

Nonpoint Pollution BMP Handbook Workshop

Stormwater Management in the USA: A Review

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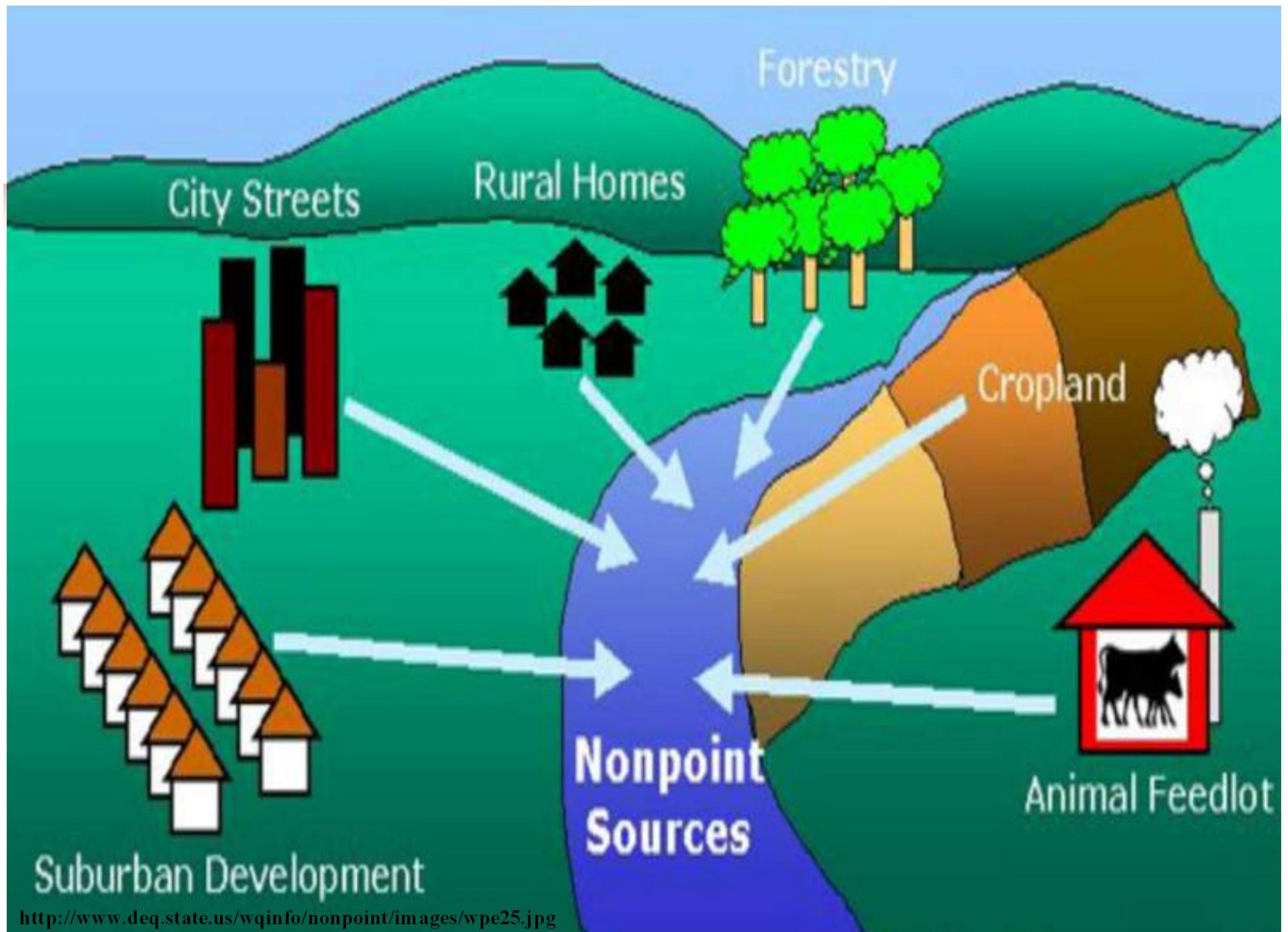
January 14, 2011

Contents of Presentation

- Introduction
- Historical Perspective
- Stormwater Management Framework –
Regulatory Basis, Technical Aspects and
Social/Economical Elements
- Lessons Learned – What Worked and What Did
Not
- Looking Ahead – LID, Green Infrastructures

Definitions & Descriptions (USEPA)

