



District of Columbia Stormwater Workshop



August 22, 2012

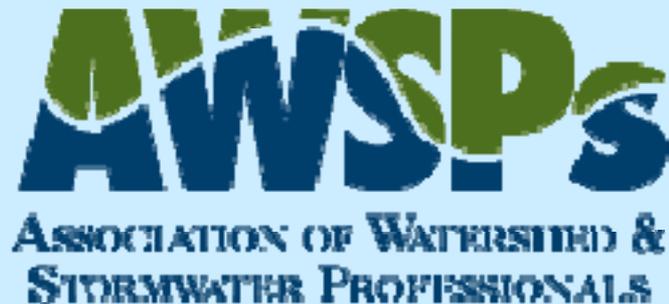
Gregory Hoffmann, P.E.
Center for Watershed Protection



About the Center for Watershed Protection

- Non-profit 501(c)3, non-advocacy organization
- Work with watershed groups, local, state, and federal governments
- Provide tools communities need to protect streams, lakes, and rivers
- 23 staff in MD, VA, and NY

www.awsp.org



www.cwp.org



Objectives for the Workshop

1. Learn about the District's new retention standard;
2. Become familiar with Runoff Reduction Methods as the approach to achieving retention.
3. Work with design and sizing guidelines for the retention practices provided in the Draft Stormwater Guidebook;
4. Become familiar with the proposed spreadsheet compliance tool through hands-on site plan design exercises.

New District Stormwater Retention Standard

Retain the first 1.2” of rainfall on site or through a combination of on-site and off-site retention.

Definitions of Stormwater Management



1. Get rid of it!

Definitions of Stormwater Management



2. Hold on to it – for a little while.

Definitions of Stormwater Management

3. Hold on to it indefinitely, remove the pollutants, but don't create flooding problems or let it be a nuisance.



NE 35th Pl & Siskiyou St.



City of Portland

What were we asking for?

- Existing Stormwater Management Criteria
 - Flood Control
 - Detention of 15-year storm event
 - Channel Protection
 - Detention of 2-year storm event
 - Water Quality
 - Capture and treat “first flush” (0.3” - 0.5” of runoff)





District Methodology for Achieving Retention

- **Draws from Runoff Reduction Method**
 - **Technical Memorandum April, 2008**

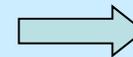
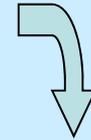


The Runoff Reduction Method

- Shift focus from Flood Control and Pollutant Removal to Runoff Reduction
- Runoff Reduction
 - Reduces runoff volume
 - Reduces pollutant loads
 - Mimics pre-development hydrology
 - Groundwater recharge
- Reduce the size of large storage BMPs

First: Reduce Stormwater Runoff By Design

- Better site planning & design techniques
 - Preserve natural areas
 - Conservation design
 - Reduce clearing & grading limits
 - Reduce roadway widths
 - Eliminate excessive impervious cover
 - And more...



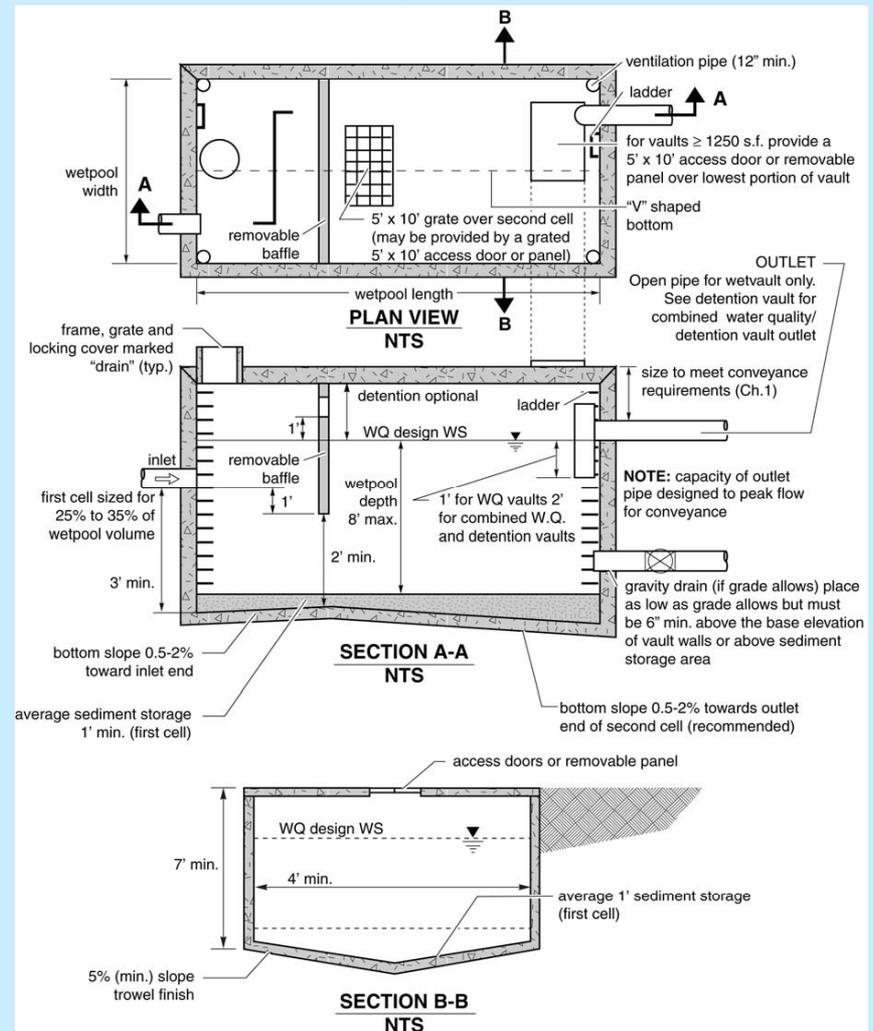
Second: Reduce Volume of Post-Construction Stormwater Runoff

- Small-scale, distributed practices
 - Soil Restoration
 - Downspout Disconnection
 - Rain Gardens/Small Bioretention Areas
 - Rainwater Harvesting
 - Permeable Pavement
 - Green Roofs
 - Natural Drainage Ways
 - Vegetated Channels
 - Site Reforestation
 - Buffers



Third: Capture & Treat Remaining On-site Minimum Volume

- Larger-scale, engineered practices
 - Filters
 - Ponds
 - Wetlands
- Each drainage area has minimum requirement.



Next: Iterate or Mitigate

When required retention volume cannot be met on site, either:

- Go back to Step 1 (Iterative site design process) OR
- Mitigate through use off-site retention:
 - Stormwater Retention Credits (SRCs)
 - In-lieu fee

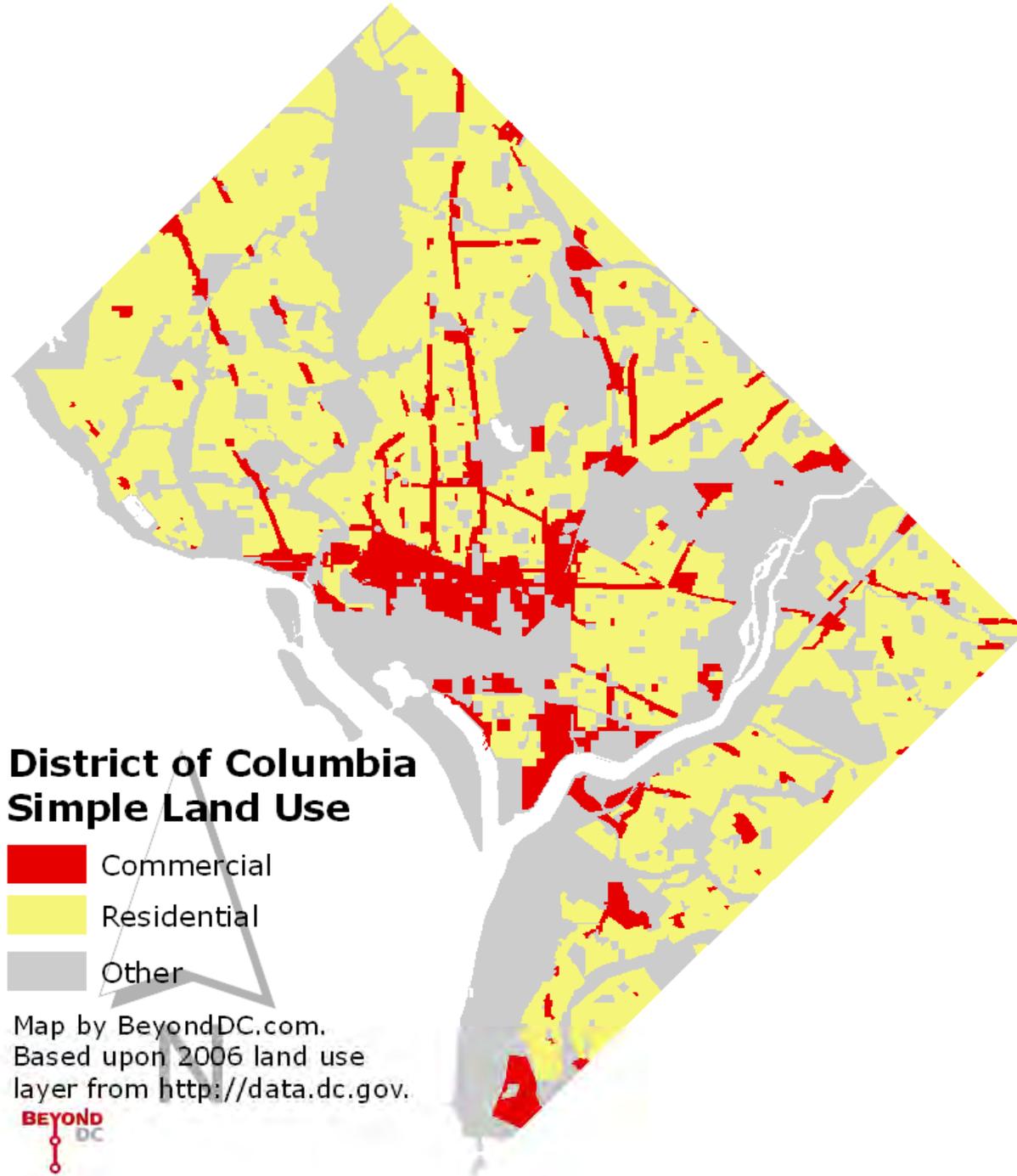
Runoff Reduction (RR) Method Details

- Avoid compaction and minimize disturbance;
- Go beyond impervious cover as the sole water quality indicator;
- Credit practice performance;
- Account for practices in series
- Apply runoff reduction practices to larger design storms.

Runoff Reduction (RR) Method Details

- Avoid compaction and minimize disturbance;
- Go beyond impervious cover as the sole water quality indicator and determinant of treatment volume;
- Credit practice performance;
- Account for practices in series
- Apply runoff reduction practices to larger design storms.





District of Columbia Simple Land Use

-  Commercial
-  Residential
-  Other

Map by BeyondDC.com.
Based upon 2006 land use
layer from <http://data.dc.gov>.



Managed Turf

- Documented impacts of grading and compaction of soils:
 - Increased bulk density
 - Decreased permeability
 - Increased runoff coefficient
- Documented impacts from turf management activities:
 - Fertilization;
 - Pest management;

Retention Volume: Beyond Impervious Cover

$$\text{SWR}_v = P (Rv_I * \%I + Rv_C * \%C + Rv_N * \%N) * SA * 7.48 / 12$$

- SWR_v = Volume required to be retained on site (gal)
- P = 1.2 inches (90th percent rainfall event for the District)
- Rv_I = 0.95 (runoff coefficient for impervious cover)
- Rv_C = 0.25 (runoff coefficient for compacted cover)
- Rv_N = 0.0 (runoff coefficient for natural cover)
- $\%I$ = % of site in impervious cover
- $\%C$ = % of site in compacted cover
- $\%N$ = % of site in natural cover
- SA = Surface area (square feet)

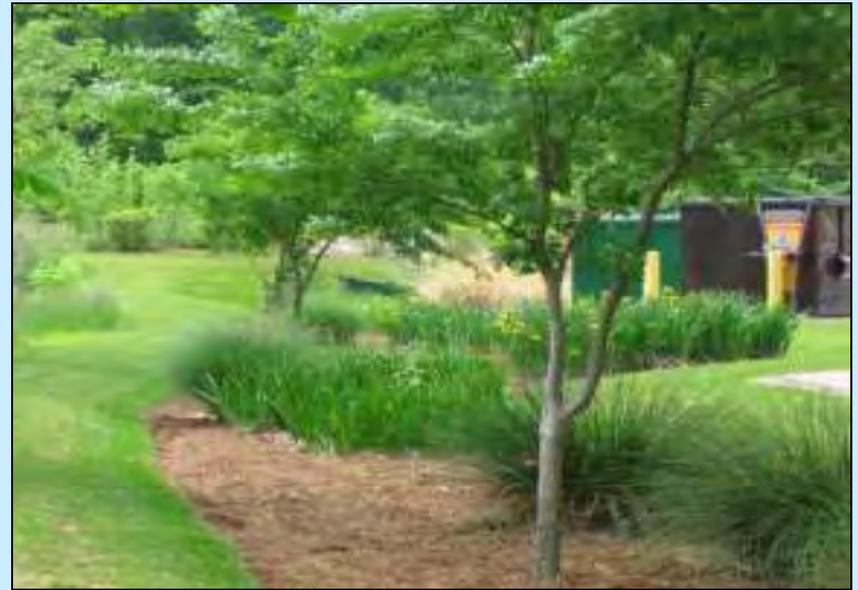
Runoff Reduction (RR) Method Details

- Avoid compaction and minimize disturbance;
- Go beyond impervious cover as the sole water quality indicator;
- Credit practice performance;
- Account for practices in series
- Apply runoff reduction practices to larger design storms.

