Low Impact Development Techniques

Stormwater Problems, Green Infrastructure Solutions

Michael Dietz, Ph.D.
CT Nonpoint Education for Municipal Officials (NEMO)
Center for Land Use Education and Research

March 24, 2014
Westport, CT

CLEAR

UCONN
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.

University of Connecticut
- College of Agriculture, Dept. of Extension
- College of Agriculture, Dept. of Natural Resources & the Environment
- Connecticut Sea Grant

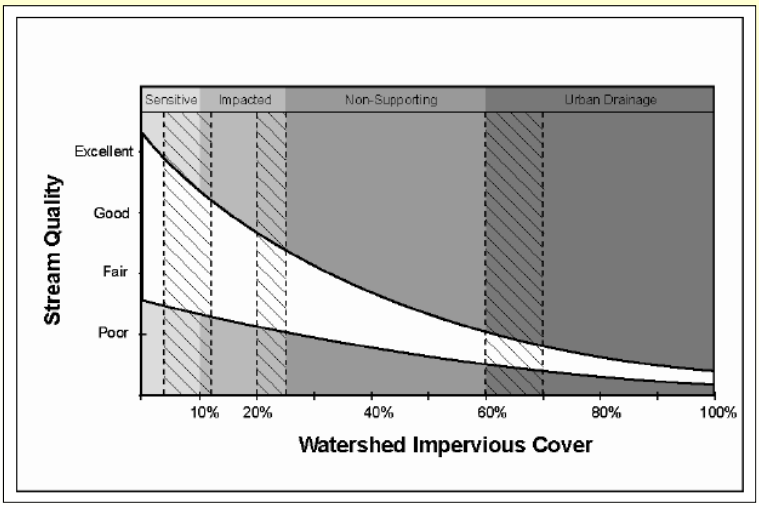
- Connecticut NEMO
- National NEMO Network
- Geospatial Training Program
- Land Use Academy
- Extension Forestry Program
- Lab for Earth Resource Information System

http://clear.uconn.edu


The "Old Era" of Water Pollution
Point Source Pollution


Nonpoint Source Pollution
Polluted Runoff is the #1 Water Quality Problem in the U.S.*
* USEPA

The (Updated) Impervious Cover Model



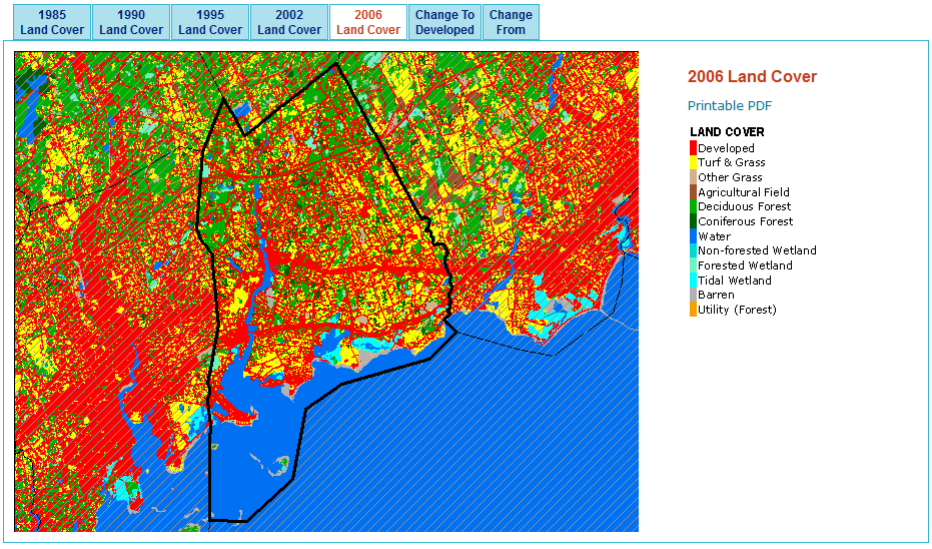
From Schueler, et al., 2009

Yeah, but is it really that big of a deal?

