Winter Performance and Maintenance of Porous Asphalt Pavements

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4Th Annual Lamprey River Symposium
University of New Hampshire
Friday January 7th, 2011

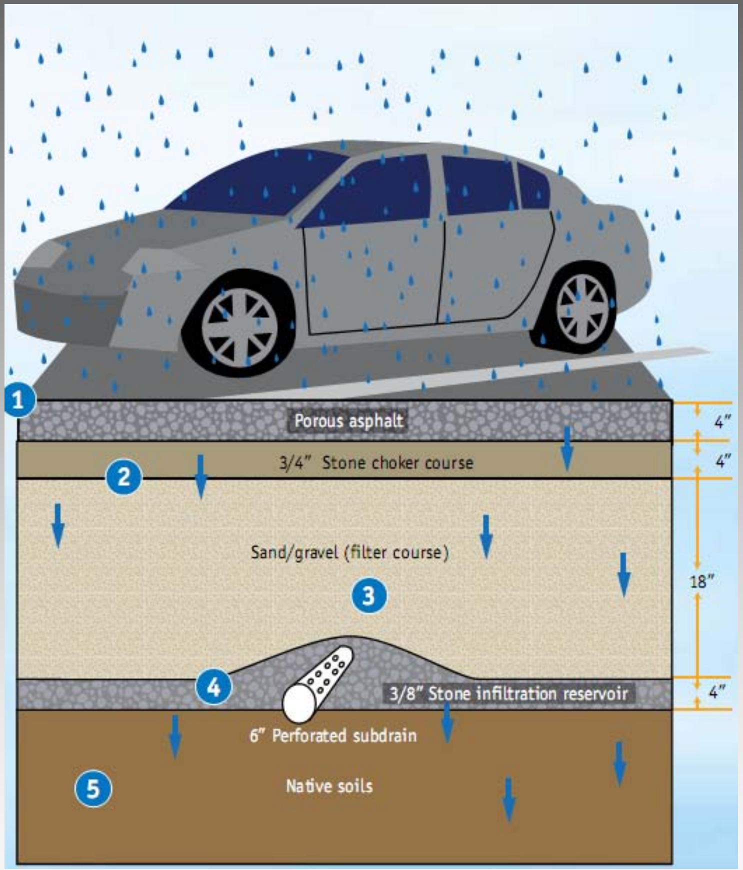
University of New Hampshire Stormwater Center
Department of Civil Engineering, University of New Hampshire

Objective

Pervious pavements for new and redevelopment are a watershed-based strategy that can both mitigate impacts for new development and reverse impacts in areas with redevelopment.

Porous Asphalt Design Overview

- Porous pavements for new and redevelopment are a watershed-based strategy that can both mitigate impacts for new development and reverse impacts in areas with redevelopment.
- Porous asphalt systems combine stormwater infiltration, storage, and structural pavement in a single system.
- PA consists of a pavement surface underlain by a stormwater storage bed. The bed is usually placed on uncompacted soil to facilitate infiltration.



Porous Asphalt Residential Lane, Pelham, NH (Source: UNHSC)

Parking Lot with Standard Aisle and Porous Asphalt Stalls, Morris Arboretum, Philadelphia, PA (Source: CH2M HILL)

Porous Asphalt Path, Grey Towers National Historic Site, PA (Source: CH2M HILL)

Porous Asphalt Commercial Parking Lot, Greenland Meadows, Greenland, NH (Source: UNHSC)

Porous Asphalt Section of State Highway, South Portland, ME (Source: ME DOT)

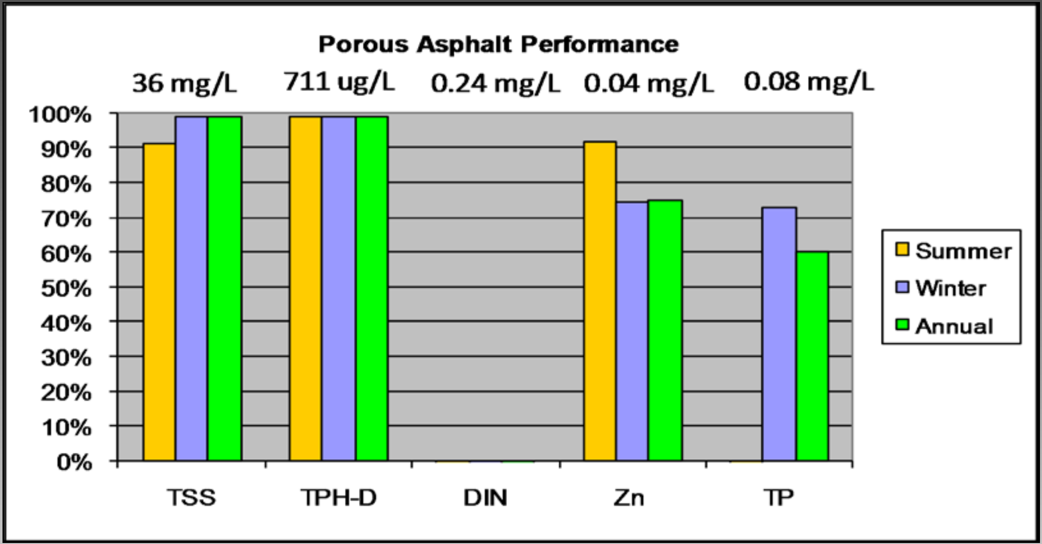
Porous Asphalt Basketball Court, Upper Darby, PA (Source: CH2M HILL)

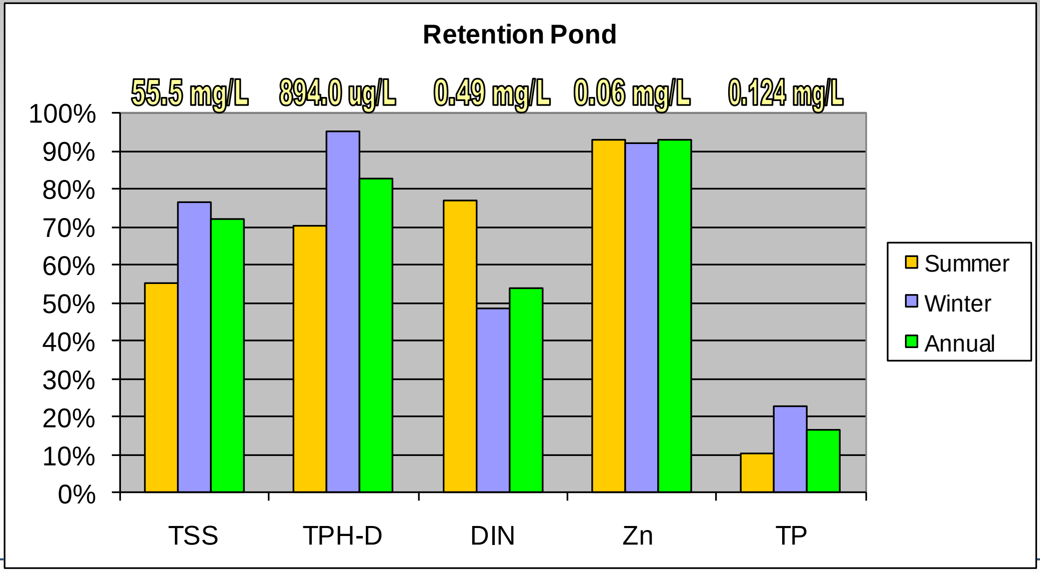
State of the Practice

- Water quality performance is strong to excellent depending on design
- Hydraulic performance is excellent
- Cold climate performance is strong
- Winter maintenance has tremendous potential salt reduction
- Design specifications are improving
- Construction and installation are developing

