The New England Stormwater Retrofit Manual:

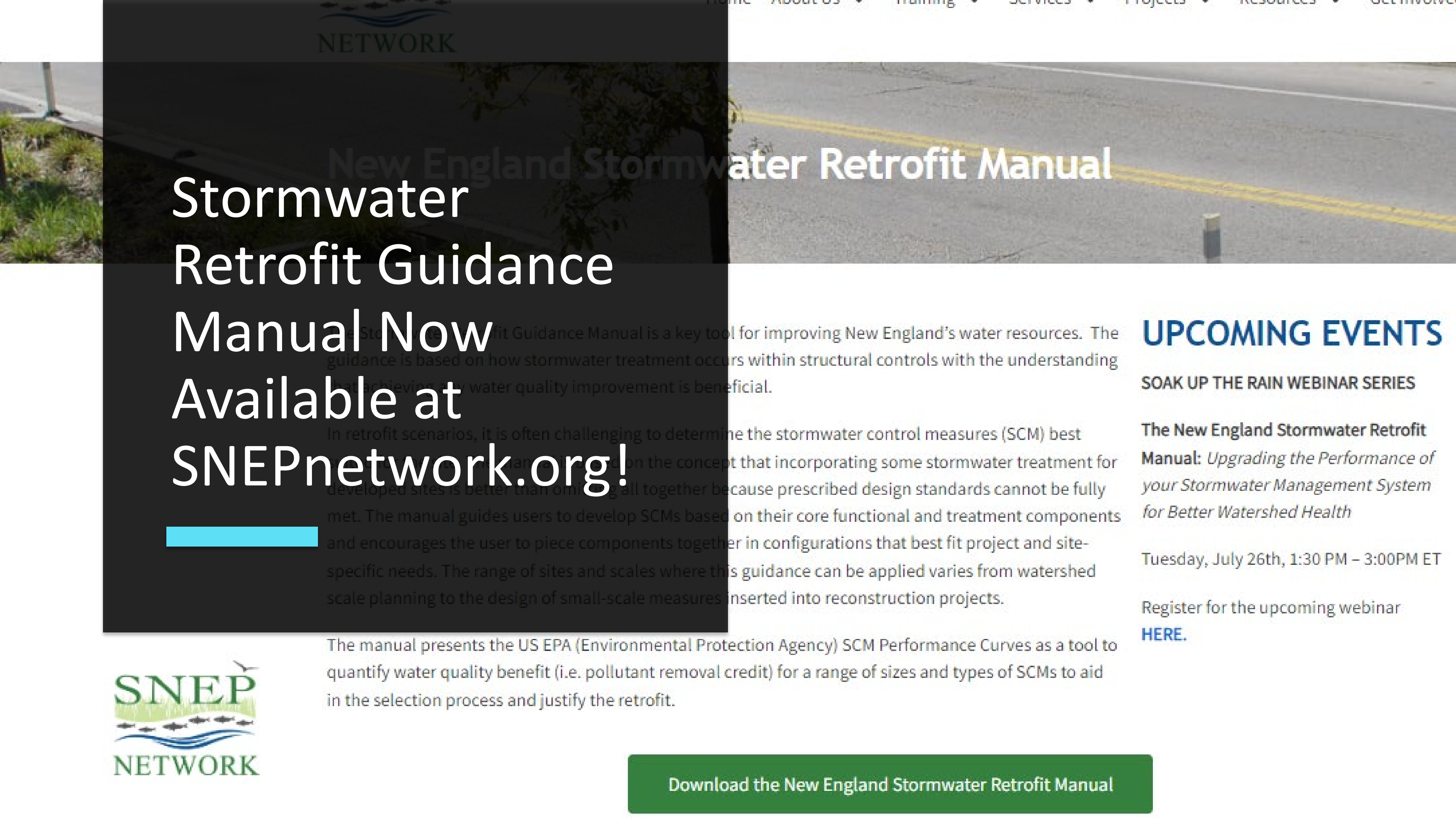
Upgrading the Performance of your Stormwater Management System for Better Watershed Health

Tuesday, July 26th, 1:30 PM – 3:00PM ET

Soak up the Rain New England Webinar Series

soak up the rain
created by U.S. EPA

Stormwater Retrofit Guidance Manual Now Available at SNEPnetwork.org!



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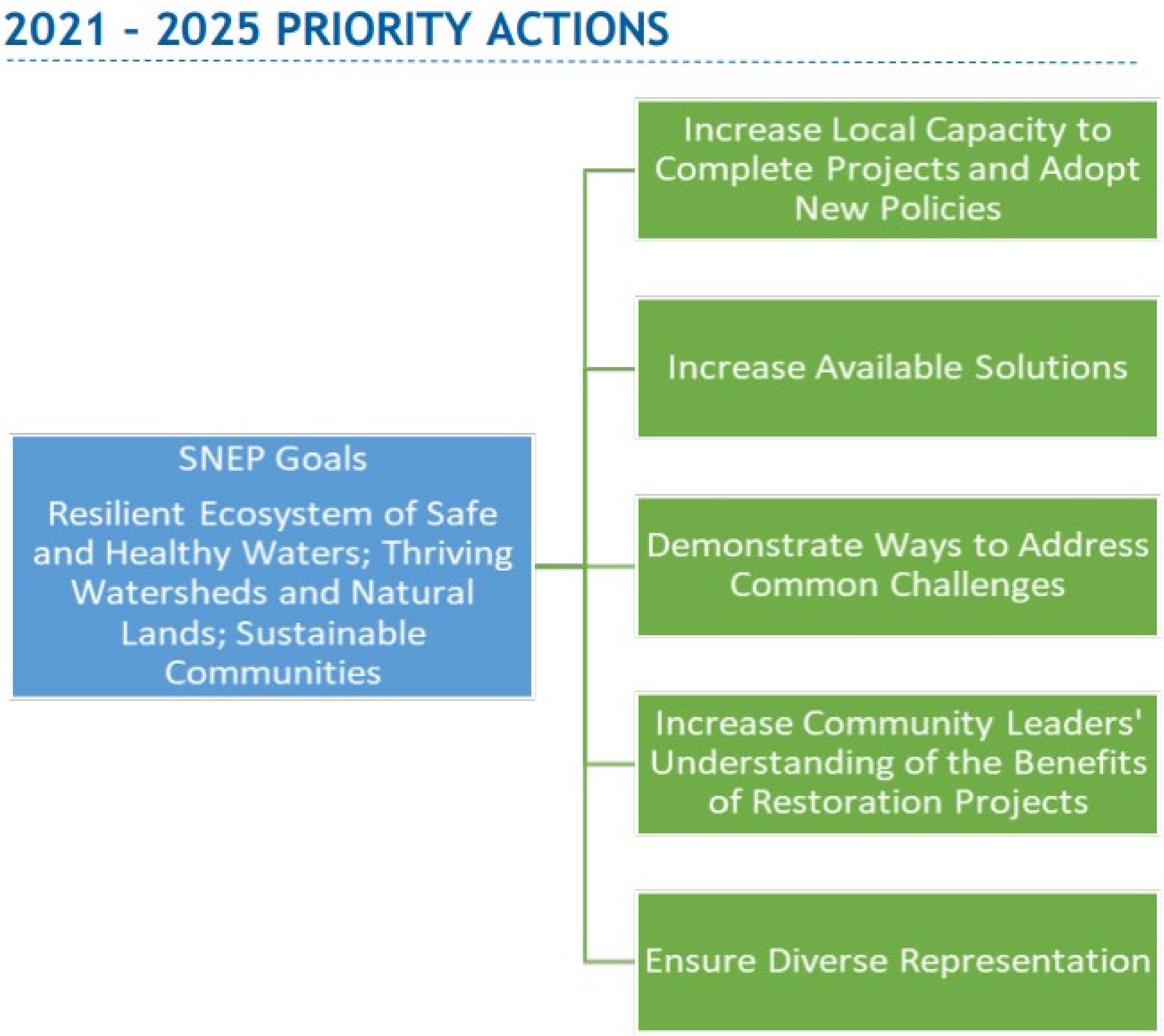
Today's Speakers

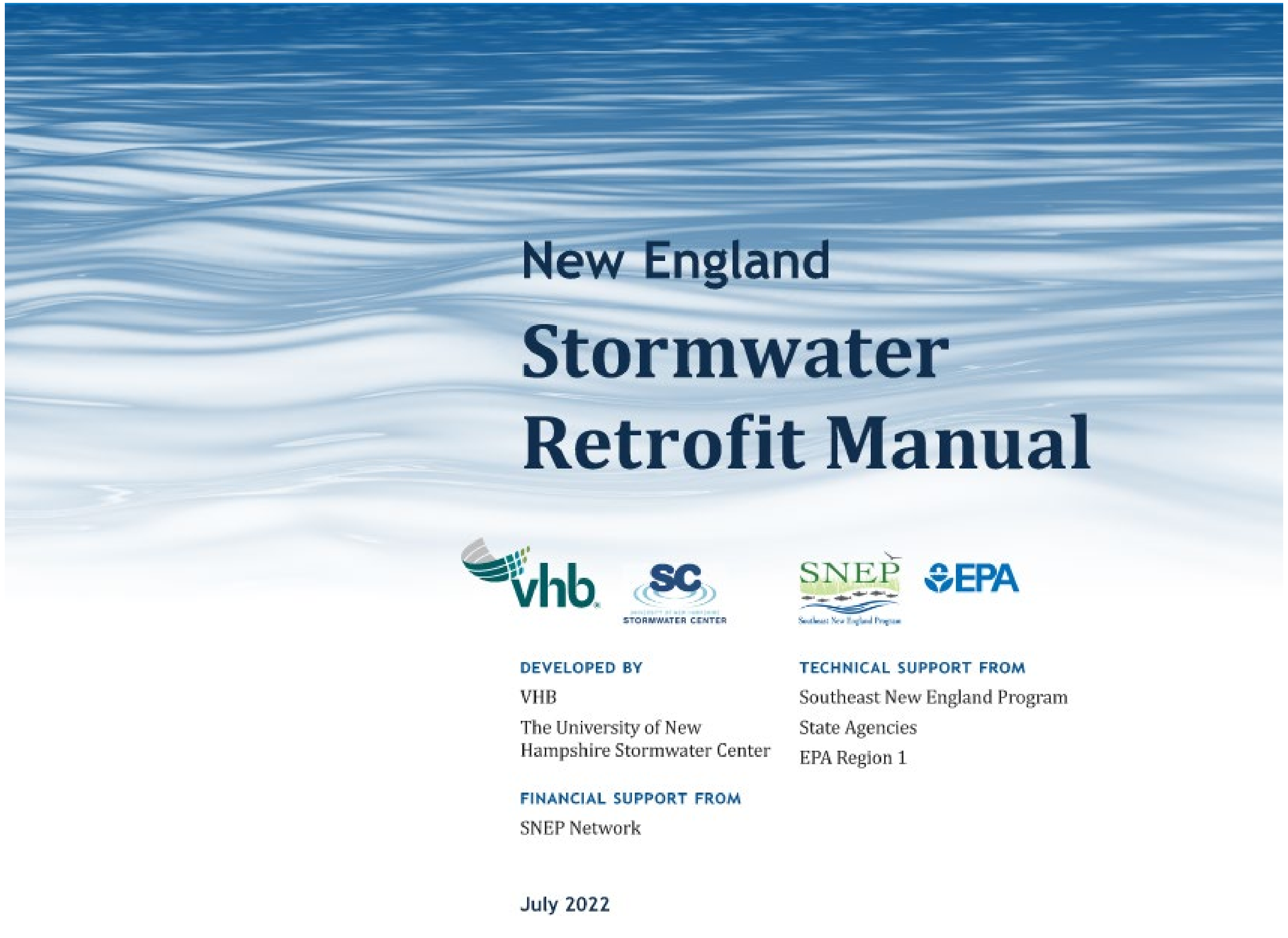
Southeast New England Program (SNEP) Network Context



Source: [Southeast New England Program Fact Sheet, February 2021 (epa.gov)]

Outline Slide

- Manual Introduction
  - Goals/Why It Matters
- Manual Highlights
  - Planning and Crediting
  - Retrofit Design Approach
  - Breaking through Prescriptive Design Guidance
- Manual Applications


