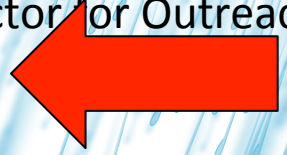
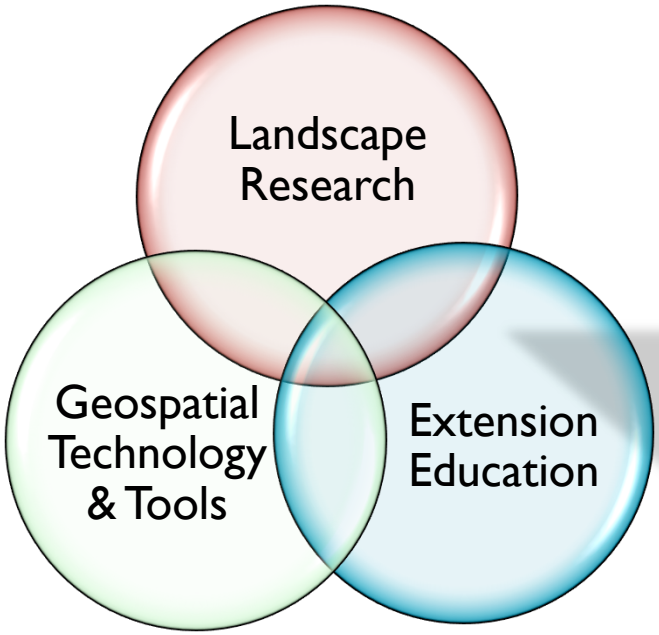
Stormwater, flooding & climate change

Chet Arnold
CLEAR Director for Outreach
NOT a P.E.