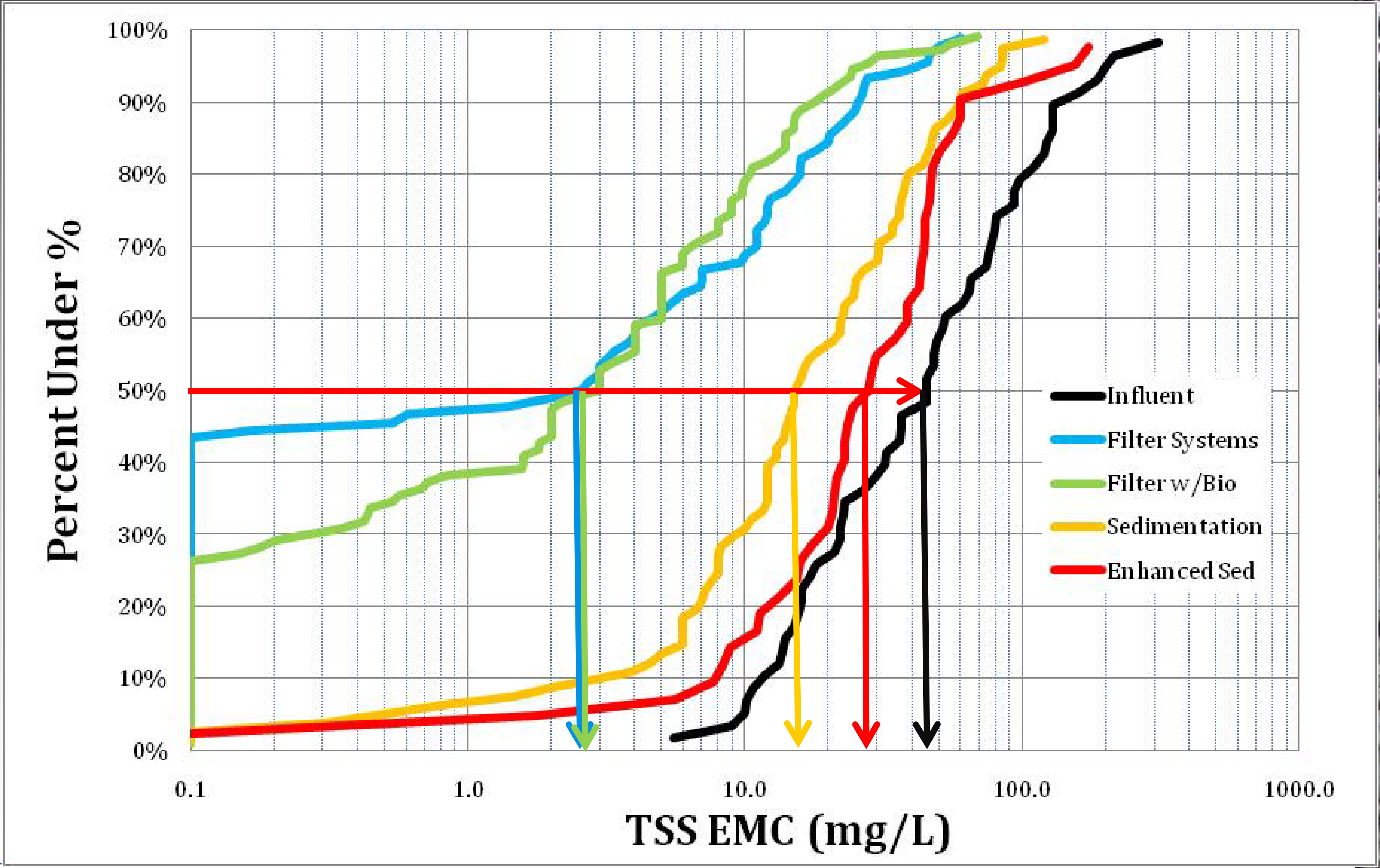
Water Quality Performance Results

Seasonal Performance Efficiencies





TSS Removal Performance



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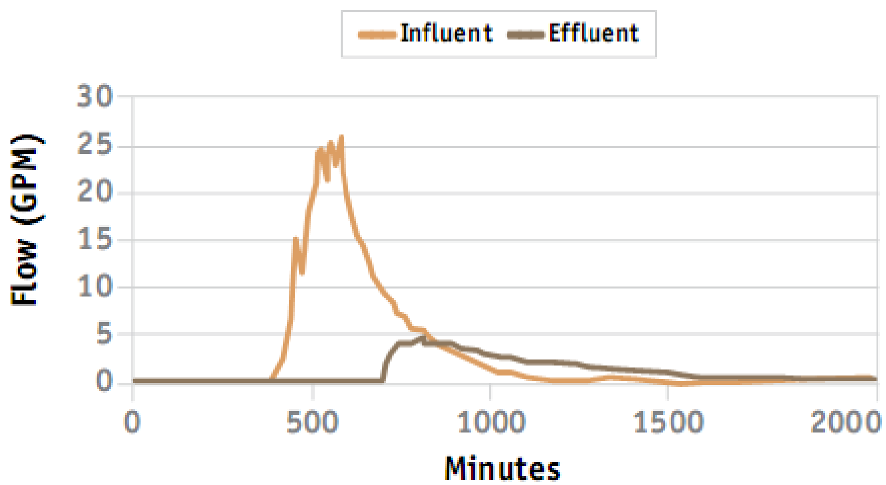
Hydrologic Performance Results

Hydraulic Performance of Porous Pavements

Porous Asphalt (HSG-C)

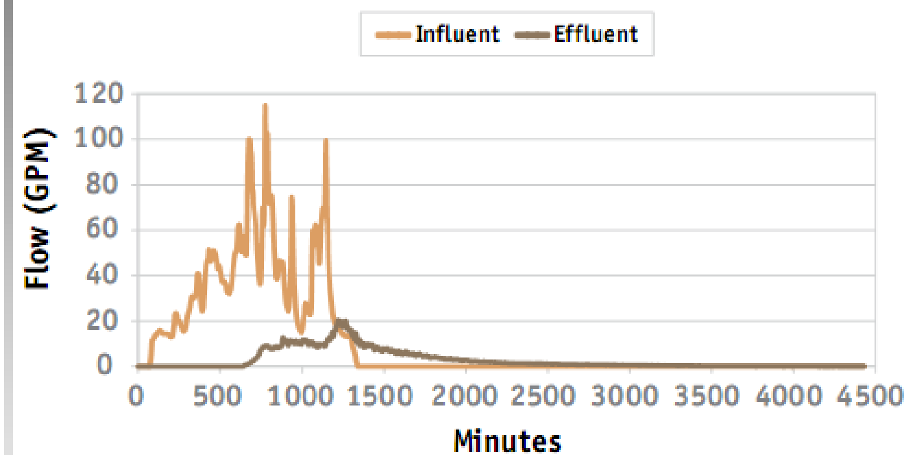
HYDRAULIC PERFORMANCE



	Winter	Summer	Annual Average
Average Peak Flow Reduction	76%	86%	82%
Average Lag Time (minutes)	1,163	1,375	1,275

Pervious Concrete (HSG-B)

