

The life & times of the 1st impervious cover TMDL in the nation



Rhode Island Land & Water Conservation Summit
March 26, 2011



Center for Land Use Education and Research

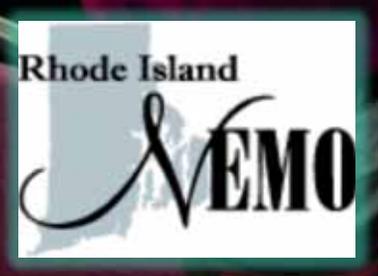


CLEAR's Mission:
**To provide information, education
and assistance to land use
decision makers in support of
balancing growth and natural
resource protection.**



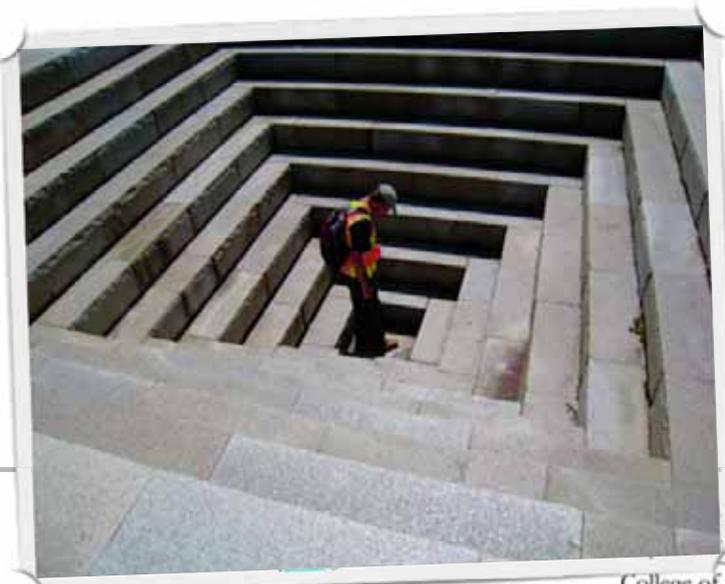
- **Dept. of Extension**
- **Dept. of Natural Resources and the Environment**
- **Connecticut Sea Grant**

CLEAR's Target Audience



Today's Tale

- Development of the IC-TMDL
- The project: technical work
- The project: implementation & progress
- Tracking progress
- Is it working?



Today s Tale

- **Development of the IC-TMDL**
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Total Maximum Daily Load

- The maximum amount of a pollutant a waterbody can receive without adverse impact to designated uses
- Under section 303(d) of the Federal Clean Water Act (CWA), states are required to develop TMDLs for impaired waters
- The end result is a Water Quality Management Plan with quantitative pollutant load reduction targets

What's polluting Connecticut's rivers?

**Probable Sources
Connecticut Rivers and Streams 2008**

[Description of this table](#)

<u>Probable Source</u>	<u>Probable Source Group</u>	<u>Miles Threatened or Impaired</u>
Source Unknown	Unknown	766.0
Unspecified Urban Stormwater	Urban-Related Runoff/Stormwater	222.2
Municipal Point Source Discharges	Municipal Discharges/Sewage	130.5
Sources Outside State Jurisdiction Or Borders	Other	106.6
Industrial Point Source Discharge	Industrial	105.3
Combined Sewer Overflows	Municipal Discharges/Sewage	78.6
Illicit Connections/Hook-Ups To Storm Sewers	Municipal Discharges/Sewage	52.0
Landfills	Land Application/Waste Sites/Tanks	49.5
Contaminated Sediments	Legacy/Historical Pollutants	48.8
Sanitary Sewer Overflows (Collection System Failures)	Municipal Discharges/Sewage	46.5
Agriculture		43.1
Impacts From Hydrostructure F Regulation/Modification		41.1
Upstream Impoundments (E.G. Structures)		39.4
Channelization		39.4
Site Clearance (Land Development Or Redevelopment)		32.3
Baseflow Depletion From Groundwater Withdrawals		32.3
Above Ground Storage Tank Leaks (Tank Spills/Dumping)		25.5

Source of Impairment

◆ Unknown

◆ Unspecified Urban Stormwater

And in Rhode Island?

Probable Sources Rhode Island Rivers and Streams 2008

[Description of this table](#)

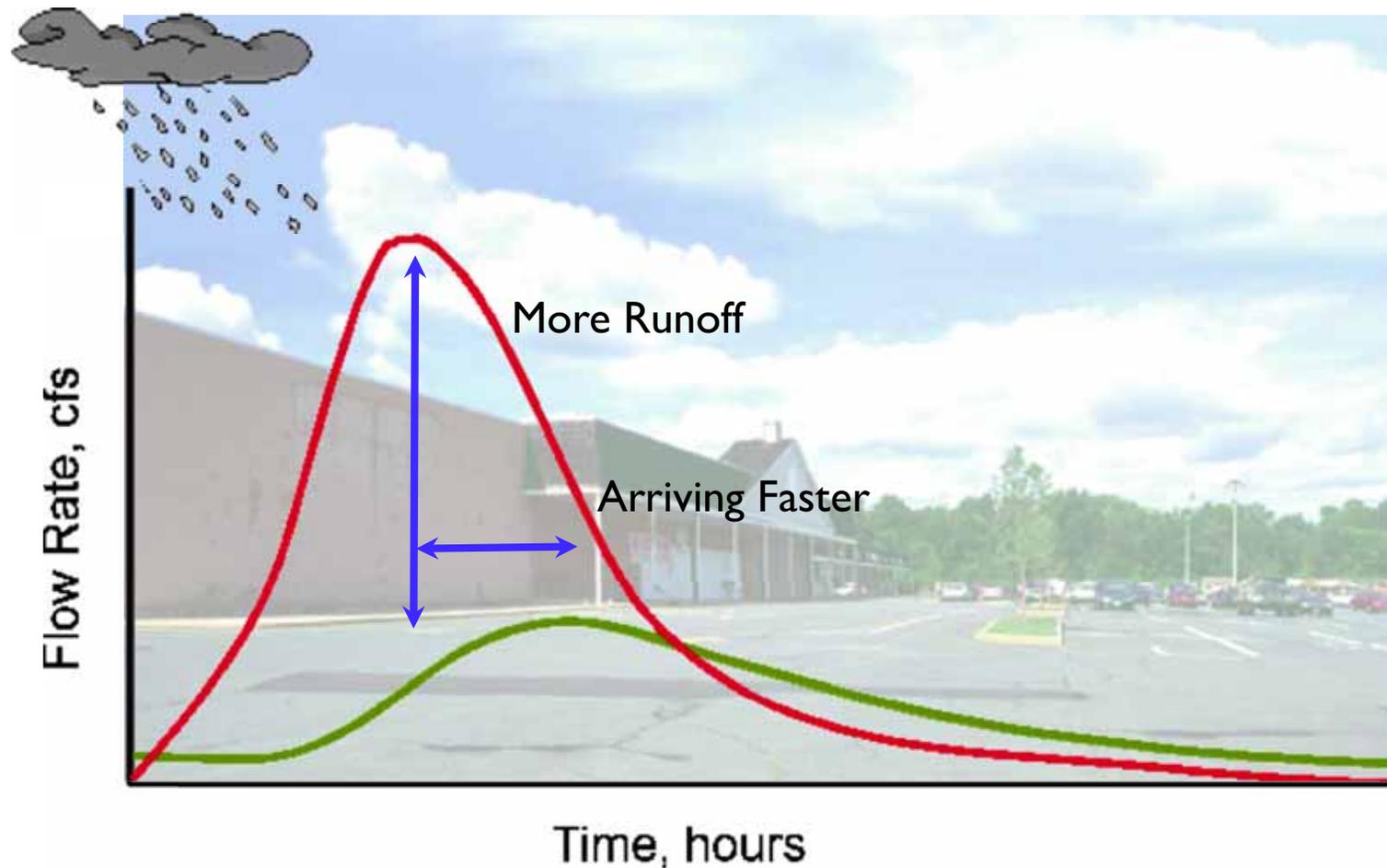
<u>Probable Source</u>	<u>Probable Source Group</u>	<u>Miles Threatened or Impaired</u>
Source Unknown	Unknown	208.9
Urban Runoff/Storm Sewers	Urban-Related Runoff/Stormwater	77.6
Wildlife Other Than Waterfowl	Natural/Wildlife	45.0
Introduction Of Non-Native Organisms (Accidental Or Intentional)	Other	40.1
Municipal Point Source Discharges	Municipal Dishcarges/Sewage	32.8
On-Site Treatment Systems (Septic Systems And Similar Decentralized Systems)	Municipal Dishcarges/Sewage	24.2
Cercla Npl (Superfund) Sites	Legacy/Historical Pollutants	22.6
Waterfowl	Natural/Wildlife	21.7
Agriculture	Agriculture	18.3
Impervious Surface/Parking Lot Runoff	Urban-Related Runoff/Stormwater	17.6
Contaminated Groundwater	Groundwater Loadings/Withdrawals	16.8
Highway/Road/Bridge Runoff (Non-Construction Related)	Urban-Related Runoff/Stormwater	13.3
Landfills	Land Application/Waste Sites/Tanks	12.9
Upstream/Downstream Source	Other	11.7
	Municipal	-

Urban Stream Syndrome

A photograph of a stream in a forest. The water is a distinct reddish-brown color, flowing over a bed of dark rocks. The stream is surrounded by dense, vibrant green vegetation, including various plants and trees. The scene is captured from a slightly elevated perspective, looking down the length of the stream.

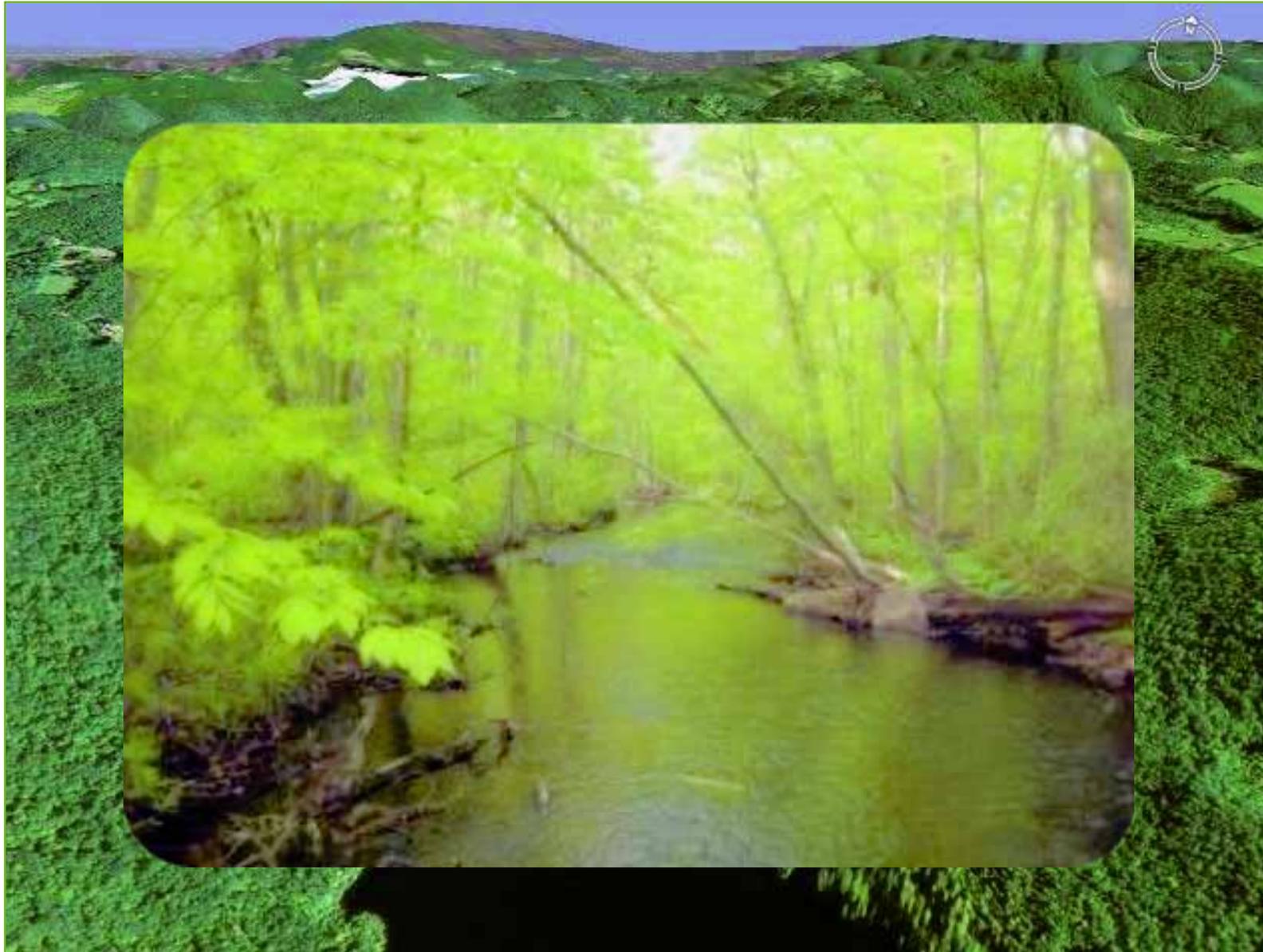
The mechanisms driving the syndrome are complex and interactive, but most impacts can be ascribed to...urban stormwater runoff delivered to streams by hydraulically efficient drainage systems.

