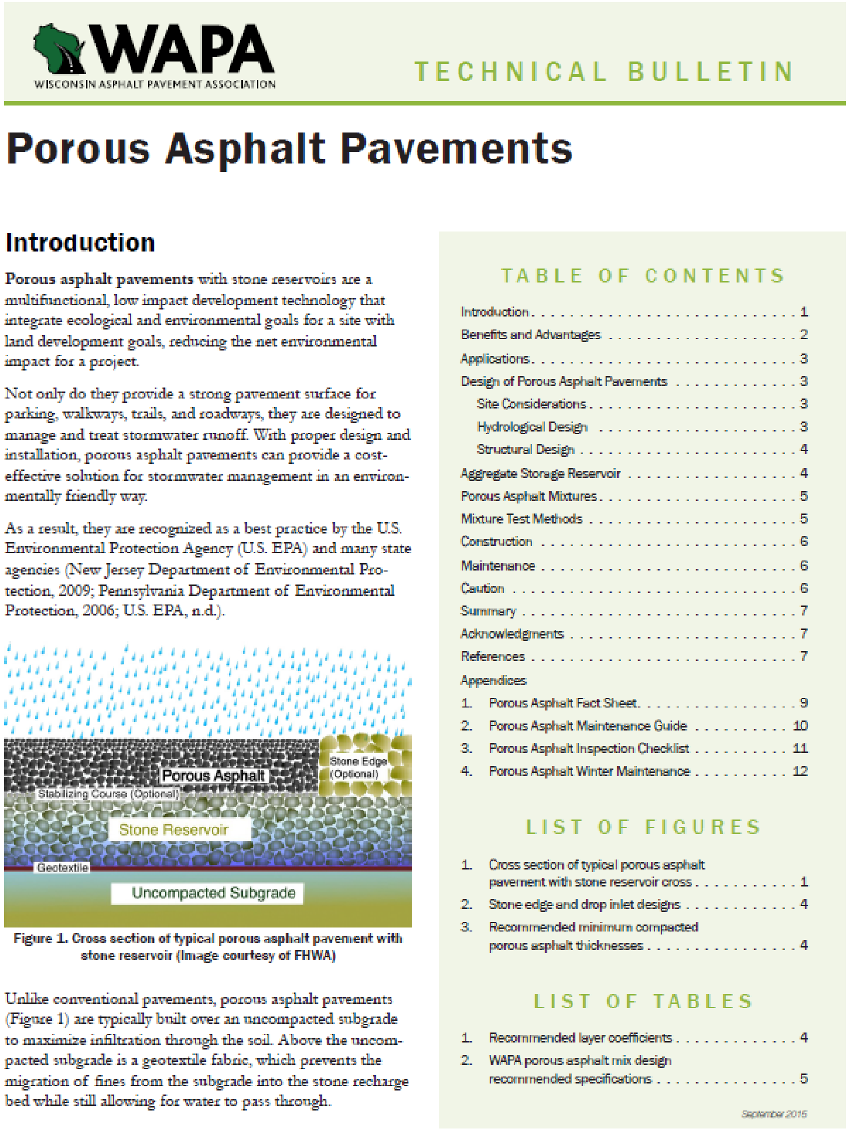
WISCONSIN ASPHALT PAVEMENT ASSOCIATION

Porous Asphalt Pavements

Fox-Wolf Watershed Alliance
19th Annual Watershed Conference
March 6, 2018

Presentation Outline

- Overview of Porous Asphalt Pavements
- Features, Benefits & Applications
- Design and Construction
- Example Projects
- Conclusions
- Questions



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TECHNICAL BULLETIN

Porous Asphalt Pavements

Introduction

Porous asphalt pavements with stone reservoirs are a multifunctional, low impact development technology that integrate ecological and environmental goals for a site with land development goals, reducing the net environmental impact for a project.

Not only do they provide a strong pavement surface for parking, walkways, trails, and roadways, they are designed to manage and treat stormwater runoff. With proper design and installation, porous asphalt pavements can provide a cost-effective solution for stormwater management in an environmentally friendly way.

As a result, they are recognized as a best practice by the U.S. Environmental Protection Agency (U.S. EPA) and many state agencies (New Jersey Department of Environmental Protection, 2009; Pennsylvania Department of Environmental Protection, 2006; U.S. EPA, n.d.).

Figure 1. Cross section of typical porous asphalt pavement with stone reservoir (Image courtesy of FHWA)

Unlike conventional pavements, porous asphalt pavements (Figure 1) are typically built over an uncompacted subgrade to maximize infiltration through the soil. Above the uncompacted subgrade is a geotextile fabric, which prevents the migration of fines from the subgrade into the stone recharge bed while still allowing for water to pass through.

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September 2015

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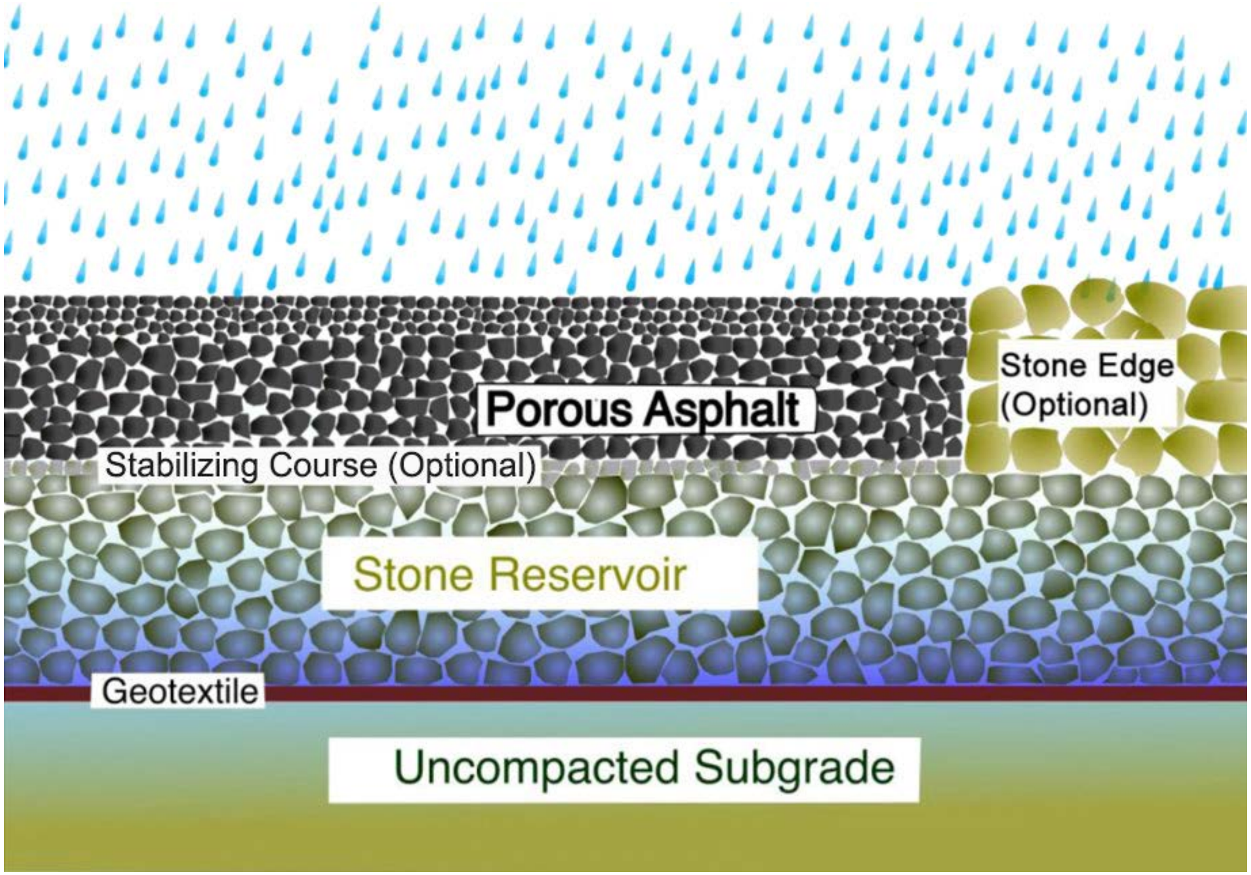
What is Porous Asphalt?



