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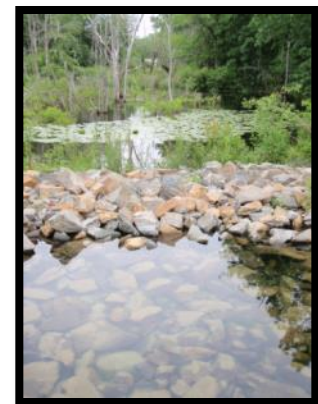
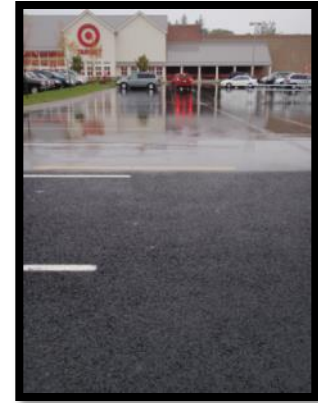
Water Quality and Hydrologic Performance of a Porous Asphalt Pavement as a Stormwater Management Treatment Strategy in a Cold Climate

Robert M. Roseen, Ph.D., P.E., D.WRE., Associate, Water Resources, Geosyntec



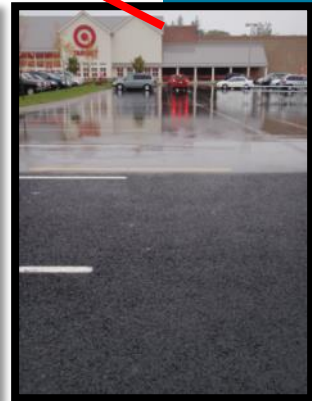
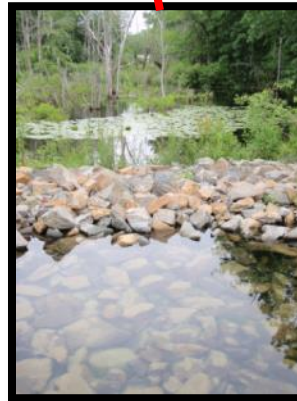
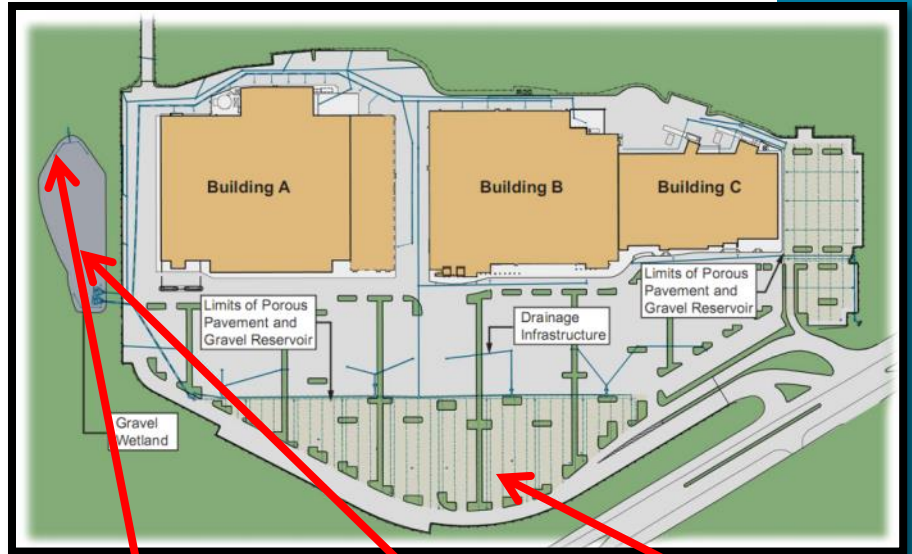
Permitting and Advanced Stormwater Management

- The use of advanced stormwater management simplified permitting (not that it was simple)
- Enabled redevelopment of an ideal property that was unattainable for 10+ years due to high bar for impaired waters



Greenland Meadows, Greenland NH

- “Gold-Star” Commercial Development
- Brownfields site, ideal location, 15yrs
- Proposed site >10,000 Average Daily Traffic count on >30 acres



Comparison of Unit Costs

		Conventional	LID	Cost
		TYPE	QUANTITY	COST
TABLE 3-3 Conventional Option Piping	Distribution	6 to 30-inch piping	9,680 linear feet	\$298,340
	Detention	36 and 48-inch piping	20,800 linear feet	\$1,356,800
		TYPE	QUANTITY	COST
TABLE 3-4 LID Option Piping	Distribution	4 to 36-inch piping	19,970 linear feet	\$457,780
	Detention*	—	0	\$0
ADDITIONAL WORK-RELATED ACTIVITY (utilities, lighting, water & sanitary sewer service, fencing, landscaping, etc.)		\$2,720,000	\$2,720,000	\$0
PROJECT TOTAL		\$10,590,300	\$9,660,300	-\$930,000

26% savings on total cost of SW infrastructure for a ~zero discharge site

Cost of Doing Business

- TT routinely designs franchise stores that are more expensive to build and operate
- Advanced proprietary stormwater management is more costly than LID
- Space is a premium and SWM that is less space intensive is preferred
- Cost is passed onto owner/operator/consumer
- Commercial real estate can be very profitable



Avoid Stormwater Utility Fees

- The property owner controls a similar site in South Portland ME
- The Maine Mall has a stormwater utility fee to support their NODES permit of \$3,000 per impervious acre per year.
- Impervious cover charge avoidance of ~\$80,000 year.



