2017

Bloomfield Farm Rain-Garden Redesign

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An independent study project report by The Hay Honey Farm Endowed Natural Lands Intern (2016-2017)

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Abstract
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My project examines two of the rain gardens already present on Bloomfield Farm. Both gardens experienced significant plant loss when the landscape plugs were installed, and as a result there are an abundance of invasive plant species on the site. My intention is to redesign both gardens so that they function effectively at water collection and infiltration, and add aesthetic value to Bloomfield Farm. Both gardens will be installed in April, 2017 with a community of plants native to Eastern North America that will look beautiful four seasons of the year and provide important benefits to pollinator species.

Disciplines
Horticulture

Comments
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ABSTRACT:

Historically, stormwater has been treated as a liability in the built environment. But the installation of a rain garden allows homeowners and organizations to view stormwater as an asset. Water that would otherwise be funneled into a complex system of pipes and ultimately released into our local streams or rivers, instead slowly infiltrates the soil of the garden, where it either recharges the existing ground water supply, or is taken up by the established plant community.

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RESEARCH

Morris Arboretum is located within the Wissahickon Creek watershed. According to the Philadelphia Water Department, impervious pavement covers 26% of the Philadelphia portion of this watershed, a 1,751.50 acre area of land. This places the watershed in the 'non-supporting' stream health category, meaning that the land use leads to fair-to-poor water quality, poor channel stability, and increased sediment, bacteria and metals in the creek water. (1)

Many of these negative impacts come from an increased level of stormwater runoff. In the built community, stormwater is directed into pipes and drains, carrying with it pollutants picked up from roads, parking lots and other man-made structures. As the existing gray infrastructure ages, the risk of spills and cross contamination with sewer lines increases.

All of these factors create problems that can be expensive to solve. In 2011 the estimated cost to repair the aging stormwater infrastructure in the city of Philadelphia was 124.7 million dollars (2). However, there are alternate ways to manage stormwater on commercial, residential and public properties. Rain gardens, when installed correctly and established with a healthy population of native plants, can collect stormwater and allow it to slowly infiltrate into the ground water. The process of moving through the soil removes dissolved pollutants, and the water itself either recharges the ground water supply or is taken up by the plant community on the site (3). Rain gardens have the benefit of being flexible in terms of layout, though their design should keep the following key elements in mind.

The first consideration is size. The surface area of the rain garden determines how much water the site can accept. A rain garden will function most effectively if it is sized to be 15 - 20% of the area of impervious surface that drains into the garden (5). The rate of water infiltration on site is also important, as the goal is to allow water to slowly drain, rather than to remain ponded within the garden. Finally, in order to prevent the failure of the installed design, it is important to select and site plants that will demonstrate high rates of survivability within the landscape (4). Based on those requirements, I assessed each garden site on Bloomfield Farm to ensure that both locations were currently functioning as rain gardens, and made a number of site visits to generate a list of plants that would be able to compete effectively both with one another and with the invasive species found on the site.

SITE ASSESSMENT

Horticulture Center Rain Garden

The Horticulture Center Rain Garden is located immediately behind the Horticulture Center, in the H4 and H5 quadrants of the Bloomfield Farm property. The garden measures 72' long by 10' wide, resulting in an area of 710 sq. feet. The garden captures runoff from the roof of the Horticulture Center, which has an area of 3,551 square feet. As a result, the area of the rain garden is within the recommended 15-20% of the surface area of the roof.

I made observations in the garden following a rain event on 9/30/2016, during which we received 0.5 inches of rain. Some ponding was observed in the basin of the garden and around the base of the rain chains, but the water had drained within hours of the rain event. I performed a percolation test and site assessment on 10/21/2016 to determine the existing conditions and found drainage to be roughly 1.5 inches

per hour, which puts the rate above the 0.5 to 1 inch per hour recommended by the Ohio State University Extension (5). I found the soil on site to be somewhat compacted, with a high clay content. However, because the garden is toward the larger end of the size recommendation, and because the drainage is adequate, I concluded that soil amendment could be avoided.

