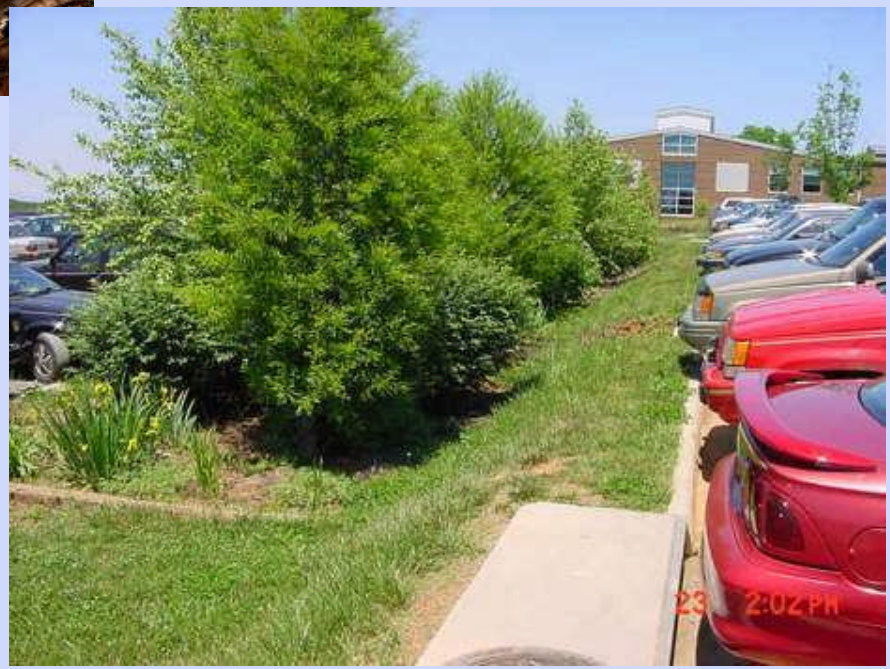
Proposed Virginia Stormwater Management Regulations:

Water Quality & Quantity Criteria & Compliance

Technical Advisory Committee
July 16, 2008



Center for Watershed Protection

Virginia Department of Conservation & Recreation

An Uphill Battle?

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
- 20 staff in MD, SC, VA, NY

www.cwp.org

www.stormwatercenter.net

CENTER FOR WATERSHED PROTECTION

CWP Role

- Update Stormwater Quality & BMP Performance Data
- Develop Stormwater Quality Approach
  - Methods & Computations
  - BMPs
- Assist with ASCE/DCR Charettes
- Participant in Stormwater Quantity Discussions

Presentation Overview

- Virginia Stormwater Epochs: 2007, 2008
- Key Concepts for Proposed Runoff Reduction Method
- Design Charettes
- Spreadsheet Tool
- Water Quantity Workgroup
- Take Home Points

Major Epochs in VA Stormwater

- BMP-ocene: Existing regs & Handbook
- LID-ocene: First round of Regs revisions, Spring/Summer 2007
- Reducto-cene: Refinements in Winter/Spring 2008 – focus on Runoff Reduction

Where We Were in 2007 (LID-ocene)

- Site-Based Load Standards for Total Phosphorus (TP) & Total Nitrogen (TN)
- 40% Impervious cutoff:
  - TP standard < 40%
  - TN standard > 40%
- LID “Credits” Based on ability to reduce runoff volume
- BMP Lookup Table
- Virginia-specific event-mean concentrations (EMCs)

Review of Available Methods

1. CBLAD Method	Reduce Load to Ave. Land Cover Condition
2. Performance Standard	Reduce Load to Site-Based Standard (e.g., 0.28 lbs/acre)
3. Technology Approach	Select from BMP Table (e.g., existing regs)
4. No Net Increase	Reduce Load to Pre-Development Levels
5. One Size Fits All	80% TSS, 40% TP

Site-Based Performance Standards

	Total Phosphorus	Total Nitrogen
Low Impervious Sites (< 40%)	0.28 lbs/acre/yr	3.00 lbs/acre/yr
High Impervious Sites (> 40%)	0.45 lbs/acre/yr	2.68 lbs/acre/yr

- Low Impervious – P is critical pollutant (yards, soil loss)
- High Impervious – N is critical pollutant (atmospheric deposition contribution to stormwater)
- BMP treatment mechanisms can be designed to treat both P & N

