

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

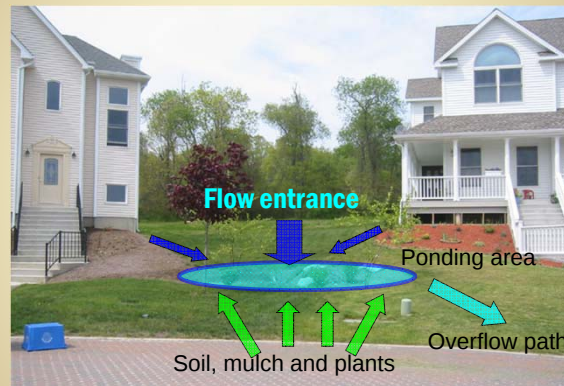
What's going on in there?

- 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
- Prince George's County, MD
- **RAIN GARDENS:** Home-scale, not typically engineered, use existing soils
 - Wisconsin design manual
 - UConn design manual

Bioretention/rain gardens



Vegetated areas designed to infiltrate and process stormwater

Residential Rain Gardens



Waterford, CT



Maryland



Haddam rain garden



Infiltrated
99% of roof
runoff!!

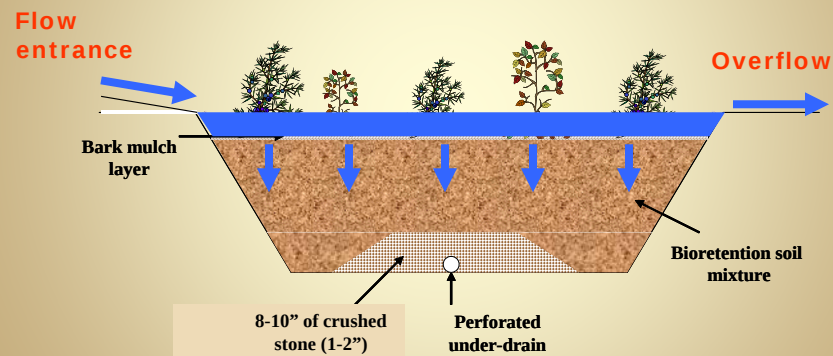
http://nemo.uconn.edu/successes/case_studies/haddam_demo/demosite_rain_garden.htm





Bioretention specifics

Bioretention profile



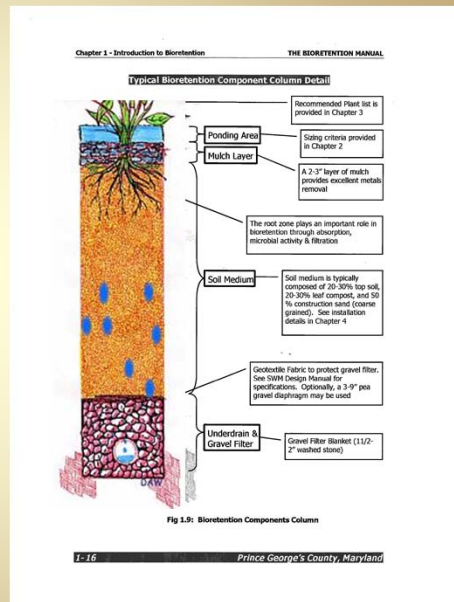
Ponding area

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



Installation materials

- Soil mix, underdrain, crushed stone, plants, mulch
- **Avoid filter fabric!!**
 - Not needed for residential sites
 - For commercial, use non-woven geotextile only if needed



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

Research bioretention



Underdrains

- Purpose is to reduce potential for extensive surface ponding
- Bioretention manual recommends underdrains for all residential rain gardens
 - May not be necessary
 - Make a decision based on site and soils
- 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

Underdrains

- Drain to grade (best) or stormwater system (OK)
- **DO NOT** wrap in filter fabric!

