LANDSCAPE PERFORMANCE SERIES

2016 Case Study Investigation
Swope Campus Parking Lot
Kansas City, Missouri

Methods Document for Landscape Performance Benefits

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Landscape Performance Benefits

Environmental Benefits

- ***E1 - Reduces stormwater runoff volumes by an average of 90.2% for 0- 0.5-in rainfall events and an average 70.5% for 0.5-2.75-in rainfall events.***
  This is calculated from unsaturated soils using pervious pavements/subsurface storage, bioswales, bioretention cells and rain gardens as measured with an ISCO sampler.

Background

The Swope campus supports the Kansas City Water Services department; the site and parking lot create a demonstration site for stormwater Best Management Practices (BMPs) to be observed by visitors and staff. Stormwater is managed through "green" infrastructure consisting of various pervious pavements/subsurface storage, bioswales, bioretention cells and rain gardens. Locations for these features are shown in **Figure E1-1**. Since a large portion of the site is occupied by parking, the seven parking bays feature various types of impervious or pervious paving for comparison. The four pervious parking bays are designed for independent infiltration testing. Other recent site improvements include new parking islands/bioswales, rain gardens, and a walking trail that follows the periphery of the site. The final stormwater outfall pipe is located on the east side of the site and empties into a creek leading to the Blue River.

Figure E1-1: Parking lot and location of four pervious parking bays with underground water storage cells, control valving, and pipe connections to outfall.
(BNIM, adapted by Tim Kellams 2016)

Methods

This metric compares measured post-construction stormwater runoff volume against the total rainfall volume falling on the site. An ISCO water sampler was installed at the site outflow pipe to take measurements every 15 minutes over the monitoring period (May 16-July 15). The ISCO measures water flow velocity (feet per second) and water depth (inches) in the 6-in outflow pipe to calculate internally and log water flow rate (million gallons per day). Post calculations were then done in Microsoft Excel to calculate flow volume accumulated every 15 minutes with all the necessary unit conversions to arrive at total water outflow volume (gal) over the duration of the rainfall event.

Total rainfall inches per event were recorded by the BL11-63rd @ Blue River (2440) rainfall gauge (www.stormwatch.com) relocated to the Swope Campus parking lot. The baseline used for comparison was simply the total volume of rain that fell on the site over the duration of the event. The pre-construction catchment area primarily consisted of an impervious asphalt parking lot, so runoff would have likely been 90% or more, therefore no correction factor was

applied.
The summary results are shown in **Table E1-1** and the summary graph is shown in **Figure E1-2**. The supporting data tables (cleaned and reformatted from raw data) are shown in **Appendix A**.

Table E1-1
Summary of Parking Area Stormwater Runoff Volume Reductions (May 16-July 13, 2016)
Kansas City, MO Water Services Site (4800 East 63rd Street, Kansas City, MO)
ISCO device Serial Number 830392901; Pipe Diameter = 6in
Catchment (ac) = 6.29 Catchment (sf) = 273,992.40

Flow Start Date/Time	Flow End Date/Time	Outflow Duration (hrs)	Rainfall Amount (in)	Time between Event Outflows (24-hr days)	Total Catchment Flow Vol (gal)	Total Meas. Outflow (gal)	Flow Reduction %
5/16/2016 12:15	5/18/2016 1:15	37.00	0.98	?	167,384	49,224	70.6%
5/23/2016 15:00	5/23/2016 19:15	4.25	0.16	5.57	27,328	853	96.9%
5/24/2016 7:00	5/24/2016 17:30	10.50	0.23	0.49	39,284	7,329	81.3%
5/26/2016 5:00	5/28/2016 14:30	57.50	3.12	1.48	532,896	361,309	32.2%
6/4/2016 4:00	6/4/2016 7:15	3.25	0.2	6.56	34,160	1,157	96.6%
7/2/2016 7:45	7/3/2016 15:15	31.50	2.72	28.02	464,576	150,475	67.6%
7/7/2016 5:45	7/7/2016 12:45	7.00	0.66	3.60	112,728	20,334	82.0%
7/9/2016 20:45	7/10/2016 1:30	4.75	0.44	2.33	75,152	9,837	86.9%
7/12/2016 6:00	7/12/2016 15:45	9.75	1.1	2.19	187,880	71,159	62.1%
7/13/2016 11:30	7/13/2016 17:15	5.75	0.36	0.82	61,488	6,699	89.1%

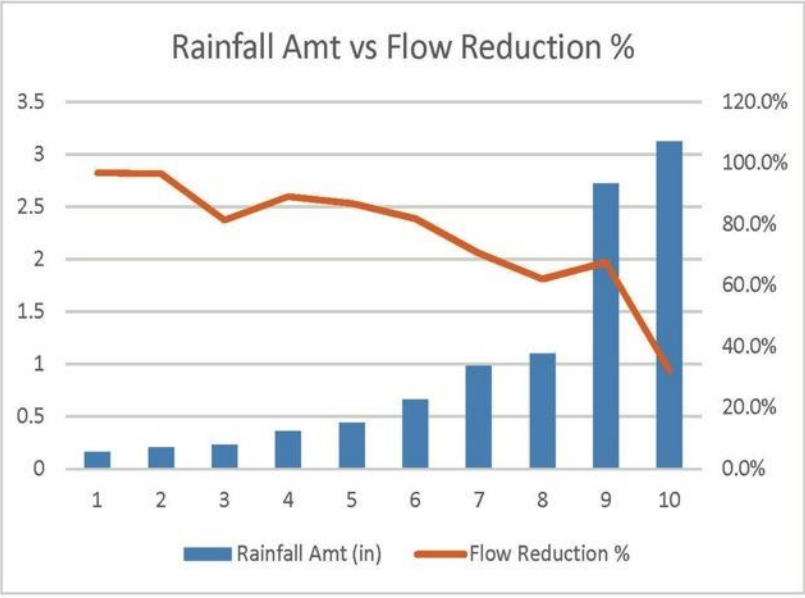


Figure E1-2: Graph of rainfall events sorted by increasing amount showing drop-off in flow volume reduction.

Note that flow reduction sharply drops off for the large 3.12-in rainfall event that occurred on May 26. This was probably attributable to water saturated soils which prevented much additional infiltration. Three factors contributed to this condition: large rainfall, long outflow duration of 57.5 hours, and short time between prior rainfall events. The remaining 32.2% reduction is likely due to the water storage capacity underneath the parking bays which are designed to hold a 10 yr, 24-hr, 5.7-in storm event.

Calculations

A portion of the supporting data tables found in Appendix A was extracted and shown here to provide context for the calculations:

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
7/13/2016 16:45		0.006142	0.3403	1.1989	4.2651	63.98		
7/13/2016 17:00		0.004925	0.3073	1.1038	3.4200	51.30		
7/13/2016 17:15		0.004071	0.2771	1.0392	2.8274	42.41		
7/13/2016 17:30		0.000000	0.0000	0.9687	0.0000	0.00		
	0.36			Total for Event		6,699	61,488	89.1%

Note: Gallons were used instead of cubic feet (cf) since ISCO used millions of gallons daily (mgd) and many people can better visualize volume in gallons rather than cf. However, some cross-checks were performed in cf to alternatively calculate volume via the Velocity and Level measurements.

<u>Using the 16:45 timeline to show volume across one 15-min interval</u>

ISCO Flow Rate (mgd): Internally calculated by ISCO (per the above table) = 0.006142
1,440 minutes per day

ISCO Flow Rate (gpm) conversion:
x million gallons per day x 1 million x 1 day / minutes per day = gallons per minute
.006142 mgd x 1,000,000 x 1 day/1,440 minutes =
6,142 / 1,440 = 4.2653 gpm

ISCO Volume (gallons over 15 min): Flow rate (4.2653 gpm) x 15 min = **63.98 gallons**

<u>ISCO volume manual calculation cross check</u>

[1]Cross-sectional flow area in 6" pipe (K) =
(r^2*(theta-sin(theta))/2 = 4.02038 sq-in x 1sf/144 sq-in = 0.02792 sf

where:
r (pipe radius) = 3 in (6" diameter outflow pipe)
h (height of flow in pipe) = 1.1989 in (from ISCO)
theta (central angle) = 2*arccos((r-h)/r) = 1.85367 radians
(http://www.ajdesigner.com/phphydraulicradius/hydraulic_radius_equation_pipe.php)

then,
Flow rate (cfs) = ISCO Velocity (.3403 feet per second) x Cross-sectional flow area (0.02792 square feet) = .00950 cubic feet per second
Flow volume (cf over 15 min) = .00950 cf/s x 60 sec/min x 15 min = 8.55 cf

Flow volume (gallons over 15 min) = 8.55 cf x 7.4805 gallons per cf = **63.96 gal (checks)**

Total ISCO measured flow volume = **6,699 gal** (summed column of 15-min volumes in full table (see Appendix A)
Total rainfall amount received in outflow catchment area (similar to pre-construction conditions of impervious asphalt runoff) = Catchment area (273,992 sf) x 0.36 in rainfall x 1ft/12in = 8,219.76 cf x 7.4805 gal/cf = **61,488 gal**

(Flow volume - Total Rainfall volume) / Total Rainfall volume = Change in water volume at outflow catchment area
(6,699 gal – 61,488 gal) / 61,488 gal = **89.1% reduction**

Limitations
The ISCO sampler measures flow velocities over time and pipe water depths which allow a relatively accurate calculation of the total water volume exiting the site over the duration of the rainfall event. Early monitoring results could have been affected by a minor leak repaired just before the July 3 rainfall event which previously allowed subsurface water storage beneath the pervious parking bays to seep into the piped outfall system, thereby slightly increasing exiting water volume (depressing the volume reduction percentage). Establishing an accurate baseline for the volume reduction comparison is more difficult since no pre-construction stormwater runoff monitoring took place. The baseline used was simply the total volume of rainfall that fell on the site over the duration of the rainfall event. It would have been more accurate to estimate pre-construction runoff based on landcover type, although the majority of the site was covered by an impermeable asphalt parking lot. The small amount of former landscape would have allowed some infiltration. This baseline estimate also would not have accounted for soil saturation which becomes a significant factor as shown by the May 25th rainfall event. Peak flow reduction calculations were not performed since extensive pre-construction storm water modeling would have been necessary beyond the limited time requirements of this case study.

Sources
Kansas City Water Services Department. 2016. Swope campus parking lot stormwater runoff data (May 16 to Jul 13, 2016) in cooperation with BNIM.

- ***E2 - Pervious parking bays effectively captured and stored water for infiltration at an average 27.45% measured capacity utilization for a 1.1-inch rain event and 66.71% for a 3.15-in rain event (within design standards). Because of the large paving area, this accounts for much of the derived benefits in runoff reduction measured with the ISCO sampler.***

Methods
The parking lot contains four pervious parking bays (two with permeable pavers; one with porous asphalt; and one with pervious concrete) to collect and filter stormwater (**Figures E1-1**

and E2-1). Underground aggregate water storage cells beneath parking bays are used to detain stormwater before release. The storage cells are designed to hold a 10-year, 24-hour storm event (5.7-in), containing over 350,000 gallons of water. Underground storage cells are drained by 6-in perforated pipes that have valves and cleanouts which allow independent measurements for comparative performance testing. When the valves are closed, water backs up into the aggregate cells for storage to reduce peak rate flow. The datalogger sample tube is hydrologically connected to the aggregate cells and maintains a common water level (**Figure E2-2**). Time based measurements taken at 1-hr increments record the water level drop corresponding to water infiltration.

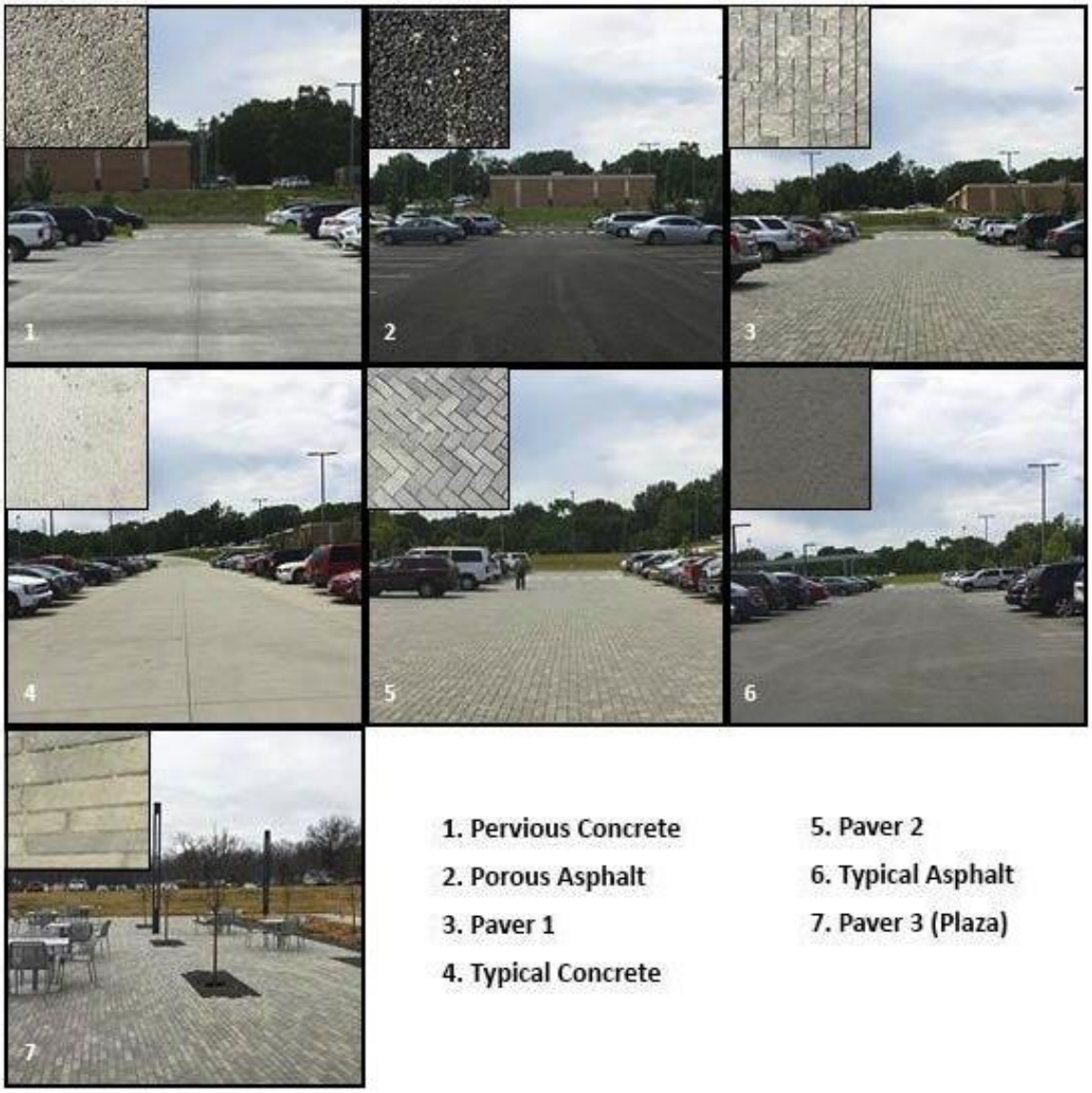


Figure E2-1: Various pervious parking surfaces to reduce peak flow runoff and test water infiltration rates.
(Timothy Kellams 2016)

Pervious Concrete: 6” slab on 12” base (#57 stone); geofabric between base and subgrade
Porous Asphalt: 6” thickness on 12” base (#57 stone); geofabric between base and subgrade
Paver 1 (Pavestone, “Eco-Venetian, Ashlar pattern,” aggregate joints) 4” paver + 2” bedding rock + 4” (#57 stone) + 12” (#3 rock) = 22” total
Paver 2 (Belgard, “Aqua Roc II, Herringbone 90,” aggregate joints) 4” paver + 2” bedding rock + 4” (#57 stone) + 12” (#3 rock) = 22” total

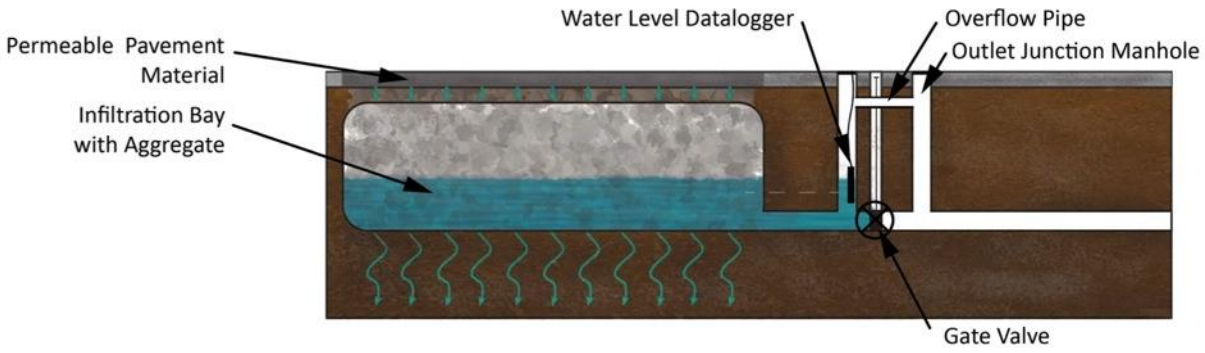


Figure E2-2: Cross section of pervious parking bays, the underground water storage cells, control valving, and water level datalogger location.
(BNIM with adaptation by Timothy Kellams)

Two rain events were analyzed in which data was recorded by all four dataloggers: May 16-17 and May 26-27, 2016. Graphical summaries of infiltration results are presented in **Figure E2-3** (May 16-17 event) and **Figure E2-4** (May 26-27 event). The supporting tabular data is included in **Appendix B**.