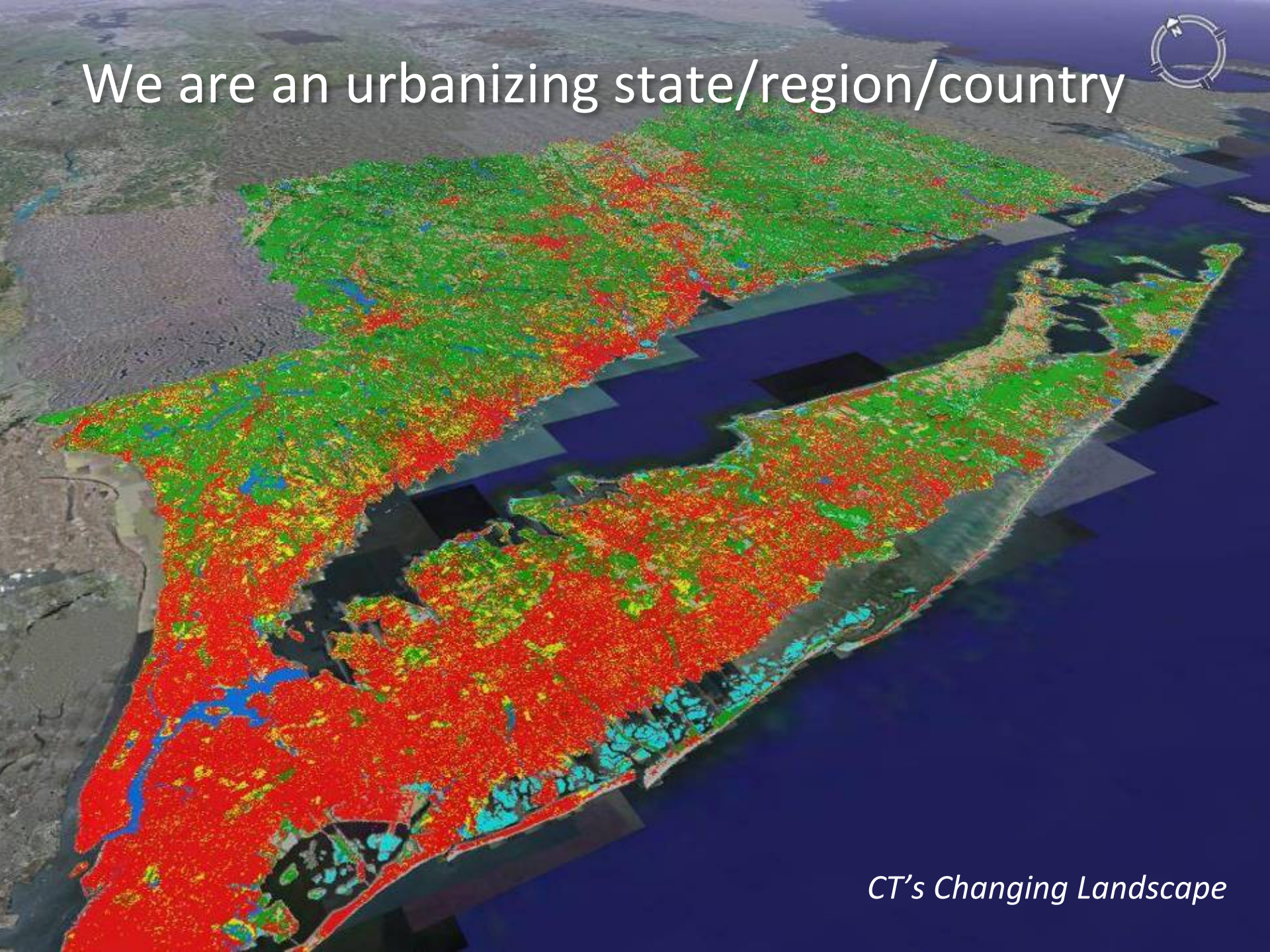
clear.uconn.edu

- Water
- Land use & climate adaptation
- Geospatial (mapping) technology



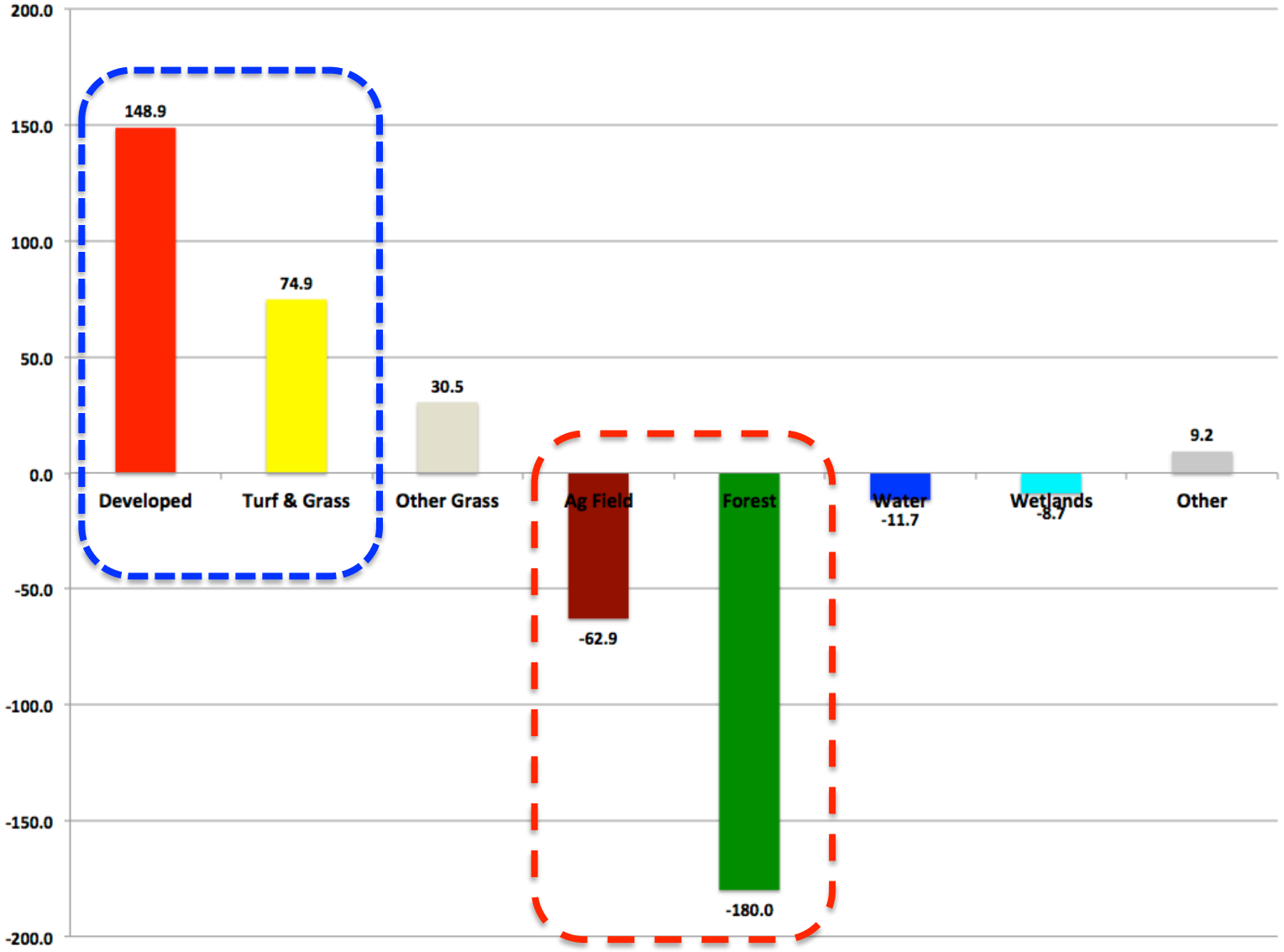
The view from Chez Arnold…

We are an urbanizing state/region/country



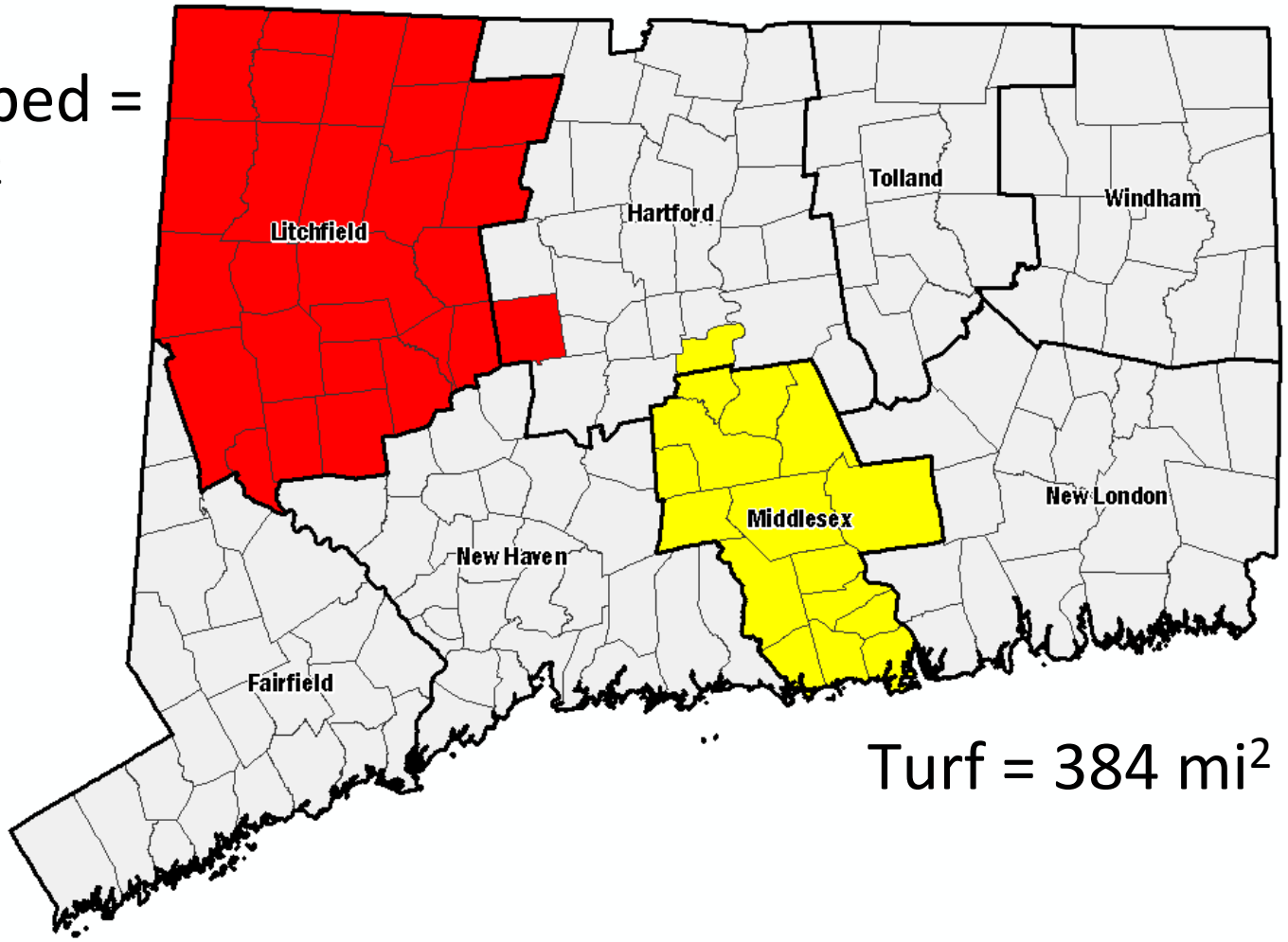
CT's Changing Landscape

CT land cover change: 1985 - 2010



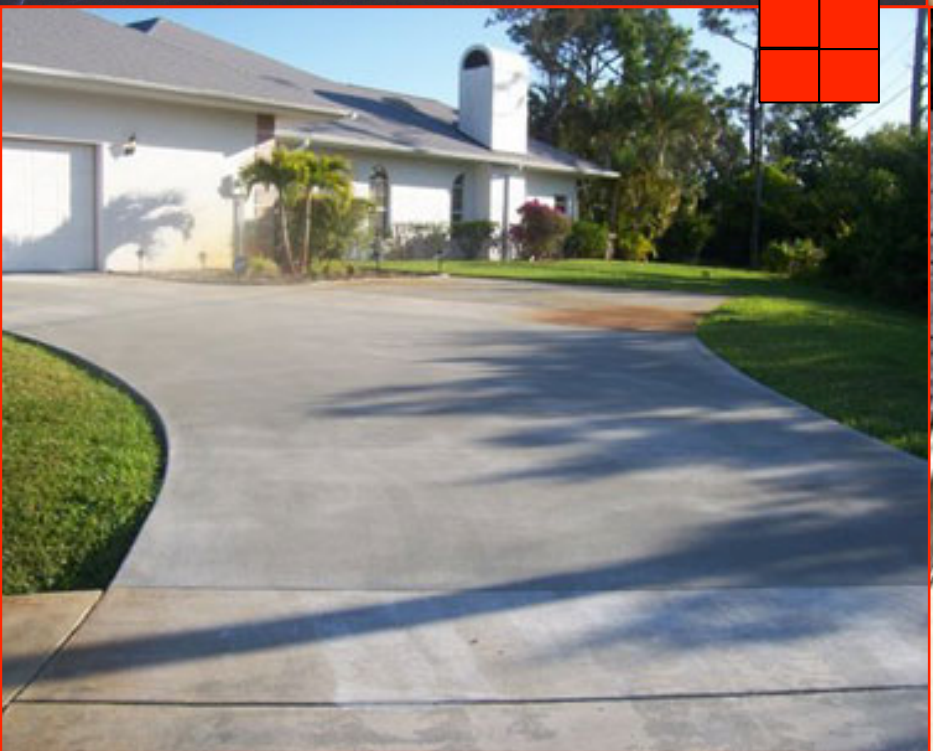
The “development footprint”…

Developed = 946 mi^2

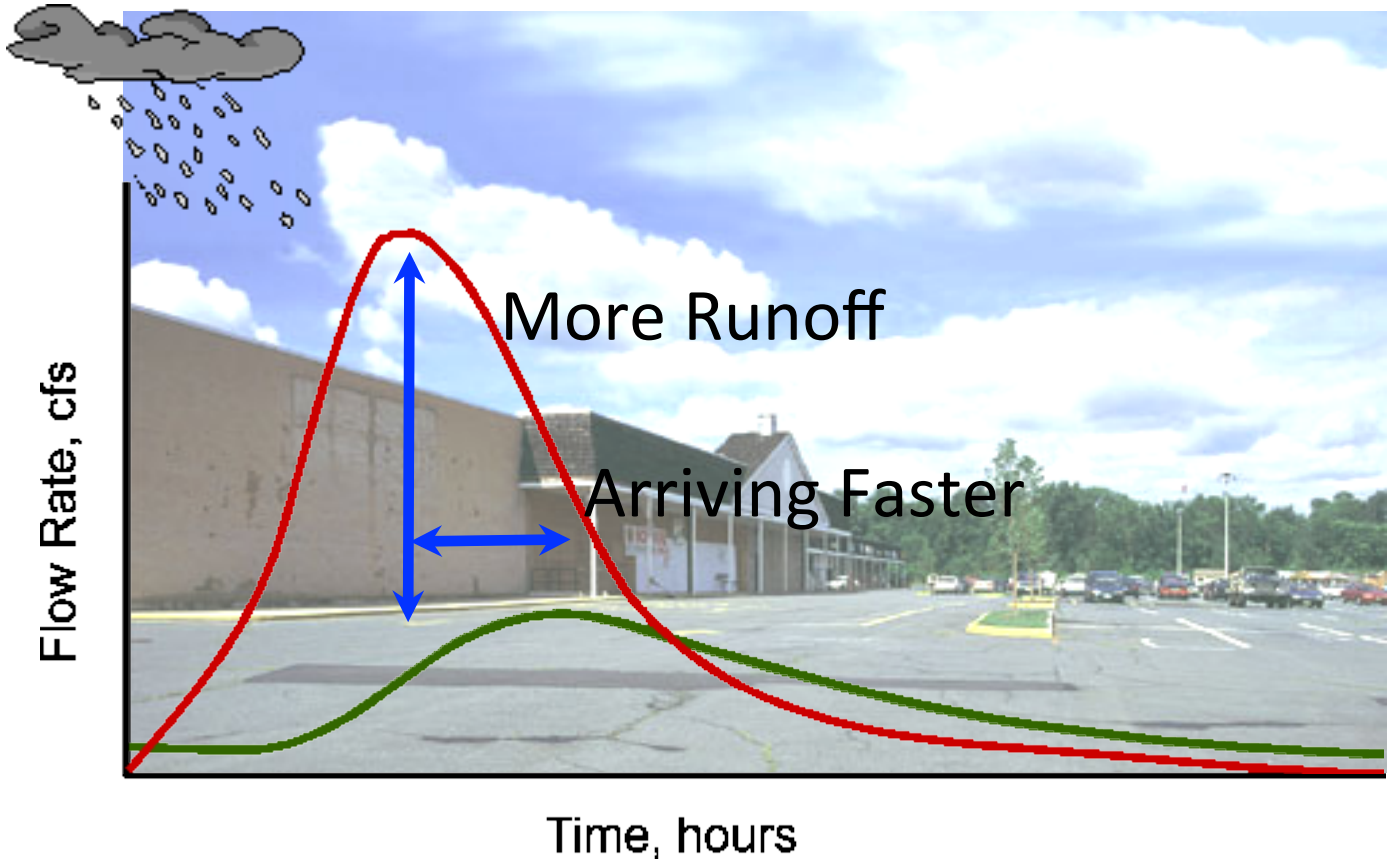


Turf = 384 mi^2

Impervious Surfaces



Hydrologic Impacts of Development



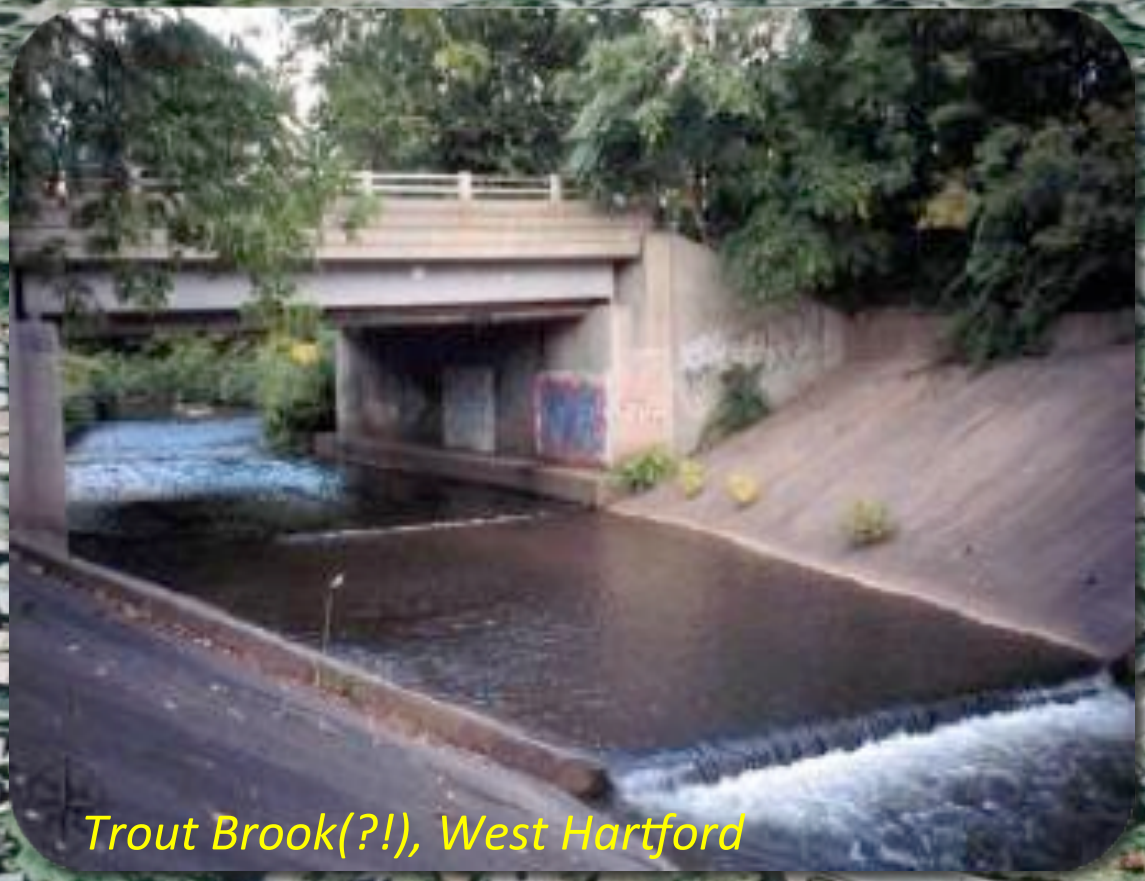
The Effects of Urbanization

Falls River, Essex

The Effects of Urbanization

Goodwives River, Darien

The Effects of Urbanization



Trout Brook(?!), West Hartford

The Effects of Urbanization: Park River, CT

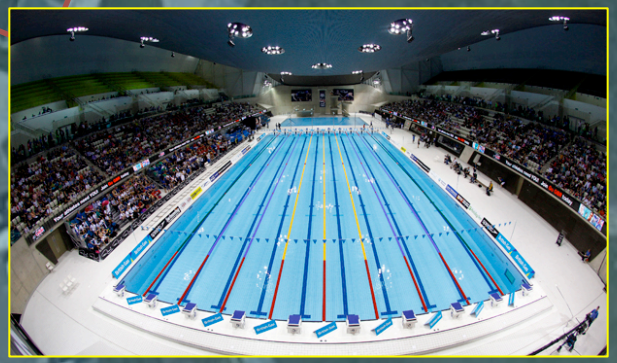
Is it really all that big a deal?

