

Crum Creek Water Quality Restoration and Protection Projects
Growing Greener Program Final Report
10/20/2004

Project Name: Crum Creek Watershed Partnership: Water Quality Restoration and Protection Projects
Project Number: SE10402
ME # 351410
Watershed: Crum Creek

A. Technical Report

1. Narrative Description of the Project

This section answers the eight questions suggested in the DEP Final Report Guidelines.

a. What was the project supposed to accomplish?

Five goals were established by the Crum Creek Watershed Partnership for this initial round of implementation projects in the lower, urbanized areas of the watershed, based on the results of previously conducted assessment studies. Three projects were selected that contribute significantly towards accomplishing these goals. The general goals were:

1. Stream bank restoration on Little Crum Creek behind Ridley High School in Ridley Township, including a constructed wetland if site conditions allow.
2. Wetland restoration in Little Crum Creek Park in Swarthmore Borough
3. Storm Sewer labeling and public education pilot projects in Springfield and Nether Providence Townships in Delaware County.
4. Monitoring of project effectiveness by faculty and students of Swarthmore College.
5. Holding the Crum Creek 2003 conference at Swarthmore College and public education associated with the project

In addition to the general goals, specific project objectives were established:

1. riparian zone restoration on Little Crum Creek behind Ridley High School in Ridley Township (a) to reestablish the riparian buffer, (b) to achieve removal of pollutants from stormwater runoff originating on the high school property using a constructed wetland for first-flush treatment, and (c) to provide a demonstration site and field laboratory for Environmental Science classes at the high school;
2. wetland restoration on Little Crum Creek in Swarthmore Borough (a) to establish native wetland vegetation in a section of Little Crum Creek Park in Swarthmore Borough, which has been maintained for many years as a lawn in spite of the

- presence of a natural spring and frequent inundation, to reestablish this area as an effective riparian buffer, and (b) to provide educational opportunities for visitors to the park.
3. reduction of polluted runoff into storm sewers from residential neighborhoods in Nether Providence and Springfield Townships through storm sewer inlet labeling combined with an aggressive program to educate the public regarding ways to reduce contamination of runoff and eliminate the illicit disposal of toxic and hazardous household chemicals into storm sewers;
 4. monitoring the effectiveness of the projects by regular sampling and laboratory analysis of nutrients and metals;
 5. evaluation of the entire scope of each project to determine how well the projects accomplished their objectives, enumeration of lessons learned, and recommendations for future implementation projects undertaken by the Partnership.

b. What we actually did and how it differs from the plan

1. Ridley High School Stormwater Constructed Wetland Site: Assessment, Planning, Implementation, and Monitoring.

The project components at the Ridley High School site proceeded according to plan, with no significant differences from the original plan. Here is some background information on our motivation for the project. In the fall of 2001, Ridley School District opened a new high school building on a site just north of the previous site. Stormwater runoff from the new building, its parking lots, and sports playing fields was directed to an outfall that was originally designed for a much smaller building. The outfall discharged onto the flood plain of Little Crum Creek, but instead of flowing directly into the stream, the flow of stormwater diverged in the downstream direction from the original riprap bed, eroding a channel parallel to the creek in the riparian zone for approximately 30 yards before entering the creek underneath a footbridge. Thus, discharges into Little Crum Creek contained untreated nonpoint pollution from the building, parking lots, and playing fields plus additional sediment from erosion of the stream bank.

A ½ acre plot of land in the flood plain in the upstream direction from the stormwater outfall was chosen for a feasibility study for a stormwater treatment wetland. During the Spring of 2002, a wetland investigation was conducted by Schnabel Engineering Associates, Inc. by a wetland scientist (see detailed Technical Report #1) which determined that a small wetland existed on the stream bank down-gradient from the stormwater outfall and that a ½ acre plot of land without preexisting natural wetlands existed up-gradient from the outfall that would be suitable for a constructed wetland.