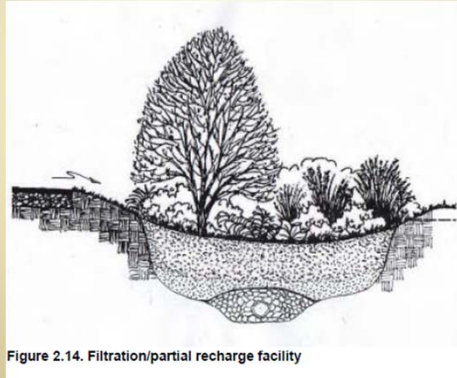


Figure 2.14. Filtration/partial recharge facility

From Bioretention Manual (2009)

Underdrains



Underdrains

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

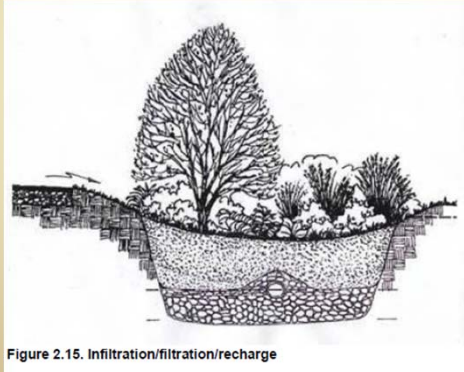


Figure 2.15. Infiltration/filtration/recharge

From Bioretention Manual (2009)

Sizing and placing a rain garden

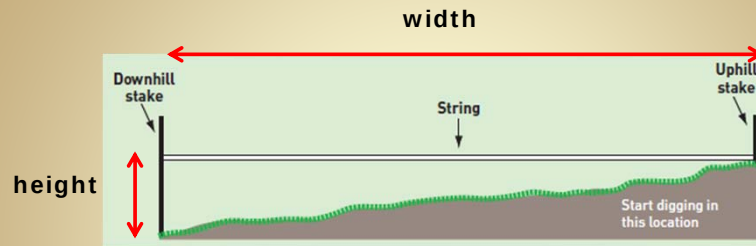
Rain garden placement

- More than 10 feet from foundation with basement
- Avoid placing over septic system or close to well
- Avoid placing in wet areas of yard-don't forget, a rain garden **IS NOT** a water garden!
- Site to most effectively catch storm runoff
- Consider overflow

Important site considerations for bioretention/rain gardens

- Avoid areas with:
 - Shallow (<3 feet) depth to bedrock
 - Seasonal high water table
- Be aware of the infiltration capacity of native soils
- Watch for steep slopes

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 20% 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 retrofit with curb cuts



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
 - Get help from your student!

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



Check 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**
- My infiltration rate is only 0.5 inches per hour... will it still work?
 - Perhaps... but find out why

Bioretention soil mix

- 50-60% sand
- 20-30% topsoil
 - Low clay content
- 20-30% **leaf** compost
 - Low phosphorus
- For a rain garden, sandy loam, loamy sand, loam soils usually OK as is

Source: The Bioretention Manual (PGC, 2009)

Soils

- **Ball test:** Roll moistened soil into a ball in hand and see how it forms
 - Hard ball – Clay/Silt soil
 - Soft ball – Loamy soil
 - No ball – Sandy soil



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

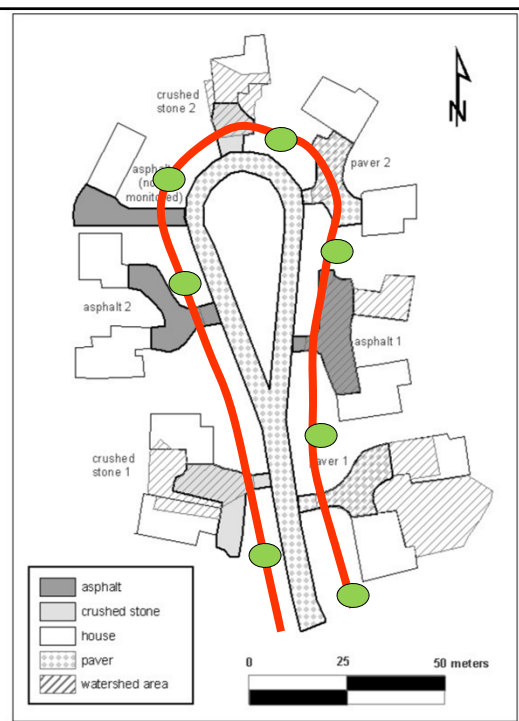
- Send sample to county Extension Office for sand/silt/clay and/or nutrient analysis
- **Loamy soils best, but others can be used with amendments**

