Historic Chapel Site: Meadows, Meanders and Meditation

U.S. EPA Campus Rainworks Challenge 2014

Project Location

University of Maryland
Registration number: D9

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Project Abstract

Our project, '**Historic Chapel Site: Meadows, Meanders and Meditation**, aims to realize the University of Maryland's potential as a leading environmental steward situated in the Anacostia watershed. The Chapel project is a 7.1 acre re-designed landscape on the University of Maryland campus that replaces the traditional lawn with a series of meadow ecologies while capturing and treating stormwater from two adjacent parking lots and surrounding rooftop through a series of bioretention terraces, bioswales, and rain gardens. This site's location serves as a gateway campus entrance on the slope just below the campus Chapel, a site for commencement, academic functions, and weddings. The Chapel project serves as an innovative dry and wet meadow garden landscape that provides habitat for vanishing pollinator and beneficial insect species, as an outdoor classroom for this land-grant institution, and as a contemplative landscape for visitors and the university community. We re-designed the stormwater system by disconnecting existing storm pipes and directing stormwater flow from two adjacent parking lots into a low impact development treatment train into the meadows. This design treats 55% of a five-year storm event and 100% of a one-year storm event. The outcomes of this project include the following:

- 2.5 acres of lawn replaced with native plants
- 1 year storm 100% treated with multiple LID controls
- 5 year storm 55% treated with multiple LID controls
- 34% runoff treated through surface changes
- 5 BMP approaches displayed for community members
- 2 acres of impervious surface removed or treated
- 73 trees historic canopy and roots protected

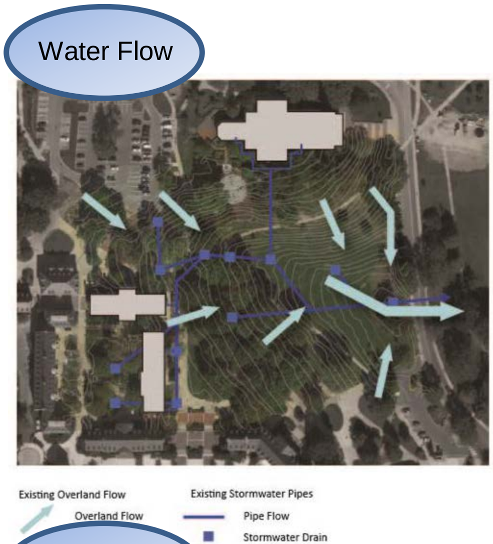
Site Selection and Site Assessment

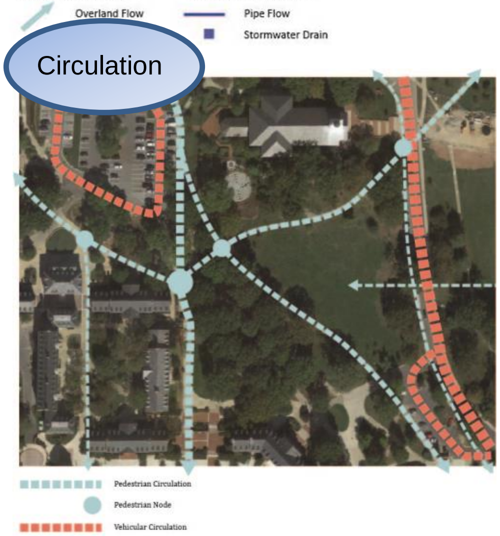
Our site selection was multi-phased, using first a hydrologic modeling approach and then consulting with several individuals from Campus facilities and Landscape Architecture program faculty members. We initially used the **Soil and Water Assessment Tool** (SWAT2012) to **model nonpoint source pollutant hotspots** (nitrogen, phosphorus, sediment, total suspended solids, and volume) for the University of Maryland campus. The hydrologic study results showed significant problems with excessive total nitrogen, total phosphorus, sediment runoff and surface runoff for particular spots on campus. Using ArcGIS, we located these areas on campus that the model predicts will have significantly greater than average pollutant and runoff generation. After speaking with several members on the advising team, we then walked the campus to get a first-hand look at the existing conditions of these areas.

