Infiltration Best Management Practices

For

Southeast Pennsylvania Association of Conservation Districts

Presented by

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Agenda

- Topics based on common questions received:
  - Loading Ratios[1]
    - Pretreatment for Infiltration
  - Infiltration in Floodplains
  - Failures – what to do next?

1. Reference: White Paper
   - *A Risk-Based Approach for Sizing Stormwater Infiltration BMPs*
   - **Paper:** ftp.state.pa.us/pub/dep/SWM/Loading_Ratios_Draft_rev_7-27-09.doc
   - **Slides:** ftp.state.pa.us/pub/dep/SWM/infiltrationBMPs03262010.pptx

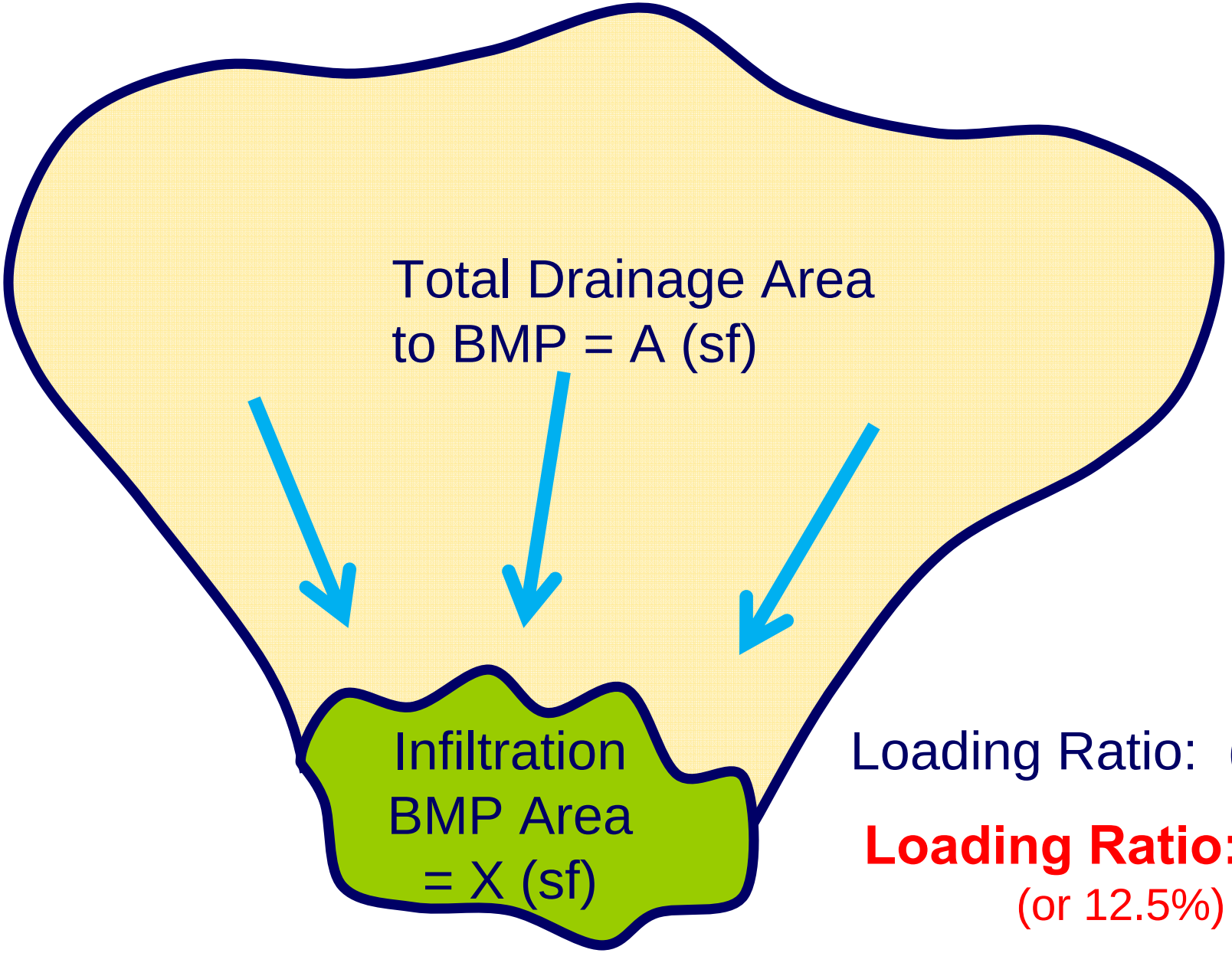
LOADING RATIOS

What is a "Loading Ratio"

Append. C, Pgs. 15 & 16

– A rule-of-thumb approach for sizing infiltration BMPs with the intent of:
  - Preventing hydraulic and pollutant overloading.
  - Sustaining a r nable design life.
– Based pur rainage area and BMP
  - Total DA o us DA*
– Not a site-sp ic approach

Total Loading Ratio = Total DA: BMP Area



Loading Ratio: (A+X)/X

Loading Ratio: 8 : 1

(or 12.5%)

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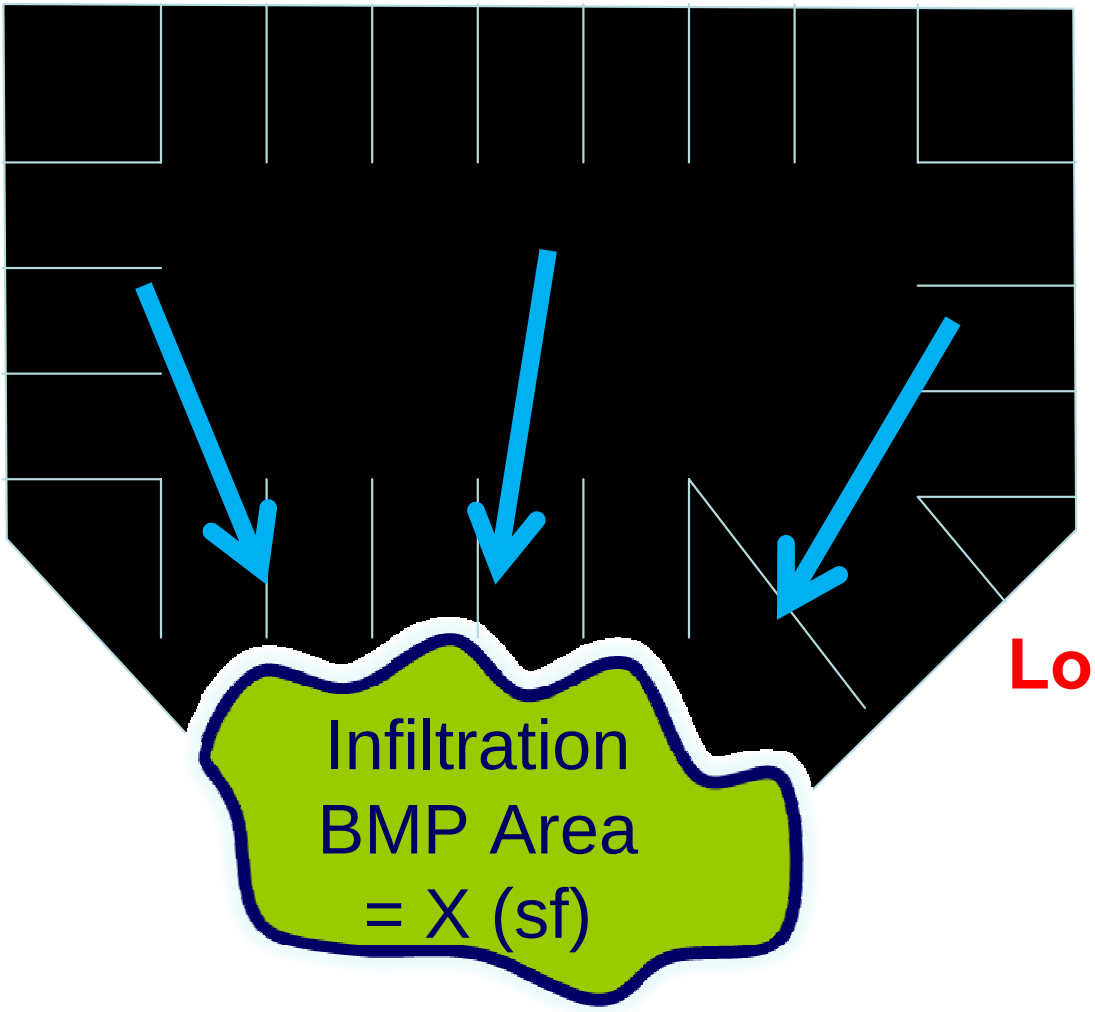
Impervious Loading Ratio = Imp. DA : BMP Area

Impervious DA to BMP = A_I (sf)



Loading Ratio:
$(A_I+X)/X$

Loading Ratio: 5 : 1
(or 20%)

In Karst: 3 : 1
(or 33%)

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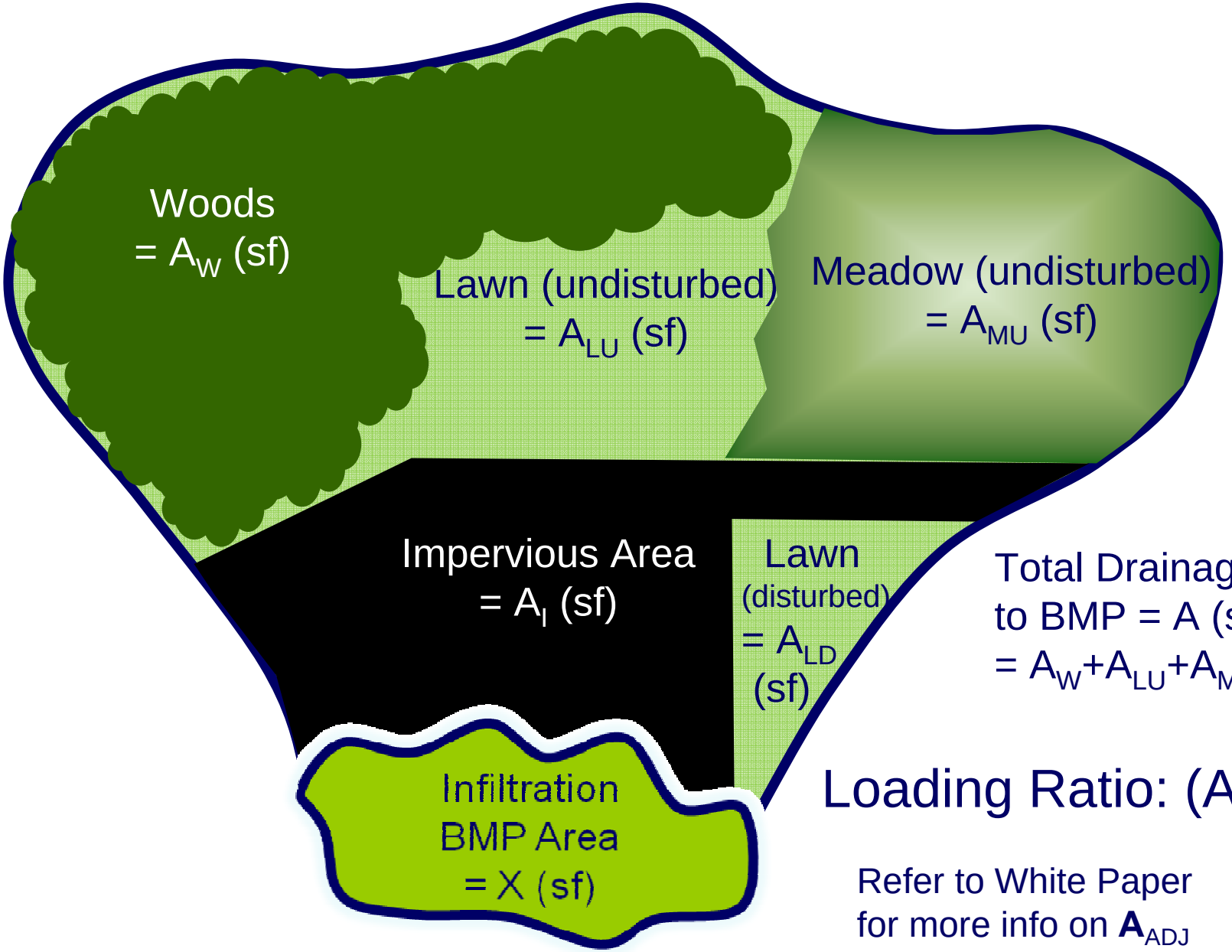
Land Use Adjustment for Total Loading Ratio



