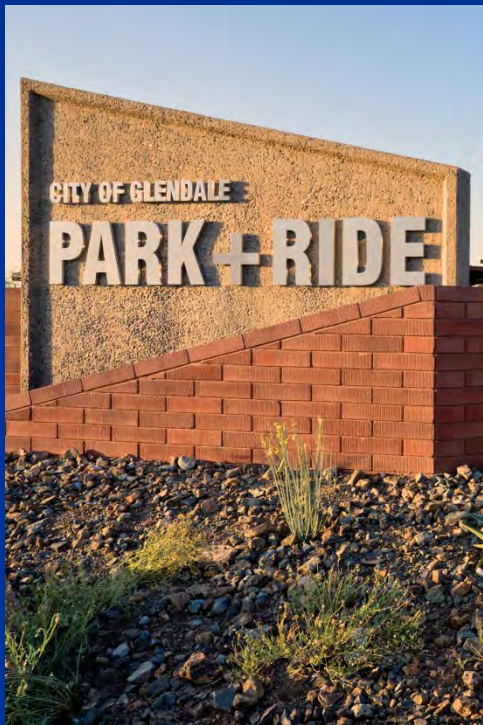


Border Green Infrastructure Forum

May 2015

Park and Ride Facility – Glendale

AZ



Overview

- ✓ Stormwater
 - ✓ LID / “Green” infrastructure
 - ✓ Pavements and pavement alternatives
- ✓ Pervious project history (Engineering perspective)
 - ✓ Project performance

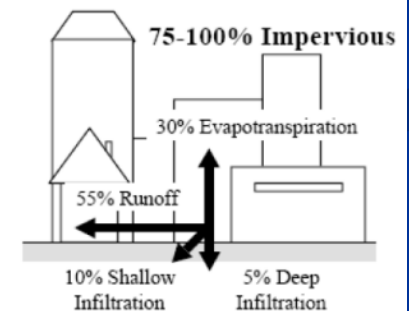
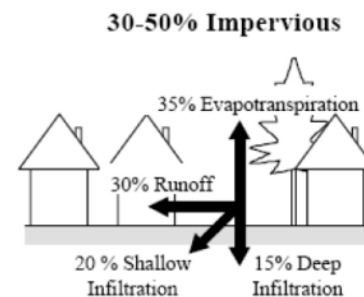
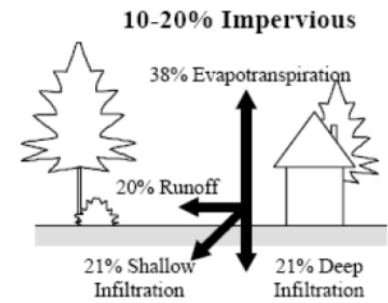
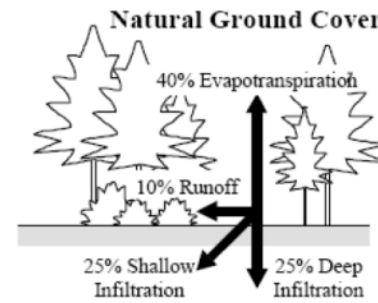


Stormwater “make-up” & runoff

REMEMBER – stormwater is not treated (MS4)



| Contaminant | Contaminant Sources |
|---------------------------------|--|
| Sediment and Floatables | Streets, lawns, driveways, roads, construction activities, atmospheric deposition, drainage channel erosion |
| Pesticides and Herbicides | Residential lawns and gardens, roadsides, utility right-of-ways, commercial and industrial landscaped areas, soil wash-off |
| Organic Materials | Residential lawns and gardens, commercial landscaping, animal wastes |
| Metals | Automobiles, bridges, atmospheric deposition, industrial areas, soil erosion, corroding metal surfaces, combustion processes |
| Oil and Grease/ Hydrocarbons | Roads, driveways, parking lots, vehicle maintenance areas, gas stations, illicit dumping to storm drains |
| Bacteria and Viruses | Lawns, roads, leaky sanitary sewer lines, sanitary sewer cross-connections, animal waste, septic systems |
| Nitrogen and Phosphorus | Lawn fertilizers, atmospheric deposition, automobile exhaust, soil erosion, animal waste, detergents |



How much water are we talking about?

