Impervious Cover Change in Maine (2001-2019) & Major Proposals

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Chapter 500
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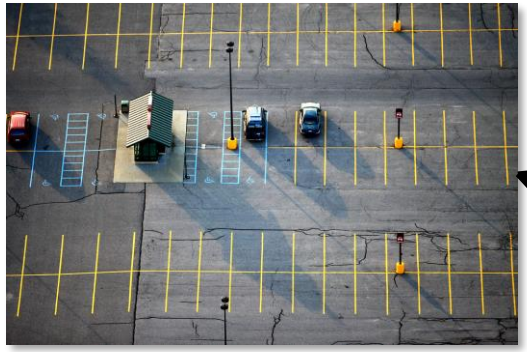
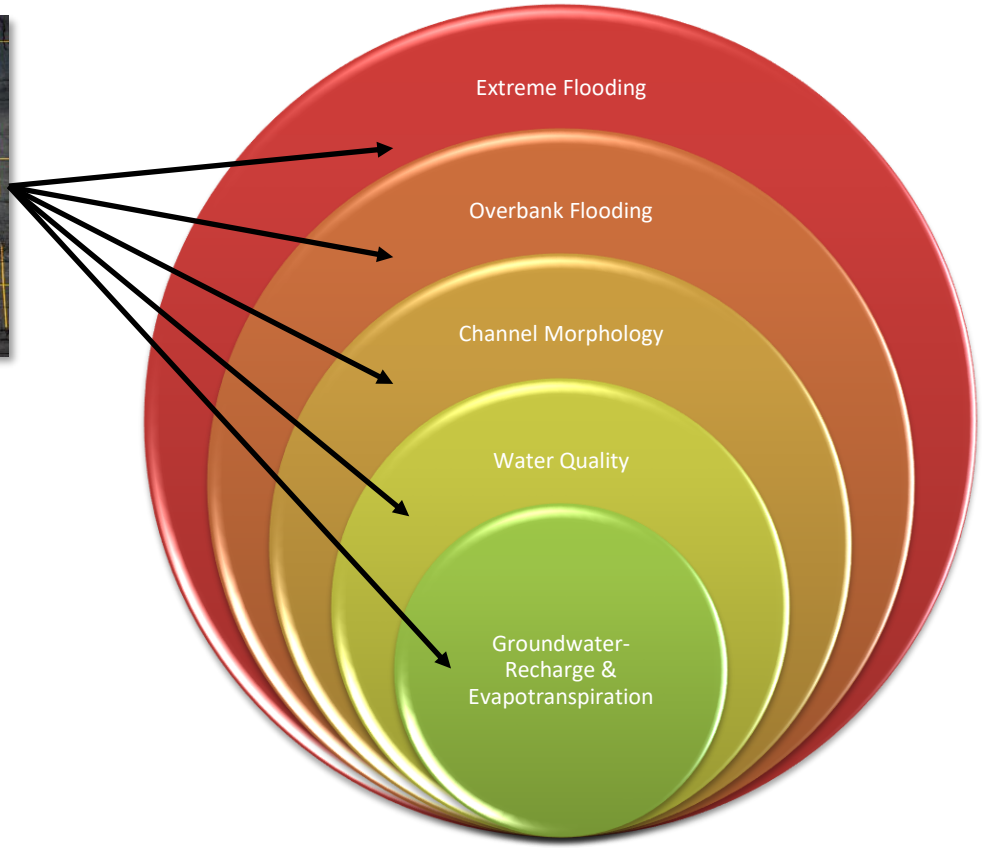
Outline

- Impervious Cover (IC) Change in Maine (2001-2019)
  - IC Analysis as a "Screening Tool": Preliminary fieldwork results from Augusta streams (Jeff Dennis)
- Overview of Major Chapter 500 Standards
  - Low Impact Development (LID) & Watershed Considerations
- LID Proposal Framework
- Flood Control Proposal
- Two-step Permitting Proposal: Decoupling MCGP and Chapter 500
- Stormwater Manual & Chapter 500:
  - Detailed design specifications in Stormwater Manual in lieu of Chapter 500
  - Flexibility to update SCMs and design specifications
- Other Proposals/Recommendations

Why is Impervious Cover Trend Important?





- **Continuous addition of impervious cover inevitably requires more resources for stormwater management, stricter standards and regulations in watersheds,**
- **Generic stormwater controls may fall short in rapidly developing watersheds,**
- **Closely monitoring impervious cover trends helps with "timely" decision-making.**

Utilize Readily Available GIS Data….

USGS	National Land Cover Database (NLCD)	DEP/MEGIS
NHDPlus HR		Data
HUC2->HUC10	NLCD 2001 Imperviousness	
HUC12*	NLCD 2019 Imperviousness	
Catchment *		

Decreasing Area

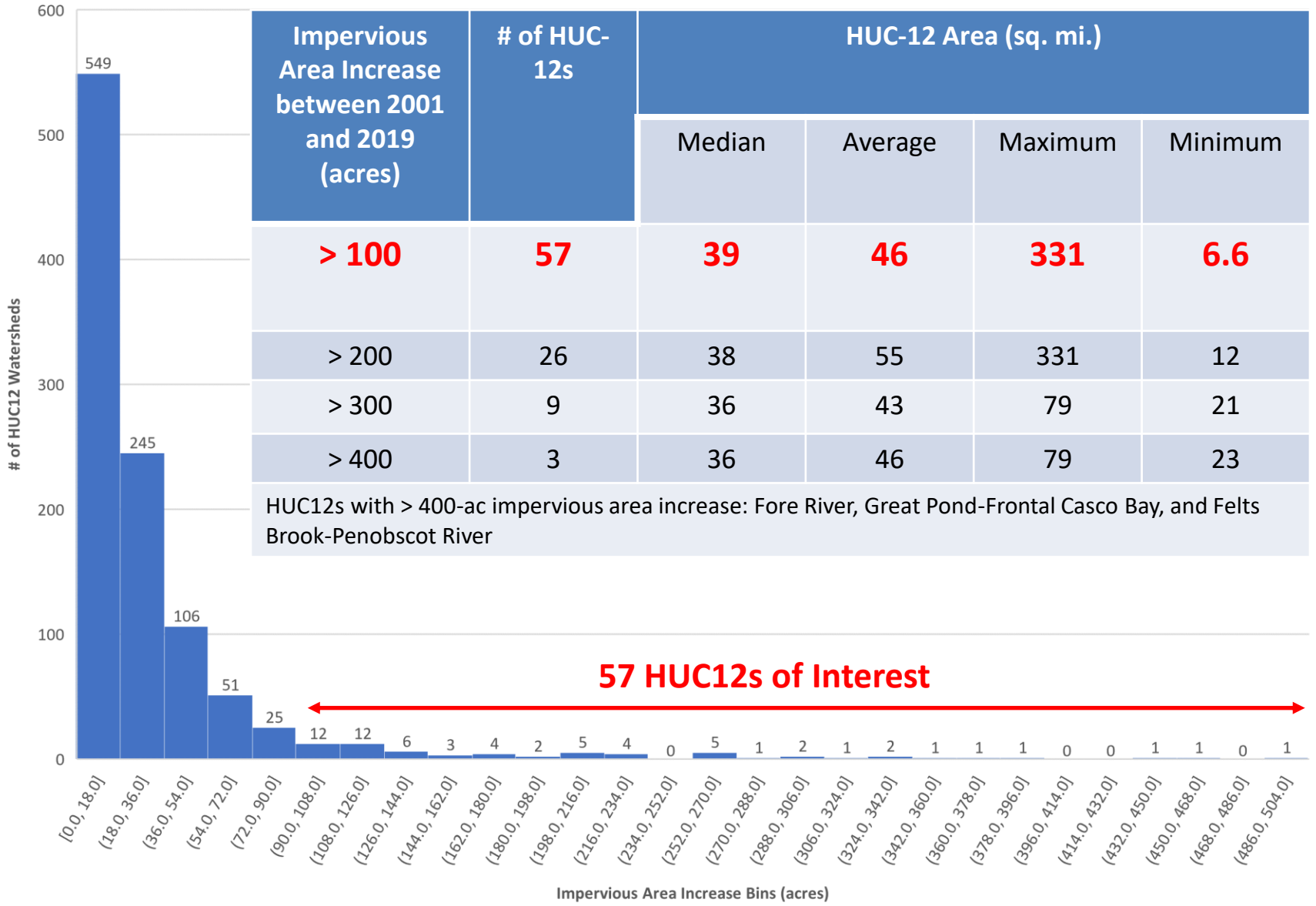
….to Analyze Impervious Cover Change in Maine from Stormwater Management Perspective…

Impervious Cover 2001 vs. 2019: Method

Spatial Units Used in the GIS Analysis	
USGS NHDPlus HR	**MEGIS/DEP**
HUC12	State
Catchment	Town
	At-risk Lake Watershed*
	UIS Watershed*
	MS4
	Municipal Growth Area
*: Listed in Chapter 502	

Impervious Cover Change within each Spatial Unit

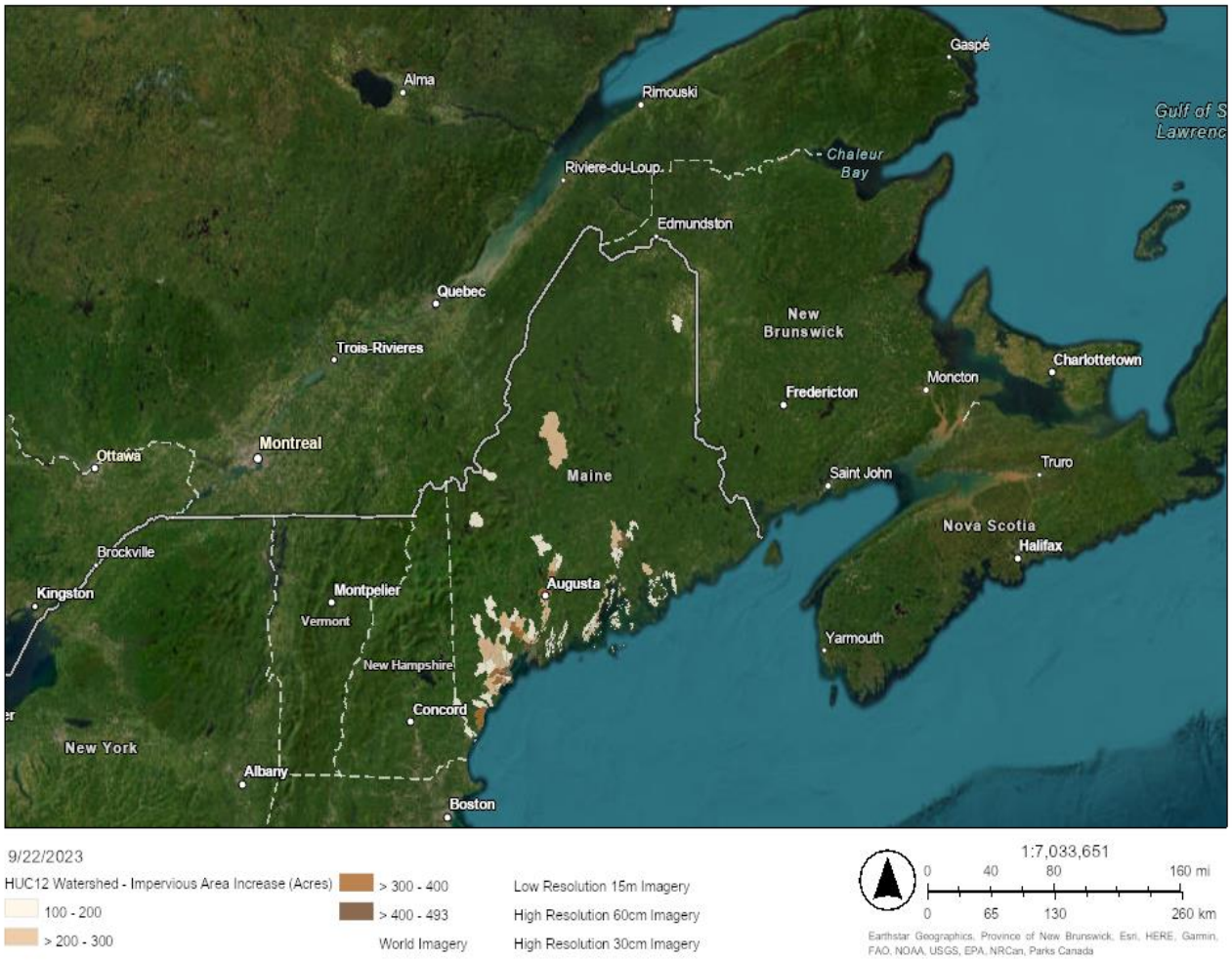
Impervious Area Change between 2001 and 2019 in HUC12 Watersheds



Impervious Area Increase between 2001 and 2019 (acres)	# of HUC-12s	HUC-12 Area (sq. mi.)			
		Median	Average	Maximum	Minimum
> 100	**57**	**39**	**46**	**331**	**6.6**
> 200	26	38	55	331	12
> 300	9	36	43	79	21
> 400	3	36	46	79	23