We selected the University Chapel and surrounding area for our project site due to its high profile as a gateway site and the challenges posed by existing stormwater issues. On-site stormwater challenges include excessive sediment runoff. Sediment runoff is an important non-point source pollutant (NPS) as defined by the Chesapeake Bay Total Maximum Daily Load (TDML) EPA regulations. The SWAT model also indicated that stormwater runoff in this part of campus generates higher than average total nitrogen and total phosphorous. On-site observations before, during, and after storm events show substantial physical evidence of excessive runoff, erosion, and flooding.

Soil analysis was conducted for several different areas of the site. Soil test results indicated primarily sandy and loamy soil types. We also conducted a percolation test on the site. Percolation test results revealed that the soil porosity is favorable for filtration and infiltration and will support a variety of native plants.

The University Chapel, beyond the hydrologic challenges, offers an example of how to create spaces that foster socialization, relaxation, and meditation. Our design builds on these existing spaces to provide students, faculty, and visitors with additional opportunities to engage with this space.



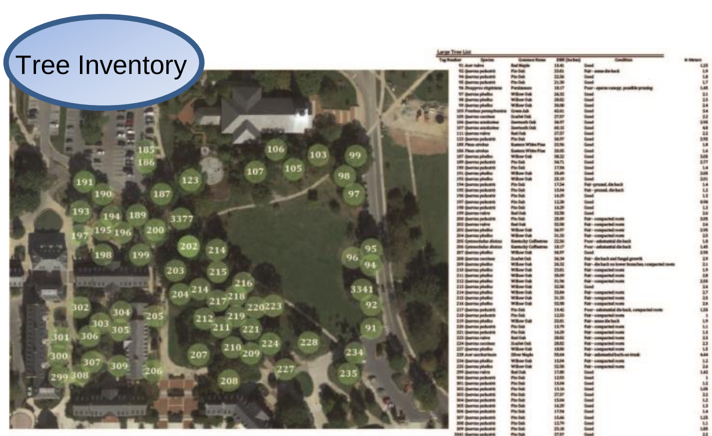


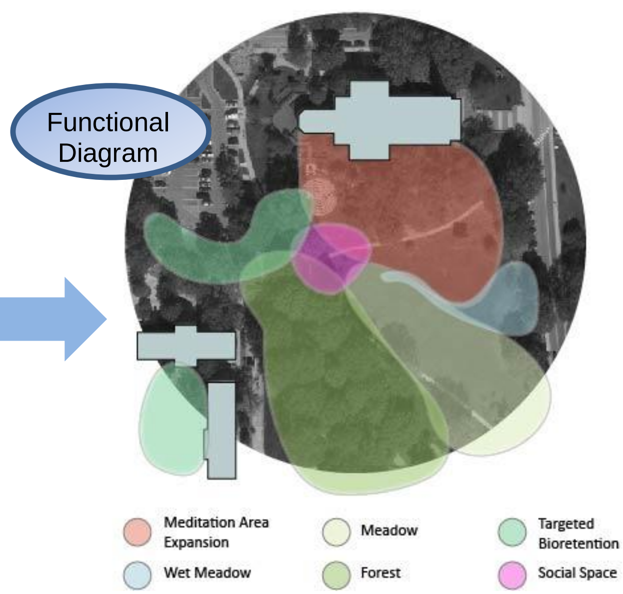
Water Flow:
Stormwater from the Chapel roof, Kent Hall, Cecil Hall, and two parking lots is creating excessive run-off. Because of the compaction of the soil in the forested area, there is almost no infiltration. Approximately 1.9 acres of the site have slopes greater than 12% which adds to the sediment erosion problems.

Circulation:
There are major pedestrian and vehicular paths in and around the site. In other areas, there are duplicative foot paths that are harming tree roots.

