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# Assessing Maintenance Techniques to Restore the Hydraulic Function of Permeable Pavements

## Évaluation des techniques d'entretien pour restaurer la fonction hydraulique des chaussées perméables

Ryan Winston, Ian Simpson, & Andrew Tirpak

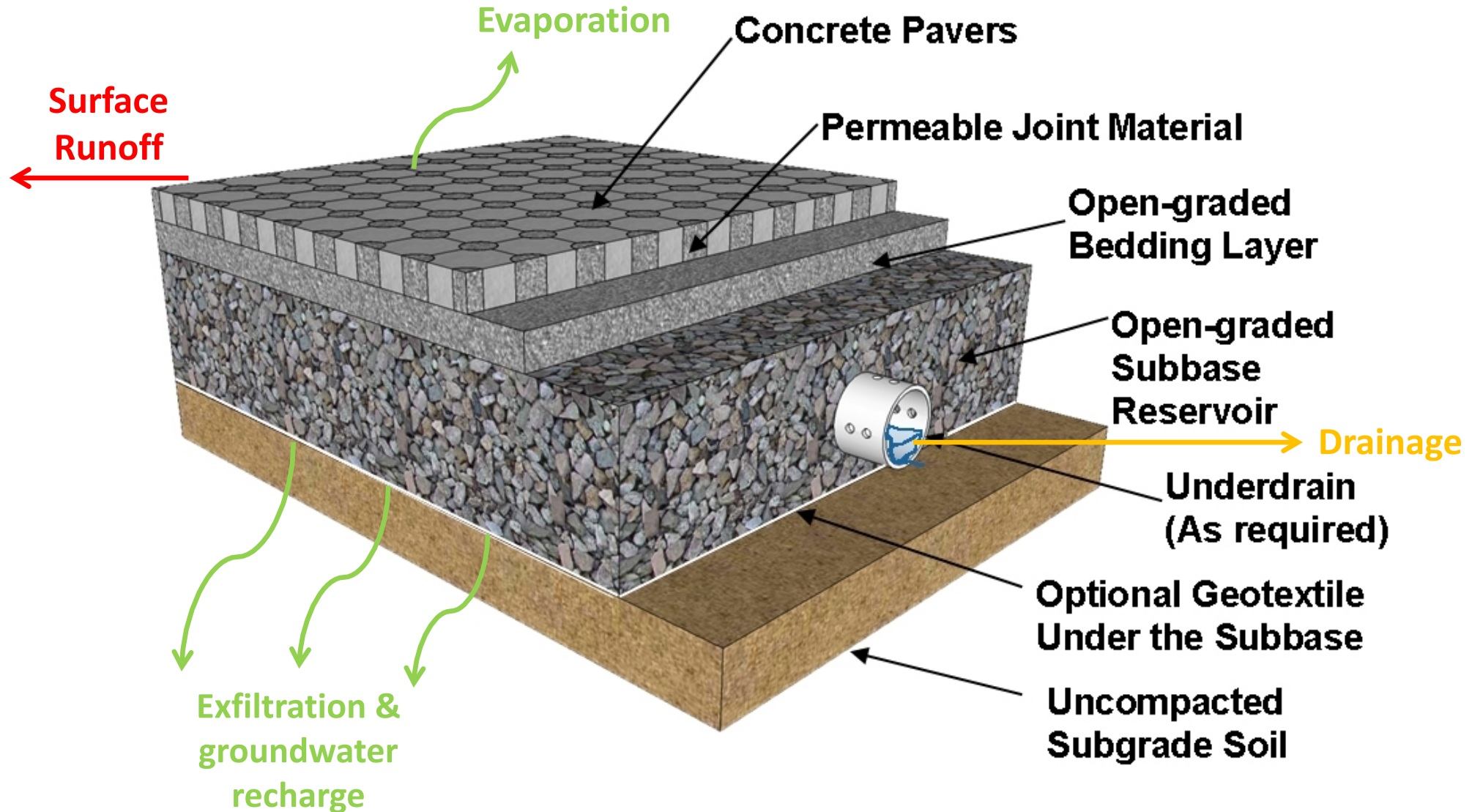
Food, Agricultural, and Biological Engineering

