Turf Work Order:
Presentation of Final Results
May 17, 2013 MIDS Workgroup Meeting

p-gen3-15i

Categories of Turf "Credits"

1. **Impervious Surface Disconnection-** turf (or green space) that captures runoff from impervious surfaces

2. **Soil Improvements (aka "Better Turf")-** vegetated pervious areas that do not capture runoff from impervious surfaces, but are maintained or amended to increase infiltration

Soil Improvements

- Soil Improvements:
  - Defined as soil maintained or amended to achieve higher infiltration rates and reduce runoff
  - Maintenance includes loosening or ripping to decrease soil density

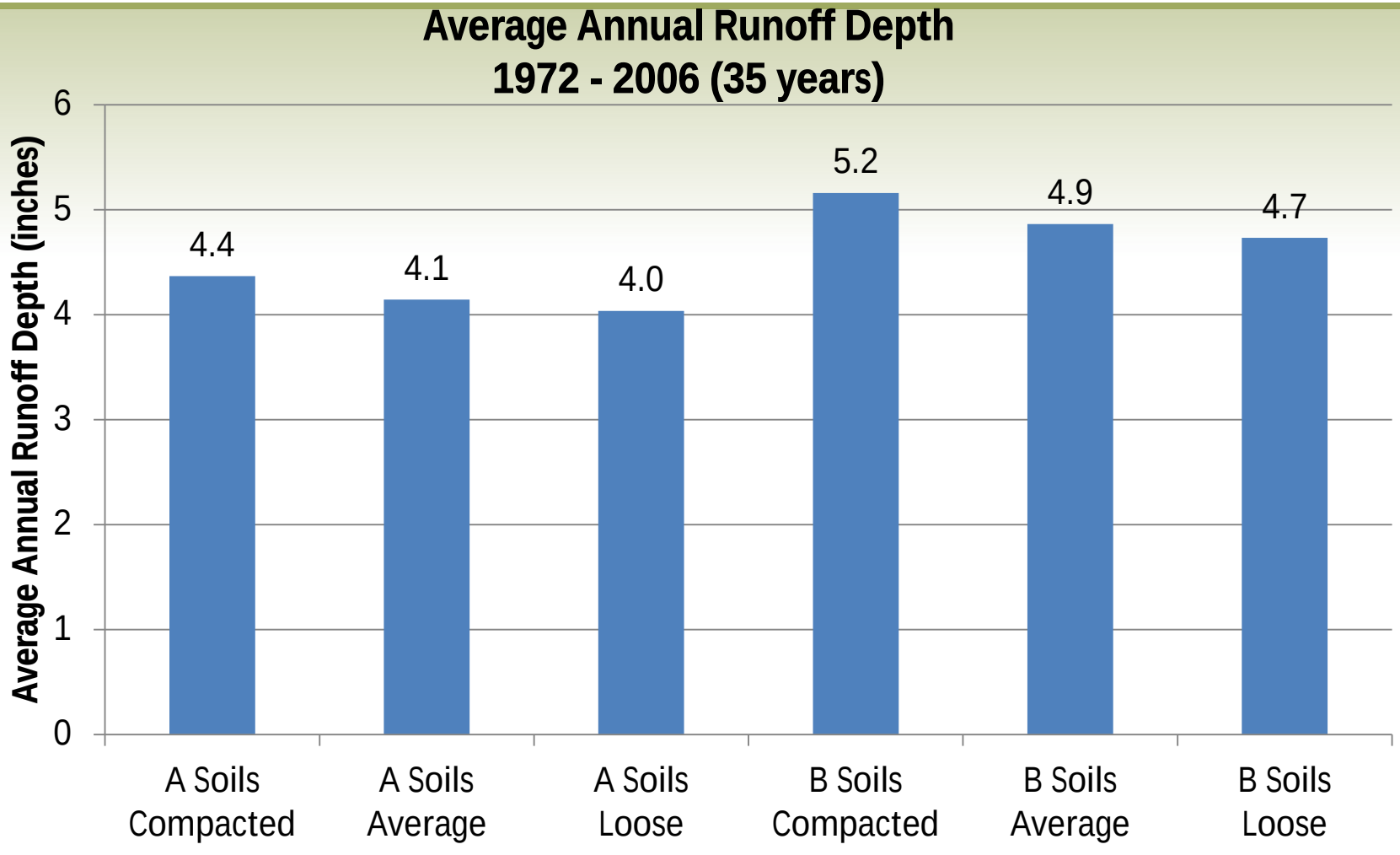
Calculating Volume Reduction from Soil Improvements