New England
Stormwater
Retrofit Manual

DEVELOPED BY
VHB
The University of New Hampshire Stormwater Center

TECHNICAL SUPPORT FROM
Southeast New England Program
State Agencies
EPA Region 1

FINANCIAL SUPPORT FROM
SNEP Network

July 2022

Goals of New England Stormwater Retrofit Manual

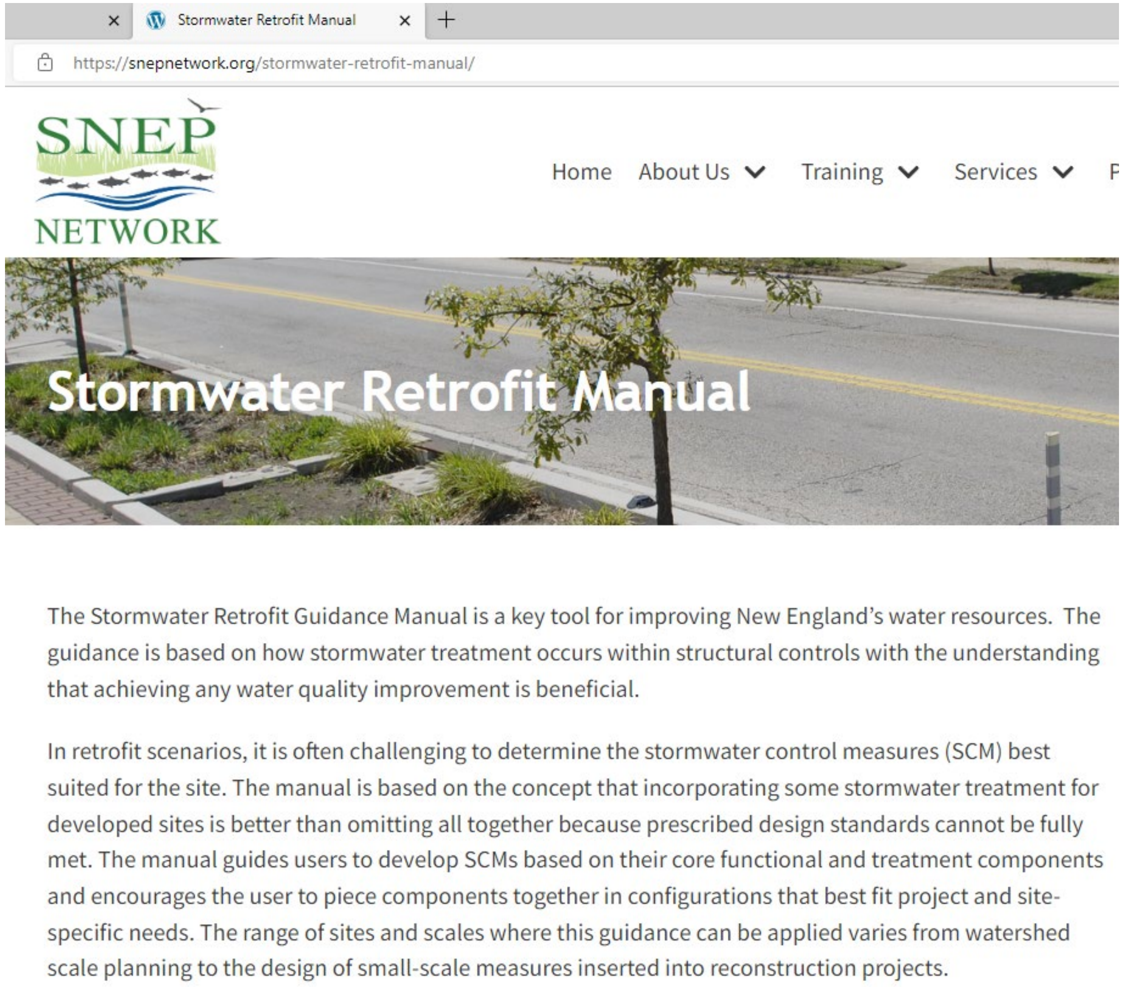
- **Retrofit:** the addition of stormwater controls on a currently developed site

Source: Arlington Installs New Rain Gardens to Reduce Stormwater Pollution

Goals of New England Stormwater Retrofit Manual

- Provide **research-based guidance** on planning, siting, and designing retrofit stormwater control measures (SCMs)
- Present a framework for **selecting the optimal SCM** for a specific project/site
- Present an approach for **crediting pollutant and runoff volume reductions** associated with these SCMs

** where regulatory requirements to not dictate prescribed specifications*

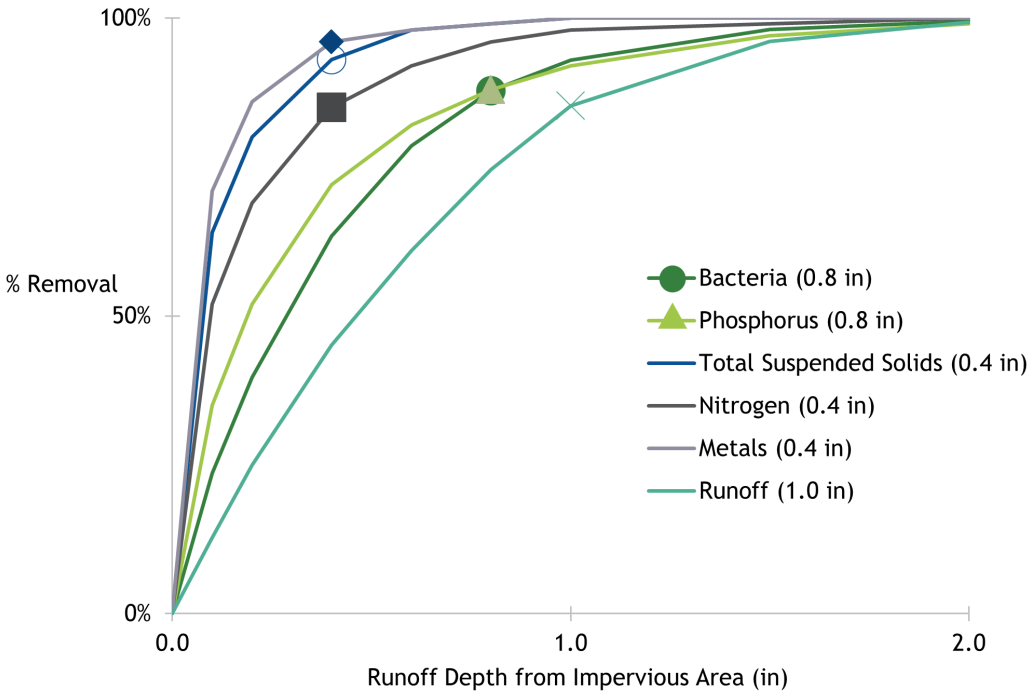


Why this Manual Matters

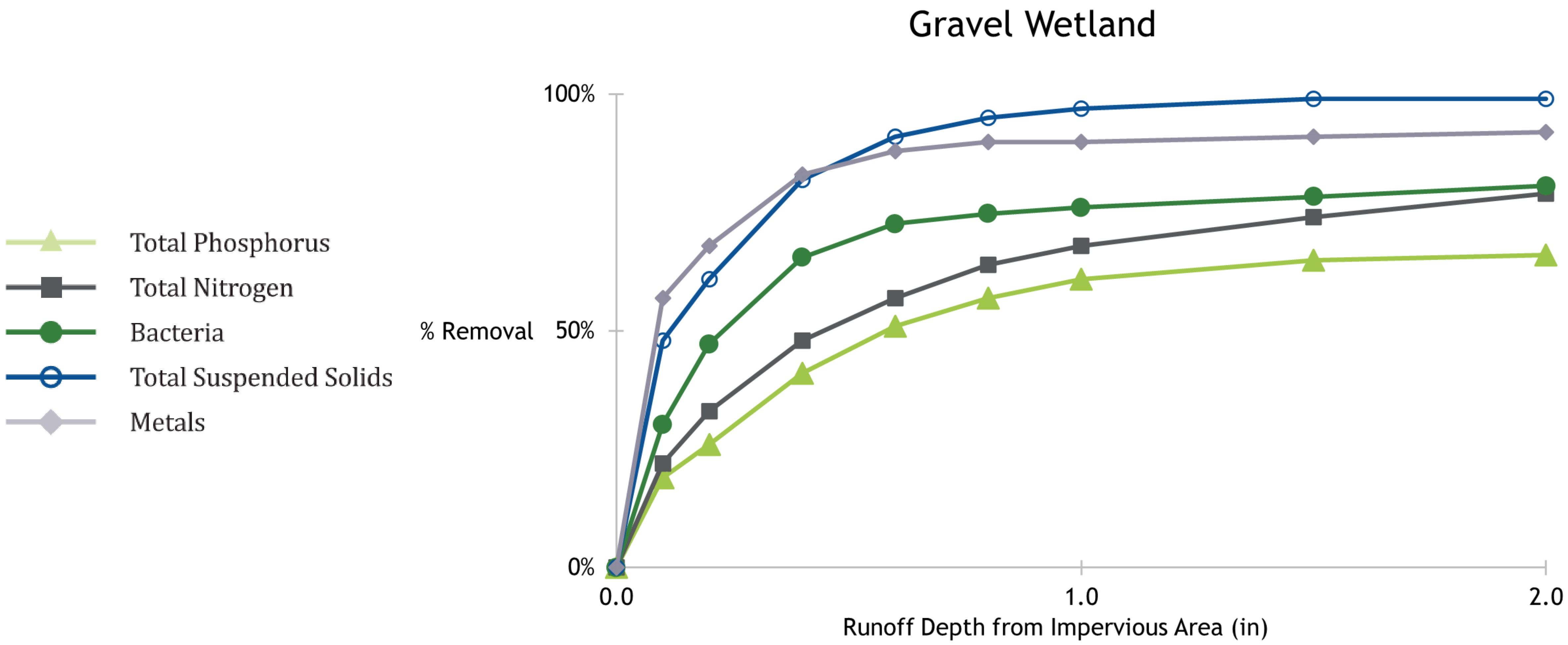
This manual…

- Encourages designers to **move beyond prescriptive new/redevelopment mindset**
- Helps designers **piece SCM components together to arrive at the best SCM** to meet project and site-specific needs
- **Promotes the use of EPA-developed water quality crediting methods** to quantify SCM impact