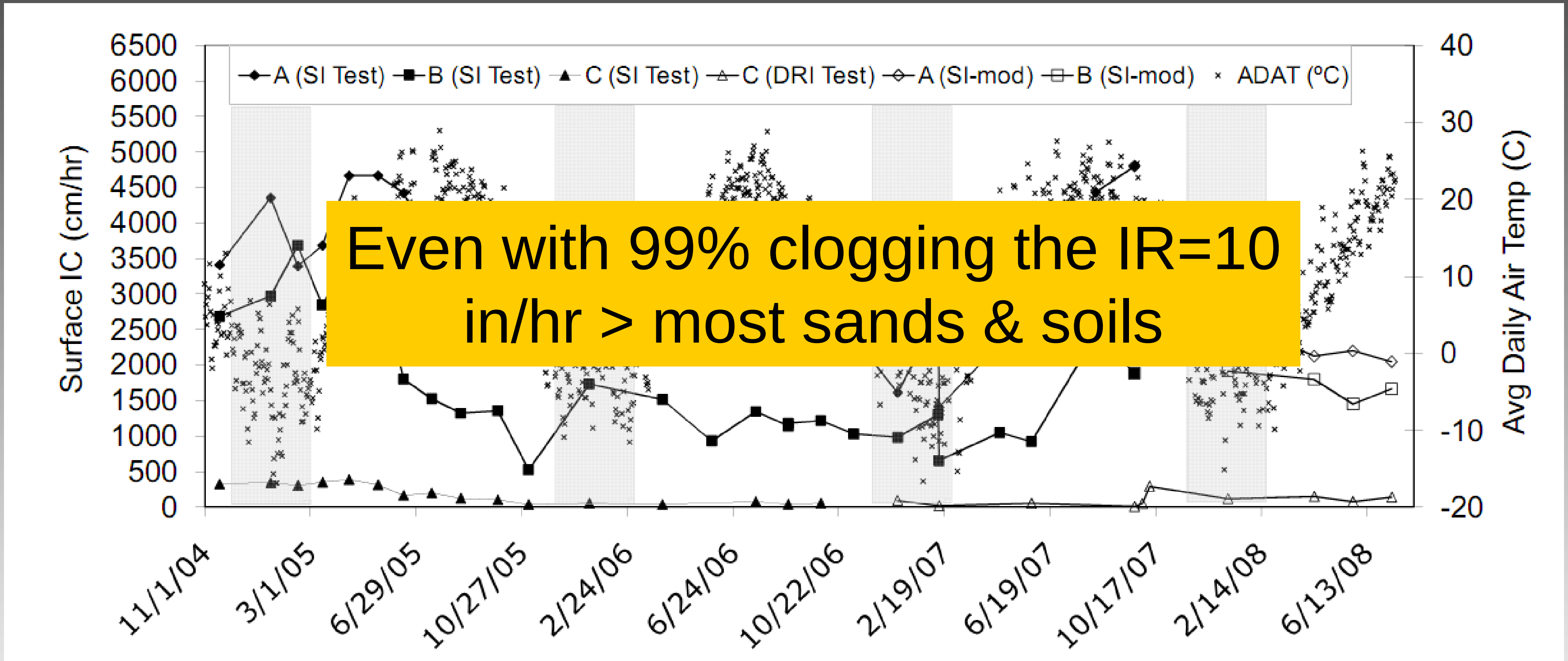
HYDRAULIC PERFORMANCE



	Winter	Summer	Annual Average
Average Peak Flow Reduction	88%	97%	93%
Average Lag Time (minutes)	848	1,365	1,144
Average Volume Reduction	91%	98%	95%

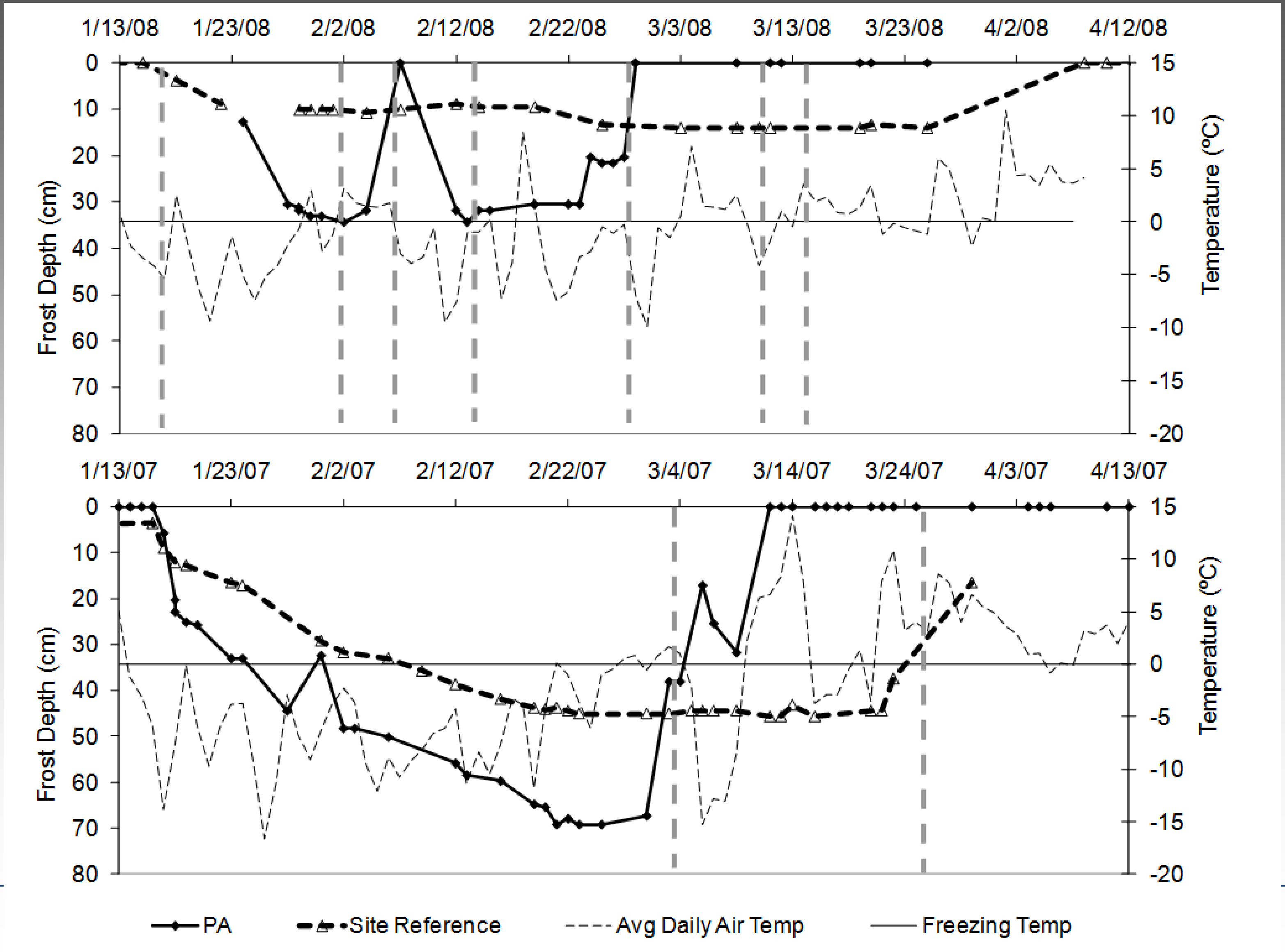
Cold Climate Performance Results

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
- Low maintenance sensitivity due to excess infiltration capacity
- Clogged areas can drain to adjacent unclogged areas