1. Need to quantify reduction in runoff volume from pervious surfaces

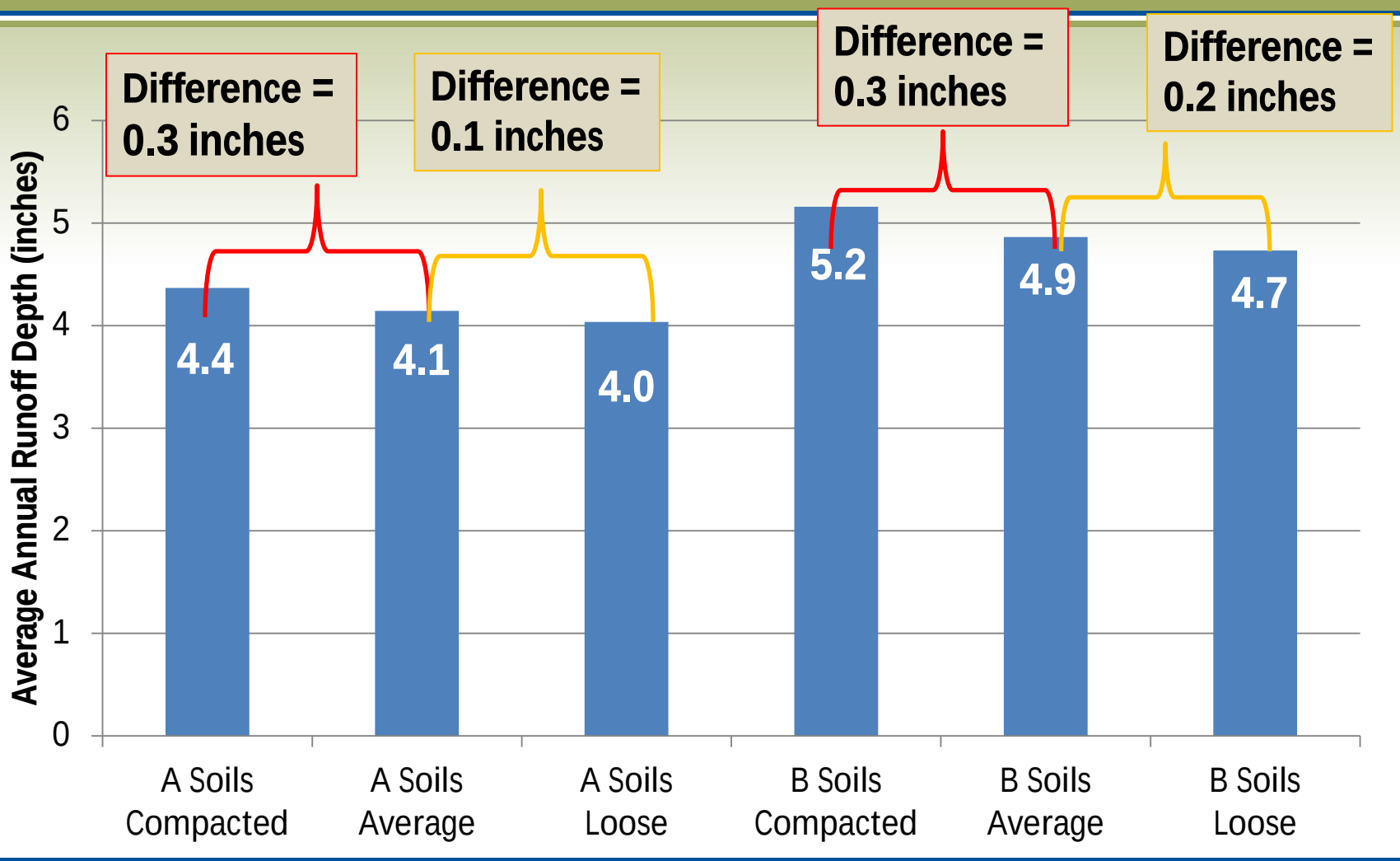
Quantifying reduction in runoff volume from pervious surfaces

- Used XP-SWMM hydrologic model to estimate the difference in annual runoff from pervious areas under varied soil conditions
  - Long-term simulation to determine annual runoff (35 years of climatic data)
  - Evaluated A, B, and C soils
- Infiltration rates were varied for each soil type to represent compacted, average, and loosened conditions
  - Infiltration rates based on a national database of observed values compiled by Rawls, et al (1998)

Annual average runoff depths from pervious areas



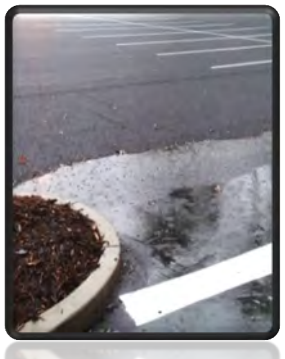
Average annual runoff depths from pervious areas



Calculating Volume Reduction from Soil Improvements

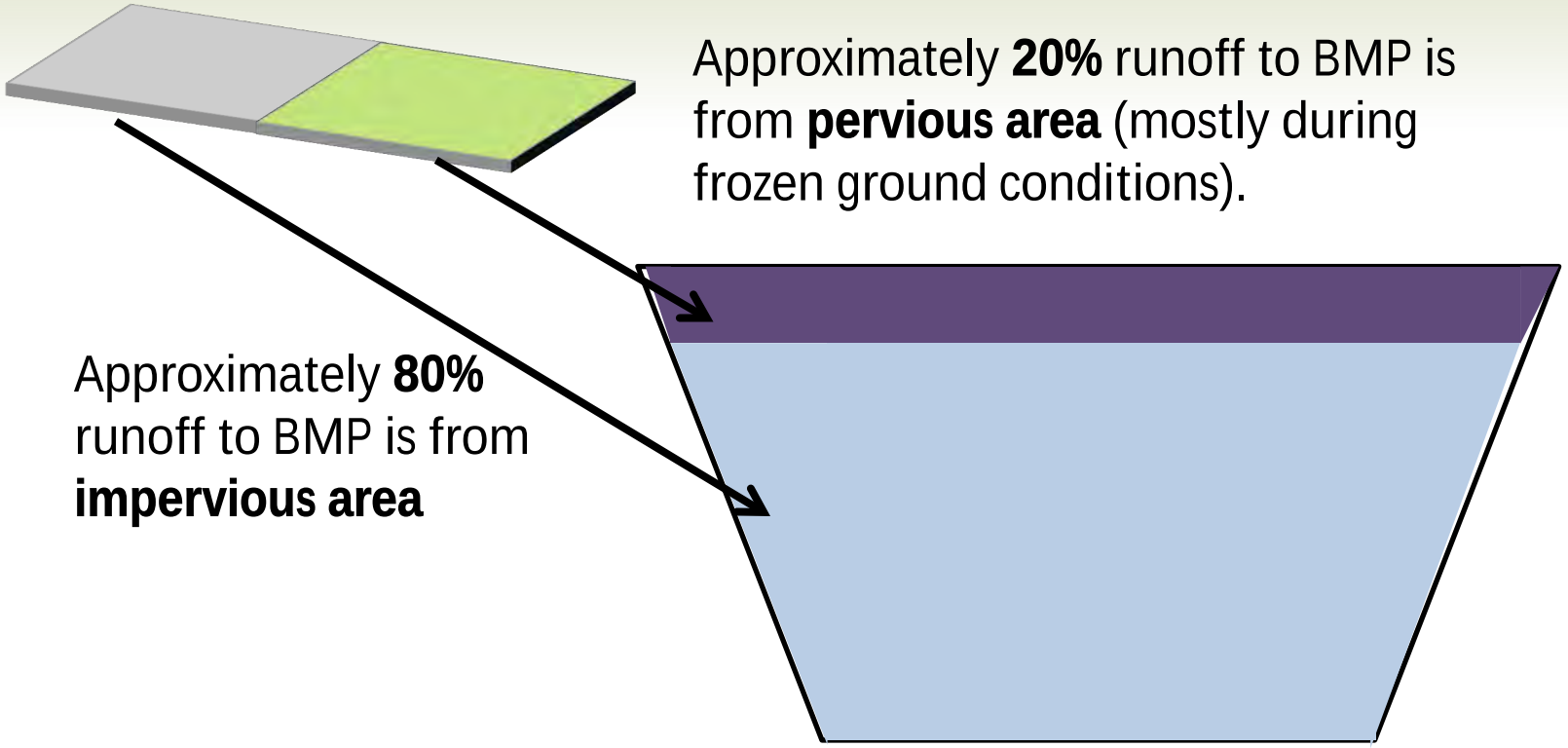
1. Need to quantify reduction in runoff volume from pervious surfaces

2. Need to quantify reduction in overall site runoff volume

site runoff volume =  +

Majority of site runoff comes from impervious surfaces

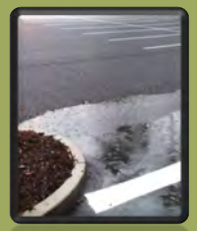
For a 50% impervious site with B soils



Approximately **20%** runoff to BMP is from **pervious area** (mostly during frozen ground conditions).

