

## The Morton Arboretum Meadow Lake & Permeable Parking Lot-- Lisle, IL Methodology for Landscape Performance

### Environmental

- 1. Retains virtually 100% annual rainfall on the site, as supported by 10 years of observations. Only one unprecedented rain event resulted in flooding.**

The permeable parking lot, composed of cast concrete L-shaped pavers placed over a 4-foot bed of gravel, allows for storage and percolation of stormwater rather than a direct run-off into Meadow Lake. The reconstruction and expansion of Meadow Lake provides additional water storage, while maximizing filtration through the planted edge and constructed wetland. Before water enters Meadow Lake from the parking lot, it is filtered and infiltrated through bioswales leading to the constructed wetland. Figure 1.1 shows water flow.

The years 2004-2012 are confirmed by project drawings and SITES documentation showing no runoff left the site.<sup>1</sup> However, during discussions with the Morton Arboretum Natural Conservation and Landscape Architecture staff, we learned that one flood event has occurred since the project's completion. In April 2013, the Chicago metro region experienced unprecedented rainfall and overland flooding from the East DuPage River caused water from Meadow Lake to combine with floodwaters.<sup>2</sup> During this time the site performed as an overflow and flood storage for the river, prevent further downstream effects. The Arboretum staff confirmed this to be true during a meeting in May 2014.

#### *Methodology:*

Nearly 100% of rainfall on the parking lot infiltrates through the permeable parking lot pavers and the bioswales. Figures 1.2 and 1.3 show rainfall and runoff documentation from 2007. In that year, 31 inches of rain fell at the Morton Arboretum, 97.4% of rainfall infiltrated the parking lot. Only 0.81 inches or 2.6% of runoff left the parking lot to flow into the constructed wetland before reaching Meadow Lake.<sup>3</sup> The 2.6% of runoff leaving the permeable parking lot is captured through the site's stormwater system by flowing to the constructed wetland of Meadow Lake. Whereas, a typical asphalt parking lot (staff lot), in 2007, reported 13.35" or 43% of runoff. The permeable parking lot runoff reduction is particularly impressive considering its tributary area is over 375% larger than the staff lot.<sup>4</sup> Calculations for runoff and infiltration are provided.

---

<sup>1</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 3.5 Summary - Manage Stormwater On-Site. 25 June 2012.

<sup>2</sup> Interview. Kurt Dreisilker. Morton Arboretum Natural Resource Manager. 9 May 2014.

<sup>3</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 3.6 Protect and Enhance On-Site Water Resources and Receiving Water Quality. Wheaton SE NOAA Rainfall Gage, located on Morton Arboretum Property. 25 June 2012.

<sup>4</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 3.6 Protect and Enhance On-Site Water Resources and Receiving Water Quality. Burke Engineering. 25 June 2012.

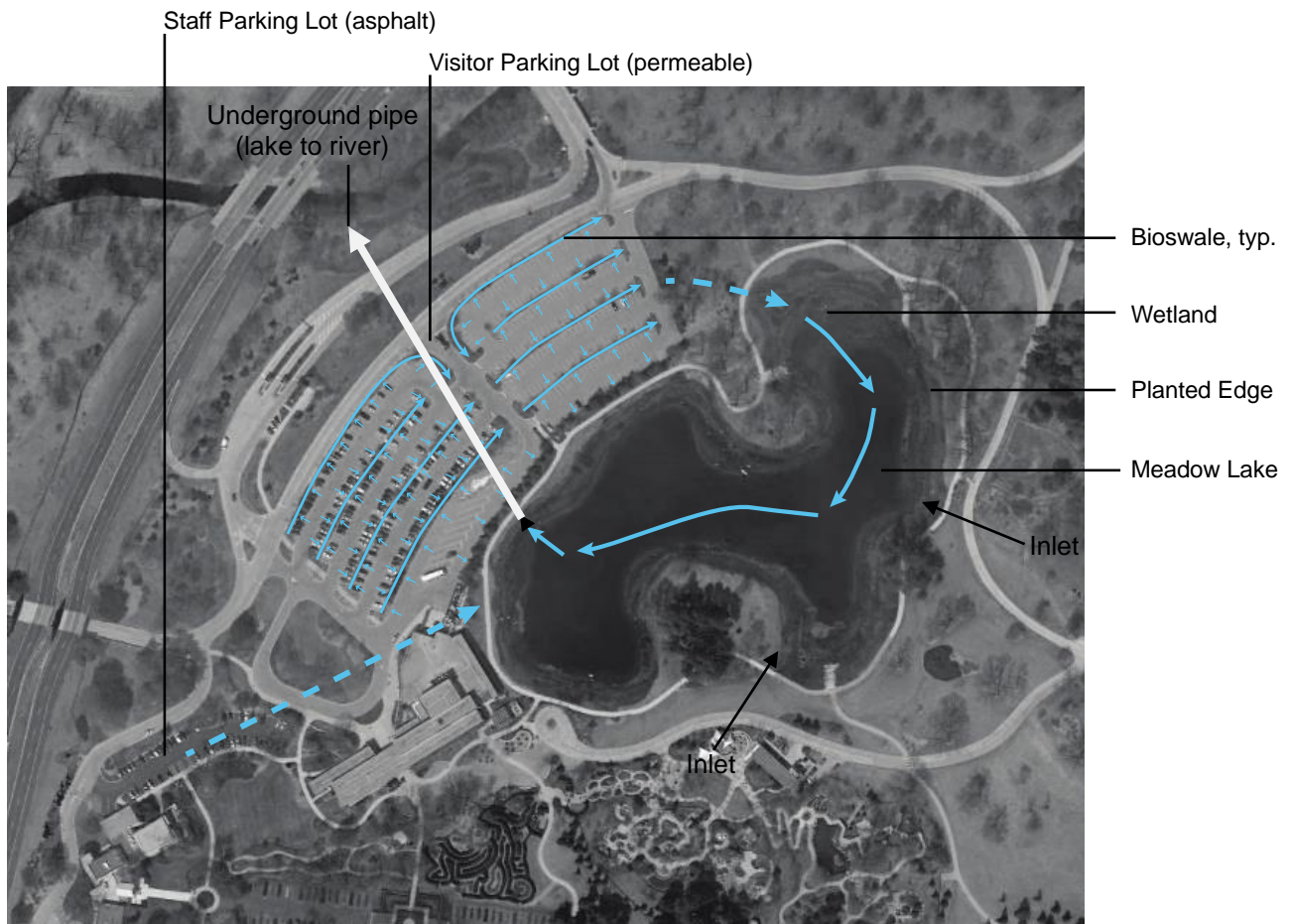


Figure 1.1, Water Flow at the Morton Arboretum Parking Lot & Meadow Lake

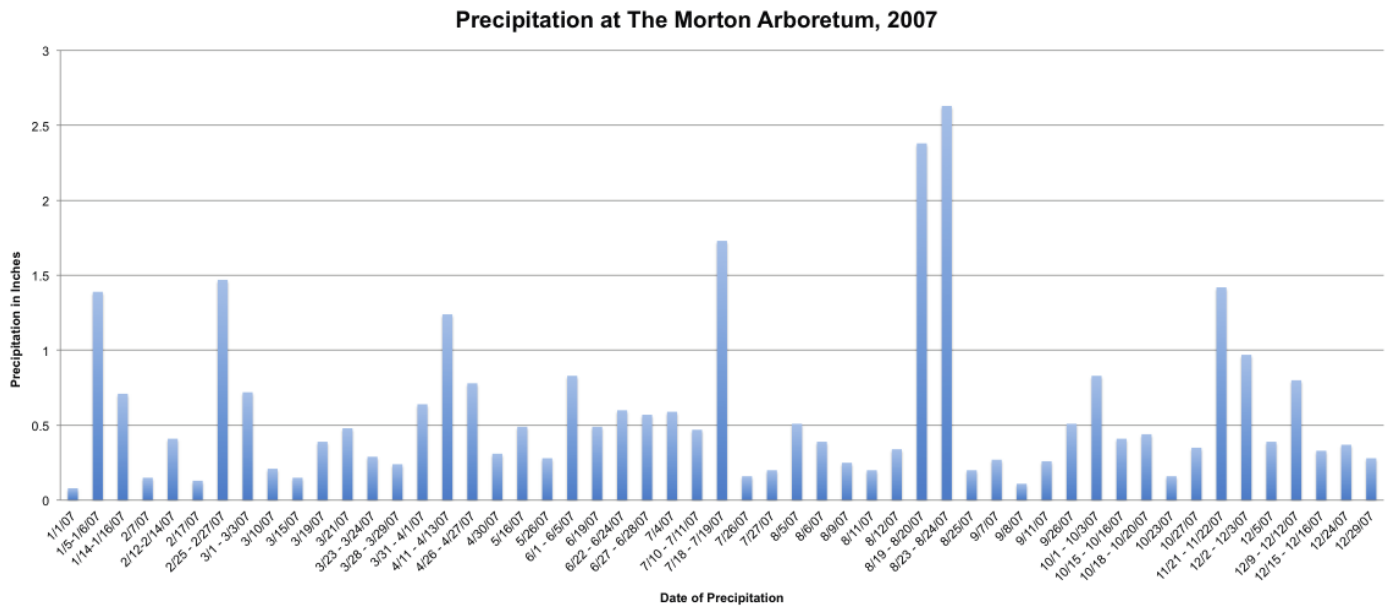


Figure 1.2, Graph of Precipitation at The Morton Arboretum for 2007. Graph based on information from the SITES 3.5 documentation.

