Impervious Cover Disconnection Expert Panel

David J. Sample
Associate Professor
Extension Specialist-Stormwater
Biological Systems Engineering
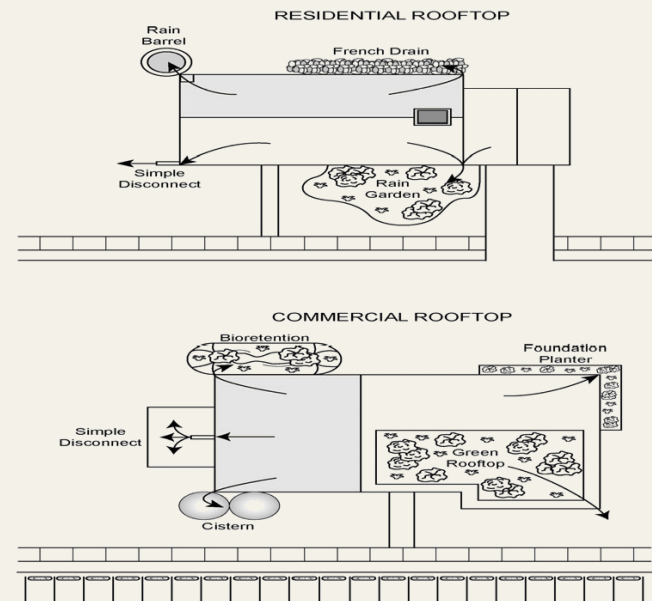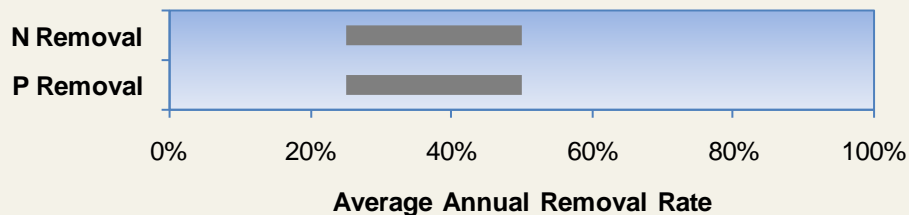
Annapolis, MD
September 15, 2015

VirginiaTech
Invent the Future

Outline

- Literature survey
- Modeling with SWMM
- Virginia Beach site models
- Proposed desktop study
- Summary

Impervious Surface Disconnection

- Redirects rooftop runoff from impervious to pervious areas

- Practice can be used alone (large lot, permeable soils), or in combination

- Most economical practice available

- Credited practice in VA, MD, DE

RESIDENTIAL ROOFTOP

Rain Barrel

French Drain

Simple Disconnect

Rain Garden

COMMERCIAL ROOFTOP

Bioretention

Foundation Planter

Simple Disconnect

Green Rooftop

Cistern

N Removal

P Removal

0%   20%   40%   60%   80%   100%

Average Annual Removal Rate

Literature Survey

- Lucas (2010) modeling study (Delaware)
  - 86% reduction in annual runoff 0%DCIA/100%
- Mueller and Thompson (2009) (Madison)
  - Using lawns for infiltration
  - Generalized model f(disconnection)
- Roy and Shuster (2009)
  - Methods for assessing DCIA widely variable
- Shuster et al. (2005)
  - Literature review and ranges of %imp, DCIA, etc.