Manual Highlights: Stormwater Control Measure Performance Curves



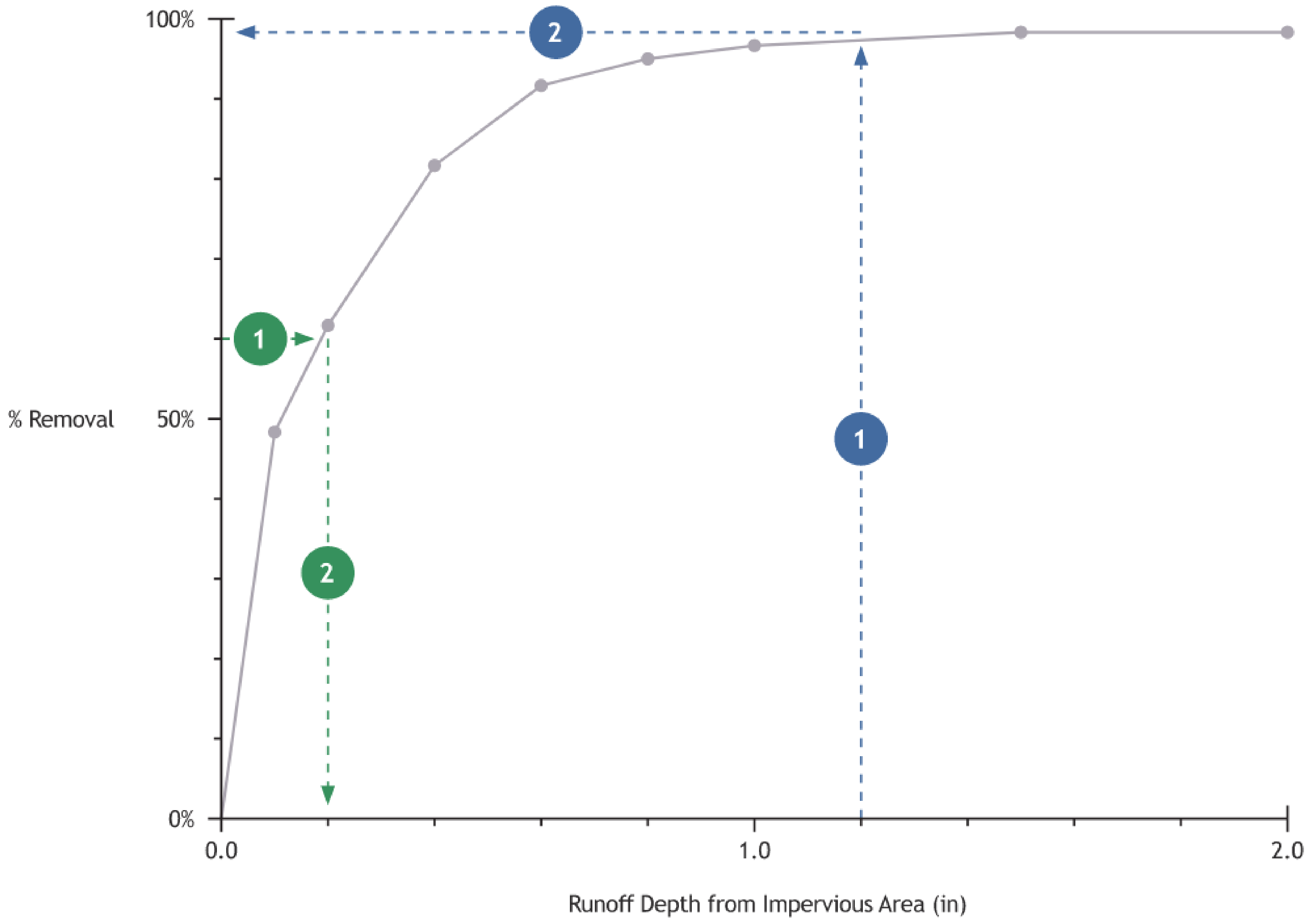
SCM Performance Curves



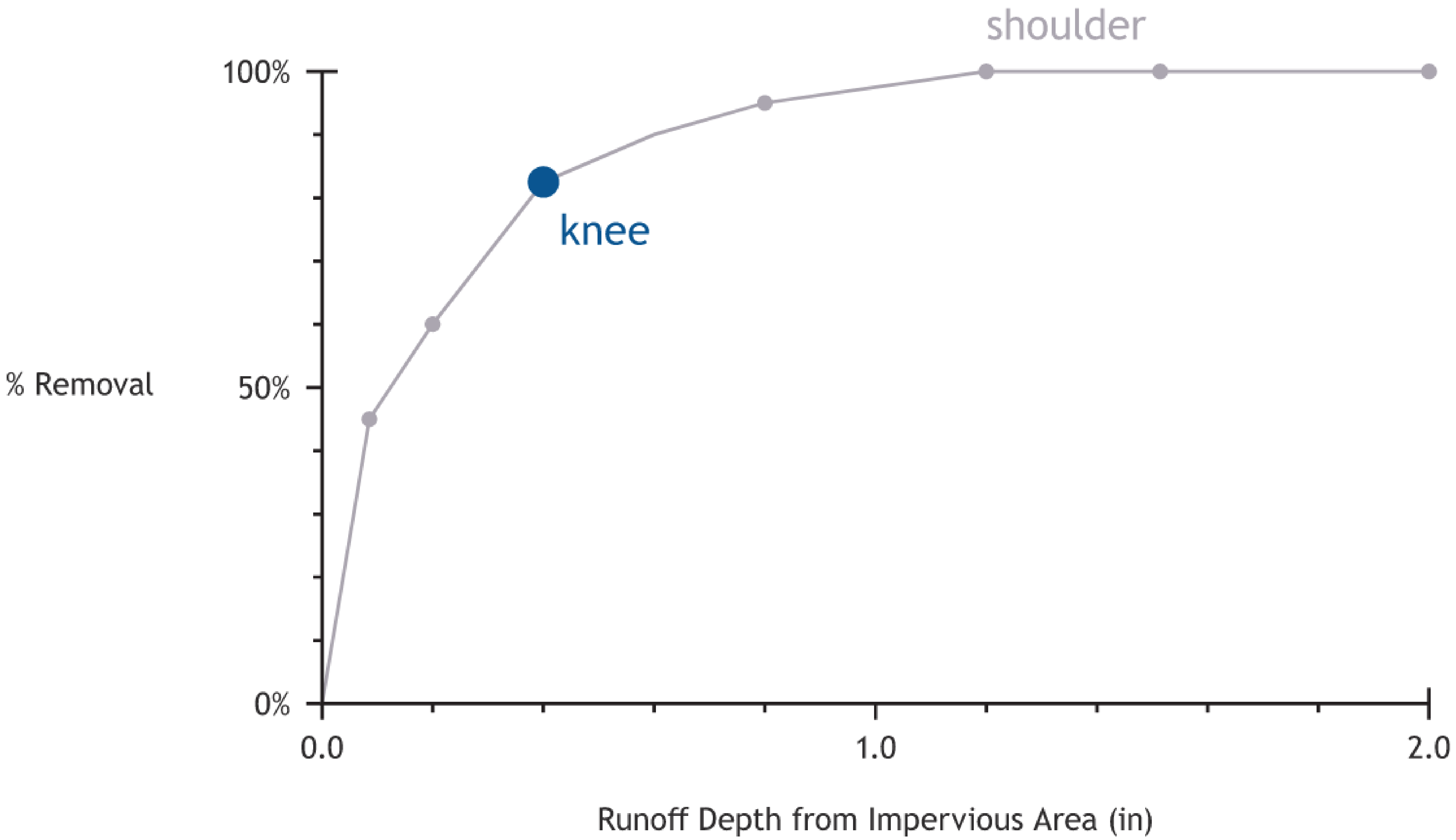
*See our handout for more information on SCM Performance Curves and how to utilize them!

1. If a designer is working on a site where a pollutant reduction of 60% is desired ...
2. ... the designer would use the curves to determine that a Runoff Depth from Impervious Area of approximately 0.2 inches achieves the desired reduction

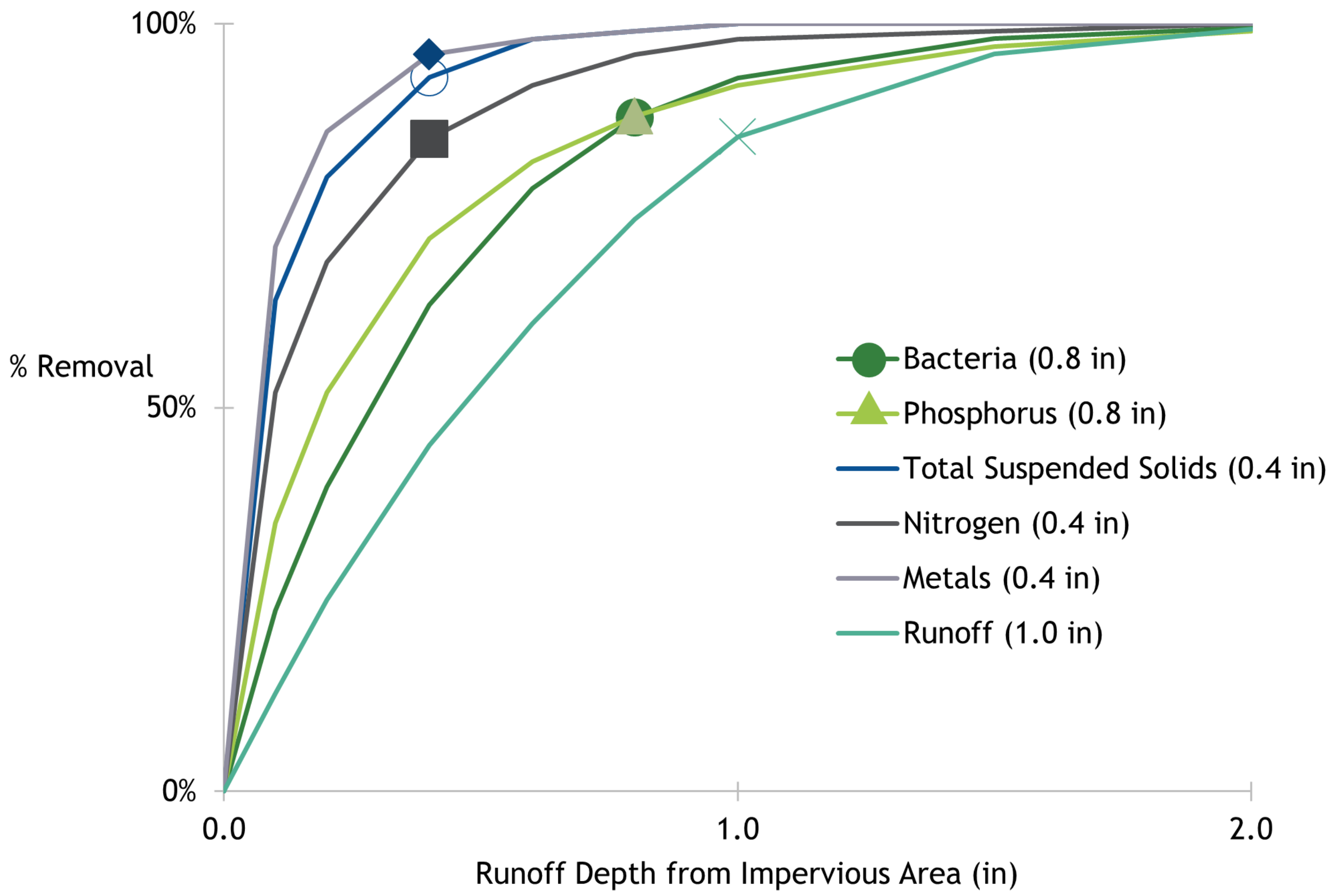
1. If a designer determines that their SCM provides a DSV equivalent to 1.2 inches from the Impervious Area ...
2. ... the designer would use the curves to determine a 98% pollutant reduction from this SCM



SCM Performance Curves: Finding the Cost-Optimal Size



Infiltration Basin (HSG C) with Cost Optimal Runoff Depths



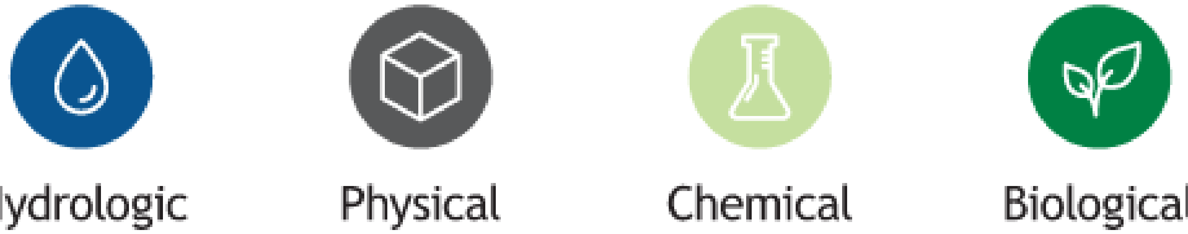
Manual Highlights: Planning Your Retrofit – SCM Selection Approach

SCM Selection and Design: Treatment Unit Operations and Processes (UOPs)

UOPs: Unit Operations and Processes

Operations: methods of treatment in which application of *Physical* and *Hydrologic* forces dominate.

Processes: methods of treatment in which *Chemical* or *Biological* activities are involved.



Selection and Design: Linking SCMs to UOPs and Performance Curves

Primary UOP	SCM Type	Performance Curve Category
Hydrologic: Infiltration ↔	Infiltration Swale ↔	Infiltration Basin
Physical: Filtration ↔	Rain Garden (with underdrain) ↔	Bio-Filtration
Biological: Nitrification/ Denitrification ↔	Gravel Wet Vegetated Treatment System ↔	Gravel Wetland

SCM Guidance: Putting It All Together

Functional Components
(Section 5.1)

» Collection & Distribution
» Pretreatment

Treatment Component(s) by Category
(Section 5.2)

» IA Disconnection
» Infiltration
» Media Filters
» Traditional

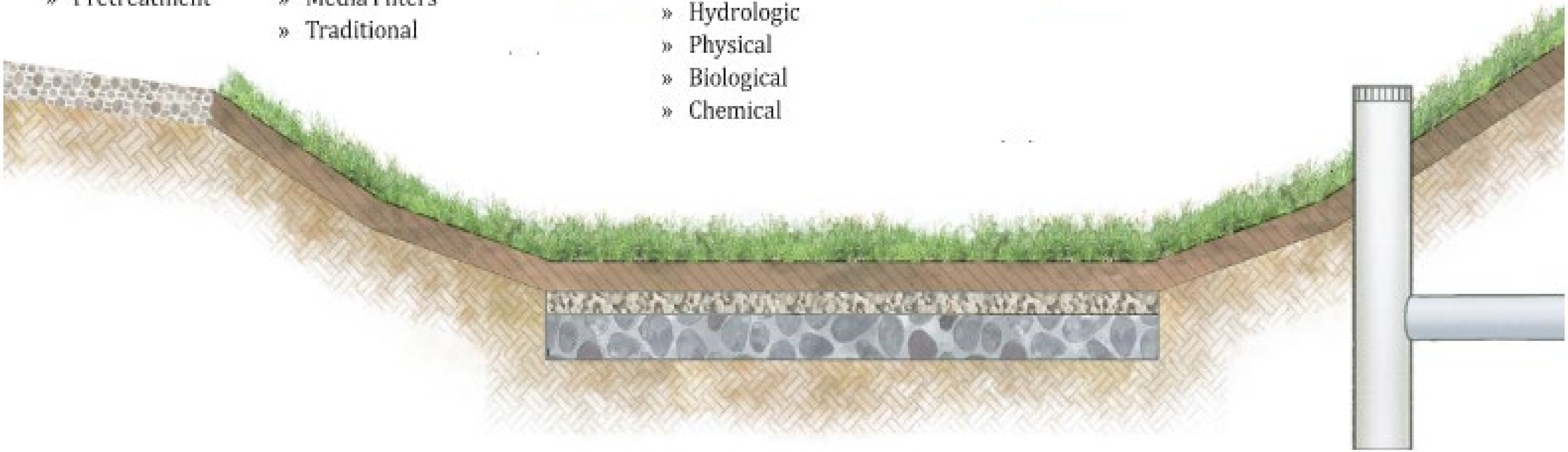
Unit Operations & Processes
(Section 4.2)

» Hydrologic
» Physical
» Biological
» Chemical

Performance Curves

Functional Components
(Section 5.1)

» Discharge



SCM Guidance: Putting It All Together

[Source: Rhode Island Department of Transportation Bio-Filtration Basin at Pawtucket/Central Falls Transit Center]