### Parking Lot Runoff at The Morton Arboretum, 2007

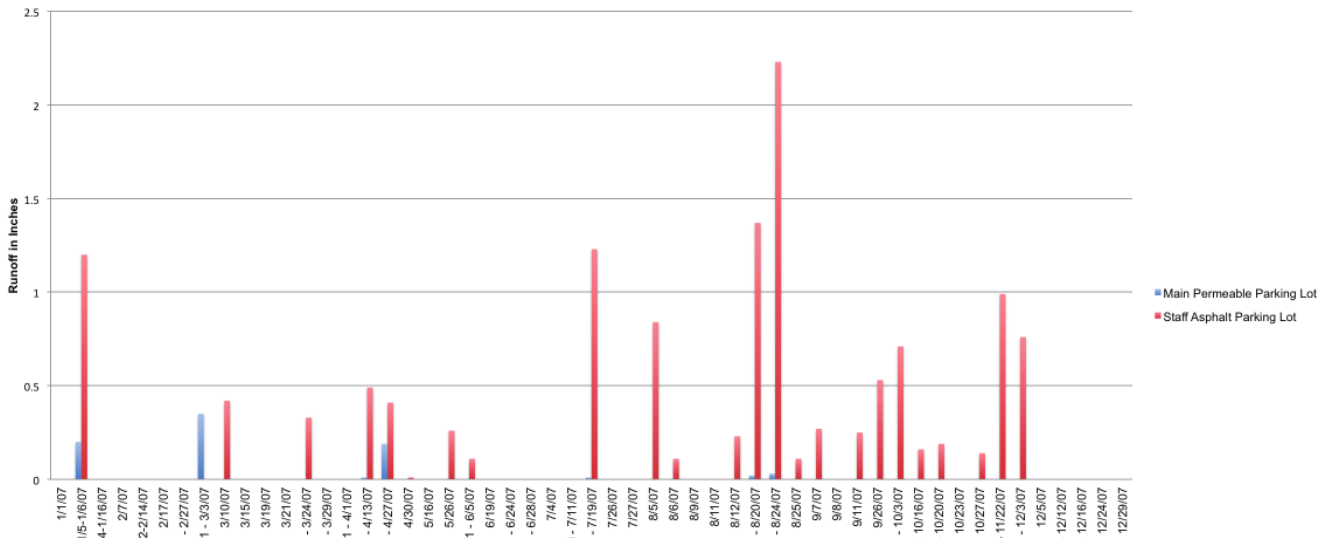


Figure 1.3, Graph of Runoff in Permeable & Asphalt Parking Lots at The Morton Arboretum for 2007. Graph based on information from the SITES 3.5 documentation.

### Permeable Parking vs. Asphalt Lot Runoff / Infiltration Calculations for 2007

Total Rainfall at The Morton Arboretum based on Wheaton Gage = 31 inches

Total Runoff for the Permeable Parking Lot = 0.81 inches

Total Runoff for Staff Asphalt Parking Lot = 13.35 inches

**Runoff of Permeable Parking Lot as Percent = 0.81 in / 31 in = 2.61%**

**Infiltration of Permeable Parking Lot as Percent = 100% - 2.61% = 97.39%**

Runoff of Staff Asphalt Parking Lot as Percent = 13.35 in / 31 in = 43.06%

Infiltration of Staff Asphalt Parking Lot as Percent = 100% - 43.06% = 56.94%

### 2. Improved water quality in Meadow Lake by helping to reduce Total Suspended Solids (TSS) by 84% and Total Phosphorus by 39%. Both reductions contribute to the penetration of sunlight and dissolved oxygen, and the increase in aquatic macrophytes.

As part of the Illinois Clean Lakes Program, Meadow Lake (a Clean Lakes Project) entered the program in 1998, and completed the Phase I Diagnostic-Feasibility Study<sup>5</sup> in 2001 that recommended stabilizing the lake's surface fluctuations and reducing phosphorous loads from groundwater and geese. Stabilizing the lake levels would increase sunlight penetration and water quality, reduce algal growth, and improve lake aesthetics. The recommendations, including the regrading of the lakeshore, construction of the slurry wall, installation of the weir and flapgate, and geese abatement, formed the basis of the Meadow Lake project beginning in 2003. Construction of the permeable parking lot and associated bioswales were then coordinated with the lake design in an overall water quality improvement scheme.

#### Data for Meadow Lake water quality:

<sup>5</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 3.6 Protect and Enhance On-Site Water Resources and Receiving Water Quality. Meadow Lake Phase II Report. Prepared for the Morton Arboretum by Baetis Environmental Services, Inc. in support of MWH Americas, Inc. April 2007. 25 June 2012.

Phase I of the Clean Lakes Project included gathering of data to produce the recommendation report in 2001, and data studies were again done in 2006 as part of Phase II monitoring. The water quality data between Phases I and II reveal that Meadow Lake was a success, showing a reduction in eutrophication effects, and increases in rooted aquatic macrophytes due to penetration of sunlight (evidenced by Secchi disc visibility from 26.7 inches prior to construction to 120.5 inches post-construction) and greater dissolved oxygen. The full data is available in the Meadow Lake Phase II Report, prepared for The Morton Arboretum by Baetis Environmental Services, Inc. in support of MWH Americas, Inc., dated 2007.<sup>6</sup> The benefit statement regarding TSS and phosphorus reductions data come from this report.

*Notes on water quality features:*

As described in SITES 3.6 documentation, the permeable pavements, bioswales and wetland “checkpoints” are integrated through the project site to infiltrate and filter water before runoff reaches Meadow Lake. These checkpoints and their associated water quality performance is as follows:

- PERMEABLE PAVERS receive pollutants directly and help to capture and filter suspended solids before water is discharged into the bioswales (permeable pavers can be swept or vacuumed with a street cleaner to help remove solids and pollutants that sit on pavement or within voids);
- BIOSWALES use planting to filter and remove heavy metals and pollutants can help to reduce pollutants such as phosphorous, aluminum, copper, nitrate, suspended solids, zinc, and turbidity; and
- NATURAL LAKE EDGE PLANTING with species that are effective in filtering stormwater pollutants work to filter copper, lead, zinc, nitrogen, phosphorous, pathogens, pesticides, fertilizer, and metals.

*The role of the checkpoints in increasing water quality within the Lake is of great value. In 2005, while Burke Engineering was gathering data related to run-off reduction (see water quantity benefit #1), they also utilized IEPA Spreadsheet Tool for Estimating Pollutant Load Region 5 Model. They used these reduction worksheets to estimate various pollutants of concern, including TSS, dissolved oxygen, Lead, Zinc, Total Nitrogen, and Total Phosphorus to estimate reductions of each pollutant. For example, for TSS, they showed that TSS is reduced by 90% through porous pavement, 75% through bioswales, 76% through the wetland, and 60% through shoreline planting.*

Plants used in the bioswales and wetlands were chosen for their performance within the site and generally are not fertilized. Based on North Carolina State University’s SoilFacts, nitrogen can make up between 13-82% of the weight of a given commercial fertilizer, while phosphorous can be 3-27% of a fertilizer’s weight.<sup>7</sup> Given the water quality improvement detailed above, the limited fertilizer use does not seem to negatively impact Meadow Lake.

