



# ***Benefits of Watershed-Based NPDES Permitting***

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# Outline

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- ◆ Introduce the concept of watershed-based approaches, including permitting
- ◆ Wet Weather
- ◆ Case Study – Richmond, VA
- ◆ Layering paradigms



# What Is Watershed-Based Permitting?

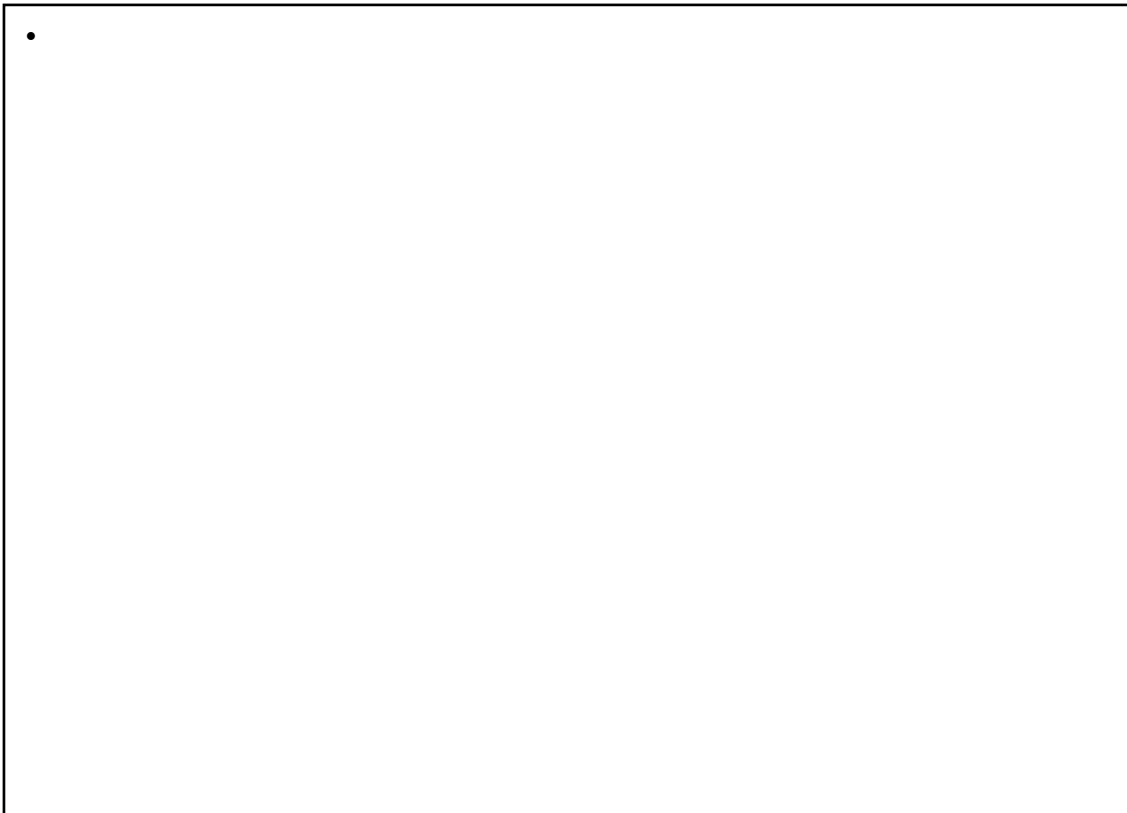
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An **approach** to NPDES permitting that results in permits:

- Designed to attain watershed goals due to the consideration of all sources/stressors in a watershed or basin
- Developed via a watershed planning framework to communicate with stakeholders and integrate permit development among monitoring, water quality standards, TMDL, nonpoint sources, source water protection and other programs



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## Expected Benefits & Challenges

- ◆ Benefits
  - ◆ Better quality NPDES permits
  - ◆ Emphasis on environmental results due to watershed planning
  - ◆ Promotes watershed monitoring plans
  - ◆ Encourages efficiencies and targets resources
  - ◆ Increased stakeholder involvement
- ◆ Challenges
  - ◆ Expanded stakeholder involvement
  - ◆ Integrating nonpoint sources
  - ◆ Transition costs



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## Who Initiates a Watershed-Based Permitting Approach?

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- ◆ Can start at any level
  - Permitting authority
  - Point sources
  - Watershed organization
  
- ◆ Requires support of Permitting Authority and EPA Regional Office



# Basic Steps to WBP

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**Step 1: Select a Watershed**

**Step 2: Identify and Engage Stakeholders**

**Step 3: Analyze Watershed Data**

**Step 4: Develop Permit Conditions**

**Step 5: Issue Watershed-Based NPDES Permit(s)**

**Step 6: Measure and Report Progress**



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## Sustainable Water Infrastructure

- Our wastewater and drinking water systems are aging
- U.S. population is increasing and shifting
- Current treatment and management may not be sufficient to address emerging issues and potentially stronger requirements
- Investment in R&D has declined
- Funding gap: \$270 billion for wastewater and \$263 billion for drinking water





## Sustainable Water Infrastructure

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- Seek innovative approaches and new technologies to help ensure that the Nation's water infrastructure is sustainable
- Accomplish this through collaboration with external stakeholders and conducting research, in the following 4 "pillar" areas:
  - Better Management
  - Water Efficiency
  - Full Cost Pricing
  - Watershed-Based Approaches



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## Sustainable Water Infrastructure

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### Watershed Approach Pillar

Integrate water utility management and watershed planning, allowing stakeholders to take advantage of the full range of tools and approaches to help them make optimal infrastructure decisions and achieve watershed goals



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# A Concept for the Integration of Wet Weather Programs



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## Key Discussion Areas

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- ◆ Wet weather discharges and what we are doing to control them?
- ◆ The need for wet weather integration
- ◆ What might an integrated wet weather program look like?



## Wet Weather Overview

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### Municipal wet weather discharges

- Combined Sewer Overflows (CSOs)
- Sanitary Sewer Overflows (SSOs)
- Stormwater runoff
- Peak wet weather flows at POTWs
- Urban nonpoint sources

What is the most effective way to control urban wet weather discharges for the best water quality outcomes?



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## Wet Weather Overview

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### Wet weather discharges:

- Contribute similar pollutants (e.g., BOD, suspended solids, pathogens, toxics)
- Collectively contribute to one of the most serious causes of impairment: discharge volume
- Often discharge simultaneously
- Are variable in terms of event frequency, duration, volume and pollutant load
- Often difficult to partition causes of impairment(s) among multiple wet weather sources



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## What is the Urban Wet Weather Problem?

- ◆ EPA's *National Water Quality Inventory 2000 Report* identified "municipal point sources" and "urban runoff/storm sewers" as leading sources of impairment
- ◆ Top 3 pollutants in impaired waters:
  - Suspended solids
  - Pathogens
  - Nutrients
- ◆ All three pollutants present in municipal wet weather sources



## What is the Urban Wet Weather Problem?

- ◆ Physical and biological impacts of wet weather discharges can be severe
  - e.g., altered hydrology → habitat impairment
- ◆ Population growth and new development → increasing demands on the urban environment
  - More difficult to achieve and maintain water quality standards in coming years



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## What is the Urban Wet Weather Problem?

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Current regulatory, management and funding approaches address wet weather sources under separate Clean Water Act, and sometimes state, programs

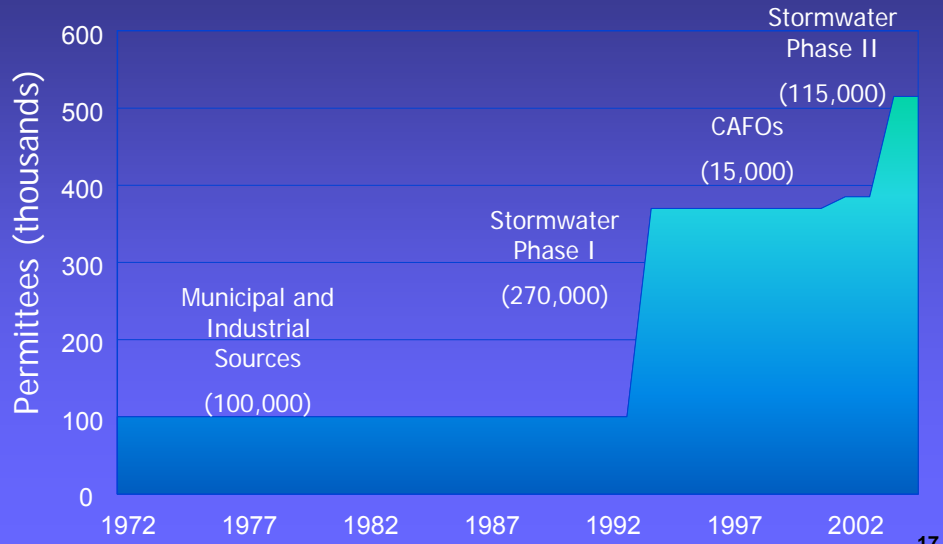


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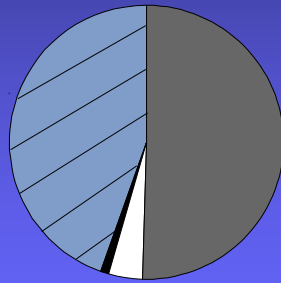


# NPDES Universe



## What is the Urban Wet Weather Problem?

### Estimated Annual Municipal Point Source Discharges



Source	Average Discharge Volume (billion gal.)
▽ Treated wastewater	11,425
▽ Urban stormwater	10,068
▽ CSO	850
▾ SSO	10
Total	22,353

