Pervious Concrete for Highway Shoulders

National Two-Lift Open House
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IOWA STATE UNIVERSITY
Civil, Construction, and Environmental Engineering

National Concrete Pavement Technology Center
Tech Center
Uniting agencies, industry, and researchers to advance concrete pavement technology

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Presentation Highlights

- Pervious concrete background
- Benefits as a shoulder
- Specifics of TX Active pervious concrete
- Design considerations for a shoulder
- Preliminary layout and monitoring

Modi-slab, The Netherlands

Pervious Concrete

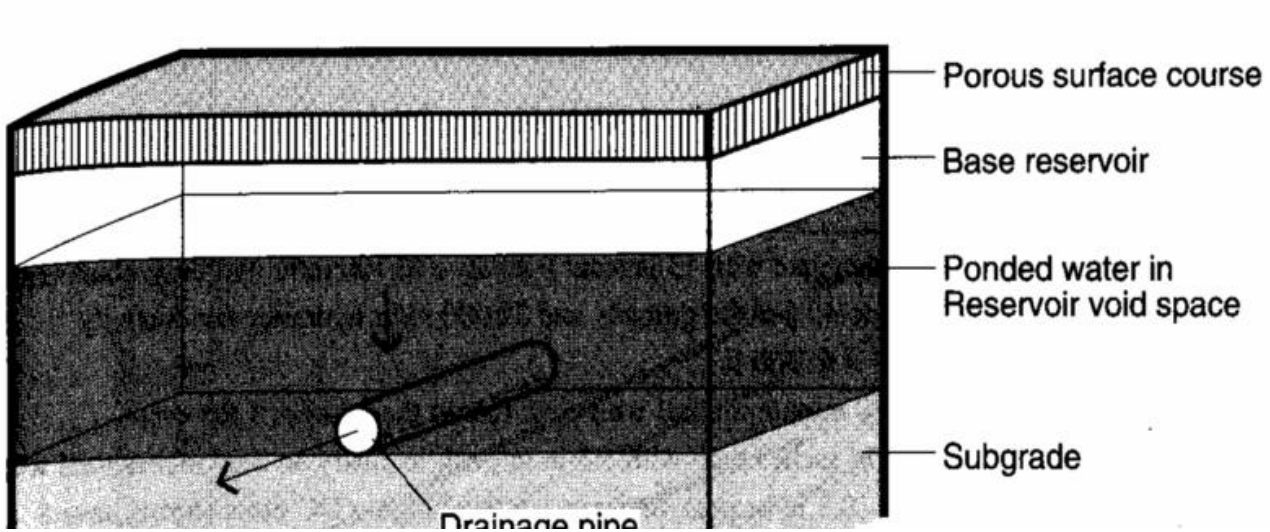


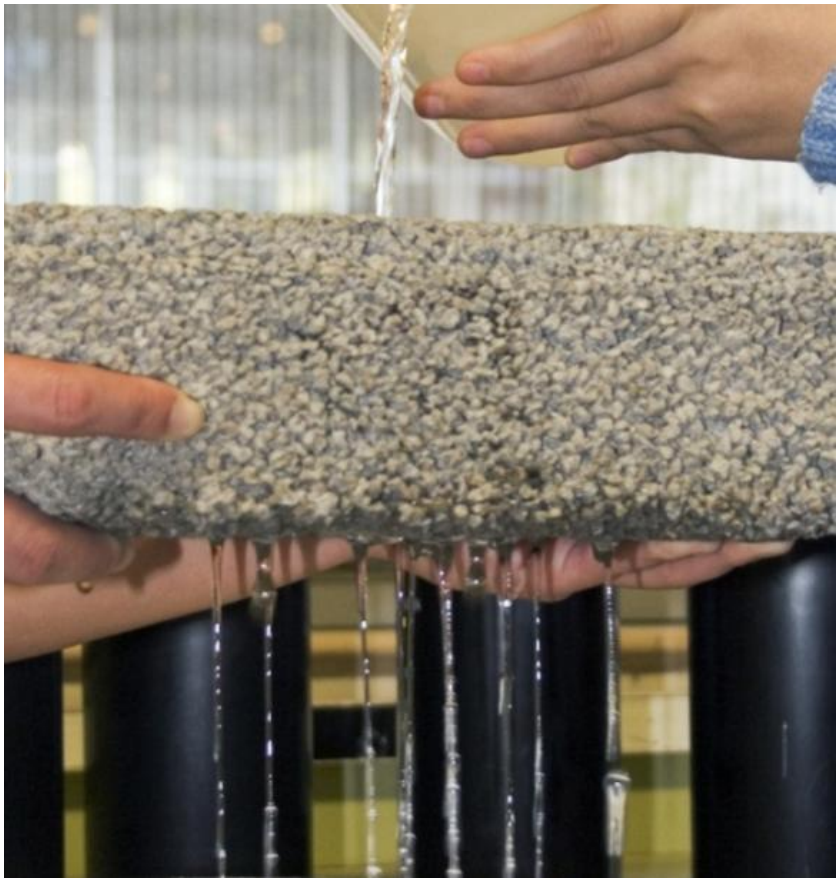
Figure 1. Cross Section of a Typical Permeable Pavement (Ferguson 2005)

Why a Pervious Concrete Shoulder?