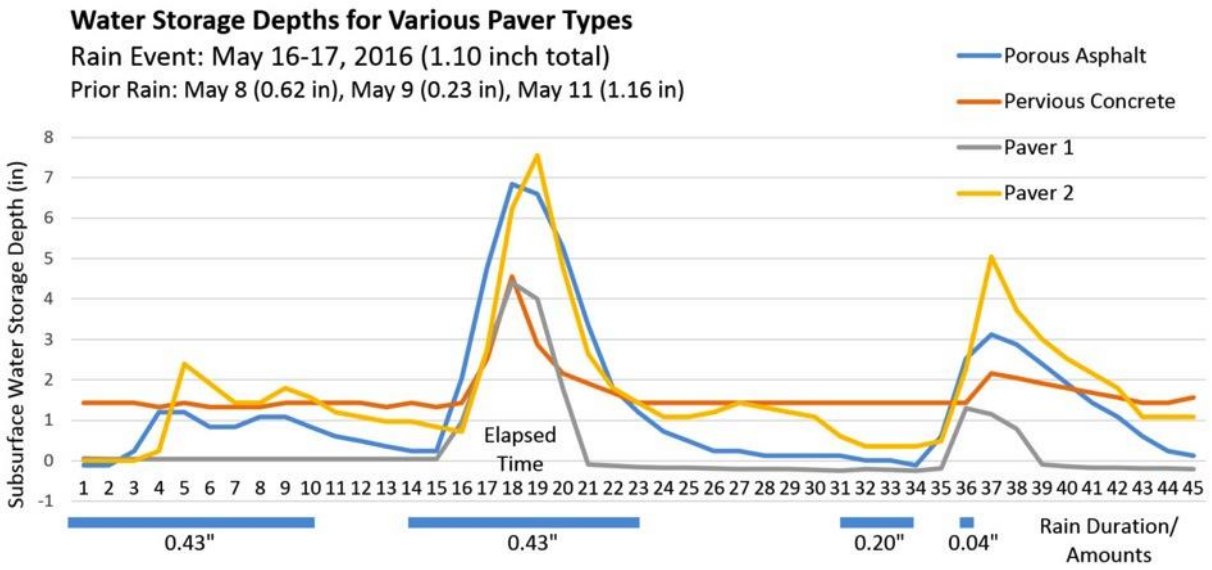


Figure E2-3: Summary data recorded during the May 16-17 in rain event for Porous Asphalt, Pervious Concrete, Paver 1, and Paver 2 parking bays at the Kansas City WSD Swope Campus. (Kansas City Water Services 2016)

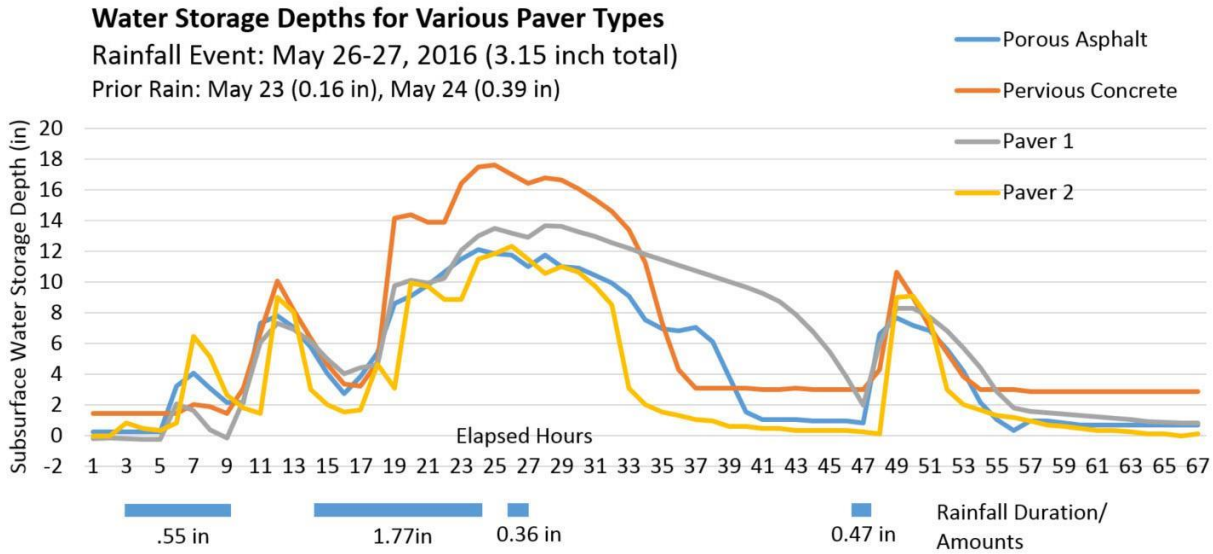


Figure E2-4: Summary data recorded during the May 26-27 in rain event for Porous Asphalt, Pervious Concrete, Paver 1, and Paver 2 parking bays at the Kansas City WSD Swope Campus. (Kansas City Water Services 2016)

Table E2-1: Measured captured rainfall storage versus storage capacity during May 16-17 and May 26-27 rain events for Porous Asphalt, Pervious Concrete, Paver 1, and Paver 2 parking bays at the Kansas City WSD Swope Campus. (Kansas City Water Services 2016)

Parking Bay Paving Material	Elapsed Hrs Until Max. Recorded Storage Depth	Maximum Storage Depth Recorded (in)	Storage Depth Capacity (in)	Storage Depth Utilization (%)
Rain Event: May 16-17, 2016 (1.1 inch total)				
Porous Asphalt	17	6.84	18	38.00
Pervious Concrete	17	4.56 (3.12)	18	17.33
Paver 1	17	4.42	22	20.09
Paver 2	18	7.56	22	34.36
Rain Event: May 26-27, 2016 (3.15 inch total)				
Porous Asphalt	24	12.12	18	67.33
Pervious Concrete	25	17.64 (14.76)	18	82.00
Paver 1	25	13.49	22	61.32
Paver 2	26	12.36	22	56.18

Note: Because of various void sizes within the paving and sub-base materials, storage capacity is not uniform within the cross section. Although more limited, the top paving materials includes voids and is included in the water storage capacity depth. As the maximum depth is approached, water will start to drain through the overflow pipe set several inches beneath the surface. Correction factors of 1.44" (May 16-17) and 2.88" (May 26-27) were applied to the pervious concrete results (see discussion section).

Discussion

Graphs of the runoff water storage provided by the four permeable surfaced parking bays show that the bays are generally performing as designed. All bays are storing significant water and allowing extended infiltration times to reduce overall runoff as measured and documented in benefit E1. For the May 26-27 rain event, the infiltration times are extended as soil saturation is approached (elapsed hours 25-47). Saturated conditions are also reflected in the quick filling response immediately following the 0.47-in rainfall event at elapsed hour 47. The rank ordering of paver/storage performance is not consistent between the May 16-17 and May 26-27 rain events. This is presumably due to different antecedent soil moisture conditions corresponding to preceding rain events as noted on the graphs.

The performance of the pervious concrete bay is an outlier which appears to not fully drain between rain events. It consistently retains 1.44 - 2.88 inches of water as shown in **Figure E2-5**.

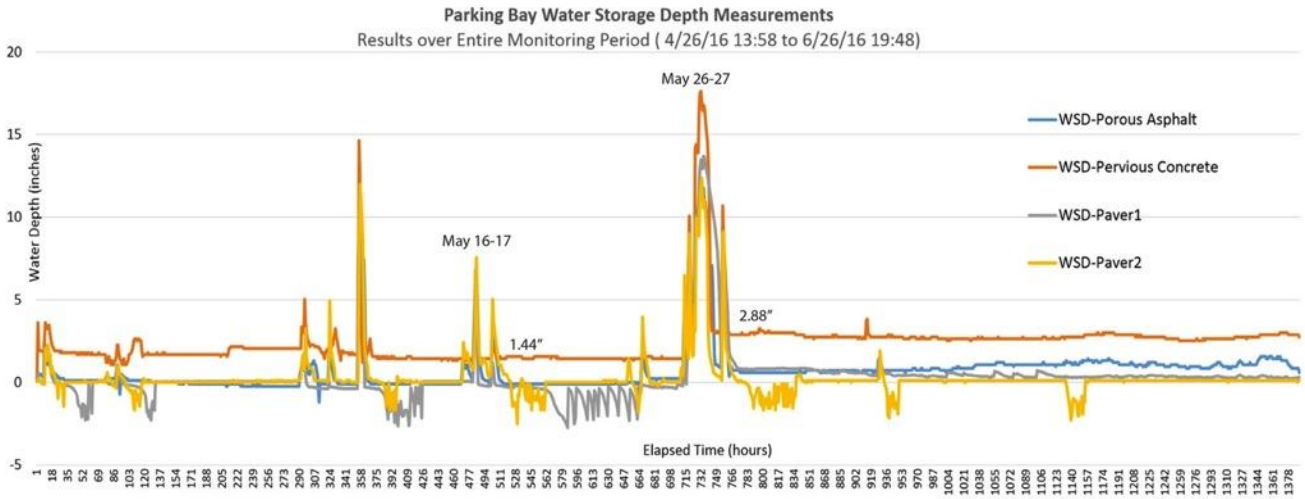


Figure E2-5: Long-term monitoring results of parking bay water storage depths for KC Water Services Swope Campus. (Kansas City Water Services 2016)

Several explanations were considered:

a) The underlying soil is a hardpan preventing infiltration: Rejected because the filling/infiltration curve generally follows the performance of the other bays, and in some instances, is infiltrating faster than two other bays (May 16-17: elapsed hours 18-23 and May 26-27: elapsed hours 25-37).
b) The datalogger probe is not level with the bottom of the monitoring well and is falsely indicating a higher water level.
c) Sediment has filled the bottom of the parking bay storage, reducing overall storage water storage capacity and thereby increasing the resultant water level.

To compensate for either b) or c), 1.44-inches was subtracted from the May 16-17 maximum storage depth and 2.88 inches for May 26-27 event.

Calculations

Percentage of 10-yr 24 hr design storm event (5.7-in):

May 16-17 rainfall total inches: 1.10
May 26-27 rainfall total inches: 3.15

May 16-17 (1.1-in/5.7-in) x 100 = 19.30%
May 26-27 (3.15-in/5.7-in) x 100 = 55.26%

Storage Depth Utilization per Bay:

	May 16-17	May 26-27
Porous Asphalt	38.00%	67.33%
Pervious Concrete	17.33%	82.00%
Paver 1	20.09%	61.32%
Paver 2	34.36%	56.18%

May 16-17: Average Bay Utilization (38.00% +27.33% +20.09% +34.36%)/4= 27.45%
May 26-27: Average Bay Utilization (67.33% +82.00% +61.32% +56.18%)/4= 66.71%

Infiltration Rates per Bay:

	May 16-17	May 26-27
Porous Asphalt	38.00%	67.33%
Pervious Concrete	17.33%	82.00%
Paver 1	20.09%	61.32%
Paver 2	34.36%	56.18%

Limitations

As previously noted in the Discussion section, results from the pervious concrete bay appeared to be slightly elevated, and a compensation was applied. As shown above, the average storage depth utilizations of the parking bays were 8.25% (27.45-19.20) and 11.45% (66.71-55.26) above the designed capacity for the storm size. Since the aggregate void sizes were approximated for capacity calculations by the engineers, the utilization results are reasonable within the design parameters. Last, more storm events could have been analyzed, but all four dataloggers were only working for the May rain events.

Sources

Kansas City Water Services. 2016. Pervious pavement infiltration rates collected for 2016 Landscape Architecture Foundation Case Study Investigation.

- ***E3 - Sequesters 3,537 lbs of atmospheric carbon annually and intercepts 4,156 gallons of stormwater through the addition of 101 new trees.***

Methods

Referencing the 2015 planting plan, a current tree inventory was conducted. Species identification and diameter breast height (DBH) were recorded, then the carbon dioxide sequestration (lbs) and intercepted stormwater runoff (gal) per tree species and number of trees were calculated using the National Tree Benefit Calculator (NTBC). The inventory, along with calculated metrics, is included in **Appendix C**.

Calculations

Calculations were conducted using the National Tree Benefit Calculator (NTBC). The National Tree Benefit Calculator uses the same database as i-Tree. The tree type, diameter, tree location by region, and land-use are entered into the NTBC. The NTBC then uses an internal formula to to develop stormwater, property value, energy, air quality, and atmospheric carbon reduction metric. These all help produce an overall benefit of the tree in U.S. dollars. More information concerning the approach and internal calculation methods can be found at:
http://www.itreetools.org/streets/resources/Streets_Reference_Cities_Science_Update_Nov2011.pdf

Limitations
There are a few limitations using this method. Some of the inventoried trees were not included in the National Tree Benefit Calculator/i-Tree database, so appropriate substitutions were made. This is also a projected, not measured metric.

Sources
Schuessler, Jim and Timothy Kellams. 2016. Tree inventory conducted as part of Landscape Architecture Foundation Case Study Investigation. Kansas City, MO: Kansas City Water Services.

http://www.treebenefits.com/calculator/treeinfor.cfm?zip=&city=&state=&climatezone=Midwest

- ***E4 - Reduces parking lot temperature contributing to heat island effect in areas of concrete and pavers by an average 8.5° F compared to typical (dark) asphalt parking lot on the same site.***

Methods

Radiant exitance measurements for various paving materials on the Swope campus were recorded using a Leaton digital luxmeter/illuminance light meter (200,000 Lux max). The instrument was held at waist height above the surface at arm's length, first facing up to record direct incident light, then turned downward for a second reading of reflected light. Measurements were taken on July 1, 2016 between 1:31pm and 1:57pm during sunny conditions.

Surface temperatures were also measured using an Etekcity Lasergrip 630 dual laser non-contact digital infrared temperature gun. The instrument was held at a consistent waist level and pointed vertically down. Ambient air temperature was 84° F. Temperature measurements were taken on July 1, 2016 at 2 p.m. under mostly sunny skies.

Measured temperatures are related to surface absorption (measured) and surface roughness/porosity. Measurements for various surface materials are shown in **Table E4-1** and graphically depicted in **Figures E4-1**, **E4-2**, and **E4-3**.

Table E4-1
(Timothy Kellams 2016)

Surface Material Reflectance and Temperature Data
Kansas City Water Services Swope Campus, Kansas City, MO
July 1, 2016, 2 p.m.; Sunny skies; ambient air temperature = 84F

Surface Material	Illuminance (Lux x100)	Exitance (Lux x100)	Reflectance	Illuminance Absorbed	Temperature (°F)
Typical Asphalt	1179	149	12.64%	87.36%	133.7
Porous Asphalt	1155	85	7.36%	92.64%	141.9
Typical Concrete	1145	380	33.19%	66.81%	114.4
Pervious Concrete	1172	303	25.85%	74.15%	125.2
White paint on P. Conc.					114.6
Paver 1	1130	180	15.93%	84.07%	125
Paver 2	1170	187	15.98%	84.02%	124.7
Paver 3 (Plaza)	1200	259	21.58%	78.42%	122
Paver 3 (under canopy)					102
Charcoal landscape rock	1210	103	8.51%	91.49%	135.1
Brown Wood Composite	1220	200	16.39%	83.61%	130.2
Mulch					147
Grass	1190	129	10.84%	89.16%	102.5
Grasscete	1210	190	15.70%	84.30%	121.1

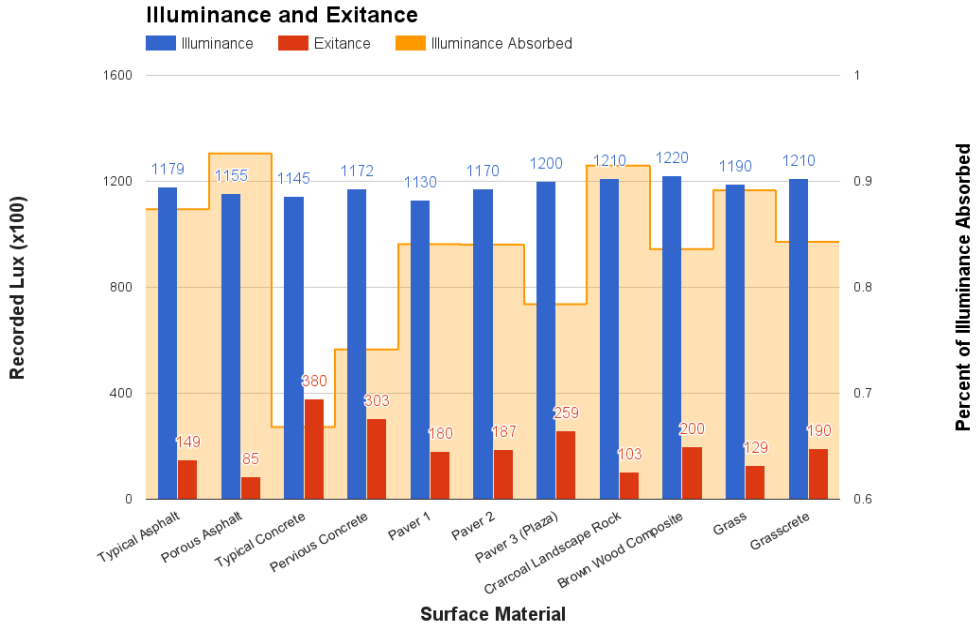


Figure E4-1: Comparison of illuminance, exitance, and absorption by various surface materials for the Kansas City Water Services Swope Campus, Kansas City, MO (Kellams 2016).

