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Rainwater Harvesting as Stormwater Mitigation

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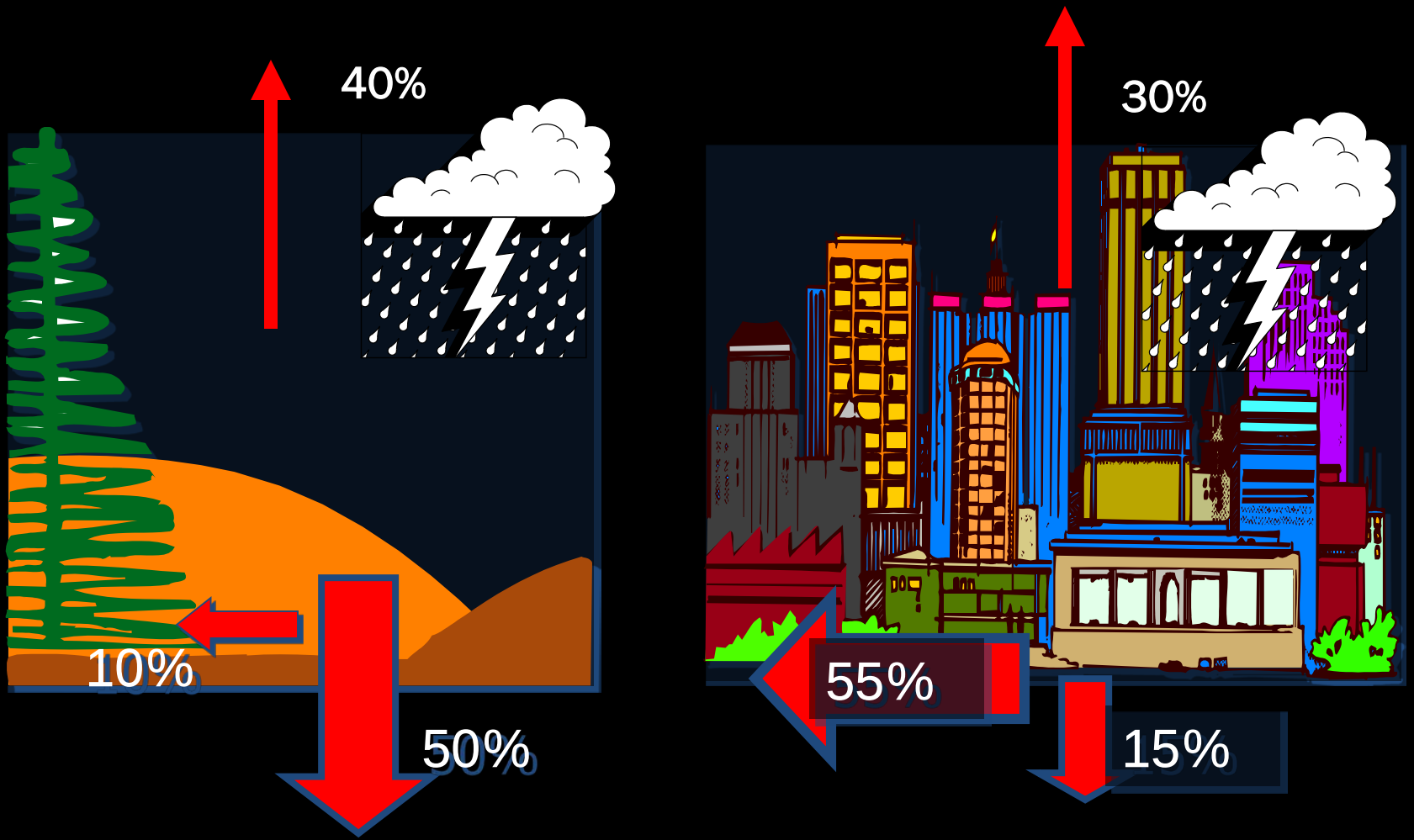
Stormwater Mitigation Practices

- Landscape Water Conservation
- Rainwater Harvesting
- Rain Garden
- Pervious Pavement
- Green Roof
- Green Wall

Rainwater Harvesting

- Rainwater Harvesting is the process of capturing, diverting, and storing rainwater for future use or release
- Conservation
  - Reduces demand on municipal water supply
  - Irrigation
- Stormwater Management
  - Reduces flooding, erosion, and contamination of surface water

Development Impacts On the Water Cycle



Development Impacts On the Water Quality

Increased Quantity

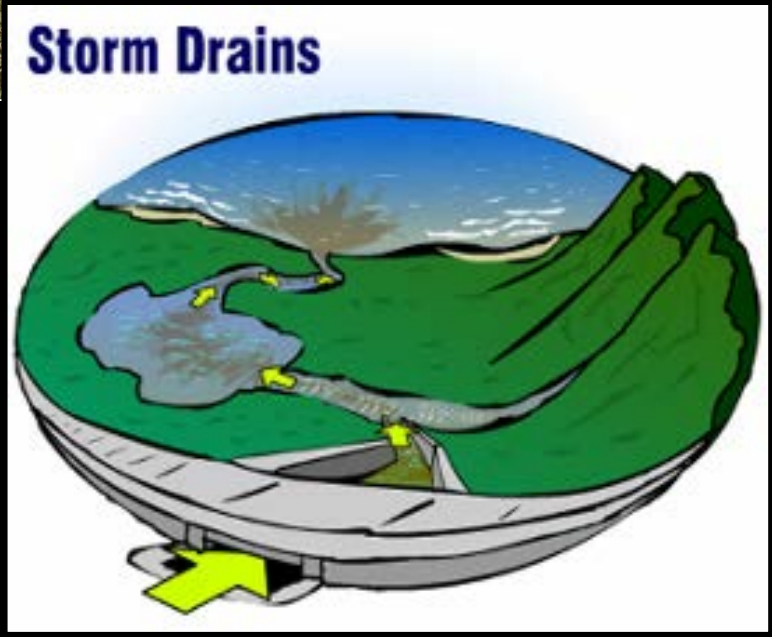
Decreased Quality

Greater Speed

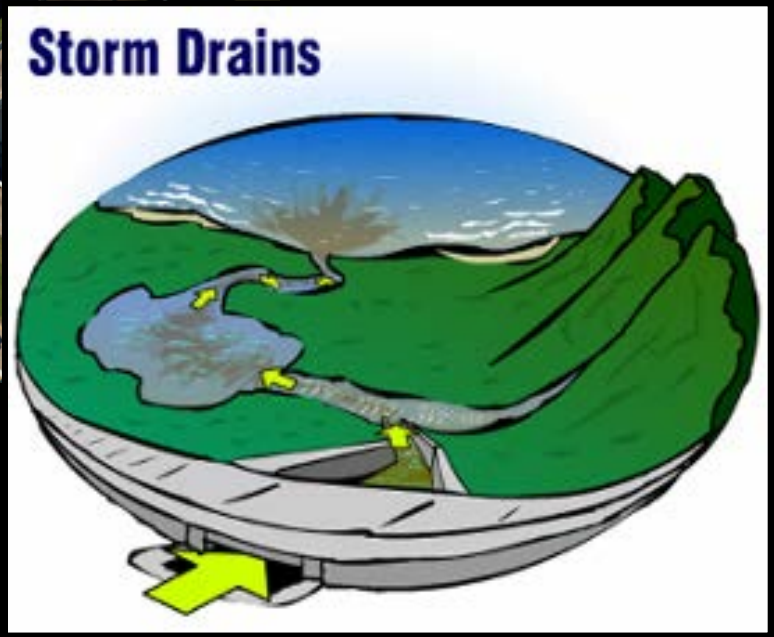
- Fertilizer
- Pesticides
- Pet Waste
- Sediments
- Toxic Contaminants
- Debris
- Thermal Stress


