EPA Storm water Construction BMP - Porous Asphalt Pavement

Brian K. Wood, P.E.
Executive Director

PLANTMIX ASPHALT INDUSTRY OF KENTUCKY

A Little about us…

- The Plantmix Asphalt Industry of Kentucky (PAIKY) is a trade association representing the interests of the asphalt paving contractors and related companies in the state
- Established in 1938, PAIKY has grown from 8 to 32 members who operate over 140 asphalt plants and serve all 120 counties in Kentucky

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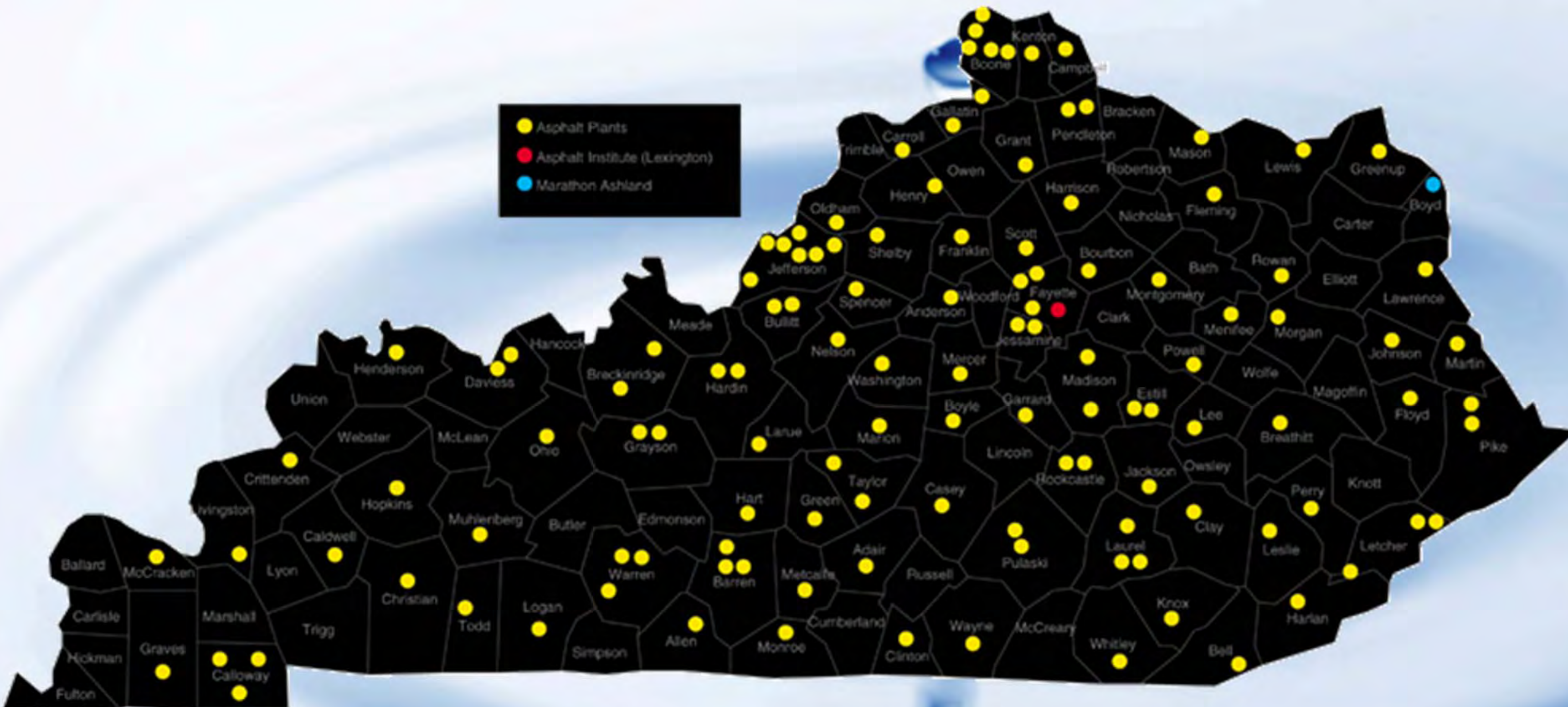
Asphalt Industry in Kentucky



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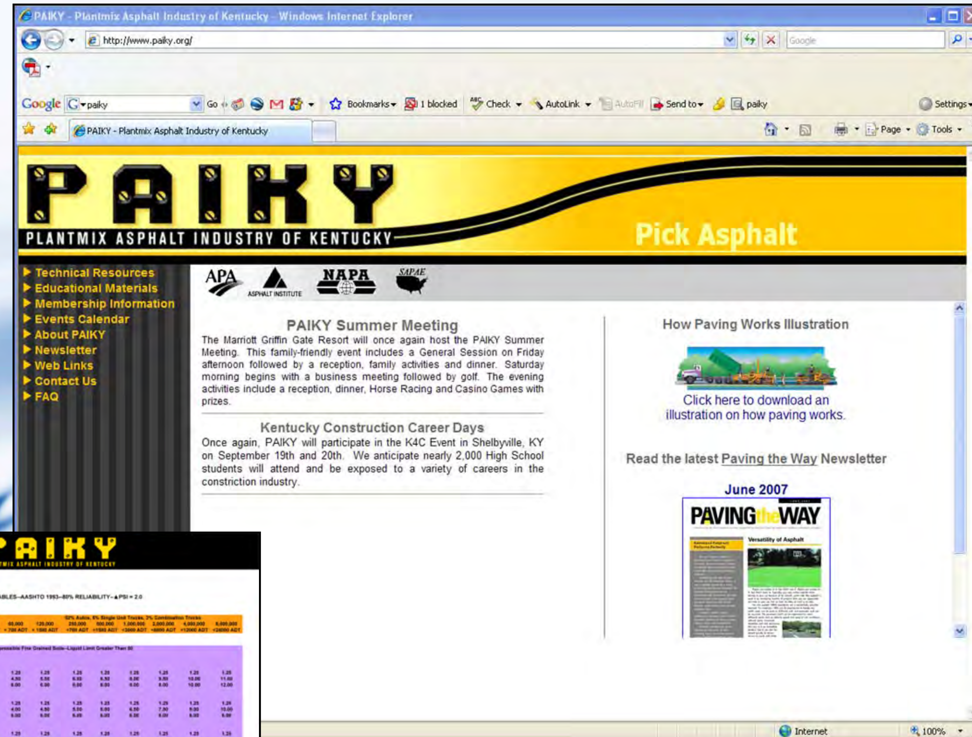
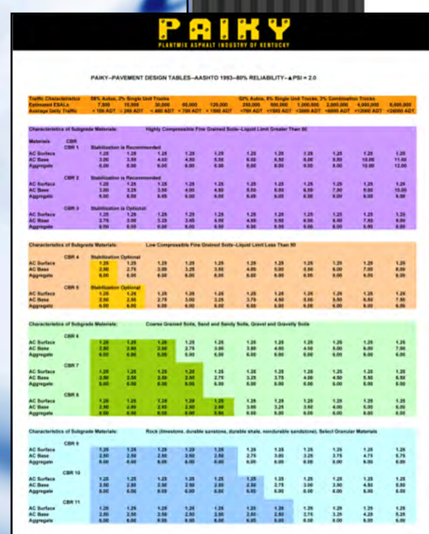
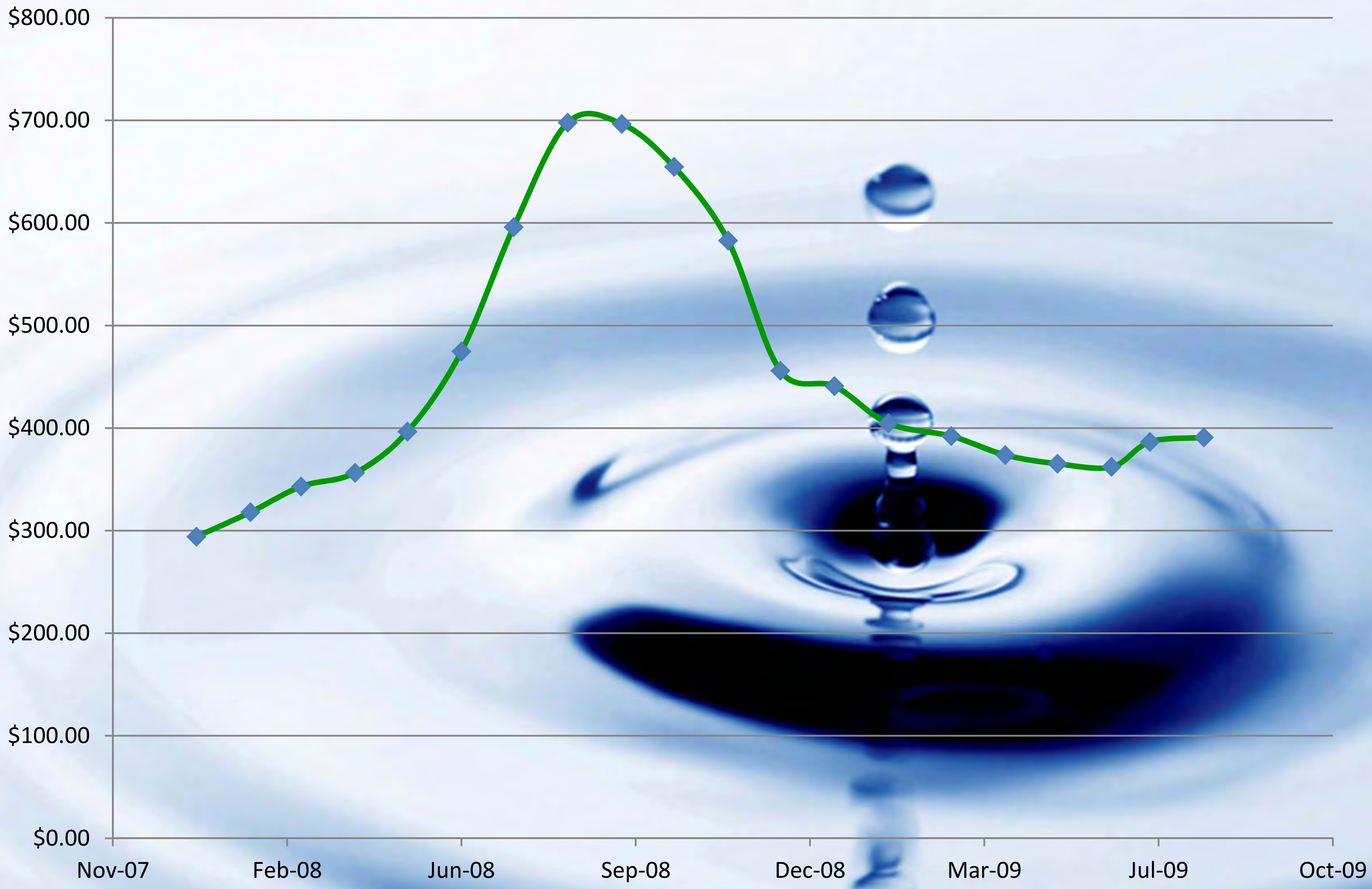
Available Resources

- Visit our website at www.paiky.org
- Technical Resources
  - Pavement Design Tools
  - Educational Information
- Calendar
- Newsletters





Market Trends – KYTC Asphalt Index



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Porous Pavements are different

- Conventional Pavements
  - Build a “roof” and do everything possible to keep the water out!
- Porous Pavements
  - Let the water through!

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Presentation Outline

- Overview of Porous Asphalt Pavements
- Benefits and Applications
- Quantity and Quality
- Design Considerations
- Construction Practices
- Kentucky Projects

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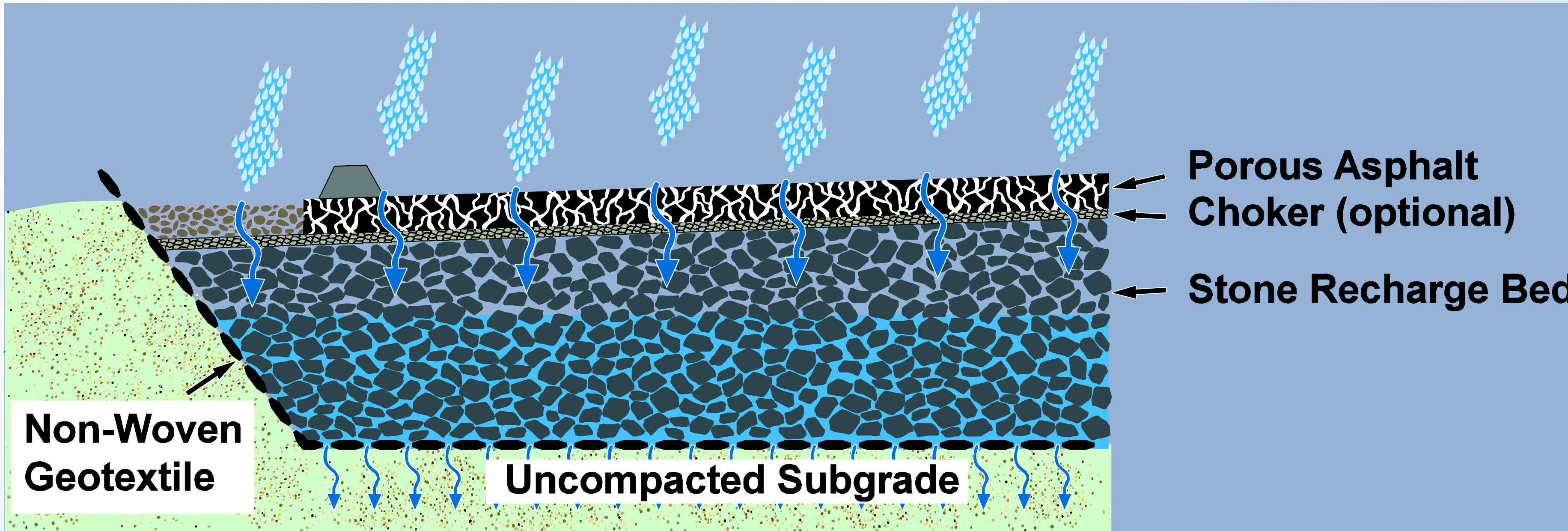
What are Porous Pavements?



