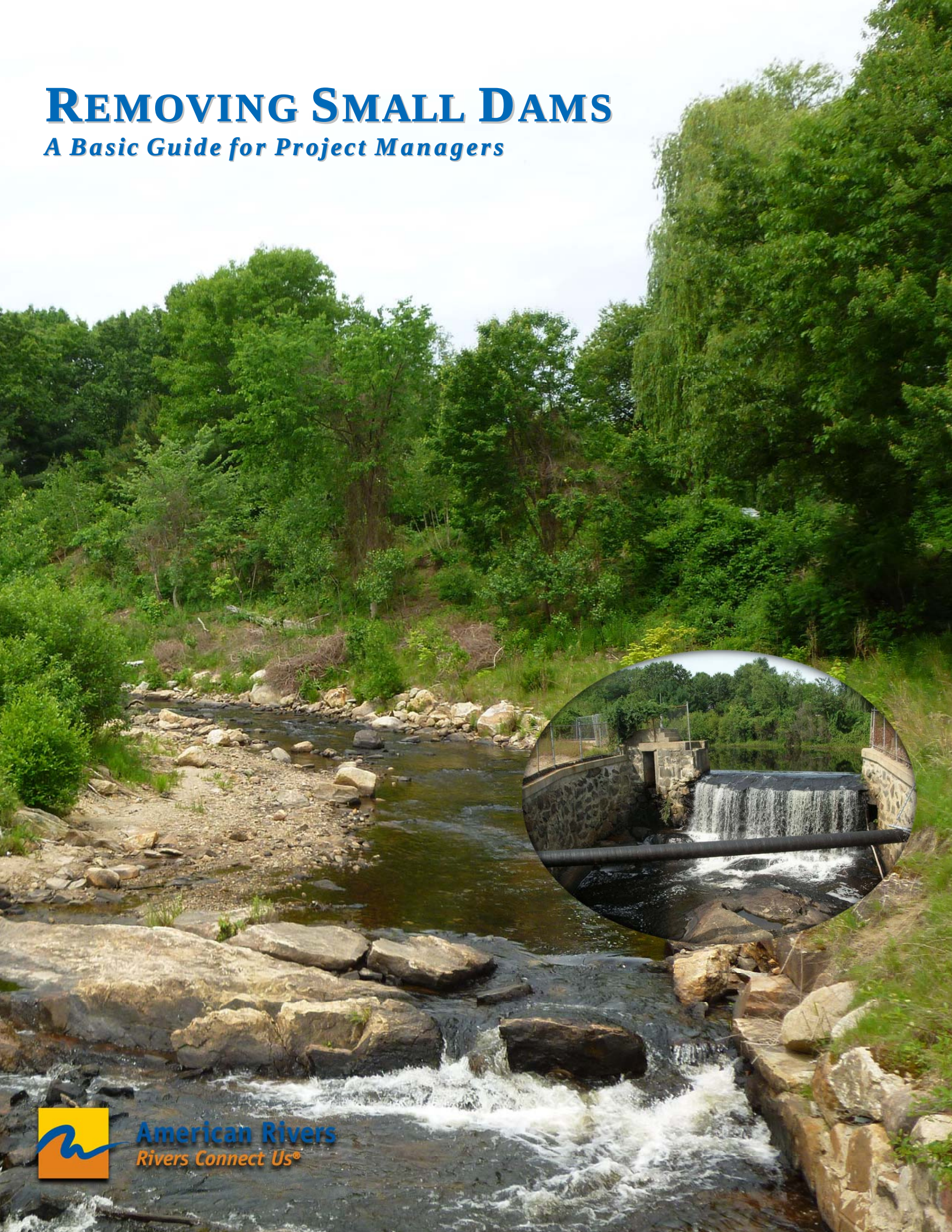
Removing Small Dams

A Basic Guide for Project Managers



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Acknowledgements

This document was written by Brian Graber, Amy Singler, Serena McClain, and Jessie Thomas-Blate of American Rivers.

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 These before (circle inset) and after photos are from the site of the former Maxwell Pond Dam on the Black Brook in Manchester, New Hampshire.

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How to Use this Guide

This report is intended to provide a starting point for project managers getting involved in dam removal work. It contains basic steps that most dam removals will require, including project management and design considerations, potential permitting issues, and ideas for funding.