43,000 ft^2 of impervious area

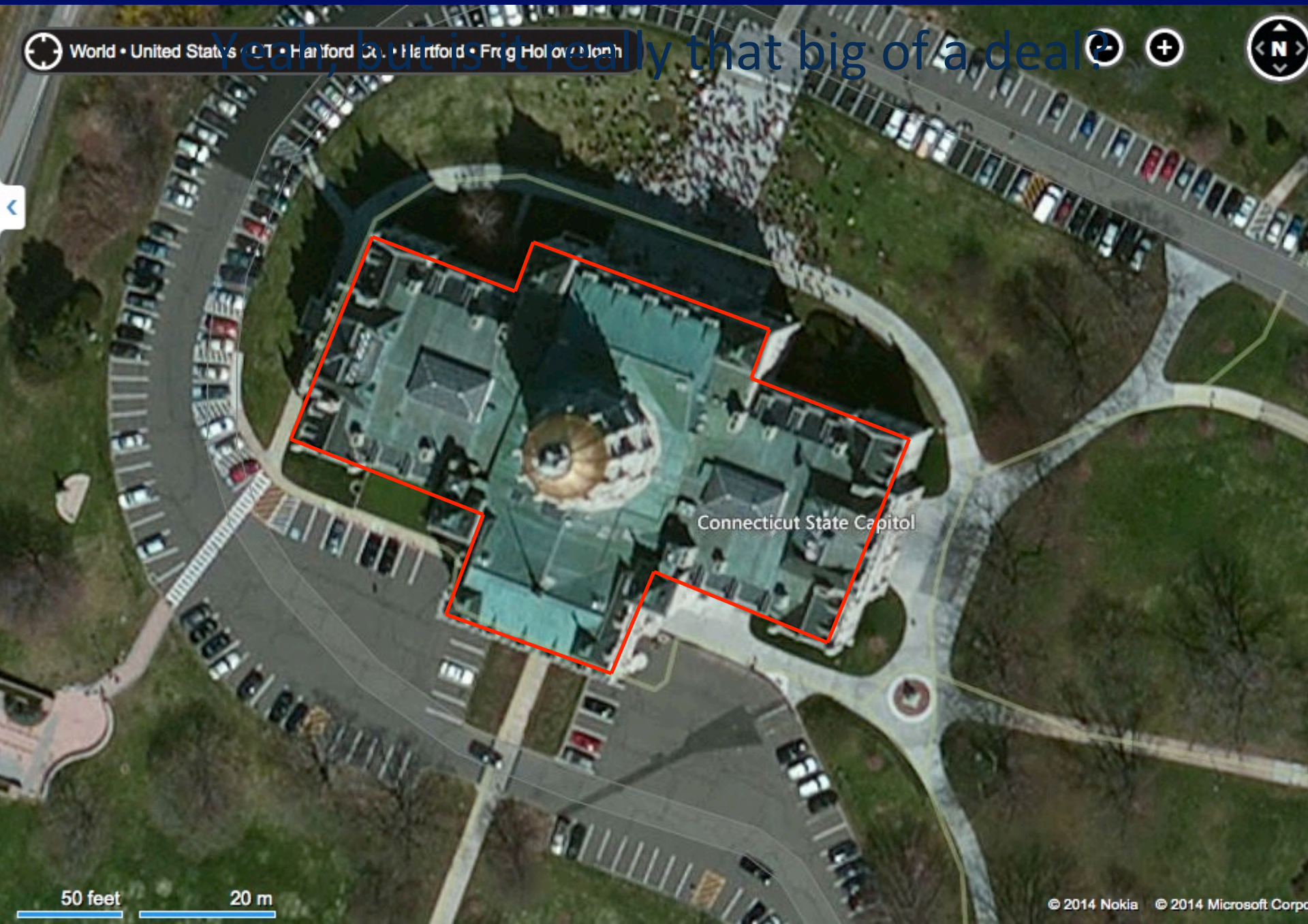
1 inch of rain = 26,810 gallons

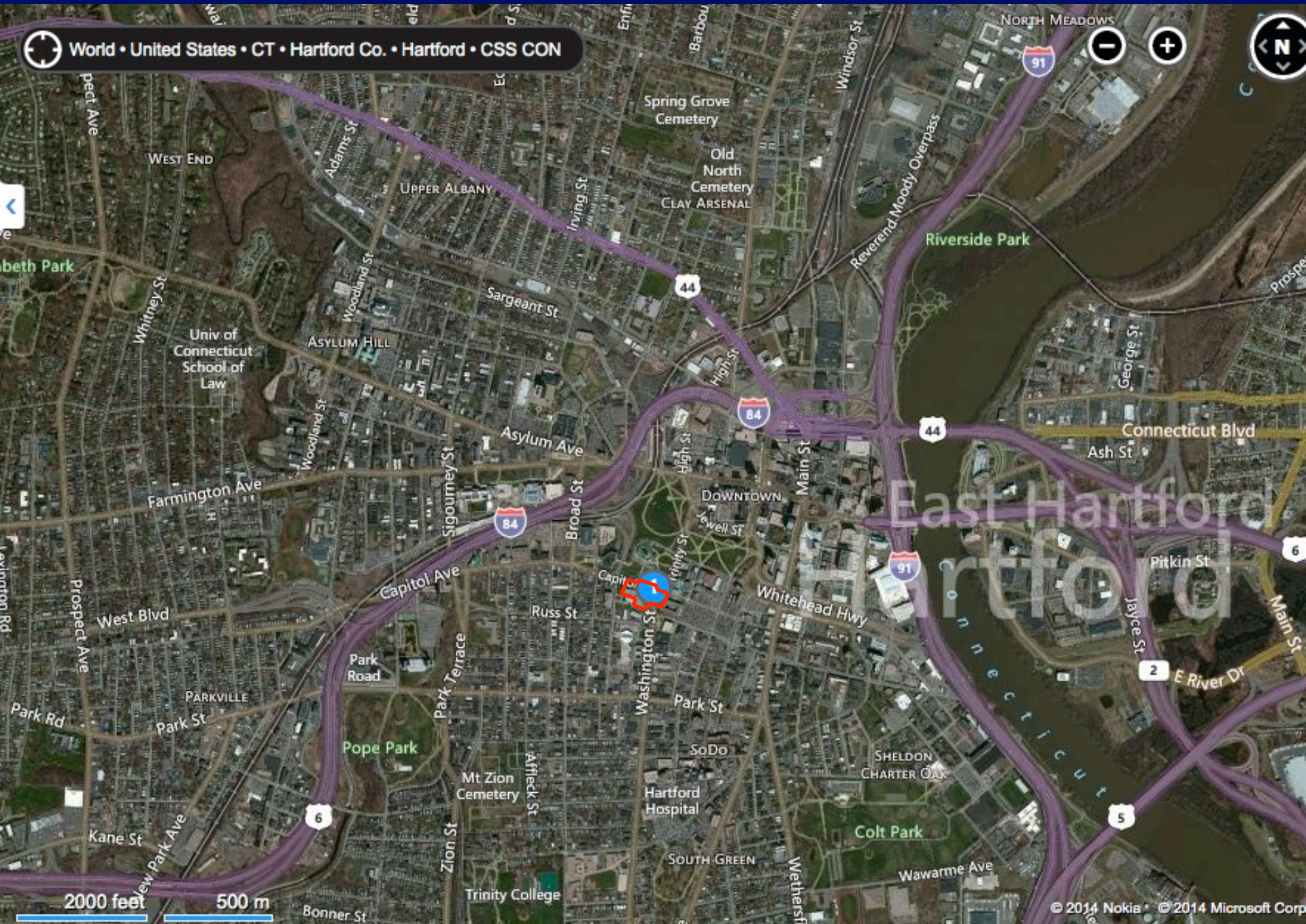
Annual (48”) = 1,286,880 gallons

= 2 Olympic pools!



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




World • United States • CT • Hartford Co. • Hartford • CSS CON
North Meadows
Spring Grove Cemetery
Old North Cemetery
Clay Arsenal
West End
Upper Albany
Riverside Park
Reverend Moody Overpass
Windsor St
Adams St
Irving St
Woodland St
Whitney St
Sargeant St
Univ of Connecticut School of Law
Asylum Hill
Asylum Ave
Farmington Ave
Sigourney St
Broad St
High St
Main St
Downtown
Jewell St
Connecticut Blvd
Ash St
George St
East Hartford
Hartford
Pitkin St
Capitol Ave
Whitehead Hwy
Russ St
Washington St
Park Terrace
Park Road
Parkville
West Blvd
Prospect Ave
Park Rd
Park St
Pope Park
Mt Zion Cemetery
Affleck St
SoDo
Hartford Hospital
Sheldon Charter Oak
Jayce St
E River Dr
Main St
Colt Park
South Green
Wawarme Ave
Kane St
New Park Ave
Zion St
Trinity College
Bonner St
Connecticut
2000 feet
500 m
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Water Pollution

Stormwater is the #1 source of water pollution in the U.S. (US EPA)

NATIONAL GEOGRAPHIC

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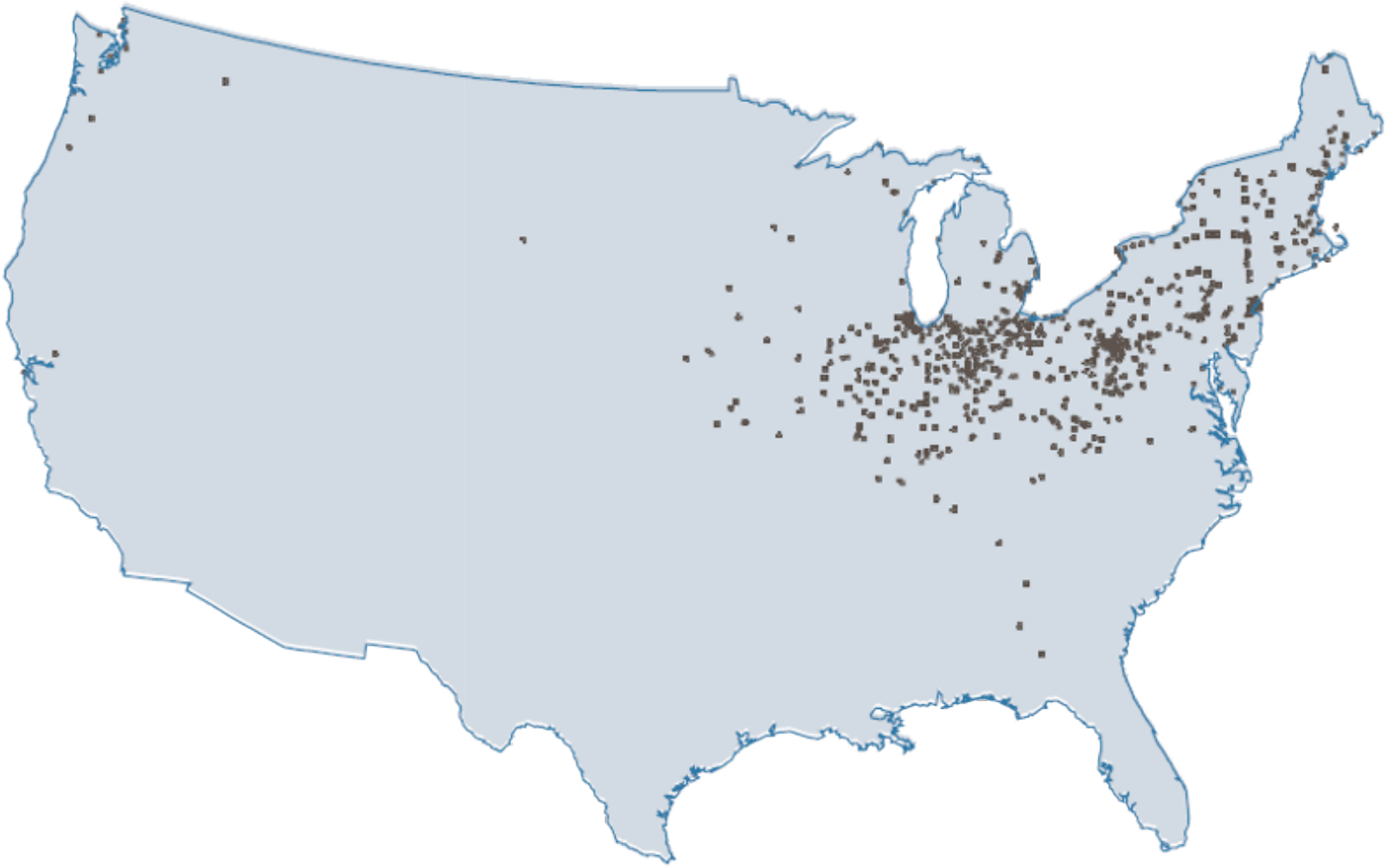
Driven by Climate Change, Algae Blooms Behind Ohio Water Scare Are New Normal

Climate change and increased runoff are triggering more potentially toxic blooms.

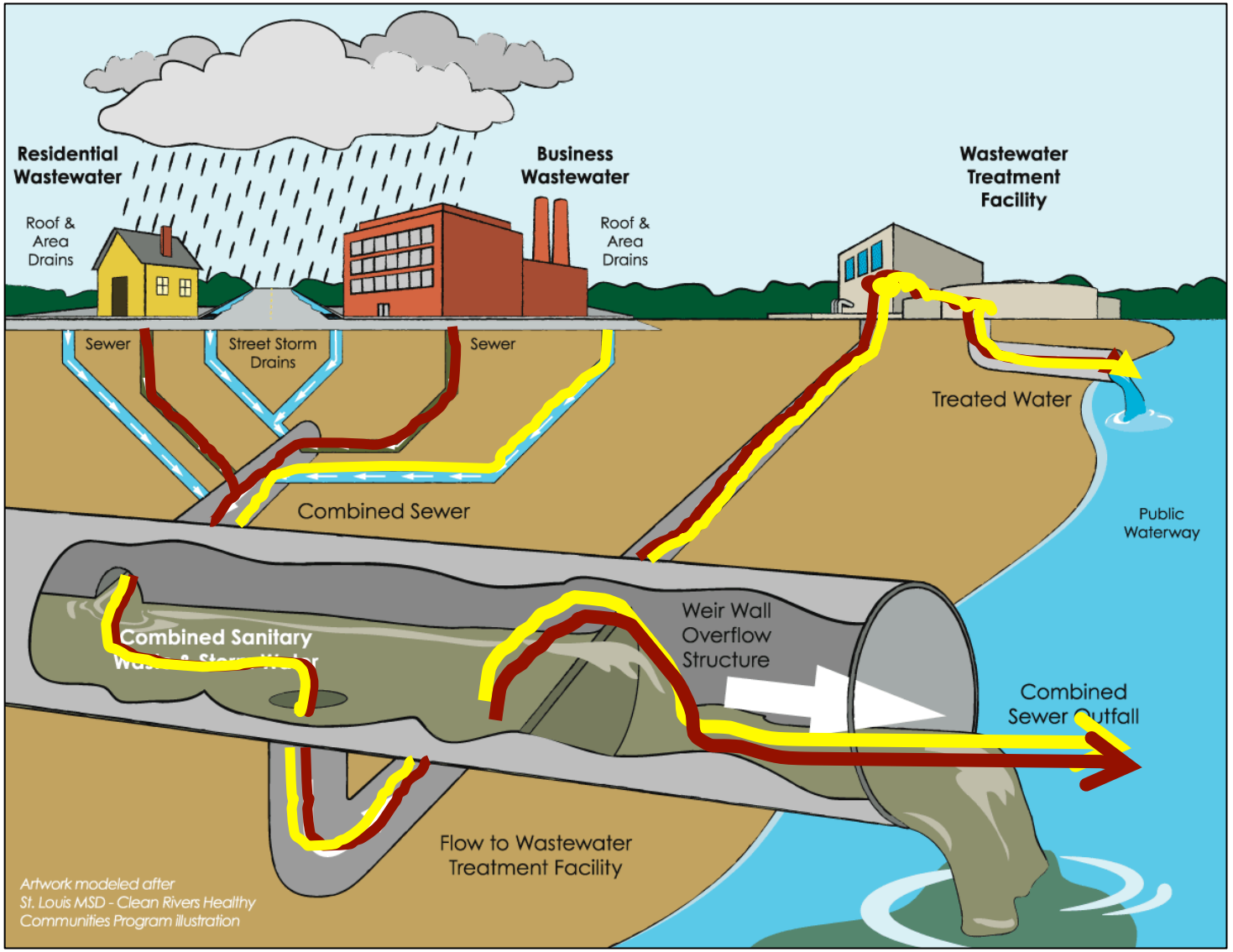
Revised Stormwater Rule (MS-4 Program)