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Cross Section Diagram

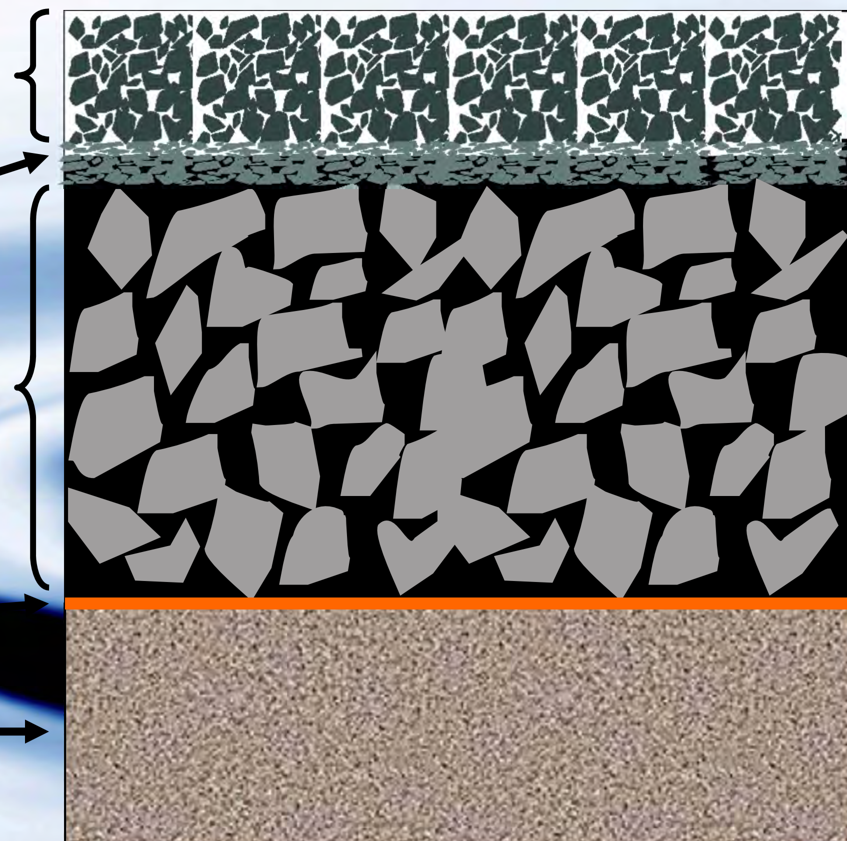
Open-Graded Asphalt ~ 2 ½"

Aggregate Interlayer ~ 1 – 2" Thick

Clean Uniformly Graded Crushed Aggregate (#2's or #3's) with 40% Voids – layer thickness ranging from 18 inches to 3 feet

Non-Woven Geotextile Fabric

Uncompacted Soil Subgrade



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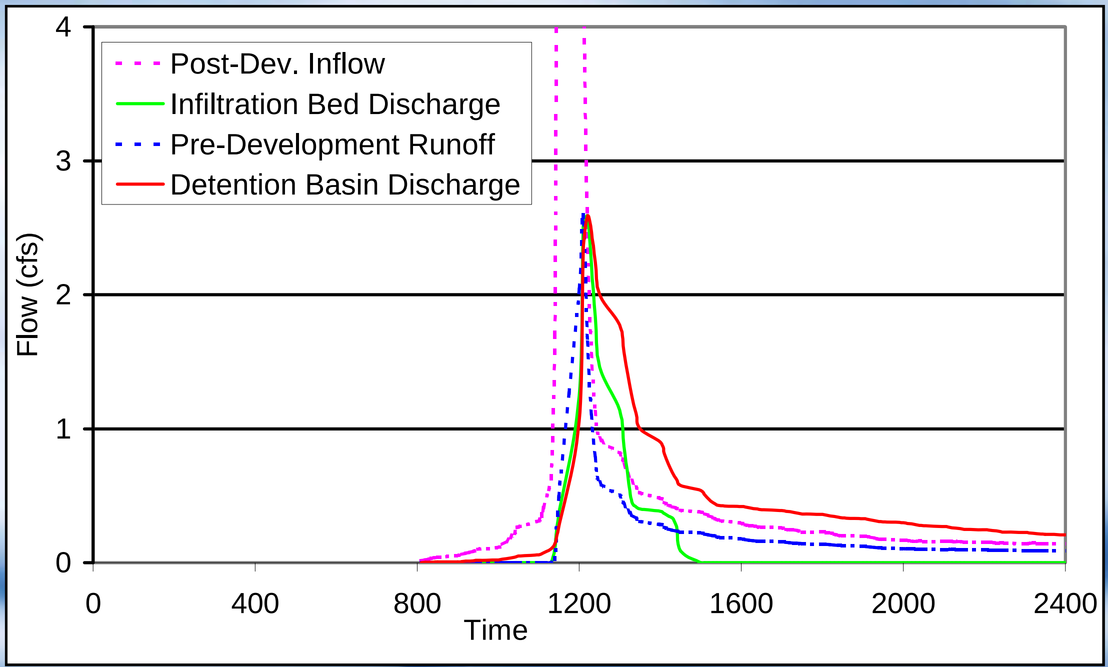
Why are they needed?

- New stormwater regulations
  - Reduce volume
  - Limiting impervious area
  - Taxing runoff
- Sustainability



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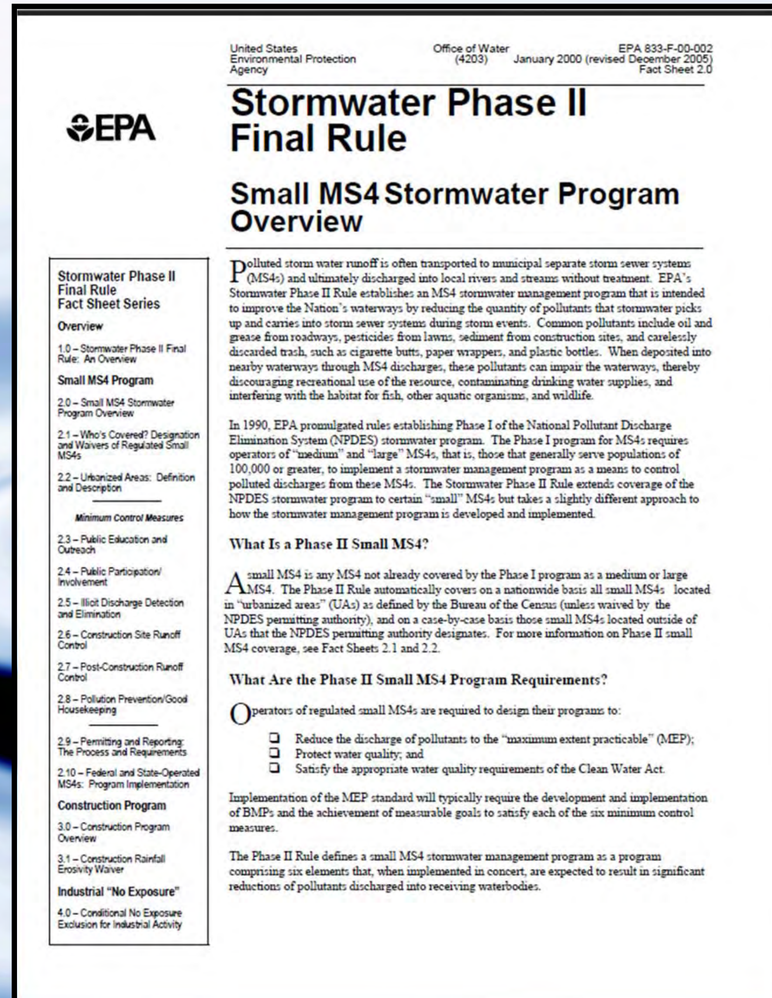
EPA MS4 Stormwater Program

- "Applicable controls could include preventative actions such as protecting sensitive areas (e.g., wetlands) or the use of structural BMPs such as grassed swales or porous pavement."



United States Environmental Protection Agency | Office of Water (4203) | EPA 833-F-00-002 January 2000 (revised December 2005) Fact Sheet 2.0

EPA

Stormwater Phase II Final Rule

Small MS4 Stormwater Program Overview

Polluted storm water runoff is often transported to municipal separate storm sewer systems (MS4s) and ultimately discharged into local rivers and streams without treatment. EPA's Stormwater Phase II Rule establishes an MS4 stormwater management program that is intended to improve the Nation's waterways by reducing the quantity of pollutants that stormwater picks up and carries into storm sewer systems during storm events. Common pollutants include oil and grease from roadways, pesticides from lawns, sediment from construction sites, and carelessly discarded trash, such as cigarette butts, paper wrappers, and plastic bottles. When deposited into nearby waterways through MS4 discharges, these pollutants can impair the waterways, thereby discouraging recreational use of the resource, contaminating drinking water supplies, and interfering with the habitat for fish, other aquatic organisms, and wildlife.

In 1990, EPA promulgated rules establishing Phase I of the National Pollutant Discharge Elimination System (NPDES) stormwater program. The Phase I program for MS4s requires operators of "medium" and "large" MS4s, that is, those that generally serve populations of 100,000 or greater, to implement a stormwater management program as a means to control polluted discharges from these MS4s. The Stormwater Phase II Rule extends coverage of the NPDES stormwater program to certain "small" MS4s but takes a slightly different approach to how the stormwater management program is developed and implemented.

What Is a Phase II Small MS4?

A small MS4 is any MS4 not already covered by the Phase I program as a medium or large MS4. The Phase II Rule automatically covers on a nationwide basis all small MS4s located in "urbanized areas" (UAs) as defined by the Bureau of the Census (unless waived by the NPDES permitting authority), and on a case-by-case basis those small MS4s located outside of UAs that the NPDES permitting authority designates. For more information on Phase II small MS4 coverage, see Fact Sheets 2.1 and 2.2.

What Are the Phase II Small MS4 Program Requirements?

Operators of regulated small MS4s are required to design their programs to:

- Reduce the discharge of pollutants to the "maximum extent practicable" (MEP);
- Protect water quality; and
- Satisfy the appropriate water quality requirements of the Clean Water Act.

Implementation of the MEP standard will typically require the development and implementation of BMPs and the achievement of measurable goals to satisfy each of the six minimum control measures.

The Phase II Rule defines a small MS4 stormwater management program as a program comprising six elements that, when implemented in concert, are expected to result in significant reductions of pollutants discharged into receiving waterbodies.

