

Permeable Pavement Design for Storm Water Management

DNR Technical Standard 1008



Pete Wood, PE

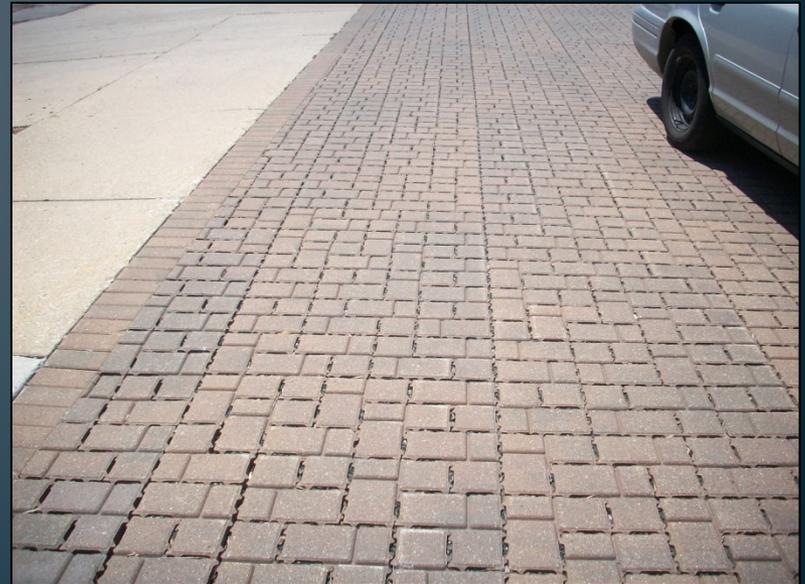
DNR Southeast Region

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Topics

- Background
- Permeable Pavement System Features
- Water Quality & Quantity Control
- Operation & Maintenance



What are DNR Post-Construction Technical Standards?

- Guidance documents
- Include design, construction and maintenance criteria for storm water control measures
- Used for compliance with NR151 post-construction storm water performance standards for new development, redevelopment and existing urban development (MS4s)

DNR Post-Construction Technical Standards

Post-construction Standards	Number	Effective Date
1. Bioretention for Infiltration [PDF 689KB] Tech Note	1004	Nov-10
2. Compost [PDF 90KB]	S100	Oct-04
3. Infiltration Basin Form 1003 [PDF 181KB] Tech Note Fig. 1 [PDF 315KB] , Fig. 2 [PDF 259KB] , Fig. 3 [PDF 83KB] , Fig. 4 [PDF 118KB]	1003	Oct-04
4. Sizing Infiltration Basins and Bioretention Devices Tech Note	n/a	n/a
5. Infiltration Trench [PDF 167KB]	1007	May-12
6. Permeable Pavement [PDF] Tech Note [PDF]	1008	Feb-14
7. Proprietary Storm Water Sedimentation Devices [PDF 193KB]	1006	Apr-09
8. <i>Rain Gardens: A how-to manual for homeowners</i> " [PDF 3MB, Exit DNR]	n/a	Aug-05
9. Site Evaluation for Stormwater Infiltration [PDF] *	1002	03/2014
10. Vegetated Infiltration Swales <i>Updated 5/10/2007</i> [PDF 228KB]	1005	May-07
11. Wet Detention Pond Part 1 [PDF 721KB] , Part 2 [PDF 21KB]	1001	Oct-07

Permeable Pavement Technical Standard Development Team



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Forum
Michelle Reynolds, DOT
Bob Roehrig, County Materials
Corporation
Scot Schwandt, WI Asphalt Pavement
Association
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Permeable Pavement - Definition

A pavement system designed to achieve water quality and quantity benefits by allowing movement of stormwater through the pavement surface and into a base/subbase reservoir. Examples include *pervious concrete (cast-in-place or precast)*, *porous asphalt* and *permeable pavers/blocks*.





STORMWATER FACILITIES KEY

PAVERS (PARK & DRIVE)

PAVERS LOCATED IN THE PARKING AND DRIVE AREAS SHALL BE UNILOCK - ECOSTONE. PICTURES AND DETAILED INFORMATION CAN BE FOUND IN APPENDIX #4.

PAVERS (PATIO & WALKS)

PAVERS LOCATED IN THE PATIO AND WALK AREAS SHALL BE UNILOCK - SERIES AND BRAND OF UNILOCK TO BE DETERMINED. PICTURES OF SAMPLE PATTERNS AND COLORS AND DETAILED INFORMATION CAN BE FOUND IN APPENDIX #4.

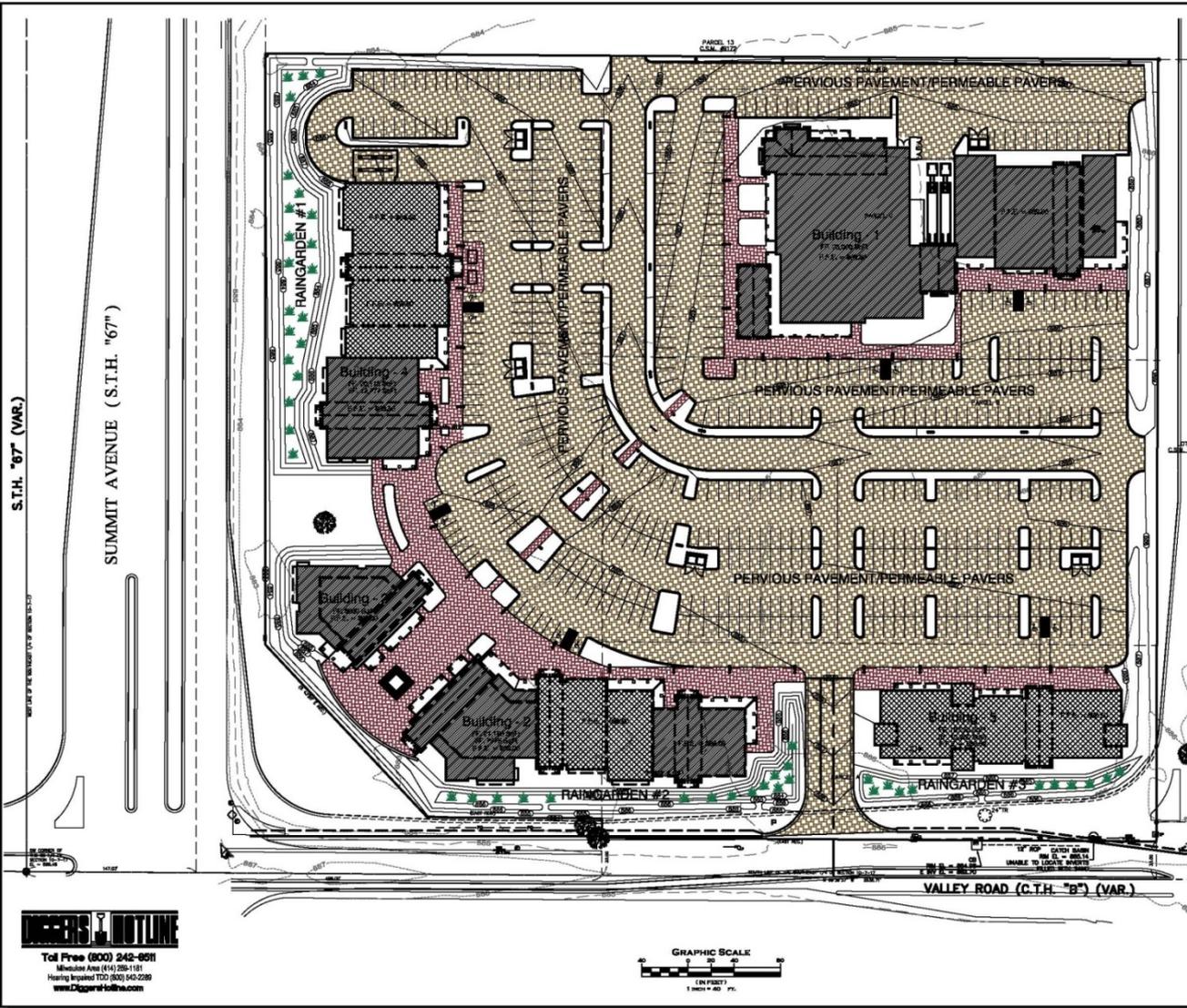
RAINGARDENS

DETAILED INFORMATION CAN BE FOUND IN APPENDIX #1-3.