Ohio State University



THE OHIO STATE UNIVERSITY  
Stormwater Management Program

# Permeable Interlocking Concrete Pavements

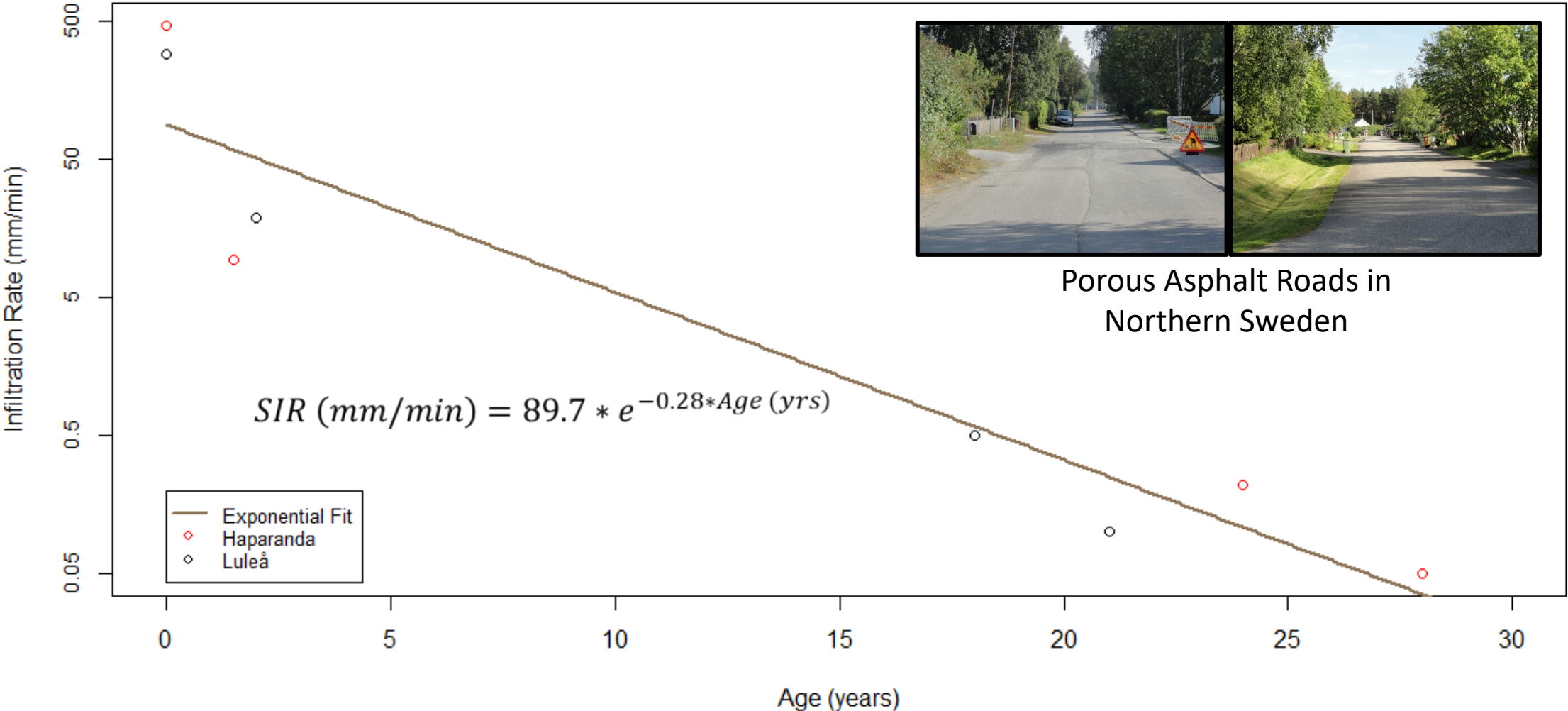


# When New, Infiltration is High

Newly installed pavements have surface infiltration rates of  $\sim 200\text{-}400$  mm/min



# Previous Research: What Happens without Maintenance?



Winston et al. (2016) – *Journal of Environmental Management*

# Research Goals



Expand understanding of various maintenance techniques & confirm performance of others



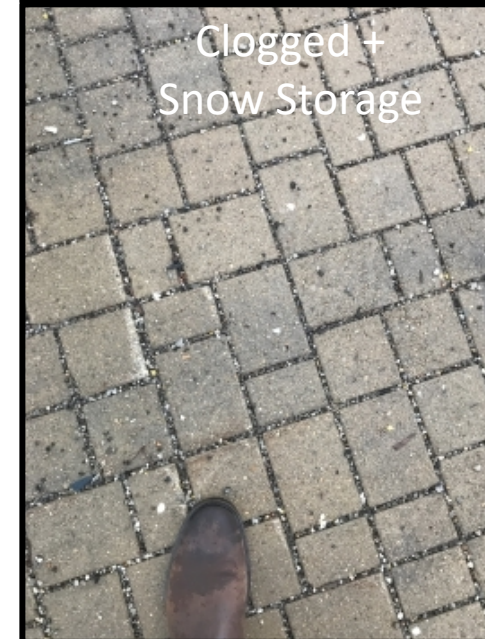
Determine whether wetting pavement prior to maintenance improves or hinders