Stormwater Practices Differ Sharply in Ability to Reduce Runoff Volume



Storage and Filters Reduce Runoff Volumes by 0 to 10%



Bioretention, Infiltration, Dry Swales and Related Practices Reduce Runoff Volumes by 50 to 90%

Runoff Reduction Processes

Runoff Reduction is not just infiltration!

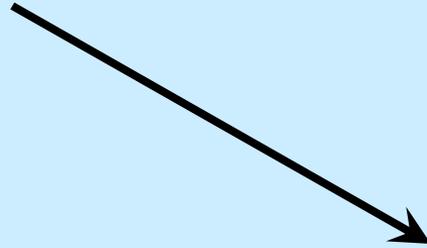
- ✓ Infiltration
- ✓ Canopy Interception
- ✓ Evaporation
- ✓ Transpiration
- ✓ Rainwater Harvesting
- ✓ Extended Filtration



Runoff Reduction (RR) Method Details

- Avoid compaction and minimize disturbance;
- Go beyond impervious cover as the sole water quality indicator;
- Credit practice performance;
- Account for practices in series
- Apply runoff reduction practices to larger design storms.

Practices in Series

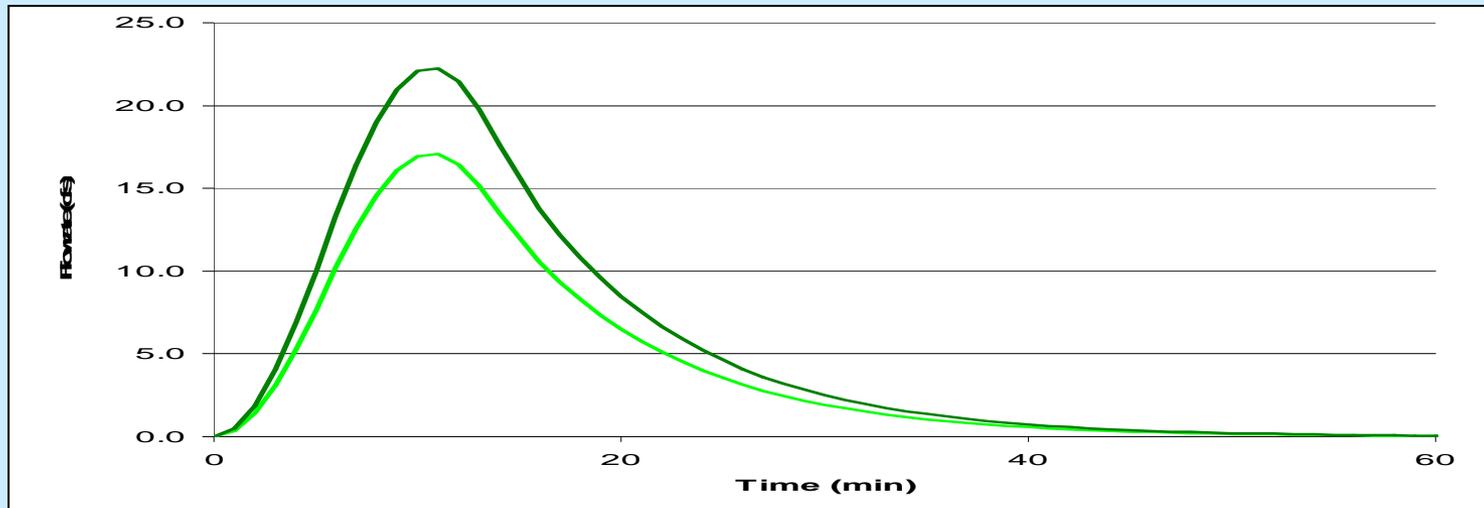


Runoff Reduction (RR) Method Details

- Codify avoidance and minimization;
- Go beyond impervious cover as the sole water quality indicator;
- Credit practice performance;
- Account for practices in series
- Apply runoff reduction practices to larger design storms.

Curve Number Reduction

1. Calculate Curve Number and Site Runoff Volume
2. Subtract Runoff Reduction Volume Achieved from Site Runoff Volume
3. Determine Reduced Curve Number based on Reduced Site Runoff Volume





Stormwater Design for Urban Watersheds

CENTER FOR
WATERSHED
PROTECTION



Agenda

- Why Managing Stormwater at Urban Sites is So Hard
- Why Managing Stormwater at Urban Sites is So Important
- Bay-wide Movement to Improve Urban Stormwater Management
- Bay-wide Design Strategies for Urban Sites

Why is Stormwater Management So Hard for Development Projects in Highly Urban Watersheds?



Why Urban SW Management is So Hard

- Lack of space and/or high cost of land
- Constrained by inverts of existing storm drains
- Conflicts with existing underground utilities
- Compacted and possibly polluted soils
- Full compliance is difficult at some sites
- Traditional and even some new LID practices developed in suburban areas don't work in our cities
- Designers have little or no experience in designing the practices that do

Why is Stormwater Management So Important for Development Projects in Highly Urban Watersheds?



Bay-wide Emphasis on SW Management in Urban Development

- Redevelopment expected to increase as a share of total development in the future
- About 2 million acres of existing IC in Bay watershed
- 42% of urban land expected to be redeveloped by 2030
- Sharp increase in growth in Bay's core cities and inner suburbs in last 5 years
- Sprawl may be slowing a bit in this economy...

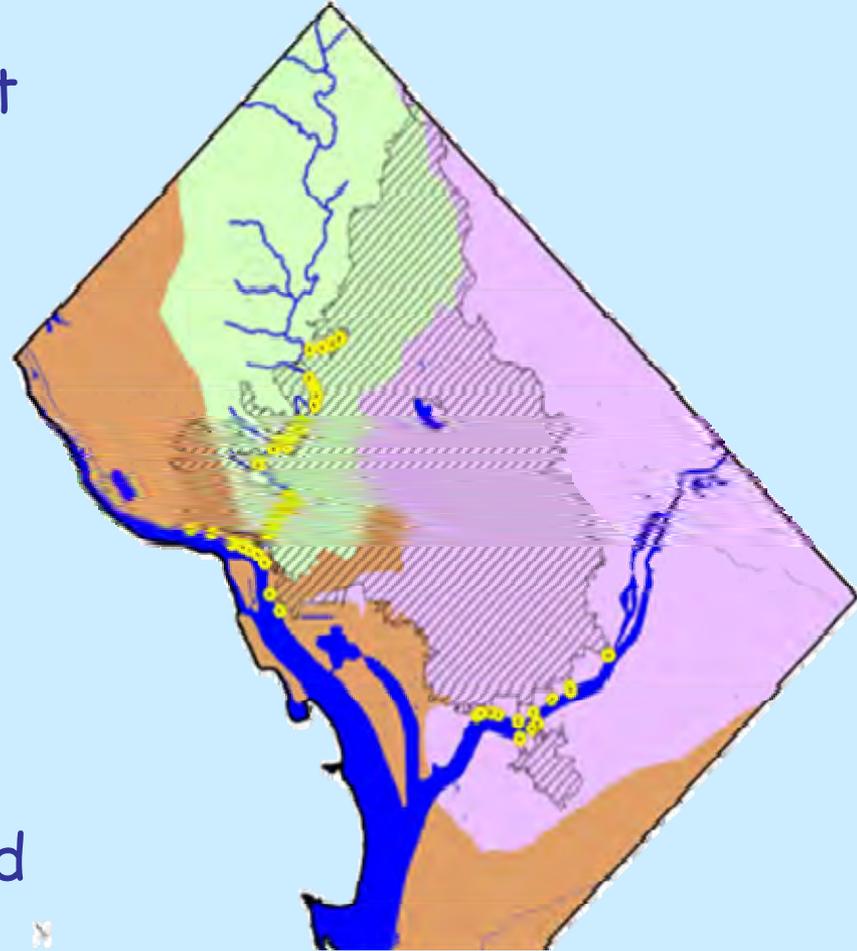
Ten Strategies to Integrate SW Management into Urban Development in the Bay



...or keys to great urban Low Impact Development engineering.

#1. Do You Understand the Watershed Facts?

- Combined or Separate Sewers
- Age of watershed development
- Habitat condition of streams
- Hydraulic capacity of existing stormwater conveyance and floodplain
- Historical flooding capacity
- Existence of watershed plans
- Other stormwater retrofit and restoration opportunities



#2. Has the Site History been Investigated?

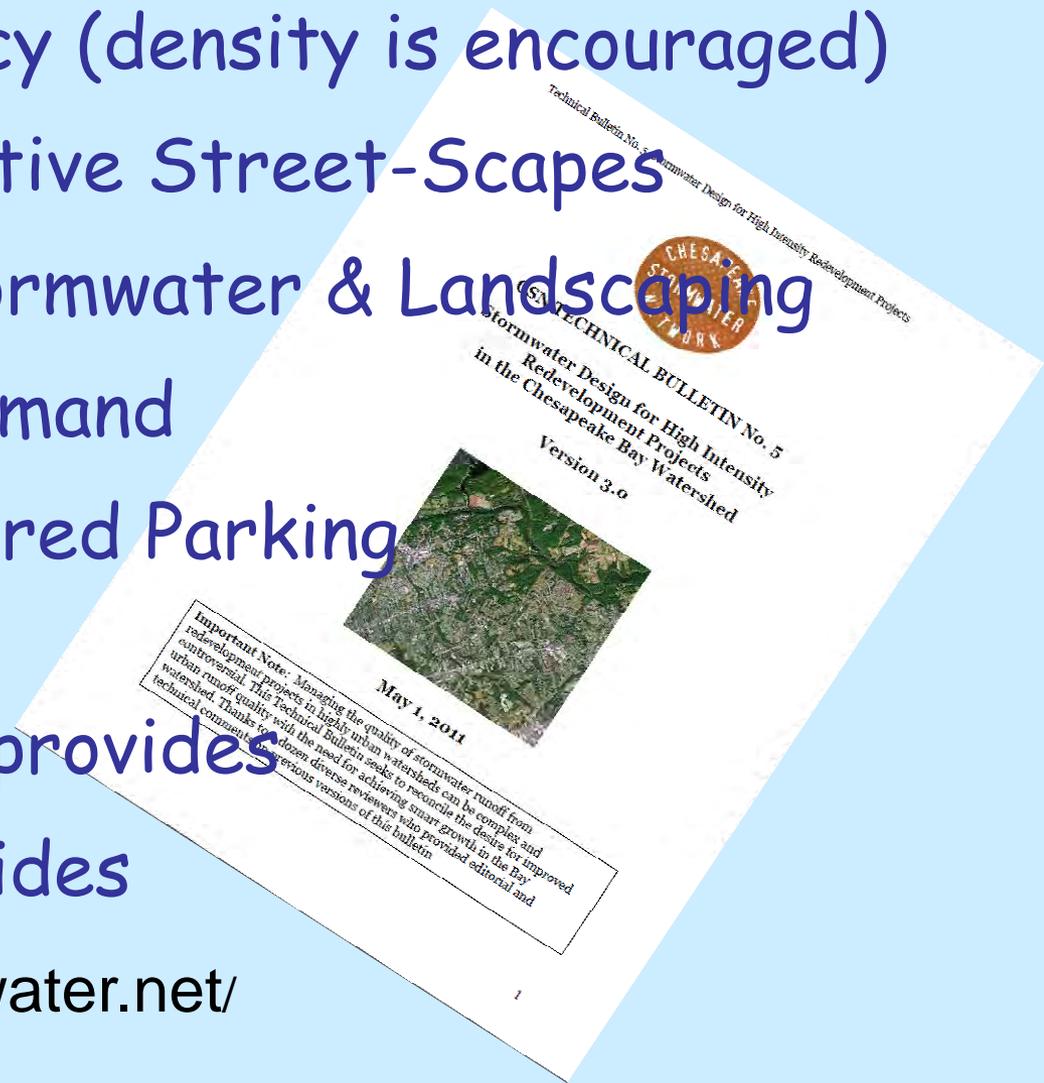
- Most urban development projects require environmental site assessment; brown fields are special cases
- Site history investigation, soil testing and groundwater analysis
- These data are critical in stormwater design to determine whether:
 - Soils need to be capped
 - Infiltration should be encouraged or discouraged
 - Historical drainage paths can be used to route stormwater
 - Existing utilities will constrain design

#3. Has the SW Management Urban Site Design been integrating into an Urban Planning Context?