Soils

- What if the texture is OK, but the soil doesn't drain?
- High water table
 - Pick a different site
- 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 bioretention

- 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 and shallower, and amend with sand and some compost
- For sandy soils:
 - Amend with compost to slow down the infiltration

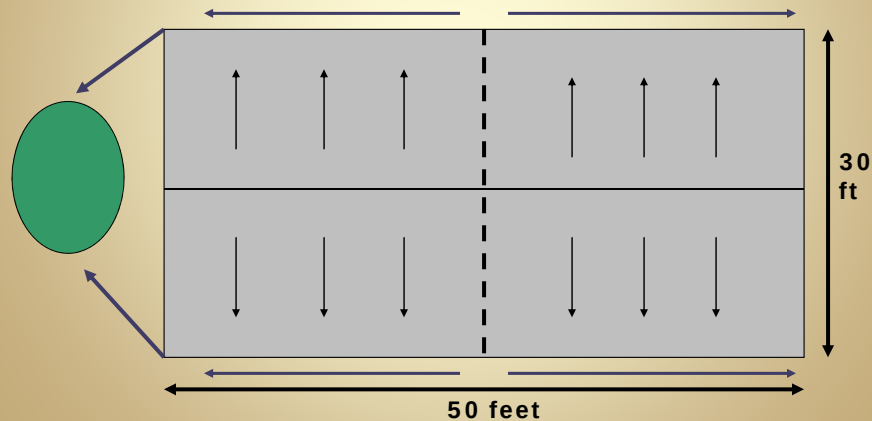
Sizing

How Big Should it Be?

- Simple method
 - Sized to store 1 inch of runoff from 100% impervious watersheds
- Bioretention Manual method
 - Based on 1 inch storage, but can be used on mixed use watersheds

Simple Sizing

- Calculate area of roof feeding to garden



Sizing, continued

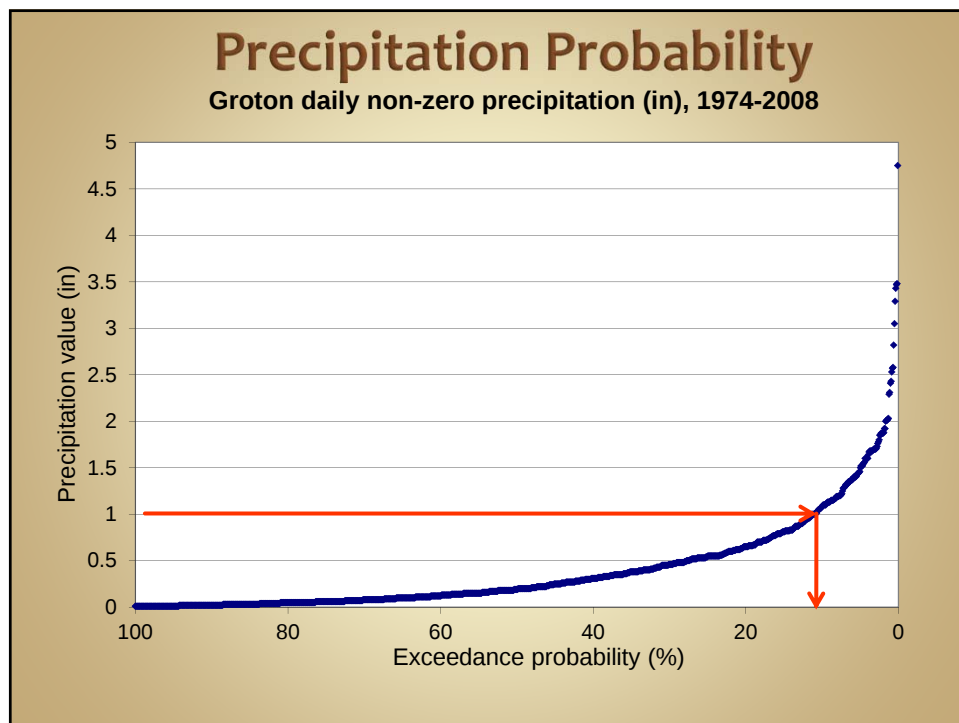
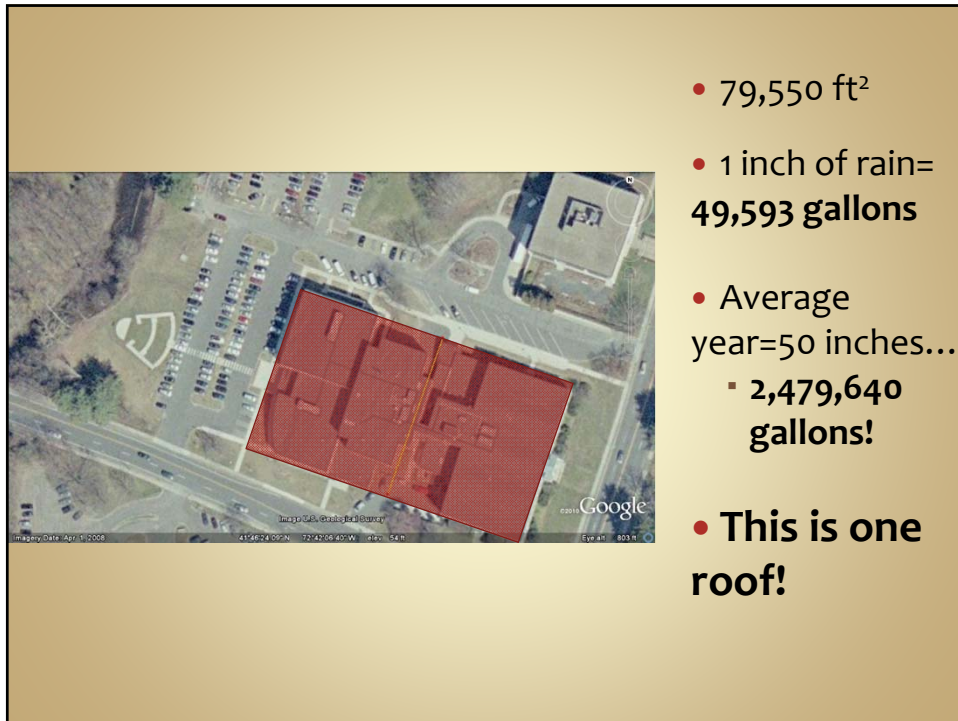
- 50 feet x 30 feet = 1500 square feet
- 1500 feet / 2 = 750 square feet
 - This is because only half the roof contributes to the garden
- 750 square feet / 6 = **125 square feet**
 - This just sizes the garden to hold 1 inch of water from the roof in a 6 inch deep rain garden