### **3. Saves approximately 327,700 gallons of potable water for the peak month of July by using**

---

<sup>6</sup>The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 3.6 Protect and Enhance On-Site Water Resources and Receiving Water Quality. Meadow Lake Phase II Report. Prepared for the Morton Arboretum by Baetis Environmental Services, Inc. in support of MWH Americas, Inc. April 2007. 25 June 2012.

<sup>7</sup> North Carolina State University. SoilFacts. *Nutrient Content of Fertilizer and Organic Materials*. <http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-18/>. Accessed 14 July 2014.

## **non-potable lake water for irrigation.**

The main permeable parking lot to The Morton Arboretum is the first entry point for visitors. As a display garden facility, The Arboretum knows that irrigation is necessary to keep plants looking their best. With this requirement in mind, The Arboretum designed the system to use non-potable water from Meadow Lake for the parking lot bioswale display gardens. During peak months from late April to November,<sup>8</sup> supplemental irrigation of the bioswales, and on occasion Meadow Lake's edge, ensures plants are alive and healthy. Meadow Lake's plantings are seldom irrigated except during extreme conditions or new planting installation. In these instances, quick couplers installed around Meadow Lake are used with hoses and sprinklers to efficiently provide water to plants.

### *Methodology:*

The parking lot bioswales include high efficiency pop-up head irrigation. These spaces are generally watered for 1 hour, 3 to 4 days per week. In times of extreme drought and heat, the irrigation runs daily for 1 hour and occasionally twice per day when necessary. The Morton Arboretum calculated typical irrigation for the peak month of July and is shown in the calculations.<sup>9</sup> Based on the documentation, a total of 327,731 gallons of potable water are saved during July, which is considered to be a peak month for irrigation at the Arboretum.

Meadow Lake has the capacity to handle the irrigation needs of the permeable parking lot and surrounding site. The amount of water used for irrigation from Meadow Lake makes up approximately 3% of its volume, shown in the calculations. The Arboretum SITES documentation lists the average rainfall for July in Lisle, Illinois as 3.9 inches. The lake and wetland system make up 7 acres. Displayed in the calculations below, it is clear that Meadow Lake sufficiently replenishes water from rainfall and has an on-site well to use in drought conditions. Despite using 327,731 gallons for irrigation, on average rainfall adds approximately 413,581 gallons or 3.9% of the lake's volume during July.

### **Average Rainfall & Irrigation Calculations**

July rainfall = 3.9 inches = .325 feet

Meadow Lake = 7 acres = 304,920 sf

July rainfall = .325 f x 304,920 sf = 99,099 cf

Conversion = 1 cf = 7.48 gallons

July rainfall = 99,099 cf x 7.48 gallons = 741,312 gallons

July irrigation = 327,731 gallons

Meadow Lake replenishment = 741,312 gallons - 327,731 gallons = 413,581 gallons

Rainfall Replenishment as Percent of Meadow Lake = 413,581 / 10,719,561 = 0.0386 = 3.86%

### **Irrigation Data for Month of July (31 days), adapted from *The Morton Arboretum SITES 3.2 Credit Documentation***

Total Mist Heads = 508 @ 0.27 gpm each = 137 gpm

Number of cycles per week = 12 @ 45 minutes per cycle = 540 minutes

Total gallons per week = 540 minutes x 137 gpm = 73,980 gallons per week

---

<sup>8</sup> Email correspondence. Ronald Picco. Morton Arboretum Horticulture Specialist. 17 June 2014.

<sup>9</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 3.2 Summary - Reduce Potable Water use for Landscape Irrigation by 50% or More. 2 April 2012.

Total gallons per month of July = 73,980 gallons x 4.43 weeks = 327,731.4 gallons per month  
Total Meadow Lake volume = 10,719,561 gallons at normal water line  
Monthly Irrigation Usage as Percent of Meadow Lake = 327,731 / 10,719,561 = 0.030 = 3%

#### **4. Increased the Biomass Density Index -- a measure of the density of plant layers covering the ground -- by 10% around Meadow Lake and the parking lot.**

Prior to the reconstruction of The Morton Arboretum's main parking lot and Meadow Lake, the planting within the site was minimal. Meadow Lake, previously a degraded detention basin, lacked edge plantings and instead had significant undercut edges. During redesign, the space became an opportunity to provide a space for recreation near the visitor center while also holding stormwater. The significant increase in planted surfaces in both the parking lot and around Meadow Lake raised the biomass density index (BDI) from pre- to post-construction by 10%. Biomass density is a useful indicator to understand how vegetation can promote improvement in pollutant reduction, water absorption, greenhouse gas regulation, and microclimate regulation.<sup>10</sup>

The BDI tables and calculations can be seen in Tables 4.1 and 4.2, and come from the application for SITES credit 4.6.<sup>11</sup> For this credit, The Arboretum calculated pre-construction conditions and post-construction or planned site BDI for 10 years after landscape installation. As the project was completed in 2005, the planned BDI is for conditions in 2015. To determine the accuracy of the planned conditions, we have referenced current planting based on an aerial photograph taken by Google on April 2, 2013 with The Arboretum's planned BDI map. It appears that the planned and actual conditions are quite similar. Figure 4.3 shows the map of post-construction overlaid by the aerial photograph.

##### **Biomass Density Index Increase Calculations**

Existing Biomass Density Index (Pre-construction) = 1.92

Planned Biomass Density Index (Post-construction in year 2015) = 2.12

Percent Increase from Existing to Planned =  $(2.12 - 1.92) / 1.92 = 10.4\%$

---

<sup>10</sup> SITES, Guidelines and Performance Benchmarks, 2009. Available here: <http://www3.cec.org/islandora-gb/en/islandora/object/islandora%3A1146/datastream/OBJ-EN/view>. Accessed 15 July 2014.

<sup>11</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 4.6 - Preserve or Restore Appropriate Plant Biomass On Site. 19 May 2011.

Land Cover/ vegetation type zones	Biomass density index* for this zone	Percent of total site area for this zone	Biomass density value x percent of total site area (column B x column C)	Land Cover/ vegetation type zones	Biomass density index* for this zone	Percent of total site area for this zone	Biomass density value x percent of total site area (column B x column C)
A	B	C	D	A	B	C	D
Trees with understory	6	0	0.00	Trees with understory	6	23	1.38
Trees without understory (less than 10 percent herbaceous/ shrub cover)	4	26	1.04	Trees without understory (less than 10 percent herbaceous/ shrub cover)	4	10	0.40
Shrubs	3	2	0.06	Shrubs	3		0.00
Desert plants	1.5		0.00	Desert plants	1.5		0.00
Annual plantings	1.5		0.00	Annual plantings	1.5		0.00
Grasslands and turfgrass	2	41	0.82	Grasslands and turfgrass	2	17	0.34
Wetlands**	6		0.00	Wetlands**	6		0.00
Impervious cover or bare ground not shaded by vegetation structures	0	31	0.00	Impervious cover or bare ground not shaded by vegetation structures	0	50	0.00
SUBTOTAL (sum of all rows)	n/a	100	1.92	SUBTOTAL (sum of all rows)	n/a	100	2.12
ADDITIONAL VALUE for other horizontal and vertical surfaces covered with vegetation (e.g., green walls, trellises, pergolas), if applicable: Calculate the total surface area of the vegetated surface, multiply by a biomass density value of 1, and divide by the total site area.				ADDITIONAL VALUE for other horizontal and vertical surfaces covered with vegetation (e.g., green walls, trellises, pergolas), if applicable: Calculate the total surface area of the vegetated surface, multiply by a biomass density value of 1, and divide by the total site area.			
<b>Existing Site BDI (sum of Subtotal and Additional Value)</b>			<b>1.92</b>	<b>Planned Site BDI (sum of Subtotal and Additional Value)</b>			<b>2.12</b>