Manual Highlights: Breaking through Prescriptive Guidance

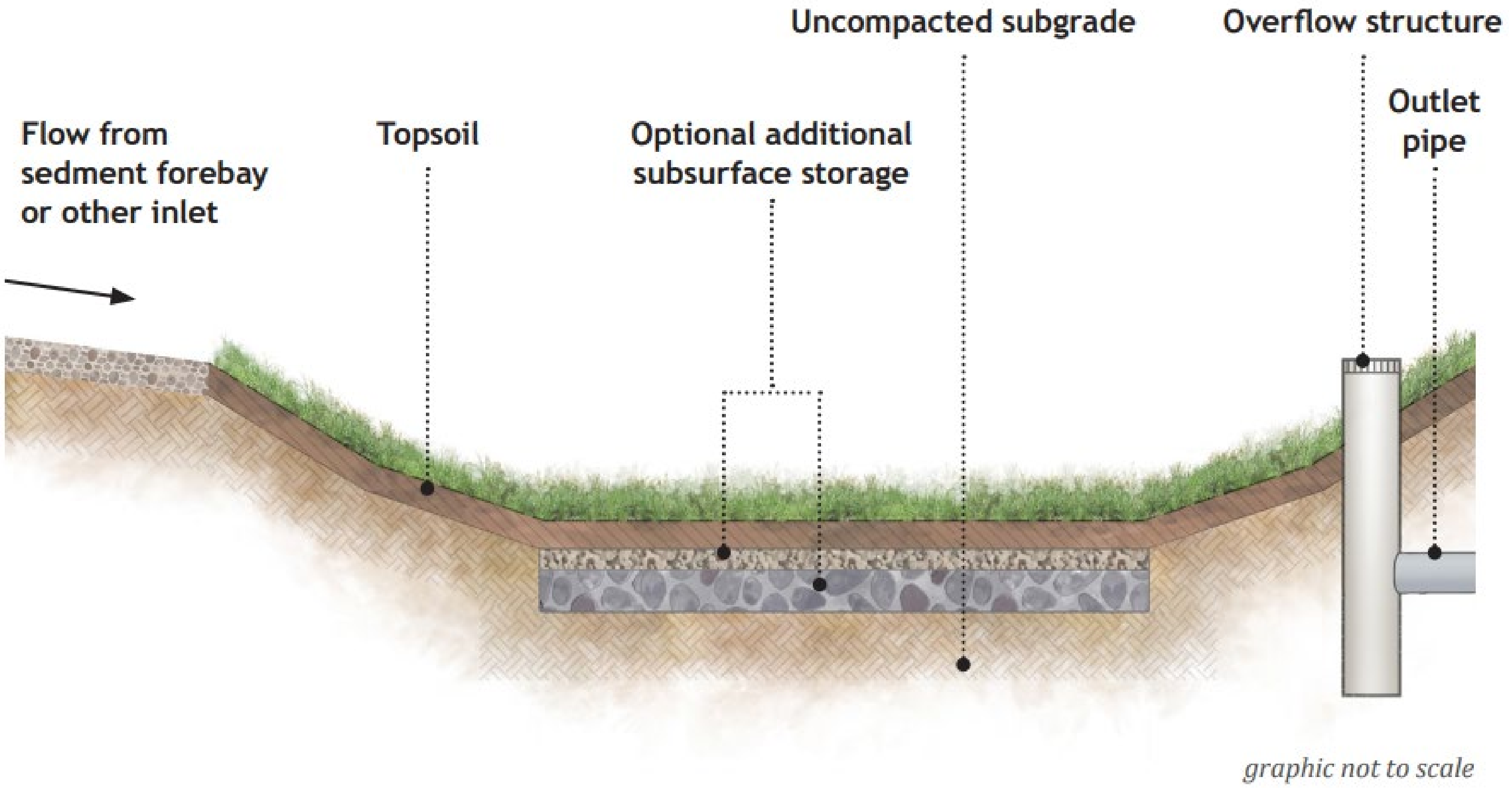
Breaking Through Prescriptive Guidance:
Separation to Groundwater/Bedrock

Current Typical Requirement:

Provide 1-3 ft of separation to groundwater/bedrock

Proposed Retrofit Guidance:

Provide 1 ft of separation to groundwater when possible (SCMs with a filtering layer should always provide 1 ft)



Breaking Through Prescriptive Guidance:
Flexibility for IA Disconnection Design Criteria

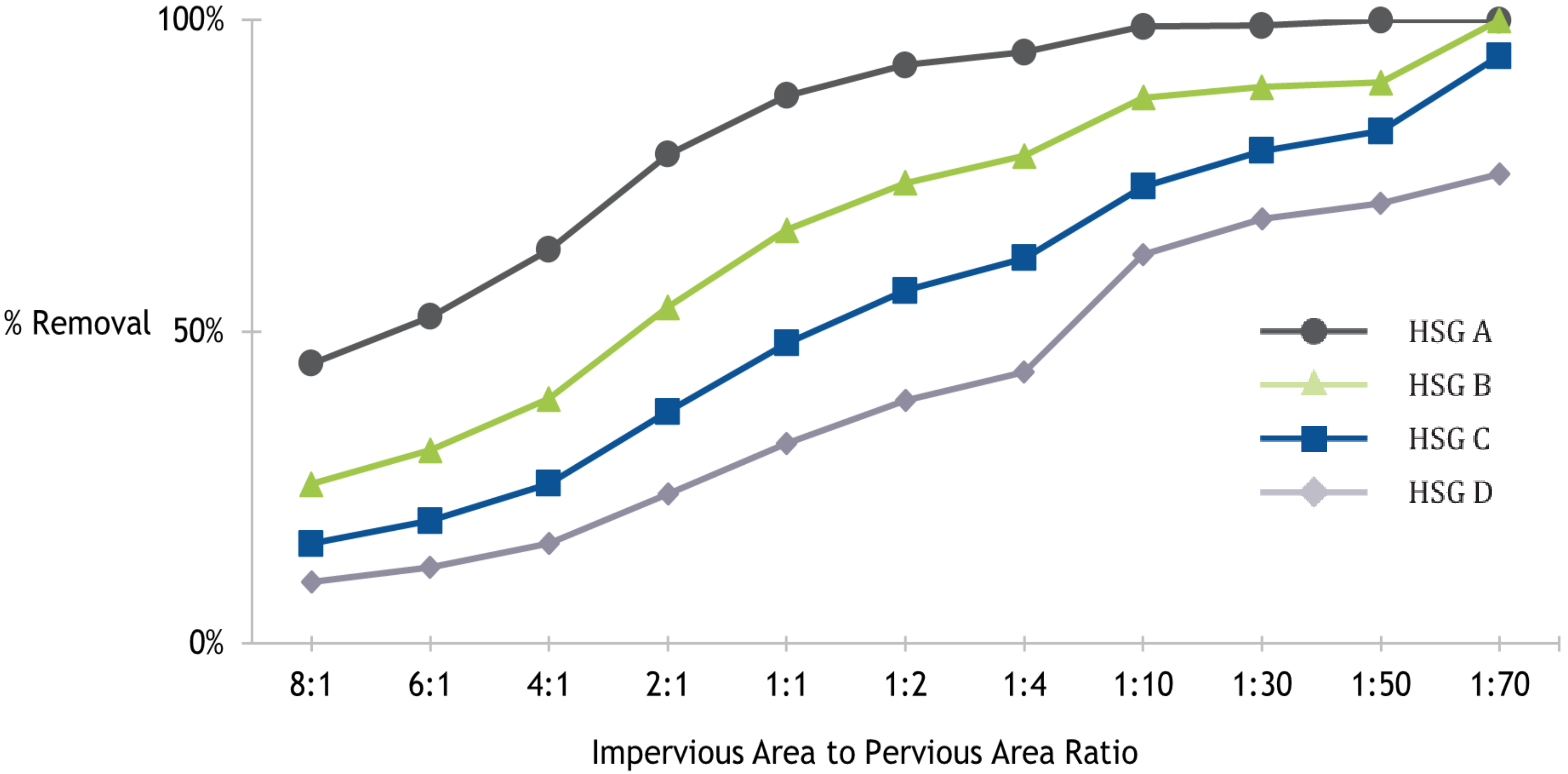
Current Typical Requirement:

Meet slope, length/width, contributing area, soils, vegetation, setback, and ownership criteria

Proposed Retrofit Guidance:

Provide IA Disconnection wherever possible and use the SCM performance curves to determine credit

Breaking Through Prescriptive Guidance:
Flexibility for IA Disconnection Design Criteria



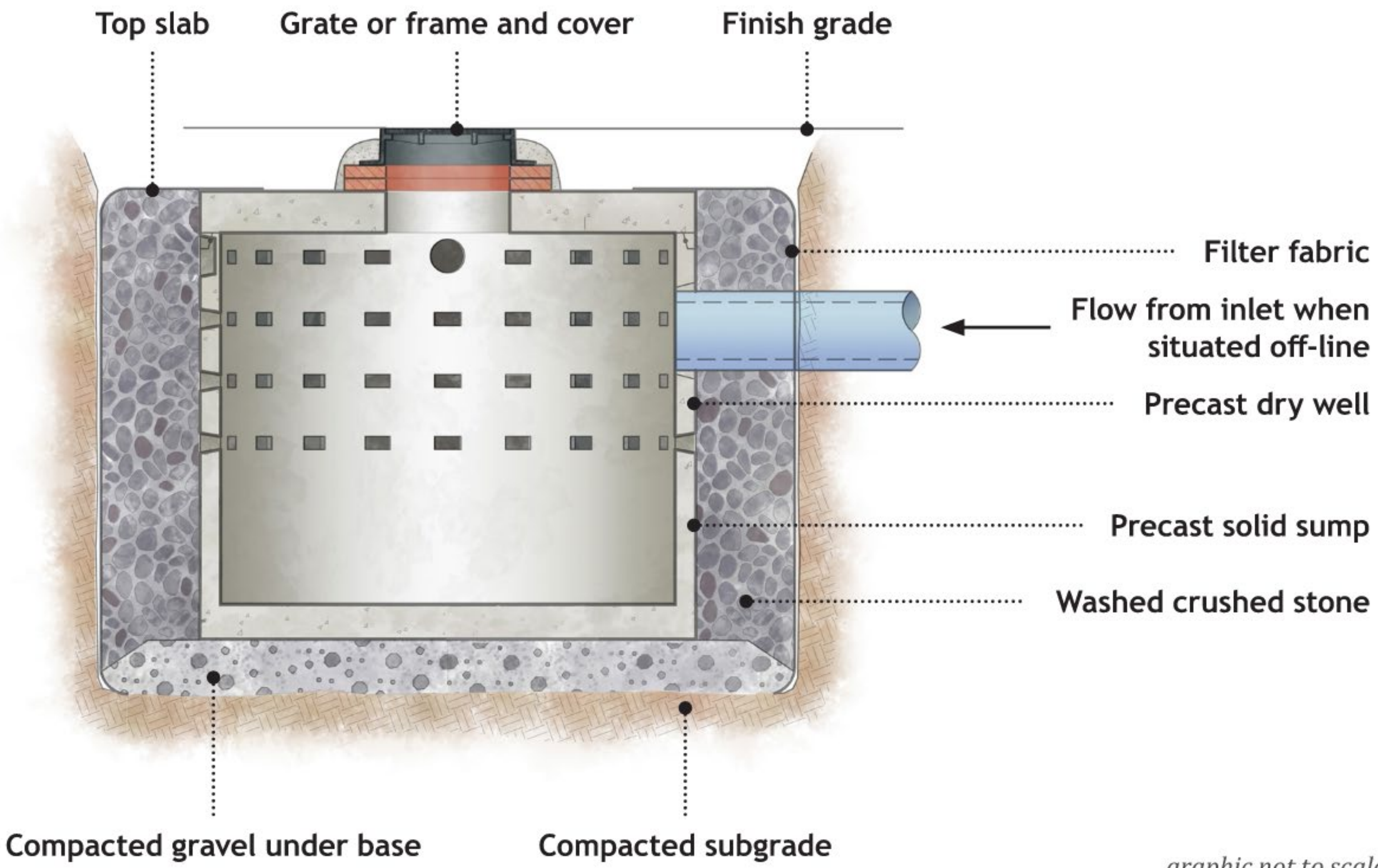
Breaking Through Prescriptive Guidance:
Pretreatment as an O+M Measure

Current Typical Requirement:

Prescribed pretreatment measure types and sizing criteria

Proposed Retrofit Guidance:

Provide pretreatment whenever possible



graphic not to scale

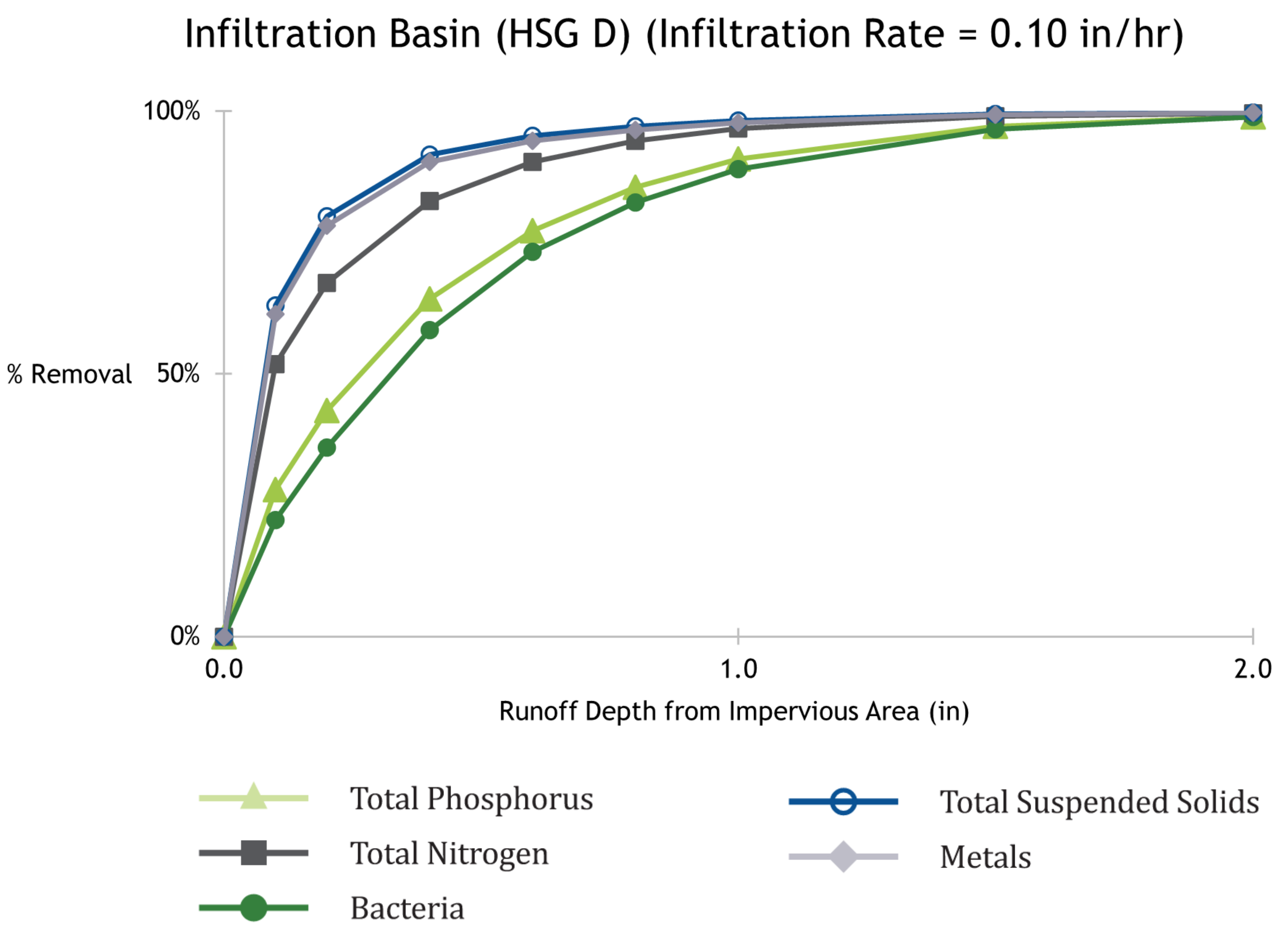
Breaking Through Prescriptive Guidance:
HSG D Infiltration

Current Typical Requirement:

Infiltration is not encouraged (and often not permitted) in HSG D Soils

Proposed Retrofit Guidance:

Consider infiltration whenever possible



Other Tools Provided in Manual

- Retrofit Site/Situation Considerations
- Tools utilizing the SCM Performance Curves to experiment with SCM Type/Size
- Considerations for retrofitting "traditional" approaches
- I+M Planning Considerations and a compiled list of I+M Manuals
- Retrofit-specific design guidance/considerations for individual SCMs

Infiltration

Variation-Specific Design Considerations

Outlet controls should be considered as a means to retain runoff through mechanisms such as impermeable check dams and raised outlet control structures. In addition, maximum depths for design events should be evaluated to ensure no flooding of adjacent infrastructure.