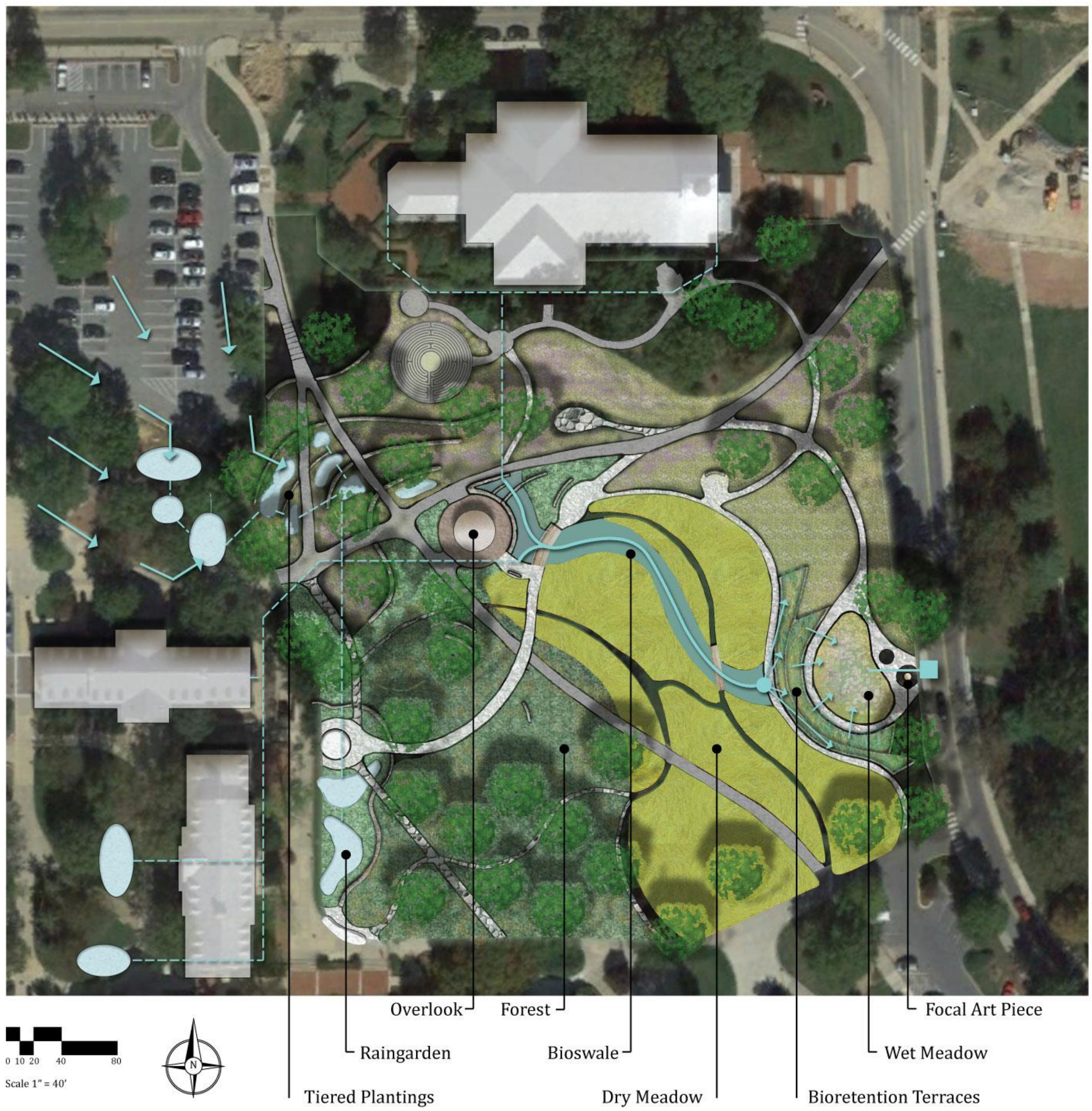
Tree Inventory:
The condition of each tree in the forested area was noted during our tree inventory. Intervention is needed to improve the compacted root conditions and address the soil erosion.