Sources:
*Lucas, W.C., 2010. Modeling impervious area disconnection with SWMM. Low Impact Development.Am W*
Mueller, G.D., Thompson, A.M., 2009. The ability of urban residential lawns to disconnect impervious area from municipal sewer, J. Am. Water Resour. As. 45 (5), 1116-1126.
Roy, A.H., Shuster, W.D., 2009. Assessing impervious surface connectivity and applications for watershed management. J. Am. Water Resour. As. 45, 198-209.
Shuster, W., Bonta, J., Thurston, H., Warnemuende, E., Smith, D., 2005. Impacts of impervious surface on watershed hydrology: A review. Urban Water J. 2, 263-275.
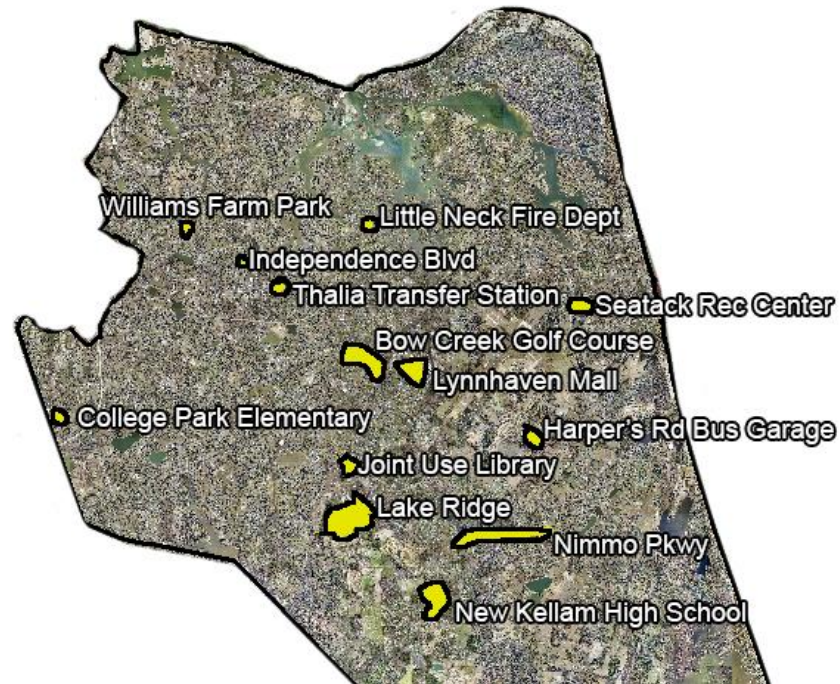
SWMM Model

- Link/node/lumped model
- Single event, continuous
- Subarea routing
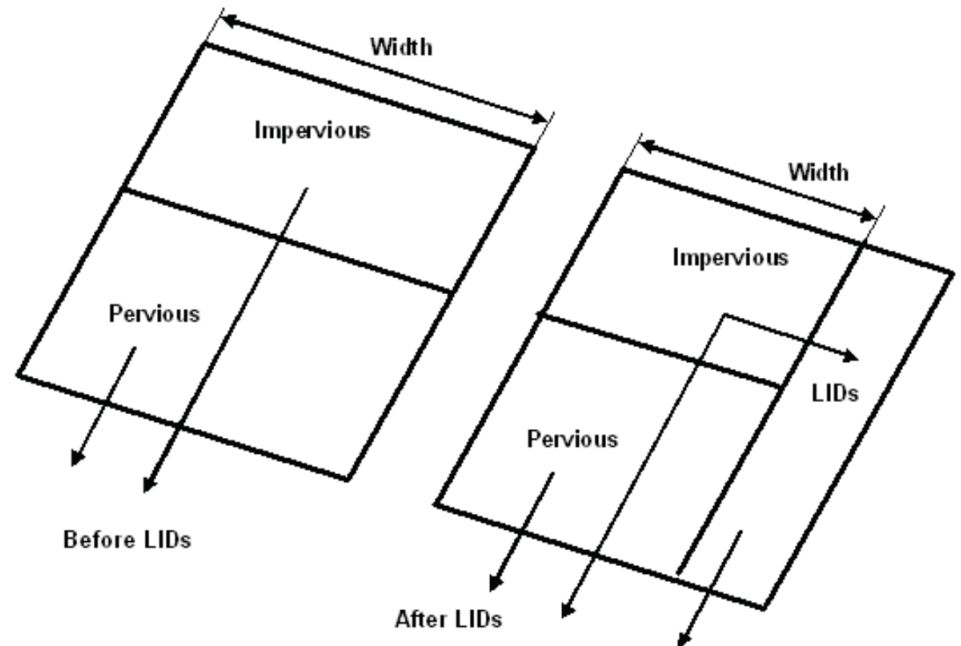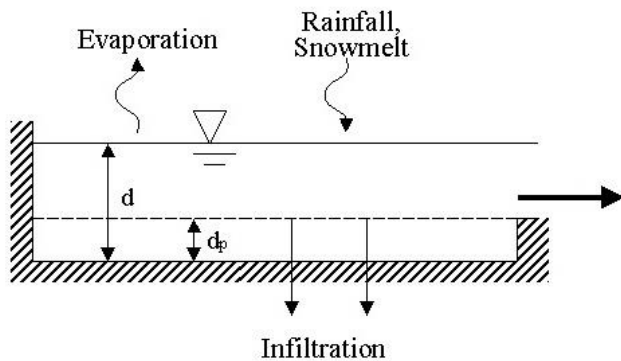
Virginia Beach Modeling Sites

