# Tools and Case Studies for Green-Gray Lifecycle Cost Analysis

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Ohio Stormwater Conference May 2018 Justin Kerns

ms consultants

### **EPA National Stormwater Calculator**

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	An official website of the United States	government.			
ş	United States Environmental Protectio Agency	'n			
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Re	lated Topics: Water Researc	ch		CONTACT US SHARE (F) (9) (2)	

#### National Stormwater Calculator

Tool to help control runoff and promote the natural movement of water

EPA's National Stormwater Calculator (SWC) is a software application that estimates the annual amount of rainwater and frequency of runoff from a specific site. Estimates are based on local soil conditions, land cover, and historic rainfall records. It is designed to be used by anyone interested in reducing runoff from a property, including site developers, landscape architects, urban planners, and homeowners.

The SWC accesses several national databases that provide soil, topography, rainfall, and evaporation information for a chosen site. The user supplies information about the site's land cover and selects low impact development (LID) controls they would like to use. The LID controls include seven green infrastructure practices.

NOTE: The mobile web application version of the SWC is undergoing maintenance and is not available at this time. We anticipate that it will be made available in late spring 2018. We apologize for any inconvenience.

Green Infrastructure as Low Impact Development Controls	+
Capabilities	+



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### Low Impact Development (LID) Controls

#### **Included LID Controls**

- Disconnection (rooftop downspouts)
- Rain Harvesting (rain barrel or cistern)
- Rain Gardens
- Green Roofs
- Street Planters
- Infiltration Basins
- Permeable Pavement

### Low Impact Development (LID) Controls

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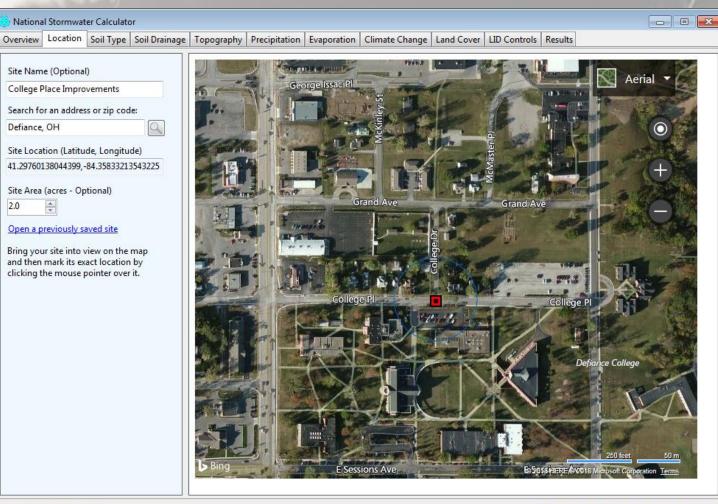
### **Modeling Capabilities**

- Hydrologic Analysis
- Cost Analysis
- Climate Scenarios

### Location and Project Information

2.0

- Site Name
- Search for Site Location
- Site Area

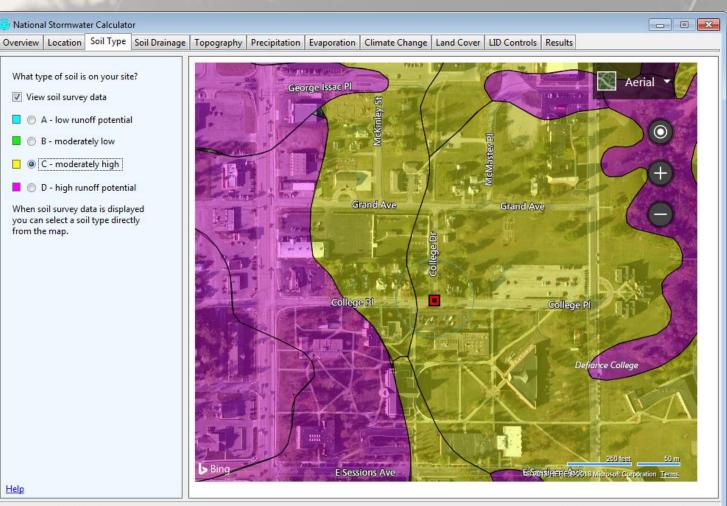


Analyze a New Site Save Current Site Exit

Locate the site on the map.

### Soil Type

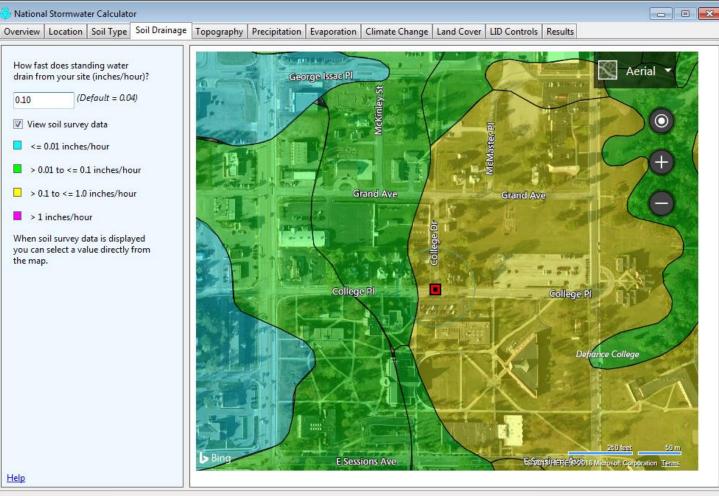
- NRCS Web Soil Survey
- Defined by Hydrologic Soil Group
  - Group A Sand
  - Group B Sandy Loam
  - Group C Clay Loam
  - Group D Clay



Select a soil type for the site.

### Soil Drainage

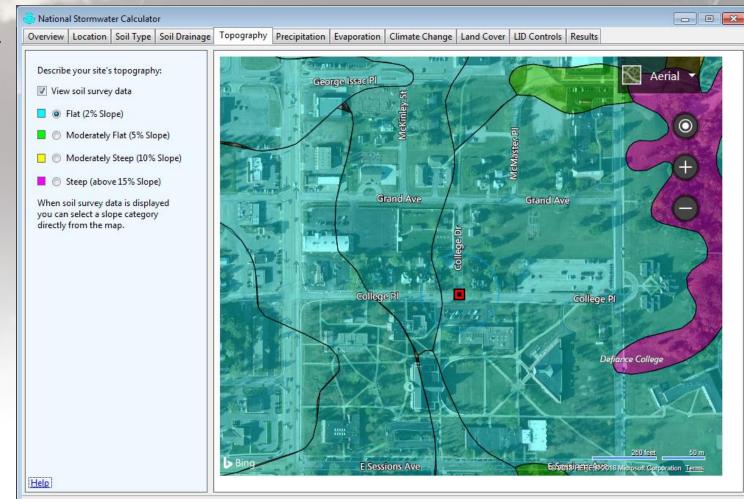
- NRCS Web Soil Survey
- Saturated Hydraulic Conductivity



Enter the soil's drainage rate.

### Topography

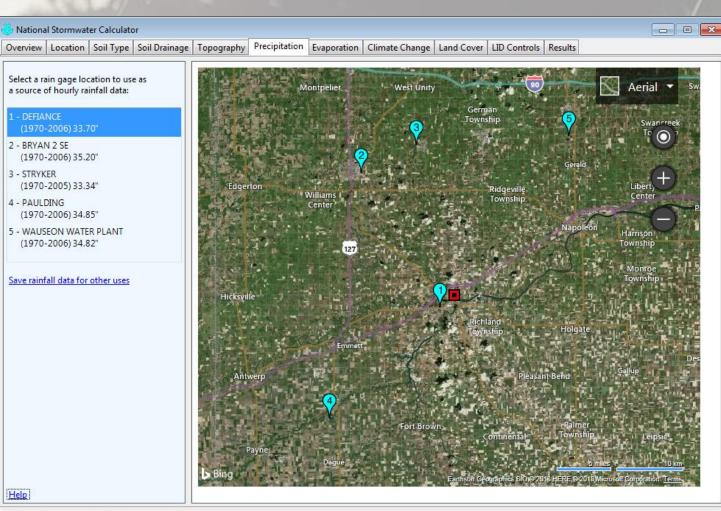
- NRCS Web Soil Survey
- Surface Slope



Describe how steep the site is.