Why 1 inch?

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

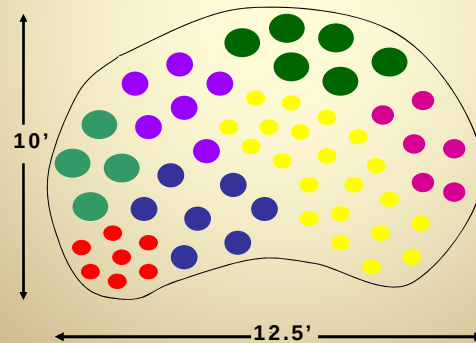
**Is it really that big of a deal ?
1 inch isn't much, right?**

Let's see how Google sees the world



Sizing, continued

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



Your turn!

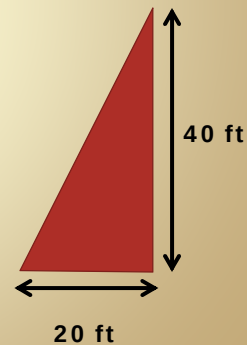
- Outside this building



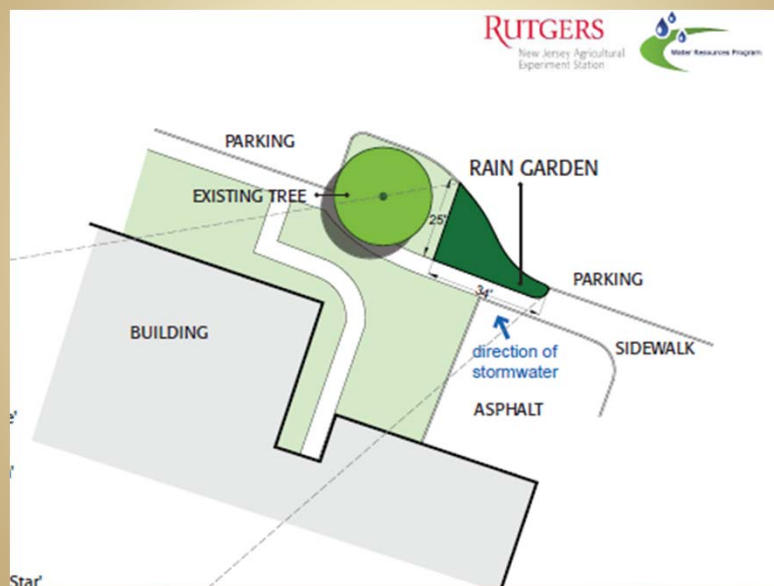
- Watershed is 100% impervious: 2394 ft²