Quantify the depth at which most clogging material accumulates in the pavement



Determine how number of passes with a maintenance vehicle improves effectiveness



# Methodology

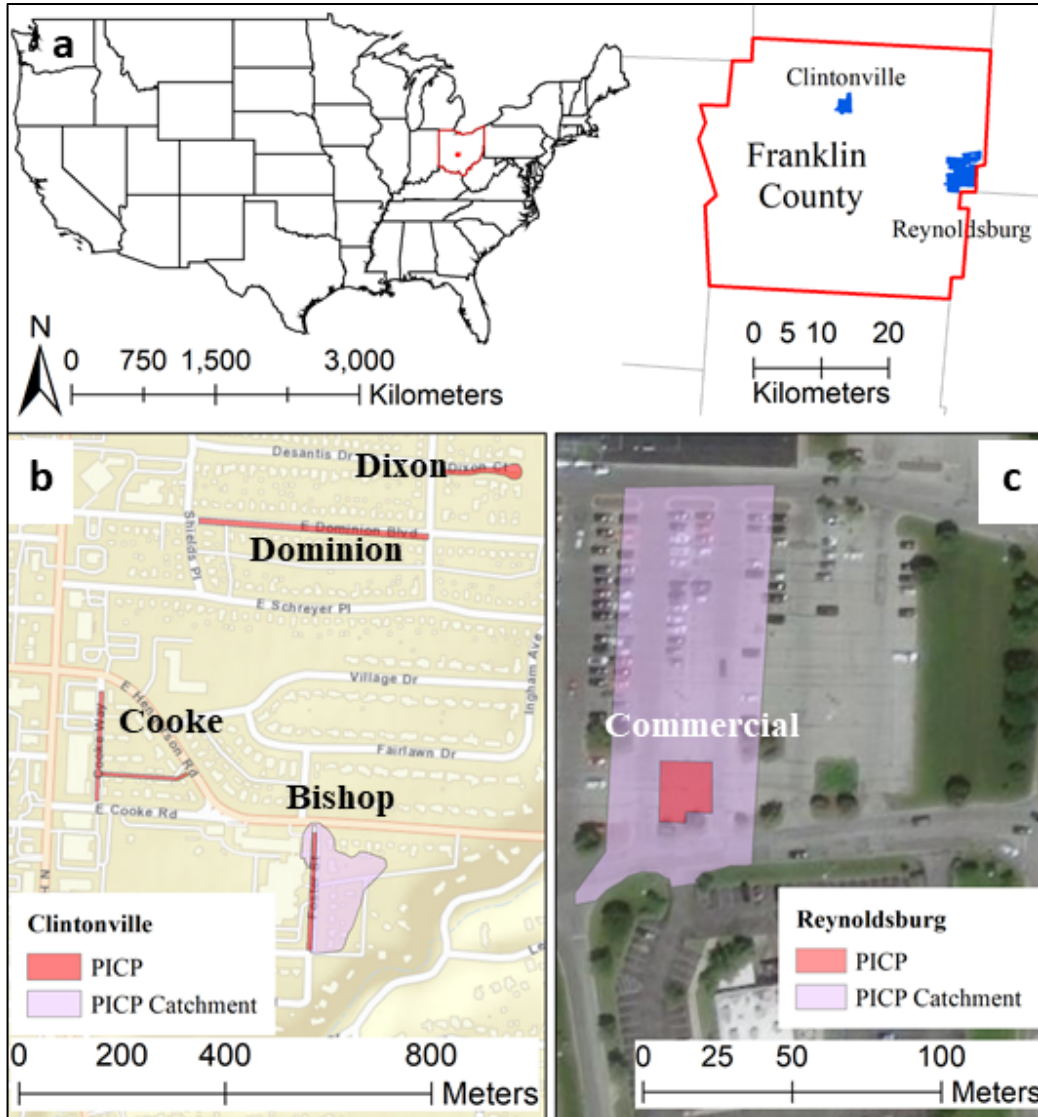
- Five permeable interlocking concrete pavements (PICPs)
  - Measured surface infiltration rate (SIR) immediately before and after maintenance
- $SIR = \text{total depth of water poured through the infiltrometer} / \text{time}$  (mm/min)



Max head of 1.5 cm



# Site Descriptions



	Bishop	Commercial	Cooke	Dominion	Dixon
<b>Surface Area (ha)</b>	0.1	0.02	0.16	0.3	0.13
<b>Catchment Area (ha)</b>	1.88	0.42	0	0	0
<b>Run-on Ratio*</b>	3.4	26.3	0	0	0
<b>Constructed</b>	Sept. 2018	Nov. 2017	Dec. 2017	Sept. 2018	Dec. 2017
<b>Age at Maintenance (yrs)</b>	1.75	1.5-2.5	2-2.5	1-1.75	2-2.5
<b>Maintenance Techniques</b>	R	R, PW, RJ, PW+RJ	R, MCV	R, MCV	R, MCV
<b>PICP Location</b>	Parking stalls	Parking stalls	Alley	Road	Cul-de-sac