A riparian restoration plan was developed during the Summer of 2002, also by Schnabel Engineering Associates, Inc. (see detailed technical report #3), which developed specifications for a constructed wetland for capture and treatment of

the “first flush” nonpoint pollution from stormwater runoff from the high school’s buildings, parking lots, and athletic fields that drain into the outfall. The plan included specifications for three hydraulic zones: I – normally inundated, II – inundated during storm events, and III – not inundated. Plants were specified for each zone, drawing exclusively from native species suitable for each hydraulic condition. Hydraulic modifications were also specified requiring removal of soil and creation of a soil berm and a rip-rap outflow zone so that the stormwater first flush would flow into the constructed wetland for capture and treatment.

During the Summer of 2002, teachers from the Ridley High School Science Department worked with the Project Director and Swarthmore College staff Ecologist Elizabeth Svenson to develop a final list of plantings and to develop curriculum for Environmental Science classes at the high school to enable use of the site as an outdoor classroom. The summer salaries for the teachers were provided by matching funds from the College’s Howard Hughes Medical Institute (HHMI) supported high school science outreach program. Project lab manager Frank Dowman supervised Swarthmore College students who began the site monitoring phase of the project with baseline monitoring of the site and nearby reaches of Little Crum Creek. Summer salaries for some of the college students were also paid by matching funds from the HHMI program.

Implementation of the construction and installation plan began in September, 2002. Equipment and labor were donated by the Frank Construction Company, the contractor already working at the site on construction of the new high school, to remove the soil, create the berm, and install the riprap outflow section. Then, high school students and other volunteer labor worked to manually move soil to create the micro-topography as specified in the plan to create the three hydraulic zones. An initial set of plantings was accomplished by students in the Ridley High School Environmental Science classes, and photo monitoring zones were established.

During the Winter of 2002-03 plans were finalized for the remaining plantings and monitoring of the site continued. Orders were placed for the plants which were installed during the Spring of 2003. Monitoring by Swarthmore College students was conducted under the supervision of the Project Director during the Winter and Spring of 2003 (see Technical Report # 5). Final construction phase was completed during the Summer of 2003 with installation of the permanent photo monitoring stations. Also, maintenance activities were required to assist in establishing the plants and controlling weeds and the invasive Japanese knotweed which has infested nearby sections of the stream bank. The knotweed problem at this site is currently the subject of a scientific research study by Swarthmore College Ecology professor Jose-Luis Machado and his students, supported by funding from Swarthmore College, that is investigating the effectiveness of different control methods.

Monitoring and computer-simulated modeling of the site were conducted during the 2003-04 academic year by Swarthmore College students under the supervision of the Project Director (see Technical Reports # 6, # 7, and # 8). Ridley High School faculty continue to include exercises involving observation of the site in Environmental Science and Biology classes (see Technical Report #9).

A summary of the monitoring data is provided in Technical Report # 10. It provides an overview of the chemical, biological, and photo monitoring data and a guide to the attached CD-ROM which contains all data and photos from the project.

2. Swarthmore Borough Little Crum Creek Park Wetland Restoration Site: Assessment, Planning, Implementation, and Monitoring.

The project components at the Swarthmore Borough Little Crum Creek Park site proceeded according to plan, with only one significant difference from the original plan described below regarding removal of drain pipes. Here is some background information on our motivation for the project. The Borough of Swarthmore acquired the tract of land containing the site in the late 1960's in order to expand a public park (Little Crum Creek Park) on adjacent property already owned by the Borough. The site is bordered by the main branch of Little Crum Creek to the west. The elevation of the site is low compared to the surrounding land, and residents of the area have noticed frequent inundation of this section of the park during wet weather for very many years, in spite of efforts by the original owners and the Borough to drain the land and create a lawn. The site can also be inundated by overflow from Little Crum Creek as occurred during Hurricane Floyd in 1999. Portions of the site are wet during extended periods without rain because of a natural spring at the eastern edge of the site, about 50 yards from the stream bank. The drain pipes diverted the flow from the spring and from storm runoff directly into Little Crum Creek, thus minimizing the possibility of buffering and pollutant removal.

