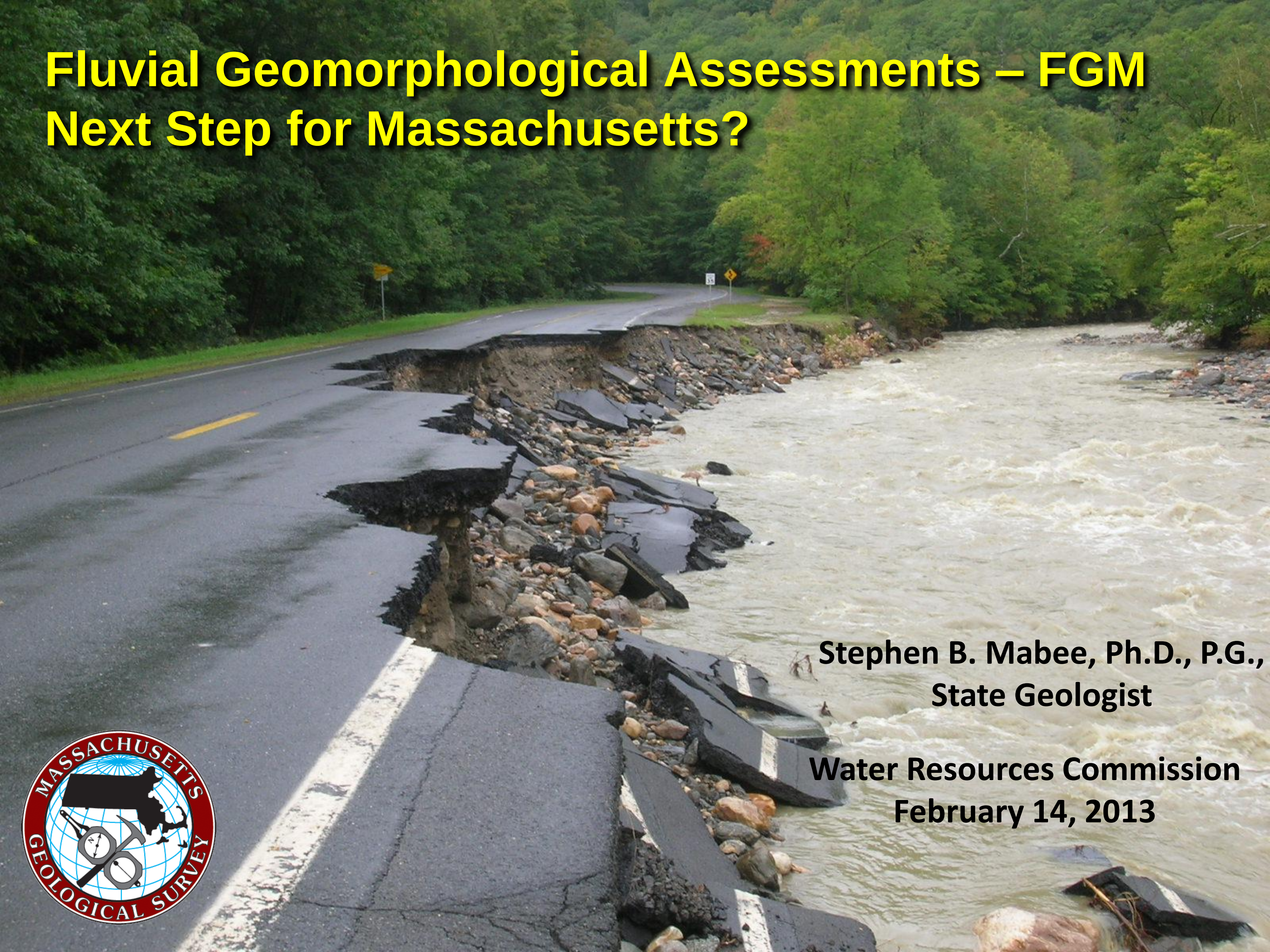


Fluvial Geomorphological Assessments – FGM Next Step for Massachusetts?

Stephen B. Mabee, Ph.D., P.G., State Geologist

Water Resources Commission
February 14, 2013

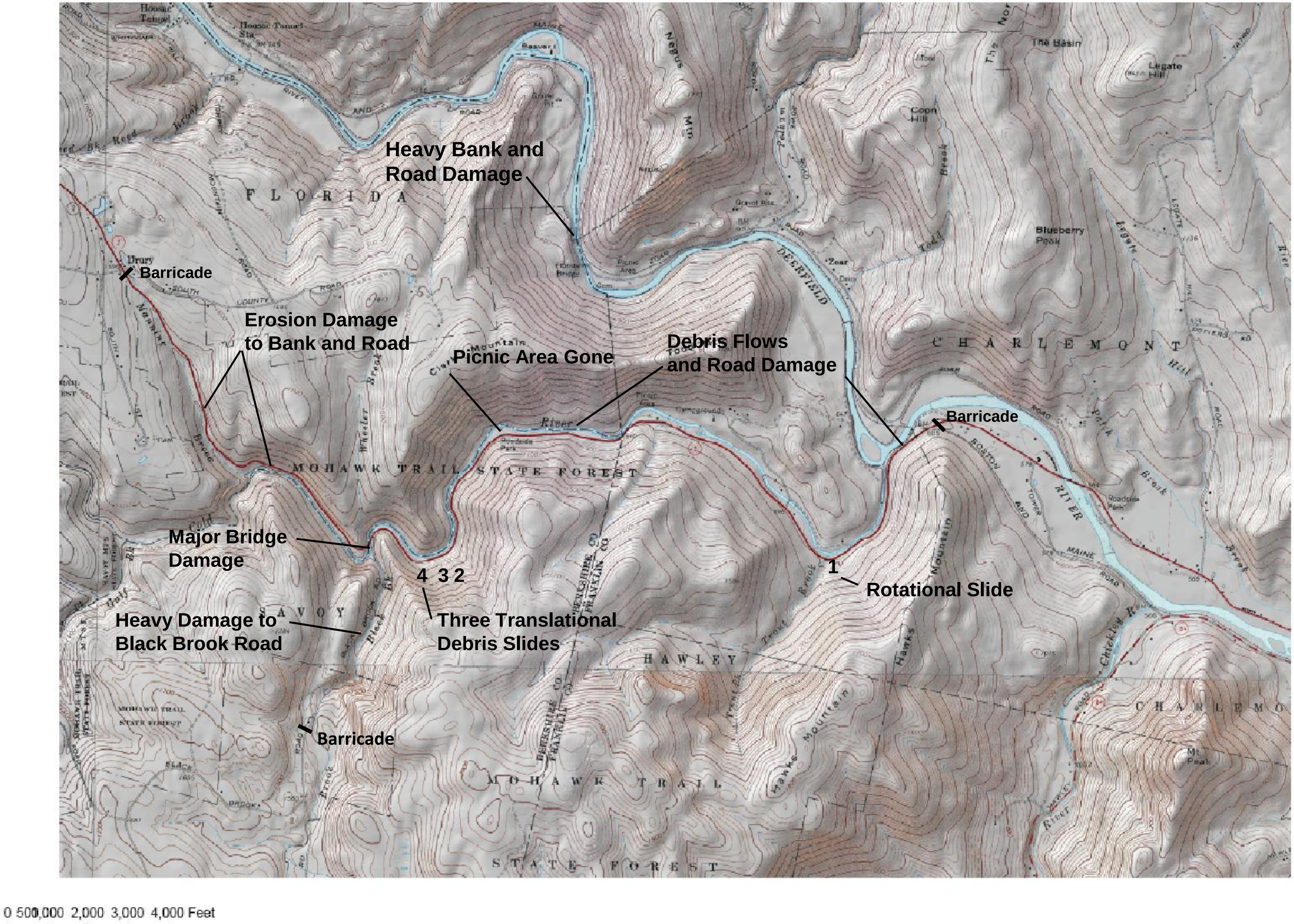

What is Fluvial Geomorphology?
So What?
Who Benefits?
Next Steps?
Photo from J. Field

What is Fluvial Geomorphology?