Hydrologic Impacts of Development





The Effects of Urbanization



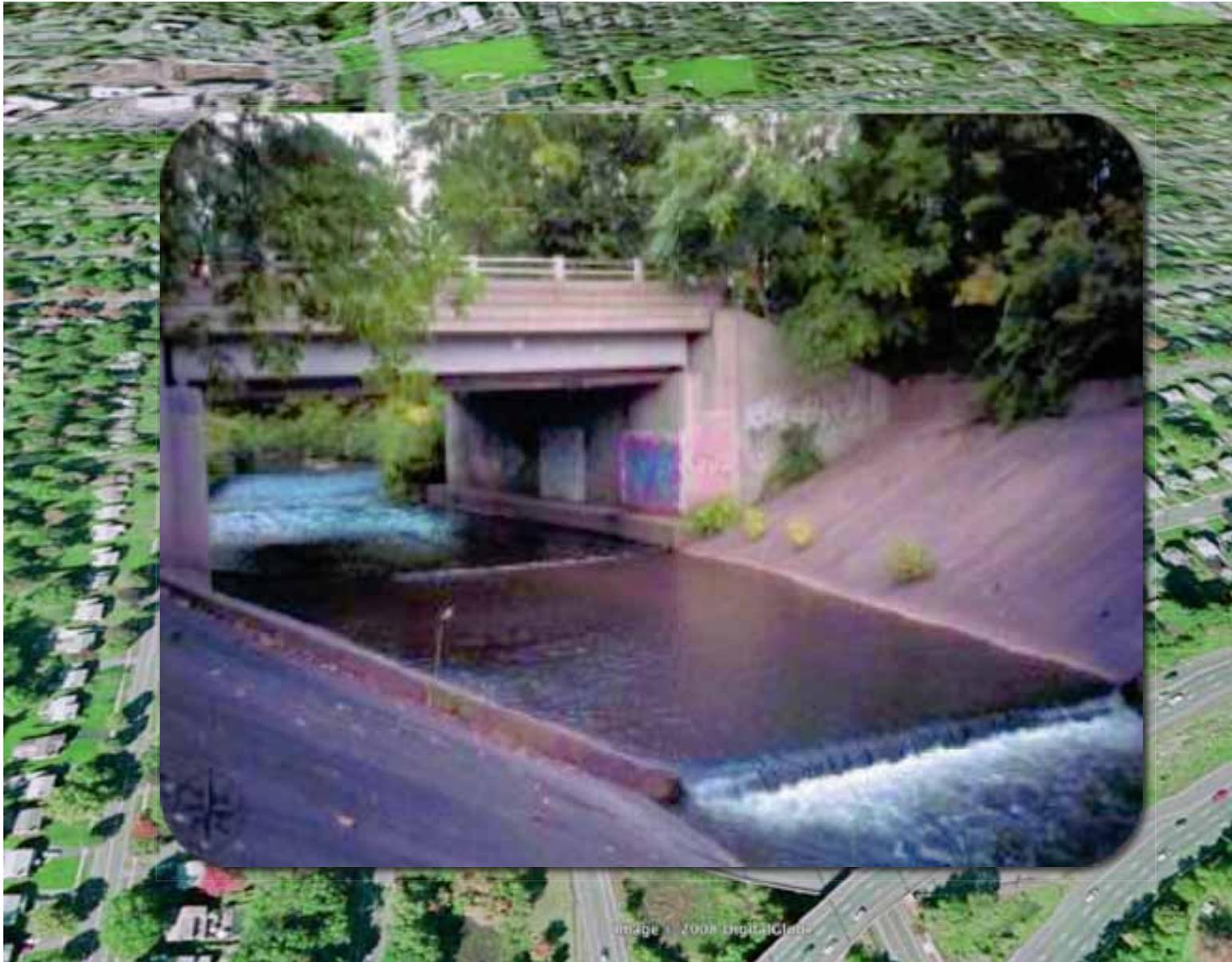


The Effects of Urbanization

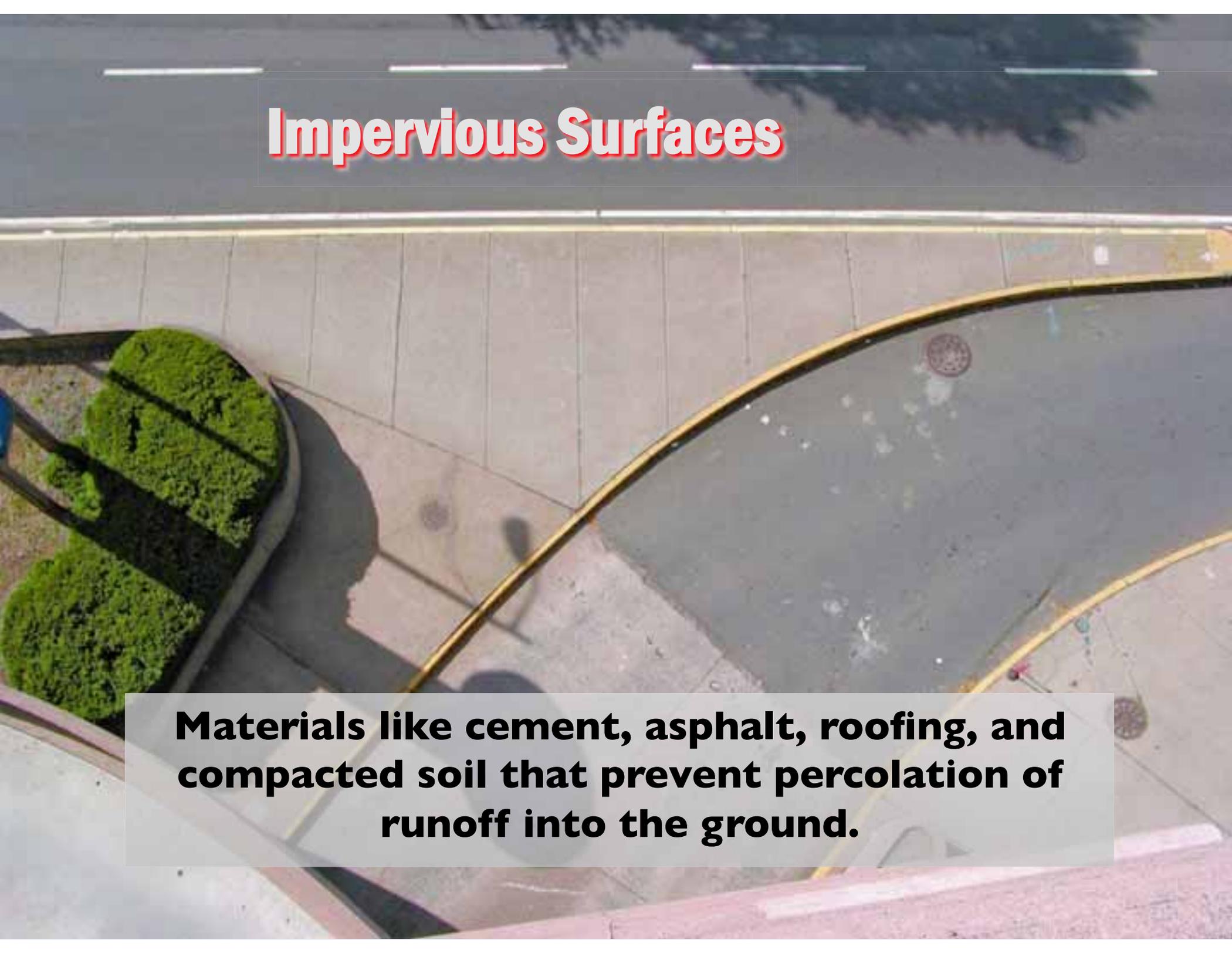




The Effects of Urbanization

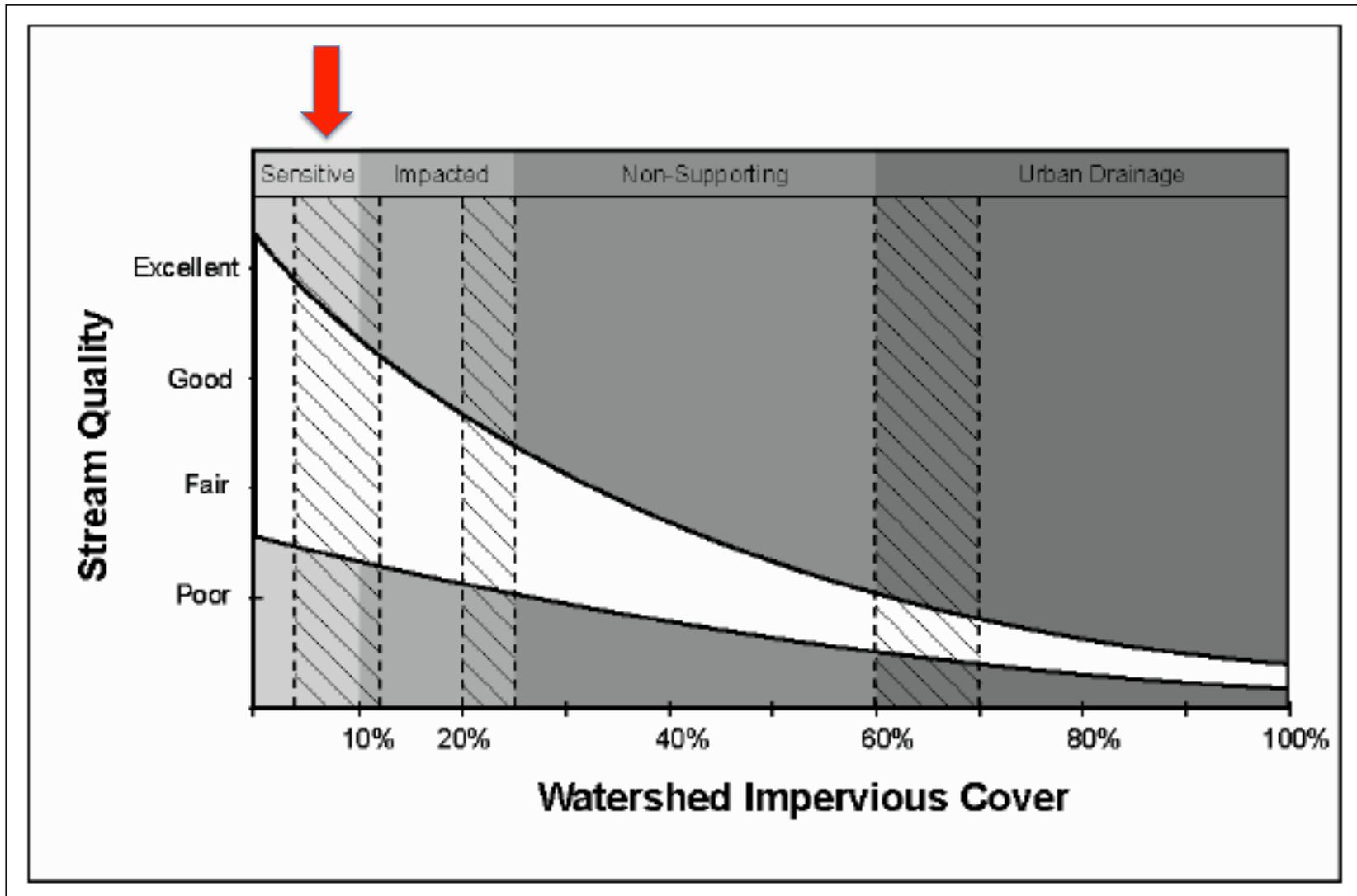


Impervious Surfaces

An aerial photograph of a city street. The top portion shows a dark asphalt road with white dashed lane markings. Below the road is a light-colored concrete sidewalk. To the left of the sidewalk is a landscaped area with several rounded, green bushes. A yellow curb runs along the edge of the sidewalk. In the bottom right corner, there is a pinkish-red curb. The overall scene illustrates typical urban impervious surfaces.

Materials like cement, asphalt, roofing, and compacted soil that prevent percolation of runoff into the ground.

The (Updated) Impervious Cover Model



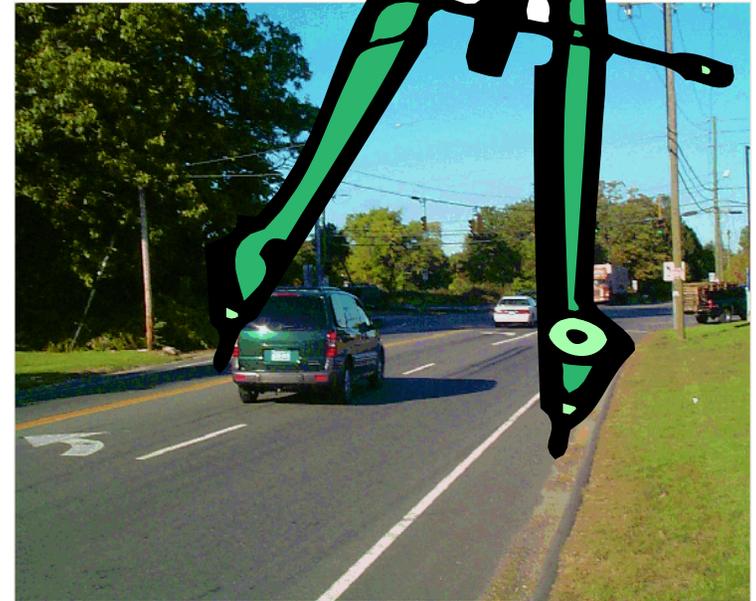
The Strength of the Evidence

More than 200 studies on relationship between IC and stream quality:

- Geomorphic (stream form) indicators
- Hydrologic Indicators
- Stream Habitat Indicators
- Water Quality Indicators
- Aquatic Diversity Indicators

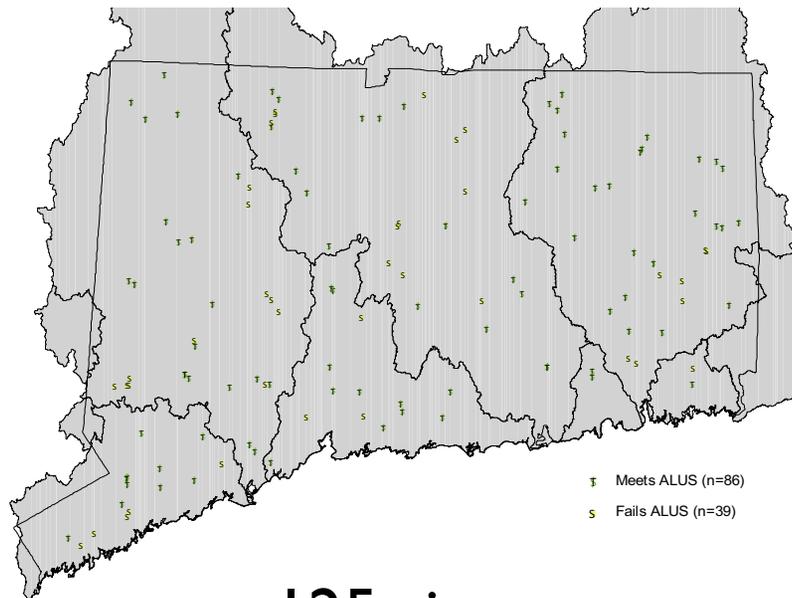
Impervious Surface as an Indicator

1. It simplifies complex impacts but is based on solid science
2. It's tangible & measurable
3. It's generated by local land use regulations

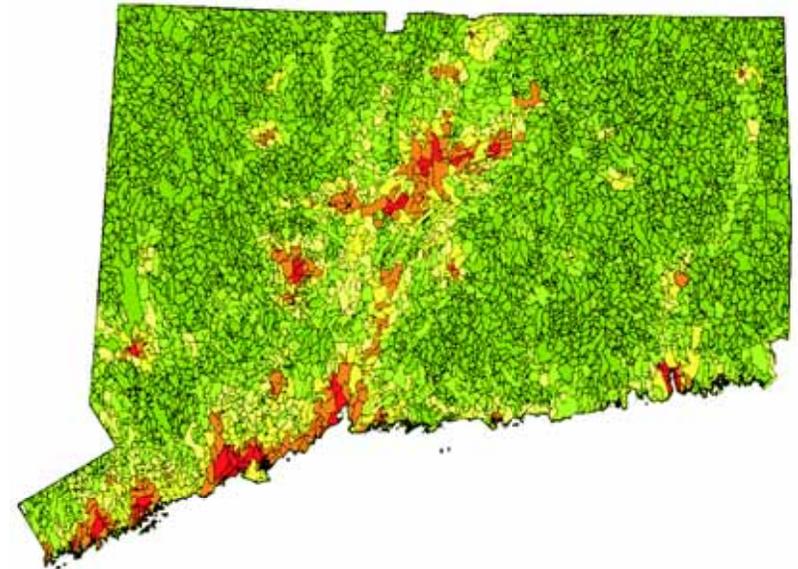


And what about in CT?

Linking Bug Data with Impervious Cover Data



+

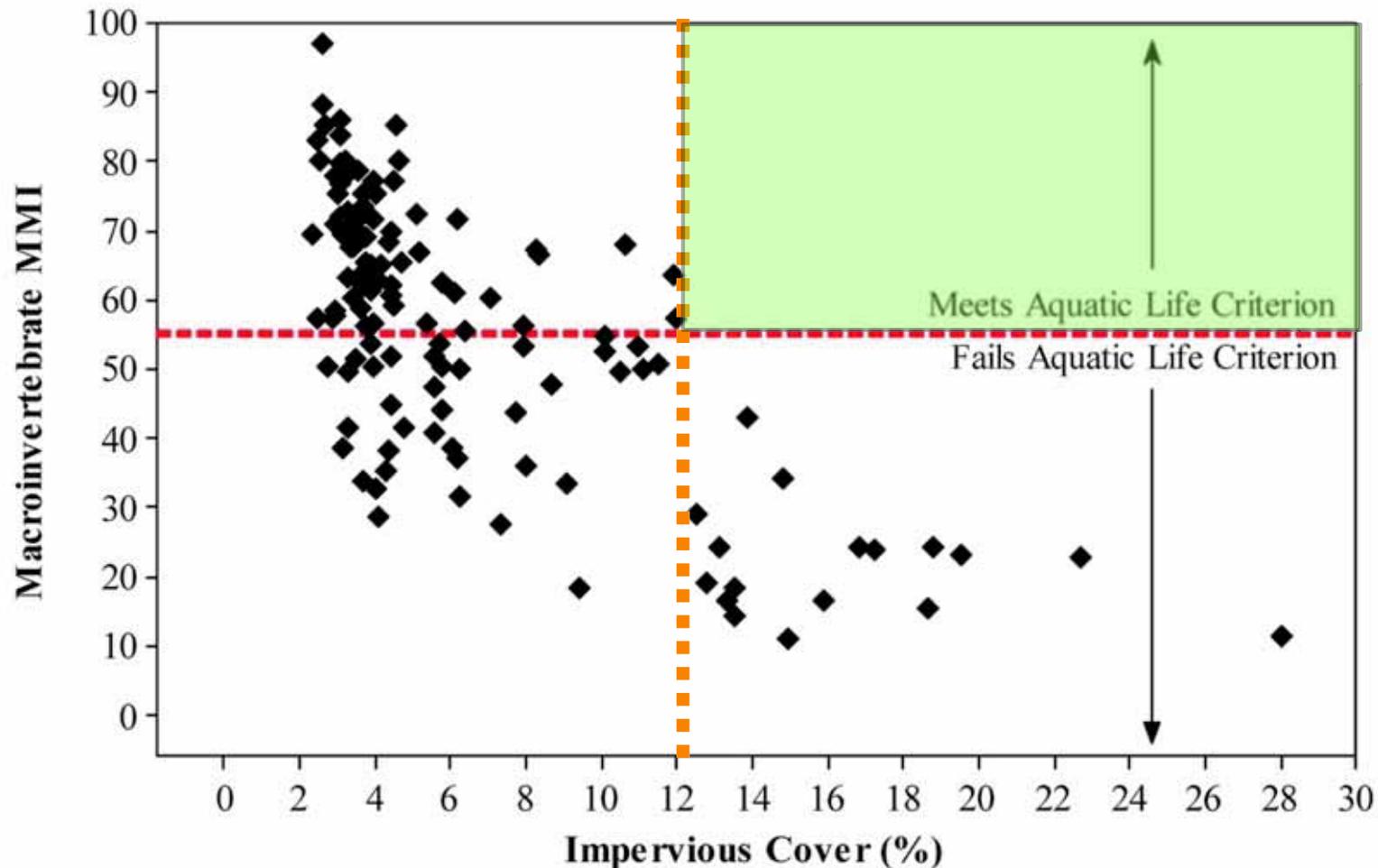


125 sites

- < 50 square miles drainage
- No point sources
- No streams with portion of watershed in another state
- Consistent level of sampling effort over time

Linking the Bug Data with Impervious Cover Data

None of the 125 study sites with IC over 12% met CT's aquatic life criteria for a healthy



Enter the IC-TMDL

“Since the impairment cannot be attributed to a specific pollutant, impervious cover (IC) was used as a surrogate measure of the complex array of pollutants transported by stormwater...”.