Long-Term Operations and Maintenance

- Operations manager is very pleased with 3 season operation
- Target requires nightly sweeping for aesthetics
- Still adjusting to winter maintenance—sees benefits and is making use of them
- Long-term operations is excellent

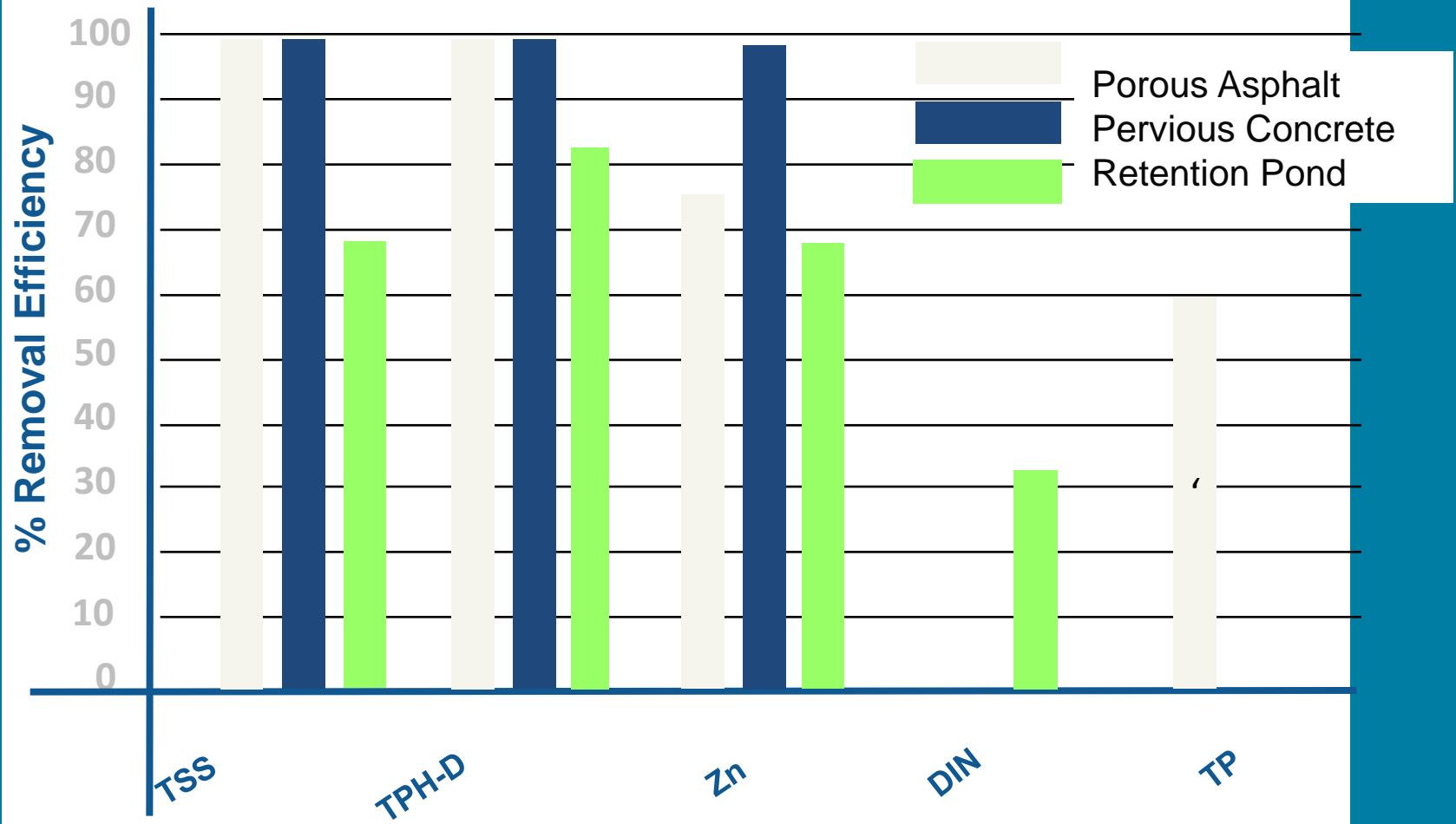




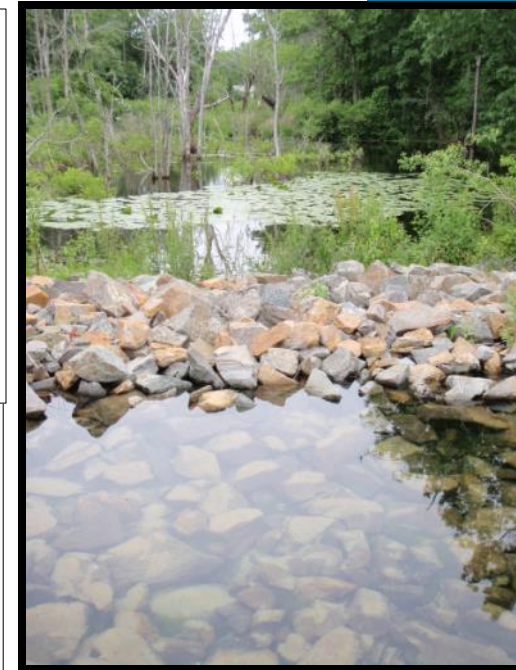
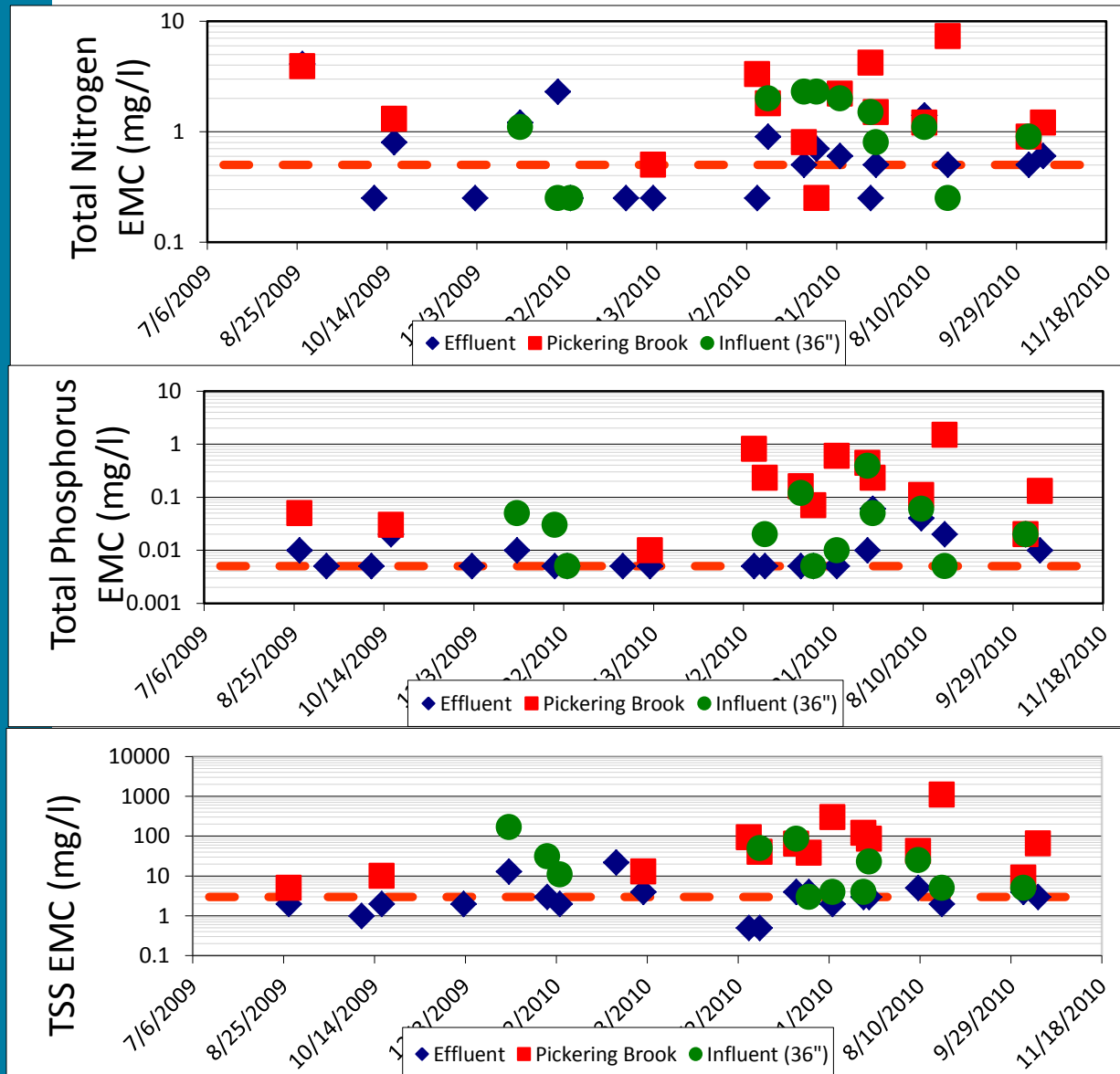
6 years post installation, November 17, 2014