Approximately **80%** runoff to BMP is from **impervious area**

Annual site runoff volume =



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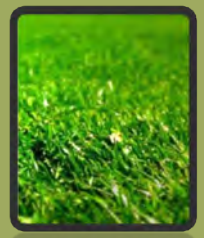


So, for 2-acre, 50% impervious site, compacted B soils

Site runoff with unimproved soils =

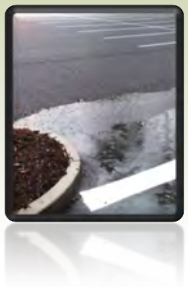
22.5 inches * 1 ac + 5.2 inches * 1 ac = 27.7 acre-inches

(impervious runoff) (pervious runoff)

Site runoff with soils improved to “loosened” conditions =

22.5 ac-in + 4.7 ac-inches = 27.2 acre-inches

Calculating Performance Goal Credits

Performance goal: 1.1 inches x 

- Since performance goal does not directly consider pervious runoff, need alternate method to account for reduction

- Calculate conformance with performance goal by calculating adjusted imperviousness of the site

Calculating Performance Goal Credits

- Runoff from the site with soils "loosened" soils on the 1-acre of pervious turf is reduced by 0.5 inches per acre

Adjusted impervious surface after improvement =

27.2 acre-inches = (I_{adj})*(22.5 in) + (1 ac)*(5.2 in)

Impervious runoff

Pre-improved pervious runoff

Adjusted Impervious Area (I_{adj}) = 0.978 acres (versus 1 acre)

Calculating Performance Goal Credits

For our 2-acre, 50% impervious site with compacted B soils, soil improvements to a "loosened" condition result in:

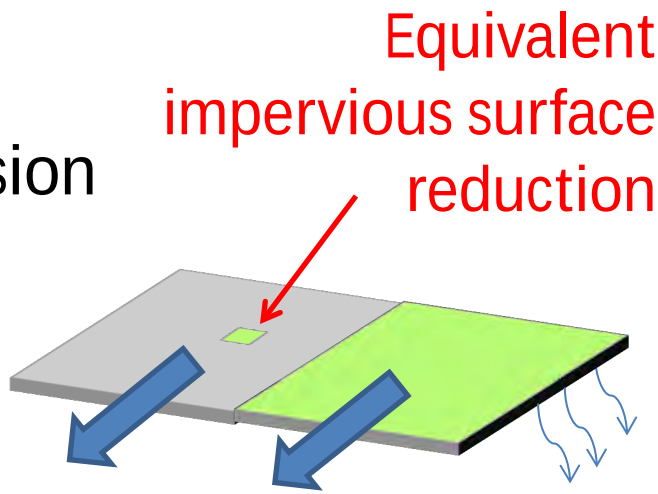
- Equivalent impervious surface reduction of

  = 1 acre – 0.978 acre = 0.022 acres (968 sq ft)

- BMP volume credit =

  = 1.1 in x 0.022 acres x unit conversion

  = 89 ft^3



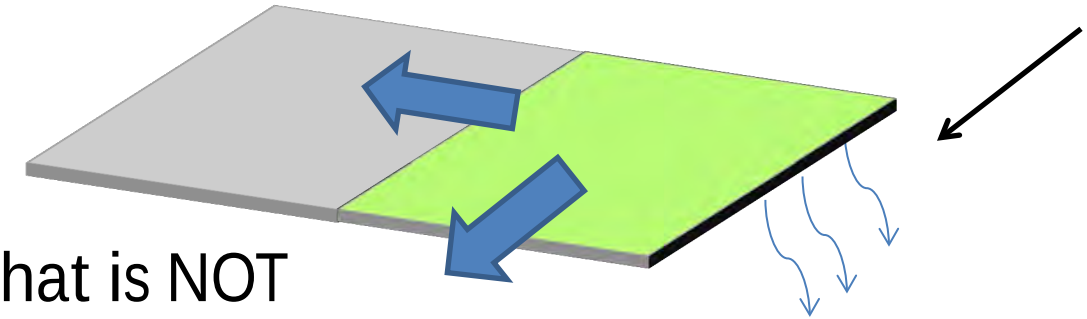
($3,993\ ft^3$ required for site)

Estimate annual performance

- Annual volume reduction determined using performance curves

- Pollutants:

Runoff that is infiltrated achieves 100% TP, DP and TSS removal



Runoff that is NOT infiltrated achieves 0% TP, DP and TSS removal

Credits for **Impervious Surface Disconnection**

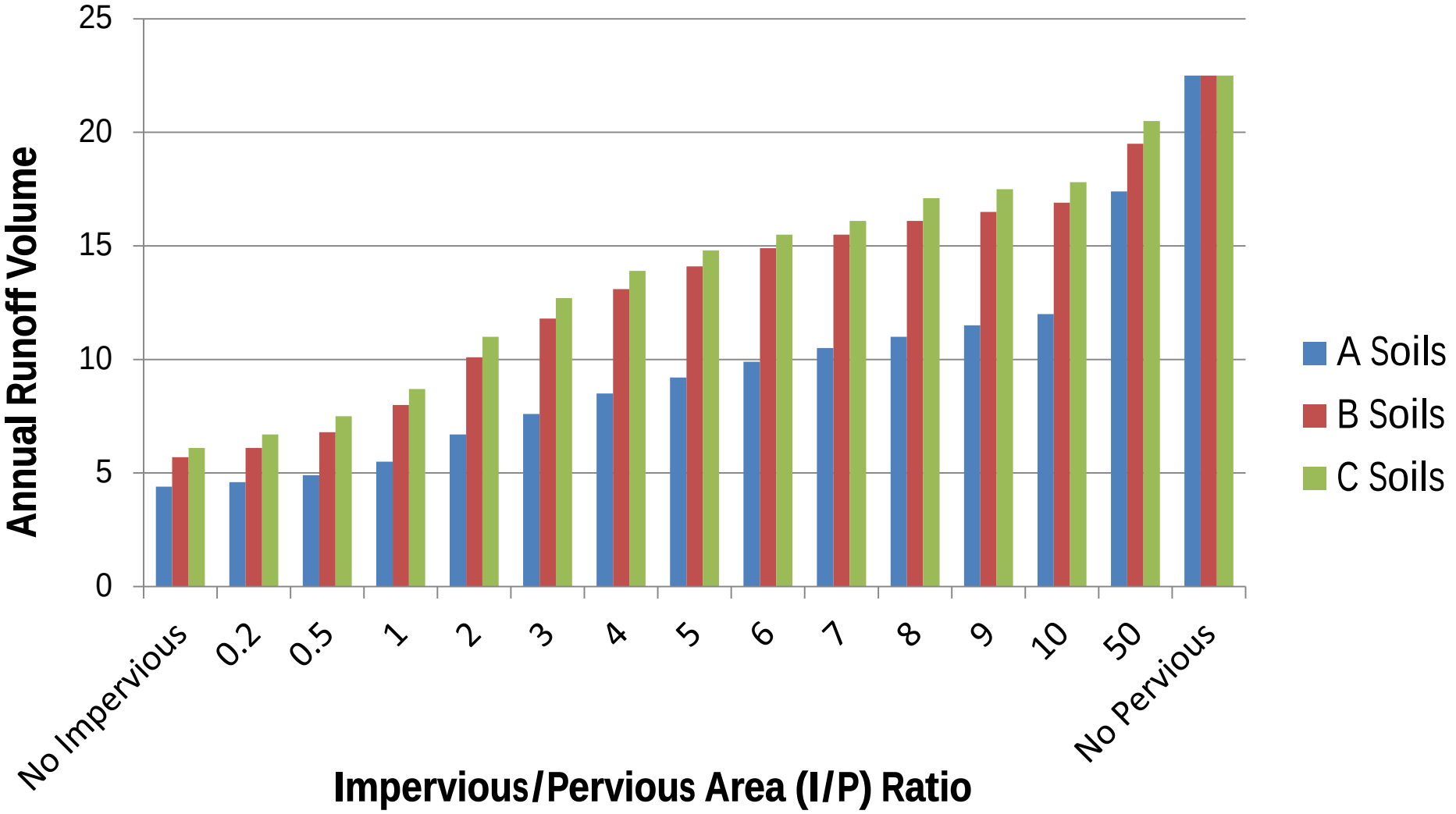
- Runoff from impervious areas (sidewalks, parking lots, etc.) is redirected to green space instead of the storm sewer
- Overall site runoff will be reduced
- Reduction will depend on the additional infiltration capacity of the turfed area (annual basis)

Photo: http://www.reporthost.com/a1qual/sample1/

Quantifying reductions in site runoff

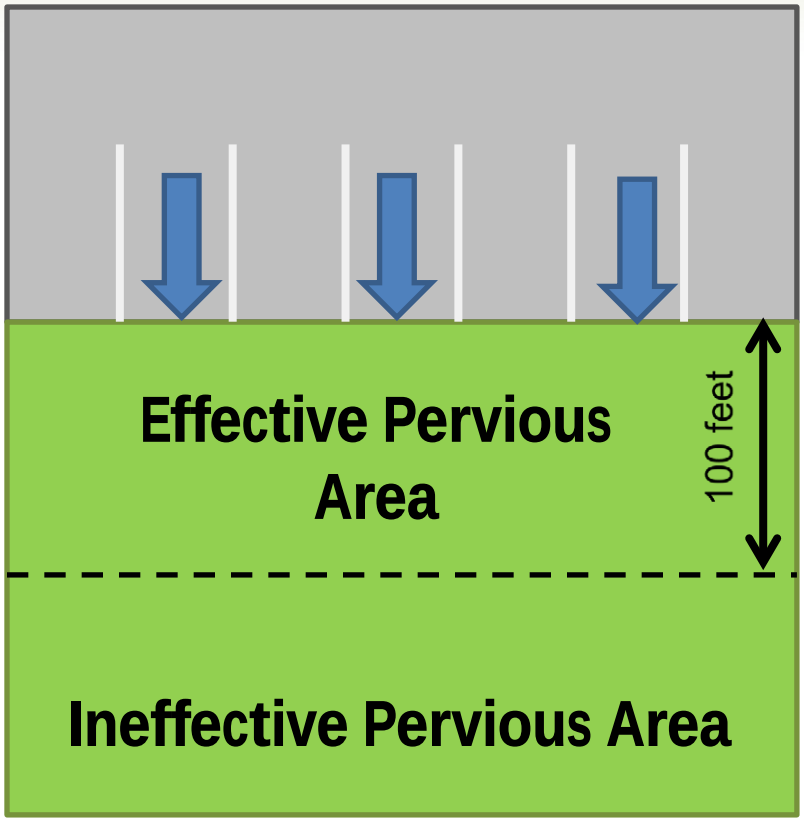
- Used XP-SWMM hydrologic model to quantify runoff reduction
  - Long-term simulation to determine annual performance (35 years of climatic data)
  - Event-based simulation to assess relation to 1.1-inch performance goal (1.1-inch storm over 15- and 30-minute durations)
- Redirected impervious runoff to pervious areas and quantified overall site runoff
- Varied soil type AND ratio of impervious to pervious area (I/P Ratio)

