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Why Did The Dam Cross The River? Getting to the Other Side of Small Dam Removal

Joint Committee on Fisheries Engineering and Science

2015 Webinar Series

Michael Chelminski, P.E., M.ASCE

Principal, Stantec Consulting Services Inc.

July 22, 2015

Preamble

Dams in the Riverscape:

- ***Ecological Impacts***
  - Altered habitat
  - Altered connectivity
- ***Infrastructure Impacts***
  - Maintenance
  - Dependent infrastructure
  - Risk and Resiliency

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Preamble: Small Dams

Small Dams in the Riverscape:

- ***Ecological Impacts***
  - *Cumulative Impacts on Connectivity*
- ***Infrastructure Impacts***
  - *Cumulative Impacts to Adjacent Infrastructure*
  - *Emergency Response*
- ***Objective:***
  - ***Improved Resiliency***

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Experience with Small Dam Removal Projects

Experience:

- **More than 55 Reconnaissance-Level Dam Removal Studies**
- **Participation in more than 25 other dam removal projects, including Penobscot River Restoration Project (PRRP).**
- **Engineer-of-Record for 11 Completed Dam Removals**

> ***Active Hydroelectric Dams = 4 (3 on PRRP)***
> ***Flood Control Dams = 0***

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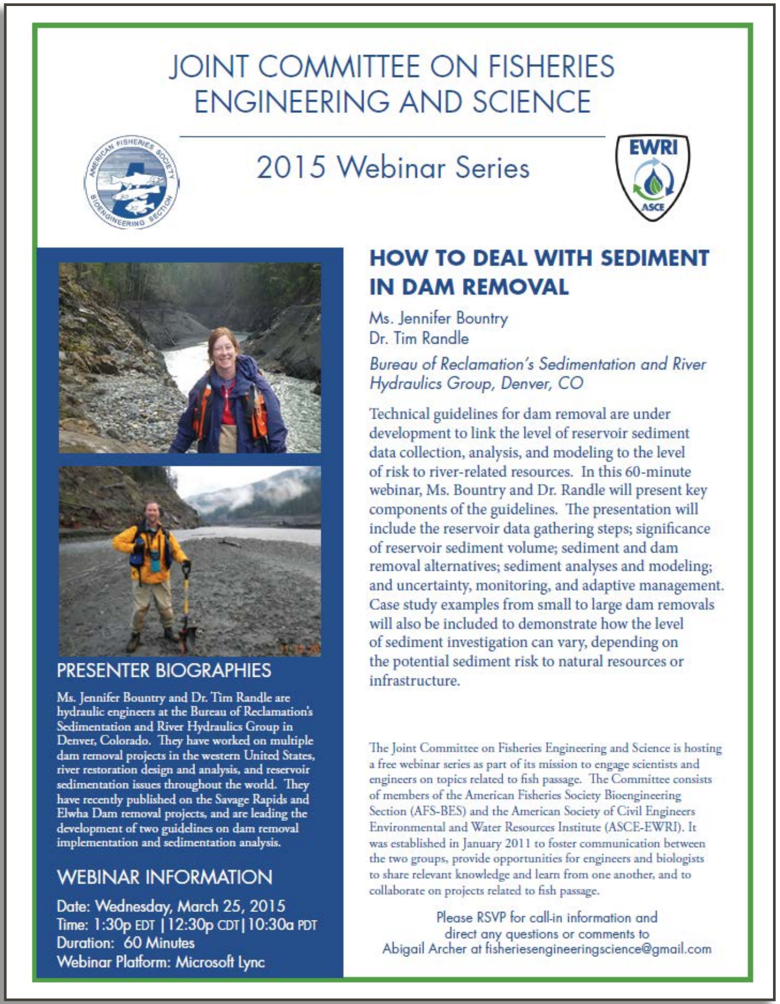
Moving Forward

- ✓ Presentation in this series by Ms. Jennifer Bountry and Dr. Tim Randle addressed sediment transport and large dam removal projects (e.g., Elwha River).

- ➢ This presentation addresses scoping and design and permitting elements for small dam removal projects.



JOINT COMMITTEE ON FISHERIES ENGINEERING AND SCIENCE

2015 Webinar Series

HOW TO DEAL WITH SEDIMENT IN DAM REMOVAL

Ms. Jennifer Bountry
Dr. Tim Randle

Bureau of Reclamation's Sedimentation and River Hydraulics Group, Denver, CO

Technical guidelines for dam removal are under development to link the level of reservoir sediment data collection, analysis, and modeling to the level of risk to river-related resources. In this 60-minute webinar, Ms. Bountry and Dr. Randle will present key components of the guidelines. The presentation will include the reservoir data gathering steps; significance of reservoir sediment volume; sediment and dam removal alternatives; sediment analyses and modeling; and uncertainty, monitoring, and adaptive management. Case study examples from small to large dam removals will also be included to demonstrate how the level of sediment investigation can vary, depending on the potential sediment risk to natural resources or infrastructure.

PRESENTER BIOGRAPHIES

Ms. Jennifer Bountry and Dr. Tim Randle are hydraulic engineers at the Bureau of Reclamation's Sedimentation and River Hydraulics Group in Denver, Colorado. They have worked on multiple dam removal projects in the western United States, river restoration design and analysis, and reservoir sedimentation issues throughout the world. They have recently published on the Savage Rapids and Elwha Dam removal projects, and are leading the development of two guidelines on dam removal implementation and sedimentation analysis.

WEBINAR INFORMATION

Date: Wednesday, March 25, 2015
Time: 1:30p EDT | 12:30p CDT | 10:30a PDT
Duration: 60 Minutes
Webinar Platform: Microsoft Lync

The Joint Committee on Fisheries Engineering and Science is hosting a free webinar series as part of its mission to engage scientists and engineers on topics related to fish passage. The Committee consists of members of the American Fisheries Society Bioengineering Section (AFS-BES) and the American Society of Civil Engineers Environmental and Water Resources Institute (ASCE-EWRI). It was established in January 2011 to foster communication between the two groups, provide opportunities for engineers and biologists to share relevant knowledge and learn from one another, and to collaborate on projects related to fish passage.

Please RSVP for call-in information and direct any questions or comments to Abigail Archer at fisheriesengineeringscience@gmail.com

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Agenda

1 Dam Removal and Small Dam Removal

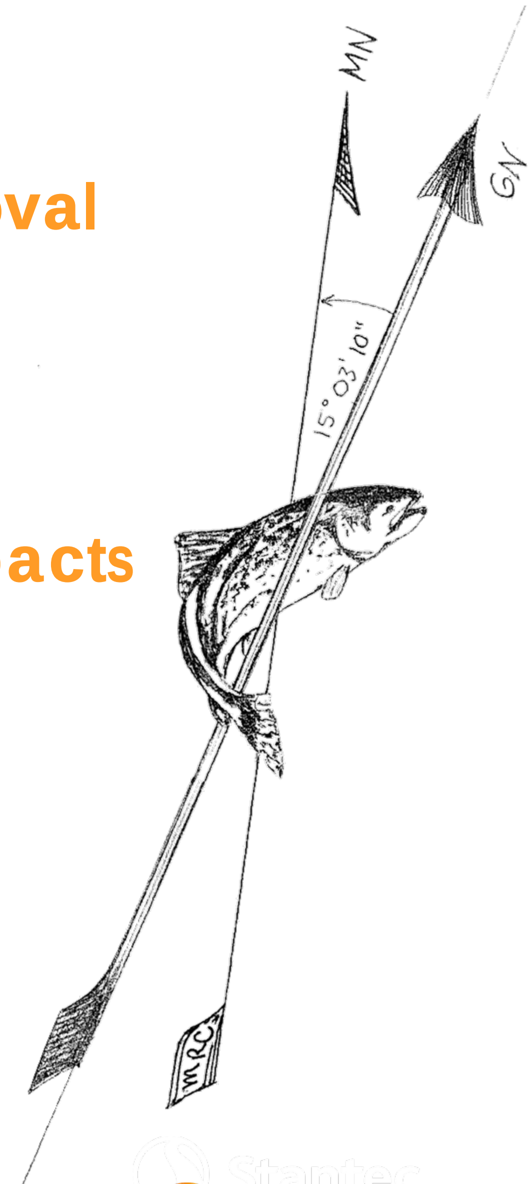
2 Primary Functions of Dams

3 Small Dam Removal Drivers and Impacts

4 Small Dam Removal Project Process

5 Engineered Dam Failure

6 Benefits of Small Dam Removal



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1 Dam Removal and Small Dam Removal

Dam Removal:

- *Removal of Large Dams*
- *Removal of Small Dams*

Objectives:

- *Distinguish between dam size and project size/scope*

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1.1 Dams

- Dams come in many shapes and sizes
- Small dams, including non-jurisdictional structures, are iconic features in the New England landscape.
- Most small dams no longer serve their intended purpose (e.g., mechanical power).
- Most small dams are not maintained.
- Most small dams lack ***safe, timely, and effective*** fish passage systems.

1.2 Small and Large Dams

What is the definition of a small dam?

- Reasonable Definition:
    - Hydraulic Height Less than 25 ft

➢ **Alternative Definition:**

- A dam that no longer serves its intended purpose and is not financially viable.
- *The basis for this alternative definition is the absence of a well defined, financially viable purpose.*

1.3 Small Dam Removal Projects

Objective

- Address appropriate design elements and scoping for small dam removal projects.
- Address permitting processes for small dam removal.
- Consider beneficial and adverse impacts relative to no-action alternative.

