Post-Construction Overview and Introduction to Smart Growth and Low Impact Development

Webcast
March 16, 2006, 1-3 pm EST

Nikos Singelis
U.S. EPA's Stormwater Program
with
Geoffrey Anderson
U.S. EPA's Smart Growth Program

Poll Question

“Storm Water” or “Stormwater?” Is it one word or two?

Overview

- Water Quality Impacts from Post-Construction Stormwater Runoff
- Post-Construction Minimum Measure
- Basic Elements of a Post-Construction Stormwater Program
- Trends in Development
  - Smart Growth
- Low Impact Development

Poll Question

- **Who is participating today?**
  - **Phase II municipality**
  - **Phase I municipality**
  - **State government**
  - **Federal government**
  - **Consultant**
  - **Academic**
  - **Other**

Water Quality Impacts from
Post-Construction
Stormwater Runoff

Why is Stormwater a Problem?

Urban Runoff is the Source of Problems in:

- **34,871 miles or 13% of all Impaired Rivers and Streams**
- **1,369,327 acres or 18% of all Impaired Lakes**
- **5045 square miles or 32% of all Impaired Estuaries**

*** Note: The National Water Quality Inventory (305(b) Report) describes the quality of assessed waters. Many of the nation's rivers, lakes and estuaries remain unassessed. The percentages above are based on assessed waters only.**

Effects of Development on Stormwater Runoff

Increases:

- Impervious surface area
- Stormwater volume
- Stormwater velocity
- Deposition of pollutants

Decreases:

- Stormwater quality
- Ground water recharge
- Baseflow
- Natural drainage systems including riparian vegetative cover

Consequences of Development to Urban Streams

- Increased rate and severity of flooding
- Increased erosion of stream banks and bottoms (stream widening and channelization)
- Increased sedimentation

Consequences of Development to Urban Streams

- Increased chemical pollution
- Altered biological populations
- Degradation of riparian habitat
- Increased stream temperatures (loss of riparian cover)

Common pollutants in urban stormwater

- Sediment
- Nutrients
- Oxygen-demanding substances
- Pathogens
- Trash
- Road Salts
- Oil and Grease
- Heavy Metals
- Heat
- PAHs

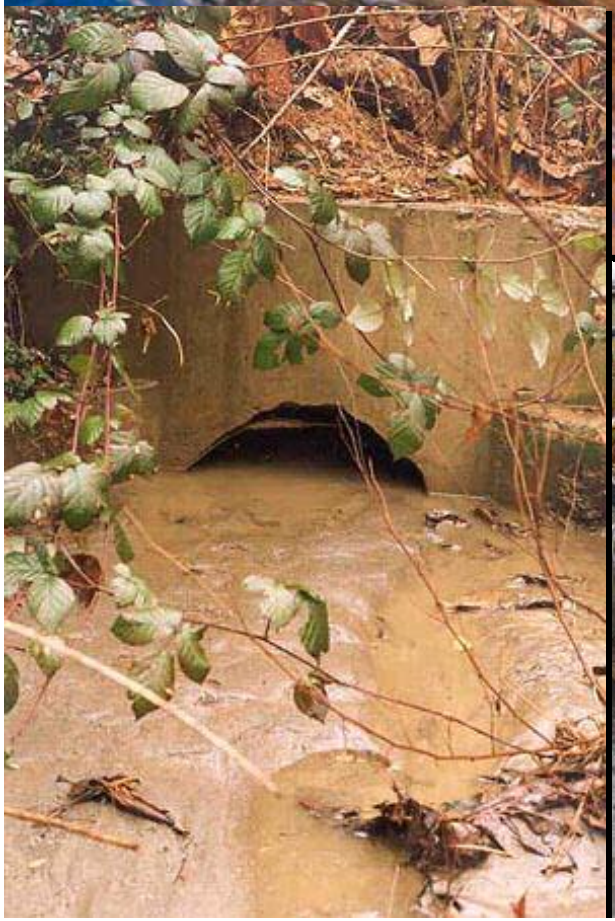
Runoff Pollution

Transportation: runoff from roads, parking lots, runways

Pollutants: salt, sand, soil, zinc, petroleum products, copper, phosphorus, glycols

Turf Grass Management & Other Yard Care Activities

Pollutants: nutrients, soil, pesticides



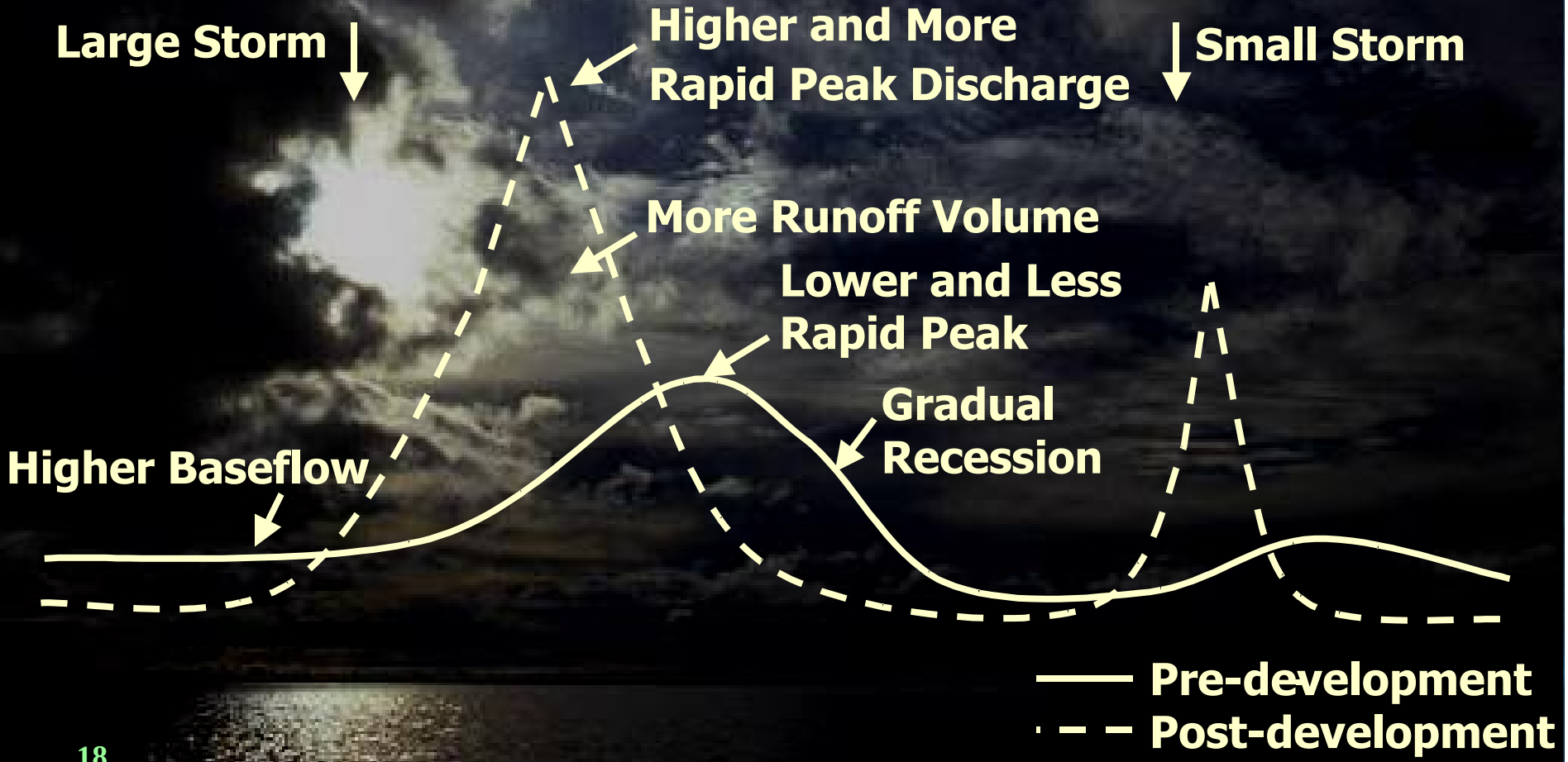
Poll Question

- **Does your local watershed have problems caused by stormwater?**
  - **Yes, leading cause of problems**
  - **Yes, secondary cause of problems**
  - **No**
  - **Not sure**