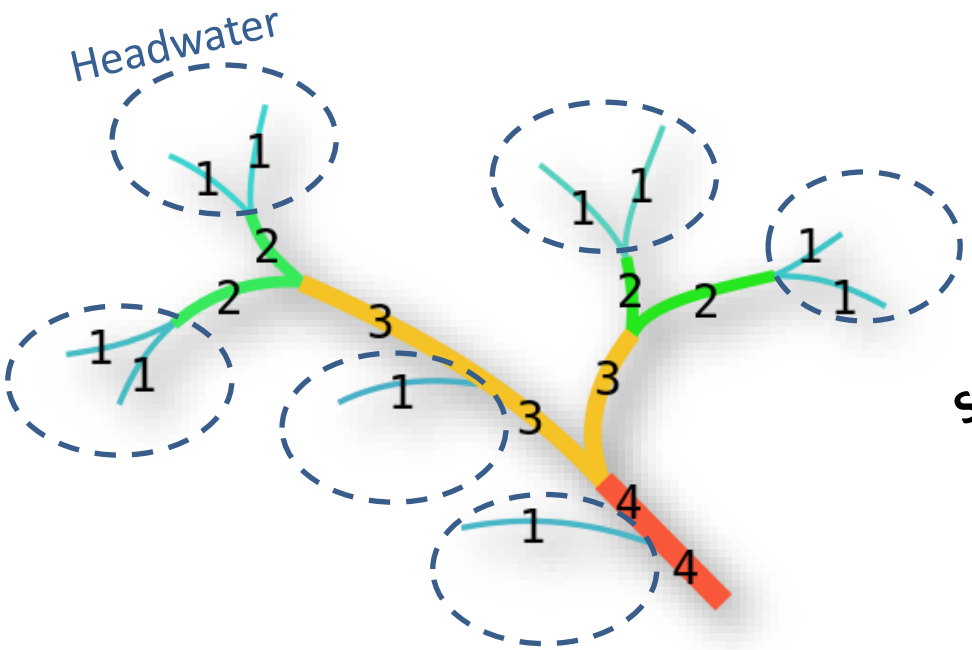
HUC12s with > 400-ac impervious area increase: Fore River, Great Pond-Frontal Casco Bay, and Felts Brook-Penobscot River

57 HUC12 Watersheds with > 100 Acres Imperviousness Increase

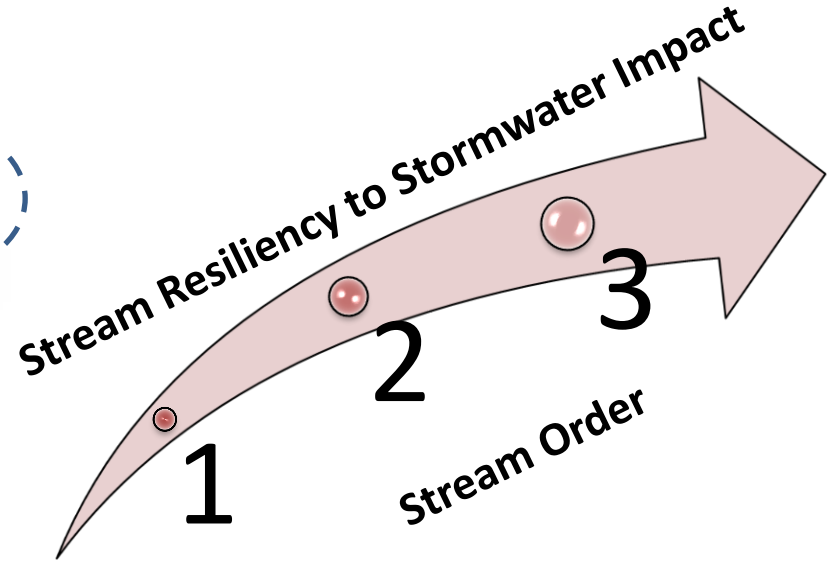


- The imperviousness increase was mainly concentrated in southern Maine and around I-95/I-295 corridors.
- Coastal imperviousness increase in Midcoast and Acadia regions are noteworthy.
- Northern Maine HUC12s shown in the map are (from East to West):
  - Arnold Brook-Presque Isle Stream,
  - Moosehead Lake,
  - Kibby Stream,
  - Rangeley Lake.
- Median percent point imperviousness increase from 2001 to 2018 was **0.8%** for the 57 HUC12s:
  - Maximum percent point increase was observed for **Fore River** HUC12, **3.4%.**

Significance of Lower Order Streams

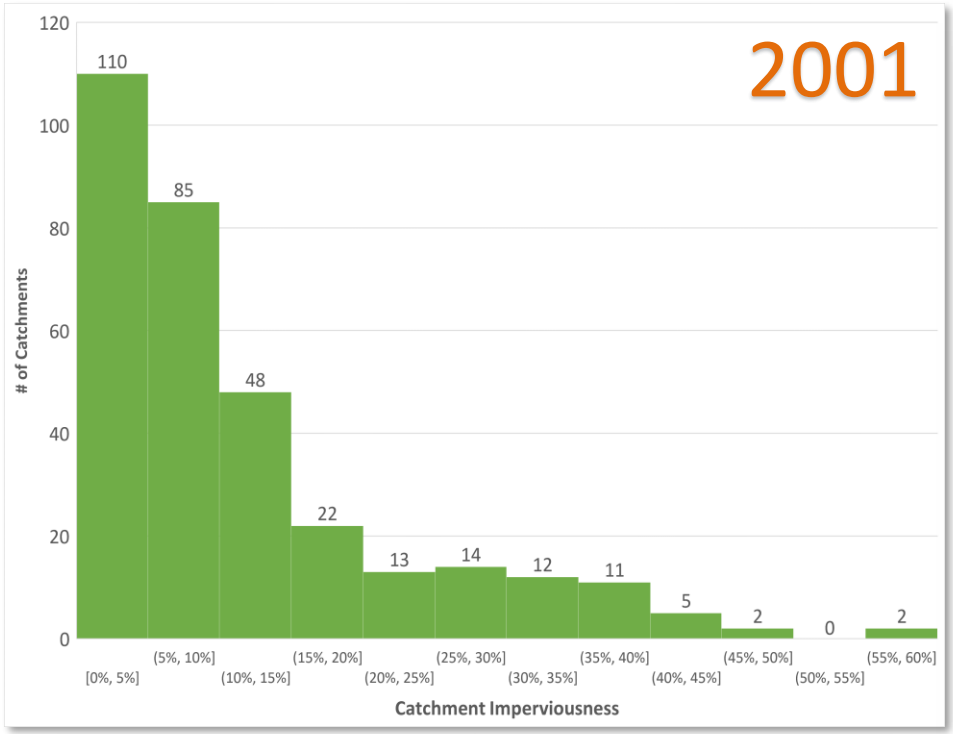


Strahler Stream Order Diagram

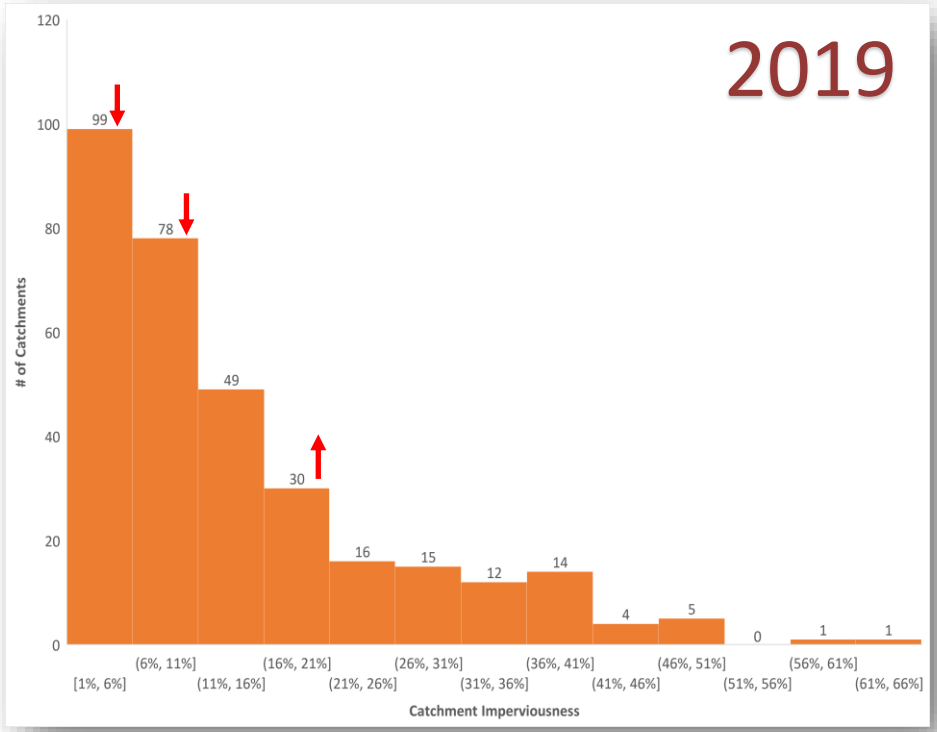


First Order Catchment Imperviousness

- Note that only catchments with an area ≥ 0.25 sq. mi. (160 ac) are presented here:
  - Minimum: 0.25 sq. mi. (160 ac); Maximum: 6.6 sq. mi. (4,208 ac); Median 0.57 sq. mi. (364 ac)



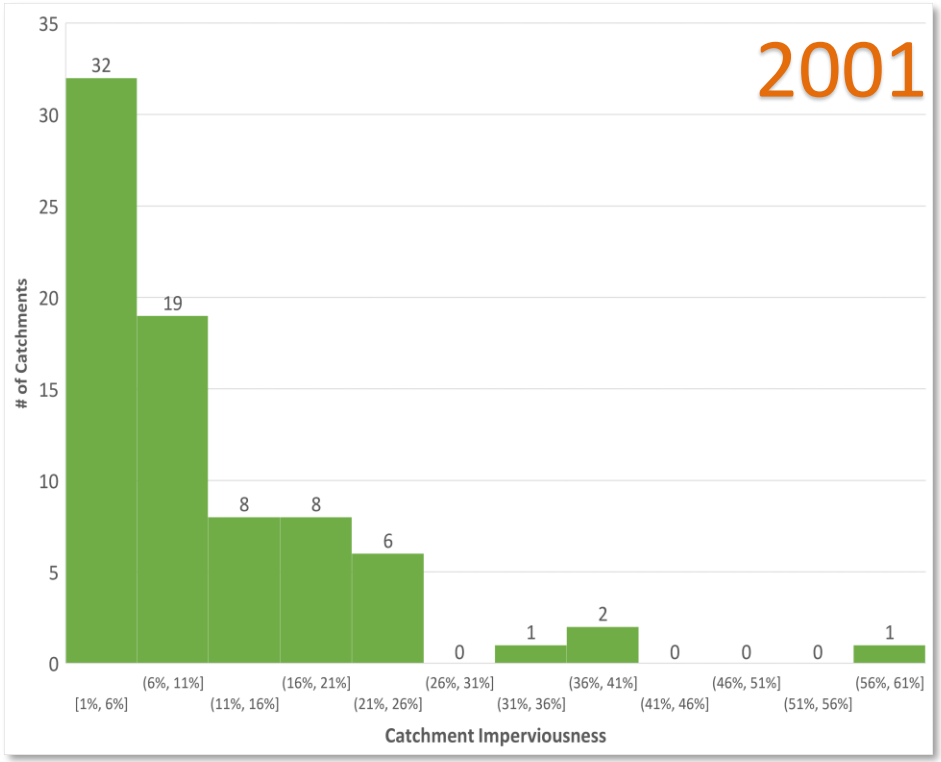
Imperviousness	# of Catchments
<10%	195
≥10%	129



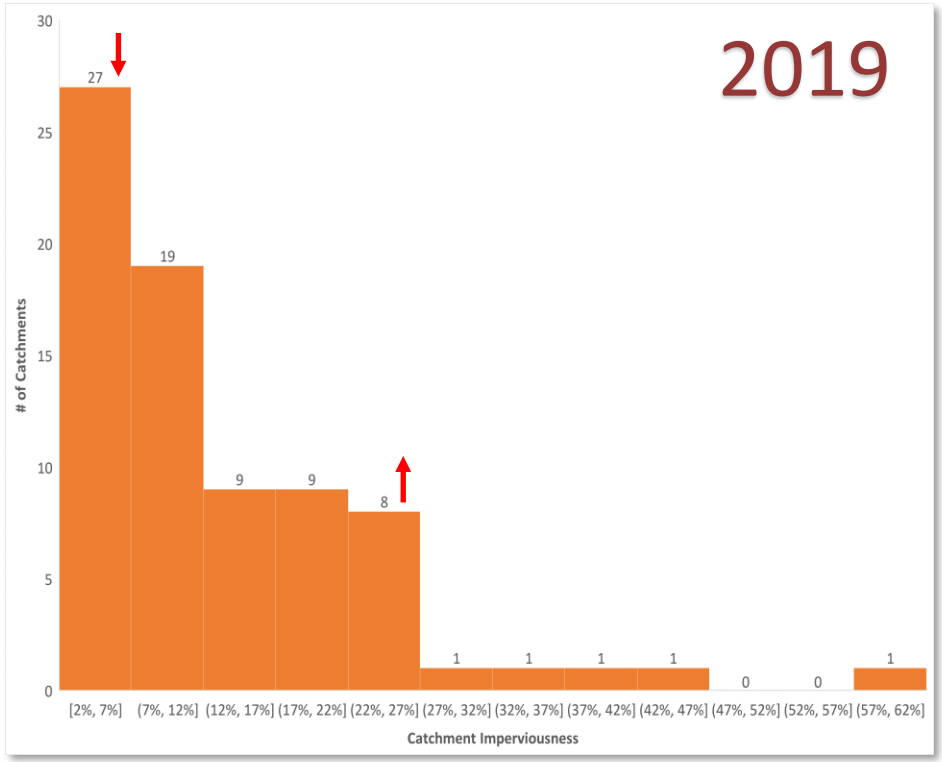
Imperviousness	# of Catchments
<10%	160
≥10%	164

