5.11

Prospect Park Boro	commercial /services	2,554,142.00	58.64
	community service	1,341,976.20	30.81
	parking-commercial/services	62,762.50	1.44
	parking-community service	148,957.60	3.42
	parking-multi family housing	20,341.20	0.47
	parking-utility	19,428.90	0.45
	recreation	1,190,054.10	27.32
	residential-multi family	3,023,533.00	69.41
	residential-single family detached	11,709,040.00	268.80
	utility	26,143.10	0.60
	water	312,041.75	7.16
	wooded	363,407.90	8.34
Radnor Twp	agriculture	27,449,905.00	630.16
	commercial /services	11,675,382.40	268.03
	community service	14,319,612.80	328.73
	parking-commercial/services	4,549,192.05	104.43
	parking-community service	1,454,092.52	33.38
	parking-multi family housing	292,542.80	6.72
	parking-recreation	207,170.50	4.76
	recreation	20,897,965.28	479.75
	residential-multi family	10,173,397.90	233.55
	residential-single family detached	181,816,745.30	4,173.94
	transportation	5,016,270.00	115.16
	vacant	895,674.00	20.56
	water	472,959.18	10.86
	wooded	35,766,161.00	821.08
Ridley Park Boro	commercial /services	1,217,367.30	27.95
	community service	249,927.50	5.74
	parking-commercial/services	262,139.50	6.02
	parking-community service	76,700.70	1.76
	recreation	335,453.00	7.70
	residential-multi family	33,402.80	0.77
	residential-row homes	210,367.00	4.83
	residential-single family detached	7,903,620.00	181.44
	wooded	1,348,860.00	30.97

Ridley Twp	commercial /services	5,291,154.03	121.47
	community service	1,808,944.40	41.53
	manufacturing-heavy	1,306,500.00	29.99
	manufacturing-light	1,524,010.00	34.99
	military	248,419.00	5.70
	parking-commercial/services	637,806.20	14.64
	parking-community service	92,697.20	2.13
	parking-manufacturing	1,067,393.43	24.50
	parking-military	63,206.40	1.45
	parking-multi family housing	222,152.80	5.10
	recreation	964,952.33	22.15
	residential-multi family	5,755,038.03	132.12
	residential-row homes	381,645.00	8.76
	residential-single family detached	33,688,953.67	773.39
	transportation	764,481.00	17.55
	utility	499,998.30	11.48
	vacant	1,274,600.00	29.26
	water	1,005,652.30	23.09
	wooded	2,818,698.20	64.71
Rutledge Boro	commercial /services	19,100.60	0.44
	community service	50,101.79	1.15
	recreation	22,023.00	0.51
	residential-single family detached	2,660,380.00	61.07
Sharon Hill Boro	commercial /services	1,647,048.50	37.81
	community service	587,636.04	13.49
	manufacturing-light	2,718,350.00	62.40
	parking-commercial/services	385,489.50	8.85
	parking-community service	203,236.50	4.67
	parking-manufacturing	678,720.80	15.58
	parking-multi family housing	58,196.40	1.34
	recreation	947,858.60	21.76
	residential-multi family	3,059,709.68	70.24
	residential-row homes	2,524,448.00	57.95
	residential-single family detached	5,922,473.00	135.96
	transportation	755,286.00	17.34
	utility	185,766.00	4.26
	vacant	56,634.91	1.30
	water	275,664.90	6.33
	wooded	1,567,134.50	35.98

Springfield Twp	commercial /services	4,481,792.13	102.89
	community service	2,956,484.44	67.87
	parking-commercial/services	3,989,887.29	91.60
	parking-community service	85,961.70	1.97
	parking-recreation	223,133.10	5.12
	recreation	9,454,792.90	217.05
	residential-multi family	191,442.90	4.39
	residential-row homes	3,468.04	0.08
	residential-single family detached	71,575,529.66	1,643.15
	transportation	309,430.00	7.10
	utility	389,614.00	8.94
	vacant	808,143.00	18.55
	wooded	11,780,961.55	270.45
Tinicum Twp	commercial /services	1,926,846.01	44.23
	community service	644,809.60	14.80
	manufacturing-light	5,980,945.10	137.30
	parking-commercial/services	3,174,042.00	72.87
	parking-community service	474,310.00	10.89
	parking-manufacturing	1,210,338.00	27.79
	parking-transportation	677,464.00	15.55
	recreation	15,649,220.20	359.26
	residential-multi family	1,563,633.00	35.90
	residential-single family detached	8,619,290.00	197.87
	transportation	17,688,906.00	406.08
	utility	236,722.00	5.43
	vacant	7,543,537.90	173.18
	water	7,661,791.70	175.89
	wooded	2,340,377.00	53.73
Tredyffrin Twp	commercial /services	5,027,542.96	115.42
	community service	544,867.60	12.51
	parking-commercial/services	1,130,486.00	25.95
	parking-community service	35,854.53	0.82
	parking-multi family housing	280,692.20	6.44
	parking-transportation	48,702.60	1.12
	recreation	416,928.45	9.57
	residential-multi family	2,024,473.59	46.48
	residential-single family detached	13,163,673.00	302.20
	wooded	267,019.00	6.13

Upper Darby Twp	commercial /services	18,517,871.60	425.11
	community service	17,358,376.55	398.49
	manufacturing-light	1,758,198.26	40.36
	mining	5,350.49	0.12
	parking-commercial/services	4,373,687.60	100.41
	parking-community service	902,160.45	20.71
	parking-manufacturing	85,058.30	1.95
	parking-multi family housing	285,615.40	6.56
	parking-recreation	117,053.60	2.69
	parking-transportation	283,002.20	6.50
	recreation	9,080,966.23	208.47
	residential-multi family	18,757,005.20	430.60
	residential-row homes	32,783,661.15	752.61
	residential-single family detached	89,326,980.14	2,050.66
	transportation	3,395,441.00	77.95
	utility	1,121,276.10	25.74
	vacant	738,418.00	16.95
	water	807,159.25	18.53
	wooded	17,681,921.00	405.92
Yeadon Boro	commercial /services	517,864.10	11.89
	community service	10,544,039.60	242.06
	manufacturing-light	2,648,115.90	60.79
	parking-commercial/services	170,933.00	3.92
	parking-community service	105,797.10	2.43
	parking-manufacturing	63,428.90	1.46
	parking-multi family housing	629,506.40	14.45
	recreation	1,498,322.20	34.40
	residential-multi family	1,602,584.00	36.79
	residential-row homes	3,966,828.45	91.07
	residential-single family detached	15,043,938.00	345.36
	vacant	223,165.70	5.12
	water	634,220.13	14.56
	wooded	7,216,630.00	165.67

APPENDIX C

Ordinance Review
Summary of Municipal Planning in the Darby Creek Watershed

In the sections below, we inventory and quickly evaluate the planning documents for the municipalities within the Darby Creek Watershed, which have been provided to us. All of the 31 municipalities in the four different counties have adopted comprehensive plans, adopted zoning ordinances, and adopted subdivision/land development regulations (although several in Delaware County still rely on a set of subdivision/land development regulations prepared by Delaware County in 19__). As has been pointed out throughout this RCP, a major challenge for at least some Watershed municipalities has been provision of state-of-the-art municipal services, including planning. Many of these municipal plans and ordinances are quite old and reflect outdated technical approaches to stormwater management, for example. Given the extreme fiscal competition for every budget item, major updating of plans and ordinances is going to be a huge challenge, however critical it may be.

These planning and management documents are important to this RCP for a variety of reasons. In terms of more general **comprehensive planning**, obviously it is of great importance how each municipality is planning for (i.e., "visioning") its respective future. Because comprehensive plans can take different forms and be structured in different ways, however, it is difficult to develop a simple and concise list of essential comprehensive plan ingredients to demonstrate RCP compatibility. Some basic issues—questions—do emerge. To what extent is the conservation and preservation of the stream valley and its tributaries set forth in the comprehensive plan (or any other plan) as a goal and/or objective? Are related environmental features addressed in the comprehensive plan and integrated into plan implementation recommendations? Are related cultural and historical values as discussed in the RCP inventoried and highlighted in the comprehensive plan; are goals and objectives established? Are recreational goals and objectives adequately defined; are recreational facilities inventoried and evaluated for adequacy (this could be dealt with in a separate recreation and open space plan if such exists)? In the implementation sections of the comprehensive plans, are there projects identified in the individual plans which can be related to the recommendations developed here for the RCP?

In terms of the implementing **zoning ordinance and subdivision/land development regulations**, again it is difficult to develop a concise list of minimum zoning ingredients necessary for RCP compatibility. Most importantly, zoning typically dictates how floodplain and riparian zones are regulated, what uses and disturbances are allowed, and so forth. Other environmental values such as wetlands and steep slopes and woodlands may also be addressed and managed in zoning. Also of importance is the entire approach given to growth and development as established in the zoning ordinance and how development and re-development is structured. Approaches in the densely developed "bottom" of the Watershed clearly can be expected to be different than approaches at the "top" of Watershed where development patterns are less dense and where innovative planning techniques such as clustering and conservation design have greater potential. Are municipalities here striving to concentrate development and maximize retention of open space where feasible?

In terms of **subdivision and land development regulations**, a variety of specific provisions are of interest, but certainly the area of greatest concern focuses directly on stormwater management and the extent to which .both water quantity and water quality are being comprehensively and effectively managed. Wastewater regulations also are set forth in subdivision, though because of the preponderance of public sewerage coupled with the manner in which this sewage is collected and treated, subdivision requirements are of limited relevance here. A variety of other development provisions are indirectly relevant as well, such as pavement width, curbing requirements, landscaping requirements, grading, and sediment and erosion control.

Not all municipalities have provided planning documentation during this RCP planning process. The summaries below are based on that information which has been provided to the RCP technical staff, after several requests have been made during the last 18 months.

Aldan Borough

- **Comprehensive Plan, 1975-1990, Excerpt.** This brief excerpt highlights the problem of flooding in Aldan.
- **Zoning.** Not provided.
- **Subdivision/Land Development.** Not provided.

Darby Borough

- **Comprehensive Plan, 1991, Excerpt.** The Plan addresses serious flooding problems in the Borough, inventorying flood problems and making recommendations as developed in the 1980 US Army Corps of Engineers report (widening of the stream channel and removal of obstructions).
- **Zoning.** Not provided.
- **Subdivision/Land Development:** Not provided.

Easttown Township

- **Comprehensive Plan, June 2001, Ray Ott and Associates.** This excellent plan first designates the bulk of the Darby Creek portion of the Township as "Low Density Suburban" (with densities less than one unit per acre, though portions of the Darby are also designated in higher density uses (the intent is to guide development in a manner similar to growth boundaries. An array of sophisticated recommendations is established to attempt to concentrate development in the most environmentally sensitive ways possible (vacant developable parcels do remain in the Darby but are not extensive). The Plan address natural resources in detail, as well as recreational and cultural resources. Specific recommendations are set forth for open space and recreation (referring back to the considerable 1993 Recreation, Open Space and Environmental Resources Plan), including the acquisition of easements or fee simple ownership of all unprotected lands adjacent to Darby Creek. Preparation of a Historic Preservation Plan is advanced. Elaborate biking and pedestrian trail recommendations are developed, although not specifically following stream valley greenways. The Plan calls for significant changes to improve stormwater management, congruent with RCP recommendations, as well as development of riparian buffer and wetlands zones along Township streams, all critical recommendations in this RCP. The Township and the Watershed has benefited substantially from donation of conservation easements (both public and private) in Easttown Township, including the very large Waterloo Mills Preserve now owned by the Brandywine Conservancy (also in Newtown Township); the Plan calls for continued use of this important opens space preservation technique, in addition to Township purchase where feasible.

- **Zoning, 1997 As Amended.** This ordinance includes a floodplain conservation district which is congruent with FEMA recently revised standards; prohibitions could be more rigorous. Other specific environmental regulations are lacking, though are discussed in the new Comprehensive Plan (above). Innovative techniques such as lot averaging are included here.
- **Subdivision and Land Development Ordinance 118, Updated.** This ordinance appears to be relatively standard and lacks important stormwater and other RCP-recommended provisions. These recommendations are included in the Comprehensive Plan, as discussed above. Development-related provisions (i.e., road widths, etc.) need to be scrutinized as well.

Glenolden Borough

- **Comprehensive Plan 1997.** This Plan, though brief, sets forth recommendations for better floodplain management and better steep slope management and better management of stormwater and wetlands which are quite consistent with the RCP recommendations. Cultural resources are also addressed.
- **Zoning.** Not provided.
- **Subdivision/Land Development.** Not provided.

Haverford Township

- **Comprehensive Plan, 1988 Volume I.** In terms of goals and objectives, this Plan relates only indirectly, encouraging enlargement of the Township's existing network of parkland as well as preservation of private open space. Cultural resources are discussed at great length with detailed recommendations made about further cultural resource work in Haverford (see Section VI). There is an excellent discussion of streams and stream valleys in the natural resources section, as well as good discussion of the functions of floodplains, woodland areas, and other natural features. The Plan argues for better management of stream valleys, where floodplain, woodlands, and steep slopes coincide in many cases. Stream valleys should be viewed as important elements in the open space system.
- **Comprehensive Plan, 1988 Volume II.** This Plan recommends the completion of greenways along Darby Creek as well as Ithan and Cobbs Creeks. There is a Darby Creek Valley Park designated along the entire length of the Township's long Darby

Creek boundary; a proposed bikeway is designated throughout this Darby Creek Valley Park. Other additions to the recreation system also are developed. Extensive stormwater management recommendations are developed as well; unfortunately the majority of these recommendations reflect a peak rate focus with the objective being the more rapid disposal/removal of stormwater from the Township. This costly approach, requiring a variety of capital improvements, would only worsen flooding downstream. The Plan includes an implementation section but this section is quite summary in nature and is quite weak.

- **Zoning.** Not provided; includes standard FEMA floodplain requirements.
- **Subdivision/Land Development, As Amended to Current.** This ordinance has special requirements for historic structures (Article IV), compatible with Draft RCP recommendations; see further discussion in Section VI. Provisions for stormwater management are quite conventional and need to be updated to be made compatible with Draft RCP recommendations. Other environmental provisions are quite general and should be made more specific, such as steep slope protection. There is provided protection of large trees as well as masses of trees, with the requirement for replacement. Similarly, floodplains requirements appear to be FEMA program-focused with the primary intent being prevention of damage to property and loss of life, rather than the careful preservation of the soil and vegetation within the floodplain area.