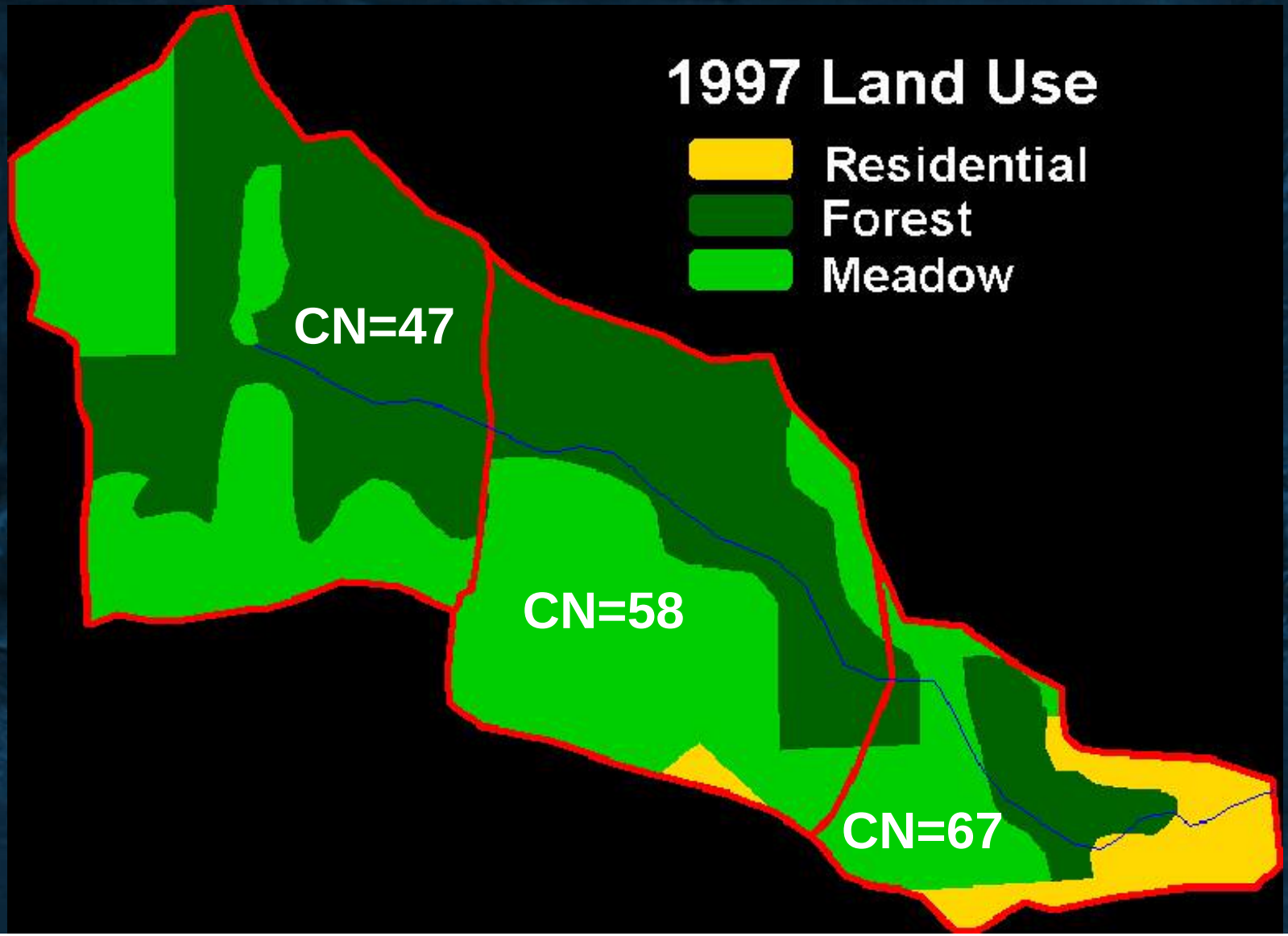
Poll Question

- **If you answered yes to previous question, what kinds of problems are you seeing? Select all that apply:**
  - **Sedimentation**
  - **Turbidity**
  - **Excess Nutrients**
  - **Bacteria**
  - **Bank erosion**
  - **Riparian area destruction**

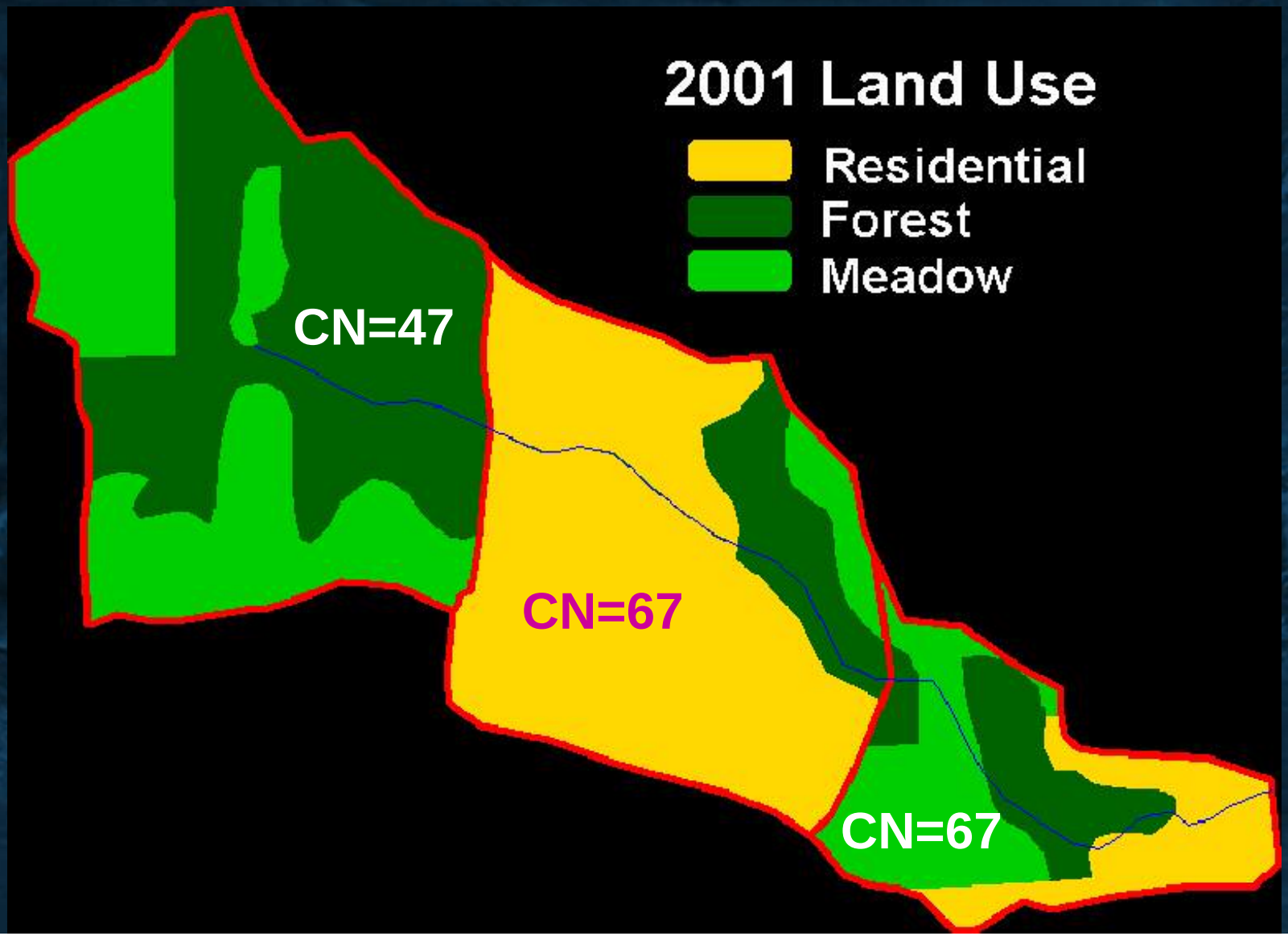
Consequences of Development to Urban Streams