- Stormwater
  - Water volume reduction
  - Water quality improvement
  - Increased time of concentration
- Urban Heat Island Mitigation
  - High albedo, evaporation, lower temp, less smog
- Safety - Increased skid resistance

Pervious and Stormwater

- About 90% of rainfall volume in the Midwest comes in storms 1 ½” and less
- Perceived infiltration much higher than measured
- Tortuous pathway delays hydrologic peak



Pollution Treatment

- About 90% of the surface pollutants are carried off by the first ½-inch to 1-inch of rainfall (first flush), WQV
- First flush passes through pavement into soil
- Soil filters and treats rainfall
- Rainfall is spread over entire parking area (instead of detention pond)
- Hydrocarbons treated by filtration and microbial conversion

Pavement Heating

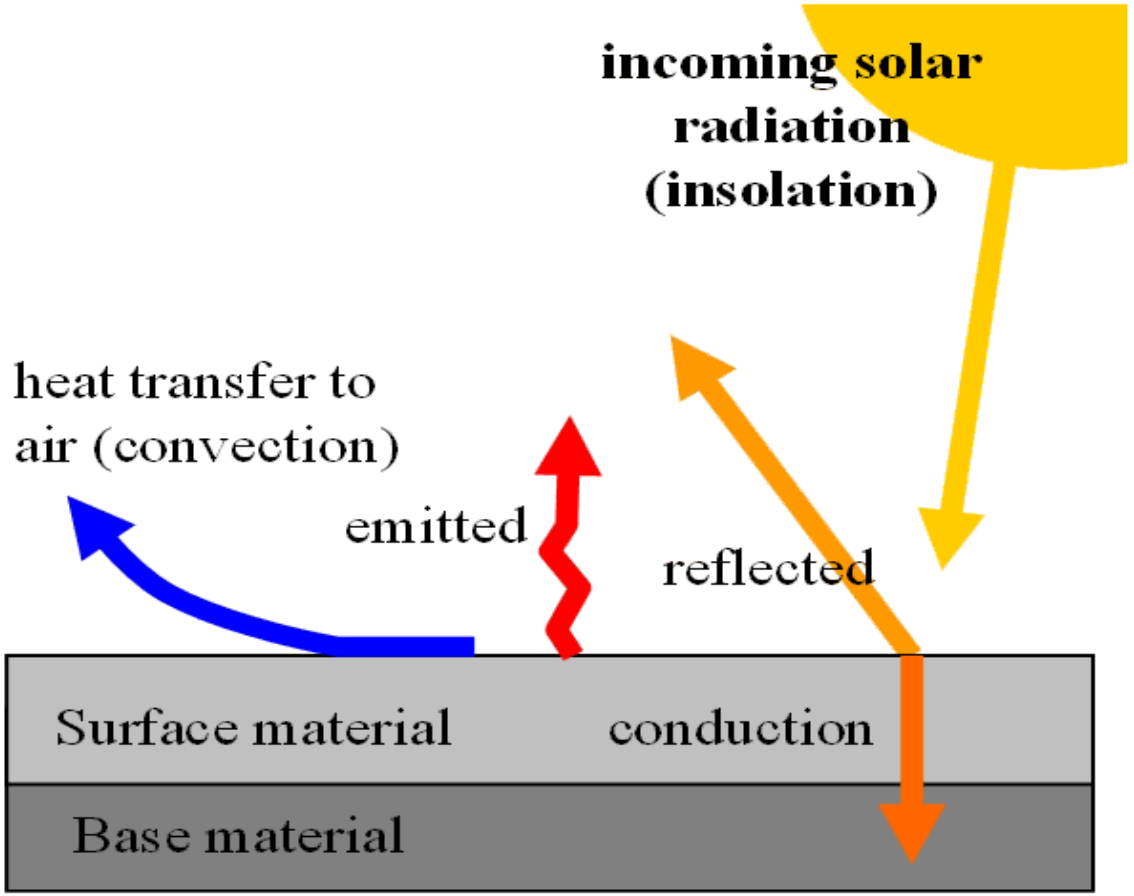


Figure 3. Thermal Behavior of Pavements (EPA 2010)