Porous Asphalt Frost Penetration



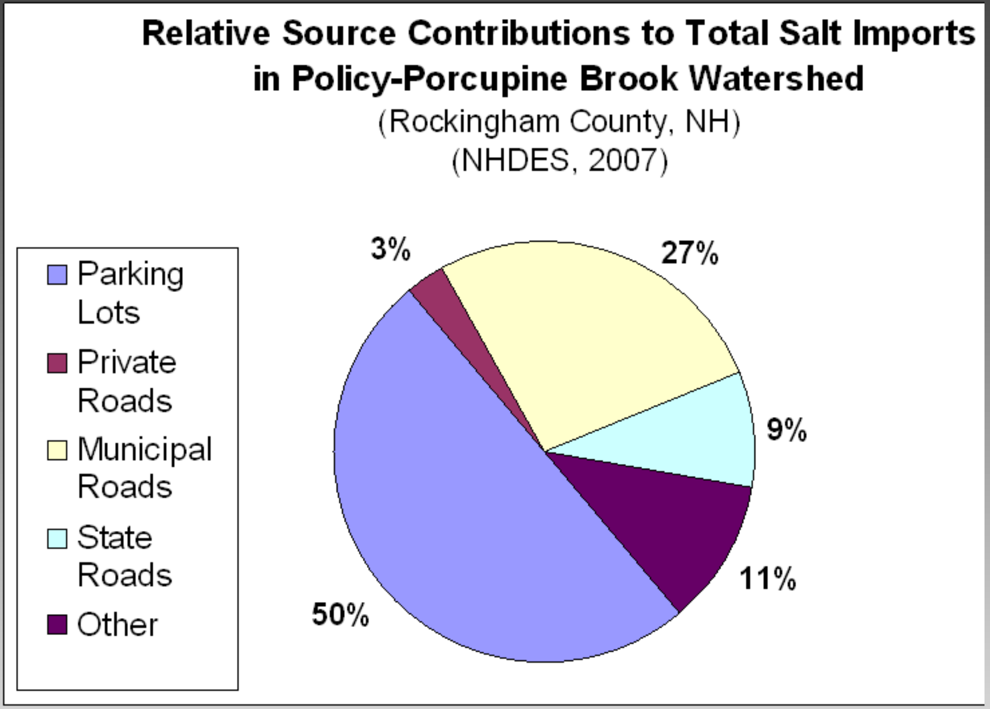
Winter Maintenance & Salt Reduction

Challenges

- Balance of liability and water quality
- Different levels of liability exposure based on usage
- Challenge of Zero Ice tolerance
- Porous asphalt is not a silver bullet

Why are we concerned about chloride ?

- No stormwater treatment removes chloride
- 6 chloride TMDLs nationwide
- Usage is on the rise
  - Need for public safety
  - Presumably because 80% TSS reduction is easily achieved by replacing sand with chloride
- Some DOT's use a 100% salt mix



Source: Trowbridge (2007); Sassan and Kahl, (2007): Beaver Brook and Policy Brook I-93 Chloride TMDL; Road salt loading by source, assuming a rate of 6.4 tons/acre/year for parking lots and driveways, and a rate of 17.8 tons/lane mile/year (average annual rate) applied to public and private roads. Most residential driveways are excluded from this calculation.

PA/DMA Snow & Ice Cover

Lots one-hour after plowing, -4*C (11AM on 2/3/07)

PA/DMA Snow & Ice Cover

Conditions after thawing and subsequent refreezing (9AM on 3/18/07)