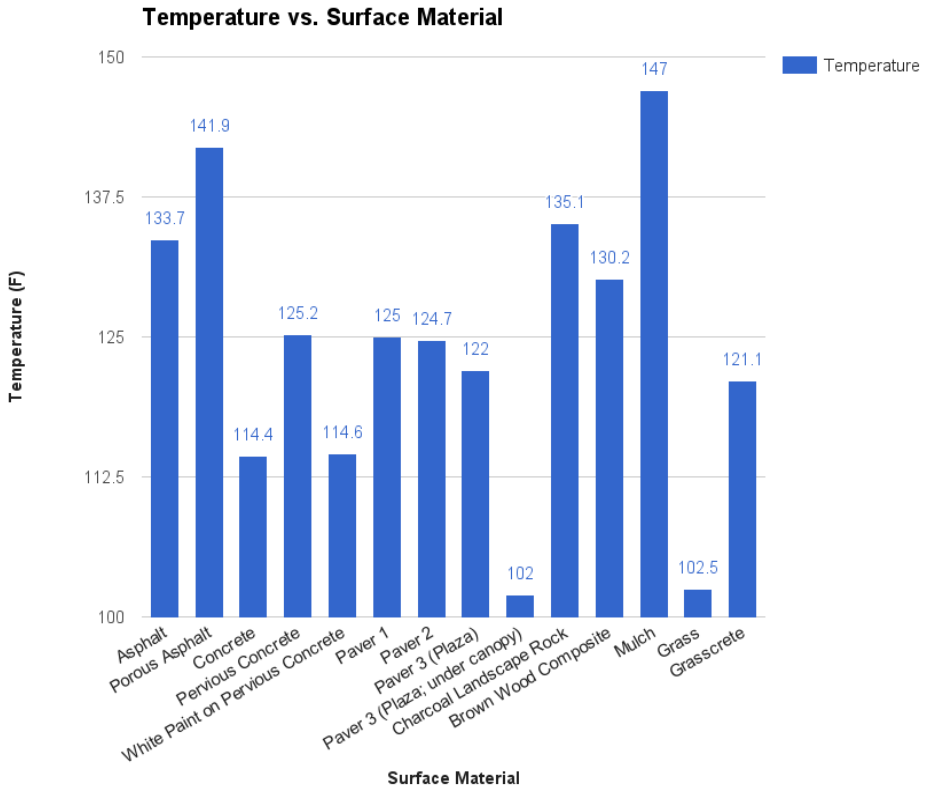


Figure E4-2: Surface temperatures for various ground materials found on the Kansas City Water Services Swope Campus on July 1, 2016 (Kellams 2016).

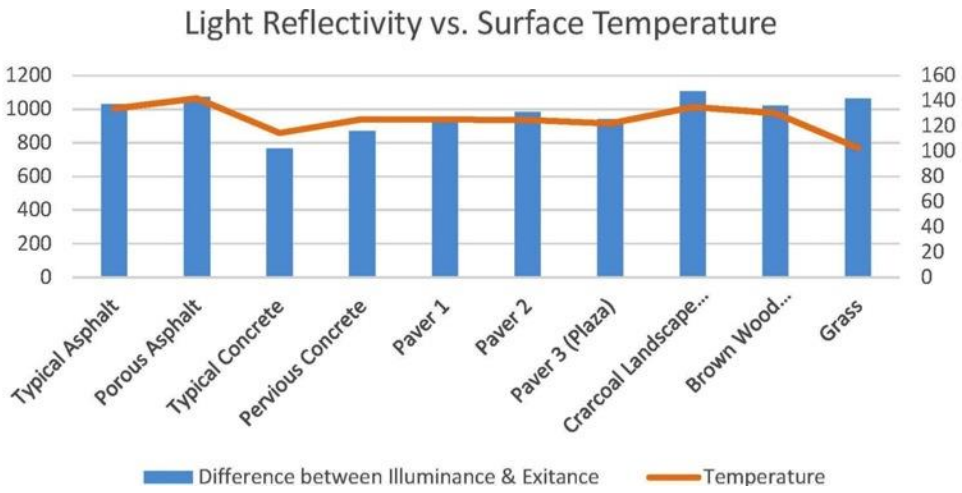


Figure E4-3: Comparison of light reflectivity and surface temperatures for Kansas City Water Services Swope Campus on July 1, 2016 (Kellams 2016).

Calculations

Surface temperatures were directly read from the Etekcity Lasergrip 630 and no calculations were performed. Reflectance was calculated by dividing illuminance by exitance and expressing as a percentage.

Limitations
While some pervious paving materials contribute to greater stormwater infiltration rates (see Benefit E3), the materials can also comparatively increase negative heat island effects. Temperature is related to reflectance (see Benefit E5) and surface texture.

Sources
Timothy Kellams. 2016. Surface temperature measurements taken as part of Landscape Architecture Foundation Case Study Investigation. Kansas City, MO: Kansas City Water Services Swope Campus.

- ***E5- Improves luminaire efficacy by 75% with high-performance LED lights as compared to a typical High Pressure Sodium (HPS) source.***

Methods
This benefit simply compares the initial luminaire efficacy for a typical LED luminaire (Philips Gardco Slenderform SFA Dual LED array) installed in the upgraded Water Services building parking lot compared to a typical HPS lamp. This comparison is expressed in lumens/watt, but does not account for light source degradation over time (which can be significant for HPS), or surface illumination levels (typically expressed in Lux or Fc) which depend on the reflector configuration, pole mounting height, and other factors. The Slenderform SFA LED lumen output and watt consumption rate was taken from product specifications (Philips 2016, p 2) for a 110LA Type 3 selection of 11,426 lumens and 107 average system watts. Typical lumens and wattage for a HPS source was taken from the publication, "Outdoor Area Lighting" (U.S. Department of Energy 2008, p 2): downward luminaire lumens = 11,200 (70% downward efficacy; not as much an issue with LED) and 183 watts.

Calculations
LED Efficacy: 11,426 lumens ÷ 107 watts = 106.8 lumens/watt
HPS Efficacy: 11,200 lumens ÷ 183 watts = 61.2 lumens/watt
Efficacy Improvement %: 106.8 lm/W − 61.2 lm/W ÷ 61.2 lm/W x 100 = 75.4%

Sources
Philips. 2015. "Gardco Slenderform Product Brochure." Accessed August 6, 2016: http://www.lightingproducts.philips.com/Documents/webdb2/Gardco/pdf/SlenderForm_SFA_SFV_LED.pdf

U.S.Department of Energy 2008. "Outdoor Area Lighting." Accessed August 6, 2016: http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/outdoor_area_lighting.pdf

Limitations
With more sophisticated modeling using laboratory photometric files, an estimate of annual potential cost savings could be calculated, but no data is available for the former light types or parameters to make an actual comparison. An attempt was made to review monthly electricity utility records from July 2013 to July 2016 for the Water Services building (4800 E. 63rd Street)

to compare pre- and post-installation of the LED lighting in the north parking lot. No HVAC or IT upgrades were made during this timeframe. The utility records were simplified and adjusted to reflect a standard billing cycle (**Table 5-1**).

Table 5-1: Electricity Use and Cost Comparison for KC Water Services building and parking lot for pre- and post-LED installation conditions.
(Adapted from KCPL Electricity Usage and Building Report by Howard Hahn and Lisa Treese)

Month	Billings Days	kWh	Cost w/ Taxes		Adj kWh[2]	Adj Cost[2]		Adj. Cost per kWh	Adj. kWh change from same month in previous year	Avg Monthly Temp (F)[3]
Jul-13	29	170,100	$0		175,966	$0				77
Aug-13	30	180,600	$0		180,600	$0				76
Sep-13	33	191,100	$0		173,727	$0				72
Oct-13	29	196,350	$0		203,121	$0				55
Nov-13	29	151,200	$0		156,414	$0				41
Dec-13	34	184,800	$0	Grp Avg	163,059	$0				28
Jan-14	33	229,950	$0	190,895	209,045	$0				25
Feb-14	29	202,650	$0		209,638	$0				25
Mar-14	30	217,350	$0		217,350	$0				40
Apr-14	28	193,200	$0		207,000	$0				54
May-14	32	201,600	$0		189,000	$0				66
Jun-14	30	195,300	$0	rate	195,300	$0	rate			74
Jul-14	32	228,900	$21,101	switch[1]	214,594	$19,782	switch[1]	0.092	38,628	74
Aug-14	64	233,100	$23,510		218,531	$22,041		0.101	37,931	78
Sep-14	60	225,750	$21,676		225,750	$21,676		0.096	52,023	67
Oct-14	58	200,550	$16,392		207,466	$16,957		0.082	4,345	58
Nov-14	58	185,850	$14,918	Grp Avg	192,259	$15,432	Grp Avg	0.080	35,845	38
Dec-14	68	269,850	$20,078	226,825	238,103	$17,716	$19,126	0.074	75,044	34
Jan-15	66	290,850	$22,368		264,409	$20,334		0.077	55,364	32
Feb-15	58	235,200	$19,758		243,310	$20,439		0.084	33,672	25
Mar-15	60	254,100	$20,022	Pre-LED	254,100	$20,022	Pre-LED	0.079	36,750	47
Apr-15	62	217,350	$17,418	Average	210,339	$16,856	Average	0.080	3,339	57
May-15	58	206,850	$17,127	**226,825**	213,983	$17,717	**$18,998**	0.083	24,983	64
Jun-15	60	173,250	$19,226	**LED Installed**	173,250	$19,226		0.111	-22,050	75
Jul-15	64	189,000	$20,576	**214,682**	177,188	$19,290	**$20,665**	0.109	-37,406	78
Aug-15	58	207,900	$22,477	Post-LED	215,069	$23,252	**Post-LED**	0.108	-3,462	75
Sep-15	60	231,000	$23,200	Average	231,000	$23,200	**Average**	0.100	5,250	73
Oct-15	58	210,000	$19,181		217,241	$19,843		0.091	9,776	59
Nov-15	62	217,350	$19,822		210,339	$19,183		0.091	18,080	48
Dec-15	64	226,800	$20,246	Grp Avg	212,625	$18,980	Grp Avg	0.089	-25,478	40
Jan-16	66	247,800	$20,918	215,122	225,273	$19,017	$19,935	0.084	-39,136	30
Feb-16	58	224,700	$20,086		232,448	$20,778		0.089	-10,862	39
Mar-16	64	223,650	$18,993		209,672	$17,806		0.085	-44,428	51
Apr-16	58	191,100	$17,807		197,690	$18,421		0.093	-12,649	57
May-16	58	193,200	$18,244		199,862	$18,873		0.094	-14,121	63
Jun-16	60	217,350	$24,045		217,350	$24,045		0.111	44,100	79
Jul-16	64	261,450	$27,693		245,109	$25,962		0.106	67,922	79

Notes

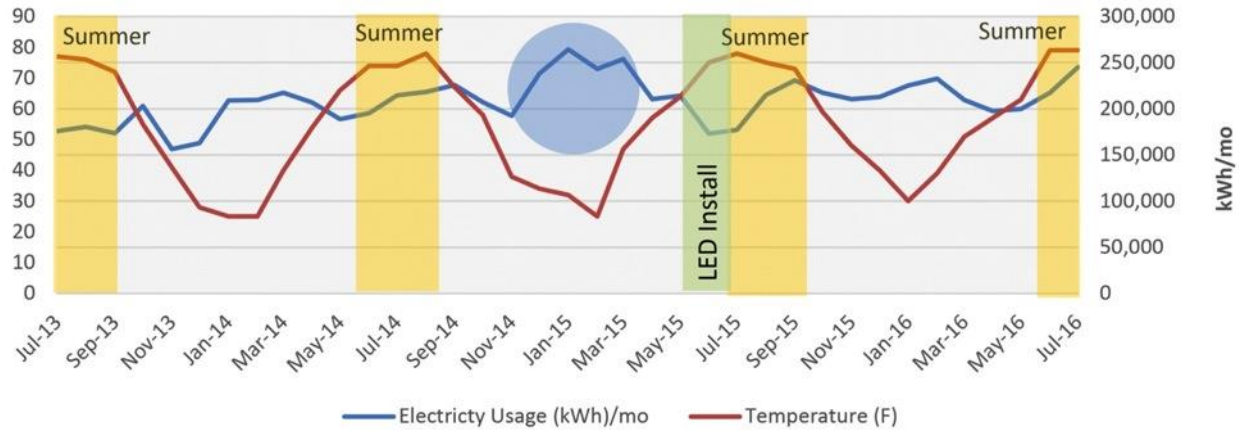
[1]Rate changed from YLGSE to 1LGSE in July 2014

[2]Adjusting KWh and Costs to standard 30-day or equivalent 60-day billing days to allow month by month comparison

[3]Monthly temperature data (MCI Airport):
https://www.wunderground.com/history/airport/KMCI/2014/6/7/MonthlyHistory.html?req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo=

At first glance, it appears that average electricity use declined slightly (-5.4%) from pre-(226,825 kWh) and post- (214,682 kWh) LED installation conditions; however, costs slightly increased (8.8%: $18,998 to $20,665). A different picture emerges when monthly electricity use is plotted across 37 months (**Figure 5-1)**. Unexpectedly, peak demand does not necessarily occur in the summer when air conditioning use is expected. Furthermore, there is a large electricity spike in January-March 2015, indicated by the blue circle. The origin of this spike is not known--perhaps use of site power on occasion for the parking lot/plaza construction?

Adjusted Monthly Electricity Usage (kWh) and Average Monthly Temperature for KC Water Services Building and Site



Additional analysis was conducted by grouping the monthly electricity use and costs roughly mid-year to mid-year (August through May) across three years to compare changes (10th table column). Comparing average electricity use between Group 2 (Aug 2015--May 2015) and Group 3 (Aug 2015--May 2016) shows many monthly decreases, but again, the electricity use spike of January-March 2015 is probably skewing results by elevating Group 2. A better comparison might be between Group 1 (Aug 2013--May 2014) and Group 3 (Aug 201--May 2016), a two-year difference, which reflects more typical conditions. In this comparison, more electricity is actually used (190,895 kWH to 215,122 kWh = 12.7% increase).

It appears there are too many variables to accurately estimate electricity use savings when the building and site share metering and many parameters remain unknown:

- How was the building thermostat programmed across times of day/night, and between seasons?
- What other building electricity parameters remain undefined?
- Since the parking lot received a major upgrade after decades, were more light poles/luminaires used for more even light distribution patterns than in the past?

To eliminate these variables, it would be preferable to meter the building and site lighting separately. As an alternative, instrumentation on several LED luminaires compared to a few legacy luminaires left behind could be used for monitoring luminaire performance.

Social Benefits

- ***S1 - Creates opportunities for 42% of 43 surveyed employee respondents to socialize with co-workers on breaks, get fresh air, or spend time alone.*** *(Survey questions 6, 7, 8, & 9)*

- ***S2 - Improves perception of safety in the parking lots and walkways for 72% of 43 respondents who indicate that conditions are "much" or "somewhat" improved.*** *(Survey question 2)*

- ***S3 - Encourages physical activity along the perimeter walking trail by 54% of 42 respondents- over triple the trail usage prior to site redesign. 30% of survey respondents exercise on the trail at least once per day.*** *(Survey questions 4 & 5)*

- ***S4 - Provides green infrastructure-related educational opportunities for site visitors through employee efforts. 53% of 43 employee respondents have mentioned green infrastructure improvements in visitor conversations or have led visitors on a tour.*** *(Survey question 11)*

Methods

For social benefits S1-S4, an online survey was prepared and distributed to 222 Kansas City Water Services employees working on the Swope Campus. Since the survey involved human subjects, solicited opinions, and research results would be published, the survey was submitted to the Kansas State University Institutional Review Board (IRB) to ensure that no significant risks were anticipated and proper research protocols were followed. After review, the survey was determined to be exempt under the category 45 CFR 46.101 (b)(2) (Proposal #8333). The survey was also reviewed and approved by the KC Water Services director. An email introducing the project and containing a survey hyperlink was distributed to all employees through the project liaison. The survey consists of eleven questions and was administered through the KSU Qualtrics online system. Response to the online survey was 19.4% (43/222) and the full survey results can be found in **Appendix D**. Although the full range of questions/responses informed project designers regarding user satisfaction, only a subset of the questions/responses directly related to landscape performance benefits.

Calculations

S1, S2, & S4: Simple tabulations of responses under various categories according to wording expressed in the social benefit.

S3: Combining first three responses *for at least once per week or more*: Walking prior to trail construction (7/42 = 16.7%); Walking after trail construction (23/43 = 53.5%). % Increase = (23-7)/7 = 228.6% (more than triple)

Limitations
S1: The trees are not yet mature enough to provide adequate shade which is inhibiting plaza use as a social benefit. A lesson learned for most landscape projects is to provide adequate supplemental structures which provide some shade prior to tree maturation. The entryway structure provides some shade, but it is located over an active walkway, and sitting areas totally rely on shade trees. Early monitoring of the green infrastructure and pervious paving performance needed to be assessed to track performance over time.

S4: The survey documents employee respondents who have provided some form of green infrastructure education to visitors. However, no procedures currently exist to count Swope Campus visitors who are curious about green infrastructure, or receive some form of education. Improvements could be made to educate employees (Question 11) and visitors through brochures, wall displays in the building reception area, or educational signage placed around green infrastructure features (Question 9).

Sources
Hahn, Howard. 2016. "Survey of Kansas City Water Services (Swope Campus) Employees' Response to Pervious Parking Lots, Entry/Plaza Improvements, and Green Infrastructure Landscape." Landscape Architecture Foundation Case Study.