*Report to Congress on the Impacts and Control of CSOs and SSO (EPA 2004)*



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## Pollutant Concentrations in Municipal Point Source Discharges

Source (Annual Volume)	BOD <sub>5</sub> (mg/l)	TSS (mg/l)	Fecal Coliform (colonies/100ml)
Treated Wastewater (11,425 BG)	30 <sup>a</sup>	30 <sup>a</sup>	<200 <sup>a</sup>
Stormwater (10,068 BG)	0.4-370	0.5-4,800	1-5,230,000
CSO (850 BG)	3.9-696	1-4,420	3-40,000,000
SSO <sup>b</sup> (10 BG)	6-413	10-348	500,000 <sup>c</sup>

<sup>a</sup>Typical limit for wastewater receiving secondary treatment/limit for disinfected wastewater

<sup>b</sup>Concentration in wet weather SSOs

<sup>c</sup>Median concentration (WDNR 2001)

*What are we Currently Doing?*

## Stormwater Permitting

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- ◆ Regulated Stormwater Discharges:
  - Stormwater Discharge from MS4s
  - Stormwater Associated with Industrial Activity
  - Stormwater Discharges from Construction Sites
  - “As Designated” Discharges



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## Stormwater Discharges

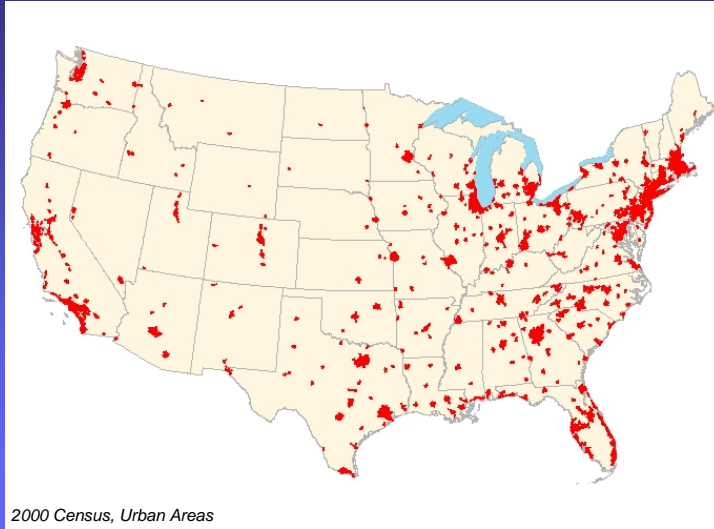
Discharger	Phase I	Phase II	Total
MS4	1,000	6,000	7,000
Construction*	200,000	200,000	400,000
Industrial	100,000	--	100,000

\* This reflects an estimate of the number of new construction starts annually based on data from Phase II Economic Analysis



What are we Currently Doing?

## Stormwater Permitting



2000 Census, Urban Areas



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*What are we Currently Doing?*

## Stormwater Permitting

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- ◆ Municipal Stormwater
  - Phase I - individual permit conditions (6mm+)
  - Phase II – 6 minimum measures
- ◆ Industrial Stormwater
  - Stormwater Pollution Prevention Plan for industrial stormwater discharges
- ◆ Construction Stormwater
  - Stormwater Pollution Prevention Plan for construction stormwater discharges; primarily erosion and sedimentation control



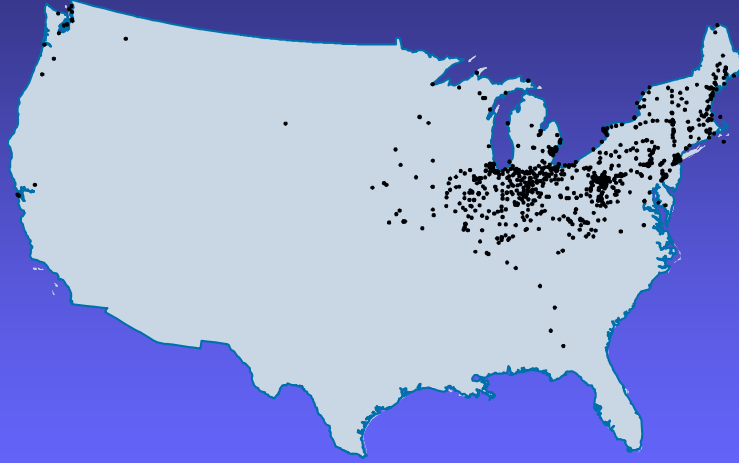
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*What are we Currently Doing?*

## Combined Sewer Overflows

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*Report to Congress on the Impacts and Control of CSOs and SSO (EPA 2004)*



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*What are we Currently Doing?*

## Combined Sewer Overflows

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- ◆ CSOs are point sources subject to NPDES permit requirements
  - **824 active CSO permits** (9,119 discharge points) in 32 states
- ◆ National CSO Control Policy (1994)
  - Nine Minimum Controls
  - Long Term Control Plan
- ◆ Wet Weather Water Quality Act (2000)
  - Reports to Congress
  - “Shall Conform”



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## CSO Control Policy Implementation

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- ◆ CWA Sec 402(q)(1) -- permits and orders “shall conform to” the 1994 CSO Policy
- ◆ Encouraging the use of EPA’s *Guidance: Coordinating CSO Long-Term Planning With Water Quality Standards Reviews* as CSO communities, NPDES and water quality standards authorities, and stakeholders coordinate in the development of LTCPs
- ◆ Providing Regions and NPDES states with guidance and assistance for reviewing and approving LTCPs



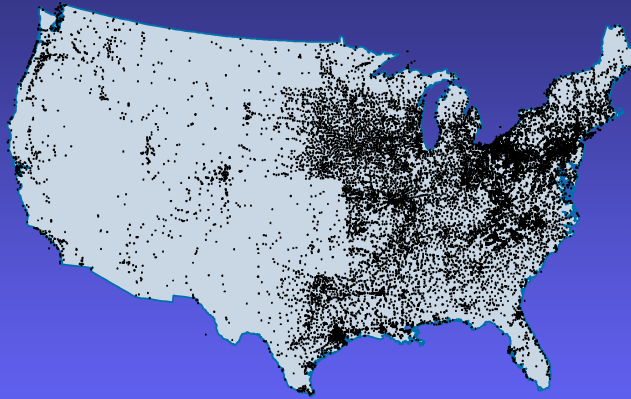
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*What are we Currently Doing?*

## Sanitary Sewer Overflows

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National SSS Distribution

(15,582 with POTWs; 4,846 satellites)



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*What are we Currently Doing?*

## Sanitary Sewer Overflows

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- ◆ Not Specifically Addressed under the CWA
- ◆ EPA does not have a national policy or regulation
- ◆ Current approach developed ad hoc through implementation of NPDES Permit, Construction Grants, and enforcement
- ◆ SSO Guidance (CMOM, reporting & recordkeeping, satellite systems)



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# Report to Congress on CSOs and SSOs

## KEY MESSAGES

- ◆ Impacts tend to be more clearly observable at the local watershed level than at the national level
- ◆ CSOs and SSOs can cause significant environmental and human health impacts at the local watershed level



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*What are we Currently Doing?*

## Peak Wet Weather Flows at POTWs

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- ◆ *National Municipal Policy on Publicly-Owned Treatment Works* – focused little attention on management of peak flows
- ◆ “Blending”/”Peak Flows”
  - Management of peak wet weather flows by routing some peak flow around treatment units, blending the rerouted flow with the flow receiving full treatment; and disinfecting if required
  - Proposed Blending Policy (99,000+ comments received)
  - New proposed policy for “Peak Flows”



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*What are we Currently Doing?*

## Nonpoint Source Pollution

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- ◆ No federal regulatory program
- ◆ Implemented through EPA-approved State programs that include a mix of non-regulatory and regulatory programs as designed by each State
- ◆ EPA's role focuses on establishing grant requirements that focus State activities on achieving WQ improvement results; providing technical guidance, working with a broad range of partners to promote the widespread demonstration and dissemination of the most effective practices, and supporting outreach and education efforts



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## What Have We Learned?

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- ◆ Wet weather programs involve sewer pipes and other infrastructure that share capacity, infiltration, and inflow problems
- ◆ Greater gap between municipal wastewater infrastructure needs and funding
- ◆ Increasingly difficult decisions about how to allocate limited resources





## Current NPDES Framework

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- ◆ Issuing permits for wet weather sources takes time and is resource intensive
  - Permit-by-Permit Conditions
  - Difficulty in establishing compliance endpoints
- ◆ Difficult to assess impacts and program effectiveness
- ◆ Municipal wet weather discharges are addressed through various regulatory and policy frameworks
  - Inefficient given commonalities between discharges



## Control of Wet Weather Discharges

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Stormwater Permitting  
Combined Sewer Overflows  
Sanitary Sewer Overflows  
Management of Peak Wet Weather  
Flows at POTWs  
(Nonpoint Sources)



**Integrated Wet Weather Programs**



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## Wet Weather Integration

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- ◆ Relatively few communities have an integrated permit or manage wet weather issues collectively
- ◆ EPA working to identify what has slowed progress to date and what could promote further integration



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## *Wet Weather Integration in Urban Areas*

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- ◆ Gathering information via community interviews:
  - Communities working to integrate their wet weather programs
    - Kentucky Sanitation District Number 1
  - Communities with integrated permit requirements
    - Clean Water Services (Oregon)
  - Communities that collectively manage urban point source issues but do not have an integrated permit
    - Philadelphia Water Department



## Benefits of Wet Weather Integration

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- ◆ Increased flexibility relative to traditional permit requirements that allows permittees to focus on watershed priorities and goals in a systematic and more cohesive manner.
- ◆ Elimination of redundant data collection, data analysis, and reporting requirements.
- ◆ Increased opportunities for efficiency, such as the opportunity for cross training and sharing responsibilities across local program activities.
- ◆ Potential cost savings through the pooling of resources (i.e., GIS applications, monitoring, and modeling).