(River) *(Landform evolution)*

- River width and depth
- Channel slope
- Floodplain
- Sinuosity or meander
- Sediment load, size
- Flow and velocity
- Erosion
- Deposition


So What?
Photo by J. Kopera


Heavy Bank and Road Damage
Barricade
Erosion Damage to Bank and Road
Picnic Area Gone
Debris Flows and Road Damage
Barricade
Major Bridge Damage
4 3 2
1
Rotational Slide
Heavy Damage to Black Brook Road
Three Translational Debris Slides
Barricade
FLORIDA
MOHAWK TRAIL STATE FOREST
CHARLEMONT
SAVOY
HAWLEY
MOHAWK TRAIL
STATE FOREST
0 500 1,000 2,000 3,000 4,000 Feet

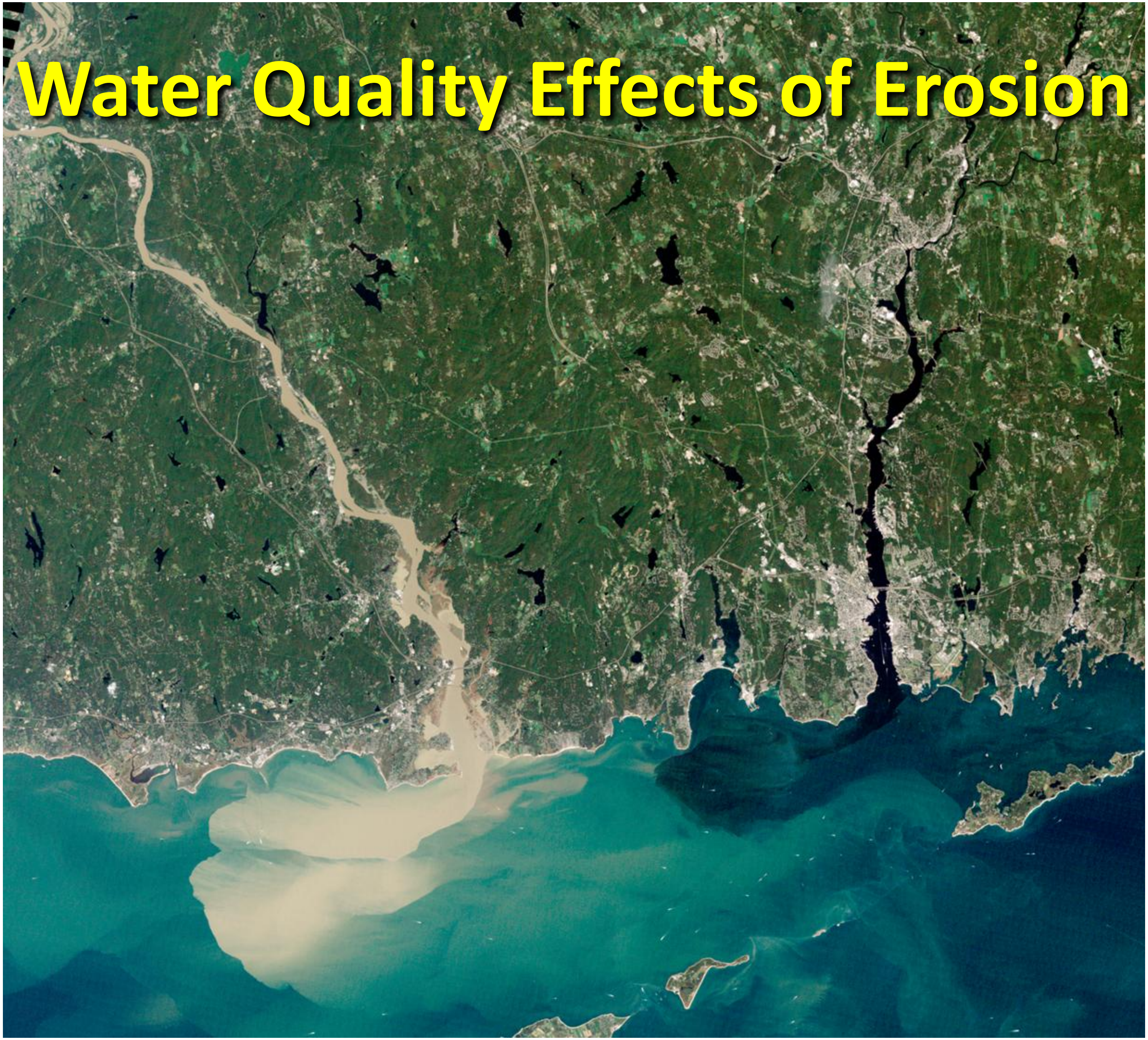
MGS, 2011

Why Should We Care?

- Development and infrastructure in river corridors
- Rivers migrate
- Rivers erode
- Development affects river channels

Photo by S. Mabee

Water Quality Effects of Erosion



Breaking the Cycle

	2011	1976
Less vulnerable	20%	0%
Same Vulnerability	40%	40%
More Vulnerability	40%	60%

Floods and Property Damage

Encroachment

Dredge, Berm and Armor

Kline, 2012

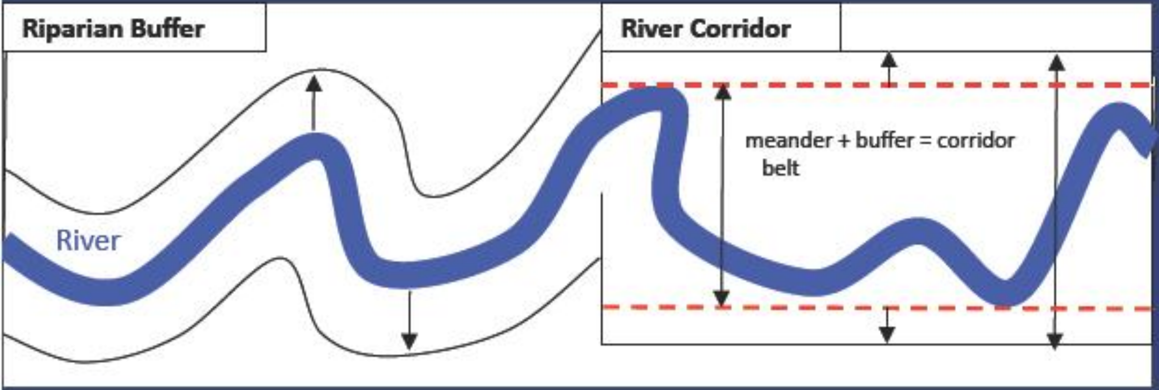
What Should We Do?

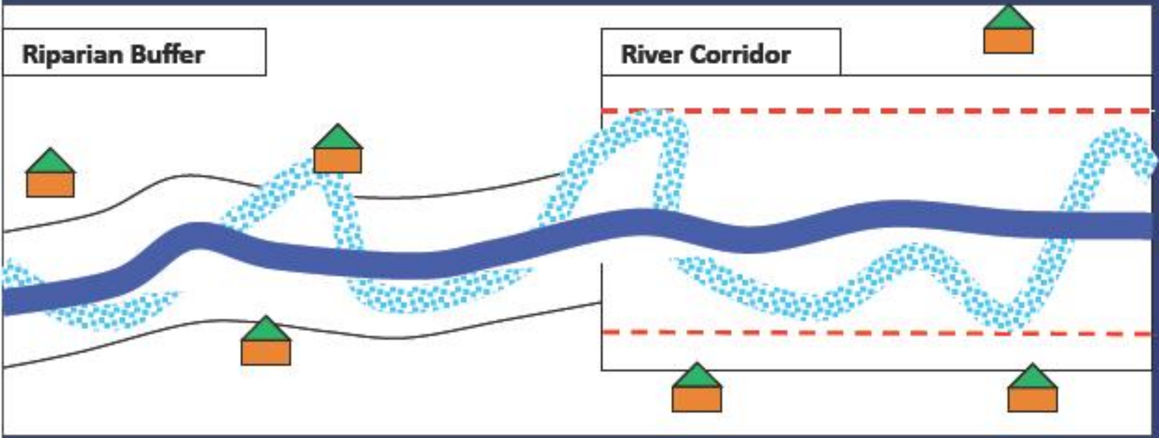
- Standardized Assessments
- Data Base of current conditions
- Management

Photo by J. Kopera


Fluvial Geomorphology
River System
Dynamic Equilibrium
Photo from J. Field

Message to Towns Encroachments on straightened and incised channels equals property loss, cost of maintaining channel works, downstream impacts, and a loss of recovery options ($$$).





Go beyond the concept of riparian buffers.

Protect river corridors and floodplains to accommodate floods and fluvial processes; distribute and dissipate energy; store sediment and woody debris; and create and maintain habitat.

