Stormwater Management Strategies for Reduction of Nitrogen and Phosphorus Loading to Surface Waters

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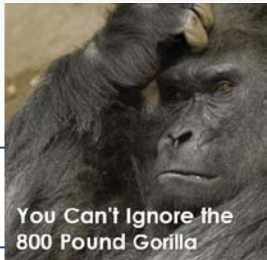
STORMWATER CENTER

Whoville has arrived

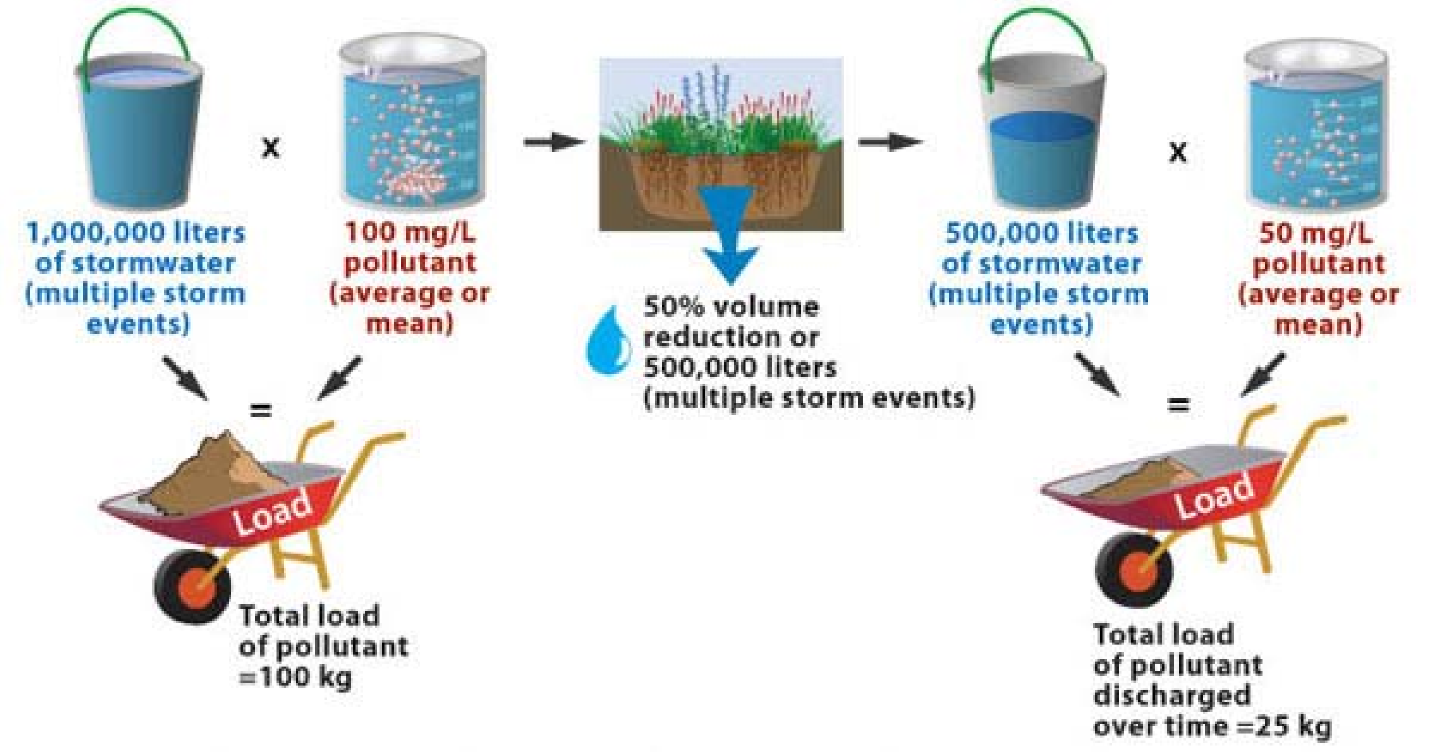
HHW-059 Horton is relieved to find the precious clover -- which had been lost in a field of hundreds of millions of identical flowers!
Photo credit: Blue Sky Studios

Regulatory Drivers

- NPDES Phase II has been largely an issue of due diligence with respect to SWMP
- TMDLs are solid WQ standards which are required where SW controls have been insufficient to achieve water quality goals—due diligence does not matter
- Region 1 has used Residual Designation Authority (RDA)—first in the US
- RDA addresses sources of pollution not covered under existing programs----Existing development
- 80% TSS Removal will not meet “no net increase standard”
- Filtration/infiltration systems will be needed to meet TMDL requirements