Agriculture Pollution
Polluted water


Construction Pollution
Polluted Water


Storm Drains

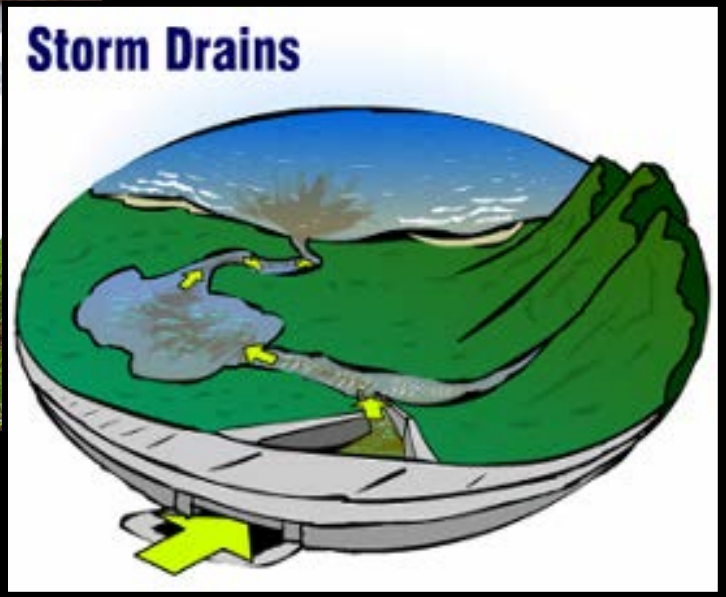

Urban Pollution
Polluted Water


Storm Drains


Residential Pollution
Polluted water


PET WASTE STATION
PLEASE CLEAN UP AFTER YOUR PET
Dog Waste Bags


Agri-Fab


Storm Drains

Incentives

- Environmental Stewardship
- Sustainability
- Many municipalities with stormwater utility fees offer a monetary credit for the correct installation and maintenance of a rain garden and/or rainwater harvesting system

Rainwater Harvesting

- Irrigation
- Stormwater Mitigation

Rain Garden
Bio- retention, Bio-swale

- Stormwater Management
- Mosquito Control
- Beautification

What is a Rain Garden?

- Beautiful landscape feature used to collect and filter stormwater
- Use to prevent non-point source water contamination

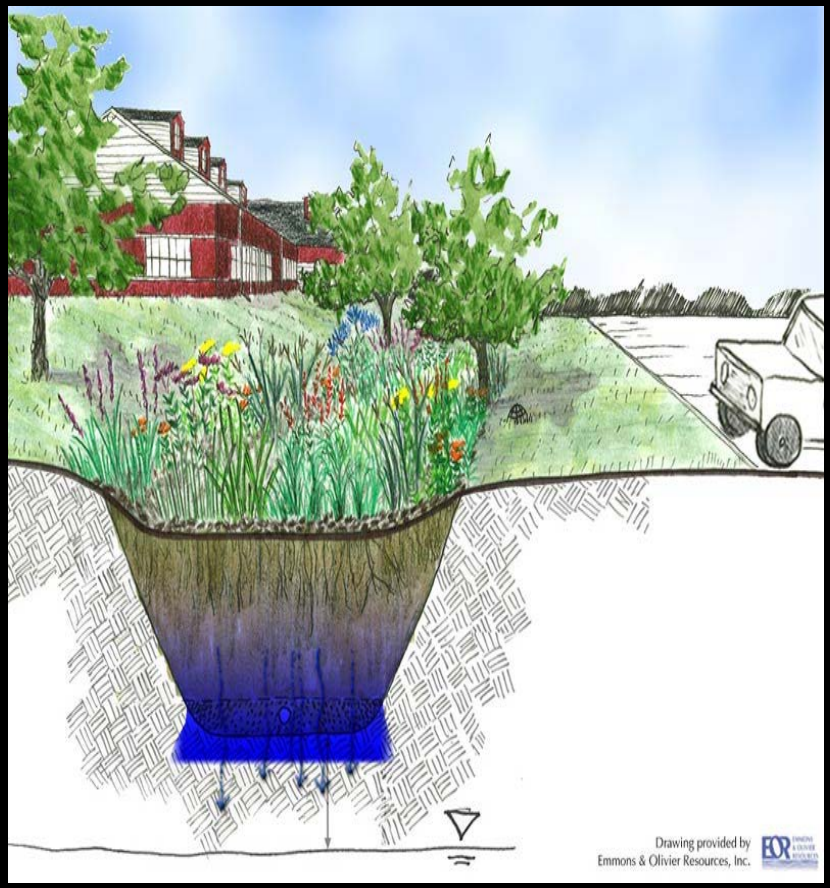
Not a Rain Garden

Why Consider Rain Gardens?

- Mimic pre-development hydrology
- Reduce runoff erosion, volume and speed
- Preserve/restore biodiversity
- Create wildlife habitat
- Aesthetics/Beautiful
- Cost-effective
- Design flexibility allows diverse use
- Capable of being retrofit to existing sites

How Does a Rain Garden Work?

