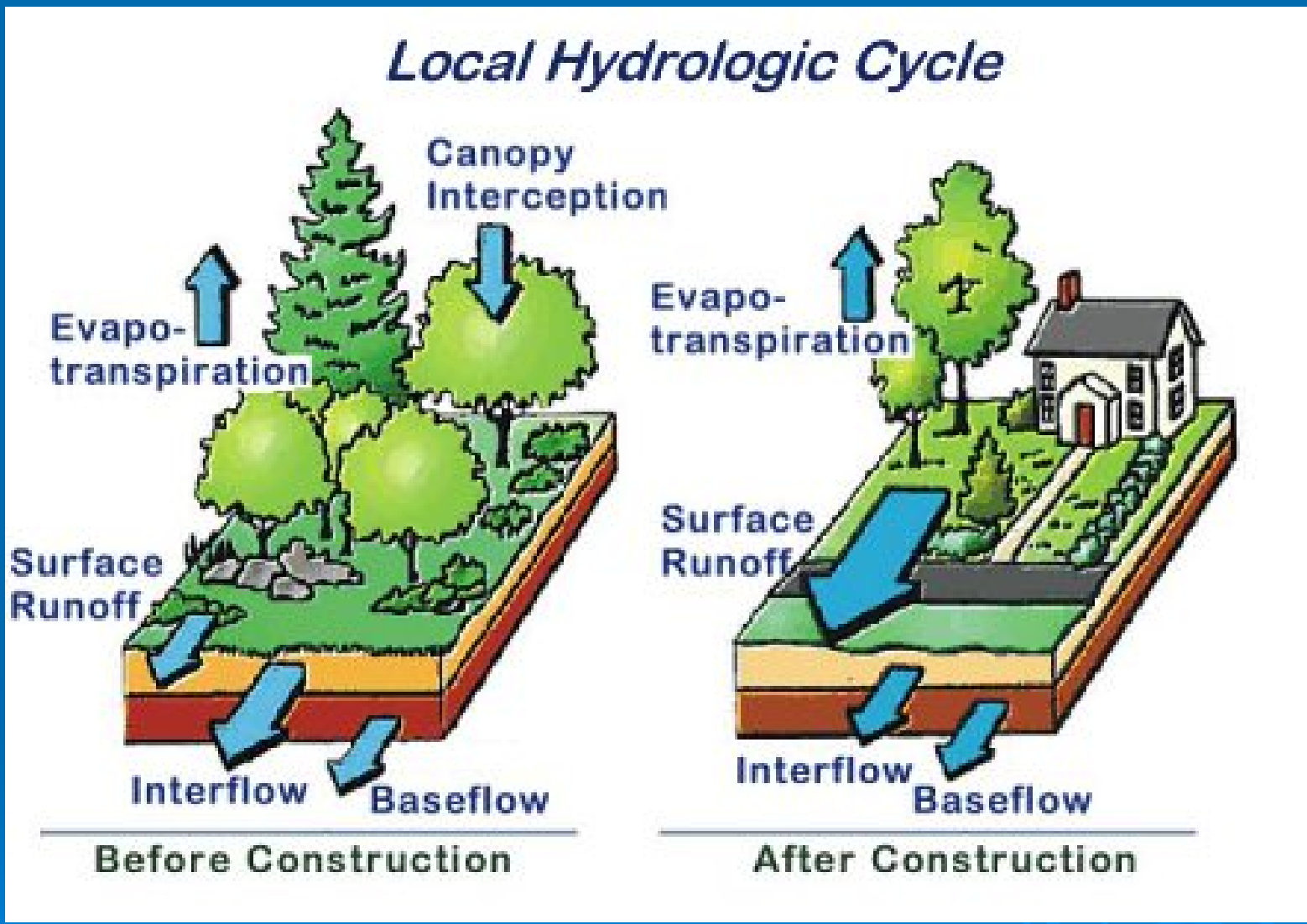
Design of Rain Gardens and Bioretention Systems


Local Hydrologic Cycle
Canopy Interception
Evapo-transpiration
Surface Runoff
Interflow
Baseflow
Before Construction
Evapo-transpiration
Surface Runoff
Interflow
Baseflow
After Construction

SOURCE: ADAPTED FROM PRINCE GEORGE'S COUNTY - DESIGN MANUAL FOR THE USE OF BIORETENTION IN STORMWATER MANAGEMENT, 1993

Site Selection

Contributing Drainage Area

- Up to 5 acres
- One acre or less preferred
- Can be used in any soil type

Sizing Criteria

Size is based on the contributing drainage area, amount of imperviousness and soil type.