I also spent time during the summer of 2016 removing invasive species on site. In particular *Microstegium vimineum* was hand weeded from the site, along with *Securigera varia* and *Artemisia vulgaris.*

Four Bay Rain Garden

The Four Bay Rain Garden is located immediately in front of the four bay garage, in the K4, K5 and J5 quadrants of the Bloomfield Farm property. The garden measures 104' long by 9' wide, resulting in an area of 936 square feet. The vegetated roof that drains into the garden has an area of 2,500 square feet. As a result, the garden is actually larger than the 15 – 20% of impervious surface area required.

I observed the Four Bay Garage Rain Garden following the 0.5 inch rain event on 9/30/16. I observed some ponding around the base of the rain chain, and underneath the *Ilex decidua* planted on the site. This ponding drained within a few hours of the rain event. I performed a percolation test and site assessment on 10/21/2016 to determine the existing conditions, and found the site to be draining at roughly 1.5 inches per hour. I found the soil to be similar to that found in the Horticulture Center Rain Garden, with perhaps slightly slower drainage. The soil demonstrated a high clay content. However, again since the garden is well sized and drained at an adequate rate, I believe we can avoid soil amendment on the site.

I also spent time removing invasive plant species during the summer of 2016. In particular, I cleared and mulched beneath the *Ilex decidua* and weeded vines of *Humulus japonicus.* This garden was mowed in December of 2016 to prepare the bed for winter and to remove woody volunteers.

Conclusions

Based on my assessment of the gardens, I concluded that both sites are currently functioning to filter stormwater. They do not need to be resized or relocated, as they conform to size and drainage parameters. However, the species represented in each garden can be improved upon to increase pollution uptake, pollinator benefit, and aesthetic value. See Fig 1 for a list of species currently found in each garden, along with details on nativity:

Fig 1.
Horticulture Center Rain Garden

Species Name	**Common Name**	**Nativity**	**Planted on Site**
Eutrochium purpureum	Joepye Weed	Native to Eastern U.S.	No
Phalaris arundinacea	Reed Canary Grass	Native to Eastern U.S.	No.
Microstegium vimineum	Stilt Grass	Invasive, Federal Class C. Noxious Weed	No.
Securigera varia	Crown Vetch	Non-Native Invasive	No.
Helianthus spp	Sunflower	Native to U.S.	No.
Artemisia vulgaris	Mugwort	Non-Native Invasive	No.

Iris versicolor	Blue Flag Iris	Native to U.S.	Yes
Aster spp.	Aster species	Native to U.S.	No
Lobelia cardinalis	Cardinal Flower	Native to U.S.	Yes
Solidago altissima	Tall Goldenrod	Native to U.S.	No.

Four Bay Garage Rain Garden

Species Name	**Common Name**	**Nativity**	**Planted on Site**
Alopecurus spp	Foxtail Grass	Non-Native Invasive	No
Phalaris arundinacea	Reed Canary Grass	Native to U.S.	No
Microstegium vimineum	Stilt Grass	Invasive, Federal Class C Noxious Weed	No
Solanum nigrum	Black Nightshade	Non-Native Invasive	No
Ageratina altissima	Snakeroot	Native to Eastern U.S.	No
Solidago graminifolia	Grassleaf Goldenrod	Native to Eastern U.S.	No.
Iris versicolor	Blue Flag Iris	Native to Eastern U.S.	Yes
Aster spp.	Aster species	Native to Eastern U.S.	No.
Humulus japonicus	Japanese Hops	Invasive, Federal Class C Noxious Weed	No.
Solidago altissima	Tall Goldenrod	Native to Eastern U.S.	No.
Verbena urticifolia	White Vervaine	Native to Eastern U.S.	No.
Apocynum cannabinum	Hemp Dogbane	Native to Eastern U.S.	No.
Rubus phoenicolasius	Wineberry	Invasive, Federal Class C. Noxious Weed	No.
Solanum carolinense	Horse nettle	Native to Eastern U.S.	No.
Daucus carota	Queen Anne's Lace	Invasive, Federal Class C. Noxious Weed	No.
Ampelopsis glandulosa	Porcelain Berry	Invasive, Federal Class C. Noxious Weed	No.
Ilex decidua	Possumhaw	Native to Eastern U.S.	Yes.
Panicum virgatum	Switchgrass	Native to Eastern U.S.	No.