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## Benefits of Wet Weather Integration (cont.)

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- ◆ Promotion of a common and well-balanced understanding of watershed priorities, as well as identification of opportunities for improvement.
- ◆ Encourages a comprehensive view of the watershed that allows evaluation and prioritization of issues at a larger scale, and also allows stakeholders to see water as one resource.
- ◆ Increases potential to achieve greater environmental benefits relative to traditional approach.
- ◆ Allow for meaningful coordination with other programs – TMDL, water quality standards, smart growth initiatives



## Keeping Water Out of Sewer Systems

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- ◆ Wet weather discharges can be hydraulically connected and controlling one source can have impacts elsewhere in the system
  - CSO separation → stormwater impacts
- ◆ *Reducing volume entering the sewer system*
  - A guiding principle for the integration of wet weather permitting programs
  - Addresses the interconnectivity across all wet weather programs (CSO, SSO, stormwater, peak POTW flows)



## *Benefits of Keeping Water Out of Sewer Systems*

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- ◆ Preservation of sewer system conveyance capacity
- ◆ Reduction of stress on existing sewer infrastructure
- ◆ Abatement of combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs)
- ◆ Reduction in the volume of storm water and associated pollutant loads delivered to water bodies
- ◆ Reduction in the erosion and scouring of small urban streams that accompanies storm water discharges





## ***Benefits of Keeping Water Out of Sewer Systems (cont)***

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- ◆ Lessening of public health, water quality, and environmental impairment attributable to urban runoff and sewer overflows
- ◆ Improved effluent quality, on average, from publicly owned treatment works (POTWs) due to lower loads during wet weather
- ◆ Better management of combined, sanitary, and separate storm sewer systems and permit programs
- ◆ Improved stream baseflow and groundwater recharge



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## Keeping Water Out of Sewer Systems

Flow Component	Management Practices	Sewer System
Reduce Storm Water Runoff	Reduce impervious cover, low impact development (LID) including green roofs and pervious pavements	Combined sewer system Separate storm sewer system
Reduce Inflow	Redirect roof leaders from the sewer systems	Combined sewer system Separate storm sewer system
Reduce Infiltration	Sewer rehabilitation techniques (e.g., grouting, lining, manhole repair, etc.)	Combined sewer system Sanitary sewer system
Reduce (Consumptive) Water Use, which in turn reduces flow to the sewer systems	Water conservation techniques (low-flow fixtures and appliances)	Combined sewer system Sanitary sewer system



## Keeping Water Out of Sewer Systems

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- ◆ Often a combination of practices to reduce impervious cover, control inflow/infiltration to sewers, promote water conservation, and enhance bio-infiltration are required



## *Keeping Water Out of Sewer Systems - Calculator*

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- ◆ **Quantify base sewer flow conditions**
  - Sanitary sewage (residential, commercial, industrial)
  - Stormwater
- ◆ **Quantify flow reductions associated with the following practices:**
  - Stormwater runoff reduction
  - Inflow control
  - Infiltration control
  - Water conservation
- ◆ **Calculate potential reductions to sewer systems**



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# QUESTIONS?



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City of Richmond



GREELEY AND HANSEN

# Watershed Program Case Studies City of Richmond



# Discussion Topics

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- **The City of Richmond and the Middle James River Watershed**
  - Introduction (Tidal & Non-tidal)
  - CSO Phases I & II Performance
  - LTCP Alternatives & WQ Model Results
  - Phase III Long Term Control Plan
  - WQS Gap
  - Chesapeake Bay Urban Non-Point Storm Water
- **Watershed Planning – Endpoint → Compliance with WQS**
  - EPA Public Health Guidelines
  - Geometric Mean and/or Single Sample Maximum
  - WQ Model Results
    - E. Coli
    - Illness Rate

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## Discussion Topics *(Continued)*

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- **How Can We Reach this Endpoint**
  - Proposed Path Forward
  - Watershed Approach - i.e. = CSO control - Case Study Richmond, Virginia
  
- **Compare and Contrast – Why the Watershed Approach**
  - Environmental. Outcome
  - Quality of life
  - Make sense
  - Cost Savings for the Public/Rate/Tax Payers

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## Watershed Stakeholders

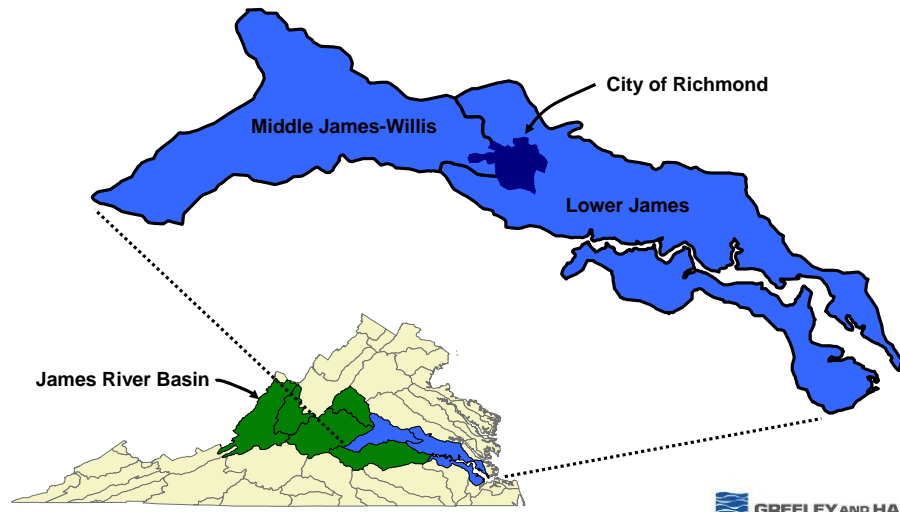
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- Public
- City of Richmond, Virginia
- Adjacent Jurisdictions
  - Henrico
  - Chesterfield
  - Goochland
  - Petersburg
  - Hopewell
  - Colonial Heights
- DEQ
  - WQS Compliance
  - TMDL Process
- EPA
- Non-Governmental Organizations
- Business
  - Agricultural
  - Manufacturing

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# Middle James River Watershed

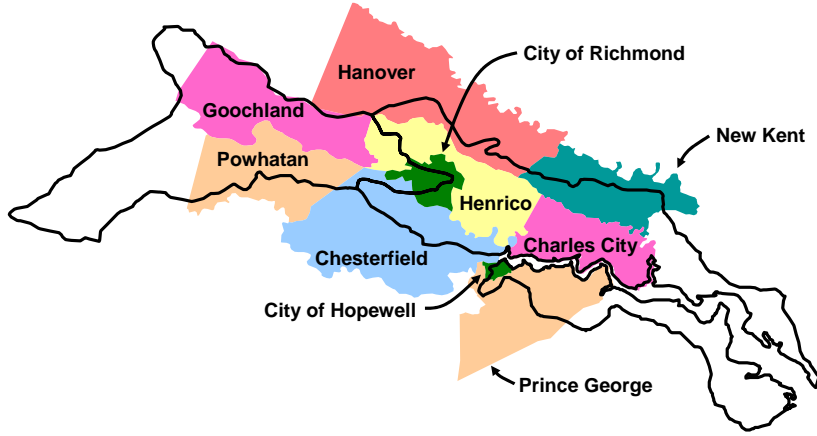


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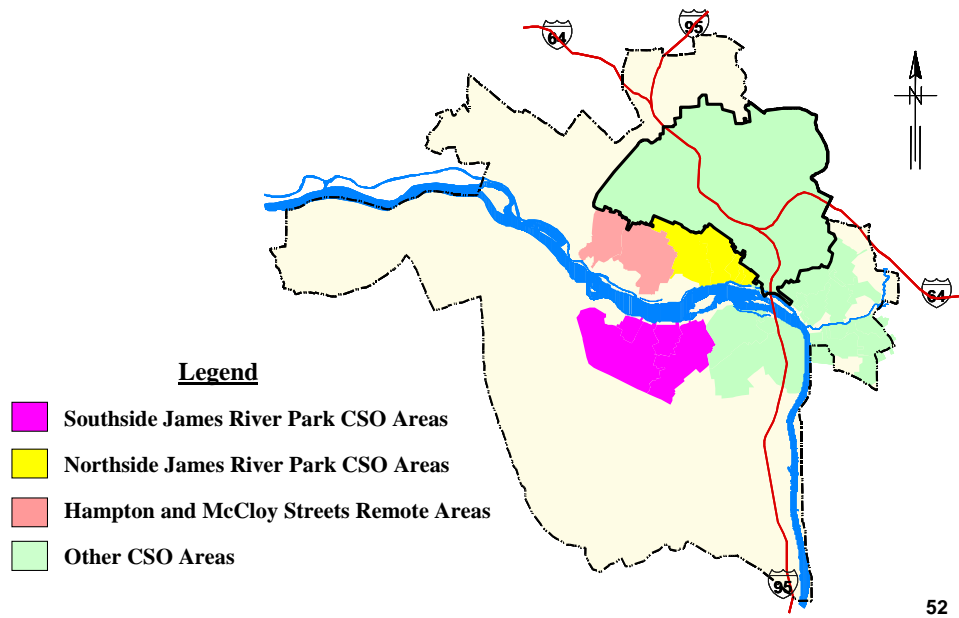
## City of Richmond, Virginia & Middle James River Watershed - Service Territory



