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The Need for SCM/WSUD Maintenance: An International Perspective

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University of Technology (Swe)



Our Locations



Singapore: A City within a Garden



Luleå – special stormwater problems



Landscape maintenance 'happens' and many SCMs are landscape features



How you value the landscape impacts SCM
Maintenance

CUGE Fellowship: SCM Inspection



Creating Tiers in Sg per Landscape Aesthetic (sim to L.o.S.)

- Tier I – Excellent
 - Daily
- Tier II – Good
 - Weekly to Monthly
- Tier III – Fair **X**
 - Monthly to Quarterly

Singapore believed they had NO practices that fell into Tier III



Example: It Looks Good, But...

- Singapore
- New Zealand
- North Carolina

Nice Looking Linear Bioretention (Sg)



Water Directed At Overflow Structure



Which is Flush with the Ground...

What's
Wrong here?



Huge Bioretention: Looks Good, but...



Sinkhole next to drop inlet









Example: For the Chil'ren...

- North Carolina
 - Singapore

Looking for Mosquitoes



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Mosquitoes Have the Edge in Singapore's Dengue War

By WAYNE ARNOLD
Published: June 27, 2007

SINGAPORE, June 26 — Under the sink, behind the cleaning detergents, Thurainadan Govindarajoo shined his flashlight into the shadows, searching for telltale signs of the enemy.

“People only think of the obvious places,” he said. “We’re looking for what I call the hidden habitats.” Under leaking sinks, in disused toilets, beneath potted plants: wherever a few drops of water can linger, mosquitoes can breed.

Mr. Govindarajoo is one of roughly 500 inspectors from Singapore’s National Environment Agency specially trained to conduct house-to-

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AESTHETICALLY PLEASING



Dry Pond "Failure"



Cattails Clogging Drawdown Structures





Gross Neglect





09/23/2008

Overgrown dry pond: Another Mosquito Haven



14 “Innovative” Wet Ponds

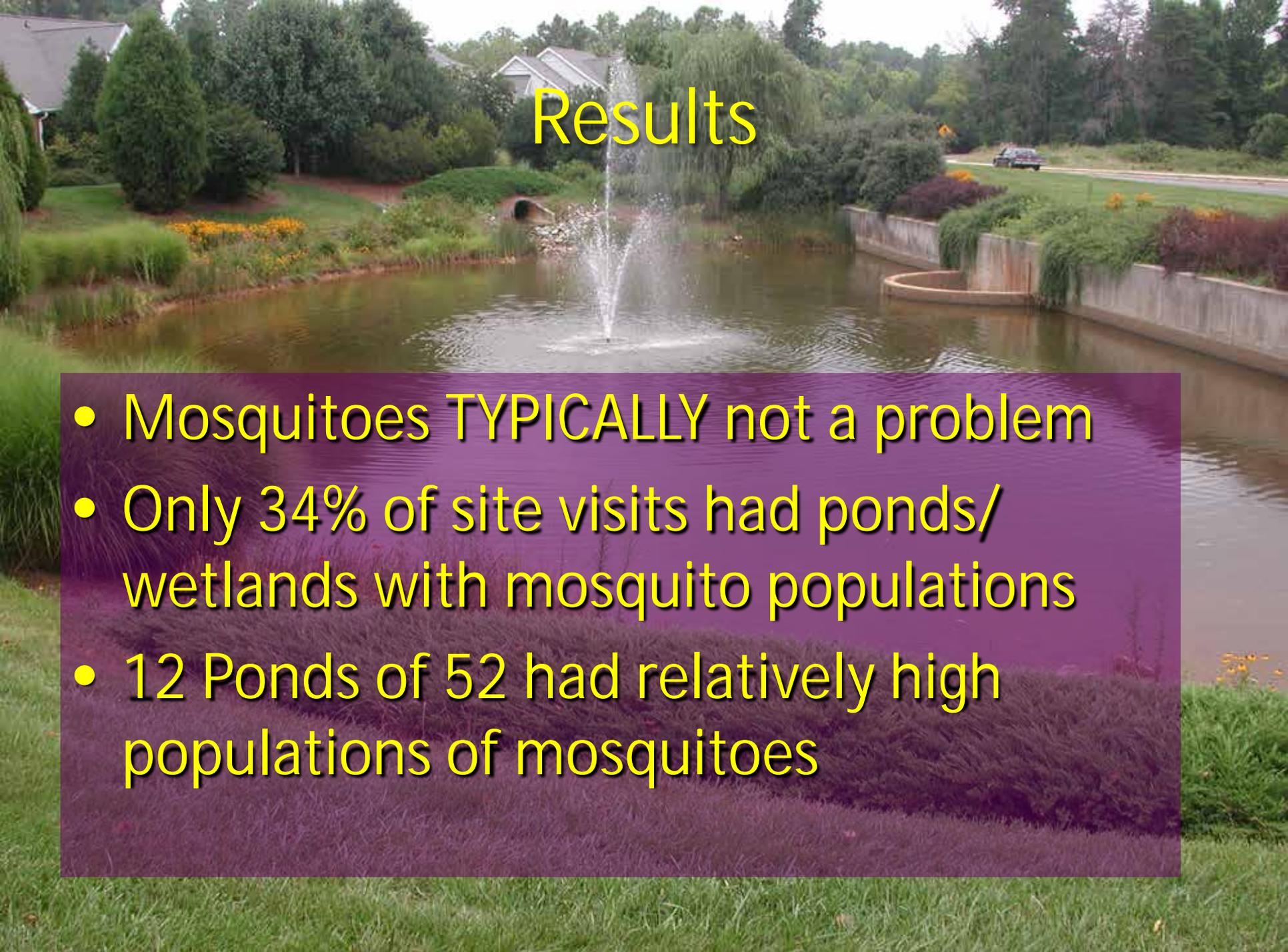


18 Stormwater Wetlands



20 “Standard” Wet Ponds

Results



- Mosquitoes TYPICALLY not a problem
- Only 34% of site visits had ponds/wetlands with mosquito populations
- 12 Ponds of 52 had relatively high populations of mosquitoes

Is this an attractive nuisance?



As a Parent of 2 (now 3) explorers, I say:
"Yes."