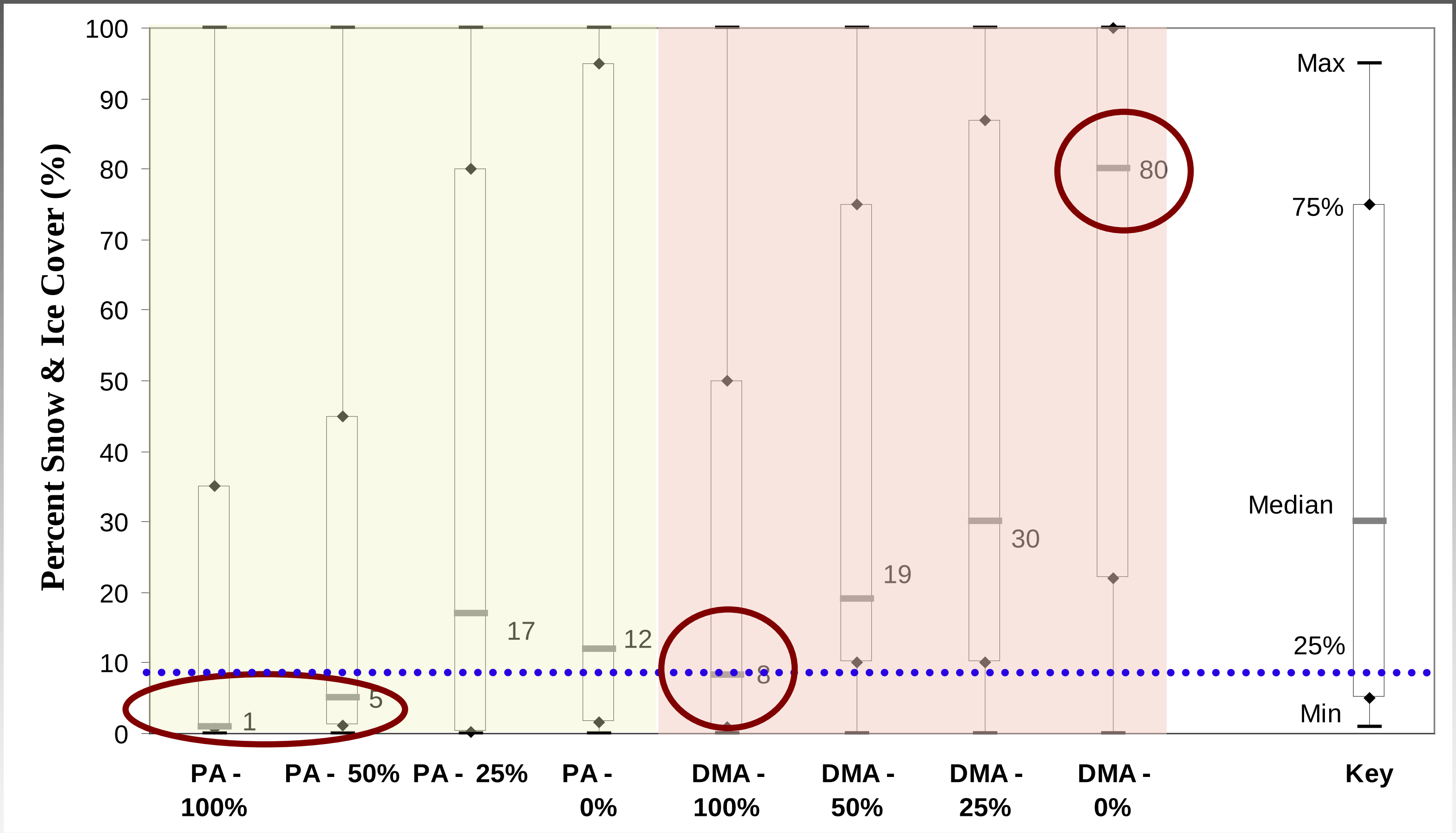
- No black ice formation on PA

PA/DMA Freezing Rain

DMA after spring rain on snow event

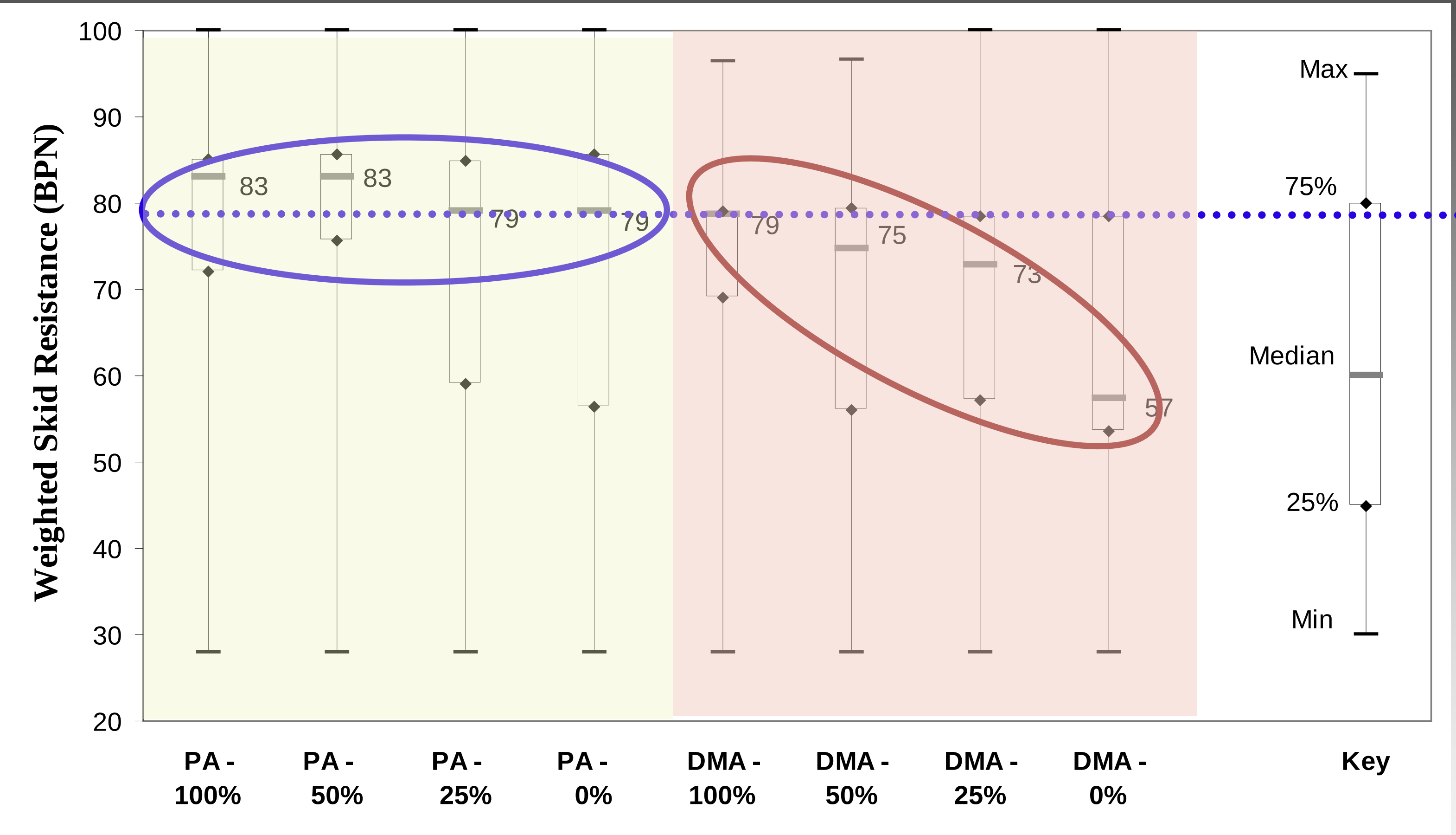
PA after spring rain on snow event

Comparison of snow/ice percent cover for study areas on all lots (winter '06-'07)



- More snow & ice present on DMA

Weighted skid resistance values as a function of surface cover for all pavement types ('06-'07)



- Weighted SR as a measure of safety
- Higher BPN = safer pavement

Effective Salt Reductions

Pavement Type	2006-2007		2007-2008		Reductions Possible when compared to DMA with 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%
PC - shade	-	-	23	31	100%	-20%
PC - sun	-	-	23	23	100%	-2%

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

Winter Maintenance Guidance

- Salt reduction potential will be site specific and vary depending on shading, climate, and hours of operation.
- 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