STORMWATER - SITE MAP

FOR
VALLEY ROAD DEVELOPMENT
 1430 VALLEY ROAD
 OCONOMOWOC, WI

DESIGNED BY:	JJR	DATE:	09-27-06
CHECKED BY:	DWS	DRAWING NO.:	S-1
CSE Job No.:	06-217	SHEET:	1 OF 3



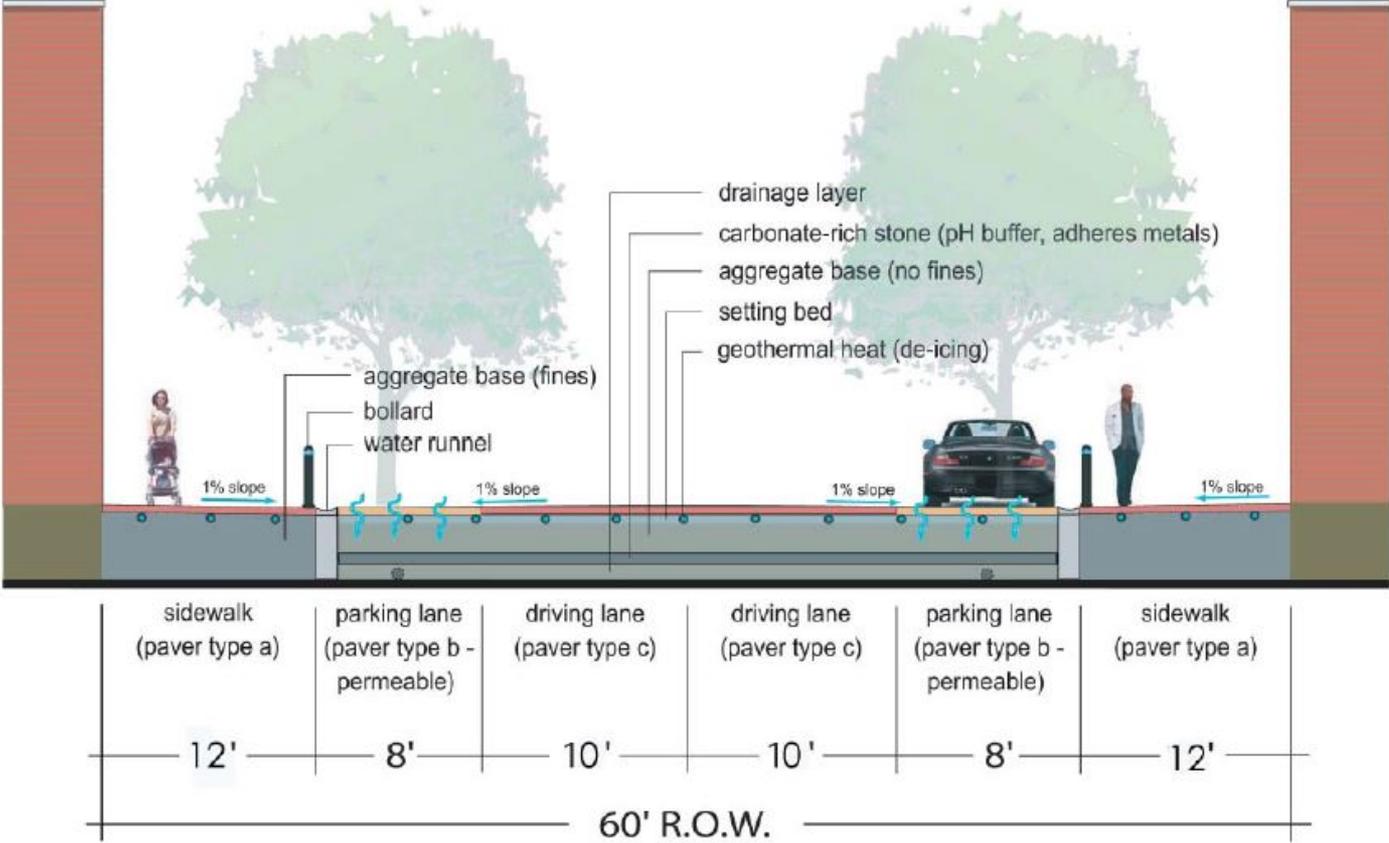
S.T.H. #67 (VAR.)
 SUMMIT AVENUE (S.T.H. #67')

VALLEY ROAD (C.T.H. #B) (VAR.)

DIAGNOSIS OUTLINE
 Toll Free (800) 242-8611
 Milwaukee Area (414) 256-1181
 Hearing Impaired TDD (800) 645-2286
 www.DiagnosisOutline.com



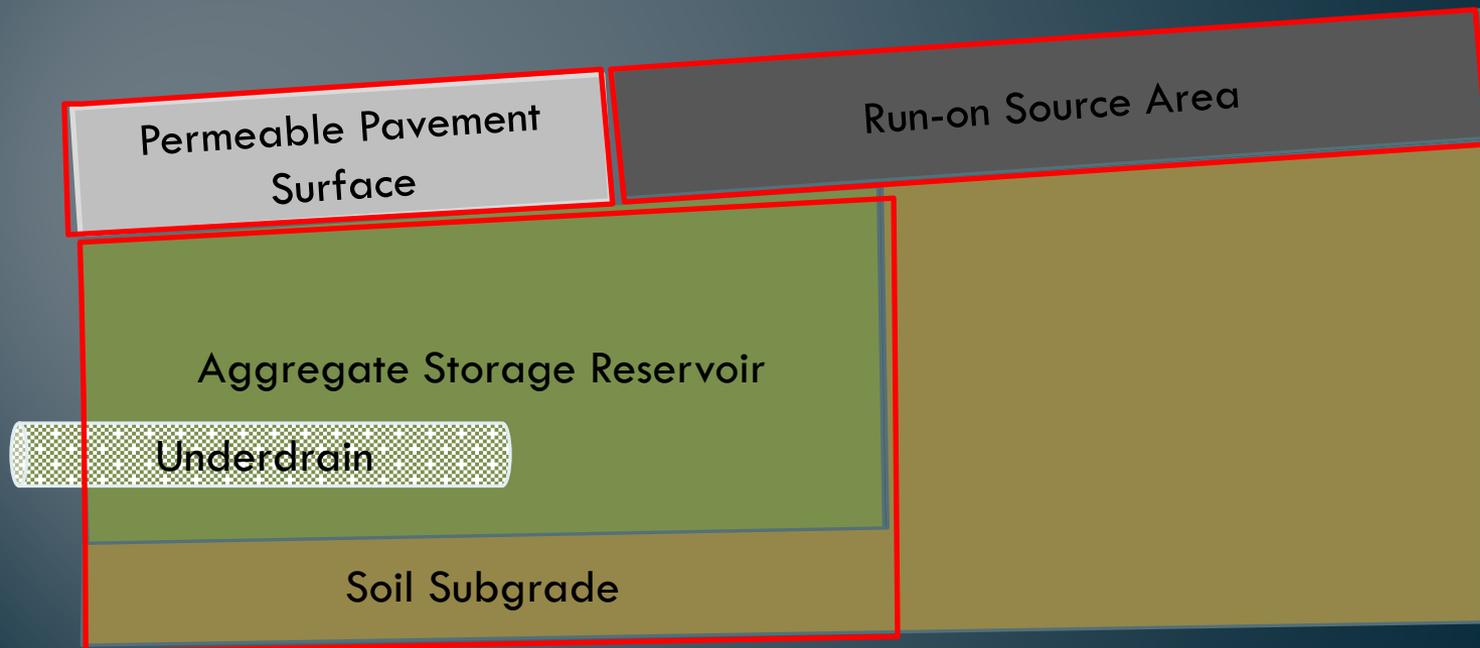
Suggested Sixth Street Enhancement Practices



