Rain Garden Overview and Design

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What is a rain garden?

- Short answer: a depression in the landscape designed to collect and infiltrate stormwater

- Besides performing this function, they also look really nice

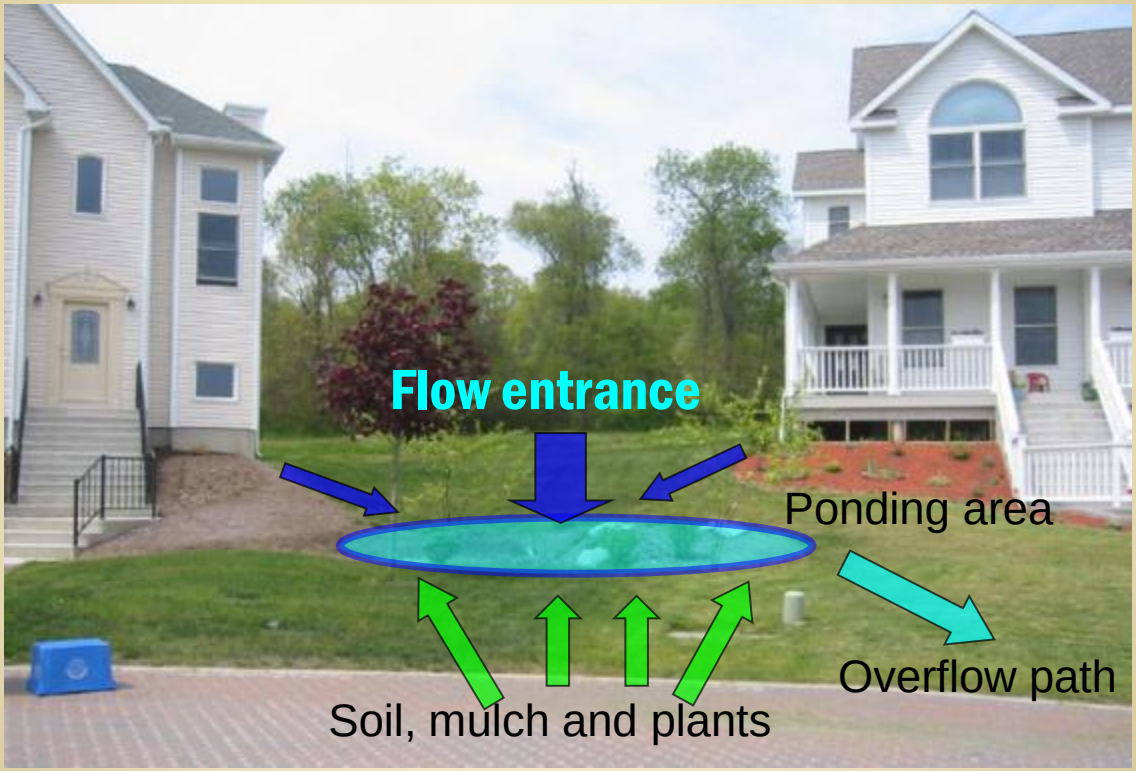
What's going on in there?

- Reduction in stormwater volume
  - Infiltration
  - Evapotranspiration
- Filtration of coarse particles
  - Sediment
  - Bacteria
- Pollutants retained
  - Taken up by plants (nitrogen, phosphorus)
  - Adsorbed to mulch, soils, or organic matter (metals)
  - Broken down by microorganisms and sunlight (hydrocarbons, bacteria)
  - Converted to gaseous form

A Word on Terminology…

- **BIORETENTION:** Commercial applications-engineered design, modified soils, usually have underdrains
  - RI DEM Stormwater Design and Installation Standards Manual
  - Prince George's County, MD
- **RAIN GARDENS:** Home-scale, not typically engineered, use existing soils
  - Wisconsin design manual
  - UConn design manual
  - Rutgers design manual

Rain Gardens



Vegetated areas designed to infiltrate and process stormwater

Residential Rain Gardens

Waterford, CT

Maryland

Ponding area

- Ponding is good, but not for more than 24 hours

Haddam rain garden

Infiltrated 99% of roof runoff!!

http://nemo.uconn.edu/successes/case_studies/haddam_demo/demosite_rain_garden.htm

Sizing and placing a rain garden

Rain garden placement

- Must be at least 10 feet from foundation with basement or where top of foundation is below ponding level

- Avoid placing within 15ft of septic system or 25 ft to private drinking well

- Avoid placing in wet areas of yard- a rain garden IS NOT a water garden!

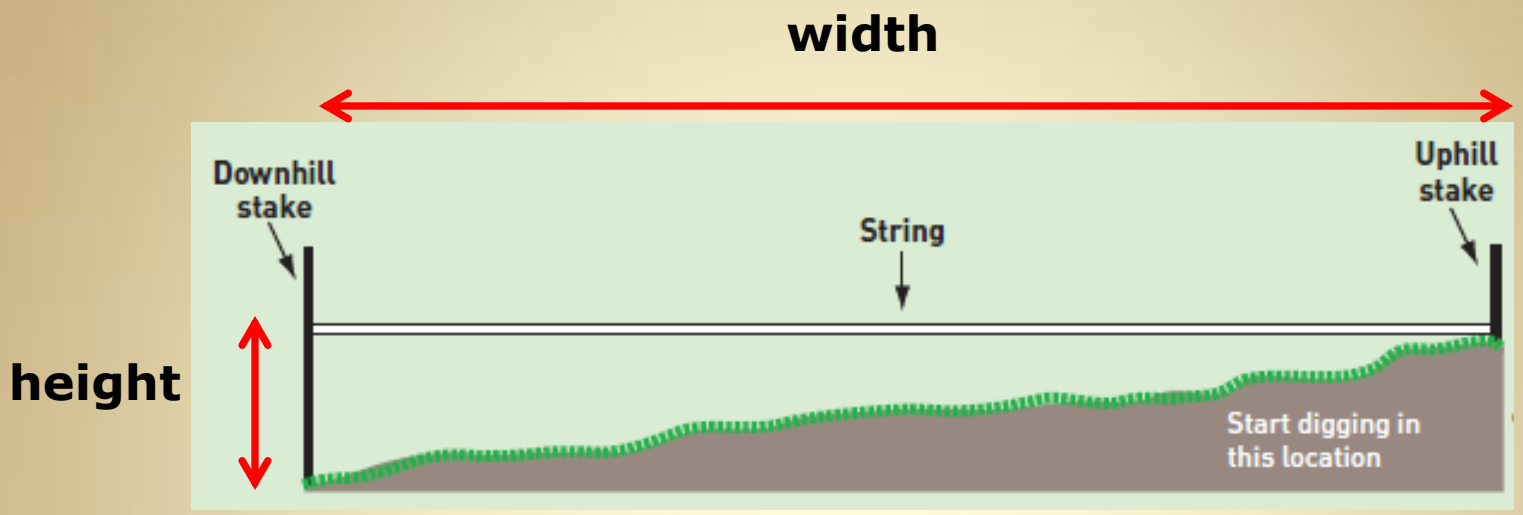
- Site to most effectively catch storm runoff

