Incentivizing Green Infrastructure Uptake with User Fee Credits

2019 FSA Winter Conference – Tampa, FL
Thursday Afternoon Session – December 5

Mike Gregory, PE – Computational Hydraulics Int'l

Stormwater Management Solutions

- Source controls: Capture and use runoff before it gets into the collection system
- Conveyance improvements: Move runoff quickly and efficiently through the collection system
- Storage improvements: Hold runoff within the collection system before discharging it downstream
- Floodplain management: Redirect/contain damaging flows OR get out of its way

LEGEND

Green Infrastructure

Grey Infrastructure

Stormwater Management Facility Design

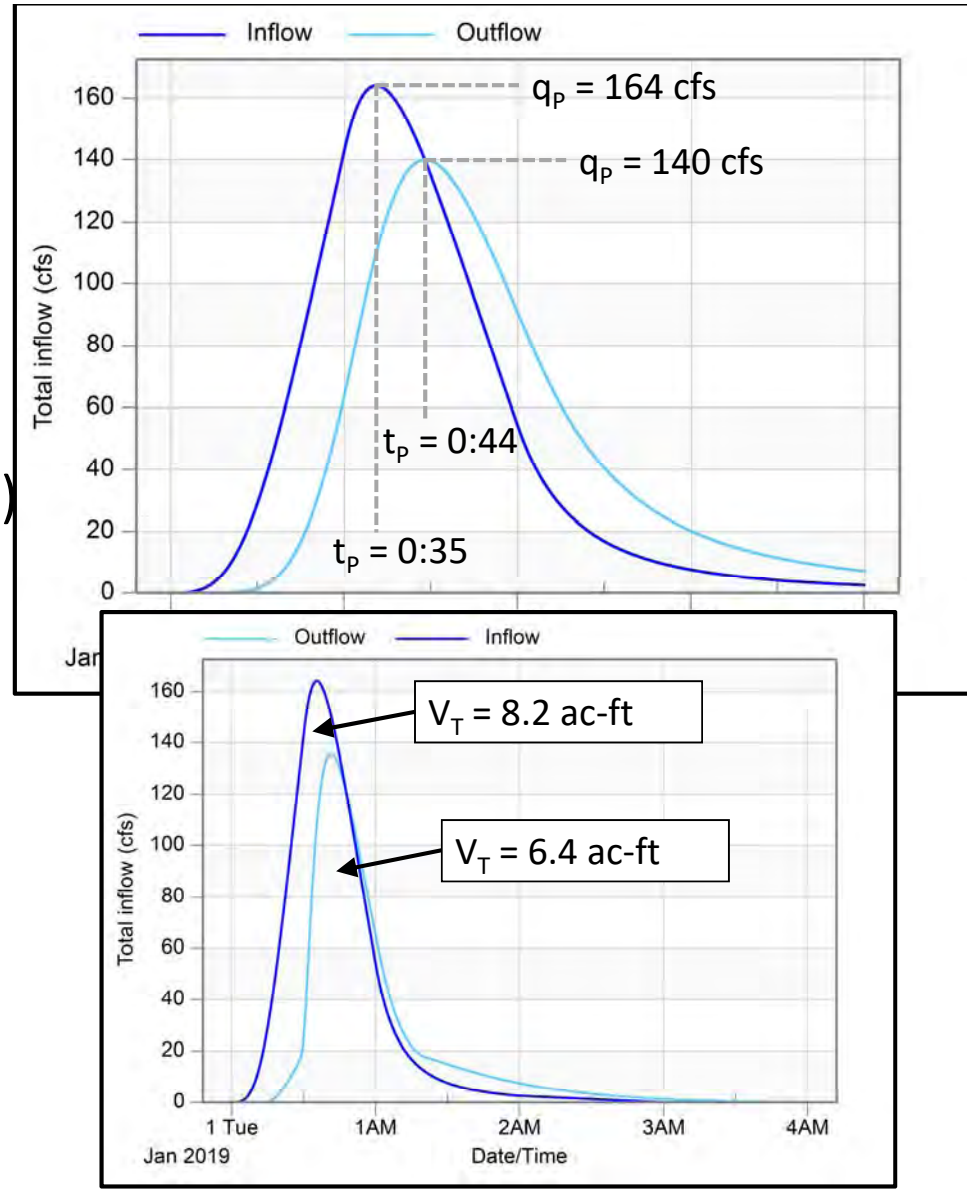
- Hazard protection: manage peak flows and velocities to protect people and property from flooding/erosion hazards
- Quality treatment: manage sediment, pollution, and temperature to protect public health, habitats, and aquatic/terrestrial resources
- Volume reduction: manage stormwater in a way that mimics pre-development conditions to preserve the natural environment
- Environmental flow maintenance: manage the intensity, duration, and frequency of flows over a wide operating range

Design Objective	Assets	Control Variables	Analysis / Design Approach	Risk Mgmt Priority
Flood Control	Pipes & Ponds	Peak flow & flood depth	Event-based hydrology	Highest
Erosion Control	Watercourses	Peak velocity & shear stress	Event-based hydrology	Medium
Quality Treatment	BMPs & Ponds	Long-term removal efficiency	Continuous simulation	Medium
On-Site Retention	Green Things	Runoff volume	Continuous simulation	Lowest
Environmental Flows	Grey & Green	Flow frequency & duration	Continuous simulation	??

Letter	Rainfall Stimulus	Runoff Response
I	Intensity	Severity of consequence
D	Duration	Duration of threshold exceedance
F	Frequency	Probability of occurrence

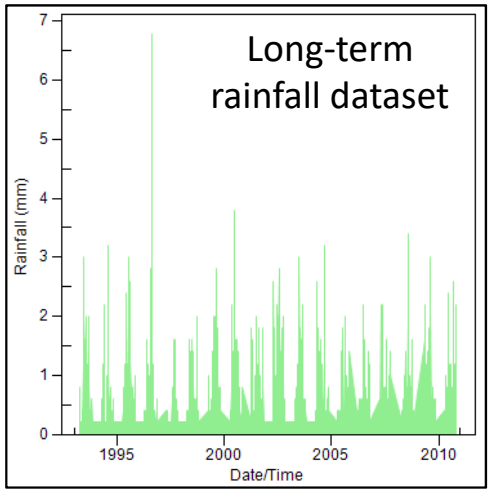
Quantity Control

- Routing (e.g., wide & flat channel)
  - Attenuation, $\Delta_{PeakFlow}$ = -24 cfs (-15%)
  - Lagging, $\Delta_{TimeToPeak}$ = 9 min (+26%)
- Routing and Retaining (e.g., recharge pond)
  - Retention, $\Delta_{TotalVolume}$ = -1.8 ac-ft (-22%)
- Controllable things in stormwater facilities
  - Conduit conveyance capacity
  - Control structure release rate(s)
  - Detention storage volume
  - Retention storage volume

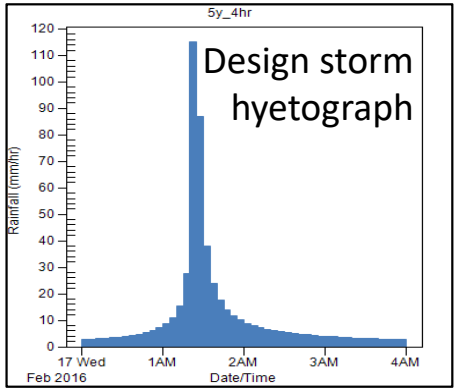


Hydrologic Simulation Options

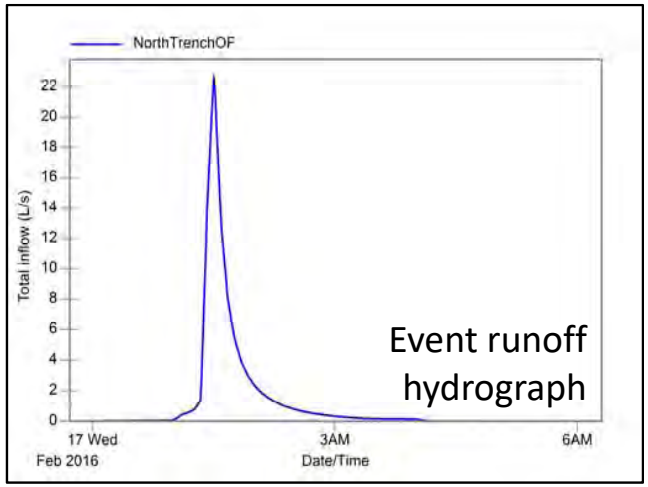
Event-Based Hydrology



Statistical analysis



Model simulation



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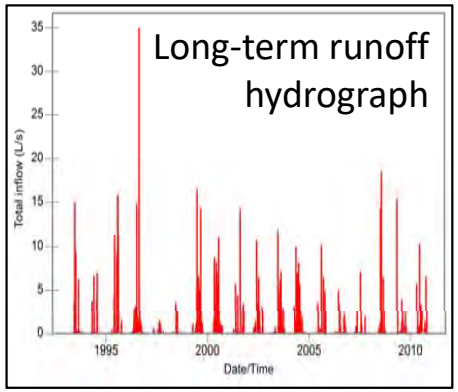

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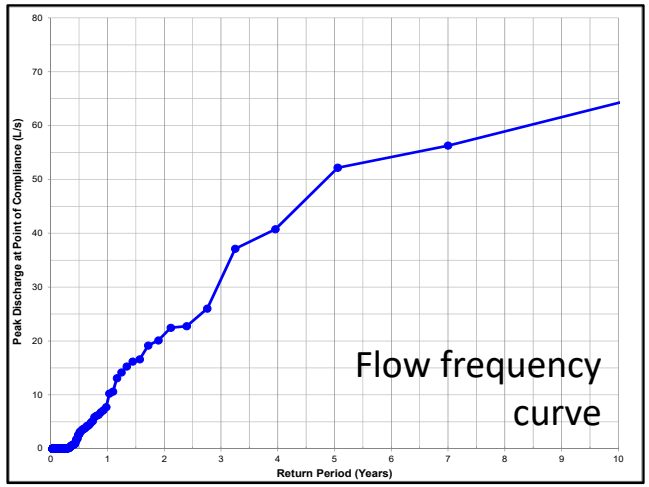
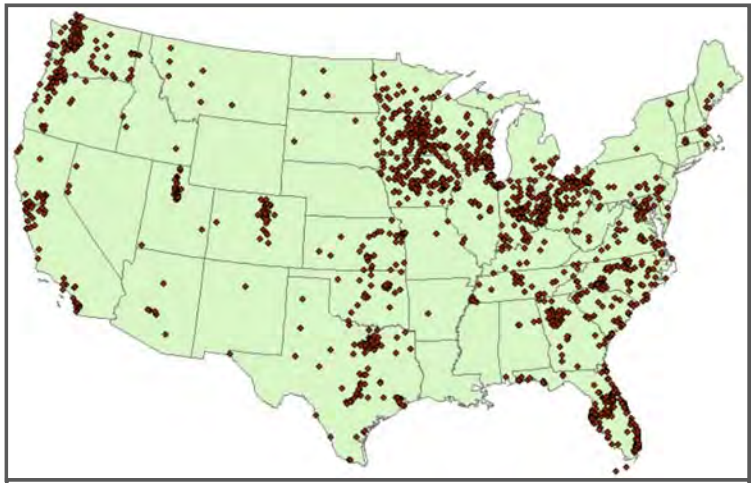


Continuous Simulation

Stormwater User Fees in North America

- >1,700 across North America, including WEF case studies in…

(Water Environment Federation, 2013)