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- Reduces Infiltration
- Increases Direct Runoff
- Increases Pollutants

LAND DEVELOPMENT ALTERS THE HYDROLOGIC CYCLE

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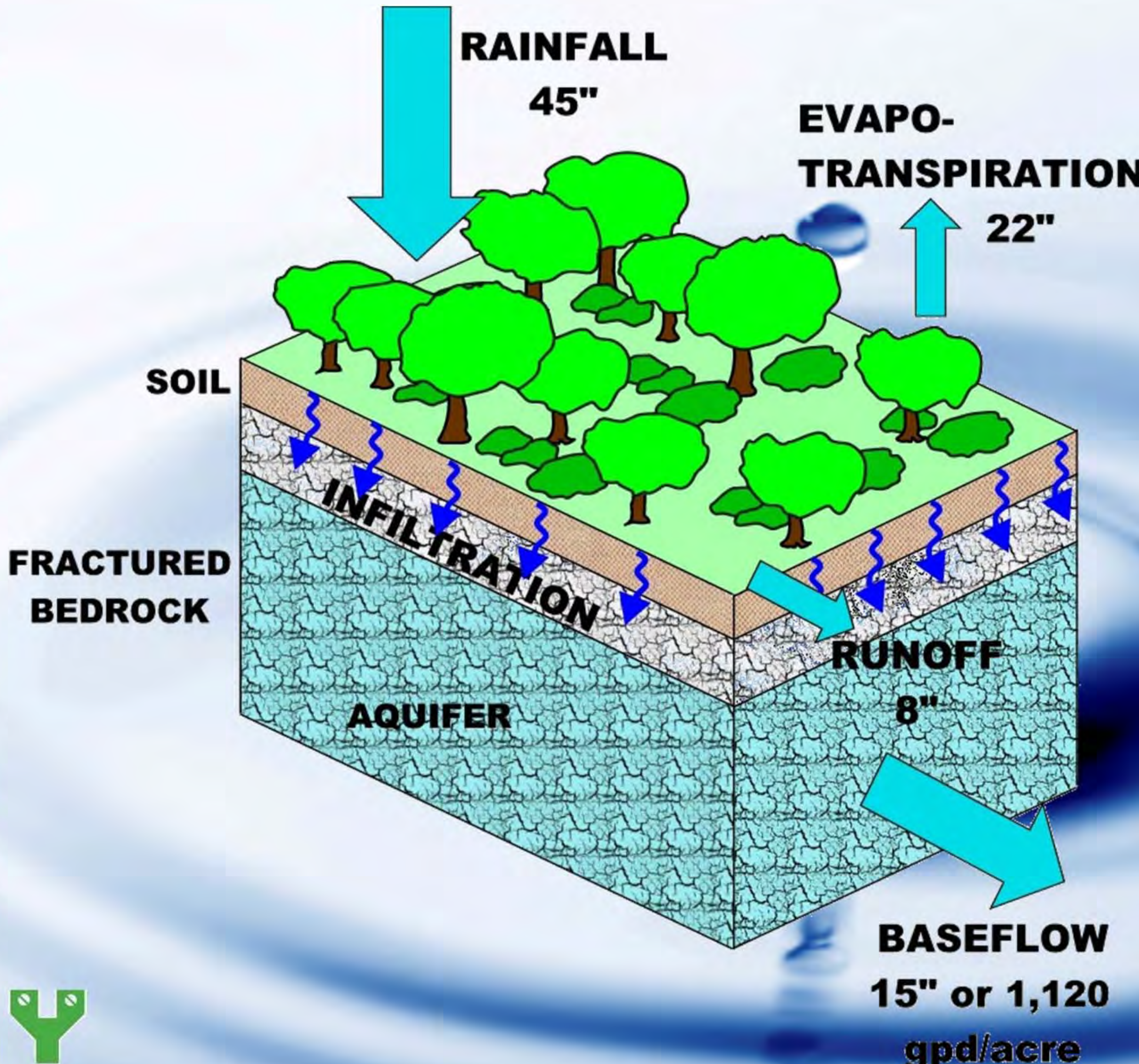
Undeveloped Land



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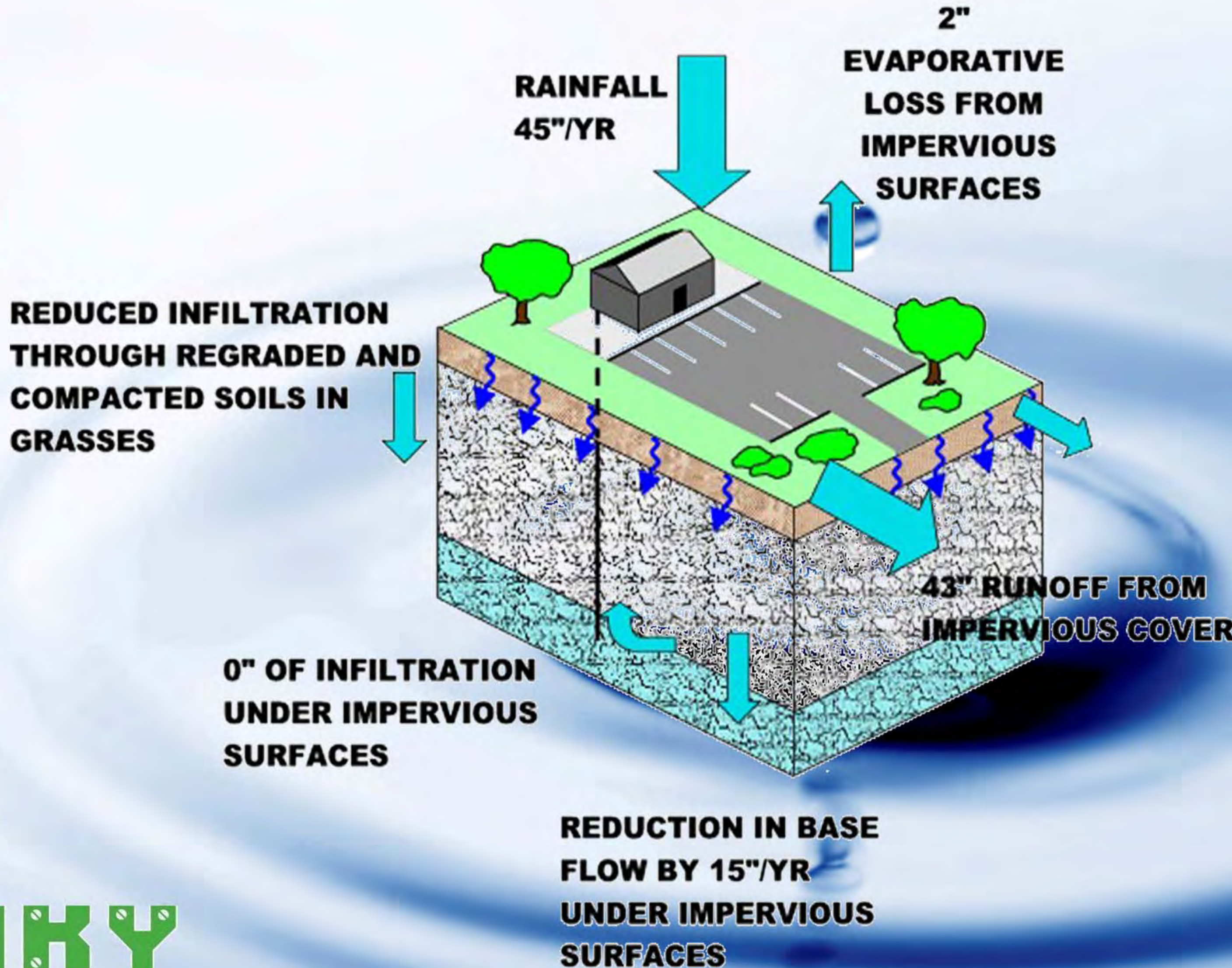
After Development



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The Problem

- More development leads to more impervious surfaces which leads to more runoff
- Detention basins and retention ponds require additional land
- Flash Flooding
- Suspended solids and other chemicals wash into our streams and rivers

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Porous Pavements offer benefits
WATER QUANTITY AND WATER QUALITY
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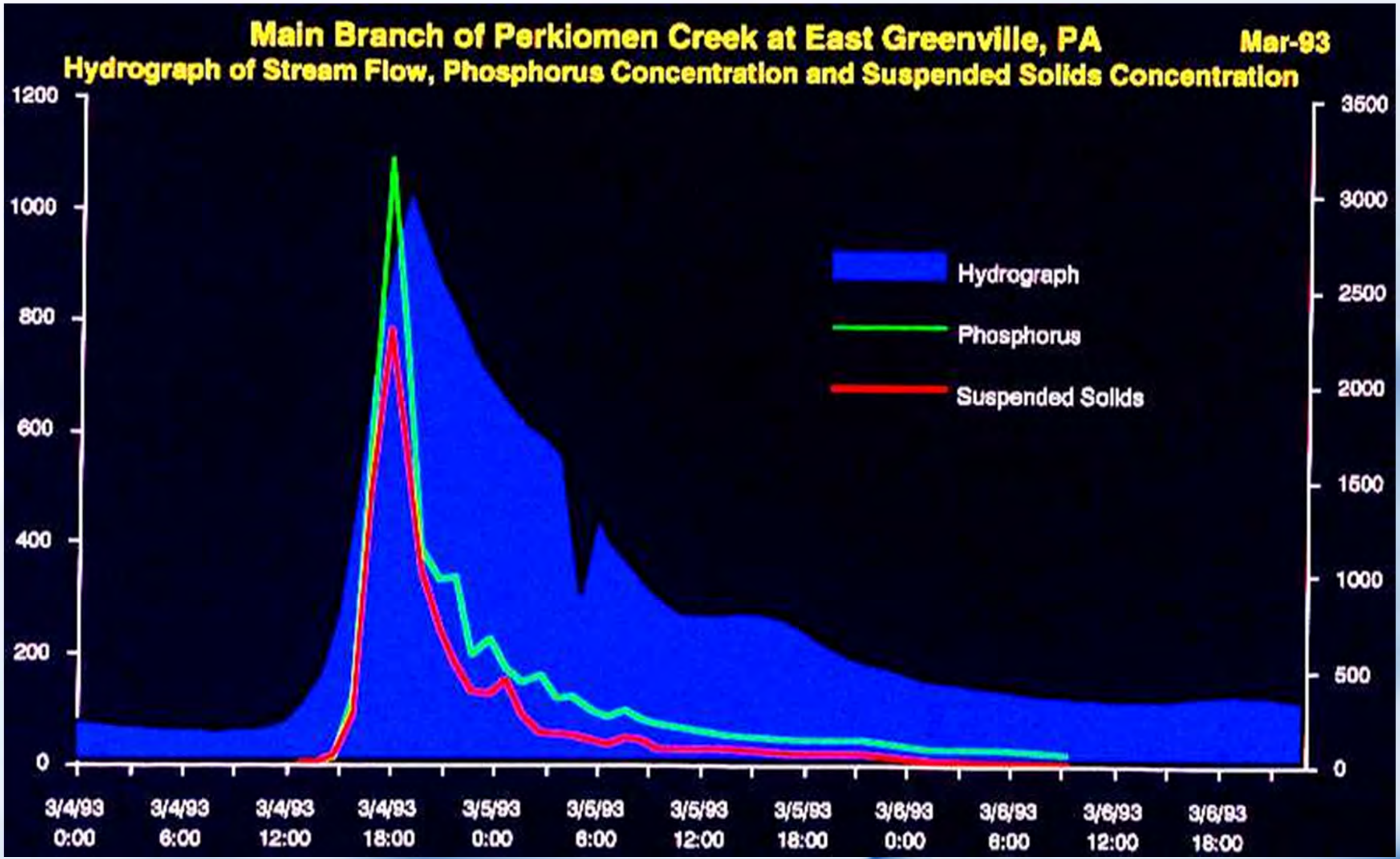
"First Flush" Example



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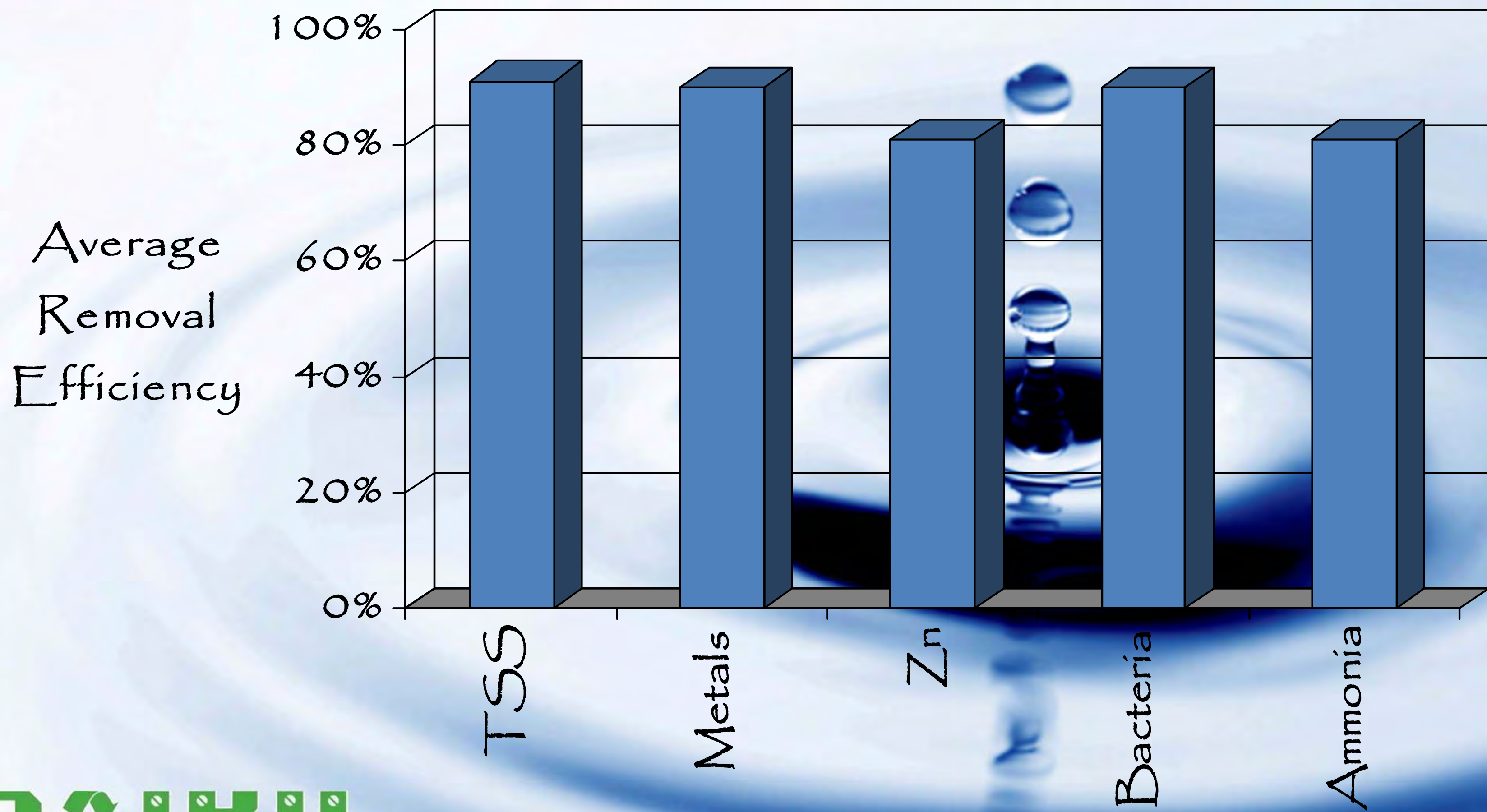
Water Quality Benefits



