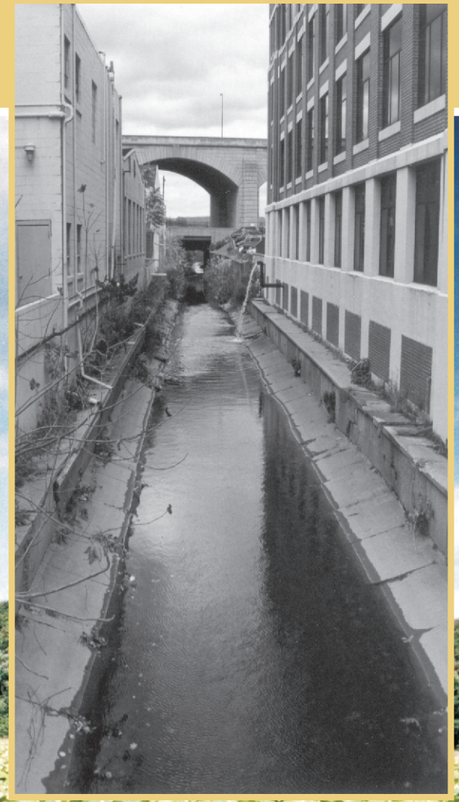
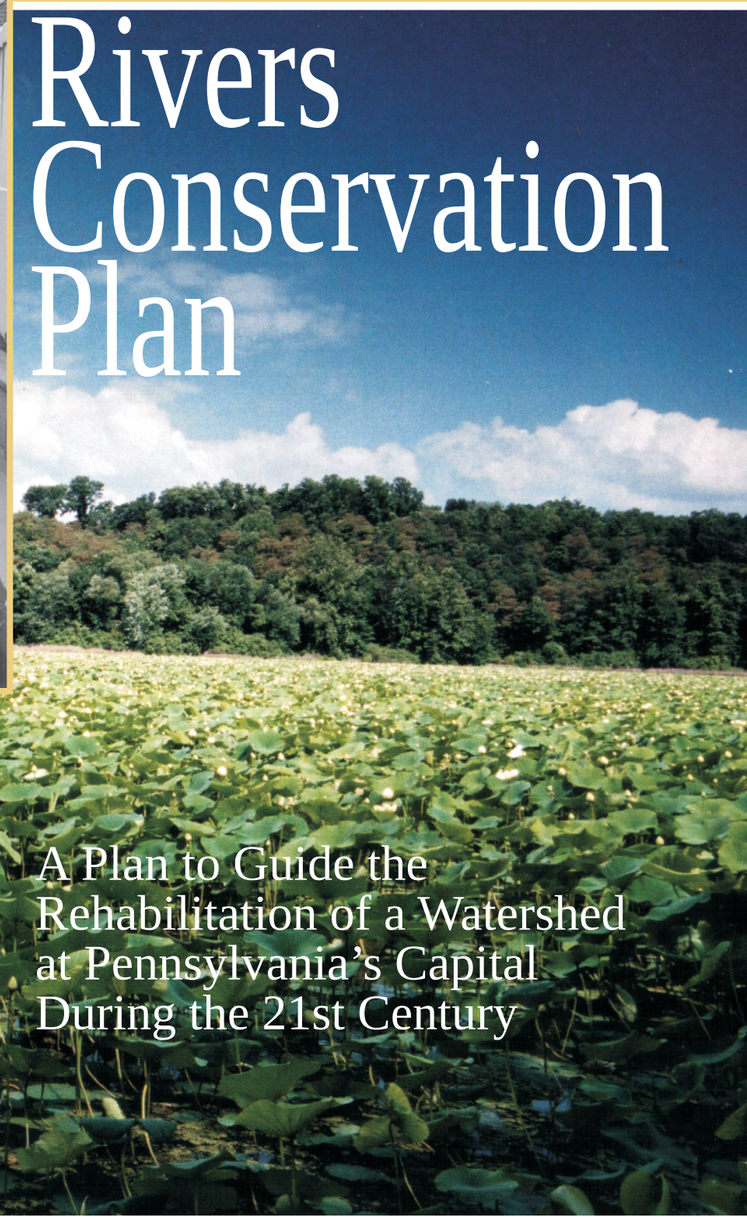
Paxton Creek Rivers Conservation Plan





A Plan to Guide the Rehabilitation of a Watershed at Pennsylvania's Capital During the 21st Century

Paxton Creek is an urban watershed in which caring stewards protect watershed resources, help make areas environmentally functional, and fully integrate the watershed's defining element – Paxton Creek, a desirable component – into the life of the watershed.

--PCWEA Board of Directors

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Paxton Creek Watershed and Education Association

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Letter to the Reader

Dear Stakeholders,

This Rivers Conservation Plan (RCP) provides the background, strategies and tactics for reaching the goals and objectives of rehabilitating and enhancing Paxton Creek. This plan is for the 80,000 people who reside, work, and play in Paxton Creek watershed.

This main RCP document is relatively short for reasons of emphasis and communication ease. Many plans founder upon excessive information. A large Appendix with supporting attachments contains the detailed aspects of the plan.

Several forms of the RCP exist to serve stakeholders: paper and digital files, the PCWEA web site, www.paxtoncreek.org and a CD-ROM. The Appendix is also available on paper and in watershed libraries.

The RCP is organized to serve partners in different ways. Enhanced by many pictures and diagrams, the plan seeks to educate as it engages readers. It advocates actions based on sound science and the priorities of stakeholders. Some of the figures, tables, and narrative are featured in both the RCP body and the Appendix for linkage and integration. Where information is lacking, the plan calls for actions to fill the gaps while watershed improvements continue. The implementation schedule for the plan accounts for these anticipated needs.

It took 300 years for Paxton Creek to undergo two major transformations, and suffer severe degradation amid ignominy. Let us hope that in only a few decades this RCP can help reverse creek conditions until Paxton Creek, indeed, is a watershed of promise..

E. Drannon Buskirk, Jr.
Paxton Creek Watershed and Education Association.

Wildwood Lake Sanctuary

Imagine, Paxton Creek!

Imagine a 50-mile green corridor that assists economic development …
Imagine recreation within walking distance of most homes …
Imagine less frequent and less severe floods …
Imagine plentiful well waters, and a creek that hardly ever dries up …
Imagine flowing waters that process waste and pollutants …
Imagine more wildlife and natural habitat close at hand …
Imagine fewer yards washed away, with less silt in pools and Wildwood Lake …
Imagine a restful greenway offering relaxing breaks …
Imagine places to soothe stresses and raise spirits …
Imagine healthy biking and walking trails between Harrisburg and municipal neighborhoods (and an alternative to traffic congestion) ...

Imagine Paxton Creek as an asset to the community (more than a ditch for stormwater runoff) … **Just Imagine!**

Acknowledgements

On behalf of watershed stakeholders Paxton Creek Watershed and Education Association expresses immense appreciation for persons and organizations providing financial, and other support for this plan. Some persons gave exceptional assistance as part of their jobs. The partners who furnished the support include:

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1 Paxton Creek - Watershed of Promise

The Setting

Paxton Creek is a small watershed at the state capital of Pennsylvania. The waterway forms in and flows through parts of four municipalities: Lower Paxton and Susquehanna Townships, Penbrook Borough, and the City of Harrisburg. Stormwater runoff from its 27 square miles area drains to the Chesapeake Bay. It is a creek with 2 mouths and 7 arms (tributaries). This urban creek carries twice the nutrients and 15 times the suspended solids washed off a forested landscape. Figure 1.0 depicts the watershed, subwatersheds, municipalities, and their locations in the state. Table 1.0 displays facts about the watershed.

Paxton Creek resources built early Harrisburg. Watershed forests were cut to make lumber, its farms produced food, its waters ground grains and sawed logs, and its clays became building bricks. Its people provided labor for business, government, and industry. Creek wetlands absorbed floods. Various reaches of the creek served simultaneously as sewers, water supplies for industry, and recreation.

For 200 years Paxton Creek was the economic facilitator and transport crossroads of the area. It was the destination of the Army of Northern Virginia, before the Confederates were stopped at Antietum and Gettysburg. Paxton Creek supported dozens of industries from iron making to beer brewing. Paxton Creek was a focus of Harrisburg's renaissance during the "City Beautiful Movement" in 1900-1915 as sewers, water filtration plants, asphalt roads, and parks were built. The creek's lower part was dammed and channelized.

Clogged Creek Channel

Table 1.0 Paxton Creek Facts

- ☑ Urban watershed with an average 30% impervious cover (asphalt and concrete surfaces of roofs, roads, and sidewalks).
- ☑ Watershed of inter-basin transfers: where most domestic water is supplied from outside the watershed, and wastewater goes to neighboring 'sheds.
- ☑ Where stormwater runoff has cut the creek banks and bottom to bedrock in places.
- ☑ Home of the large Wildwood Lake, a superb wetland with American Lotus, a plant species found at one of only two places in the Commonwealth.
- ☑ Home of the Paxton Boys, famed militiamen also known for a massacre of friendly Indians during the French and Indian War (1760s).

Adapted from Healthy Creek Project document: What's Your Paxton Creek IQ?

In subsequent decades industry and infrastructure declined, and Harrisburg lost population. Further declines occurred as farms were replaced by homes, businesses, and roads in the last half century. **Paxton Creek has become little more than a stormwater drain, and a conduit for floodwaters from the Susquehanna River, made worse by runoff from upstream communities.**

Paxton Creek is both a stream of shame and a promising opportunity. Joining Harrisburg's revival and changes to the other watershed municipalities, rehabilitation of the creek can improve the quality of life of both its peoples and creatures. This can be done by constructing a 50-mile green corridor to protect the creek, reduce pollution, process waste (at reduced cost), replenish well waters, enhance transportation, aid economic redevelopment, increase wildlife and natural habitat, soothe urban stress, and provide recreation within walking distance of homes in most neighborhoods–all this with implementation of the Paxton Creek Rivers Conservation Plan (RCP).

"Paxton Creek is both a stream of shame and a prospect of immense promise at Pennsylvania's capital."

Paxton Creek - Watershed of Promise

Paxton Creek mainly flows from the top of Blue Mountain to its southern boundary roughly paralleling Route 22, and from near Linglestown and Mountain Road westward to the railroad at Sixth Street in Harrisburg, encompassing part of the Capitol complex and southward into the Susquehanna River near Steelton, and also north of Wildwood Lake into the river. Reinforcing Dauphin County's plan, the RCP is the only plan addressing integrated, multiple dimensions of the watershed. It has a limited three-part focus: protection of watershed resources; solutions for watershed problems; enhancement of watershed attributes.

The RCP does not seek to restore the watershed. Three centuries of land degradation and future needs make this impractical. The plan addresses protection and rehabilitation of resources (floodplains, water quality), and enhancement of others (recreation, education).

In addition to using simpler words with many images to make communication easy, the RCP has other unique features absent from some Rivers Conservation Plans. It aims at assisting watershed goals such as economic redevelopment. An example: The RCP presents a conceptual design for trails and miniparks in the New Baldwin economic enterprise zone (channelized creek reaches near Cameron Street in Harrisburg) to enhance business and commercial opportunities. The RCP will also look backwards as well as forward at itself. Example: the RCP will consider the potential for subwatershed plans such as the Paxton Creek North plan to meet watershed goals, through water treatment models that compare BMP performance expectations with the plan's quantitative objectives (pounds of pollutants avoided/removed).

Community Watershed Planning

The RCP integrates creek-related concerns of all the watershed municipalities, addressing the connection of woodland buffers along the creek, an interconnecting trails system among municipalities, and flooding concerns in Harrisburg. The plan provides recommendations that compliment the watershed's Act 167 stormwater plan. It may also lay the groundwork for a stormwater management utility for watershed municipalities that could occur in the intermediate future. Upon adoption by municipalities, the RCP will be submitted for listing on the Pennsylvania Rivers Conservation Registry.

The nearly two dozen Geographical Information System (GIS) maps prepared during the RCP development that will be available through Pennsylvania State Data Access are a significant resource for both the area and state.

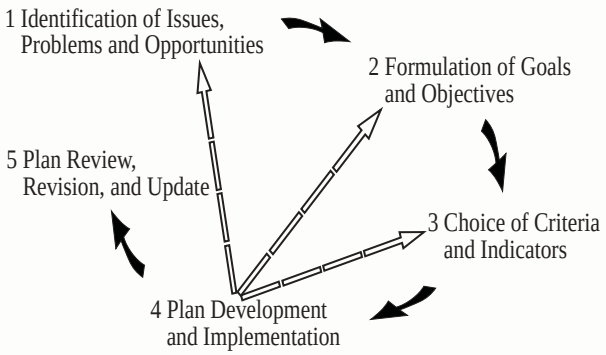
BMPs Tour to Maryland

Figure 1.0
Paxton Creek Watershed

2 Making the RCP for Paxton Creek

The development of the RCP is a multifaceted endeavor involving a problem solving (planning) procedure, with various modes of public participation, professional reviews of plan components, and other activities.

Figure 2.0 RCP Planning Process



RCP planning follows a five-step problem solving procedure. (Figure 2.0)

- *Watershed problems, issues, and opportunities* are identified through visioning meetings, surveys, workshops, interviews, data evaluations, and other means. An information baseline with data on dozens of factors and maps for comparing factors (what conflicts, reinforces, cooperates) are compiled.
- *Plan goals* are determined based upon the problems, issues, and desires; the goals are different for various parts of the watershed (subwatersheds).
- *Criteria and indicators* the rules and measures for making plan decisions, and evaluating goal success are selected.
- The heart of the process, *plan development and implementation* involves: putting the information together, integrating upland and riparian projects, prioritizing potential rehabilitative efforts, and monitoring basically deciding what, when, where, and how for watershed improvement.
- *Reviews, revisions, and updates* will be necessary during the coming decades in response to changes in the watershed and RCP circumstances (funding, personnel, rehabilitative techniques).

Planning Methods and Sources

The RCP uses a variety of methods. These approaches collect information, analyze data, perform other planning tasks throughout the planning process, and include input from stakeholders during all phases.

Stormwater Retrofit Survey

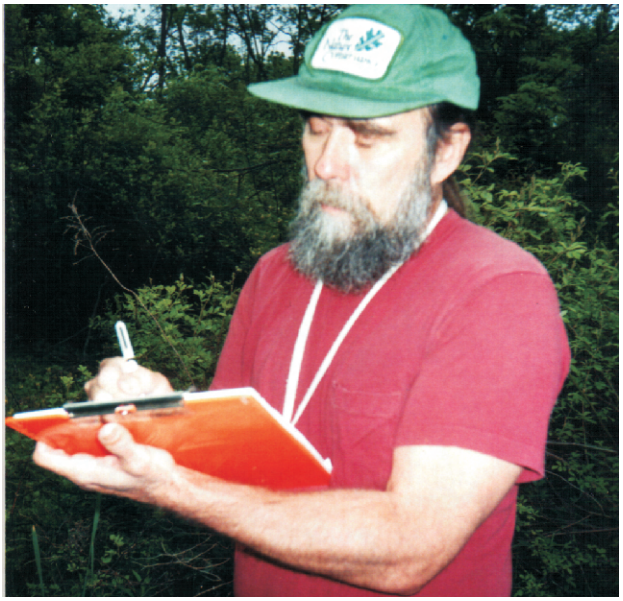
Existing information includes data files, records, reports, books, maps (paper and digital format), project blueprints, diagrams, drawings, and photographs. Particularly useful (with a few examples) are original data files (Paxton Creek water quality monitoring data), primary study reports (*Paxton Creek Stream Corridor and Watershed Assessment, Paxton Creek Roundtable*); secondary reports based upon primary and secondary information (*Dauphin County Draft Comprehensive Plan)*. The main procedure was to review existing information, get additional explanations or clarifications, as necessary, and make integrative evaluations.

New studies were performed in subject areas with insufficient data. These studies by PCWEA and partners using standard scientific procedures were of the following types -- primary data collected directly from the watershed: terrestrial vegetation;

"Mowing lawns to creek banks just love them to death!"

Making the RCP for Paxton Creek

landowner and stakeholder issues, practices, and preferences; comprehensive riparian habitat assessment, vegetation, water chemistry, macroinvertebrate abundance and diversity; land cover and impervious surface maps; stormwater detention pond inspections; codes and ordinances evaluation; *Paxton Creek Baseline and Stormwater Retrofit Assessment* study; *Paxton Creek North Subwatershed Restoration Plan*; primary and secondary data compiled and reworked for watershed focus (Census 2000 Summary 3, GIS maps, stormwater infiltration). Most work was performed by professionals. Some was achieved by college students under professional guidance. Studies on two subjects (creek flows and pollutant loads) were started during the planning period.



Vegetation Inventory

Part of this RCP, and as a precursor for ongoing and future activities, is a plan for the Paxton Creek North (PCN) subwatershed. This work involved a review of existing hydrologic, biological, water quality, and geomorphologic (creek processes) data, followed by making maps from remote sensing images, locating sites of potential problems and opportunities on the maps, performing a subwatershed delineation which established precise water flow boundaries, and making an analysis of impervious cover. Field methods involved an inventory of stormwater retrofit facilities, and teams performing stream and upland assessments with techniques called the Unified Stream Assessment (USA), the Unified Subwatershed and Site Reconnaissance (USSR).

The USA is a comprehensive stream walk for evaluating the physical, riparian, and floodplain conditions in small urban watersheds. The USSR assesses potential subwatershed pollution sources, and restoration opportunities in areas outside the stream corridor. (CWP, 2004) Together, the stream, subwatershed, and inventory methods were used to identify sites for 10 categories of watershed rehabilitation and enhancement projects: pollution source controls, on-site stormwater facility retrofits, riparian reforestation, creek rehabilitation, septic wastewater discharge prevention, upland reforestation, flood controls, trails installation, education, and recreation with economic redevelopment. Following prioritization of the projects by the Watershed Restoration Template (CVI and DEP, 2004), the RCP implementation costs were estimated using unit cost figures for subwatershed planning compiled by the Center for Watershed Protection (1998). Late in the process subwatershed modeling flow estimates became available (DCCD, 2005). Although this information was too late for incorporation in the choice of projects, it can be used in future project prioritizations, and applications with the Watershed Treatment Model (Center for Watershed Protection, 2002), a desktop spreadsheet approach for estimating pollution load reductions (sediment, nutrients) from various treatment options associated with different projects. An RCP objective was the formation of an implementation matrix integrating project and program activities (Table 8.4). This matrix shows: the types of activities; associated goals, objectives, strategies, and tactics; evaluation indicators; required costs and resources; participants and responsible parties; schedule.

Stakeholders Meeting

Making the RCP for Paxton Creek

Public Involvement

Plan analyses and findings were submitted to agencies for review and comment, and to watershed stakeholders and the public at workshops, meetings, website interactions, and library displays. Planning materials were supplied to an advisory group and technical committee for deriving input into the plan. The PCWEA quarterly newsletter contained stories issue by issue about particular planning studies, and plan status updates. A special newsletter issue accompanied the release of the draft plan.

Planning Workshop

Planning workshops began the process (RCP launch), occurred near the end of data gathering phase (PCN Stakeholders Gathering, and State of the Watershed Report), and accompanied the preparation of the draft plan (RCP Projects Prioritization Workshop). The initial and final workshops, guided by planning professionals, featured proposed plan inputs and GIS maps. RCP small group discussions focused upon select plan themes (water resource management, recreation, economic development). The website contained a plan summary with links to the Appendix sections, and invited comments from participants. During February, 2005 library displays designed by college students at the East Shore Area Library featured monitoring, and the planning process with inputs into the RCP. The educational materials for follow up and implementation include the brochure *Are You Loving Paxton Creek to Death? (AYLPCTD?)*, slide shows on Paxton Creek and a subwatershed, and 7 fact sheets on practices specific to residential, municipal, land development, and business behaviors that can improve the watershed. A copy of the education brochure *AYLPCTD?* is attached (RCP-1).

The RCP brings a new era to the watershed: projects. Although past public involvement was extensive, the public involvement program will need new emphases better attuned to the needs of specific stakeholders. Examples: PCWEA sponsorship of tours to proposed project sites, neighborhood and subwatershed focus groups formed for local advisory and facilitation roles, frequent meetings at regular times, and continuing partnerships with local people will be necessary so people can understand better, participate more meaningfully, and even lead projects in their communities.

Creek Habitat Education

Making the RCP for Paxton Creek

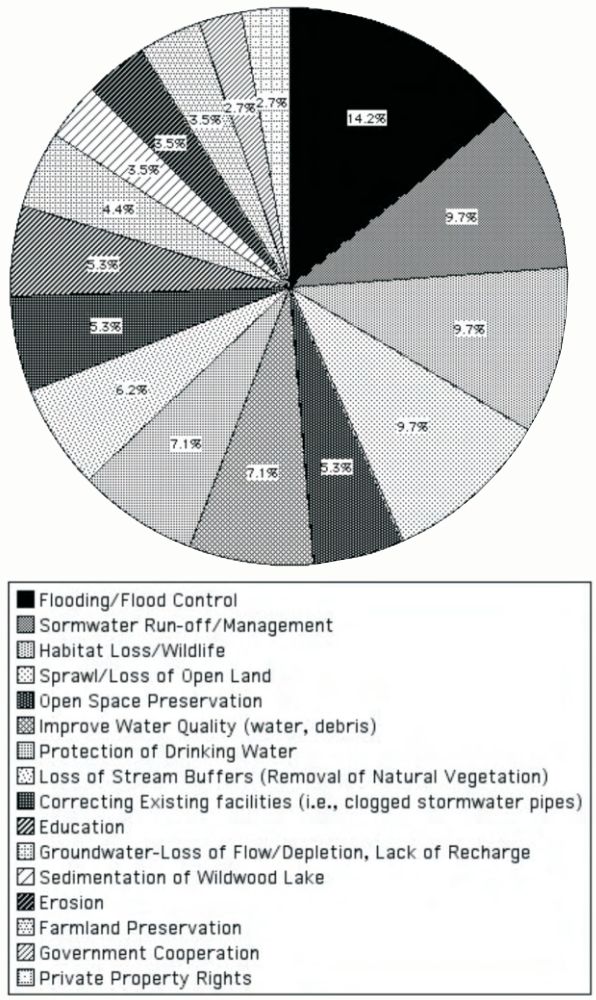
Community Context: Concerns and Practices

Even before the RCP process was officially underway, the public pulse of the watershed was being taken. At 4 visioning gatherings conducted by PCWEA throughout the watershed, 4 main sets of frequent concerns were found to dominate 91% of the stakeholder interests: floods, stormwater runoff; water quality, and related issues; sprawl and open space; vegetative habitat and wildlife. Forty concerns were expressed by 124 persons at the visioning meetings. (Figure 2.1) Additional insights about watershed concerns were gathered by surveys, interviews, participative workshops, and other means involving hundreds more stakeholders.

Some people came to visioning sessions looking for immediate assistance with specific problems (particularly flooding), not merely to respond with their opinions. Some never attended other watershed association events. This experience points to a central tenet: a Paxton Creek RCP stands little chance of being implemented unless the people have a shared image. This requires the RCP coordinators to take actions that help stakeholders share common goals, understand what is involved, agree on what to do, have clear expectations, enjoy widespread participation, and exercise patience. PCWEA must help stakeholders give input, and enjoy their accomplishments in implementing the RCP and subwatershed plans:

Broad consensus on goals. Actively share data and maps, make evaluations, select planning criteria and indicators, and customize subwatershed management tools.
Watershed understanding. Increase watershed awareness and stewardship involving intergenerational educational activities, and technical training.
Agreement on tasks. Promote ways and establish programs for accomplishing goals involving public private partnerships while building community cohesion.
Widespread participation. Encourage involvement by all stakeholders, so as to build upon the diversity and strengths of the entire watershed, while aiming for synergism.
Realistic expectations and patience. Help participants appreciate the benefits and take pride in their achievements, so as to avoid boredom and burnout.