Blakeslee Creek



Blakeslee Creek

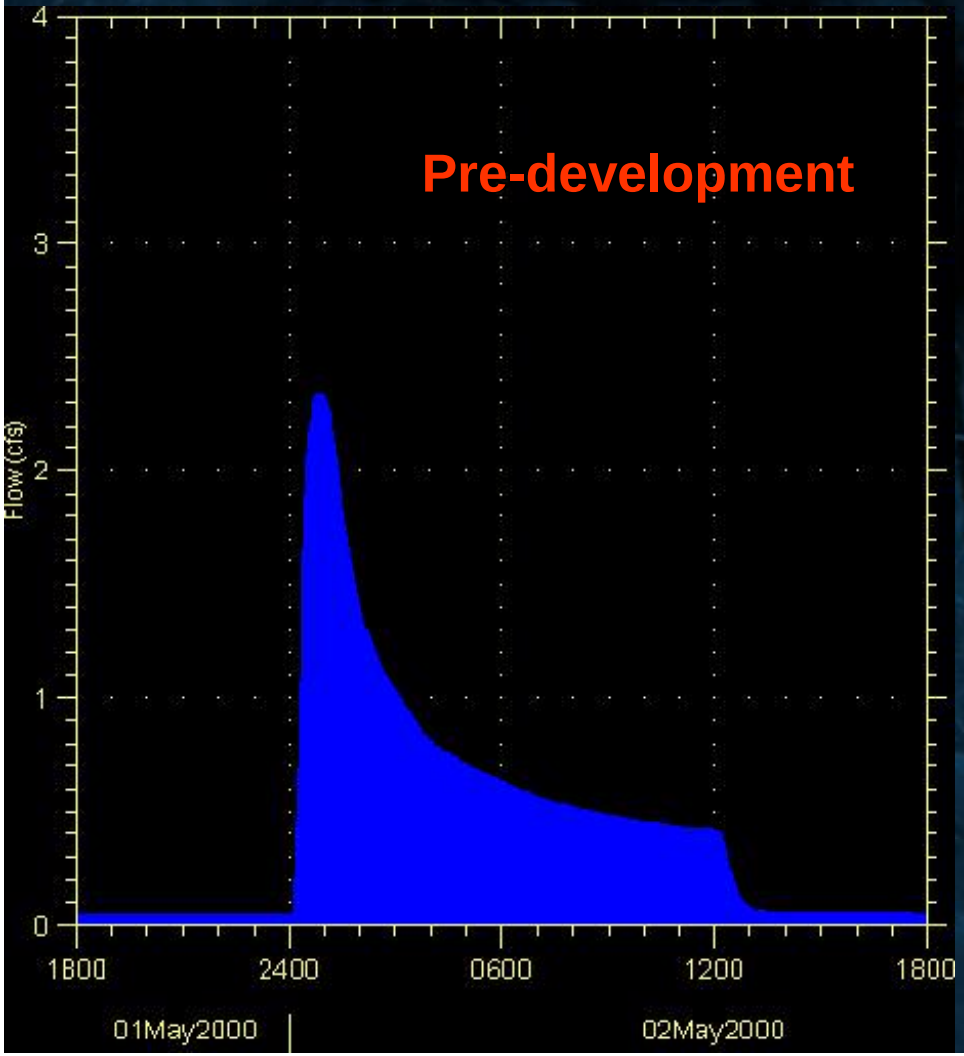


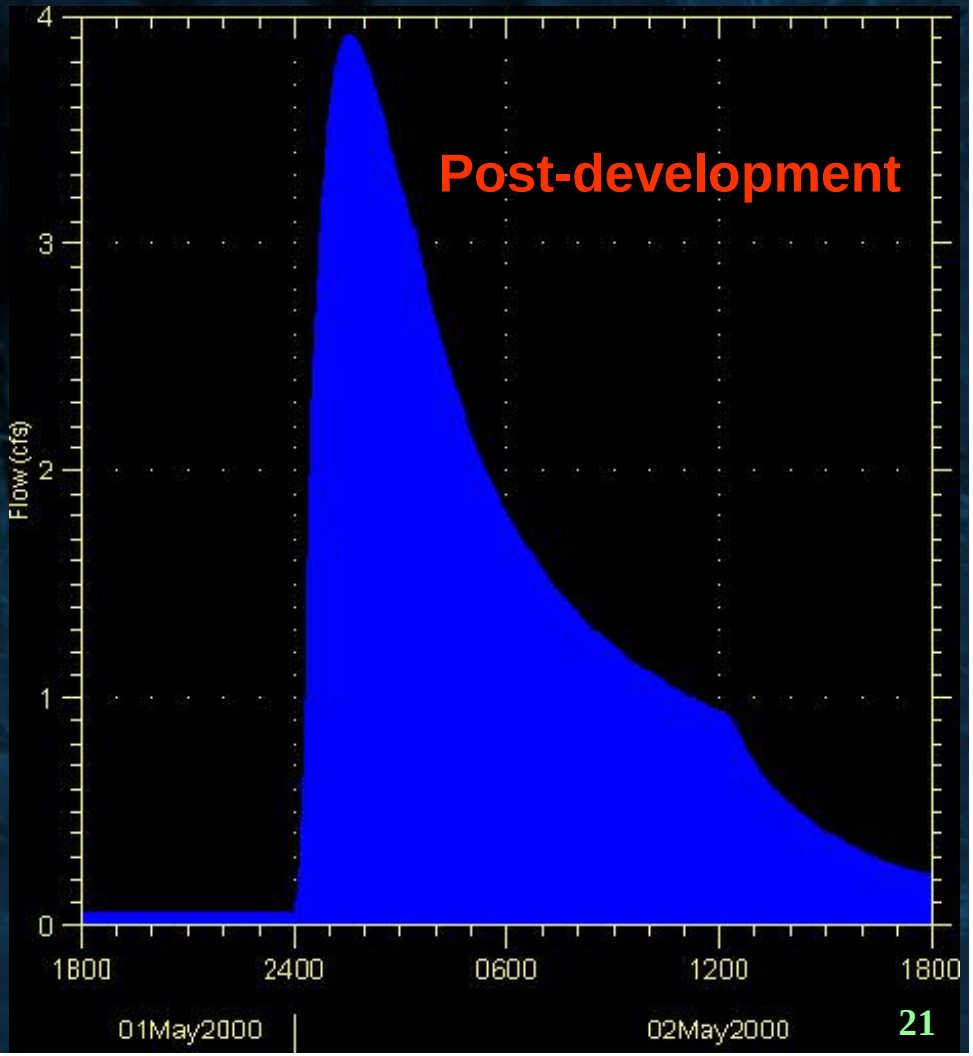
Blakeslee Creek

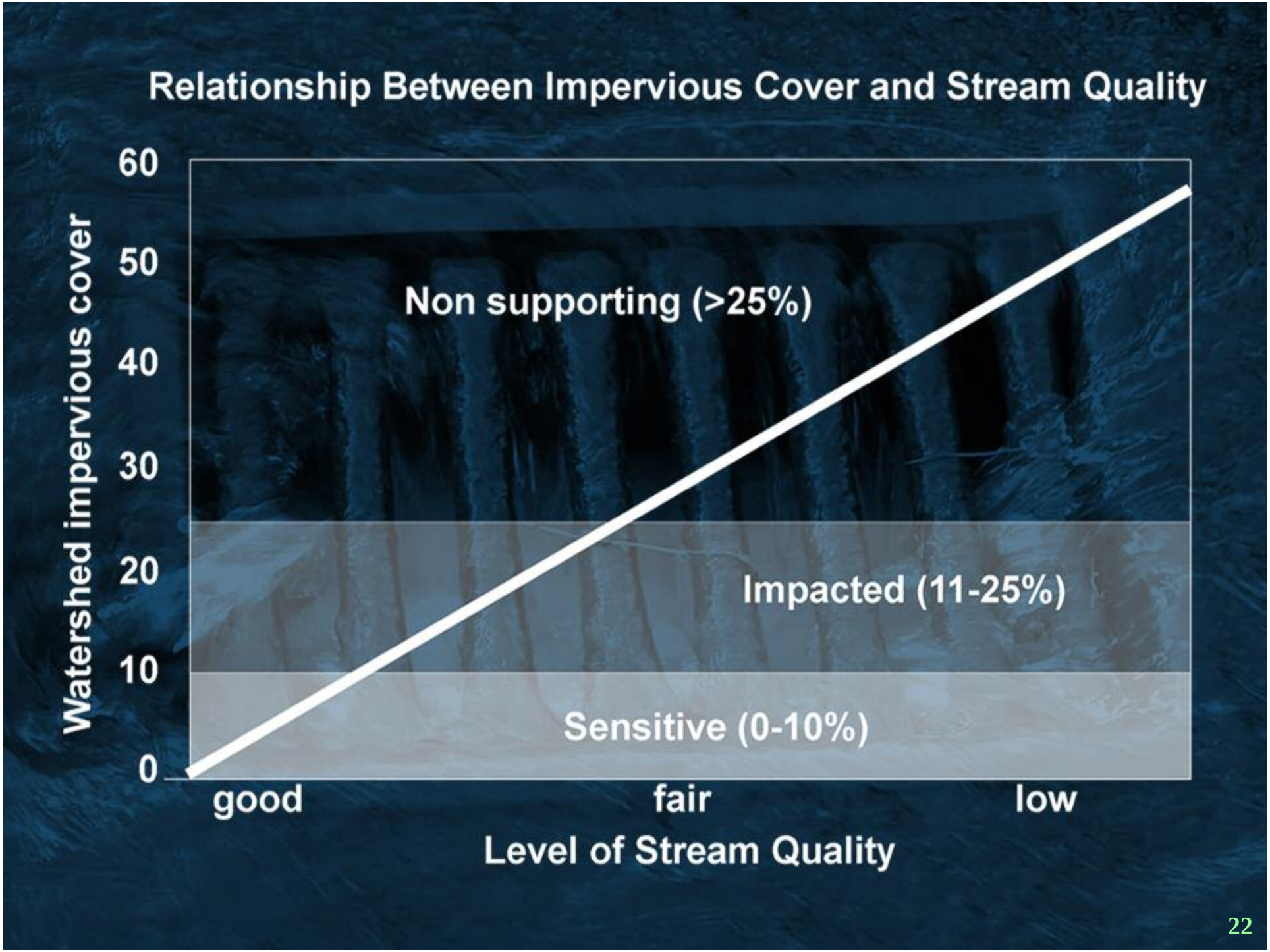
70% increase in peak flow

170% increase in runoff volume

Former instantaneous peak flow now lasts ~4 hours



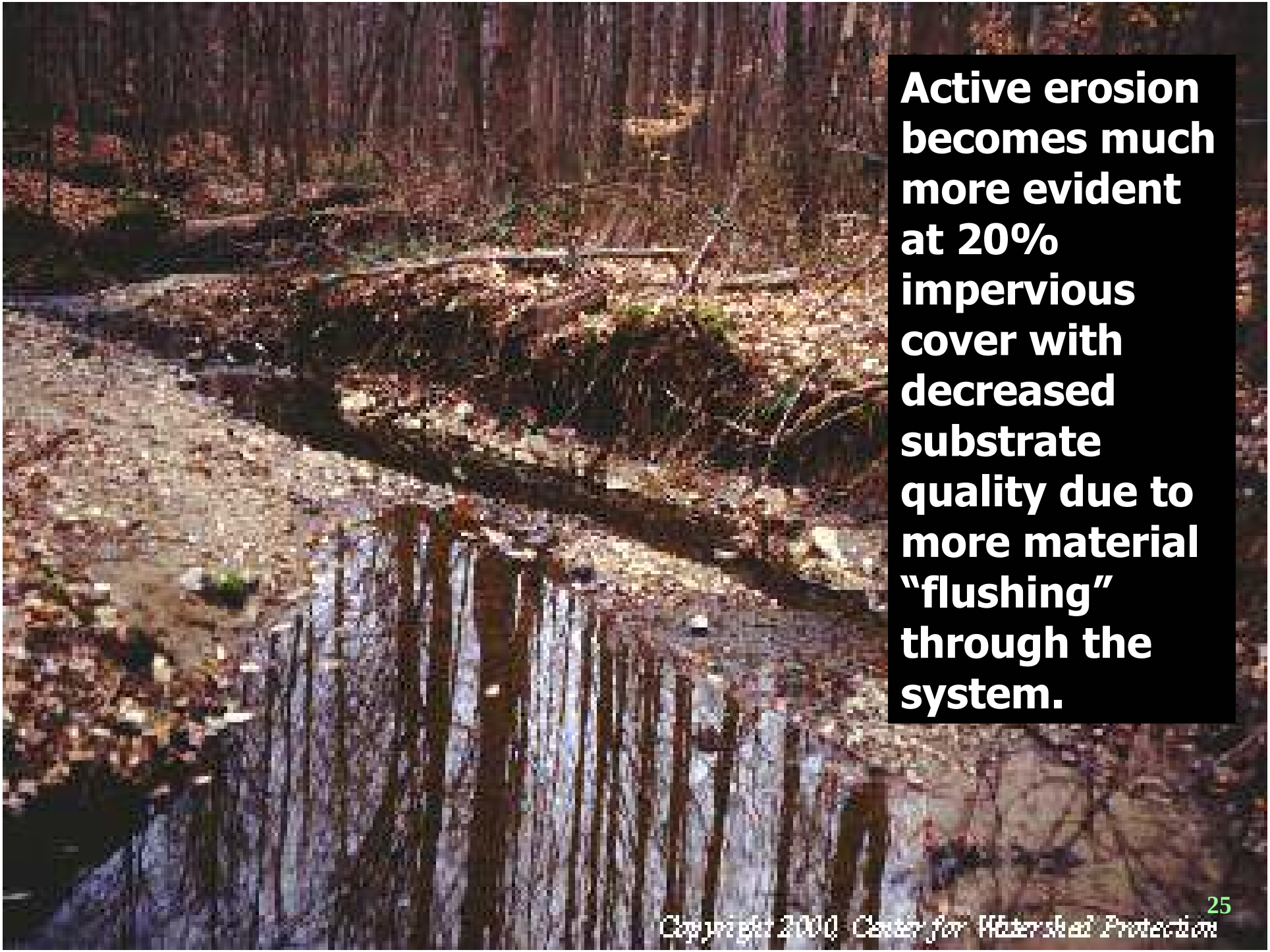


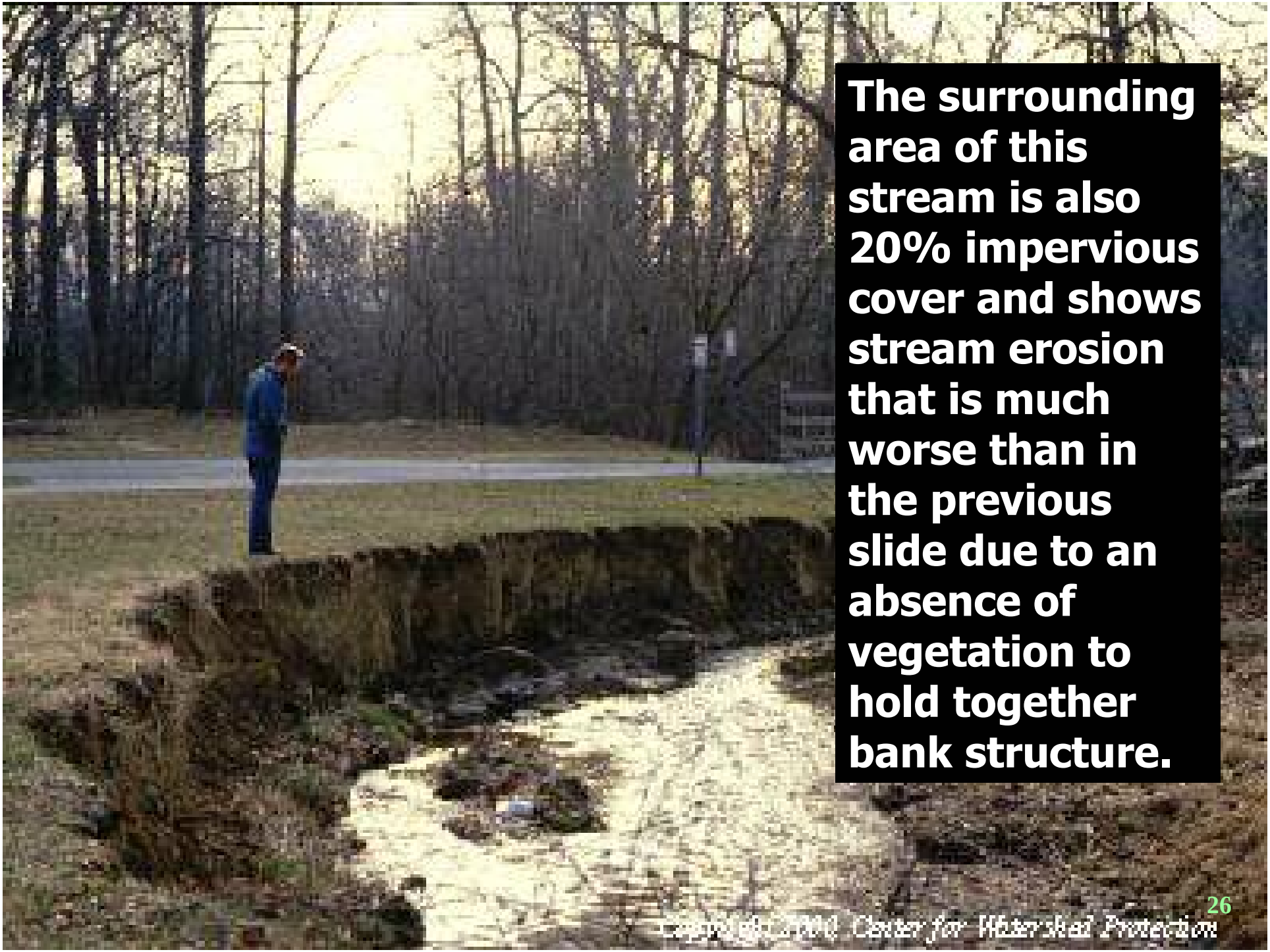

Relationship Between Impervious Cover and Stream Quality
Watershed impervious cover
60
50
40
30
20
10
0
Non supporting (>25%)
Impacted (11-25%)
Sensitive (0-10%)
good
fair
low
Level of Stream Quality

In watersheds with less than 5% impervious cover, streams are typically stable and pristine, maintaining good pool and riffle structure, a large wetted perimeter during low flow, and a good riparian canopy coverage.

At 10% impervious cover, the stream is more visibly impacted. The stream has approximately doubled its original size, tree roots are exposed, and the pool and riffle structure seen in sensitive streams is lost.

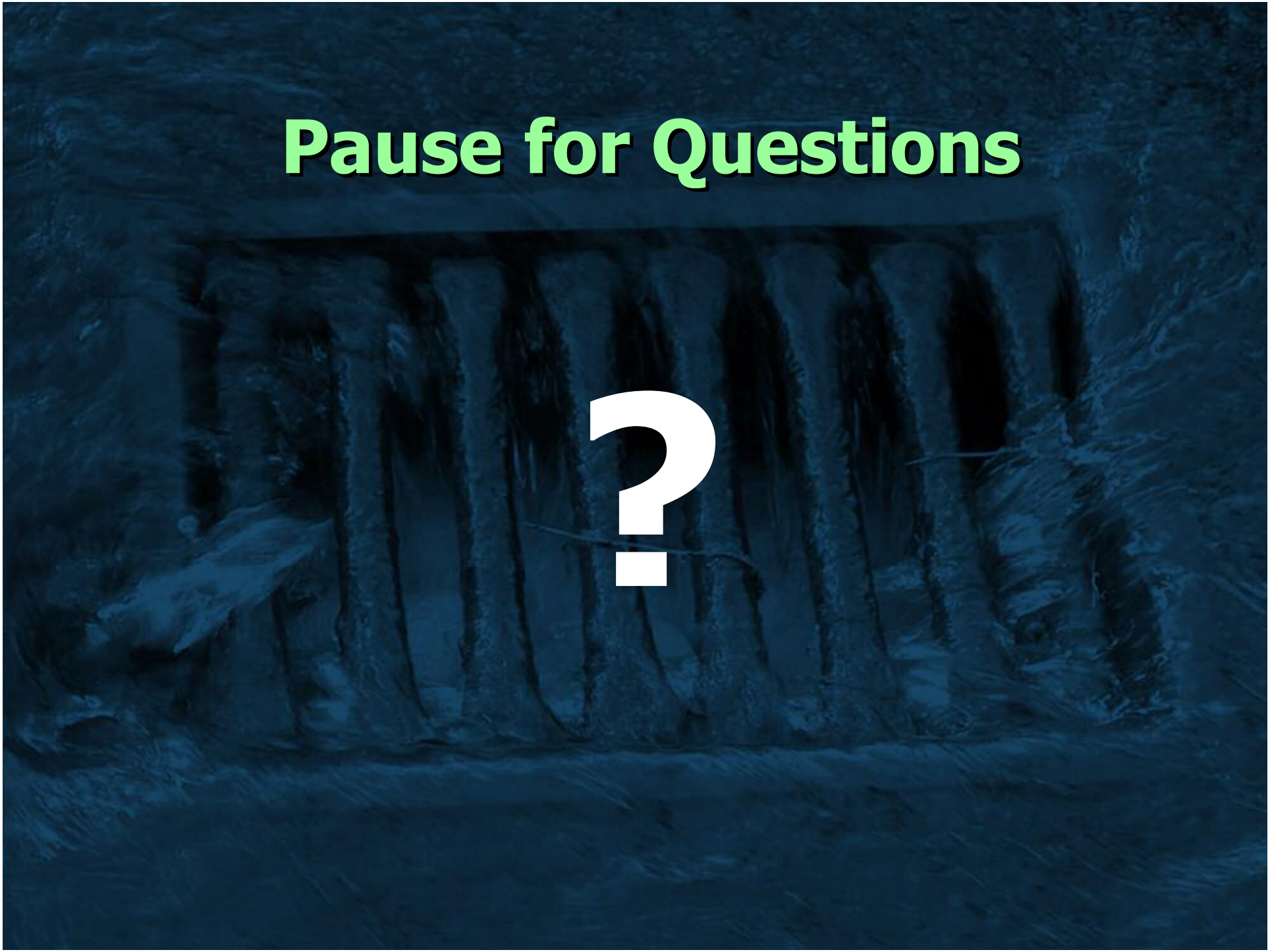
24


Active erosion becomes much more evident at 20% impervious cover with decreased substrate quality due to more material "flushing" through the system.
Copyright 2000 Center for Watershed Protection



Copyright © 2000 Center for Watershed Protection

Pause for Questions



Post-Construction
Minimum Measure

What are the benefits of a stormwater program?

- Meet regulatory requirements