Load Reduction



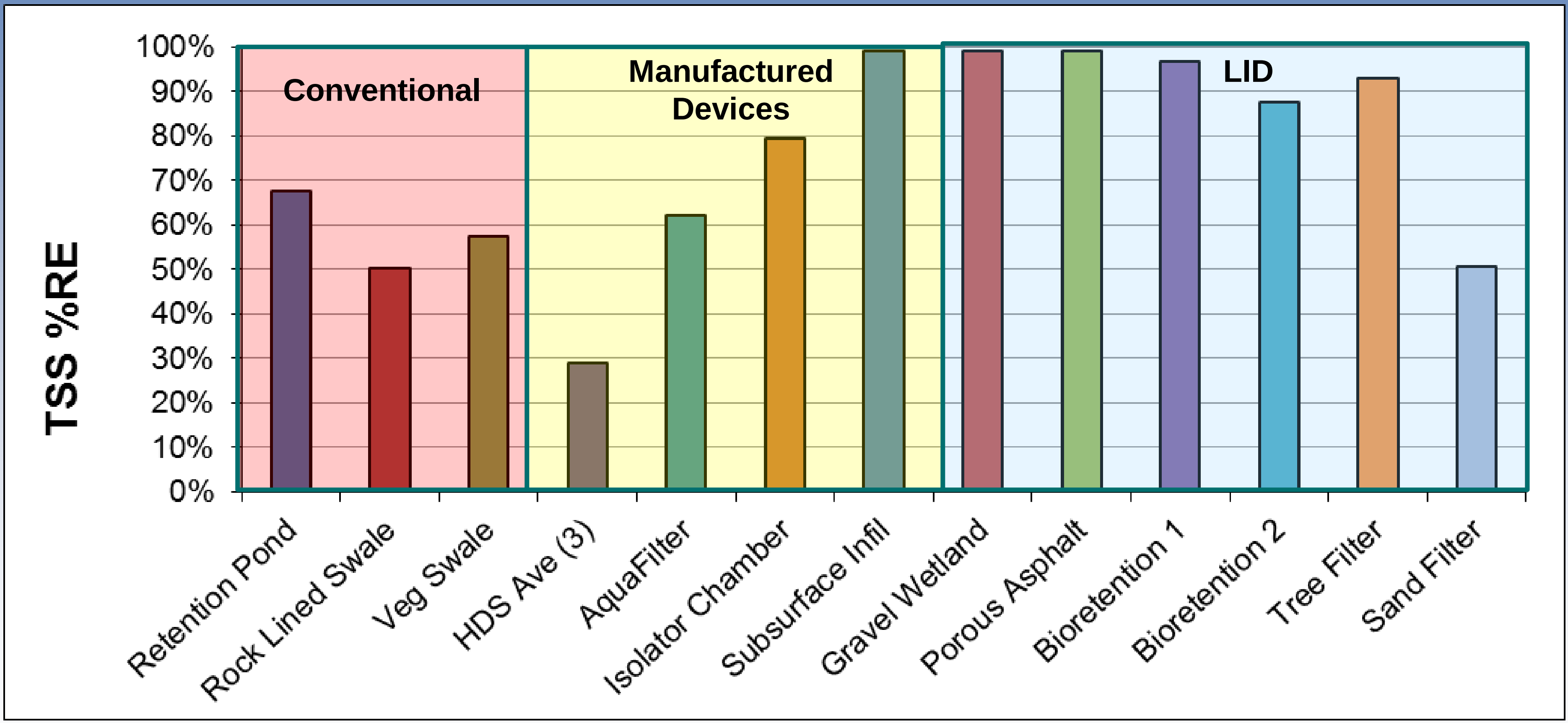
Two Parts to Load Reduction

1. Concentration Reduction IE. System Efficiency
2. Volume Reduction

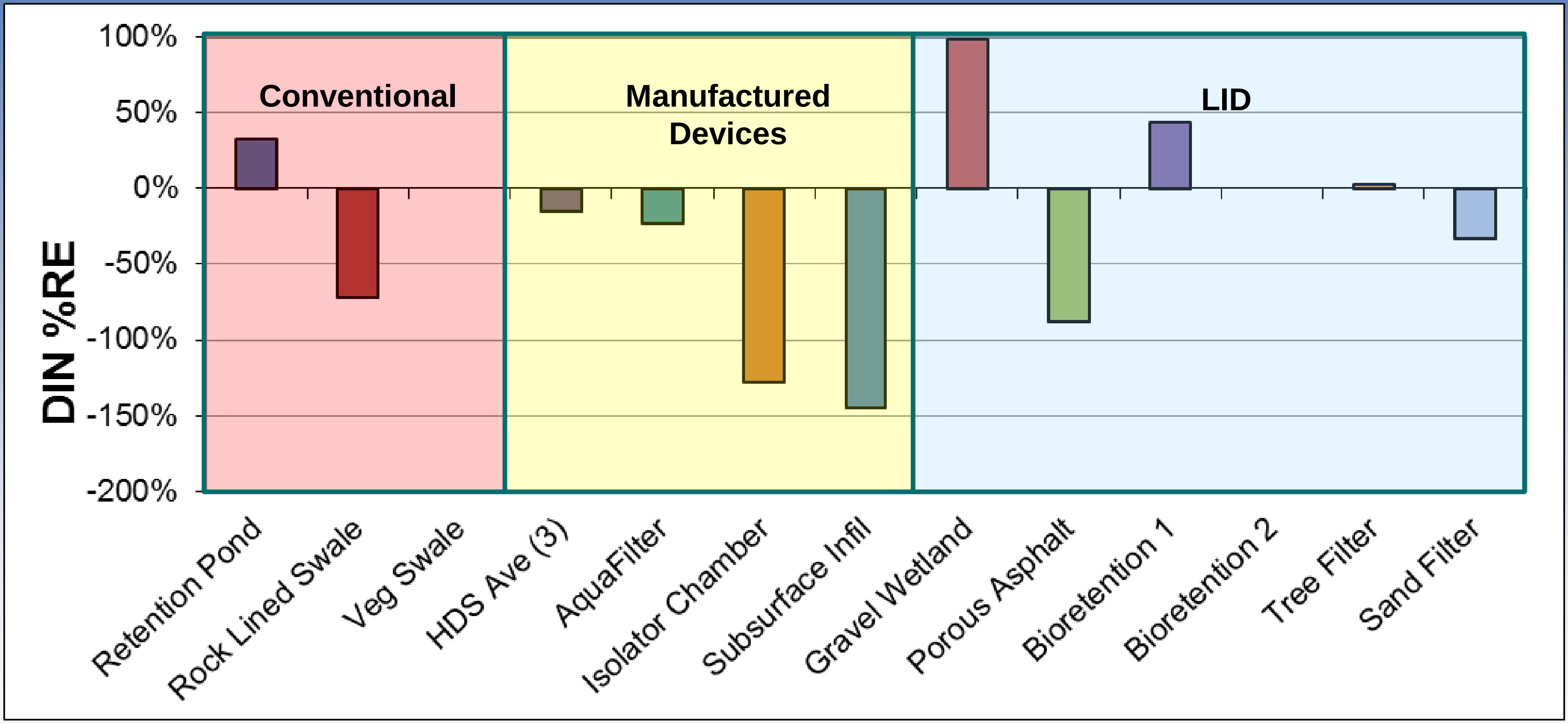
$$Pollutant\ X\left(\frac{mg}{L}\right) \times Runoff\ Volume\,(L) = Load\ (mg)$$