Lower Merion Township

- **Comprehensive Plan 1979 (Volume I and II**). Lower Merion Township has done extensive planning. In addition to the documents provided here, the Township has also produced an Open Space and Environmental Resource Protection Plan, a Scenic Road Corridor and Viewshed Analysis, and a Lower Merion Township Natural Areas Study which have not been provided or reviewed for this report. The existing Comprehensive Plan is dated and is likely to be superseded by these various other official and unofficial documents. The bulk of the Township is located outside of the Darby Creek Watershed, although a critical portion along Lancaster Avenue, including most of Ardmore, and extending to City Line Avenue, is located within the Darby Creek Watershed. This Plan does include a variety of recommendations for the Darby Creek Watershed portion of Lower Merion, although these recommendations are not related to the stream system per se. For example, a hiking/biking route is proposed; however the proposal appears to follow the existing street system and not the stream system.
- **Park and Recreation Plan 1996:** The focus of this Plan is primarily recreational facilities. Furthermore, much of the discussion relates to areas beyond the Darby Creek Watershed portion of the Township. There is a section which addresses trails/ hiking/biking though this is not a focus in the plan recommendations.
- **Zoning Ordinance, Chapter 155, 2000.** This new ordinance includes some excellent provisions. There are special sections on wooded lots, steep slopes,

floodplains, and an historic resource overlay district. The Historic Resource Overlay District, as discussed above in Section VI, creates a management district through a mapped overlay, based on a detailed historic resource inventory. The floodplain district includes basic FEMA program requirements. Steep slope requirements mandate enlargement of lot areas as slope increases. Removal of wooded areas is also regulated, to both limit removal of existing trees and require replanting of trees when trees are removed. A variety of other provisions are included in this code which are generally compatible with the overall recommendations of the Draft RCP to concentrate development and limit development of open space (all undeveloped residential lots greater than five acres must adhere to the open space overlay requirements, requiring 50 to 60 percent open space preservation). Surprisingly, there are no riparian area protection provisions in this ordinance. This is probably the most "RCP-compatible" ordinance in the Watershed.

- **Subdivision/Land Development, Chapter 135, 1998.** This relatively new ordinance keys in other Code Chapters, including Chapter 121 Stormwater and Chapter 101 Natural Features Conservation (mirroring zoning requirements) and Chapter 149 Watercourses. These stormwater requirements are closer to those being recommended in the Draft RCP than any others in the Watershed, given their attention to recharge and infiltration as well as water quality (ironically, the requirements for recharge, assuming they are being implemented, actually exceed requirements for recharge being recommended in the Draft RCP by calling for recharge of storms up to the 100-year storm). It should be noted, however, that requirements vary substantially by district, and because the Darby Watershed portions of the Township happen to fall into the least rigorously managed districts, the positive effects of the ordinance are somewhat lost on the Darby Creek Watershed.

Marple Township

- **Comprehensive Plan, April, 1991, Norman Day.** The Land Use Plan map does show an OS category though it is designated in very limited areas along the Darby Creek system, including small portions though not all of the floodplain area itself, as well as the alluvial soils, hydric soils, high water table soils which also are mapped. Some significant portions of "OS" are designated for the very large Archdiocese parcels at the Sproul Road/Blue Route intersection. The good news is that a Conservation and Recreation Plan is developed with two major areas of park acquisition established (it is not clear what the status of these projects is currently). Unfortunately, neither of these facilities, the Langford and Lawrence Roads facility and the South Sproul Road facility (between Reed Road and the Blue Route) relate to the Darby Creek system. Unfortunately, although the Plan contains some interesting elements and recommendations that can be interpreted as compatible with those in the RCP, there is relatively little discussion of and appreciation for the Darby Creek and its tributaries per se in this Plan. There is little in the way of stream valley awareness, environmentally or recreationally, for either the Darby Creek or the Crum Creek, both of which embrace the Township. Perhaps this can be explained at least on the Darby side by the reality of the Darby Creek valley being so impacted by the Blue Route pathway down the stream valley, obliterating so many stream values.

- **Zoning, Amended May 1998**, possibly more recently. Based on excerpts supplied to us, the zoning requirements do encourage some clustering and resource protection (an RCP positive). We have not been able to review the entire ordinance and its requirements for each district, however. Environmentally, the ordinance does have a specific section for environmental protection, adopted in 1998, which paraphrases the Ridley Township ordinance (basically, this includes the new and more elaborated requirements under FEMA for floodplain protection and some protection for two categories of steep slopes, though in neither case are the requirements sufficiently absolute to fully protect floodplain and steep slope areas from any encroachment or disturbance). Additionally, the requirements also add tree protection for trees in excess of 12 and 18 inches in diameter, including tree replacement. There is protection provided for historic resources through demolition permits and other requirements. Buffers also are required to protect incompatible uses; it should be noted that this is not a riparian buffer program but a landscape buffer program designed to maximize screening effects (i.e., aesthetics, noise, etc.) of proper landscaping between adjacent land uses.
- **Subdivision/Land Development Regulations:** Not provided.

Narberth Borough

- **Comprehensive Plan.** Not provided.
- **Zoning, Chapter 124, Undated (Current Amendments through 2001).** This ordinance is conventional for this highly developed borough. There are no environmental provisions per se, such as a floodplain district.
- **Subdivision/Land Development Regulations, Chapter 113, As Amended 1985. Includes Stormwater Management Ordinance 863.** This ordinance is patterned after Lower Merion's Chapter 121. See the discussion above. The body of the SLDO is otherwise conventional.

Newtown Township

- **Comprehensive Plan**. Draft October 2001. This draft unofficial plan is a sophisticated planning document that is largely consistent with RCP recommendations, even though the Draft Plan does not acknowledge the Darby Creek RCP process and does not address the Darby Creek system (or the Crum Creek for that matter) to any degree in terms of inventory or analysis. Both recreational facilities and cultural facilities are well documented. The detailed Growth Management Plan (p. 3-2-1) sets forth Development Pattern goals to "…Preserve and enhance the physical and environmental characteristics…" and "…minimize degradation of the natural and cultural environments…" and Conserve open areas…." Policies include promoting residential clustering and establishing a permanent open space network and expanding the trail system and parklands in selected locations.

Community Services policies are even more detailed, including promoting development of a network of cycling and pedestrian paths through open spaces and along roadways and utility corridors (unfortunately no mention is made of the stream systems), working to create more open space linkages, using clustering to enhance recreational and open space areas and their interconnection, and other recommendations. Resource Protection goals, objectives, and policies are set forth and at least indirectly address the Darby through focus on wetlands and floodplains and streams. Cultural resources and aesthetics are emphasized and stressed. A Land Use Plan is developed (p. 3-3-1) which underscores the need for "…an extensive system of open space throughout the township…" with "Greenways along major roadway corridors… ...Based as it is on existing natural features such as floodplains associated with Crum Creek, Darby Creek and their tributary stream courses, the system can be said to be at least partly established already….The Land Use Plan incorporates these significant natural resource areas, including woodlands, together with recreational lands, buffers, and greenways, to create the open space framework for the community….The continuous, interconnected, permanent open space network is intended to serve several purposes: 1) to conserve areas of environmentally-sensitive and culturally-valuable resources; 2) to provide appropriate buffers, where possible, between areas of incompatible land use; 3) to provide a structure for the extension of the township's trail system; 4). to permit pedestrian and bicycle access to a variety of destinations, including adjacent and nearby residential developments, schools, special natural features, shopping, and specific sites for recreational facilities; 5). to create sites where public recreational facilities may be developed; 6). to provide for some of the private open space and recreational space needs of the residents of new residential developments; 7). to provide appropriate buffers between high-volume traffic arteries and residential areas; and 8). to maintain and enhance wildlife habitat." (p. 3-3-2)

- **Zoning Ordinance.** Map provided but Zoning Ordinance not provided. There are both floodplain (Chapter 91) and steep slope overlay districts (Chapter 134) in the Township. The floodplain district is consistent with minimum FEMA program requirements and therefore allows more disturbance to the floodplain than is recommended in this Draft RCP. The steep slope district requirements are good and limit disturbance to the two slope districts which are created.
- **Subdivision/Land Development Regulations, 1995.** This ordinance includes provisions for recreation and open space lands (1 acre per 40 lots). These stormwater regulations have been amended to require infiltration. Chapter 104 Natural Features and Landscaping also is provided which reinforces the requirements from the zoning ordinance, with special emphasis on vegetation, buffering, landscaping (the most elaborate landscaping ordinance in the Watershed; much of this ordinance is driven by aesthetics, as well as environmental functions and benefits).

Prospect Park Borough

- **Comprehensive Plan.** Being updated.

- **Zoning, 1993**. Map provided. The zoning appears to be relatively simple for this small borough; there are no special conservation-related designations on the map, such as a floodplain conservation district.
- **Subdivision/Land Development Regulations.** Not provided.

Radnor Township

- **Comprehensive Plan. Norman Day, 1988.** A new comprehensive plan is being prepared. This existing plan stresses open space in a variety of ways, plus recreational needs and cultural resource protection. In fact, both recreation and cultural resources are dealt with extensively. A Park, Public Recreation and Open Space Network Concept is developed (p. 42) and sets forth an elaborate system of Open-Space Pathways/Linkages (Bike or Pedestrian Paths); unfortunately, this system tends to follow existing roadways rather than the stream corridor system. A listing of the most important recommendations focuses on natural resources and open space features (floodplains, woodlands steep slopes, wet soils, and so forth). Nevertheless, the importance of the Darby Creek and its tributaries is not given substantial treatment either in the setting forth of Environmental Goals (p. 17) or Recommendations (p. 21; several of the recommendations do indirectly relate to stream corridor protection). In terms of general growth management, the Plan establishes RCP-compatible goals and identifies RCP compatible recommendations for that point in time.
- **Parks, Recreation and Open Space Plan, Carter Van Dyke, 1991.** Very few other municipalities in the Watershed have developed detailed recreation plans, especially one that is as complex as this Plan. This Plan builds on the 1988 Comprehensive Plan and elaborates in the inventory of existing facilities, need for additional facilities, and specific plans for expanding the recreational system. The few remaining open space parcels are identified and evaluated. An open Space Plan is developed. Stream corridors are delineated schematically rather than representing specific resources in detail. Preservation of opens pace within stream corridors will ensure protection of sensitive natural resources such as floodplains, wetlands and adjacent steep slopes, and provide linked areas of contiguous open space for wildlife habitat. Some stream corridors may provide potential locations for trails as shown on the pedestrian/cyclist plan."). Additionally, some detailed discussion is given to pedestrian/bicycle trail network. "To help foster support for a township-wide trail system, the township should actively pursue a demonstration project such as the Darby Creek Trail or other multi-purpose trail." (p. IV.5) The Darby Creek Trail is defined as a trail that would parallel the Little Darby Creek and create a spine to connect the Willows Park, Skunk Hollow Park, and Sawmill Parks; with most of the land already under Township ownership, implementation should be facilitated. The trail would increase usage of Skunk Hollow and Sawmill.
- **Zoning Ordinance, Chapter 280, May 2001.** This zoning ordinance, which has been updated multiple times, includes a variety of requirements which are consistent

with and promote RCP recommendations. Article XX includes lot averaging, slope controls, and wetlands controls. Article XVII focuses exclusively on floodplain protection, although again the requirements are generally consistent with minimum FEMA requirements and still allow for disturbance of floodplain soil mantle and natural vegetation. Article XIX addresses density modification and promotes clustering and open space although these requirements could be more far-reaching. There are no riparian zone requirements. The overall structure of uses and their requirements are relatively conventional.

- **Subdivision Regulations, Chapter 225, September 2000.** Stormwater requirements are quite traditional and surprisingly summary in nature. Major work is needed here. Other requirements are similarly conventional, including street widths and curbing and the like (meaning that these requirements need to be made to be compatible with RCP recommendations which strive to minimize land disturbance at a development site and impervious area and stormwater generation).

Ridley Township

- **Comprehensive Plan, 1974, Buchart-Horn.** The Plan identifies floodplain and steep slopes, as well as soils and their suitability for development. The Future Land Use Map very clearly designates all streams and stream valleys as "Open Space/ Recreation." Some specific recreation facilities are set forth in the five-year capital program but due to the age of this Plan, this recommendation is of limited value.
- **Zoning, May 2001.** This very new ordinance allows for Planned Residential Developments, which is beneficial. There also are both Floodplain and Steep Slope Districts, with detailed floodplain requirements which reflect the recently revised FEMA requirements for the flood insurance program (floodplain disturbance is still allowed). The Steep Slope requirements are a step in the right direction but should be additionally tightened to further discourage any soil/vegetation disturbance of any type, especially on the greater than or equal to 25 percent slope category.
- **Subdivision and Land Development Regulations, Chapter 268, March 2001.** Stormwater focuses on peak rate control only and is quite summary. Other elements are similarly unsophisticated from an environmental perspective.

Sharon Hill

- **Comprehensive Plan.** Not provided.
- **Zoning, 1995.** Although this ordinance is relatively new, it includes no environmental provisions, such as floodplain protection and riparian zone protection, per se.
- **Subdivision of Land, Chapter 108.** These regulations are minimal. Stormwater is addressed minimally. Floodplain protection is addressed minimally here rather than in the zoning ordinance. No other environmental requirements as recommended in the RCP are included.

Springfield Township

- **Comprehensive Plan, 1983.** This rather dated Plan is relatively weak in its treatment of natural resources, although steep slopes and floodplains are discussed in some detail. The reality of the Darby Creek and its tributaries appears to be very removed from this Plan. On the other hand, the Plan does focus on historic preservation and both inventories and recommends additional management for the resources which exist. Recreationally, the Plan also inventories existing facilities and recommends that additional facilities be developed. There is virtually no mention of open space protection/preservation.
- **Zoning, March 2001.** This new zoning ordinance includes PRD provisions and an open space development option in the A residence District, as well as the updated FEMA floodplain regulations which still allow disturbance. For the good, open space provisions are added in Article 18, which unfortunately are relevant only to very limited situations. There are no special riparian area or wetland or steep slope or other environmental provisions, as recommended in the RCP.
- **Subdivision and Land Development, Chapter 123, 2000.** Although stormwater requirements have been updated and expanded, the focus remains on peak control; these regulations do not adequately address water volumes and water quality. Other elements of land development also need to be scrutinized and modified to minimize impervious areas and disturbance occurring with land development.

Tinicum Township

- **Comprehensive Plan.** Being revised.
- **Zoning, Chapter 61, March 2000.** This ordinance does not include environmental restrictions. Also provided is a proposed project, the Riverfront Zoning Extension, which appears to alter existing zoning with a Long Hook Creek Project, extending the Creek's open flow between the Darby Creek and the Delaware River.
- **Subdivision/Land Development Regulations.** Being Revised.

Tredyffrin Township

- **Comprehensive Plan, 1987.** This plan, which may have been updated, deals in depth with cultural and natural resources. Because only a small portion of Township is located within the Darby Creek Watershed, relatively little is said about the Darby Creek, however. Most of the Watershed area is comprised of relatively low-density residential uses which are projected to remain as low density residential uses in the Plan.
- **Open Space, Recreation, and Environmental Resources Plan, Draft 1992**. This Plan builds on the Comprehensive Plan. This Draft copy did not include maps, which is a significant drawback. Recommendations include a variety of specific zoning and SLDO-linked recommendations with both environmental, recreational, and cultural resource ramifications. Although these specific recommendations do not relate specifically to the Darby Creek Watershed, they are very much consistent with the

RCP recommendations. Unfortunately, although much is said about a walkway/trail network, proposed locations for the system are all outside of the Darby Creek Watershed.