- $7200ciA$ where C controls the amount !!!
 - 1 Acre impervious (surface) yields 74,200 gallons ($C=0.95$)
 - Park and Ride = 240,000 gallons for a 100 year event.
 - Retention requirements of property owners (cities too)
 - Most expensive part of development – land / development
 - Basins use up valuable land – why not eliminate?
 - What to do with all that water?



Low Impact Design (LID)

- LID - approach to work with nature to manage stormwater as close to its source as possible
 - Try to recreate natural features (parking lot?) to treat stormwater BEFORE it leaves the site
 - Minimizing imperviousness or “pass thru” stormwater. Actually USES stormwater as a resource rather than a waste product



LID “Toolkits” from an Engineers Perspective

- LID is a requirement of NPDES permit (AZ)
 - City of Glendale / City of Mesa LID toolkit
- In use, must assume capacity of system will be exceeded for all swales, basins, curb cuts, bio retention!
- In arid SW, still requires additional water sources such as irrigation
- Maintenance of LID item (ROW / Private?)
- Engineer – function is most important!
 - Flow control, detention, retention, filtration, infiltration, treatment – DUST WILL accumulate !!!!

Surface types

Flexible pavements – asphalt (HMA)

Rigid Pavements – concrete (PCCP)

Surface treatments – additives / emulsions

ALL

Lead to higher peak flows (Q's) – sheet flows

Reduce or substantially inhibit infiltration

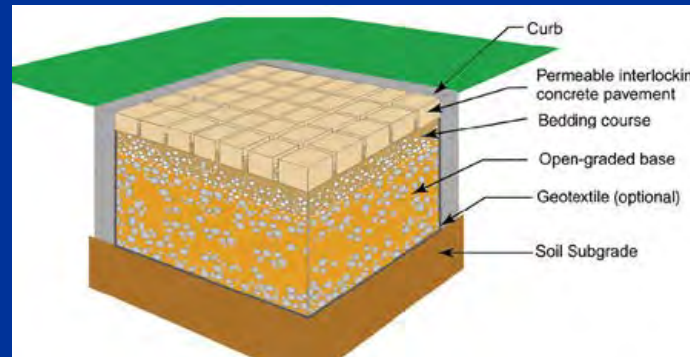
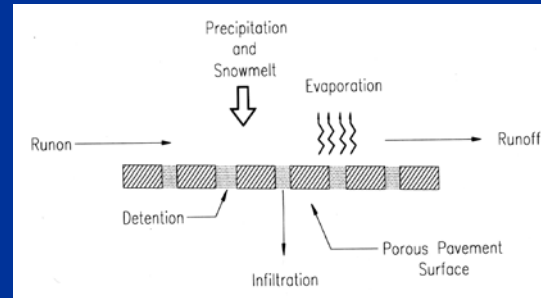
Lead to potentially unfiltered and contaminated stormwater runoff

Increase pollutant loads on streams / washes / “Waters of the US & Mexico”



What to do? - Open jointed pavers & geogrids

- “Permeable” pavements – allow water to pass around
 - Initial infiltration rates reduced less
 - Urban heat island effect reduced / mitigated
- LEED’s credit (Leadership in Energy and Environmental Design)
 - Mechanically installed – no cure time!



What else do to?

Pervious (porous) concrete / ~~asphalt~~ –
allow water to pass thru...