- IC can be used as **surrogate**
- Target is 11% impervious cover (I2 – I)
- Benefits of Using IC
 - ✓ Simplifies complex impacts but based on good science
 - ✓ Good correlation between IC and stream health
 - ✓ IC data available statewide
 - ✓ Measurable and generated by local land use

**A Total Maximum Daily Load Analysis
for
Eagleville Brook, Mansfield, CT**

Final: February 8, 2007

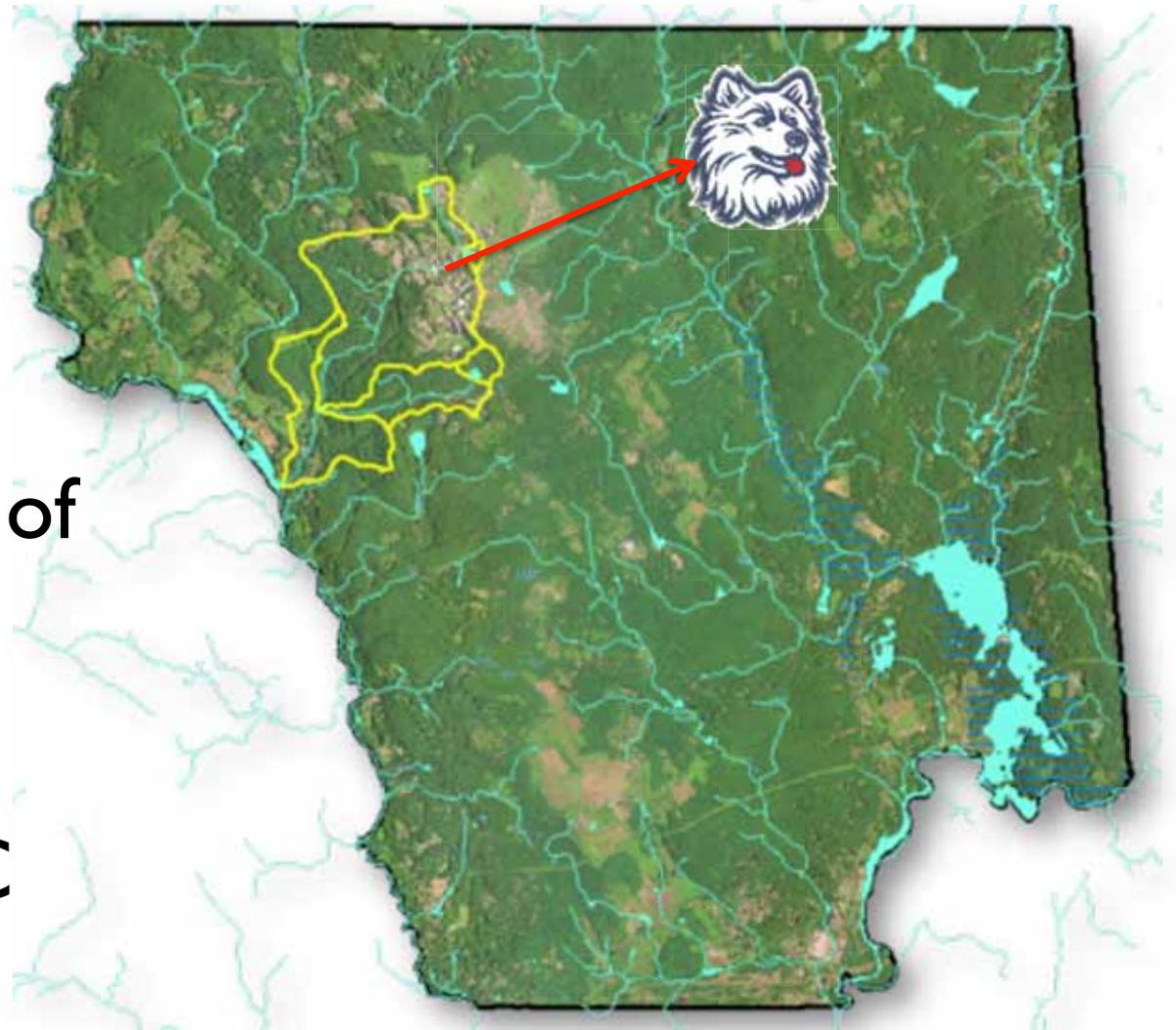
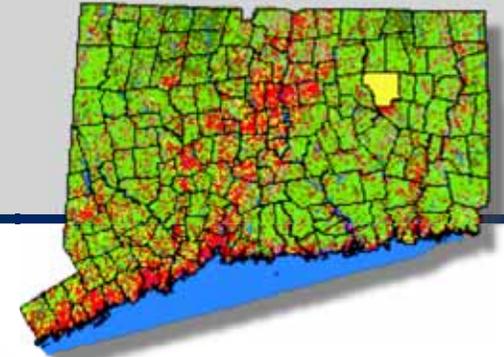
This document has been established pursuant
to the requirements of Section 303(d)
of the Federal Clean Water Act:

Anney Marvella Deputy Commissioner	Date
Betsy Wingfield, Chief Bureau of Water Protection and Land Reuse	Date

The seal of the State of Connecticut Department of Environmental Protection, featuring a sun, a tree, and a river within a circular border containing the text "CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION".

STATE OF CONNECTICUT
DEPARTMENT OF
ENVIRONMENTAL PROTECTION
79 Elm Street
Hartford, CT 06106-5117
(860) 424-5820
Gina McCarthy, Commissioner

Eagleville Brook Watershed



- 2.4 sq miles
- UConn and Town of Mansfield
- No MS4s
- 18% watershed IC

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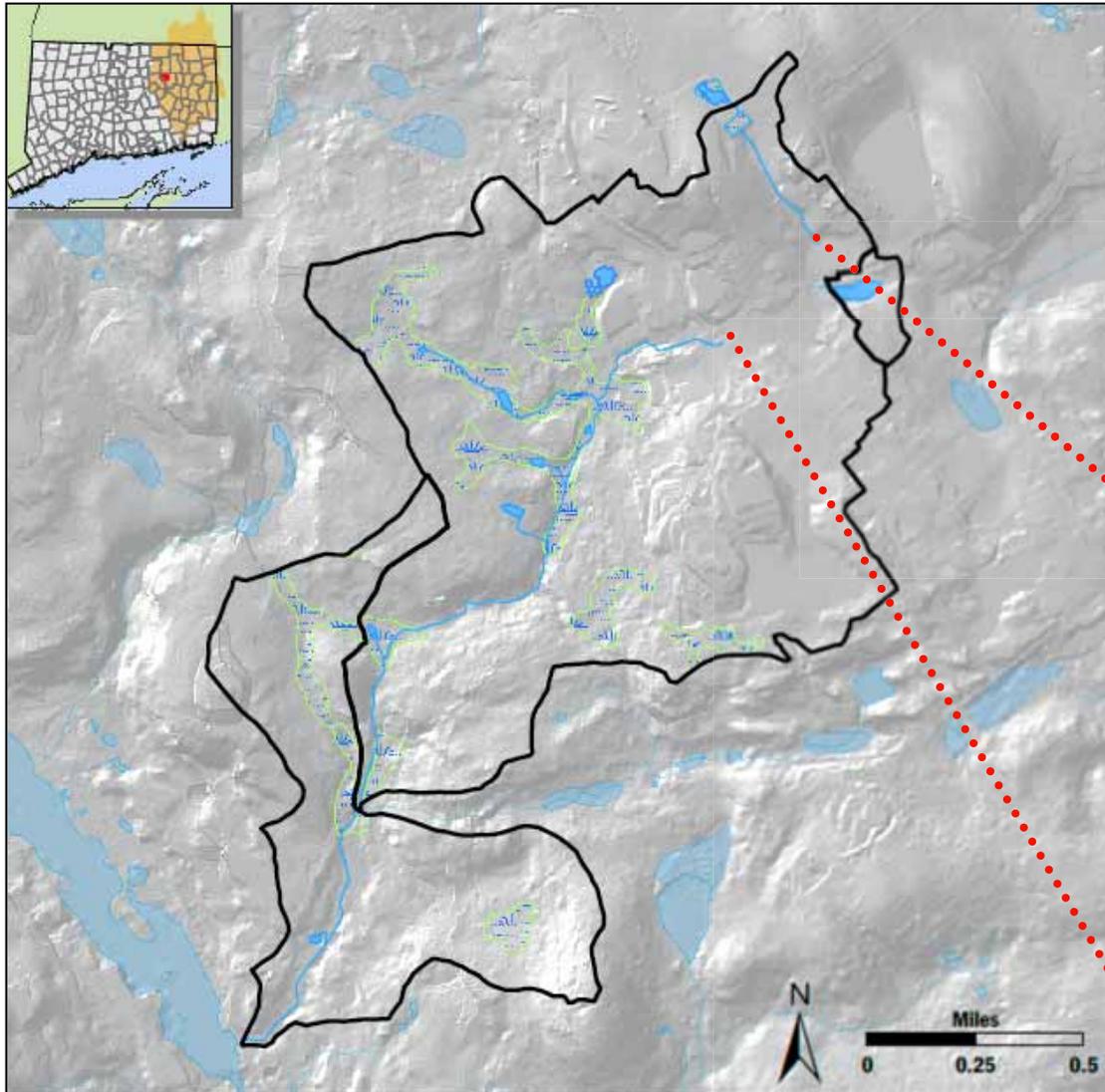


Project Partners

- UConn CLEAR/NEMO
- Center for Watershed Protection
- Horsley & Witten Group
- UConn Architectural & Engineering Services
- UConn Office of Environmental Policy
- CTDEP TMDL & Nonpoint Source Programs
- Town of Mansfield



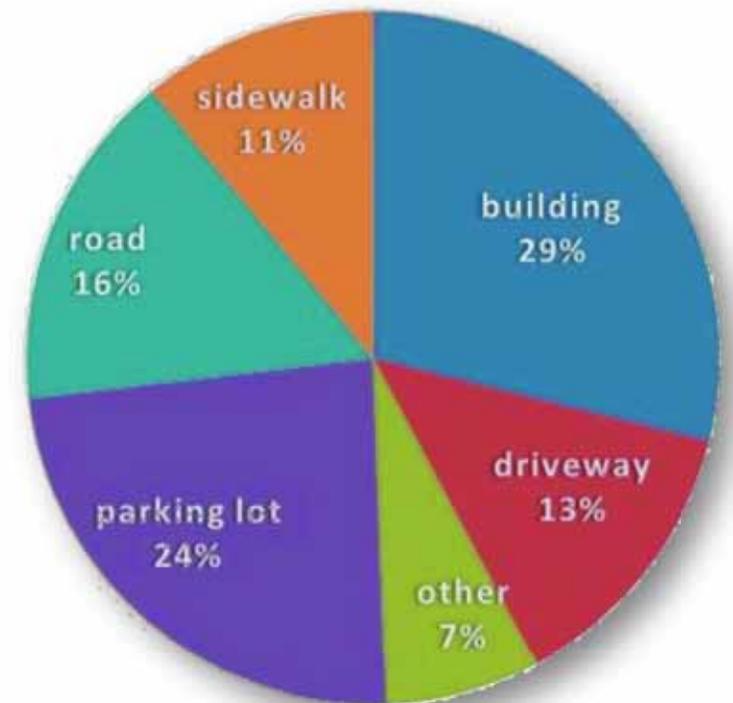
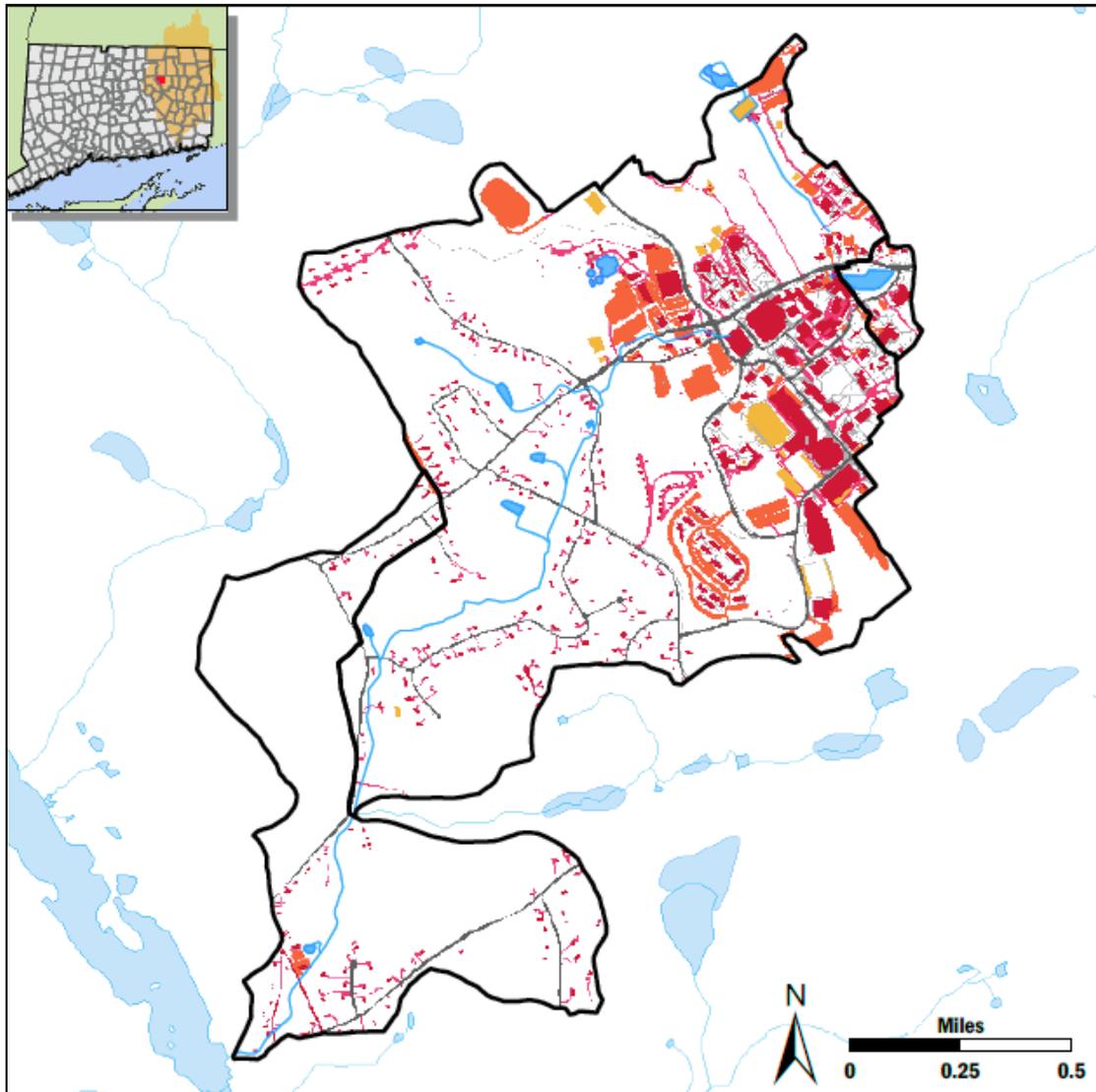
Eagleville Brook watershed



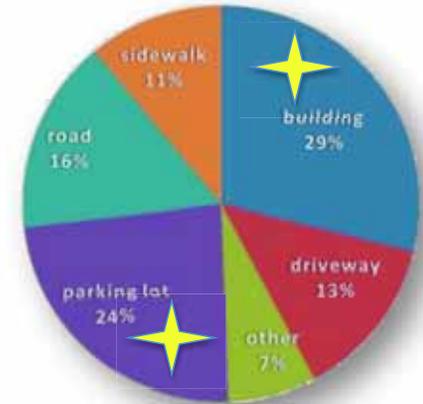
brook runs underground
below much of campus



The many-splendored IC of Eagleville Brook



Center of Campus = Highly Urbanized



Project Goals

Goal *is not* to reduce the % IC in the watershed per se, but to reduce the *impact* of IC through *stormwater management* to levels equivalent to $< 11\%$ IC

The emphasis is on runoff (volume) reduction, but opportunities to improve water quality will not be neglected



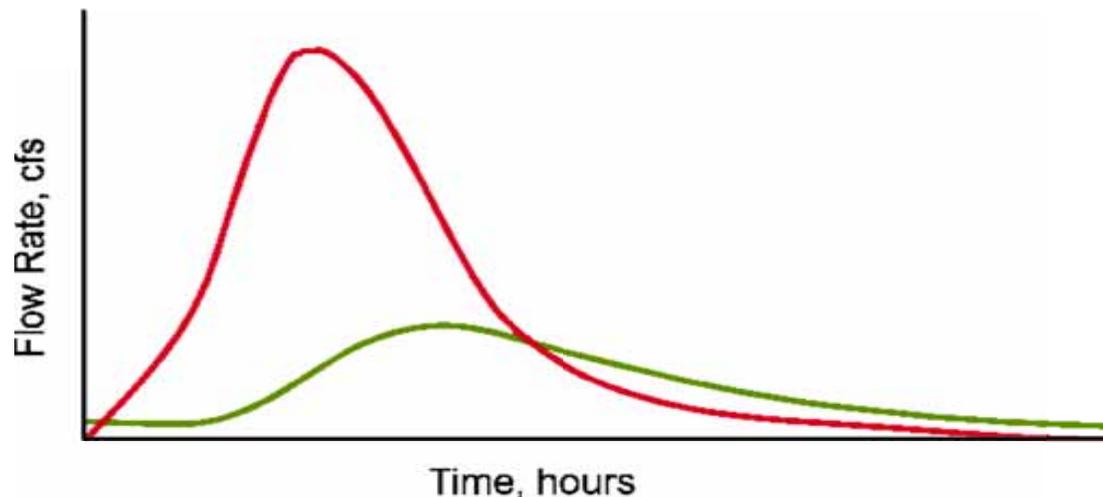
Implementation Strategies



1. Reduce IC where practical
2. Disconnect IC from surface waterbody (e.g., disconnect roofs)
3. Retrofit with distributed stormwater practices (LID) to reduce runoff volumes & improve water quality
4. Increase tree canopy cover and restore permeability of open areas
5. Change plans & regulations to promote use of LID

Low Impact Development (LID)(?)