School example

- Since watershed is 100% impervious, use simple method
- Divide total area by 6
 - Gives rain garden size, with 6" ponding depth
- $2394 \text{ ft}^2 / 6 = 399 \text{ ft}^2$ (say 400 ft^2)
- Area of a triangle?
 - $\frac{1}{2} \times \text{base} \times \text{height}$



How about 34 ft x 25 ft?

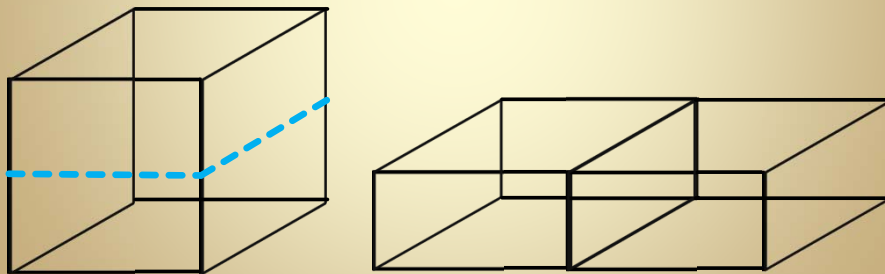


Bioretention Manual Method

- 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)

Bioretention manual method

- Gives volume in cubic feet
- For 6” ponding depth, double the size



UConn Rain Garden



A bit more complicated... (but not impossible!)

- Grass: **8694 ft²**
- Sidewalk: **1914 ft²**
- Total watershed area: **10,608 ft²**
- **Hints:**
 - Find out what percent of watershed is impervious
 - Use equation $WQ_v = [(P)(R)(A) / 12]$
 - $P = 1.0$ inch
 - $R = 0.05 + 0.009(I)$
 - $I = \text{Percent impervious (1-100)}$
 - $A = \text{Total watershed area (square feet)}$
 - Convert to square feet, 6 inches deep

Solution

- Grass: **8694 ft²**
- Sidewalk: **1914 ft²**
- Total watershed area: **10,608 ft²**
- Percent impervious:
 - $(1914 \text{ ft}^2 / 10,608 \text{ ft}^2) * 100 = 18\%$, so $I=18$
- $P=1.0$ inch
- $R=0.05 + [0.009 \times (18)] = 0.212$
- $WQ_v = (1 \times 0.212 \times 10,608) / 12 = 0$
- 187 ft² (12 inches deep)
- Multiply by 2 (for 6 inches deep) = **375 ft²**

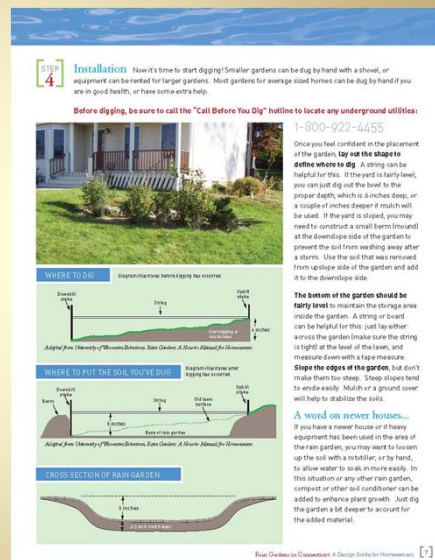
Let's get digging!

