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




Rhode Island Land & Water Conservation Summit

March 26, 2011

CLEAR

University of Connecticut
College of Agriculture and Natural Resources

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**

University of Connecticut
College of Agriculture and Natural Resources

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

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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

Probable Source	Probable Source Group	Miles Threatened or Impaired
Source Unknown	Unknown	766.0
Unspecified Urban Stormwater	Urban-Related Runoff/Stormwater	222.2
Municipal Point Source Discharges	Municipal Dishcarges/Sewage	130.5
Sources Outside State Jurisdiction Or Borders	Other	106.6
Industrial Point Source Discharge	Industrial	105.3
Combined Sewer Overflows	Municipal Dishcarges/Sewage	78.6
Illicit Connections/Hook-Ups To Storm Sewers	Municipal Dishcarges/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 Dishcarges/Sewage	46.5
Agriculture		
Impacts From Hydrostructure F Regulation/Modification		
Upstream Impoundments (E.G. Structures)	Hydromodification	41.1
Channelization	Hydromodification	39.4
Site Clearance (Land Developme Redevelopment)		
Baseflow Depletion From Groun Withdrawals	Hydromodification	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

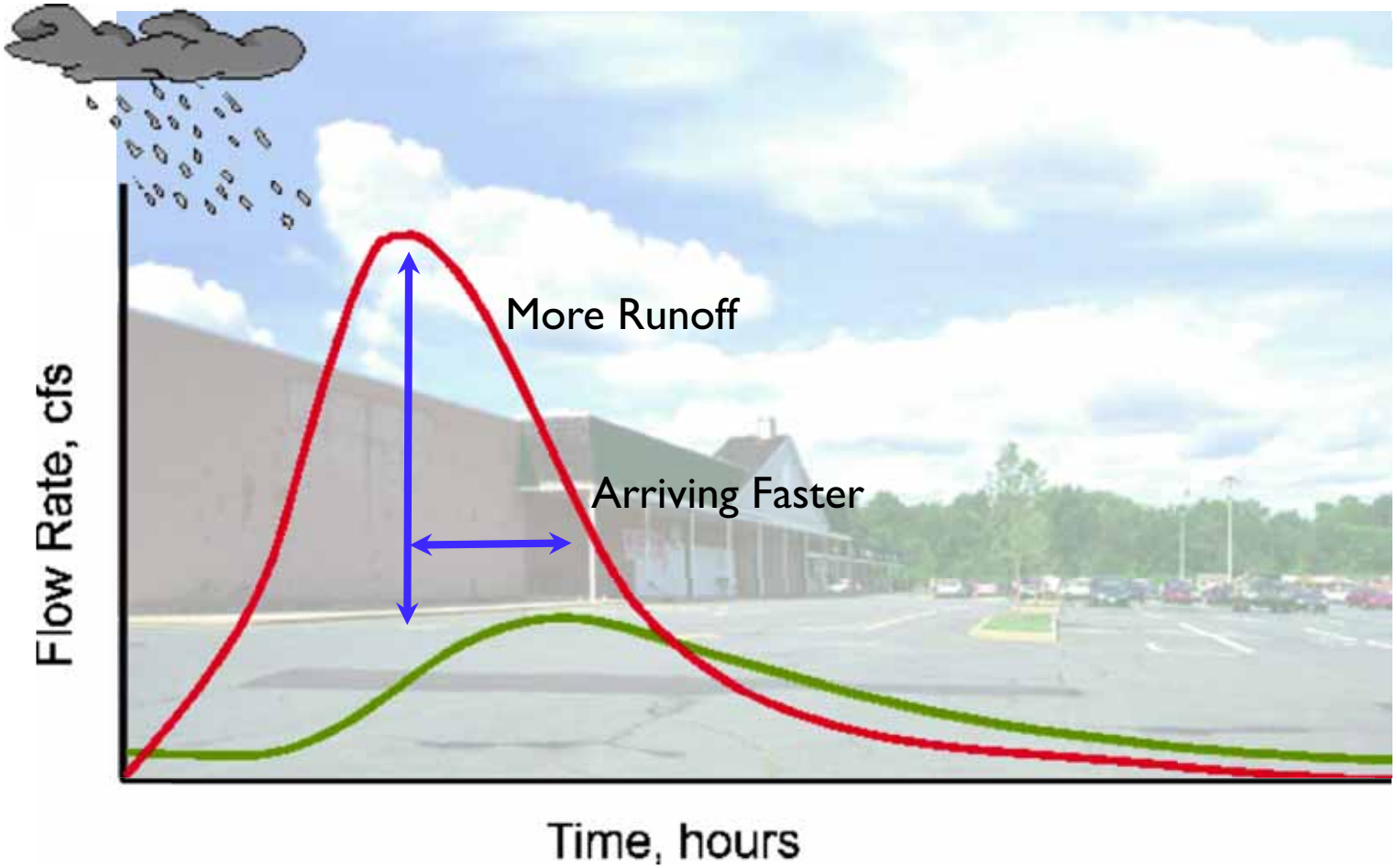
Probable Source	Probable Source Group	Miles Threatened or Impaired
Source Unknown	Unknown	208.9
Urban Runoff/Storm Sewers	Urban-Related Runoff/Stormwater	77.6
Wildlife Other Than Waterfowl	Natural/Wildlife	45.0
Introduction Of Non-Native Organisms (Accidental Or Intentional)	Other	40.1
Municipal Point 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

Urban Stream Syndrome

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.

Walsh et al., 2005

Hydrologic Impacts of Development



The Effects of Urbanization

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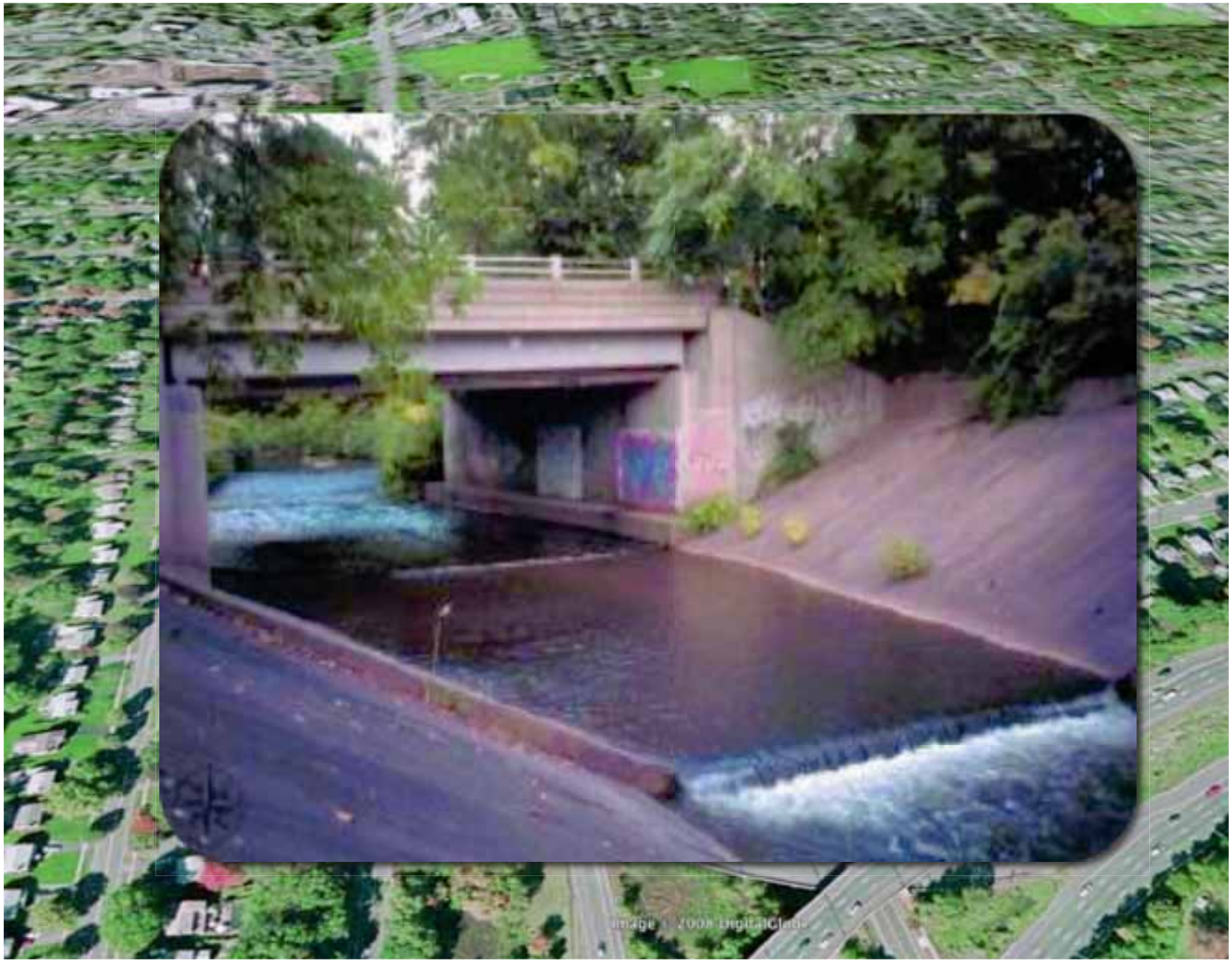
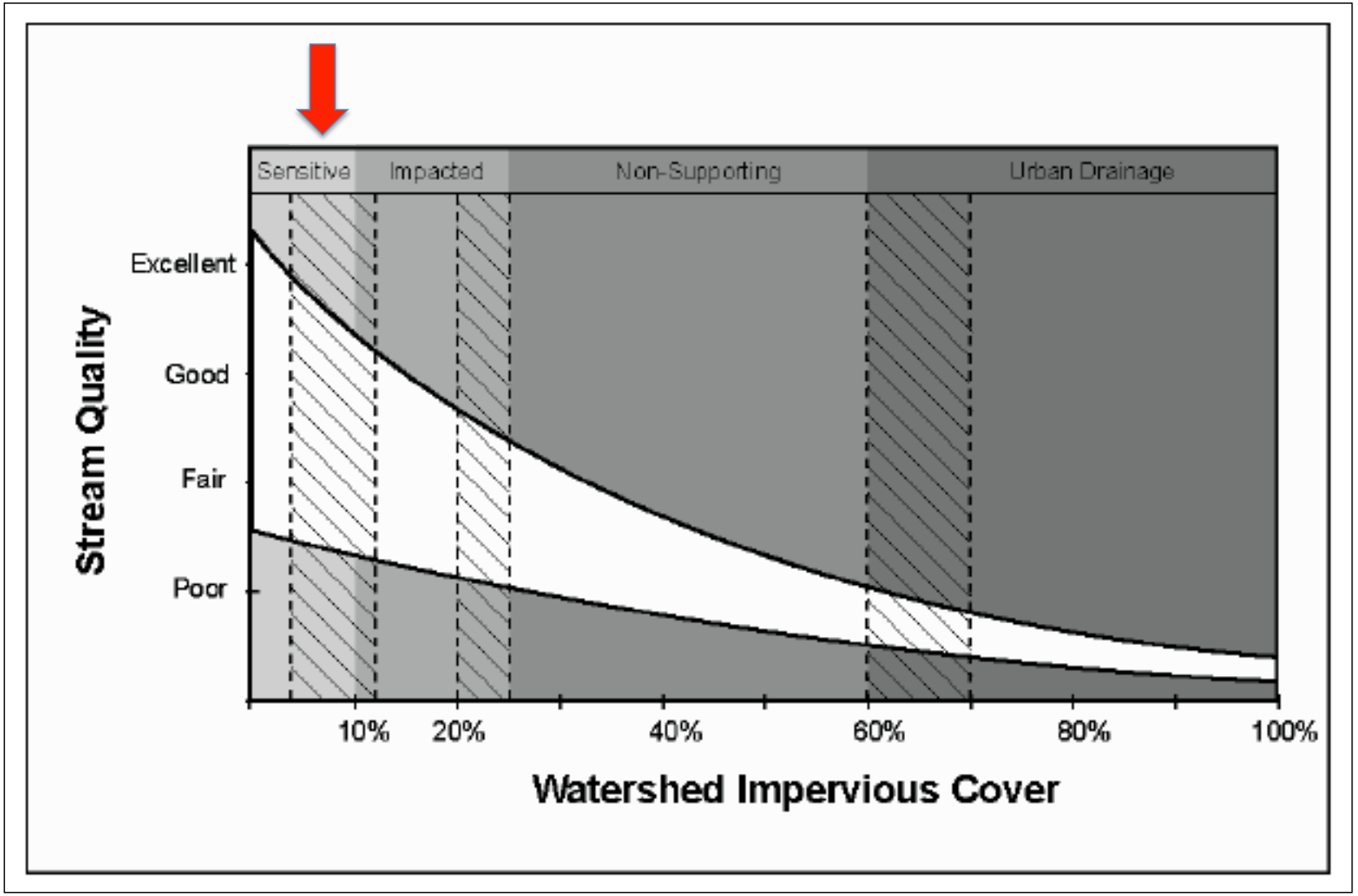


Impervious Surfaces

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

The (Updated) Impervious Cover Model



From Schueler, et al., 2009.

