Abstract

Our current storm water management practices are inadequate in that flooding occurs easily, runoff carries chemical waste and debris to local bodies of water, and soils are now compacted and cannot absorb storm water. Designing with water by using a rain garden allows for better infiltration and cuts down on runoff and flooding as well as beautifying a natural habitat.

Bioswales are important for drainage and they help prevent erosion. Maryland began developing the idea of rain gardens for the Chesapeake Bay's pollution problem; the idea sought to reduce silt and pollution as well as incorporate natural habitats and absorbs 30% more runoff than a lawn. The native plants incorporated into a rain garden and or a bioswale should be planted at least 18 inches away from each other to provide a dense vegetative cover for better filtration and erosion control. Maintenance is only necessary for the first couple years and includes cutting the dead stalks down in spring, weeding, and removing any trash from runoff.

Introduction

A wetland can be described as an "inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" ("Wetlands delineation manual," 1987). The Litzsinger Road Ecology Center is focused on the education aspect of ecology. The site is equipped with woodland, prairies, a pond, a glade, a large rain garden, and a creek. In order to further the Gateway Foundation's attitude toward ecological education, a learning wetland area should be incorporated. Currently the site that was once Bob's house has somewhat of a draining problem and also allows water from the street to runoff onto the grass. Pooling water forms after rain where the drain lets out underneath the gravel road.

Research was conducted to learn more about rain gardens and bioswales as wetlands. Researching the plants, infiltration, soil type, as well as storm water management was done to get a better understanding of the system of a rain garden and a bioswale. More research was based on five main questions. They were: How might the rain garden/open wetland function in the type of soil on the site? Why would that be one of the best areas for a rain garden on the site? How would native species cope with excess water and the soil type? How might students and teachers use this area as a beneficial learning tool? Looking long term, how might erosion impact the creek bed, the swale, or the rain gardens?

Materials and Methods

To gather information about the soil type and suitability for a rain garden, a soil probe was used. First, the soil probe was pushed into the ground as far as possible. Then, the horizons are visually broken up into parts. Each is checked for roots, mottles, and mottles and their color through the Munsell soil color charts.

Then, each is determined to be a certain type. The soil type test is determined first by adding a small amount of water to the soil and rolling it into a ball and squeezing it, if it breaks apart it is sand. If the ball cannot be pushed into a ribbon, it is loamy sand. If the ball can be pushed into a ribbon, there are three categories to further classify it by: a weak ribbon less than 2.5 cm, a medium ribbon less than 2.5 cm, or greater than 5 cm long.

After this test, a small portion of soil is completely saturated with water and then felt for smoothness or sandiness. If it is in the first ribbon length category and feels gritty it is a sandy loam, if it is smooth it is silty loam, and if it is neither it is just a loam. If it is in the second ribbon length category and feels gritty it is a sandy clay loam, if it is smooth it is a silty clay loam, and if it is neither it is a clay loam. If it falls under the third ribbon length category and feels gritty it is sandy clay, if it feels smooth it is silty clay, and if it is neither it is just a clay soil.

Once the soil-boring test was complete, observation of the moisture holding capacity after a rain and during a dry period was done. A six-inch hole was dug and filled with water to see how long it would take to infiltrate the soil. This test was necessary in order to see if the water would be able to infiltrate fast enough or slow enough.

Using GPS, the areas of the rain gardens and the swale were determined as well. After importing the coordinates into Google Earth and measuring the site with a measuring wheel, a plan could be scaled and drawn out.

After looking at the Shaw Nature Reserve's issue of *Rain Gardening and Storm Water Management*, a plant list was developed for proper native plants that like water and have a variety of height, color, and interest. Research was conducted using the Missouri Botanical Plant Finder to figure out the blooming season, color, and height. Low Impact Development, The American Society of Landscape Architects, The Environmental Protection Agency, and The Army Corps of Engineers all had information on bioswales, rain gardens, or wetlands that was useful in research.

