TMDL REQUIREMENTS IN AN MS4 PERMIT

CHARLES RIVER WATERSHED EXAMPLE

NEWTON TEDDER

EPA REGION 1

BOSTON

PRESENTATION OVERVIEW

- REGULATION BACKGROUND
- CHARLES RIVER HISTORY AND STORMWATER BMP PERFORMANCE IN NEW ENGLAND
- CHARLES RIVER PERMIT REQUIREMENTS
- COMPLIANCE TOOLS
- QUESTIONS

CWA 402(P)(3)(B) AND IMPLEMENTING REGULATIONS IN 40 CFR §§ 122.26 AND 122.34

REQUIRE NPDES PERMITS FOR STORMWATER DISCHARGES FROM MS4S TO EFFECTIVELY PROHIBIT NON-STORMWATER DISCHARGES INTO THE SEWER SYSTEM; AND TO REQUIRE CONTROLS TO REDUCE POLLUTANT DISCHARGES TO THE MAXIMUM EXTENT PRACTICABLE (MEP) INCLUDING BMPS, AND OTHER PROVISIONS AS EPA DETERMINES TO BE APPROPRIATE FOR THE CONTROL OF SUCH POLLUTANTS

ANATOMY OF A PHASE II MS4 GENERAL PERMIT

SIX MINIMUM CONTROL MEASURES

- PUBLIC EDUCATION
- PUBLIC INVOLVEMENT
- ILLICIT DISCHARGE DETECTION & ELIMINATION
- CONSTRUCTION SITE RUNOFF
- POST-CONSTRUCTION STORMWATER MANAGEMENT
- GOOD HOUSEKEEPING/POLLUTION PREVENTION

WATER-QUALITY BASED REQUIREMENTS?

WATER QUALITY STANDARDS IN MS4 PERMITS

GENERIC

- NO AUTHORIZATION FOR THOSE DISCHARGES NOT MEETING WATER QUALITY STANDARDS

2003 PHASE II MA/NH PERMIT APPROACH

SPECIFIC

- SPECIFIC BMP IMPLEMENTATION REQUIREMENTS ABOVE MEP
- NUMERIC TARGETS WHERE APPLICABLE
- SCHEDULES WHERE APPROPRIATE

2016 PHASE II MA PERMIT APPROACH

2014 TMDL AND STORMWATER SOURCES MEMO

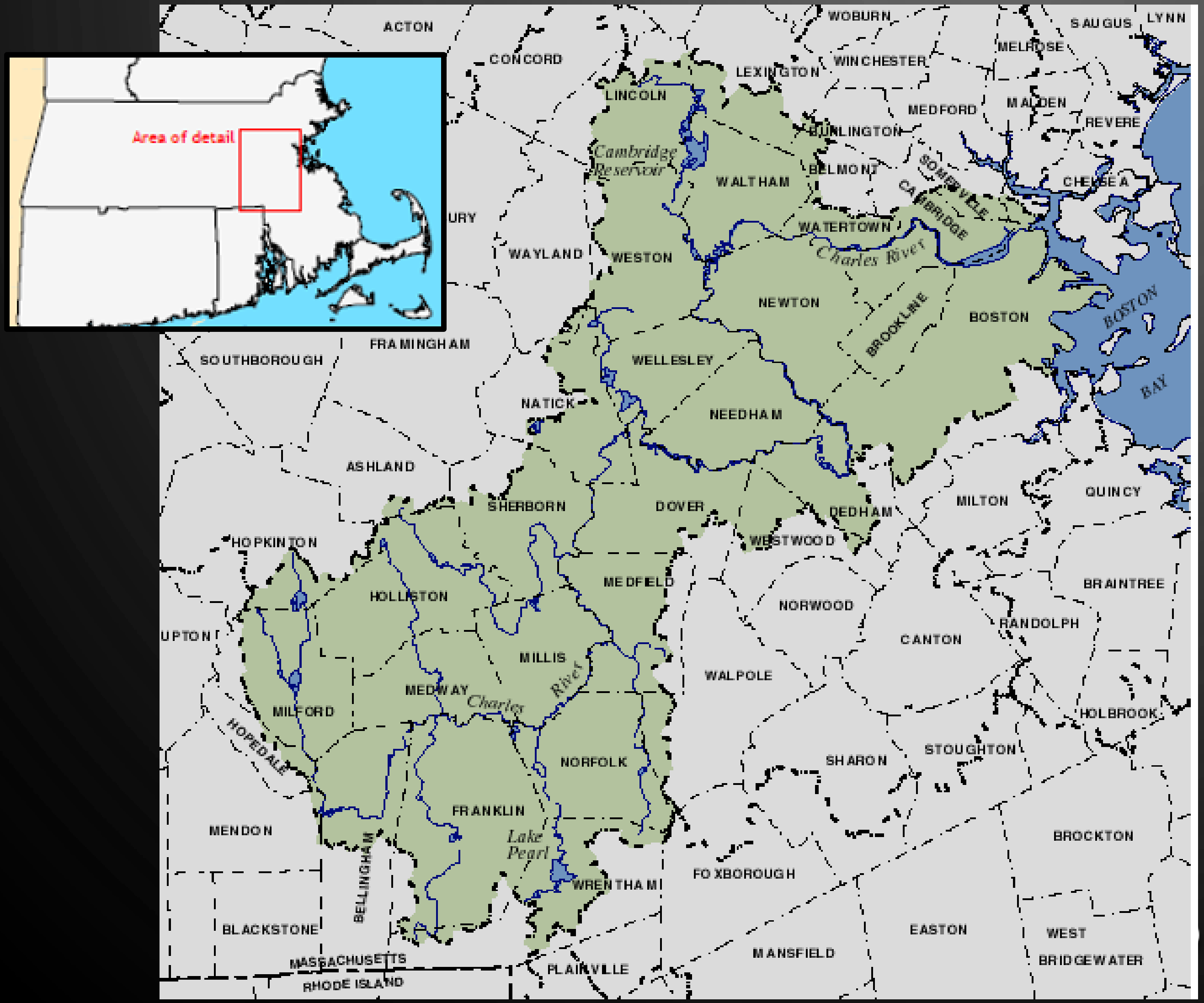
WHERE THE NPDES PERMITTING AUTHORITY DETERMINES THAT MS4 DISCHARGES HAVE THE REASONABLE POTENTIAL TO CAUSE OR CONTRIBUTE TO A WATER QUALITY STANDARD EXCEEDANCE, THE PERMITTING AUTHORITY SHOULD "EXERCISE ITS DISCRETION" TO INCLUDE THE NECESSARY REQUIREMENTS TO MEET WATER QUALITY STANDARDS

"Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs" (November 26, 2014)

WHEN IS MEP NOT ENOUGH

- CATEGORY 5 WATERS IMPAIRED FOR:
  - NITROGEN OR PHOSPHORUS
  - METALS
  - SOLIDS
  - BACTERIA OR PATHOGENS
  - CHLORIDE
  - OIL AND GREASE
- TMDLS WITH WLA'S OR LA'S FOR STORMWATER SOURCES

LOWER CHARLES RIVER PHOSPHORUS TMDL CHARLES RIVER WATERSHED

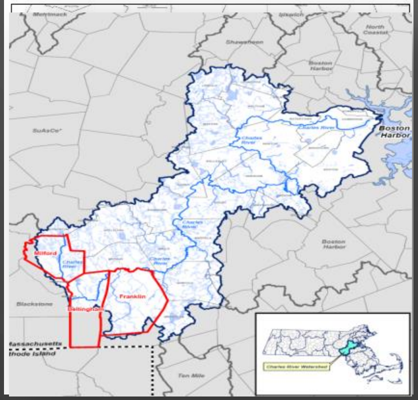


- 308 Square Mile Watershed (61 sq. mi. (39,000 ac.) of impervious cover (IC)
- 80 Miles in Length
- All or part of 35 Cities and Towns
- ~900,000 population
- ~747,000 in Boston, Cambridge and Brookline

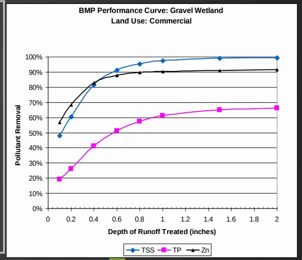
HISTORICAL OVERVIEW

Charles River P TMDLs, (Lower 2002–2007 Upper/Middle 2006-2011)

Residual Designation Petition,~2007



SW Control Performance Analyses 2007-10



Stormwater Management Optimization Analysis, 2010-11

Draft Residual Designation Permit, ~2010

MS4 Permits with TMDL Related Reductions Requirements MA Final (2016) NH Draft (2013,15)

Accounting System Phosphorus Source Loads & Credible SW Control Reduction Credits ~2010-14

Low Cost SW Control Performance Analyses ~2013

Sustainable Funding Study & EPA Updated Optimization Analysis, 2010-11

Permitting Tools: Stormwater Management Optimization Tool "Opti-Tool" (2013-16), and BMP Accounting and Tracking Tool "BATT" (2015-2016)

LOWER CHARLES RIVER PHOSPHORUS TMDL WASTE LOAD ALLOCATIONS

Source	Existing Load (kg/year) (1998-2002)	Waste Load Allocation (kg/year)	Load Allocation (kg/year)	TMDL (kg/year)	% Reduction
Upstream Watershed at Watertown Dam[a]	28,925	15,109	0	15,109	48%
CSOs[b]	2,263	90[c]	0	90[c]	96%
Stony Brook Watershed	5,123	1,950	0	1,950	62%
Muddy River Watershed	1,549	590	0	590	62%
Laundry Brook Watershed	409	155	0	155	62%
Faneuil Brook Watershed	326	125	0	125	62%
Other Drainage Areas	1,455	550	0	550	62%
Explicit Margin of Safety	-	-	-	979	
TOTAL	40,050	18,565	0	19,544	54%