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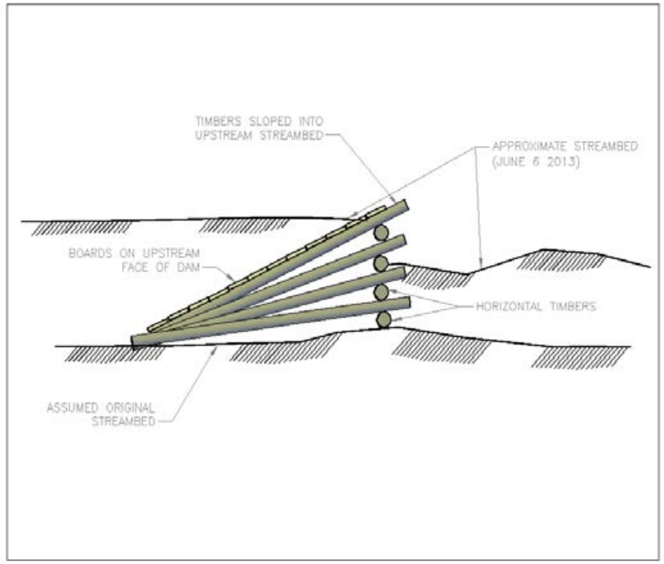
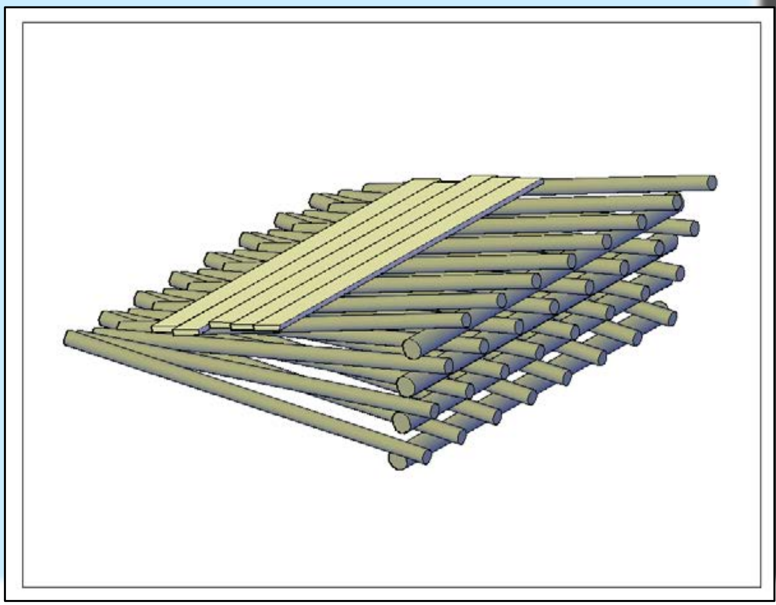
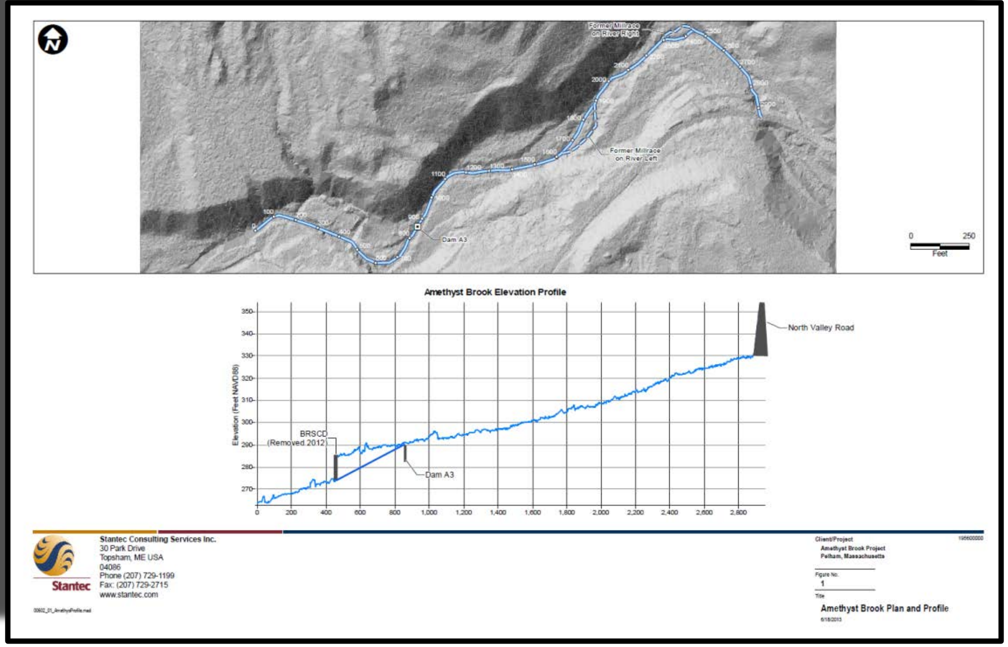
EXAMPLE PROJECT SITE

- Buried for > 100 Years
- Exposed following dam removal
- Uncertainty of Conditions







2 Primary Functions of Dams

- *Hydropower*
- *Flood Control*
- *Water Supply*

Dedicated uses are often accompanied by dedicated financial resources.

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2.1 Hydropower in Maine

Maine Hydropower Study (February 2015)

- Prepared for the Governor's Energy Office by Kleinschmidt Group.
- Identifies 47 potential sites with 56 MW of potential capacity.
- Installed hydropower capacity in Maine is 750 MW.

More than 1,000 dams in Maine

- 131 federally regulated dams are in good repair.
- 47 potential sites with 56 MW of potential capacity.

Worumbo Dam, Androscoggin River, Maine

This is Hydropower

Distinctions:

- ✓ **Maintenance**
- ✓ **+ROI**
- ✓ **Owner is Vested**

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Orland Village Dam
Orland, ME

High Tide

Low Tide

This is Not Hydropower

Distinction:

✓ **-ROI**

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2.2 Flood Control

Do Small Dams Provide Flood Control?

- Some Storage & Attenuation
- What does FEMA Say?
  - Check FIS
  - If Flows are not attenuated, then not real flood control.

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Maine Dams – Flood Control?

Head Tide Dam, Sheepscot River, Alna

- ✓ Not flood control

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Maine Dams – Flood Control?

Monstweag Dam, Woolwich & Wiscasset (removed in 2010)

✓ Not flood control

Maine Dams – Flood Control?

Howland Dam, Piscataquis River

✓ Not flood control

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Maine Dams – Flood Control?

Veazie Dam, Penobscot River (removed 2013)

- ✓ Not flood control

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‘Need Flood Control? Call the Corps.

Townshend Dam, West River, Vermont

✓ *Flood control that you can count on.*

2.3 Water Supply

Dedicated Water Supply Dams Vary in Size

- Water supply is often a secondary use.
- Water treatment requirements can preclude cost-effective use of some impoundments.

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3 Small Dam Removal: Drivers and Impacts

- Natural Resource Restoration
- Infrastructure Management
- Maintenance
- Dam Failure (or removal)

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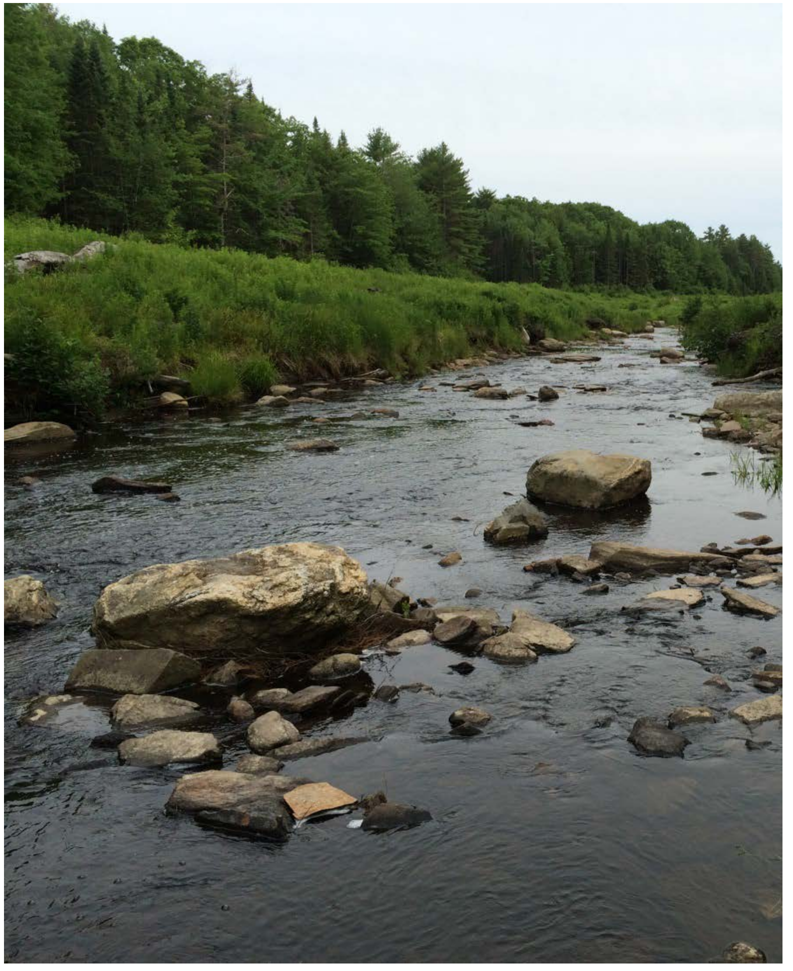
3.1 Natural Resource Restoration