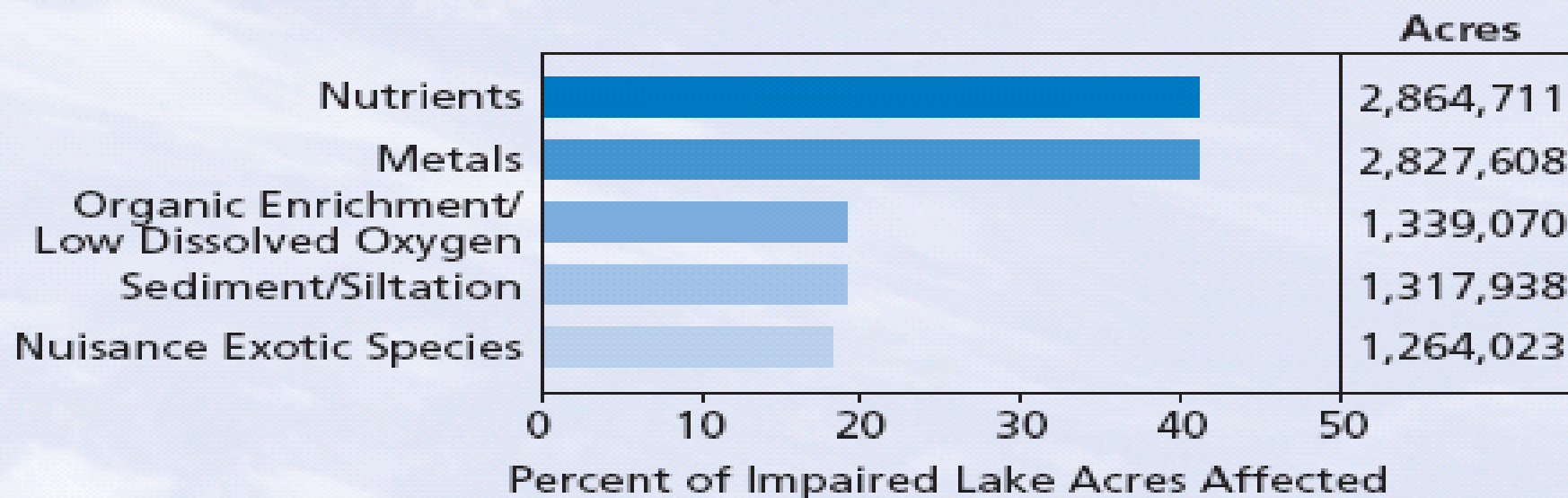
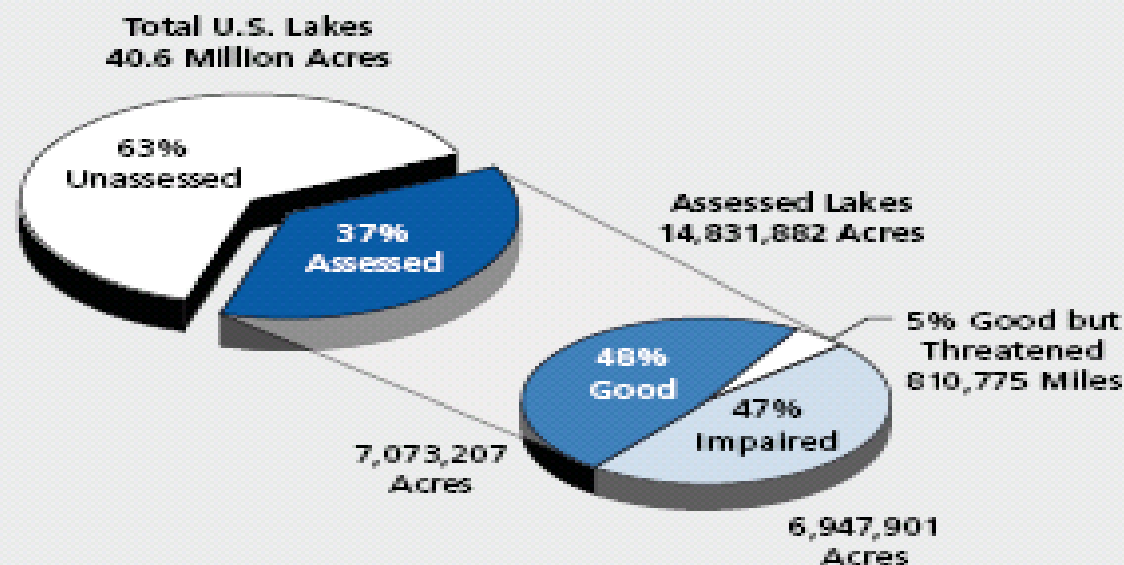
- NPS Pollution (NPS), unlike pollution from industrial & domestic wastewater discharges (Point source or PS) comes from many diffuse sources and is usually caused by rainfall or snowmelt runoff
- NPS pollutants include:
 - **Excessive fertilizers, herbicides & insecticides from agricultural lands & urban areas**
 - **Oil, grease & toxic chemicals**
 - **Sediment from erosion & washoff**
 - **Salt from irrigation, deicing practices and acid drainage from mines**
 - **Bacteria & nutrients from livestock, pet waste, etc.**
 - **Heavy metals from industrial sites, highways, etc.**
 - **Atmospheric deposition**



Lake/Reservoir/Pond Assessment in the USA – 2007

- ~ 40 million acres of total lake area; about 15 million acres assessed.
- 53% - Good Quality (5% Threatened)-Decrease
- 47% - Impaired (Pollution or Habitat Loss)-Increase
- Leading Pollutants – Nutrients, Metals, Siltation, Dissolved Solids, Organics, Algal Growth, Pesticides.
- Leading Pollutant Sources – Agriculture, Urban Runoff & Other Nonpoint Sources such as Highway Runoff, Atmospheric Deposition, Municipal Point sources, Land Disposal
- USEPA requires regular assessments by states

Table 5. Top Causes of Impairment in Assessed Lakes, Ponds, and Reservoirs*.



Lake/Reservoir Pollution

- Lake/Reservoir Characteristics – Physical (Length, Depth, Area, Volume, etc.); Hydrologic (Inflow, Outflow, Evaporation, Seepage, etc.); Temperature Stratification
- Sources of Pollution – Point Sources (Wastewater); Nonpoint Sources (Runoff, Atmospheric Deposition)
- Common Problems – Eutrophication (Excessive Nutrients, Oxygen Problems); Toxicity; Turbidity (Watershed Erosion/Sediment- Man's Activities)

Feitsui Water Quality Concerns – Siltation and Eutrophication. Main Sources of Pollution – Tea Gardens, Urban Areas, Roads.



China – Taihu (3rd largest freshwater lake in China) Algal Bloom 2007



Algae Bloom Blocked Water Supplies to Millions of People in Wuxi Summer of 2007

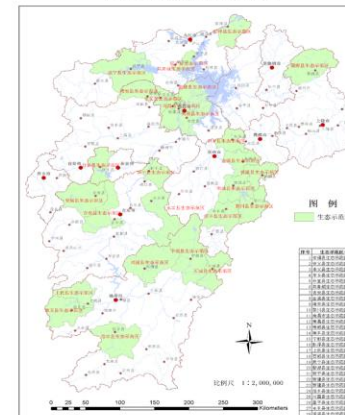
China to spend \$14.5 billion to clean up Lake Taihu



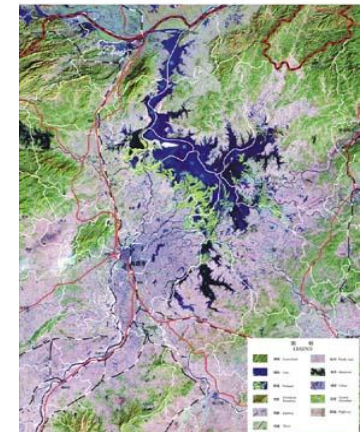
Poyang Lake in Jiangxi Province Needs Protection (Modified from Bao, 2006)

- The largest fresh water lake in China with important impact on Jiangxi and the lower Yangtze river regions
- Rich in natural and biological resources (One of the 10 ecological conservation areas in China designated by WWF with 102 species of aquatic plants, 122 species of fish, and more than 280 species of birds)
- Fragile ecosystem with frequent floods
- Popular in schistosomiasis which was re-emerged in last several years
- Relatively lagged development until recently
- Under severe risks – Urbanization, industries, agriculture, etc. Major problems – sedimentation, loss of wetlands, eutrophication, metals, etc.