R=Regenerative air, PW=Pressure washer, RJ=Rejuvenater, MCV=Machine Cleaning Vehicle

\*Run-on ratio defined as the ratio of impervious area in catchment to PICP surface area

# Maintenance Techniques



a) Pressure washer (P)

a) 45° angle, 290 kPa

b) Regenerative air street sweeper

- Blower + vacuum

- Tymco 435/600

c) Rejuvenater (RJ)

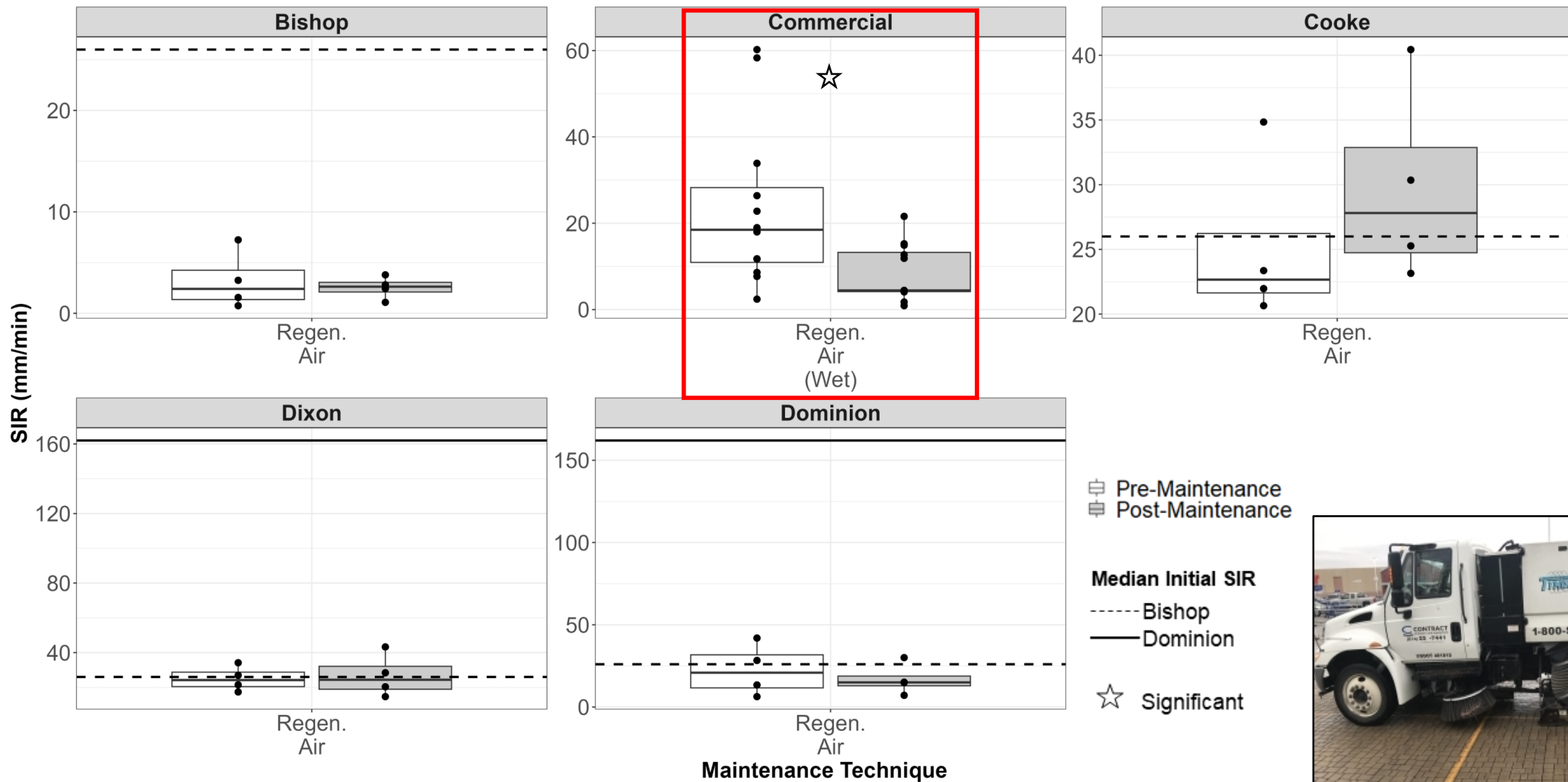
- Vacuum + rotating pressure washer nozzles

d) Machine Cleaning Vehicle (MCV)

