

US EPA ARCHIVE DOCUMENT

Performance Evaluations for a Range of Stormwater Treatment Devices in a Cold Climate

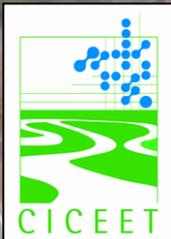
New England Association of Environmental Biologists
Attitash Grand Summit Hotel, Bartlett, NH
Thursday, April 10, 2008
The UNH Stormwater Center



The UNH Stormwater Center Durham, New Hampshire

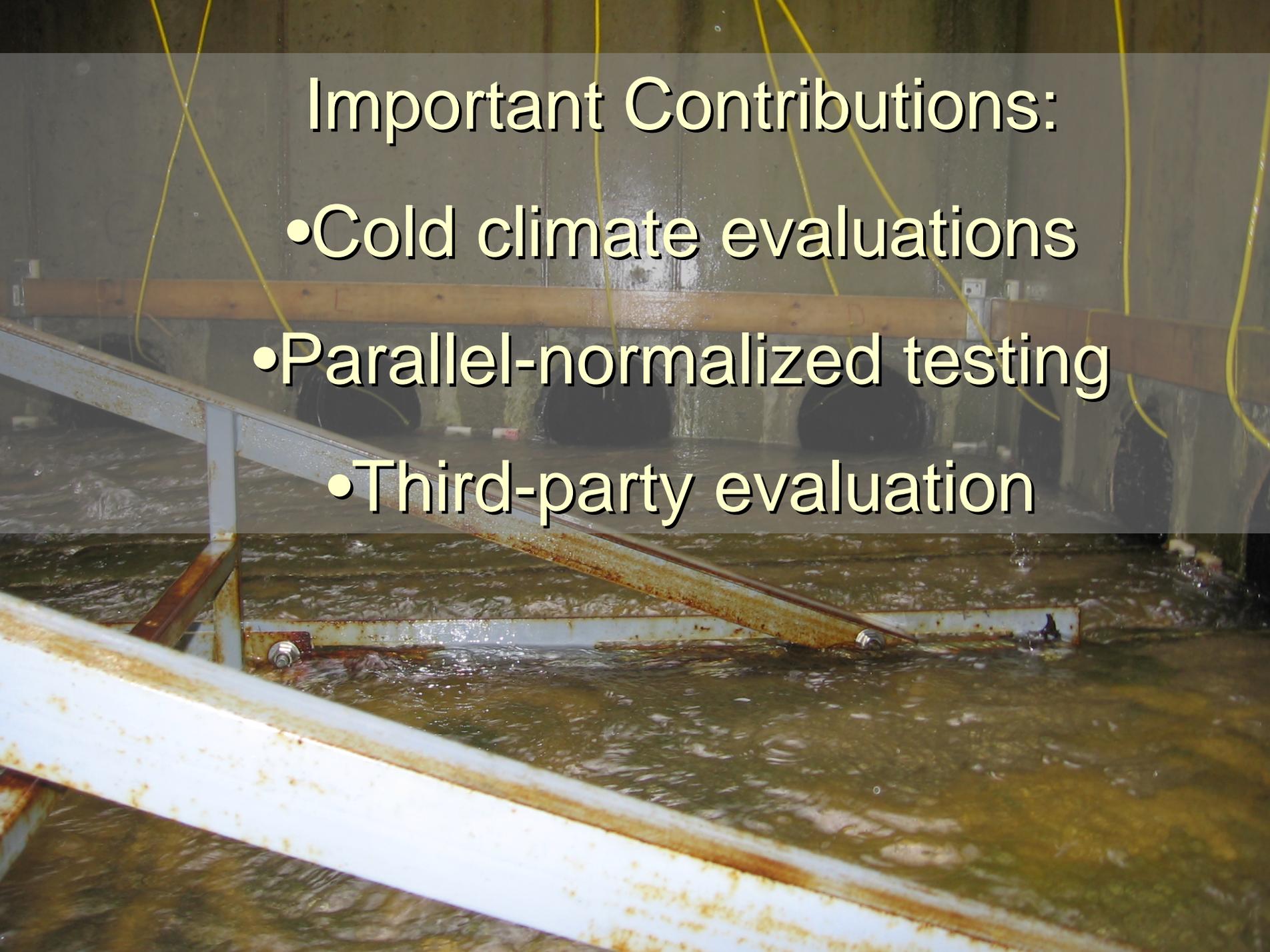
1. Research and development of stormwater treatment systems
2. To provide resources to stormwater communities currently involved in design and implementation of Phase II requirements

<http://www.unh.edu/erg/cstev>



Important Contributions:

- Cold climate evaluations
- Parallel-normalized testing
- Third-party evaluation

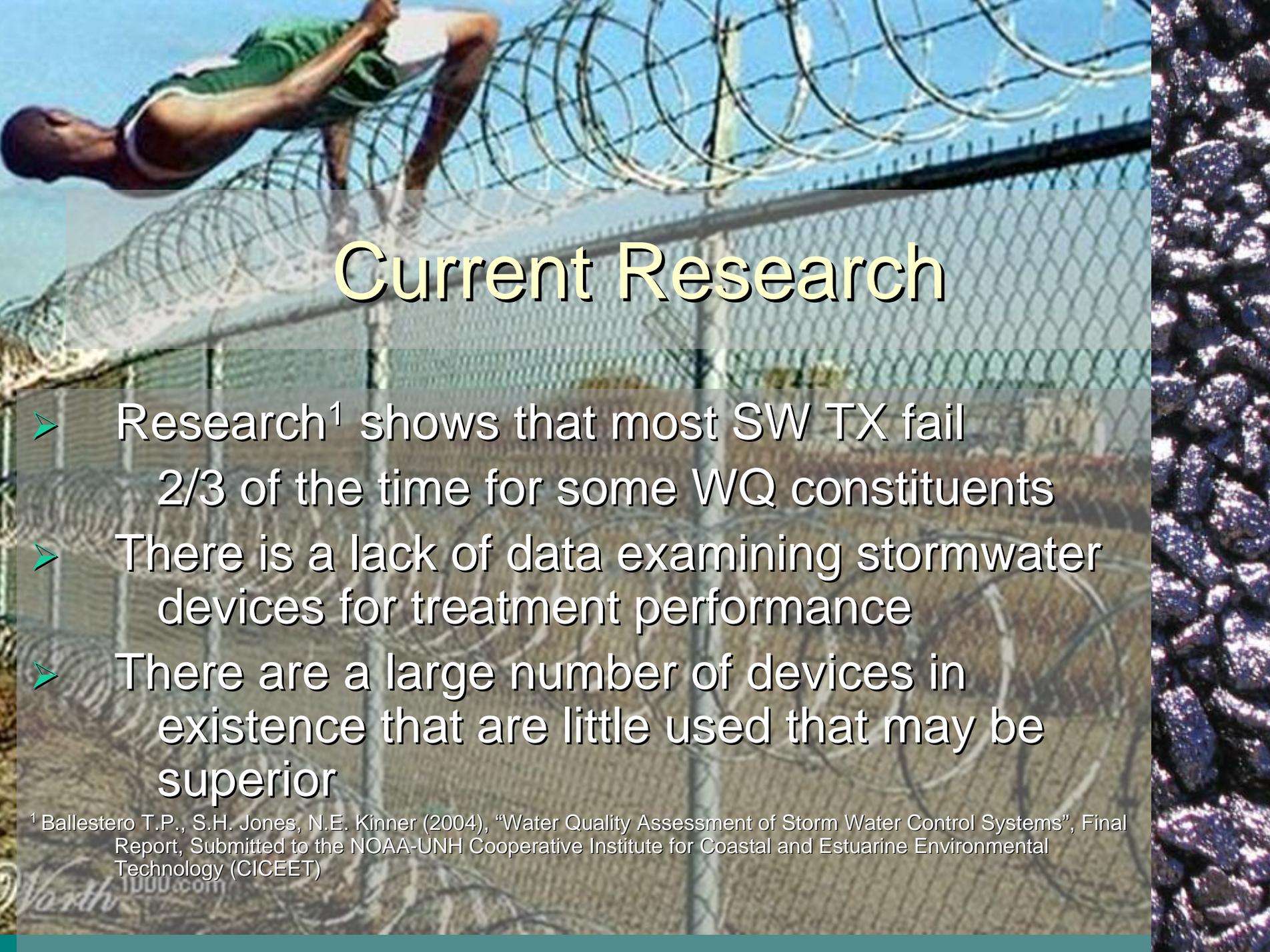




1952 Fire on the Cuyahoga River

When Did We Start to Care About Stormwater?

SMP97-11/1-CLEVELAND, O.: Firemen stand on bridge over Cuyahoga River to play water on tug Arizona as fire, started in an oil slick on the river, swept docks at the Great Lakes Towing Co., here today. The blaze destroyed three tugs, three buildings and the ship repair yards. Damage was not estimated. UNITED PRESS TELEPHOTO rw

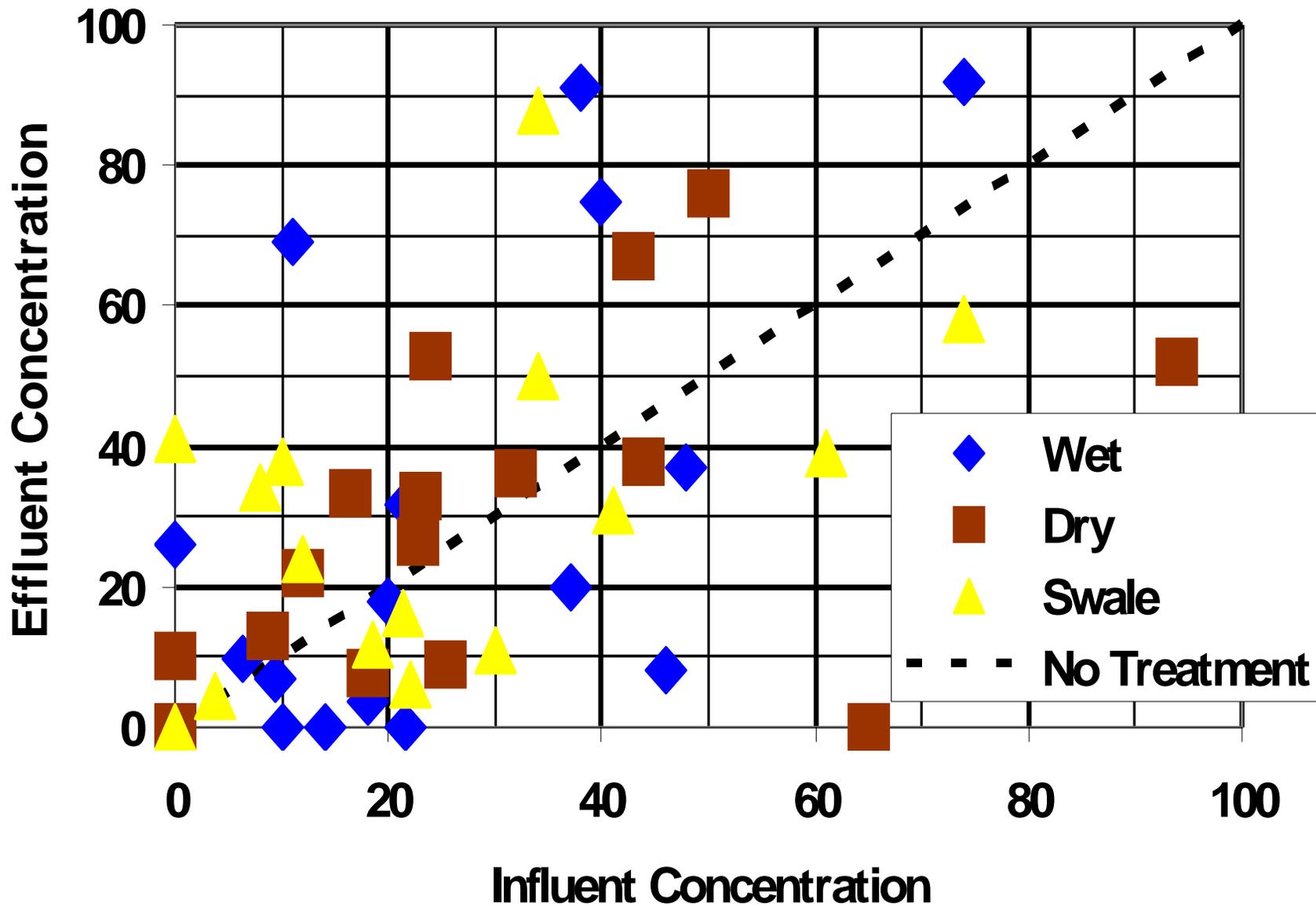


Current Research

- Research¹ shows that most SW TX fail 2/3 of the time for some WQ constituents
- There is a lack of data examining stormwater devices for treatment performance
- There are a large number of devices in existence that are little used that may be superior