Of the species currently present on both sites only the *Iris versicolor* in both gardens and *Ilex decidua* in the Four Bay garden were included in the original planting. The *Lobelia cardinalis* was intentionally added later and has persisted well on the site. However, three of the ten species present in the

Horticulture Center Rain Garden and seven of the eighteen species found in the Four Bay Garage Rain Garden are listed as invasive. As a result, my main goal is to increase the diversity and stability of the native plant population in both rain gardens.

SITE VISITS

In the interest of successfully installing attractive and stable gardens on both sites I visited a number of gardens in Pennsylvania, New Jersey, and Delaware in order to assess how each was planted and maintained. From each visit I extracted data that influenced my species choices and design.

Pleasant Run Nursery, New Jersey

This was a relatively new rain garden, installed not long before my visit with a mix of native and non-natives that the nursery had in stock and believed would do well on the site. Examples of plants used were *Ilex spp.* and *Hibiscus spp.* The maintenance plan for the site will be fairly minimal, and additional species will be added as the nursery grows plants that they would like to trial in a rain garden setting. The main corridor of the garden will direct water flow, and the installed stones will hopefully improve infiltration. This garden as not designed to be an aesthetic showcase, but rather to trial plants that can be recommended for use in a home rain garden.

North Creek Nursery, Pennsylvania

The rain gardens at North Creek Nursery were more complex than those found at Pleasant Run Nursery. There were a series of rain gardens that included drier locations, and one constructed wetland. The planting style in each location was dense, predominantly native, and layered to reduce labor input. The planned maintenance is minimal once the plants are established on the site. The density and layered nature of the planting is intended to keep down weed species and allow the site to more effectively filter water. Species observed on site included *Amsonia spp*, *Aster nova-angliae,* and a variety of grass species adapted to varying levels of soil moisture and sun exposure.

Stroud Water Research Center, Pennsylvania

Stroud had the most complex rain gardens that I visited. Their gardens were scaled to accommodate a larger influx of stormwater, an estimated 2 ¼ inches in a 24 to 48 hour period. Their gardens were also lined to prevent infiltration into the basements of their facilities, and all overflow from each garden was funneled into a pipe, which brought it down and away from the facility into a level spreader, where it was released evenly across either native meadow habitat or a riparian stream planting. The gardens near the center were densely planted with native plants, including *Schizachyrium scoparium, Panicum virgatum* and *Amsonia hubrichtii*. Limited weeding is done on site, and maintenance is restricted mainly to mowing. However, these three species all did well, and spread out to fill in more open areas. There was some minimal trouble with sediment deposition in some of the gardens that filtered water from the upper parking lot, but creating sediment retention areas and ultimately paving the upper lot resolved those issues. All twelve rain gardens at Stroud were installed in 2013, and the majority of the plant communities established on the site have persisted, with the exception of some shrub loss in the gardens exposed to high levels of silt.

Villanova University, Pennsylvania

Of the gardens visited, Villanova University had the most comprehensive research program based on their rain gardens, including some basic survivability studies, as well as studies that looked at the rain garden's efficacy in removing pollutants. Data on pollution removal has been on-going since 2003 and the test garden has demonstrated success at removing 94.5% of suspended solids, 85.7% dissolved solids, 85.1% total nitrogen and 49.5% of the total phosphorus. The garden has also shown high rates of heavy metal absorption, removing 80.4% total lead and 62.7% total chromium (6). This rain garden filters runoff from a large parking area, so the levels of these pollutants is likely higher on that site than in either of the rain gardens present on Bloomfield Farm. However, we can assume from this data that, with a similar planting style, site grading, soil composition, and maintenance plan, both of our rain gardens should demonstrate comparable levels of success. This hypothesis cannot be confirmed without testing our own runoff, but it provides us with a good rule of thumb for estimating potential pollution reduction on site.