- Reduce flooding
- Improve water quality
- Prevent erosion
- Preserve biological populations
- Sustainable infrastructure

What are the benefits of a stormwater program?

- Improve aesthetics
- Protect riparian areas
- Increase property values
- Educate the community
- Reduce infrastructure and maintenance costs

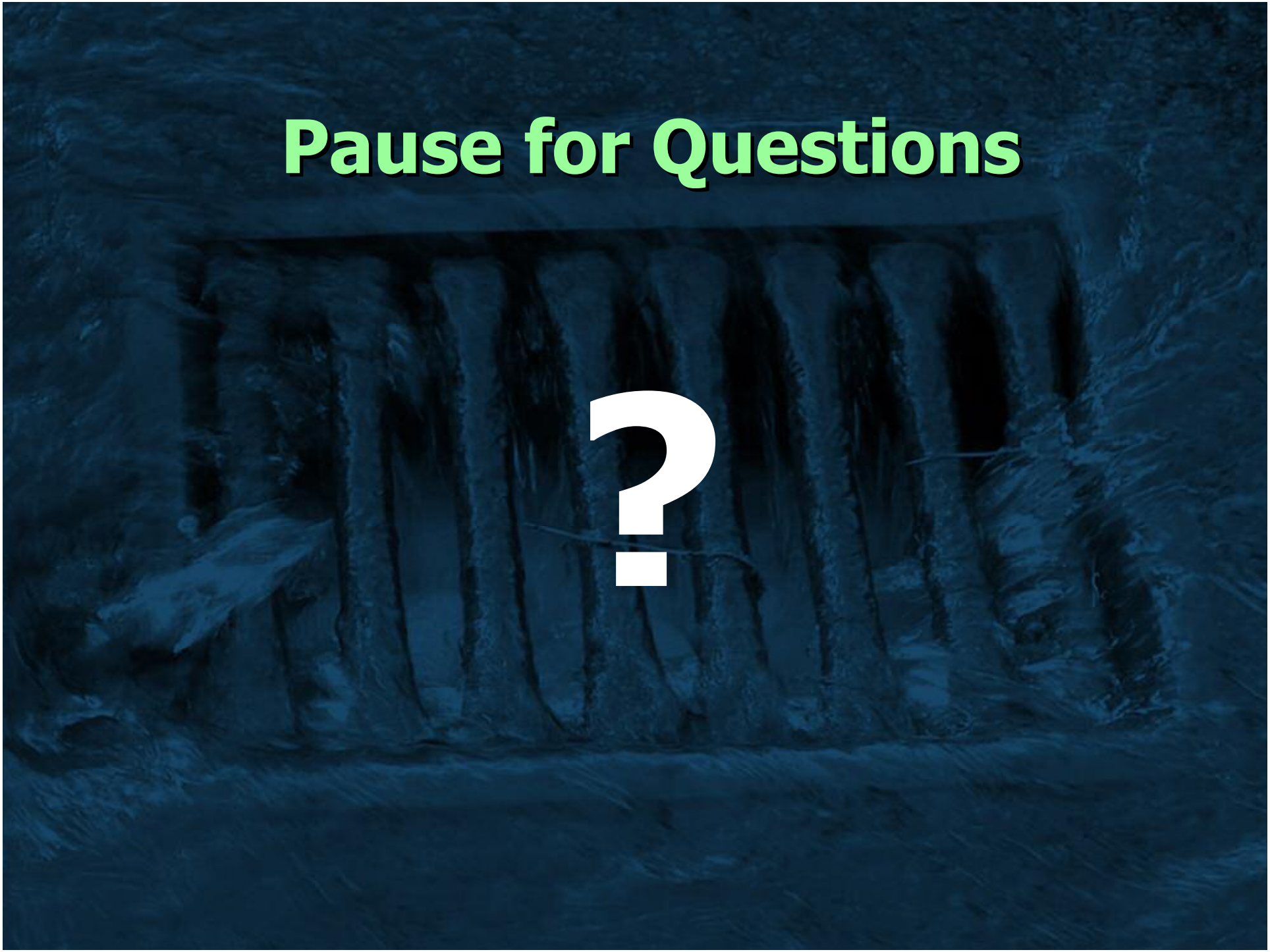
Phase II Minimum Control Measure:
Post-Construction Stormwater Management in New Development and Redevelopment

- Develop a program, using an ordinance or other regulatory means, to address runoff from new development and redevelopment projects that disturb $\geq$ 1 acre
- Implement strategies with a combination of structural and/or non-structural BMPs
- Ensure adequate long-term operation & maintenance (O&M) of BMPs

Phase II Minimum Control Measure:
Post-construction Stormwater Management in New Development and Redevelopment

- **The BMPs chosen should:**
  - **be appropriate for the local community**
  - **minimize water quality impacts**
  - **attempt to maintain pre-development runoff conditions**
- **Participate in watershed planning efforts**
- **Assess existing ordinances, policies, and programs that address stormwater runoff quality**
- **Provide opportunities for public participation**

Pause for Questions



Basic Elements of a
Post-Construction
Stormwater Program

What are the common elements of a post-construction program?