Let's look out the window…

- 93,200 ft^2 of impervious area
- 1 inch of rain = **58,100 gallons!**
- Annual (48") = **2,789,000 gallons!**
- **This is one building!**

"CCL" Project



http://clear.uconn.edu/projects/landscape/index.htm

Change in Westport: 1985 - 2006

Westport Land Cover and Land Cover Change

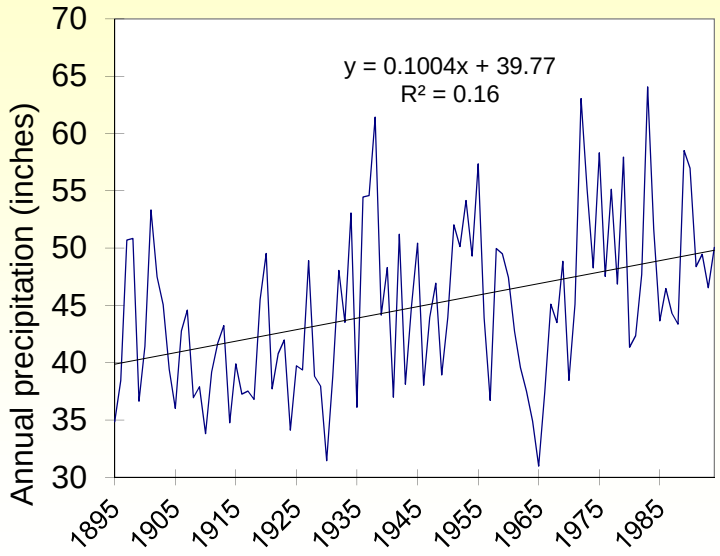
	1985		1990		1995		2002		2006		Change	
	acres	% of town	acres	% of town	acres	% of town	acres	% of town	acres	% of town	acres	% change
Developed	5540	%42.9	5623	43.5%	5673	43.9%	5712	44.2%	5754	44.6%	214.9	3.9%
Turf & Grass	2666	20.6%	2665	20.6%	2685	20.8%	2703	20.9%	2758	21.3%	91.4	3.4%
Other Grasses	130	1%	132	1%	127	1%	138	1.1%	141	1.1%	11.2	8.6%
Agricultural Field	74	0.6%	60	0.5%	60	0.5%	15	0.1%	14	0.1%	-60.1	-80.9%
Deciduous Forest	2621	20.3%	2584	20%	2555	19.8%	2543	19.7%	2482	19.2%	-139.7	-5.3%
Coniferous Forest	863	6.7%	855	6.6%	838	6.5%	827	6.4%	792	6.1%	-70.4	-8.2%
Water	316	2.4%	313	2.4%	312	2.4%	310	2.4%	306	2.4%	-10.2	-3.2%
Non-forested Wetland	20	0.2%	22	0.2%	22	0.2%	22	0.2%	21	0.2%	1.1	5.7%
Forested Wetland	291	2.3%	267	2.1%	248	1.9%	248	1.9%	247	1.9%	-44.2	-15.2%
Tidal Wetland	209	1.6%	200	1.5%	202	1.6%	199	1.5%	194	1.5%	-14.6	-7%
Barren	179	1.4%	188	1.5%	187	1.5%	193	1.5%	200	1.5%	20.8	11.6%
Utility (Forest)	7	0.1%	7	0.1%	7	0.1%	7	0.1%	7	0.1%	-0.2	-3.1%

Precipitation Regime Changing

- Research shows higher annual totals, and more high-intensity events in some parts of the Northeast

Rhode Island-Spring 2010

Annual precipitation in CT

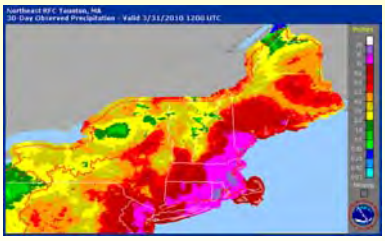


Source: Miller, et al. 2003. Precipitation in Connecticut. Report No. 38. Institute of Water Resources, University of Connecticut.

Sediment plume from Irene

Storm Frequency Analysis

100 year flood? 500 year storm?



- Probability of occurrence of a given precipitation event
  - Based on magnitude and duration of a rainfall event

e.g., "*the 100-year, 24 hour storm is 8.1 inches*"

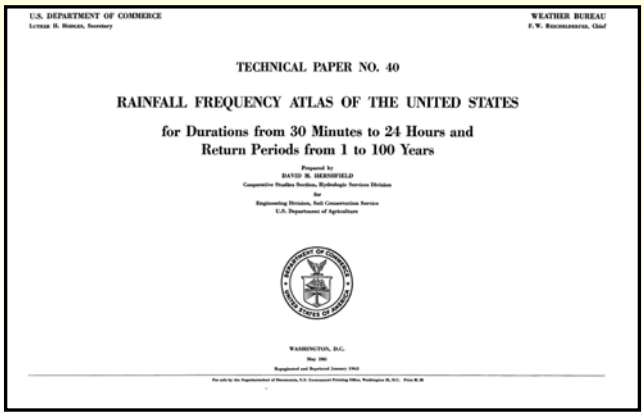
Probability and Return Period

Recurrence interval (years)	Probability of occurrence in any given year	Percent chance of occurrence in any given year
100	1 in 100	1
50	1 in 50	2
25	1 in 25	4
10	1 in 10	10
5	1 in 5	20
2	1 in 2	50

http://ga.water.usgs.gov/edu/100yearflood.html

Uses of storm frequency values

- Engineering design of culverts, storm drainage
  - TP-40 values (1961)