Average Annual Runoff Impervious Ratio Comparison



Calculating Volume Reduction from Impervious Surface Disconnection

1. Determine “effective” pervious area (Area $_{P\ eff}$)



Calculating Volume Reduction from Impervious Surface Disconnection

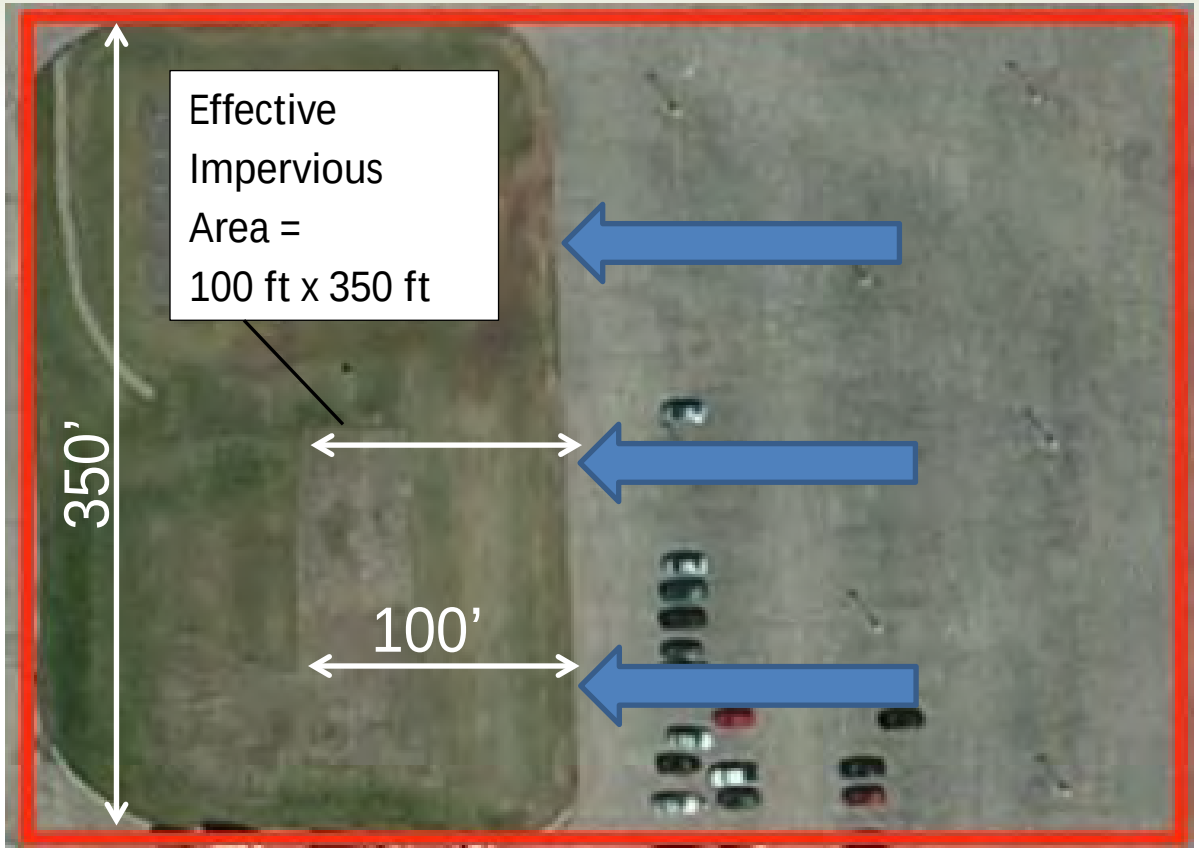
1. Determine “effective” pervious area on 3-acre, 50% impervious site

Area $_{Peff}$ =

= 100 ft x 350 ft

= 35,000 ft^2

= 0.8 acres



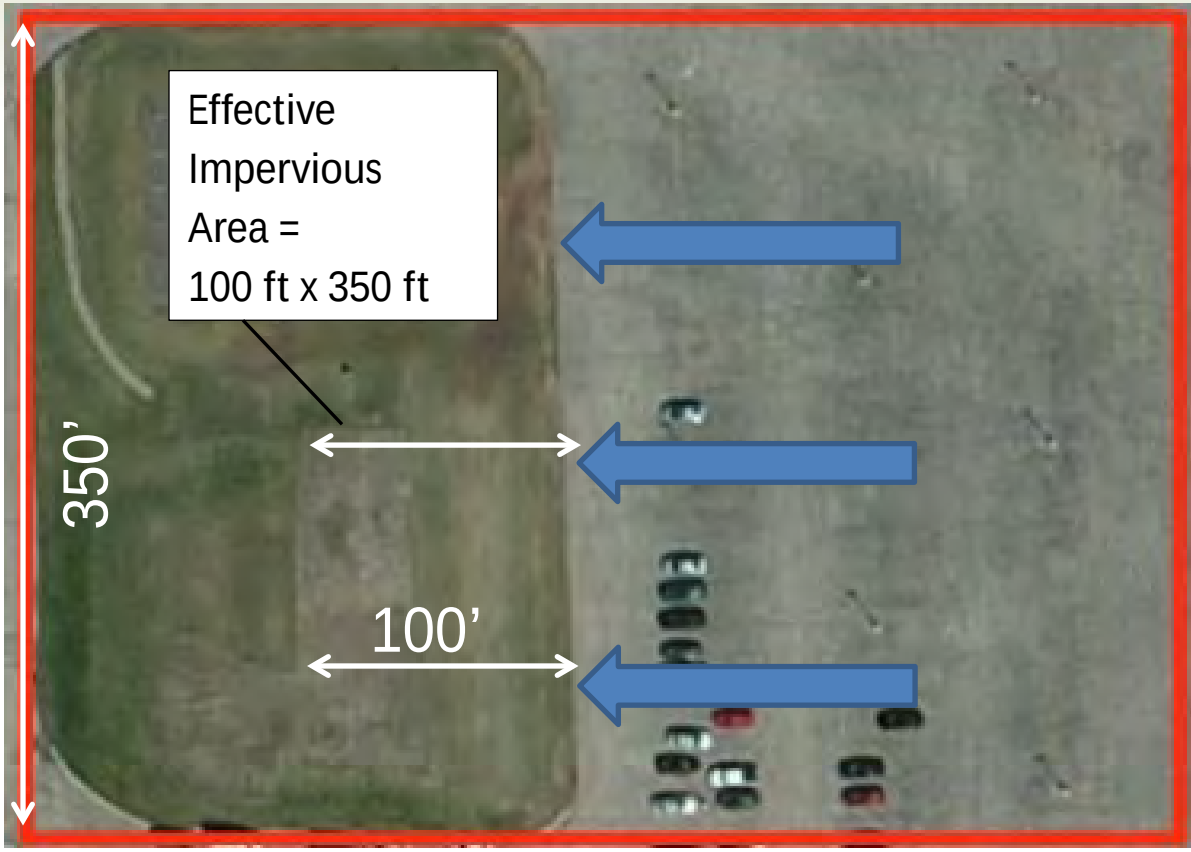
Calculating Volume Reduction from Impervious Surface Disconnection