Economic Benefits

- ***Ecn1- Saves $8,800 in annual mowing costs through inclusion of a shortgrass prairie and numerous BMPs featuring native plants requiring minimal trimming compared to a traditional manicured landscape.***

Methods
Planting plans were reviewed to categorize planting areas as: existing fescue, seeded fescue, sod fescue, shortgrass prairie, bioretention areas, bioswale areas, rain gardens, and planters. Areas were then tabulated (**Figure Ecn1-1**). The existing and new fescue areas are not irrigated, but receive regular mowing. Existing and recently established fescue areas amount to 173,320 sf (3.98 ac). The shortgrass prairie and BMP areas total 96,855 sf (2.22 ac).

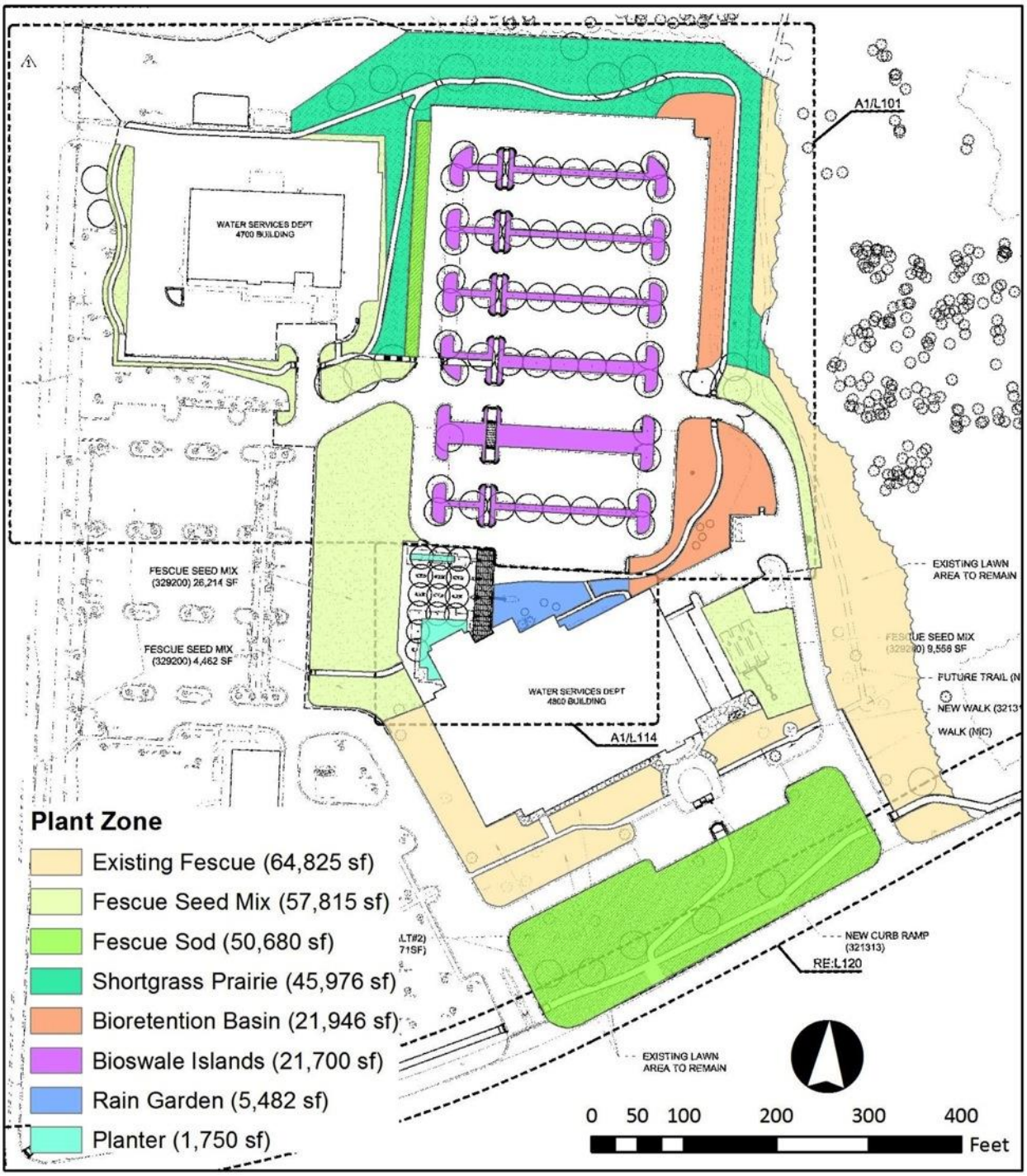


Figure Ecn1-1: Planting zone areas for Kansas City Water Services Swope Campus. (Hahn 2016)

Maintenance records for 2012-2016 were reviewed, and mowing cost estimates were averaged for 2015 and 2016. Based on planting area take-offs established in **Figure Ecn1-1**, the annual fescue mowing cost per acre was calculated. If the prairie and BMP areas were fescue, then the equivalent mowing cost can be calculated by multiplying the area by the unit cost.

Calculations
Average mowing costs:($15,026 (2015) + $16,530 (2016))/2 = $15,778.
Mowing cost per acre for existing and new fescue: $15,778/3.98 acres = $3,964/ac
Equivalent fescue mowing cost for prairie and BMP areas: $3,964/ac x 2.22 ac = $8,800.

Limitations
None.

Sources
Treese, Lisa. 2016. Estimated maintenance costs for KC Water Services Swope Campus. Kansas City: Water Services Department.

- ***Ecn2 - Saves an estimated $34,635 in annual potable water costs compared to a traditional irrigated turf landscape in Kansas City, MO.***

Methods
Since establishment of native/low water use plants around the KC Water Services building, no potable water is currently used to support the landscape. Based on the landscape area of 270,174 sf (6.20 acres) determined for Ecn1, a rough estimate of water can be made for an equivalent amount of irrigated turf landscape. Assumptions include: 1" of water per week is needed to support turf; spray head application efficiency is 67% for triangular spacing (Rainbird 2016); 24 weeks for the growing season (May-September); and water rates specified in "2016 Schedule of Water and Sanitary Sewer Services Rates" (KCMO Water Services 2016, p 2). Water and sewer fees are substantially higher than surrounding municipalities due to the water and sewer upgrades being undertaken to meet the EPA mandated reduction of Kansas City Combined Sewer Overflow (CSO) impacts.

Calculations
Amount of water required per week: ((1in/wk x 1ft) ÷ 12in) x 270,174 sf = 22,515 cf/wk
Amount of water applied to achieve 1in/wk = 22,515 ÷ .67 (efficiency) = 33,604 cf/wk
Water applied during 24-week growing season: 33,604 cf/wk x 24 wks = 806,496 cf/season

<u>Water Cost</u>:
As detailed in the "2016 Schedule of Water and Sanitary Sewer Services Rates" (page 1), the commodity charge is based on the total volume of water purchased, and is applied as a tiered rate according to usage.

• "First 600 cf at $4.60 per 100 cf": 600 x $4.60 ÷ 100 cf = $27.60
• "Next 4,400 cf at $5.09 per 100 cf": 4,400 x $5.09 ÷ 100 cf = $223.96
• "Next 995,000 cf at $4.29 per 100 cf": (806,496 cf - 600 cf - 4,400 cf) = 801,496 cf x $4.29 ÷ 100 cf = $34,384.18

$27.60 + $223.96 + $34,384.18 = **$34,635.74**

Limitations
1 in per week is a very general assumption.

Sources
Kansas City Water Services. 2016. "Schedule of: Water & Sanitary Services Rates, Stormwater Fees, Meter Readings, Billing Practices, and Bill Payment Guarantees." Accessed August 6: https://www.kcwaterservices.org/wp-content/uploads/2013/04/2016-Water-Rate-Book.pdf

Cost Comparison

Methods
Unit costs of various installed paving were pulled from project construction records. Costs for traditional stormwater detention and retention were collected from BNIM project histories. Ground material and paver unit costs are presented in **Table CC-1**.

Table CC-1: Ground material and paver unit costs (Schuessler 2016).

Ground Material	Unit Cost/sf	Area (sf)	Item Cost
Permeable Paver – Type 1 *Pavestone 'Eco-Venetian' on 18-36" of base rock, made locally*	$15.20	11,783	$179,102
Permeable Paver – Type 2 *Belgard 'Aqua Rock II' on 18-36" of base rock, made locally*	$15.12	11,783	$178,159
Permeable Paver – Type 3 *Unilock 'Eco-line'; included irregular shapes and walkways; 18" inches of base rock, shipped 500 miles*	$21.63	7,865	$170,120
6-Inch Porous Asphalt *on 12-36" of base rock*	$10.92	11,783	$128,670
Pervious Concrete *on 12-36" of base rock*	$10.65	11,783	$125,489
5" Molded Pulp Formed Grasscrete *Includes 6" base rock, filter fabric, soil, and seed*	$21.51	3,043	$65,562
Total permeable material area and cost		58,040	$847,102

7” Reinforced Concrete Drive *(no base rock)*	$9.00	88,792	$799,128
4” Reinforced Granite Sidewalk with Deactivator *(no base rock)*	$8.00	15,350	$122,800

Calculations

Parking Bay Stormwater Detention Costs

If a permeable paving/subsurface water storage system was not used for the parking bays, typical 7” impervious concrete would have be used. The cost difference represents the “added value” of the subsurface water storage system used to provide stormwater detention:

Porous Asphalt ($10.92/sf installed) - equivalent 7” concrete ($9.00/sf installed) = $1.92/sf
Pervious Concrete ($10.65/sf installed) - equivalent 7” concrete ($9.00/sf installed) = $1.65/sf
Paver 1 ($15.20/sf installed) - equivalent 7” concrete ($9.00/sf installed) = $6.20/sf
Paver 2 ($15.12/sf installed) - equivalent 7” concrete ($9.00/sf installed) = $6.12/sf
$1.92 + $1.65 + $6.20 + $6.12 = $15.89 per square foot
$15.89 / 4 = $3.97 per square foot average residual value for stormwater storage

As a comparison:
EPA Region 7 Headquarters Site Stormwater Detention Costs (LAF 2016)
Traditional Detention Basin (estimated): $311,335/77,101 sf (1.77 ac) = $4.04/sf
Treatment Train including sand filter and wetland: $340,993/77,101 sf (1.77 ac) = $4.42/sf

Cost Reduction of Using Porous Asphalt/ and Pervious Concrete/Subsurface system
Average Porous Asphalt ($1.92) & Pervious Concrete ($1.65) stormwater detention cost = $1.79
Cost reduction compared to traditional detention basin: ($1.79-$4.04)/$4.04 x100 = 55.7%
Cost reduction compared to stormwater treatment train: ($1.79-$4.42)/$4.42 x100 = 59.5%

Cost Increase of Using Permeable Pavers/Subsurface system
Average for Paver 1 ($6.20) & Paver 2 ($6.12) stormwater detention = $6.16
Cost increase compared to traditional detention basin: ($6.16-$4.04)/$4.04 x100 = 52.48%
Cost increase compared to stormwater treatment train: ($6.16-$4.42)/$4.42 x100 = 39.37%

Limitations

None

Sources

Landscape Architecture Foundation. 2016. Landscape Performance Series, “EPA Region 7 Headquarters”.
Schuessler, Jim. 2016. CFS Engineers, Kansas City, MO.

Appendix A

Parking Area Stormwater Outfall Data

Parking Area Stormwater Outfall Drain: ISCO Monitoring Data (Storm Events May 16-July 13, 2016)

Kansas City, MO Water Services Site (4800 East 63rd Street, Kansas City, MO)

