MULTI-USE RAIN GARDENS: BEST PRACTICE CASE STUDIES OF THE FINANCIALLY CHALLENGED AND CREATIVELY RICH

Sarah Betts[1]

INTRODUCTION

Multiuse trails have been a prominent feature of park lands for many years. Now, multiuse rain gardens may become a prominent feature of many parks. Rain gardens have traditionally been used for catchment, retention, and filtration of impervious surface storm water runoff. Why can't they be used for more? County park districts and other agencies across Ohio (and elsewhere) are being pushed more and more toward finding inexpensive creative multi-solutions to issues as a result of limited budgets. Rain Gardens, bio-swales, butterfly gardens, nature education, natural play, and natural habitat creation all go hand-in-hand… naturally.

KEYWORDS

nature education, wildlife monitoring, habitat creation and enhancement, wetland and prairie habitat creation, impervious surface water detention and filtration, rain barrel, roof runoff, catchment.

BACKGROUND

Oakwoods Nature Preserve currently consists of approximately 227 acres of woods, water, prairies, meadows, and farm ground located on the southwest edge of Findlay, Ohio. The Richard S. "Doc" Phillips Discovery Center was constructed at Oakwoods Nature Preserve and opened in 1994. It has and still serves as the primary building for Nature Education within the Hancock Park District.

For many years, there was limited parking by the Discovery Center building. Two parking spaces were available immediately outside with five more approximately twenty-five yards to the south. A larger parking lot was located within a two and a half minute brisk walk down a dimly-lit and often treacherous boardwalk, when the weather was bad. There was a need for additional parking closer to the main activity area.

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FIGURE 1: Current aerial view of Oakwoods Nature Preserve, located next to Interstate Highway I-75, just south of State Highway 15 interchange. Source: Hancock County Auditor, <http://hancock. iviewauditor.com>.

FIGURE 2: October 21, 2009, Shank Lake and the fishing deck can be seen beyond the two handicapped spaces by the building. Betts[1]

FIGURE 3: By November 17, 2009, tree removal from future site of the parking lot and bio-swales was complete. Betts[1]

FIGURE 4: Site preparations continued for single lane drive to be expanded to two-lane. November 17, 2009. Betts[1]

In the fall of 2009, staff began to clear out a view to Shank Lake, an abandoned quarry over seven surface acres on site, in preparation for the parking lot expansion. Park Manager, Joe Mosher, operated the heavy equipment to clear out the parking area and also remove trees and brush along the drive back to the building so it could be widened to a standard two-lane road width. Since limestone bedrock is close to the surface on this site, sometimes covered with 3" or less of soil, tree removal was fairly easy and accomplished quickly.

FIGURE 5: Bio-swales on March 4, 2010, indicated by the dark soil on either side of the stone lot, are visible and already retaining water from the melting snow. Betts[1]

FIGURE 6: Large bio-swale shallow depth visible with two to three inches of soil covering the limestone bedrock. March 16, 2010. Betts[1]

FIGURE 7: One overflow pipe partially visible behind tuft of grass. The second pipe located beyond farthest large tree at edge of lake, approximately thirty-five feet apart. March 13, 2010. Betts[1]

By the beginning of March 2010 much of the stone base for the parking lot was brought in and the bio-swales constructed adjacent to the long sides of the parking area. A mix of native wetland and mesic prairie species were used for seeding. Some seed was held back and started in the greenhouse to use for planting plugs in early summer with community volunteer groups. Overflow pipes were placed at the far ends of each bio-swale near the lake to help reduce the potential for considerable water flow across the parking lot (between bio-swales) once it was paved. This was a concern since there was a substantially sized pre-existing natural swale that traversed this area each spring.

FIGURE 8: August 11, 2011, approximately one and a half years after initial construction and seeding of bio-swales. The construction of the building addition can be seen in the background with grade material piled on original stone base. Betts[1]

FIGURES 9 & 10: By October 31, 2011, (Left) parking lot is paved and (Right) first surface water runoff fills bio-swales. Betts[1]

FIGURE 11: Blustery winter day at Oakwoods with a blanket of snow covering the site. January 12, 2015. Betts[1]

Site development continued with the expansion of the Discovery Center, open shelter with fireplace, new sidewalks, and landscaping around the building. Four areas became Rain Gardens, each in their own respect, with a large and small Bio-Swale, Butterfly Garden, and Wetland. In general terms, rain gardens are any natural or man-made depression that uses native water-tolerant plants to increase infiltration by allowing storm water and snowmelt to naturally seep into the ground. Two Bio-Swales were required due to the impervious asphalt parking lot installation and were incorporated into the site design to help drain surface water from the parking lot, drive, and parts of the building roof. The Butterfly Garden was incorporated into the planning process and designed primarily as a landscape island by the building and used for surface water runoff absorption from the sidewalks. The Wetland was a pre-existing railroad roundhouse that naturally worked well to catch storm water runoff from the back part of the building roof when it was constructed adjacent to the roundhouse in 1994. A Rain Barrel amenity was not included in the original engineered site plan, however, was added between building construction phases out of necessity. The remainder of this article will probe individualized aspects of each Rain Garden case study and their multi-use capabilities.