### Precipitation

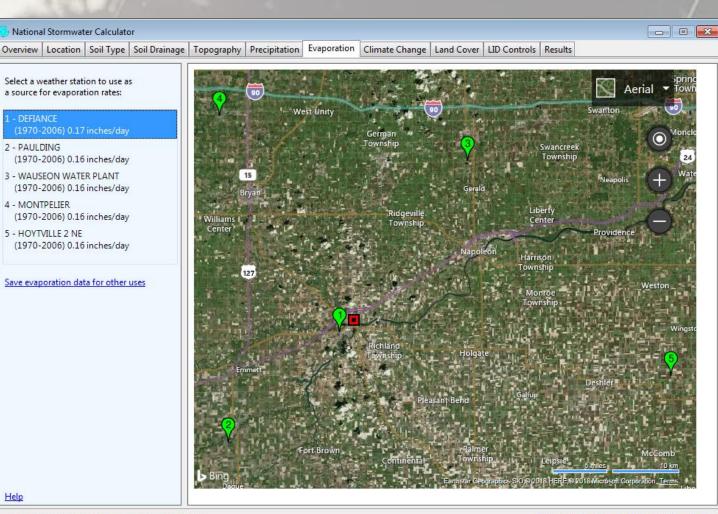
- Measured at nearby National Weather Service rain gage
- Average annual rainfall based on long-term historical data



Select a source of long-term hourly rainfall data.

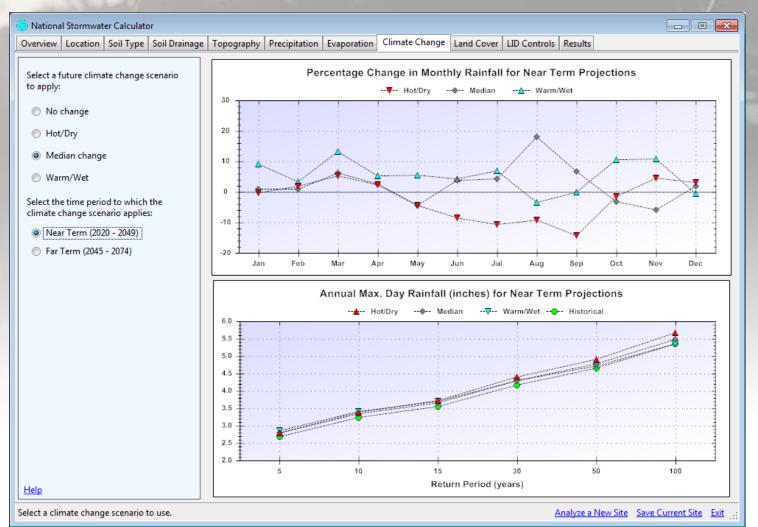
### Evaporation

- Measured at nearby National Weather Service weather station
- Monthly evaporation rates calculated from long-term historical data



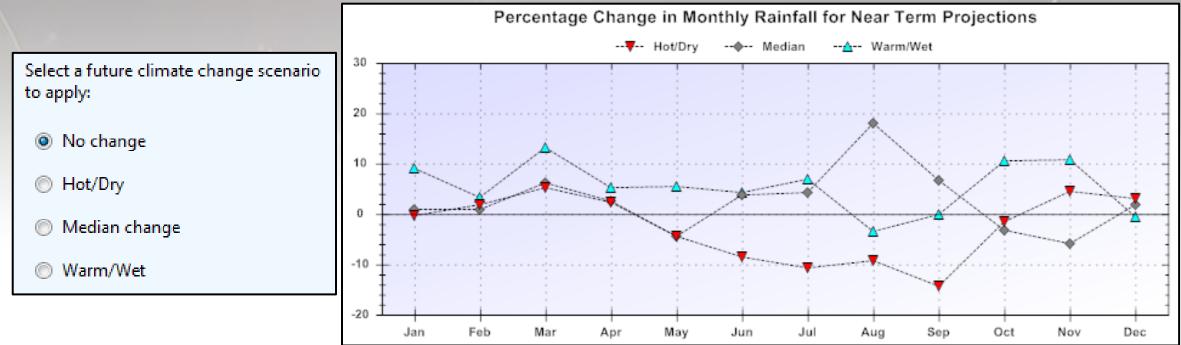
Select a source of monthly average evaporation rates.

- Climate projections produced by the World Climate Research Programme (WCRP)
- Scenarios model future changes in temperature and precipitation

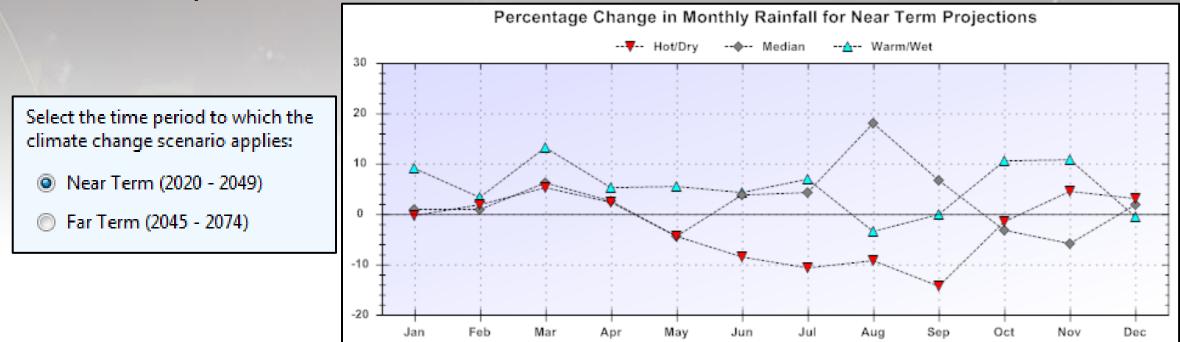


May 2018

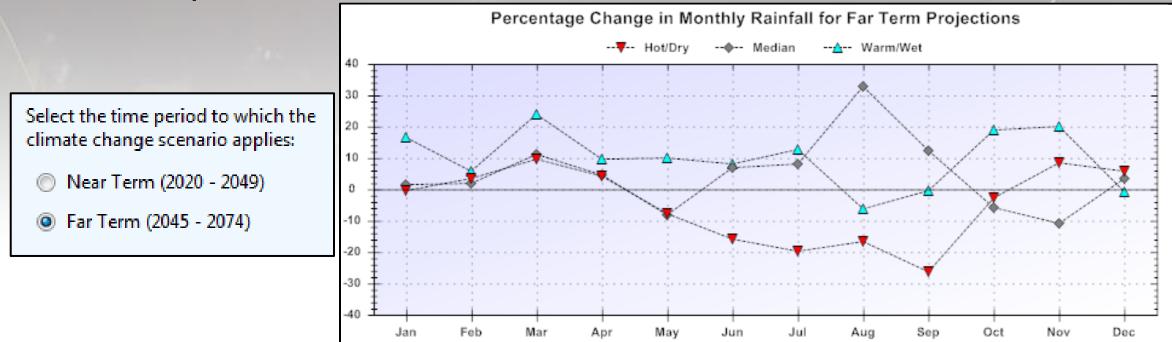
- Climate projections affect the average monthly rainfall
- Three scenarios
- Two time periods



- Climate projections affect the average monthly rainfall
- Three scenarios
- Two time periods



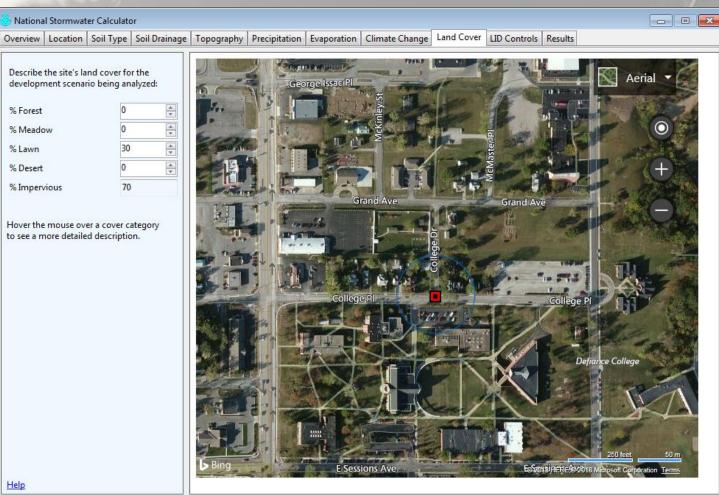
- Climate projections affect the average monthly rainfall
- Three scenarios
- Two time periods



### Land Cover

# Select the percent of site area covered by:

- Forest
- Meadow
- Lawn
- Desert
- Impervious



Describe the site's land cover.

