PA DEP Stormwater Manual Updates

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WRAC November 17th 2022

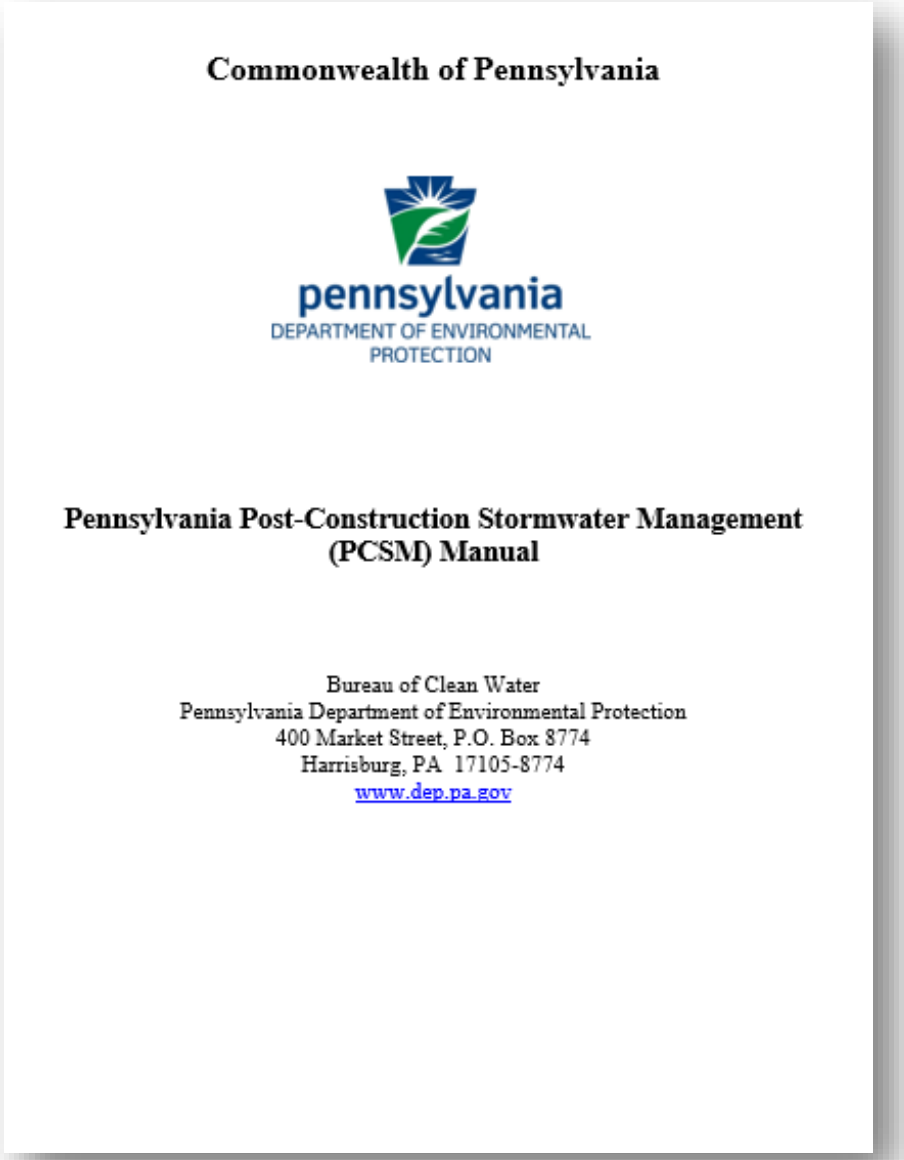
Protect Waters of the Commonwealth

Purpose:

"This guidance establishes standards for the management of stormwater through the implementation of SCMs and other measures to comply with the regulatory requirements under 25 Pa. Code Chapter 102. This guidance may also be used for other purposes where the intent is to design, install, and maintain SCMs."

Overarching Principles

- Better Science at all stages
- Focus on Resilience
- Focus on Agility –
  - Enabling approaches that meet Pa. Code Chapter 102 for difficult sites
  - Enable approaches that can be expected to surpass their design objectives, and / or contribute to other benefits to the community.
  - Embrace simpler but appropriate approaches where appropriate.
- Best science of today with ability to update the Manual


Commonwealth of Pennsylvania

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Pennsylvania Post-Construction Stormwater Management (PCSM) Manual

Bureau of Clean Water
Pennsylvania Department of Environmental Protection
400 Market Street, P.O. Box 8774
Harrisburg, PA 17105-8774
www.dep.pa.gov

How this is addressed

- Acknowledges and Addresses Climate Change
- Right SCM(s) for the job
  - Right design expertise
  - Understanding of site infiltration capabilities
  - Promote resilient, correctly sized SCM tailored to the soil capacity, precipitation patterns and watershed
  - Landowner must be able to maintain
- System Approach
  - Focus on Manage
  - Site Evaluation, Design, Construction, Inspection, Maintenance
- Separate Volume / Water Quality SCM from Rate Control
- Expand Stormwater Analysis Methods

Nothing works when not designed, built, and maintained correctly…

or

when designed, constructed, and maintained correctly we expect it to work

Rochester Times

NEWS & SPORTS OF ROCHESTER, FARMINGTON, MILTON & SURROUNDING TOWNS

U.S. POSTAGE PAID FREE

Rochester Times, Rochester, N.H. Thursday, July 3, 2008 Volume 16 — No. 27

FEMA probe reveals rain caused floods

By JOHN NOLAN

ROCHESTER — The conclusion of a federally-funded, independent evaluation of the floods of May 2006 and April 2007 is in line with what many local residents surmised — that these catastrophic events were caused by prodigious amounts of rain in a relatively short period.

The study, costing $330,000 and funded by the Federal Emergency Management Agency (FEMA), will deliver its final report at the end of July. In the interim, three public information meetings have been held in the state to reveal and discuss initial findings. The most recent gathering was in Spaulding High School auditorium on June 25 and was attended by around 75 residents from around southeast New Hampshire, where the impact of flooding from the Salmon Falls, Cocheco, Isinglass, Lamprey and Oyster rivers and their tributaries was particularly severe. Officials from FEMA, the Department of Environmental Services (DES) and contracted experts were all present in the auditorium, as were members of an independent review committee

GERALD E. GALLOWAY
Brigadier General
(retd.)

Brent McCarthy of Watershed Concepts, one of the two firms contracted to collect and analyze data, explained that both flood events occurred when the ground was already saturated. In 2006, up to 14 inches of rain fell in the Seacoast area in a three-day period, and in 2007, while the rainfall over two days amounted to about eight inches, that situation was exacerbated by snowmelt.

During the latter flood, the highest flows ever recorded by the U.S. Geological Survey occurred on five southern NH rivers, including the Cocheco near Rochester.

One conclusion of the study in the Salmon Falls River basin, is that the presence of dams played no aggravating role in the flooding — had they not been there, the impact would have been virtually the same, the audience was told, although during public comment time, one or two citizens disputed this finding.

In a slide presentation, Milton Three Ponds was calculated, in the April flood, to have had an inflow of 15,700 acre/feet and an outflow of 14,700 acre/feet, confirming that the dam has very little water storage capability. Further downstream toward Rochester, the Spaulding Pond dam has no ability to control flooding. The study has indicated, though, that the installation of a second automated gate at the Three Ponds dam might be a potential improvement.

Arthur Walsh of Salmon Falls Road said that too much attention was given to recreational people coming into New Hampshire and not enough to people who have lived here a while. He opined that if dams were not generating electricity they should be taken out.

"Dams cause floods. Let the water run. Don't stand up there and sell insurance," said Walsh to the FEMA officials, who administer the Flood Insurance program.

Consultant Mark Woodbury of Riverside Technology responded, "If the dams were empty, there would be little or no impact on large storms. It might help with a five or a 10-year storm."

MITIGATING FUTURE FLOODING

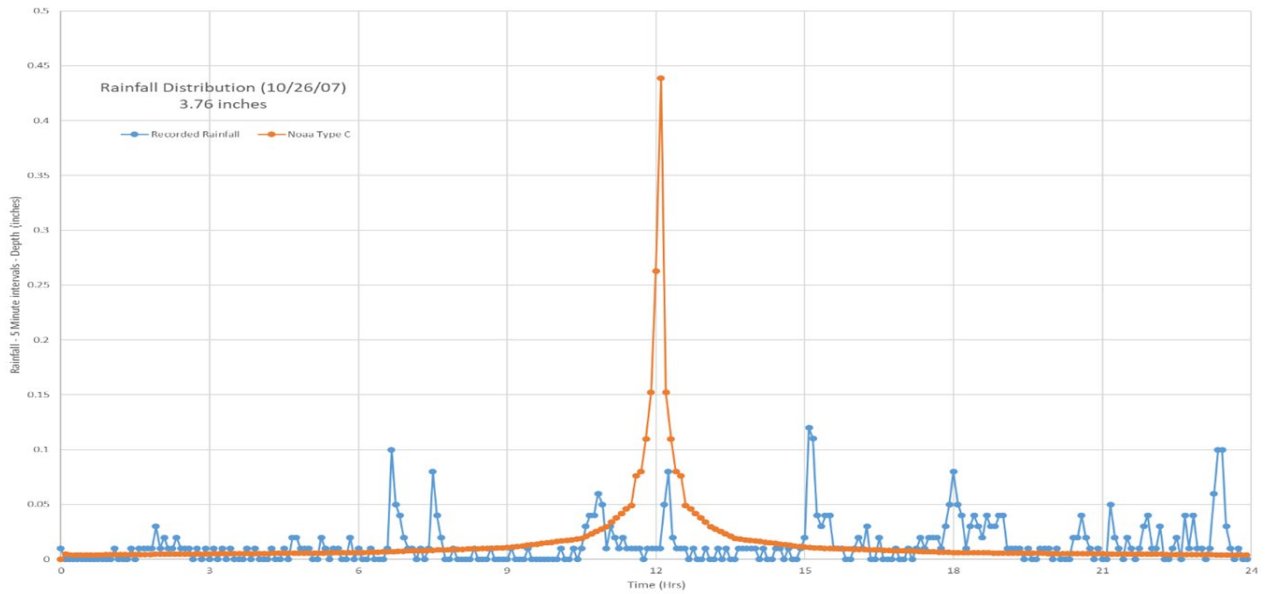
The interim reports recommendations to mitigate the impacts of floods include:

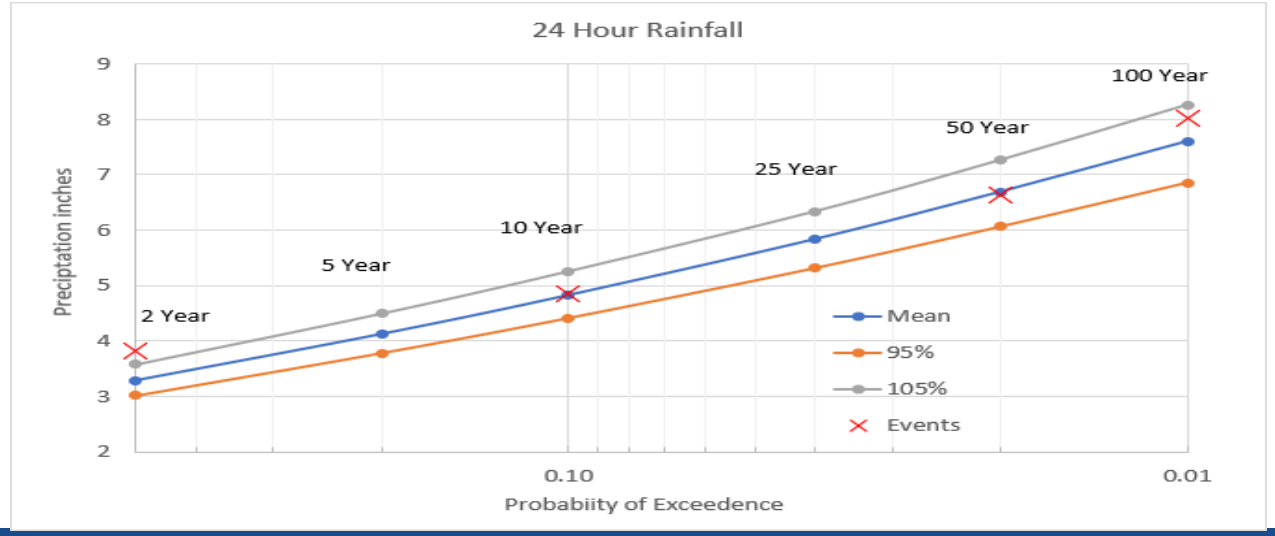
— improving flood plain management by updating mapping that may be 25

FEMA, PAGE A2

Stormwater Analysis Methods

- Volume Management Analysis Methods
  - Design Storm
  - Continuous Simulation
  - Water Balance
- Water Quality Management Analysis Method
  - mass-load based
  - linked to volume method
- Peak Rate Management Analysis Methods
  - Design Storm
  - Storm of Record





General Stormwater Manual Layout

Chapters

- 1: Introduction
- 2: PCSM Requirements
- 3: SCM Technical Guidance

Appendices

- A: Precipitation
- B: Soil Physics, Characterization, and Infiltration Testing
- C: Karst Terrain
- D: Evapotranspiration
- E: Hydrologic Budget and Water Balance
- F: Volume Management Analysis Methods
- G: Water Quality Analysis Methods
- H: Peak Rate Analysis Methods
- I: Vegetation for Use in Stormwater Management
- J: SCM Components and Specifications
- K: Construction Inspection, Operation and Maintenance
- L: Definitions and Acronyms
- M: Errata Sheet

Bringing Better Science to Stormwater Management

- Updated Hydrology to Include Climate Change
- Clarifies that Diverse Professionals are Required
- Establishes PCSM Objectives - CH102.8(b)
- Stipulates Pre-Development Site Analysis
- Includes design guidance for SCMs

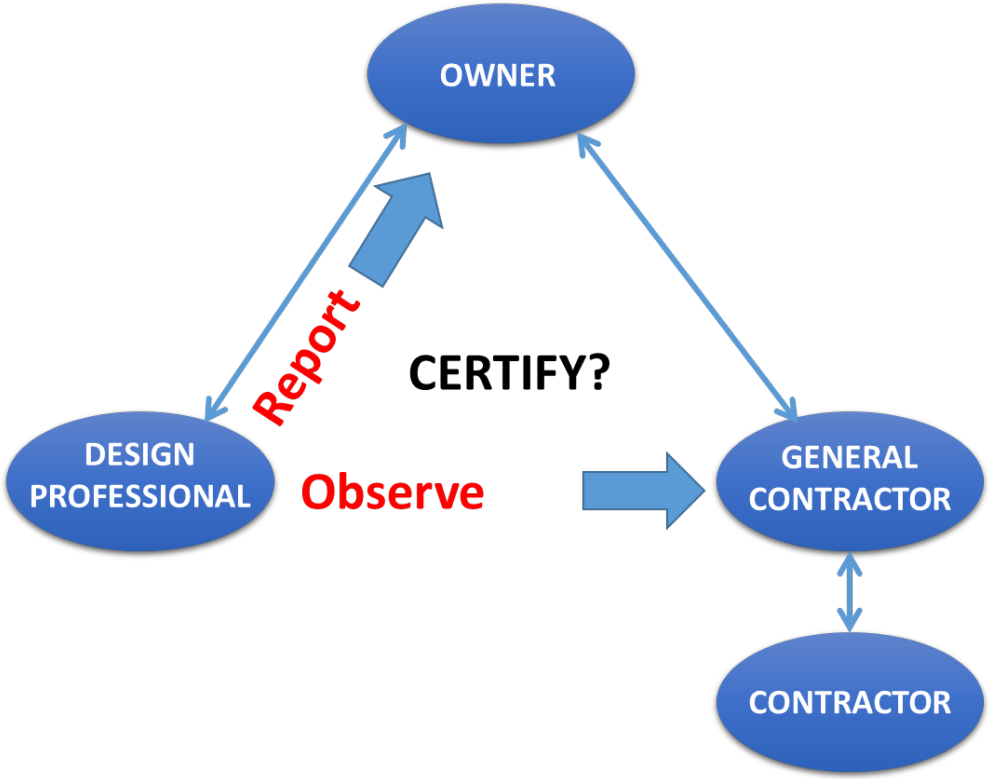
Better Science at All Stages

Engineer, Land Surveyor And Geologist Registration Law
Act of May 23, 1945, P.L. 913, No. 367 Cl. 63

- Design Includes Licensed Professionals

- PCSM Plan Preparer – "*Trained and Experienced*" Chapter 102.8(e)
  - Not required to be a "Licensed Professional."
  - Must engage Licensed Professionals (ACT 367)
    - Professional Engineers – Must oversee computations
    - Land Surveyors
    - Geologists
    - Soil Scientists

- Certain Designs Require Professional Services
  - Karst
  - Infiltration
  - Floodplain Restoration
  - Structural SCMs
  - MRC

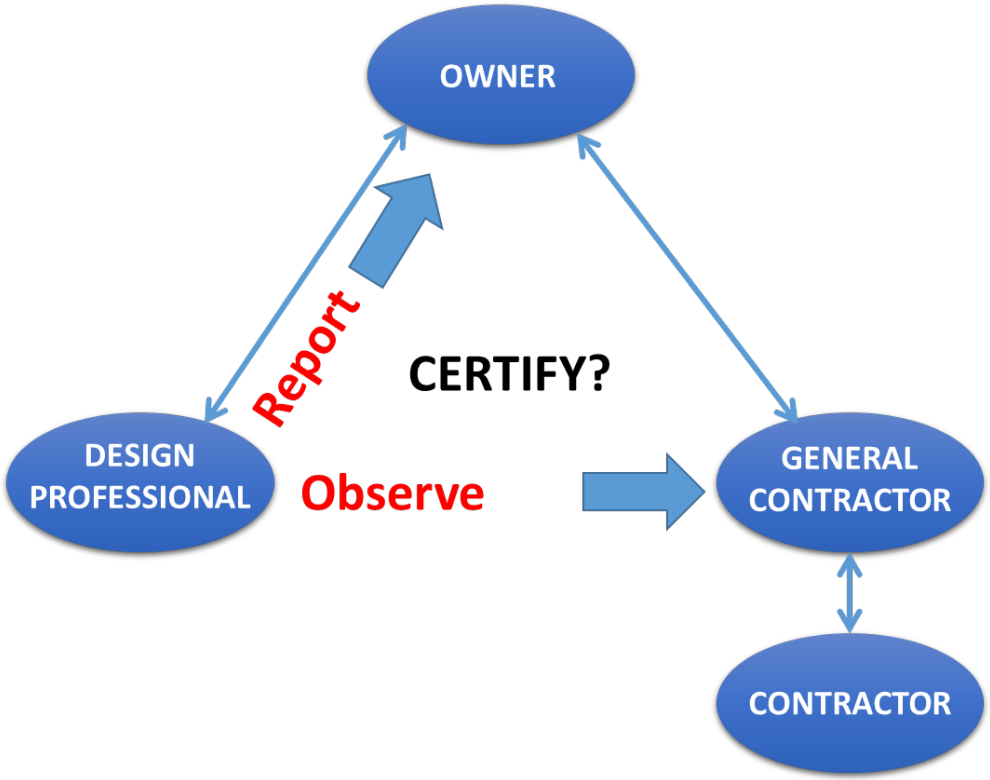


Better Experience at All Stages

- Licensed Professional Oversight of Construction

  The *permittee should enter into an agreement with the licensed professional* that specifies how the licensed professional will act as the permittee's representative and how the owner will assure that the operator addresses any concerns raised by the licensed professional promptly and completely.

