Low-Impact Development Programs

Prince George's County, Maryland

20 Years Experience and Lessons Learned

PRINCE GEORGE'S COUNTY
Department of Environmental Resources

LID Presentation Outlines

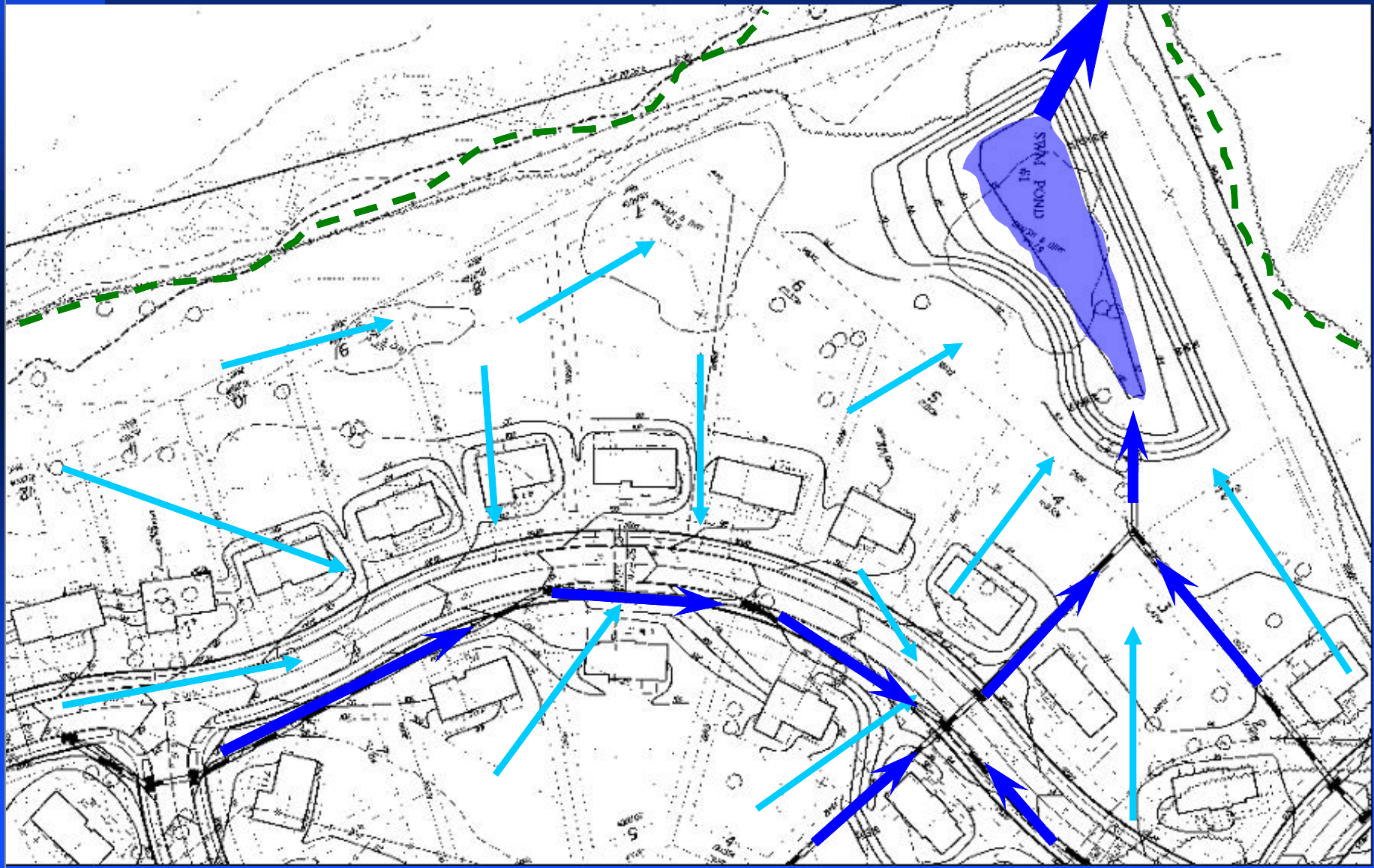
- Overview of LID Concepts
- LID Retrofit Project Implementation
- Outreach and Public Education
- Monitoring and Evaluations
- Modeling (BMP-DSS Model)
- Green Highway/Street Programs
- New LID Research
- Technology Transfer and Technical Assistance

Low-Impact Development Programs

(1)

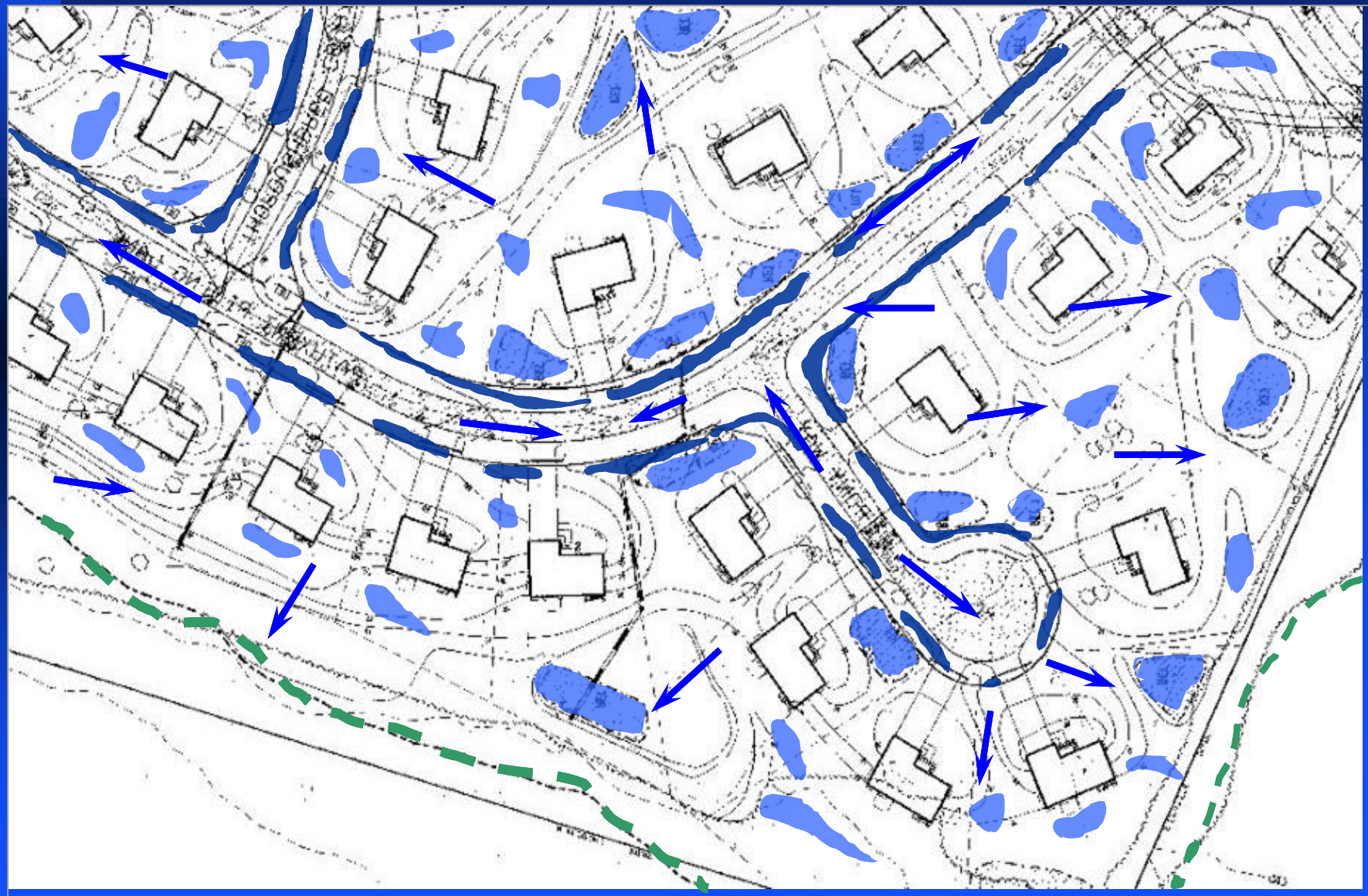
New Land Developments

Conventional Pipe and Pond Centralized Control



Stormwater Management Pond

LID Uniform Distribution of Micro Control



Residential Bioretention

Low-Impact Development Programs

(2)

Urban Retrofits

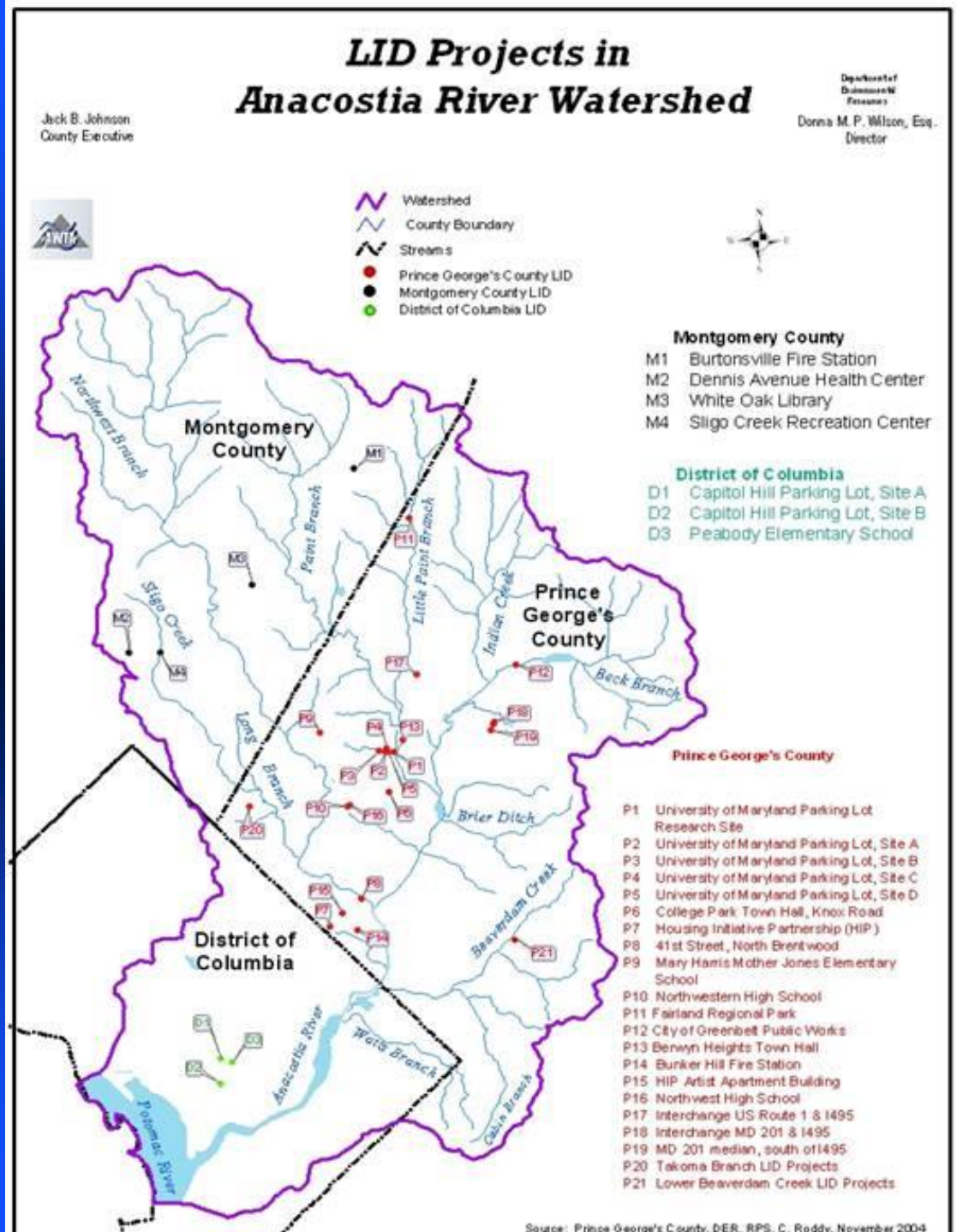
LID Options (Unlimited)

- Bioretention/Rain Gardens
- Strategic Grading
- Amended Soils
- Resource Conservation
- Flatter Wider Swales
- Flatter Slopes
- Tree/Shrub Depression/Filtration
- Turf Depression Storage
- Landscape Island Storage/Filtration
- Rooftop Detention/Retention
- Roof Leader Disconnection
- Parking Lot/Street Storage/Filtration
- Smaller Culverts, pipes & Inlets
- Alternative Surfaces & Building Materials
- Reduce Impervious Surface
- Surface Roughness Technology
- Rain Barrels/Cisterns/Water Use
- Catch Basins/Seepage Pits
- Sidewalk Storage
- Infiltration Swales & Trenches
- Tree Box Filters
- Trash Collectors
- Maximize Sheet flow
- Tree Planting & Landscaping
- Reforestation
- Pollution Prevention

After Completion - January 2001


MAY 29 2001

Green Highway Program



Typical LID Urban Retrofit Projects

Before

After

Before

After

University of Maryland LID Sites

University of Maryland LID Sites

Outreach and Public Education

Public Education Activities

- Conducted various LID workshops
- Prepared Design Manuals, Technical Notes, Design Charts, etc.
- Held Conferences or Seminars
- Constructed Demonstration Projects

The County held the First National LID Conference at University of Maryland in Sept 2004

Student LID Design Contest

First Prizes

Individual

Group

LID Monitoring Program

COMPONENTS OF A TYPICAL BIORETENTION FACILITY

Laboratory Studies

Field Studies: Beltway Plaza

BIORETENTION
% POLLUTANT REMOVAL

		Cu	Pb	Zn	P	TKN	NH4	NO3
BOX	Upper	90	93	87	0	37	54	-97
	Middle	93	99	98	73	60	86	-194
	Lower	93	99	99	81	68	79	23
	Field	**97**	**96**	**95**	**65**	**52**	**92**	**16**

Dr. Allen Davis, University of Maryland

Field Monitoring Comparison

Between

Conventional and Low-Impact Developments

Sommerset Subdivision

Somerset Monitoring Program

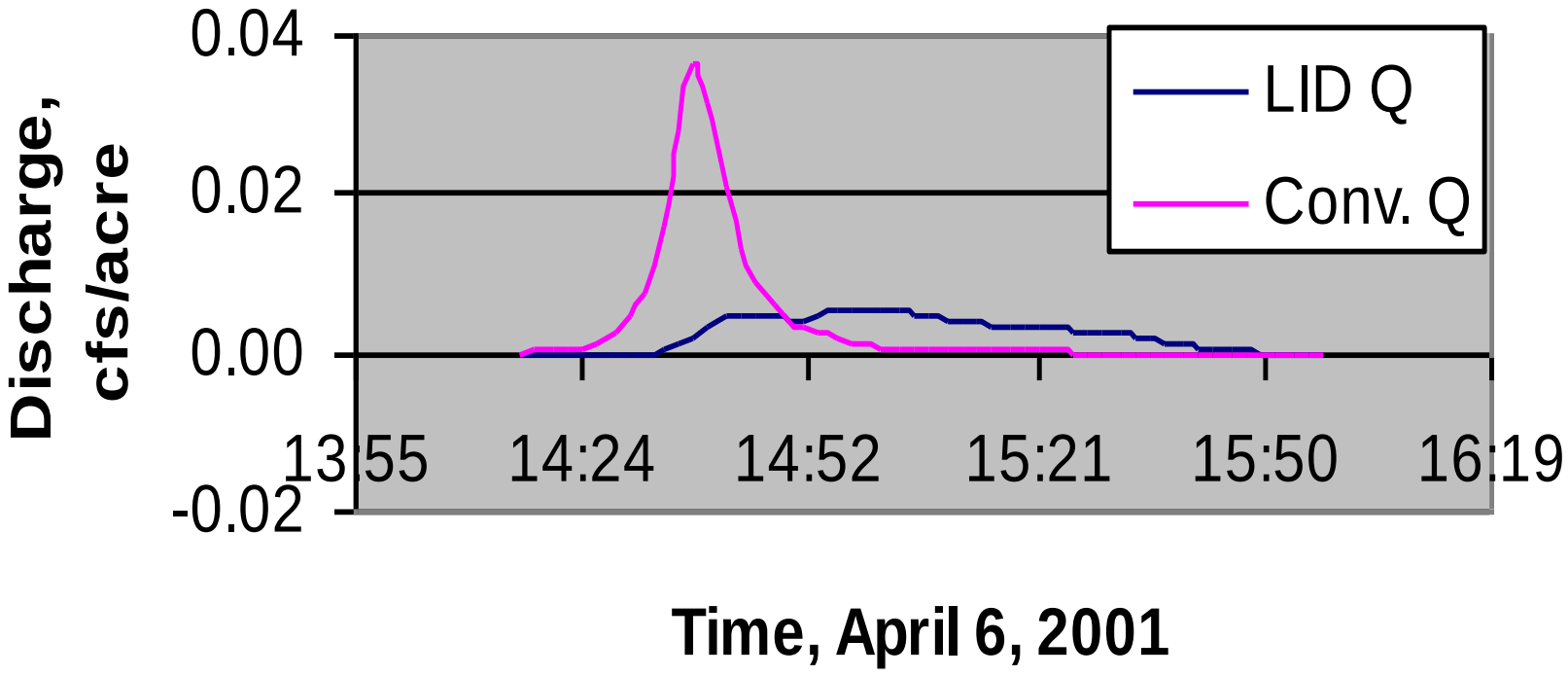
- Paired Watershed Monitoring Program Started in October 2000
- Comparison of Hydrologic Differences between Conventional and LID Stormwater Management
- 8.43 Acre Curb,Gutter and Pipe System
- 11.84 Acre Swale,Bioretention System