2018 Stormwater Utility Survey (Western Kentucky University)

Stormwater User Fees – Charge Reductions

- Property owners may be eligible for reduced fees by installing:
  - Natural assets: reduced fee through adjustment process (lower base charge)
  - Stormwater facilities: reduced fee through credit process (base charge minus credit)
- There is a wide range between utilities:
  - Eligibility requirements
  - Credit categories
  - Max. credits in each category

Stormwater Management Design Objective / Category	Non-Residential Credit		
	Guelph	Kitchener	Mississauga
Structural Facilities			
Water Quantity - Peak Flow Reduction	15%	25%	40%
Water Quantity - Volume Reduction	40%	n/a	15%
Water Quality - Suspended Solids Removal	15%	15%	10%
Non-Structural Activities			
Operations - Paved Area Sweeping	5%	5%	n/a
Planning - Pollution Prevention, Risk Management	5%	n/a	5%
Planning - Salt Management	10%	5%	n/a
Educational Program	5%	5%	n/a
Capped Total	**50%**	**45%**	**50%**

Credit Criteria Examples

City of Guelph

Credit Category	Description / Basis for Charge Reduction	Maximum Credit
Peak Flow Reduction	Facilities that control the peak flow of stormwater discharged from the property, based on the outlet rate in comparison to natural hydrologic conditions.	15%
Runoff Volume Reduction	Facilities that control the amount of stormwater retained on the property, based on retention volume resulting from increased infiltration, evapotranspiration, or reuse.	40%
Water Quality Treatment	Facilities that control the quality of stormwater discharged from the property, based on treatment type, pollutant load reduction, or MOECC level of protection.	15%
Operations and Activities	Non-structural measures including education programs and pollution prevention / risk management practices.	15%
	Maximum Credit Available (Capped)	**50%**

City of Mississauga

Category	Evaluation Criteria	Total Credit (50% max)	
Peak Flow Reduction	Per cent reduction of the 100 year post-development flow to pre-development conditions of the site.	Up to 40%	Up to 50%
Water Quality Treatment	Per cent of site (hard surface) receiving water quality treatment consistent with Provincial criteria for enhanced treatment.	Up to 10%	
Runoff Volume Reduction	Per cent capture of first 15 mm of rainfall during a single rainfall event.	Up to 15%	
Pollution Prevention	Develop and implement a pollution prevention plan.	Up to 5%	

City of Tampa

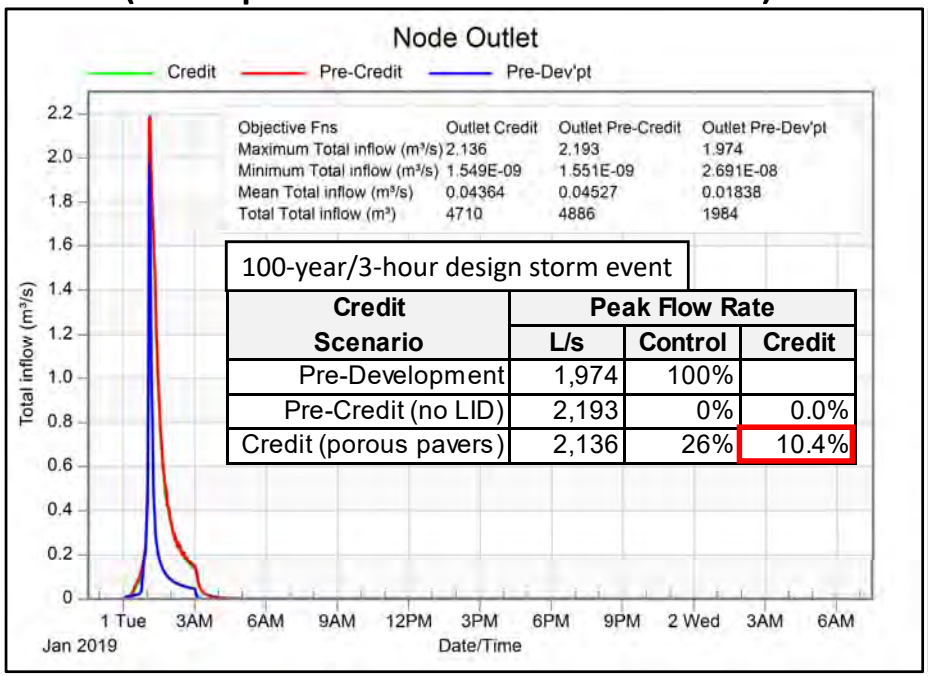
Credits

Condition	Mitigation Credit
1. Parcels With No Offsite Discharge of Stormwater to City System: The credit for such parcels will be 100% since the City bears no expense in managing the offsite discharge of the site's flow.	100%
NEW 2. Parcel Owner owns, operates and maintains a stormwater facility that provides attenuation and treatment equal to that necessary for the 50-year storm event (2% chance of occurrence in any one year). The credit for such parcels is based upon a linear interpolation between the 10% credit for mitigation of the 25-year storm (4% chance of occurrence in any one year) and a 100% credit for mitigation of a 100-year storm (1 % chance of occurrence in any one year).	40%
3. Parcel Owner Contributes to Maintenance of Private System: The credit for such parcels will be based upon the percentage of the City's stormwater operation and maintenance (O&M) budget providing for maintenance of stormwater ponds but in no case shall this be less than 10%. The O&M Budget does not include funds devoted to capital projects addressing conveyance system extension and capacity upgrades	10%
4. Parcels With Properly Functioning On-site Treatment and Attenuation: The credit for such parcels will be based upon the percentage of the City's stormwater operation and maintenance (O&M) budget providing for maintenance of stormwater ponds but in no case shall this be less than 10%. The O&M Budget does not include funds devoted to capital projects addressing conveyance system extension and system upgrades.	10%

Water Quantity Credits – An Example

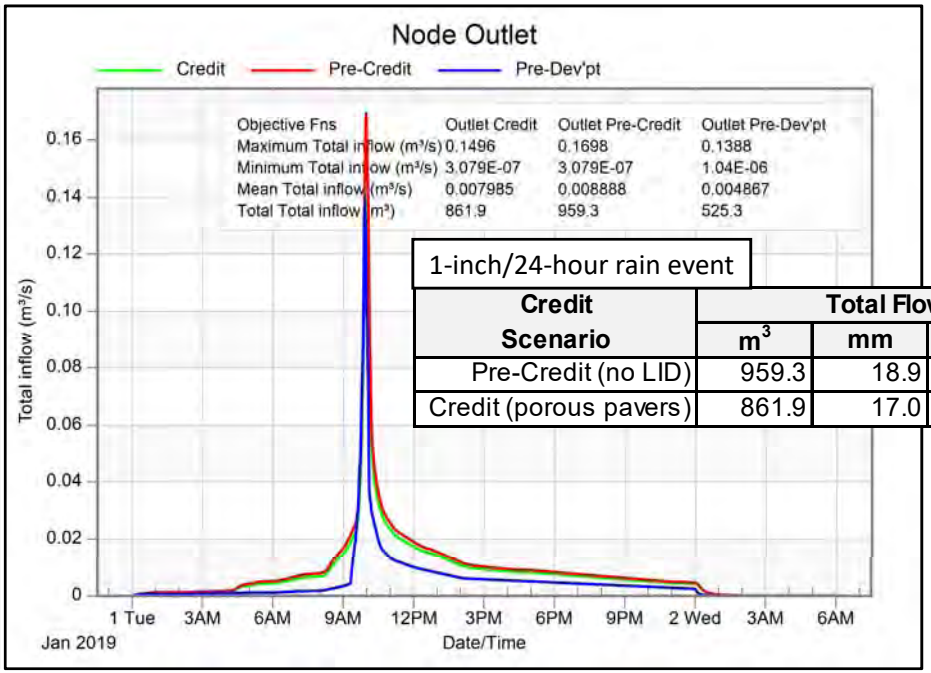
- Peak Flow Reduction (max. 40%): based on level of control (between uncontrolled and pre-development conditions)
- Runoff Volume Reduction (max. 15%): based on volume retained (compared to uncontrolled)

Gross area (ha):	10.6902
Impervious area (m2):	50,673.9
Imperviousness:	47.4%
STM Billing Units:	189.8
2019 STM Rate:	$106.10
Base Charge:	**$20,138**
Credits	
Peak Flow:	10.4%
Runoff Volume:	1.9%
Total :	12.3%
Less Credits:	**$2,484**
Net Annual Charge:	**$17,654**



100-year/3-hour design storm event

Credit Scenario	Peak Flow Rate L/s	Control	Credit
Pre-Development	1,974	100%	
Pre-Credit (no LID)	2,193	0%	0.0%
Credit (porous pavers)	2,136	26%	10.4%