- Removal of dams restores habitat
- Removal of dams restores continuity of riverine and riparian systems
- Removal of dams restores fluvial process



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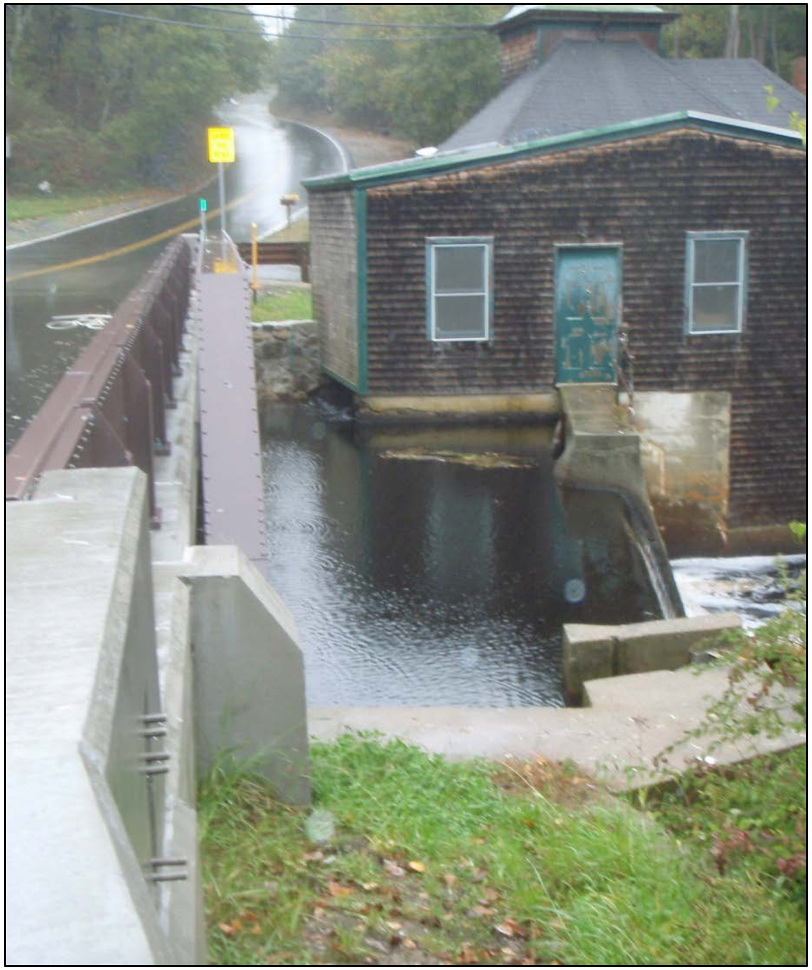
3.2 Infrastructure Management

- Dams affect adjacent infrastructure.
- Dam failure can precipitate failure of adjacent infrastructure.
- Dam removal provides an opportunity to decouple infrastructure dependence



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Orland Village Dam Project: Infrastructure

- Dam
- Fish Ladder
- Herring Harvest Equipment
- Herring Harvest Site
- Fire-Suppression Water Supply
- Water Supply
- **Bridges**
  - **SR 175**
  - **US Route 1**
  - Upper Falls Road
  - ST 46

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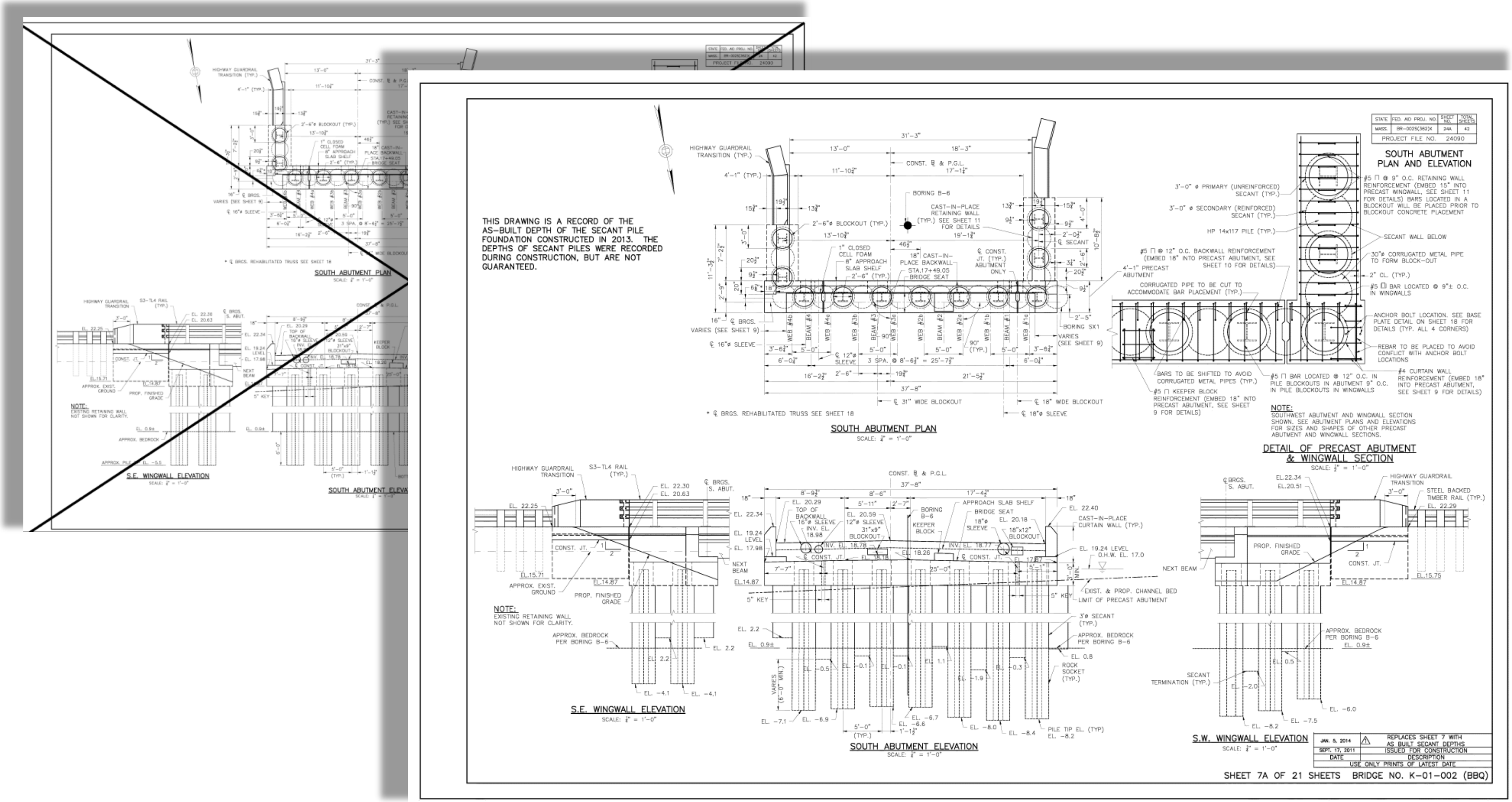
Infrastructure Management: Planning for Resiliency



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3.3 Maintenance

Infrastructure Management: Bridges

Let's Talk About Bridges...

2008 Report Card: D+

2012 Report Card: C-

*ASCE 2009 Report Card for America's Bridge Infrastructure: "**C**"*

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Infrastructure Management: Bridges (cont.)

...And How We Maintain Them.

Photos here reflect a bridge where identified deficiencies have been addressed.

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3.4 Dam Failure (or removal)

Direct Impacts:

- Alteration of Hydrology
  - *Lower Water Surface Elevations*
  - *Increased Flow*

Indirect Impacts

- Alteration of Habitat
- Alteration of Fluvial Processes

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Dams Fail (source – State of Maine)

- On October 20, 1996, **Willet Brook Dam,** owned by the town of Bridgton in Cumberland County, failed and **affected the public water supply** for the town (population 4,307).
- In 1997, the **Owens Marsh Dam** in Concord Township, owned by the Department of Inland Fisheries and Wildlife breached after three days of heavy rain, **causing over a million dollars in road damages**.
- In 1997, the **Apple Valley Dam** in Monmouth breached, **causing about $350,000 in damages**.
- In 2004, the **Meadow Cove Dam** in Boothbay breached, **causing about $30,000 in damages**.
- In 2005, during the April flooding events, the **Sherman Lake Dam** in Newcastle washed out. Placement of approximately 1,075 cubic yards of stone riprap was required to stabilize the existing channel and protect the **State Route 1 Bridge substructure elements**.
- In the storm of March 30, 2010, **Colcord Pond Dam** in Porter gave way, **washing out two county roads**.

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Infrastructure Dependence:

Shoreys Brook Dam Failure & Removal

Head-of-tide dam in Eliot and South Berwick, Maine

Project Objective:

- Restore intertidal habitat & aquatic habitat continuity

Adjacent Infrastructure:

- State Route 101 Culvert

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Infrastructure Dependence:

- Culverts
- Bridges
- Utilities
- Retaining Walls

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Infrastructure Dependence:

Shoreys Brook Dam Failure & Removal

Adjacent Infrastructure:

- State Route 101 Culvert
- Failure of Dam:
  - Lower Upstream WSEL
  - Culvert Rot

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4 Small Dam Removal Project Process

4.1: Bases for Small Dam Removal

4.2: Typical Process

4.3: Scoping for Design and Permitting

4.4: Permitting Process(es)

4.5: Design and Permitting

4.6: Project Studies

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4.1 Bases for Small Dam Removal

- ✓ Targeted based on expected beneficial impacts to natural resources.