U.S. DEPARTMENT OF COMMERCE
Luther H. Hodges, Secretary

WEATHER BUREAU
F. W. Reichelderfer, Chief

TECHNICAL PAPER NO. 40

RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

for Durations from 30 Minutes to 24 Hours and
Return Periods from 1 to 100 Years

Prepared by
DAVID M. HERSHFIELD
Cooperative Studies Section, Hydrologic Services Division

for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

WASHINGTON, D.C.
May 1961
Reprinted and Reprinted January 1963

Effects of Using Outdated TP-40 Values

- Due to changes in precipitation intensity and frequency, older return period estimates are inaccurate
  - This can lead to undersized stormwater infrastructure
- Researchers at Cornell have updated these values

http://precip.eas.cornell.edu/

Westport, CT Precip. Values (24 hr)

RI	TP-40 (in)	Updated values (in)
1	2.5	2.85
5	4.0	4.31
10	5.0	5.11
25	6.0	6.39
50	6.5	7.57
100	7.0	8.97

Low Impact Development (LID) Site Planning and Design Concepts

- The Goal: To preserve pre-development hydrology
  - Runoff volume and rate
  - Groundwater recharge
  - Stream baseflow
  - Runoff water quality

Site Planning and Design Concepts

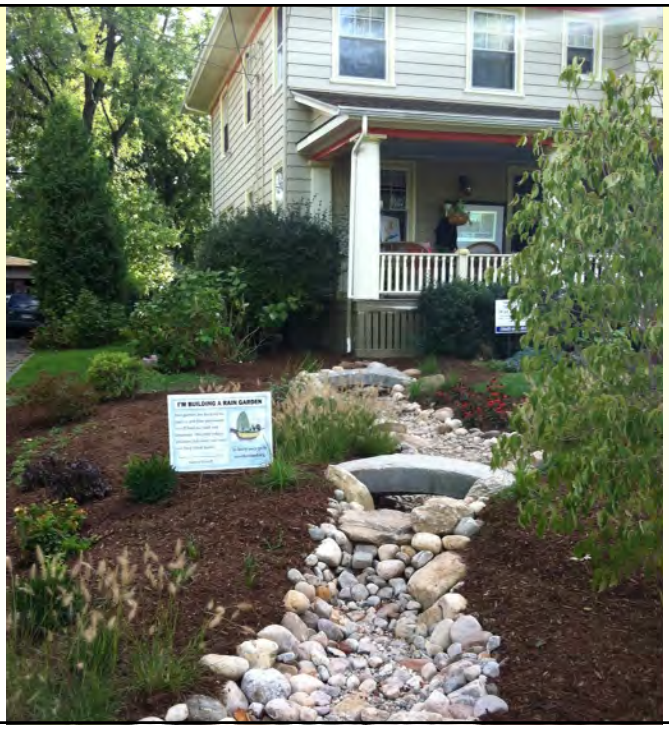
- Design developments to fit the natural terrain
- Maintain pre-development vegetation
- Provide setbacks and vegetated buffers
- Limit land disturbance
- Reduce or disconnect impervious areas

The Practices (the sexy part of LID)

- Bioretention/rain gardens
- Pervious pavements
- Green roofs
- Rainwater harvesting

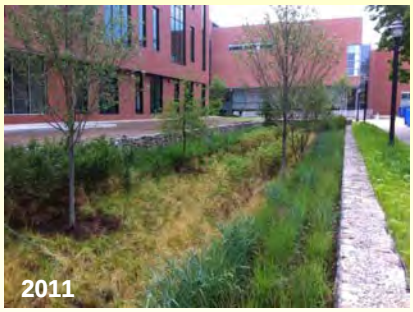
Bioretention/rain gardens

Photo courtesy of
Steve Trinkaus



Rain Gardens

Bioretention at UConn



Haddam, CT bioretention

99% of inflow retained!