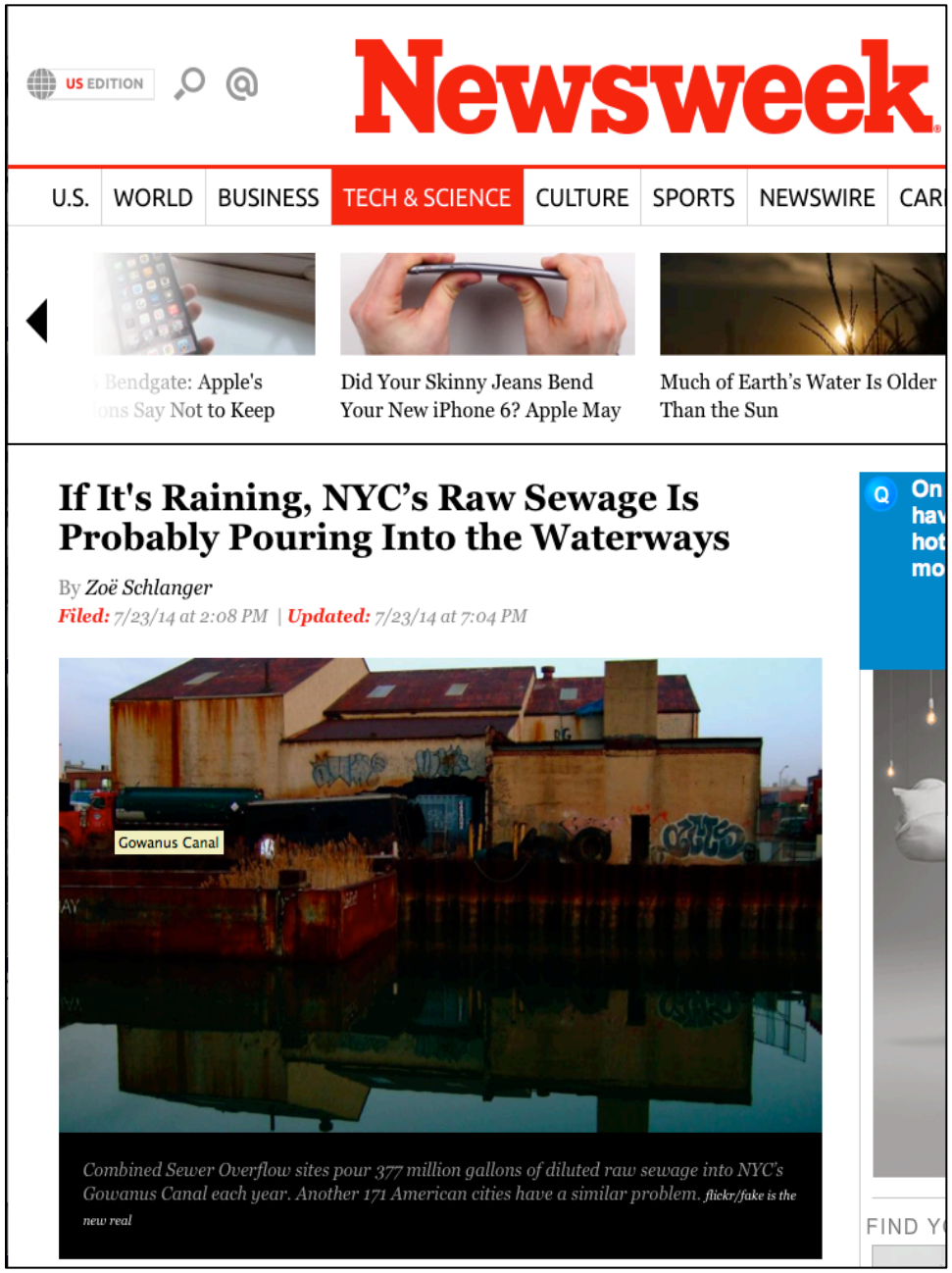
- More towns (basically, everybody) covered
- State and federal properties covered
- Same 6 “minimum management measures” but:
  - More detailed guidance/requirements
  - Heavy emphasis on green infrastructure
  - Stronger maintenance requirements

Cities with Combined Sewers



Combined Sewer Overflows





CSOs in NYC are triggered by as little as 0.05" of rain

And now….*climate change*

May 1, 2014

49° Broken Clouds

The Courant

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Sewage Spill In Stamford Closes Beaches, Cancels Regatta

By KELLY GLISTA, Kglista@courant.com
5:55 pm, May 1, 2014

STAMFORD — Heavy rains overnight caused about 25 million gallons of partially-treated sewage to spill into the Stamford Harbor from the wastewater treatment plant, officials said Thursday.

The city has closed the beaches and shellfish beds, and canceled a regatta that was scheduled for this weekend as a precaution, city Director of Administration Mike Handler said. Increased beach patrols are planned as well.

The spill began at about 10:30 p.m. Wednesday, Handler said, when the water flow exceeded what the wastewater treatment plant was designed to handle. Early Thursday morning the plant experienced the highest level of water flow ever recorded there, he said.

The water flow level decreased throughout the day Thursday and is expected to return to normal levels Thursday night, Handler said.

A state Department of Energy and Environmental Protection spokesperson said that they've been in touch with Stamford officials since early Thursday morning. The city Health Department will be taking samples of the water to measure bacteria levels, which are expected to be very high.

Heavy Rain Caused Sewage Spills In State Waterways

"Early Thursday morning the plant experienced the highest level of water flow ever recorded…"

Flooding

August 13, 2014

Newsday knows why the Kardashians won't be taking Plum Island.

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Weather Newsday > News

Reprints

34 Comments

Day after historic rainfall, help for residents as cleanup continues

Originally published: August 14, 2014 8:12 AM
Updated: August 14, 2014 9:45 AM
By JOHN VALENTI john.valenti@newsday.com

Road closures across Long Island as heavy rain falls

00:00 01:18

Roads across Long Island were flooded Wednesday morning, Aug. 13, 2014, by heavy rain that began overnight. The flooding snarled the morning commute and caused delays and cancellations on the Long Island Rail Road. (Credit: Newsday / Staff)

Related media

On the morning after a storm of biblical proportions deluged Long

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Newsday on social media

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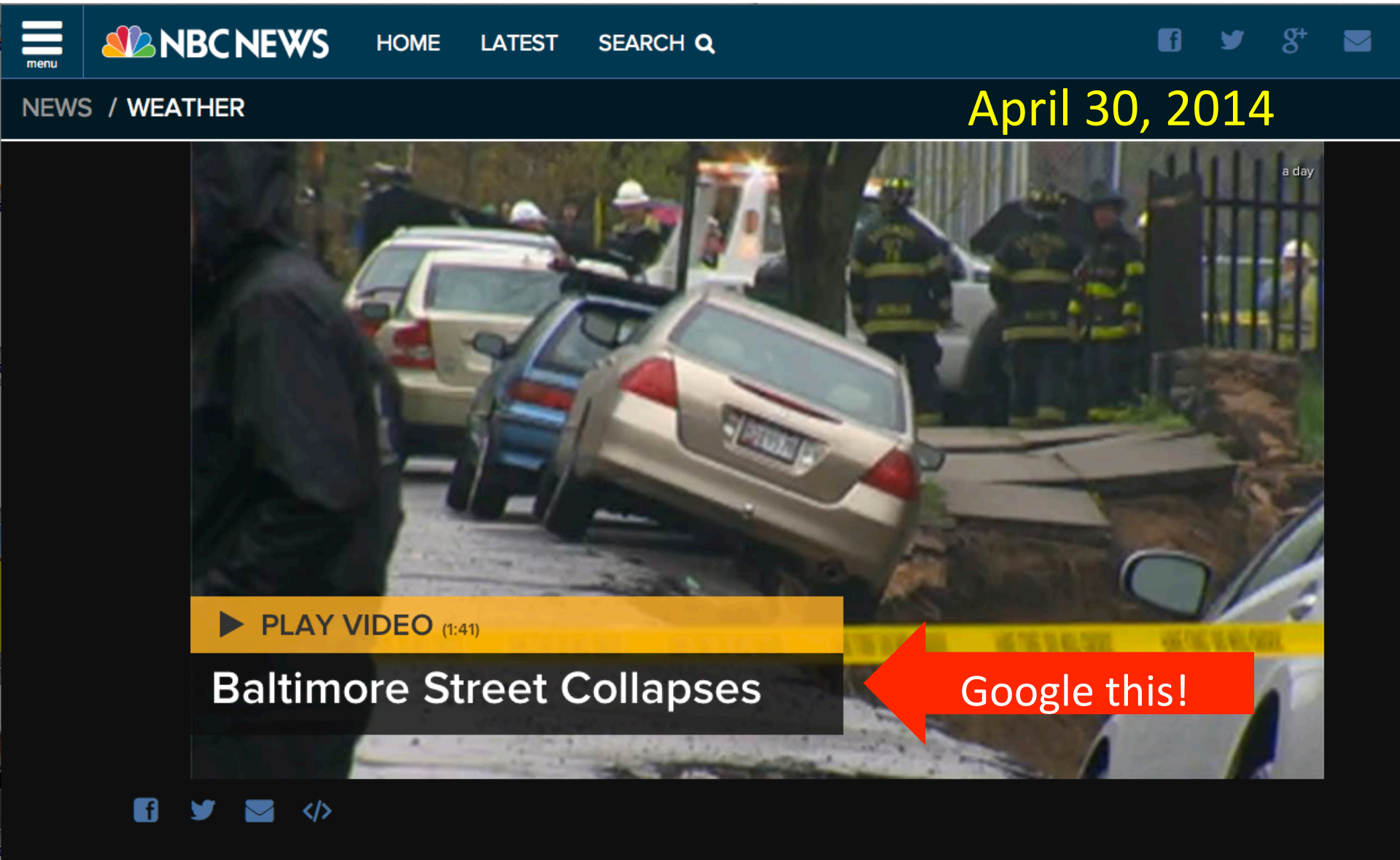
Erosion