Permeable Pavement - Conditions Where Practice Applies

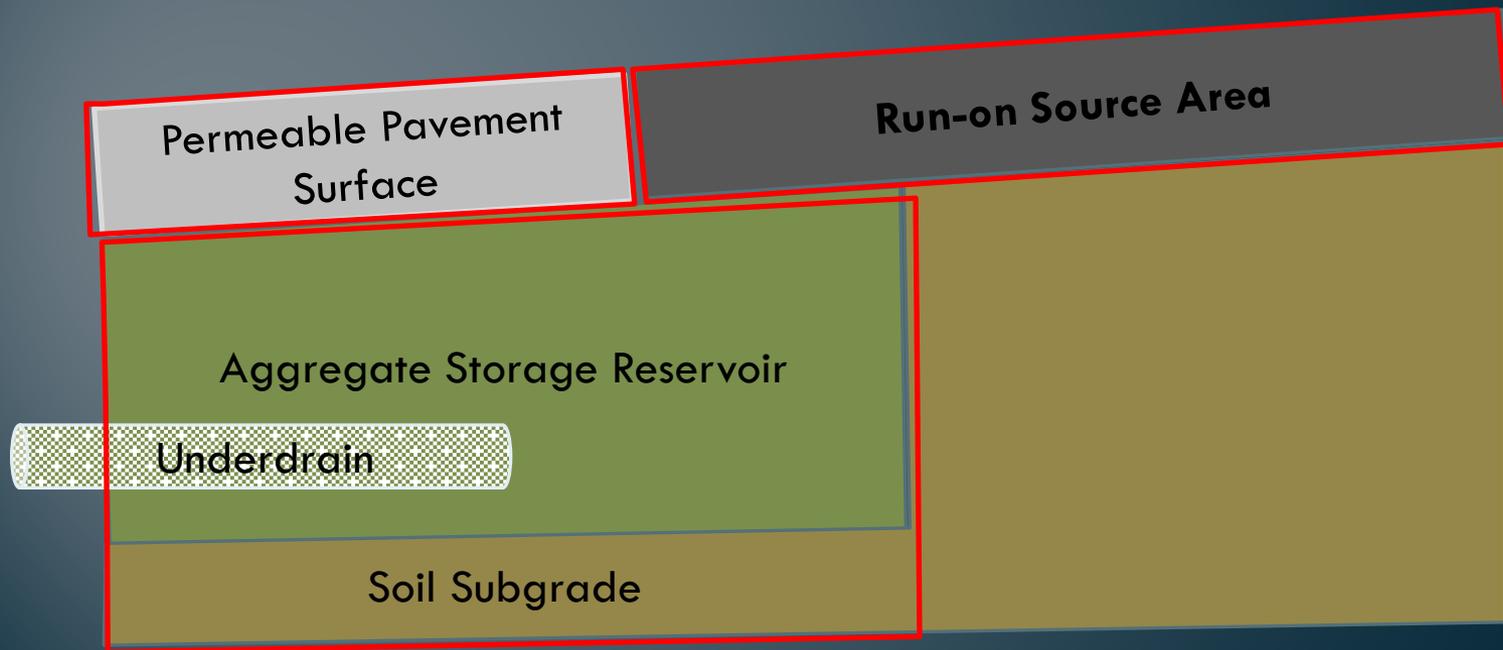
- Alternative to other pavements and storm water control measures (Run-on?)
- Most effective in areas where soil and groundwater conditions are suitable for storm water infiltration (Infiltration pre-treatment?)
- May be used in areas where infiltration is prohibited or limited when liners and/or underdrains are installed (Filtration-Sedimentation-Adsorption?)