Issues With 2007 Method

- Split TP/TN standard problematic
  - Incentive to create more impervious cover?
- LID Credits separate (optional) loop
- Lacked sizing/treatment criteria for BMPs
- Not integrated with water quantity
  - Channel Protection
  - Flood Control

2008 Refinements

"Reducto-cene" – **Runoff Reduction Method**

- More research on BMP performance
- Runoff Reduction as unifying approach
- Integrated with sizing/design
- Comply with TP; design for broader range of pollutants (including TN)
- No "Credits" – all BMPs (conventional, LID) in play
- Treatment train
- Compliance/site planning spreadsheet
- Integrating with water quantity

2008 Refinement Period Process

- Developed Spreadsheet
- ASCE/DCR Charettes
- CWP Tech Memo
  - www.cwp.org > Resources > Controlling Runoff & Discharges > Stormwater Management > National/Regional Guidance
- Quantity Workgroup

Compliance/Site Planning Spreadsheet

1. Post-Development Project & Land Cover Information

Constants					
Annual Rainfall (inches)	43				
Target Rainfall Event (inches)	1.00				
Phosphorus EMC (mg/L)	0.28				
Target Phosphorus Load (lb/acre/yr)	0.28				
Pj	0.90				
Land Cover (acres)					
	A soils	**B Soils**	**C Soils**	**D Soils**	**Totals**
Forest/Open Space -- undisturbed, protected forest/open space or	0.0	2.0	4.0		6.0
Managed Turf -- disturbed, graded for yards or other turf to be		6.0	14.0		20.0
Impervious Cover (all soil types)	14.0				14.0
				Total	40.0
Rv Coefficients					
	A soils	**B Soils**	**C Soils**	**D Soils**	
Forest/Open Space	0.02	0.03	0.04	0.05	
Managed Turf	0.15	0.20	0.22	0.25	
Impervious Cover	0.95				

Key Concepts for Runoff Reduction Method

1. Site-Based Pollutant Loads
2. Water Quality – Beyond Impervious Cover
3. Treatment Volume
4. Runoff Reduction (RR) & Pollutant Removal (PR) Practices
5. Level 1 & 2 BMP Designs
6. Spreadsheet Compliance Tool

1. Site-Based Pollutant Load Standards

- <u>What we do now</u>
  - Total phosphorus
  - Post-to-pre, OR
  - Average land cover condition, OR
  - NOTHING
- <u>What is proposed</u>
  - TP basis for comps; TN also considered
  - No comparison to pre-development
  - Load limit tied to Trib Strategy goals for Urban Land = 0.28 lbs/acre/year (TP)

2. Water Quality – Beyond Impervious Cover

- <u>What we do now</u>
  - Simple Method, CB Method
  - Rv = 0.05 x 0.009(I)
  - I = impervious cover
  - Impervious is sole indicator of water quality
- <u>What is proposed</u>
  - New runoff coefficients for turf (disturbed soils), forest cover
  - Incentives in design process to keep forest, minimize soil disturbance