- Verify/Validate RRM use in Coastal VA
  - Select variety of comparison sites
  - Delineate Drainage areas to BMPs
  - Use continuous modeling with SWMM
  - Includes groundwater, evapotranspiration

Approach: Physically Based Modeling

| Land Use	Small	Medium	Large
Commercial/Industrial	Little Neck Fire Station	Harpers Rd. School Bus Facility	Lynnhaven Mall Ponds
Schools	College Park Elementary	Joint Use Library	Kellam High School
Multipurpose Sites	Seatack Recreation Center	Williams Farm Rec Center and School	Bow Creek Rec Center and Golf Course
Linear Projects	Thalia Rd. Transfer Station	Independence Rd.	Nimmo Rd. Extension

Selected Site BMP Distribution

| Site	Rooftop Disconnection	Sheetflow to Open Space	Grass Channels	Soil Restoratio	Vegetated Roofs	Rainwater Harvesting	Permeable Pavement	Infiltration	Bioretention	Dry Swale	Wet Swale	Filtering Practices	Constructed Wetlands	Wet Pond	Extended Detention Pond
Little Neck Fire Station			●												●
College Park Elementary		●				●	●		●	●					
Seatack Recreation Center										●					
Thalia Rd. Transfer Station									●						
Harpers Rd. School Bus Facility	●				●			●	●					●	
Joint Use Library													●		●
Williams Farm Rec Center and School		●	●											●	
Independence Rd.															●
Lynnhaven Mall Ponds														●	
Kellam High School	●					●			●					●	
Bow Creek Rec Center and Golf Course			●								●			●	
Nimmo Rd. Extension												●			●