(2 year period of study)

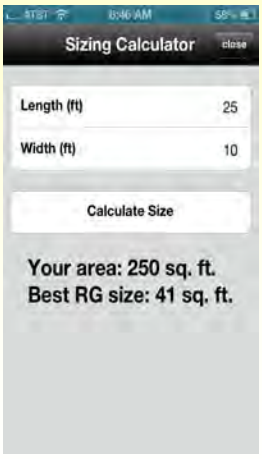
Despite measurable frost, no decrease in infiltration in winter!

Plants

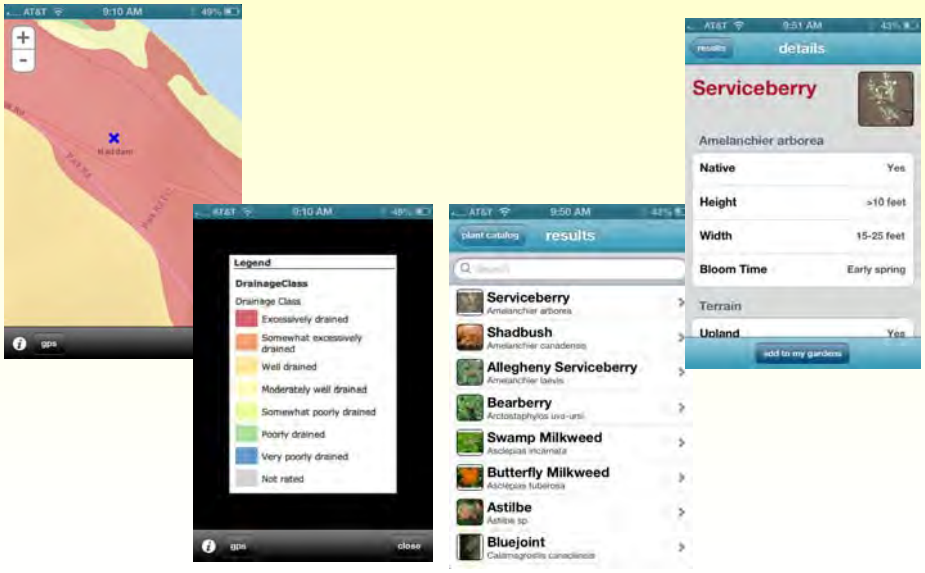
- Native or well-adapted non-natives
- Plants that like wet feet, but can tolerate extended dry periods
- Database in app or website

http://nemo.uconn.edu/raingardens

Smartphone app!



Rain garden app



Important factors with bioretention

- Seasonal high water table, bedrock
- Soil compaction before, during construction

Green Roofs - *intensive*

Green Roofs - *extensive*

Ford Motor Company
Assembly Plant, Dearborn, MI

Courtesy of Michigan State University Dept. of Horticulture

Green Roofs

- Yes we have some in CT!

Green Roofs at UConn

Retained 54% of precipitation

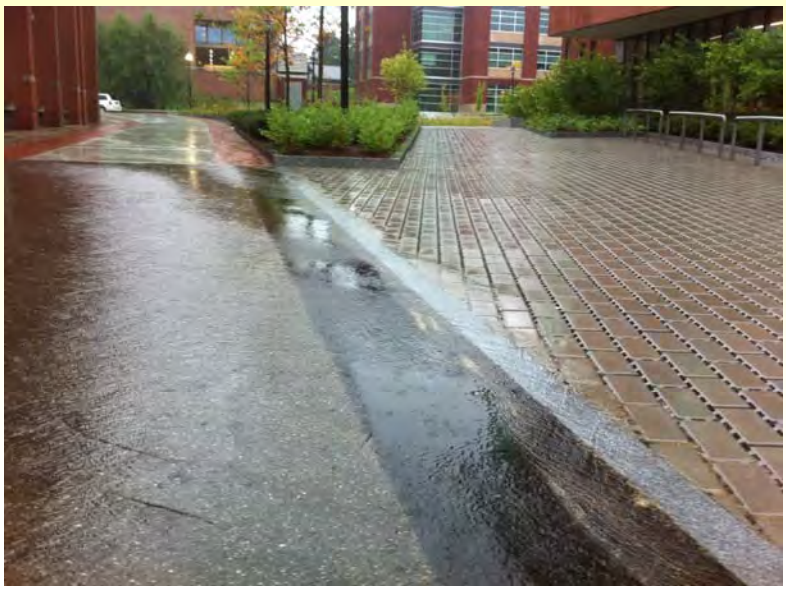
Gregoire, B., and J. Clausen. 2011. Effect of a modular extensive green roof on stormwater runoff and water quality. *Ecological Engineering.* Vol. 37, pp. 963-969.