- **Zoning, Amended 1979.** No map provided. This version of Zoning, which may have been updated, includes a floodplain protection district (minimum floodplain requirements)and a rural conservation district (minimum lot size of 5 acres). Additionally, requirements for steep slopes and other sensitive natural features are included, compatible with the SLDO ordinance requirements (below). A variety of clustering and lot averaging provisions are included to promote open space preservation.
- **Subdivision/Land Development Regulations, Chapter 181, July 1998.** These regulations include requirements for a Natural Features Conservation Plan, an Erosion, Sedimentation and Stormwater Control Plan, and a Landscape Plan. Natural Features requires the mapping of steep slopes, a variety of types of vegetative cover in detail, wetlands, geological formations, floodplains, soils with their constraints, and trails (pedestrian and equestrian). Detailed analysis of impacts is required. Exact standards establishing limits of impact are not always developed, though there are also detailed natural features protection standards presented as well. In terms of stormwater management, this ordinance sets forth what is probably the most sophisticated stormwater management program in the Watershed, including total volume control and water quality in its requirements. Recreation and open space requirements are established. Three pages of minimum and general landscaping requirements are included. Some building requirements such as street widths and so forth should be revisited to minimize impervious cover. Although the ordinance does have some shortcomings in terms of the RCP recommendations, nevertheless, this is one of the best SLDO's extant within the Watershed. Other municipalities should review this ordinance carefully.

Upper Darby Township

- **Comprehensive Plan.** Not provided. The Township did provide a detailed listing of all parks and recreation area facilities in the Township.
- **Zoning Ordinance, No. 2906, 2001 (With Map).** A separate Upper Darby Township Floodplain Ordinance exists but was not provided. There is also a Shade Tree Ordinance.
- **Subdivision/Land Development Regulations**. Not provided.

Summary of Planning Documents in the Darby Creek Watershed, Delaware County (as provided with the assistance of the Delaware County Planning Department, Summer 2001)

Municipality	**Comp. Plan**	**Zoning**	**SLDO**
Aldan	1975	1990	1990
Clifton Heights	1975	1993	County
Collingdale	1971(5)	1993	County
Colwyn	1971	1994	
Darby Bor.	1991	1998	County
Darby Twp.			
Folcroft	1982	1990	County
Glenolden	1997	1987-95	County
Haverford	1988	1984-96	1993
Lansdowne			
Marple	1990	1999	1978-85
Newtown	In prep.	1995	1995
Norwood	1982	1975-90	County
Prospect Park	1967	1994(?)	
Radnor	1988; in prep.		
Ridley	1974	1990	1982
Ridley Park	1998	1990	1989
Rutledge	1971	1998	1976
Sharon Hill	1971	1995	1974-81
Springfield	1983	1997	1995
Tinicum	1981	In prep.	1993
Upper Darby	1989	1986	County
Yeadon	In prep.		County

SLDO Subdivision/Land Development Ordinance

APPENDIX D

John Heinz National Wildlife Refuge at Tinicum
Bird Species List

U.S. Fish and Wildlife Service

John Heinz National Wildlife Refuge at Tinicum is one of over 500 refuges in the national wildlife refuge system administered by the U.S. Fish and Wildlife Service. The national wildlife refuge system is a network of lands and waters managed specifically for the protection of wildlife and wildlife habitat and represents the most comprehensive wildlife management program in the world. Units of the system stretch across the United States from northern Alaska to the Florida Keys and include small islands in the Caribbean and South Pacific. The character of the refuges is as diverse as the nation itself.

The Service also manages national fish hatcheries, and provides Federal leadership in habitat protection, fish and wildlife research, technical assistance and the conservation and protection of migratory birds, certain marine mammals and threatened and endangered species.

For further information, contact:

Refuge Manager
John Heinz National Wildlife Refuge at Tinicum
Scott Plaza 2, Suite 104
Philadelphia, PA 19113
Telephone: (610) 521-0662

or

Visitor Contact Station
86th Street & Lindbergh Boulevard
Philadelphia, PA 19153
Telephone: (215) 365-3118

Hard of hearing or deaf visitors may call the Pennsylvania Relay Center at 1-800-654-5984 TDD/1-800-654-5988 voice.

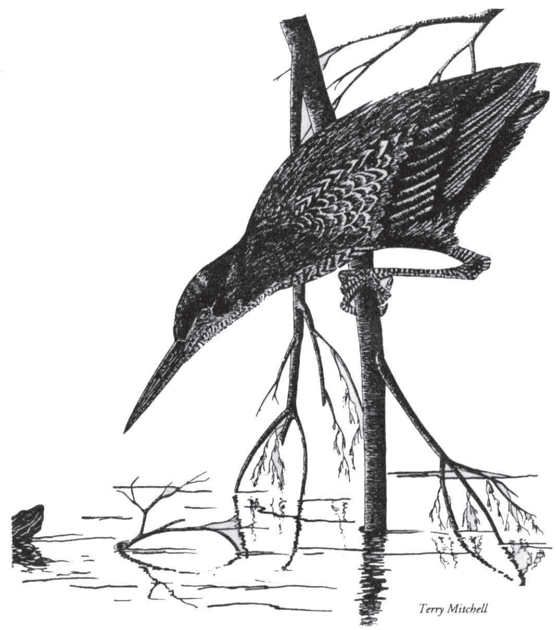
This list was compiled with the aid of John C. Miller, Prospect Park, Pennsylvania.

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

RL-52550 September 1994

Birds

JOHN HEINZ National Wildlife Refuge at Tinicum

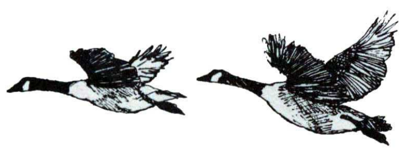


Philadelphia, Pennsylvania

John Heinz National Wildlife Refuge at Tinicum is located in Philadelphia and Delaware Counties, Pennsylvania, about one mile from the Philadelphia International Airport. The refuge was established by public law in 1972 to protect the last 205 acres of freshwater tidal marsh in pennsylvania. When acquisition is completed, the refuge will total nearly 1200 acres.

Diking, dredging and filling over the years have created a wide variety of habitat conditions at the refuge from stream, pond, and tidal marsh to oldfield and lowland woods.

Bird watchers have recorded 288 species of birds on the refuge and its immediate environs. Over 85 species have nested here. Migratory birds such as Canada geese, great blue herons, egrets, kildeer, sandpipers, and a large variety of ducks within the Atlantic Flyway use the refuge as a resting and feeding stop during spring and fall. In addition, approximately 35 species of warblers visit the refuge during their migration.



This brochure lists 288 birds that have been identified on the refuge, and is in accordance with the Sixth American Ornithologists Union Checklist.

Most birds are migratory, therefore, their seasonal occurrence is coded as follows:

SEASON

s	Spring	March – May
S	Summer	June – August
F	Fall	September – November
W	Winter	December – February

RELATIVE ABUNDANCE

a	abundant	a species which is very numerous
c	common	likely to be seen or heard in suitable habitat
u	uncommon	present, but not certain to be seen
o	occasional	seen only a few times during a season
r	rare	may be present but not every year

• *Birds known to nest on or near the refuge*
Italics indicate threatened/endangered species

	s	S	F	W
LOONS – GREBES				
___ Red-throated Loon			r	r
___ Common Loon	o		o	o
___ • Pied-billed Grebe	c	r	c	o
___ Horned Grebe	r		r	r
___ Red-necked Grebe	r			r
GANNETS – PELICANS – CORMORANTS				
___ Northern Gannet			r	r
___ Double-crested Cormorant	c	r	c	r
BITTERNS – HERONS – IBISES				
___ • American Bittern	c	r	o	r
___ • Least Bittern	o	c	o	
___ Great Blue Heron	a	c	a	c
___ • Great Egret	a	a	a	r
___ • Snowy Egret	a	a	a	
___ Little Blue Heron	o	c	c	
___ Tricolored Heron	o	o	o	
___ Cattle Egret	o	o	r	
___ • Green-backed Heron	c	a	a	r
___ • Black-crowned Night-Heron	a	a	a	o
___ Yellow-crowned Night-Heron	r	r	r	
___ White Ibis	r		r	
___ Glossy Ibis	o	o	o	
SWANS – GEESE – DUCKS				
___ Tundra Swan	r		r	r
___ Mute Swan	o	o	o	o
___ Snow Goose	r	r	r	r
___ Brant	r		r	r
___ • Canada Goose	a	a	a	c
___ • Wood Duck	a	c	a	o
___ • Green-winged Teal	c	o	a	c
___ • American Black Duck	a	c	a	c
___ • Mallard	a	a	a	c
___ • Northern Pintail	c	o	c	c
___ • Blue-winged Teal	c	c	c	r
___ • Northern Shoveler	c	r	c	o
___ Gadwall	o	r	o	o
___ Eurasian Wigeon	r		r	r
___ American Wigeon	o		o	o
___ Canvasback	o		o	r
___ Redhead	r	r	r	r
___ Ring-necked Duck	o	r	o	o
___ Greater Scaup	c	r	o	o
___ Lesser Scaup	o		o	o
___ Oldsquaw	r		r	r
___ White-winged Scoter	r		r	r
___ Common Goldeneye	r	r	r	r

	Species	s	S	F	W
___	Bufflehead	o		o	r
___	• Hooded Merganser	o	r	o	r
___	Common Merganser	o		o	o
___	Red-breasted Merganser	o		r	r
___	Ruddy Duck	c	o	c	c

VULTURES – HAWKS – FALCONS

	Species	s	S	F	W
___	Turkey Vulture	o	o	o	o
___	Osprey	o	o	o	
___	*Bald Eagle*	u	r	u	u
___	• Northern Harrier	c	o	c	c
___	Sharp-shinned Hawk	o	r	o	r
___	Cooper's Hawk	o	r	o	o
___	Northern Goshawk	r		r	r
___	Red-shouldered Hawk	o	r	o	o
___	Broad-winged Hawk	o	o	c	r
___	• Red-tailed Hawk	c	r	c	c
___	Rough-legged Hawk	r		o	o
___	Golden Eagle	r		r	r
___	• American Kestrel	c	c	c	c
___	Merlin	o	r	o	r
___	*Peregrine Falcon*	r	r	r	r

GROUSE – QUAIL – TURKEY

	Species	s	S	F	W
___	• Ring-necked Pheasant	a	a	a	a
___	• Northern Bobwhite	r	r	r	r

RAILS – CRANES

	Species	s	S	F	W
___	Yellow Rail	r		r	
___	• King Rail	o	o	o	r
___	• Virginia Rail	o	o	o	r
___	• Sora	o	o	o	r
___	• Common Moorhen	u	u	u	r
___	• American Coot	c	o	c	o

PLOVERS – SANDPIPERS

	Species	s	S	F	W
___	Black-bellied Plover	o	r	c	r
___	Lesser Golden-Plover	r		c	
___	Semipalmated Plover	c	r	c	
___	*Piping Plover*	r		r	
___	• Killdeer	a	a	a	o
___	Greater Yellowlegs	c	o	c	r
___	Lesser Yellowlegs	o	o	o	r
___	Solitary Sandpiper	c	o	c	
___	Willet	r		r	
___	• Spotted Sandpiper	c	c	c	
___	Upland Sandpiper	r	r	r	
___	Whimbrel	r		r	
___	Hudsonian Godwit			o	
___	Marbled Godwit			r	
___	Ruddy Turnstone	r	r	r	
___	Red Knot	r		r	
___	Sanderling	r		r	
___	Semipalmated Sandpiper	c	o	c	r
___	Western Sandpiper		r	o	r
___	Least Sandpiper	o	o	o	r
___	White-rumped Sandpiper	o	o	o	
___	Baird's Sandpiper	r	r	r	
___	Pectoral Sandpiper	c	o	c	r
___	Dunlin	o		o	r
___	Curlew Sandpiper	r	r	r	
___	Stilt Sandpiper	r	r	o	
___	Buff-breasted Sandpiper			r	
___	Ruff	o	r	o	r
___	Short-billed Dowitcher	o	r	o	r
___	Long-billed Dowitcher	o	r	o	r
___	Common Snipe	c	r	c	o
___	• American Woodcock	c	c	c	r
___	Wilson's Phalarope	r	r	r	
___	Red-necked Phalarope	r		r	

JAEGERS – GULLS – TERNS – AUKS

	Species	s	S	F	W
___	Laughing Gull	o	o	c	r
___	Bonaparte's Gull	o	r	o	r
___	Ring-billed Gull	c	o	c	c
___	Herring Gull	c	o	c	c
___	Iceland Gull	r		r	r
___	Glaucous Gull	r		r	r
___	Great Black-backed Gull	c	o	c	c
___	Caspian Tern	o	r	o	
___	Common Tern	r	r	r	
___	Forster's Tern	r	o	c	
___	*Least Tern*	r	r	r	
___	Royal Tern			r	
___	Black Tern	o	r	o	
___	Gull-billed Tern			r	

DOVES – CUCKOOS – OWLS – SWIFTS – HUMMINGBIRDS

	Species	s	S	F	W
___	Rock Dove	o	o	o	o
___	• Mourning Dove	c	c	c	c
___	• Black-billed Cuckoo	o	o	o	
___	• Yellow-billed Cuckoo	o	o	o	
___	• Barn Owl	c	c	c	c
___	• Eastern Screech-Owl	r	r	r	r
___	• Great Horned Owl	c	c	c	c
___	Snowy Owl	r		r	r
___	Barred Owl	r	r	r	r
___	Long-eared Owl	r		r	r
___	Short-eared Owl	o		o	o
___	Northern Saw-whet Owl	r	r	r	r

		s	S	F	W
___	Common Nighthawk	c	o	c	
___	Whip-poor-will	r	r	r	
___	Chimney Swift	c	c	c	
___	• Ruby-throated Hummingbird	c	o	c	
___	Belted Kingfisher	c	o	c	o
	WOODPECKERS – FLYCATCHERS				
___	Red-headed Woodpecker	r	r	r	
___	Red-bellied Woodpecker	r	r	r	r
___	Yellow-bellied Sapsucker	u	r	o	r
___	• Downy Woodpecker	c	c	c	c
___	Hairy Woodpecker	o	o	o	o
___	• Northern Flicker	c	c	c	o
___	Olive-sided Flycatcher	r		u	
___	Eastern Wood-Pewee	o	r	o	
___	Yellow-bellied Flycatcher	r	r	u	
___	Acadian Flycatcher	r	r	u	
___	• Alder Flycatcher	o	o	u	
___	• Willow Flycatcher	c	c	u	
___	• Least Flycatcher	r	r	u	
___	• Eastern Phoebe	c	o	o	r
___	• Great Crested Flycatcher	o	r	o	
___	Western Kingbird			r	
___	• Eastern Kingbird	c	c	c	
	LARKS – SWALLOWS – JAYS – CROWS				
___	Horned Lark	r	r	r	r
___	• Purple Martin	o	r	c	
___	• Tree Swallow	a	a	a	
___	Northern Rough-winged Swallow	c	o	o	
___	Bank Swallow	c	o	c	
___	Cliff Swallow	o	r	o	
___	• Barn Swallow	a	a	a	
___	• Blue Jay	c	c	c	c
___	• American Crow	c	c	c	c
___	• Fish Crow	c	c	c	c
	TITMICE – NUTHATCHES – WRENS				
___	Black-capped Chickadee	o	r	o	o
___	• Carolina Chickadee	c	c	c	c
___	• Tufted Titmouse	c	c	c	c
___	Red-breasted Nuthatch	o		o	o
___	White-breasted Nuthatch	o	o	o	o
___	Brown Creeper	c		c	c
___	• Carolina Wren	c	c	c	c
___	Bewick's Wren	r	r	r	
___	• House Wren	c	c	c	r
___	Winter Wren	o		c	r
___	• Sedge Wren	r	r	r	
___	• Marsh Wren	c	c	c	r