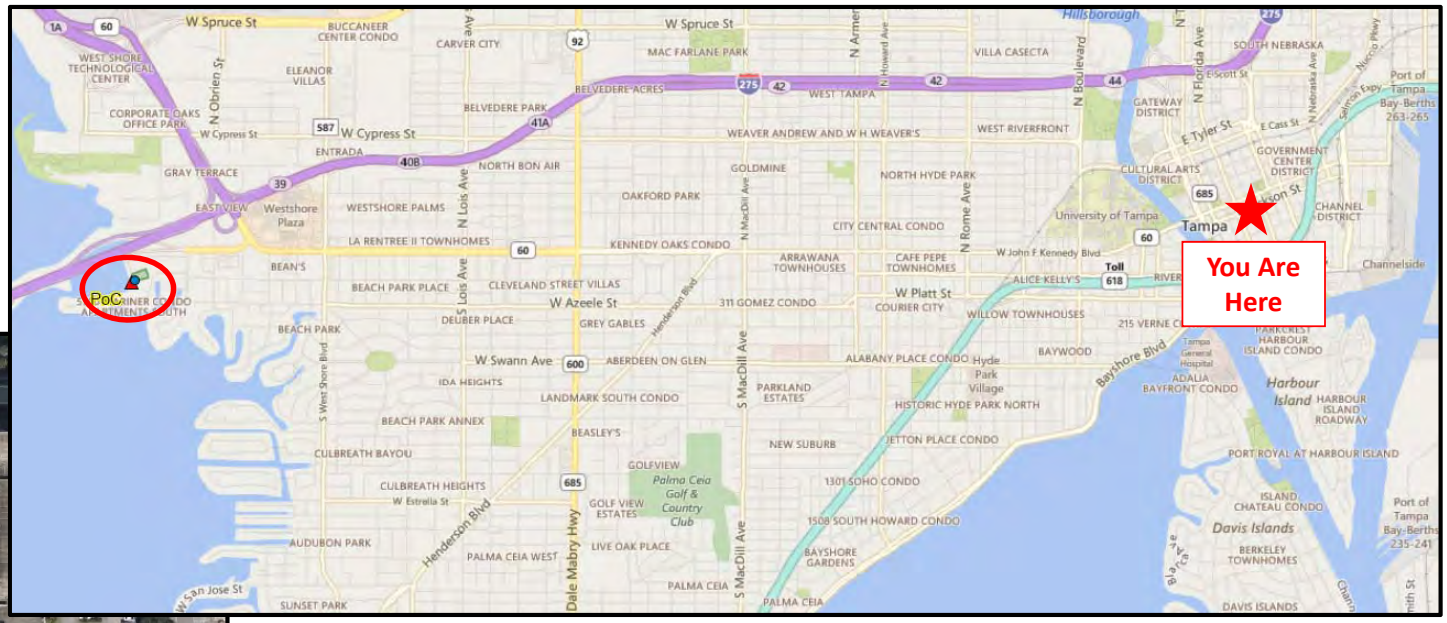


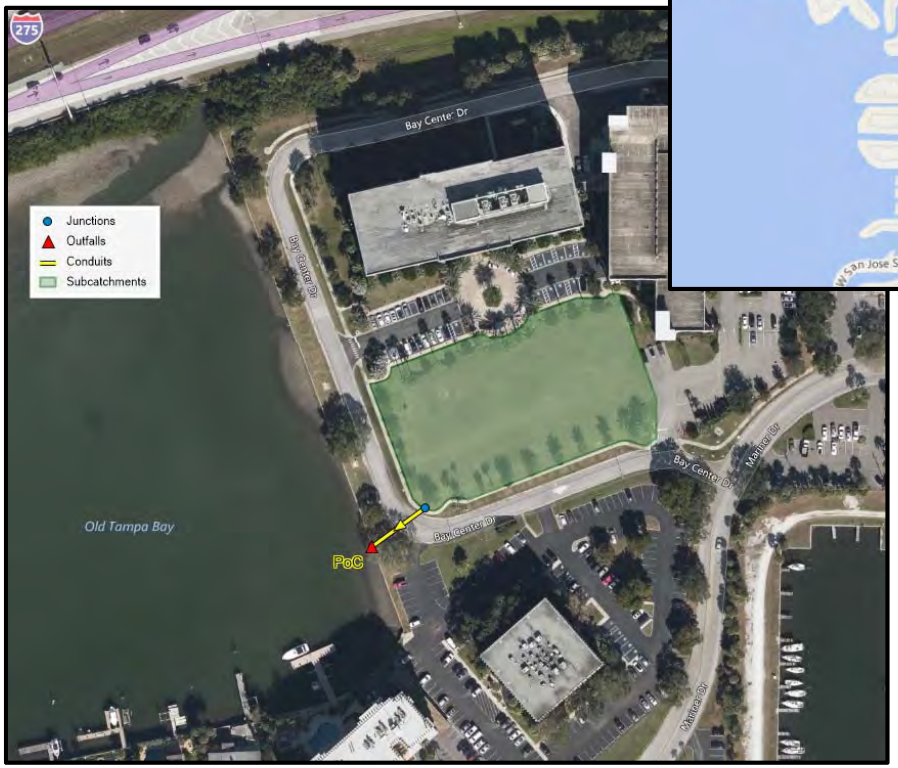
1-inch/24-hour rain event

Credit Scenario	Total Flow Volume m^3	mm	$\Delta_{Uncontrolled}$	Credit
Pre-Credit (no LID)	959.3	18.9	0.0	0.0%
Credit (porous pavers)	861.9	17.0	-1.9	1.9%

Case Study

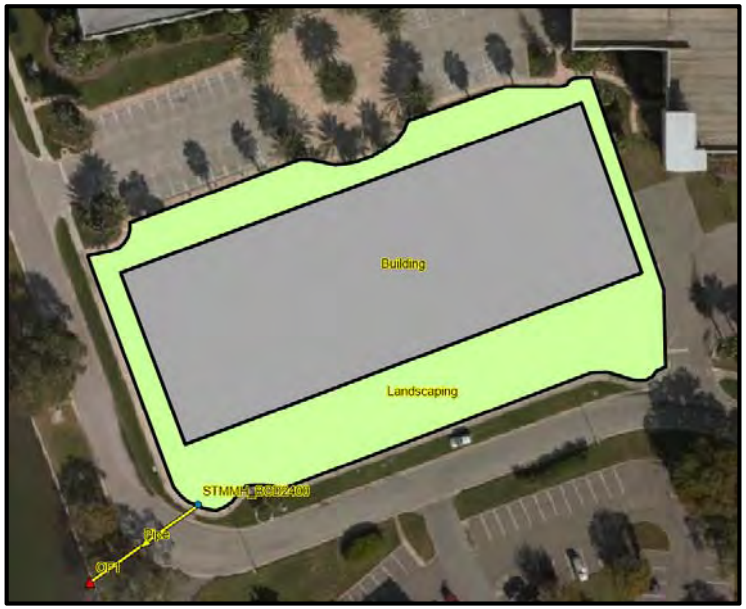
- A 1.5-acre property for sale across town…



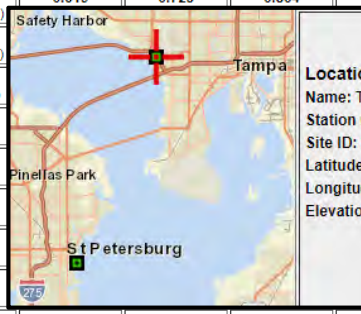


The Site (After Development)

- Surface statistics
  - Total property area: 1.4741 ac
  - Impervious area: 37,293 ft^2 (58% impervious)
  - City of Tampa ESFIA: 3,310 ft^2 ($82/ESFIA/year)
  - Number of billing units: 11.3
  - Base Charge: $927 per year
- Atmospheric statistics (from NOAA Atlas 14)

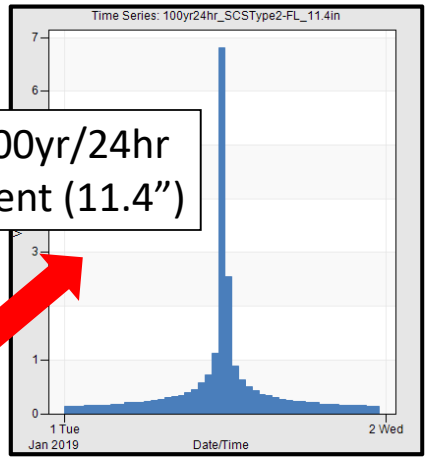


Duration	Average recurrence interval (years)						
	1	2	5	10	25	50	100
5-min	0.554 (0.486-0.642)	0.619	0.723	0.804	0.910	0.988	1.06 (0.808-1.34)
10-min	0.811 (0.711-0.940)						1.55 (1.18-1.97)
15-min	0.989 (0.867-1.15)						1.89 (1.44-2.40)
30-min	1.48 (1.30-1.72)						2.87 (2.18-3.63)
60-min	1.91 (1.67-2.21)						3.97 (3.02-5.03)
2-hr	2.33 (2.05-2.68)						5.07 (3.88-6.40)
3-hr	2.54 (2.24-2.91)						5.85 (4.51-7.40)
6-hr	2.94 (2.61-3.35)						7.29 (5.68-9.27)
12-hr	3.43 (3.06-3.88)	3.73 (3.32-4.23)	4.41 (3.91-5.01)	5.14 (4.53-5.88)	6.41 (5.53-7.92)	7.59 (6.29-9.45)	8.95 (7.07-1
24-hr	3.91 (3.51-4.40)	4.32 (3.87-4.87)	5.24 (4.67-5.92)	6.24 (5.52-7.08)	7.95 (6.90-9.78)	9.54 (7.95-11.8)	11.4 (9.02-14.5)



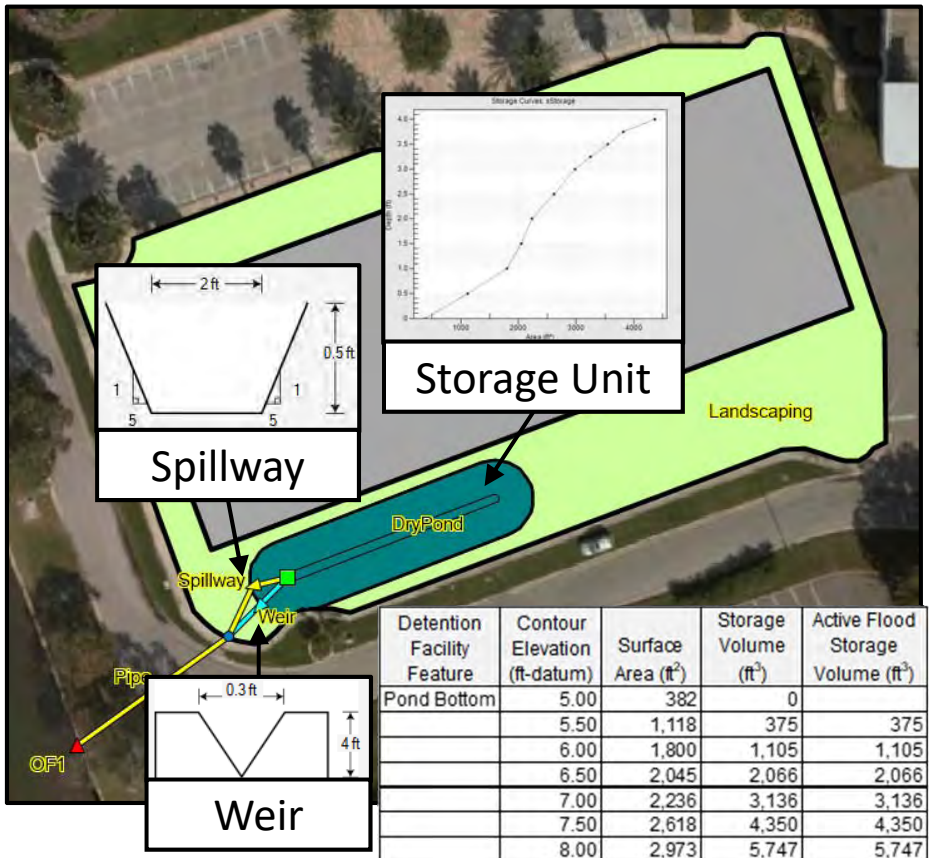
Location information:
Name: Tampa, Florida, USA*
Station name: TAMPA WSCMO AP
Site ID: 08-8788
Latitude: 27.9614°
Longitude: -82.5403°
Elevation: 19 ft

100yr/24hr event (11.4”)



