Rain Gardens for Water Quality Improvement in 3M Communities

Final report for 3M Corporation
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the 3M Corporation

The Partnership for the Delaware Estuary brings together people, businesses, and governments to restore and protect the Delaware River and Bay. We are the only organization that focuses on the entire environment affecting the river and bay — beginning at Trenton, including the greater Philadelphia metropolitan area, and ending in Cape May, New Jersey and Lewes, Delaware. We focus on science, encourage collaboration, and implement programs that help restore the natural vitality of the river and bay, benefiting the plants, wildlife, people, and businesses that rely on a healthy estuary.
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Introduction & Background

The Partnership for the Delaware Estuary (PDE) is one of 28 National Estuary Programs designated by Congress that exist throughout the coastal United States to enhance the health of estuaries. PDE’s mission is to lead science-based and collaborative efforts to improve the tidal Delaware River and Bay, which spans Delaware, New Jersey, and Pennsylvania. The PDE employs science-based efforts to prevent pollution, protect wetlands, and restore mussels and oysters while aiming to reconnect people to the water where they live, to foster care and support for the health of the entire estuary through festivals, workshops, and river cleanup activities.

Stormwater runoff is a growing concern in the Delaware Estuary. As open land is developed, the increase in impervious surfaces allow more stormwater to enter our waterways as ever before. Stormwater runoff carries pollutants from our streets, parking lots and roofs into our streams and rivers, and can contribute to erosion, degrading natural communities that help to buffer pollution and cleanse the water. In response, the PDE has been involved in habitat enhancement/outreach programs for many years, with the goal to engage local partners regarding the use of natural habitats to mitigate the undesirable circumstances of excess runoff in areas where opportunities are available. In 2016, PDE proposed this rain garden project with the 3M corporation to educate and involve their employees and the wider community in addressing concerns about stormwater run-off through the construction of a rain garden in each of three communities where 3M has facilities.

The initial locations targeted for rain garden installations in the grant submission for rain garden installation were unable to be realized for a variety of reasons, three new locations, still near 3M facilities, were selected:

A. Newark High School, Newark, DE
B. Talley Middle School, Wilmington, DE
C. Pottsgrove High School, Pottstown, PA

Each project directly involved teachers, students, and school administrators from each school as well as employees from the 3M offices in both rain garden creation and maintenance. These partnerships facilitated a sense of community ownership and investment in each project and created a connection between the local schools and the 3M corporation. Additionally, local schools offered superior demonstration and educational opportunities within the local communities.

The objective of this project was to create three rain gardens on school campuses with a high volume of impervious surfaces. These projects aimed to help citizens and communities shift their understanding and to treat water as a resource rather than a waste product. The rain gardens were strategically placed to intercept the maximum amount of polluted stormwater runoff reaching the local rivers as possible, thereby conserving water, reducing stream scouring, reducing landscape maintenance (time and money), and creating diverse habitats for birds and insects/pollinators. A secondary objective was to educate the students and public about polluted runoff, native plants, species diversity, and the positive effects of small landscape changes on our local water quality.

To accomplish these goals, PDE worked to create three rain gardens on public lands near school districts where 3M offices are located. Environmental Concern, a PDE partner on past rain garden projects, states:
"At the local watershed level, school footprints can represent a sizeable portion of land use. On average an elementary school takes up 5-10 acres, a middle school 20-30 acres and a high school 30-40 acres. Dominated by impervious surfaces, schools represent an opportunity to exact real and measurable watershed improvements with regard to decreasing storm water run-off and resulting non-point source pollution. However, the benefits of utilizing schoolyards extend much further. As outdoor classrooms they improve academic achievement. As aesthetic enhancements, they increase school pride and decrease vandalism. As demonstration projects, they create awareness and understanding throughout the community, leading to increased stewardship."

Installing these rain gardens in the Delaware River Watershed helped reduce the area of impervious surface and thus runoff from entering the Delaware Bay. Additionally, these installations enabled PDE to promote the benefits of rain gardens and the Rain Garden's for the Bay Campaign, as well as educate the public on how small changes to our land, like rain gardens, can protect and improve water resources. Educational signs were installed at each site to inform visitors about the purpose of a rain garden, how they function and to recognize 3M's support of the three projects.

The following report outlines how each rain garden project completed the various tasks outlined in our grant submission. Each section is divided into three sections, focusing on the site-specific needs of each school. The overall project goals are discussed at the end of the report.