Harpers Road School Bus Facility

Harpers Rd SWMM Model
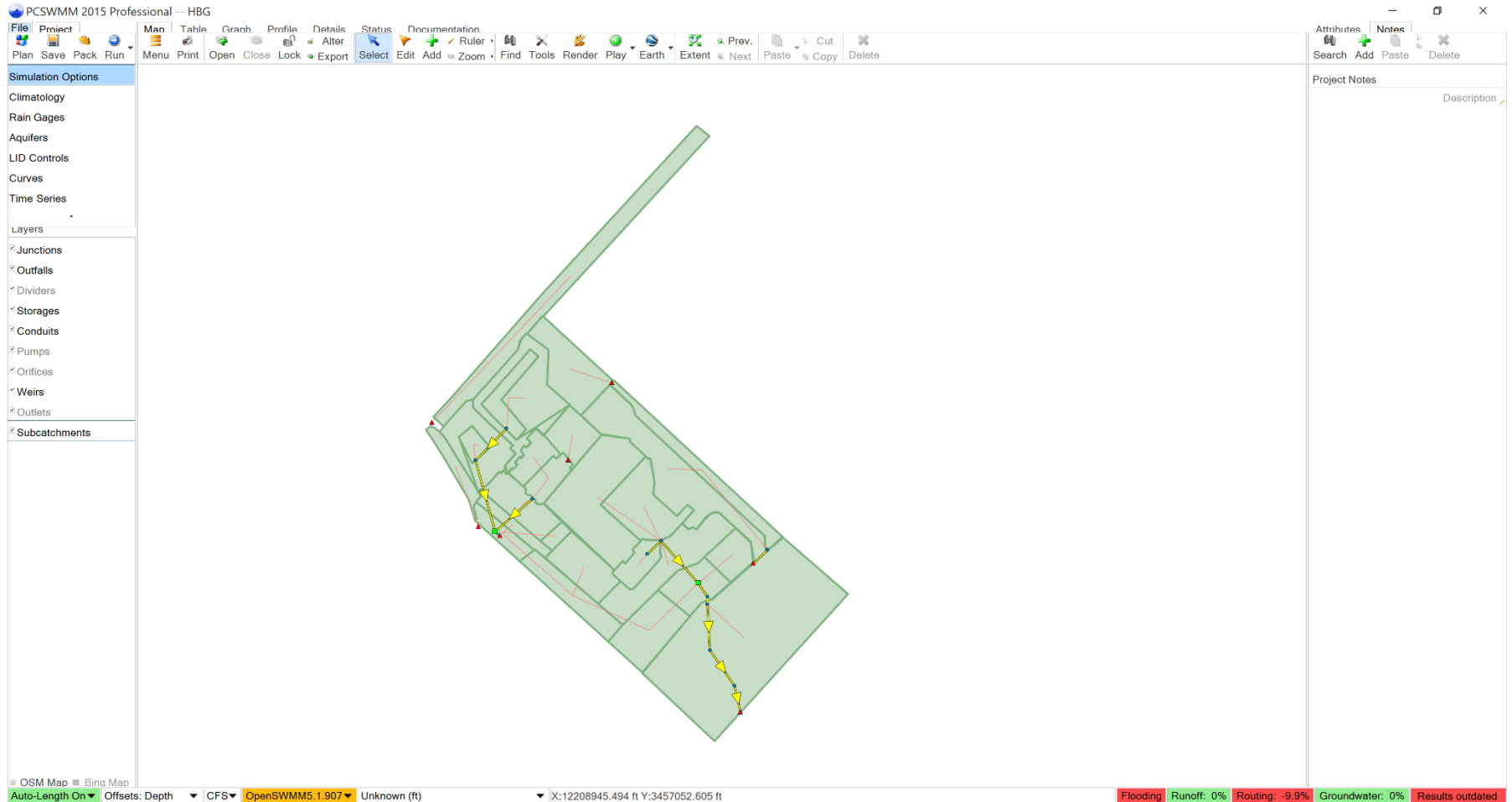