Large portions of Vermont arriving at Long Island Sound after Irene…

Infrastructure Meltdown



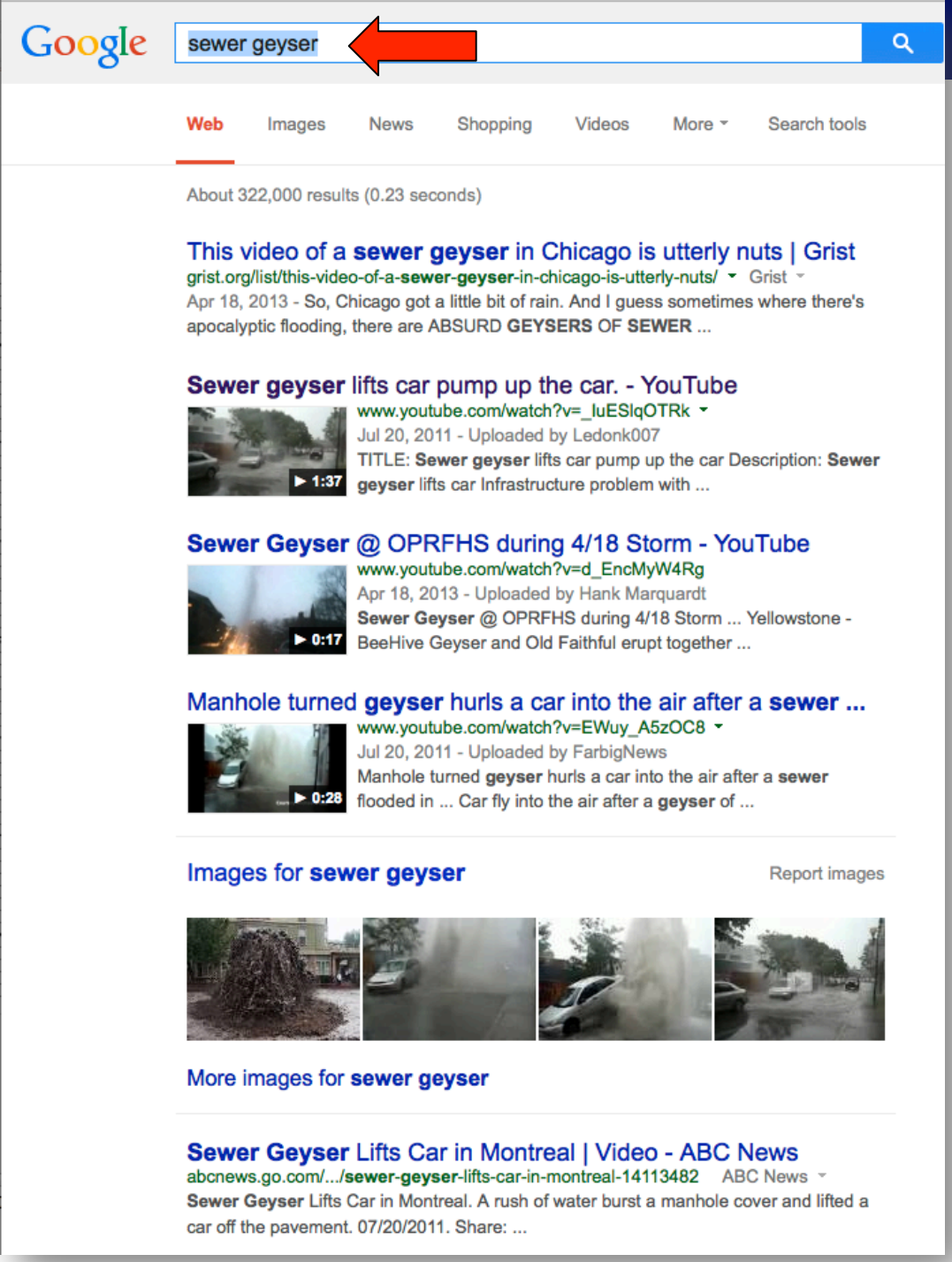
A partial list of road closings during 2013 Colorado flooding ⟶

Photo By Tim Rasmussen/The Denver Post

- U.S. 287 at Big Thompson River in Loveland from Colorado 402 to 5th Street
- U.S. 287 southbound at Wyoming line for commercial vehicles
- Colorado 7 between Lyons and Estes Park
- Colorado 8 between Morrison and U.S. 285
- Colorado 14 between Ted's Place and Walden
- Colorado 30 (Havana Street/Aurora) at Alameda Avenue
- Colorado 44 (104th Avenue) at Riverdale Road
- Colorado 52 eastbound from County Road (CR) 1 to U.S. 287
- Colorado 60 at CR 46
- Colorado 66 between 53rd Street (Longmont) and Lyons
- Colorado 66 between CR 13 and CR 19
- Colorado 72 between 72nd and 80th avenues
- Colorado 72 between Colorado 93 and Colorado 119 (Coal Creek Canyon)
- Colorado 74 between CR 73 (Evergreen) and Morrison
- Colorado 83 (Parker Road) between Florida and Jewell avenues
- Colorado 93 between 64th Avenue and Colorado 128
- Colorado 119 between Boulder and Nederland (Boulder Canyon)
- Colorado 119 between County Line Road and I-25
- Colorado 257 between Colorado 60/Milliken to U.S. 34

Roads that have reopened include:

- U.S. 6 (Vasquez Boulevard) between 60th and 74th Avenues
- U.S. 36 eastbound from Table Mesa Drive to 96th Street
- Colorado 265 (Old Brighton Road) at Colorado Boulevard in Commerce City

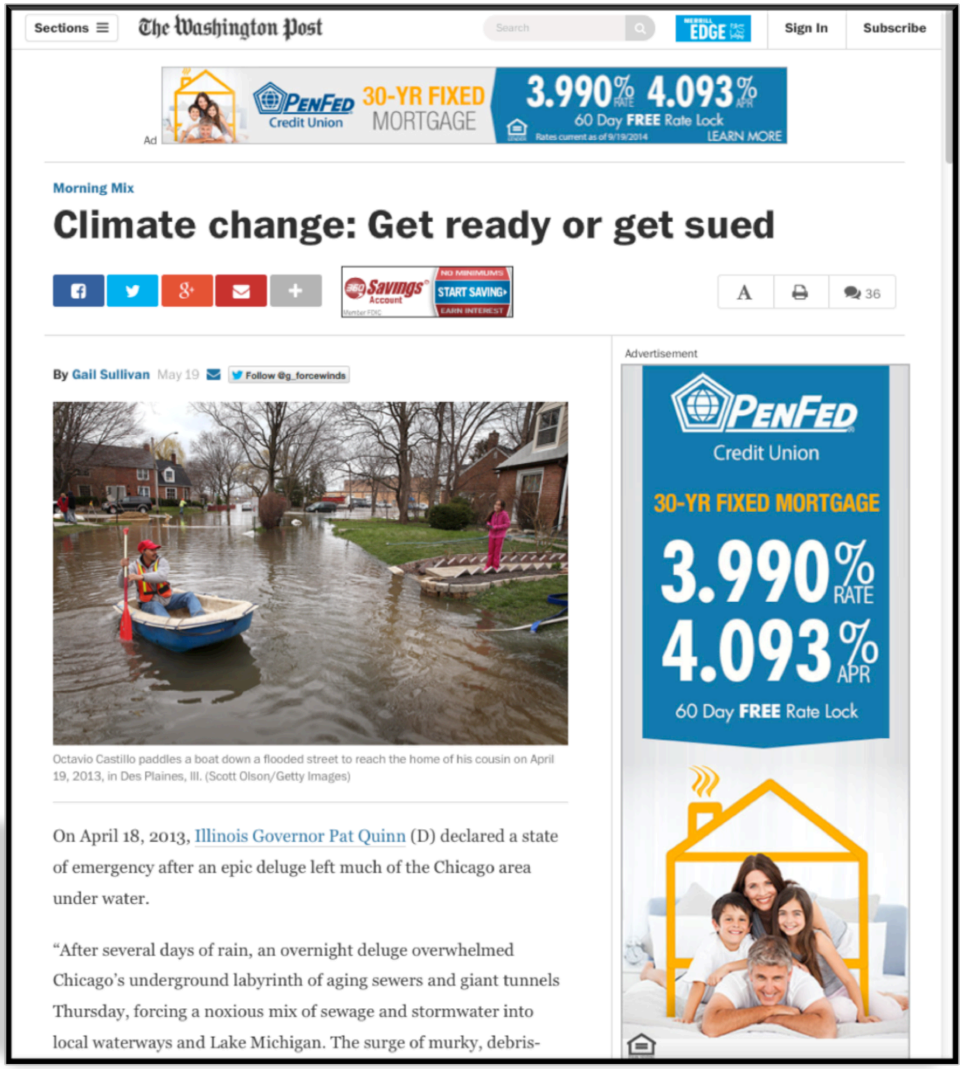


Infrastructure meltdown of the geyser kind

Liability for communities (??!?!)

"Now a major insurance company is suing Chicago-area municipal governments saying they knew of the risks posed by climate change and should have been better prepared."…

"The storms are not an act of God, the suit claimed, but a carbon-driven reality…"



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Morning Mix

Climate change: Get ready or get sued

By Gail Sullivan May 19 Follow @g_forcewinds

Octavio Castillo paddles a boat down a flooded street to reach the home of his cousin on April 19, 2013, in Des Plaines, Ill. (Scott Olson/Getty Images)

On April 18, 2013, Illinois Governor Pat Quinn (D) declared a state of emergency after an epic deluge left much of the Chicago area under water.

"After several days of rain, an overnight deluge overwhelmed Chicago's underground labyrinth of aging sewers and giant tunnels Thursday, forcing a noxious mix of sewage and stormwater into local waterways and Lake Michigan. The surge of murky, debris-

Liability, continued

"A frog-fearing New York state man has won a $1.6 million payout [from his town] after a developer drained so much storm water onto his property it turned into a wetland inundated with the slimy amphibians."

Homeowner with a FROG phobia is awarded $1.6M after runoff flood water inundates his property with the slimy creatures

By HELEN POW

PUBLISHED: 17:18 EST, 8 April 2013 | **UPDATED:** 17:26 EST, 8 April 2013

Comments (19) | Share +1 0 Tweet 36

A frog-fearing New York state man has won a $1.6 million payout after a developer drained so much storm water onto his property it turned into a wetland inundated with the slimy amphibians.

Paul Marinaccio Sr. described himself as 'a prisoner in my own home' after the Town of Clarence, a suburb in Buffalo, gave Kieffer Enterprises the go-ahead to divert water onto his 40-acre property, making it the ideal habitat for frogs.

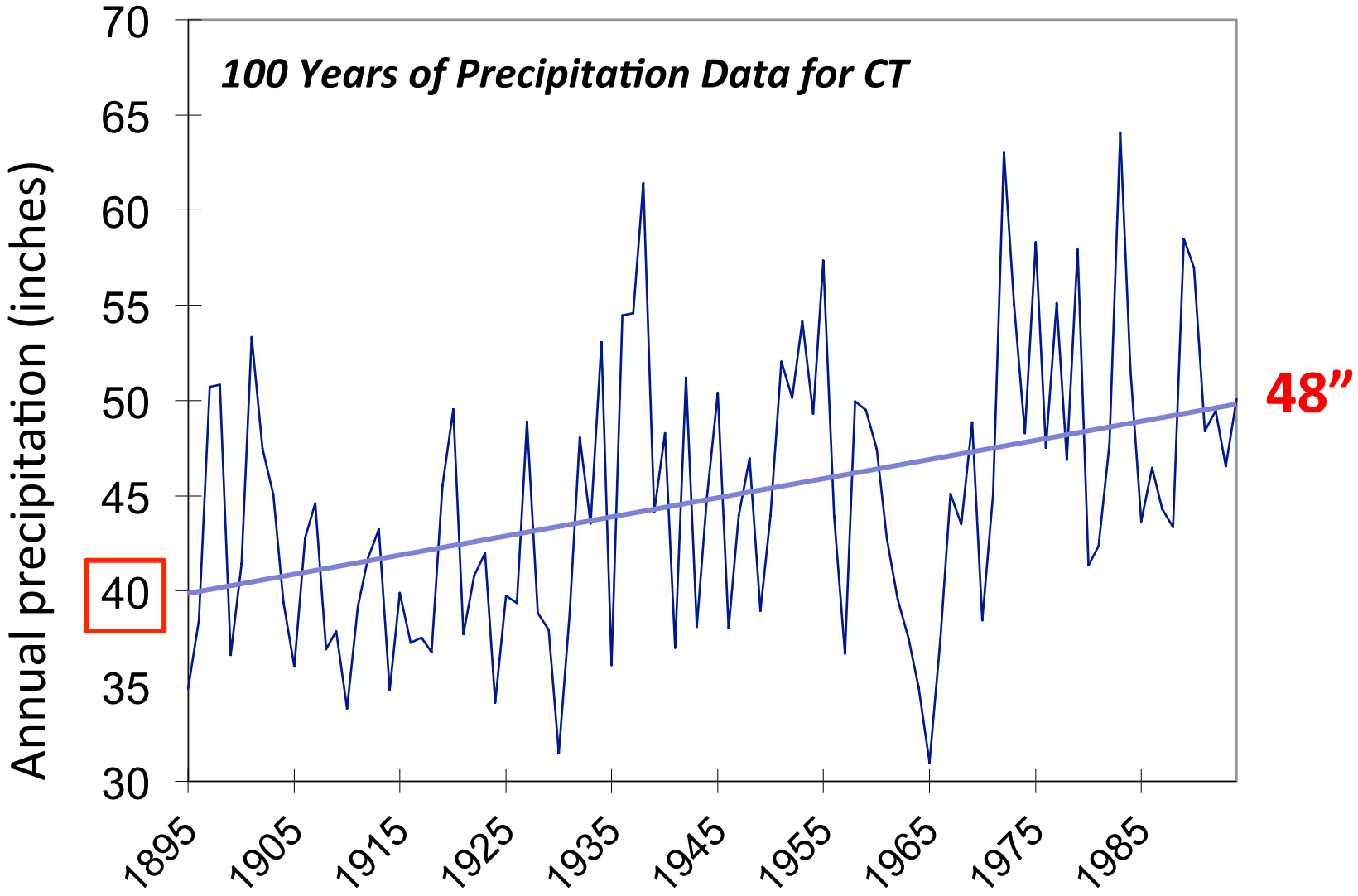
While the state's highest court ruled a couple of weeks ago that he wasn't entitled to an additional $250,000 in punitive damages, he's still come out a winner, and the town has also agreed to dig a drainage channel to dry up his land and, hopefully, the frogs.

Winner: Paul Marinaccio, pictured on April 6, has been awarded $1.6 million in damages

And more to come…

All studies indicate more rainfall, and more intense rainstorms, in the Northeastern U.S.