Permeable Pavement System



Permeable Pavement System

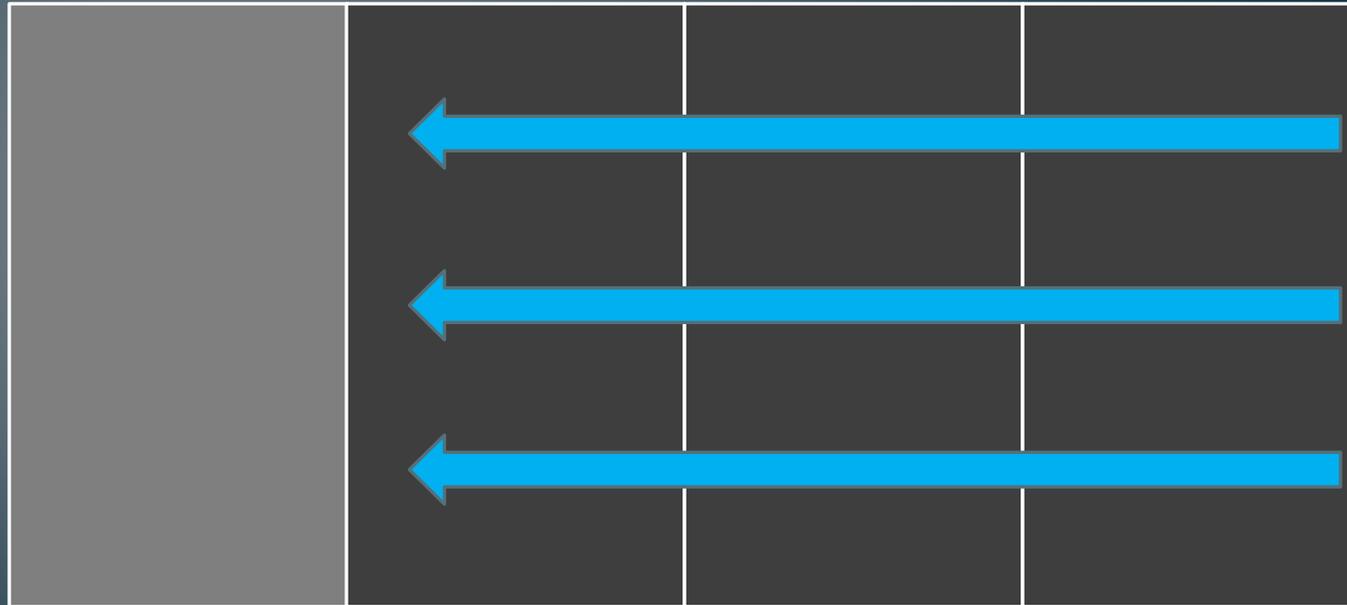
Run-on



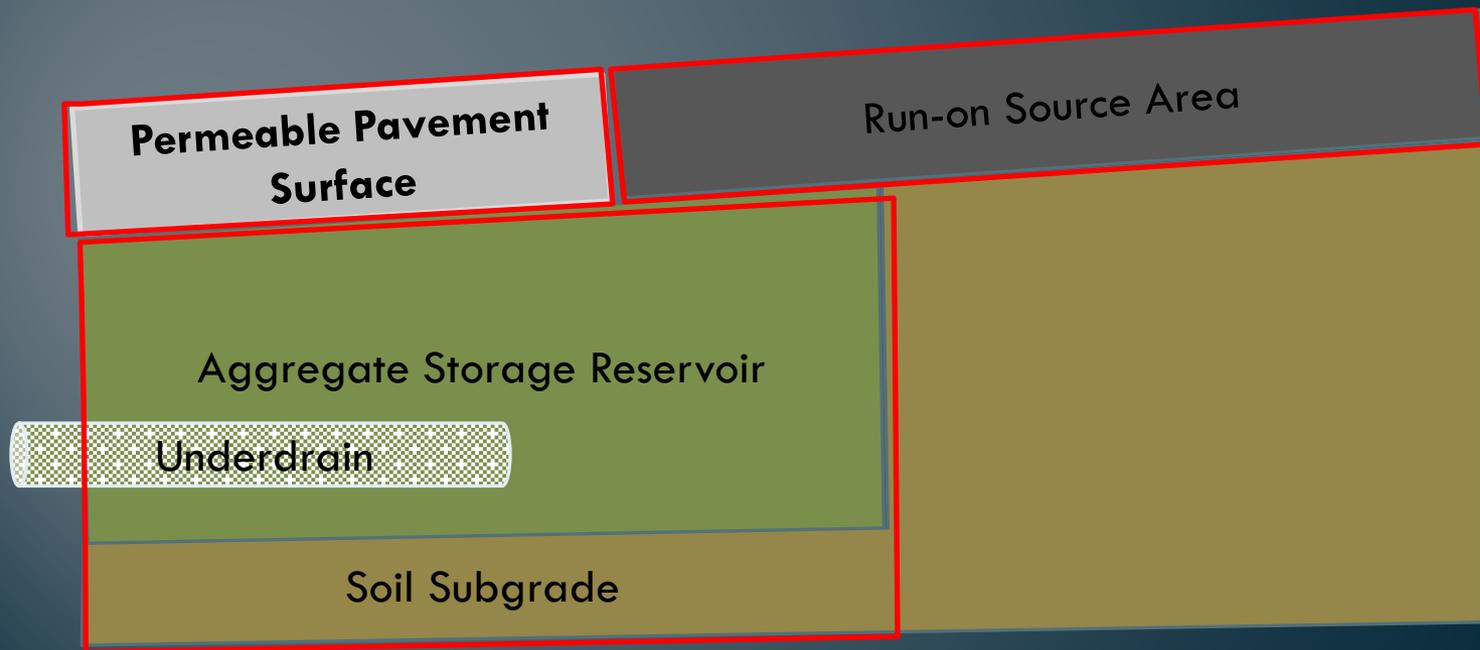
Pavement Surface Run-on Ratio

- High risk areas prohibited:
 - Industrial storage & loading, vehicle fueling & maintenance
- Impervious surfaces:
 - Maximum 3:1 for roads, 5:1 for others surfaces (including parking)
- Pervious areas:
 - Minimize landscaping beds, case by case for lawns
- Considerations:
 - Runoff distribution
 - Source areas
 - Cleaning frequency
 - Anticipated life

3:1 Run-on Ratio



Permeable Pavement System Surface



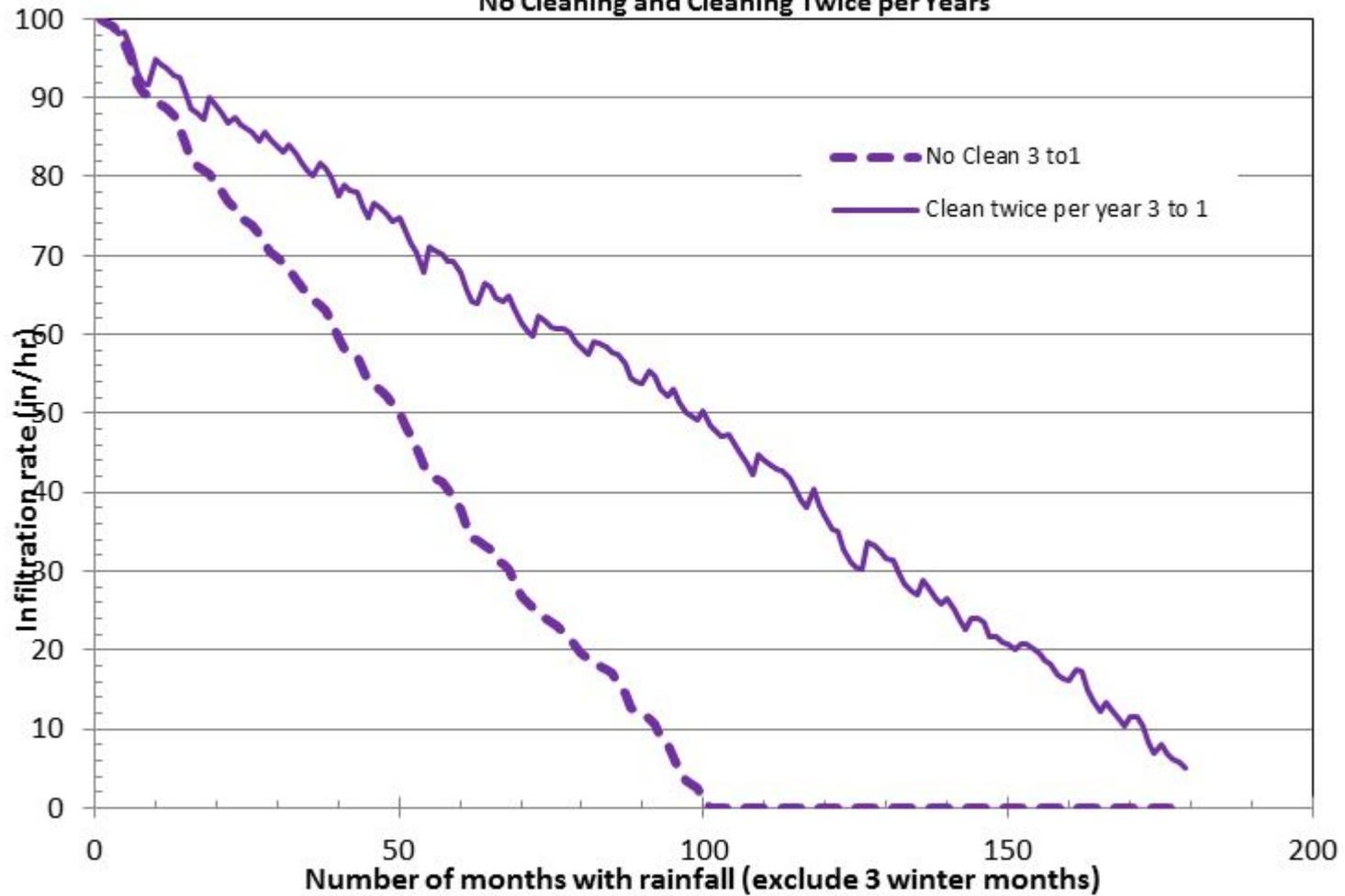
Permeable Pavement Surface - Installed

- Follow industry standards and recommendations for materials, installation and cleaning methods
- Surface Infiltration Rate – Installed
 - Minimum 100 in/hr initial
 - Minimum 10 in/hr in service