These observations by Partnership members led to an exploratory visit by a team of water quality experts in February, 2001 when it was suggested that the site was probably a natural wetland that could not function properly because of the attempts to drain it. One of the first tasks of the Growing Greener project was to set up monitoring wells at the site and to perform a wetland delineation. This was accomplished by wetland scientists from Schnabel Engineering in March 2002 and the boundaries of a natural wetland were established as a crescent-shaped area extending across the entire length of the site, from the spring on the eastern edge to the stream bank on the western edge (see detailed Technical Report #2).

A wetland restoration plan was developed during the Summer of 2002, also by Schnabel Engineering Associates, Inc. (see detailed technical report #4), which developed specifications for the installation of native wetland plants. The plan included specifications for four ecological zones in the delineated wetland and in

the surrounding upland areas: sedge meadow, fern meadow, open shrubland and wet forest. Plants were specified for each zone, drawing exclusively from native species suitable for a variety of soil moisture and tree canopy conditions (see detailed Technical Report #4).

Uncertainties regarding the location and condition of the drain pipes made it difficult to determine how soil moisture conditions would change if the drain were to be blocked or removed. Thus, some adjustments to the original plan were required based on observations made at the site after a section of the pipe was located and removed in September, 2002. The location of the drain pipe was unknown for certain until a crew of student volunteers from Swarthmore College manually uncovered and removed about 50 feet of pipe. The effects of the hydraulic modification on groundwater levels and surface water ponding were observed during the fall of 2002. After the drain pipes were removed, standing water was observed on the surface at all times, usually around 500 square feet in size and sometimes much more, in the lowest elevations of the site near the stream bank.

During the fall and winter of 2002, final plans for plants and planting zones were made, and public meetings were held at Swarthmore Borough Hall to explain our plans to the community. Extra effort was made to involve residents of properties neighboring the site in the process. A large poster was made describing the plans and showing photos of many of the plants selected for planting, and it was put on display prominently in Borough Hall. Frequent updates were given by project staff at Swarthmore College to members of the Borough's Environmental Advisory Council (EAC) and contacts were made with a 5th grade teacher at Swarthmore-Rutledge School to involve students in the project. The EAC helped to recruit other volunteers from the community for the spring planting events.

The planting strategy included four vegetation zones: sedge meadow, fern meadow, open shrubland and wet forest. About 6300 native plants representing over 50 species were installed in the wetland. More than 100 volunteers participated in the planting events. 5th graders from Swarthmore-Rutledge School, high school students from Strath Haven, Ridley and Sun Valley High Schools, Swarthmore College students, and over 80 community members representing neighbors, Scout troops, the Swarthmore Garden Club, and the Scott Arboretum among other organizations.

The changes to the site brought about by the project are substantial and even dramatic. In the sunny zone just downslope from the spring, the groundwater table has risen to the surface resulting in continuous saturation and successful establishment of thousands of individual plants representing native wetland species. In the shaded zone, lower in elevation and closer to the stream bank, pools of standing water have become permanently established. These pools grow or contract in size depending on the amount of rain, but they have not dried up. Most of the trees planted in this zone are thriving, and many have pushed up out

of their protective planting tubes. Long term benefits expected to come from this project include improved stormwater management and better water quality in Little Crum Creek, creation of significant wildlife habitat, and establishment of a diverse collection of plants displaying color year-round.

3. Storm Sewer Inlet Labeling Projects in Springfield and Nether Providence Townships.

Nether Providence Township: Inlet Labeling Summary and Lessons Learned (by Gary Snyder, Chair, Nether Providence Environmental Advisory Committee)


The Township's Environmental Advisory Committee (EAC), with the support of the Commissioners and funding from PADEP, successfully completed labeling of all the Township's inlets. The effort involved mapping, preparing and labeling almost 700 inlets in this small suburban community. The effort also included a public relations campaign to advertise the labeling program and stormwater Best Management Practices (BMPs), in print and local cable television media.

The labeling program required significant preparation. Planning meetings and mapping the existing inlets took several months, much longer than anticipated. The mapping effort underscored the minimal understanding the Township had for their system and the importance to have accurate maps. Inlet preparation, much like mapping, was completed sporadically and as the Township staff was available. This resulted in a prolonged period before the actual labeling began.