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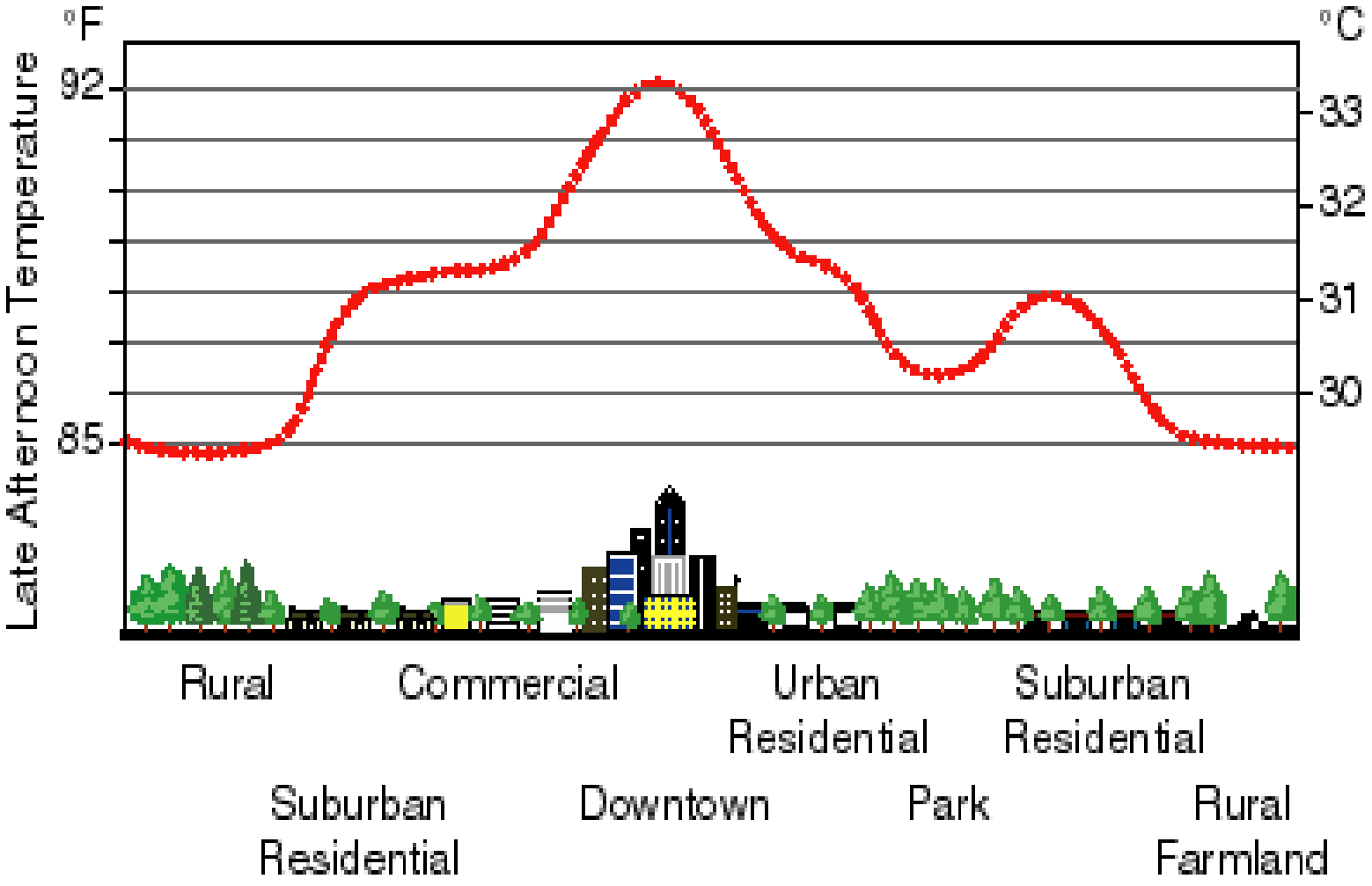
Sketch of an Urban Heat-Island Profile