Park and ride Design concept

ORIGINAL concept

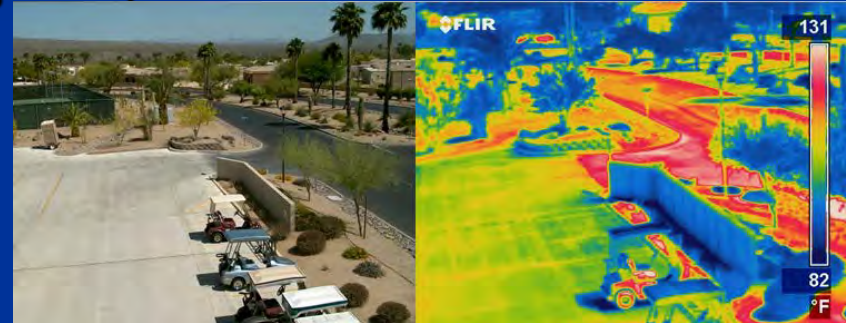
- Hot mix asphalt (HMA) on aggregate base course (ABC) for site
- Standard shade canopies for parking stalls

RE-EVALUATED concept (Council input / direction)

- Gravel Pave / Grass-pave / Geogrids / Pavers— ruled out for striping / use / consistency
- Upgraded shade canopies
- Pervious Concrete
 - Presented by Jacobs Engineering
 - Dr. Kamil E. Kaloush, PhD – ASU

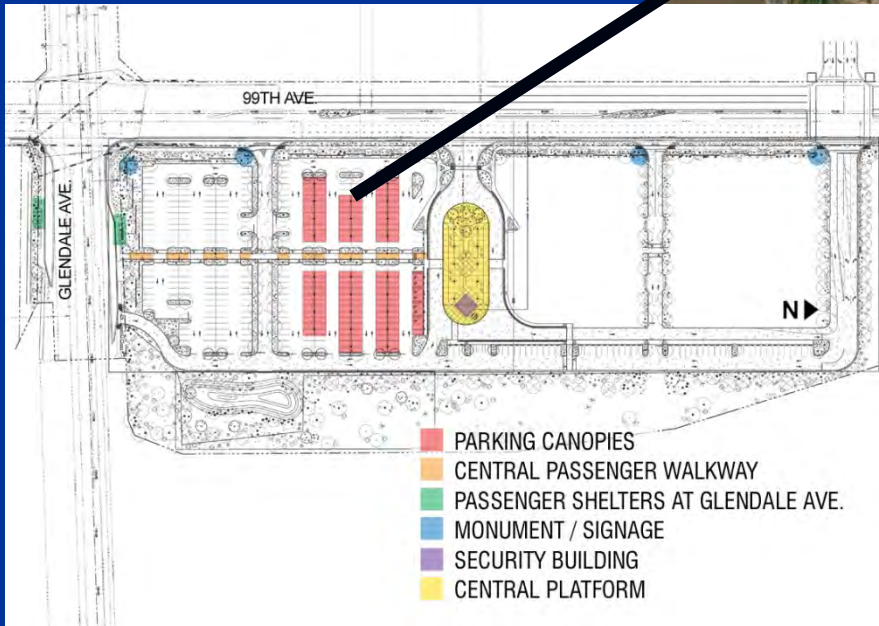
■ Attributes

- Not structurally sufficient – ONLY parking
- Mitigates heat island effect
- Size down or eliminate basins (0.95 to 0.3 -)
- Hydrocarbon remediation (97.6% to 99%)
 - Large surface area + food for bacteria etc.
 - Air degrades as well



Glendale Avenue Park and Ride

12 Acres - NE corner of 99th Avenue and Glendale
388 spaces (Phase 1) + 254 (Phase 2) = 642 at build-out



City Engineering concerns

■ Cost\$ (think benefits too!)

- HMA - \$693,570 (20 yr. = \$844,962)
- Pervious - \$916,460 (20yr. = \$844,070)
- Difference - \$222,890 (20 yr. = \$892)
 - Crack seal, slurry, striping, overlay, mill / overlay / oxidation



■ Primarily used in non-arid climates

- Arizona dust storms + “no rain” = pore clogging
- Installation during HOT summer months
- Increased Maintenance costs, long term durability
- Subsurface drainage / Developing specifications / Testing
 - Site characteristics, no arid specs. / compression & materials testing, surface spalling

More thinking

Acceptance / acceptance testing – (all LID) “Non-conventional” sampling techniques