- ✓ Targeted based on dam maintenance/safety need as alternative to dam reconstruction

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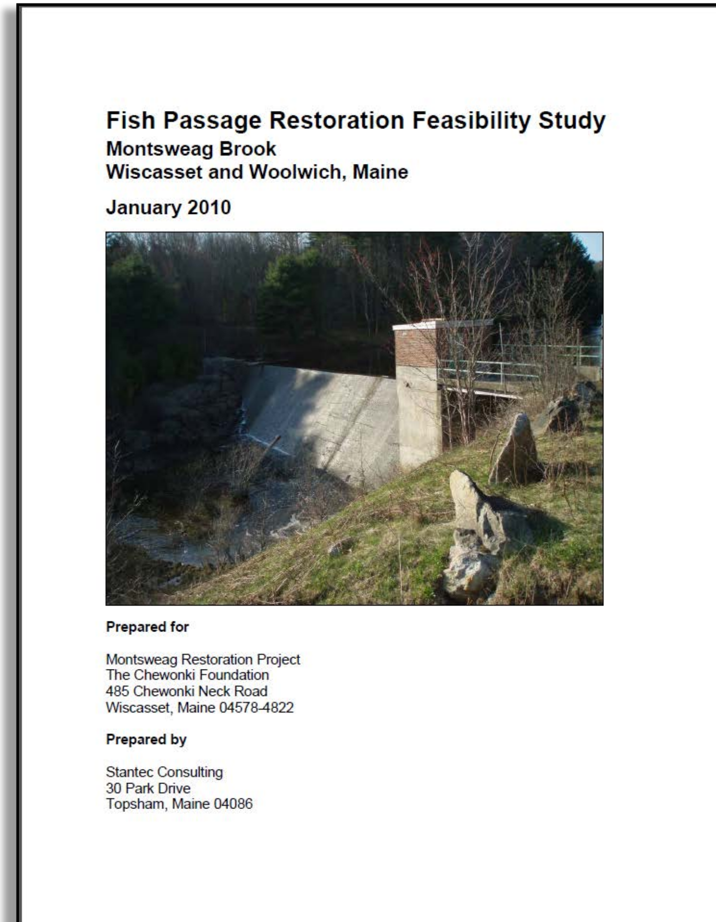
4.2 Typical Process

Typical Process

1. **Feasibility Study**
2. **Design**
3. **Permitting**
4. **Construction**

Feasibility studies must be properly scoped acknowledge that primary issues are usually associated with costs and social factors. Technical issues usually be addressed as part of design.


Fish Passage Restoration Feasibility Study
Montsweag Brook
Wiscasset and Woolwich, Maine

January 2010

Prepared for

Montsweag Restoration Project
The Chewonki Foundation
485 Chewonki Neck Road
Wiscasset, Maine 04578-4822

Prepared by

Stantec Consulting
30 Park Drive
Topsham, Maine 04086

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4.3 Scoping for Design and Permitting

- Scoping for dam removal can be difficult.
- Regulatory requirements and drivers are not well adapted for dam removal.
- Design may be broad-brushed and not focused and result in high associated cost.
- Dam removal projects require work in protected resources.
- Uncertainty and varying opinions regarding beneficial and adverse impacts.
- Scoping benefits from a multi-disciplinary process.
- **Engage and Inform Stakeholders.**

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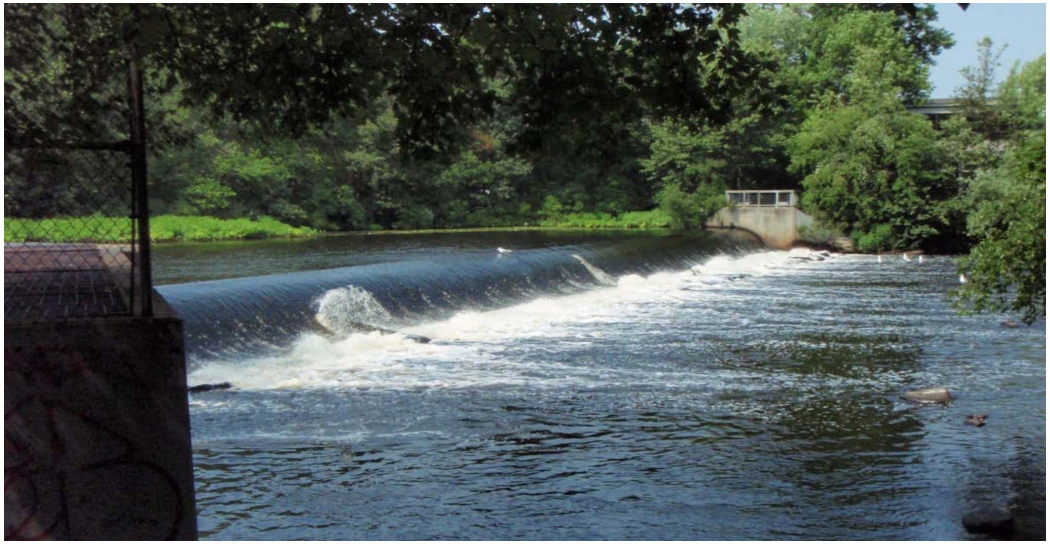
Example: Watertown Dam, Charles River, MA

Recon Study, June 2011:

- **Fish Passage**
- **Predation**
- **Cost**



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4.4 Permitting Process(es)

Background

- Natural Resource Permitting Requirements are Focused on Development-Based Activities.
- Regulatory Agencies are Stakeholders

Approach

- Top-down approach (e.g., permitting follows design) may not be efficient or effective

✓ Integration of design and permitting

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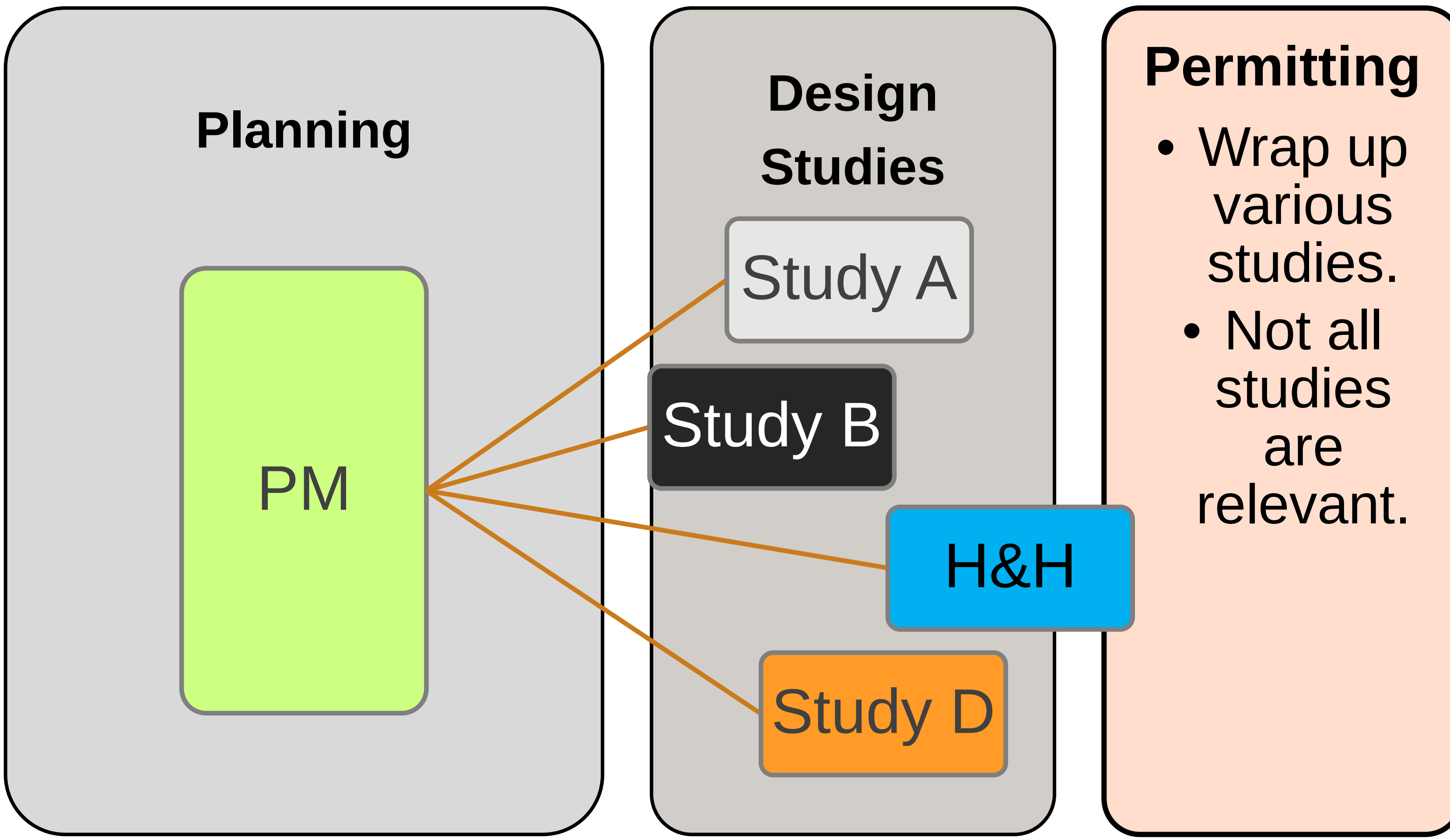
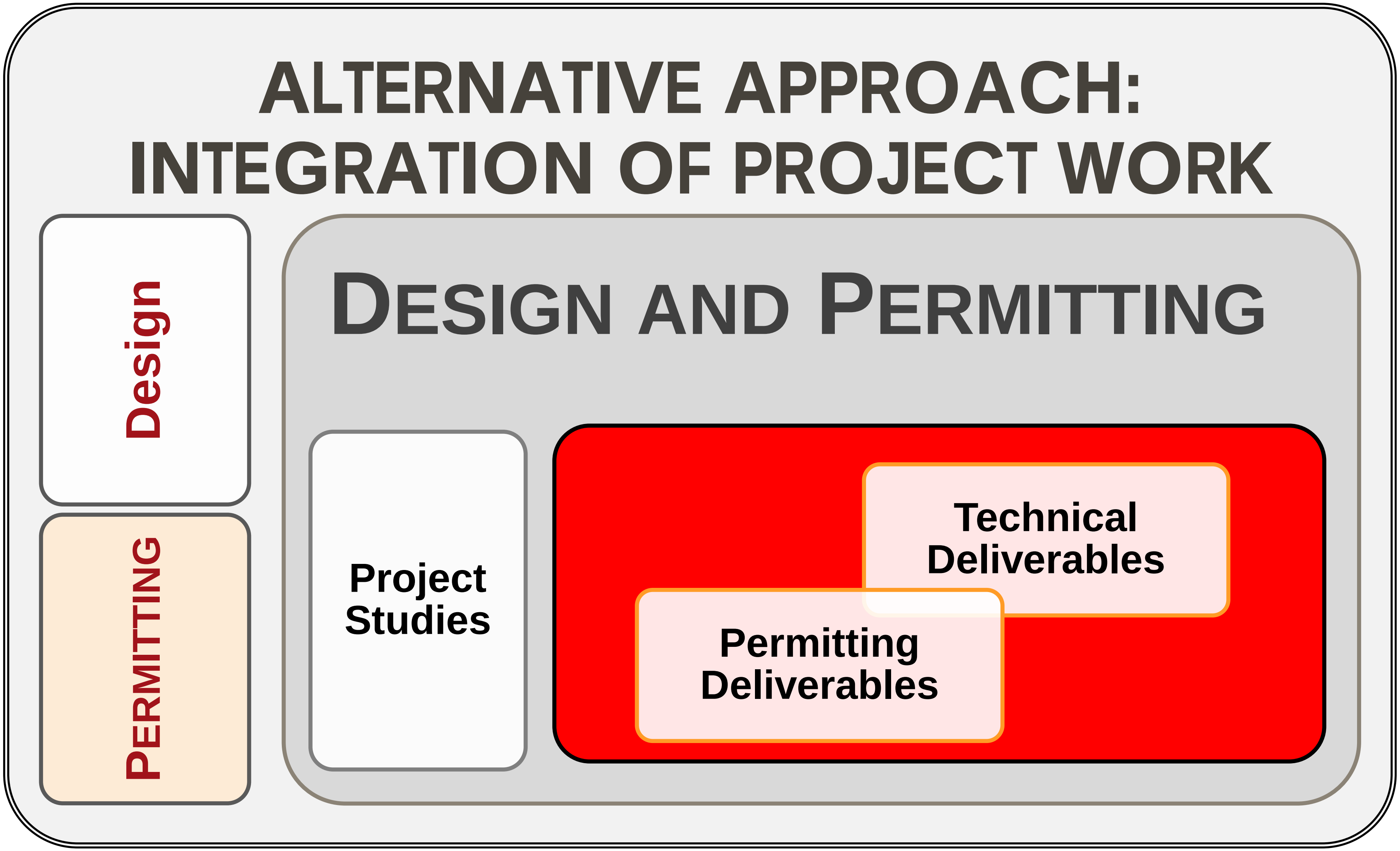
4.5 Design, Permitting