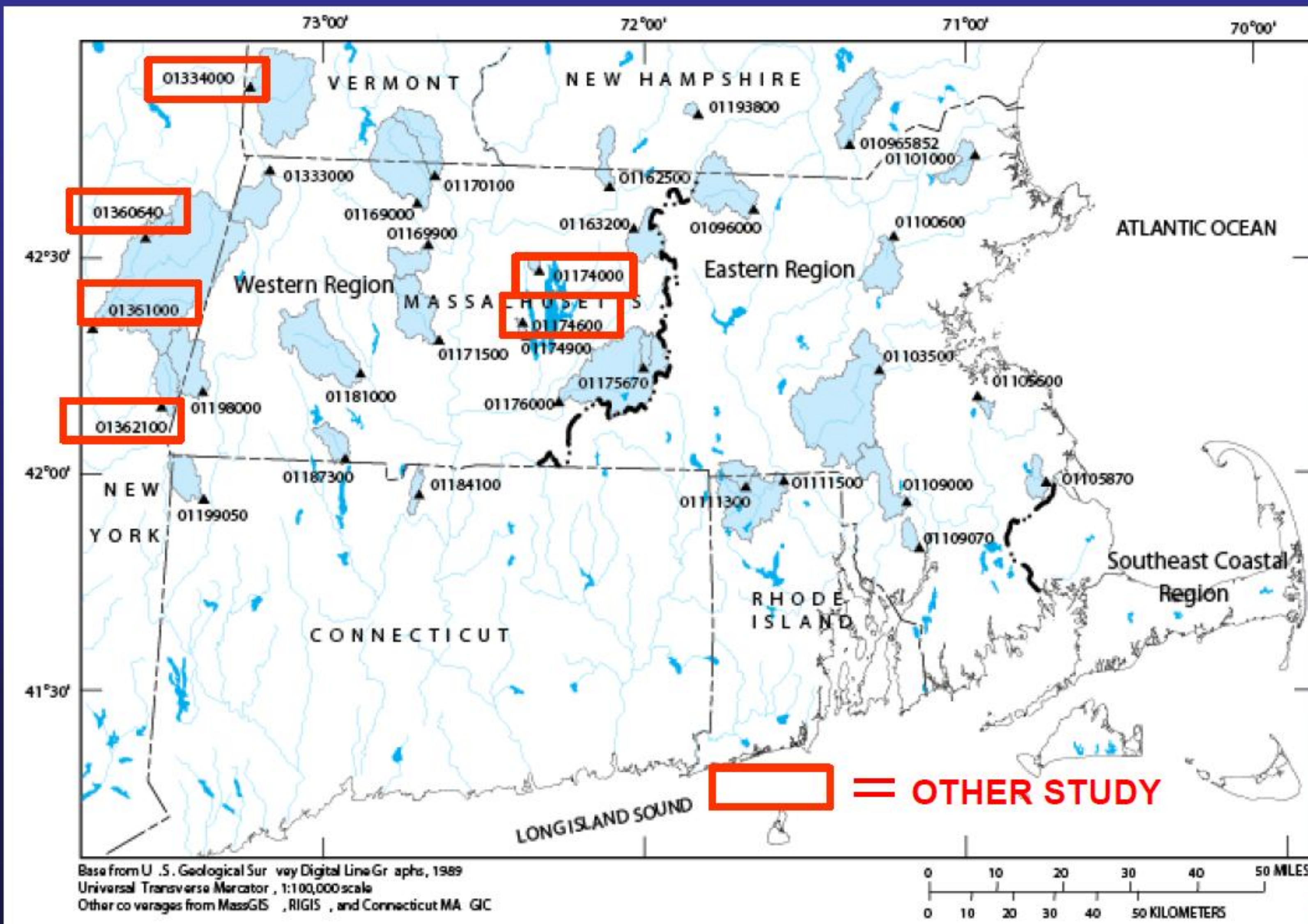
Kline, 2012


Phase I
Topo
Land Use
Geology
Map and Photographs
Field, 2012


River Corridor
Oxbow
Active meander
Oxbow
Field, 2012

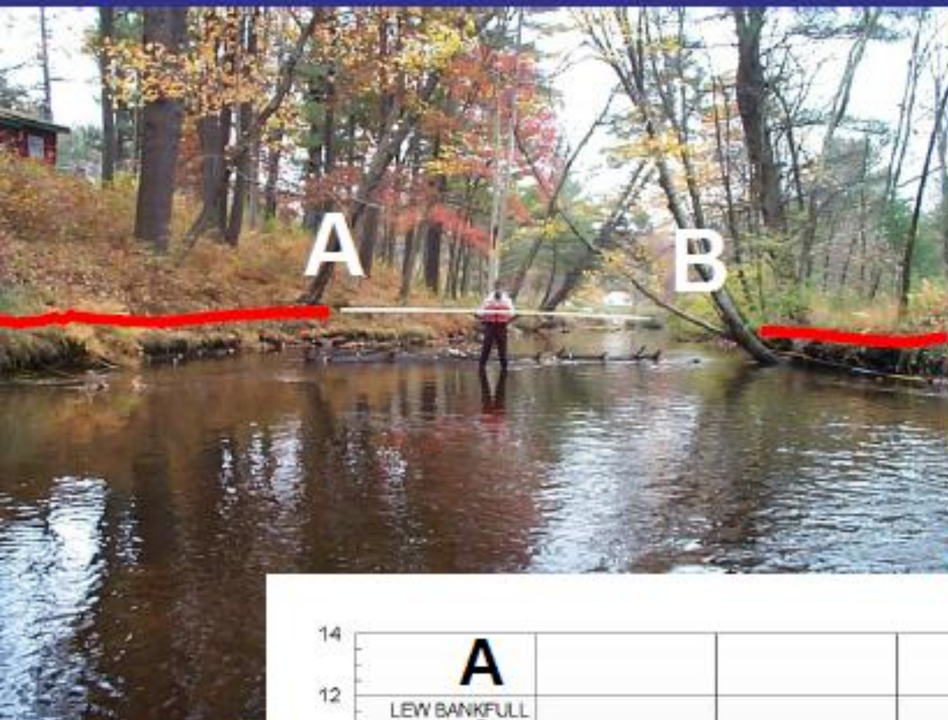
Phase II
The Reference Stream
Gather Data
ID Reaches
Bankfull depth, width, area
Photographic log, substrate
Erosion, habitat
Baldigo (2004)

