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Practical Stormwater Data Collection with Small Unmanned Aerial Systems

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Getting Down and Dirty: Dollars for GSI maintenance

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Green stormwater infrastructure (GSI) has become a popular stormwater management tool, but many municipalities have found that they are creating a new challenge by installing rain gardens, bio-swales, a variety of wetlands, and bio-retention basins: maintenance. How do we maintain these new areas? And how much does it cost?

A natural reaction to GSI is to be concerned about maintenance and costs. One might first ask if your community is already or should be investing in water quality. If water quality improvement is a goal, these spaces are often the most effective and cost-effective way to address the #1 source of pollutant loading—our road drainage systems. Studies since the 1970s have documented the loading per curb mile of a wide range of pollutants, including lead, mercury, cadmium, manganese, phosphorous, zinc, copper, and many more toxins. These considerations may help you move to thinking value versus cost.

Since 2015, the City of Ann Arbor has funded a project within the Water Resources Commissioner's Office to create and implement a maintenance plan. Over three years, maintenance needs and cost estimates have been developed for GSI assets. GSI maintenance spending in 2018 was $104,000, and while not yet approved for 2019, the sum of individual plans would total $147,000 in maintenance. Altogether there are 124 individual assets at 48 sites, with most installed in the past decade. In comparison, vactor and street sweeping costs have been typically budgeted at close to $1,800,000 annually.

GSI is proven to be much more effective (100% per the Center for Watershed Protection) at pollutant removal. Remembering that our goal here is to optimize the cost of addressing pollutant load per unit of pavement,

we are working on Key Performance Indicators (KPI's) related to cost per unit area and mass for street sweeping vs GSI. In addition, through this process of reviewing and standardizing maintenance, design techniques have also been identified to reduce maintenance expenses while maximizing pollutant capture.

At right is a table detailing maintenance needs and average costs for three GSI assets.

Note that the total acres for each site decreases from the first to the last site, but the total price per square foot increases significantly. And although there is a total of 30 public GSI acres, 45% of the total budget is spent on just two acres. Those two acres are made up of 26 individual sites that are less than 10,000 square feet but often are in highly visible locations. So, on a unit cost basis, smaller GSI sites are more expensive to maintain, although we have learned that clustering small sites together helps offset costs. Data averaged from 48 sites show that the average cost per square foot varies widely, from $23 to $10,000 per acre. Detailed data can be found on the www.washtenaw.org/drains website.

SITE	MAINTENANCE NEEDS	COMPLETED BY	TIMELINE	COST/YEAR	TOTAL/100 SQUARE FEET
Mary Beth Doyle Mitigated Wetland & Detention Basin 7.5 acres or 326,700 square feet Level of Service: Medium	Controlled burns	Contractor	1 every 3 years	$317	$0.54
	Invasive control	Contractor	2 visits per year	$620	
	General maintenance & monitoring	Staff & volunteers	61 hours per year	$825	
			total	**$1,762**	
Stone School Road Rain Gardens 1.35 acres or 58,806 square feet Level of Service: High	Controlled burns	Contractor	1 every 3 years	$150	$15
	Invasive control	Contractor	5 visits per year	$7,000	
	Sediment removal	Staff	1 every 5 years	$1,000	
	General maintenance & monitoring	Staff & volunteers	26 hours per year	$500	
			total	**$8,650**	
Kingsley & 1st Rain Garden 0.05 acres or 2,178 square feet Level of Service: High	Controlled burns	Contractor	1 every 3 years	$216	$28
	General maintenance & monitoring	Volunteers	58 hours per year	$0	
	General maintenance & monitoring	Staff	4 visits per year	$400	
			total	**$616**	

Levels of care

To prioritize maintenance, the public rain gardens in the City of Ann Arbor are categorized into levels of service based on aesthetics. High Aesthetic sites receive the highest level of care and have the goal to look formal and tidy. These gardens are kept weed free, dead-headed in the late fall and trimmed throughout the year. Often, these sites are found in road rights-of-way or by park entrances.

Medium Aesthetic sites have the invasive plants removed and the edges trimmed but common lawn weeds are not managed. These sites are often in parks and have a distinct edge that distinguishes it from the surrounding landscape.

Low Aesthetic sites receive the least amount of care and are allowed to look informal. Invasive plants are removed

Controlled burn in the City of Ann Arbor – Miller Avenue rain garden

City of Ann Arbor – Miller Avenue rain garden.
Photo by Linda Prieskorn.

from these sites, but no pruning or trimming work is done. Often, these sites are adjacent to natural areas and blend in with the surrounding prairies or woodlands.