Cross section of typical porous asphalt pavement with stone reservoir

(Image courtesy of FHWA)

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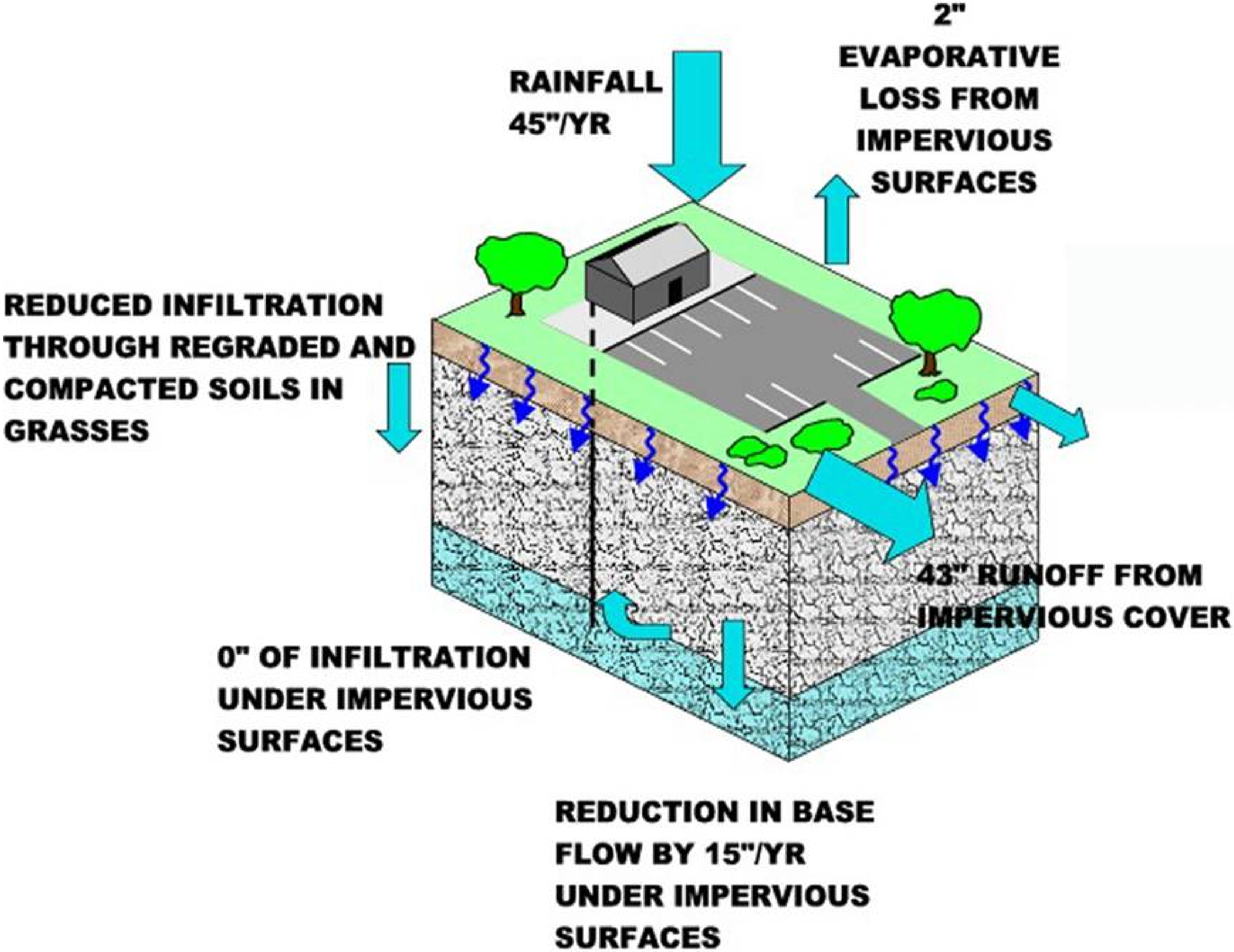
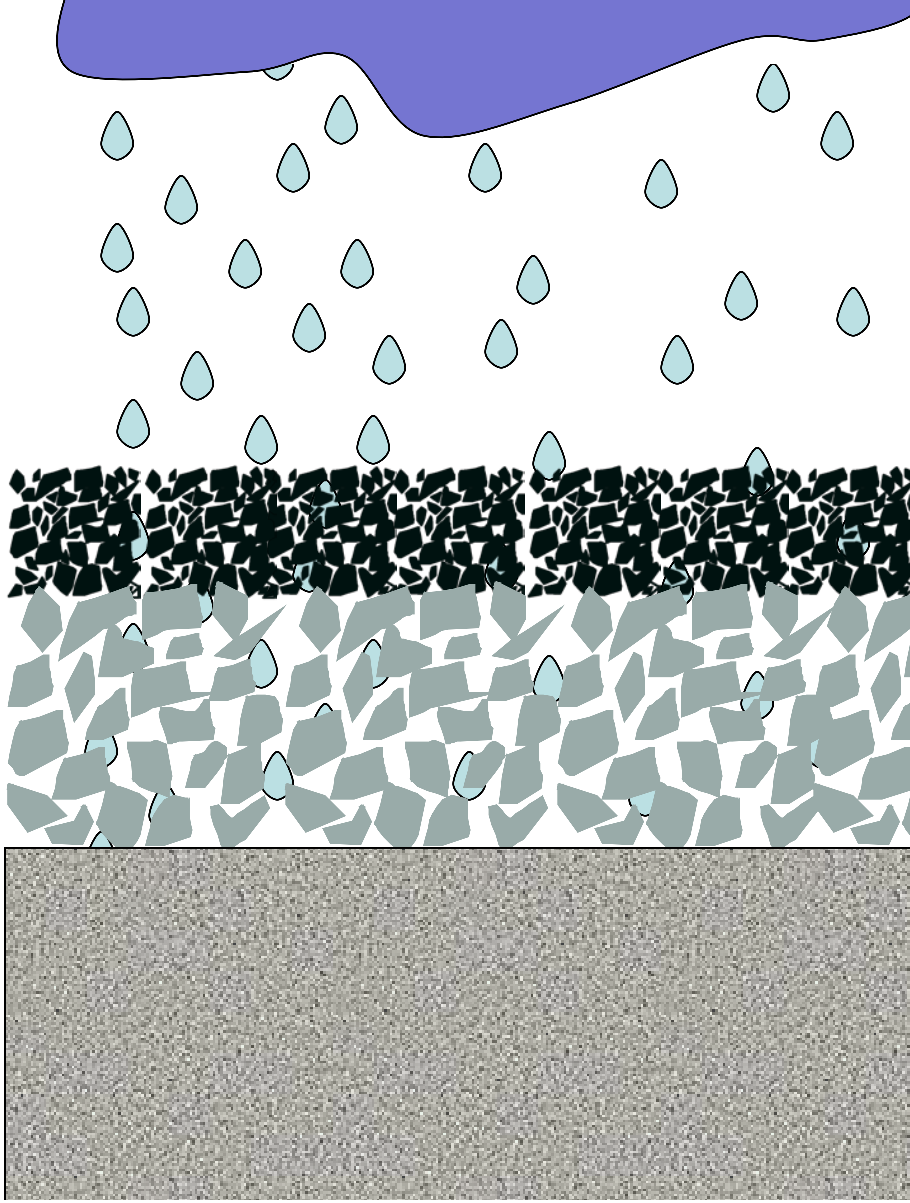
The concern/problem