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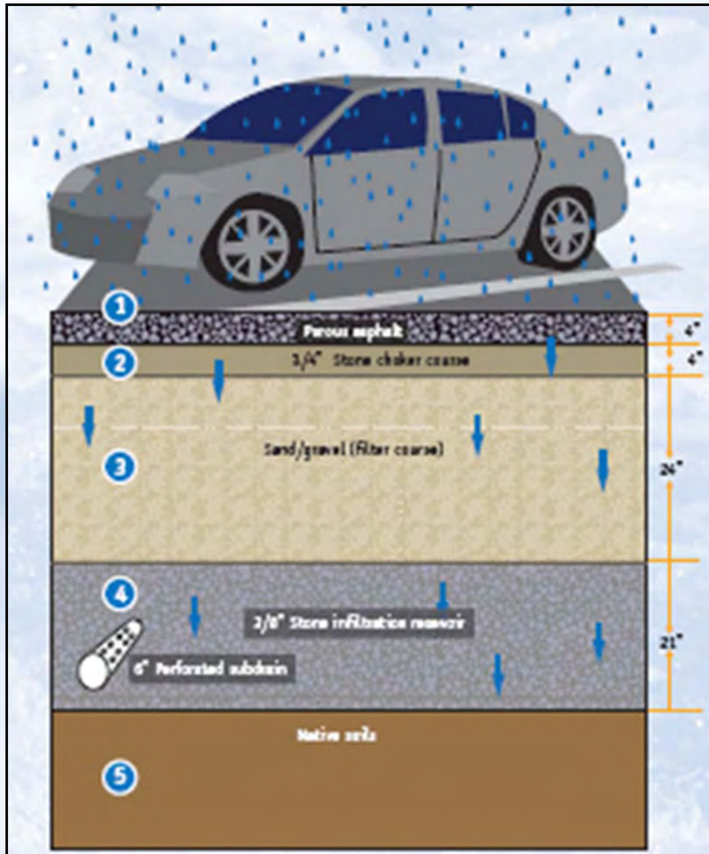
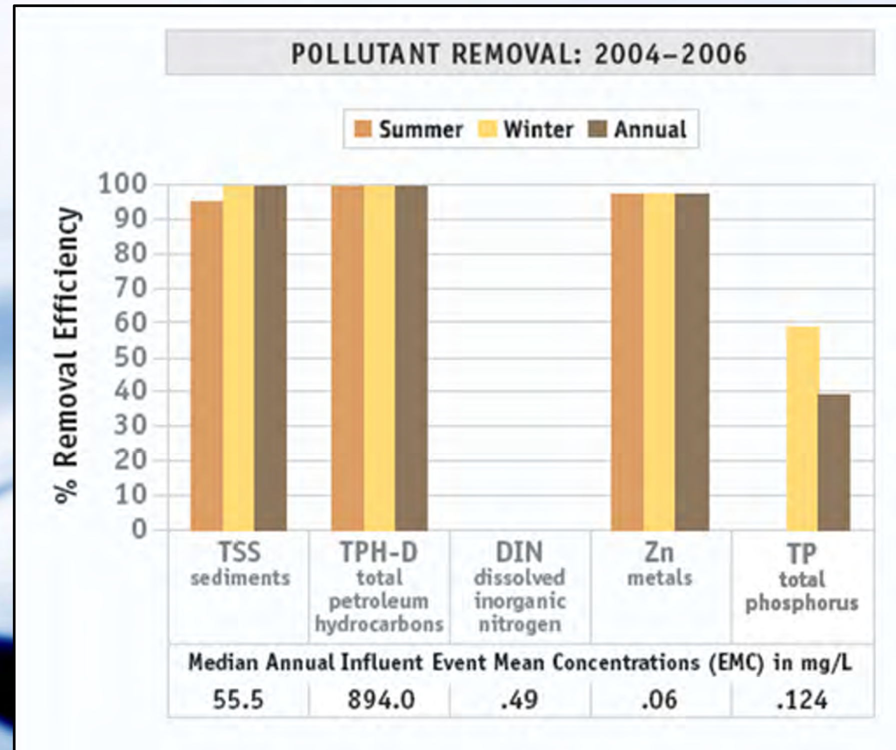
New Hampshire Stormwater Center



Ref: University of New Hampshire Stormwater Center 2007 Annual Report

Water Quality Research

- The asphalt lot has demonstrated excellent performance in terms of water quality
- Consistently exceeds EPA's recommended level of removal of suspended solids



Ref: University of New Hampshire Stormwater Center 2007 Annual Report

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A tool in the toolbox…

POROUS APPLICATIONS

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Porous Applications

- Parking Lots
  - The majority of the focus on porous pavements has been in parking lots
- Recreational Facilities and Paths
  - These facilities are very suitable for porous pavements
- Roads
  - Its possible but there are many challenges and limitations

Typical Porous Parking Lot

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Recreational Facilities

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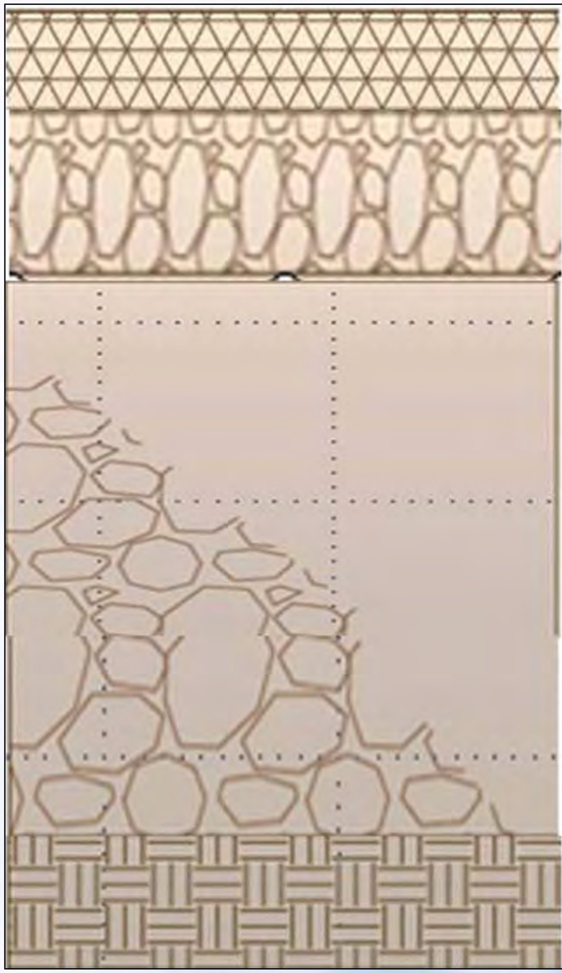
Roads in Oregon



1.5" Porous Surface Course
Porous Asphalt Cement Concrete

3.0" ATPB Choker Course
1-2" Provides working surface for construction

10.0" Reservoir Course
Clean uniformly
Graded Crushed Aggregate
Approximately 40% voids

8.0" Pit Run Subbase
4" - 0 Clean

Uncompacted Subgrade
Uncompacted to retain permeability

Porous Pavement Considerations

DESIGN

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Pavement Design

- Typically not designed for traffic… designed for a rain event instead
  - Traditional pavements consider traffic and subgrade support materials
  - Porous pavements are designed to accommodate a certain rainfall event
- The anticipated water from a storm event is the primary factor in determining the thickness of the aggregate section

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What about ESALs & CBRs?

- For lightly loaded parking lot facilities (passenger cars and trucks), a porous pavement will be <u>over</u>-designed in terms of structural thickness requirements (largely due to the thick stone reservoir layer needed to retain the storm water)
- Porous pavements can be utilized where some truck traffic is anticipated but require some additional thickness and special considerations

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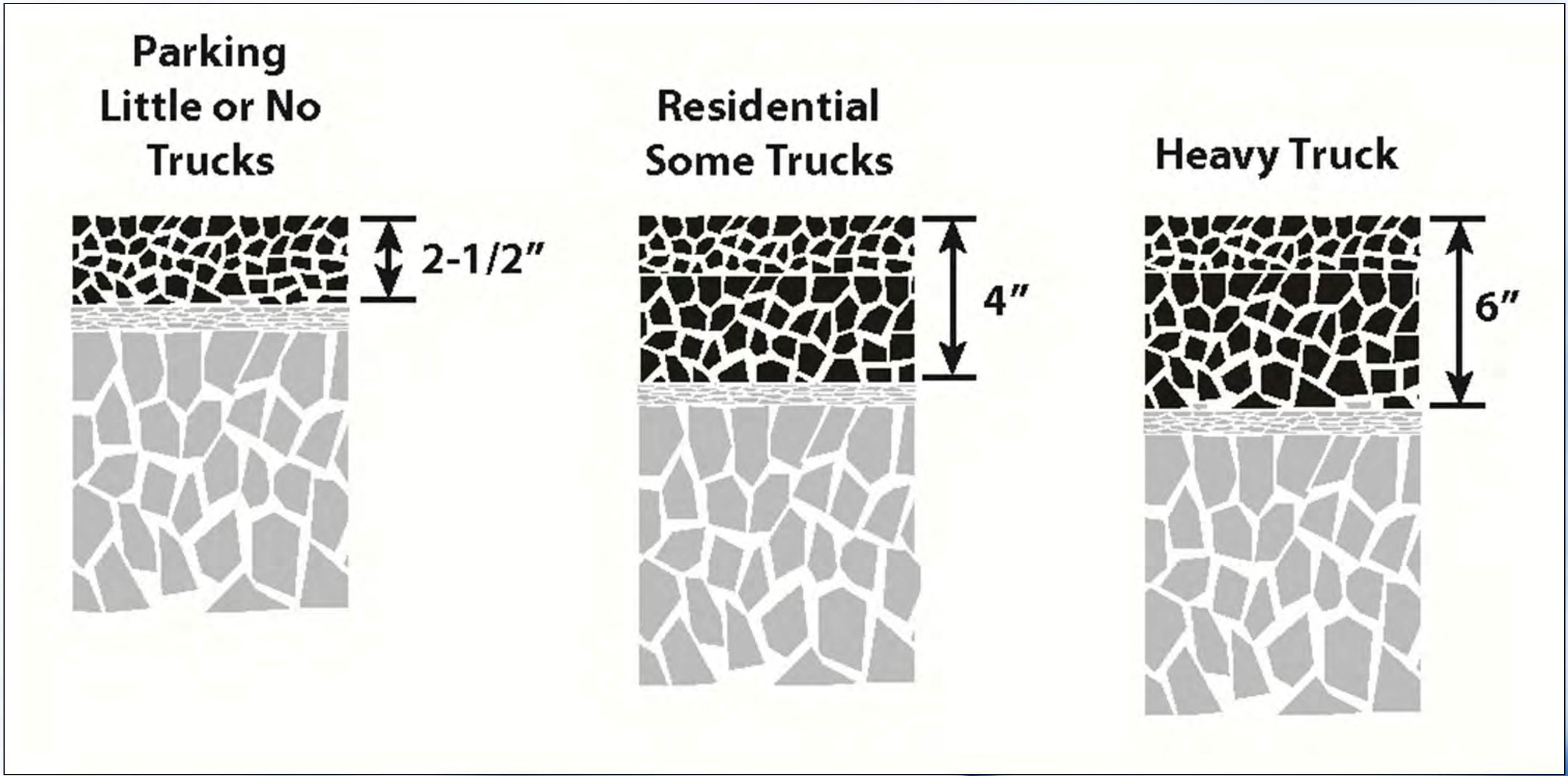
Minimum Thickness Recommendations



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Site Considerations for Success

- Location, location, location
- Hydrology
- Soil infiltration rates
- Depth to bedrock and seasonal water tables
- Slopes – bottom of the infiltration bed needs to be flat
- Look for opportunities to route runoff from nearby impervious areas to the infiltration bed to minimize stormwater structures