Figure 1. Location of Newark high School

Figure 2. Aerial view of a portion of Newark High School. The red circle indicates approximate location of rain garden installation.
Task 1 & 2-Planning and Site Evaluation

Newark High School
Biology professor Robert McDowell was our point of contact for developing a rain garden in the Newark High School’s courtyard (Figures 1 & 2). The courtyard, under direction from Mr. McDowell, had already undergone some significant natural improvements, but specific areas were occasionally experiencing flooding during heavy storms due to runoff from the school’s roof. Upon evaluation, there was one area of the courtyard that seemed suitable for a rain garden that could mitigate some of these flooding issues. Following initial meetings, a 409 sqft rain garden project was approved by both the principal of the school and Mr. McDowell for implementation with the suggestion that students from the school’s environmental club would work on installation and site maintenance over the years. Due to the spatial constraints of the courtyard, equipment access was limited, and the owner of General Excavating visited the site prior to plan finalization to make sure the necessary work could be performed.

Talley Middle School
Bonnie Wilson, Science and Technology Education Teacher (STEM), was the primary point of contact for site selection at Talley Middle School (figure 3). One particular section of the school lawn was experiencing localized flooding sourced from a roof down spout after rain.

Figure 3. Location of Talley Middle School

Figure 4. Aerial view of Talley Middle School. The red circle indicates where the “demonstration garden” was planted. The yellow circle indicates where the secondary was planned to be placed, but not installed.
events. Due to initial concerns from administration a “demonstration garden” was suggested for initial implementation to test the ideas and tactics to be used in a “full” rain garden at a later time. The demonstration garden would be put in the school’s courtyard where visibility and access were highest (figure 4). Initial plans for a 607 sqft rain garden were developed in partnership with Ms. Wilson and the school principal, for the “demonstration garden.” Native plantings and an outflow using a rain barrel connected to one of the school’s downspouts were planned. After a one-year investigative period, the “full” garden would then be installed the following year. However, after the demonstration garden was installed the school deemed a second garden to be too great a time investment for Ms. Wilson and students. In the future, the second garden may be re-visited, but for this report the scope of the project remained on the “demonstration garden.”

Pottsgrove High School

Initial work with Montgomery County Conservation (MCCD) District to identify potential schools that had a need for a rain garden resulted in the selection of Pottsgrove High School (figure 5). Krista Scheirer of MCCD made initial contact and engaged with biology teacher Glenn Adams, maintenance director Jeffrey Caldwell, and school Principal William Zeigler to develop the rain garden plan. The school had multiple storm water issues, all of which were unfortunately unable to be addressed within the scope of this grant. However, there was a pre-existing rain garden in the front of the school that had been installed in order to attempt to mitigate some runoff from the building that was flooding an adjacent parking lot (figure 6). The garden had not been well maintained, and it was decided that completely redesigning the 680 sqft rain garden would provide the school with the most benefit.

Figure 5. Location of Pottsgrove High School

Figure 6. Aerial view of Pottsgrove High School. The red circle indicates where the rain retention garden was planted.
Task 3- Design & Plant Selection

Newark High School

The NHS design was a “classic” rain garden comprised of a mix of perennial flowers and a few shrubs. Due to periodic flooding of the area during rain events and other site conditions, facultative wetlands plants were deemed most appropriate for the site. To attempt to maintain saturated soil conditions, a trench from an existing downspout into the garden was excavated. Planting plan can be seen in figure 7.

Plant List:

- Highbush blueberry
- Serviceberry
- Button Bush
- Redtwig Dogwood
- Cardinal flower
- Joe-Pye Weed
- Blue-Flag Iris
- Swamp Milkweed
- Goldenrod
- White Turtlehead

Talley Middle School

The borders of the demonstration garden were defined by existing infrastructure and the surrounding picnic area was already allocated for occasional outdoor activities with the students. The garden site was not receiving water from outside sources at the time of design, so a rain barrel

Figure 7. Planting design layout for Newark High School. Inside rectangle represents the basic outline of the garden (409sqft). Each plant species is represented by a different color. The growth range of the plants is approximated by the size of the circles, which may extend outside the original confines of the garden, which was not a problem.
and sprinkler hose were used to create a wetter habitat appropriate for a rain garden. As there were already some trees planted in the area, the rain garden was primarily planted with herbaceous wetland plants. See garden planting plan in figure 8.