The actual labeling was completed with the help of the local Boy Scout Troop 277 as part of a requirement for one of the Troop's Eagle Scouts. These "workers" with the assistance of EAC staff completed the actual labeling in the course of several weekends. Zones of labeling were identified for specific work groups. This organization allowed for a quicker completion. However, when the groups mobilized and started to label, it was evident that despite the Townships best efforts, the inlets were not correctly mapped. In fact there were almost twice as many inlets as previously mapped. This delayed some of the labeling as the crews required more supplies, particularly adhesive.

Nether Providence Storm Water Inlet Labeling Program

- Place "No Dumping" decals on 300 Township Inlets
- Increase residents awareness of storm water management
- Improve the surface water quality in the Township
- Promote a cleaner environment



Nether Providence Environmental Advisory Committee (EAC)
In association with
Wallingford Boy Scout Troop 277
With support from
Nether Providence Twp. PADEP

For more information call 610-566-4516

The labeling crews used two adhesive types, the caulking gun and the tube application. The caulking gun was found to be cumbersome and slow, despite having several caulking guns available. The tube application was easy and neat to apply, and could be used by more people.

The project was well received by the Commissioners and the public. The

project team arranged for articles to be placed in two local papers with wide circulation in the local community. In addition, PowerPoint slides were incorporated into the Townships local cable channel (see inserted graphic example). This was continuously shown for several weeks before and during the labeling episodes. This was useful in that the public was adequately informed of the work. Consequently, the Township did not receive one complaint during the labeling. In fact, several citizens contacted Township personal indicating their support for the labeling program.

In general, the program was a complete success. Originally, we had thought that only a fraction of the inlets could be labeled as part of this project, but because of the favorable prices that were negotiated and the successful volunteer effort, we believe that close to 100% of the storm sewer inlets were labeled with medallions. We would like to thank all those who assisted in the effort and the PADEP for financially supporting the program.

Springfield Township: Inlet Labeling Summary and Lessons Learned (by Paul Horna, Nether Providence Environmental Advisory Committee)

Springfield's Environmental Advisory Committee (EAC), with the support of the Commissioners and funding from PADEP, successfully completed labeling of storm sewer inlets in two township wards as part of this project. Plans are underway to label all of the inlets in the township, incorporating the lessons learned during this pilot project. Storm sewer labeling is important because labels serve as a constant reminder that water quality is affected by the waste disposal practices of the residents. The labeling project also provides an excellent opportunity to educate the community about watershed stewardship, including proper disposal of liquid and hazardous wastes. Effective public education creates compliance with dumping regulations and minimizes the need for enforcement by police.

Our initial attempts at storm sewer labeling involved spray paint applied with stencils. This method was unsatisfactory for several reasons, including complaints by residents who thought the labels were unsightly and who sometimes mistook the volunteers for vandals involved in graffiti. Medallions were chosen for the project because of their more professional and attractive appearance and because they do not easily deteriorate. Several additional lessons were learned through our experience. Safety of the volunteers applying the medallions is crucial, so proper supervision and reflective orange safety vests should be provided. Application of the adhesive and proper attachment of the medallion to the curb surface requires significant strength, so volunteers should be at least 14 years of age and physically fit. Also, proper curing of the adhesive requires that the temperature be above 65 degrees F for several hours after application, so winter application is usually not possible, and during the early spring or late autumn, application should be done in the late morning so that sufficient time is available in the warmer part of the day to allow proper curing. Vandalism was a problem after one application session when the medallions were removed the same day they were installed before the adhesive

had time to cure. Whenever possible, application events should be scheduled to avoid vulnerability to vandalism during the period of adhesive curing.

We estimate that approximately 20% of the storm sewer inlets in the township are not suitable for medallion application because there is no curb available in the proximity of the drain to attach a medallion. In such cases, a stenciling program may have to be adopted in spite of the problems noted previously. Safety and liability concerns prevented application of curb medallions by our volunteer crews on sections of busy highways including Baltimore Pike and U.S. Route 1. Rather, members of our Environmental Advisory Committee are installing the remaining medallions in these locations.

Overall, the program was a quite successful. We would like to thank all those who assisted in the effort and the PADEP for financially supporting the program.