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## CSO Areas Associated with Parks & Public Access





## History

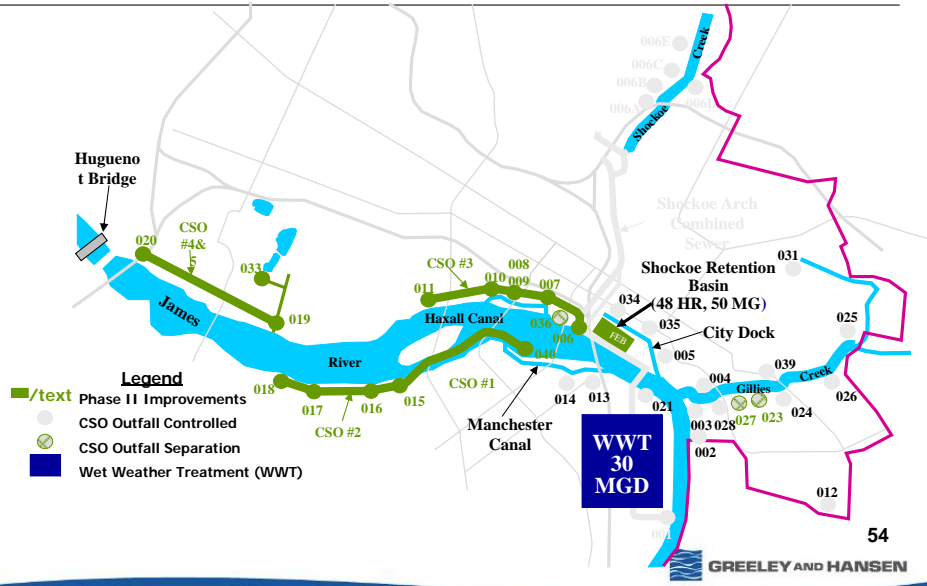
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- 1950's Construction of WWTP & Interceptors
- 1970's First CSO Study
- 1983 Shockoe Retention Basin Completed
- 1985 VPDES Permit Addresses CSO's
- 1988 Comprehensive CSO Study
- 1992 Original Consent Order (Amended in 1996 & 1999)
- 2002 Completion of Phases I & II
- 2002 LTCP
- 2005 Phase III Consent Order
- 2006 Program Project Plan

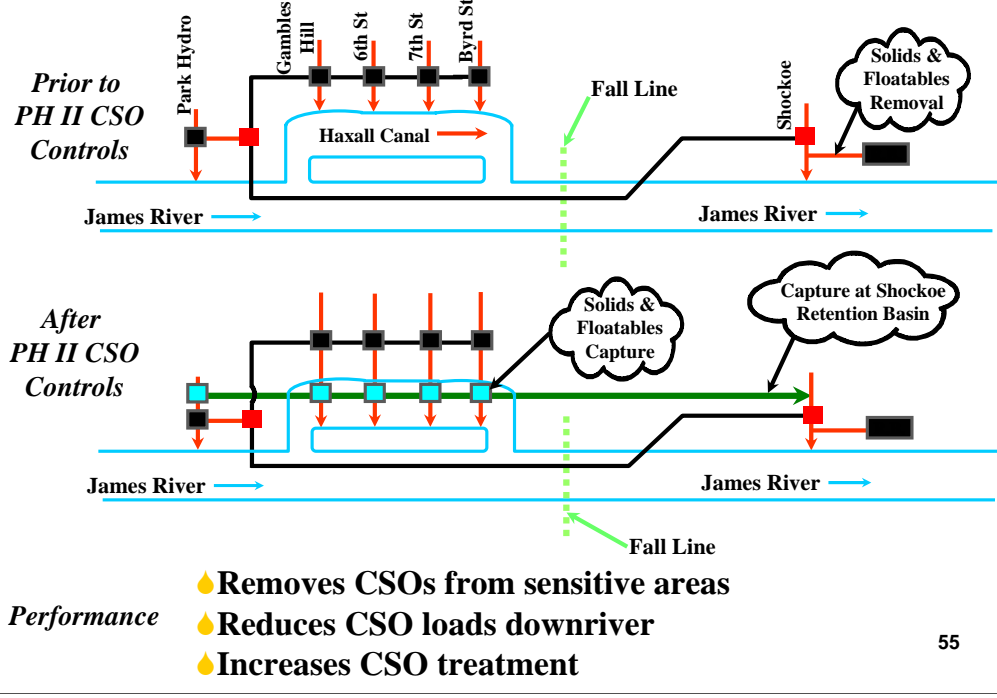
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# Richmond's CSO Control Plan After Phase II Improvements



# North Side James River CSO Controls





# Gambles Hill CSO Outfall

## Prior to CSO Control (1996)



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## Gambles Hill (July '99)



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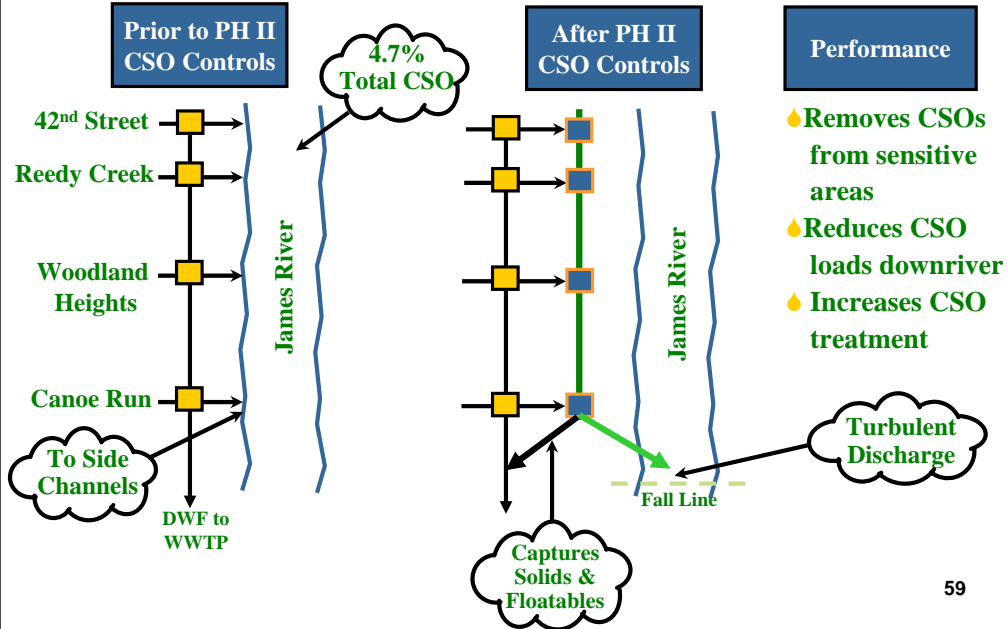
# Gambles Hill Performance

During Tropical Storm/ Hurricane Dennis (9/6/99)



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# South Side James River CSO Controls





## 42nd Street Regulator Performance During Tropical Storm/ Hurricane Dennis (9/6/99)



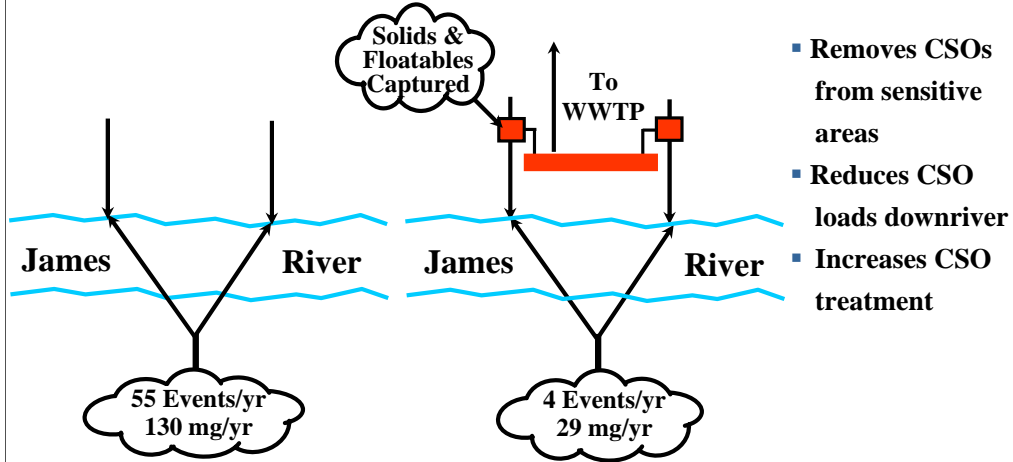
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# Retention CSO Controls