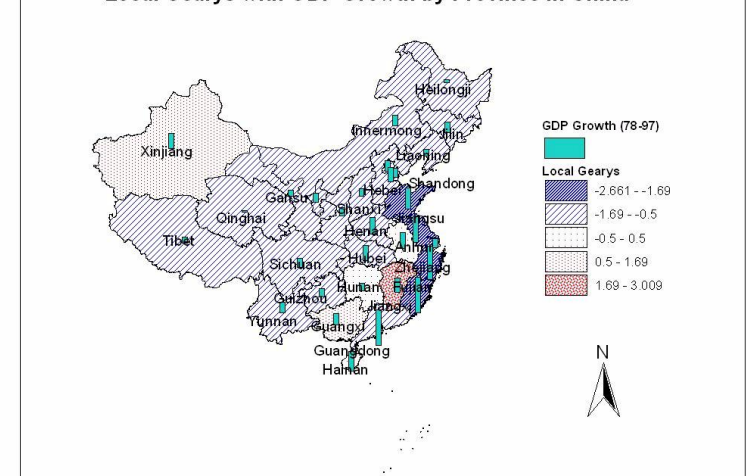
江西省生态示范区分布图



鄱阳湖区卫星影像图



Local Gearys with GDP Growth by Province in China



NPS Rules and Regulations

Flood Control

Erosion & Sediment Control

Water Quality Management

NPS Control Legislation

- **1991 - Phase I Stormwater Permit Program**
- **Certain Industries, Large Municipalities (MS4's) and Construction Sites >5 acres**
- **1995 - Phase I Program Expanded to Include More Industries and Medium Municipalities**
- **2000 - Phase II Program Announced - Add Small Municipalities and Construction Sites between 1 to 5 acres**

NPS Control Legislation-More

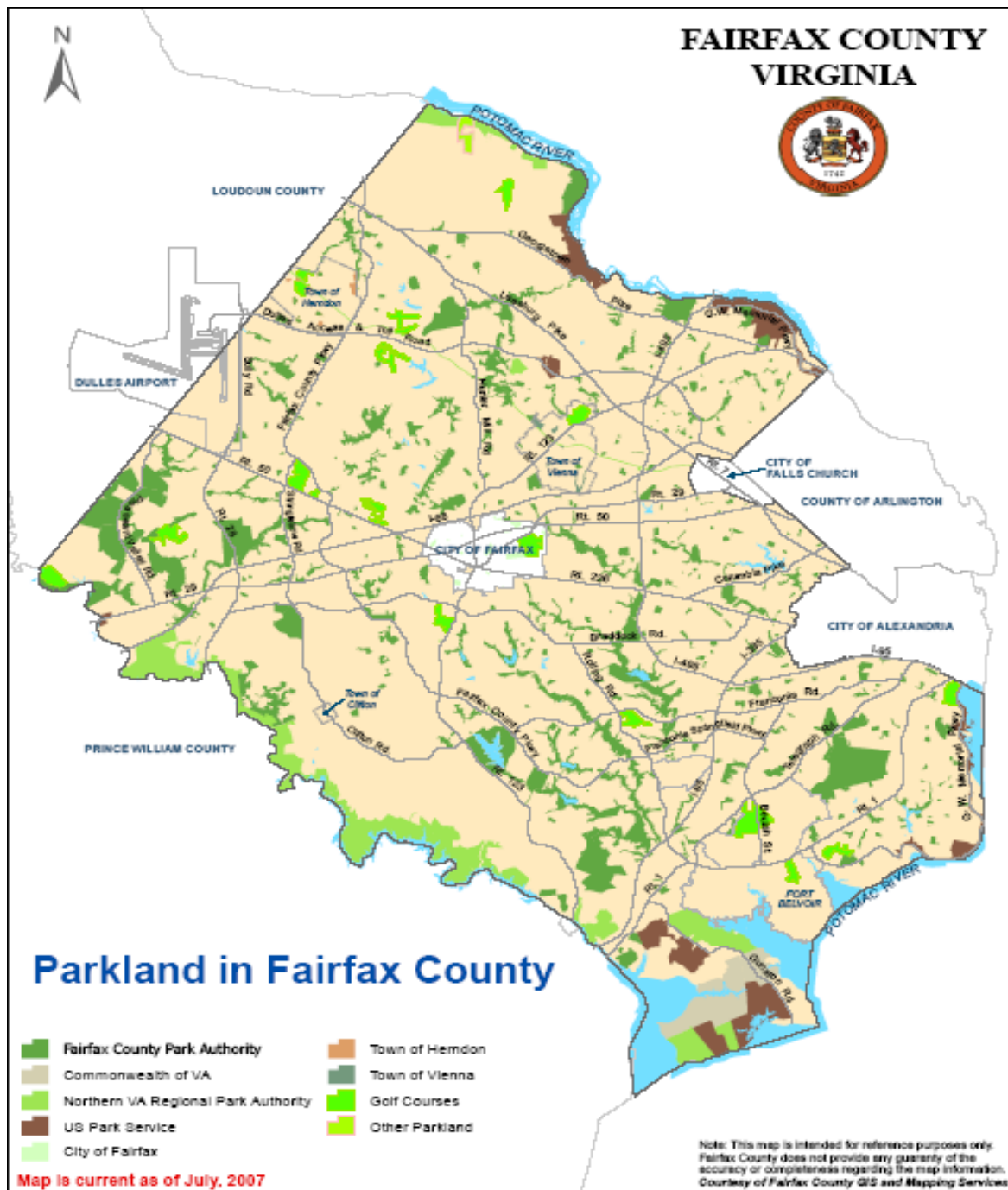
- **Phase II Implemented in Early 2003.
Specific Compliance Dates are as Follows**
- **Oct.,2000- Menu of BMPs Issued by EPA**
- **Oct. 2001- EPA Issues Guidance on
Setting Measurable Goals**
- **Dec.,2002- Phase II Permit Application**
- **Mar.,2003- Phase II Permit Required**
- **2008 -Full Implementation of Stormwater
Management Programs Required**

More Water Pollution Control Legislations

- *Section 305(b) and the National Water Quality Inventory: Report to Congress.*
Every 2 years, states are required to submit a report to Congress detailing the health of their waters.
- *Section 404 – Wetlands Protection*
Permit requirement for wetland modifications