The Strength of the Evidence

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

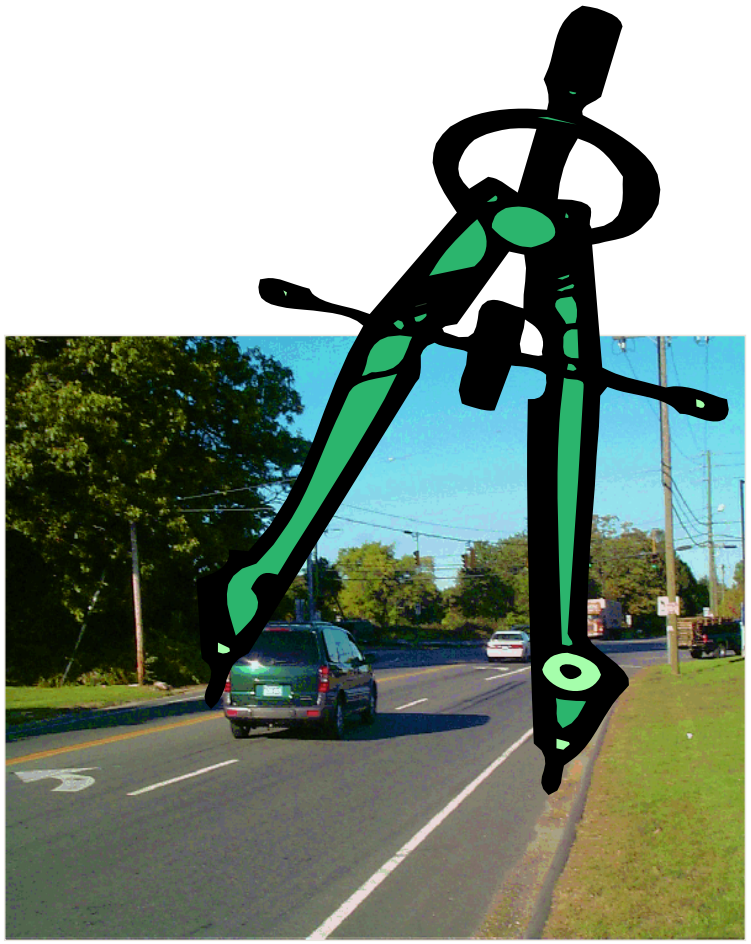
- Geomorphic (stream form) indicators
- Hydrologic Indicators
- Stream Habitat Indicators
- Water Quality Indicators
- Aquatic Diversity Indicators

Impervious Surface as an Indicator

1. It simplifies complex impacts but is based on solid science

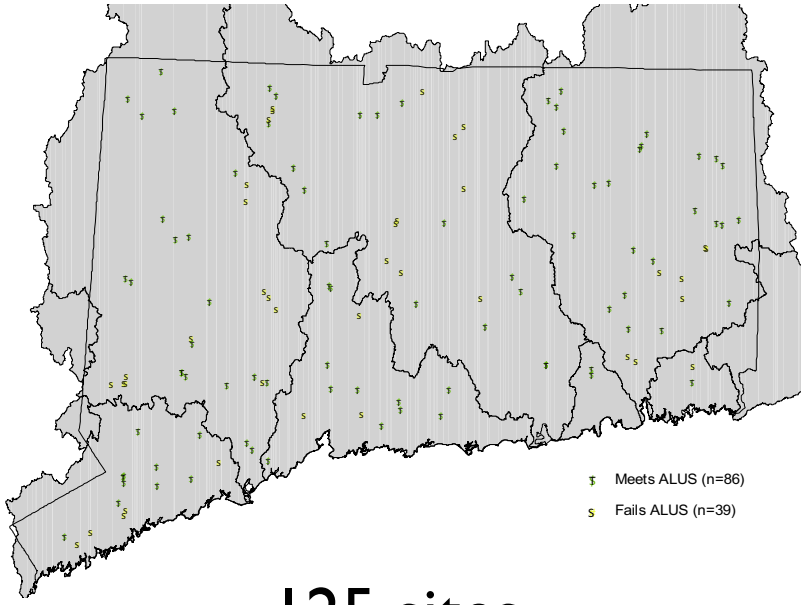
2. It's tangible & measurable

3. It's generated by local land use regulations



And what about in CT?

Linking Bug Data with Impervious Cover Data



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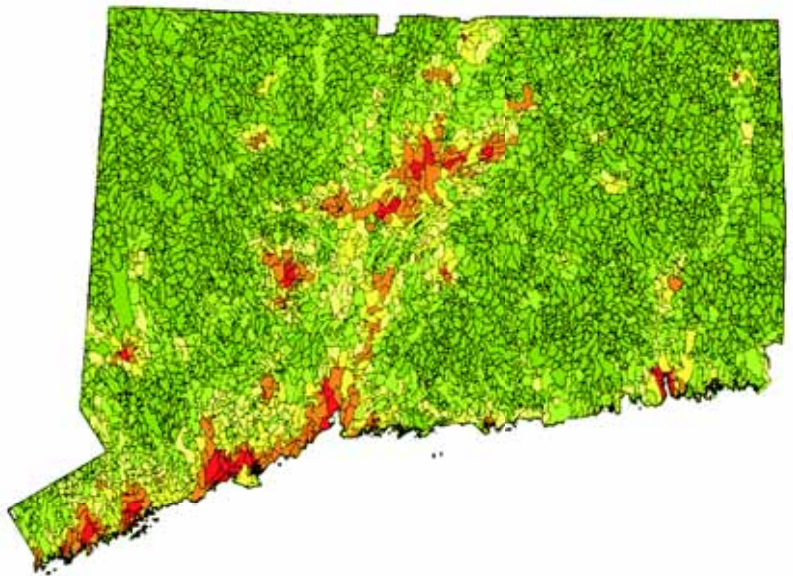
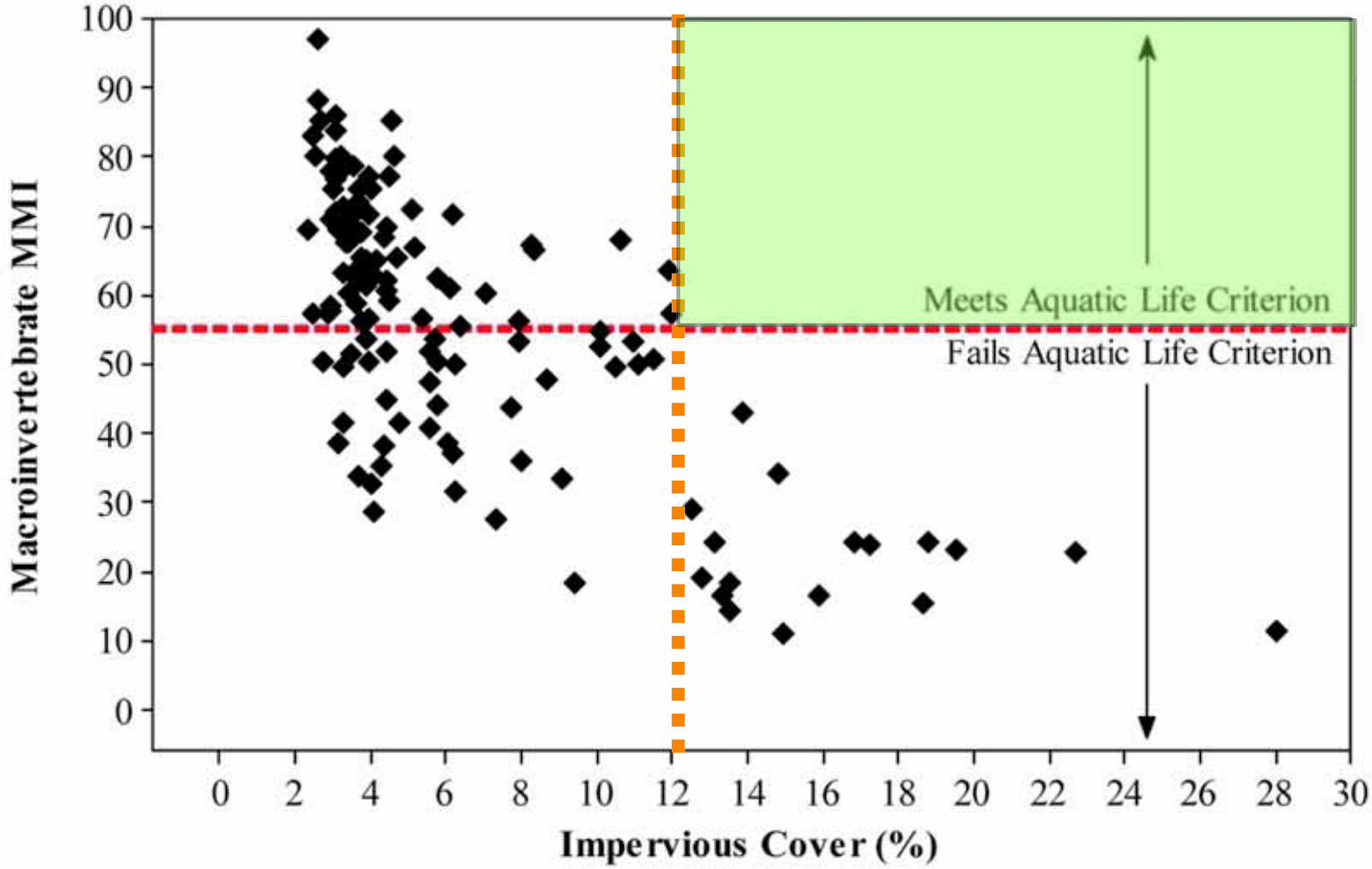


125 sites

- < 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

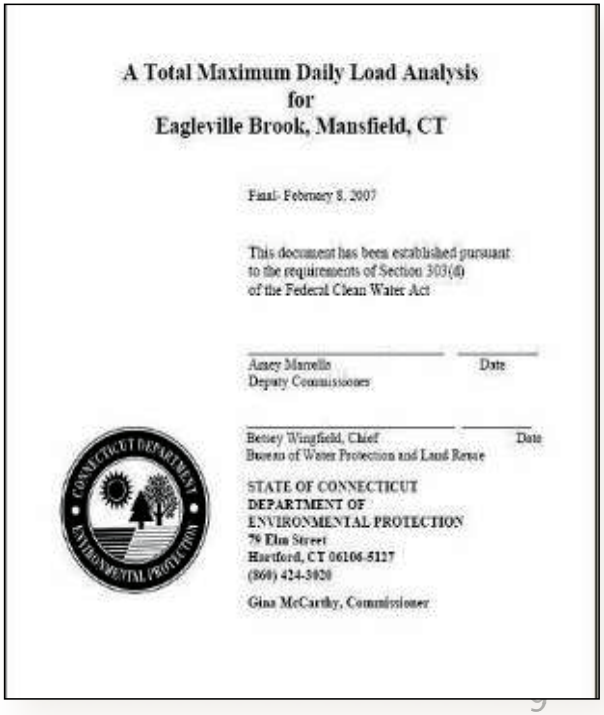
None of the 125 study sites with IC over 12% met CT's aquatic life criteria for a healthy



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 (12 – 1)
- 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

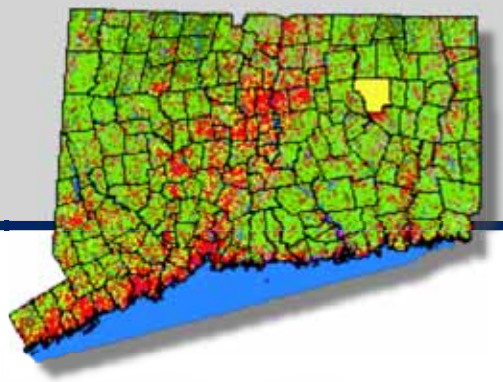
Amey Marrella Date
Deputy Commissioner

Betsey Wingfield, Chief Date
Bureau of Water Protection and Land Reuse

STATE OF CONNECTICUT
DEPARTMENT OF
ENVIRONMENTAL PROTECTION
79 Elm Street
Hartford, CT 06106-5127
(860) 424-3020

Gina McCarthy, Commissioner

Eagleville Brook Watershed



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

Today's Tale

- Development of the IC-TMDL
- The project: technical work
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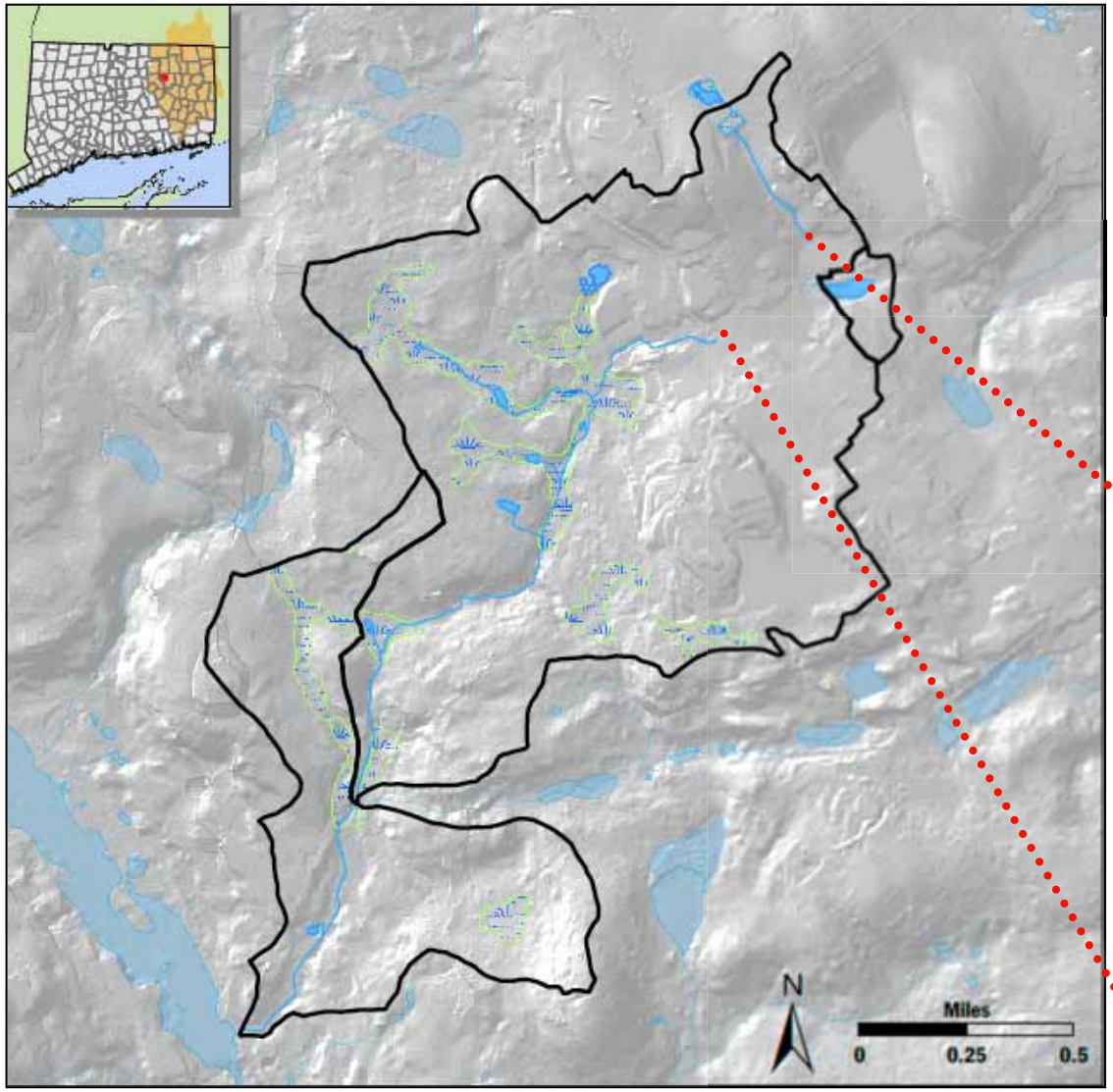
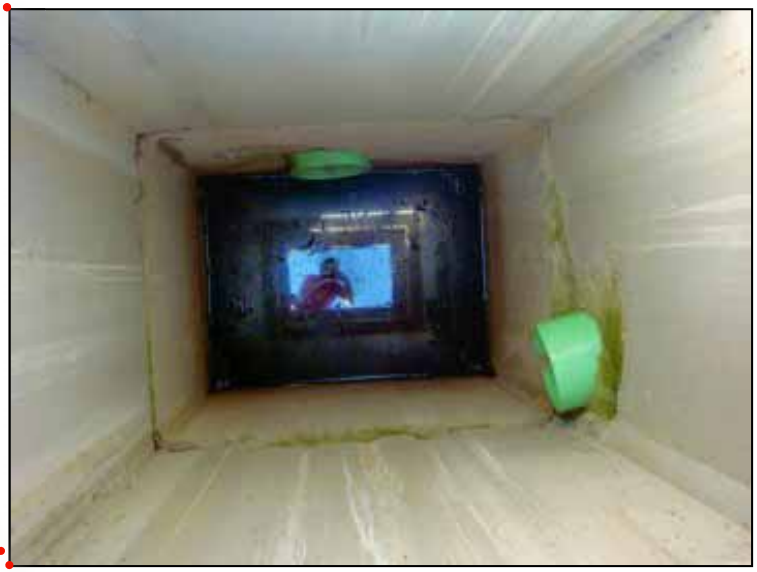
Project Partners