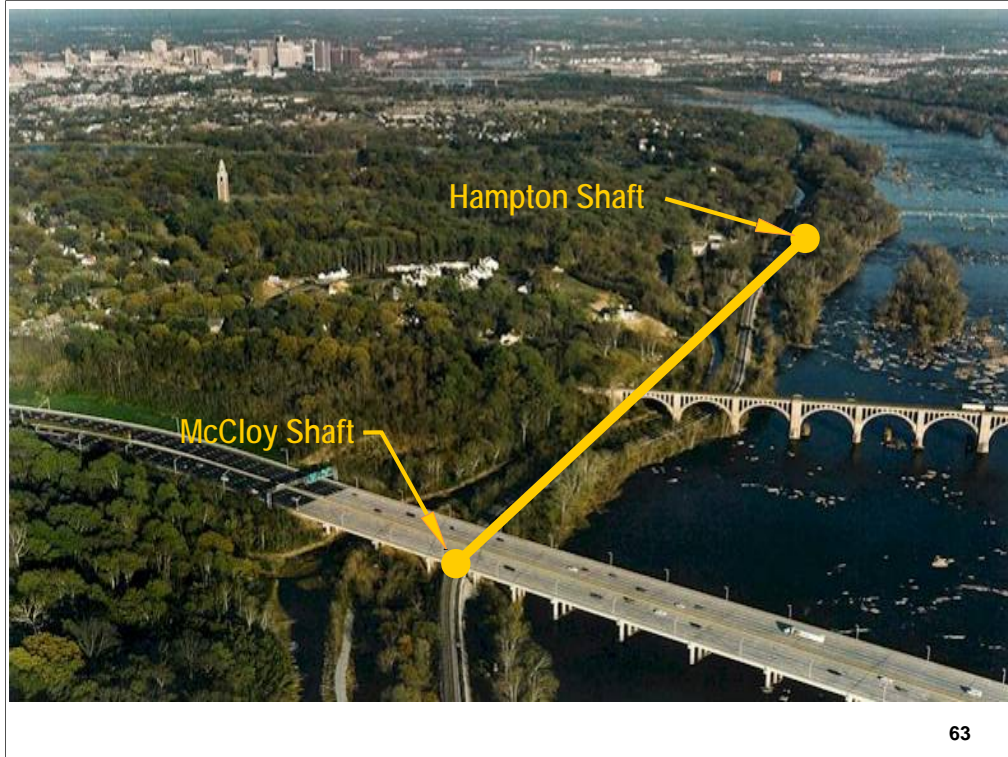
Prior to PH II CSO Controls

After PH II CSO Controls

Performance









## Richmond CSO Program Compliance

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- The City Has Been Operating Under Successive Orders With the Board Since 1992
- For 15 Years the City Has Met & Exceeded All Its Commitments to DEQ

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## Local and National Recognition Earned by City's CSO Program

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- Endorsement from the *Falls of the James Scenic River Advisory Committee* for City's CSO Program Special Order (June 14, 1999)
- *"Friend of the River Award"* from the James River Association (October 3, 1999)
- *1999 National CSO Control Program Excellence AWARD* from the USEPA
- Feature article in the 1999 September issue of "Civil Engineering Magazine"

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## Local and National Recognition Earned by City's CSO Program *(continued)*

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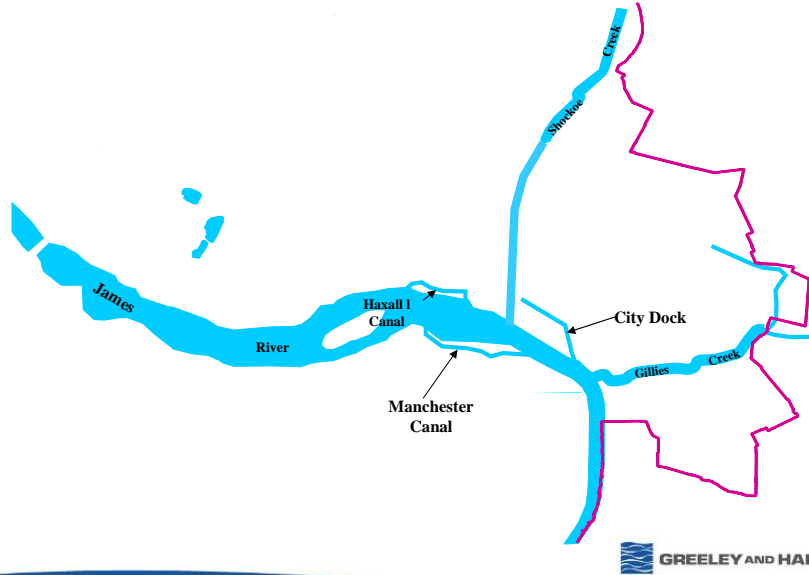
- *Engineering Excellence Honor Award* from the Consulting Engineers Council of Illinois & American Consulting Engineers Council
- *Grand Conceptor Award* from the Virginia /American Council of Engineering Companies
- *Merit Award* from the American Society of Landscape Architects
- Featured in FHWA Transportation Enhancement – ISTEAs First of a Kind Project

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# Background A1

Represents City Replaced with Open Field



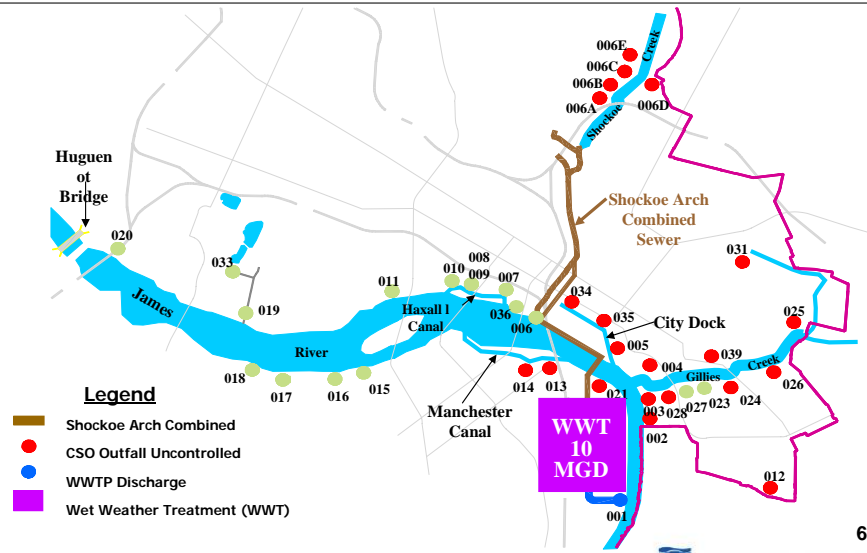
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# Background A2

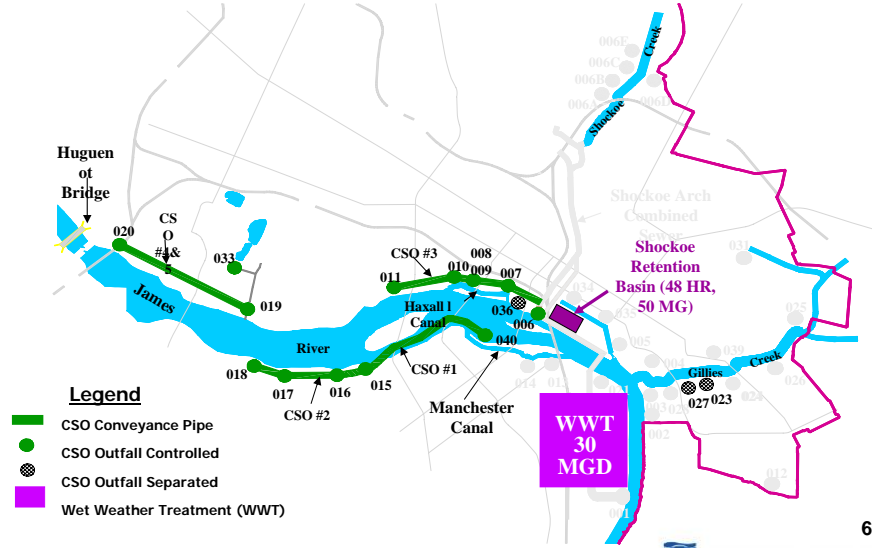
## City Prior to CSO Controls





# Background B

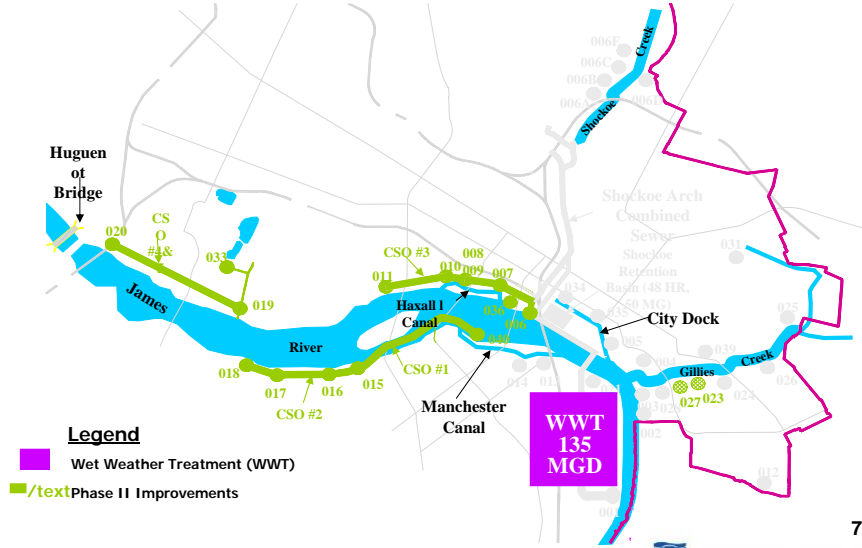
## After Phase II Improvements





# Alternative C

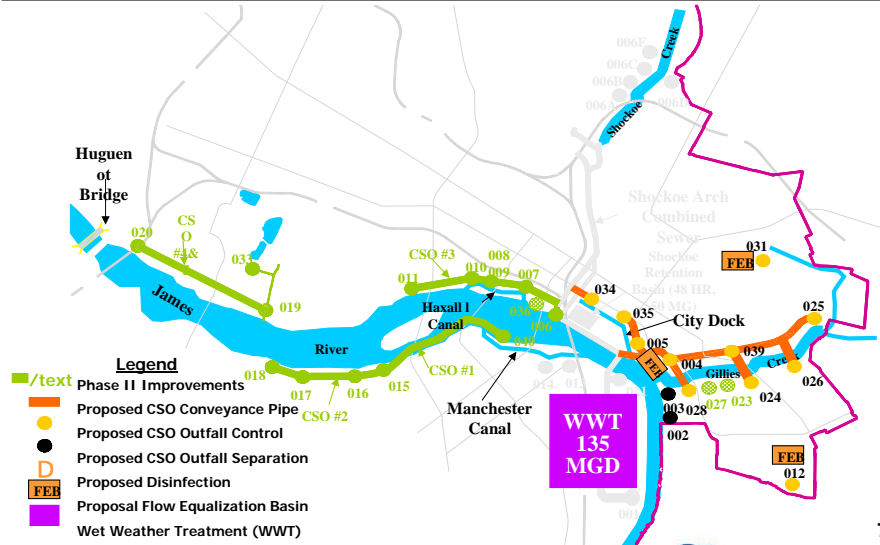
## Maximize CSO Wet Weather Flow Treatment