- Land Use Efficiency (density is encouraged)
- Unique and Attractive Street-Scapes
- Integration of Stormwater & Landscaping
- Reduce Parking Demand
- Shared or Structured Parking

Technical Bulletin 5 provides weblinks to other guides

<http://chesapeakestormwater.net/>



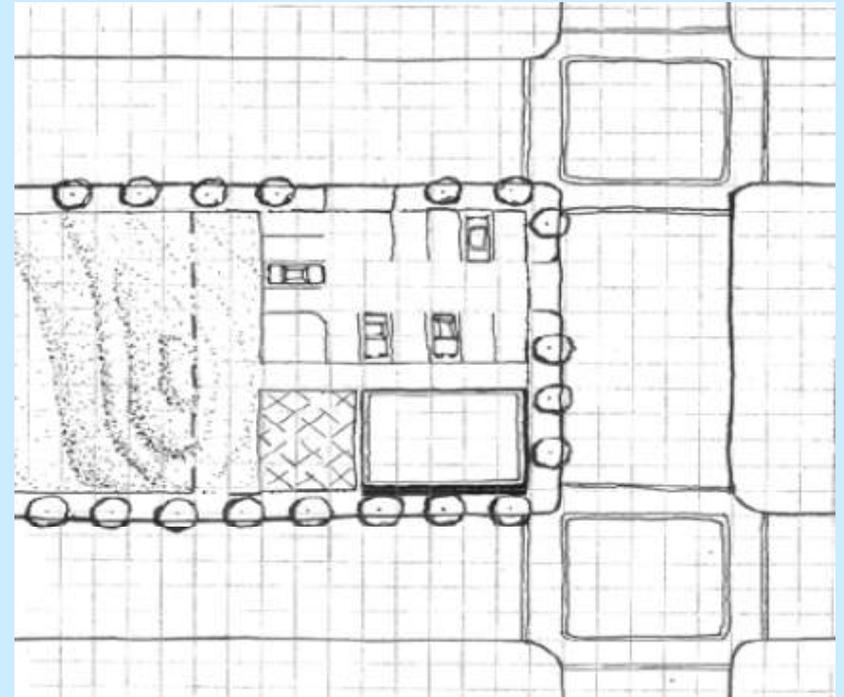
#4. Have the Potential Hotspot Generating Areas (HGAs) been identified?

- Review future site operations and activities
- Common areas include loading/unloading, fueling, outdoor storage, dumpsters, compactors and maintenance
- Identify areas of high pedestrian and vehicular traffic
- HGAs usually only a fraction of site area
- Isolate HGA in design and cover or filter runoff
- Integrate pollution prevention into design



#5. Has the Site's Imperviousness Been Reduced?

- A Site Designer is rewarded with a lower regulated retention volume to manage with small changes to the impervious footprint
- Similar incentive to adjust limits of disturbance to give best answers



#5. Caveat: A Site's Reduced Impervious Cover should be designed to...

- ...perform hydrologically as if it were uncompacted grass, and ideally should be used to filter some runoff from remaining hard surfaces
- any commitment to *Natural Cover* is part of maintenance covenant



The District's Proposed Design Guidelines value disconnection to amended soils for Retention

- Plans should show the specific areas for amended soils
- Underlying soils should be deep tilled and amended with compost to restore porosity
- Areas should be graded to accept runoff from adjacent hard surfaces
- Planting plan should reflect landscaping objectives

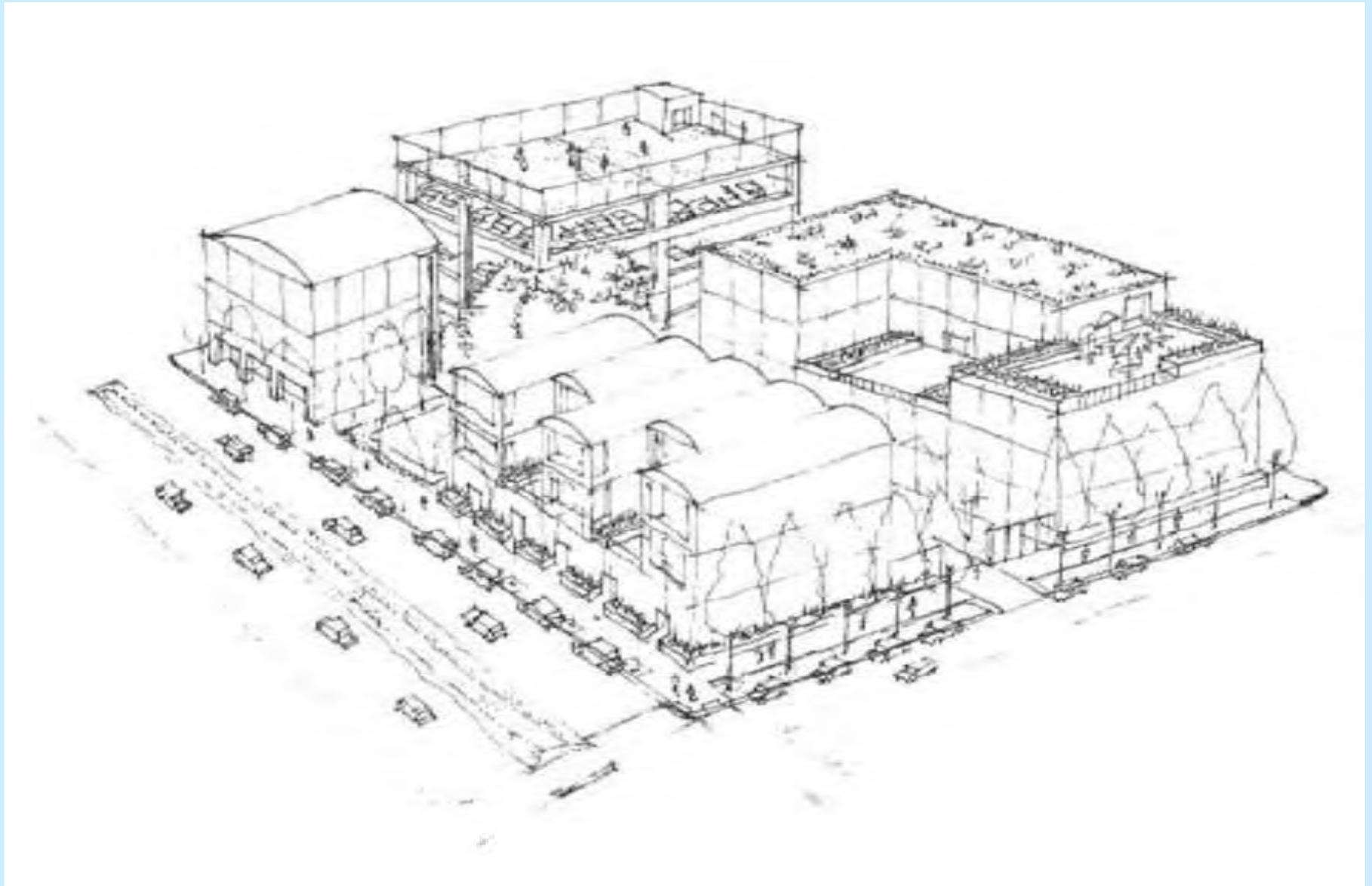


Courtesy S. Schwartz

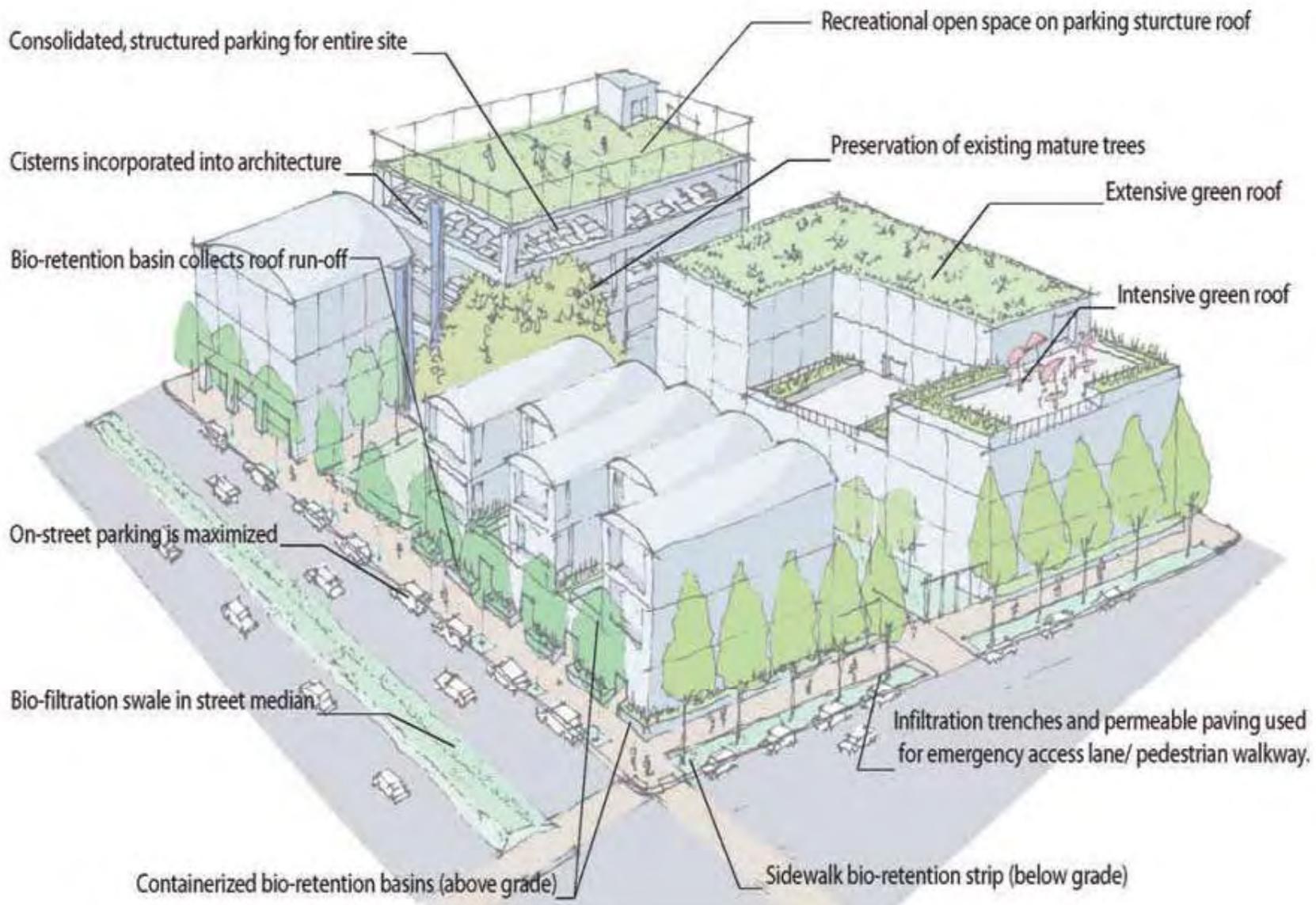
#6. Can the Site be Decomposed into Smaller Drainage Units?



Units may be as small as a few thousand square feet up to a few acres

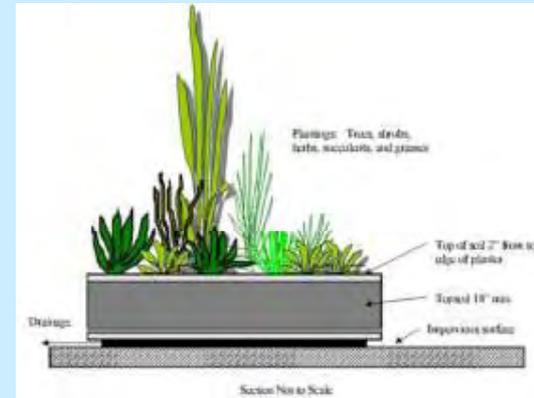


Source: COE,(2005)

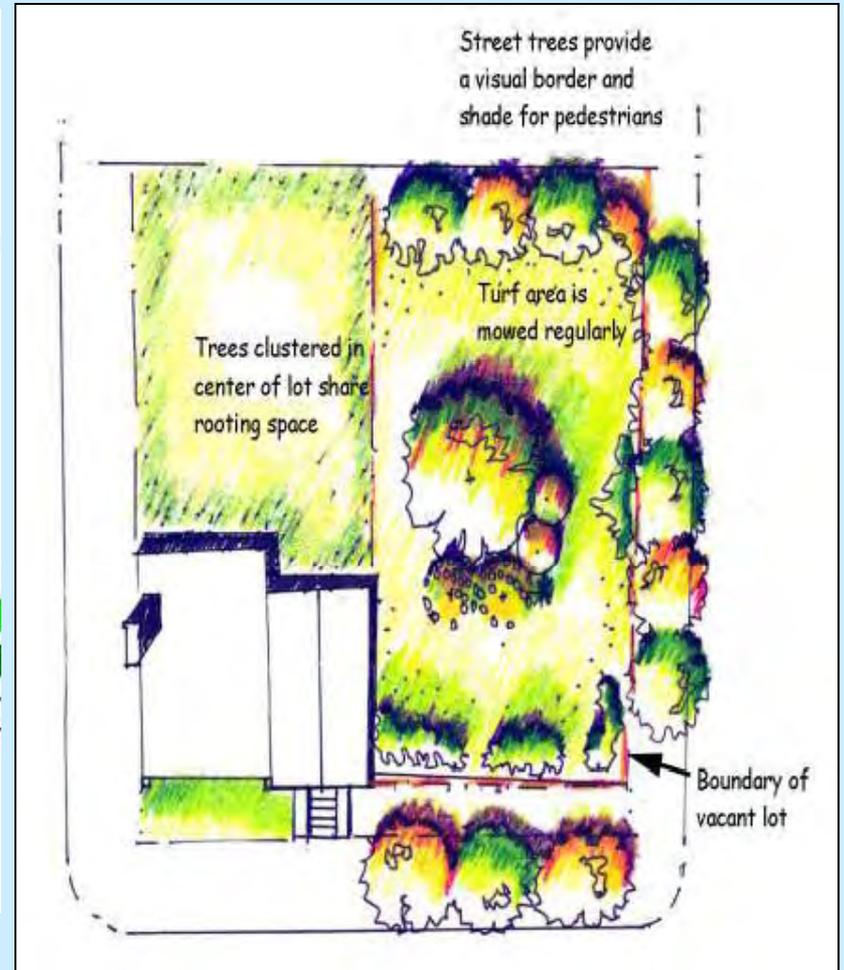


Source: COE,(2005)

#7. "Roof to Street" Design Approach



#8. Has the Forest Canopy been Maximized and Natural Area Remnants Restored?