Performance Results

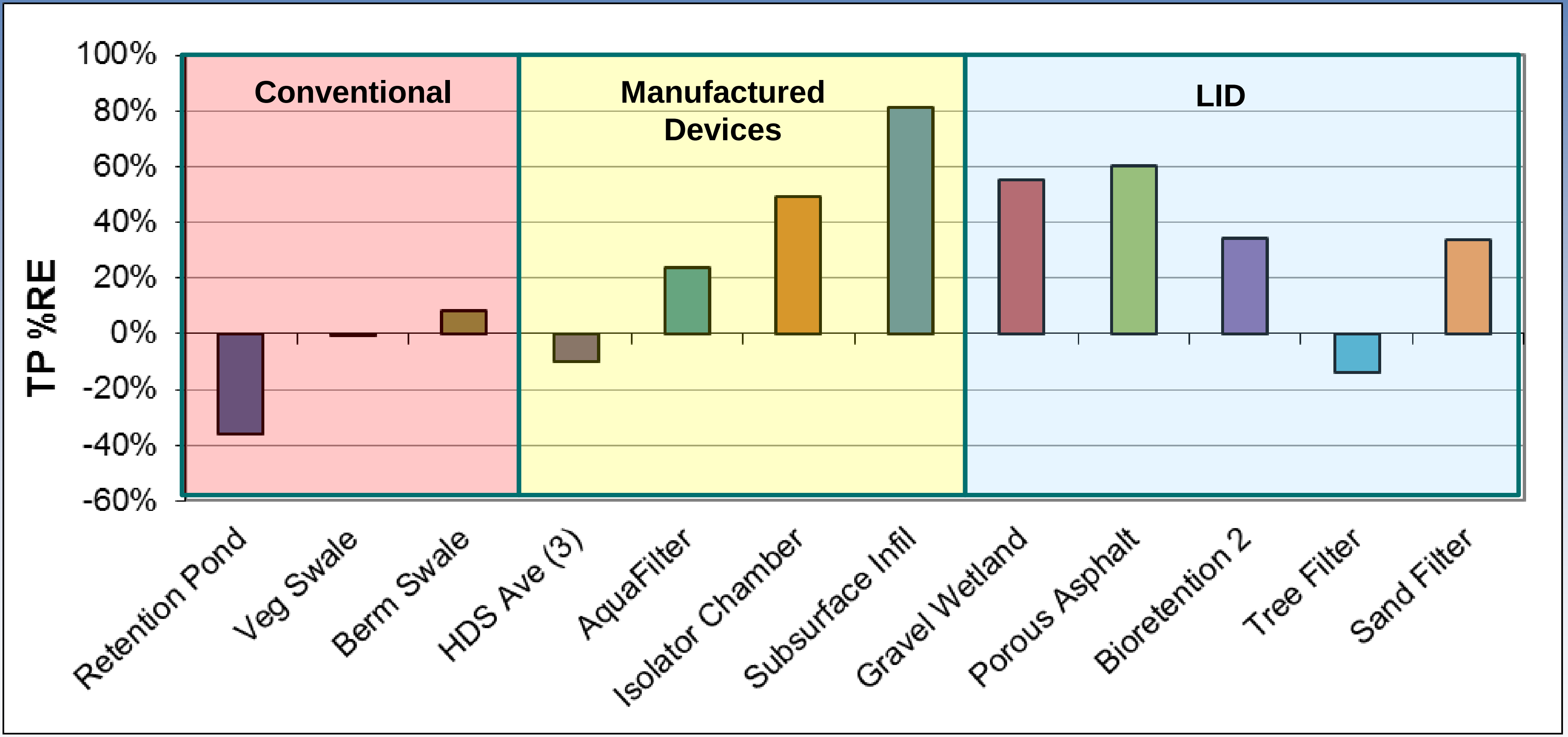
Solids Removal Performance by System Type



DIN Removal Performance by System Type



TP Removal Performance by System Type



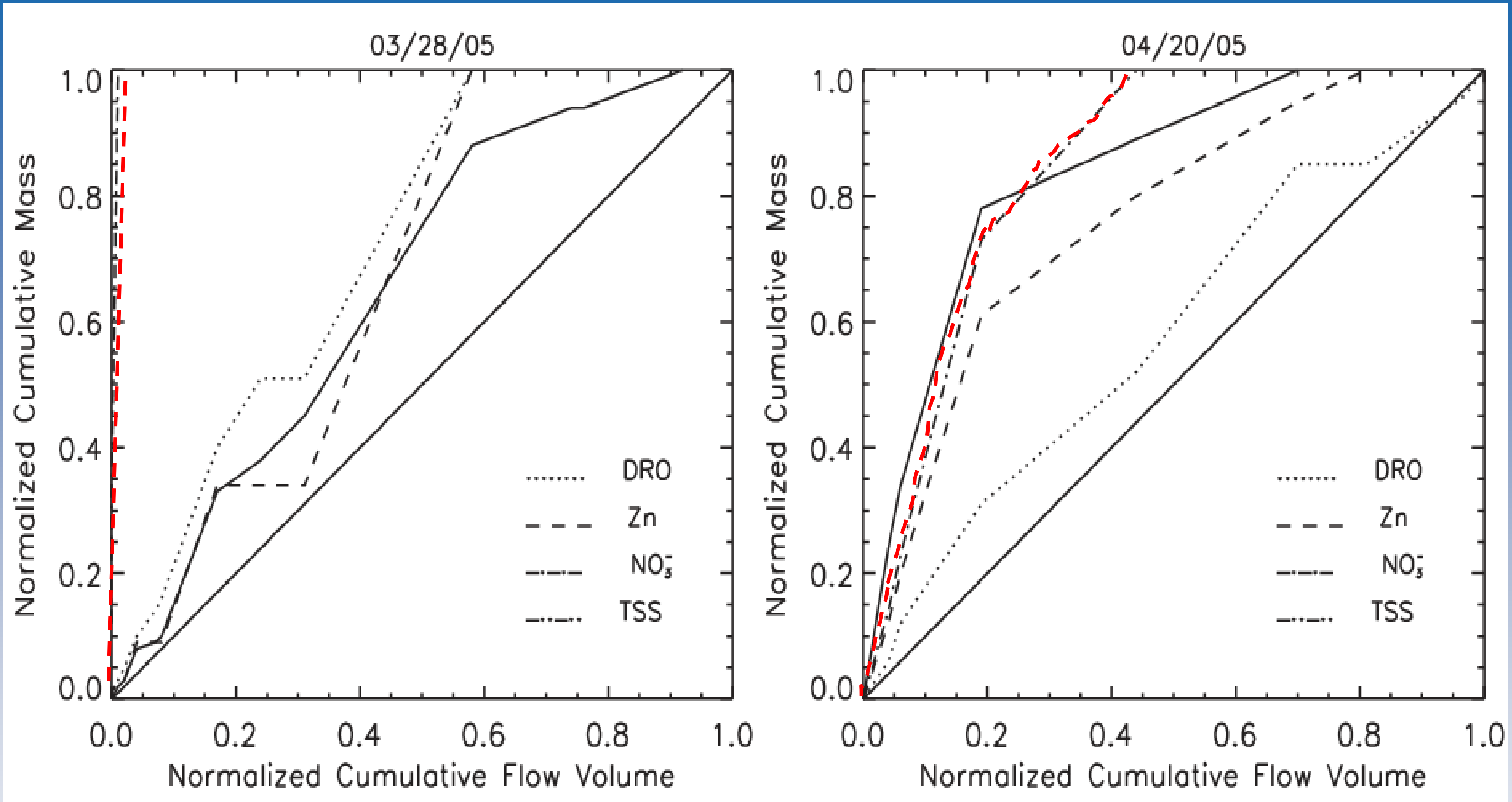
Where Should We Be Heading?