FIGURE 12: Current aerial photo of multi-use project areas, including two Bio-swales, Butterfly Garden, Wetland, and Rain Barrel. Photo courtesy Hancock County Auditor, <http://hancock.iviewauditor.com>.

This first case study investigation will be an in-depth look at multi-use rain garden capabilities that may also be similar to other case studies that follow. The information will not be repeated for each, but will be mentioned briefly in those subsequent areas of relevance.

CASE STUDY I: BIO-SWALES… AS RAIN GARDENS AND MORE!

FIGURE 13: Bio-swale 1 April 16, 2015, holding water during the spring rains with cattail growth over eight inches high and frogs already calling for a week. Betts[1]

Habitat Creation

The Northwest Ohio landscape is now crisscrossed with ditches, man-made canals, widened and straightened creeks with little vegetation, and millions of miles of underground tiles. The area was once filled with wooded vernal pools, vast swamps, and wetlands. If you glance through the Ohio Department of Natural Resources (ODNR) lists of rare, threatened, and endangered species, it is brutally obvious that our natural landscape has been greatly altered.

More people are living in arid parts of the country and using deep wells to attempt to live, farm, and manufacture in those areas that were once dry open plains and ranches. Impervious surfaces continue to sprawl across the landscape, reducing the ability to recharge underground aquifers. Many cities across the United States have already begun feeling the consequences of depleting these essential underground water resources.

Over the years, there have been many features that have been required of impervious surface construction such as detention ponds, ditches, and curb-to-storm water sewer infrastructure systems that may all have their place in certain circumstances. These systems were designed to collect high volumes of water being shed from surrounding parking lots, roof tops, and roads. A great many designs lack in aesthetics, multi-functionality, do not address water quality concerns, and end up being maintenance nightmares.

Water collection, detention, filtration, and infiltration are crucial concepts that should be included into all site plans. These concepts can be attractive features and focal points that

FIGURE 14: Bio-swale collecting water flow from inlet pipes, surface water from surrounding yards, and impervious surface runoff from neighborhood. Photo courtesy Cornell University, <http://climatechange.cornell.edu/re-plumbing-our-watersheds>.

are naturally multi-mutually beneficial… if they are designed, engineered, planted, and maintained with this directive in mind.

The primary purposes of a bio-swale consist of:

- surface water runoff collection from impermeable surfaces (whether from the direct flow of ground surface runoff over the edge of the bio-swale, tiled collection of surface runoff, or roof runoff)
- water detention
- water filtration (vegetation is required for filtration, cattails have proven to be one of the best)
- water infiltration (slow percolation of water back into the soil under and around the bio-swale)
- SLOW conveyance of excess water to an end location

Bio-swales are an excellent choice for multi-mutually beneficial projects that create attractive and functional environments. There are many terms floating around in the world of green construction that are not fully synonymous with the functions of a bio-swale, such as "ditch," "grass swale or grass waterway," and "filter strip."

FIGURE 15: Typical road-side ditch during a rain, where water is rushing over bare clay-lined bottom, side slopes are steep, and vegetation is maintained at a low levels. Photo courtesy Cornell University, <http://climatechange.cornell.edu/re-plumbing-our-watersheds>.

- Ditch – a trench used to quickly drain water (primarily from fields and roads) and convey it to another location.
  Drawbacks: transport velocity is generally extremely high and dangerous during storm events, transports high sediment loads and pollution to another location (often a natural river system), offers little to no detention, filtration, or infiltration.
- Grass swale / grass waterway – densely vegetated grassed waterways, usually shaped parabolicly, to quickly convey water to another location (usually a natural river system) without causing erosion, and reducing solids from water.

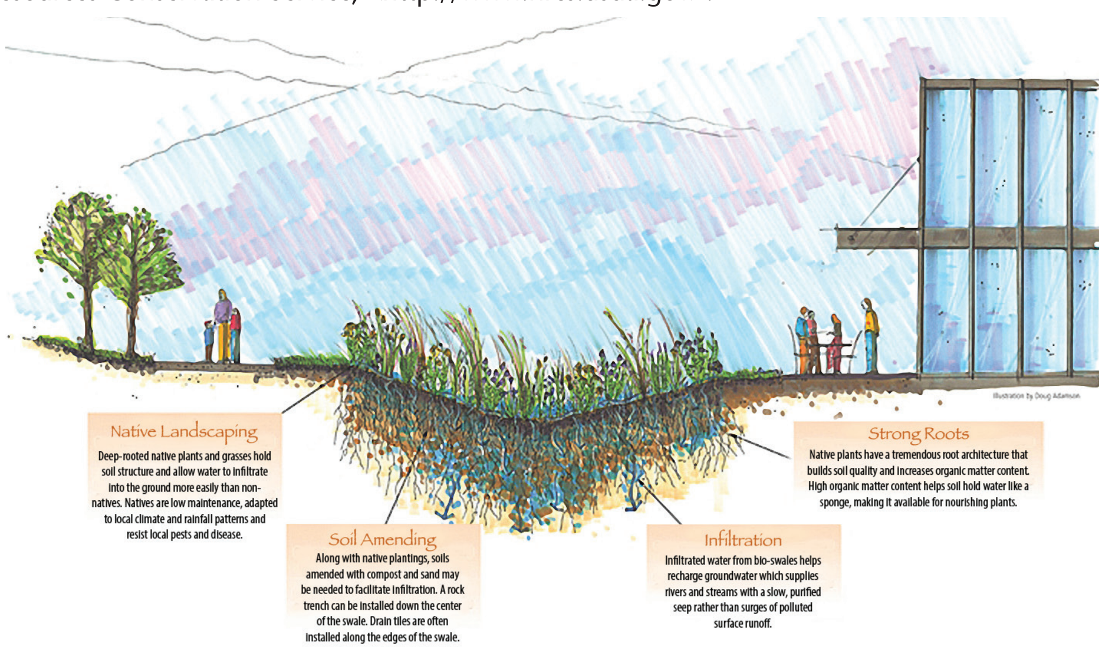
FIGURE 16: Grass waterway through farm field, following natural drainage pattern. Photo courtesy NRCS Wisconsin, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/wi/about/?cid=nrcs142p2_020778