- Consider overflow

Important site considerations for rain gardens

- Avoid areas with:
  - Shallow (<3 feet) depth to bedrock
  - Seasonal high water table (<2ft from bottom)
- Be aware of the infiltration capacity of native soils
- Watch for steep slopes
  - 25 ft setback up-gradient from natural slopes >15%

Slope



$$\frac{\text{Height}}{\text{Width}} \times 100 = \% \text{ Slope}$$

- For flat areas, no berm needed
- Moderate slopes, use berm
- Heavier slopes, use retaining wall design
- **More than 12% slope, look for another location**

Different siting applications

- Take water from:
  - Roof
  - Parking lot/road
  - Turf/mixed use

Roof

- Typically intercept gutter downspout leader
  - Can pipe, or run over pervious area first

Roof

- Drains to turf, sloped to garden

Parking lots/roads

- Either curbless, or can use curb cuts

Parking lots/roads

- Curbless

Alternate cul-de-sac

Parking lots & roads

- Provide forebay or turf filter area for sediment accumulation and cleanout
  - Preserves integrity of garden
  - Easier to maintain

North Carolina. From Traver, et al., 2007

Mixed use

- Can be difficult to figure out watershed and measure areas
- Observe in rain storm
- Break it up into shapes

UConn Rain Garden

Considerations for all types:

- Where flow is concentrated or in a pipe, provide something to break up energy
  - Reduces erosion potential

All types: Overflow

- For rain gardens, typically adjacent turf or wooded area
  - Avoid concentrating flow-spread it out to reduce erosion potential

Soils

- Simple percolation test
  - Dig hole 6 inches deep, and fill with water.
  - If there is still water in the hole after 24 hours, the site is **not suitable** for a rain garden

Soils

Better percolation test:

Steps:

1. Dig a hole 12 inches deep by 6 inches in diameter.
2. Fill hole with water and let stand until all the water has drained into the ground.
3. Refill the empty hole with water again. Measure the depth of water with a ruler.
4. Check the depth of water with a ruler every hour for 4 hours.
5. Calculate how many inches of water drained per hour.

~1.5 inches of water draining per hour is ideal

Soils

- My infiltration rate is only 0.8 inches per hour… will it still work?
  - **YES, with some simple amendments or sizing adjustments**
- My infiltration rate is only 0.5 inches per hour… will it still work?
  - Perhaps… but find out why

Soils

- Ball test: Squeeze a moistened ball of soil in the hand

- **Soils break with slight pressure** - Sand or sandy loam
- **Stay together but change shape easily** - Sandy loams and silt loams
- **Soils resist breaking** - clayey or clayey loam

Soil Ribbon Test

- Ribbons less than 1”
  - Feels gritty = coarse texture (sandy) soil
  - Not gritty feeling = medium texture soil high in silt
- Ribbons 1-2”
  - Feels gritty = medium texture soil
  - Not gritty feeling = fine texture soil
- Ribbons greater than 2” = fine texture (clayey) soil

Soils

- Send sample to county Extension Office for sand/silt/clay and/or nutrient analysis