- NRMCA (8 hour course) – City and consultants attended !
- Mix Temperature $<95\text{F}$ ($<90\text{F}$), voids by volumetric unit weight - truck batch weights
- 28 day compressive strength / thickness, unit weight / voids
- Thickness investigated if $>0.25\text{in.}$ MAG Specifications govern for removal-initially cored 14d samples for unit weights & thickness



Initial placement – August 2007

(110 degrees +/-)



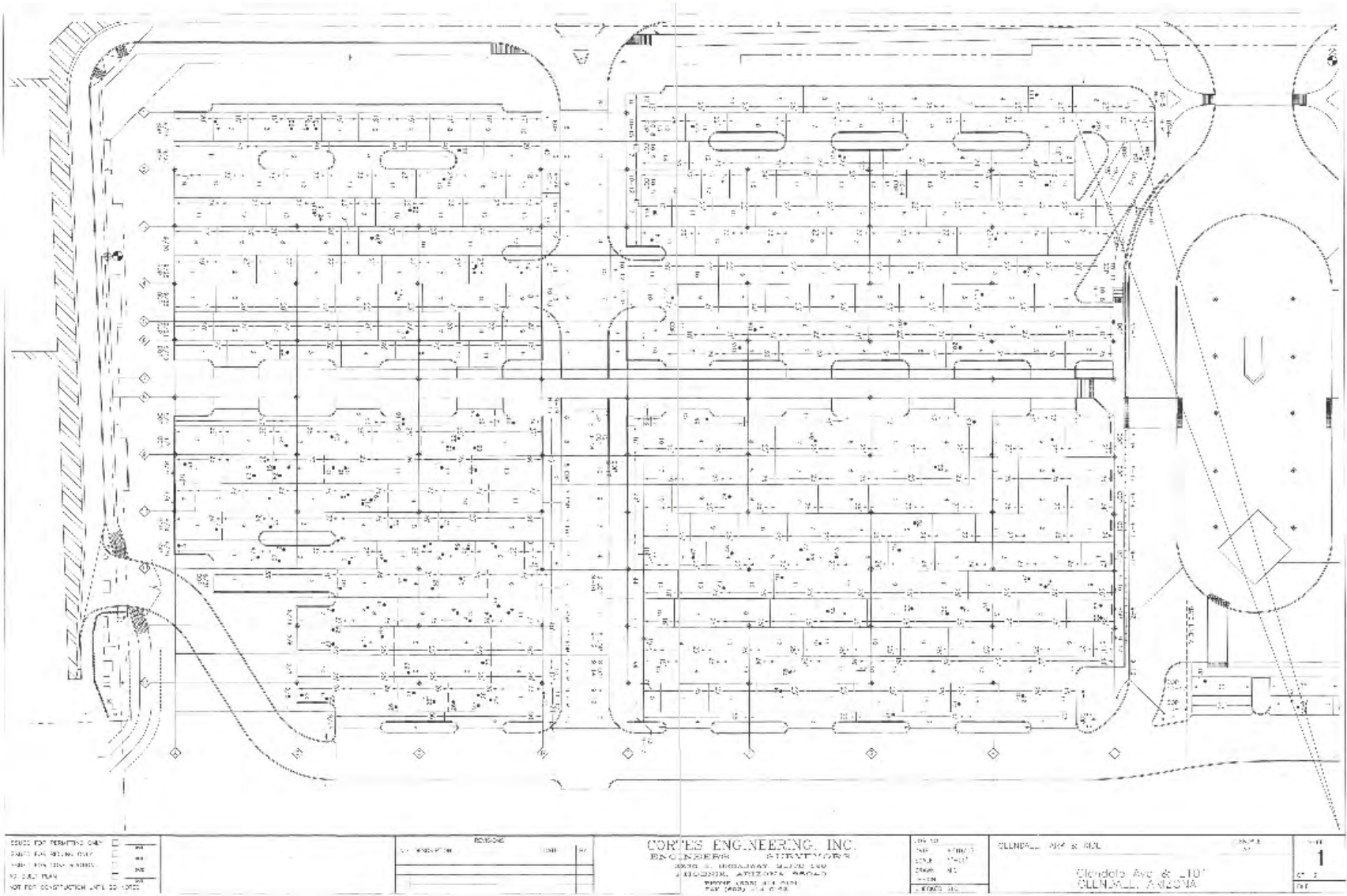
Continued placement thru October



Project acceptance – March 2008



Quality Assurance



SCALE FOR PERMITTING ONLY
DATE: 04/18/00
BY: [Signature]
NOT FOR CONSTRUCTION - 04/18/00

| NO. | REVISION | DATE | BY |
|-----|----------|------|----|
| | | | |
| | | | |

CORTES ENGINEERING, INC.
ENGINEERS ARCHITECTS
1000 N. HIGHLANDWAY SUITE 200
TULSONE, ARIZONA 85087
PHONE: (602) 414-0281