Drawbacks: the dense vegetation required to reduce erosion is often too dense at the soil surface to allow for productive deep soil infiltration, does not function in steep locations, and (in the more frequent high volume storm events that are now occurring given the change in weather patterns) the water typically moves too quickly to allow filtration.

FIGURE 17: Grass filter strip planted along one edge of a stream. Photo courtesy USDA NRCS

- Filter strip – narrow strips of vegetated land (generally non-native grass planting) located on gently sloping areas before the sheeting surface flow of water reaches ditches or streams. They should allow for slow conveyance of water to allow and promote water filtration (through sedimentation) and infiltration.
  Drawbacks: strips are often designed too narrow, do not contain enough substantial vegetative structure to allow for deep soil infiltration (unless native plants are used), are placed in areas too steep to provide the intended benefits, and are not equipped to handle high volume storm events.

FIGURE 18: **BioSwale in a Corporate Setting:** Sketch of an inexpensive, natural-looking, functional bio-swale without extensive drainage system, gravel underlayment, organic soil pit, or mulch overlay. Illustration by Doug Adamson, RDG Planning & Design, provided by USDA-NRCS in Des Moines, Iowa. Image courtesy United States Department of Agriculture, Iowa Natural Resources Conservation Service, <http://www.nrcs.usda.gov>.



Even with the limited depth option of our bio-swales, they are fully functional. Minimal depth capacity for water collection was compensated by broadening the length and width dimensions of each bio-swale. The detention level is adjustable with movable-height overflow pipe openings. The longer water can be held, the greater the ability for filtration of water through sedimentation and plant uptake. As plants take up water, they also help purify the water by storing chemicals and pollutants and releasing clean water back into the environment through transpiration. Larger plants also offer greater amounts of carbon sequestering benefits. The infiltration process is made possible using more horizontal structure, and by having more perimeter feet of surface area accessible of highly permeable and absorptive organic soil zone found naturally on-site. Native plants add to infiltration ability by helping to break through dense and rocky soil to allow water to percolate more efficiently. Wider is better for bio-swales to function at their peak level, since greater depth often enters into impermeable soil horizons in this part of the state. Bio-swales with a wider and flatter bottom contour offer greater surface area per volume for more infiltration potential.

The habitat that has been created in the rain gardens (Bio-swales, Butterfly Garden, and Wetland) have also improved habitat elsewhere. I have worked with volunteers and other staff to collect seed from these plants to distribute in other parts of the bio-swales and for use in restoration projects on additional properties.

Our planned and managed bio-swales have created natural habitat for many species to use. We know because we also monitor these areas as part of an overall habitat inventory and monitoring approach to management of our natural areas that I began implementing in 2007. The primary types of monitoring include: birds, frog and toads, reptiles, and wildflowers.

FIGURE 19: Indigo Bunting commonly seen in most of the park areas. Photo taken at Springville Marsh during a spring bird banding session in 2014. Betts[1]

FIGURE 20: Birders watch a Cooper's hawk perch on tree by Discovery Center during a birding session on April 15, 2008. Betts[1]

Monitoring Birds

Being located in a direct migratory path (that leads to and from Lake Erie) offers the area a multitude of avian species to view from warblers to waterfowl and everything in between. Many residents have reported that they regularly record over one hundred fifty different species every year in northwest Ohio with little effort. The bio-swales easily fit into the monitoring process by providing food and water to attract birds to an easily viewable area. Our Bird Surveys are conducted year-round by Natural Resource Assistant, Bob Sams, and open to the public. In addition to our own permanent records, results have been posted regularly on e-bird <http://ebird.org> and in the *Ohio Breeding Bird Atlas II* that is slated to be published in April 2016.

FIGURE 21: Tadpoles blacken the bottom of the large bio-swale each spring. May 20, 2011. Betts[1]

Monitoring Frogs & Toads

Water instinctively attracts frogs and toads, as they are amphibians and need to return to water each spring to breed and lay eggs. Some frogs also remain in or around wet areas most of their lives to keep their skin moist, find food, and seek the protection that the water and surrounding vegetation offers. I began incorporating amphibian monitoring at Oakwoods in 2009 as part of the State Wide Frog and Toad Calling Survey.