- Vacuum + rotating pressure washer nozzles



# Results: Regenerative Air Street Sweeping

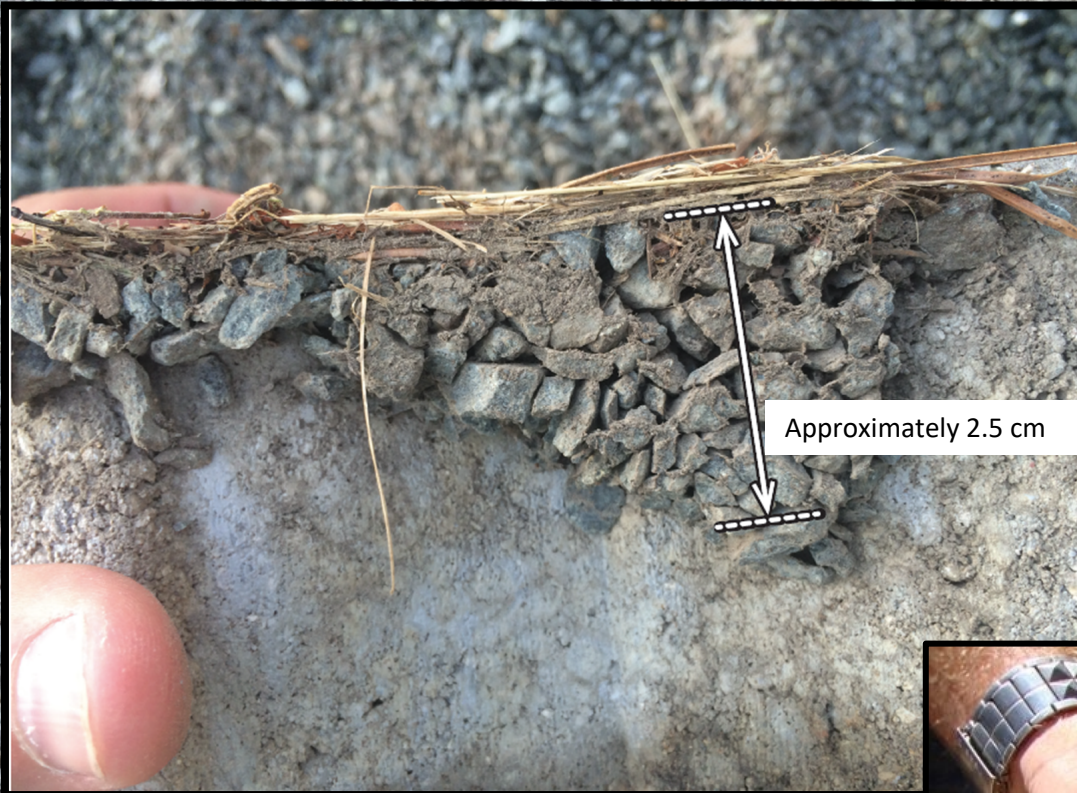


# Regenerative Air Street Sweeping

- Dry weather
  - No significant impact (in contrast to the literature)
  - In-situ pavement conditions
- Wet weather
  - Made clogging worse due to formation of crusted seal
  - Median SIRs from 19 to 4 mm/min



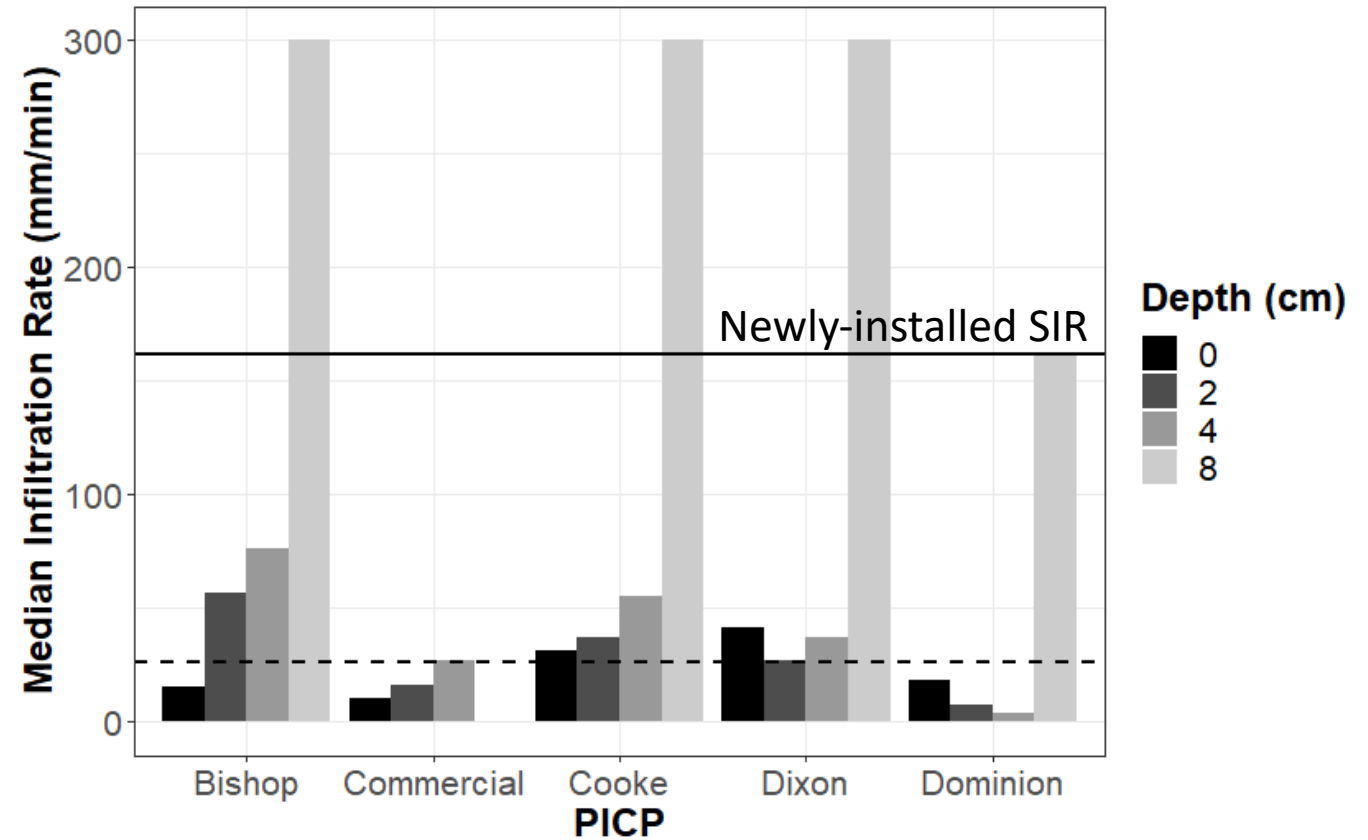
At what depth does  
clogging occur in the  
pavement?