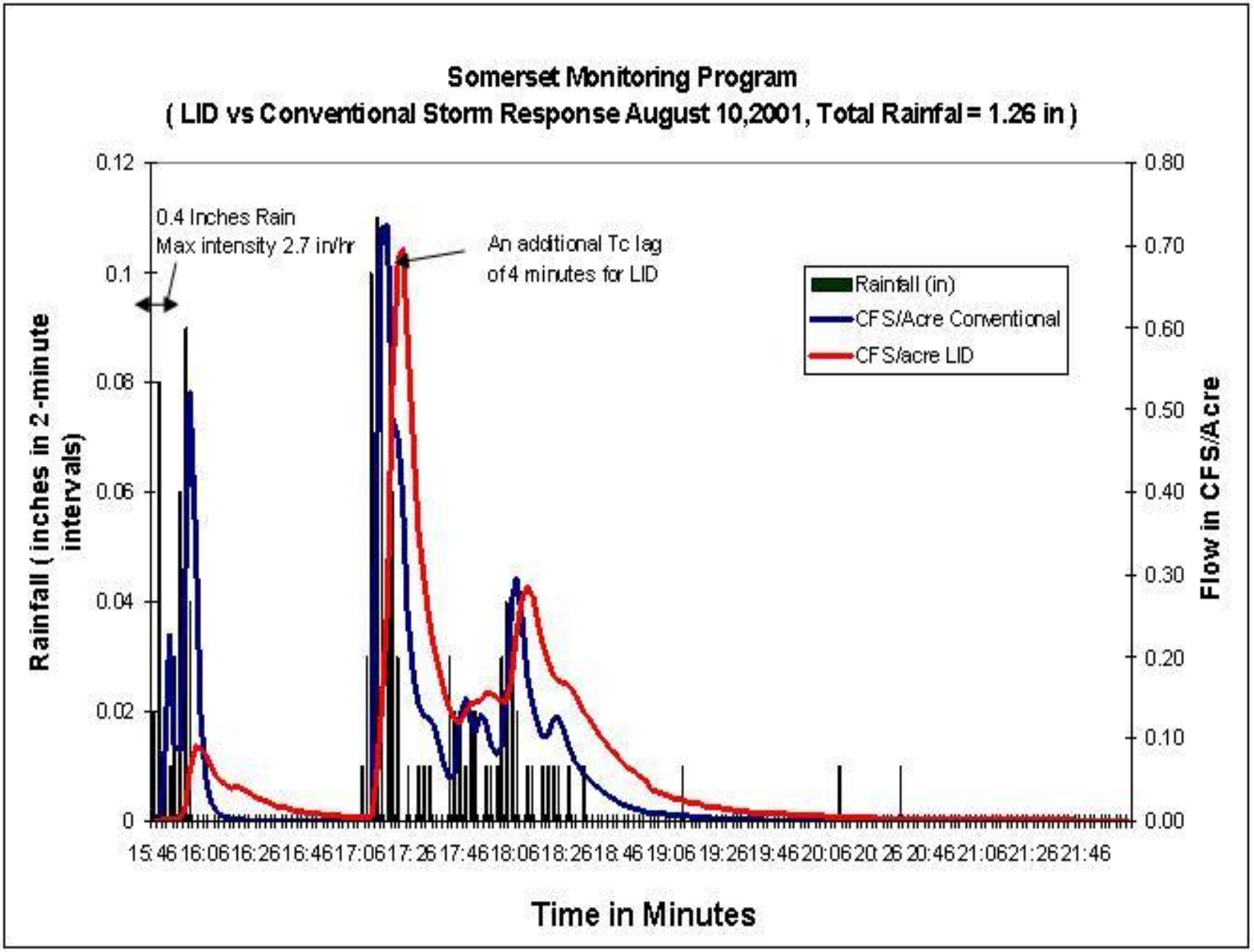
Conventional Development Site

Low-Impact Development site

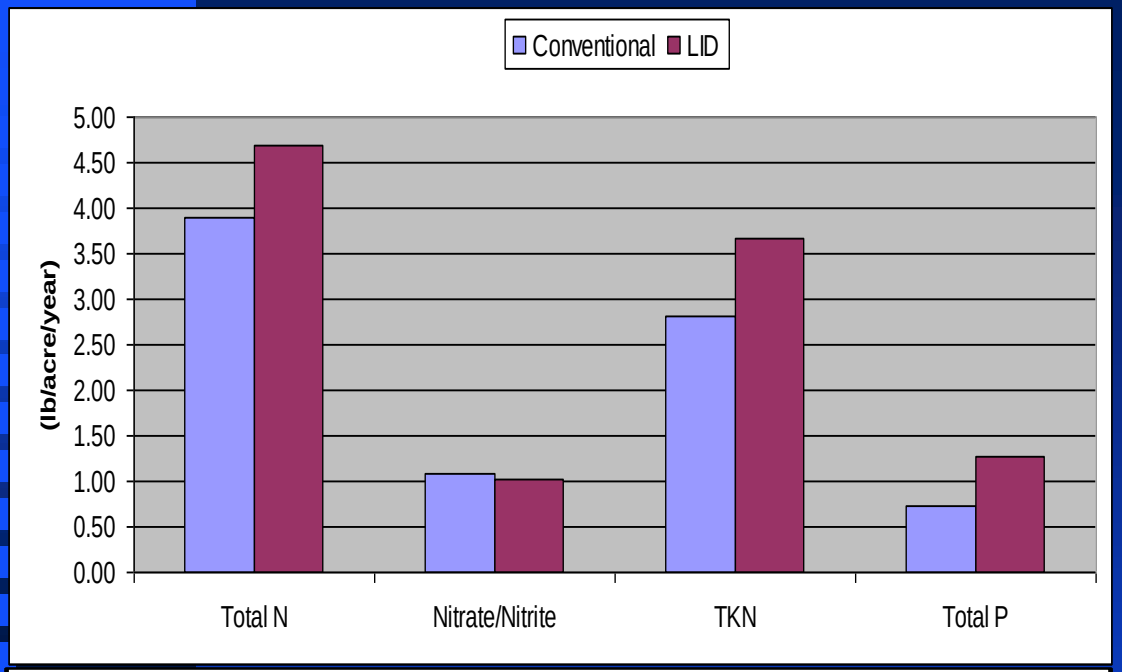
Rain Gauge & Automatic Sample

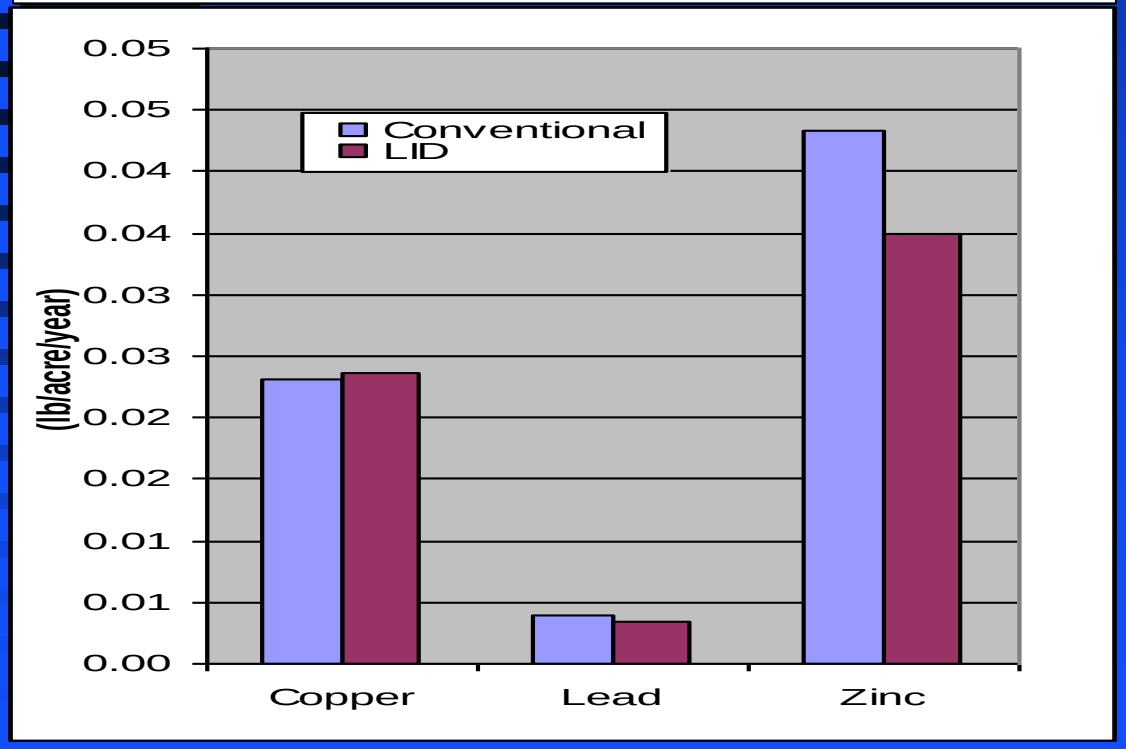
Discharge Comparision

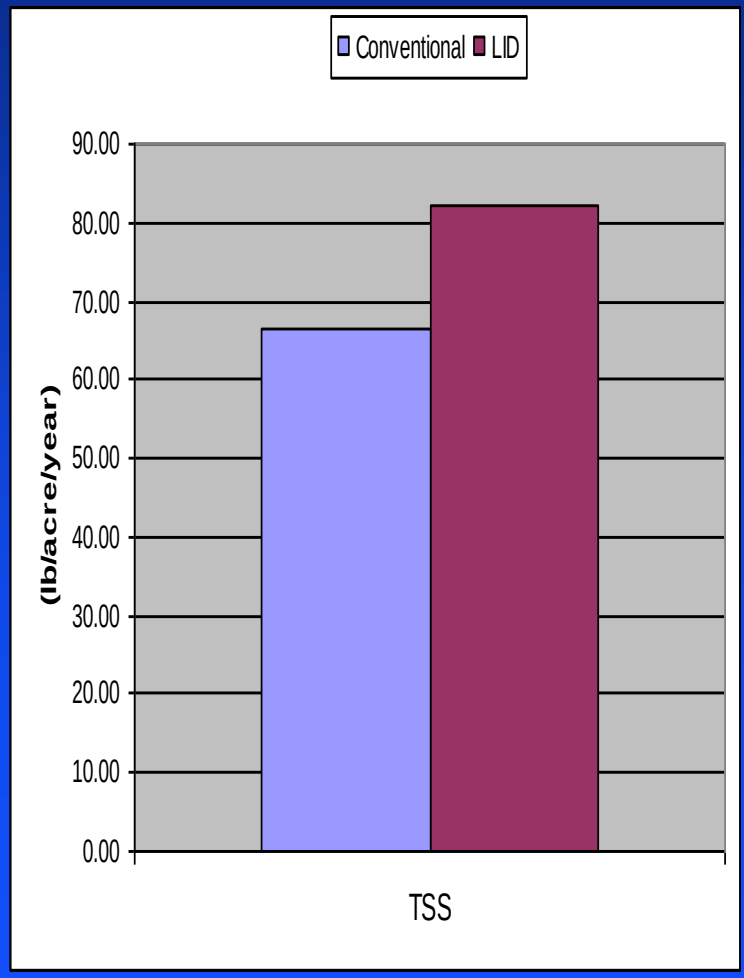



Somerset Monitoring Program
(LID vs Conventional Storm Response August 10,2001, Total Rainfal = 1.26 in)
0.4 Inches Rain
Max intensity 2.7 in/hr
An additional Tc lag
of 4 minutes for LID
Rainfall (in)
CFS/Acre Conventional
CFS/acre LID
Rainfall (inches in 2-minute intervals)
Flow in CFS/Acre
0.12
0.1
0.08
0.06
0.04
0.02
0
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
15:46 16:06 16:26 16:46 17:06 17:26 17:46 18:06 18:26 18:46 19:06 19:26 19:46 20:06 20:26 20:46 21:06 21:26 21:46
Time in Minutes

Three-Year Average





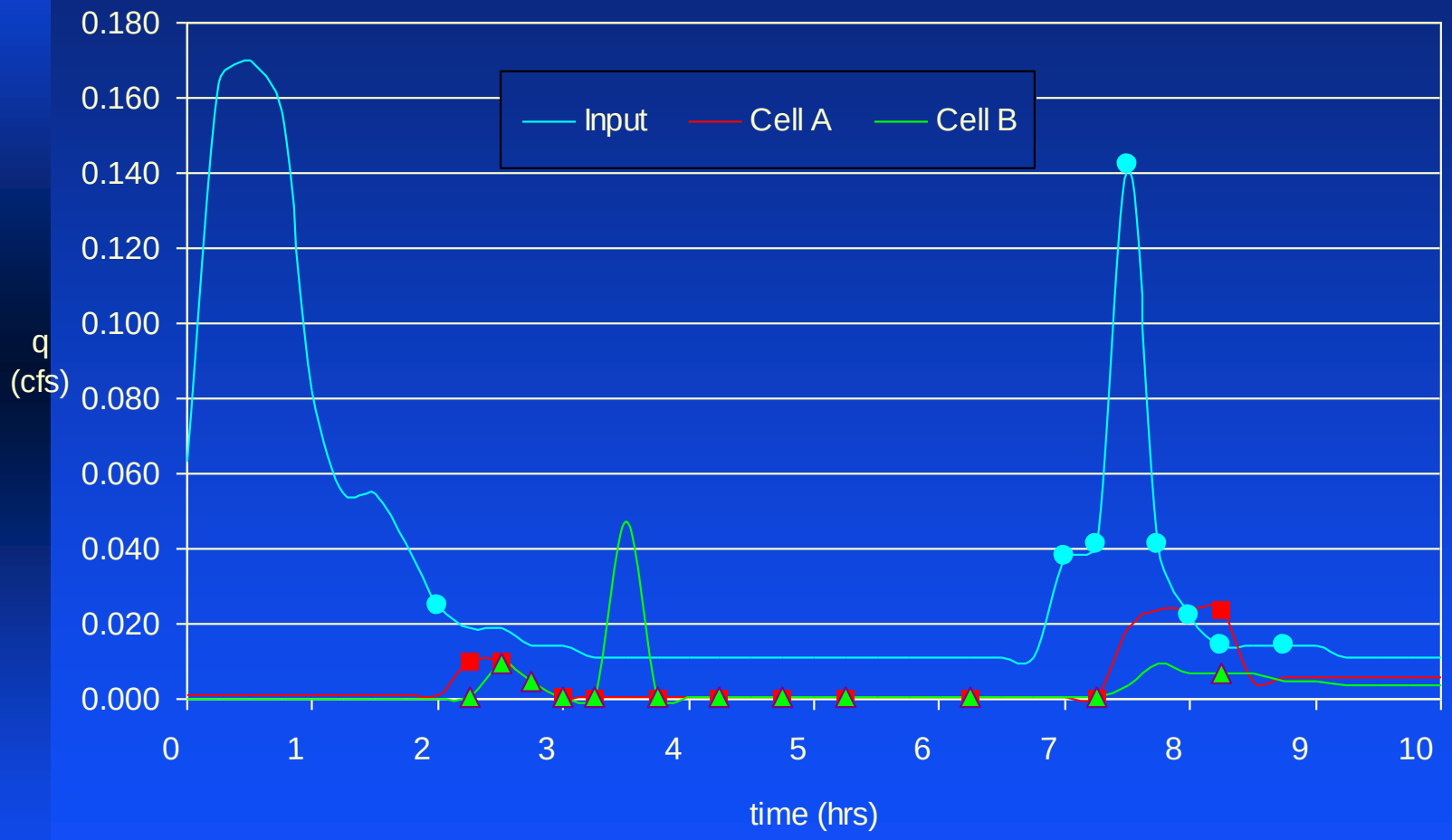


Water quality improvements at the LID site are not significant because:

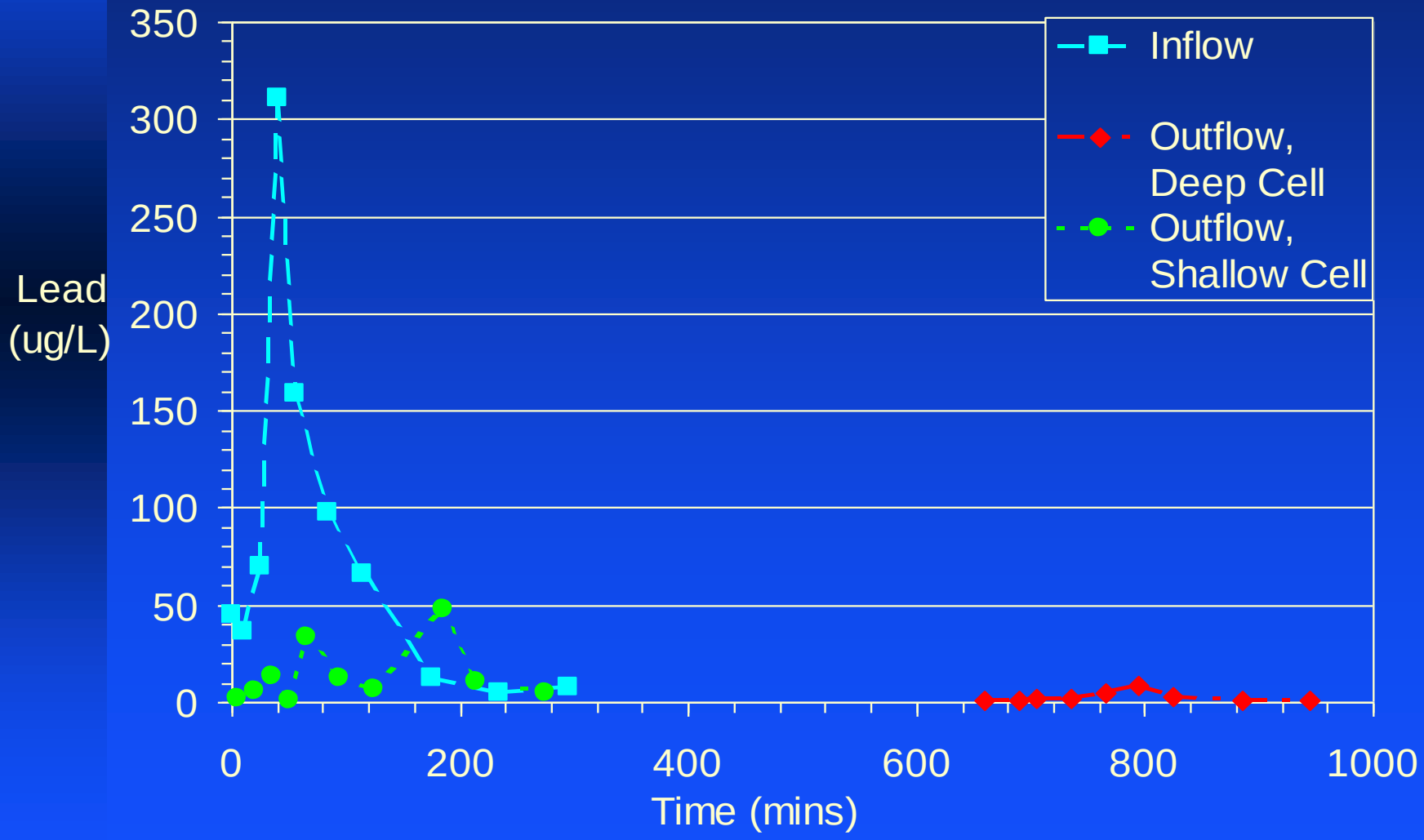
- The LID site was just recently completed; site and soil conditions are not stabilized yet
- Statistically, homeowners at a new subdivision usually apply more fertilizers than those who live in a old subdivision
- For the third year, one inlet was broken and created a significant problem of sediment / erosion and pollutants

Monitoring at the University of Maryland

UMD Bioretention Hydrograph, July 28-29, 2003



Total Lead, November 28, 2003

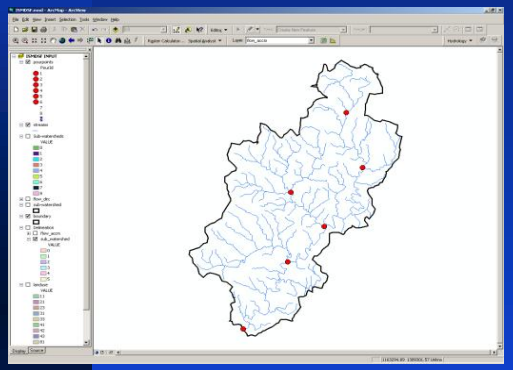


BMP-Decision Support System (BMP-DSS)

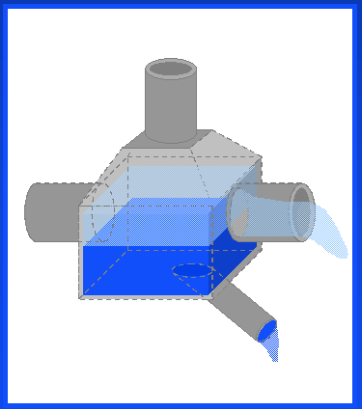
for

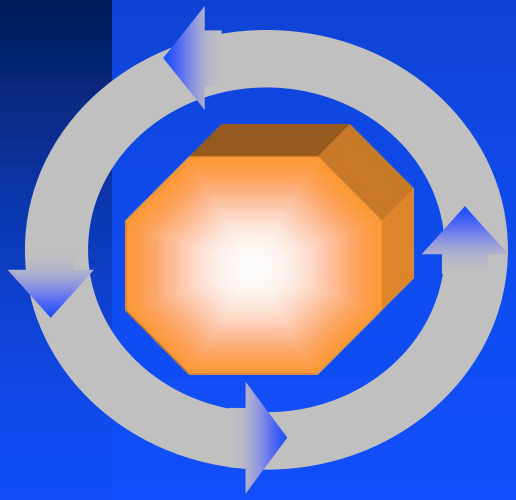
Watershed-based and Site-based Stormwater Management Projects

Major Module Elements



- BMP Simulation
- GIS Linkage
- LID – CSO Linkage
- Optimization
  - Location, types & dimensions





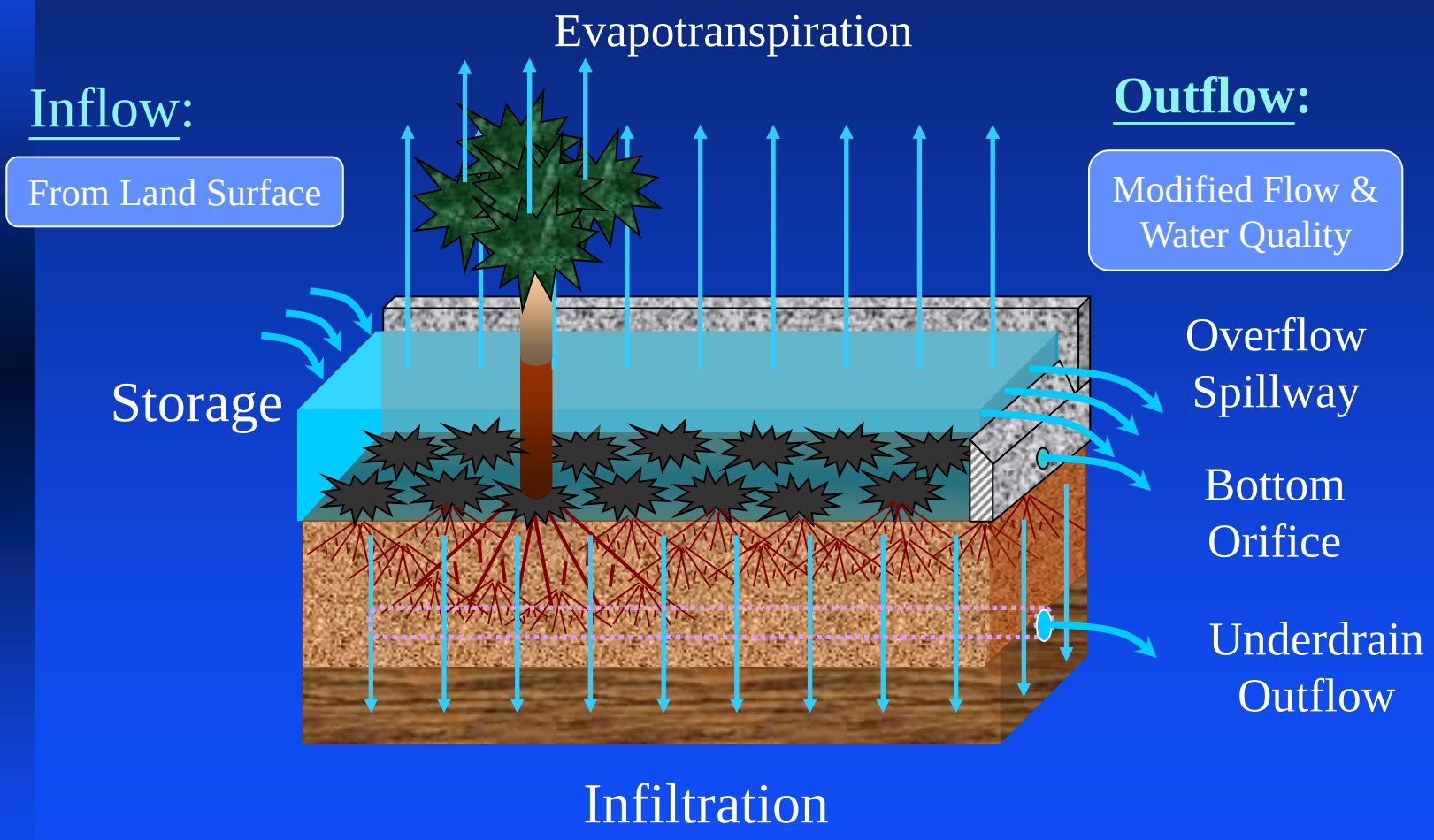
Project Background

- County-wide storm water monitoring
  - 1993 to present
- Development of HSPF model parameters
  - 1995-1999
- BMP Module development
  - Phase I: 1999 to 2003
    - 100% County funded ($80,000)
  - Phase II: 2003 to 2006
    - 80% EPA Region III; 20% County ($250,000)
    - EPA Office of Research & Development ($250,000)
  - Phase III: 2007 to 2011
    - 95% EPA Region III; 5% County ($250,000)

BMP Module

- **Physical Process Representation:**
  - Evapotranspiration
  - Infiltration – Holtan's Equation
  - Orifice outflow
  - Weir-controlled overflow spillway
  - Underdrain outflow
  - Bottom slope influence
  - Bottom roughness influence
  - General loss or decay of pollutant
    (Due to settling, plant-uptake, volatilization, etc)
  - Pollutant filtration through soil medium
    (Represented with underdrain outflow)
- **Depending on the design and type of the BMP, any combination of processes may occur during simulation**

BMP Class A: Storage/Detention

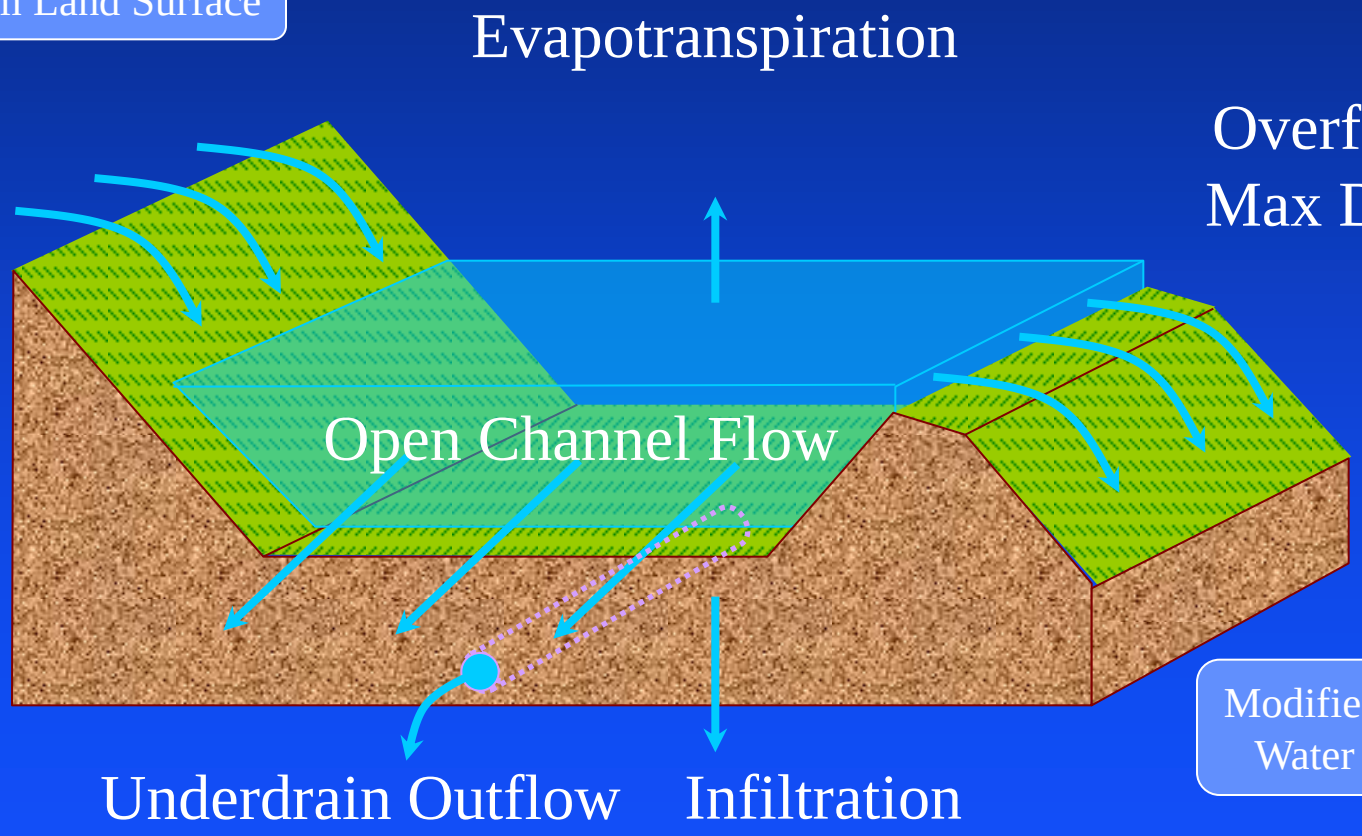


BMP Class B: Open Channel

Inflow:

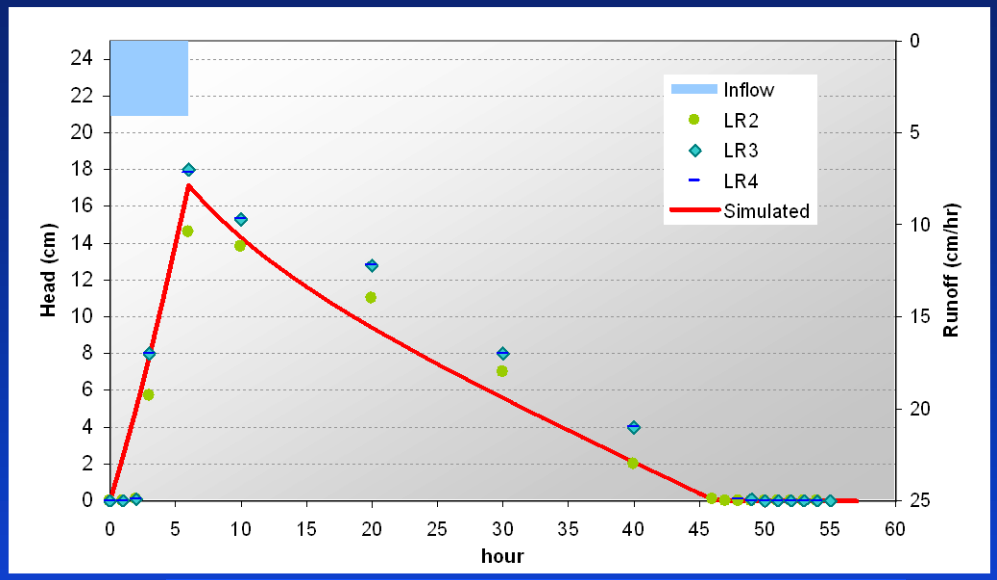
From Land Surface

Outflow:

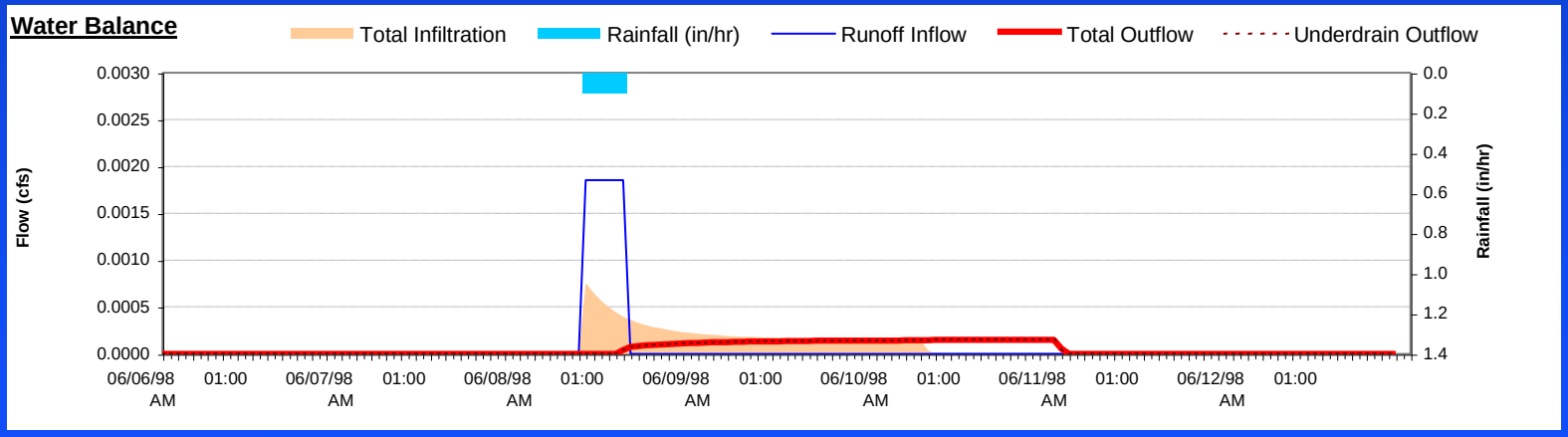


Modified Flow & Water Quality

Laboratary Hydrology Calibration

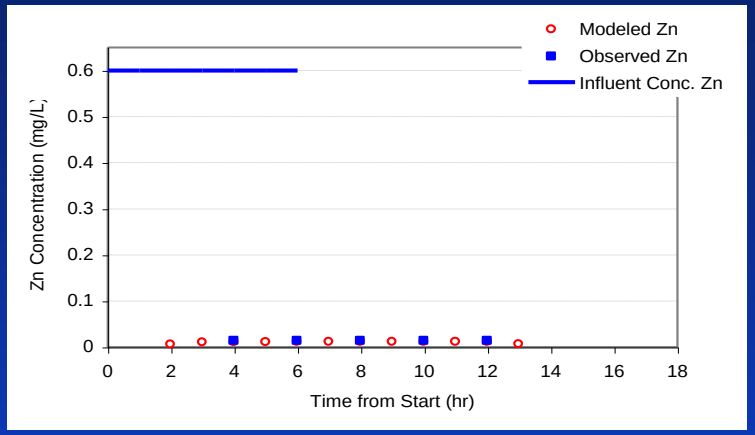


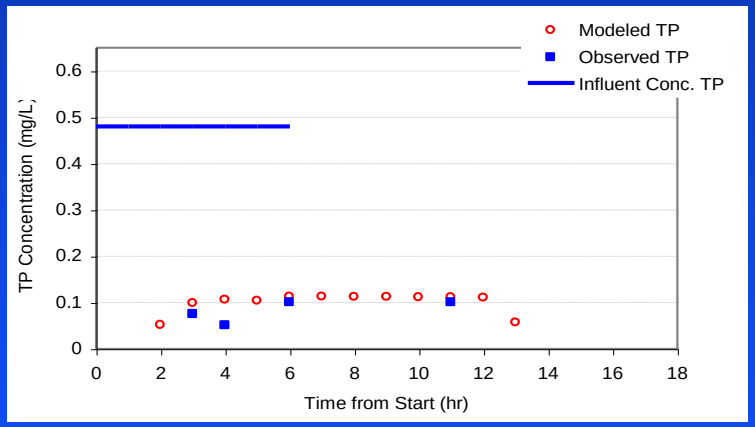
Head Development Curve (Laboratory).



Inflow and Outflow Hydrograph and Water Balance (Laboratory)

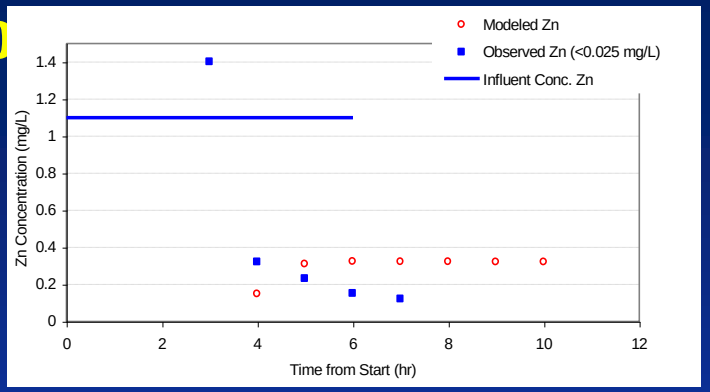
Water Quality Calibratio

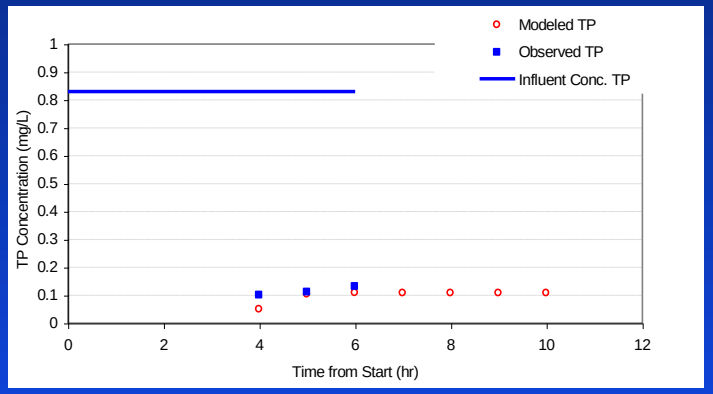


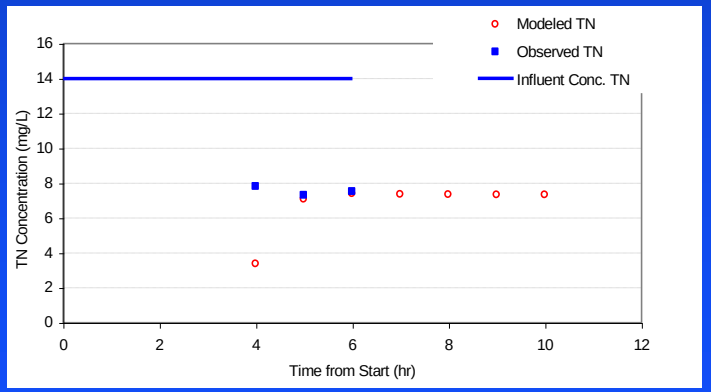


Removal of Zn and TP through small bioretention box

(Laboratory)





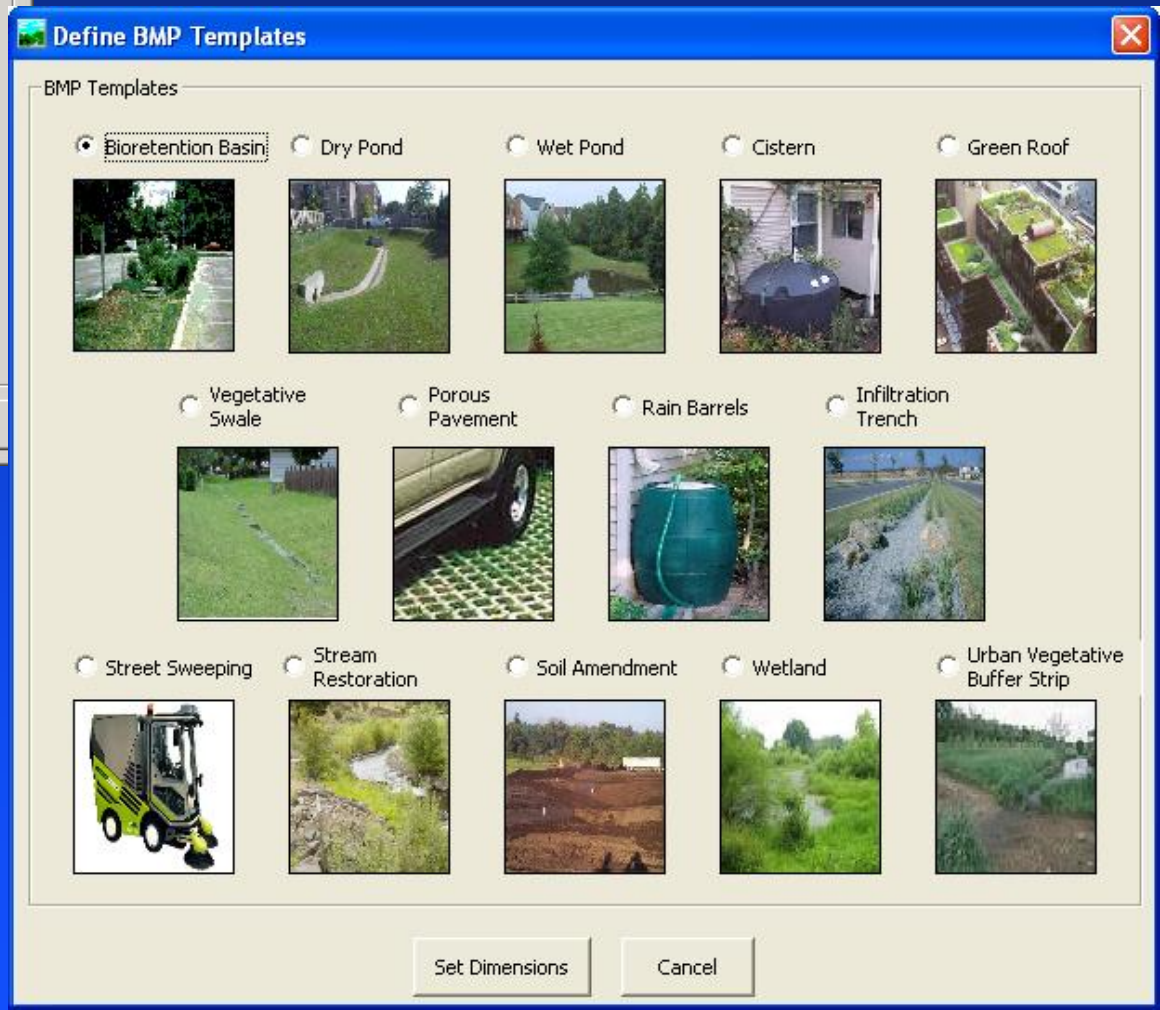


Removal of Zn, TP, and TN through Inglewood (Largo) Biorentention system.