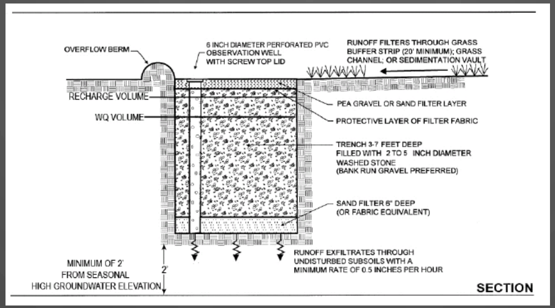
KEY QUESTIONS ALONG THE WAY

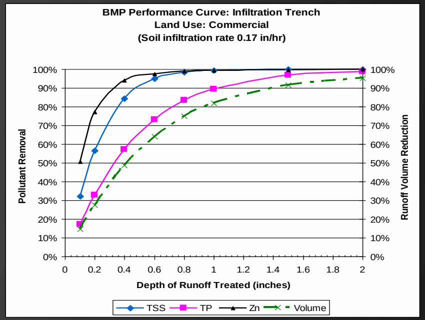
- SW PHOSPHORUS LOADS: FROM WHERE AND HOW MUCH?
- TECHNICAL FEASIBILITY:
  - CAN IT BE DONE?
    - WHAT ARE THE EFFECTIVENESS OF VARIOUS SW CONTROLS?
    - WHAT CONTROLS AND DESIGNS CAN INCREASE TECHNICAL AND ECONOMIC FEASIBILITY?
  - HOW CAN IT BE DONE?

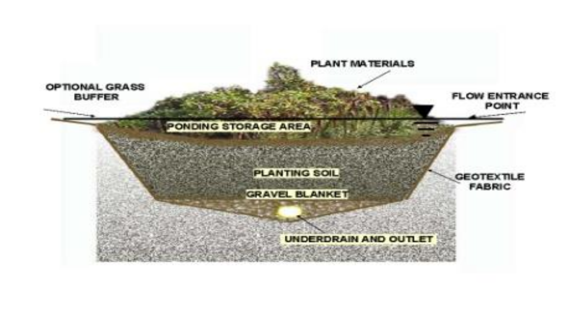
- ACCOUNTABILITY: HOW DO WE ENSURE REAL AND CREDIBLE PROGRESS IS BEING MADE BY PERMITTEES AND AVOID “CREATIVE” ACCOUNTING?
- WHAT ARE THE MOST COST EFFECTIVE APPROACHES TO ACHIEVE REDUCTIONS?
- HOW MUCH WILL IT COST AND HOW CAN IT BE PAID FOR?
- WHAT TOOLS AND ASSISTANCE ARE NEEDED FOR PERMITTEES TO DEVELOP AND IMPLEMENT CREDIBLE AND MOST COST EFFECTIVE PROGRAMS?

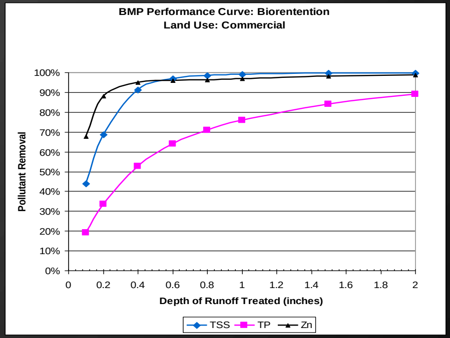
GENERATION OF SW CONTROL PERFORMANCE CURVES FOR NEW ENGLAND REGION

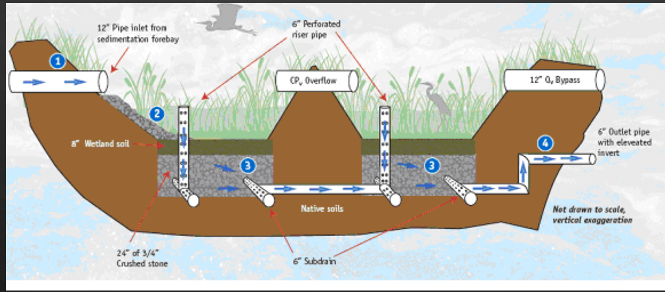
SW Controls
Surface Infiltration (6 infiltration rates)
Infiltration trenches (6 infiltration rates)
Bio-filtration
Porous pavement with underdrain
WQ Swales (non-infiltration)
Gravel wetland
Enhanced Bio-filtration*
* Optimized for N and P removal