WATERWAY BUFFER ZONE
VEGETATION PROTECTED
BY COUNTY CODE

www.hpgolf.ca

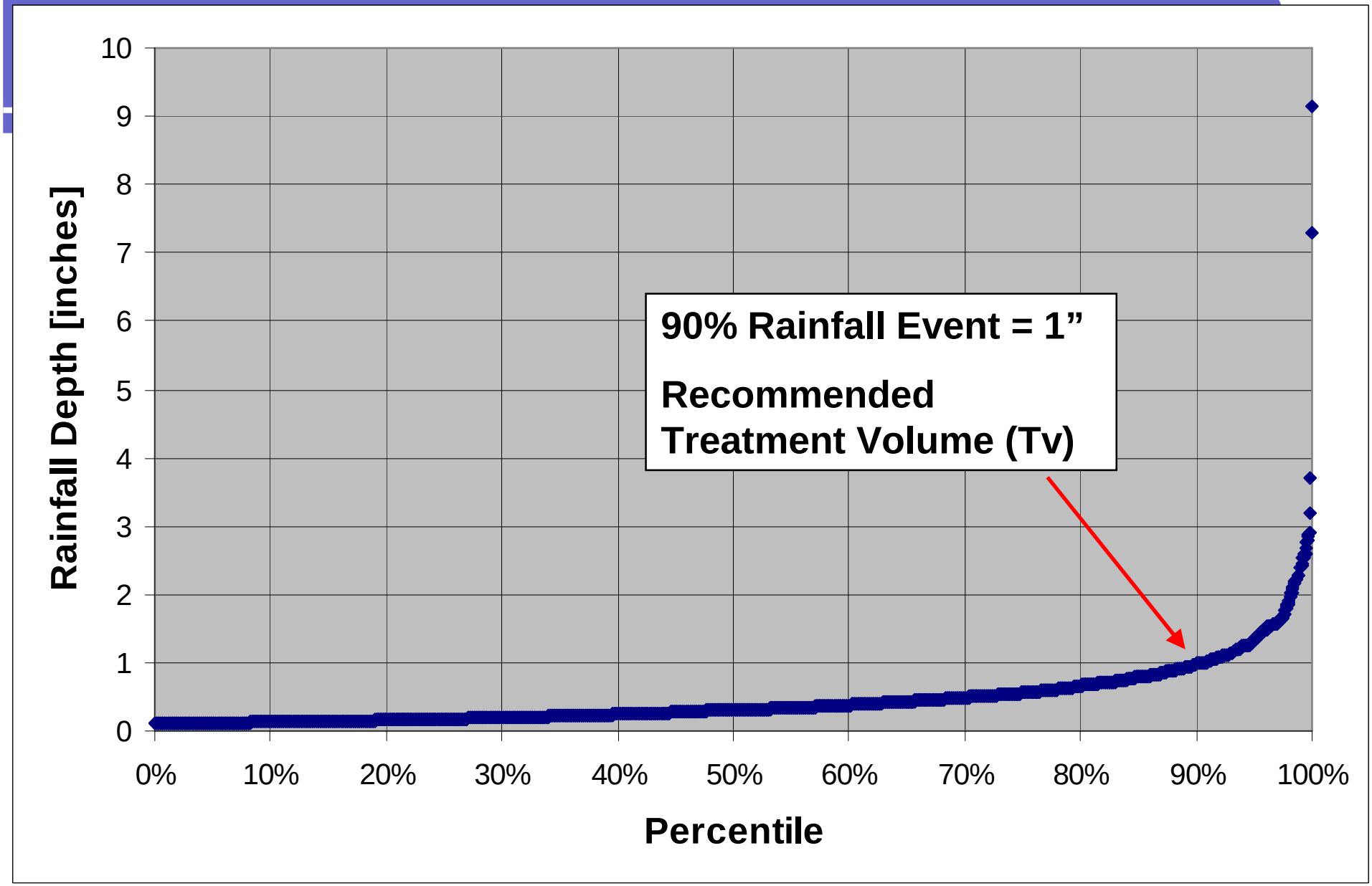
Derivation of Land Cover Coefficients

Based on Recent Research on

- Compacted Soils and Watershed Forestry
- Disturbed Soils (Pitt et al 2005)
- Forests (Cappiella et al 2005)
- IC (Adapted from Schueler, 1987)

3. Treatment Volume

- <u>What we do now</u>
  - WQV = 0.5” x impervious
- <u>What is proposed</u>
  - Tv = 90th percentile storm event (1”) x Site Rv


Rainfall Depth [inches]
10
9
8
7
6
5
4
3
2
1
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percentile
90% Rainfall Event = 1”
Recommended
Treatment Volume (Tv)

Rainfall Analysis Around VA

Location	**90th Percentile Rainfall Depth (in)**
Abington	0.97
Near Harrisonburg	1.05
Lynchburg	1.23
Richmond	1.29
Northern Virginia	1.14

Benefits of Treatment Volume

✓Provides incentives to preserve forest, reforest, conserve soils and restore soils

✓ Captures and treat the 90% Storm (1 inch) and provides some treatment for larger storms

✓Consistent with other state manuals and is widely accepted

✓ Based on the most recent science in regard to runoff coefficients and the performance of practices