Figure 2.1 Watershed Concerns



Digging Rain Garden

Making the RCP for Paxton Creek

For the most part stakeholders are cooperative, agreeable, and have good intentions, but many of their current practices are harmful to the creek. (Table 2.0)

Table 2.0 Practices Harming Paxton Creek

- ☑Careless use of substances (oils, fertilizers, cleaners) pollute the creek through stormwater runoff.
- ☑Mowing lawns to the edge of creeks for a tidy appearance can greatly accelerate erosion, and allow pollutants to wash into the creek.
- ☑Clearing creek side vegetation for a neat or landscaped appearance.
- ☑Connecting drain pipes from basements, washing machines, and toilets (illegal discharges!) directly to the creek or wetlands.
- ☑Separating and poorly coordinating pollution prevention, stormwater management, and watershed enhancement (recreation, economic redevelopment) by municipalities.
- ☑Beginning conventional land development with complete, sometimes careless, land clearance (clearing and grubbing).
- ☑Failure to recognize unique site aspects worth conserving or protecting before engineering plans for land development are begun.
- ☑Stripping top soils (vastly diminishing stormwater infiltration, and productivity of gardens), at the start of land developments.
- ☑Continued building of homes and other developments (roads, utilities) on the mountain and in headwater areas.
- ☑Conventional land development ordinances focusing protection upon sites, but not downstream properties (causing erosion, floods).
- ☑Running stormwater off streets into curbs, drains, and ponds, rather than simply soaking into swales and vegetation beds.
- ☑Ordinance requirements for overly wide and long streets.
- ☑Largely unnecessary parking areas, as for "once-in-a-century" commercial sales events (excess space even required by ordinances).
- ☑Creek corridors with vegetative buffers too narrow and too sparse to keep polluted waters out of the creek.
- ☑Landowners using the last inches of their properties by encroaching upon creek corridors with walls and outdoor storage piles.
- ☑People who complain of upstream runoff causing them damage (floods, erosion), but who do little to reduce runoff on their own land.
- ☑Rooftop and other runoff discharged onto driveways, sidewalks, and streets rather than local, onsite soaking into soils and vegetation.
- ☑Loss of open space resulting in groundwater losses (dry wells, low creek flows, wildlife habitat loss, diminished recreation potential).
- ☑Use of the creek almost entirely as a drain, without any consideration for other possibilities (creek-based recreation, wildlife habitat, trails/alternative transport, economic redevelopment).
- ☑Participation in occasional, isolated rehabilitation events (creek cleanup, tree planting, trail maintenance), where ongoing, repetitive actions are really needed to make a big difference.

The list goes on.

The workshops and other public participation activities show limited public understanding of how a watershed works. Generally, citizens are more likely to be aware of crises–hazardous waste spills, floods, wet basements, and droughts and demonstrate less knowledge about the big picture of watershed health. Similarly, local government officials lack an understanding of watershed dynamics, but are becoming increasingly aware of the interconnections, and need to implement policy, programs, and regulations that best balance land use practices with the quality and quantity of water resources.

Lawn Mown to Creek Edges

3 Watershed Basics 101

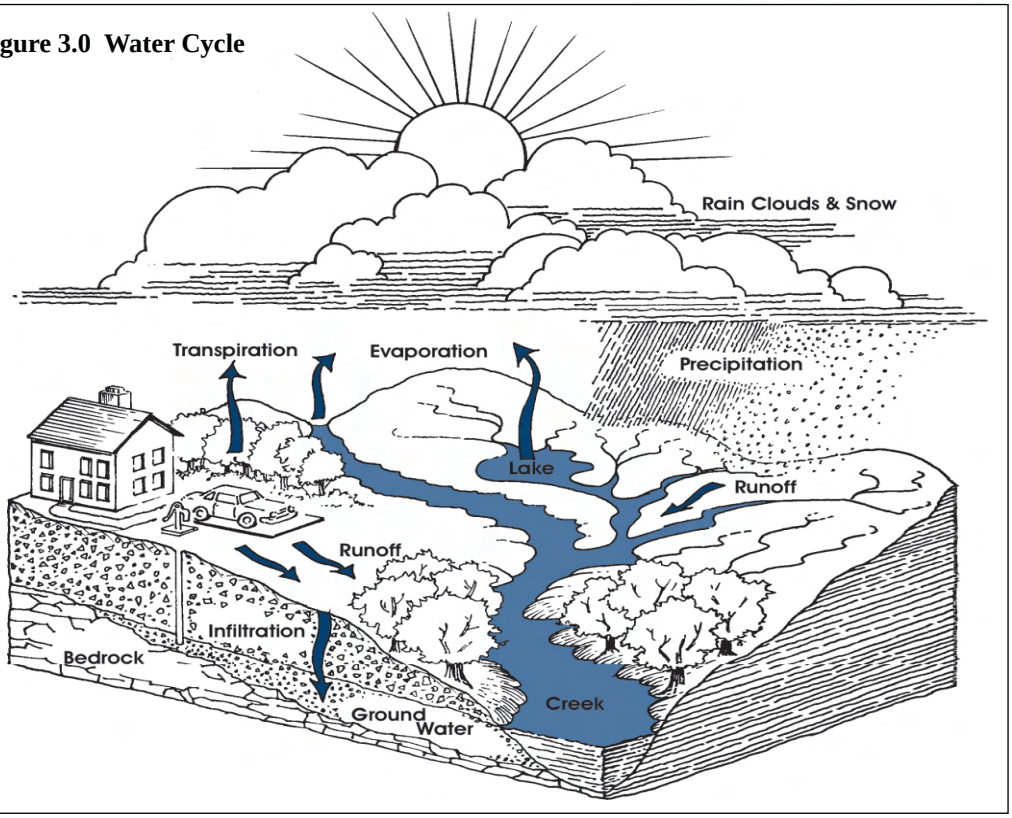
To enhance watershed understanding and to keep readers and RCP partners on the same page about the terms, concepts, and principles used in this plan, *Watershed Basics 101* explains the water cycle, the 'sheds, and how other aspects of Paxton Creek work. A separate Appendix provides extensive details. A glossary of Terms, Abbreviations, and Acronyms located at the end of this RCP document can also be of assistance.

Can You Park Your Water Cycle in a 'Shed?

Paxton Creek's problems and solutions start with the *water cycle*. Natural water flows are a cyclic process involving various forms of precipitation (mainly rain and snow) that fall to the ground, soak into soils, and fill crevices and cracks in rocks. (Figure 3.0) While local water uses and land changes are often too small to alter the overall water cycle, such activities can markedly affect local water patterns (trees cut, and soils covered or compacted can decrease stormwater infiltration and increase runoff).

"Fellow watershed planners, we have just received some decision making materials from the folks in a neighboring watershed!"

Figure 3.0 Water Cycle

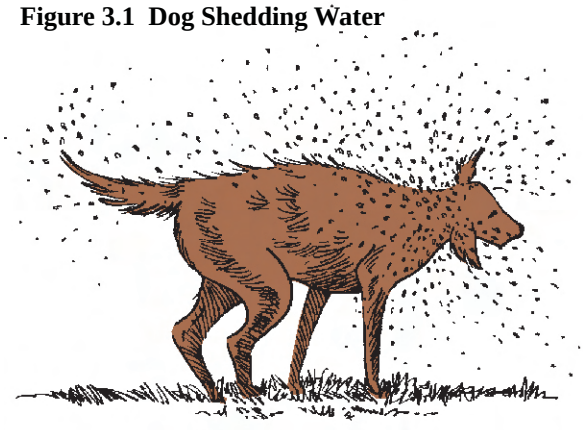


"Limiting stormwater responsibilities to development sites doesn't give a d#mx about people downstream."

Watershed Basics 101

Water that doesn't soak into the ground runs off the landscape from areas called watersheds. Analogous to water falling off a dog, watersheds are places ('sheds) where the water runs off lands. (Figure 3.1) The boundaries of 'sheds are mainly determined by landscape topography. Water runs from high points (elevations) in all directions downslope until the next 'sheds. Watersheds include everything in drainage areas – all vegetation, roads, buildings, streams, lands, and groundwater. Watersheds come in all sizes, and different terms are used to describe them. (Figure 3.2) They typically range from catchments of a few acres or smaller, to increasingly larger areas: subwatersheds, watersheds, and basins. While integrated water resource planning may occur at the watershed level, the ideal size for implementation and management is often the subwatershed. The subwatershed planning unit is small enough to get things done, and still contribute to the big picture. It is small enough to determine the causes of creek degradation, allows recognition of local development impacts, and reduces the need to deal with multiple political jurisdictions. Tasks like mapping, monitoring, and other assessments can be done in a shorter time, without undue burdens on work in the larger watershed. A subwatershed plan can generally be carried out within a year, still allowing time for the essential tasks of: goal development, data collection and evaluation, project design, agency coordination, and stakeholder involvement. It will be necessary to plan individual rehabilitation projects at the catchment level.

Figure 3.1 Dog Shedding Water



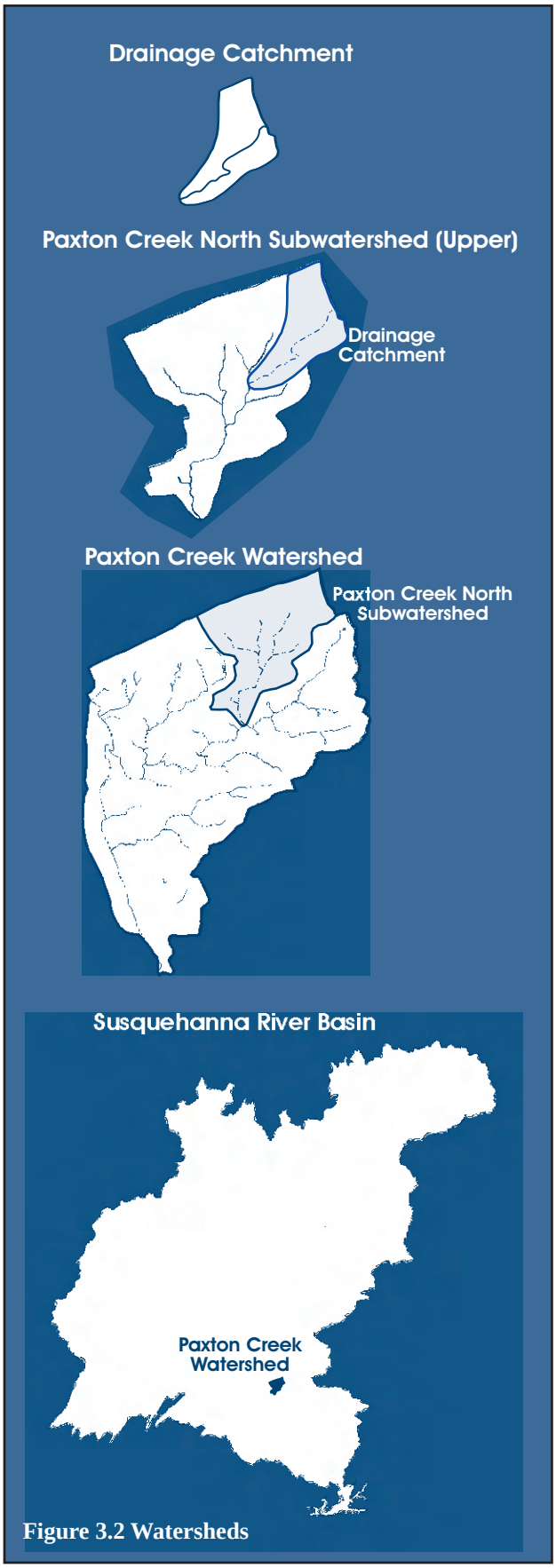


Figure 3.2 Watersheds

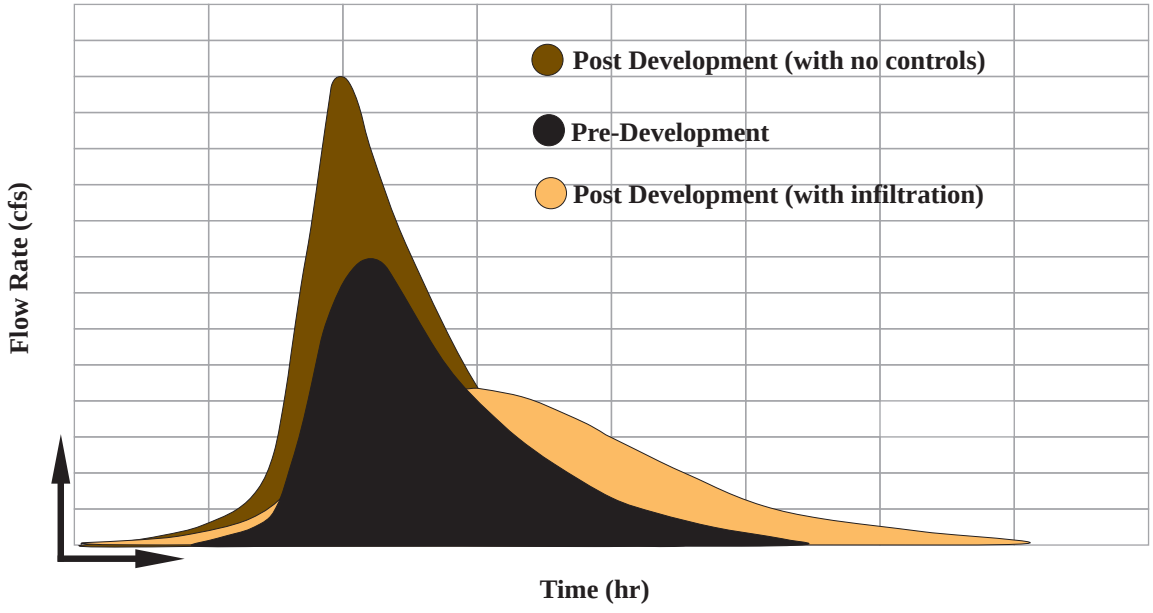
Where is the Rapid Runoff Rapid?

A water diagram called a *hydrograph* represents the amount and pattern of water flow during a given time period. A hydrograph generally has a shape similar to an abstract profile of a mountain peak (Figure 3.3) This diagram also shows the runoff pattern where the land cover is steeper, harder, or smoother, allowing stormwater to run off faster and have higher maximum flows, especially from surfaces that are impervious (blocked) to water flows.

Stormwater flowing off impervious surfaces (roofs, roads, parking lots, packed dirt, and even tight grasses) rises higher and falls more quickly. The higher peaks reflect increasing potential for flooding, worsening water quality (higher sediment and phosphorus loads), increasing creek warming (detrimental to fish), and decreasing biodiversity (kinds of aquatic insects, fish, and other wildlife).

The lowest, broad peak below (orange color) illustrates the effect of stormwater soaking into the ground where the precipitation falls or close by. In housing developments this occurs where runoff is directed into yards (rain gardens, conservation landscaping, swales) rather than conveyed by gutters, drains, and pipes directly to streams.

Figure 3.3 Stormwater Runoff Hydrographs



Note: Modified from DEP, 2005

The aim of effective stormwater control practices is to shorten the hydrograph peak and broaden its shape. Conventional ways of managing stormwater runoff in central PA aim at reducing the peaks on hydrographs at development sites, but developers focus on sites, not downstream impacts. Upstream waters released too quickly from multiple places can, and do combine downstream to cause flooding, severe erosion, sedimentation, and other problems. This pattern has been the bane of Paxton Creek watershed, especially during the initial land transformation period and the last half century of accelerated urbanization.

Impervious Cover Model

Following a review of hundreds of studies, the Center for Watershed Protection (2000) proposed a scheme for classifying urban streams based on extent of imperviousness. This approach assigns streams to three management categories: under 10 percent imperviousness, sensitive; 11-25 percent imperviousness, impacted; 26 percent and above, non-supporting (of wildlife). Different watershed improvement approaches are recommended according to this breakdown. (Figure 3.4)

This scheme is used in the Paxton Creek RCP. Paxton Creek has extensive impervious surface (30% overall, and a range of 9 to 56% in the subwatersheds). (Table 4.1)

This impervious cover model is a general screening tool, not the basis for decisions on specific sites. Paxton Creek has some places with stream quality better than the model suggests (Upper Paxton Creek North headwaters), just as the poor stream habitat near the Harrisburg (East) Mall does not represent Spring Creek's ability to support a thriving trout population downstream

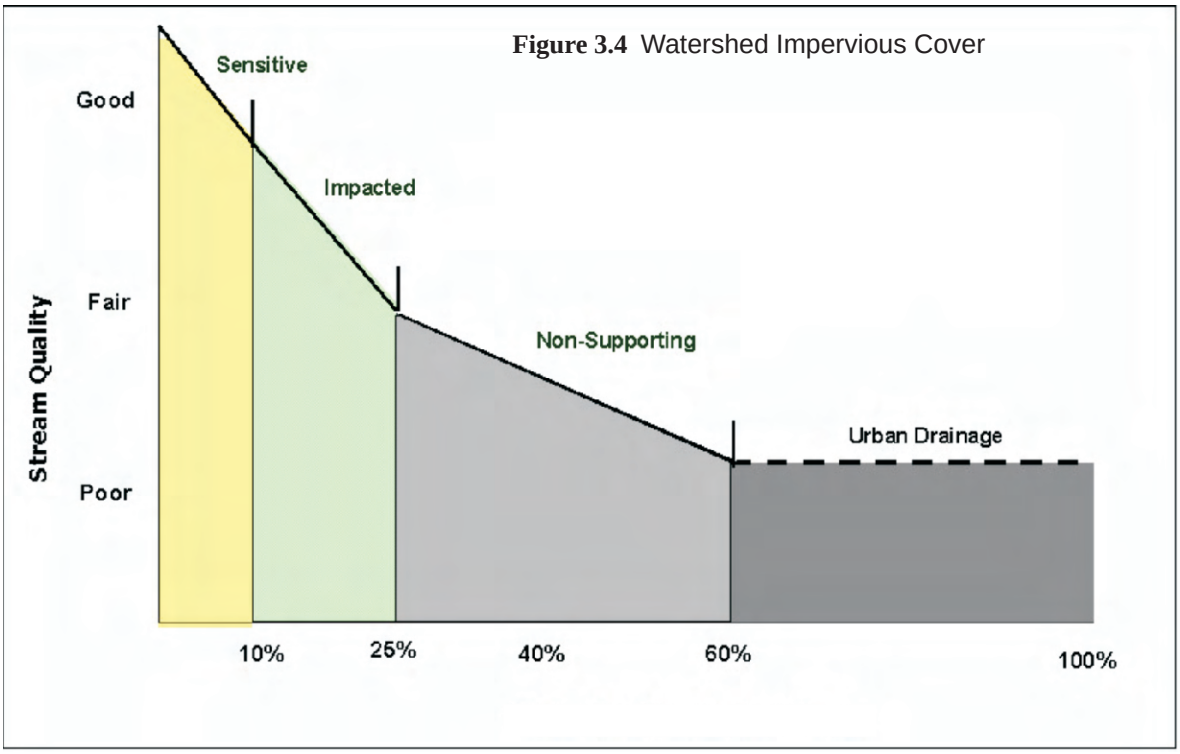


Figure 3.4 Watershed Impervious Cover

Source: CWP, 2004

Are Surface Waters Well Grounded?

The watershed has water in the ground, on the surface, and in the air. Ground water is precipitation that has percolated into rock fractures underground, and/or into soils, saturating particles of sand, gravel, silt and clay. The underground rock layers containing ground water are called *aquifers*. (Figure 3.0)

Ground water that seeps into streams makes up their *base flows*, and sustains animal critters during droughts. In Paxton Creek, the base flows are reduced where stormwater runs off, rather than infiltrates into the ground.

The quality of ground water is generally better than surface water, due to cleansing of polluted water as it seeps through the soils. Ground and surface waters are interconnected, making ground water vulnerable to contamination by surface water, and vice versa.

Surface waters, mainly in creek tributaries, lakes, and ponds are determined by geology, drainage area, topography, land cover, land uses, and climate (storm intensity and duration). Most surface waters in the watershed are branches of the creek formed from precipitation falling into low landscape depressions, and running down slopes to combine with other runoff, forming larger and larger flows. The initial small flows forming distinct streams are often termed *first order* tributaries. These can be the creek headwaters.

Erosion and Bank Slump

Throughout much of Paxton Creek watershed, surface waters have deeply incised the creek channels. Erosion has occurred to an extent that only runoff from major storms will cause the creek to rise above its banks and empty onto the floodplains. Excessive runoff has cut the creek, first to bedrock and then sideways, causing damage to the creek's channels and banks. Impacts include loss of aquatic habitat for animals, toppled trees, lowered water quality, and under recharged aquifers with associated degradation. The creek cannot adapt quickly enough to the accelerated stormwater runoff, making Paxton Creek a stream out of balance with its watershed.

How About Water Quality?

When people talk about quality, they are concerned about how good or bad something is. When the subject is water, the concern is what is in the water (kinds and amounts), sources, and the water conditions (waterway erosion, habitat suitability for wildlife). The things in the water that restrict, or limit water uses are called *pollutants*. Some pollution in natural waters is common. All things in water are not bad, but most can be problems if they are excessive or too sparse for desired conditions.

Collecting Sediment Sample

Various categories of factors used in assessing water quality are called *parameters*. They generally are of three types: physical, chemical and biological. The physical parameters are factors such as water temperature, flow level, and current speed. A wide variety of chemical parameters include pH (amount of acidity), dissolved oxygen, nutrients, and metals. The biological parameters are plants and animals living in waters. Creatures play a special role in water quality determinations. While physical and chemical measurements can show harmful conditions or substances when they are present, populations of organisms can function as "floral and faunal memories" for sites. Their abundance and diversity reflect past history, and may indicate a poison, major stress, or even a beneficial factor affecting or passing through the aquatic community. In Paxton Creek all three types of parameters are used in monitoring. (Table 3.0)

Table 3.0 Paxton Creek Pollutants

Pollutant	Source
Fecal Coliform Bacteria	Sewers and other animal waste sources (e.g., pets, wildlife, livestock, truckers)
Debris	Landscape and yard waste, local floods
Heat	Asphalt and concrete surfaces (e.g., parking areas, roads), industrial discharges
Metals	Transport vehicles, industries, degradation (e.g., rusting)
Nutrients	Agriculture, lawns, gardens, vehicle emissions, golf courses
Pesticides	Agriculture, lawns, gardens, homes, businesses, golf courses
Petroleum Hydrocarbons	Vehicle emissions, fuel and lubricant spills, lot and road runoff
Salt (NaCl)	Roads, sidewalks, landscape materials
Sediment	Erosion of soils

Another way to look at pollutants is their source. Two broad groups are *point source* and *nonpoint source pollutants*. Those from point sources typically emanate from distinct places such as animal feedlots and pipes from toilets, industrial plants, and municipal treatment facilities. These point sources were the main regulatory focus for over 30 years, and programs were established for their systematic monitoring.