Example: “The Case of the Unknown”

- Brisbane, QLD, Australia

Australian Wetland's Outlet



After 1st Year of Construction

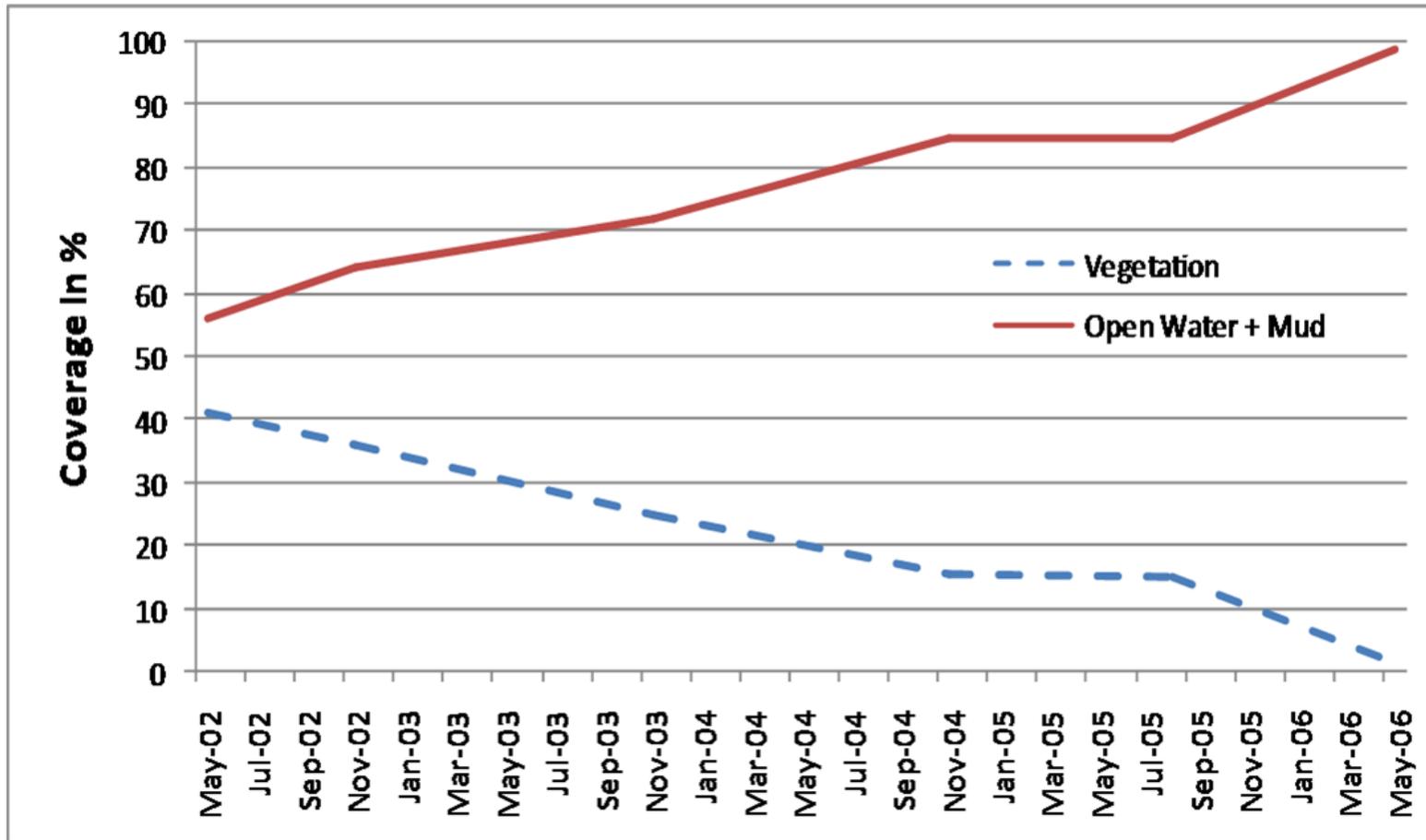


Is this a Wetland?

7 years later...



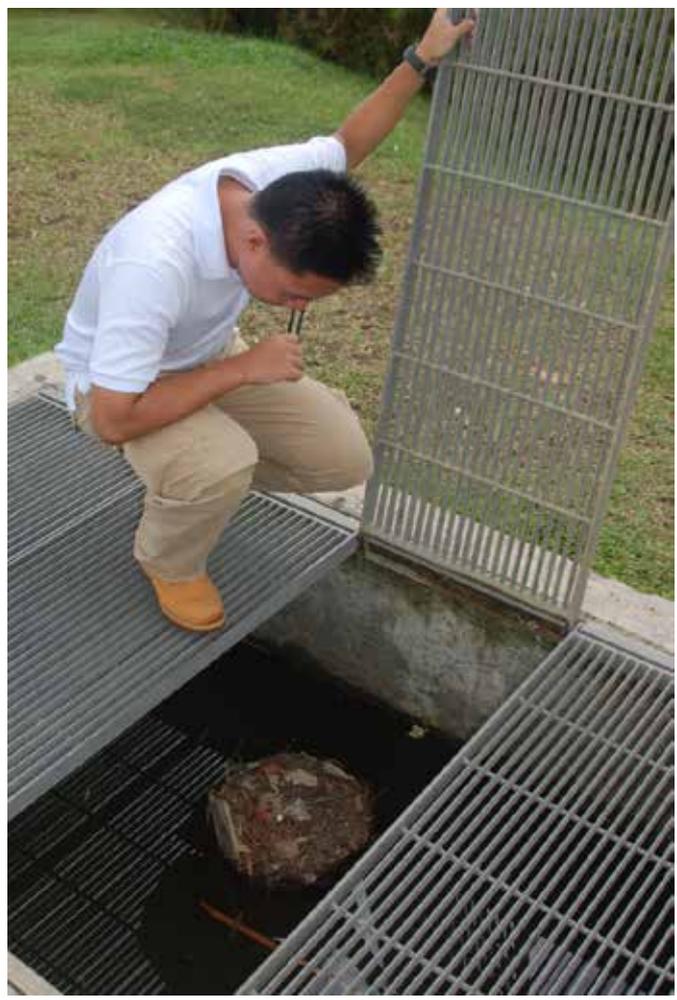
% Vegetative Coverage



Sengkang Park- Singapore: Wetland



Hmmm... wonder why?