2 Determine I/P_{eff} Ratio

I/P_{eff} Ratio =

= (1.5 acre)/(0.8 acre)

= 1.9



Calculating post-disconnection site runoff

So, for 3-acre, 50% impervious site, A soils (average)

Post-disconnection site runoff =

6.55 inches * 1.5 ac + 4.4 inches * 1.5 ac = 18 acre-inches

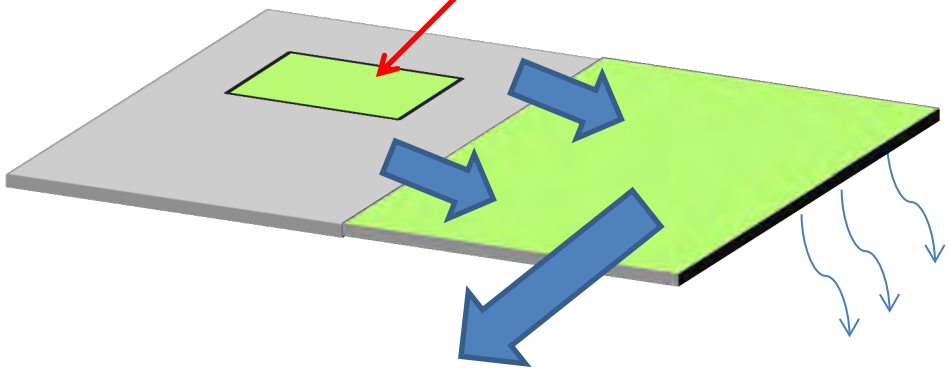
Runoff from impervious + effective pervious areas (interpolated from model results based on I/P ratio)

Runoff from ineffective pervious areas (from model results)

Calculating Performance Goal Credits

- Calculate conformance with performance goal by calculating adjusted imperviousness of the site

What amount of impervious surface reduction is equivalent to the reduced runoff from impervious surface redirection?



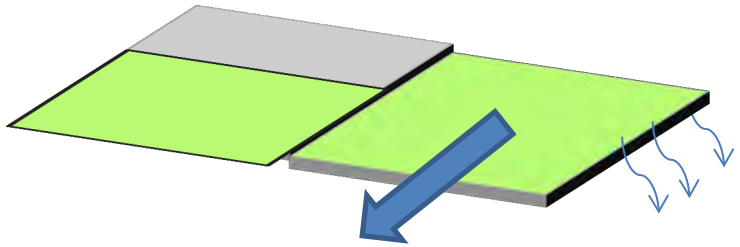
Calculating Performance Goal Credits

Adjusted impervious surface after improvement =

18 acre-inches = (I_{adj})*(22.5 in) + (1.5 ac)*(4.4 in)

- Runoff from site w/redirected impervious area
- Impervious runoff
- Runoff from pervious areas

Adjusted Impervious Area (I_{adj}) = 0.5 acres (versus 1.5 acres)



Calculating Performance Goal Credits

- BMP volume credit =

  = 1.1 in x 0.5 acres x unit conversion

  = 3,941 ft^3

  (5,990 ft^3 required for meeting 1.1 inch goal on site)

- BMP volume credit equates to about 0.7 inches off the impervious surface

Calculating Performance Goal Credits- difference between soil types

What if we have B soils, instead of A soils?

- Adjusted impervious area = 0.8 acres (0.5 acres w/ A soils)
- BMP volume credit =

  = 1.1 in x 0.8 acres x unit conversion

  = 2,771 ft^3

  (5,990 ft^3 required for meeting 1.1 inch goal on site)

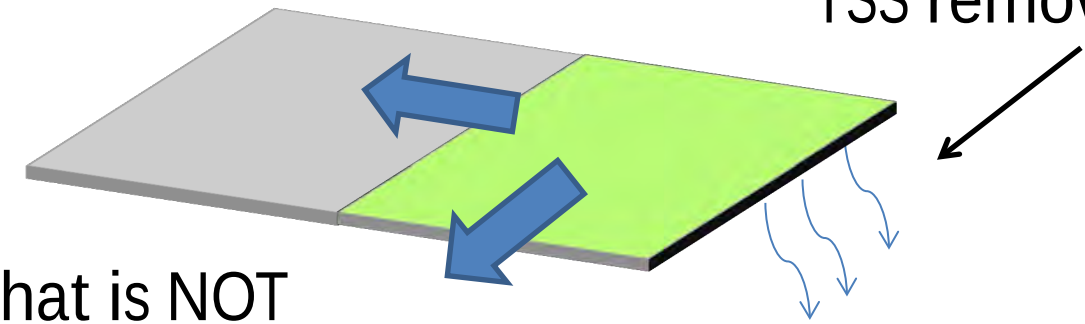
- BMP volume credit equates to about 0.5 inches off the impervious surfaces

Estimating annual performance

- Annual volume reduction determined using performance curves based on BMP volume credit

- Pollutants:

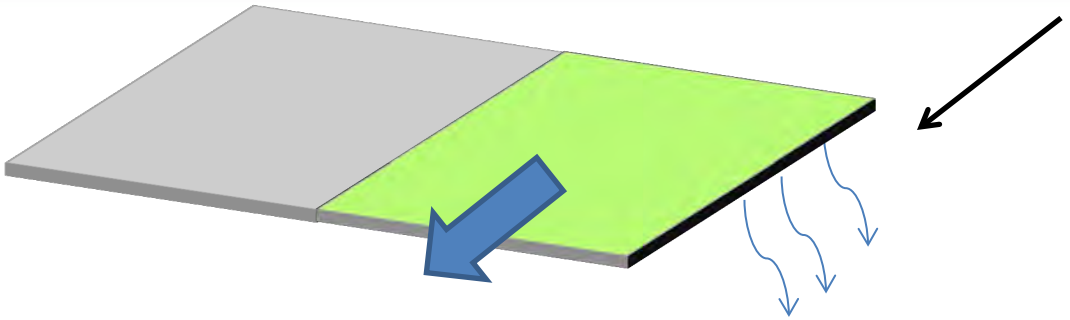
Runoff that is infiltrated achieves 100% TP, DP and TSS removal



Runoff that is NOT infiltrated achieves 0% TP and DP and 68% TSS removal (based on MN SW Manual)