*A site design strategy intended to maintain or replicate a site's **natural hydrology** systems through the use of **small-scale** controls integrated throughout the site to manage runoff **as close to its source as possible***



Key LID Concepts

- Preserve the pre-development hydrology
- Site-level stormwater control
- Deal with the Water Quality Volume (first 1" of rainfall)
- Minimize disturbance on site
- Use a “treatment train” approach to stormwater
- Maximize travel time
- Treat stormwater as a resource rather than a waste product

Site Level: **Low Impact Development**

- Bioretention
- Rain Gardens
- Vegetated Swales, Buffers, and Filter Strips
- Permeable Pavements
- Rainwater Harvesting
- Green Roofs



But Does it Work??

- Bioretention
- Rain Gardens
- Vegetated Swales, Buffers, and Filter Strips
- Permeable Pavements
- Rainwater Harvesting
- Green Roofs



LID...Connecticut-style

Glen Brook Green (Jordan Cove)
Research/Demo Project



LID Cluster

Conventional

“LID Cluster” subdivision

Low-mow areas

cluster layout

Bioretention cul-de-sac

Rain gardens

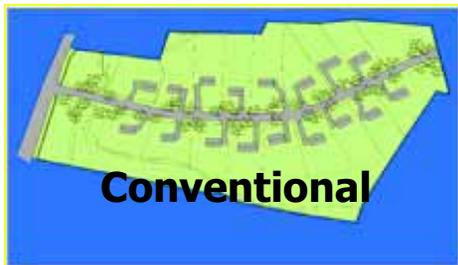
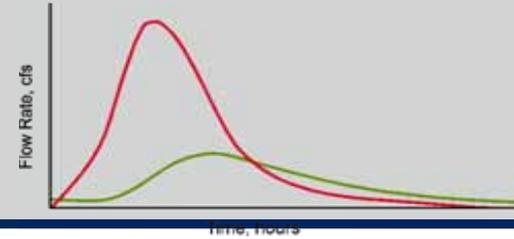
pervious & shared driveways

grassed swales

pervious & narrow road

- 12 lots clustered on 6.9 acres
- Designed to minimize site runoff

Jack Clausen's \$ 1M graph...



Can it be done???

1. Mapping Analysis

- characterizing IC and drainage

2. On-the-Ground Investigations

- characterizing IC and drainage, part 2
- locating retrofit options & opportunities

3. Back at the Desk

- prioritizing projects
- codifying procedures

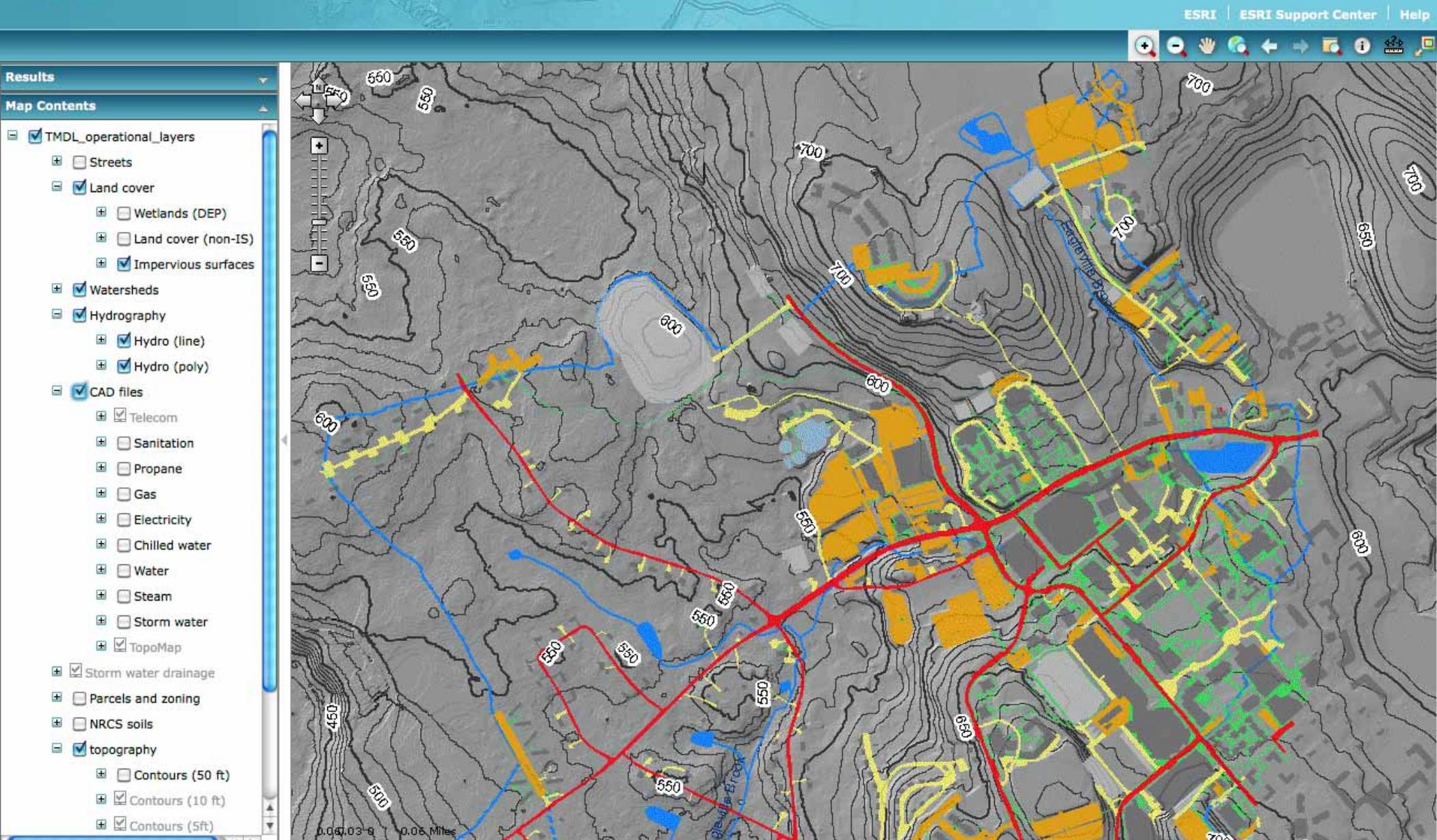
4. Keeping Track

- Is it as easy as it seems?



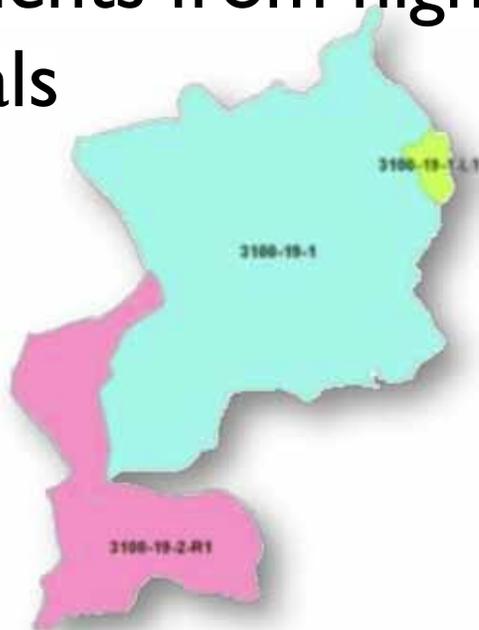
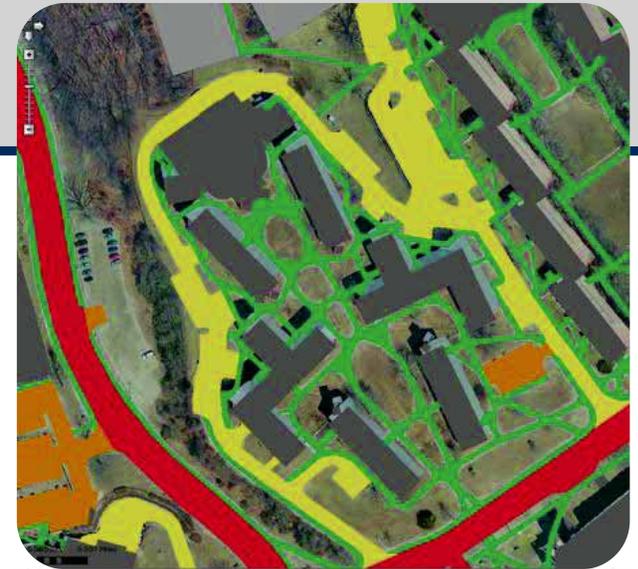
Collection Digital Data for the Watershed

TMDL_v2



Mapping analysis

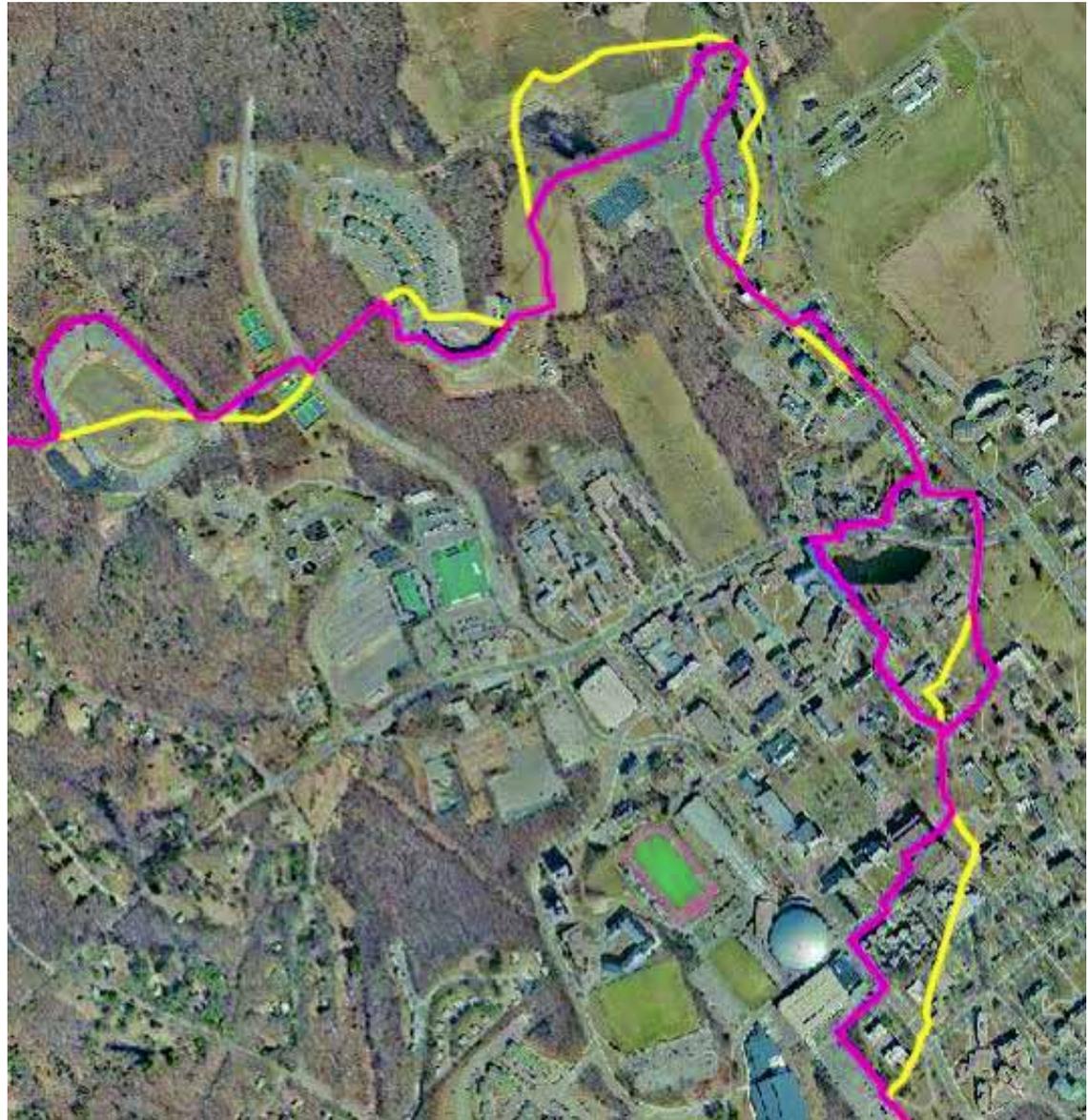
- Original IC estimates based on 2002 ISAT and land use coefficients
- Revised IC based on digitized measurements from high resolution 2008 aerials



BASIN NUMBER	IC Acres	
	TMDL	Direct measure GIS
3100-19-1 (Upper)	126	194
3100-19-1-L1 (Swan Lake)	3.6	6.4
3100-19-2-R1 (Lower)	15.6	14.9

On-the-Ground Investigations: watershed boundary

- Revised watershed boundary based on field verification
- Revisions to boundary changes TMDL drainage area and IC assumptions



Drainage in urban areas is not obvious



On-the-Ground Investigations: disconnected IC

- Identifying “disconnected” IC
 - Drains to pervious area
 - Managed by existing BMP
- 51 acres of IC already disconnected in “upper” subbasin



On-the-Ground Investigations



Eagleville Brook	TMDL Estimate	Desktop Adjusted	Field Adjusted
Watershed DA (ac)	1225 ac	1225 ac	1199 ac
Watershed IC (ac)	145 ac	218 ac	167 ac
Watershed IC (%)	11.80%	17.80%	13.90%
IC to Disconnect (ac)	34 ac	107 ac	35 ac

On-the-Ground Investigations: Opportunities

- Retrofit Assessment
 - **51** sites visited
 - **110** individual retrofits identified
 - **127 IC acres** potentially managed
- Met with UConn planners, researchers, facility managers
- Link with Master Plans and Landscaping

IC-TMDL Strategies

Large surface parking lots

Redesign to make use of bioretention, permeable pavement



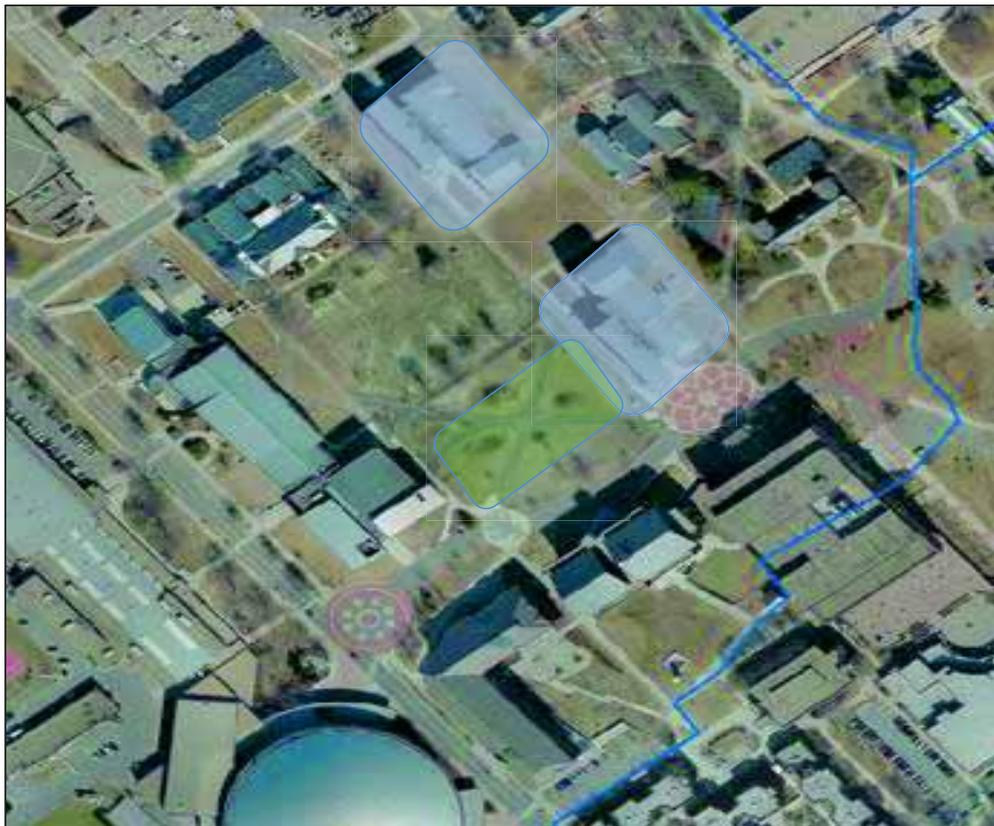
Gettysburg College, Gettysburg, PA



IC-TMDL Strategies

Center campus / academic core

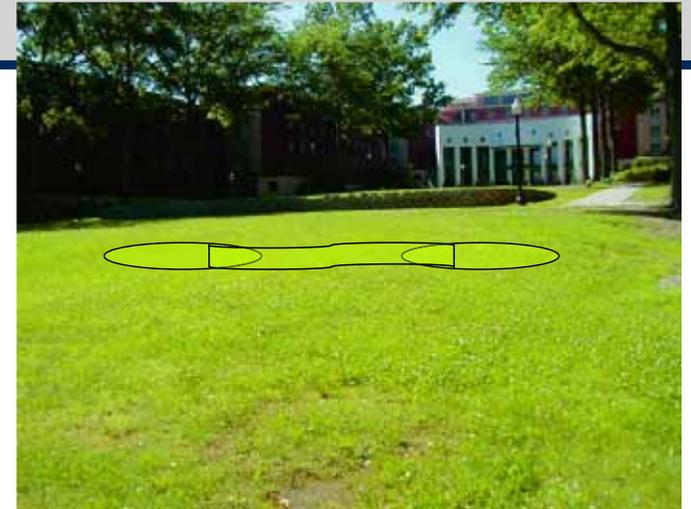
Concentrate on roof runoff using green roofs, cisterns, and rooftop leader disconnects to rain gardens