- Update of General/Comprehensive Plan and Environmental Review Procedures
- Development of Stormwater Design Standards / Ordinance
- Process for Review and Approval of Stormwater Plans for New Development
- Post-construction BMP Maintenance, Tracking and Inspection
- Penalty Provisions for Noncompliance
- Training and Education

Update of Comprehensive Plan and Environmental Review Procedures

- General/Comprehensive plan amendments:
  - Some cities are required by the State to develop plans to guide in decision-making process for planning (e.g., General Plans or Comprehensive Plans)
  - These plans should include watershed and stormwater quality and quantity policies

Update of Comprehensive Plan and Environmental Review Procedures

- **Environmental review procedures**
  - **Many cities review or screen projects for potential environmental impacts**
  - **Ensure that the City's review procedures address stormwater quality impacts**
  - **Should address both construction and post-construction**

Development of Stormwater Design Standards / Ordinance

- Stormwater Design Standards are used by both the development community and City engineers
- Sets minimally acceptable BMPs and sizing criteria
- Ordinance should require compliance with stormwater design standards

Poll Question

- **Does your city/county have a stormwater ordinance in place that meets these requirements?**
  - **Yes**
  - **Working on it (drafted/proposed)**
  - **No**
  - **Not sure**

Process for Review and Approval of Stormwater Plans

- **Cities must review and approve stormwater plans for new development and redevelopment**
  - **Review will be based on the City's Stormwater Design Standards**
  - **Document the process for plan review and approval**
  - **Develop process to review both construction and post-construction plans**
  - **Address requirements for long-term O&M during review**

Maintenance

- A good maintenance program is critical to any successful post-construction program
- Strategic decision – Who is responsible for maintenance?
  - City/county?
  - Homeowners, associations and individuals?
  - Businesses?
  - Combination?
- Detailed maintenance agreements
- Tracking system
- Training program
- Inspections and variable "enforcement"

Penalty Provisions for Noncompliance

- Can include non-monetary penalties, fines, bonding requirements, permit denial, or denial of occupancy permit.
- Develop an escalating enforcement plan to document steps that will be taken to address non-compliance
- Educate staff on how to use penalty provisions when necessary

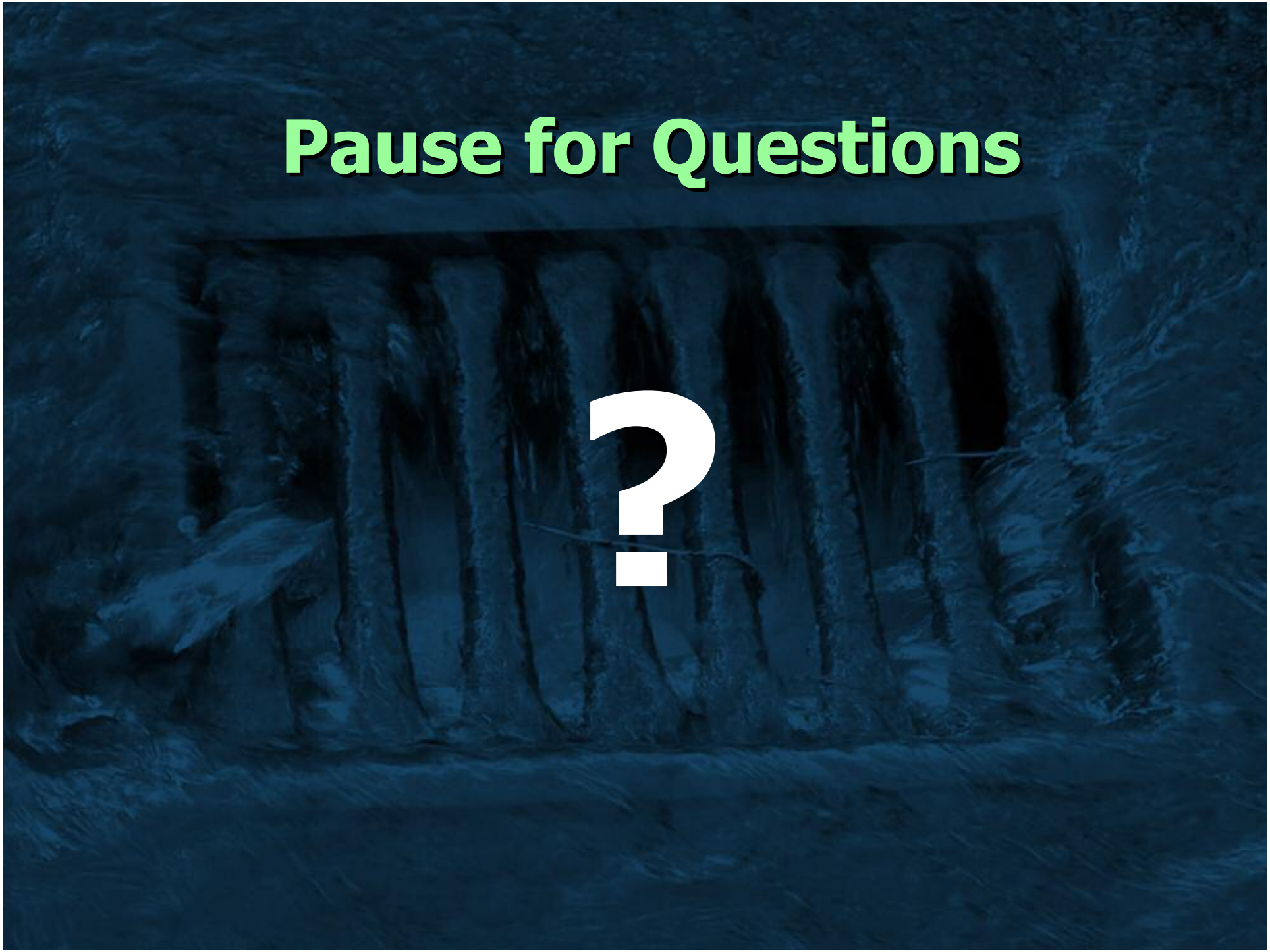
Training and Education

- The City must train it's own staff on the post-construction program
  - Plan review staff
  - Construction inspectors
  - BMP maintenance inspectors
  - Code enforcement, others?
- Local developers and engineers must also be educated so they develop adequate plans.
- Education for property owners on maintenance of BMPs

Poll Question

- **Who is responsible for maintaining BMPs in your city/county?**
  - City/county government exclusively
  - Homeowner's associations
  - Combination of above
  - Not sure

Pause for Questions



Trends in New Development
Smart Growth

Poll Question

- **Are there discussions going on now in your community about smart growth?**
  - **Yes**
  - **No**
  - **Not sure**

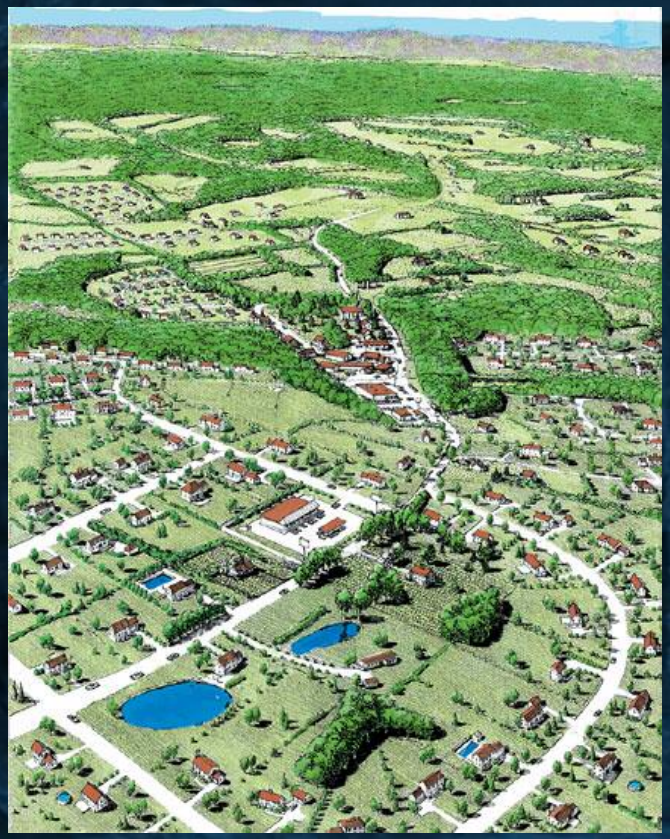
Trends in Development

- Are we focused at the right level?