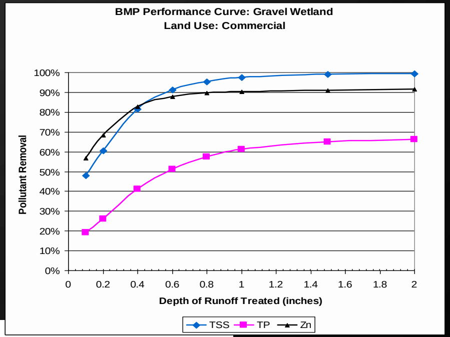


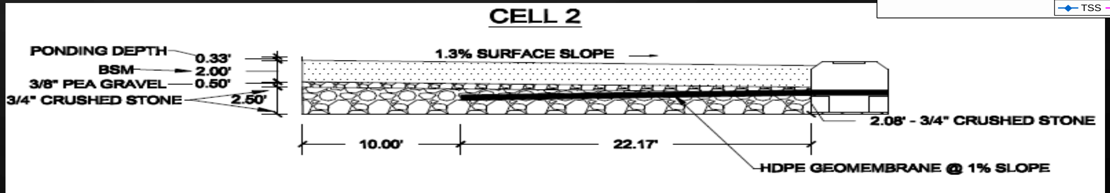




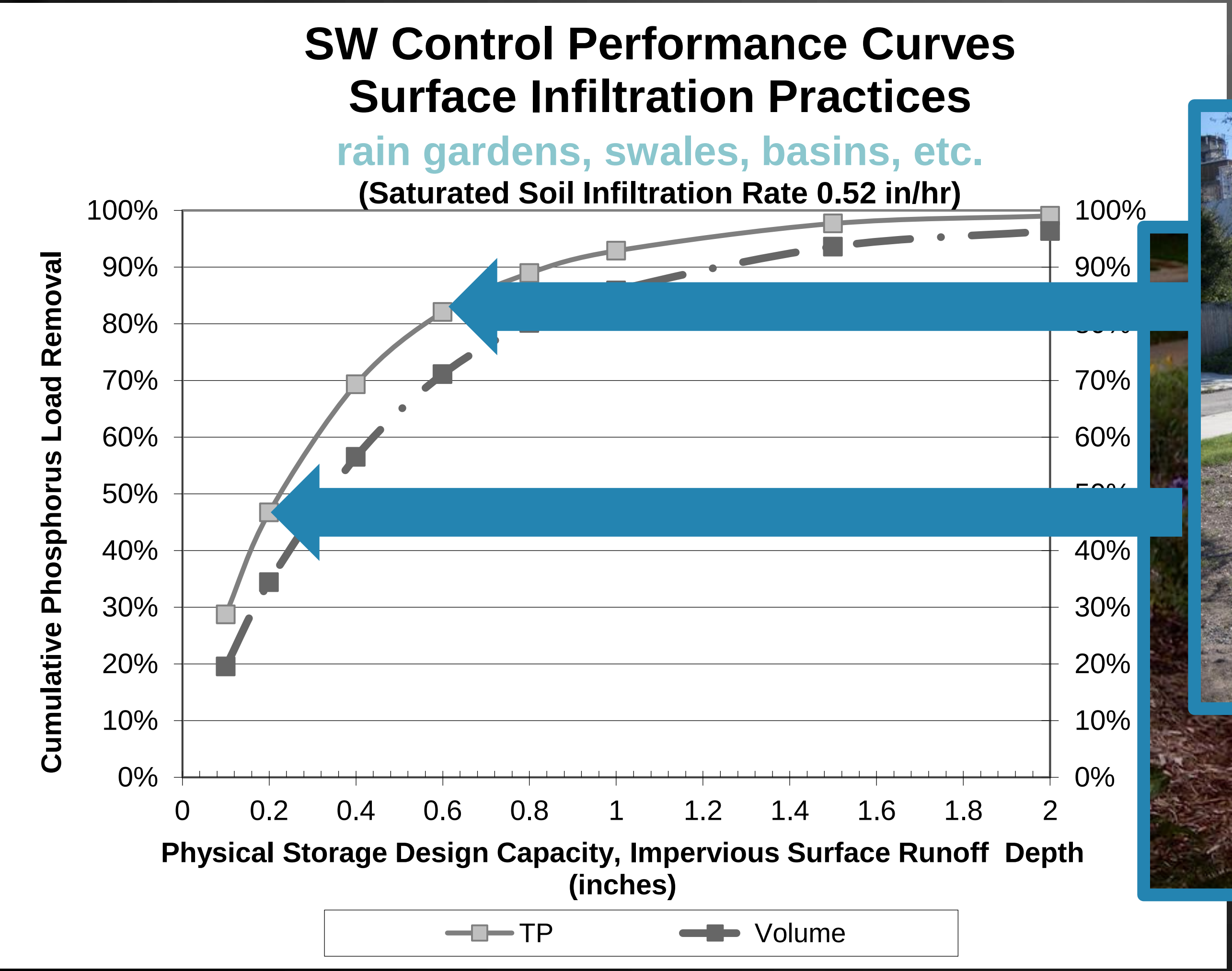








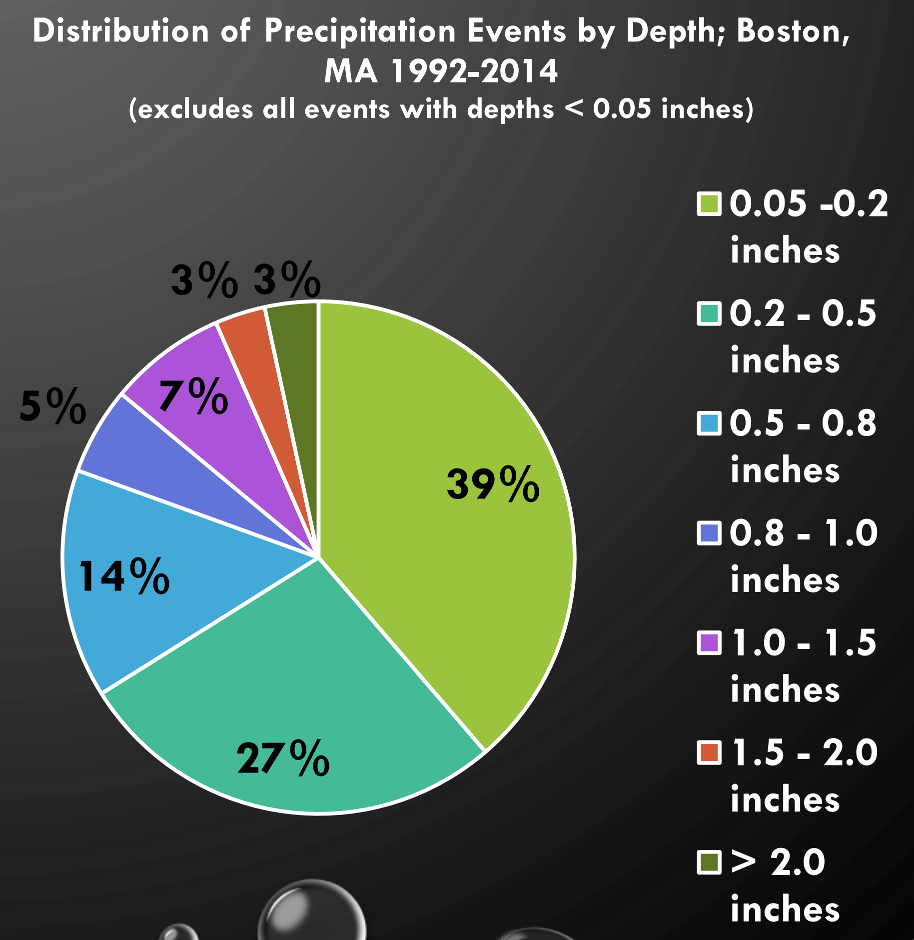
SW CONTROL LONG-TERM CUMULATIVE PERFORMANCE CURVE CONCEPT



Small Rain Garden http://www.flickr.com/photos/cdwilliams1/2915660835/
Larger Stormwater Basin http://www.flickr.com/photos/leonizzy/6232922661/

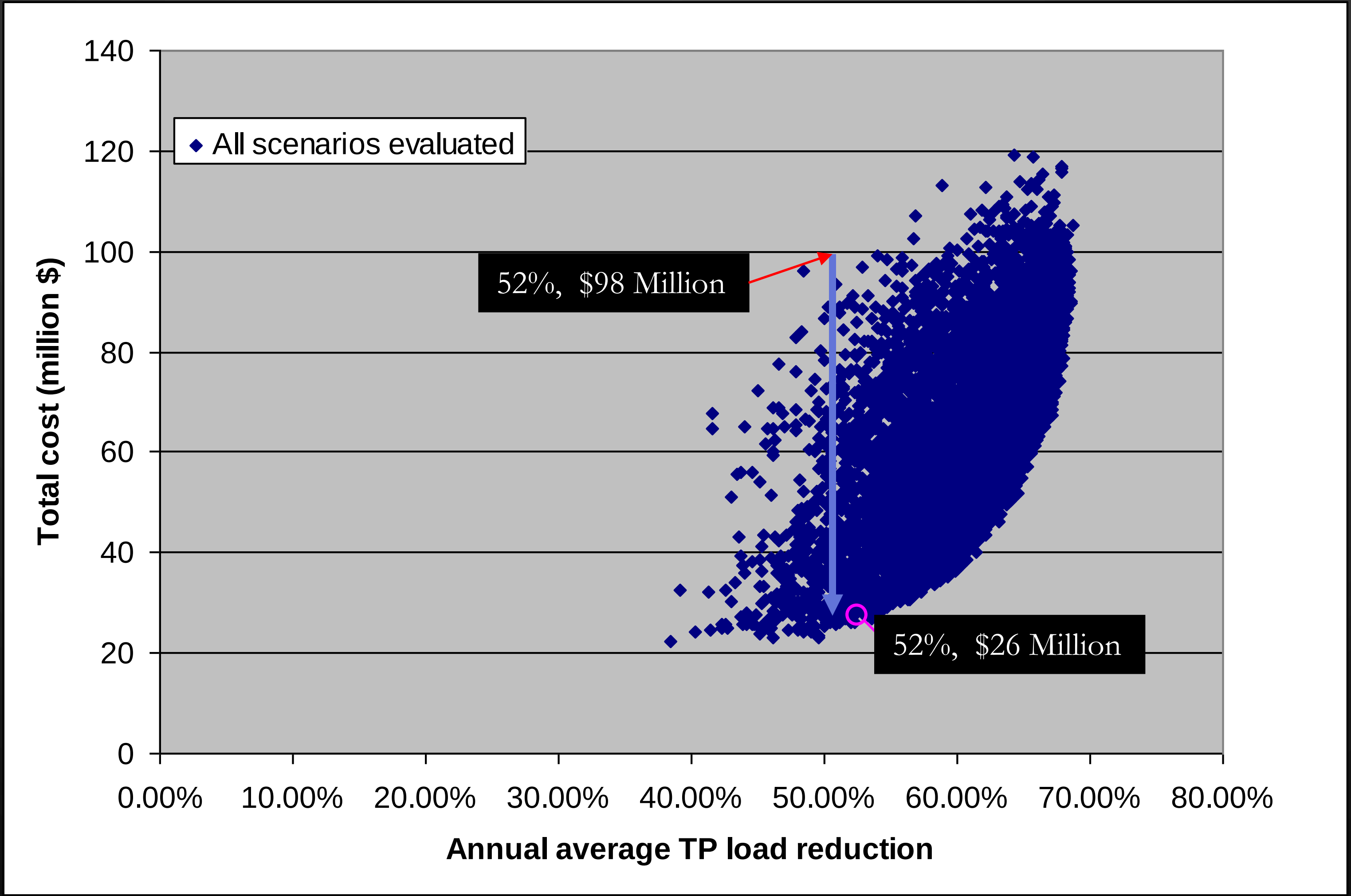
NEW ENGLAND REGION PRECIPITATION PATTERNS
RELEVANT POINTS

- MOST RAIN EVENTS ARE SMALL IN SIZE;
- OCCUR REGULARLY (AVERAGE ABOUT ONCE EVERY THREE DAYS)
- THE TOTAL VOLUME AND EVENT SIZE DISTRIBUTION ARE RELATIVELY CONSISTENT ACROSS NEW ENGLAND REGION
- IMPORTANT DRIVER FOR POLLUTANT LOAD DELIVERY AND CUMULATIVE PERFORMANCE OF SW CONTROLS