Example: Case of the “We Forgot”

- Northern Sweden (Lulea and Haparanda)
- Mid-Atlantic US
- New Bern, NC

Permeable Pavement Maintenance Research Aim

Long-term performance of permeable pavements:

- extend of clogging
- effect of different materials
- effect of different designs

Recovery of infiltration capacity

- vacuum cleaning

Permeable asphalt

Medium to coarse mean
particle size

Little variation in particle
size

20-30% air void

Underlain by
coarse
macadam





Haparanda

1986/87



Luleå

1993/94



Luleå

LULEÅ TEKNISKA UNIVERSITET

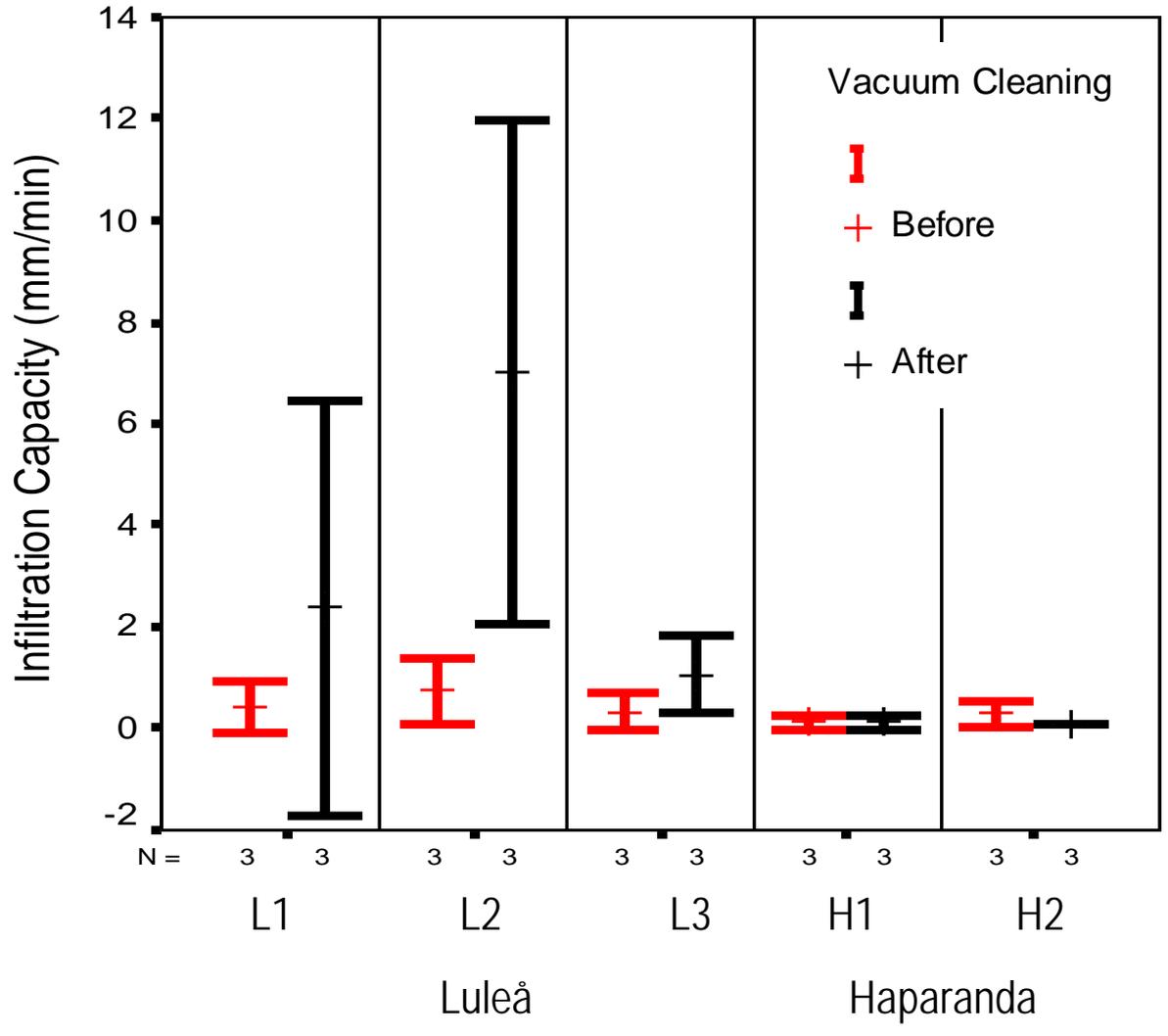
Method

Infiltrationskapacitet

Double ring infiltrometer



Results



Infiltration capacity (mm/min)

Luleå

Initial (1994): 290
 After 1 year: 7.4-19
 After 17 years:
 before VC 0.6 ± 0.3
 after VC 3.6 ± 3.0

Haparanda

Initial (1987): >400
 After 3 years: 6-20
 After 24 years:
 before VC 0.2 ± 0.2
 after VC 0.1 ± 0.1



Results

- Severe **clogging** of both asphalts
infiltration near-zero in Haparanda
lack of maintenance at both sites
- **Vacuum cleaning**: improved infiltration capacity in
Luleå. No effect in Haparanda
Infiltration capacity still far below initial values

Study on Surface Infiltration Rates

Bean et al.
2007a



Surface Infiltration Rates (rate at which water passes through the pavement surface) indicate long term clogging.

Maintenance

- Remove top 12 - 19 mm (0.5-0.75 in) of material
 - Street sweeper
 - Gerrits & James (2002)
- Repeat Surface Infiltration Test