Total Drainage Area to BMP = A (sf)
= $A_W+A_{LU}+A_{MU}+A_{LD}+A_I$

Loading Ratio: $(A_{ADJ}+X)/X$

Refer to White Paper for more info on $\mathbf{A}_{ADJ}$

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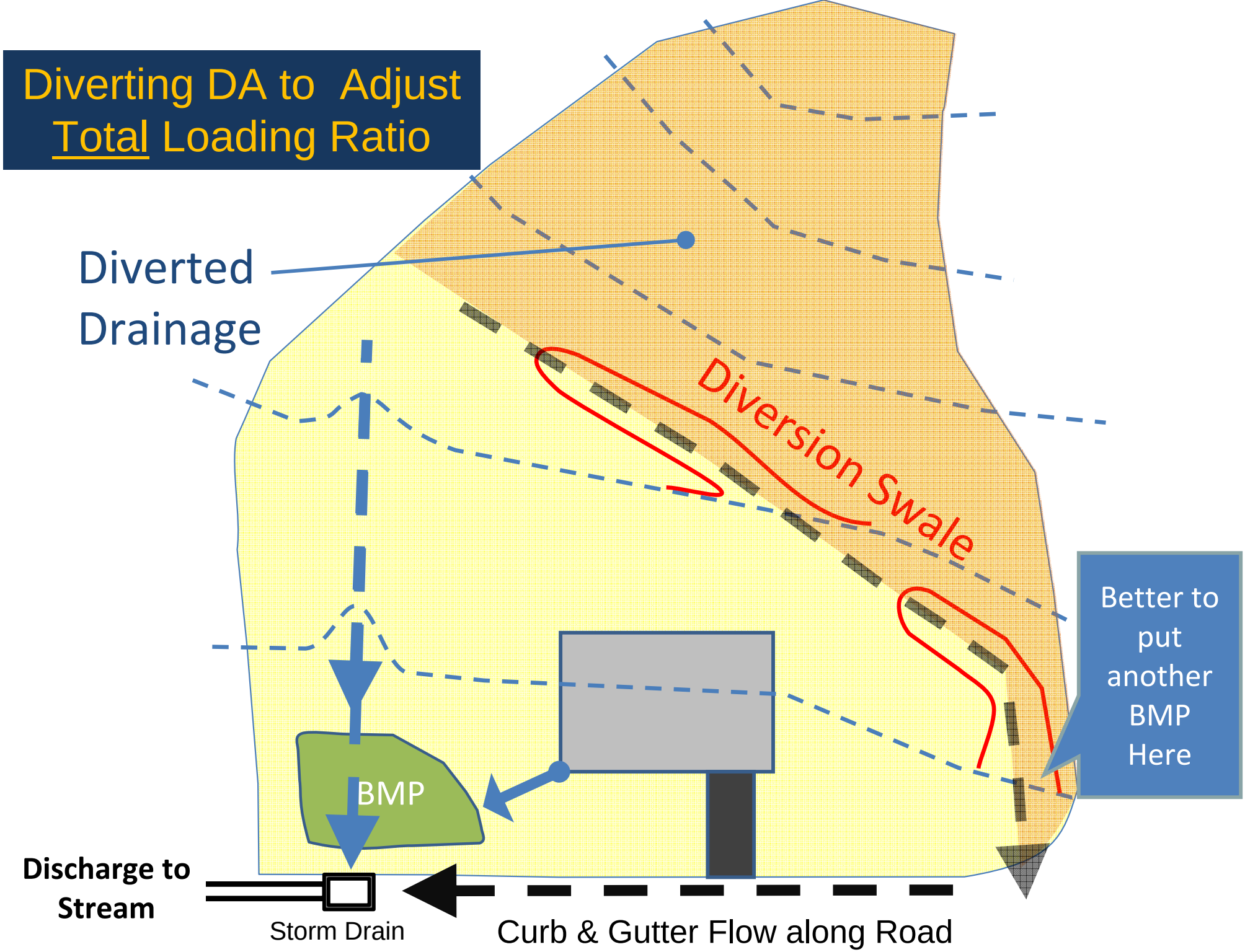
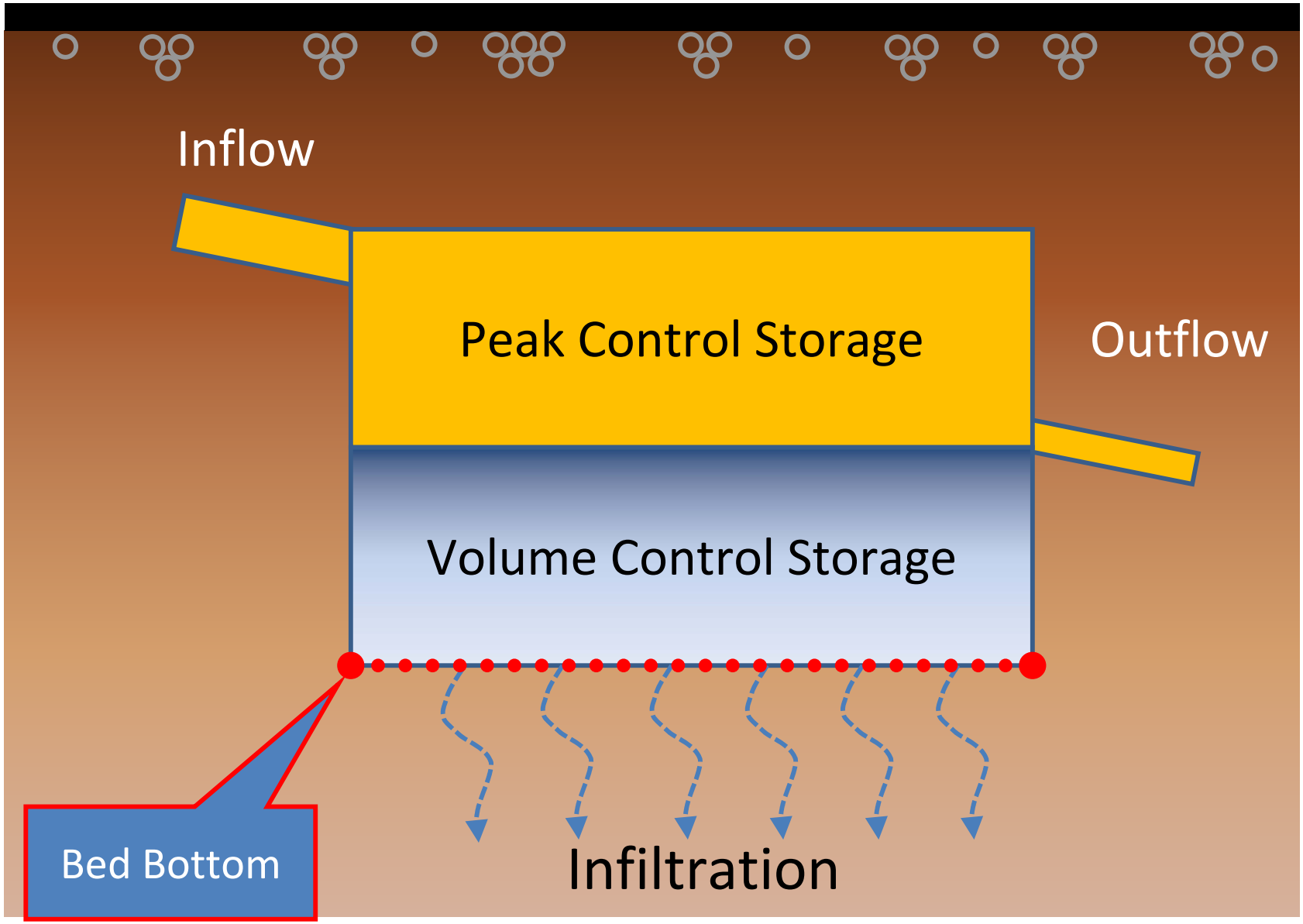
Diverting DA to Adjust Total Loading Ratio



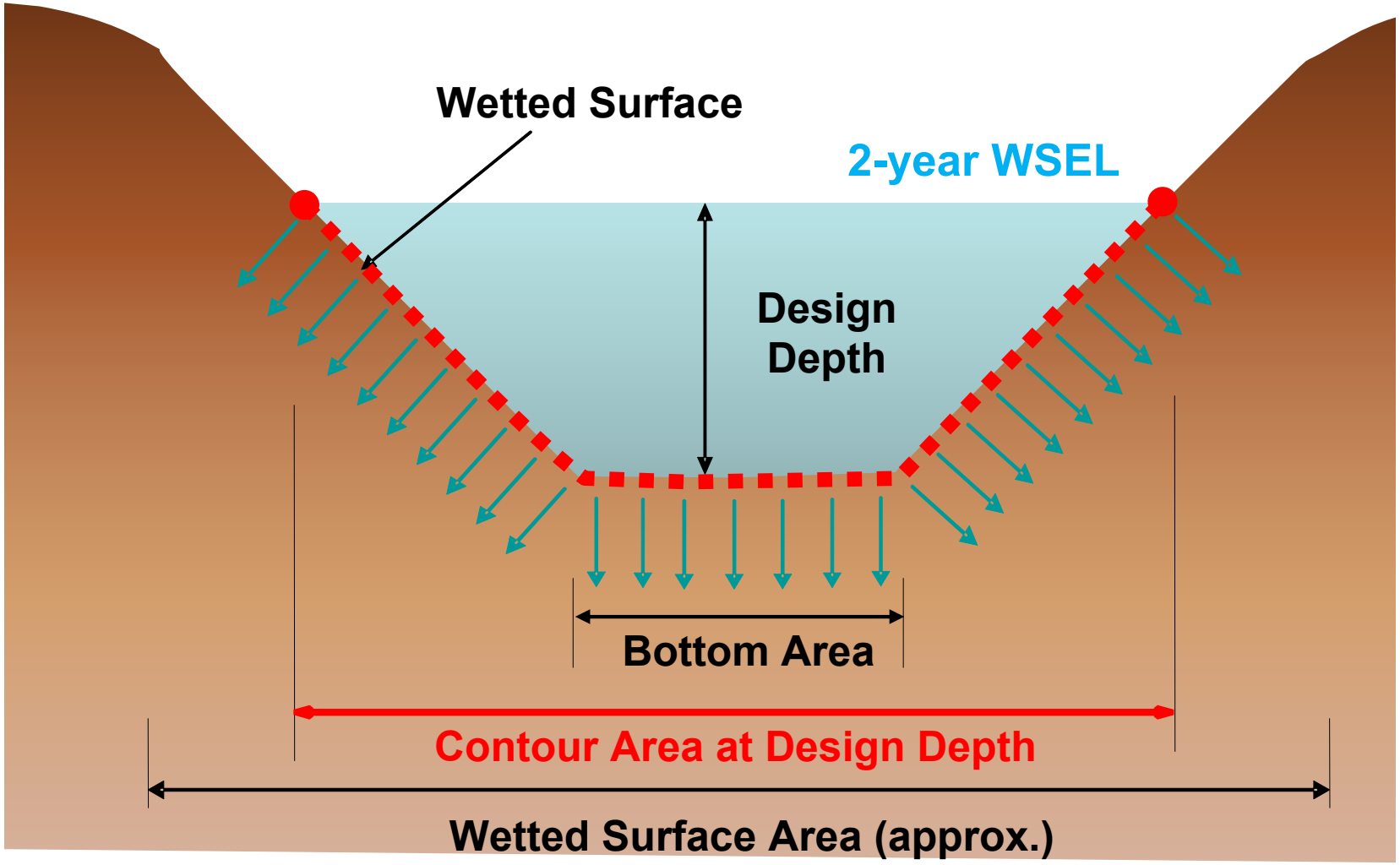
What is the "BMP" Area?

- Depends on the type of Infiltration BMP:
  - Underground facilities* are limited to the footprint of the bed bottom. Sides are usually neglected.
  - Surface facilities* typically have a larger footprint (side slopes) and take better advantage of the surrounding soil.

Underground Infiltration



Surface Infiltration



Site Specific Approach

More than just DA and BMP Area:

- Soils
- Geology
- Vegetation/Surface Cover
- Topography
- BMP Strategy
  - Pretreatment
- Discharge Point/ Receiving Stream

SWM → Multi-Disciplinary

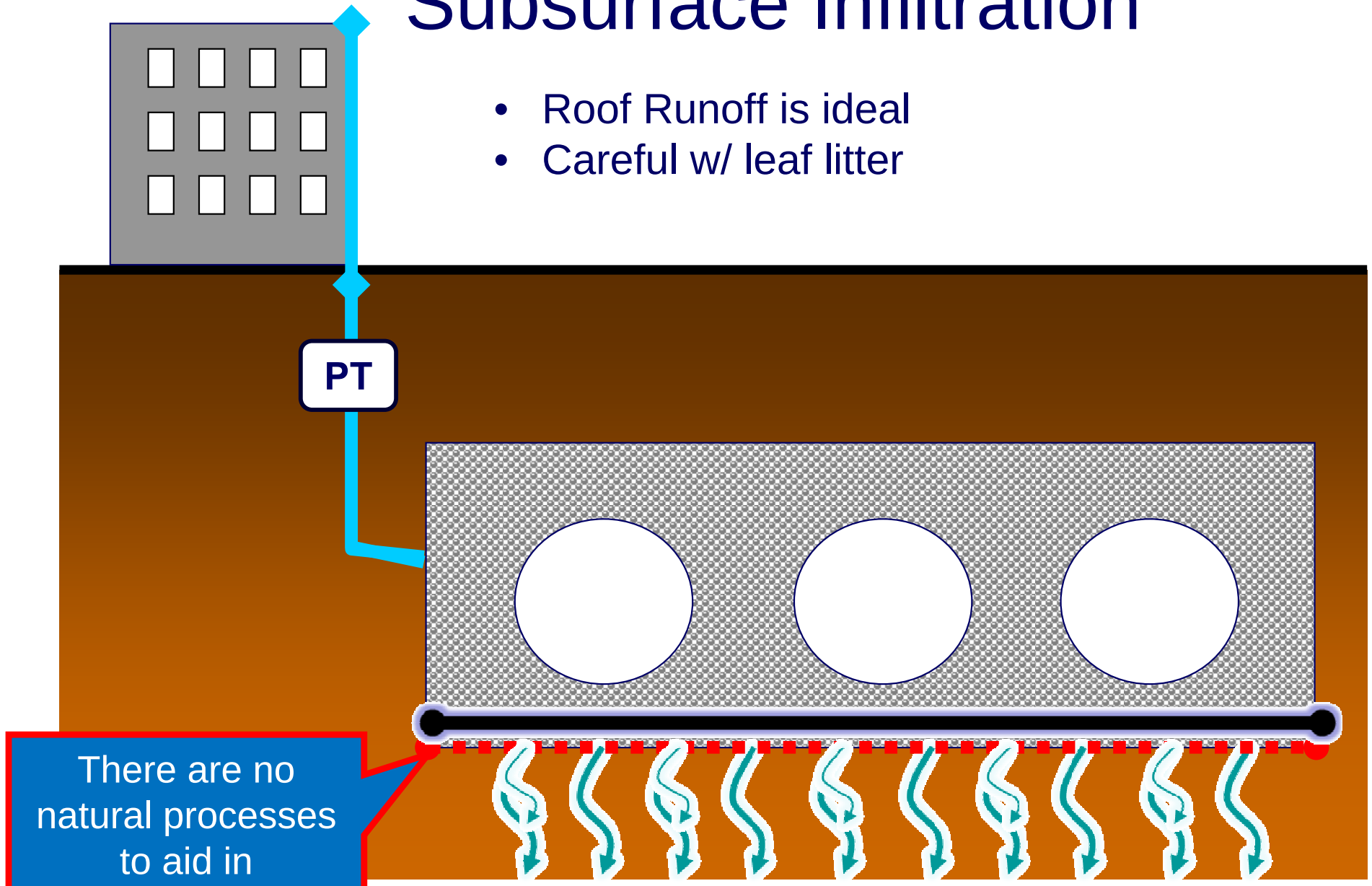
- Site-Specific Approach often needs to include other experts besides the PE.
  - Soil Scientist
  - Geologist
  - Ecologist
  - Others?

Pretreatment for Infiltration

- BMP manual doesn't mandate pretreatment,
- However, SWM has evolved to a point where it is imperative for sustainability.
- Pretreatment is most critical for subsurface infiltration systems*.
- Target parameters:
  - Oil/Grease; trash; TSS; Phos; Nitrates

Subsurface Infiltration

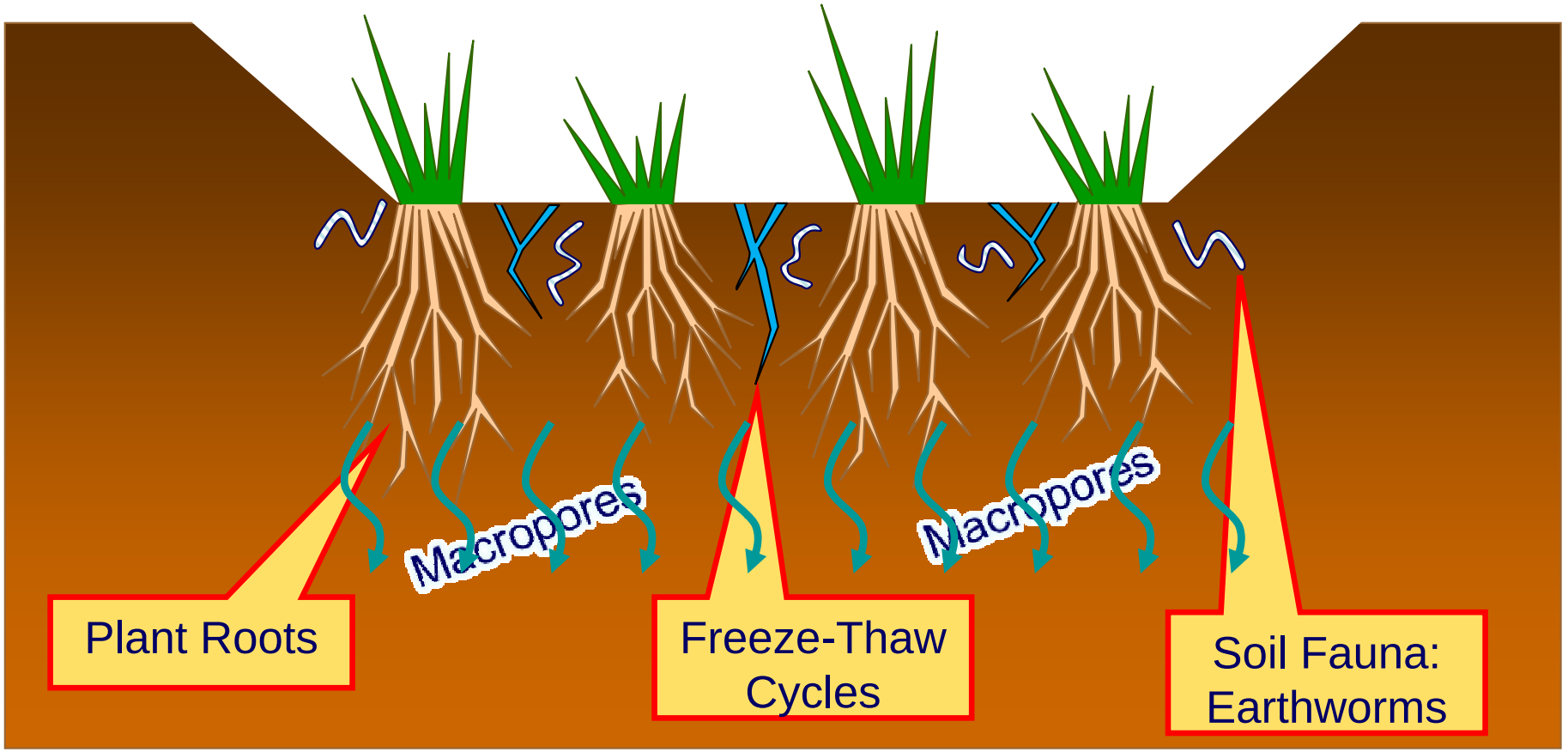
- Roof Runoff is ideal
- Careful w/ leaf litter