- **Sandy or loamy soils best, but others can be used with amendments**

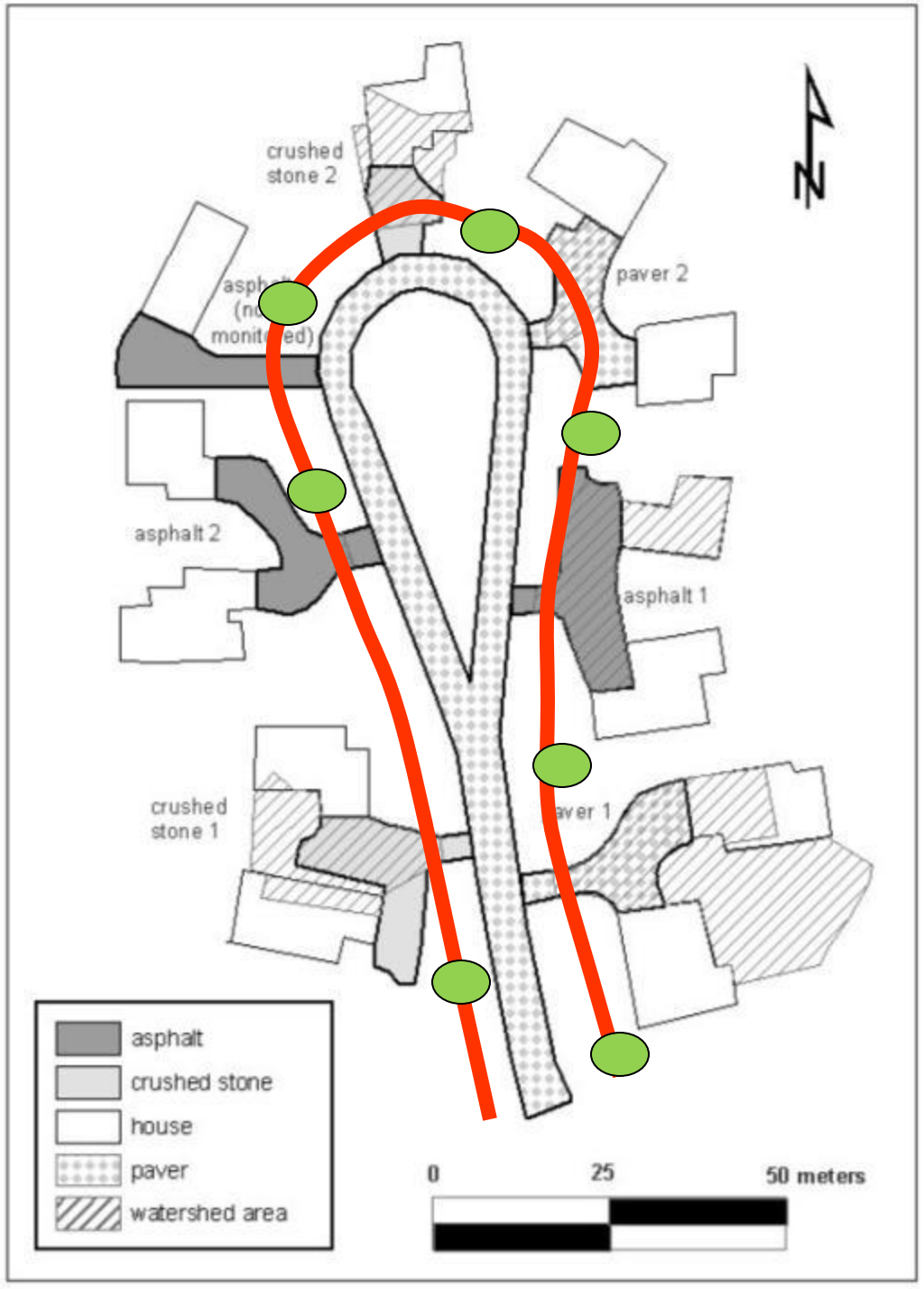
Soils

- What if the texture is OK, but the soil doesn't drain?
- High water table
  - Pick a different site or see difficult sites information
- Compaction-the silent killer of rain gardens…
  - New construction especially prone

Site preparation

- AVOID COMPACTION!!!
  - Compacted soil **will cause** a rain garden or bioretention area to fail

- If it is highly compacted, need to remove, or loosen and aerate



Important factors with rain gardens

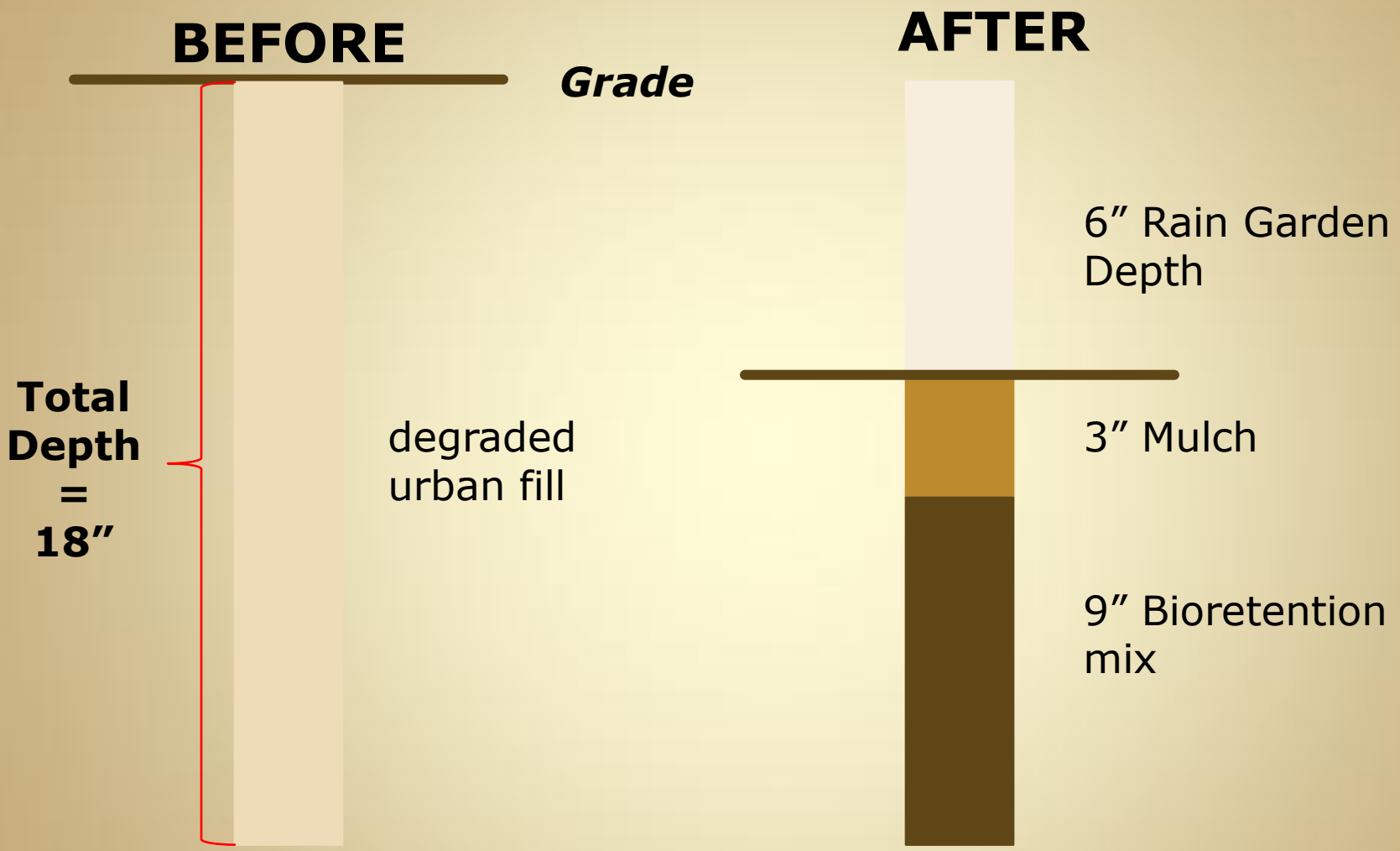
- SOIL COMPACTION before, during construction

Soil Amendments

- For compaction, loosen up and remove some of the compacted soil, and replace with sand/compost mixture

- For clay soils:
  - Make garden larger (based on soil sizing coefficient) and shallower, and amend with sand and some compost
- For very sandy soils:
  - Amend with compost to slow down the infiltration
- For urban fill soils, other adjustments may be needed

Worcester YC Site Specific Limitations



Let’s get digging!