Permeable Pavements

Permeable Interlocking Concrete Pavers (PICPs)

- Similar to traditional block pavers
- When installed, there are voids in between pavers that get filled with peastone or turf

PICPs at UConn



2013
Hillside Rd Snow Shelf

Plastic grid pavers

- NetPave®50

Pervious asphalt at CT State Capitol

Pervious asphalt at UConn

Towers-2009

Northwoods-2010

Pervious concrete at CT State Capitol

Other pervious concrete in CT

- Field house parking lot, UConn Storrs

Pre-cast pervious concrete

- "Stormcrete" from Porous Technologies (Yarmouth, ME)

Other products

- Variations on the theme of aggregate with binder, minus the fines

Gravel-Lok

- Polymer binder for any type of aggregate

Low Impact Development Practices

- Rainwater Harvesting
  - Rain barrels
  - Cisterns

Tracking stormwater reduction at UConn

	Location	Watershed	Sub-code	Type	Date Installed	Stormwater treated to date (ft^3)	Stormwater treated to date (gal)
1	Towers dorms	Eagleville		Bioretention	Oct-03	101706	760859
2	Towers dorms	Eagleville		Pervious asphalt	Aug-09	433971	3246539
3	Lakeside apartments	Eagleville		PICP	Jun-05	30405	227463
4	Hilltop dorms	Eagleville		Bioretention	Aug-05	157621	1179160
5	Burton-Shenkman	Eagleville		Bioretention	Aug-05	2335250	17470008.3
6	Field House	Eagleville		Pervious concrete	Aug-09	195216	1460411
7	MSB	Eagleville		Green roof	Sep-09	23485	175690
8	Northwoods apartments	Eagleville	Building 1	Bioretention	Jul-10	212788	1591869
9	Northwoods apartments	Eagleville		Pervious asphalt	Jul-10	471002	3523566
10	Hillside Rd. snow shelf	Eagleville	sw	PICP	Jun-11	109923	822330
11	Hillside Rd. snow shelf	Eagleville	se	PICP	Aug-12	27958	209152
12	Hillside Rd. snow shelf	Eagleville	n	PICP	Oct-12	40496	302952
13	Laurel Hall	Eagleville		Bioretention	Jul-11	234290	1752723
14	Laurel Hall	Eagleville		PICP	Jul-11	30888	231075
15	Laurel Hall	Eagleville		Green roof	Jul-11	59833	447611
16	Water reclamation facility	Eagleville		Bioretention	Jul-12	139711	1045181
17	Water reclamation facility	Eagleville	Rain water harve	Water harvest	Jul-12	65382	489123
18	Sundial	Eagleville		PICP	May-13	5160	38599
19	Mansfield apartments	Fenton	east	Bioretention	Sep-10	28111	210299
20	Mansfield apartments	Fenton	west	Bioretention	Sep-10	82647	618282
21	Storrs Hall	Fenton		Pervious asphalt	Aug-12	32308	241696
22	Oak Hall	Fenton	north	Bioretention	Aug-12	48367	361833
23	Oak Hall	Fenton	south	Bioretention	Aug-12	51208	383086
24	Oak Hall	Fenton		PICP	Aug-12	22466	168067
25	Storrs Hall	Fenton		Green roof	Sep-12	5591	41823
26	Whetton	Fenton		Bioretention	Sep-13		0
27	Whetton	Fenton		Pervious asphalt	Sep-13		0
						Grand Total	36,999,397

Daily rainfall

Cumulative volume of stormwater reduction by campus LID practices

□56 x

Total area of impervious cover disconnected by campus LID practices = >10 acres =

7.3 x

In summary…

- We have drastically altered the hydrologic cycle
- Changing climate will only make problems worse
- LID practices work, they enhance aesthetics, increase property values, and can cost less!!

LID Atlas

- http://nemo.uconn.edu, click on LID Inventory

Resources

- CLEAR resources
  http://clear.uconn.edu
- Webinars
  http://clear.uconn.edu/webinars/CLEARseries/index.htm
- Rain garden page
  http://nemo.uconn.edu/raingardens
- TMDL Project
  http://clear.uconn.edu/projects/tmdl
- Jordan Cove
  http://jordancove.uconn.edu

Questions??

michael.dietz@uconn.edu

Funding for the monitoring of the Haddam rain garden was provided by a Long Island Sound License Plate Grant

Funding for the Jordan Cove project was provided by the CT DEP through a US EPA §319 nonpoint source Clean Water Act grant