# Alternative D

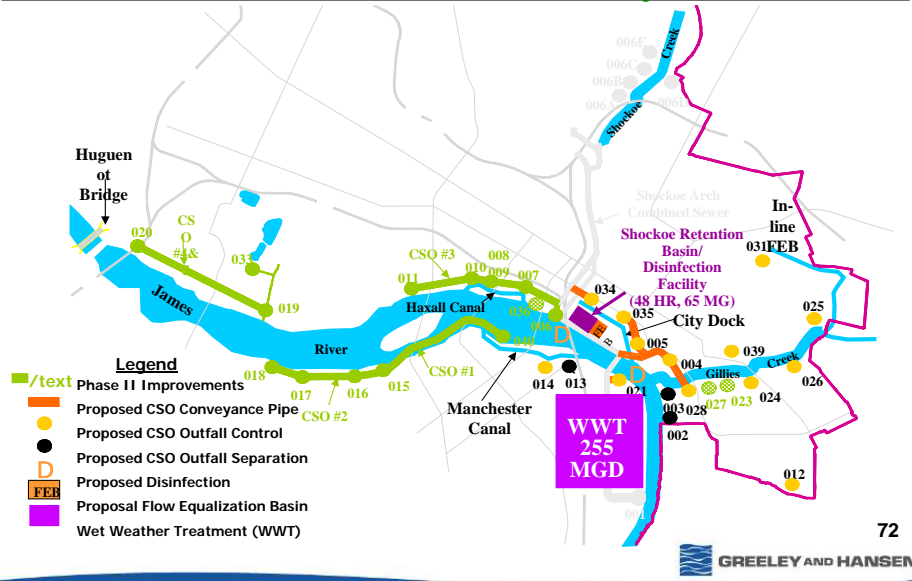
## North Side & Peripheral Flow Equalization & Gillies Ck Conveyance





# Alternative E

Increase CSO WWF Treatment & Shockoe Expansion With Disinfection Plus Lower Gillies Creek Conveyance

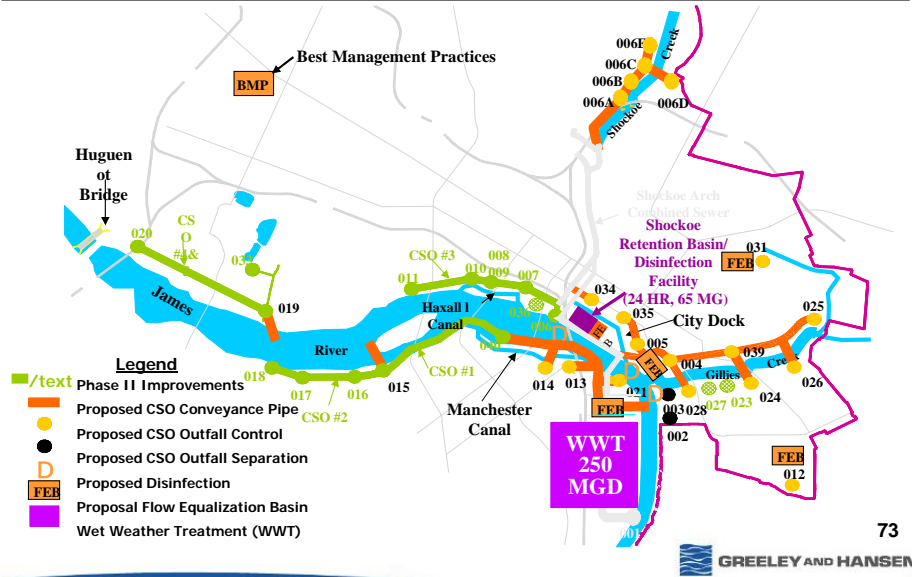






# Alternative F

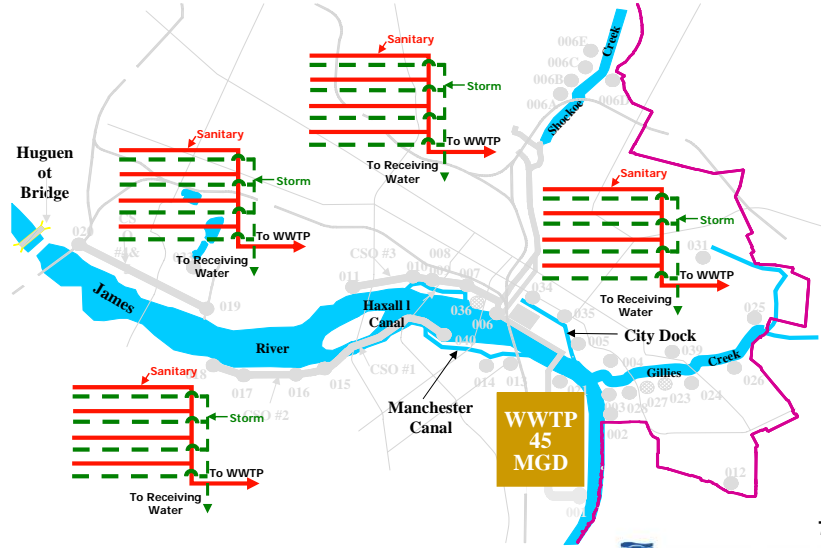
## Control CSOs to 4 Overflows Per Year





# Alternative G

## Complete Citywide Sewer Separation



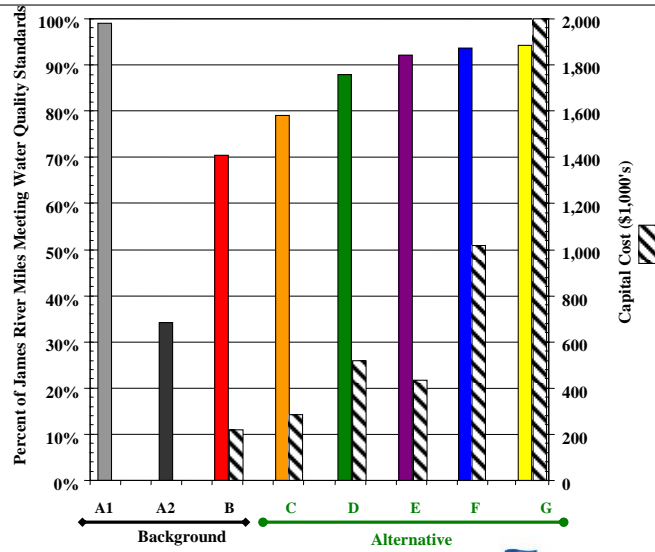
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# Comparative Water Quality & Cost Performance of Alternatives

**Note:**  
The  
bacteriological  
water quality  
standard is based  
on the fecal  
coliform 30-day  
geometric mean  
of 200 MPN per  
100 mL



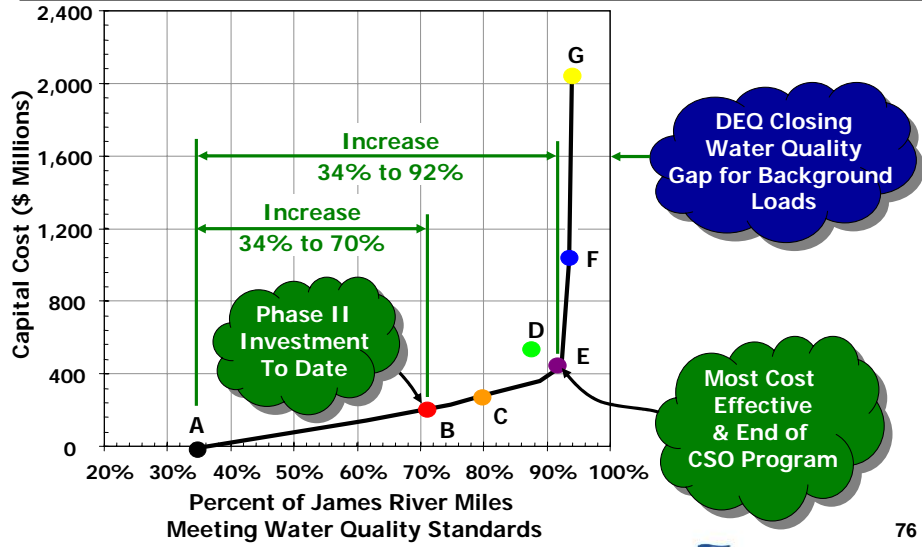
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# Water Quality Standards Coordination