Table 4.1, Pre-Construction (Existing) Site BDI

Table 4.2, Post-Construction (Planned) Site BDI

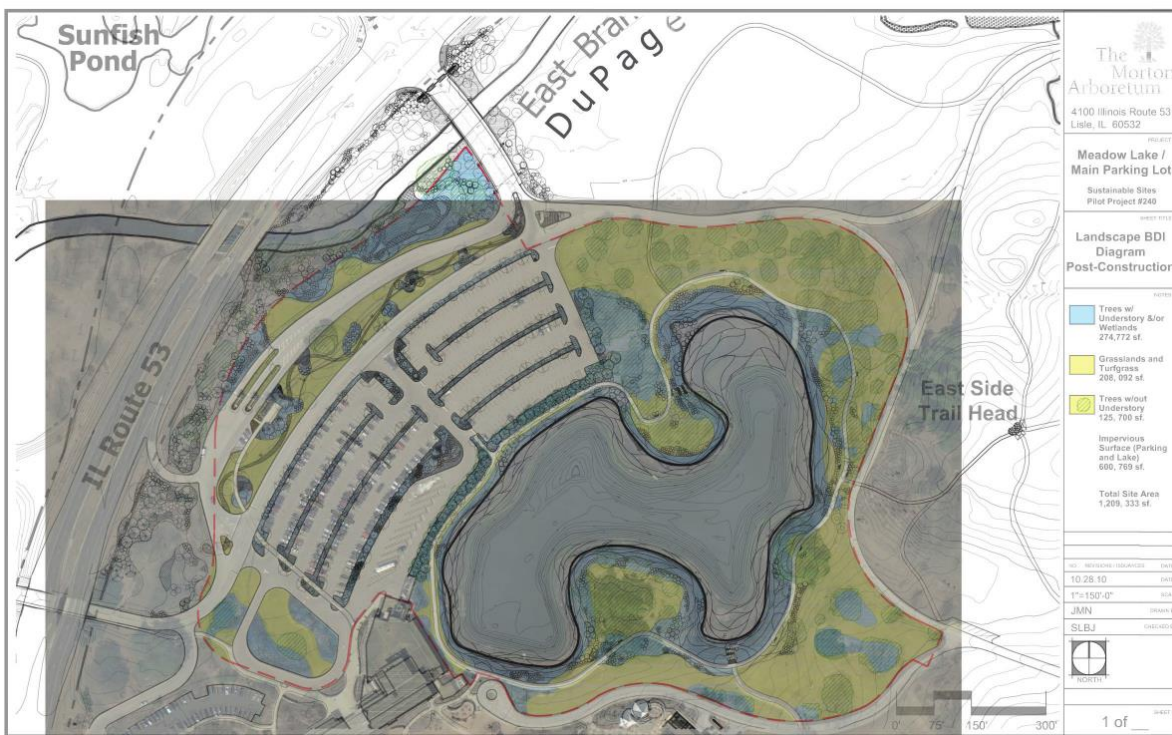


Figure 4.3, Post-Construction BDI compared to Current Aerial with Vegetation

**Limitations of research:**

Current BDI reference image is over one year old as the photograph is from 2013. The image, taken in early April, was a time when plants had limited foliage. As BDI uses leaf coverage for surface area calculation, this poses a limitation.

**5. Prevents the establishment of all invasive species around Meadow Lake through ongoing monitoring and integrated pest management.**

Integrated pest management techniques are used to ensure invasive species are controlled around Meadow Lake’s edge or within the parking lot bioswales. Integrated pest management (IPM) processes that the Arboretum follows fall within IPM’s four-tier approach. The steps of IPM include setting action

thresholds; monitoring and identifying potential pests on a regular basis, using prevention tactics in advance of treatment, and when control is required, using the least damaging but most effective method of pest removal.<sup>12</sup> The Arboretum maintenance staff conducts daily and/or weekly monitoring for signs of pests and treats any problems early through use of spot treatment rather than large swath pesticide spraying. Staff are trained to recognize potential problems before they become large-scale issues and higher level staff experts are often consulted to determine the best course of action.<sup>13</sup> Since construction, Meadow Lake has not had any invasive species communities established within its edge plantings.<sup>14</sup>

### **Invasive Species Monitoring Procedures**

<i>Activity</i>	<i>Frequency</i>	<i>Staffing Requirements</i>
Hand weeding & spot herbicide treatment needed, volunteers	daily review	3 full time, seasonal as
Maintenance & review for irregularities as needed	daily	3 full time, seasonal
Identified pests & diseases - spot treatments/removal seasonal as needed	weekly monitoring	3 full time,
Educate maintenance staff about invasive species maintenance crews	as needed	high level staff &
Educate & inform volunteers and visitors responsible	as needed	collective approach - all
Monitoring for new regional invasive species & maintenance crews remove	constant	high level staff
Controlled burns in wetland / prairie of Meadow Lake maintenance & consultants	spring	trained

#### *Notes on Meadow Lake planting design:*

The Morton Arboretum’s Meadow Lake functions not only as a water treatment and retention basin but also as a landscape amenity. It is a highly managed garden that is an example of maintained native plants using a naturalistic design approach. In order for The Arboretum to keep Meadow Lake’s edge distinct, native plants are grouped in clusters of one or two dominant species. As native plants have tendencies to seed and spread, the clear groups of plants require a great deal of maintenance and any plants that move beyond their cluster groupings are considered 'weeds' from a design standpoint. They are removed to ensure the cohesion is visible.<sup>15</sup>

Another aspect of this highly maintained native planting is that it is costly to keep looking properly arranged. The Morton Arboretum understands this regime may not be suitable for all parties interested in native planted lakes. As a display garden facility, they are committed to maintaining the garden’s visual appearance and design intent, and having a full-time employee dedicated to working at Meadow Lake, as well as many volunteers.

<sup>12</sup> US EPA, Integrated Pest Management Principles. <http://www.epa.gov/opp00001/factsheets/ipm.htm>.

<sup>13</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 8.1 - Site Maintenance Plan Worksheet. 25 June 2012.

<sup>14</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 4.1 - Control and Manage Known Invasive Plants Found Onsite. 25 June 2012.

<sup>15</sup> Interview. Kurt Dreisilker. Natural Resources Manager at The Morton Arboretum. 29 May 2014.



**8. Reused approximately 31,000 cu yd of excavated soil and fill materials from the parking lot site to create a portion of a berm to buffer the Arboretum from the adjacent highway.**

The Morton Arboretum's construction of the new permeable parking lot and lake expansion coincided with a decision to create a noise and pollutant barrier berm from the adjacent roadways. Interstate 88 borders the Arboretum's property to the south, while Highway 53 runs between the property's east and west sides. At the time, Interstate 88 was problematic to The Arboretum's plants and grounds by causing pollution and high noise levels. Excavated soil and fill from the permeable parking lot and Meadow Lake expansion were used in the construction of a portion of the protective berm along the property's southern edge.

*Methodology:*

An estimated amount of material saved was calculated as part of The Arboretum's SITES application 7.5 credit. Numbers used are based on available documentation and testing conducted on The Arboretum grounds for typical material depths. Materials are separated by category, topsoil, mineral/rock, and vegetative waste. Calculations provided for material reuse amounts.

**Soil & Material Savings Assumptions <sup>16</sup>**

Area disturbed by construction = 394,239 SF (includes parking lot with bioswales area = 287,092 SF & surrounding construction area = 107,147 SF)

Meadow Lake surface area expansion = 60,984 SF

Volume of additional lake excavated = 4.86 AF (acre feet) = 7,840.8 CY

Original topsoil depth (based on average of soil test results) = 1.19'

Average depth of mineral / rock excavation (non-topsoil) in areas outside lake expansion = 0.25'

\*Average depth of vegetative materials (used for generating volume of materials) = 0.125'

\*Depth of vegetative materials accounts for turf, herbaceous materials, chipped trees, shrubs, etc.

**Topsoil Savings Calculation**

Total disturbed area and lake excavation surface area = 394,239 SF + 60,984 SF = 455,223 SF

Total Savings = 455,223 SF x 1.19 F = 541,715.37 CF

Total CY Savings 541,715.37 CF = 20,063.5 CY

**Total Mineral / Rock Calculation**

Total Disturbed Area = 394,239 SF

Total Savings = 394,239 SF x 0.25 F = 98,559.75 CF

Total CY Savings = 98,559.75 CF = 3,650 CY

Total Lake Excavation = 7,840.8 CY

Total Lake Excavation of Topsoil = 2,687 CY

Total Mineral / Rock Savings = 3,650 CY + 7,840.8 CY - 2,687 CY = 8,803 CY

**Total Vegetative Waste Calculation**

Total disturbed area and lake excavation surface area = 394,239 SF + 60,984 SF = 455,223 SF

---

<sup>16</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 7.5 Summary - Reuse or Recycle Vegetation, Rocks, and Soil Generated During Construction. 2 April 2012.