Remember, any commitment to *Natural Cover* is part of the property's long term maintenance obligation.

#9. Evaluate if Infiltration and Recharge Are Possible?

- Consider past development that may have destroyed soil structure, soil remediation may be needed
- Setbacks and underdrains may be necessary to protect foundations and infrastructure
- What is really under the ground (rubble fill, soil pollutants, etc.)?



Issues with Urban Fill Soils

- Many development projects will encounter urban fill soils
- Fill soils **cannot** be classified into any hydrological soil group
- Infiltration into fill soils may not be practical



Even at Brownfield Sites, Retention is Achievable...

- An environmental site assessment will determine if a project has "brownfield" remediation obligations
- Site history investigation, soil testing and groundwater analysis will inform the specific design
- If a site is a brownfield, consider above ground retention practices such as green roofs, harvesting for non-potable uses, bioretention planters, lined and under drained bioretention etc...



Stormwater Practices for Urban Development

High Density Urban Development Projects

Preferred	Adequate	Restricted	Marginal
Impervious Cover Removal	Sand Filters	Infiltration	Ponds & Wetlands
Green Roof and Rain Tanks	Bioretention	Proprietary Practices	Wet Swales
Permeable Pavers*	Soil Restoration	Dry Wells	Grass Channels & Filter Strips
Foundation Planters	Tree planting		Most Disconnection credits
Expanded Tree Pits	Dry Swales		
Green Street Retrofits			

#10. Have You considered Off-site Options?

- The District of Columbia is pioneering a Market based Trading program for projects with *Retention* deficits
- The Trading program features a gallon for gallon exchange that any site may participate in after achieving the minimum on-site floor
- Bay-wide other jurisdictions are exploring similar concepts (stay tuned)



In Partnership with



and



Questions and Answers





Stormwater BMP Specifications

Changes to the Stormwater Guidebook

New Additions	Existing BMPs
Permeable Pavement	Filters
Green Roof	Infiltration
Bioretention	Open Channels
Rainwater Harvesting	Storage Practices
Tree Planting/Preservation	Stormwater Ponds
Proprietary Practices	Wetlands

Specification Format

- Feasibility Criteria
- Conveyance Criteria
- Pretreatment Criteria
- Design Criteria
- Landscaping Criteria
- Construction Sequence
- Maintenance Criteria
- Retention Value Calculations
- References



3.4 Permeable Pavement

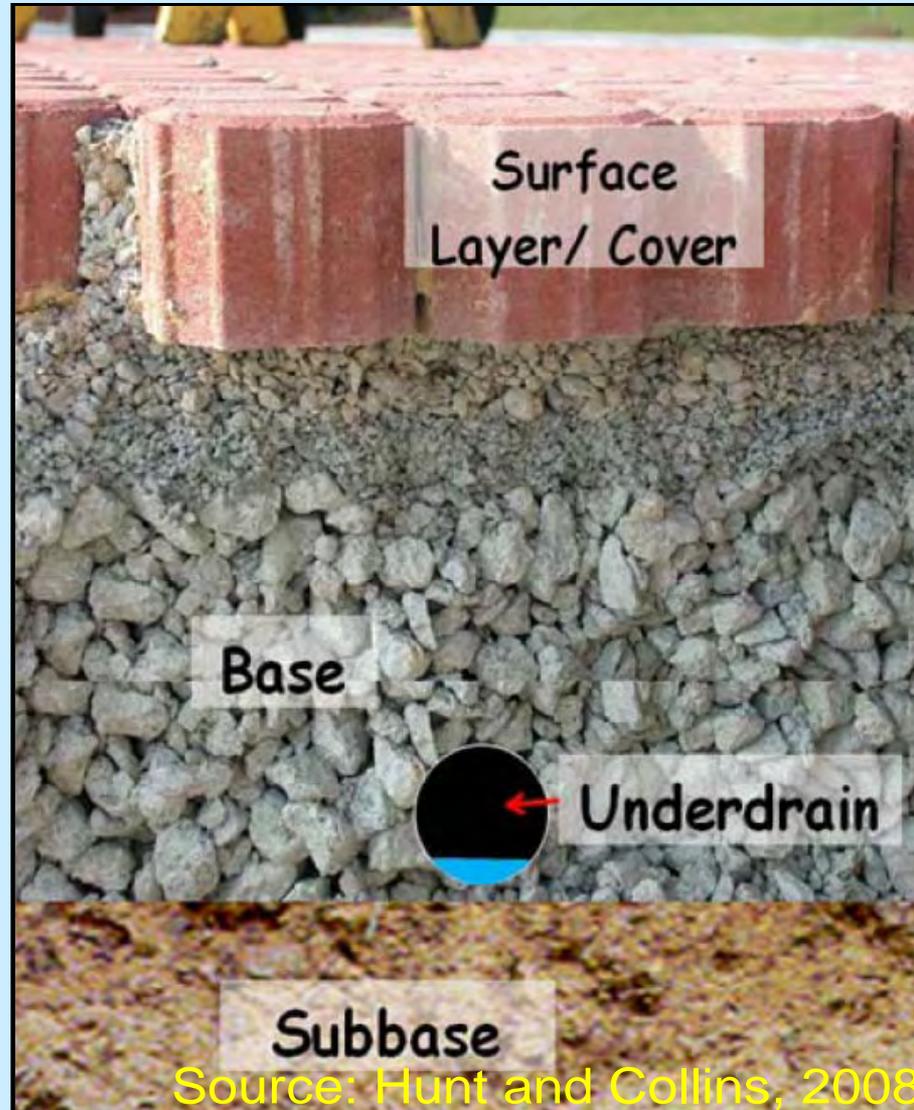
Permeable Pavement Specification

- Likely to become more common due to efficient use of space and high retention value.

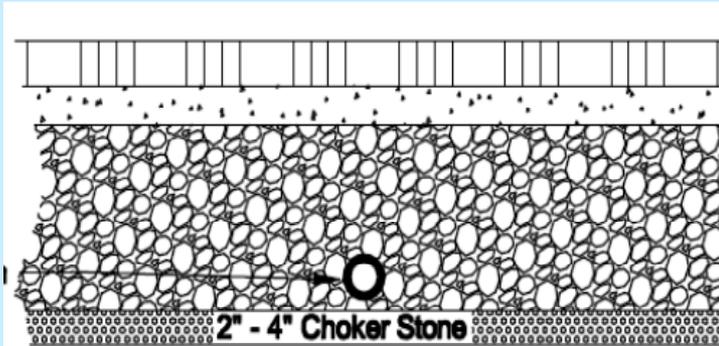
Permeable Pavement



Permeable Pavement

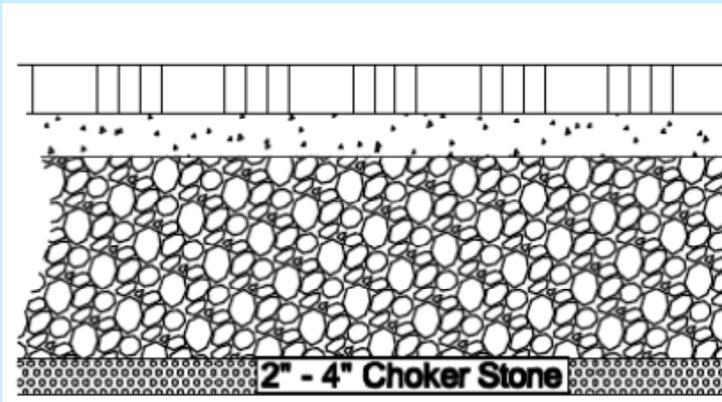
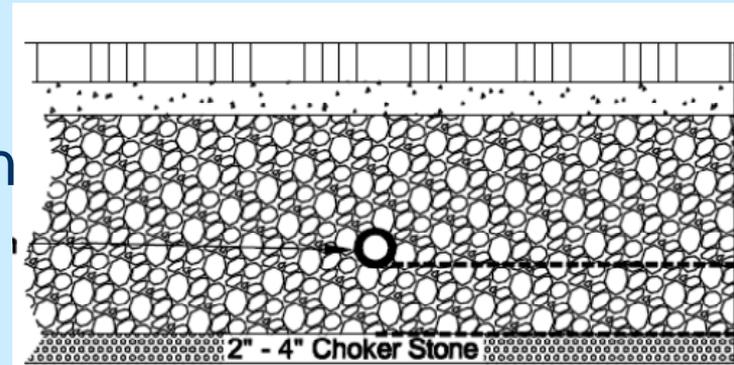


Permeable Pavement Versions



Standard

Enhanced with Underdrain



Enhanced without Underdrain

Permeable Pavement Feasibility Criteria

- Ratio of external contributing impervious surface to permeable pavement is **5:1**
- CDA should consist of impervious cover only
- Other requirements for water table depth, minimum head, setbacks, slopes, etc.

Conveyance Criteria and Pretreatment

- Large storm events must be managed via
 - overdrains/overflow inlets
 - Extra storage depth
 - underground detention
- Pretreatment not required, so long as CDA is 100% impervious.

Permeable Pavement Design Criteria

- Specifications for each layer/element
 - Reservoir Layer – No. 57 or No. 2 stone; sized for design storm
 - Underdrains – PVC with 3/8 inch perforations; drain practice in 48 hours
 - Infiltration Sump – No. 57 or No. 2 stone; must drain in 48 hours
 - Filter Layer – No. 8 choker stone for optional separation.

Permeable Pavement Design Criteria

- Structural Design based on
 - Total traffic;
 - In-situ soil strength;
 - Bedding and Reservoir layer design
- Hydraulic Design based on design volume

Permeable Pavement Design Criteria

$$d_p = \frac{\{(P \times Rv_i \times DA / Ap) - (\frac{1}{2}i \times t_f)\}}{\eta_r}$$

Equation 3.4.1:

- d_p = Depth of the reservoir layer (or the depth of the infiltration sump, for enhanced designs with underdrains) (ft.)
- DA = Total contributing drainage area, including the permeable pavement surface (sf.)
- Ap = Permeable pavement surface area (sf.)
- P = The rainfall depth for the SWR_v, WQT_v, or other design storm (ft.)
- Rv_i = 0.95 (runoff coefficient for impervious cover)
- i = The field-verified infiltration rate for the subgrade soils (ft./day). If an impermeable liner is used in the design then $i = 0$.
- t_f = The time to fill the reservoir layer (day) – assume 2 hours or 0.083 day
- η_r = The effective porosity for the reservoir layer (0.35)

Permeable Pavement Design Criteria

Equation 3.4.2:

For enhanced design only.

$$t_d = \frac{d_p \times \eta_r}{1/2^i}$$

t_d = Time to drain (days) (must be < 2.0)

d_p = Depth of the reservoir layer (ft.)

η_r = The effective porosity for the reservoir layer (0.35)

i = The field-verified infiltration rate for the subgrade soils (ft./day). If an impermeable liner is used in the design then $i = 0$

Equation 3.4.3:

$$Sv = d_p \times \eta_r \times A_p$$

Sv = Storage Volume of Practice (ft³)

A_p = the permeable pavement surface area (ft²)

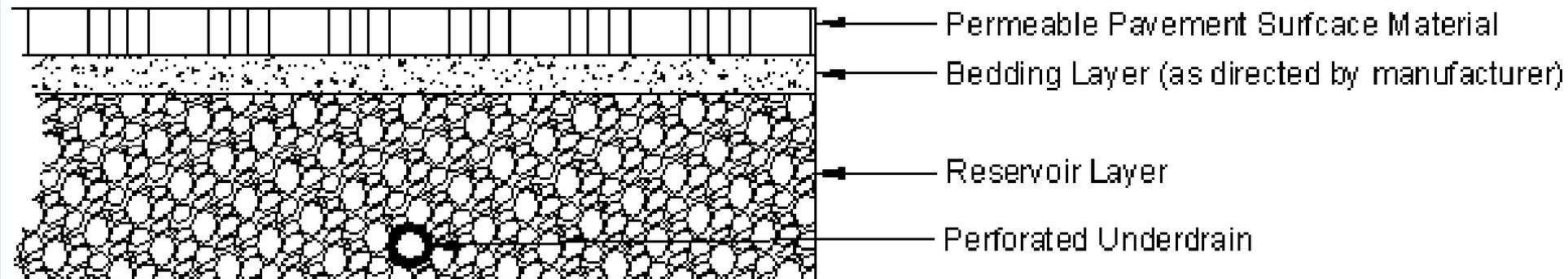
Additional Specification Sections

- Landscaping Criteria
- Construction Sequence
- Maintenance Criteria

Permeable Pavement Retention Value Calculations

Standard Design

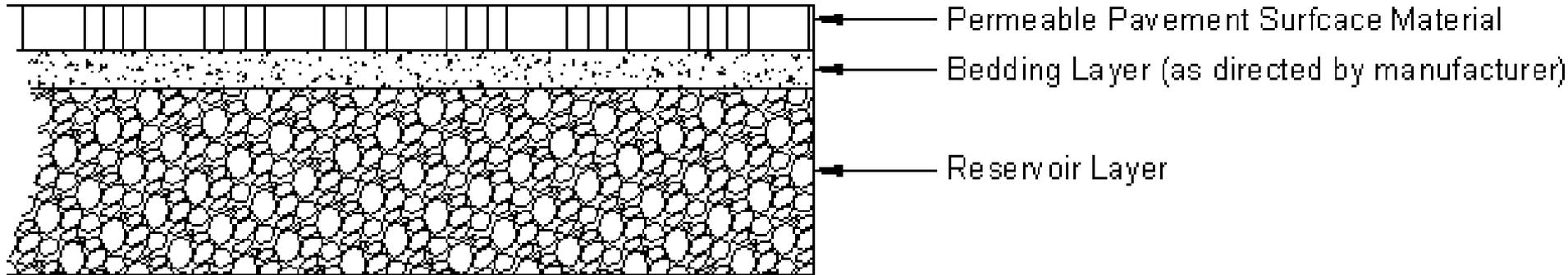
- Retention Value = 4.5 CF per 100 SF of practice area
- (approximately 45% volume reduction)
- 65% TSS removal for storage volume provided in Reservoir Layer.