Pond Design Details

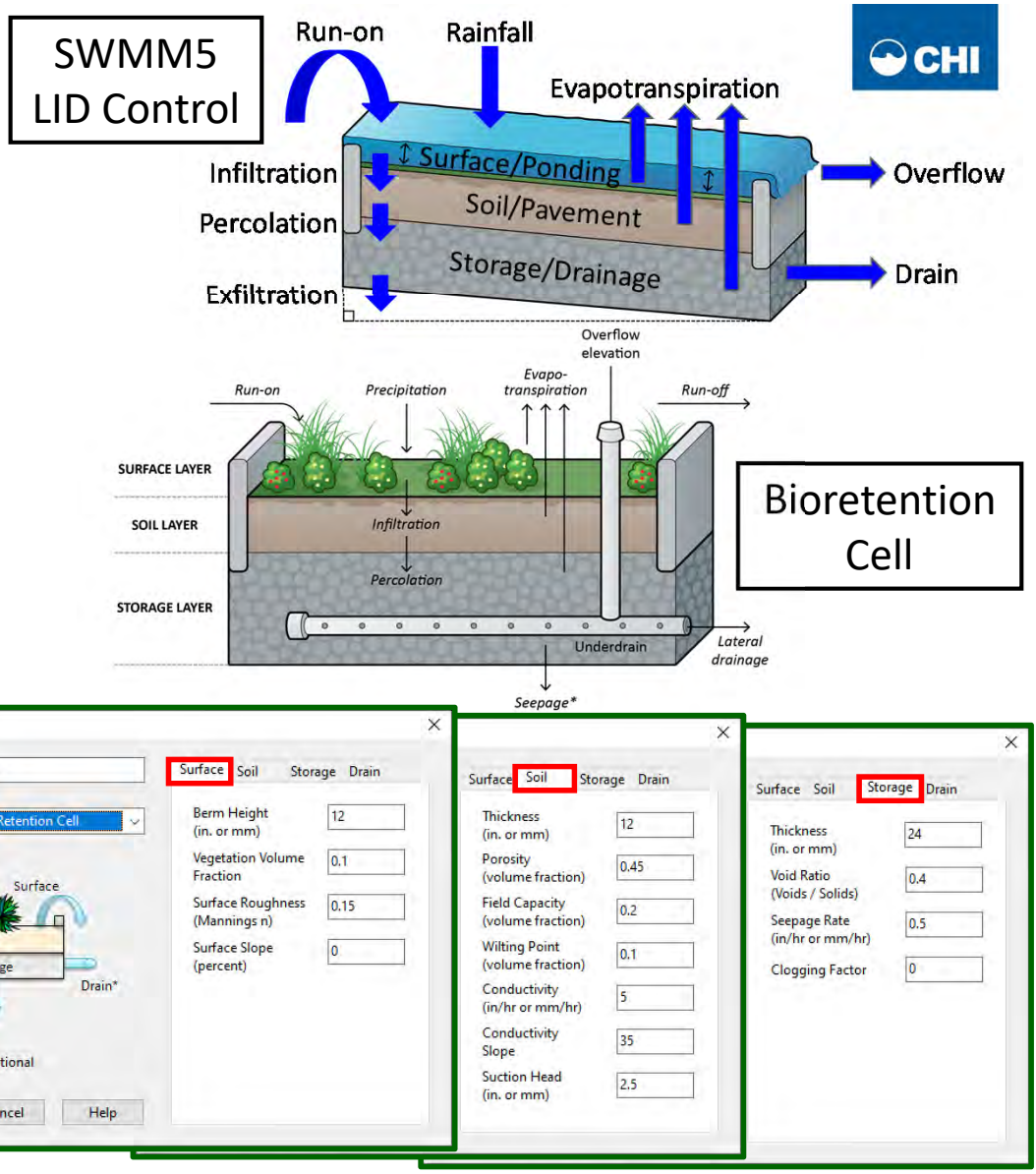
- Dimensions:
  - Bottom: 1 foot above seasonal GWT
  - Top of berm: 4 feet above bottom
  - Pond footprint area: 4,360 ft^2
  - Storage capacity: 0.21 ac-ft
- Pond control structures:
  - V-notch weir (bottom to top of berm)
  - Spillway (0.5ft below top of berm)
- Available at openswmm.org/SWMMExamples



Detention Facility Feature	Contour Elevation (ft-datum)	Surface Area (ft^2)	Storage Volume (ft^3)	Active Flood Storage Volume (ft^3)
Pond Bottom	5.00	382	0	
	5.50	1,118	375	375
	6.00	1,800	1,105	1,105
	6.50	2,045	2,066	2,066
	7.00	2,236	3,136	3,136
	7.50	2,618	4,350	4,350
	8.00	2,973	5,747	5,747
	8.25	3,245	6,525	6,525
Spillway	8.50	3,545	7,373	7,373
	8.75	3,818	8,294	8,294
Top of Berm	9.00	4,364	9,316	9,316

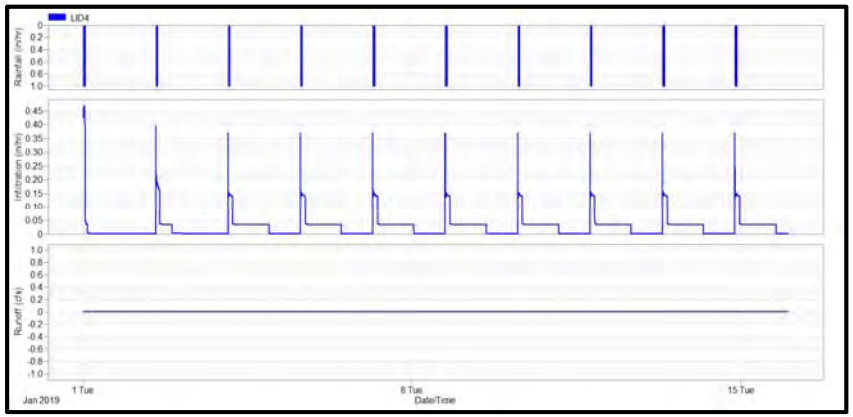
LID Design Details

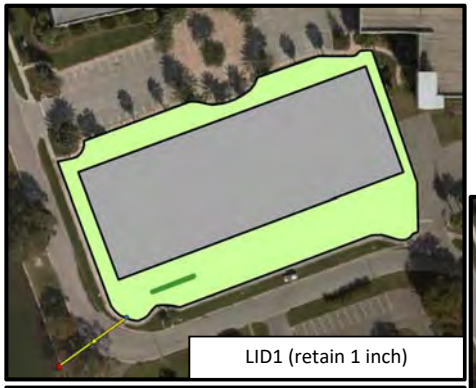
- Dimensions:
  - Bottom: 1 foot above seasonal GWT
  - Top of berm: 4 feet above bottom
  - Footprint area: 220 - 4,320 ft^2 (impervious loading ratio: 173:1 - 9:1)
- Bioretention cell details:
  - Surface berm height: 1 foot
  - Soil layer thickness: 1 foot
  - Storage layer height: 2 feet
  - No underdrain
  - Assumed 15% initially saturated

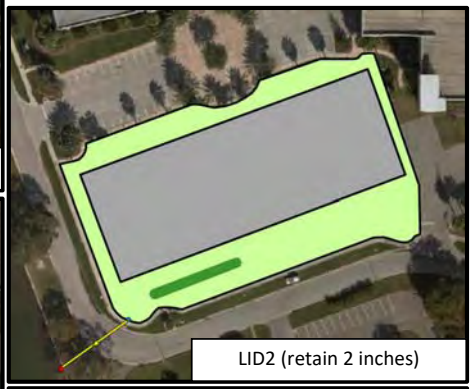


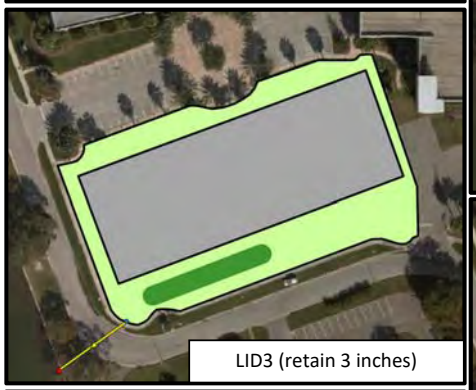
Range of Sizes Evaluated

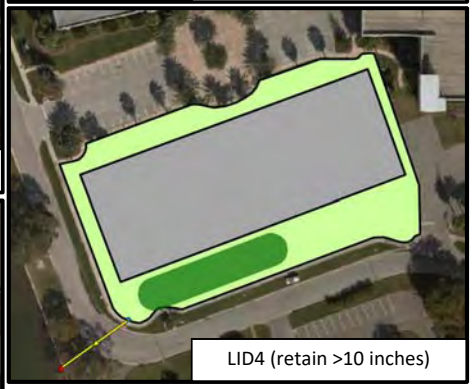
- LID1 = retain all runoff from 1-inch storm
- LID2 = retain all runoff from 2 back-to-back 1-inch storms (separated by 36hr)
- LID3 = retain all runoff from 3 consecutive 1-inch storms (separated by 36hr)
- LID4 = retain all runoff from >10 consecutive 1-inch storms

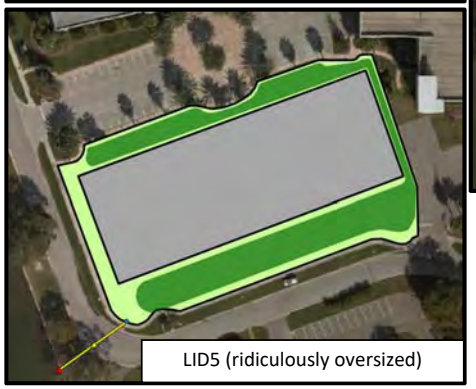






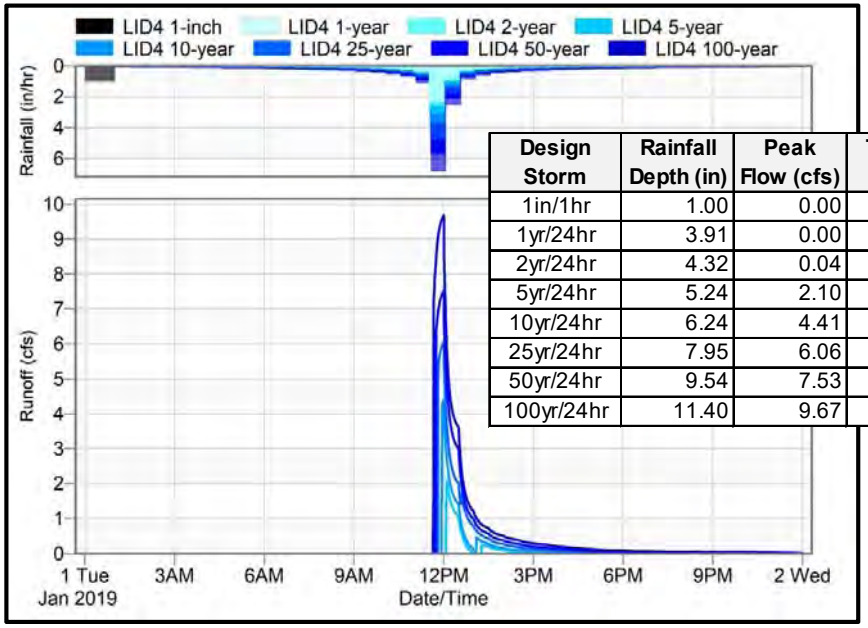




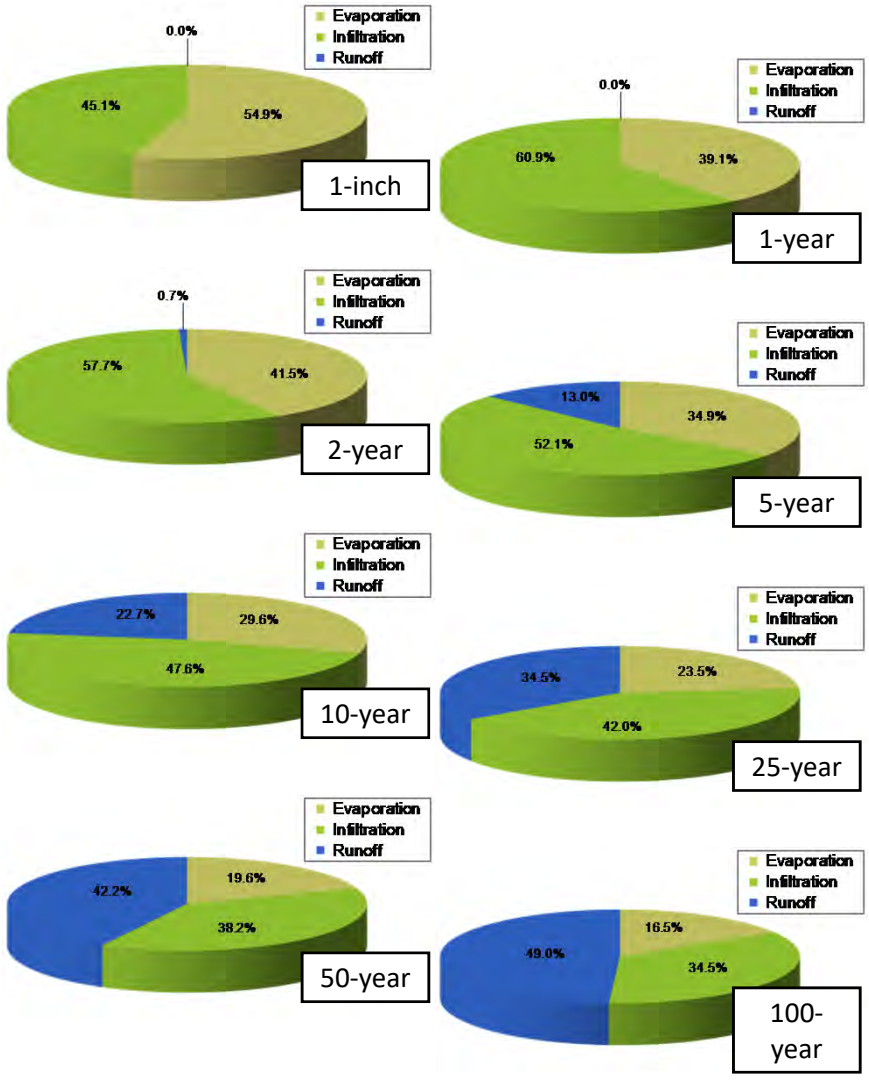


Design Storm Performance

- Retention volume is compared to developed condition without LID (i.e., direct pipe discharge to outfall)