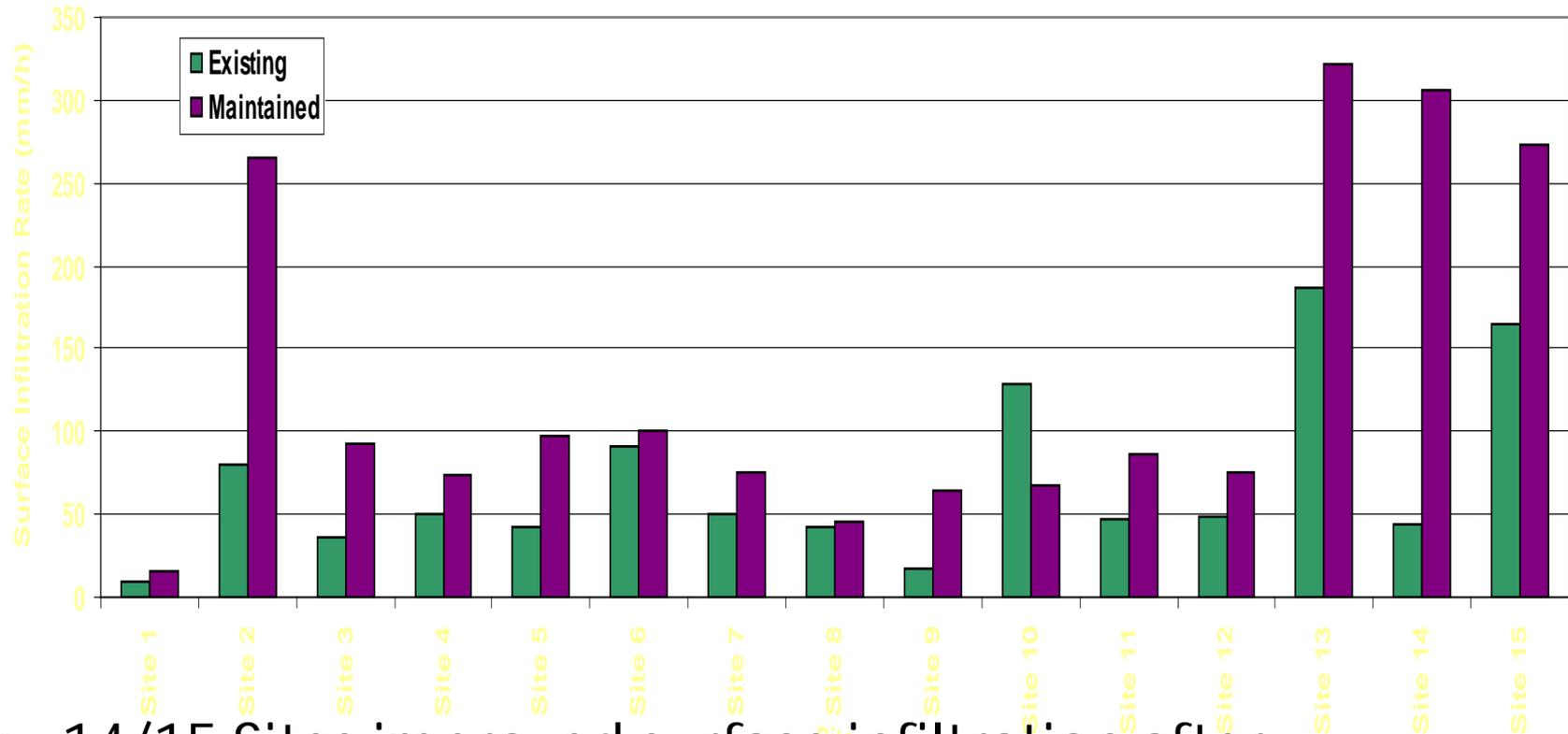


Clogging: Maintenance



“Reach” of Bristles: ~1/2 in

Infiltration Rates Pre- & Post- Simulated Maintenance



- 14/15 Sites improved surface infiltration after maintenance

CGP Results

- Existing CGP
 - SIR = 49 mm/h (1.9 in/h)
- Maintained CGP
 - SIR = 86 mm/h (3.4 in/h)
- 66% increase
- 99% confidence statistically significant difference

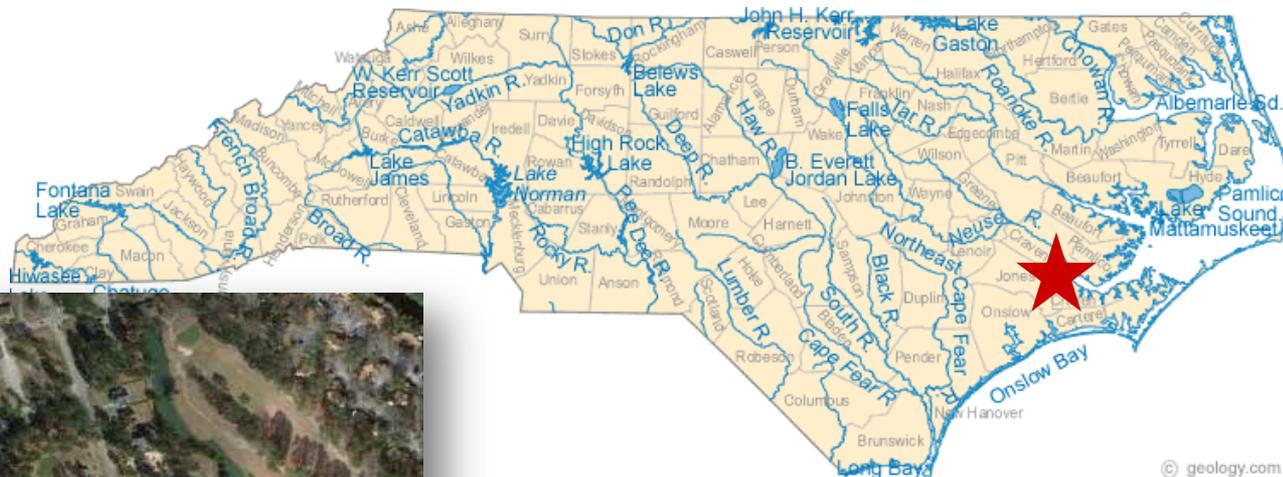


**So... what happens if my outlet
remains freely draining, but I
otherwise neglect my stormwater
wetland?**



Wetland Site

River Bend,
NC



© geology.com

- 115 ac Watershed
- 0.37 ac Wetland
- Very Permeable
 - CN = 54
 - Impervious = 23%
 - Sandy Soils