- Settling
- Chemical reaction in soil
- Biological degradation of stormwater pollution in root zone
- Plant uptake
- Evaporation

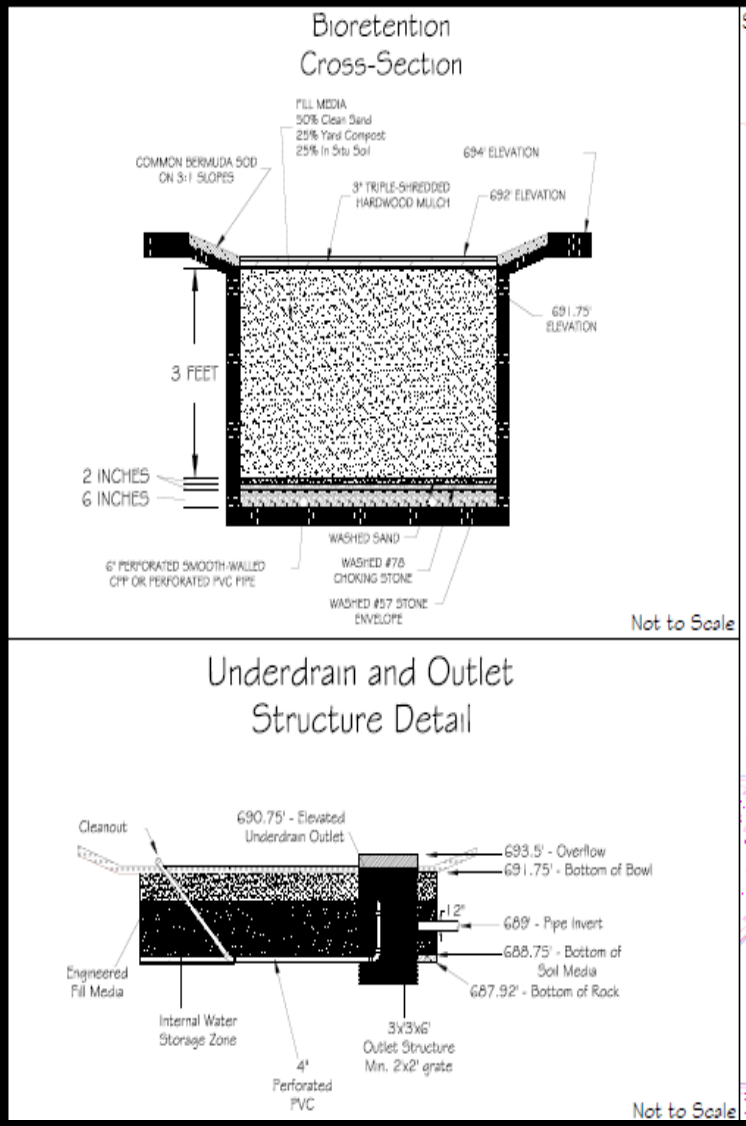


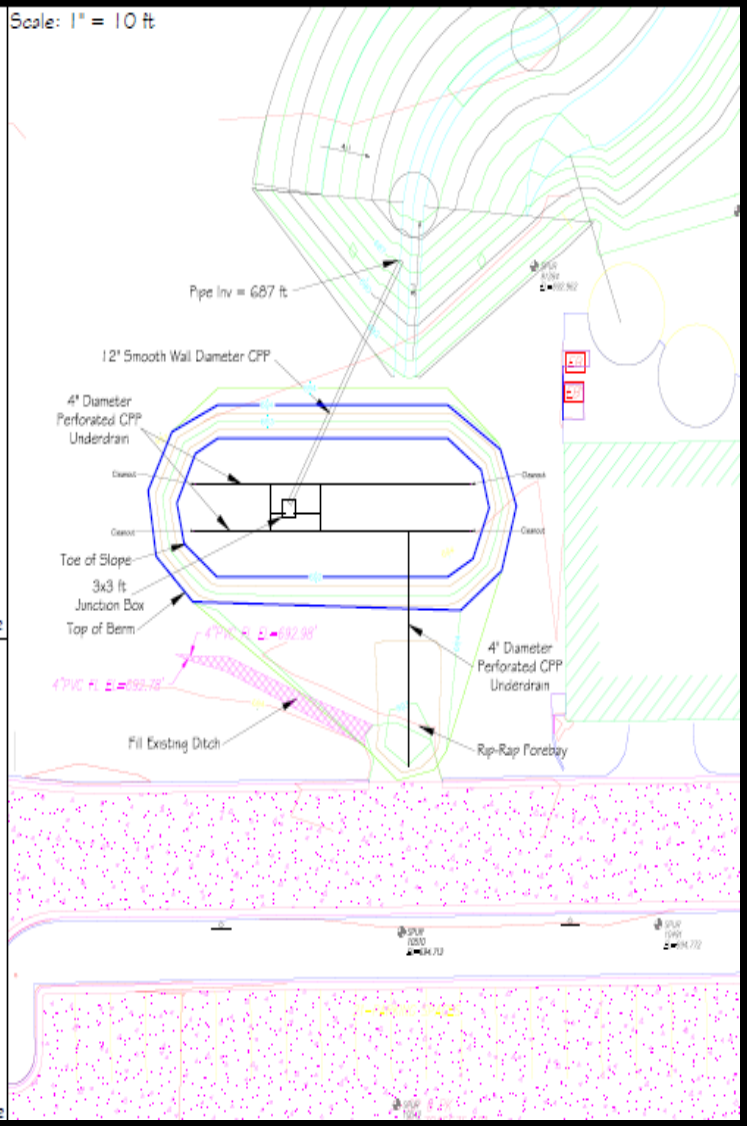
Bioretention Design

Texas A&M Research and Extension Center - Dallas

- Collected from 37,000 square foot parking lot
- Include Internal Water Storage (IWS)
- Total Media Depth was 4 feet with 1.75 feet ponding depth
- Media: 25% yard waste compost, 50% sand, 25% native soil
- Planted with native plants
- 4 inch perforated pipe at bottom