Permeable Pavement Retention Value Calculations

Enhanced Design without Underdrain

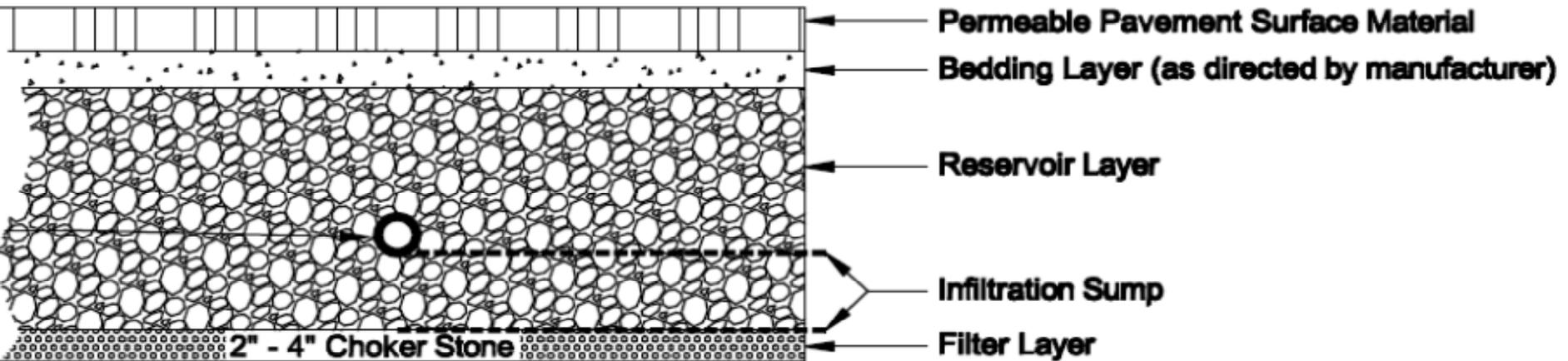
- Retention Value = 100% of Storage Volume in Reservoir Layer



Permeable Pavement Retention Value Calculations

Enhanced Design with Underdrain

- Retention Value = 100% of Storage Volume in Infiltration Sump Layer
- Additional 4.5 CF/sf and 65% TSS removal for storage volume in reservoir layer.



Questions





3.1 Green Roofs

Green Roof Specification

- Preferred practice in high intensity redevelopment areas
- Recognizes that there are many different vendors and systems

Green Roofs

- Extensive or Intensive
- Structural design considerations
- High installation cost
- Increased roof longevity
- Additional urban environmental benefits
- Can be major element of compliance at urban development sites
- 70% of Bay engineers have never designed one





Green Roof Feasibility Criteria

- Structural Capacity of Roof
- Roof Pitch
- Setbacks from HVAC, etc.
- Compliance with Building Codes

Conveyance and Pretreatment

- Drainage layer and roof drains must safely convey overflows.
- No requirements for Pretreatment

Green Roof Design Criteria

- Material specifications for each layer.



Green Roof Design Criteria

Sizing Equation

$$Sv = SA [d * \eta_1) + (DL * \eta_2)]/12$$

Sv = storage volume (cu. ft.)

SA = green roof area (sq. ft.)

d = media depth (in.)

η_1 = media porosity (typically 0.25 but consult manufacturer specs)

DL = drainage layer depth (in.)

η_2 = drainage layer porosity (consult specific product specifications)

Green Roof Landscaping Criteria

- Drought- and fire-resistant plants that can withstand wind, snow-loading, heat-stress, etc.

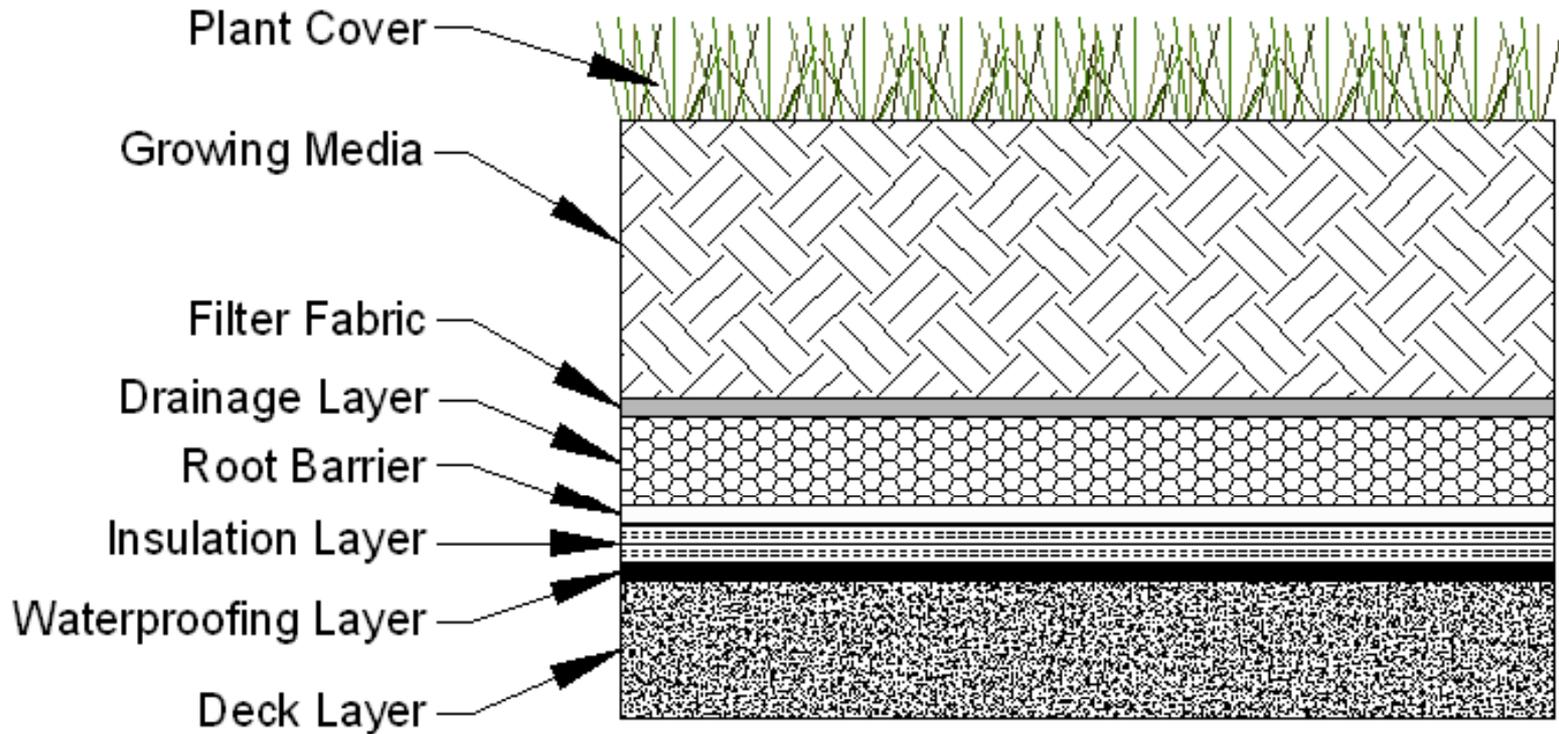
Table 3.1.2. Ground Covers appropriate for Green roofs in the District.

Plant	Light	Moisture Requirements	Notes
<i>Delosperma cooperii</i>	Full Sun	Dry	Pink flowers; grows rapidly
<i>Delosperma 'Kelaidis'</i>	Full Sun	Dry	Salmon flowers; grows rapidly
<i>Delosperma nubigerum</i> 'Basutoland'	Full Sun	Moist-Dry	Yellow flowers; very hardy
<i>Sedum album</i>	Full Sun	Dry	White flowers; hardy
<i>Sedum lanceolatum</i>	Full Sun	Dry	Yellow flowers; native to U.S.
<i>Sedum oreganum</i>	Part Shade	Moist	Yellow flowers; native to U.S.
<i>Sedum stoloniferum</i>	Sun	Moist	Pink flowers; drought tolerant
<i>Sedum telephiodes</i>	Sun	Dry	Blue green foliage; native to region
<i>Sedum ternatum</i>	Part Shade-Shade	Dry-Moist	White flowers; grows in shade
<i>Talinum calycinum</i>	Sun	Dry	Pink flowers; self sows

Note: Designers should choose species based on shade tolerance, ability to sow or not, foliage height, and spreading rate. See Snodgrass and Snodgrass (2006) for definitive list of green roof plants, including accent plants.

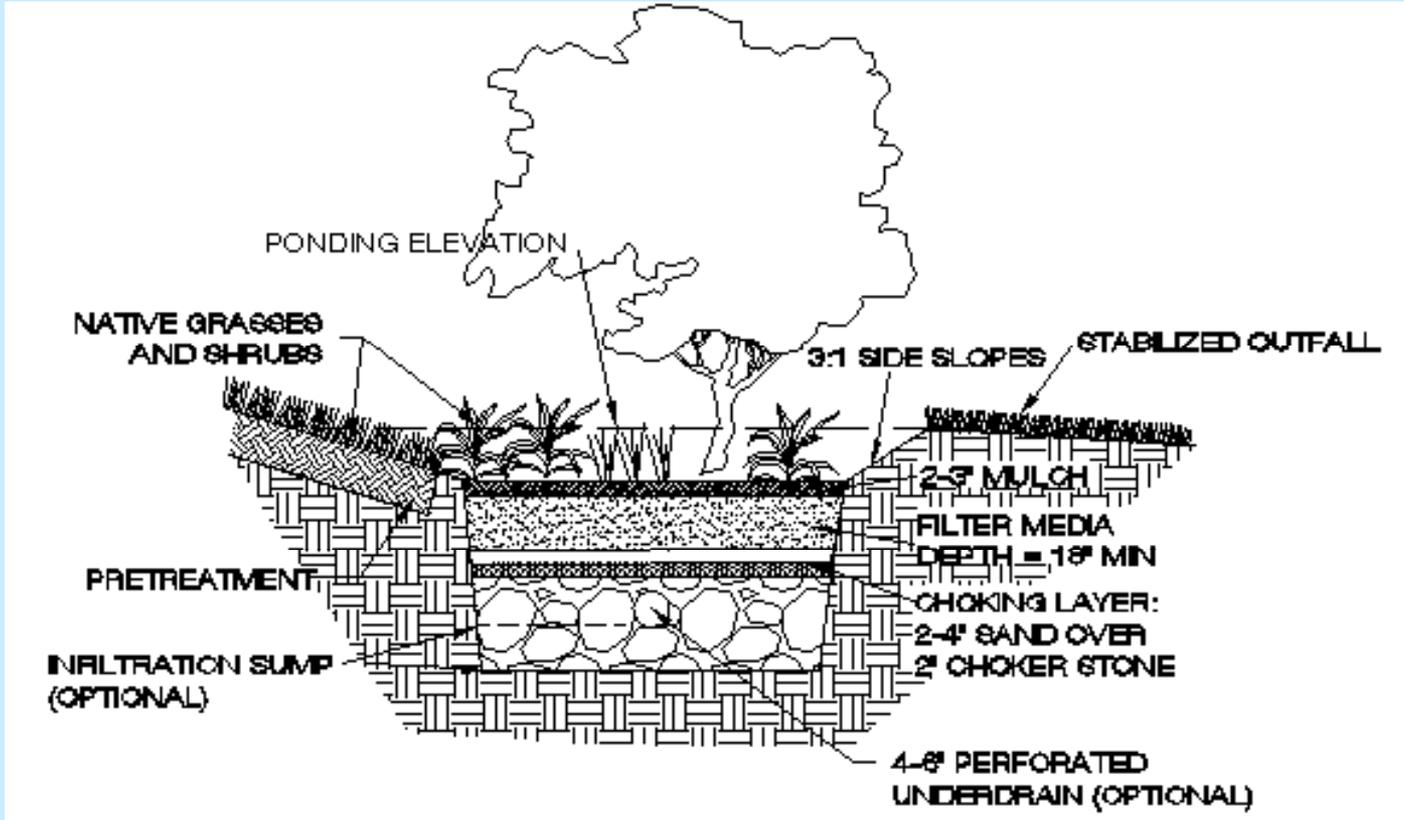
Green Roof Retention Value Calculations

Retention Value = S_v = 100% of Storage Volume in Media and Drainage Layer



Questions





3.5 Bioretention

Bioretention Specification

- Not much detail on bioretention in last Manual
- Will be a popular practice on sites with some surface land available
- A great deal of new research and experience
- Multiple design options