Installation

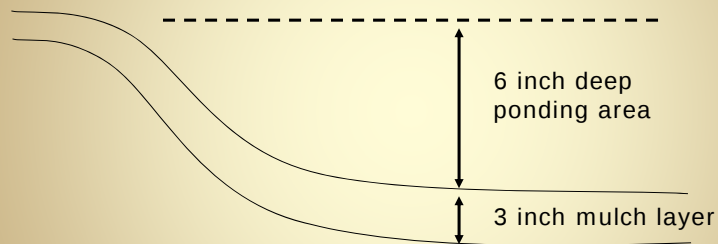
- Call hotline to locate underground utilities (at least 2 days in advance) **1-800-922-4455 or 811**
- Mark area to be dug
- Smaller gardens can be dug by hand (**friends+beer=rain garden**), or equipment can be rented for larger gardens

Installation, continued

- Dig out 8-9 inches of soil, keeping the bottom fairly level
 - A string or board can be used as a guide
 - Berm the bottom end, if necessary
 - Provide a gradual slope to the sides
 - Typical ponding depth is **4-8 inches** (aim for 6 inches)



Depth



Installation by hand (18 hands!)



Bioretention excavation

- Avoid compaction/sealing of bottom with bucket



Foot traffic only



Erosion

- Don't allow runoff from an open, unstabilized construction site to enter the garden
 - Surface of bioretention will become clogged



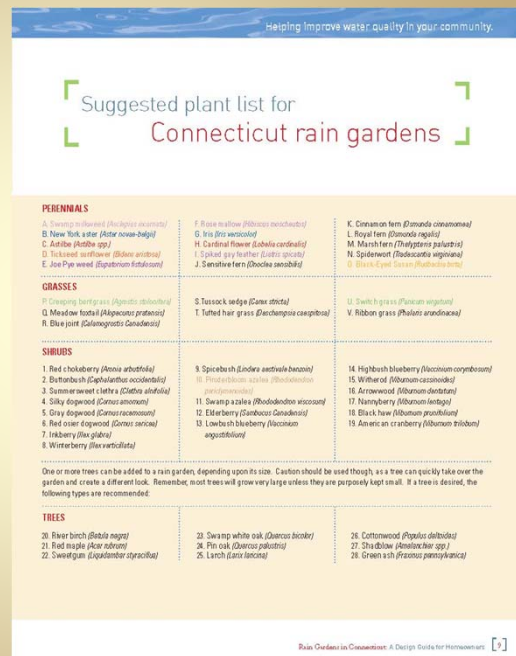
Important factors with bioretention

- Make sure storage depth is correct at installation



Planting

- See the UConn or Rutgers publications for plants to use in this area



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



A well-installed bioretention area...



- ✓ 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



References of interest:

NEMO

- <http://www.nemo.uconn.edu>

Low Impact Development

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

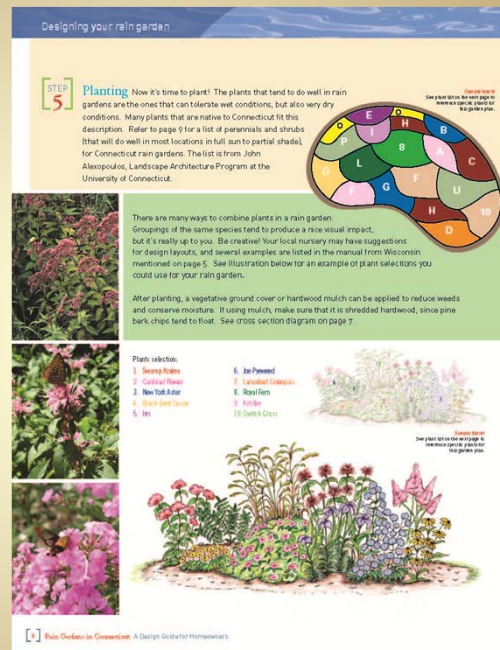
GreenScapes New England-

- <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 layouts



Step 6: Maintenance

- Similar to other landscaped areas
 - Yearly mulch, if desired
 - Prune plants, if desired
 - Irrigate/water as necessary
- Sediment removal if required
- **MOST IMPORTANTLY:** Maintain flow paths and storage area

Rain gardens are easier



Maintenance (bioretention)

- Flow paths and storage
- Watch for sediment accumulation



Branford Police Station



More excess mulch...



Flow paths and erosion





Any questions?