Raingarden Sizing Criteria

Rain gardens less than 30 feet from downspout

	3-5 inch deep	6-7 inch deep	8 inch deep
Sandy Soil	0.19	0.15	0.08
Silty Soil	0.34	0.25	0.16
Clayey Soil	0.43	0.32	0.2

Rain gardens greater than 30 feet from downspout

	3-5 inch deep
Sandy Soil	0.19
Silty Soil	0.34
Clayey Soil	0.43

Water depth based on ground slope.
Ground Slope <4%, depth = 3-5 ft
Ground Slope 5 – 7%, depth = 6-7 inches
Ground Slope 8-12%, depth = 8 inches

Contributing Drainage Area X size factor = Rain garden surface area

Bannerman, Roger and Ellen Considine. 2003. Rain Gardens A How to Manual for Homeowners

Bioretention Sizing Criteria

Rain Garden Surface Area (A_f)

$A_f = WQV * (d_f)/k*(h+ d_f)(t_f)$

$WQV = rainfall * R_v$

$R_v = 0.05 + 0.009$ (% imperviousness)

A_f = Drainage Area * 5% * R_v

Treatment Train

Construction Cost Comparison

Patuxent Riding		
	Conventional	Low Impact
Grading /Roads	$ 569,698	$ 426,575
StormDrains	$ 225,721	$ 132,558
SWM Pond / Fees	$ 260,858	$ 10,530
Bioretention / Micro	$ -	$ 175,000
Total	$ 1,086,277	$ 744,663
Unit Cost	$ 14,679	$ 9,193
Lot Yeild	74	81

Maintenance

Immediately After construction

- Visually inspect basin after significant rain events for signs of erosion. Repair any erosion that develops.
- Visually inspect basin after significant rain events for loss of mulch in flow paths. Replace any mulch lost.
- Water plants every day there is no rainfall for 14 days after planting.
- Remove or replace any plantings that do not take hold.

Maintenance

Routine Maintenance

- Inspect for signs of erosion several times throughout the year.
- Replace mulch at least once per year. Twice per year is recommended.
- Identify dead or diseased plants and replace.
- Prune woody vegetation annually to provide for healthy vegetation and conform to adjacent uses (parking, electric wires, recreation uses, etc.
- Inspect the inflow location twice per year for signs of any blockage or buildup.

Maintenance

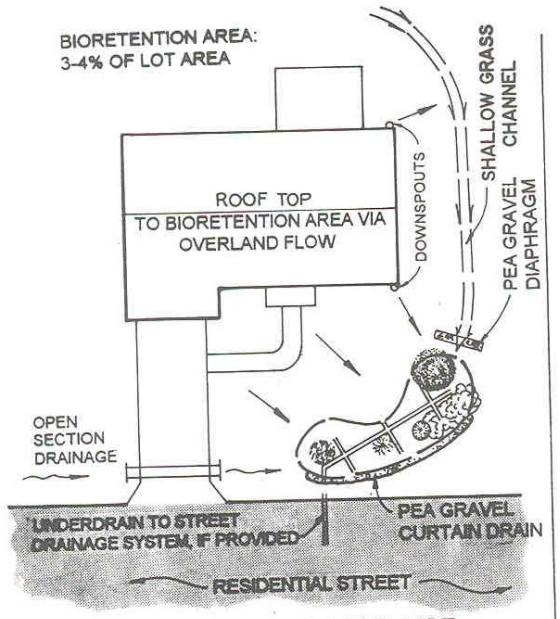
Long Term Maintenance

If the rain garden takes more than 36 hours to drain, remove mulch and several top inches of soil. Till the remaining soil add fresh soil mixture and mulch.