ISCO device Serial Number 830392901; Pipe Diameter = 6in

Catchment (ac) = 6.29 Catchment (sf) = 273,992.40

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/16/2016 12:00		0.000000	0.0000	0.0000	0.0000	0.00		
5/16/2016 12:15		0.002897	0.3130	1.0406	2.0116	30.17		
5/16/2016 12:30		0.009453	0.3060	1.7523	6.5648	98.47		
5/16/2016 12:45		0.008493	0.3171	1.4843	5.8976	88.46		
5/16/2016 13:00		0.006921	0.2929	1.4492	4.8065	72.10		
5/16/2016 13:15		0.007099	0.2966	1.4622	4.9297	73.95		
5/16/2016 13:30		0.006619	0.2815	1.4441	4.5962	68.94		
5/16/2016 13:45		0.006675	0.2888	1.4267	4.6352	69.53		
5/16/2016 14:00		0.006827	0.2961	1.4241	4.7412	71.12		
5/16/2016 14:15		0.006664	0.2740	1.4790	4.6280	69.42		
5/16/2016 14:30		0.009259	0.3400	1.6027	6.4299	96.45		
5/16/2016 14:45		0.024365	0.5754	2.2069	16.9199	253.80		
5/16/2016 15:00		0.071408	1.0673	3.1284	49.5887	743.83		
5/16/2016 15:15		0.103888	1.3044	3.6053	72.1443	1,082.16		
5/16/2016 15:30		0.115274	1.3831	3.7466	80.0516	1,200.77		
5/16/2016 15:45		0.127824	1.4728	3.8793	88.7668	1,331.50		
5/16/2016 16:00		0.171501	1.8016	4.2126	119.0979	1,786.47		
5/16/2016 16:15		0.370281	3.4711	4.7012	257.1397	3,857.10		
5/16/2016 16:30		0.409770	3.7159	4.8675	284.5625	4,268.44		
5/16/2016 16:45		0.324872	3.0253	4.7333	225.6052	3,384.08		
5/16/2016 17:00		0.179416	1.8046	4.3868	124.5944	1,868.92		
5/16/2016 17:15		0.147215	1.5810	4.1287	102.2324	1,533.49		
5/16/2016 17:30		0.127320	1.4787	3.8528	88.4169	1,326.25		
5/16/2016 17:45		0.099975	1.2513	3.6150	69.4268	1,041.40		
5/16/2016 18:00		0.083657	1.1345	3.3831	58.0954	871.43		
5/16/2016 18:15		0.075371	1.0946	3.2008	52.3409	785.11		
5/16/2016 18:30		0.060663	0.9207	3.0906	42.1274	631.91		
5/16/2016 18:45		0.052402	0.8720	2.8752	36.3903	545.85		
5/16/2016 19:00		0.050631	0.8521	2.8502	35.1602	527.40		
5/16/2016 19:15		0.043665	0.7759	2.7332	30.3232	454.85		
5/16/2016 19:30		0.040077	0.7404	2.6531	27.8315	417.47		
5/16/2016 19:45		0.036093	0.6843	2.6012	25.0648	375.97		
5/16/2016 20:00		0.032879	0.6798	2.4366	22.8326	342.49		
5/16/2016 20:15		0.030890	0.6456	2.4170	21.4513	321.77		
5/16/2016 20:30		0.027326	0.6148	2.2875	18.9766	284.65		
5/16/2016 20:45		0.027068	0.6287	2.2342	18.7972	281.96		
5/16/2016 21:00		0.024469	0.5577	2.2658	16.9927	254.89		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/16/2016 21:15		0.023587	0.5633	2.1888	16.3801	245.70		
5/16/2016 21:30		0.022620	0.5415	2.1849	15.7085	235.63		
5/16/2016 21:45		0.021426	0.5340	2.1210	14.8788	223.18		
5/16/2016 22:00		0.019854	0.5125	2.0670	13.7877	206.82		
5/16/2016 22:15		0.020940	0.5433	2.0593	14.5417	218.13		
5/16/2016 22:30		0.019030	0.5062	2.0221	13.2155	198.23		
5/16/2016 22:45		0.019482	0.5314	1.9854	13.5289	202.93		
5/16/2016 23:00		0.018740	0.4969	2.0270	13.0141	195.21		
5/16/2016 23:15		0.017436	0.4798	1.9729	12.1084	181.63		
5/16/2016 23:30		0.016381	0.4749	1.8995	11.3754	170.63		
5/16/2016 23:45		0.016120	0.4518	1.9465	11.1947	167.92		
5/17/2016 0:00		0.015141	0.4455	1.8791	10.5148	157.72		
5/17/2016 0:15		0.015002	0.4399	1.8839	10.4178	156.27		
5/17/2016 0:30		0.015516	0.4552	1.8832	10.7751	161.63		
5/17/2016 0:45		0.013825	0.4123	1.8610	9.6005	144.01		
5/17/2016 1:00		0.013700	0.4286	1.7977	9.5139	142.71		
5/17/2016 1:15		0.012422	0.4081	1.7355	8.6263	129.39		
5/17/2016 1:30		0.012347	0.3981	1.7592	8.5741	128.61		
5/17/2016 1:45		0.011636	0.3771	1.7529	8.0809	121.21		
5/17/2016 2:00		0.011147	0.3732	1.7121	7.7413	116.12		
5/17/2016 2:15		0.009940	0.3506	1.6493	6.9026	103.54		
5/17/2016 2:30		0.009289	0.3465	1.5848	6.4506	96.76		
5/17/2016 2:45		0.008771	0.3304	1.5738	6.0907	91.36		
5/17/2016 3:00		0.008363	0.3198	1.5571	5.8074	87.11		
5/17/2016 3:15		0.008027	0.3117	1.5402	5.5741	83.61		
5/17/2016 3:30		0.006923	0.2942	1.4449	4.8076	72.11		
5/17/2016 3:45		0.007003	0.2933	1.4596	4.8629	72.94		
5/17/2016 4:00		0.006325	0.2701	1.4398	4.3924	65.89		
5/17/2016 4:15		0.005793	0.2593	1.3927	4.0230	60.34		
5/17/2016 4:30		0.005686	0.2575	1.3814	3.9487	59.23		
5/17/2016 4:45		0.005236	0.2432	1.3570	3.6362	54.54		
5/17/2016 5:00		0.005138	0.2408	1.3484	3.5683	53.53		
5/17/2016 5:15		0.004822	0.2359	1.3083	3.3489	50.23		
5/17/2016 5:30		0.004468	0.2241	1.2855	3.1027	46.54		
5/17/2016 5:45		0.003959	0.2033	1.2647	2.7491	41.24		
5/17/2016 6:00		0.003885	0.2083	1.2269	2.6977	40.47		
5/17/2016 6:15		0.003810	0.2128	1.1924	2.6461	39.69		
5/17/2016 6:30		0.003256	0.1868	1.1702	2.2614	33.92		
5/17/2016 6:45		0.003067	0.1884	1.1160	2.1299	31.95		
5/17/2016 7:00		0.002801	0.1718	1.1171	1.9449	29.17		
5/17/2016 7:15		0.002646	0.1687	1.0872	1.8374	27.56		
5/17/2016 7:30		0.002568	0.1688	1.0643	1.7833	26.75		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/17/2016 7:45		0.002428	0.1630	1.0488	1.6860	25.29		
5/17/2016 8:00		0.002530	0.1645	1.0725	1.7570	26.35		
5/17/2016 8:15		0.002423	0.1654	1.0368	1.6827	25.24		
5/17/2016 8:30		0.002600	0.1705	1.0661	1.8058	27.09		
5/17/2016 8:45		0.002484	0.1640	1.0611	1.7249	25.87		
5/17/2016 9:00		0.002719	0.1716	1.0952	1.8884	28.33		
5/17/2016 9:15		0.003913	0.2062	1.2419	2.7174	40.76		
5/17/2016 9:30		0.006830	0.2925	1.4370	4.7434	71.15		
5/17/2016 9:45		0.008181	0.3141	1.5526	5.6813	85.22		
5/17/2016 10:00		0.011769	0.3880	1.7313	8.1727	122.59		
5/17/2016 10:15		0.026636	0.6062	2.2680	18.4969	277.45		
5/17/2016 10:30		0.058424	0.9281	2.9813	40.5725	608.59		
5/17/2016 10:45		0.068342	1.0114	3.1531	47.4595	711.89		
5/17/2016 11:00		0.060937	0.9786	2.9560	42.3172	634.76		
5/17/2016 11:15		0.059076	0.9433	2.9694	41.0248	615.37		
5/17/2016 11:30		0.056178	0.8987	2.9650	39.0124	585.19		
5/17/2016 11:45		0.057034	0.9028	2.9896	39.6071	594.11		
5/17/2016 12:00		0.052773	0.8739	2.8862	36.6483	549.72		
5/17/2016 12:15		0.052546	0.8654	2.8985	36.4900	547.35		
5/17/2016 12:30		0.049908	0.8592	2.8005	34.6581	519.87		
5/17/2016 12:45		0.046930	0.8203	2.7680	32.5903	488.85		
5/17/2016 13:00		0.044669	0.7968	2.7251	31.0203	465.30		
5/17/2016 13:15		0.040013	0.7462	2.6340	27.7865	416.80		
5/17/2016 13:30		0.039004	0.7356	2.6117	27.0858	406.29		
5/17/2016 13:45		0.035935	0.6821	2.5989	24.9548	374.32		
5/17/2016 14:00		0.033518	0.6899	2.4448	23.2765	349.15		
5/17/2016 14:15		0.030966	0.6458	2.4208	21.5041	322.56		
5/17/2016 14:30		0.028920	0.6142	2.3880	20.0833	301.25		
5/17/2016 14:45		0.026742	0.5880	2.3268	18.5708	278.56		
5/17/2016 15:00		0.026375	0.6029	2.2608	18.3163	274.74		
5/17/2016 15:15		0.023444	0.5638	2.1775	16.2808	244.21		
5/17/2016 15:30		0.021662	0.5181	2.1864	15.0429	225.64		
5/17/2016 15:45		0.021561	0.5347	2.1288	14.9732	224.60		
5/17/2016 16:00		0.020387	0.5015	2.1416	14.1576	212.36		
5/17/2016 16:15		0.019422	0.5102	2.0408	13.4874	202.31		
5/17/2016 16:30		0.018793	0.5034	2.0119	13.0506	195.76		
5/17/2016 16:45		0.018346	0.4840	2.0344	12.7400	191.10		
5/17/2016 17:00		0.017549	0.4748	1.9973	12.1870	182.80		
5/17/2016 17:15		0.016298	0.4621	1.9302	11.3181	169.77		
5/17/2016 17:30		0.016126	0.4593	1.9240	11.1983	167.98		
5/17/2016 17:45		0.014652	0.4303	1.8817	10.1748	152.62		
5/17/2016 18:00		0.014464	0.4314	1.8608	10.0445	150.67		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/17/2016 18:15		0.014639	0.4388	1.8541	10.1662	152.49		
5/17/2016 18:30		0.012944	0.4007	1.8114	8.9891	134.84		
5/17/2016 18:45		0.011620	0.3705	1.7735	8.0698	121.05		
5/17/2016 19:00		0.011446	0.3782	1.7284	7.9486	119.23		
5/17/2016 19:15		0.010223	0.3561	1.6644	7.0991	106.49		
5/17/2016 19:30		0.009338	0.3342	1.6326	6.4848	97.27		
5/17/2016 19:45		0.009333	0.3390	1.6151	6.4811	97.22		
5/17/2016 20:00		0.008564	0.3191	1.5862	5.9469	89.20		
5/17/2016 20:15		0.007633	0.3032	1.5158	5.3009	79.51		
5/17/2016 20:30		0.006801	0.2773	1.4876	4.7227	70.84		
5/17/2016 20:45		0.006495	0.2730	1.4561	4.5102	67.65		
5/17/2016 21:00		0.005912	0.2594	1.4125	4.1055	61.58		
5/17/2016 21:15		0.005609	0.2575	1.3680	3.8949	58.42		
5/17/2016 21:30		0.005196	0.2437	1.3475	3.6081	54.12		
5/17/2016 21:45		0.004897	0.2364	1.3207	3.4009	51.01		
5/17/2016 22:00		0.004449	0.2168	1.3121	3.0898	46.35		
5/17/2016 22:15		0.004478	0.2357	1.2427	3.1098	46.65		
5/17/2016 22:30		0.004056	0.2192	1.2202	2.8165	42.25		
5/17/2016 22:45		0.003699	0.1961	1.2366	2.5690	38.54		
5/17/2016 23:00		0.003445	0.1879	1.2124	2.3927	35.89		
5/17/2016 23:15		0.003253	0.1806	1.1974	2.2588	33.88		
5/17/2016 23:30		0.003099	0.1747	1.1845	2.1518	32.28		
5/17/2016 23:45		0.003064	0.1756	1.1708	2.1276	31.91		
5/18/2016 0:00		0.002729	0.1664	1.1218	1.8951	28.43		
5/18/2016 0:15		0.002615	0.1670	1.0862	1.8160	27.24		
5/18/2016 0:30		0.002518	0.1606	1.0867	1.7483	26.22		
5/18/2016 0:45		0.002185	0.1472	1.0465	1.5175	22.76		
5/18/2016 1:00		0.002280	0.1611	1.0127	1.5836	23.75		
5/18/2016 1:15		0.002153	0.1496	1.0242	1.4951	22.43		
5/18/2016 1:30		0.000000	0.0000	0.9720	0.0000	0.00		
	0.98			Total for Event		49,224	167,384	70.6%
5/20/2016 7:15		0.000000	0.0000	1.0515	0.0000	0.00		
5/20/2016 7:30		0.002597	0.1654	1.0881	1.8035	27.05		
5/20/2016 7:45		0.002903	0.1860	1.0834	2.0158	30.24		
5/20/2016 8:00		0.002637	0.1719	1.0709	1.8314	27.47		
5/20/2016 8:15		0.002616	0.1726	1.0618	1.8166	27.25		
5/20/2016 8:30		0.002596	0.1763	1.0406	1.8025	27.04		
5/20/2016 8:45		0.002320	0.1607	1.0263	1.6108	24.16		
5/20/2016 9:00		0.000000	0.0000	1.0155	0.0000	0.00		
	NA							