Permeable Pavement Surface - Design

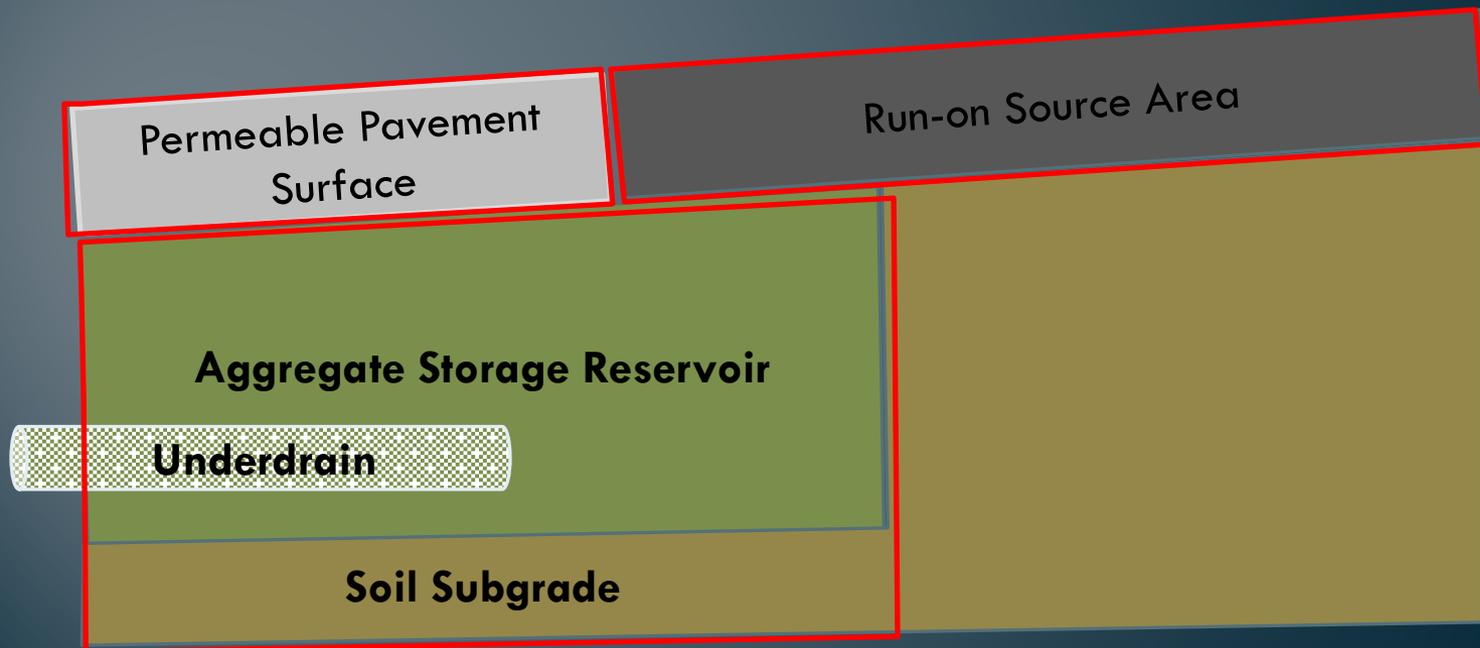
- Surface Infiltration Rate – Design
 - Design goal = No less than 10 in/hr surface infiltration rate for anticipated pavement life
 - Model input parameters
 - Rainfall data for anticipated pavement life (e.g., 20 years)
 - 100 in/hr initial surface infiltration rate
 - 0.6 lbs/sf surface clogging capacity
 - 50% pavement cleaning efficiency
 - Minimum twice per year surface cleaning

Average monthly infiltration rate on 3:1 ratio of
Permeable Pavement when Loading Rate is 0.6 lb/sq-ft
No Cleaning and Cleaning Twice per Years



Permeable Pavement System

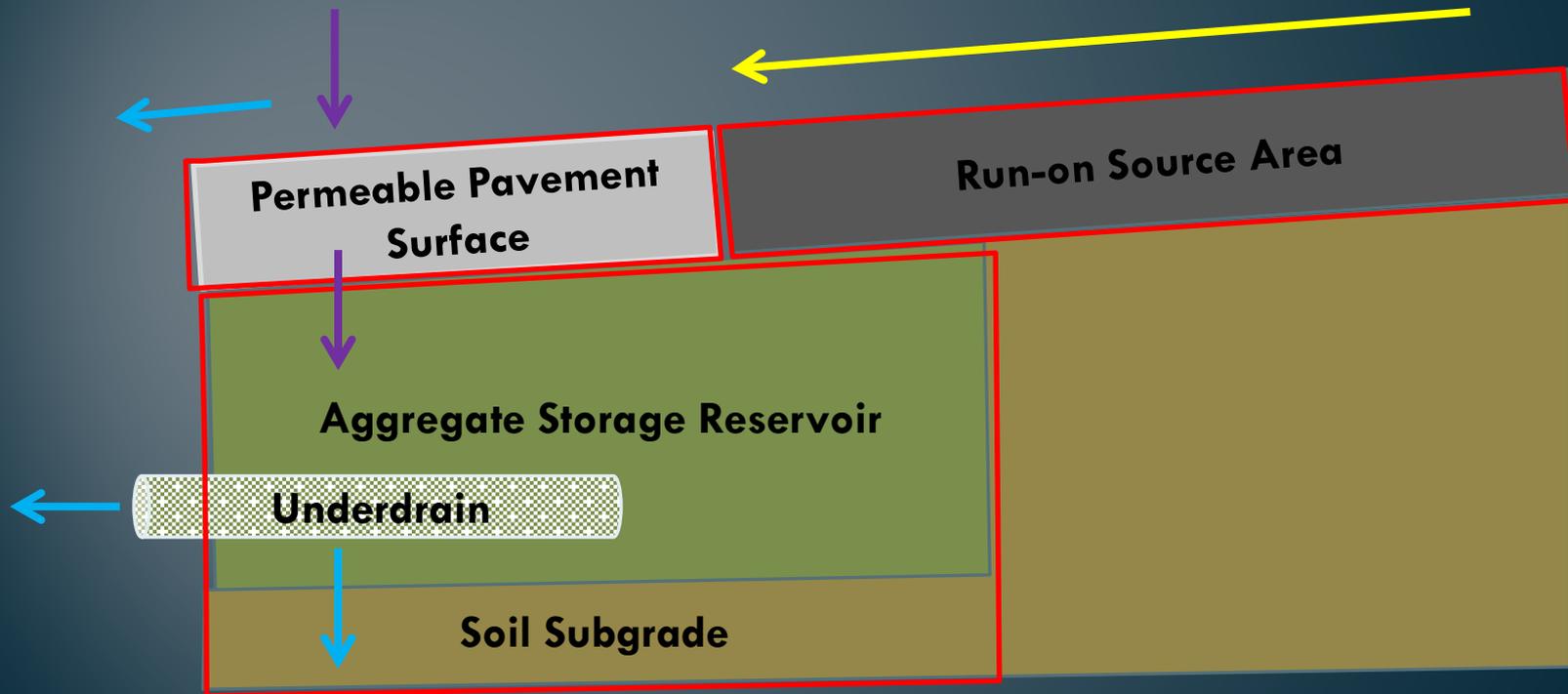
Aggregate Storage Reservoir



Aggregate Storage Reservoir

- Aggregate:
 - Open graded base, crushed stone or crushed gravel, no greater than 5% passing the No. 200 sieve, 30% minimum porosity
- Soil Subgrade:
 - As flat as possible but no greater than 2%, use series of aggregate storage reservoir cells if necessary
 - Follow DNR Site Evaluation for Storm Water Infiltration Tech Standard 1002 to determine design soil infiltration rate
- Underdrains:
 - If needed to ensure aggregate storage reservoir will drain down in no more than 72 hours
- Construction Practices:
 - Protect from sedimentation and over compaction during construction