Trends in Development

- **Need to consider what is happening at a broader scale – neighborhoods, cities, watersheds**

Trends in Development

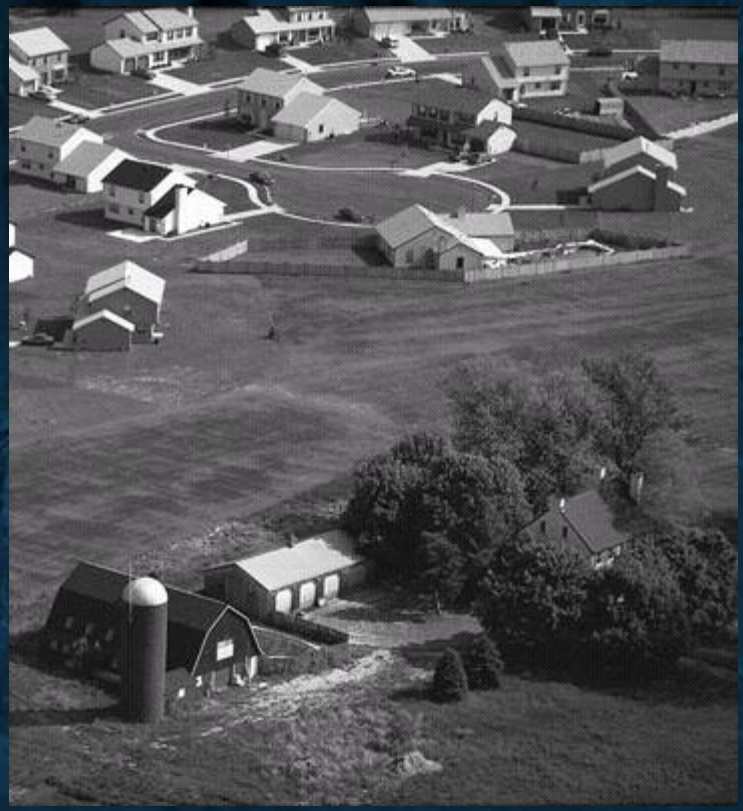


Current development trends are characterized by low-density housing, farmland conversion, and dependence on cars, which:

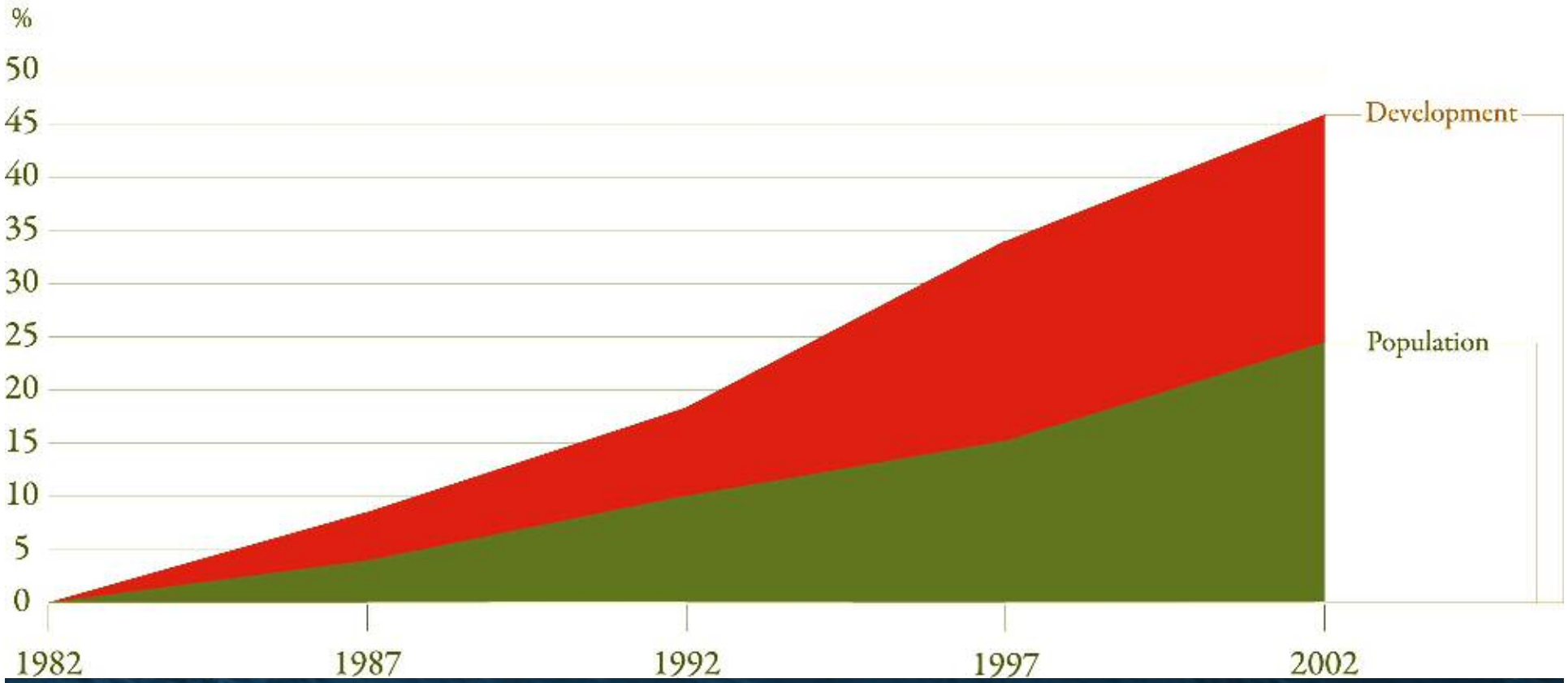
- Consumes land at a faster rate
- Transforms farmland
- Separates houses from stores, businesses, and other land uses
- Increases time spent in cars

Development patterns

- 80% of residential development occurs on urban fringe or beyond
- 94% of that development on 1 acre or more



Land Development and Population Growth in the US, 1982-2002



It's how and where we are growing that are driving our significantly increasing rate of land consumption, not domestic population growth.

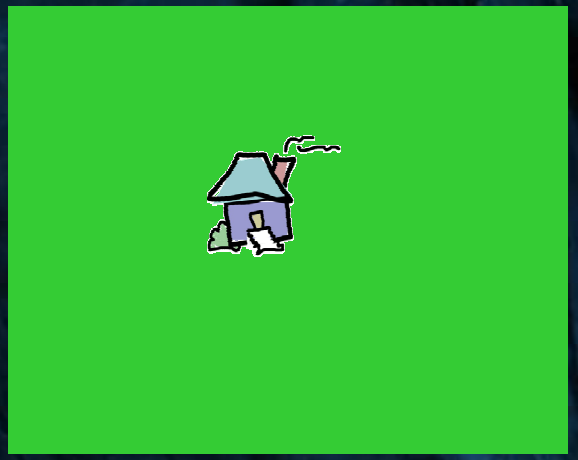
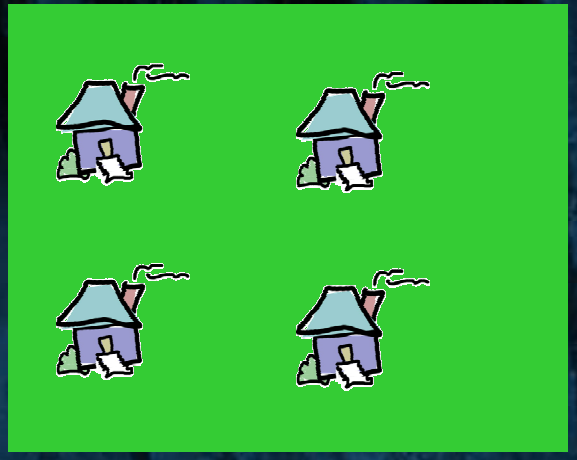
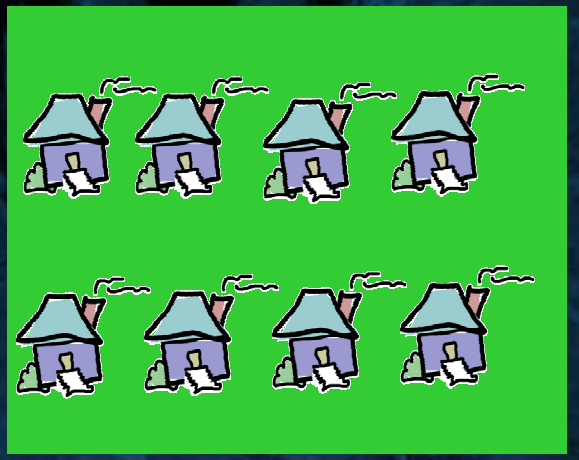
Which is Better for Water Quality on a Watershed Basis?

OR

Low Density

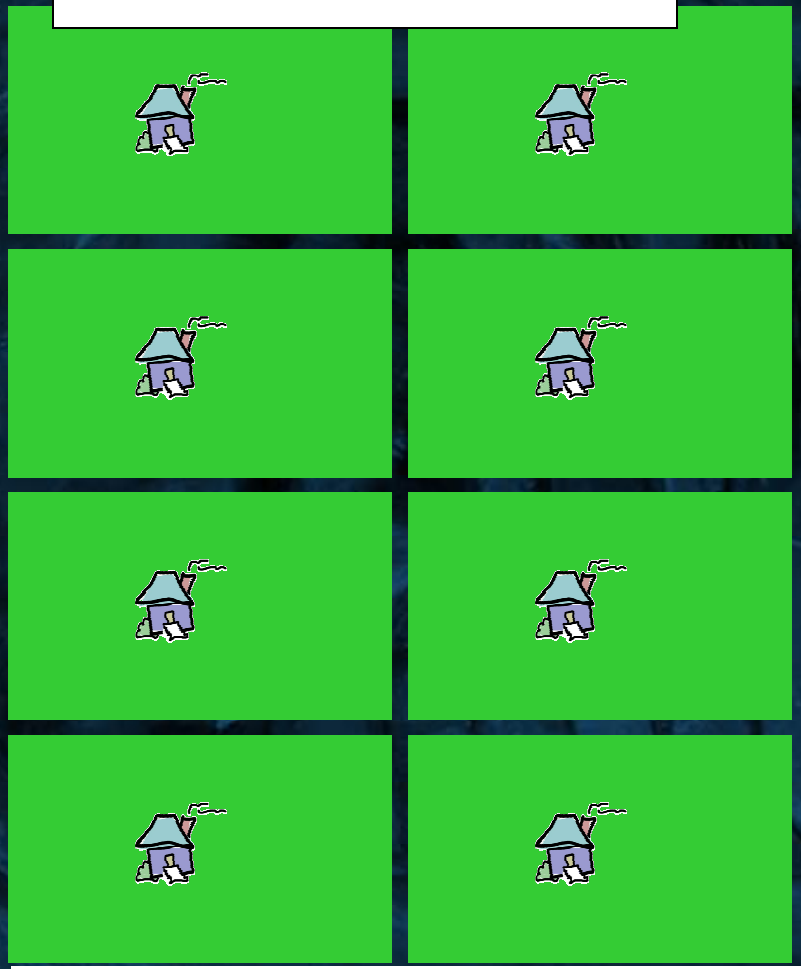
Higher Density

EPA Research on Smart Growth & Water

Scenario A: *1 unit/acre*	*Scenario B:* *4 units/acre*	*Scenario C:* *8 units/acre*
		
Impervious cover = 20% Runoff/acre = 18,700 ft^3/yr Runoff/unit = 18,700 ft^3/yr	Impervious cover = 38% Runoff/acre = 24,800 ft^3/yr Runoff/unit = 6,200 ft^3/yr	Impervious cover = 65% Runoff/acre = 39,600 ft^3/yr Runoff/unit = 4,950 ft^3/yr