Design by Unit Process and Treatment Train, incorporate Filtration and Infiltration

Precip Frequency Distribution

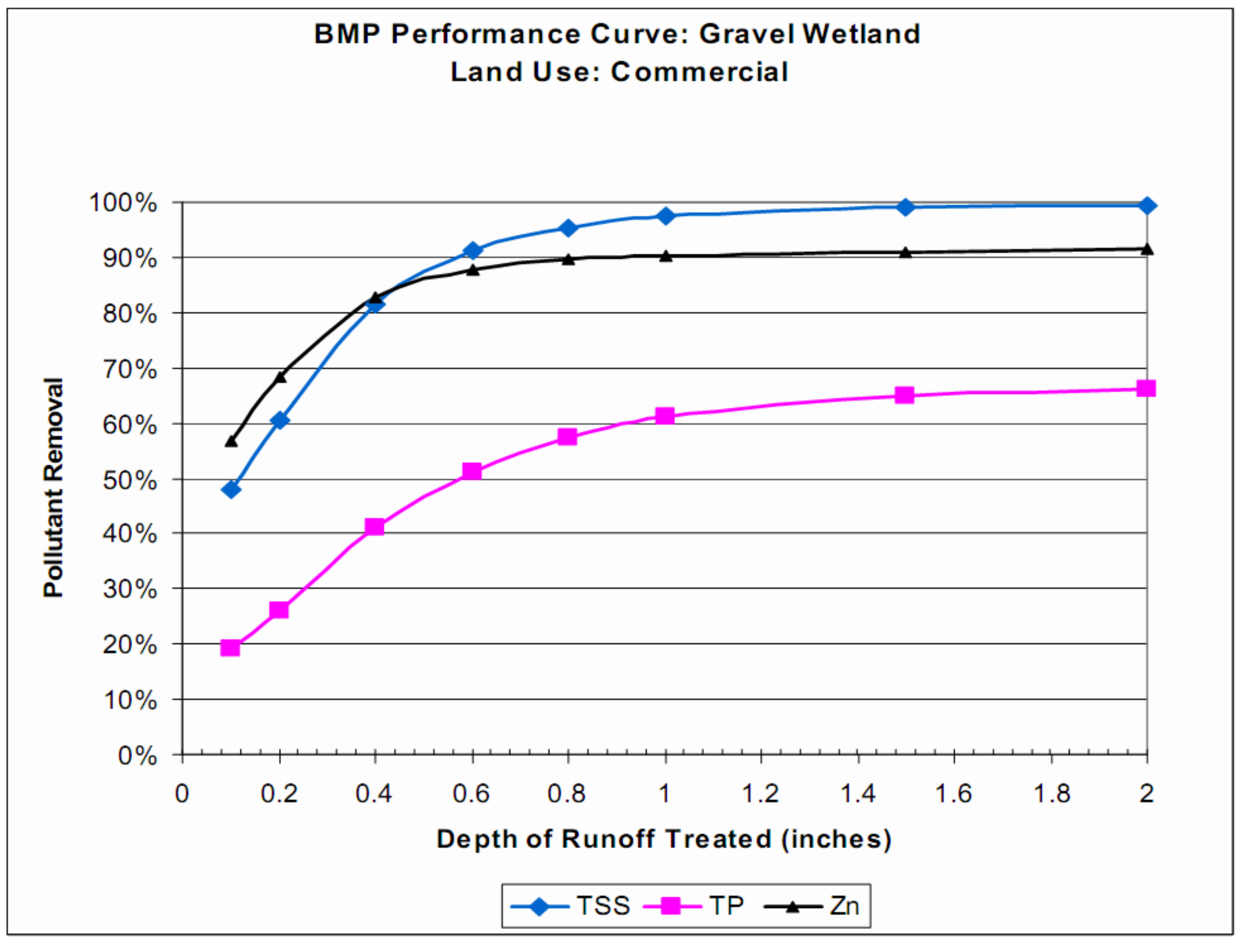
Station ID	Station name	Precipitation amount (inches)		
		< 0.1	0.1-1.0	> 1
CT0806	Bridgeport Sikorsky Airport	46%	46%	8%
CT3456	Hartford Airport	48%	44%	8%
MA0120	Amherst	45%	47%	8%
MA0770	Boston Logan Int'l Airport	49%	44%	7%
MA9923	Worcester Airport	48%	44%	8%
ME0273	Augusta	45%	47%	8%
ME6905	Portland Airport	49%	47%	8%
NH1683	Concord	49%	47%	5%
NH5712	Nashua	47%	45%	8%
RI6698	Providence Airport	48%	44%	8%
VT0277	Ball Mountain Lake	43%	49%	8%
VT1081	Burlington Int'l Airport	56%	41%	3%
Average of all stations		48%	45%	7%

Source: BMPDSS 2009



Mass loading for DRO, Zn, NO3, TSS as a function of normalized storm volume for two storms: (a) a large 60 mm rainfall over 1685 minutes; (b) a smaller 15 mm storm depth over 490 minute. DRO=diesel range organics, Zn= zinc, NO3= nitrate, TSS= total suspended solids