Examples of State & Local Regulations

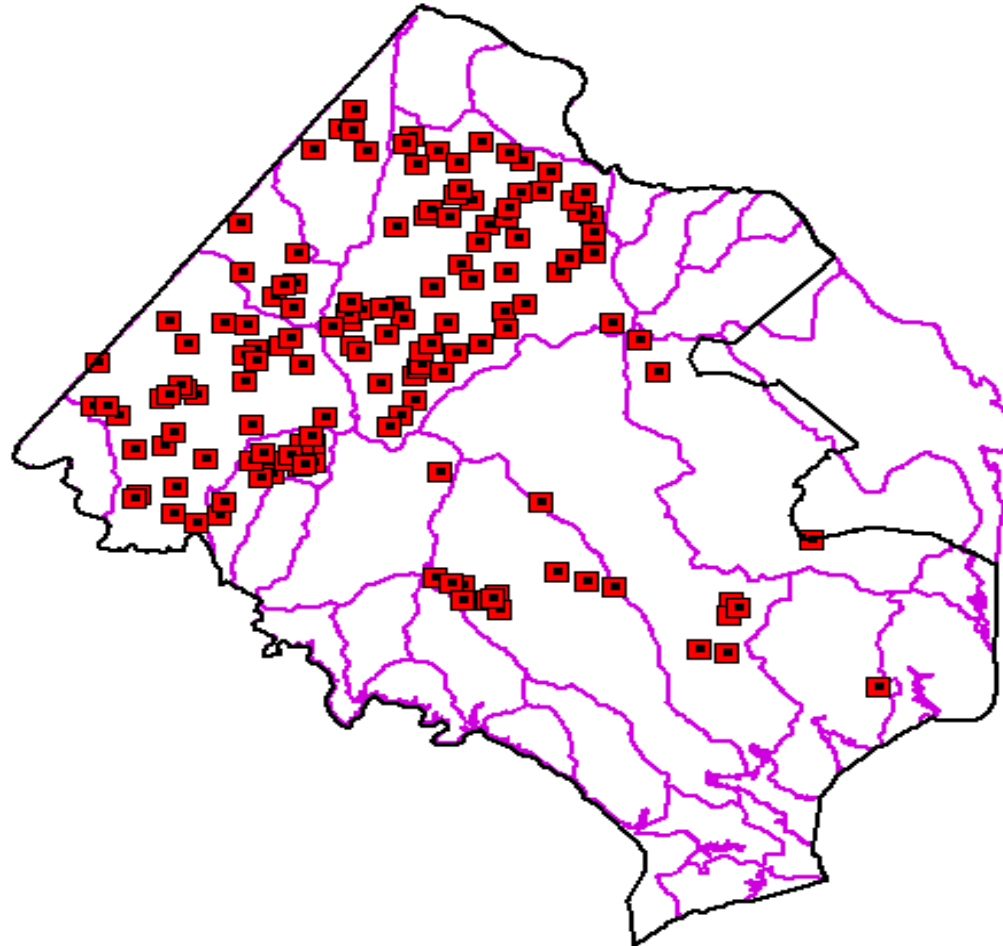
- State of Virginia
 - ❖ Erosion & Sediment Control Laws
 - ❖ Stormwater Management Laws
 - ❖ Special Regional Regulations
 - e.g., Chesapeake Bay Regulations
- Local Regulations
 - e.g., Fairfax County



STORMWATER MANAGEMENT HISTORY IN FAIRFAX COUNTY (Source: Fairfax County 2007)

- 1950 - Population 100,000
- 1967 - Erosion and Sediment Control Ordinance
- 1970's - Stormwater detention - 2 and 10 year storms
- 1990's - Federal, State NPDES Stormwater Regulations and Local Runoff Control Ordinance, Stormwater Utilities
- 1993 - Chesapeake Bay Ordinance - Water Quality
- 2000 - County > 80% developed, population nearly 1 million
- 2002 - Watershed Management plans initiated
- 2002 - Board direction to study regional ponds and other controls
- 2003 - Federal NPDES Stormwater Regulations - Phase II
- 2005 - Low Impact Development Practices Encouraged
- 2006 - County-wide Watershed BMP Studies

Location of Regional Pond Sites



Recent Activities

- USEPA is promoting the use of “low impact development, or LID, practices as a preferred BMP strategy.
- Many states, including Maryland and Virginia, are encouraging and some locals are requiring the use of LID practices.
- Stormwater management is promoted as a means of reducing CSOs.

Stormwater Management Framework

- Regulatory Basis
- Technical Aspects
- Social/Economical Aspects

Regulatory Basis

- NPDES for nonpoint sources (as described earlier)
- CWA – TMDL process is in full-implementation stage
- State and local regulations
- Regional such as the Chesapeake Bay protection laws
- Recent LID Ordinances, e.g., Los Angeles

Technical Aspects

- Structural and non-structural BMPs
- Non-structural BMPs aim at removing or reducing pollutant at the source, e.g., street sweeping, fertilizer management.
- Structural BMPs use mainly storage and infiltration mechanisms for removing pollutants
- In early years, mainly detention ponds. Now LID practices are preferred.

LID Design Principles

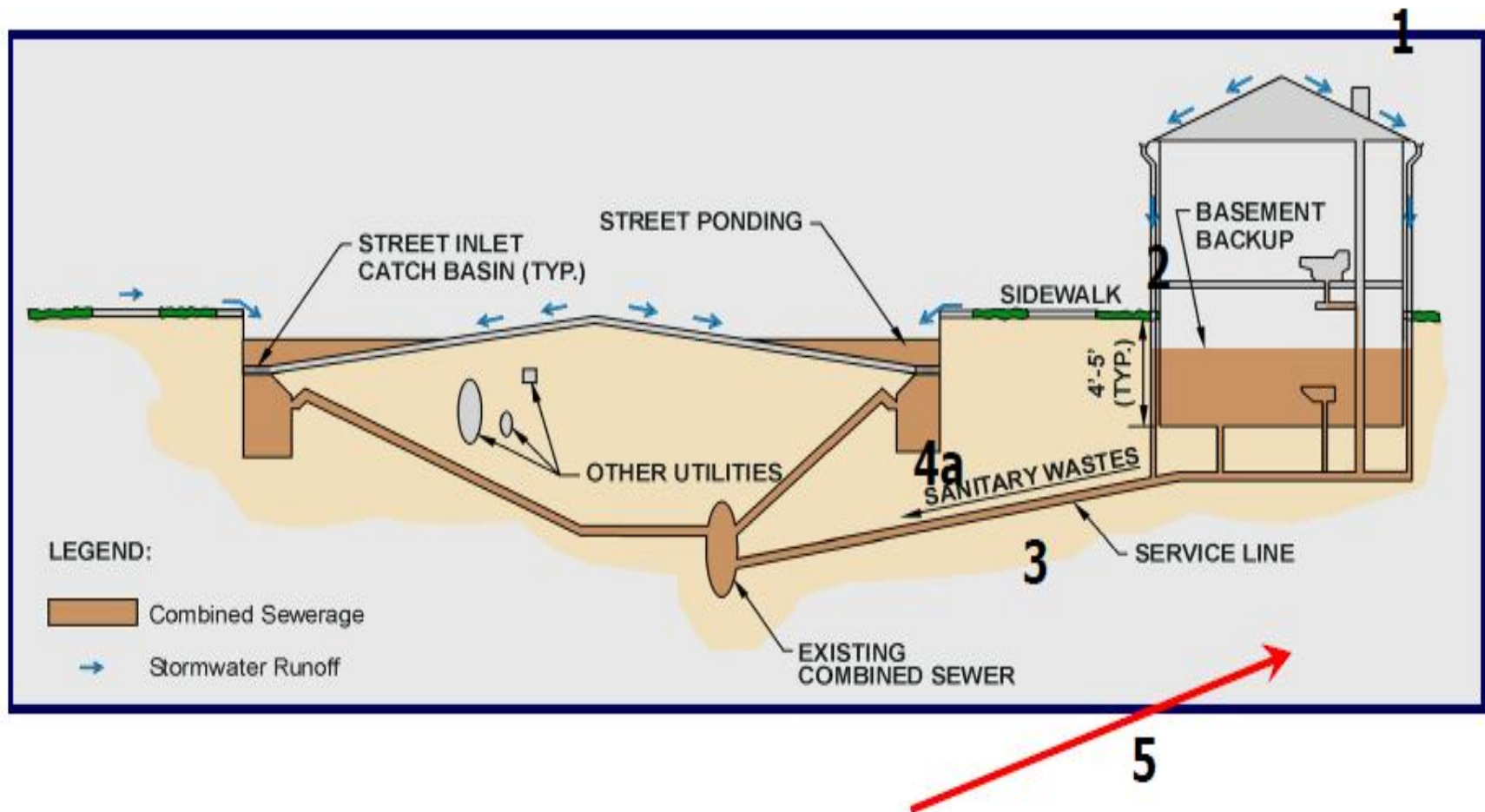
- “Mimic” Natural Hydrology
- Control micro storms while maintaining traditional drainage and flood control functions
- Distribute storage and conveyance in the watershed in an optimal way
- Use local plants in “green” BMPs and integrate controls into the landscape