Water Quality & Quantity Control



Permeable Pavement System

Runoff Volume Reduction (Infiltration)

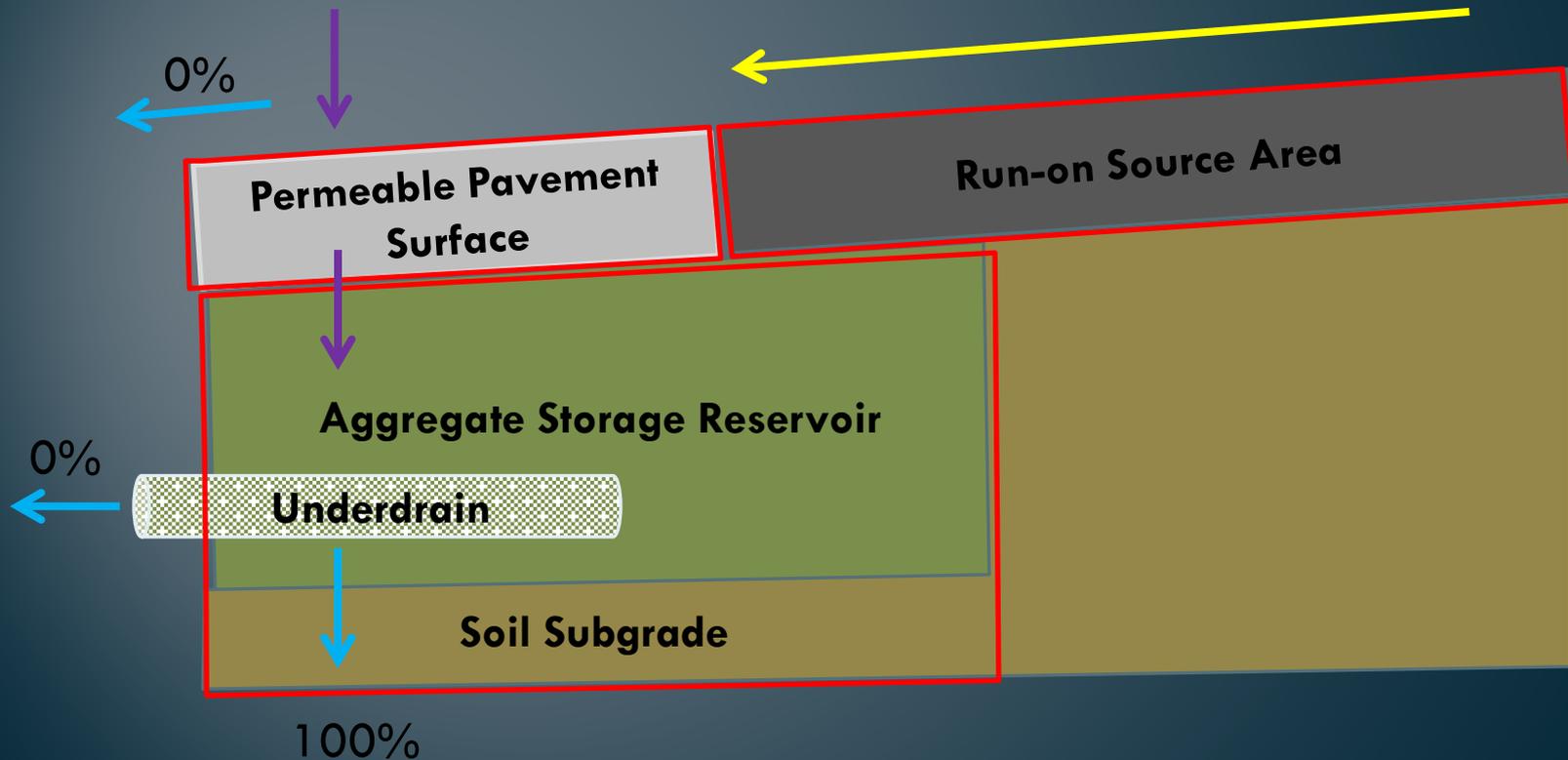
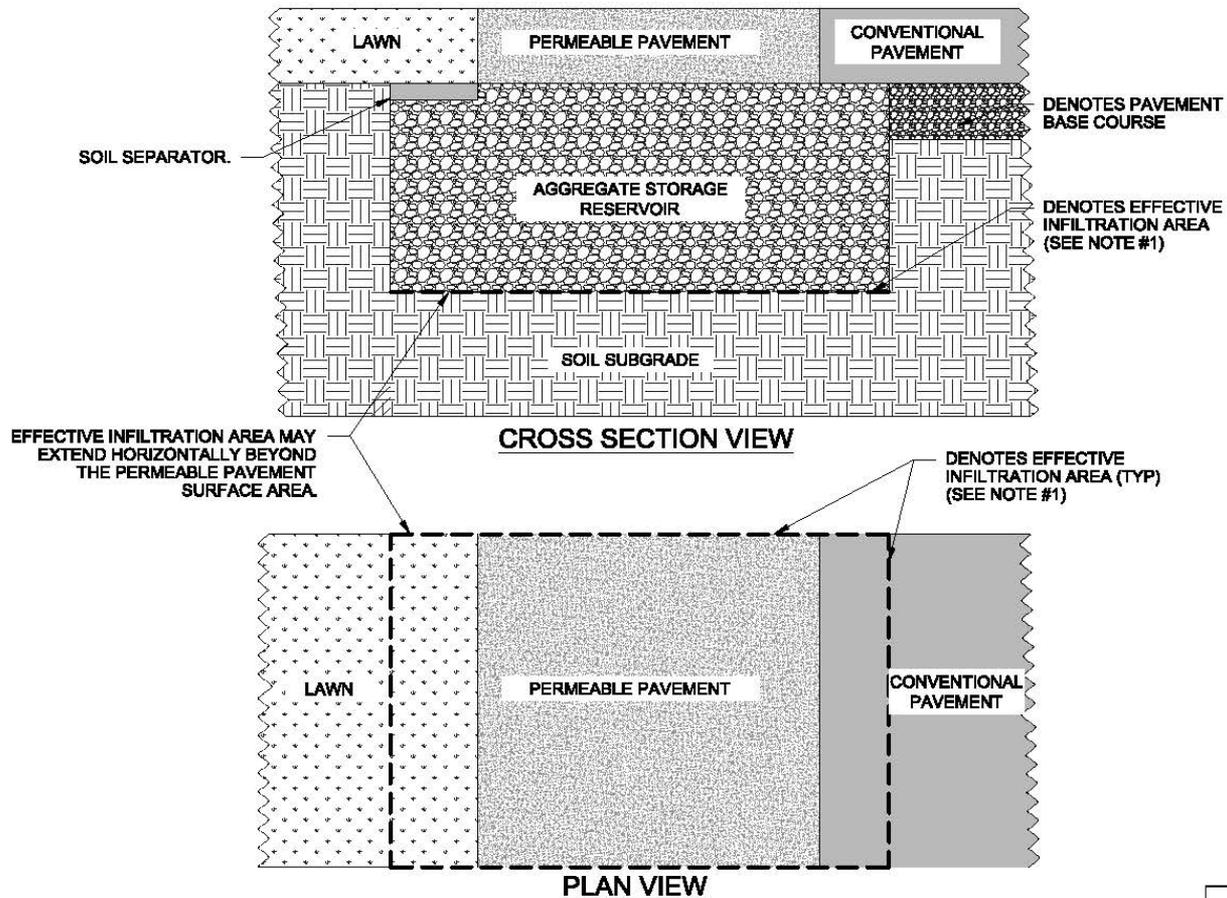