Functional Diagram:
After collecting and analyzing the above information, we used an iterative design process, which included consulting with experts in the fields of landscape architecture, civil engineering, entomology and stormwater management, to develop a number of functional diagrams. The diagram below shows the results of the analysis and concept development.





Our site plan addresses stormwater using a treatment train that includes rain gardens, tiered plantings, forest understory plantings, dry and wet meadows, and a newly created bioswale. It provides opportunities to learn about stormwater management and encourages socialization by providing seating areas and a new pavilion. The existing meditation areas are expanded upon creating new contemplative spaces.



Water Flow: Slow----Filter----Collect----Infiltrate

While our site design will provide important benefits toward increasing biodiversity and improving campus social connections, our primary goal was to improve stormwater management and infrastructure on the site. Our team used **three strategies** to slow surface runoff and increase filtration and infiltration.

1) **Improve surface types** around the site by replacing, for example, superfluous impervious paths with dense native plantings that slow surface flow. Long stretches of existing lawn were also replaced with meadow plantings.
2) **Disconnect existing stormwater drain systems** from around the site and feed into an exposed swale. Rather than transferring water off the site as quickly as possible, the swale, which feeds into the meadows, slows the flow of water and allows the water to infiltrate as it passes over the site.
3) **LID controls** were introduced around the site to capture, filtrate, and infiltrate stormwater. Rain gardens capture runoff from the impervious parking lots and courtyards before it enters the stormwater pipes. Once the water reaches the bottom of the swale, the flow is spread into two terraced meadows that filter and store water before passing into a larger wet meadow. The wet meadow acts as an infiltration basin and allows water to pond up into the terraced meadows during larger storm events.

Terraced Meadows

Stormwater Modeling

The effects of this treatment train were modelled using two systems, the **EPA Stormwater Calculator**, and **TR-55 Software**. TR-55 allowed us to calculate the runoff for the current site, and then to compare this with our proposed site design. The results for a one year storm event, using a rainfall intensity of 2.63, are shown below.

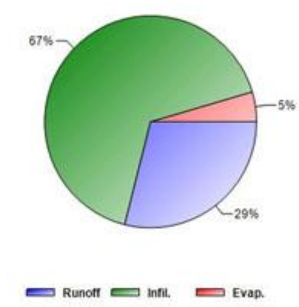
Existing Conditions	**Proposed Surface Changes**
Runoff Amount (1 Year Storm)	
1.034 inches	.682 inches
Volume (1 Year Storm)	
26649 cubic feet	17577 cubic feet

Through surface changes alone, **runoff volume was decreased by 9072 cubic feet, or 34%**. Our proposed **LID controls store 17859 cubic feet of** water, treating the entire remaining 17577 cubic feet of a 1 year storm. These results are show in the table below.

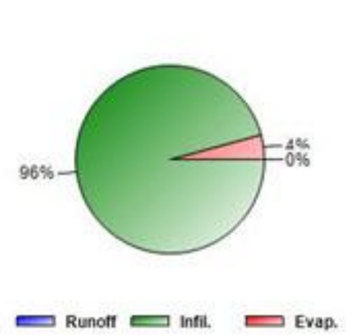
LID Controls		
Rain Gardens	5,355 sf. @ average 1.5ft. depth	8,032 cubic ft.
Wet Meadow	3,097 sf. @ average 2ft. depth	6,194 cubic ft.
Bioretention Terraces	3,633 sf. @ average 1ft. depth	3,633 cubic ft.
Total		**17,859 cubic ft.**

The EPA stormwater calculator was used to confirm our results. Using local annual rainfall, soil, and slopes data, combined with the results of our on-site percolation test, the EPA stormwater calculator predicted runoff and infiltration over an average year for both the existing site and our designed site. The **existing site will retain 3.16 inches of rain**, allowing 29% of rainfall to run off the site**.** Our **designed site will retain 4.74 inches of rain,** capturing all rainfall from a 1 year storm.