Second Order Catchment Imperviousness

- Note that only catchments with an area ≥ 0.25 sq. mi. (160 ac) are presented here:
  - Minimum: 0.25 sq. mi. (160 ac); Maximum: 4.8 sq. mi. (3,065 ac); Median: 0.71 sq. mi. (456 ac)



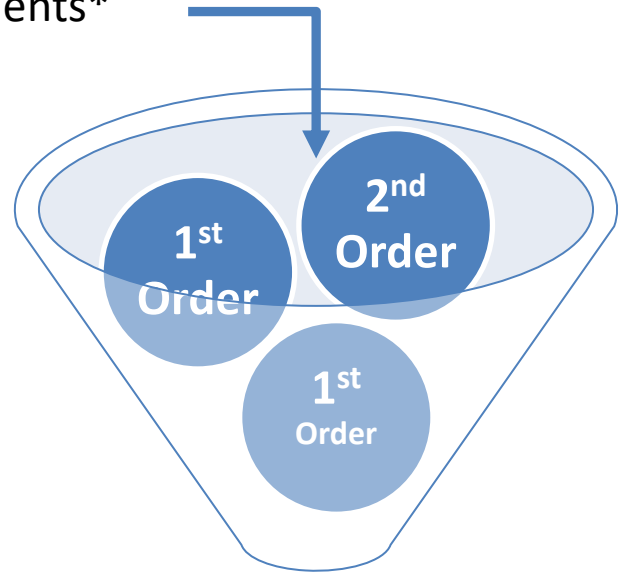
Imperviousness	# of Catchments
<10%	50
≥10%	26



Imperviousness	# of Catchments
<10%	40
≥10%	36

GIS Imperviousness Analysis as a "Screening Tool"

Thousands of Stream "Catchments*" in Maine



*: USGS NHDPlus HR Catchments

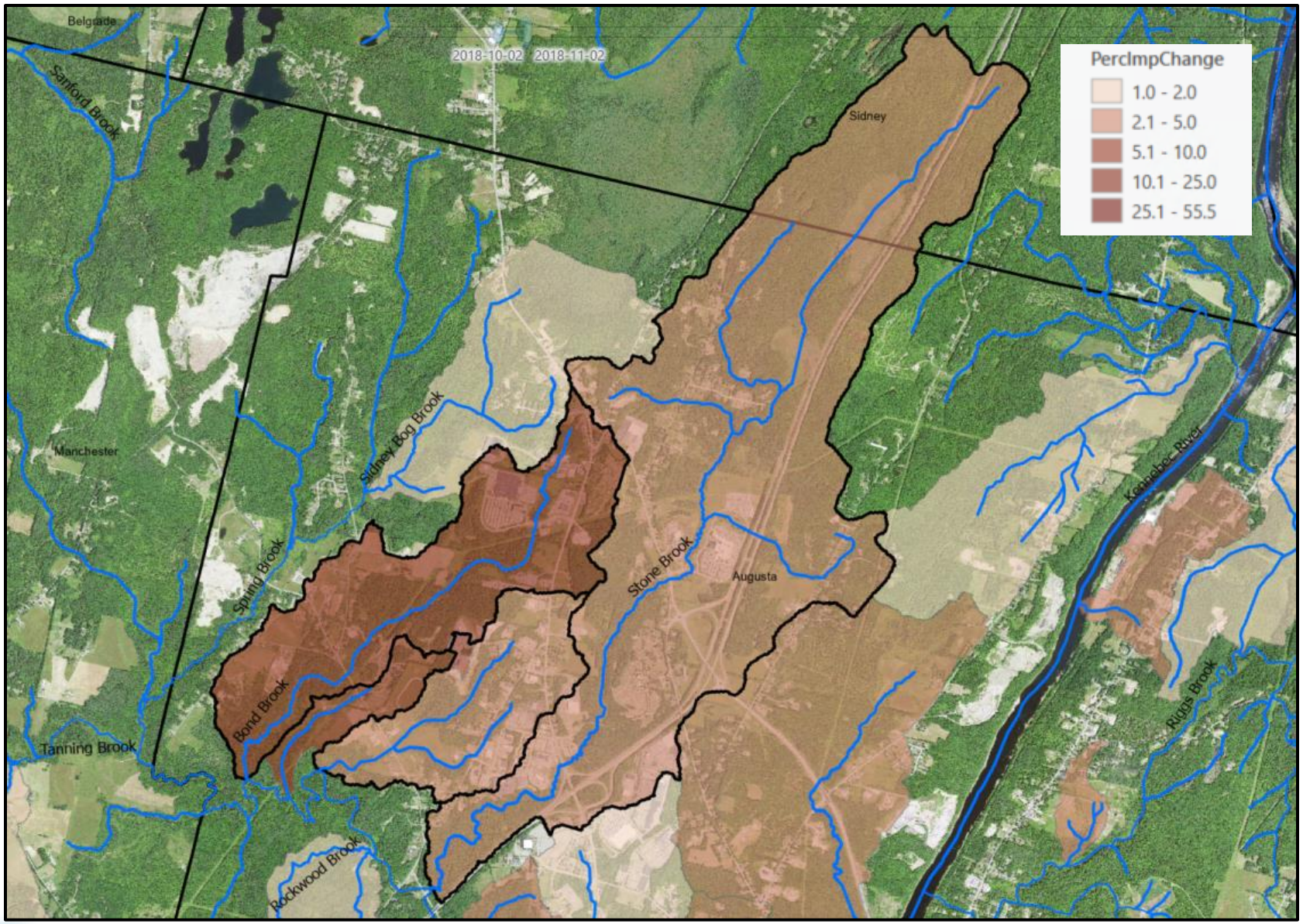
Select Subcatchments based on Imperviousness Increase:

- Biomonitoring
- Water Quality Monitoring
- Stream Habitat/Morphology

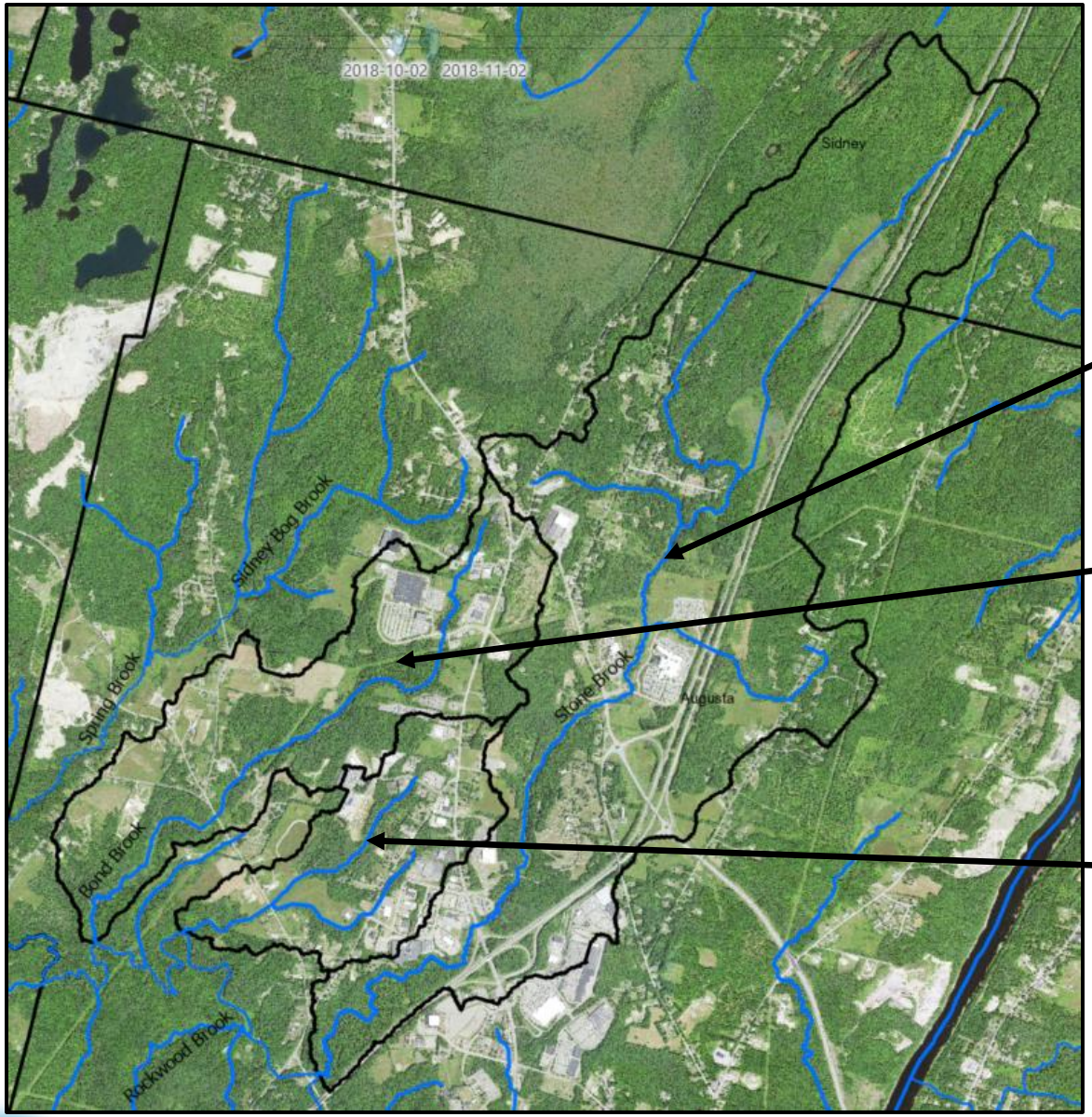
Long Term

Inferences on the Effectiveness of the Stormwater Management Standards

Impervious Change Analysis – 1st and 2nd order catchments >1%



Bond Brook Tributary Sensitive and Threatened Watersheds



Stone Brook Watershed

Bond Brook Headwater Catchment

Meadow Brook Watershed

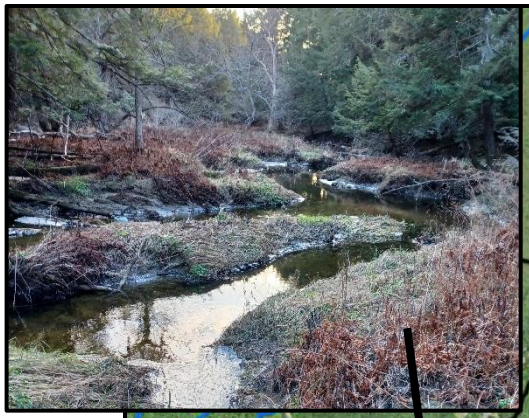
Stone Brook - Augusta

Watershed Area 3.6 sq miles

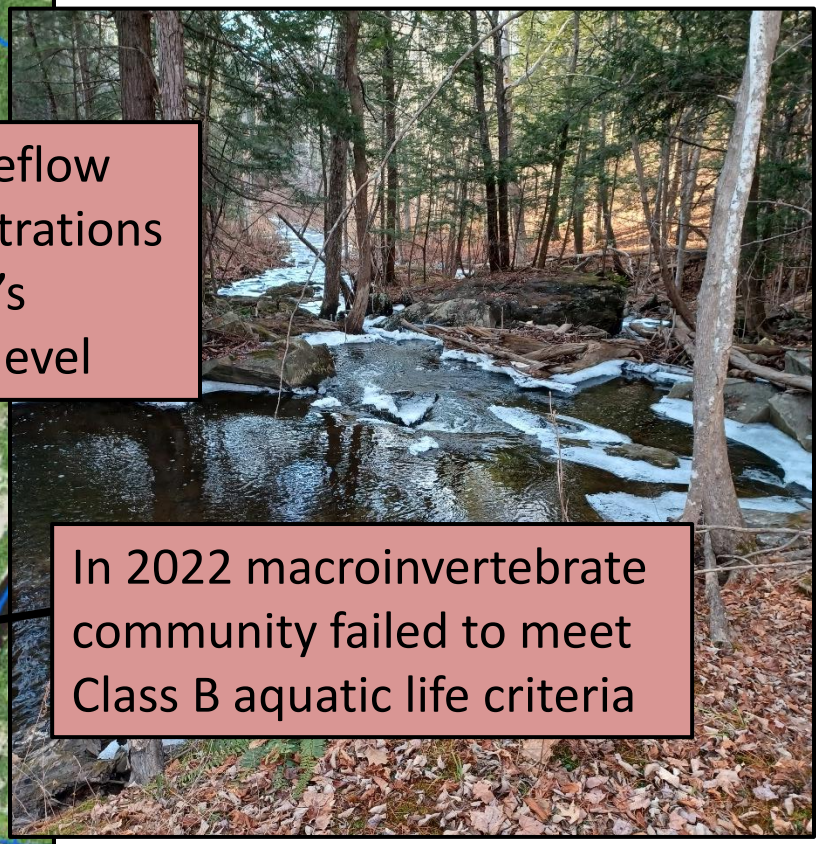
2001 % Imp Cover 10.3 %

2019 % Imp Cover 15.1 %

Change in Imp Cover 4.8 %

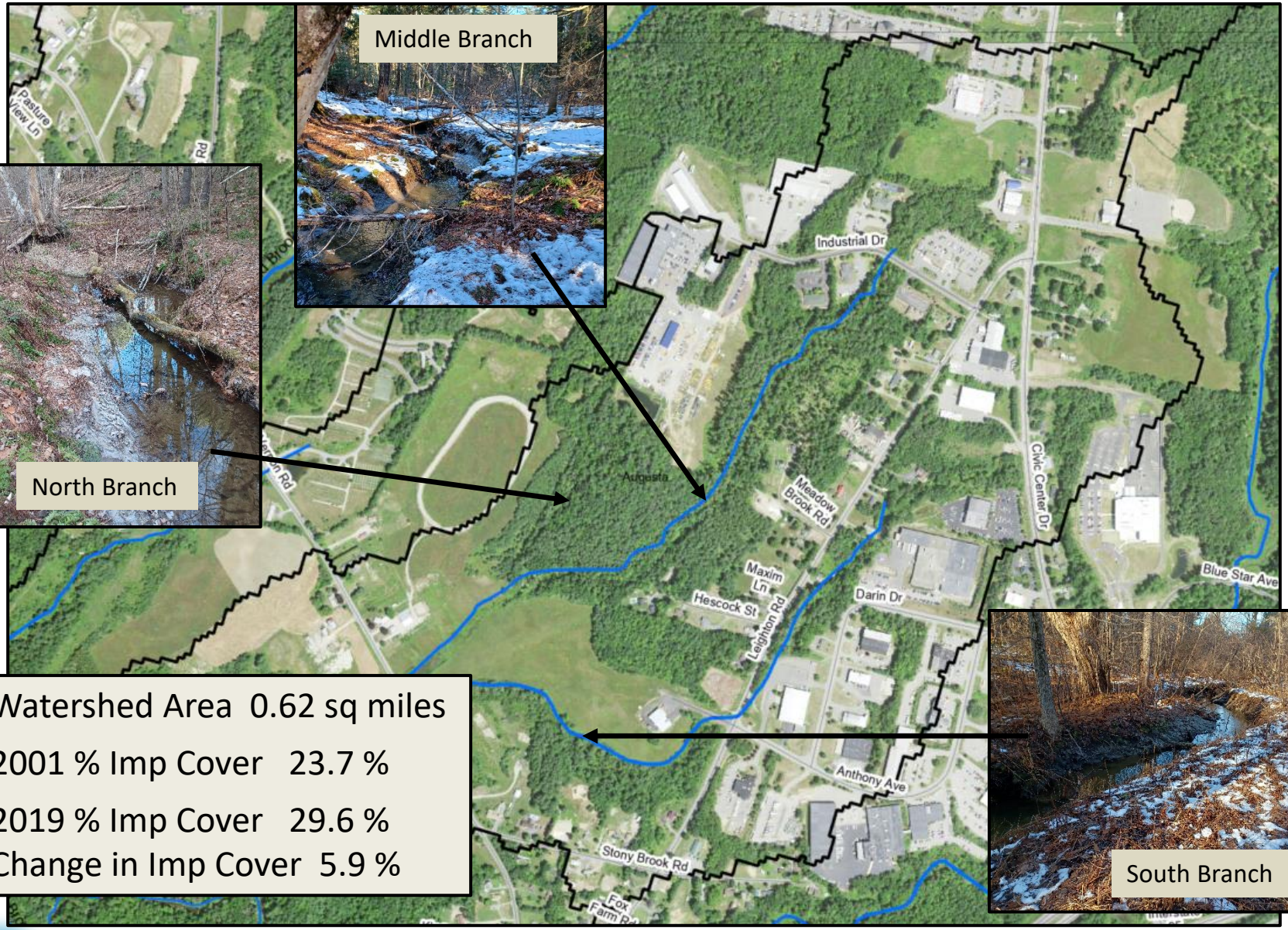


Already has baseflow chloride concentrations that exceed EPA's chronic toxicity level



In 2022 macroinvertebrate community failed to meet Class B aquatic life criteria

Meadow Brook - Augusta



Watershed Area 0.62 sq miles

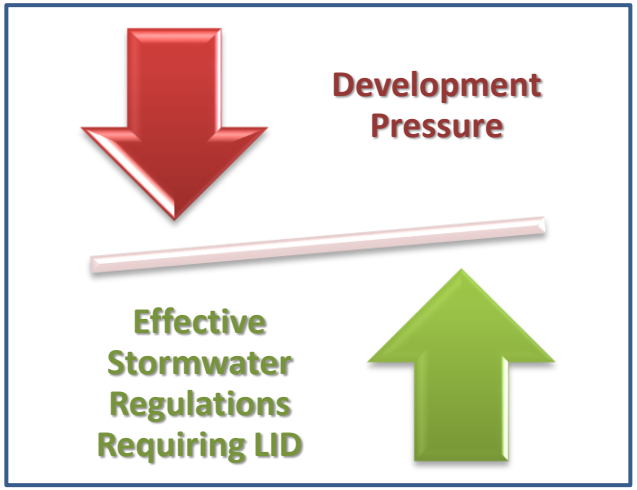
2001 % Imp Cover 23.7 %

2019 % Imp Cover 29.6 %

Change in Imp Cover 5.9 %

Preliminary Take-aways from the Imperviousness Analysis

- In the past two decades,
  - Imperviousness increase mainly happened along the major transportation corridors and around major cities,
  - Imperviousness continued to increase in the areas where stormwater regulations have got stricter after the promulgation of SML in 1997:
    - The data does not corroborate "Stormwater regulations cause development sprawl." argument.

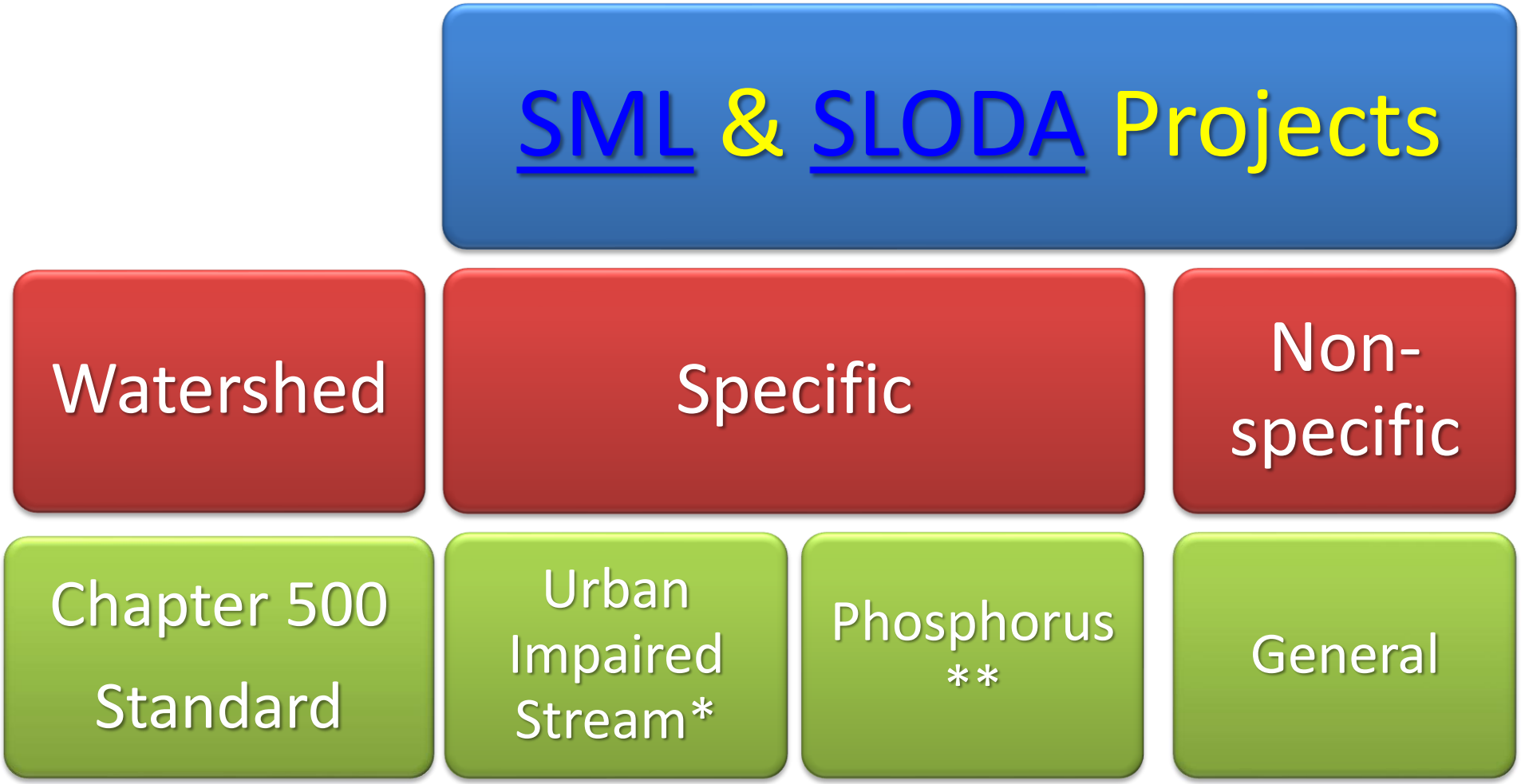


- Readily available GIS data and tools can be leveraged for:
  - Continuously tracking development trends in watersheds to assist biomonitoring and water quality monitoring decisions,
  - Identify and Update "Sensitive and Threated Watersheds" (Mandated by the SML). Effective stormwater regulations requiring LID can prevent "future" impairment. Costly restoration efforts are avoided.

Overview of Major Chapter 500 Standards

- Watershed & Low Impact Development (LID) Considerations

Watersheds & Existing Chapter 500 Standards



*: Apply to SLODA projects in the Urban Impaired Stream watersheds (Chapter 502).
**: Apply to the projects in the lake watersheds.

Urban Impaired Stream Standard (Chapter 500(4)(E))

Chapter 501: Table 1		
Type of surface	Compensation fee (per acre*)	**Mitigation credits required (per acre*)**
Non-roof impervious area	$12,500	**0.5 credits**
Roof	$5,000	**0.2 credits**
Landscaped area	$2,500	**0.1 credits**
*** fees or credits for fractions of an acre are prorated.**		

- SLODA projects in UIS watersheds are required to comply with the General Standards
- In addition, they are subject to additional requirements:

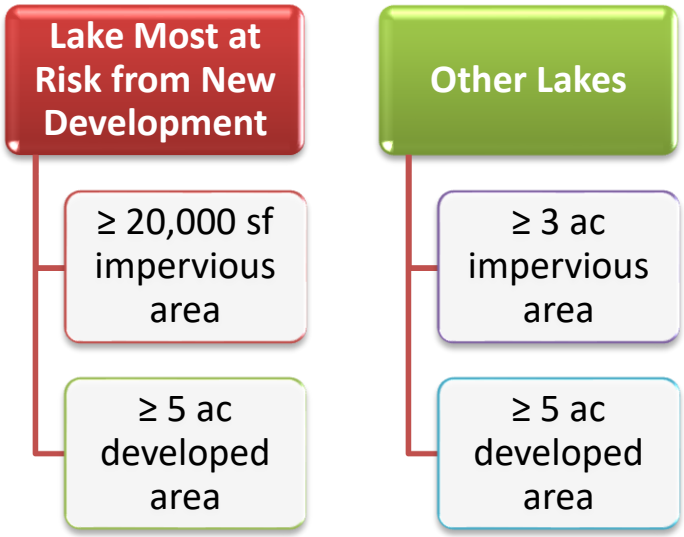
a. Mitigate stormwater impact of the existing developed areas through treatment or elimination,