Data and Research

Today, storm sewers are common for storm water management (USDA, 2007). The EPA discusses the problem with our system of water drainage: runoff from roads, roofs, lawns, and gardens creates a pollution problem in the drainage networks by bringing the fertilizer, pesticides, waste, and debris to the water (Soil and Water, 2006). About 70% of pollution in bodies of water is caused by storm water runoff from roofs, parking lots, roads, and lawns. Soils that should be absorbing the water are now compacted or impervious (SNR and Grow Native). Research shows that water is running out and we must make a strong case to harvest rainwater to make sure the water returns to the ground without the bother of pollution (Dunnett, & Clayden, 2007).

Humans are drawn to water and using it in design brings people together (Dunnett, & Clayden, 2007). By using a water retention garden, or a rain garden, storm water can infiltrate the soil much quicker. Using Low Impact Development (LID), a natural site can be preserved through a steady water flow instead of periodic flood surges, as well as preventing runoff into storm sewers (USDA, 2007). The incorporation of bioswales and rain gardens can help solve the issue of flooding and heavy storm water runoff. They can be used for educational purposes, they can invite wildlife, and they can beautify an area (SNR and Grow Native).

A bioswale is a vegetated area that allows water to flow through it at a lower elevation than the rest of the ground. It is a channel for drainage. Two types of swales can be used, wet and dry. Wet swales allow "natural growth to reduce peak discharge" while the soil and plants filter the water. Dry swales are used to aid the runoff and flood water levels. The bioswale first filters the large particles from the runoff, and then the smaller particles. Major factors to the design of a bioswale are soil type, groundwater table, size, impervious surfaces around, and slope (Clark, & Acomb, 2008). When designing a bioswale, LID suggests using an existing swale for a natural water drainage path that requires less maintenance and prevents erosion (USDA, 2007). Bioswales need gravel or rocks to prevent fast storm water flow (SNR and Grow Native).

In 1990 Maryland began using rain gardens with the Chesapeake Bay's pollution problem. The idea for the rain garden developed from the usage of bioretention basins (Soil and Water, 2006). Rain gardens help reduce silt and pollution flow into bodies of water. Natural habitats for biodiversity are achieved with rain gardens (SNR and Grow Native). A study in Portland shows that short mown grasses retained 27% of runoff whereas forbs and native grasses retain 41%. Rain gardens absorb about 30% more runoff from storms than a lawn (Dunnett, & Clayden, 2007).

Rain gardens are created with a depression and a berm to keep the water stored and absorbed into the soil (City of Portland). The depth of a rain garden is 4-

8 inches. If it is too deep it will hold water too long, and if it is too shallow the rain garden needs more area to allow water to infiltrate the soil better (Rain Gardens, 2002). The first step to creating a rain garden is to map the area with topography and see how the water naturally flows in a storm. Knowing what plants are already growing around the area helps identify what will be there voluntarily. By understanding the previous site usage and the amount of rainfall, an analysis of the site can be achieved. A spillway is necessary for drainage to enter the creek. The soil type and impervious surfaces nearby can determine the size of the rain garden.

There are two types of rain gardens: natural and traditional. The natural style is a natural wetland with random plantings, groundcovers, boulders, and birdhouses with an equal ratio of grasses and sedges to forbs. The traditional style is a conventional massing approach, where the repetition of plants is used. Usually in the traditional style, there are more forbs than grasses, and texture and year round interest are important factors in choosing forbs (SNR and Grow Native).

The use of native plants is a filtration device that is naturally-occurring (USDA, 2007). Native plants prevent erosion and provide a natural habitat for animals (City of Portland). A dense covering of vegetation is best to filter the large parts in the water, and helps create biodiversity and prevents pollution (Clark, & Acomb, 2008). Planting forbs and grasses is much less time consuming than seeding, as it takes less time for plants to establish. Larger areas can be seeded in early winter, but can take 3-4 years to establish plants. In a traditional style of rain garden, large plants should be about 2-3 feet apart, while single species should be bunched together for a show of flowers. In the natural style, plants are about 1.5 feet away from each other. Watering plants should occur every 2-3 days to have healthy plants in 3-4 weeks. Fertilizing the garden is unnecessary, but using light compost in late fall or early winter helps the soil within the first season (SNR and Grow Native).