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/23/2016 14:45		0.000000	0.0000	-0.3558	0.0000	0.00		
5/23/2016 15:00		0.005385	0.2764	1.2652	3.7398	56.10		
5/23/2016 15:15		0.006315	0.2979	1.3422	4.3851	65.78		
5/23/2016 15:30		0.005523	0.2739	1.2959	3.8351	57.53		
5/23/2016 15:45		0.005387	0.2891	1.2261	3.7407	56.11		
5/23/2016 16:00		0.004916	0.2701	1.2062	3.4137	51.21		
5/23/2016 16:15		0.005367	0.2832	1.2408	3.7274	55.91		
5/23/2016 16:30		0.005447	0.2749	1.2800	3.7828	56.74		
5/23/2016 16:45		0.005697	0.2759	1.3176	3.9566	59.35		
5/23/2016 17:00		0.005149	0.2758	1.2278	3.5758	53.64		
5/23/2016 17:15		0.004914	0.2629	1.2289	3.4123	51.18		
5/23/2016 17:30		0.004591	0.2519	1.2074	3.1882	47.82		
5/23/2016 17:45		0.004137	0.2365	1.1732	2.8732	43.10		
5/23/2016 18:00		0.003732	0.2223	1.1400	2.5920	38.88		
5/23/2016 18:15		0.003410	0.2173	1.0876	2.3677	35.52		
5/23/2016 18:30		0.003020	0.2026	1.0497	2.0972	31.46		
5/23/2016 18:45		0.003048	0.2112	1.0264	2.1169	31.75		
5/23/2016 19:00		0.003023	0.2122	1.0171	2.0991	31.49		
5/23/2016 19:15		0.002866	0.2098	0.9877	1.9900	29.85		
5/23/2016 19:30		0.000000	0.0000	0.9631	0.0000	0.00		
	0.16			Total for Event		853	27,328	96.9%
5/24/2016 6:45		0.000000	0.0000	0.0661	0.0000	0.00		
5/24/2016 7:00		0.009034	0.4104	1.3784	6.2737	94.11		
5/24/2016 7:15		0.077386	1.1502	3.1422	53.7405	806.11		
5/24/2016 7:30		0.051755	0.9197	2.7330	35.9412	539.12		
5/24/2016 7:45		0.039205	0.7794	2.5093	27.2255	408.38		
5/24/2016 8:00		0.036668	0.7274	2.5137	25.4639	381.96		
5/24/2016 8:15		0.034295	0.7018	2.4554	23.8158	357.24		
5/24/2016 8:30		0.032004	0.6986	2.3395	22.2251	333.38		
5/24/2016 8:45		0.027102	0.6253	2.2453	18.8208	282.31		
5/24/2016 9:00		0.024024	0.5929	2.1363	16.6836	250.25		
5/24/2016 9:15		0.021572	0.5448	2.1005	14.9807	224.71		
5/24/2016 9:30		0.019889	0.5361	2.0026	13.8117	207.18		
5/24/2016 9:45		0.019692	0.5236	2.0229	13.6752	205.13		
5/24/2016 10:00		0.018275	0.5041	1.9695	12.6913	190.37		
5/24/2016 10:15		0.018278	0.5144	1.9408	12.6933	190.40		
5/24/2016 10:30		0.017021	0.4935	1.8993	11.8201	177.30		
5/24/2016 10:45		0.016602	0.4699	1.9329	11.5293	172.94		
5/24/2016 11:00		0.015777	0.4705	1.8610	10.9560	164.34		
5/24/2016 11:15		0.015507	0.4540	1.8860	10.7685	161.53		
5/24/2016 11:30		0.014650	0.4368	1.8614	10.1739	152.61		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/24/2016 11:45		0.014852	0.4346	1.8866	10.3141	154.71		
5/24/2016 12:00		0.014308	0.4293	1.8528	9.9364	149.05		
5/24/2016 12:15		0.012965	0.4013	1.8118	9.0037	135.06		
5/24/2016 12:30		0.011361	0.3804	1.7120	7.8897	118.35		
5/24/2016 12:45		0.010823	0.3685	1.6918	7.5161	112.74		
5/24/2016 13:00		0.010745	0.3779	1.6527	7.4615	111.92		
5/24/2016 13:15		0.009854	0.3483	1.6470	6.8432	102.65		
5/24/2016 13:30		0.009128	0.3386	1.5911	6.3390	95.08		
5/24/2016 13:45		0.008887	0.3270	1.6005	6.1718	92.58		
5/24/2016 14:00		0.007607	0.2958	1.5388	5.2829	79.24		
5/24/2016 14:15		0.007209	0.2835	1.5265	5.0064	75.10		
5/24/2016 14:30		0.006913	0.2825	1.4854	4.8010	72.02		
5/24/2016 14:45		0.005682	0.2464	1.4243	3.9456	59.18		
5/24/2016 15:00		0.005468	0.2458	1.3887	3.7969	56.95		
5/24/2016 15:15		0.004772	0.2229	1.3515	3.3142	49.71		
5/24/2016 15:30		0.005096	0.2440	1.3285	3.5392	53.09		
5/24/2016 15:45		0.004336	0.2222	1.2662	3.0109	45.16		
5/24/2016 16:00		0.003621	0.1920	1.2367	2.5145	37.72		
5/24/2016 16:15		0.003269	0.1829	1.1909	2.2702	34.05		
5/24/2016 16:30		0.003278	0.1846	1.1854	2.2762	34.14		
5/24/2016 16:45		0.000000	0.0000	1.1363	0.0000	0.00		
5/24/2016 17:00		0.000000	0.0000	1.0742	0.0000	0.00		
5/24/2016 17:15		0.017980	1.1970	1.0551	12.4860	187.29		
5/24/2016 17:30		0.016681	1.1757	1.0142	11.5841	173.76		
5/24/2016 17:45		0.000000	0.0000	0.9802	0.0000	0.00		
	0.23			Total for Event		7,329	39,284	81.3%
5/26/2016 4:45		0.000000	0.0000	0.8215	0.0000	0.00		
5/26/2016 5:00		0.003828	0.2605	1.0391	2.6580	39.87		
5/26/2016 5:15		0.009124	0.3700	1.4934	6.3361	95.04		
5/26/2016 5:30		0.054608	0.9491	2.7802	37.9225	568.84		
5/26/2016 5:45		0.263074	2.7016	4.3018	182.6905	2,740.36		
5/26/2016 6:00		0.164467	1.8512	3.9595	114.2132	1,713.20		
5/26/2016 6:15		0.117990	1.4838	3.6007	81.9376	1,229.06		
5/26/2016 6:30		0.079950	1.1688	3.1839	55.5206	832.81		
5/26/2016 6:45		0.059522	0.9636	2.9375	41.3351	620.03		
5/26/2016 7:00		0.046252	0.8501	2.6634	32.1192	481.79		
5/26/2016 7:15		0.040824	0.7940	2.5513	28.3501	425.25		
5/26/2016 7:30		0.035675	0.7432	2.4228	24.7743	371.62		
5/26/2016 7:45		0.031319	0.6875	2.3298	21.7490	326.23		
5/26/2016 8:00		0.031140	0.6745	2.3531	21.6248	324.37		
5/26/2016 8:15		0.024986	0.6211	2.1250	17.3511	260.27		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/26/2016 8:30		0.025147	0.6114	2.1600	17.4633	261.95		
5/26/2016 8:45		0.022714	0.5854	2.0694	15.7736	236.60		
5/26/2016 9:00		0.021935	0.5819	2.0263	15.2327	228.49		
5/26/2016 9:15		0.020385	0.5373	2.0358	14.1566	212.35		
5/26/2016 9:30		0.017300	0.5083	1.8812	12.0141	180.21		
5/26/2016 9:45		0.017836	0.5050	1.9322	12.3860	185.79		
5/26/2016 10:00		0.017653	0.5127	1.8970	12.2591	183.89		
5/26/2016 10:15		0.018733	0.5278	1.9392	13.0087	195.13		
5/26/2016 10:30		0.538184	5.0043	4.7406	373.7391	5,606.09		
5/26/2016 10:45		0.595272	5.0623	5.2411	413.3836	6,200.75		
5/26/2016 11:00		0.544201	4.9246	4.8786	377.9177	5,668.76		
5/26/2016 11:15		0.330986	3.3747	4.3308	229.8516	3,447.77		
5/26/2016 11:30		0.140300	1.6122	3.8885	97.4309	1,461.46		
5/26/2016 11:45		0.104906	1.3560	3.5192	72.8516	1,092.77		
5/26/2016 12:00		0.084092	1.1881	3.2725	58.3970	875.96		
5/26/2016 12:15		0.067368	1.0469	3.0334	46.7834	701.75		
5/26/2016 12:30		0.056135	0.9388	2.8642	38.9825	584.74		
5/26/2016 12:45		0.050780	0.8675	2.8173	35.2636	528.95		
5/26/2016 13:00		0.044396	0.8054	2.6901	30.8305	462.46		
5/26/2016 13:15		0.038231	0.7661	2.4945	26.5496	398.24		
5/26/2016 13:30		0.036626	0.7294	2.5062	25.4349	381.52		
5/26/2016 13:45		0.034238	0.6913	2.4804	23.7766	356.65		
5/26/2016 14:00		0.030840	0.6677	2.3540	21.4166	321.25		
5/26/2016 14:15		0.027871	0.6372	2.2605	19.3552	290.33		
5/26/2016 14:30		0.028962	0.6321	2.3398	20.1123	301.68		
5/26/2016 14:45		0.026934	0.5994	2.3063	18.7041	280.56		
5/26/2016 15:00		0.024714	0.5822	2.2108	17.1628	257.44		
5/26/2016 15:15		0.023941	0.5911	2.1357	16.6257	249.38		
5/26/2016 15:30		0.022633	0.5509	2.1581	15.7172	235.76		
5/26/2016 15:45		0.025906	0.6104	2.2105	17.9904	269.86		
5/26/2016 16:00		0.077416	1.0936	3.2728	53.7611	806.42		
5/26/2016 16:15		0.080801	1.1314	3.2963	56.1117	841.68		
5/26/2016 16:30		0.088531	1.2037	3.3760	61.4796	922.19		
5/26/2016 16:45		0.084450	1.1887	3.2824	58.6460	879.69		
5/26/2016 17:00		0.072648	1.0617	3.1849	50.4497	756.75		
5/26/2016 17:15		0.061180	0.9563	3.0194	42.4859	637.29		
5/26/2016 17:30		0.051285	0.8430	2.9028	35.6146	534.22		
5/26/2016 17:45		0.095632	1.2696	3.4425	66.4113	996.17		
5/26/2016 18:00		0.572390	4.9805	5.0979	397.4933	5,962.40		
5/26/2016 18:15		0.591057	5.2000	5.0332	410.4563	6,156.84		
5/26/2016 18:30		0.700130	5.6184	5.7070	486.2011	7,293.02		
5/26/2016 18:45		0.641884	5.2749	5.4889	445.7530	6,686.30		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/26/2016 19:00		0.611575	4.9851	5.5571	424.7049	6,370.57		
5/26/2016 19:15		0.629624	5.2243	5.4136	437.2387	6,558.58		
5/26/2016 19:30		0.546156	4.8487	4.9821	379.2749	5,689.12		
5/26/2016 19:45		0.553240	4.9447	4.9450	384.1944	5,762.92		
5/26/2016 20:00		0.375535	3.7322	4.4373	260.7881	3,911.82		
5/26/2016 20:15		0.168203	1.7537	4.2419	116.8075	1,752.11		
5/26/2016 20:30		0.140730	1.5999	3.9251	97.7294	1,465.94		
5/26/2016 20:45		0.118118	1.4548	3.6642	82.0262	1,230.39		
5/26/2016 21:00		0.390586	3.6974	4.6548	271.2401	4,068.60		
5/26/2016 21:15		0.504744	4.7288	4.7040	350.5164	5,257.75		
5/26/2016 21:30		0.456628	4.1544	4.8505	317.1027	4,756.54		
5/26/2016 21:45		0.389735	3.8274	4.4886	270.6493	4,059.74		
5/26/2016 22:00		0.514895	4.9222	4.6091	357.5658	5,363.49		
5/26/2016 22:15		0.579052	5.0166	5.1240	402.1192	6,031.79		
5/26/2016 22:30		0.491461	4.6371	4.6702	341.2922	5,119.38		
5/26/2016 22:45		0.767380	6.0469	6.7135	532.9030	7,993.54		
5/26/2016 23:00		0.729077	5.7451	6.9873	506.3037	7,594.56		
5/26/2016 23:15		0.712152	5.6117	7.0264	494.5502	7,418.25		
5/26/2016 23:30		0.717905	5.6571	6.8020	498.5453	7,478.18		
5/26/2016 23:45		0.648772	5.1123	7.2632	450.5361	6,758.04		
5/27/2016 0:00		0.760102	5.9896	6.5388	527.8484	7,917.73		
5/27/2016 0:15		0.780719	6.1520	6.9295	542.1662	8,132.49		
5/27/2016 0:30		0.768637	6.0568	6.7823	533.7760	8,006.64		
5/27/2016 0:45		0.753476	5.9374	6.6147	523.2471	7,848.71		
5/27/2016 1:00		0.723746	5.7031	6.7902	502.6011	7,539.02		
5/27/2016 1:15		0.717526	5.6541	6.4647	498.2817	7,474.23		
5/27/2016 1:30		0.693494	5.4647	6.1845	481.5927	7,223.89		
5/27/2016 1:45		0.648074	5.1655	5.7853	450.0516	6,750.77		
5/27/2016 2:00		0.567505	4.6007	5.6060	394.1009	5,911.51		
5/27/2016 2:15		0.405161	3.9775	4.4902	281.3616	4,220.42		
5/27/2016 2:30		0.151320	1.6558	4.0598	105.0833	1,576.25		
5/27/2016 2:45		0.126450	1.4930	3.7984	87.8126	1,317.19		
5/27/2016 3:00		0.111660	1.3563	3.7074	77.5418	1,163.13		
5/27/2016 3:15		0.094905	1.1953	3.5961	65.9060	988.59		
5/27/2016 3:30		0.359359	3.6083	4.3940	249.5547	3,743.32		
5/27/2016 3:45		0.617504	5.4721	4.9923	428.8219	6,432.33		
5/27/2016 4:00		0.653418	5.2053	5.7922	453.7623	6,806.43		
5/27/2016 4:15		0.644584	5.4147	5.3244	447.6275	6,714.41		
5/27/2016 4:30		0.620903	5.3007	5.2160	431.1826	6,467.74		
5/27/2016 4:45		0.541941	4.6329	5.2071	376.3481	5,645.22		
5/27/2016 5:00		0.500407	4.4775	4.9389	347.5047	5,212.57		
5/27/2016 5:15		0.197282	1.9889	4.3772	137.0013	2,055.02		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/27/2016 5:30		0.148552	1.6068	4.1021	103.1609	1,547.41		
5/27/2016 5:45		0.128384	1.4819	3.8734	89.1554	1,337.33		
5/27/2016 6:00		0.112598	1.3436	3.7640	78.1930	1,172.90		
5/27/2016 6:15		0.100635	1.2500	3.6381	69.8854	1,048.28		
5/27/2016 6:30		0.092832	1.1950	3.5313	64.4669	967.00		
5/27/2016 6:45		0.089734	1.2003	3.4213	62.3154	934.73		
5/27/2016 7:00		0.082781	1.1360	3.3505	57.4869	862.30		
5/27/2016 7:15		0.074659	1.0547	3.2728	51.8467	777.70		
5/27/2016 7:30		0.069440	1.0007	3.2208	48.2225	723.34		
5/27/2016 7:45		0.060081	0.9076	3.1021	41.7231	625.85		
5/27/2016 8:00		0.054318	0.8634	2.9799	37.7208	565.81		
5/27/2016 8:15		0.051690	0.8300	2.9564	35.8959	538.44		
5/27/2016 8:30		0.049683	0.8338	2.8565	34.5019	517.53		
5/27/2016 8:45		0.049443	0.8494	2.8051	34.3353	515.03		
5/27/2016 9:00		0.043855	0.7555	2.7991	30.4546	456.82		
5/27/2016 9:15		0.043810	0.7677	2.7628	30.4238	456.36		
5/27/2016 9:30		0.042345	0.7356	2.7811	29.4061	441.09		
5/27/2016 9:45		0.041297	0.7366	2.7253	28.6782	430.17		
5/27/2016 10:00		0.039500	0.7221	2.6745	27.4309	411.46		
5/27/2016 10:15		0.039690	0.7305	2.6606	27.5627	413.44		
5/27/2016 10:30		0.036535	0.7141	2.5418	25.3712	380.57		
5/27/2016 10:45		0.035549	0.6818	2.5785	24.6868	370.30		
5/27/2016 11:00		0.034133	0.6563	2.5735	23.7032	355.55		
5/27/2016 11:15		0.033884	0.6654	2.5329	23.5307	352.96		
5/27/2016 11:30		0.032315	0.6378	2.5231	22.4409	336.61		
5/27/2016 11:45		0.030551	0.6378	2.4189	21.2159	318.24		
5/27/2016 12:00		0.029081	0.6194	2.3829	20.1950	302.92		
5/27/2016 12:15		0.029321	0.6231	2.3869	20.3618	305.43		
5/27/2016 12:30		0.028612	0.5996	2.4118	19.8694	298.04		
5/27/2016 12:45		0.025400	0.5610	2.3192	17.6387	264.58		
5/27/2016 13:00		0.025158	0.5472	2.3460	17.4705	262.06		
5/27/2016 13:15		0.022951	0.5448	2.1985	15.9379	239.07		
5/27/2016 13:30		0.023159	0.5435	2.2170	16.0825	241.24		
5/27/2016 13:45		0.021571	0.5075	2.2131	14.9797	224.70		
5/27/2016 14:00		0.022480	0.5296	2.2107	15.6111	234.17		
5/27/2016 14:15		0.020704	0.5045	2.1565	14.3777	215.67		
5/27/2016 14:30		0.020582	0.4956	2.1755	14.2929	214.39		
5/27/2016 14:45		0.019110	0.4743	2.1274	13.2707	199.06		
5/27/2016 15:00		0.017159	0.4401	2.0769	11.9159	178.74		
5/27/2016 15:15		0.015938	0.4274	2.0104	11.0683	166.02		
5/27/2016 15:30		0.015723	0.4272	1.9910	10.9189	163.78		
5/27/2016 15:45		0.014814	0.4091	1.9679	10.2877	154.32		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/27/2016 16:00		0.013478	0.3951	1.8843	9.3596	140.39		
5/27/2016 16:15		0.012333	0.3682	1.8597	8.5647	128.47		
5/27/2016 16:30		0.012011	0.3682	1.8245	8.3410	125.11		
5/27/2016 16:45		0.011449	0.3636	1.7785	7.9509	119.26		
5/27/2016 17:00		0.011703	0.3620	1.8124	8.1268	121.90		
5/27/2016 17:15		0.010472	0.3360	1.7653	7.2719	109.08		
5/27/2016 17:30		0.010537	0.3410	1.7545	7.3172	109.76		
5/27/2016 17:45		0.010180	0.3373	1.7252	7.0698	106.05		
5/27/2016 18:00		0.009959	0.3291	1.7285	6.9162	103.74		
5/27/2016 18:15		0.009385	0.3202	1.6893	6.5171	97.76		
5/27/2016 18:30		0.008944	0.3108	1.6673	6.2113	93.17		
5/27/2016 18:45		0.009054	0.3177	1.6556	6.2875	94.31		
5/27/2016 19:00		0.008129	0.2924	1.6264	5.6449	84.67		
5/27/2016 19:15		0.007718	0.2861	1.5920	5.3598	80.40		
5/27/2016 19:30		0.007291	0.2755	1.5702	5.0630	75.94		
5/27/2016 19:45		0.006849	0.2641	1.5480	4.7561	71.34		
5/27/2016 20:00		0.006560	0.2660	1.4936	4.5559	68.34		
5/27/2016 20:15		0.005802	0.2420	1.4639	4.0293	60.44		
5/27/2016 20:30		0.005451	0.2347	1.4317	3.7854	56.78		
5/27/2016 20:45		0.004553	0.2104	1.3618	3.1618	47.43		
5/27/2016 21:00		0.004512	0.2074	1.3672	3.1334	47.00		
5/27/2016 21:15		0.004198	0.2010	1.3282	2.9155	43.73		
5/27/2016 21:30		0.003770	0.1881	1.2904	2.6178	39.27		
5/27/2016 21:45		0.003612	0.1890	1.2479	2.5084	37.63		
5/27/2016 22:00		0.003492	0.1869	1.2284	2.4247	36.37		
5/27/2016 22:15		0.002961	0.1698	1.1705	2.0563	30.84		
5/27/2016 22:30		0.002417	0.1463	1.1275	1.6783	25.17		
5/27/2016 22:45		0.000000	0.0000	1.0581	0.0000	0.00		
5/27/2016 23:00		0.000000	0.0000	0.9678	0.0000	0.00		
5/27/2016 23:15		0.000000	0.0000	0.8776	0.0000	0.00		
5/27/2016 23:30		0.124050	1.5248	3.6704	86.1455	1,292.18		
5/27/2016 23:45		0.490083	4.7692	4.5286	340.3351	5,105.03		
5/28/2016 0:00		0.535863	5.0340	4.6910	372.1272	5,581.91		
5/28/2016 0:15		0.502779	4.5292	4.9025	349.1524	5,237.29		
5/28/2016 0:30		0.497741	4.8475	4.5252	345.6536	5,184.80		
5/28/2016 0:45		0.447834	4.2471	4.6461	310.9956	4,664.93		
5/28/2016 1:00		0.196430	1.9973	4.3421	136.4098	2,046.15		
5/28/2016 1:15		0.126082	1.4833	3.8102	87.5569	1,313.35		
5/28/2016 1:30		0.104032	1.3067	3.6044	72.2447	1,083.67		
5/28/2016 1:45		0.090589	1.2235	3.3944	62.9090	943.64		
5/28/2016 2:00		0.077497	1.0909	3.2822	53.8171	807.26		
5/28/2016 2:15		0.066874	1.0203	3.0777	46.4401	696.60		

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Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
5/28/2016 2:30		0.057842	0.9154	2.9901	40.1683	602.52		
5/28/2016 2:45		0.047743	0.8583	2.7089	33.1552	497.33		
5/28/2016 3:00		0.041872	0.7672	2.6699	29.0779	436.17		
5/28/2016 3:15		0.037190	0.7272	2.5411	25.8265	387.40		
5/28/2016 3:30		0.033003	0.6787	2.4463	22.9186	343.78		
5/28/2016 3:45		0.030992	0.6653	2.3690	21.5225	322.84		
5/28/2016 4:00		0.027711	0.6350	2.2565	19.2439	288.66		
5/28/2016 4:15		0.025726	0.6152	2.1865	17.8651	267.98		
5/28/2016 4:30		0.023369	0.5579	2.1893	16.2285	243.43		
5/28/2016 4:45		0.023243	0.5635	2.1645	16.1412	242.12		
5/28/2016 5:00		0.021282	0.5326	2.1146	14.7793	221.69		
5/28/2016 5:15		0.020130	0.5093	2.0978	13.9792	209.69		
5/28/2016 5:30		0.018238	0.5000	1.9781	12.6654	189.98		
5/28/2016 5:45		0.018176	0.4967	1.9829	12.6222	189.33		
5/28/2016 6:00		0.015550	0.4475	1.9096	10.7987	161.98		
5/28/2016 6:15		0.014737	0.4351	1.8746	10.2340	153.51		
5/28/2016 6:30		0.013552	0.4271	1.7883	9.4115	141.17		
5/28/2016 6:45		0.012939	0.4111	1.7780	8.9857	134.79		
5/28/2016 7:00		0.012265	0.4002	1.7442	8.5174	127.76		
5/28/2016 7:15		0.010807	0.3751	1.6685	7.5046	112.57		
5/28/2016 7:30		0.010074	0.3587	1.6385	6.9961	104.94		
5/28/2016 7:45		0.009556	0.3509	1.6026	6.6361	99.54		
5/28/2016 8:00		0.008756	0.3307	1.5711	6.0808	91.21		
5/28/2016 8:15		0.007915	0.3188	1.5009	5.4968	82.45		
5/28/2016 8:30		0.007928	0.3245	1.4838	5.5052	82.58		
5/28/2016 8:45		0.007310	0.3105	1.4453	5.0764	76.15		
5/28/2016 9:00		0.007053	0.2931	1.4679	4.8982	73.47		
5/28/2016 9:15		0.006326	0.2813	1.3994	4.3929	65.89		
5/28/2016 9:30		0.005623	0.2625	1.3522	3.9048	58.57		
5/28/2016 9:45		0.005438	0.2553	1.3470	3.7766	56.65		
5/28/2016 10:00		0.004892	0.2429	1.2950	3.3975	50.96		
5/28/2016 10:15		0.005045	0.2561	1.2750	3.5036	52.55		
5/28/2016 10:30		0.004396	0.2283	1.2546	3.0529	45.79		
5/28/2016 10:45		0.004114	0.2175	1.2392	2.8569	42.85		
5/28/2016 11:00		0.003739	0.2070	1.2000	2.5968	38.95		
5/28/2016 11:15		0.003909	0.2210	1.1821	2.7146	40.72		
5/28/2016 11:30		0.003648	0.2100	1.1676	2.5335	38.00		
5/28/2016 11:45		0.003645	0.2139	1.1519	2.5313	37.97		
5/28/2016 12:00		0.003270	0.2079	1.0896	2.2708	34.06		
5/28/2016 12:15		0.003215	0.2086	1.0740	2.2326	33.49		
5/28/2016 12:30		0.003019	0.1932	1.0846	2.0965	31.45		
5/28/2016 12:45		0.002743	0.1842	1.0487	1.9048	28.57		