OR

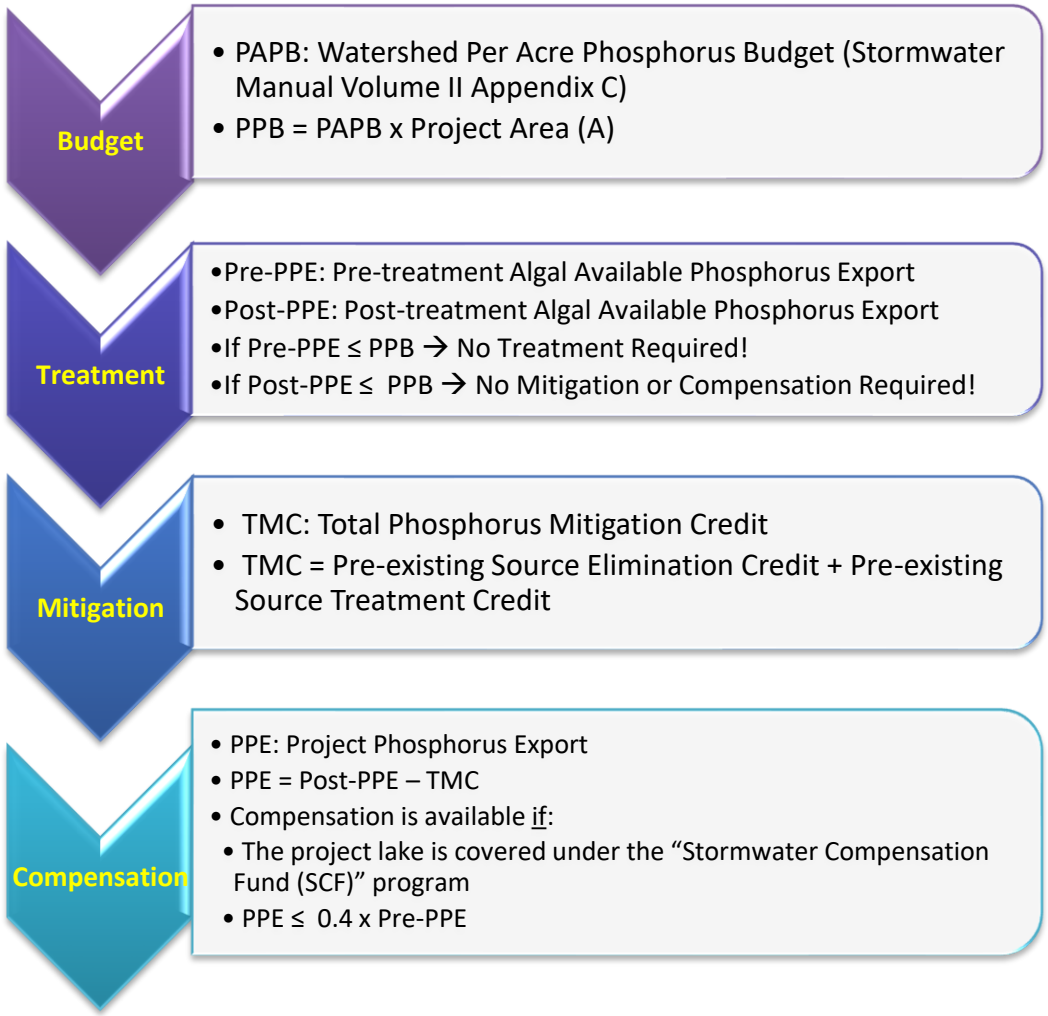
b. Pay a compensation fee to the administrator.

- Mitigation and compensation procedure is in Chapter 501.
- The Department may require the use of alternative or additional stormwater treatment measures to address a specific stressor.

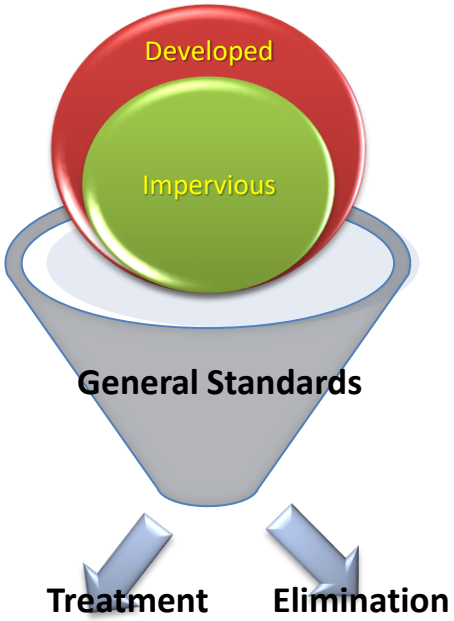
Phosphorus Standard



- Phosphorus standard incentivizes:
  - Treatment and/or mitigation of the relatively high phosphorus exporting developed areas:
    - Roads, driveways, parking >> Landscaped areas, roofs
  - Projects that develop relatively a small portion of a parcel:
    - No treatment may be required for certain projects
- Compliance with the standard can be challenging for
  - The projects that have relatively low PAPB and/or develop relatively a large portion of a parcel
  - The project is in a lake watershed <u>not</u> covered under the SCF program



Projects in All Other Watersheds



Objectives of the General Standards (Chapter 500(4)(C)(2))

A stormwater management that will:

- Provide for pollutant removal or treatment,
- Mitigate for the increased frequency and duration of channel erosive flows due to runoff from smaller storms,
- Mitigate for potential temperature impacts.

Required Level of Treatment for New Development* (%)	
Impervious Area	Developed Area
95%	80%
Required Level of Treatment for Redevelopment (%)**	
SML Project: Developed Area (%)	SLODA Project: Developed Area (%)
0-80%	50-80%
Low Impact Development (LID) Credit (%)* (Chapter 500(4)(C)(4))**	
Reduce Developed Area Requiring Treatment by	10-20%

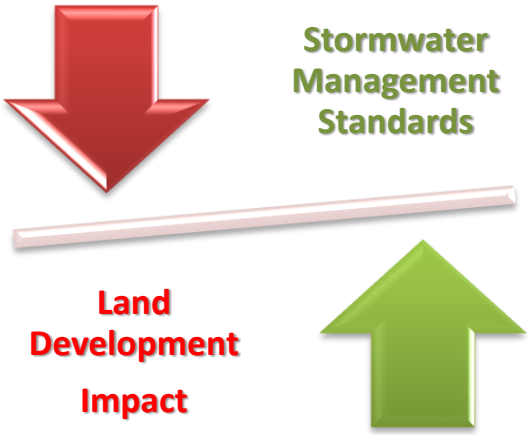
The standards are met through treating developed areas using allowable treatment measures and/or eliminating existing developed areas

*: Certain exceptions can be allowed to reduce the required level of treatment (Chapter 500(4)(C). For instance, linear portion of the project → 75% impervious area; 50% developed area.

**: Sliding scale based on the "Ranked (Pollutant) Impact Change Due to Redevelopment": more pollutant reduction, more reduction in the required level of developed area treatment.

***: Sliding scale based on the "Percentage of the Developed Area Treated with LID Measures".

Chapter 500 Standards: Assessment from LID- and Watershed-centric Perspective



- Chapter 500 standards usually do not consider regulated activities' watersheds except for the ones in the UIS and lake watersheds:

	Watershed Level of Development		
Chapter 500 Standards	**Rural**	**Suburban**	**Urban**
General	x	x	x

- Providing same level control for almost all stream watersheds means:
  - Overly protective stormwater management standards for rural watersheds under minimal development pressure,
  - Less effective stormwater management standards for urbanizing and urbanized watersheds.

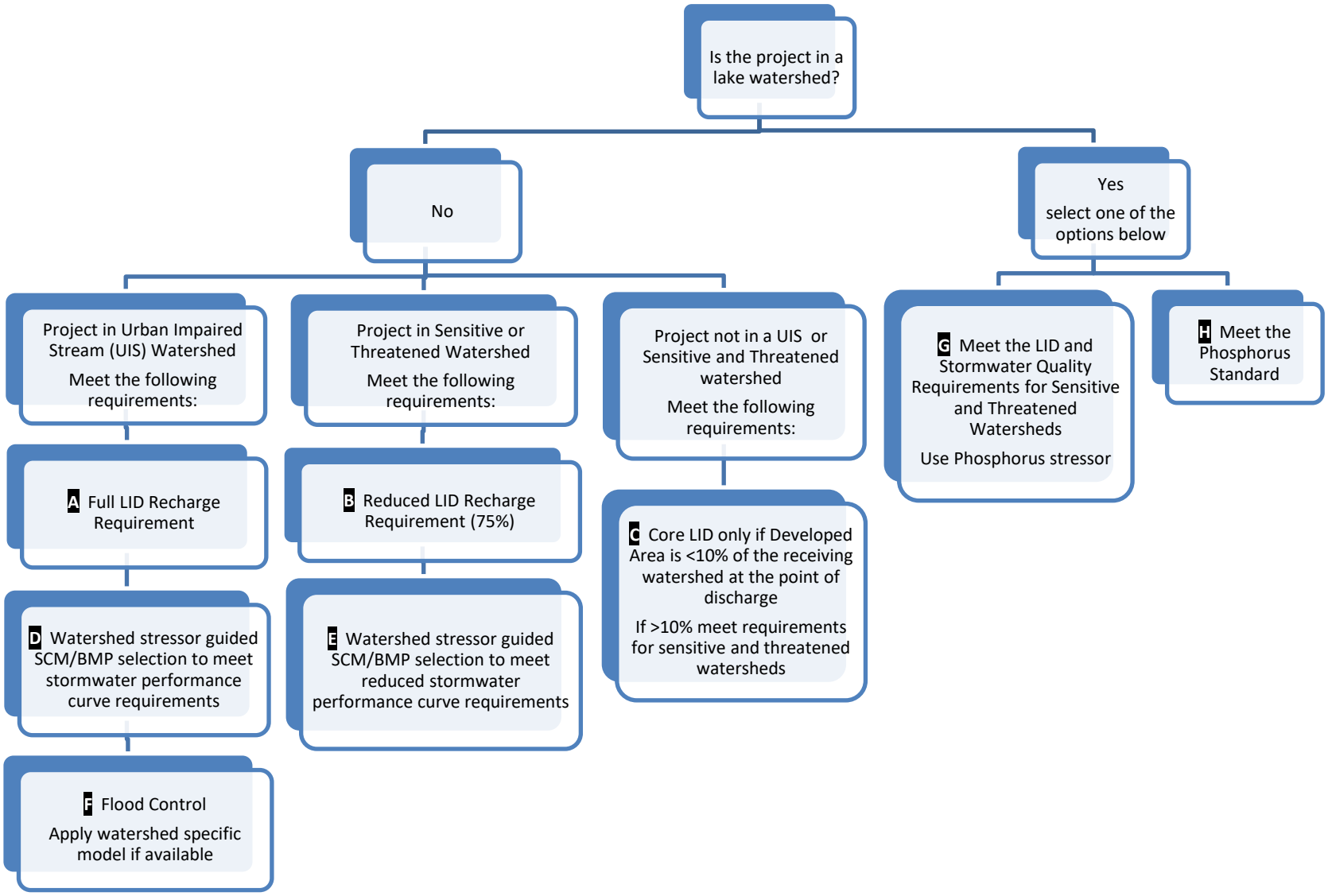
LID Principles	Current Chapter 500	Current Stormwater Management Design Practice
Mimic Predevelopment Hydrology	Not required; but, encouraged: LID Credit & Stormwater Manual Vol. III Chapter 10	Implementation of these practices are mostly decided by the applicants and/or the consultants. SML projects exclusively using stormwater buffers are generally more in line with the LID principles. *Common practice:* Large structural measures (ponds) at the low point of development parcel.
Treat Stormwater Close to the Source	Maximum one-acre impervious drainage area requirement for optional LID credit. Maximum size guidelines for vegetated soil filter ponds in Stormwater Manual Vol. III.	
Prioritize Nature-based Solutions	Not required. Vegetated measures are among the allowable stormwater measures.	

LID Standard Proposal Framework

#	Component	New Provision	Applicability	Justification	Precedent for New Provisions
1	Groundwater Recharge Level of Control	Yes	Projects in Specific Watersheds: UIS, Sensitive and Threatened	Multiple LID benefits on water quality/aquatic biota, stream channel form, flood control*	Required in CT, MA, NH, NJ
2	Core LID Standards: • Protect Natural Drainageways • LID Envelope • Vegetated Open-channel Conveyance • Utilize Low-maintenance and Native Vegetation	Yes	All Projects Required to Implement Water Quality Level of Control/Obtain Full SML or SLODA Permit	Multiple LID benefits on water quality/aquatic biota, stream channel form**	Developed using LID strategies listed in current Chapter 500 & Stormwater BMP Manual (Vol. III Ch. 10)
3	Sensitive and Threatened Watersheds	Yes	Watersheds Threatened by Land Development (Demonstrated by Impervious Cover Trends)	Protect water quality/aquatic biota, stream channel form through mitigating cumulative stormwater impact by groundwater recharge level of control	Mandated by SML Subsection 4
4	Watershed Stressor-guided SCM Selection	Yes	All Projects Required to Implement Water Quality Level of Control	Promote LID & address stressor of interest more effectively	

*: Groundwater recharge level of control has been shown to effectively attenuate 10-year storm peak flows: Appendices for FDC Phase 2, Task Order B: Next-Generation Watershed Management Practices for Conservation Development, Final Report - October 2022 (epa.gov). Note that additional detention measures are required for flood control for larger, less infrequent storms.
**: Importance of riparian buffers on the aquatic life in Maine streams was demonstrated by the Department (Danielson et al. 2016: https://www.maine.gov/dep/water/monitoring/biomonitoring/materials/dep-effects-of-urbanization-on-streams.pdf)