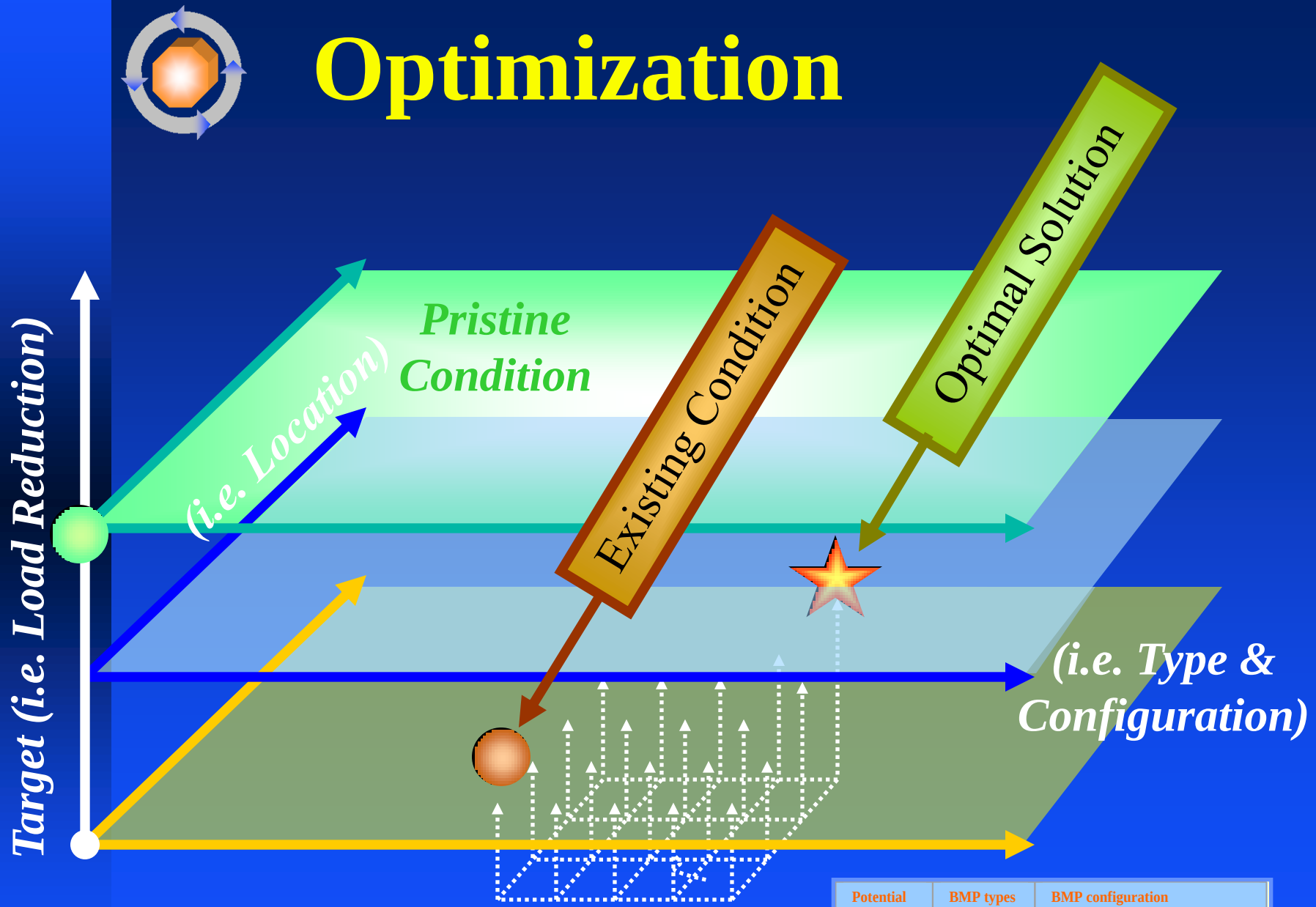
BMP Options

Phase II

Phase III



Optimization

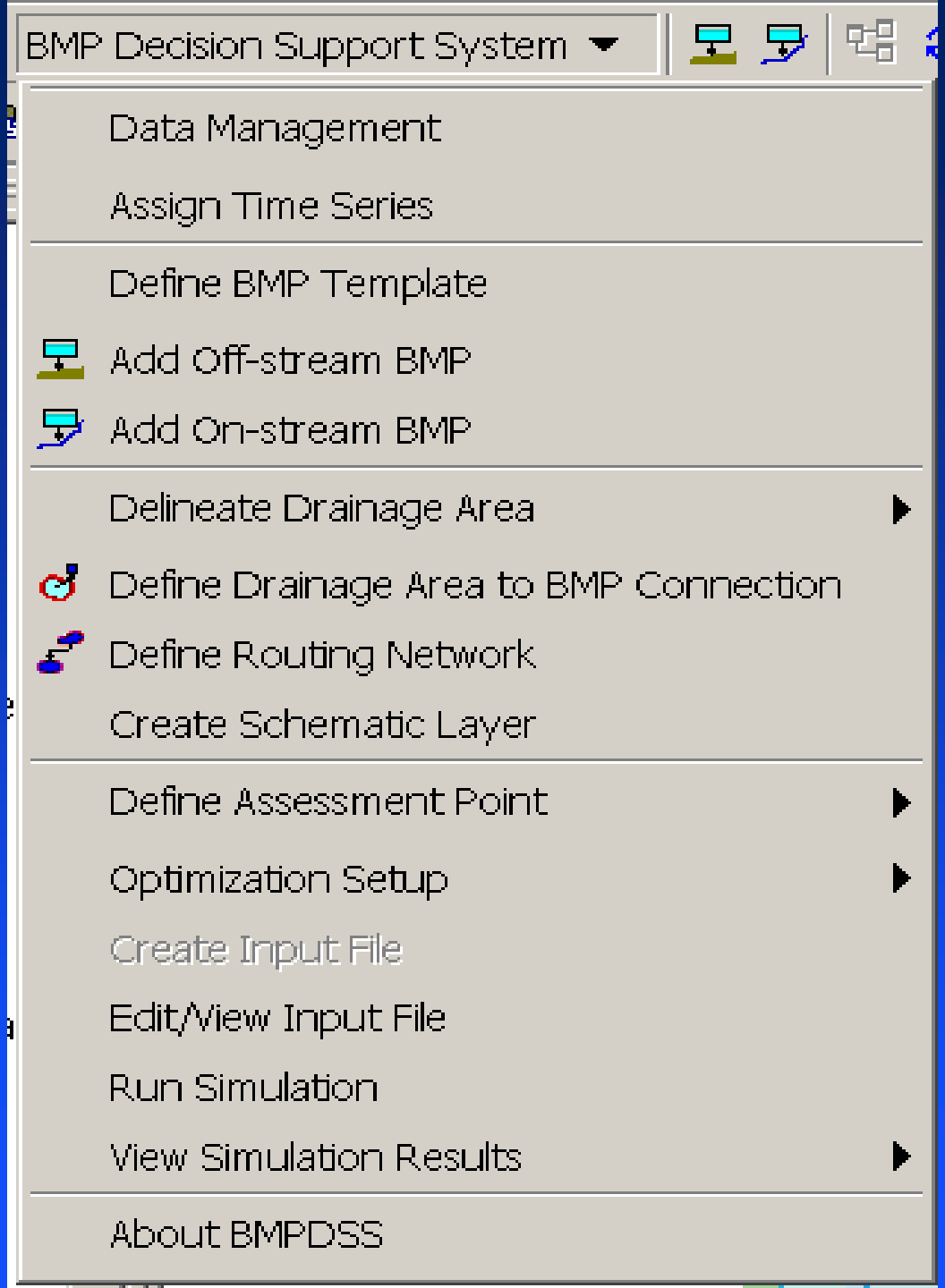


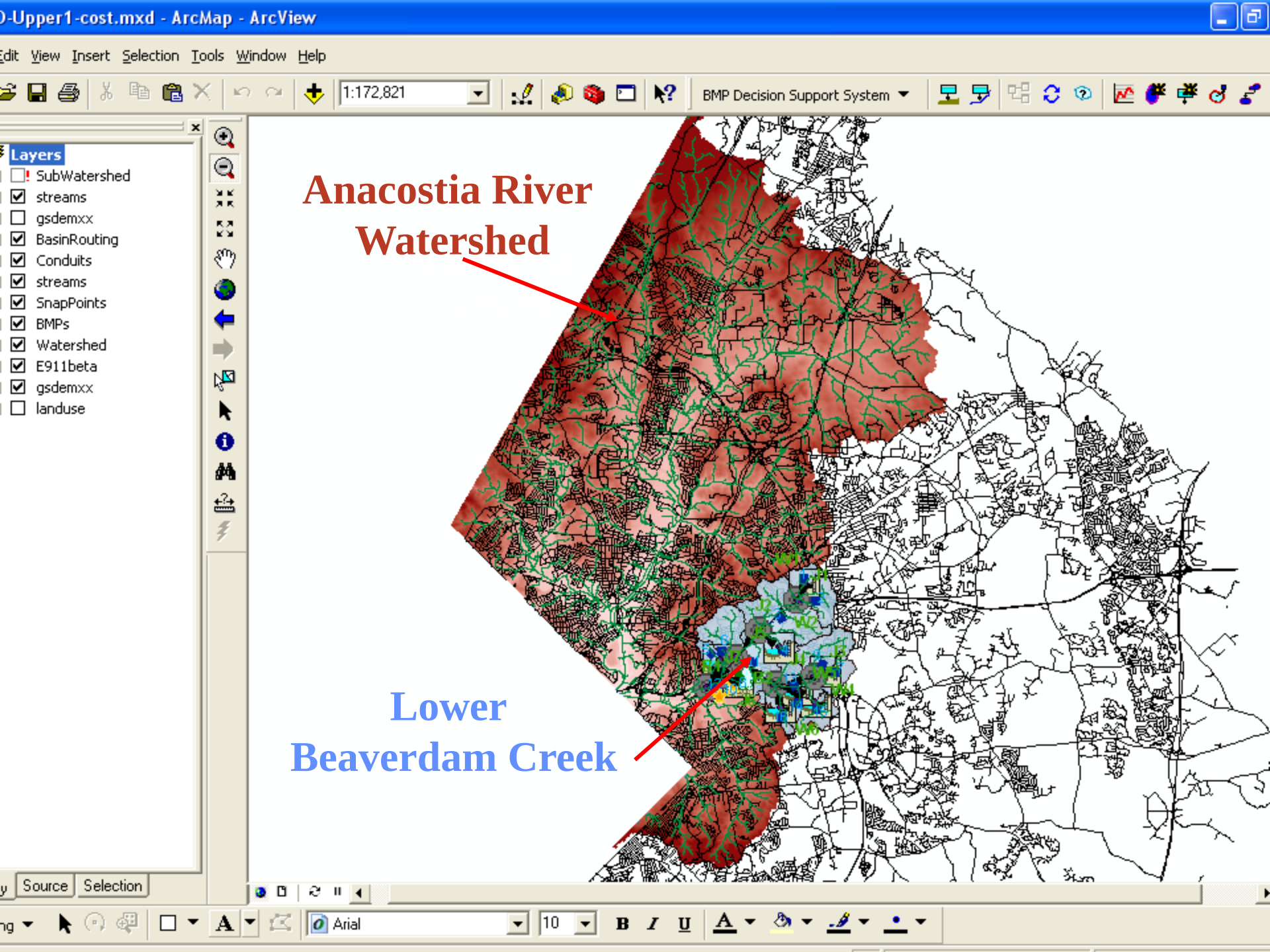
Potential Location	BMP types	BMP configuration		
1 (0-1)	A, B, C…	Depth	Surface area	…
2 (0-1)	A, B, C…	Depth	Surface area	…

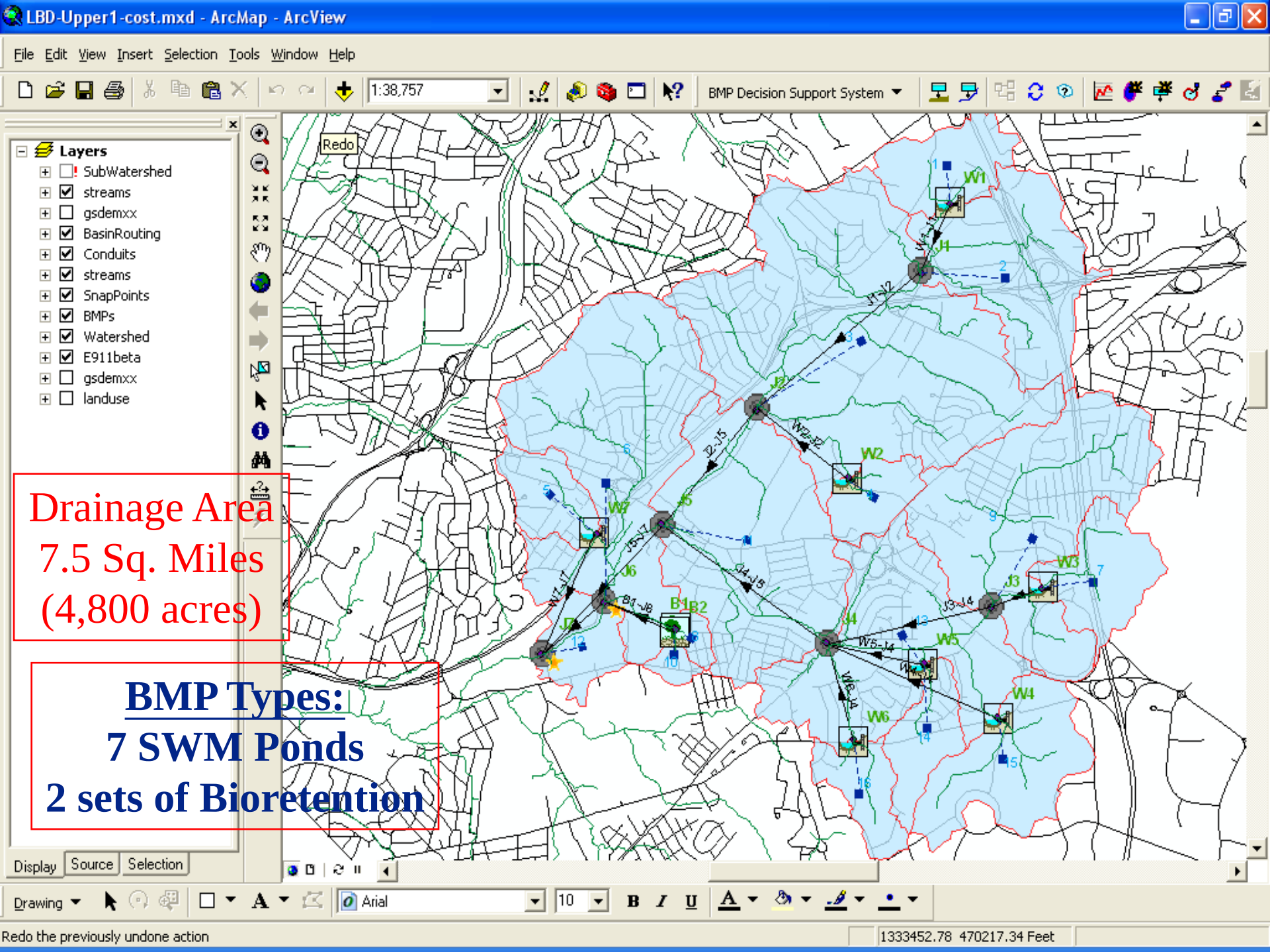
Feasible Alternatives

GIS Interface Functions

Automation




D-Upper1-cost.mxd - ArcMap - ArcView
Edit View Insert Selection Tools Window Help
1:172,821
BMP Decision Support System
Layers
SubWatershed
streams
gsdemxx
BasinRouting
Conduits
streams
SnapPoints
BMPs
Watershed
E911beta
gsdemxx
landuse
Source
Selection
Arial
10
Anacostia River Watershed
Lower Beaverdam Creek


LBD-Upper1-cost.mxd - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
1:38,757
BMP Decision Support System
Layers
SubWatershed
streams
gsdemxx
BasinRouting
Conduits
streams
SnapPoints
BMPs
Watershed
E911beta
gsdemxx
landuse
Redo
Drainage Area
7.5 Sq. Miles
(4,800 acres)
BMP Types:
7 SWM Ponds
2 sets of Bioretention
Display
Source
Selection
Drawing
Arial
10
Redo the previously undone action
1333452.78 470217.34 Feet

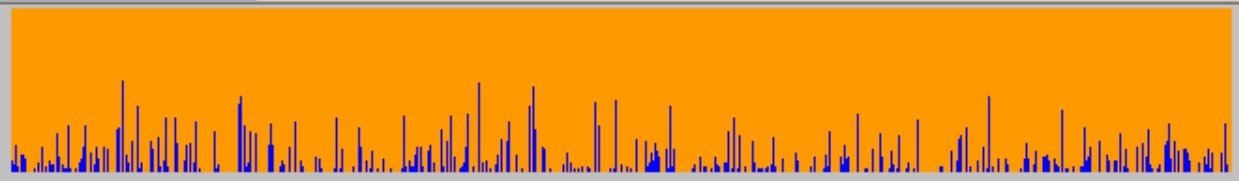
Microsoft Excel - BMPDSSAnalysis.xls

File Edit View Insert Format Tools Data Window BMP Analysis Help

Type a question for help

Arial 12

LT_SumTable | Indicator

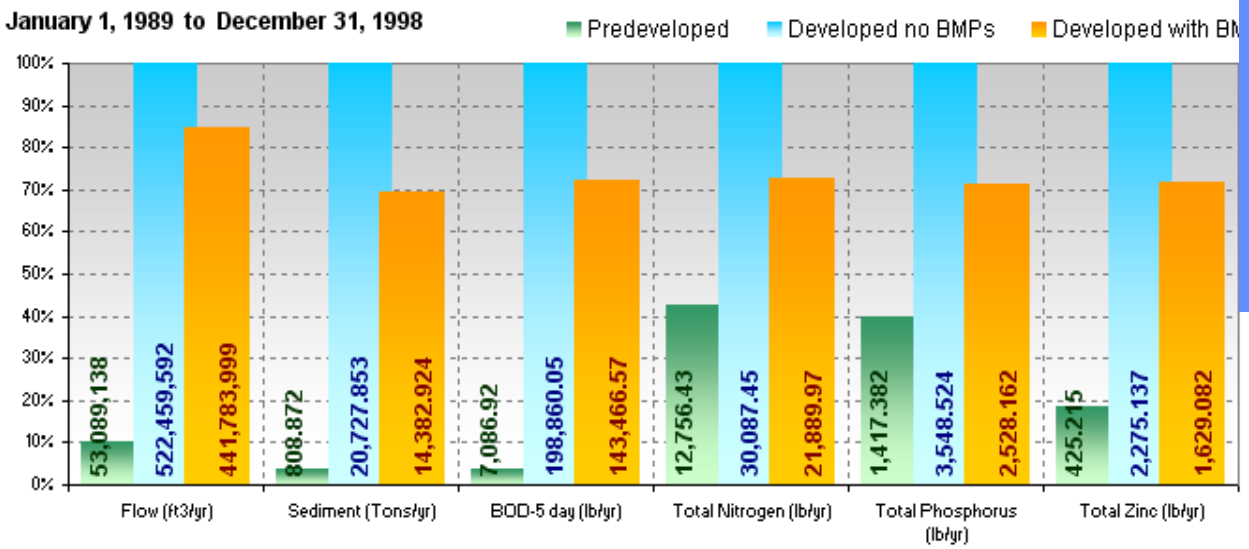


Selected Assessment Period:
January 1, 1989 to December 31, 1998

Start Date / End Date — Month Year Pan Selection

Total Rainfall:
407.56 in

Indicator	Units	Predeveloped	Developed no BMPs	Developed with BMP
Flow	ft³/yr	53,089,138	522,459,592	441,783,999
Sediment	Tons/yr	808.872	20,727.853	14,382.924
BOD-5 day	lb/yr	7,086.92	198,860.05	143,466.57
Total Nitrogen	lb/yr	12,756.43	30,087.45	21,889.97
Total Phosphorus	lb/yr	1,417.382	3,548.524	2,528.162
Total Zinc	lb/yr	425.215	2,275.137	1,629.082