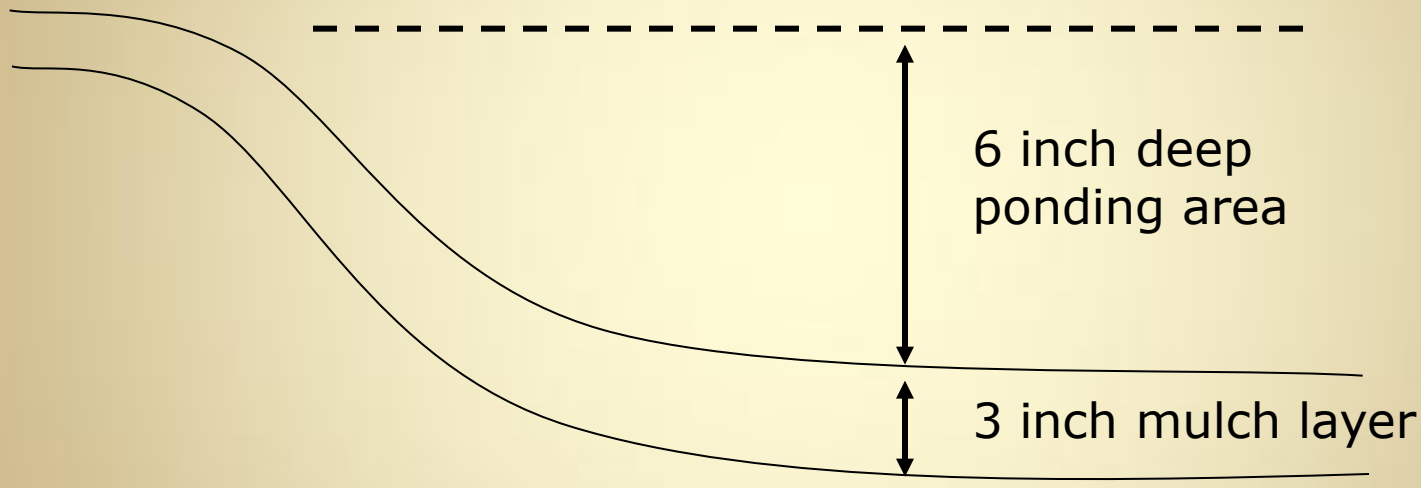
Installation

- Call hotline to locate underground utilities (at least 3days in advance) **1 – 800 – DIG - SAFE**

- Mark area to be dug

- Smaller gardens can be dug by hand or equipment can be rented for larger gardens

Depth



****May need to add compost if soils aren't great *****

Foot traffic only

North Kingstown Example

- Roof runoff from the North Kingstown Town Hall contributing to road flooding

North Kingstown Example

- Area Marked with flags and topsoil removed

North Kingstown Example

- Area dug out and underground pipe connecting gutter installed

Plants

- Native or well-adapted non-natives
- Plants that like wet feet, but can tolerate extended dry periods
- NOT wetland plants!
- Can use different plantings for different parts of rain garden

Plants

Mulch

- Best is aged, shredded hardwood bark mulch
  - About 3 inches in depth
- NOT pine bark nuggets!
  - They float

Important factors with Rain Gardens

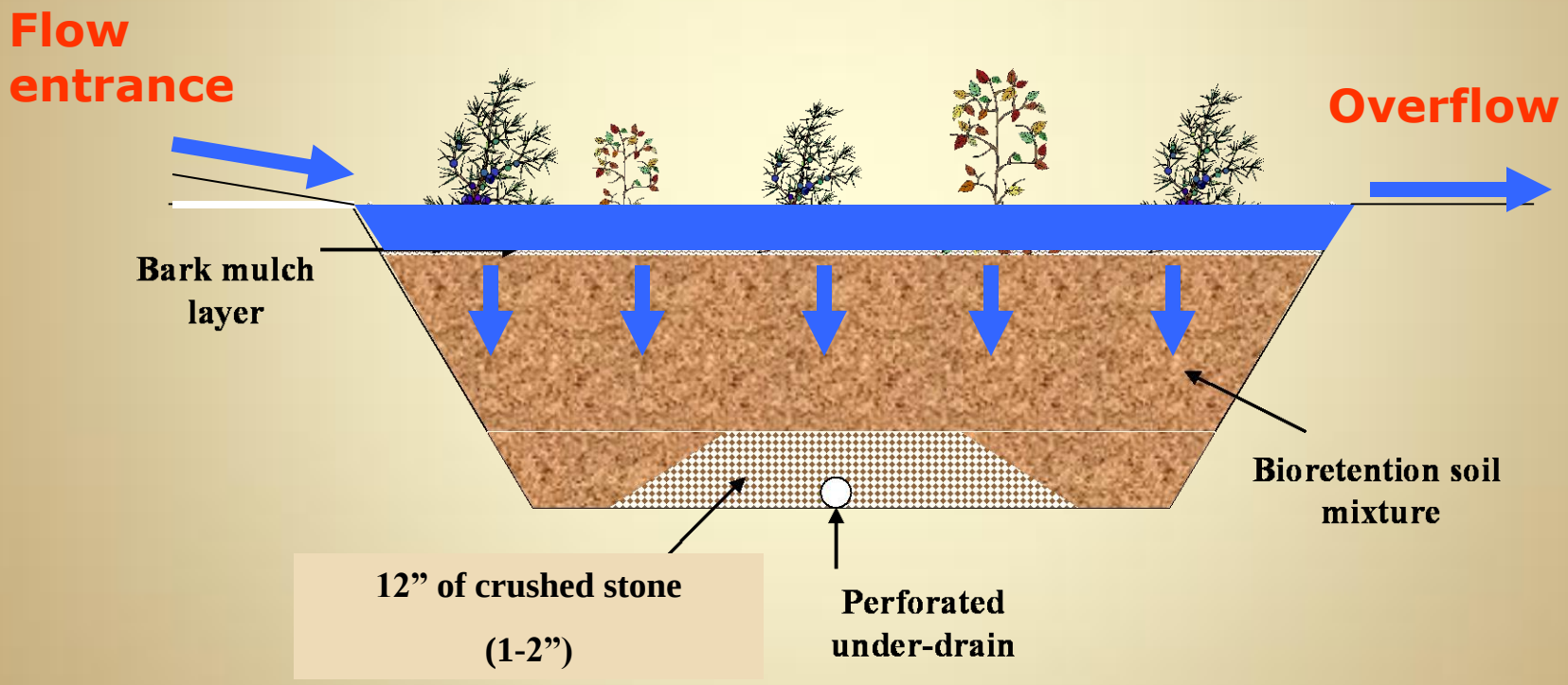
- Make sure storage depth is correct at installation