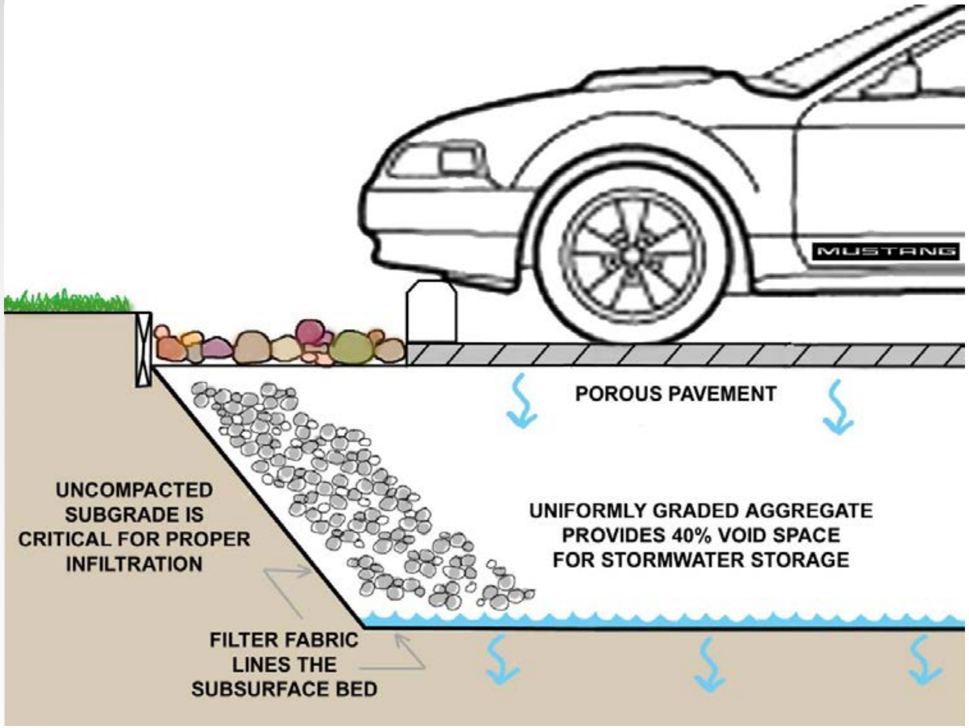
- Run-off from impervious surfaces
- Detention basins and retention ponds require additional land
- Pollution


RAINFALL
45"/YR
2"
EVAPORATIVE
LOSS FROM
IMPERVIOUS
SURFACES
REDUCED INFILTRATION
THROUGH REGRADED AND
COMPACTED SOILS IN
GRASSES
43" RUNOFF FROM
IMPERVIOUS COVER
0" OF INFILTRATION
UNDER IMPERVIOUS
SURFACES
REDUCTION IN BASE
FLOW BY 15"/YR
UNDER IMPERVIOUS
SURFACES



Why Porous Asphalt?

- Reduce impervious surface
- Reduces runoff
- Recharge ground water
- Improve water quality
- Eliminate need for detention basins
- Reduce permitting requirements



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Why Porous Asphalt?

- Reduces hydroplaning
- Reduces glare
- Reduces tire spray
- Reduced tire-pavement noise
- Less susceptible to frost
- Reduces use of de-icing chemicals

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POROUS ASPHALT FACT SHEET

Porous Asphalt Pavement for Stormwater Management	
Benefits and Uses	Porous asphalt can be used in place of traditional stormwater management measures given the proper conditions. Porous asphalt's primary advantages are: • Quantity and flood control. • Water quality treatment. • Recharges groundwater to underlying aquifers. • Allows for reduction of stormwater infrastructure (piping, catch basins, retention ponds, curbing, etc.). • Suitable for cold-climate applications; maintains recharge capacity when frozen. • Allows for reduced salt usage due to low/no black ice development. • Maintains traction while wet. • Reduced spray from traveling vehicles; reduced roadway noise. • Extended pavement life due to well-drained base and reduced freeze/thaw.
Disadvantages	• Requires routine vacuum sweeping/pressure washing. • Proper construction stabilization and erosion control are required to prevent clogging. • Seal coating or similar surface treatment will cause failure.
Cost and Maintenance	• Total project cost for porous asphalt with reduced stormwater infrastructure is comparable to standard pavement applications where typical stormwater infrastructure is required. • Materials cost is more than traditional asphalt but can be offset by deicing costs. • Long-term maintenance is required by routine vacuum sweeping. • Sweeping cost may be offset by reduced deicing costs. • Repairs can be made with standard asphalt, not to exceed 15% of surface area.
Design Criteria	• Recommended drainage time of 24–48 hours. • Sub-drains should be used to minimize frost damage where proper drainage may be an issue. • Most appropriate for use with low-volume roadways, pathways, and parking lots.
For More Information	See WAPA's *Porous Asphalt Pavements Design Guide*.