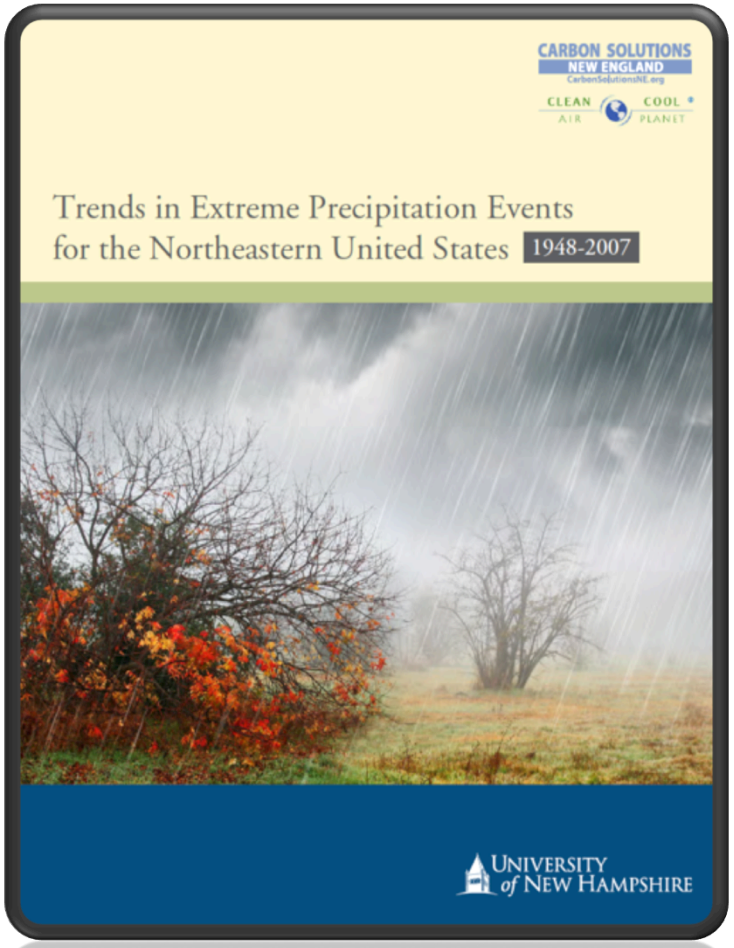
Our soggy prospects: more rain



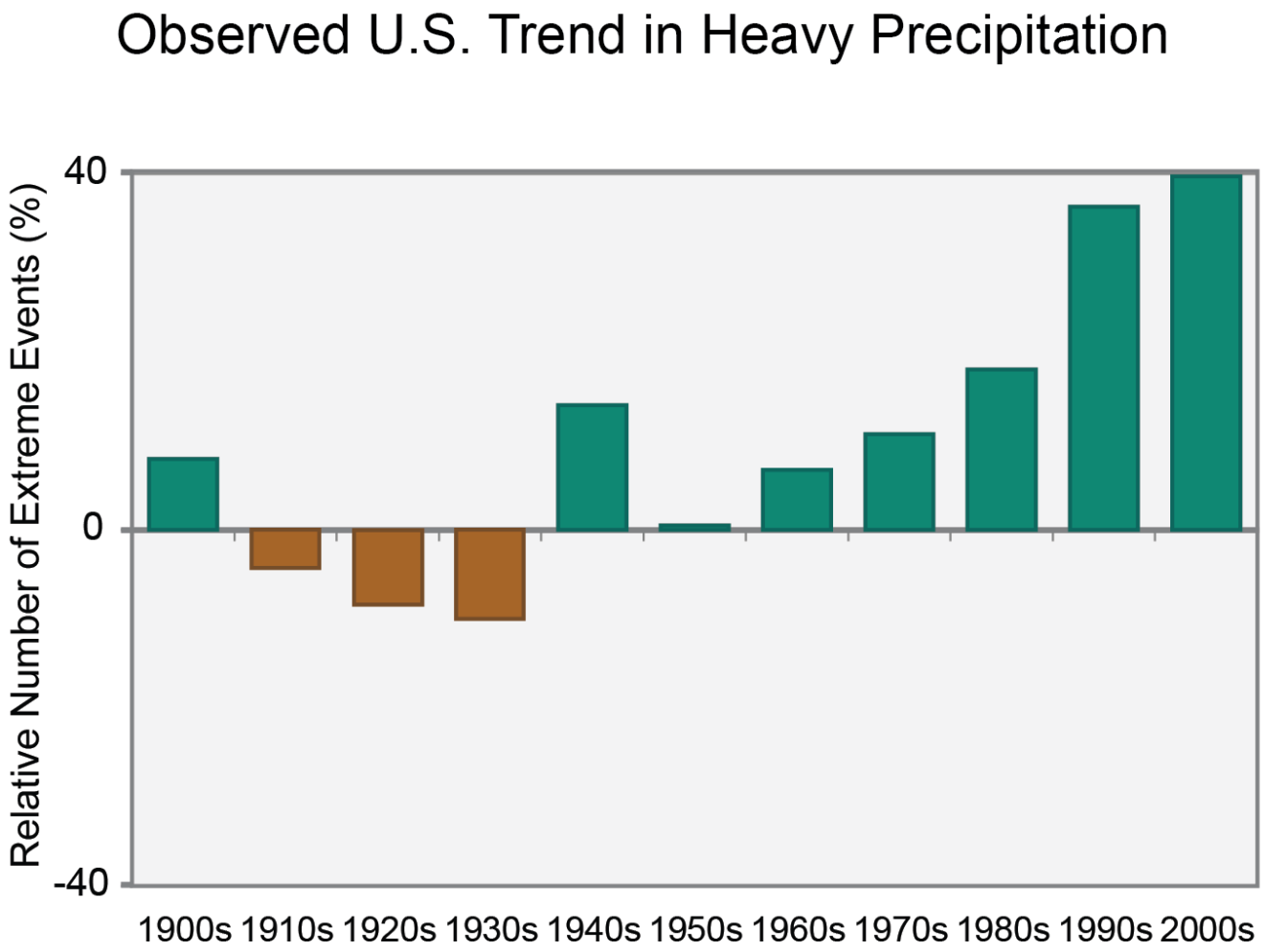
Source: Miller, et al. 2003. Precipitation in Connecticut. Report No. 38. Institute of Water Resources, University of Connecticut.

Our soggy prospects: more intense storms

In this study, a range of definitions for extreme precipitation was examined to provide a robust indicator of climate change in the Northeastern United States. All of the definitions…indicate that the occurrences of extreme precipitation events, and the intensity of rainfall, are increasing.

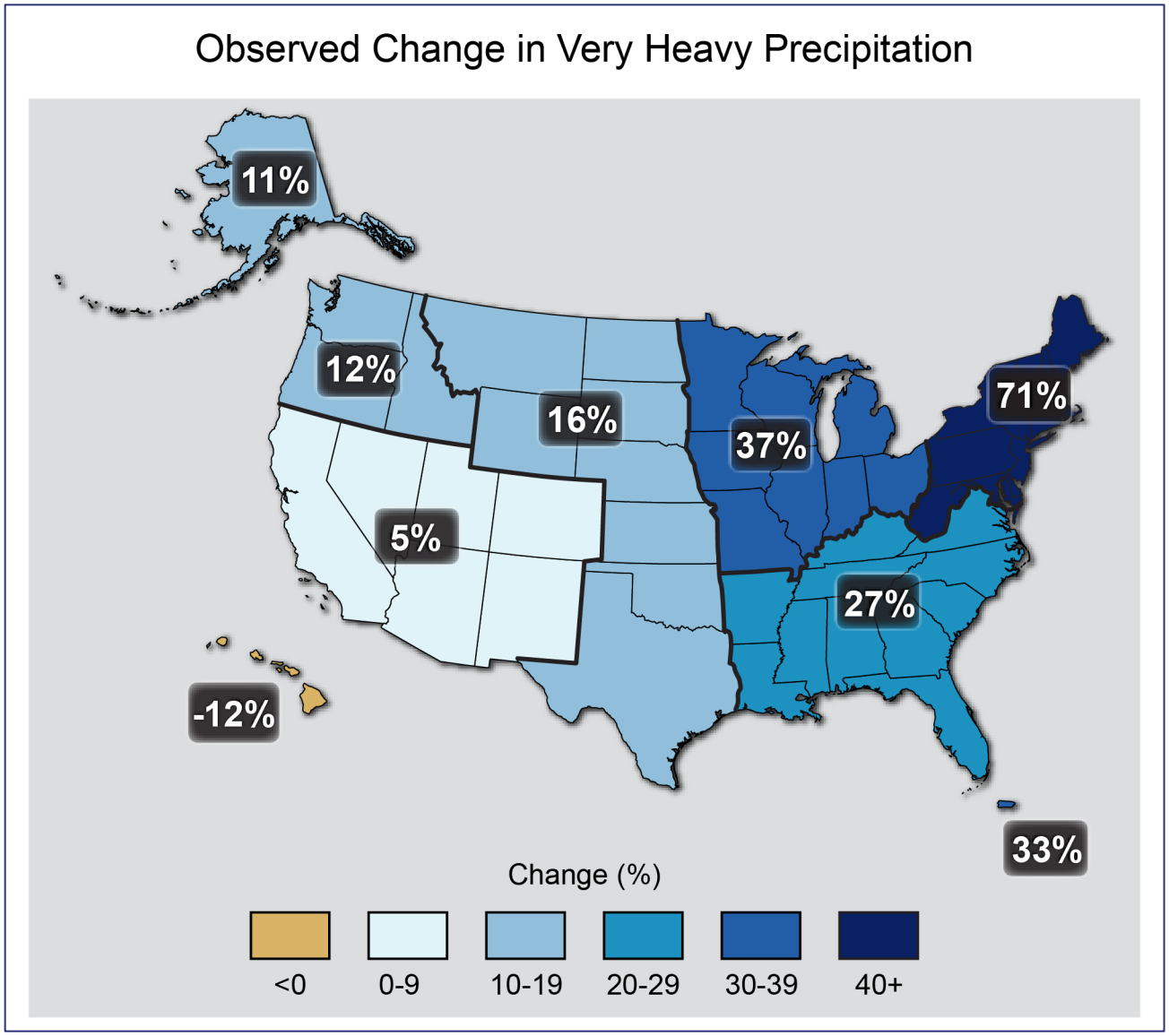


From the National Climate Assessment



Decadal average anomalies for the number of 2-day, 5-year precipitation events (difference between the decade and the 1901-1960 average precipitation) for the contiguous U.S.

From the National Climate Assessment



Extreme Precipitation in New York & New England

An Interactive Web Tool for Extreme Precipitation Analysis

About this Project | Data & Products | Daily Monitoring | Documentation

"...the frequency of 2 inch rainfall events has increased since the 1950s and storms once considered a 1 in 100 year event have become more frequent. Such storms are now likely to occur almost twice as often.

Past Extreme Rainfall Analyses

climatology excludes almost 50 additional years of data. The National Weather Service is using a regional approach to update [illegible] southwestern and middle Atlantic regions of the U.S. The Mid-Atlantic analysis extends as far north as Pennsylvania and thus excludes New York and New England. In these states, several regional and state-specific extreme rainfall analyses were conducted in the 1990 and early 2000s, but even these analyses are over a decade old and differences in the data records used do not provide a consistent regional analysis of rainfall extremes.

Extreme Rainfall Since the 1960s

The previous climatologies have been based on the premise that the extreme rainfall series do not change through time. Therefore it is assumed that older analyses reflect current conditions. Recent analyses show that this is not the case, particularly in New York and New England where the frequency of 2 inch rainfall events has increased since the 1950s and storms once considered a 1 in 100 year event have become more frequent. Such storms are now likely to occur almost twice as often.

Project Mailing List

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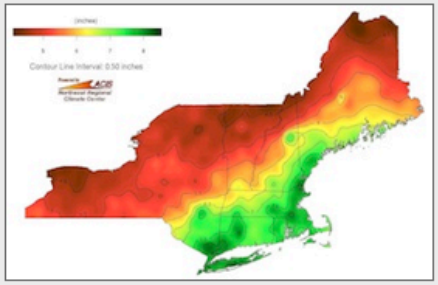
Web Site Features

compatible with the NWS analysis for the Middle Atlantic region and to enhance its usability. The design of the [illegible] and its products have [illegible] Conservation Service (NRCS), various state agencies, and private engineering consulting firms. The site includes estimates of extreme rainfall for various durations (from 5 minutes to 10 days) [illegible] nce intervals (1 year to 500 years). These data are interpolated to a 30-second grid. Confidence intervals for these values are also included as are the partial duration rainfall series used in their computation. Regional extreme rainfall maps and graphic products are also available. Precipitation distribution curves can be generated for each grid either directly or from the USDA NRCS Win TR-20 software, eliminating the need to use a static Type II or Type III curve.