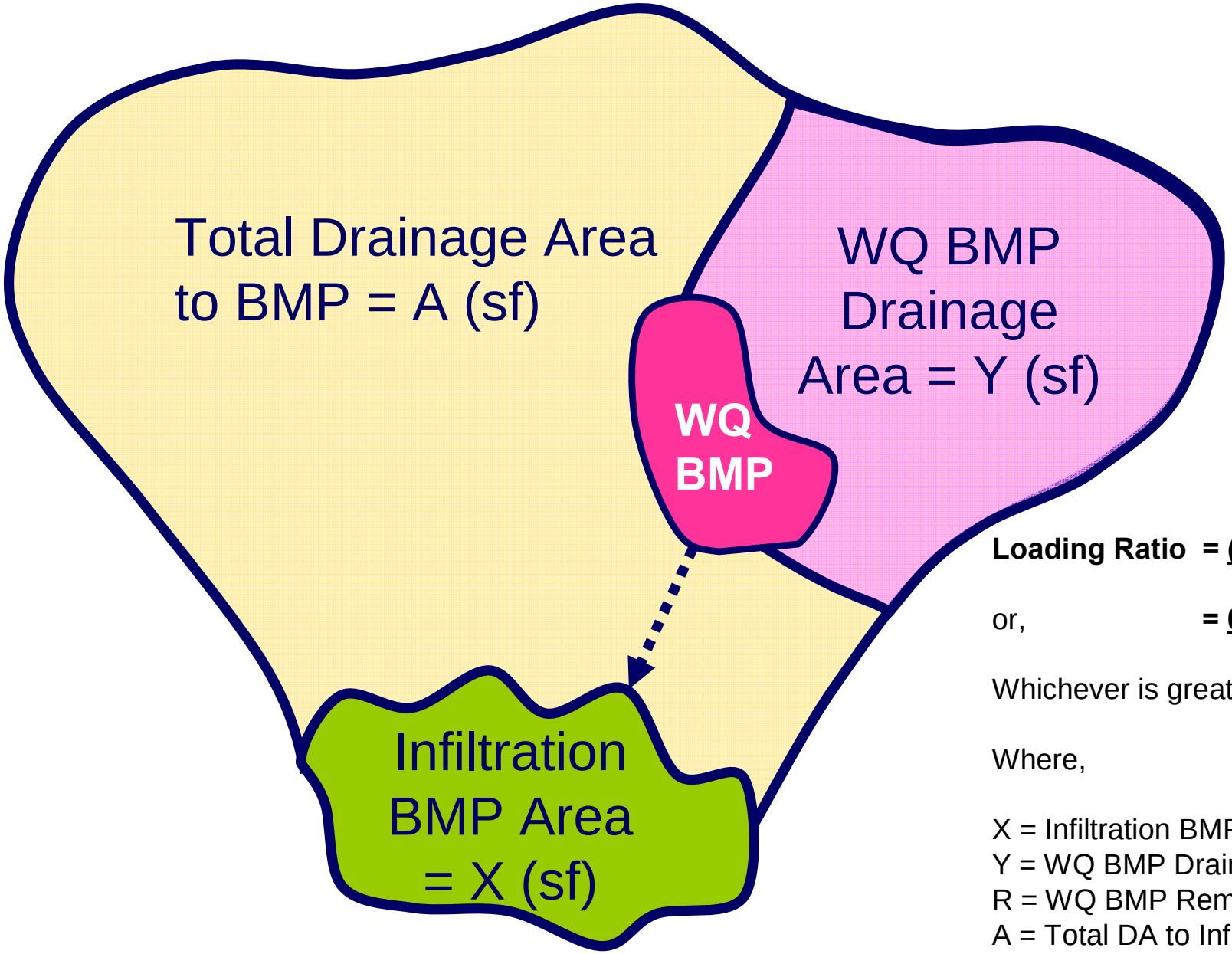
There are no natural processes to aid in rejuvenating the soils permeability.

Surface Infiltration

- For low pollutant load areas, accomplishes pretreatment objectives.
- Additional Pretreatment may be needed depending on source.



Water Quality Adjustment for Total Loading Ratio



Loading Ratio $= \frac{(A-(Y*R)+X)}{X}$

or, $= \frac{0.5 * (A+X)}{X}$

Whichever is greater.

Where,

X = Infiltration BMP Area
Y = WQ BMP Drainage Area
R = WQ BMP Removal Efficiency
A = Total DA to Infiltration BMP

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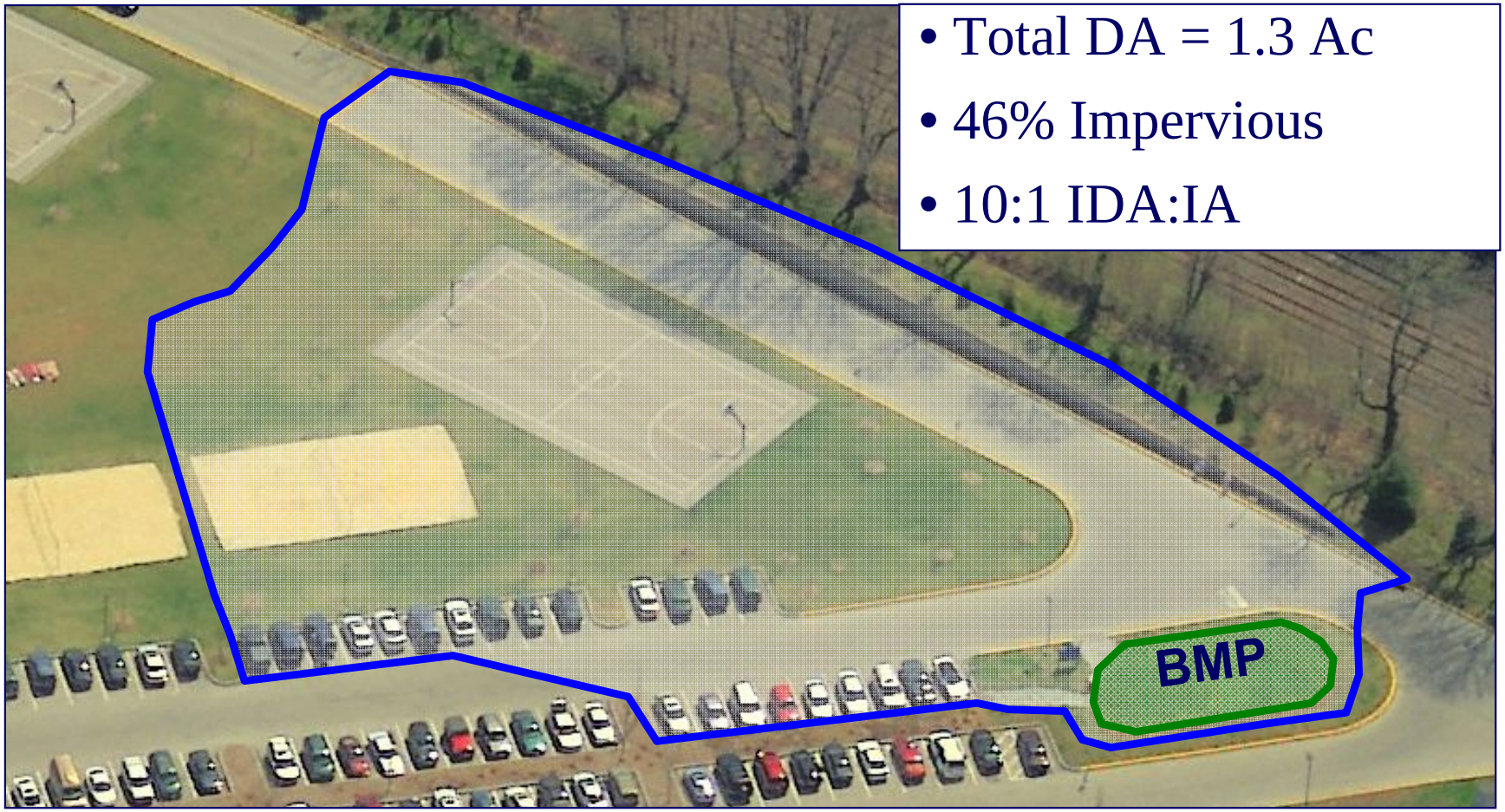
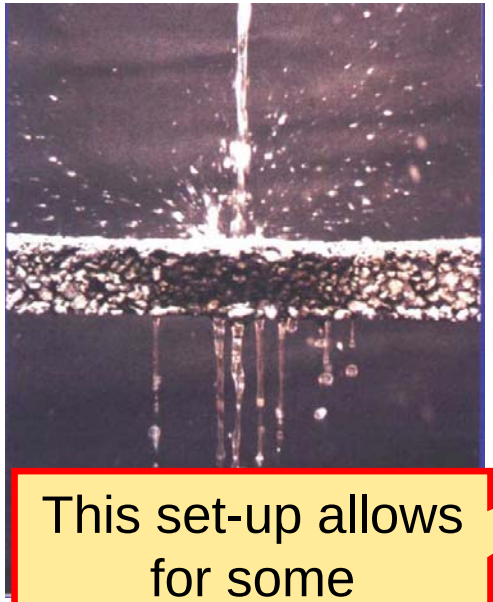
INFILTRATION BMPs

BioInfiltration Traffic Island (BTI) at Villanova Univ.