IC-TMDL Strategies

Dorms/Residence Areas

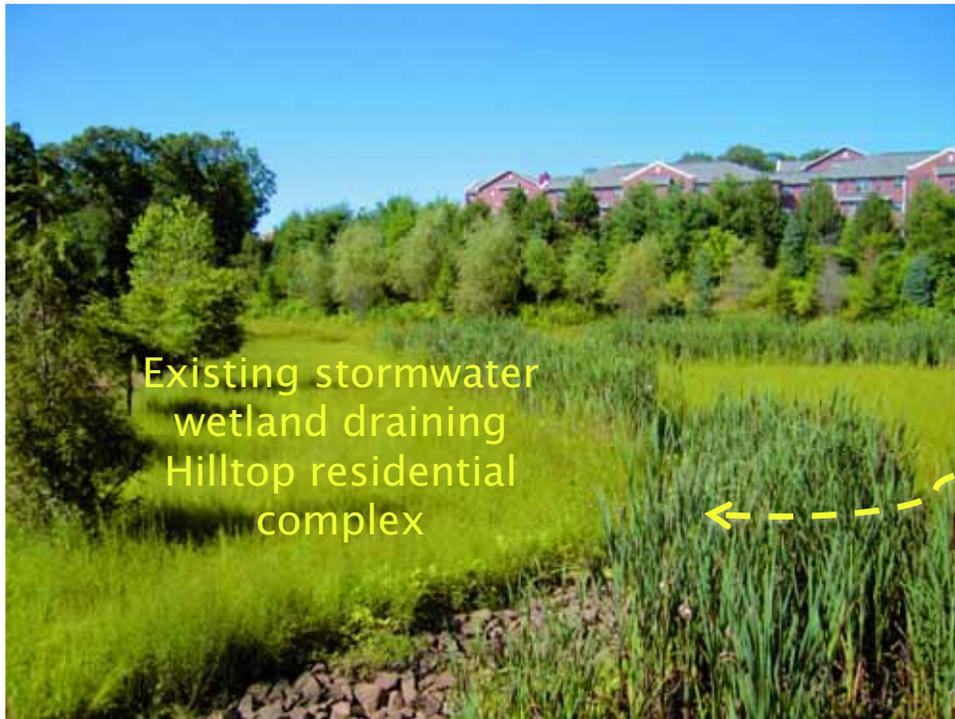
Pervious and/or redesigned walkways, rain garden bioretention, roof leader disconnects



IC-TMDL Strategies

Peripheral areas: athletic complex

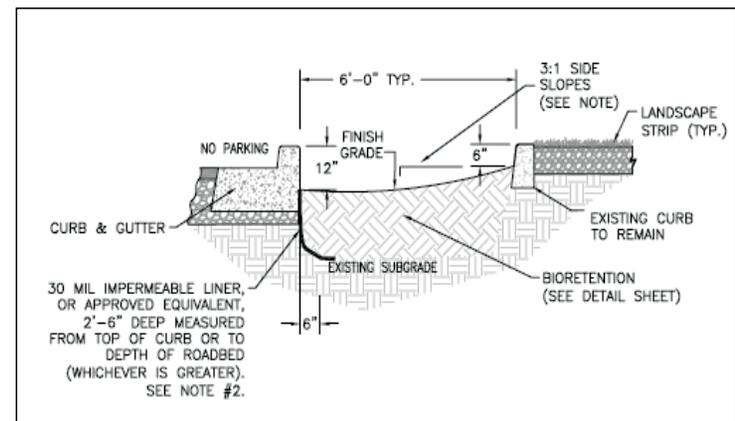
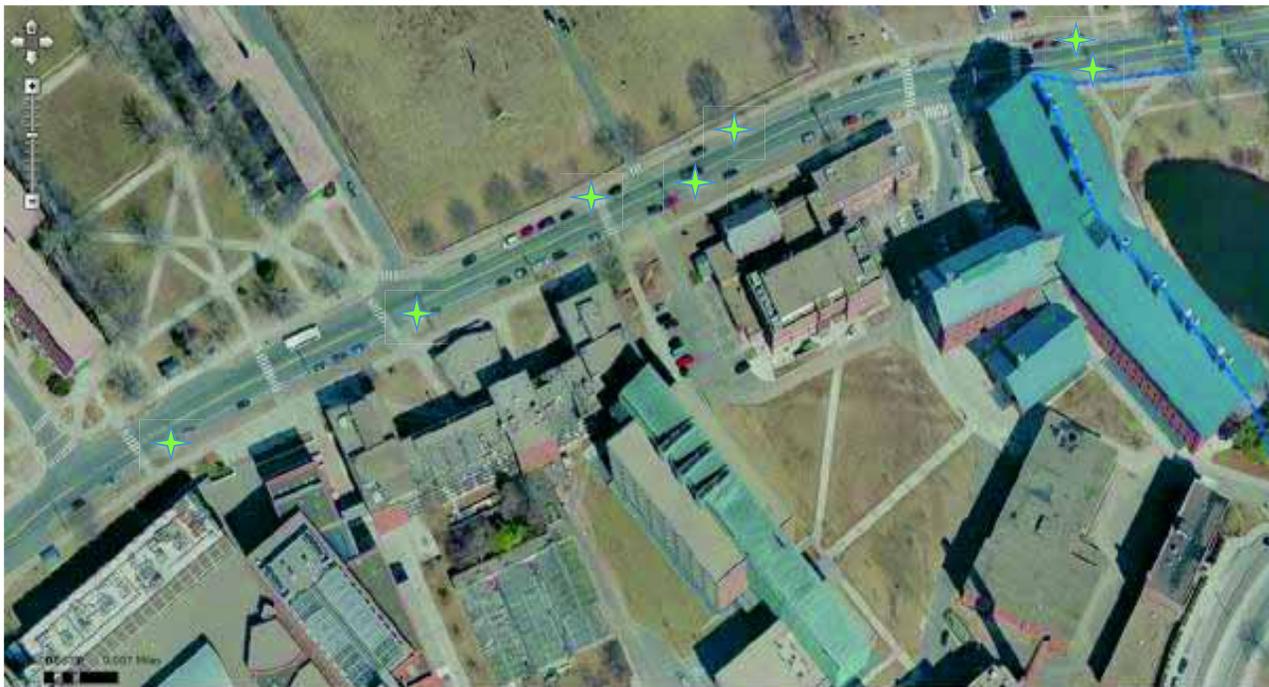
Innovative biological stormwater BMPs to reduce impact of runoff from athletic fields & facilities



IC-TMDL Strategies

Roads

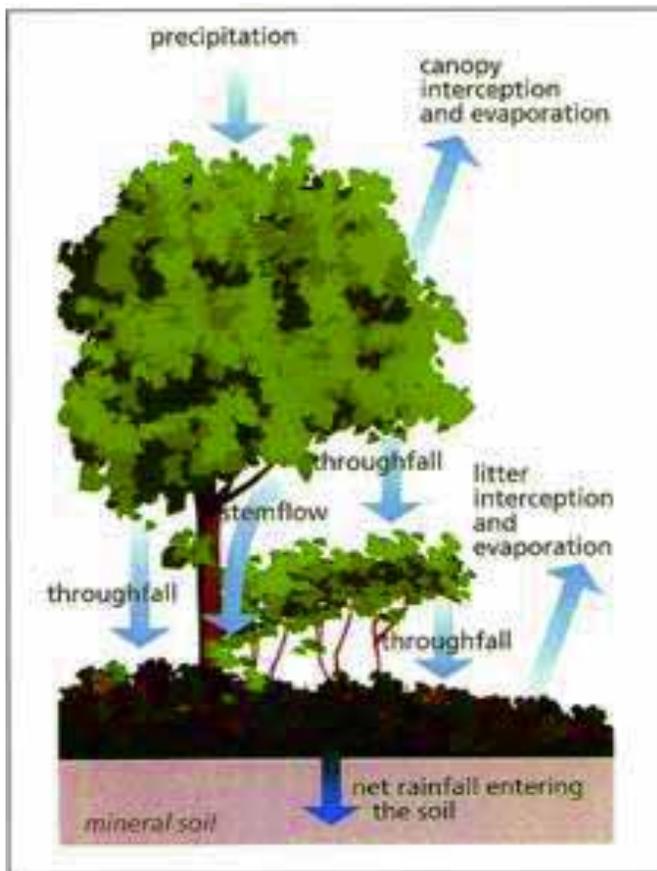
Combine aesthetics, stormwater management & safety with traffic calming & vegetated strips



IC-TMDL Strategies

Campus-wide

Increase tree cover in collaboration with UConn Master Landscape Plan



From draft Landscape Master Plan

Prioritizing Retrofit Opportunities



51 retrofit opportunities analyzed



“Top Ten” opportunities selected



Complete site reports & 25% drawings for Top Ten



Considerations for “Top 10”

- Amount of IC removed / disconnected
- Use of different LID practices
- Locations in various parts of campus
- Retrofits involving different types of development (academic buildings, dorms, parking lots, etc.)
- Education potential
- Feasibility & opportunity (timeline & cost)
- WQ benefits beyond just reduction of volume

Road Map to IC TMDL Implementation

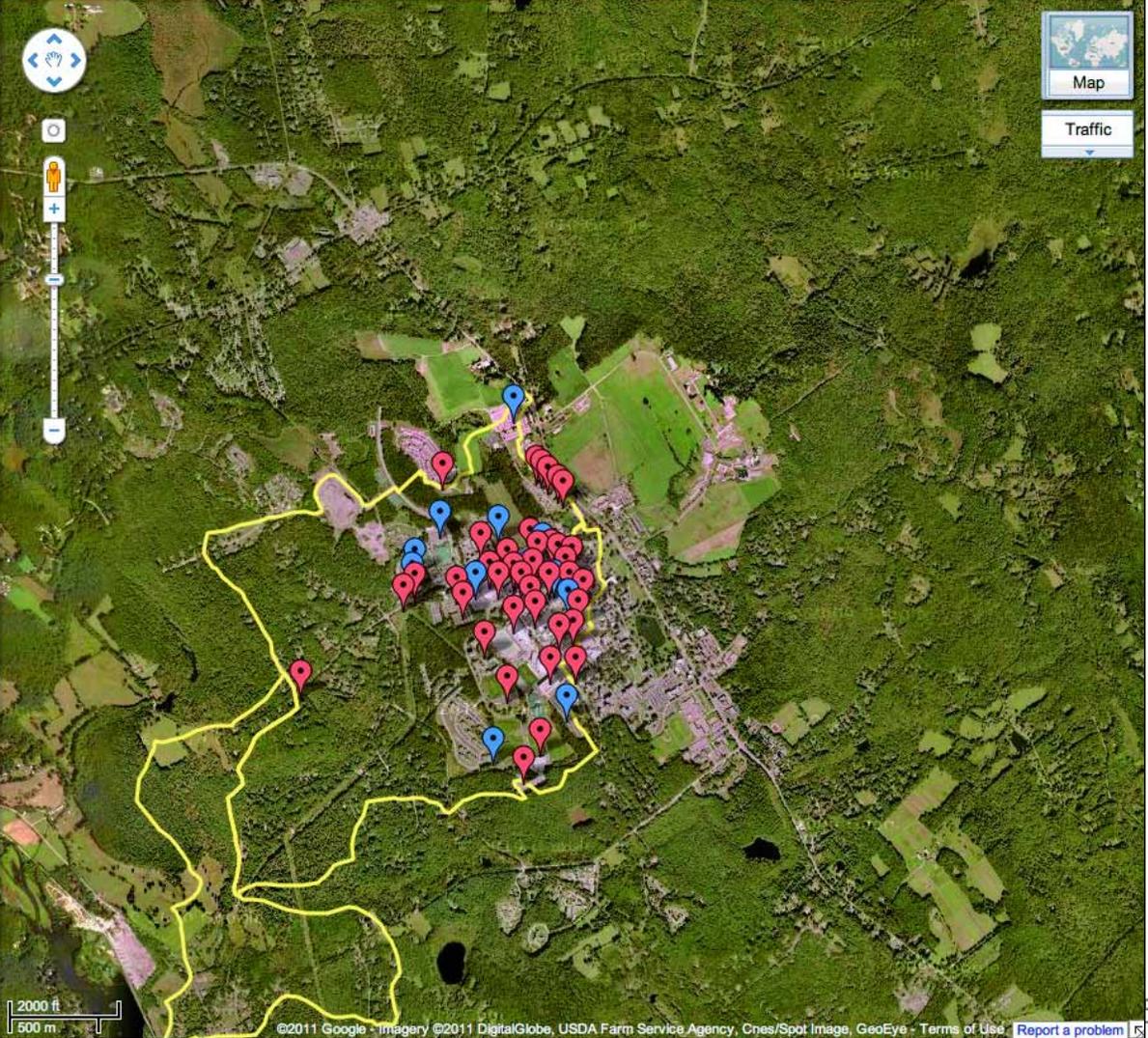
Google maps Search Maps

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[Collaborate](#) Edit

Eagleville TMDL Project Sites
 Results of the IC-TMDL field work. Potential IC reduction/treatment projects on campus, with the top 10 projects selected.
 4,171 views - Public
 Created on Oct 19, 2009 - Updated Sep 9, 2010
 By John - 7 Collaborators
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-  [A3-Terraced Bioretention](#)
Fact Sheet Drawing Field Report
-  [A4-Bioretention](#)
Fact Sheet Drawing Field Report
-  [A5-Sand Filter/Green Roof](#)
Fact Sheet Drawing Field Report
-  [A11-Parking Bioretention](#)
Fact Sheet Drawing Field Report
-  [B3-Gravel Wetlands](#)
Fact Sheet Drawing Field Report
-  [B5-Parking Bioretention](#)
Fact Sheet Drawing Field Report
-  [B11-Parking bioretention](#)
Fact Sheet Drawing Field Report
-  [C4-CUE Rooftop Disconnect/Bioretention](#)
Fact Sheet Drawing Field Report
-  [C5-Gentry Rooftop Disconnect/Bioretention](#)
Fact Sheet Drawing Field Report
-  [C17-Quad by Chemistry Bioretention](#)
Fact Sheet Drawing Field Report
-  [C18-Eagleville Road](#)
Fact Sheet Drawing Field Report
-  [A7-NW Dining Hall](#)
Field Report
-  [A1-Bioretention](#)
Field Report
-  [A2-Wetlands Restoration](#)
Field Report
-  [A6-Rooftop Disconnect/Bioretention](#)
Field Report
-  [A8-Rooftop Disconnect/Bioretention](#)
Field Report



2000 ft
500 m

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The "mashup"

Eagleville TMDL Project Sites
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- B11-Parking bioretention
Fact Sheet Drawing Field Report
- C4-CVE Rooftop Disconnect/Biorentention
Fact Sheet Drawing Field Report
- C5-Gentry Rooftop Disconnect/Biorentention**
Fact Sheet Drawing Field Report
- C17-Quad by Chemistry Bioretention
Fact Sheet Drawing Field Report
- C18-Eagleville Road
Fact Sheet Drawing Field Report
- A7-MW Dining Hall
Field Report
- A1-Biorentention
Field Report
- A2-Wetlands Restoration
Field Report
- A6-Rooftop Disconnect/Biorentention
Field Report

C5-Gentry Rooftop Disconnect/Biorentention
Last Updated by Emily on Aug 13, 2010
Fact Sheet
Drawing
Field Report
Directions Search nearby Save to... more▼

Site C4/5: Education/Gentry Buildings and Sundial Garden

Integrating Stormwater and Landscape Management

Project Summary

Parameter	C4/5a	C4/5b	C4/5c
Impervious Cover	0.12	0.07	0.34
Storage (1000)			
Runoff Reduction	182	101	474
Volume (in 9 per 1" rain event)			
TN Removal (lb/yr)	1.42	0.89	4.17
TP Removal (lb/yr)	0.16	0.1	0.48
TSS Removal (lb/yr)	35.73	22.28	104.88
Estimated Cost	\$11,000	\$1,000	\$13,000

Site Description
The proposed retrofit concept is located on the UConn Campus at the Education and Gentry Buildings. These two buildings are mirrored in design, and are separated by the Sundial Garden quad area.