- 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

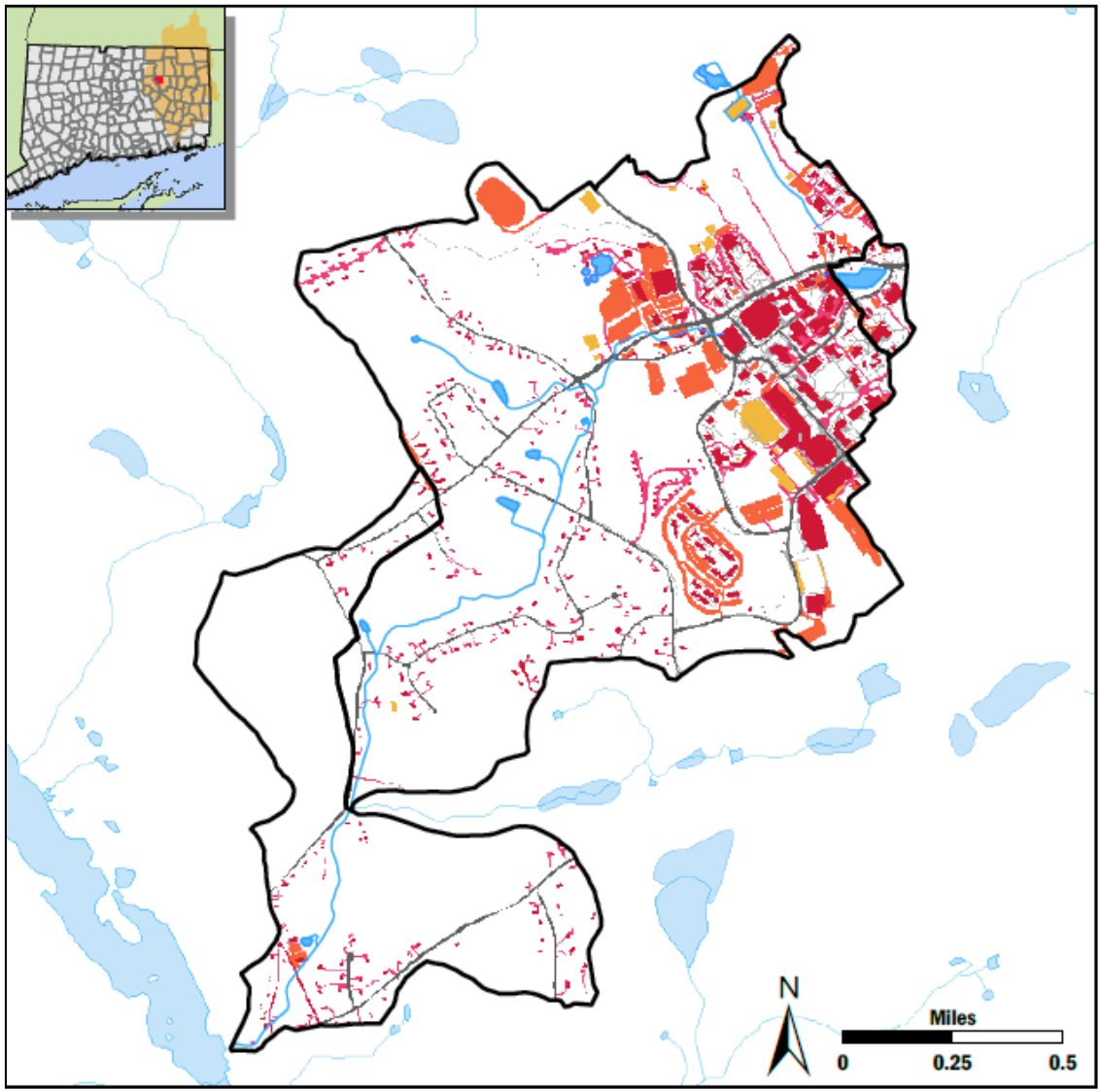
Eagleville Brook watershed



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

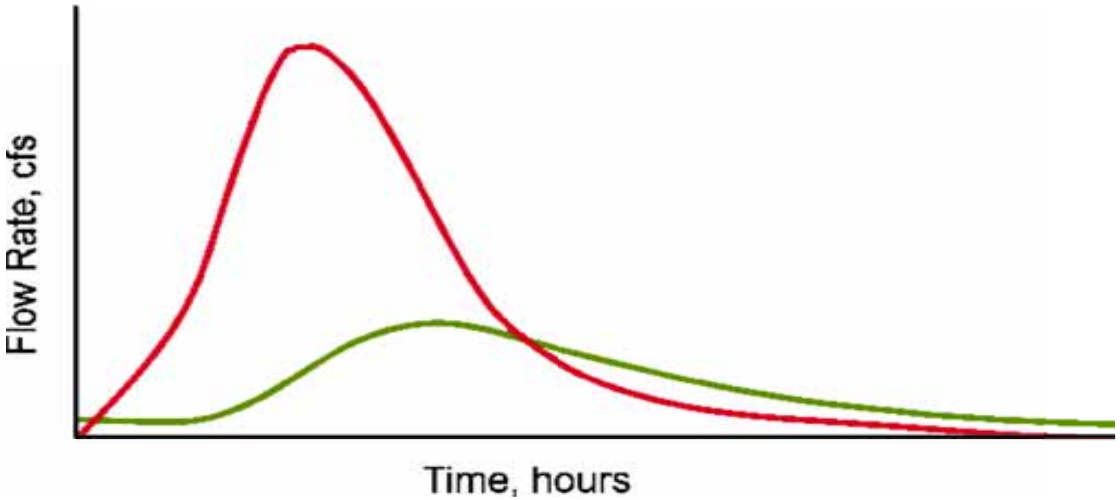
The emphasis is on runoff (volume) reduction, but opportunities to improve water quality will not be neglected

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

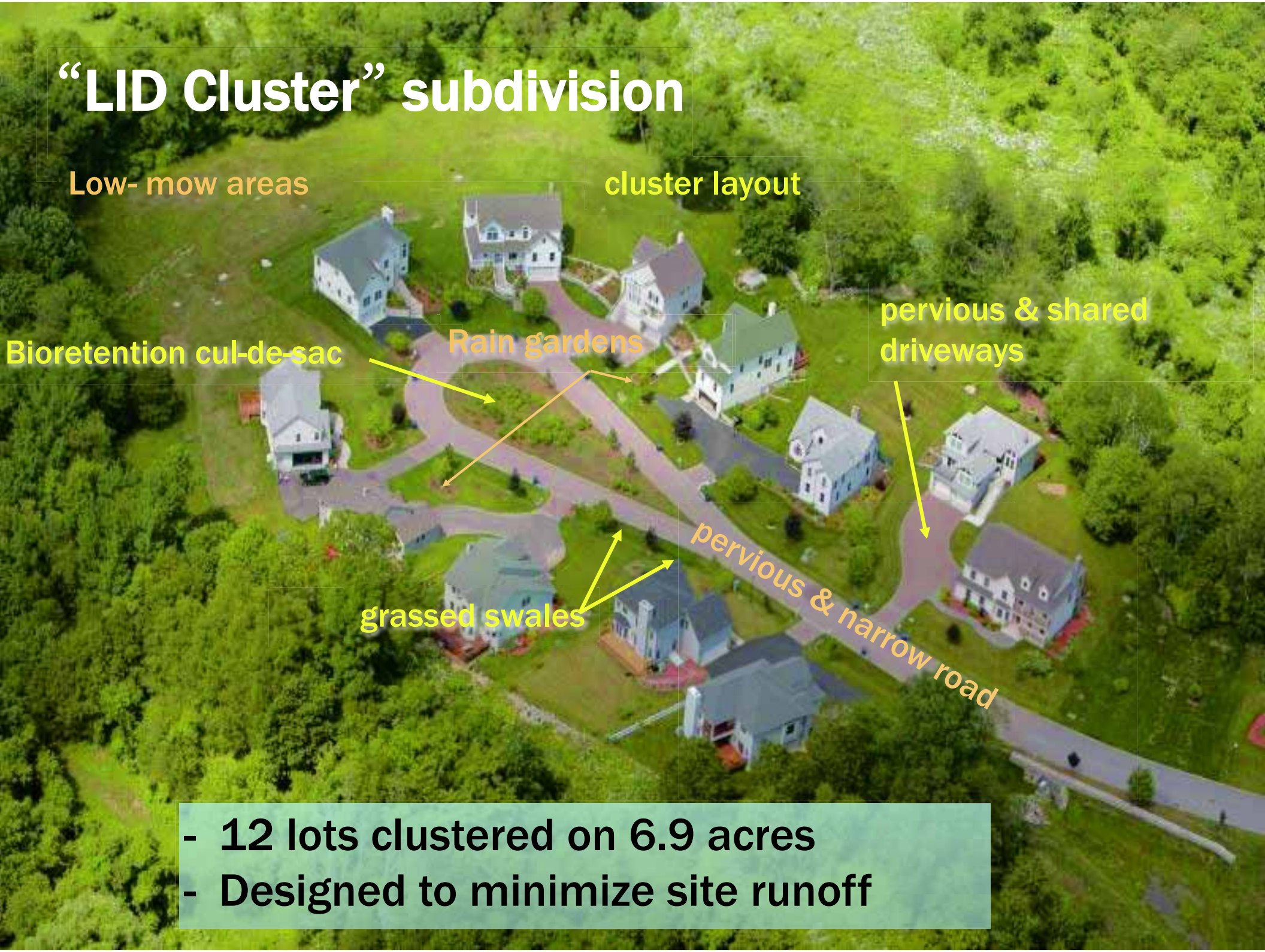
Site Level:
Low Impact Development

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

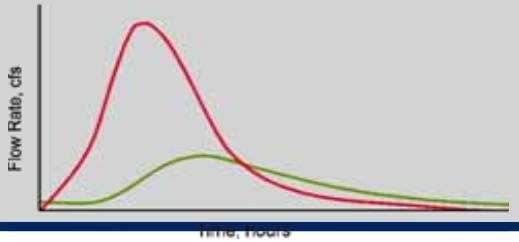
But Does it Work??

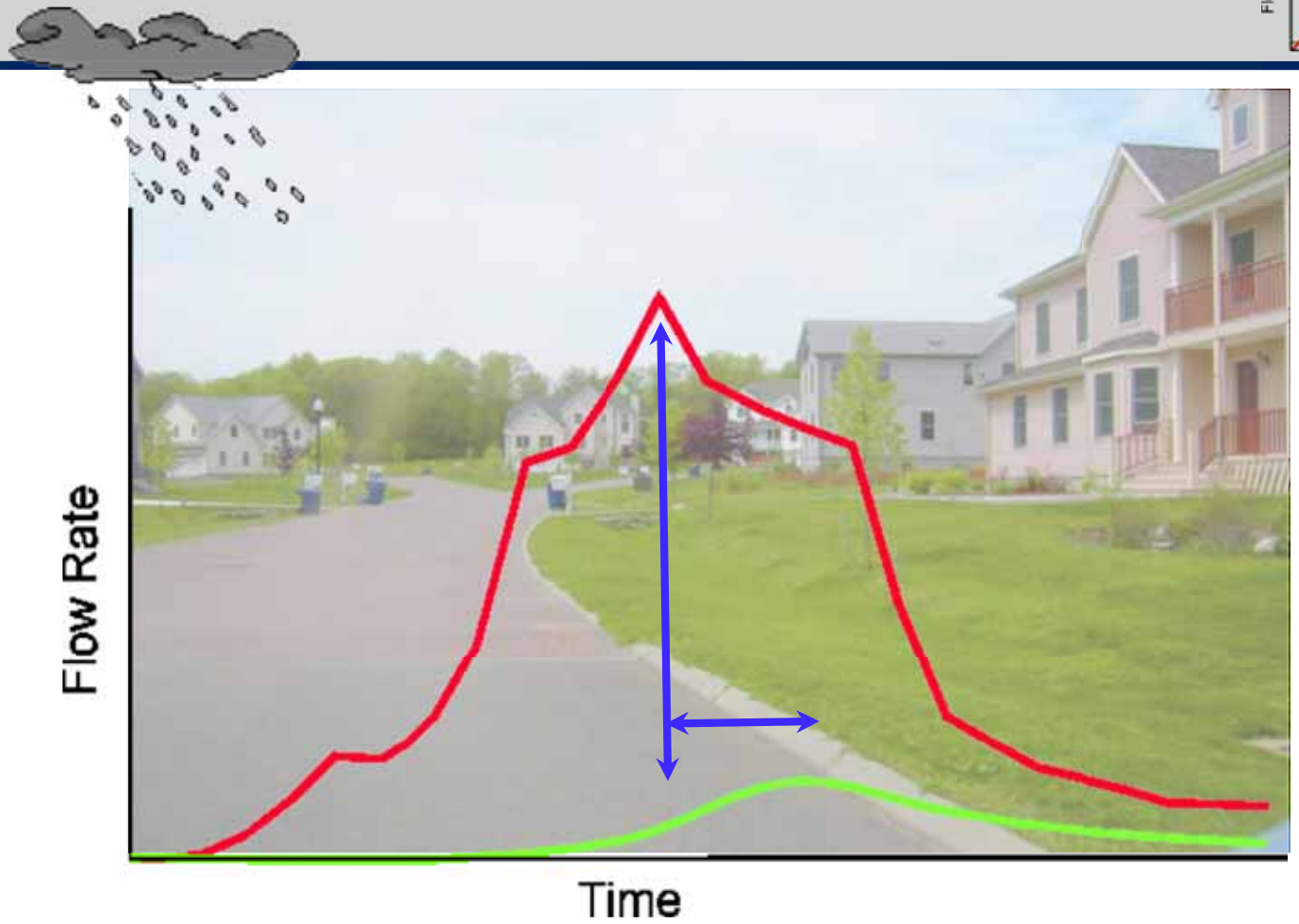
- Bioretention
- Rain Gardens
- Vegetated Swales, Buffers, and Filter Strips
- Permeable Pavements
- Rainwater Harvesting
- Green Roofs

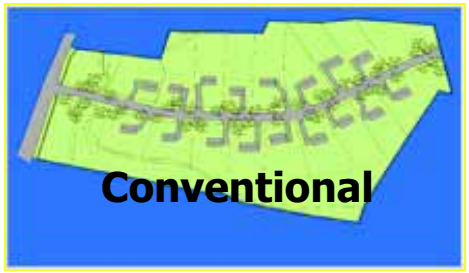
LID...Connecticut-style

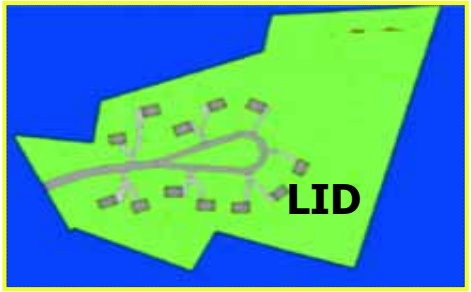

"LID Cluster" subdivision
Low- mow areas
cluster layout
Bioretention cul-de-sac
Rain gardens
pervious & shared driveways
grassed swales
pervious & narrow road
- 12 lots clustered on 6.9 acres
- Designed to minimize site runoff

Jack Clausen's $ 1M graph...