Survivability studies have been on-going in a parking lot rain garden since the site's installation in 2001. Results showed that *Panicum virgatum* was able to withstand pressures from species such as mugwort and Canada thistle, both of which were present on the site and are also found in the rain gardens on Bloomfield Farm. As with the other gardens, maintenance on site is minimal and restricted predominantly to mowing.

University of Delaware, Delaware

The rain gardens at the University of Delaware need to be able to handle the highest sediment load of the gardens that I visited because they received runoff from an active farm. As a result they also need to successfully filter the highest levels of pollutants. They were installed in 2008 and planted with a mixture of native plugs, shrubs, and trees including *Iris versicolor, Lobelia cardinalis,* and *Panicum virgatum* all of which were surviving on the site. The maintenance plan included some basic invasive plant removal done by seasonal staff hired in the summer months, but the focus of that project was primarily on the wetland area and the removal of *Phragmites australis.* Maintenance on the rest of the garden is minimal. At this time no studies are being done to assess the amount of pollutants being filtered out on site.

DESIGN AND INSTALLATION

Following the completion of my site visits and site assessment, I compiled my design recommendations for both locations. All plantings recommended will be native to the Eastern United States, with the exception of *Amsonia hubrichtii* that has a slightly more western range, and *Cornus sanguinea* that is native to Northern Europe and Northwestern Asia. The recommended species are also deer resistant, suitable for placement in a rain garden setting, and sufficiently hardy and vigorous to contend with the pressures from invasive species on site. A low growing *Carex* species will be planted in each garden to help preserve the shrubs and edges against weed pressure.

The Four Bay Rain Garden will be planted with species more tolerant of dry soil and full sun. These species will include the eight *Cornus sanguinea*, and three *Ceanothus americanus* planted in groups throughout to create shrub masses. *Carex pensylvanica* will be installed beneath these shrubs in order to prevent opportunistic weed species from filling open soil. *Panicum virgatum* 'North Wind' will be planted along the back of the bed in order to create height in the garden. Drifts of *Schizachyrium scoparium* will be placed against the backdrop of *P. virgatum* for visual interest in the autumn, and *Amsonia hubrichtii* will also be planted in clumps, for the contrasting fall color and to create visual harmony with the parking lot rain gardens. Finally, *Pycnanthemum muticum* will be used to fill in areas toward the front of the garden site because of its ability to colonize rapidly, and its benefit to pollinator species.

The soil in the Horticulture Center Rain Garden has a higher moisture content than the Four Bay Rain Garden. Accordingly, this garden will be planted with species that can tolerate periods of inundation followed by dry conditions. There are populations of *Iris versicolor* and *Lobelia cardinalis* on site that have persisted from the original planting, so additional plants from each species will be added to increase species visibility. *Carex radiata* will be inter-planted with both *Iris* and *Lobelia* to suppress weed species as the plants are getting established, and to showcase the blooms. *C. radiata* was chosen for its ability to successfully colonize wetter areas. *Panicum virgatum* will be planted in drifts in the center portion of this garden to give the space height and provide cover for birds visiting the feeders hanging adjacent to the garden. *Amsonia hubrichtii* will also be planted in drifts for its fall color. *Carex muskingumensis* will be used against the backdrop of the *P. virgatum* to highlight the shape of *A. hubrichtii* and to help colonize the wetter portion of the garden. Finally, *Eupatorium coelestinum* will be planted for its attractive blooms and to provide benefit for pollinator species.

In both gardens the plants were chosen to blend with the existing landscape. The Four Bay Rain Garden will have a more cohesive drift style planting than the surrounding meadow, but will echo the appearance, color, and character of the established plant community. The Horticulture Center Rain Garden will be attractive when viewed from inside the office building and complement the backdrop of the established trees.