Optimization Goal

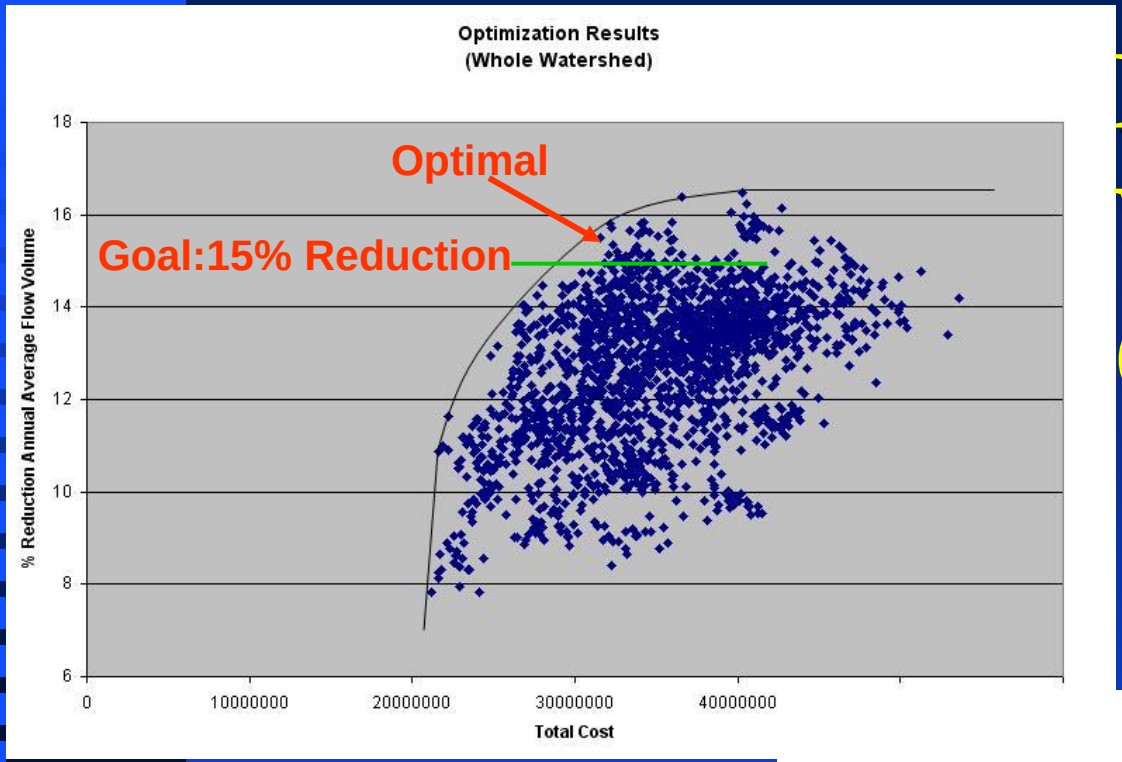
15% Flow Volume Reduction

30% TSS Volume Reduction

Long Term | Week-HydroGraph | Week-Report | MultiStorm | MultiStorm Table

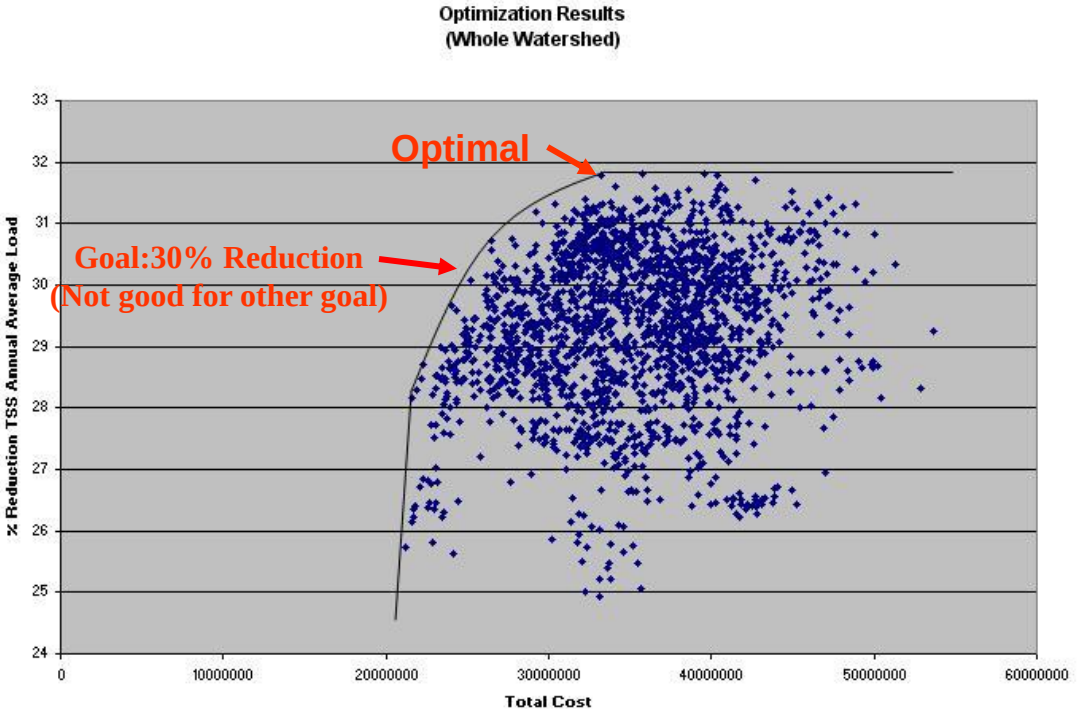
Draw AutoShapes

Ready



Flow Volume Optimum

TSS Load Optimum



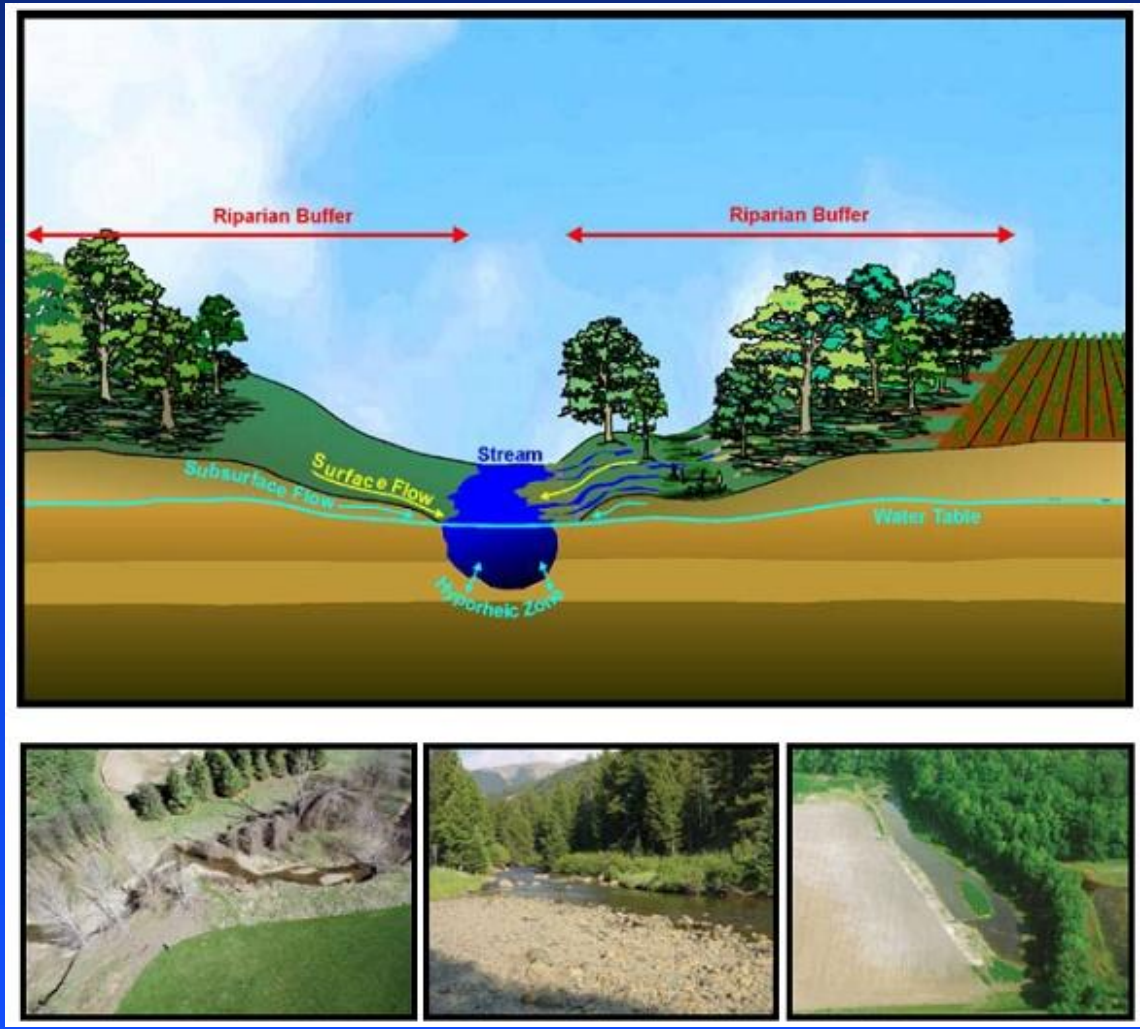
Phase III Enhancements

- Include more BMP types
  - Wetland
  - Stream over-bank buffer/vegetation
  - Soil amendment
  - Porous concrete/pavement
  - Stream restoration
- Include the optimization of BMP "Locations"
- More detailed analysis processes
  - Add the "Green Ampt" Approach for infiltration
  - Include a much more detailed Bioretention model
  - Improve the reach/conduit simulation
- Build in the option of the automated calibration to the observed data.

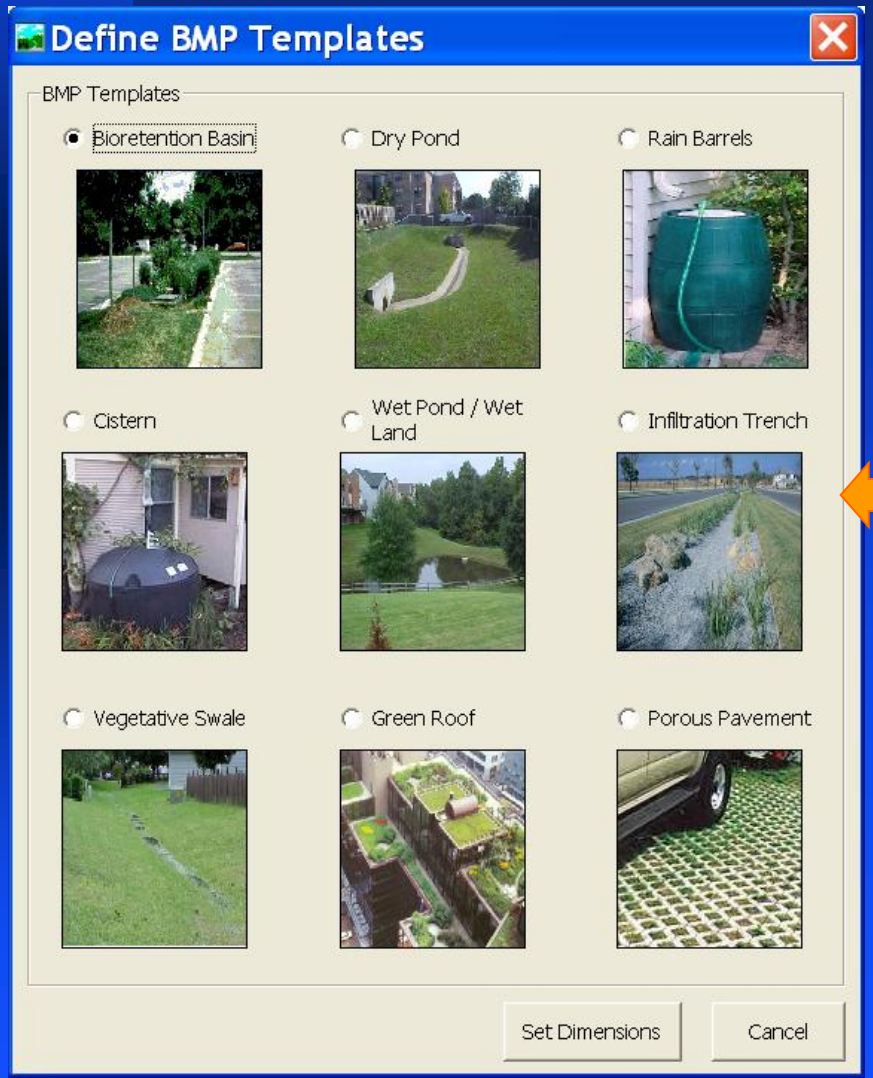
Wetland Module

- Hydrology
- Water Quality

Vegetative Buffer Strip Module

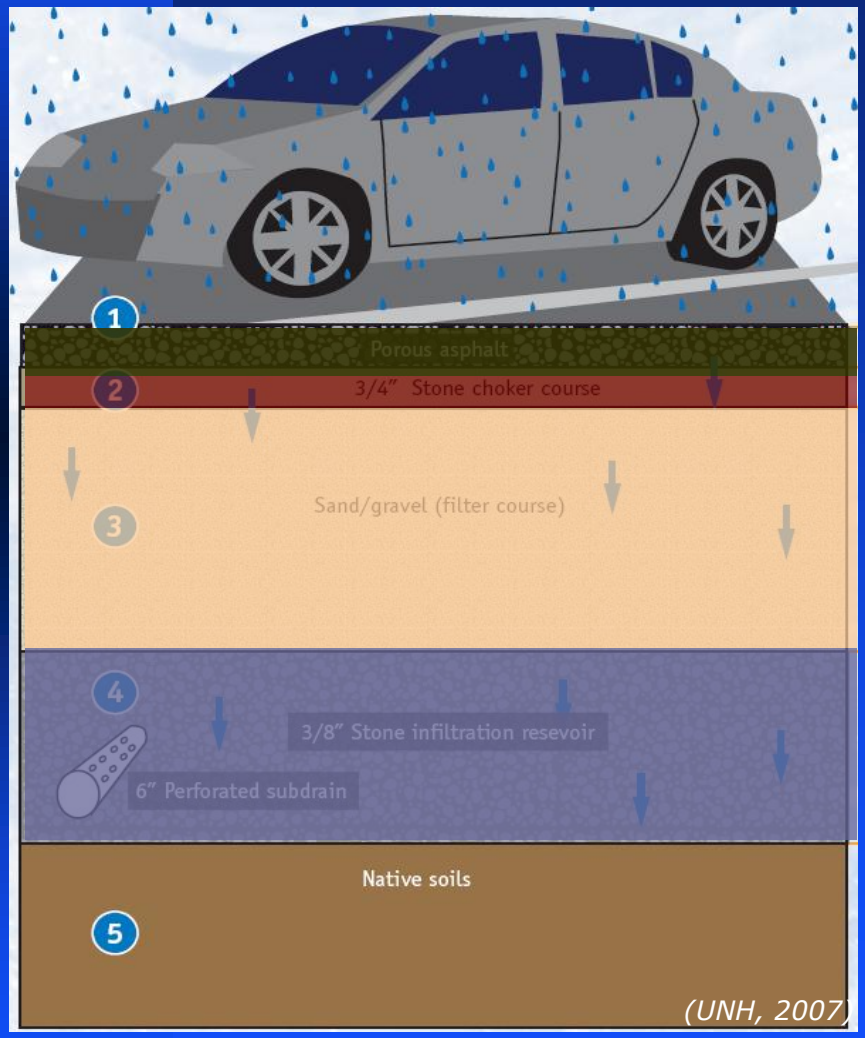


Add the soil amendment option in the BMP selection window



Southern Maryland Wood Treating Site: On-Site Thermal Desorption of Contaminated Soils, Final Grading and LeafGro Placement
(Source: US EPA)
Copied from:
http://www.lowimpactdevelopment.org/qapp/lid_design/soilamend/soilamend_benefits.htm