### Low Impact Development (LID) Controls

Select percent of impervious area to be treated by each LID type

Enter design storm to be used for LID sizing

#### National Stormwater Calculator

What will be

Verify Pr O Pr

Help

Overview Location Soil Type Soil Drainage Topography Precipitation Evaporation Climate Change Land Cover LID Controls Results

What % of your site's impen will be treated by the followi practices?			5	George	A COMPANY AND A COMPANY			THE NEW	Ae	rial 🔻
<u>Disconnection</u>	0	A V	Fr.		e y s	Barrie F	2 6			
Rain Harvesting	0	×		1	Ç					$(\bigcirc)$
Rain Gardens	0	A V		-	J. C. S	ALL HAR	sterl			
Green Roofs	0	*				14	C Mai		hp 5	(+)
Street Planters	12	A V					N N	-0 Th.9	Est an	De d
Infiltration Basins	0	*	LITE	TE Calinaman	Grand Ave		Gr	and Ave		
Permeable Pavement	0	*		T F marito				R		
Design Storm for Sizing (inches) (see H <mark>e</mark> lp)	3.74	×				ollege D				
Click a practice to customize	e its desigr	n.			NOT ST		and:	· "		
/erify cost-estimation variab	les below			100	College Pl	Rends	TAP	Colle	ge Pl	
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Project is <u>New Develop</u>	<u>ment</u>					N Berry			Defiance College	
Site Suitability - Poor								×7 6	Denance Conege	2
Site Suitability - Modera	te		and Guis		0		1.5			2-1
Site Suitability - Excellen	<u>nt</u>							V		$\sim 1$
Cost Region Cincinnati (94	4 miles) 1.(	0. 🗸							1.5	Cast and a
Regional Multiplier 1.07			Is Bing		- AMART IN				250 feet	50 n
Help					E Sessions Ave			bax018/AEKE	C2018 Microsoft Corpo	ration <u>Term</u> :

Assign LID practices to capture runoff from impervious areas.

Analyze a New Site Save Current Site Exit

### **Rain Gardens**

- Ponding Height
- Soil Media Thickness
- Soil Media Conductivity
- % Capture Ratio (ratio of LID area to desired captured area)

erview Location	ID Design			×
/hat % of your site's	Rain Garden			
ractices? isconnection ain Harvesting ain Gardens			Rain Gardens are shallow depressions filled with an engineered soil mix that supports vegetative growth. They are usually used on individual home lots to capture roof runoff.	*
reen Roofs reet Planters filtration Basins	A state of the sta		Typical soil depths range from 6 to 18 inches. The Capture Ratio is the ratio of the rain garden's area to the impervious area that drains onto it.	
<u>ermeable Pavemen</u> esign Storm for Siz nches) (see Help)	Name of States	Strengt		-
ck a practice to cu	Ponding Height (inches)	6	Set.	
ify cost-estimatio	Soil Media Thickness (inches)	12		
Project is <u>Re-De</u>	Son Wedia Thickness (inches)		A CONTRACT OF A	
Project is <u>New [</u>	Soil Media Conductivity (in/hr)	10.00 🜲		
Site Suitability - Site Suitability - Site Suitability -	% Capture Ratio Has Pre-treatment	5	A LINE AND	
est Region Cincil			Learn more	
gional Multiplier				-
l <u>p</u>	Size for Design Storm	estore Defaults	Accept Cancel	

### **Street Planter**

- Ponding Height
- Soil Media Thickness
- Soil Media Conductivity
- Gravel Bed Thickness
- % Capture Ratio (ratio of LID area to desired captured area)

😔 National Stormwater	r Calculator			
Overview Location	LID Design			X
What % of your site's will be treated by the	Street Planter			
practices? <u>Disconnection</u> <u>Rain Harvesting</u> <u>Rain Gardens</u> <u>Green Roofs</u> <u>Street Planters</u> <u>Infiltration Basins</u> <u>Permeable Pavemen</u>	WALL PELTER FABILIC - CONTINUE FILTER FABILICAL - CONTINUE FILTER FABILIC - CONTINUE FILTER FABILIC - CONTINUE FILTER FABILICAL -	STRUCTURAL	Street Planters consist of concrete boxes filled with an engineered soil that supports vegetative growth. Beneath the soil is a gravel bed that provides additional storage. The walls of a planter extend 3 to 12 inches above the soil bed to allow for ponding withing the unit. The thickness of the soil growing medium ranges from 6 to 24 inches while gravel beds are 6 to 18 inches in depth.	E
Design Storm for Sizi (inches) (see Help)			The planter's Capture Ratio is the ratio of its area to	-
Click a practice to cu	Ponding Height (inches)	6		
Verify cost-estimatio	Soil Media Thickness (inches)	18		
<ul> <li>Project is <u>Re-De</u></li> <li>Project is <u>New D</u></li> </ul>	Soil Media Conductivity (in/hr)	10.00		
<ul> <li>Site Suitability -</li> <li>Site Suitability -</li> </ul>	Gravel Bed Thickness (inches)	12 ×	1 1 1 1	
Site Suitability -	% Capture Ratio	-	Learn more	
Cost Region Cincil Regional Multiplier				
Help	Size for Design Storm Re	estore Defaults	Accept Cancel	
Assign LID practices to o	capture runoff from impervious areas.		Analyze a New Site Save Current	<u>Site Exit</u>

#### Permeable Pavement

- Pavement Thickness
- Gravel Layer Thickness
- % Capture Ratio (ratio of LID area to desired captured area)

National Stormwater Ca				
erview Location LI	D Design			×
hat % of your site's ill be treated by the actices?	Permeable Pavement			
sconnection	Design Guidelines for Porous Asphait with Subsurface Infiltration	A.	Continuous Permeable Pavement systems are excavated areas filled with gravel and paved over	<b>^</b>
in Harvesting			with a porous concrete or asphalt mix.	
<u>sin Gardens</u> reen Roofs	RECHARGE DED		Modular Block systems are similar except that permeable block pavers are used instead.	ш
reet Planters		Y GRADED	Normally all rainfall will immediately pass through	
filtration Basins	UNCOMPACTED STORE	TH BPACE	the pavement into the gravel storage layer below it	les i fi
ermeable Pavemen	PALTER PARALLE	HARGE Store	where it can infiltrate at natural rates into the site's native soil.	
sign Storm for Siz ches) (see Help)		4 A	Pavement layers are usually 4 to 6 inches in height	÷
ick a practice to cu	Pavement Thickness (inches)	6		Laborat .
ifv cost-estimation Project is <u>Re-De</u>	Gravel Layer Thickness (inches)	18		
Project is <u>New E</u>	% Capture Ratio	100		
Site Suitability -	Has Pre-treatment		4//////////////////////////////////////	
) Site Suitability - ) Site Suitability -				
ost Region Cinci			Learn more	
gional Multiplier				-
lp	Size for Design Storm Resto	re Defaults	Accept Cancel	
n LID practices to cap	ture runoff from impervious areas.		Analyze a New Site Save Current	Site Exit

### Site Suitability

- Physical Obstructions
- Utility Conflicts
- Ease of Access

#### Impacts

- Construction Cost
- Maintenance Cost

National Stormwate	er Calculator
Overview Location	LID Design
What % of your site's will be treated by the practices? <u>Disconnection</u>	Moderate Site Suitability Site suitability is a measure of construction feasibility and includes factors such as topography, soil type, slope, and other physical features that might result in higher implementation costs.
Rain Harvesting Rain Gardens Green Roofs Street Planters	Moderate site suitability refers to sites that have several of the following characteristics:       .         .       Few physical obstructions         .       Few utility conflicts,         .       Other features that may make construction of stormwater management infrastructure challenging and likely more costly, but less than a site with poor site suitability.
Infiltration Basins Permeable Pavemen Design Storm for Siz (inches) (see Help)	Parking closures
Click a practice to cu Verify cost-estimatio Project is <u>Re-De</u>	Few physical Underground utilities present
<ul> <li>Project is <u>New C</u></li> <li>Site Suitability -</li> <li>Site Suitability -</li> <li>Site Suitability -</li> </ul>	Sites determined to have moderate suitability for LID practices may result in higher costs because of the potential need for additional excavation, accommodation for physical obstructions including utilities, required retaining walls, moderately challenging access, limited dewater, the addition of engineered or custom media blends, or need to address geotechnical or groundwater concerns. Selecting "Site Suitability - Moderate" on the "LID Controls" tab of the National Stormwater Calculator influences the site
Cost Region Cinci Regional Multiplier	complexity, and may shift the costs towards a higher complexity cost estimation compared to.
Help	whether complex, typical, or simple cost curves apply. See User Guide for more information.
Assign LID practices to	capture runoff from impervious areas. <u>Analyze a New Site</u> <u>Save Current Site</u> <u>Exit</u>