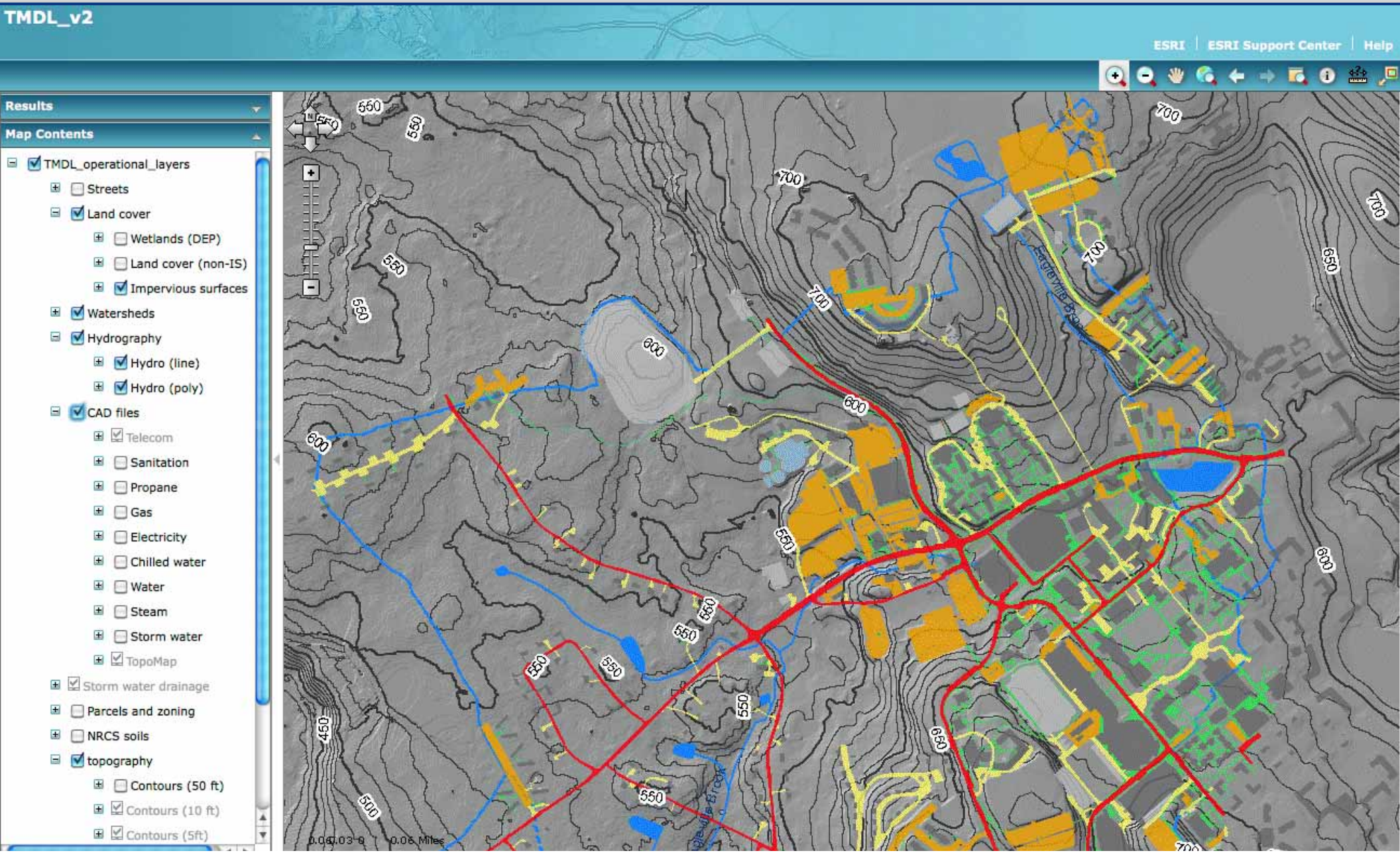


Adapted from J. Clausen, UConn

Can it be done???

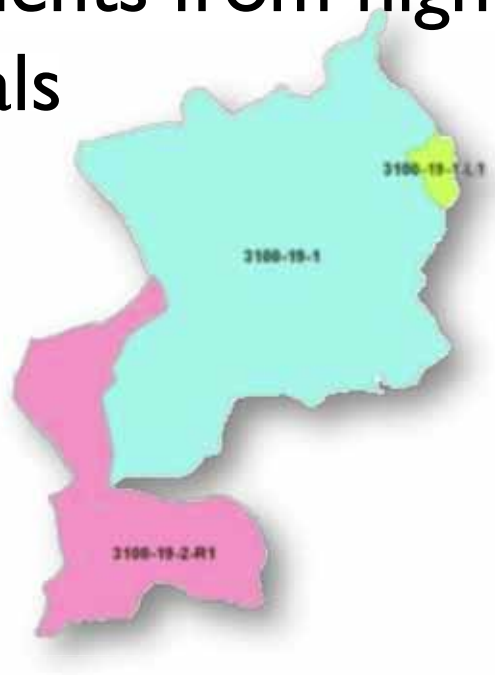
1. Mapping Analysis
   - characterizing IC and drainage
2. On-the-Ground Investigations
   - characterizing IC and drainage, part 2
   - locating retrofit options & opportunities
3. Back at the Desk
   - prioritizing projects
   - codifying procedures
4. Keeping Track
   - Is it as easy as it seems?

Collection Digital Data for the Watershed



Mapping analysis

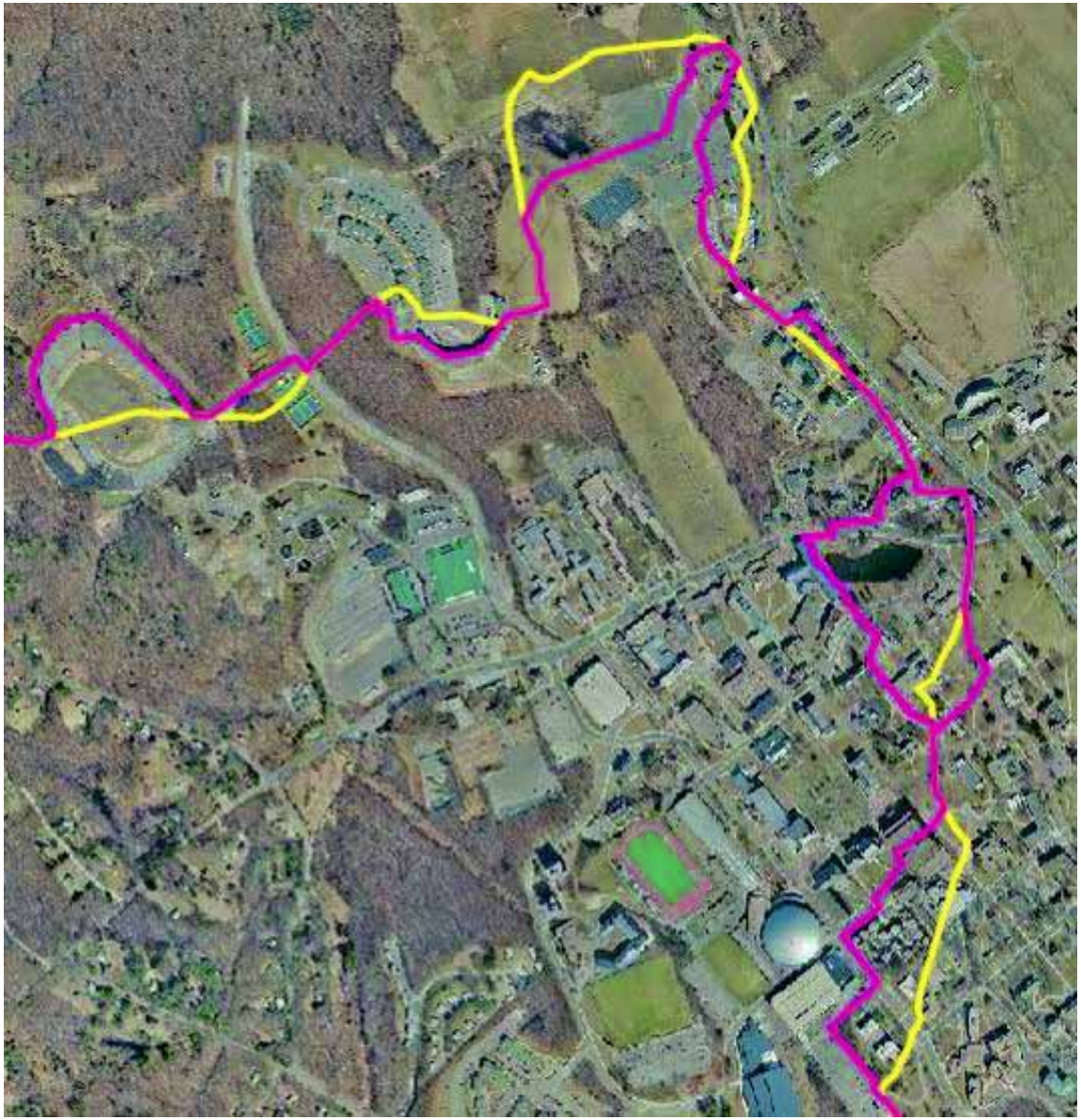
- Original IC estimates based on 2002 ISAT and land use coefficients
- Revised IC based on digitized measurements from high resolution 2008 aerials



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

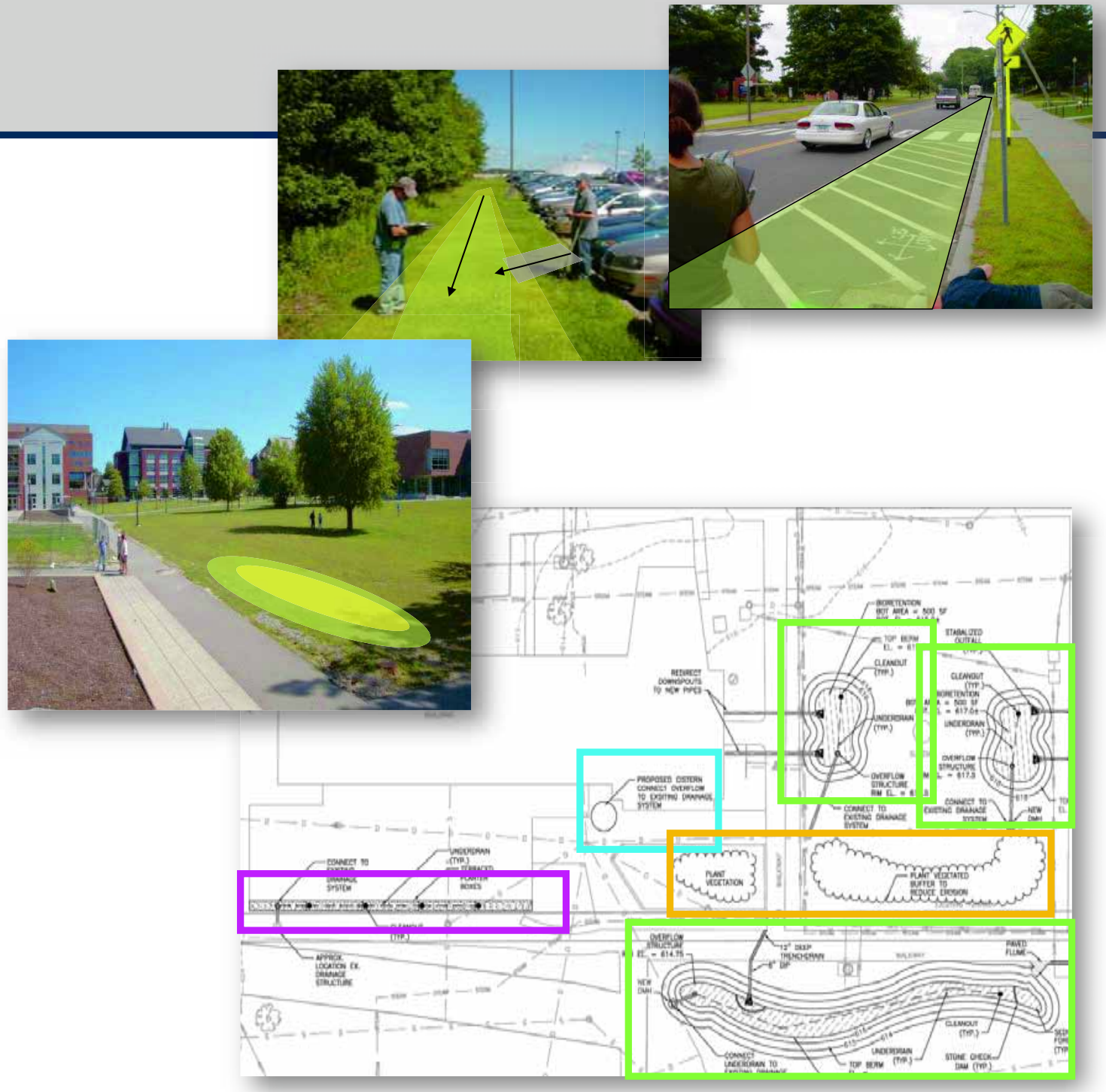
Eagleville Brook	TMDL Estimate	Desktop Adjusted	Field Adjusted
Watershed DA (ac)	1225 ac	1225 ac	**1199 ac**
Watershed IC (ac)	145 ac	218 ac	**167 ac**
Watershed IC (%)	11.80%	17.80%	**13.90%**
IC to Disconnect (ac)	34 ac	107 ac	**35 ac**

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

Retrofit Types

- Bioretention
- Swales
- Tree planters/filters
- Gravel-based wetland
- Sand filter
- Green roofs
- Cisterns
- Pervious pavement
- Soil Amendments