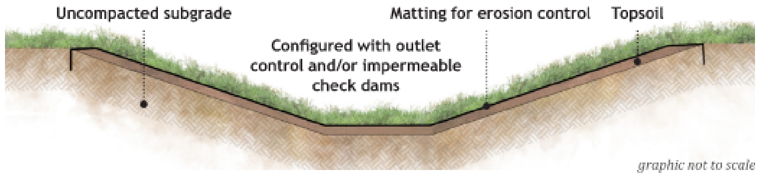
Flow velocity should be zero for the DSV of the SCM; there should be no flow in the system, and therefore all captured runoff will be stored and infiltrated. Flow velocities for larger design events should be evaluated to avoid erosion and resuspension.

Check dams are often included to isolate cells within the linear basin. Check dams should have an impermeable core to force retention and vertical infiltration. Surface treatments of the check dam can vary to support maintenance needs.

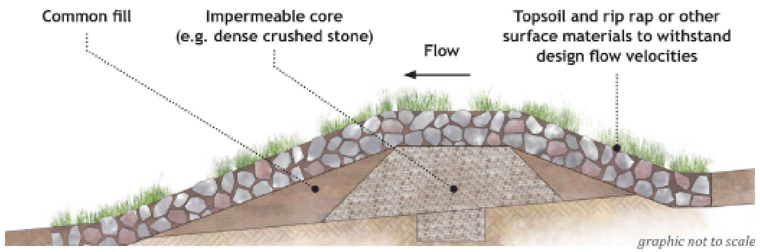
Linear Configuration

Linear Configuration SCMs are basins configured within more linear areas. They contain one or more cells designed to store and infiltrate stormwater into the underlying soils. Overflows are commonly conveyed in the linear system like a swale.

Infiltration Linear Configuration



Check Dam



Well suited for sites with...

≈ A linear stretch of above-ground space (such as a roadway shoulder, a roadway median, or dividing areas within large parking lots)

Not well suited for sites with...

≈ Contaminated underlying soils

≈ Steep slopes

Manual Highlights: Examples of Using Manual Concepts

Retrofit Approaches

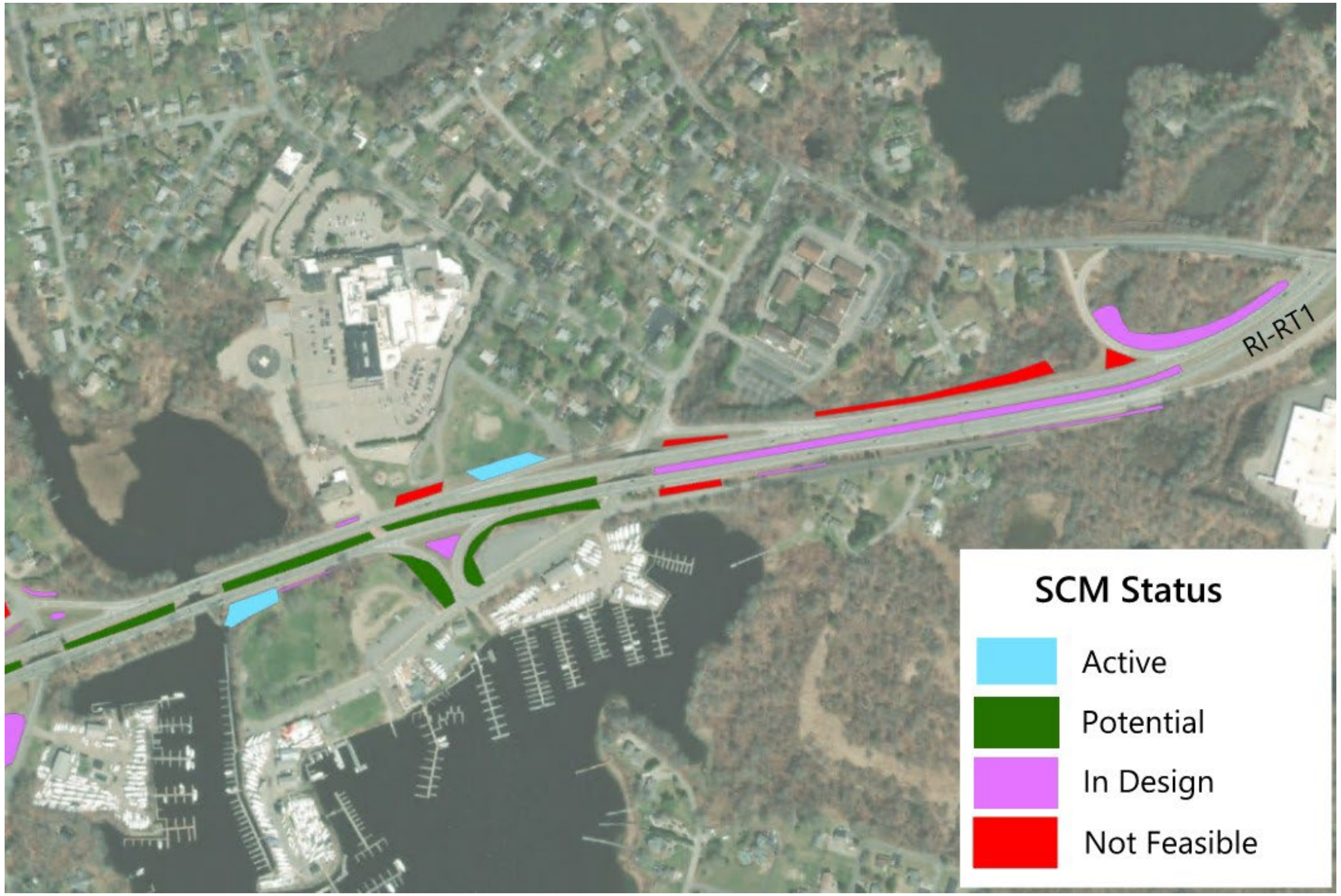
Planning Approach

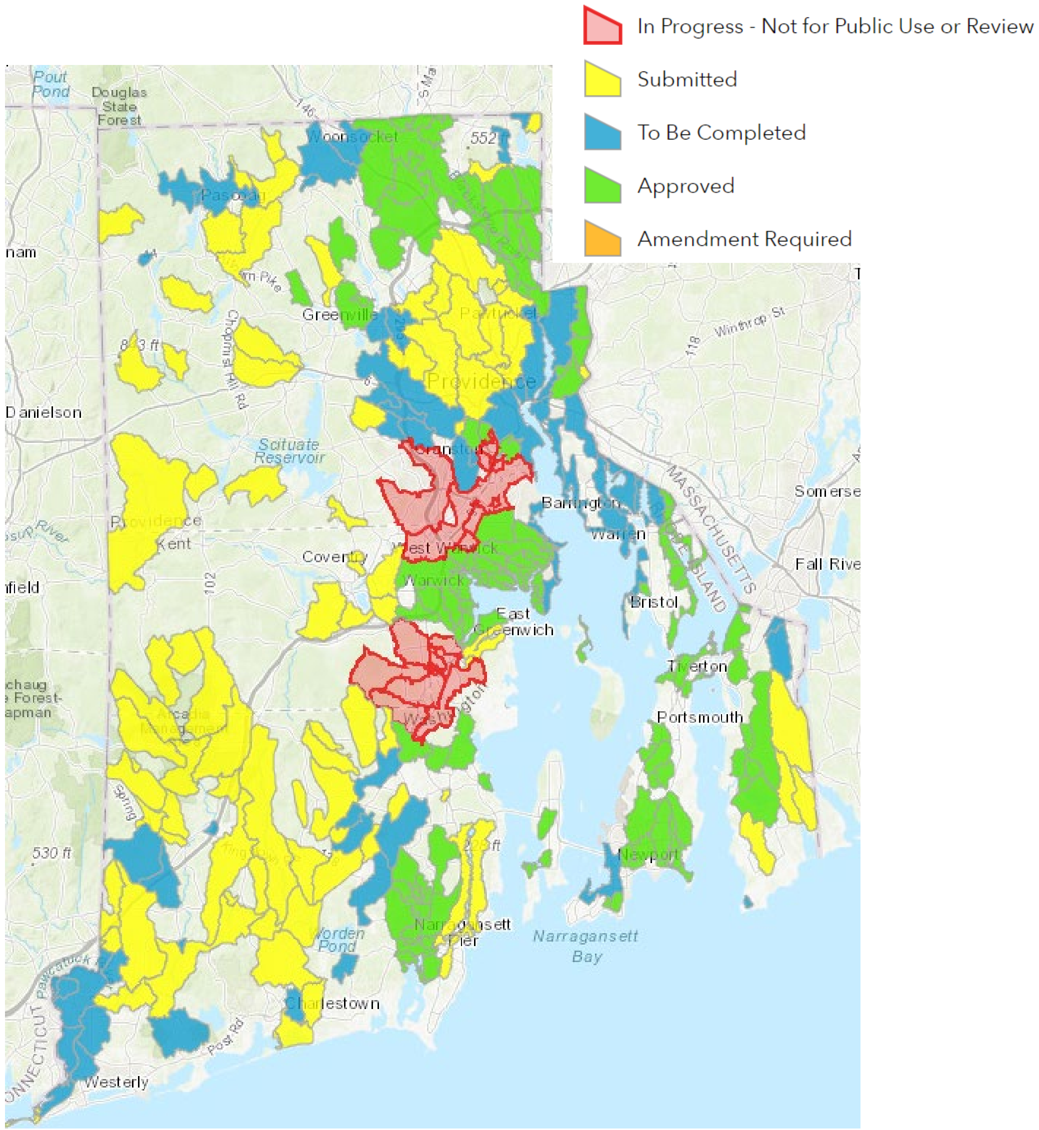
- Proactively planning retrofits and prioritizing sites
- Steps:
  1. **Understand and Quantify Goals**
  2. **Identify Potential Sites**
  3. **Identify SCMs**
  4. **Prioritize Sites and Controls**
  5. **Implement SCMs**

Opportunistic Approach

- Incorporation of SCMs into already planned and needed construction projects
- Key Considerations:
  - **Be proactive in identifying opportunities.**
  - **Develop a suite of typical SCMs.**
  - **Be willing to be flexible with the project specifications**
  - **Tailor the scale and type of SCMs to the project**

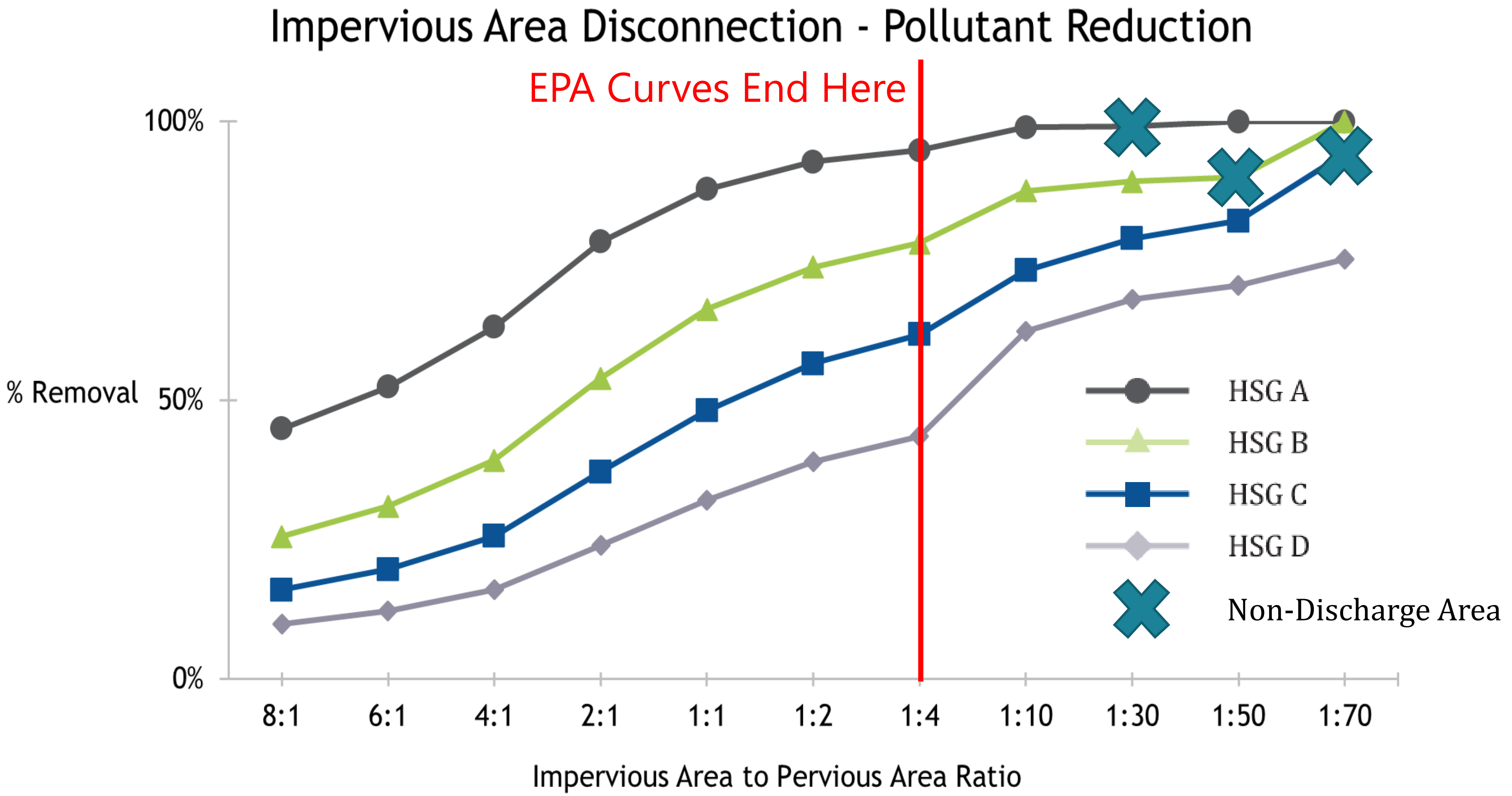
Planning Approach: Rhode Island Department of Transportation Stormwater Control Plans