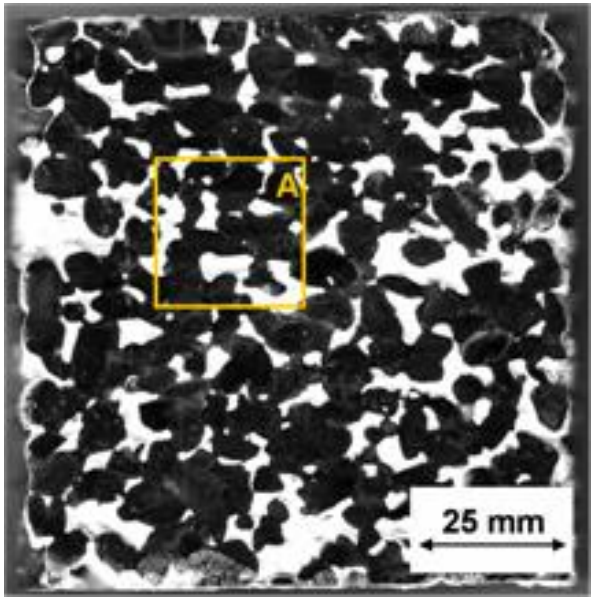


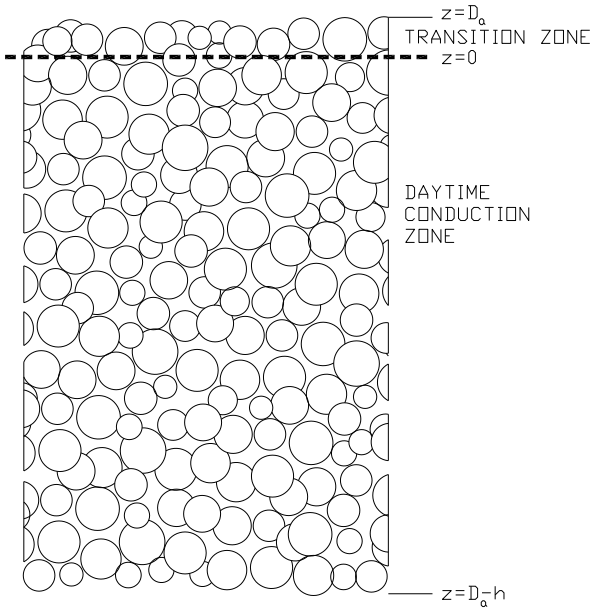
Urban Heat Islands

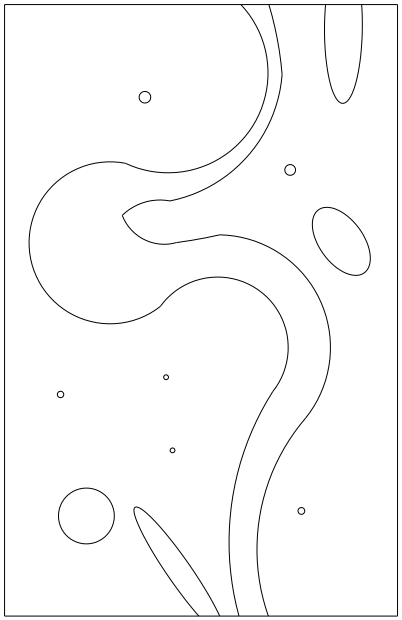
- 6 – 12 °F Hotter in daytime
- Up to 22 °F Hotter at night
- More Smog Occurrences
- High Level of Ground-Level Ozone
- More Frequent Air Quality Alerts
- Increased Health Problems
- Higher Energy Demand

Pervious and UHI

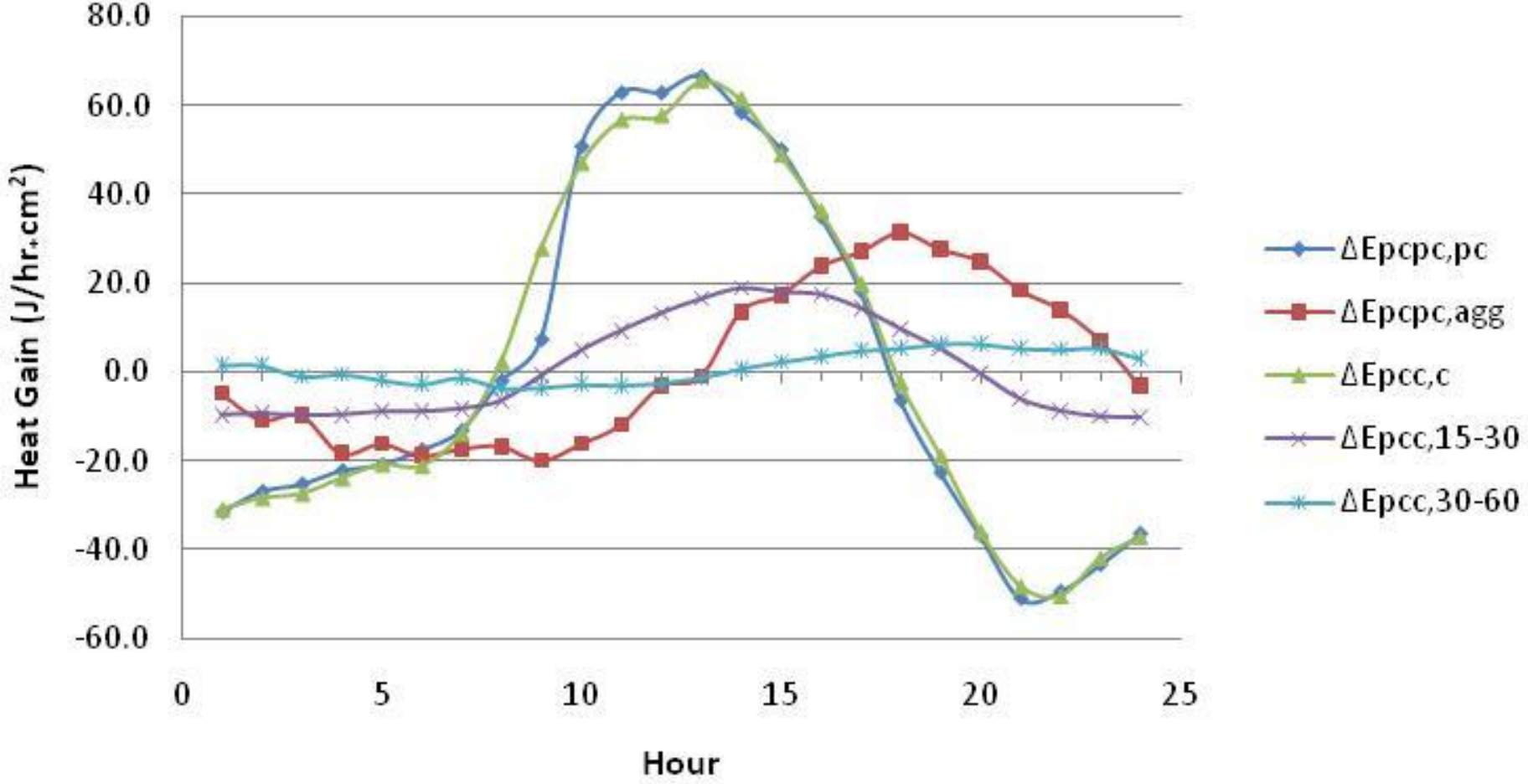
- Less Materials
- Poorly Connected
- Non-Uniform Heating
- Transient Air
- Transient Water