4. Crum Creek Conference

Two Crum Creek Conferences (March 2003 and March 2004) were held during the period of this grant on the campus of Swarthmore College. The first was supported, in part, with funds from the grant and the second was supported by matching funds. Public presentations on the projects supported by this grant were made at both conferences, and field trips were organized so that conference participants could visit the sites. The 2003 conference was attended by about 75 persons, and the 2004 conference was attended by about 60 persons. Each year, about 20 persons attended the field trips to the project sites. The powerpoint presentations made at the conferences on these projects are included on the accompanying compact disk. The proceedings of these conferences, showing all of the presentations made, are also included on the CDROM.

c. What were the successes and reasons for the successes?

The descriptions above of the different components of the projects demonstrate many successful aspects of these projects including reduction of nonpoint pollution from urban stormwater, partnership building, public education, and accumulation of experience in watershed management through coordination of the efforts of professionals and volunteers. The projects were successful because of the efforts of many individuals who contributed much time and thoughtful consideration to the jobs of site selection, planning, site evaluation, design, coordination of volunteers, monitoring of performance, and maintenance and because sufficient funds and in-kind services were provided by the funding agencies and supporting institutions.

d. What problems were encountered and how we dealt with them

The descriptions above provide details on many of the problems that were encountered and how we dealt with them. Perhaps the most difficult problems to handle were those associated with the uncertainties associated with predicting the effects of the hydraulic modifications at both sites. It was necessary for us to select plants before the modifications were made based on predictions of what the hydraulic

conditions would be after modification. Fortunately, our monitoring program has confirmed that at both wetland sites, the supply of water has been sufficient to maintain healthy growth of emergent wetland plants in submerged areas but not too great that plants in the upland zone have been drowned by excessive submersion. One key to this success was to design transition zones at both sites in which plants were chosen that can thrive in a wide range of hydraulic conditions.

e. How our work contributed to solution of original problems

The descriptions above provide details of the specific problems relating to urban runoff nonpoint pollution that were addressed by these projects and how they were solved. Of course, these projects represent only the beginning of the massive effort that will be necessary to solve the nonpoint pollution problems in the lower reaches of the Crum Creek Watershed. These projects serve as examples for future efforts. The experience gained by the Crum Creek Partnership through these projects will be applied in the future to develop additional projects.

f. What else needs to be done

At the Ridley High School site, future work should be directed towards the flow that remains along the stream bank to avoid bank erosion and undermining of the footbridge. Our wetland delineation revealed that a natural wetland is developing in this part of the riparian zone. Future efforts to enhance this wetland through plantings similar to those we made at the Swarthmore site would minimize the risks of future bank erosion. Such a project could be incorporated into the wetland curriculum that was established at Ridley High School as part of this project. At both wetland sites, ongoing maintenance will be required, especially to avoid infestation by invasive species such as Japanese Knotweed.

g. Plans for disseminating results of our work

Much has already been done to disseminate the results of our work through the public education components of the projects and through the two Crum Creek Conferences held at Swarthmore College. In addition, this report will be posted on the Crum Creek Watershed Partnership's website at <http://watershed.swarthmore.edu>. Over the years, these projects will be part of ongoing environmental education projects at Ridley High School and the Swarthmore-Rutledge School. Swarthmore College's programs in Environmental Studies and Engineering will continue to use these sites in field studies.

h. How well our spending aligned with our budget request

The total amounts required in each of the major budget categories aligned quite well with the actual spending. Some adjustments within minor budget categories were required, as documented in our progress reports and invoices.

2. Summary suitable for sharing with the public (50 words or less)

Three watershed protection and restoration projects have recently been completed that will help to improve water quality in the lower Crum Creek Watershed. The Crum Creek Watershed Partnership sponsored these Growing Greener projects, funded by the Pennsylvania Department of Environmental Protection, to reduce the harmful effects of polluted stormwater runoff. Wetlands were created and restored in Ridley Township and Swarthmore Borough to improve the quality of Little Crum Creek. The main branch of Crum Creek is being protected by storm sewer inlet labels and public education in Nether Providence and Springfield Townships. The projects were directed by Swarthmore College professor Art McGarity who was assisted by the Environmental Advisory Councils of all three municipalities and the science faculty of Ridley High School.