Important also to the watershed is pollution from nonpoint sources, which by definition are places dispersed across the landscape such as farm fields, parking lots, yards, motorized vehicles -- almost everywhere. These nonpoint source pollutants typically are conveyed as contaminants in stormwater runoff.

What Are Some Ways To Improve the Watershed?

The current term for optimal approaches dealing with watershed resources is *Best Management Practices (BMPs*). BMPs are methods, measures, or practices to avoid, prevent, reduce, or mitigate undesirable effects or outcomes.

BMPs are of two types: structural and nonstructural. The structural ones use physical entities (soils, vegetation, machines) to accomplish objectives. The nonstructural alternatives include approaches such as schedules, operation and maintenance procedures, and changed practices for achieving the desired results. Well managed BMP programs often integrate the two groups.

Figure 3.5 Rain Garden

Water Resource BMPs

Water resource BMPs have various functions: reduce runoff, infiltrate water, recharge aquifers, prevent pollution, and improve water quality, while achieving other benefits such as yard and garden beautification and increased wildlife habitat. Especially useful in Paxton Creek are retrofits of existing facilities for better stormwater management, and pollution removal. Combinations of BMPs are necessary to achieve all the benefits. The most effective water resource BMPs generally simulate crucial elements of natural processes. Typical water resource BMPs are landscape depressions such as *rain gardens* (Figure 3.5) , *bioretention areas*, and *swales* where vegetation captures and treats stormwater runoff before it enters receiving waters; *pollution prevention/source control practices* that reduce or prevent nonpoint source pollution from yards and dumpsters; *forested* creek corridors (shrub and tree buffers) that filter runoff and reduce pollutants entering the creek, stabilize stream banks, regulate creek temperatures, and provide habitat for aquatic and terrestrial wildlife. (Figure 3.6)

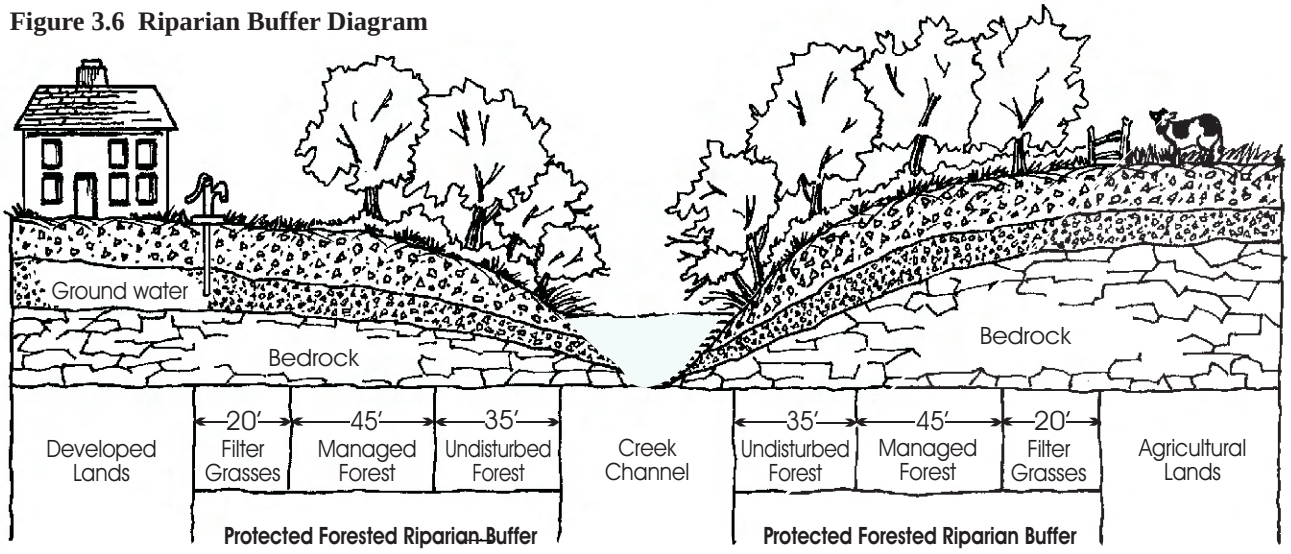
Land Management BMPs

Land–the way it is used, who owns it, who manages it, and how it is regulated are keys to watershed degradation and rehabilitation. Much of Paxton Creek's decline is due to past and recent land disturbances. (Table 2.1)

Figure 3.7 Roundtable Planning

Alternative ways for diminishing land use problems, while providing many benefits, are conservation or better site design (BSD), and low impact development (LID) techniques. The dozens of land related BMPs include: *growth management strategies* (utilities, roads restricted to areas of desired growth); *impervious surface retrofits* (converting impervious cover into areas where stormwater soaks into soils thereby reducing runoff and enhancing water quality – backed by n*ew ordinances* used by creek municipalities. Many approaches are included in a booklet of 23 non-binding development principles formed and adopted by representatives of home builders, community organizations, and local government staff during recent Paxton Creek Roundtable discussions. (Table 3.1; Figure 3.7)

Figure 3.6 Riparian Buffer Diagram



Adapted from Water Resources Authority, 2002

Table 3.1 Partial Paxton Creek Roundtable Principles

Streets and Parking Areas

☑Allow narrow streets, and reduce their total length.
☑Eliminate road curbs, gutters, drains & use vegetated swales for stormwater.
☑In cul-de-sacs use depressed landscape islands with infiltration & bioretention practices to reduce impervious cover and to treat stormwater runoff.

Building Lots

☑Offer density bonuses and other incentives for connecting open space developments.
☑Reduce minimum front and side yard setbacks, and lot frontage.
☑Direct rooftop, patio, or other runoff into pervious areas such as yards, rain barrels, rain gardens, open channels and other techniques to infiltrate runoff.

Natural Area Protection

☑Adopt ordinances requiring riparian buffers of suitable width with native vegetation.
☑Minimize clearing and grading (grubbing) native vegetation; conserve trees; and protect open space.
☑Consider incentives to encourage the preservation of large, contiguous land parcels such as allowing greenways, density compensation, and property tax reductions.
☑Establish a pre-planning process for development sites to address the incorporation of better site design principles up front in the planning stage (natural features protection, site inspection) …etc.

Adapted from *Alliance for the Chesapeake Bay,* 2003

Beautiful, Bountiful Buffers

Buffers play a special role in watershed management. These vegetated strips between lands and waters are possibly the most important of all the BMPs. In addition to the benefits already described, buffers can prevent many creek problems from ever starting! If they are so good, why don't we see more of them? Why are they often fragmented and of poor quality? It is a matter of priorities and ignorance: some people want to develop every inch of their lands; others don't want wildlife around; others like clean, immaculate yards (effective buffers often look dense, and messy), and so on. Effective buffers vary greatly in width (20 to 300 feet) and consist of one of more bands (3 zones depicted in Figure 3.6), depending on what is wanted (from water temperature modulation to wildlife habitat), and local conditions (soils, slope, amount of runoff, types of pollutants). What is best for Paxton Creek watershed, an urban area where buffers may also contain trails? A width of at least 75 feet is recommended.

Attachment RCP-2 contains the complete array of development principles adopted by the Paxton Creek Roundtable. Both water and land management approaches have been slow to come to central Pennsylvania for various reasons and excuses: liability concerns; reluctance to try new things; bias towards concrete and steel rather than solutions featuring vegetation; ignorance of technical details; lack of laws and ordinances with incentives encouraging BSD, LID; and other approaches.

Planting Creek Buffer

Many more BMP alternatives with details and expansive considerations concerning land, water, and other topics (creek-based recreation, economic development education) are associated with strategies and tactics in the plan Attachment RCP-3.

4 The Baseline: Portraits of the Watershed

Degraded watersheds are like sick people. They have to be observed and undergo tests before adverse conditions are relieved, and most ills are cured. In short, an information baseline is necessary before strategies and projects for fixing and improving the creek can be done.

The baseline for Paxton Creek watershed provides a broad range of topical information that is the foundation for a meaningful Rivers Conservation Plan. Information on the watershed's natural resources, its history and culture, and its problems and prospects are summarized in this chapter.

Stakeholders Speak on Watershed Issues!

Building upon the watershed visioning exercises, further efforts at taking the general stakeholders' pulse involved four planning workshops, two written surveys, and other vehicles. Issues important to watershed stakeholders are evident:

- ☑Water resources (floods, stormwater, groundwater, and water quality)
- ☑Sprawl with preservation of farmland and open space
- ☑Natural resource losses (habitat, natural vegetation, soils, wildlife) in urbanizing Paxton Creek watershed.

Educational Gathering

Insights were gained also through data inspections, interviews with resource professionals and municipal officials, and numerous discussions at meetings, conferences, and river festivals (Table 4.0). These opinions reinforced those of the general stakeholders, and pointed out additional watershed concerns and opportunities:

- ☑Culture and development (recreation, urban redevelopment)
- ☑Education and outreach (watershed awareness and creek-based education).

Table 4.0 Watershed Issues and Problems

Category	Issue or Problem	Issue or Problem
Water	Excessive Runoff	Frequent Floods
	Insufficient Groundwater Recharge and Inter-basin Water Transfers	Water Quality Decline
Land	Degraded Uplands Impervious Cover Excess Sparse Open Space	Degraded Creek Channels Severe Erosion Diminishing Wildlife Habitat
Culture and Development	Additional Creek-based Recreation	Lagging Urban Redevelopment
Education (and Outreach)	Lack of Watershed Awareness	Insufficient Creek-based Education

"Paxton Creek: Among the biggest sediment producers...of the* nation's most endangered river *(American Rivers, Kober 2005)"

In written surveys stakeholders including land owners indicated support for various future land uses (woodlands, open space), and specific rehabilitation approaches (tree buffers, low impact development). They show only moderate to low support for improvements featuring trail/path systems, greenways for economic development, floodwaters storage, protected areas for beauty and history, and additional recreation sites. The watershed landowners value very highly their residences, views of wildlife/nature, and leisure walks near the creek. They do not care much for all terrain vehicle or snowmobile recreation.

Trail Link

In terms of revenue-and non-revenue generating activities, respondents have very low support for light industrial facilities, and additional commercial and residential development. Substantial support exists for modest tax increases to pay for watershed improvements, and the use of private lands for creek projects, but opinions differ on amounts and responsibilities. This situation underscores a big problem: revenue generating land uses (industry and commerce) are not favored. This places greater financial responsibility on existing property owners, and the need for alternative financing of watershed improvement projects.

Another way of looking at concerns and issues is the collective perspectives of different groups of stakeholders such as residents, government officials, conservationists/environmental professionals, and water/wastewater managers They have additional insights which include concerns for future growth, revenues, aging water infrastructure, and protection of water supply resources.

Growth: Population, Developed Land and Impervious Cover

Prior to development, the watershed was nearly all forested. During the 1700s and 1800s, many trees on flat or rolling terrain were logged for lumber, farming, and related purposes. The population boomed in Harrisburg and Penbrook bringing with it a heavy concentration of roads, residences, businesses, government, commerce, and industry that continues today, as shown in a current land cover and land use map for the watershed (Figure 4.0).

After World War II, the watershed underwent a growth spurt. New development shifted to the suburbs, beginning in Susquehanna Township in the 1950s and 1960s and continuing most notably, today, in Lower Paxton Township. As the population in Harrisburg decreased by half in the last half century, the Lower Paxton population increased ten fold!

Population projections for watershed municipalities to 2020 show a further loss in Harrisburg, a small increase in Penbrook, and roughly 15% increases in the two townships. (Park, 2003) More roads, homes, stores, businesses, schools, churches, and utilities typically accompany increased growth.

Vacant developable land in the watershed is projected to diminish by 90% in the next 20 years. Almost half of an estimated additional 15,500 dwelling units are projected for Lower Paxton Township, and about a quarter each for Susquehanna Township and the City of Harrisburg. Penbrook's projected increase is miniscule (<1%). A comparison of 1949 and 2003 aerial photographs shows marked changes from rural to urban landscape in Upper Paxton Creek North subwatershed, and illustrates what has happened throughout Paxton Creek. (Figure 4.1)

Figure 4.0

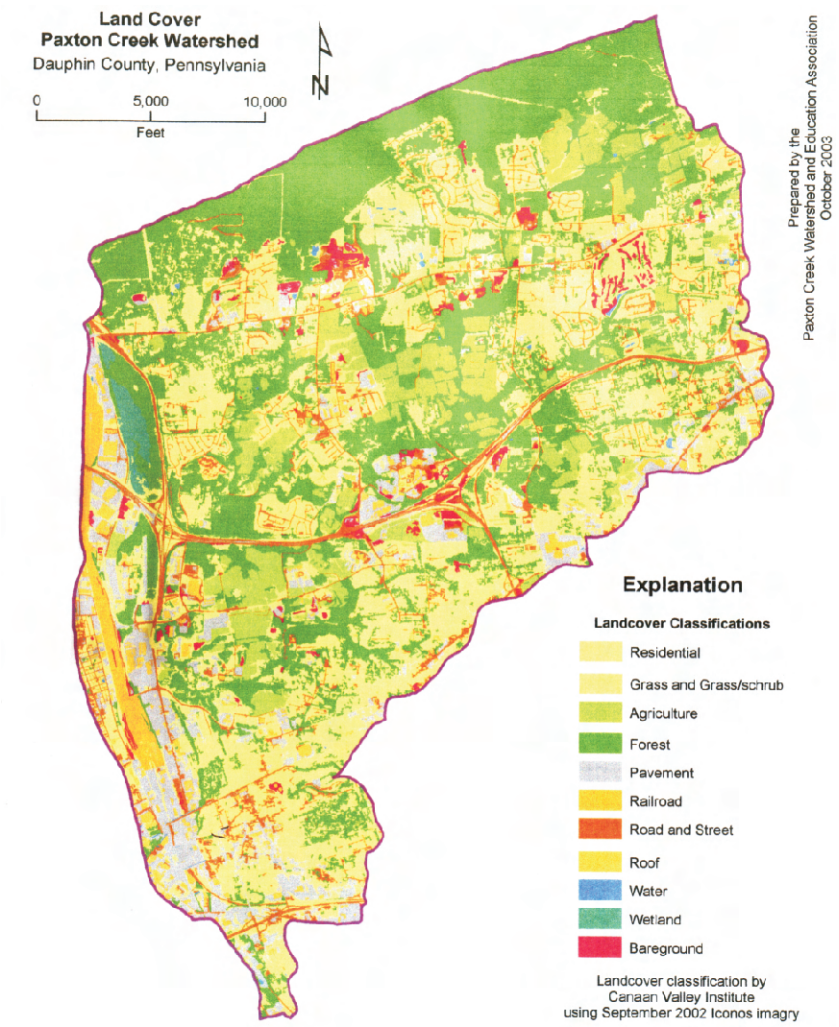
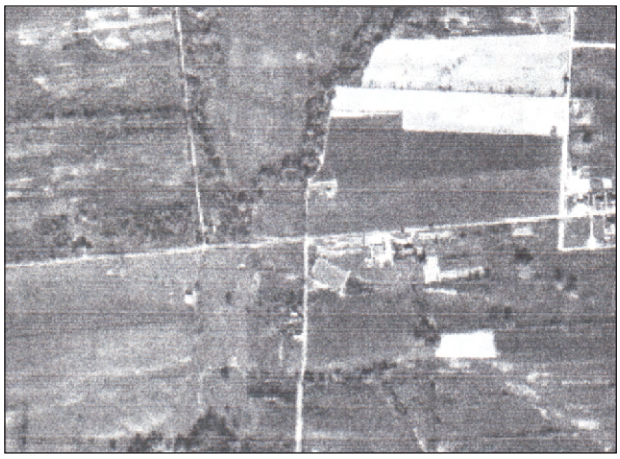
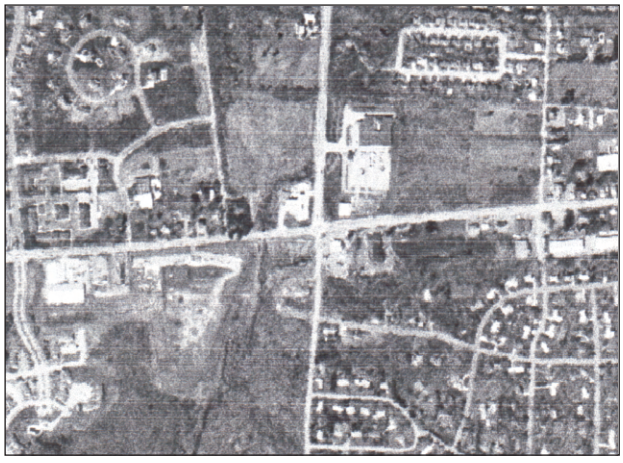


Figure 4.1 A Half Century of Sprawl: Landscape at the junction of Linglestown Road (Route 39) and Colonial Road



1949



2003

Table 4.1 Impervious Cover Estimates

Subwatershed	Total Area		Impervious Cover (%)		
			Current	Future Estimate*	
	(ac)	(mi^2)		(low)	(high)
Asylum Run	2411.5	3.8	30	44	50
Black Run	2234.1	3.5	21	30	42
Devonshire	861.6	1.3	37	46	56
Linglestown	1960.7	3.1	25	26	42
Lucknow	281.2	0.4	10	25	40
Mountaindale (Fox Run)	734.6	1.1	21	23	38
Paxton Creek (low main stem)	2964.8	4.6	56	58	63
Paxton Creek North (Upper & Lower)	4709.9	7.4	18	30	42
Paxtonia	853.8	1.3	36	39	52
Wildwood Lake	522.1	0.8	38	36	41
Watershed Total	**17,534.3**	**27.4**	**30**	**37**	**48**

* High future impervious cover levels are estimated from maximum impervious acreage allowed by zoning in 2003 and continuation; low estimates are based on average impervious cover coefficients determined for land uses.

The impervious surface associated with watershed development is extensive (30% overall), and is estimated to grow another 12 to 18% by year 2020 (Table 4.1), with the projected changes shown on a map. (Figure 4.2)

Land ownership is mixed in the watershed. Most lands have private tenure, but lands owned by local, state, and federal agencies exist in various locations in the subwatersheds. Most public lands are in the City of Harrisburg and Susquehanna Township.

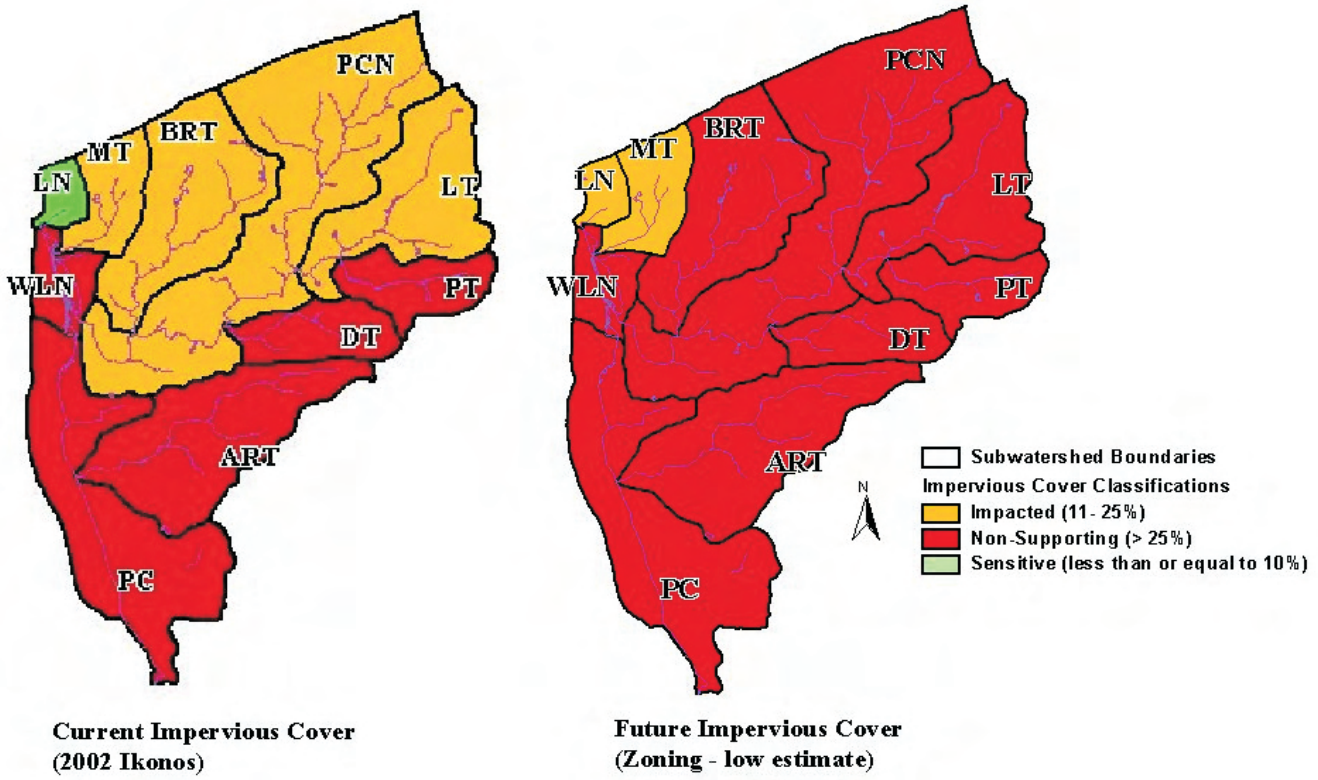


Figure 4.2 Current and Future Impervious Cover

The Baseline: Portraits of the Watershed

What Are the Paxton Creek People Like?

Paxton Creek people are a hardy and diverse lot. They include descendents of *The Paxton Boys* (Scotch-Irish settlers who survived devastating Indian raids); canal men, wagon and motor vehicle drivers; river boatmen and railroad workers; politicians and government employees; European immigrant families who worked the farms, iron works, and neighboring coal mines; returnees from World War II who fueled the second great watershed transformation; Asian refugees from a civil war; and persons displaced by hurricanes and floods. Successful rehabilitation and enhancement of the watershed will require extensive cooperation, participation, and vigor by these persons and others through public-private partnerships over the coming decades. Other characteristics of the area's population in race, income, employment, housing, and education vary among the subwatershed residents. (Table 4.2) Most statistics are for parts of communities that are in the watershed, not the whole municipalities.

