
# How to Design and Implement a Dam Removal

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Illinois Dam Removal Project Management Training
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# Before/After Project Examples

# Billington Street Dam
# Town Brook, Plymouth, MA

Before


During (fall 2002)

# Billington Street Dam
# Town Brook, Plymouth, MA

After (2011)

Two other Town Brook dams block 95% of fish even with fish ladders

# Merrimack Village Dam
# Souhegan River
# Merrimack, NH

# Merrimack Village Dam former impoundment immediately after removal

# Black Brook
# Manchester, NH

Weeks after removal

# Woolen Mills Dam
# Milwaukee River
# West Bend, WI

One week after removal

Winter 1988

# Riverside Park
# Milwaukee River, West Bend, WI

# Cotton Mill Dam

Satucket River
August 11, 2001

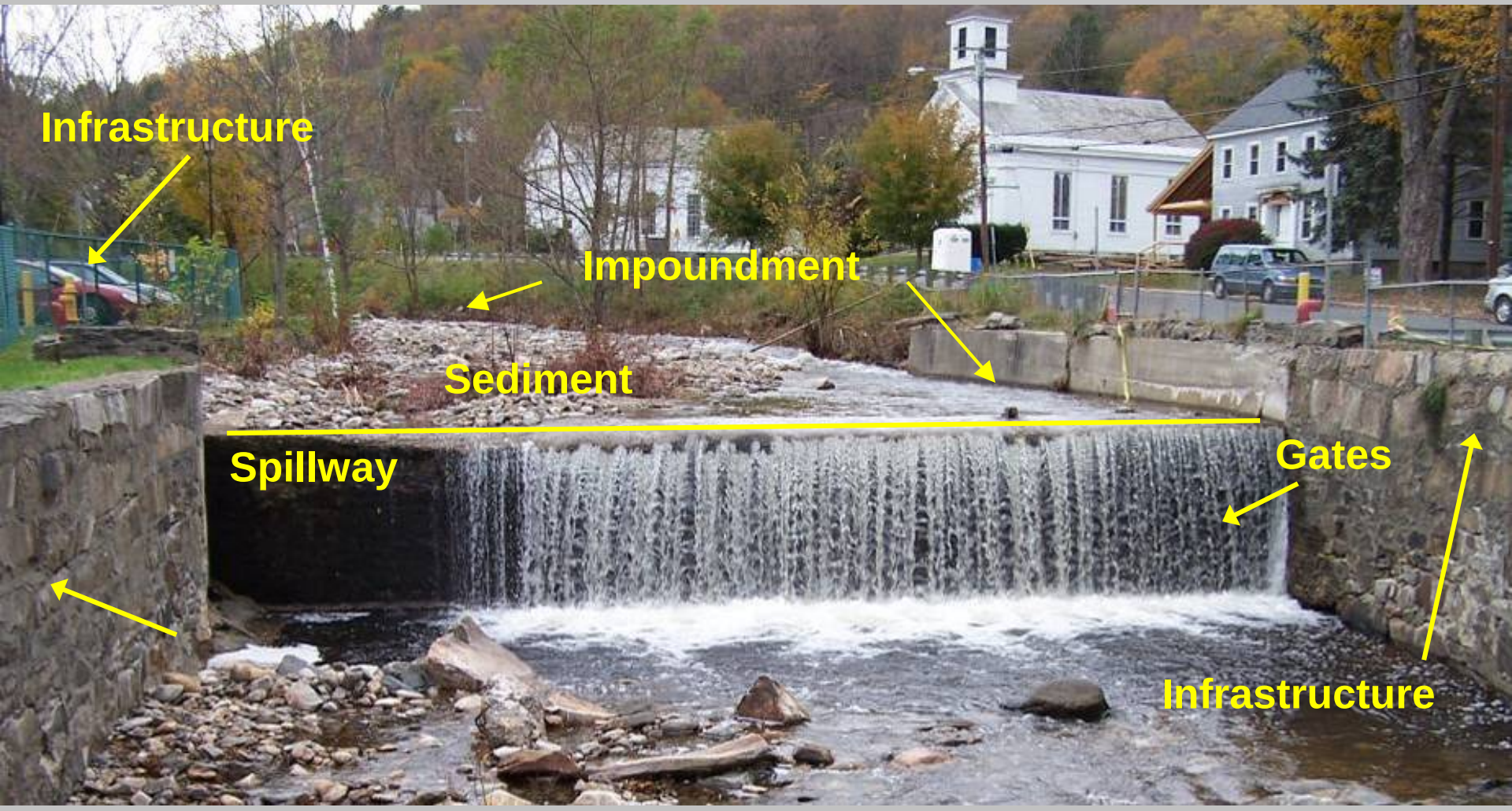
Satucket River
October 3, 2001

# Goals:

1) Understand the dam removal process

2) Be able to scope out the components of a project


# Dam Components



# Dam removal science/design includes 6 components

# Consider long-term benefits vs. short-term impacts




# Some *short-term* impacts occur during construction

Sediment movement

Construction access

Habitat change

# There are 3 potential long-term impacts if not managed well

Contaminants

T & E species

Infrastructure

# Data Collection and Surveying

# Find existing data on the dam and the river

Past Dam Inspections (state dam safety)

FEMA - FIS, profiles, plans, and computer model (state, town library or engineer), or
http://www.msc.fema.gov

Aerial or orthophotographs (web or order)
http://maps.google.com
http://earth.google.com

USGS topographic mapping

Local topographic mapping (town, state, web)

Sanborn mapping (commercial properties to 1867):
http://www.edrnet.com/sanborn.htm

Historic topo maps: http://historical.maptech.com
For northeast:
http://docs.unh.edu/nhtopos/nhtopos.htm

Tax Assessors Mapping (town)

Geological mapping

GIS Data (town, region, or state)

State Rare & Endangered Species Mapping

Wetland Mapping

EPA Watershed Mapping & Info
http://www.epa.gov/surf/

USGS Gauge Data (flow & sediment)
http://water.usgs.gov/

Additional Flow Data (state, web, ACOE, local group, old reports)

Fisheries Data (state)

Past Plans (of dam, site, or nearby construction) (DOT, town engineer, state)

Permit applications (town, state, feds, or web)

Old Reports (environmental, historic, engineering, planning, state studies, etc.)