FIGURE 2. EFFECTIVE INFILTRATION AREA



NOTES:

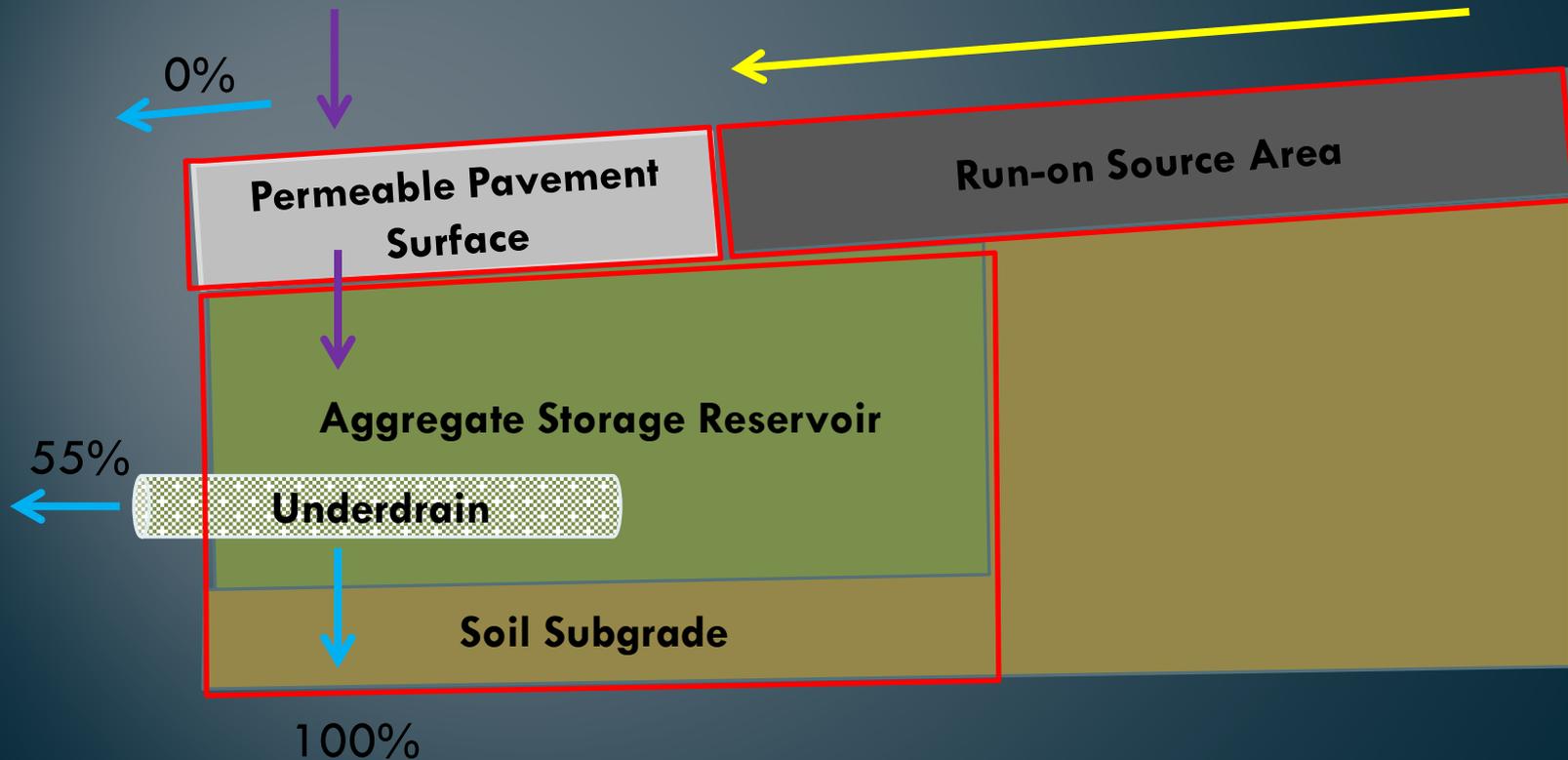
1. THE EFFECTIVE INFILTRATION AREA CAN BE INCREASED BY EXTENDING THE AGGREGATE STORAGE RESERVOIR UNDER CONVENTIONAL PAVEMENT SURFACES OR IN OTHER APPROPRIATE AREAS, SUCH AS LAWNS WITH SOIL SEPARATOR (e.g., FILTER FABRIC).
2. EFFECTIVE INFILTRATION AREA IS THE AREA USED TO INFILTRATE RUNOFF INTO THE SOIL SUBGRADE AS DEFINED IN s. NR 151.002(12) OF THE WIS. ADM. CODE.
3. FOR PERMEABLE PAVEMENT SYSTEMS THAT WILL RECEIVE RUN-ON FROM ROAD AND / OR PARKING LOT SOURCE AREAS, THE RATIO OF RUN-ON AREA TO EFFECTIVE INFILTRATION AREA SHALL BE NO GREATER THAN 3:1.