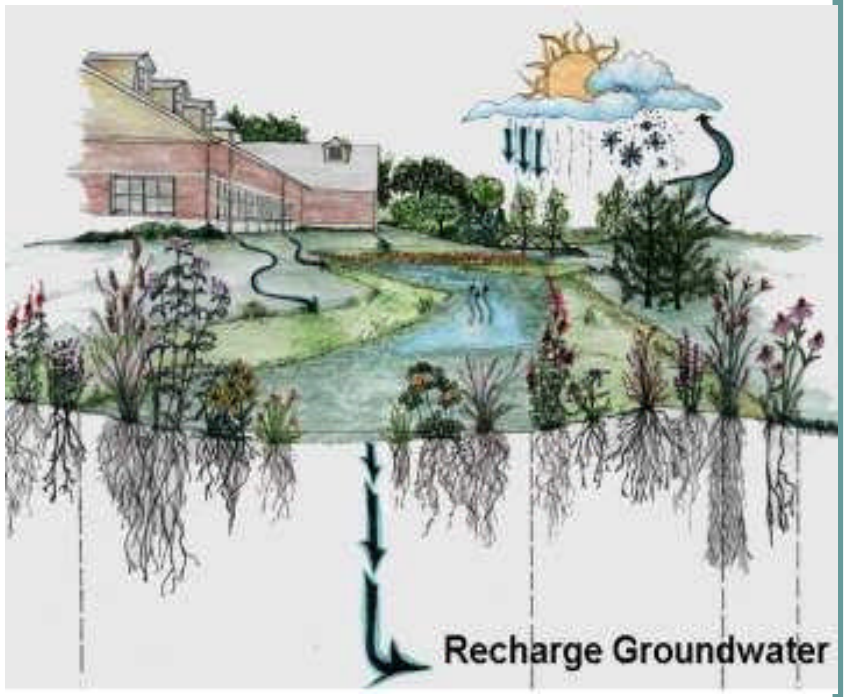
Can Also Help Address Channel Protection

4. Runoff Reduction (RR) & Pollutant Removal (PR) Practices

- <u>What we do now</u>
  - BMP performance based solely on pollutant concentrations in vs. out
  - Performance for some BMPs under-reported
  - Not all practices (e.g., LID) assigned rates
- <u>What is proposed</u>
  - Runoff reduction + Pollutant removal = Total BMP Performance

Runoff Reduction (RR)

Runoff reduction is defined as the total volume reduced through canopy interception, soil infiltration, evaporation, rainfall harvesting, engineered infiltration, extended filtration or evapotranspiration at small sites



Recharge, water quality, and even channel protection requirements can be collapsed into a single runoff reduction volume that would maintain predevelopment runoff conditions

Stormwater Practices Differ Sharply in Ability to Reduce Runoff Volume

Wet Ponds, ED Ponds and Constructed Wetlands and Filters Reduce Runoff Volumes by zero to 10%

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

Benefits of Runoff Reduction (RR)

Provides common basis to measure aggregate performance of site design runoff reduction practices and standard stormwater practices together

Can better maintain predevelopment runoff volume, duration and velocity.

Promotes groundwater recharge

Enhances reliability of pollutant MASS reductions

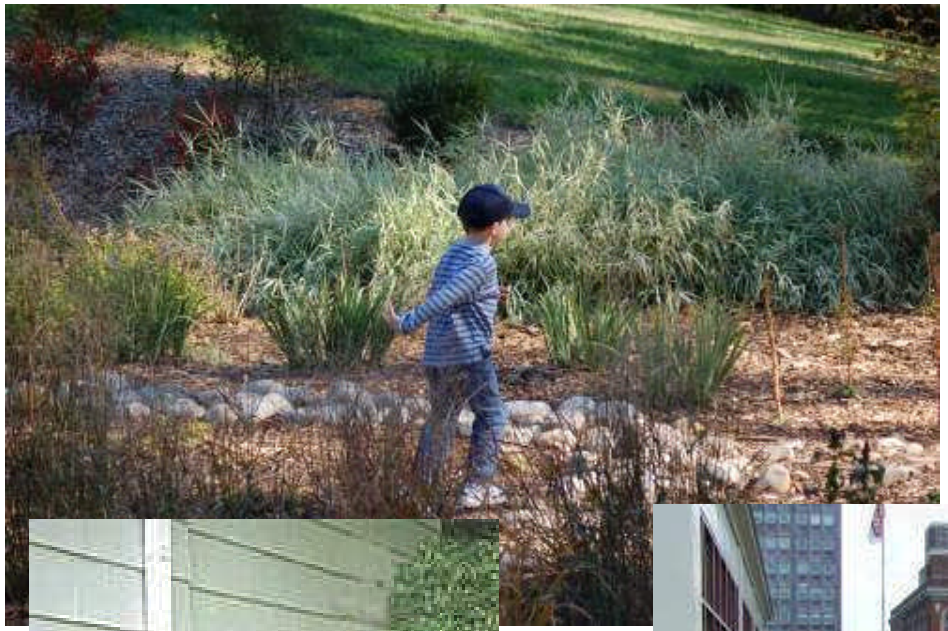
Runoff Reduction Practices *

1. Protected Open Space Receiving Runoff from Developed Areas
2. Rooftop Disconnection (4 options)
3. Pervious Parking
4. Green Roof
5. Grass Channels
6. Bioretention & Dry Swales
7. Wet Swales
8. Infiltration
9. Extended Detention