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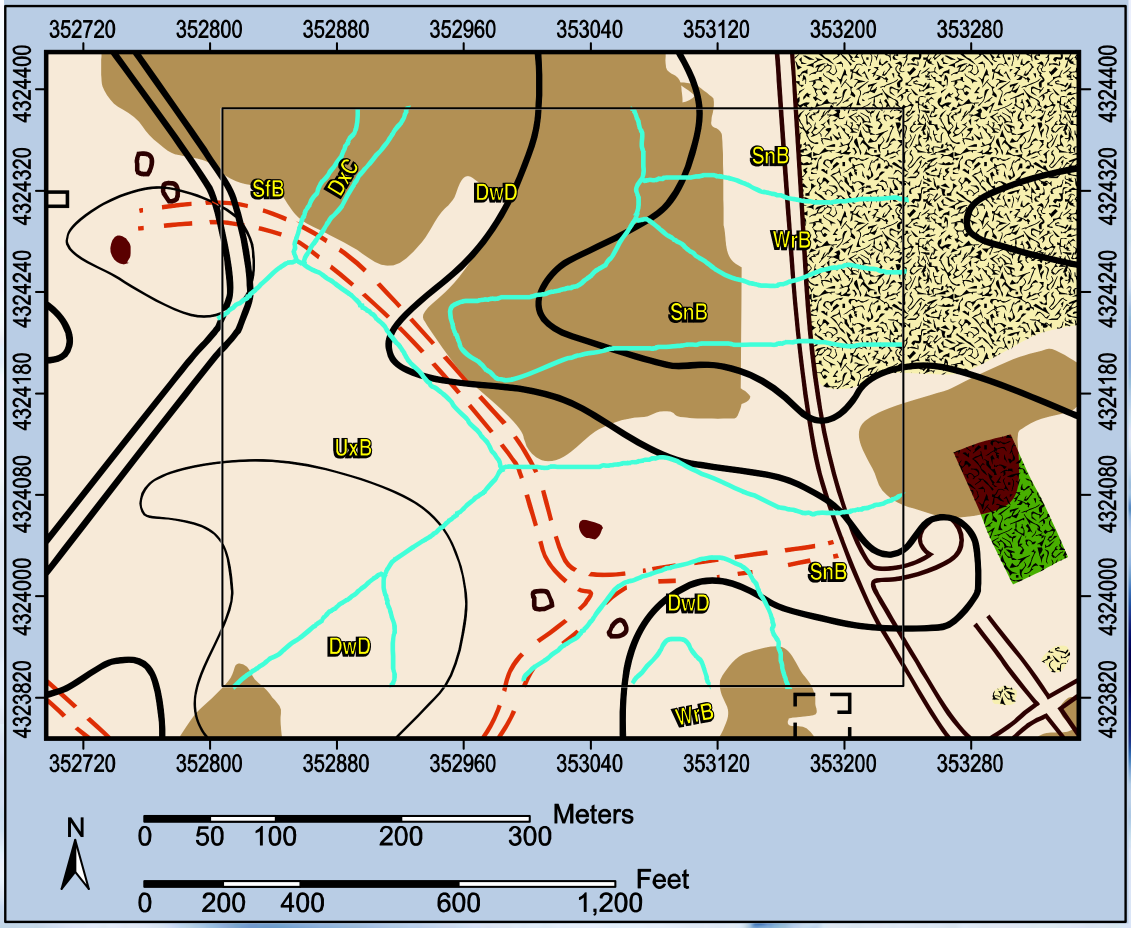
Pick the Right Application

Figure 2: Example Hydrologic Soil Group Map



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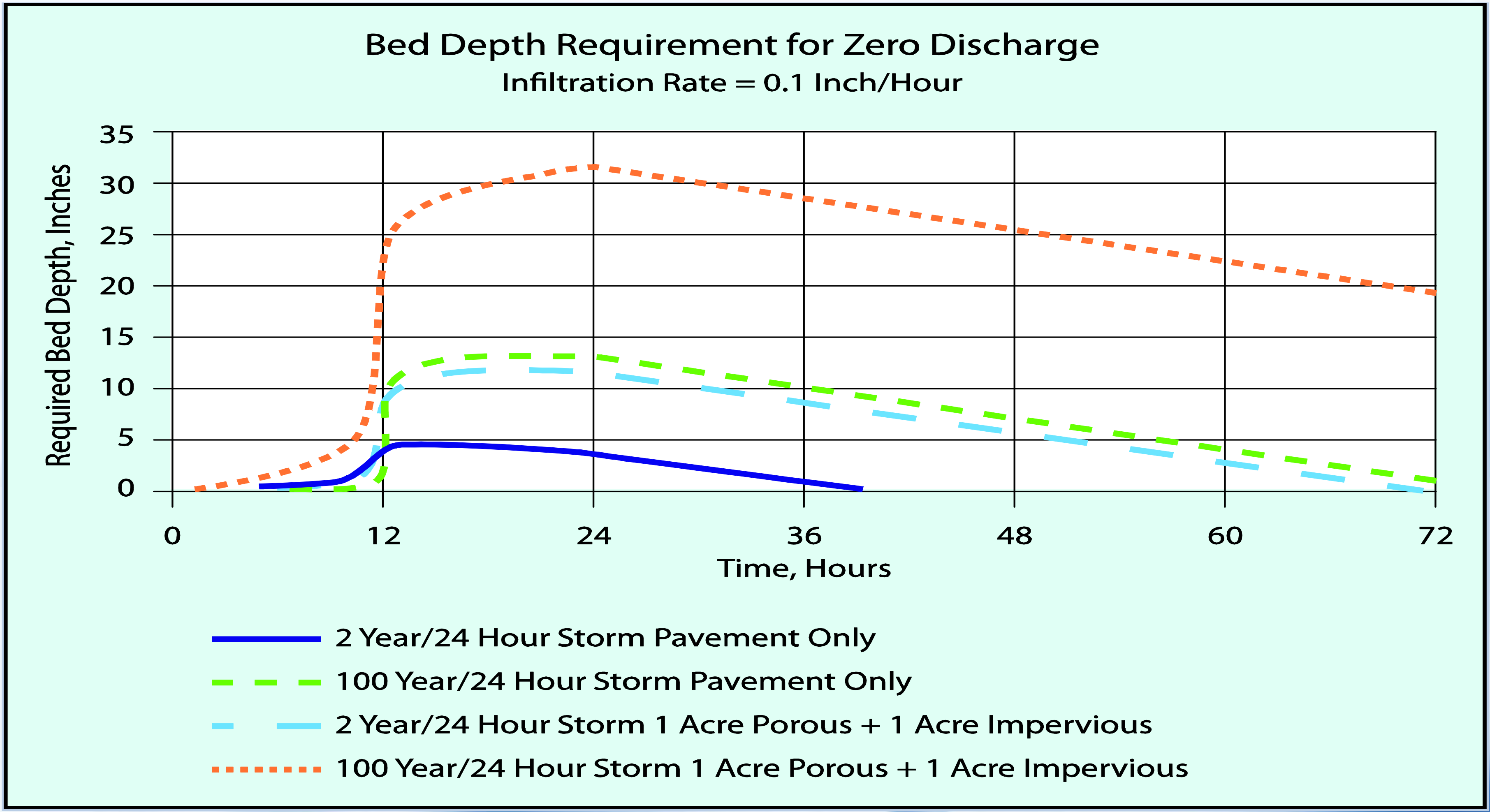
Hydraulic Design



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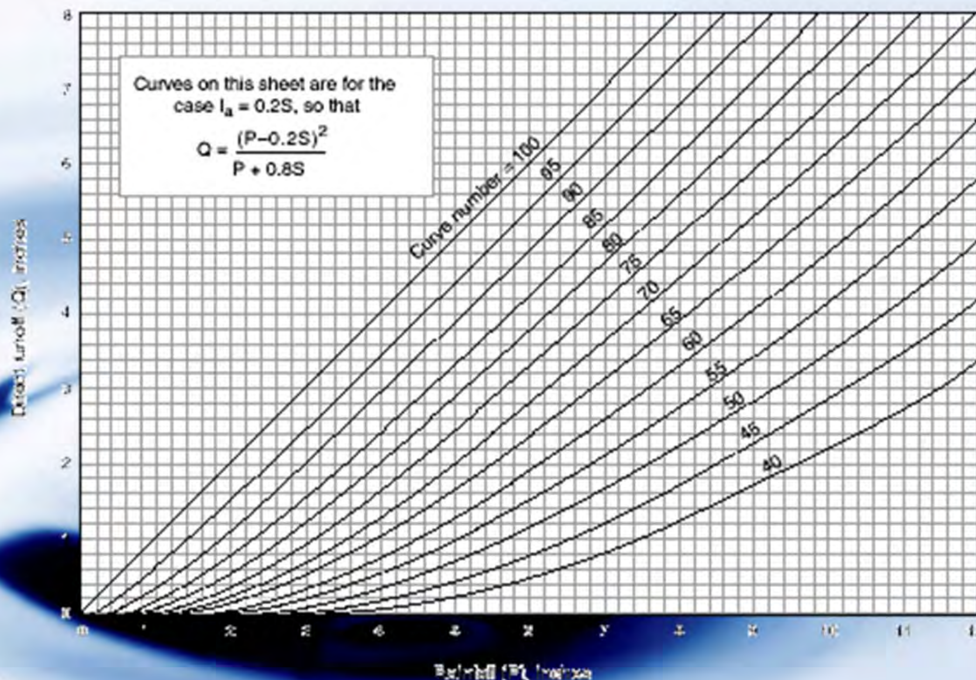
Modeling

- SCS Curve Number (CN) method most common
- Use CN=98 (standard for pavement)
  - Route runoff through stone recharge bed
- Rainfall
  - Typical designs for 6 month/24 hour storm
  - Conservative design for 20 year/24 hour storm



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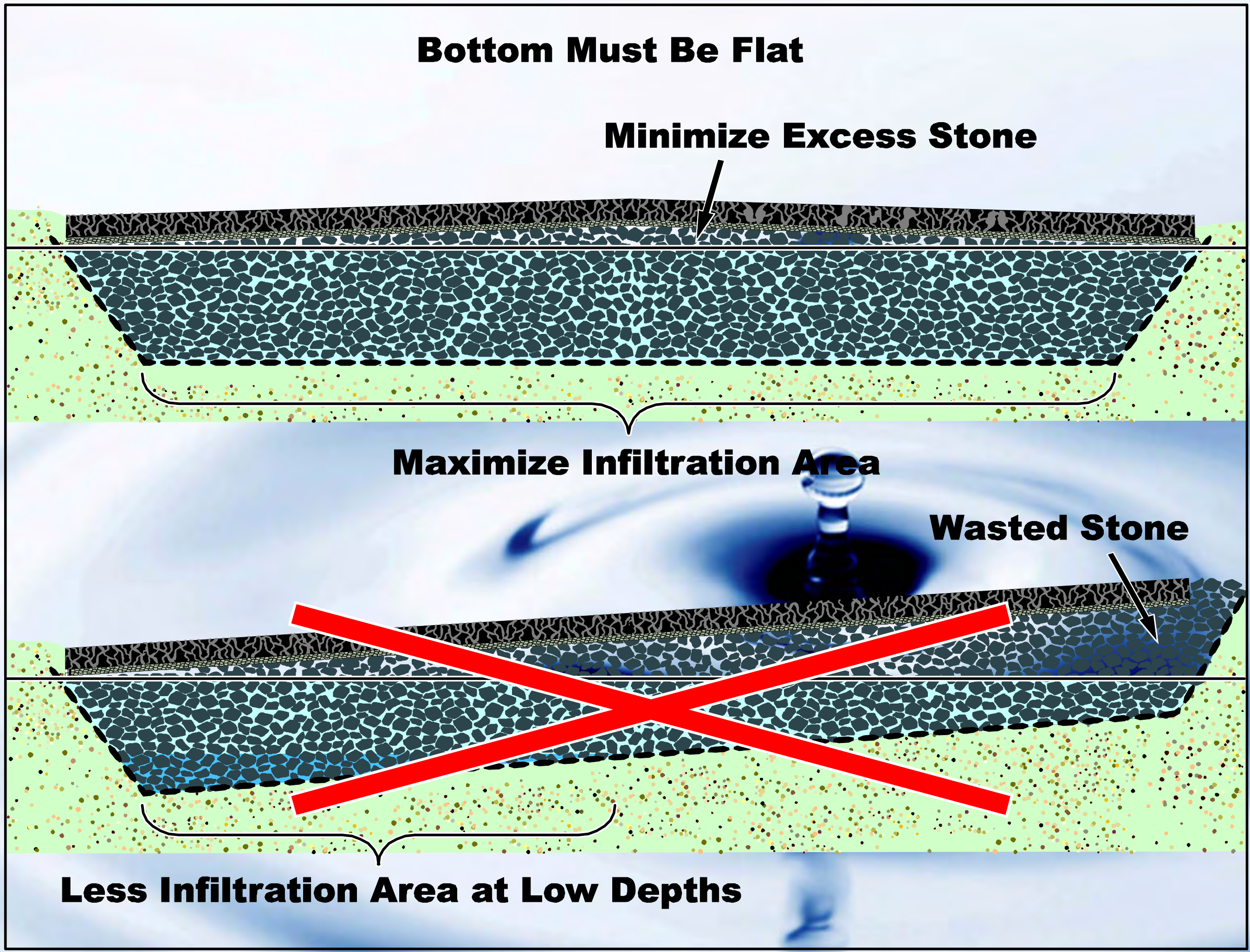
Design with Flat Recharge Beds