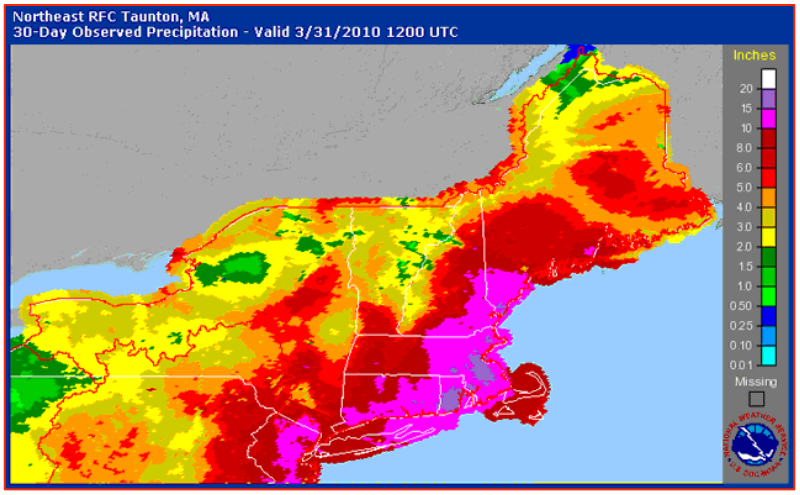


This project is a joint collaboration between:

Northeast Regional Climate Center (NRCC) Natural Resources Conservation Service (NRCS)

Storm Frequency Analysis

100 year flood? 500 year storm?



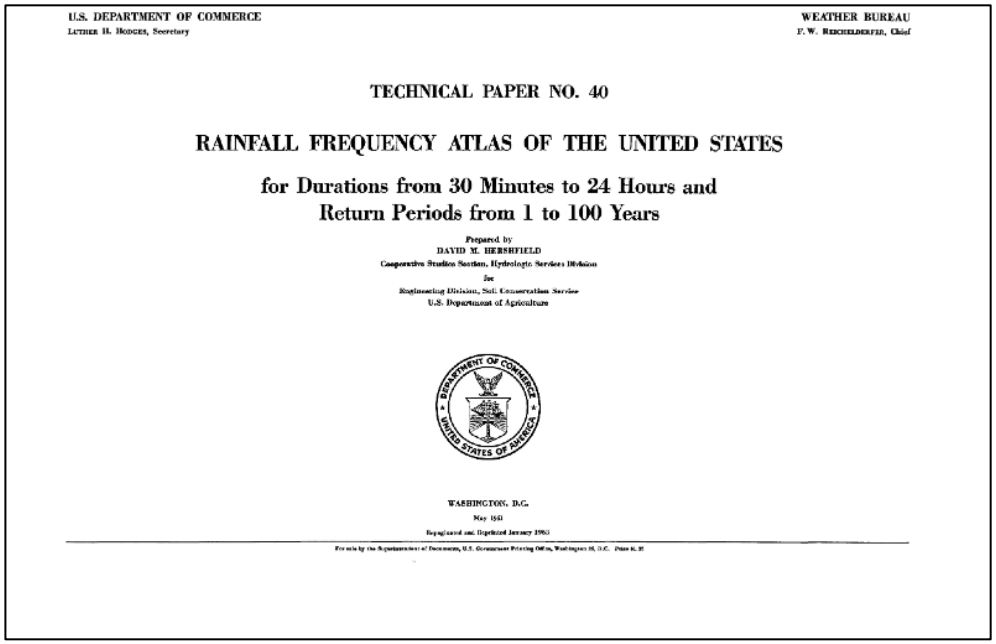
- Probability of occurrence of a given precipitation event
- Based on magnitude and duration of a rainfall event, e.g., "*the 100-year, 24 hour storm is 8.1 inches*"
- Calculated from past data for a measurement location

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

Technical Paper 40 (TP-40)

- NOAA report published in 1961
- Rainfall data for every county in the country
  - Frequency/recurrence intervals of 1 yr to 100 years
  - Storm durations of 30 minutes to 4 days



U.S. DEPARTMENT OF COMMERCE
LUTHER H. HODGES, Secretary

WEATHER BUREAU
F. W. REICHELDERFER, Chief

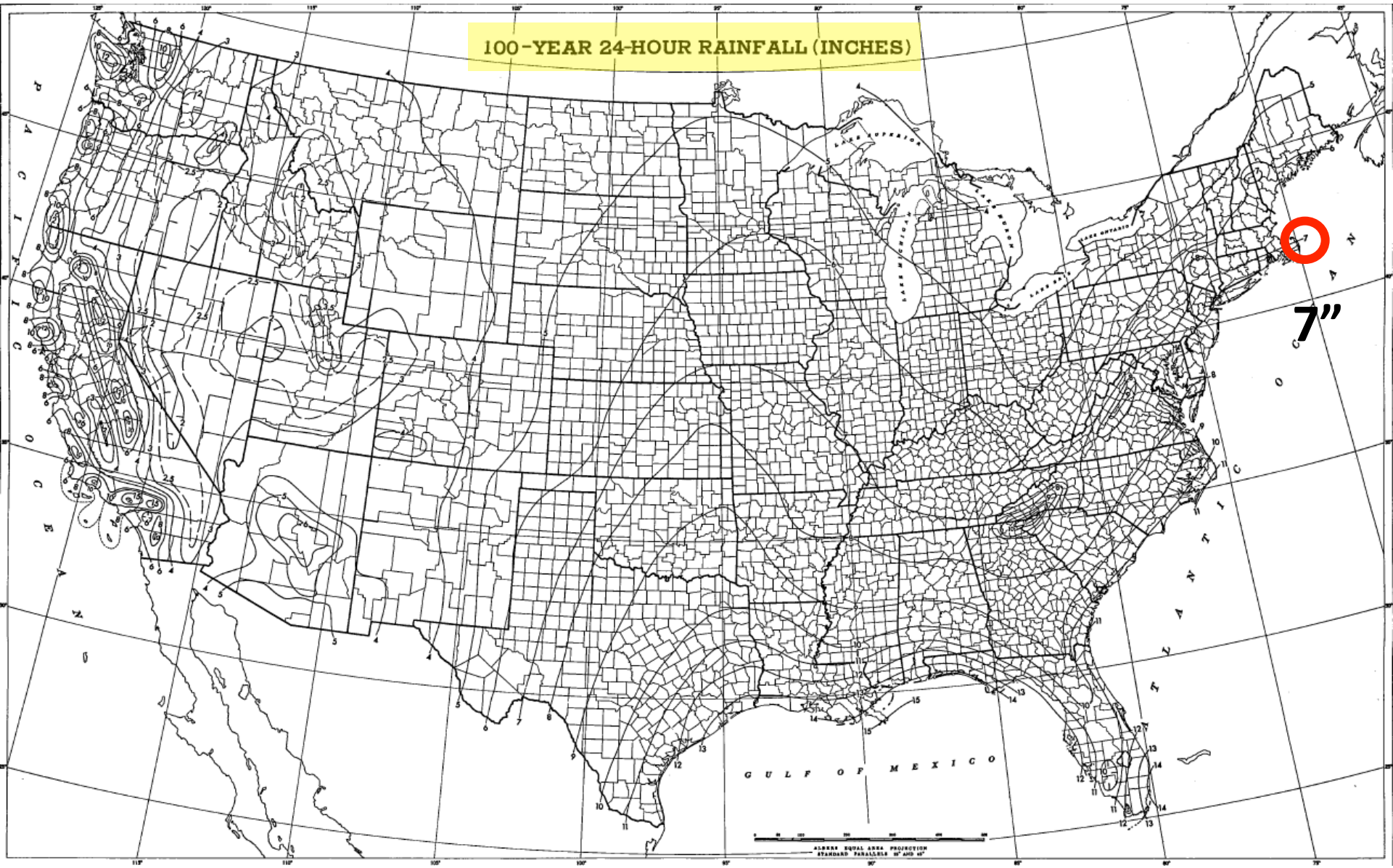
TECHNICAL PAPER NO. 40

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


100-YEAR 24-HOUR RAINFALL (INCHES)
7”
GULF OF MEXICO

The "100-yr storm" is the new 50

Probability model for New London, CT, updated with recent rainfall data

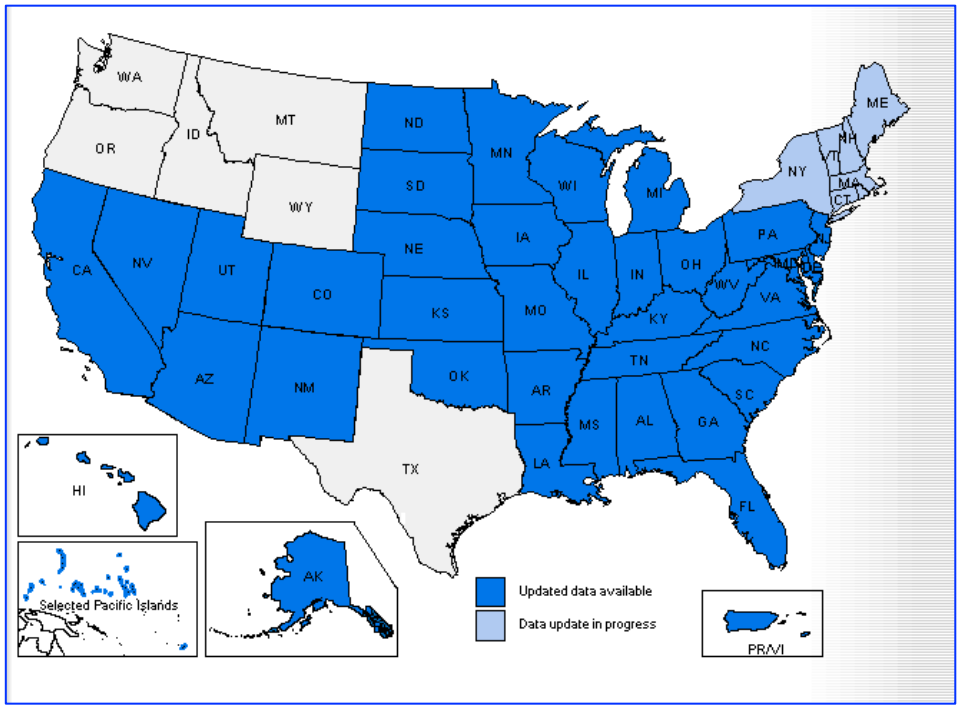
Recurrence Interval	TP-40 (in)	Updated values (in)
1	2.5	2.80
5	4.0	4.14
10	4.5	4.85
25	5.5	5.99
50	6.0	7.02
100	7.0	8.25

Future considerations & strategies

1. Updated info & guidance

A Revised TP-40?: "ATLAS-14"

-- Longer period of record
-- denser data network
-- greater ranges of durations and recurrence



2. Better analysis and monitoring

3. Major infrastructure projects

Storage Tunnels

Tunnels & Conduits

- South & North Tunnel
  - South Tunnel is under design
  - Construction will begin 2014
  - Deep rock tunnel with 19 foot diameter and 2.5 miles long

MDC

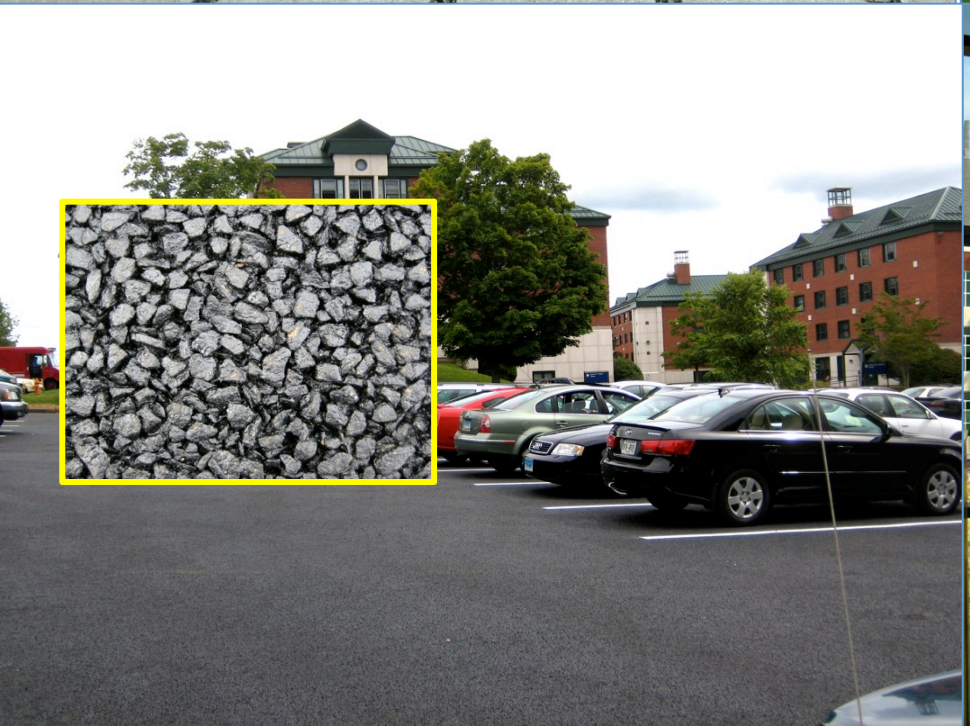
Roads & stream crossings

- identify priority flood-prone areas
- Revise drain and culvert standards based on the new precipitation regime
- Build this into the capital expenditures plan