Monitoring protocol consists of visiting a ten-site circuit within a township, once a month from March to June. Where, after dark, each site is visited and calls recorded on a digital recorder. Written documentation is also taken at each site as to species heard and density of each species on a zero, one, two, and three category scale, with three being considered a full chorus where there are too many individuals to give an actual count. Since the bio-swale additions, we have been able to record and view the amphibian population cycles and species with relative ease due to the gently tapering grade of the bio-swale edges.

FIGURE 22: Eastern garter snakes in this area are highly variable in color and often have muted stripes. This individual has "typical" yellow strips of the species and was found sunning itself April 5, 2008. Betts[1]

FIGURE 23: Four foot square plywood reptile research plot. Underneath, a shallow catacomb system can be seen. Tunnels may have been created by voles, but utilized by many different animal species, especially snakes that prey on rodents. August 31, 2015. Betts[1]

Monitoring Reptiles

Many reptilian species frequent the shallow bio-swale habitat that was created. David Ostreich, local resident and herpetological enthusiast, has been volunteering to monitor reptiles (and amphibians) for many years in several areas of the parks and added a site to the bio-swale after it was created. His monitoring methods utilize a four foot square piece of plywood or particle board that is placed on the ground to offer cover for reptiles (and other fauna). Each monitoring day, the board is flipped to one side to count and identify species underneath, then replaced for the next monitoring day.

FIGURE 24: A local high school environmental class assists with an early spring wildflower monitoring session on April 8, 2008. Betts[1]

FIGURE 25: Bug spray in tow, Graduate Intern Lauren Emsweller gets a close-up of some low growing summer wildflowers. August 8, 2013. Betts[1]

Monitoring Wildflowers

A nine to ten week window of opportunity unfolds on the floor of wooded areas every year in northwest Ohio, from around the third week in March to mid-May. Monitoring these sensitive plants gives us a general standardized health reading of our woodlots. Often called indicator species, if spring wildflower populations disappear, that indicates that something is wrong and can then be investigated to quickly determine the problem.

I began spring wildflower monitoring at Oakwoods in 2008. Public participation is encouraged for mature youth and adults only - toddlers and dogs have proven to have too short an attention span, are sometimes difficult to control (even with harnesses – yes, I'm referring to both), and don't seem to mind what they eat, step in, or leave behind (also referring to both). Participants help identify plant species and record growth and development of populations along trails through the woods. Both written and photographic records are taken of the plant development, however, photography of any species is fair game if seen. Fungus, lichens, birds, reptiles, amphibians, dragonflies, damselflies, butterflies, moths, spiders, and others dot our lists every year.

FIGURE 26: Spiders can be found in many interesting places, like in the embrace of flower petals. August 8, 2013. Betts[1]

Two items I found lacking in our records were documentation of the seed develop stages of many of the spring wildflowers and blooming periods of summer and fall flora whose foliage was visible during the spring, but often left without a name since most identification keys are based on the flower parts. Without flowers, it is much more difficult to identify plants in their early stages. To counter those issues, I established summer and fall flora monitoring. Many of the plants of the rain gardens are summer and fall blooming plants. Therefore, adding the bio-swales to the monitoring regime resulted with great success.

Self-Guided Nature Exploration

Exploring "wild" areas is enticing for many people of all ages. Stepping stones were placed in the larger bio-swale (Bio-swale 2) for people to explore the area anytime of the year without worry about getting their feet wet. However, we found that the public needs to be taught how to use these self-guided exploration zones. To encourage more interaction, a sign for the entrance of Bio-swale 2 was created. Ron Harvey of Harvey Advertising, a local advertising firm, took my sketches and information to not only create a sign for the bio-swale, but signs for the Butterfly Garden and Rain Barrel amenity as well (the latter two signs can be seen in their related sections of the article FIGURES 55 & 64 respectively).

FIGURE 27: A new perspective can re-awaken the soul. Frog level view of a stepping stone in Bio-swale 2. August 31, 2015. Betts[1]

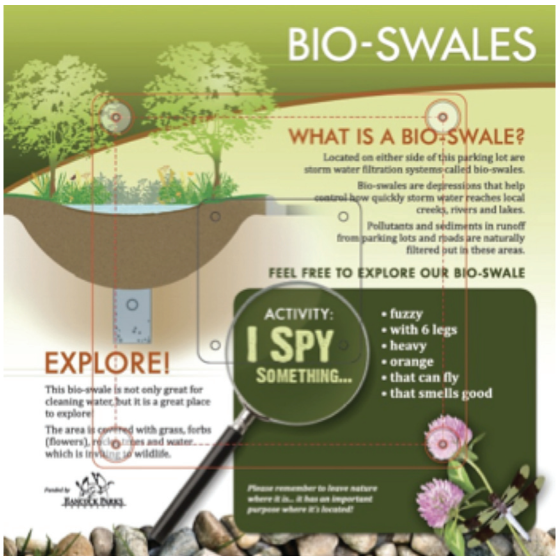


FIGURE 28: Entry sign for Bio-swale 2 with mounting bracket markings for single post installation. Proof provided by Harvey Advertising, 2015.