KINGLETS – THRUSHES – THRASHERS

	s	S	F	W
___ Golden-crowned Kinglet	o		c	o
___ Ruby-crowned Kinglet	c		c	o
___ Blue-gray Gnatcatcher	o	r	o	r
___ Eastern Bluebird	o		o	r
___ Veery	c	o	c	
___ Gray-cheeked Thrush	c	o	c	
___ Swainson's Thrush	c	o	c	
___ Hermit Thrush	o	c	c	r
___ • Wood Thrush	c	c	c	r
___ • American Robin	a	a	a	o
___ • Gray Catbird	c	c	c	o
___ • Northern Mockingbird	c	c	c	c
___ • Brown Thrasher	c	c	c	o

WAXWINGS – SHRIKES – STARLINGS

	s	S	F	W
___ American Pipit	o	r	o	o
___ • Cedar Waxwing	o	o	o	o
___ Northern Shrike				r
___ Loggerhead Shrike	r	r	r	r
___ • European Starling	a	a	a	a

VIREOS – WOOD WARBLERS

	s	S	F	W
___ • White-eyed Vireo	c	c	c	
___ Solitary Vireo	c	r	c	
___ Yellow-throated Vireo	o	r	o	
___ • Warbling Vireo	c	c	c	
___ Philadelphia Vireo	r	r	r	
___ • Red-eyed Vireo	c	o	c	
___ Blue-winged Warbler	o	o	o	
___ Golden-winged Warbler	r	r	r	
___ Tennessee Warbler	o	r	o	
___ Orange-crowned Warbler	r		o	r
___ Nashville Warbler	o	r	o	
___ Northern Parula	c	r	c	
___ • Yellow Warbler	a	a	a	r
___ Chestnut-sided Warbler	c	r	c	
___ Magnolia Warbler	c	r	c	
___ Cape May Warbler	o	r	c	
___ Black-throated Blue Warbler	c	r	c	
___ Yellow-rumped Warbler	c	r	c	o
___ Black-throated Green Warbler	c	r	c	
___ Blackburnian Warbler	c	r	c	
___ Pine Warbler	o	r	o	
___ Prairie Warbler	c	r	c	
___ Palm Warbler	c	r	c	r
___ Bay-breasted Warbler	c	r	c	
___ Blackpoll Warbler	c	r	c	
___ Cerulean Warbler	r	r	r	
___ Black-and-white Warbler	c	r	c	r
___ • American Redstart	c	r	c	
___ Prothonotary Warbler	r	r	u	
___ Worm-eating Warbler	r	r	u	
___ Ovenbird	c	r	c	
___ Northern Waterthrush	c	r	c	r
___ Louisiana Waterthrush	r	r	u	
___ Kentucky Warbler	r	r	u	
___ Connecticut Warbler	r	r	u	
___ Mourning Warbler	o	r	o	
___ • Common Yellowthroat	c	c	c	r
___ Hooded Warbler	r	r	u	
___ Wilson's Warbler	c	r	u	r
___ Canada Warbler	c	r	c	
___ • Yellow-breasted Chat	c	c	c	r

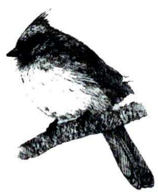
TANAGERS – SPARROWS

	s	S	F	W
___ Summer Tanager	r	r	r	
___ Scarlet Tanager	c	r	c	
___ • Northern Cardinal	c	c	c	c
___ Rose-breasted Grosbeak	c	r	o	
___ • Blue Grosbeak	u	u	u	r
___ • Indigo Bunting	c	c	c	
___ Dickcissel	r	r	r	r
___ • Rufous-sided Towhee	c	c	c	r
___ American Tree Sparrow	c		c	c
___ Chipping Sparrow	o	o	o	o
___ Clay-colored Sparrow	r		r	
___ • Field Sparrow	c	o	c	c
___ Vesper Sparrow	c	o	o	o
___ • Savannah Sparrow	c	r	c	r
___ Grasshopper Sparrow	r		r	
___ Henslow's Sparrow	r		r	
___ Sharp-tailed Sparrow			r	
___ Fox Sparrow	u		u	u
___ • Song Sparrow	c	c	c	c
___ Lincoln's Sparrow	r		r	r
___ • Swamp Sparrow	c	c	c	c
___ White-throated Sparrow	c	r	c	c
___ White-crowned Sparrow	c		c	c
___ Lark Sparrow	r		r	
___ Harris' Sparrow	r			
___ Dark-eyed Junco	c	r	c	c
___ Lapland Longspur	r		r	o
___ Snow Bunting	r		r	r

BLACKBIRDS – FINCHES

	s	S	F	W
___ Bobolink	o	r	c	
___ • Red-winged Blackbird	a	a	a	c
___ Eastern Meadowlark	o	r	o	r
___ Rusty Blackbird	c	r	c	o

	s	S	F	W
___ Brewer's Blackbird			r	r
___ • Common Grackle	c	c	c	o
___ • Brown-headed Cowbird	c	c	c	o
___ • Orchard Oriole	o	u	r	
___ • Northern Oriole	c	o	c	r
___ Purple Finch	o	r	c	o
___ • House Finch	o	c	c	c
___ Red Crossbill				r
___ White-winged Crossbill				r
___ Common Redpoll	r		r	r
___ Pine Siskin	r	r	o	o
___ • American Goldfinch	c	c	c	c
___ Evening Grosbeak	r		r	r
___ House Sparrow	c	c	c	c



ACCIDENTALS

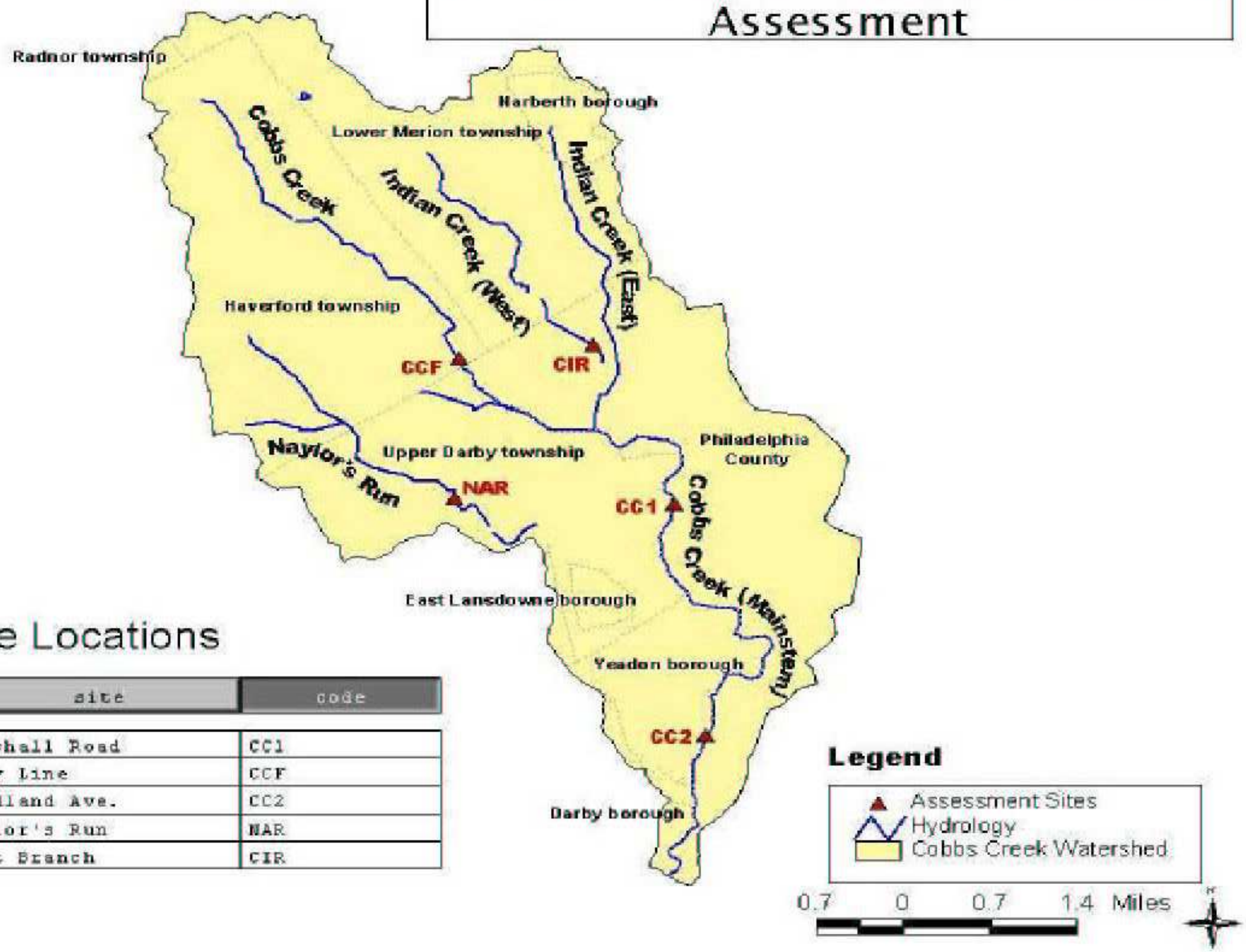
The following species are outside their normal range:

	Number of Sightings
___ Black Rail	3
___ Purple Gallinule	5
___ Sandhill Crane	2
___ Black-necked Stilt	3
___ American Avocet	6
___ Spotted Redshank	2
___ Black-tailed Godwit	1
___ Spoonbill Sandpiper	1
___ Black Skimmer	3
___ Monk Parakeet	numerous records during late 1960s; now rare
___ Black-backed Woodpecker (Three-toed)	1
___ Scissor-tailed Flycatcher	1
___ Sprague's Pipit	1
___ Golden-crowned Sparrow	1
___ Yellow-headed Blackbird	2
___ Brewer's Blackbird	7
___ Boat-tailed Grackle	3
___ Parasitic Jaeger	1

APPENDIX E

PWD Biological Assessment Technical Memorandum #4
Selected Maps and Tables

Figure 1. Cobbs Creek Ichthyfaunal Assessment



Site Locations

Shape	ID	site	code
Point	1	Marshall Road	CC1
Point	2	City Line	CCF
Point	3	Woodland Ave.	CC2
Point	4	Naylor's Run	NAR
Point	5	West Branch	CIR

Table 5. Species abundance, richness and diversity (H')at the five sampling locations on Cobbs Creek

Species	CIR	CCF	NAR	CC1	CC2
American Eel	0	15	19	6	8
Brown Bullhead	0	0	0	0	2
White Sucker	10	190	0	19	20
Banded Killifish	0	0	0	0	74
Mummichog	0	0	17	16	171
Redbreast Sunfish	0	0	3	0	31
Pumpkinseed	0	14	6	1	2
Common Shiner	0	415	21	52	1
Spottail Shiner	0	0	0	3	1
Swallowtail Shiner	0	5	549	145	49
Fathead Minnow	0	0	0	0	48
Green Sunfish	0	0	1	0	0
Blacknose Dace	86	651	333	59	48
Creek Chub	7	48	0	0	1
Total Number	**103**	**1338**	**949**	**301**	**456**
Total Taxa	**3**	**7**	**8**	**8**	**13**
Shannon-Weiner Diversity Index (H')	**0.243**	**0.534**	**0.424**	**0.629**	**0.806**