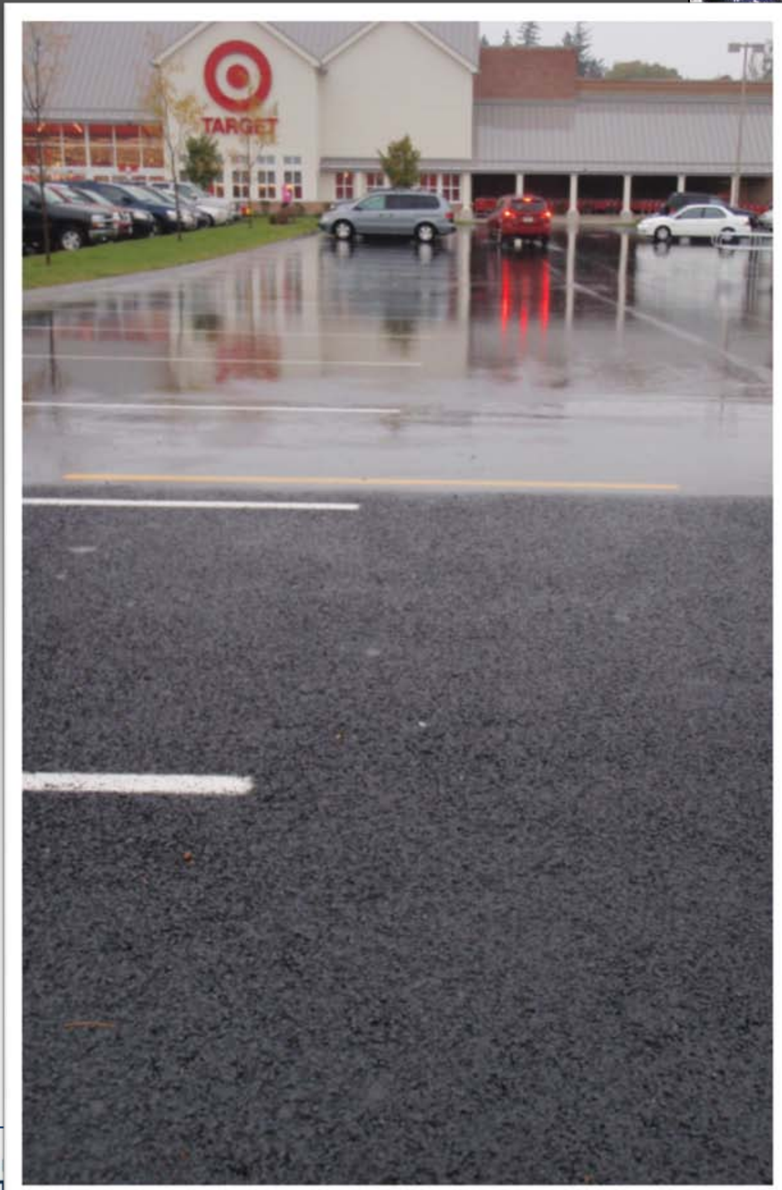
Future Research Needed

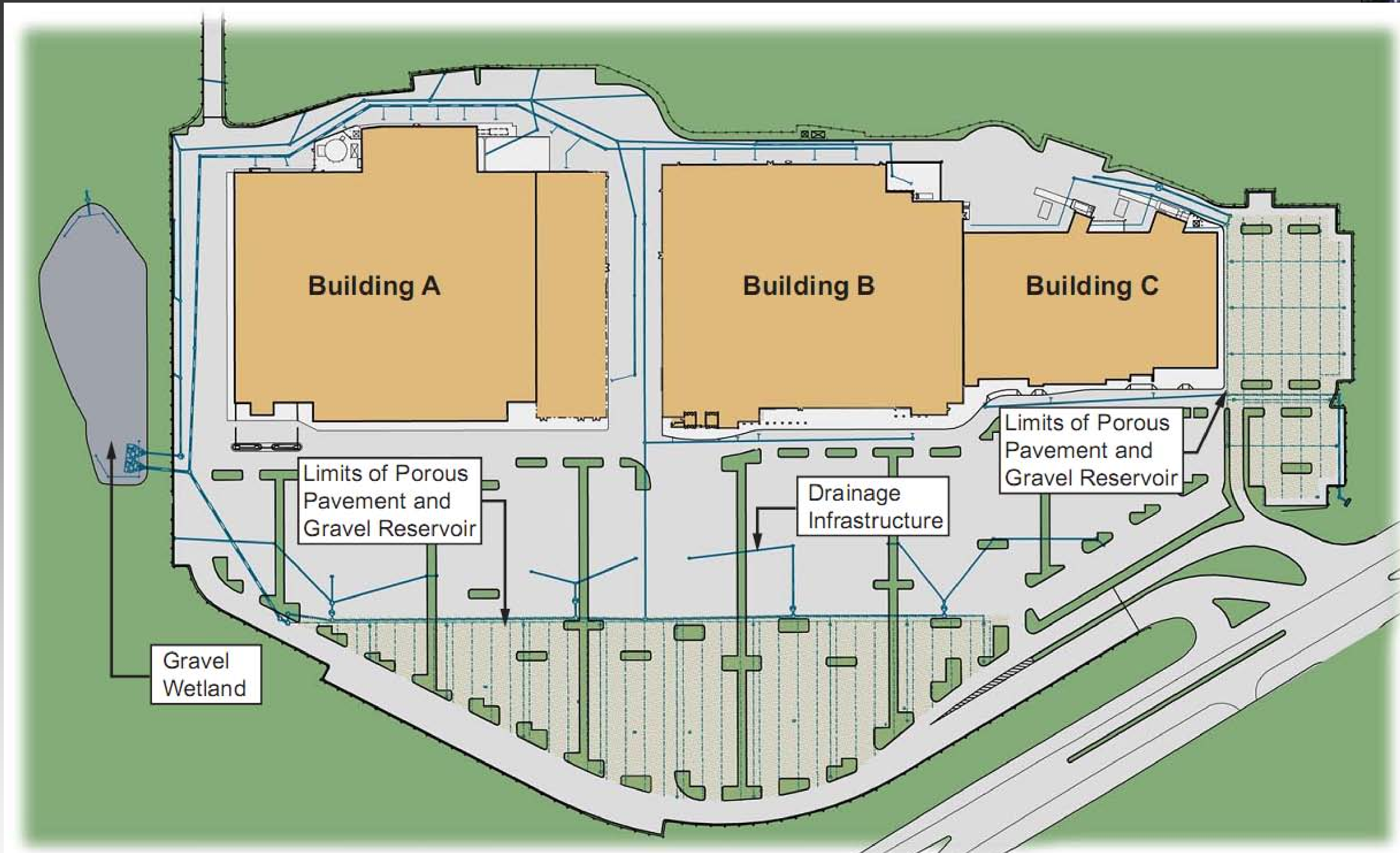
- Additional research is needed to examine salting loading at high loading rates common to commercial applications
- MN Recommended application rates of 3lbs per 1000 square feet appear to be exceptionally low in comparison to commercial rates.

Example Sites in the Northeast

Greenland Meadows Commercial

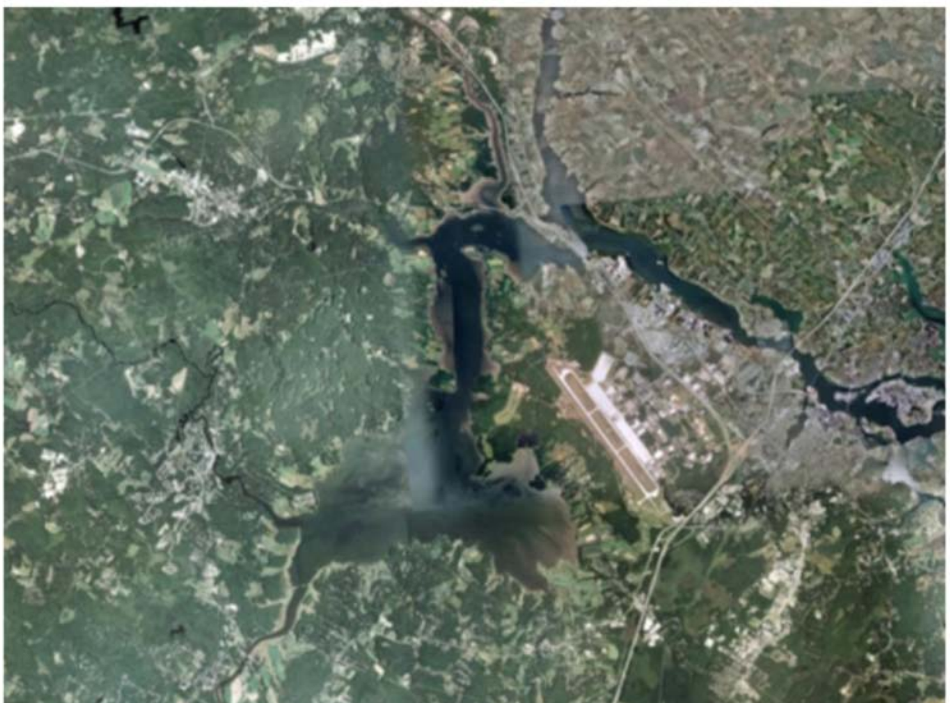
- "Gold-Star" Commercial Development
- Cost of doing business near Impaired Waters/303D
- Saved $930,000 on total cost of SWM (26%), on drainage, and MTD
- Brownfields site, ideal location, 15yrs
- Proposed site >10,000 Average Daily Traffic count on >30 acres