A well-installed Rain Garden…

- Has open flow paths, overflow and an adequately sized storage area
- Has proper materials installed
- Has NON-COMPACTED soils!
- Is only used after the surrounding site is stabilized
- Has proper plantings/ground cover
- Has a provision for short term care (watering), and in arid climates irrigation

Bioretention specifics

Bioretention profile



Bioretention soil mix

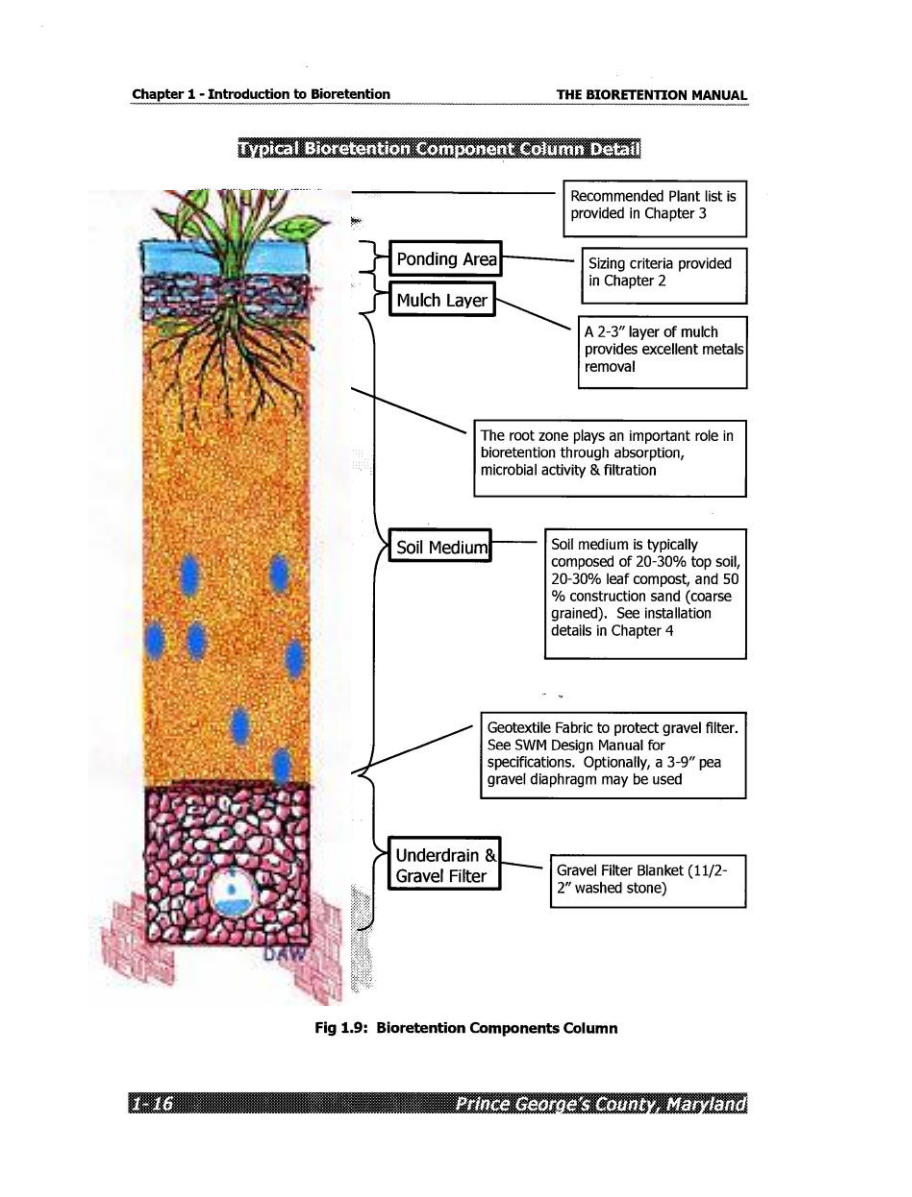
- PGC Bioretention Manual defines bioretention soil mix as follows:

  coarse sand: 50 - 60%
  leaf compost: 20 – 30%
  topsoil: 20 – 30%

- For a rain garden, native soils amended with compost and mulch layer is recommended

Installation materials

- Soil mix, plants, mulch (underdrain, crushed stone)
- Filter fabric only placed above underdrain
  - Not needed for residential sites
  - Don't line bioretention, don't wrap underdrain pipe
  - Non-woven geotextile



What about a liner?