Parking Lot Impervious Cover

Table 4.2 Municipality and County Demographic Statistics

Description	Watershed Area				
	Paxton Creek	City of Harrisburg	Penbrook	Susquehanna Township	Lower Paxton
Land Area (square miles)	27.1	5.3	0.2	10.2	11.4
Population per Square Mile	2,214	4,969	8,370	1,477	1,462
Population 2000 Census (no.)	59,774	26,338	1,674	15,071	16.671
Population Cohorts (no.)					
Support Ages (1-21)	18,566	9,693	530	3,806	4,537
Productive Ages (22-49)	23,696	10,606	757	6,525	6,808
Mature Ages (50-64)	9,178	3,462	206	2,608	2,902
Race (no.)	59,775	26,339	1,676	15,062	16,670
Caucasian	33,371	6,571	1,237	10,753	14,820
Afro-American	20,527	15,795	281	3,486	965
Asian	1,592	719	38	319	515
Hispanic	4,449	3,687	85	330	345
Housing Units (no.)	26,536	12,093	780	6,549	7,117
Owner Occupied	14,477	4,735	382	4,564	4,779
Renter Occupied	9,355	5,287	347	1,689	2,031
Vacant	3,708	2,054	51	295	307

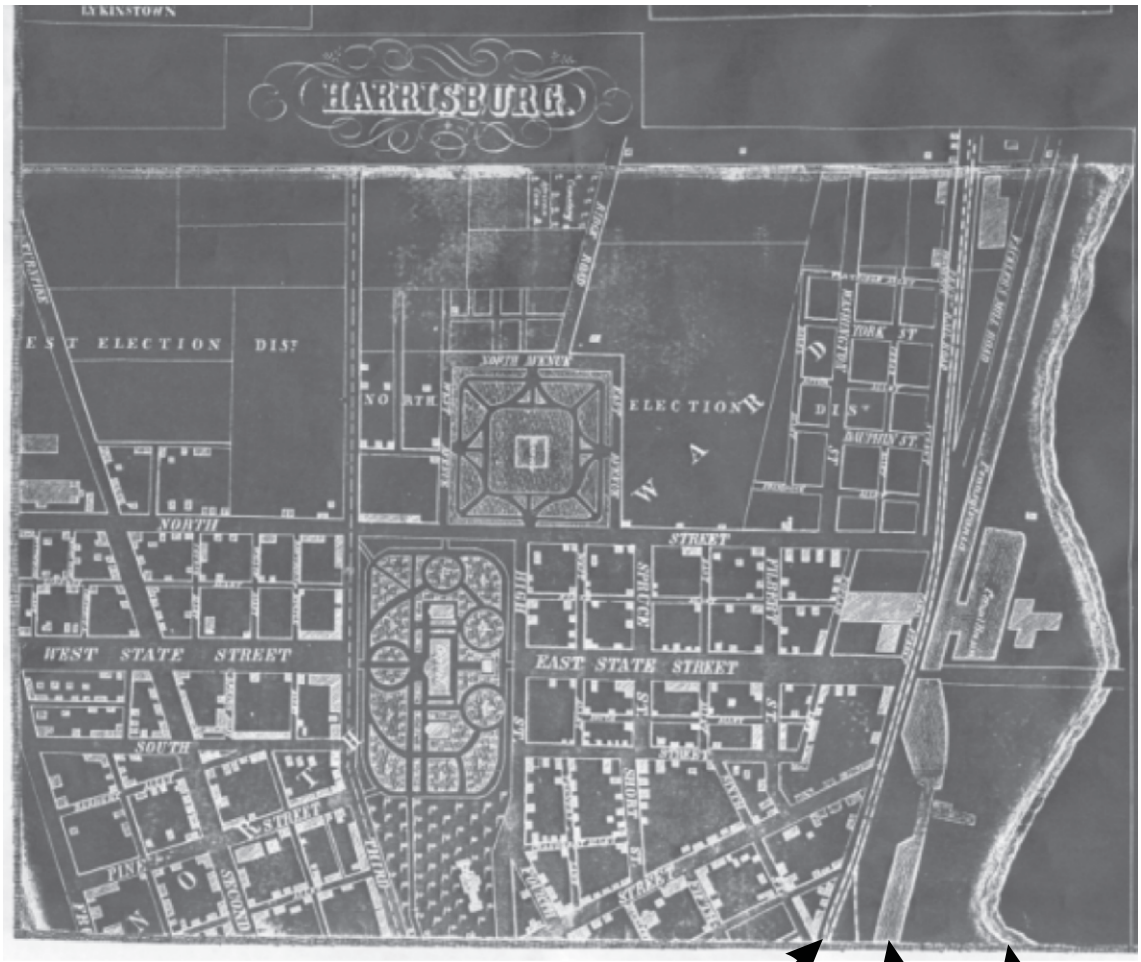
Source: US Census 2000; compiled from subwatershed proportions of Census tracts, block groups, and blocks; omits minor totals (<25 total persons) for Middle Paxton and Swatara Townships *statistics represent county or total municipal populations rather than watershed portions.

The Baseline: Portraits of a Watershed

Rich History and Culture

Paxton Creek watershed has been a crossroads for thousands of years. Its topography includes a nearby great water gap, a section of Blue Mountain carved open by the force of melting glaciers that created the Susquehanna River. The natural terrain provided land and water routes going east to west and north to south. Three centuries ago foot paths began giving way to roads, highways, a canal, trolleys, and railroads as humans settled and transformed the watershed.

Paxton Creek history is rich. The watershed is the site of a grand state capitol built with watershed materials, a place that experienced real terrorism during its settlement (Indian raids), contributed to the success of the American Revolution, and served as a mustering point for 300,000 Union soldiers during the Civil War. The Paxton Creek area was a pioneer in the nation's early Industrial Age, underwent significant community development during its City Beautiful Movement a century ago, and experienced a subsequent decline in watershed health. Today, Paxton Creek sits on the brink of watershed recovery and enhancement.



Harrisburg in 1855

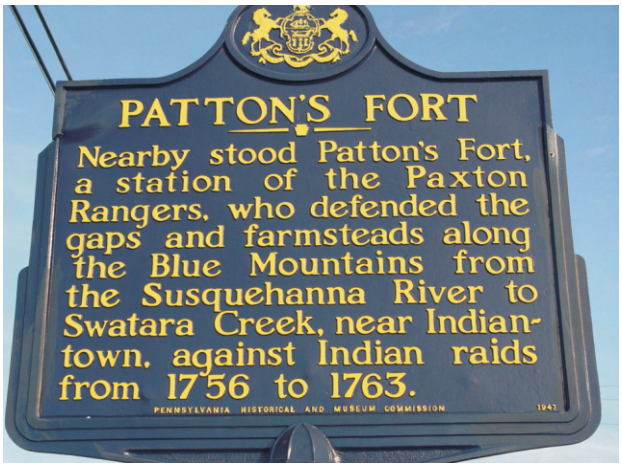
Three hundred years of settlement activities have taken their toll on watershed history, inadvertently destroying historical sites, and changing landscapes with artifacts. The following significant historical and cultural resources have been tallied (Figure 4.3):

- ☑ 8 Historic markers
- ☑ 4 Listed archeological sites (unmapped for protection)
- ☑ 11 Historical cultural features
- ☑ 12 Historic structures on registers
- ☑ 3 Museums, special facilities
- ☑ 5 Historic districts
- ☑ 3 Trails and CA Greenbelt
- ☑ 24 Local unlisted historical sites
- ☑ 2 State forests and game lands

Other historical and cultural landmarks are on the watershed periphery (Susquehanna River Water Gap, Fort Hunter, State Archives, Susquehanna River Water Trail, Paxtang Parkway, Pennsylvania State Museum).

Currently a shortage of creek-based recreation land exists in watershed municipalities. Guided by recommended standards of the National Parks and Recreation Association, the Tri-County Regional Planning Commission estimates an additional 665 acres are needed for municipal parks in Dauphin County by 2020 (Park, 2003), of which nearly a quarter of the acreage (24%) should be located in the watershed (as per projected residential populations).

Figure 4.3 Historical Marker



Watershed Wildlife and Habitats -- Some Surprises

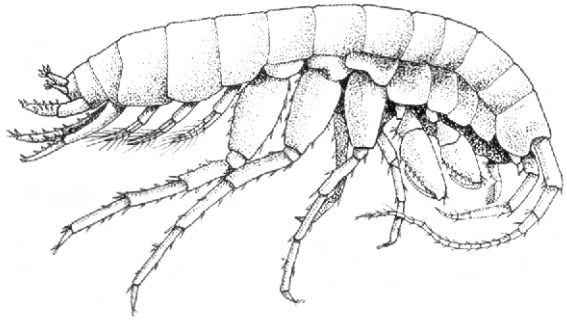
By many measures, Paxton Creek watershed has greater biological resources than habitat conditions suggest. In regional studies done by both the EPA and the USGS, overall watershed conditions for wildlife were found to be poor, because of adverse situations such as small and fragmented natural cover, poor quality of riparian vegetation, development on steep slopes, roads located close to creeks, and absence of interior forest. “A legacy of habitat disturbance” is how one report labeled Paxton Creek's condition (Gap, 1999).

Wetland Habitat

Despite these disturbances, the watershed has small but significant biological resources:

- ☑**Terrestrial (land) and aquatic (water) vegetation:** More than 331 species in major types of plant communities (forest, grassland including wet meadow, and wetland); 33 species of upland plants rarely found in PA; and 3 species on a list of biota with threatened or endangered status maintained by the Pennsylvania Natural Heritage Program (PNHP, formerly the PNDI).
- ☑**Terrestrial and aquatic fauna:** 288 animal species (amphibians, reptiles, turtles, mammals, birds, fish, and macroinvertebrates - commonly known as water bugs) observed or listed in assessment reports; RCP studies found for the first time a rare animal species (creek-bottom dwelling, blind water bug called *Stygobromus* sp.) in Wildwood Lake Sanctuary also listed on the PNHP. (Figure 4.4)

Figure 4.4 Rare Water Bug *Stygobromus* sp.



☑**Five important places with habitat suitable for biota in and near the watershed:** 1) linear forest remnants along the creek provide habitat and create travel corridors for species that use forest edges for access to food and cover; 2) fields and meadows provide significant habitat for butterfly and bird species; 3) Blue Mountain (designated Important Bird Area 51) where updrafts and habitat are used by 150 migratory bird species across the Northeast and Middle Atlantic states; 4) Wildwood Lake Sanctuary containing a superb 90 acre wetland that supports plant and animal species, provides a resource for residential wildlife, and serves as a stopover place for birds in-transit along Blue Mountain; and 5) river islands/surroundings near the creek's mouths having unique biota that temporarily might reside in or visit the watershed.

Top of the Watershed

The challenge is to protect the abundance and diversity of remaining biota, and to increase the habitat's capacity to support higher numbers of plants and animals.

Wildlife diversity in Paxton Creek generally declines from upstream to downstream and from north to south in the watershed. In 2004, wildlife health was better than expected in certain subwatersheds (Paxton Creek) and worse than expected in others (Asylum Run).

Mixed Bag of Headwaters (First Order Tribs)

Paxton Creek has a mixed bag of headwaters, the uppermost channels of drainage areas. Headwaters are small streams (also called first order tributaries or *tribs*) that begin in two ways. They can start as very small flows from the natural landscape. These headwaters have functional floodplains and are often the least degraded parts of watersheds. At the same time, headwaters can be vulnerable to water withdrawals and pollutants. Headwaters can also start as flows from impervious surfaces in built environments. Streams with these origins typically have faster and larger flows, and tend to erode lands more quickly and more severely. They may carry greater amounts of pollutants and create sediment deposits in pools and slow-moving reaches.

In Paxton Creek watershed, only 24% of its headwaters (6.5 miles) are those originating from natural landscapes. The majority begin as runoff from urban lands. Asylum Run, for instance, starts as runoff from the Colonial Park Mall. Urban runoff also contributes significant flow to Linglestown, Devonshire, Paxtonia, Paxton Creek, and Wildwood Lake subwatersheds. These headwaters typically need rehabilitation, whereas headwaters based on natural flow–those starting on Blue Mountain (Lucknow, Martindale, Paxton Creek North, and Black Run subwatersheds)–need protection from conventional development.

Stormwater - The Bane of Paxton Creek Watershed

Paxton Creek's accelerated stormwater runoff creates three major problems for the watershed: 1) more frequent and intense flooding, 2) greater transport of pollutants, and 3) accelerated erosion and sedimentation.

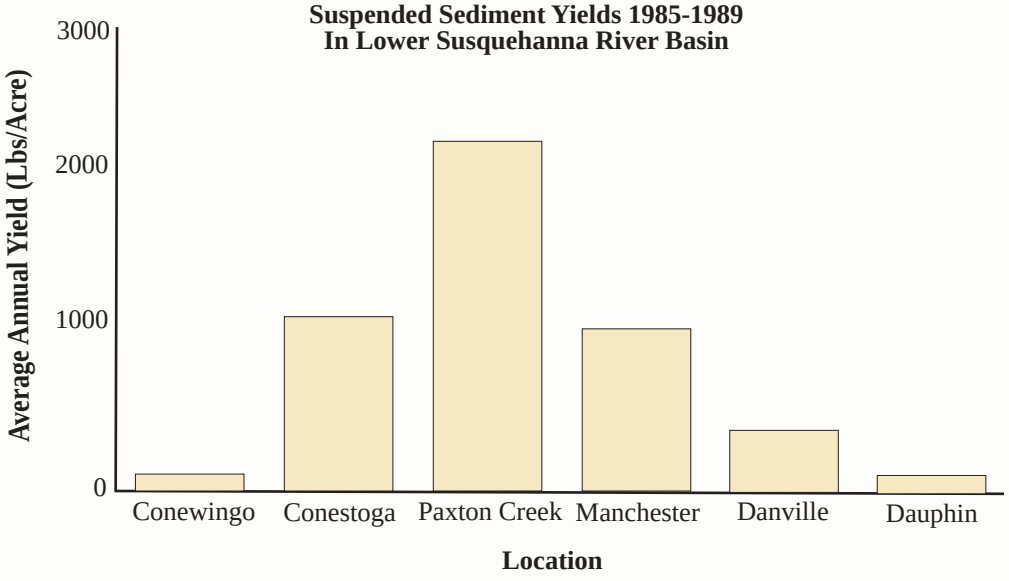
The soil erosion and sedimentation has been so severe that forested deltas have formed in Wildwood Lake, nearly cutting the lake into parts and vastly reducing the lake's water depth. The process has made Wildwood a superb wetland, replacing its value as a fully functioning lake (boating, swimming, storing stormwater).

The amount of sediment carried by Paxton Creek waters varies, but it can be huge. The average annual suspended sediment concentration recorded for Paxton Creek is among the highest (2,300 pounds/acre) in the Susquehanna River basin, an amount 2 to 22 times greater than runoff from places such as Dauphin, Danville, and Conestoga. (Figure 4.5) Paxton Creek is among the worst sediment producers of the Susquehanna River, the nation's most endangered river among thousands nominated for the annual America's Most Endangered Rivers Report. (Kober, 2005)

Lower Creek Flooding

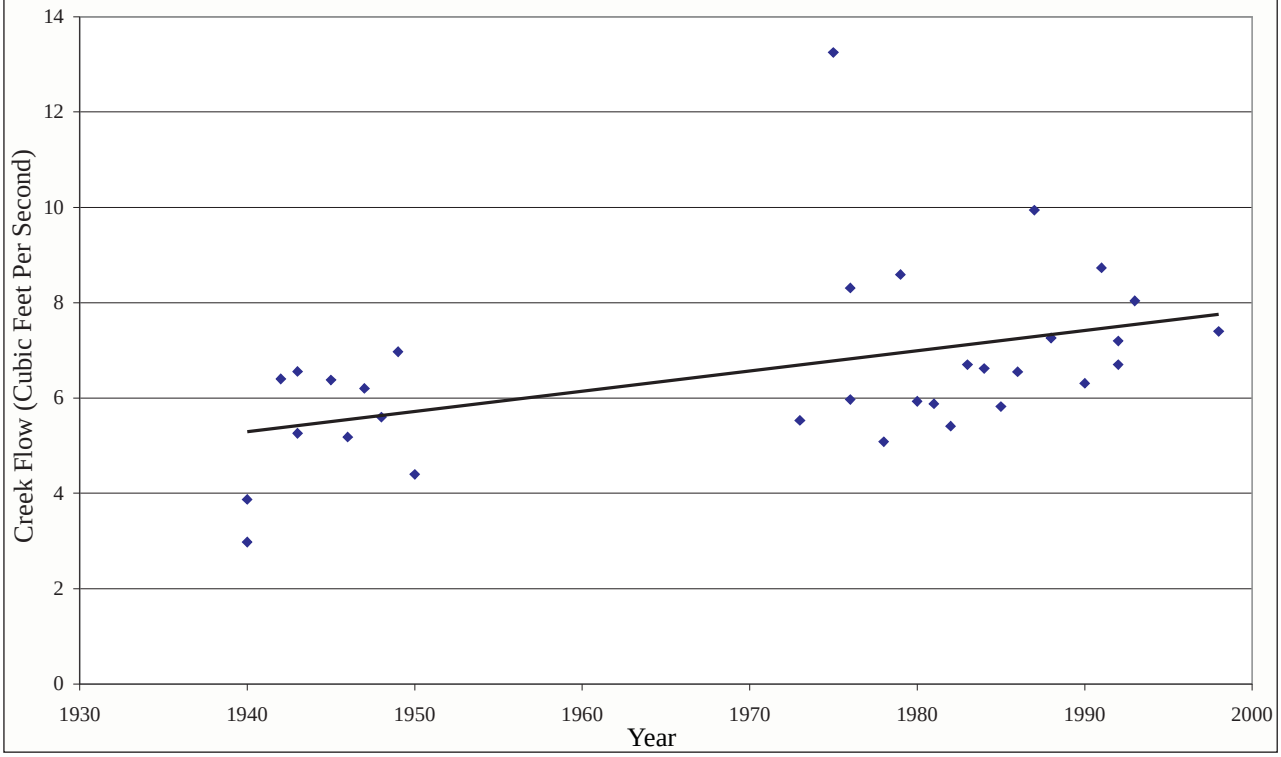
Increased impervious cover in watersheds causes higher and more frequent peak flows of stormwater runoff. (Figure 4.6) This appears to be happening in places along Paxton Creek, such as the Farm Show grounds on Cameron Street. Here the creek's hydraulic gradient is low (bottom is nearly level in the creek channel), causing the creek waters to become sluggish, spill over their banks, and back up into drains on Cameron and Maclay Streets. The situation is made worse by the confluence of high water flows from Asylum Run joining the main stem Paxton Creek only a block downstream from the Farm Show.

Figure 4.5



Data Source: Ott, 1991

Figure 4.6 Rising Trend in Peak Discharge



Data Source: http://nwis.waterdata.usgs.gov/nwis

Paxton Creek is often blamed for additional flooding that is actually caused by the Susquehanna River. During flood stage, the river can rise and back up into Paxton Creek, inundating the Shipoke neighborhood, Shanois and Cameron Streets in south Harrisburg, and other places depending upon the height of the river.

Pollutants wash off the landscape into Paxton Creek during storms. This occurs especially during the beginning of a storm, known as the first flush. The substances carried by stormwater include sediment, nutrients, metals, and coliform bacteria (bacteria associated with animal feces). Although the general origin of sediment and other pollutants in Paxton Creek are evident, analysts do not know the amounts, or loads, carried by stormwater in different parts of the watershed. This information is needed for better watershed planning, projects design, and resource commitment.

Headwaters Flooding

How Clean Are Paxton Creek Waters?

As a result of rapid urbanization, land development practices, and aging infrastructure, Paxton Creek's streams, ponds, and lakes have fair to poor water quality.

Besides sediment, the main water quality problems in Paxton Creek are plant nutrients, dissolved oxygen, coliform bacteria, and, to a limited extent, certain metals. Pesticides and toxic substances have been detected in assessments at only a few sites, but many known toxic waste sites exist. However, no comprehensive watershed study has been conducted of toxic materials.

The PA Department of Environmental Protection (DEP) and the US Environmental Protection Agency (EPA) are aware of the watershed degradation. Segments of the creek have been added to the DEP 303(d) list of impaired water bodies in the Commonwealth. The impairment parameters include high nutrient concentrations, organic enrichment, low dissolved oxygen, high suspended solids, high biological oxygen demand, and excessive silt.

Paxton Creek is in EPA Ecoregion IX, a classification based on soil types, land cover, and other factors. Regarding nutrient criteria developed for this region, Paxton Creek has high nitrogen and phosphorus loads–2.5 times the total nitrogen, and 10 times the total phosphorus recommended limits.

A summary integration of a dozen research reports on surface waters gives a picture of the Paxton Creek water quality:

☑Overall, surface water quality declines from the upper (Blue Mountain) to lower creek reaches for major categories of parameters–chemistry, macroinvertebrates, bacteria, and habitat.

☑Macroinvertebrate populations are generally richer where the creek is in cool, forested areas. The diversity decreases from upstream to downstream; populations of clean water species markedly decline from the mid-to-downstream subwatersheds.

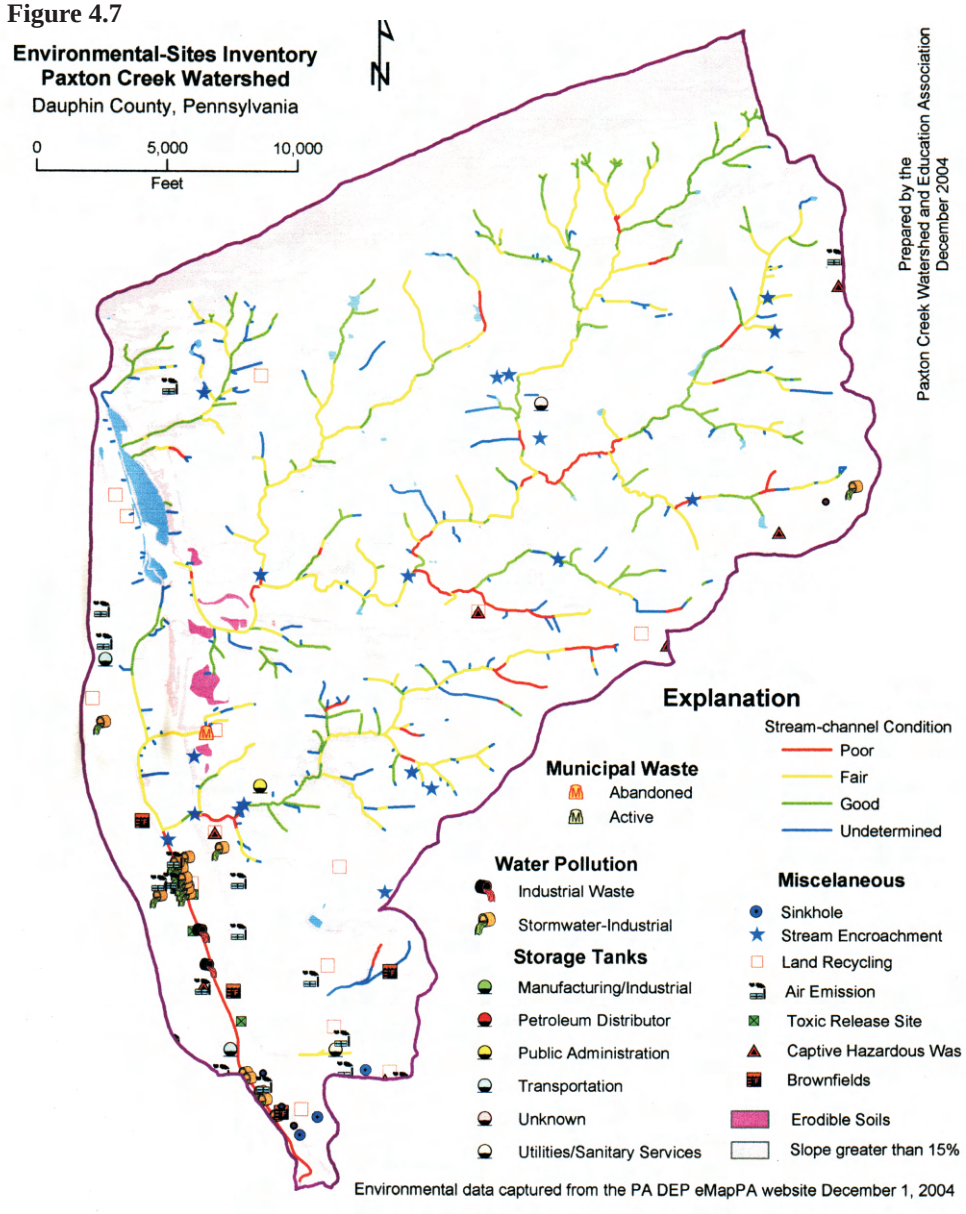
☑Parameters often testing high include sediment, nutrients (nitrogen and phosphorus), metals (zinc, copper, lead–the latter exceeding drinking water standards), and coliform bacteria near points of septic waste contamination or illegal discharges.