Both gardens will be installed in late April with the assistance of the horticulture volunteers. At the time of this submission I have sourced plants from Kurt Bluemel Inc, North Creek Nursery and Babikow. The budget for the design is between 2,500 and 3,000 dollars. Refer to Fig. 2 for planting lists:

Fig 2.

Four Bay Rain Garden

Scientific Name	**Common Name**
Cornus sanguinea (8)	Blood Twig Dogwood
Ceanothus americanus (3)	New Jersey Tea
Panicum virgatum 'Northwind'	Switch Grass
Schizachyrium scoparium	Little Blue Stem
Carex pensylvanica	Pennsylvania Sedge
Amsonia hubrichtii	Blue Star
Pycnanthemum muticum	Mountain Mint

Horticulture Center Rain Garden

Scientific Name	**Common Name**
Lobelia cardinalis	Cardinal Flower
Iris versicolor	Blue Flag Iris
Amsonia hubrichtii	Blue Star
Eupatorium coelestinum	Blue Mist Flower
Panicum virgatum 'Northwind'	Switch Grass
Carex muskingumensis	Palm Sedge
Carex radiata	Eastern Star Sedge

For a visual lay out of both gardens, see Fig 4, following the conclusion page.

MAINTENANCE

Both rain gardens will need a higher initial level of maintenance while they establish themselves on the site. During the first season of growth, supplemental water should be provided until the plants can develop the root mass needed to access ground water. Additionally some hand weeding will be necessary to remove weed species that colonize the area immediately following soil disturbance. Some spot application of herbicide may also be necessary, as invasive species regrow. In particular, the Horticulture Center Rain Garden has a colony of *Microstegium vimineum* running down the length of the garden facing the office windows. Portions of that population may be treated with selective herbicide, however care should be taken due to its proximity to desirable grass and sedge species. Where application is not possible, hand weeding may be needed. A regime of fall mowing for the Four Bay Garden and spring mowing for the Horticulture Center Garden should continue in order to suppress woody volunteer species on site. Refer to fig. 4 for a season by season maintenance plan