Drainage systems

- identify priority flood-prone areas
- Revise drain and pipe standards based on the new precipitation regime
- Build this into the capital expenditures plan

4. Green Infrastructure

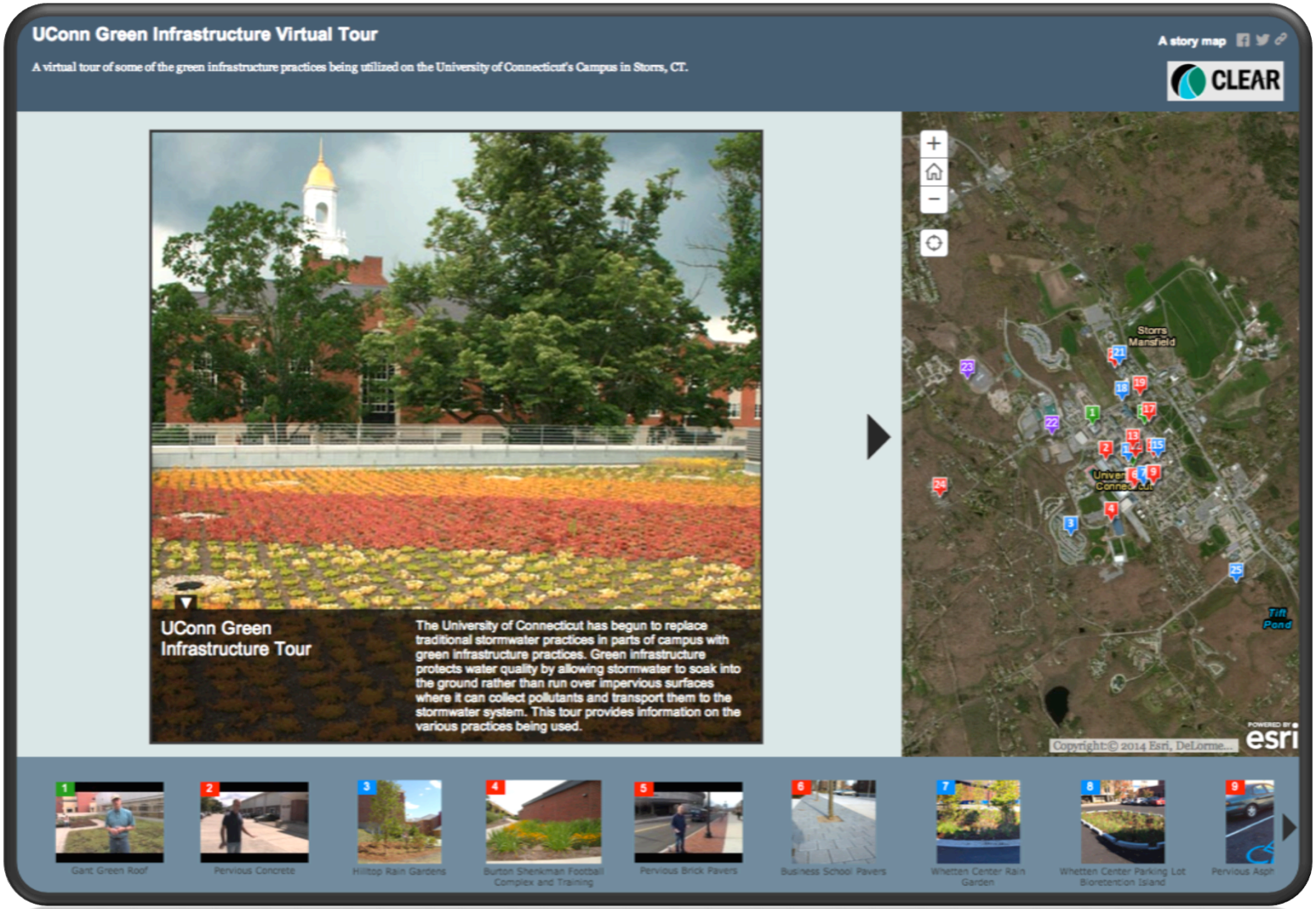


Major urban centers leading the way

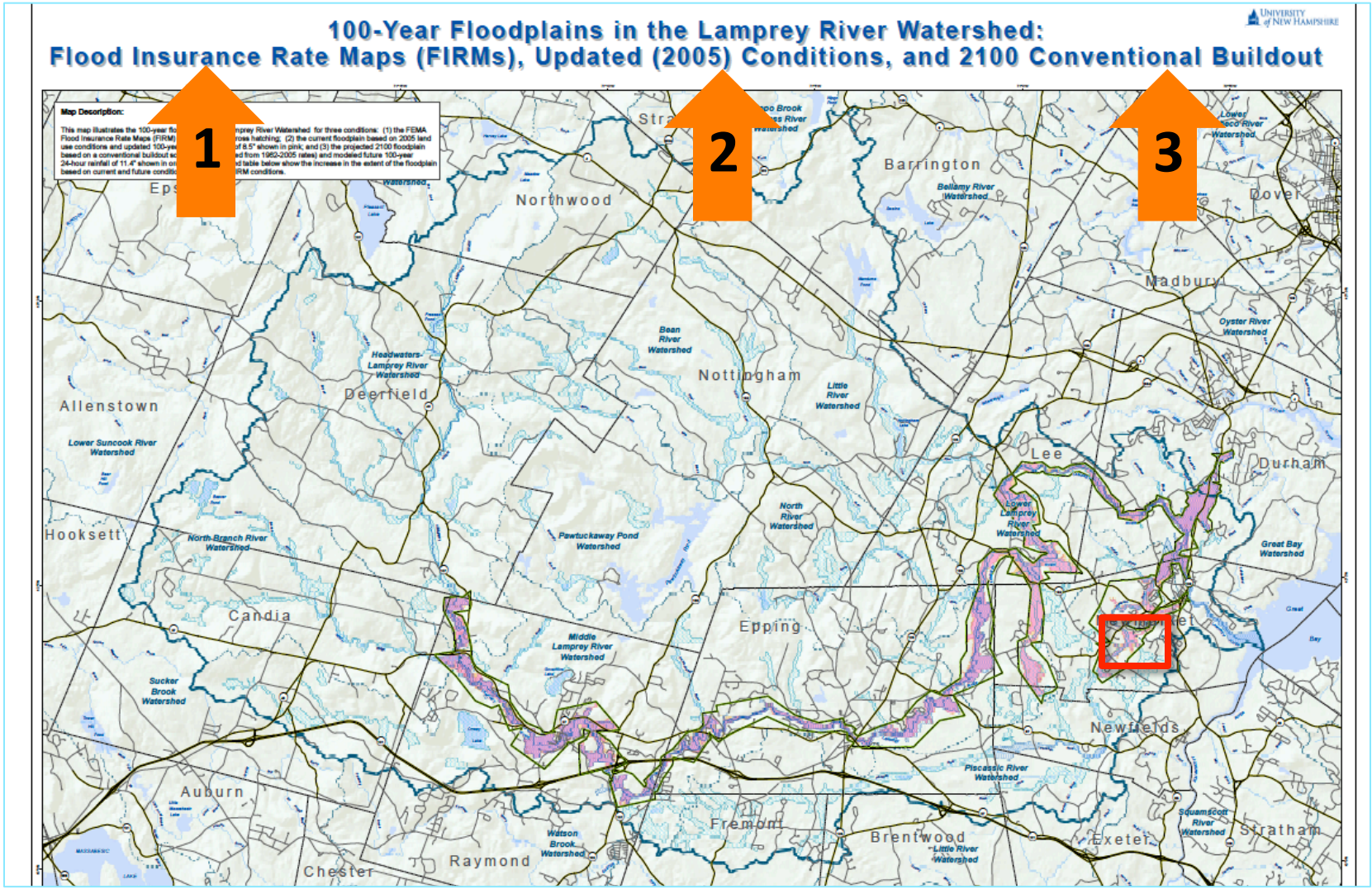
Philadelphia AFTER Green City, Clean Waters Initiative

NRDC Switchboard Blog

UConn campus



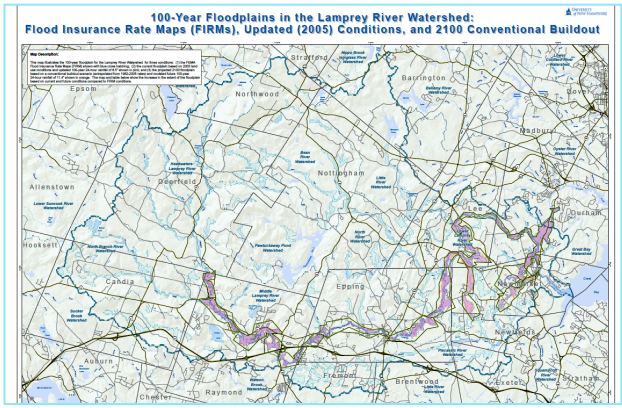
5. Policy & planning revisions

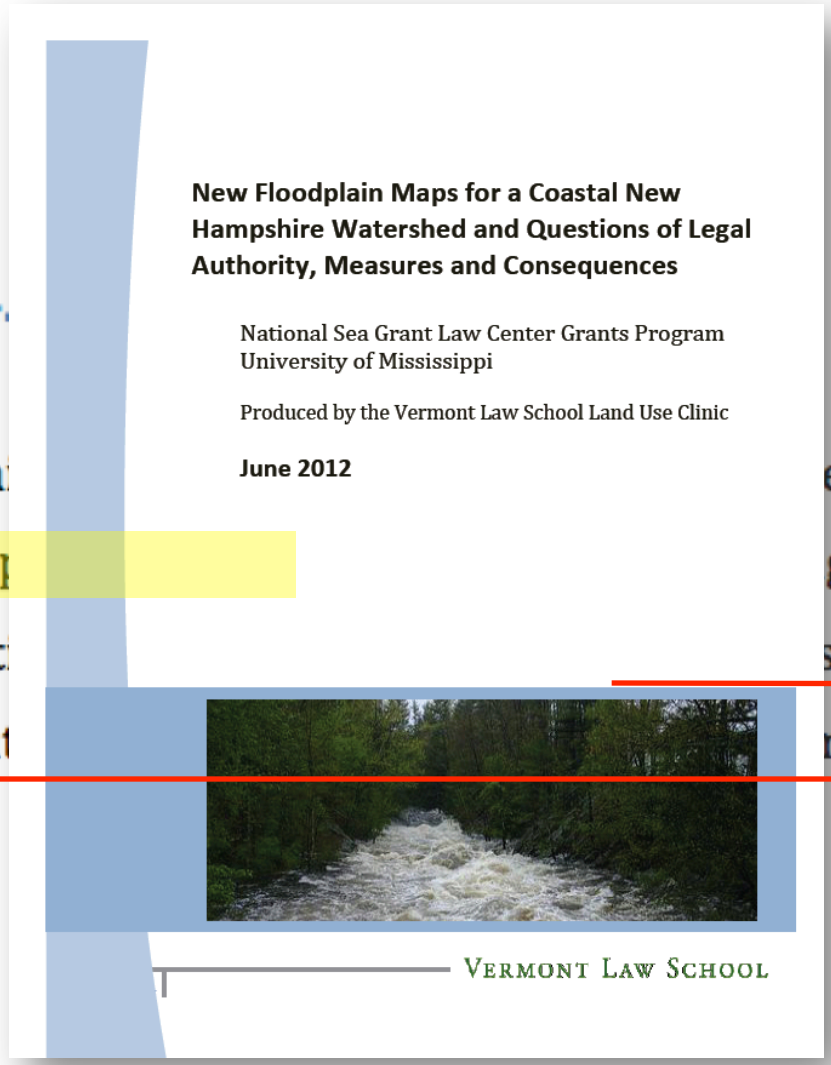


University of New Hampshire


Updated (2005) 100-Year Floodplains
2100 100-Year Floodplains: Conventional Buildout
Effective Zone AE 100-Year Floodplains: Special Flood Hazard Areas with Base Flood Elevations (BFEs) determined

Planning & policy revisions, the sequel





6.4.

Wh eme Court jurisprudence provides some

help g to amend their zoning regulations to

mit still numerous case-by-case circumstances

that npensable regulatory taking has occurred.

6. All the rest!

Barriers to Action by Town Type

	Town type			
Type of Barrier	**Coastal** (n=24[1])	**Riverine** (n=44[2])	**Inland** (n=89)	**All types** (n=151[3])
Lack of funding	66%	75%	71%	71%
Insufficient state/federal coord.	42%	50%	43%	44%
Lack of public information	33%	45%	33%	35%
Other issues take priority	13%	39%	38%	34%
Climate change skepticism	8%	18%	34%	26%
Insufficient private/public coord.	13%	18%	12%	14%
Insufficient staff	13%	16%	21%	19%
Other barriers	8%	2%	2%	3%

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THANKS!


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