Water Bug and Chemistry Assessment

☑Parameters that are adequate most of the time are pH (acidity) and dissolved oxygen (DO). The pH is usually slightly above 7, possibly due to carbonate rock buffering. The DO is generally 6 or more parts per million (ppm), which is adequate for most aquatic creatures, but occasionally extreme levels occur (<4 ppm).

☑The low DO levels, high coliform bacteria counts (animal feces), increased conductivity, and high ammonia, phosphorus, and lead concentrations are common in the channelized segment of Paxton Creek in Harrisburg from the Industrial Road crossing (renamed Wildwood Drive) by the Farm Show, southward toward the creek mouth. Along these channelized creek reaches hundreds of outfalls (pipes) exist, including combined sewer overflow outlets (CSOs). Although more wildlife has been seen in the channelized areas in recent years, these reaches are less healthy than the rest of the watershed. Habitat and macroinvertebrate indices for the bottom-dwelling bugs at these sites are typically one third to one half of those for the upstream watershed.

Figure 4.7



Ins and Outs of Domestic Water and Wastewater

Much of the water consumed or used in the watershed is not Paxton Creek water! Drinking waters come into the watershed, and wastewaters are discharged outside the watershed in what professionals call inter-basin water transfers. Most domestic water used in homes, businesses, and institutions comes from surface water sources, specifically the Susquehanna River and Dehart Dam Reservoir on Clark Creek located north of Blue Mountain. These waters are pumped and treated when necessary to watershed municipalities served by the City of Harrisburg and United Water Company.

These sources currently provide an average 23 million gallons per day (mgd), and can meet a projected, combined water demand of 35 mgd. Concerns exist, however, over the delivery infrastructure (deteriorating pipes, equipment replacement), limited supply from groundwater or other surface water sources (a single pipe 6 miles long connects Dehart Reservoir and Harrisburg.), and additional protection of water supply

sources from incompatible land uses and other threats. In the event of a major disruption groundwater supply would be inadequate. Because much stormwater runs off and does not soak into the ground, aquifer recharge is poor (rough estimate of 9 mgd for a typical moderate storm), vastly limiting groundwater as a source of supply.

Paxton Creek wastewater is handled mainly by sewers carrying sanitary waste, and sometimes stormwater. Wastewater interceptor sewers run in many of the creek corridors. In older, urban areas like Harrisburg, combined sewer systems were built to collect rainwater runoff and wastewater. They are conveyed together in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant using interceptor sewer pipes. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess storm and wastewater directly to nearby streams, rivers, or other waterways. What was considered a sound approach to rid cities of mixed wastewater and stormwater a century ago is now a major source of water contaminants. Pennsylvania leads the nation in the number of combined sewer outfalls (CSOs) along the creek. A study of Harrisburg's 31 permitted CSOs is scheduled for completion this year, followed by addressing the problems within 10 years.

Private septic systems are required for areas not served by municipal sewers. However, septic systems need adequate space and the right soils to function properly. As development occurs the need increases for additional municipal sewers and wastewater treatment facilities.

The public waste disposal systems are operated by various municipal authorities. They supervise, maintain, and finance the conveyance and disposal of wastewater, sharing the fees with water providers. Two plants treat Paxton Creek wastewater–the Advanced Wastewater Treatment Facility of the City of Harrisburg and the Swatara Treatment Plant. Both plants remove phosphorous. Average current wastewater processed by both facilities are 25 mgd, with 44 mgd permitted capacity (almost 50% reserve).

Combined Sewer Outlet

The Watershed a Recovering Economic Engine

For various reasons (flooding, changed economy, aging infrastructure), economic prosperity has lagged downstream of Wildwood Lake, in other urban neighborhoods, and in semi-rural areas. Prior to World War II Paxton Creek watershed along Cameron Street was the economic workhorse for the area, from the Phoenix Iron Works near the creek mouth to 4 miles upstream at the Lucknow rail yards. This area has been moribund for decades. Only recently have economic stirrings begun (Farm show expansions, hotels proposed to serve the Farm Show area, rail yard upgrade, major commercial redevelopment planned for a large Herr-State Streets parcel. Active upstream economic expansions are also occurring at highway nodes (N. Progress Avenue and I-81), business centers (Interstate Drive, Valley Road), and major connector roads (Routes 22 and 39, Mountain Road). Work-related opportunities still lag, however, as in the enterprise zones.

All this is being done without explicit creek-based alternatives such as miniparks and trails that can assist economic redevelopment.

This RCP is only one effort addressing Paxton Creek's problems. Other initiatives underway in 2005 include an update of the Act 167 stormwater plan for the watershed, the planning and implementation of studies by municipalities dealing with nonpoint source pollution called Municipal Separate Sanitary and Storm Sewer Systems (MS4s), the formation of specific Total Maximum Daily Loads (TMDLs) for Paxton Creek pollutants, a large EPA Targeted Watershed Grant proposal, construction of demonstration stormwater BMPs by the Dauphin County Conservation District, and technical stormwater and low impact development educational programs conducted by various organizations.

Many Persons Don't Know Much About Paxton Creek

The public perceives Paxton Creek watershed mainly as a stormwater drain. As many as one half to three quarters of local stakeholders are neither aware of, nor appreciative of the creek's many functions and benefits. Many persons consider Paxton Creek a non-issue…until floods or droughts occur, land washes away, neighboring open space undergoes development, a major spill occurs, or people get hurt.

The watershed is vastly underused in both formal and non-formal education. Public schools generally fall short in using Paxton Creek watershed in classroom curriculums, and as an outdoor learning environment. Transport cost, liability concerns associated with field trips, and curriculum designs are among the reasons given for under-using this local resource. Although PCWEA has been particularly active in community education, averaging 1.2 educational activities each month for three years, watershed awareness and creek-based education still languish. Options for enhanced educational awareness, creek-based curriculum (even a teaching database on the PCWEA website), mentoring, and skill training are available through activities sponsored by PCWEA and its partners. The informational brochure created during plan preparation *Are You Loving Paxton Creek To Death?* is an RCP Attachment.

Creek Trash Removal

Problems and Opportunities

Based on what is known about Paxton Creek's history, culture, and natural resources, as well as past and projected development, problems and opportunities become evident. They might be considered flip sides of the same coin. For instance, fragmented riparian forests and sparse creek-based recreation are also opportunities to build greenways with educational programs, and miniparks that have economic spinoffs.

The wide array of problems and opportunities that exist in Paxton Creek watershed are diverse and extensive. (Table 4.3) These problems are also depicted on a map. (Figure 4.7) These numbers will change in the future as nine additional subwatersheds are assessed, more projects are inventoried, and rehabilitation progresses. Keep in mind that Paxton Creek subwatersheds vary in characteristics and channel conditions (Table 4.4).

Table 4.3 Problems and Opportunites

Problems or Places of Concern (and Promise)	Additional Opportunities*
Impervious Surface, 8.2 sq. miles	Impervious Surface Retrofit Sites, 58; Phase 1, 20
Impaired Tributaries on 303(d) List, 14.3 miles	Land Recycling Areas, 11
Riparian Reaches Assessed with High Degradation, 10 miles; Intermediate, 27 miles; Low, 25 miles	Potential Greenways and Trails, 30 miles; Phase 1, 0.3 mile.
Vulnerable Headwater Reaches, 6.5 miles	Stream (Channel) Rehabilitation Sites; Phases 1 and 2, 20
Creek Channel Hotspots (Debris Jams, Unstable Slumps), over 17	Upland Reforestation Sites, Phase 1, 4
Channelized Creek, 3.6 miles	Forested Buffer Reaches, 6.5 miles
Abandoned Dump and Municipal Waste Sites, 3	Pollution Source Control Sites; Phase 1, 6
Brownfield Sites, 4	Riparian Areas Needing Vegetation, 68; Phase 1, 10
Toxic Release Sites, 4	Areas Needing Floodplain Modification, 24
Known Contaminated Groundwater Sites, 3	Outfall Protection Sites, 28
Air Emission Sites, 16	Discharge Prevention; Phase 1, 5+ (probable).
Industrial Waste Sites, 4	Piped Sites, 171; Potential Day Lighting Projects, Phase 1, 2
Stormwater-Industrial Sites, 10	Ground Water Recharge Areas: Total, 18.8 sq miles; Priority 1, 8 sq miles.
Steep Slopes, 9-15%, 3.1 sq miles	Additional Watershed Historic Sites, Phase 1, 25
Wetland Areas, 195 acres	Miniparks, Phase 1, 4
Stormwater Facililites (Detention Ponds), 76	Water Facility Recreation Sites, Phase 1, 3
Outfall Protection, 28	Economic Development Related Sites, Phase 1, 3
Creek Crossings, 419	Environmental Hazard Locations, 70
Large Groundwater Withdrawal Sites, 4	Floodplain Reinstatement Areas 24, Phase 1, 8.
Mapped Stream Encroachments, 14	Minor Channel Enhancement Sites (Dozens), Phase 1, 2
Frequent Flooding Areas, 6	Off-creek Stormwater Management (Dozens), Phase 1, 3
Combined Sewer Outfalls, 31	
Sinkholes, 3	

*Phase I pertains to the initial decade of the RCP

Table 4.4 Subwatershed Characteristics

Sub-watershed	Area (mi^2)	Current Impervious Cover (%)	Future Impervious Cover (%)	Channel Length (miles)	Priority I Reaches (%)	Piped Stream (%)	Outfalls per mi^2 (no)	Stormwater Facilities (no.)	Forest (%)	Roads (acres, %))	Macro-inverte-brates Rating	Management Classification
LK	0.44	10%	25-40%	1.5	0%	21%	2	1	69%	6, 2.2	Good	Protection
PCN (Upper & Lower)	7.38	18%	30-42%	20.9	5%	5%	9	19	52%	317, 25.7*	Good-Fair	Protection
BR	3.49	21%	30-42%	7.2	6%	7%	7	21	43%	135, 6.1	Good-Fair	Protection
MT	1.15	21%	23-38%	4.0	0%	19%	12	5	55%	41, 5.6	Good-Fair	Protection
LT	3.06	25%	26-42%	8.1	16%	8%	7	6	30%	151, 7.5	Good-Fair	Protection
AR	3.78	30%	44-50%	12.3	16%	15%	19	7	25%	121, 5.1	Fair-poor	Rehabilitation
DT	1.38	35%	46-56%	4.5	30%	18%	38	12	23%	81, 9.8	Fair	Rehabilitation
PT	1.30	36%	39-52%	3.5	14%	9%	12	2	25%	62, 7.3	Fair	Rehabilitation
WL	0.82	38%	36-41%	0.92	14%	49%	16	1	24%	38, 7.3	Good-poor	Rehabilitation
PC	4.63	56%	58-63%	8.2	40%	20%	35	2	13%	250, 8.3	Poor	Enhancemnt

Notes:. Subwatershed acronyms: LK, Lucknow; PCN, Upper and Lower Paxton Creek North; BR, Black Run; MT, Mountaindale; LT, Linglestown; AR, Asylum Run; DT, Devonshire; PT, Paxtonia; PC, Paxton Creek main stem. Priority I reaches, those most degraded. *Road area includes I-81 crossing.

Adapted from CWP, 2003

5 RCP Goals, Objectives, and Strategies

Goals

Goals are important for establishing guidance and setting benchmarks of plan progress. The RCP goals reflect the types of watershed problems and stakeholder desires identified for Paxton Creek. (Table 5.0) These goals can vary among different subwatersheds and their component parts.

Table 5.0 RCP Goals

Issue Category	Goal
Water Management	Improve Water Quality; Reduce Stormwater Runoff and Diminish Flooding;
Natural Resources	Reduce Erosion with Sedimentation, and Rehabilitate Creek Channels; Conserve and Rehabilitate Riparian Habitat and Contiguous Forest;
Open Space and Sprawl	Protect Open (Green) Space, Large Tracts and Mountain Land;
Culture and Development	Support Urban Redevelopment; Enhance Creek-based Recreation;
Education and Outreach	Promote Watershed Awareness, Understanding, and Stewardship; Conduct Creek-based Education.

An effective RCP needs local commitment for identifying locally important concerns, and providing support for the long term implementation of the plan's objectives. The RCP addresses nine goals set by stakeholders for the rehabilitation and enhancement of Paxton Creek watershed.

☑**Improve Water Quality** by reducing pollutant loads, and treating stormwater runoff.

☑**Reduce Stormwater Runoff and Flooding** through less impervious cover and more onsite infiltration.

☑**Decrease Channel Erosion and Rehabilitate Creek Reaches** to reduce clogged waterways, enhance runoff storage, restore floodplain function, and improve wildlife habitat.

☑**Conserve and Expand Contiguous Forest** in a continuous network of creek buffers to stabilize banks, remove pollutants, provide shade, and enhance wildlife habitat.

☑**Protect Open Space, Mountain Lands and Large Undeveloped Tracts** for ground water infiltration and protection, and opportunities for recreation and greenways transportation.

☑**Support Urban Redevelopment** to reduce sprawl and make areas more livable through watershed retrofit, removal of impervious cover, adoption of conservation development techniques, and watershed improvements such as flood controls and trails.

☑**Enhance Creek-based Recreation** to increase the parks, public open space, and outdoor recreation opportunities in the watershed.

☑**Promote Watershed Awareness, Understanding, and Stewardship** which are crucial to watershed protection, rehabilitation and enhancement.

☑**Perform Creek-based Education** on watershed awareness, creek curriculum, and practices to solve creek problems and improve lives.

"STORMWATER - the bane of Paxton Creek (and most urban watersheds)"

RCP Goals, Objectives, and Strategies

Objectives, Strategies and Tactics

Objectives, strategies, and tactics are crucial in reaching RCP goals. One builds upon another. At the top are goals, or broad statements for change, as in Paxton Creek's second goal to reduce stormwater runoff. Related objectives may be to reduce impervious cover, by as much as 25% (*achievement* objective) and by retrofitting old sites (*management* objective). Strategies are approaches to meeting these objectives. In this case the strategy would be to use public-private partnerships involving municipalities, businesses, and PCWEA. Tactics are specific actions guided by the strategies. Tactics might include an outreach campaign, lobbying, securing grants, using volunteer labor, or soliciting in-kind supplies and equipment.

Some objectives can serve the needs of more than one goal, similar to multiple tactics serving a single strategy. Those objectives that can be measured quantitatively are most desirable for assessing RCP progress, and for communicating results to partners and the public.

Subwatershed Focus

Most watershed improvements occur at specific sites in subwatersheds. Effective RCP management at this level requires appropriate goals for individual subwatersheds. The subwatershed goals and associated objectives, strategies, and tactics are based on community needs, existing subwatershed characterization data, and information analysis. They are the basis upon which PCWEA coordinators will choose appropriate management tools.

For initial guidance during Phase I of the RCP implementation, the goals are organized in three proposed management groups or themes: creek protection, rehabilitation, and enhancement. This classification approach (Table 5.1) mainly relates to the subwatershed water quality and habitat, caliber of water bug (macroinvertebrate) communities, impervious cover, and unique features.

Table 5.1 Subwatershed Differences and Approaches

Themes/Goals	Subwatersheds	Characteristics	Objectives and Strategies
Protection Improve water quality; conserve and expand forest; protect open space, reduce erosion and sedimentation;	Black Run (BR) Linglestown (LT) Lucknow (LK) Mountaindale or Fox Run – (MT) Upper Paxton Creek North (PCN)	Good macroinverte-brate community 10-25% imper- vious cover (IC) Most have headwaters on natural landscape Suburb Location	**C**onduct land conservation, water quality and infiltration retrofits; **P**erform Better Site Design and LID in new developments; **D**evelop riparian buffers with transfer of development rights (TDRs) & conservation easements; **I**ncrease erosion and sediment controls;
Rehabilitation Improve water quality; rehab creek channels; reduce erosion & sedimentation; conserve and expand forest; enhance recreation;	Asylum Run (AR) Devonshire (DT) Paxtonia (PT) Lower Paxton Creek North (PCN) Wildwood Lake (WLN)	Fair or poor macroinverte-brate populations mainly reflecting habitat >25% IC Most headwaters in developed areas	**I**mprove water quality via IC retrofits; **R**ehabilitate stream channels; **C**onduct pollution prevention and awareness education; **D**etect illicit discharges; **D**evelop miniparks and public trail system; **C**onstruct buffers with TDRs & conservation easements;
Enhancement Improve water quality; reduce stormwater runoff & floods; support urban redevelopment; conduct creek education; enhance trails and recreation; improve sewers.	Paxton Creek (PC)	56% IC Poor habitat and water quality for biota Stream has been channelized and concrete lined Sewage discharges likely Combined sewer overflows and many pollution sources	**D**etect and remediate illicit discharges; **R**emove IC and overburden; **F**ocus on stewardship; **P**romote conservation landscaping and buffers; **E**ducate the public with creek and outdoor emphasis; **R**educe combined sewer overflow outlets; **A**ctively encourage infill and redevelopment; **C**onduct awareness and pol- lution prevention education.

Adapted from Center for Watershed Protection (2004)

RCP Goals, Objectives, and Strategies

The Paxton Creek North subwatersheds (Upper and Lower) were selected for the initial RCP focus for multiple reasons: in addition to manageable sizes for watershed improvements, these subwatersheds together span most watershed municipalities; they constitute nearly a quarter of the watershed area; they are centrally located; they have a diverse set of representative problems and opportunities; they have undeveloped lands, and one has minimally degraded headwaters in need of immediate management or protection. They have excellent potential for demonstration projects, an important aspect when launching the RCP. Asylum Run will be the second subwatershed to be assessed; Linglestown or Paxton Creek the third; and so on.

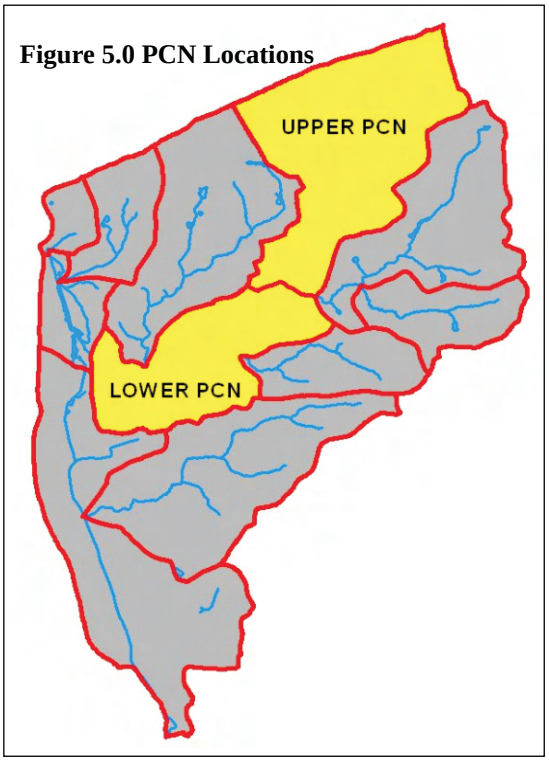
Paxton Creek North Subwatersheds

The Paxton Creek North subwatersheds (Upper and Lower) comprise the backbone for most of the subwatersheds upstream of Wildwood Lake. After headwaters form on Blue Mountain, the creek runs through Lower Paxton and Susquehanna Townships to Wildwood Lake Sanctuary in Harrisburg (Figure 5.0).

The two subwatersheds have nearly half (44%) of Paxton Creek's stream miles. Their land uses include a mixture of undeveloped lands, low and medium density residential with some business, commercial, and institutional development. A few large open tracts still exist in the upper areas of both subwatersheds. Considerably more forest occupies Upper PCN. Future residential growth is projected for the forested headwaters, as allowed in municipal zoning and ordinances. The creek is deeply incised from stormwater runoff in both subwatersheds, but less so in Upper PCN, especially in the headwater areas. Typical creek degradation (lawns mown to creek edges, outdoor storage close to creek banks, lack of protective vegetation buffers) is in evidence throughout both subwatersheds. A couple of sites are promising for potential stormwater storage.

Upper PCN subwatershed is larger in area and has less impervious cover. This subwatershed has more diverse water bug (macroinvertebrate) communities containing clean-water organisms, exhibits better water quality (that degrades as it flows downstream), and has fewer creek reaches with the worst (Priority I) bank-channel instabilities and eroded-deforested creek habitats (138 of 6,015 feet). Except for schools, a few municipal parks, and a driving range (where errant golf balls are washed all the way to Wildwood Lake), outdoor recreation facilities are absent in areas of these subwatersheds. Many 18th and 19th century historical sites remain near Linglestown Road and Colonial Road, but they are only recognized locally. An old grist mill pond remains near the Lower Paxton-Susquehanna Township boundary. Although the Upper PCN now has the same management status as Lower PCN, (impacted), it is expected to have a different management theme upon maximum build out (rehabilitation for Upper PCN; enhancement for, Lower PCN).

Figure 5.0 PCN Locations



These data and other information indicate that the PCN subwatersheds need additional outdoor recreation facilities, creek corridor and upland reforestation, rehabilitated creek reaches, stormwater runoff reduction, education on pollution avoidance and abatement, septic discharge prevention, and consideration of stormwater storage. As the RCP is implemented, and other subwatersheds are assessed, additional objectives and strategies for watershed improvement will be necessary.