Porous Pavements and Pond Water Quality

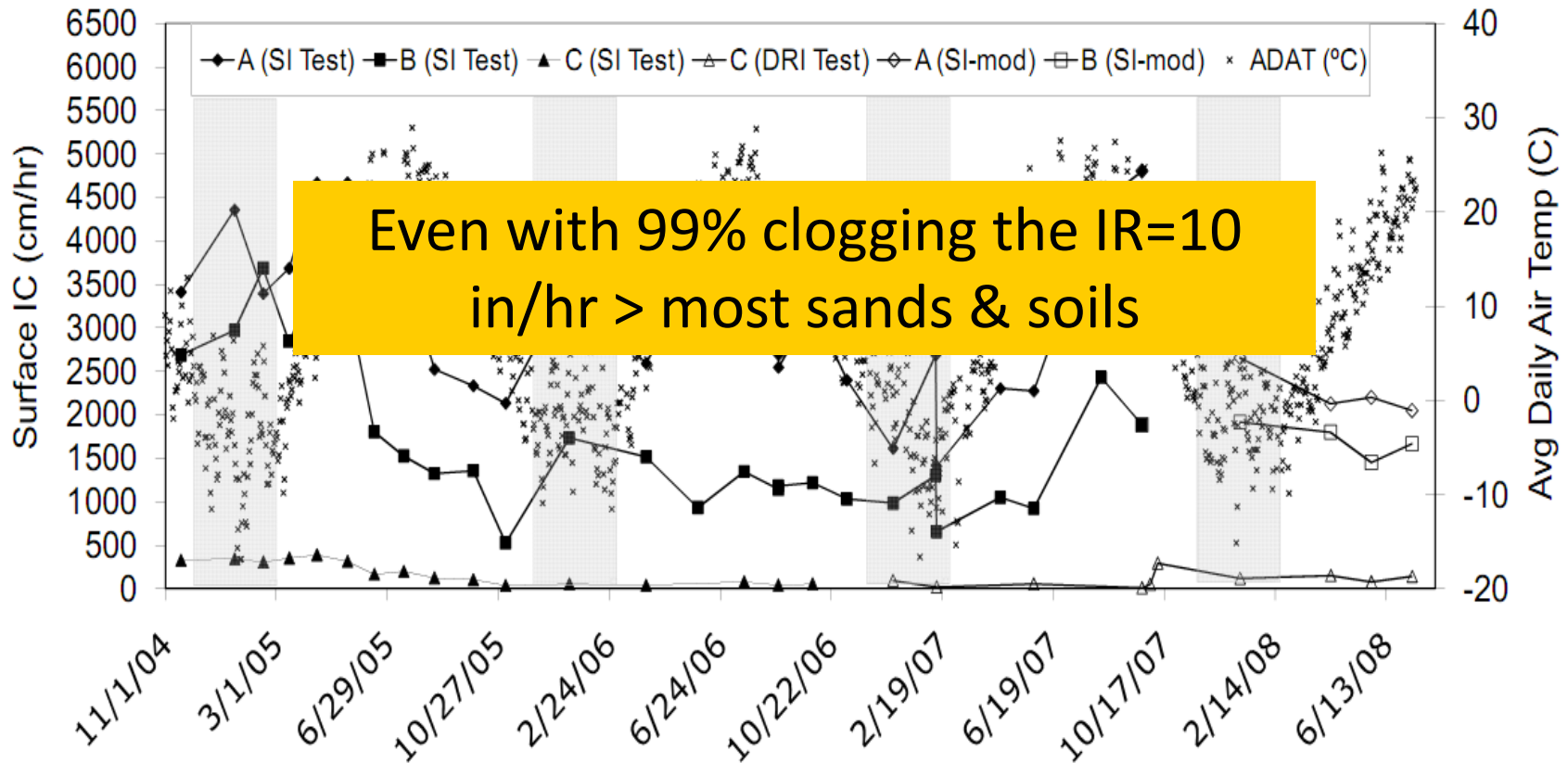


Discharge to Impaired Waters