Green Infrastructures (LID BMPs)

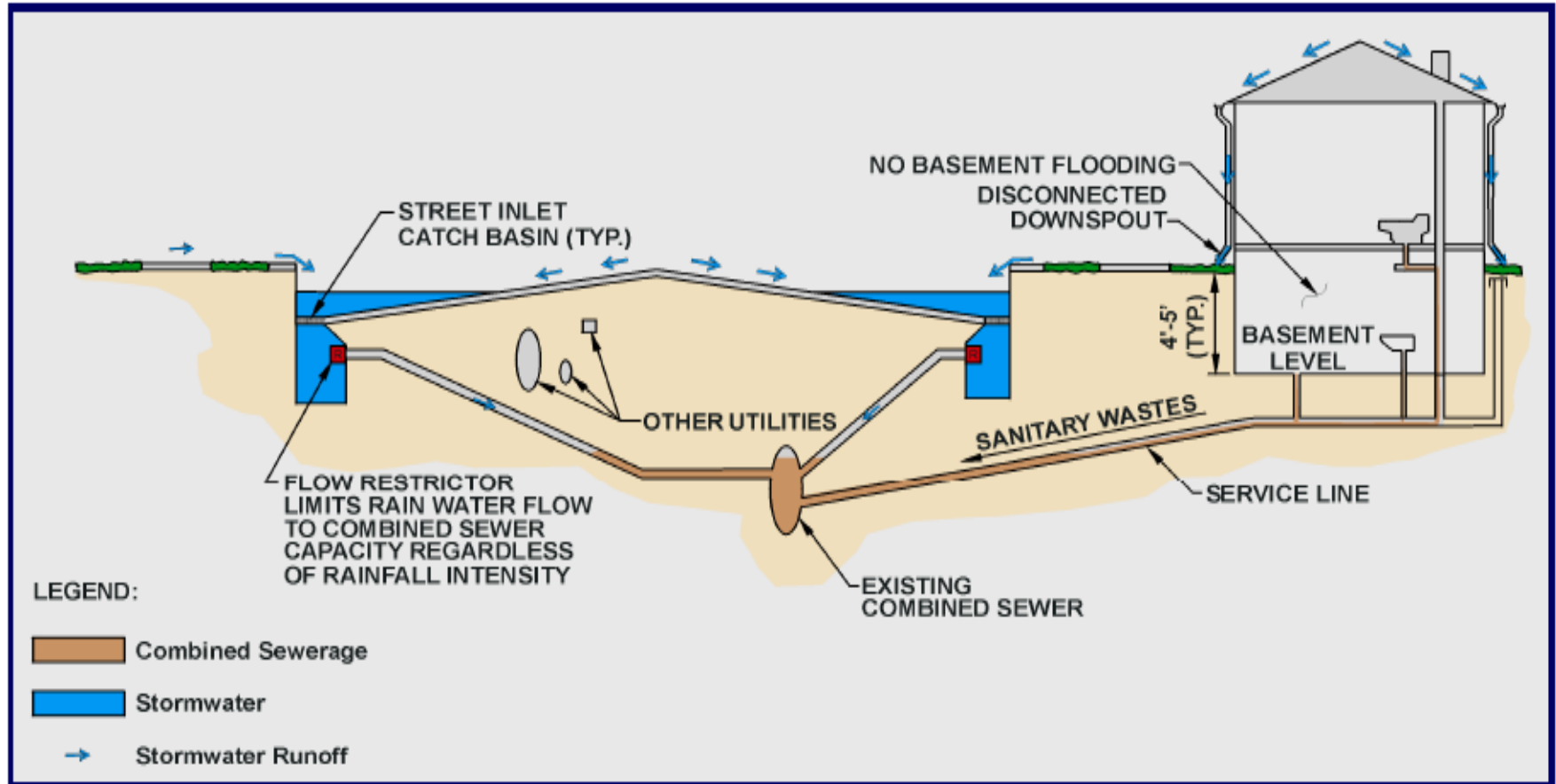
Beneficial Functions

- Reduce flooding
- Improve water quality
- Enhance groundwater recharge
- Reduce stormwater and combined sewer system expenditure
- Reduce energy use
- Improve air quality
- Enhance aesthetics and property values
- Increase educational opportunities

Basement and Street Flooding with Sewer Waste Due to Excessive Stormwater in Combined Sewer System



Downspout Disconnection and Rain Blockers



LID Structural BMPs

Volume/Peak Rate by Infiltration

- Rain Garden/Bioretention
- Porous Pavement
- Infiltration Basin
- Infiltration Trench
- Vegetated Swale
- Infiltration Bed
- Vegetated Filter Strip
- Infiltration Berms