Concentration Reduction Based on System Size



Source: EPA Region 1, BMPDSS 2009

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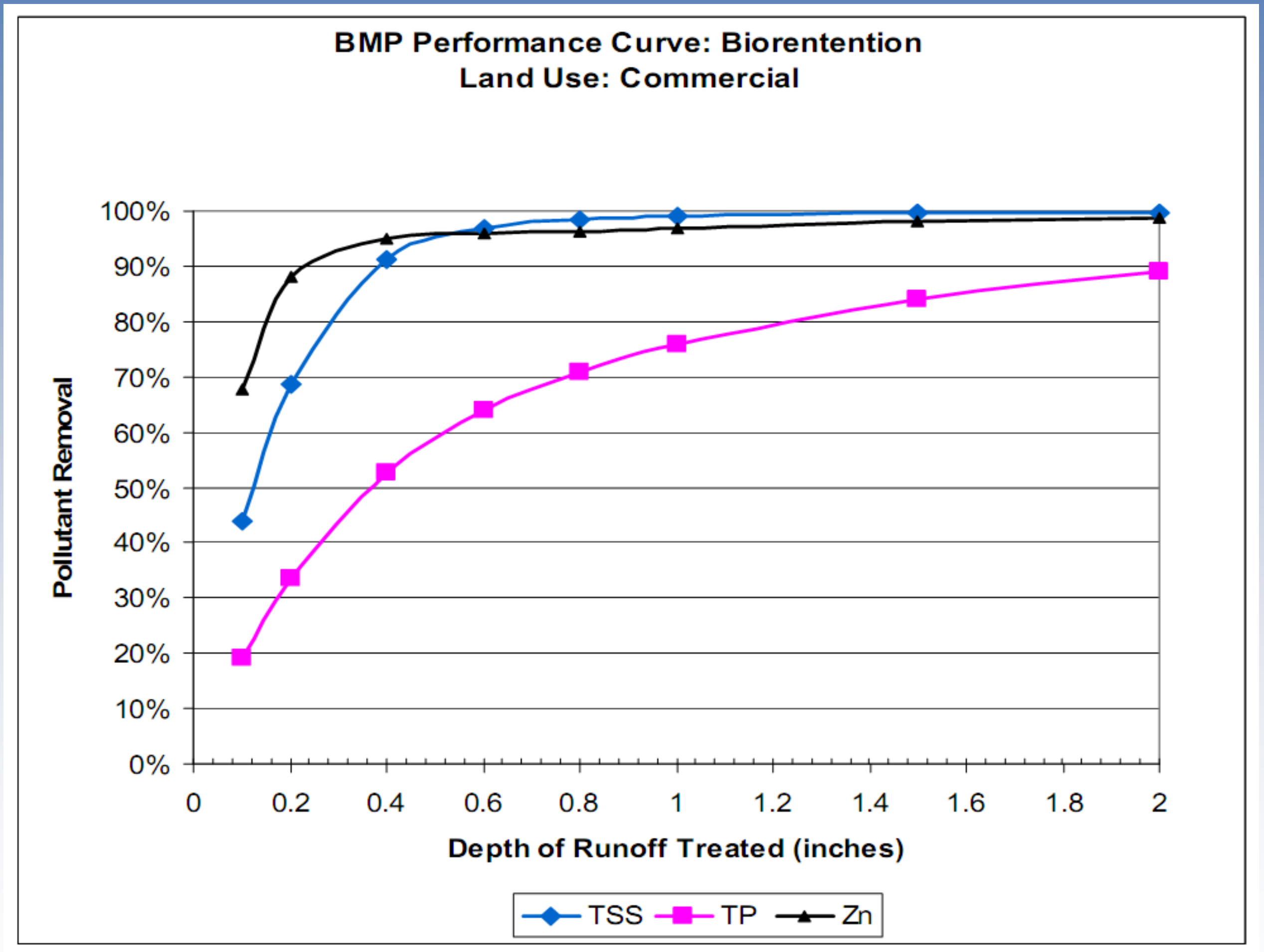
Concentration Reduction Based on System Size