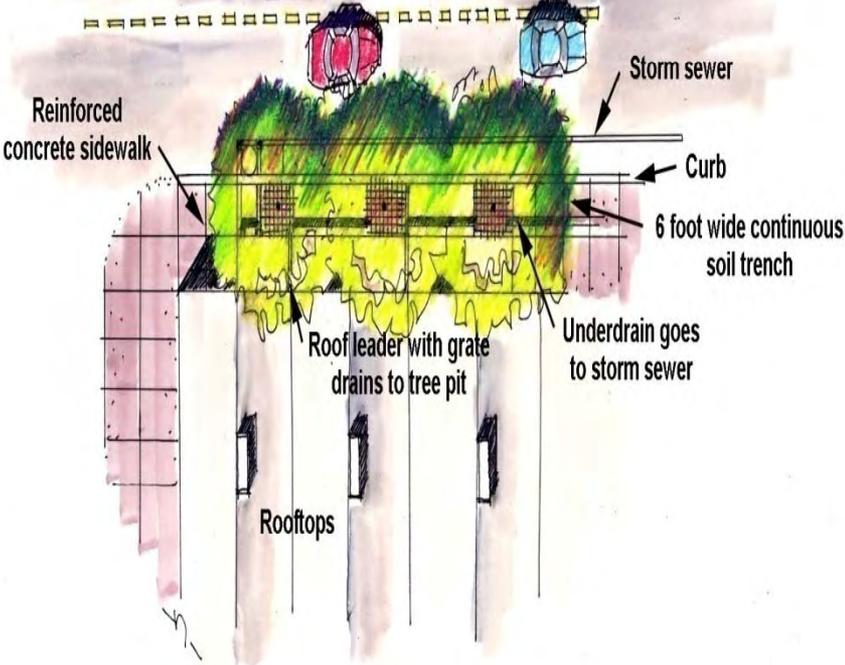
B-1 Traditional Bioretention



B-2 Streetscape Bioretention



B-3 Engineered Tree Pits



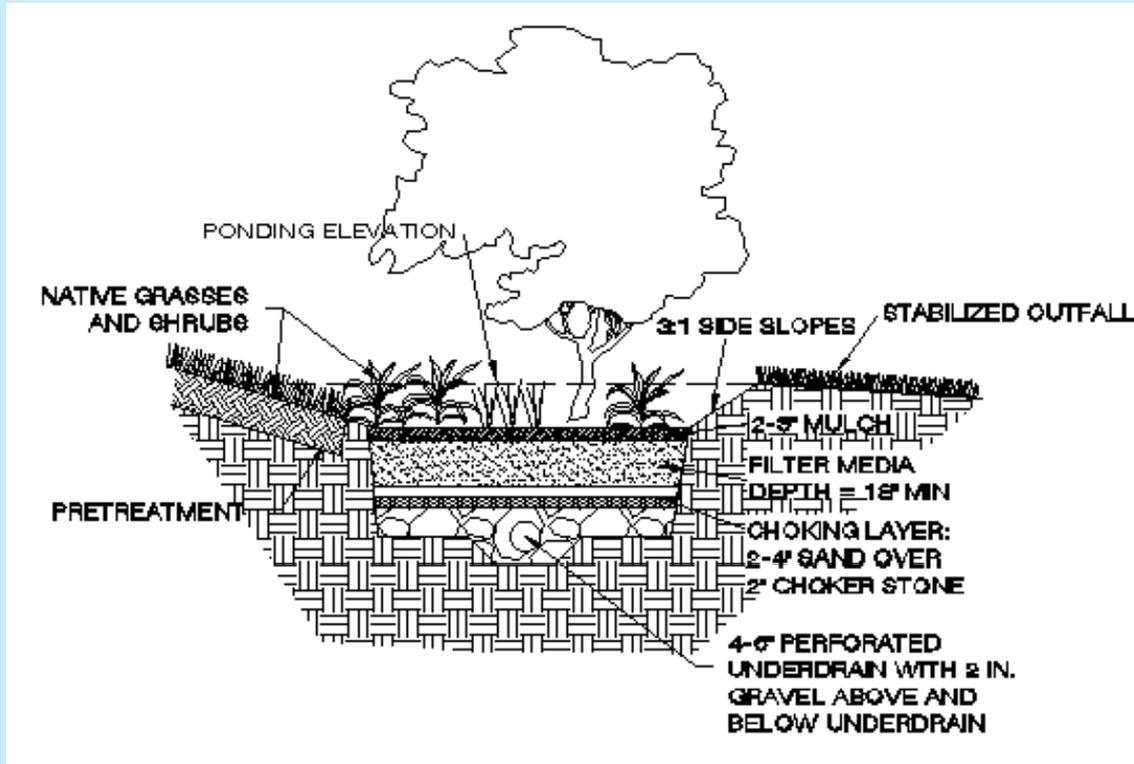
B-4 Foundation Planters



B-5 Residential Rain Gardens

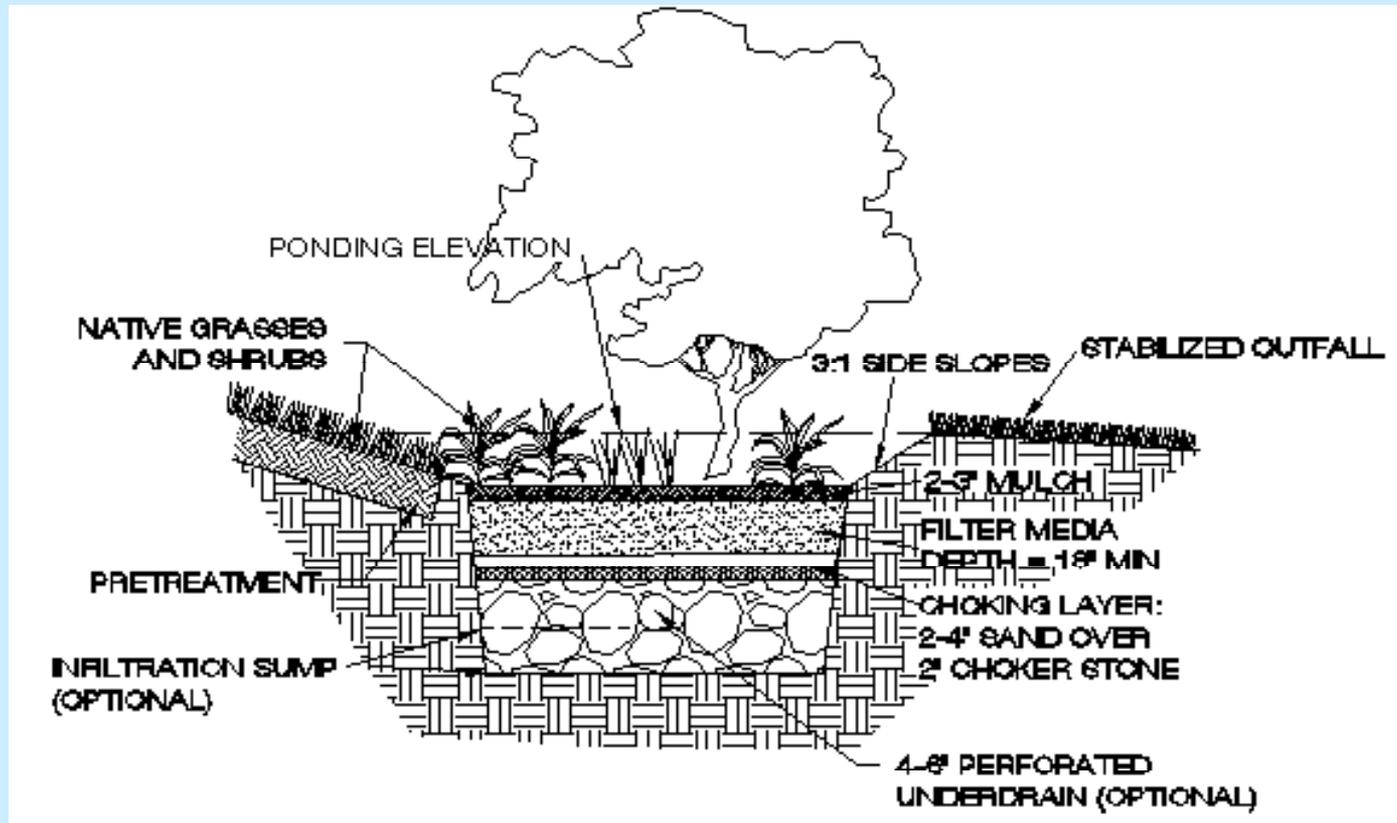


Standard Bioretention Design



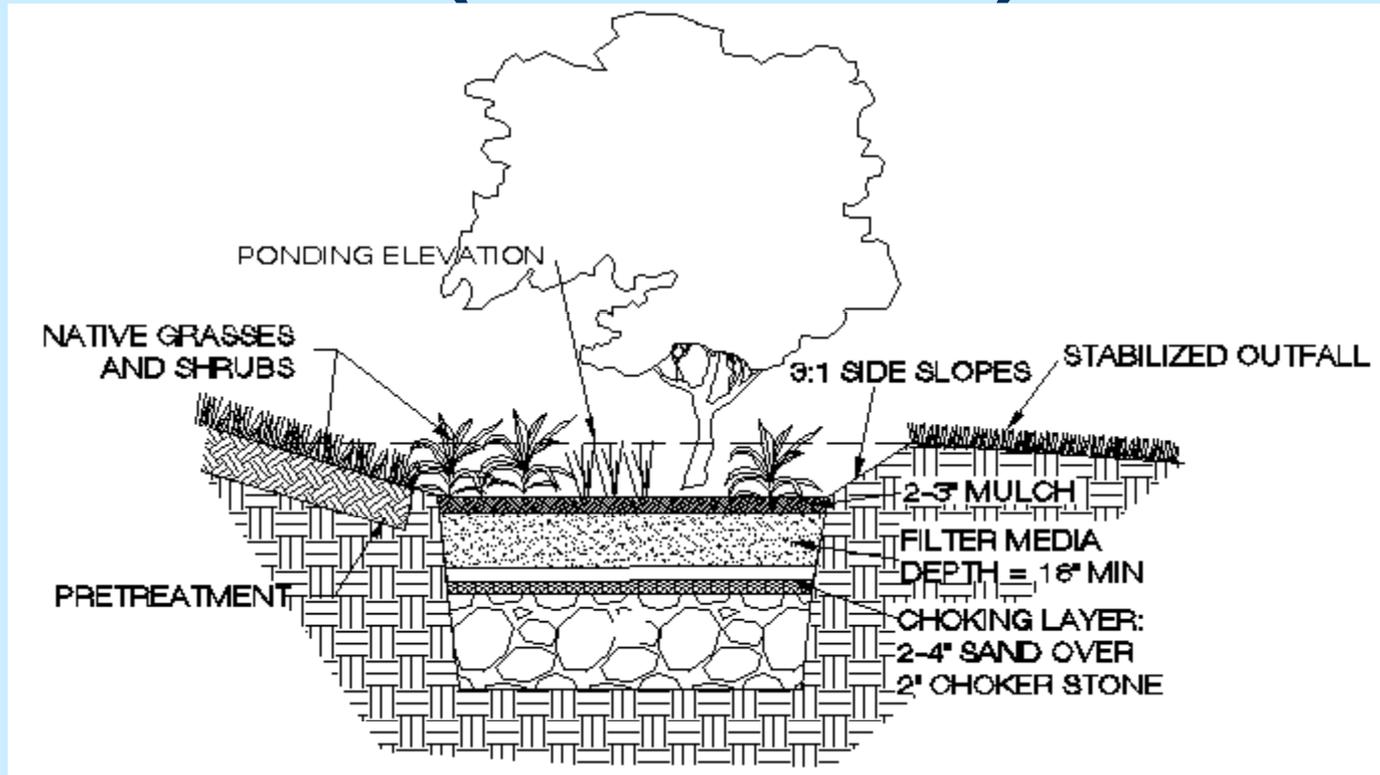
- Underdrain designs without enhanced features
- Less than 24" media
- 60% retention value for the design storm captured + additional TSS removal
- Oversizing practice can result in meeting full criteria

Enhanced Bioretention 1



- Underdrain designs with infiltration sump and 24" media
- 100% retention value for the design storm captured

Enhanced Bioretention 2 (Infiltration)



- For infiltration designs (storage volume must infiltrate within 72 hours)
- Retention value for the design storm captured

Bioretention Feasibility Criteria

- Works for all soil types and most site conditions
- Contributing slopes 1 to 5%
- 4 to 5 feet of head
- No irrigation or baseflow
- Liner required for hotspots, with liner

Conveyance Criteria and Pretreatment

- Conveyance: Off-line vs. On-line.
 - On-line requires overflow device
- Pretreatment Required
 - Pre-treatment Cell
 - Grass Filter Strips
 - Stone Diaphragm
 - Etc.

Bioretention Design Criteria

- Max ponding depth: 18", with 3:1 side slopes
- Minimum filter depth:
 - 24" for enhanced designs
 - Can be reduced to 18" for small-scale practices
- Infiltration designs: min soil infiltration rate: 0.5"/hr
- Ponding Volume = at least 75% of storage volume.