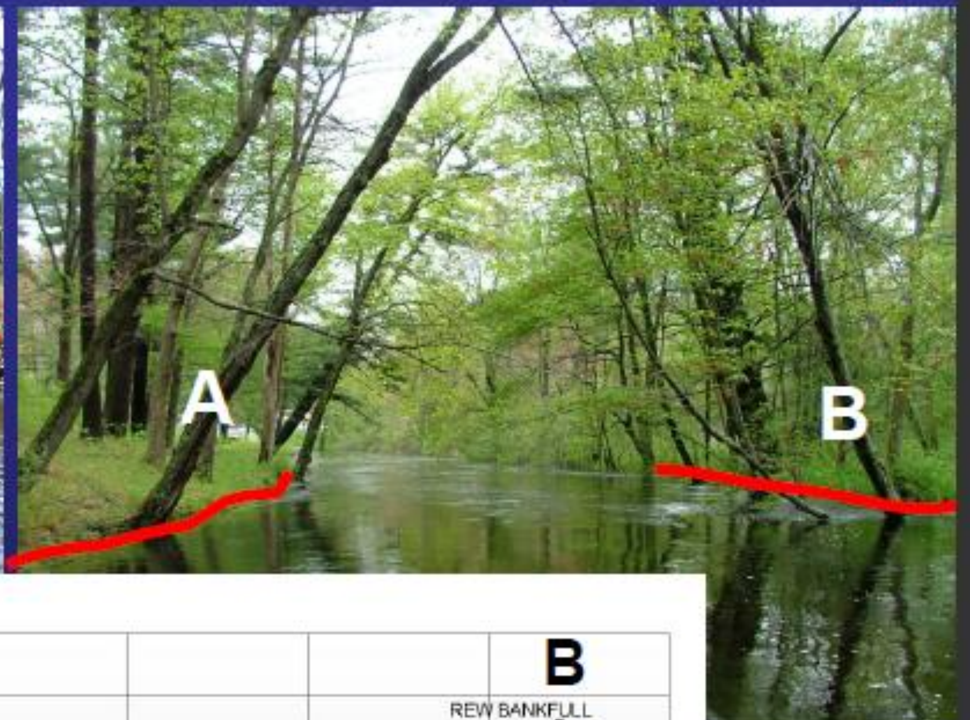
BF REFERENCE STUDY SITES

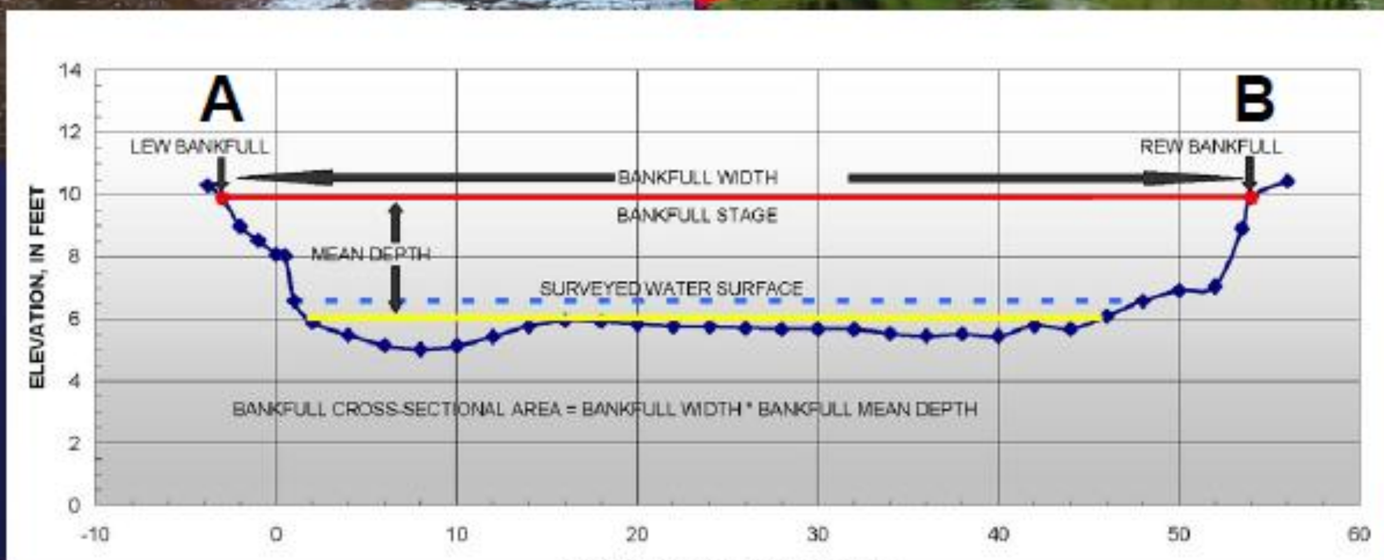


USGS
science for a changing world

BANKFULL ASSESSMENTS

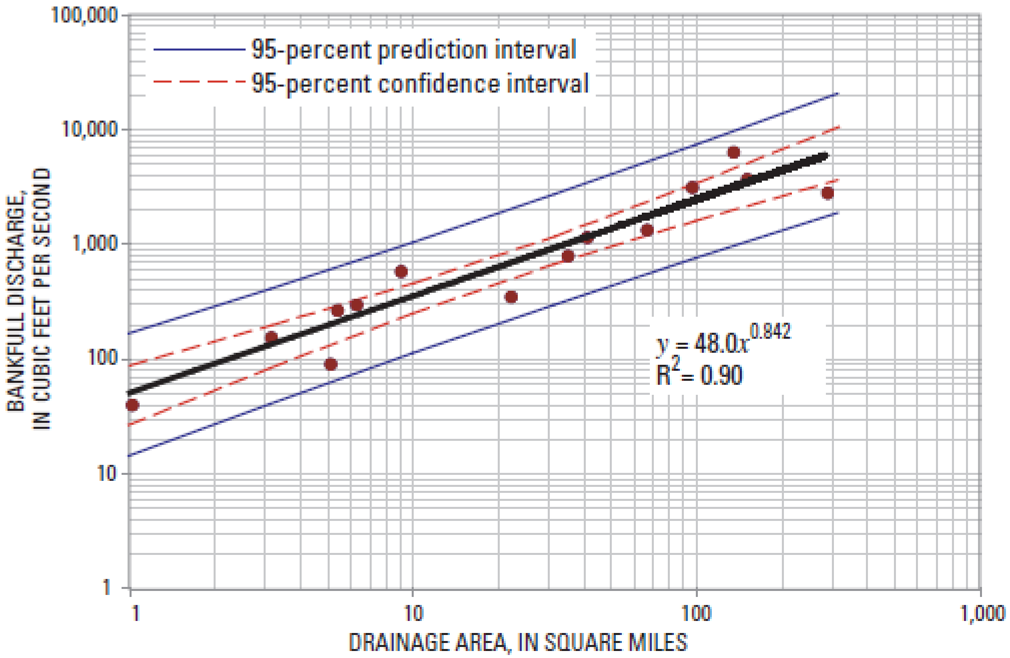






USGS
science for a changing world

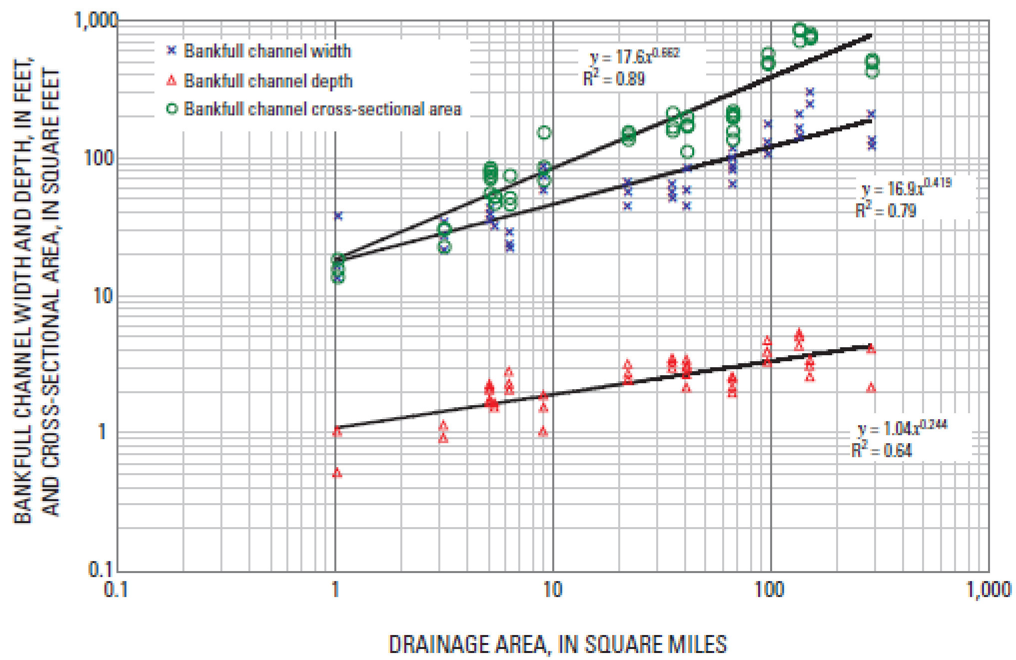
Regional Reference Curves



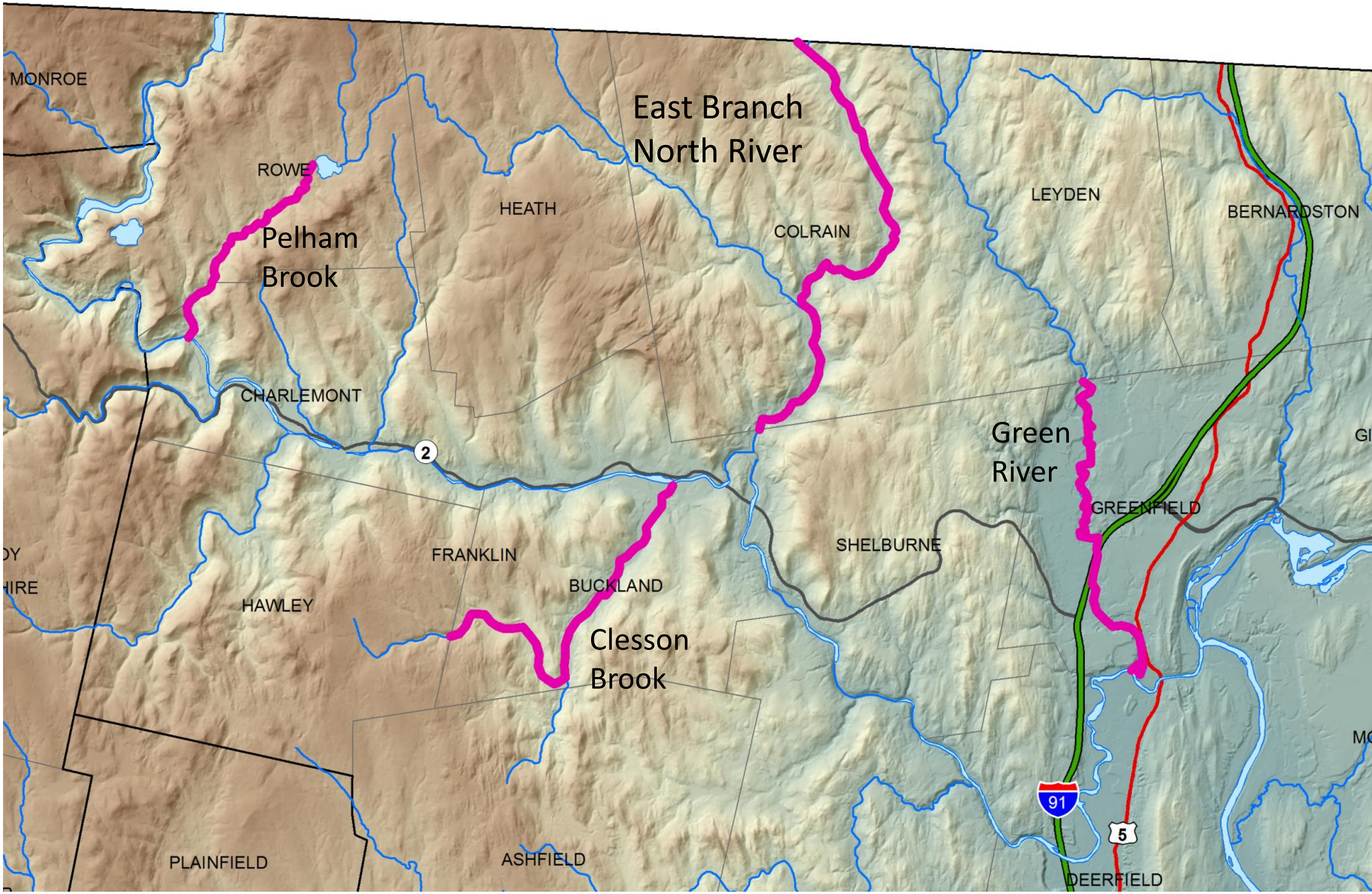
Width, depth, area, discharge
Correlated with drainage area

Compare your stream that
Shares similar geology,
Physiography and
Climate with the reference streams

USGS developing for MA & NE

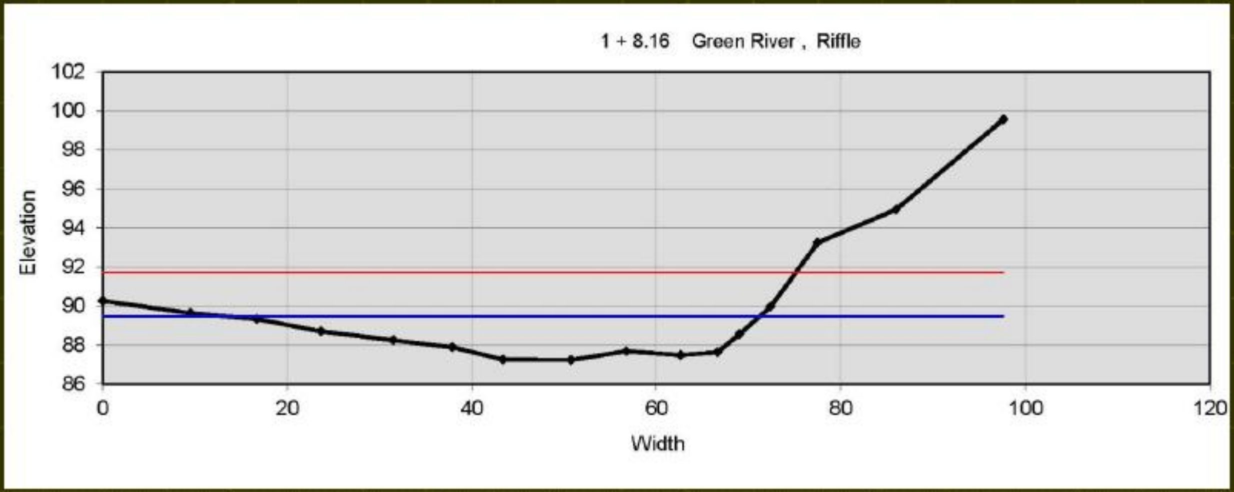


Mulvihill et al. (2005)