Total Savings = 455,223 SF x 0.125 F = 56,902.9 SF

Total CY Savings = 56,902.9 SF = 2,107.5 CY

**Total Material Savings = 20,063.5 + 8,803 + 2,107.5 = 30,974 CY**

**9. Supplements the Arboretum topsoil production with nearly 100% or 138-cy of the site's plant debris and clippings composted annually.**

To promote sustainable practices, the Morton Arboretum composts all of its healthy yard waste onsite. Wood materials are chipped and stored for reuse while other plant debris is composted. The Arboretum maintains three everyday compost bins in which clippings from the entire grounds are placed. The bins are separated by wood material and chips; wood chips that have been shredded and treated for use as premium bark mulch, and leafy material for leaf mold composting. When these bins become full, maintenance crews haul the compost to The Arboretum's general composting collection site and the compost is used to supplement topsoil making.<sup>17</sup> Figure 10.1<sup>18</sup> shows the proximity of the three compost bins to Meadow Lake and the parking lot as well as the location of the general composting collection.

*Methodology:*

To calculate the amount of debris collected on-site and composted on Arboretum grounds, SITES 8.3 documentation has been used. In 8.3-1, The Arboretum states that approximately 1.5 dump trailers worth of landscape material is gathered from the site on a weekly basis during the months of collection, April to October. Each trailer holds 3-cy of waste, which calculates to 137.7-cy of material composted for soil making annually.

**Meadow Lake and Permeable Parking Lot Landscape Waste Calculations**

1.5 dump trailers x 3 CY = 4.5 CY of landscape waste

April 1 - October 31 = 30.6 weeks

4.5 CY x 30.6 weeks = 137.7 CY of landscape waste is composted annually

---

<sup>17</sup> Email correspondence. P.J. Smith. Morton Arboretum Construction Supervisor. 30 June 2014.

<sup>18</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 8.3 - Summary, Physical Activity Opportunity Map. 28 October 2010.

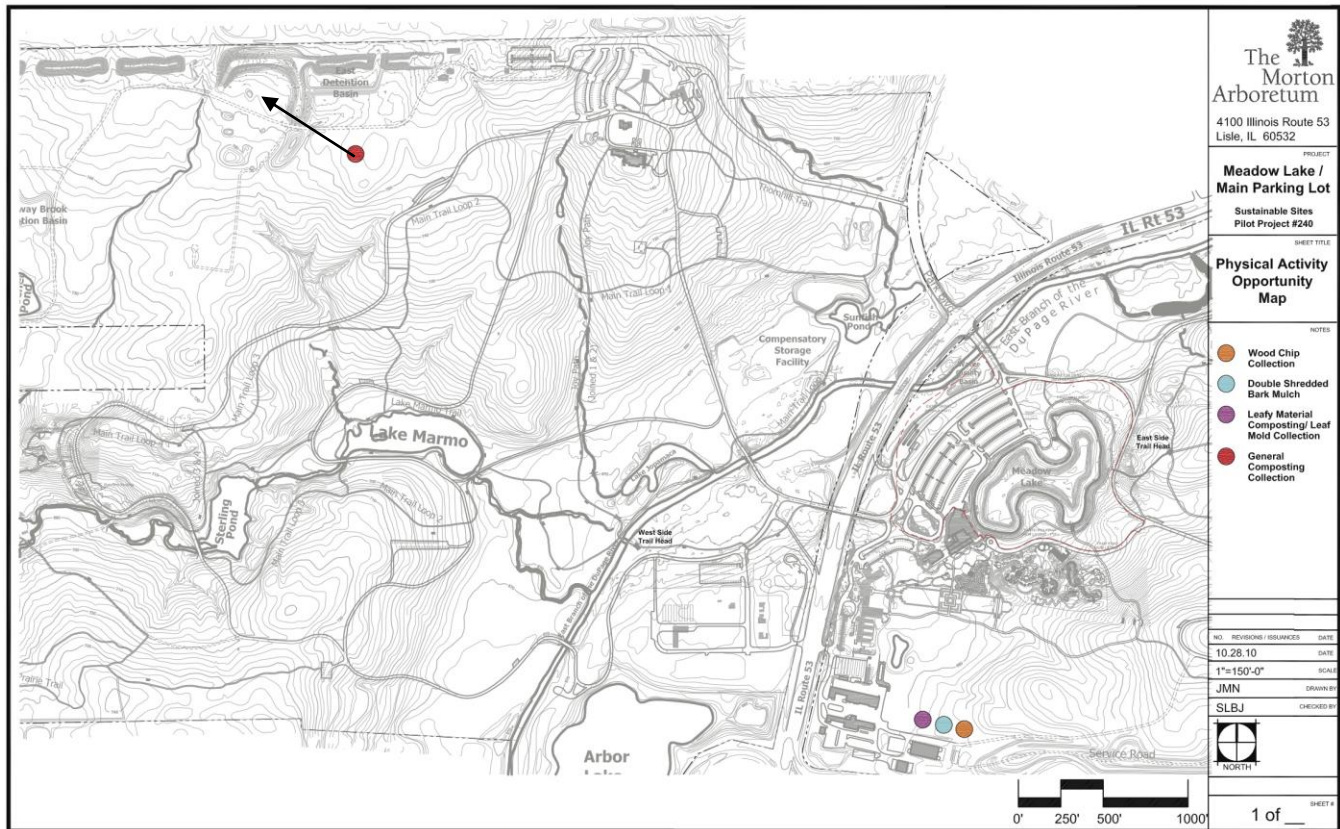


Figure 9.1, Map of Composting Locations at The Morton Arboretum

*Limitations of research:*

Only dangerously diseased plant material that would put soil making at risk of contaminating new planting would not be composted with the rest of the Arboretum’s plant clippings. Diseased plants are removed from Meadow Lake or the parking lot bioswales and special care is taken to avoid spreading plant disease further. Although, the Arboretum has a very low rate of diseased plant material because plants are carefully monitored and problems are dealt with early as part of invasive species management and plant health. If diseased plant material is removed from site, careful procedures are in place to avoid contamination of other plants, and then it is either burned or chipped and taken offsite.<sup>19</sup> The Arboretum does quantify percent of material that is diseased or amount of materials collected that is not composted it is nearly 100%.

**Social**

**6. Educates the Arboretum’s 850,000 annual visitors about the stormwater management features with 34% of Arboretum members and 32% of volunteers surveyed saying that they learned something new from the interpretive signs.**

When people arrive at the Arboretum, they typically park in the main permeable parking lot. Visitors walking through the parking lot can view the educational signage that promotes stormwater

<sup>19</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 8.1-3 - Site Maintenance Plan Worksheet. 25 June 2012.

management awareness, and permeable parking and native planting benefits. The Visitor Center provides a starting or return point for patrons of the Arboretum with amenities including a dining room overlooking Meadow Lake, an information desk with personnel available to answer questions, and additional informational brochures. Visitors frequently use this facility along with the main permeable parking lot and Meadow Lake.

When The Morton Arboretum completed a master plan redevelopment as part of a capital improvement expansion program, it focused efforts on becoming an institution that would attract a wide range of users.<sup>20</sup> The Arboretum visitorship expanded from 350,000 to 850,000 annually.<sup>21</sup> Although The Arboretum's attendance numbers fluctuate from year to year, in the last few they have remained over 850,000, and in 2013 exceeded that number by more than 30,000 to accommodate a total of 884,600 visitors.<sup>22</sup>

#### *Methodology:*

Questionnaire-based surveys were sent via email with a Survey Monkey link to two communities of The Morton Arboretum- members and volunteers with assistance from Susan Jacobson, landscape architect at The Arboretum. The question formats included multiple choice, multiple selection and ranking choices. Approximately 3,800 members selected at random were emailed with the survey and we received 368 member responses. The volunteer surveys sent out to 900 yielded 261 responses.

The surveys gathered feedback on interaction with and perception of Meadow Lake and the permeable parking lot. A goal of the surveys was to learn about visitor and volunteer understanding of the stormwater features included in this site. When questioned about awareness of the stormwater management features of The Arboretum's main parking lot and its functional relationship to Meadow Lake, 50% of volunteers selected the answer, "Yes, I'm very familiar," while 42% selected "Yes, somewhat, I don't know how they work, but I know the parking lot and lake help to retain water and improve water quality." When asked the same question, members responded by 26% stating, "Yes, I'm very familiar" and 52% with "Yes, somewhat..." Of members, 23% were not aware of the stormwater features, while only 9% of volunteers stated they were unaware of this aspect of the site. This question achieved a 93% response rate (243 of 261) for volunteers and a nearly 100% response rate from members (367 of 368).