FAX: (602) 414-0282

DATE: 04/18/00
TIME: 10:00
DRAWN BY: [Signature]
CHECKED BY: [Signature]
PROJECT NO. 000000

CLIENT: [Name] & [Name]
ADDRESS: Glendale Ave & 110'
TULSONE, ARIZONA
SHEET NO. 1 OF 2

Final data summation

- Average strengths = 1325 psi to 2900 psi = 2174 psi average
- Unit weight = 103.7pcf to 124.5pcf = 115.1 pcf average
- Temperature – 1 load >95F (rejected by contractor)
- Voids = 21.3% to 34.6% Average = 27.3%
- Thickness 6.0” with 5.75” average – need to monitor depth of pavement
- Deficient thickness in about 10-15% of cores (<5.5”) – differing opinions on thickness measurement – **NEED TO MONITOR PLACEMENT @ QC** – not acceptance (too late)

DID / DOES / WILL IT WORK?

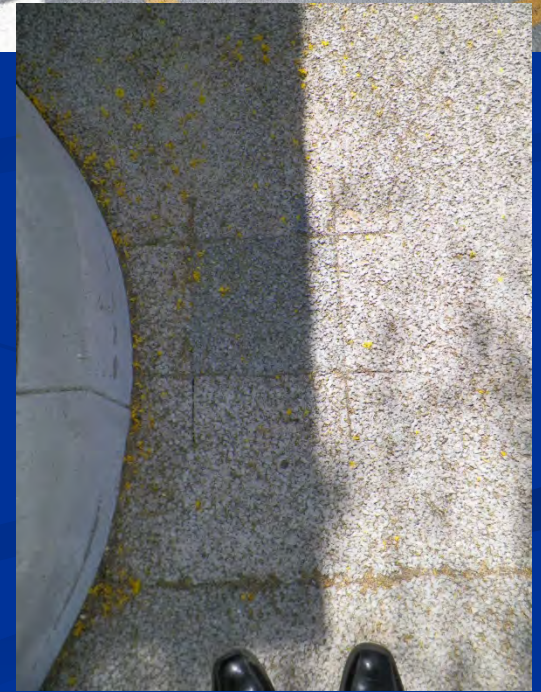
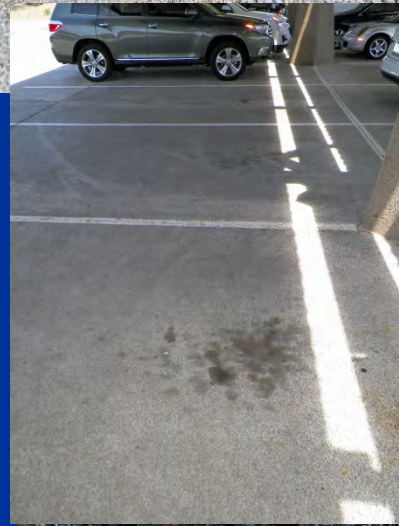
April 2010 (25 months old – 2 yr. +)



January 2013 (58 months old - < 5 yrs.)