#### Select cost region

#### Impacts

- Construction Cost
- Maintenance Cost

#### National Stormwater Calculator

Overview Location Soil Type Soil Drainage Topography Precipitation Evaporation Climate Change Land Cover LID Controls Results

What % of your site's impe will be treated by the follow practices?		5		rge Issad Pl		Conversion of the second
<u>Disconnection</u>	0	Ter.	13	T. Dr		1
Rain Harvesting	0	P ball				
Rain Gardens	0		160 ×	- FOR		No.
Green Roofs	0					-
Street Planters	12	5-L		J. R.	ELU	
Infiltration Basins	0	1.11	To The second	Grand	Ave	A COLOR
Permeable Pavement	0		ing . F me	16		N.
Design Storm for Sizing (inches) (see Help)	3.74				ollege D	
Click a practice to customiz	ze its design.	SE		College Pl		3005- 3005-
Verify cost-estimation varia	bles below			Conege n		11.
Project is <u>Re-Developm</u>	nent	AND A Y	E. F			143 and
Project is <u>New Develop</u>	oment					-
Site Suitability - Poor				NI		
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Site Suitability - Excelle		The second se	12:	K-A-		en
Banianal Mult Cincinnati (	4 miles) 1.07 👻 94 miles) 1.07 26 miles) 0.94		J. J	at See		
Cieveland (1	165 miles) 1.09 (NA) 1.03	<b>b</b> Bing	21.	E Sessions	Ave	
Assign LID practices to captu	re runoff from im	pervious areas.				

Analyze a New Site Save Current Site Exit

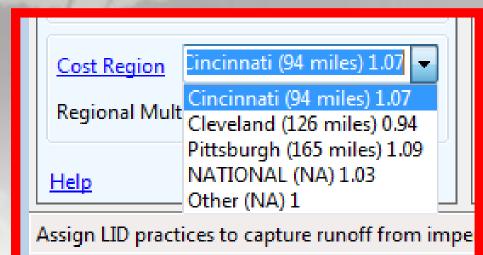
#### Select cost region

#### Impacts

- Construction Cost
- Maintenance Cost



#### Select cost region



#### National Stormwater Calculator

Overview Location Soil Type Soil Drainage Topography Precipitation Evaporation Climate Change Land Cover LID Controls Results

Disconnection	<u>n</u>	0	A.V
Rain Harvestir	ng	0	*
Rain Gardens		0	A
Green Roofs		0	*
Street Planter	<u>s</u>	12	(A)
Infiltration Ba	sins	0	*
Permeable Pa	vement	0	*
Design Storm (inches) (see l		3.74	×
Click a practio	ce to customi	ze its desigi	n.
/erify cost-est Project is	imation varia <u>Re-Developr</u>	bles below nent	n.
Click a practic /erify cost-est Project is Project is Site Suital	imation varia <u>Re-Developr</u> <u>New Develop</u> bility - <u>Poor</u>	bles below nent pment	n.
erify cost-est Project is Project is Site Suital Site Suital	imation varia <u>Re-Developr</u> <u>New Develop</u> bility - <u>Poor</u> bility - <u>Mode</u>	bles below nent pment	
<ul> <li>(erify cost-est</li> <li>Project is</li> <li>Project is</li> <li>Site Suital</li> <li>Site Suital</li> </ul>	imation varia <u>Re-Developr</u> <u>New Develop</u> bility - <u>Poor</u> bility - <u>Moder</u>	bles below nent pment rate 4 miles) 1.0	7
/erify cost-est Project is Project is Site Suital	imation varia <u>Re-Developr</u> <u>New Develop</u> bility - <u>Poor</u> bility - <u>Mode</u> <u>incinnati (9</u>	bles below <u>ment</u> <u>pment</u> rate 4 miles) 1.0 94 miles) 1.0	7 ⊽ 94

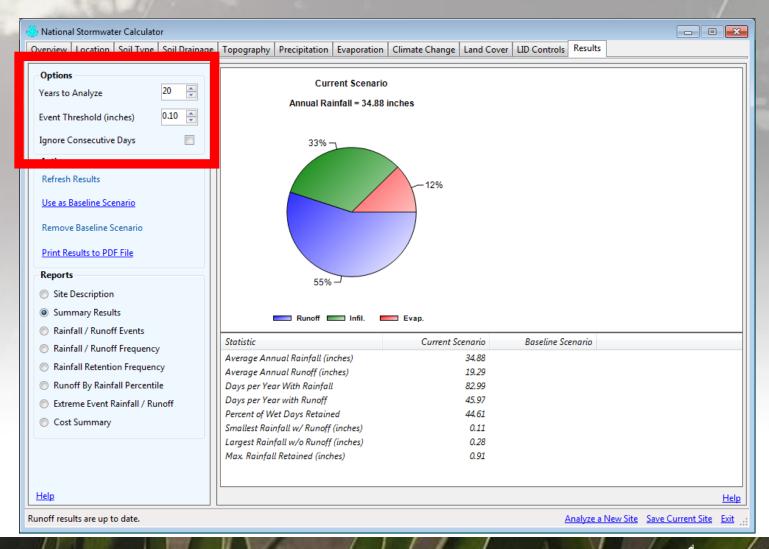


Analyze a New Site Save Current Site Exit

areas.

### **Model Options**

- Select number of years to analyze
- Enter event threshold
- Consecutive Days



# Compare multiple scenarios at once

#### Reports

- Site Description
- Summary Results
- Rainfall / Runoff Events
- Rainfall / Runoff Frequency
- Rainfall Retention Frequency
- Runoff By Rainfall Percentile
- Extreme Event Rainfall / Runoff
- Cost Summary

	age Topography Precipitation Evaporation Clin	nate Change Land Cove	r LID Controls Results	
Options	Current Scenario		Baseline Scenar	io
Years to Analyze 20 🚔	Annual Rainfall = 36.16 inche		Annual Rainfall = 36.1	
Event Threshold (inches) 0.10		:5	Annual Kaimaii – 50.10	sinches
Ignore Consecutive Days				
Actions			63% -	
Refresh Results		\ \		
Use as Baseline Scenario	82%	-6%		-7%
Remove Baseline Scenario				
Print Results to PDF File		/13%		
Reports				-30%
Site Description				
Summary Results	📟 Runoff 📼 Infil. 💻 B	wan.	Runoff III.	Evap.
Rainfall / Runoff Events				Evap.
Rainfall / Runoff Frequency	Statistic	Current Scenario	Baseline Scenario	
Rainfall Retention Frequency	Average Annual Rainfall (inches)	36.16	36.16	
Kaintali Ketention Frequency	Average Annual Runoff (inches)	4.66	10.87	
	Days per Year With Rainfall	82.99	82.99	
Runoff By Rainfall Percentile		11.49	32.53	
<ul> <li>Runoff By Rainfall Percentile</li> <li>Extreme Event Rainfall / Runoff</li> </ul>	Days per Year with Runoff	11.45	C0.01	
Extreme Event Rainfall / Runoff	Percent of Wet Days Retained	86.15	60.81	
			0.21	
Extreme Event Rainfall / Runoff	Percent of Wet Days Retained	86.15		
Extreme Event Rainfall / Runoff	Percent of Wet Days Retained Smallest Rainfall w/ Runoff (inches)	86.15 0.29	0.21	

#### Site Description

🐣 National Stormwater Calculator						X
Overview Location Soil Type Soil Drainag	ge Topography Precipitation Evap	ooration Climate Change	Land Cover LID Controls	Results		
Options	Parameter	Current Scenario	Baseline Scenario			*
Years to Analyze 20 🚔	Site Characteristics					_
	Site Area (acres)	2	2			
Event Threshold (inches) 0.10	Hydrologic Soil Group	С	С			
Ignore Consecutive Days	Hydraulic Conductivity (in/hr)	.4	.4			
Actions	Surface Slope (%)	2	2			
	Precip. Data Source	BRYAN 2 SE	BRYAN 2 SE			
Refresh Results	Evap. Data Source	DEFIANCE	DEFIANCE			
Use as Baseline Scenario	Climate Change Scenario	Median/Near Term	Median/Near Term			
	Land Cover					-
Remove Baseline Scenario	% Forest	0	0			
	% Meadow	0	0			
Print Results to PDF File	% Lawn	40	40			
Reports	% Desert	0	0			=
Site Description	% Impervious	60	60			
	LID Controls					-
Summary Results	Disconnection	15/100	6/100			
Rainfall / Runoff Events	Rain Harvesting	0	0			
Rainfall / Runoff Frequency	Rain Gardens	10/5	12/5			
Rainfall Retention Frequency	Green Roofs	0	0			
Runoff By Rainfall Percentile	Street Planters	10/6	0			
-	Infiltration Basins	0	0			
Extreme Event Rainfall / Runoff	Porous Pavement	50/100	30/100			
Cost Summary	Analysis Options					- 11
	Years Analyzed	20	20			
	Ignore Consecutive Wet Days	False	False			
	Wet Day Threshold (inches)	0.10	0.10			
						*
Help						<u>Help</u>
Runoff results are up to date.			An	alyze a New Site	Save Current Site	Exit