Note that this report is intended to provide basic guidance on river restoration and dam removal projects. It is not intended to be an exhaustive description of all issues that need to be analyzed at every dam removal project, and it is in no way intended to be a substitute for site-specific analysis by qualified professionals.

We hope you find this manual useful as you begin to develop your own river restoration projects. More than 1,100 dams have been removed around the country and there is a lot of experienced assistance available for new project managers. For more information, visit AmericanRivers.org/initiatives/dams/.

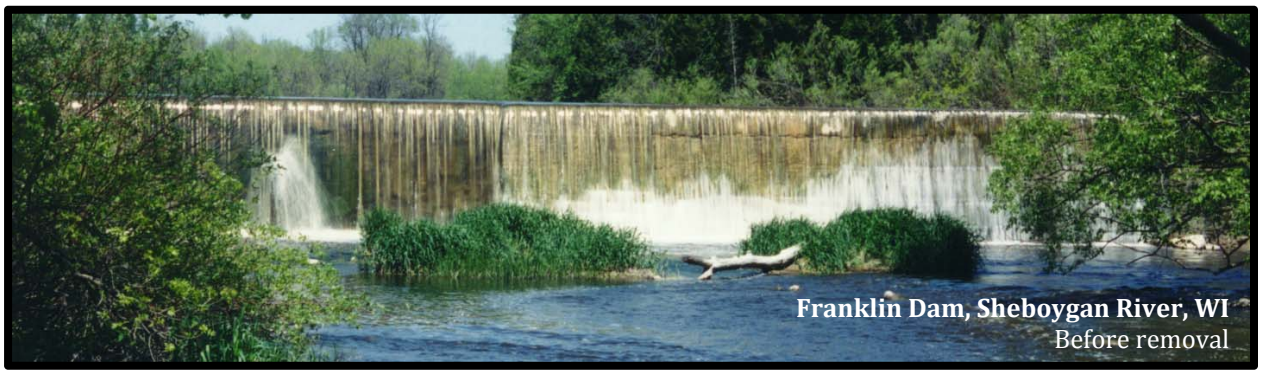
If you're ready, let's dig in and restore some rivers!

Step 1: Recruit a Good Project Manager

An effective project manager is critical for a successful dam removal project. The project manager's role is to provide leadership and oversee the steps outlined in this manual. Many tasks will be delegated to project partners or consultants, but the project manager leads the team and provides overall coordination.

The most important qualities of a good project manager are persistence and knowing when to seek assistance. While to some degree the project manager needs to be a jack-of-all-trades, he or she does not need to be a technical expert. A project manager should know when to call on experts to help make decisions and be skilled at building partnerships.

On any given day, a project manager may promote the project to a potential funder; meet with environmental regulators; oversee or help out with field work; write press releases; coordinate a conference call; or remind a project partner to follow through on a commitment. The project manager serves as the point of contact for partners and the public and often as the "face" of the project.



Franklin Dam, Sheboygan River, WI
Before removal

Step 2: Get Out Your Dam Removal Checklist

The general steps involved in a dam removal project are listed below. You can consider this as a checklist of sorts to refer to as you move through a project. These steps are intended to be very general because every dam removal process will have different site-specific engineering, environmental, and community issues. **In some cases, not all of these steps will be necessary.** Evaluate each step presented here to determine if it is necessary for your project. Also, these steps do not always conform to a set order. For example, stakeholder and pre-permitting meetings may need to be held earlier in some cases.

Harvell Dam removal
Appomattox River, Petersburg, Virginia

While different projects have different timeframes, in general, expect projects to take approximately three years from conception to completion - year one for planning, feasibility, and pre-permitting; year two for engineering design and permitting; and year three for implementation.

1) Initial Reconnaissance – Determine the Breadth and Scope of the Project

- Articulate the potential benefits of the project
- Determine dam owner and point of contact
- Determine if the dam owner is interested in dam removal
- Determine the current uses of the dam and impoundment
- Consider land ownership around the impoundment and the dam structure
- Identify potential infrastructure impacts: utilities, roads, bridges, etc.
- Determine if the dam, impoundment, or adjacent land are in rare species habitat
- Determine potential "hooks" for funding possibilities
- Consider the potential for sediment contamination
- Assess potential community interests/concerns – flooding, recreation, historic, habitat

2) Site Visit and Planning Meeting

- Identify potential project partners
- Conduct a site visit with the dam owner and project partners to plan next steps