Source: EPA Region 1, BMPDSS 2009

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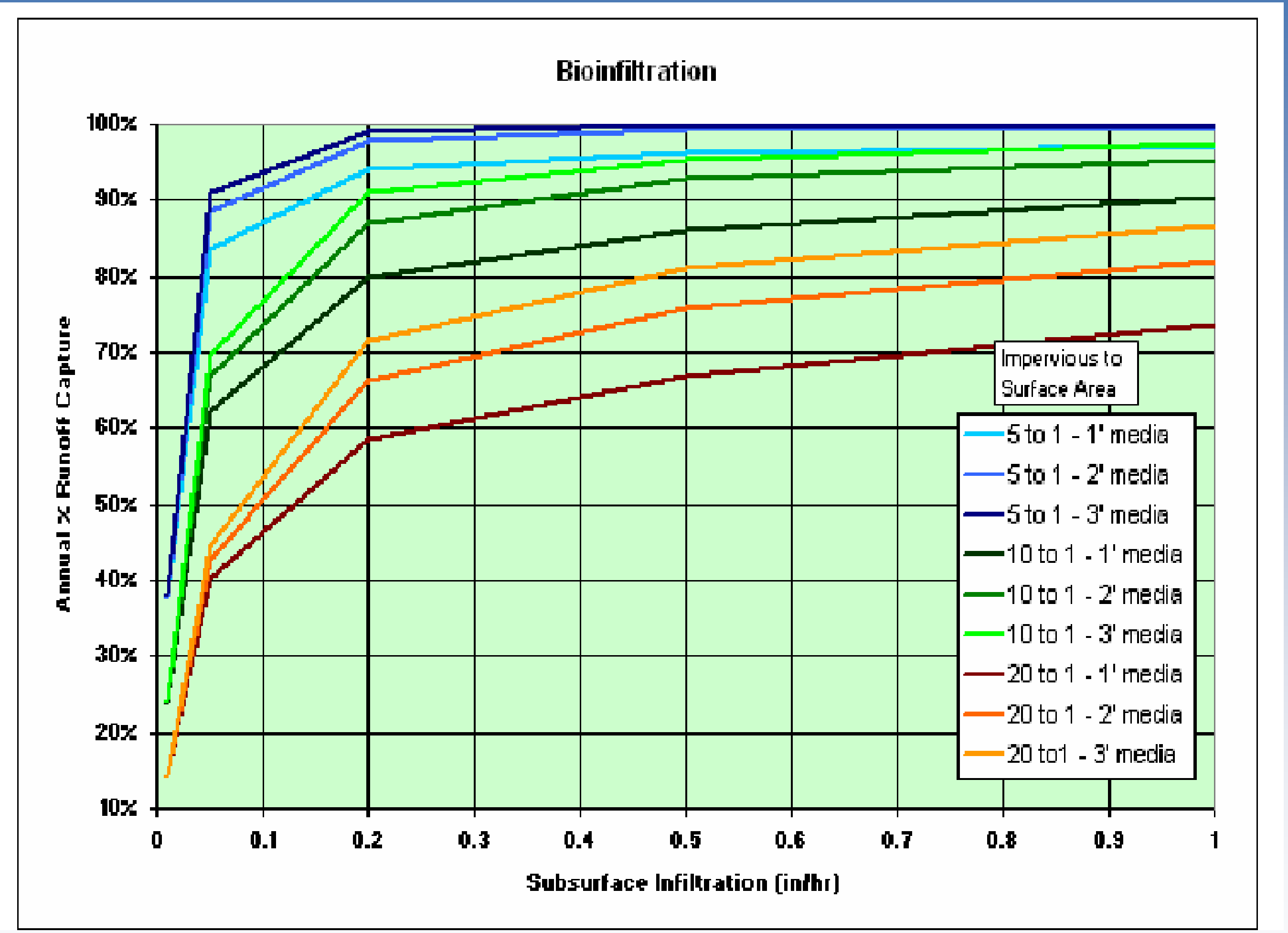
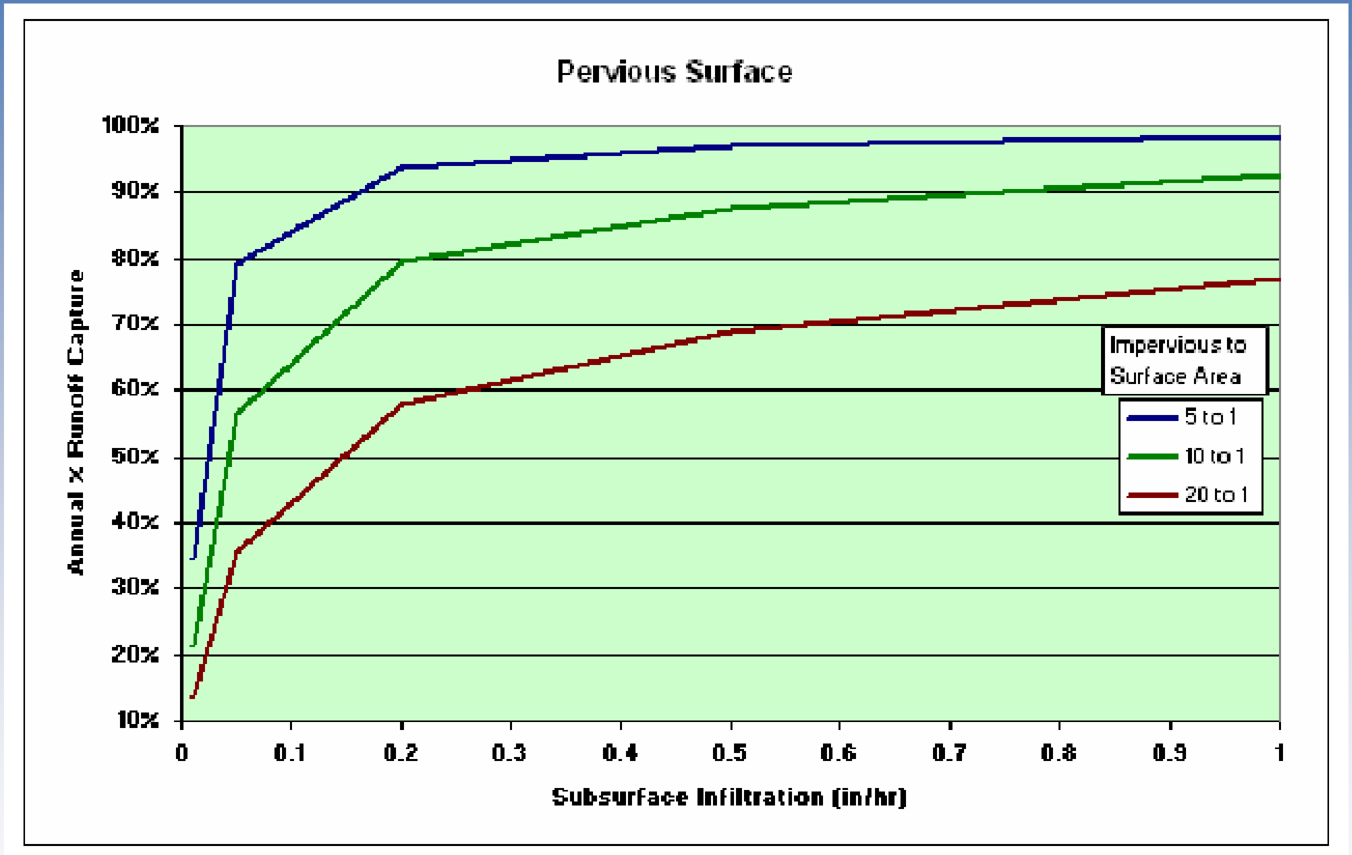
Volume Reduction