Bioretention Design Criteria

- Filter Media Specifications
 - 85%-88% sand
 - 8%-12% top soil
 - 3%-5% organic matter (leaf compost)
 - P concentrations between 7 and 21 mg/kg
- Surface Cover Options:
 - Mulch and perennial vegetation
 - Turf
 - Stone with perennial vegetation

Bioretention Design Criteria

Sizing Equation

$$Sv_{practice} = SA_{bottom} [(d_{media} \times n_{media}) + (d_{gravel} \times n_{gravel})] + (SA_{average} \times d_{ponding})$$

Where:

$Sv_{practice}$ = total storage volume of practice (cu. ft.)

SA_{bottom} = bottom surface area of practice (sq. ft.)

d_{media} = depth of the filter media (ft)

n_{media} = effective porosity of the filter media (typically 0.25)

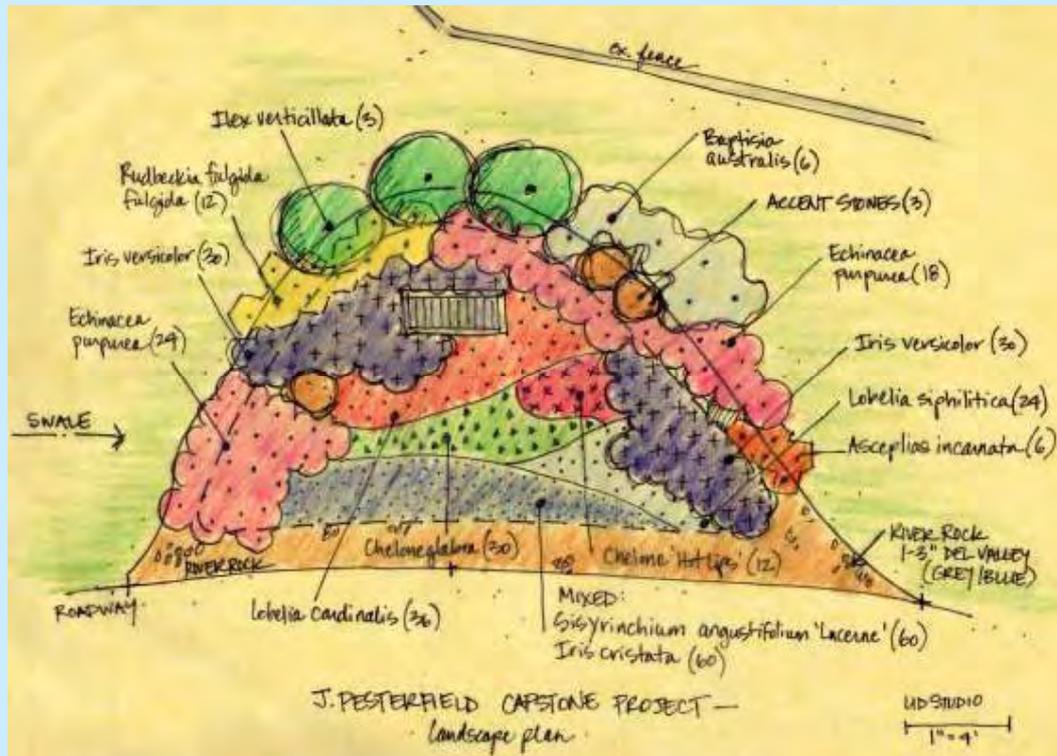
d_{gravel} = depth of the underdrain and underground storage gravel layer(ft)

n_{gravel} = effective porosity of the gravel layer (typically 0.4)

$SA_{average}$ = the average surface area of the practice (sq. ft.) typically = $\frac{1}{2}$ x (top area plus the bottom (SA_{bottom}) area)

$d_{ponding}$ = the maximum ponding depth of the practice (ft).

Bioretention Landscaping Criteria



Questions





3.2 Rainwater Harvesting

Rainwater Harvesting Specification

- May become a key BMP in heavily urban areas.
- Effectiveness for retention requirements depends on size of tank and dedicated demand.

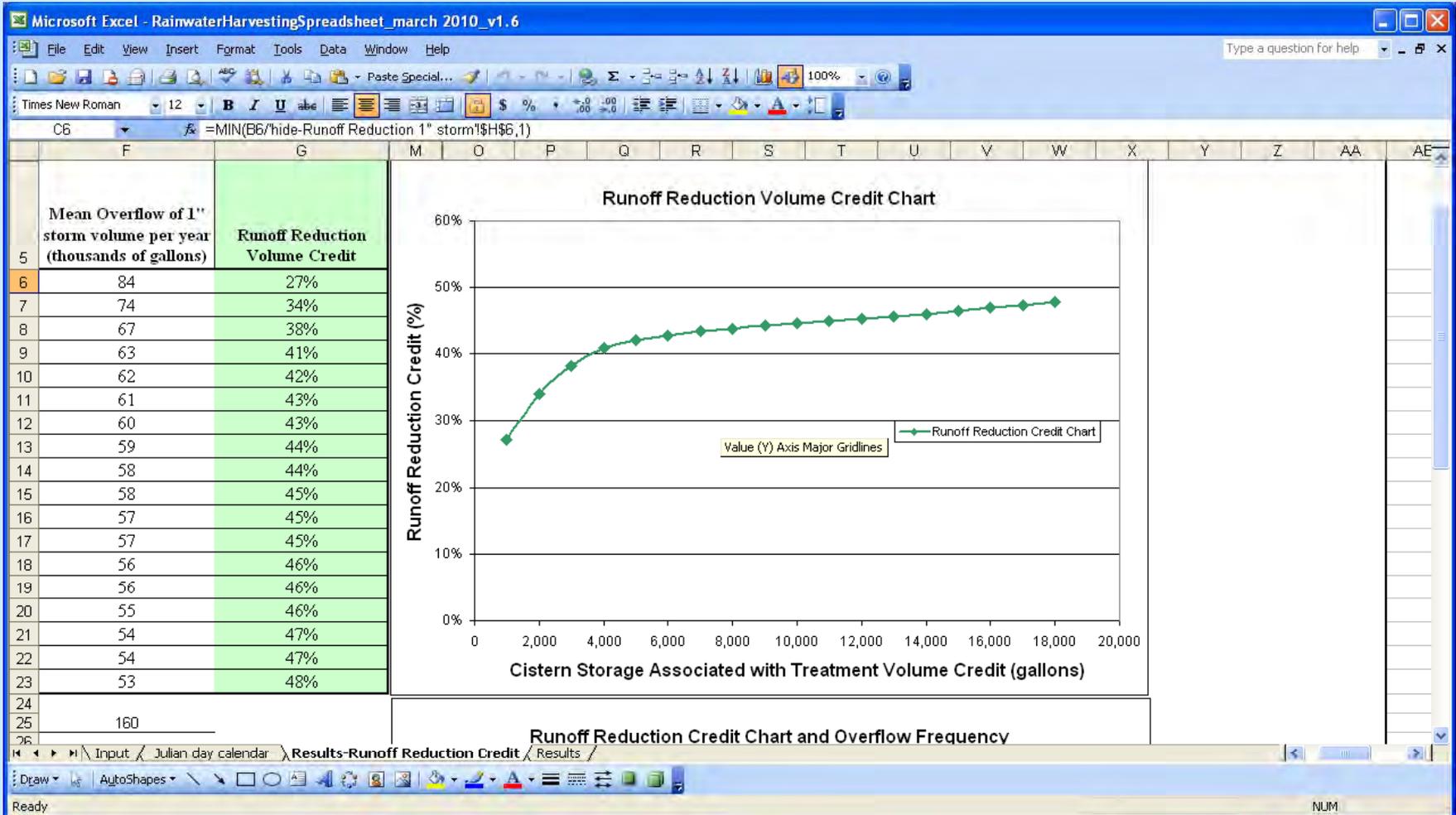
Rainwater Harvesting Feasibility Criteria

- Minimal space or setback requirements.
- Filters, pumps, and overflow devices are generally necessary.
- **Risk Assessment needed to determine any treatment requirements.**

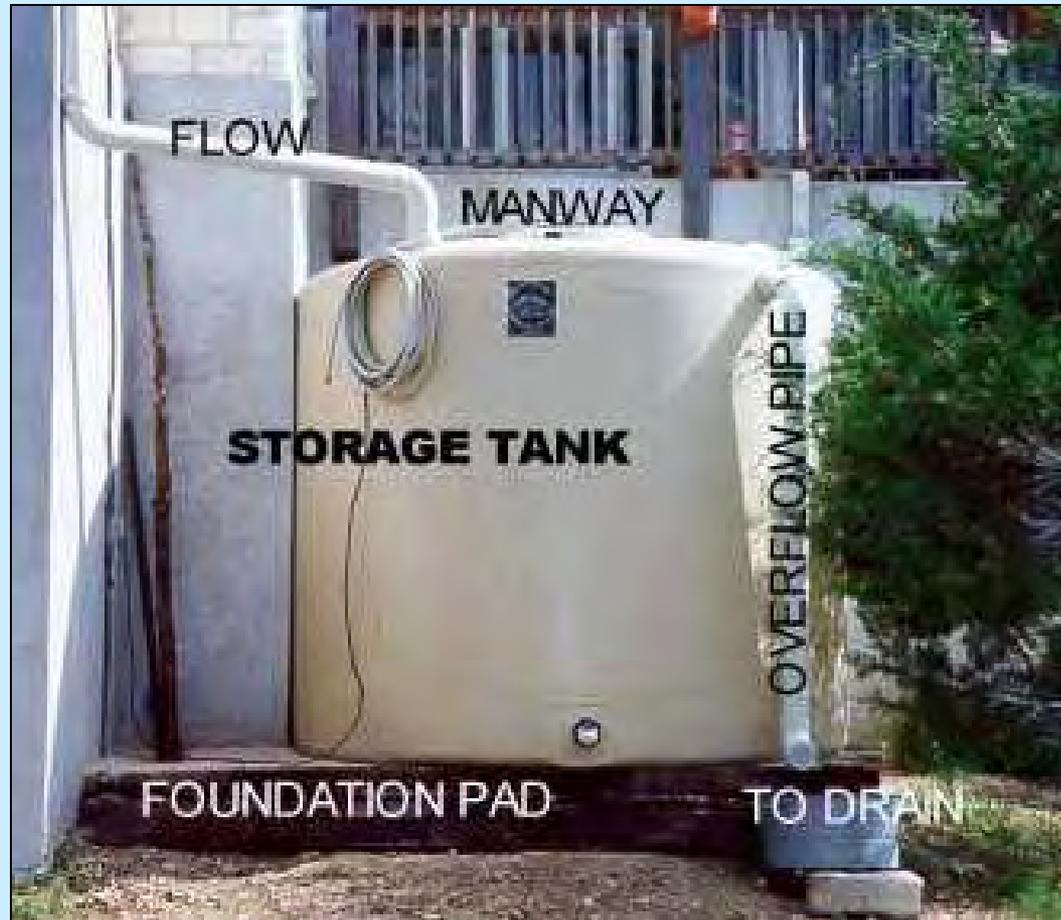


Cistern Design Spreadsheet

- Retention value determined through cistern design spreadsheet.



Questions





3.3 Impervious Surface Disconnection

Disconnection Specifications

- Difficult in ultra-urban situations
- Requires careful site planning, but utilizes green space efficiently
- Turns runoff source into BMP

Three Disconnection Options

D-1 Simple Disconnect to Pervious Area

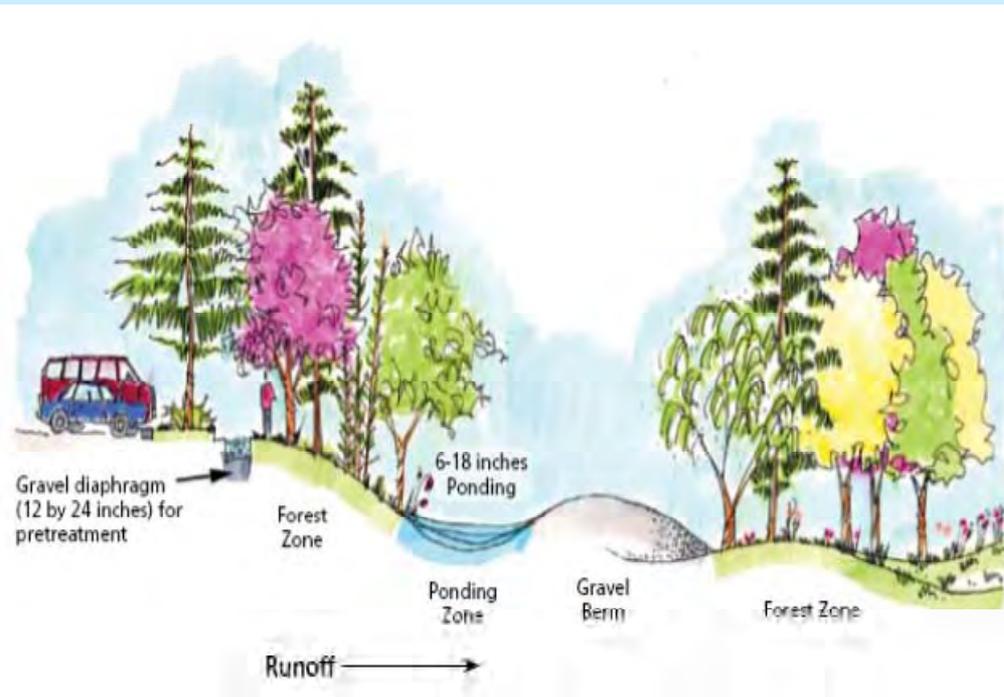
D-2 Simple Disconnect to Conservation Area

D-3 Simple Disconnect to Compost Amended Filter Path

D-1 Disconnection to Pervious Area



D-2 Disconnection to Conservation Area



D-3 Disconnection to Compost Filter Path



SOIL RESTORATION BAY-WIDE DESIGN SPECIFICATION

VERSION 1.0

OPEN FOR COMMENT UNTIL JUNE 1, 2008



How You Can Develop the First Soil Restoration Design Spec in the Chesapeake Bay

Our goal is to produce a simple standard specification that can boost performance, increase longevity, reduce maintenance burden, and create an attractive amenity – and at the same time drive down the unit cost of treatment. So please give this a careful review, and e-mail your comments to Tom Schuster at wschuste@h2onut.com, or post comments or upload information at chESAPEAKEstormwater.net. This draft has annotations highlighting key issues and design needs. This draft is open until June 5 2008, when a final draft will be produced based on your comments. Thanks in advance for your participation in this important project.