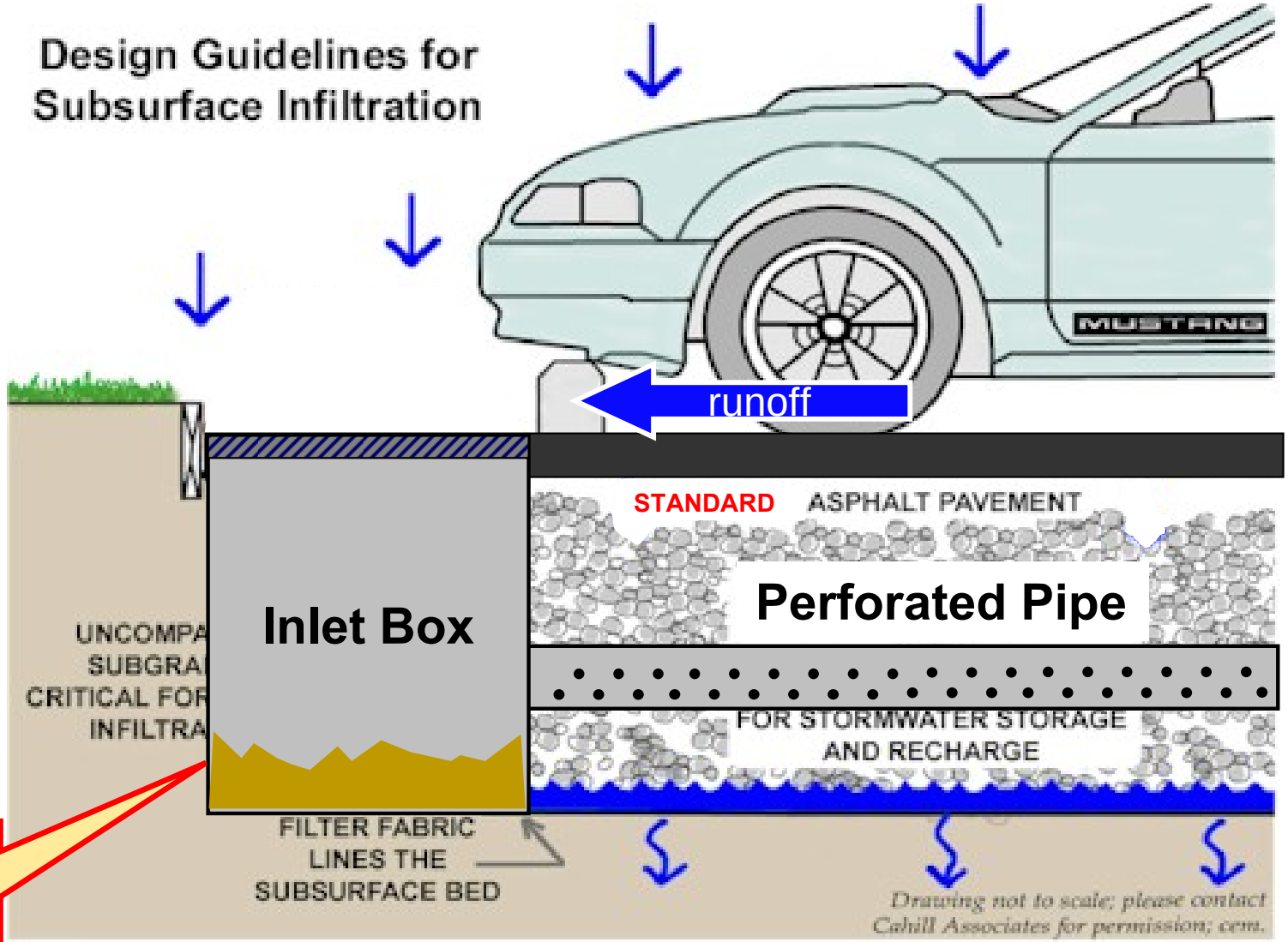


For more info go to: www.villanova.edu/VUSP

Porous Pavement

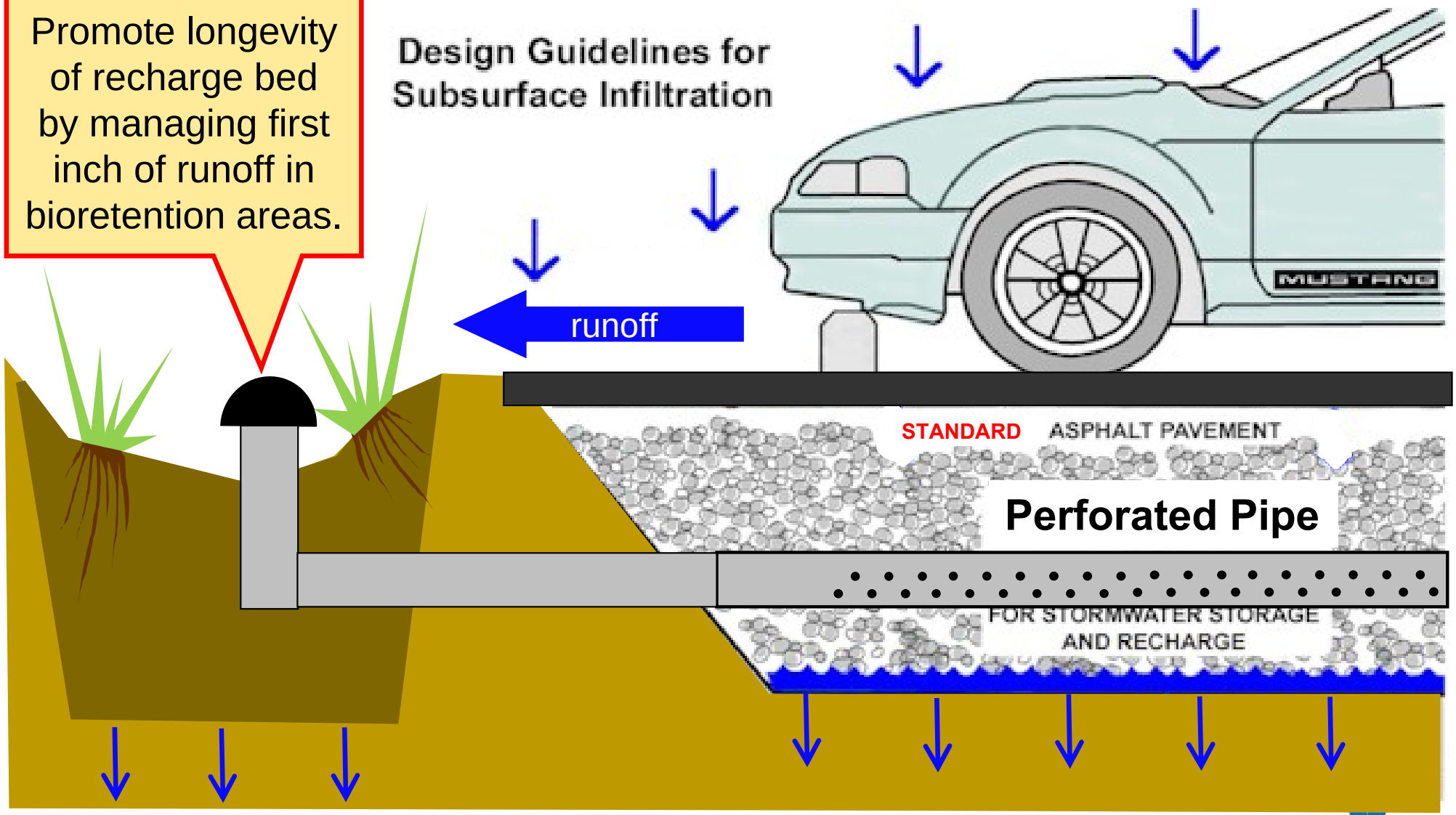


This set-up allows for some pretreatment



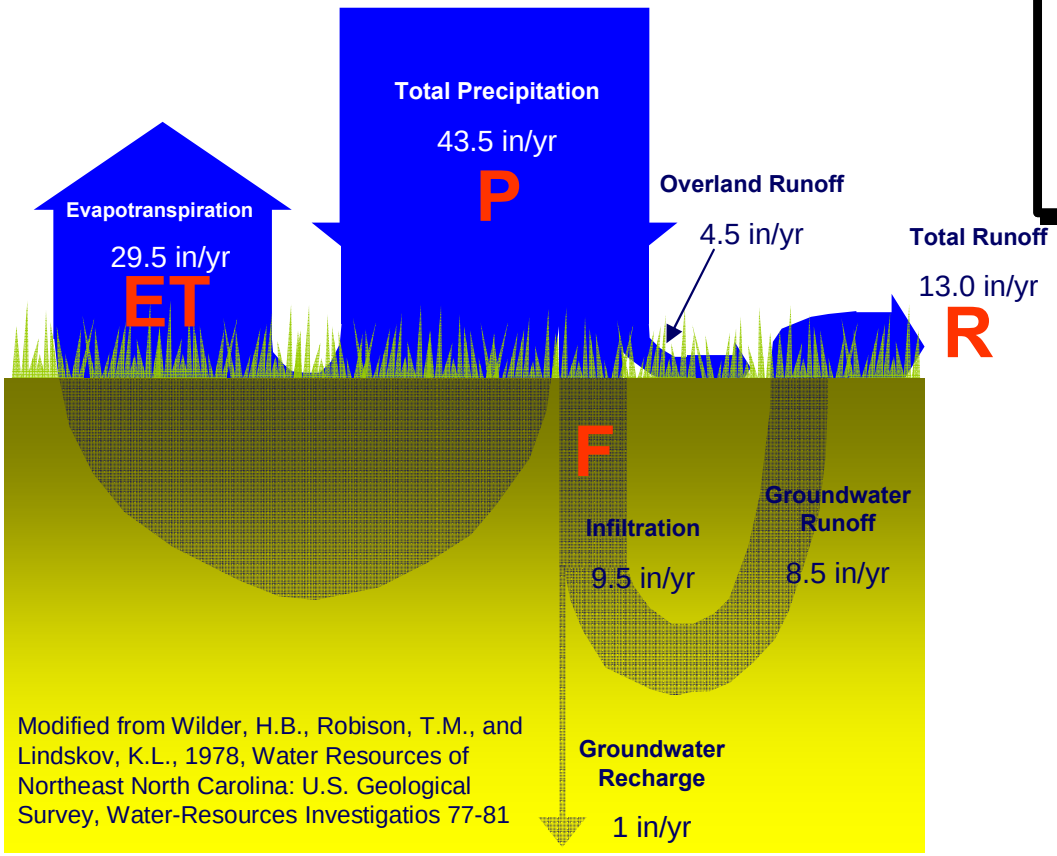
Even better……

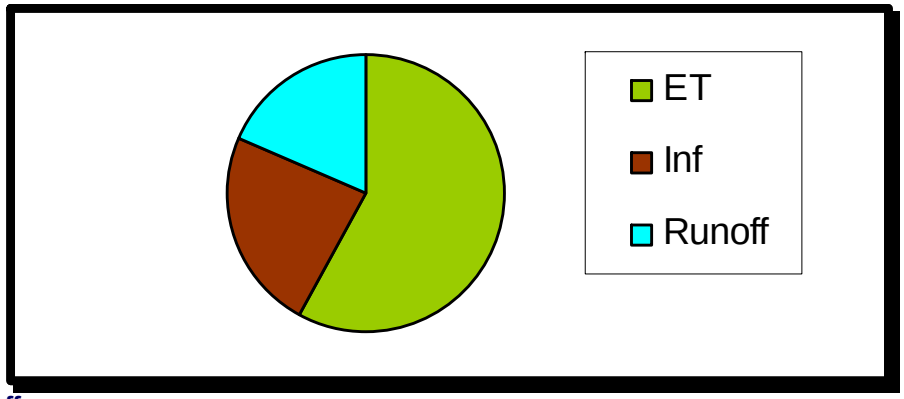
Promote longevity of recharge bed by managing first inch of runoff in bioretention areas.



Other Benefits to Surface Infiltration

- Quick Look at natural water balance.