3. Accomplishment Worksheets – in Microsoft Word file on CDROM.

4. Photographs. These projects included extensive photo-monitoring. The CDROM contain many photographs in digital JPEG format. A guide to the photos on the CDROM is provided in section 3 of Technical Report #10. Many photos are provided at both the Ridley and Swarthmore sites, and at each site, photos are provided before the project, during the project, and after completion of the project. Here, we show one photo selected from each category.

4a. Ridley High School Site

1. Ridley Site Before Project



2. Ridley Site During Project:



3. Ridley Site After Project:



4b. Swarthmore Borough Site

1. Swarthmore Site Before Project



2. Swarthmore Site During Project



3. Swarthmore Site After Project



5. Detailed Technical Reports

The following detailed technical reports have been completed and are available from the Project Director. They are included in PDF format on the accompanying CDROM.

1. "Wetland Investigation Report: Little Crum Creek Riparian Restoration Ridley High School Site, Delaware County, Pennsylvania (Schnabel Reference 01151187), submitted by Jane Rowan, Schnabel Engineering Associates, Inc. July 16, 2002.
2. "Wetland Investigation Report: Little Crum Creek Riparian Restoration Swarthmore Site, Delaware County, Pennsylvania (Schnabel Reference 01151187), submitted by Jane Rowan, Schnabel Engineering Associates, Inc. July 16, 2002.
3. "Riparian Restoration Plan for Little Crum Creek at Ridley High School," submitted by Jane Rowan, Schnabel Engineering Associates, Inc. September, 2002.
4. "Riparian Restoration Plan for Little Crum Creek At Little Crum Creek Park Swarthmore Borough," submitted by Jane Rowan, Schnabel Engineering Associates, Inc. September, 2002.
5. "Ridley High School Constructed Wetland Monitoring Project," Swarthmore College Engineering Student Research Project Report by D.A. Neff, A.J. Phoun, D. Urban, May, 2003
6. "Advanced Stormwater Wetland Research Project Report," Swarthmore College Engineering Student Research Project Report by A.J. Phoun, February 4, 2004 (note: this student was awarded membership in the honorary Sigma Xi Scientific Research Society on the basis of this report.)
7. "Hydrological Modeling of the Constructed Wetlands at Ridley High School," by David K. Urban, Senior Engineering Design Project submitted to the Department of Engineering, Swarthmore College, as a requirement for the Bachelor of Science degree in Engineering, May, 2004.
8. "The Removal of Copper, Zinc, and Lead from Storm Runoff in a Constructed Wetland," by Mark Pouy, Honors Thesis submitted to the Department of Chemistry and Biochemistry, Swarthmore College as a requirement for the Bachelor of Arts degree with High Honors in Chemistry, May, 2004.
9. "Educational Resource Materials for the Ridley High School Constructed Wetland: Part 1 – Student Resource Book and Part 2 – Data Sheets," by Elaine Lennox, Barbara Clevensine, and Elizabeth Svenson, August, 2002..
10. "Summary of Chemical and Photo Monitoring Results: Wetland Restoration in Little Crum Creek Park, Swarthmore Borough and Stormwater Constructed Wetland at Ridley High School, Ridley Township," by Arthur E. McGarity, June 2004.

6. Operation, Maintenance, and Replacement Plans

The Ridley High School site will be maintained by the Ridley School District. The science faculty at the high school have developed curriculum that involves use of the site as an outdoor classroom. Thus, there is significant motivation to keep the site maintained and free of invasive plant species.

The Swarthmore Borough site will be maintained by volunteers from the Swarthmore Borough Environmental Advisory Council, which has been involved in the project from the beginning. This group has already organized regular work sessions in the restored wetland. In addition, the Borough's paid work crew regularly mows the perimeter of the wetland and the access path to the observation station on the edge of the wetland.

The storm sewer inlet labels in Nether Providence and Springfield Townships will be maintained by the township maintenance crews as part of their regular street and sewer maintenance duties.

B. Financial Report – Final Invoice - attached.