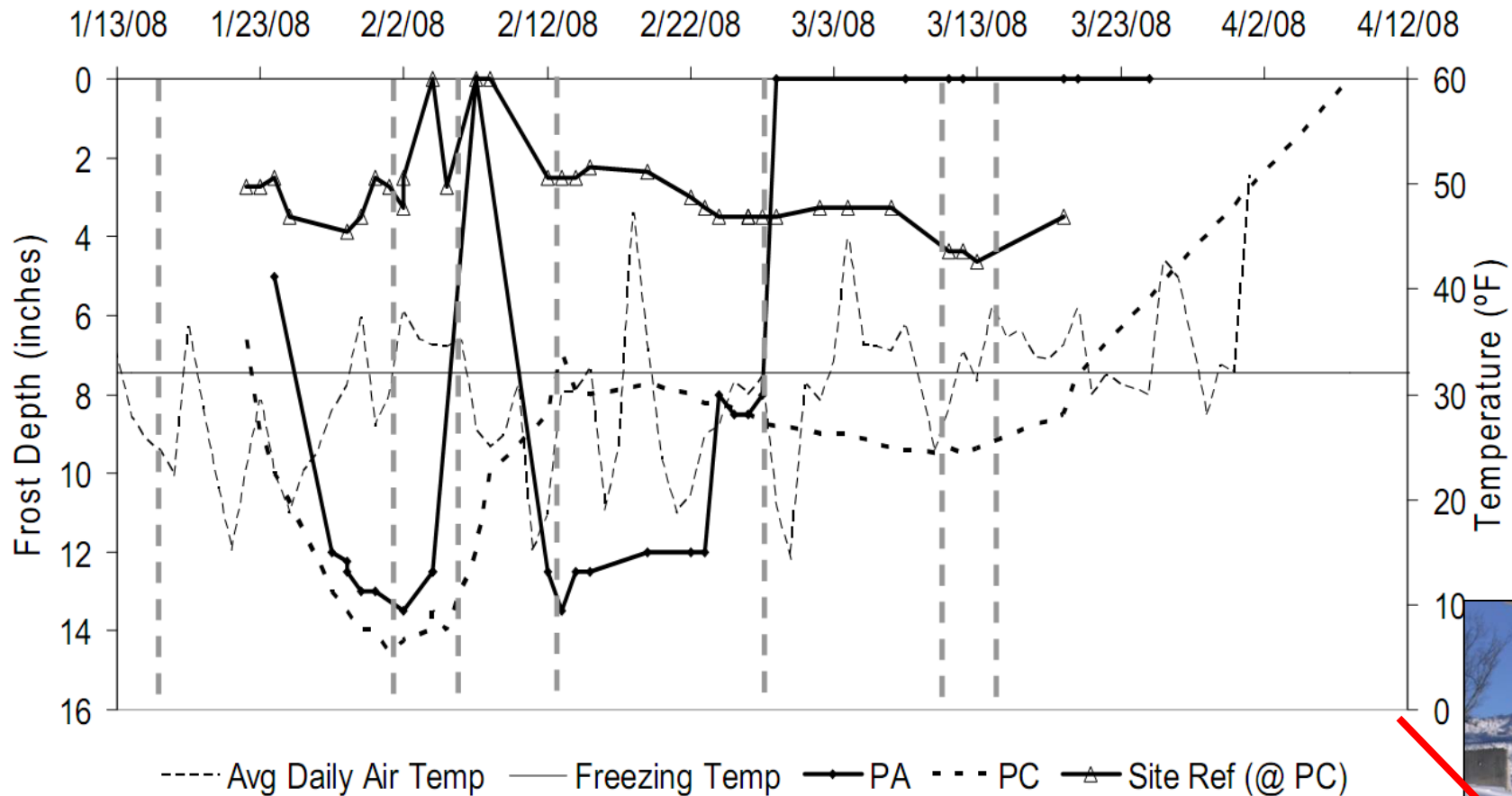
**Cool clear
baseflow
that
discharges
for up to 4+
days after
storm**