When questioned about the usefulness of interpretive signage throughout the main parking lot, 33% of volunteers and 34% of members learned new information, whereas 38% of volunteers and 22% of members were previously aware of the information but classify the signs as helpful to educate visitors. Although the majority of survey respondents appreciate the educational component of the parking lot, 16% of volunteers and 16% of members believe the signs are helpful but even more education could be provided on the parking lot stormwater management features. Comments regarding active education on the parking lot included training for designers, builders and homeowners on the merits of permeable pavement and stormwater management construction, providing information about the actual costs and savings of the parking lot system now that it has been in place for several years, and giving examples

---

<sup>20</sup> Interview. Susan Jacobson. Landscape Architect at The Morton Arboretum. 2 April 2014.

<sup>21</sup> The Sustainable SITES Initiative. 2013. The Meadow Lake / Main Parking Lot at the Morton Arboretum. <http://www.sustainable-sites.org/caseimages/show.php?id=40>. Accessed 25 March 2014.

<sup>22</sup> Email Correspondence with Susan Jacobson, Landscape Architect at The Morton Arboretum. 2 & 15 July 2014.

of other projects in the region to visit that use similar permeable pavement. This question achieved a 93% response rate (244 of 261) for volunteers and a nearly 100% response rate from members (367 of 368).

Lastly, while members and volunteers seem to appreciate the stormwater management and water quality improvement features of the parking lot and Meadow Lake systems, they provided feedback regarding the functionality of permeable pavement. Numerous comments throughout both surveys reflected difficulty of walking on the surface, especially for seniors, women in high heels and children. Although these types of pavement do a lot to mitigate environmental concerns, they are not without design challenges regarding human interaction. It is worth noting that this was a first generation of permeable pavement that has since been refined in design, and newer permeable pavements have been adjusted to address this issue.

**7. Draws people to the lake, with over 85% of volunteers and 83% of members saying that they visit Meadow Lake every time they visit the Arboretum. Reasons include physical exercise, mental restoration and to experience nature.**

Based on the surveys of Morton Arboretum members and volunteers, researchers gained insight as to how many and for what purpose members and volunteers use Meadow Lake. Both user groups reported visiting Meadow Lake during each visit, regardless of their primary reason for being at the Arboretum.

Volunteers were asked if they perform duties that include interaction with Meadow Lake, 42% responded yes to this statement. Included in these duties are plant and bird monitoring, safety patrol, maintenance, docent tours, and educational workshops. Despite less than half of volunteers working at Meadow Lake, 85% stated they visit the lake for personal reasons while volunteering at the Arboretum. A second question intended to understand why volunteers choose to spend time at Meadow Lake. Volunteers were asked to select all that apply as reasons for personal visits to Meadow Lake. Results of the survey were to experience nature, such as animal and bird watching (66%), for physical exercise (64%), for mental restoration (56%), for social reasons (25%), and other (8%). Among the 'other' selection, reasons included photography, personal inventories of plants, and to educate others about the pollution control aspect of the wetland and lake edge plantings.

The member survey asked respondents to rank reasons for visiting Meadow Lake. Members' primary reasons included physical exercise (45%), to experience nature (24%), mental restoration (18%), social activity (11%), and educational purposes (3%). Secondary reasons to visit the lake were to experience nature (27%), mental restoration (26%), physical exercise (26%), social activity (19%), and education purposes (2%). Tertiary reasons were mental restoration (33%), social reasons (22%), experience nature (21%), physical exercise (17%), and educational purposes (7%).

In addition, members were questioned if Meadow Lake provides any of the following: calms and restores mental state, provides a beautiful setting for small social gatherings, is a beautiful background to the Visitor Center dining room, or is an important educational component of the Arboretum. Choosing all that apply, members responded with it is a beautiful background to the Visitor Center dining room (88.9%), it calms and restores mental state (66.3%), provides beautiful setting for small social

gatherings (44.9%), is an important educational component (35.7%), and other (6.9%). Further information provided in comments suggested that Meadow Lake is accessible for small children and seniors because of its paved pathways. Families with children enjoy the stairs to the wetland and lakefront.

It is fair to say that a large portion of attendees to the Arboretum interact with Meadow Lake on some level. Additionally, numerous events use Meadow Lake and its surrounding area as a meeting point, as the main location of an event, or as staging grounds. A list of events that take place in this area is provided.<sup>23</sup>

### **Meadow Lake Events<sup>24</sup>**

April	Arbor Day 10k Run
April	Arbor Day Tree Planting & Stories with Curious George
May	Mother's Day Celebration
May & September	Tails on the Trails
June	Habitat History Walk: Meadow Lake <sup>25</sup>
June - August	Thursday Family Nights <sup>26</sup>
June - August	Summer Science Camp
October	Fall Color 5k Run & Walk
October	Fall Color Festival
October	Scarecrow Walk at Meadow Lake involves local school & scout groups
2009 - 2011	Nature Art Exhibits - installations around Meadow Lake

## **Economic**

### **10. Saves approximately \$3,300 annually and over 235 maintenance hours through efficient spring burning versus only hand weeding around Meadow Lake.**

The Illinois DNR states that prairie burning “is an excellent management tool”<sup>27</sup> and The Morton Arboretum promotes environmentally sustainable maintenance practices while creating efficient procedures. Seasonal burning closely reflects the historic natural processes of a prairie ecosystem that once dominated in this region. Rather than dead heading, burning provides a faster, more efficient way of removing plant debris, and is a common regional landscape practice for managing prairie and wetland ecosystems.

The Arboretum typically burns Meadow Lake during the spring on an annual basis. Plantings are

---

<sup>23</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 6.2 Summary - Promote Equitable Site Use. 2 April 2012.

<sup>24</sup> The Morton Arboretum. Events and Programs. Links available to listed events. <http://www.mortonarb.org/visit-explore/plan-visit/events-and-programs>. Accessed 12 June 2014.

<sup>25</sup> The Morton Arboretum. Learn & Experience. Habitat History Walk. <http://www.mortonarb.org/courses/habitat-history-walk-meadow-lake>. Accessed 16 June 2014.

<sup>26</sup> The Morton Arboretum. Science Camp. <http://www.mortonarb.org/learn-experience/kid-and-family-programs/science-camp>. Accessed 12 June 2014.

<sup>27</sup> Illinois DNR, *Prairie Establishment and Landscaping. Part I: Prairie Establishment, Prescribed Burning*. 1997. <http://dnr.state.il.us/conservation/naturalheritage/prairie/burn.htm>. Accessed 15 July 2014.

grouped so that herbaceous material is in one area when burning occurs. Woody species are planted in limited quantities in select areas and are protected during burning, though sometimes the burning can reach these plants. Controlled burns help to remove brown and dried herbaceous material and burns are completed on days when the weather conditions are appropriate.

#### *Methodology:*

Based on the May 29, 2014 site walk and interview with Kurt Dreisilker, burning at Meadow Lake takes place in the morning hours when fewer visitors are present. Burning is completed by midday and typically lasts between 5-6 hours from preparation to completion. Meadow Lake landscape maintenance employees' duties include weeding, an activity that takes between 30 minutes and three hours per 1,000-sf according to Dow AgroSciences Hand-Weeding Calculator.<sup>28</sup> As Meadow Lake does not have established invasive species present, the majority of weeding that takes place is removal of native plants that have relocated to unwanted areas within the planting design, and therefore is predicted to take less time than a typical prairie, approximately 30 minutes per 1,000-sf. The area with native plants that would require weeding is 120,510-sf. Using the hand-weeding calculator information, Meadow Lake's planting would take 60.26 hours to completely weed and would cost approximately \$755 per hand-weeding cycle, or \$3010 per year. According to the *Sourcebook on Natural Landscaping for Local Officials* and Pizzo Associates, prairie burning costs \$550 per year for a five-acre site.<sup>29</sup> Since the Meadow Lake burn area is only 2.77 acres, using these numbers, the Morton Arboretum saves \$2,708.30. Seasonal prescribed burning also equates to a savings of over 235 hours when compared with time-spent hand weeding. Calculations provided demonstrate specific information.