**Plant List:**
- Silky Dogwood
- Witch Hazel
- Prairie Dropseed
- Switch Grass
- Highbush Blueberry
- New York Aster
- Wild Bergamot
- Purple Coneflower
- Black-eyed Susan
- Swamp Milkweed
- Wild Pinks
- Coral Honeysuckle

**Pottsgrove High School**

The area under consideration for a rain garden was at the front of the school and had been poorly maintained. Water retention during storm events was common, which was causing some flooding and sedimentation issues in the adjacent parking lot. Krista and an engineer from MCCD performed soil testing and found it to be shallow with dense rock below the surface. This did not allow for guaranteed filtration of the garden within 24-48hrs after a rain event, as required by a classic rain garden definition. The plans were changed slightly to create a “rain retention garden” rather than a traditional rain garden, knowing that the site would hold water for longer than recommended. The site was large enough for a mix of wetland shrubs and herbaceous plants to be selected, see figure 9 for planting plan.
Plant List:
- Summersweet
- Redtwig Dogwood
- Winterberry Holly
- Sweetbay Magnolia
- Red Maple
- Inkberry Holly
- Swamp Milkweed
- Blue Flag Iris
- Soft Rush
- Obedient plant
- Monkey Flower
- Cardinal Flower

Task 4-Site Preparation

Newark High School

On May 21, 2016, existing topsoil and a drainage trench leading from a downspout to the garden were excavated. The downspout on the school was cut and a 6in rain conductor was attached and buried in the trench leading to the rain garden. General Excavating added 12 inches of screened topsoil and 6 inches of triple shredded mulch (figures 10).

Figure 9. Planting design layout for Pottsgrove High School. The black outline represents the basic shape of the garden (680sqft). Each plant species is represented by a different color. The growth range of the plants is approximated by the size of the circles.

Figure 10. Site excavation and preparation at Newark High School.
Tally Middle School

The top layer of sod was removed from the already established delineated garden and the soil was tilled. Six inches of mulch was added to the surface (figure 11).

Pottsgrove High School

Due to the previously mentioned water retention issues, we worked with Montgomery County Conservation District to help engineer a rain retention garden. A percolation test was performed, but the water did not drain within a timeframe suitable for a classic rain garden design (figure 12). To compensate for the extended surface water storage, additional engineering considerations were incorporated into the design, including spillways for overflow. The remnants of the old rain garden, and 8 inches of soil were removed from the area and replaced with ~9 cubic yards (CY) of soil (50% sand, 35% topsoil with minimal clay, 15% leaf compost) and 7 CY of triple shredded hardwood mulch. River rock was also placed along the overflows to slow down run-off during storms (figure 13).
Task 5-Planting

Newark High School

Initial planting at Newark High School occurred during late May 2016 and was completed during one planting event. Students from the NHS environmental club, their teacher Mr. McDowell, as well as Rob Romeo from 3M assisted with the planting (figures 14 & 15).

Talley Middle School
The Talley Middle School planting occurred and was completed on June 2, 2016. Students from the school’s green club and their teacher Ms. Wilson helped with planting, which consisted of primarily herbaceous plants, and the spreading of mulch (figures 16 & 17). They were also given cardinal flower seeds to try to grow over the summer to then plant in the garden the following year.

Figure 16. Planting at Talley Middle School

Figure 17. Preparing for planting at Talley Middle School
Pottsgrove High School

The planting at Pottsgrove High School was conducted in two phases due to weather constraints. The first planting occurred on November 16, 2016, and consisted only of woody shrubs due to the threat of frost (figures 18 & 19). The second, minor, planting of herbaceous plants was done simultaneously with the maintenance day on June 1, 2017. The school’s environmental club and biology teacher Mr. Adams assisted with both plantings. There was also continued help from Montgomery County Conservation District and the school maintenance department.

Figure 18. Planting at Pottsgrove High School.

Figure 19. Planting at Pottsgrove High School.
Task 6—

Education

All schools received instruction and education throughout the construction and planting processes. Appropriate materials describing rain gardens were distributed to all parties. Additionally, all participants received on site education related to the important work rain gardens can do to mitigate the impacts of runoff. Distributed materials, when available, focused on the local waterways surrounding the schools. The teachers at each school were also given access to the “Understanding the Urban Watershed” curriculum which provides resources and materials to facilitate discussions on watersheds and clean water.