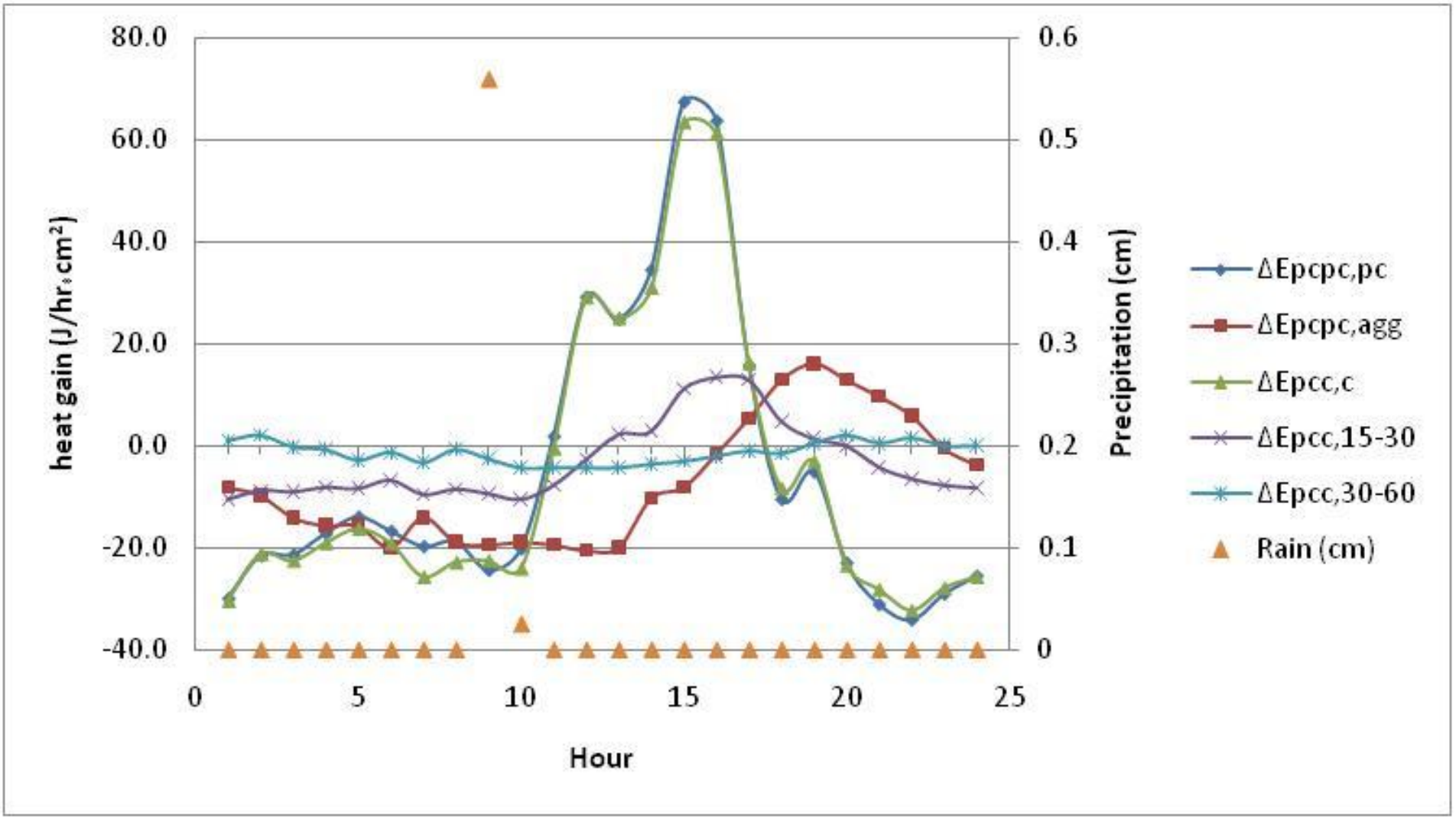




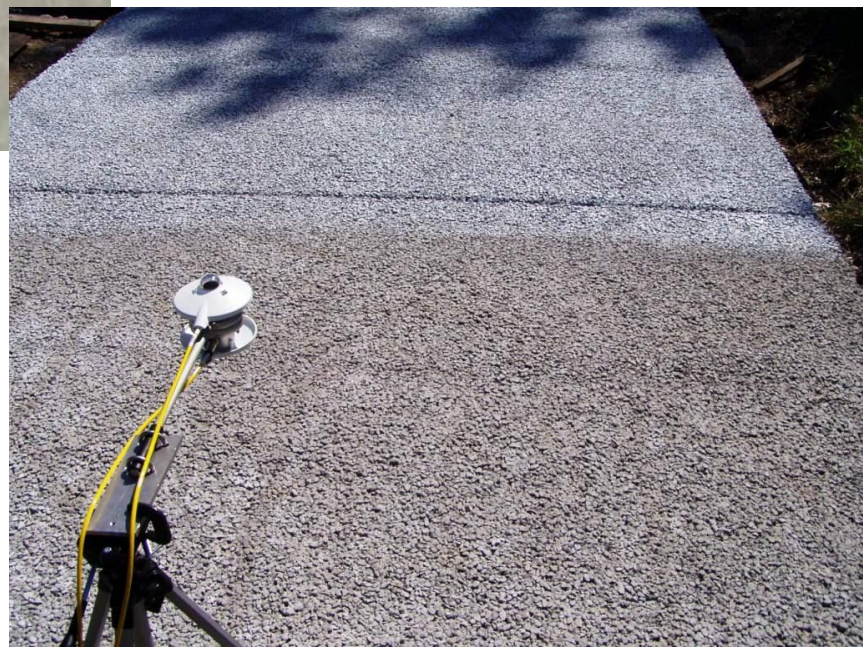
Heat Gain w/out Precip



Heat Gain w/ Precip



Albedo



Traditional and pervious concrete before and after high reflectivity coating

Winter Safety


Jeep
GMC


NISSAN
186 ADW

TX Active Pervious

- Surface area exposed to sunlight is 3-5 times greater than traditional pavement (more reactive)
- Light color reflects energy (less energy stored)
- Surface temp gets hotter than impervious concrete (more reactive)