Hierarchal Approach to Planning, Design, and Permitting



Planning, Design and Permitting



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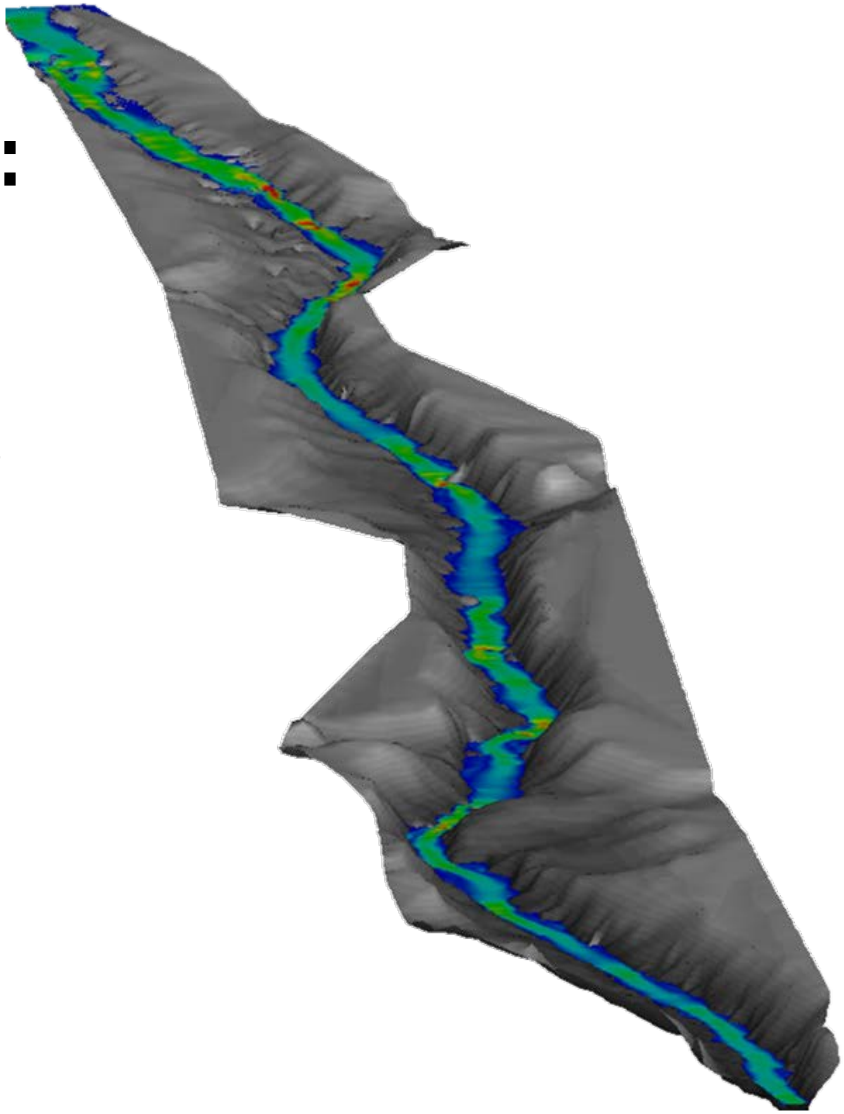
4.6 Project Studies

Typical Studies Address:

1. **Project Site**
2. Hydrology & Hydraulics
3. Natural Resource Impacts
4. Sediment Constituents
5. **Water Management**
6. Sediment Transport
7. **Constructability**
8. **Safety**



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Small Dam Removal & Hydraulic Modeling

1. *Project Site – Maine, USA*
2. *Project Goals:*
   - *Upstream Fish Passage*
   - *Decommission Infrastructure*
3. *Constraints*
   - ***Sediment***
   - *Recreational Use*
   - *Upstream Fish Passage*

Hydraulic Model Applications

- **Direct Evaluation**
  - ***Typically used to model pre- and post-action WSELs***
  - ***Flow speeds***
- **Indirect Evaluation**
  - ***Sediment Transport***
  - ***Infrastructure Impacts***
  - ***Fish Passage/AOP***