Each Practice Must Meet Design Specs to Receive the RR "Credit"

* Forest conservation, soil conservation, soil restoration are "self crediting"

Runoff Reduction Practices



5. Level 1 & 2 BMP Design

- <u>What we do now</u>
  - Poor verification of BMP performance based on design choices (Blue Book)
- <u>What is proposed</u>
  - Design checklists & specs
    - Level 1 – standard design (median performance)
    - Level 2 – enhanced design (75th percentile performance)

Deriving Level 1 and 2 Design Factors

Extensive Process to Assign Design Factors to Level 1 and 2:

- ✓ Design Point Tables in Stormwater Retrofit Manual
- ✓ Updated National Pollutant Removal Database
- ✓ Extensive Research on Runoff Reduction Rates
- ✓ Review of more than 100 BMP performance studies
- ✓ Professional Judgement

Primary Design Factors

Five Factors to Segregate Level 1 and 2 Design:

Increased Treatment Volume

Increased Runoff Reduction Capability

Enhanced Design Geometry

Vegetative Condition

Multiple Treatment Pathways

Example of “Short” Design Table

Table 8 Wet Pond Design Guidance	
Level 1 Design (RR: 0 TP: 50)	**Level 2 Design (RR: 0 TP: 75)**
TV= (Rv)(A	TV = 1.5(Rv) (A)
Single Pond Cell, with Forebay	Wet ED or Multiple Cell Design
Pool Depth Range of 3 to 12 feet	Pool Depth Range of 4 to 8 feet
Flow path 1:1 or less	Flow path 1.5:1 or more
Pond intersects with groundwater	Adequate Water Balance

The Treatment Train

Several runoff reduction practices are needed in a series to achieve compliance at most sites

Utilize Step-Wise Design Approach

- ✓ **Conserve Natural Areas & Soils**
- ✓ **Apply Good Site Design (Reduce Impervious & Disturbed Soils)**
- ✓ **Apply Engineered Runoff Reduction Practices**
- ✓ **Apply Standard Treatment Practices**
- ✓ **Offset Fee for Unmet Load (Local Option)**

6. Spreadsheet Compliance Tool

- <u>What we do now</u>
  - Variable – most use Blue Book method
  - Worksheets or spreadsheets
- <u>What is proposed</u>
  - Somewhat uniform use of spreadsheet tool

ASCE/DCR Design Charettes

- 5 workshops
- Over 250 participants
  - Design consultants (over 50%)
  - Local gov’t (over 25%)
  - State & Federal gov’t
  - Environmental
  - Academic
  - Vendors

Feedback from Charettes

- **Integrate with Water Quantity**
- In some cases, had to reach deep for compliance (for sample plans)
- BMPs in series, spreadsheet bug
- Good site planning tool
- Runoff reduction practices optional??? (should they be required)

Feedback from Charettes (cont.)

- Redevelopment?
- Cost/maintenance for distributed practices
- Compliance for linear projects
- Local code conflicts
- Design-specific runoff reduction rates
- Add TN to spreadsheet

Spreadsheet – Beta Version

- TN comps included
- Accomodates BMPs in series
- Compliance by site – BMP design by drainage area
- <u>Some</u> water quantity comps
- Working out kinks

Will the new method ensure nitrogen loads do not increase loads from urban land as a result of future land development?

- ✓ We really think so
- ✓ Better BMP Math
- ✓ Better BMP Design
- ✓ More Reliable

TP & TN Computations

Site Results		
Phosphorous		
TOTAL LOAD REDUCTION REQUIRED (LB/YEAR)	**15.18**	
AFTER APPLICATION OF RUNOFF REDUCTION PRACTICES		
TOTAL ADJUSTMENT TO TREATMENT VOLUME (cf)	19,116	
ADJUSTED TREATMENT VOLUME (cf)	21,540	
ADJUSTED TREATMENT VOLUME (ac-ft)	0.49	
ADJUSTED POST-DEVELOPMENT PHOSPHOROUS LOAD (TP) (lb/yr)	13.5	
PHOSPHOROUS LOAD REDUCTION ACHIEVED (LB/YR)	**12.01**	
AFTER APPLICATION OF POLLUTANT REMOVAL RATES		
Step 3 Load Reduction (lb/yr) for Site	**3.56**	
Remaining Load Reduction (lb/yr) Needed	CONGRATULATIONS!! YOU EXCEEDED T	
Nitrogen		
TOTAL LOAD REDUCTION REQUIRED (LB/YR)	83.58	
AFTER APPLICATION OF RUNOFF REDUCTION PRACTICES		
ADJUSTED POST-DEVELOPMENT LOAD (TN) (LB/YR)	96.8	
LOAD REDUCTION ACHIEVED (LB/YEAR)	85.92	
AFTER APPLICATION OF POLLUTANT REMOVAL RATES		
Step 3 Load Reduction (lb/yr) for Site	**20.58**	
Remaining Load Reduction (lb/yr) Needed		T