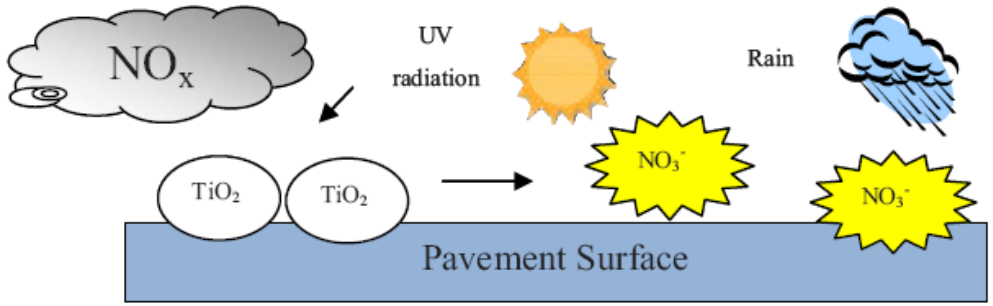


Fig. 1. Mechanism of photocatalytic reaction

Hassan 2010

Design Considerations for Shoulder

- Mix Design (strength, durability)
- Hydraulic (infiltration rate, run-on velocity)
- Hydrologic (base depth, soil infiltration)
- Pavement Design (thicknesses, base saturation)
- Construction (fast, consistent, doable)
- Maintenance (required infiltration rate)

Project Outline

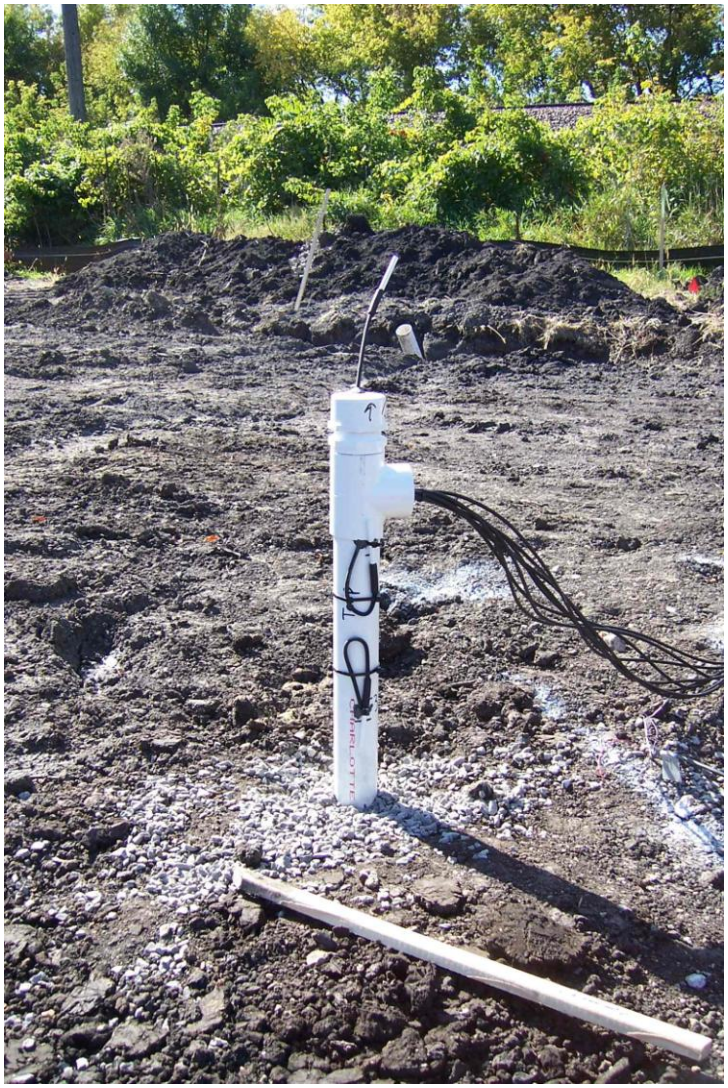
- 3 Test Sections
  - Control concrete w/ pcc/ac shoulders
  - TX Active impervious roadway
  - TX Active pervious shoulder

Project Testing

- Field Monitoring
  - Temperature in pavement profile
  - Albedo
  - Stormwater (quantity, quality, temperature)
  - Condition
  - Pervious infiltration rate
  - Pervious stormwater balance
- Lab Testing
  - Material thermodynamic properties
  - Stormwater degradation