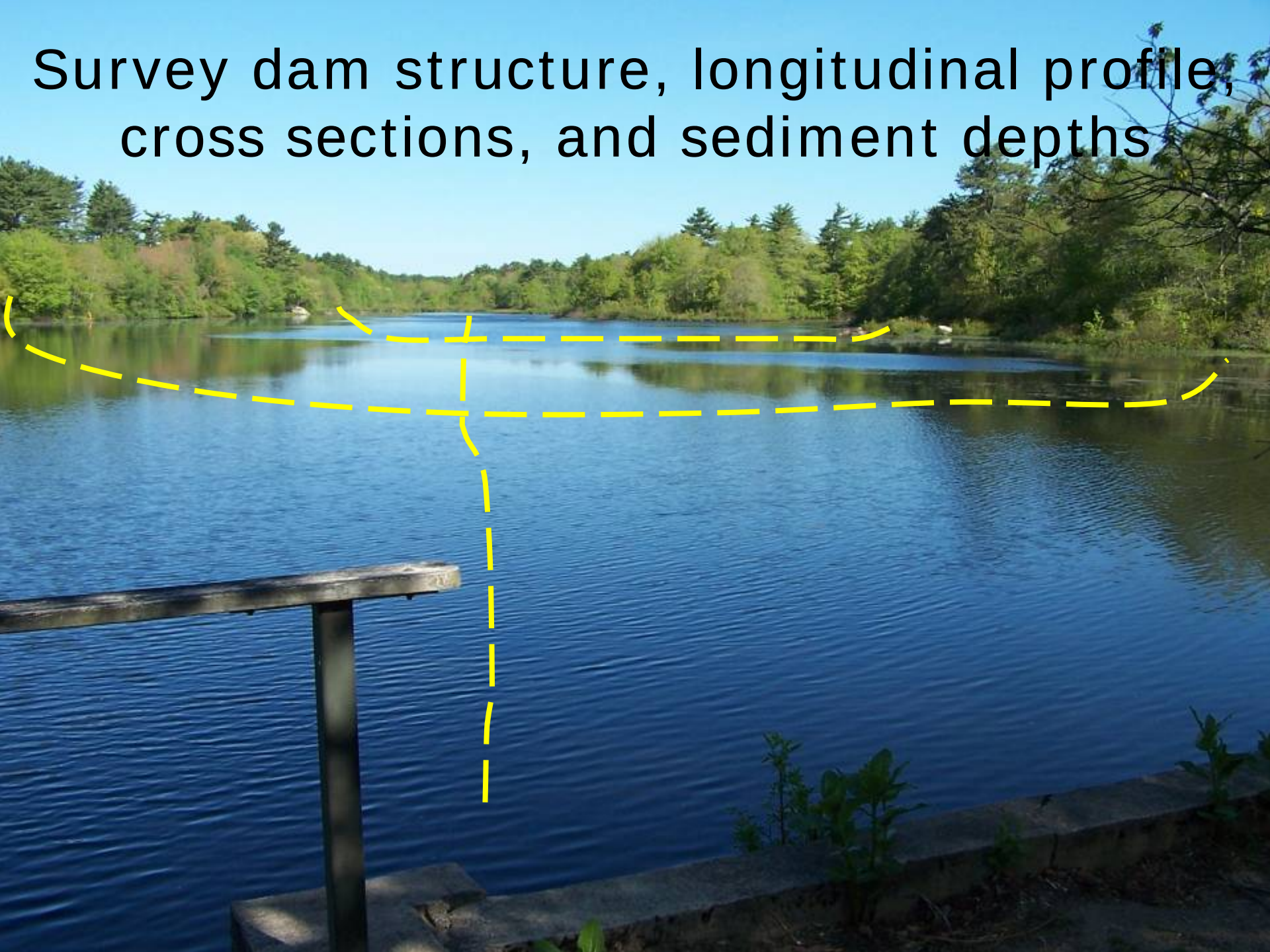
Photographs (current and historic) (town, neighbors)

Historic Records (town, state)

FERC Reports: http://elibrary.ferc.gov

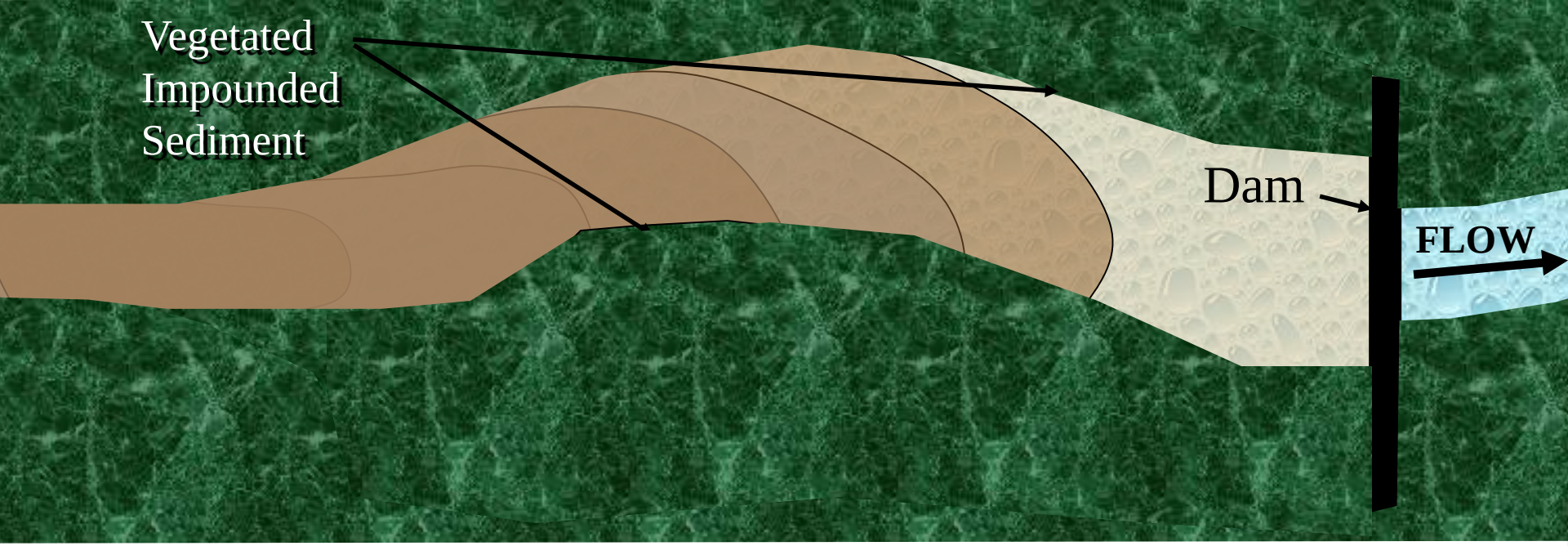
Utility Information (town or state)