- Lining is only needed in very specific applications
- Partial lining where you don't want water to go
- Full lining in "hot spots"
  - Gas stations, industrial facilities, brown field sites
  - Bioretention is just a filter in these cases

Underdrains

- Purpose is to reduce potential for extensive surface ponding

- Highly recommended for commercial/urban bioretention

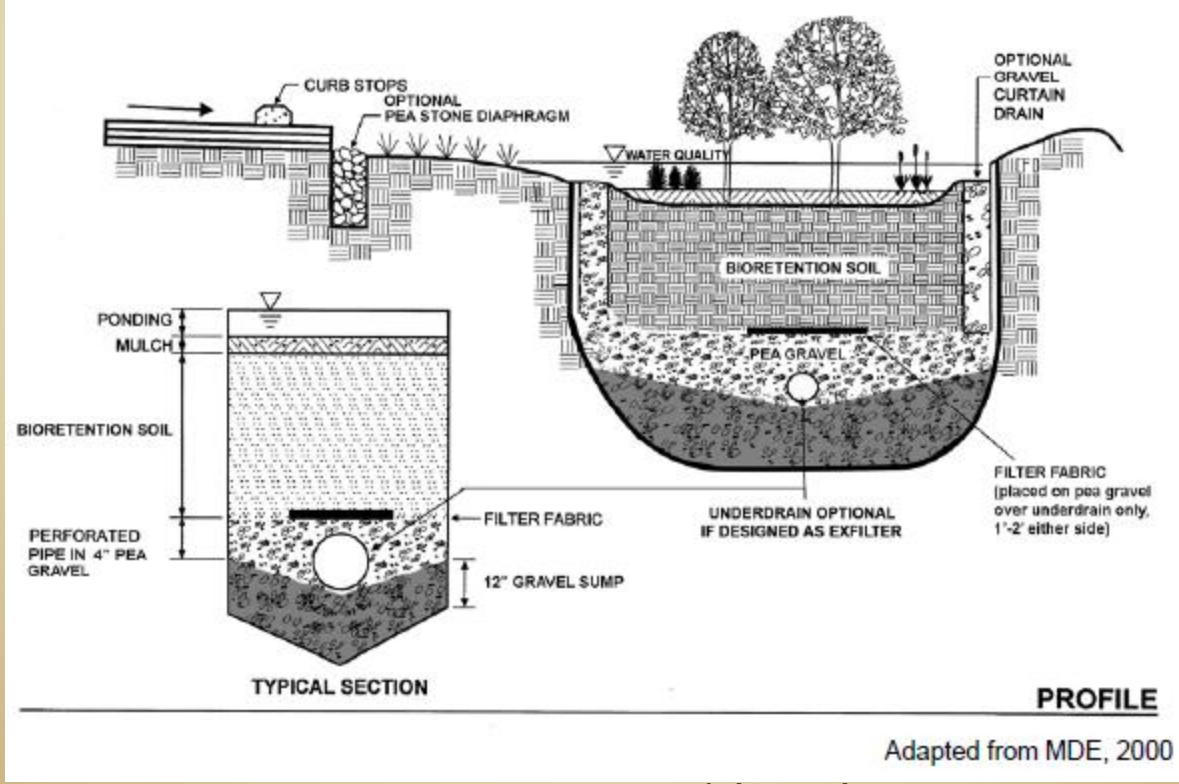
- Slotted (ADS) or perforated (PVC) pipe at bottom or just above bottom of bioretention, surrounded by crushed stone/gravel blanket

Crushed stone

- 1-2 inch washed crushed stone around pipe, then a pea-stone gravel “blanket” on top, before soil mix gets applied.

Underdrains

- Drain to grade (best) or stormwater system (OK)
- Underdrains can be placed on a minimum 3'-0" wide section of geotextile. Pipe is placed next, followed by the gravel bedding.
  - Filter fabric should be used only on top of the portion of the pea gravel layer that is over the underdrain



From RI Stormwater Manual (2010)

Underdrains

Underdrains

- Elevated drain
  - Increases chance of infiltration into native soils
  - Provides good environment for denitrification

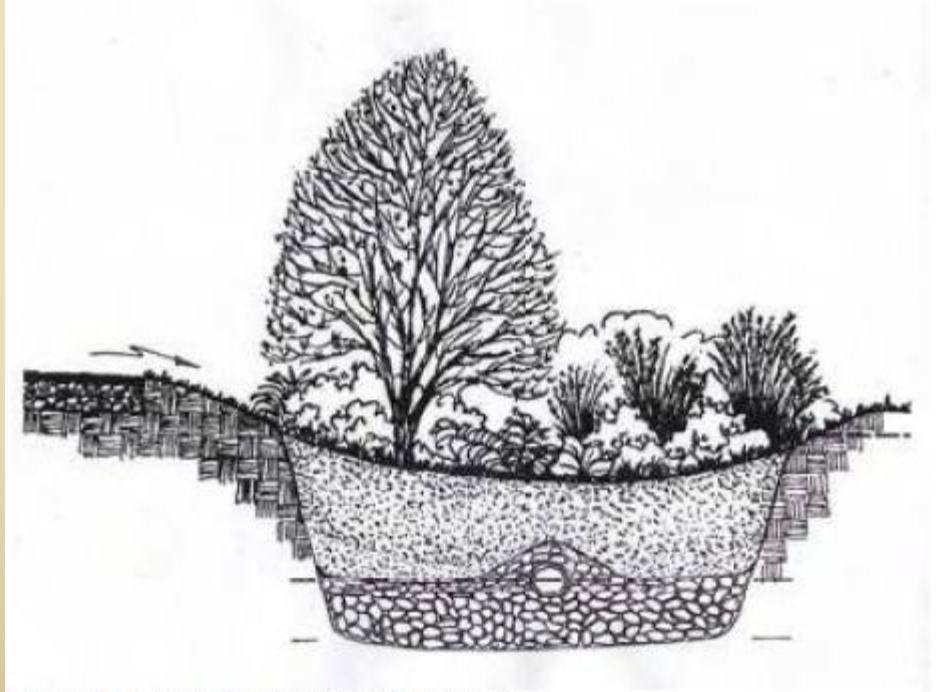


Figure 2.15. Infiltration/filtration/recharge

From Bioretention Manual (2009)

Overflow

- Typically stormwater system


? ?
?
Questions ?