3) Fundraising

- Develop a fundraising strategy and a list of potential grant sources
- Gather letters of support
- Apply for funding

4) Preliminary Design – Assess Scientific and Engineering Challenges and Conceptual Approaches

- Collect existing data
- Survey and map the site
- Assess hydrology and hydraulics
- Assess sediment quantity, quality, and mobility
- Assess approaches for avoiding or enhancing habitat for species of concern
- Assess whether surrounding infrastructure is at risk and determine appropriate approaches for moving, stabilizing, or avoiding infrastructure

Woodside Dam II removal
Twelve Mile River, South Carolina

- Determine which federal, state, and local permits will be required and complete resource delineations and calculations necessary for those permits
- Complete pre-project monitoring as required or desired, including setting up photo stations, and considering monitoring approaches for water quality, fish and other species, geomorphology, and vegetation response
- Develop cost estimates
- Develop conceptual drawings or preliminary design plans for:
    - Removal of structures
    - Sediment management
    - Channel and riparian habitat restoration

5) Stakeholder/Community Meeting(s)

- Meet with people who own land adjacent to the project and other stakeholders
- Community visioning and planning

6) Pre-permitting Meeting(s)

- Meet with local, state, and federal regulators, dam safety officials, and historic preservation representatives to present initial plans and confirm regulatory requirements

7) Engineering and Restoration Design

- Develop engineering design plans of dam removal, sediment management, infrastructure protection, channel restoration, and other issues identified during the preliminary design phase
- Develop "Project Specifications" that detail necessary construction equipment, material specifications and quantities, project sequencing, staging areas, and site access
- Provide an "Engineer's Cost Estimate" for construction

8) Permitting

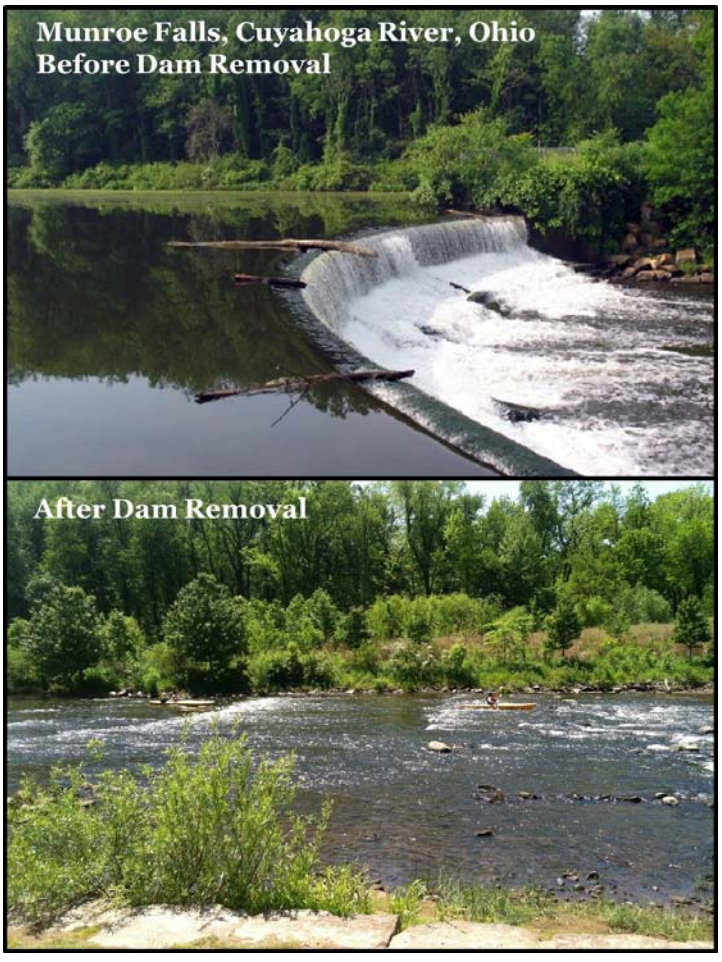
- File all regulatory permits
- Attend public hearings
- Respond promptly to regulator questions and requests for additional information

9) Project Implementation

- Hire contractor
- Drawdown impoundment
- Remove dam structure
- Complete infrastructure stabilization, sediment management, channel restoration, impoundment revegetation, etc., based on design details
- Publicize your project!