Web pages for local recreation

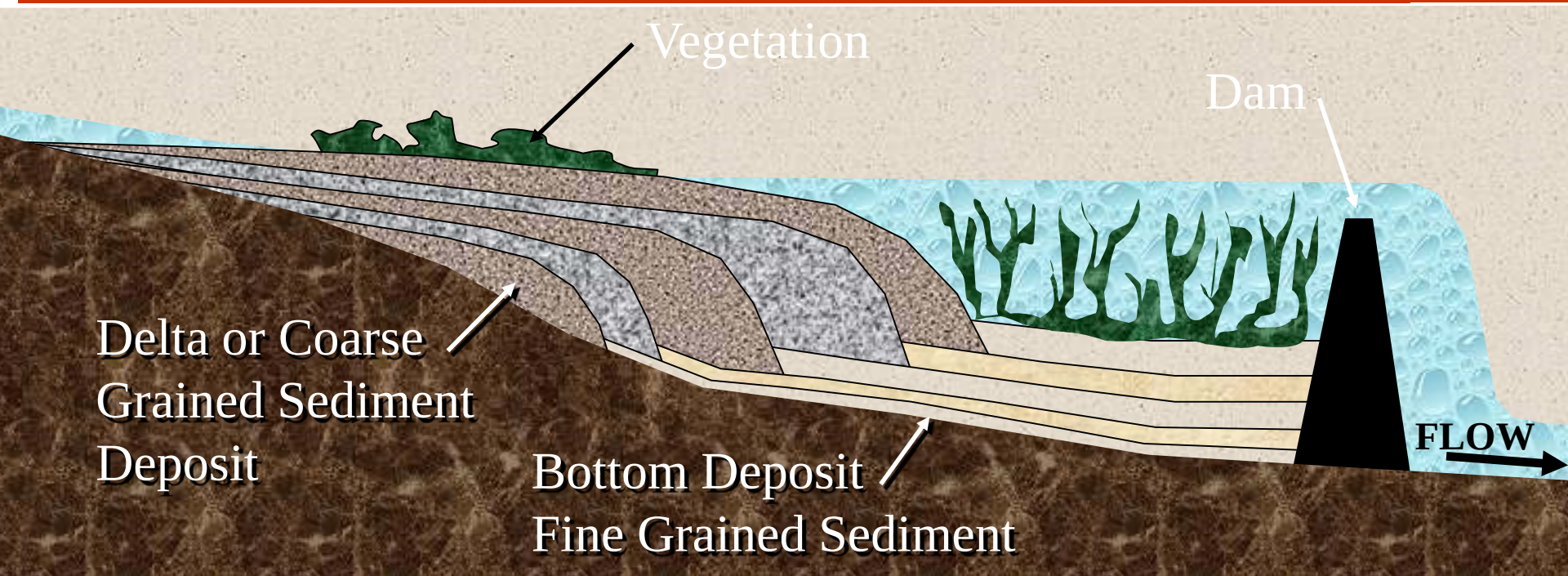

Survey dam structure, longitudinal profile, cross sections, and sediment depths

# Sediment depth can be measured with a sediment probe or a metal rod

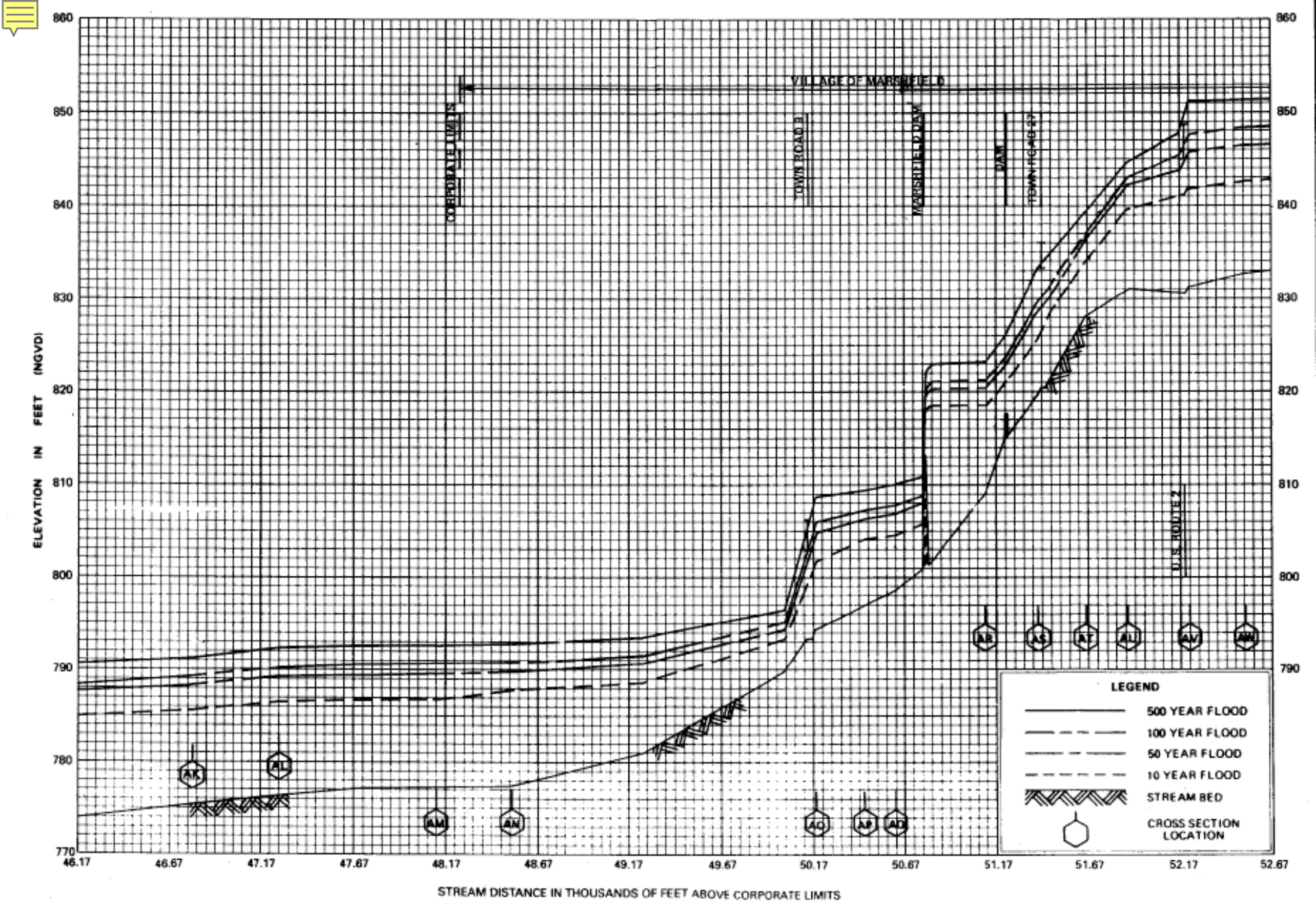
# Be careful to survey through extent of original impoundment


Vegetated
Impounded
Sediment
Dam
FLOW

**TIME**


Vegetation
Dam
Delta or Coarse
Grained Sediment
Deposit
Bottom Deposit
Fine Grained Sediment
FLOW

Rindge Dam
Malibu Creek, CA




Design Components: Data Collection/Surveying

# Hydrology/Hydraulics

# What's the difference between hydrology and hydraulics?

Hydrology:

Magnitudes and probabilities of flows

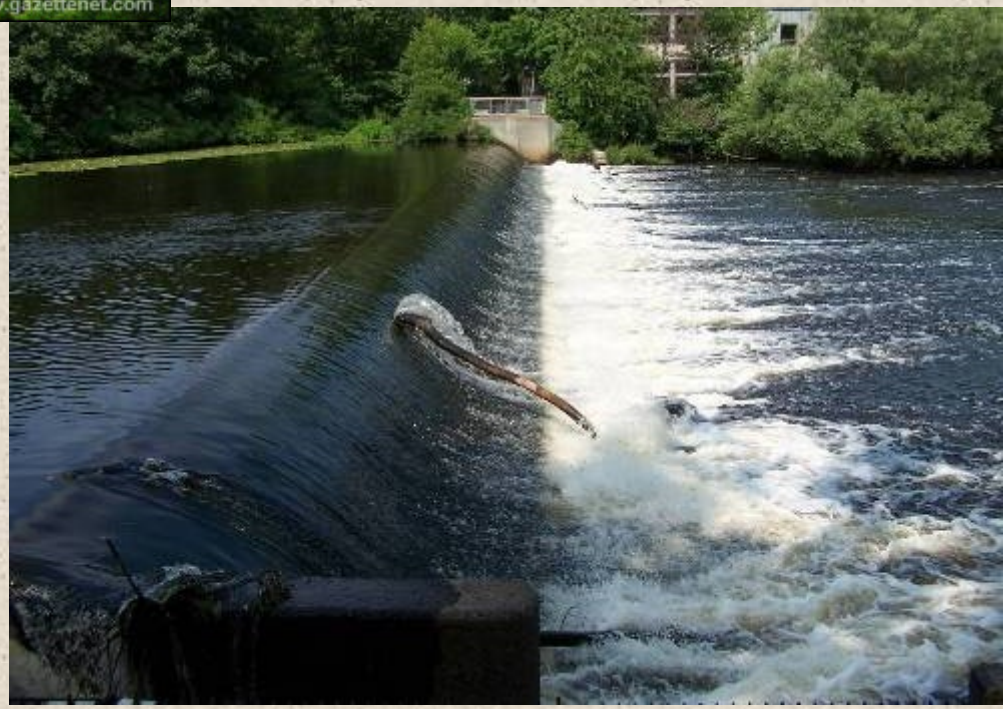
Hydraulics:

Depths and velocities of flows

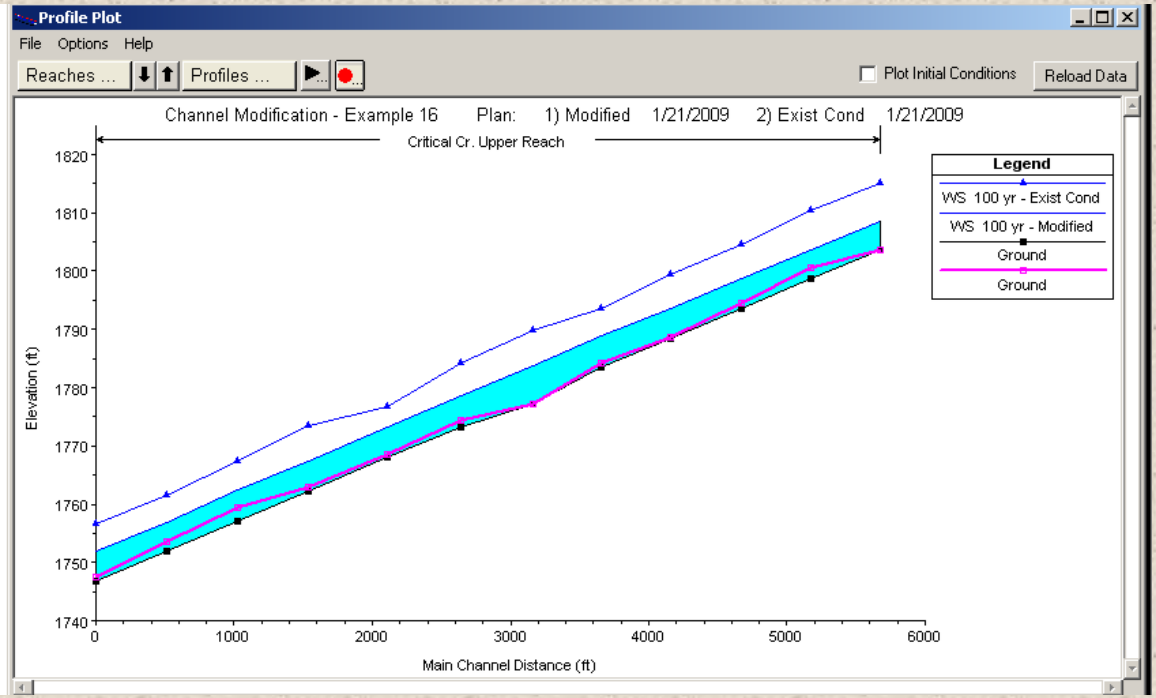

# Does your dam provide flood control? Probably not

<u>No Flood Storage Potential</u>: has full impoundment and constant flow over spillway

<u>Flood Storage Potential</u>: has storage volume and flow through a controlled outlet



# What's a HEC-RAS and when do you need one?




- Infrastructure protection
- To prove fish passage
- Post-project water levels for stakeholders
- Advanced sediment transport modeling
- To address flood control?

# Sediment Management

# General Concepts in Dam Removal
# Sediment Management

# Rivers naturally carry sediment

# Sediment can be harmful or beneficial

# Coarse grain sediment can be beneficial to habitat

Fine grain sediment release (clay and silt)

- Can clog habitat downstream
- Can have direct impacts on species respiration

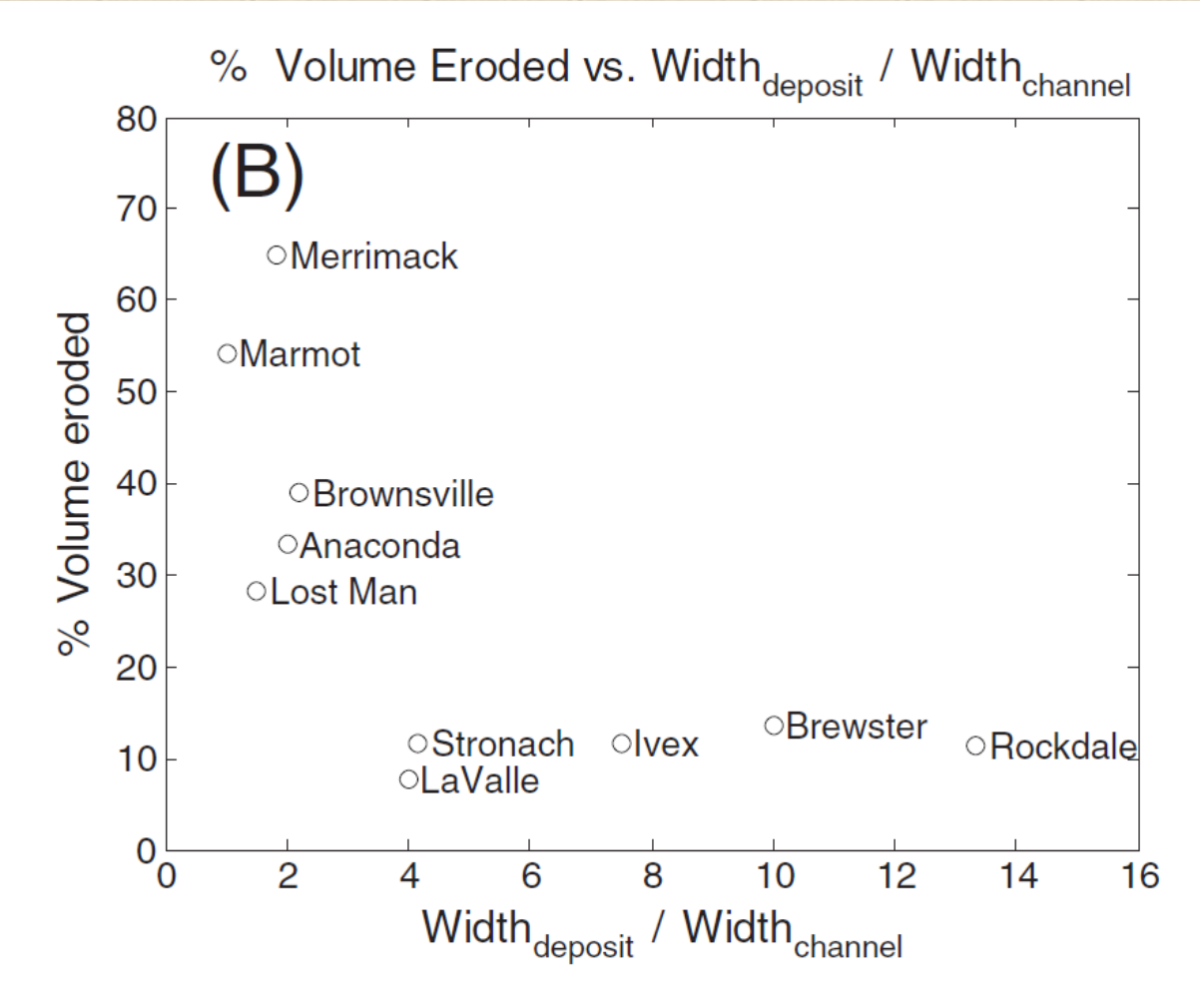
Coarse grain (cobble and gravel)