MONROE
ROWE
HEATH
East Branch
North River
COLRAIN
LEYDEN
BERNARDSTON
Pelham
Brook
CHARLEMONT
2
Green
River
GREENFIELD
FRANKLIN
SHELBURNE
BUCKLAND
HAWLEY
Clesson
Brook
91
5
PLAINFIELD
ASHFIELD
DEERFIELD

MGS, 2011

Green River Cross Section 2009 (not stable due to encroachment of floodplain)



bankfull: 62'
bankfull depth: 1.5'
bankfull area: 92'

NEEI & MGS, 2012

Post T-S Irene survey 8/2012

bankfull: 185’ (+123’)

bankfull depth: 8.0’ (+6.5’)

bankfull area: 737 sq ft (+64

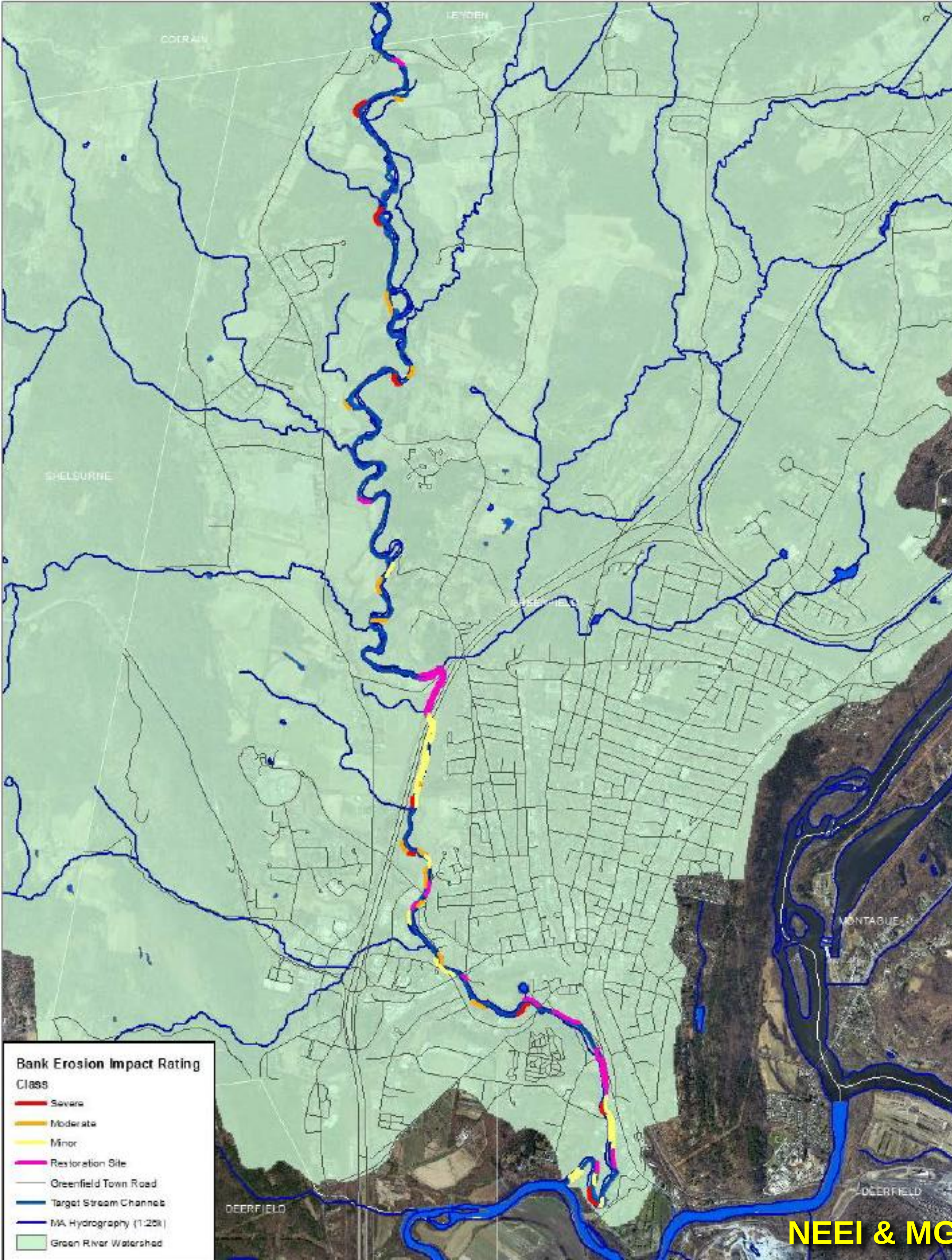
Berms cutting off the floodplain are NOT RESILIENT

Green River bank restoration (2007) using geomorphic channel design (regional curve= 90') bankfull bench, woody debris & log vanes

Site After T-S Irene: no erosion or failure geomorphically stable/resilient

NEEI

Draft
Bank erosion hazard maps
Green River
Greenfield, MA



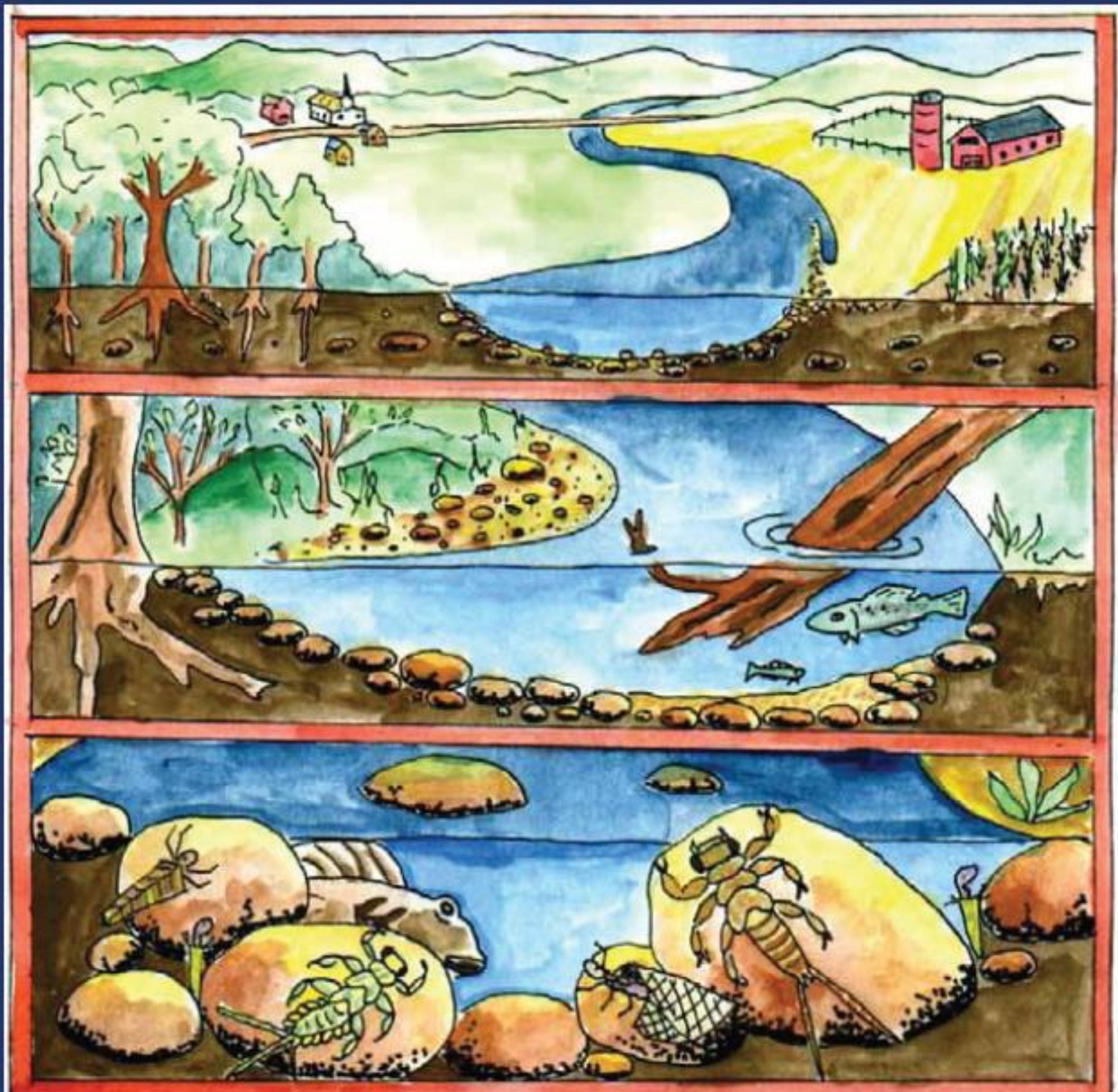
NEEI & MGS, 2012

Bank Erosion Impact Rating

Class

- Severe
- Moderate
- Minor
- Restoration Site
- Greenfield Town Road
- Target Stream Channels
- MA Hydrography (1:25k)
- Green River Watershed