Independence Rd (Ponds)
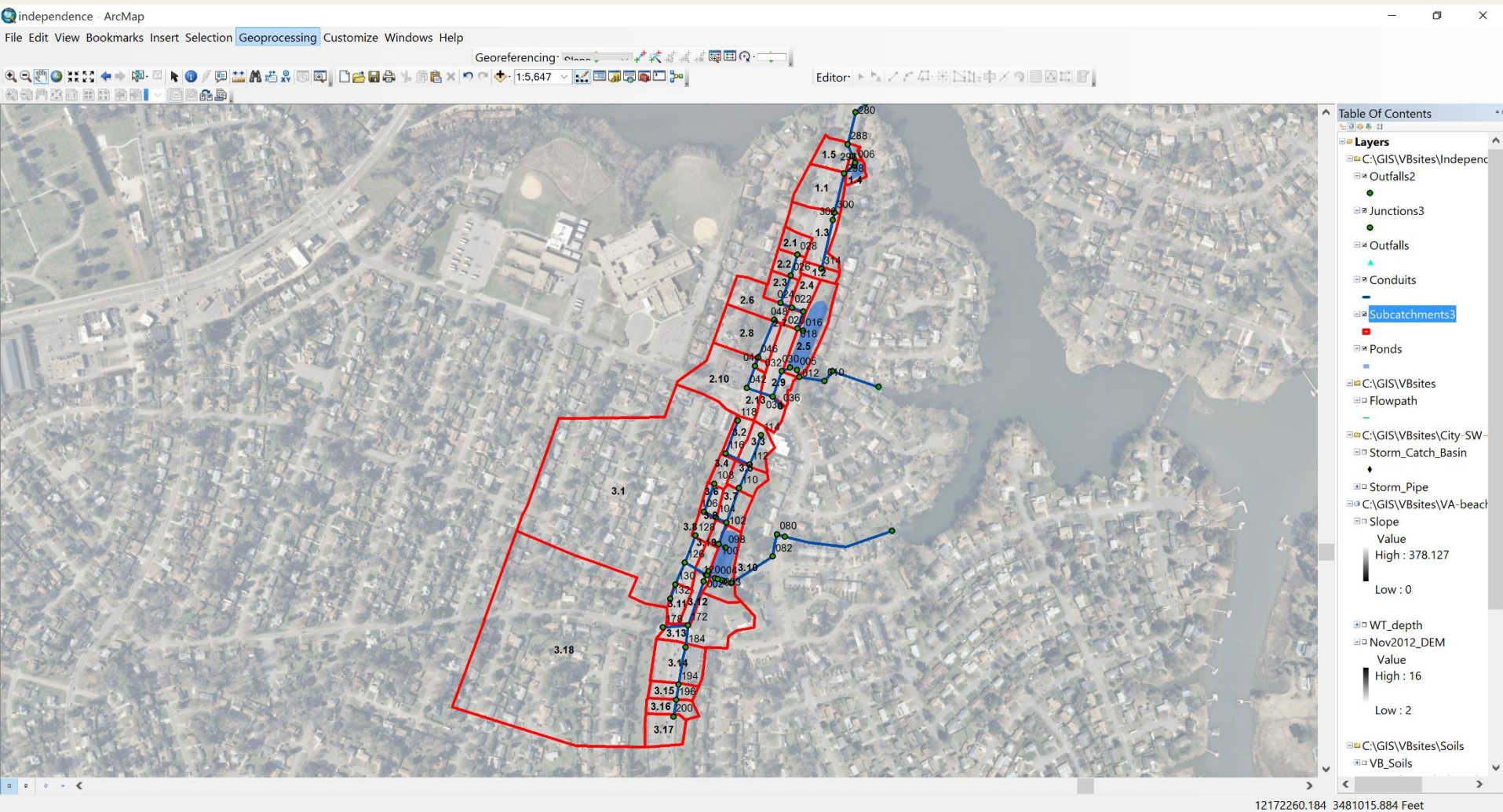
Independence SWMM Model