Annual Rainfall = 42.41 inches



Existing Conditions



Proposed Conditions

Plants

Many comparisons between traditional lawns and grass-free lawns have been made. Traditional lawns represent a highly standardized synanthropic habitat, and lawns with the highest traditional aesthetic value are those with the lowest species richness (Borman et al. 2001; Muller 1990). Our design replaces 2.5 acres of lawn with designed vegetation that is created to be both aesthetically pleasing and ecologically sensitive. Increases in plant diversity have been repeatedly shown to support greater beneficial insect populations (Hooper et. Al. 2005). Several factors were considered in choosing the plant selections for the site. The criteria included: 1) ability to survive in both wet and dry conditions; 2) ability to filter nonpoint source pollutants and pollutants from parking lot runoff; 3) provide habitat for vanishing beneficial insects and wildlife; 4) enhance biodiversity; and 5) suitable for the campus aesthetic. The results include:

- An estimated **45:1** factor increase in pollinator diversity in **native meadow plant community** to replace **non-native turf lawn** (Tallamy, 2014)
- 2 ½ acres of lawn replaced with dry and wet meadow plantings
- Rain gardens created adjacent to parking lots to capture water where it falls
- Ferns and shrubs planted as an understory for forest fragments

Specific plant selections are detailed below.

Herbaceous Perennials for Dry Meadow

Scientific Name	Common Name		Habitat	Wildlife
Aquilegia candadensis	Eastern Columbine		Ledges, pastures, roadside banks	Butterfly Birds Beneficial Insects
Asclepias tuberosa	Butterfly weed		Dry fields, roadside banks	Butterfly Beneficial Insects
Baptista australis	False blue indigo		Alluvial thickets, streambanks, floodplains	Butterfly Beneficial Insects
Chrysopsis mariana	Golden aster		Openings, roadsides, serpentine barrens	
Coreopsis verticillata	Tall coreopsis		Thickets, old fields, forest edges, roadsides	Birds
Eupatorium hyssopifolium	Hyssop-leaved thoroughwort		Dry fields, roadsides, woods, meadows	Butterfly Birds Beneficial Insects
Geranium maculatum	Wild Geranium		Woods, roadsides, fields	Butterfly Birds Beneficial Insects
Oenothera fruiticosa	Common evening primrose		Cultivated fields, meadow, roadsides	Humming bird Beneficial Insects
Phlox carolina	Thick-leaved phlox		Open woods, meadows	Butterfly

Herbaceous Perennials for Moist Meadow

Scientific Name	Common Name		Habitat	Wildlife
Asclepias incarnate	Swamp milkweed		Marshes, meadows, woods, ditches	Butterfly Mammal Beneficial Insects
Chelone glabra	White Turtlehead		Woods, stream banks, swamps	Butterfly Humming bird
Erythronium Americana	Trout lily		Woods, rich slopes, meadows	
Helenium autumnale	Yellow sneezeweed		Woods, swamps, meadows, marshes, ditches	Butterfly
Lobelia cardinalis	Cardinal flower		Marshes, wooded swamps, rivers, streams	Butterfly Bird Beneficial Insects
Lobelia siphilitica	Great blue lobelia		Woodlands, meadows, swamps	Butterfly Bird Beneficial Insects
Monarda didyma	Beebalm		Creek banks, floodplains, woods	Butterfly Birds Beneficial Insects
Polemonium reptans	Jacob's ladder		Rich or rocky woods, wooded flodplains	
Polygonatum biflorum	Solomon's Seal		Woods	

Dry and Wet Meadows with constructed swale through the middle. A viewing platform provides the opportunity to observe both the ecology and stormwater management LID solutions.