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Where to use Porous Asphalt?

- Parking lots
- Low volume roadways
- Alleyways
- Recreational Facilities
  - Playgrounds
  - Tennis courts
  - Pathways
  - Bike Paths
  - Shoulders

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Design

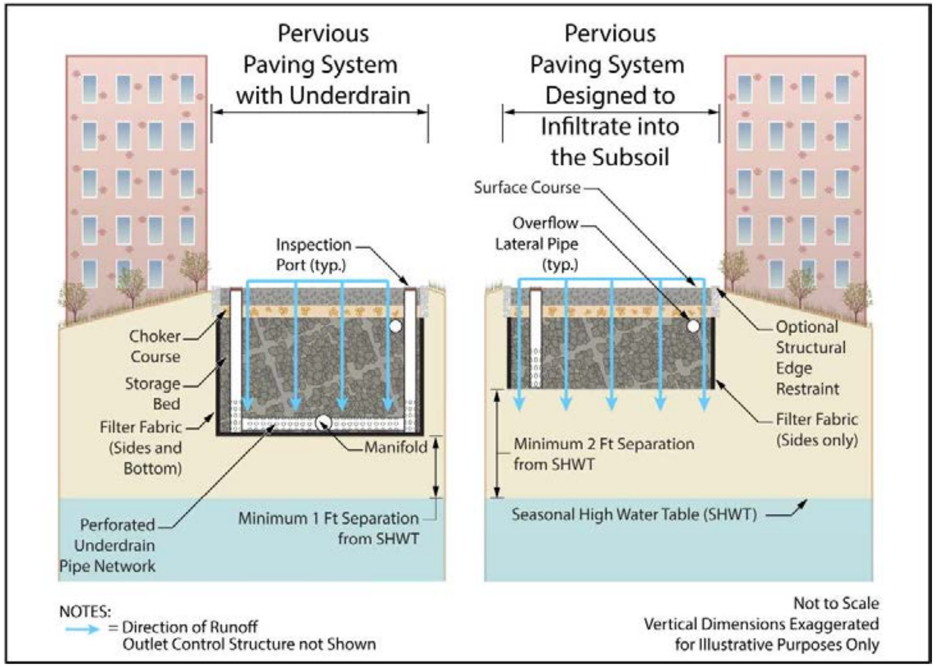
Porous Asphalt Pavements

History of Porous Asphalt Pavements

- Developed by the Franklin Institute – 1972
- Tested in pilot projects during 1970's
- Development of geotextiles in 1979
- Current design since 1980
- Thousands of projects have been constructed in the Midwest
- You will hear about quite a few locally as well

Important Considerations

- Subgrade condition
  - Sand
  - Silt
  - Clay
- Seasonal high groundwater table
- Discharge system?
  - Infiltration
  - Mechanical (Underdrain)



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Keys to Success-Site Conditions

- Soil permeability/infiltration rate
  - EPA recommends 0.5 inches/hour
  - 0.1 to 10 inches/hour is acceptable
- Depth to bedrock greater than 2 feet
- Depth to high water greater than 3 feet
- Fill – not recommended
- Frost - research says 30% of frost depth

Soils Investigation

- Borings and/or test pits
- Test permeability
- Determine depth to high water table
- Determine depth to bedrock

Keys to Success

- Slope-limit surface slope to 5%
- Terrace when necessary
- Use conventional HMA for steeper slopes
- Avoid the costs of piping water long distances
  - Use the recharge bed to collect stormwater from other impervious areas
- Spread infiltration over largest area possible
  - 5 acres impervious/1 acre porous

Typical Cross Section

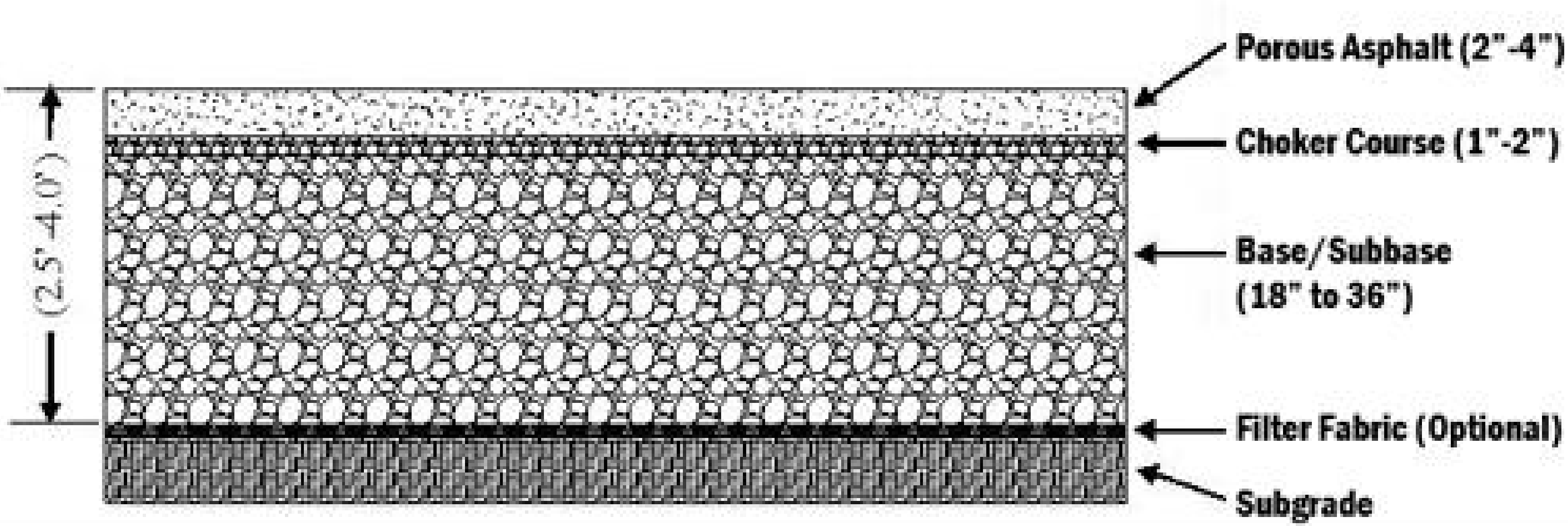

Figure 3. Typical Porous Asphalt Pavement Section *(diagram adapted from US EPA)*

Materials – Stabilization Course

- Engineering judgment is required to determine if a stabilization course is necessary
- A stabilization course should be used if there is a potential for the subgrade to compress or to be subject to lateral movement during construction

Materials – Reservoir Bed

Best practices:

- Storage bed aggregate must be **clean**, uniformly-graded broken stone whose size designation is appropriate for the surface course desired and design load conditions. The stone must be washed, prior to placement, to minimize the amount of stone dust and other fine particles that can clog the surface of the subsoil.