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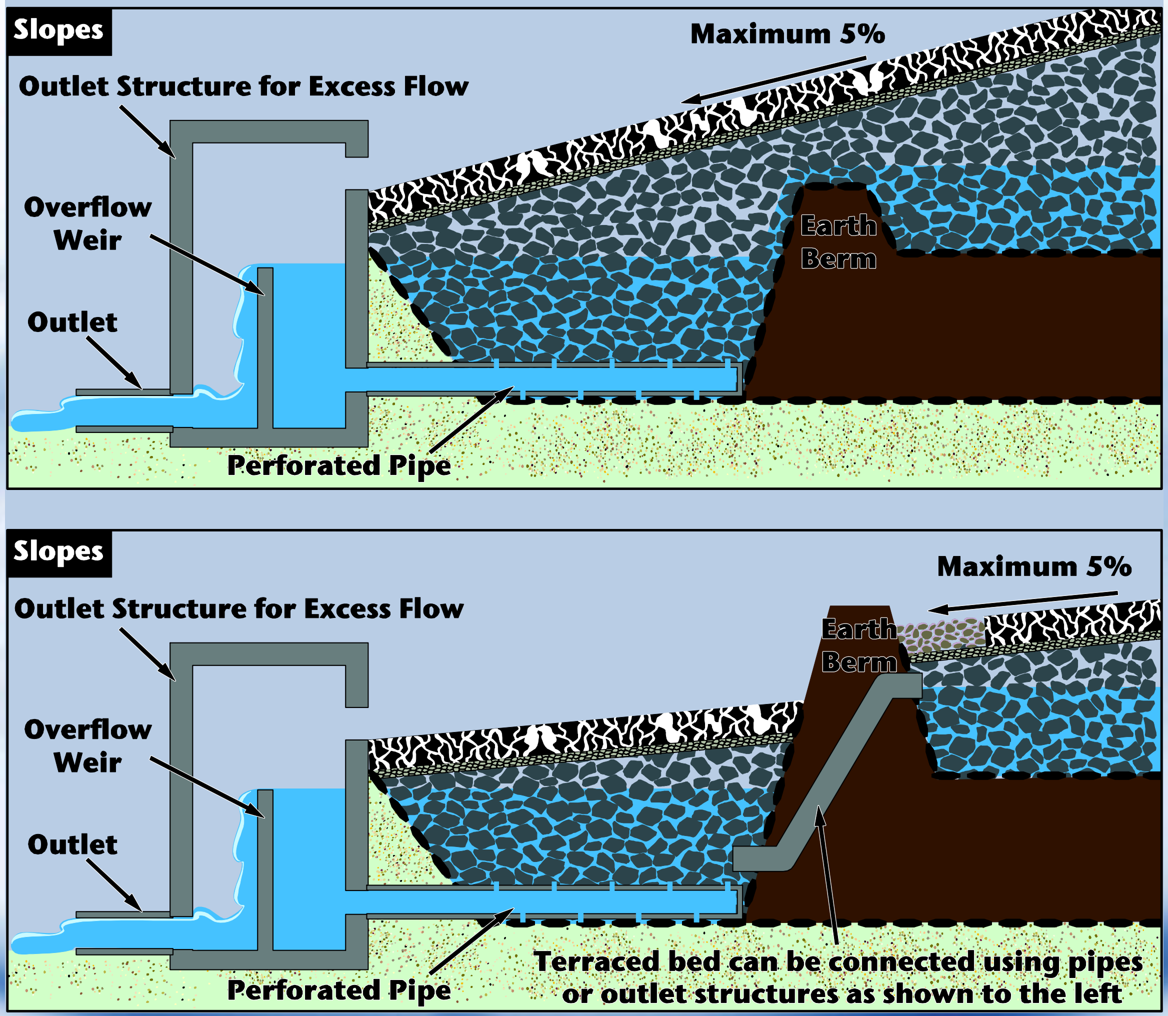
Slopes

- Limit to 5%
  - Conventional pavement can be utilized on steeper slopes
- Terrace
  - Utilize when necessary



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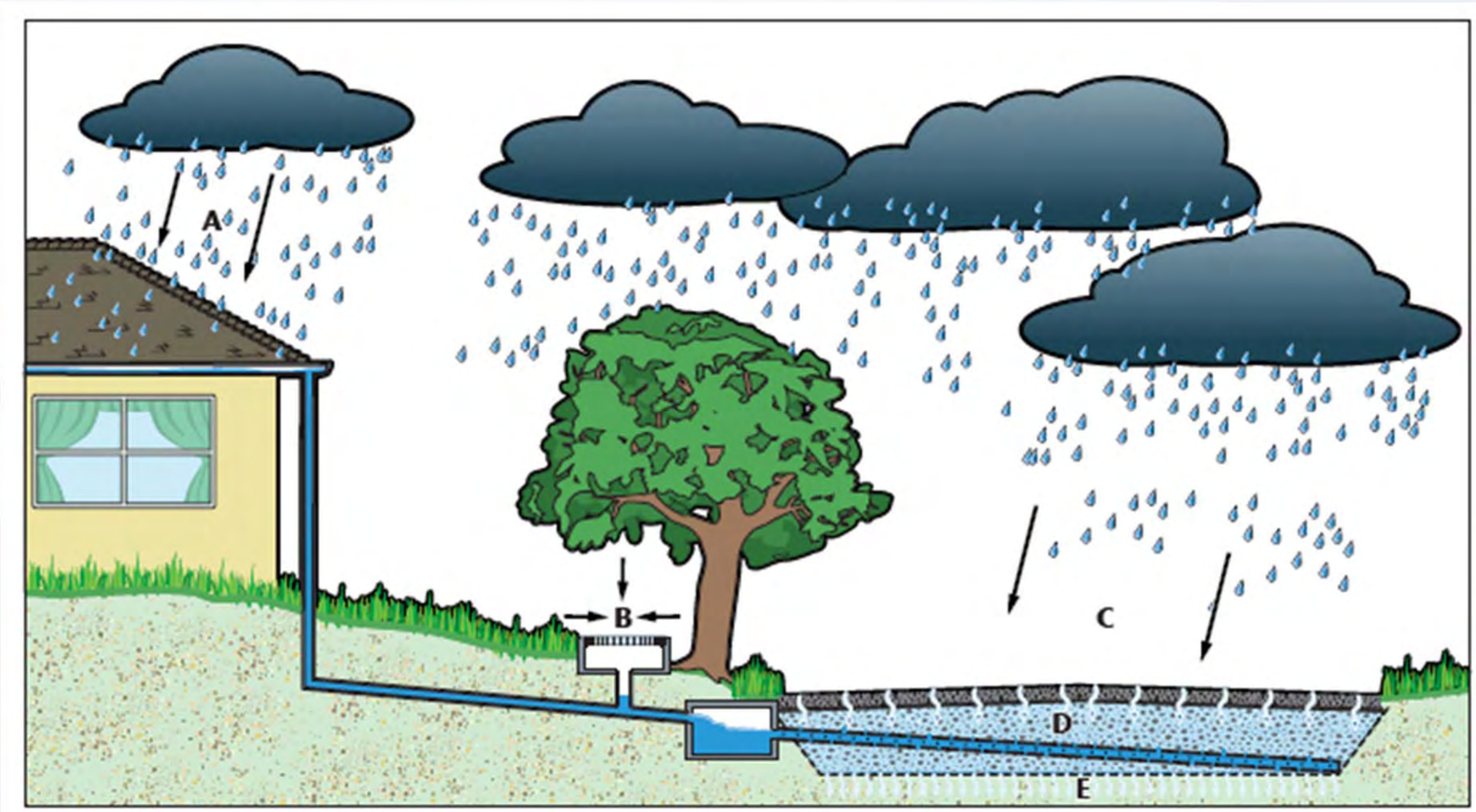
Frost Depth

- Previously recommended that the bottom of the recharge bed exceed the depth of frost penetration
- There is limited research on this issue – performed at the University of New Hampshire (UNH)
  - UNH conservatively recommends the depth of the bed be 65 percent of the frost depth

Water from other Impervious Areas



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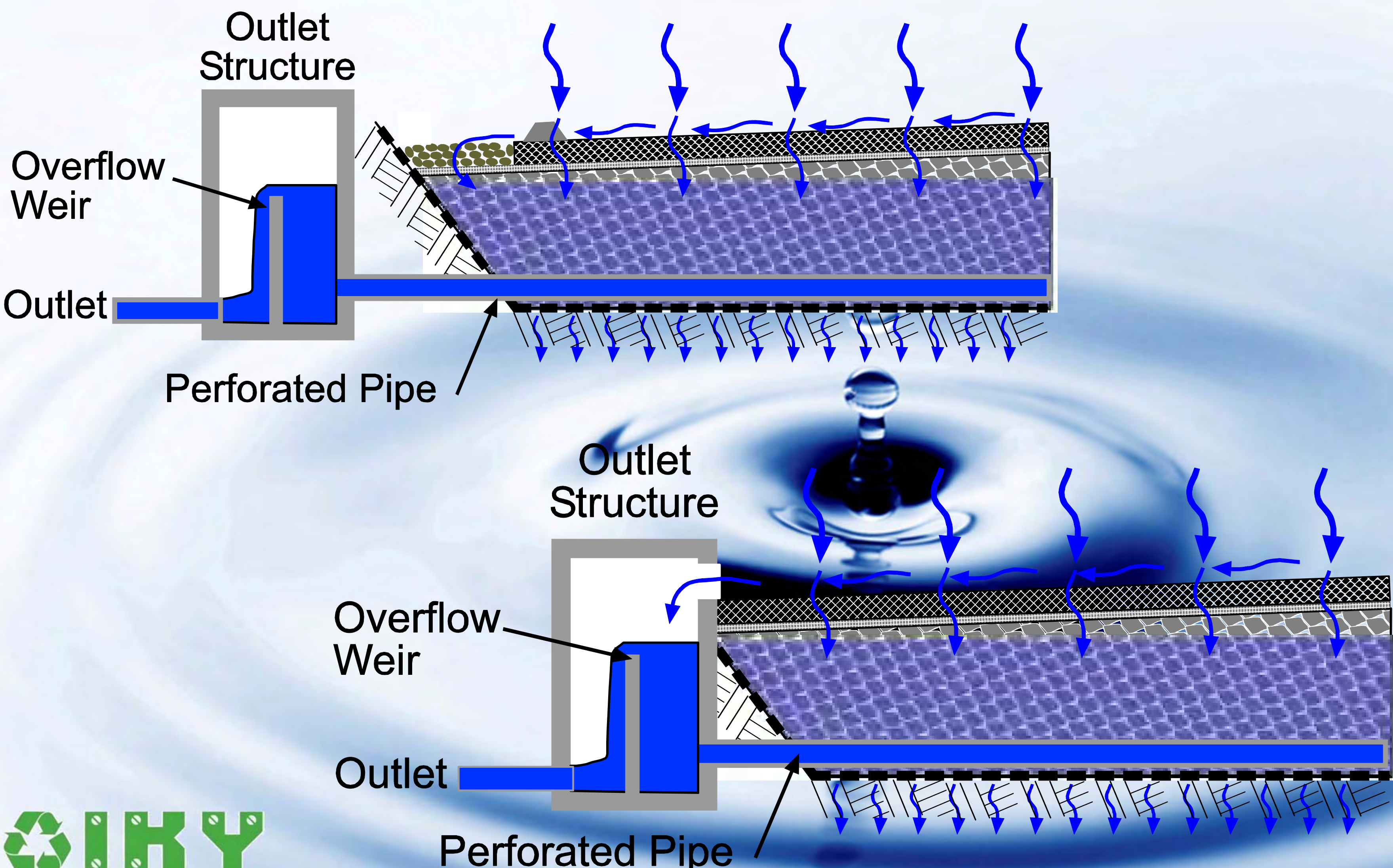
Alternate Path and Overflow