A rain garden will need to be maintained until the plants have been established; eliminating weeds, removing trash, repairing eroded areas, and

replacing plants that aren't doing well (CRWA Vegetated Swale). The dead stalks left over in the winter should be left standing. Then mowing the area in the springtime, or clipping the dead stalks in the spring allows new growth to begin (Rain Gardens, 2002). Mulching should only be done after storm season is over to prevent it from ending up in the creek. The only maintenance for a rain garden would be cutting back aggressive plants as well as weeding the garden. Maintained edges are important to set the garden apart from the rest of the area; this can be done using stones, grasses, shrubs, and mown grass (SNR and Grow Native).

Results

9701 Litzsinger Road was previously the site of the director's house. The site gets a lot of water drainage problems with runoff from Litzsinger road and the drain underneath the driveway. Water tends to pool near the drain outlet. Currently, a restoration plan is in the works to incorporate: a swale, a landscaped island, a wooded landscaped roadside, getting rid of invasive plant species on the stream banks, and restoring the former house site and driveway by planting more native species.

The pooling of the water can be solved with better drainage pathways and water infiltration sites. The incorporation of two smaller rain garden sites will enable water to be absorbed into the soil. The rain gardens will also act as a wetland habitat. It is necessary to dig the rain gardens down to a six-inch depth and leveled on the bottom. The dirt dug up can be used for a small berm to block water flow from the rain garden.

Another necessary part of drainage is the swale located on site. To allow better water flow, the swale should be widened to a foot and a half and turned into a bioswale. Heavy vegetation needs to be incorporated for better filtration and absorption. Seasonal interest through good fall color, and a variety of plants that bloom in different seasons is an important part of planting new plants. It must have a nice look year round to keep interest.

After soil boring the ground for soil testing, the soils located in the southern rain garden area include the A and B-horizons as silty clay and the lower portion was silty clay loam. The northern site included the A horizon and B-horizons as clay loam and the bottom portion as loam. The swale's soil included the A horizon as clay loam, the B-horizons as silty clay loam, and the bottom portion of silt loam. These soils are acceptable for water retention. Clay soils have some trouble absorbing water, but by enlarging the area, more water will be infiltrated.

The southern rain garden needs more filtering of water, as it is nearest to the driveway, and suggested to be all grasses, sedges, and rushes for better absorption and filtration. A berm will need to be in place to stop water from running over. For best planting practices, it is suggested to plant each at least 1.5 feet away from each other. The plants should fill in easily in between the plantings. The southern rain garden is located in the sun and will need some wet soil plants.

Suggested plants for the southern rain garden are Northern Creek Oats, *Chasmanthium latifolium;* Switch Grass, *Panicum virgatum*; Raven's Foot Sedge, *Carex crus-croui*; Emory's Sedge, *Carex emoryii;* Davis's Sedge, *Carex davisii;* Brown Bog Sedge, *Carex buxbaumii;* Frank's Sedge, *Carex frankii;* Meadow Sedge, *Carex granularis;* Bur Sedge, *Carex grayii;* Yellow-Fruited Sedge, *Carex annectens;* Fringed Sedge, *Carex crinita;* Crested Sedge, *Carex cristatella;* Palm Sedge, *Carex muskingsumensis;* Short's Sedge, *Carex shortiana;* Soft Rush, *Juncus effuses;* Heavy Sedge, *Carex gravida;* Squarrose Sedge, *Carex squarrosa;* Tussock Sedge, *Carex stricta;* and Fox Sedge, *Carex vulpinoidea.*

For the northern rain garden is suggested to only incorporate forbs about 1.5 feet apart to compare the filtration to the grass, sedge, and rush rain garden. Since the northern rain garden is partially shaded, some shade plants are necessary. Seasonal interest through the forbs is also important. There is also a need for plants that can tolerate moisture from the stored water. The runoff water within the rain garden will flow into the bioswale, so a berm is unnecessary.