10) Post-project Monitoring

The following pages describe many of these steps in more detail.



Step 3: Conduct Initial Reconnaissance

The initial reconnaissance phase is intended to determine the overall breadth of the project and the likely project challenges. During this phase, you will determine whether the project is simple and straightforward, or complex, requiring such activities as extensive community outreach, contaminated sediment remediation, and infrastructure replacement. Consider how each of the issues below will affect the cost and scale of the project. This phase is not intended to provide in-depth analysis. It can be completed with existing and readily available information, including conversations with resource agencies.

Dam Removal Initial Reconnaissance Example Info Sheet

Dam Name _____

Location _____

Ownership:

Dam Owner _____

Land Ownership Around Impoundment _____

_____

Ecology:

Benefits _____

_____

Rare Species _____

_____

Sediment Quality _____

_____

Community:

Benefits _____

_____

Concerns _____

_____

Other:

Existing Dam Uses _____

_____

Infrastructure Issues _____

_____

Funding Possibilities _____

_____

Ownership

If the dam owner is not initiating the removal, you must first determine who owns the dam, and, if necessary, a point of contact for the dam owner. This may sound like a simple step, but in some cases dams have been abandoned for decades or land owners do not realize that they own dams.

A dam owner who is committed to dam removal is essential to the success of the project. Many dam owners will express interest in dam removal due to economic, liability, or even environmental reasons. Some simply no longer want the long-term hassle of repairing and maintaining their structure. You may need to meet with an owner several times to explore options before he or she is ready to express interest. You should refrain from spending large amounts of money on the project until the dam owner is willing to commit to it.

Wyomissing Creek Dam removal
Schuylkill River, Berks County, Pennsylvania

Do a preliminary survey of land ownership around the impoundment and the dam structure. Dam impoundments with abutting residential backyards, public beaches, and motorboats on them will be much more challenging community outreach efforts than dam impoundments entirely under the ownership of one entity who is interested in removal.

Ecology

Benefits

Summarize the expected ecological benefits of the project, as they will become selling points for funders, regulators, and the public. What will you achieve by removing the dam? Consider factors such as:

- Connected river miles upstream and downstream
- Length of impoundment that will be converted back to native river habitat
- Improvements in water temperature and dissolved oxygen
- Types of native species that will benefit

Rare Species

Determine if the dam, impoundment, or adjacent land are in an area that provides habitat for rare species. If these species or their known habitats are present, projects can only proceed through close consultation with state and federal biologists. In some cases, the dam removal project will provide significant new habitat for these species. In other cases, construction must be carried out in certain ways to minimize impacts to species or habitat. Contact the protected resources professionals in your state natural resources agency for more information on this issue.

Atlantic Sturgeon
Photo By: Virginia State Parks

Sediment Quality

The need for contaminant cleanup can significantly increase project complexity and cost. Assess the potential for contaminants trapped behind the dam by considering current and past upstream land uses, such as industrial activity and road density. Information on water and sediment quality in the river may also be available from past environmental studies.

Analyzing a sediment sample may even be useful at this reconnaissance phase in order to understand the breadth of the project, especially if other assessments are insufficient to determine the probability of contamination. A core sample should be taken from the fine-grained portion of the impounded sediment and analyzed at a lab for heavy metals and organic constituents.

Community

Benefits

Consider the additional benefits that dam removal may provide to the community, such as:

- Eliminating a flood hazard

- Eliminating a drowning hazard
- Improving boating or fishing
- Catalyzing efforts to support additional amenities, such as riverside walking trails or parks

Projects such as this can build unique coalitions, including local businesses, town planning commissions, conservation commissions, etc. Diverse coalitions have the ability to mobilize a greater range of project supporters and funders and will make public outreach and communication more effective.

Concerns

Assess potential community interests and concerns, such as:

- Is the impoundment currently used for recreation?
- Is the dam structure an important historic resource?
- Is the structure on the town seal?

Other

Dam Uses

Determine if the dam and impoundment are currently serving any purpose that will need to be replaced. Many dams no longer serve the purpose for which they were designed, but some continue to provide important functions. For example, dams that provide water supply, hydropower, or flood control are much less viable for removal than structures that do not provide these services. In some cases, dam uses can be replaced by other means [See Beyond Dams: Options and Alternatives].