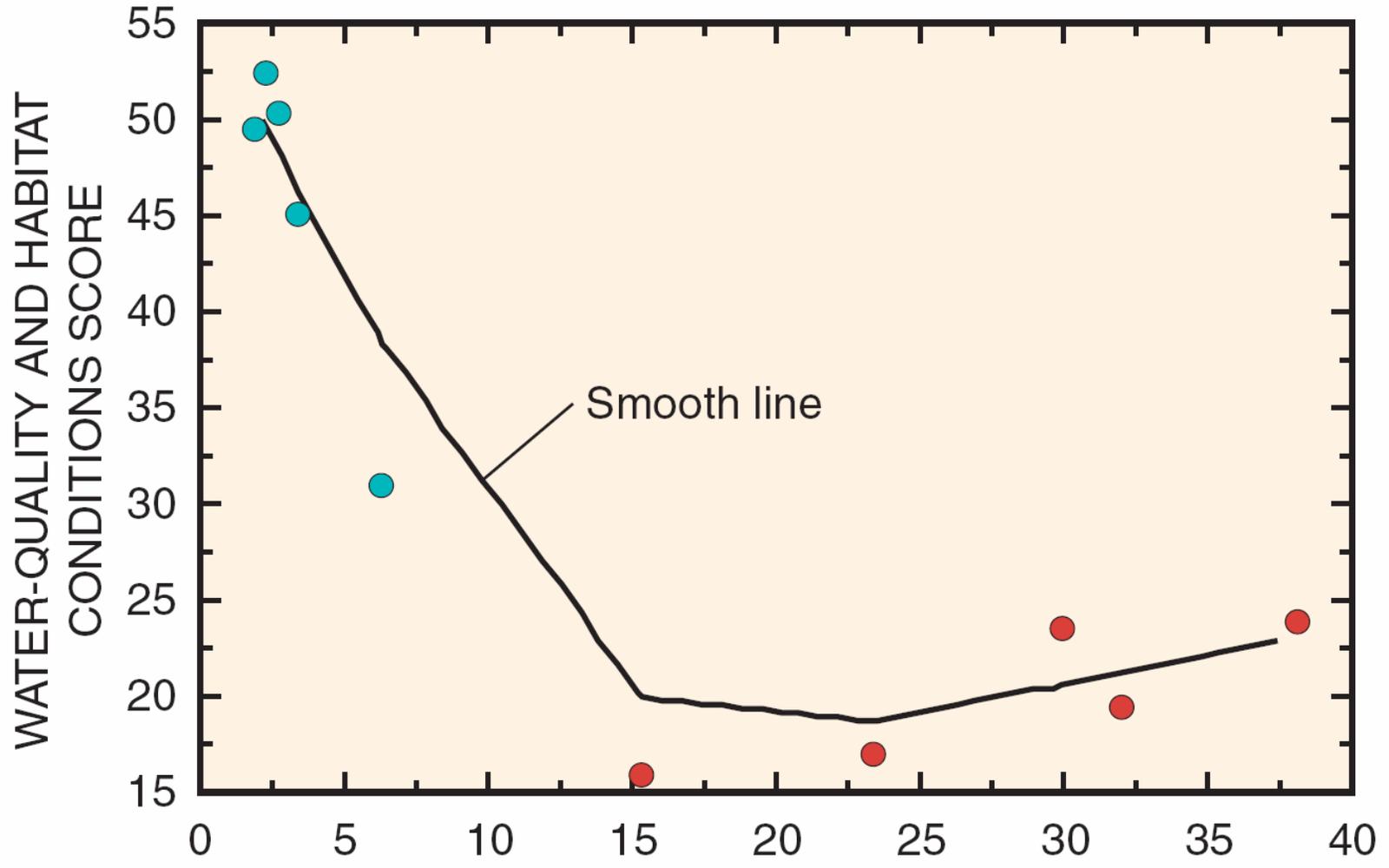
¹ Ballesteros T.P., S.H. Jones, N.E. Kinner (2004), "Water Quality Assessment of Storm Water Control Systems", Final Report, Submitted to the NOAA-UNH Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET)

Sediment Data (TS, TSS, VSS)



Ecological Impacts of Imperviousness and Hydrologic Alterations

A.



Stream Alteration

Recent research examining impacts of climate change on rainfall depths demonstrated existing urban infrastructure are under-capacity by 35%



Is that TSS in your stormwater?

100% Mass Removal!



Where are we today?

- Point-source technology based standards have largely been successful.
- Water quality-based standards (nonpoint source) have been difficult to achieve and enforce.