Staff/Volunteer Directed Nature Education

During public and school programs that are led by staff and volunteers, participants enter into the bio-swale for a variety of educational areas of study. Topics may include: insects, amphibians, spiders, metamorphosis, life cycles, plants, photosynthesis, seeds, seed dispersal, ecology, water cycle, watersheds, general aquatic study, best management practices, green living concepts. Even for the very young, three years and younger, colors, shapes, smells, textures, and sounds of nature programs are offered.

FIGURE 29: Water quality monitoring program with local high school environmental class. May 19, 2008. Betts[1]

FIGURE 30: Spring Nature Journaling workshop focuses on improving observation through use of line drawings. April 30, 2011. Betts[1]

> Come, sit, stay a while. Become enveloped in the moment... and revel in the wonders that are ever unfolding around you.
> – Sarah Betts

Sharon Hammer-Baker, a local retired teacher, professor, private art instructor, and volunteer has taken this notion to heart. She and I started a Nature Journaling class several years ago that utilizes these natural landscapes throughout the year. The goal of this class has been to teach participants about the natural world through the use of observation, creative writing, and art.

The Art In Nature concept has also been expanded to Plein Air sessions once a month, led by Mrs. Hammer-Baker. Plein Air refers to (painting) "in the open air". However, artists may use a variety of media including watercolor, acrylics, charcoal, pastels, pencil, and pen & ink.

CASE STUDY II: BUTTERFLY GARDEN... AS RAIN GARDEN AND MORE!

The Butterfly Garden is an insect oasis created in 2012 that has also become an attraction for humans in a variety of ways. Completely surrounded by concrete walkways and nestled on the southwest side of the Discovery Center, its' 850 square feet collects impervious surface water runoff.

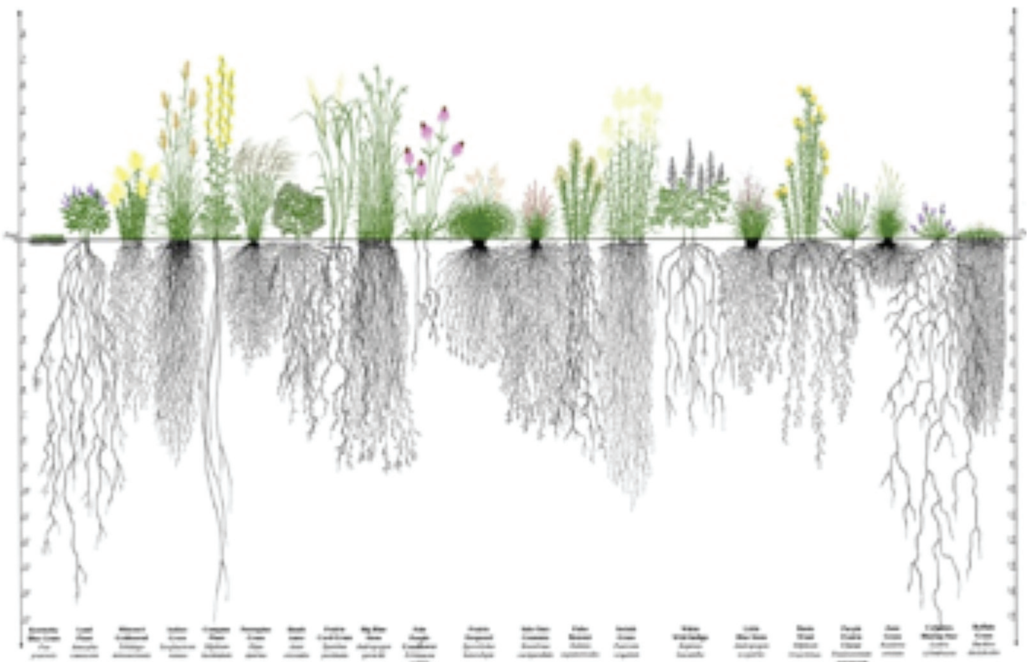
FIGURE 31: A much needed splash of color in early May after a long cold winter. Redbuds chosen to accent front entry doors of building; one placed on either side in cutout landscape zones. May 7, 2015. Betts[1]

Pollinator Habitat Creation

Decline in pollinator habitat in recent years has had a dramatic impact on beneficial insect populations that humans also require for pollination of our food production. According to the United States Department of Agriculture (USDA), over 80% of the world's flowering plants require pollinator assistance. Pollinators include a wide range of insects, such as ants, bees, beetles, butterflies, moths, and wasps. Birds, bats, and small rodents are also considered pollinators. Even small "butterfly gardens" like ours can make a difference by offering feeding locations for local and migratory insects (and birds), larval nurseries for young insects to grow and feed, fall feeding locations for seed eaters, and wintering locations that provide much needed cover through the frigid temperatures and snow and ice covered landscape of northwest Ohio.

FIGURE 32: Monarch caterpillar hiding beneath a half-eaten Sullivant's milkweed leaf in the Butterfly Garden. August 6, 2015. Betts[1]

FIGURE 33: Extensive root systems make native plants the perfect choice for rain gardens and other environments which require water infiltration to function. Illustration provided by Heidi Natura of the Conservation Research Institute. Image courtesy United States Department of Agriculture, Illinois Natural Resources Conservation Service, <http://www.nrcs.usda.gov>.