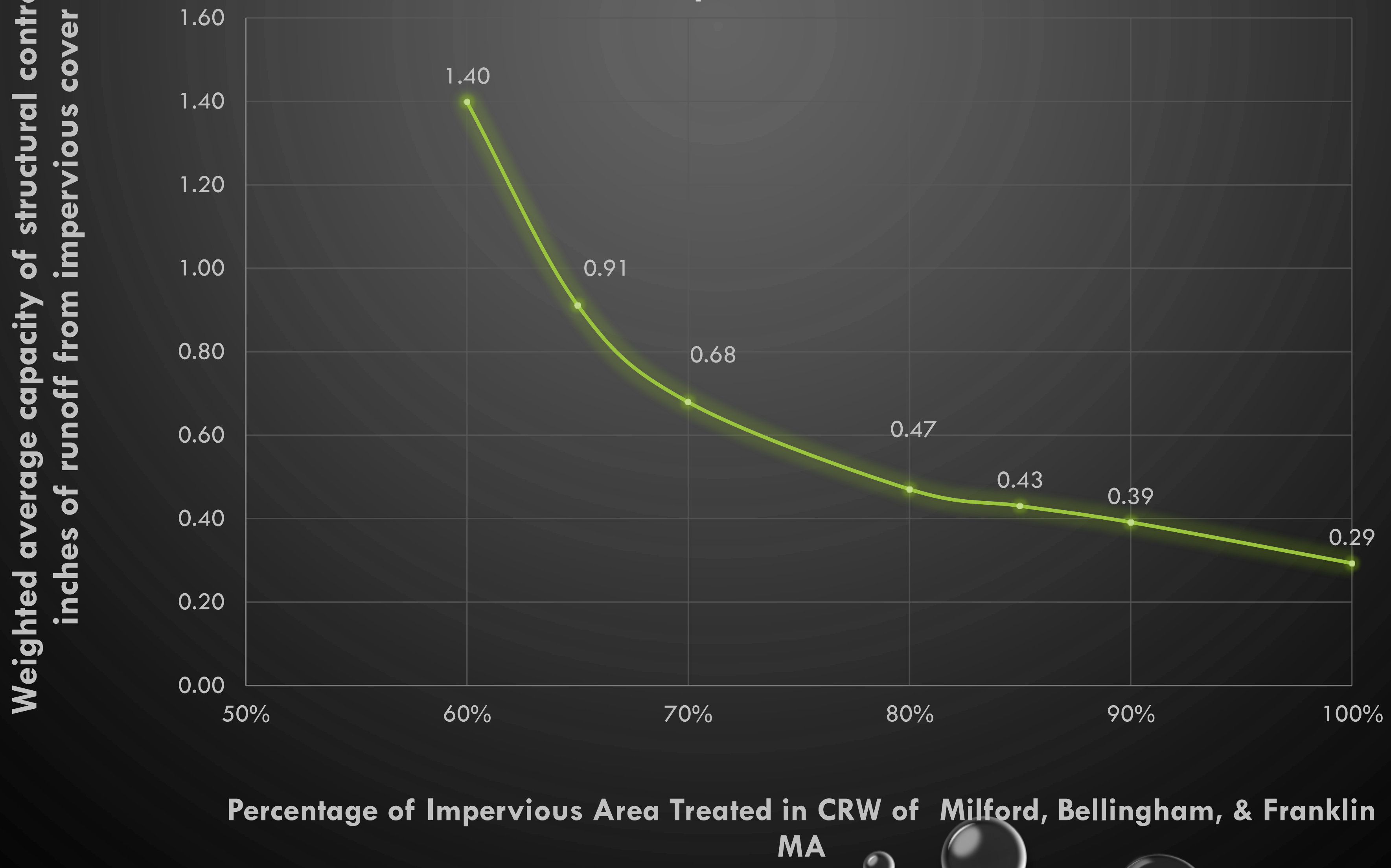
DEMONSTRATION PROJECT: OPTIMIZATION ANALYSIS FOR 3 UPPER CHARLES TOWNS

- CONDUCTED BY TETRA TECH, INC. TO EVALUATE BROAD SW MANAGEMENT STRATEGIES TO INFORM PERMIT DEVELOPMENT
- BIG PICTURE KEY FINDINGS:
  - THE RANGE IN ESTIMATED COSTS FOR IMPLEMENTATION OF SW CONTROLS WATERSHED-WIDE TO ACHIEVE A SET PHOSPHORUS REDUCTION TARGET IS HUGE
  - STANDARDIZE SIZING OF CONTROLS (ONE SIZE FITS ALL) WILL BE MUCH MORE EXPENSIVE (ADMINISTRATIVE EASE MAY BE UNAFFORDABLE AND UNWISE)
  - COMPREHENSIVE OPTIMIZATION PROCESS WILL HELP IDENTIFY THE BEST COMBINATION OF CONTROLS, DESIGN CAPACITIES AND LOCATIONS TO ACHIEVE REQUIRED LOAD REDUCTION AT LEAST COST

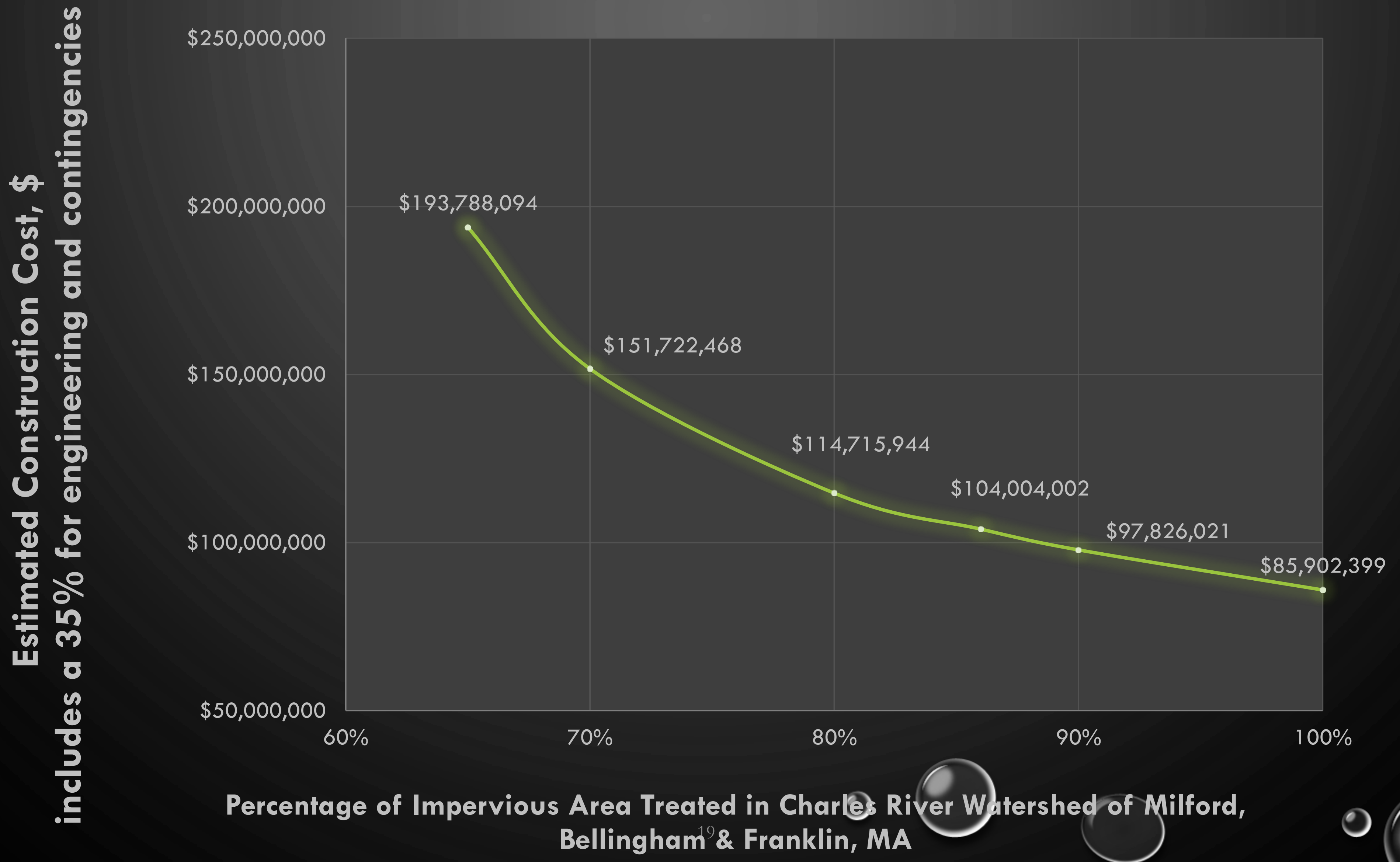


All scenarios evaluated
52%, $98 Million
52%, $26 Million
Total cost (million $)
140
120
100
80
60
40
20
0
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
Annual average TP load reduction

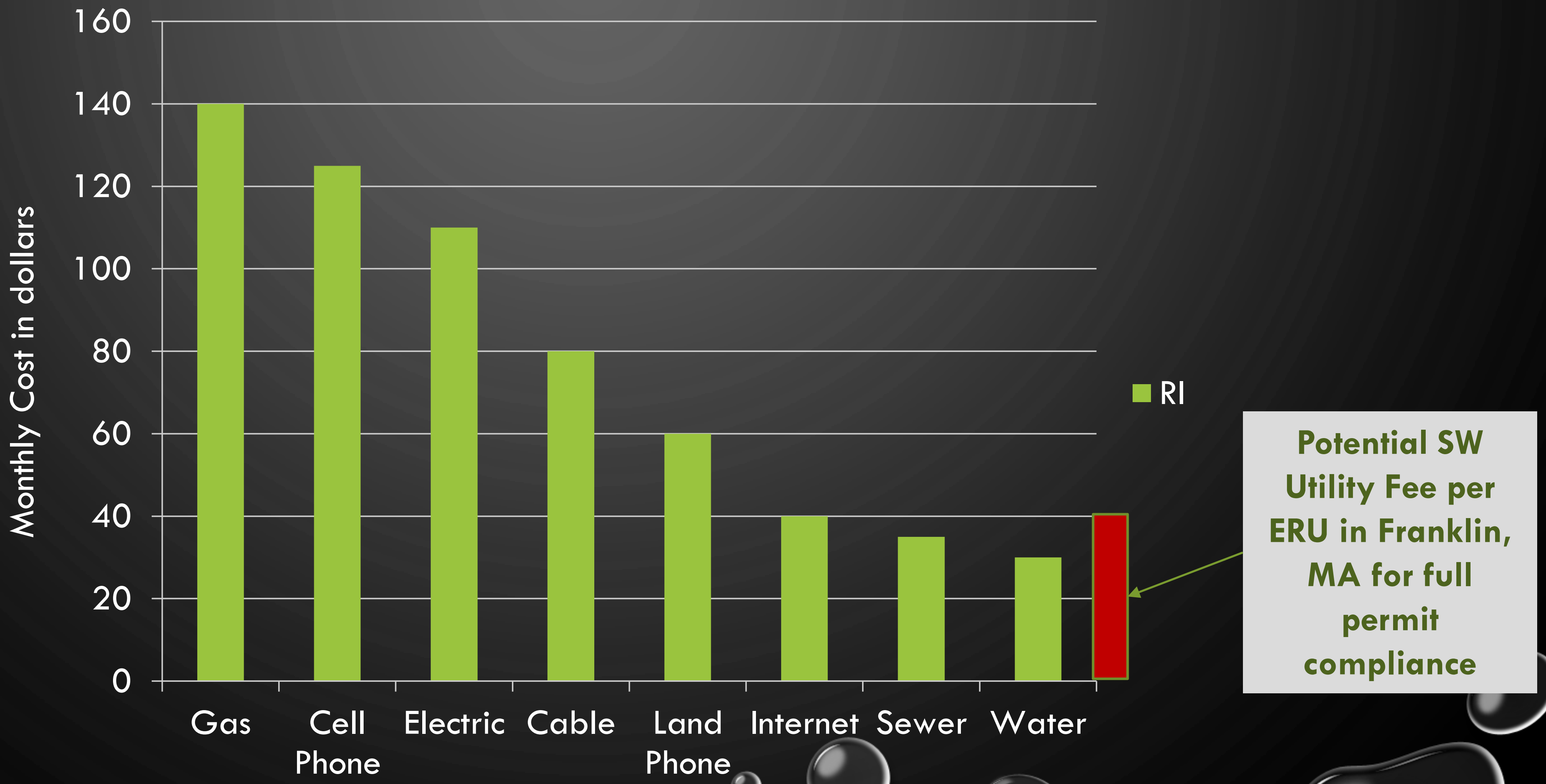
Average Capacity of structural controls needed to achieve a phosphorus load reduction of 40% in the Charles River Watershed of Milford, Bellingham & Franklin, MA based on the treatment of varying amounts of impervious area