IC-TMDL Strategies

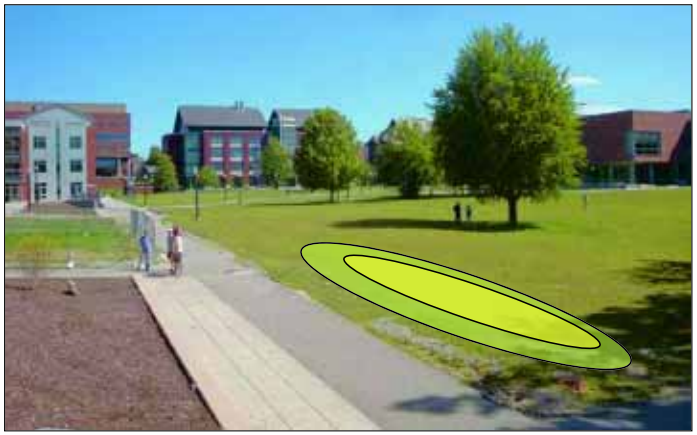
Large surface parking lots

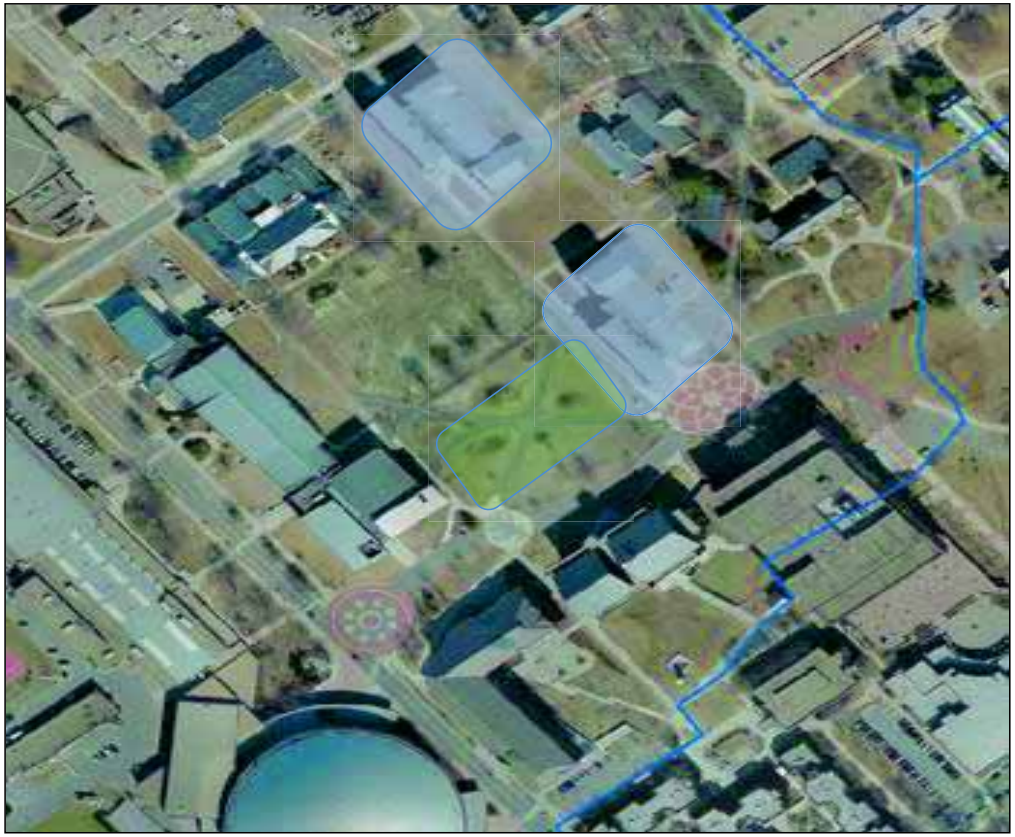
Redesign to make use of bioretention, permeable pavement

IC-TMDL Strategies

Center campus / academic core

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

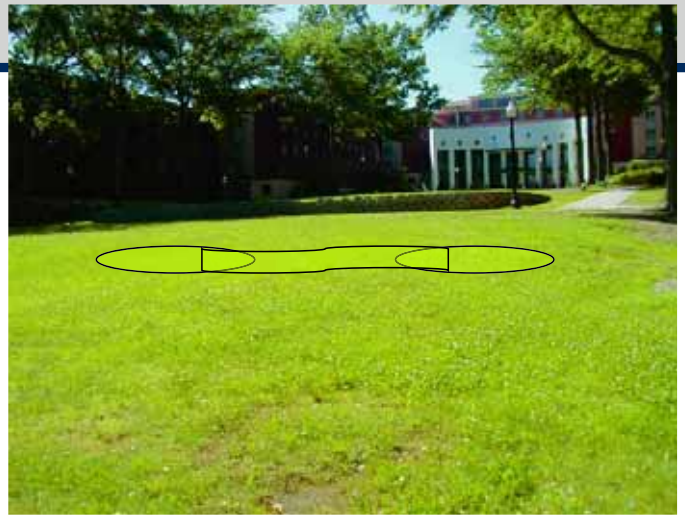




IC-TMDL Strategies

Dorms/Residence Areas

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



IC-TMDL Strategies

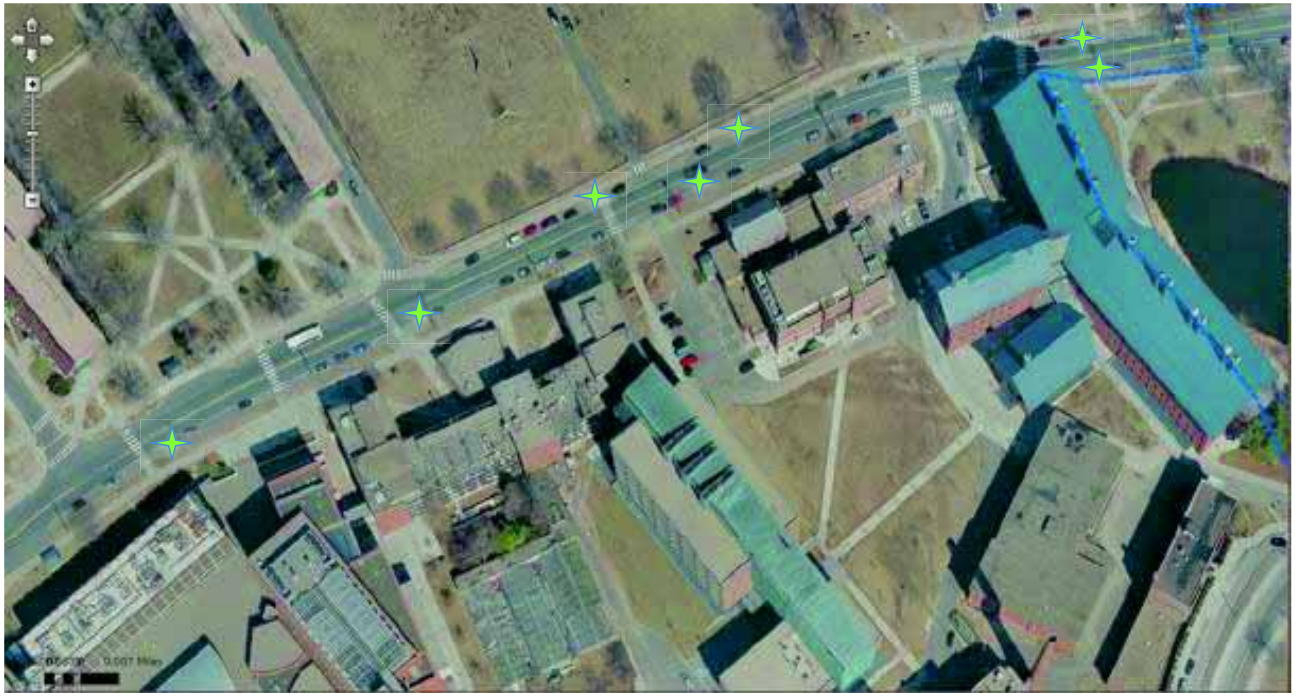
Peripheral areas: athletic complex

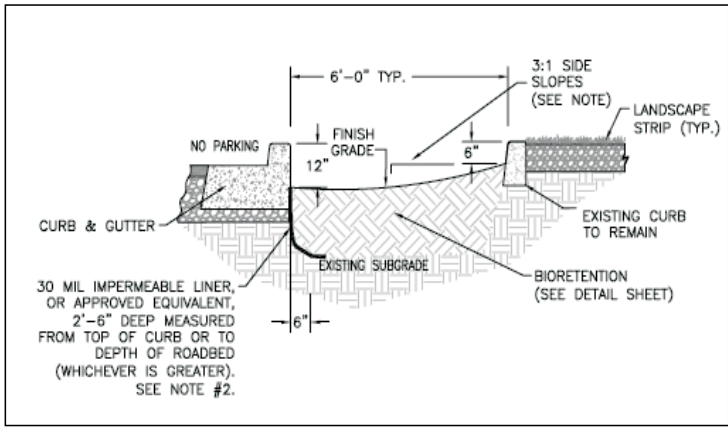
Innovative biological stormwater BMPs to reduce impact of runoff from athletic fields & facilities

IC-TMDL Strategies

Roads

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

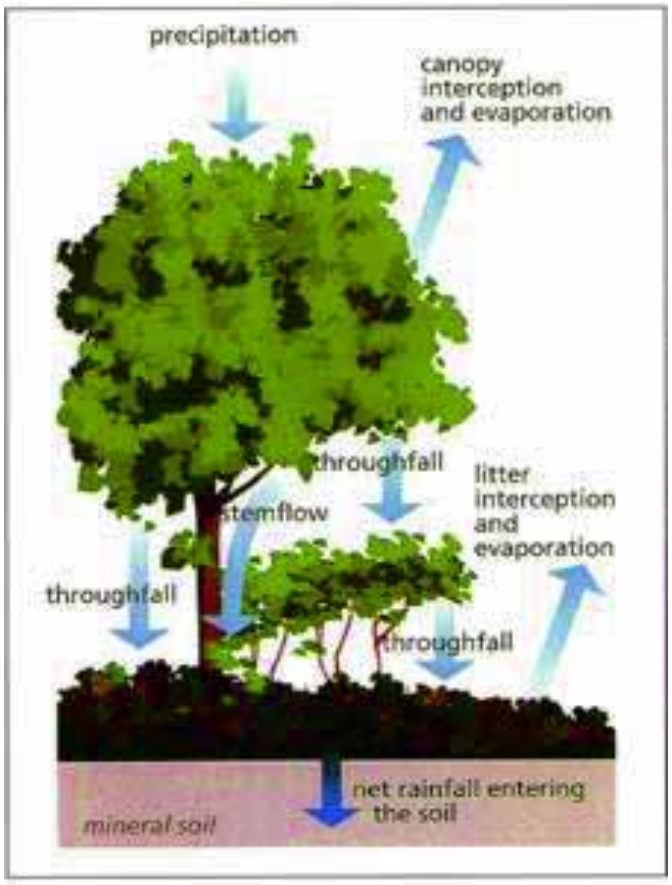




IC-TMDL Strategies

Campus-wide

Increase tree cover in collaboration with UConn Master Landscape Plan



From draft Landscape Master Plan

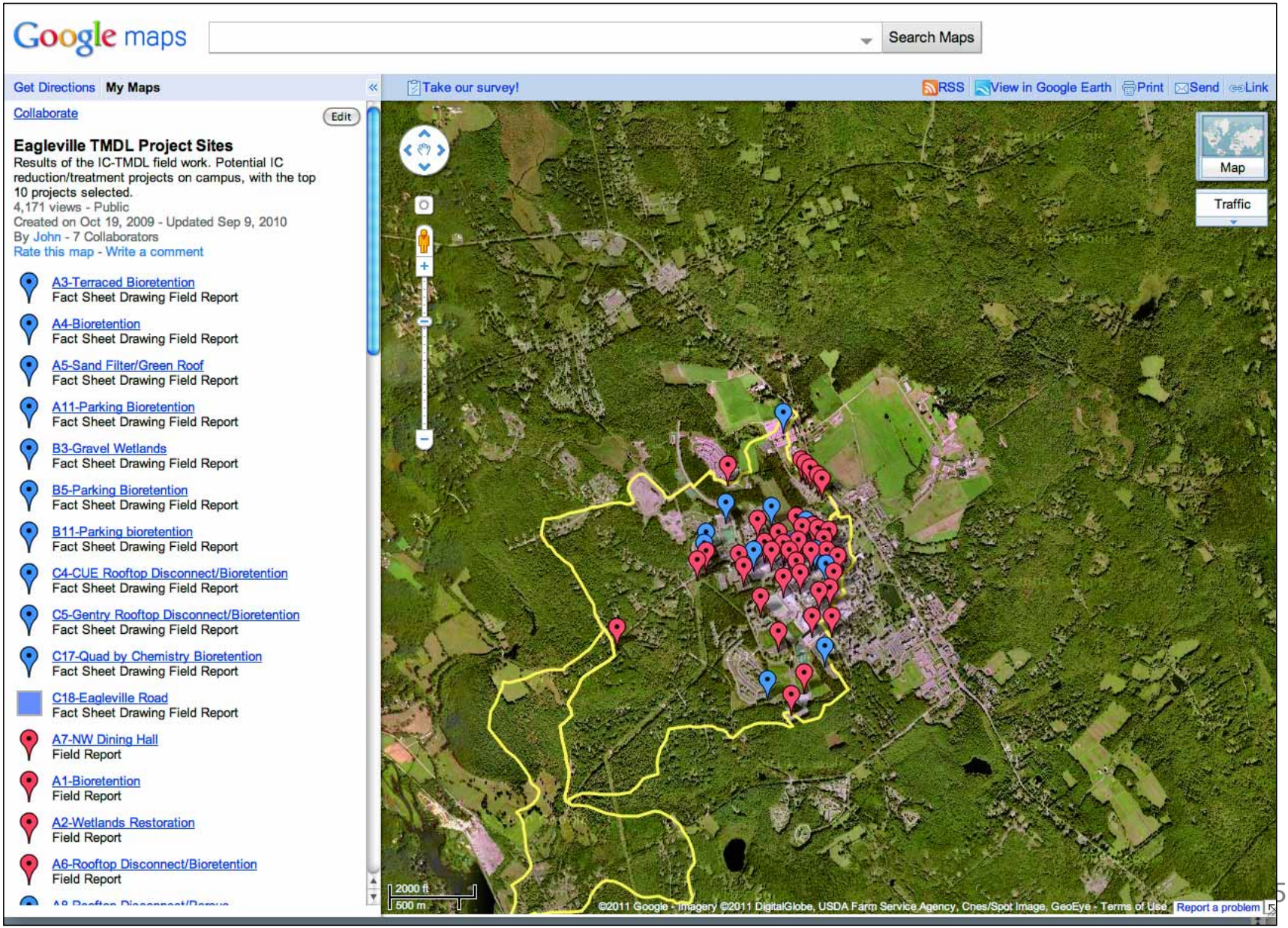
Prioritizing Retrofit Opportunities

51 retrofit opportunities analyzed → "Top Ten" opportunities selected → Complete site reports & 25% drawings for Top Ten