Historically, this region of Ohio was primarily wooded with islands of prairie and sandy ridges left from an ancient lake bed when the glaciers receded. Native prairie plants that grew in these open islands are extremely hardy, drought resistant, and can tolerate and thrive in extreme micro-climate conditions like those created around buildings, parking lots, and walkways. These plants can survive long periods of dry conditions and periods of water inundation due to their extensive root structures. Roots may extend beyond fifteen feet deep, like the compass plant, and over four feet in total underground biomass diameter, like side oats gramma grass. (See FIGURE 33) Many of these plants are referred to as "clay busters" due to their root growth capabilities through the dense clay allowing aeration of soil and increased water infiltration into lower soil horizons.

Native plants can be used in any type of landscape design if the growth patterns of these plants are understood and if the right plants are chosen for the desired design. Our Butterfly Garden was planted in an extended pyramidal shape, having taller plants in the center with outer accent rings of mid-sized and low-growing plants by the sidewalk. This design was chosen to help create a natural visual buffer and wind barrier between the parking lot and the open shelter.

FIGURE 34: The end of June brings considerable growth and outer ring color with: yellow coreopsis, orange butterfly weed, and purple coneflower are in full bloom. June 30, 2015. Betts[1]

FIGURE 35: Butterfly weed still blooming in the foreground, with Sullivant's milkweed blooming in mid-ground, and the developing buds of Joe-Pye weed towering behind. July 10, 2015. Betts[1]

The tall center section of the design is comprised of just two species: Sweet-scented Joe-Pye Weed and Tall Ironweed. Both species have moderately to good self-supporting stems, but can lean considerably or break if high wind is an issue at the site. Planting mid-sized plants around them helps to offset much of these issues, as was done in our Butterfly Garden. (FIGURES 36 & 37)

FIGURE 36: Sweet-scented Joe-Pye Weed
(Eupatorium purpureum)
Height: 3-10'
Color: Pale pink flowers with purple stems
Early bloom with flower buds just beginning to open.
July 10, 2015. Betts[1]

FIGURE 37: Tall Ironweed
(Vernonia altissima)
Height: 3-10′
Color: Purple
Adds intense fall color and winter texture if stems are left to stand through the winter.
August 8, 2013. Betts1

The mid-sized plants of our Butterfly Garden include the following species: Common Boneset, Wild Bergamot, Purple Coneflower (picture not included), Sullivant's Milkweed, New England Aster, Black-eyed Susan, Dense Blazing Star, Northern Blazing Star, and Culver's Root. (FIGURES 38-45)

FIGURE 38: Common Boneset
(Eupatorium perfoliatum)
Height: 2-5′
Color: White
Grows to fill in an area with dark green foliage and many white blooms on nearly all stems.
July 24, 2013. Betts[1]

FIGURE 39: Wild Bergamot
(Monarda fistulosa)
Height: 2-3′
Color: Lilac or purple
Seed collection can often begin in late August.
July 10, 2015. Betts[1]

FIGURE 40: Sullivant's Milkweed (Asclepias sullivantii)
Height: 1-4′
Color: Brownish-pink
Spreads by underground rhizomes, leave space for a patch to grow and fill in.
June 30, 2015. Betts[1]

FIGURE 41: New England Aster (Aster novae-angliae)
Height: 2-8′
Color: Violet-Purple
Extremely hardy with early foliage and long fall bloom period.
August 31, 2015. Betts[1]

FIGURE 42: Black-eyed Susan (Rudbeckia serotina)
Height: 1-3′
Color: Yellow with brown disk
Extremely hardy with long bloom period, multi-headed, and intense color.
July 10, 2015. Betts[1]

FIGURE 43: Dense Blazing Star
(Liatris spicata)
Height: 1-5′
Color: Purple
A native substitute for the exotic and invasive loosestrife species still sold by many nurseries.
July 24, 2013. Betts[1]

FIGURE 44: Northern Blazing Star
(Liatris borealis)
Height: 1-4′
Color: Purple
Another native substitute for the exotic and invasive loosestrife species still sold by many nurseries.
July 24, 2013. Betts[1]

FIGURE 45: Culver's Root
(Veronicastrum verginicum)
Height: 2-7′
Color: White
Long-lasting white blooming spires make this an attractive plant.
June 30, 2015. Betts[1]

Low-growing plants of the Butterfly Garden typically have more dense foliage closer to the ground, but may have flower heads that extend more than two feet high. Species include: Wild Columbine, Butterfly Weed, Rattlesnake Master, Purple Prairie Clover, Crooked-stem Aster, Calico Aster (picture not included), and Lance-leaved Coreopsis. (FIGURES 46-51)

FIGURE 46: Wild Columbine
(Aquilegia canadensis)
Height: 1-3′
Color: Scarlet with yellow center
Low growing foliage during fall, winter, and spring with spring blooms.
October 16, 2014. Betts[1]

FIGURE 47: Butterfly Weed
(Asclepias tuberosa)
Height: 1-2′
Color: Orange
Intense, long-lasting blooms and is essential for monarch butterflies at all stages of life.
August 6, 2015. Betts[1]

FIGURE 48: Rattlesnake Master
(Eryngium yuccifolium)
Height: 2-5′
Color: White
Basal leaves look much like yucca leaves and is multi-headed.
July 24, 2013. Betts[1]