Volume/Peak Rate Reduction BMPs

- Vegetated Roof



- Rooftop Runoff Capture & Reuse



Runoff Quality/Peak Rate BMPs

- Constructed Wetland
- Wet Pond / Retention Basin
- Dry Extended Detention Basin
- Water Quality Filter



Restoration BMPs

- Landscape Restoration
- Riparian Buffer and Floodplain Restoration
- Soils Amendment & Restoration



Bioretention Cells

Pretreatment (optional)

Flow entrance

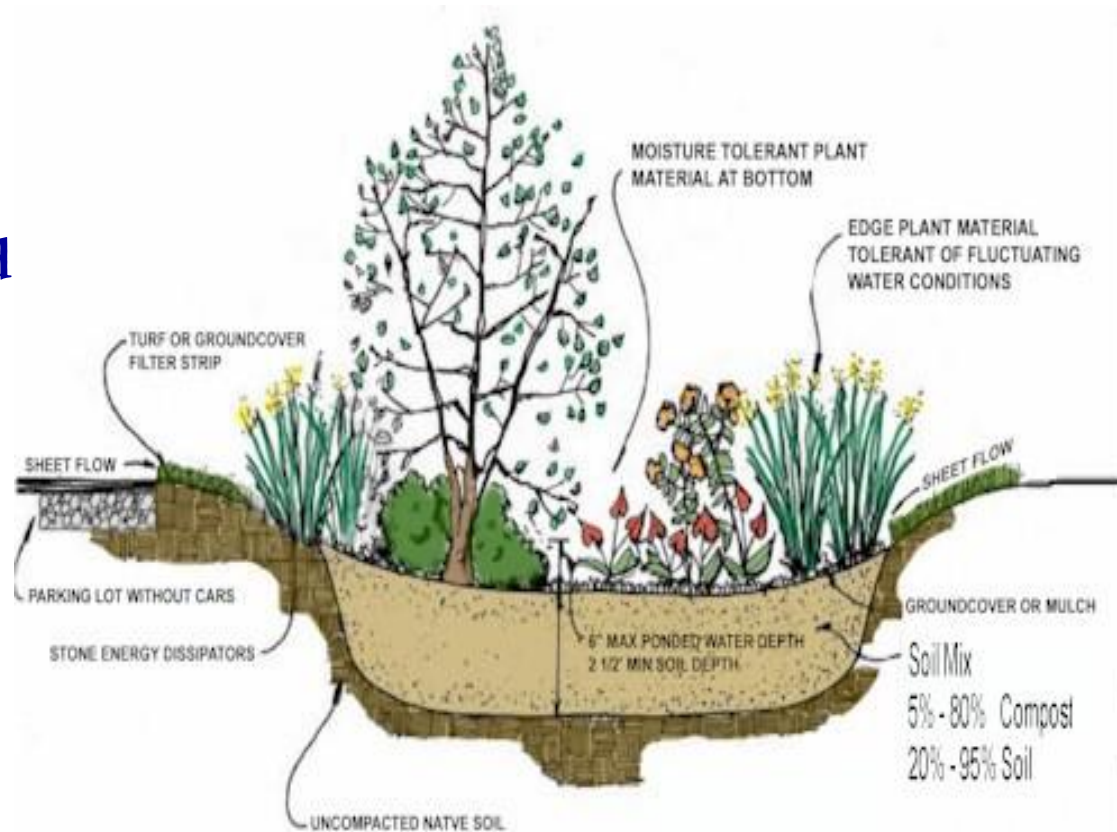
Ponding area

Plant material

Organic layer or mulch

Planting soil/storage bed

Positive overflow



Source: Low Impact Development Center (2007)