Educational signs were developed with PDE Education and Outreach staff for each of the three gardens which were placed on site at each location (Figure 20). Each sign was tailored to the individual garden at each school, and provided general information about rain gardens and their benefits to the surrounding landscape.

Individual plant identification signs were also placed in the gardens to allow students and visitors to quickly identify the various plants and shrubs (Figure 21). This is helpful especially to anyone from the public who may wish to install their own rain gardens.

Task 7—Maintenance & Monitoring
Maintenance guides were developed for all three schools which provided basic information on rain garden maintenance (such as weeding, watering, mulching, etc.). The guide also provides information on how to create and manage a maintenance schedule, to ensure necessary tasks are being performed. Accountability is one of the biggest challenges that face rain gardens in the long term—“who is doing what task and when” often gets overlooked and turnover among school employees can lead to breaks in communication. The guide offers suggestions to help the team develop consistency regarding garden maintenance. A sample maintenance guide can be seen in Appendix A.

Newark High School

A maintenance day was conducted on Friday June 30, 2017, during which the educational sign was installed and weeding of the garden was conducted. At this time the school was provided with a rain barrel and bird house as well as a maintenance guide. Unfortunately, students were unable to assist with the maintenance on this day, but Rob Romeo from 3M participated (figure 22).

Talley Middle School

Maintenance of the rain garden occurred over three days; one during Fall of 2016 and two more in Fall of 2017. In 2016, general weeding was performed. Unfortunately, by 2017, an invasive vine, Japanese hops (figure 23), covered a large portion of the garden. The students, Ms. Wilson and PDE staff worked on it for 2 days to remove the vine and other weeds, and a third maintenance day was held to plant new plugs to hopefully keep the invasive vine from growing back. The new plugs included native bluestem golden rod, geraniums, and columbine. The education
signage and plant signs were also installed in Fall 2017. A rain barrel, bird house and sprinkler hose were also given to the school.

**Pottsgrove High School**

On June 1, 2017, some additional herbaceous plants and signage were installed at Pottsgrove High School, and general pruning and maintenance were conducted (figure 24 & 25). Students from the school’s environmental club assisted with the planting and maintenance activities. Additionally, on this date a bird house and maintenance guide were provide to the school.

Figure 24. Plantings during maintenance day at Pottsgrove High School

Figure 25. Pottsgrove High School volunteers on garden maintenance day.
Reaching Project Goals

In line with the completion of task 1-7 as outlined above, all project goals have been met, and success was measured in the following ways:

Installation:

- Three rain gardens have been installed/updated improving 1686 total square feet of natural space.

Community Engagement:

- The school and surrounding communities have been engaged and educated about rain gardens and storm water.
  - 3M employees were invited to several of the planting and maintenance days.
  - Students were involved with many aspects of the planting of maintaining of the gardens and opportunities were taken at every step of the process to engage and inform them in the importance of storm water management. Approximately 40 students participated in the garden installations and maintenance.
  - Three teachers were also involved, as well as administrators.

- The projects were promoted on social media to help broaden the reach. Three posts about the projects were made to PDE’s Facebook page. The posts received 15 likes and reached over 2000 people. Two additional posts were made to PDE’s Instagram page, garnering another 85 likes.

- The Pottsgrove High School garden was featured in a story in the local Newspaper, the Pottstown Mercury.

- There was engagement with the public for using green solutions to storm water challenges (social media, educational signs). However, there were no direct responses or inquiries regarding rain gardens directly from these activities.

Local Ecology

- Native plants were used throughout the gardens and bird houses were placed in all the gardens. Each garden has created a supply of food for birds, butterflies and other wildlife. The maintenance guide at each school highlighted the different wildlife attributes of each of the plants added to garden, see Appendix A for an example. During our maintenance days, the gardens were all seen to be in use by native insects, including butterflies.

Conclusions

Through the generous funding of the 3M Corporation, and work from PDE and associated school & municipal partners we were able to install rain gardens in three locations near 3M facilities. Each garden, as it matures, will make a significant impact in the managing and filtering of stormwater runoff at these locations. Our efforts have helped us reduce pollutants entering nearby waterways at all three locations. Through the process,
we have also engaged three separate communities and hopefully educated students, teachers, and the public about the importance of reducing runoff, and how rain gardens can help do this important work.