- Forms the basis of habitat for many species

# Not all dams have a lot of sediment

# Not all sediment moves

# As impoundment width increases, percent sediment release decreases

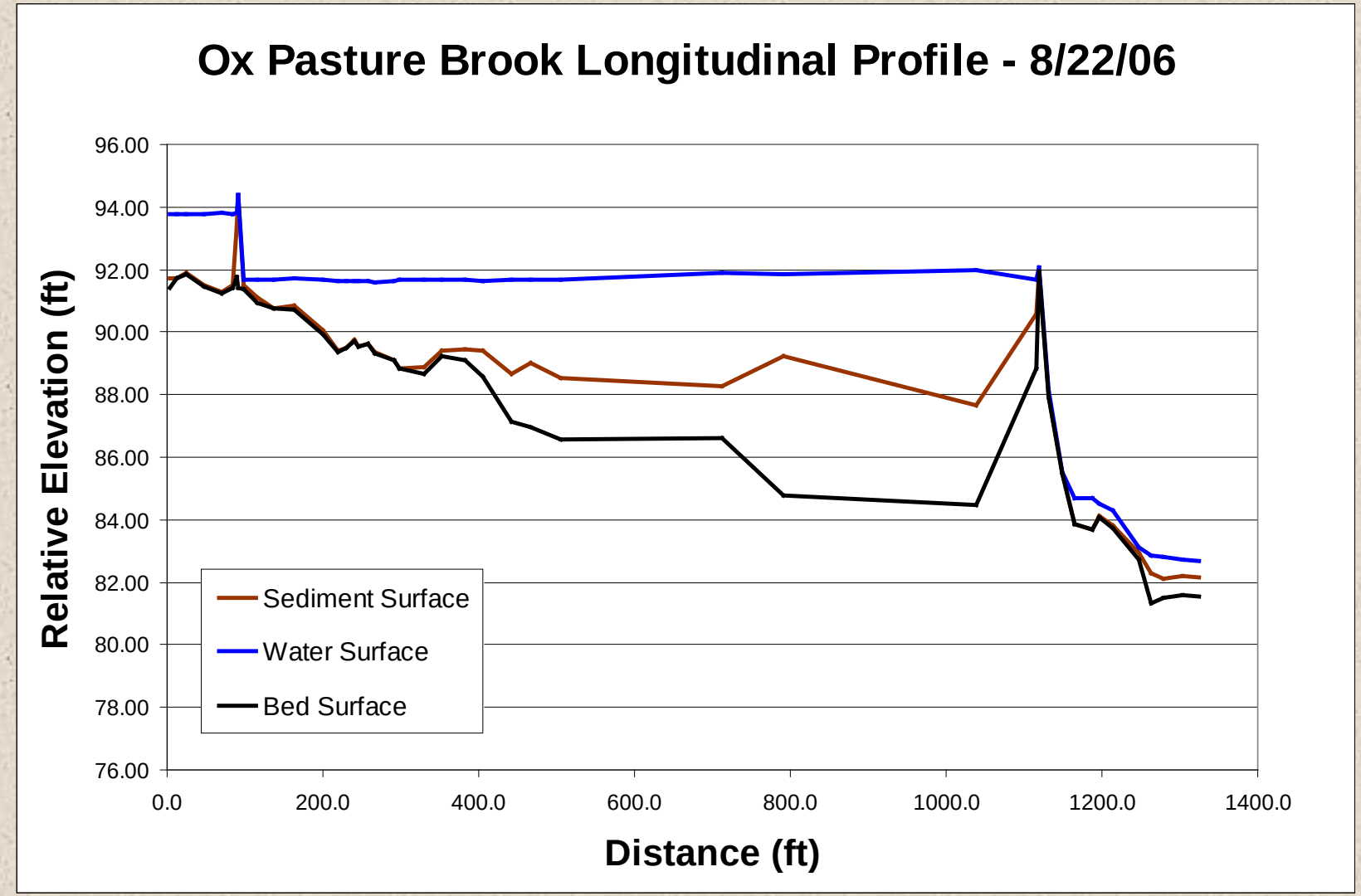



From: Sawaske, S.R. and Freyberg, D.L. 2012. A comparison of past small dam removals in highly sediment-impacted systems in the U.S. *Geomorphology* 151-152: 50-58.