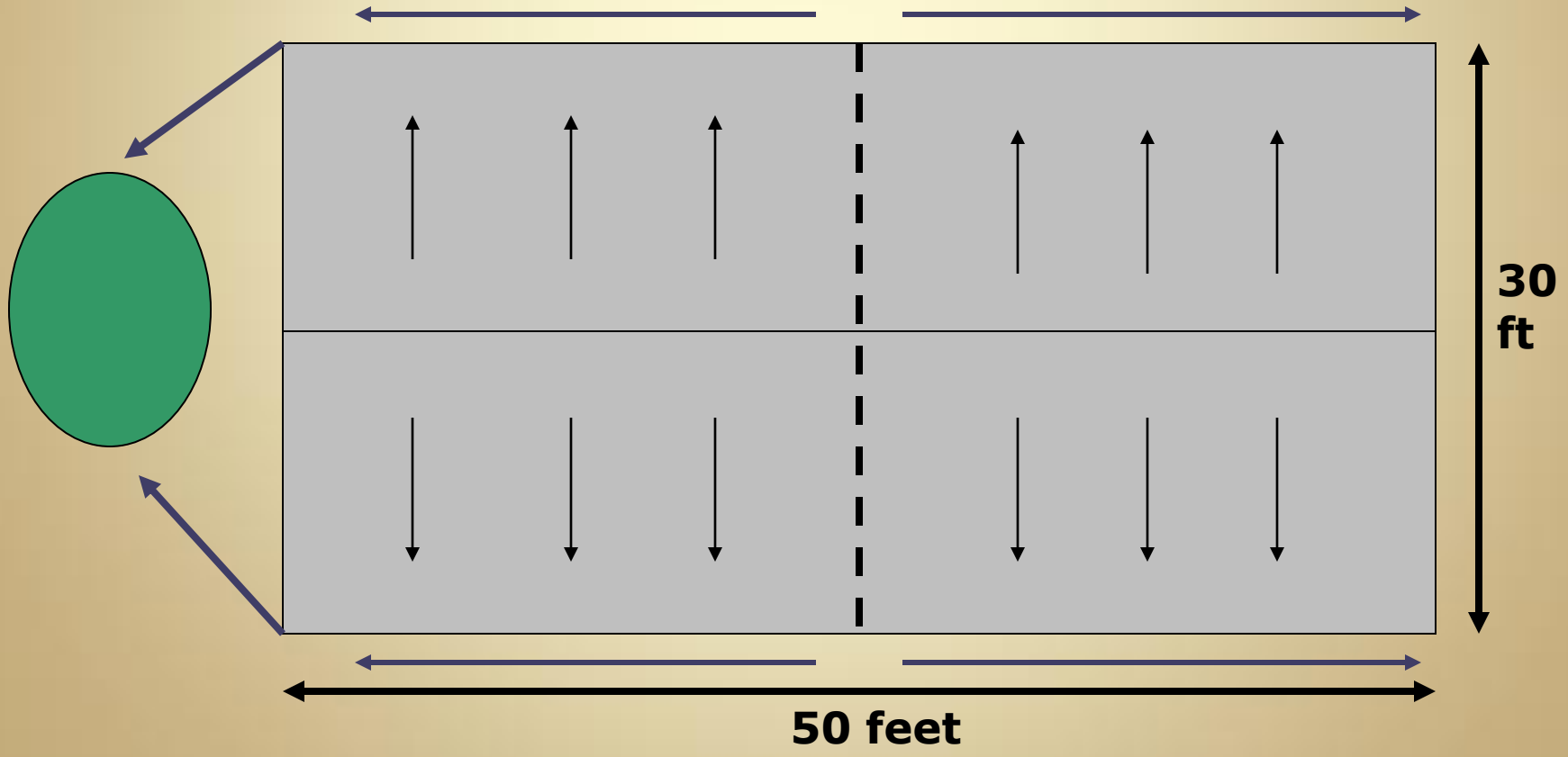
Sizing Your Rain Garden

How Big Should it Be?

- Simple method
  - Sized to store 1 inch of runoff from 100% impervious watersheds
- Soil Based method
  - Multiply drainage area by soil sizing coefficient

Simple Sizing

- Calculate area of roof feeding to garden

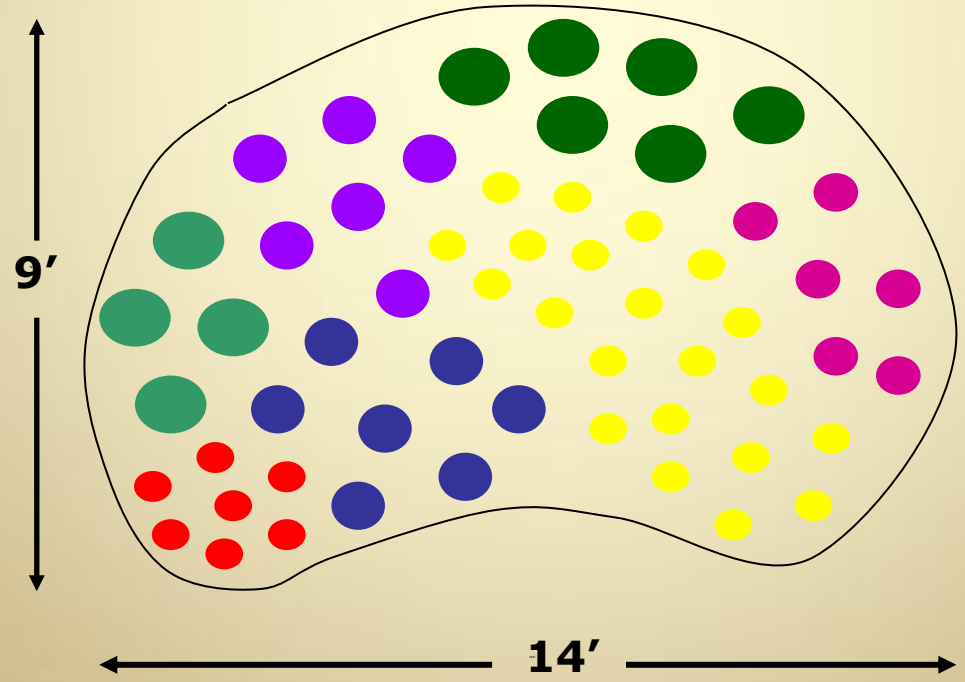


Simple Sizing, continued

- 50 feet x 30 feet = 1500 square feet
- 1500 feet / 2 = 750 square feet
  - This is because only half the roof contributes to the garden
- 750 square feet / 6 = **125 square feet**
  - This just sizes the garden to hold 1 inch of water from the roof in a 6 inch deep rain garden