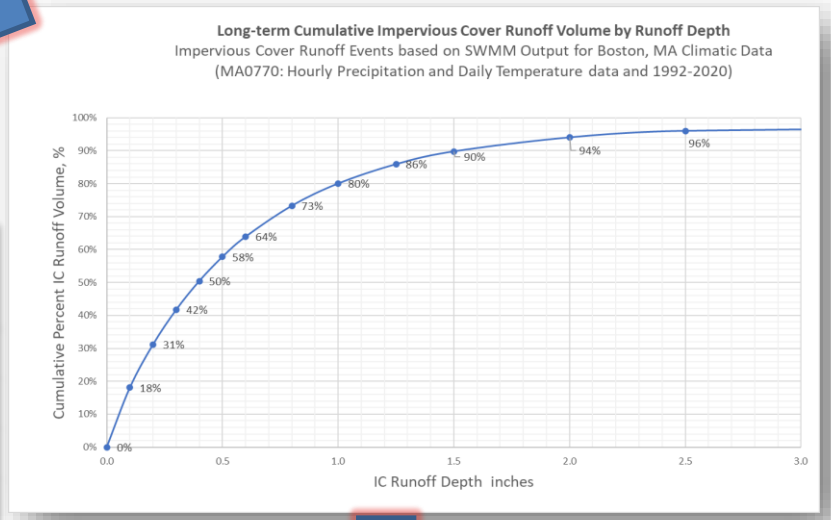
LID Standard Implementation Chart



Groundwater Recharge Requirement

Predevelopment Land Cover Being Converted to Impervious Cover (IC)	IC Runoff Yield (in/yr) A	Target Groundwater Recharge Volume (in/yr)	Required Groundwater Recharge + 10% ET loss at SCM (in/yr) B	Percent Reduction in Average Annual IC Runoff Volume B/A x 100
Meadow/Forest HSG A	40.2	24.7	27.3	**68%**
Meadow/Forest HSG B	40.2	22.5	24.7	**62%**
Meadow/Forest HSG C	40.2	18.8	20.6	**51%**
Meadow/Forest HSG D	40.2	14.7	16.2	**40%**

- Values in the bottom table are the "cumulative" runoff depth that must be captured for groundwater recharge.
- The cumulative runoff depths are <u>not</u> directly used to size the stormwater control measures.
- The Department proposes to require a higher groundwater recharge for the impervious cover replacing a forested area.



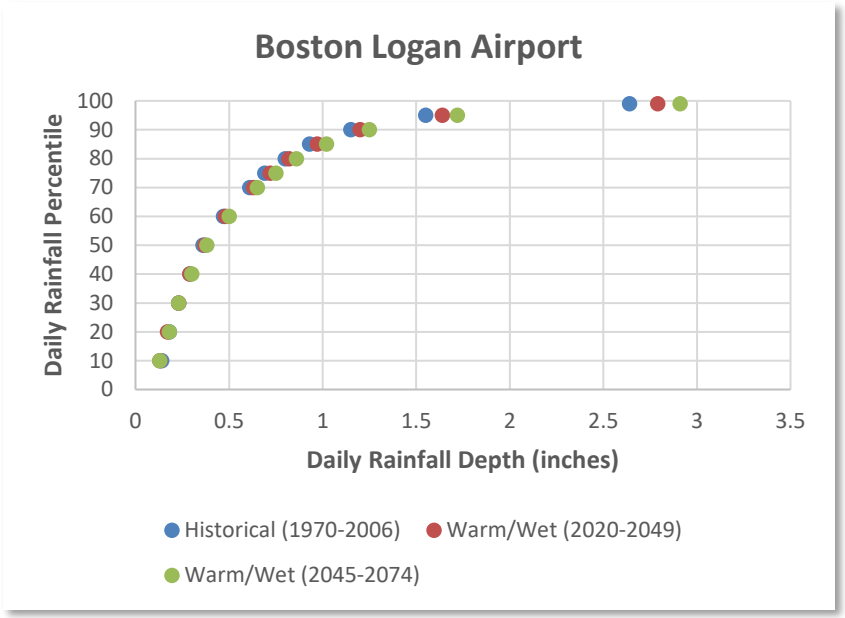
Cumulative Runoff depth (inches) from project impervious area that must be infiltrated

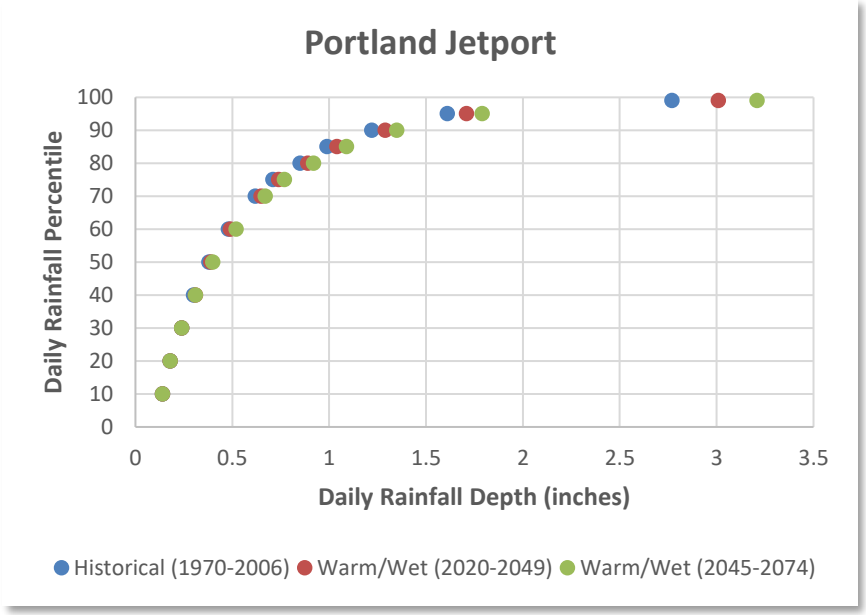
Hydrologic Soil Group	Predevelopment condition replaced by impervious area	
	Meadow/Field	Forest*
A	0.69	0.79
B	0.56	0.66
C	0.41	0.52
D	0.28	0.38

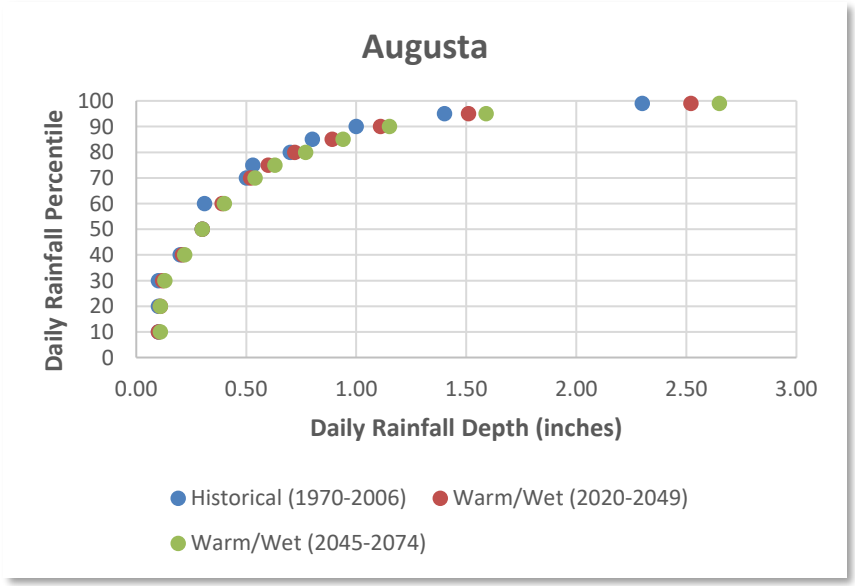
***: The Department increased the values in this column by 0.1 inch to recognize the forest's surface storage potential and to disincentivize the development of forested areas.**

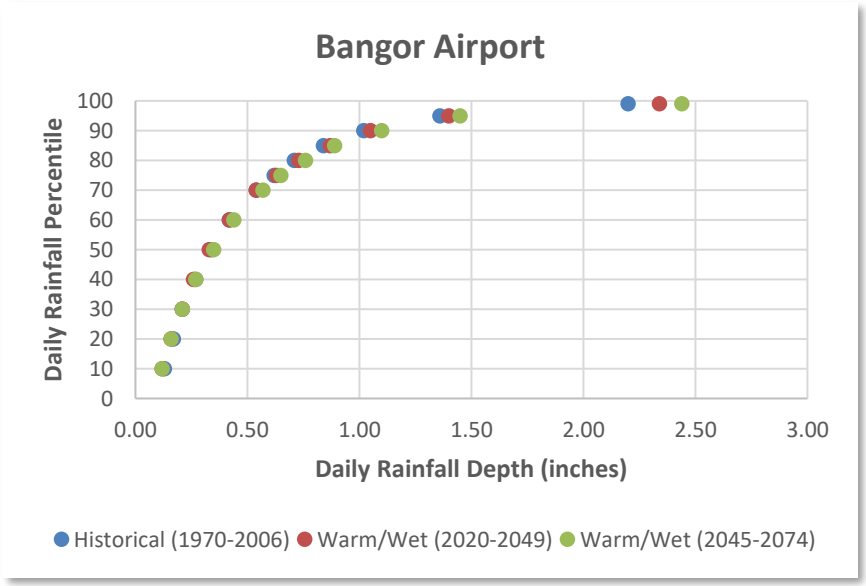
SCM must infiltrate up to 0.69 inches of runoff from impervious area

Reference: EPA. 2022. https://www.epa.gov/snep/holistic-watershed-management-existing-and-future-land-use-development-activities#pptsc









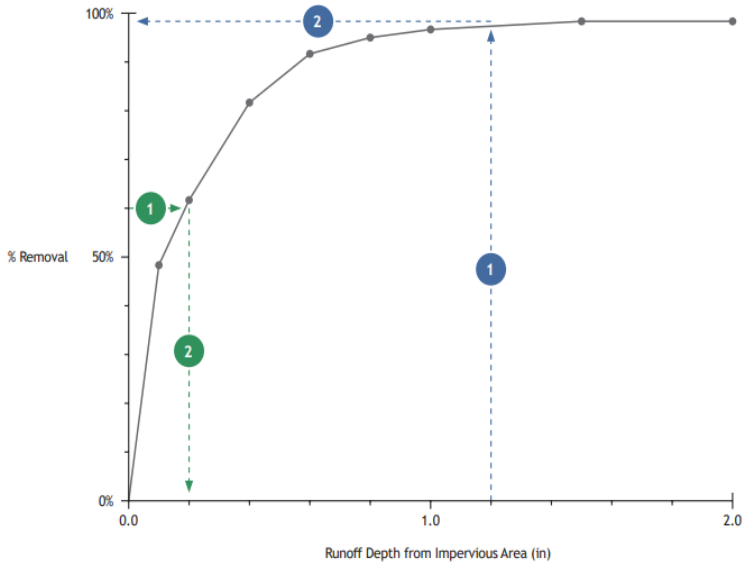
Data Source: [EPA National Stormwater Calculator Desktop Version]

Stormwater Control Measure Performance Curves

- Performance curves for SCMs are developed using long-term cumulative performance modeling tools (EPA SWMM, Opti-tool, and SUSTAIN)
- Performance curves quantify "SCM sizing - pollutant removal performance" relationship. They can be used in SCM design aiming to provide groundwater recharge and/or water quality level of control
- Most recent compilation of the performance curves is available in the New England Stormwater Retrofit Manual
- Performance curves can be improved as new monitoring data becomes available

How is Performance Curve Used for SCM Design?

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



Using Performance Curve for Meeting Groundwater Recharge Requirement

Percent Runoff Removal Required for new Impervious Cover

Y-axis of Performance Curve (PC)

Design Storage Volume (DSV) = Runoff Depth from Impervious Area (x-axis in PC) x Impervious Area

Reference: Figure 3-1 in New England Stormwater Retrofit Manual

Water Quality Level of Control & Performance Curves

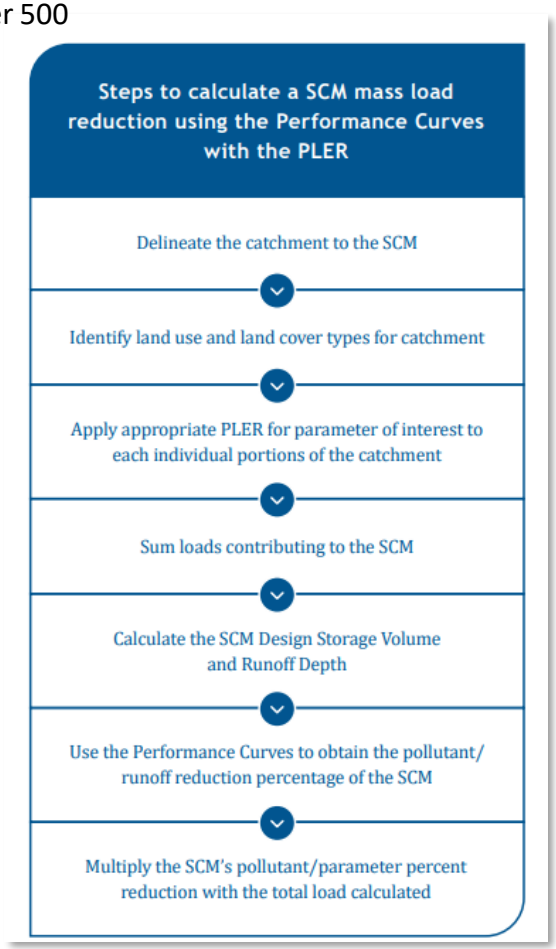
- Proposal for water quality level of control in Chapter 500:
  - Identify the target stormwater pollutant,
  - Stressor-specific Stormwater Control Measure selection pathways.