Bioretention Area





Rain Garden At Texas A&M Research and Extension Center Dallas

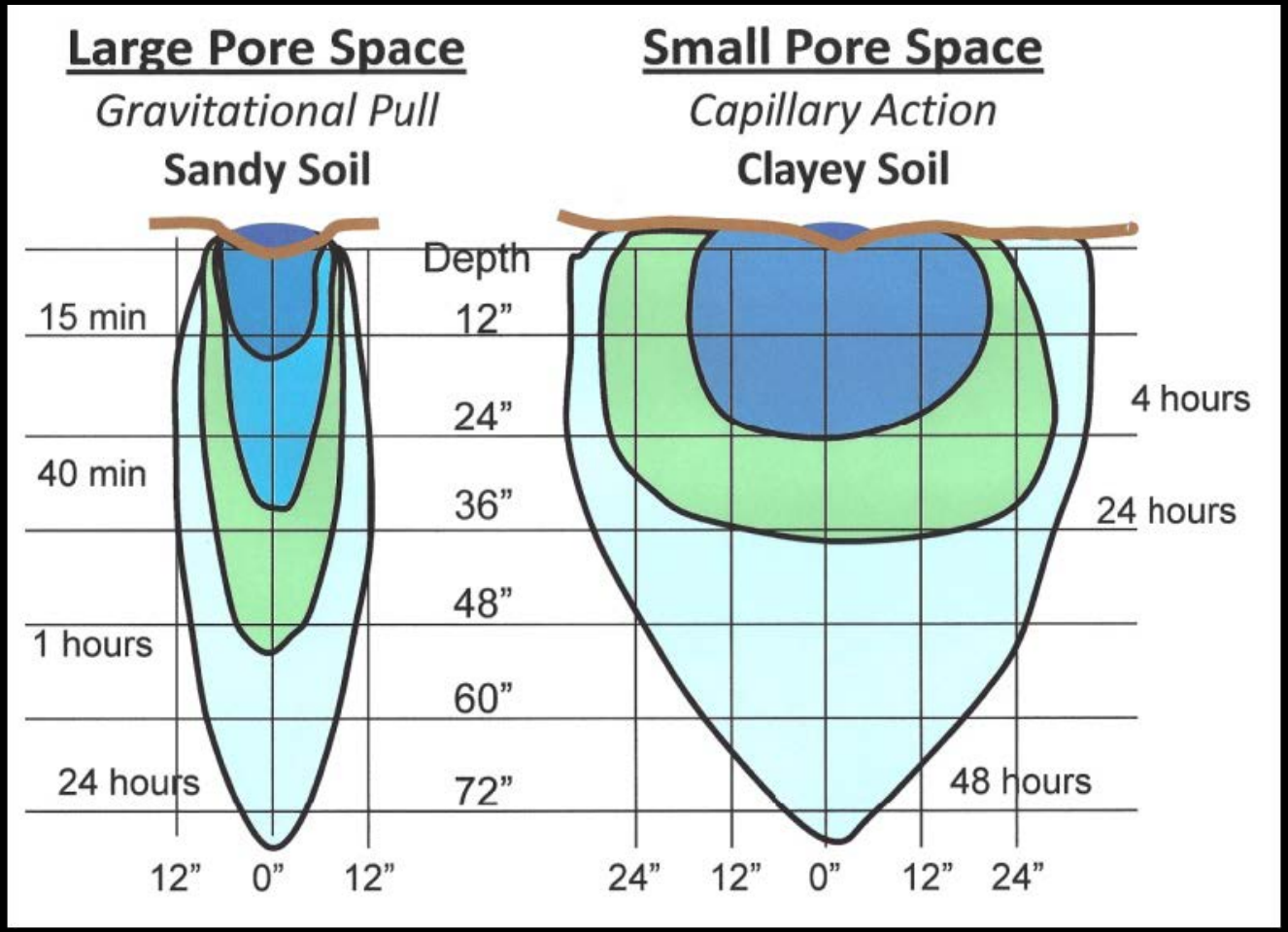
Volume Reduction

Date	Rainfall (in)	Inflow (gallons)	Outflow (gallons)	Reduction (%)
4/11/2013	0.46	2608	1271	51.26%
4/18/2013	0.87	9148	4458	51.26%
5/10/2013	0.25	451	220	51.26%
5/16/2013	1.96	31146	15179	51.26%
5/22/2013	0.89	9510	4635	51.26%
6/7/2013	0.45	2479	527.57	78.72%
6/10/2013	1.08	13068	11185	14.41%
6/17/2013	0.67	5710	2342	58.98%
7/11/2013	0.72	6534	3849	41.10%
7/17/2013	1.12	13841	2091	84.89%
7/19/2013	0.37	2904	1710	41.11%
Total		**44536**	**21704.57**	**51.26%**

Contamination Reduction

Contaminant	Inflow (lbs)	Outflow (lbs)	% reduction
NO3	94070	20268	**78%**
NH4	15102	5192	**66%**
TKN	177932	63353	**64%**
Orthophosphate	3190	2056	**36%**
Total Phosphorus	9082	5320	**41%**
TSS	2020645	341401	**83%**

Infiltration/Percolation Rates



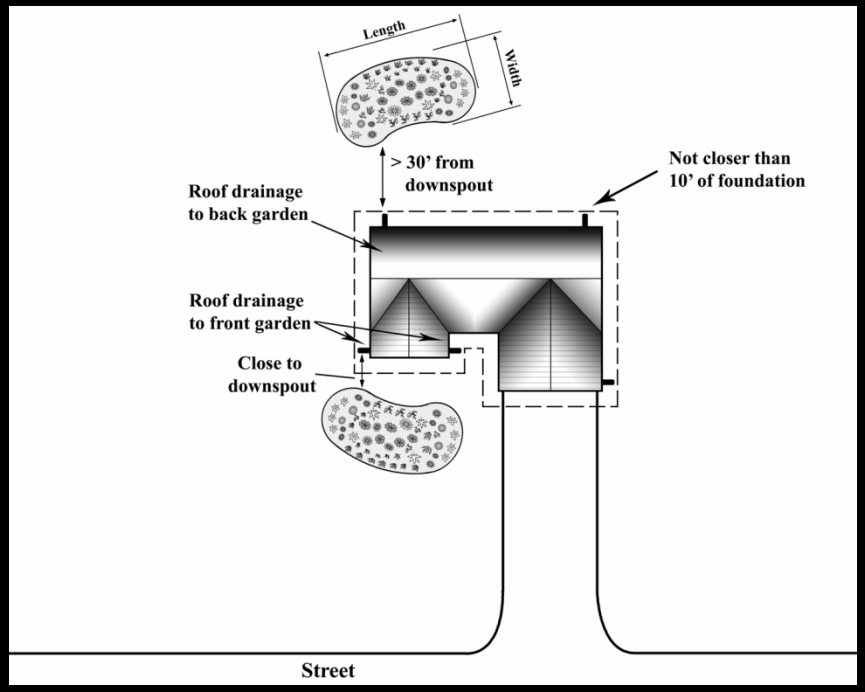
Perk Test

- Soil Type
  - Clay
  - Silt
  - Sand
- Soil Texture
- Plant Roots

Large Rain Garden

Is a Rain Garden Feasible?

- Utilizes existing guttering and downspouts, natural runoff from road or other landscapes
- Materials
  - Shovel, rake, carpenters level, stakes, string
- Gravity fed system
  - No pumps or electricity required



Rain Garden Location Considerations

- Slope less than 12%
- At least 10 Feet from foundation
- Distance from downspout
- Catchment area
- Sun exposure