Field Facility at the UNH WEST EDGE LOT

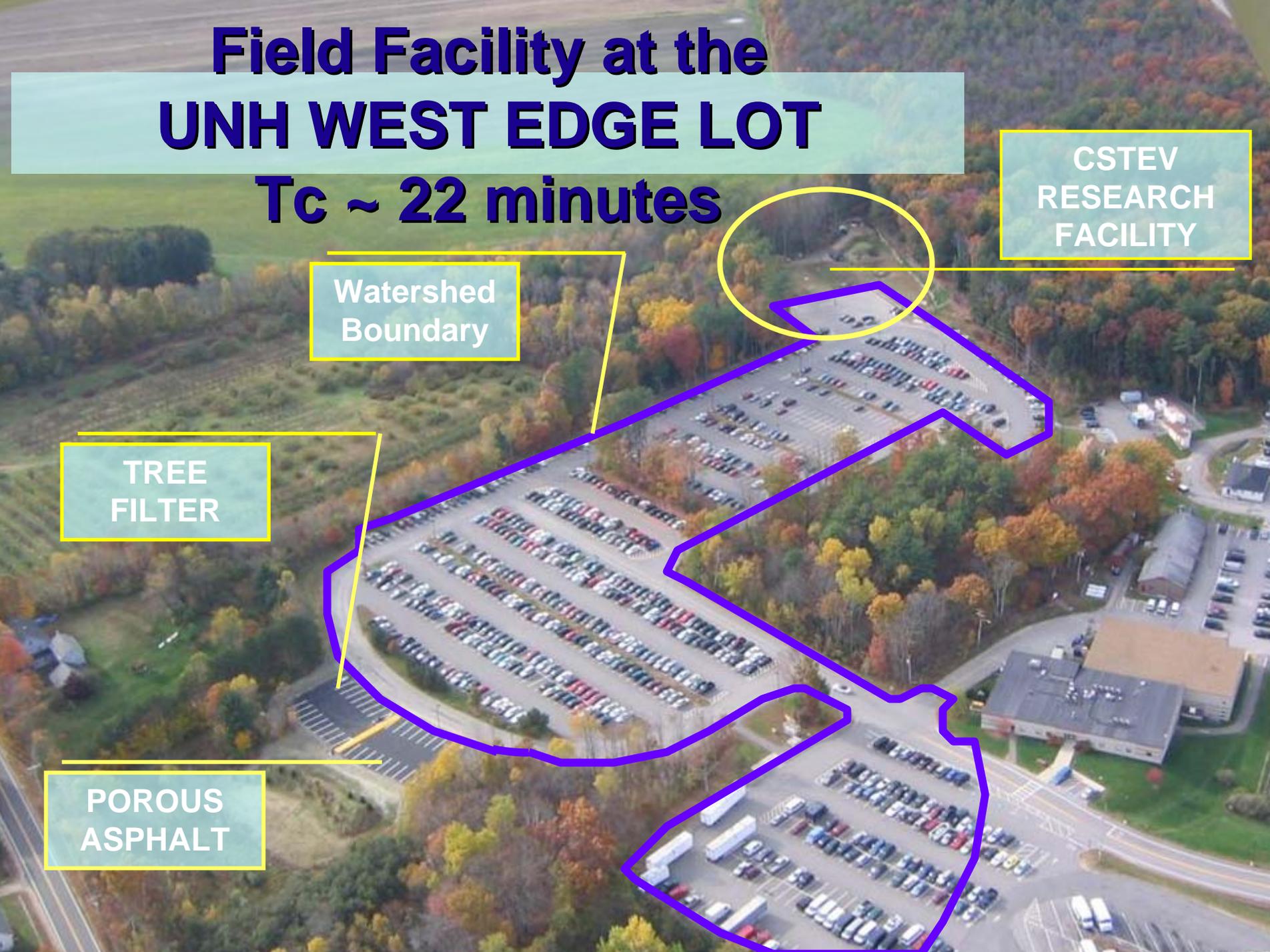
Tc ~ 22 minutes

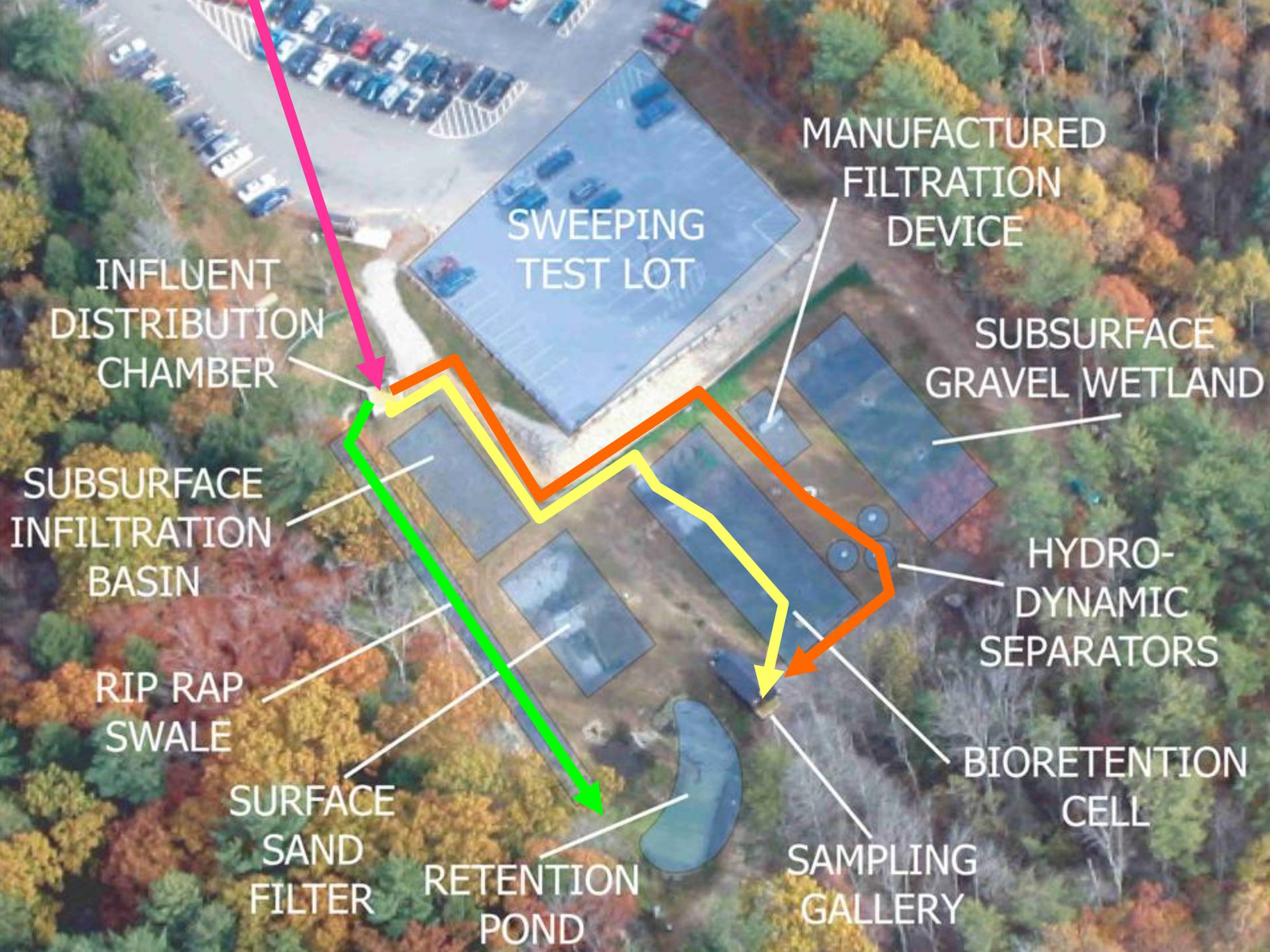
CSTEV
RESEARCH
FACILITY

Watershed
Boundary

TREE
FILTER

POROUS
ASPHALT





SWEEPING TEST LOT

MANUFACTURED FILTRATION DEVICE

SUBSURFACE GRAVEL WETLAND

INFLUENT DISTRIBUTION CHAMBER

HYDRO-DYNAMIC SEPARATORS

BIORETENTION CELL

SUBSURFACE INFILTRATION BASIN

RIP RAP SWALE

SURFACE SAND FILTER

RETENTION POND

SAMPLING GALLERY



Hydrodynamic Separator



Subsurface Infiltration Unit



Filter Unit



Porous Asphalt



Retention Pond



Rip Rap Swale



Gravel Wetland



Sand Filter



2005 Bioretention Unit

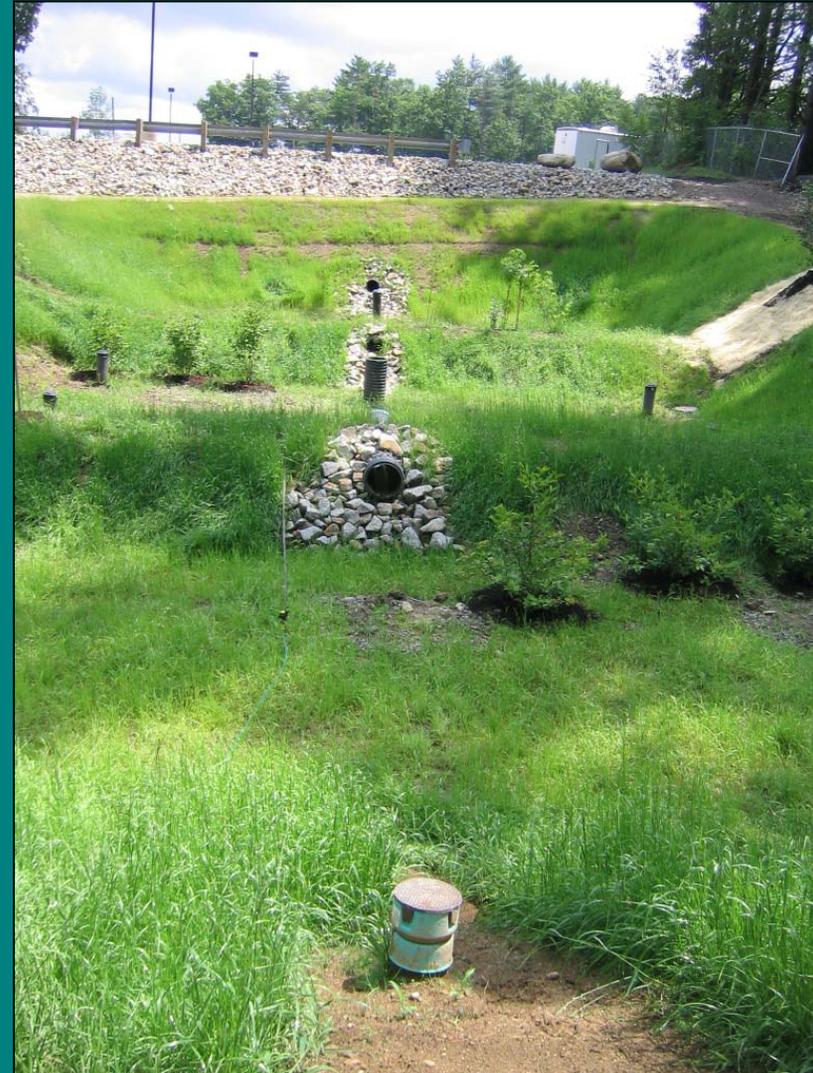


Tree Filter

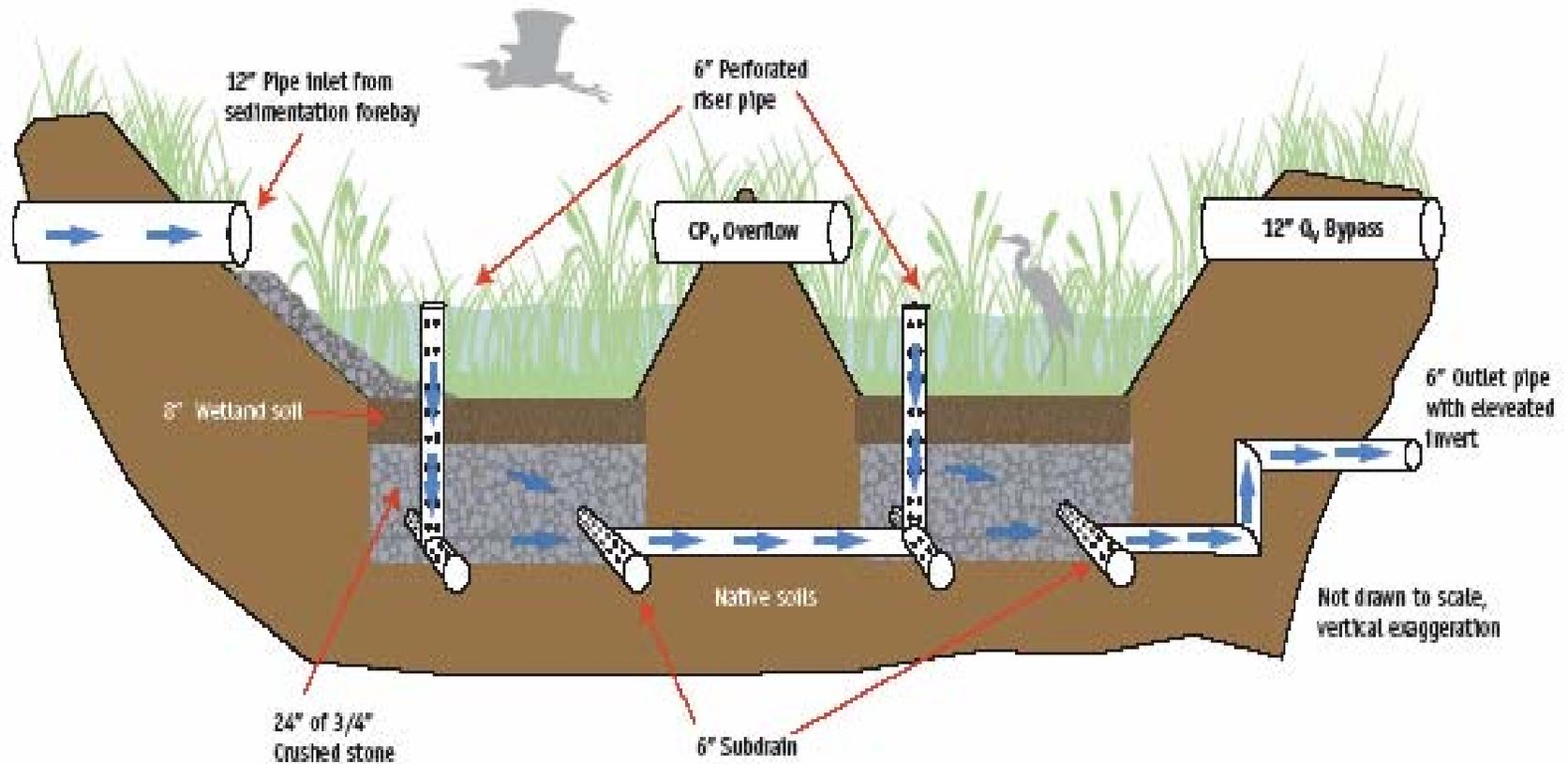
Bioretention



Gravel Wetland



Gravel Wetland





Porous Pavement



- = binder + aggregate
- Modification of Open Grade Friction Course (OGFC)
- Aggregate gradation is coarse w/ few fines
- Asphalt binder often modified (polymers, fibers) but not necessary
- Air voids 18-22%

Standard Porous Asphalt Mixes

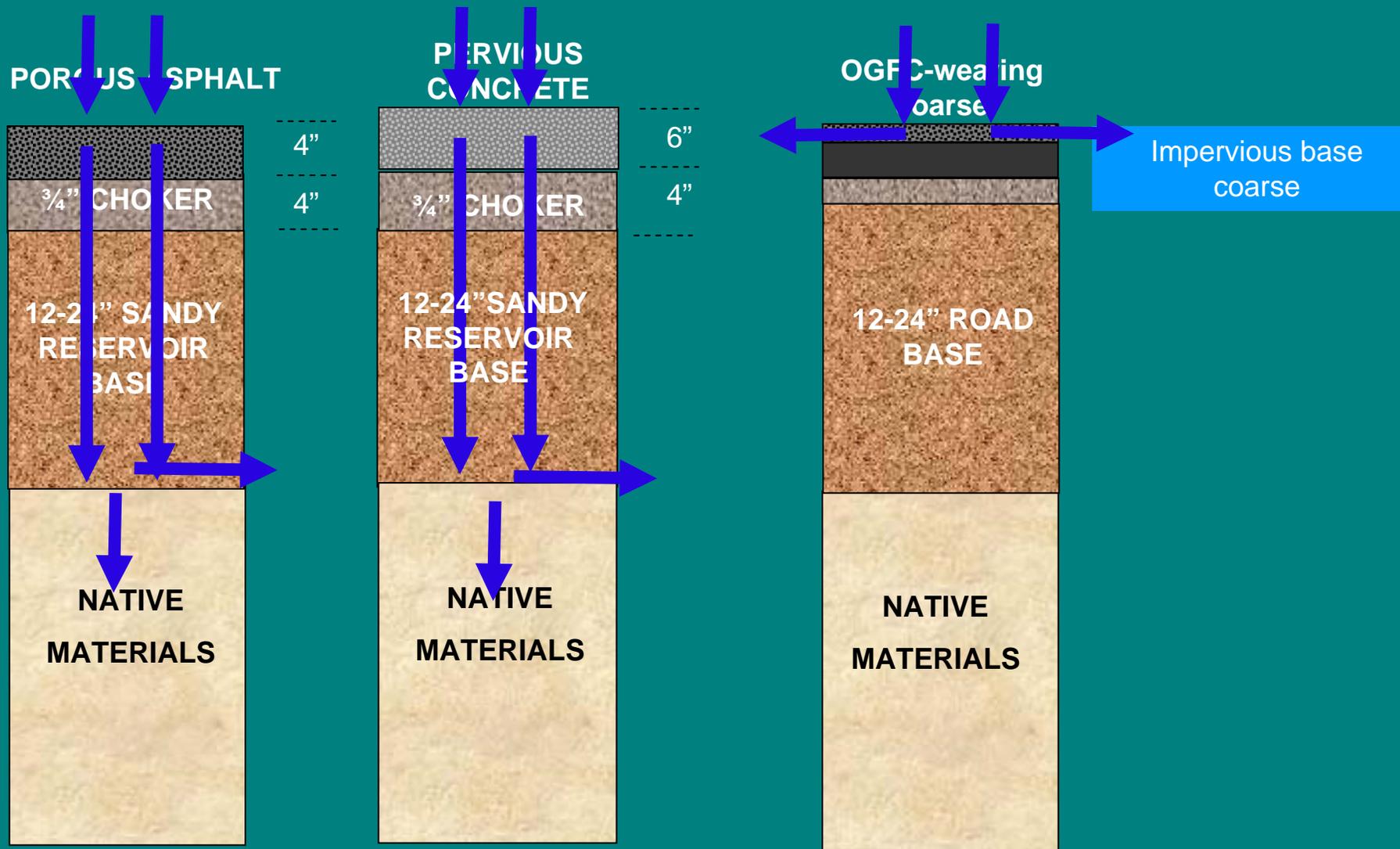
US Standard Sieve Size	Percent Passing
1/2 in.	100
3/8 in.	95
#4	35
#8	15
#16	10
#30	2

Percent bituminous 5.75-6.0% by weight

How Do Permeable Pavements Work?