April 2015 (86 months old – 7 yrs. +)

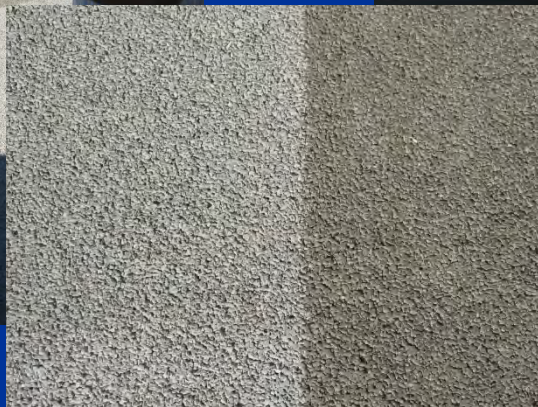


Challenges expected?

- Surface spalling?
- Crack propagation?
- Differential settlement
- Joint expansion
- Void structure durability

Maintenance

- Flush 4 times / yr. using water truck (remote)
- Inspect joints for cracks / debris
- Personal involvement
- Past maintenance
 - March 2012 (48mos)



| Total Seconds for Test | Total Inches Per Hour Test 8 lbs |
|------------------------|----------------------------------|
| 91 | 77.5 |
| 53.6 | 131.5 |
| 69.8% | |
| 38.8 | 181.7 |
| 36.9 | 191.0 |
| 5.1% | |
| 59.4 | 118.7 |
| 51.2 | 137.7 |
| 16.0% | |

Comparative uses / removals

| BMP Type | Typical Pollutant Removal (percent) | | | | |
|-------------------------------------|-------------------------------------|----------|------------|-----------|----------|
| | Suspended Solids | Nitrogen | Phosphorus | Pathogens | Metals |
| Dry Detention Basins | 30 - 65 | 15 - 45 | 15 - 45 | < 30 | 15 - 45 |
| Retention Basins | 50 - 80 | 30 - 65 | 30 - 65 | < 30 | 50 - 80 |
| Constructed Wetlands | 50 - 80 | < 30 | 15 - 45 | < 30 | 50 - 80 |
| Infiltration Basins | 50 - 80 | 50 - 80 | 50 - 80 | 65 - 100 | 50 - 80 |
| Infiltration Trenches/ Dry Wells | 50 - 80 | 50 - 80 | 15 - 45 | 65 - 100 | 50 - 80 |
| Porous Pavement | 65 - 100 | 65 - 100 | 30 - 65 | 65 - 100 | 65 - 100 |
| Grassed Swales | 30 - 65 | 15 - 45 | 15 - 45 | < 30 | 15 - 45 |
| Vegetated Filter Strips | 50 - 80 | 50 - 80 | 50 - 80 | < 30 | 30 - 65 |
| Surface Sand Filters | 50 - 80 | < 30 | 50 - 80 | < 30 | 50 - 80 |
| Other Media Filters | 65 - 100 | 15 - 45 | < 30 | < 30 | 50 - 80 |

Other projects in AZ?

- ASU Arts Building parking lot 2007
- NAU – Engineering building 2006
 - Failed – freeze / thaw (not in Southern AZ)
- Glendale Park and Ride 2008
- Superlite Block Facility
- Phoenix Cement Terminal

Pervious references

- Dr. Kamil Kaloush, PhD., P.E. – ASU Smart Technology Center
- Ken Ricker of RAMM Engineering – Specs. & Testing
- Mark Wavering / Pam Iacovo – Jacobs
- Mike Riggs (Owner) Progressive Concrete Works Inc. – Placement Contractor *Pervious Concrete You tube video*
- ASU National Center of Excellence “Pervious Concrete: Questions Answered” January 17, 2007 - Whitepaper
- National Redi-Mix Concrete Association (NRMCA)- Pervious Certification Course

Final closing comments

- Park and Ride has exceeded our expectations at the 7 year mark
 - Maintenance will be ongoing BUT surface is remarkably “new”
 - Use is at about 70-80%
 - Consideration for new Park / Ride in North Glendale – adjacent to the new river
 - LID Private is being integrated but for retention (require?)
 - LID ROW is being “integrated” at a calculated rate
 - Curb cuts, vegetated swales, bio retention – POST Inspections for NPDES

Questions ?????