Monitoring Plan

- Temperature sensors throughout profile



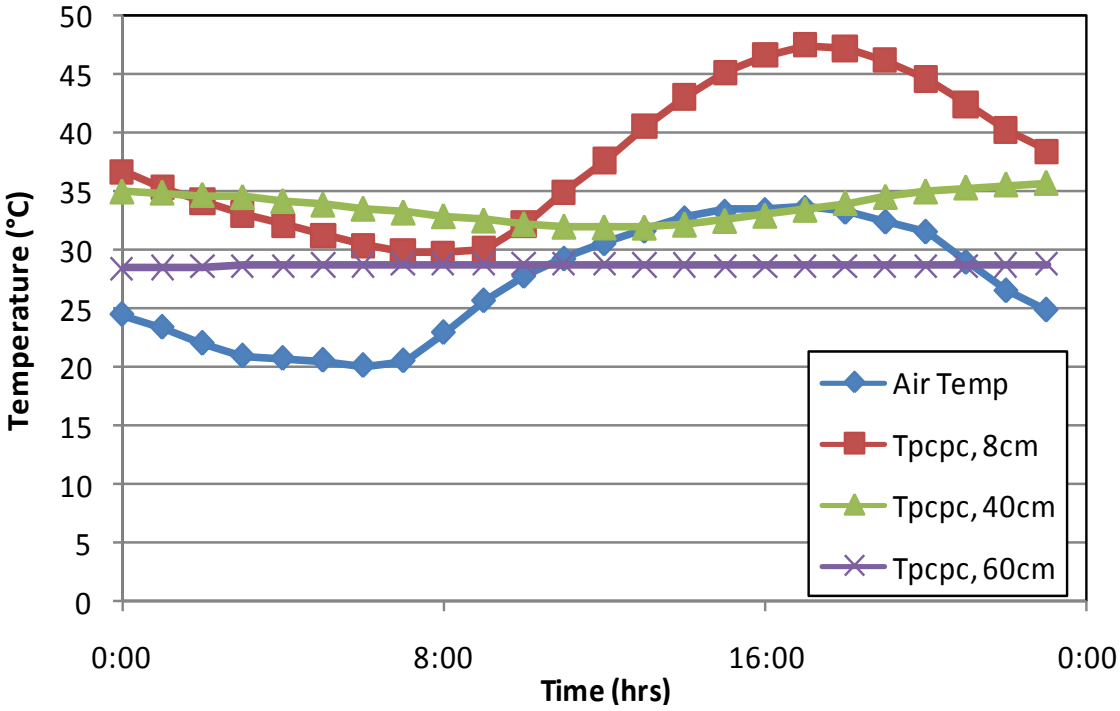


Figure 5. Hot Weather Temperature Behavior of a Pervious Concrete System (Kevern et al. 2009a)

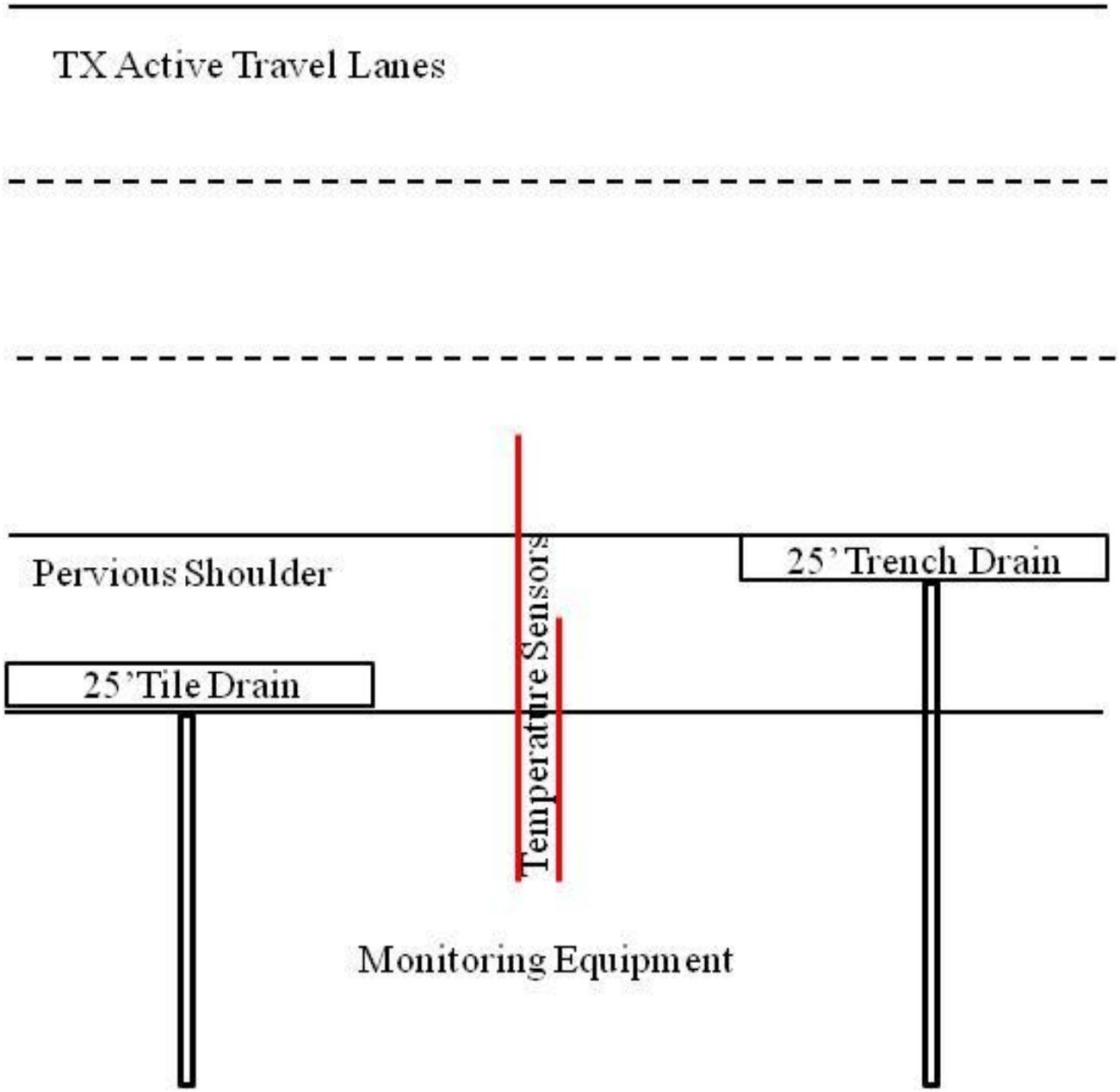
Temperature sensors before aggregate base and concrete construction