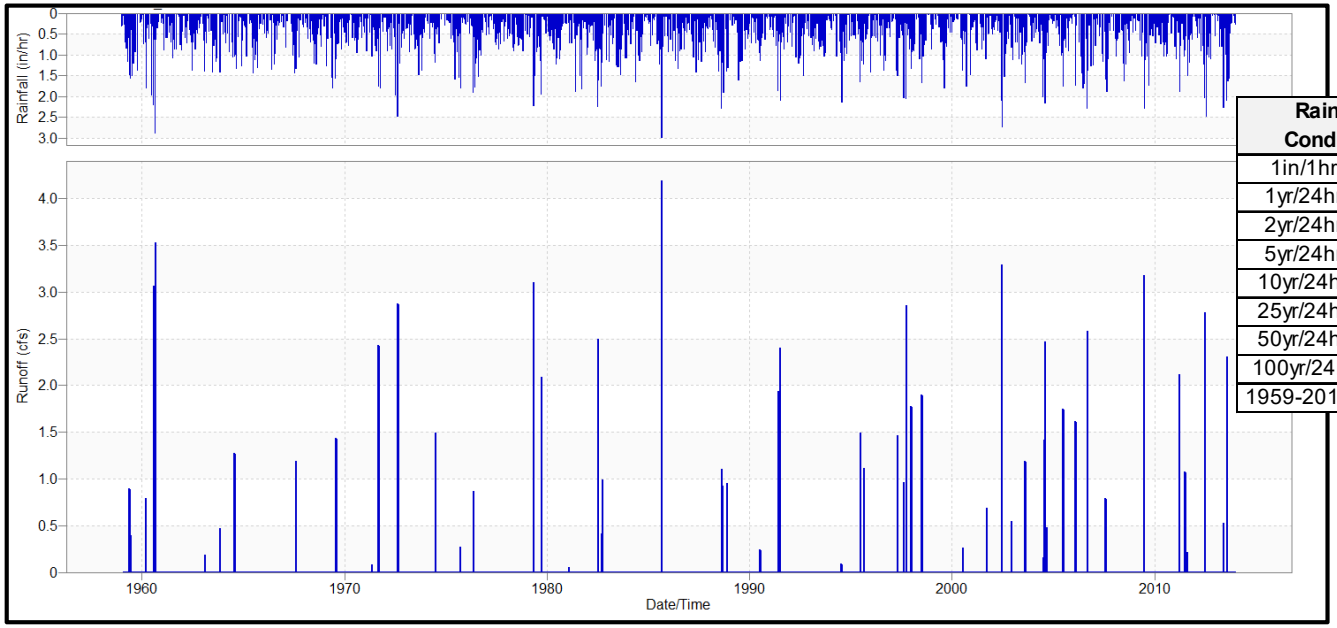


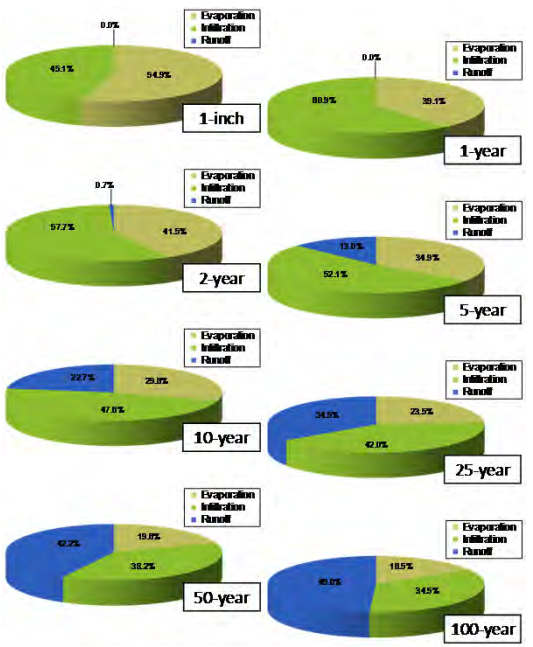
Design Storm	Rainfall Depth (in)	Peak Flow (cfs)	Total Runoff Volume (cf)	Total Runoff Volume (% of Rain)	Retention Volume (in)
1in/1hr	1.00	0.00	0	0.0%	0.1
1yr/24hr	3.91	0.00	0	0.0%	1.4
2yr/24hr	4.32	0.04	168	0.7%	1.6
5yr/24hr	5.24	2.10	3,649	13.0%	1.6
10yr/24hr	6.24	4.41	7,593	22.7%	1.7
25yr/24hr	7.95	6.06	14,705	34.5%	1.7
50yr/24hr	9.54	7.53	21,523	42.2%	1.7
100yr/24hr	11.40	9.67	29,944	49.0%	1.7



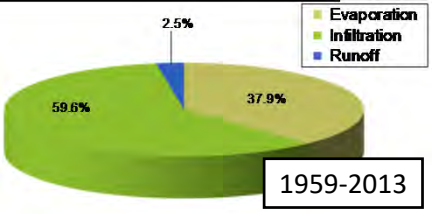
Real Rainfall Performance

- Using 55-year hourly rainfall record available from NOAA (1959-2013)
- Average annual retention volume = 438 ÷ 55 = 8 in/year

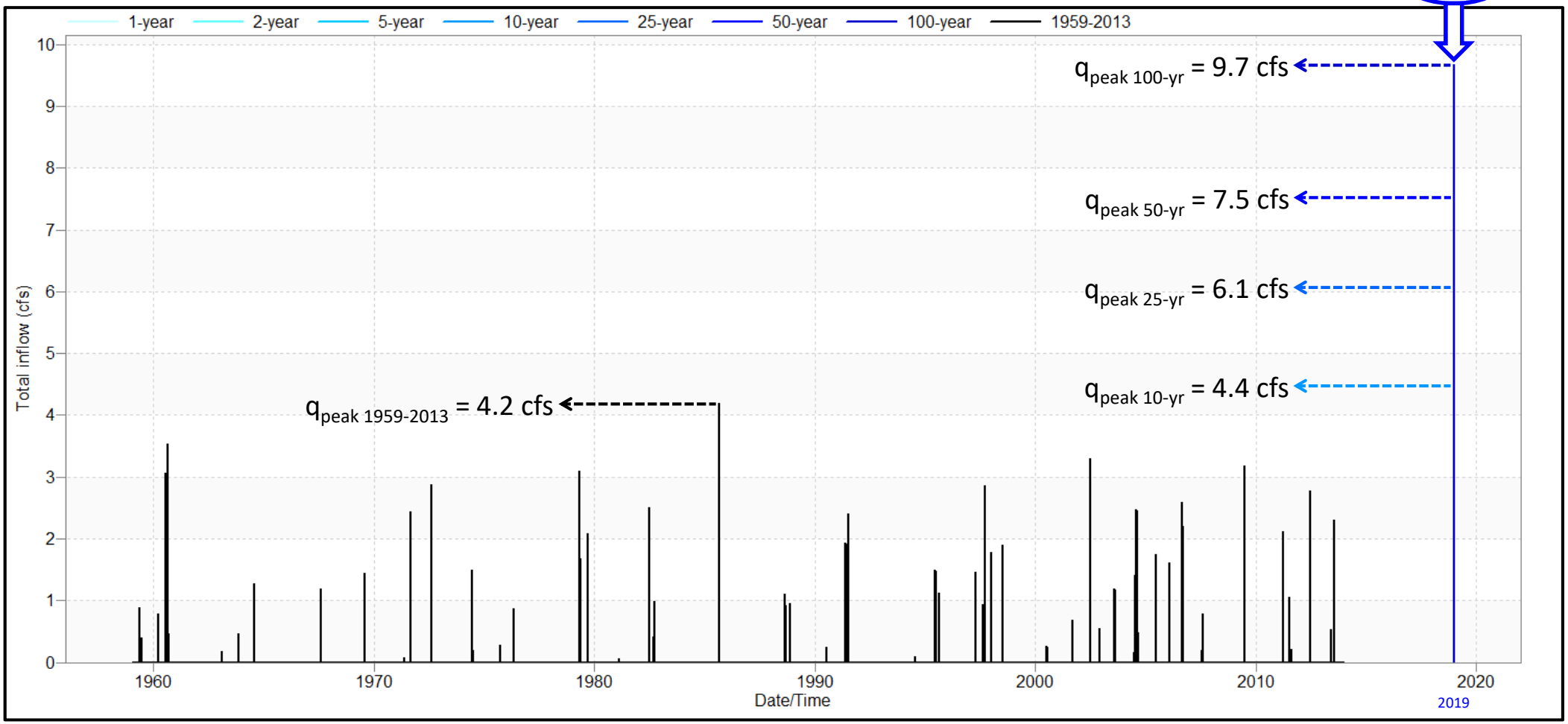




Rainfall Condition	Rainfall Depth (in)	Peak Flow (cfs)	Total Runoff Volume (cf)	Total Runoff Volume (% of Rain)	Retention Volume (in)
1in/1hr event	1.00	0.00	0	0.0%	0.1
1yr/24hr event	3.91	0.00	0	0.0%	1.4
2yr/24hr event	4.32	0.04	168	0.7%	1.6
5yr/24hr event	5.24	2.10	3,649	13.0%	1.6
10yr/24hr event	6.24	4.41	7,593	22.7%	1.7
25yr/24hr event	7.95	6.06	14,705	34.5%	1.7
50yr/24hr event	9.54	7.53	21,523	42.2%	1.7
100yr/24hr event	11.40	9.67	29,944	49.0%	1.7
1959-2013 record	2539.51	4.20	337,944	2.5%	438.0



Real Rainfall Performance (continued)



Facility Summary

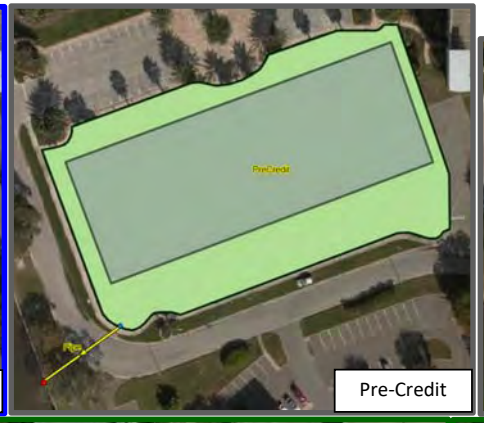
Grey infrastructure

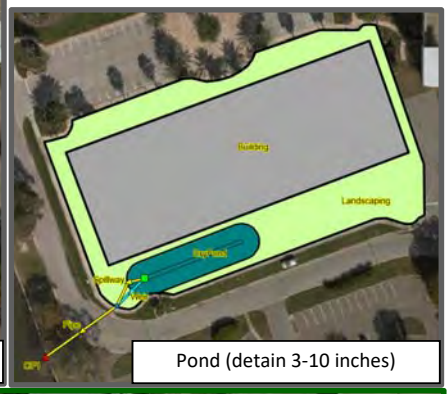
- Pond footprint: 4,364 ft^2
- Impervious area capture ratio = 9:1