Source: RIDOT Stormwater Program Public Web Mapping Application

Planning Approach: Rhode Island Department of Transportation Stormwater Control Plans

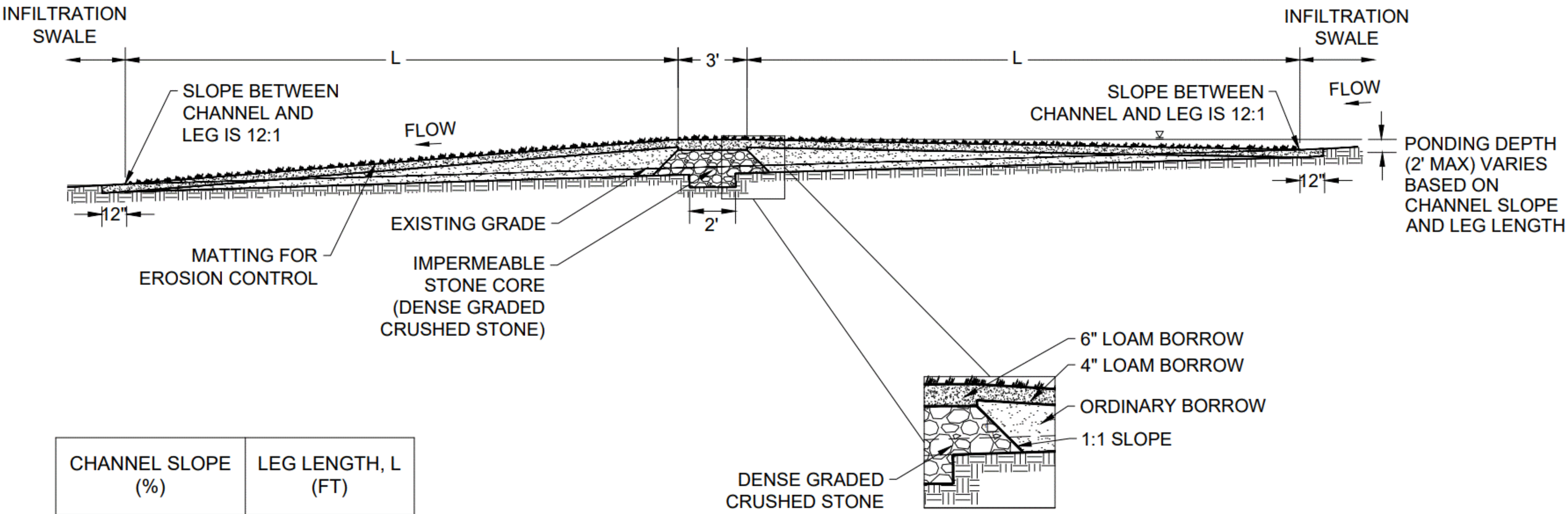


Planning Approach: Rhode Island Department of Transportation Stormwater Control Plans

Challenges/Lessons Learned

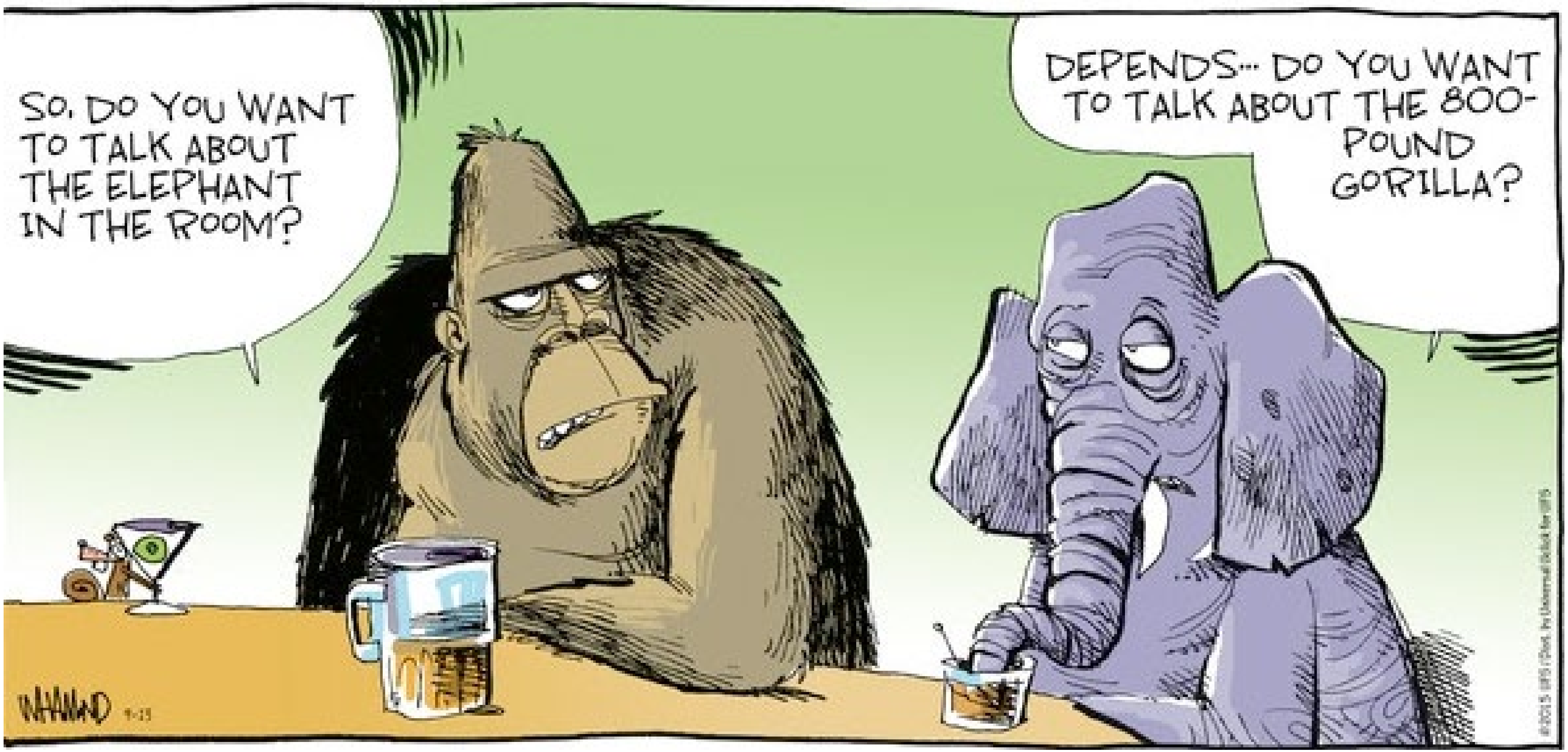
- Working with designers who have regulatory requirements ingrained
- Providing enough treatment to meet goals
- Developing new credits for new SCMs
- Approaches to prioritization

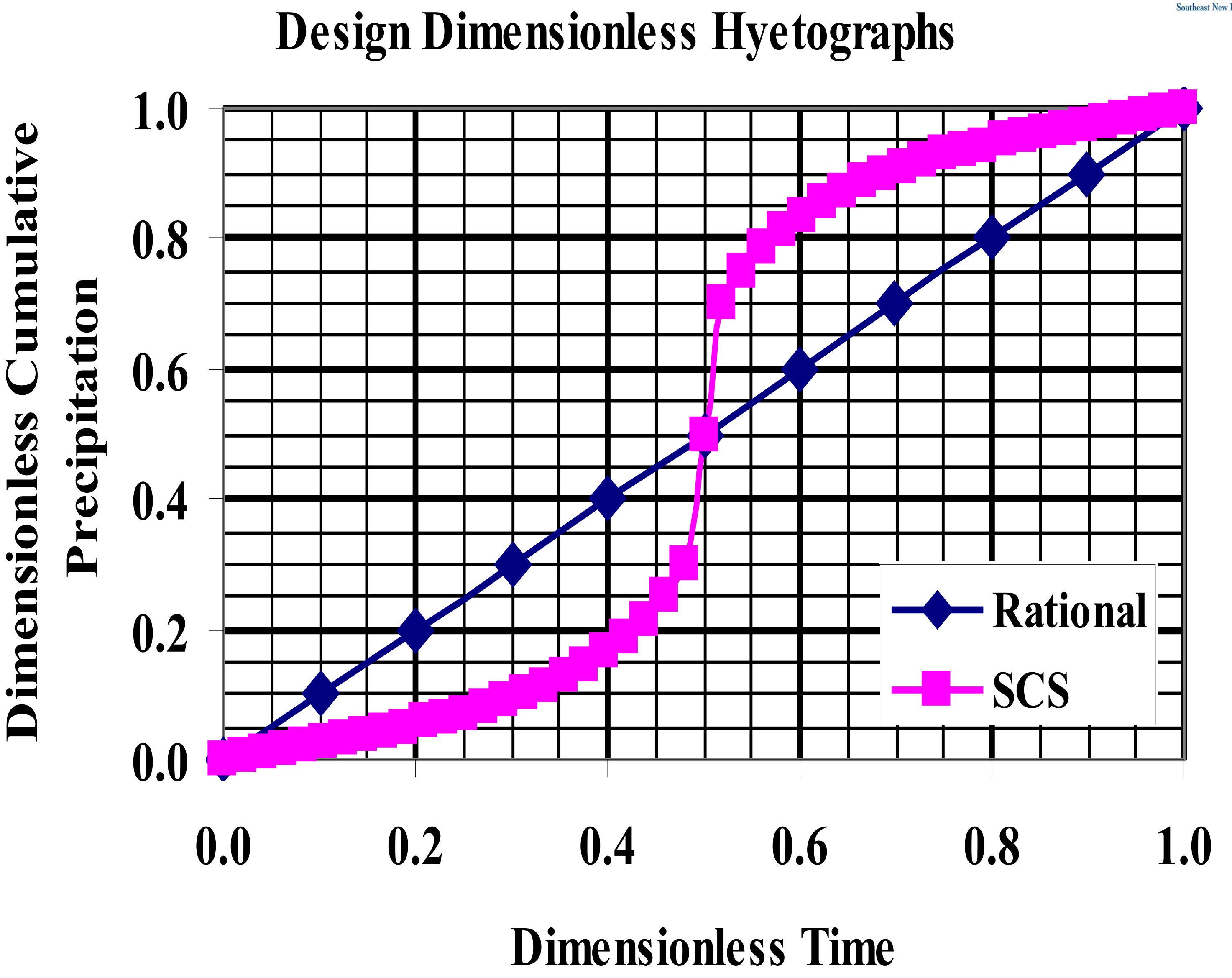
Opportunistic/Planning Approach: MassDOT Check Dams