FIG. 3

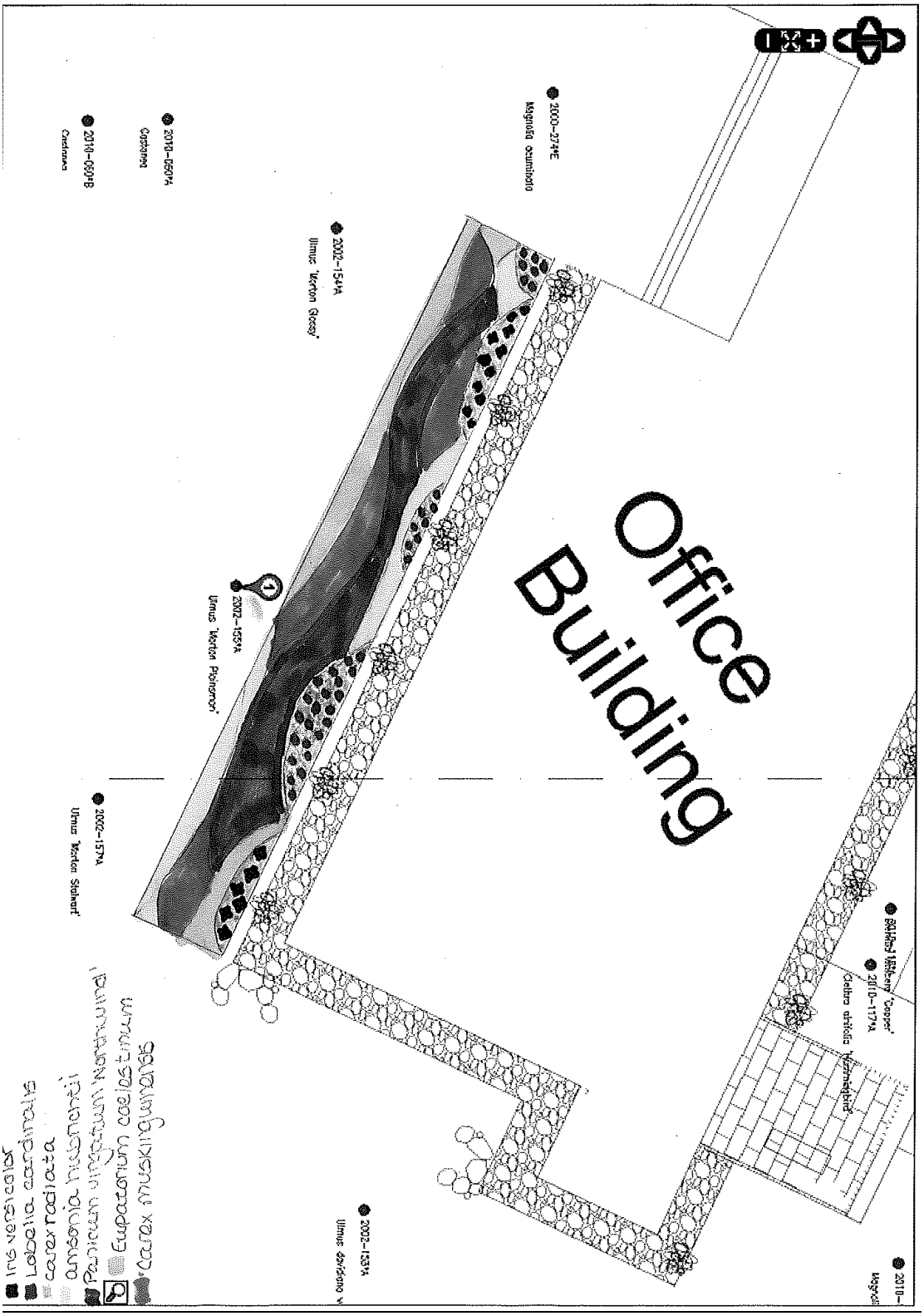
Season	**Maintenance Tasks**
Spring	*In first year provide supplemental watering* Monitor site for weeds and invasive plants and control using chemical or mechanical methods Remove duff from previous season leaf fall Hort Center Rain Garden – Cut and remove last season's growth
Summer	*In first year provide supplemental watering*