- Contractors engaged to construct infiltration SCMs should have verifiable experience in the construction of similar facilities.



Pennsylvania Climate Projections for 2022 to 2050

- 8% increase in annual rainfall
- 14% increase in winter precipitation
- 3.3°C warmer
- More storms >1.2 in of rainfall in 1 day
- Expected increase in intensity and frequency of cloudburst events
- No. of days with >3 in of rainfall is projected to increase:
  - 52% by mid-century
  - 93% by end-of-century

In general: warmer, wetter, and more intense

Pennsylvania Climate Impacts Assessment 2021

Extreme Rainfall Adjustment

- Use 90% confidence level event rainfall depth
  - NOAA Atlas 14 Point Precipitation Frequency Estimates
  - 10% to 20% higher than what is used today
  - Inlet design
- Chesapeake Bay IDF Curves – Rand Corp. 2021
- EPA SWMM Climate Adjustment Tool (SWMM-CAT)

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION

PF tabular | PF graphical | Supplementary information

Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
24-hr	**2.70** (2.50-2.93)	**3.26** (3.01-3.54)	**4.12** (3.80-4.47)	**4.84** (4.45-5.24)	**5.90** (5.40-6.37)	**6.80** (6.18-7.32)	**7.77** (7.03-8.36)	**8.84** (7.93-9.49)	**10.4** (9.22-11.2)	**11.7** (10.3-12.6)

Projected Intensity-Duration-Frequency (IDF) Curve Data Tool for the Chesapeake Bay Watershed and Virginia

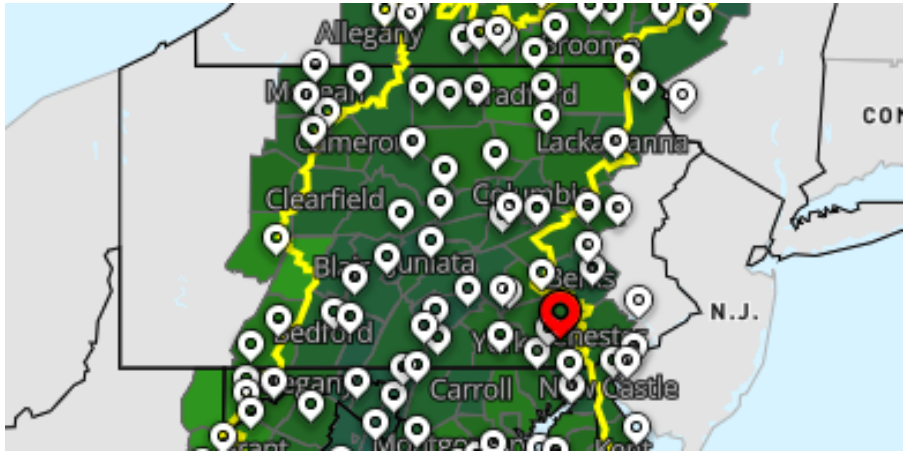
MARISA
a NOAA Mid-Atlantic RISA team

Chesapeake Bay Program
Science. Restoration. Partnership.

Technical Resources | Using the Data | Using the Tool

- Use mean climate-adjusted storm depth

https://midatlantic-idf.rcc-acis.org/



Selection Panel

Return Period: 2-year

Emissions Scenario: High RCP 8.5

Time Period: 2020-2070

Area of Interest: Chesapeake Bay Watershed

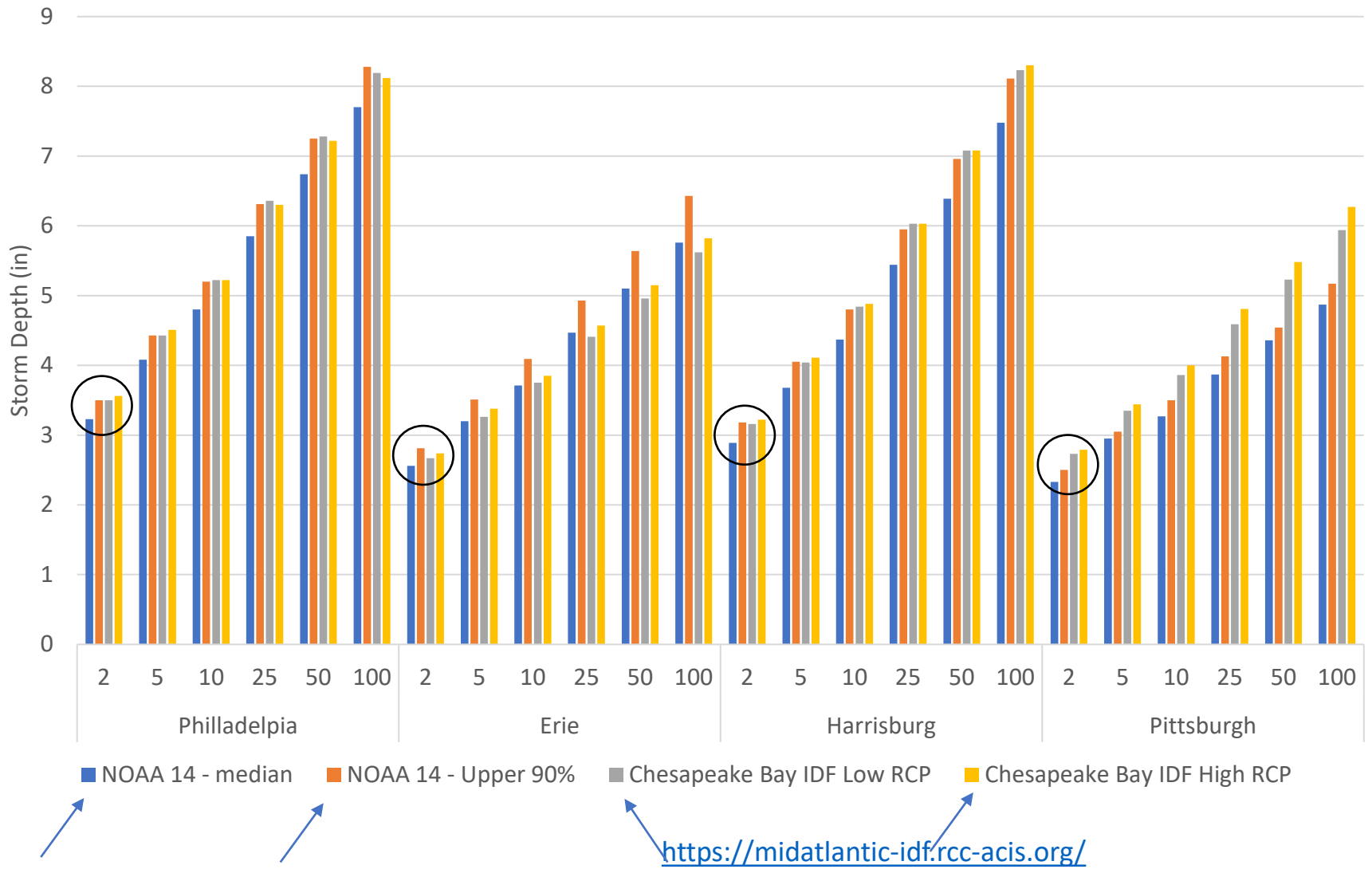
Percentile	10th	25th	Median	75th	90th	
County Change Factors:	1.04	1.06	1.11	1.16	1.22	Atlas 14 Depth (inches)
Duration	Projected 2020-2070 Depth (inches)					
24 hr	3.14	3.20	3.35	3.50	3.68	3.02

Climate Change Incorporation – Design Storm

- NOAA 14 is outdated (no change since 2006)
- **Use upper 90% confidence interval for 2-year/24-hour storm for NOAA**

PDS-based

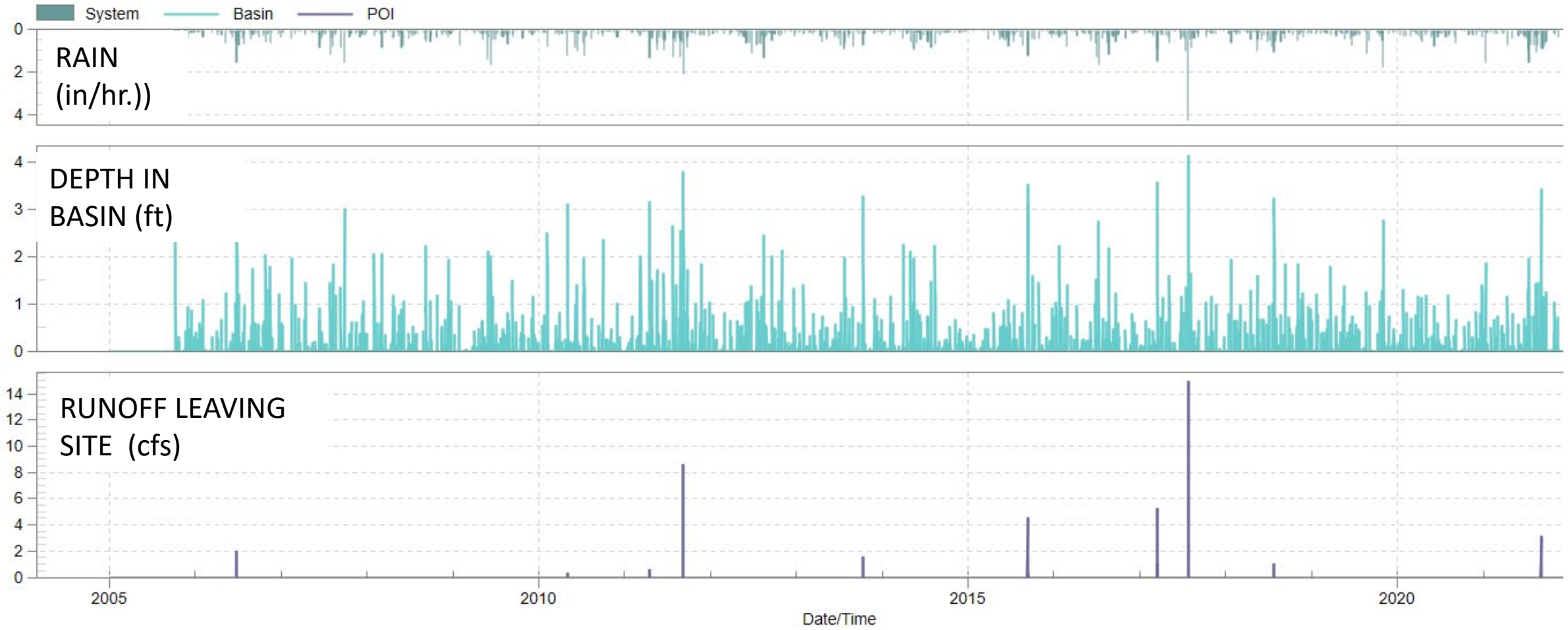
Duration	1	2
5-min	**0.347** (0.320-0.378)	**0.414** (0.380-0.451)
24-hr	**2.70** (2.50-2.93)	**3.26** (3.01-3.54)



https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

https://midatlantic-idf.rcc-acis.org/

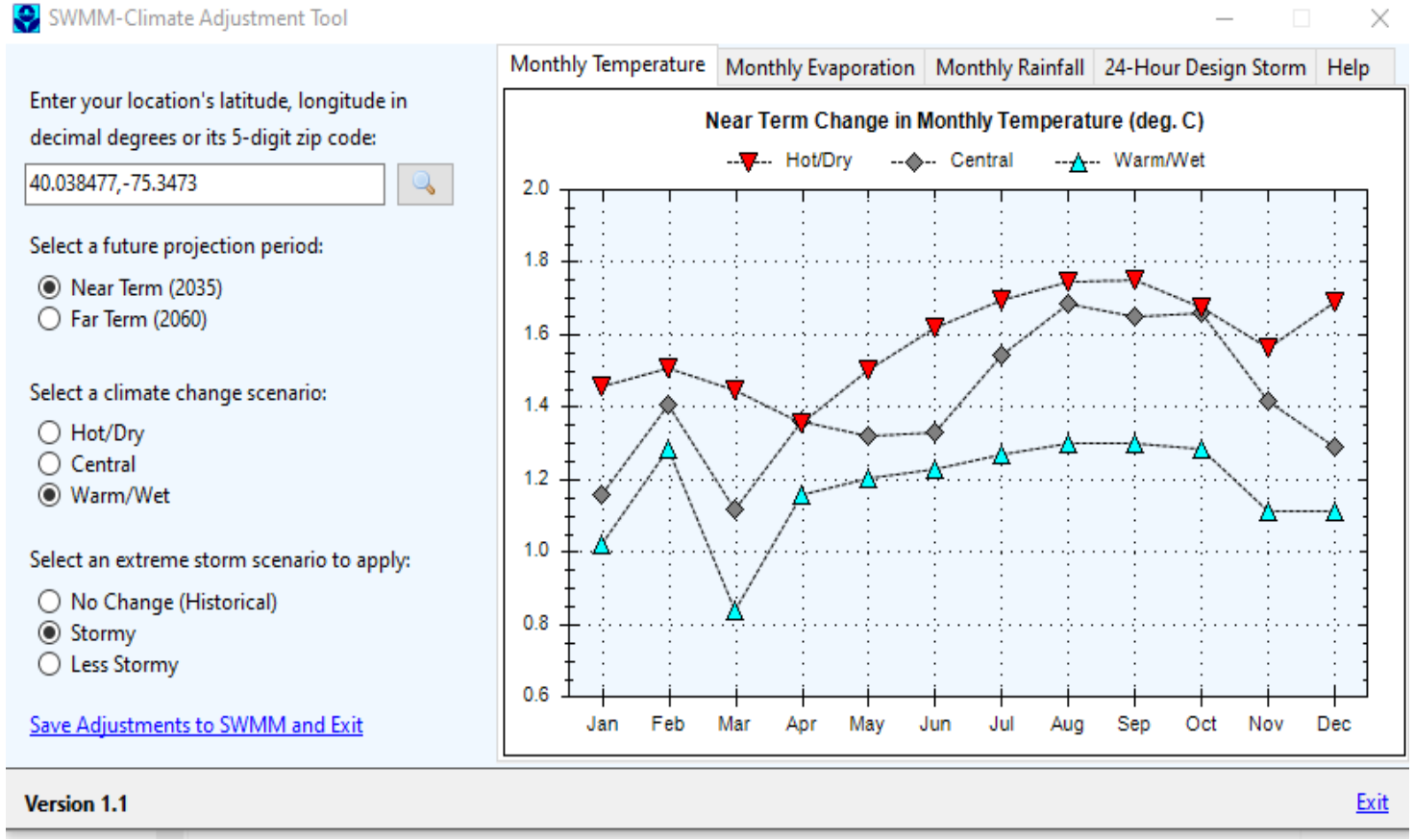
Continuous Simulation Modeling Example



EPA SWMM with Climate Adjustment Tool (SWMM-CAT)

Climate Change Incorporation – Continuous Simulation/Water Balance

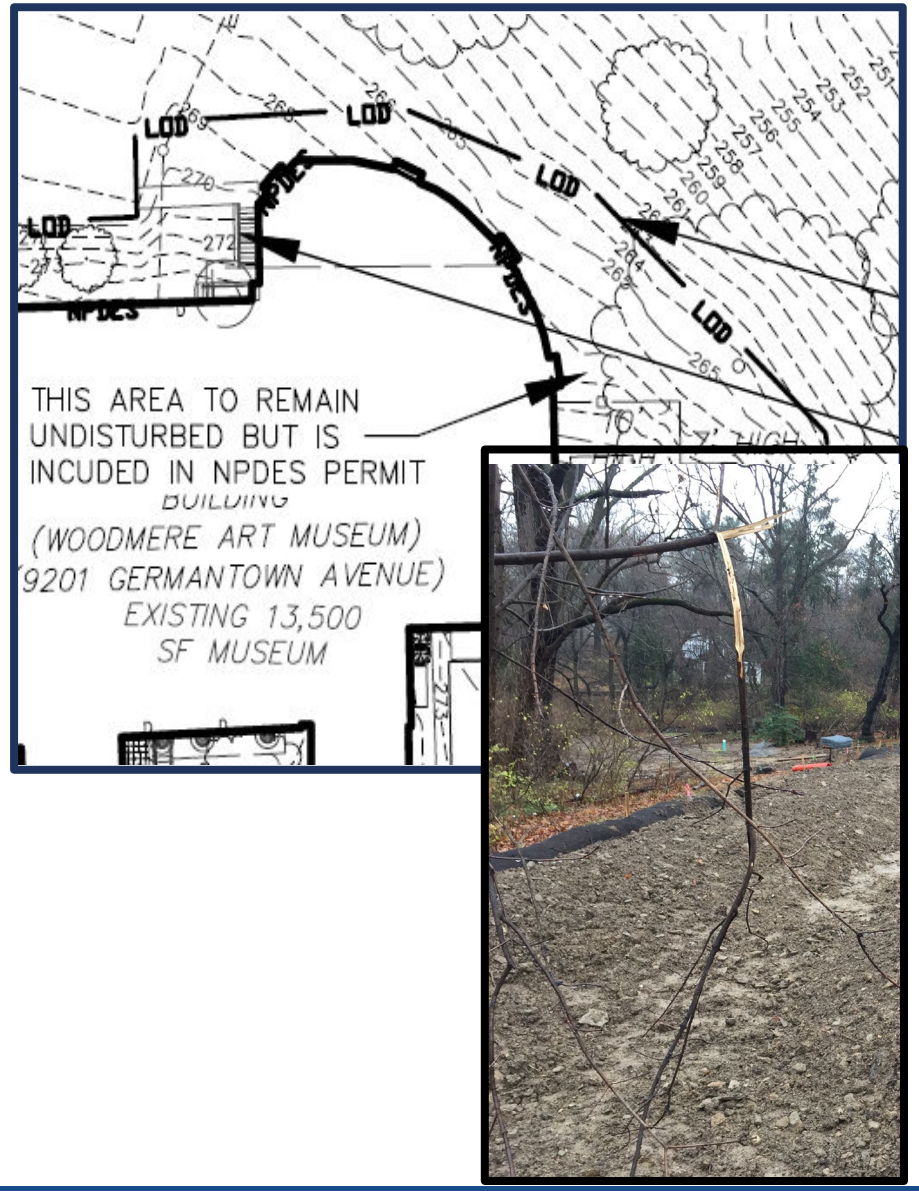
- Long-term climate change record is very difficult to determine and typically location based
- Recommends monthly SWMM CAT 1.1 Adjustments (near term & Warm/Wet) applied to precipitation
- Includes temperature impact on ET and infiltration
- Updated 8/3/2022