    Two major SCM selection pathways are envisioned:
    - **Conventional Pollutants:** effectively treated with conventional and LID SCMs. Represented by the nutrients, nitrogen and phosphorus.
    - **Challenging Pollutants:** recalcitrant, hard to treat by conventional SCMs. Source control, innovative SCMs, and non-LID SCMs required

      Example: chloride
- For projects required to provide water quality level of control, minimum level of conventional pollutant removal:
  - 70% for Urban Impaired Stream watersheds
  - 60% for other watersheds

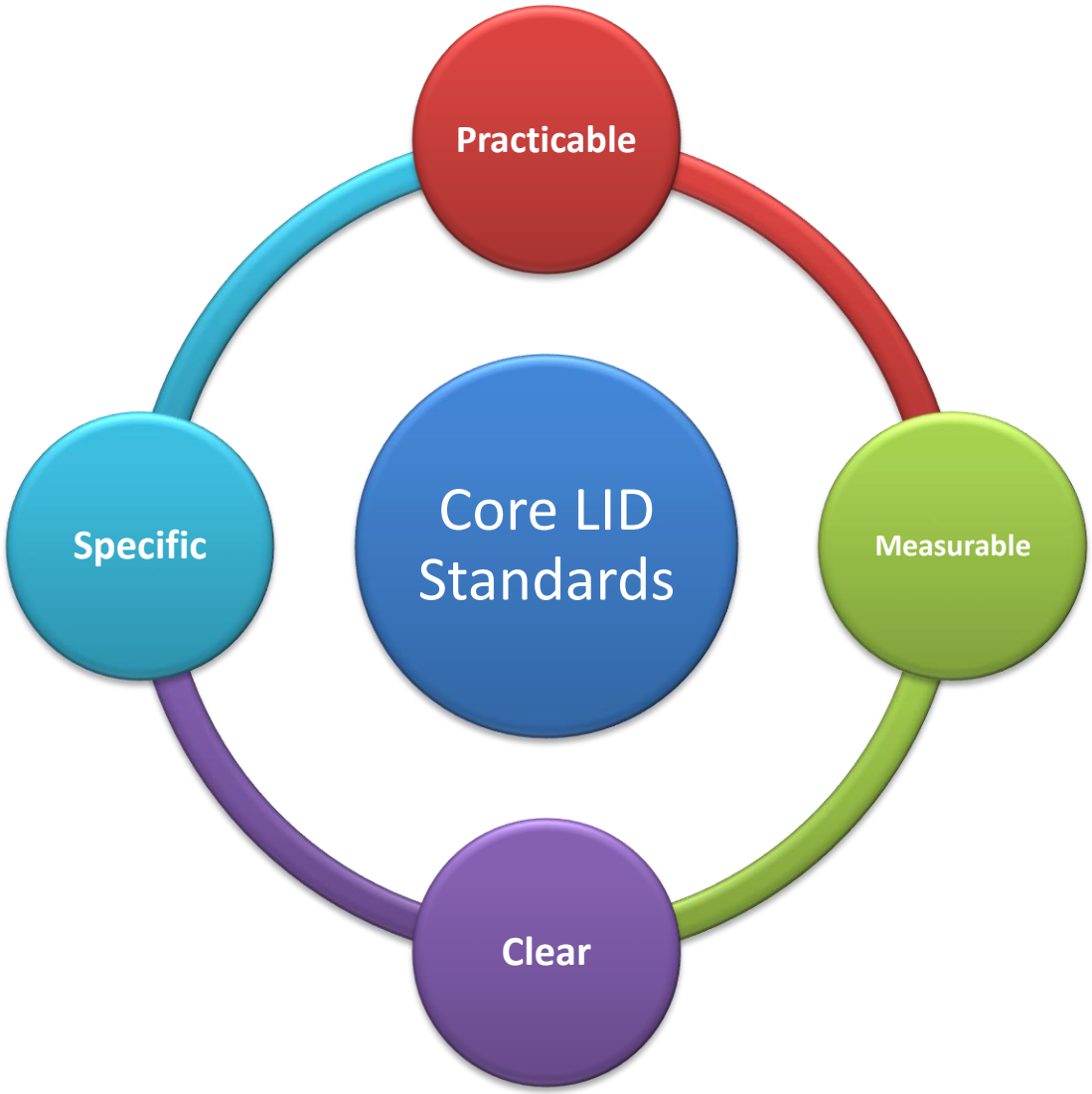
New Chapter 500: Tentative Steps to Follow for Treating Conventional Pollutants

Note that similar steps are followed to comply with the Phosphorus standard in current Chapter 500



PLER: Pollutant Load Export Rate

Reference: New England Stormwater Retrofit Manual


Practicable
Specific
Core LID Standards
Measurable
Clear

A. Natural Drainageways — Protect "Major Natural Drainageways (MND)"

- Natural drainageways that originate upgradient and enter project area or leave project area are considered MND.
- Protect MNDs by:
  - Providing undisturbed buffers: 100 ft and 50 ft depending on NRPA jurisdiction on MND
  - Preserving MND contributing drainage area
- 25% rule: Allowable impact no more than 25% on MND

B. Limit Development Footprint — Develop within the "LID Envelope"

- Proposed development must be within the LID Envelope which excludes:
  - 100-ft buffer associated with downgradient protected natural resources and major drainageways
  - 50-ft setback from downgradient parcel
  - HSG A and B soils
  - Areas with sustained slopes greater than 25%
  - Protected natural resources
- 25% rule: No more than 25% of the non-linear development can be outside LID Envelope.

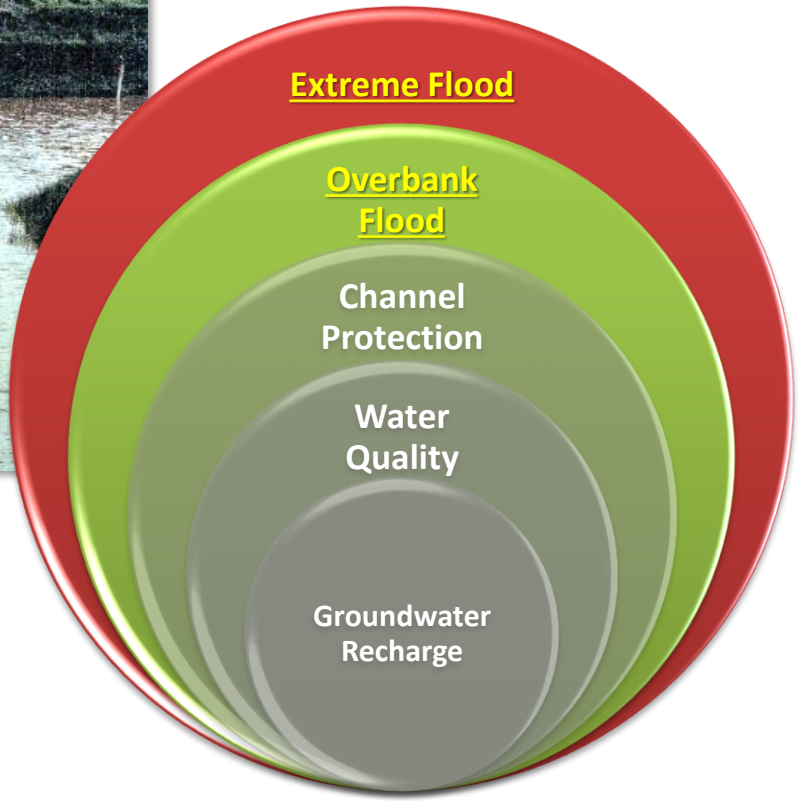
C. Open-channel Conveyance — Green (Swale) over Grey (Pipe)

- Vegetated open-channel conveyance must be used for stormwater conveyance. Closed-channel conveyance can serve
  - *New Development:* ≤25% of the impervious area
  - *Redevelopment:* ≤50% of the existing impervious area or ≤25% of the proposed impervious area, whichever is higher.

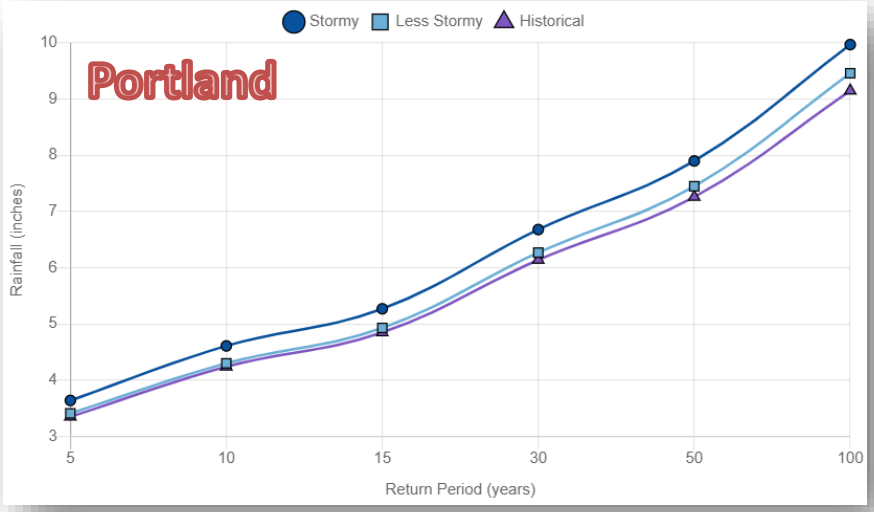
D. Low-maintenance Native Vegetation — Maine native or climate-resilient Northeastern plant use

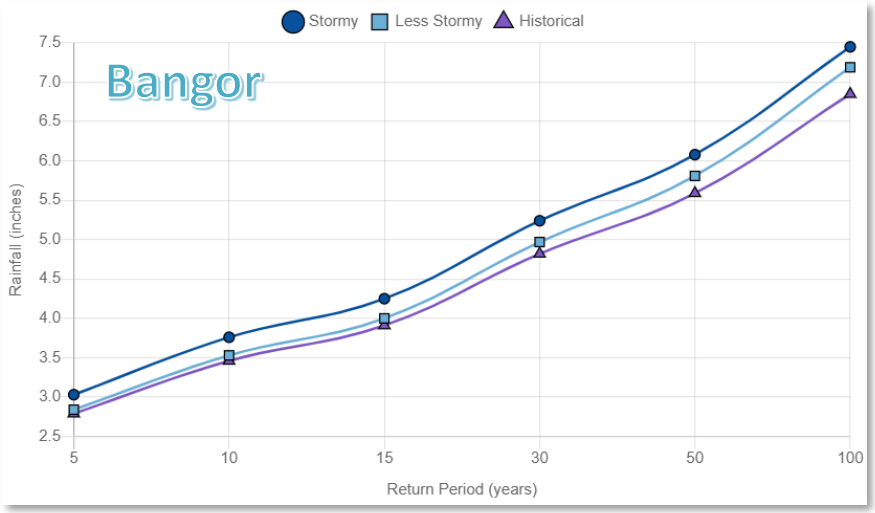
Can't meet A and/or B? "Alternatives Analysis" and Meet the Standards for "Sensitive & Threatened Watersheds"

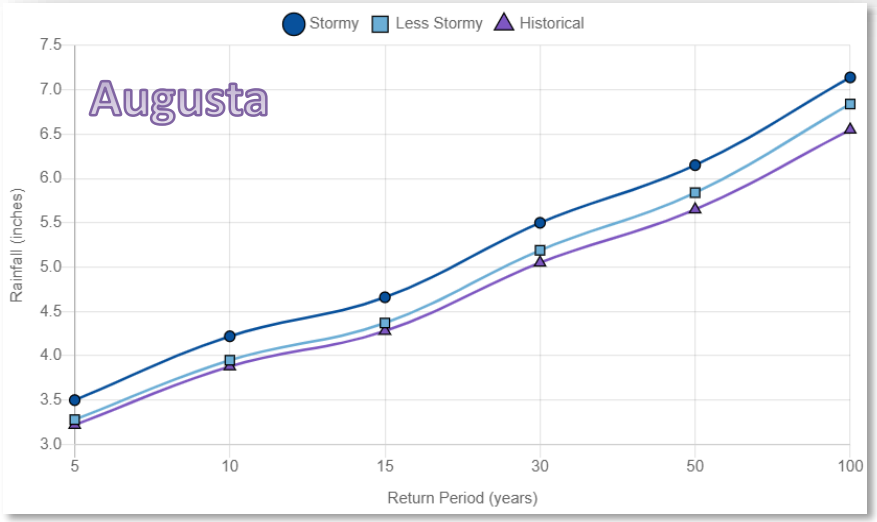
Flood Control Proposal



Annual Maximum Day Rainfall: Far Term Projections (2050-2070)







Historical -> Stormy (+9% Increase)

	10 year	50 year	100 year
Portland	4.24 -> 4.61	7.26 -> 7.9	9.15 -> 9.97
Augusta	3.88 -> 4.22	5.65 -> 6.15	6.55 -> 7.14
Bangor	3.46 -> 3.76	5.59 -> 6.08	6.85 -> 7.45

Data Source: EPA National Stormwater Calculator

Peak Flow Attenuation Requirements of New England States

- Peak flow control for 2-year storms aims for providing channel protection level of control rather than flood control.

