Executive Summary

The water system of any community is a key concern of its residents. People expect a safe and adequate water supply, options to swim and fish in the waterways, and of course protection from floods. The residents of the Pennypack Creek Watershed of southeastern Pennsylvania have similar expectations. However, they have been exposed to a number of critical issues related to their watershed, caused by natural and man-made reasons.

The Pennypack Creek Watershed covers 56 square miles of twelve municipalities and includes a population of more than 300,000 people (2000 Census). Over the past thirty years, the watershed has undergone considerable development and suburbanization. This has led to a number of problems, including increased incidence of flooding and ecological degradation. The key issues identified in this watershed are unplanned land development, poor stormwater management, impaired water quality, and outdated floodplain maps.

The purpose of the *Pennypack Creek Watershed Study* was to initiate a comprehensive study focusing on these key issues. The study was undertaken by a multi-disciplinary research team of the Center for Sustainable Communities (CSC) of Temple University. The study consisted of the following major components:

- hydrologic modeling to determine new floodplain boundaries;
- geographic information system (GIS) mapping and data inventory creation;
- water quality studies;
- evaluation of existing stormwater facilities;
- assessment of open space and corridor alternatives; and
- recommendations.

Hydrologic Modeling

One of the major focuses of this study was to update the existing Flood Insurance Rate Maps (FIRMs) by delineation of new floodplain boundaries that result from two hypothetical (design) storms: 100-year and 500-year storms. The existing FIRMs for the Pennypack Watershed were developed based on pre-1970 hydrologic conditions and coarse contour data. New maps have taken advantage of more accurate data and improved technologies for identifying flood hazards.

The Pennypack Watershed was divided into ten sub-basins. The hydrologic model was calibrated to twelve historic storms that occurred over the watershed area. In comparison with prior studies, new floodplains emerged due to improved modeling and the high accuracy of topography data used in this study. However, there was no systematic difference. In other words, the extent of the new floodplains was not always larger or smaller than prior studies; it is worth mentioning, however, that the difference was sometimes as large as 400 feet. Overall, the study delineates 3.4 square miles of 100-year floodplain areas, compared to 2.74 square miles in the existing maps.

Floodplain Mapping and GIS Data Inventory

The CSC created a GIS data inventory that helped assess the watershed and delineate new floodplains. It also allowed computational analyses and selection of building footprints inside the floodplains. These data sets were later used to create new floodplain maps for the municipalities throughout the watershed.

The key focus of the GIS-based data inventory was to create 2 ft resolution elevation data, including Digital Elevation Model (DEM), Triangulated Irregular Network (TIN), and contour intervals. Other data sets include 2003 digital ortho-photographs (1 ft pixel resolution), updated stream network, flow-paths, bridges and culverts, dams, and building foot prints. The CSC has collected and edited a number of GIS data layers from different sources which include political and hydrologic boundaries, soil, geology, land cover, streets, transportation facilities, parcels, land use, trails, and parks and open space. The CSC has also converted a number of paper maps to GIS data layers, including the zoning maps. A complete list of data layers used in this project is included in Section 3.

Water Quality Studies

The goal of the water quality monitoring program was to examine the human impact on stream water quality and identify potential factors to mitigate some of these impacts in the Pennypack Watershed. This study did not attempt to measure the overall water quality of the Pennypack Creek. Instead, this program examined several problems on a small scale where human activity has the potential to alter water quality.

Observations from the small scale studies include:

- rapid rise in water level after storms shows the importance of overland flow;
- similarity in conductivity and nutrients at storm pipes and buffer zones also shows the importance of overland flow;
- temperatures were warmer in upstream ponds, but rapidly dissipated downstream;
- water downstream of the Upper Moreland – Hatboro Wastewater Treatment Plant had higher nitrate, conductivity, and temperature; and
- urban discharge had generally higher conductivity and more variability than the non-urban discharge monitored at the same site; the variability could not be predicted by land use patterns but was influenced by a combination of source terms and local hydrology.