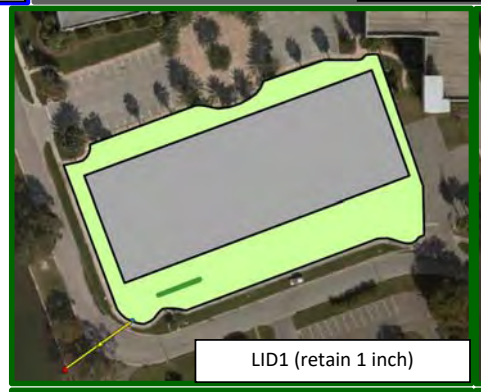
Green infrastructure

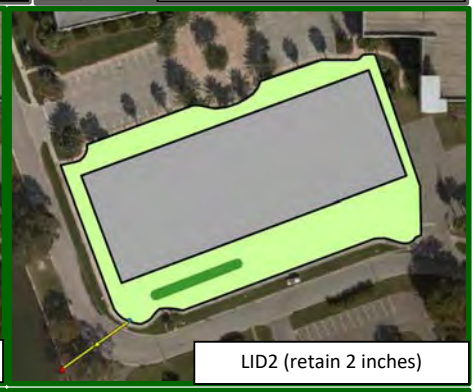
- LID1: 215 ft^2, 173:1 capture ratio
- LID2: 915 ft^2, 41:1 capture ratio
- LID3: 2,420 ft^2, 15:1 capture ratio
- LID4: 4,323 ft^2, 9:1 capture ratio

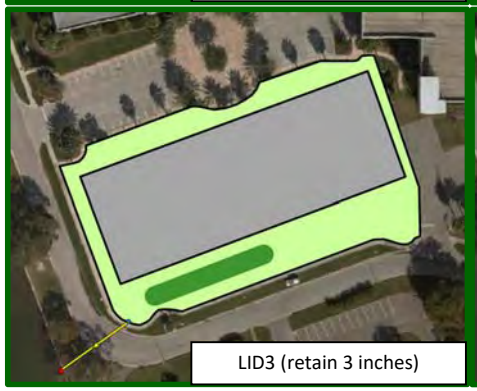
- Credit scenarios (past, present & future):
  - Pre-development: 5% impervious
  - Pre-credit: 58% impervious, uncontrolled
  - Credit: 58% impervious, pond or LID

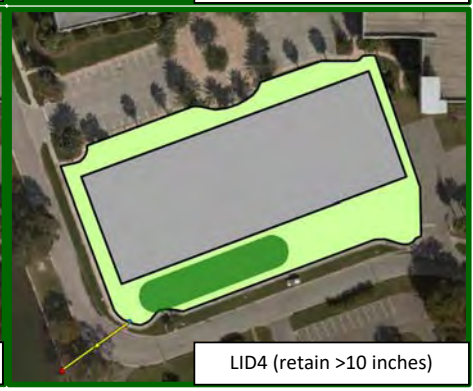












Water Quantity Credits

- Peak Flow Reduction (max. 35%): based on level of control (between uncontrolled and pre-development conditions)
- Runoff Volume Reduction (max. 15%): based on volume retained, up to 2 inches (compared to uncontrolled)

Dry Pond

100-year/24-hour design storm event

Credit Scenario	Peak Flow Rate		
	cfs	Control	Credit
Pre-Development	5.77	100%	35.0%
Pre-Credit (pipe)	9.67	0%	0.0%
Credit (pond)	9.59	2%	0.7%

1-inch/1-hour rain event

Credit Scenario	Total Flow Volume				
	ft^3	in	$\Delta_{Uncontrolled}$	Retained	Credit
Pre-Credit (pipe)	329	0.06	0.00	0.0%	0.0%
Credit (pond)	291	0.05	-0.01	0.3%	0.1%

Gross area (ac):	1.4741
Impervious area (sf):	37,293
Imperviousness:	58.1%
STM Billing Units:	11.3
2019 Rate (per annum):	$82.0
Base Charge:	**$927**
Credits	
Peak Flow:	0.7%
Runoff Volume:	0.1%
Total :	0.8%
Less Credits:	**$7**
Net Annual Charge:	**$919**

Bioretention Cell

100-year/24-hour design storm event

Credit Scenario	Peak Flow Rate		
	cfs	Control	Credit
Pre-Development	5.77	100%	35.0%
Pre-Credit (pipe)	9.67	0%	0.0%
Credit (LID4)	9.67	0%	0.0%

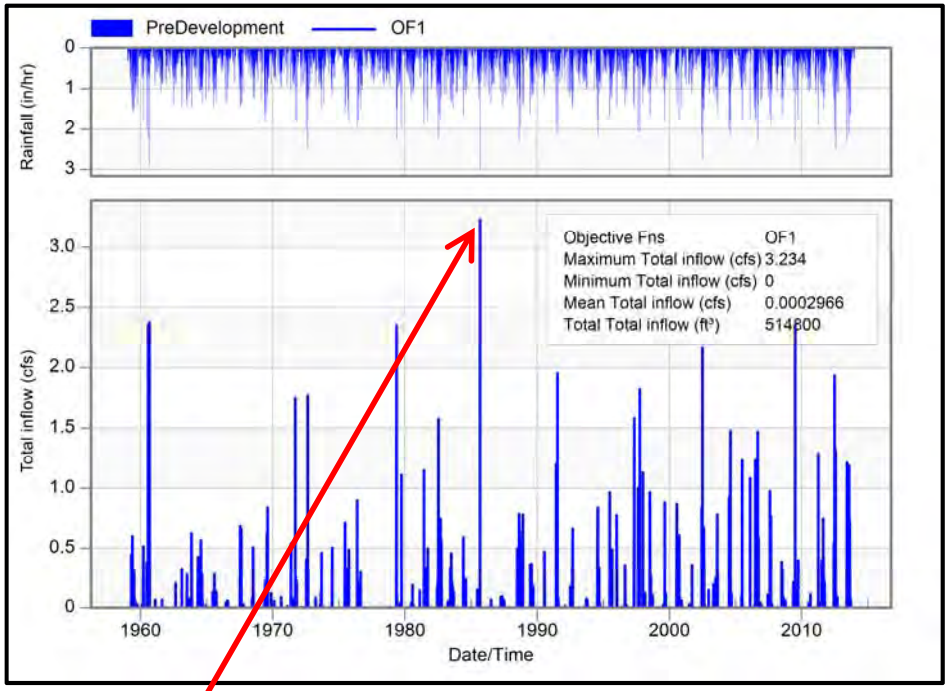
1-inch/1-hour rain event

Credit Scenario	Total Flow Volume				
	ft^3	in	$\Delta_{Uncontrolled}$	Retained	Credit
Pre-Credit (pipe)	329	0.06	0.00	0.0%	0.0%
Credit (LID4)	0	0.00	-0.06	3.1%	0.5%

Gross area (ac):	1.4741
Impervious area (sf):	37,293
Imperviousness:	58.1%
STM Billing Units:	11.3
2019 Rate (per annum):	$82.0
Base Charge:	**$927**
Credits	
Peak Flow:	0.0%
Runoff Volume:	0.5%
Total :	0.5%
Less Credits:	**$4**
Net Annual Charge:	**$922**

Streamflow Analysis

- Overall peak flow: 3.23 cfs (but this is not very useful for performance evaluation)
- Parse flow hydrograph into events and determine peak flow return periods
  - $Q_{3\text{-month}}$ = 0.06 cfs
  - $Q_{6\text{-month}}$ = 0.32 cfs
  - $Q_{1\text{-year}}$ = 0.63 cfs
  - $Q_{2\text{-year}}$ = 1.00 cfs
  - $Q_{5\text{-year}}$ = 1.67 cfs
  - $Q_{10\text{-year}}$ = 2.17 cfs
  - $Q_{25\text{-year}}$ = 2.36 cfs
  - $Q_{50\text{-year}}$ = 2.61 cfs




```
Number of events:                1639
Plotting position:       Cunnane
Function:        Maximum Total inflow (cfs)

Return Period (y)
100      N/A
50       2.609
25       2.363
10       2.169
5        1.674
2        0.998
1        0.634
0.5      0.32
0.25     0.056
0.083    0.002
```

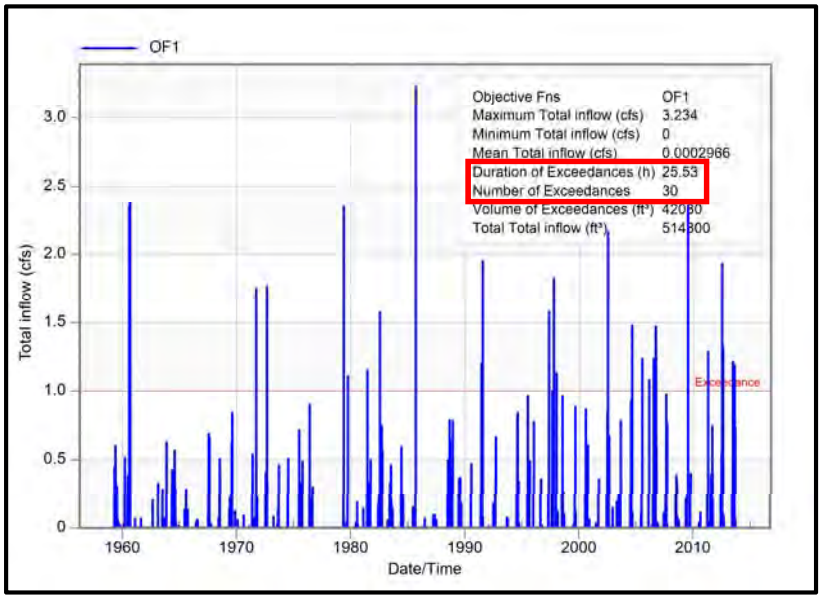
Event	Date	Duration (h)	OF1	
			Maximum Total inflow (cfs)	Return Period (y)
784	Sep 03,1985 8:05 PM	4.17	3.234	92
67	Aug 31,1960 3:00 PM	3.25	2.378	34.5
1490	Jun 30,2009 5:10 PM	40.92	2.357	21.231
60	Jul 28,1960 10:25 AM	30.75	2.352	15.333
583	May 08,1979 5:00 AM	24	2.352	15.333
1271	Jun 24,2002 5:00 PM	3.5	2.164	9.857
971	Jul 13,1991 10:05 AM	4.92	1.954	8.364