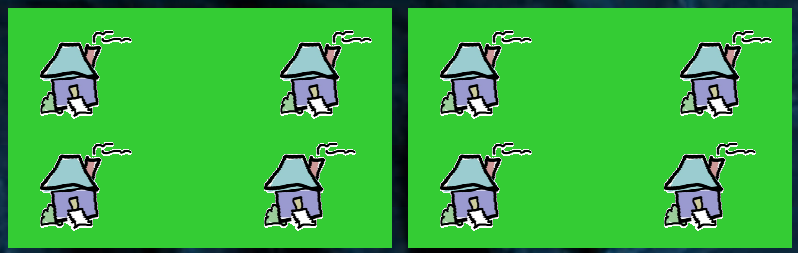
Accommodating the same number of houses (8) at varying densities

Scenario A: 1 unit/acre



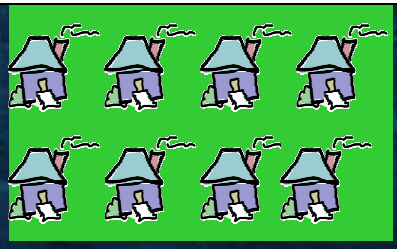
Impervious cover = 20%
Total runoff = 149,600 ft³/yr
Runoff/house = 18,700 ft³/yr

Scenario B: 4 units/acre



Impervious cover = 38%
Total runoff = 49,600 ft³/yr
Runoff/house = 6,200 ft³/yr

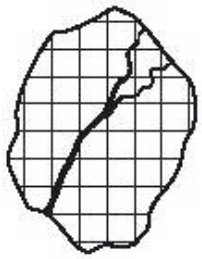
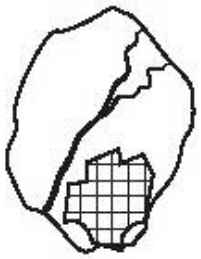
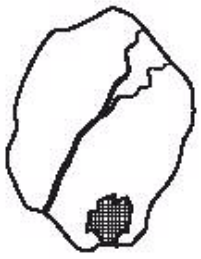
Scenario C: 8 units/acre



Impervious cover = 65%
Total runoff = 39,600 ft³/yr
Runoff/house = 4,950 ft³/yr

And at the watershed level…

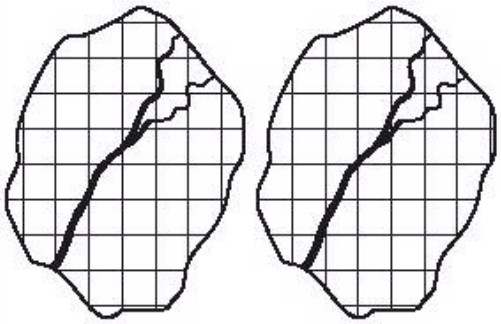
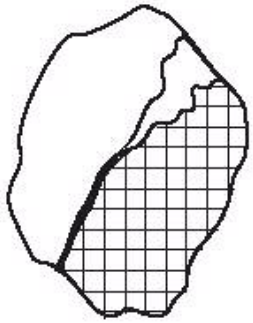
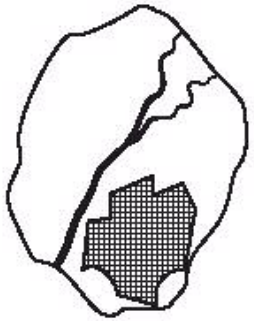
Accommodating 10,000 units on a 10,000 acre watershed at different densities

Scenario A	Scenario B	Scenario C
		
10,000 houses built on 10,000 acres produce: 10,000 acres x 1 house x 18,700 ft^3/yr of runoff = **187 million ft^3/yr of stormwater runoff** **Site: 20% impervious cover** **Watershed: 20% impervious cover**	10,000 houses built on 2,500 acres produce: 2,500 acres x 4 houses x 6,200 ft^3/yr of runoff = **62 million ft^3/yr of stormwater runoff** **Site: 38% impervious cover** **Watershed: 9.5% impervious cover**	10,000 houses built on 1,250 acres produce: 1,250 acres x 8 houses x 4,950 ft^3/yr of runoff = **49.5 million ft^3/yr of stormwater runoff** **Site: 65% impervious cover** **Watershed: 8.1% impervious cover**

The lower density scenario creates more runoff and consumes 2/3 more land than the higher density scenario.

In 20 years, they have doubled their populations…

So by 2026, they might look like…

Scenario A	Scenario B	Scenario C
		
20,000 houses accommodated on 20,000 acres at a density of *1 house per acre* will consume 2 watersheds.	20,000 houses accommodated on 5,000 acres at a density of *4 houses per acre* will consume ½ of 1 watershed.	20,000 houses accommodated on 2,500 acres at a density of *eight houses per acre* will consume ¼ of 1 watershed.

Smart Growth Principles

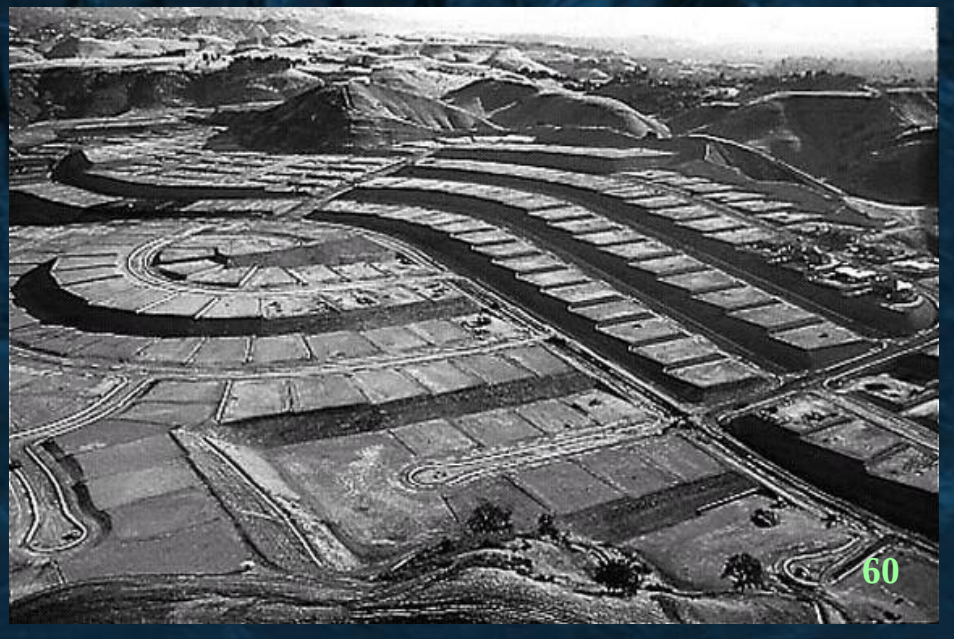
- Mix land uses
- Take advantage of compact building design
- Create a range of housing opportunities and choices
- Create walkable neighborhoods
- Foster distinctive, attractive communities with a strong sense of place
- Preserve open space, farmland, natural beauty, and critical environmental areas

Smart Growth Principles (con't)

- Strengthen and direct development towards existing communities
- Provide a variety of transportation choices
- Make development decisions predictable, fair, and cost-effective
- Encourage community and stakeholder collaboration in development decisions

Water Quality & Smart Growth

- Density and imperviousness are not equivalent
- Lawns do not equal undisturbed land, such as forests or meadows
- Low-density developments have more impervious infrastructure
- Growth is coming to the region—limiting density on a site doesn't eliminate that growth



Which is Better for Water Quality on a Watershed Basis?

Housing like this….

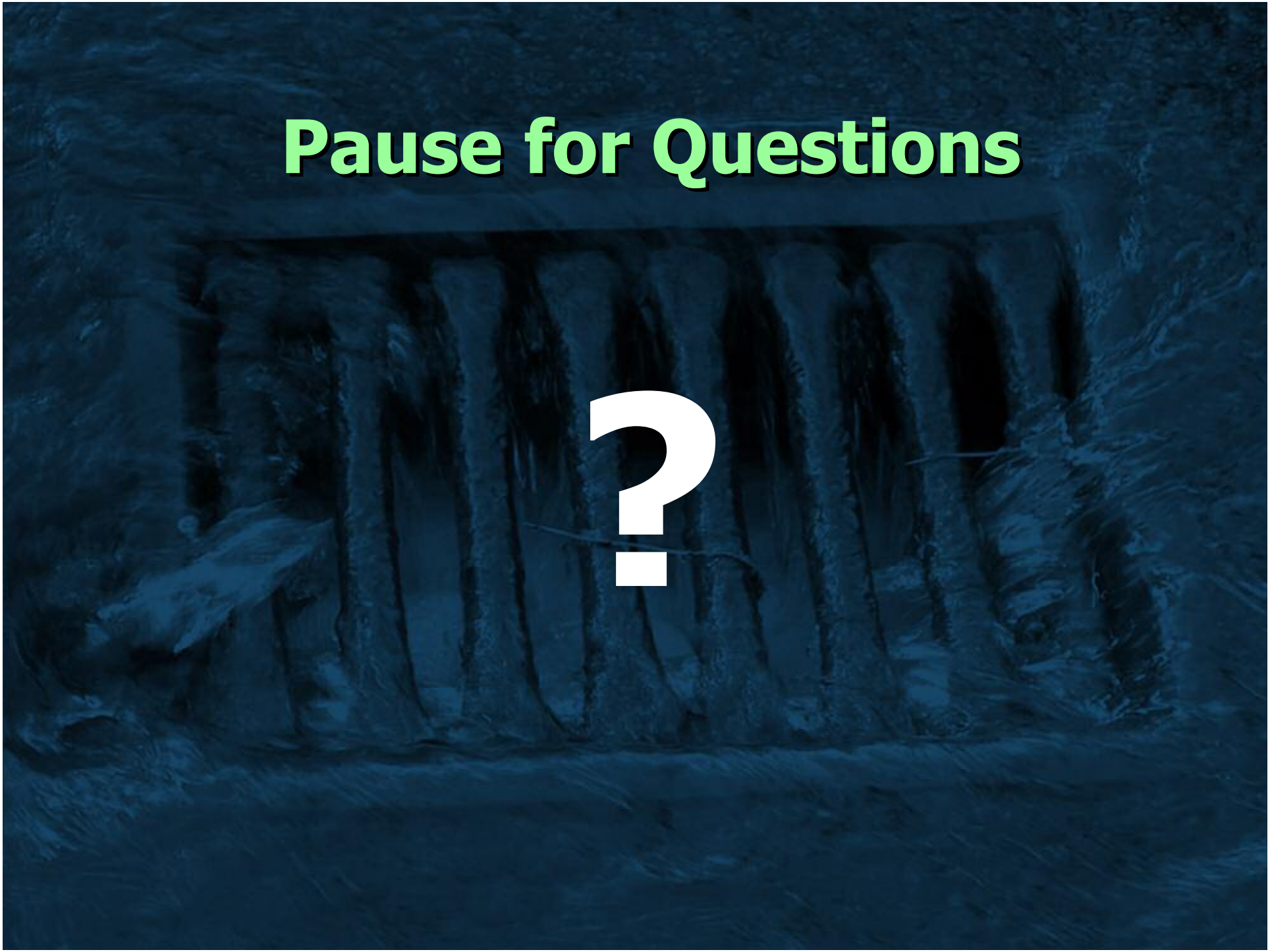
…is, by design, served by retail and roads like this