Project Site & Limit of Disturbance

- **Project Site (Chapter 102.1)**
  - The entire area of activity, development, or sale including:
    - the area of an earth disturbance activity
    - the area planned for an earth disturbance activity
    - and **other areas which are not subject to an earth disturbance activity**

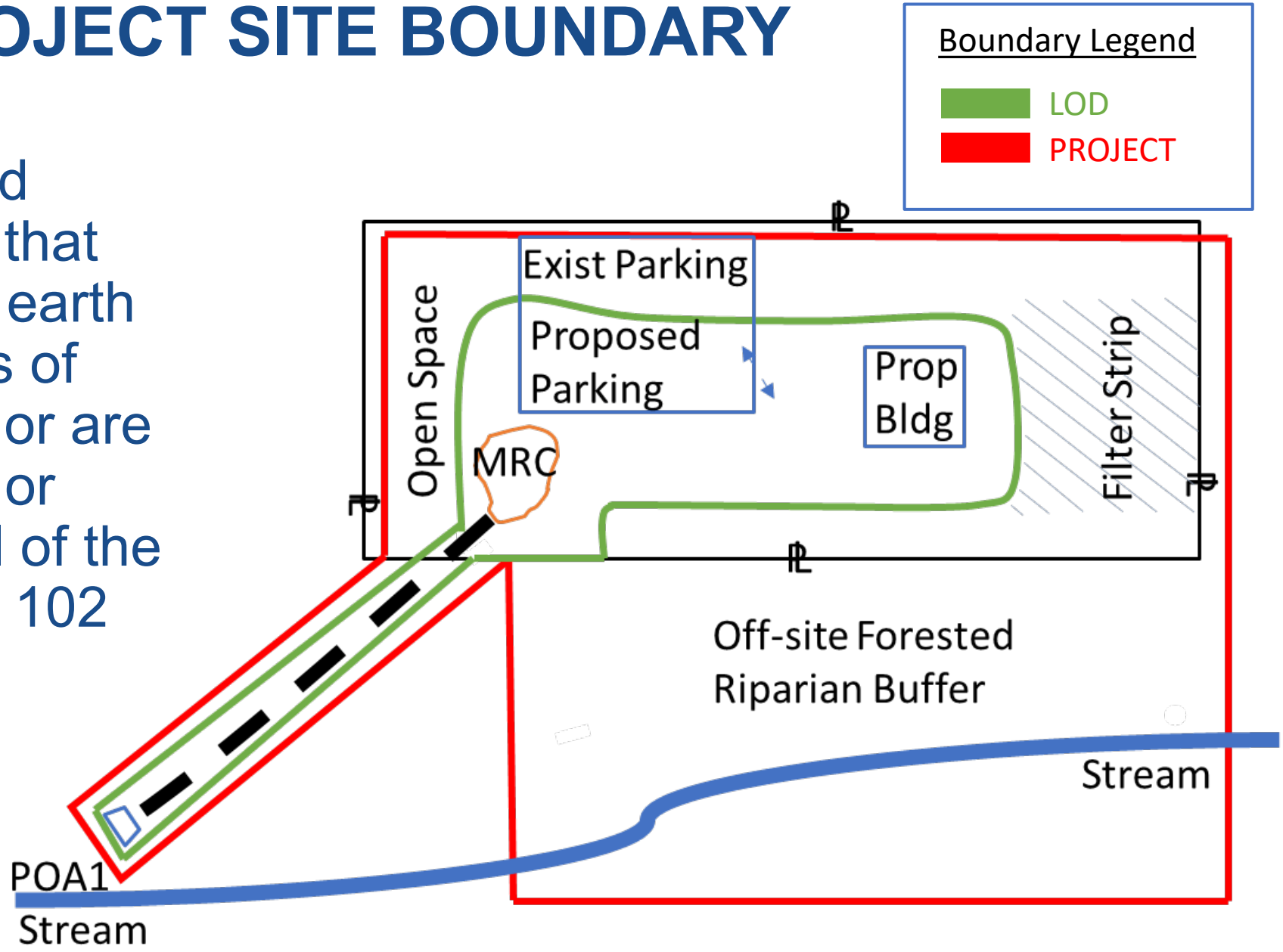
- **Limit of Disturbance (LOD)**
  - The boundary within which it is anticipated that earthmoving, including installation of BMPs, will take place.
  - **Emphasis in new manual is on minimizing land clearing and grading**



PROJECT SITE BOUNDARY

- Must enclose all earth disturbance, SCMs, and conveyances to SCMs that manage runoff from all earth disturbance, regardless of whether the SCMs are or are not on property owned or under the direct control of the applicant for a Chapter 102 permit.

Natural Landscape SCMs in Boundary



Pre-Development Site Characterization

- Examine: Hydrology, Geology, Soils, Plants, Protected Species, Natural Landscapes, Surface Waters, Environmental Hazards

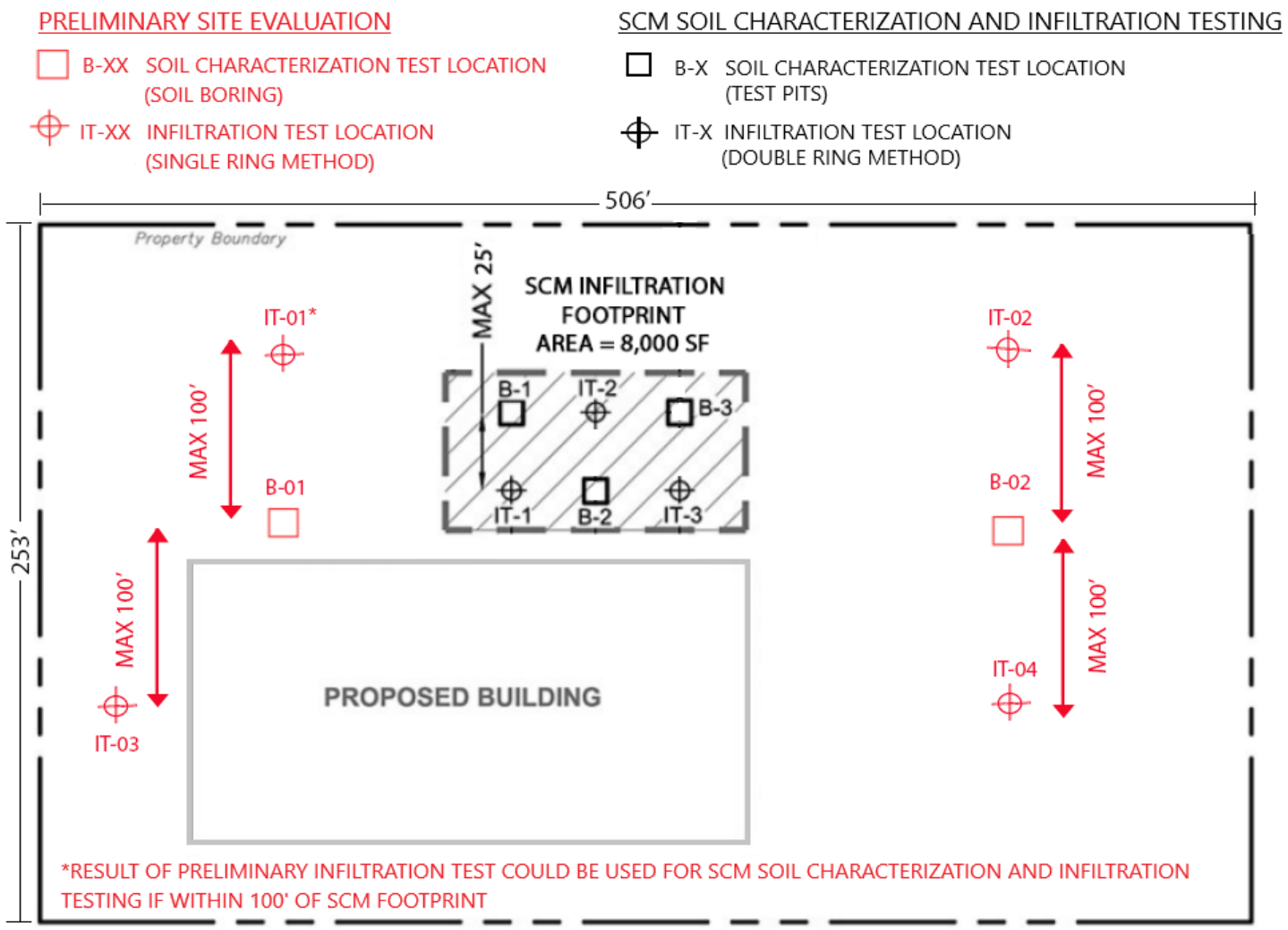
- Preliminary infiltration testing needed for entire site
  - One test for every 40,000 square feet
  - Geologic and Soils information needed
  - Groundwater information needed

- Identify areas that “Protect Surface Waters”
  - Riparian Buffers
  - Natural Landscape

Infiltration Testing & Soil Characterization

Testing for infiltration capacity and Soil characterization is required during:

- Preliminary Site Evaluation
- SCM-Specific



Infiltration Testing Requirements

Can use:

- Double Ring Infiltrometer Method
- Single Ring (Modified Philip-Dunne and Dual-Head Infiltrometers)
- Case Borehole (If conditions render the excavation of test pits impractical, due to existing structures, utilities, space constraints, depth of test, etc.)

Criteria	Number of tests required per infiltration test type		
	Double Ring	Single Ring	Cased Borehole
Minimum number of Tests for each SCM	5 tests	8 tests	8 tests
Or the following if more conservative	1 test per 4,350 square feet	1 test per 2,900 square feet	1 test per 2,900 square feet

Confirmation Testing for Infiltration Capacity

Construction confirmation testing for infiltration capacity is…	For…
Required	Infiltration SCMs where the contractor does not meet the experience criteria (constructed at least 3 successful infiltration SCMs in the past 2 years).
	All infiltration SCMs that have been converted from an E&S sediment trap or basin (regardless of contractor experience).
Waived when all of these criteria are satisfied	Infiltration SCMs that have not been converted from an E&S sediment trap or basin; and
	The contractor meets the experience criteria (constructed at least 3 successful infiltration SCMs in the past 2 years); and
	The permittee enters into an agreement with a licensed professional to regularly report to the permittee, and the permittee regularly enforces the recommendations of the licensed professional.
Highly recommended/considered good engineering practice	Infiltration SCMs where there is concern of compaction during construction.
	Infiltration SCMs overlying soils with a saturated hydraulic conductivity of less than 0.57 inch/hour (upper range of HSG C soils).

Can be done by 1) a simulated runoff test, 2) inspection during and after a large storm event, or 3) infiltration testing methods

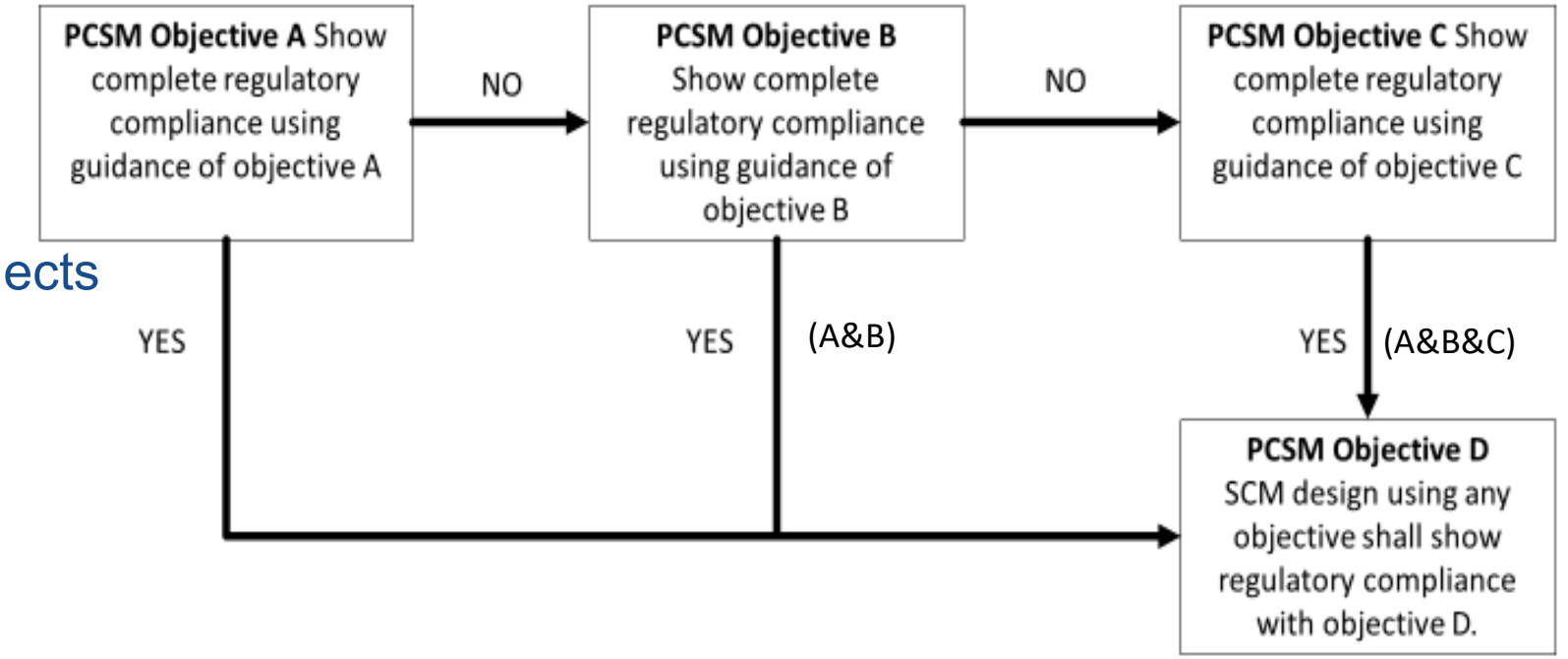
Underdrain guidance based on soil

Designation for underlying soils	Geometric mean design sat. hydraulic cond. rate	Implications to SCM guidance
Limited	≤0.25 inch/hour	MRC is applicable due to infiltration limitations, but this does not negate the need to explore other SCM options
Marginal	>0.25 and ≤0.4 inch/hour	Use of infiltration-based SCMs is recommended*. Capped backup underdrain (preferably with an IWS) within infiltration-based SCMs is recommended.
Not limited or marginal	>0.4 inch/hour and ≤5 inches/hour	Use of infiltration-based SCMs is recommended*. Underdrains not recommended.
	>5 inches/hour and ≤10 inches/hour	Use of infiltration-based SCMs is recommended*. Licensed professional is required to evaluate the appropriateness of infiltration rates with respect to unintended flow paths. Underdrains not recommended.
	>10 inches/hour	Use of infiltration-based SCMs is recommended*. Soil media should be placed on the underlying soils to limit this rate. Underdrains not recommended.

*unless there are structural or environmental reasons not to

PCSM Objectives

- **Objective A** – Natural Landscape SCM's - wherever practicable
- **Objective B** – Volume/quality management
  - Through infiltration, evapotranspiration, and natural landscape SCMs
- **Objective C** – Managed Release Concept (MRC)
  - Includes a wider variety of SCM
- **Objective D** –Rate Control
  - Minimized by A through C
  - In separate facility for larger projects



PCSM Objectives by SCM

A

3.3	PROTECT AND PRESERVE NATURAL LANDSCAPE PROCESSES
3.3.1	Protected Natural Stormwater Features
3.3.2	Preserved Natural Open Spaces
3.4	ENHANCED NATURAL LANDSCAPE SCMs
3.4.1	Disconnection of Impervious Surface with Filter Strip
3.4.2	Riparian Buffer Establishment and Enhancement
3.4.3	Floodplain Restoration
3.4.4	Revegetation and Soil Restoration
3.4.5	Retentive Grading
3.4.6	Vegetated Conveyance

B

3.5	INFILTRATION-BASED SCMs
3.5.1	Bioinfiltration
3.5.2	Surface Infiltration Basin
3.5.3	Permeable Pavement
3.5.4	Infiltration Trench
3.5.5	Underground Infiltration Basin

B

3.6	NON-INFILTRATION SCMs
3.6.1	Bioretention
3.6.2	Green Roof
3.6.3	Regenerative Step Pool Systems
3.6.4	Stormwater Capture and Use
3.6.5	Blue Roof
3.6.6	Engineered Stormwater Treatment Wetland
3.6.7	Water Quality Filtration and Treatment

