Porous Asphalt Pavements
"Some cause happiness wherever they go; others, whenever they go."
- Oscar Wilde (1854-1900)

But really, I am here to work with you!

Timothy R. Murphy, P.E.
President

Murphy Pavement Technology
Hello OH...With Love from IL
Special Thanks and Resources

NAPA

University of Washington

Oregon Asphalt Pavement Association

Tom Cahill

Cahill Associates Environment Consultants
Storm water Best Management Practices (BMP’s) in an Ultra-Urban Setting

• Porous asphalt has the potential to be an effective ultra-urban BMP.
• Porous asphalt works by allowing:
  ✓ streets,
  ✓ parking lots,
  ✓ sidewalks, and other impervious covers to retain their natural infiltration capacity while maintaining the structural and functional features of the materials they replace.
Construction Must-Haves

1. Sufficient pavement thickness to reduce overstressing the sub-grade.
2. Quality base and sub-base materials that can support the applied loads.
3. Stable surface that serves as the wearing course for traffic.
4. Compaction of all materials to provide strength and to resist densification under traffic.
Things I Thought Would Never Happen

• White Sox would win the World Series.
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• Chief Illiniwek would be under attack from the outside.
Things I Thought Would Never Happen

- White Sox would win the World Series.
- Chief Illiniwek would be under attack from the outside.
- Blackhawks would win the Stanley Cup.
Things I Thought Would Never Happen

• White Sox would win the World Series.
• Chief Illiniwek would be under attack from the outside.
• That I would make it here today.
Things I Thought Would Never Happen

• White Sox would win the World Series.
• Chief Illiniwek would be under attack from the outside.
• That I would make it here today.
• I would marry off a graduate and party like a pirate.

graduate and party like a pirate.
Things I Thought Would Never Happen

- White Sox would win the World Series.
- Chief Illiniwek would be under attack from the outside.
- Designing porous asphalt would be a good way to build structures.
What are Porous Pavements?

Open-Graded HMA ~ 2 ½” – 6”
½” Agg. (#57) ~ 1 – 3” Thick
Clean Uniformly Graded 2”-3” Crushed Agg. (#2) – 40% Voids for ~ 24” – 36”
Non-Woven Geotextile
Uncompacted Subgrade
Porous Asphalt
We have porous asphalt occasionally by accident...
Natural Conditions

Typical Annual Water Budget

Forested Land Cover

37.4% Evaporation-Transpiration

Surface 0.3% Runoff

Groundwater 36.6%

Interflow 25.7%

Courtesy May, U of W
Natural Conditions
Developed Conditions

Typical Annual Water Budget

Urbanized Land Cover

- 25% Evaporation-Transpiration
- 30% Runoff
- 30% Interflow
- 15% Groundwater

Courtesy May, U of W
Developed Conditions
Developed Conditions
Rainfall: 45"/yr

Evaporative loss from impervious surfaces: 2"

Reduced infiltration through regraded and compacted soils in grasses

0" of infiltration under impervious surfaces

Reduction in base flow by 15"/yr under impervious surfaces

43" runoff from impervious cover
Comparison of Detention vs. Infiltration Design Systems

![Graph showing discharge rates over time for Predevelopment, Post Development, Post Development with Detention, and Post Development with Recharge](image)
We call this development...
Porous bituminous pavement

- Developed by the Franklin Institute – 1972
- Tested in pilot projects during 1970’s
- Development of geo-textiles in 1979
- Current design since 1980
- CA has built over 150 projects since 1980
- Outstanding engineering project - 2000
Design

• Rainfall
  ✓ Typical designs for 6 month/24 hr storm
  ✓ Conservative design for 20 year/24 hr storm range from 1.4 to 15 in./24 hr.

• Meet Local & State wastewater mitigation requirements.
Keys to Success – Site Conditions

• Soil permeability/infiltration rate
  ✓ EPA recommends 0.5”/hour
  ✓ 0.1”/hour still OK

• Depth to bedrock > 2’

• Depth to high water > 3’

• Fill – not recommended

• Frost – pavement section should exceed frost depth
Soils Investigation

Borings and/or test pits

- Test permeability
- Determine depth to high water table
- Determine depth to bedrock
Keys to Success - Design

• Slope – limit surface slope to 5%
  ✓ Terrace when necessary
  ✓ Use conventional HMA for steeper slopes
• Avoid piping water long distances
• Spread infiltration over largest area possible; 5:1 Impervious: Infiltration
Avoid piping long distances
Reservoir and choker stone
Bottom Must Be Flat
Keys to Success – Design

• Usage / Vehicle Loading; Lightly loaded areas such as:
  ✔ Parking lots
  ✔ Low volume roads (limited truck use)
  ✔ Recreational Areas

• Establish structural requirements
Open-Graded HMA

- Binder Content 6.0% - 7.0%
- Consider using stiffer asphalt such as:
  - Modified asphalt
  - Fibers
- Thicker OGFC Hot Mix Asphalt – 2 layers?
  - ¾” top size bottom lift
  - ½” top size surface lift
Keys to Success – Construction

- Build porous pavement last
  - Protect from construction debris
  - Protect from soil laden runoff
- Protect site from heavy equipment
- Excavate to subgrade (soft footprint)
  - Don’t compact subgrade
  - Place filter fabric
Keys to Success – Construction

- Place reservoir course 1½” to 3” stone (if granular source then 95% double fracture).
- Place 1~2 inch layer of ½” stone to stabilize the reservoir course.
- Place porous asphalt course (2” to 4”) usually compacted with 2-3 passes of a 10-ton roller.
Paving and Compaction

- Paving as usual – recommend track paver
- Minimize truck movement over aggregate
- Static compaction
Construction Guidelines

- Restrict traffic for 24 hrs.
- Protect porous pavement from contamination:
  - Runoff sediment
  - Construction debris
Final construction step…
…does it work?
Maintenance

- Inspect several times first few months during storm events.
- Inspect annually thereafter.
- Pavement surface may be flushed or jet washed.
- Damage pavement can be repaired using dense hot mix provided <10% area.
Have a plan B

- Seal coats,
- Sand,
- Clogging over time.
Cost

- Cost of pavement structure more
- May be offset by reducing drainage structure costs
Keys to Success

- Maintenance
  - No sand
  - Install signs to designate porous pavement
- Patch with conventional asphalt < 10% area
Morris Arboretum
Philadelphia, PA

1984
Diagram of infiltration bed at Morris Arboretum
What about alleys?
What about roads?
Roads

- **Challenges**
  - ✔ Cuts and fills
  - ✔ Slope
  - ✔ Variable soil conditions
  - ✔ Utilities

- **Limited use**
Residential Streets
Residential Streets
Residential Streets
Residential Streets
Port of Portland
It does rain in Arizona
18 Years Later
Parking lot at the Florida Aquarium in Tampa. Serves 700,000 visitors annually. Designed as a research and demonstration project. Results found that load removal efficiencies for metals (copper, iron, lead, manganese and zinc) ranged from 23 to 59% for asphalt pavement with a swale.
Conclusions

• Porous pavements offer good alternative to conventional storm water mitigation.
• Site Conditions must be right.
• Need to protect pavement from contamination during and after construction.
• Properly designed and constructed will last more than 20 years.
In particular
HMAT
Magazine Vol. 13, # 3 Titled
Greening the Blacktop
Sustainability Counts in Today’s Market
Questions before I leave for the Windy City?

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