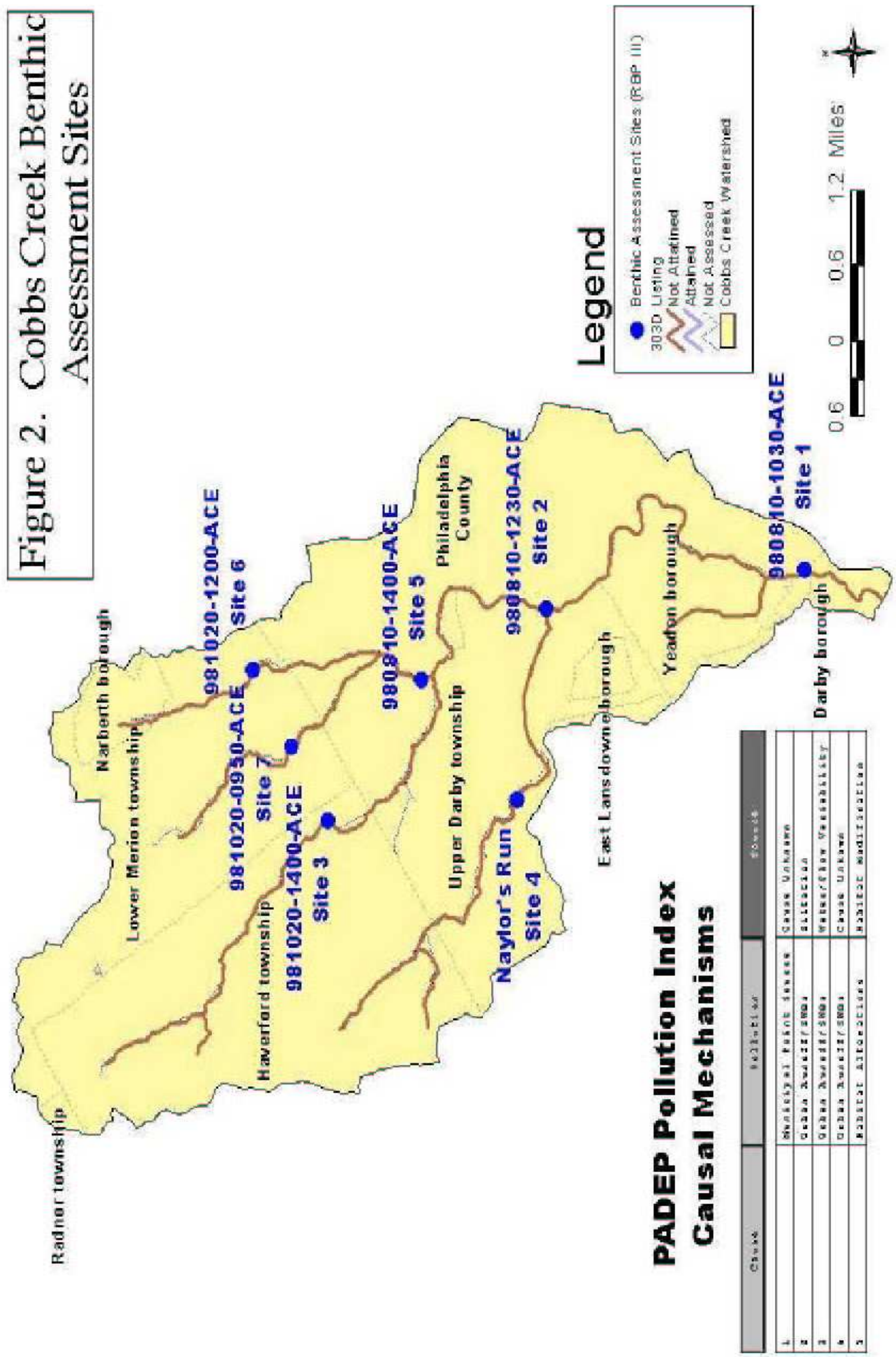


Figure 2. Cobbs Creek Benthic
Assessment Sites
Legend
Benthic Assessment Sites (RBP III)
303D Listing
Not Attained
Attained
Not Assessed
Cobbs Creek Watershed
0.6
0
0.6
1.2 Miles
Radnor township
Lower Merion township
Narberth borough
Haverford township
Upper Darby township
East Lansdowne borough
Yeadon borough
Darby borough
Philadelphia County
981020-1200-ACE
Site 6
981020-0930-ACE
Site 7
981020-1400-ACE
Site 3
980910-1400-ACE
Site 5
980810-1230-ACE
Site 2
980810-1030-ACE
Site 1
Naylor's Run
Site 4
PADEP Pollution Index
Causal Mechanisms

Table 19. Habitat Assessments Of Each Biological Monitoring Station And Percent Of Comparability to the Reference Sites

Habitat Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Instream Cover	10	11	15	11	12	14	11
Epifaunal Substrate	5	11	11	15	16	12	11
Embeddedness	8	9	12	5	10	11	9
Velocity/Depth	13	10	14	11	12	12	9
Channel Alteration	4	8	14	11	13	11	13
Sediment Deposition	5	16	15	11	7	15	13
Frequency Of Rifles	4	16	17	16	11	16	11
Channel Flow Status	14	6	12	10	15	6	14
Condition Of Banks	16	12	13	13	11	12	7
Bank Vegetation Protection	14	9	15	14	11	13	11
Grazing/Disruptive Pressure	12	6	16	8	10	6	7
Riparian Zone Width	4	2	12	5	5	2	2
Total	109	116	166	130	133	130	118
Percent Of Comparability (%)	60.22	64.09	91.71	74.71	76.44	74.71	67.82
Assessment Category	Partially Supporting	Partially Supporting	Comparable To Reference	Partially Supporting	Supporting	Partially Supporting	Partially Supporting

APPENDIX F

Recreation Facility Information by Municipality

MUNICIPALITY	SITE_NAME	SITE_ID	DATA SOURCE
Aldan Borough	Aldan Recreational Area	45005101497	DCNR
Aldan Borough	Providence Road Trianglee	45005101496	DCNR
Aldan Borough	Jeffrey Road Field	45005101495	DCNR
Colwyn Borough	John S. Bosacco Park	45055100212	DCNR
Darby Township	Ashland M.S./Darby Twp E.S.	45070100784	DCNR
Darby Township	Beech Ave. Playground	45070100827	DCNR
Darby Township	Conway Park	45065101178	DCNR
Darby Township	Grobes Playground	45070100831	DCNR
Darby Township	Studevan Field	45070100543	DCNR
Darby Township	Orange Avenue Playground	45070000566	DCNR
Darby Township	South Hermesprota Run Playground	45070100832	DCNR
Darby Township	Pine & Spruce Streets Playground	45070100828	DCNR
Darby Township	Park Drive Playground	45070101180	DCNR
Darby Township	Westbridge Playground	45070100829	DCNR
Easttown Township	Bridge Avenue Park	0	Township
Easttown Township	Beaumont Elementary School	29090101429	DCNR
Easttown Township	Devon Elementary School	29090101430	DCNR
Easttown Township	Spring Knoll Estates	0	Township
Easttown Township		0	Twp. OS, Rec, En
Easttown Township	Devon Horse Show Grounds	0	Munc. Comp Plan
Easttown Township	Hilltop Park	0	Munc. Comp Plan
Easttown Township	Beaumont Elementary School	0	Mun. Comp Plan
Folcroft Borough	Delcroft E.S.	45090100781	DCNR
Haverford Township	Bailey Park	45100100207	DCNR
Haverford Township	Brookline Learning Center	45100100985	DCNR
Haverford Township	Chatham Park	45100000571	DCNR
Haverford Township	Chatham Park E.S.	45100100984	DCNR
Haverford Township	Chatham Glen	45100100209	DCNR
Haverford Township	Cadwalader Tract	45100100208	DCNR
Haverford Township	Chesnutwold School	45100100983	DCNR
Haverford Township	Coopertown E.S.	45100100982	DCNR
Haverford Township	Elwell Park	45100100211	DCNR
Haverford Township	Farwood Tot-Lot	45100100212	DCNR
Haverford Township	Foster Tract	45100100213	DCNR
Haverford Township	Gest Tract	45100100214	DCNR
Haverford Township	Glendale Road Park	45100100215	DCNR
Haverford Township	Grange	45100100216	DCNR
Haverford Township	Grange Field	45100100217	DCNR
Haverford Township	Grasslyn Park	45100100218	DCNR
Haverford Township	Haverford Middle School	45100100986	DCNR
Haverford Township	Haverford Senior H.S.	45100100977	DCNR
Haverford Township	Highland Farms Park	45100000570	DCNR
Haverford Township	Hilltop Park	45100100219	DCNR
Haverford Township	Lawrence Road Park	45100100220	DCNR
Haverford Township	Lynnewood E.S.	45100100981	DCNR
Haverford Township	Lynnewood Park	45100100221	DCNR
Haverford Township	Manoa E.S.	45100100979	DCNR
Haverford Township	Williamson Tract	45100100980	DCNR
Haverford Township	Veterans Field	45100100229	DCNR

Haverford Township	Oakmont E.S.	45100100978	DCNR
Haverford Township	Merwood Park	45100100223	DCNR
Haverford Township	Merion Golf Manor	45100100222	DCNR
Haverford Township	Polo Field	45100100225	DCNR
Haverford Township	Preston Field	45100100226	DCNR
Haverford Township	Paddock Farms	45100100224	DCNR
Haverford Township	Richland Farms	45100100227	DCNR
Haverford Township	Thompson Tract	45100100228	DCNR
Haverford Township	Walnut Hill Lane Park	45100100230	DCNR
Haverford Township	Westgate Hills	45100100231	DCNR
Lansdowne Borough	Shrigley Park	45105000564	DCNR
Lower Merion Township	Wynnewood Valley Park	91110100296	DCNR
Lower Merion Township	Wynnewood Station Park	91110100284	DCNR
Lower Merion Township	Shortridge Memorial Park	91110100052	DCNR
Lower Merion Township	South Ardmore Park	91110100037	DCNR
Lower Merion Township	St. Pauls Tot Lot	91110100055	DCNR
Lower Merion Township	Penn Wyne Elementary School	91110100949	DCNR
Lower Merion Township	Penn Wyne Park	91110100058	DCNR
Lower Merion Township	Polo Field	91110100057	DCNR
Lower Merion Township	Austin Memorial Park	91110100043	DCNR
Lower Merion Township	Vernon V. Young Memorial Park	91110100036	Township
Lower Merion Township	Ardmore Ave. Community Center	91110100039	DCNR
Lower Merion Township	Haverford Ave Twp. Park	0	Township
Lower Merion Township	Essex Ave Twp Park	0	Township
Lower Merion Township	Senior Citizens' Center of Ardmore	0	Township
Lower Merion Township	Bryn Mawr Community Center	0	Township
Lower Merion Township	Sharpe Park & Bird Sanctuary	0	Township
Lower Merion Township	Packer Park	0	Township
Lower Merion Township	Lower Merion High School	0	Township
Marple	Folcroft Park	0	Mun. Comp Plan U
Marple Township	Marple Elementary School (R.E.T.S.)	45120100246	DCNR
Marple Township	Russell Elementary School	45120100242	DCNR
Marple Township	Loomis Elementary School	45120100241	DCNR
Marple Township	Paxon Hollow Middle School	45120100244	DCNR
Marple Township	Paxon Hollow Country Club	0	Mun. Comp Plan U
Marple Township	Kent Park	0	Mun. Comp Plan U
Marple Township	Larchmont Park	0	Mun. Comp Plan U
Marple Township	Township Park	0	Mun. Comp Plan U
Marple Township	New Ardmore Park	0	Mun. Comp Plan U
Marple Township	Lawrence Park Swim Club	0	Mun. Comp Plan U
Marple Township	Lawrence Park	0	Mun. Comp Plan U
Marple Township	Township Park	0	Mun. Comp Plan U
Marple Township	Drexel Swim Club	0	Mun. Comp Plan U
Marple Township	Cardinal O'Hara High School	0	Mun. Comp Plan U
Marple Township	Township Park	0	Mun. Comp Plan U
Marple Township	Gamma Tennis & Swim Club	0	Mun. Comp Plan U
Marple Township	Township Park	0	Mun. Comp Plan U
Marple Township	Marple Newtown Swim Club	0	Mun. Comp Plan U
Marple Township	Township Park	0	Mun. Comp Plan U
Marple Township	Marple Gardens park	0	Mun. Comp Plan U
Marple Township	Malin Road Tot Lot	0	Mun. Comp Plan U
Morton Borough	Morton Borough Hall & Gym	45140001833	DCNR
Newton Township	Aronimink Golf Club	0	Mun. Comp Plan
Newtown Township	Brookside Park	45150100597	DCNR
Newtown Township	Culbertson E.S.	45150100240	DCNR
Newtown Township	Winding Way Park	45150100596	DCNR
Newtown Township	Marple Newtown High School	45150100247	DCNR
Newtown Township	Marple Newtown Senior H.S.	45150100245	DCNR
Newtown Township	Marple Newtown Leisure Services	0	Mun. Comp Plan

Phila.	Granahan	0	Phila.Rec-Dept
Phila.	Cobbs Creek Ice Rink	0	Phila.Rec-Dept.
Phila.	Morris RC	0	Phila.Rec-Dept
Phila.	Christy RC	0	Phila.Rec-Dept.
Phila.	Carroll Park	0	Phila.Rec-Dept.
Phila.	Shepard RC	0	Phila.Rec-Dept.
Phila.	Nichols Park	0	Phila.Rec-Dept.
Philadelphia	John Heinz Natl. Wildlife Refuge - Tinicum	45070100636	DCNR
Philadelphia	Rose	0	Phila.Rec-Dept
Philadelphia	Barkan Park	0	Phila.Rec-Dept.
Philadelphia	Malcolm Park	0	Phila.Rec-Dept.
Philadelphia	Cedar Park	0	Phila.Rec-Dept
Philadelphia	Tustin RC	0	Phila.Rec-Dept.
Philadelphia	Sherwood Park	0	Phila.Rec-Dept.
Philadelphia	Myers Francis RC	0	Phila.Rec-Dept.
Philadelphia	McCreesh	0	Phila.Rec-Dept.
Philadelphia	Connell Park	0	Phila.Rec-Dept.
Philadelphia	Island RC	0	Phila.Rec-Dept.
Philadelphia	Elmwood Park	0	Phila.Rec-Dept.
Philadelphia	Clearview Park	0	Phila.Rec-Dept.
Philadelphia	Eastwick Regional Park	0	Phila.Rec-Dept.
Philadelphia	Pepper School	0	Phila.Rec-Dept.
Philadelphia	82nd and Lyons Park	0	Phila.Rec-Dept.
Philadelphia	Eastwick Walkway	0	Phila.Rec-Dept.
Prospect Park Borough	Witmer Field	0	Township
Prospect Park Borough	Park Square	0	Township
Radnor Township	Rosemont Park	45170100907	DCNR
Radnor Township	Cowan Field	45170100904	DCNR
Radnor Township	Fenimore Woods	45170100909	DCNR
Radnor Township	Encke Park	45170100902	DCNR
Radnor Township	Fifth Ward Park	45170000567	DCNR
Radnor Township	Harford Park	45170100900	DCNR
Radnor Township	Ithan Valley Park	45170100901	DCNR
Radnor Township	Odoriso Park	45170100906	DCNR
Radnor Township	Saw Mill Park	45170000569	DCNR
Radnor Township	Willows Park	45170100908	DCNR
Radnor Township	Skunk Hollow	45170100903	DCNR
Radnor Township	South Devon Park	45170100905	DCNR
Radnor Township	Unkefer Park	0	Township
Radnor Township	Converse Field	0	Township
Radnor Township	Main Line Senior Center	0	Township
Radnor Township	Radnor Middle School	0	Township
Radnor Township	Wayne Elementary School	0	Township
Radnor Township	Ithan Elementary School	0	Township
Radnor Township	Martha Browns Woods	0	Township
Radnor Township	Radnor High School	0	Township
Radnor Township	North Wayne Field	0	Township