C

3.7	MANAGED RELEASE CONCEPT
3.7.1	MRC Bioretention
3.7.2	MRC Storage Systems
3.7.3	MRC Karst

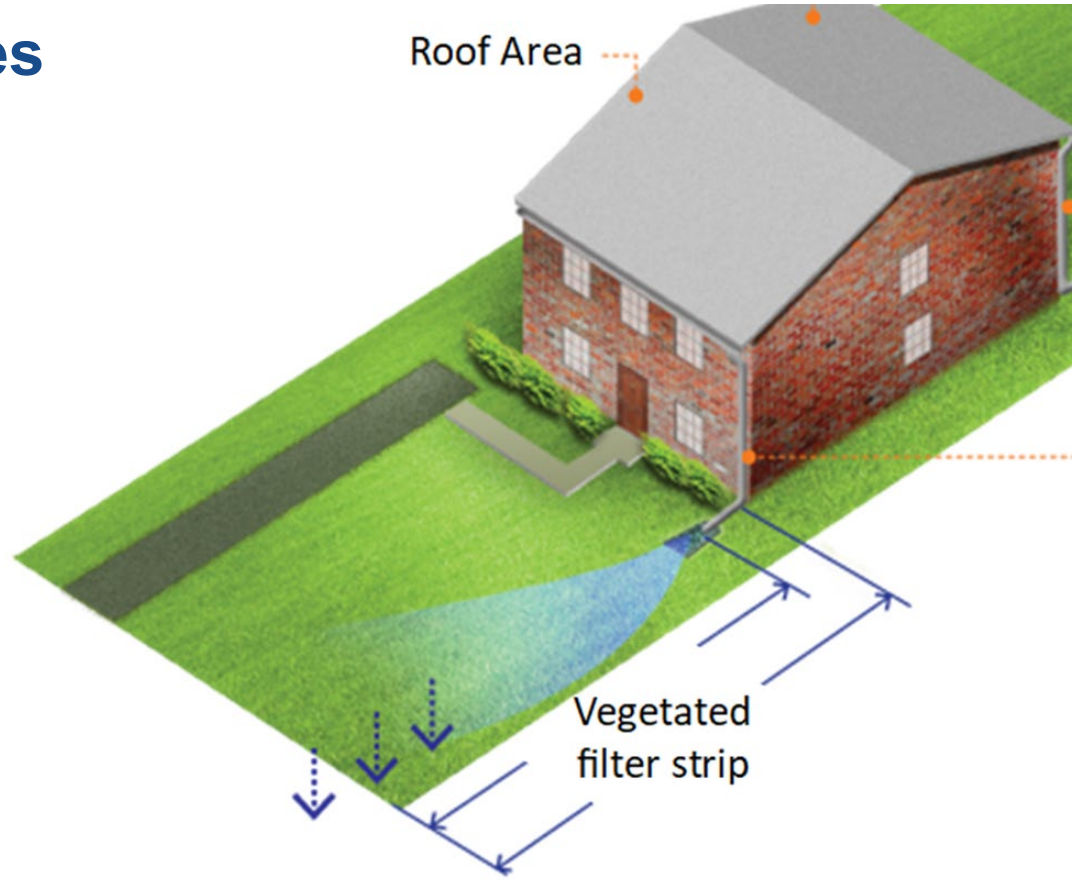
D

3.8	RATE CONTROL SCMs
3.8.1	Wet Basin
3.8.2	Naturalized Detention Basin
3.8.3	Underground Detention

Objective A: Protect & Preserve Natural Landscape Processes

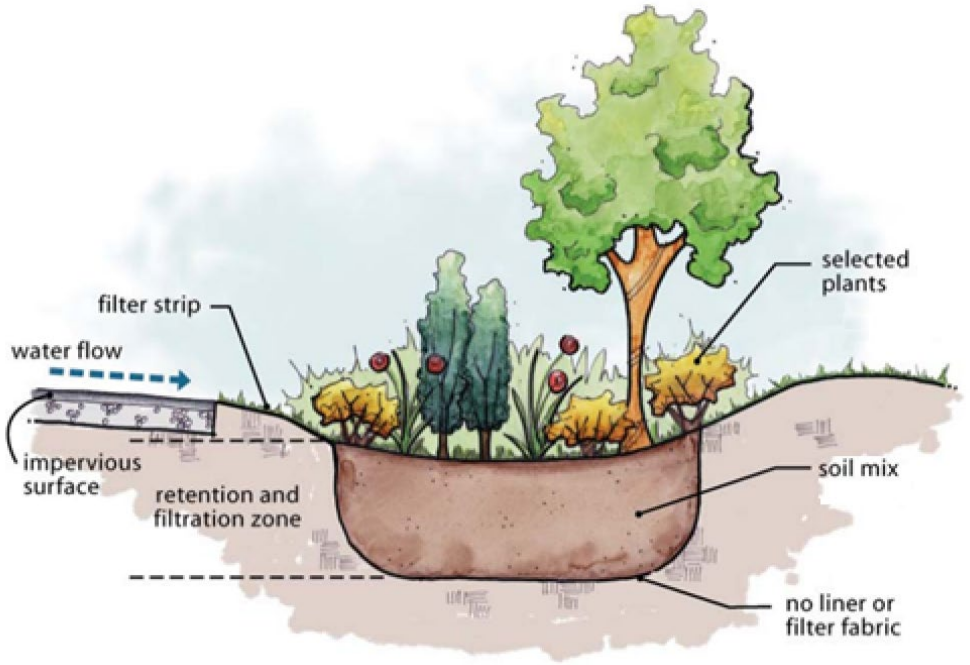
Areas within the project boundary, or otherwise included in a stormwater permit application, that are preserved and protected by a recorded long-term stipulation for the purposes of providing stormwater management benefit.

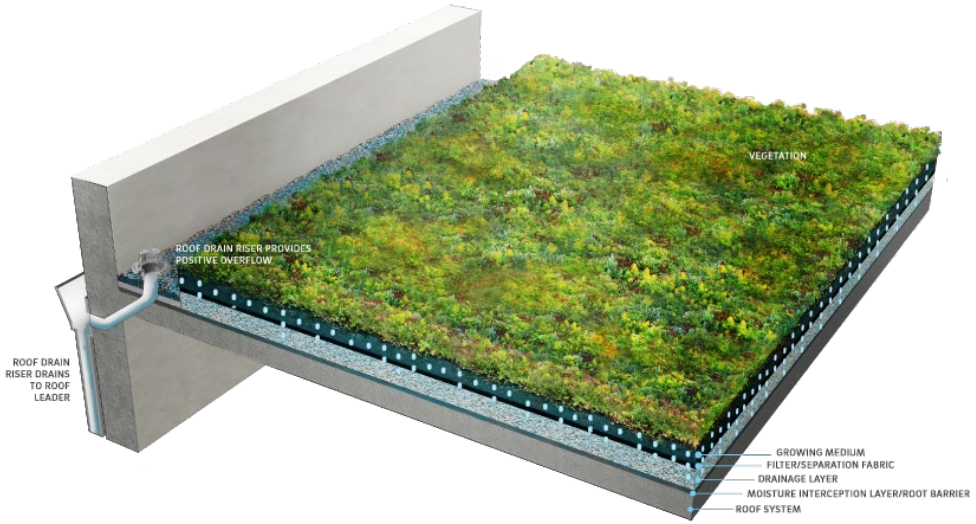
- **Protected Natural Stormwater Features**
- **Preserved Natural Open Spaces**
- **Enhanced Natural Landscape SCMs**



Objective B: Infiltration and Non-infiltration based

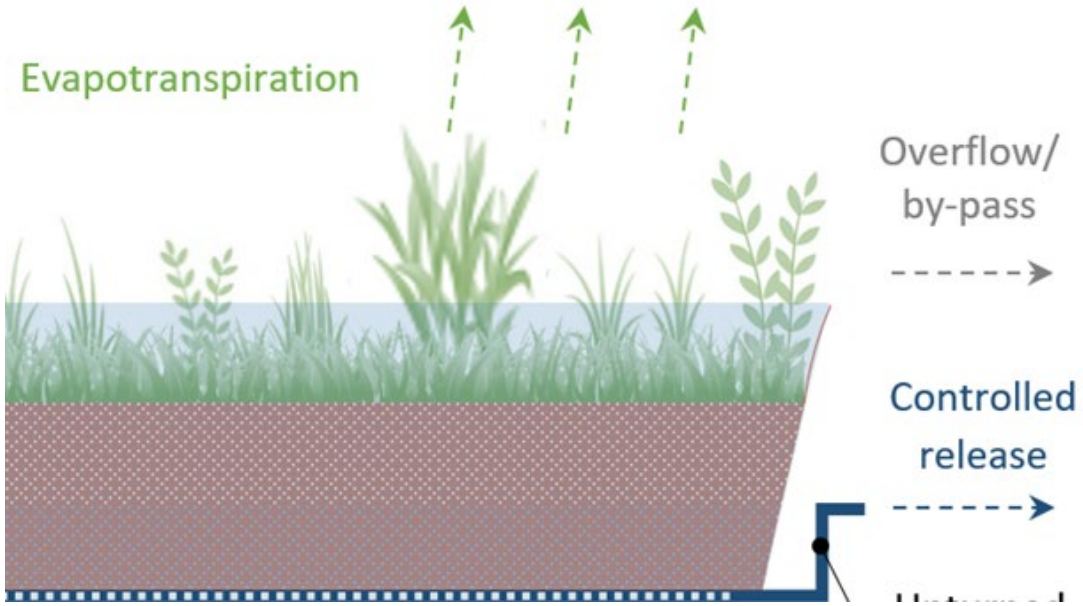
- Manage the net change for storms up to and including the 2-year/24-hour storm event for runoff volume and water quality (or Act 167 Plan) through SCMs that provide infiltration, ET, or capture and use SCMs to the extent practicable
- *Provide pretreatment in accordance with the guidance provided for each SCM*
- *Divert runoff from storm events that exceed the design capacity of PCSM Objective B SCMs is recommended.*





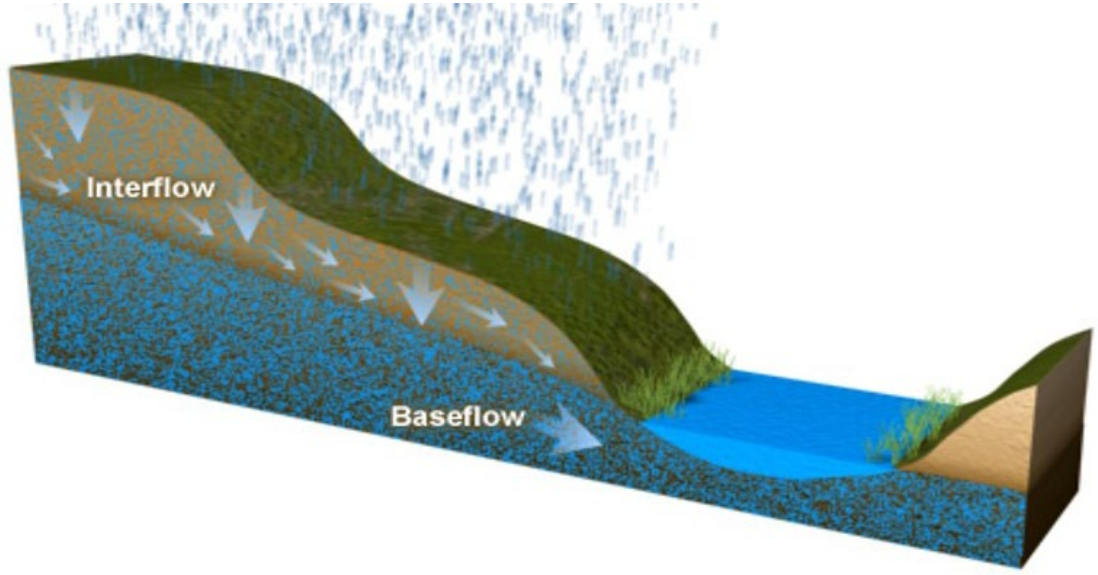
Objective C: MRC

A PCSM strategy involving the capture, filtration, treatment, and controlled release of runoff from an SCM that may be used when there are environmental limitations on a project site and where natural landscape processes, ET and infiltration are implemented to the maximum extent practicable.



Managed Release includes:

- **Controlled Release**
- **Geomorphologic Protection**
- **Internal Water Storage (IWS)**

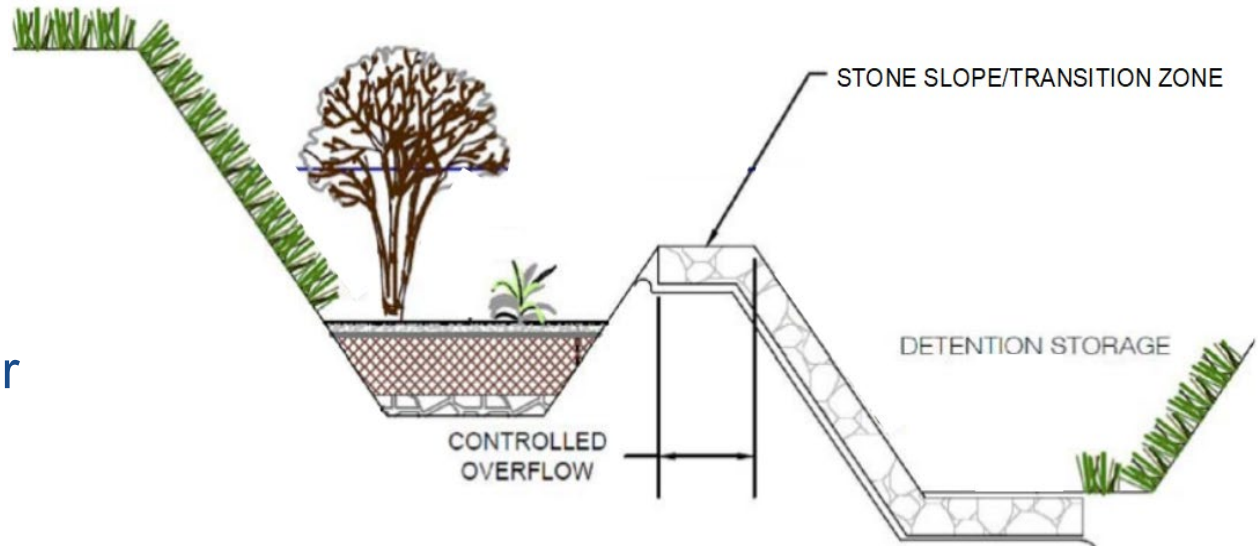


Resilience - Separate Volume/Water Quality (A,B,C) from Rate Control (D)

- Larger storms should be diverted when Volume/WQ SCM capacity is reached

- Why?
  - Preserves the function of Volume/WQ SCMs
  - Reduces maintenance, promotes longevity
  - Reduces the footprint of the basins needed for peak rate control
  - Climate Change

- Manual acknowledges that this is not always possible



Inlet Limitation – Climate Change

- The storm that the SCM is designed to manage must reach the basin. The inflow component must be sized to accept the SCM design storm.

OR

- A flow path for flows in excess of storm drain capacity is needed.

- Discharge from the SCMs should also be considered with respect to Climate Change

DUAL DRAINAGE CONCEPT

Construction Inspection of PCSM SCM's

- **Purpose**
  - Ensure site conditions match assumptions
  - Ensure that design assumptions can be implemented
  - Ensure SCMs are constructed as designed

- **Licensed Professional Oversight**
- **Critical Stages** – Per 25 Pa. Code 102.8(f)(7), PCSM plan must identify inspection schedule for all critical stages, performed by a licensed professional

Critical Stages of Construction

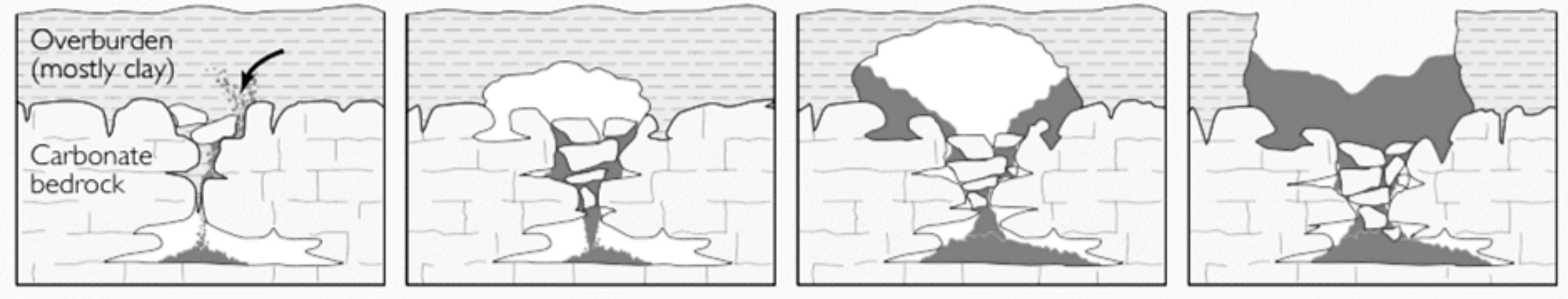
- **Infiltration New Major Critical Stages –**
  - Post construction infiltration confirmation testing
  - Final inspection, confirming no fines (particularly from construction dust) are in the SCM or its components
  - Excavation to, and preparations of, infiltration surface
  - Construction of any outlet pipes or structures, including the underdrain
  - Conversion from temporary ESPC BMP (sediment basin) to permanent PCSM SCM
- **Chapter 3 - Critical Stages for Each SCM**

Operation & Maintenance of PCSM SCM's

- **Routine Inspection** – Each SCM should be inspected annually and after storm events exceeding 2.5 inches of rainfall.
- **Routine Maintenance** – Performed on a scheduled basis; grass & vegetation management, sediment & trash removal
- **Corrective Maintenance** –Repairs that are typically more involved than what occurs during regular maintenance.

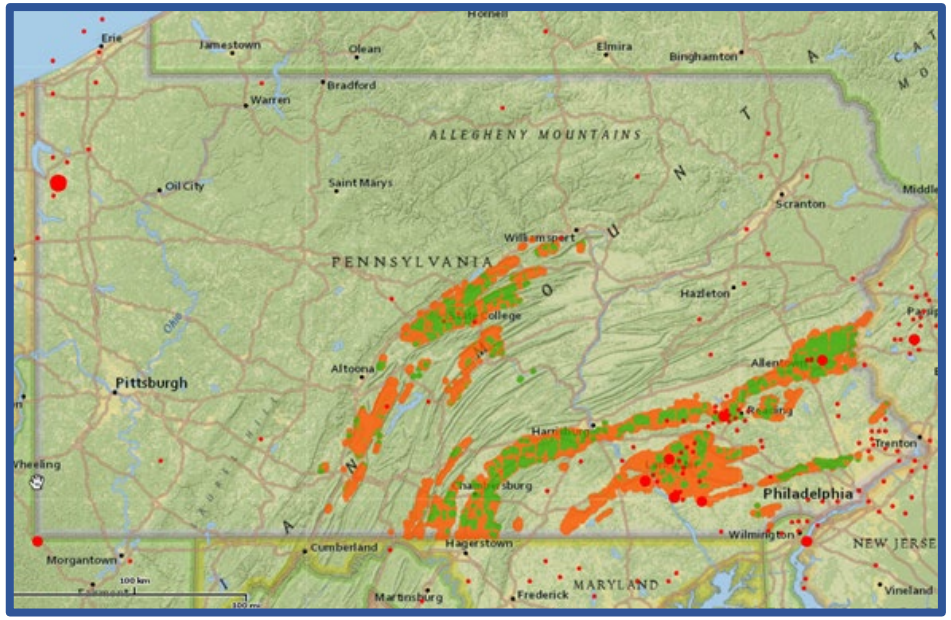
PCSM in Karst Terrain

- Intensive predevelopment site investigation required
  - Desktop study including map of topography, soils, geography, etc.
  - Field investigation including documentation of any features not shown in desktop study, and search for information on neighboring properties
  - Downstream analysis
- Full geotechnical and/or engineering report is required to be submitted to PADEP that includes findings of site investigation and approach to PCSM design



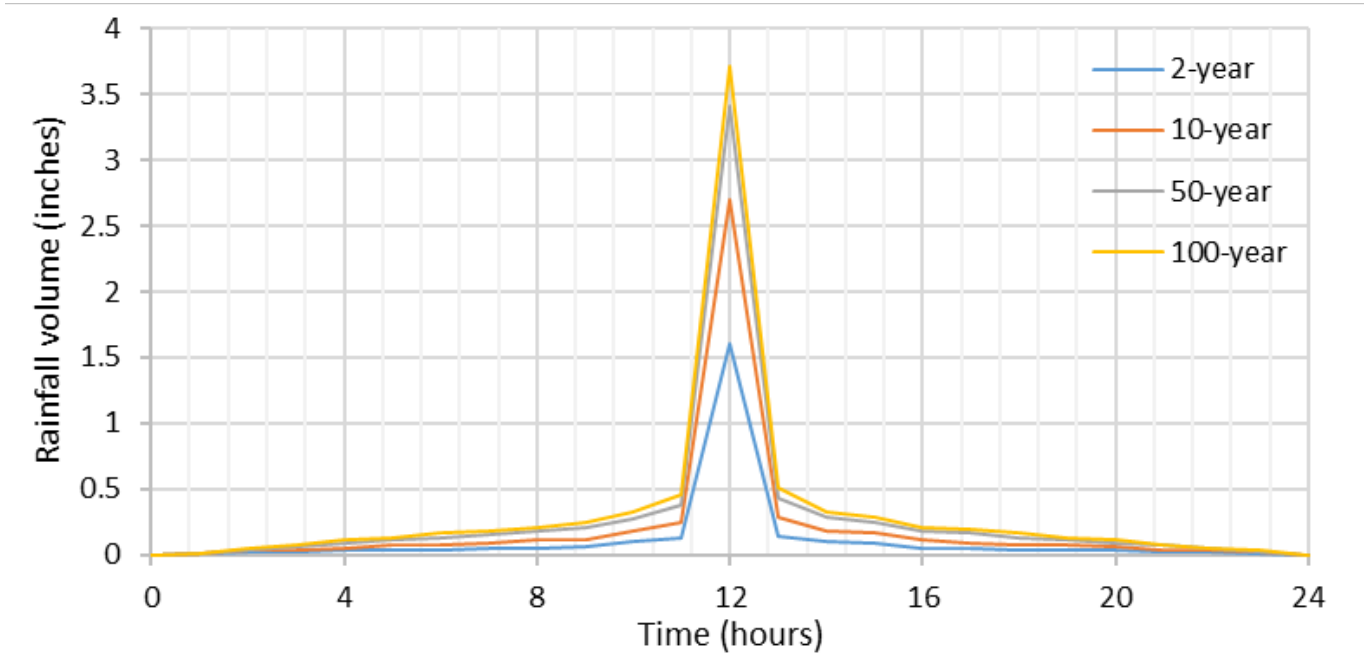
PCSM in Karst Terrain

- **Pre-development analysis**
  - Analysis of existing Infiltration
  - Analysis of depression storage
  - Evaluation of open caves
  - Actual cover condition (not assumed meadow)
- **Post development**
  - Pretreatment and filtration
  - Limit infiltration to pre-development
  - Limit off-site discharge to historic flow
  - Separate rate control
  - Karst MRC