Estimated Construction Costs for Structural Stormwater Controls to Achieve a 40 % Reduction in Phosphorus Load form the Charles River Watershed in Milford, Bellingham & Franklin based on Amount of Impervious Area Treated



TYPICAL MONTHLY UTILITY AND SERVICE COSTS FOR HOUSEHOLDS IN RHODE ISLAND



IMPORTANT LESSONS LEARNED FOR MANAGING SW IN DEVELOPED WATERSHEDS

- CREDIBLE ACCOUNTING SYSTEM IS NEEDED FOR CONSISTENCY AND TO AVOID CREATIVE ACCOUNTING. ALSO, NEEDED FOR CONDUCTING COMPREHENSIVE PLANNING AND OPTIMIZATION ANALYSES.

- COMPREHENSIVE PLANNING WITH OPTIMIZATION IS A WORTHWHILE INVESTMENT FROM BOTH COST EFFECTIVENESS AND ENVIRONMENTAL BENEFIT VIEWPOINTS

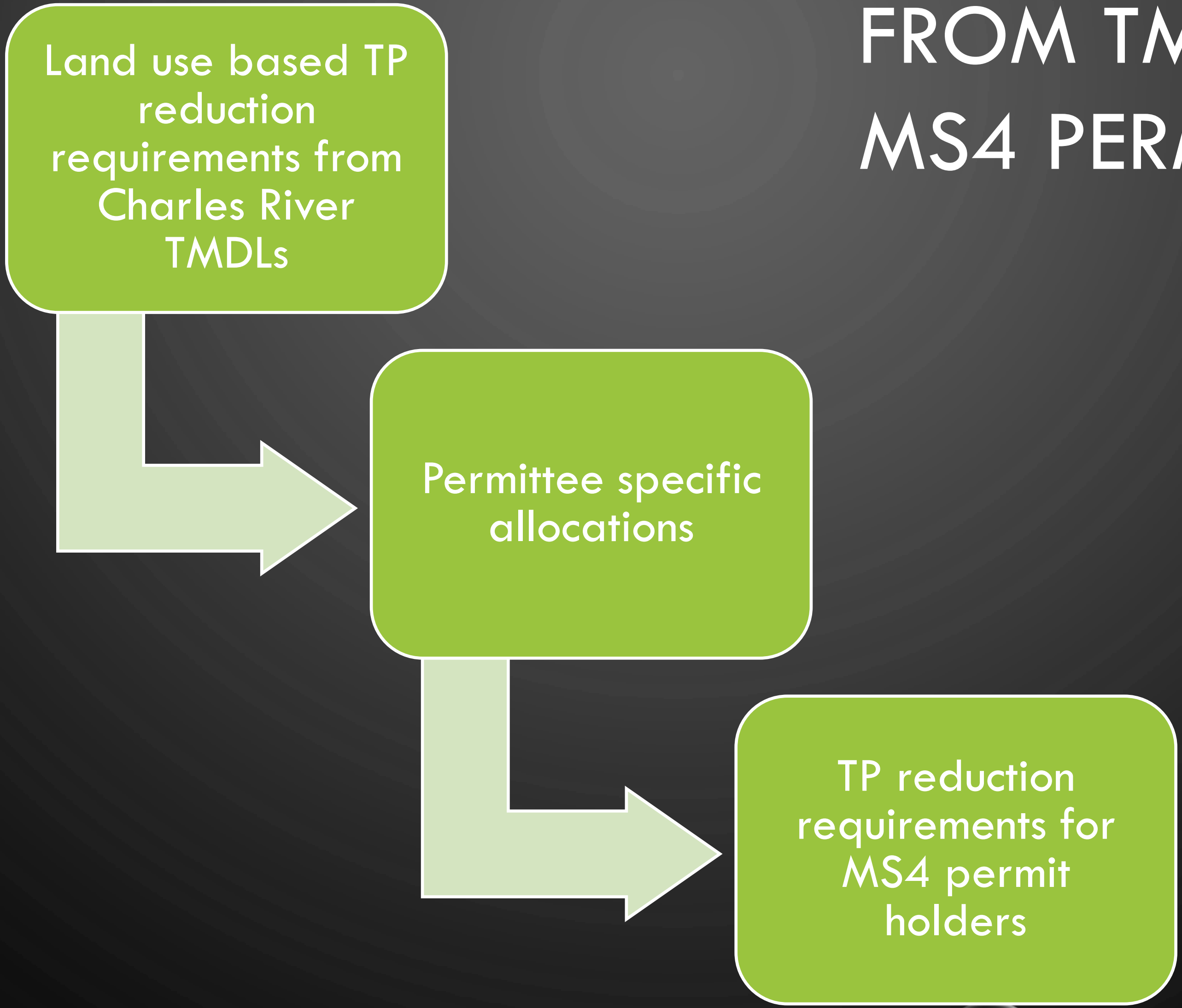
- SW PROFESSIONALS WILL NEED READY ACCESS TO CREDIBLE INFORMATION AND SW MANAGEMENT OPTIMIZATION TOOLS TO SHIFT PARADIGMS FROM CONVENTIONAL APPROACHES (E.G., ONE-SIZE FITS ALL)TO MORE FLEXIBLE- COST-EFFECTIVE-OPTIMIZED APPROACHES.

- CONSIDERATION OF SMALL CAPACITY SW CONTROLS (E.G., 0.2 TO 0.5 INCHES) INCREASES BOTH TECHNICAL AND ECONOMIC FEASIBILITY FOR IMPLEMENTING CONTROLS IN DEVELOPED LANDSCAPES & WILL ENCOURAGE INNOVATION

ACCOUNTING PRINCIPLES

- **THE ACCOUNTING METHODOLOGY MUST:**
  - BE BASED ON CREDIBLE INFORMATION FOR QUANTIFYING SOURCES AND REDUCTION CREDITS FOR VARIOUS CONTROL PRACTICES
  - ALLOW FOR ACCOUNTING ACROSS JURISDICTIONAL AND SUB-WATERSHED BOUNDARIES WITHIN THE WATERSHED OF INTEREST (ENSURES CONSISTENCY AND FAIRNESS AMONG PERMITTEES & AVOIDS CREATIVE ACCOUNTING)
  - BE RE-VISITED FROM TIME TO TIME TO UPDATE INFORMATION AND INCORPORATE NEW INFORMATION

FROM TMDL TO MS4 PERMIT



UPPER/MIDDLE AND LOWER CHARLES TMDL WLAS

Land Use Group	Upper TMDL WLA % Reduction Rate	Lower TMDL WLA % Reduction Rate
Commercial	65%	62%
Industrial	65%	62%
High Density Residential	65%	62%
Medium Density Residential	65%	62%
Low Density Residential	45%	62%
Highway	65%	62%
Open Space	35%	62%
Agriculture	35%	62%
Forest	0%	0%

INTERPRETATION OF WLAS

Final Lower Charles River Phosphorus Load Reduction Recommendations											
Charles River Watershed	All Commercial	All Industrial	High Density Residential	Medium Density Residential	Low Density Residential	Agriculture	Forest	Open Land	WWTF	CSO	Total
Drainage Area (hectares)	2168	3891	9232	9331	11077	2063	30844	8428	NA	NA	**77034**
Annual Phosphorus Loads (kg/yr)	3676	5718	10437	5278	503	1042	4018	289	6825	2263	**40050**
TMDL Recommended Phosphorus Loads (kg/yr)	1268	1972	3600	1820	276	672	4018	187	4663	90	**18565**
Needed % Reduction	65%	65%	65%	65%	45%	35%	0%	35%	32%	96%	**53.6%**

Phosphorus load reductions by source category based on Final Total Maximum Daily Load for Nutrients In the Lower Charles River Basin, Massachusetts (CN 301.0), June, 2007.