Source: AMEC Environmental 2009

Volume Reduction



Source: AMEC Environmental 2009

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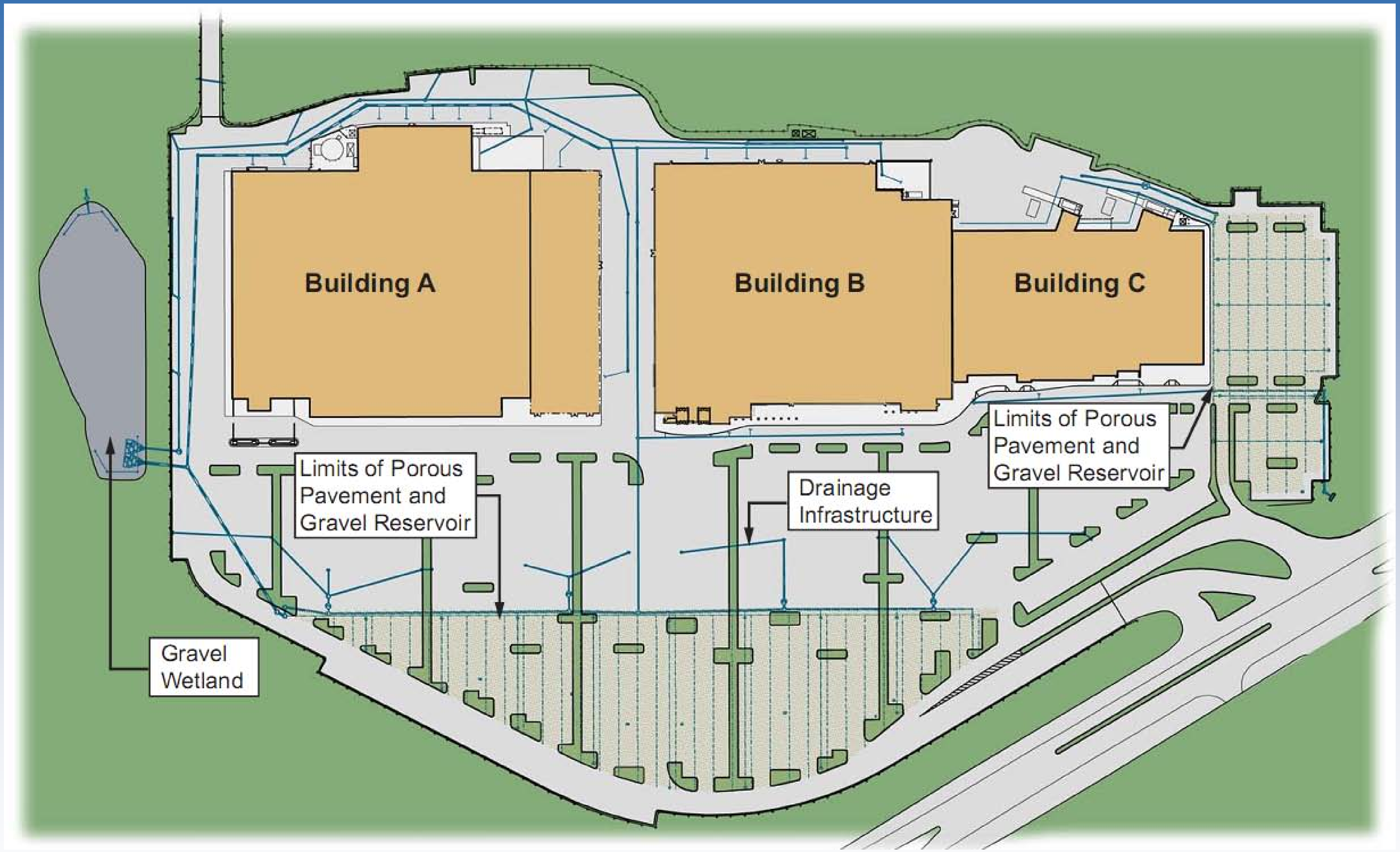
Example Retrofits in the Northeast

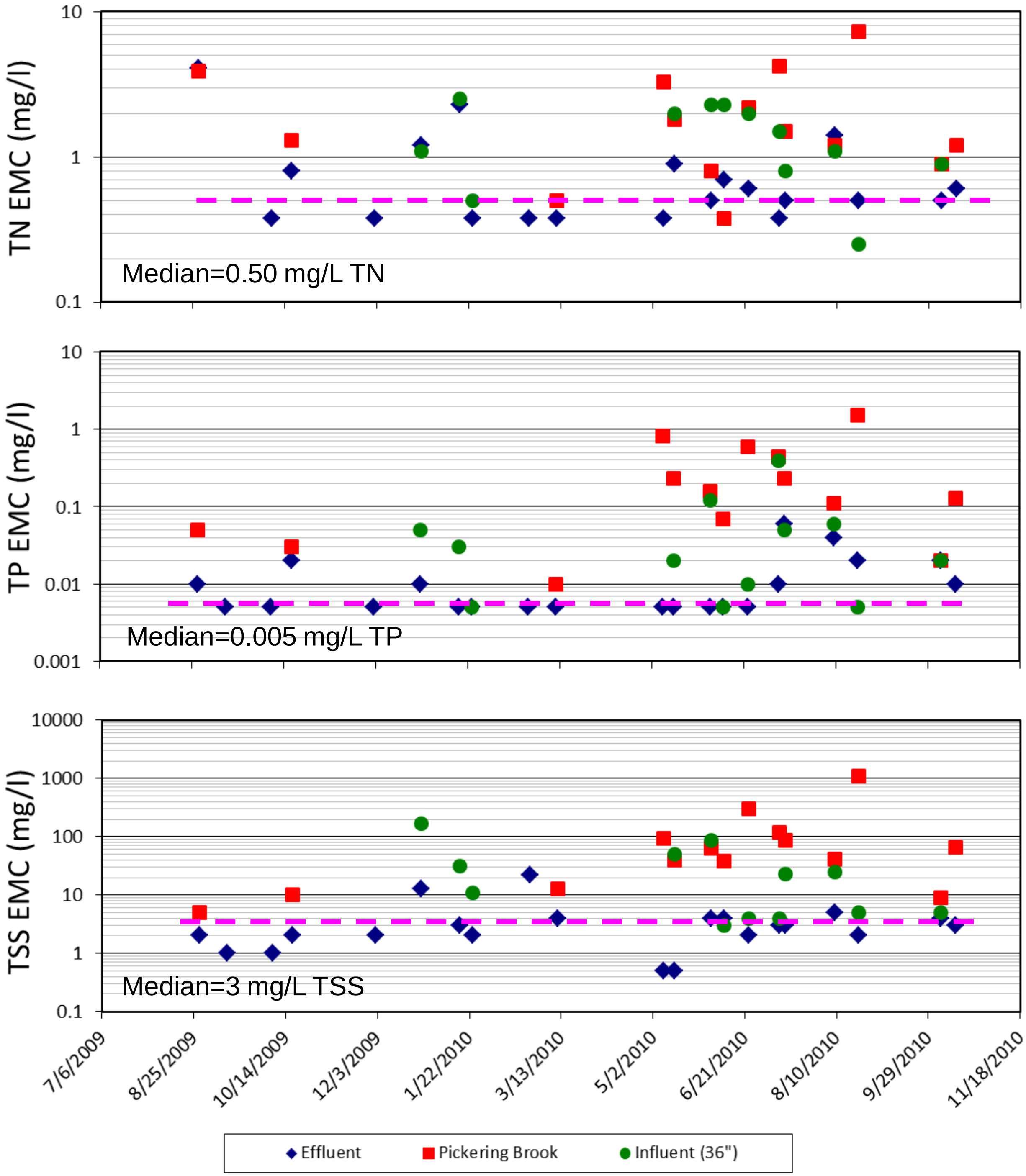
Greenland Meadows Commercial

- "Gold-Star" Commercial Development
- Cost of doing business near Impaired Waters/303D
- Saved $800k in SWM on costly piping and advanced SWM proprietary ($3.3M vs $2.5M)
- Brownfields site, ideal location, 15yrs
- Proposed site >15,000 Average Daily Traffic count on >30 acres