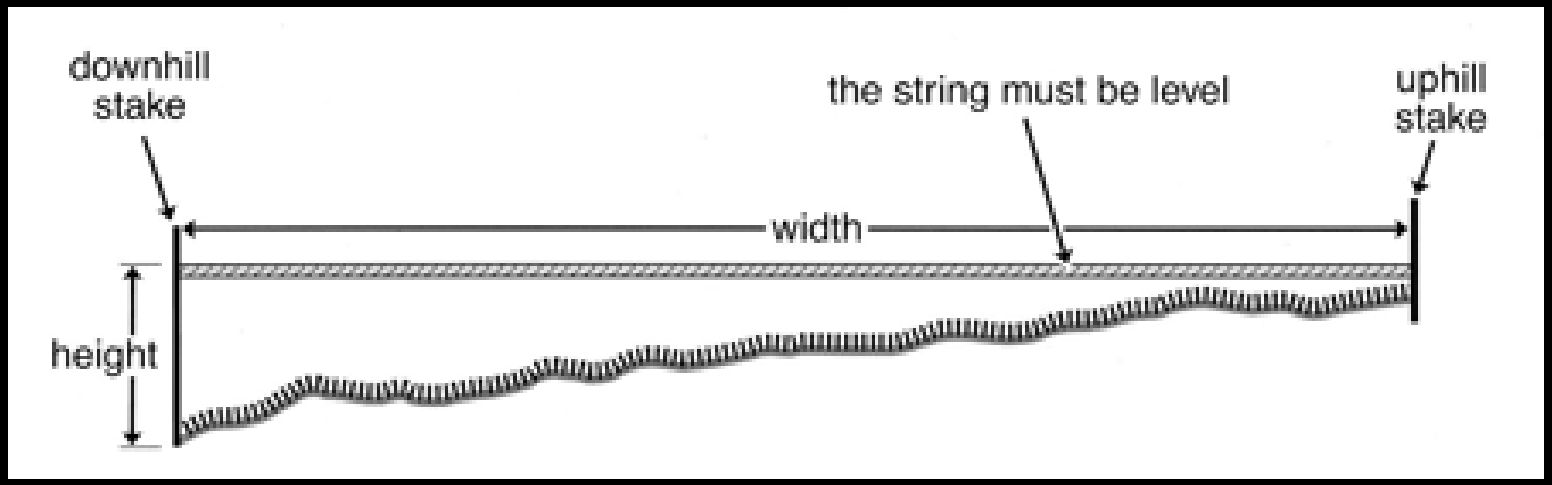
Sq Ft X rainfall X 0.623 = gallons

7.48 gallons= 1 cubic foot

Size Considerations

- Slope
- Watershed
- Soil Type and Infiltration
- Recommended design depths for selected slopes/location/desired look
- Determine Rain Garden depth
- Determine Rain Garden Surface area

How to Measure Slope



- % Slope = height/width X 100

Residential Rain Garden – Slope vs. Depth

- Slope
  - Recommended design depths for selected slopes to minimizes effort

% Slope	Depth (in)
< or = to 4%	3-5
5-7%	6-7
8-12%	8

Recommended design depths for selected slopes to facilitate easiest construction. (Bannerman et al., 2003)

Size of Drainage Area

- Rooftop: Width x Depth.
- If 1 downspout used, divide by number of downspouts. Include yard area between house and rain garden
- Large impervious areas (e.g. parking lots) require surveying; seek professional help if pipe inflow needed

Rule of Thumb:

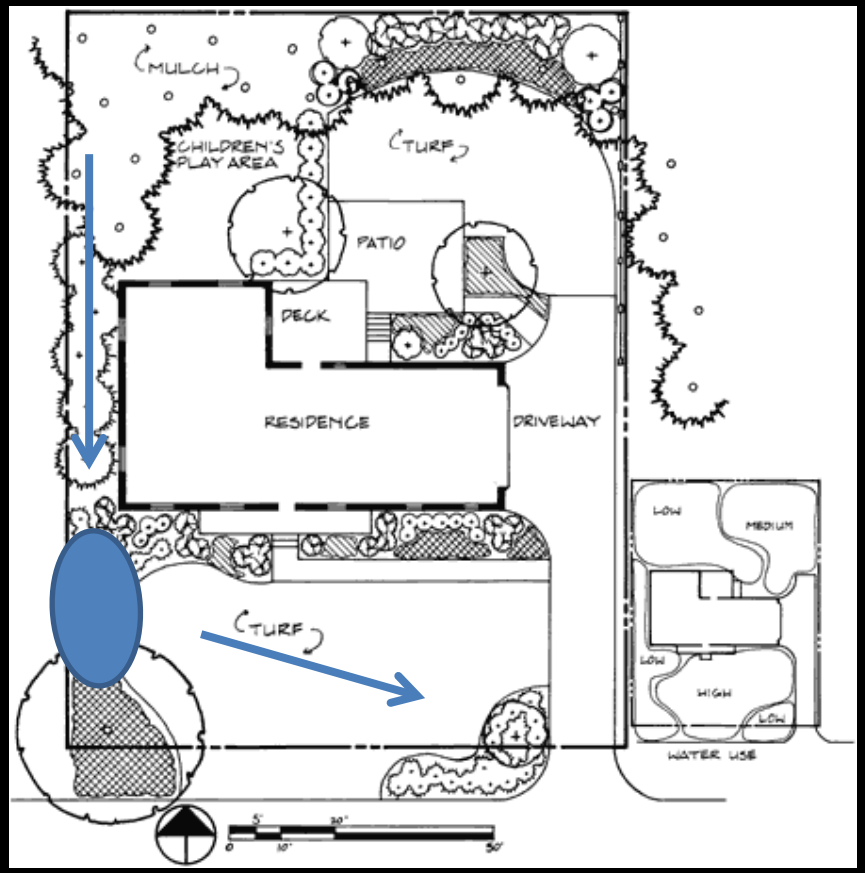
1 square inch of downspout
drains
100 square feet of roof top

2 inch by 3 inch downspout =
600 square feet of roof top
600 X 0.623 = 374 gallons