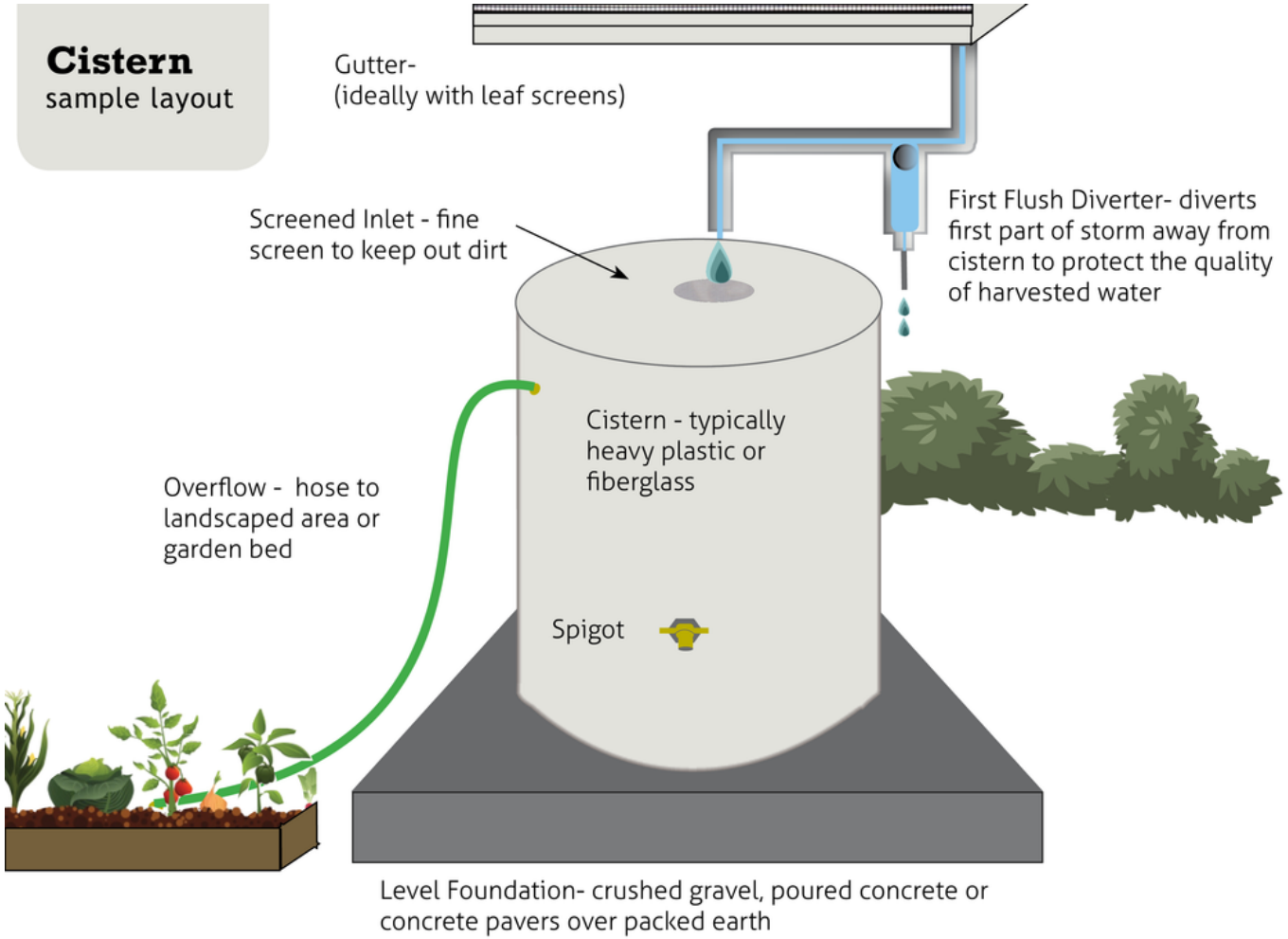
Volume, Water Quality and Peak Rate

- Three Volume methods:
  - PCSM Spreadsheet Design Storm Approach (current)
  - Water Balance (only for certain SCMs)
  - Continuous simulation (most recent 15 years)
- Water quality method
  - Tied to volume method
  - Mass Approach
- Peak Rate
  - Design Storm Approach
  - Storm of Record Approach



Volume Management Analysis Approaches- Water Balance

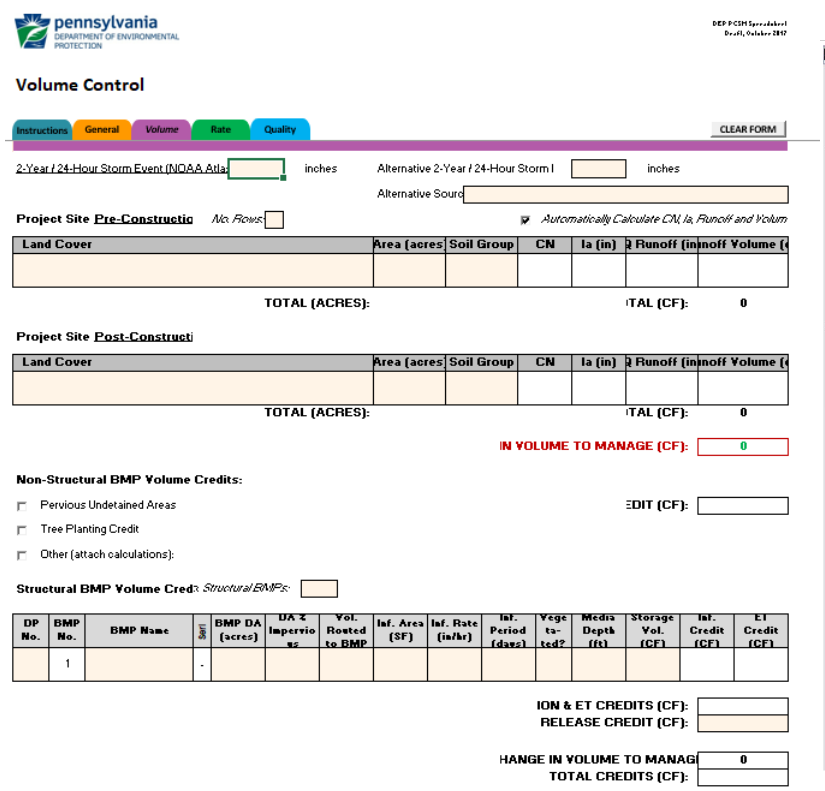
- Can include SCMs in combination with Harvesting and Use
- Design Storm method
  - 1-yr/10-min storage volume (recover in 3 days)
  - Release less then 0.05 cfs / acre for 1.2 inch two hr storm
- Water Balance method
  - Long-term, minimum time step of daily accounting
  - 90% of all 1.2 storms captured (adapted from Managed Release Concept)
- Geomorphological management (2-yr to 1-yr)

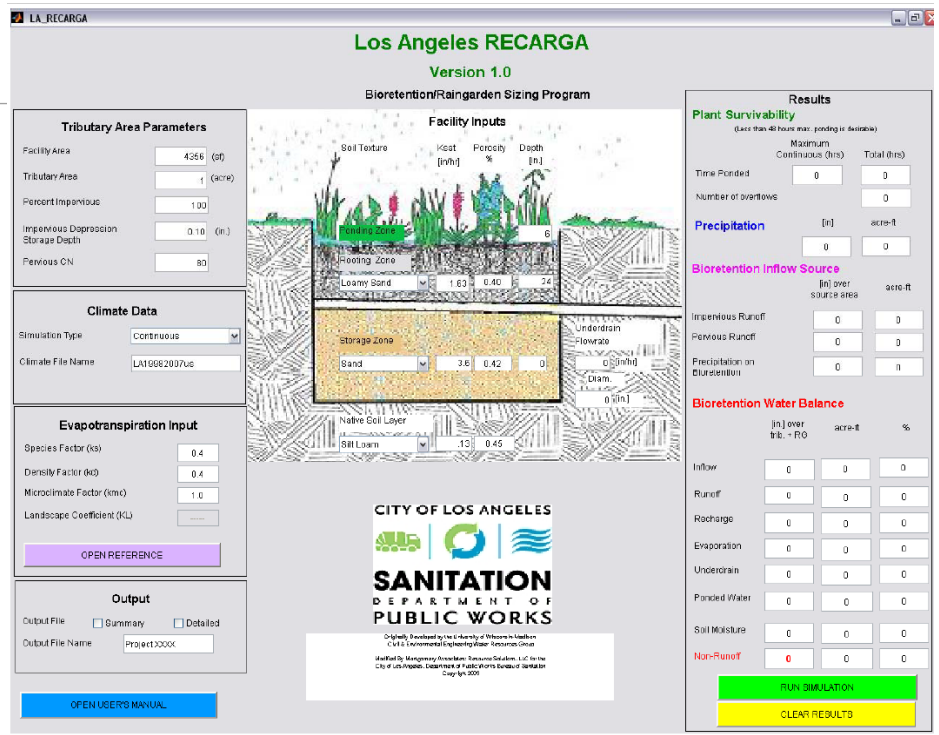


Ann Arbor

Volume Management Analysis Approach – DEP PCSM Spreadsheet

- Compared 2-year/24-hour storm event from PA DEP Spreadsheet with LA RECARGA
- Spreadsheet – allows for static number of hours of infiltration and ET as void space
- LA RECARGA– allows for dynamic processes (ET and Infiltration)



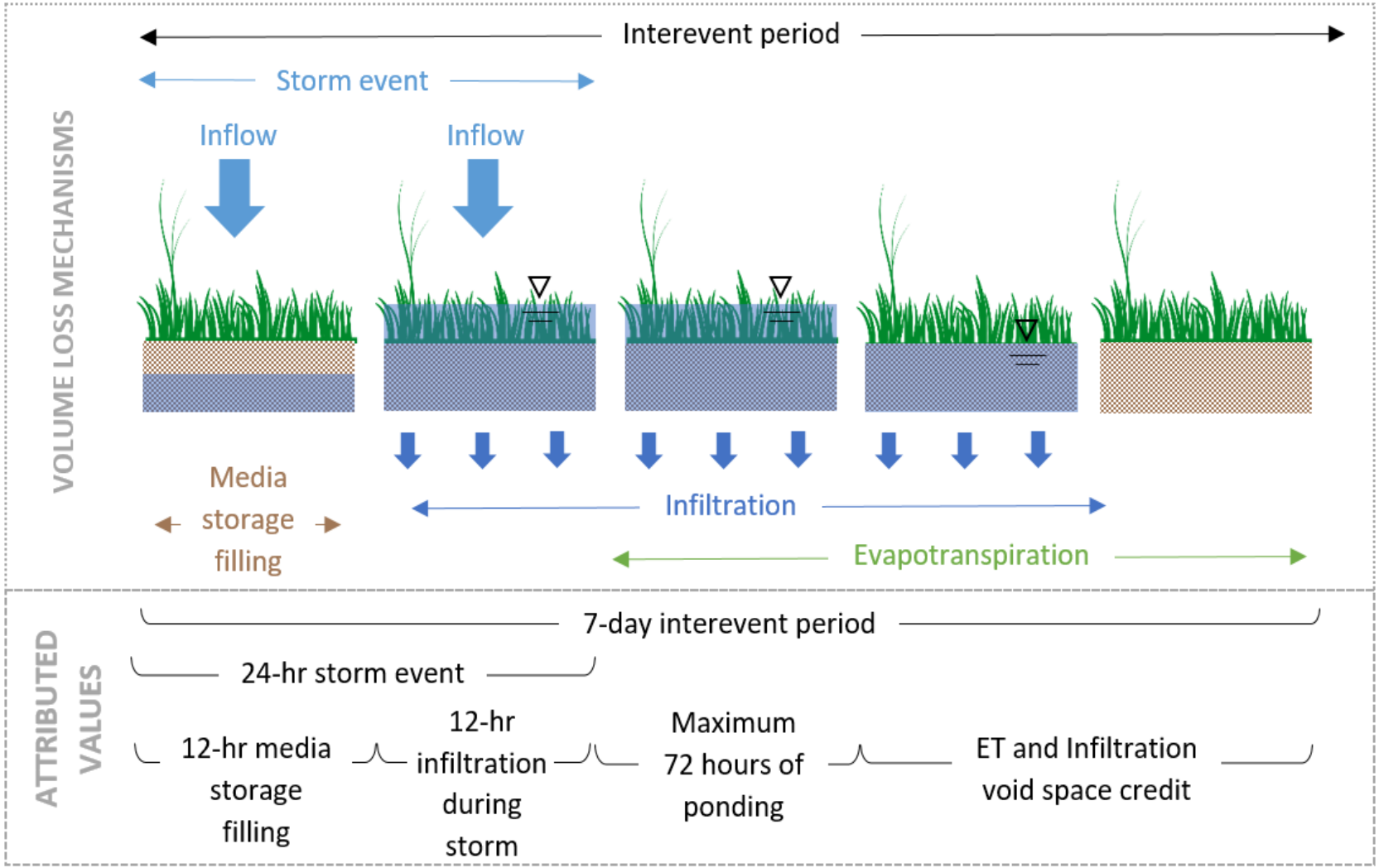


PA DEP Spreadsheet Vs. LA RECARGA

There is nothing stopping an applicant from using LA RECARGA or another model for this type of approach in conjunction with the spreadsheet.

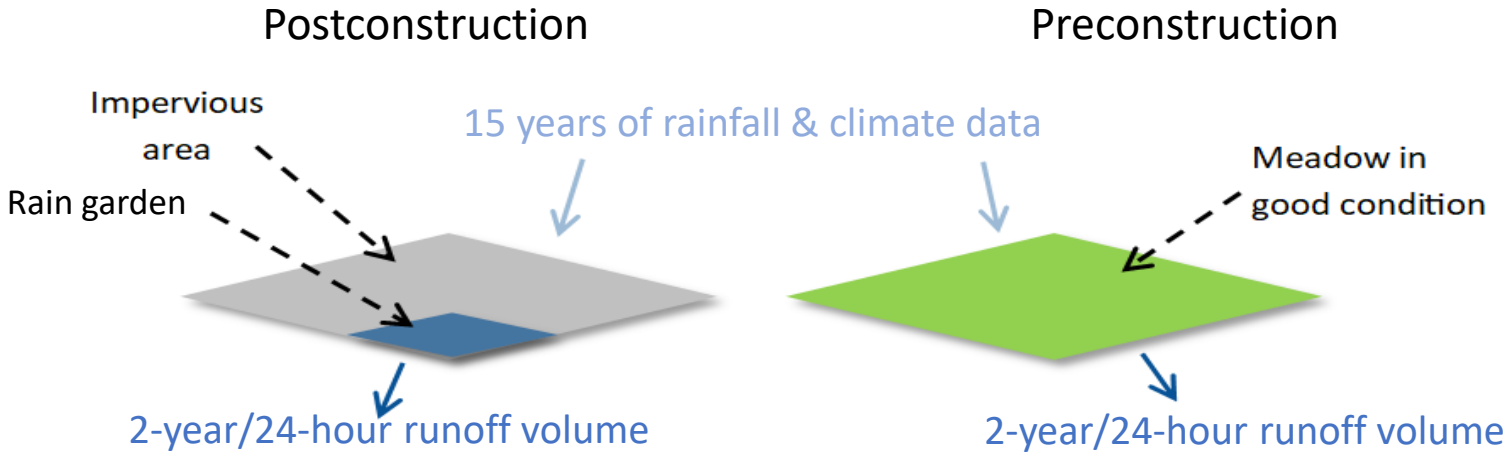
Volume Management Analysis Approach – DEP PCSM Spreadsheet

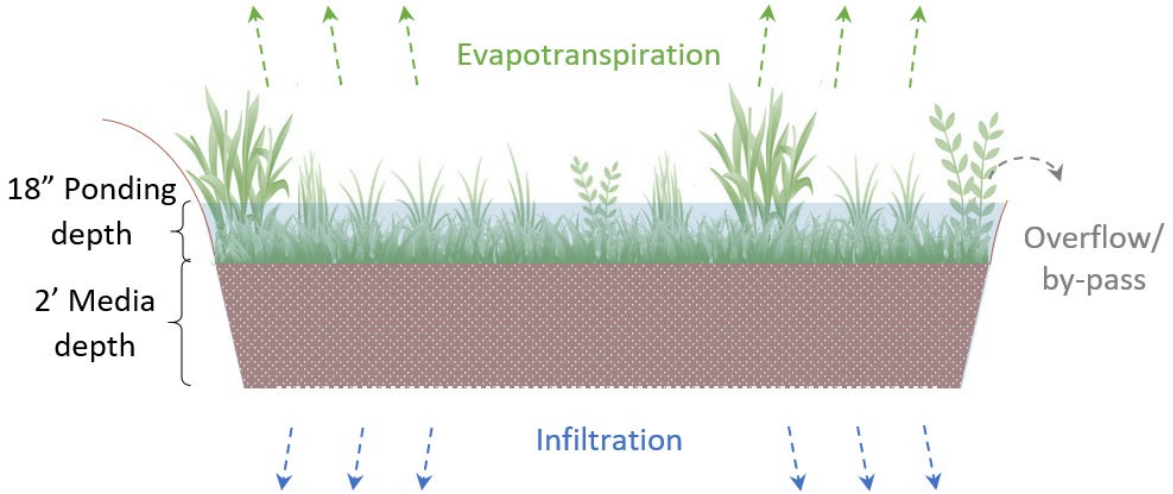
- Number of hours to account for infiltration during storm event is limited to 12 hours to remain conservative
- Amount of infiltration is limited by:
  - amount routed to SCM
  - amount stored in bowl after event