This slide courtesy Bill Selbig, Upper Midwest  
Water Science Center, USGS

# How Deep Does it Clog?

- Manually removed all joint material in increments of 2 cm
- Repeated SIR testing after subsequent removal of joint material

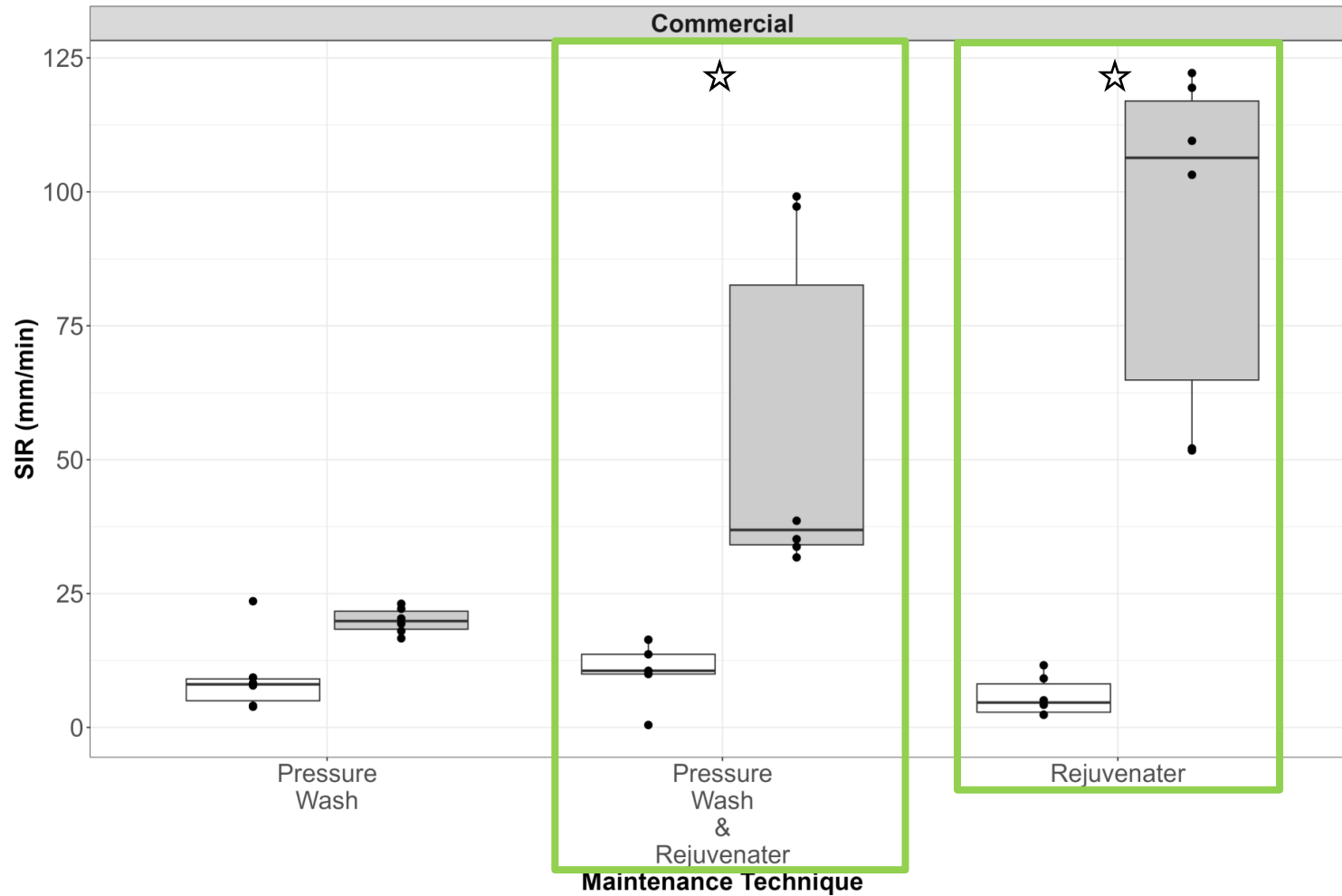


# Following PICP Maintenance, Must Refill Gaps with Gravel

Recommend limiting joint material removal to 2-5 cm below the pavement



# Results: Pressure Wash & Rejuvenater



Pre-Maintenance  
 Post-Maintenance

**Median Initial SIR**

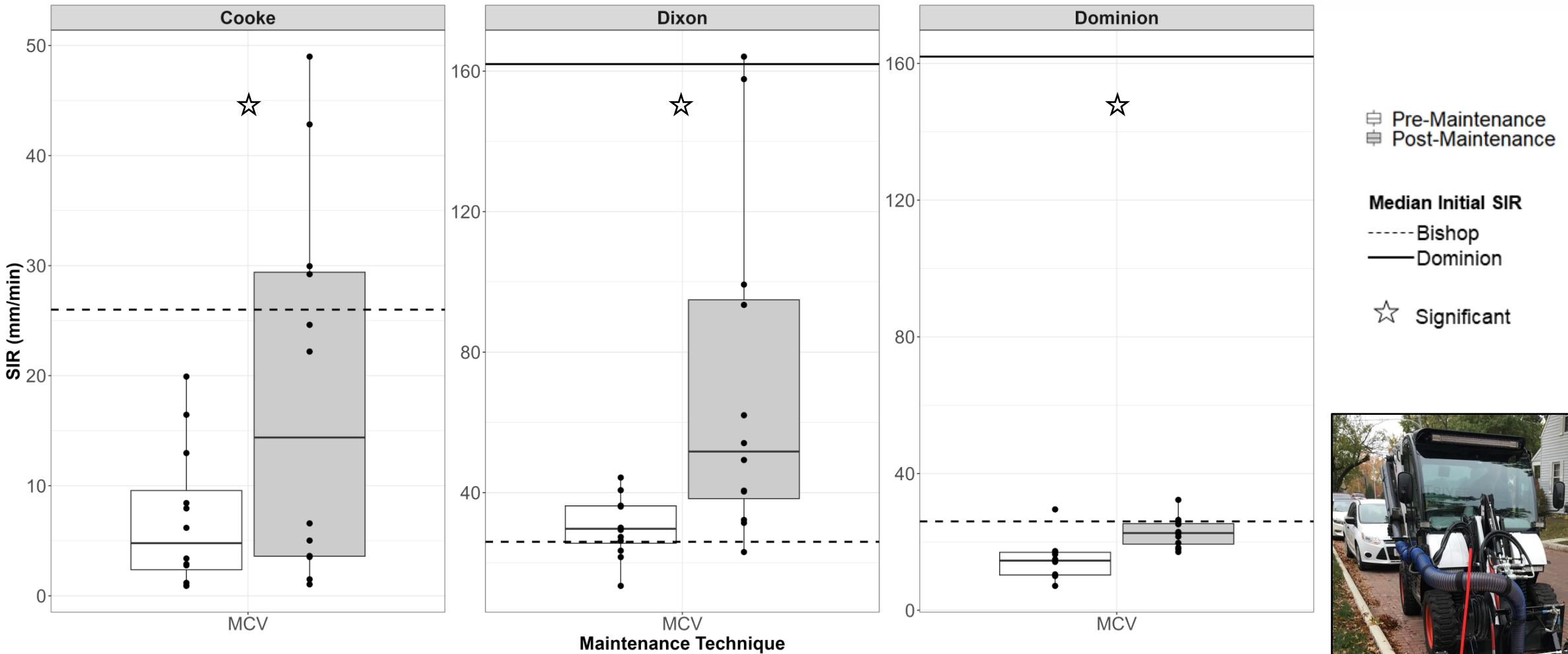
Bishop  