Some Comps for Water Quantity

Channel Protection	
Allowable $Q_{Developed} = Q_{Forested} \times V_{forested} / V_{Developed}$	
Target Rainfall Event (in)	2.60
Runoff Reduction Volume (cf)	19,116.22
Drainage Area A	
Drainage Area (acres)	19.00
Runoff Reduction Volume (cf)	12,657.08
Drainage Area B	
Drainage Area (acres)	18.00
Runoff Reduction Volume (cf)	6,459.13

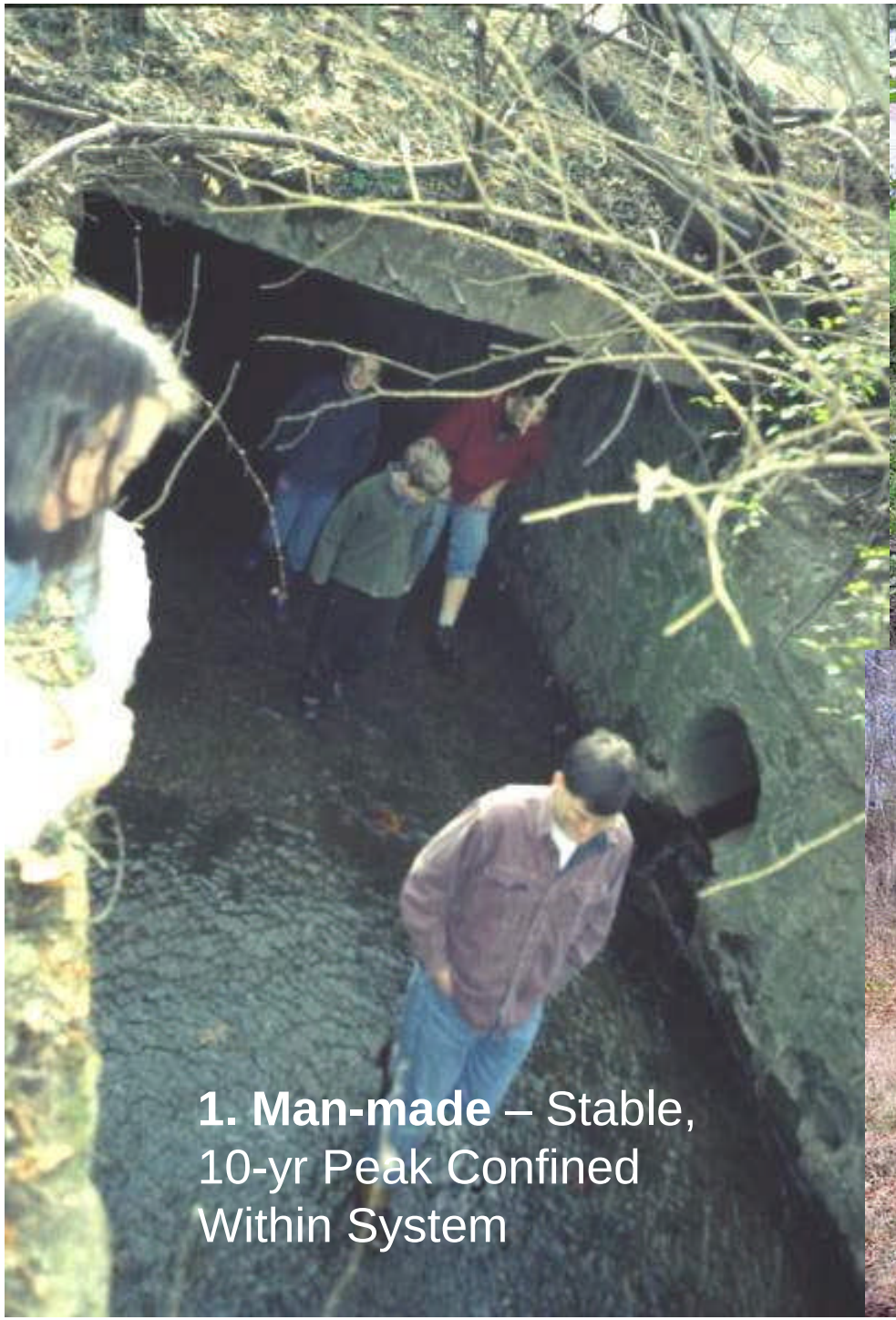
Water Quantity Workgroup

- 4 meetings; work in between