Volume Analysis Approach – Continuous Simulation

- Rain Garden using SWMM
- Most recent 15 years - Philadelphia international airport
- 1 acre
- Green & Ampt equation
- Obtain 2-year/24-hour runoff volumes





Parameter	Post-construction (impervious)	Pre-construction (pervious meadow)
Depression storage value	0.05	0.13
Manning's n-value	0.01	0.15

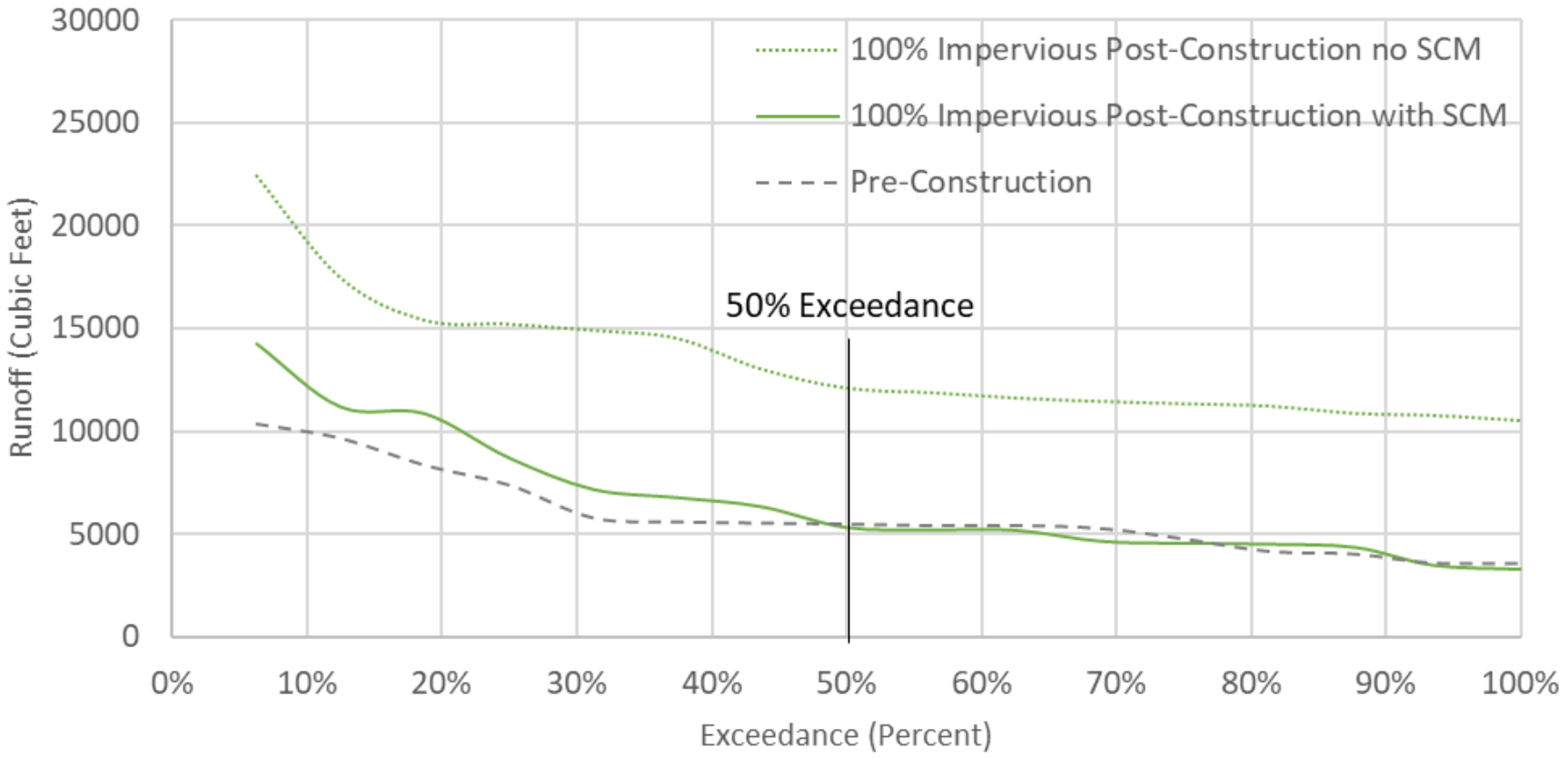
Saturated hydraulic conductivity: 0.2 in/h

Soil suction: 5 psi

Volume Analysis Approach – Continuous Simulation

Percent exceedance (ranking) vs. runoff volume

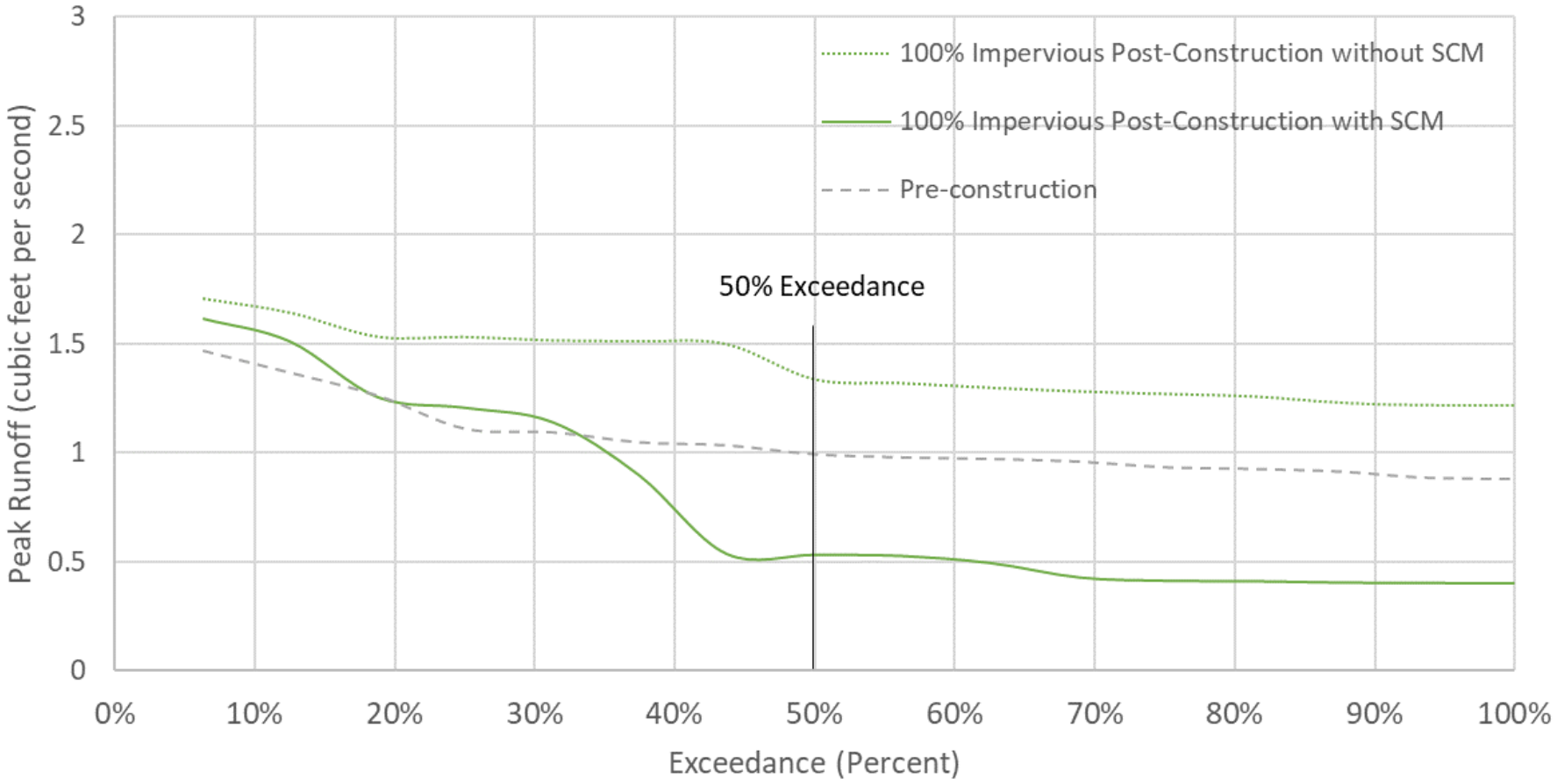
- 2-year storm = ½ % chance of exceedance in one year (i.e., 50%)
- Took largest daily runoff volume using partial duration probability



Example site in Philadelphia – Runoff Rate

Percent exceedance (ranking) vs. runoff rate

- 2-year storm = ½ % chance of exceedance in one year (i.e., 50%)
- Took largest daily runoff volume using partial duration probability

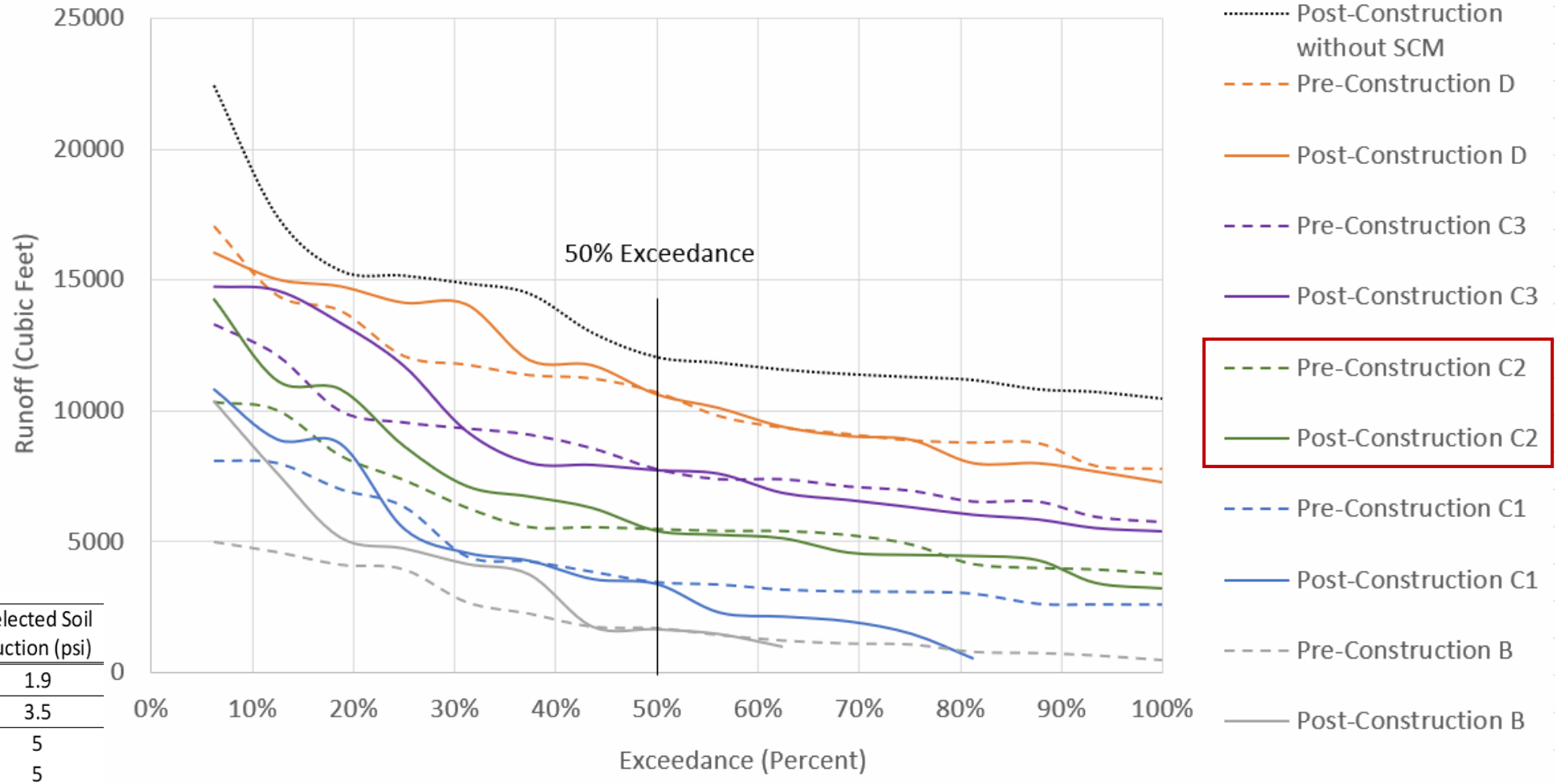


Volume Analysis Approach – Continuous Simulation

Percent exceedance vs. runoff volume

"C2" scenario is same as before

Scenario Name	Selected Saturated Hydraulic Conductivity Rate (in/hr)	Selected Soil Suction (psi)
A	1.5	1.9
B	0.6	3.5
C1	0.32	5
C2	0.2	5
C3	0.1	6
D	0.03	8



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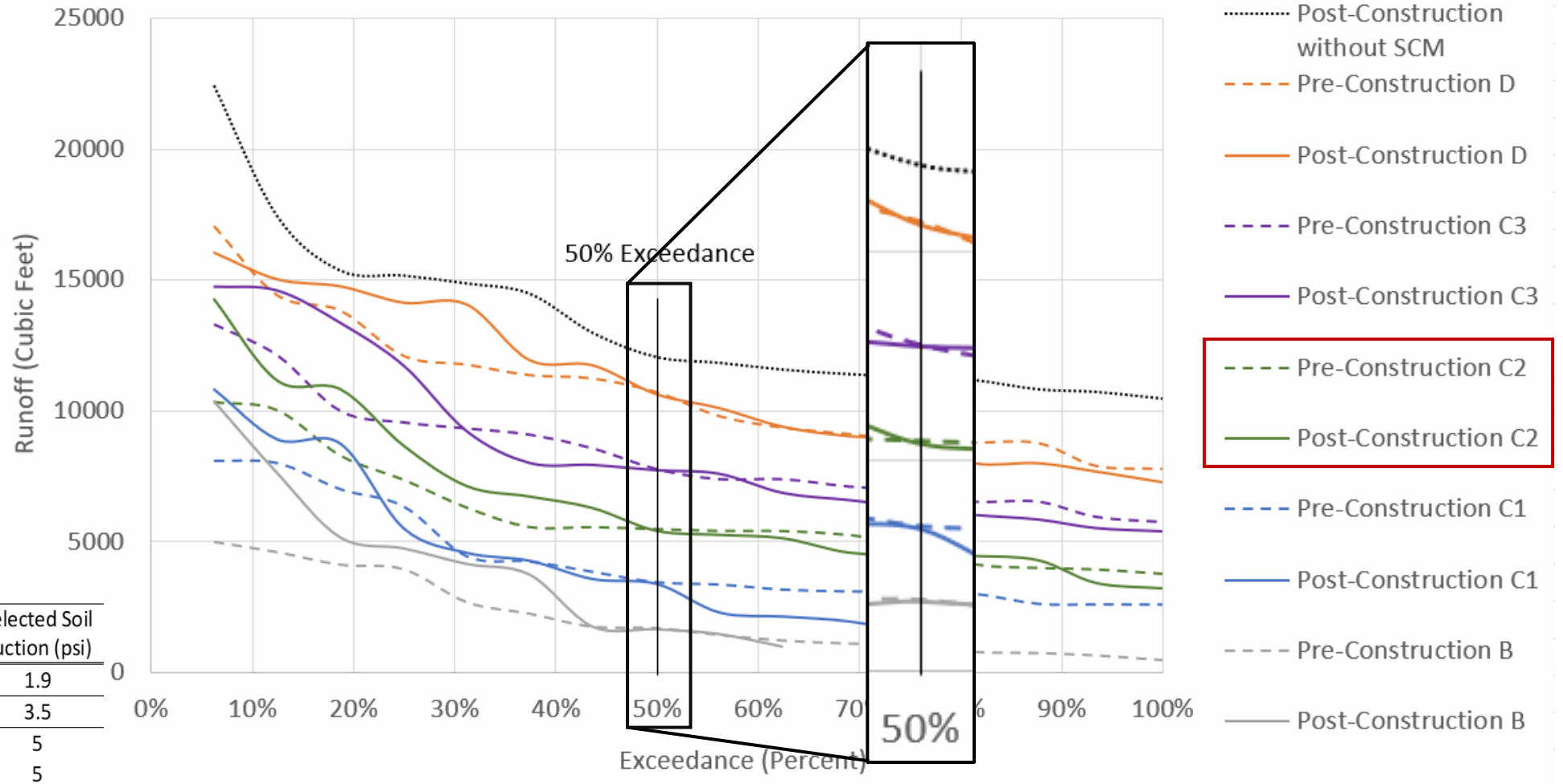
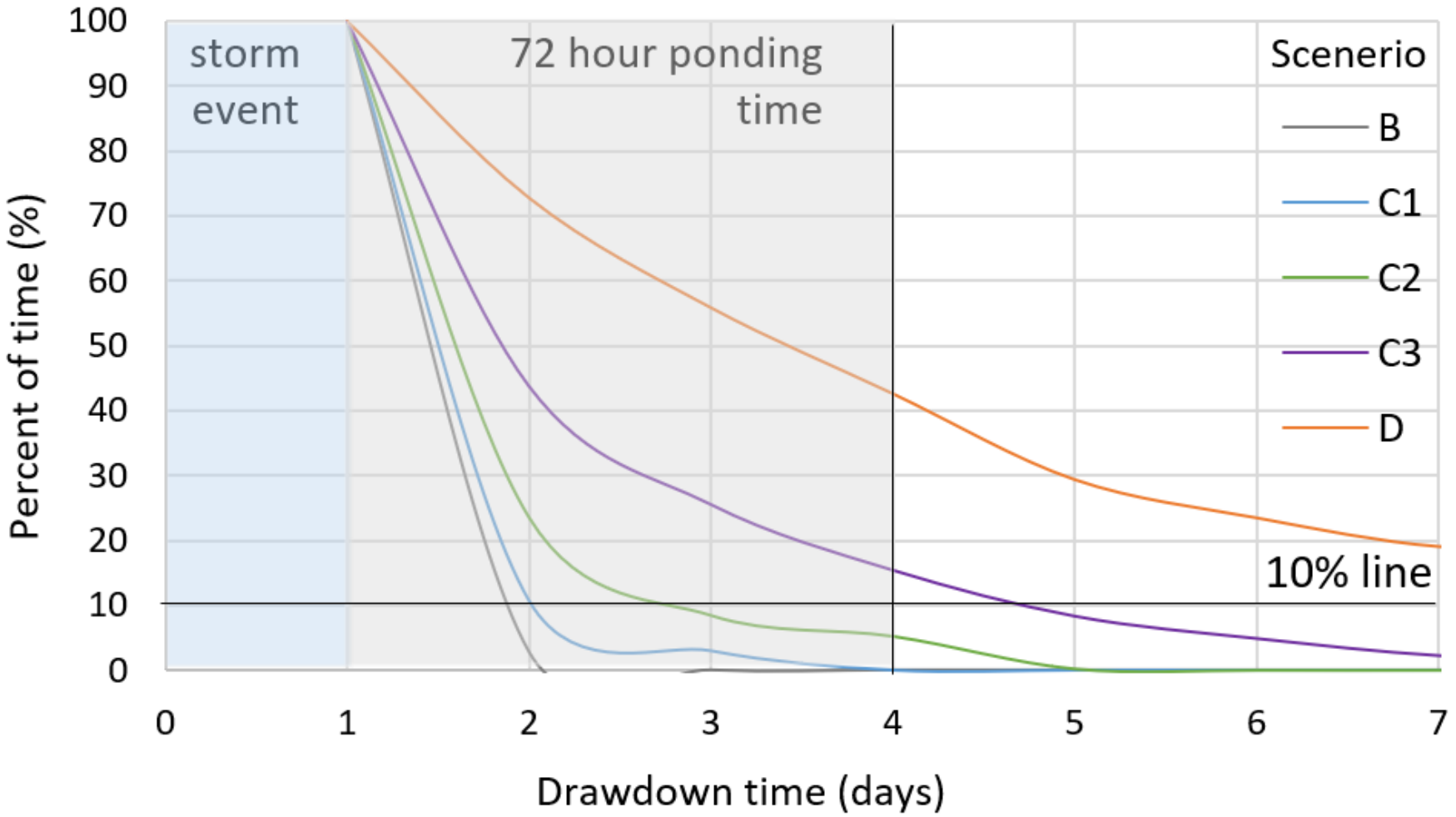