Site Design using LID and MTD



28 ac site, initially >95% impervious, now <10%EIC, with all drainage through filtration, expected to have minimal WQ impact except thermal and chloride


TN EMC (mg/l)
10
1
0.1
Median=0.50 mg/L TN
TP EMC (mg/l)
10
1
0.1
0.01
0.001
Median=0.005 mg/L TP
TSS EMC (mg/l)
10000
1000
100
10
1
0.1
Median=3 mg/L TSS
7/6/2009
8/25/2009
10/14/2009
12/3/2009
1/22/2010
3/13/2010
5/2/2010
6/21/2010
8/10/2010
9/29/2010
11/18/2010
Effluent
Pickering Brook
Influent (36")

School Street School, Rochester NH

Conclusions

High level treatment with ***filtration systems*** combined with volume reduction through ***infiltration*** is the only to achieve substantial load reduction

Funding

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Questions?

Tree Filter, Portsmouth NH

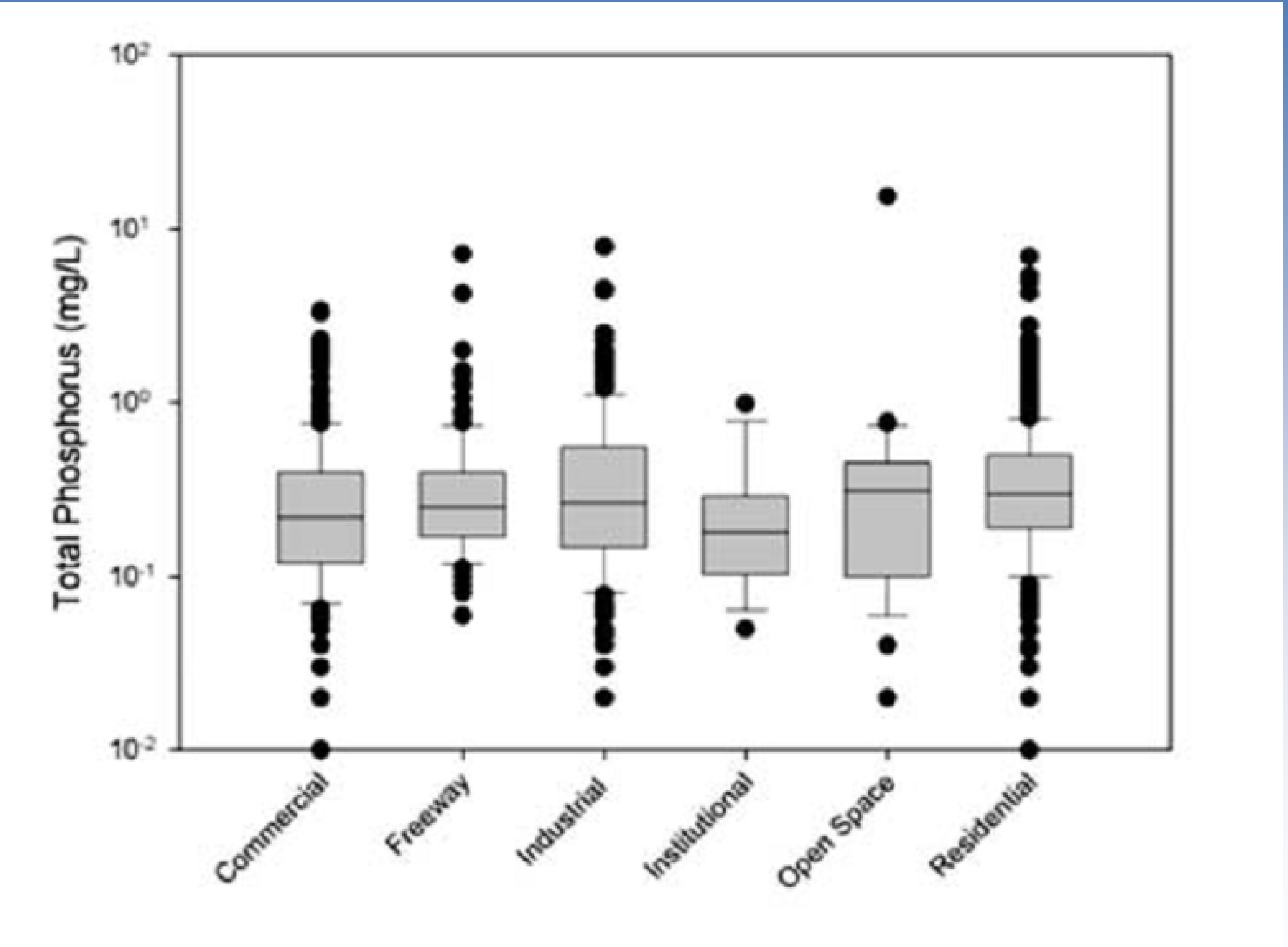
Phosphorous is typically in 3 forms:

- **Soluble Reactive Phosphorous.** SRP usually consists largely of the inorganic orthophosphate (PO_4) form of phosphorous. Measurements of orthophosphate are commonly used to quantify SP.
- **Soluble Unreactive or Soluble Organic Phosphorous.** SUP are organic forms of phosphorous and chains of inorganic phosphorous molecules termed polyphosphates.
- **Particulate Phosphorous.** PP contains all material, inorganic and organic, particulate and colloidal, that is captured on a 0.45-micron membrane filter.

SRP +SUP= soluble phosphorous (SP)

SP+PP=total phosphorous (TP)

Phosphorous in Stormwater



Nitrogen in Stormwater Water

- Systems must be vegetated, sedimentation plays a minor role
- Biologically-mediated conversion processes, whether aerobic or anaerobic. Microbial decomposition of organic matter produces reduced NH_3 which is treated commonly through biological oxidation (nitrified) to NO_2/NO_3 and then treated by biological reduction anaerobically to N_2

$$TN = \text{Organic } N + NH_3 + NH_4 + NO_2 + NO_3$$

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Nitrogen in Stormwater