Porous Asphalt Surface Infiltration Rates

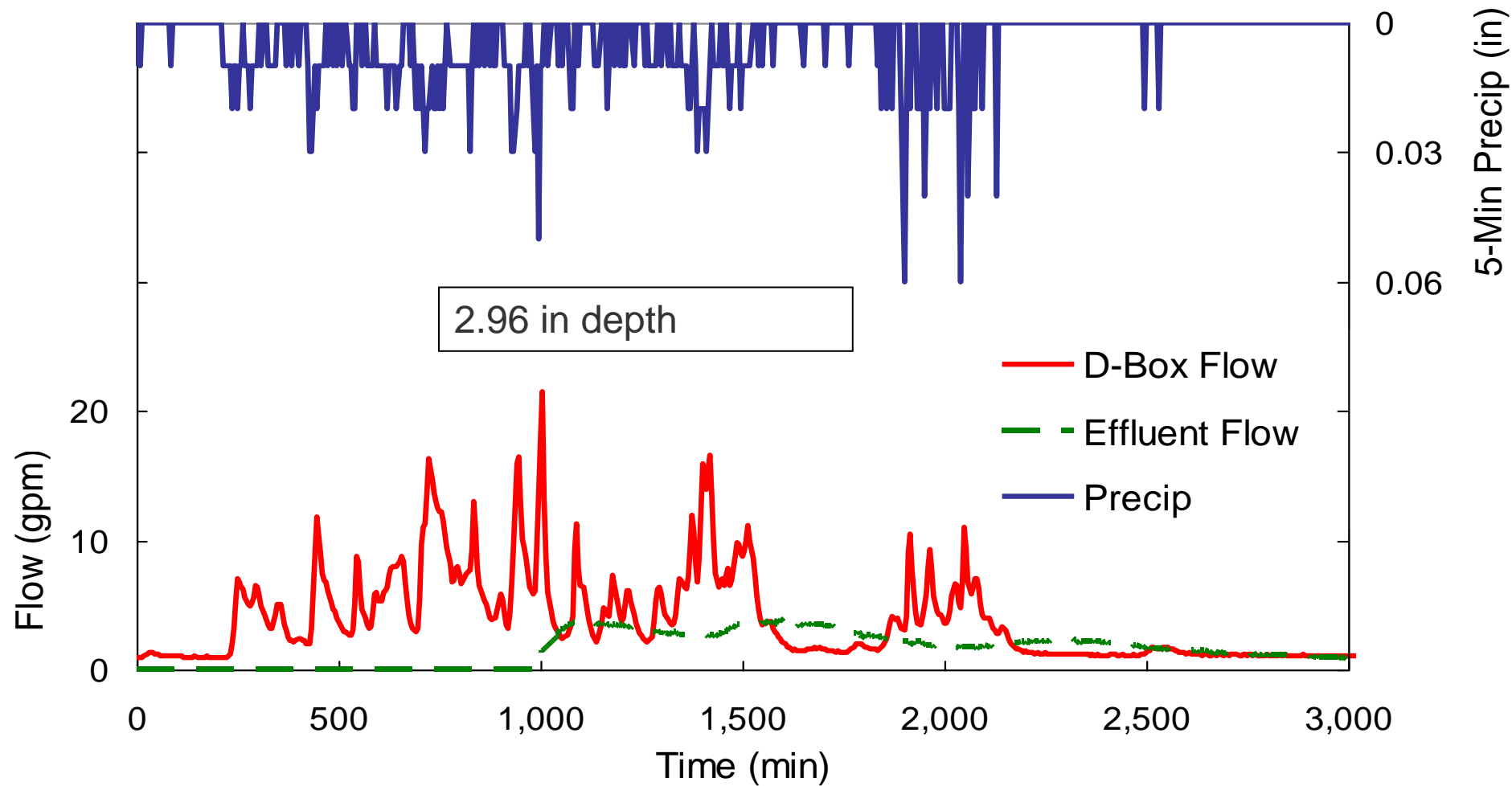


- Worst case scenario, no maintenance performed for 3 yrs
- Certain areas have reduced IC (drive lanes) while parking areas remain unchanged