- Where/when quantity control needed; where not?
  - Channel Protection
  - Flood Control
- Integrate with MS-19
- Link with runoff reduction

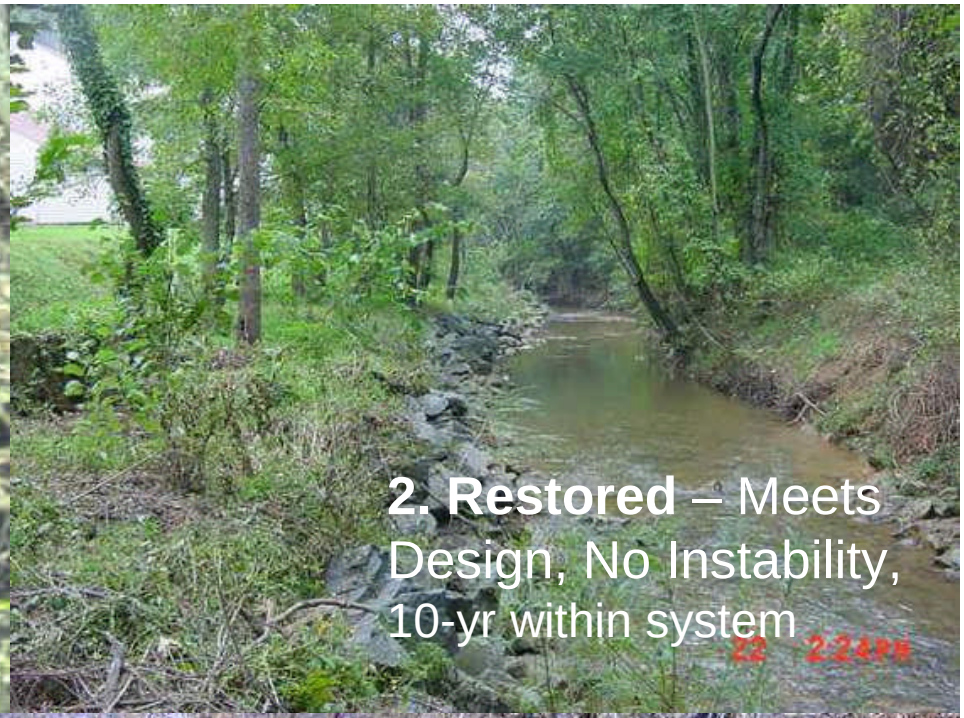
Quantity Control Options

1. Discharge to man-made system
2. Discharge to restored system
3. Discharge to “natural” stable system
   - Energy (developed) ≤ Energy (pre-development)
4. Energy Balance
   - Energy (developed) ≤ Energy (forested) (1-yr storm)
   - Q_{10} post to pre