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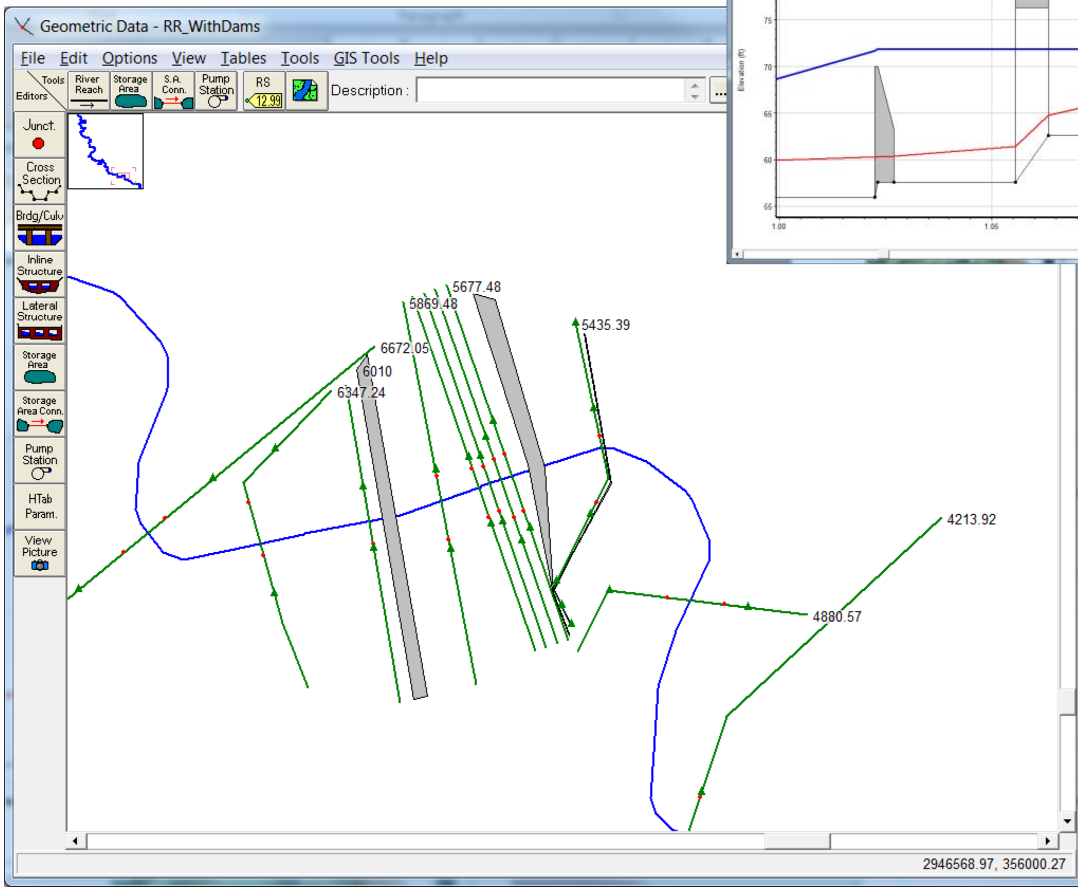
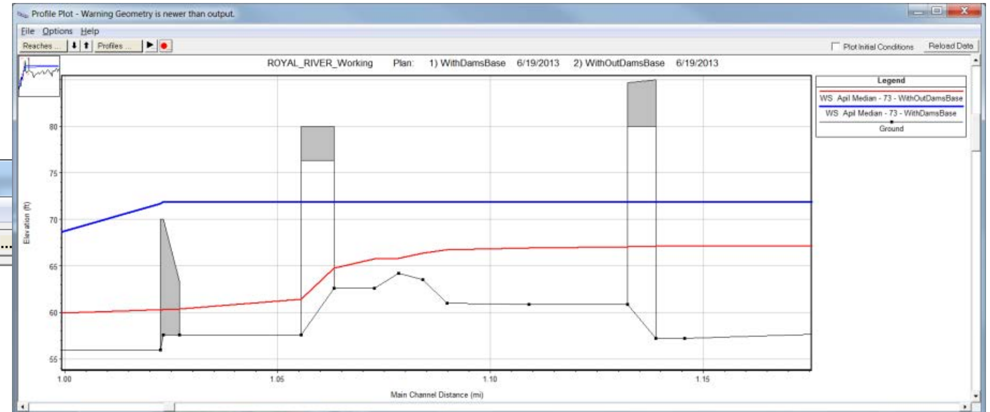
Small Dam Removal Evaluation

<u>HEC-RAS Model</u>





1. **Relevance**
   - ✓ **Dam Removals Typically Occur in Waterways**
2. **Appropriateness**
   - **Accuracy, Precision?**
   - **Fixed or Mobile Bed?**
3. **What Value Is Provided?**

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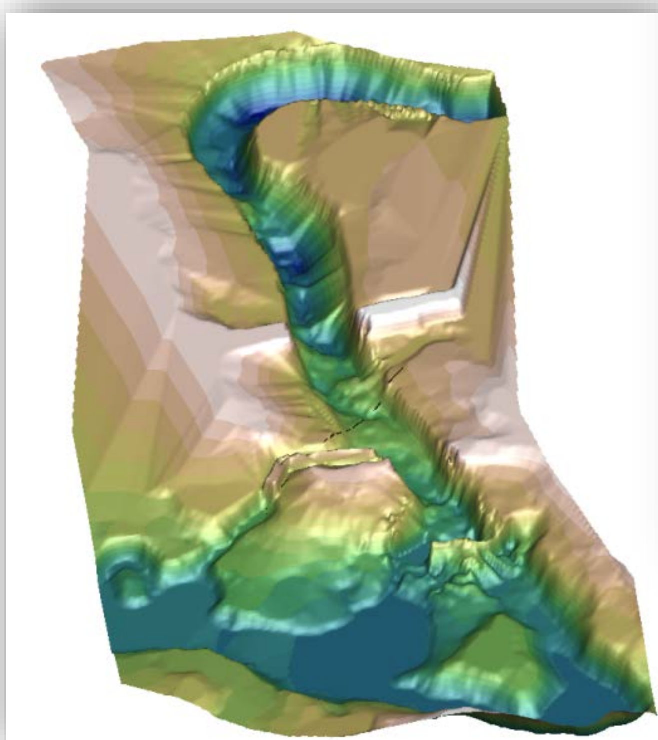
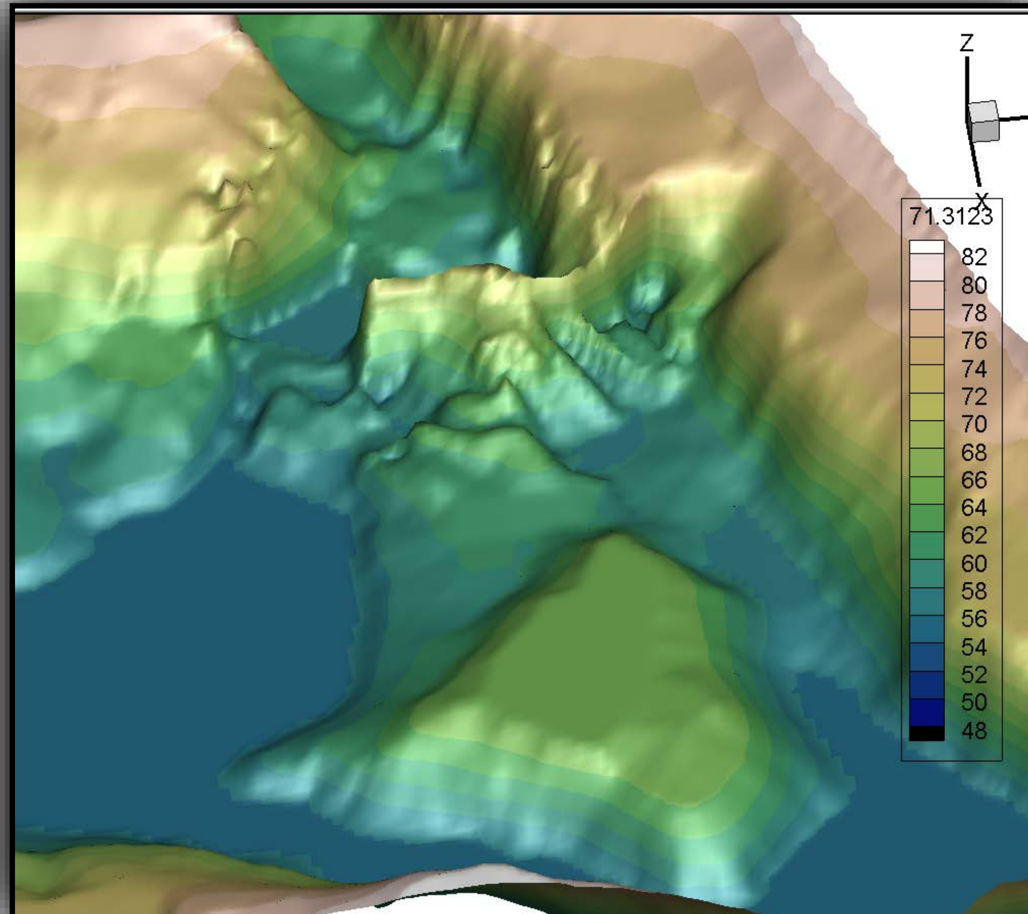
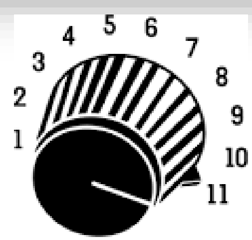
SMALL DAM REMOVAL EVALUATION

- *Terrain Model*
- *Difficult to Evaluate*







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Small Dam Removal Evaluations:
Delphi / Reference Reach Approach