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### Summary

Contract Contraction (See Cyper See See	age Topography Precipitation Evaporation Cli	imate Change   Land Cove	r LID Controls Results	
Options       Years to Analyze       Event Threshold (inches)	Current Scenario Annual Rainfall = 36.16 inch	hes	Baseline Scena Annual Rainfall = 36.1	
Ignore Consecutive Days				
Actions Refresh Results	82%		63%	7%
Use as Baseline Scenario Remove Baseline Scenario		-6%		
Print Results to PDF File		-13%		
Demoste				-30%
Reports				
Site Description	Runoff 📼 Infil. 💻	Evap.	Runoff 💻 Infil.	Evap.
Site Description				
<ul> <li>Site Description</li> <li>Summary Results</li> </ul>	Statistic	Current Scenario	Baseline Scenario	
<ul> <li>Site Description</li> <li>Summary Results</li> <li>Rainfall / Runoff Events</li> <li>Rainfall / Runoff Frequency</li> </ul>	Statistic Average Annual Rainfall (inches)	Current Scenario 36.16	Baseline Scenario 36.16	
<ul> <li>Site Description</li> <li>Summary Results</li> <li>Rainfall / Runoff Events</li> <li>Rainfall / Runoff Frequency</li> <li>Rainfall Retention Frequency</li> </ul>	Statistic Average Annual Rainfall (inches) Average Annual Runoff (inches)	Current Scenario 36.16 4.66	Baseline Scenario 36.16 10.87	
<ul> <li>Site Description</li> <li>Summary Results</li> <li>Rainfall / Runoff Events</li> <li>Rainfall / Runoff Frequency</li> <li>Rainfall Retention Frequency</li> </ul>	Statistic Average Annual Rainfall (inches) Average Annual Runoff (inches) Days per Year With Rainfall	Current Scenario 36.16 4.66 82.99	Baseline Scenario 36.16 10.87 82.99	
<ul> <li>Site Description</li> <li>Summary Results</li> <li>Rainfall / Runoff Events</li> <li>Rainfall / Runoff Frequency</li> <li>Rainfall Retention Frequency</li> <li>Runoff By Rainfall Percentile</li> </ul>	Statistic Average Annual Rainfall (inches) Average Annual Runoff (inches) Days per Year With Rainfall Days per Year with Runoff	Current Scenario 36.16 4.66 82.99 11.49	Baseline Scenario 36.16 10.87 82.99 32.53	
<ul> <li>Site Description</li> <li>Summary Results</li> <li>Rainfall / Runoff Events</li> <li>Rainfall / Runoff Frequency</li> <li>Rainfall Retention Frequency</li> <li>Runoff By Rainfall Percentile</li> <li>Extreme Event Rainfall / Runoff</li> </ul>	Statistic Average Annual Rainfall (inches) Average Annual Runoff (inches) Days per Year With Rainfall Days per Year with Runoff Percent of Wet Days Retained	Current Scenario 36.16 4.66 82.99 11.49 86.15	Baseline Scenario 36.16 10.87 82.99 32.53 60.81	
<ul> <li>Site Description</li> <li>Summary Results</li> <li>Rainfall / Runoff Events</li> <li>Rainfall / Runoff Frequency</li> <li>Rainfall Retention Frequency</li> <li>Runoff By Rainfall Percentile</li> <li>Extreme Event Rainfall / Runoff</li> </ul>	Statistic         Average Annual Rainfall (inches)         Average Annual Runoff (inches)         Days per Year With Rainfall         Days per Year with Runoff         Percent of Wet Days Retained         Smallest Rainfall w/ Runoff (inches)	Current Scenario 36.16 4.66 82.99 11.49 86.15 0.29	Baseline Scenario 36.16 10.87 82.99 32.53 60.81 0.21	
<ul> <li>Rainfall / Runoff Frequency</li> <li>Rainfall Retention Frequency</li> <li>Runoff By Rainfall Percentile</li> </ul>	Statistic         Average Annual Rainfall (inches)         Average Annual Runoff (inches)         Days per Year With Rainfall         Days per Year with Runoff         Percent of Wet Days Retained         Smallest Rainfall w/ Runoff (inches)         Largest Rainfall w/o Runoff (inches)	Current Scenario 36.16 4.66 82.99 11.49 86.15 0.29 0.94	Baseline Scenario 36.16 10.87 82.99 32.53 60.81 0.21 0.42	
<ul> <li>Site Description</li> <li>Summary Results</li> <li>Rainfall / Runoff Events</li> <li>Rainfall / Runoff Frequency</li> <li>Rainfall Retention Frequency</li> <li>Runoff By Rainfall Percentile</li> <li>Extreme Event Rainfall / Runoff</li> </ul>	Statistic         Average Annual Rainfall (inches)         Average Annual Runoff (inches)         Days per Year With Rainfall         Days per Year with Runoff         Percent of Wet Days Retained         Smallest Rainfall w/ Runoff (inches)	Current Scenario 36.16 4.66 82.99 11.49 86.15 0.29	Baseline Scenario 36.16 10.87 82.99 32.53 60.81 0.21	
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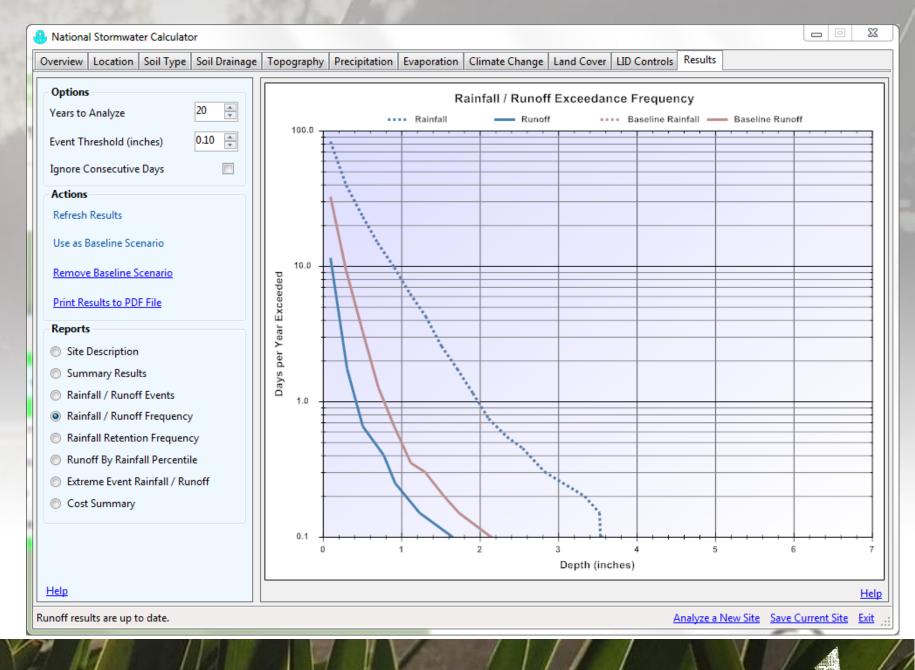
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#### Rainfall / Runoff **Events**

🐣 National Stormwater Calculator	_				
Overview Location Soil Type Soil Drainage	Topography	Precipitation Evaporation Climate	Change Land Cover LID Cor	ntrols Results	,
Options Years to Analyze 20			Rainfall / Runoff Events <sup>Current Scenario</sup> 🗖 Baseli	ne Scenario	
Event Threshold (inches)	3.5				
Ignore Consecutive Days					1
Actions Refresh Results	3.0			0	-
Use as Baseline Scenario	2.5				
Remove Baseline Scenario	() () () () () () () () () () () () () (				
Print Results to PDF File	Daily Runoff (inches)				
Reports	loff (		•		
Site Description	1.5 -				-
Summary Results     Rainfall / Runoff Events	Daily		e .		-
Rainfall / Runoff Frequency	1.0				
Rainfall Retention Frequency			•••		
Runoff By Rainfall Percentile	0.5				
<ul> <li>Extreme Event Rainfall / Runoff</li> <li>Cost Summary</li> </ul>	0.0		•		
	0.0				
	0	1 2	3 4 Daily Rainfall (inches)		6 7
Help	·				<u>Help</u>
Runoff results are up to date. <u>Analyze a New Site</u> Save Current Site Exit					