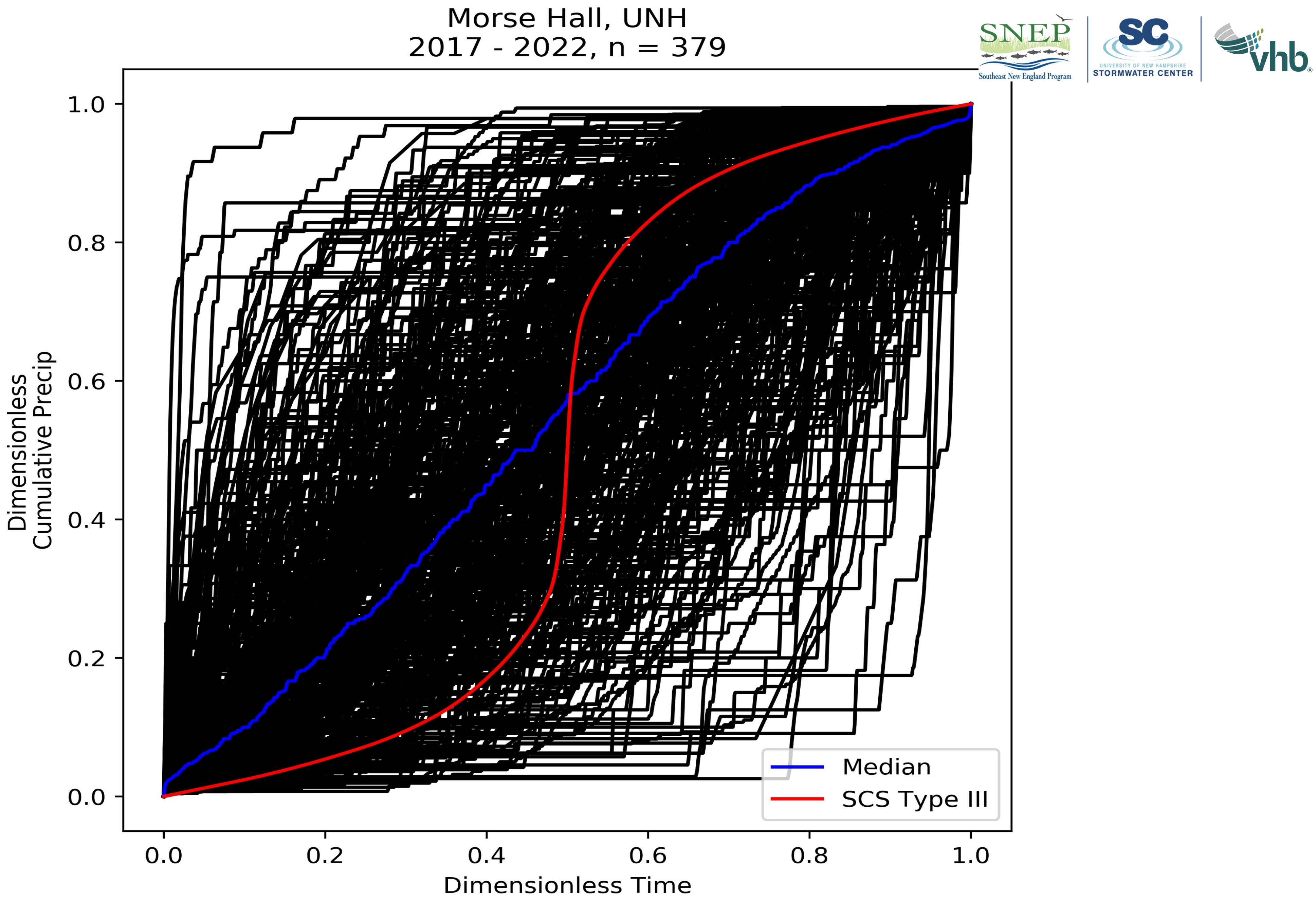


CHANNEL SLOPE (%)	LEG LENGTH, L (FT)
0 - 2.8	24
>2.8 - 5.0	36

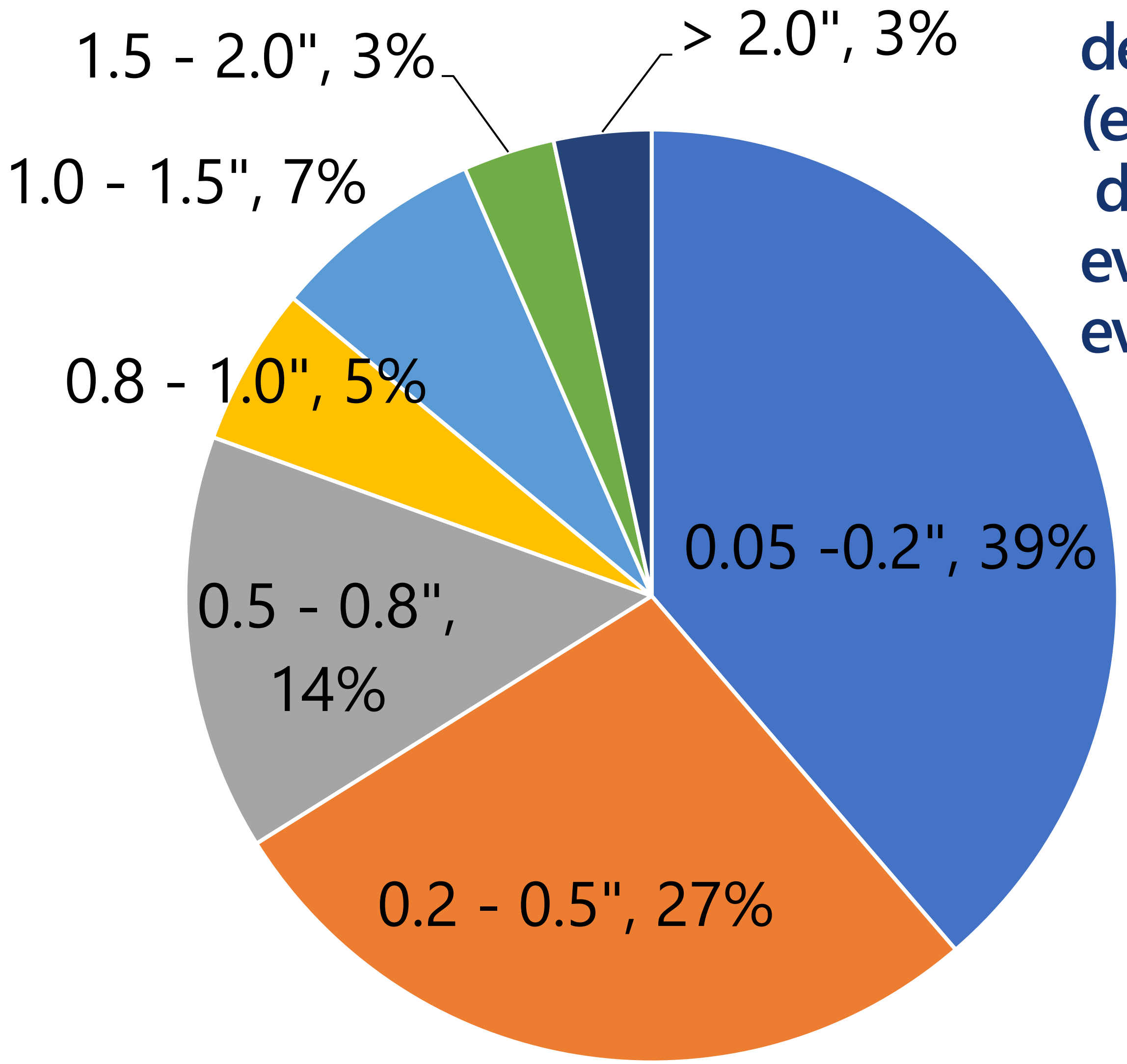
Yes, climate change gives us pause to think, but IC is the 800-pound gorilla




Design Dimensionless Hyetographs
Dimensionless Cumulative Precipitation
Dimensionless Time
0.0
0.2
0.4
0.6
0.8
1.0
Rational
SCS



Morse Hall, UNH
2017 - 2022, n = 379
SNEP
Southeast New England Program
SC
UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER
vhb
Dimensionless
Cumulative Precip
Dimensionless Time
0.0
0.2
0.4
0.6
0.8
1.0
Median
SCS Type III



Distribution of precipitation depth, Boston, MA 1992 – 2014 (excludes events with depths < 0.05 in. and defines an event by minimum 6-hour inter-event dry period

Sizing for Performance

Sizing Details

System	WQV ft³ (m³)	Actual WQV ft³ aka DSV (m³)	% of normal design	Rain Event in aka PSC (mm)	Sizing Method
SGWSC	7,577 (214.6)	720 (20.4)	10%	0.10 (2.5)	Static
IBSCS	1,336 (37.8)	310 (8.8)	23%	0. 23 (5.8)	Dynamic

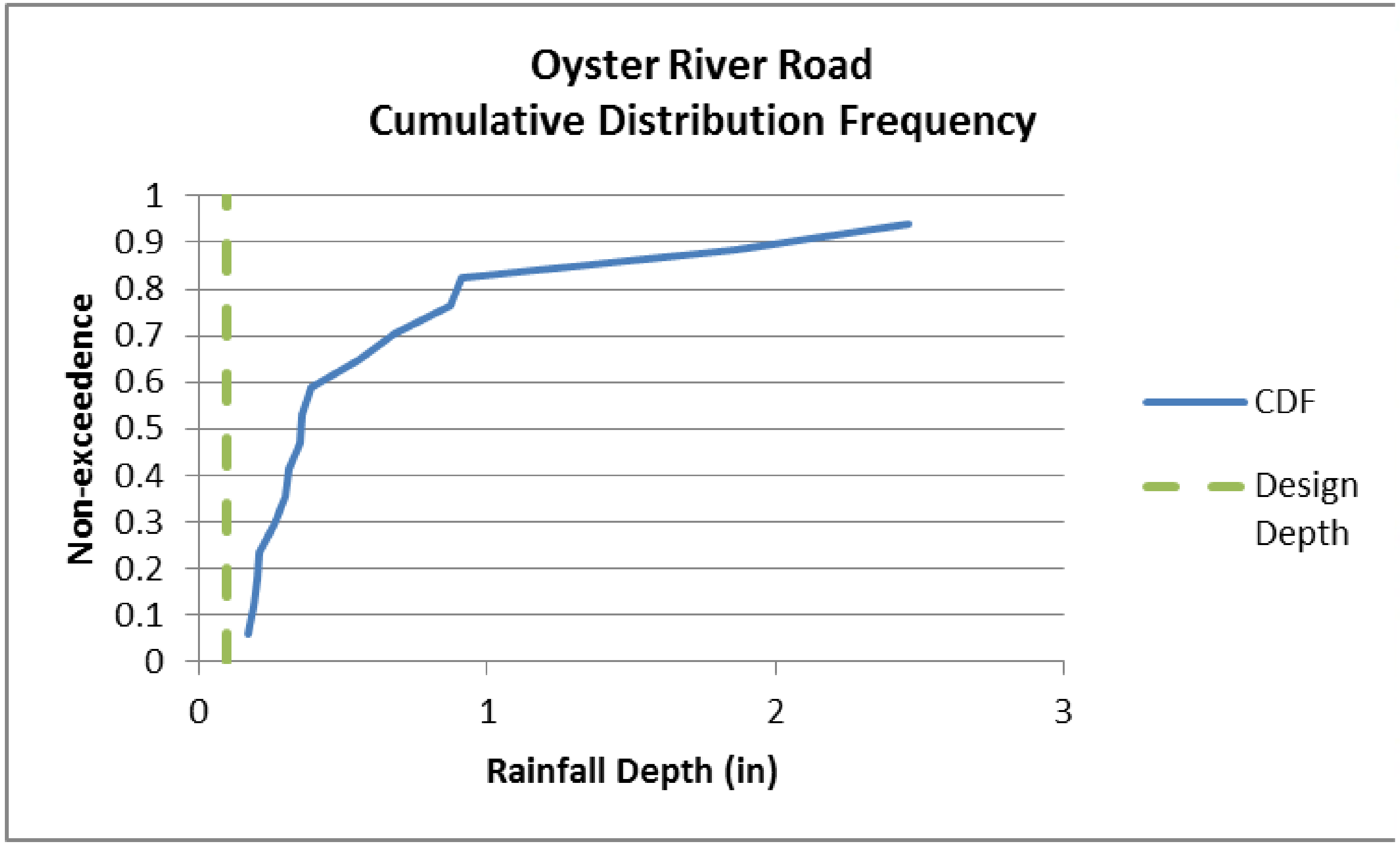
$$WQV = \left(\frac{P}{12}\right) x\, IA$$