Sizing, continued

- 125 square feet
  - Garden can be shaped in a variety of ways

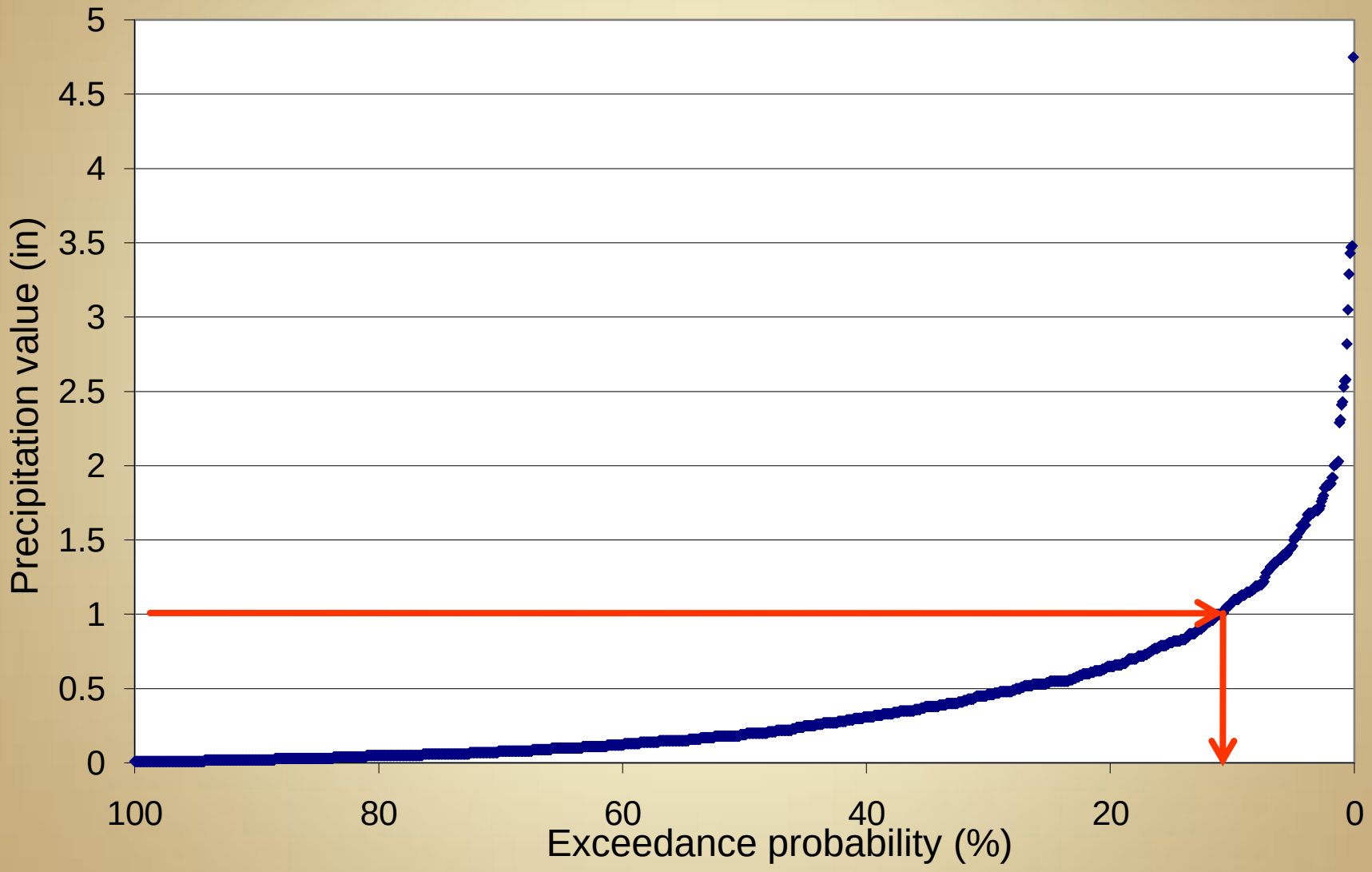


Why 1 inch?

- In the East and Midwest, around 90% of storms are 1” or less
- Wisconsin design guide
- UConn design guide
- Bioretention manual

Precipitation Probability

Groton daily non-zero precipitation (in), 1974-2008



Is it really that big of a deal ?
1 inch isn't much, right?

Let's see how Google sees the world

- 15,700 ft²
- 1 inch of rain= **9,787 gallons**
- Average year=48 inches..
  - **469,807 gallons!**
- **This is one small area!**

Your turn!

Drainage area
15,700 sq ft

Rain Garden Location

Watershed is 100% impervious = 15,700 ft^2

Simple example

- If watershed is 100% impervious, size to capture 1 inch of runoff

- 15,700 ft^2 / 6 = **2,616** square feet (6 inches deep)

So… can we do it?

- Many considerations for this site:
  - Urban fill soils need to be removed
  - Seasonal high water table/flooding
  - Costs to remove material
  - Costs for new soil media
  - Plants
- Made garden 800 square feet, about 3 times smaller than recommended
- Installed underdrain and tied in to nearby catch basin

For Mixed-Use Drainage Areas

- Based on "Water Quality Volume"
  - 1 inch
- Use equation $WQ_v = [(P)(R_v)(A) / 12]$
  - P= 1.0 inch
  - R_v= 0.05 + 0.009(I)
  - I=Percent impervious (1-100)
  - A=Total watershed area (square feet)

From Bioretention Manual (Prince George's County, 2009)

References of interest:

UCONN NEMO

- http://nemo.uconn.edu/

Low Impact Development

- http://epa.gov/region01/topics/water/lid.html
- http://www.lowimpactdevelopment.org/

GreenScapes New England-

- http://epa.gov/region01/topics/waste/greenscapes.html

Rain Gardens

- http://www.raingardennetwork.com/
- http://www.raingardens.org/Index.php
- http://www.dnr.state.wi.us/runoff/rg/

Sample Planting Schemes