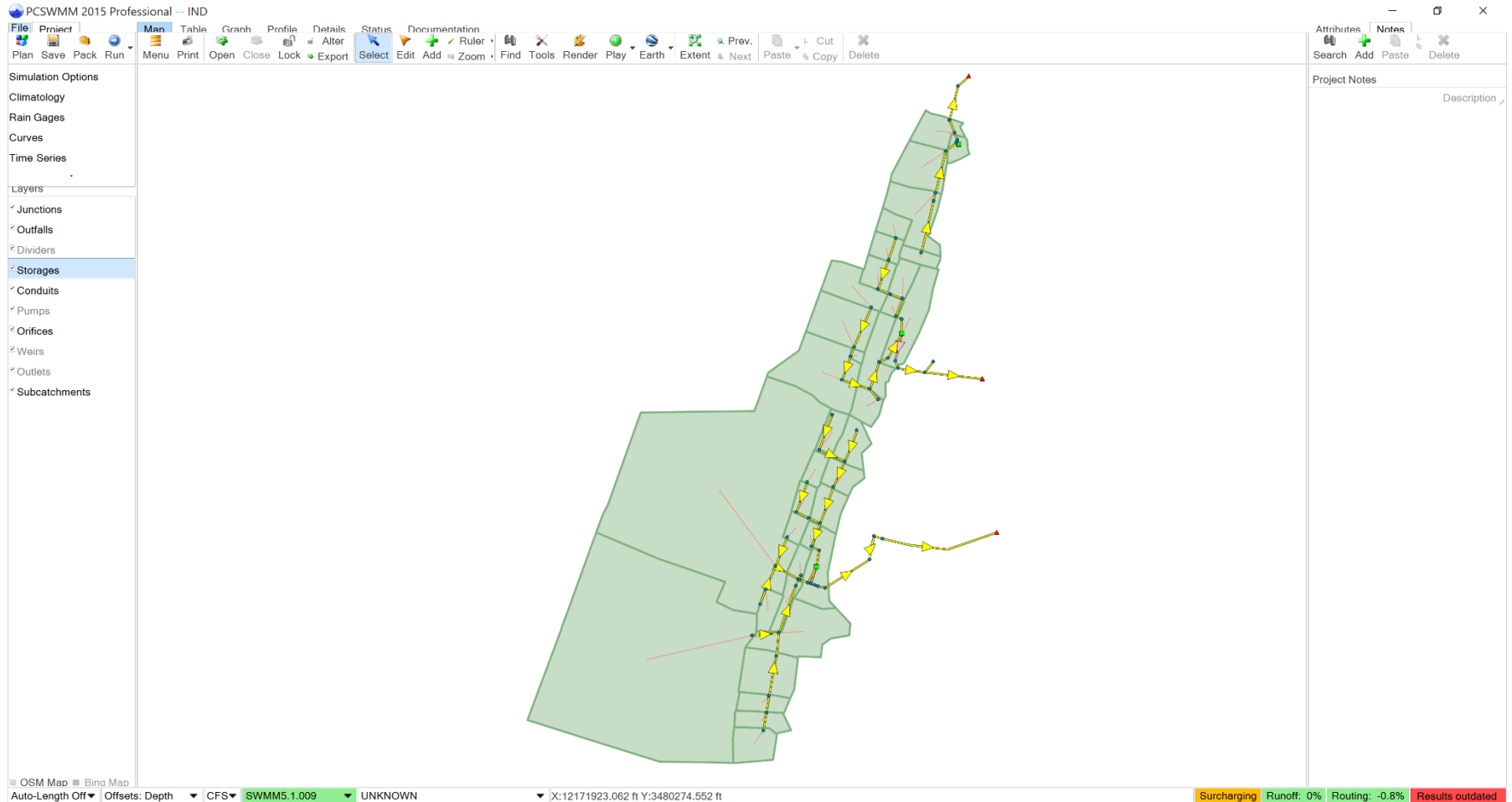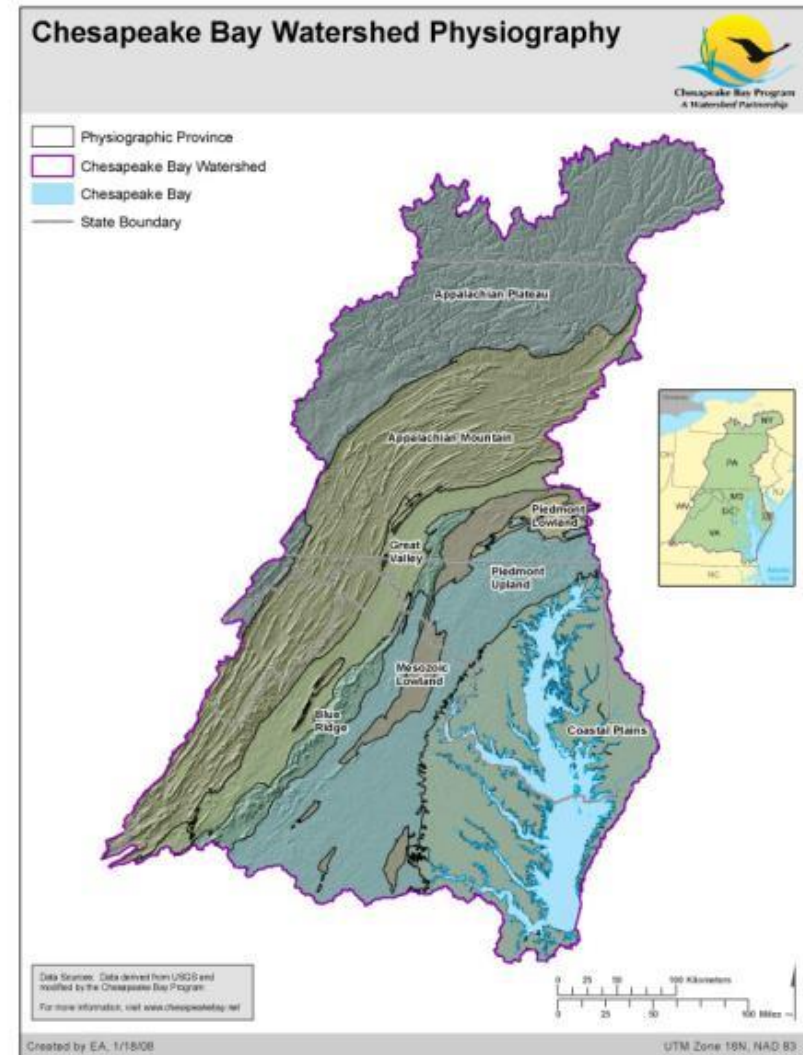
Aggregation