Materials – Choker Course

Best practices:

- The choker course must consist of **clean**, **washed** broken stone whose size designation is appropriate for the surface course desired and design load conditions. The smallest size designation that may be used is AASHTO No. 57.

The choker course will lock in the reservoir bed, providing a smooth surface for paving

Aggregate Materials

AGGREGATE		
Property		**Value**
LA Abrasion (% Loss) [AASHTO T96]	100 revolutions	13 max
	500 revolutions	45 max
Soundness (% Loss) Using Sodium Sulfate [AASHTO T104]		12 max
Freeze/Thaw Soundness (% Loss) [AASHTO T103]		18 max
Fractured Faces (% by Count) [ASTM D5821]	2 faces	90 min
	1 face	100 min
Flat and Elongated (% by Weight) [ASTM D7064M]		5% max; 5:1 ratio

Aggregate Gradation

BLENDED AGGREGATE GRADATION			
Property		Value	
		12.5 mm NMAS	9.5 mm NMAS
Sieve (% Passing)	3/4"	100	n/a
	1/2"	85-100	100
	3/8"	55-75	90-100
	#4	10-25	15-40
	#8	3-15	5-20
	#200	1-4	2-6
Voids in Mineral Aggregate (%)		24 min	25 min

HMA Mixtures

MIX		
Property	**Value**	**Notes**
Binder Content	5.5%	5.2–6.0% is recommended depending on Nmas gradation.
Binder Grade	28	Minimum high temperature of 64°C is recommended. PG 64-28 or PG 70-28 modified binders can be specified in an effort to provide improved mix stability and durability.
Percent Binder Replacement	25 max	
% Air Voids (V_a @ 50 gyrations)	18–22	
Dust to Effective Binder Ratio	1.0 max	
Tensile Strength Ratio (TSR @ 50 gyrations and design air voids) [ASTM D4867]	70% min	
Draindown at Production Temperature	0.3% max	Effective measures to reduce draindown include the use of manufactured sand in lieu of crusher screenings as well as the use of fibers or recycled asphalt shingles.
NOTE: It is also considered to be acceptable practice to follow ASTM D6752, "Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method," as the method to determine the bulk specific gravity for the air voids determination.		

Construction

Porous Asphalt Pavements

Bed Excavation

- Excavate bed to plan elevation using equipment w/ “soft footprint”
- Don’t compact subgrade*

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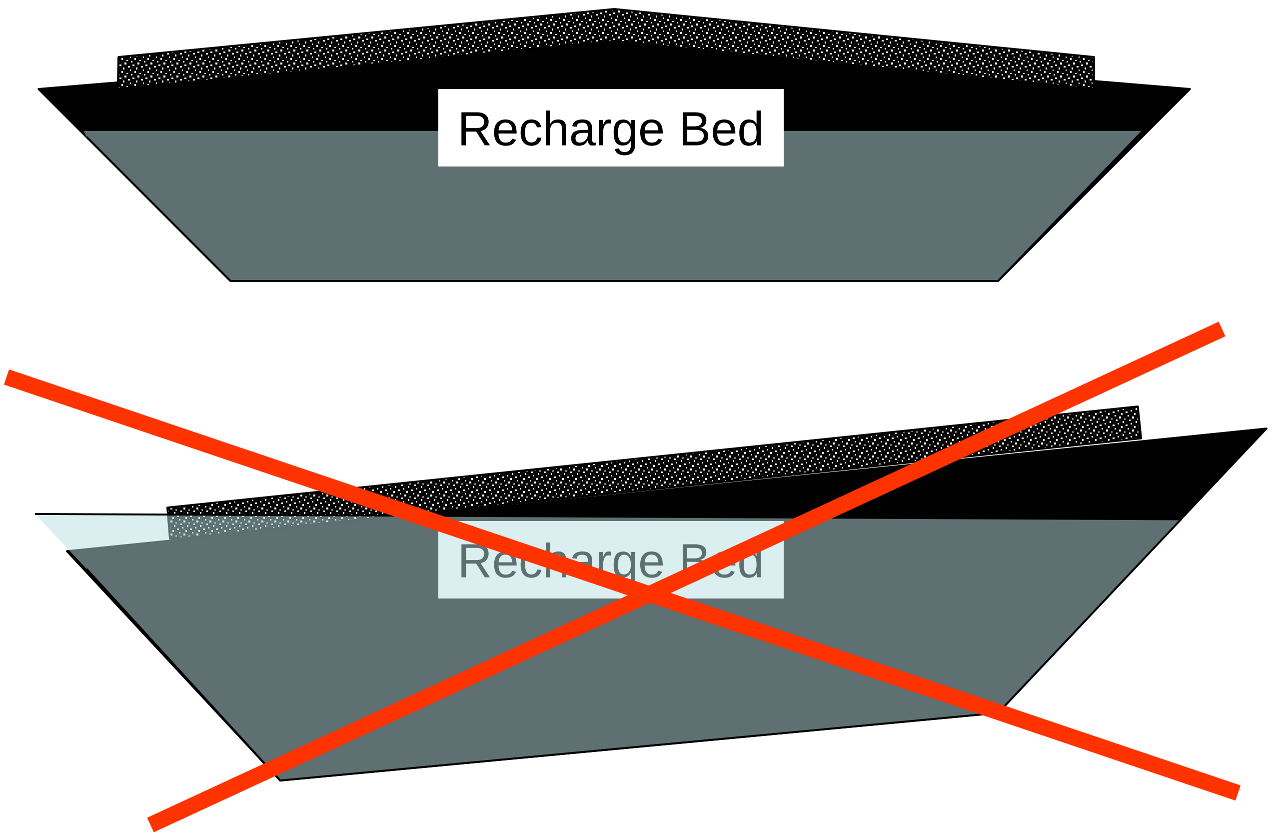
Bottom Must Be Flat



Non-woven Geotextile

- Spread geotextile immediately after fine grading
- Overlap fabric >16” at seams
- Install drainage pipes if used
- Excess fabric (>4’) folded over aggregate until paving will occur, then cut away

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Stone Recharge Bed

- Place **clean**, single size (1½"-3"), **washed** aggregate
- Do not drive trucks on fabric
- Spread and grade with tracked equipment in 8" lifts
- Light compaction – static (40% air voids)
- Protect pipes

Choker Course

- Place "Choker" course – ½" clean washed aggregate
  - Creates a stable paving platform
  - Typically 1 – 2" thick
  - Grade and compact
    - Static
    - Vibratory if using low amplitude, high frequency