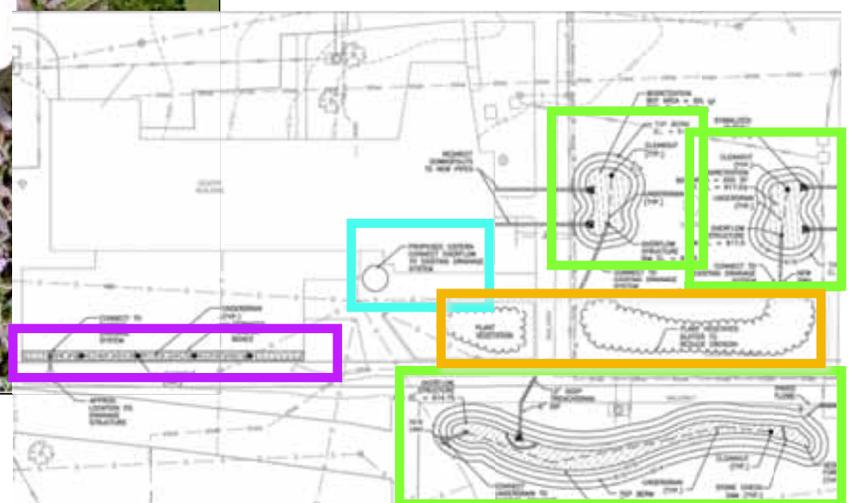
Existing Conditions
The roof leaders from both buildings are directly connected to the storm drain system. The adjacent green space in the Sundial Garden is highly compacted. Across the walkway in the student center quad, the soils are somewhat compacted. Several areas of localized soil erosion were noted.

Proposed Concept
Several retrofit opportunities were identified in each building (Figure 1). The locations of these projects are shown in attachment B:

- C4/5 (a) - Direct the front roof leaders into a new stormwater planter basin.
- C4/5 (b) - Connect the two downspouts near the main building entrances into systems. Water from the drains can be used to water the building landscaping.
- C4/5 (c) - Arrange the soils to create the permeable area in the Sundial Garden and plan trees and a vegetative buffer along the southeast edge of the garden to reduce runoff and soil erosion.
- C4/5 (d) - Direct the two downspouts above the building side entrance into a bioretention area in the Sundial Garden. These bioretention areas can be incorporated into additional landscaping plans for this Garden.

Figure 1. C4/5-1-4/5 Potential locations for stormwater planter basins. (C4/5-1) Potential location for a mirror. (C4/5-2) Comparison in the Sundial Garden area and the proposed location of soil amendments and bioretention. (C4/5-3) Proposed location of larger bioretention project.

Site C4 and C5, Education Building, Gentry Building, and Sundial Garden



REST PERIOD

Questions or comments?

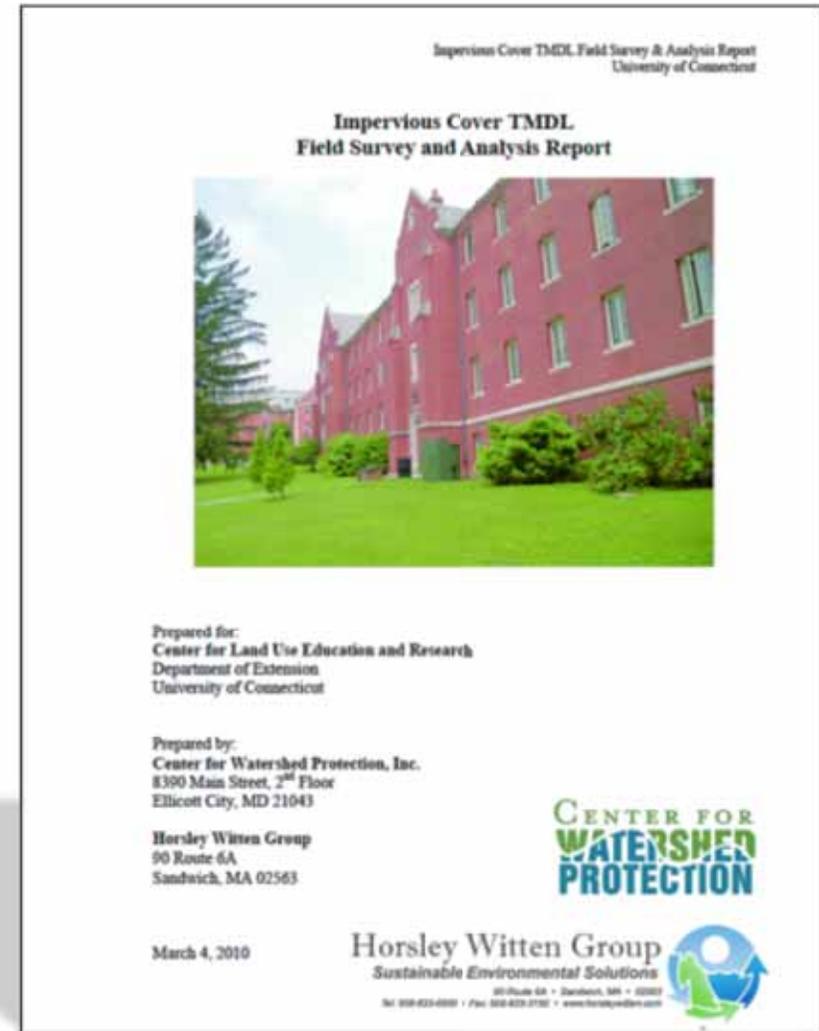
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Project Status

- Technical report is done
- Watershed Based Plan drafted, in review
- Implementation has begun

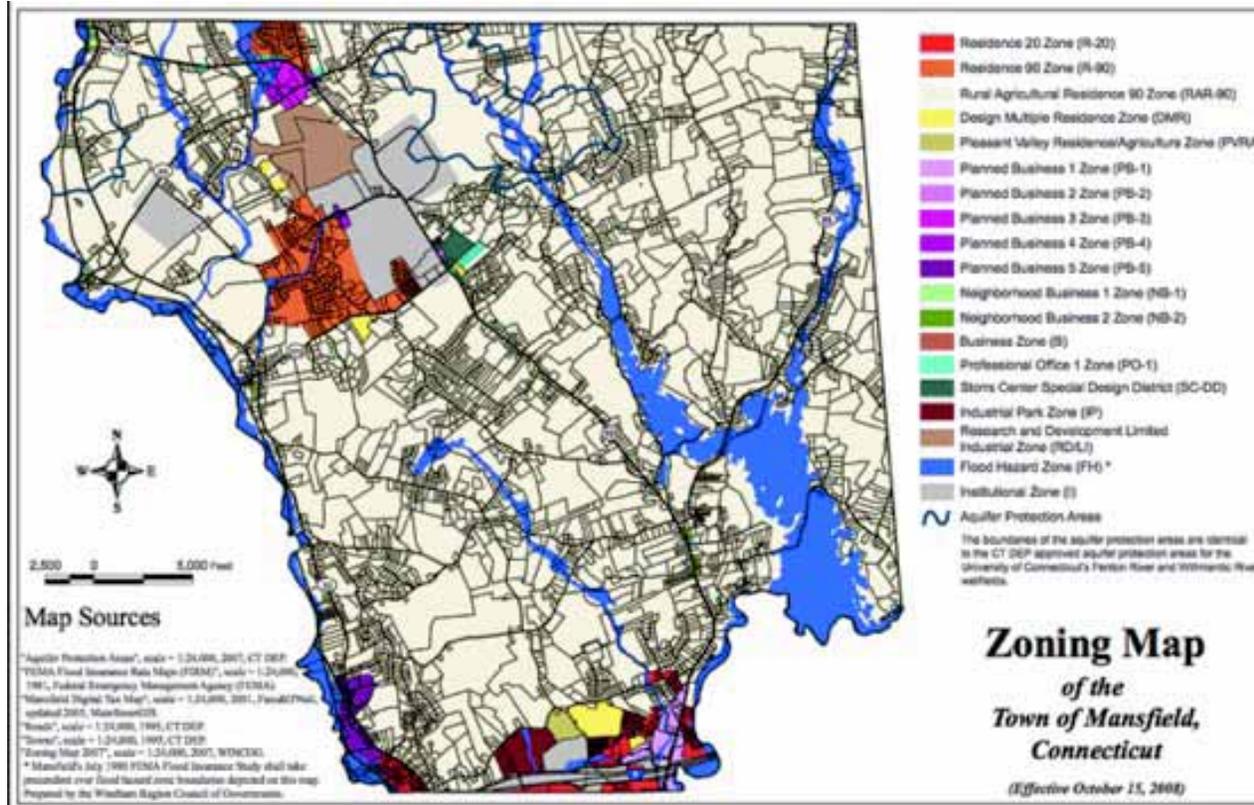


9-Step Watershed-Based Plan



1. Re-emphasize strategies & priorities
2. Provide a single cohesive reference document
3. Create a standard process for incorporating LID
 - use of LID checklist

Next up: Town of Mansfield regulations



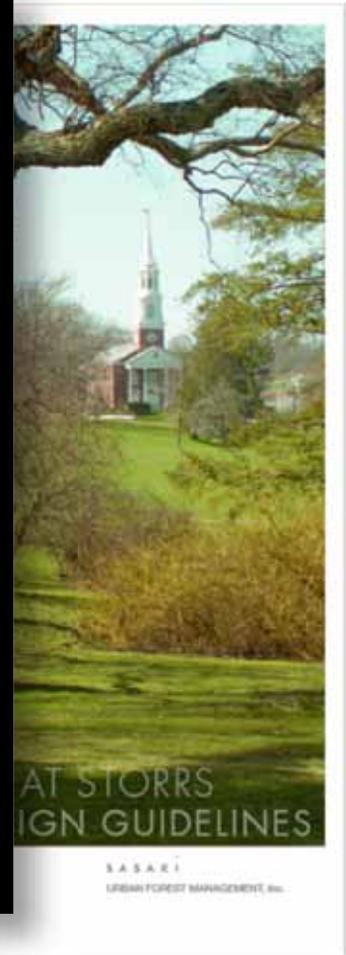
- Insert LID into subdivision, road standards
- Recommend similar LID checklist

Basic Concepts of TMDL Implementation

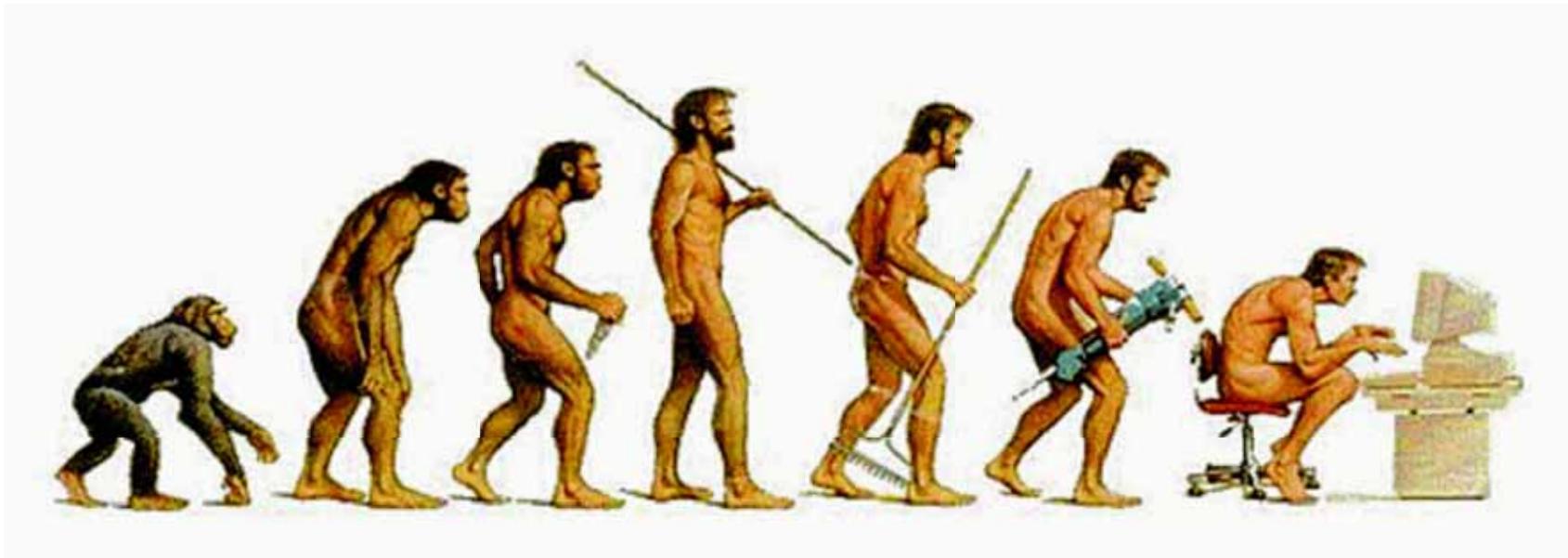
- The goal is to apply implementation concepts to all of campus and town, not just to the Eagleville watershed
- Implementation will be integrated with the Master Plan, Master Landscape Plan, Sustainable Development Guidelines and Master Drainage Plan at Uconn; POCD, regulations and road standards in Mansfield
- Implementation will take place during the course of ongoing UConn and Mansfield activities, as opportunities occur at the site level

The Need for Codifying New Procedures at UConn

The screenshot shows the UConn Office of Environmental Policy website. The header includes the UConn logo and the text "UConn Office of Environmental Policy". Below the header is a navigation bar with four tabs: "Policy Statement", "EPAC", "Green Building", and "Environmental Compliance Office". The "Green Building" tab is selected. On the left side, there is a sidebar with links: "EcoHusky Home", "EcoHusky Students", "Contact Us", "Green Building Homepage", and "Sustainable Development Workgroup". The main content area features the title "Sustainable Design & Construction Policy" in green, followed by a decorative flourish. Below this is the title "The University of Connecticut Sustainable Design and Construction Policy (Adopted March 2007)". The text states: "The University of Connecticut shall plan, design, construct, renovate and maintain sustainable, energy- and water-efficient buildings that:" followed by a bulleted list of three points: 1. Yield cost savings through lowered lifetime operating costs, 2. Provide enhanced learning atmospheres for students and healthier environments for all building occupants and visitors, and 3. Realize the University's commitment to responsible growth and environmental stewardship. The text concludes with: "Accordingly, for any building construction or renovation project entering the pre-design planning phase, and whenever the estimated total project cost exceeds \$5 million, excluding the cost of equipment other than building systems, the University shall establish the Leadership in Energy & Environmental Design (LEED) Silver rating as a minimum performance requirement. The University shall comply with all applicable LEED protocols, including registering the project with the US Green Building Council at the beginning of the design phase and applying for LEED certification at project completion."



Progress (?)



Field House Porous Concrete Parking Lot



Field House Porous Concrete Parking Lot



Maintenance Guide for Field House Parking Lot

Uconn Project No.: 901318-D
BL Companies Project No.: 08c2926-006

Introduction

Maintenance and care of the porous concrete lot is key to its longevity. Routine cleanings of the Field House parking lot will ensure that pore obstruction is minimized, allowing higher rates of infiltration and better overall performance of the lot's hydrology. Additionally, regular monitoring should be implemented to evaluate the impact of the weather, wear on the condition of the porous pavement structure and its effectiveness as a drainage media.

The following shall serve as maintenance guidelines for University of Connecticut Facilities and staff.

Towers Apartments Porous Asphalt Parking Lot



Northwoods Apartments



Rain gardens
for all roofs



Porous concrete
parking stalls

Green Roof



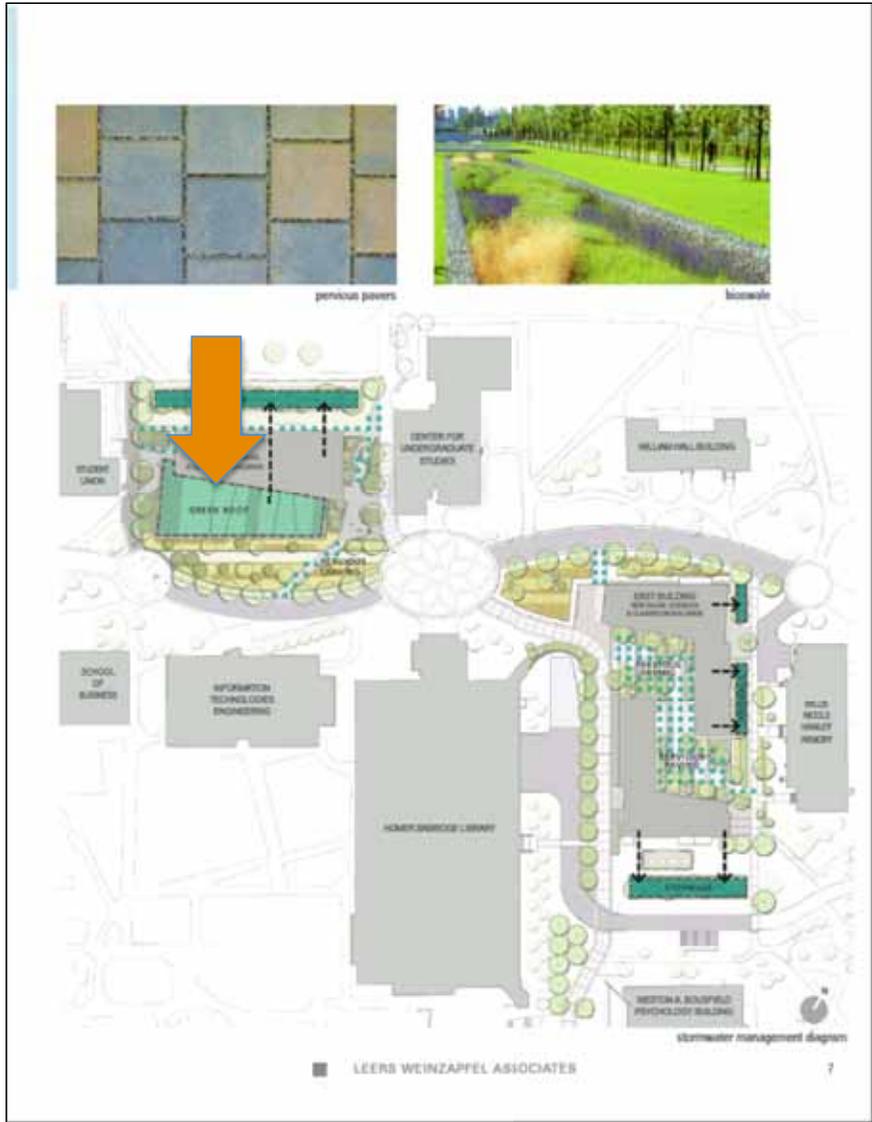
In process...