# Assess the quantity, particle sizes, quality, and potential mobility of impounded sediment



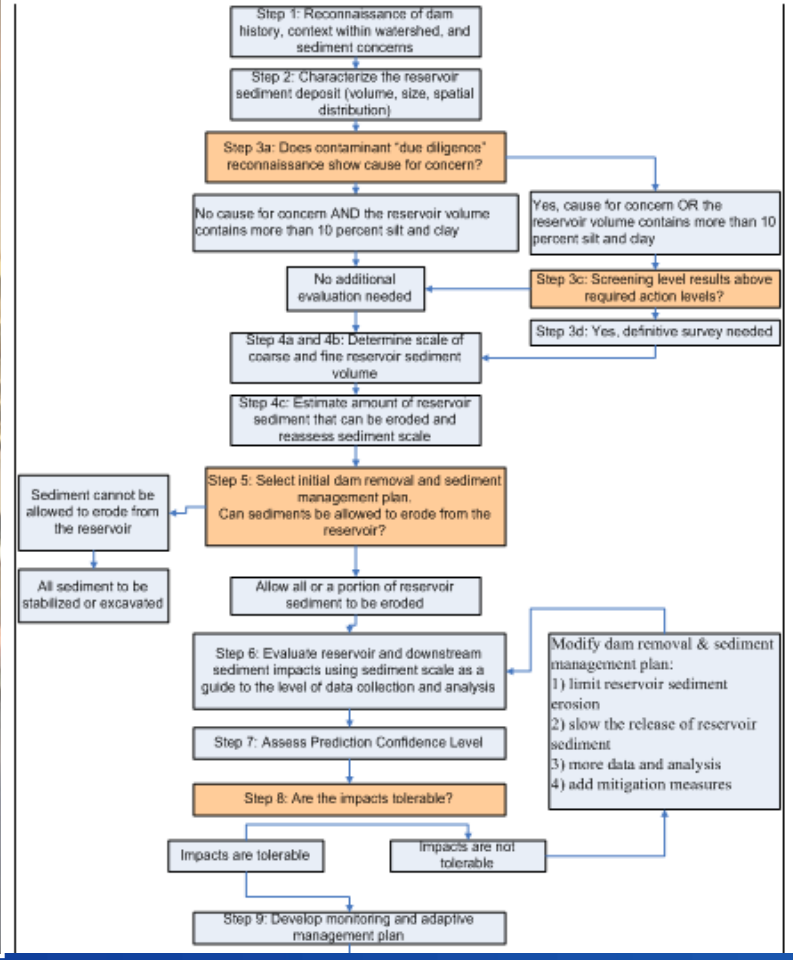

# The longitudinal profile is a fundamental sediment analysis tool



# Test sediment for contaminants and compare to ecological and human risk thresholds

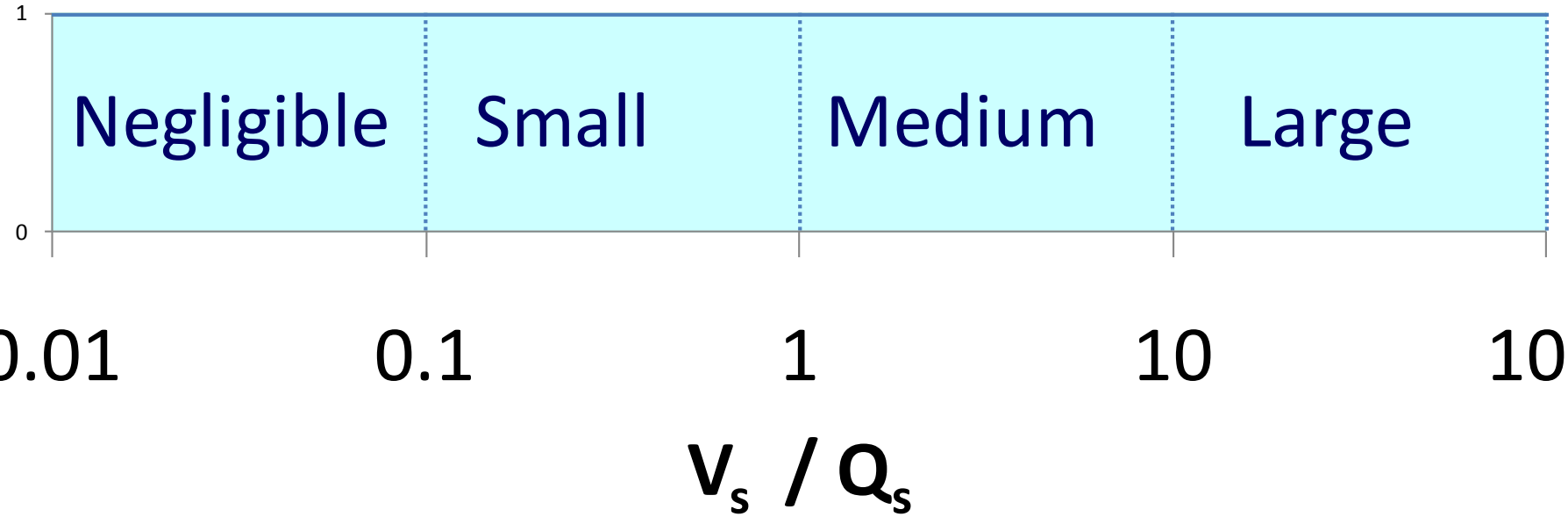

- Complete ‘due diligence’
- Assess quantity of sediment
- Collect sediment cores (not grabs)
- Test for organics and heavy metals
- Compare test concentrations to human risk and ecological thresholds