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






Boulder Hills, Pelham, NH

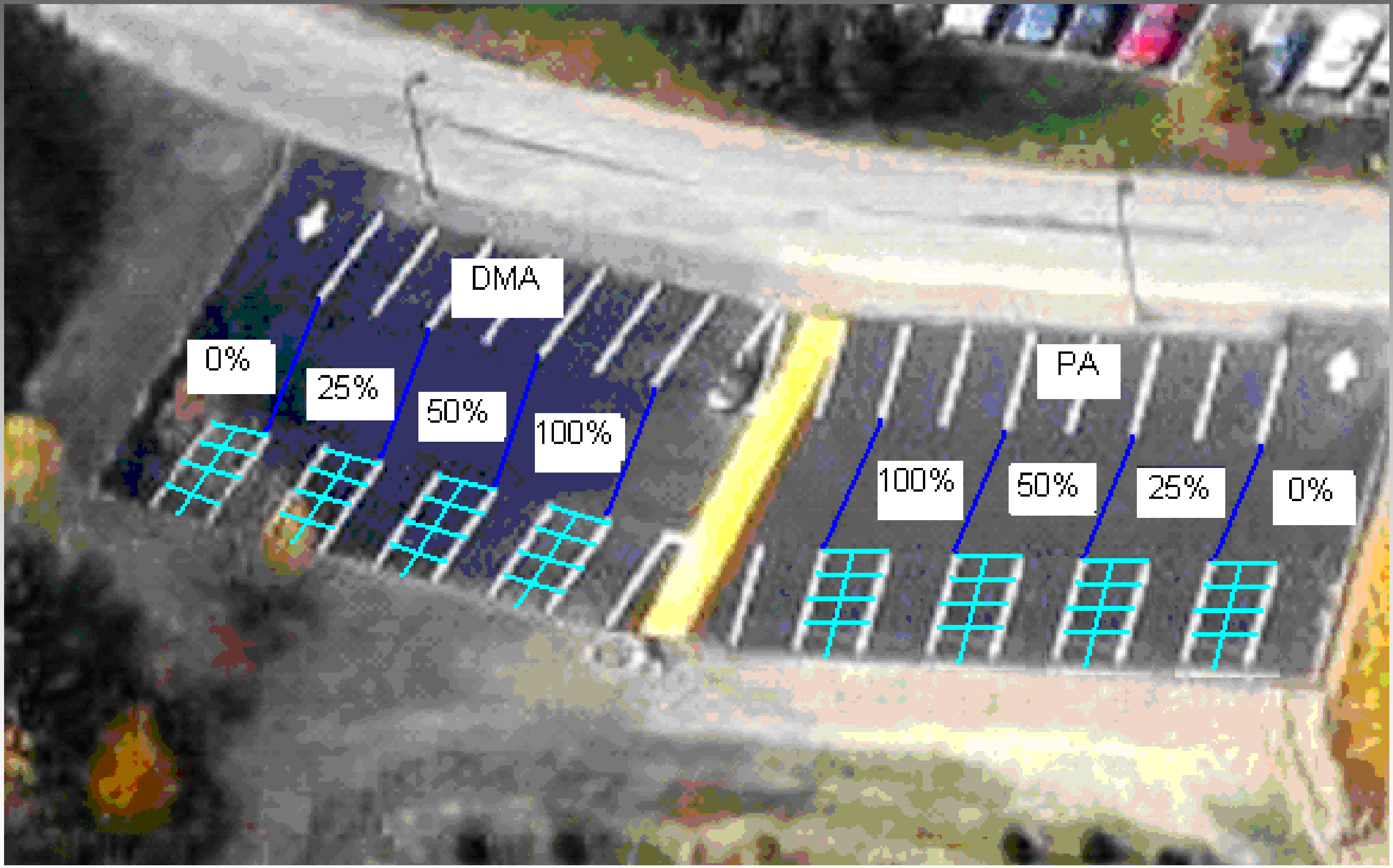
- 2009 Installation of 900’ of first PA private residential road in Northeast
- Site will be nearly Zero discharge
- LID subdivision 55+ Active Adult Community
- Large sand deposit
- Cost 25% greater per ton installed

Acknowledgements

- Jeff Pochily, David Duncan, Mary Wescott, Pike Industries
- Andrew Potts, P.E., LEED AP, Water Resources Project Manager, CH2M HILL
- ASCE Committee Report on Recommended Design Guidelines for Permeable Pavements—Late 2010
- Bethany Eisenberg, VHB, Committee Chair
- Kelly Collins, CWP, Committee Vice Chair
- National Asphalt Pavement Association (NAPA): Information Series (IS)-131 Porous Asphalt Pavements (2008)
- NAPA IS-115 Open-Graded Friction Courses (2002)


Questions?