Paving

- Paving should be done last
  - 2-4” single lift
  - Recommend track paver
  - Less rolling required
- Avoid truck movements over aggregate
  - Stability may be an issue
  - Avoid disturbing aggregate surface
- Plan for production to be less than normal

Compaction

- Use Static compaction
- Breakdown with a 10 ton steel wheel roller
  - 2 – 4 passes total
- Finish with a 3.5-5 ton roller

Rolling Temperature is Critical

- Beware of asphalt surface cooling too quickly
- Wind speed ideally 0-3 mph
- No paving of surface course under 50°
- Forecast not showing impeding storms until paving is complete

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Post Construction

- Limit traffic for 48 hours to allow to set up
- Keep sediment control in place until vegetation is established
- Protect pavement from contamination
- Inspect for design compliance several times during storm event for the first few months-then annually

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POROUS ASPHALT INSPECTION CHECKLIST

Inspection Checklist for Porous Pavements			
LOCATION		INSPECTOR	
DATE	TIME	SITE CONDITIONS	
DATE SINCE LAST RAIN EVENT			

Inspection Items	Satisfactory (S) or Unsatisfactory (U)	Comments/ Corrective Action
1. Salt/Deicing		
Use salt only for ice management	S or U	
Piles of accumulated salt removed in spring	S or U	
2. Debris Cleanup (2–4 times a year minimum, spring and fall)		
Clean porous pavement to remove sediment and organic debris on the pavement surface via vacuum street sweeper	S or U	
Adjacent nonporous pavement vacuumed	S or U	
Clean catch basins (if available)	S or U	
3. Controlling Run-On (2–4 times a year)		
Adjacent vegetated areas show no signs of erosion and run-on to porous pavement	S or U	
4. Outlet/Catch Basin Inspection (if available) (2 times a year and after large storm events)		
No evidence of blockage	S or U	
Good condition; no need for cleaning/repair	S or U	
5. Poorly Draining Pavement (2–4 times a year)		
Pavement has been pressure washed and vacuumed	S or U	
6. Pavement Condition (2–4 times a year minimum, spring and fall)		
No evidence of deterioration	S or U	
No evidence of improper design load applied	S or U	
7. Signage/Stockpiling (as needed)		
Proper signage posted indicating usage for traffic load	S or U	
No stockpiling and no seal coating	S or U	

Corrective Action Needed	Due Date
1.	
2.	
3.	
4.	
5.	

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Maintenance

Porous Asphalt Pavements

Maintenance Considerations

Proper maintenance is critical to the success of porous pavement systems

- DO NOT use a porous pavement for storage of any materials (including plowed snow)
- DO NOT use sealers or coatings of any kind that will clog the surface
- DO Inspect the surface course annually for any distress – repair areas by removal and replacement of the surface course

Maintenance Considerations

- DO NOT set plow blades to a level that will damage the surface
- DO NOT use sand, cinders, or any de-icing materials that don't dissolve in solution
- DO maintain adjacent vegetated areas

Maintenance Considerations

- Two-four times a year the pavement should be vacuumed-not power swept
  - Vacuum for Spring cleanup after final snow event
  - Vacuum for Fall cleanup after the leaves have fallen
  - Power wash after vacuuming
  - Pressure washing can be effective for clogged areas

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POROUS ASPHALT MAINTENANCE GUIDE

Regular Inspection and Maintenance Guidance for Porous Pavements

Regular inspection and maintenance are critical to the effective operation of porous pavement. It is the responsibility of the owner to maintain the pavement in accordance with the minimum design standards. This page provides guidance on maintenance activities that are typically required for these systems along with the suggested frequency for each activity. Individual systems may have more or less frequent maintenance needs, depending on a variety of factors, including the occurrence of large storm events, seasonal changes, and traffic conditions.

Inspection Activities

Visual inspections are an integral part of system maintenance. This includes monitoring pavement to ensure water drainage, debris accumulation, and surface deterioration.

ACTIVITY	FREQUENCY
Check for standing water on the surface of the pavement after a precipitation event.	2–4 times per year; more frequently for high-use sites or sites with higher potential for run-on
Vacuum sweeper shall be used regularly to remove sediment and organic debris on the pavement surface. The sweeper may be fitted with water jets.	
Pavement vacuuming should occur during spring cleanup following the last snow event to remove accumulated debris, at a minimum.	
Pavement vacuuming should occur during fall cleanup to remove dead leaves, at a minimum.	
Power washing can be an effective tool for cleaning clogged areas.	
Check for debris accumulating on pavement, especially debris buildup in winter. For loose debris, a power/leaf blower or gutter broom can be used to remove leaves and trash.	
Check for damage to porous pavements from nondesign loads.	

Maintenance Activities

Routine preventative cleaning is more effective than corrective cleaning.

ACTIVITY	FREQUENCY
Controlling run-on and debris tracking is key to extending the life of porous surfaces. Erosion and sedimentation control of adjacent areas is crucial.	As needed
Repairs may be needed following utility repairs. Repairs can be made using standard (nonporous) asphalt for most damages. Repairs using standard asphalt should not exceed 15% of total area.	
Do not store materials such as sand/salt, mulch, soil, yard waste, and other stockpiles on porous surfaces.	
Stockpiled snow areas on porous pavements will require additional maintenance and vacuuming. Stockpiling snow on porous pavements is not recommended and will lead to premature clogging.	
Posting of signage is recommended indicating presence of porous pavement. Signage should display limitations of design loads (i.e., passenger vehicles only, light truck traffic, etc., as per pavement durability rating).	
Damage can occur to porous pavement from nondesign loads.	

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POROUS ASPHALT WINTER MAINTENANCE

Winter Maintenance Guidelines for Porous Pavements	
Maintenance Guidelines	• If possible, plow with a slightly raised blade; while not necessary, this will help prevent pavement scarring. • Up to approximately 75% salt reduction for porous asphalt can be achieved. Salt reduction amounts are site-specific and are affected by degree of shading. • Apply anti-icing treatments prior to storms if possible. Anti-icing has the potential to provide the benefit of increased traffic safety at the lowest cost and with less environmental impact. • Deicing is NOT required for black ice development. Meltwater readily drains through porous surfaces thereby preventing black ice. • Apply deicing treatments during and after storms as necessary to control compact snow and ice not removed by plowing. • Vacuum porous areas a minimum of 2–4 times per year, especially after winter and fall seasons when debris accumulation and deposition are greatest. • If ponding water is observed during precipitation, cleaning is recommended.
Winter Maintenance Challenges	• Mixed precipitation and compact snow or ice are problematic for all paved surfaces, but are particularly problematic for porous surfaces. This is corrected by application of additional deicing materials. • Deicing materials work by lowering the freezing point of water. Generally, the longer a deicing chemical has to react, the greater the amount of melting. Meltwater readily drains through porous surfaces thereby reducing chemical contact time. This is corrected by application of additional deicing materials. • Additional salt application in these instances is offset by the overall reduced salt during routine winter maintenance.
For More Information	See WAPA's *Porous Asphalt Pavements Design Guide*.