Representation of porous asphalt



BMPDSS representation

Composite layer

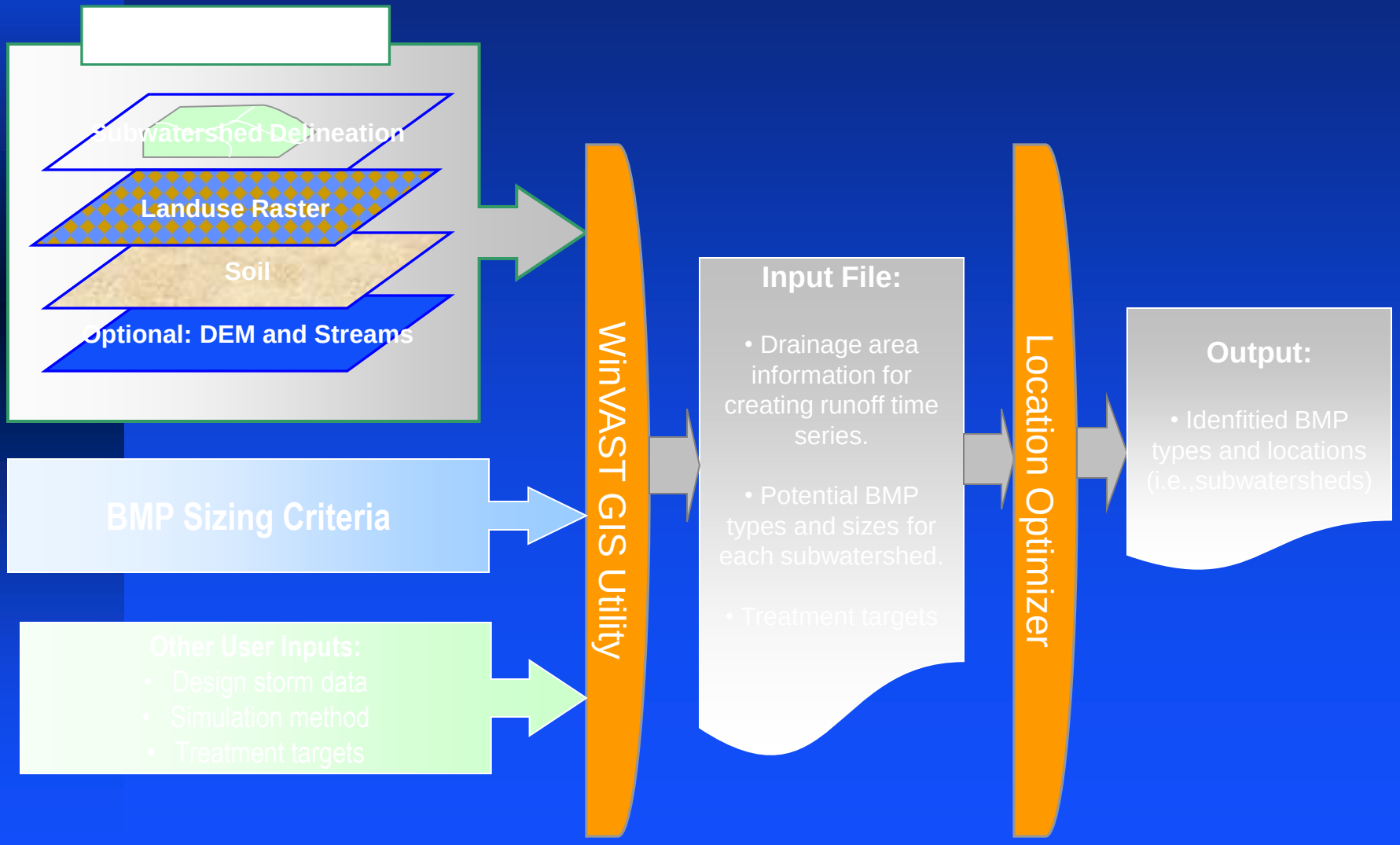
Gravel layer

Street Sweeping Module

Mechanical sweeper

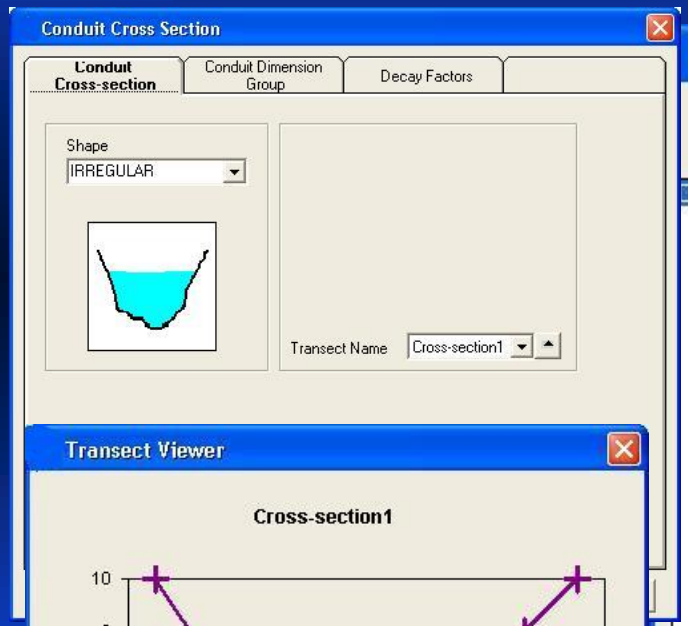
Vacuum sweeper

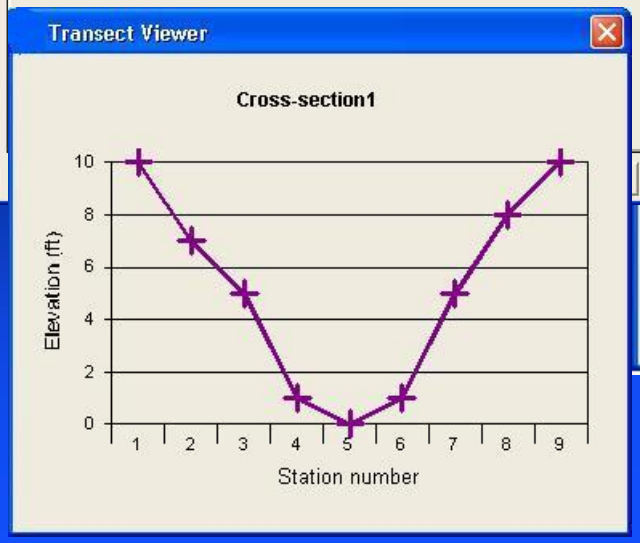
Location Optimization

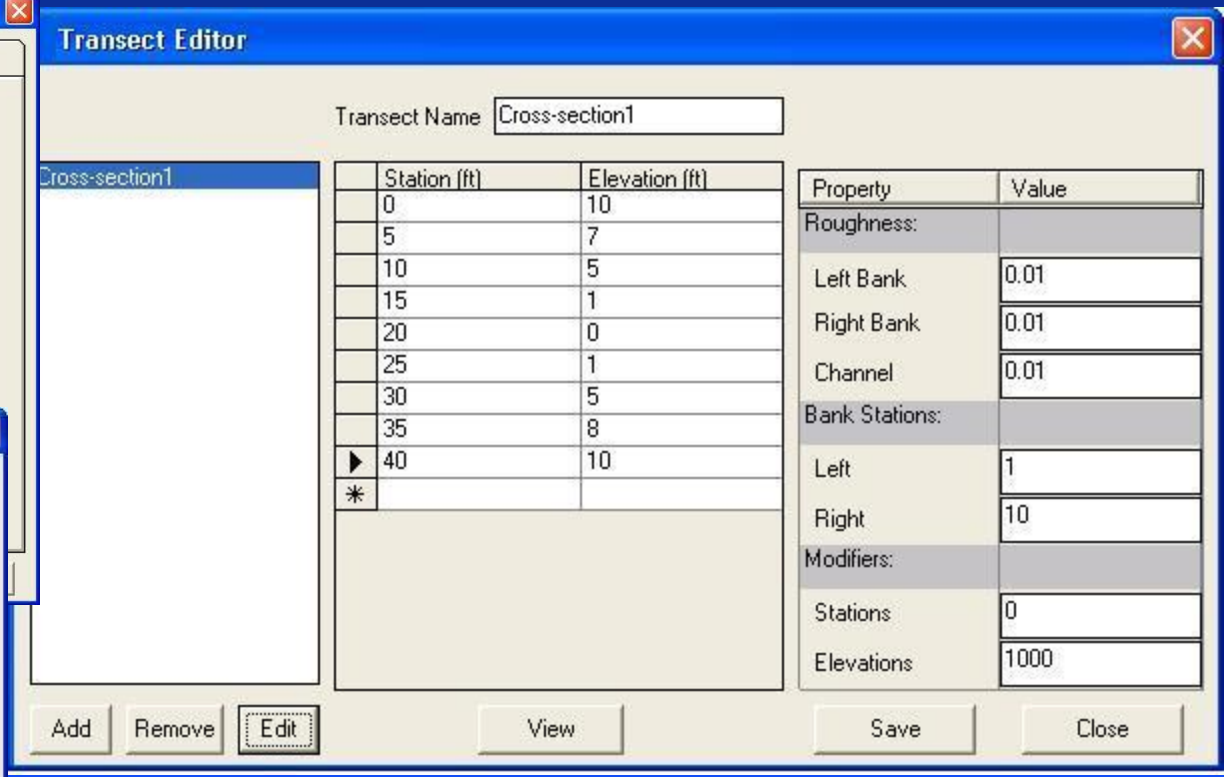


Irregular Cross-Section

- Similar to SWMM Routine Capability







Green Highway/Street Program

in

Prince George's County, MD

PRINCE GEORGE'S COUNTY
Department of Environmental Resources

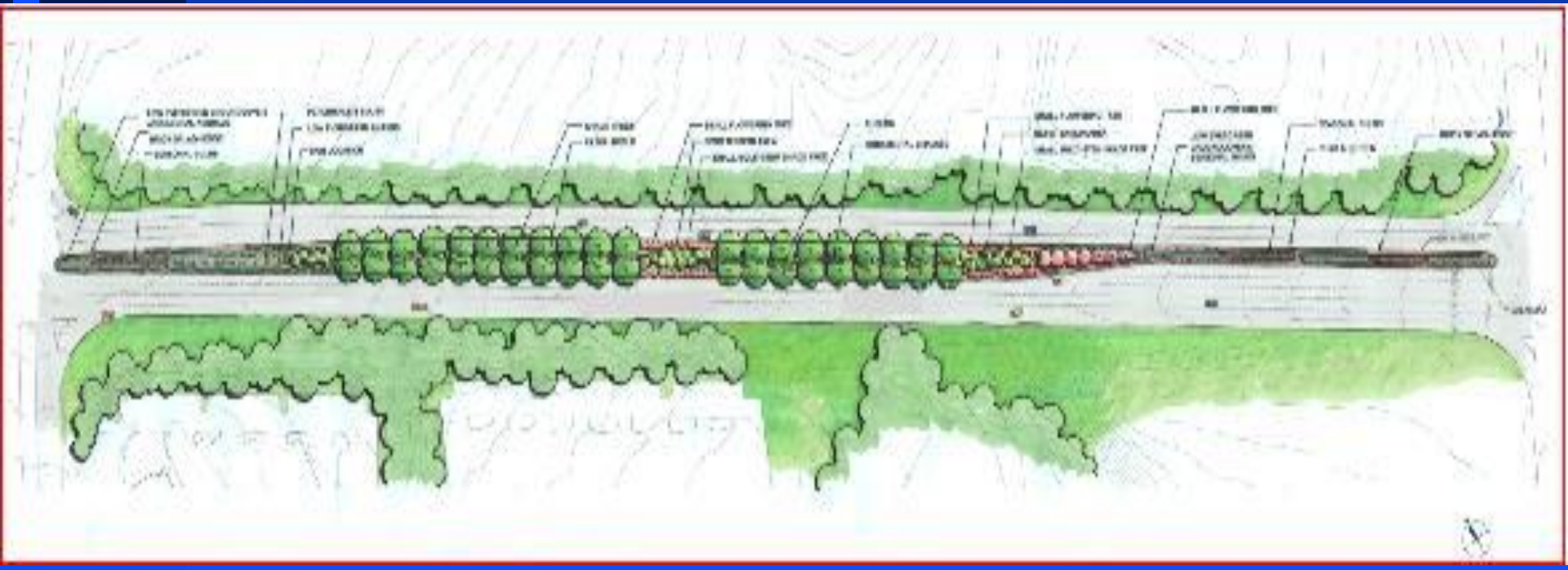
Highway Runoff Treatment

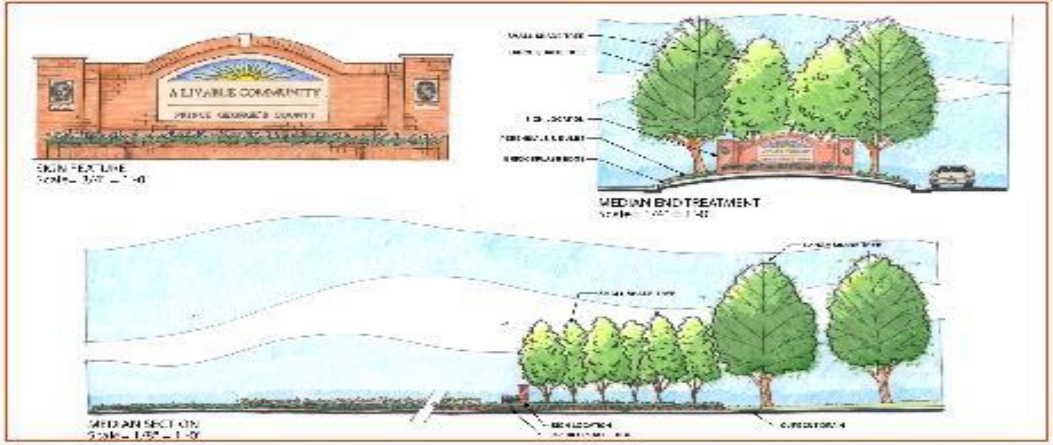
Gateway Projects (Green Highway Program)

To improvement water quality by retrofitting the highway median and interchanges

To demonstrate how LID techniques can treat stormwater pollutants generated by highway traffic