Charles River Watershed Community	Commercial	Industrial	High Density Residential	Medium Density Residential	Low Density Residential	Agriculture	Forest	Open Land	Total	Percent Reduction Required
Bellingham										
Drainage Area (ha)	58.8	212.0	134.2	240.0	212.2	57.1	1315.9	245.0	2475.3	
1998-2002 Loading (kg/yr)	99.8	311.7	151.9	135.9	9.7	28.8	171.6	8.4	917.8	
TMDL Loading (kg/yr)	34.4	107.5	52.4	46.9	5.3	18.6	171.6	5.4	442.1	**51.8%**
Belmont										
Drainage Area (ha)	7.2	10.0	105.1	0.9	30.5	0.0	99.9	96.5	350.1	
1998-2002 Loading (kg/yr)	12.3	14.7	118.9	0.5	1.4	0.0	13.0	3.3	164.1	
TMDL Loading (kg/yr)	4.2	5.1	41.0	0.2	0.8	0.0	13.0	2.1	66.4	**59.5%**
Boston										
Drainage Area (ha)	587.1	541.5	2556.5	43.4	20.2	7.4	688.2	1444.0	5888.3	
1998-2002 Loading (kg/yr)	996.4	796.4	2892.4	24.6	0.9	3.7	89.7	49.6	4853.8	
TMDL Loading (kg/yr)	343.7	274.7	997.6	8.5	0.5	2.4	89.7	32.0	1749.0	**64.0%**
Brookline										
Drainage Area (ha)	135.9	10.0	588.2	209.4	254.8	42.9	157.0	357.1	1755.5	
1998-2002 Loading (kg/yr)	230.7	14.8	665.5	118.5	11.6	21.7	20.5	12.3	1095.5	
TMDL Loading (kg/yr)	79.6	5.1	229.5	40.9	6.3	14.0	20.5	7.9	403.8	**63.1%**
Cambridge										
Drainage Area (ha)	123.1	126.9	205.7	0.0	0.0	0.0	3.1	181.7	640.4	
1998-2002 Loading (kg/yr)	208.9	186.6	232.7	0.0	0.0	0.0	0.4	6.2	634.8	
TMDL Loading (kg/yr)	72.0	64.3	80.3	0.0	0.0	0.0	0.4	4.0	221.1	**65.2%**

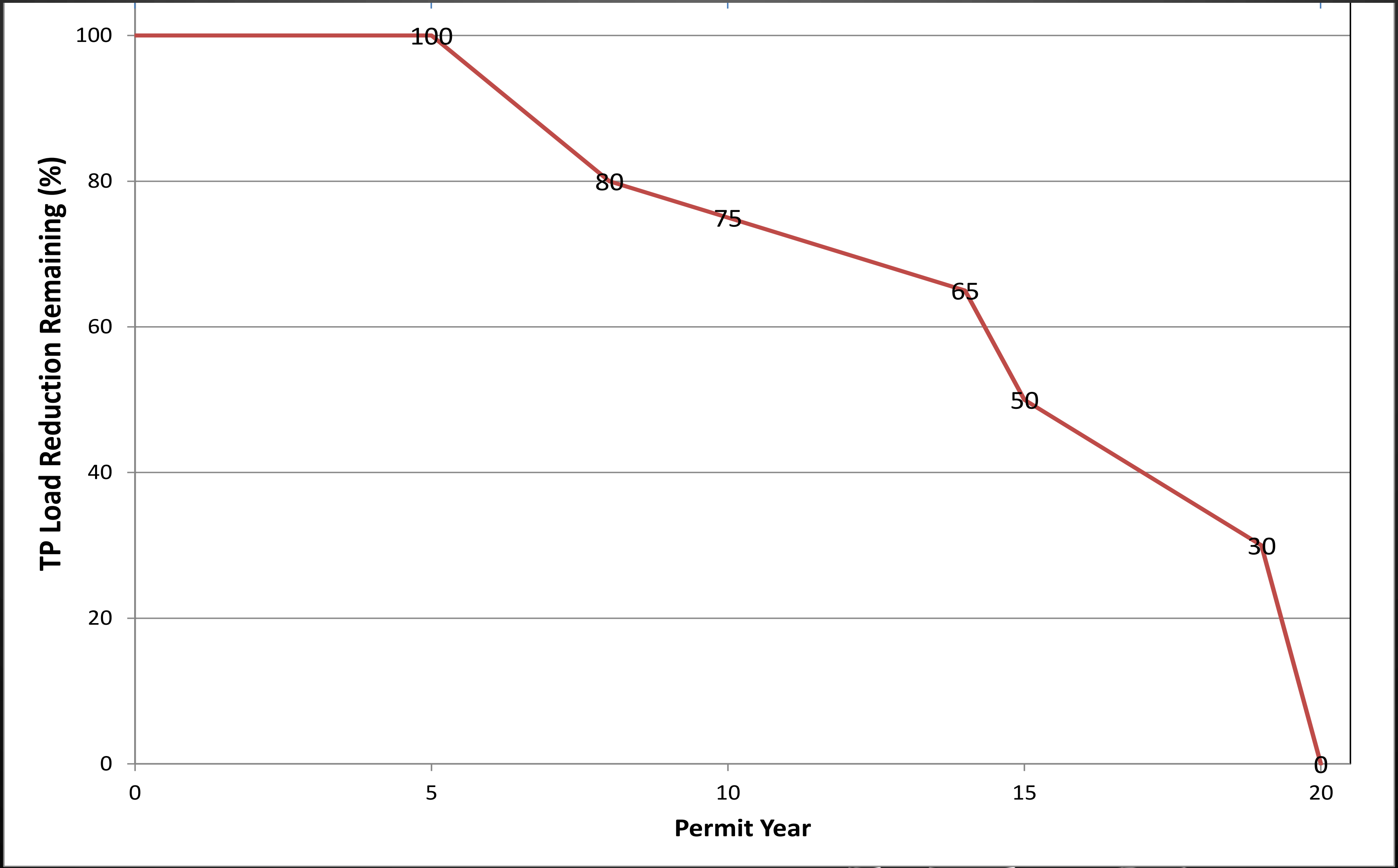
NUMERIC REDUCTION REQUIREMENTS IN THE PERMIT

Community	Community - Table F1			Regulated Area - Table F2		
	Baseline (lb/yr)	Reduction (lb/yr)	Reduction (%)	Baseline (lb/yr)	Reduction (lb/yr)	Reduction (%)
Bellingham	2,112	759	36	1,790	670	37
Franklin	5,219	1,916	37	5,146	1,905	37
Medway	2,351	743	32	2,293	723	32
Natick	2,531	946	37	2,276	886	39
Somerville	1,870	300	16	448	95	21

IMPLEMENTATION SCHEDULE

5 years after permit effective date	5-10 years after permit effective date	10-15 years after permit effective date	15-20 years after permit effective date
Create Phase 1 Plan	Implement Phase 1 Plan		
	Create Phase 2 Plan	Implement Phase 2 Plan	
		Create Phase 3 Plan	Implement Phase 3 Plan

IMPLEMENTATION SCHEDULE



DEMONSTRATING COMPLIANCE

$$P_{exp}\left(\frac{mass}{yr}\right) = P_{base}\left(\frac{mass}{yr}\right) - \left(P_{Sred}\left(\frac{mass}{yr}\right) + P_{NSred}\left(\frac{mass}{yr}\right)\right) + P_{DEVinc}\left(\frac{mass}{yr}\right)$$

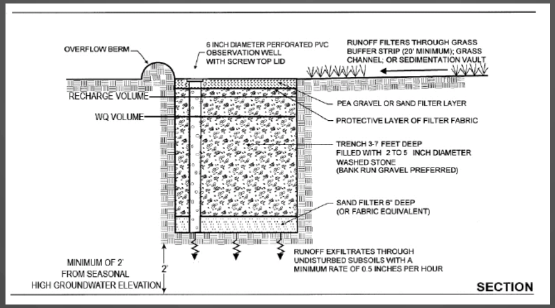
Equation 1. Equation used to calculate yearly phosphorus export rate from the chosen PCP Area. P_{exp}=Current phosphorus export rate from the PCP Area in mass/year. P_{base}=baseline phosphorus export rate from LPCP Area in mass/year. P_{Sred}= yearly phosphorus reduction from implemented structural controls in the PCP Area in mass/year. P_{NSred}= yearly phosphorus reduction from implemented non-structural controls in the PCP Area in mass/year. P_{DEVinc}= yearly phosphorus increase resulting from development since 2005 in the PCP Area in mass/year.

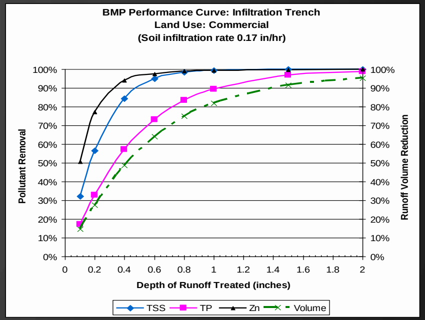
Table 1: Average Annual Phosphorus Load Export Rates for use in the MA MS4 Permit