June 2007



October 2008



February 2013



May 2013

Monitoring Periods

2007 – 2008

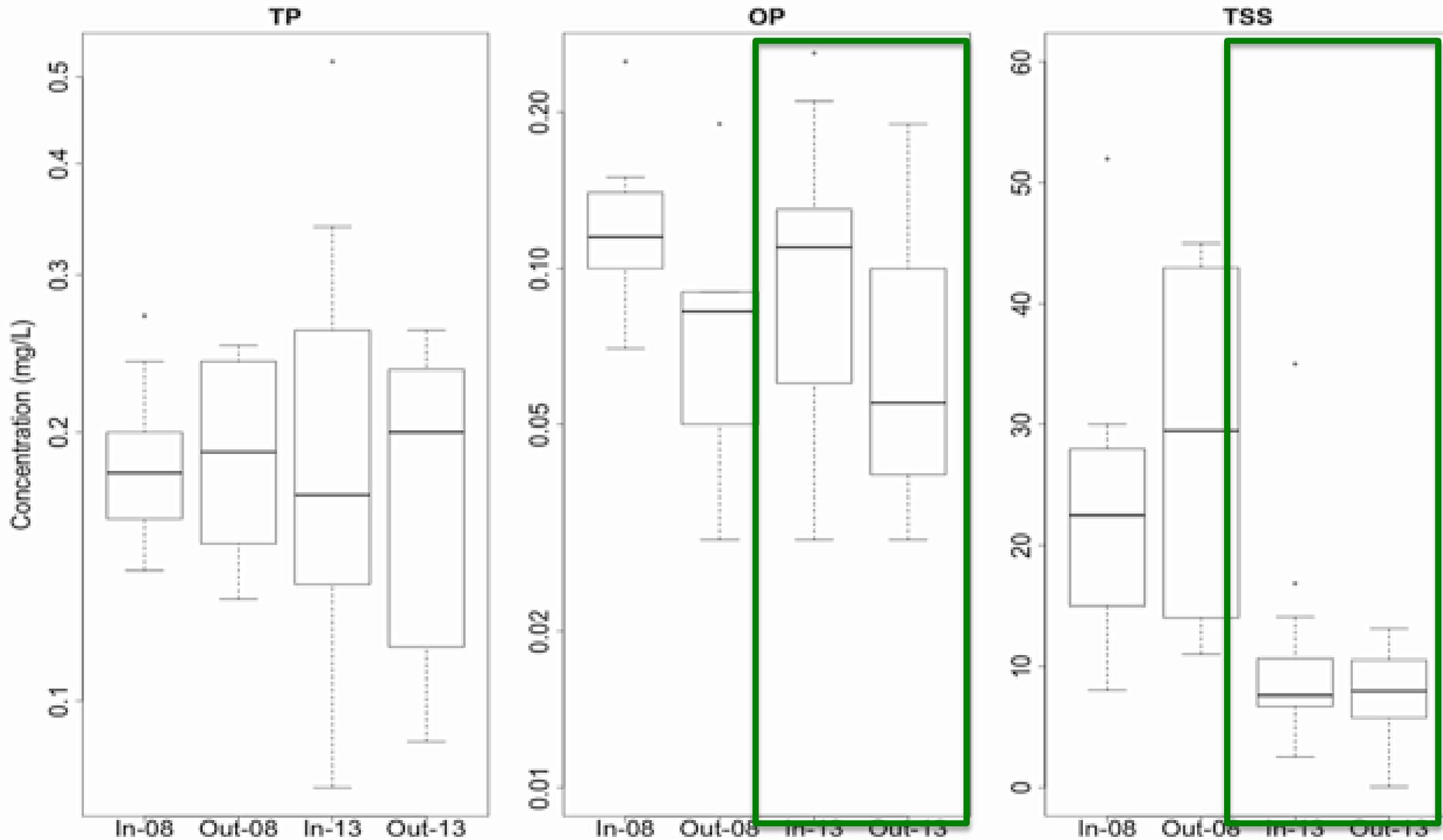
2012 – 2013



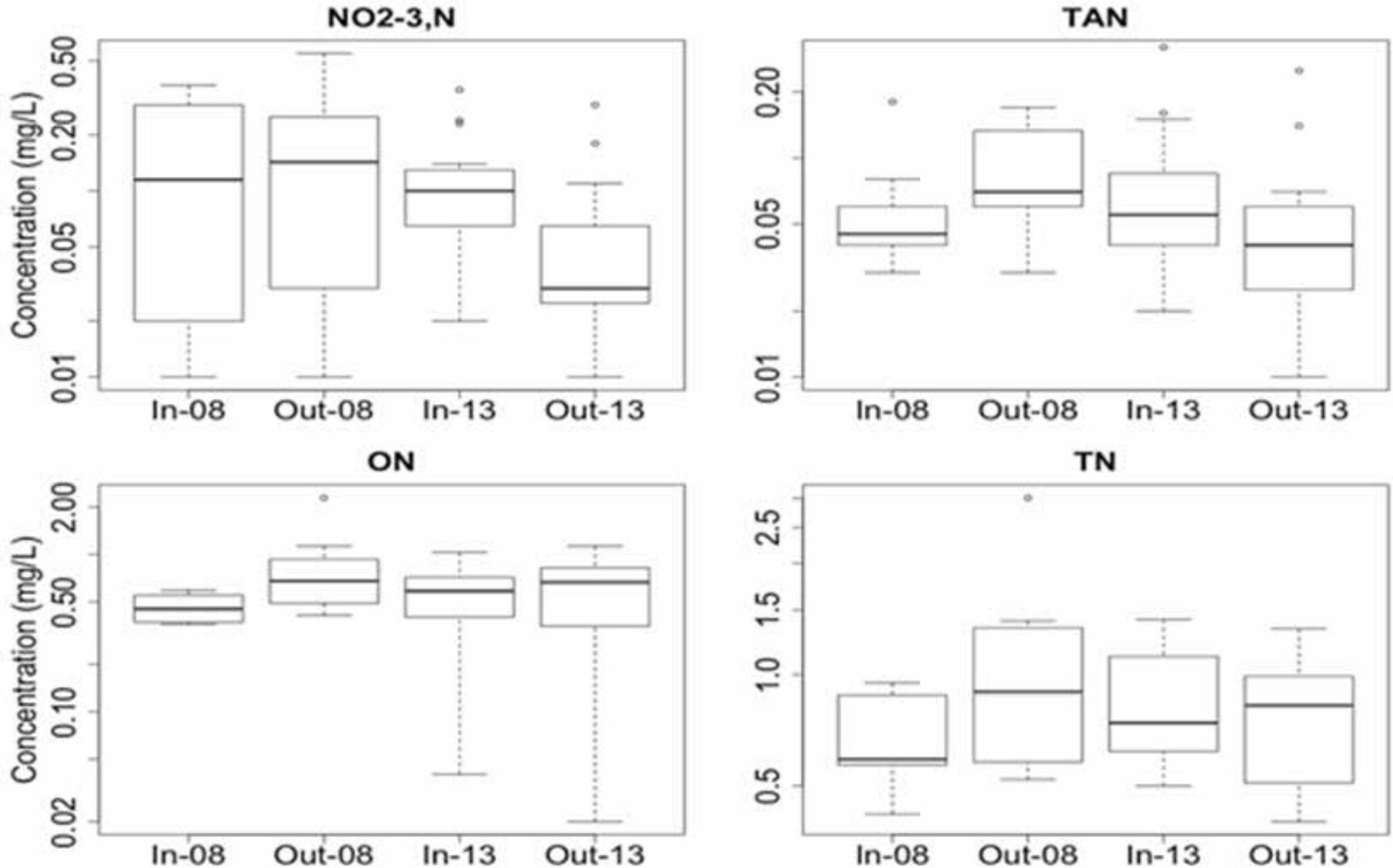
No Maintenance for
5 Years



Water Quality: Phosphorus & TSS



Changes in Nutrient Removal?



Key to this Performance?