Sustainable Design Principles

University of Connecticut
New Social Sciences & Classroom Buildings
February 11, 2009

LEERS WEINZAPFEL ASSOCIATES



On the drawing board

Web Images Videos **Maps** News Shopping Gmail more - Sign in

Google maps

Get Directions My Maps RSS View in Google Earth Print Send Link

0/11 Eagleville TMDL Project Sites

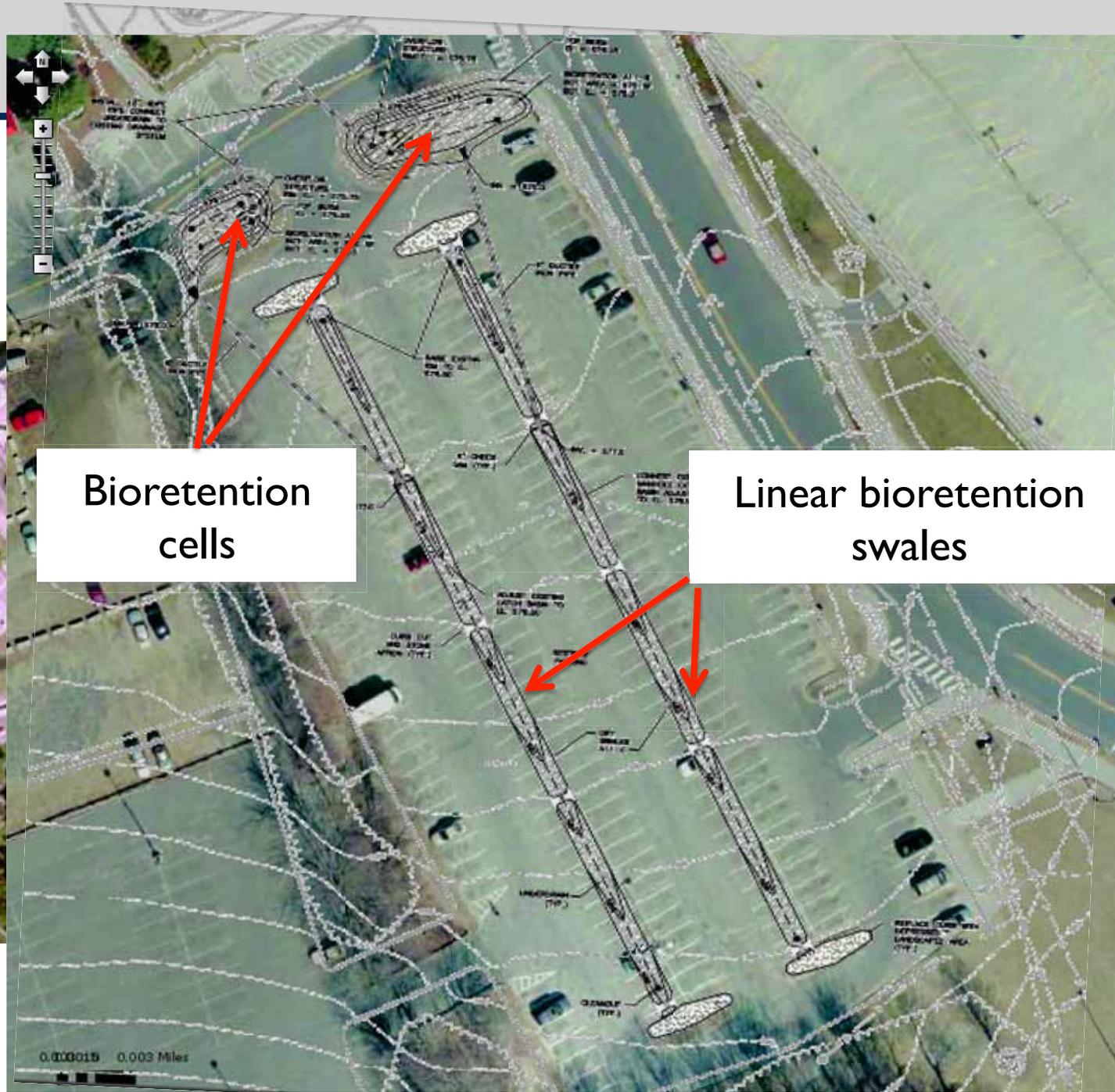
Results of the IC-TMDL field work. Potential IC reduction/treatment projects on campus, with the top 10 projects selected.

4,125 views - Public
Created on Oct 19, 2009 - Updated Sep 9, 2010
By John - 7 Collaborators
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- 📍 [A3-Terraced Bioretention](#)
Fact Sheet Drawing Field Report
- 📍 [A4-Bioretention](#)
Fact Sheet Drawing Field Report
- 📍 [A5-Sand Filter/Green Roof](#)
Fact Sheet Drawing Field Report
- 📍 [A11-Parking Bioretention](#)
Fact Sheet Drawing Field Report
- 📍 [B3-Gravel Wetlands](#)
Fact Sheet Drawing Field Report
- 📍 [B5-Parking Bioretention](#)
Fact Sheet Drawing Field Report
- 📍 [B11-Parking bioretention](#)
Fact Sheet Drawing Field Report
- 📍 [C4-CUE Rooftop Disconnect/Bioretention](#)
Fact Sheet Drawing Field Report
- 📍 [C5-Gentry Rooftop Disconnect/Bioretention](#)
Fact Sheet Drawing Field Report
- 📍 [C17-Quaid by Chemistry Bioretention](#)
Fact Sheet Drawing Field Report
- 📍 [C18-Eagleville Road](#)
Fact Sheet Drawing Field Report
- 📍 [A7-NW Dining Hall](#)
Field Report
- 📍 [A1-Bioretention](#)
Field Report
- 📍 [A2-Wetlands Restoration](#)
Field Report
- 📍 [A6-Rooftop Disconnect/Bioretention](#)
Field Report
- 📍 [A8-Rooftop Disconnect/Porous Pavement/Bioretention](#)
Field Report
- 📍 [A9-Porous Pavement](#)
Field Report
- 📍 [A10-Parking Bioretention/Bioswale](#)
Field Report

The map displays an aerial view of the University of Connecticut campus. Numerous project sites are marked with pins: blue pins for projects A3 through C18, and red pins for projects A1 through A10. A prominent blue line highlights Eagleville Road, which is also listed in the legend. Three orange arrows point to specific locations on the map: one points to a blue pin in the upper right quadrant, another points to a blue pin in the center, and a third points to a blue pin in the lower right quadrant.

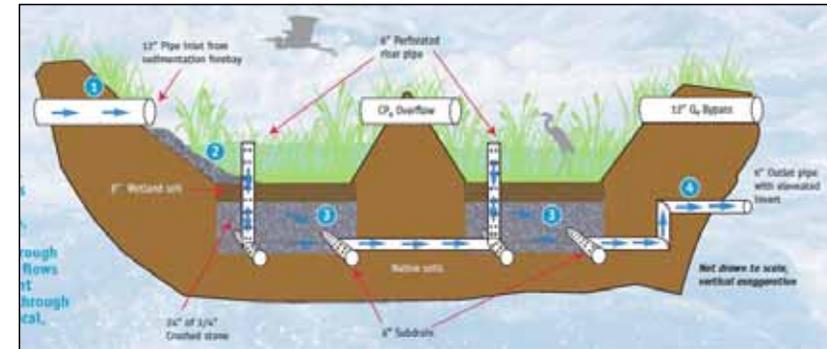
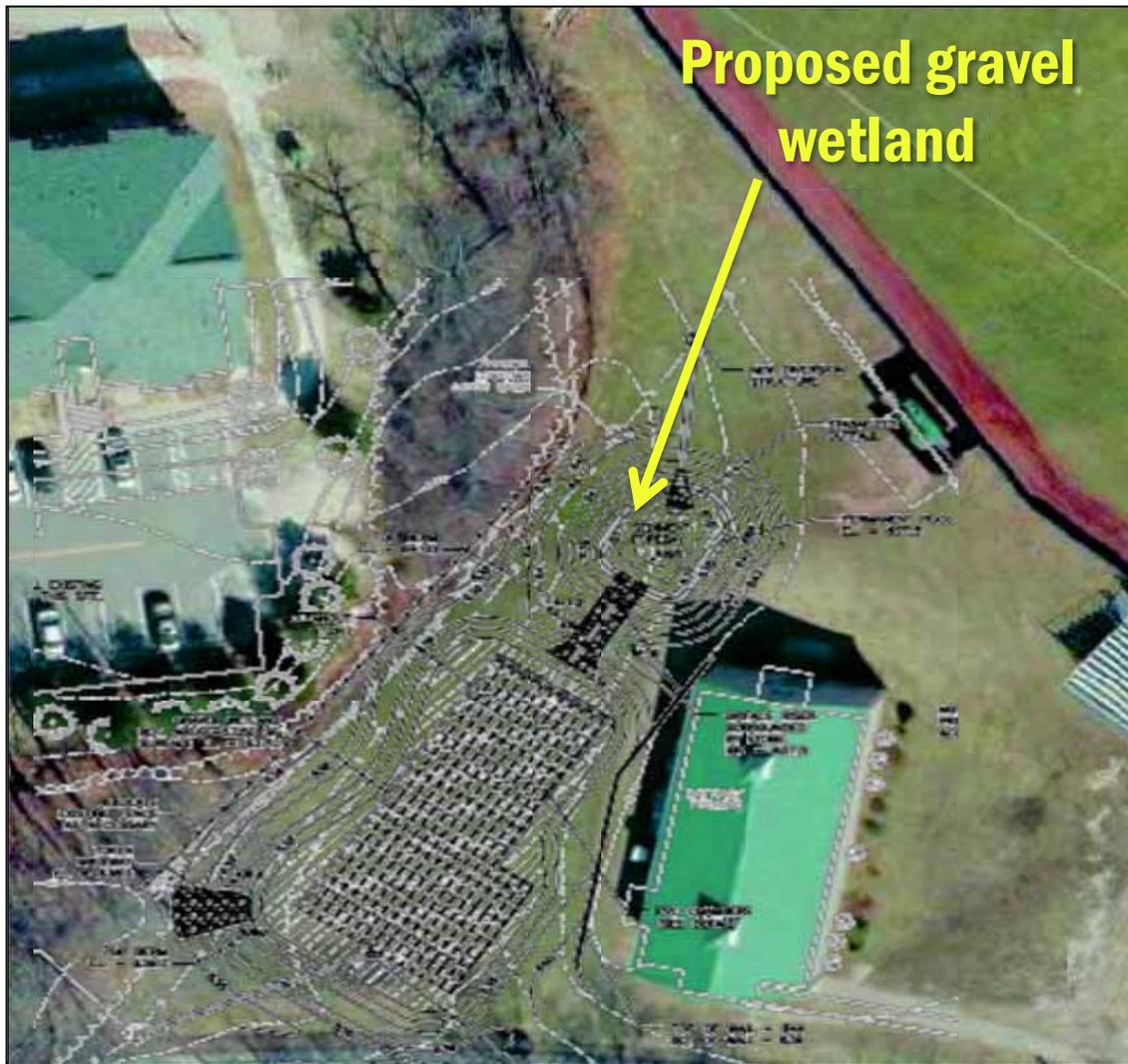
Lot 9



Bioretention cells

Linear bioretention swales

Athletic Complex – Gravel Wetland



"The gravel wetland does an exceptional job of removing nearly all of the pollutants commonly associated with stormwater treatment"
Univ. of New Hampshire Stormwater Center



Today s Tale

- Development of the IC-TMDL
- The project: technical work
- The project: implementation & progress
- **Tracking progress**
- Is it working?



Tracking Progress

Tracking progress is not as easy as it seems.



Tracking Progress

1. Impervious Cover Mitigation

IC reduced (pervious lots)

IC disconnected (bioretention)

2. Volume Reduction

Stream volume monitoring at downstream weir

Runoff reduction estimates in report

Possible runoff reduction modeling by UConn Engineering Dept.

3. Beyond Volume & Cover

Water quality projects (gravel wetland, source reduction)

Rehabilitate & plant trees

Rehabilitate soils

Restore stream buffers

4. Back to the Bottom Line: Bugs

Adding up the acres

Table 2. Estimated progress toward the TMDL target of 11% impervious cover if the recommended retrofits were implemented.

Estimated Result of Retrofit Implementation						
Sites	Drainage Area Treated, km ² (acres)	Impervious Area Treated, km ² (acres)	Watershed IC after Implementation km ² (acres)	Target IC (11% of watershed), km ² (acres)	Watershed IC after Implementation (%)	Estimated Cost (\$)
Top Ten Retrofit Sites	0.30 (74)	0.13 (32)	0.54 (133)	0.53 (132)	11.1%	\$1,350,000
All 51 Retrofit Sites	0.47 (115)	0.25 (61)	0.42 (104)	0.53 (132)	8.7%	\$5,800,000

Notes: The Top Ten retrofits bring the watershed to 11.1% impervious cover, essentially in compliance with the target; implementing all 51 retrofits would far exceed the target, reducing impervious cover to just over 3%. These estimates do not factor in new impervious cover added with additional building or renovations. IC, impervious cover.

Estimated Benefits after Implementation

Sites	Watershed IC	Runoff Reduced (CF)	TN (lb/yr)	TP (lb/yr)	TSS (tons/yr)
Top 10 Retrofit Sites	11.1%	797,600	207.5	37.5	3.2
All 51 Retrofit Sites	8.7%	2,494,150	521.5	72.4	7.5

Tracking Progress

Accounting Issues

1. Is it OK to take already disconnected IC off the table?



Tracking Progress

Accounting Issues

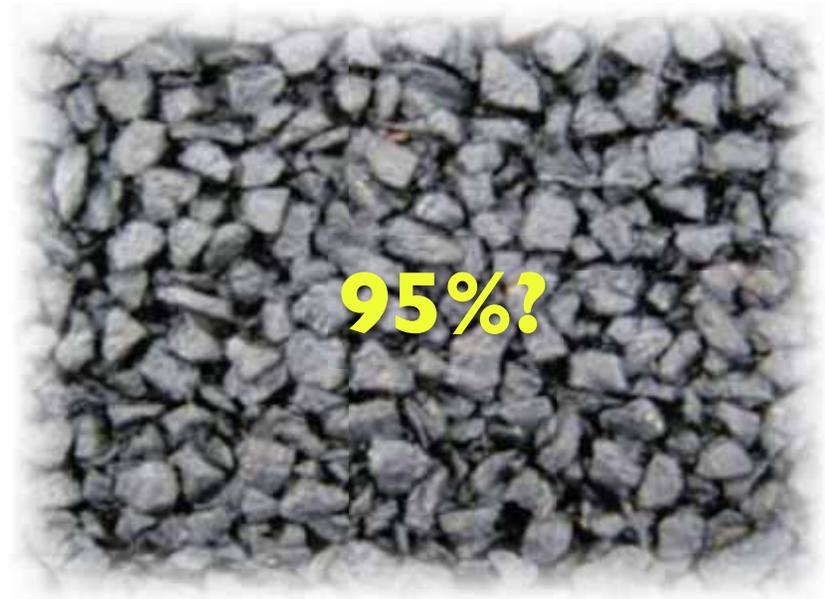
2. What's "pervious," and how does that fit into the picture?