Tree box filter at the
Washington, DC
Navy Yard

Tree box filter
at the Pentagon

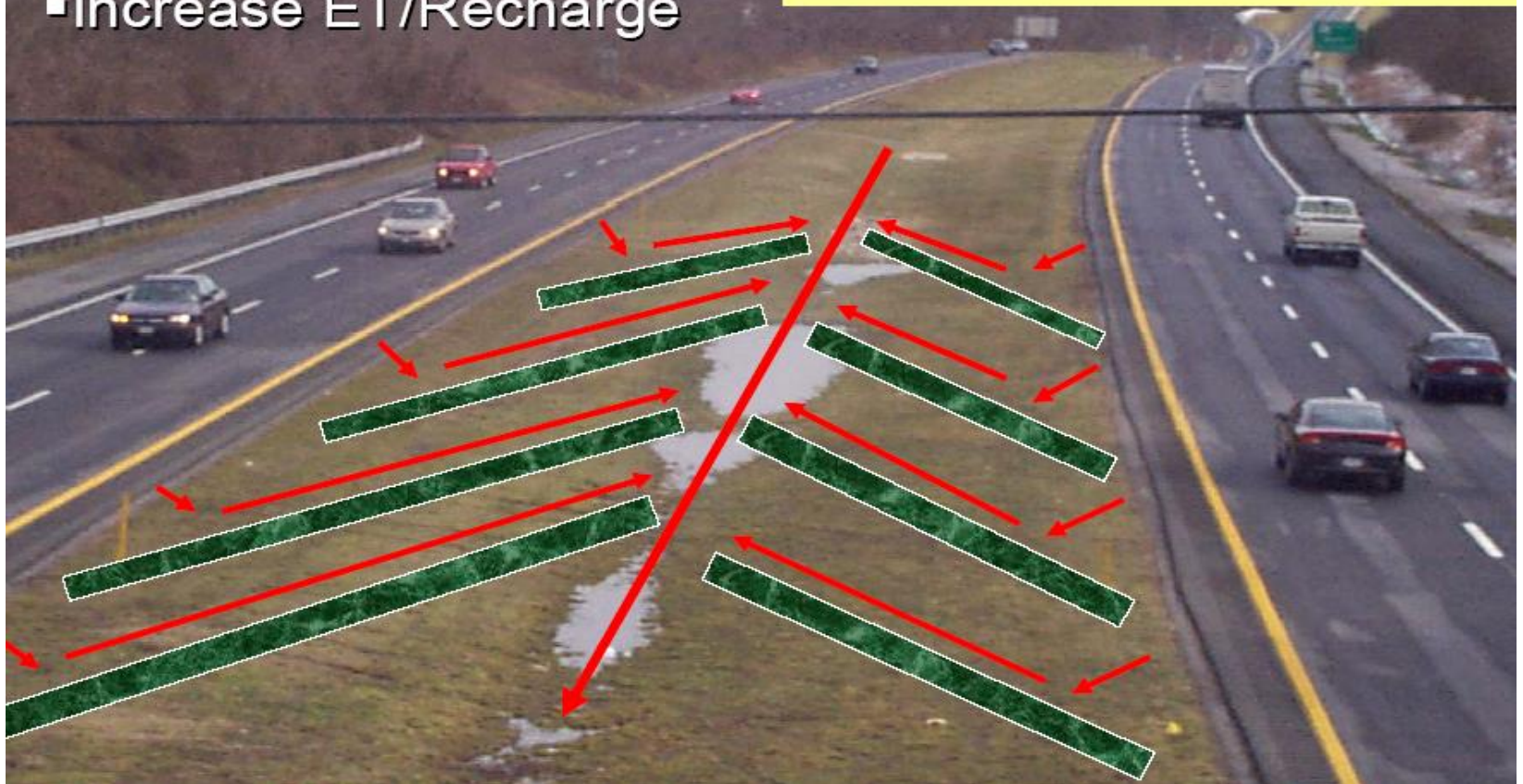


Normal flow
into tree box

High flow bypass
to conventional inlet

Green Highways Initiative

- Increase flow paths
- Increase timing
- Increase ET/Recharge



S









Portland “Green Street” Project – Street Planter Boxes



Portland "Green Street" Project: Landscaped Curb Extension



Social/Economical Aspects

- Cost, cost and cost !!
- Life time cost is needed.
- Innovative funding methods are needed.
Currently – Utility tax, stormwater surcharge tax, federal/state funding, etc.
- Outreach is very important.
- Income tax breaks
- Those who benefit help pay – New York watershed BMP programs.

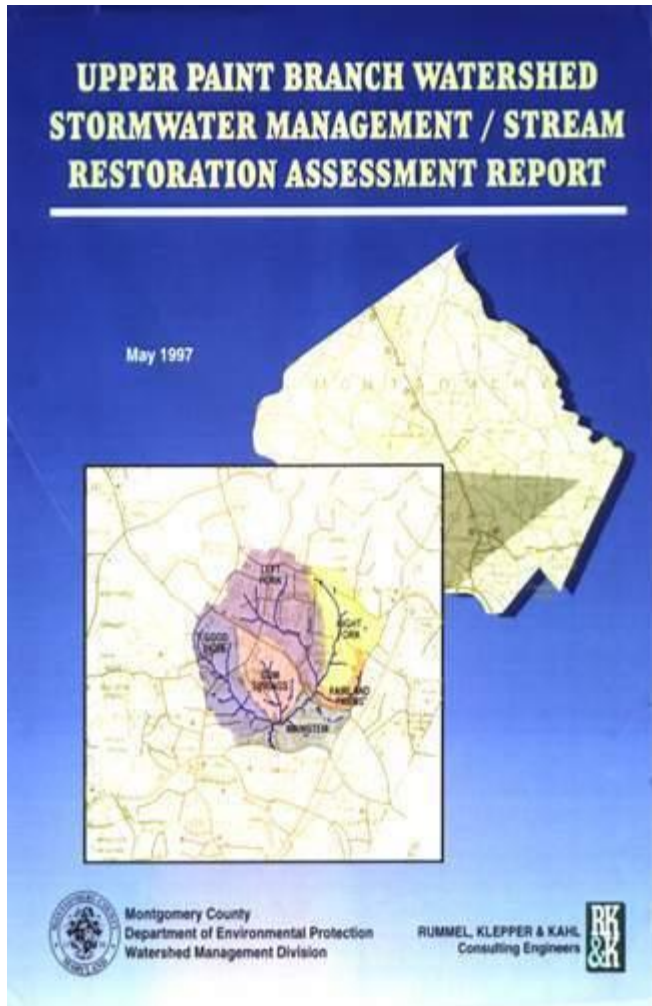
Montgomery County's Stream Restoration Program

- Program began in 1991
- Focused on stream restoration and stormwater retrofit (including new facilities)
- 17 miles of stream restoration
- 33 retrofit projects with a total drainage area of approximately 4,000 Acres and an impervious area of approximately 1,000 Acres.
- Total cost approximately \$24 million.

NPDES MS-4 Permit Requirements

- New permit requires providing SWM control for 20% of the uncontrolled impervious area in the County (~5,200 impervious acres) to the maximum extent practicable (MEP).
- Make progress toward meeting TMDLs
- Meet Potomac Trash Treaty commitments
- Use Environmental Site Design (ESD) / Low Impact Development (LID) techniques to the Maximum Extent Practicable (MEP)

Watershed Studies



- DEP has watershed studies that identify >300 potential retrofit projects
- Projects are ranked within evaluated sub-watersheds
- Developing inventories of LID retrofits for public property (roads, schools, libraries, etc)

Types of Retrofits

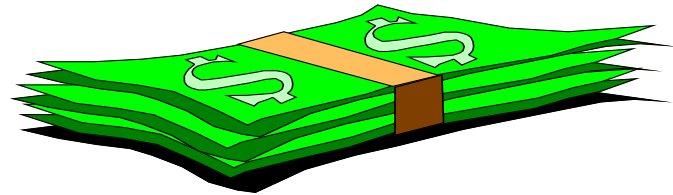
- Construction of new ponds
- Retrofitting of existing ponds
- Create Pocket Wetlands at Storm Drain Outfalls
- Retrofit with LID
- Retrofit using conventional stormwater devices (sand filters, underground storage, etc.)

Challenges Encountered

- Putting 10 pounds in a 5 pound bag
- Citizen Concerns
 - Flooding concerns
 - Tree removal
 - Aesthetics of retrofitted pond
 - Concerns about mosquitoes & snakes
 - Construction noise and dust
- Existing utilities
- Permitting
- Changing regulatory climate
- Interagency coordination

Costs for Stream Protection in Developed Urban/Suburban Watersheds

- Stormwater Management Retrofits Cost
 - ***\$1,000 - \$4,000 / drainage acre to retrofit existing pond***
 - ***\$4,000 - \$6,000 /drainage acre for a new pond***
 - ***\$12,000 / per impervious acre treated***
- LID Costs
 - ***\$100,000 - \$200,000 per impervious acre treated***



Stormwater Fee

Water Quality Protection Charge

- Current rate \$45.50. Approximately \$8,500,000
- Funds stormwater facility inspection and maintenance, and water quality monitoring.
- Evaluating new incentives to promote installation of stormwater facilities on residential and commercial property.

Lessons Learned

1. Anticipate and address permitting issues early in the project design
2. Prioritize projects to mitigate the greatest damage
3. Evaluate benefits vs environmental impacts (this requires involving ecologists in the project goals and concept)
4. Solicit community support
5. Don't give up on a project because you hit a problem, but know when the problems are insurmountable and be prepared to kill the project

Lessons Learned

- What worked – regulatory requirements vs. voluntary programs.
- Works better with strong citizen support and participation, e.g. the Villanova Stormwater Partnership in Philadelphia.
- What did not work – the earlier infiltration practices, ponds everywhere, etc.
- Funding is not continuous.