# National Subcommittee on Sedimentation Protocols




RECLAMATION

# Reservoir Sediment Volume ($V_s$) Relative to the Average Annual Sediment Load ($Q_s$)

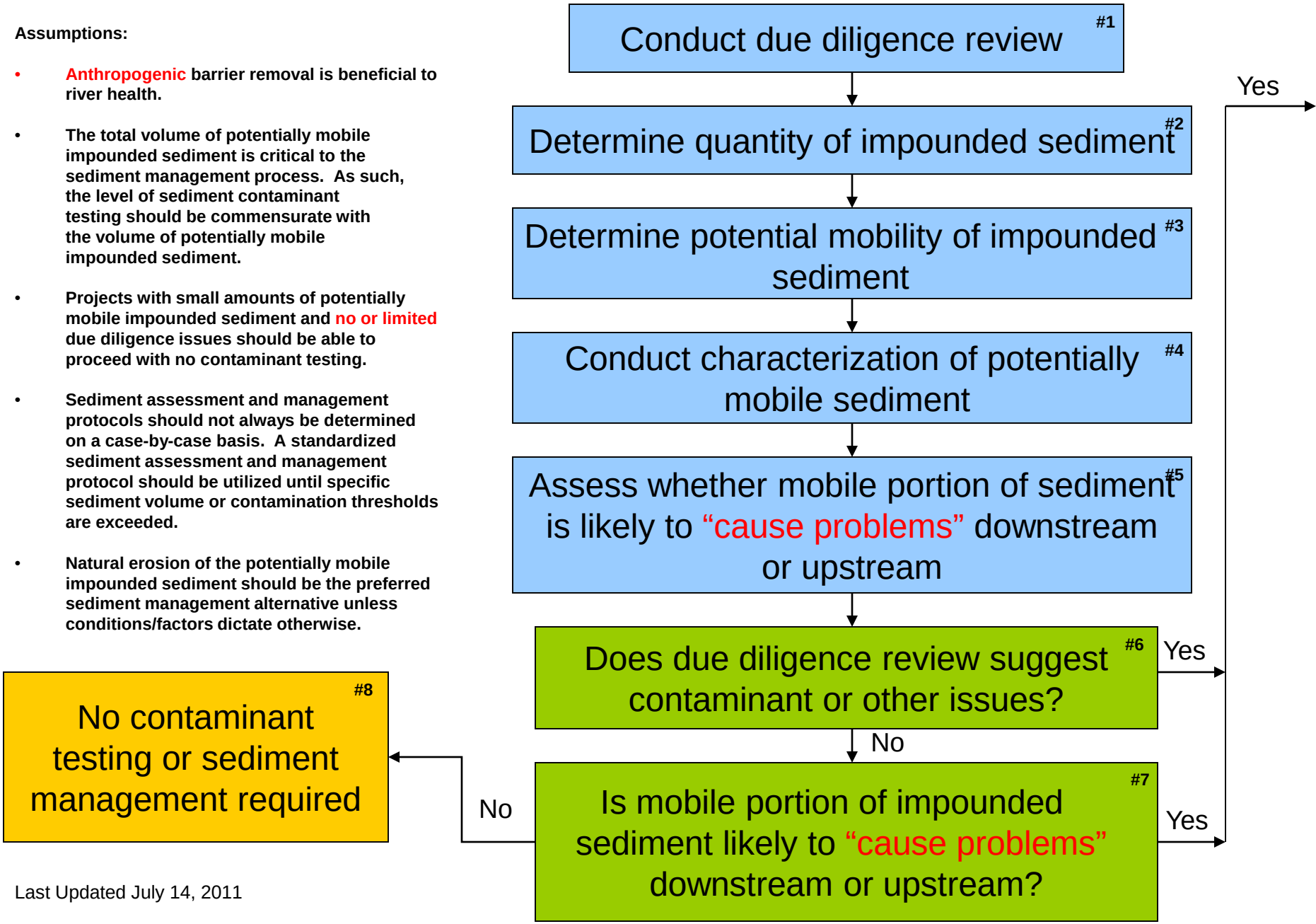



Scale analysis and management to sediment volume

# NH Barrier Removal Sediment Assessment & Management Protocol Flow Chart

**Assumptions:**

- **Anthropogenic barrier removal is beneficial to river health.**
- **The total volume of potentially mobile impounded sediment is critical to the sediment management process. As such, the level of sediment contaminant testing should be commensurate with the volume of potentially mobile impounded sediment.**
- **Projects with small amounts of potentially mobile impounded sediment and no or limited due diligence issues should be able to proceed with no contaminant testing.**
- **Sediment assessment and management protocols should not always be determined on a case-by-case basis. A standardized sediment assessment and management protocol should be utilized until specific sediment volume or contamination thresholds are exceeded.**
- **Natural erosion of the potentially mobile impounded sediment should be the preferred sediment management alternative unless conditions/factors dictate otherwise.**




Last Updated July 14, 2011

# There are several approaches to managing clean sediment (depending on quantity and particle sizes)

Photo: John Gussman

- Natural erosion
- Sediment removal (dredging)
- Stabilize in place
  - Open dam gates
  - Remove dam slowly
  - Remove dam in stages
- Combined approaches

# There are fewer approaches to managing contaminated sediment

- Management options
  - Remove and dispose
  - Isolate and cap
- If contaminant management is necessary, can greatly add to cost of project
- Conundrum: dams are not good hazardous waste containment facilities

# Merrimack Village Dam
# Souhegan River, NH

Design Components: Natural Erosion

# Dufresne Dam, Battenkill, VT

# Protecting Infrastructure

# Look in and along impoundment and in the dam for at-risk bridges, retaining walls, or utilities

# Assess whether any infrastructure is at risk

Bridges

Retaining walls

Utilities

# Consider if infrastructure can be moved first; next consider direct stabilization

Bridges

Retaining walls

Utilities

# Species Protection

# Identify if species of concern could be affected by dam removal

- Contact Illinois Natural Heritage Program for species of concern database search
- Species information by county is available online

# Manage for Aquatic Species




# Revegetate and consider multiple species and multiple life stages in additional restoration plans

# The majority of the habitat restoration comes from removing the dam

Water quality, flow regime, connectivity, complexity

- Restored fish passage
- Restored connectivity along bed, banks, riparian area
- Temperature regime improvement (and associated dissolved oxygen)
- Restored riverine flow characteristics
- Restored sediment dynamics
- Cleaned substrate
- Restored vegetative cover long-term
- Restored riverine bed features long-term

Dam removal sets river on a trajectory to restore long-term habitat if given freedom to do its own work

# Habitat Formation

Is the river free to create habitat?

- Urban settings
- Give the river as much space as possible

Stream Power:

Baseflow dominated spring creeks take longer to form habitat than powerful rivers

# Woody habitat provides:

- Habitat cover
- Bed complexity
  - Creates and maintains pools
- Habitat stability: Decreased erosive power
  - wood only 2% of streambed area, but accounted for 50% of the total flow resistance (Manga and Kirchner 2000)
- Better species response than other active habitat additions