PP vs OGFC



I-95 North, June 2005,
NO OGFC overlay

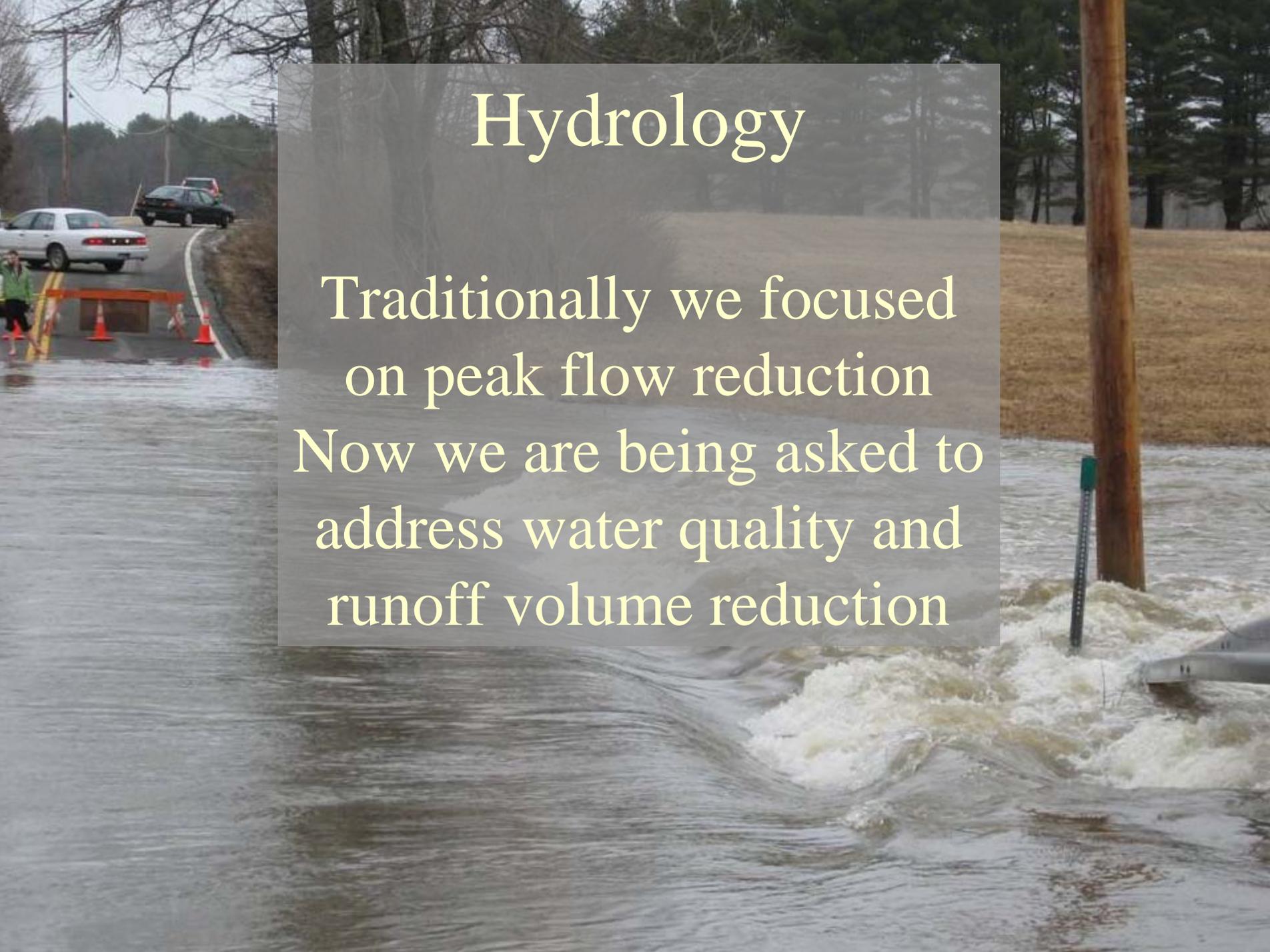
I-95 North, June
2005, OGFC overlay

I-95 South, June 2005, NO OGFC
overlay on right-hand side

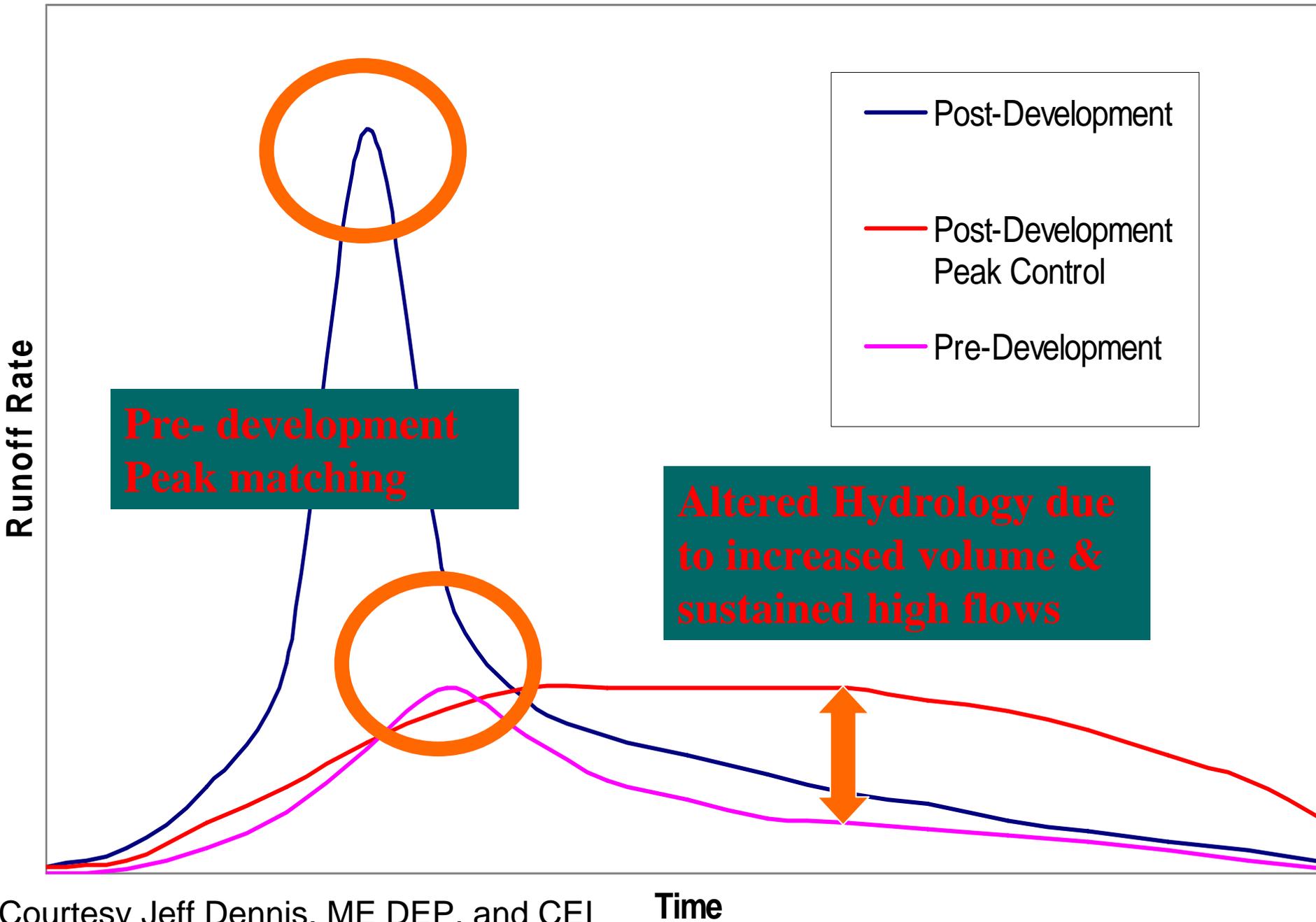


Hydrology

Traditionally we focused
on peak flow reduction
Now we are being asked to
address water quality and
runoff volume reduction

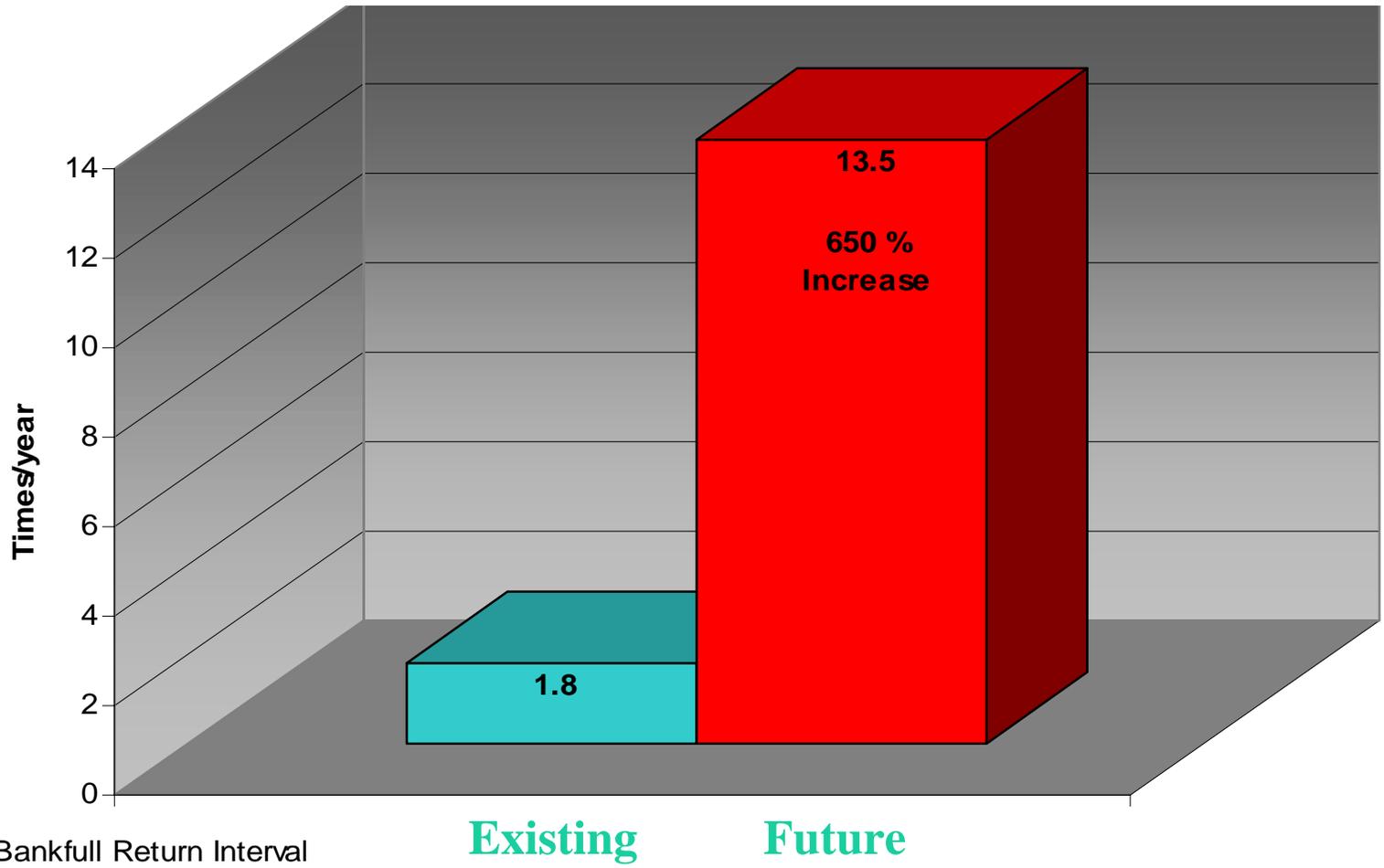


Pre and Post Development Hydrographs



Impact of Development

Bank Full Conditions



Cold Climate Issues

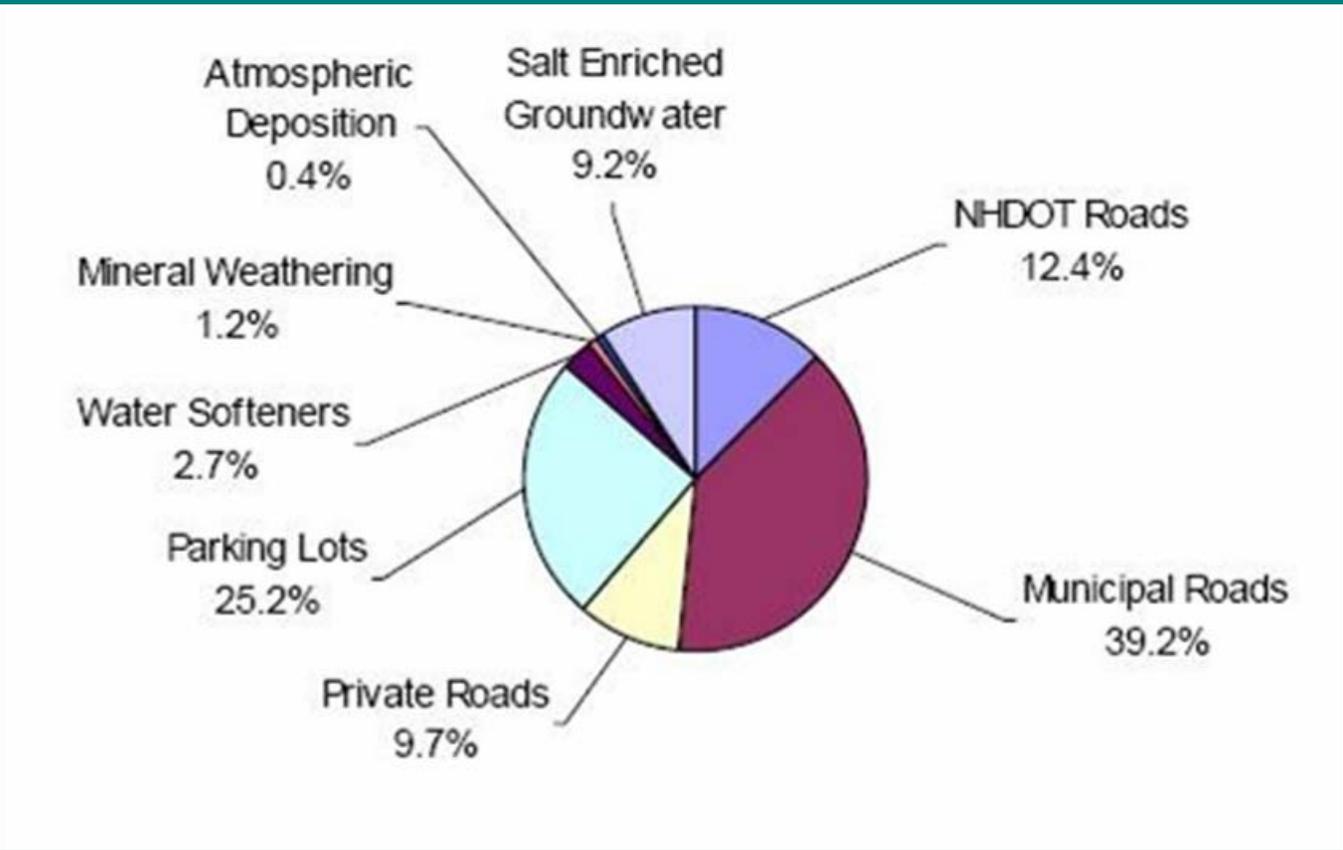


CHLORIDE TOXICITY DEFINED

Courtesy of Doug Heath, USEPA Region 1

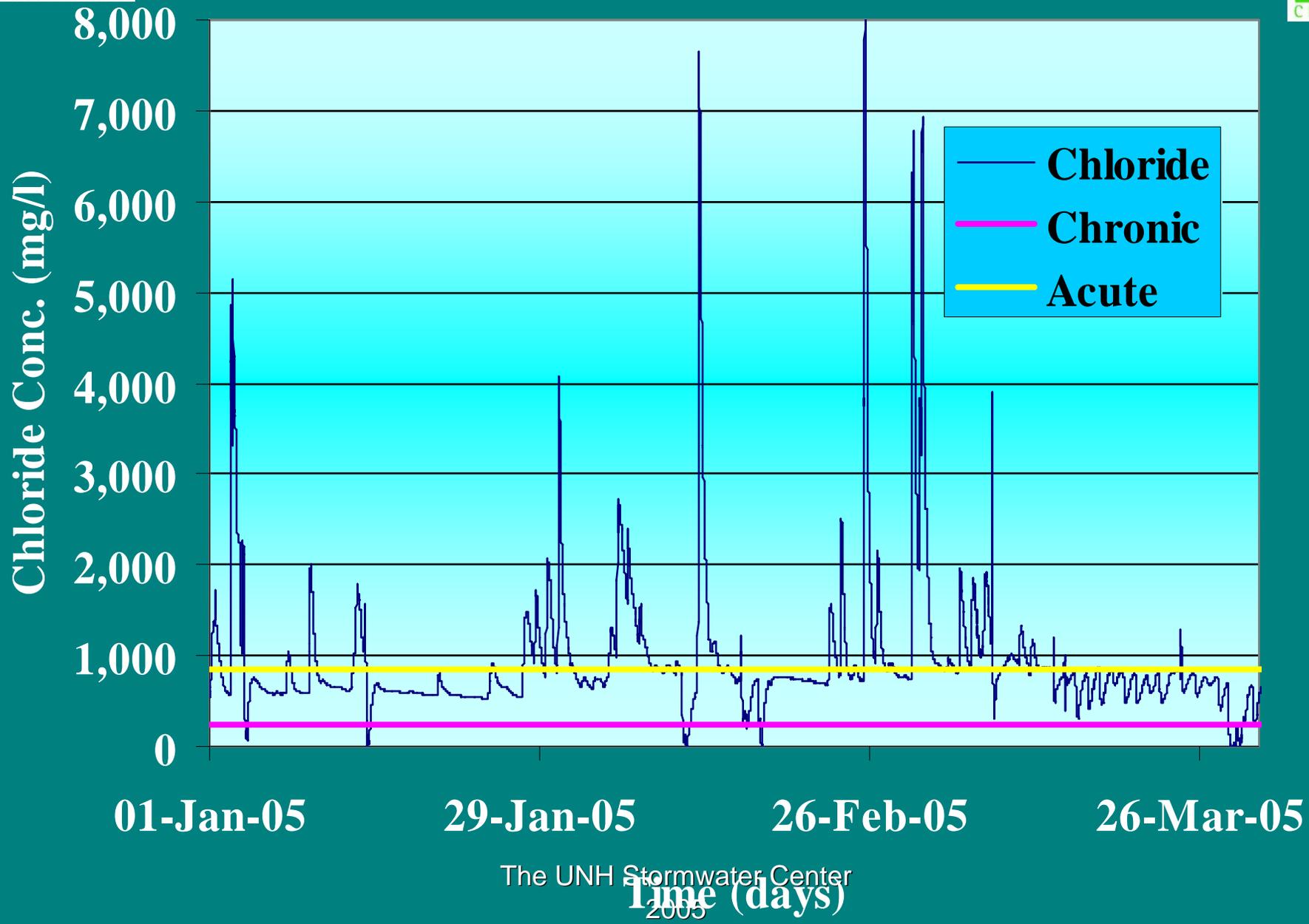
- **CHRONIC** – “THE FOUR-DAY AVERAGE CONCENTRATION OF DISSOLVED CHLORIDE, WHEN ASSOCIATED WITH SODIUM, DOES NOT EXCEED 230 MG/L (~850 uS/cm) MORE THAN ONCE EVERY 3 YEARS ON THE AVERAGE”
- **ACUTE** – “THE ONE-HOUR AVERAGE CONCENTRATION DOES NOT EXCEED 860 MG/L (2855 uS/cm) MORE THAN ONCE EVERY 3 YEARS ON THE AVERAGE.”
- [SOURCE: USEPA, 1988, *AMBIENT WATER QUALITY CRITERIA FOR CHLORIDE – 1988*: OFFICE OF WATER REGULATIONS AND STANDARDS, CRITERIA AND STANDARDS DIVISION, WASHINGTON, DC, EPA 440/5-88-001, P. 8]