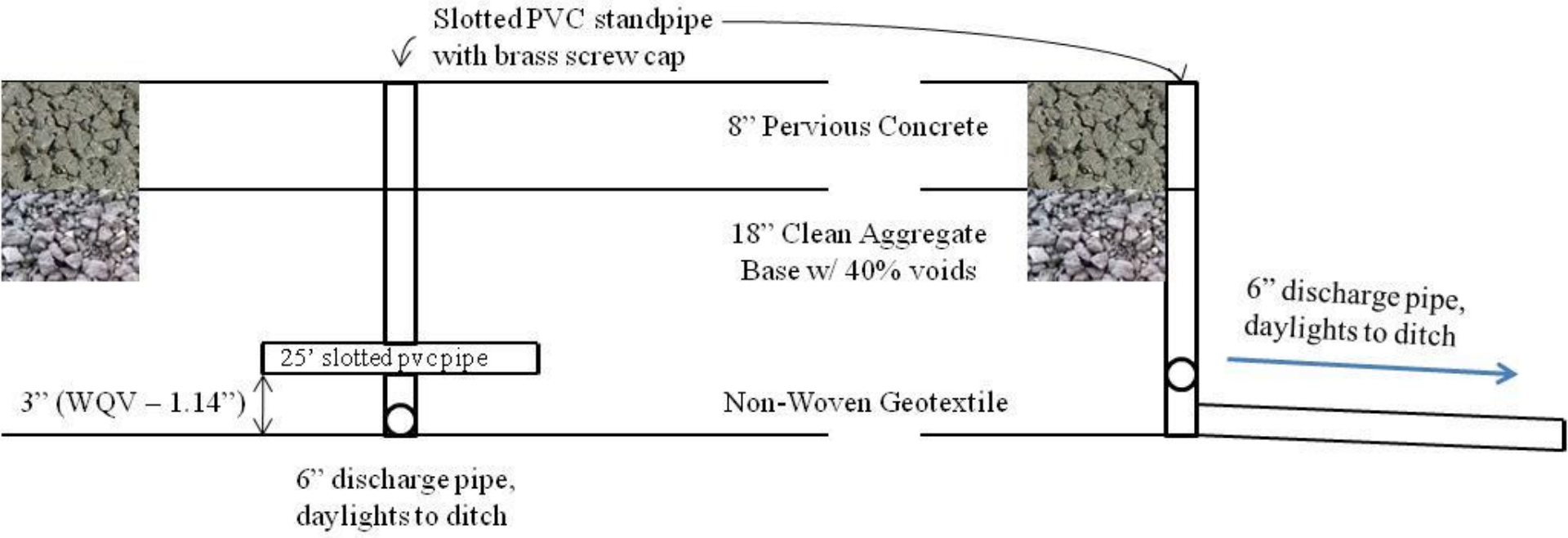
Stormwater Monitoring

- Stormwater reductions through runoff and infiltration
- First flush stormwater quality (hydrocarbons, heavy metals)
- Surface infiltration

Pervious concrete surface infiltration

First flush samplers in Texas


TX Active Travel Lanes
Pervious Shoulder
25' Trench Drain
25' Tile Drain
Temperature Sensors
Monitoring Equipment


Slotted PVC standpipe
with brass screw cap
8" Pervious Concrete
18" Clean Aggregate
Base w/ 40% voids
6" discharge pipe,
daylights to ditch
25' slotted pvc pipe
3" (WQV – 1.14")
Non-Woven Geotextile
6" discharge pipe,
daylights to ditch

Questions?


I'M WORRIED ABOUT GLOBAL WARMING BECAUSE THERE'S NO EASY SOLUTION.
WHAT ABOUT ASPHALT?
ASPHALT?
ROADS. PARKING LOTS. ROOFS. IF ALL THE ASPHALT IN THE WORLD WERE PAINTED WHITE (WHICH REFLECTS HEAT) INSTEAD OF BLACK (WHICH ABSORBS HEAT) THE WORLD WOULD BE MUCH COOLER... PERHAPS EVEN CHILLY.
RRRIGHT.
5/13
STILL WORRIED ABOUT GLOBAL WARMING?
NO.
NOW I'M WORRIED ABOUT YOUR BRAIN.
TELL HER ABOUT YOUR ALUMINUM FOIL HAT IDEA...
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