VT ANR Stream Geomorphic Assessment Program



Watershed – Phase 1

Land use, Riparian, Channel, Floodplain and Valley Modifications

Reaches – Phase 2

Condition - Departure
Adjustments - Evolution
Sensitivity - Rate

Sites – Phase 3

Hydrology & Hydraulics
Sediment Transport

Habitat Assessment

Bridge/Culvert/Dam

Kline, 2012

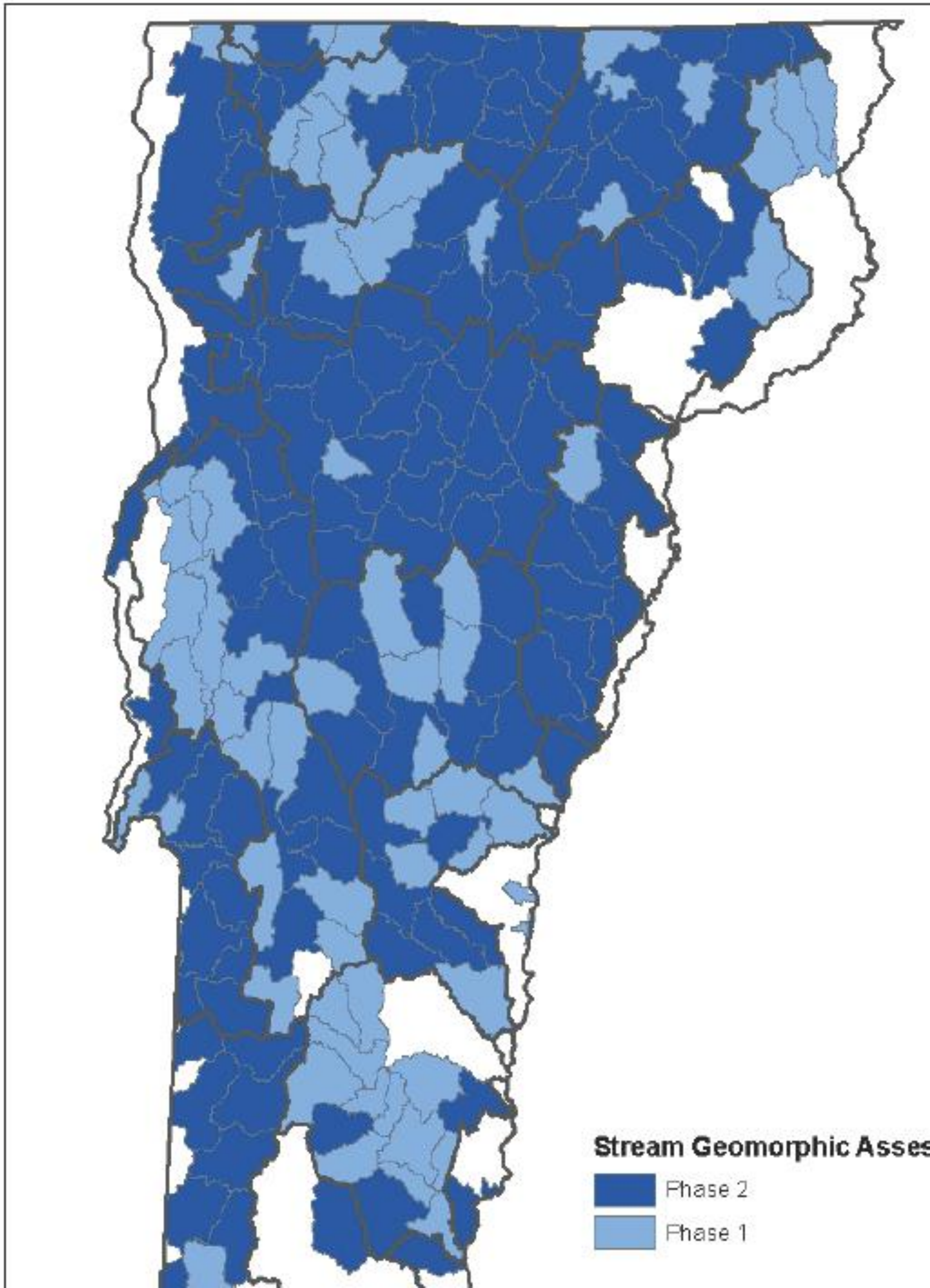
10 years of assessment completed by leveraging multiple funding sources

Phase 1 – 6,094 miles

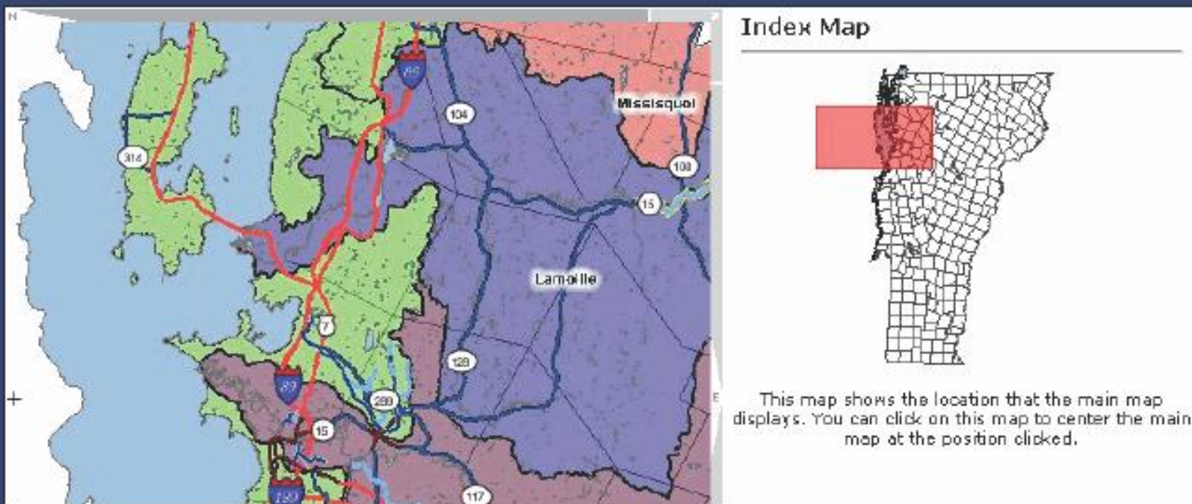
Phase 2 – 1,760 miles

Assessments sponsored by local & regional groups

Status of statewide data and map development



Co-development and integration of statewide programs made possible by the availability of data.

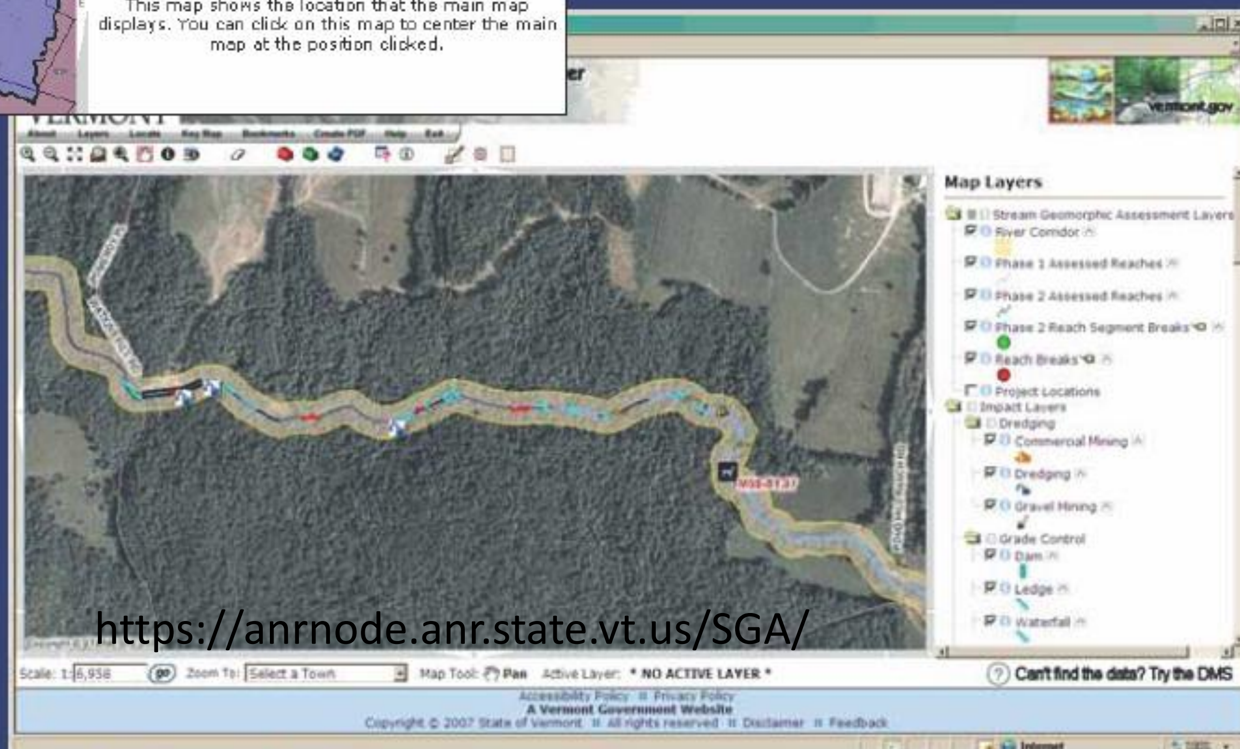


SGAT

Stream Geomorphic Assessment Tool

A GIS Extension

On-line map and data retrieval systems



https://anrnode.anr.state.vt.us/SGA/

Kline, 2012

So Why Don't We Adopt Vermont's Protocol?