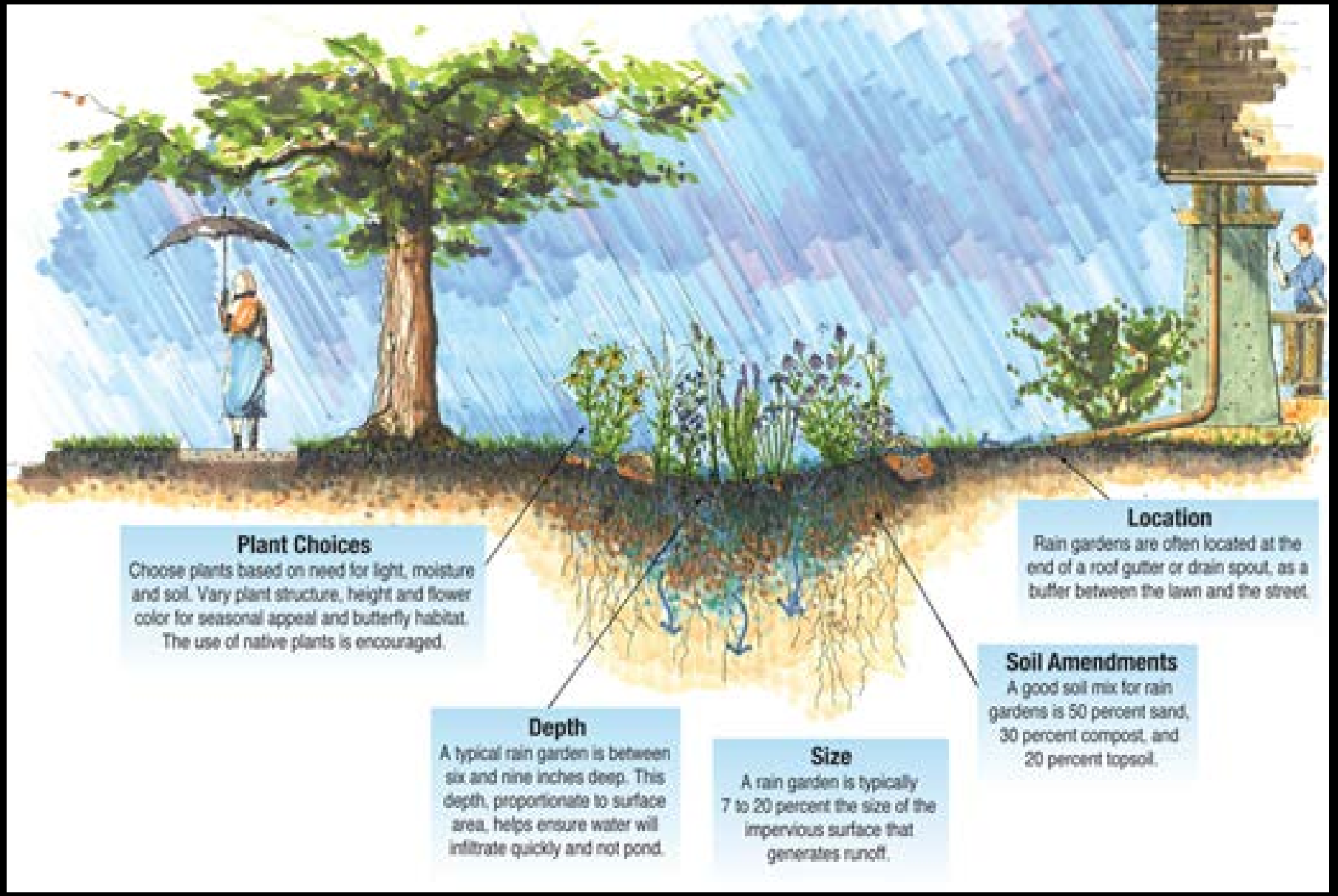
3 inch by 4 inch downspout =
1,200 square feet of roof top
1,200 X 0.623 = 720

Rain Garden Considerations

- Catchment area
  - Determine catchment area
  - Footprint of roof/parking/sidewalk/driveway and any area of lawn between the downspout and the rain garden



Between Neighbors


Plant Choices
Choose plants based on need for light, moisture and soil. Vary plant structure, height and flower color for seasonal appeal and butterfly habitat. The use of native plants is encouraged.
Depth
A typical rain garden is between six and nine inches deep. This depth, proportionate to surface area, helps ensure water will infiltrate quickly and not pond.
Size
A rain garden is typically 7 to 20 percent the size of the impervious surface that generates runoff.
Soil Amendments
A good soil mix for rain gardens is 50 percent sand, 30 percent compost, and 20 percent topsoil.
Location
Rain gardens are often located at the end of a roof gutter or drain spout, as a buffer between the lawn and the street.

Shade Rain Garden

Sunny Rain Garden

Rain Garden Collects Stormwater off Roof and Parking Lot

Rain Garden Considerations

- Sizing factor (Fraction of watershed)
  - Sizing factor for rain gardens less than 30 feet from a downspout.

	3-5 in. deep	6-7 in. deep	8 in. deep
Sandy soil	0.19	0.15	0.08
Silty Soil	0.34	0.25	0.16
Clayey soil	0.43	0.32	0.20

Sizing Factors for Raingardens Less Than 30 Feet from a Downspout (Bannerman et al.,2003).

Sizing Factor

- Sizing factor
  - Sizing factor for rain gardens more than 30 feet from a downspout.

	Size Factor, for all depths
Sandy Soil	0.03
Silty Soil	0.06
Clayey soil	0.10

Sizing Factors for Raingardens More Than 30 Feet from a Downspout (Bannerman et al.,2003).

Determining Size of Rain Garden

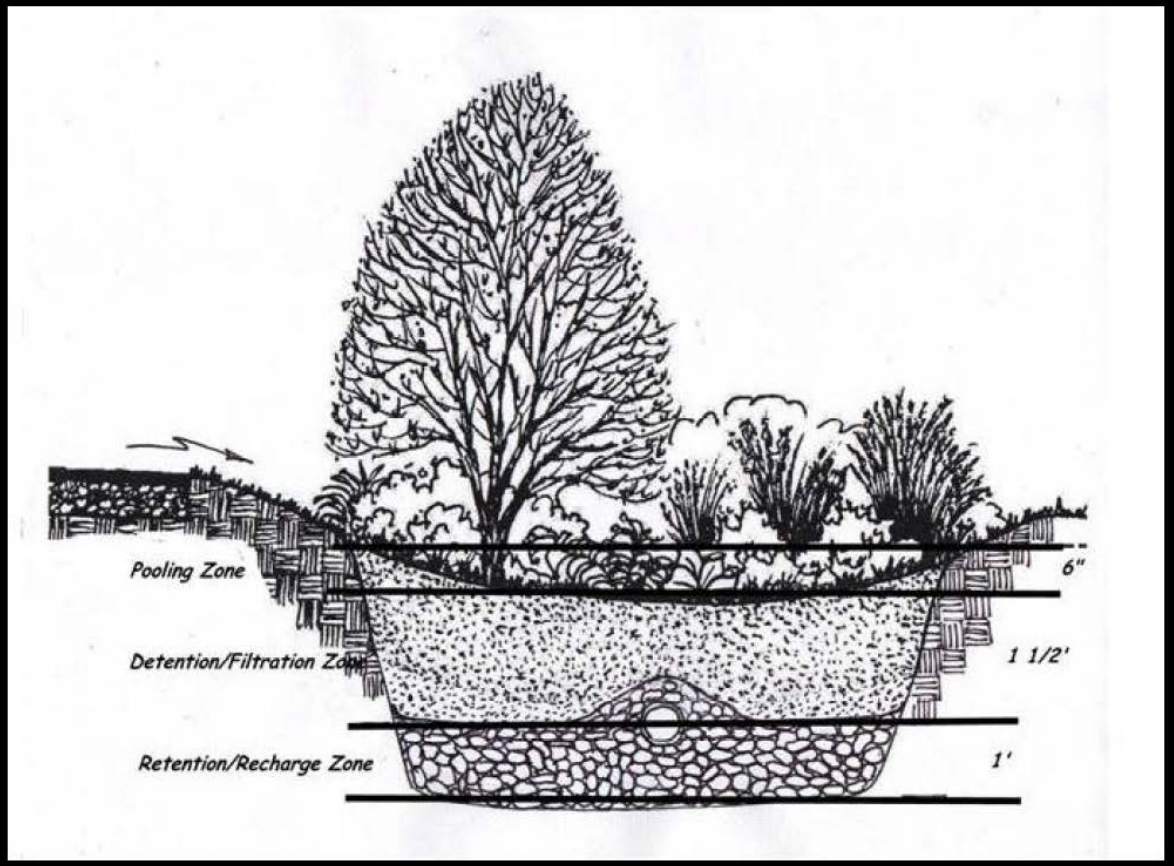
- Multiply the size factor from the previous tables by the catchment area based on soil type and desired depth
- This number is the recommended rain garden surface area
- If area is greater than 300 ft^2 then it may be best to divide into multiple gardens

Determine Size and Shape

- Typically rain gardens are designed in a 2 to 1 length to width ratio
- Sizes, shapes, and orientations vary based on site
- High spots in the garden will cause water to pond and not allow even infiltration

Commercial Rain Garden's Depth

- If drainage area is large and underlain by clay soils, depth 3 feet. Must hold 7-12" of water.