- 1) Relatively "Clean" & Permeable Watershed
 - Limited Sediment Accumulation (Forebay)
- 2) **Clog-Resistant** and **Low Head Outlet** Structure



Example: Enter the Subcontractor

- North Carolina

'Crusher Run' Gravel Base



Sedimentation & Clogging Layer



Drawdown

- NC recommended bowl drawdown rate
 - 12 hours (25 – 50 mm/hr)
- Actual drawdown rate
 - 48+ hours (2.5 – 12 mm/hr)



Long-term Ponding also =



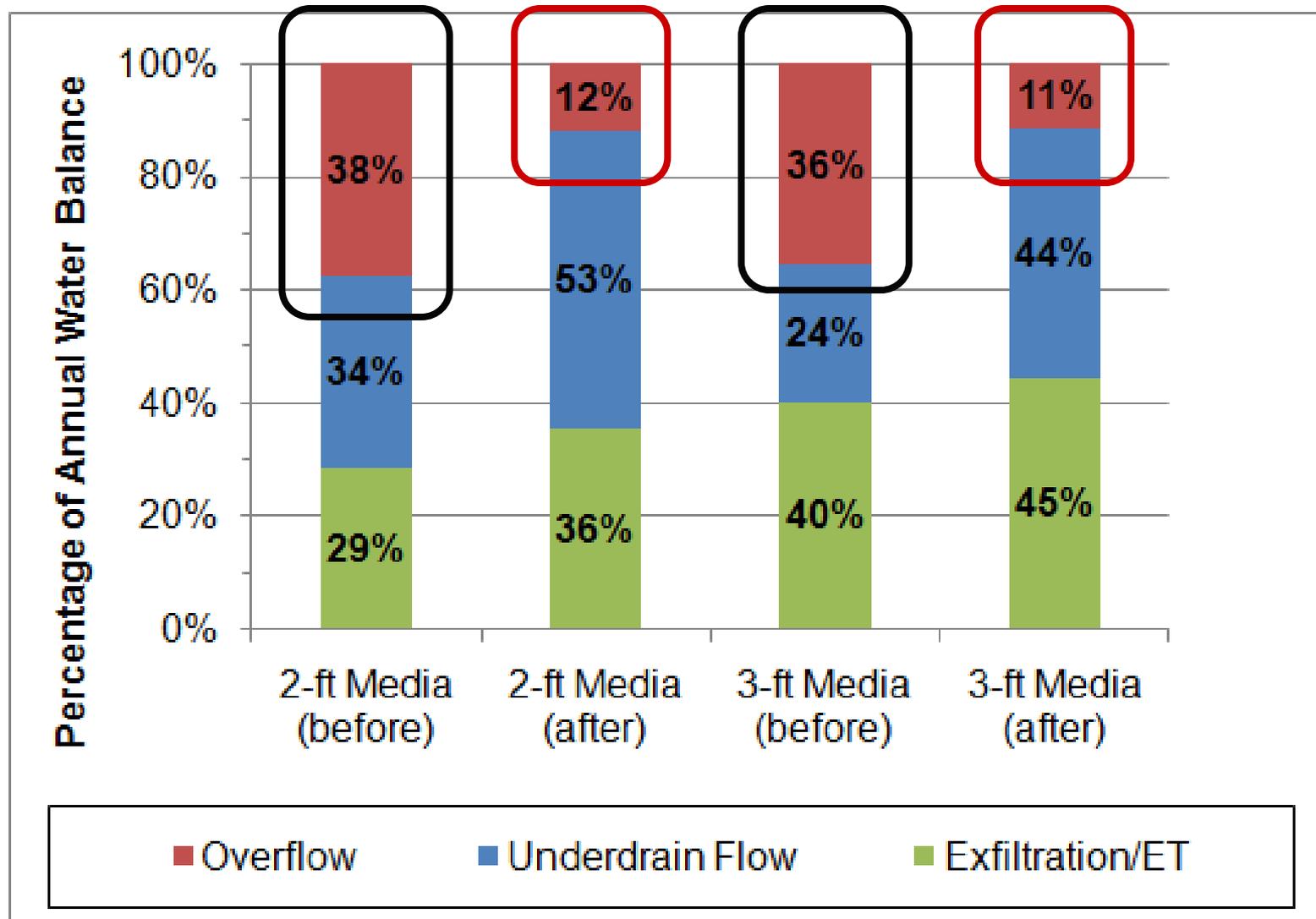
Do we really want these guys in areas where
Bioretention Cells are located?

Fixing Bioretention

- Remove clogging layer & top 75 mm of media to increase surface ponding volume



Pre- & Post-Repair: Fate of Runoff

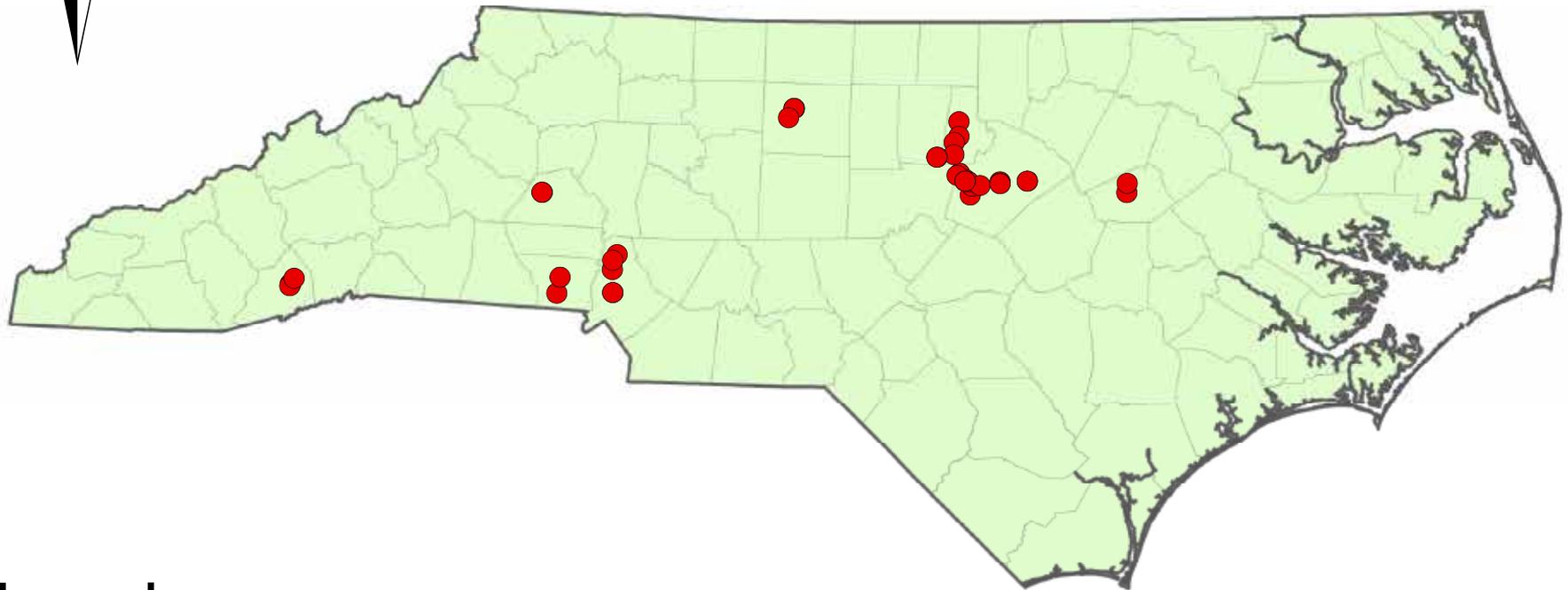
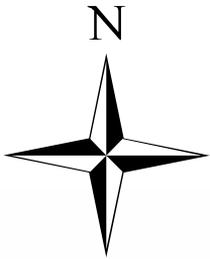