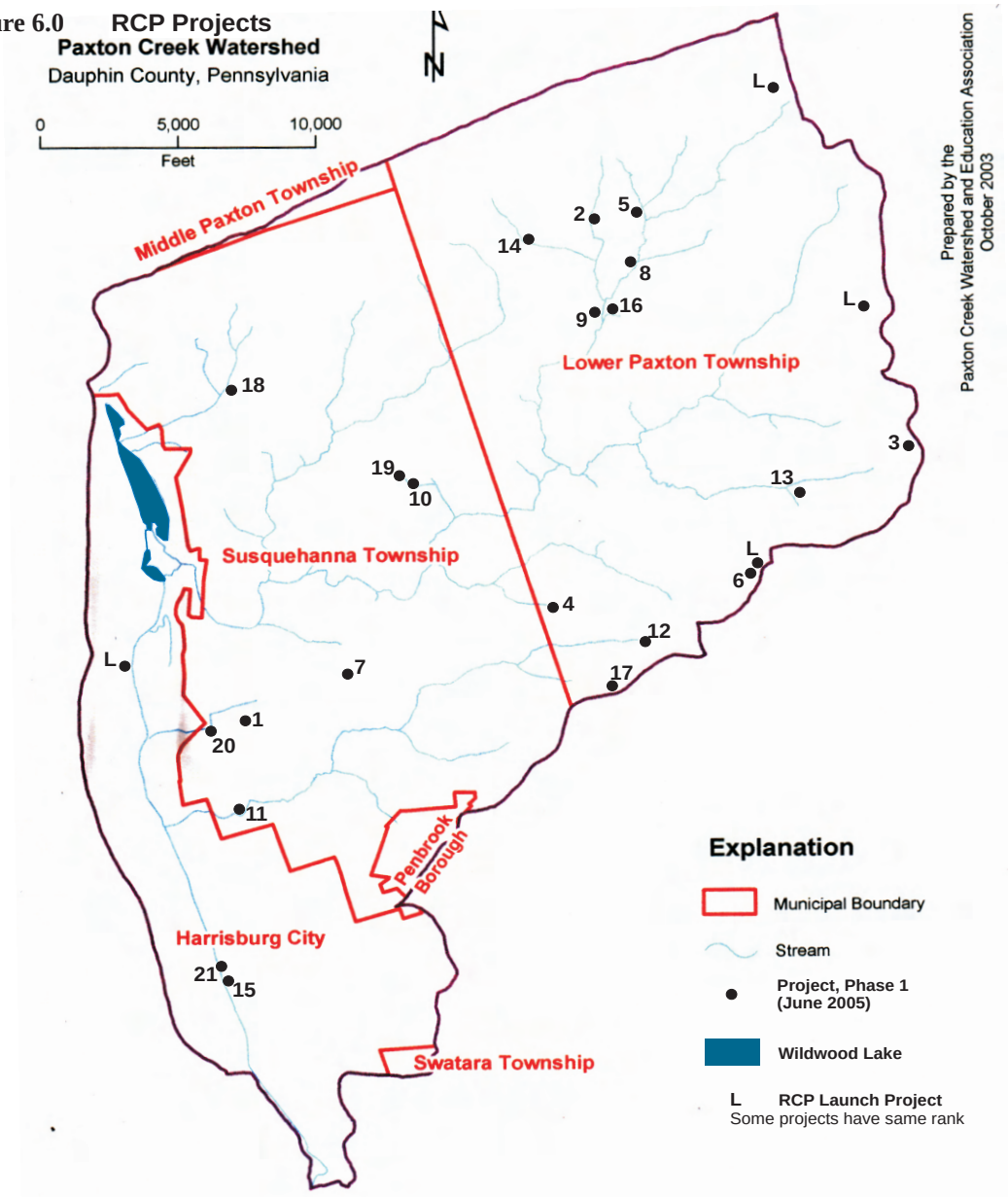
6 Projects to Fix, Enhance and Protect

Hundreds of places in Paxton Creek are in need of protection, rehabilitation, and enhancement. Studies have identified dozens of project areas. More will undoubtedly be added to the list, as additional subwatersheds are assessed. Since only a limited number of projects can be accomplished each year, the challenge is to choose wisely. This chapter covers the selection of potential watershed projects.

In various studies 184 projects were identified. (Table 6.0) From this pool of potential projects, four were selected to launch the RCP, and 21 were chosen for initial prioritization and implementation.

Aspects of these projects include location in headwater areas, multiple watershed goals, landowner support, exceptional demonstration potential, volunteer labor feasibility, potential problem solutions, and other attributes. These projects (Figure 6.0) address the main categories of the RCP actions: water management, land management, creek-based recreation, development, and education in the context of ten types of projects.

Figure 6.0 RCP Projects



"Projects for everybody: to each his or her own."

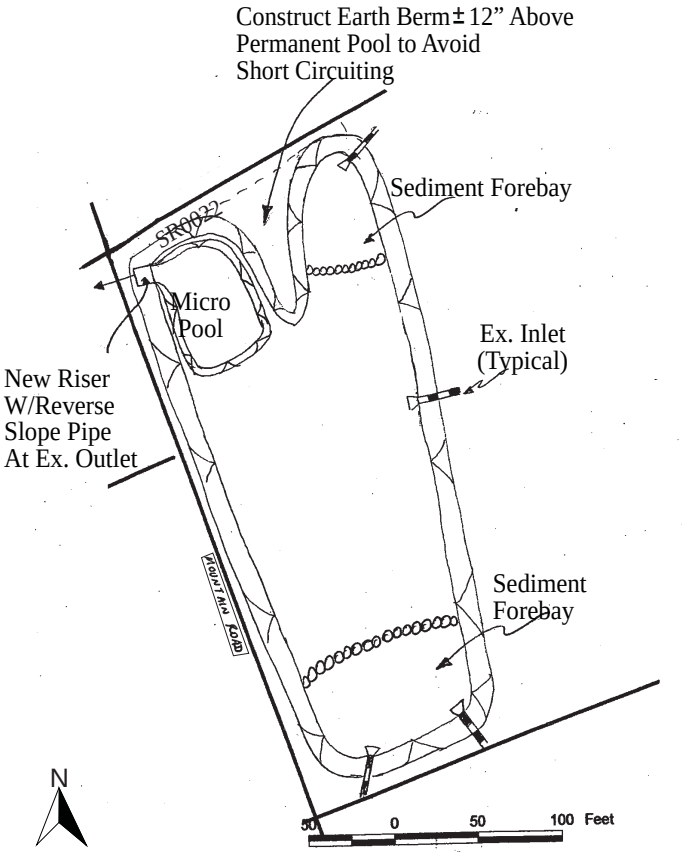
Projects to Fix, Enhance and Protect

Clean Up Trash Tally

Design concepts were prepared for many projects. These designs aim at communicating essential aspects of projects, establishing a sound technical case for the watershed plan, and supporting organized campaigns for helping stakeholders to carry out the projects. A bioretention project design for a stormwater detention pond retrofit at a shopping center (Paxton Square, Rt. 22 and Mountain Road) illustrates the conceptual designs provided in the Appendix. (Figure 6.1) A graphic of the proposed City Beautiful Gang minipark in the channelized creek is another type of design portrayal (Figure 6.2)

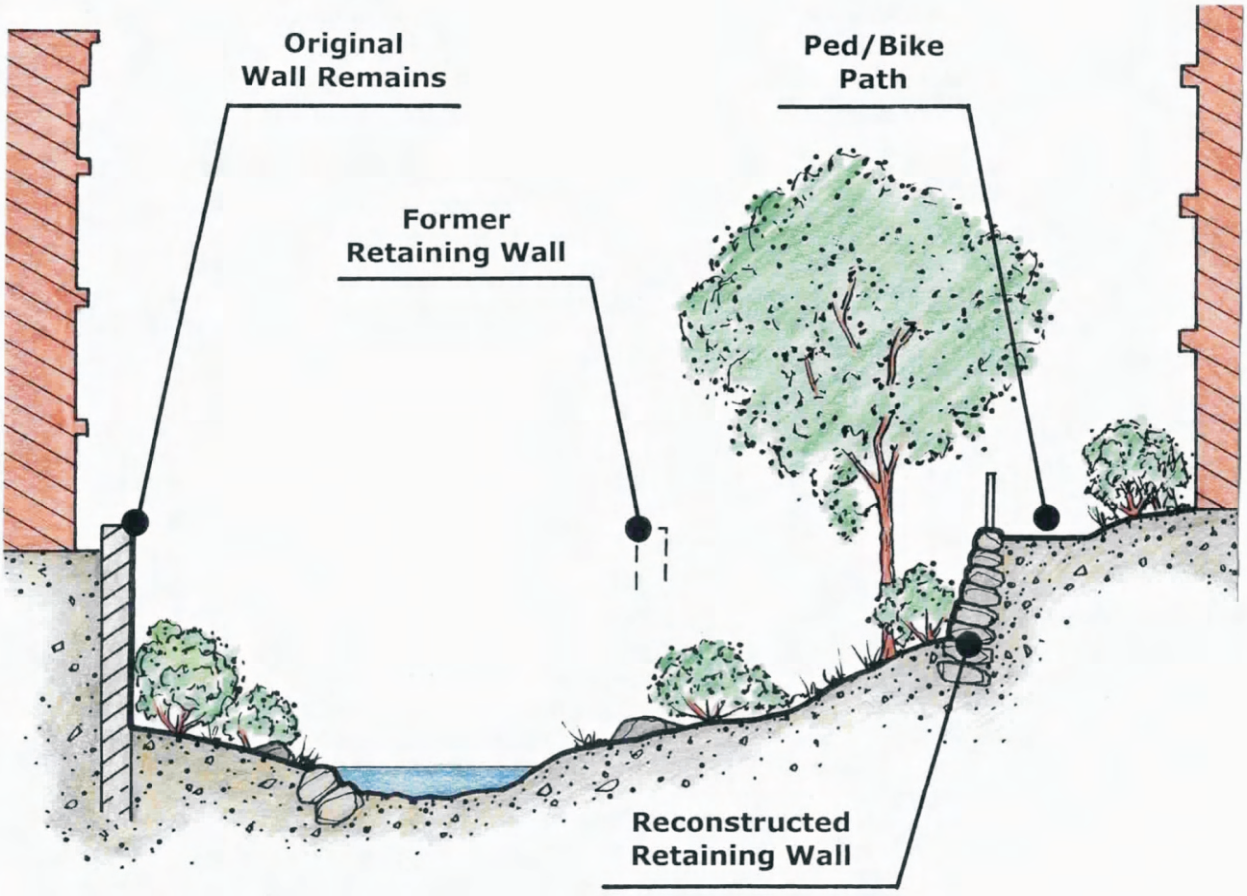
Tables 6.1 and 6.2 contain data on the projects selected for launch, and initial prioritization and implementation. Attributes of these large and small projects include location in headwater areas, multiple watershed goals, landowner support, exceptional demonstration potential, volunteer labor feasibility, potential problem solutions, and other aspects.

Figure 6.1 Detention Pond Retrofit Conceptual Design



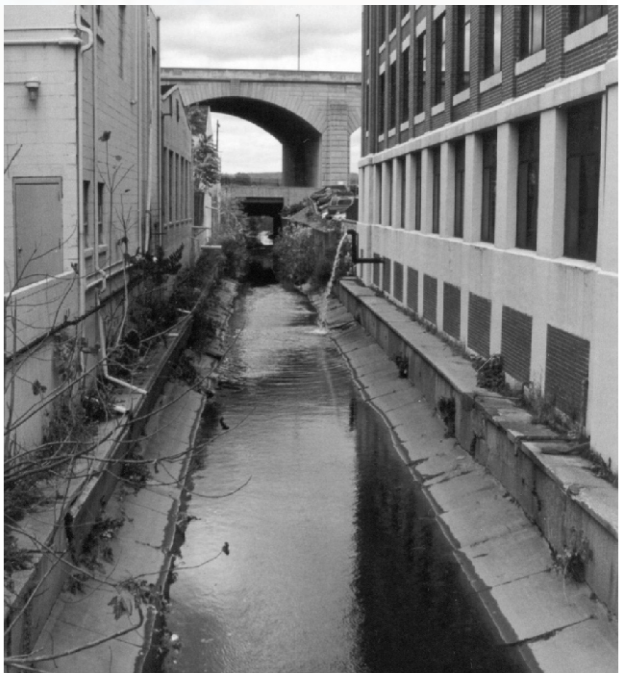
Detention Pond at Paxton Square
View North

Figure 6.2 Channelized Area Revitalization Concept



"Much of Paxton Creek (in the City) is channelized and confined by adjacent buildings (RCP cover photograph) … No physical constraints appear to prevent the conversion of this area from its present condition … to a significant community amenity and focal point for economic redevelopment." -- Todd Moses, Skelly and Loy, March, 2003

Large-scale projects are more complex, requiring more design, engineering, capital, and construction equipment. Small scale projects need less engineering, and involve volunteers for a major part of the required effort. The Appendix (Implementation and Management section) contains descriptions and conceptual designs of many large-scale and small-scale priority projects.



Channelized Paxton Creek

Criteria and Prioritization

Criteria are simply factors that help set priorities for action. In effect, criteria constitute the basis upon which planning decisions are made. Project assessment criteria are used to prioritize rehabilitation and enhancement projects. These criteria help decide what projects to implement, and their execution order. These prioritizations are only temporary. Subsequent subwatershed assessments and new data can affect project rankings, and additional assessment criteria may be added. Rankings are likely to change with major reviews of project lists.

In assigning priority to rehabilitation and enhancement projects for the watershed, PCWEA compiled the following 10 criteria for project assessment:

Goals and Environmental Effects. How many goals (stormwater management, recreation, development, other) does the project address? Is the project consistent with subwatershed goals? What environmental problems or benefits (pollution removed, areas improved, services provided) are associated with the project?

Site Suitability. Is the project located in an area with relatively good water quality, severe channel erosion, forest degradation, development pressure, education opportunity, upstream protection, or other circumstances?

Land Ownership. Is the site public or private? Have landowners given consent? Are owners willing to implement the rehabilitation or enhancement efforts?

Technical Feasibility. What is the size of the area affected? Are structural (bricks and mortar) or nonstructural practices (schedules, behavior) involved? Are permits necessary? Is there concern over access, utility arrangements, conflict with surroundings, or safety concerns? Does it provide technical synergism (integrate with other rehabilitation or enhancement efforts for increased effects)?

Financial Feasibility. What are the monetary and in-kind or other costs? Is it located near other projects to help reduce cost and maximize volunteer labor? Are there financial synergism possibilities?

Funding Availability. Are public-private partnerships planned? What are the likely funding arrangements (particularly from local sources) for implementation? Are funding resources timely and forthcoming?

Public Support. Are organizations, municipalities, the general public, and watershed stakeholders cooperative and supportive of the project?

Educational Value and Visibility. Can the project demonstrate awareness, stewardship behaviors or practices, and/or help convey watershed lore? Is it suitable for contribution to formal or nonformal education systems?

Human Resources. Can the project be implemented by PCWEA members, and/or other volunteers? Donated rotational labor? Professional or other paid labor? Is labor readily available?

Operation, Maintenance (O & M) and Future Needs. Is O and M accounted for in the project design phase? Are future project components anticipated or expected?

Stakeholders applied these criteria to RCP projects at a May 2005 prioritization workshop. An assessment process called the Watershed Restoration Template (CVI and DEP, 2004) was used to rank these protection, rehabilitation, and enhancement projects for Paxton Creek. At the center of this assessment scheme is a project prioritization matrix determined by ranking and weighting the criteria applied to the projects. (Tables 6.1 and 6.2) Although these projects are located throughout the watershed, they reflect the RCP procedure on assigning ranks according to subwatershed evaluations (first, Paxton Creek North). The initial assessment shows the projects in the upper third (rankings 1-7) tend to deal more with downstream effects, protect headwaters, exhibit high visibility (education with demonstration value), and have public ownership. Common characteristics of those in the lowest third (rankings 14-21) are sites mainly on private properties, have several goals, and consist of multiple components.

Subsequent project prioritizations will be conducted by watershed stakeholders, led by PCWEA.

Table 6.1 Large Scale Priority Rehabilitation Projects

Project (rank no., name, & sub'shed)	Project Type	Area Treated (acres)	Stream Length Modified (ft)	Priority Reason	Planning Level Cost Estimate
5 Centennial Acres (PCN)	Pocket Wetland Stream Rehabilitation Riparian Reforestation Better Site Design	5	1,000	Headwater Location Multiple Components Downstream of Development Site Drainage Treatment	$105,000
21 Capitol View Commerce Center (PC)	Riparian Reforestation Bioretention/Conservation Landscaping	5.4	700	Multiple Components Multiple Goals Willing Landowner	$35,000
8 Fairfax Village North (PCN)	Stormwater Retrofit & Bioretention Riparian Reforestation Stream Rehabilitation Trash Cleanup	1	800	Headwater Location Multiple Components Multiple Goals Willing Landowners	$100,000
19 Vartan Offices Property (PCN)	Stormwater Retrofit Recreation (Minipark)?	2.4	N/A	Multiple Components Runoff Causing Erosion on Multiple Properties Willing Landowner?	$50,000 to $75,000
7 S. Police Headquarters and Vicinity (PCN,AR)	Stormwater Bioretention, Riparian Reforestation & Creek Rehabilitation	14.0	300	Public Land Good Access Severe Erosion Visible Location	$105,000
9 Bumble Bee Golf Center (PCN)	Stormwater Bioretention & Riparian Reforestation	2	600	Highly Visible Site Multiple Components Mid-water Location	$30,000
20 PA DEP Offices (PC)	Stormwater Retrofit	1.2	N/A	Visible Location Multiple Components	$50,000
18 Fargreen Road (MT)	Stream rehabilitation Riparian Reforestation	N/A	2,500	Active Degradation of Major Wetlands (Wildwood Lake) High Visibility	$200,000
11 Hbg State Hospital Grounds (AR)	Flood Control Stormwater Retrofit Stream Rehabilitation	2	600	Public Land Floodplain Rehabilitation Good Access	$250,000to $400,000
15 M.L. Dock Minipark (PC)	Recreation (Minipark) & Development & Stream Rehabilitation	0.02	N/A	Development Help Recreation Launch? Willing Partner	$350,000
12 The Brook Apartments and Colonial Park Mall (AR)	Stormwater Retrofit Stream Rehabilitation Riparian Reforestation, Treatment Train, Recreation & Trail?	2	1,700	Headwater Location Multiple Components High Visibility Good Access	$250,000 to $400,000

Planning-level costs estimates are based on average costs for local, similar types of projects. More specific estimates require additional information on precise drainage area and impervious cover, location of utilities, resources (particularly labor) availability, and necessary permits; subwatershed acronyms (AR, Asylum Run; MT, Mountaindale; PC, Paxton Creek; PCN, Paxton Creek North.

Table 6.2 Small Scale Launch and Priority Rehabilitation Projects

Project (rank no., name, & sub'shed)	Project Type	Area Treated (acres)	Stream Length Modified (ft)	Priority Reason	Planning Level Cost Estimate
* Linglestown Schools (LT)	Rain Garden Stormwater Bioretention	0.3	N/A	Urban Headwater Location Public Land High Visibility Volunteers Facilitation RCP Launch Site	$5,000
*Harrisburg Area Community College (PC)	Parking Lot Stormwater Bioretention	1.3	N/A	Semi-Public Land High Visibility Volunteers Facilitation RCP Launch Site?	$13,000
* Friendship Community Center (DT)	Retrofit Dry Pond Bioretention	7.4	N/A	Headwater Location Public Land Volunteers Facilitation RCP Launch Site	$20,000
* Parkway West Road Farms (PCN)	Riparian Restoration	N/A	2,000	Natural Headwater Location Erosion Prevention Need Volunteers Facilitation RCP Launch Site?	$5,000
2 Centennial Acres Park (PCN)	Stormwater Bioretention & Upland Reforestation	0.4 -3	N/A	Headwater Location Public Land Multiple components Uncomplicated design	$10,000
1 Farm Show Overflow Parking (PC)	Stormwater Retrofit	17.9	N/A	Urban Headwater Location Public Land	$5,000
14 Forest Hills (PCN)	Riparian Reforestation	1.4 –2	600-1,000	Headwater Location Uncomplicated Design Land Owned by a single Entity (HOA)	$3,000 to $5,000
10 Davis Landscaping (PCN)	Stormwater Bioretention	TBD	N/A	Willing Landowner Downstream Erosion From Runoff Design/Place Economy	$8,000
17 PennDOT I-83 Cloverleaf Bioretention (PCN)	Stormwater Retrofit	0.5	N/A	Highway runoff pollution Public land Uncomplicated design	$5.000
16 3Bs Ice Cream (PCN)	Stormwater Retrofit	2.3	N/A	Headwater location Uncomplicated design High visibility	$5,000
13 Village Knoll Apartments (PT)	Stormwater Bioretention	7.5	N/A	Volunteer facilitation Single landowner	$8,000
4 Valley Road near I-83 (DT)	Micropool Pond Storage	144.0	N/A	Good Access (ROW) Severe erosion/NPS pollution High visibility	$100,000
6 Wetlands near Friendship Community Center (DT)	Stream Rehab	13.0	N/A	Headwater storage High visibility	$15,000
3 Paxton Square at Rt. 22 (PT)	Stormwater Retrofit	16.0	N/A	Runoff pollution abatement Headwater location High visibility	$10,000

Planning level cost estimates are based on best professional judgment and average costs for similar local projects. Assumptions for riparian reforestation costs include: trees planted on ten foot spacing using small container stock at $5 per tree (from native plant nurseries) and planted by volunteers; subwatershed acronyms -DT, Devonshire; LT, Linglestown; MT, Mountaindale; PC, Paxton Creek; PT, Paxtonia; PCN, Paxton Creek North.
* RCP launch project.

Watershed Projects: Now, Tomorrow and Beyond

ln 2005 more watershed rehabilitation projects are underway than were conducted in the previous decade. Initial projects for launching the RCP include huge buffer plantings (hundreds of trees and shrubs) planted by over a hundred people, coupled with a rain garden at Linglestown Middle & Elementary Schools, parking lot bioretention areas at Harrisburg Area Community College (HACC), and retrofitted stormwater detention ponds at Friendship Community Center. (Figure 6.3)

In addition to the four PCWEA projects scheduled for summer-fall 2006, Lower Paxton Township will support a headwater stream rehabilitation and trail bridge construction project in Brightbill Park (Devonshire subwatershed). This past summer, the Capital Area Greenbelt and Susquehanna Township finished a trail link connecting the Veterans Park vicinity to the CA Greenbelt crossing the Harrisburg State Hospital grounds. Other additional projects have partial funding from the EPA and DEP: a day lighting scheme on Mish Run (Belleview Park area of Paxton Creek subwatershed), stabilization of creek banks along a short stretch of Asylum Run in Harrisburg, rehabilitation of a significant sediment source draining to Wildwood Lake, designs for increasing the stormwater storage capacity and clearing a major clogged channel of the lake, and a stream rehabilitation project at the mouth of Black Run subwatershed in Susquehanna Township. Near Dauphin Borough, the Dauphin County Conservation District used Growing Greener funds to construct a demonstration site at the District office off Peters Mountain Road. This site features many types of pavement, and another 15 stormwater best management practices.

Figure 6.3 RCP Launch Projects

Rain Garden Site

Bioretention Site

Detention Pond Retrofit Site

Projects to Fix, Enhance and Protect

Subwatershed Distribution

Paxton Creek subwatersheds vary greatly in their land area, impervious surface, stream channel length, forest cover, stream degradation, and other features. Consequently, the types of potential projects desired for subwatersheds vary. For example, needed are more flood control projects in downstream areas, and more protective creek buffers at the natural headwaters. Watershed wide, extensive opportunities exist for riparian reforestation, stormwater retrofits, miniparks, trails, conservation landscaping, and other types of stream protection, rehabilitation, and enhancement. Table 6.3 provides a general list of projects for the coming decades.

Table 6.3 Subwatershed Projects: Summary List 1

Subwatershed	Projects
Asylum Run	Seven reaches (1.5 miles) riparian reforestation; 3 stormwater retrofits and 2 stream rehabs; 1 major flood storage, and 5 early action projects (debris jams, eroding gullies, meandering head cuts); 1 trail;
Black Run	Two reaches (1.2 miles) riparian reforestation; 1 retrofit and 2 stream rehabs; 1 trail;
Devonshire	Four reaches (1.3 miles) riparian reforestation; 1 trail; 2 stormwater retrofits and 1 stream rehab; 2 flood storage ponds;
Linglestown	Five reaches (3.2) miles riparian reforestation, 1 rain garden, and 1 stormwater retrofit; 1 long trail;
Mountaindale (Fox Run)	One reach (0.2 mile) riparian reforestation;
Paxton Creek	Four channelized reaches (3.1 miles) riparian reforestation; 7 stormwater retrofits; 1 creek day lighting; 2 conservation landscaping;1 hydrodynamic retrofit; 3 redevelopment; 2 miniparks; 4 trail segments;
Paxton Creek N (Upper and Lower)	Fourteen reaches (5.7 miles) riparian reforestation; 20 stormwater retrofits; 9 stream rehabs; 1 flood storage; 8 other projects (upland reforestation, discharge prevention and pollution source controls); 1 minipark; 1 long trail; 1 fishing platform for physically-challenged persons;
Paxtonia	Three reaches (0.4 mile) riparian reforestation; 4 stormwater retrofits; 2 stream rehabs;
Wildwood Lake	Two stream rehabs; 1 flood storage; 1 major debris jam removal; transportation museum; PA Canal demo site.