Design techniques

Design techniques can be used to reduce the maintenance needs. First, sizing green infrastructure appropriately is important. The main factors determining the cost of a site are size and level of care. In comparing the rain gardens at Stone School Road and Kingsley and 1st, both sites have a high level of service but the annual cost to maintain Stone School is much higher because of the size. Smaller sites can afford to have higher levels of service but as the size increases, it is important to consider during the design process that costs can become prohibitive if a high level of service is expected.

Second, the type of plants and their placement has an impact on the amount of maintenance required. Some plants are needier than others. For example, Switchgrass, *Panicum virgatum*, needs to be cut back every 2-3 years or it will shade out its own new sprouts. Controlled burns in established rain gardens will encourage native growth, reduce some invasive plants and removes the standing dead stalks—like that of Switchgrass.

Tall plants like Rose Mallow, Hibiscus moscheutus and Asters, Asteraceae sp, can cause visibility issues along roadsides and begin to crowd pathways. These plants must be trimmed frequently. It is recommended to plant wide swaths of short plants like Wild Strawberry, Fragaria virginiana, Common Cinquefoil, Potentilla simplex, and Sedges, Carex sp., as a border to reduce the need to trim along pathways and roads. These plants are appropriate for the Great Lakes Region. In general, hardy, deep rooted, drought tolerant, short plants that match the sunlight and soil requirements for the site are recommended.

Third, simple planting designs make it easier for novices to care for GSI. The six public rain gardens along Madison Street in Ann Arbor have just two species of plants, a Blue Flag Iris and either Canada Anemone, Purple Coneflower or Autumn Joy Sedum. This makes for a dramatic sweep of color when the plants are in bloom and an easy site for volunteers to maintain.

Finally, an assortment of designs for storm inlets along roads and parking lots have been designed to convey water into the green infrastructure asset with varying levels of success. See the pros and cons of the various methods below:

Concrete splash pad – Miller Avenue Rain Gardens

- Pros: sediment accumulates in one place
- Cons: can be dangerous to clean out along roadsides so is no longer a volunteer job in Ann Arbor; must be cleaned out two times per year

Stone Channel – Zamboni Rain Garden

- Pros: slows stormwater as it enters garden so effective for sites with high-velocity flows; simple and safe way to clean so is completed by volunteers in Ann Arbor
- Cons: time consuming to clean out because all rocks must be moved out to clear out sediment; must be cleaned out annually

Drop Chamber – Stone School Road

- Pros: maintenance is needed once every five years
- Cons: sediment must be removed with a vactor truck which is costly; while sediment is being removed from roadside sites, traffic control is necessary and permits from the local municipality must be pulled

Lessons learned

Since GSI is often located in areas with shared jurisdiction, it is important to develop a multi-pronged approach to maintenance. In the case of Ann Arbor, City Parks and Recreation staff, Washtenaw County Water Resources staff, volunteers and contractors all play a role in maintenance. Over three years, appropriate roles have been identified for each player. For example, individual volunteers work in small rain gardens because they are simple and pleasant to care for. Parks and Recreation staff help herbicide, conduct controlled burns and organize workdays on GSI in parks. Contract work is typically reserved for non-park locations that are too large in size for volunteers. It is important to be fiscally prepared to hire a contractor and not rely solely on volunteers.

Volunteers play a key role in the maintenance of GSI in Ann Arbor. With over 40 volunteer stewards who have adopted individual sites and approximately 30 group volunteer workdays, nearly 2,000 volunteer hours were logged in 2018. This work not only helps remove weeds, prune and plant new plants, volunteers are ambassadors in the community. Volunteers spread their knowledge and excitement about GSI to friends, family and people passing by the gardens.

City of Ann Arbor – Madison Avenue neighborhood planting workday. Photo by Linda Prieskorn.

GSI has the potential to improve stormwater management, create wildlife habitat and enhance the beauty of a neighborhood.

Conclusion

In most urban areas, municipal ROW is on the order of 15% of the drainage land area but has little or no stormwater treatment or retention. As a result, scientists estimate (Schuler, et al) around 50% of the stormwater and thus pollutant load for the community is from municipal ROW. So, maintenance needs in GSI should be appropriately budgeted for these assets to continue to function and be accepted by the public. Design techniques can be adjusted to allow for simplified maintenance and to create opportunities for volunteer involvement.

GSI has the potential to improve stormwater management, create wildlife habitat and enhance the beauty of a neighborhood. Maintenance is key for ongoing success and acceptance of GSI.

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