Were these errors symptomatic of a larger problem?

- Researchers did make visits to the site during construction
- Design appeared to be competent
- Maintenance staff was consulted
- **Are the 100's of other "more neglected" BRCs undersized?**



Site Selection (n=43)

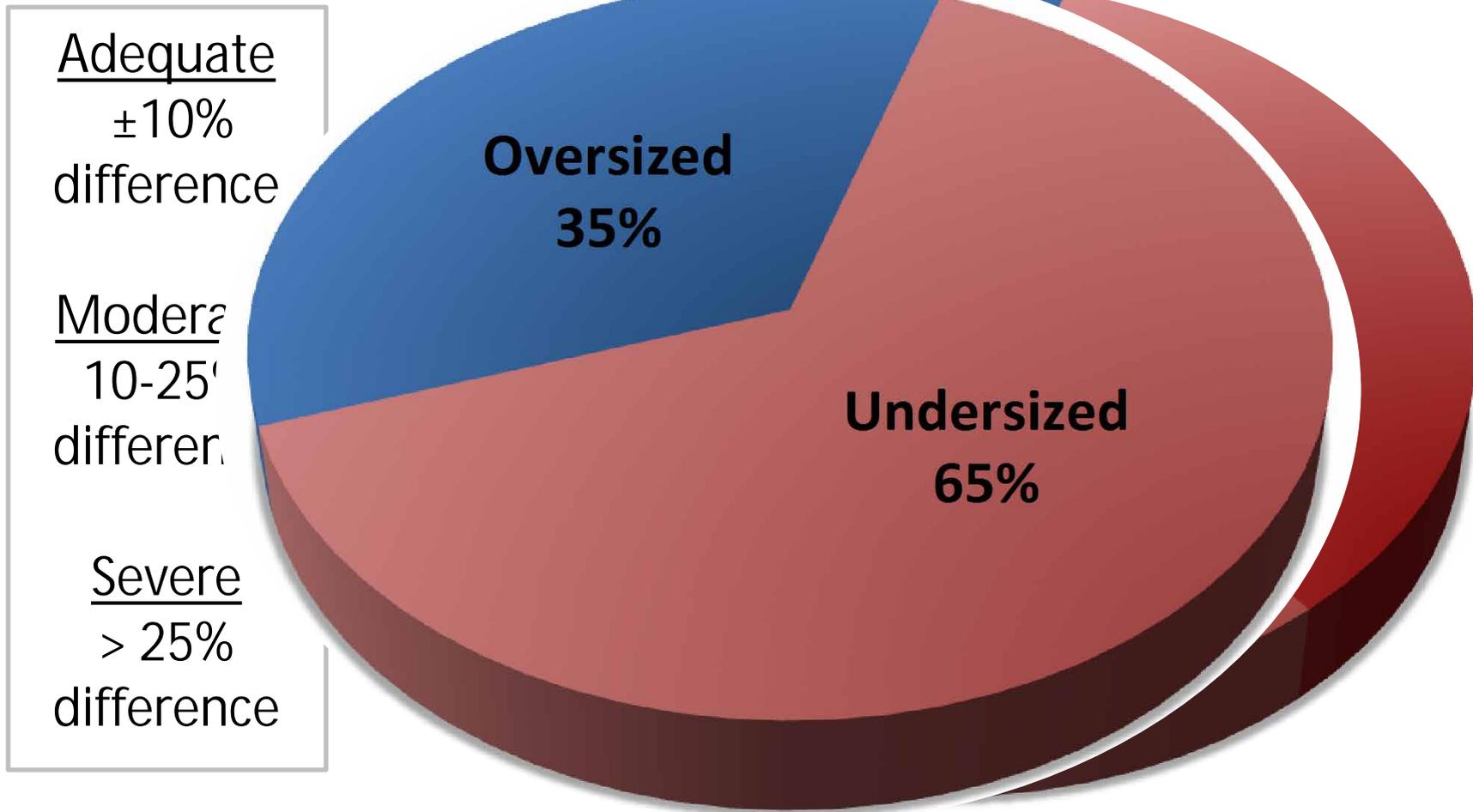


Legend

- Site Location
- County Boundaries

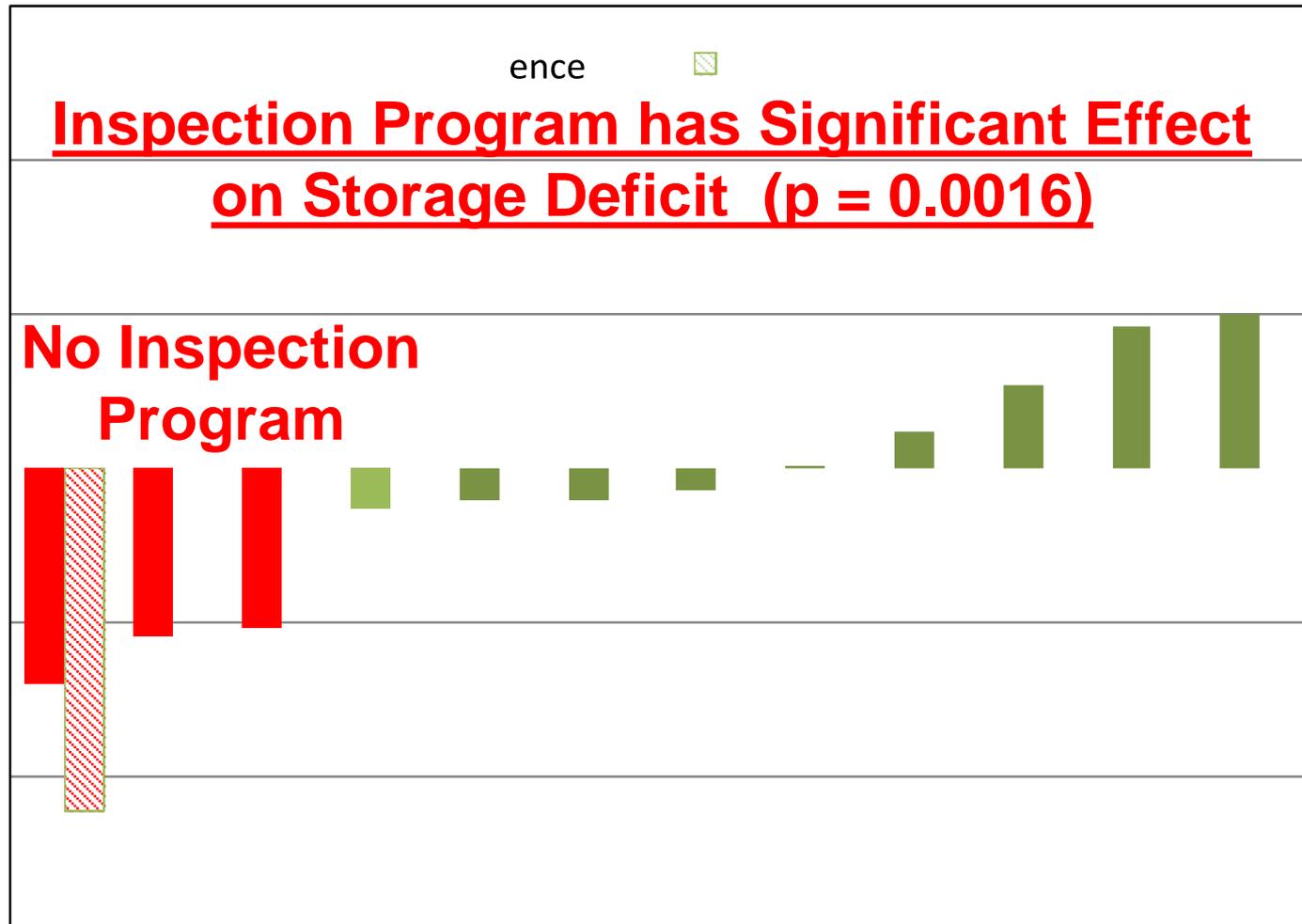
0 50 100 200 Kilometers

Results: Storage Volume



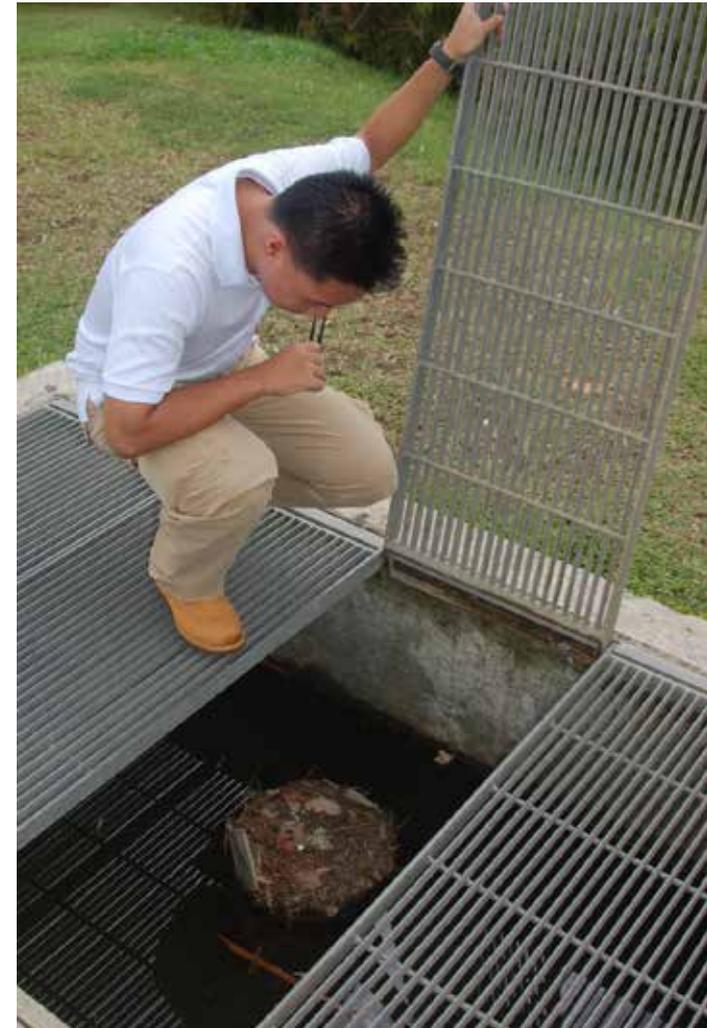
(n = 40)

Results: Storage Volume



Universal Maintenance Tasks, SCMs Need...

- Regular inspection of components



SCMs need

- Specialized pruning/
Weeding



Bioretention in Sg



Rather Jam Packed with Veg



Would we tolerate this in the US? Bioretention Pruning







Singapore and the Death Penalty

A recent amendment saves one drug mule. But should death for drug crimes be ended altogether?

By Jeraldine Phneah

November 20, 2013



221 Shares
10 comments

Singapore's approach to combating drug trafficking has traditionally entailed the use of capital punishment. According to Amnesty International, over the last two decades Singapore has **hanged hundreds of people** – including dozens of foreigners – for narcotics offences. So it was a pleasant surprise for many last Thursday morning when the courts **lifted the death penalty on a drug trafficker** for the first time in its history. Yong Vui Kong, a Malaysian who was



Human rights lawyer M. Ravi stands in front of an anti-drugs poster.

Image Credit: REUTERS/Nicky Loh

WW

SCMs need

- Plant & Pest management



SCMs need

- Protection from sediment



BMPs need

- Regular Rubbish/ Trash cleaning



Maintenance Visits Biotope Every Day



Why?

International Maintenance Themes

- Aesthetics can be a big motivator
 - Singapore
- ...and a Deceiver
- Don't Ask, Don't Tell
 - Lack of knowledge among landscapers & public works employees
- If I can just make it through installation...
- Human Health
- Maintenance Does Matter
 - Without it, many SCMs are a huge waste of \$



Questions?