### **Hand Weeding & Burning Calculations**

#### *Hand Weeding Time Spent*

Average length of time to hand-weed 1,000-sf = 0.5 hrs

Meadow Lake weeded area = 120,510 sf = 2.77 acres

Average length of time to hand-weed Meadow Lake edge planting =  $120,510/1000 = 120.51 \text{ sf} \times 30 \text{ min} = 3,615.3 \text{ min}/60 \text{ min} = 60.26 \text{ hrs}$

Average time spent hand-weeding per year =  $60.26 \text{ hrs} \times 4 [1 \text{ major weeding per season}] = 241.04 \text{ hrs}$

#### *Handing-weeding Costs*

Average cost to hand-weed per hour = \$15

Average cost to hand-weed one acre =  $43,560 \text{ sf} / 1000 \text{ sf} = 43.56 \text{ sf} \times 30 \text{ min} = 1306.8 \text{ min} / 60 \text{ min} = 21.78 \text{ hrs} \times \$15 = \$326.70$

Average cost to hand-weed Meadow Lake =  $\$326.70 \times 2.77 \text{ ac} = \$904.96$

Average annual cost of hand-weeding =  $\$15 \times 241.04 \text{ hrs} = \$3,615.60$

#### *Burning Time Spent*

Average length of time to burn half of Meadow Lake planting = 5-6 hrs

Average number of times burning occurs per year = 1

Average length of time spent burning Meadow Lake planting per year =  $5.5 \text{ hrs} \times 1 = 5.5 \text{ hrs}$

#### *Burning Costs*

Annual expense to burn after initial 5 year establishment period = \$550 per year for 5 acres

Annual expense to burn one acre =  $\$550 / 5 = \$110 \text{ per acre}$

---

<sup>28</sup> Dow AgroSciences. Hand-weeding Calculator. <http://www.dowagro.com/turf/calculator/>. Accessed 15 July 2014.

<sup>29</sup> Sourcebook on Natural Landscaping for Local Officials.

[http://www.chicagowilderness.org/files/4413/3087/4878/natural\\_landscaping\\_sourcebook.pdf](http://www.chicagowilderness.org/files/4413/3087/4878/natural_landscaping_sourcebook.pdf)

Meadow Lake weeded area = 120,510 sf = 2.77 acres

Annual Meadow Lake burn expense = \$110 x 2.77 = \$304.70

*Burning vs. Hand-weeding Time & Cost Savings*

Annual time spent hand-weeding = 241 hrs

Annual time spent burning = 5.5 hrs

Annual time savings by using burning = 241 - 5.5 = 235.5 hrs

Annual hand-weeding expense = \$3,615.60

Annual burning expense = \$304.70

Annual cost savings by using burning = \$3,615.60 - \$304.70 = \$3,310.90

#### *Limitations of research:*

This case study as well as the SITES application for this project site has alerted The Morton Arboretum to recognize the need for better record of maintenance regimes. While design and administrative staff work to improve this issue, it proves challenging because maintenance crews are not accustomed to this type of record keeping. Numbers used for time spent burning and hand-weeding are estimates based on discussion with Morton Arboretum staff. The salary information is not an actual salary of Morton Arboretum staff but comes from a sampling and averaging of landscape maintenance titles from salary.com.<sup>30</sup> Due to strict burn constraints and the possibility of shifting weather, it is hard to know exact timing and length of burns.

### **11. Reduces parking lot maintenance costs by approximately \$25,100 per year when averaged over 50 years by eliminating seal coating, striping and resurfacing.**

When considering permeable pavers as a solution for the Morton Arboretum's main parking lot, they were concerned with the installation and future maintenance costs associated with a relatively new material for the region. To understand the associated costs, The Arboretum conducted a lifecycle analysis with the assistance of Burke Engineering to determine the viability of this sustainable solution. The lifecycle of 50 years was chosen based on the expectation that a concrete paver system would hold up for this time period based on engineering performance studies in Europe and Australia.<sup>31</sup>

Over the course of 50 years, asphalt parking lots in free-thaw climates, like this region, would require significant maintenance including crack and pothole filling and at least one reconstruction of the parking lot. On the other hand, a permeable parking lot would only require restriping, cleaning and/or vacuuming of aggregate in the paver gaps. Figure 11.1<sup>32</sup> lists maintenance expenses for each pavement over 50 year; permeable pavement costs significantly less over the long-term. Moreover, based on a discussion on May 29, 2014 with Morton Arboretum staff, Susan Jacobson and Kurt Dreisilker, the parking lot has only been restriped once in 2013 since its installation. In the lifecycle analysis, striping is factored into maintenance costs more frequently, every two years.

---

<sup>30</sup> Salary.com - landscape maintenance.

[http://swz.salary.com/SalaryWizard/LayoutScripts/Swzl\\_SelectJob.aspx?jobkeyword=landscape%20maintenance&location=60532,%20Lisle,%20IL](http://swz.salary.com/SalaryWizard/LayoutScripts/Swzl_SelectJob.aspx?jobkeyword=landscape%20maintenance&location=60532,%20Lisle,%20IL). Accessed 15 July 2014.

<sup>31</sup> Sikich, Andrew J. & Kelsey, Patrick D. The Morton Arboretum's "Green" Parking Lot. Christopher B. Burke Engineering West, Ltd.

<sup>32</sup> The Morton Arboretum records and Interlocking Concrete Pavement Institute Case Study of Morton Arboretum. 2011.

<http://www.icpi.org/sites/default/files/MortonArboretumCaseStudy.pdf>. Accessed 2 May 2014.



*Methodology:*

The per year maintenance costs are based on industry standards, researched by the project engineers,<sup>33</sup> as presented by the Morton Arboretum to the Chicago Post Society of American Military Engineers on October 19, 2005. The engineer’s lifecycle analysis, shown in Figure 11.1, provided the basis for determining the amount of money saved for pervious pavement over asphalt listed in Figure 11.2. Figure 11.2 describes benefits of permeable parking versus asphalt including the annual cost comparison over 50 years.<sup>34</sup>

**Calculations for Permeable Pavement vs. Asphalt Maintenance**

Asphalt maintenance for 50 years = \$1,319,500

Asphalt per year maintenance over 50 years = \$1,319,500 / 50 = \$26,390

Permeable pavement maintenance for 50 years = \$62,250

Permeable pavement per year maintenance over 50 years = \$62,250 / 50 = \$1,245

Savings per year by using permeable pavement = \$26,390 - \$1,245 = \$25,145

Savings over 50 years by using permeable pavement = \$1,319,500 - \$62,250 = \$1,257,250

Permeable pavement is 95.3% less expensive than asphalt per year for maintenance.

( $\$1,245 / \$62,250 = 0.047 \times 100 = 4.7\% = 100 - 4.7\% = 95.3\%$ )

Year	Permeable Interlocking Concrete Pavement			Heavy Duty / Standard Asphalt Pavement		
	Maintenance Item	Per Year Expenditure	Accumulated Expenditure	Maintenance Item	Per Year Expenditure	Accumulated Expenditure
1	Initial Install	\$980,000			\$650,000	
3	Striping	\$2,625	\$982,625	Crack Filler, Seal Coating and Striping	\$24,375	\$674,375
5	Striping & Cleaning	\$6,625	\$989,250	Minor Patch, Crack Filler & Seal Coating	\$30,500	\$704,875
7	Striping	\$2,625	\$991,875	Crack Filler, Seal Coating and Striping	\$24,375	\$729,250
9	Striping & Cleaning	\$6,625	\$998,500	Minor Patch, Crack Filler & Seal Coating	\$36,625	\$765,875
19	Striping	\$2,625	\$1,019,625	Minor Patch, Crack Filler & Seal Coating	\$30,500	\$997,250
21	Striping & Cleaning	\$6,625	\$1,026,250	Crack Filler, Seal Coating and Striping	\$24,375	\$1,021,625
23	Striping	\$2,625	\$1,028,875	Minor Patch, Crack Filler & Seal Coating	\$36,625	\$1,058,250
25	Striping & Cleaning	\$6,625	\$1,035,500	Crack Filler, Seal Coating and Striping	\$24,375	\$1,082,625
27	Striping	\$2,625	\$1,038,125	Minor Patch, Crack Filler & Seal Coating	\$42,750	\$1,125,375
29	Striping & Cleaning	\$6,625	\$1,044,750	Mill & Overlay, Patching and Striping	\$109,375	\$1,234,750
45	Striping & Cleaning	\$6,625	\$1,081,750	Crack Filler, Seal Coating and Striping	\$24,375	\$1,551,500
47	Striping	\$2,625	\$1,084,375	Minor Patch, Crack Filler & Seal Coating	\$30,500	\$1,582,000
49	Striping & Cleaning	\$6,625	\$1,091,000	Crack Filler, Seal Coating and Striping	\$24,375	\$1,606,375
51	Striping	\$2,625	\$1,093,625	Minor Patch, Crack Filler & Seal Coating	\$36,625	\$1,643,000

Figure 11.1, Lifecycle Cost Comparison for the Morton Arboretum Permeable Parking Lot, courtesy of ICPI Morton Arboretum Case Study

<sup>33</sup> Email Correspondence with Susan Jacobson, Landscape Architect at The Morton Arboretum. 2 & 15 July 2014.