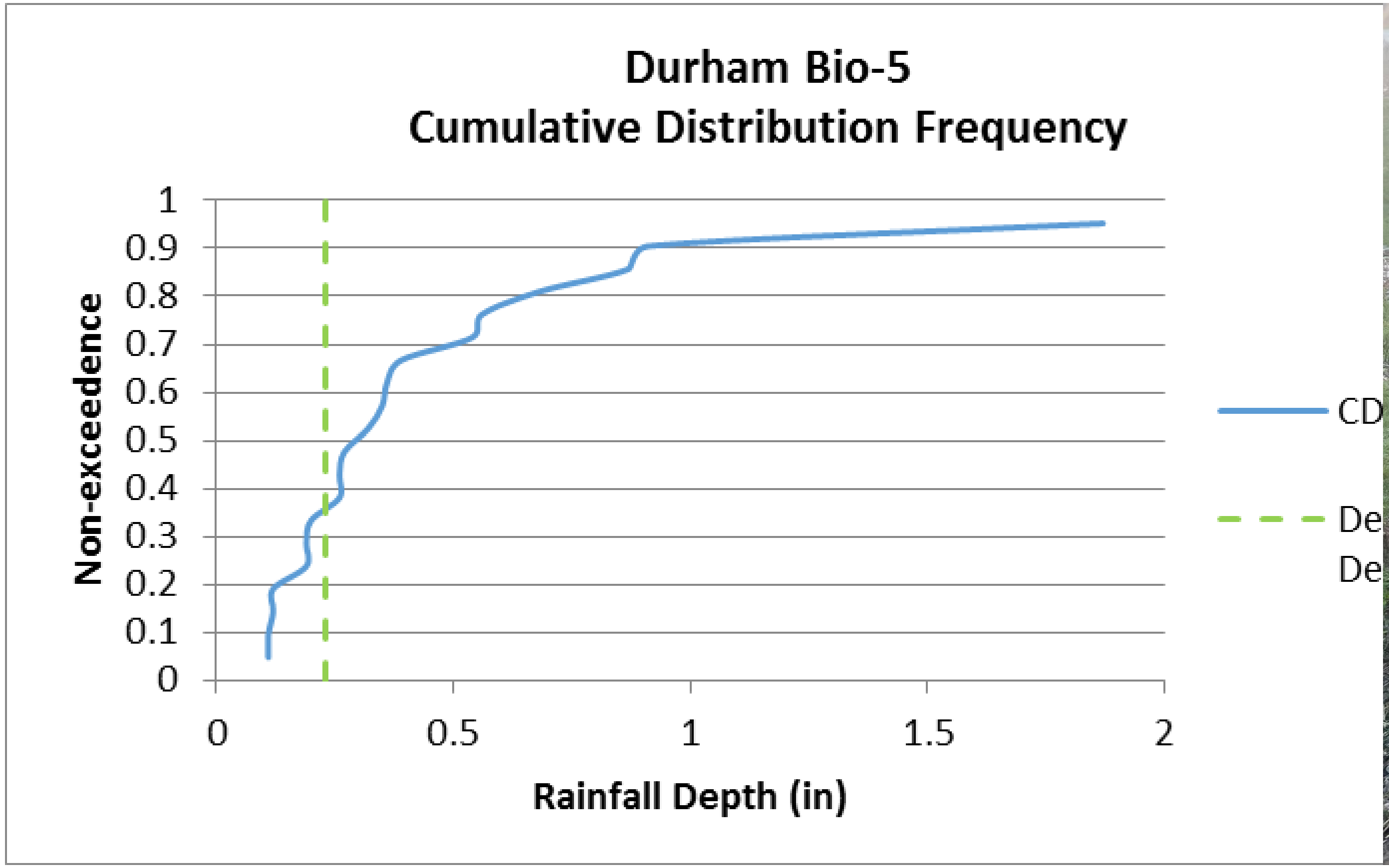
Dynamic Bioretention Sizing

$$Af = Vwq * \frac{df}{(i(hf + df)tf)}$$

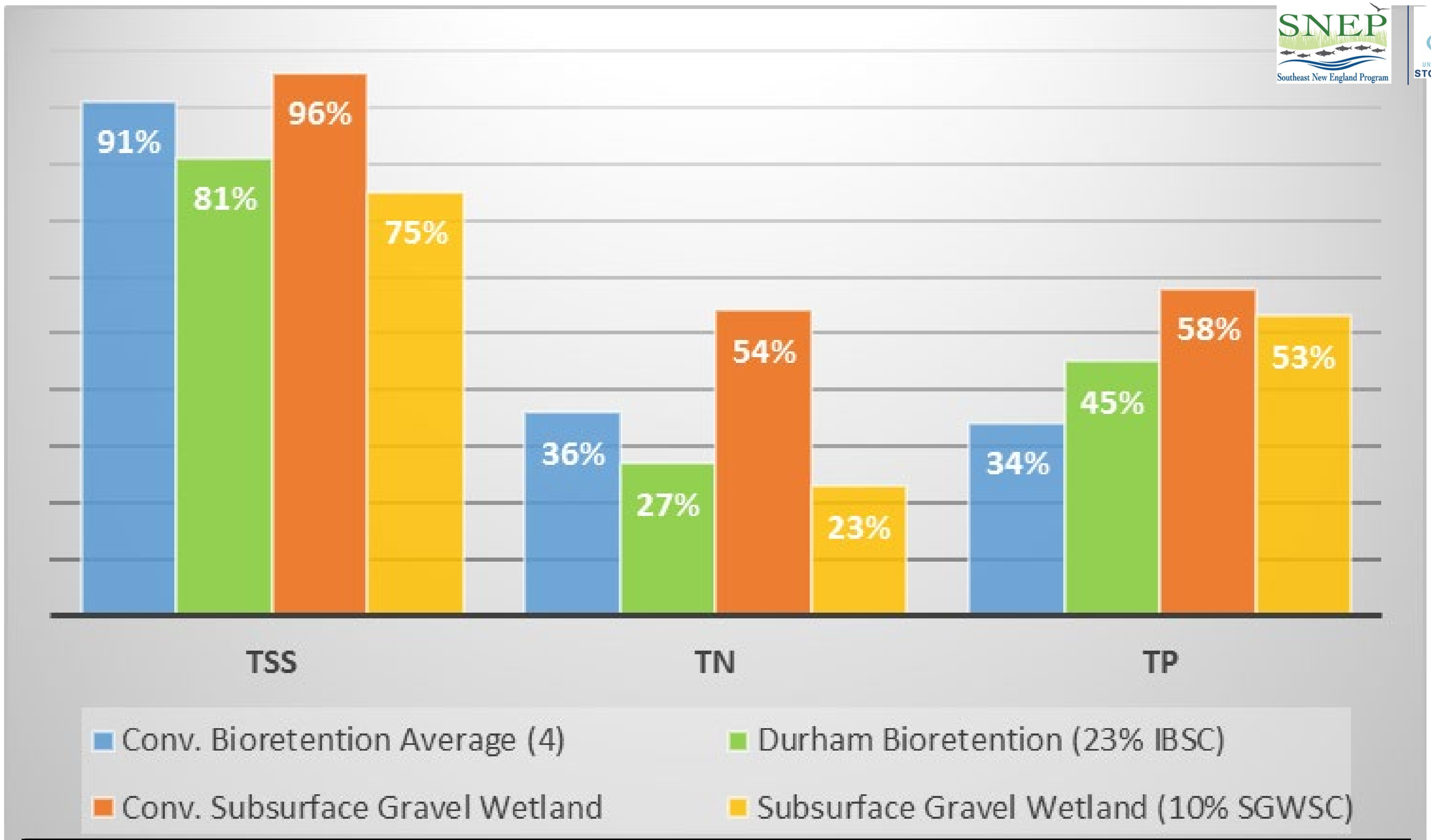
Static SGW System Sizing

$$Q = CdA\sqrt{2gh}$$

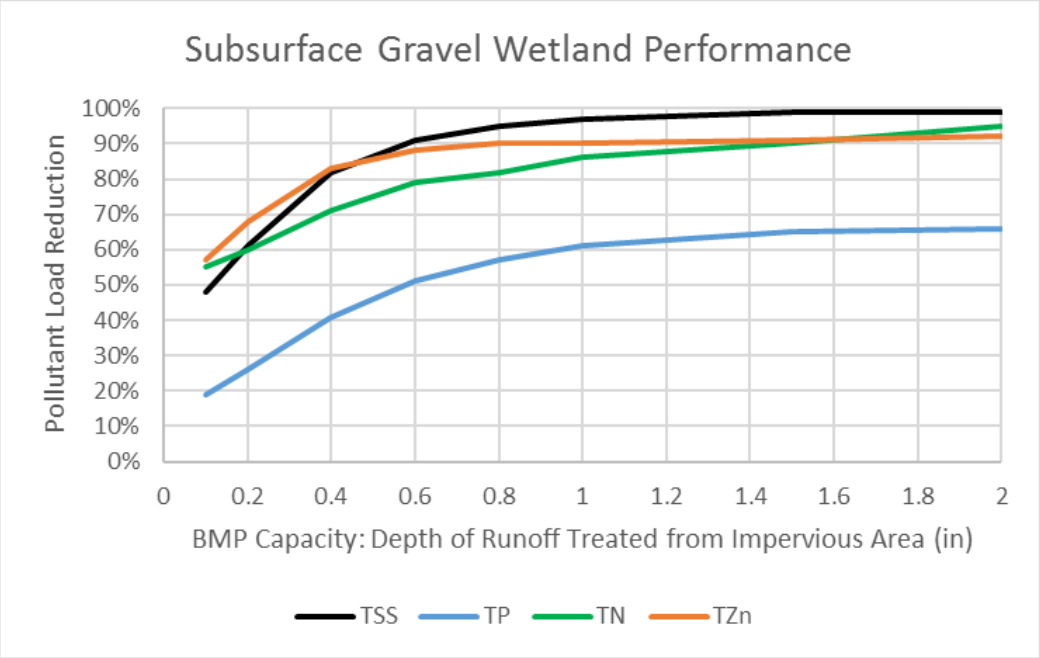

Oyster River Road
Cumulative Distribution Frequency
Non-exceedence
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
Rainfall Depth (in)
CDF
Design Depth

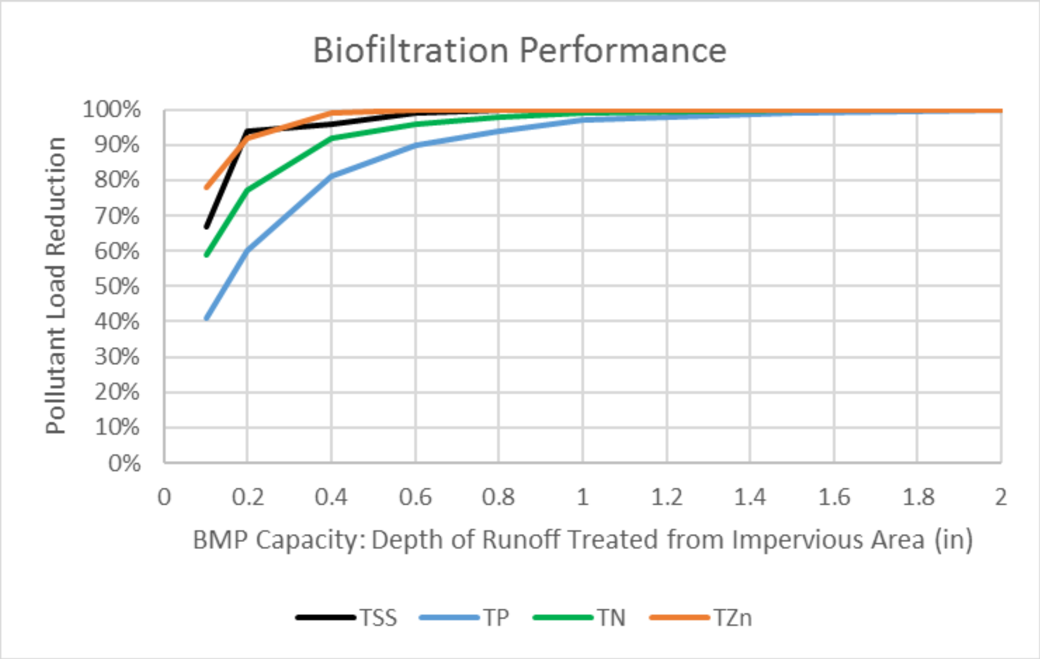


Durham Bio-5
Cumulative Distribution Frequency
Non-exceedence
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
Rainfall Depth (in)
CD
De
De



System	TSS	TN	TP
Conv. Bioretention Average (4)	91%	36%	34%
Durham Bioretention (23% IBSC)	81%	27%	45%
Conv. Subsurface Gravel Wetland	96%	54%	58%
Subsurface Gravel Wetland (10% SGWSC)	75%	23%	53%





Design Storage Volume (DSV) - runoff depth from IA (in)

Analyte	Depth txt	Modeled RE	Measured RE
TSS	0.1	48	75
TZn	0.1	57	75
TN	0.1	55	23
TP	0.1	19	53

Analyte	Depth txt	Modeled RE	Measured RE
TSS	0.23	70	81
TZn	0.23	88	86
TN	0.23	60	27
TP	0.23	35	45

Output	*Intermediate Calculations*	Design Storage Volume	DSV	cf	1,200
		Impervious to Pervious Ratio *(range of 0.014 - 8)*	IA/PC	ac/ac	N/A
		Physical Storage Capacity: Depth of Runoff from IA *(range of 0 - 2, goal > 0.1, optimal 0.4)*	PSC	in	0.11
		PSC Notes			DSV small, increase for optimal range 0.3 ≤ PSC ≤ 0.6
	Performance Curve Removal Efficiencies	Removal Efficiency: Volume	Vol_{RE}	-	0%
		Removal Efficiency: P	P_{RE}	-	20%
		Removal Efficiency: N	N_{RE}	-	23%
		Removal Efficiency: TSS	TSS_{RE}	-	49%
		Removal Efficiency: Zn	Zn_{RE}	-	59%
		Removal Efficiency: Bacteria	FIB_{RE}	-	32%
	Loading Rate	Load: Volume	Vol_{LER}	Mgal/yr	3.29
		Load: P	P_{LER}	lb/yr	6.2
		Load: N	N_{LER}	lb/yr	44.3
		Load: TSS	TSS_{LER}	lb/yr	1,378
		Load: Bacteria	FIB_{LER}	Billion MPN/y	20
	Reductions	Reduction: Volume	Vol_{Red}	Mgal/yr	0.00
		Reduction: P	P_{Red}	lb/yr	1.2
		Reduction: N	N_{Red}	lb/yr	10.1
		Reduction: TSS	TSS_{Red}	lb/yr	682
		Reduction: Bacteria	FIB_{Red}	%/yr	32%
	Costs	Estimated Total Costs		$	$22,000
		Removal Costs: Volume		$/Mgal-yr	N/A
		Removal Costs: P		$/lb-yr	$17,940
		Removal Costs: N		$/lb-yr	$2,170
		Removal Costs: TSS		$/lb-yr	$30
		Removal Costs: Bacteria		$/%-yr	$700
	O&M	Estimated O&M Hours		hr/yr	68

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https://www.unh.edu/unhsc/ms4-resources
https://www.unh.edu/unhsc/sites/default/files/media/unhsc_performance_curve_calculator_v2.3.xlsm

Conclusions/Next Steps

- All the guidance and recommendations are based on science and empirical research.
- Retrofit is a unique and often uncharacterized opportunity that requires flexibility
- Stormwater is a quickly evolving field and this manual forwards new research and new approaches to economically meet WQ standards.
- State departments are updating stormwater manuals and we hope that the retrofit guidance compliments updates and fills gaps in applied approaches.

Access the manual here:
https://snepnetwork.org/stormwater-retrofit-manual/

Acknowledgments

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    - Alisa Richardson – RIDOT
    - Michael Sadler – VTDEC
    - Laura Schifman – MADEP
    - Newt Tedder – EPA

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Thank You!

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