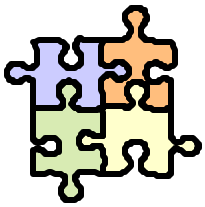
Stormwater Management

Based on a field assessment of the entire Pennypack Creek Watershed, the CSC research team evaluated the condition and functionality of existing stormwater facilities, assessed the potential for retrofitting such facilities so as to improve both their environmental and flood control performance, and sought locations for recommended new stormwater Best Management Practices (BMPs).

Opportunities that municipalities can take advantage of immediately are those which they can implement on publicly owned lands, such as municipal administration buildings and schools. Each municipality owns and/or manages sites that could be potentially "retrofitted" with some form of BMPs. The municipalities can also create stormwater management districts to provide a source of funding to retrofit sites on both public and private lands. The research team has identified priority sites within each sub-basin where BMPs can have a significant and cost-effective impact on controlling stormwater runoff.

Open Space and Corridor Alternatives

This study also has found that many of the municipalities within the watershed have initiated new open space plans or updated existing ones. While each municipality has taken a slightly different approach, it is encouraging to see that municipalities have conducted in-depth analyses of their open space inventory. However, it is likely that some but not all of the municipalities have looked outside of their boundaries in order to identify potential synergies and linkages. It is critical that municipalities look beyond their political jurisdiction in order to make recommendations for preservation of valuable open space linkages.



Recommendations

Based on the evaluations of the study components, the CSC research team has developed the following recommendations:

Floodplain Management – Each municipality in the watershed regulates development within the floodplain to varying degrees. It is imperative that these regulations be more rigorously enforced. The CSC recommends that once the new 100-year floodplain maps have been approved by FEMA, they should be enacted by the municipalities as their official floodplain

maps. The CSC also recommends that the municipalities consider updating their existing ordinances to enable them to more rigorously enforce the new floodplain boundaries.

Model Stormwater Management Ordinance –The communities within the watershed should adopt more progressive and rigorous stormwater management ordinances, and strive for consistency watershed-wide. The CSC has developed a draft model stormwater management ordinance that is consistent with the new stormwater regulations recently adopted by the City of Philadelphia on January 1st, 2006. These regulations were modeled after the ordinance developed through the Pennsylvania Act 167 Stormwater Management Planning process in Delaware County for the Darby and Cobbs Creek Watershed.

BMPs and Retrofit Priorities – The comprehensive control of stormwater runoff for the entire Pennypack Watershed can be achieved through stormwater management in each of its ten sub-basins. Retrofitting existing stormwater facilities as well as areas developed prior to the implementation of any stormwater management controls with BMPs is the key to reducing water quality and quantity problems within the Pennypack Watershed. The CSC researchers recommend that each municipality create a stormwater management utility to provide sufficient revenues to fund such retrofits. Furthermore, each municipality should concentrate initial resources on implementing retrofits at the priority sites within each sub-basin where BMPs can have a significant and cost-effective impact on controlling stormwater runoff.

Wastewater Treatment Plant Upgrades – The Upper Moreland-Hatboro Wastewater Treatment Plant discharges high concentrations of nutrients to Pennypack Creek. As noted in Section 4, observed nitrate concentrations range from 10 to 22 mg/L and phosphorus levels are also well above recommended limits. The research team recommends that the Upper Moreland-Hatboro Joint Sewer Authority conduct a feasibility study to evaluate possible upgrades to improve the plant's performance to significantly reduce nutrient levels in its effluent. Possible treatment options include biological removal (BNR) or chemical additives. Although the team's recommendations on new, improved, or preserved stormwater BMPs focus mainly on the goal of reducing peak discharge and/or runoff volumes, most, if not all, of the recommended practices would have significant beneficial impacts on water quality as well.

Open Space Planning and Preservation – The research team has developed recommendations for open space in the watershed. The team assessed a proposed trail configuration and made recommendations concerning its implementation. An unused railroad right-of-way owned by the South Eastern Pennsylvania Transportation Authority (SEPTA) appears to be the best choice for the location of the Pennypack Trail. The Montgomery County Planning Commission (MCPA) has included the Pennypack Trail and this right-of-way in its County Open Space Plan. Given its regional interest and extent, the MCPC, in consultation with the Bucks County Planning Commission, should initiate discussions with SEPTA and seek the resources necessary to implement the trail.