Highway Median LID Layout





Plants and Vegetations

MD 202 (Largo Road) Green Highway Projects

Completed in January 2005

The First Green Highway/Street Project in the Washington Metropolitan Area

MD 201 (Kenilworth Avenue)
Green Highway Project
Completed September 2006

US 1 (Baltimore Avenue) Green Highway Project

Completed December, 2006

Sligo Creek
Green Street Program

Completed 2007

Low-Impact Development Research Projects

Prince George's County, Maryland

&

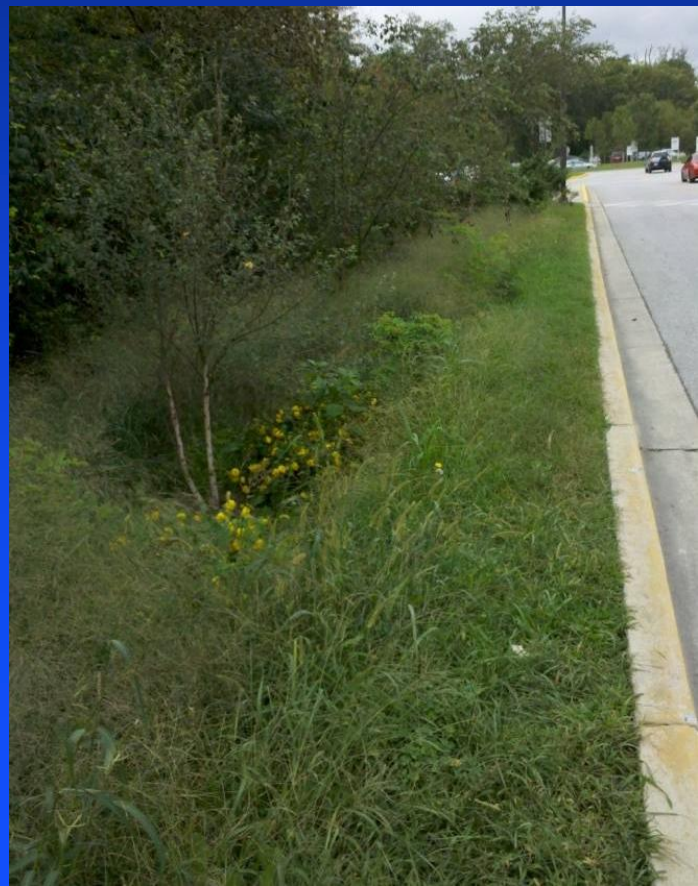
University of Maryland

Funded by NFWF

05/24/2012

Project Site:
University of Maryland Campus in College Park, Maryland

Three Phases

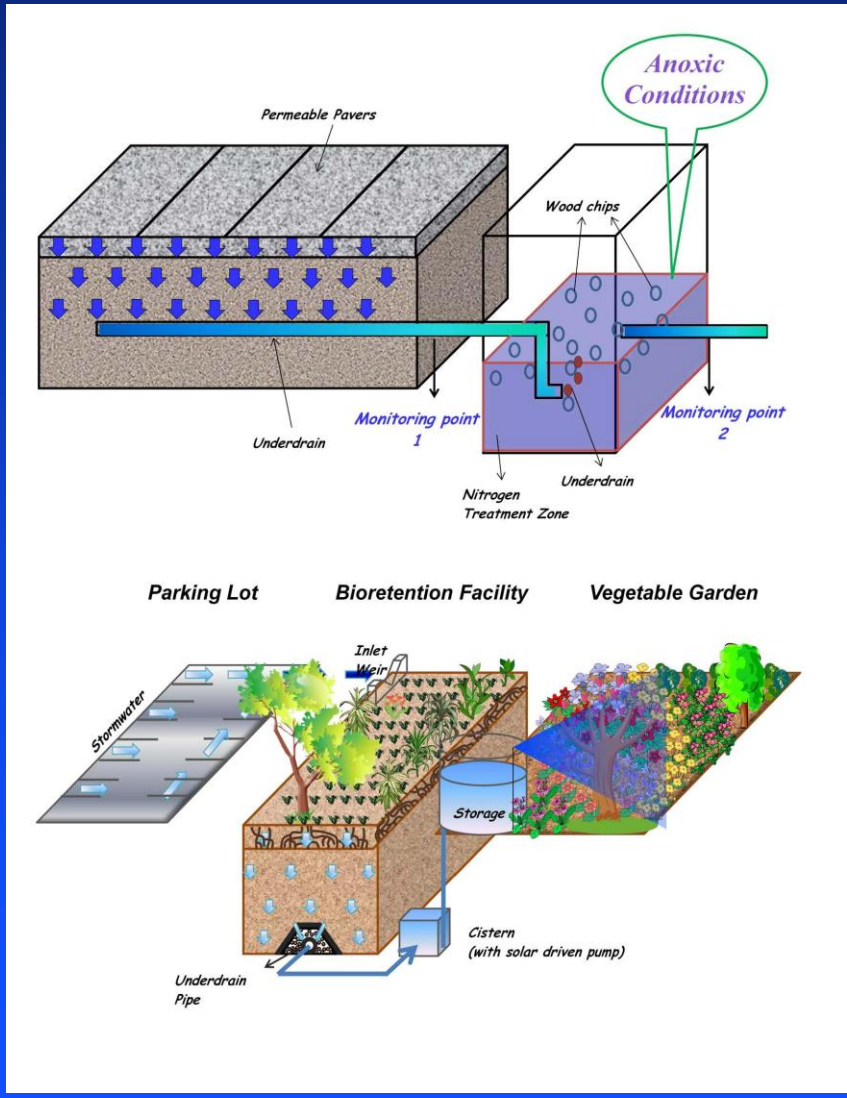


On-going Research Project Phase I

- Contract between the County and the University of Maryland
- Funded by the County and an EPA grant through the National Fish and Wildlife Foundation (NFWF) – 50/50
- Enhance Bioretention Phosphorus removal efficiency using recycling materials in media

Project Components

1. **Bioretention retrofit for enhanced phosphorus removal:** Monitoring stage
2. **Permeable pavers/ porous concrete parking area for enhanced nitrogen removal:** under construction
3. **Bioretention with a Sump Pump and Cistern to collect Treated Runoff Discharge for Irrigation:** Permit stage



Completed Laboratory Project

Typical Urban Concentration:
TN: 2.28 mg/l
TP: 0.33 mg/l

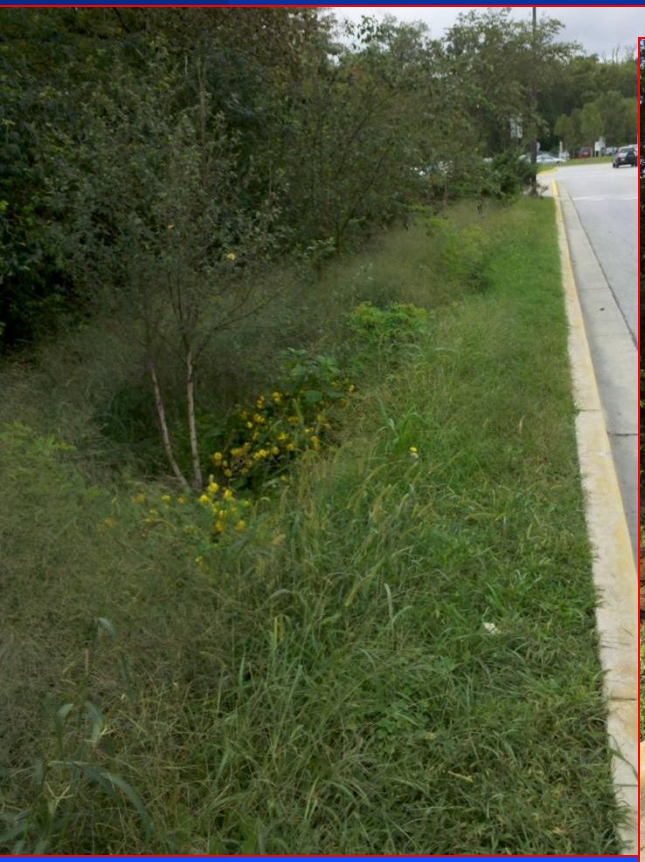
Total Input P to Columns over a 6 months period (`10 exp.): 111 mg

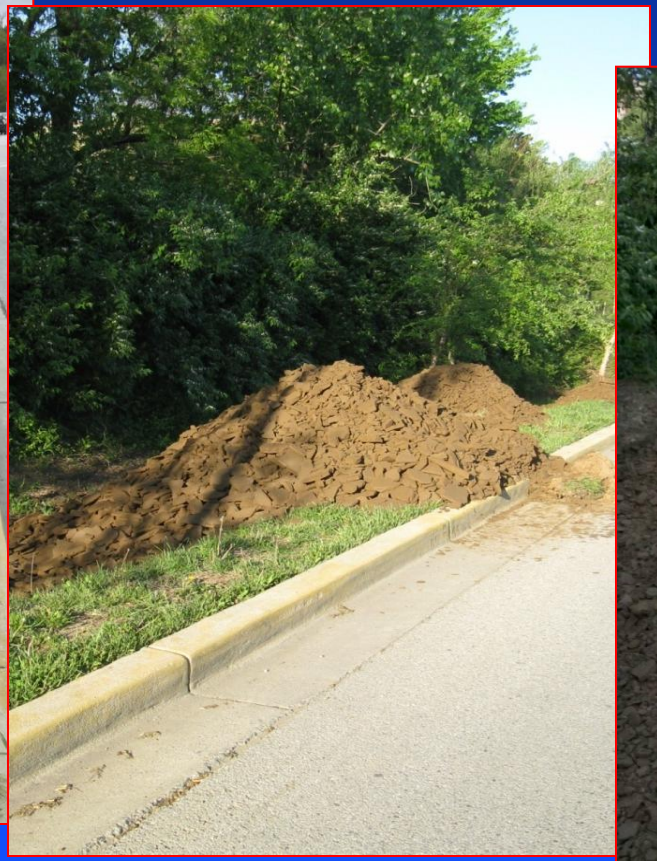
Output P from Traditional Bioretention Media: 190 mg

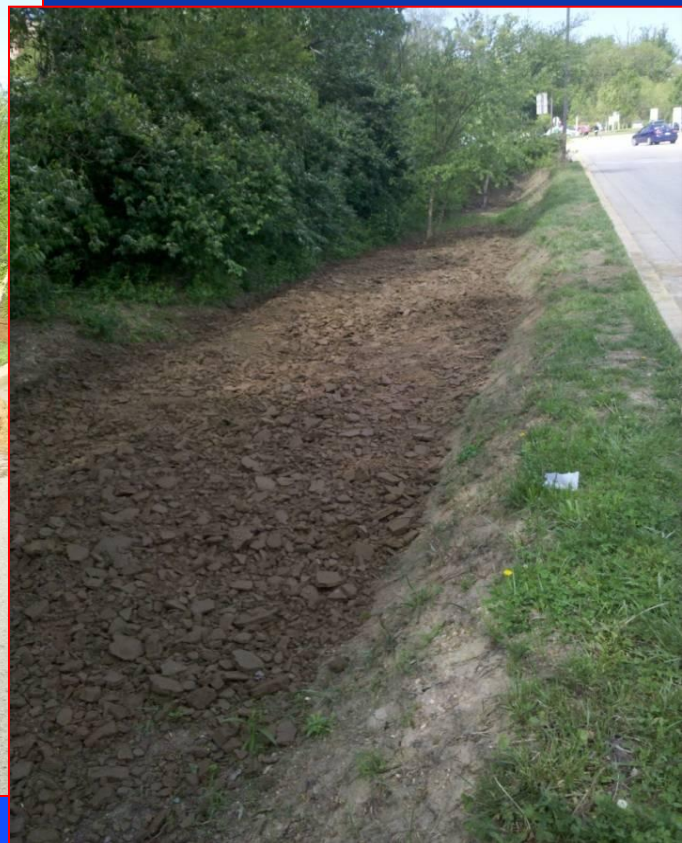
Output P from Amended Bioretention Media (w/ Recycling Materials): 13 mg

UMD Enhanced P Bioretention

- Using Recycling Materials
- Grant funding from U. S. EPA



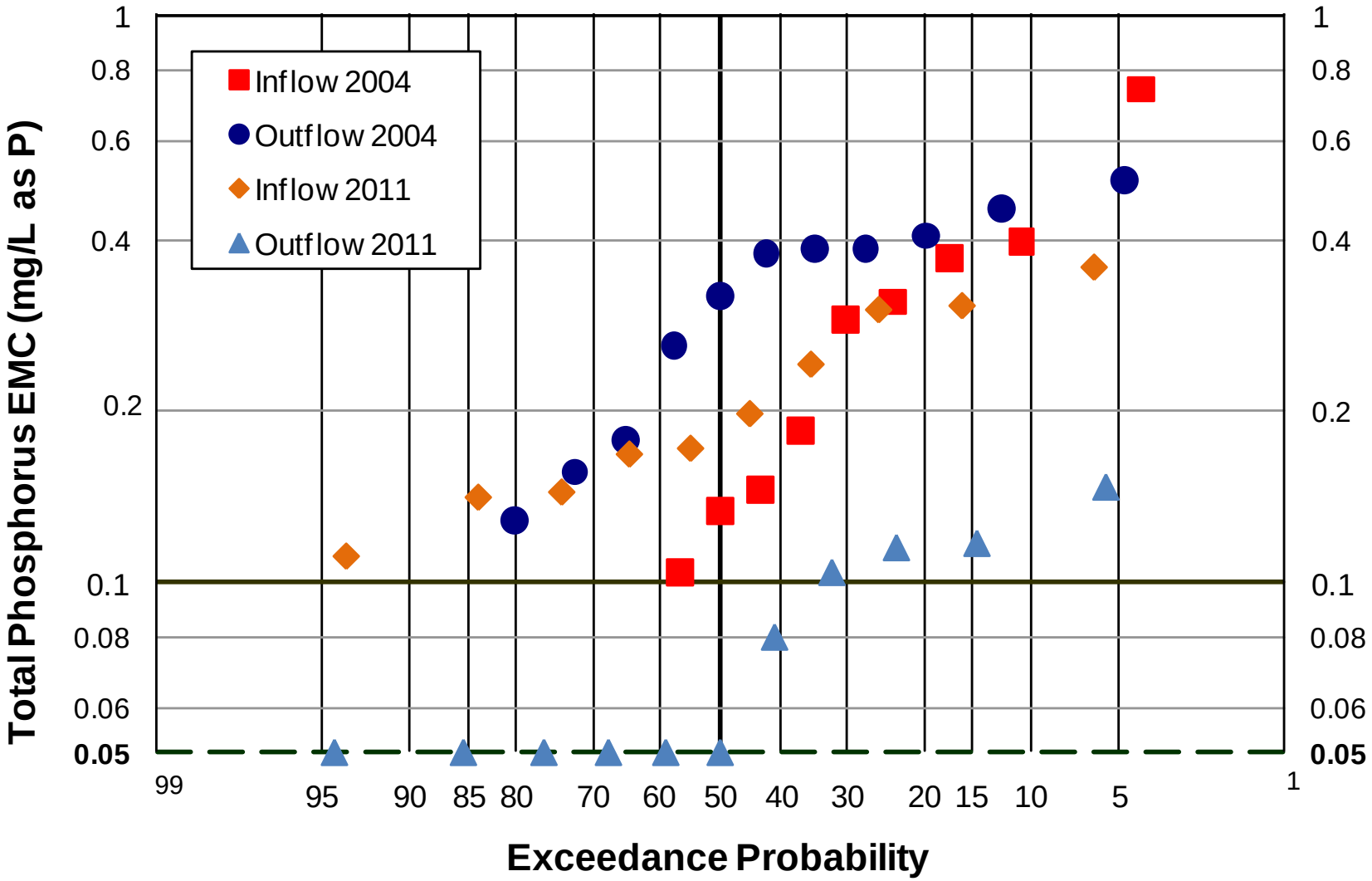




Current Research Status

- Construction was completed in April 2011
- It has been in the full monitoring phase since May 2011
- Approximately 25 storm events have been Monitored
- Date are being complied and Evaluated

Preliminary Results
Exceedance Probability for TP



Project Needs; Phase II

- The WIP-II mandates will cost the County approximately $800,000,000 to implement.
- The LID practices' pollutant removal efficiencies are high; but the unit costs (per impervious area) are also very high
- The County needs to find LID Designs that are cost-effective

Project Objectives

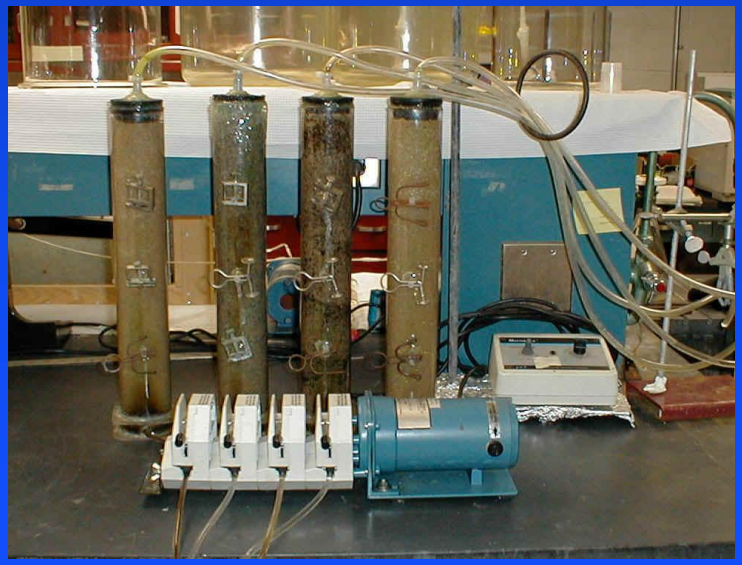
- Continuation of Phase I to further evaluate Media and Configurations to enhanced N & P Removal from Urban runoff
- Increase infiltration rate of media so the facilities can treat more impervious areas
  - Reduce unit cost per impervious area treated
  - Keep high pollutant removal efficiencies
- P: Enhanced Adsorption (media materials)
- N: Media & Configurations for Denitrification for better N removal
- Overall: Treat more impervious acres

Project Approaches

- Focus on Bioretention and Sand Filters
- Detailed Literature Searches
- Laboratory Studies to Optimize Media, Conditions, & Configurations
- Limited monitoring of Field Verification Facilities (Construction is extra)
- Open Communication with Regulatory Agencies (EPA and MDE)

P Tasks

- Evaluate Al & Fe oxide amendments on P uptake
- Find sources of Al & Fe amendments for use
- Optimize with flow rates and vegetation
- Field Studies



N Tasks

- Evaluate media system for conversion of all N to nitrate
- Evaluate configurations for denitrification
- Evaluate media for denitrification
- Field Studies

Example Design Option: Layered Bioretention

With high infiltration media and deep denitrification

Kim , Seagran, Davis, Water Environ. Res. 2003

Additional Research Works Phase III

- More testing and Monitoring efforts
- Construct & monitor a field LID facility each in Prince George's County and Montgomery County in the Anacostia River watershed to incorporate the research recommendations.
- N & P Credits for leaf collection.
- Optimal Design with limit site spaces.

Technology Transfer and Technical Assistance

- Provide technical assistance:
  - LID modeling,
  - suitability of certain types of projects in order to accomplish intended goals, and
  - review of construction design plans
- Transferability of the LID technologies
  - Two watershed restoration projects using LID technologies in the State of Pennsylvania receive assistances including site visits, model run, plan review and assorted incidentals

Lessons Learned

- It is difficult to adopt a new technology.
- Unit cost for a LID facility is more expensive than a conventional device.
- But, **the pollutant removal efficiency is much better**.
- Public education/outreach is a very important task.
- Grading of a site is very critical.
- Maintenance is also critical.

Questions and Answers