Porous Asphalt Frost Penetration

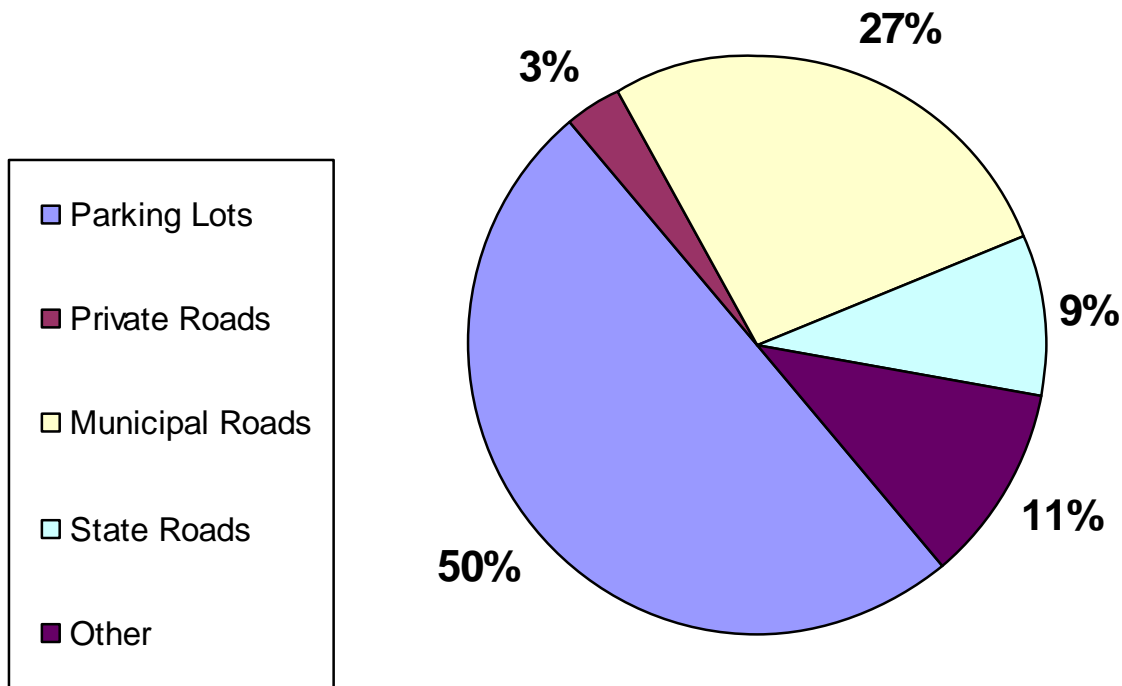


Flow Attenuation

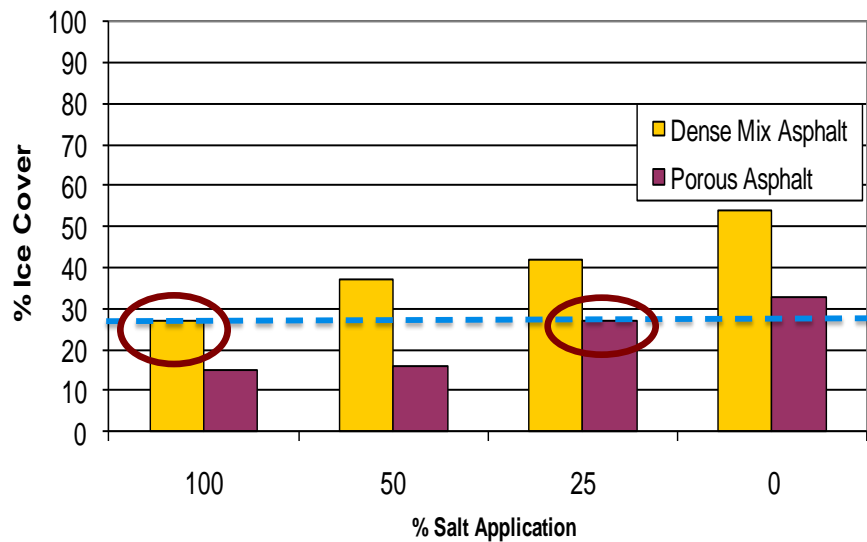


How to Manage Salt Reductions to Balance with Public Safety

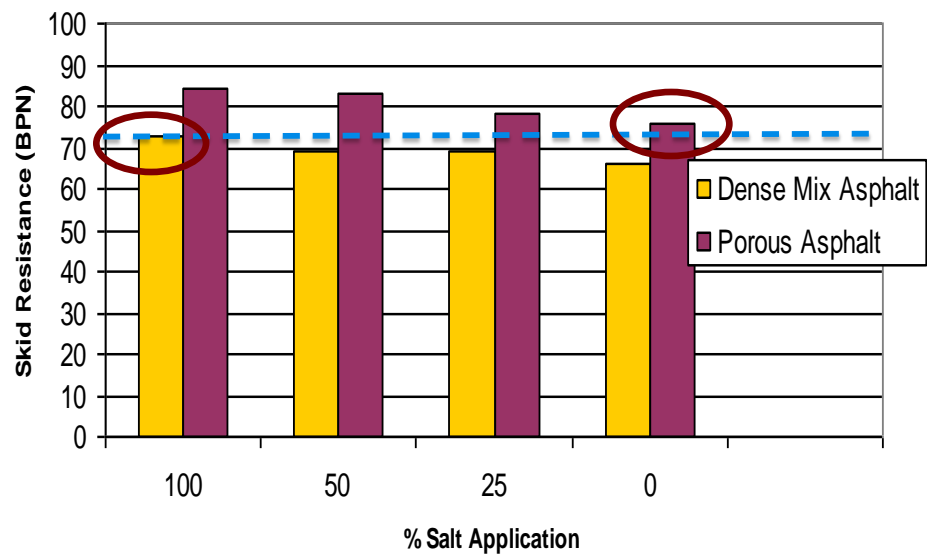
**Sources of Salt Loading
From Vehicular Surface Deicing
(Rockingham County, NH)
(NHDES 2007)**



% Ice Cover



Weighted Skid Resistance (BPN)