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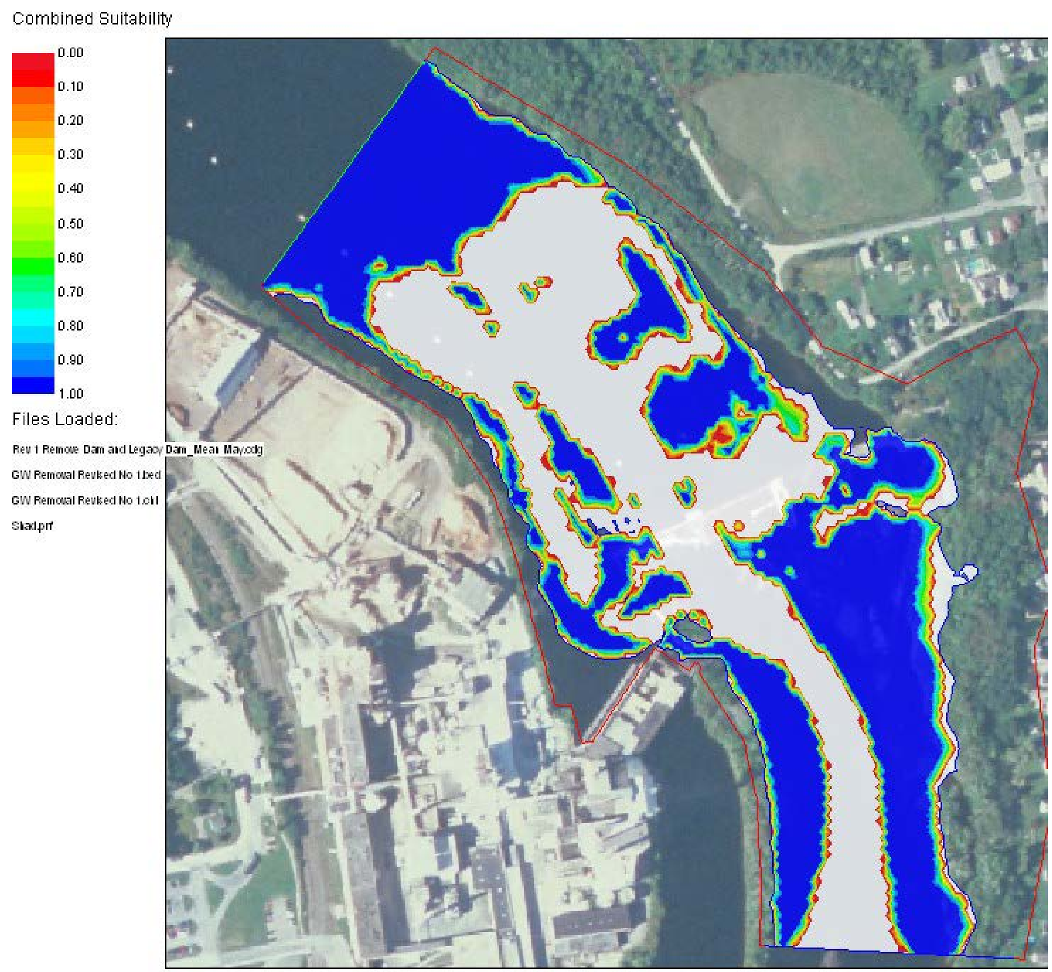
CALIBRATION AND VALIDATION

Dam Removal Poses Problems for Calibration & Validation

- **Existing Conditions in the dam impoundment at low flow are of little value for calibration/validation**
- **Existing Conditions in the dam impoundment at high flow are of little value for calibration/validation**
- ***Example:***
  - ***Calibration at low flow -> level pool***
  - ***Calibration at high flow -> not reasonably similar to post-action conditions.***

Upstream Fish Passage Evaluation

1. Evaluation based on precise criteria.
2. Resolution of models is questionable.
3. Technical difficulties:
   - Proposed conditions (CAD vs construction)
   - Hydraulic Model
   - What do the fish think?
- ***Followed on a well-scoped process***



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4.X Sedimentation Management

- Sediment will be present
- Site-specific evaluation
- Regionally-specific consideration
- Site Relevant Management
- Consequences of release
    - *Consequences of "blow-and-go"*
    - *Consequences of "instream sediment management"*
- **Assimilative capacity**

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5 Engineered Dam Failure

5.1: Engineered Dam Failure (EDF)

5.2: Context

5.3: Definition

5.4: Drivers for EDF Approach

5.5: EDF Process

5.6: EDF Project Examples

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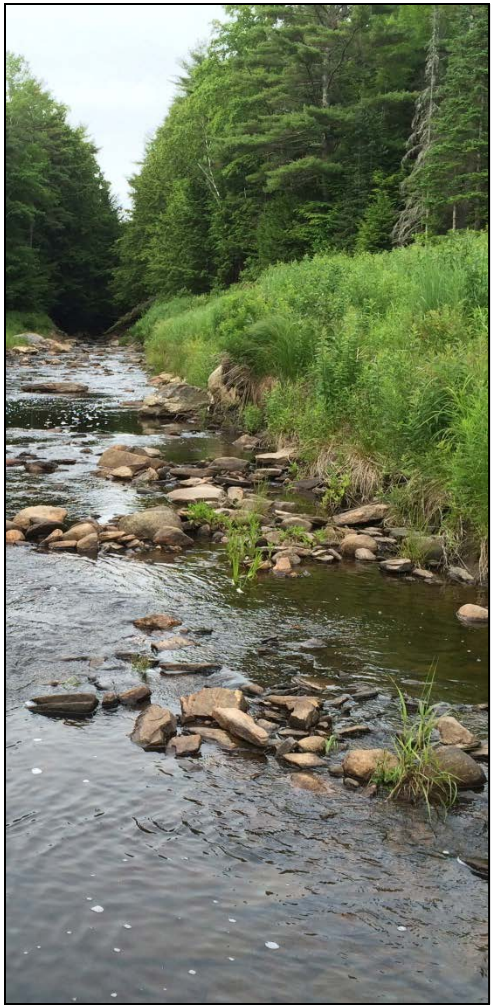
5.1 Engineered Dam Failure

A Potentially Suitable Approach For:

1) *Management of Legacy Infrastructure*
2) *Restoration of Natural Resources*
3) *Basis for Design and Permitting for Small Dam Removal Projects*



From "Engineered Dam Failure – An Approach to Aquatic Ecosystem Restoration"
Presented at "Designing for Success: Ecological Restoration in Times of Change"
The Society for Ecological Restoration – New England Chapter and
The Conway School – Master of Science in Ecological Design Program
Hampshire College, Amherst, MA
April 25, 2014

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5.2 Context

- Dam removal is an effective means to restore aquatic habitat and decommission legacy infrastructure.
- Dams influence upstream & downstream river reaches.
- Natural & anthropogenic dams fail.

Ox Pasture Brook Dam Removal, William Forward Wildlife Management Area (Rowley, MA)
August 2010

5.3 Definition

"Engineered Dam Failure" (EDF) is an approach to dam removal that relies largely on natural processes to advance post-removal site restoration.

- EDF <u>does</u> include planning, design, and permitting.
- Selection & application of EDF is site-specific and informed by restoration objectives and identified site constraints.

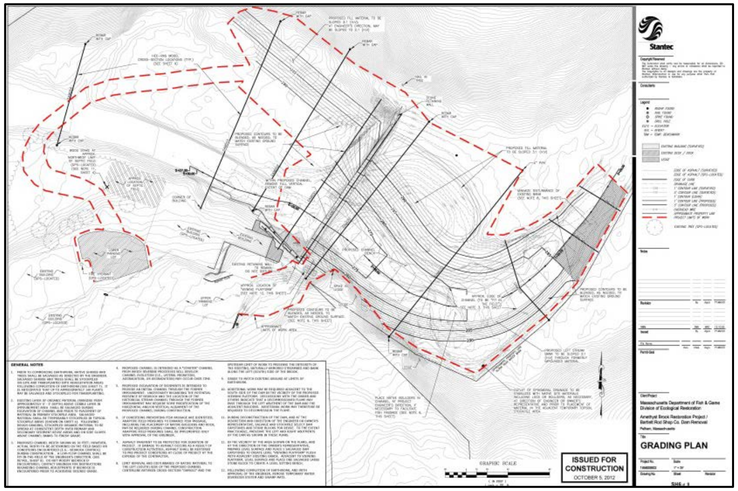
Gravesleigh Pond Dam Removal

Construction-phase water management

5.4 Drivers for the EDF Approach

Factors common to small dam removal projects:

- Funding constraints
- The need to balance short- term impacts and long-term benefits



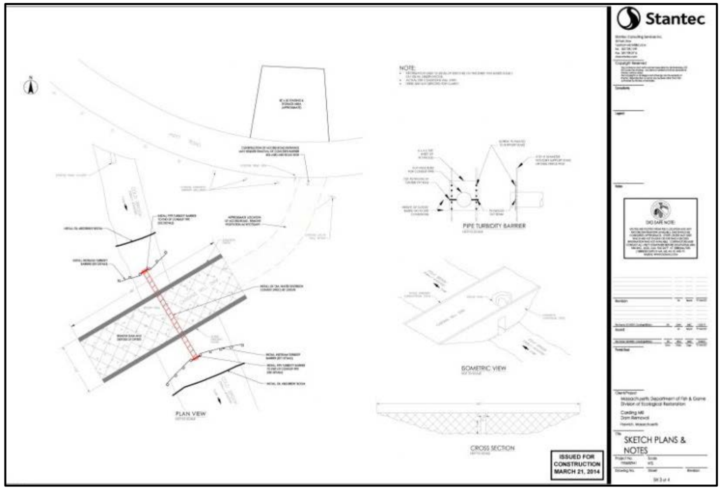
Amethyst Brook Restoration Project (2012)

Revegetation of former Bartlett Rod Shop Co. Dam impoundment on Amethyst Brook

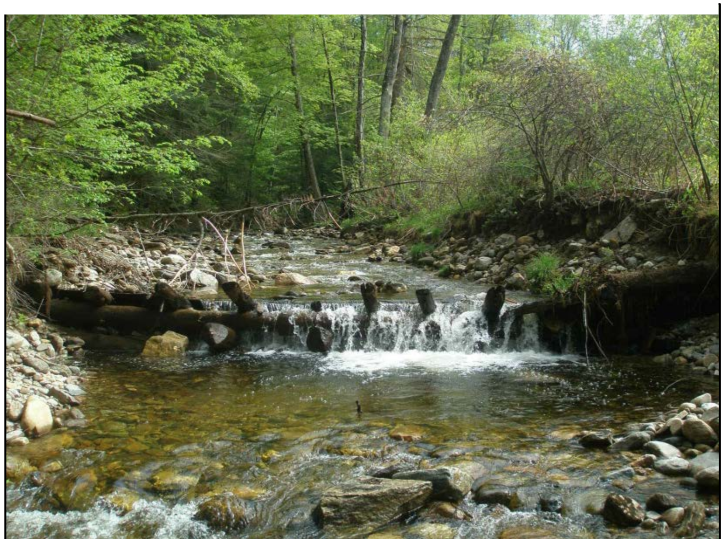
Drivers for the EDF Approach

Where appropriate, EDF may:

- Reduce project cost
- Reduce planning and construction timeframes
- Provide ecological benefits, including:
  - Reduced spatial &temporal construction-phase impacts
  - Downstream sediment supply through instream sediment management
  - Channel formation through natural fluvial processes
- Accommodate uncertainty



Carding Mill Dam Removal (March 2014)



Relic timber dam identified following removal of Bartlett Rod Shop Co. Dam

5.5 EDF Process

Assessment

- Factors influencing applicability of EDF:
  - Restoration objectives
  - Infrastructure
  - Environmental contaminants
  - Sensitive species
  - Post-removal site use
- Due diligence
  - Identification of direct and indirect impacts
- Decision to proceed with EDF

Gravesleigh Pond Dam

Bartlett Rod Shop Company Dam

5.6 EDF Project Examples

- Ox Pasture Brook
- Sackett Brook
- Amethyst Brook

Restored channel through former Primary Dam location, Phillipston Reservoir Dam Removal Project (Phillipston, MA)
June 29, 2013

EDF Example 1

Ox Pasture Brook Dam Removal

Head-of-tide dam in William Forward Wildlife Management Area, Rowley, MA

Project Objective:

- Restore intertidal habitat & aquatic habitat continuity

Project Constraints:

- Environmental contaminants
- Construction access

Ox Pasture Brook Dam

Ox Pasture Brook Dam Impoundment

EDF Example 1

Ox Pasture Brook Dam Removal

(December 2009)

3 years planning, design, permitting
2 weeks dam removal construction
1 growing season passive site revegetation
3 years of post-construction monitoring

Former impoundment (December 2009)

Former impoundment (August 2010)

EDF Example 2
Gravesleigh Pond Dam Removal

Sackett Brook in Mass Audubon's Canoe Meadows Wildlife Sanctuary, Pittsfield, MA

Gravesleigh Pond Dam

Project Objective:

- Restore aquatic and riparian habitat continuity

Project Constraints:

- Environmental contaminants
- RTE species

Bridge downstream from dam

EDF Example 2

Gravesleigh Pond Dam Removal

6 years of project planning
1 year design plans & permitting
2 weeks dam and bridge removal

Bridge demolition & water management

Sackett Brook in location of former bridge and dam, Canoe Meadows Wildlife Management Area (Pittsfield, MA)
November 19, 2013

EDF Example 3

Bartlett Rod Shop Co. Dam

Located on Amethyst Brook in Pelham, MA. First dam upstream from CT River.

Bartlett Rod Shop Co. Dam

Project Objectives:

- Remove legacy infrastructure
- Restore habitat continuity and sediment transport

Bartlett Rod Shop Co. Dam

Project Constraints:

- Sediment volume
- Adjacent infrastructure

EDF Example 3
Bartlett Rod Shop Co. Dam

3 years design & permitting
6 weeks of construction
4,000 CY repositioned sediment

Excavation of impounded sediment

Amethyst Brook in location of former Bartlett Rod Shop Co. Dam (Pelham, MA)
June 22, 2013

6 Benefits of Small Dam Removal

6.1: Improved Infrastructure Management

6.2: Benefits to Natural Resources

6.3: Improved Resilience of Infrastructure and Natural Resource

6.1 Improved Infrastructure Management

- ✓ Elimination of nuisance structures
- ✓ Elimination of dam failure risk
- ✓ Exposure of infrastructure deficiencies
- ✓ Improved resiliency of infrastructure
- ✓ Improved emergency response

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6.2 Natural Resource Management

- Elimination of Anthropogenic Barriers in Riverine and Riparian Corridors
- Restoration of Fluvial and Riparian Habitat
- Elimination of Altered Habitat Restoration of Fluvial Processes

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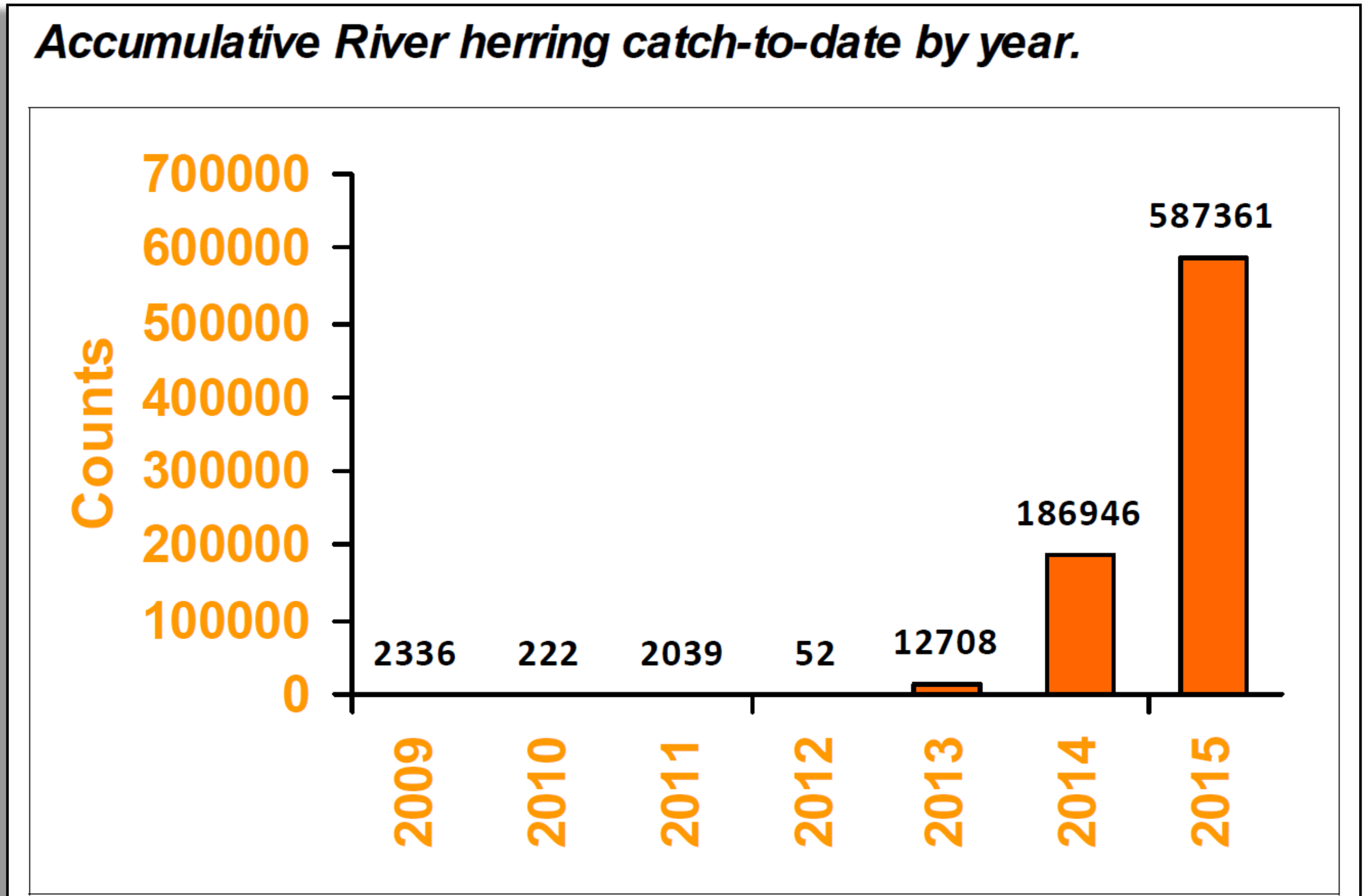
Anadromous River Herring Response to Removal of Veazie and Great Works Dams, Penobscot River, Maine



Preliminary Data dated June 22, 2015, from the Maine Department of Marine Resources, Bureau of Sea Run Fisheries and Habitat

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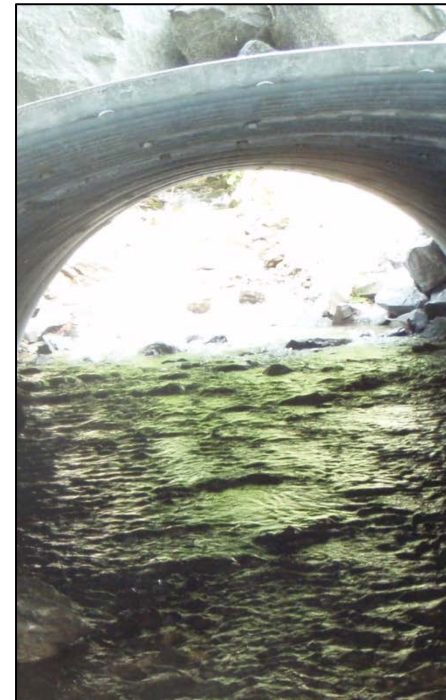
6.3 Improved Resilience

- Reduced Infrastructure
- Improved Infrastructure
- Restoration of Fluvial Processes
- Restoration of Natural Resources



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6.4 Appropriate Processes Are Necessary

- Quantifying of Benefits from Small Dam Removal Should Consider Restored Continuity of Habitat.

- Regulations Developed for Protection of Natural Resources are poorly adapted for evaluation of beneficial and adverse impacts that may result from removal of small dams.

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Questions?