Costs

Porous Asphalt Pavements

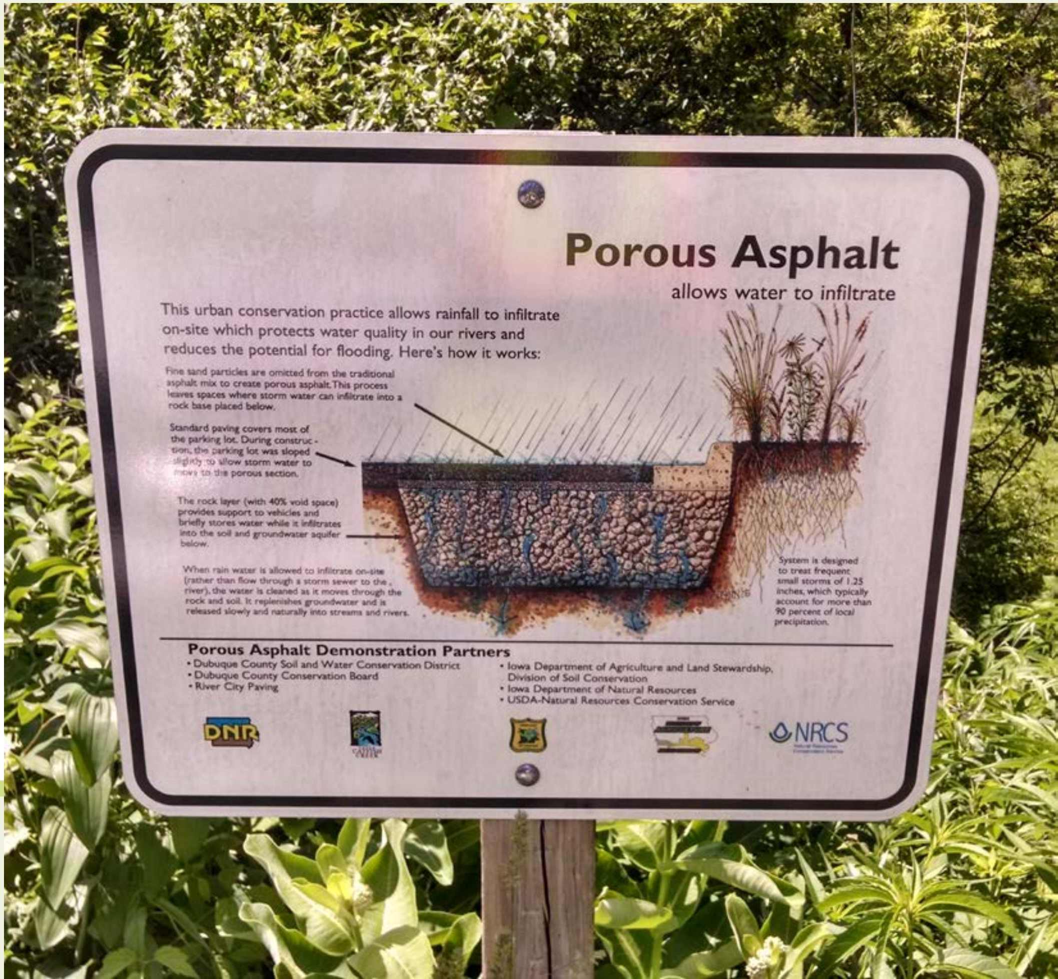
Cost Breakdowns

- Decrease in Costs
  - Decrease in quantity of HMA needed
  - Ice mitigation budgets decreased 75-100%
  - Can shorten construction time if other features aren't necessary
  - Decrease of other drainage features
    - Retention ponds
    - Detention basins
    - Others

- Increase in Costs
  - Pavement structure typically costs more
  - Labor costs are higher; slower production; more hands on
  - Materials are more expensive
    - Clean aggregates
    - Polymer binders
    - Additives
    - Fiber potential