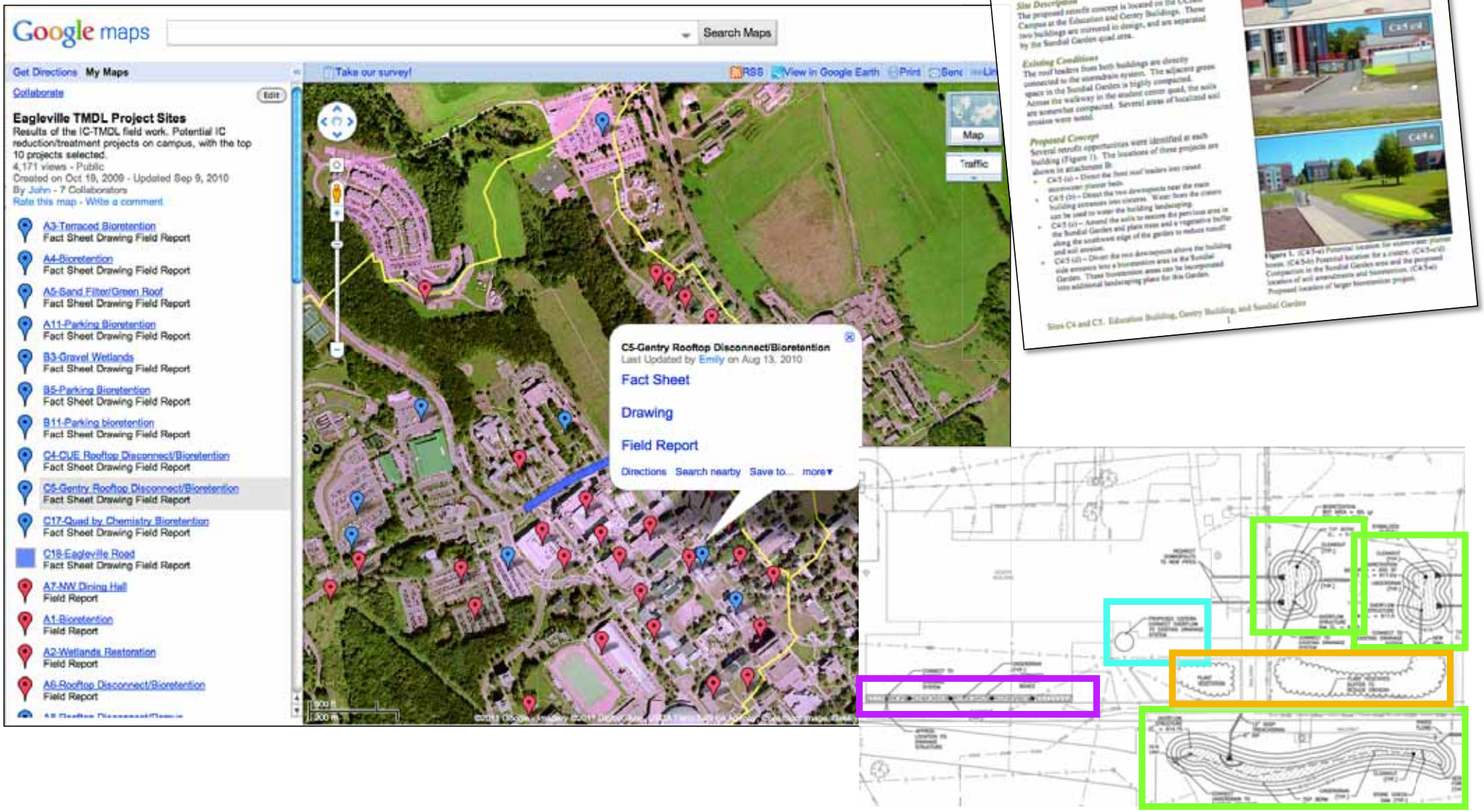
Considerations for "Top 10"

- 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



The "mashup"


Google maps
Search Maps
Get Directions
My Maps
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
Rate this map - Write a comment
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
Take our survey!
RSS
View in Google Earth
Print
Send
Map
Traffic
C5-Gentry Rooftop Disconnect/Bioretention
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
Project Summary


REST PERIOD
Questions or comments?

Today's Tale

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

Project Status

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

Impervious Cover TMDL Field Survey & Analysis Report
University of Connecticut

Impervious Cover TMDL
Field Survey and Analysis Report

Prepared for:
Center for Land Use Education and Research
Department of Extension
University of Connecticut

Prepared by:
Center for Watershed Protection, Inc.
8390 Main Street, 2nd Floor
Ellicott City, MD 21043

Horsley Witten Group
90 Route 6A
Sandwich, MA 02563

March 4, 2010

CENTER FOR WATERSHED PROTECTION

Horsley Witten Group
Sustainable Environmental Solutions

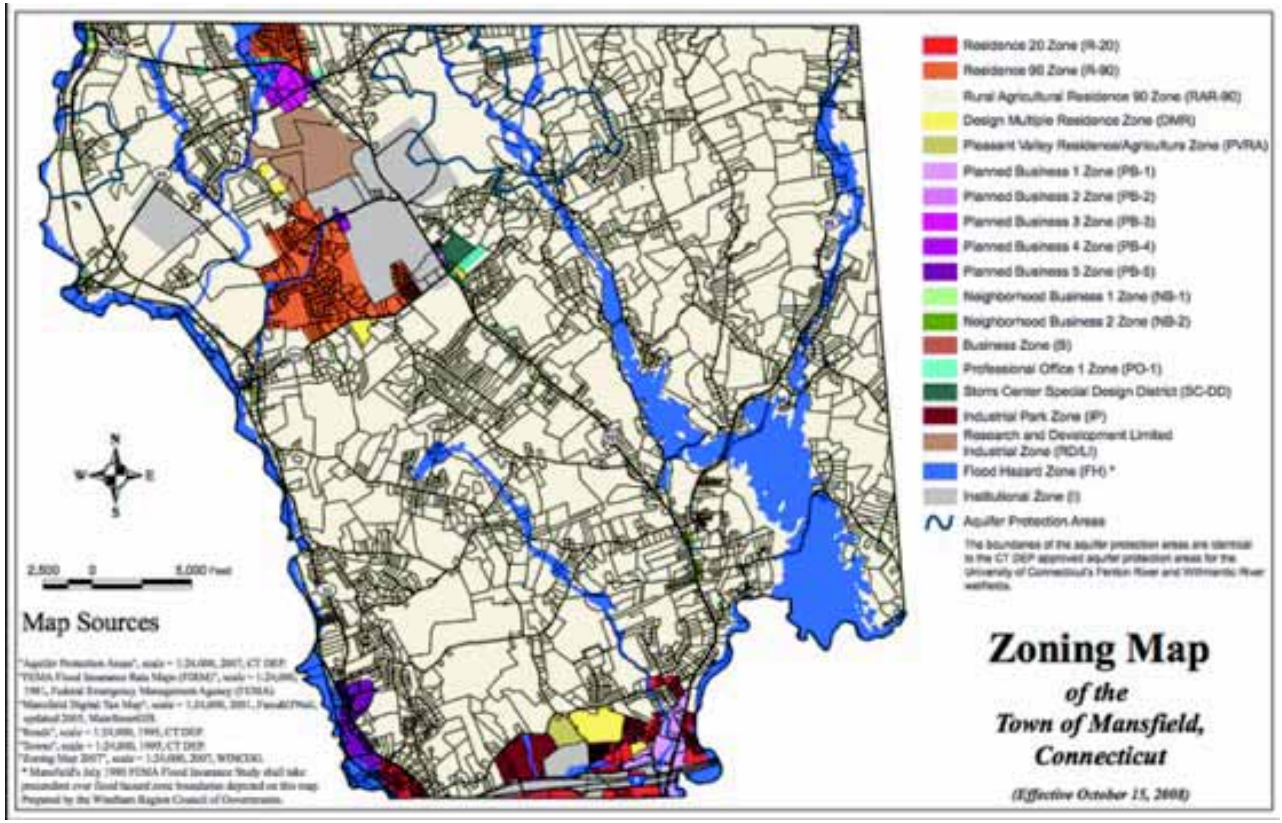
9-Step Watershed-Based Plan

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

UConn
Office of Environmental Policy

Policy Statement | EPAC | Green Building | Environmental Compliance Office

EcoHusky Home
EcoHusky Students
Contact Us
Green Building Homepage
Sustainable Development Workgroup

Sustainable Design & Construction Policy

The University of Connecticut Sustainable Design and Construction Policy

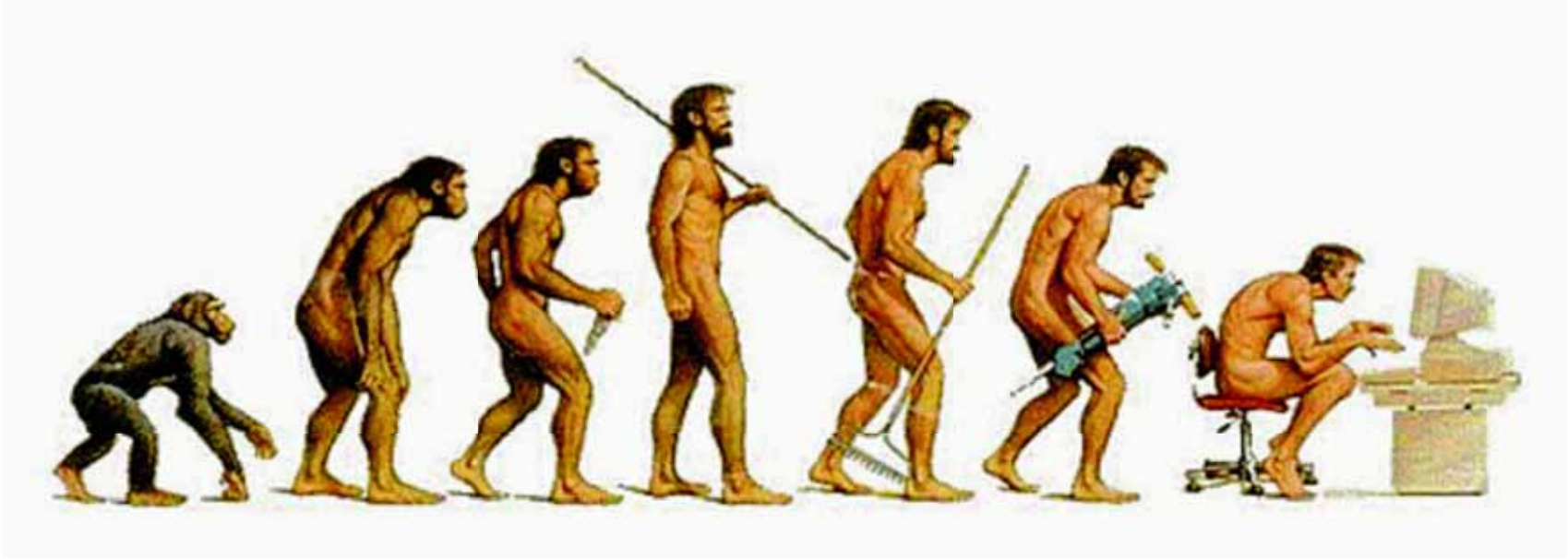
(Adopted March 2007)

The University of Connecticut shall plan, design, construct, renovate and maintain sustainable, energy- and water-efficient buildings that:

- Yield cost savings through lowered lifetime operating costs,
- Provide enhanced learning atmospheres for students and healthier environments for all building occupants and visitors, and
- Realize the University's commitment to responsible growth and environmental stewardship.

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.

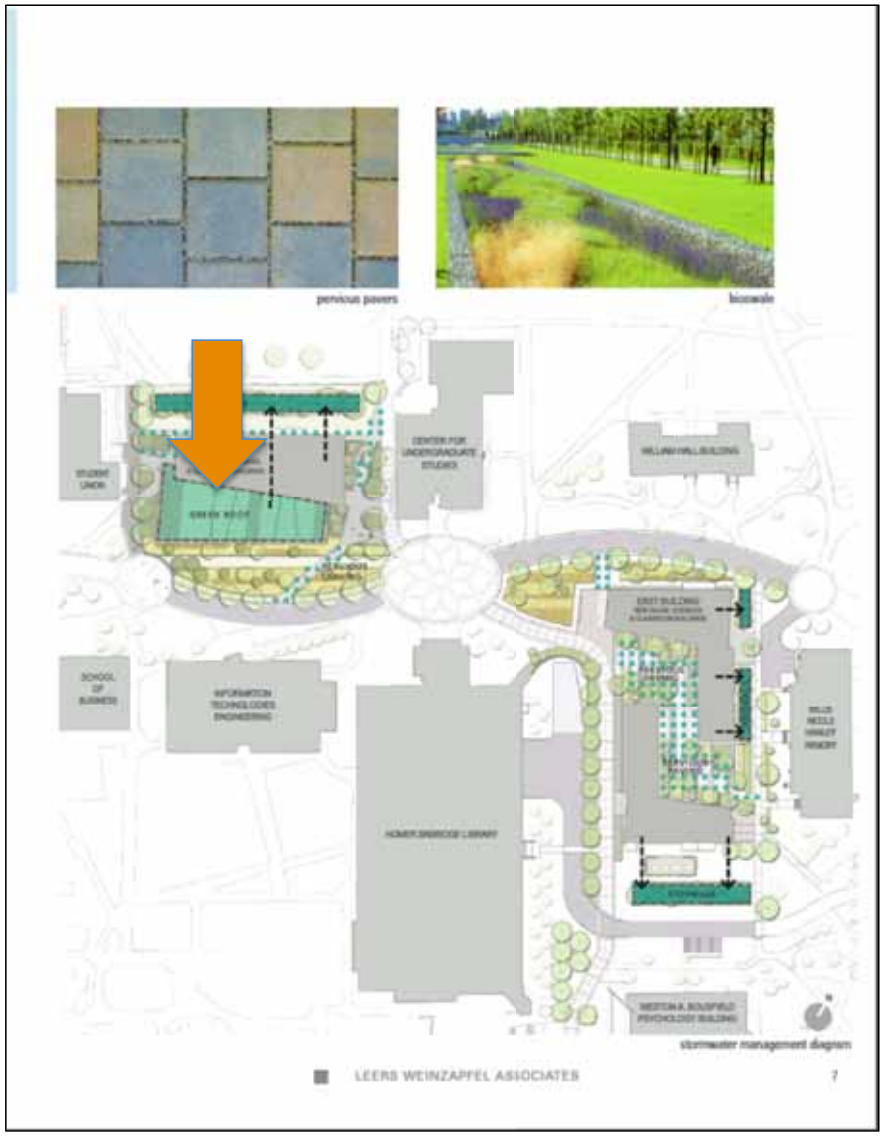
Towers Apartments Porous Asphalt Parking Lot

Northwoods Apartments

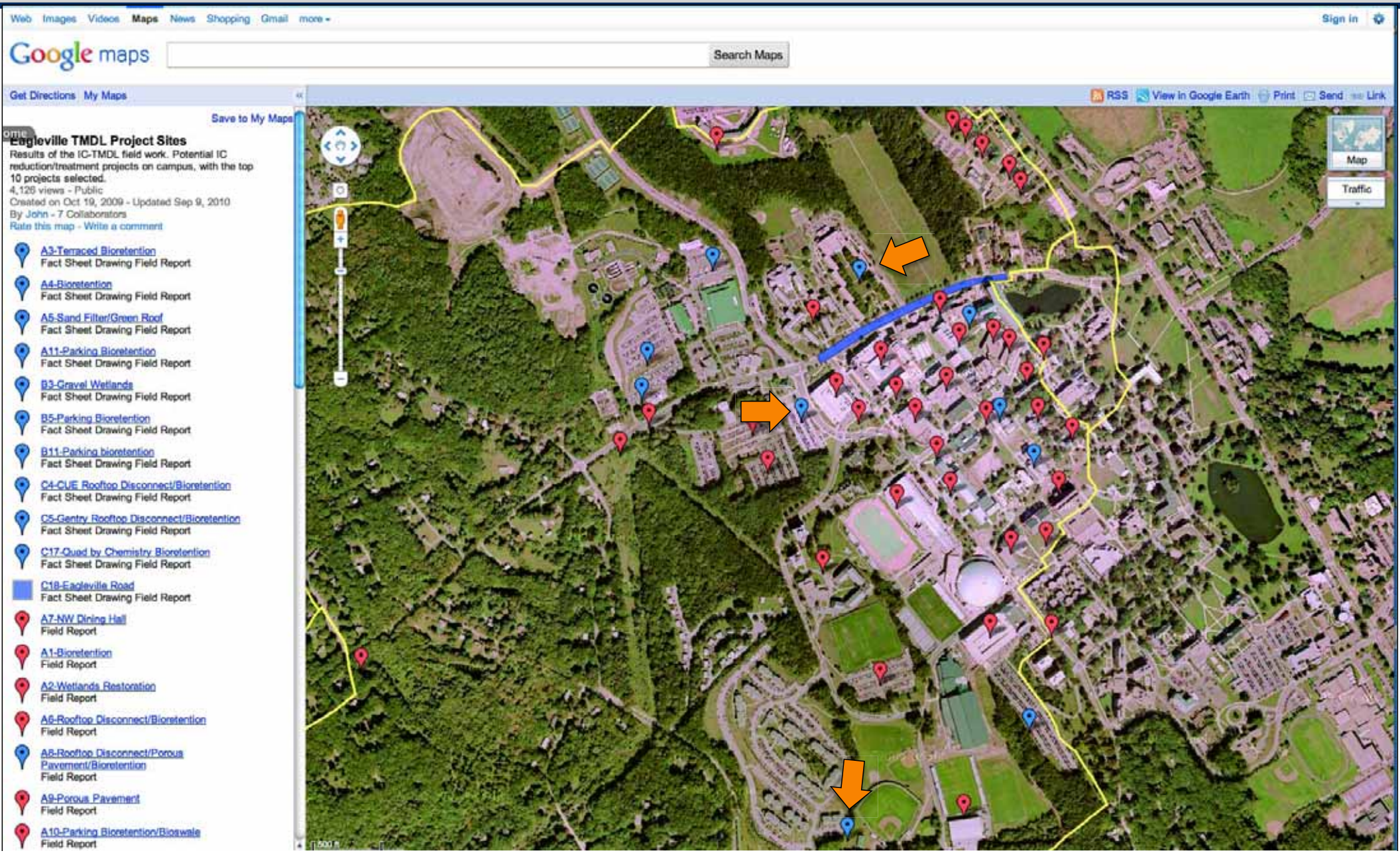
Green Roof

In process...