## Percent of James River Miles Meeting Fecal Coliform WQS

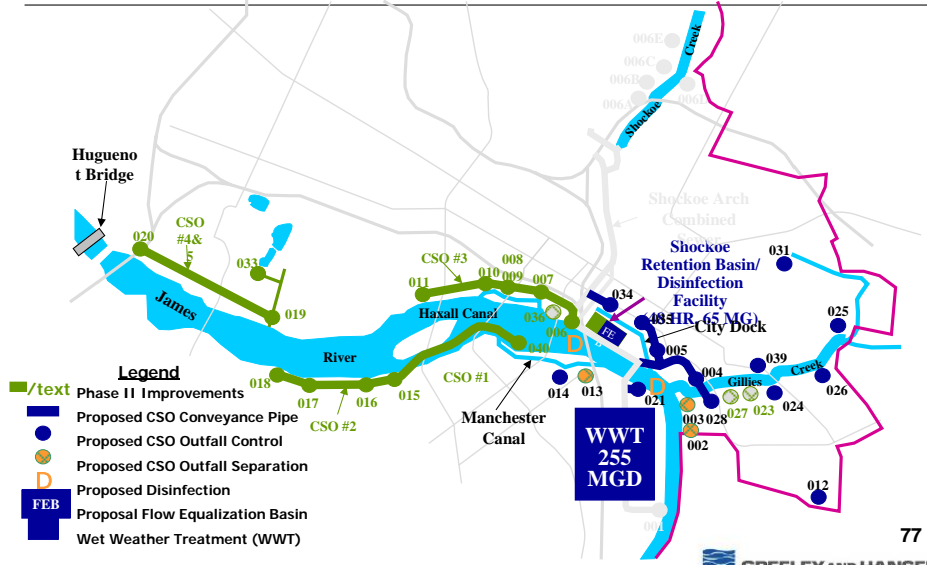


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# Alternative E

## Increase CSO WWF Treatment & Shockoe Expansion With Disinfection Plus Lower Gillies Creek Conveyance

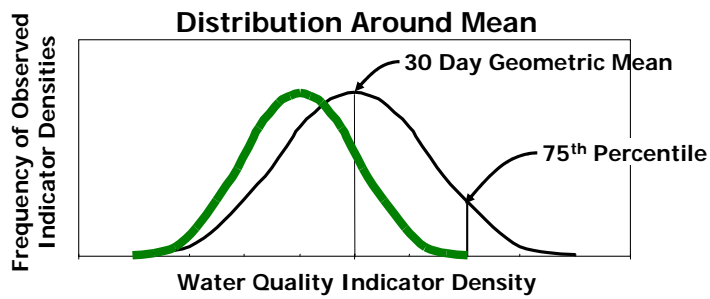




## EPA's Implementation Guidance for Ambient Water Quality Criteria for Bacteria

November 2003 Draft Guidance (*Continued*)

- **75<sup>th</sup> Upper Percentile Value (UPV)**
  - 25% of samples greater than 75<sup>th</sup> UPV
  - More values greater than UPV, higher probability of exceeding the geometric mean

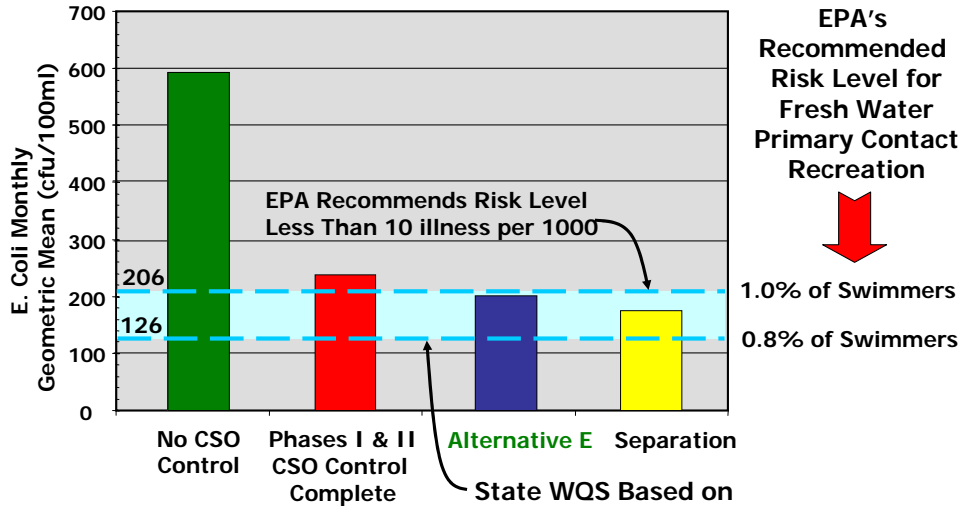


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# Richmond CSO Control Program

30 Day Geometric Mean & Associated Risk Level  
Maximum Month for Critical Reach



**PRELIMINARY**

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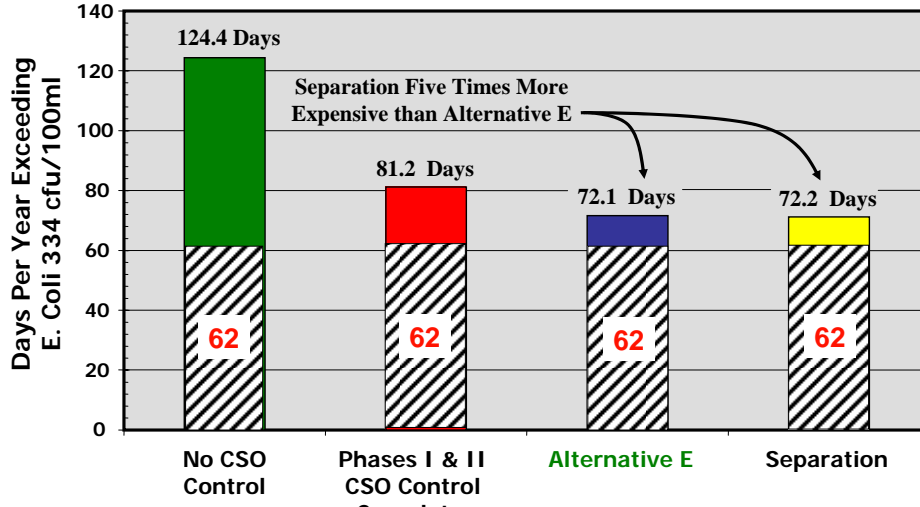




# Richmond CSO Control Program

Average of River Reaches

Days Per Year Exceeding E. Coli 75th Upper Percentile Value



**PRELIMINARY**

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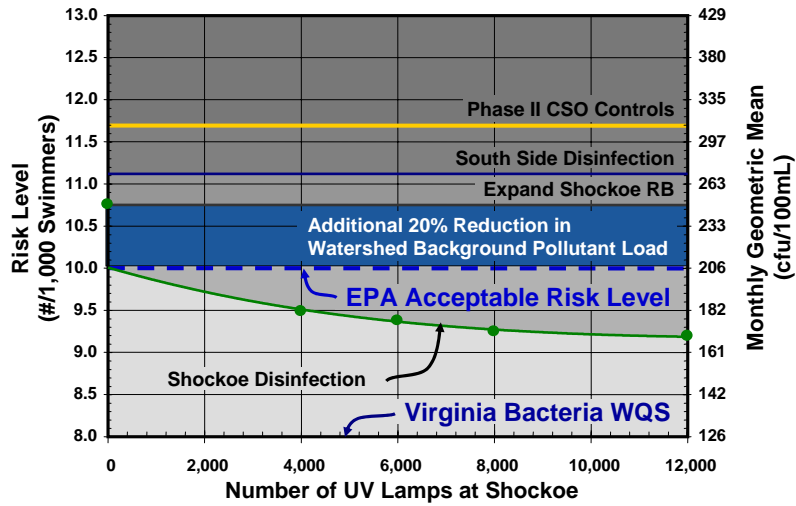






# Shockoe UV Facility Performance

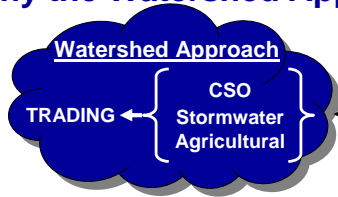
## James River Reach 13 for August



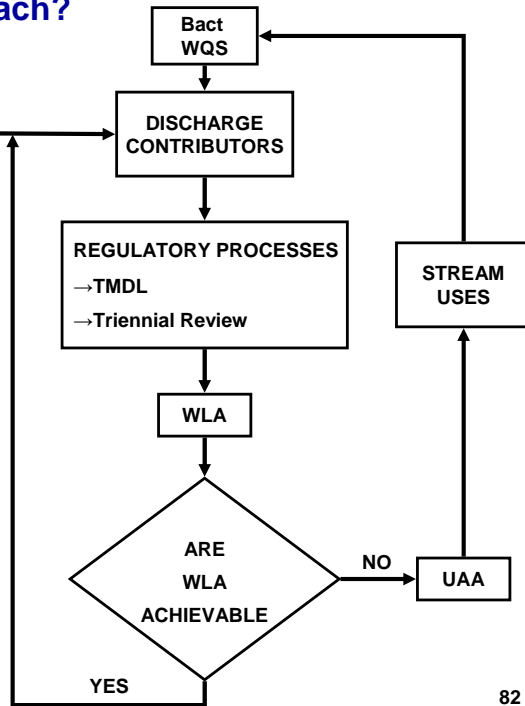
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## Why the Watershed Approach?