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5/28/2016 13:00		0.003010	0.1848	1.1163	2.0905	31.36		
5/28/2016 13:15		0.002525	0.1790	1.0102	1.7534	26.30		
5/28/2016 13:30		0.002794	0.1983	1.0093	1.9400	29.10		
5/28/2016 13:45		0.002633	0.1781	1.0435	1.8286	27.43		
5/28/2016 14:00		0.002259	0.1615	1.0045	1.5688	23.53		
5/28/2016 14:15		0.002348	0.1626	1.0266	1.6303	24.46		
5/28/2016 14:30		0.002256	0.1647	0.9896	1.5666	23.50		
5/28/2016 14:45		0.000000	0.0000	0.9790	0.0000	0.00		
	3.12			Total for Event		361,309	532,896	32.2%
6/4/2016 3:45		0.000000	0.0000	0.8954	0.0000	0.00		
6/4/2016 4:00		0.005309	0.2806	1.2392	3.6868	55.30		
6/4/2016 4:15		0.007970	0.3439	1.4295	5.5347	83.02		
6/4/2016 4:30		0.008769	0.3662	1.4627	6.0897	91.35		
6/4/2016 4:45		0.010237	0.3976	1.5399	7.1090	106.64		
6/4/2016 5:00		0.011070	0.4023	1.6146	7.6873	115.31		
6/4/2016 5:15		0.011219	0.4114	1.6045	7.7912	116.87		
6/4/2016 5:30		0.011071	0.4064	1.6032	7.6884	115.33		
6/4/2016 5:45		0.010187	0.3900	1.5558	7.0742	106.11		
6/4/2016 6:00		0.008945	0.3698	1.4733	6.2120	93.18		
6/4/2016 6:15		0.007209	0.3302	1.3705	5.0062	75.09		
6/4/2016 6:30		0.006081	0.2954	1.3146	4.2226	63.34		
6/4/2016 6:45		0.005264	0.2842	1.2211	3.6557	54.84		
6/4/2016 7:00		0.004226	0.2457	1.1594	2.9350	44.02		
6/4/2016 7:15		0.003468	0.2262	1.0701	2.4084	36.13		
6/4/2016 7:30		0.000000	0.0000	0.9651	0.0000	0.00		
	0.2			Total for Event		1,157	34,160	96.6%
7/2/2016 7:30		0.000000	0.0000	-0.1871	0.0000	0.00		
7/2/2016 7:45		0.008423	0.3981	1.3404	5.8495	87.74		
7/2/2016 8:00		0.007038	0.3642	1.2578	4.8874	73.31		
7/2/2016 8:15		0.016319	0.5574	1.6879	11.3325	169.99		
7/2/2016 8:30		0.031186	0.7631	2.1498	21.6566	324.85		
7/2/2016 8:45		0.053919	1.0086	2.6281	37.4437	561.66		
7/2/2016 9:00		0.081378	1.2724	3.0188	56.5125	847.69		
7/2/2016 9:15		0.101408	1.4138	3.3079	70.4223	1,056.33		
7/2/2016 9:30		0.076068	1.2182	2.9625	52.8249	792.37		
7/2/2016 9:45		0.046047	0.9231	2.4937	31.9770	479.66		
7/2/2016 10:00		0.029138	0.7413	2.0892	20.2344	303.52		
7/2/2016 10:15		0.018225	0.5569	1.8285	12.6564	189.85		
7/2/2016 10:30		0.013716	0.5002	1.6106	9.5250	142.87		
7/2/2016 10:45		0.010250	0.4424	1.4290	7.1178	106.77		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
7/2/2016 11:00		0.011579	0.4654	1.5030	8.0407	120.61		
7/2/2016 11:15		0.009644	0.4277	1.4019	6.6973	100.46		
7/2/2016 11:30		0.007416	0.3841	1.2571	5.1497	77.25		
7/2/2016 11:45		0.005871	0.3557	1.1267	4.0773	61.16		
7/2/2016 12:00		0.004542	0.2996	1.0618	3.1540	47.31		
7/2/2016 12:15		0.000000	0.0000	0.9319	0.0000	0.00		
7/2/2016 16:15		0.000000	0.0000	0.6953	3.1540	47.31		
7/2/2016 16:30		0.004052	0.2832	1.0202	2.8141	42.21		
7/2/2016 16:45		0.000000	0.0000	0.8465	0.0000	0.00		
7/2/2016 20:45		0.000000	0.0000	0.4382	0.0000	0.00		
7/2/2016 21:00		0.658952	5.2577	5.7725	457.6055	6,864.08		
7/2/2016 21:15		0.751257	5.9407	5.9023	521.7060	7,825.59		
7/2/2016 21:30		0.737228	5.8093	6.5409	511.9640	7,679.46		
7/2/2016 21:45		0.720083	5.8956	5.5194	500.0576	7,500.86		
7/2/2016 22:00		0.000000	0.0000	4.8989	0.0000	0.00		
7/2/2016 22:15		0.640222	5.2679	5.4786	444.5985	6,668.98		
7/2/2016 22:30		0.583136	5.3328	4.8239	404.9552	6,074.33		
7/2/2016 22:45		0.598004	5.3186	4.9720	415.2807	6,229.21		
7/2/2016 23:00		0.553241	5.1032	4.7803	384.1953	5,762.93		
7/2/2016 23:15		0.454864	4.9569	4.0748	315.8776	4,738.16		
7/2/2016 23:30		0.485141	4.5014	4.7512	336.9037	5,053.56		
7/2/2016 23:45		0.368931	3.6361	4.4730	256.2019	3,843.03		
7/3/2016 0:00		0.172045	1.8909	4.0438	119.4755	1,792.13		
7/3/2016 0:15		0.150104	1.7567	3.8274	104.2390	1,563.58		
7/3/2016 0:30		0.129556	1.6155	3.6263	89.9694	1,349.54		
7/3/2016 0:45		0.157735	1.7771	3.9561	109.5384	1,643.08		
7/3/2016 1:00		0.467878	4.6679	4.4209	324.9150	4,873.72		
7/3/2016 1:15		0.447256	4.5969	4.2984	310.5943	4,658.91		
7/3/2016 1:30		0.505212	4.4918	4.9739	350.8415	5,262.62		
7/3/2016 1:45		0.419162	4.4806	4.1462	291.0850	4,366.28		
7/3/2016 2:00		0.514083	4.6666	4.8622	357.0022	5,355.03		
7/3/2016 2:15		0.485884	4.8449	4.4232	337.4194	5,061.29		
7/3/2016 2:30		0.513269	4.8012	4.7115	356.4371	5,346.56		
7/3/2016 2:45		0.488819	4.6100	4.6724	339.4579	5,091.87		
7/3/2016 3:00		0.441126	4.3672	4.4537	306.3376	4,595.06		
7/3/2016 3:15		0.363367	3.5874	4.4656	252.3381	3,785.07		
7/3/2016 3:30		0.266200	2.5490	4.6015	184.8613	2,772.92		
7/3/2016 3:45		0.218952	2.1613	4.4664	152.0502	2,280.75		
7/3/2016 4:00		0.162188	1.8380	3.9360	112.6306	1,689.46		
7/3/2016 4:15		0.133232	1.6806	3.5915	92.5220	1,387.83		
7/3/2016 4:30		0.106666	1.4888	3.3048	74.0738	1,111.11		
7/3/2016 4:45		0.091557	1.4171	3.0430	63.5812	953.72		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
7/3/2016 5:00		0.080534	1.3326	2.8879	55.9264	838.90		
7/3/2016 5:15		0.072170	1.2380	2.8084	50.1181	751.77		
7/3/2016 5:30		0.069085	1.2458	2.7024	47.9755	719.63		
7/3/2016 5:45		0.066250	1.2219	2.6564	46.0072	690.11		
7/3/2016 6:00		0.057161	1.1412	2.5015	39.6949	595.42		
7/3/2016 6:15		0.055875	1.1180	2.4972	38.8024	582.04		
7/3/2016 6:30		0.060492	1.0412	2.8010	42.0083	630.12		
7/3/2016 6:45		0.057863	1.0108	2.7694	40.1828	602.74		
7/3/2016 7:00		0.055667	0.9883	2.7351	38.6578	579.87		
7/3/2016 7:15		0.049474	0.9427	2.5913	34.3567	515.35		
7/3/2016 7:30		0.046964	0.9223	2.5329	32.6141	489.21		
7/3/2016 7:45		0.042860	0.8870	2.4348	29.7638	446.46		
7/3/2016 8:00		0.037025	0.7909	2.3777	25.7115	385.67		
7/3/2016 8:15		0.031657	0.7575	2.1856	21.9840	329.76		
7/3/2016 8:30		0.028306	0.7001	2.1328	19.6570	294.86		
7/3/2016 8:45		0.024544	0.6433	2.0441	17.0444	255.67		
7/3/2016 9:00		0.021382	0.6367	1.8630	14.8486	222.73		
7/3/2016 9:15		0.021471	0.6328	1.8769	14.9106	223.66		
7/3/2016 9:30		0.019190	0.5854	1.8307	13.3265	199.90		
7/3/2016 9:45		0.017125	0.5458	1.7738	11.8926	178.39		
7/3/2016 10:00		0.015729	0.5497	1.6604	10.9229	163.84		
7/3/2016 10:15		0.015385	0.5427	1.6494	10.6840	160.26		
7/3/2016 10:30		0.013087	0.5034	1.5506	9.0885	136.33		
7/3/2016 10:45		0.012538	0.4890	1.5355	8.7066	130.60		
7/3/2016 11:00		0.011757	0.4894	1.4661	8.1646	122.47		
7/3/2016 11:15		0.012584	0.5021	1.5109	8.7391	131.09		
7/3/2016 11:30		0.010990	0.4792	1.4189	7.6321	114.48		
7/3/2016 11:45		0.010727	0.4647	1.4254	7.4494	111.74		
7/3/2016 12:00		0.009815	0.4409	1.3893	6.8156	102.23		
7/3/2016 12:15		0.009904	0.4560	1.3653	6.8779	103.17		
7/3/2016 12:30		0.009134	0.4379	1.3271	6.3428	95.14		
7/3/2016 12:45		0.008999	0.4389	1.3110	6.2492	93.74		
7/3/2016 13:00		0.008263	0.4174	1.2793	5.7382	86.07		
7/3/2016 13:15		0.008230	0.4089	1.2941	5.7150	85.73		
7/3/2016 13:30		0.007622	0.4039	1.2370	5.2927	79.39		
7/3/2016 13:45		0.006885	0.3830	1.1957	4.7812	71.72		
7/3/2016 14:00		0.006552	0.3766	1.1687	4.5502	68.25		
7/3/2016 14:15		0.006413	0.3722	1.1609	4.4537	66.81		
7/3/2016 14:30		0.005559	0.3433	1.1116	3.8601	57.90		
7/3/2016 14:45		0.005249	0.3402	1.0751	3.6454	54.68		
7/3/2016 15:00		0.004686	0.3214	1.0335	3.2542	48.81		
7/3/2016 15:15		0.004249	0.3030	1.0061	2.9509	44.26		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
7/3/2016 15:30		0.000000	0.0000	0.9760	0.0000	0.00		
	2.72			Total for Event		150,475	464,576	67.6%
7/7/2016 5:30		0.000000	0.0000	-0.6375	0.0000	0.00		
7/7/2016 5:45		0.022337	0.6106	1.9825	15.5121	232.68		
7/7/2016 6:00		0.081831	1.2250	3.1244	56.8269	852.40		
7/7/2016 6:15		0.088816	1.3161	3.1498	61.6778	925.17		
7/7/2016 6:30		0.150086	1.7366	3.8652	104.2264	1,563.40		
7/7/2016 6:45		0.154719	1.7870	3.8713	107.4439	1,611.66		
7/7/2016 7:00		0.166970	1.9051	3.9126	115.9511	1,739.27		
7/7/2016 7:15		0.162736	1.8652	3.8973	113.0114	1,695.17		
7/7/2016 7:30		0.149117	1.7381	3.8407	103.5535	1,553.30		
7/7/2016 7:45		0.117725	1.5056	3.5505	81.7534	1,226.30		
7/7/2016 8:00		0.120787	1.5519	3.5368	83.8802	1,258.20		
7/7/2016 8:15		0.121685	1.5796	3.5069	84.5038	1,267.56		
7/7/2016 8:30		0.104306	1.4213	3.3699	72.4347	1,086.52		
7/7/2016 8:45		0.085589	1.2452	3.1963	59.4368	891.55		
7/7/2016 9:00		0.071357	1.1177	3.0145	49.5531	743.30		
7/7/2016 9:15		0.061834	1.0367	2.8586	42.9400	644.10		
7/7/2016 9:30		0.052945	0.9762	2.6571	36.7673	551.51		
7/7/2016 9:45		0.043972	0.8901	2.4756	30.5359	458.04		
7/7/2016 10:00		0.035511	0.7834	2.3211	24.6606	369.91		
7/7/2016 10:15		0.029151	0.7094	2.1586	20.2436	303.65		
7/7/2016 10:30		0.025384	0.6602	2.0556	17.6281	264.42		
7/7/2016 10:45		0.021899	0.6218	1.9283	15.2074	228.11		
7/7/2016 11:00		0.018704	0.5741	1.8227	12.9887	194.83		
7/7/2016 11:15		0.016268	0.5332	1.7385	11.2973	169.46		
7/7/2016 11:30		0.013220	0.4829	1.6088	9.1805	137.71		
7/7/2016 11:45		0.010400	0.4368	1.4568	7.2220	108.33		
7/7/2016 12:00		0.007926	0.3940	1.2938	5.5043	82.56		
7/7/2016 12:15		0.006837	0.3644	1.2320	4.7480	71.22		
7/7/2016 12:30		0.005563	0.3341	1.1335	3.8632	57.95		
7/7/2016 12:45		0.004341	0.2892	1.0546	3.0149	45.22		
7/7/2016 13:00		0.000000	0.0000	0.9694	0.0000	0.00		
	0.66			Total for Event		20,334	112,728	82.0%
7/9/2016 20:30		0.000000	0.0000	-0.6380	0.0000	0.00		
7/9/2016 20:45		0.009564	0.4079	1.4411	6.6417	99.63		
7/9/2016 21:00		0.061429	1.0337	2.8504	42.6590	639.89		
7/9/2016 21:15		0.111600	1.4495	3.5052	77.4999	1,162.50		
7/9/2016 21:30		0.121064	1.5254	3.5948	84.0721	1,261.08		
7/9/2016 21:45		0.123685	1.5772	3.5590	85.8921	1,288.38		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
7/9/2016 22:00		0.114038	1.5090	3.4518	79.1933	1,187.90		
7/9/2016 22:15		0.087254	1.2496	3.2368	60.5928	908.89		
7/9/2016 22:30		0.063967	1.0510	2.9039	44.4218	666.33		
7/9/2016 22:45		0.052515	0.9577	2.6794	36.4691	547.04		
7/9/2016 23:00		0.044677	0.8889	2.5079	31.0258	465.39		
7/9/2016 23:15		0.034838	0.7756	2.3055	24.1933	362.90		
7/9/2016 23:30		0.029295	0.7073	2.1712	20.3435	305.15		
7/9/2016 23:45		0.022592	0.6117	1.9962	15.6888	235.33		
7/10/2016 0:00		0.017037	0.5379	1.7859	11.8311	177.47		
7/10/2016 0:15		0.014283	0.4997	1.6592	9.9188	148.78		
7/10/2016 0:30		0.011198	0.4437	1.5182	7.7765	116.65		
7/10/2016 0:45		0.009442	0.4187	1.4021	6.5570	98.36		
7/10/2016 1:00		0.006766	0.3520	1.2532	4.6989	70.48		
7/10/2016 1:15		0.005223	0.3209	1.1156	3.6271	54.41		
7/10/2016 1:30		0.003917	0.2787	1.0076	2.7202	40.80		
7/10/2016 1:45		0.000000	0.0000	0.9258	0.0000	0.00		
	0.44			Total for Event		9,837	75,152	86.9%
7/12/2016 5:45		0.000000	0.0000	0.7942	0.0000	0.00		
7/12/2016 6:00		0.484177	5.0189	4.2646	336.2339	5,043.51		
7/12/2016 6:15		0.684248	5.4506	5.7928	475.1723	7,127.58		
7/12/2016 6:30		0.714148	5.6275	6.2153	495.9363	7,439.04		
7/12/2016 6:45		0.710414	5.6218	5.8893	493.3433	7,400.15		
7/12/2016 7:00		0.661008	5.2380	5.8667	459.0334	6,885.50		
7/12/2016 7:15		0.656610	5.2763	5.6926	455.9795	6,839.69		
7/12/2016 7:30		0.576385	4.7986	5.3887	400.2671	6,004.01		
7/12/2016 7:45		0.417721	4.0865	4.5053	290.0839	4,351.26		
7/12/2016 8:00		0.278419	2.8033	4.3825	193.3464	2,900.20		
7/12/2016 8:15		0.204639	2.1936	4.1357	142.1104	2,131.66		
7/12/2016 8:30		0.171859	1.9680	3.9003	119.3468	1,790.20		
7/12/2016 8:45		0.147695	1.8117	3.6768	102.5663	1,538.49		
7/12/2016 9:00		0.128609	1.6614	3.5209	89.3117	1,339.67		
7/12/2016 9:15		0.116549	1.5872	3.3714	80.9370	1,214.05		
7/12/2016 9:30		0.105816	1.5185	3.2317	73.4836	1,102.25		
7/12/2016 9:45		0.100184	1.5002	3.1237	69.5725	1,043.59		
7/12/2016 10:00		0.086650	1.3732	2.9870	60.1734	902.60		
7/12/2016 10:15		0.080762	1.2797	2.9872	56.0849	841.27		
7/12/2016 10:30		0.071743	1.1506	2.9591	49.8218	747.33		
7/12/2016 10:45		0.065361	1.0854	2.8799	45.3894	680.84		
7/12/2016 11:00		0.055007	0.9995	2.6868	38.1996	572.99		
7/12/2016 11:15		0.046418	0.9056	2.5453	32.2348	483.52		
7/12/2016 11:30		0.035616	0.7979	2.2948	24.7331	371.00		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
7/12/2016 11:45		0.030078	0.7300	2.1627	20.8873	313.31		
7/12/2016 12:00		0.027248	0.7105	2.0518	18.9221	283.83		
7/12/2016 12:15		0.022621	0.6549	1.9013	15.7089	235.63		
7/12/2016 12:30		0.021824	0.6257	1.9149	15.1558	227.34		
7/12/2016 12:45		0.017736	0.5827	1.7356	12.3165	184.75		
7/12/2016 13:00		0.014688	0.5359	1.6100	10.2000	153.00		
7/12/2016 13:15		0.013846	0.5175	1.5827	9.6152	144.23		
7/12/2016 13:30		0.014168	0.5290	1.5838	9.8391	147.59		
7/12/2016 13:45		0.011559	0.4693	1.4924	8.0274	120.41		
7/12/2016 14:00		0.010571	0.4571	1.4272	7.3410	110.12		
7/12/2016 14:15		0.009286	0.4113	1.4032	6.4484	96.73		
7/12/2016 14:30		0.008894	0.4016	1.3843	6.1763	92.64		
7/12/2016 14:45		0.007723	0.3807	1.3013	5.3633	80.45		
7/12/2016 15:00		0.006616	0.3714	1.1882	4.5948	68.92		
7/12/2016 15:15		0.005713	0.3294	1.1663	3.9675	59.51		
7/12/2016 15:30		0.004757	0.3092	1.0727	3.3035	49.55		
7/12/2016 15:45		0.003870	0.2788	0.9991	2.6876	40.31		
7/12/2016 16:00		0.000000	0.0000	0.9341	0.0000	0.00		
	1.1			Total for Event		71,159	187,880	62.1%
7/13/2016 11:15		0.000000	0.0000	-0.6960	0.0000	0.00		
7/13/2016 11:30		0.013561	0.4991	1.6001	9.4175	141.26		
7/13/2016 11:45		0.048321	0.9025	2.6311	33.5560	503.34		
7/13/2016 12:00		0.055920	0.9795	2.7635	38.8336	582.50		
7/13/2016 12:15		0.066221	1.0960	2.8874	45.9866	689.80		
7/13/2016 12:30		0.064571	1.0782	2.8675	44.8407	672.61		
7/13/2016 12:45		0.053124	0.9625	2.6928	36.8918	553.38		
7/13/2016 13:00		0.043497	0.8676	2.5031	30.2065	453.10		
7/13/2016 13:15		0.033836	0.7706	2.2669	23.4972	352.46		
7/13/2016 13:30		0.033816	0.7589	2.2917	23.4834	352.25		
7/13/2016 13:45		0.032334	0.7363	2.2671	22.4540	336.81		
7/13/2016 14:00		0.028677	0.6956	2.1636	19.9144	298.72		
7/13/2016 14:15		0.026111	0.6604	2.0982	18.1323	271.98		
7/13/2016 14:30		0.023484	0.6251	2.0211	16.3082	244.62		
7/13/2016 14:45		0.021044	0.6013	1.9197	14.6140	219.21		
7/13/2016 15:00		0.019106	0.5825	1.8315	13.2681	199.02		
7/13/2016 15:15		0.016496	0.5297	1.7643	11.4558	171.84		
7/13/2016 15:30		0.012860	0.4760	1.5936	8.9306	133.96		
7/13/2016 15:45		0.010817	0.4455	1.4773	7.5119	112.68		
7/13/2016 16:00		0.009265	0.4108	1.4022	6.4340	96.51		
7/13/2016 16:15		0.007803	0.3871	1.2956	5.4190	81.28		
7/13/2016 16:30		0.007066	0.3645	1.2605	4.9069	73.60		