Estimate annual pollutant removal

Runoff that is infiltrated achieves 100% TP, DP and TSS removal



Runoff that is NOT infiltrated achieves

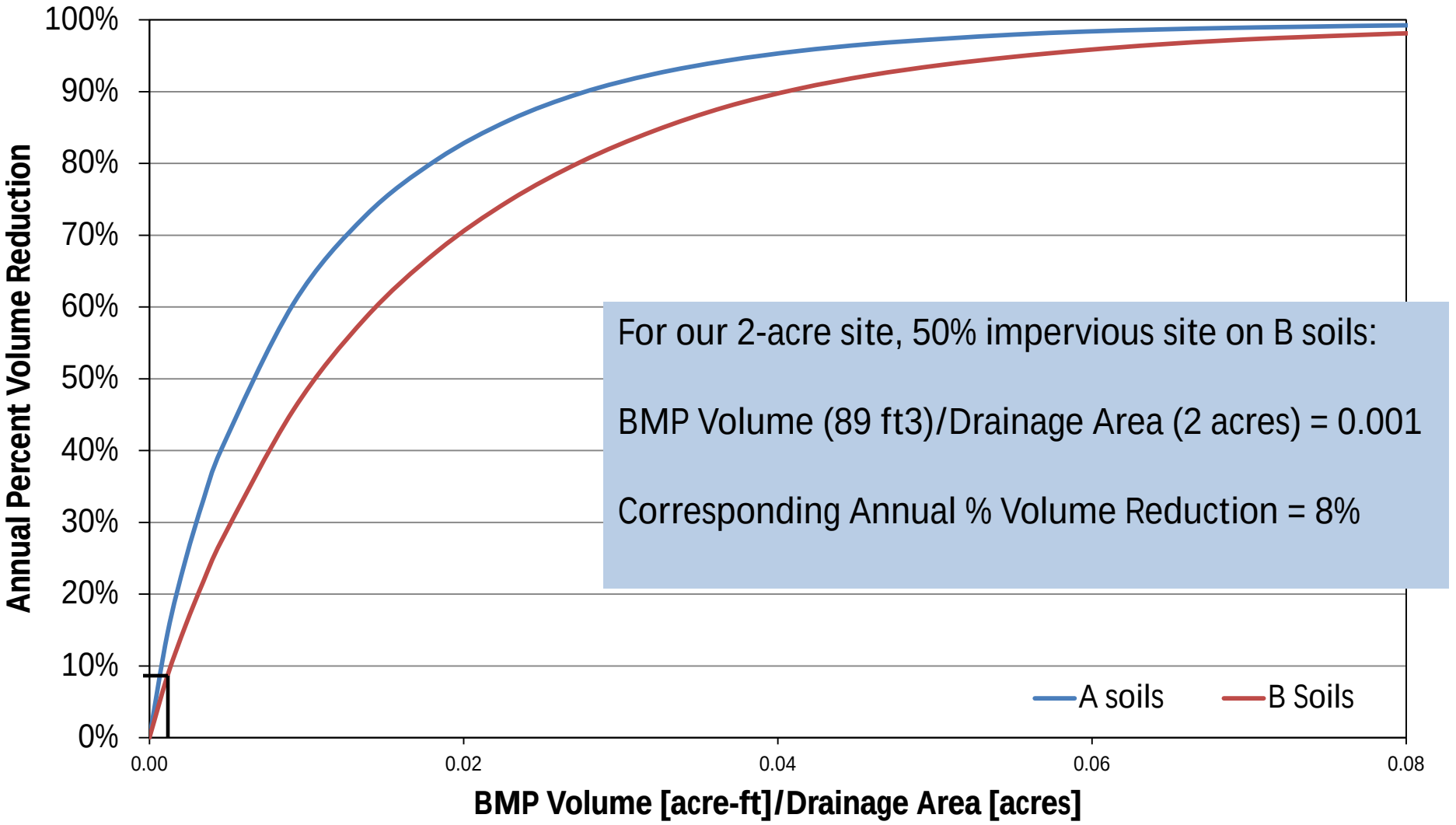
- 0% TP and DP removal, and
- 68% TSS removal (consistent w/MN SW manual)

Questions?

Summary of credits for soil improvements on B soils

Hydrologic Soil Group	% Site Imperviousness	Initial Condition	Improved Condition	BMP Volume Credit (ft^3)	Equivalent Inches Off Impervious Surface (in)
B	20	Compact	Average	426	0.059
B	20	Average	Loosened	284	0.039
B	20	Compact	Loosened	710	0.098
B	50	Compact	Average	266	0.015
B	50	Average	Loosened	177	0.010
B	50	Compact	Loosened	444	0.024
B	80	Compact	Average	106	0.004
B	80	Average	Loosened	71	0.002
B	80	Compact	Loosened	177	0.006