Commercial Rain Garden Sizing

- For example, 0.75 inch = 53700 gals of runoff off 110769 square feet
- 12” of water retained in rain garden
- Surface area of rain garden:

Surface Area = Volume ÷ (max water depth)

Surface Area = 53700 ÷ (12 x 0.623) =7200 ft^2

- This equivalent to 6.5% of the total drainage area

Small Area Rain Garden

Native Plant Rain Garden

EPA National Headquarters
Washington, DC

Menard Elementary School

Construction

- Key to the success and long term operation of the system
- Soil Compaction
  - Compacted soil has a low infiltration rate
  - Aeration or loosening of the soil may be needed
- Berm
  - Utilize as much of the soil from the garden (particularly clay)
  - If no clay soil, have some delivered
  - Compact soil in the berm
  - Gentle slopes

Rain Garden on 3 Acres

Top Soil Mix

- Typical soil mix ratios vary based on your native soil:
  - Silt-Clay
    - 25% expanded shale;
    - 50% yard waste compost ; and
    - 25% silt and clay (native soil).
  - Sand- Sand loams
    - 75% native soil
    - 25% compost

Overflow Structure

- If the rainfall rate exceeds the infiltration rate of the growing media, the rain garden may overflow

Construction


27 9:26

Plant Selection

- Plants will tolerate temporary wet roots
- Native or adapted
- No problems with cotton root rot or other soil borne diseases

Plants


ASTERS
Goldenrod

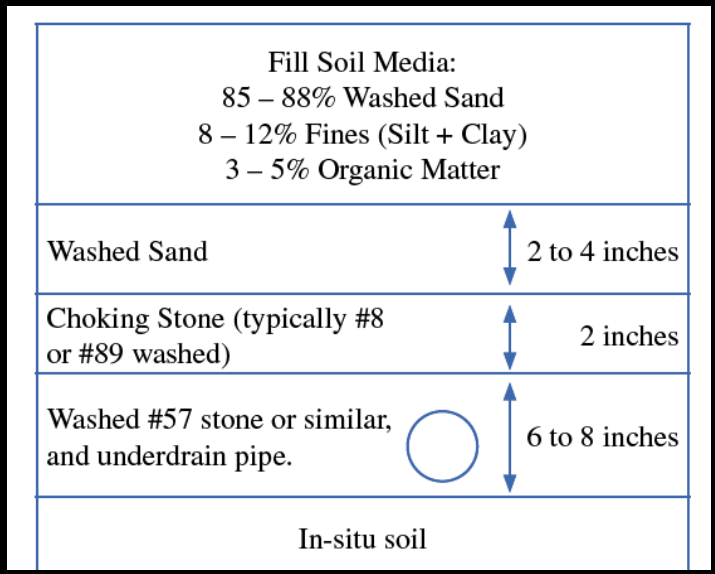

Beebalm

Key Maintenance Test

- Visit site within 24 hours of 1 inch rain event (avg 11-12 /yr)
- If water is still ponded site has clogged
- Action needed
- Do this once or twice per year

Underdrain Maintenance

- Surprisingly uncommon
- Clogging potential: filter fabric vs choking stone
- Cleanouts make it easy



Underdrain Cleanouts

Bad

Better

Mulching: Benefits

- Prevents weeds from sprouting
- Adds organic matter, active zone for microorganisms
- Conserves moisture during dry periods
- Cools soil
- Attractive

Bioretention Maintenance Task Schedule

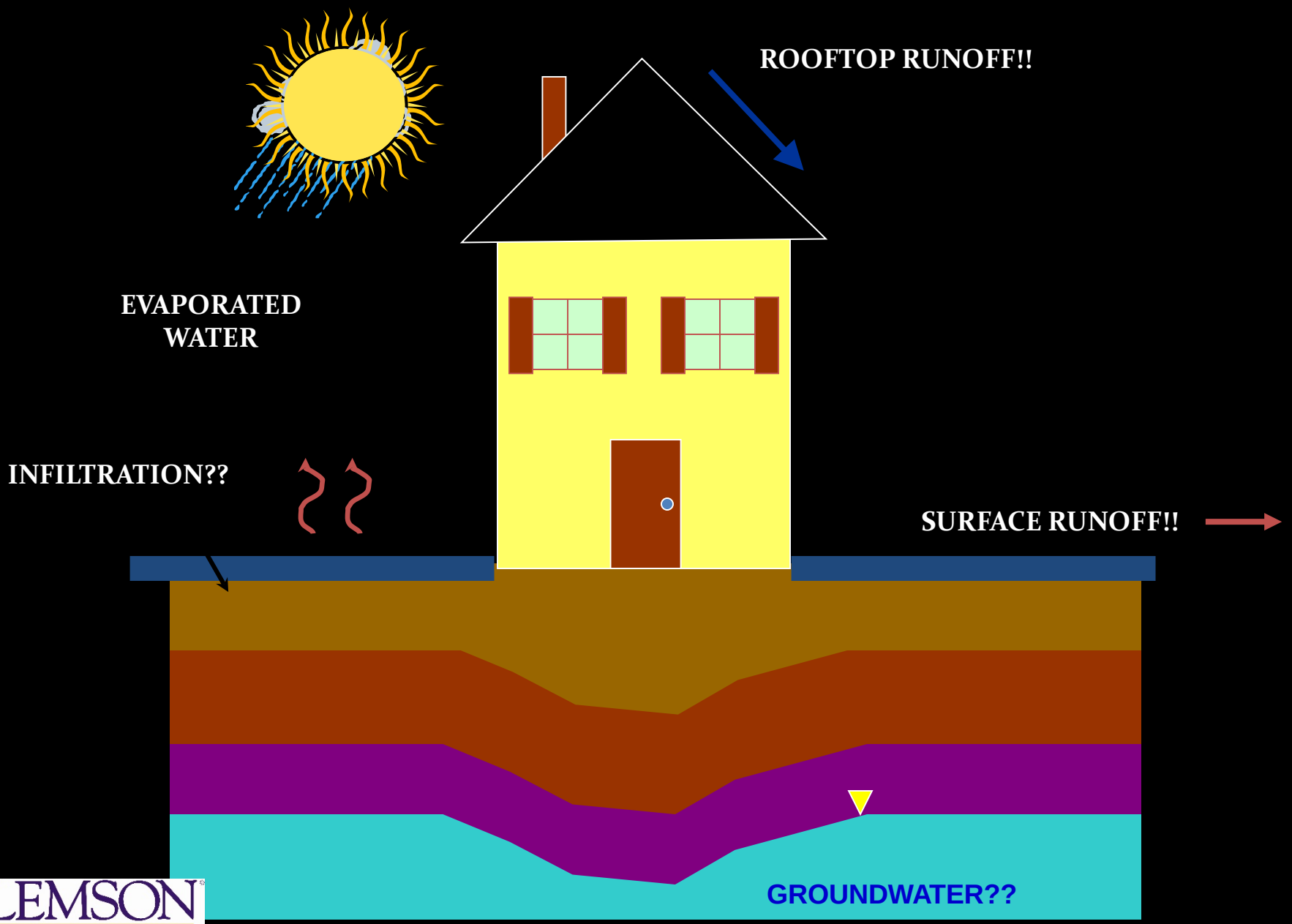
Task	Frequency	Maintenance Notes
PRUNING	1 – 2 times/yr	Nutrients in runoff often cause bioretention vegetation to flourish
MOWING	2 – 12 times/yr	Frequency depends upon location and desired aesthetic appeal
MULCH REMOVAL	Once every 2 – 3yrs	Mulch accumulation reduces available water storage volume. Removal of mulch also increases infil. rate
WATERING	Once every 2 -3 days for first few months. Seldom after establishment	During droughts, watering after initial year may be needed
FERTILIZATION	Once initially	
REMOVE AND REPLACE DEAD PLANTS	Once per year	>10% of plants may die, survival rates increase over time
MISCELLANEOUS	Monthly	Trash collection, spot weeding, removing mulch from overflow