FIGURE 49: Purple Prairie Clover
(Dalea purpurea)
Height: 1-2′
Color: Purple
Multi-headed small purple flowers.
July 24, 2013. Betts[1]

FIGURE 50: Crooked-stem Aster
(Aster prenanthoides)
Height: 1-3′
Color: Blue-violet
Wonderful long-lasting fall color with many blooms.
October 9, 2014. Betts[1]

FIGURE 51: Lance-leaved Coreopsis
(Coreopsis lanceolata)
Height: 10-24"
Color: Yellow
Will produce many blooms June to October if dead-headed between blooms.
July 24, 2013. Betts[1]

Two short grasses were also added to the mid-sized and low-growing areas, which include: Little Bluestem and Prairie Dropseed. Both are native grasses that are clump-forming, meaning they do not spread to create a mat, like turf grass, but will continue to grow and form bunches of multi-stem individuals. This is a perfect growth trait for formal plantings and other landscape designs where the grasses will stay in place where they are planted. (FIGURES 52 & 53)

FIGURE 52: Little Bluestem
(Andropogon scoparius)
Height: 1 ½ - 4'
Color: Blue during growing season, turning more reddish in fall with tiny white tufted seeds on the ends.
July 28, 2010. Betts1

FIGURE 53: Prairie Dropseed
(Sporobolus heterolepis)
Height: 1 ½ - 3 ½′
Individual plants will create circular grass tufts of arching leaves with flower and seed heads extending straight up and out to the sides. Great to use several plants for filling in large open areas.
July 28, 2010. Betts1

Nature Education & Self-Guided Exploration

Since the Butterfly Garden is situated so close to our main education building, the garden is able to be utilized by Staff and Volunteers for a variety of Nature Education topics such as insect investigations, life cycles, monarch programs, plants, pollination, seeds, seed dispersal, and more.

FIGURE 54: Human's innate attraction to life, movement, sound, color, smell, and texture make a butterfly garden the perfect focal point to include in the landscape design around buildings. Even an inchworm can enthrall a group of youth. November 4, 2008. Betts[1]

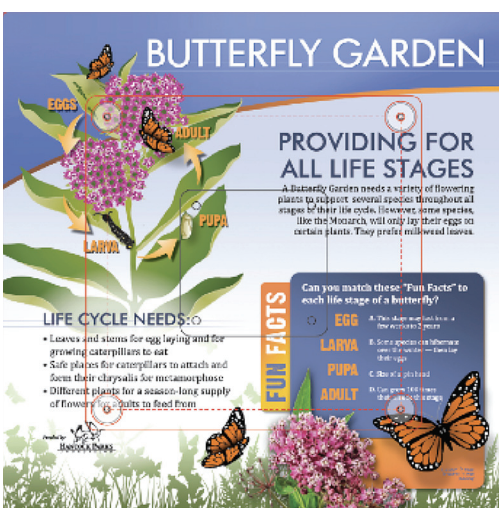


FIGURE 55: Interpretive sign for Butterfly Garden with mounting bracket markings for single post installation. Image courtesy Harvey Advertising, 2015.

For visitors who come to the site on their own, a 24”x 24” interpretive sign was created for the Butterfly Garden focusing on the life cycle of butterflies and what each life cycle stage requires of the environment.

CASE STUDY III: WETLAND... AS A RAIN GARDEN AND MORE!

Evaluating the property and researching the history of the site should be the first step in all site planning efforts. Finding treasures, like the roundhouse at Oakwoods, that can be incorporated into a site plan or become a focal point and be used for multiple purposes can save on costs. Instead of three individual projects, each with their own expenditures, the same purposes can be condensed into one project with one far reduced budget.

FIGURE 56: (Left) Bird watering pond is positioned off the deck to the left along the rock roundhouse wall. **FIGURE 57:** (Right) Rock wall of the railroad roundhouse can be seen extending across the background with wetland vegetation in the center, back deck on the left, and outdoor recycling toilet building on the right. April 24, 2008. Betts[1]

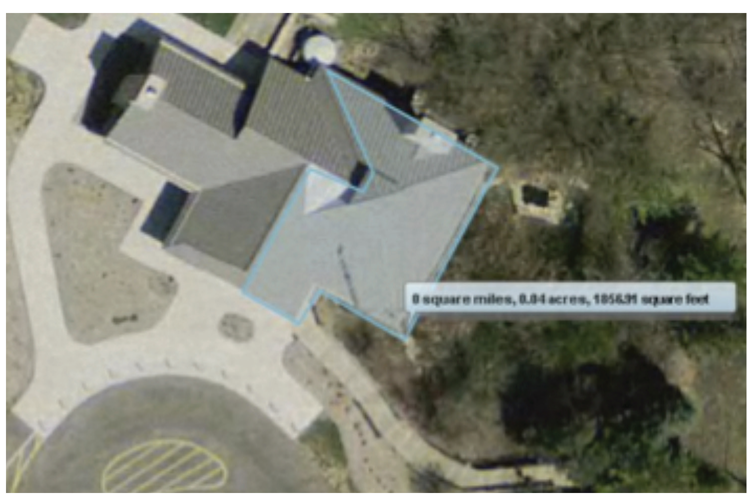


FIGURE 58: Over 1,800 square feet of roof runoff is directed into wetland. Photo courtesy Hancock County Auditor, <http://hancock.iviewauditor.com>.