% Salt Load by Source

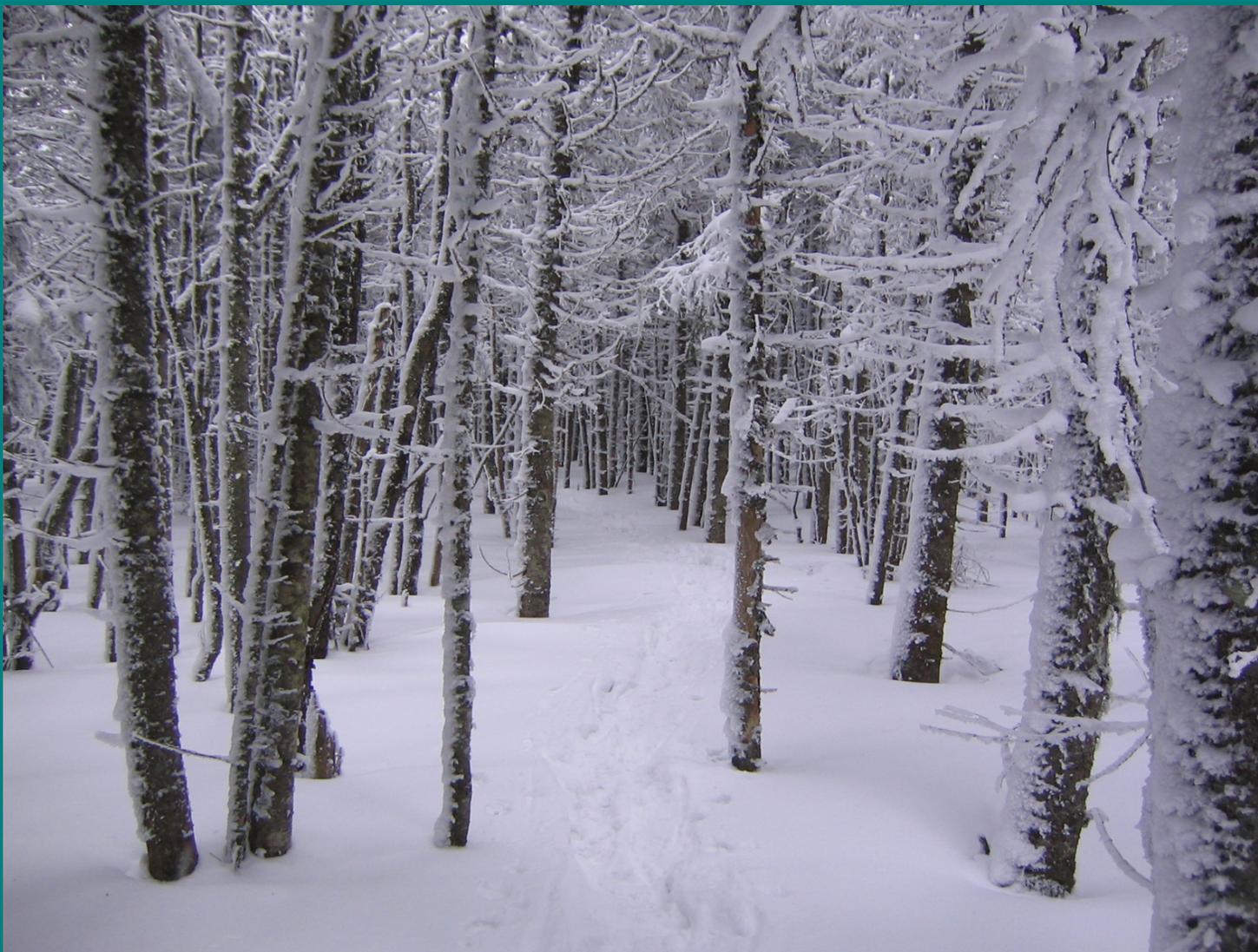


NHDES Estimate, 2006

Chloride Concentration Jan-Mar 2005

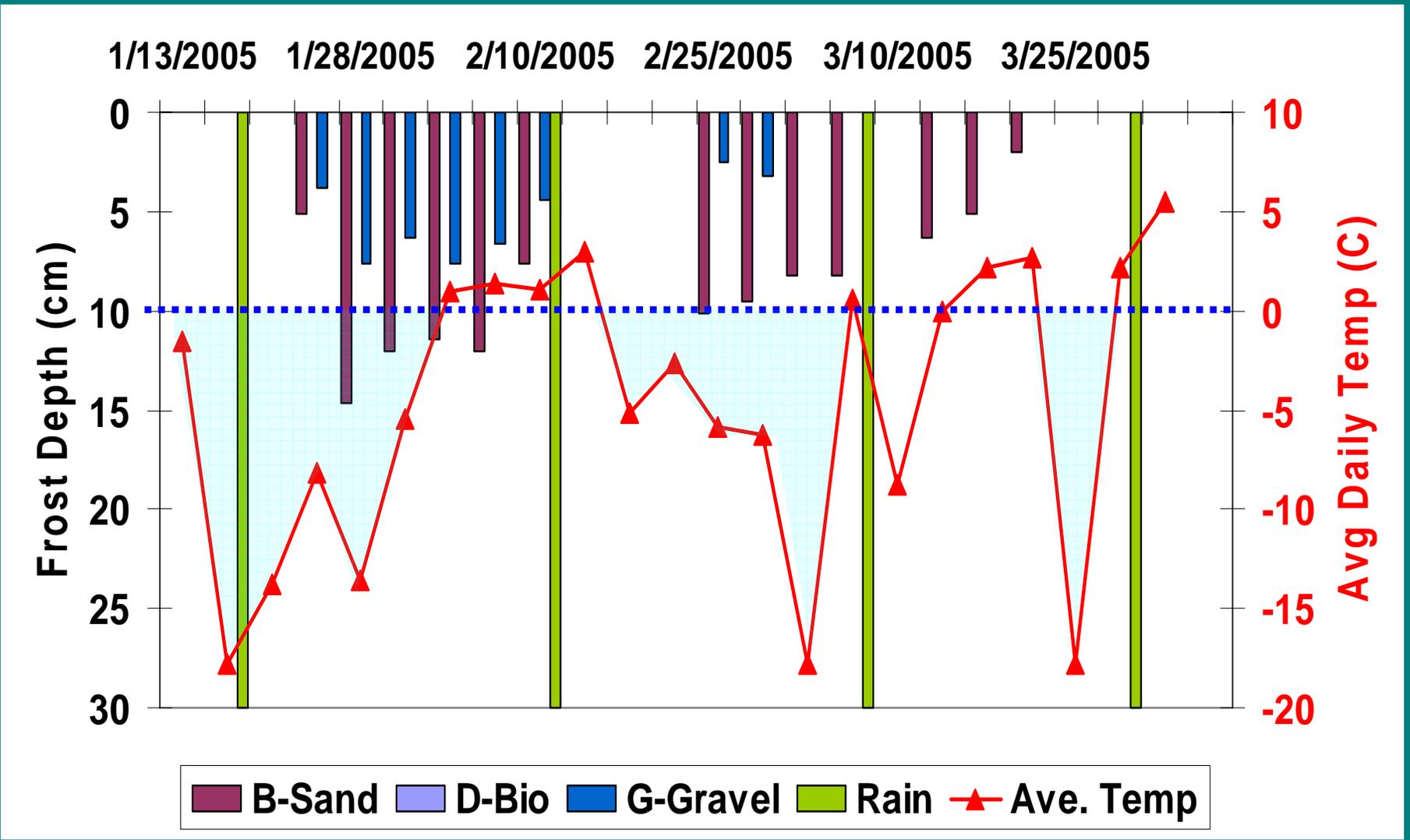


Seasonal Monitoring



The UNH Stormwater Center
2005

Filter Media Frost Penetration



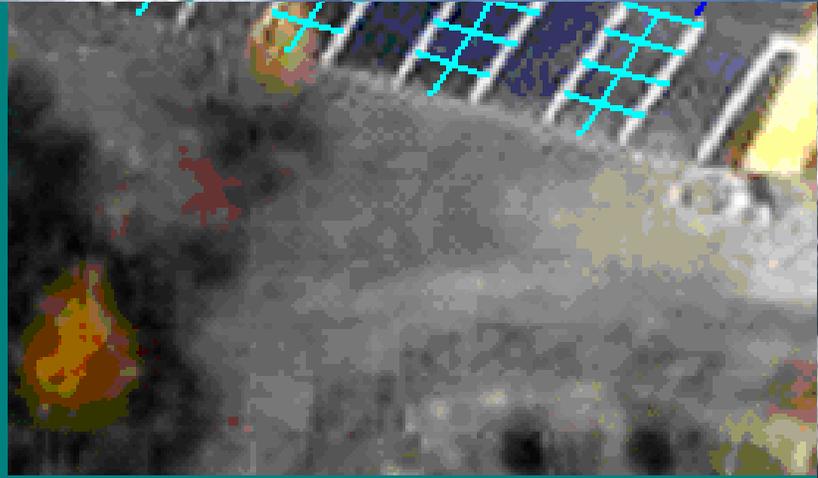
Salt Reduction and Porous Asphalt



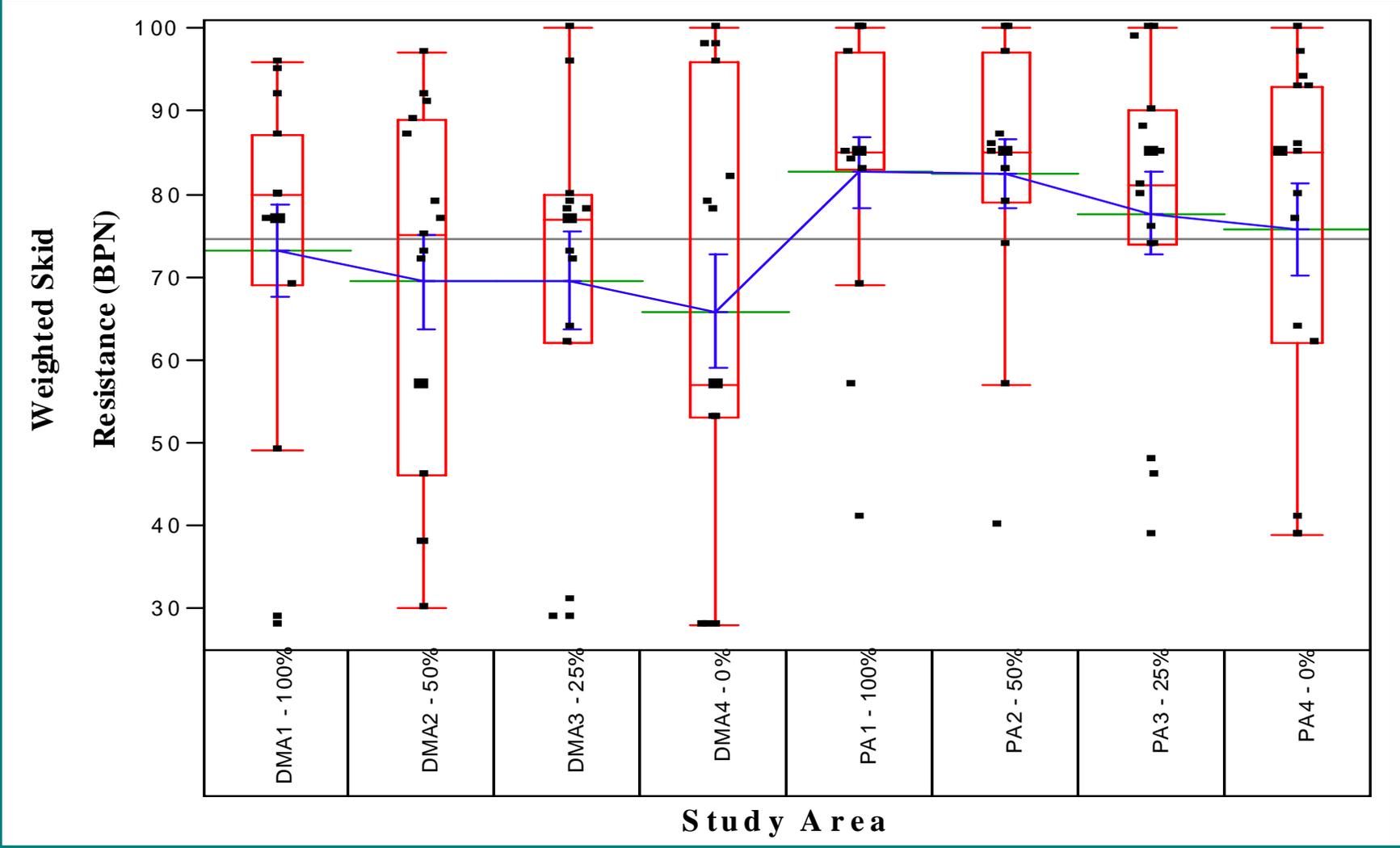
DMA 1-HR AFTER PLOWING,
11AM -4°C