Photo from J. Field

HOW DO WE CLASSIFY THESE?

MILONE & MACBROOM


Who Benefits?
DCR
DEP
USFW
NRCS
RPAs
DER
Photos by S. Mabee

Davis, DEP, 2012

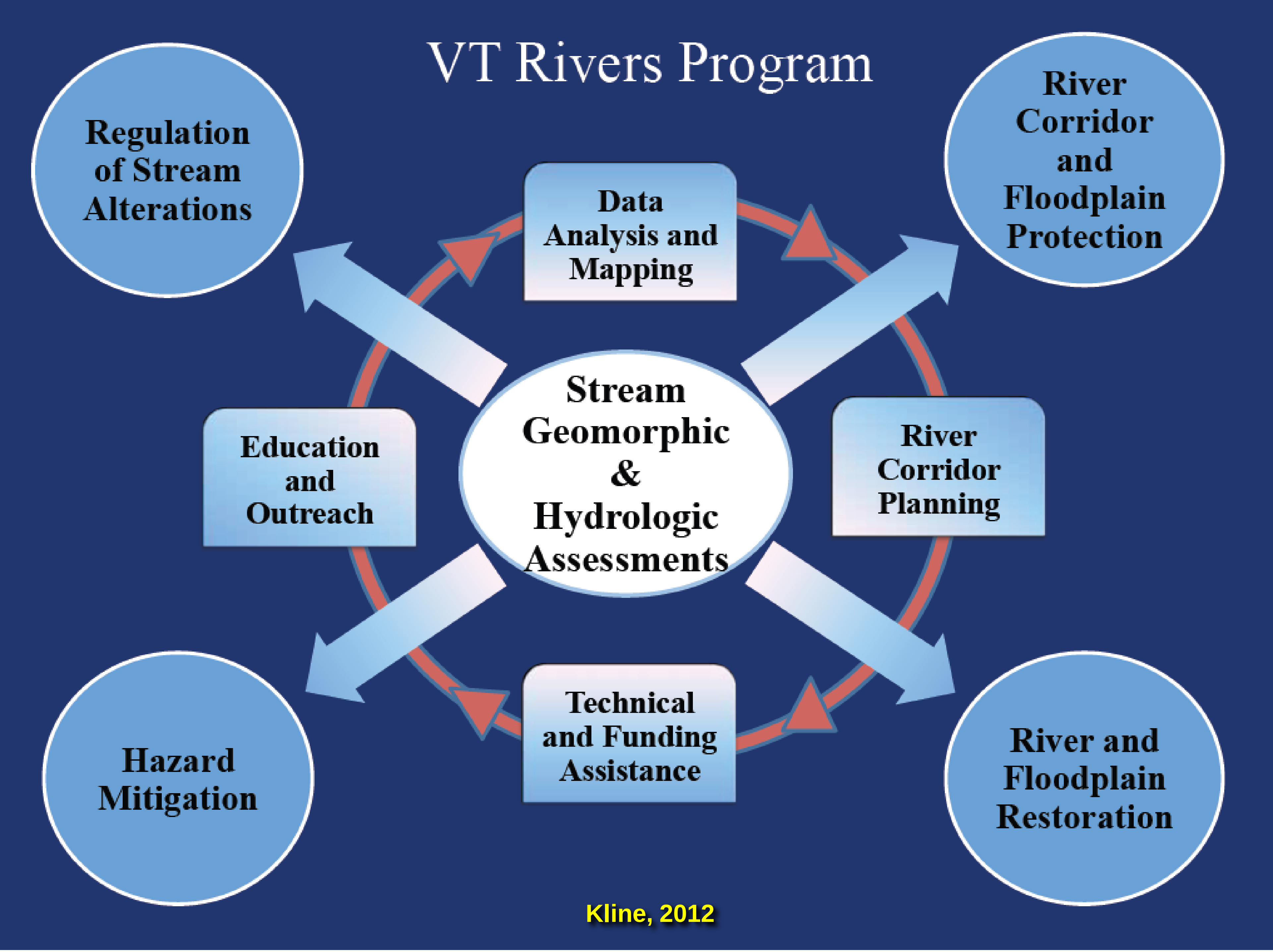
FGM NEEDS

Identification of Unstable Reaches

Identification of Fluvial Erosion Hazard Zones

Outreach and Education

Davis, DEP, 2012


VT Rivers Program
Regulation of Stream Alterations
River Corridor and Floodplain Protection
Data Analysis and Mapping
Education and Outreach
Stream Geomorphic & Hydrologic Assessments
River Corridor Planning
Technical and Funding Assistance
Hazard Mitigation
River and Floodplain Restoration
Kline, 2012

Vermont River Corridor Planning

Kline, 2012

Public Safety and Property Protection

Very High Water Quality

Healthy Riparian Ecosystems

Economically and ecologically sustainable relationship with rivers by managing toward *dynamic equilibrium*

Mitigate Flood and Fluvial Erosion Hazard

Reduce Sediment and Nutrient Loading

Restore / Protect Meandering, Connectivity, Flows & Wood

Limit Encroachments / Remove Constraints / Manage Emergency Measures / Restore Floodplain Function / Maintain Woody Buffers / Manage Stormwater

Fluvial Geomorphological Workshop
Umass-Amherst
October 25, 2012

Tentative Management Objectives:

1. To manage fluvial erosion hazards to protect public health and safety
2. To protect water quality to maintain vibrant riparian habitat

Development of a Task Force (18 members) to act in an advisory capacity (DEP DCR, DER, NRCS, Umass WRRC, MGS, DOT, Mike Kline VT, practitioners)

Developing a Proposal (HMGP 5% Initiative, March 15, 2013)(VT funded this way)

MA Fluvial Geomorphic Handbook and Protocol
Database Development
Demonstration Projects
Model River Corridor Management Plans
Implementation Plans
Training and Education

Demonstration Projects:

- Green River, Greenfield
- Saugus River– coastal urban
- Shawsheen River--urban

Photo from J. Field

Table 3-4. Indirect Mitigation Scoring Matrix									
Category	Mitigation Action	Instream Flow Improvement (max 10)	Aquatic Habitat[1] Improvement (max 30)			Water Supply Protection (max 10)	Generic Total Score	Permit Specific Adjustments
			Water Quality[2] Improvement (max 10)	Habitat Improvement (max 10)	Stream Continuity Improvement (max 10)			
Habitat Improvement	Remove a dam or other flow barrier[3]	5	5	5	10		25	During agency consult total score may be adjusted based on site specific information such as the location or scale of the activity.
Habitat Improvement	Culvert replacement to meet stream crossing standards		5	5	10		20	
Habitat Improvement	Streambank restoration		5	10			15	
Habitat Improvement	Stream channel restoration			10	5		15	
Habitat Improvement	Stream buffer restoration		5	10			15	
Habitat Improvement	Other habitat restoration project			10			10	
Habitat Improvement	Install and maintain a fish ladder[3]				10		10	
Habitat Protection	Acquire property in Zone I or II					10	10	
Stormwater	Stormwater bylaw with recharge requirements	5	5				10	
Stormwater	Stormwater utility meeting environmental requirement[4]	5	5				10	
Stormwater	Implement MS4 requirements[4]		10				10	
Habitat Improvement	Establish/contribute to aquatic habitat restoration fund			5			5	
Habitat Protection	Acquire property for other natural resource protection		5				5	
Wastewater	Infiltration/Inflow removal program	5					5	
TBD	Other project proposed by applicant	TBD[5]	TBD[5]	TBD[5]	TBD[5]	TBD[5]	TBD	
							165	

1. Aquatic habitat improvement can include instream water quality improvement, stream corridor habitat improvement, stream continuity improvement and cold water fishery improvement.
2. Water quality improvement can include reduction in cultural-source sediments, reduction in other pollutants, or -for CFR - mitigation of thermal impacts.
3. More credits can be considered if on a coldwater fishery resource.
4. Must result in increased recharge to get credit.
5. No benefit = 0 credits; Indirect benefit/improvement = 5 credits; Direct benefit/improvement = 10 credits


Photo by D. Boutt


Photo by John Fellows

WRC's Role

- State environmental agency staff time will be needed to participate in grant/task force
- Eventually, develop policies to incorporate FGM considerations into design standards and environmental permitting
- Consider opportunities to incorporate FGM assessments into regulatory programs

Water Policy Connections/Regulatory Programs

- MEPA review process
- MA Water Policy 2004 included “stream processes.”
- State Hazard Mitigation Plan: Flood/Fluvial Erosion Hazard
  - (dentification and Mitigation Strategy
- DEP Wetlands/Rivers Protection Act
- DEP Water Quality/Watershed Management
- DFG Aquatic Habitat
- DER Aquatic Habitat Restoration
- Community River Corridor Management Plans
- Conservation Commission/Planning zoning overlays
- DOT design standards for bridges, roads