Cost

Activity/Material	Unit	Unit cost
Contractual/Services		
~~Excavation/Hauling~~	~~Cubic yard~~	~~$3.50~~
New soil import and installation	Cubic foot	$.5
Gravel import and installation	Cubic foot	$.5
Filter fabric	Square foot	$.5
Mulch	Square foot	$0.5
Perforated pipe	Linear foot	$2
Overflow drop box	1 box	$50
Plants	Square foot	$2

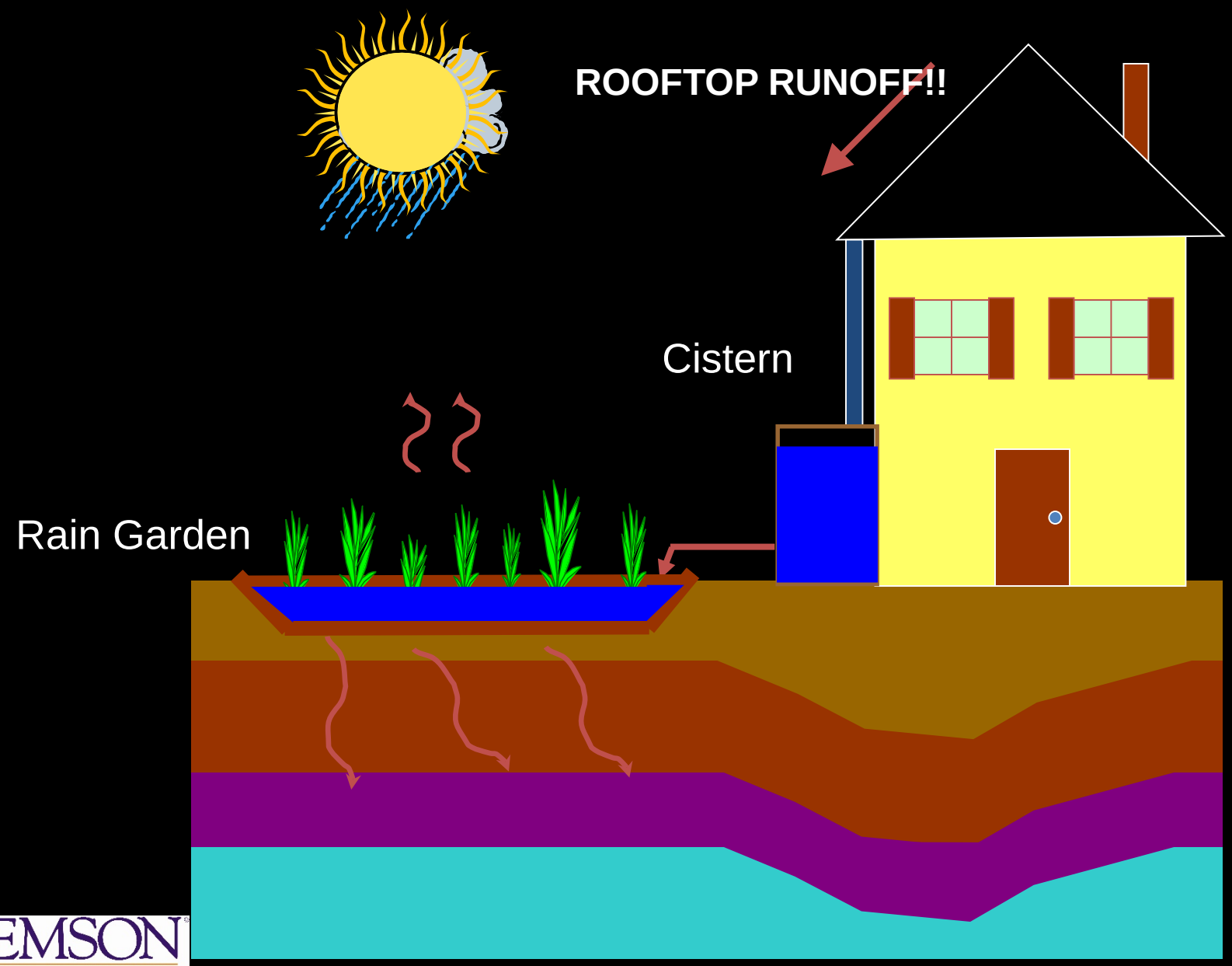
- Estimated cost per square foot: $3-6
- Estimated size of rain garden: 6-10% of catchment area

Urban Water Budget – Pavement and Rooftop Scenario



CLEMSON PUBLIC SERVICE

Urban Water Budget – Rainwater Harvesting Scenario



Web Site Information

- **www.rainwaterharvesting.tamu.edu**
- **www.arcsa.org**
- **www.texrca.org**

Resources

- http://chesapeakestormwater.net/
- http://extension.oregonstate.edu/stormwater/choose-right-rain-garden
- http://city.milwaukee.gov/sustainability/City-Operations/Stormwater.htm#.V-QizE_rvIU

Questions?

Presentation is based on

Stormwater Management: Rain Gardens

AgriLife Bookstore #B-6247

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