Forest Understory

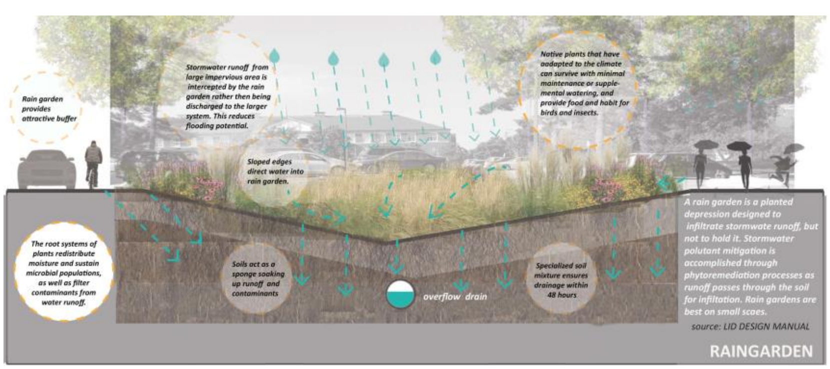
Ferns

Scientific Name	Common Name	Habitat	Wildlife
Adiantum pedatum	Northern maidenhair fern	Moist woods, rocky shaded habitats	
Dennstaedtia punctilobula	Hay-scented fern	Open woods and fields	
Onoclea sensibilis	Sensitive fern	Fresh tidal marshes, meadows, woods	Waterfowl Mammal
Osmunda cinnamomea	Cinnamon fern	Woods, marshes, swamps, streamsides	Bird Mammal
Polystichum acrostichoides	Christmas fern	Woods, thickets, rocky slopes	Mammal
Thelypteris noveboracencis	New York fern	Forested wetlands, dry to damp woods, thickets	Birds Mammal

Small Shrubs

Common Name	Habitat	Wildlife
American beautyberry	Fields, open woods	Bird Mammal
Sweetfern	Forested wetlands, bogs, woods	Butterfly Bird Beneficial Insects Mammal
Wintergreen	Steep slopes, woods, bogs	Bird Mammal
Dangleberry	Woods, thickets	Bird Mammal
Wild hydrangea	Woods, floodplain	
Mountain laurel	Woods, fields, swamps, meadows	Bird Mammal

Rain Gardens



Forest Understory

Rain Gardens

Scientific Name	Common Name	Habitat	Wildlife
Andropogon virginicus	Broomsedge	Wet meadows, transition areas	Bird Mammal
Carex stricta	Tussock sedge	Open, dry, sandy or rocky woods, wooded slopes	Bird Waterfowl
Chasmanthiums latifolium	Wild oats	Streambanks, alluvial woods	
Monarda didyma	Beebalm	Creek banks, floodplains, woods	Butterfly Birds Beneficial Insects
Panicum virgatum	Switchgrass	Fresh and brackish marshes, wet meadows, open woods	Bird Mammal Waterfowl
Vernonia noveboracencis	New York Ironweed	Streambanks, fields, marshes	Butterfly

Materials

Brick

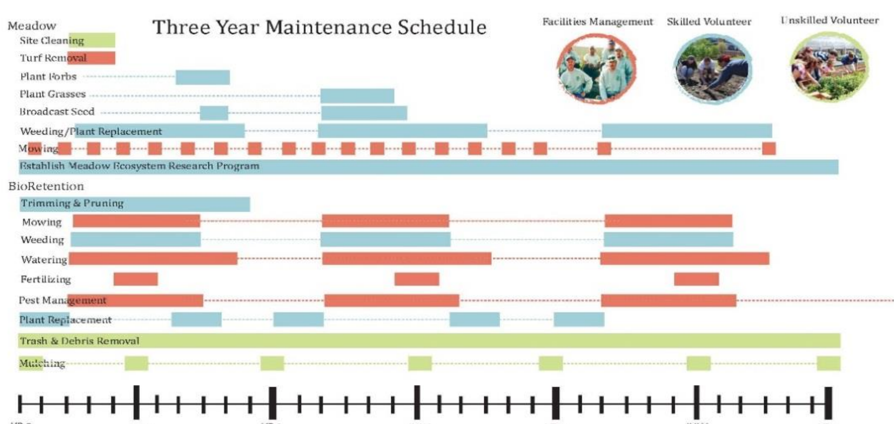
Corten Steel

Gravel

The pergola will be built with brick in keeping with the Chapel design. Corten steel will be used at the edges of the meadow. This will help indicate that the meadow space is well defined and being cared for. Gravel will be used for the new paths throughout the meadows.