PA 1-HR AFTER PLOWING,
11 AM -4°C



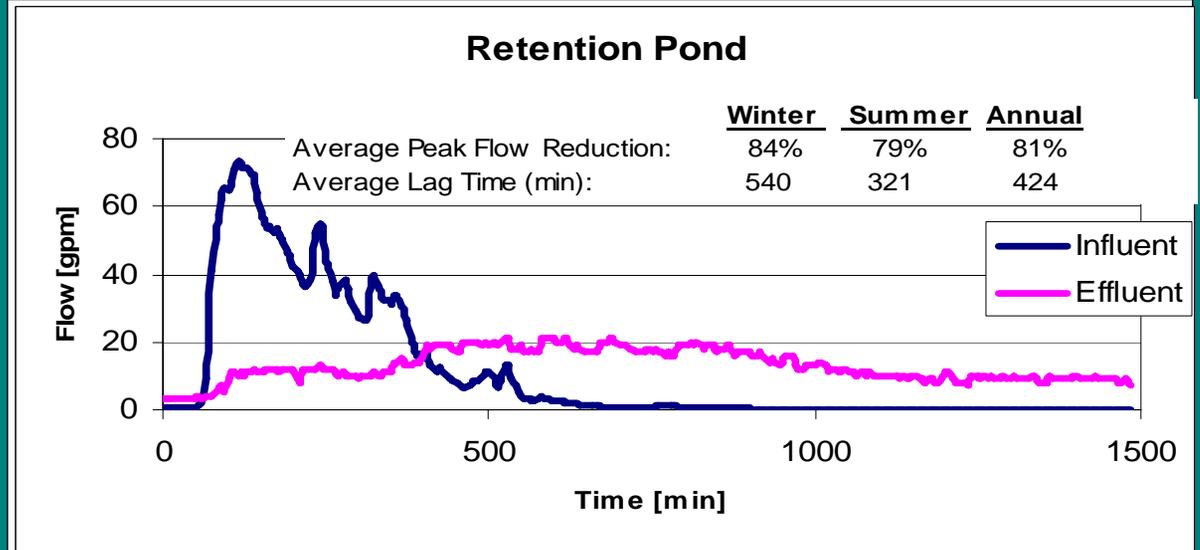
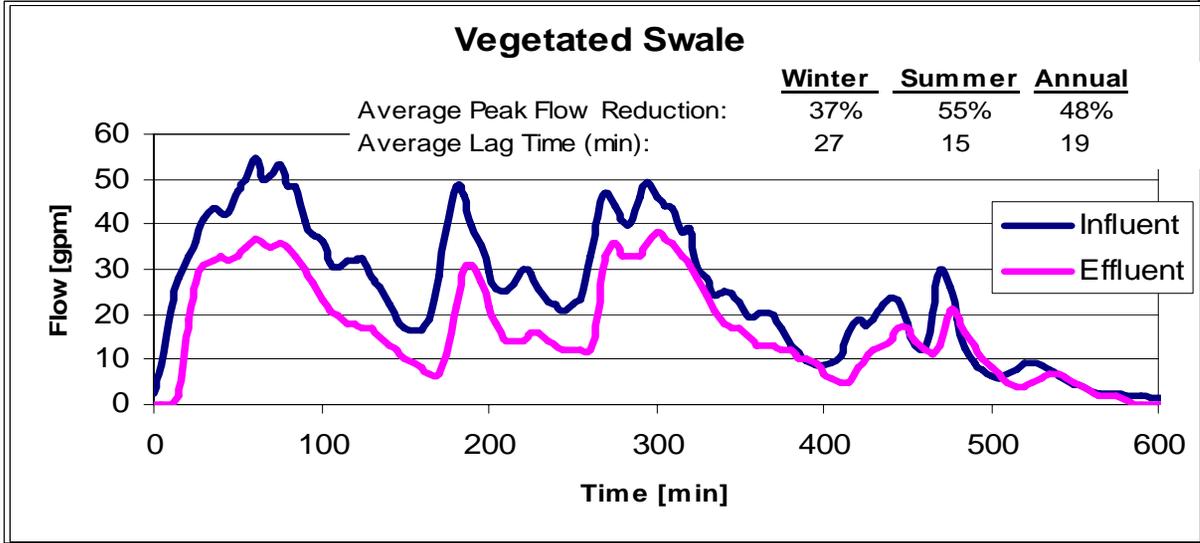
Salt Reduction and Porous Asphalt



Performance Results



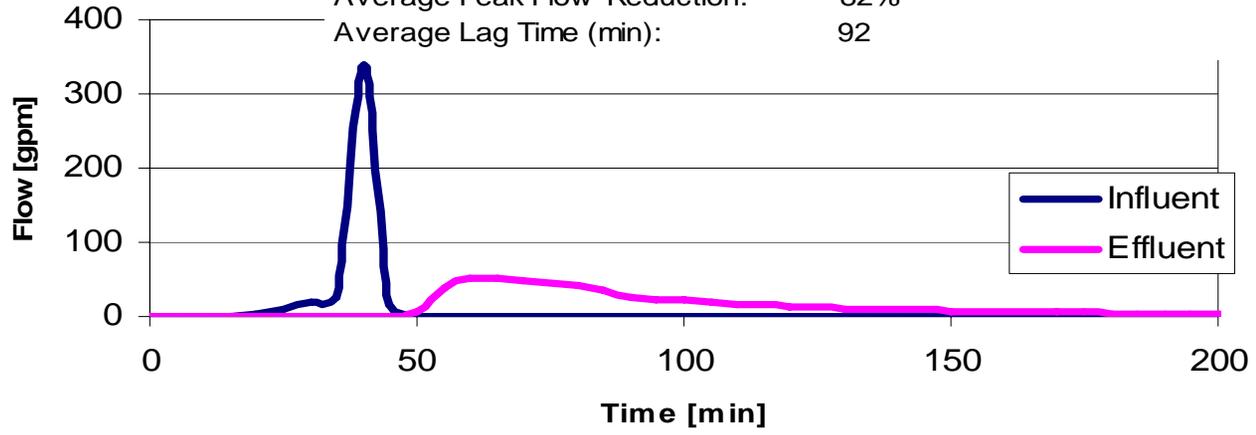
Performance Efficiencies -Conventional



Bioretention II

Annual

Average Peak Flow Reduction: 82%
Average Lag Time (min): 92

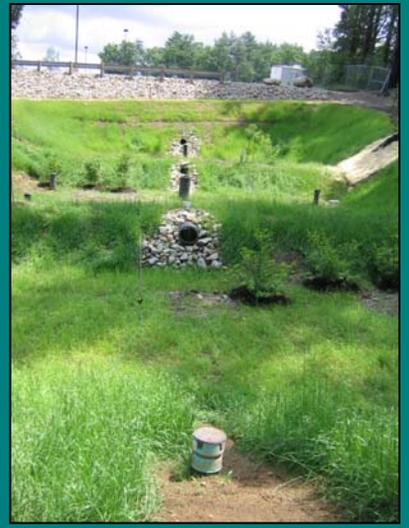
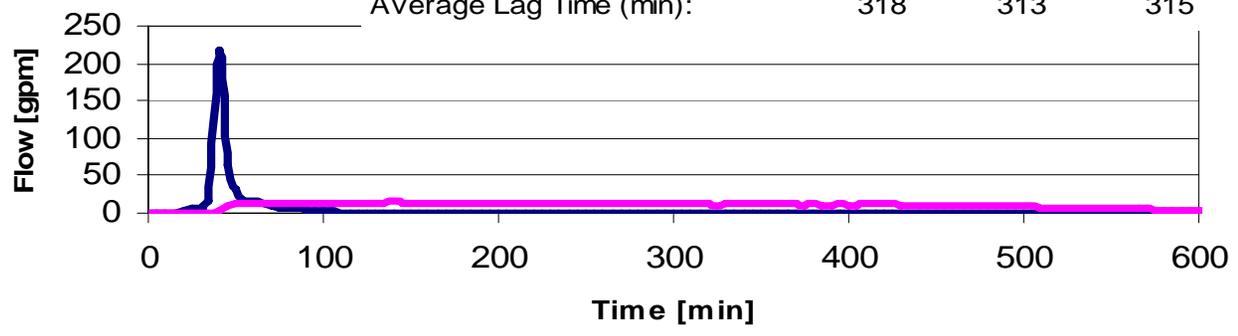