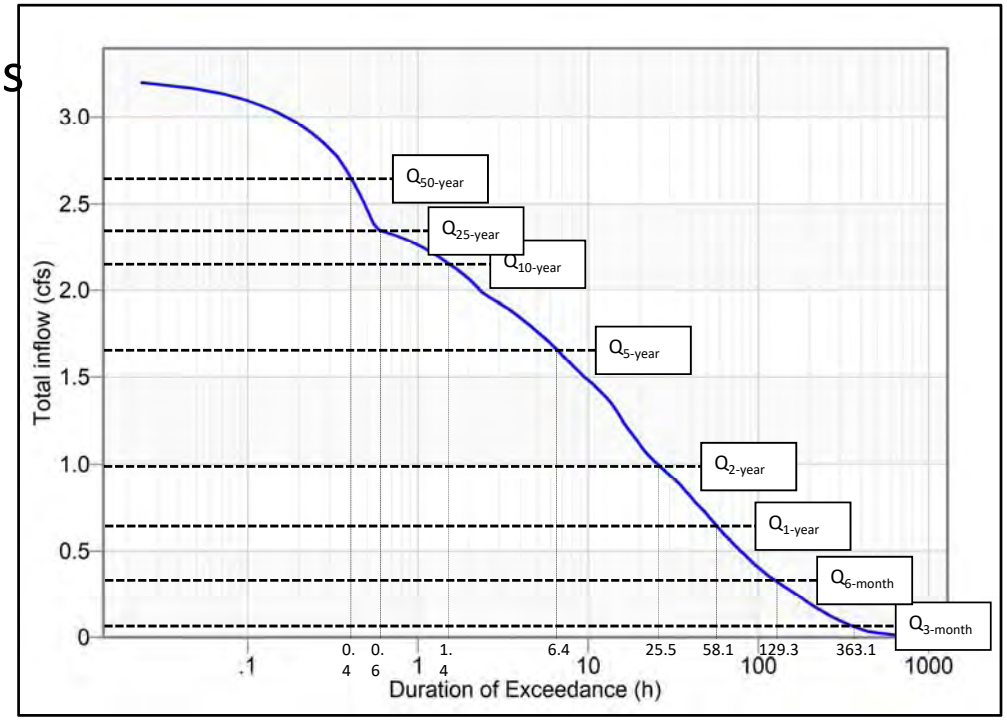
Another Perspective on Performance…

- Notice anything missing?
- The letter “D”
- Flow duration curve: track cumulative duration above a range of flow thresholds

Letter	Rainfall Stimulus	Runoff Response
I	Intensity	Severity of consequence
D	Duration	Duration of threshold exceedance
F	Frequency	Probability of occurrence

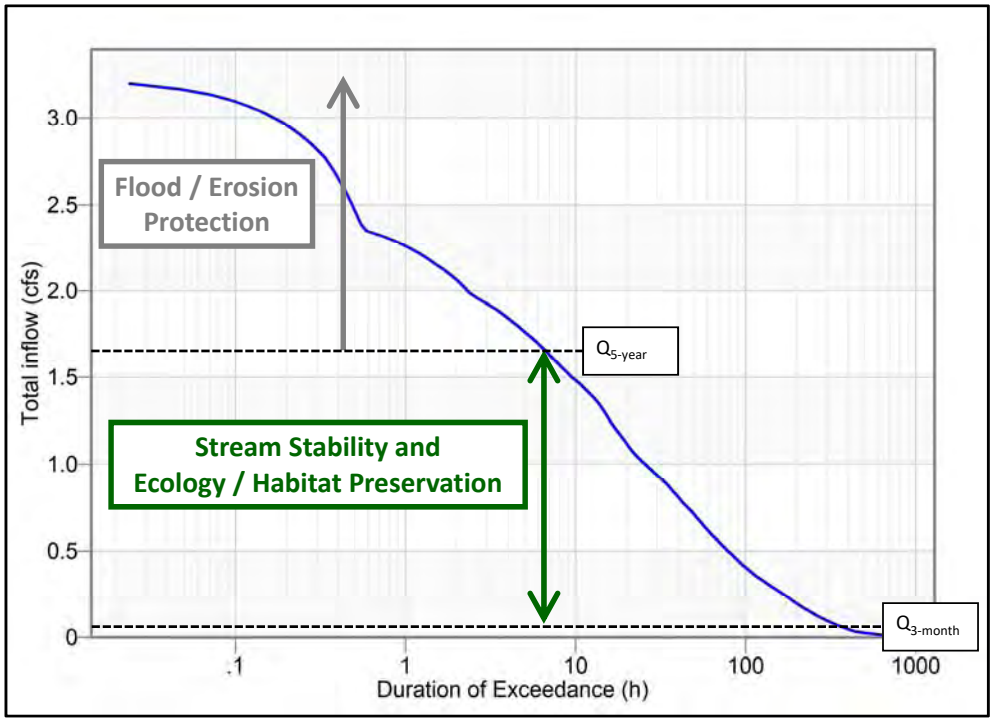
Flow Thresholds		Threshold Exceedances	
Return Period	Flow Rate (cfs)	Number of Occurrences	Cumulative Duration (hr)
3-month	0.06	232	363.1
6-month	0.32	117	129.3
1-year	0.63	60	58.1
2-year	1.00	30	25.5
5-year	1.67	13	6.4
10-year	2.17	5	1.4
25-year	2.36	2	0.6
50-year	2.61	1	0.4





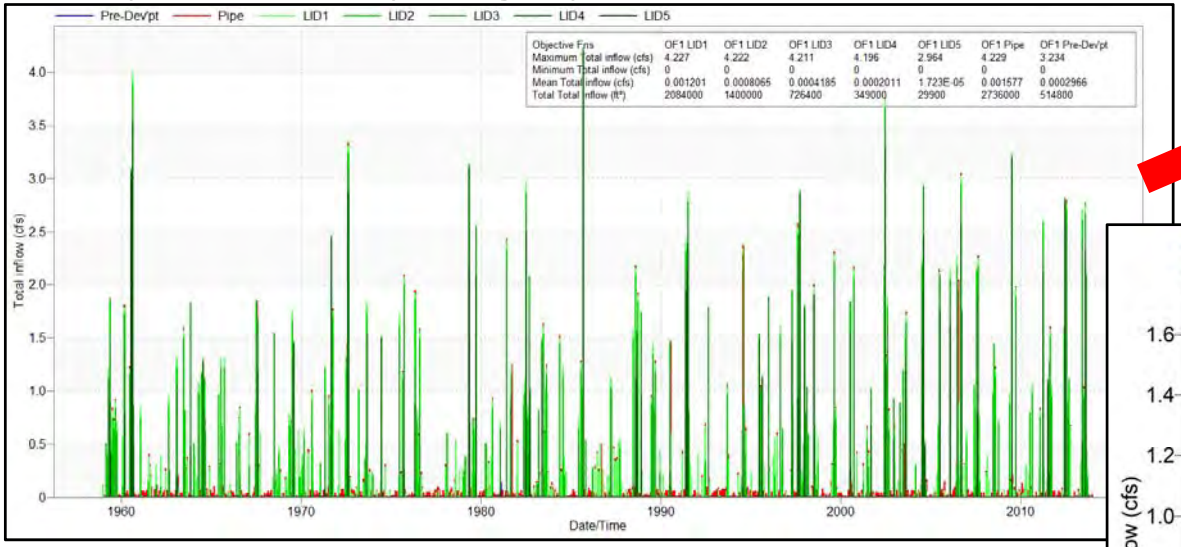
Flow Duration Control

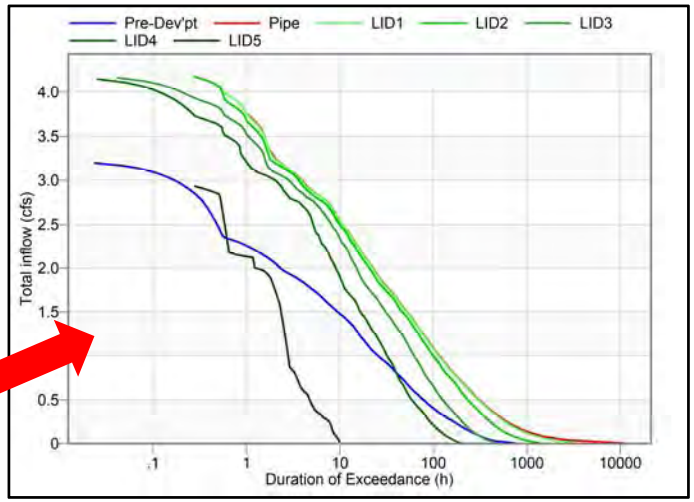
- Critical flow duration thresholds
  - $Q_{3\text{-month}}$ (0.06 cfs): 363.1-hour exceedance
  - $Q_{5\text{-year}}$ (1.67 cfs): 6.4-hour exceedance
- Represents channel-forming flow range and most ecologically sensitive regime
- Flood hazards become critical above the top operating point
- Natural variability, draught tolerance, regular operations/maintenance, system resiliency below bottom operating point



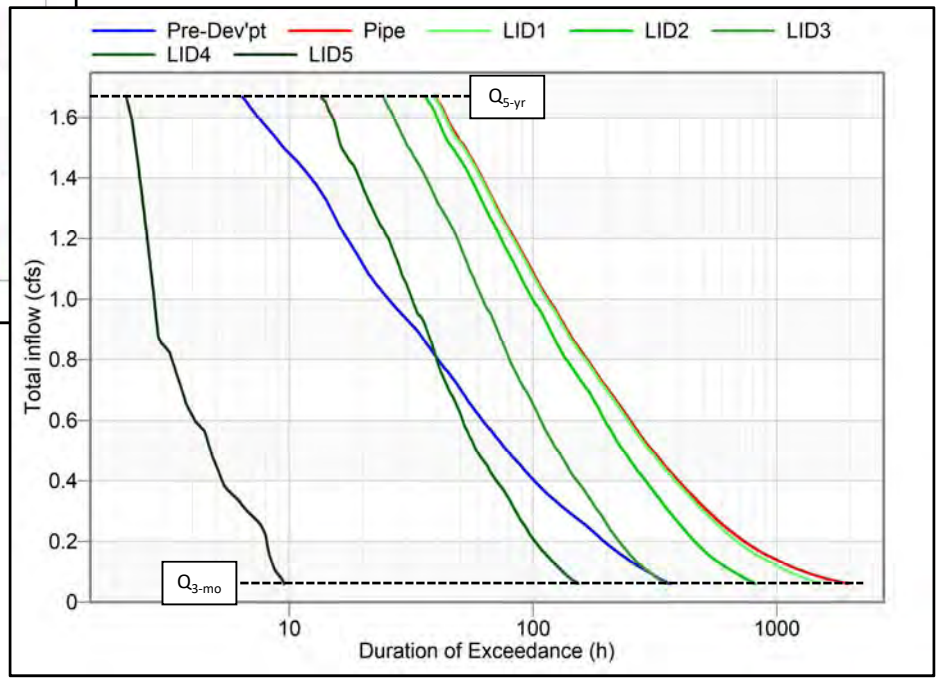
Water Quantity Control (I-**D**-F)

- Step 1: Flow hydrographs → flow duration curves…



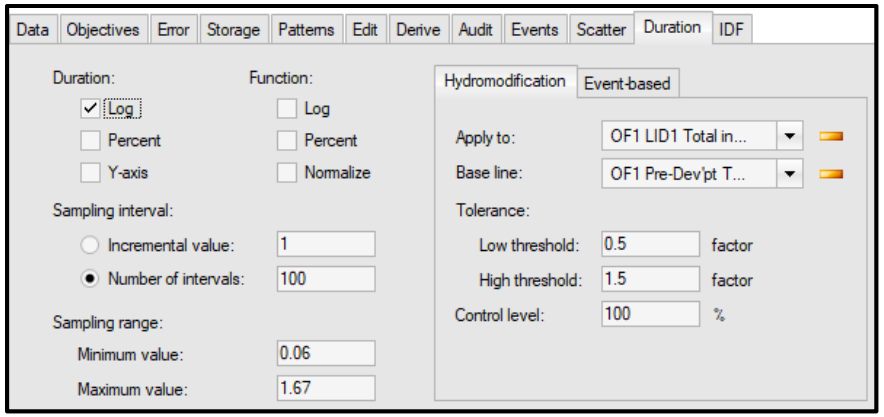


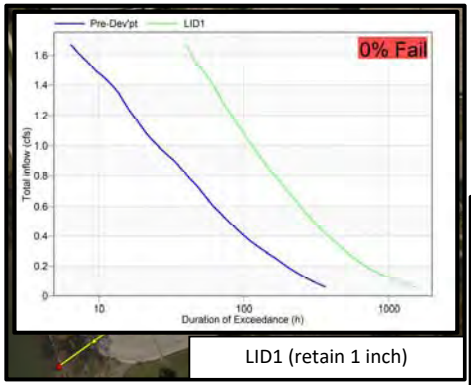
- Step 2: Focus on relevant operating range