SHALE GAS
IN MA

National Assessment of Oil and Gas

Assessment of Undiscovered Oil and Gas Resources of the East Coast Mesozoic Basins of the Piedmont, Blue Ridge Thrust Belt, Atlantic Coastal Plain, and New England Provinces, 2011

Introduction

During the early opening of the Atlantic Ocean in the Mesozoic Era, numerous extensional basins formed along the eastern margin of the North American continent from Florida northward to New England and parts of adjacent Canada. The basins extend generally from the offshore Atlantic continental margin westward beneath the Atlantic Coastal Plain to the Appalachian Mountains. Using a geology-based assessment method, the U.S. Geological Survey (USGS) estimated a mean undiscovered natural gas resource of 3,860 billion cubic feet and a mean undiscovered natural gas liquids resource of 135 million barrels in continuous accumulations within five of the East Coast Mesozoic basins (fig. 1; table 1): the Deep River, Dan River-Danville, and Richmond basins, which are within the Piedmont Province of North Carolina and Virginia; the Taylorsville basin, which is almost entirely within the Atlantic Coastal Plain Province of Virginia and Maryland; and the southern part of the Newark basin (herein referred to as the South Newark basin), which is within the Blue Ridge Thrust Belt Province of New Jersey (fig. 1). The provinces, which contain these extensional basins, extend across parts of Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, and Massachusetts (fig. 1).

The basins formed along the continental margin in response to the regional uplift, extension (rifting), and crustal thinning that occurred during the early opening of the Atlantic Ocean in middle Carnian (Late Triassic) time, approximately 227 million years ago. The basins were filled with a variety of sediments as they formed, including boulder beds, coarse-grained fluvial to deltaic sandstones, red siltstones, mudstones, gray and black shales, and coal. These deposits represent the diverse fluvial to deltaic and lacustrine environments that existed within the basins. The rifting ended early in the Jurassic with the onset of regional volcanism and intrusion of diabase dikes and sills.

Source Rocks

The source rocks for oil and gas within the Mesozoic basins include the gray and black shales and the coal beds. The shales accumulated in nearshore deltas, in interdistributary bays, and in the deeper portions of the lakes that

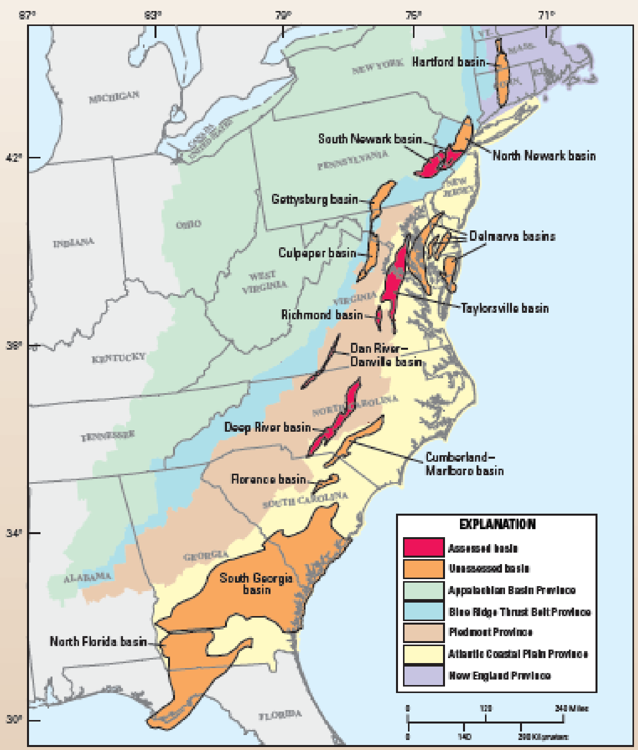


Figure 1. Map of the Eastern United States showing the locations of the five quantitatively (volumetrically) assessed East Coast Mesozoic basins, the nine basins that were not volumetrically assessed, and the U.S. Geological Survey province boundaries. Each basin includes one continuous gas assessment unit (tables 1, 2).

Composite Total Petroleum System

Continuous gas accumulation

USGS Fact Sheet 2012-1975

Studies of the Early Mesozoic Basins of the Eastern United States

U.S. GEOLOGICAL SURVEY BULLETIN 1776

310 CMR 27.00

(2) Class II. Wells used to inject fluids:

(a) which are brought to the surface in connection with conventional oil or natural gas production and that may be commingled with wastewater from gas plants as an integral part of production operations, unless those waters are classified as hazardous waste at the time of injection;

(b) for enhanced recovery of oil or natural gas; and

(c) for storage of hydrocarbons that are liquid at standard temperature and pressure.

27.04: Prohibited Activities

(1) No person shall inject fluids into or through an injection well and no person shall construct, install, operate or maintain any Class I, II or III injection well, except as authorized by 310 CMR 27.00.

SHALE GAS IN MASSACHUSETTS

Shale gas basins have been identified.
Will there be winners and losers?
When might development start?
What are potential environmental impacts?

This program will provide an information-exchange opportunity among experts with experience of areas where shale-gas has been developed and citizens and communities in central Massachusetts where shale-gas might be developed. A principal citizen concern is likely to be that of the potential impact on the long-term environmental sustainability of water sources and water-dependent ecosystems. However, in addition to environmental issues in areas of shale-gas development, there are typically legal and jurisdictional questions concerning property rights, property values, infrastructure capability, planning and zoning authority and economic benefits. The objective of this program is to facilitate informed discussion to ensure that when the time comes for energy development in the Hartford Mesozoic Basin, that science-based policy decisions are made that will best serve the interests of citizens in central Massachusetts.

AMERICAN GROUND WATER TRUST ★ GROUND WATER EDUCATION ★

December 13th, Amherst, Massachusetts
University of Massachusetts - Amherst
Lincoln Campus Center, One Campus Center Way
Room 163C

Program Organizer:

American Ground Water Trust
501(c)(3) education organization

AMERICAN GROUND WATER TRUST ★ GROUND WATER EDUCATION ★

NOT PAMELA LECKIE? THEN CLICK HERE.

SIGN UP

ENVIRONMENT MASSACHUSETTS

ABOUT US ISSUES NEWS ACTION JOBS DONATE

Keep Fracking out of Massachusetts!

With shale gas recently discovered in Western Massachusetts, the dirty drilling known as *fracking* could soon be coming to our backyards.

Let's keep this dirty drilling practice out of Massachusetts. Sign the petition today.

SEND MESSAGE

a publication of Working Assets

CREDO action

more than a network.
a movement.

Ban fracking in Massachusetts

Fracking is a dangerous method of natural gas extraction that can turn tap water flammable, produces cancer-causing air emissions and radioactive waste, and heats the planet.

Geologists recently discovered gas deposits in Western Massachusetts that could be extracted with fracking, so it's urgent for Massachusetts to pass legislation banning this inherently toxic practice before it starts.[1]

The Massachusetts Geological Survey

MAIN MENU:

- About the Massachusetts Geological Survey
- About Massachusetts Geology
- Educational Resources
- Maps / Data / Publications
- Shale Gas in MA
- Resources for Geothermal Energy
- Natural Hazards
- Water Resources
- Geology Links
- Home

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Amherst, MA 01003-9297

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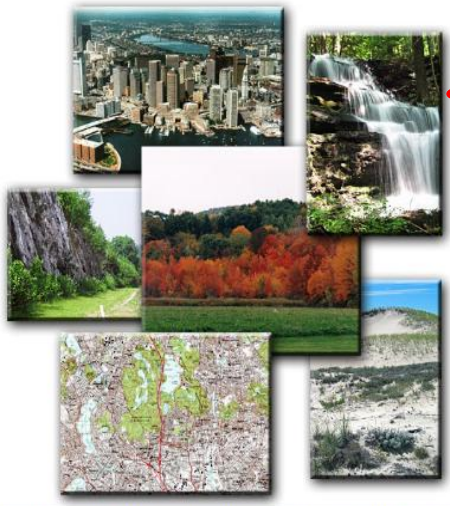
(413)545-1200 (fax)
sbmabee [at]
geo.umass.edu



The Massachusetts Geological Survey (formerly the Office of the Massachusetts State Geologist) is your first stop for earth science information, subsurface data, geologic maps, and educational resources for learning about the geology, groundwater, geothermal and mineral resources of Massachusetts. If you can't find what you need on this website, just give us a call or e-mail us and we can help you find it!

News and hot links:

- **Resources on Shale Gas and Hydraulic Fracturing for Massachusetts Residents** (updated 12/11/2012)
- New surficial geologic maps of **southeastern Massachusetts** are now available from the USGS.
- A new bedrock geologic map and report of the **Grafton quadrangle** is now available from the USGS.
- Massachusetts Mineral and Fossil Localities, by Peter Gleba, is now available as a PDF **here.**
- New **surficial geologic maps of the Connecticut Valley Area** are now available!
- A new Massachusetts Geology / Geography GIS App is now available for the iPhone! **Click here for more info.**
- **Recent USGS Publications for Massachusetts**
- Recent news appearances, technical papers, and meeting abstracts by MGS staff and affiliates (under construction).
- **Searchwell** - MassDEP's new database to search water-well boring records.

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Last updated 12/11/2012

http://www.geo.umass.edu/stategeologist/shalegas.htm