Gravel Wetland

— Influent
— Effluent

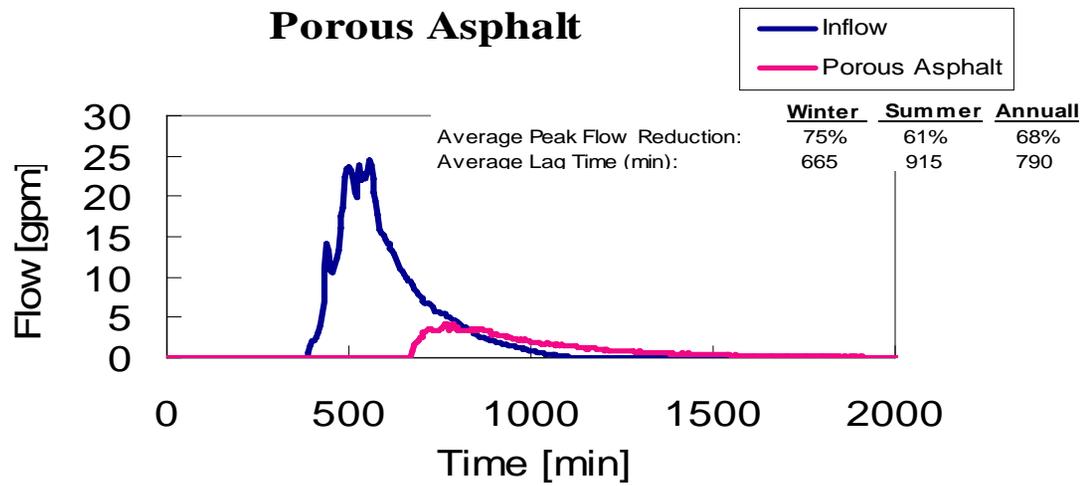
Winter Summer Annual

Average Peak Flow Reduction: 85% 77% 81%
Average Lag Time (min): 318 313 315

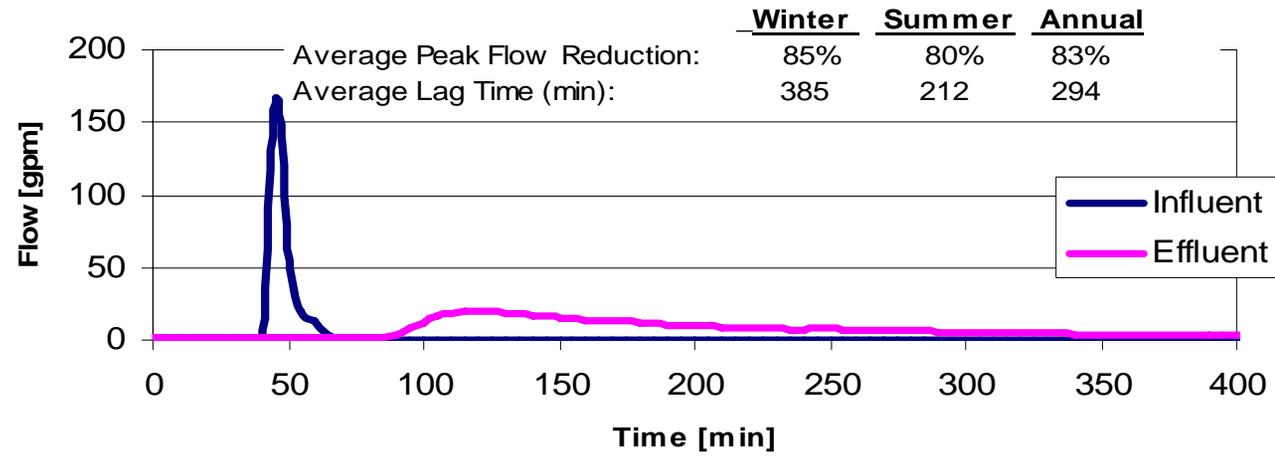


Performance Efficiencies –Filtration/Infiltration

Porous Asphalt

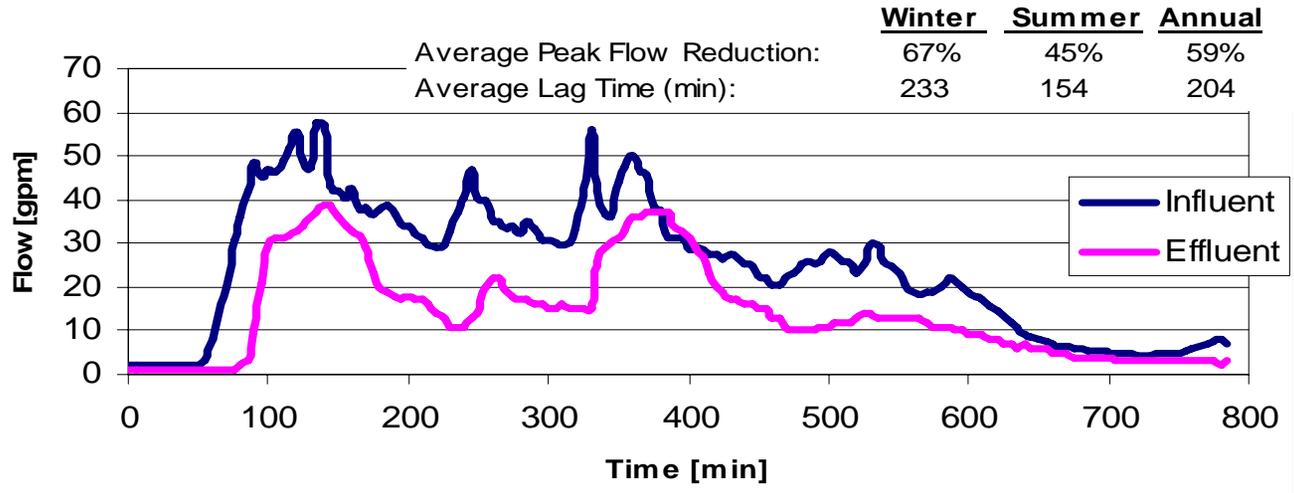


Advanced Drainage System

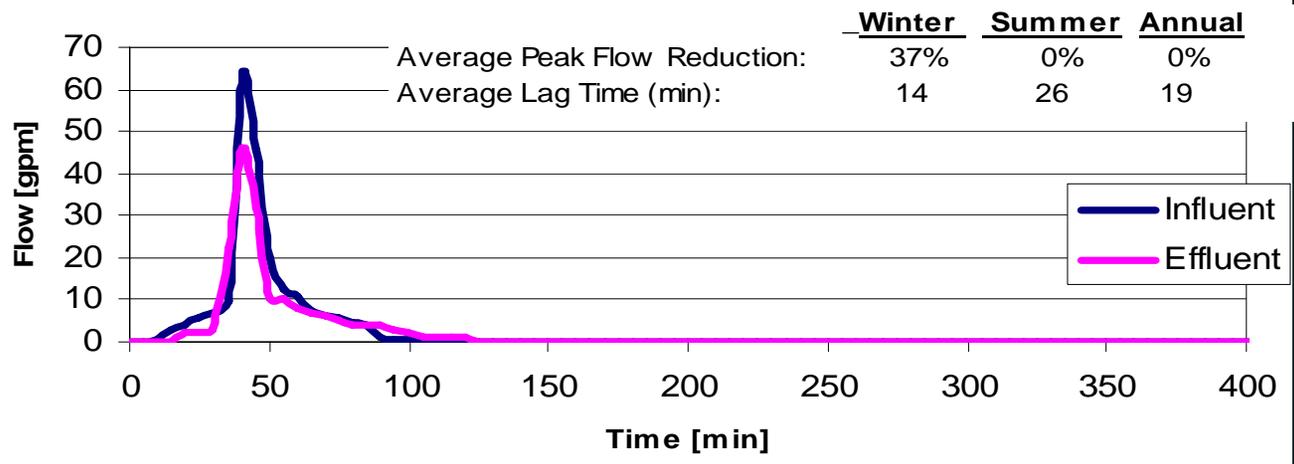


Performance Efficiencies –Filtration/Infiltration

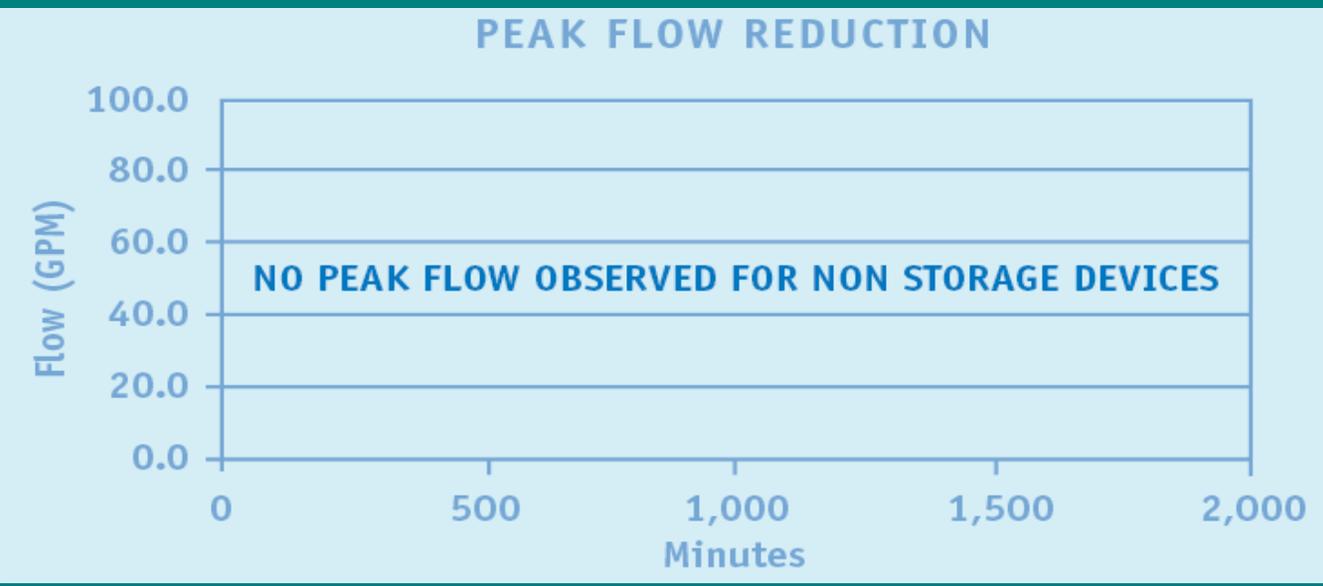
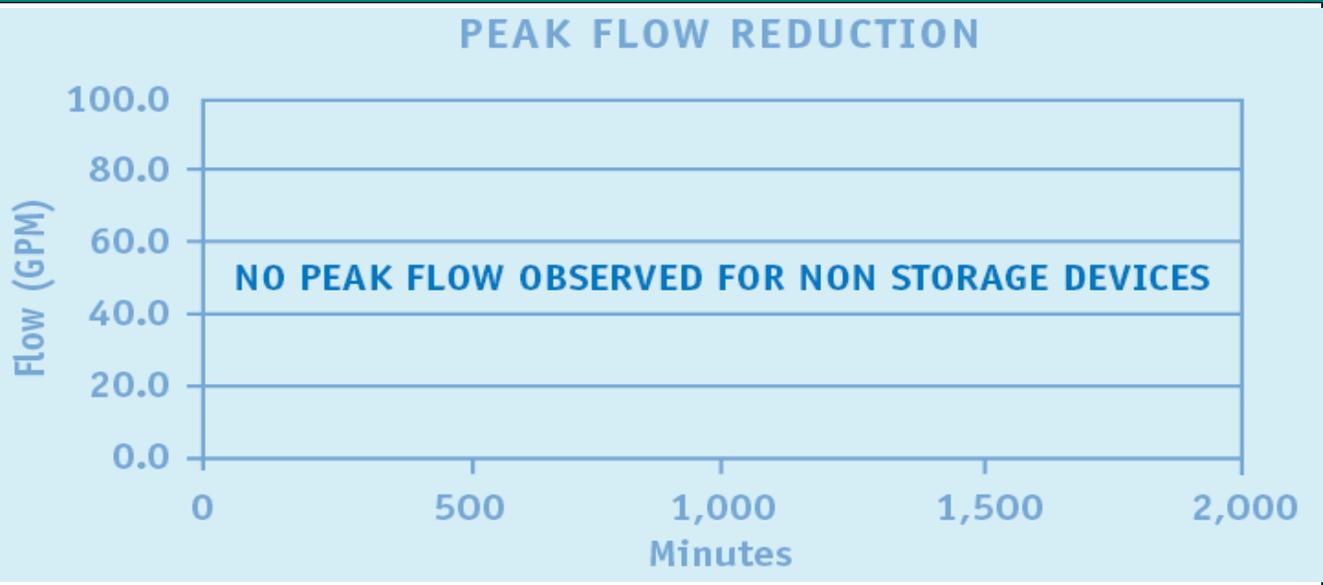
Sand Filter



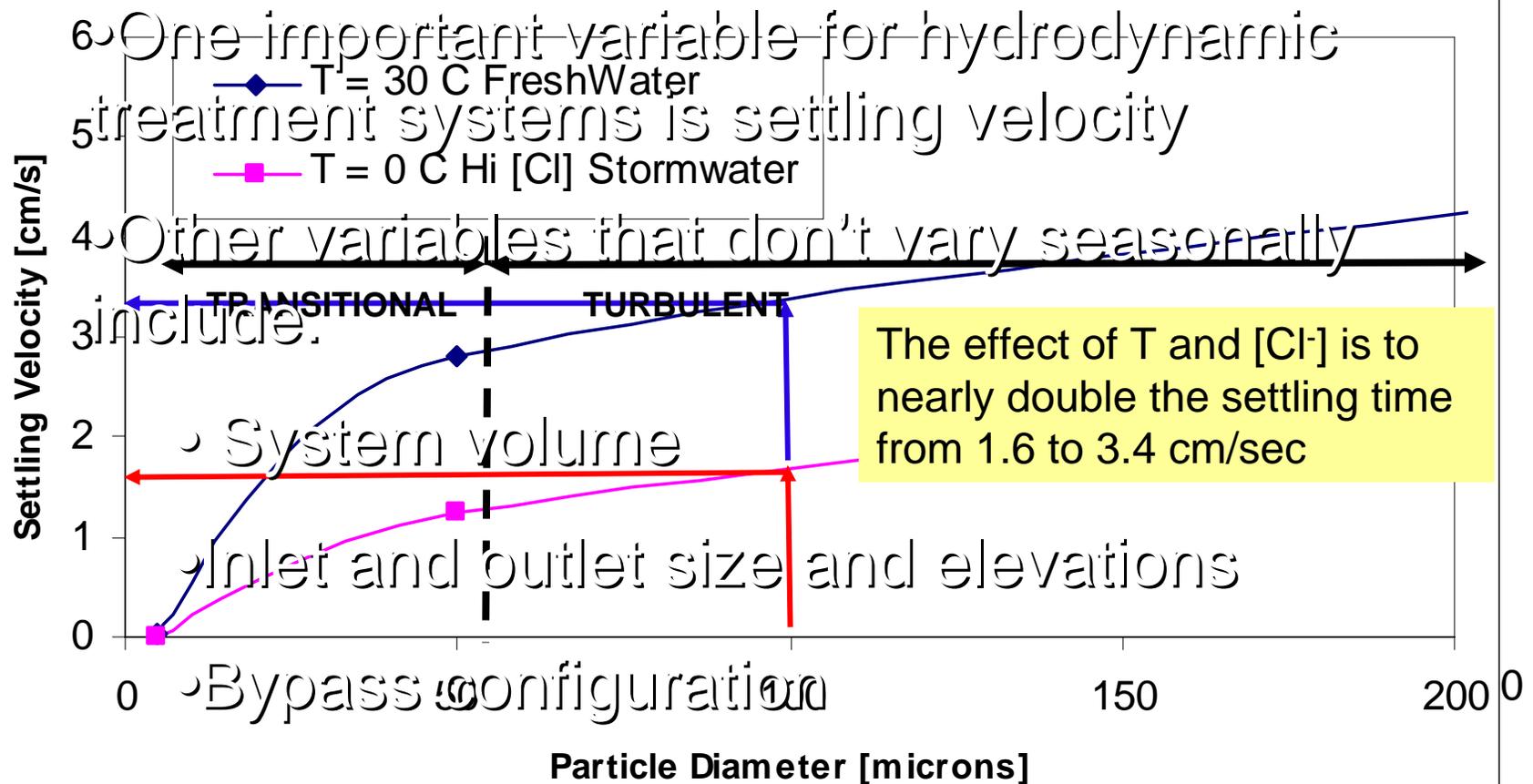
Tree Filter



Performance Efficiencies-Manufactured System



Temperature and Salinity Effects on Settling Velocity





Summary Conclusions

- While concerns exist for LID in cold climates, seasonal variations are observed for conventional BMPs and Manufactured systems
- Infiltration and filtration systems have the highest removal efficiency
- The standard of practice is moderate at best, and low especially for stone lined swales
- Systems dependent on particle settling show the greatest affect by season and temperature variability.
- Bacterial concentrations are only reduced significantly by LID systems and subsurface infiltration (exception is sand filter)

Acknowledgements

Funding Source:



Manufacturers:

Hydro International, Stormtech, CONTECH,
ADS, CDS, Environment 21, AquaShield

Questions?