Use performance curves to estimate annual volume reduction

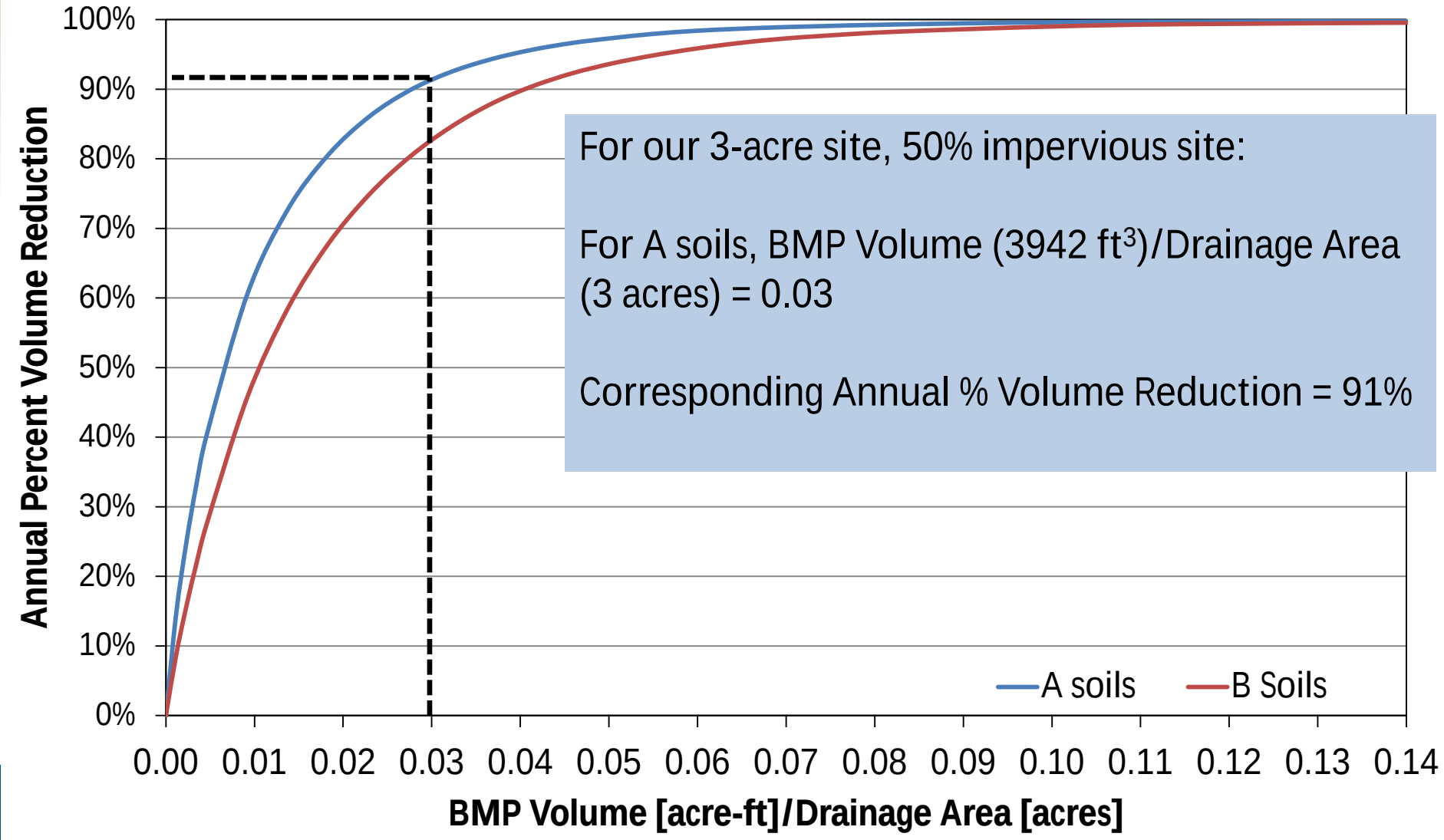
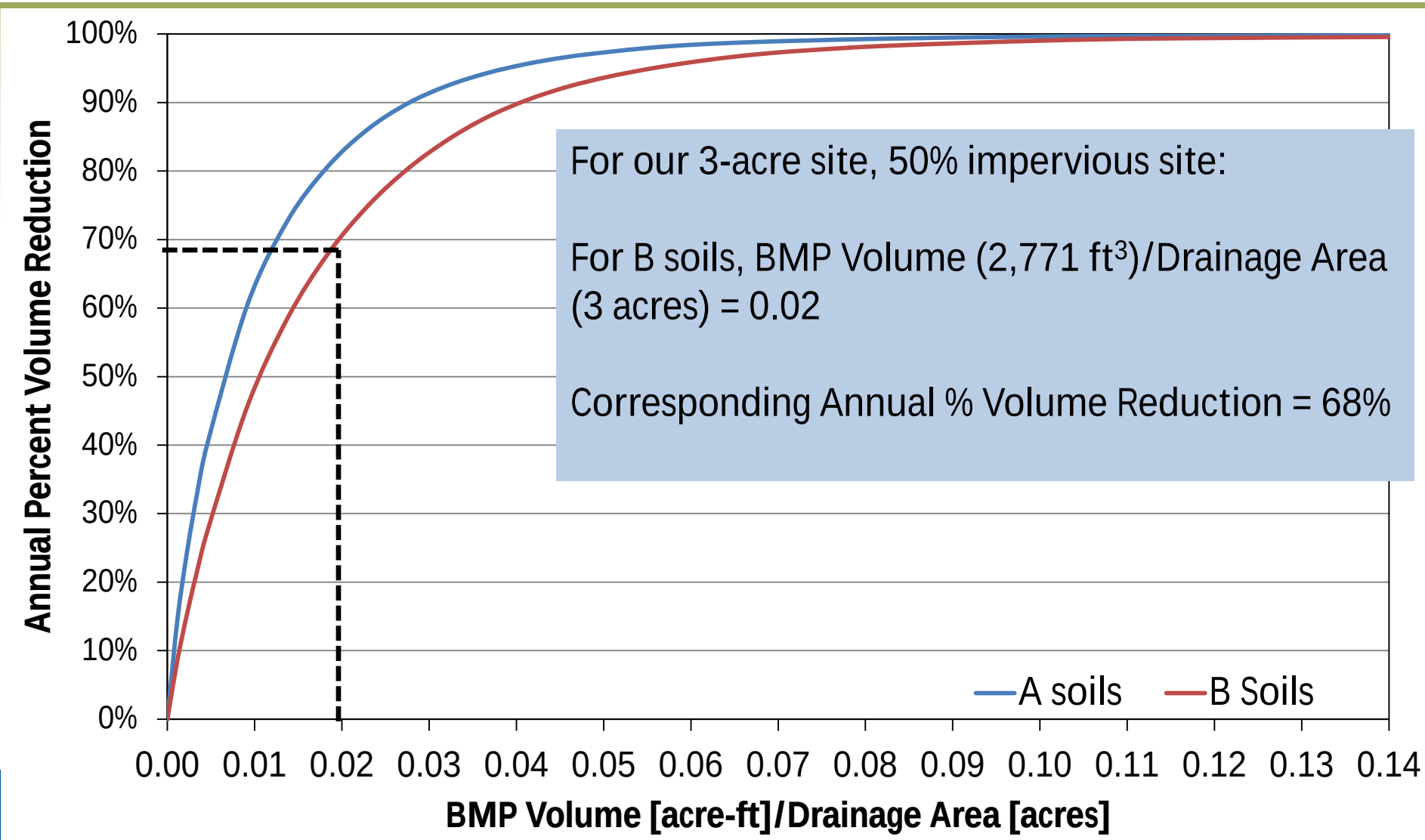


For our 2-acre site, 50% impervious site on B soils:

BMP Volume (89 ft3)/Drainage Area (2 acres) = 0.001

Corresponding Annual % Volume Reduction = 8%

Use performance curves to estimate annual volume reduction



Use performance curves to estimate annual volume reduction