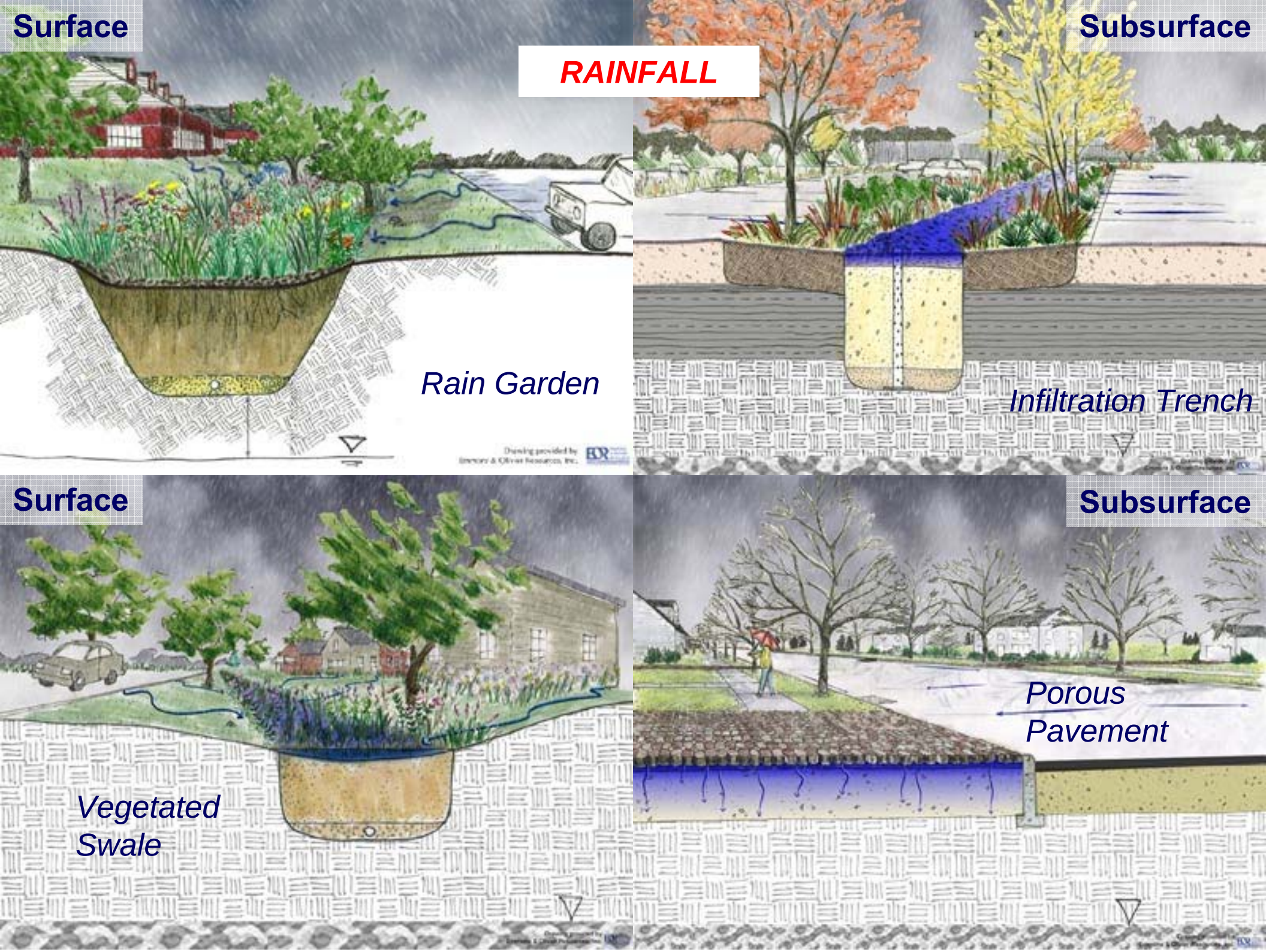


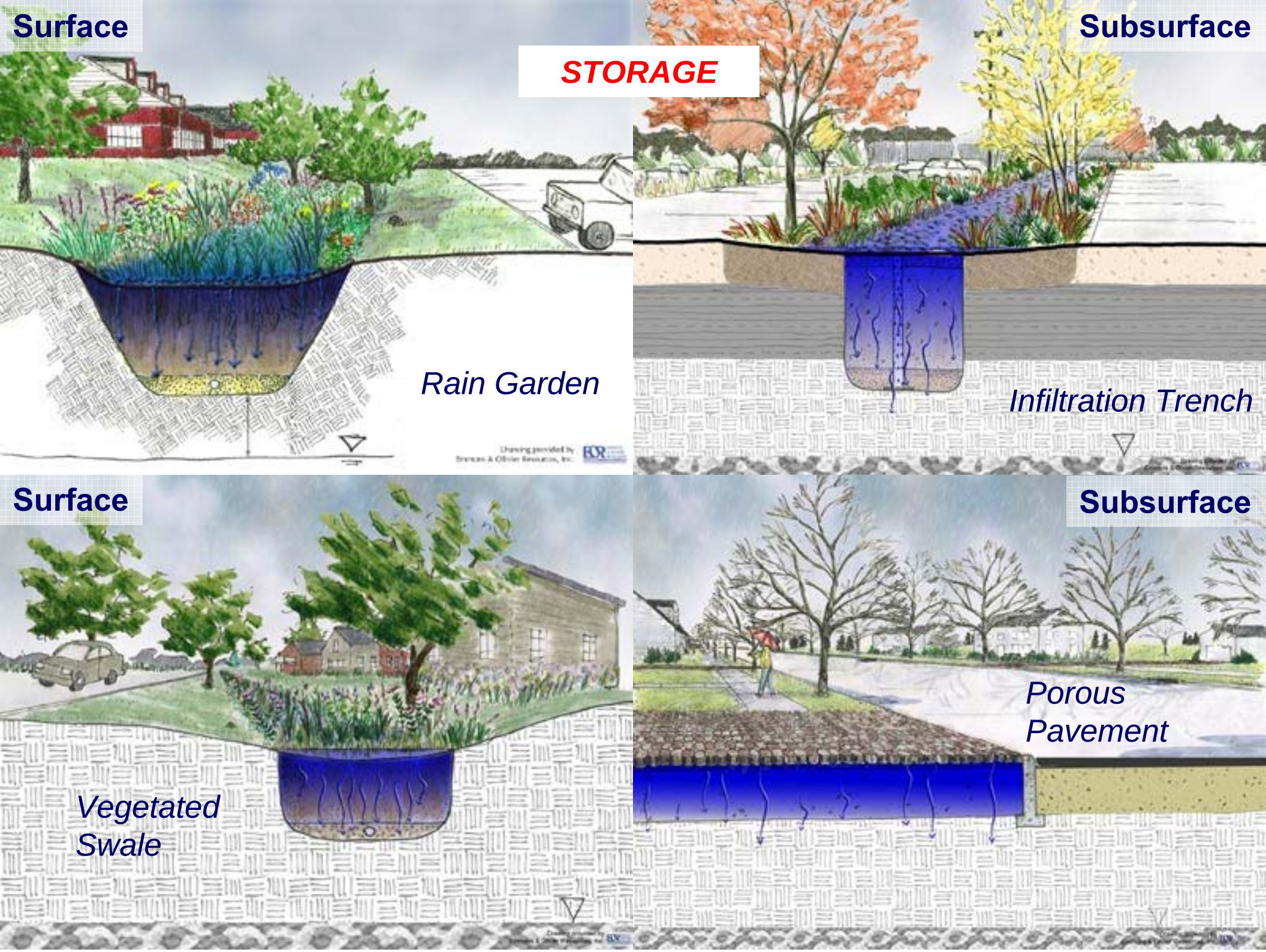
P = Rainfall

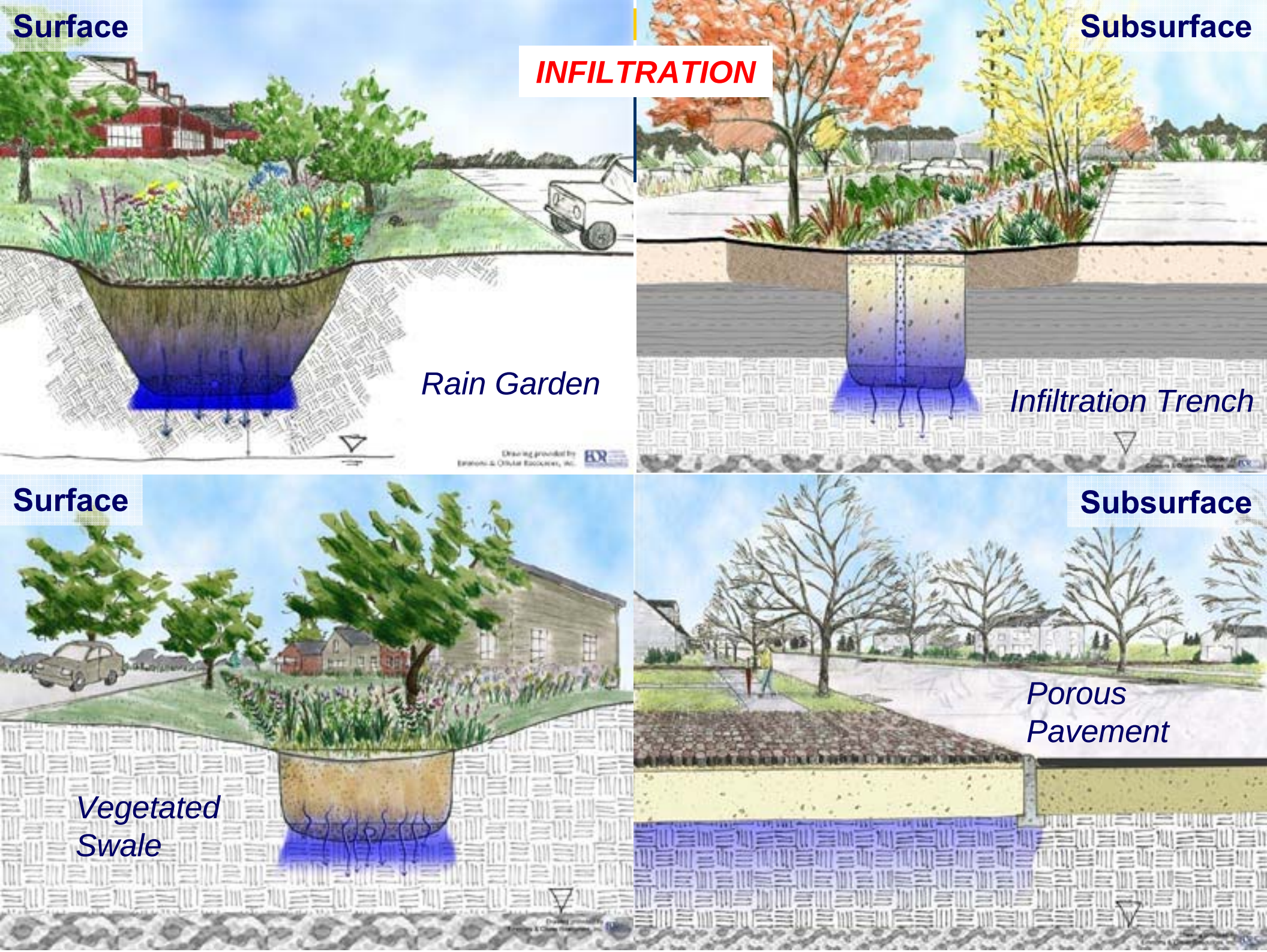
R = Runoff

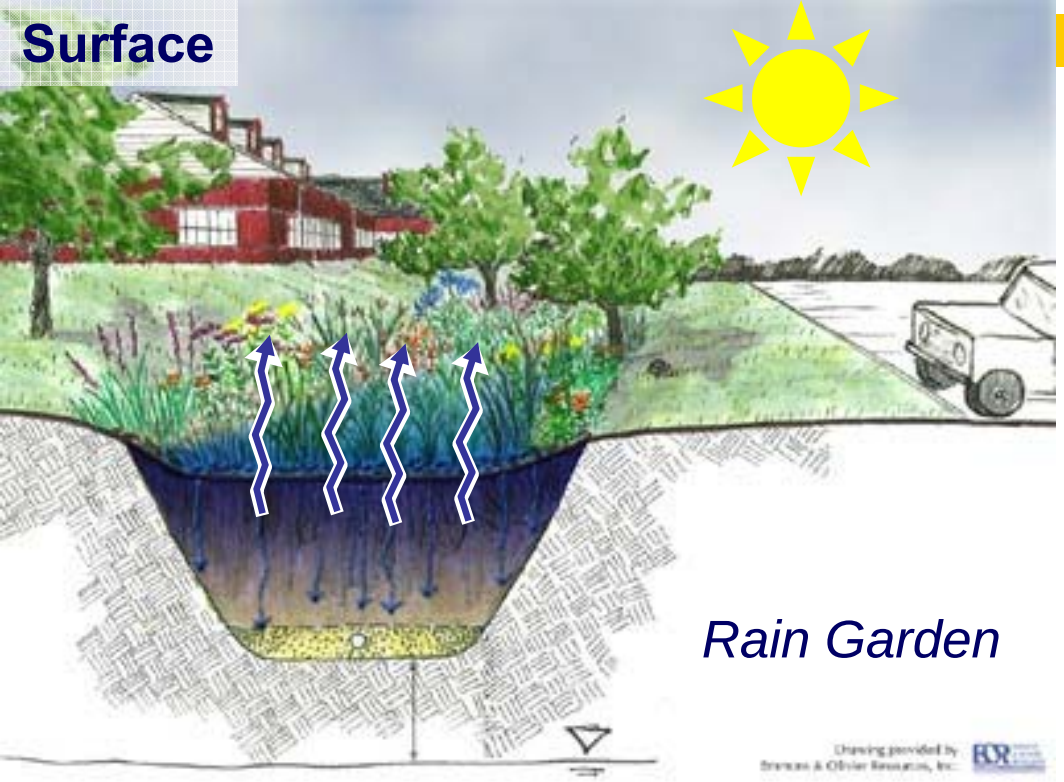
F = Infiltration

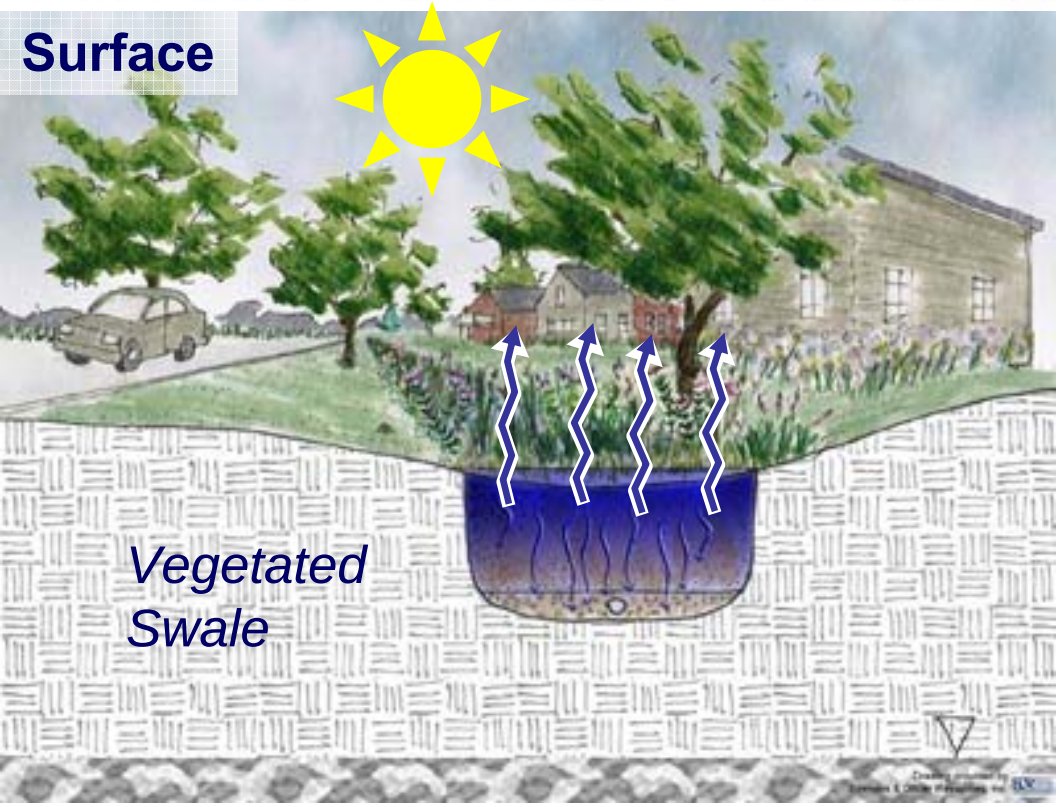
ET = Evapo-Transpiration


Surface
Subsurface
RAINFALL
Rain Garden
Infiltration Trench
Surface
Subsurface
Vegetated Swale
Porous Pavement


Surface
STORAGE
Subsurface
Rain Garden
Infiltration Trench
Surface
Subsurface
Vegetated Swale
Porous Pavement


Surface
INFILTRATION
Subsurface
Rain Garden
Infiltration Trench
Surface
Subsurface
Vegetated Swale
Porous Pavement



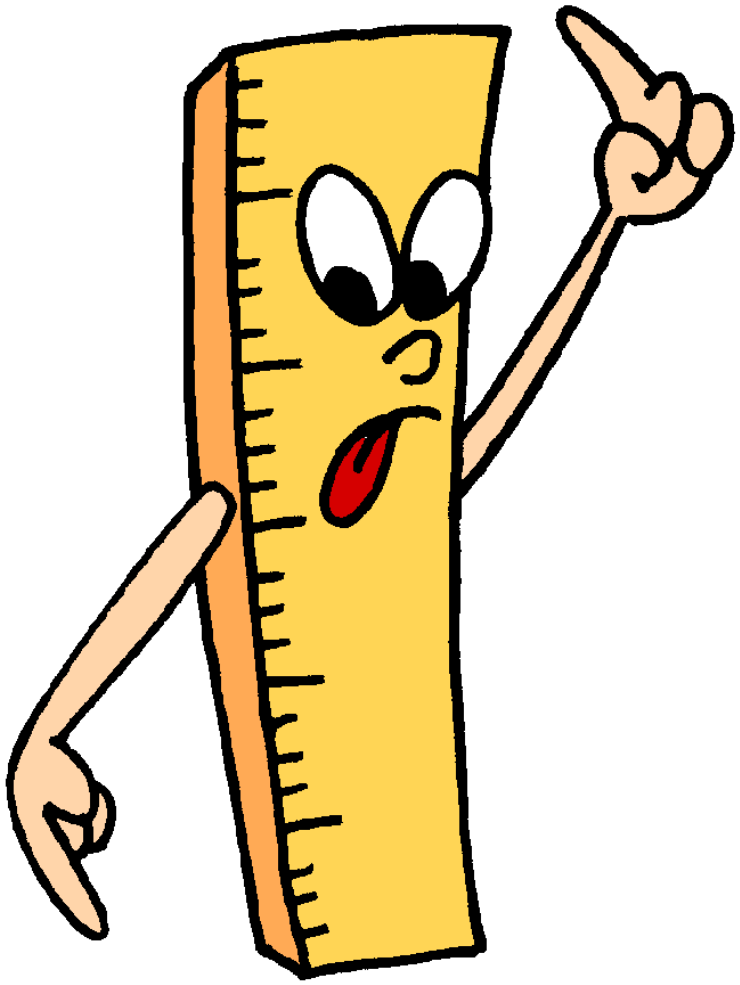


Evapotranspiration:

- The “missing link”
- Dual processes at work.
- Occurs between storms – making storage essential.
  - Not event-based
  - Water Balance Model

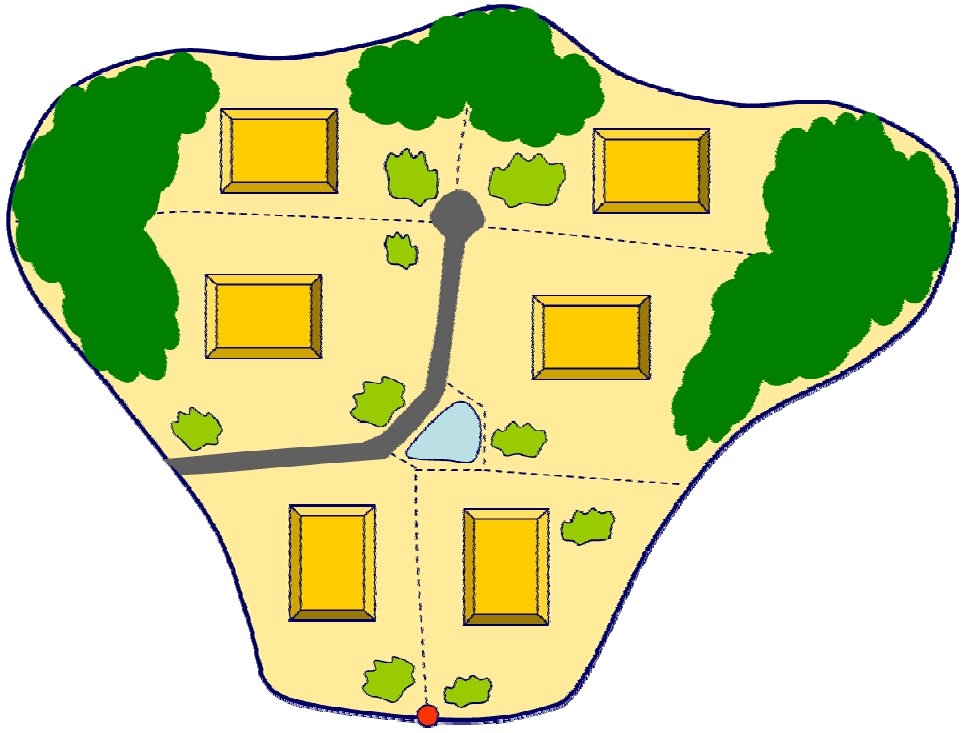
Size does matter!!!

- BMP Size → Drainage Area
- For sustainability of Infiltration BMP:
  - Keep DA per BMP relatively low.
    - Keep below 5 acres.
      - Below 1 acre is preferable.
    - DA>5 acres may not be able to seek loading ratio adjustments.
    - In some cases, BMPs with large DA's may need more conservative loading ratios.



Infiltration Goals

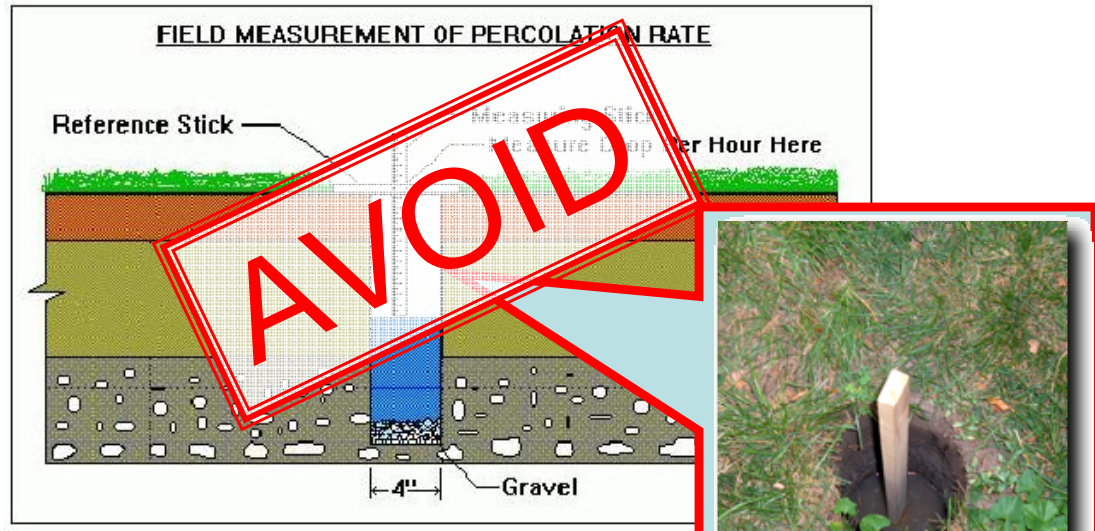
- Utilize several smaller BMPs, dispersed through entire site – close to the source.
- Incorporate vegetative component, where feasible.
- On-lot BMPs are ideal for individual roof and driveway runoff in LID,
- Keep BMPs for common drainage off of private lots.