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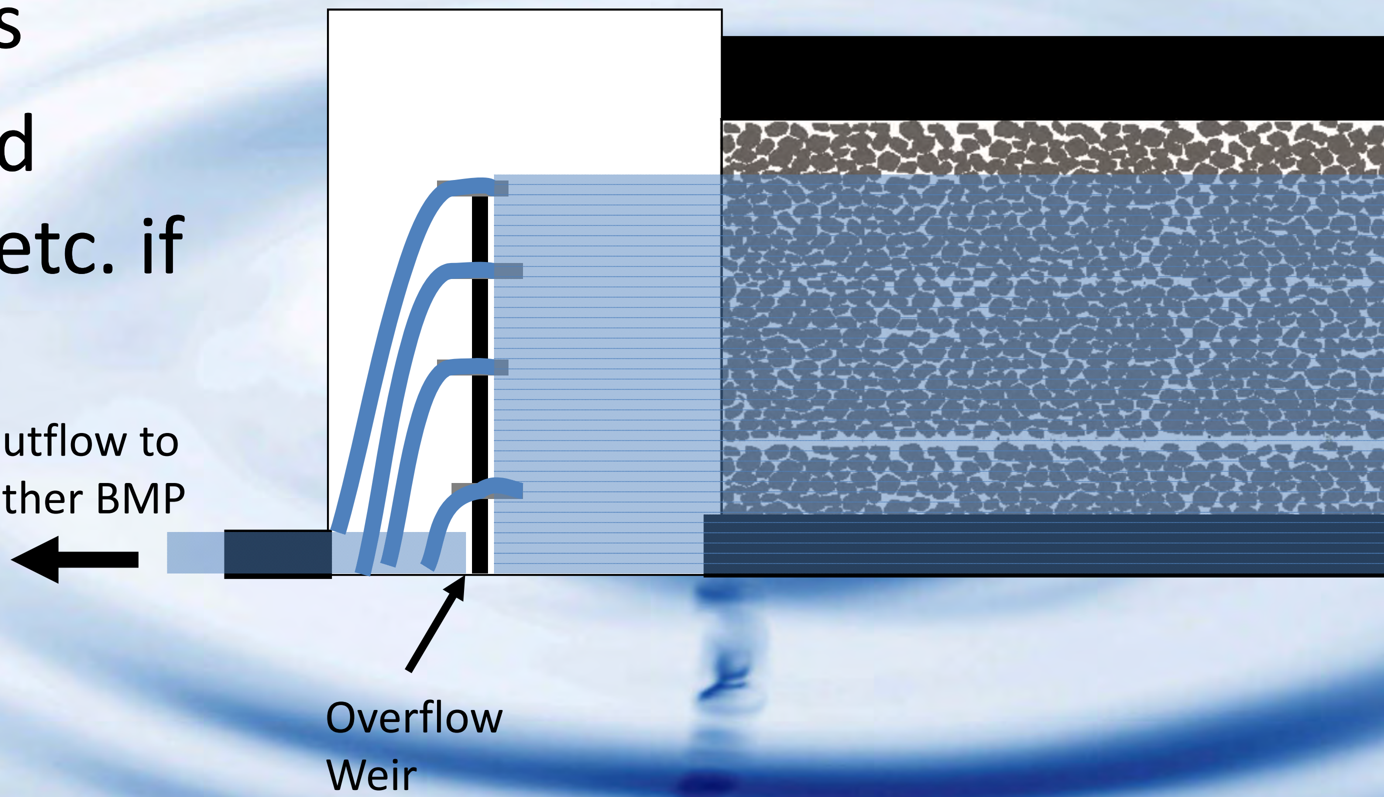
Slow Infiltration?

- Recharge bed should drain in 72 hours
- Can send swales, etc. if needed



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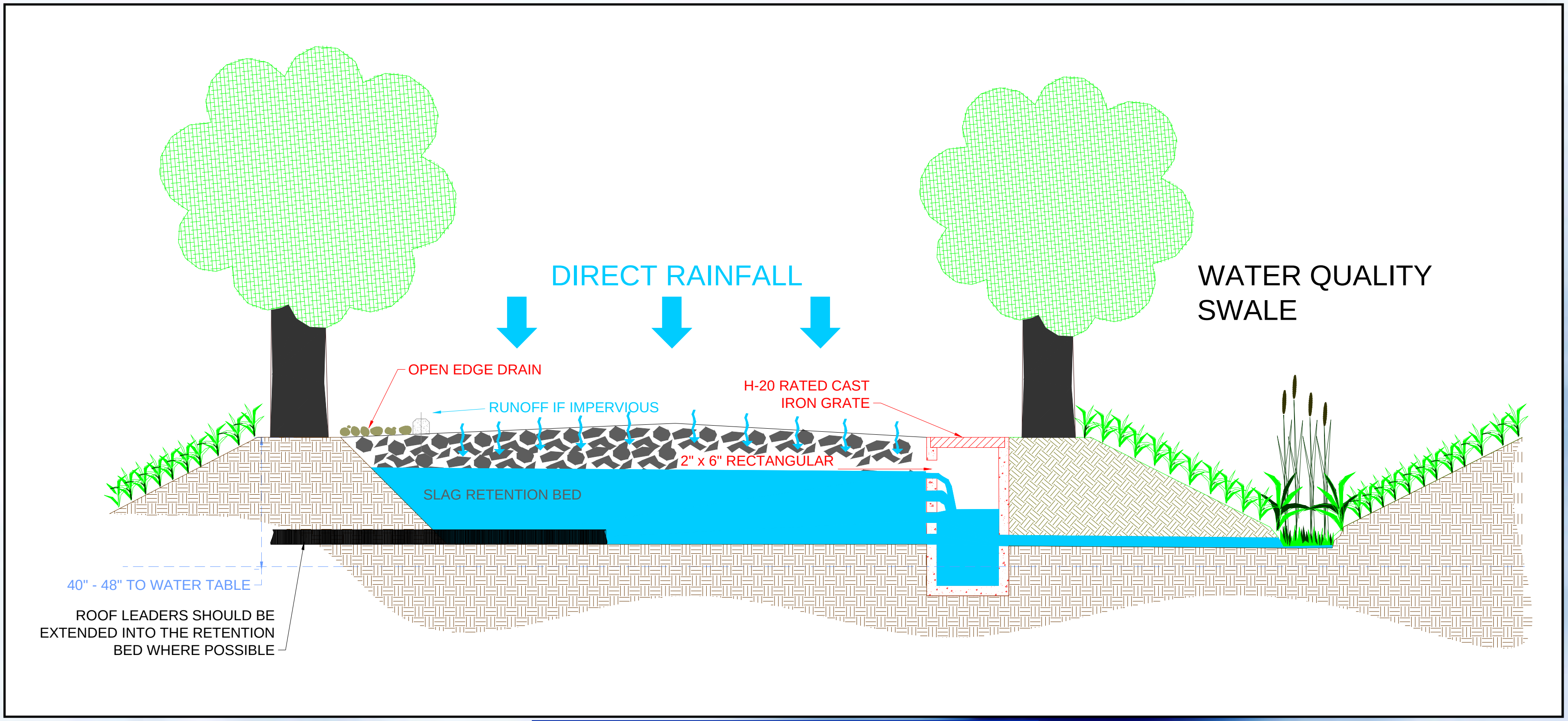
Example of Reduced Infiltration



Ford Motor Company

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Unpaved Edges

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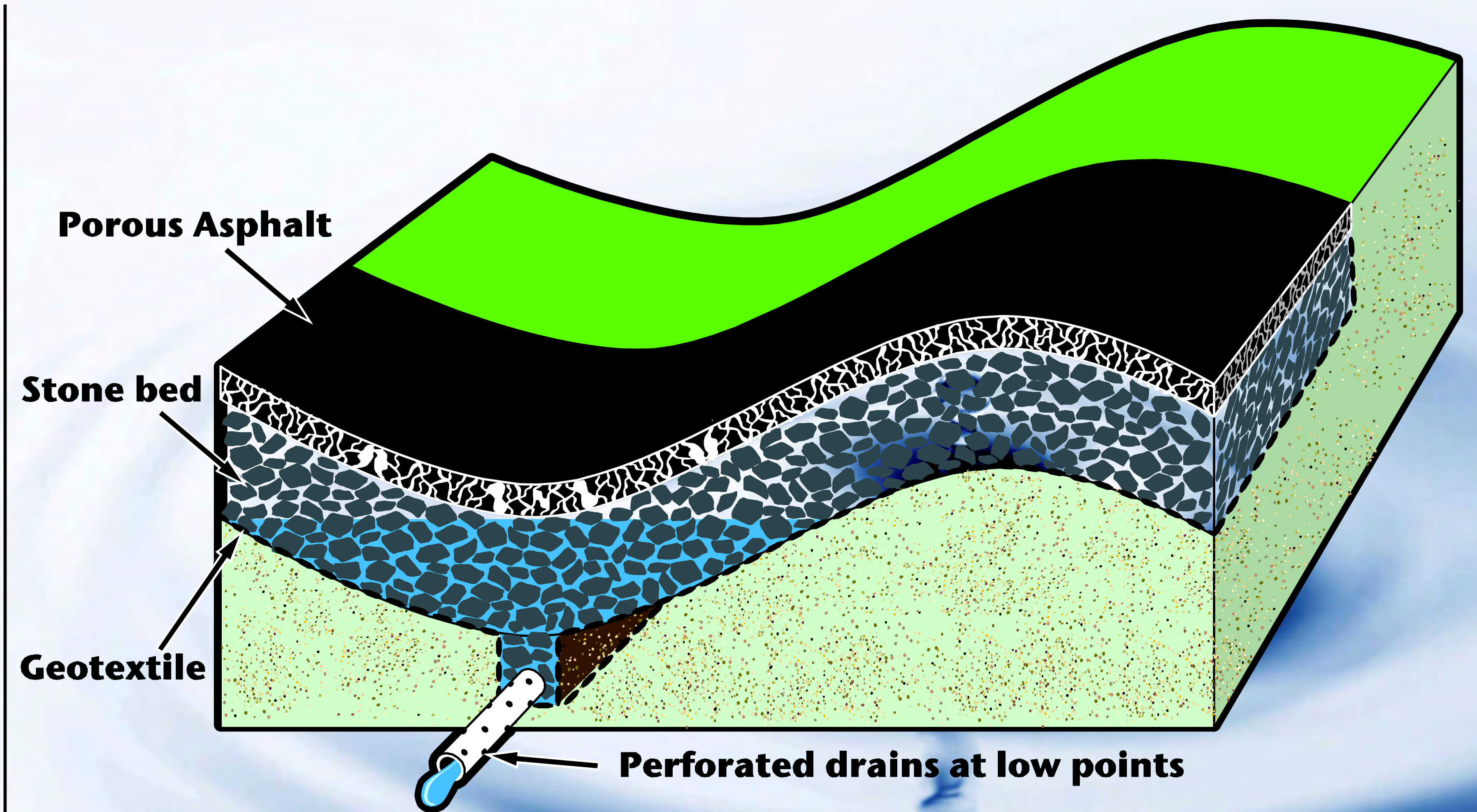
Similar Design for Paths



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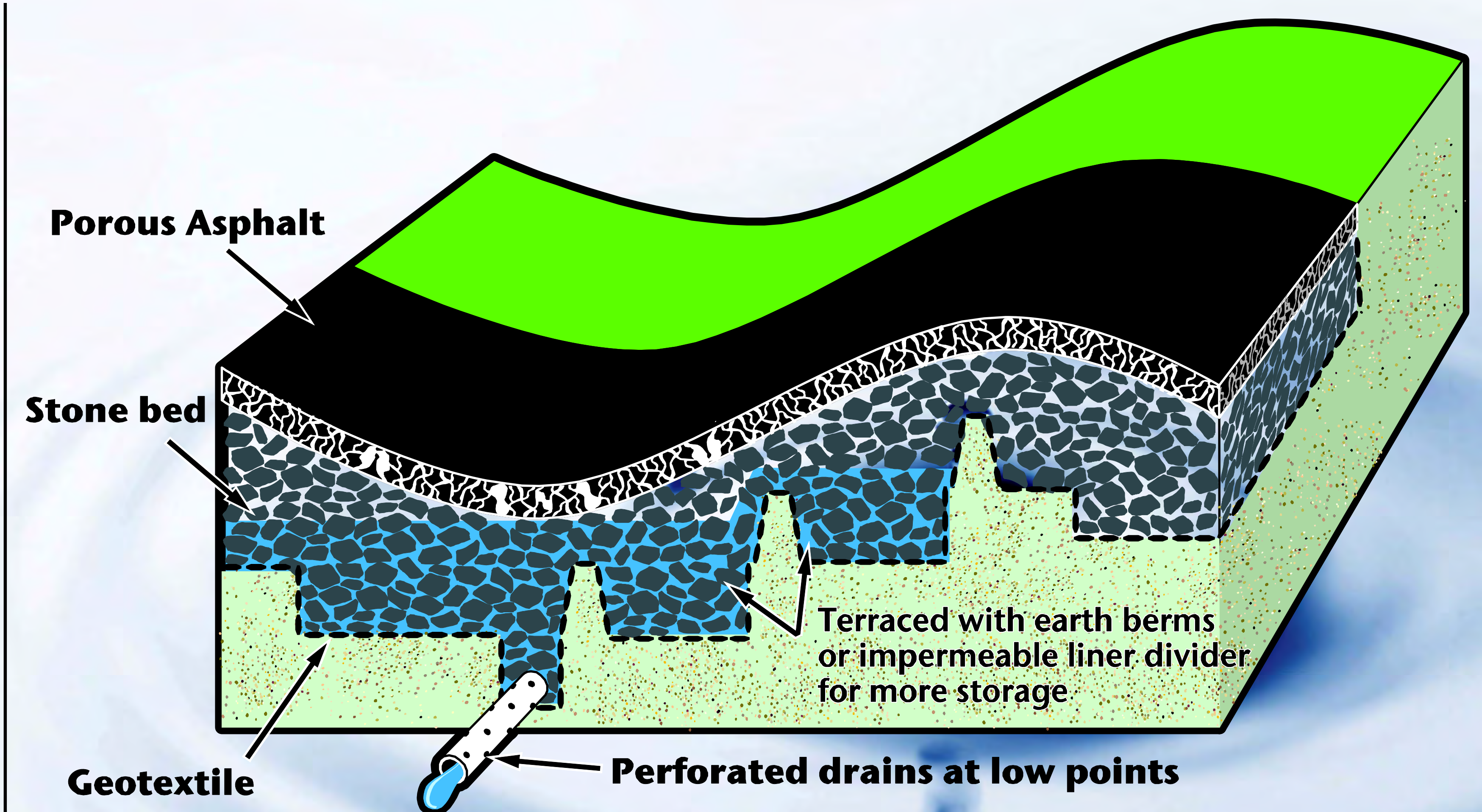
Paths with more storage



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Design of Open-Graded (Porous) Mix

- Utilize an open graded friction course asphalt mixture
  - 16-18 percent air voids
  - High asphalt content
- Bump the PG Binder grade from 64-22 to a PG 76-22 for durability
  - Produce at lower plant temperatures to prevent draindown

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Surface Texture

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Porous Pavement Considerations

CONSTRUCTION

Site Planning

- Plan to build LATE in the construction process
  - Wait until all the "dirty work" is done
  - Wait until vegetation is established or keep runoff controls in place until established
  - Excavate to within 1 foot of the planned elevation during construction and then excavate to the planned depth when ready
- Use equipment with a soft footprint and do not intentionally compact the subgrade

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Bed Excavation

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Non-woven Geotextile

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Stone Recharge Bed

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Aggregates

- Crushed
- Clean with low percentage of fines (wash if needed)
- Single-size
- #2 for recharge bed
  - 40% void space
- #57 or #9's for choker course
- NO DGA or CSB!