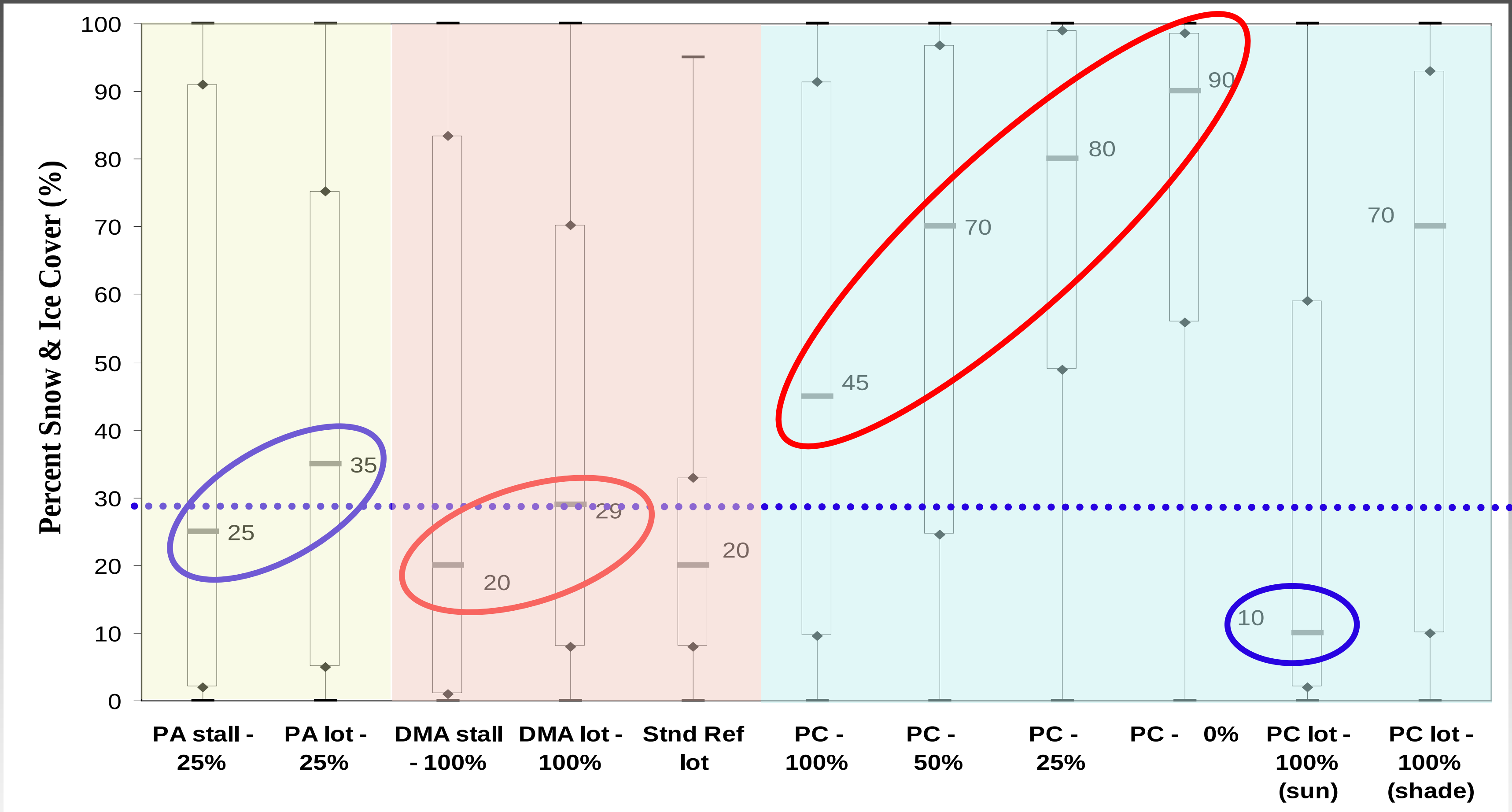
PA Study Area Orientation



Measuring Skid Resistance w/ BPT

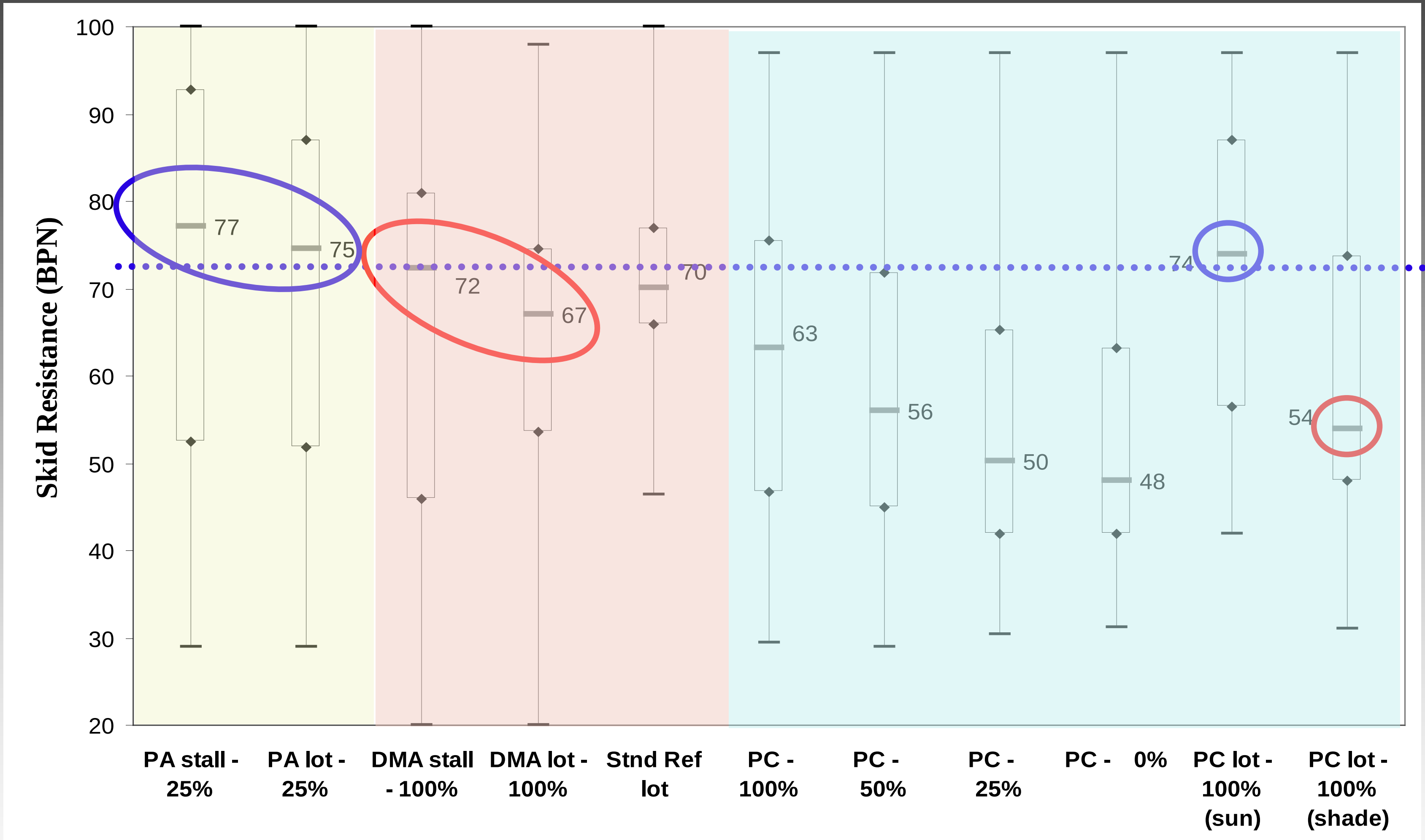
ASTM STANDARD E303-93

Comparison of snow/ice percent cover for study areas on all lots (winter '07-'08)



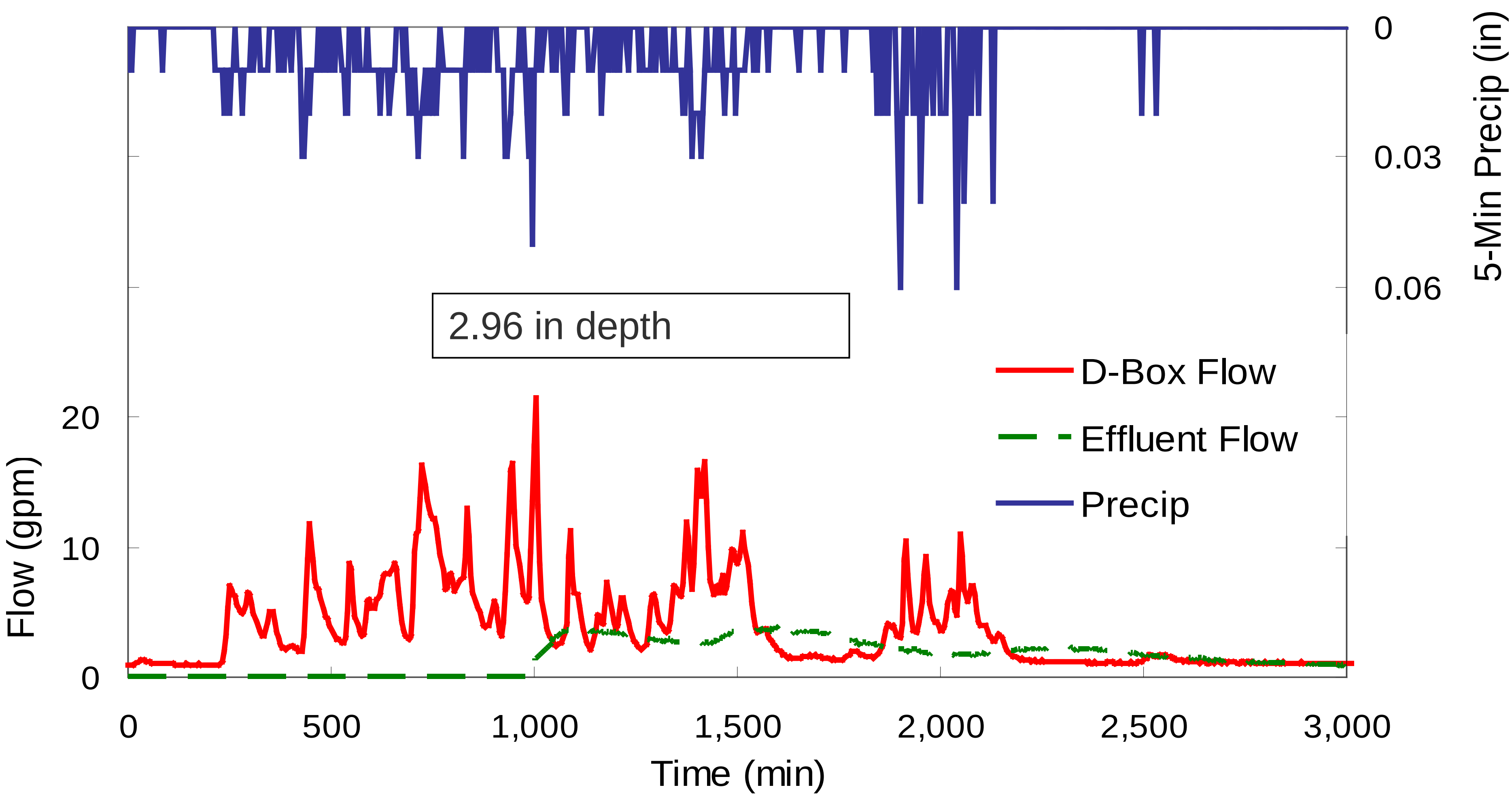
- Snow and Ice Cover is comparable for PA 25%, PC 100% (full sun) and DMA 100% application
- PC does poorly in shaded areas for deicing—no issue for most commercial apps

Weighted skid resistance values as a function of surface cover for all pavement types ('07-'08)



- Skid resistance is higher for all conditions for PA
- PC has higher skid resistance (sun only) and is very sensitive to sun exposure

Flow Attenuation



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