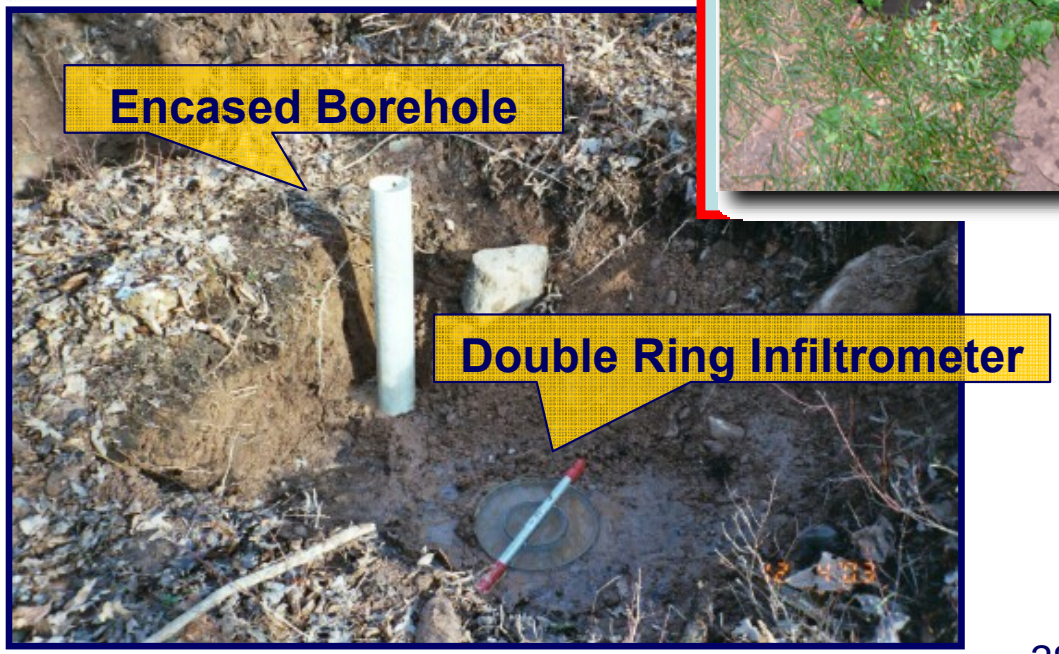


One SW BMP at Low Point
Dispersed SW BMPs

Recommendations

- Soil Infiltration Testing:
  - Avoid using the “perc” test
  - Use acceptable infiltration test.
  - Use a minimum Factor of Safety of 2
- Avoid hydraulic head > 2’.
- Dewater in less than 72 hours.
- Follow Loading Ratio or other acceptable sizing criteria.

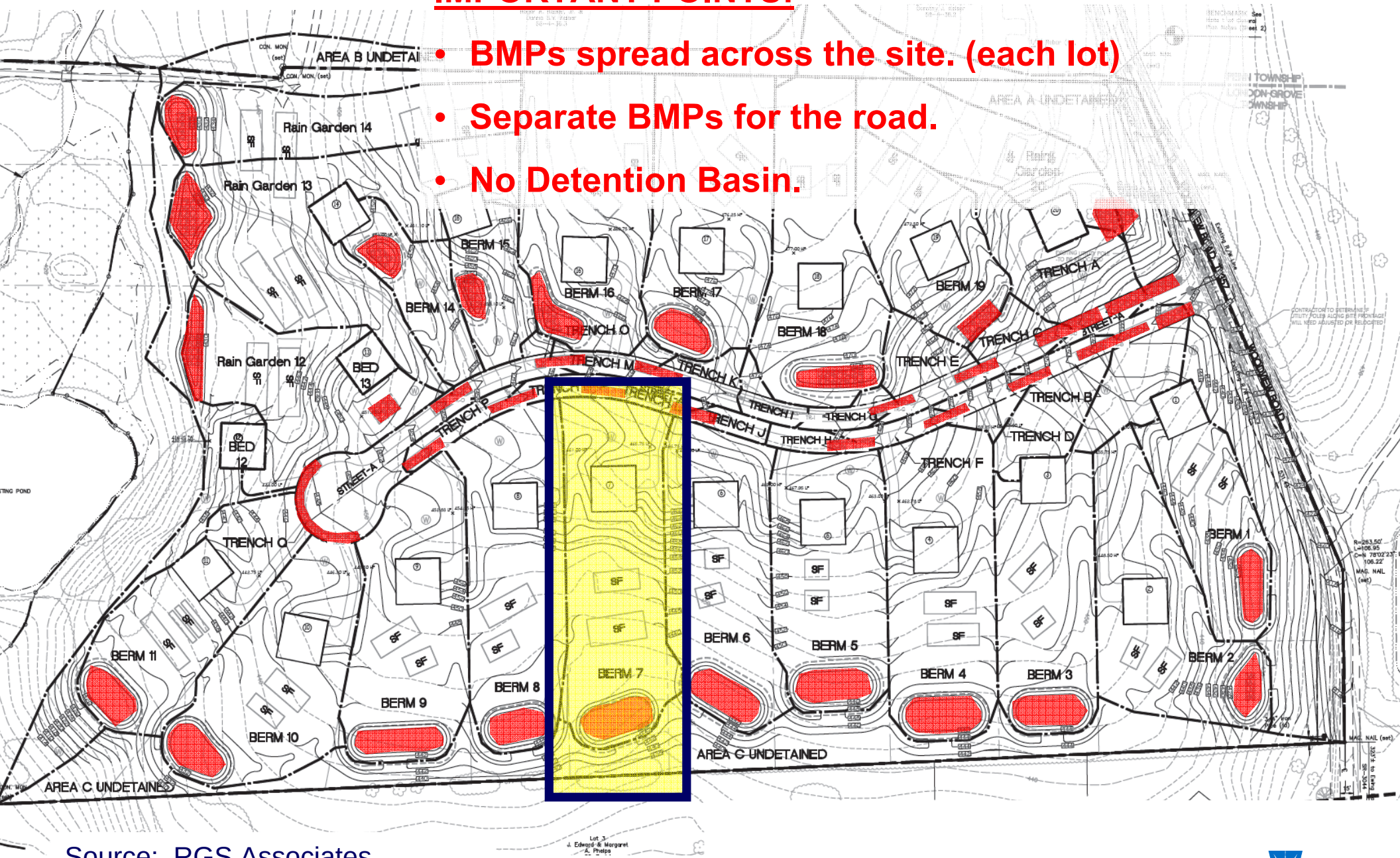




Examples of Improving Infiltration

IMPORTANT POINTS:

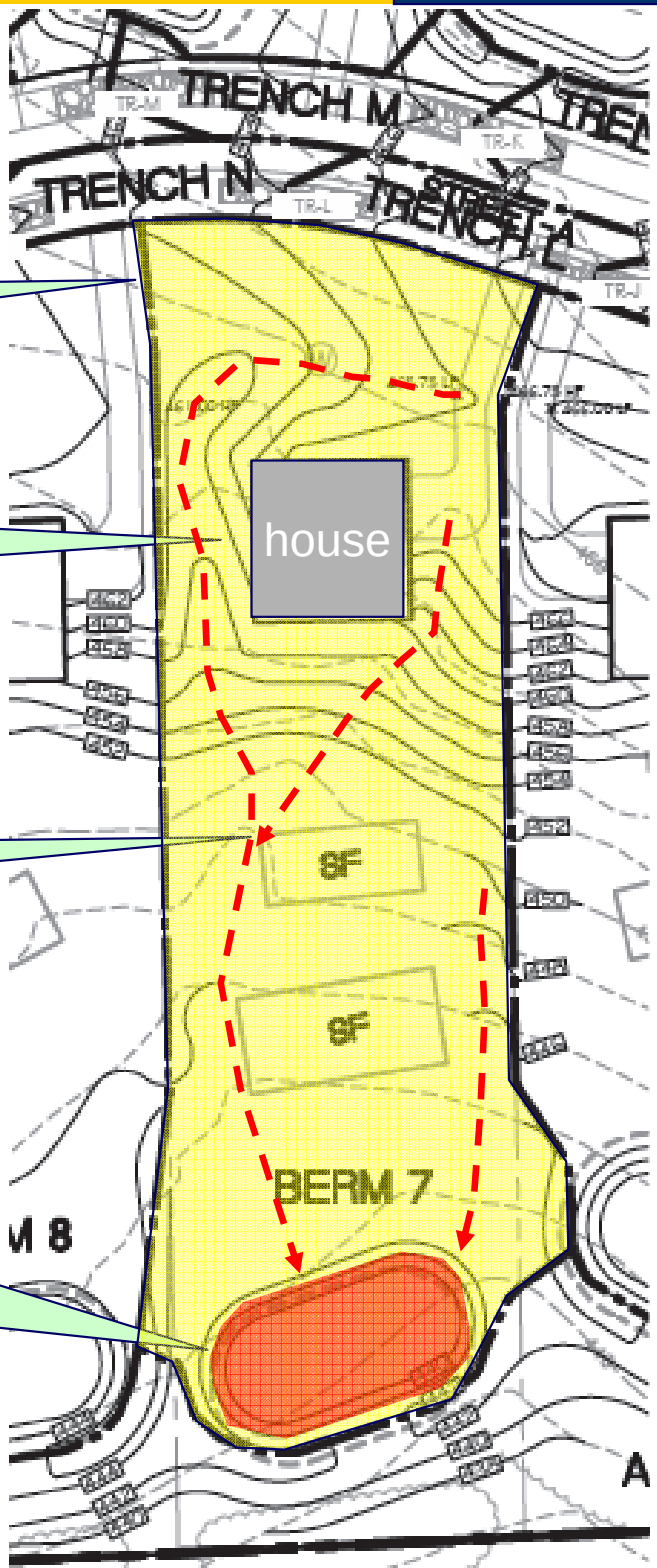
- BMPs spread across the site. (each lot)
- Separate BMPs for the road.
- No Detention Basin.

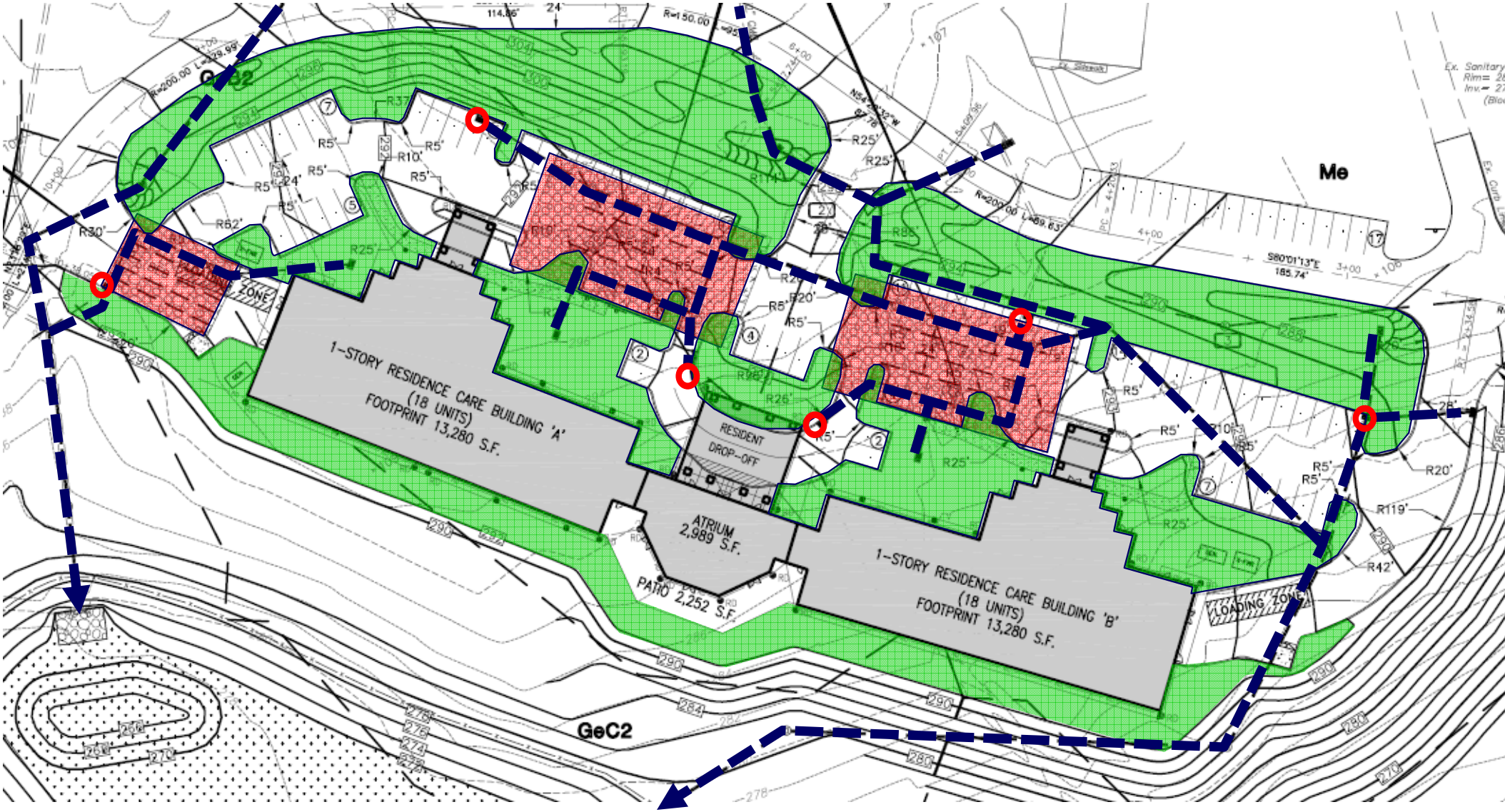


Source: RGS Associates

Single Lot

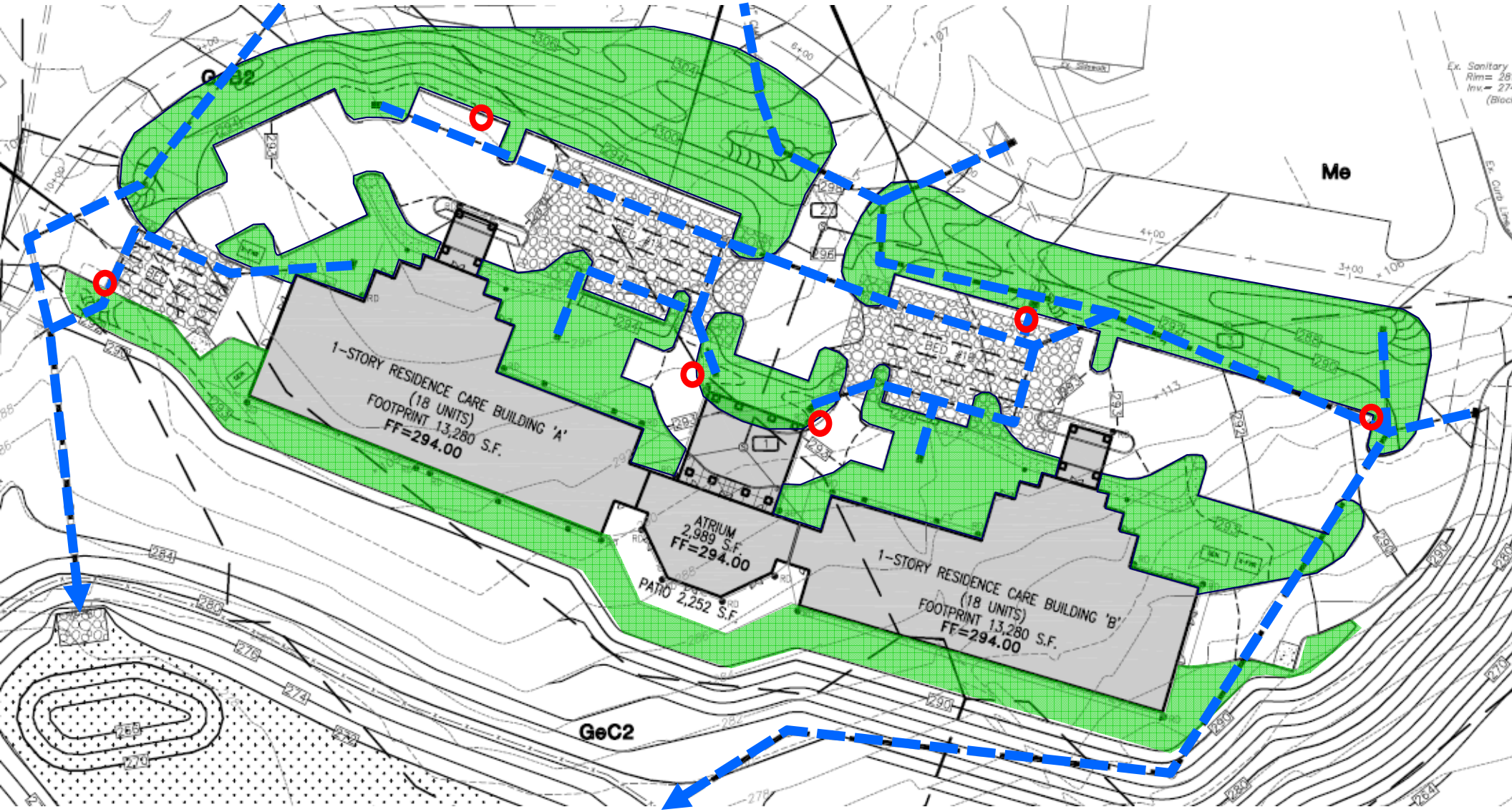
- Drainage area is basically the property line.
- Long lot w/ house relatively close to frontage.
- Surface drainage around house and septic field.
- Infiltration BMP w/ emergency spillway.
- Designed to 100 year storm to comply w/ local rate control requirements.