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Choker Course Completed

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Paving

- Utilize conventional paving equipment and techniques
- Recommend track paver
- Stability on aggregates may be an issue
- Typically pave at cooler mix temperatures than with convention mixes
- Production will be less

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Paving on the Recharge Bed

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Compaction ("Seating")

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After Compaction

- Limit traffic for 24 hours
  - Open graded mixtures are more tender and may require additional cooling time
- Keep sediment controls in place until vegetation is established
- Don’t use sand or ash for snow and ice removal
- Don’t seal the parking lot!

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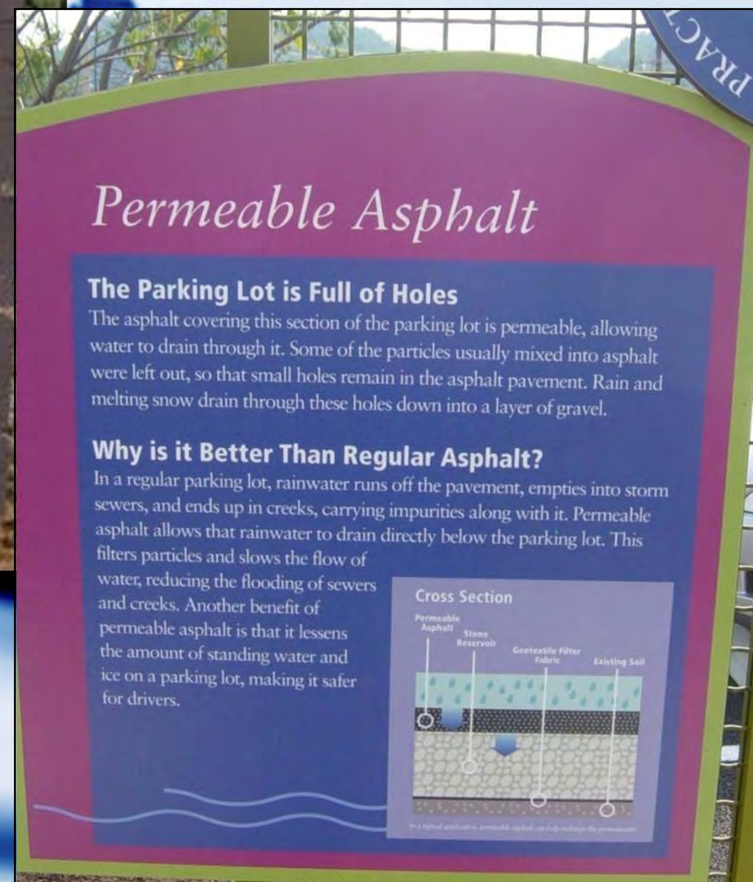
Educational Signs



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Examples

KENTUCKY PROJECTS

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Sanitation District #1 - Covington

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Murray State University

Photo taken in 2004

Photo taken in 2009

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City of Georgetown

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Small Parking Lot in Georgetown

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Covington Park and Ride

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TANK Park & Ride

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Georgetown Fire Station

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Performance During Rain Events

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Seminars and Demonstrations

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Porous Video

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How are they different?

POROUS ASPHALT COSTS

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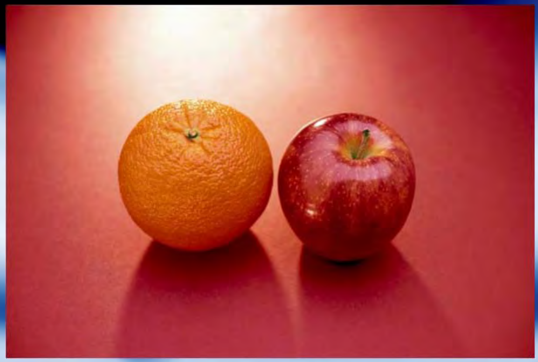
Porous Pavement Cost Factors

- Additional cost in the excavation (if a cut job)
- Additional cost in thick rock layer
- Porous Asphalt Mixture is more expensive than conventional mixtures due to high asphalt content and PG 76-22
- Low production adds cost
- Annual maintenance

- Don’t compare pavement costs alone
- Consider cost and space savings versus retention ponds
- How do you quantify water quality improvements?



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Cost Analysis

- UK Graduate Student recently completed a Capstone Design Project entitled:
  - "Cost efficiency of porous asphalt to reduce stormwater runoff from paved impervious services for the Fayette County"
- Provided an example of a doctor's office with 50 parking spaces with a total of 25,000 square feet in parking area

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Cost Analysis

- Prices can vary widely based on the depth of the stone layer and the production rates for the specific project. Findings for the 25,000 sf parking lot were as follows:
  – Porous asphalt parking lot @ $4.54 per square foot (includes fabric, stone, & asphalt) = $113,500
  – Conventional Parking Lot @ $3.08 per square foot (includes fabric, stone, & asphalt) = $77,000

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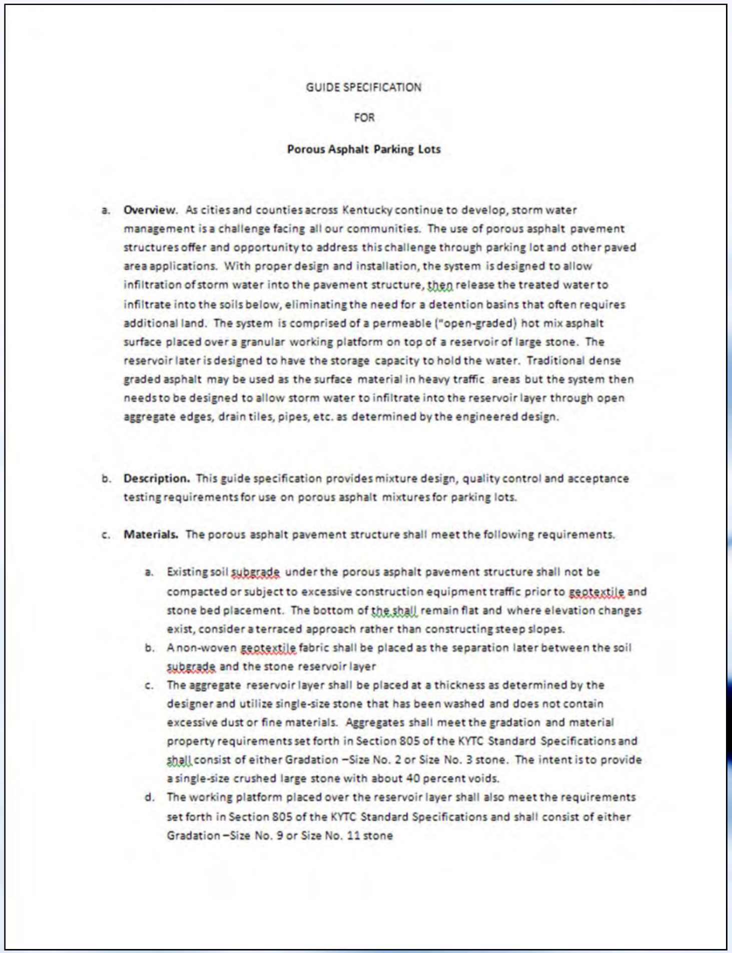
Additional Resources



GUIDE SPECIFICATION

FOR

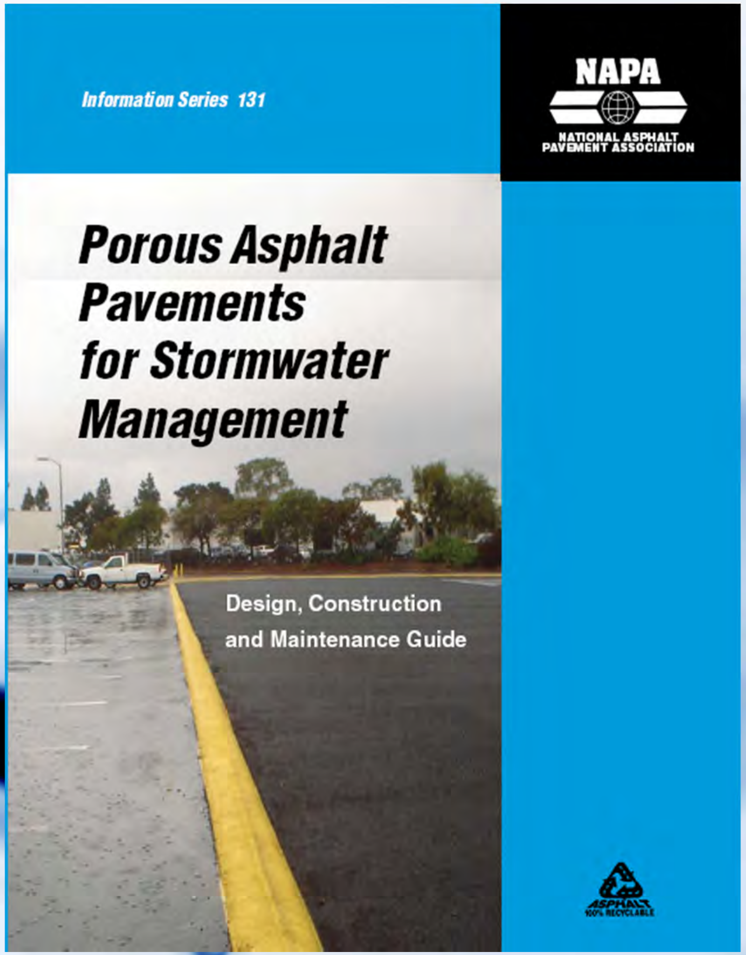
Porous Asphalt Parking Lots

a. **Overview.** As cities and counties across Kentucky continue to develop, storm water management is a challenge facing all our communities. The use of porous asphalt pavement structures offer and opportunity to address this challenge through parking lot and other paved area applications. With proper design and installation, the system is designed to allow infiltration of storm water into the pavement structure, then release the treated water to infiltrate into the soils below, eliminating the need for a detention basins that often requires additional land. The system is comprised of a permeable ("open-graded) hot mix asphalt surface placed over a granular working platform on top of a reservoir of large stone. The reservoir later is designed to have the storage capacity to hold the water. Traditional dense graded asphalt may be used as the surface material in heavy traffic areas but the system then needs to be designed to allow storm water to infiltrate into the reservoir layer through open aggregate edges, drain tiles, pipes, etc. as determined by the engineered design.

b. **Description.** This guide specification provides mixture design, quality control and acceptance testing requirements for use on porous asphalt mixtures for parking lots.

c. **Materials.** The porous asphalt pavement structure shall meet the following requirements.

    a. Existing soil subgrade under the porous asphalt pavement structure shall not be compacted or subject to excessive construction equipment traffic prior to geotextile and stone bed placement. The bottom of the shall remain flat and where elevation changes exist, consider a terraced approach rather than constructing steep slopes.
    b. A non-woven geotextile fabric shall be placed as the separation later between the soil subgrade and the stone reservoir layer
    c. The aggregate reservoir layer shall be placed at a thickness as determined by the designer and utilize single-size stone that has been washed and does not contain excessive dust or fine materials. Aggregates shall meet the gradation and material property requirements set forth in Section 805 of the KYTC Standard Specifications and shall consist of either Gradation –Size No. 2 or Size No. 3 stone. The intent is to provide a single-size crushed large stone with about 40 percent voids.
    d. The working platform placed over the reservoir layer shall also meet the requirements set forth in Section 805 of the KYTC Standard Specifications and shall consist of either Gradation –Size No. 9 or Size No. 11 stone



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CONCLUSIONS

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Tool in the Toolbox

- Porous Asphalt Pavements offer a good alternative to conventional storm water mitigation
- Site conditions must be right and properly designed
- Protect pavement after construction
- Properly designed and constructed porous pavements have a history of excellent performance for 20+ years

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LEEDs Green Building

- Porous Pavement can be utilized to obtain LEED credits for stormwater management
- Additional LEEDs credits are available for:
  - Open graded mixtures mitigate heat-island effect
  - Recycled Asphalt Pavement (RAP) is commonly used by contractors
  - Warm Mix Technology
- Asphalt is Green!

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QUESTIONS?

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