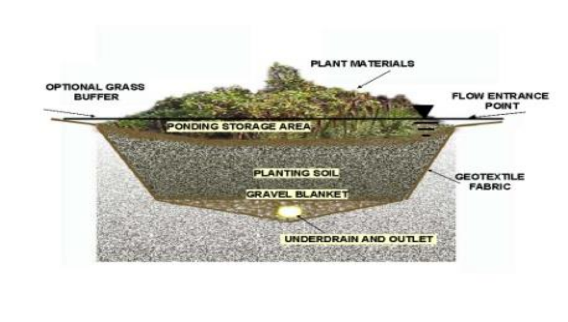
Phosphorus Source Category by Land Use	Land Surface Cover	Phosphorus Load Export Rate, Kg/ha/yr	Comments
Commercial (Com) and Industrial (Ind)	Directly connected impervious	2.0	Derived using a combination of the Lower Charles USGS Loads study and NSWQ dataset. This PLER is approximately 75% of the HDR PLER and reflects the difference in the distributions of SW TP EMCs between Commercial/Industrial and Residential.
	Pervious	See* DevPERV	
Multi-Family (MFR) and High-Density Residential (HDR)	Directly connected impervious	2.6	Largely based on loading information from Charles USGS loads, SWMM HRU modeling, and NSWQ data set
	Pervious	See* DevPERV	
Medium -Density Residential (MDR)	Directly connected impervious	2.2	Largely based on loading information from Charles USGS loads, SWMM HRU modeling, and NSWQ data set
	Pervious	See* DevPERV	
Low Density Residential (LDR) - "Rural"	Directly connected impervious	1.7	Derived in part from Mattson Issac, HRU modeling, lawn runoff TP quality information from Chesapeake Bay and subsequent modeling to estimate PLER for DCIA (Table 14) to approximate literature reported composite rate 0.3 kg/ha/yr.
	Pervious	See* DevPERV	
Highway (HWY)	Directly connected impervious	1.5	Largely based on USGS highway runoff data, HRU modeling, information from Shaver et al and subsequent modeling to estimate PLER for DCIA for literature reported composite rate 0.9 kg/ha/yr.
	Pervious	See* DevPERV	
Forest (For)	Directly connected impervious	1.7	Derived from Mattson & Issac and subsequent modeling to estimate PLER for DCIA that corresponds with the literature reported composite rate of 0.13 kg/ha/yr (Table 14)
	Pervious	0.13	
Open Land (Open)	Directly connected impervious	1.7	Derived in part from Mattson Issac, HRU modeling, lawn runoff TP quality information from Chesapeake Bay and subsequent modeling to estimate PLER for DCIA (Table 14) to approximate literature reported composite rate 0.3 kg/ha/yr.
	Pervious	See* DevPERV	
Agriculture (Ag)	Directly connected impervious	1.7	Derived from Budd, L.F. and D.W. Meals and subsequent modeling to estimate PLER for DCIA to approximate reported composite PLER of 0.5 kg/ha/yr.
	Pervious	0.5	
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group A	Pervious	0.03	Derived from SWMM and P8 - Curve Number continuous simulation HRU modeling with assumed TP concentration of 0.2 mg/L for pervious runoff from developed lands. TP of 0.2 mg/L is based on TB-9 (CSN, 2011), and other PLER literature and assumes unfertilized condition due to the upcoming MA phosphorus fertilizer control legislation.
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group B	Pervious	0.13	
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C	Pervious	0.24	
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C/D	Pervious	0.33	
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group D	Pervious	0.41	

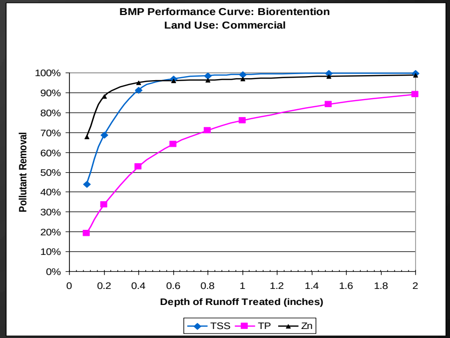
GENERATION OF SW CONTROL PERFORMANCE CURVES
FOR NEW ENGLAND REGION

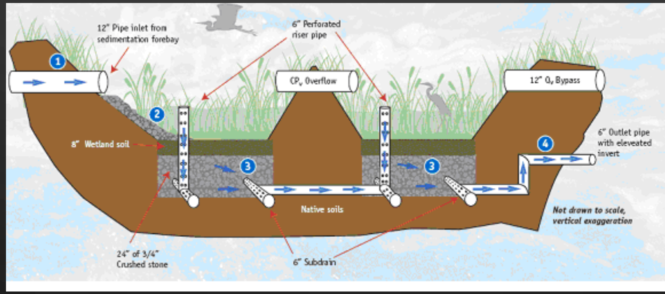
SW Controls
Surface Infiltration (6 infiltration rates)
Infiltration trenches (6 infiltration rates)
Bio-filtration
Porous pavement with underdrain
WQ Swales (non-infiltration)
Gravel wetland
Enhanced Bio-filtration*   * Optimized for N and P removal