Looking Ahead

- LID practices – Green Infrastructure
- Integrated Water Management – Managing rainwater/runoff, water supply and wastewater together.
- LID/Green BMP benefits in terms of carbon reduction and energy-saving.
- Integrating engineering with landscaping – working with architects

The ASLA Headquarters Building in Washington, DC – Green Roof

- Green roofs are highly effective at stormwater volume reduction. To produce runoff from green roofs, storms generally have to be larger than 1 inch in a 24-hour period, and often must come in quick succession. The ASLA green roof retained approximately three quarters of the total rainfall volume that fell on it.

Green Roof Monitoring Study at Sichuan University

Sponsored by USEPA and Sichuan
University, Chengdu, China

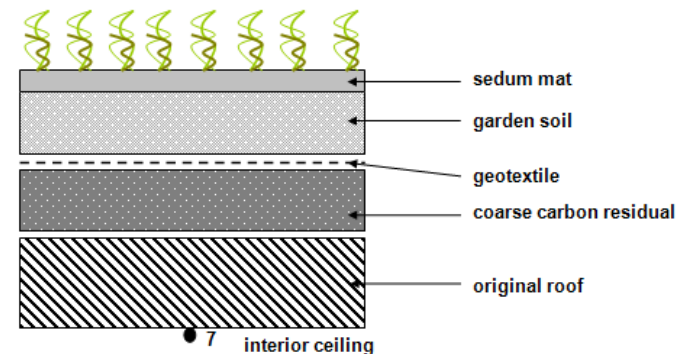
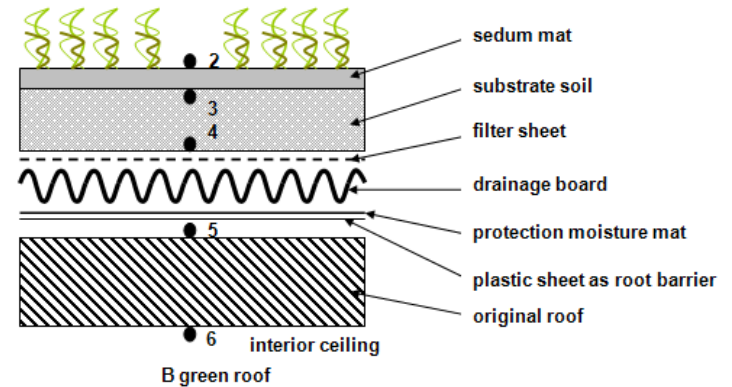
Completed in December, 2010

Temperature Monitoring



Thermometer

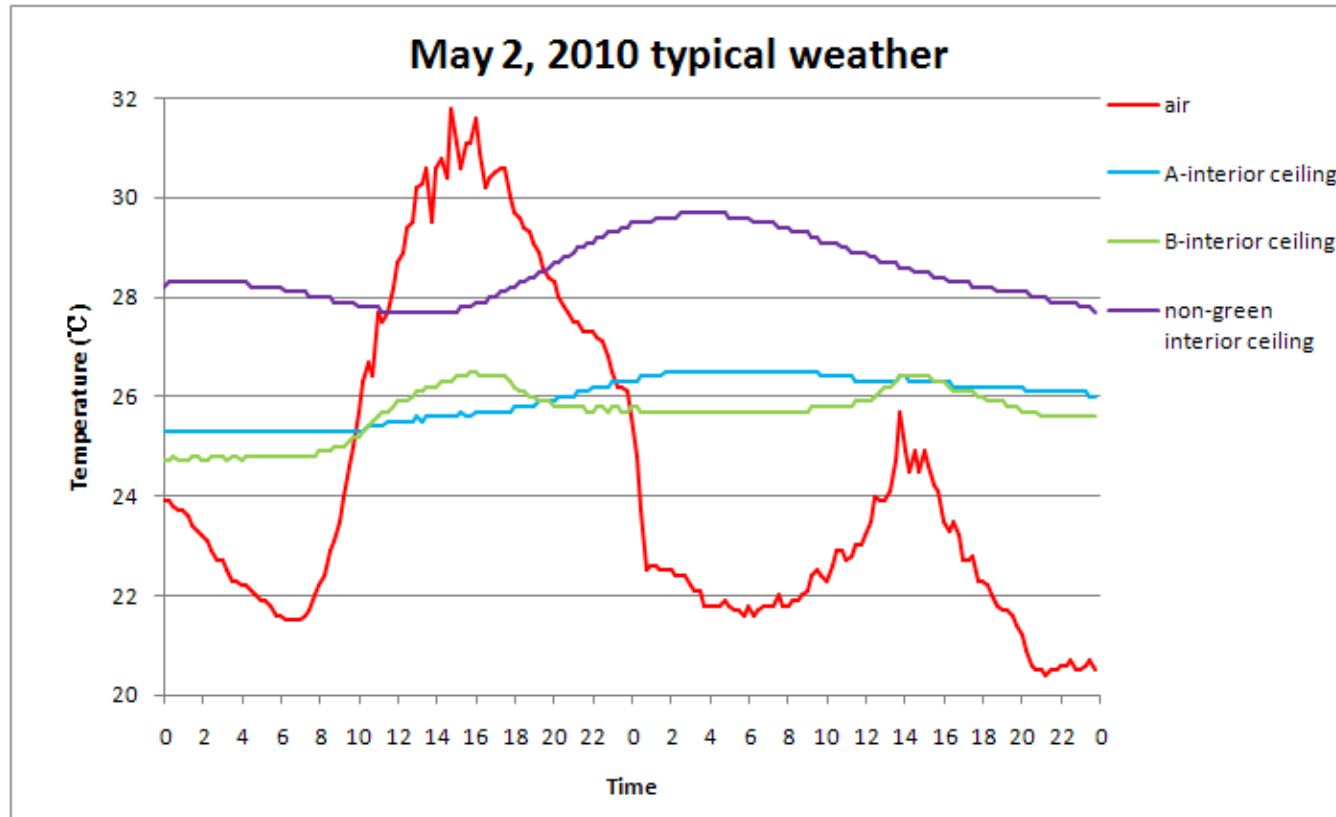
● 1 150mm above sedum mat



Test Point Sensor Location

Temperature Collection from Different Layers of B Green Roof

Temperature Data from Different Rooms



While A-interior ceiling surface temperature changed with the air temperature, the temperature fluctuation of inner ceiling surface of the room under B roof was similar as the temperature fluctuation of inner ceiling surface of the room without green roof. The two trends were opposite.