Maintenance

Once established, meadows require significantly less maintenance than a traditional lawn. For a period of one to two years after planting, it will be necessary to carry out a weed control program to insure the successful establishment of the meadows. By mowing every six weeks to a height of four to six inches, annuals will become established without giving weeds a chance to seed. A sample three year maintenance schedule is shown below.



UMD Historic Chapel Site: Meadows, Meanders, Meditations					
Material		Amount	$ per unit	Cost	Notes
Benches/Seating Structures		4	3000-5,000	$16,000.00	Cost varies depending on size and type of structure
Boulders		15 tons	$200 per ton	$3,000.00	80 to 100 lbs per cu. Foot. 3'x3' boulder @ 3000lbs. Sandstone .09-.12 per lb. Contractor source (homewyse) between $800-$1000 per 5 tons.
Brick		500 sq. ft.	$4500 per 100 sq. ft.	$22,500.00	Includes 50 hours of labor per unit.
Corten Steal		1500 linear ft.	$8 per linear ft.	$12,000.00	1/4", 4', 8'. $200 per sheet (Sheet will edge meadow 16' @ 2 ' high, 32' high if 1 foot. (another source says $5-15 per linear foot.)
Delaware River Jack		400 cu. Yds.	37.85 per cubic yard	$15,140.00	for Swale bed as needed
Infiltration Terraces		275 cu. Yds.	$225 per cubic yard	62, 010	Weeping walls of repurposed concrete
Permeable Concrete		102 cu. Yds.	$619.30 per cubic yard	$63,168.00	New Trail starting under the underpass, moving by wet meadow. Underdrains back into SW system
Rain gardens		7600 sq. ft.	$20 per square foot	$152,000.00	Price ranges from $5-$40 per square foot. Some volunteer work could be utilized here. Avg. cost was assumed.
Repurposed Concrete		100 cu. Yds.	$52 per cubic yard	$5,200.00	Intend to use repurposed concrete from campus construction projects other sites. Cost includes hauling and and installation only.
Stone (trails)		600 sq. ft.	$24 per sq. ft.	$14,400.00	(landscaping network.com)
Structure			NA	$100,000.00	Cost estimate could vary, structure should be built to complementary to chapel architecture.
Top Soil			NA	$0.00	Re-used from soil excavated from meadow area. Used in forest rehabilitation area to replace eroded topsoil, for terracing around the Garden of Rememberance, and for creating small contour
Wet Meadow Installation		1800 sq. ft	$20 per square foot	$36,000.00	
Soil Amendment (as needed)		As needed		$30,000.00	
Excavation		16,500 cu. Yds.	$12 per cubic yard	$198,000.00	For reuse on site as fill
Placement of on-site Materials		16,500 cu. Yds.	$8 per cubic yard	$132,000.00	
Interpretive Materials/signs			$25,000	$25,000.00	
Art Sculpture Installations			$5,000 ea.	$10,000.00	
Native and Perennial Grasses, Upland/Riparian /Wildflower Mix	Seed	25 lbs seed	$82.50 per lb	$2,100.00	One pound of seed to cover 2000 sq feet of average cover
Native and Perennial Grasses, Upland/Riparian/ Wildflower Mix	1-2' Plug	4500 sq. ft a 12' spacing	$1.65 each	$7,500.00	
Additional Plant Materials				$10,000.00	
Initial Budget Estimate:				**$854,008.00**	

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