WISCONSIN
DEPT. OF NATURAL RESOURCES

1008
TECHNICAL STANDARD No.
01/2014
REVISION DATE
NOT TO SCALE

Permeable Pavement System

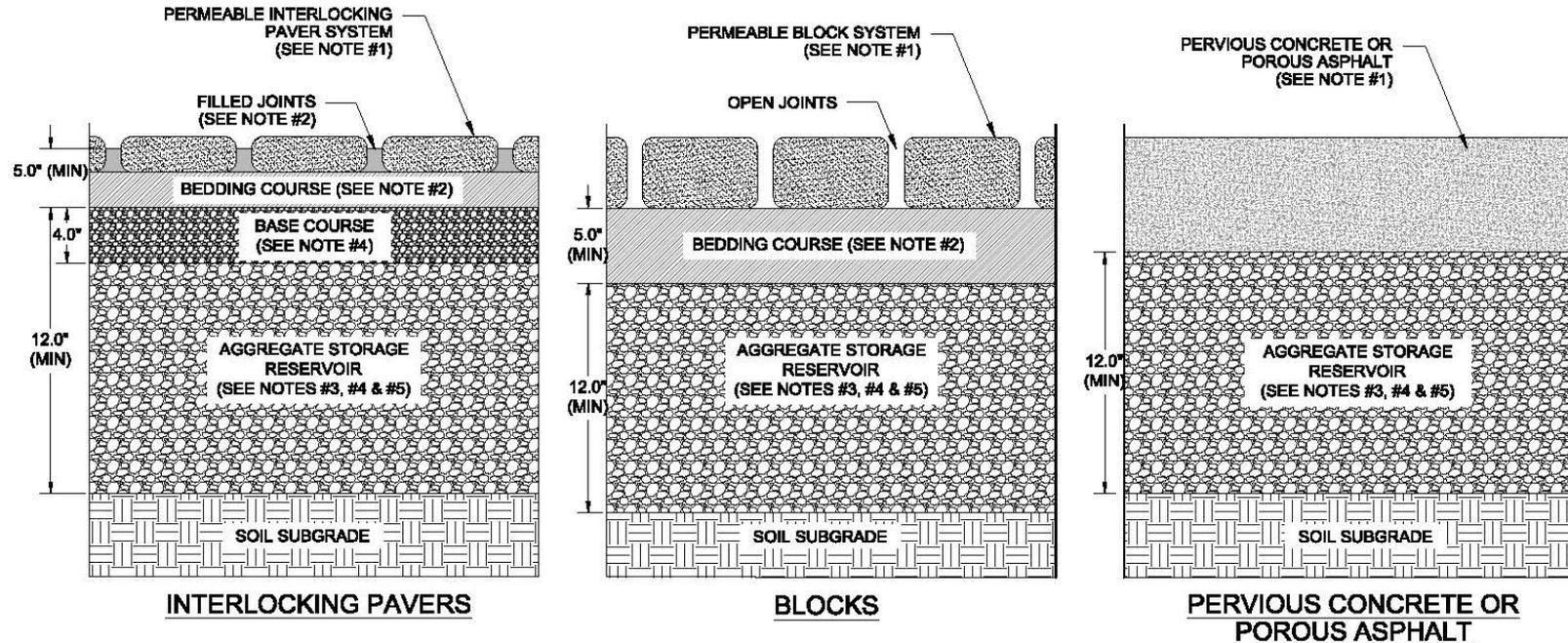
TSS Removal (Madison Study)



Pre-Treatment for Infiltration & Underdrain Discharge Credit Criteria

- Maximum permeable pavement surface percent voids = 25%
- Minimum 5 inches of No. 8, 89, 9 or 57 aggregate for paver/block systems
- Minimum 12 inch aggregate storage reservoir depth

FIGURE 1. CRITERIA FOR UNDERDRAIN DISCHARGE AND INFILTRATION PRETREATMENT CREDITS



NOTES:

1. PAVEMENT SURFACE PERCENT VOIDS SHALL BE LESS THAN 25%.
2. JOINT STONE AND BEDDING COURSE SHALL CONSIST OF ASTM C-33, 8, 9, 89, OR 57 AGGREGATE.
3. AGGREGATE STORAGE RESERVOIR DEPTH SHALL BE A MINIMUM OF 12 INCHES.
4. BASE AND / OR SUBBASE COURSES WITH MINIMUM POROSITY OF 30% CAN BE CONSIDERED AGGREGATE STORAGE RESERVOIR. BASE COURSE FOR PERMEABLE INTERLOCKING PAVERS SHALL BE 4.0" DEPTH OF ASTM C-33, 57 AGGREGATE AND CAN BE CONSIDERED PART OF THE AGGREGATE STORAGE DEPTH.
5. UNDERDRAINS CAN BE LOCATED WITHIN OR BELOW THE AGGREGATE STORAGE RESERVOIR. UNDERDRAINS (OR EQUIVALENT) ARE REQUIRED IF THE AGGREGATE STORAGE RESERVOIR DRAIN DOWN TIME WILL EXCEED 72 HOURS.



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Operation & Maintenance

- Minimum surface cleaning frequency of twice per year using industry recommended method
- Winter operations – No sand, minimize sodium chloride usage (clay soils)
- Annual inspection of surface and subsurface drainage

Questions



Bioretention:

Design Considerations for Living Storm Water Management



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What is it? (in simple terms please)

- It is a vegetated area designed to collect, filter and discharge runoff from **small, frequent events**
 - It has plants with root structure (not turf grass)
 - It has a filtering layer
 - It has an underdrain
 - It has a storage layer
- It is a living thing! “Bio-filter” = **life-filter**
- From Webster’s: *living* adjective:
 - Not dead: having life
 - Currently active or being used
 - Exhibiting the life or motion of nature



Why do we do bioretention?

- We have to. Meet performance standards
 - TSS control
 - Peak flow reduction
 - Infiltration
 - Thermal mitigation
- Site limitations
 - High groundwater/bedrock
 - Poor soils
 - Space / Earth balance
- Other values
 - Promote green infrastructure, LID
 - Safety
- Sometimes, we want something that is aesthetic while still meeting the rules



Why do we do bioretention?

KEY POINT:

- We do it when constructing an infiltration basin is not feasible



Key design considerations

- Bioretention with lower run-on ratios will perform better, last longer, and require less costly maintenance
- Compost is necessary for plant growth, not for pollutant removal
- The engineered fill filtering layer is the workhorse for pollutant removal
- Take advantage of even a little bit of infiltration – raise the underdrain
- Disperse the flow
- Pretreatment is necessary
- Plant survival is important



Run-on ratios

- Consider bioretention as smaller source area controls (0.5-1 acre areas at most)
 - Greater risk/stress on systems with larger, end of pipe outfall control
- 12" max ponding depth, 24 hour drawdown
- Maximum 2 acre contributing area



Compost

- Want to minimize compost material to amount necessary to provide nutrients for plant growth
- 15-30% Compost / 70-85% Sand
- Must use S100 compost
 - Check with US Composting Council Seal of Testing Assurance (STA) participants

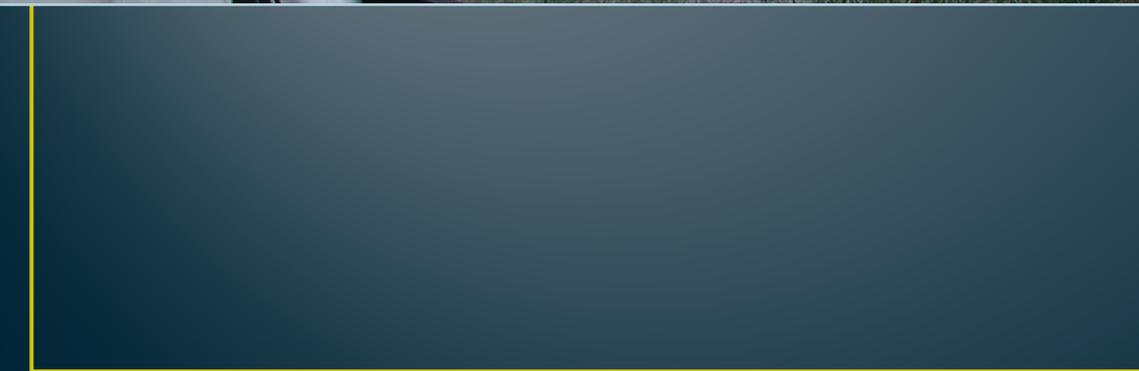
<http://compostingcouncil.org/seal-of-testing-assurance/>



Plant survival is important

- Plant functions
 - Uptake of nutrients and some heavy metals
 - Help disperse flow across treatment area
 - **Keeps soil loose, maintains hydraulic conductivity**
 - Looks nice if healthy
 - Looks horrible if dead and barren
- If the plants are thriving, then everything is working correctly











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Enterprise

ATI

PIZZA

SportCaps

20 20
20 20