Example:

Virginia Beach (Independence):

- Level 1-Aggregated
- Level 2-Medium disaggregation
- Level 3-Fine disaggregation

Evaluating Effective Impervious Areas

- Criteria
  - Monitoring Data (or ease of collecting)
  - GIS availability
  - Model availability
  - Physiography
  - Climatology
- Sites
  - Virginia Beach (Independence, VT)
  - Baltimore (Gwynn's Falls, UMBC LTER)
  - Fairfax (Difficult Run, USGS, VT)
  - Blacksburg (Stroubles Creek, VT)
  - Harrisburg (Shirley Clark, PSU-Harrisburg)

Chesapeake Bay Watershed Physiography

Water Quality Submodel

N, SRP, TSS:

$$C_{t+\Delta t} = C^* + (C_t - C^*)e^{\left(\frac{-k}{d}\right)*\Delta t}$$

PP, TP:

PP; R=0.7*R_RSS
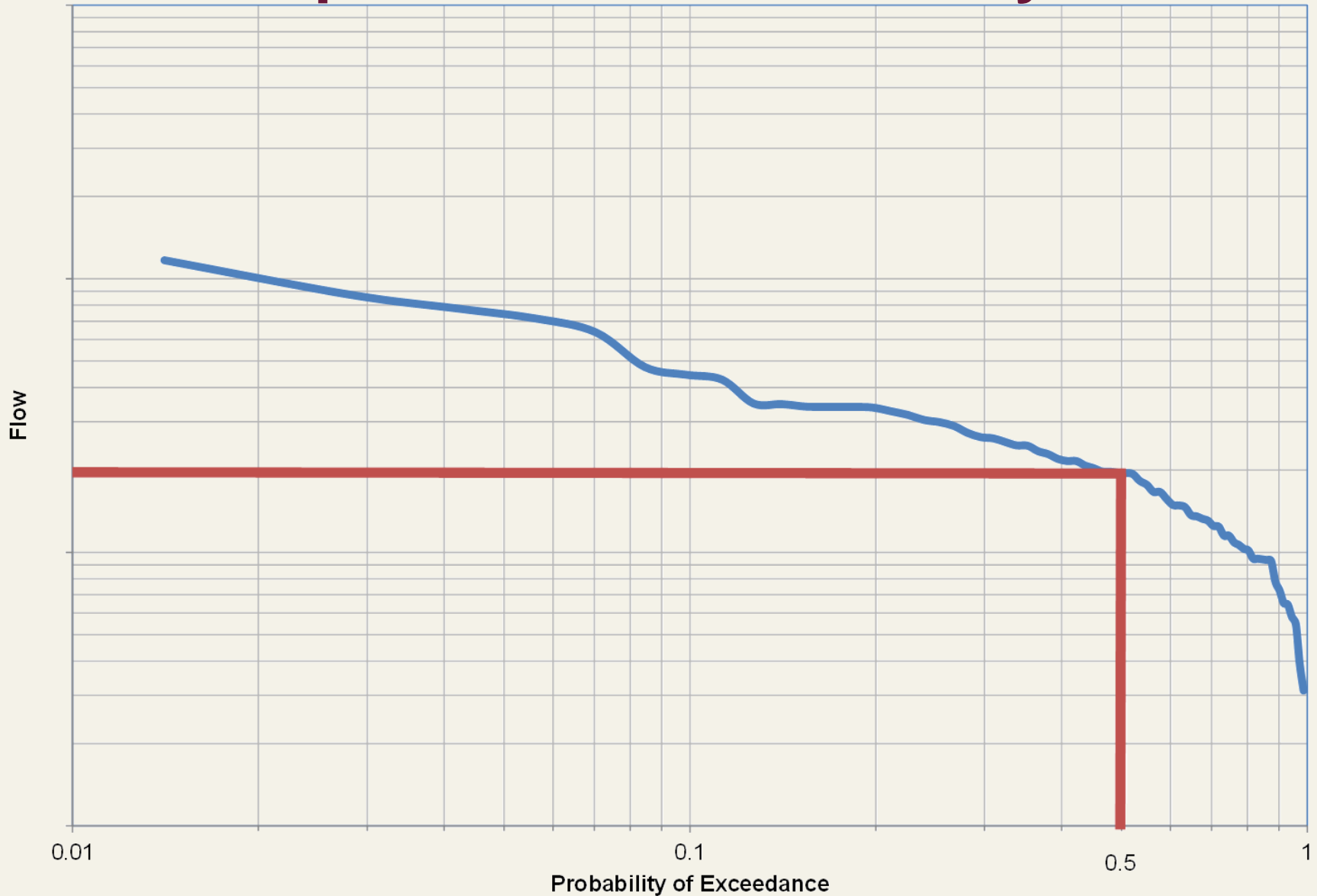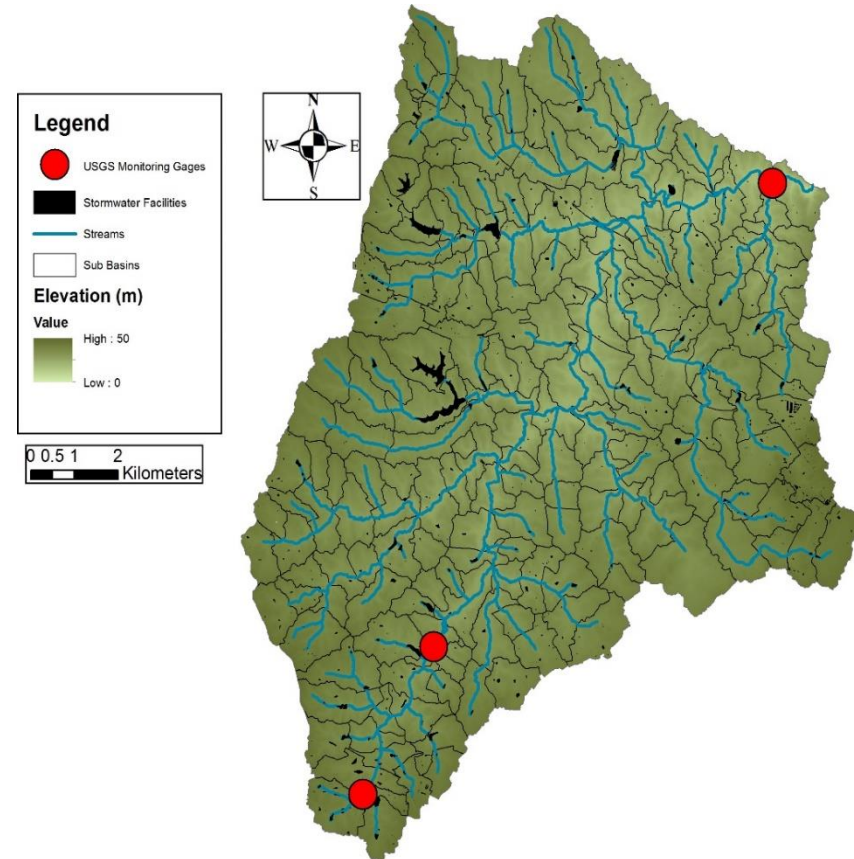
TP=SRP+PP

Parameter	k (ft/day)	C* (mg/L)
TSS	9.0	20
TN	0.4	1.9
TP	4.5	0.23

Comparison: Duration Analysis

Approach

- Characterize fine level disaggregation in upper catchment
- Field confirmation of DCIA
- Modify existing SWMM model
- rSWMM
  - Automatic calibration focused on DCIA
  - Frequency duration analysis
- Evaluate RR results for existing disconnection, and then for multiple (2X,3X,4X,10X)

Legend
- USGS Monitoring Gages
- Stormwater Facilities
- Streams
- Sub Basins

Elevation (m)
Value
High : 50
Low : 0

0 0.5 1 2 Kilometers

Summary

- Disconnection is difficult to assess
  - Field
  - Modeling
- Disconnection does have an impact on annual runoff
- Desktop modeling studies may provide insight

Questions?

dsample@vt.edu