Tracking Progress

Accounting Issues

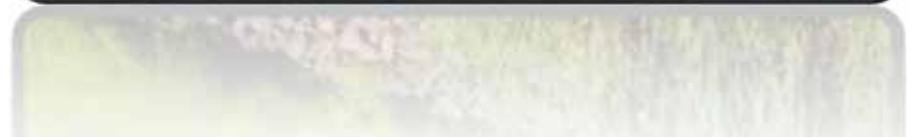
3. *How do we give credit for “partial” IC disconnection?
(We account for it in the volume estimates, but not the IC estimates).*



Tracking Progress

Accounting Issues

4. *How do we give credit for water quality practices that have no real effect on water quantity / disconnection?*



Tracking Progress

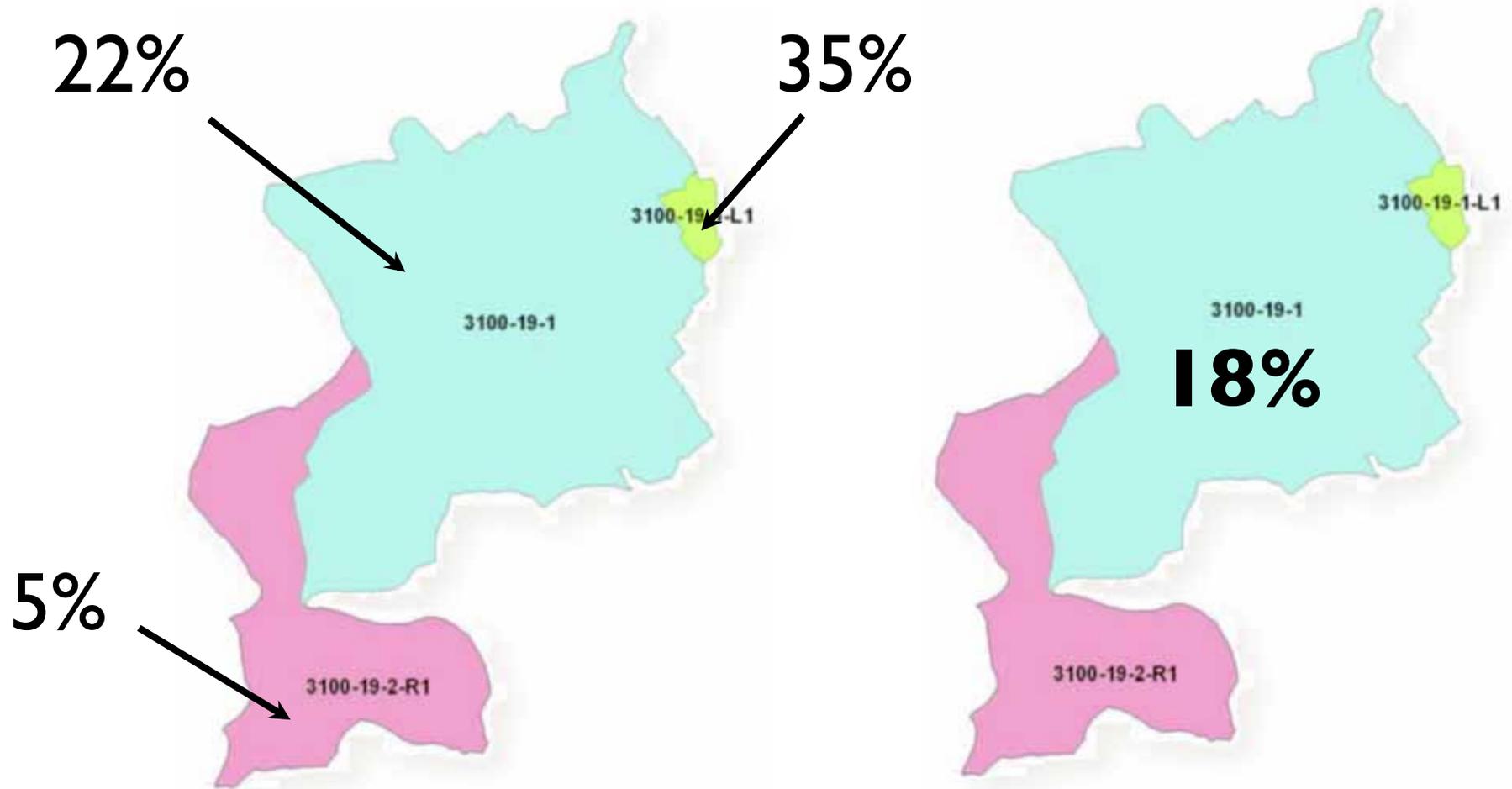
Beyond IC acres: monitoring weir



- Collaboration with Jack Clausen in NRE at UConn
- Real-time equipment just installed

Remaining Questions

What watershed scale is appropriate for an IC-TMDL?



(corrected numbers, before subtracting disconnected IC)

Important considerations/lessons



Importance of Field Work

1. There were discrepancies between actual IC and TMDL estimates
2. Field verification resulted in re-drawing of watershed boundaries
3. You gotta look in a lot of manholes to track urban drainage
4. Determining connected vs disconnected impervious area can be difficult

Important considerations/lessons

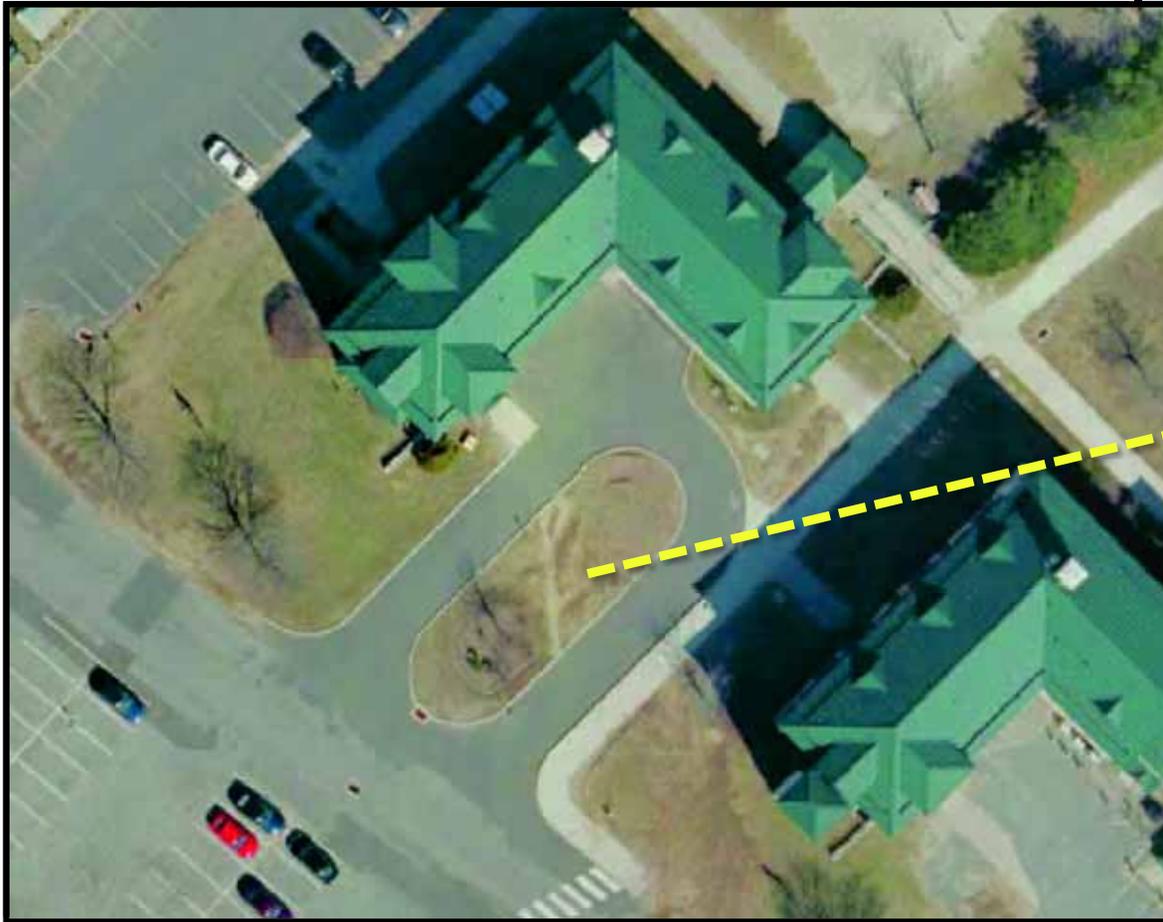


Doing Stuff

1. It's challenging to find feasible, cost-effective retrofits in dense campus (urban) setting
2. An opportunistic approach is more likely to get things done than a rigid list and schedule
3. Make friends with (and educate) your local landscape architects
4. A simple checklist can be a powerful tool to promote LID, by putting the burden of proof on applicants

Important considerations/lessons

Sticking with the learning curve



A quick fix during the field survey



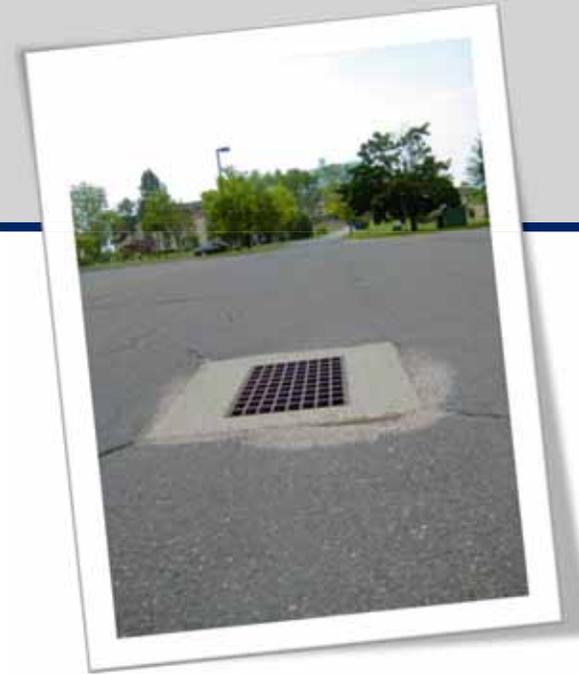
Today s Tale

- Development of the IC-TMDL
- The project: technical work
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- Tracking progress
- **Is it working?**



Coming to a watershed near you soon!

- TMDLs
- NPDES Stormwater permits



“A more straightforward way to regulate stormwater contributions to waterbody impairment would be to use flow or a surrogate, like impervious cover, as a measure of stormwater loading.”

National Academy of Sciences Report (2009)

(Final tentative, interim, provisional conclusion)

Yes, it's working...

(so far)



clear.uconn.edu/projects/tmdl

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Impervious Cover TMDL

Total Maximum Daily Load (TMDL) Project in Connecticut's EAGLEVILLE BROOK WATERSHED

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The Eagleville Brook Impervious Cover TMDL

[TMDL HOME](#)

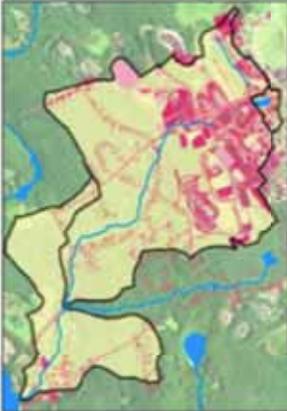
[THE PROJECT](#)

[THE WATERSHED](#)

[FINDINGS](#)

[PROGRESS](#)

[LIBRARY](#)



In 2007, the Connecticut Department of Environmental Protection issued the first total maximum daily load (TMDL) in the country based on impervious cover (IC).

What does an "IC-TMDL" mean, and how does one respond to it? This website describes a project designed to answer these questions.

The **Watershed** section includes some basic watershed maps in PDF format and an interactive web map, giving you access to baseline information.

The **Findings** section includes a Google Maps "mashup," with information on the project's recommended retrofit sites and the field data and suggested stormwater practices for each site.

The **Progress** section contains documentation of plans and practices created in response to the IC-TMDL.

The **Library** is a multimedia collection of articles, photos, and videos related to the project.



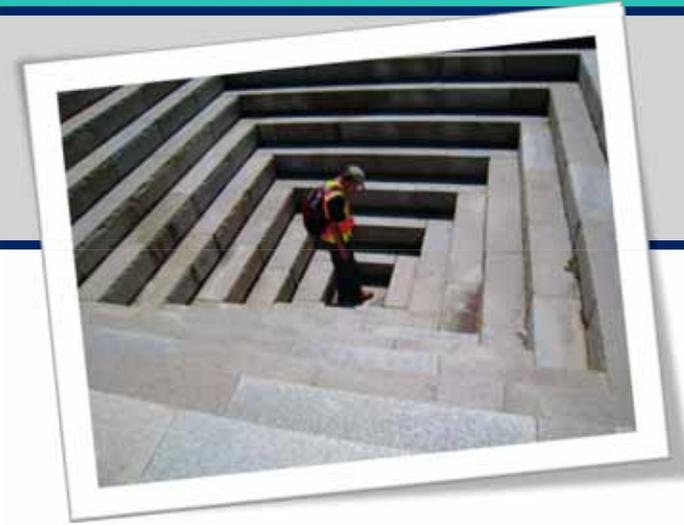


The IC-TMDL Project is a partnership of the Connecticut Department of Environmental Protection (CTDEP), the University of Connecticut, and the Town of Mansfield, CT. Major funding has been provided by CTDEP's Clean Water Act Section 319 Nonpoint Source Program and the University of Connecticut. The Town of Mansfield has also provided funding.

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Contact CT MEMO
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 Email: nemo@uconn.edu

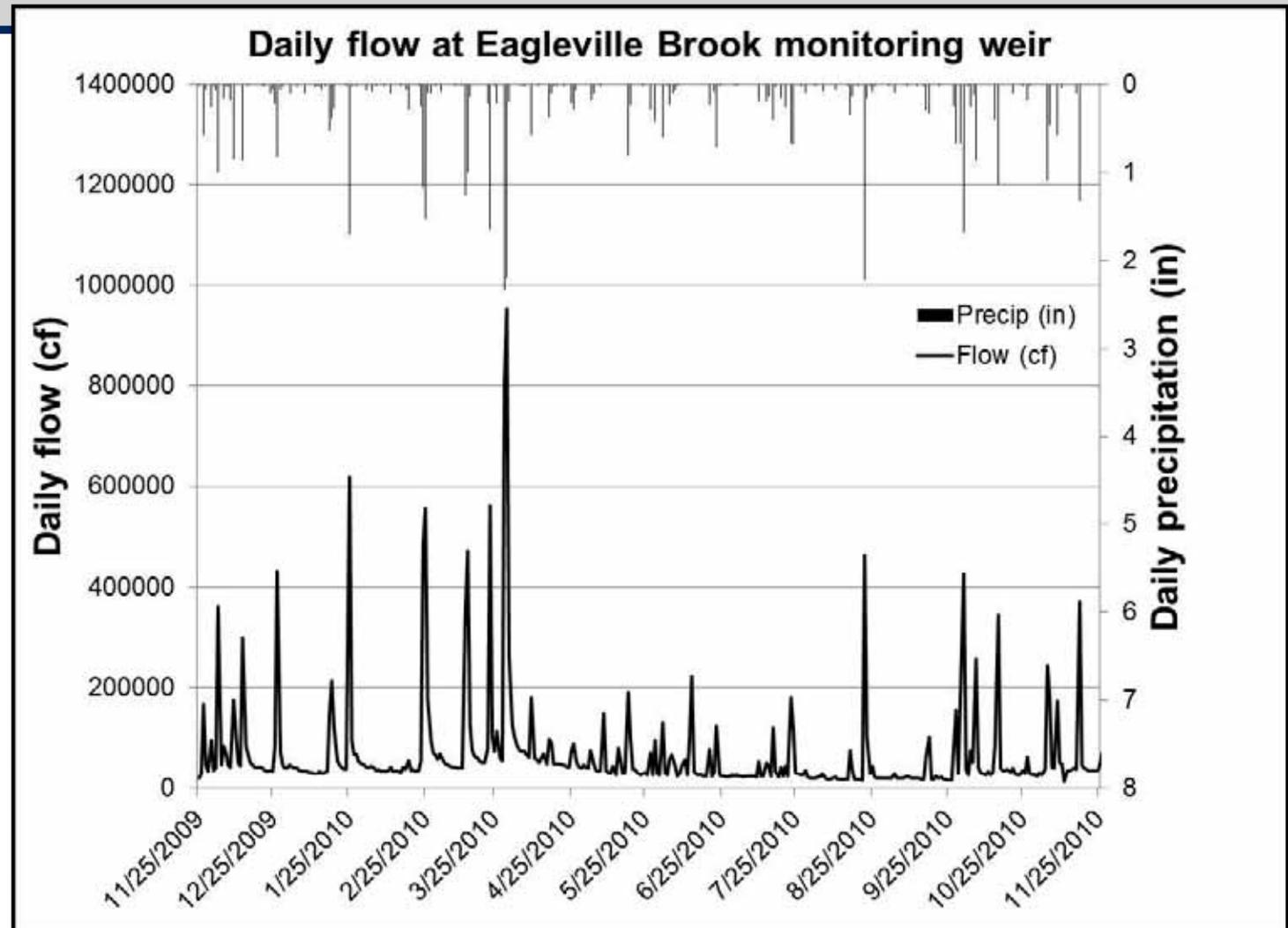
Important considerations/lessons



Keeping Track

1. Acres of IC disconnected ain't perfect, but is a good usable interim metric
2. That said, there are a lot of gray areas about determining disconnection (what's pervious? How much is disconnected?)
3. Who will keep track of long-term (hydrologic, biological) impacts?

One year of flow data



- Runoff coefficient = **0.72**
- Watershed of weir has 48% IC