- Environmental
- Consensus Approach
- Quality of life
- Makes sense
- Cost Savings for the Public - Rate/Tax Payers





City of Richmond



GREELEY AND HANSEN

Questions?



Managing wet weather along the continuum from watershed scale to site scale is critical.

Coupling smart growth and conservation site design paradigms is absolutely necessary to effectively protect water quality.

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## Conservation Site Designs

Using an ecosystem-based approach to manage storm water

## Basic Premise

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Maximize infiltration of precipitation where it falls.

- Prevents contamination of storm water because it doesn't have a chance to wash over surfaces picking up contaminants.
- Promotes ground water recharge.
- Minimizes flooding concerns.
- Minimizes in-stream scouring because peak flows are not unnecessarily exacerbated or prolonged by increased runoff.
- Eliminates or minimizes the need for large, expensive storm water collection, conveyance, storage and treatment systems.



## Minimize Runoff

- ◆ Reduce storm pipes, curbs and gutters
- ◆ Reduce building footprints
- ◆ Preserve sensitive soils
- ◆ Reduce road widths
- ◆ Minimize grading
- ◆ Limit lot disturbance
- ◆ Reduce impervious surfaces

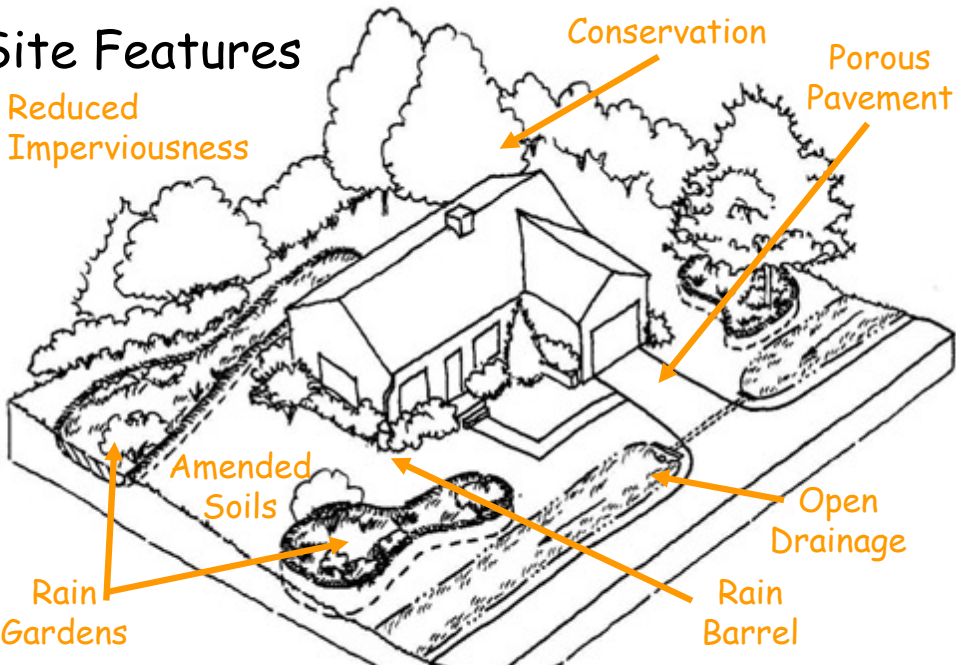


# Site Features

Reduced Imperviousness

Conservation

Porous Pavement



Amended Soils

Rain Gardens

Open Drainage

Rain Barrel

Create a Hydrologically Functional Lot



## Site to Neighborhood Scale

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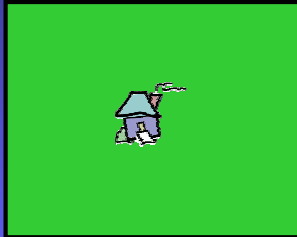
In addition to promoting more stable hydrologies with site designs, neighborhood designs can also reduce impervious surfaces across a segment of the scale continuum.

- Parking
- Street Designs
- Infill and Redevelopment



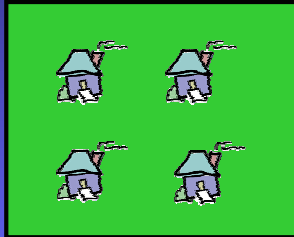
## Development & Runoff

*Scenario A:  
1 unit/acre*



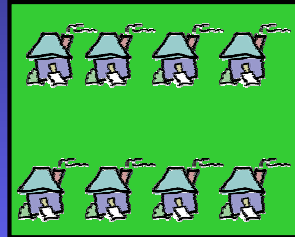
- ◆ Impervious cover = 20%
- ◆ Runoff/acre = 19,000 ft<sup>3</sup>/yr
- ◆ Runoff/unit = 19,000 ft<sup>3</sup>/yr

*Scenario B:  
4 units/acre*



- ◆ Impervious cover = 38%
- ◆ Runoff/acre = 25,000 ft<sup>3</sup>/yr
- ◆ Runoff/unit = 6,000 ft<sup>3</sup>/yr

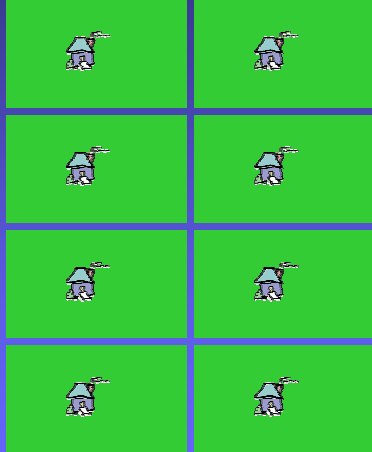
*Scenario C:  
8 units/acre*



- ◆ Impervious cover = 65%
- ◆ Runoff/acre = 40,000 ft<sup>3</sup>/yr
- ◆ Runoff/unit = 5,000 ft<sup>3</sup>/yr

## Accommodating the same number of houses (8) at varying densities

### Scenario A: 1 unit/acre



- ◆ Impervious cover = 20%
- ◆ Total runoff = 150,000 ft<sup>3</sup>/yr
- ◆ Runoff/house = 19,000 ft<sup>3</sup>/yr

### Scenario B: 4 units/acre



- ◆ Impervious cover = 38%
- ◆ Total runoff = 50,000 ft<sup>3</sup>/yr
- ◆ Runoff/house = 6,000 ft<sup>3</sup>/yr

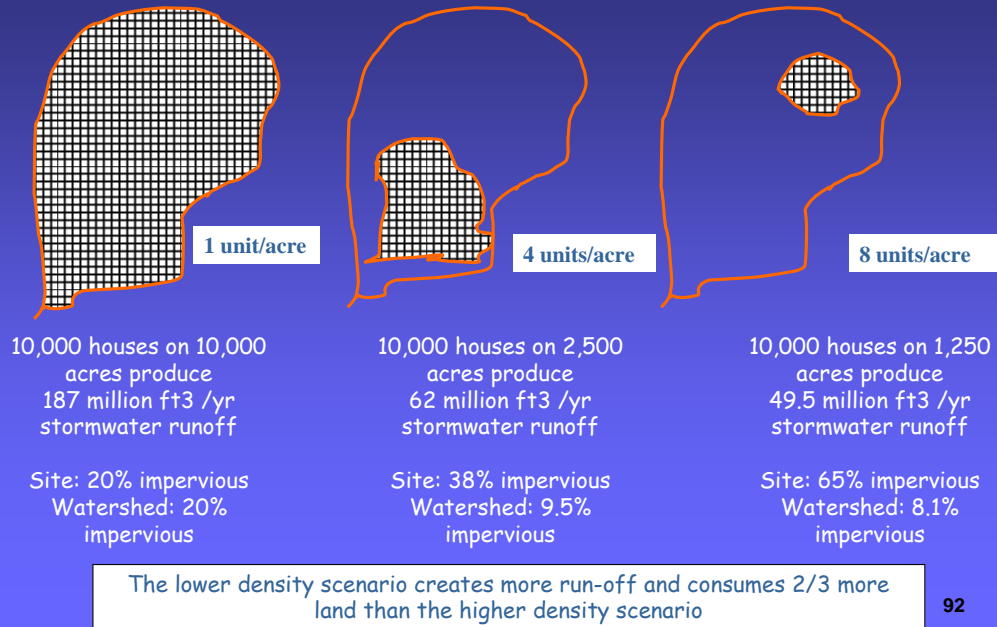
### Scenario C: 8 units/acre



- ◆ Impervious cover = 65%
- ◆ Total runoff = 40,000 ft<sup>3</sup>/yr
- ◆ Runoff/house = 5,000 ft<sup>3</sup>/yr

## But watershed managers are not dealing with 8 houses...

Accommodating 10,000 units on a 10,000 acre watershed at different densities



## Principles of Smart Growth

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- ◆ Mixed Use, Walkable Neighborhoods, Public Transit – fewer car trips, less pavement: less impervious surface
- ◆ Compact Building Designs – smaller footprints: less impervious surface
- ◆ Preserve open space, critical natural areas
- ◆ Direct development where there is existing infrastructure; maintain existing infrastructure



## Coupling of Conservation Development Paradigms like LID and Smart Growth

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- ◆ There is no inherent conflict between these approaches, and in fact they work well together when fully understood
- ◆ Balances small and large scale concerns
- ◆ Requires regional planning and coordination
- ◆ Can be facilitated by good permit language



Office Wastewater Management



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# QUESTIONS?

[Additional resources](#)



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