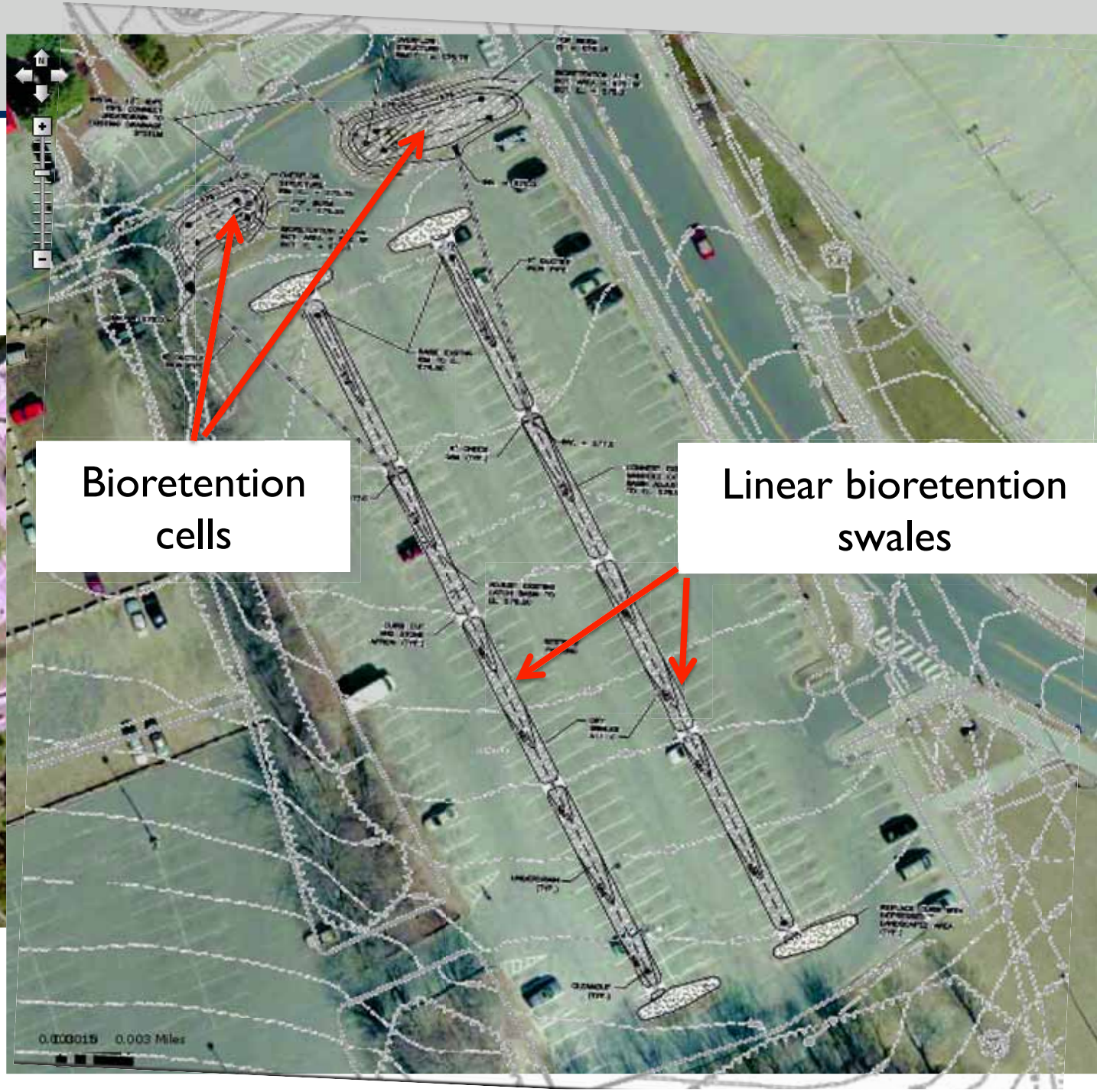

Sustainable Design Principles
University of Connecticut
New Social Sciences & Classroom Buildings
February 11, 2009
LEERS WEINZAPFEL ASSOCIATES


pervious pavers
bioswale
stormwater management diagram
LEERS WEINZAPFEL ASSOCIATES

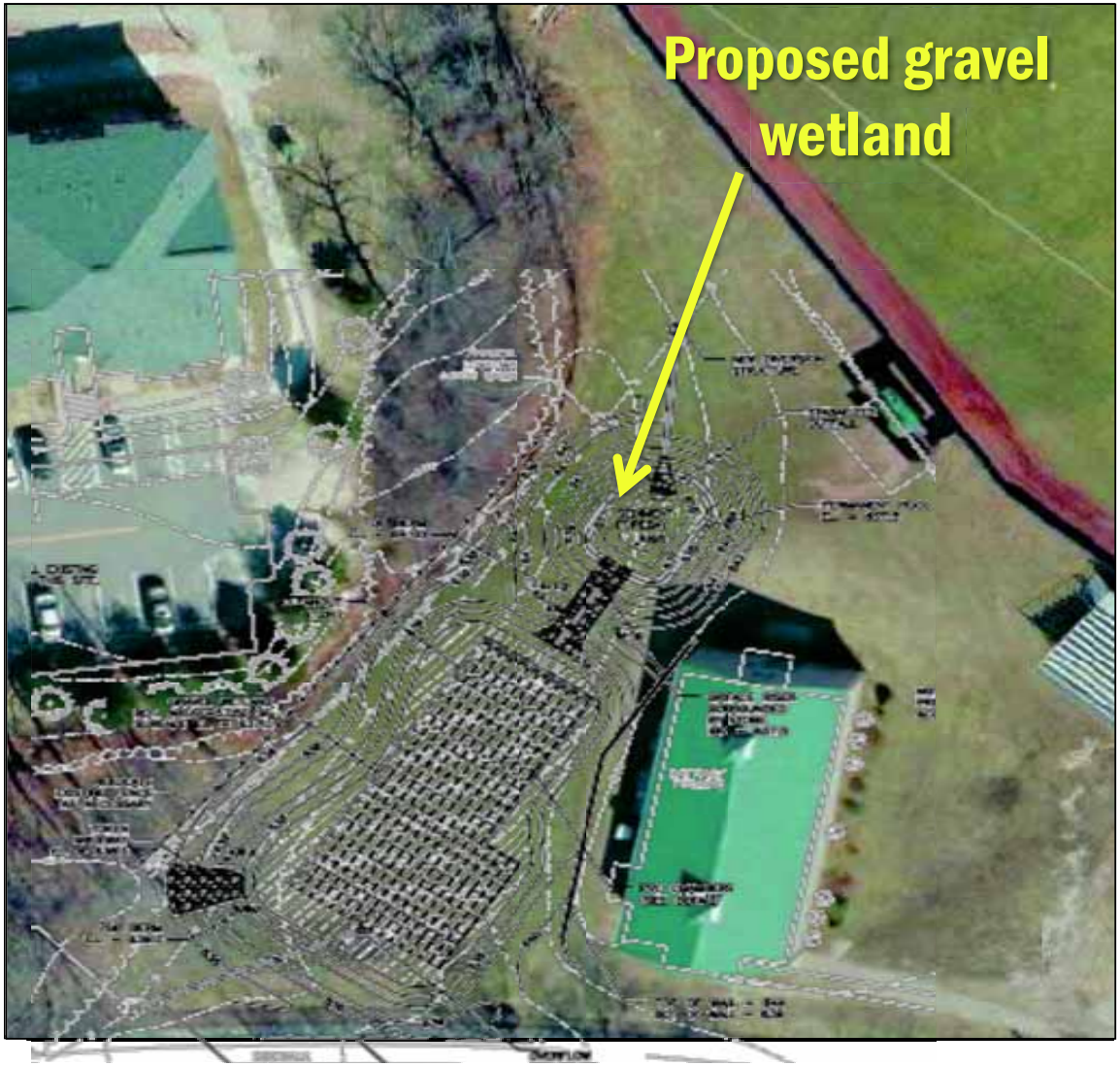
On the drawing board

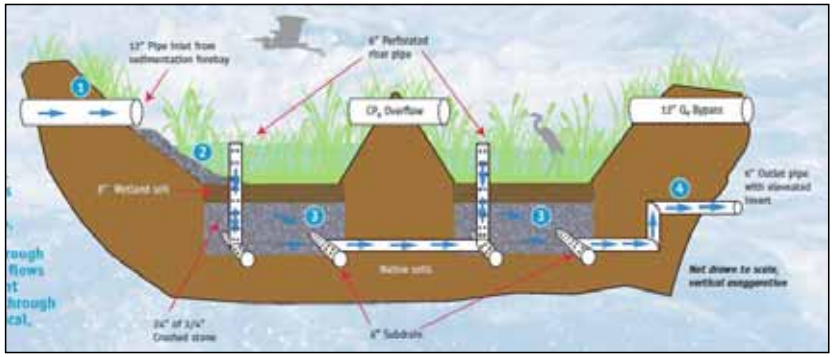


Lot 9


Bioretention cells
Linear bioretention swales
0.003 Miles

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, km2 (acres)**	**Impervious Area Treated, km2 (acres)**	**Watershed IC after Implementation km2 (acres)**	**Target IC (11% of watershed), km2 (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

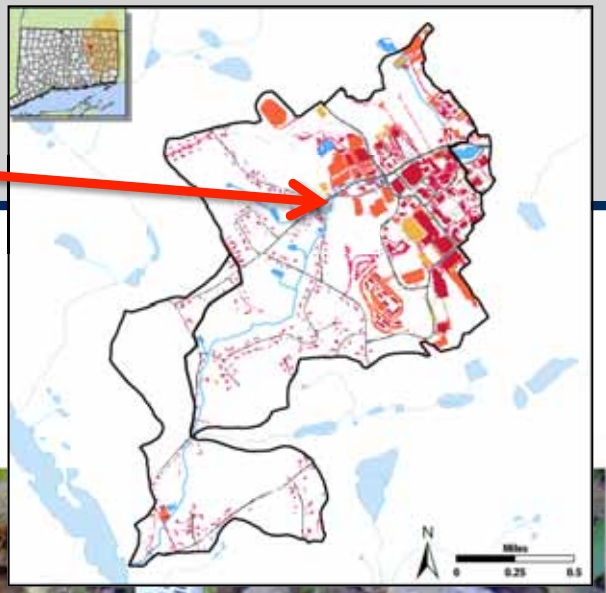
3. How do we give credit for "partial" IC disconnection?
(We account for it in the volume estimates, but not the IC estimates).