Pollutant Removal Effectiveness

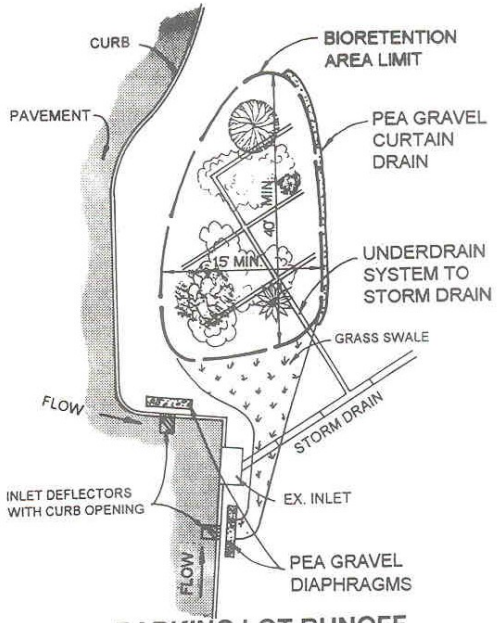
Pollutant Removal Effectiveness of Two Bioretention Areas in Maryland (EPA)

Pollutant	Removal (%)
Copper	43 - 97
Lead	70 - 95
Zinc	64 - 95
Phosphorus	65 - 87
Total Kjeldahl Nitrogen	52 - 67
Ammonia Nitrogen	92
NO_3	15 -16
Total Nitrogen	49
Calcium	27



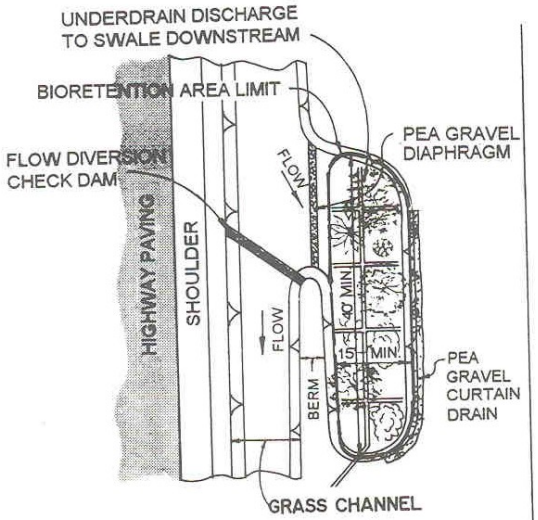
RESIDENTIAL LAND USE
ON-LINE APPLICATION