O = storm drains that directly discharge to underground infiltration beds without any pretreatment.

Source: Stantec

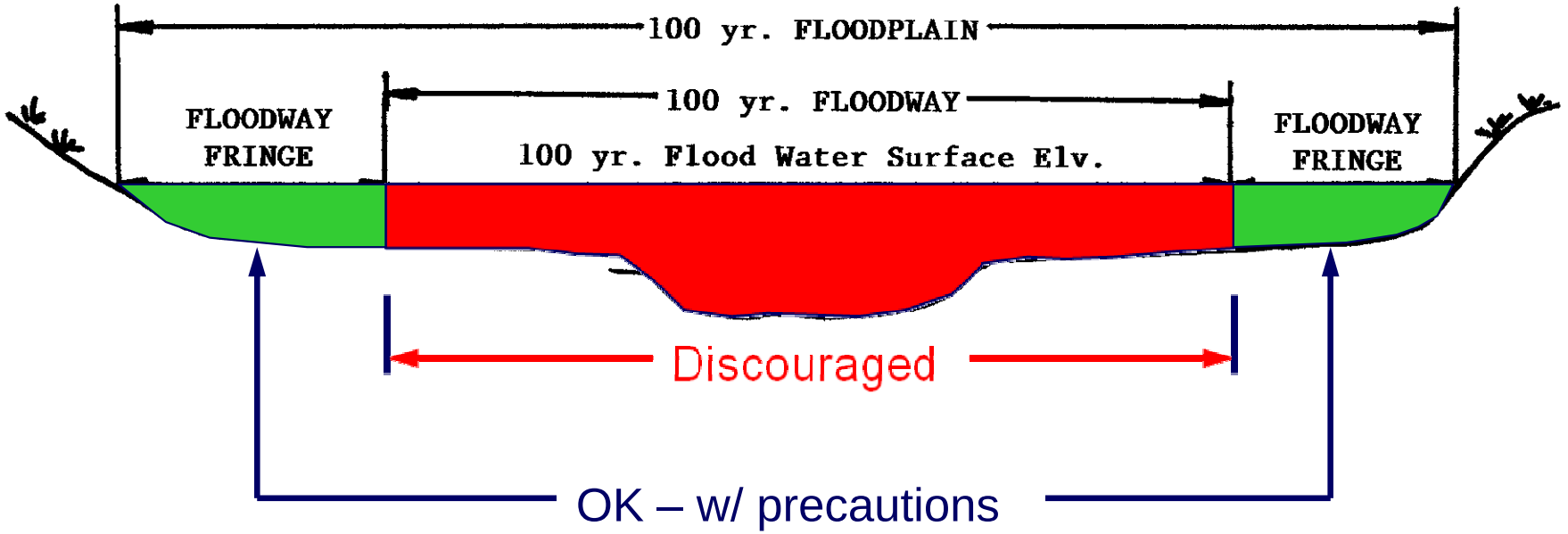

1-STORY RESIDENCE CARE BUILDING 'A'
(18 UNITS)
FOOTPRINT 13,280 S.F.
FF=294.00
ATRIUM
2,989 S.F.
FF=294.00
PATIO 2,252 S.F.
1-STORY RESIDENCE CARE BUILDING 'B'
(18 UNITS)
FOOTPRINT 13,280 S.F.
FF=294.00
GeC2
Me

INFILTRATION IN FLOODPLAINS

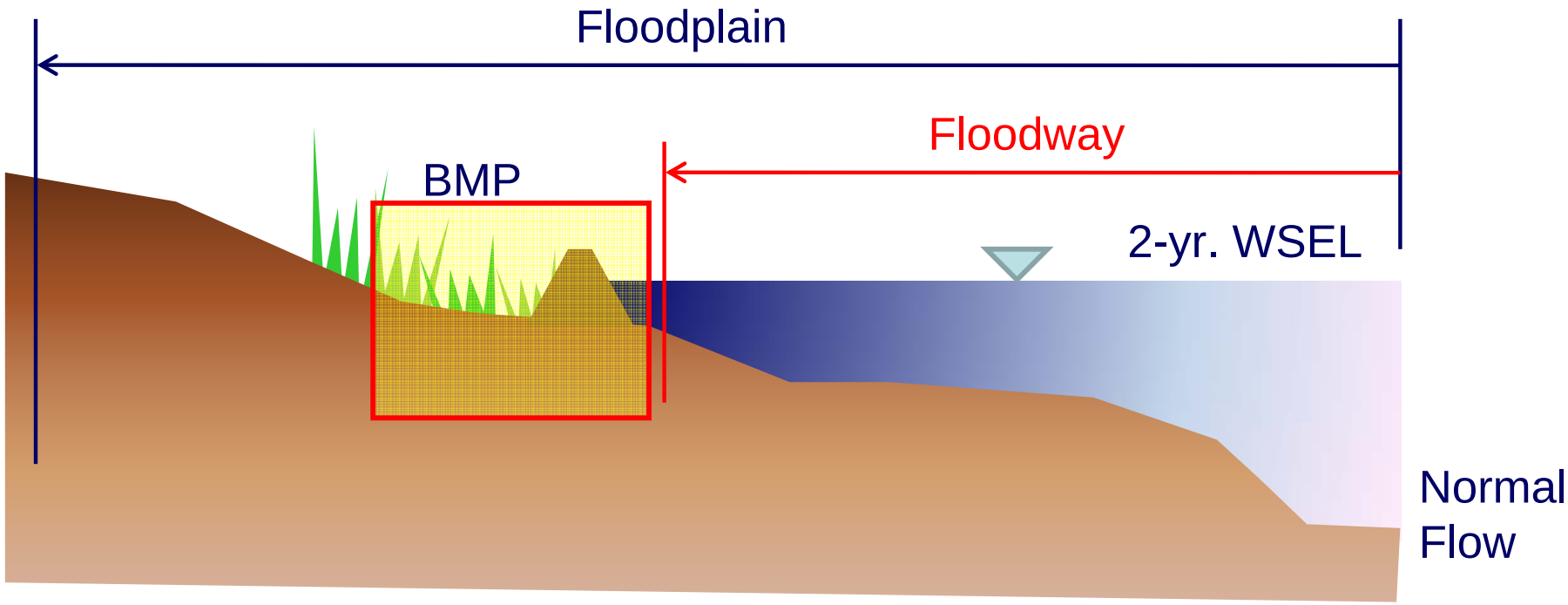
Floodplain vs. Floodway

Since floodplain development is allowed, infiltration BMPs are also allowable.

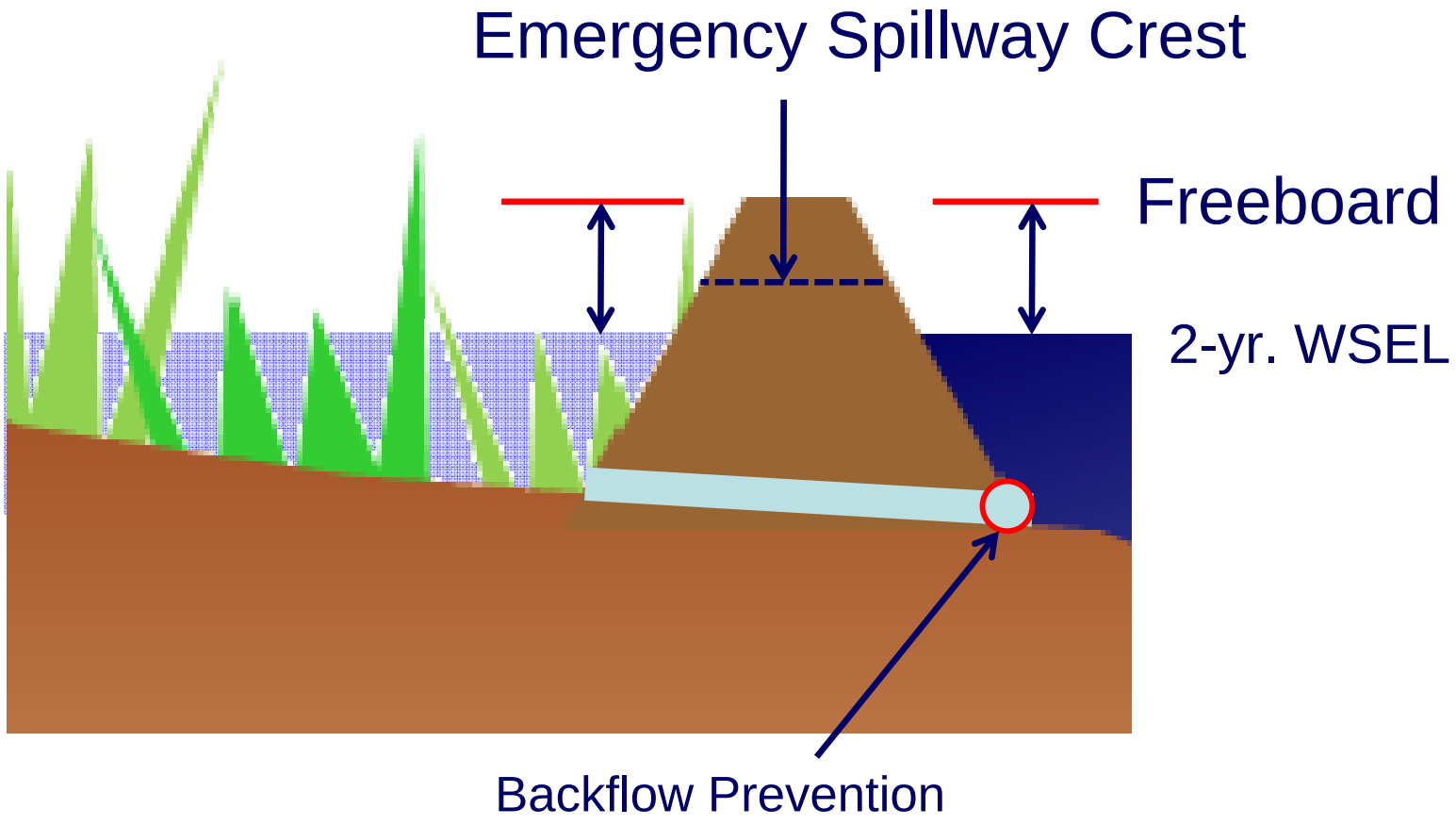
- Discourage “floodway” areas for BMPs
- Seek “floodway fringe” areas for BMPs.