Impermeable Surface Disconnection

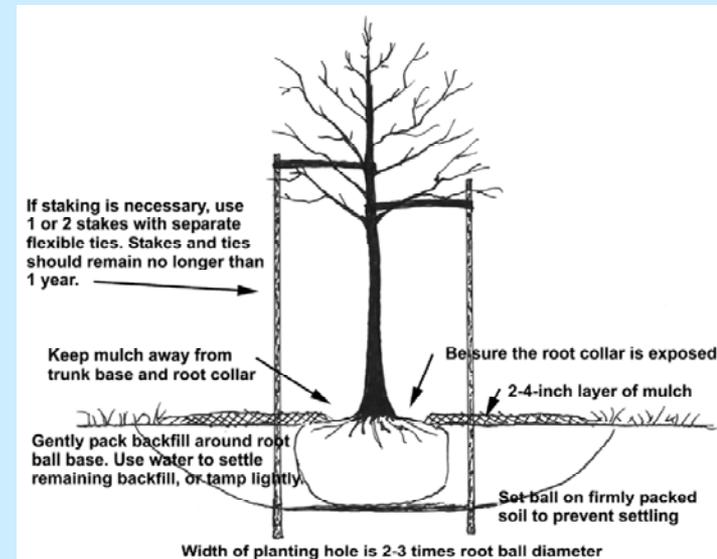
- For rooftops, CDA \leq 1000 sf per disconnection
- For non-rooftop, the longest contributing impervious area flow path \leq 75'.
- The available receiving area must be at least 10' – 25' wide and 15' – 100' long.
- Width can be greater if runoff is conveyed via sheet flow or a level spreader.

Disconnection Retention Values

- **To a pervious area:** 2.0 cubic feet per 100 square foot of receiving pervious area
(21% volume reduction)
- **To a conservation area:** 6.0 cubic feet per 100 square foot of receiving pervious conservation area
(63% volume reduction)
- **To a soil compost amended filter path:** 4.0 cubic feet per 100 square foot of receiving pervious area
(42% volume reduction)

3.13 Tree Planting and Preservation Specifications

- Gives Retention Value for Individual Trees
- Proper planting and maintenance required.
- Each preserved tree gets 20 cubic foot retention value.
- Each newly planted tree gets 10 cubic foot retention value.



3.12 Proprietary Practices

- Approval procedures involve field studies and/or lab tests.
- Variable retention and TSS removals.
- In general, low retention value and high TSS removal.



3.6 Stormwater Filtering Systems

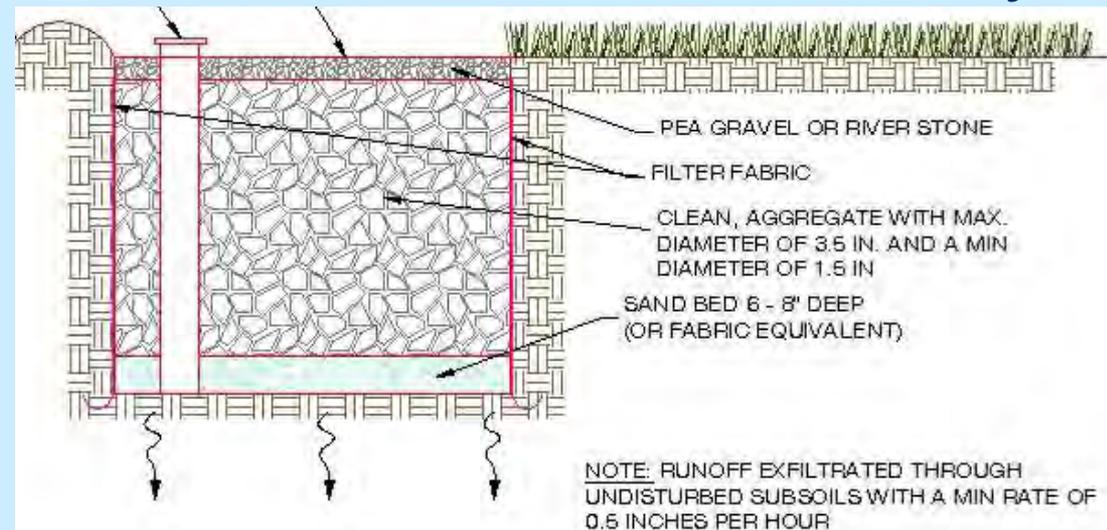
- Updated, but kept largely the same.
- 0% Retention Value. 60% TSS removal.
- Will likely be less prevalent in the future.



Image: Albemarle County

3.7 Stormwater Infiltration

- Expanded, especially for materials, installation, and maintenance.
- 100% Retention Value for water that infiltrates in 72 hours.
- $\frac{1}{2}$ measured infiltration rate used as safety factor.

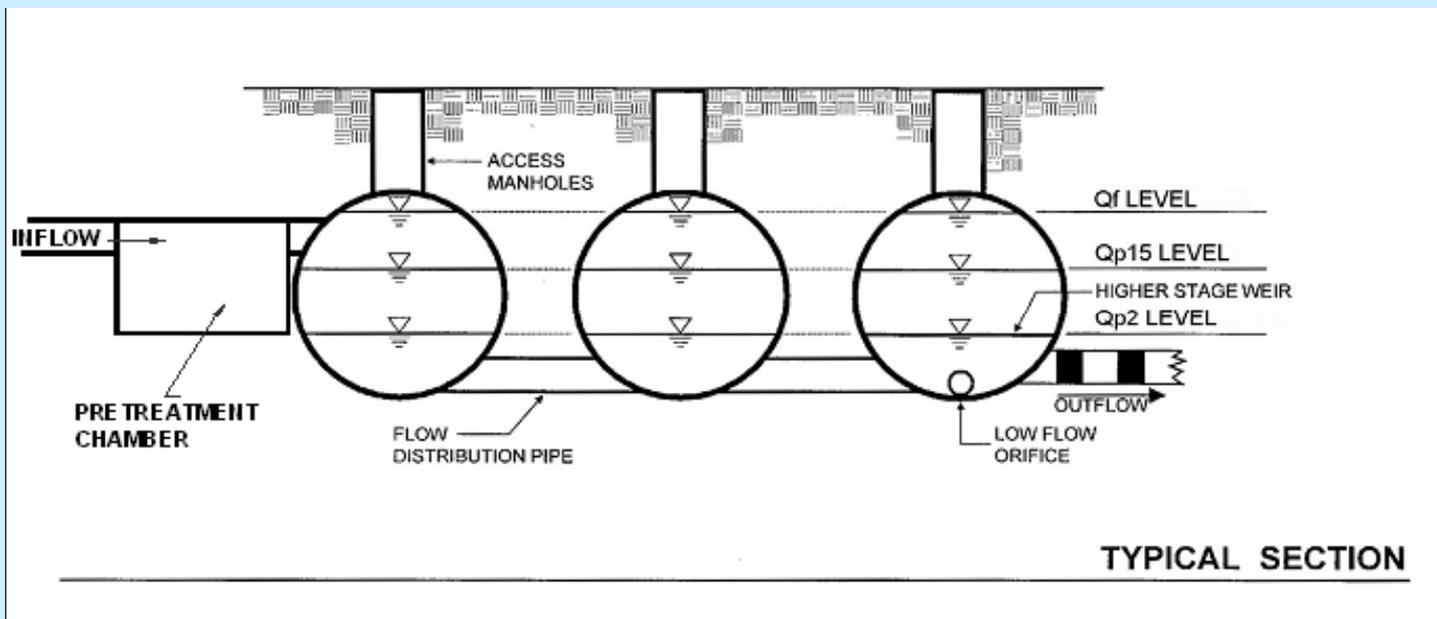


3.8 Open Channels

- Includes dry swale, wet swale, and grass channel
- Not high priority BMPs.
- Dry Swale = 60% Retention + 50% TSS
- Wet Swale = 40% TSS removal
- Grass Channel = 10% - 30% Retention + 30% TSS

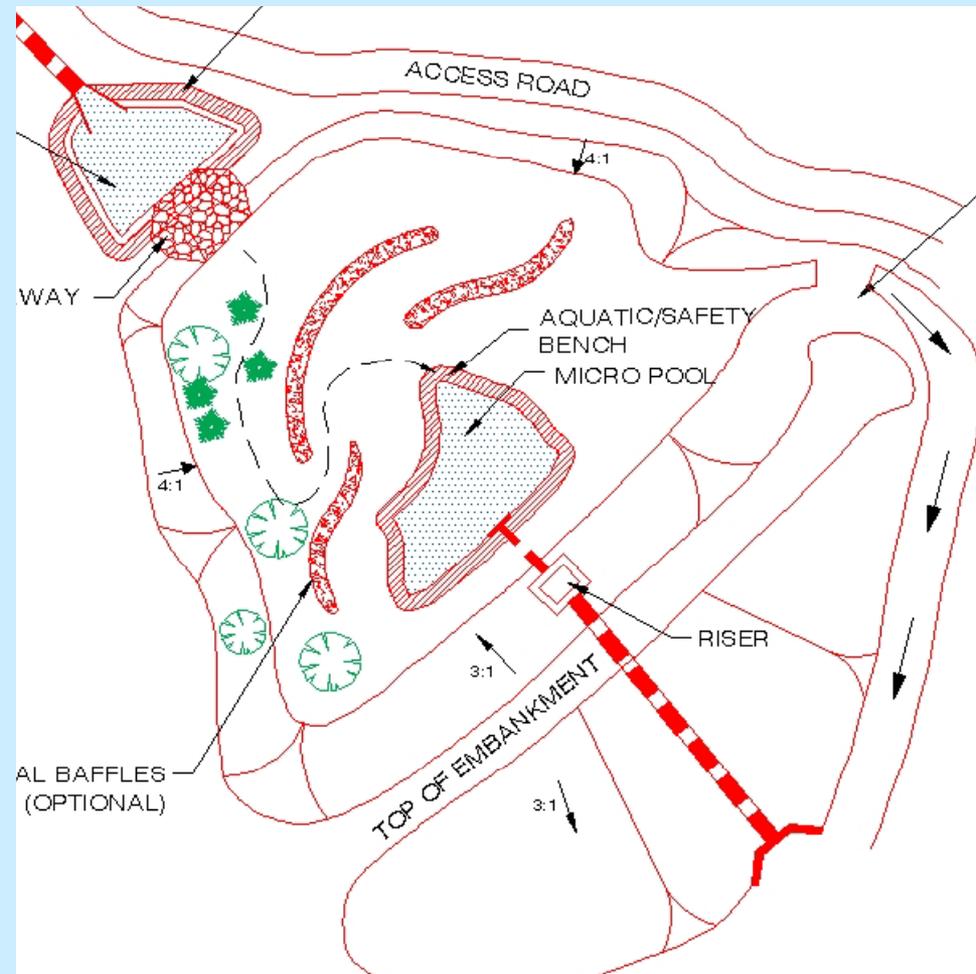
3.11 Storage Practices

- More detailed specification, but no retention or TSS removal value.
- Intended only for large storm events.



3.9 Stormwater Ponds & 3.10 Stormwater Wetlands

- More detailed specifications, few major changes
- 0% retention value.
- 50% TSS removal.



Questions





Stormwater in the District

- Managing Peak Flows by Maintaining:
 - 2 yr to pre-development conditions
 - meadow standard used as a surrogate for land conditions before land disturbance
 - Maintain 15 yr to pre-project conditions
 - based on existing capacity of receiving infrastructure
- Proposed Revisions add Static Volume:
 - Runoff Prevention (e.g. conservation, reforestation)
 - Runoff Reduction (e.g. LID, water reuse)
 - Runoff Treatment (e.g. sand filter)

MS4 Permit Requirements



- Retention standard, 90th percentile (1.2 inch)
- Major substantial improvement projects
- Retention to the Maximum Extent Practicable (MEP) in the existing Right of Way (ROW)
- Revision of Stormwater Management Guidebook
- Develop off-site options



Compliance Flexibility: Highlights

- Choice of thirteen BMP categories
- Over control within drainage areas
- Harvested water quality end use standards vary by use and potential risk-not always maximum
- Shared BMPs can provide onsite retention
 - a neighborhood scale approach



Compliance Flexibility: Highlights

- Minimum on-site *retention floor*; use off-site options for the balance
 - In-Lieu Fee to DDOE
 - Stormwater Retention Credit (SRC) Trading - private
- Procedure to go below the *retention floor*
 - relief for extraordinarily difficult site conditions
 - balance allowed through off-site options
- Use adjacent public right of way (PROW)
 - retain public runoff in the PROW
 - SRCs certified and tracked by DDOE
 - maintenance agreements with DDOT