Example site in Philadelphia – Ponding

- SCM sizing primarily based on 2-year/24-hour storm
- Need to meet ponding time requirement
  - 90% of the time ponding is under ponding time limit
  - Only needed to adjust footprints for C3 and D soils



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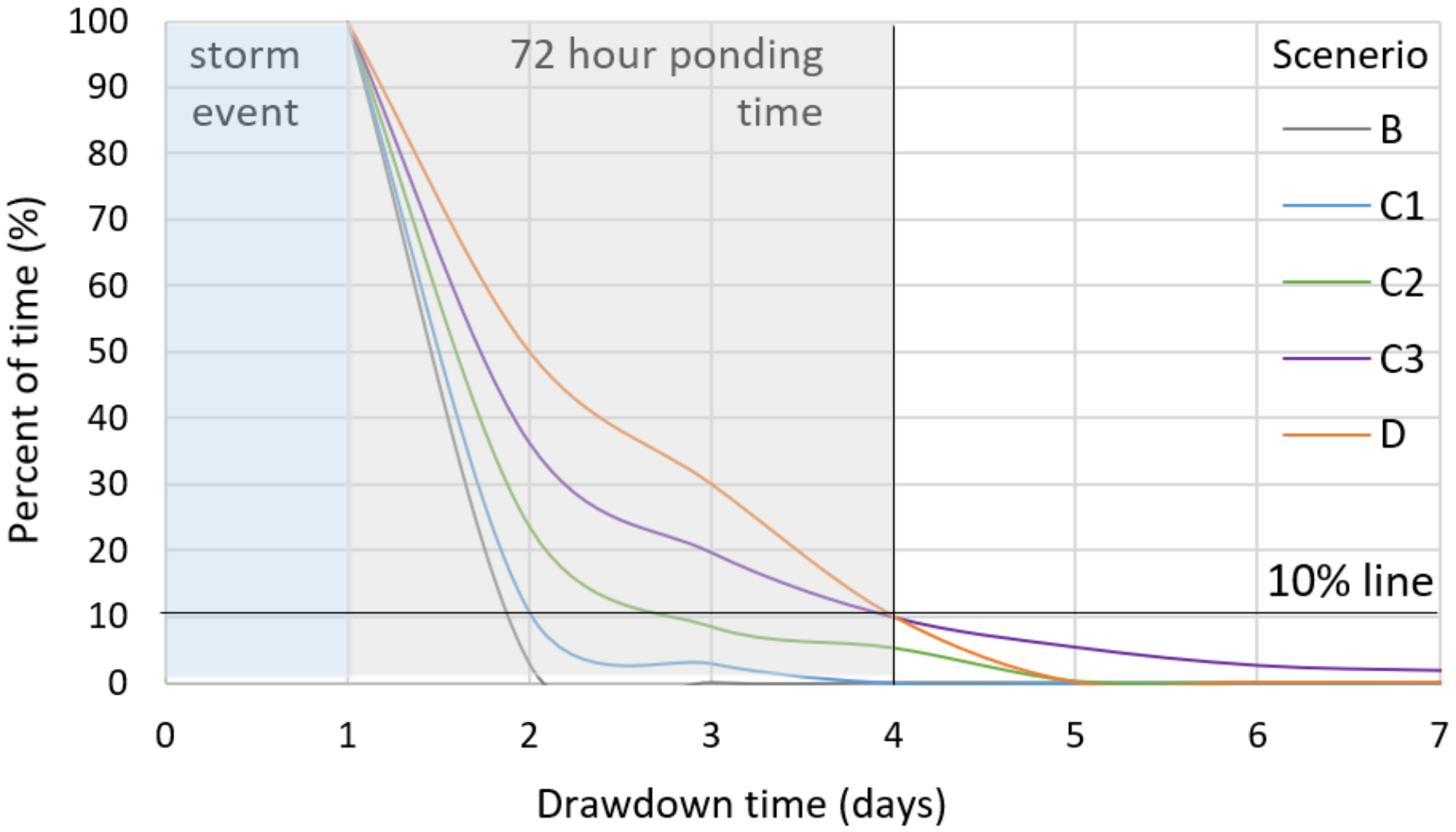
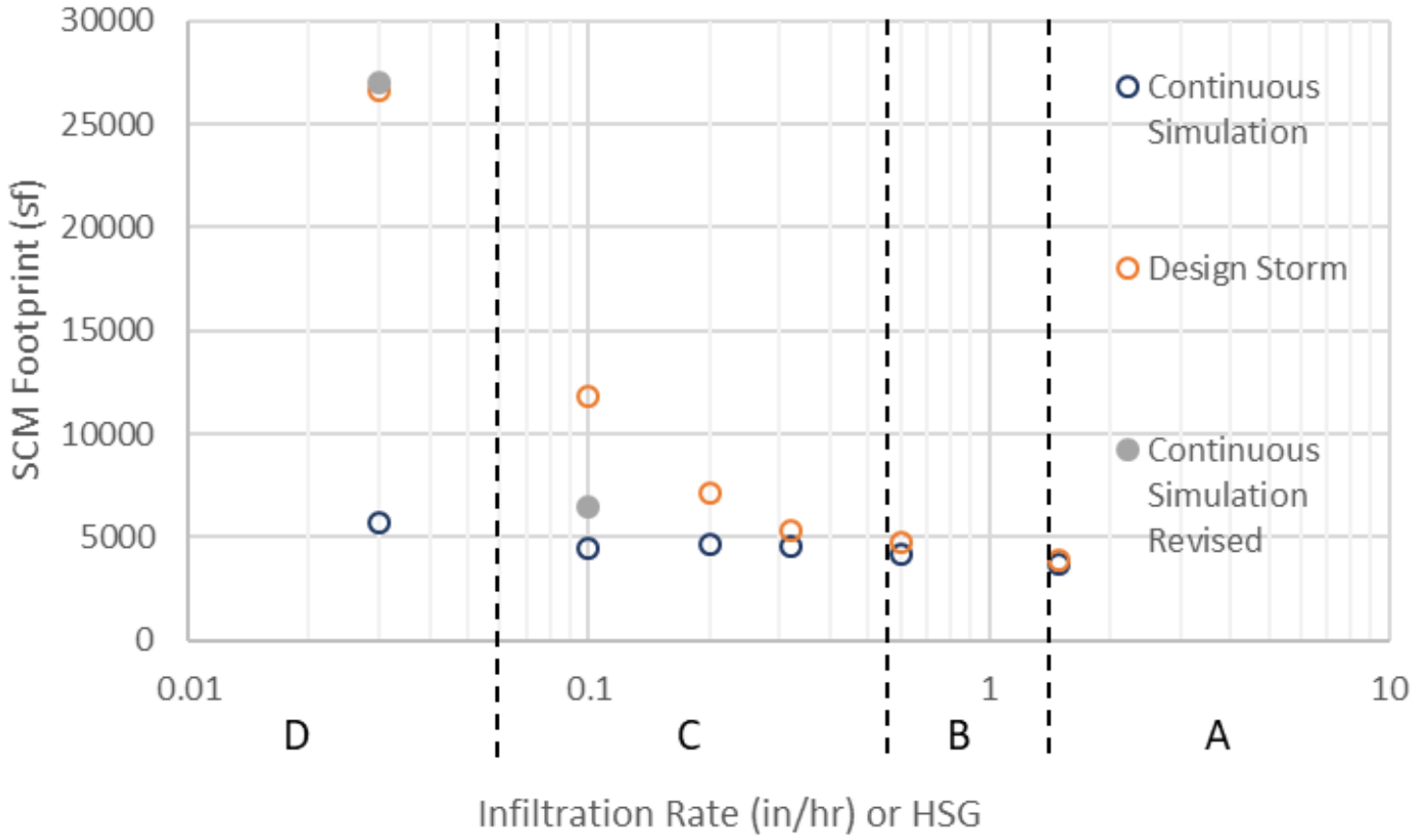


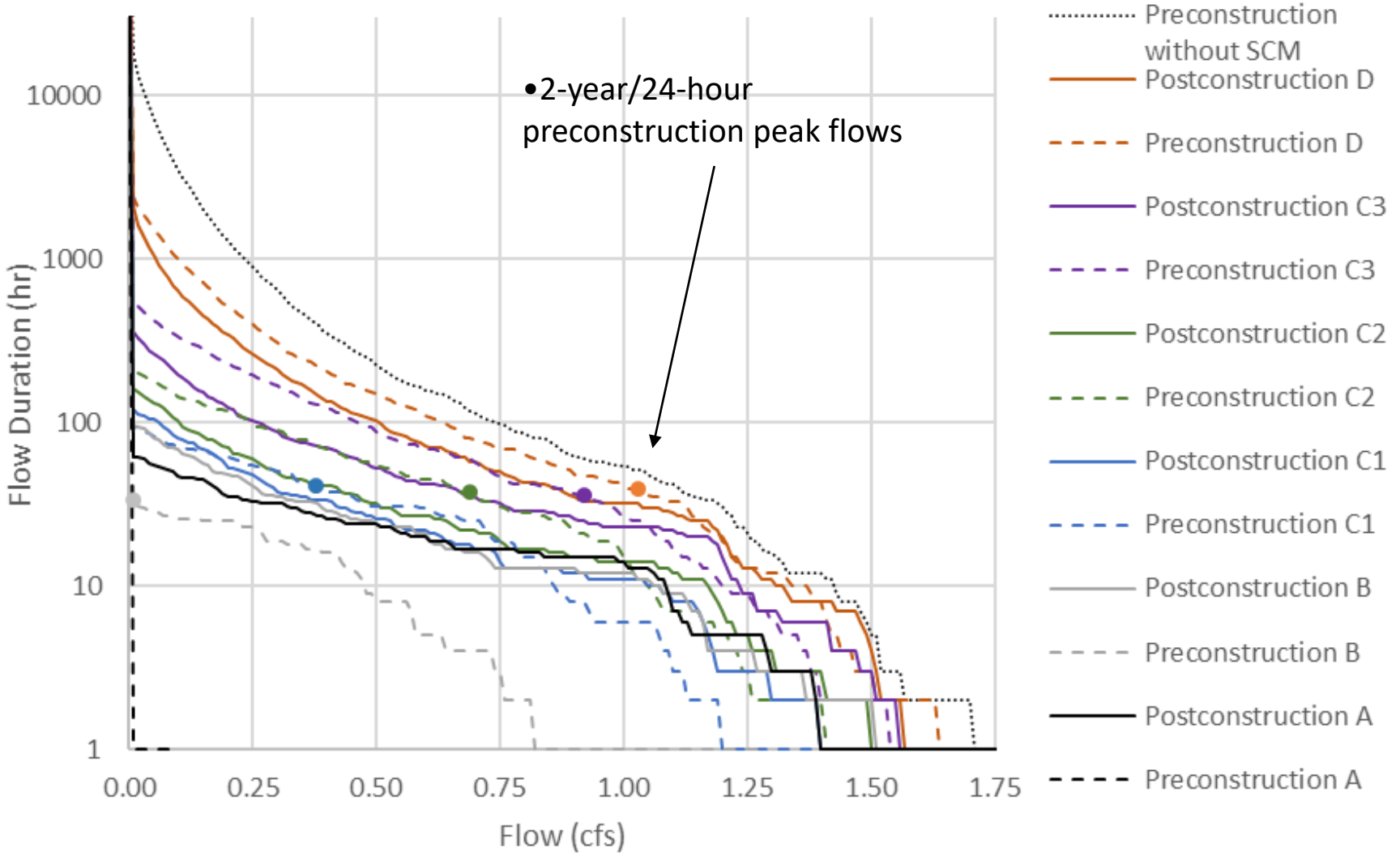
Continuous Simulation vs. Design Storm

- Continuous simulation approach vs. design storm approach sizing
- Low C and D soils would require underdrains or managed release concept
- Limited to 3 days of ponding



Example site in Philadelphia – Flow Duration

- Number of hours for each flow rate leaving the SCM
- Important for geomorphological concerns
  - 2-year/24-hr preconstruction peak flow is not exceeded in postconstruction
  - Duration of all flows <2-year/24-hr peak
  - All C & D reduced
  - A&B flowrate insignificant



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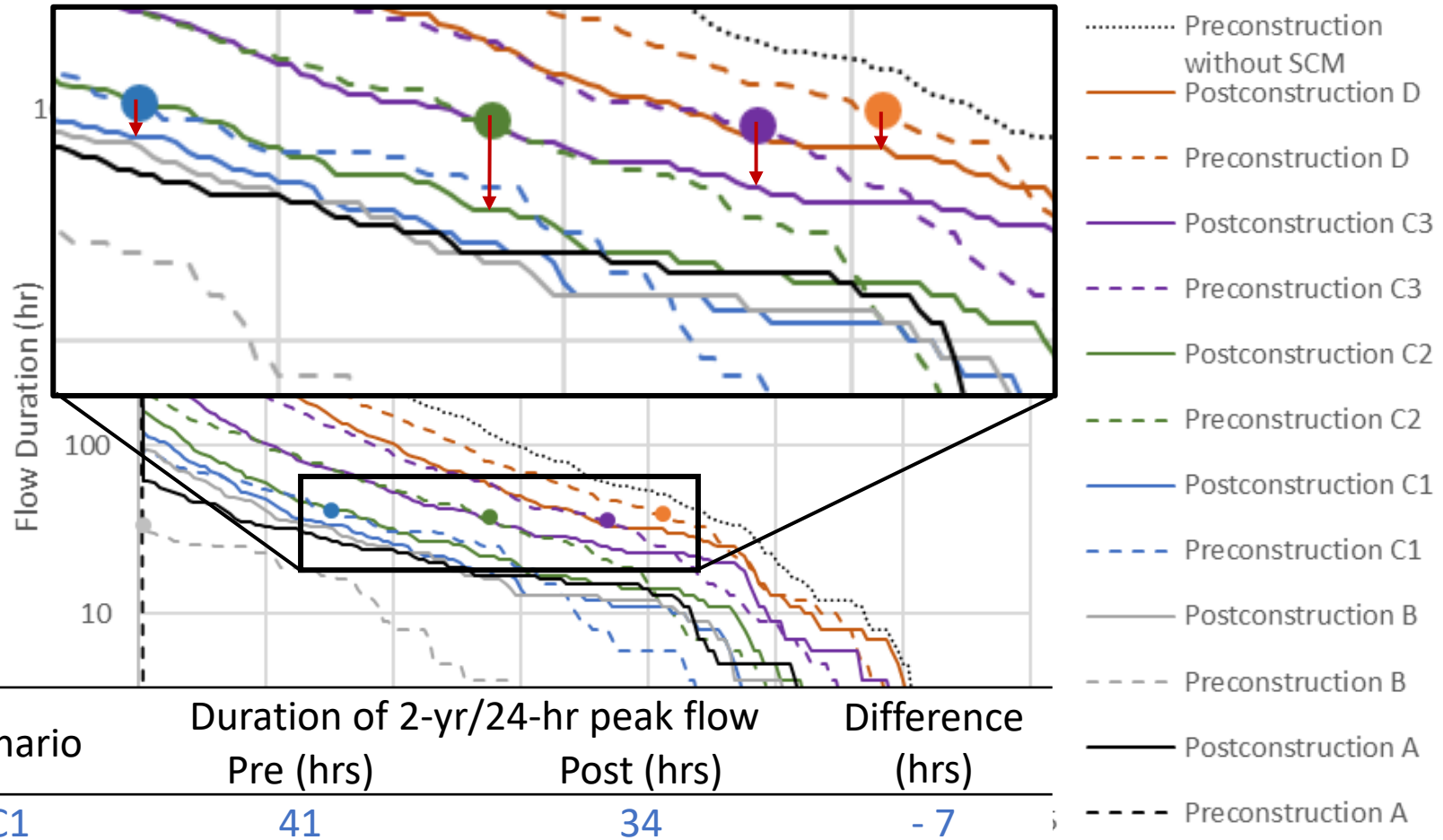
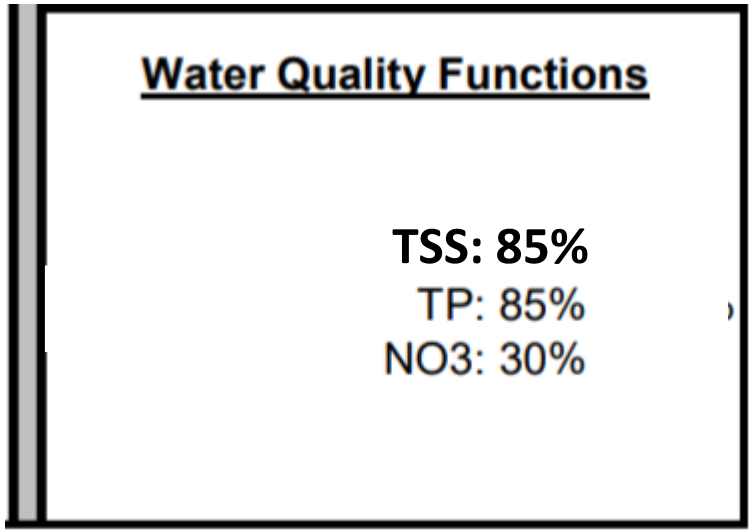


Scenario	Duration of 2-yr/24-hr peak flow Pre (hrs)	Post (hrs)	Difference (hrs)
C1	41	34	- 7
C2	37	22	-15
C3	36	25	-11
D	39	32	- 7

Water Quality

- 2006 version:
  - Built BMP according to manual
  - Assumed percent removal
  - Treatment train adds removals – not appropriate.
  - Example Bioinfiltration



- 2022 Version
  - Mass Loading - TSS, TP, TN
  - Using International ASCE BMP Database outflow concentrations (mg/l) for the last water quality SCM
  - Using National Water Stormwater Quality Database for watershed quality concentrations (mg/l)
  - PA has already adopted this new method (PCSM Spreadsheet)

Water Quality for Land Use

- National Stormwater Quality Database (NSQD)
  - Based on land use from MS4 communities – adapted into BMP database (http://www.bmpdatabase.org/nsqdstat.html)
  - Provides median concentrations of pollutants

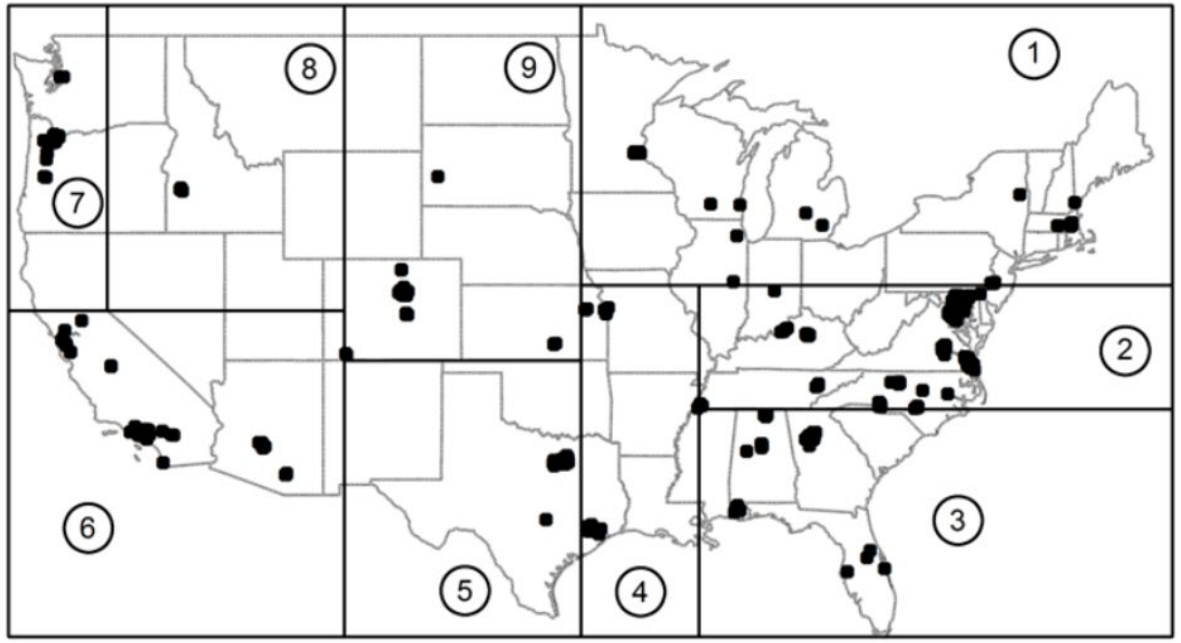


Figure 1. Distributions of NSQD data sources per EPA rainfall zones.