Tracking Progress

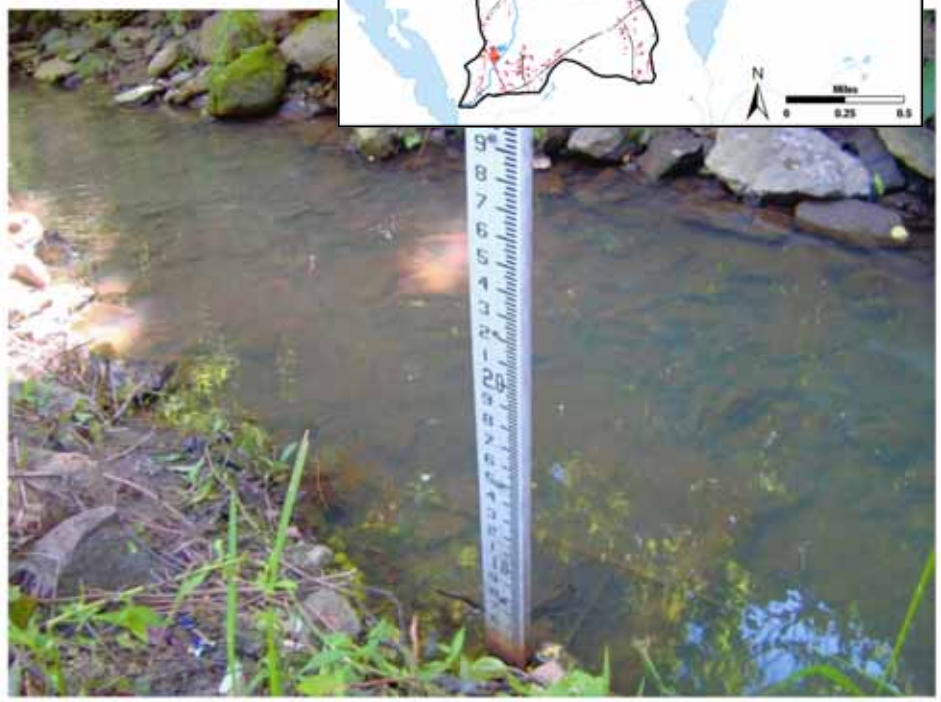
Accounting Issues

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

Tracking Progress



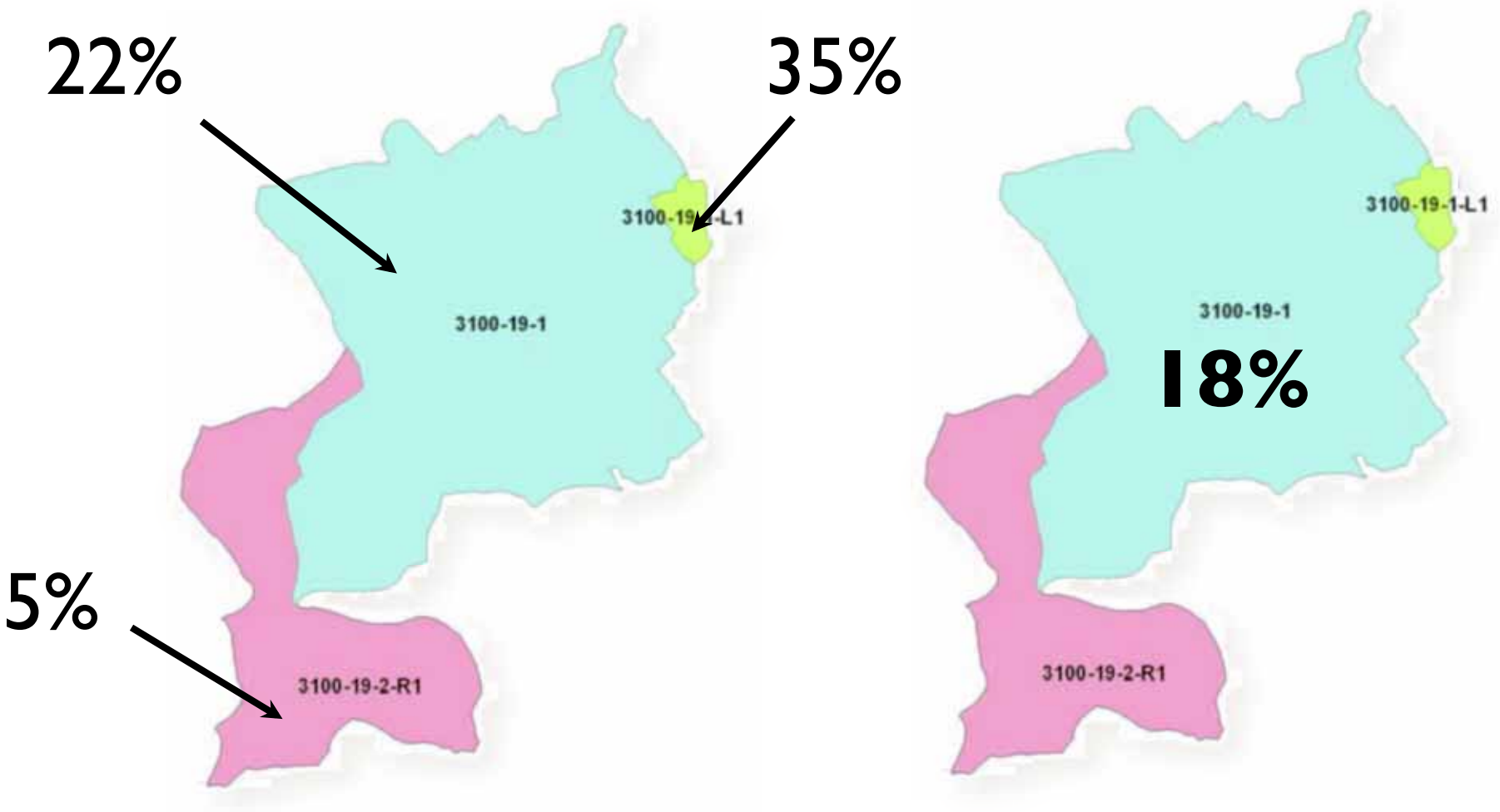
Beyond IC acres: monitoring weir



- 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

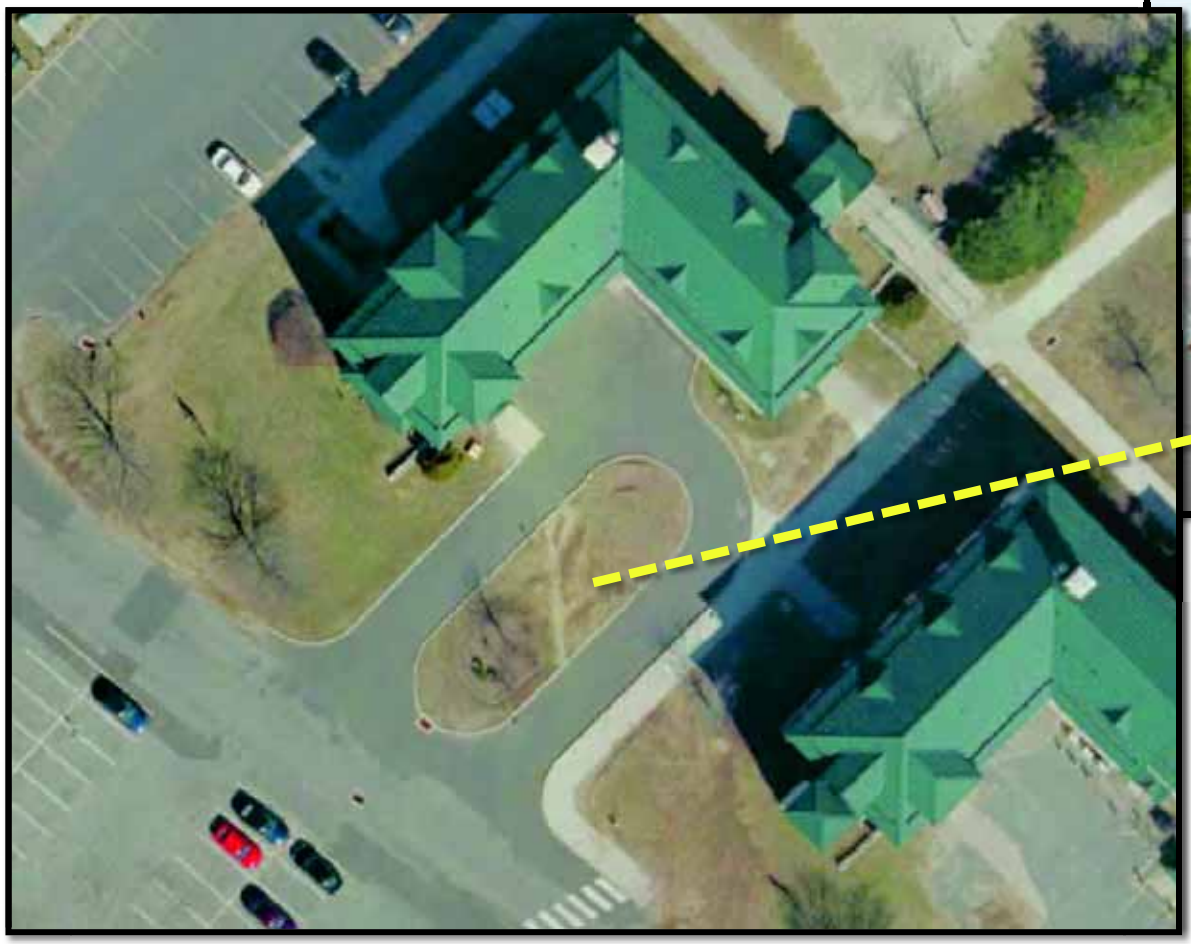
2. An opportunistic approach is more likely to get things done than a rigid list and schedule

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
- The project: implementation & progress
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- 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."

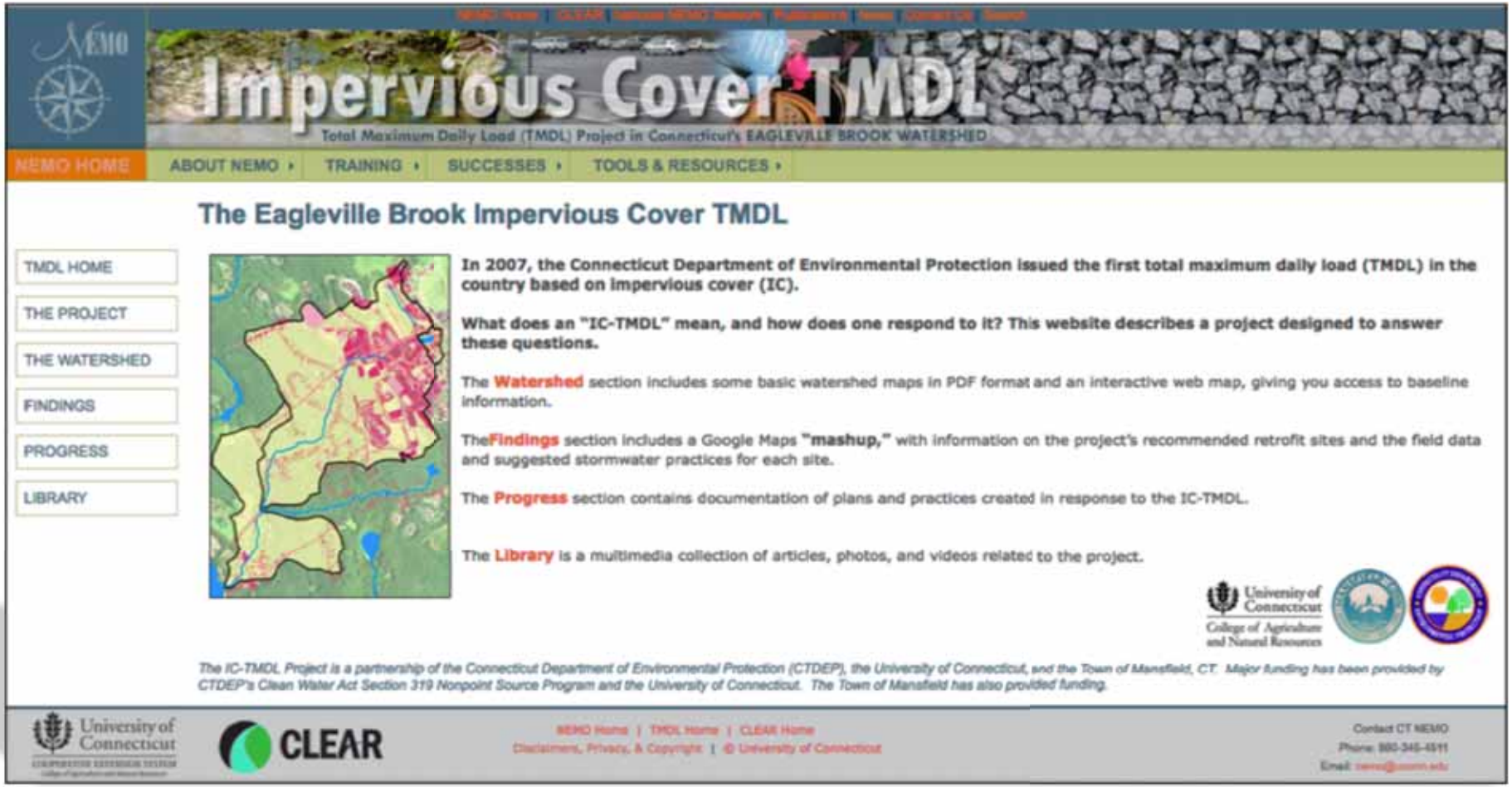
National Academy of Sciences Report (2009)

(Final tentative, interim, provisional conclusion)

Yes, it's working...

(so far)

clear.uconn.edu/projects/tmdl

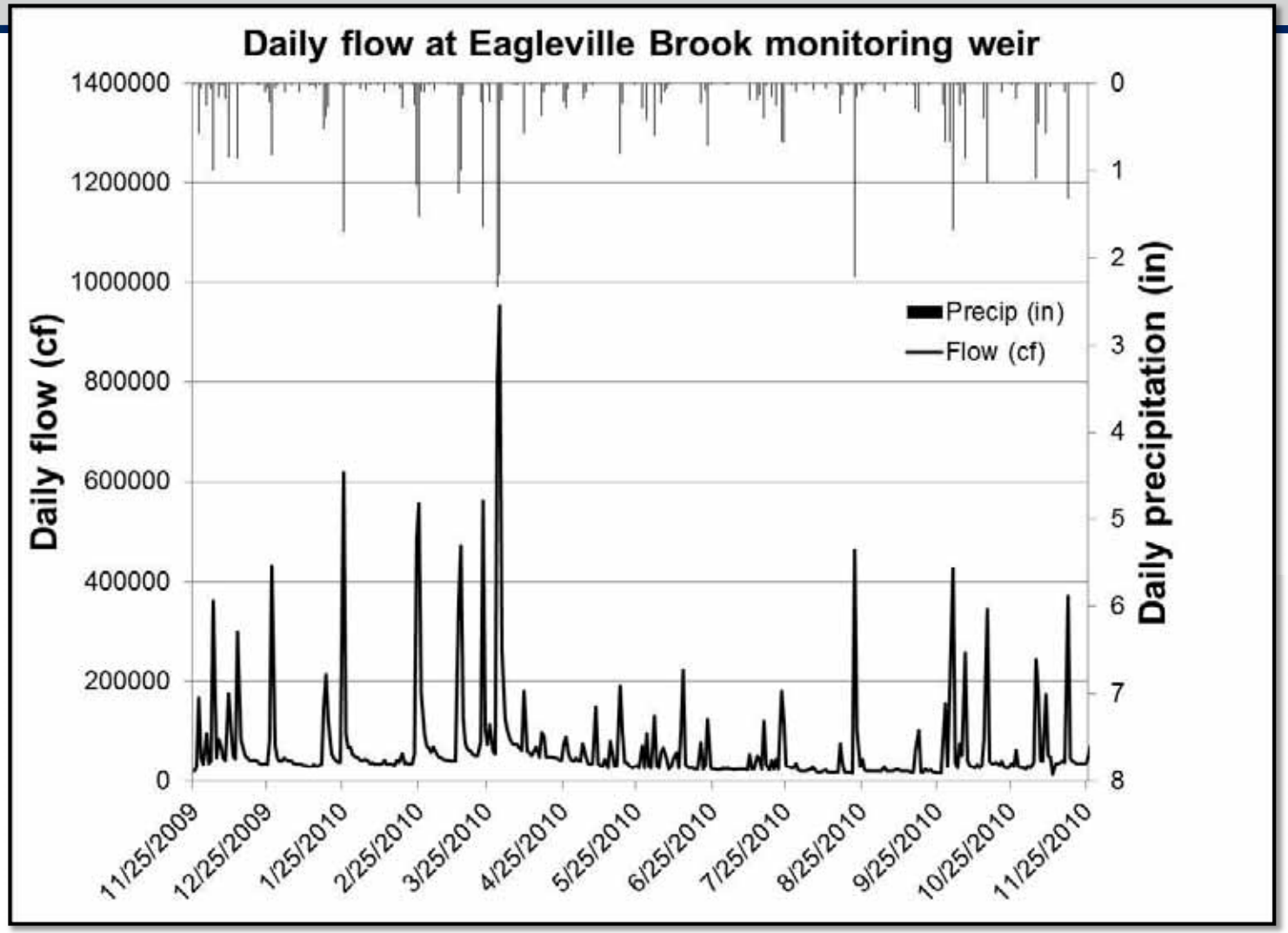


Important considerations/lessons

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