Ridley Park Borough	Boeing Recreational Facility (Private)	45180100494	DCNR
Ridley Park Borough	Bonnes Park	45180100490	DCNR
Ridley Park Borough	East Lake Park	45180100483	DCNR
Ridley Park Borough	Ridley Park Swim Club (private)	45180100492	DCNR
Ridley Park Borough	Ridley Park Golf Club	45180100487	DCNR
Ridley Park Borough	Veterans Park	45180100488	DCNR
Ridley Park Borough	Tome Street Tot Lot	45180100485	DCNR
Ridley Park Borough	Recreation Park	45180100484	DCNR
Ridley Park Borough	Nevin Street Park	45180100486	DCNR
Ridley Park Borough	Lakeview Elementary School	45180100493	DCNR
Ridley Park Borough	Hetzel Road Park	45180100489	DCNR
Ridley Park Borough	Flatiron Park	45180100491	DCNR
Ridley Township	Amosland E.S.	45177001844	DCNR
Ridley Township	Brookwood Playground	45070100830	DCNR
Ridley Township	Ridley H.S.	45177000549	DCNR
Ridley Township	Ridley M.S.	45177000551	DCNR
Ridley Township	Woodlyn E.S.	45177000550	DCNR
Rutledge Borough	Rutledge Triangle Park	45190001835	DCNR
Rutledge Borough	Rutledge Community Hall	45190001836	DCNR
Sharon Hill Borough	Academy Park	45195100921	DCNR
Sharon Hill Borough	Academy Park H.S./Sharon Hill E.S.	45195100785	DCNR
Sharon Hill Borough	Memorial Park	45195100321	DCNR
Sharon Hill Borough	unknown	0	Township
Springfield Township	Crowell Park	45200000573	DCNR
Springfield Township	Ellson Glen Park	45200000583	DCNR
Springfield Township	Doe Run Park	45200000584	DCNR
Springfield Township	Greenbriar Park	45200000582	DCNR
Springfield Township	Maple Street Park	45200000621	DCNR
Springfield Township	Pennsdale Park	45200000628	DCNR
Springfield Township	Levis Road Park	45200000622	DCNR
Springfield Township	Indian Rock Park	45200000625	DCNR
Springfield Township	Walsh Park	45200000579	DCNR
Springfield Township	Veterans Memorial Park	45200000576	DCNR
Springfield Township	Rolling Green Park	45200000577	DCNR
Springfield Township	Jane Lownes Park	45200000624	DCNR
Springfield Township	Woodland Park	45200000572	DCNR
Springfield Township	Spring Valley Park	45200000575	DCNR
Springfield Township	Thomson Park	45200000574	DCNR
Springfield Township	Lehigh Circle Park	45200000623	DCNR
Springfield Township	Meadowgreen Park	45200000626	DCNR
Springfield Township	Netherwood Park	45200000627	DCNR
Springfield Township	Wagner Wayside Park	45200000578	DCNR
Springfield Township	Williams Park	45200000581	DCNR
Springfield Township	Wildwood Avenue Park	45200000580	DCNR
Springfield Township	Kerr Park	0	Township
Springfield Township	Ampitheater @ Williams Park	0	Township
Tinicum Township	Governor Printz Park	45215100357	DCNR
Tinicum Township	John Heinz Natl. Wildlife Refuge-Tinicum	45070100636	DCNR
Tinicum Township	Manor Field	0	Township
Tinicum Township	Westinghouse Grove	0	Township

Tredyffrin Township	Conestoga Senior High School	29255101423	DCNR
Upper Darby Township	Aronimink E.S.	45235100256	DCNR
Upper Darby Township	Beverly Hills M.S.	45235100255	DCNR
Upper Darby Township	Beverly Hills Recreation	45235100379	DCNR
Upper Darby Township	Bishop Park	45235100367	DCNR
Upper Darby Township	Brookwood Park	45235100380	DCNR
Upper Darby Township	Bywood E.S.	45235100257	DCNR
Upper Darby Township	Clark Play Area	45235100366	DCNR
Upper Darby Township	Drexel Park Gardens	45235100364	DCNR
Upper Darby Township	Drexel Hill E.S.	45235100258	DCNR
Upper Darby Township	Drexel Hill M.S.	45235100254	DCNR
Upper Darby Township	Dermond Recreational Area	45235100363	DCNR
Upper Darby Township	Garrettford E.S.	45235100259	DCNR
Upper Darby Township	Westbrook Park E.S.	45235100264	DCNR
Upper Darby Township	Primos E.S.	45235100262	DCNR
Upper Darby Township	Gillispee Park	45235100385	DCNR
Upper Darby Township	Golf Rd. Play Area	45235100382	DCNR
Upper Darby Township	Highland Park E.S.	45235100260	DCNR
Upper Darby Township	Hillcrest E.S.	45235100261	DCNR
Upper Darby Township	Huey Park	45235100370	DCNR
Upper Darby Township	Keystone Play Area	45235100381	DCNR
Upper Darby Township	Kirklyn Play Area	45235100369	DCNR
Upper Darby Township	Manison Park	45235100384	DCNR
Upper Darby Township	Multi Service Center	45235100368	DCNR
Upper Darby Township	Mckinley Play Area	45235100372	DCNR
Upper Darby Township	Penn Pines Park	45235100373	DCNR
Upper Darby Township	Scullion Park	45235100376	DCNR
Upper Darby Township	Second Ward Play Area	45235100374	DCNR
Upper Darby Township	Stonehurst Hills Elementary School	45235100263	DCNR
Upper Darby Township	Upper Darby Senior High School	45235100253	DCNR
Upper Darby Township	Watkins Ave. House	45235100387	DCNR
Upper Darby Township	Westview Play Area	45235100365	DCNR
Upper Darby Township	Pine & Spurce Streets Playground	45070100828	DCNR
Upper Darby Township	Observation Hill Park	45235100371	DCNR

APPENDIX G

Political Districts in the Watershed

In a watershed of 31 municipalities, it is important for residents to know who the local legislators are (Table G-1). In order to visualize the political jurisdiction it is as simple as referring to a map (Figures G-1 through G-3). In order to take action on behalf of the watershed, it is recommended (Section 7) that interested parties consult the local legislator, be it a Federal Congressperson, State Senator, or State Representative (Table G-2).

Table G-1 Legislative Districts within the Darby Creek Watershed Municipalities, 12-2001

Darby Municipalities	U.S. Congressional Districts	PA Senatorial Districts	PA House of Representative Districts
Delaware County			
Aldan	7th	26th	163
Clifton Heights	7th	26th	163
Collingdale	7th	26th	162
Colwyn	1st	26th	162
Darby Boro	2nd	8th	162
Darby Twp.	1st	26th	163 / 185 (see map)
East Lansdowne	7th	26th	164
Folcroft	1st	26th	162
Glenolden	1st	26th	162 / 163
Haverford	7th	17th	166
Lansdowne	2nd	26th	163
Marple	7th	26th	165
Millbourne	7th	26th	164
Morton	7th	26th	161
Newtown	7th	26th	168
Norwood	7th	26th	162
Prospect Park	7th	9th	162
Radnor	7th	17th	165 / 166 / 167 (see map)
Ridley Park	7th	9th	161
Ridley Twp.	7th	9th	161
Rutledge	7th	26th	161
Sharon Hill	7th	26th	162
Springfield	7th	26th	161 / 165 (see map)
Tinicum	1st	9th	162
Upper Darby Twp.	7th	26th	163 / 164 / 165 (see map)
Yeadon	2nd	8th	191
Chester County			
Easttown	7th	19th	167th
Tredyffrin	7th	19th	157th
Montgomery County			
Lower Merion	13th	17th	147 / 148 (see map)
Narberth	13th	17th	148
Philadelphia County			
Philadelphia	1 / 2 (see map)	8th	185 / 188 / 190 / 191 / 192 (see map)

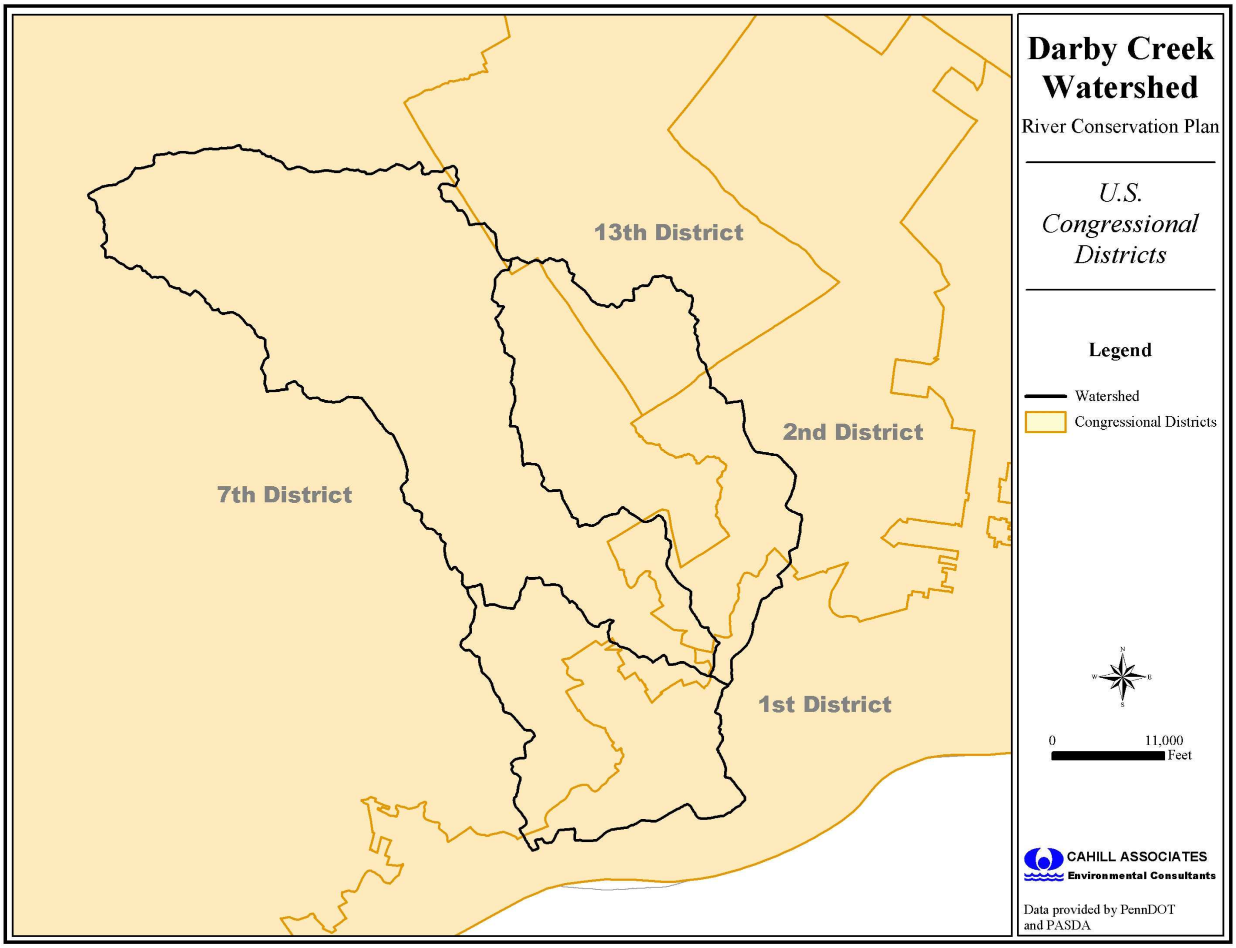


Figure G-1 U.S. House of Representative Districts in the Darby Creek Watershed, 12-2001