Surface BMP in Floodplain

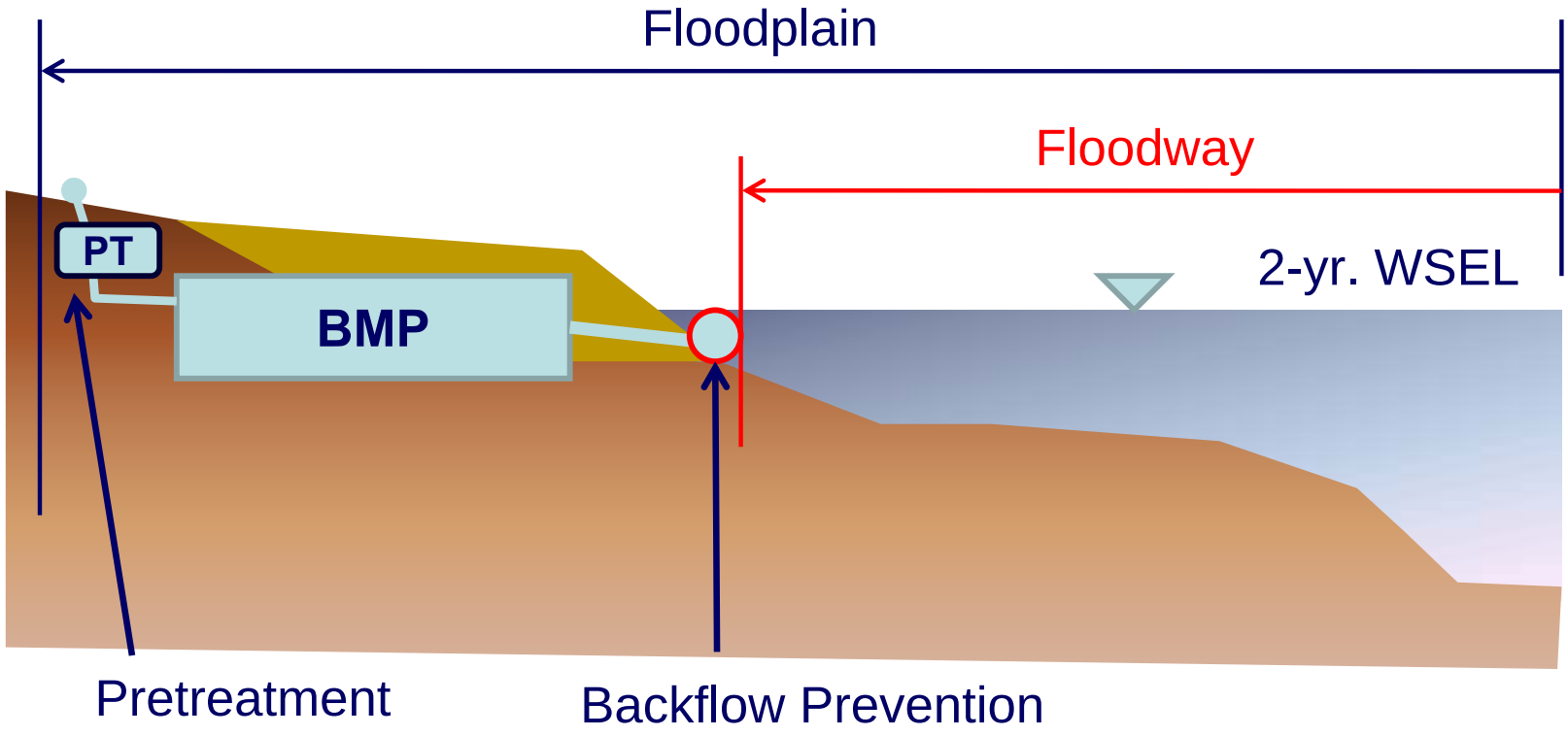


Berm Detail



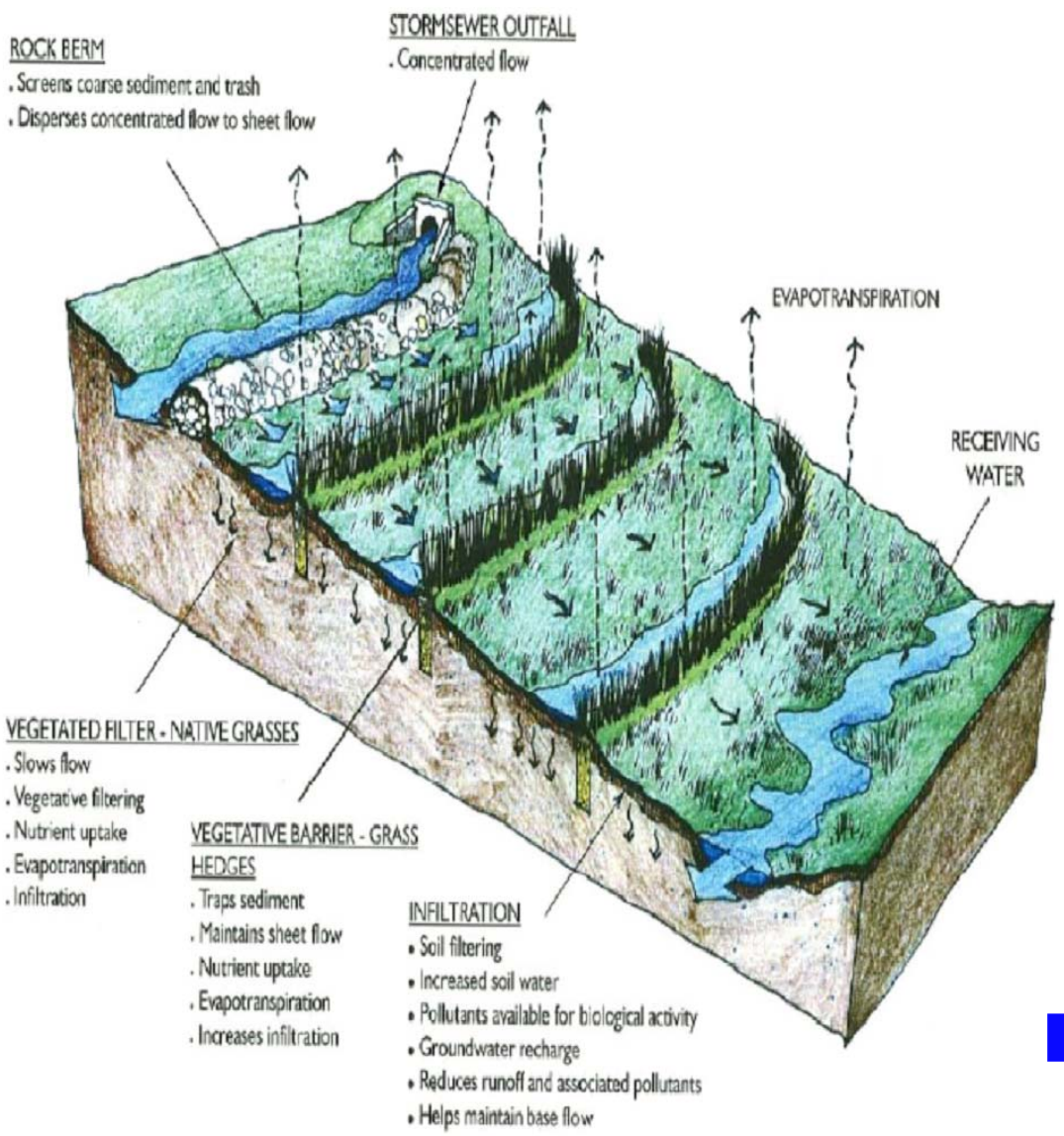
O&M Plan will need to include steps to take after significant floods that inundate the BMP.

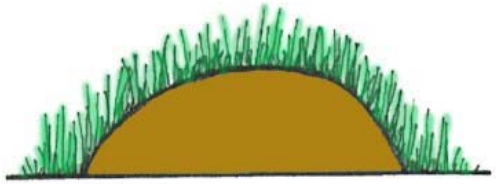
Subsurface BMP in Floodplain



For Subsurface BMPs - If Backflow Prevention not possible, then the bed bottom will need to be kept at a higher level such as the 10-year storm.

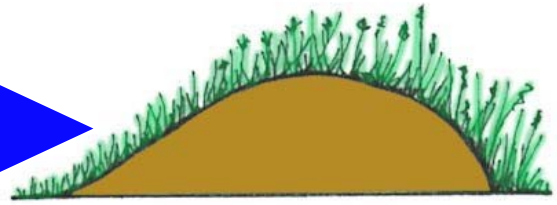
Infiltration Berms /Bio-Detention





undesirable shape for a berm

runoff



desirable shape for a berm

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Summary for Floodplain Infiltration

- It can be done.
  - Need to follow certain precautions.
- Higher likelihood of shallow water table.
- Higher risk* category
- May be better to look at infiltration berms rather than any excavation.
- DEP is not condoning Floodplain Dev.
  - Floodplain Dev. is controlled at local level

FAILURES – WHAT TO DO NEXT?

Infiltration -Risk Based Approach

- Infiltration should be undertaken more responsibly.
- Elements of risk should be assessed:

High Risk

- No pretreatment
- Large Subsurface Seepage Beds
- High Pollutant Areas (Hot Spots)
- Utilized for E&S during Construction
- Low Permeability (< 0.25 in/hr)

Moderate Risk

- Pretreatment Provided
- Medium Subsurface Seepage Beds
- Moderate Pollutant Areas
- Moderate Permeability (0.25-0.75 in/hr)

Low Risk

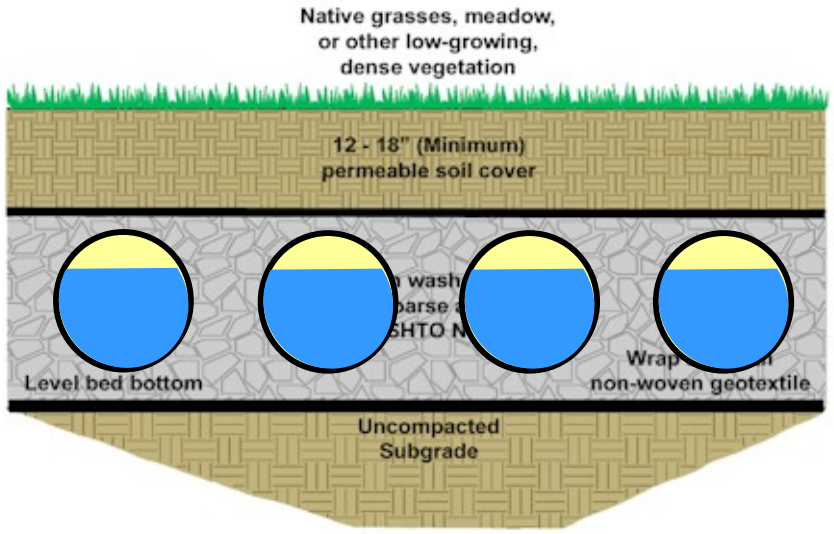
- Small Subsurface Seepage Beds
- Surface (Vegetated) BMPs
- Low Pollutant Areas
- High Permeability (> 0.75 in/hr)

Proactive vs. Reactive

- Better Design
  - Analyze Risk
  - Loading Ratios
- Better Construction Techniques
- Construction Oversight
- Post construction Monitoring

- Retrofit
- Complete Replacement
- Abandon and build another BMP

Infiltration Basin - Subsurface



Vegetated Systems

Permit Compliance

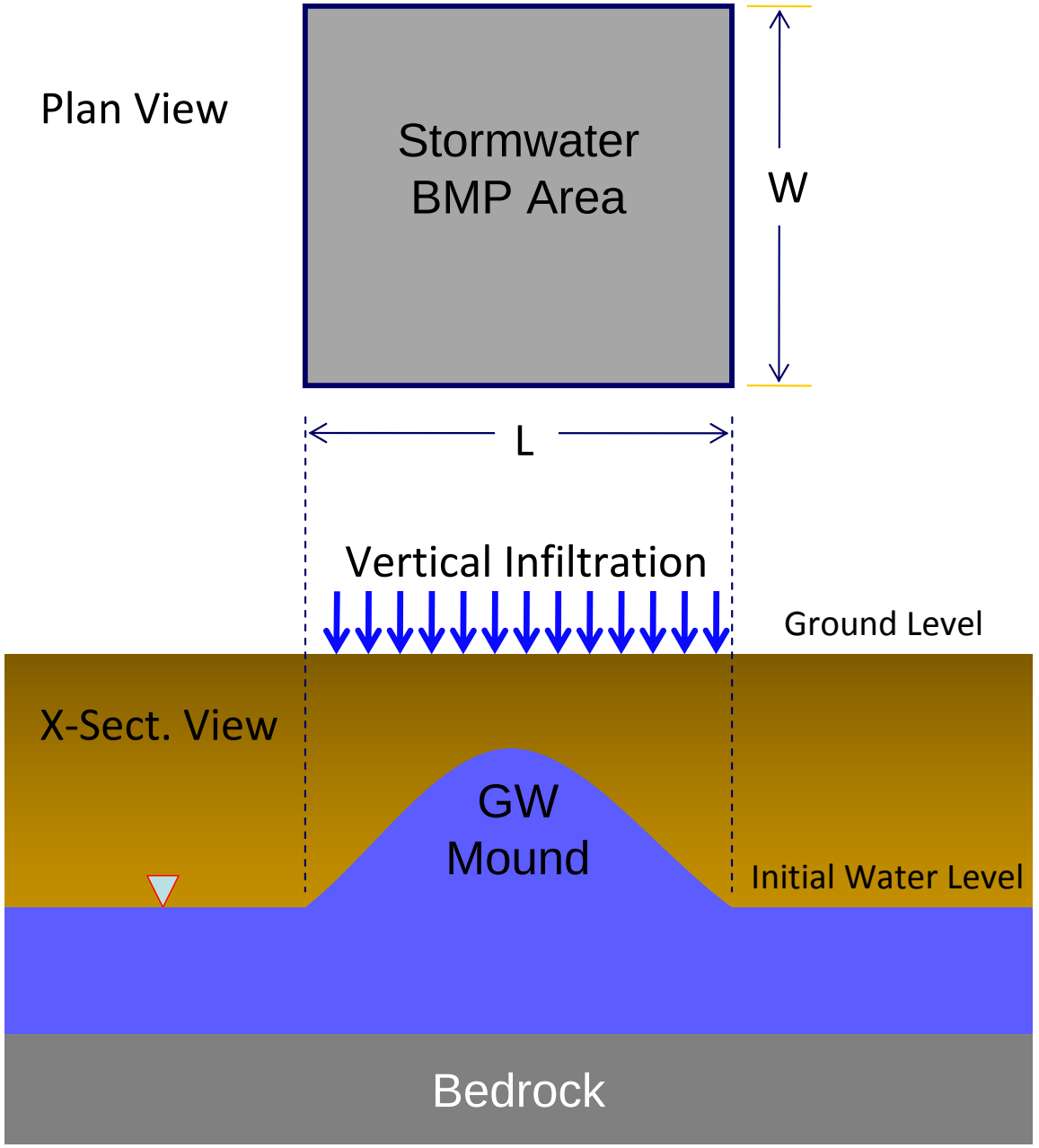
- Projects will be expected to comply with the terms of the permit that was issued.
- If unable to meet the permit terms, then it is the permittee's responsibility to find other suitable alternatives.
- Permit non-compliance leads to stream degradation and pollution.
- Can face enforcement action & penalties.

Checklist for Success

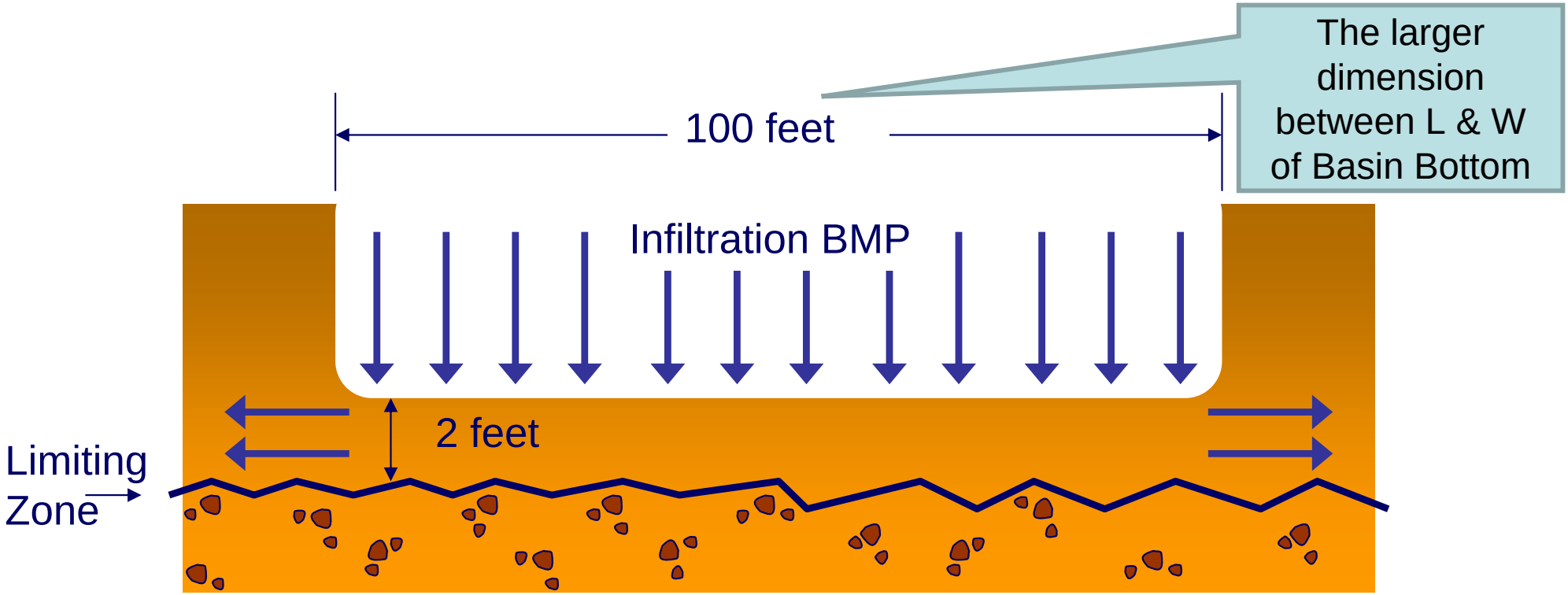
- Fully analyze risk with design.
  - Higher risk situations will need to be designed more conservatively.
- Select reputable contractor
  - Ideal to coordinate design with contractor upfront.
- Provide Construction Oversight of BMPs
- Develop a hearty O&M Plan.

Groundwater Mounding

- GW Mounding can become an issue when:
  - Shallow bedrock
  - Shallow water table
  - Perched aquifer
  - Infiltration BMPs with large footprint



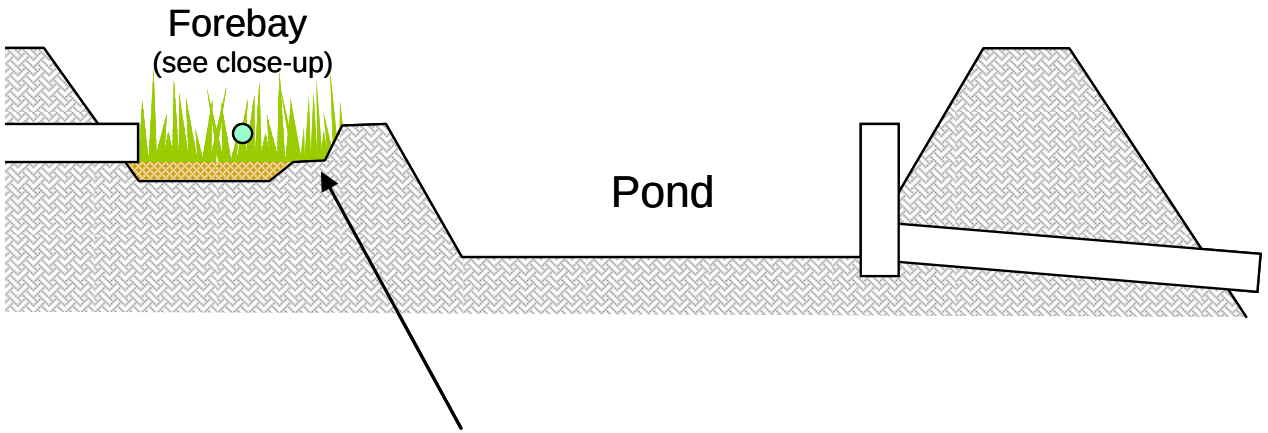
Transmissivity



Cross Section View

N.T.S.

For Large DA's, keep infiltration BMPs off-line



Plan View

N.T.S.