- 1% Rule (exemption)
  - DA or %

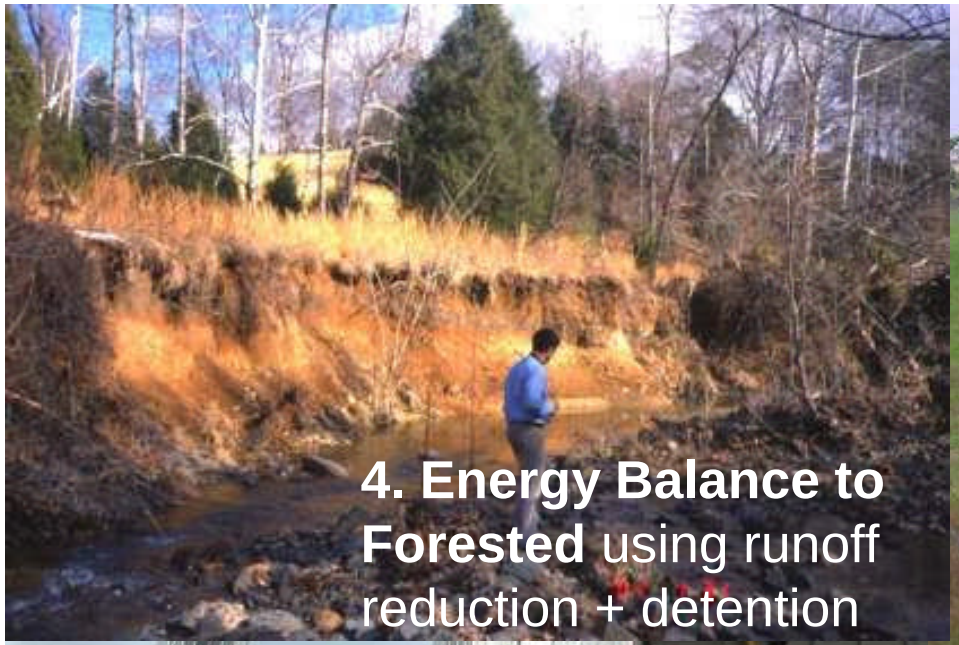


1. Man-made – Stable, 10-yr Peak Confined Within System

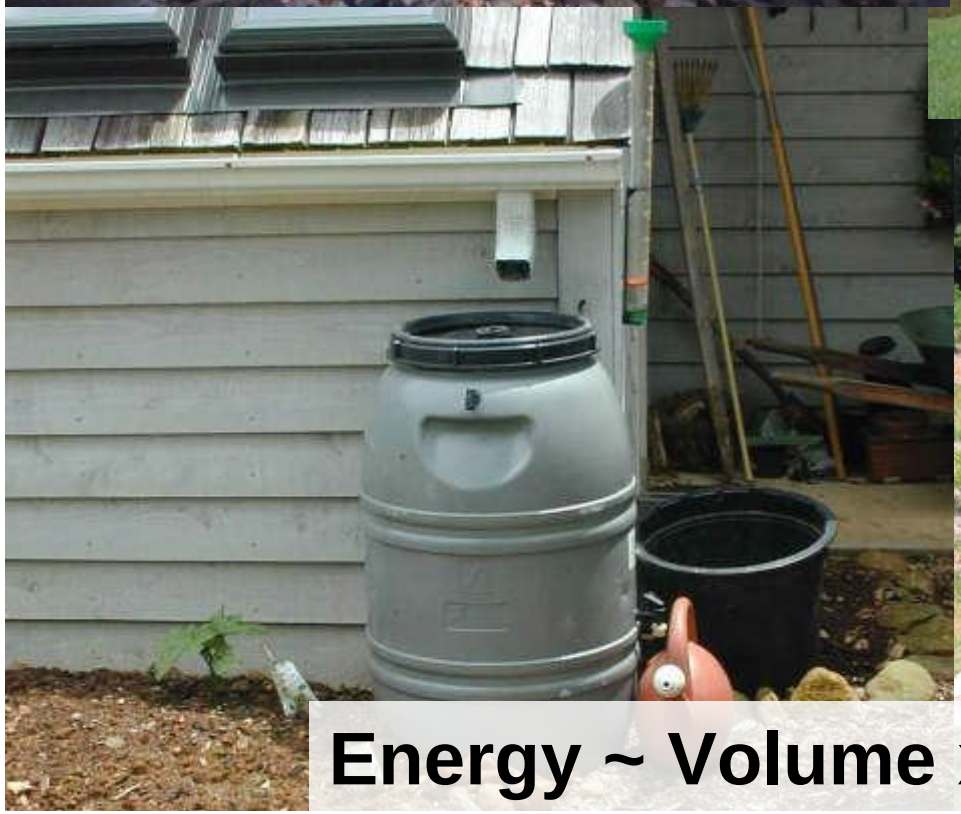


2. Restored – Meets Design, No Instability, 10-yr within system

3. Natural – No instability, Energy to pre-development, 10-yr within system



4. Energy Balance to Forested using runoff reduction + detention



Energy ~ Volume x Peak Discharge

Take Home Points

- Focus on Good Design & Better BMPs
- Integrate Structural, Non-structural, LID
- Incentives to Preserve/Restore Forest & Reduce Disturbed Soils
- Quality & Quantity Play Nice Together
- Feasible/Achievable Across Range of Sites
- Meets Water Quality Goals

Accountability for Trib Strategies

Easy to Understand & Use

Achievable On-the-Ground Outcomes

Incorporates LID

Integrates With Other Standards