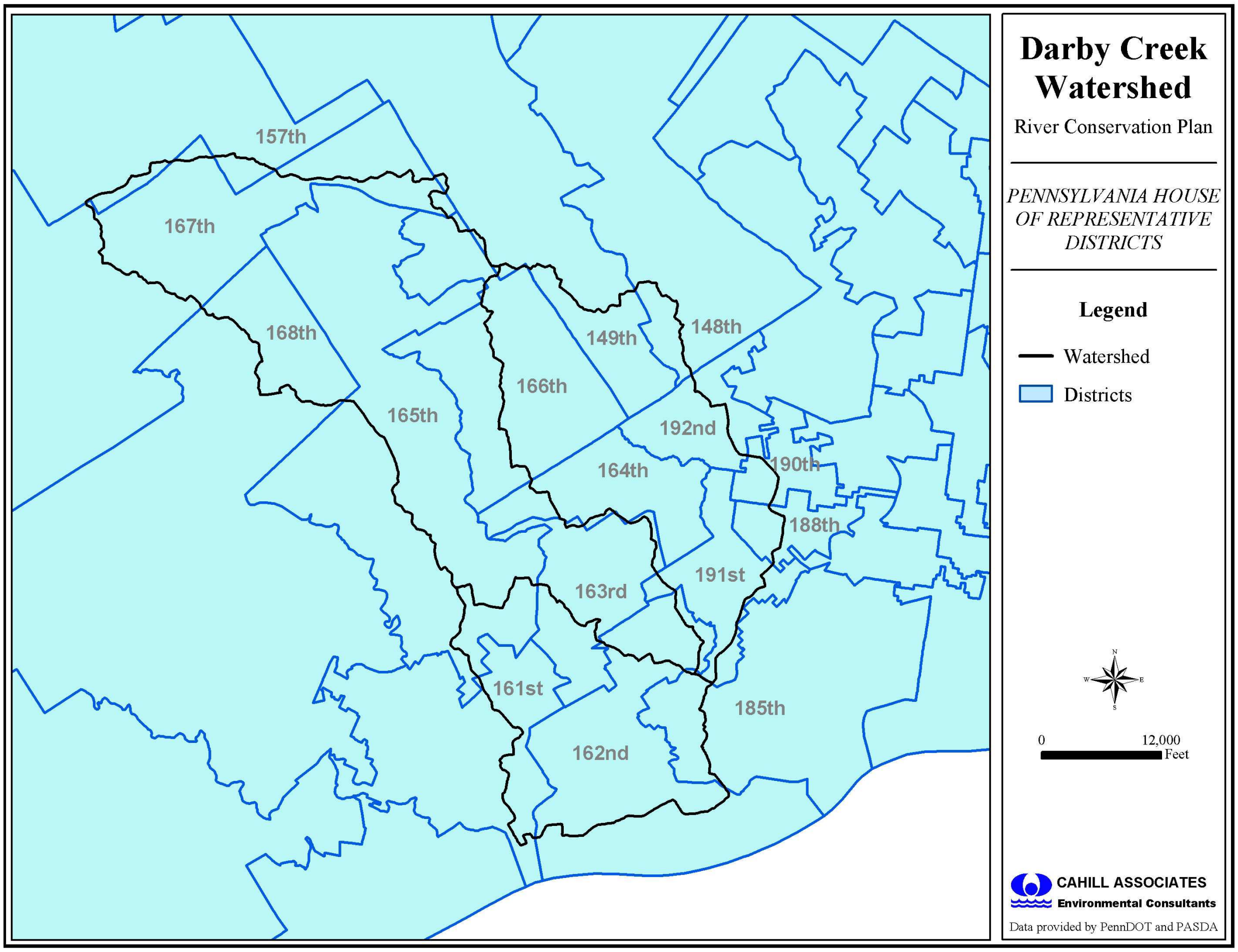


Figure G-2 PA Senatorial Districts in the Darby Creek Watershed, 12-2001

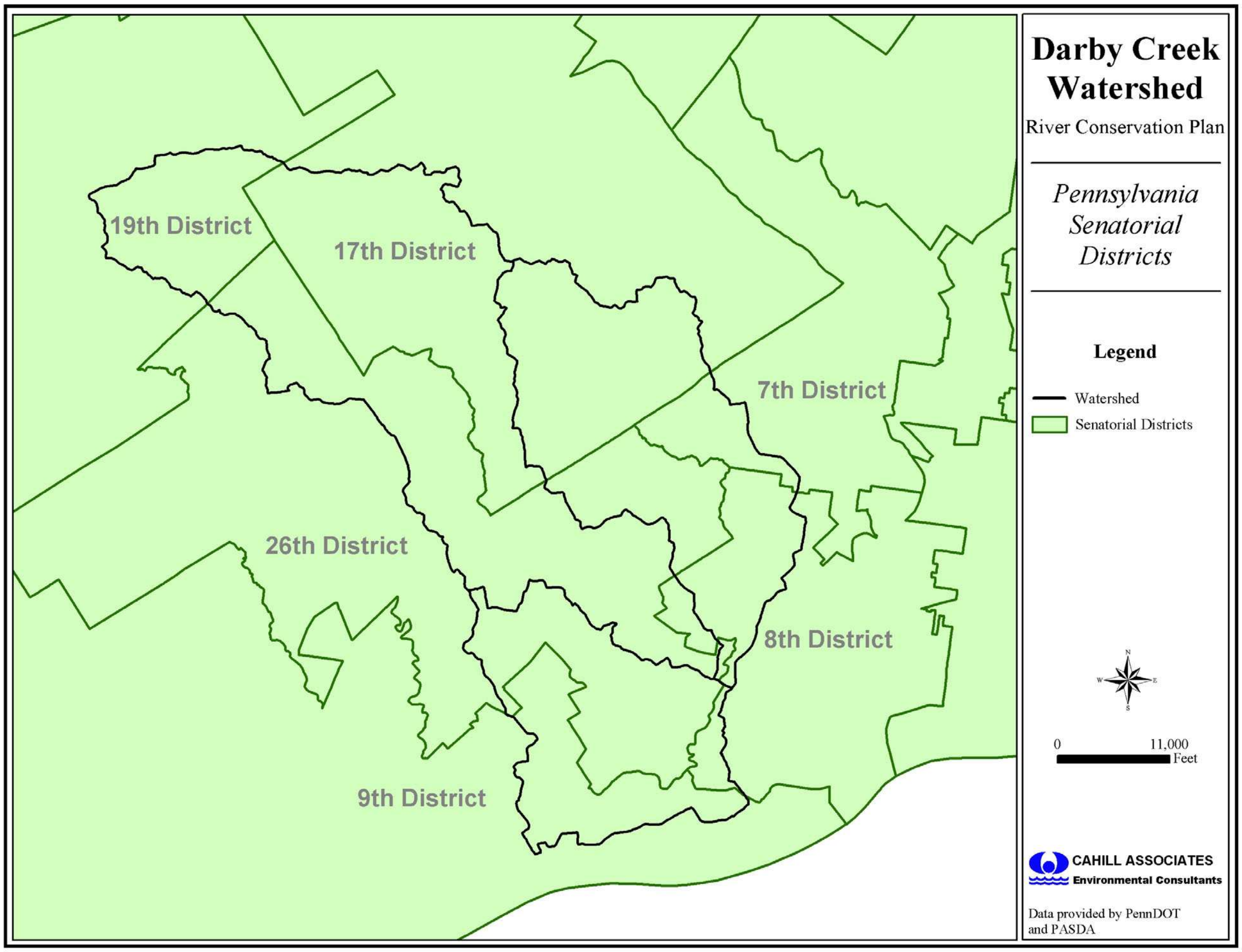
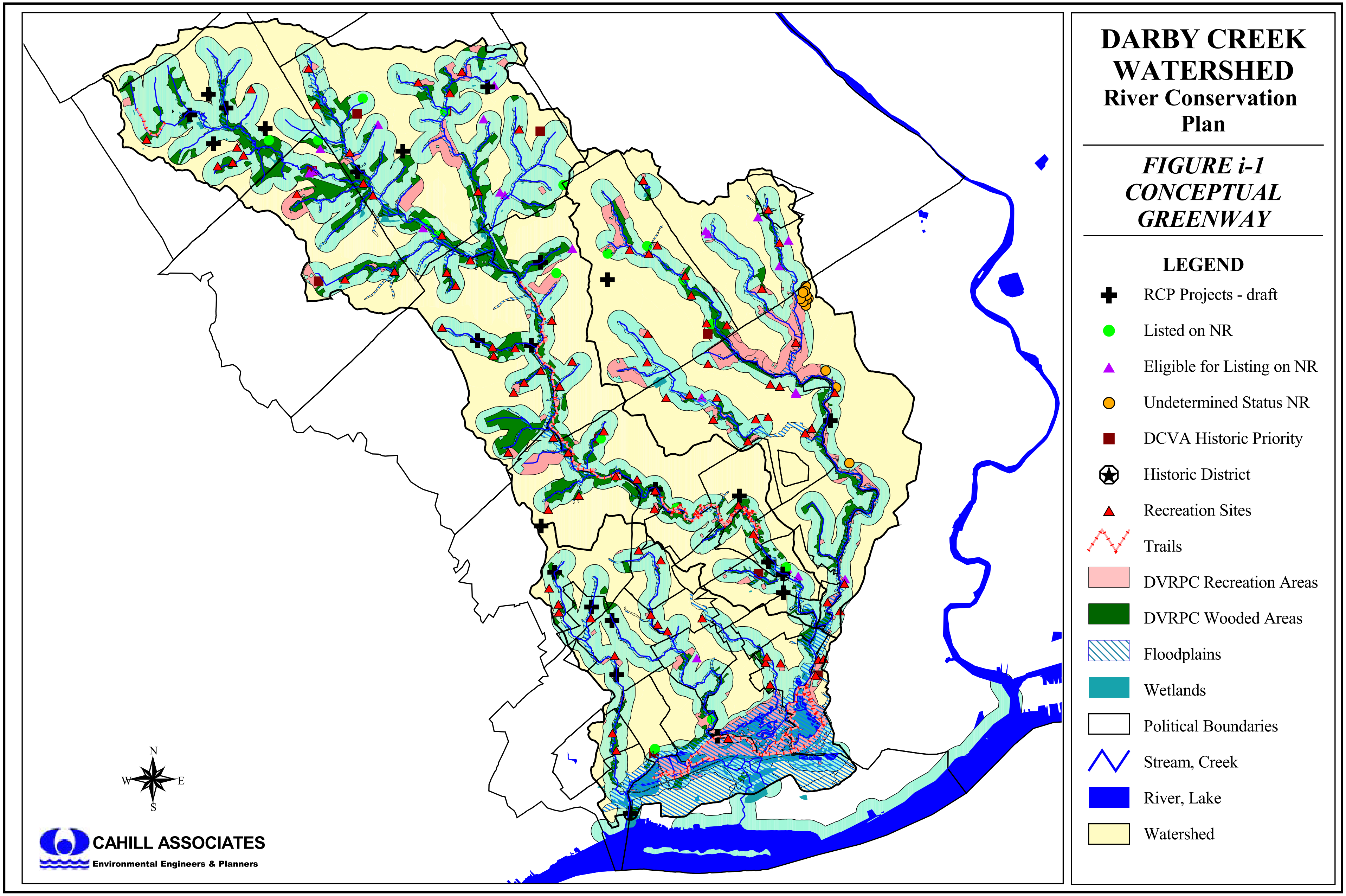
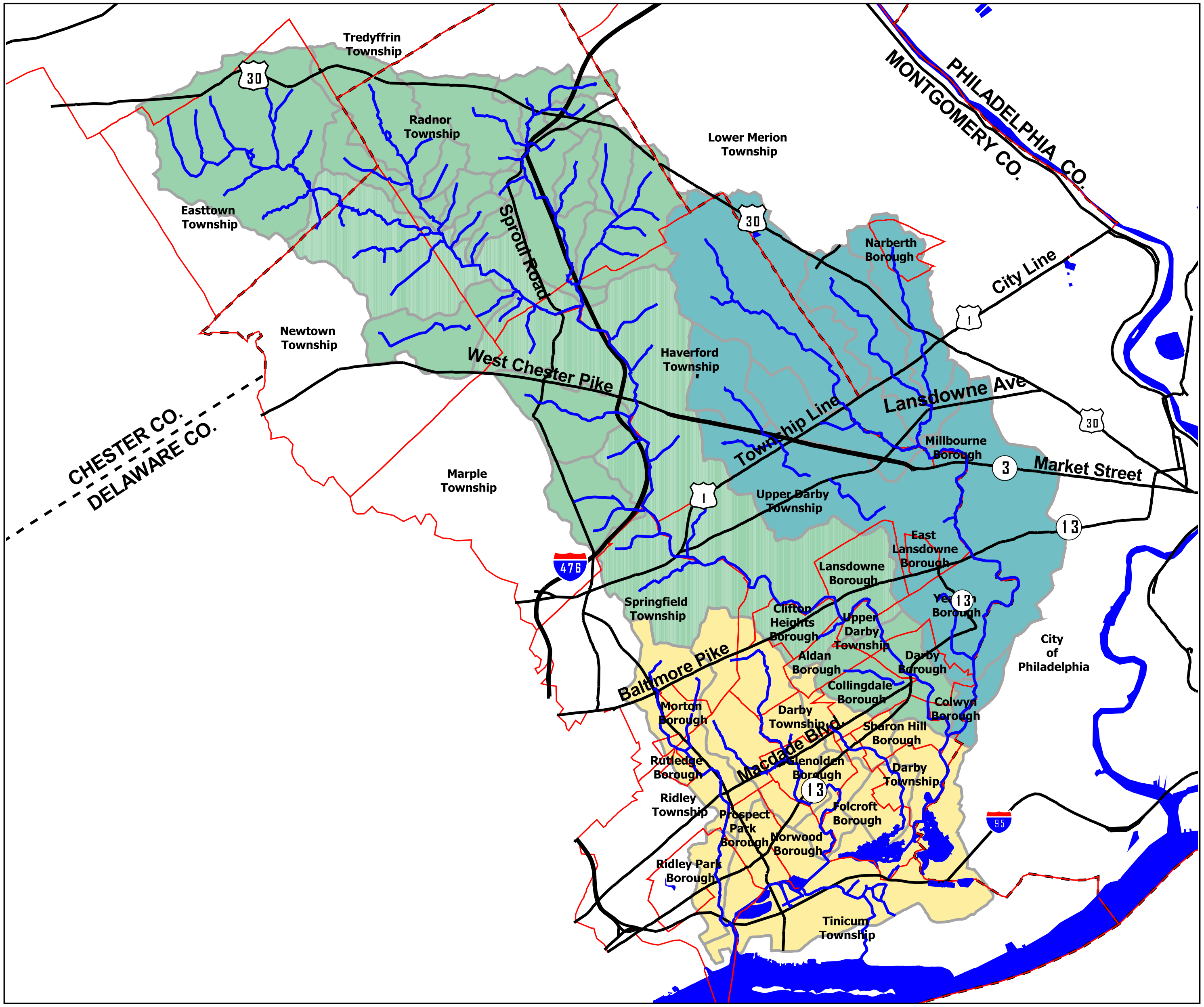


Figure G-3 PA Senatorial Districts in the Darby Creek Watershed, 12-2001

Table G-4 Contact Information for Legislative Representatives for Watershed Municipalities, 12-2001

District	Name	Address		Telephone	Fax (if available)
U.S. Senators - Local Contact Information http://www.senate.gov/					
District	**Name**	**Address**		**Telephone**	**Fax (if available)**
PA	Arlen Specter (Rep)	9400 Federal Bldg., 600 Arch St.	Philadelphia, PA 19106	(215) 597-7200	(202) 228-1229
PA	Richard (Rick) Santorum (Rep)	1 South Penn Square, Widener Bldg., Suite 960	Philadelphia, PA 19107	(215) 864-6900	(215) 864-6910
U.S. House of Representatives - Local Contact Information http://www.house.gov/					
District	**Name**	**Address**		**Telephone**	**Fax (if available)**
1	Robert A. Brady (Dem)	Colony Building, 511 Welsh Road	Chester, PA 19013	(610) 874-7094	(215) 596-4665
2	Chaka Fattah (Dem)	4104 Walnut Street	Philadelphia, PA 19104	(215) 387-6404	-
7	Curt Weldon (Rep)	1554 Garrett Road	Upper Darby, PA 19082	(610) 259-0700	-
13	Joseph M. Hoeffel	1768 Markley Street	Norristown, PA 19401	(610) 272-8400	(610) 272-8532
Pennsylvania Senators - Local Contact Information http://www.pasen.gov/welcome.html					
District	**Name**	**Address**		**Telephone**	**Fax (if available)**
8	Anthony Hardy Williams (Dem)	5008 Baltimore Ave, 2nd Floor Suite, Mercy Wellness Center	Philadelphia, PA 19143	(215) 662-5519	(215) 644-0660
9	Clarence D. Bell (Rep)	280 N. Providence Road	Media, PA 19063	(610) 565-9100	-
17	***Constance H. Williams (Dem)***	***601 S. Henderson Rd. Suite 201***	***King of Prussia, PA 19406***	***(610) 992-9790***	***(610) 768-3104***
17	***Richard A. Tilghman***	***406 Gatcombe Lane***	***Bryn Mawr, PA 19010***	***(610) 525-7674***	***-***
19	Robert J. Thompson (Rep)	15 W. Gay Street	West Chester, PA 19380	(610) 692-2112	(610) 436-1721
26	Edwin B. Erickson (Rep)	5037 Township Line Road	Drexel Hill, PA 19026	(610) 853-4100	(610) 853-4136
Pennsylvania House of Representatives - Local Contact Information http://www.house.state.pa.us/					
District	**Name**	**Address**		**Telephone**	**Fax (if available)**
147	Raymond Bunt, Jr. (Rep)	105 Memorial Drive, Lower Suite 1	Schwenksville, PA 19473	(610) 287-4181	(610) 287-4348
148	Lita Indzel Cohen (Rep)	117 East 4th Ave.	Conshohocken, PA 19428	(610) 397-0505	(610) 397-0508
157	Carole A. Rubley (Rep)	500 Chesterbrook Blvd., Suite E-2A	Wayne, PA 19087	(610) 640-2356	(610) 640-2354
161	Thomas P. Gannon (Rep)	310 Amosland Rd.	Holmes, PA 19043	(610) 461-5543	(610) 534-6881
162	Ron Raymond (Rep)	1337 Chester Pike	Sharon Hill, PA 19079	(610) 534-1002	(610) 534-1710
163	Nicholas A. Micozzie (Rep)	6 South Springfield Rd.	Clifton Heights, PA 19018	(610) 259-2820	(610) 259-7019
164	Mario J. Civera, Jr. (Rep)	232 Long Lane	Upper Darby, PA 19082	(610) 352-7800	(610) 352-3389
165	William F. Adolph, Jr. (Rep)	920 W. Sproul Rd.	Springfield, PA 19064	(610) 544-9878	(610) 338-2294
166	Greg Vitali (Dem)	1001 E. Darby Rd.	Havertown, PA 19083	(610) 789-3900	(215) 560-4197
167	Robert J. Flick (Rep)	229 W. Lancaster Ave.	Devon, PA 19333	(610) 688-8002	(610) 688-6266
168	Matthew J. Ryan (Rep)	214 N. Jackson St.	Media, PA 19063	(610) 566-2000	(610) 566-2003
185	Robert C. Donatucci (Dem)	1615-17 Porter St.	Philadelphia, PA 19145	(215) 468-1515	(215) 952-1164
188	James R. Roebuck, Jr. (Dem)	4800 Baltimore Ave.	Philadelphia, PA 19143	(215) 724-2227	(215) 724-2230
190	Mike J. Horsey (Dem)	5151 Walnut Street	Philadelphia, PA 19139	(215) 747-0757	(215) 560-2682
191	Ronald G. Waters (Dem)	6027 Ludlow St., Unit A	Philadelphia, PA 19139	(215) 748-6712	(215) 748-1687
192	Louise Williams Bishop (Dem)	1991 North 63rd Street	Philadelphia, PA 19151	(215) 879-6625	(215) 879-8566