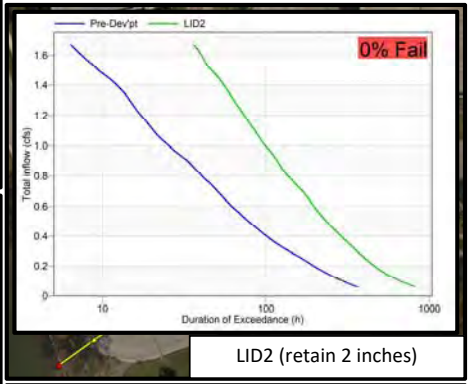
New Credit Criteria

- Suggest 1% control credit for each flow threshold value within ±50% of the pre-development flow duration curve
  - 100% control = within ±50% for all 100 flow thresholds between $Q_{5\text{-year}}$ and $Q_{3\text{-month}}$
  - 0% control = none of the 100 flow thresholds are within ±50%
- Spreadsheet analysis or automated tools…

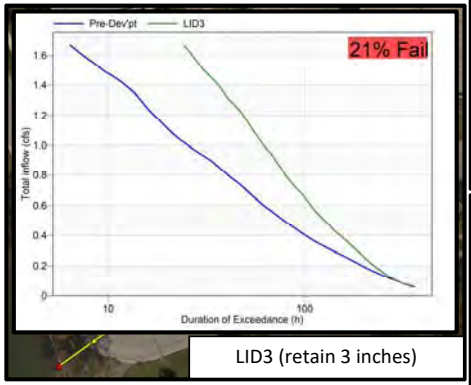




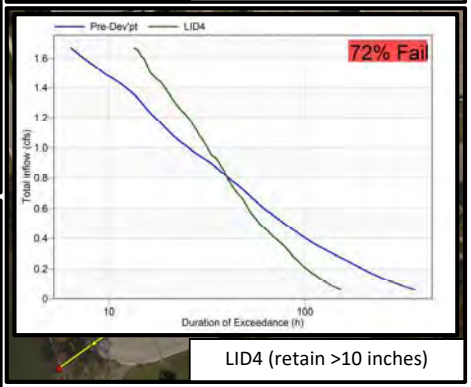
LID1 (retain 1 inch)



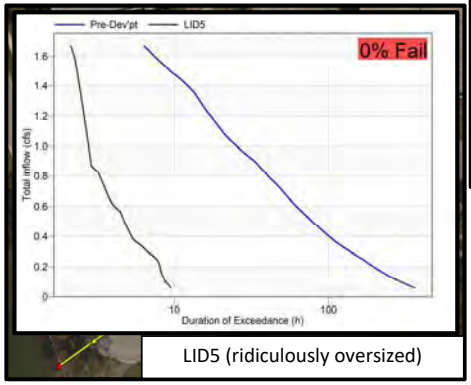
LID2 (retain 2 inches)



LID3 (retain 3 inches)



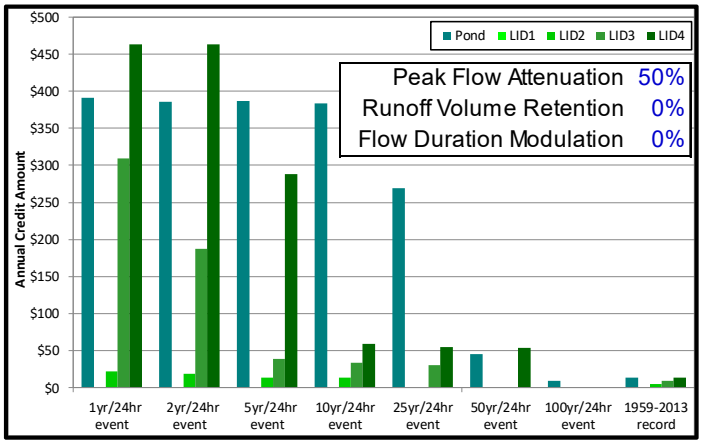
LID4 (retain >10 inches)

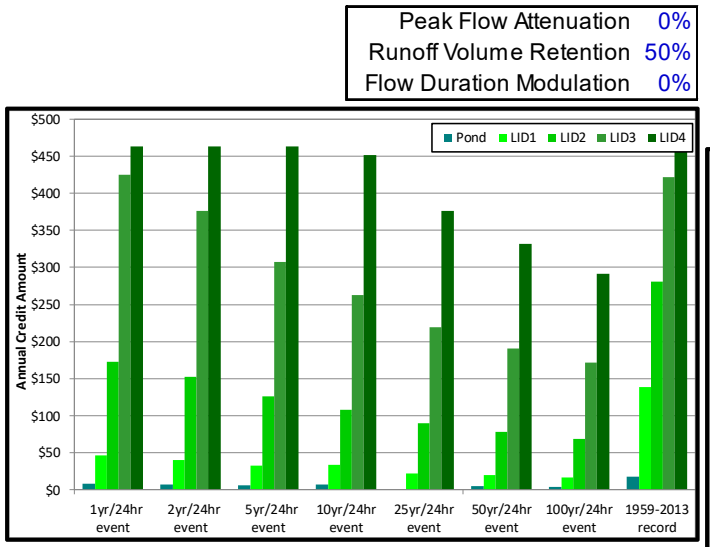


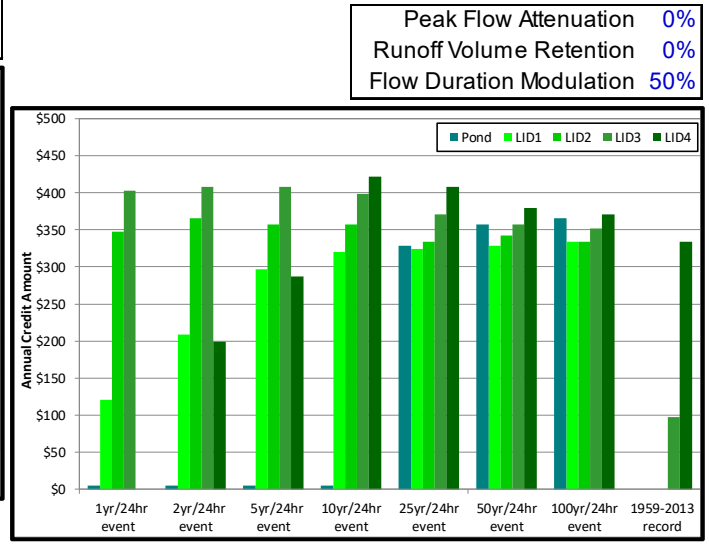
LID5 (ridiculously oversized)

Water Quantity Credit Categories

- Control metrics:
  - Peak flow attenuation: within range between pre-dev'pt and existing conditions
  - Runoff volume retention: relative to existing conditions only
  - Cumulative flow duration modulation: relative to pre-development conditions only
- Assume maximum total credit awarded will not exceed 50%, options include…







Water Quantity Credits, Revisited

- Suggested maximum credit allocations:

Quantity Credit Category	Old	New
Peak Flow Attenuation	35%	20%
Runoff Volume Retention	15%	15%
Flow Duration Modulation	n/a	15%

Dry Pond

100-year/24-hour design storm event

Credit Scenario	Peak Flow Rate		
	cfs	Control	Credit
Pre-Development	5.77	100%	20.0%
Pre-Credit (pipe)	9.67	0%	0.0%
Credit (pond)	9.59	2%	0.4%

1959-2013 hourly rainfall record

Credit Scenario	Cumulative Duration			
	Qmin	Qmax	Control	Credit
Pre-Development	0.06	1.67	100%	15.0%
Credit (pond)	0.06	1.67	0%	0.0%

1-inch/1-hour rain event

Credit Scenario	Total Flow Volume				
	ft^3	in	$\Delta_{Uncontrolled}$	Retained	Credit
Pre-Credit (pipe)	329	0.06	0.00	0.0%	0.0%
Credit (pond)	291	0.05	-0.01	0.3%	0.1%

Gross area (ac):	1.4741
Impervious area (sf):	37,293
Imperviousness:	58.1%
STM Billing Units:	11.3
2019 Rate (per annum):	$82.0
Base Charge:	**$927**
Credits	
Peak Flow:	0.4%
Runoff Volume:	0.1%
Cumulative Duration:	0.0%
Total:	0.5%
Less Credits:	**$4**
Net Annual Charge:	**$922**

Old criteria…

Gross area (ac):	1.4741
Impervious area (sf):	37,293
Imperviousness:	58.1%
STM Billing Units:	11.3
2019 Rate (per annum):	$82.0
Base Charge:	**$927**
Credits	
Peak Flow:	0.7%
Runoff Volume:	0.1%
Total :	0.8%
Less Credits:	**$7**
Net Annual Charge:	**$919**

Water Quantity Credits, Revisited

- Suggested maximum credit allocations:

Quantity Credit Category	Old	New
Peak Flow Attenuation	35%	20%
Runoff Volume Retention	15%	15%
Flow Duration Modulation	n/a	15%

Bioretention Cell

100-year/24-hour design storm event

Credit Scenario	Peak Flow Rate		
	cfs	Control	Credit
Pre-Development	5.77	100%	20.0%
Pre-Credit (pipe)	9.67	0%	0.0%
Credit (LID4)	9.67	0%	0.0%

1959-2013 hourly rainfall record

Credit Scenario	Cumulative Duration			
	Qmin	Qmax	Control	Credit
Pre-Development	0.06	1.67	100%	15.0%
Credit (LID4)	0.06	1.67	72%	10.8%

1-inch/1-hour rain event

Credit Scenario	Total Flow Volume				
	ft^3	in	$\Delta_{Uncontrolled}$	Retained	Credit
Pre-Credit (pipe)	329	0.06	0.00	0.0%	0.0%
Credit (LID4)	0	0.00	-0.06	3.1%	0.5%

Gross area (ac):	1.4741
Impervious area (sf):	37,293
Imperviousness:	58.1%
STM Billing Units:	11.3
2019 Rate (per annum):	$82.0
Base Charge:	**$927**
Credits	
Peak Flow:	0.0%
Runoff Volume:	0.5%
Cumulative Duration:	10.8%
Total:	11.3%
Less Credits:	**$104**
Net Annual Charge:	**$822**

Old criteria…

Gross area (ac):	1.4741
Impervious area (sf):	37,293
Imperviousness:	58.1%
STM Billing Units:	11.3
2019 Rate (per annum):	$82.0
Base Charge:	**$927**
Credits	
Peak Flow:	0.0%
Runoff Volume:	0.5%
Total :	0.5%
Less Credits:	**$4**
Net Annual Charge:	**$922**

Closing Remarks

- Peak flow control:
  - Traditional credit category that rewards facilities that provide flood protection

Grey infrastructure is good

  - Design storm events are appropriate for allocating credits (not continuous simulation)
- Runoff volume control:
  - Traditional credit category rewards facilities that provide retention

Green is good

  - Either design storms or continuous simulation are appropriate for allocating credits
- Flow duration control:
  - New category that rewards facilities that maintain environmental flows

Green & grey work well together

  - Continuous simulation is appropriate for allocating credits (not design storm events)

Thank you for your attention!

CHI

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