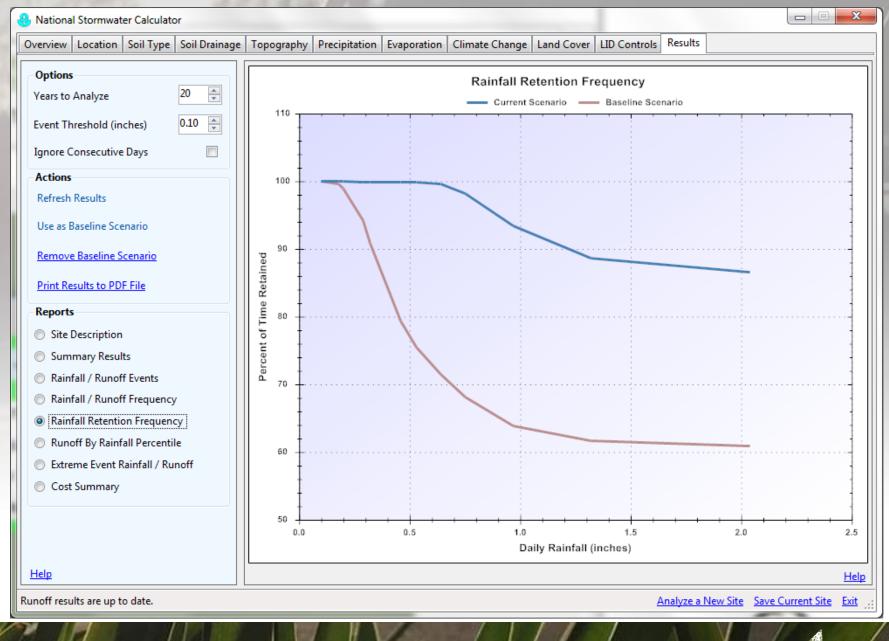
#### Rainfall / Runoff Frequency



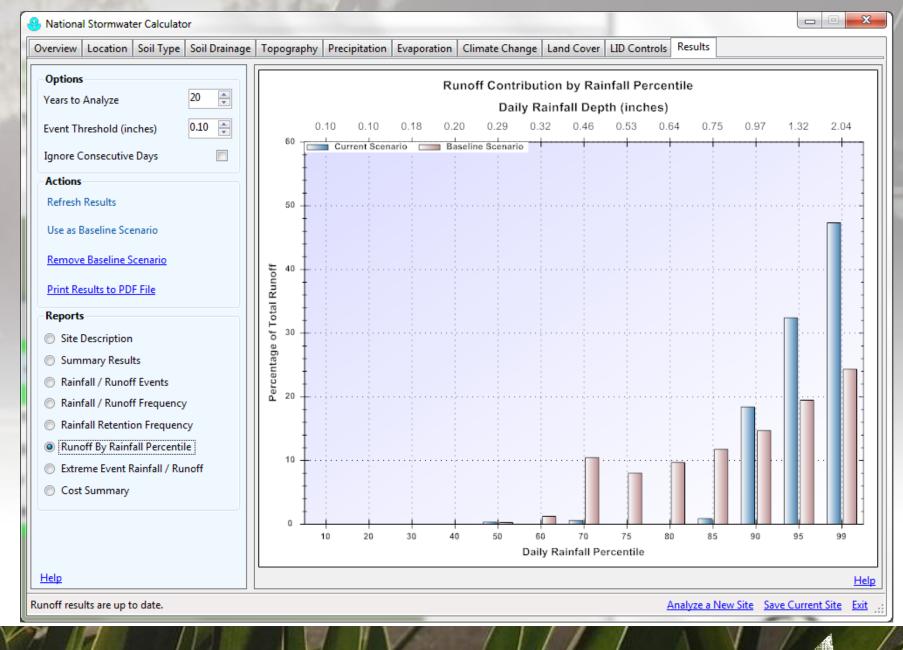
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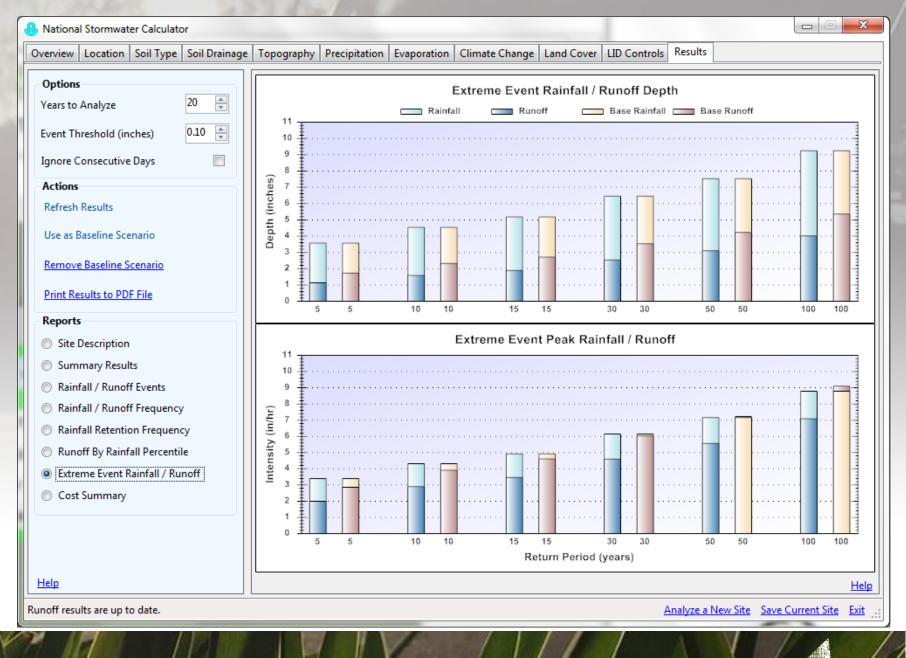
#### Rainfall / Retention Frequency



# Runoff by Rainfall Percentile



#### Extreme Event Rainfall / Runoff



### **Capital Cost** (tabular)

			Soil Drainage	Topography	Precipitation	Evaporation			and Cover LID				
Options Years to			20 🚔		Estin	nate of P	robable	Capita	l Costs (es	stimates	in 2017	US.\$)	
Event Th	reshold (ir	nches)	0.10 🌩				Main	ntenance C	osts   Graphical	<u>View</u>			
Ignore C	onsecutiv	e Days				Drainage	Has Pre-	Current	Scenario (C)	Baseline	Scenario (B)	Differen	ice (C - B)
Actions						Area %	trt?	Area Tre	eated 2.00 ac	Area Trea	ated 2.00 ac	Area Trea	ted 0.00
Refresh	Results			Cost By L	ID Control	Current /	Current /	Low	High	Low	High	Low	High
Hee as P	Baseline Sc	enario		Туре		Baseline	Baseline						
030 03 0	Jasenne Je	chano		Disconne	ction	15/6	No / No	\$89,995	\$106,588	\$38,612	\$45,896	\$51,383	\$60,69
Remove	e Baseline S	Scenario		Rainwate	<sup>r</sup> Harvesting	NA / NA	No / No	\$0	\$0	\$0	\$0	\$0	\$0
Print Results to PDF File		Rain Gard	ens	10/12	No / No	\$14,010	\$18,506	\$14,509	\$19,177	-\$499	-\$671		
Print Ke	SUITS TO PL	<u>r rile</u>		Green Ro	ofs	NA / NA	No / No	\$0	\$0	\$0	\$0	\$0	\$0
Reports				Street Pla	nters	10 / NA	No / No	\$22,417	\$31,337	\$0	\$0	\$22,417	\$31,33
🔘 Site l	Descriptior	n		Infiltratio	n Basins	NA / NA	No / No	\$0	\$0	\$0	\$0	\$0	\$0
Sum	mary Resu	lts		Permeabl	e Pavement	50 / 30	No / No	\$396,75	5 \$476,384	\$239,770	\$287,994	\$156,985	\$188,3
	fall / Runo			Total		85 / 48	Varies	\$523,17	7 \$632,816	\$292,891	\$353,067	\$230,286	\$279,7
-		ff Frequency	,	Note: site co	mplexity variable	s that affect cos	t shown below	:					
Raint	fall Retenti	on Frequen	cy			Currer	nt Scenario			Baselin	e Scenario		
Runo	off By Rain	fall Percenti	le	Dev. Type Re-development			Re-development						
	-	Rainfall / Ru		Site Suitability Moderate				Moderate					
<u> </u>				Topography Flat (2% Slope)				Flat (2% Slope)					
Cost Summary			Soil Type C Cost Region Cincinnati (94 miles) 1.07					C					
					Cost R	egion Cincini	nati (94 mile	s) 1.07		Cincinn	iati (94 miles)	1.07	
Help													

Runoff results are up to date.