Habitat Creation & Enhancement

In this case, the building was constructed next to the roundhouse so storm water runs directly from the roof into the wetland contained within the roundhouse. Gutters from the sides of the building also drain into the roundhouse wetland. Having this structure alleviated the need and cost for any additional water retention structures. It also solved the issue of installing an underground storm water system, which is impossible on this site due to the shallow soil depths covering solid bedrock. Blasting or extensive and costly excavating are the only ways to install such structures in this area, neither of which were a viable solution given our limited budget.

Quality wetland habitat was created in the process and is used by a variety of amphibians, mammals, birds, insects, and others much like the bio-swale areas described earlier.

Nature Education & Self-Guided Exploration

The building views and educational aspects were also considered and planned with the wetland in mind. Four large glass doors were incorporated into the back of the building with a full view of the wetlands from inside. The center two glass doors can be slid open for access to a deck that was constructed across the back of the building and extends over part of the wetland. The deck allows "entry" into the wetland environment without damaging the wetland that was created.

FIGURE 59: (Left) Winter view of wetland and several bird feeding stations from inside the Discovery Center. **FIGURE 60:** (Right) Junco waiting in the shrubs for an opening on the crowded deck railing where other birds feast on seeds that were spread. January 12, 2015. Betts[1]

Educational nature programs can be conducted year-round from inside the heated and air conditioned building while enjoying pleasant views outside. Programs can also easily access this back deck area when needed. Several bird feeding stations were placed around the rim of the roundhouse and supplied with food during the winter months. In conjunction with these, Project Feeder Watch (a public monitoring program by Cornell University) can be conducted from inside the building on scheduled days from November to March. Chairs are positioned by the doors and participants record what species they see and in what abundance.

FIGURE 61: Rain Barrel collecting water off the Discovery Center roof from a spring rain. April 30, 2009. Betts[1]

FIGURE 62: Over 430 square feet of roof runoff is directed to the rain barrel. Photo courtesy Hancock County Auditor, <http://hancock.iviewauditor.com>.

CASE STUDY IV: RAIN BARRELS… AS RAIN GARDEN AMENITIES AND MORE!

During the original construction of the Discovery Center in 1994, a well was drilled on the north side of the building and a hand pump was mounted for public and staff use. Over the years as public water regulations became stricter, the pump was restricted to the public and then removed altogether. As this was the only running water on-site, there became an immediate need for an alternative water source. My solution was to install a rain barrel… a very large rain barrel.

FIGURE 63: Flexible downpipe extensions are attached to the gutter and directed into the top of the rain barrel. July 10, 2015. Betts[1]

In 2009 I secured funding from the Hancock Parks Foundation to purchase a 1,000 gallon tank from a local farm store. It was placed on old rail-road ties that had been discarded by the rail-road company, and by an eave spout opening. Two flexible downspout extensions from the hardware store were attached together and then to the eave opening. The other end was bent into the top of the rain barrel. A removable screen with a cutout for the downspout was attached to the top of the rain barrel to help reduce debris that people may want to put in the rain barrel (yes, someone put fish in once and other trash).

Tree frogs are often found inside, but can easily move in and out with their spectacular toe-pad adaptation, so they are left to do as they please. A small overflow hole was drilled near the top for excess water to drain when full, although, there are times that it fills so quickly that it also runs over the top. Restrictors were placed in the side opening so that an easy to use 90 degree handle spigot could be attached for direct water flow or hose usage. Estimates of water storage from the 15'x 20' area of roof being drained have been visually measured. Some years, the rain barrel has been filled approximately four times, while being drained completely between fillings.

Green Living Education

Many visitors have been surprised at the amount of water that can be collected from such a small section of roof. An interpretive panel was created with basic information for visitors to learn more about the benefits of rain barrels and how much water many of us use in the United States.

FIGURE 64: Interpretive sign for Rain Barrel with mounting bracket markings for single post installation. Proof provided by Harvey Advertising, 2015.

Nature Education

The constant flow of water from the rain barrel helps with live program animal upkeep, on-site programs, and other site activities. A hand washing station is setup for summer camps along with a rinse stations for those children whom immerse themselves in nature. Over the winter months there is reduced activity at Oakwoods. This is a benefit, for the time being, since one extreme limitation we have found with the current setup is that it must be taken down in early November and reset every March so the water doesn't freeze and fracture the spigot or tank.

Other Uses

Having the ability to power wash or spray down the activity area, watering landscape plants, and filling and cleaning the small landscape pond used for the bird watching stations have benefited from the rain barrel's water supply.

CONCLUSION

Many engineers, architects, and landscape designers know the nuts and bolts of design and building, striving for a structurally sound and appealing end result. In the world of green-thinkers, there should be no "end" result. Positive impacts of projects should be felt now and for years to come radiating out like ripples from a drop of water across a lake. A little creative thinking, planning, adaptation, and a new perspective to find continued ways to merge uses of built structures works to better the environment and all the life that comes to visit or call it home.