a



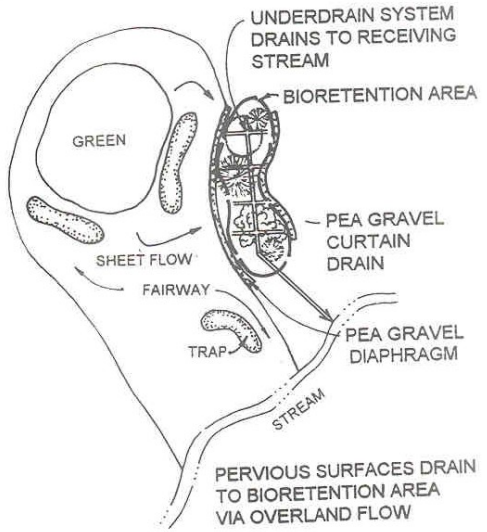
PARKING LOT RUNOFF
OFF-LINE APPLICATION

b



HIGHWAY DRAINAGE
OFF-LINE APPLICATION

c



PERVIOUS SURFACE (GOLF COURSE)
ON-LINE APPLICATION

d

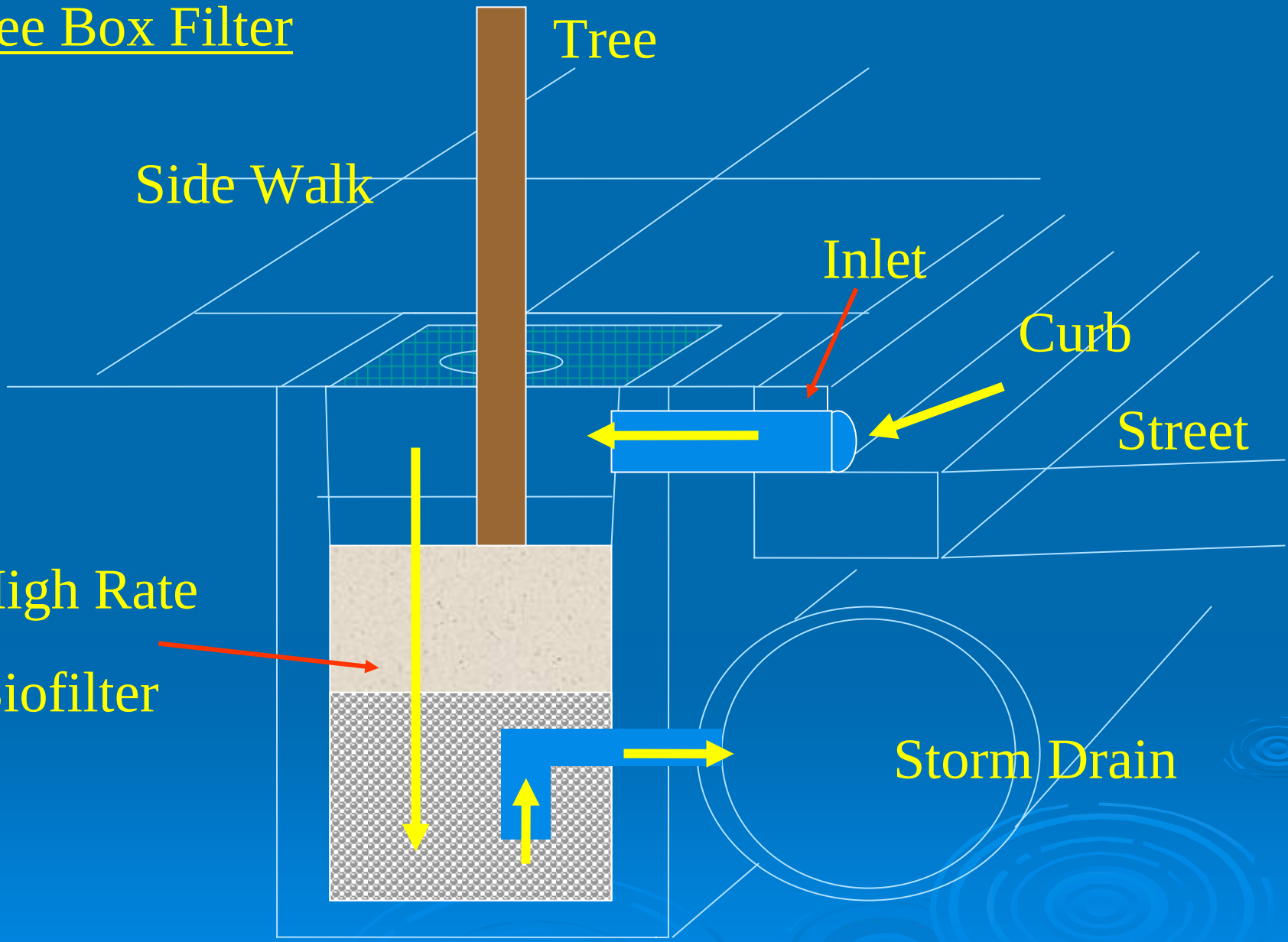
After Completion - January 2001

Buckman Heights courtyard with infiltration garden

MAY 21 2001

F150
TRD OFF ROAD

Tree Box Filter



TREE FILTER SCHEMATIC

Design Documents

Design of Stormwater Filtering Systems. 1996. Center for Watershed Protection.

Rain Gardens, A How-to Manual for Homeowners. 2003. Wisconsin Department of Natural Resources.

http://clean-water.uwex.edu/pubs/raingarden/rgmanual.pdf

EPA Menu of Stormwater BMPS — Bioretention

http://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater#post