Mothers Day Floods May 2006

Bacterial Colonies

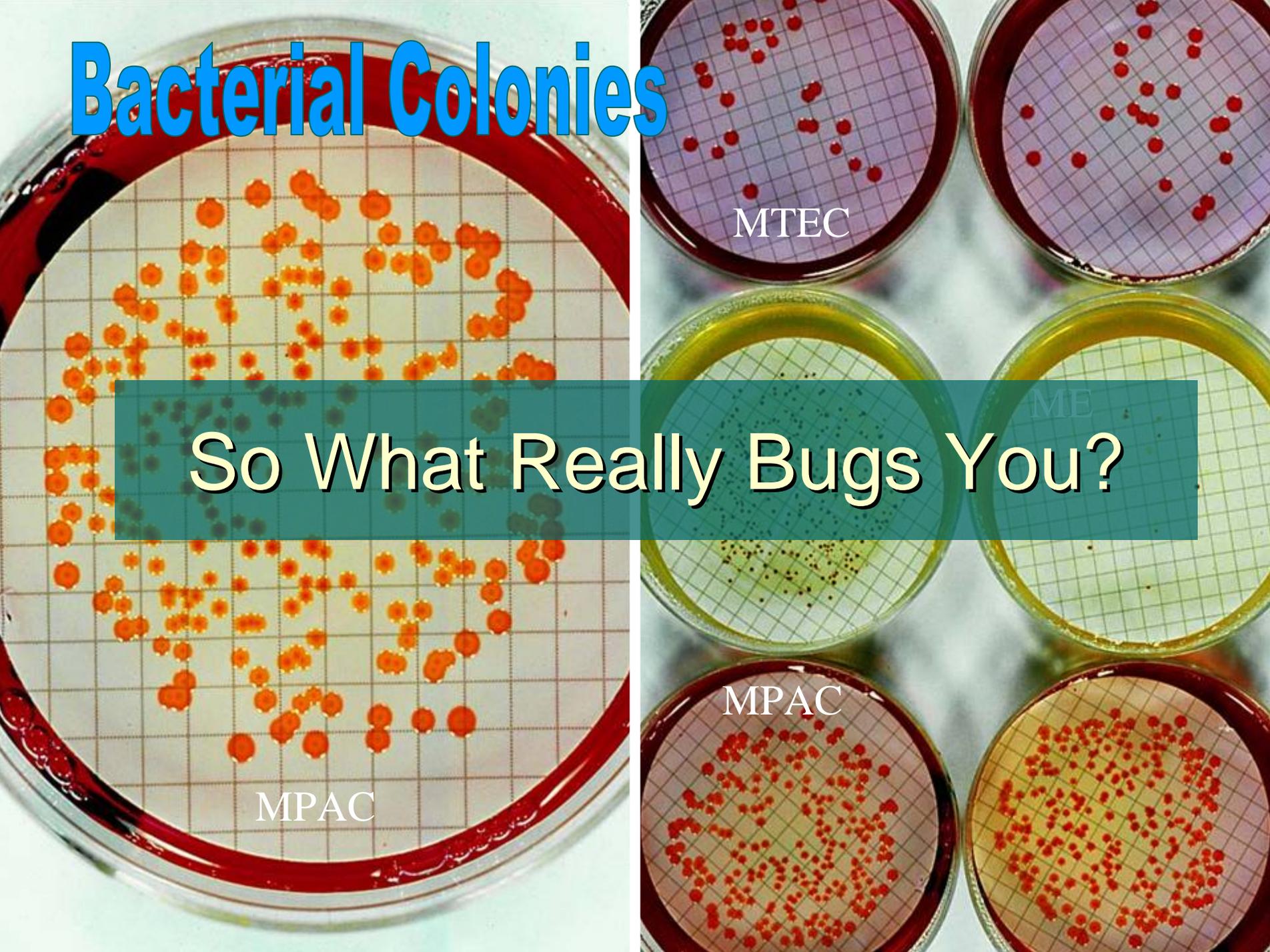
So What Really Bugs You?

MPAC

MTEC

MPAC

ME

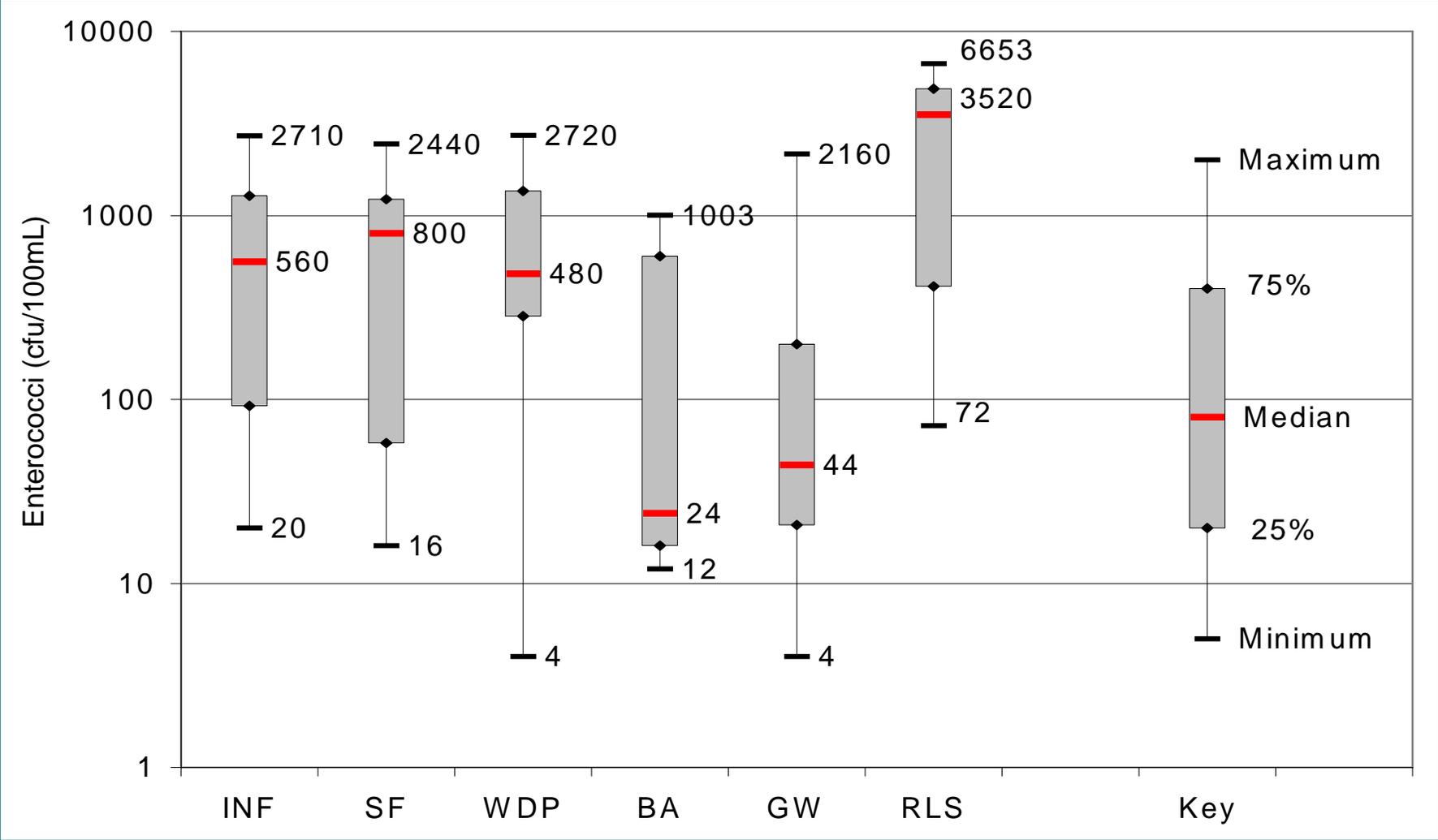




**NH Shellfishing beds are closed after
>1/4 inch of rainfall in 24 hours**

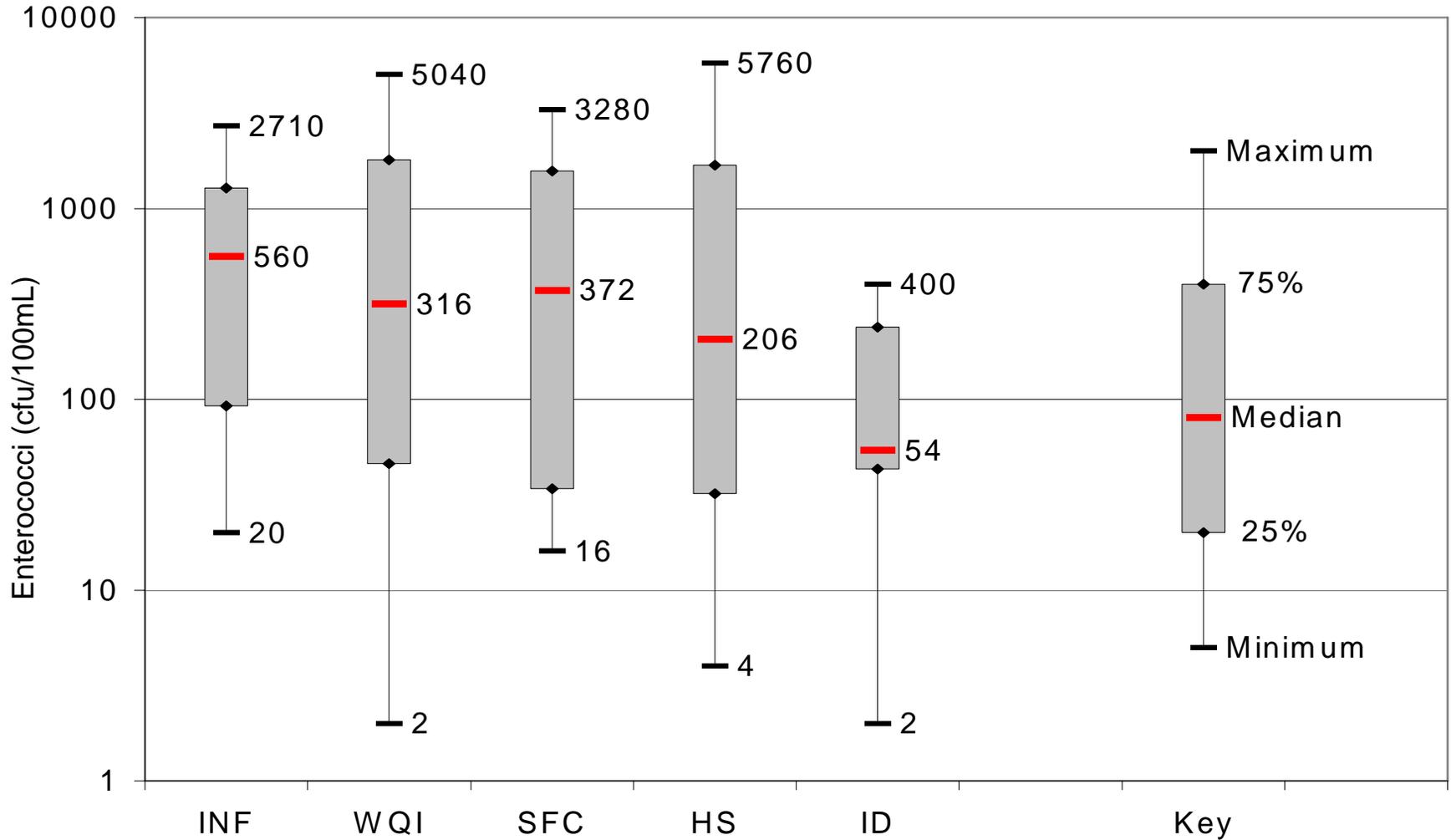


Bacterial Concentrations for Structural Systems

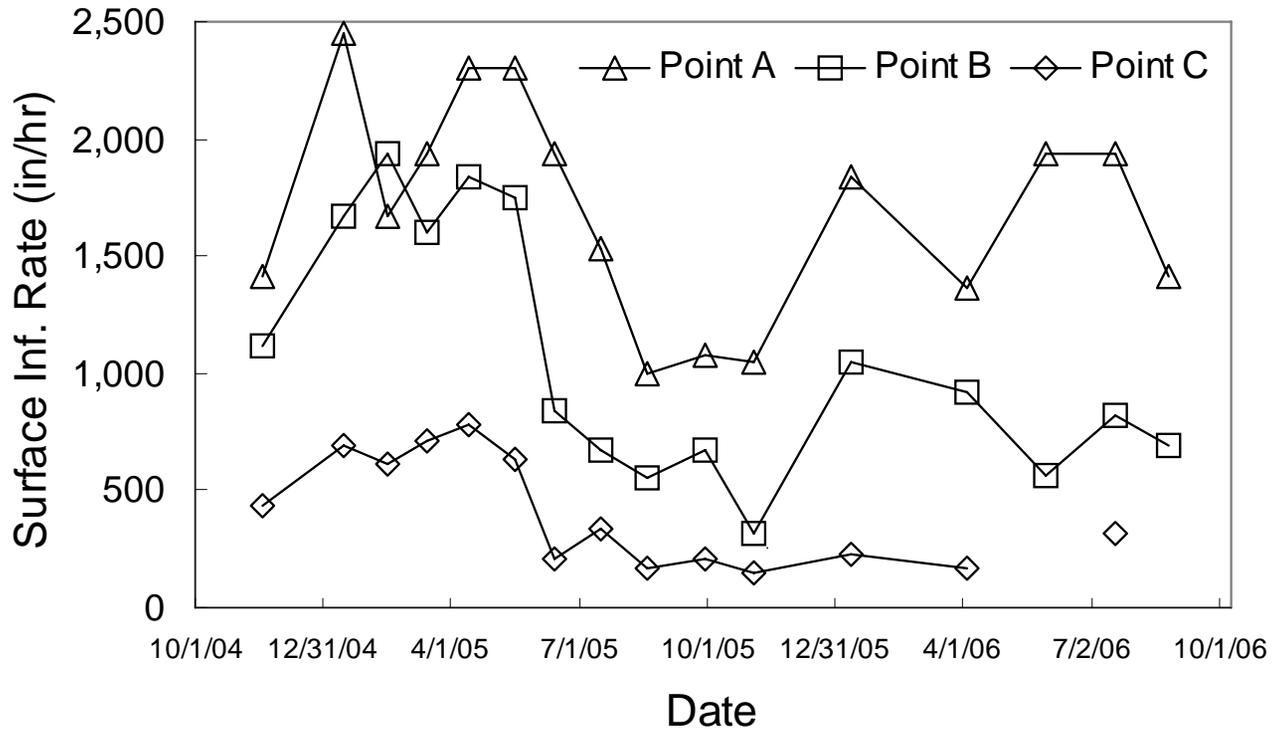




Bacterial Concentrations for Manufactured Systems



Surface infiltration rates for the porous asphalt 11/04-4/06



2,500

Even with 99% clogging the IR=10 in/hr > most sands & soils

Point