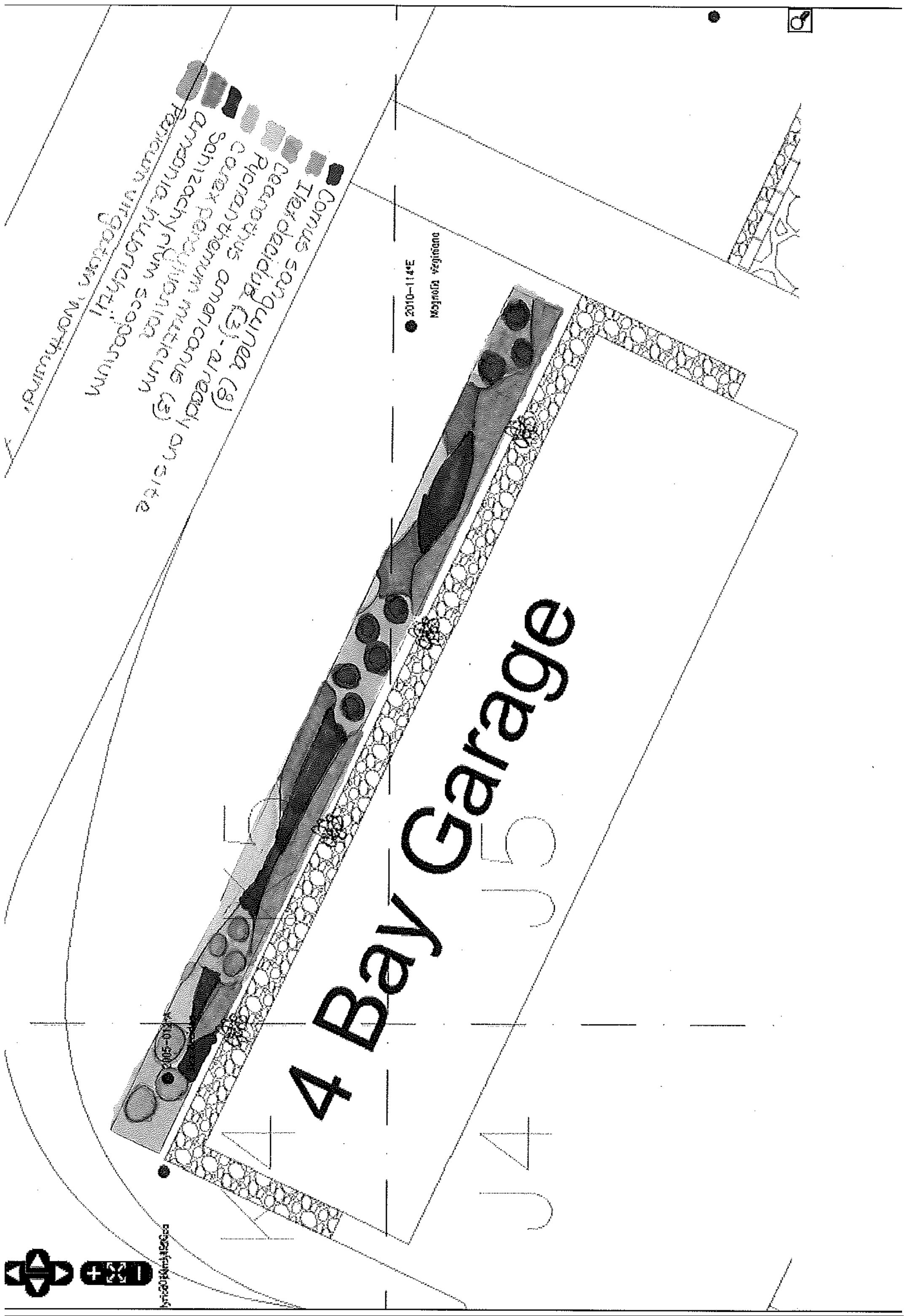
	Monitor site for weeds and invasive plants and control using chemical or mechanical methods Maintain fencing around new shrubs to provide protection against deer. String trim stilt grass to prevent seeding
Fall	*In first year provide supplemental watering* Monitor site for weeds and invasive plants and control using chemical or mechanical methods Four Bay Garage: Cut/Mow garden and rake out duff
Winter	Four Bay Garden: Check health of *C. sanguinea* and *C. americanus,* prune for health and structure, remove root suckers as needed. Hort Center Garden: Leave garden uncut to provide cover for birds and winter interest. Check for evidence of vole/groundhog nests and remove or fill in holes to prevent herbivory and plant loss.

CONCLUSION

Through assessments of both rain garden sites, as well as visits to other rain gardens in Pennsylvania, New Jersey, and Delaware, I have designed two gardens that should successfully collect rain water from feeder areas of impervious surface, allow that water to filter down into the soil and remove pollutants, and provide ecological benefits to the pollinator species present on Bloomfield Farm. Both rain gardens should be relatively low maintenance, and will continue to be functional for years to come. With further control, the populations of invasive species found in both gardens should decrease, and as the planted species stabilize additional flowering herbaceous plants can be installed to increase visual interest and pollinator benefit. Both Rain Gardens will complement the parking lot rain gardens redesigned by former Natural Lands Intern, Anna Bower, and increase the visibility of this important stormwater best management practice for the visiting public.

Fig 4: Horticulture Center Rain Garden




Panicum virgatum 'Northwind'
Amsonia hubrichtii
Schizachyrium scoparium
Carex pensylvanica
Pycnanthemum muticum (3)
Ceanothus americanus (3)
Cornus sanguinea (8)
4 Bay Garage
J4
J5

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