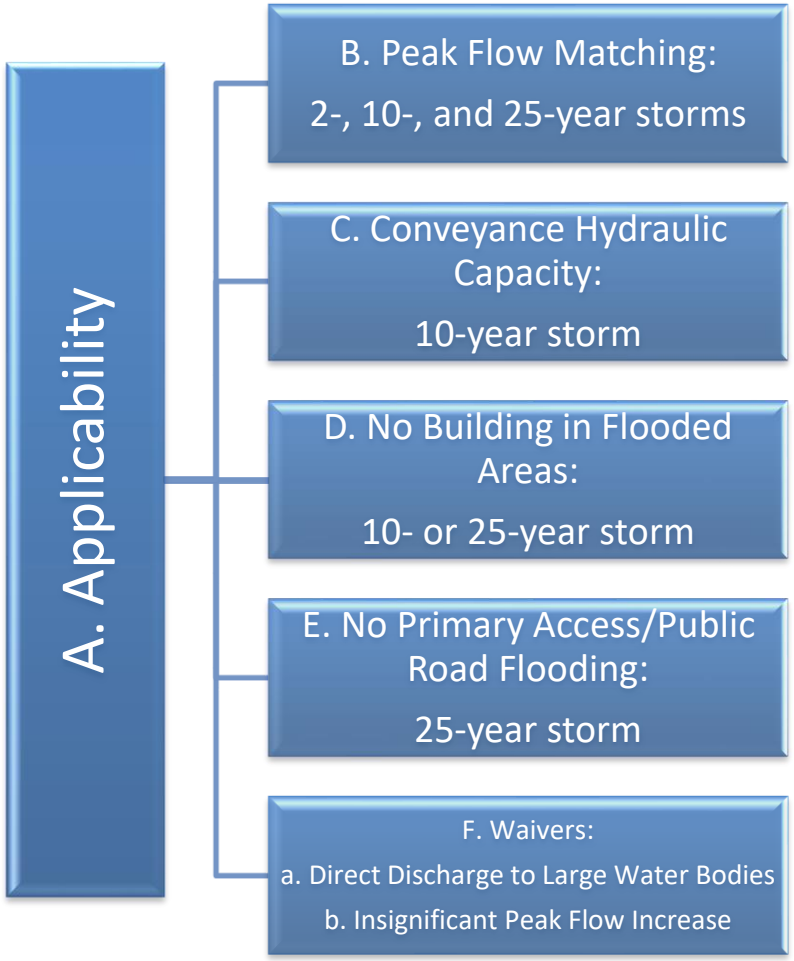
- 10-, 50-, and 100-year storms are commonly used for overbank and extreme flood control.

State	Peak Flow Attenuation Standard	Precipitation Data	Storm Distribution	Reference #
Connecticut	• $Q_{2,Post} \leq 0.5 \times Q_{2,Pre}$ • $Q_{10,Post} \leq Q_{10,Pre}$ • $Q_{100,Post} \leq Q_{100,Pre}$*	50th Percentile (Median) NOAA Atlas 14	NOAA Type D	1
Massachusetts**	• $Q_{2,Post} \leq Q_{2,Pre}$ • $Q_{10,Post} \leq Q_{10,Pre}$ • $Q_{100,Post} \leq Q_{100,Pre}$	0.9 x Upper Confidence Limit (NOAA Atlas 14)	NOAA Type C or D	2
New Hampshire***	• $Q_{10,Post} \leq Q_{10,Pre}$ • $Q_{50,Post} \leq Q_{50,Pre}$	Technical Paper #40 (TP40) or Other Acceptable Data (e.g., NRCC)	Unspecified	3, 4
Rhode Island	• $Q_{10,Post} \leq Q_{10,Pre}$ • $Q_{100,Post} \leq Q_{100,Pre}$	NRCC	NRCS Type III	5
Vermont	• $Q_{10,Post} \leq Q_{10,Pre}$ • $Q_{100,Post} \leq Q_{100,Pre}$	NOAA Atlas 14 or its replacement	NRCS Type II	6

$Q_{X, Pre\ or\ Post}$: Peak flow for "X"-year return period, 24-hour storm at the analysis point. "Pre" and "Post" subscripts stand for "Pre-development" and "Post-development" conditions, respectively.
*: At the discretion of the review authority.
**: Official rulemaking is currently underway. Proposed amendments are shown in this table.
***: New Hampshire also has 2-year peak flow control under its "channel protection" requirements which are not shown in this table.

Improving Flooding Standard

Current Flooding Standard

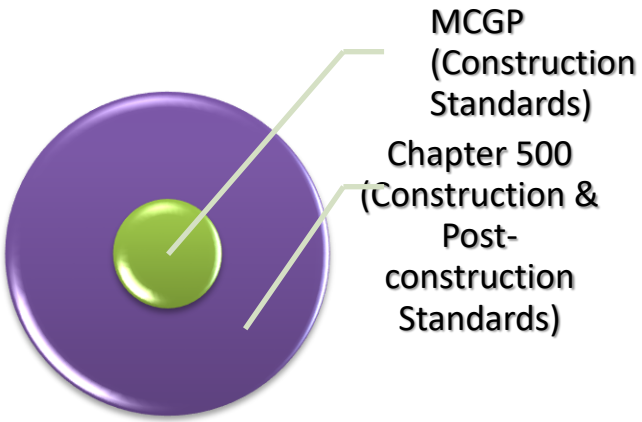


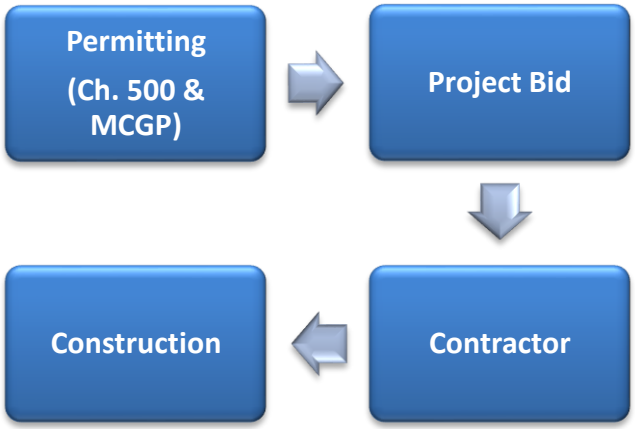
New Chapter 500

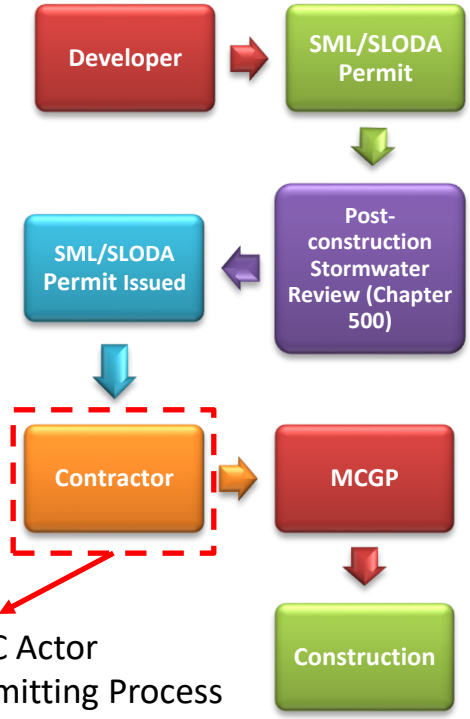
	Proposals/Recommendations
A	Maintain current thresholds
B	• Eliminate 2-year peak flow attenuation req. • Eliminate static precipitation data (Appendix H). Use best available precipitation data. <u>Detailed technical work necessary on</u>: • Watershed-specific flood control (UIS and Sensitive/Threatened Watersheds) • Design storms* • Precipitation data source* • Storm distribution*
C	• Improve/expand this standard to apply on the projects requiring SML permit
D	• Clarify design storm requirement
F	• Evaluate the waivers

*: Climate change consideration.

Two-step Permitting: Post-construction → Construction



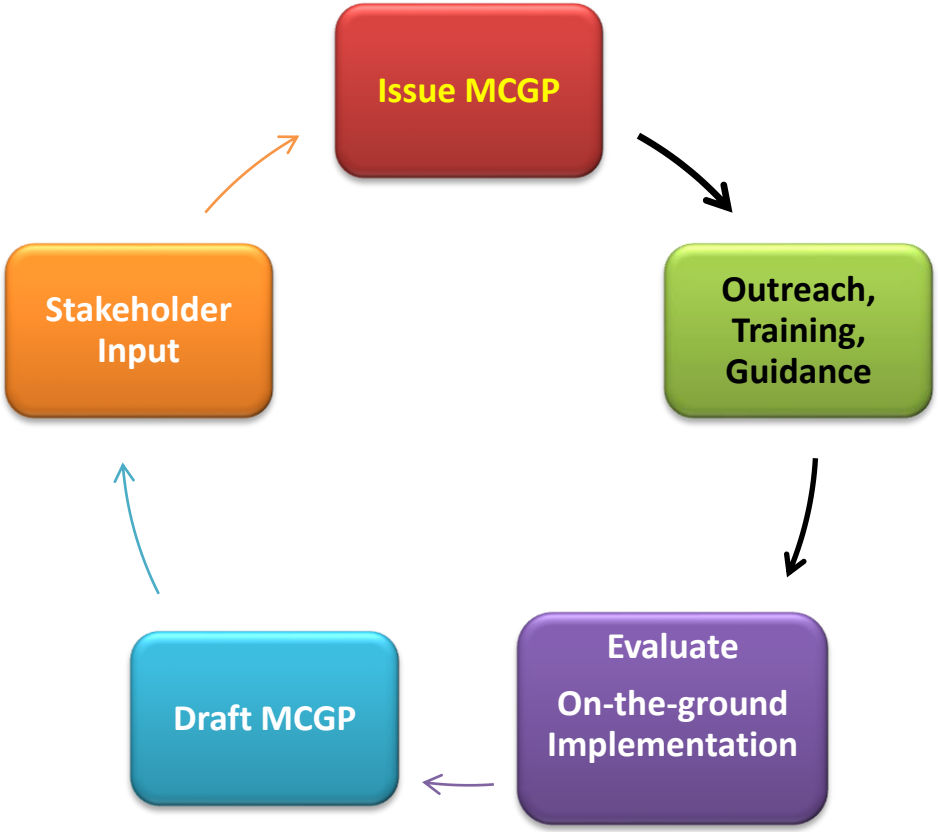




- **<u>Contractor</u>**: Key actor in ESC is usually unidentified during permitting,
- Boiler-plate ESC plans are prepared without contractors' input: on-site ESC practice differs from approved ESC plan,
- The Department has difficulty tracking construction start dates, on-site responsible parties.

Key ESC Actor
Included in Permitting Process

More Effective & Responsive Construction Stormwater Management



Technical Guidance: Stormwater Manual

Chapter 500	Stormwater Manual
What?	How?

- Stormwater management field is dynamic.
  - New, innovative SCMs are introduced,
  - Performance and effectiveness data available for the SCMs is improved (e.g., International Stormwater BMP Database),
  - SCM "performance curves" are improved (see "LID Standard" proposal).

- Current Chapter 500 has highly prescriptive standards on the SCM design and specifications.

- Updating Chapter 500 requires major substantive rulemaking, which is a long process.

- Therefore, the Department proposes that:
  - "Core" post-construction stormwater standards be specified in Chapter 500,
  - Detailed design specifications of the SCMs provided in the "Stormwater Manual" which will be updated with best available information regularly,
  - A section must be dedicated to the "Stormwater Manual" explaining its role in Chapter 500 compliance and the procedure that must be followed for major revisions of the manual (e.g., stakeholder input, public comment).

Other Proposals/Recommendations

Five-year Recertification

Standard Condition for SML/SLODA Projects: Recurring Requirement

- Evaluate "Five-year Recertification Program" and consider:
  - A recertification fee
  - Revising the program scope and requirements
  - Specify the minimum criteria to be recertified in the "Stormwater Manual".

Construction Oversight

Current SML/SLODA Permit Requirement

- Evaluate and improve "Construction Oversight" requirement to ensure that:
  - Structural SCMs are built under the oversight of a licensed professional engineer,
  - Consider requiring executed oversight contract as a part of MCGP Notice of Intent submission,
  - Specify the "Construction Oversight" reporting requirements in the "Stormwater Manual".

As-built Plan

Current SML/SLODA Permit Requirement

Evaluate and improve "As-built Plan" submission requirement to ensure that:

- The Department receives as-built plans for completed SML and SLODA permit projects,
- Consider requiring as-built plan submission as a part of MCGP Notice of Termination submission.
- Specify the "As-built Plan" submission requirements in the "Stormwater Manual".

Phosphorus

Update Chapter 501

- The Department proposes to eliminate **Table 3** in Chapter 501.
- $25,000 flat compensation fee per pound of phosphorus exported.

Acknowledgements

- Impervious Cover Analysis Project:
  - Becky Schaffner (DEP GIS Coordinator)
  - Karen McNeil (DEP Intern & UMaine Student)