 Dominion

Significant



- Wetting prior to additional maintenance hinders SIR recovery

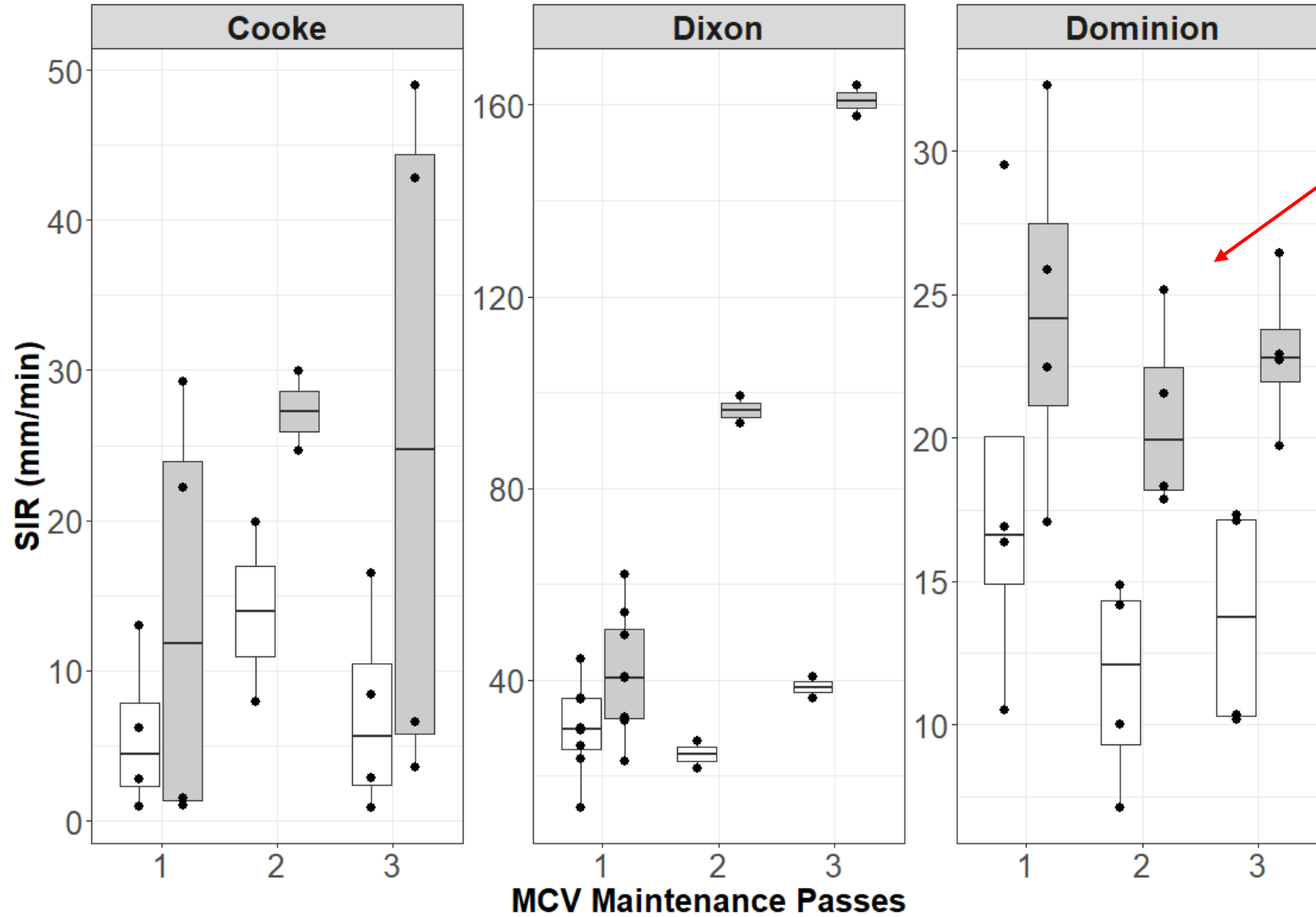
# Results: MCV



- Median SIRs improved from 15 to 26 mm/min improvements varied by site
- Tended to work better at sites with less clogging



# Number of Passes with MCV



Most of clogging material >4 cm into pavement profile

Time

- Pre-Maintenance
- Post-Maintenance





# Lessons Learned

- Regenerative air
  - Routine maintenance
  - Not enough suction for restoration
- In U.S., industry moving toward combined pressure washing and vacuum
- Avoid maintenance after wet weather
- Operation is critical to later maintenance
  - Deeper clogging due to failure to replace joint aggregate after maintenance
  - Vehicular wheel suction & snow plowing
- Number of passes generally  $\propto$  SIR



# Questions?



Source: London Economic

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Assessing maintenance techniques and in-situ pavement conditions to restore hydraulic function of permeable interlocking concrete pavements

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