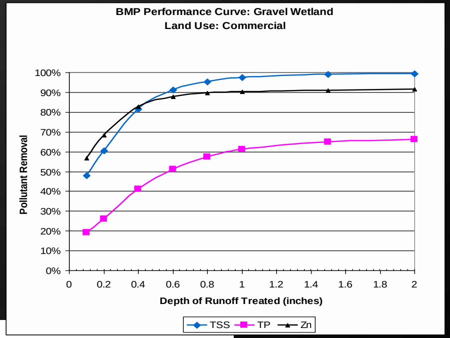


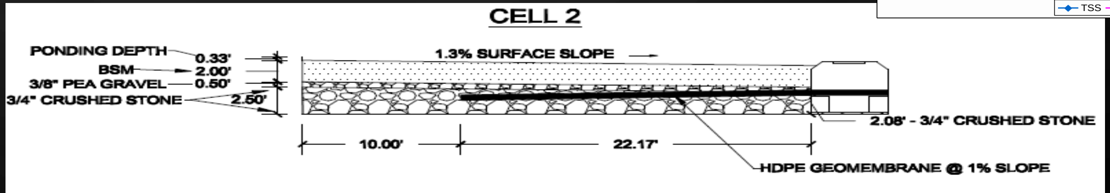






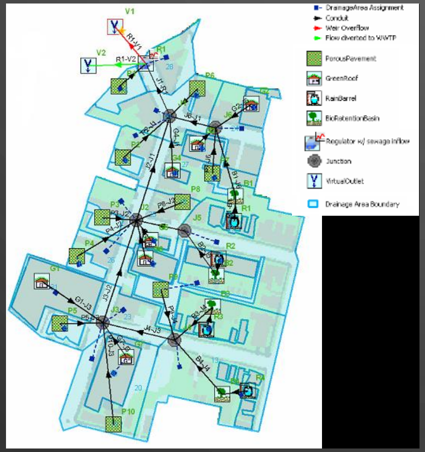


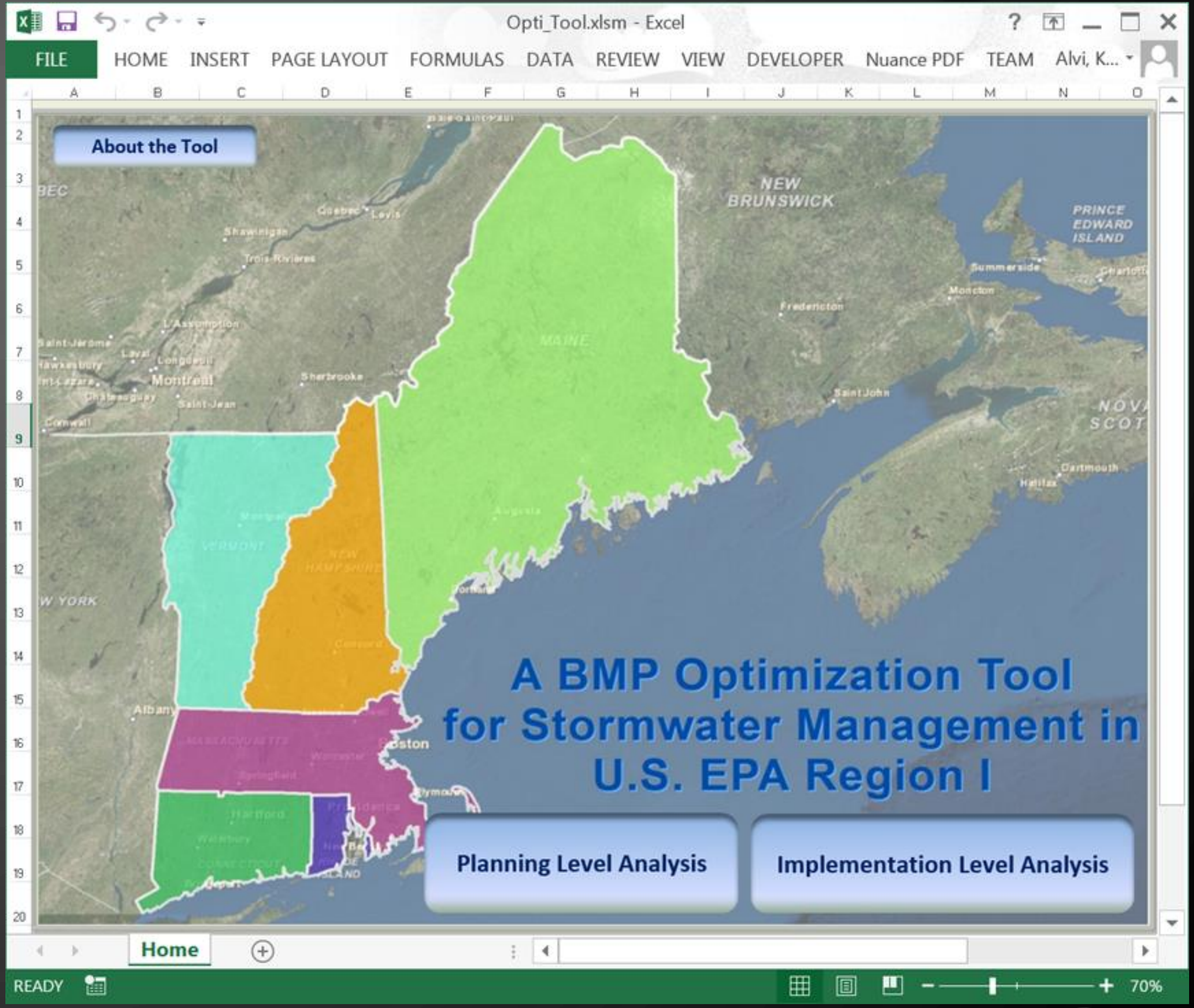


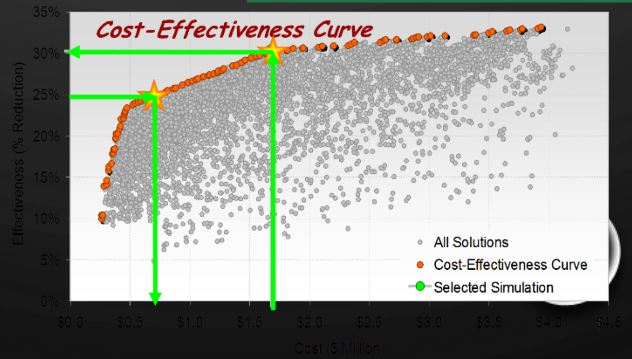


OPTI-TOOL

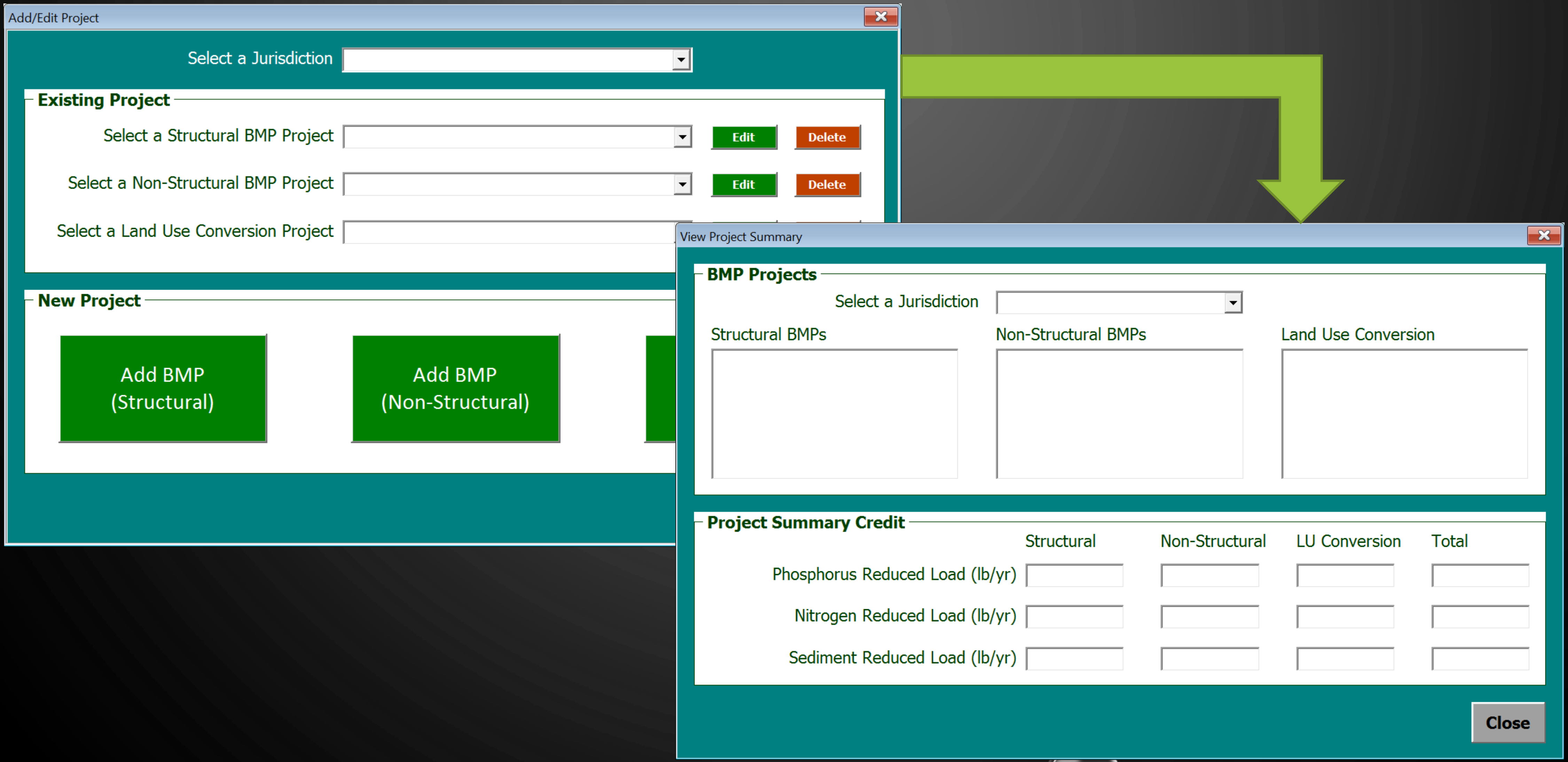
- A SPREADSHEET-BASED BMP OPTIMIZATION TOOL
  - PLANNING LEVEL ANALYSIS (EPA REGION 1 BMP PERFORMANCE CURVES)
  - IMPLEMENTATION LEVEL ANALYSIS (EPA SUSTAIN BMP SIMULATION AND OPTIMIZATION ENGINE)
- CUSTOMIZED FOR EPA REGION 1







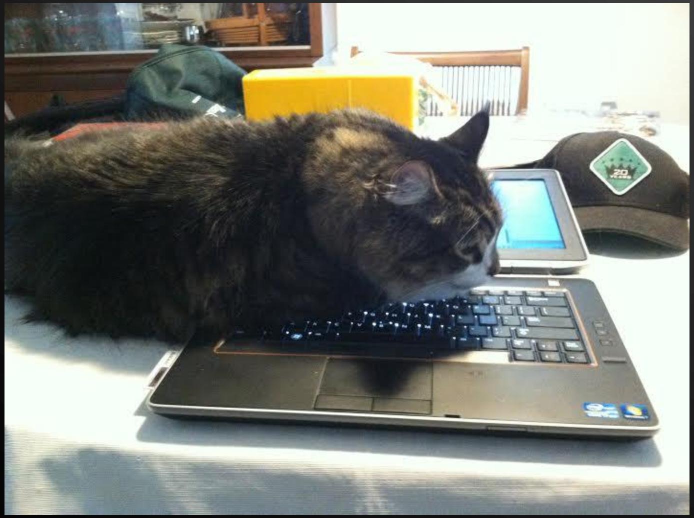
BATT


Add/Edit Project
Select a Jurisdiction
Existing Project
Select a Structural BMP Project
Edit
Delete
Select a Non-Structural BMP Project
Edit
Delete
Select a Land Use Conversion Project
New Project
Add BMP (Structural)
Add BMP (Non-Structural)
View Project Summary
BMP Projects
Select a Jurisdiction
Structural BMPs
Non-Structural BMPs
Land Use Conversion
Project Summary Credit
Structural
Non-Structural
LU Conversion
Total
Phosphorus Reduced Load (lb/yr)
Nitrogen Reduced Load (lb/yr)
Sediment Reduced Load (lb/yr)
Close

BATT AUTOMATED CALCULATIONS

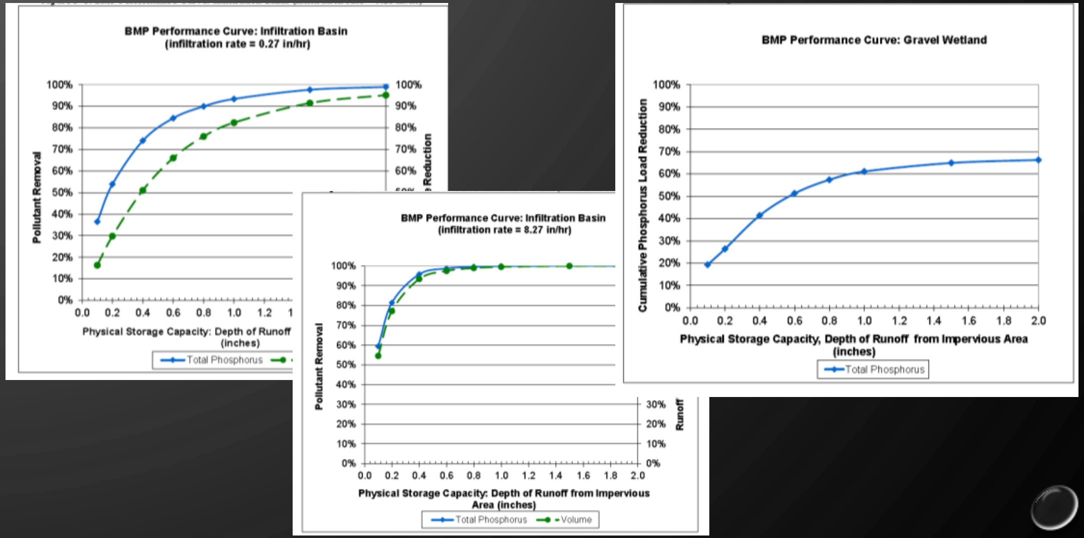
LAND AREA POLLUTANT LOADING:

- BASED ON LAND USE, SOIL TYPE, IMPERVIOUS AREA
- ANNUAL PHOSPHORUS LOAD EXPORT RATES (PLERS) FROM PERMIT BUILT INTO TOOL



BMP POLLUTANT REDUCTIONS:

- EPA/TETRATECH WORK ON BMP CURVES FOR STRUCTURAL BMPS IN PERMIT AND BUILT INTO TOOL



- LITERATURE VALUES FOR NON-STRUCTURAL BMPS FROM PERMIT BUILT INTO TOOL

THANK YOU

MA SMALL MS4 WEBSITE:

HTTPS://WWW3.EPA.GOV/REGION1/NPDES/STORMWATER/MS4_MA.HTML

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