<sup>34</sup> The Morton Arboretum. The Morton Arboretum Main Parking Lot Presentation for Chicago Post S.A.M.E. 19 October 2005.

Pervious Pavement	vs.	Asphalt
<ul style="list-style-type: none"> <li>▪ Slows down/ absorbs run-off</li> <li>▪ Non-toxic</li> <li>▪ Water is cleaner when it leaves the system</li> <li>▪ Life span of approx. 50 yrs</li> <li>▪ Higher installation cost (1.7 times the cost of asphalt)</li> <li>▪ Maintenance cost estimated to be \$1,245/yr over 50 yrs</li> <li>▪ 50 yr maintenance cost \$62,250</li> <li>▪ 25% cheaper than asphalt</li> </ul>		<ul style="list-style-type: none"> <li>All water runs off</li> <li>Toxic</li> <li>Water has more contaminants when it leaves the system</li> <li>Life span of approx. 15 yrs</li> <li>Lower installation cost</li> <li>Maintenance cost estimated to be \$26,390/yr over 50 yrs (21.2 times the cost of pervious)</li> <li>50 yr maintenance cost \$1,319,500</li> </ul>

Figure 11.2, Lifecycle Cost Comparison for the Morton Arboretum Permeable Parking from a Presentation to Chicago S.A.M.E.

*Limitation of research:*

Additional maintenance records and initial installation costs to provide specific numbers related to actual savings are not available for this project.

**Cost Comparison Methodology**

- **The life cycle cost for the parking lot demonstrates that interlocking permeable concrete pavers are less expensive than asphalt pavement over time. The permeable pavement system had a higher upfront installation cost in 2004 of \$42 per sq yd, compared to \$17 per sq yd for an asphalt lot. But the real costs of both systems accumulate with maintenance: Over a 50-year period, maintenance costs for an interlocking permeable concrete pavers system are projected to be \$45 per sq yd, compared to \$80 per sq yd for asphalt. Based on these forecasted annual costs, year 23 is projected as the break-even point for the permeable pavement system.**

The data used to make this comparison come from the ICPI (Interlocking Concrete Pavement Institute) Morton Arboretum Case Study citing standard costs for both systems.<sup>35</sup> The case study states that the cumulative costs over a 50-year period for maintenance of asphalt make it a more expensive option than permeable concrete pavers in the long-term; and per the life cycle cost analysis, by year 23 there would be a break-even point in anticipated expenditures (see comparison). Sikich and Keylsey’s report<sup>36</sup> provides detailed information on how these time frames and costs are derived and apply to the

<sup>35</sup> Interlocking Concrete Paving Institute. Morton Arboretum. Case Study. Herndon, VA; 2011.

<sup>36</sup> Sikich Andrew E. and Patrick D. Kelsey. The Morton Arboretum’s “Green”Parking Lot”. (Summary of research undertaken as part of US-EPA Clean Lakes Program grant funding) no publication date.

parking lot at The Morton Arboretum. During the case study investigation in summer of 2014, we learned that The Arboretum may have reached a financial break-even point at year 10 after installation. This is an astounding achievement, however, we didn't receive documentation to confirm this statement.

The Morton Arboretum parking lot is often cited as one of the premier examples of such an installation in the Chicago metropolitan region. The primary reason that The Morton Arboretum has had lower than expected maintenance costs is that the cleaning of the pavement openings has not been nearly what they expected. The Arboretum staff reported that they have only vacuumed the surface once in the 10-year period, and this was due primarily as a demonstration as part of a workshop on permeable pavement.

**Cost comparison data provided by (2002):**

Initial installation: Asphalt = \$17/sq. yd. Permeable pavement = \$42/sq. yd  
 Maintenance costs over 50 years: Asphalt = \$80/sq. yd Permeable pavement = \$45. sq. yd.

A breakdown of maintenance items is provided:

Year	Permeable Interlocking Concrete Pavement			Heavy Duty / Standard Asphalt Pavement		
	Maintenance Item	Per Year Expenditure	Accumulated Expenditure	Maintenance Item	Per Year Expenditure	Accumulated Expenditure
1	Initial Install	\$980,000			\$650,000	
3	Striping	\$2,625	\$982,625	Crack Filler, Seal Coating and Striping	\$24,375	\$674,375
5	Striping & Cleaning	\$6,625	\$989,250	Minor Patch, Crack Filler & Seal Coating	\$30,500	\$704,875
7	Striping	\$2,625	\$991,875	Crack Filler, Seal Coating and Striping	\$24,375	\$729,250
9	Striping & Cleaning	\$6,625	\$998,500	Minor Patch, Crack Filler & Seal Coating	\$36,625	\$765,875
19	Striping	\$2,625	\$1,019,625	Minor Patch, Crack Filler & Seal Coating	\$30,500	\$997,250
21	Striping & Cleaning	\$6,625	\$1,026,250	Crack Filler, Seal Coating and Striping	\$24,375	\$1,021,625
23	Striping	\$2,625	\$1,028,875	Minor Patch, Crack Filler & Seal Coating	\$36,625	\$1,058,250
25	Striping & Cleaning	\$6,625	\$1,035,500	Crack Filler, Seal Coating and Striping	\$24,375	\$1,082,625
27	Striping	\$2,625	\$1,038,125	Minor Patch, Crack Filler & Seal Coating	\$42,750	\$1,125,375
29	Striping & Cleaning	\$6,625	\$1,044,750	Mill & Overlay, Patching and Striping	\$109,375	\$1,234,750
45	Striping & Cleaning	\$6,625	\$1,081,750	Crack Filler, Seal Coating and Striping	\$24,375	\$1,551,500
47	Striping	\$2,625	\$1,084,375	Minor Patch, Crack Filler & Seal Coating	\$30,500	\$1,582,000
49	Striping & Cleaning	\$6,625	\$1,091,000	Crack Filler, Seal Coating and Striping	\$24,375	\$1,606,375
51	Striping	\$2,625	\$1,093,625	Minor Patch, Crack Filler & Seal Coating	\$36,625	\$1,643,000

Figure C.1, Lifecycle Cost Comparison for the Morton Arboretum Permeable Parking Lot, courtesy of ICPI Morton Arboretum Case Study

Note: That 60% of the installation cost of the permeable pavement and the entire pavement section was covered by the EPA 319 grant because the permeable pavement is a sustainable practice, whereas asphalt pavement is not.

Sustainable Features

- Meadow Lake increases habitat through 68,000 plants of 165 species, 98% of which are native. Wetland plantings demonstrate submergent, emergent, and wet mesic plant zones, and unique plants such as *Dirca palustris* (leatherwood) have been propagated from the surrounding Arboretum grounds.

Pre-construction conditions in the parking lot and around the detention basin featured a majority of non-native species that were removed during construction. Over 80% of the species chosen for the new design are endemic to the region, and almost 98% of Meadow Lake’s plantings are native.<sup>37</sup> Not all plants utilized in the planting design are strictly native; certain species are used for their display features or their ability to perform in a particular manner, such as biofiltration capability. Figures S.1 and S.2 on the following page highlight native planting around Meadow Lake and in the parking lot.

**Native Plant Calculations, total species based on lists provided in SITES 4.7 documentation<sup>38</sup>**

Total species, including shrubs, trees, grasses, forbs, and perennials around Meadow Lake = 166

Native species around Meadow Lake = 163

Percent Native Species around Meadow Lake =  $163 / 166 = 0.981 \times 100 = 98\%$

Total species in permeable parking lot = 88

Native species in permeable parking lot = 42

Percent Native Species in permeable parking lot =  $42 / 88 = 0.477 \times 100 = 47.7\%$

Total species in permeable parking lot and around Meadow Lake =  $166 + 88 = 254$

Total native species in permeable parking lot and around Meadow Lake =  $42 + 163 = 205$

Percent Native Species in permeable parking lot =  $205 / 254 = 0.807 \times 100 = 80.7\%$



Figure S.1, Native Planting vs Non-native planting around Meadow Lake

<sup>37</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 4.8/4.9 - Preserve Plant Communities Native to the Ecoregion. 19 May 2011.

<sup>38</sup> The Morton Arboretum. Sustainable SITES Initiative Pilot Program. 4.7 - Use Native Plants.. 19 May 2011.



Figure S.2, Native Planting vs Non-native planting in Parking Lot