	Meas.	ISCO Measured or Internal Calc.			Post Calculation			
Date/Time	Total Rainfall (in)	Flow Rate (mgd) (calc.)	Velocity (fps) (meas.)	Level (in) (meas.)	Flow Rate (gpm) (conv.)	Outflow Volume (gal/15min)	Total Rainfall Vol (gal)	% Vol. Reduction
7/13/2016 16:45		0.006142	0.3403	1.1989	4.2651	63.98		
7/13/2016 17:00		0.004925	0.3073	1.1038	3.4200	51.30		
7/13/2016 17:15		0.004071	0.2771	1.0392	2.8274	42.41		
7/13/2016 17:30		0.000000	0.0000	0.9687	0.0000	0.00		
	0.36			Total for Event		6,699	61,488	89.1%

Appendix B

Parking Lot Rainwater Storage Data

Swope Campus Parking Lot Stormwater Infiltration Data (Rain Event: May 16-17, 2016)

Kansas City, MO Water Services Site (4800 East 63rd Street, Kansas City, MO)

Rainfall Gauge: BL11-63rd St. (2440); Infiltrometer and datalogger installed under each parking bay

				Standing Water Depth (in)			
Date/Time	Rain Duration (start/end time)	Rain Amount (in)	Elapsed Hours	Porous Asphalt	Pervious Concrete	Paver 1	Paver 2
5/15/16 23:58	23:58		0	-0.12	1.44	0.06	0
5/16/16 0:58			1	-0.12	1.44	0.048	0
5/16/16 1:58			2	0.24	1.44	0.048	0
5/16/16 2:58			3	1.2	1.32	0.048	0.24
5/16/16 3:58			4	1.2	1.44	0.048	2.4
5/16/16 4:58			5	0.84	1.32	0.048	1.92
5/16/16 5:58			6	0.84	1.32	0.048	1.44
5/16/16 6:58			7	1.08	1.32	0.048	1.44
5/16/16 7:58			8	1.08	1.44	0.048	1.8
5/16/16 8:58			9	0.84	1.44	0.048	1.56
5/16/16 9:58	9:43	0.43	10	0.6	1.44	0.048	1.2
5/16/16 10:58			11	0.48	1.44	0.048	1.08
5/16/16 11:58			12	0.36	1.32	0.036	0.96
5/16/16 12:58			13	0.24	1.44	0.036	0.96
5/16/16 13:58	13:35		14	0.24	1.32	0.036	0.84
5/16/16 14:58			15	2.04	1.44	0.96	0.72
5/16/16 15:58			16	4.8	2.52	2.724	2.76
5/16/16 16:58			17	6.84	4.56	4.416	6.24
5/16/16 17:58			18	6.6	2.88	4.008	7.56
5/16/16 18:58			19	5.28	2.16	1.8	4.8
5/16/16 19:58			20	3.36	1.92	-0.096	2.64
5/16/16 20:58			21	1.8	1.68	-0.132	1.8
5/16/16 21:58			22	1.2	1.44	-0.156	1.44
5/16/16 22:58	22:27	0.43	23	0.72	1.44	-0.168	1.08
5/16/16 23:58			24	0.48	1.44	-0.168	1.08
5/17/16 0:58			25	0.24	1.44	-0.192	1.2
5/17/16 1:58			26	0.24	1.44	-0.204	1.44
5/17/16 2:58			27	0.12	1.44	-0.216	1.32
5/17/16 3:58			28	0.12	1.44	-0.216	1.2
5/17/16 4:58			29	0.12	1.44	-0.228	1.08
5/17/16 5:58			30	0.12	1.44	-0.24	0.6
5/17/16 6:58	7:11		31	0	1.44	-0.204	0.36
5/17/16 7:58			32	0	1.44	-0.228	0.36
5/17/16 8:58			33	-0.12	1.44	-0.24	0.36
5/17/16 9:58	10:13	0.20	34	0.6	1.44	-0.192	0.48
5/17/16 10:58			35	2.52	1.44	1.296	2.28
5/17/16 11:58	11:27	.04	36	3.12	2.16	1.152	5.04
5/17/16 12:58			37	2.88	2.04	0.78	3.72
5/17/16 13:58			38	2.4	1.92	-0.096	3
5/17/16 14:58			39	1.92	1.8	-0.144	2.52
5/17/16 15:58			40	1.44	1.68	-0.18	2.16
5/17/16 16:58			41	1.08	1.56	-0.18	1.8
5/17/16 17:58			42	0.6	1.44	-0.192	1.08
5/17/16 18:58			43	0.24	1.44	-0.192	1.08
5/17/16 19:58			44	0.12	1.56	-0.204	1.08

Swope Campus Parking Lot Stormwater Infiltration Data (Rain Event: May 26-27, 2016)

Kansas City, MO Water Services Site (4800 East 63rd Street, Kansas City, MO)

Rainfall Gauge: BL11-63rd St. (2440); Infiltrometer and datalogger installed under each parking bay

				Standing Water Depth (in)			
Date/Time	Rain Duration (start/end time)	Rain Amount (in)	Elapsed Hours	Porous Asphalt	Pervious Concrete	Paver 1	Paver 2
5/26/16 2:58			3	0.24	1.44	-0.192	0.84
5/26/16 3:58	4:41 start		4	0.24	1.44	-0.216	0.48
5/26/16 4:58			5	0.24	1.44	-0.216	0.36
5/26/16 5:58			6	3.24	1.44	2.064	0.84
5/26/16 6:58			7	4.08	2.04	1.644	6.48
5/26/16 7:58			8	3.12	1.92	0.372	5.16
5/26/16 8:58			9	2.16	1.44	-0.12	2.64
5/26/16 9:58	10:28 end	0.55 in	10	2.16	3.12	2.328	1.8
5/26/16 10:58			11	7.32	6.72	6.084	1.44
5/26/16 11:58			12	7.8	10.08	7.32	9
5/26/16 12:58			13	7.08	8.16	6.948	8.04
5/26/16 13:58			14	5.76	6.36	6.12	3
5/26/16 14:58	15:30 start		15	4.08	4.68	5.016	2.04
5/26/16 15:58			16	2.76	3.36	4.032	1.56
5/26/16 16:58			17	3.84	3.24	4.428	1.68
5/26/16 17:58			18	5.4	4.8	4.632	4.68
5/26/16 18:58			19	8.64	14.16	9.768	3.12
5/26/16 19:58			20	9.12	14.4	10.116	9.96
5/26/16 20:58			21	9.84	13.92	9.936	9.72
5/26/16 21:58			22	10.68	13.92	10.248	8.88
5/26/16 22:58			23	11.52	16.44	12.096	8.88
5/26/16 23:58			24	12.12	17.52	13.032	11.52
5/27/16 0:58	0:54 end	1.77 in	25	11.88	17.64	13.488	11.88
5/27/16 1:58			26	11.76	17.04	13.2	12.36
5/27/16 2:58	3:23	0.36 in	27	11.04	16.44	12.936	11.52
5/27/16 3:58			28	11.76	16.8	13.68	10.56
5/27/16 4:58			29	11.04	16.68	13.656	11.04
5/27/16 5:58			30	10.92	16.08	13.308	10.68
5/27/16 6:58			31	10.44	15.36	12.96	9.72
5/27/16 7:58			32	9.96	14.64	12.576	8.52
5/27/16 8:58			33	9.12	13.44	12.216	3.12
5/27/16 9:58			34	7.56	11.28	11.832	2.04
5/27/16 10:58			35	6.96	7.32	11.484	1.56
5/27/16 11:58			36	6.84	4.32	11.112	1.32
5/27/16 12:58			37	7.08	3.12	10.74	1.08
5/27/16 13:58			38	6.12	3.12	10.404	0.96
5/27/16 14:58			39	3.84	3.12	10.032	0.6
5/27/16 15:58			40	1.56	3.12	9.684	0.6

				Standing Water Depth (in)			
Date/Time	Rain Duration (start/end time)	Rain Amount (in)	Elapsed Hours	Porous Asphalt	Pervious Concrete	Paver 1	Paver 2
5/27/16 16:58			41	1.08	3	9.276	0.48
5/27/16 17:58			42	1.08	3	8.736	0.48
5/27/16 18:58			43	1.08	3.12	7.92	0.36
5/27/16 19:58			44	0.96	3	6.816	0.36
5/27/16 20:58			45	0.96	3	5.448	0.36
5/27/16 21:58			46	0.96	3	3.864	0.36
5/27/16 22:58	23:05	0.47 in	47	0.84	3	1.98	0.24
5/27/16 23:58			48	6.6	4.32	5.988	0.12
5/28/16 0:58			49	7.68	10.68	8.292	9
5/28/16 1:58			50	7.2	9	8.292	9.12
5/28/16 2:58			51	6.84	7.08	7.728	7.56
5/28/16 3:58			52	5.64	5.4	6.84	3
5/28/16 4:58			53	4.2	3.84	5.724	2.04
5/28/16 5:58			54	2.16	3	4.44	1.68
5/28/16 6:58			55	1.08	3	2.892	1.32
5/28/16 7:58			56	0.36	3	1.812	1.2
5/28/16 8:58			57	0.96	2.88	1.608	0.96
5/28/16 9:58			58	0.96	2.88	1.5	0.72
5/28/16 10:58			59	0.84	2.88	1.404	0.6
5/28/16 11:58			60	0.72	2.88	1.308	0.48
5/28/16 12:58			61	0.72	2.88	1.224	0.36
5/28/16 13:58			62	0.72	2.88	1.14	0.36
5/28/16 14:58			63	0.72	2.88	1.056	0.24
5/28/16 15:58			64	0.72	2.88	0.948	0.12
5/28/16 16:58			65	0.72	2.88	0.864	0.12
5/28/16 17:58			66	0.72	2.88	0.828	0
5/28/16 18:58			67	0.72	2.88	0.828	0.12

Appendix C

Tree Inventory, Kansas City Water Services Swope Campus

Tree	Other Tree (if used)	Caliper at 6-inches (in)	Stormwater interception by one tree (gal)	CO2 reduction by one tree (lbs)	Benefit of one tree ($)	Estimated number of tree found on site	Total Intercepted stormwater runoff (gal)	Total CO2 reduction (lbs)	Total annual benefit ($)
Tulip Tree		2	44	26	6	12	176	104	24
American Linden 'Green Spire'	Little Leaf Linden	2.25	21	35	4	20	420	700	80
Honeylocust Skyline	Honey Locust	2	46	39	6	15	874	741	114
Swamp White Oak		2	37	37	6	8	296	296	48
Hillspire Juniper	Juniper	2	51	12	6	7	357	84	42
Emerald Sunshine	Elm	2	44	26	6	18	528	312	72
Shortleaf Pine	Virginia Pine	5	255	66	18	3	765	198	54
Ivory Silk Japanese Tree Lilac	Japanese Tree Lilac	2	18	24	3	15	270	360	45
Valley Forge American Elm	American Elm	3	50	42	5	3	50	42	5
Total						**101**	**4,156**	**3,537**	**564**
							(gal)	**(lbs)**	**($)**

Appendix D

Landscape Architecture Foundation
2016 Landscape Performance Case Study

"Survey of Kanas City Water Services (Swope Campus) Employees' Response to Sustainable Landscape"
Administered July 8- July 16, 2016 to 222 employees through the KSU Qualtrics Online system

1. Please tell us your level of overall satisfaction with the recent improvements that have been made to the parking lot, entry experience, entry courtyard, native oriented landscaping, and walking trail?

Response	*%*	*Response options*
20	47%	Very satisfied
13	30%	Satisfied
3	7%	Neutral
6	14%	Unsatisfied
1	2%	Very unsatisfied
43	100%	*Total responses*

2. Do you feel that the parking lot improvements and walkways improved safety within the parking lot/campus?

Response	*%*	*Response options*
21	49%	Much improved
10	23%	Somewhat improved
9	21%	No real difference
0	0%	Somewhat worse
3	7%	Much worse
43	100%	*Total responses*

3. How much do you think the campus improvement project has improved the appearance of the Water Services Swope campus?

Response	*%*	*Response options*
31	72%	Much improved
5	12%	Somewhat improved
5	12%	No real difference
1	2%	Somewhat worse
1	2%	Much worse
43	100%	*Total responses*

4. Prior to the improvement project, how often did you walk on the Swope campus during comfortable weather?

Response	*%*	*Response options*
3	7%	Once a day
1	2%	Couple time a week
3	7%	Once a week
7	17%	Couple times a month
28	67%	Never
42	100%	*Total responses*

5. How often do you use the new walking trail during comfortable weather?

Response	%	Response options
13	30%	Once a day
6	14%	Couple time a week
4	9%	Once a week
4	9%	Couple times a month
16	37%	Never
43	100%	*Total responses*

6. How often have you used the new outdoor plaza near the building entry?

Response	%	Response options
4	9%	Once a day
1	2%	Couple time a week
3	7%	Once a week
10	23%	Couple times a month
25	58%	Never
43	100%	*Total responses*

7. How do you use the entry plaza? (select ALL that apply)

Response	%	Response options
7	12%	Socialize with coworkers on breaks
1	2%	Hold outdoor meetings
17	29%	Get fresh air
2	3%	Eat snack or lunch
1	2%	Read
5	9%	Spend time alone/reflect
21	36%	Do not use it
4	7%	Other: (Responses: not usable as designed; no overhead covering; people watching; private cell calls)
58	100%	*Total responses*

8. What would increase your use of the entry plaza? (select ALL that apply)

Response	%	Response options
27	66%	More shade until trees are mature
5	12%	More screening from parking and people entering the building
3	7%	More landscaping/plants
3	7%	Other (Responses: Informal meetings; stretch exercise sessions, occasional scheduled social meetings)
3	7%	Just not part of my routine
41	100%	*Total responses*

9. What ONE THING would you most like to change about the new improvements?

Response	%	Response options
0	0%	Location of green infrastructure features
1	3%	Add more green infrastructure types
4	10%	Different plant selection
19	49%	Shade within the new plaza area
1	3%	Design of entry canopy
9	23%	Orientation of parking bays
5	13%	Add directional and/or educational signage
39	100%	*Total responses*

10. What do you think is the BEST improvement that was made as a result of this project?

Response	%	Response options
4	10%	Entry experience from the parking stalls
11	26%	New rain garens/green infrastructure
8	19%	Added outdoor canopy and plaza area
17	40%	Added perimeter walking path
2	5%	Other
42	100%	*Total responses*

11. Since project completion, have you ever mentioned the campus green infrastructure improvements to visitors or led a tour?

Response	%	Response options
23	53%	Occasionally
7	16%	The opportunity has not arisen
2	5%	I do not know much about the green infrastructure improvements
11	26%	Not appropriate for my duties
43	100%	*Total responses*