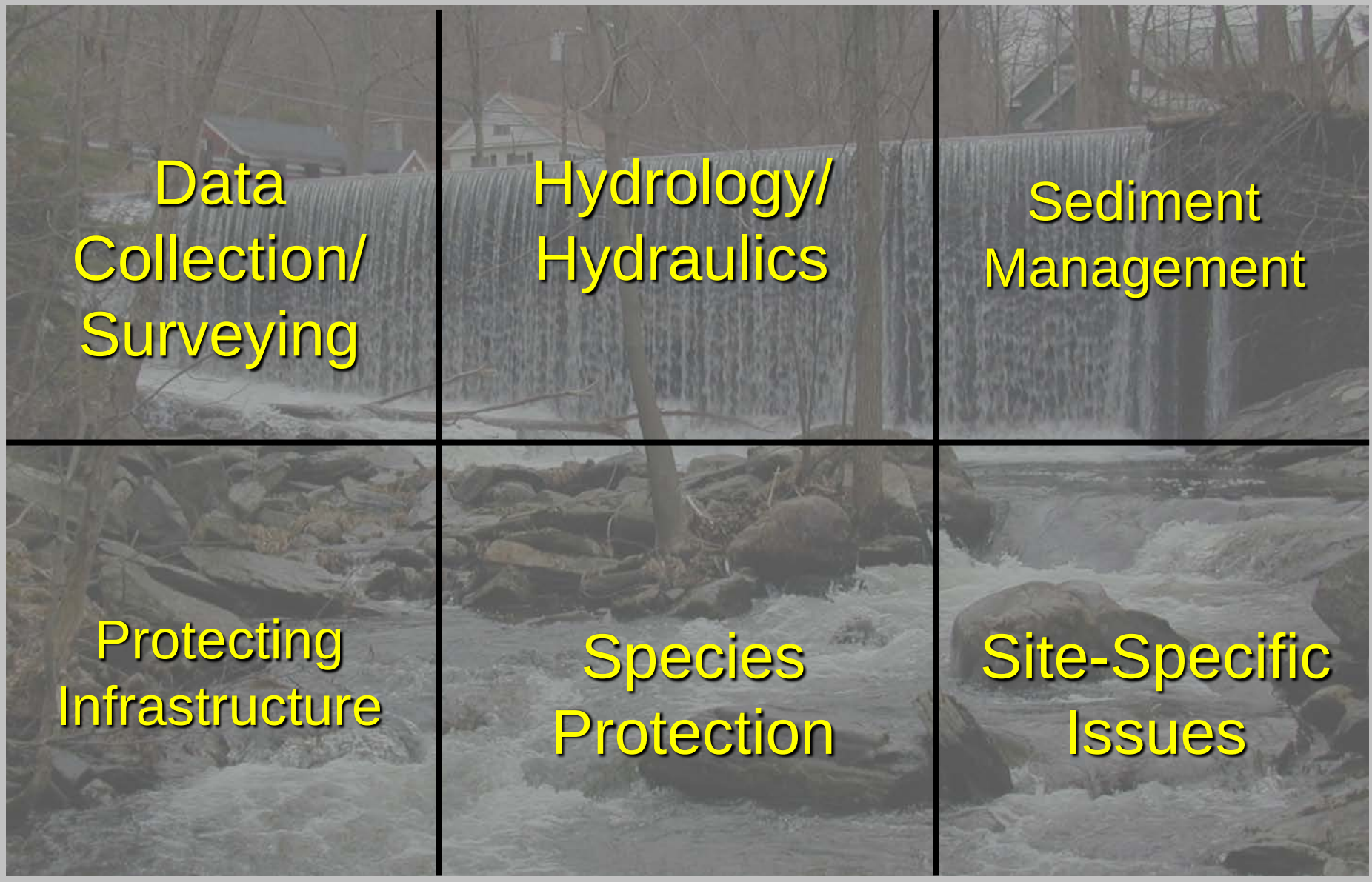
# Site-Specific Issues

# Dam uses can often be replaced

Other site-specific issues:

well impacts, parks, walking trails, renderings, etc.

# You now have the basis for writing a scope of work



# There are several approaches to removing a structure

Explosives


Heavy Machinery

By Hand

# Explosives are rarely used in most parts of the country

Eagle & Phenix Dam
Chattahoochee River, Georgia

Ledger-Enquirer

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## Dam blasting set for Wednesday to sound like boom of 20 cannons

By TIM CHITWOOD — tchitwood@ledger-enquirer.com
Posted: 12:06am on Mar 18, 2012; Modified: 5:50pm on Mar 20, 2012

Like 6 people like this. Be the first of your friends.

# Tim Chitwood: Crank that dam blast up to a crowd pleaser

By Tim Chitwood — tchitwood@ledger-enquirer.com

For gosh sakes will someone please blow something up here in a way folks can appreciate?

"My dog didn't even jump," said a woman hugging a wee pup Wednesday when a portion of the Eagle & Phenix dam was dynamited, and so many dreams of devastation were deferred.

"Is that it?" asked another bystander.

"I can't believe that's all it was," said a third.

It was a dam shame that so dam many were drawn downtown by a dam explosion that was so dam disappointing.

The dam blew up precisely as planned, and that totally ticked everyone off. No one got hurt, no windows broke, and no shattered rock rained upon witnesses, not even people partying in luxury lofts within the old Eagle & Phenix mill that once ran on dam power.

In fact the blast was so well contained that some could hardly hear it. Critics compared it to the flatulence of small animals, favoring fish for brevity and alliteration. The wind broken by digesting popcorn also was mentioned.

This is what happens when you let professionals handle dynamite: They so well calculate the explosive force needed, and so well cover the blast site with fabric and metal fence, that no rock or other debris goes airborne to plummet upon cars, buildings or passersby.

Leave that work to volunteers and you wouldn't have that problem.

# First, slowly drain the impoundment

# Most commonly a backhoe with a hydraulic hammer will breach one side and then move across

We have also used more careful construction approaches

# Near-site disposal of material saves money and is often preferred by regulators

# (De)construction approaches usually work “in the wet”


Massachusetts: Billington Street Dam Removal, Town Brook


Massachusetts: Ox Pasture Brook Dam Removal, Ox Pasture Brook


Connecticut: Union City Dam Removal, Naugatuck River


New Hampshire: Merrimack Village Dam Removal, Souhegan River


North Carolina: Dynamo Dam Removal, Little River


Things that Go Wrong
(And How to Make
Them Go Right)

# Along with experience, look for non-technical skills and integration of skills

Important non-technical skills:

- Responsiveness and project management
- Permitting
- Presentation skills
- Willingness to advocate for resource and project

No one firm is truly good at all of these

Integration of technical skills:

- Engineering
- Geomorphology
- Ecology

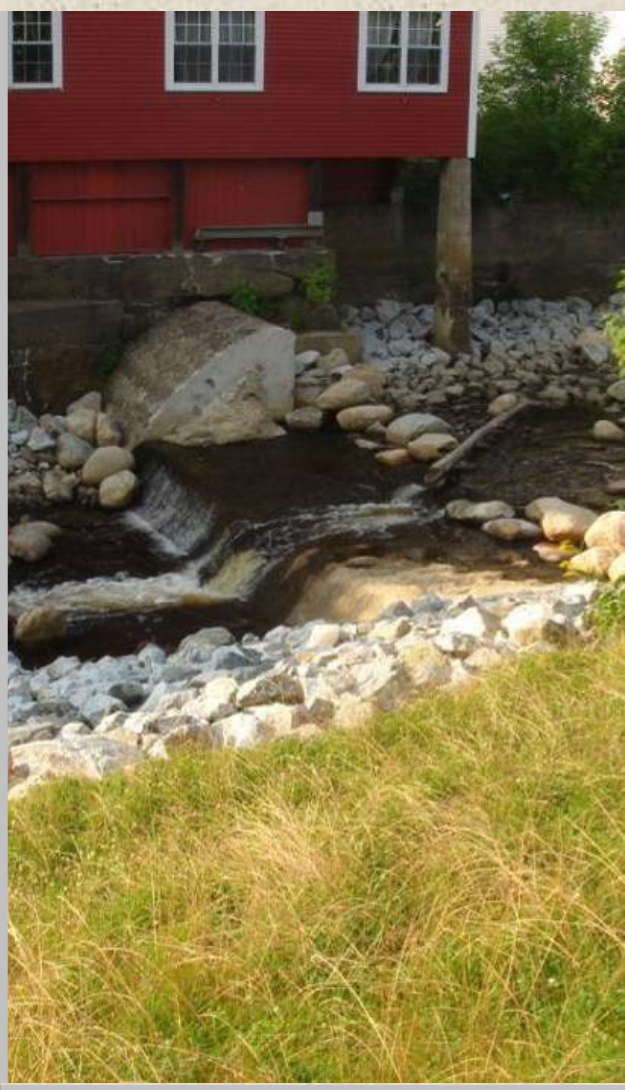
# Traditional engineers may miss river context and habitat

# Blend geomorphology, ecology, and engineering skills:

# Remove the full vertical extent of the dam (and as much of the lateral extent as possible)

# Construction oversight is critical

# Be cautious/skeptical with structural approaches



# Active habitat additions (cross vanes, weirs, lunkers, etc.) need to be used appropriately

- High failure risk
  - 40-70% failure rate shown in studies
  - higher in volatile environment of drained impoundment
- Can take river out of context (forcing different structure on river)
- May not actually help habitat long-term (according to several studies)

# Decision-Making Process for Applied Habitat Management

1) What will happen if we do nothing besides remove the dam?

   - consider 50-100 year timeframe

2) Assess whether river has the power and material to build habitat once freed

3) Simulate nature if actively managing

# Dam Removal Clearinghouse:
## http://wrca.library.ucr.edu/CDRI/

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