DARBY CREEK
WATERSHED
River Conservation
Plan
FIGURE i-1
CONCEPTUAL
GREENWAY
LEGEND
RCP Projects - draft
Listed on NR
Eligible for Listing on NR
Undetermined Status NR
DCVA Historic Priority
Historic District
Recreation Sites
Trails
DVRPC Recreation Areas
DVRPC Wooded Areas
Floodplains
Wetlands
Political Boundaries
Stream, Creek
River, Lake
Watershed
N
S
E
W
CAHILL ASSOCIATES
Environmental Engineers & Planners



DARBY CREEK WATERSHED
River Conservation Plan

FIGURE I-1
STUDY AREA

LEGEND

County Boundary
Municipal Boundary
Stream / Creek
River / Lake

Sub-Watersheds
Darby Creek Sub-Basins
Cobbs Creek Sub-Basins
Direct Drainage Sub-Basins

N
W E
S

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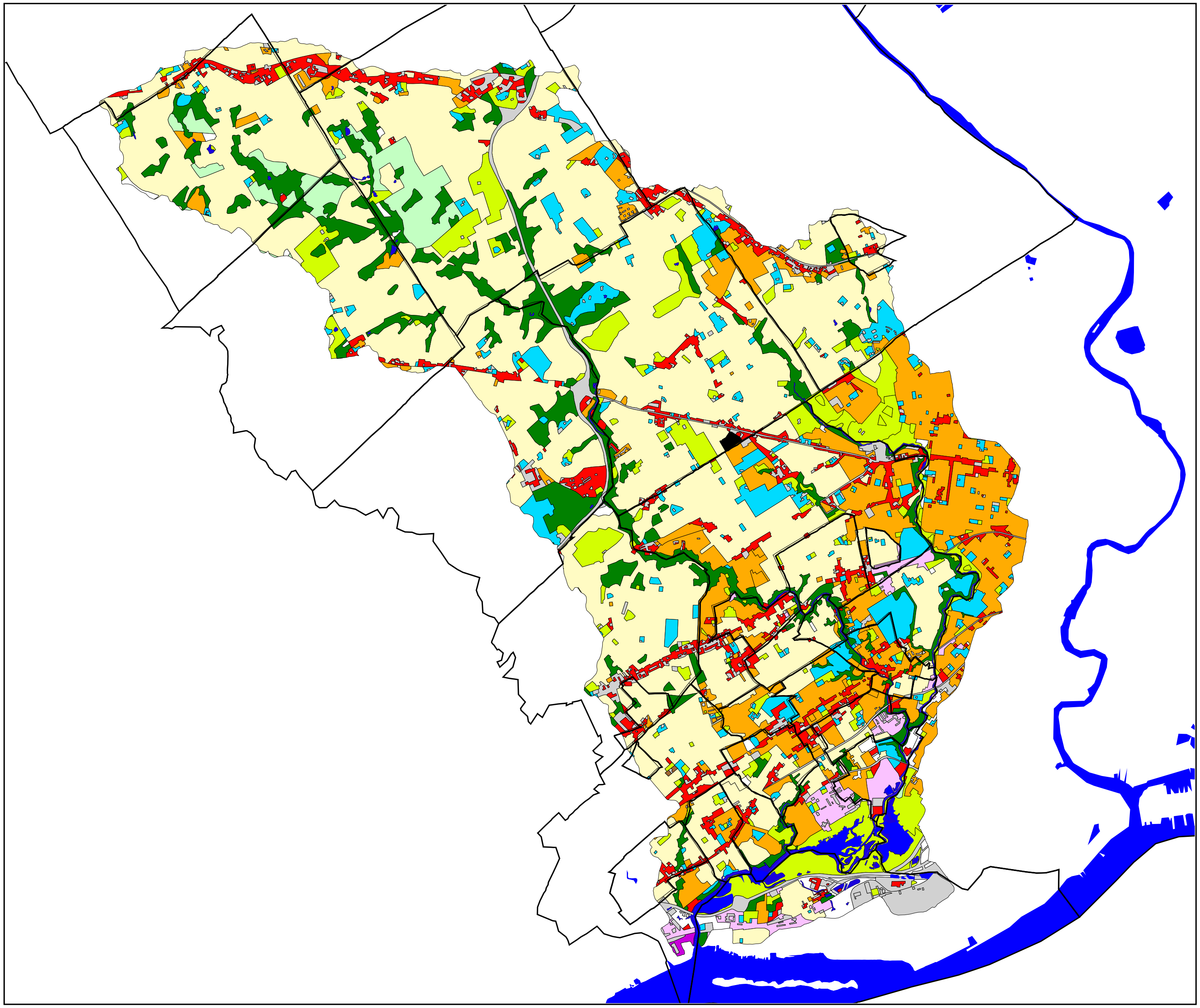
Environmental Engineers & Planners

GIS data provided by Philadelphia Water Department, Office of Watersheds.



DARBY CREEK WATERSHED

River Conservation Plan

FIGURE II-4

1995 LANDUSE

LEGEND

Municipal Boundary

Land Use Classification

- Agriculture
- Commercial / Services
- Community Service
- Manufacturing- Heavy
- Manufacturing- Light
- Military
- Mining
- Transportation
- Recreation
- Resdtl - Single-Family Detached
- Resdtl- Medium to High Density
- Utility
- Vacant
- Water
- Wooded

N W E S

CAHILL ASSOCIATES

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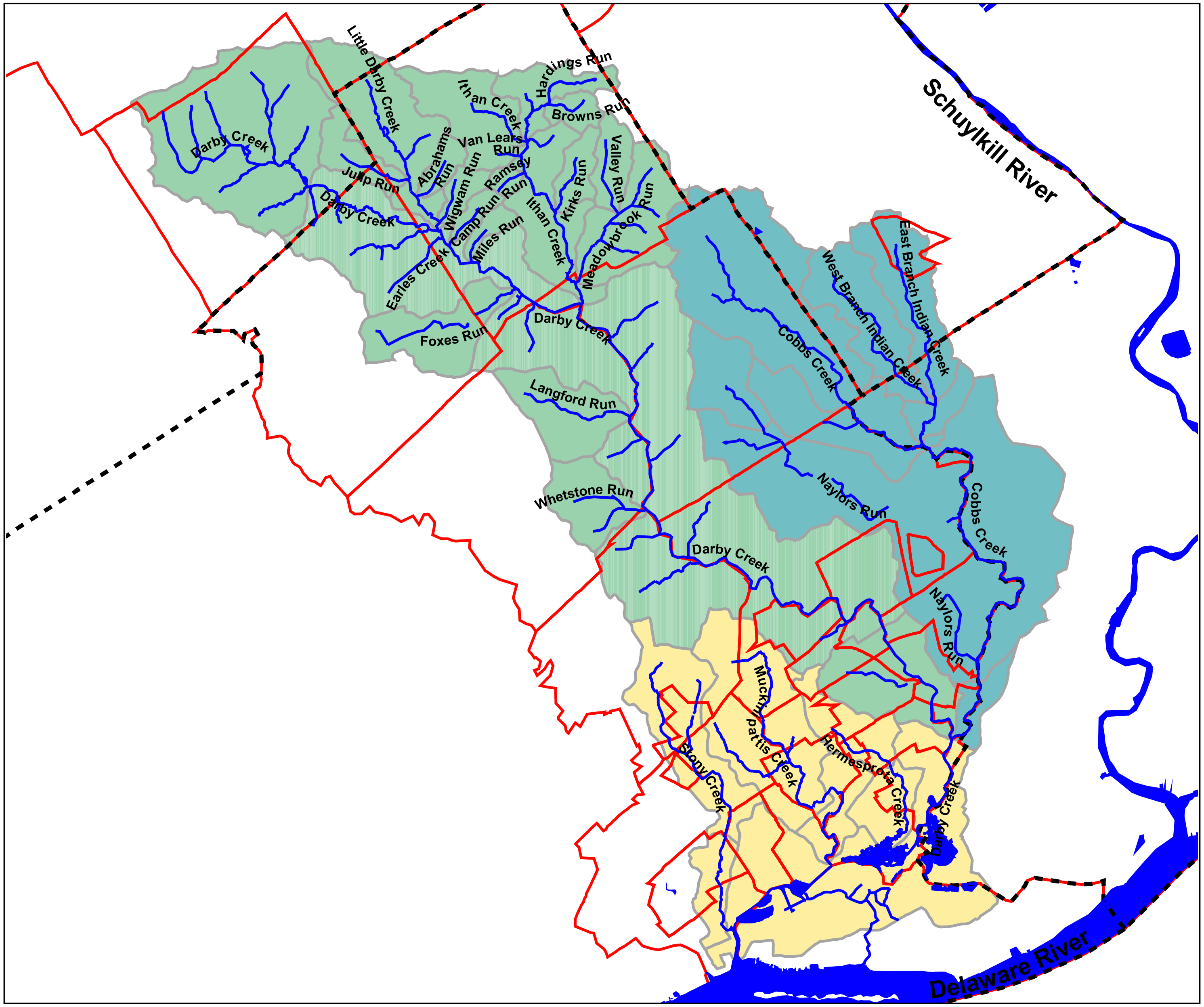
1995 GIS land use data provided by Delaware Valley Regional Planning Commission. Other data provided by PWD Office of Watersheds.



DARBY CREEK WATERSHED
River Conservation Plan

FIGURE IV-1 HYDROLOGY

LEGEND

- County Boundary
- Municipal Boundary
- Stream / Creek
- River / Lake

Sub-Watersheds

- Darby Creek Sub-Basin
- Cobbs Creek Sub-Basin
- Direct Drainage Sub-Basins

N E S W

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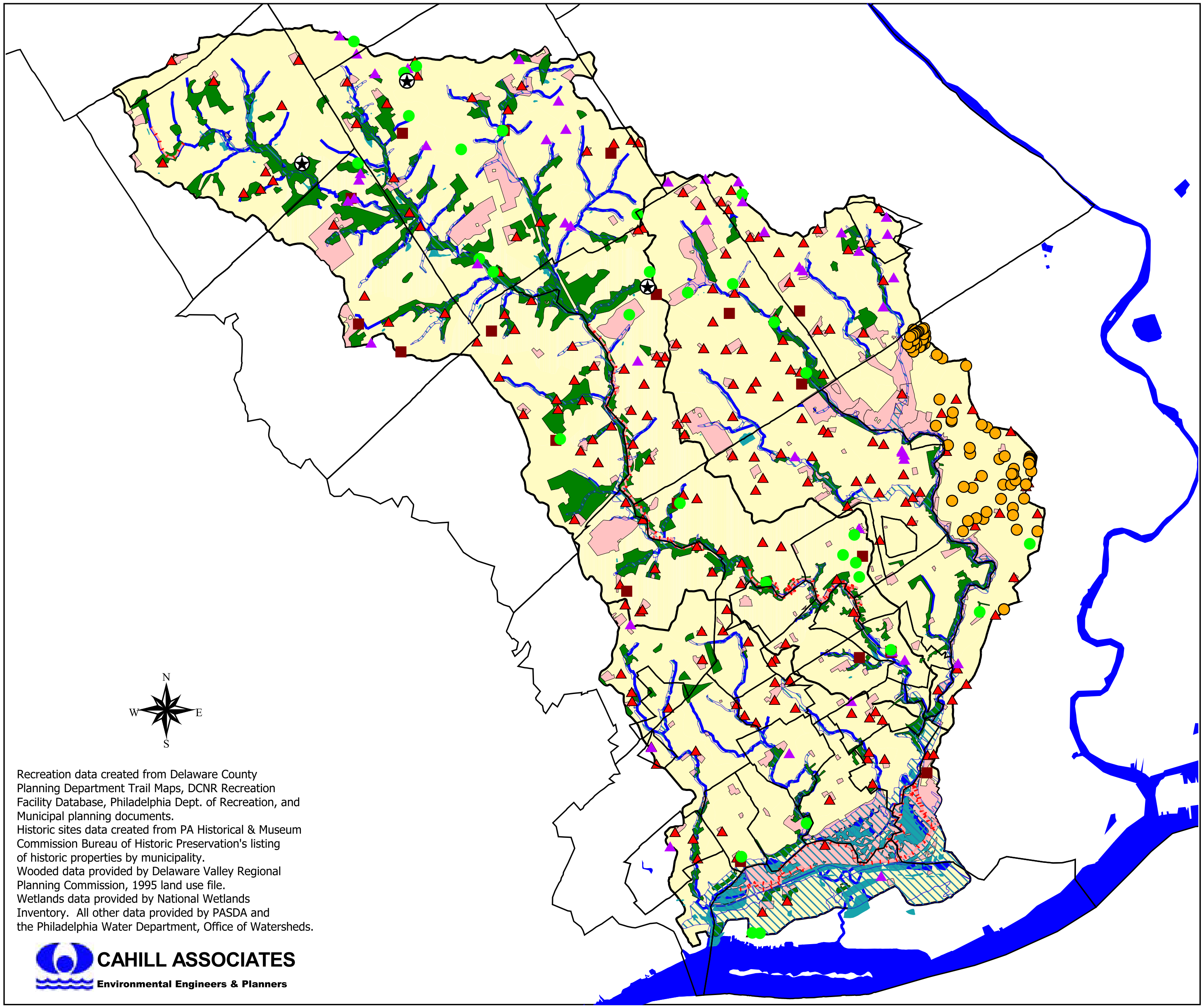
GIS data provided by Philadelphia Water Department, Office of Watersheds.

DARBY CREEK WATERSHED
River Conservation Plan

FIGURE VII-12
NATURAL & CULTURAL RESOURCES OVERLAY



LEGEND

- Listed on National Register
- Eligible for Listing on National Register
- Undetermined Status on National Register
- DCVA Historic Priority
- Historic District
- Recreation Sites
- Trails
- DVRPC Recreation Areas
- DVRPC Wooded Areas
- Floodplains
- Wetlands
- Political Boundaries
- Stream, Creek
- River, Lake
- Watershed