Effective Salt Reductions

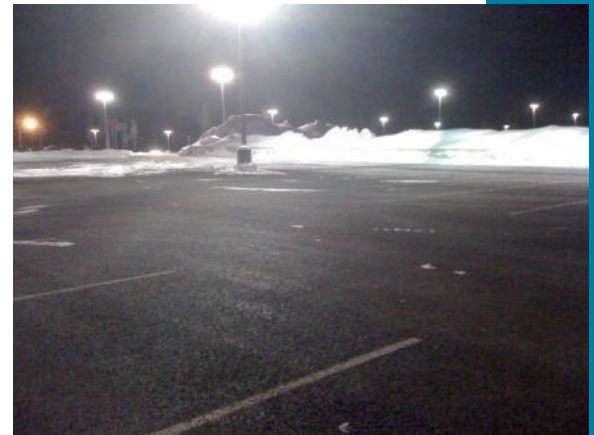
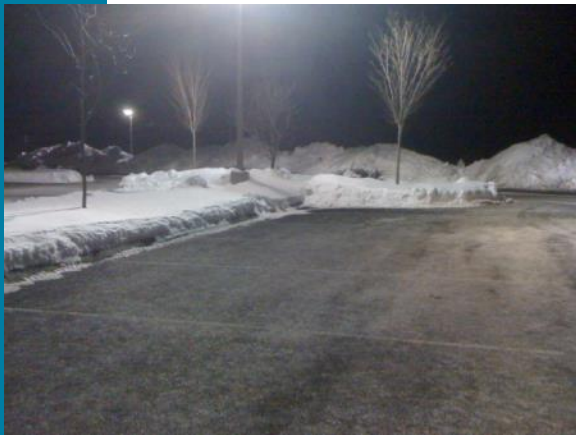
Pavement Type	2006-2007		2007-2008		Reductions when compared to DMA 100% App. Rate	
	Anti-Icing Apps.	Deicing Apps.	Anti-Icing Apps.	Deicing Apps.	App. Rate	Average Mass Reduction * ('06-'08)
DMA	15	14	23	22	100%	0%
PA	15	6	23	27	25%	75%

* Reduction possible with no loss in skid resistance (safety)

Winter Performance and Black Ice



Standard Asphalt HEAVY salt usage and black ice formation, Jan 23, 2011



**Porous asphalt modest salt and very little black ice , Jan 23, 2011;
*note use of PA as snow dump because of positive drainage**

Pavement Durability



Damage may occur and maintenance is typical



June 2010 Conditions, Standard (left), Concrete (middle), Porous (right)

Thank you

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Geosyntec
consultants

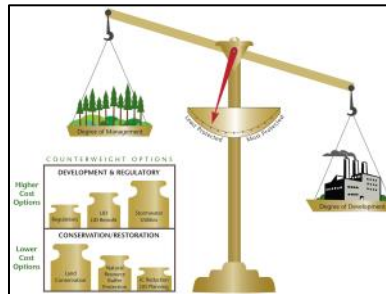
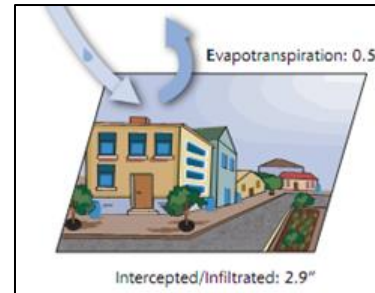
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Summary Conclusions

- Substantial frost penetration is observed
- Melt-water thaws open-graded frozen filter media
- Hydraulics are minimally affected by freezing
- Surface infiltration capacity of pervious pavements is minimally affected by freezing



Green Is Good for Business

- LID project costs are often lower from 6% in residential developments to as high as 26% in commercial projects.
- Municipal use of GI reported cost reductions of 21% to as high as 44%.
- Reduced flood damage and increased resiliency of drainage infrastructure.
- Reductions of 33 to 50% in energy demands for heating and cooling.
- A 50% reduction in time to sale, and increased property values of 12-16%.
- Reduced time to permitting
- Impervious cover charge avoidance--@ \$3,000 per impervious acre, this site would be ~\$80,000 year

Winter Maintenance Guidance

- Salt reduction potential will be site specific and vary depending on shading and climate.
- Plow after every storm.
- Apply anti-icing treatments prior to storms. Anti-icing has the potential to provide the benefit of increased traffic safety at the lowest cost and with less environmental impact.
- Deicing is NOT required for black ice development.
- Apply deicing treatments during, and after storms as necessary to control compact snow and ice not removed by plowing. Excess may be required.

Winter Maintenance Guidance

- Mixed precipitation and compact snow or ice is particularly problematic for porous surfaces. This is prevented by appropriate plowing and corrected by application of excess deicing chemicals.
- In certain instances of compact snow and ice, excess salt may be required, however loading is offset by the overall reduced salt during routine winter maintenance and salt reduction.
- With good sun exposure some porous asphalt installations will require no deicing.
- Porous asphalt provides exceptional treatment for rain on snow events which commonly result in dangerous refreezing

PA Winter Infiltration



REFERENCES

Roseen, R. M., Ballesterro, T. P., Houle, K. M., Heath, D., and Houle, J. J. (2013-In review). "Assessment of Winter Maintenance of Porous Asphalt and Its Function for Chloride Source Control." *Journal of Transportation Engineering*.

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