Do the RCP Projects Have Any Serious Conflicts?

Probably not, but maybe.

A big benefit of a Geographical Information System (GIS) is maps that are produced to the same scale. This makes comparison of different facts relativity easy, and accurate, if information are collected and entered carefully into the GIS databases. It is almost like laying data sets one atop another, and viewing the results for conflicts, reinforcement, and patterns.

A map of the RCP projects was compared with maps on other watershed information (environmental inventory, cultural features, sinkholes, erodible soils). During the field surveys, the sites had already been assessed for access, steep slopes, and other considerations that are apparent by visual inspection. These map comparisons indicated the following: the Capital View Commerce Center and the Myra Lloyd Dock minipark projects are on the 100-year floodplain; the HACC parking lot bioretention area on the 500-year floodplain and a former dump site; Capital View Commerce Center on brownfields; regional DEP parking lot atop an abandoned municipal waste site. Because of mapping scale, and potential database inaccuracies with associated ramifications these project sites may warrant closer looks (soils, groundwater, and/or other tests). Another potential watershed project may be in jeopardy due to the presence of a water bug. A significant sediment pollution source of Wildwood Lake Sanctuary may be home for this bug.

Bioretention Area in Old Dump

Some RCP projects can be detrimental over the short run where wetlands or wildlife habitat are disturbed. Vegetation can be removed in rehabilitating creek banks, waterway bottoms can be cleared or smothered in dredging activities, and so on. These effects are temporary. Much worse are impacts associated with land developments, particularly in forested areas as on Blue Mountain. Significant environmental declines occur with as little as 10% impervious cover (allowable under conservation zoning!) Many suburban residential developments in Paxton Creek have up to 35% impervious surface as allowed by ordinances. Problems with the roads, roofs, driveways, and parking lots really add up.

Preferences for Flood Mitigation

Major Paxton Creek flooding occurs mainly in two places: the vicinity of the Farm Show Building, and along Cameron Street south of I-83 around Shanois Street. It has two different causes. The Farm Show situation is from upstream waters released from Wildwood Lake, and made worse by confluence with runoff from Asylum Run drainage. The lower floodwaters are from the Susquehanna River, backing into Paxton Creek to inundate south Harrisburg, the old steel mill lands, and Shipoke. Various schemes for remedying the situations call for millions spent on lower creek vitialization and levees. PCWEA favors different approaches for the two locations:

- ☑ Abandon development of the southern floodplain, acquire FEMA relief funds (up to 8% allowed) to clear the remaining buildings west of S. Cameron Street, and use the lands for open space, recreation, trails, and related functions.
- ☑ Solve the upper problem through offsite actions. Clear a clogged channel that is directing most Paxton Creek drainage southward from Wildwood Lake, so some flows can go northward. Install sediment forebays in the creek near Route 322 before waters cross into Wildwood Lake. Run the waters through a split water control structure that allows waters to go north and south; the latter are needed to supply the recreational programs involving Olewine Nature Center and the marsh boardwalks. During storm events raise the walls of the Morning Glory drain (original drain design that has fallen into disrepair), and lower the walls afterwards.
- ☑ Construct extensive impervious cover retrofit and bioretention facilities on upstream reaches in Asylum Run, to reduce stormwater runoff. Consider stormwater storage ponds, where appropriate, as in subwatersheds severely impaired with 20-30% IC; initial inspections show several potential sites exist in Paxton Creek North and Asylum Run subwatersheds.

Additional issues remain (maintenance responsibilities of the sediment forebays and flow control structures, potential contaminants in the clogged soils and their disposal, disruption of American Lotus–a threatened species, and disturbance of recreation programs).

Paxton Creek North Projects

Upper and Lower Paxton Creek North (PCN) subwatersheds have many of the launch and ranked projects. Of over four dozen projects identified for PCN (Figure 6.4), 10 are among those chosen for initial RCP implementation. These priority projects concern a township park, residential developments, offices, golf center, State Police facility, headwater farms, businesses, and an interstate highway. Although these PCN projects for protection, rehabilitation, and enhancement deal mainly with bioretention, stormwater retrofit, and creek rehabilitation, they address most of the PCN subwatershed objectives: additional outdoor recreation opportunities, creek corridor and upland reforestation, creek reaches rehabilitation, stormwater runoff reduction, and education on pollution avoidance and abatement.

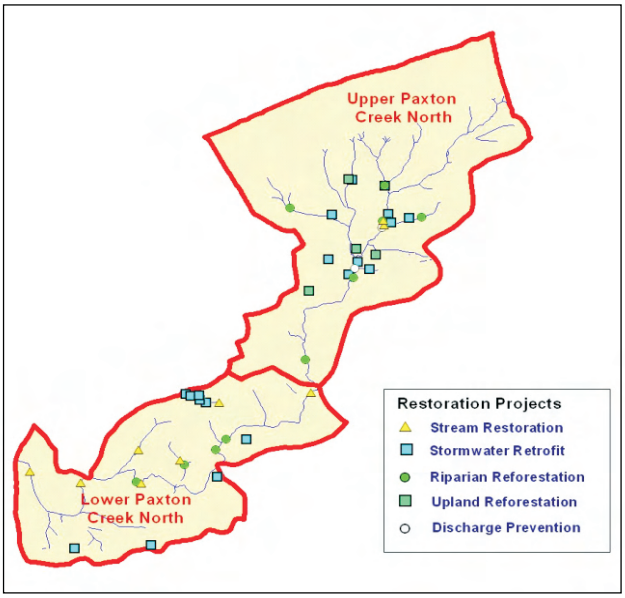


Figure 6.4 Projects in Paxton Creek North Subwatersheds

Table 6.0 Rehabilitation and Enhancement Projects		
Project Type	**Description**	**Number of Projects Identified in 2005**
Stormwater Retrofits	Retrofits apply new science to impervious surface and existing stormwater facilities such as detention ponds, that only minimally improve water quality and reduce the runoff. Retrofits include modifying facilities to increase stormwater infiltration, and alter stormwater storage or conveyance systems (e.g., remove curbs and gutters, or unbury ("day light") streams that were put into pipes and covered (built over). Retrofit techniques often maximize the use of soils and vegetative materials, reduce impervious cover, and create other land use opportunities besides stormwater management.	58
Creek Rehabilitation	Stream rehabilitation practices enhance stream stability, structure, function, and appearance. Rehabilitation techniques include simple stream cleanups, bank stabilization, grade controls, in-stream habitat enhancement (e.g., vegetation plantings), and removal of fish barriers.	17
Discharge Prevention	The aim of discharge prevention is to keep sewage and other pollutants out of the creek. These discharges may be caused by illicit wastewater connections, failing septic systems, leaky sewers, industrial releases, and transport spills. Rehabilitation techniques find, fix, and prevent the illicit discharges, beginning with surveys of known and new stormwater or other pipes to identify suspicious discharges for further investigation.	32
Riparian and Upland Reforestation	Riparian and upland projects restore the quality of forests and wetlands within, and outside stream corridors, respectively. Trees, shrubs, and other vegetation stabilize stream banks, regulate stream temperature, remove pollutants from runoff, and provide habitat for aquatic and terrestrial wildlife. Reforestation techniques include vegetation planting, improvement of soil quality for vegetation growth and stormwater infiltration, removal of invasive species, promotion of natural forest growth, and discontinued mowing. The riparian efforts are commonly called *buffer projects*. They typically are accompanied by conservation easements or purchase/transfer of development rights on private lands.	38 & 4
Habitat and Open Space Protection	Although reforestation and creek rehabilitation enhance wildlife habitat, the key to significant open space improvement is increased areas of undeveloped, contiguous landscape. This is accomplished through approaches such as dedication of preserved lands, conservation easements for land use protection, adoption of better site design and low impact development techniques with accompanying ordinances, sprawl hindrance (i.e., through directed growth management), and emphasis on urban infrastructure and services renewal.	3
Pollution Sources Control	Pollution sources control is achieved through reduction/prevention of pollution from residential neighborhoods and stormwater hotspots (i.e., commercial, industrial, institutional, municipal or transport-related operations that produce high levels of stormwater pollutants and/or present higher potential risk for spills, leaks, and discharges). Pollution source control methods include education and/or enforcement efforts that can prevent or reduce polluting behaviors and operations. Examples: educating landowners about techniques for storing materials outdoors, reducing fertilizer and pesticide use, disposing of pet waste, and keeping stormwater runoff in yards.	6
Flood Control	Areas of Paxton Creek have declined in value, and lagged in redevelopment because of floods. Approaches for lessening the frequency and size of the floods are projects to decrease the runoff upstream, provide storage (and subsequent release) of potential flood waters, and decrease runoff in flood-prone areas. Flood control projects include preserving wide valleys and ravines where creek stormwater can be detained (such as the grounds at Harrisburg State Hospital), increasing water storage at places such as Wildwood Lake, and infiltrating stormwater rather than allowing it to run off the land.	5
Trails	Trails and greenways alongside the creek, located, perhaps, in interceptor sewer rights-of-way, can serve multiple functions. Besides providing ready maintenance access to the sewers, these trails are a relatively safe alternative to motorized transportation, promote healthy lifestyles (exercise, recreation), provide education, mitigate pollution and floods, join existing trails (Capital Area Greenbelt), and assist economic development by connecting residences, work places, entertainment sites, and shopping areas. Appropriate short, initial trail routes would be near the miniparks, as in the Herr-Walnut Streets corridor. Potential long intermunicipal connecting routes to be developed initially could be in Asylum Run from the Susquehanna Township link to the Colonial Park Mall, and in Paxton Creek North subwatershed as it extends from the west end of Paxton Church Road, near Wildwood Lake Sanctuary, to a creek headwaters in Lower Paxton Township at Centennial Acres Park.	8
Recreation and Development	Miniparks and other recreation/education sites situated along Paxton Creek can help fill the current gap in recreation opportunities in the watershed. Examples of small (1,000 sq ft) miniparks include sites with gardens and benches connected to trails, as near commerce, industrial, and residential sites, and places with historical or natural resource significance. These miniparks and other recreation sites can be sources of neighborhood pride, and help satisfy local needs for recreational experiences. These recreational initiatives can also assist economic redevelopment. Creek-based projects that remedy watershed flooding, enhance enterprise zone developments, and possibly assist a Lucknow rail yard conversion resulting in unification of Harrisburg, an expanded tax base, and improved cooperation among watershed municipalities.	8
Education	Paxton Creek is rarely the focus of efforts to build watershed awareness and knowledge. Both formal and nonformal science education under-use Paxton Creek as a teaching tool. Existing watershed resources and rehabilitation activities offer opportunities for hands-on learning, community service, and mentoring. The plan calls for additional outreach activities, such as workshops, publications, mass media, and extensive work with teachers to incorporate the watershed's rehabilitation into school activities, integrating formal and nonformal education.	5

7 Plan Schedule and Costs

Reversing three centuries of degradation will be neither quick nor cheap. The rehabilitation of Paxton Creek will take decades and cost millions of dollars.

Schedule

The RCP will be implemented in three phases. Phase I will cover the first ten years, Phase II the next ten years, and Phase III 20 years and beyond. (Table 7.0) During the first three years of Phase I, PCWEA will establish the RCP framework and partner with a major organization for program set up and administration of initial projects. This RCP start-up phase will establish a project finance system and a rotational volunteers program. PCWEA will also build a stronger support base, increasing the PCWEA Board of Directors, expanding membership, arranging coordinators for priority rehabilitation programs and projects (training PCWEA members on watershed initiatives, monitoring, special studies, making additional subwatershed assessments). During this implementation period projects will be initiated at the rate to two per year. In the latter part of Phase I the educational program will grow beyond startup and demonstration functions, basically institutionalizing the integration of nonformal and formal education experiences which likely will extend into Phase II.

During Phase II, watershed projects of all types will be conducted at a rate of 2-3 per year. In this phase, PCWEA will also encourage and assist municipalities in forming an inter-municipal stormwater utility or authority for more efficient, cost-effective runoff management. Support for initiatives on ordinances, education, and monitoring will continue.

Phase III activities call for community watershed projects to continue with increased emphasis on urban best management practices such as impervious cover retrofits, in-fill development, channel rehabilitation, and day lighting of buried streams. Trail and minipark projects may take on increased priority as anticipated support by stakeholders grows.

Creek Loot (Encrusted Coins) in Bag

Besides the designated projects, certain types of projects will be conducted on a regular basis during all the Phases:

- ☑Conservation landscaping and rain barrel workshops/implementation for residences and businesses every other year;
- ☑Retrofit of malfunctioning and underperforming detention ponds on alternate years;
- ☑Buffer plantings on creek reaches every year, until no longer needed (not expected);
- ☑Education activities each year, related to projects and as general outreach;
- ☑Subwatershed assessments, 1 each year for 9 years of Phase I;
- ☑Monitoring every year;
- ☑Research on local soil infiltration, floodplain augmentation, and certain BMPs for 3 years of Phase I, and afterwards.

"The price of a promising watershed? Million of dollars for hundreds of projects!"

Plan Schedule and Costs

Educational program initiatives will accelerate in the later half of Phase I. Emphasis on certain activities do not occur until Phases II and III because of the anticipated time requirements associated with the demands of the PCWEA programs setup and the subwatershed characterizations. In all these phases, monitoring activities will be at the center of watershed management and project tracking. (Table 7.0)

Poor data exist on the origins and amounts of stormwater and pollution (creek flows, pollutant loads). Without this information watershed planning is hindered (needed to estimate the maximum effects for efforts undertaken). This information will affect individual projects, rather than alter the overall RCP implementation schedule.

Costs

Plan costs are figured by applying unit cost estimates to organization activities, project components, and RCP tasks such as subwatershed assessments with monitoring. (Table 7.1) Although in-kind resources and volunteer labor may reduce these costs, the overall level is likely to increase 5-7 fold upon evaluation of the whole watershed. Initial details are in the Appendix.

Costly Oil Spill Cleanup

The RCP calls for over 14 dozen projects that are subject to project scoping and budgeting. Only 25 are addressed, a number sufficient for the 10-year period of Phase I. Costs for long term or large-scale initiatives, such as the railroad yard conversion, lower floodplain open space reservation, and potential lower creek rerouting are not computed. These are too nebulous, problematic, or far off to be useful guides.

Table 7.0 Plan Schedule

Phase 1	Phase 11	Phase III
RCP Administration & Program Set Up, PCWEA Capacity Building & Training, Subwatershed Assessments, 2 Projects/Year, Research & Education Emphasis, Monitoring	2-3 Projects/Year, Stormwater Management Utility & Education Emphasis, Monitoring	2-3 Projects/Year– IC Retrofits, Infill & Creek Rehab Miniparks & Trails Emphasis, Monitoring

Plan Schedule and Costs

Table 7.1 Plan Costs Summary

Tasks, Practices, and Tools	Reserve Cost* ($)	Phase I ($)
Organization Operations		
Start up Facilitation, Office, Stakeholders Involvement, Volunteer Coordination & Training, Special Studies (Flows, Sediment), Research & Monitoring, Education (Formal-Nonformal Programs, Stewardship & Mentoring)	860,000	510,000
Remaining 9 Subwatershed Evaluations	145,000	145,000
BMP Projects		
Stormwater and Open Space/Habitat Management (Reforestation, Creek Rehabilitation, IC Retrofit, Bioretention)	6,312,500	2,328,700
Pollution Source Controls (Practices and Behaviors Education, Landscaping and Stormwater Infiltration, Cleanups, Filters)	225,000	85,000
Recreation and Transport (Miniparks, Trails, Special Facilities)	4,834,800	240,000
Economic Development (BMPs Advisement, Green Infrastructure)+	60,000	30,000
Totals	12,438,000	3,339,000

*Cost estimates based upon data from reports (Skelly and Loy, 2003; Center for Watershed Protection, 2003 and 2004), and field assessment of 2 (of 11) subwatersheds; + Costs mainly accounted in trails, buffers, and miniparks estimates; IC impervious cover; BMPs, best management practices; *Reserve costs are for all phases.

Only cursory attention has been given to flood control and redevelopment projects. Other organizations have made estimates and are likely to lead flood control efforts ($280,000 by the City of Harrisburg for modifications and dredging in Wildwood Lake; $16 million by Skelly and Loy for the revitalization of Paxton Creek subwatershed). PCWEA will play a supportive role with volunteer labor, education, and related efforts, such as advocacy of best management practices with stormwater on-site infiltration.

These initial planning level costs ($655,000 for operations, and $2.7 million for watershed projects) in Phase I are sufficient for general plan guidance. These are ballpark estimates rather than near and long term cost estimates made with a discounting procedure, because of the high uncertainties associated with the benefit and cost components.

The monetary costs for doing the initial Paxton Creek North subwatersheds work are approximately $118,000 (2/11th of operations), and $483,000 for the initial RCP projects. Site specific estimates are necessary for individual projects and funding proposals.

Costs vary greatly among the subwatersheds and parts of subwatersheds because of the types and amounts of improvement projects. An example: in suburban yards where nearly all labor can be provided by residents and friends, disconnected roof downspouts with rain barrels, conservation landscaping, rain gardens, and soak-aways can be accomplished with as little as $50. Monetary costs are much greater ($200-400 per *linear foot*) in highly urbanized areas where creek branches are channelized, enclosed in pipes, and covered with dirt and impervious material. These are design, construction and installation estimates. Maintenance costs are not figured.

8 Implementation and Management

Consideration of what it takes to implement the RCP is as important as the plan's content. Two types of considerations are involved: First are the technical and administrative components such as design, construction, inspection, maintenance, finance, and project component installation sequence. Second are the strategy and tactics for shepherding the RCP through bureaucratic and political processes. Project implementation involves flexibility, effective communication, sensitive leadership, consensus building, and in-house training among other areas of expertise. Successful implementation requires partnership building, funding arrangements, ongoing monitoring, evaluation, aftercare, education, and community outreach.

Partners and Stakeholders

The most important element in rehabilitating and enhancing the watershed is people. The RCP requires the integrated efforts of many partners and stakeholders. Partners are organizations or people that cooperate or share resources in pursuit of common goals or objectives. Stakeholders are all people who reside, work, or play in a watershed. They range from very strong partners and enthusiastic stakeholders to peripheral participants. Through a shared vision, stakeholders of all degrees can be advocates for Paxton Creek watershed.

Paxton Creek watershed improvements will involve dozens of partners and over 80,000 stakeholders. They are from the private and public sectors, profit and non-profit organizations, and municipal, state, and federal agencies. In regard to the RCP, they will provide resources, regulate activities, help plan and carry out actions, and extend consolation when things don't work out. They are at all levels. The groups are a mixture of nonprofit, service, governmental, business, and educational organizations. (Table 8.0)

Planting Rain Garden

Partnership Expansion

As implementation proceeds, additional partners are needed to address watershed problems and enhancement opportunities. These partners can be of the following types: business and economic organizations, service organizations, educational institutions, churches and clubs, sports groups, trade groups, nongovernmental organizations, government agencies, and politicians. Every vocation and avocation can contribute to implementation of the RCP. (Table 8.0)

Many practices are necessary for reinforcing relationships with partners. These approaches include more frequent and targeted communications (interactions through a coordination steering committee), and creation of various kinds of honors and awards for recognizing partner contributions. Table 8.3 provides examples of strategies and tactics that contain these options.

"For maximum benefit partners need to become stakeholders (if they aren't), and participating stakeholders need to become partners!"

Table 8.0 Stakeholder Participation Opportunities

Potential Activity	Potential Area Partners
Watershed awareness campaign	Publicity & ad agencies, churches, bars, sportsmen, Scouts, schools, restaurants, media companies
Fact sheets, BMP flyers	Institutes, engineering associations, schools, accounting firms, printers
Plan and project videos, oral history CDs	Schools, photography clubs, historical societies, retirement centers, churches, libraries
Headwaters hoe-down dance (featuring Wildwood Stomp) fund raisers	Dance groups, recreation associations, social clubs, musicians
Adopt-a-stream reaches, and/or periodic creek cleanup/protection	Service & sportsman clubs, Alliance for the Chesapeake Bay (ACB), Scouts, trade associations, Susquehanna River Basin Commission (SRBC)
Watershed Day, festivals, watershed driving tours	Environmental agencies, American Automobile Association, auto dealers, driving schools, Olewine Nature Center (ONC), historical groups, environmental organizations
Better Site Design (conservation) ordinances	ACB, municipalities, builders associations, Dauphin County Conservation District (DCCD), Department of Environmental Protection (DEP), engineering consultants
Formal and nonformal education grants, initiatives	School districts, home/charter/private schools, tradesmen, technical education institutes, colleges, National Science Foundation,
Midwinter Macros & Creek Critter Safaris/other education	Environmental organizations, ONC, Harrisburg Area Community College (HACC), DEP, DCNR, Trout Unlimited, Dauphin County Conservation District (DCCD)
Creek channel rehabilitation	Excavators, engineering consultants, schools, sportsmen associations, nurseries, garden centers, garden clubs, Department of Environmental Protection (DEP), Canaan Valley Institute (CVI), ACB
Watershed monitoring & mentoring	PA Senior Environment Corps, watershed associations, DEP, schools, US Geological Survey, PA Geological Survey, SRBC
Riparian buffers, conservation easements, & transfer/purchase of development rights	Schools, garden clubs, lawyers, Central PA & Manada Conservancies, conservation groups, Chesapeake Bay Foundation, PA Land Trust Association, engineering consultants, CVI, DCCD
Surprising watershed views, trails, & miniparks	Garden clubs, schools, Harrisburg Civic Club, Department of Conservation and Natural Resources, governmental recreation departments, Capital View Commerce Center
Land & waters protection & pollution seminars, workshops, & tours	HACC, municipalities, DCCD, Pennsylvania Environmental Council, DEP, planning agencies

Implementation and Management

Monitoring Partners

The point is there is something for just about everybody. If responsibilities can be shared, and people have common watershed goals, most will support the creek revitalization efforts. The next paragraphs describe the anticipated roles (3 each) of partners in helping implement the RCP.