Smart Growth Resources

- Using Smart Growth Techniques as Stormwater Best Management Practices – December 2005
- Protecting Water Resources with Higher-Density Development – January 2006
- Parking Spaces/Community Places, Finding the Balance through Smart Growth Solutions – January 2006

www.epa.gov/smartgrowth

Pause for Questions



Low Impact Development

Good site design is critical to successful stormwater management

Site Design

- Traditional stormwater management that focuses on moving water off the landscape often exacerbates the stormwater problem
- Techniques that manage stormwater on-site and promote infiltration result in:
  - Pollution reduction
  - Volume reduction

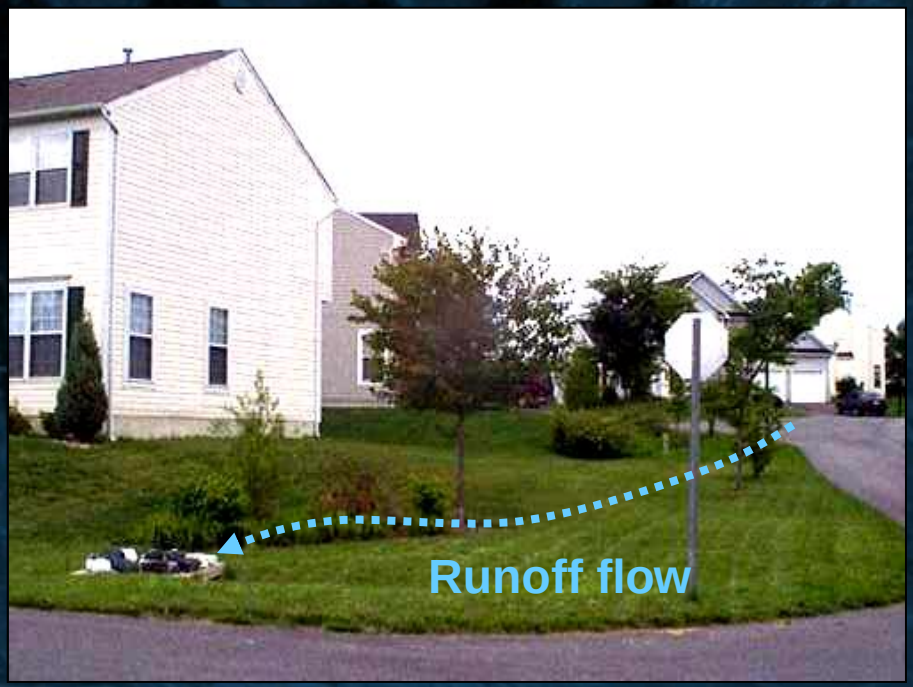
Basic Premise of Low Impact Development

- Design site to minimize pollutant loadings and runoff volumes and velocities
- Use distributed small scale treatment systems
- Maximize infiltration/ground water recharge
- Reduce infrastructure costs
- Protect ecosystem functions and values

Low Impact Development

Low Impact Development

- Smaller-scale, distributed BMPs
- Focused on retention and infiltration
- Multiple benefits in addition to stormwater control



Residential bioretention system

Minimize Development Impacts

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

Maintain Site Runoff Rate

- Maintain natural flow paths
- Decentralize and micromanage stormwater at its source
- Use open drainage
- Flatten slopes
- Disperse drainage
- Lengthen flow paths
- Save headwater areas
- Maximize sheet flow

Design standards should encourage alternatives to curb and gutter where practical

Common LID Management Practices

- Disconnectivity
- Bioretention (Rain Gardens, Infiltration Trenches)
- Permeable and Porous Pavements
- Green Roofs
- Planter Boxes
- Soil Amendment
- Open Swales
- Rain Barrels

Disconnectivity

Open Swales

Bioretention

Parking Lot Infiltration

Rain Gardens

Permeable and Porous Pavements

Green Roofs

Rain Barrels, Cisterns and Storage Tanks

Soil Amendment

Soil aeration

Soils amended to a depth of 12 inches

Planter Boxes

Poll Question

- **Are any Low Impact Development BMPs used/encouraged in your community**
  - **Yes**
  - **Working on it**
  - **No**
  - **Not sure**

Other Local Ordinances

- **Modifying other local ordinances is the key to successful implementation of LID and Smart Growth**
- **Look at:**
  - **Fire codes**
  - **Street codes**
  - **Building codes**
  - **Parking requirements**
  - **Etc.**

Conventional
Low Impact
Conventional
Functional Landscape Design
'96 6 4

Construction Cost Comparison

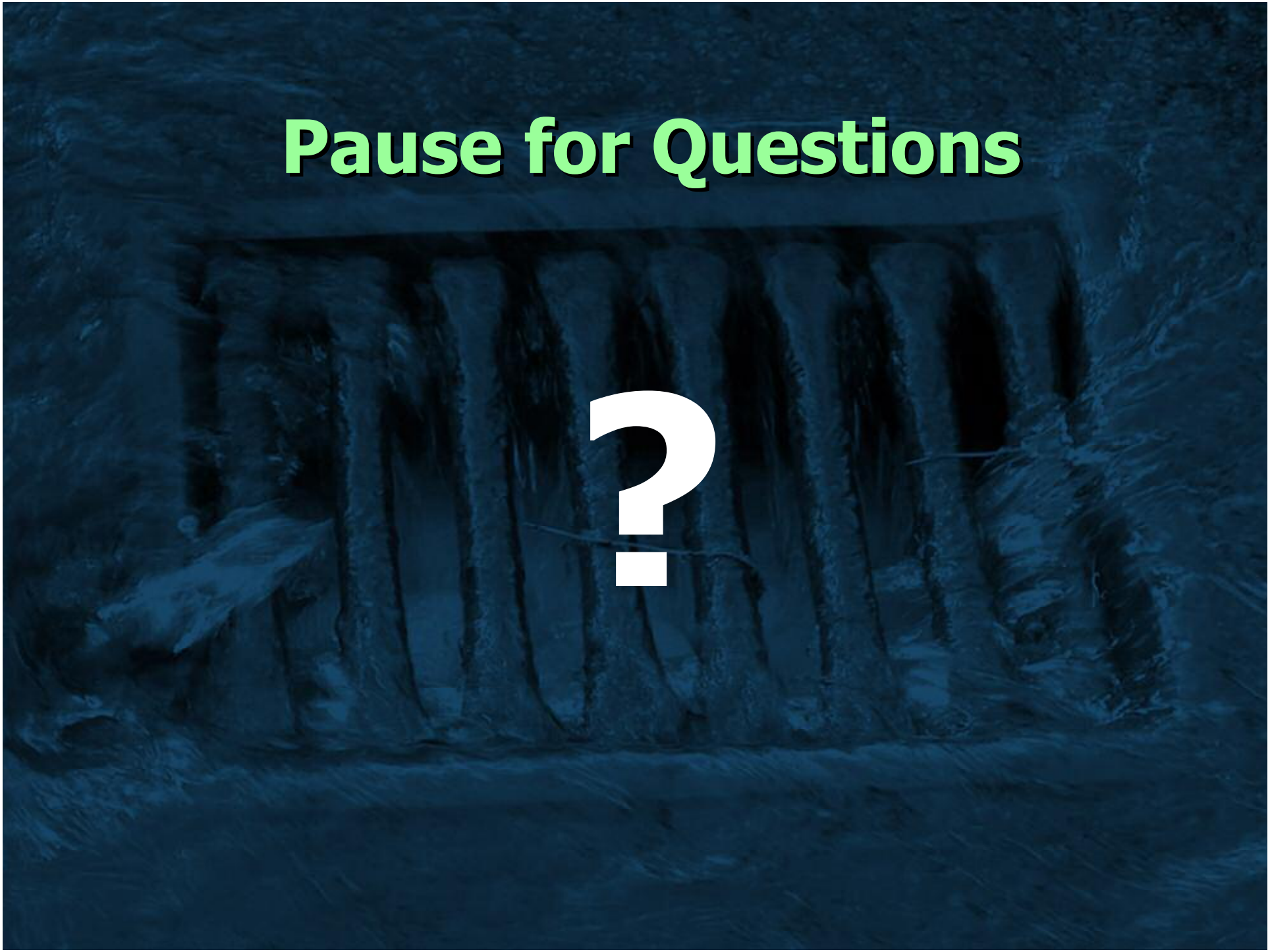
	Conventional	Low Impact
Grading/Roads	$569,698	$426,575
Storm Drains	$225,721	$132,558
SWM Pond/Fees	$260,858	$ 10,530
Bioretention/Micro	—	$175,000
Total	$1,086,277	$744,663
Unit Cost	$14,679	$9,193
Lot Yield	74	81

Post-Construction
Smart Growth
Low Impact Development

Post-Construction Guidance

- Developing a comprehensive guide for Phase II communities
- Will include detailed guidance on program setup, creating an ordinance, sizing criteria, smart growth, low impact development, etc.
- Working with the Center for Watershed Protection to develop
- Publication late 2006

Pause for Questions



Contact Information

Nikos Singelis
EPA, Office of Wastewater Management
1200 Pennsylvania Ave, NW
Washington, DC 20460
202-564-0692
singelis.nikos@epa.gov

Sign up for NPDES News – our email newsletter at www.epa.gov/npdes

Resources

- Education and Outreach Materials
  www.epa.gov/npdes/stormwatermonth
- Training resources

  www.epa.gov/npdes/training

  www.epa.gov/owow/watershed/wacademy/
- Menu of BMPs
  www.epa.gov/npdes/menuofbmps
- Smart Growth www.epa.gov/smartgrowth
- Low Impact Development
  www.epa.gov/owow/lid and
  - Center for Watershed Protection www.cwp.org
- MS4 Case Studies—approximately 20
  www.epa.gov/npdes/casestudies
- Illicit Discharge Manual—Developed by Center for Watershed Protection
  www.epa.gov/npdes/stormwater