🐣 National Stormwater Calculator

Analyze a New Site Save Current Site Exit

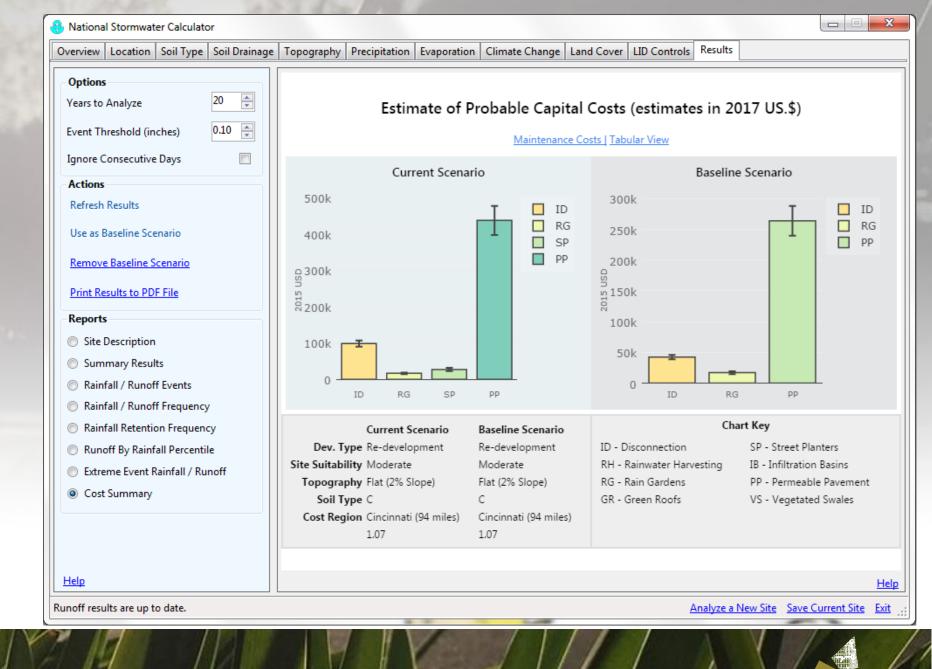
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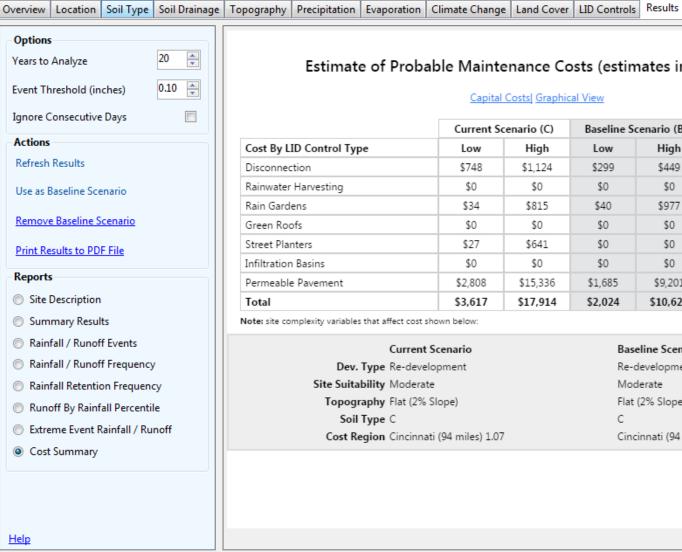
Capital Cost (graphical)



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### Maintenance Cost (tabular)



Runoff results are up to date.

🐣 National Stormwater Calculator

Estimate of Probable Maintenance Costs (estimates in 2017 US.\$)

#### Capital Costs| Graphical View

	Current Scenario (C)		Baseline Scenario (B)		Difference (C - B)	
Cost By LID Control Type	Low	High	Low	High	Low	High
Disconnection	\$748	\$1,124	\$299	\$449	\$449	\$674
Rainwater Harvesting	\$0	\$0	\$0	\$0	\$0	\$0
Rain Gardens	\$34	\$815	\$40	\$977	-\$7	-\$163
Green Roofs	\$0	\$0	\$0	\$0	\$0	\$0
Street Planters	\$27	\$641	\$0	\$0	\$27	\$641
Infiltration Basins	\$0	\$0	\$0	\$0	\$0	\$0
Permeable Pavement	\$2,808	\$15,336	\$1,685	\$9,201	\$1,123	\$6,134
Total	\$3,617	\$17,914	\$2,024	\$10,628	\$1,592	\$7,286

	Current Scenario
Dev. Type	Re-development
Site Suitability	Moderate
Topography	Flat (2% Slope)
Soil Type	C
Cost Region	Cincinnati (94 miles) 1.07

**Baseline Scenario** Re-development Moderate Flat (2% Slope) С Cincinnati (94 miles) 1.07

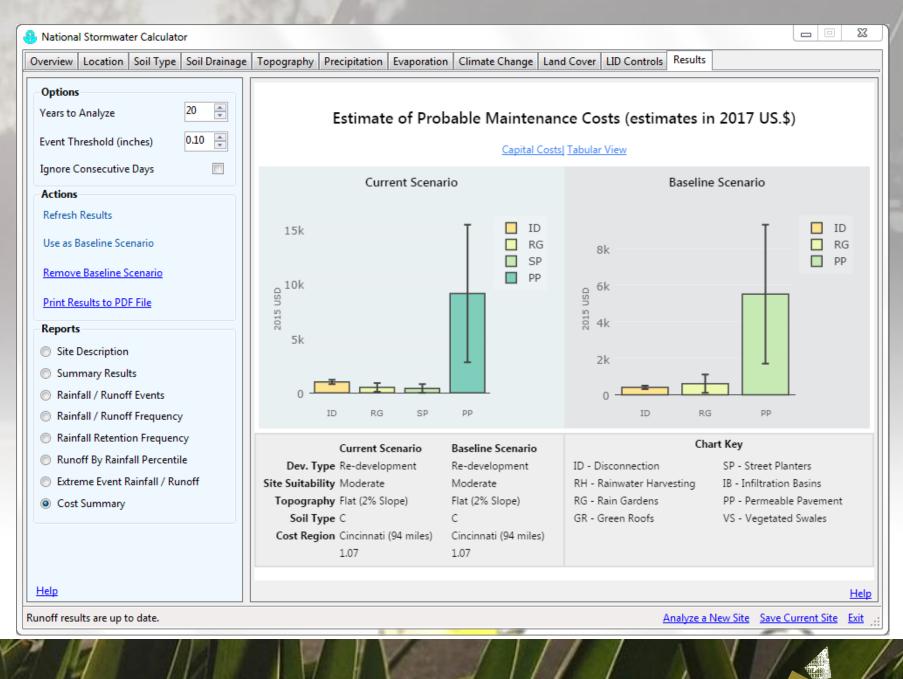
> Analyze a New Site Save Current Site Exit

> > ms

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Help

# Maintenance Cost (graphical)



## **Quantifying Costs**

#### **Traditional Costs**

- Capital Costs
- Maintenance Costs

#### **Indirect Costs**

- R/W Acquisition Costs
- Treatment Plant Costs
- Snow removal
- Water Re-Use
- Energy Savings
- Tax Incentives / Utility Fees