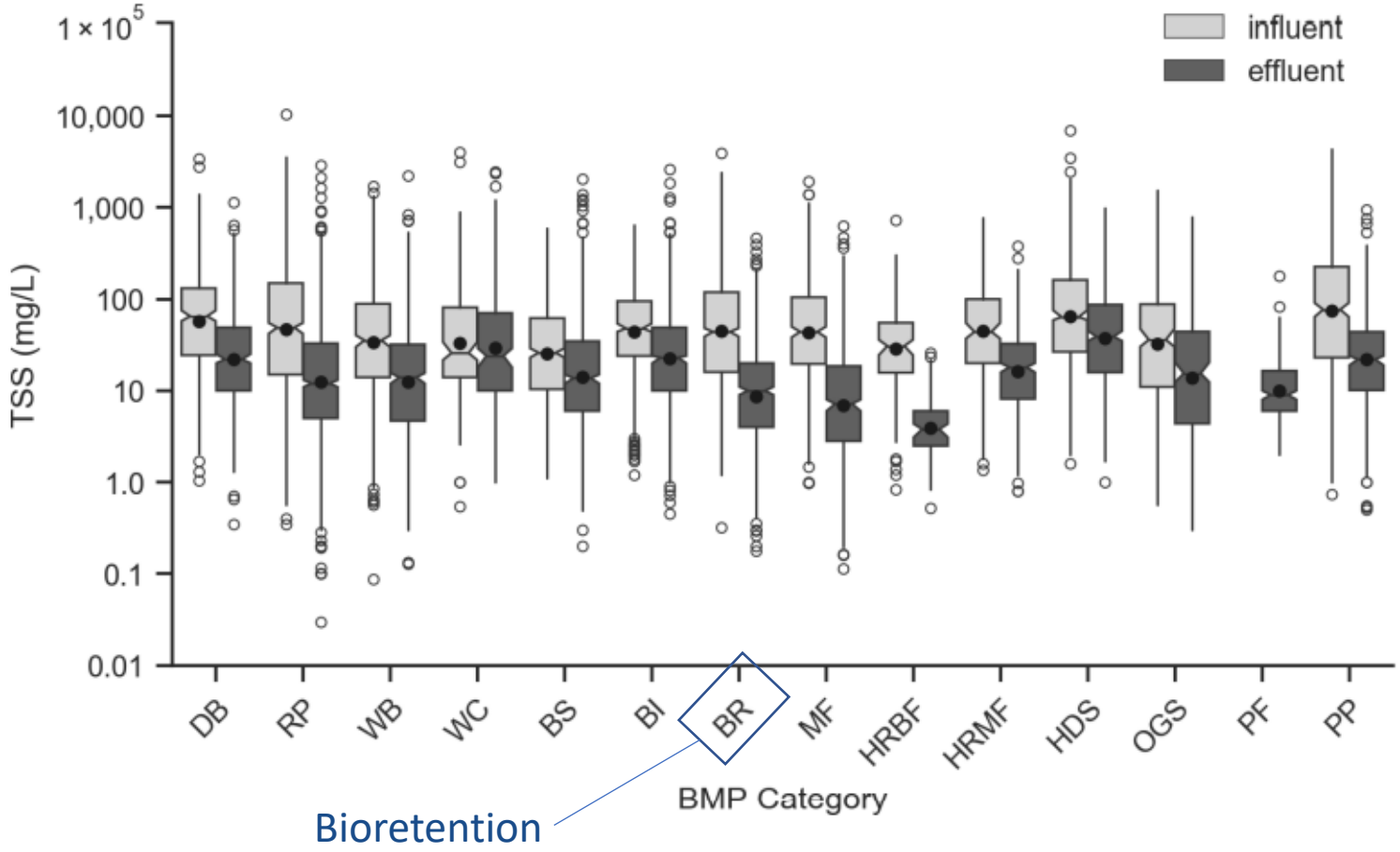
The National Stormwater Quality Database (NSQD), Version 4.02, February 17, 2018

	Area (acres)	% Imperv.	Precip. Depth (in)	Runoff Depth (in)	Cond. (uS/cm @25°C)	Hardness (mg/L CaCO3)	Oil and Grease (mg/L)	pH	Temp. (C)	TDS (mg/L)	TSS (mg/L)	NH3 (mg/L)	N02+NO3 (mg/L)	Nitrogen, Total Kjeldahl (mg/L)	Phos., filtered (mg/L)	Phos., total (mg/L)
Open Space (49)																
Number of observations	49	37	41	11	2	8	19	19	2	45	44	32	44	45	44	46
% of samples above detection	100	100	100	100	100	100	36.8	100	100	97.8	95.5	18.8	84.1	71.1	79.6	84.8
Median	85	2.0	0.52	0.05	113	150	1.3	7.70	14.6	125	48.5	0.18	0.59	0.74	0.13	0.31
Coefficient of variation	1.5	1.0	1.2	1.4	0.5	0.6	0.7	0.08	0.7	0.7	1.5	1.24	0.9	0.9	0.9	3.5

*TN : TKN + NO2/3

Water Quality for SCM

- International Stormwater Best Management Practices Database (BMP Database)
  - Based on SCM type
  - Effluent median concentrations of pollutants

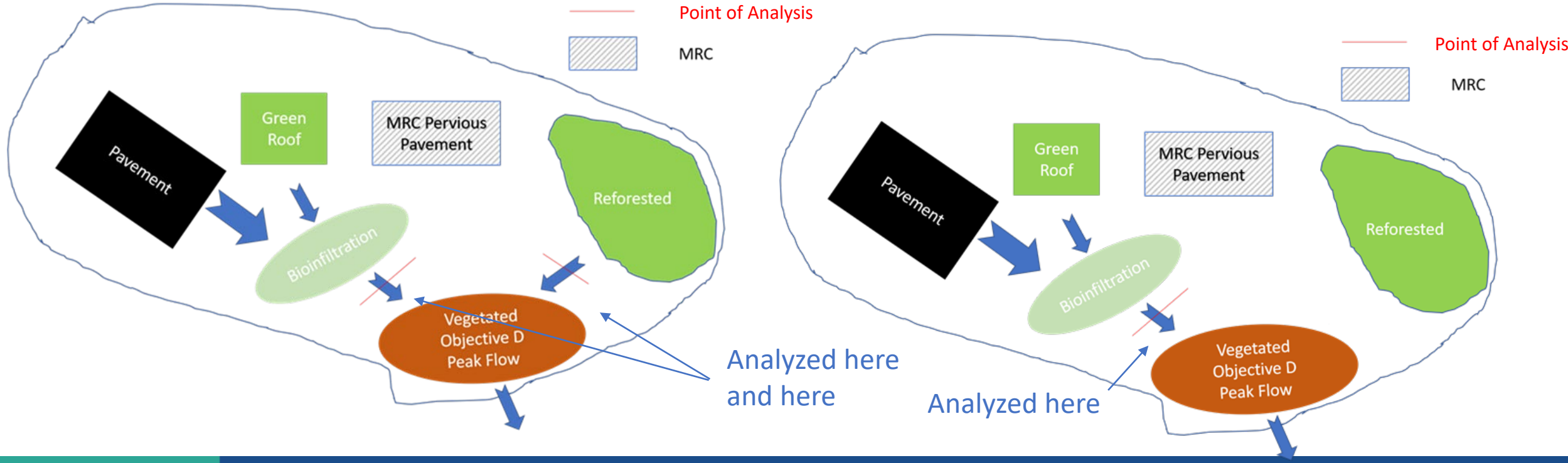


https://www.waterrf.org/system/files/resource/2020-11/DRPT-4968_0.pdf

Water Quality – Point of Analysis

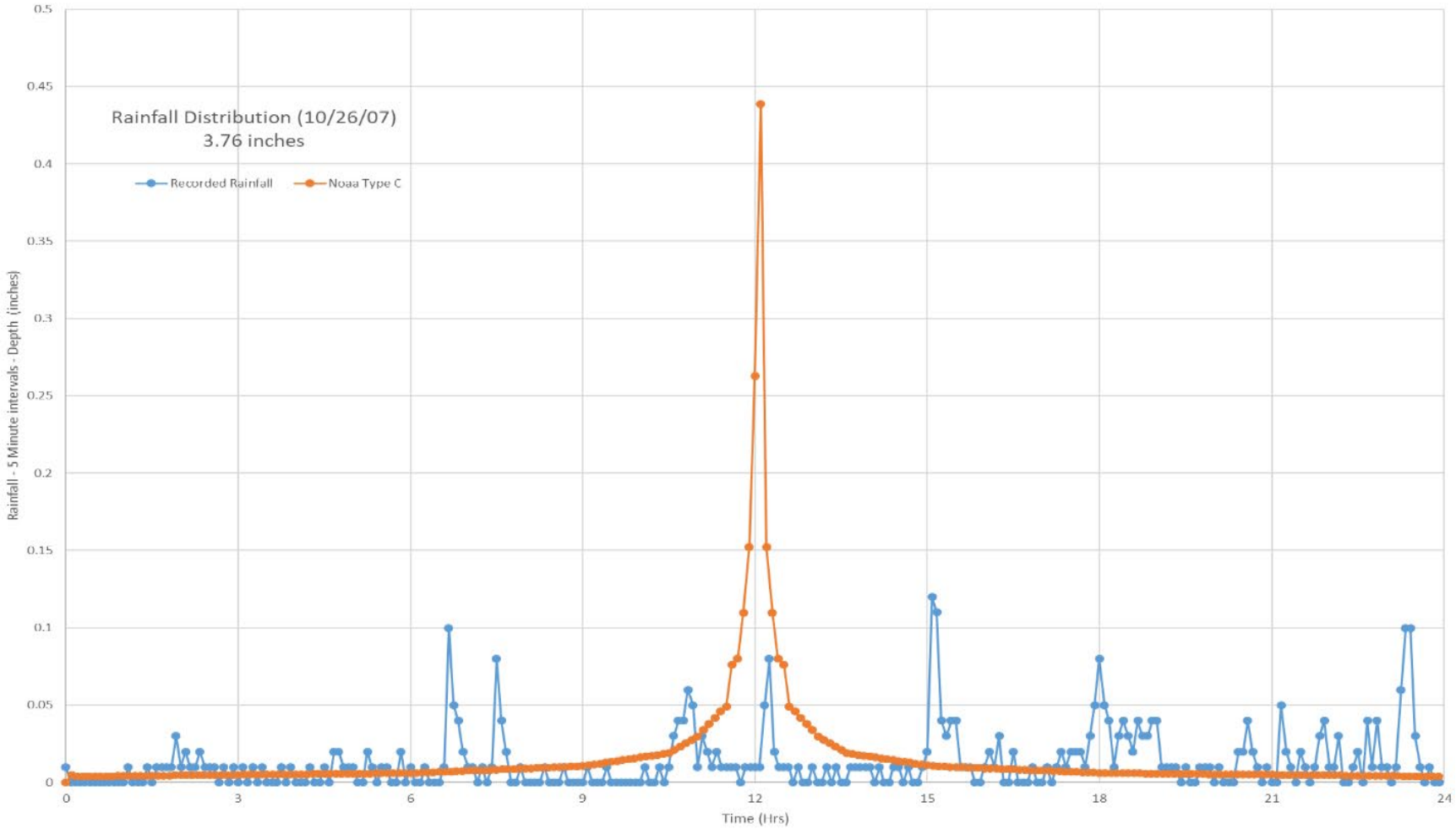
Post-Construction POI

- POI at most downstream Objective A or B SCM Outfall
- Objective C MRC SCM assumed to meet water quality
  - MRC SCMs and Objective A SCM can be assumed met and left unanalyzed (right)
- Objective D not considered to have a significant WQ Benefit.
  - ASCE International Database does show small reduction in inflow to outflow concentration



Peak – Design Storm Approach

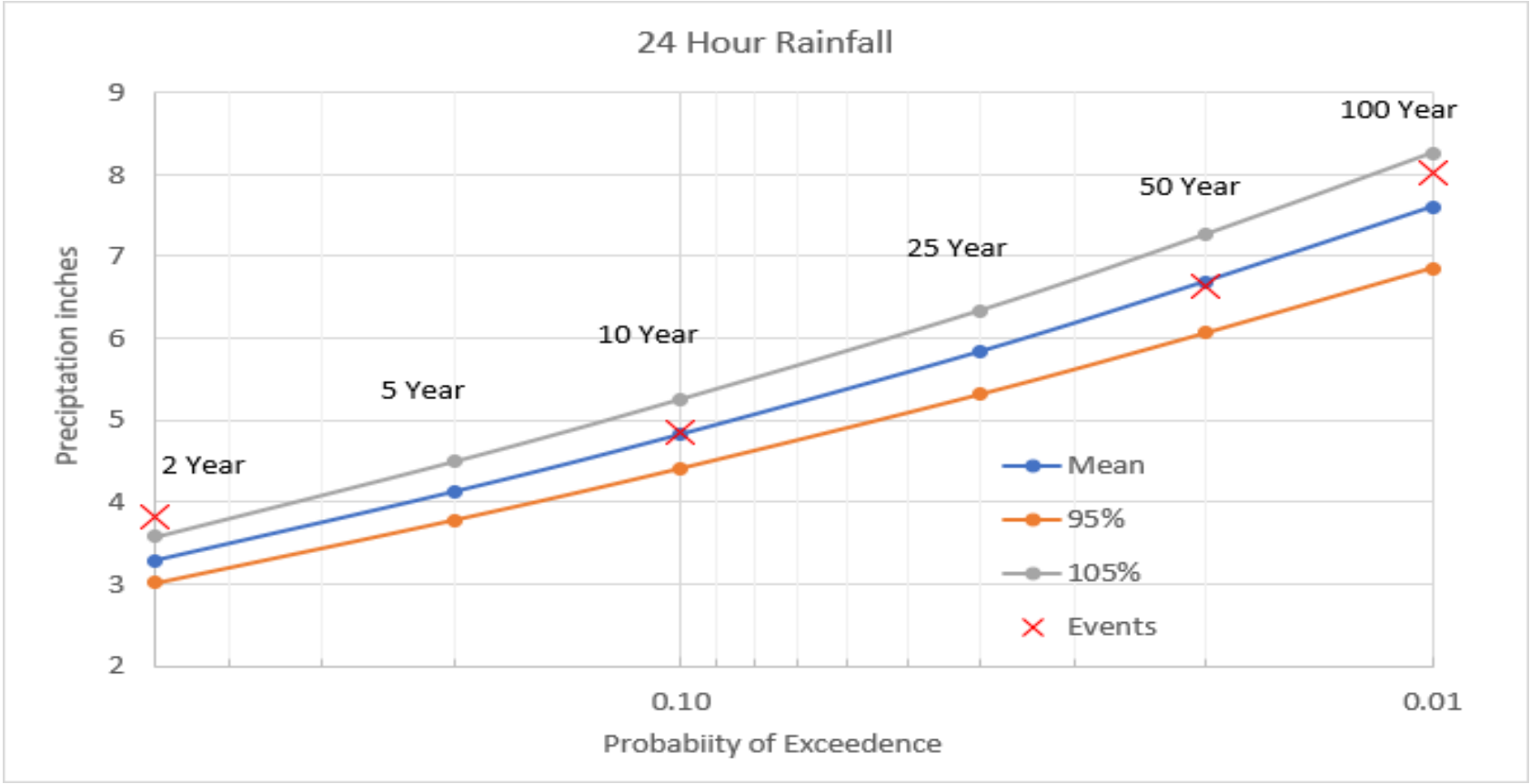
- **PA Code § 102.8.(g)(3):** *"manage the net change in peak rate for the 2-, 10-, 50-, and 100-year/24-hour storm events in a manner not to exceed preconstruction rates."*
- Real storm events are often not well represented by the center peaking distribution
- Median NOAA-14 depths for the 24-hour storms



Peak Rate – Storm of Record Approach

- Select storms from the period of record to represent the 2-, 10-, 50, and 100-year/24-hour NOAA-14 volume.
- 2-,10-, 50-year/24-hour storms must fall within the 90% CI of the NOAA 14 data

- 100-year/24-hour storms
  - use a value that exceeds the mean
  - If not available, use one within the 90% CI
  - If not available, use next largest storm greater then 50-year frequency
  - Or use design storm



Goal is to be able to run data from one data set to address peak.

Questions?

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Mark Bowen, PE, CFM, CCR, NTM Engineering
Amanda Hess, PhD, PE, Villanova University