Projects

Porous Asphalt Pavements



Permeable Pavement Test Site- Sycamore Avenue Madison

Bay Beach Amusement Park

Bay Beach Amusement Park

UW-Platteville Football Field

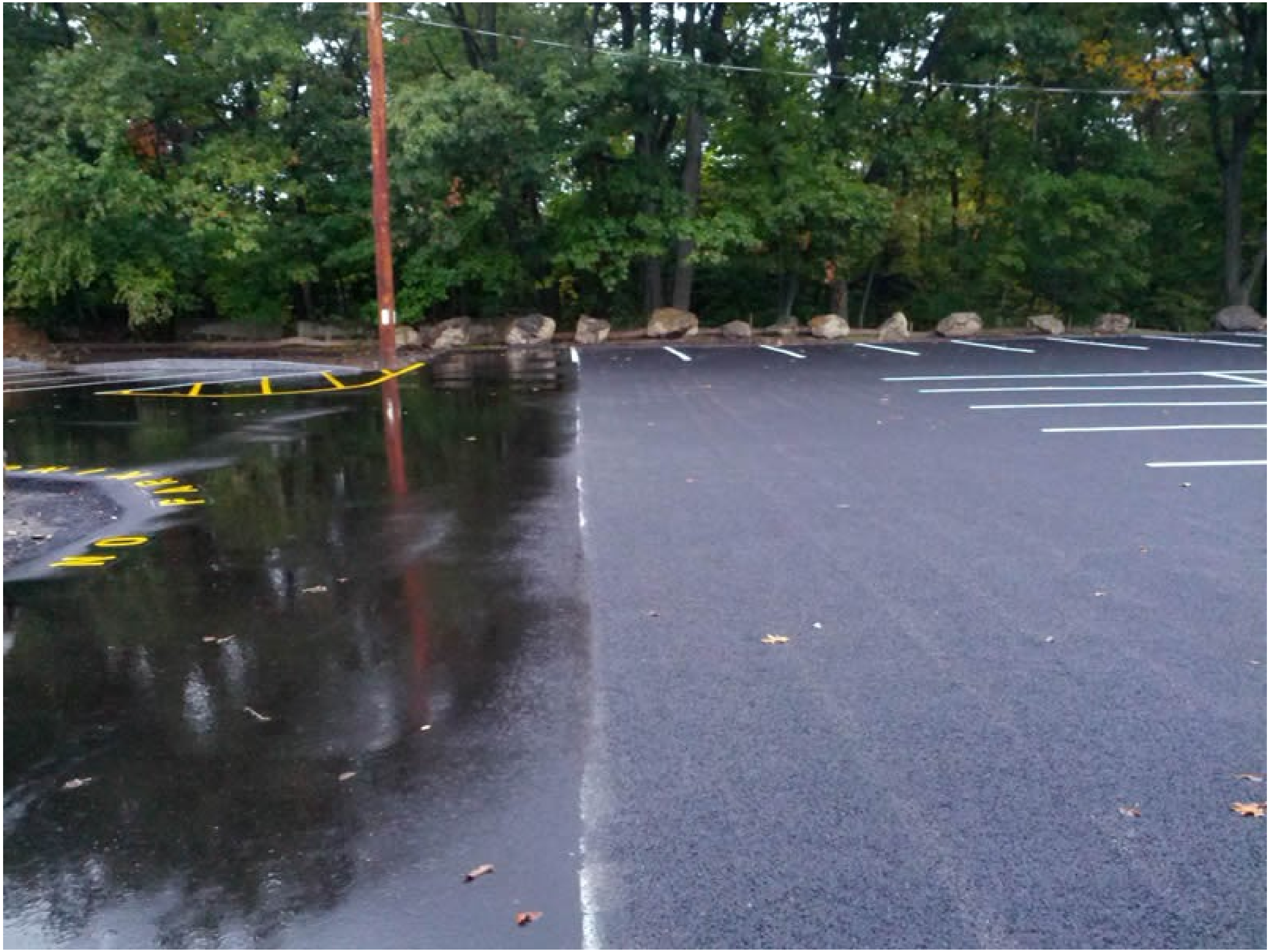
UW-Lacrosse Football Field

Volk Airport Field

10th Street

Bayfield Resort

Dubuque Parking Lot-6 years old



TYPES OF POROUS PAVEMENT

Porous Asphalt

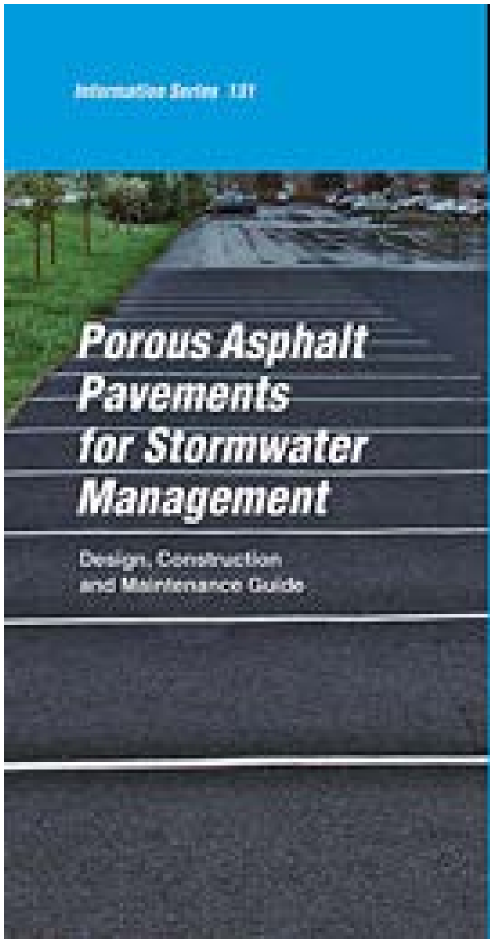
Figure 2. Infiltration of 30 gallons per minute from a 2-inch hose at UNH.

Image courtesy University of New Hampshire Stormwater Center

Conclusions

- Porous pavements offer good alternative to conventional stormwater 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
- Porous Pavements can be produced from a standard HMA facility and placed with typical paving equipment. But experience matters for both production and placement

Resources



TechBrief

The Asphalt Pavement Technology Program is an integrated national effort to improve the long-term performance and cost effectiveness of asphalt pavements. Managed by the Federal Highway Administration through partnerships with state highway agencies, industry and academia, the program's primary goals are to reduce congestion, improve safety, and foster technology innovation. The program was established to develop and implement guidelines, methods, procedures and other tools for use in asphalt pavement materials selection, mixture design, testing, construction and quality control.

U.S. Department of Transportation
Federal Highway Administration

Office of Asset Management, Pavements, and Construction

FHWA-HIF-15-009

April 2015

Porous Asphalt Pavements with Stone Reservoirs

This Technical Brief provides an overview of the benefits, limitations and applications of porous asphalt pavements with stone reservoirs. Considerations for design and construction, as well as maintenance, are discussed.

Introduction

Porous asphalt pavements with stone reservoirs are a multifunctional low impact development (LID) technology, which integrates ecological and environmental goals for a site with land development goals, reducing the net environmental impact for a project. Not only do they provide a strong pavement surface for parking, walkways, trails, and roads; they are designed to manage and treat stormwater runoff. With proper design and installation, porous asphalt pavements can provide a cost-effective solution for stormwater management in an environmentally friendly way. As a result, they are recognized as a best practice by the U.S. Environmental Protection Agency (EPA) and many state agencies (EPA n.d.; PDEP 2006; NJDEP 2004).

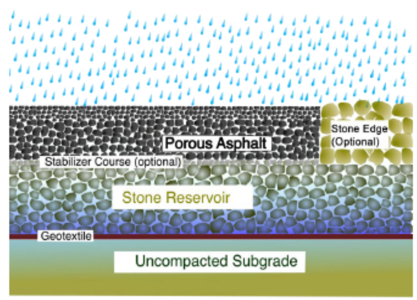
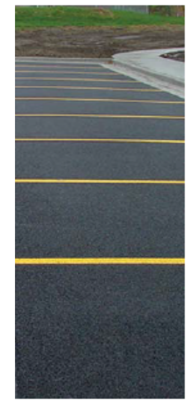


Figure 1: Typical porous asphalt pavement with stone reservoir cross section



POROUS ASPHALT PAVEMENTS

Porous asphalt is an environmentally friendly tool for stormwater management.

ɘ natural environment, rainfall sinks into soil, filters through it, and inds its way to streams, ponds, lakes, and underground aquifers. ıvironment, by way of contrast, seals the surface. Rainwater and ecome runoff which may contribute to flooding. Contaminants are m surfaces directly into waterways without undergoing the filtration intended.[1]

nwater management tools can mitigate the impact of the built environtural hydrology. Unfortunately, however, they also can lead to unsound ıch as cutting down stands of trees in order to build detention ponds. ıs asphalt pavements allow for land development plans that are more harmonious with natural processes, and sustainable. They conserve ce runoff, promote infiltration which cleanses stormwater, replenish ıd protect streams.

ical porous pavement has an open-graded surface over an underlying ırge bed. The water drains through the porous asphalt and into the then, slowly, infiltrates into the soil. Many contaminants are removed nwater passes through the porous asphalt, stone recharge bed, and ıh filtration and microbial action.

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