## **Quantifying Costs**

#### **Traditional Costs**

- Capital Costs
- Maintenance Costs

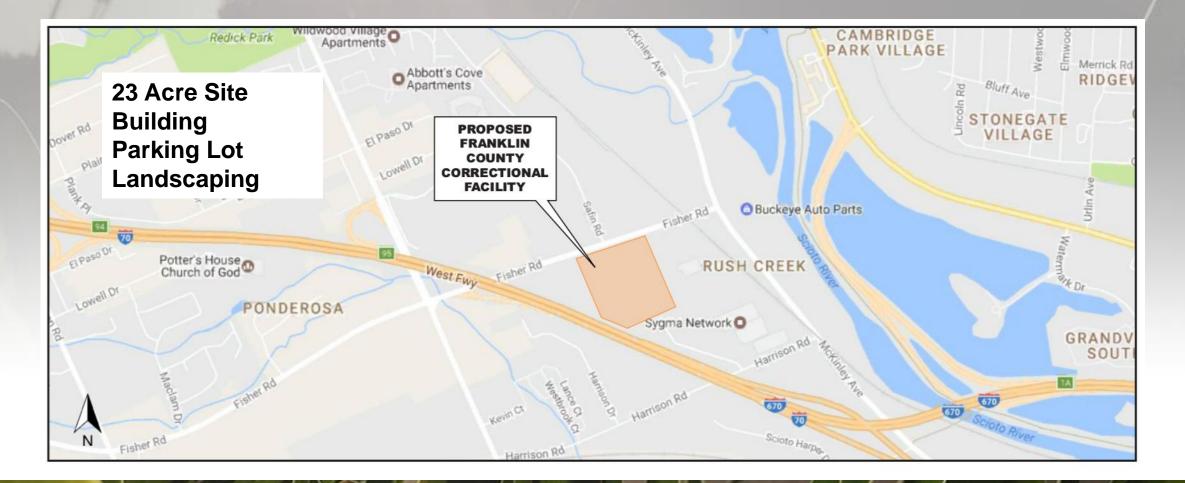
#### **Non-Monetary Costs**

- Air Quality
- Water Quality
- Habitat Quality

#### **Indirect Costs**

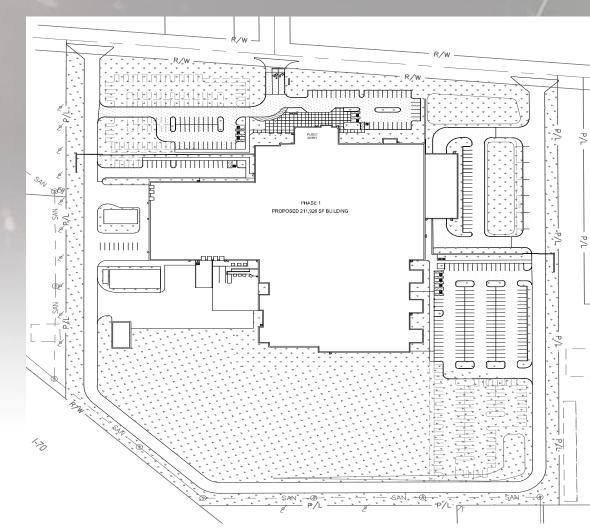
- R/W Acquisition Costs
- Treatment Plant Costs
- Snow removal
- Water Re-Use
- Energy Savings
- Tax Incentives / Utility Fees

### Franklin County Correctional Facility



#### **Traditional Stormwater Gray Infrastructure**

- Asphalt Parking Lot
- Storm Sewer
- Catch Basins
- Detention Basin
- Maintenance (30 Years)

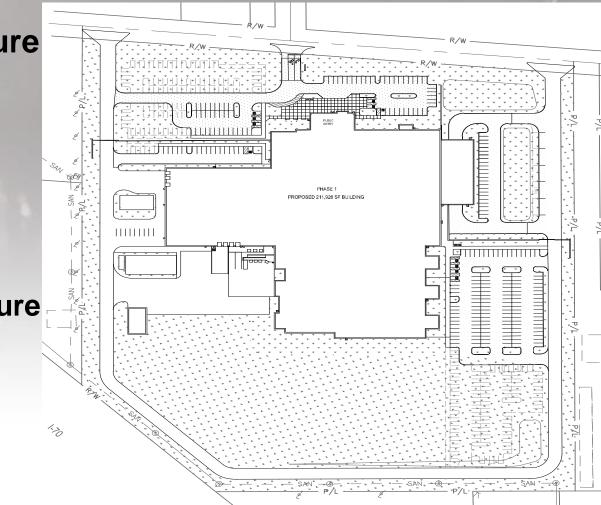


#### **Traditional Stormwater Gray Infrastructure**

- Asphalt Parking Lot
- Storm Sewer
- Catch Basins
- Detention Basin
- Maintenance (30 Years)

#### Low Impact Development Green Infrastructure

- Permeable Pavers
- Storm Sewer
- Catch Basins
- Detention Basin
- Maintenance (30 Years)

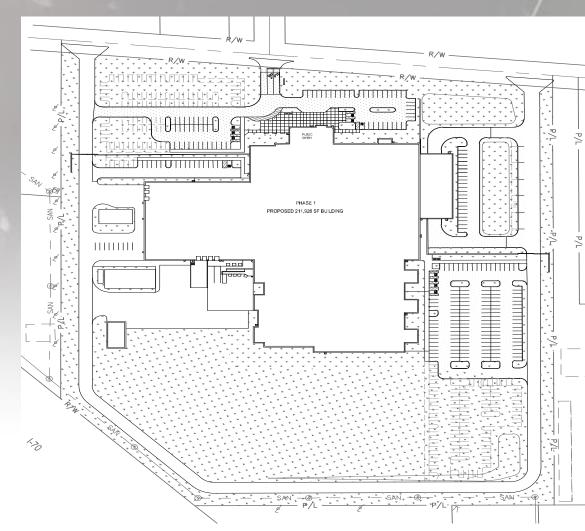


#### Traditional Stormwater Gray Infrastructure

- Capital Cost = \$1,350,000
- Maintenance Cost (30 years) = \$430,000
- Total = \$1,780,000

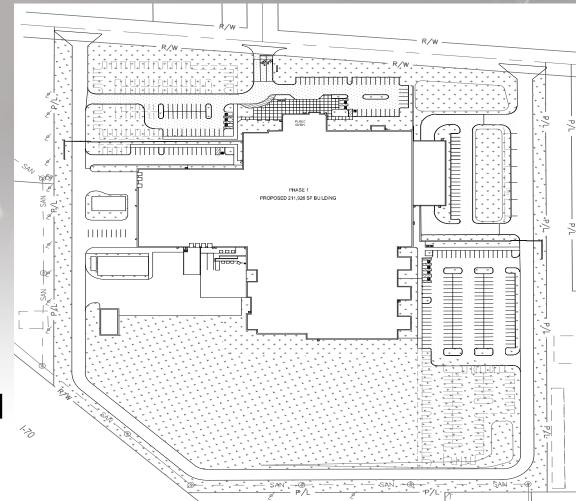
#### Low Impact Development Green Infrastructure

- Capital Cost = \$1,710,000
- Maintenance Cost (30 years) = \$380,000
- Total = \$2,090,000



#### **City of Columbus Stormwater Utility Fee**

- Based on property's contribution to stormwater runoff
- 2,000 SF Impervious Area = 1 ERU (Equivalent Residential Unit)
- 23 Acres Impervious = 500 ERU
- Annual Stormwater Fee = \$27,040
- 30 Year Fee = \$811,200
- GI used to meet all water quantity and quality requirement = 100% credit

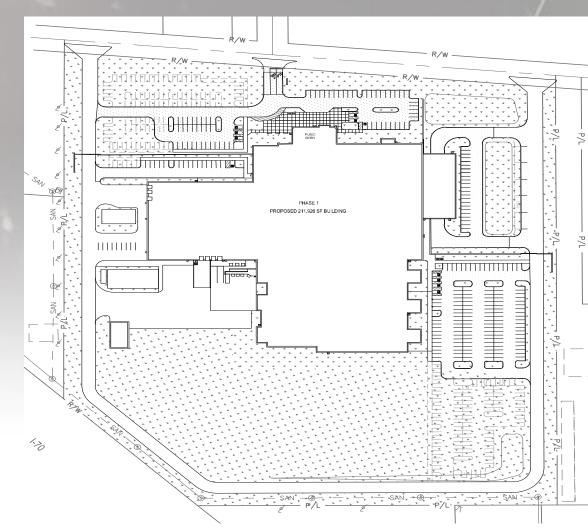


#### Traditional Stormwater Gray Infrastructure

- Capital Cost = \$1,350,000
- Maintenance Cost (30 years) = \$430,000
- Stormwater Fee (30 years) = \$811,000
- Total = \$2,590,000

#### Low Impact Development Green Infrastructure

- Capital Cost = \$1,710,000
- Maintenance Cost (30 years) = \$380,000
- Total = \$2,090,000



### **Questions?**

Justin Kerns ms consultants, inc. 2221 Schrock Rd, Columbus, OH 43229 614-898-7100 jkerns@msconsultants.com