Local Government: Municipalities and Dauphin County Officials

1 Incorporate creek use and rehabilitation in municipal decision making (stormwater runoff, water quality improvement, creek-based recreation)
2 Revise municipal comprehensive plans and ordinances to reflect Paxton Creek Roundtable principles (required buffers, stormwater infiltration)
3 Encourage land owners and developers to implement the conservation design principles of the Roundtable

Regional Organizations: Susquehanna River Basin Commission, Canaan Valley Institute

1 Promote intermunicipal actions in integrated water resource planning and management
2 Provide technical, administrative, and funding assistance for RCP programs such as stormwater infiltration and education outreach
3 Use the Paxton Creek watershed for urban BMP applications

Dauphin County Conservation District

1 Encourage and actively promote administration of Roundtable principles by municipalities and land developers
2 Help accelerate BMP techniques associated with Roundtable principles
3 Continue guidance on stormwater management, water quality improvement and related topics for the watershed municipalities & county

Builders and Trade Professionals: Home Builders Association of Metropolitan Harrisburg, Construction Contractors, Consultants

1 Adopt and implement Roundtable principles in construction practices
2 Encourage municipalities and their advisors of the need for new development approaches incorporating BMPs and Roundtable principles
3 Assist and participate in the community RCP projects

State and Federal Agencies: PA Departments of Environmental Protection and Conservation and Natural Resources; US Environmental Protection Agency, US Geological Survey

1 Provide technical guidance, funding assistance, and permit facilitation for RCP projects and programs
2 Promote and provide resources to assist municipalities in adopting integrative, effective land and water management ordinances
3 Assist in equipment, finance, and training for water quality monitoring and BMP evaluation

Environmental and Education Advocates: Alliance for the Chesapeake Bay, Harrisburg Area Community College, Central Penn Conservancy, School Districts

1 Participate in joint projects and funding proposals for watershed improvement initiatives, education, mentoring and stewardship
2 Serve as supporting organizations in RCP projects involving watershed protection and enhancement, various BMPs, and education initiatives
3 Assist watershed municipalities in integrating watershed resources, concerns, and issues with those of the communities

Land Owners and Managers: Private Property Owners, Home Owner Associations

1 Facilitate the installation of BMPs that are beneficial to both the property owners and the community
2 Participate with labor, money or in-kind resources on RCP projects
3 Increase awareness and understanding of watershed workings: the first step in watershed stewardship.

Current RCP Organizational Partners: ***local*** - schools (Harrisburg Area Community College, Londonderry School, Harrisburg and Central Dauphin School Districts), Boy and Cub Scouts (Pack and Troop 360), businesses (Hornung's Ace Hardware, Smith Paint Products; KUTCO Printing and Products), consultants (Skelly and Loy; Herbert, Rowland and Grubic), Dauphin County Conservation District, Dauphin County Parks and Recreation, municipal and county staff and officials (Dauphin County, Penbrook Borough, City of Harrisburg, Lower Paxton and Susquehanna Townships), The Harrisburg Authority, the Home Builders Association for Metropolitan Harrisburg, PPL Electric Utilities, Retired Seniors Volunteer Program, Trout Unlimited, Tri-County Regional Planning Commission, United Water, other organizations; ***state*** - governmental politicians (Reps Ron Marsico and Sen. Jeffrey Piccola), Pennsylvania Department of Environmental Protection, Pennsylvania Department of Conservation and Natural Resources, Entomological Society of Pennsylvania, Pennsylvania Environmental Council, Pennsylvania Environmental Foundation (Greenworks); ***region*** - Canaan Valley Institute, Chesapeake Bay Foundation, Susquehanna River Basin Commission, Alliance for the Chesapeake Bay; ***nation*** - U.S. Representative Tim Holden, Center for Watershed Pro-tection, National Fish and Wildlife Foundation, United States Geological Survey (USGS), United State Environmental Protection Agency (EPA), The Nature Conservancy, The American Clean Water Foundation.

Figure 8.0 Current PCWEA Partners

Clearing Creek Debris

Creek Supporters Lead Wave

It would take a huge earthquake, asteroid impact, or whatever to make a big wave in usually shallow Paxton Creek. One of a different kind–people is expected to implement the RCP. The current supporters will lead this wave. These people are at all levels: local, state, regional, and national organizations. (Figure 8.0) They range from Cub Scouts and middle school pupils, to professionals and agency officials. Several changes in the support base are likely to occur: broader PCWEA membership and additional participant groups (churches, sportsmen, politicians, government officials) currently under-represented, and those of local focus (residents, professional businesses persons in project subwatersheds).

Installing Flow Level Gauge

Community Outreach and Stewardship

People across the watershed community in all four municipalities need to share the common vision portrayed in the RCP. This will be promoted through various types of outreach activities. The plan will be launched following municipal approvals, but full support will come later as people see projects unfold on the landscape and develop an increased awareness of the watershed. Stewardship is the key word. It means taking responsibility for maintaining a healthy balance between human activities and watershed resources. Paxton Creek needs more stewards like the late Ralph Kinter of Lower Paxton Township:

Ralph maintained 3 miles of the Appalachian Trail on his own for nearly a quarter century. When his health no longer allowed him to remove fallen trees and perform other physically arduous tasks, he adopted responsibility for wetlands as in Wildwood Lake Sanctuary. He taught himself wetland botany, and became so proficient that no experts would challenge his assessments. (Dollard, 2002)

Education

Education has been a focus of PCWEA from the outset, as is shown in the Association's name, web site (teachers' database), and this RCP (Watershed Basics 101). The RCP envisions three types of education: messages to build further awareness about watershed issues; technical training of PCWEA members and others; integration of formal and nonformal educational programs.

Educational awareness activities and events were conducted almost monthly for the three calendar years by PCWEA. These included workshops, tours, library displays, conference presentations, creek cleanups, buffer plantings, quarterly newsletters, web site postings, teaching database, brochures, booklets and flyers on the RCP and Best Management Practices. The brochure *Are You Loving Paxton Creek to Death?*, slide shows, and flyers were prepared for this RCP. Similar efforts are likely to be done during the RCP implementation. Various technical training will have additional emphases. Some training will occur through workshops sponsored by other organizations, while other training will be in-house, or assisted by/conducted with organizations such as Canaan Valley Institute, the Department of Environmental Protection, Dauphin County Conservation District, and the United States Geological Survey. During the latter part of Phase I, formal (school curriculum) and nonformal education resources (trade skills) will be integrated into the RCP.

Studying Detention Pond

Plan Evaluation and Indicators

Ongoing evaluation of the RCP is crucial to its success. The RCP is a dynamic document and will be adjusted as its progress is monitored and new information is acquired. The evaluation process documents achievements, establishes a basis for future financial support, increases credibility of the plan, strengthens PCWEA partnerships, and provides accountability to the public and participants. It measures short and long-term success, while also revealing weaknesses that need to be addressed. Performance assessment and adaptive management will be used to answer a series of questions. What worked? Were crucial issues and areas addressed? Were there unanticipated results, occurrences, or obstacles? Was the allocation/reallocation of RCP resources the wisest use?

Indicators constitute the basis upon which plan actions are evaluated. They can be both quantitative (numbers) and qualitative (sensory perceptions). A set of proposed indicators for Paxton Creek watershed rehabilitation and enhancement are organized along the themes of the RCP goals. (Table 8.1) During the initial RCP implementation period, these indicators will be assessed for their usefulness and continued inclusion in the evaluation process.

An immediate shortcoming is lack of numbers. Until certain information is known (creek flows, pollution loads of each subwatershed), indicators such as amount of impervious surface to remove, and areas of infiltration to prepare can not be determined, making performance objectives little more than guesses.

Table 8.1 Evaluation Indicators: Partial List

Goal	Indicators
Improve Water Quality	Pollutants reduction (mg/L, pounds), CSOs separated (no.), stormwater facilities retrofitted (no.).
Reduce Runoff & Flooding	Stream flows altered (cu ft/sec), reduced peak flows, (feet), Impervious cover reduced (acres).
Reduce Erosion/Sedimentation & Creek Channel Rehabilitation	Erosion reduced (tons, inches, %), Reaches Rehabilitated (feet).
Conserve Riparian Habitat & Forest	Amount buffer planted (feet, acres), Easements and development rights transferred or purchased (no.).
Protect Open (Green) Space & Mountain Lands	Land area protected (acres), Municipalities with adequate protection ordinances (no.).
Support Urban Revelopment	Miniparks, buffers, trails, conservation landscaping areas Installed (no., area, length).
Enhance Creek-based Recreation	Day lighting, minipark, trail projects, special facilities (no., area).
Promote Watershed Awareness, Understanding & Stewardship	Flyers, fact sheets, booklets (no.). Talks/workshops/training (no., hrs).
Conduct Creek-based Education	Private-public partnerships (no.), instruction session per educational mode (no., hrs).

Note: CSOs, combined sewer outlets

Testing Habitat Assessment Protocol

Monitoring

Through RCP monitoring, changes to the watershed and RCP impacts will become evident. Anticipated are five monitoring approaches: project tracking and assessment, long-term sentinel stations, performance monitoring, special studies, and site and incident checking.

The tracking system will chronicle the progress of specific projects, record the fates of their components, and point toward problems and opportunities for future projects. In sentinel monitoring, selected indicators are measured at fixed stations for long time periods. Data from these stations should show the extent of changed watershed conditions and, perhaps, the aggregate impacts of multiple projects. Most of these stations are located where 17 staff gauges are installed throughout the watershed. Performance monitoring will be used to assess how well specific rehabilitative practices work. Besides BMP effectiveness, additional considerations are involved (design certification, construction quality, agency permits). Site and incident checking is preliminary, ballpark monitoring. It is needed from time to time to check environmental conditions, and to respond to reported problems such as spills and seepages. Usually it is performed by volunteers with testing kits. Special monitoring studies (flows, sediment, chemical pollutants) are efforts apart from regular monitoring that require different equipment, personnel, procedures, schedules, and even scope (perhaps, the whole watershed at once!).

The RCP looks at overall watershed health, with initial emphasis upon the Paxton Creek North subwatersheds. Continuing monitoring and assessments during Phase 1 will be needed for the additional nine subwatersheds using the riparian (USA) and upland (USSR) protocols, similar to work done in Upper and Lower Paxton Creek North subwatersheds.

Plan Aftercare and Maintenance

The RCP will not succeed simply because it's been adopted and approved. Things done after the plan is adopted, a phase called *aftercare* is necessary to carry out the plan's action agenda, build the public's acceptance of the RCP, and refine the plan far into the future. Aftercare activities may also include ancillary actions that complement the RCP, such as providing assistance to municipal planning groups, promoting better site design principles for new development, and getting the RCP on the Pennsylvania Rivers Registry (which enhances funding opportunities).

A particular concern is maintenance of the on-the-ground projects. Stormwater facilities can degrade with age, and vegetated areas can become susceptible to invasive species, damage by browsing deer, and suffer other fates. Depending on the type of project, regular maintenance may be required, and may be extensive. Requiring maintenance provisions at the design stage, and establishing memoranda of understanding for maintenance responsibilities are two options to ensure the long term integrity of facilities and natural areas. Maintenance would also be enhanced by a stormwater utility. This inter-municipal utility could function similar to wastewater management authorities, have responsibility for most, if not all, of the entire watershed, and involve additional municipalities because of artificial, but minor, stormwater exchanges occurring between Paxton Creek and an adjacent watershed.

Rehabilitation, Riparian Reforestation and Flood Control Site

Finance and Funding Sources

A finance strategy is necessary to tackle the enormous cost of watershed recovery ($12.4 million, a partial estimate). This strategy starts with actions that will build the PCWEA capacity to raise funds and resources necessary to get the job done. It comes back to the main element of implementation: partnerships. Public-private partnerships are the key to financing RCP implementation. All watershed resources are needed for creek rehabilitation, protection, and enhancement, from support by restaurants to schools, trades, and professions. RCP finance will be achieved under the following guidelines:

- ☑Market-based solutions will be sought for the watershed problems.
- ☑Watershed protection and enhancement will be compatible, and consistent with community goals;
- ☑Funding resources will be coordinated and leveraged so as to insure long-term financial sustainability;
- ☑Close cooperation with agencies and partners will be developed so as to avoid duplication of efforts and waste;
- ☑Watershed rehabilitation will support Pennsylvania priorities in regards to allowable pollution levels (Total Maximum Daily Loads) determined for Paxton Creek, and Tributary Strategies for the Chesapeake Bay;
- ☑Public-private partnerships will be a focus.
- ☑Partners will be approached to contribute money and in-kind resources on a *rotational* basis, so partners are not contacted unduly or too often an approach implemented in the initial 3 years of the RCP.

For the near future, project support will depend on monetary grants and local resources, the latter mainly in the form of in-kind labor and equipment. The medium and long-term viability of the RCP anticipates a strategic shift of funding resources to the private sector, with grants serving only seed purposes. The Appendix contains annotated lists of potential partners at all levels.

In time, perhaps, Phase II stormwater management for Paxton Creek may be conducted by an authority or intermunicipal utility with tax-based funding. The stakeholder and landowner survey respondents indicated support for this funding option. If the utility is established, effectively reduces stormwater flows, enhances surface water quality, and reduces flooding, major stormwater efforts by PCWEA may no longer be necessary. Other watershed protection and enhancement activities (recreation, development, education) will be needed in work that likely will require decades.

Integration

Table 8.2 brings together summary details on the initial projects to get the RCP underway (project names, subwatersheds, activity/project types, goals, objectives, costs, participants). Attachment RCP-3 contains similar information on another 21 priority projects, together with a long list of strategies and tactics for implementing them. Table 8.3 presents a sample of these strategies and tactics–all to create the watershed of promise: Paxton Creek!

Ancient Paxton Creek *Ichthystickungus* fish?

Table 8.3 Illustrative Strategies and Tactics

Partners and Stakeholders

Form an RCP implementation steering committee through invitations to leaders of organizations to attend PCWEA events, or participate in their meetings to discuss the benefits of plan implementation for them, together with the PCWEA mission and activities.

Design an award program for major businesses participating in stormwater management or other watershed achievements, perhaps involving plaques and certificates, coupled to publicity for cooperative businesses.

Community Outreach and Stewardship

Distribute the RCP to municipalities, state agencies, libraries, major private implementation partners, and other interested stakeholders.

Prepare communication modules introducing the RCP to service clubs, schools, and community organizations at their meetings and other activities.

Education and Training

Make programs on RCP and BMP implementation geared to specific categories of stakeholders (levels of awareness, interest, understanding) and specific subwatersheds

Sponsor a compilation CD featuring music, oral histories, stories and other pieces to promote watershed awareness through education.

Train PCWEA teams for recruiting potential partners for various initiatives (projects, conservation easements) illustrating participant benefits and watershed needs.

Plan Evaluation

Form a core group to conduct annual performance assessments by persons involved for multiple years to achieve evaluation continuity.

Compile an annual State of the Watershed Report on plan progress, review of the previous year's activities, and projected future

Monitoring

Create databases for monitoring results which typically involve compilation of computer spreadsheets, with procedures for timely data reporting and posting.

Develop data quality management and quality assurance project plans to make data consistent, reliable, and well documented.

Plan Aftercare

Inform agency contacts about the RCP release, contents, and needs, while expressing future interactions and opportunities.

Prepare key generic proposal components in anticipation of rapid response to grant opportunities

Maintenance

Make maintenance provisions part of the design and installation process of the RCP, so maintenance is considered from the outset.

Arrange routine maintenance by community organizations (service clubs, schools, sports Clubs) so as to spread responsibilities among partners and build community ownership.

Finance

Make arrangements with a major partner to administer a large grant that will complete watershed data needs and assist in establishing the financial approach of the RCP.

Enhance relationships with funding organizations through frequent up-to-date advisements and progress briefings, tours, and invitations to activities and events such as annual State of the Watershed Reports.

Table 8.2 RCP Elements for Launch Projects

Activity/ Project & Subwatershed	Activity or Project Type	Goals	Objectives	Indicators	Costs	Potential Partners	Phase & Priority
Harrisburg Area Community College (PC)	Parking lot stormwater bioretention	Improve water quality, reduce stormwater RO, decrease erosion, provide education & awareness	Install bioretention areas (media, widths & depths) with monitoring wells, install education signage & develop brochure	Bioretention (ac, no.), reduced pollutant load (mg/L), educational signs installed (no.) & brochure copies distributed (no.)	$18,000	PCWEA, HACC, CBF, NFWF, Lower Paxton Township	I, +
Friendship Community Center (DT)	Retrofit Dry pond bioretention	Improve water quality, reduce stormwater RO, decrease erosion, provide education & awareness	Convert dry detention ponds to bioretention areas with under-drains, install education signage & make brochure	Bioretention (ac, no.), reduced pollutant load (mg/L), educational signs installed (no.) & brochure copies distributed (no.)	$20,000	PCWEA, Skelly & Loy, Lower Paxton Township, NFWF, CBF	1, +
Linglestown Schools (LT)	Rain Garden Stormwtaer bioretention	Improve water quality, reduce stormwater RO, decrease erosion, provide education & awareness	Install rain garden to treat parking area runoff, invite pupil participation in design, install education signage & make brochure	Bioretention (ac, no.), reduced pollutant load (mg/L), pupil participants (no.), educational signs installed (no.) & brochure copies distributed (no.)	$10,000	PCWEA, Skelly & Loy, NFWF, CBF, Central Dauphin School District	1, +

Note: CBF, Chesapeake Bay Foundation; +, RCP launch project; RO, runoff; NFWF, National Fish and Wildlife Foundation; PCWEA, Paxton Creek Watershed and Education Association; subwatersheds – PC, Paxton Creek; DT, Devonshire Tributary; LT, Linglestown Tributary; PCN, Paxton Creek North; HACC, Harrisburg Area Community College.

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Egret in Wildwood Lake

Glossary

Terms, Abbreviations and Acronyms

ac, Acre	Land area measure (43,560 sq ft);size similar to football field
Acre-Feet (ac-ft)	Water volume of an area: acre with a water depth of a foot
Aquifer	Part(s) of rock formation(s) saturated with groundwater
Base Flow	Portion of stream flow from groundwater
Benthic	Bottom terrain of water body (usually submerged)
BMP, Best Management Practice	Method, measure, or approach to accomplish objective with minimal undesirable effects or outcomes
Brown Field	Area of polluted soils with potential for cleanup and reuse
BSD	Better site design with most approaches similar to Low Impact Development (LID)
Buffer	Vegetative protective strip along stream bank
cfs	Cubic feet per second rate measure for flowing water
CVI	Canaan Valley Institute, principal PCWEA partner
CWA	Clean Water Act
CWP	Center for Watershed Protection
Confluence	Junction of streams making a larger one
Conservation Easement	Technique of resource protection through deed restrictions on land uses
Daylight	Expose creek reaches by removal of pipes and overburden
DCCD	Dauphin County Conservation District
DCNR	PA Department of Conservation and Natural Resources
DEP	PA Department of Environmental Protection
Detention Pond	Area for holding stormwater for a short time before release
Discharge	Water released, or flowing by a given point
DO	Oxygen dissolved in a fluid (usually water) often as ppm
Ecosystem	Living organisms interacting with their environment
Erosion	Wearing away of materials by a fluid (water, wind or other)
Exotic Species	Foreign organism(s) occupying habitat of native species
Flood Plain	Land adjacent to waterways which receives waters flowing over creek banks during and following severe storms
FGM, Fluvial	Scientific management of streams involving physical geomorphology relationships among flows, geology, soils and other factors
Flay Back	Cut, grade, and shape landform
ft, Foot	Measure of length (12 inches or 30.5 centimeters)
GIS	Acronym for geographical information system, a digital data mapping technique
Habitat	Suitable environment for plant and animal communities
HACC	Harrisburg Area Community College
HOA	Home owners association
Hydrology	Study of water effects on ground surface, soils, and air
IC	Impervious cover/surface; does not allow passage of water
Impaired Stream	Degraded water body that is unable to meet its designated uses and associated water quality standards
Infiltration	Soaking (percolation) of water into soils
kg, Kilogram	Unit of weight (mass) equivalent to 2.2 pounds
Load	Measure of materials (example: kg/ac/yr) carried by a stream
mgd, Million Gallons per Day	Quantitative measure of water demand or use
MS4	Municipal Separate Storm Sewer System for managing stormwater, and reducing nonpoint source pollution

Glossary

NFWF	National Fish and Wildlife Foundation
NPDES	National Pollution Discharge Elimination System; acronym for program requiring pollution monitoring and reporting
NPS, Nonpoint Source Pollution	Pollution from undefined places across the landscape, called nonpoint sources (as compared to pollution from distinct places such as landfills or the ends of pipes)
O&M	Operation and maintenance
PA	Pennsylvania
ppm, mg/L	Reporting measures for substances in a fluid (water, air); termed parts per million, or equivalent to milligrams per liter
RCP	Rivers Concentration Plan for Paxton Creek
Recharge	Replenishment of groundwater in aquifers through infiltration
Retrofit	Modification of stormwater management system or facility that improves water flow and/or quality
Riparian	Pertaining to anything in, or adjacent to bodies of water
ROW	Right of way corridor for roads and utility lines (power, gas)
Runoff	Stormwater flowing atop and not soaking into the landscape
Sediment	Soil, sand and minerals washed from the land
Sheet Flow	Broad, shallow water movement across the land surface, before reaching stream channels
sq, Square	Quantity or measure of an entity multiplied by itself
SRBC	Susquehanna River Basin Commission
Swale	Landscape depression or a wide, very shallow ditch
TBD	To be determined
TDR, PDR, T/PDR	Transfer or purchase of development rights; technique of resource protection through land deed restrictions
TMDL	Total maximum daily load; allowable quantity of a pollutant released into a water body that will not affect adversely water quality as determined by a regulatory agency
USA, USSR	Acronyms for land use, habitat, and pollution assessment protocols of riparian (USA) and upland (USSR) areas
Watershed	Land area that drains to particular place or body of water
Wetland	Low lying area inundated with water enough for the area to have distinctive soil, water, and vegetation characteristics
yr, Year	Unit of time (usually 365 days)

Natural Area on Edge of City

Paxton Creek Watershed
Memorandum of Understanding

This Memorandum of Understanding is entered into by the Townships of Lower Paxton and Susquehanna, Penbrook Borough, City of Harrisburg, Dauphin County, and Paxton Creek Watershed and Education Association (the Participants) with respect to future planning, development, and watershed rehabilitation in Paxton Creek. The effective date of this Memorandum of Understanding is June 1, 2006.

Recital

Whereas, growth continues in Dauphin County and in particular in Paxton Creek watershed there is an increasing need to protect and improve water resources, open space, and wild creature habitat, while allowing desirable land development with resource conservation and enhancements as recreation, and economic redevelopment in appropriate locations–

Terms

With a shared goal of encouraging coordinated, comprehensive rehabilitative strategies in conjunction with desirable development in the watershed, the Participants agree to the following cooperative efforts:

1. To give early notice to the Participants about proposed developments affecting the watershed, and to encourage comments from, and participate in, the consultative and review processes for these projects and rehabilitative efforts.
2. To participate in quarterly meetings to share information and resources in developing watershed protection and enhancement strategies with particular attention to water quality, flood protection, stormwater management, habitat quality, resource conservation, and urban enhancement throughout the watershed.
3. To encourage the participation and submittal of combined grant applications as appropriate to funding organizations as well as regional, state, and federal agencies, and private sources for assistance in joint planning efforts and projects development. The Paxton Creek Watershed and Education Association will coordinate the respective efforts with the cooperation of the Participants.
    a. To incorporate appropriate mitigation and enhancement strategies and tactics for use within the watershed.
    b. To accomplish said endeavors without creating any additional regulatory requirements, or cause delays in development application processes. This Memorandum of Understanding is intended to begin formulation of watershed-wide resource conservation and enhancement which can be implemented voluntarily by the Participants.

Lower Paxton Township

Susquehanna Township

City of Harrisburg

Penbrook Borough

County of Dauphin

Paxton Creek Watershed and Education Association

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