Suggested forbs for the rain garden include Short Stemmed Iris, *Iris brevicaulis;* Smooth Phlox, *Phlox glaberrima;* Bluestar, *Amsonia tabernaemontana;* Prairie Milkweed, *Asclepias sullivantii;* Queen of the Prairie, *Filipendula rubra;* Copper Iris, *Iris fulva;* White Turtlehead, *Chelone glabra;* Rose Mallow, *Hibiscus lasiocarpus;* Monkey Flower, *Mimulus ringens;* Prairie Ironweed, *Vernonia fasciculate;* and Blue Lobelia, *Lobelia siphilitica.*

For the bioswale it is suggested to mix grasses, sedges, and rushes with forbs. For the bioswale, parts of it are under areas that will be shady once trees grow taller, and therefore need plants that can tolerate shade. The majority of the swale is in the sun and needs plants that can be in full sun for the majority of the day. As a large portion of the site, it is necessary for plants with seasonal interest to be planted.

Shining Bluestar, *Amsonia illustris;* Southern Blue Flag, *Iris virginica var. Shrevei;* Smooth Phlox, *Phlox glaberrima;* Meadow Phlox, *Phlox maculata;* Cardinal Flower, *Lobelia cardinalis;* Prairie Sundrops, *Oenthera pilosella;* White Turtlehead, *Chelone glabra;* Swamp Milkweed, *Asclepias incarnata;* Foxglove Beard Tongue, *Penstamon digitalis*; False Aster, *Boltonia asteroides;* False Dragonhead, *Physostegia virginiana;* Garden Phlox, *Phlox paniculata;* Rose Turtlehead, *Chelone obliqua;* New England Aster, *Aster novae-angliae;* Swamp Aster, *Aster puniceus;* Joe Pye Weed, *Eupatorium fistulosum;* Sneezeweed, *Helenium autumnale;* Swamp Goldenrod, *Solidago patula;* Northern Creek Oats, *Chasmanthium latifolium;* Switch Grass, *Panicum virgatum;* Raven's Foot Sedge, *Carex crus-croui;* Emory's Sedge, *Carex emoryi;* Frank's Sedge, *Carex frankii;* Meadow Sedge, *Carex granularis;* Bur Sedge, *Carex grayii;* Yellow-Fruited Sedge, *Carex annectens;* Fringed Sedge, *Carex crinita;* Crested Sedge, *Carex cristatella;* Palm Sedge, *Carex muskingsumensis;* Short's Sedge, *Carex shortiana;* Soft Rush, *Juncus effusus;* Heavy Sedge, *Carex gravida;* Squarrose Sedge, *Carex squarrosa;* Tussock Sedge, *Carex stricta;* and Fox Sedge, *Carex vulpinoidea* are plants suggested to be planted.

It is suggested that plants in the bioswale be planted in phases. Because the Bald Cypresses, *Taxodium distichum,* and the River Birches, *Betula nigra,* are still premature trees, planting full sun plants in those areas wouldn't be advised. Instead, shade plants such as Smooth Phlox, *Phlox glaberrima* and White Turtlehead, *Chelone glabra* should not be planted in the bioswale until the trees have been established.

Likewise, full sun plants such as Southern Blue Flag, *Iris virginica var. Shrevei;* Prairie Sundrops, *Oenthera piloselia;* Foxglove Beard Tongue, *Penstamon digitalis;* Garden Phlox, *Phlox paniculata;* New England Aster, *Aster novae-angliae;* Swamp Aster, *Aster puniceus;* Sneezeweed, *Helenium autumnale;* Swamp Goldenrod, *Solidago patula;* and Switch Grass, *Panicum virgatum* should not be planted near the trees so that once they are established they will not overshadow the full sun plants.

Planting and incorporating two rain gardens and a bioswale will help the visiting schools understand the importance of water retention and infiltration. Also by including two separate types of rain gardens, kids will be able to compare the water quality and the habitats within each of them. The drainage pathways on site will provide great learning opportunities for schools as well as give them an idea for their own homes and schools.

Conclusion

In conclusion, the site of 9701 is in need of a proper drainage network including two rain gardens and a bioswale. These drainage proposals are necessary to prevent harmful runoff chemicals and silt from entering Deer Creek. Rain gardens and bioswales also help prevent erosion with the use of native plants, which can also provide a filter for chemicals and particles. The southern rain garden will be made to filter out the particles by using only sedges, rushes, and grasses, while the northern rain garden will be only forbs to compare the filtration. The bioswale on site will be a mixture of grasses, sedges, rushes, and forbs. The rain gardens and bioswale will provide a great learning tool for the kids and teachers.

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