Bloede Dam Sewer Line Abutment
Patapsco River, Maryland

Infrastructure Issues

Identify any potential infrastructure that could be impacted by dam removal. For example, if bridges cross any portion of the impoundment, an assessment will need to be made of potential impacts to bridge piers and abutments during preliminary design studies. In some places, water and sewer pipes cross through dams or through the impoundment and alternatives will need to be assessed for protecting or moving them. Some dams are attached to mill buildings or retaining walls, requiring a stability assessment.

Funding Possibilities

Determine potential "hooks" for funding possibilities. Foundations and agencies that provide grants for river restoration and dam removal have different interests. Some provide funds for projects that help anadromous fish such as herring or salmon or for other sport fish such as trout. Others will provide funds for private landowners working to improve habitat on their land. Based on these "hooks" some projects can be almost entirely funded by outside sources, while others will receive very little outside funding. With overall project costs typically in the hundreds of thousands, this is a critical early step.

The owner of the dam should expect to cover some of the cost of the dam removal project, particularly if the dam is failing and the removal is eliminating a significant expense and liability from the owner. Contributions to the project can include in-kind services or cash.

Potentially Useful Reconnaissance Resources

A wide variety of site-specific information can be found with only a small amount of work. Photos, maps, historical documents, biological data, etc., will enable you to more effectively determine how simple or complex your project may be. Included below is a list of resources that will allow you to build a more complete picture of your project site. American Rivers can also help provide technical assistance for evaluating site-specific reconnaissance issues.

FEMA (Federal Emergency Management Agency)

- What: Flood Insurance Studies (FIS), profiles, plans, and computer models
- https://msc.fema.gov/portal
- For similar information, see also: State agencies, town library, engineers, and/or Dewberry

Sanborn Maps

- What: Digital fire insurance maps for more than 12,000 American towns and cities
- http://sanborn.umi.com/
- http://www.loc.gov/rr/geogmap/sanborn/

Aerial or Ortho Photographs and Maps

- What: Real-life aerial imagery that shows what is actually in the area of concern that you might not see from the ground
- https://www.google.com/maps/ in "Earth View"
- http://www.terraserver.com/home.asp
- http://www.trails.com/maps.aspx

Example aerial photo of Searsville Dam
San Francisquito Creek, California

U.S. Geological Survey Data

- What: Topographic maps
- http://topomaps.usgs.gov/
- What: Gauge data for flow and sediment
- http://water.usgs.gov/nsip

Environmental Protection Agency: Surf Your Watershed

- What: Watershed mapping and information
- http://cfpub.epa.gov/surf/locate/index.cfm

Federal Energy Regulatory Commission

- What: Documents, reports, and filings related to hydropower dam licenses
- www.ferc.gov

Note that your state or county may also have useful information through other offices

- Tax assessment mapping through the State Department of Taxation
- Other mapping though county government websites
- Past dam inspections through the State Dam Safety Program
- Past plans of dam/site/nearby construction through the Department of Transportation, town engineer, or other state office
- Utility information from town or state offices
- Photographs (current and historic) and other historic records through state or local historical society, town, or neighbors
- Local boating or outdoor recreation agencies or organizations
- See also: www.americanwhitewater.org and www.acanet.org

Shopiere Dam removal
Turtle Creek, Wisconsin

Step 4: Find Funding for Your Dam Removal Project

Dam removal projects often require contributions from a combination of different sources to piece together all of the necessary funding. Funders are more likely to invest in a project with multiple partners, strong state or local support, and effectively completed initial assessments. Each funding source has different interests, so project proponents need to determine which funding sources have some synergy with the likely benefits of their project. Also, project proponents should carefully consider funding deadlines relative to the project schedule, as many funders have a time limit on using their funds, potentially necessitating that a project be split in phases.

Dam owners should not enter into a project with the expectation that the project will be free to them through the available funding sources. Most funders require matching contributions and are more likely to fund projects with a contributing owner. Currently, most dam removal projects range from $50,000 to $500,000 in total costs.

Potential Federal Funding Sources

NOAA Funding Opportunities

- What: The National Oceanic and Atmospheric Administration (NOAA) Restoration Center provides funding through several national and regional programs that support restoration of coastal and riverine habitats. NOAA programs focus on migratory fish, so projects would have to benefit species such as river herring, Atlantic Salmon, American Shad, or American Eel.
- Funding Range: $100,000 to $10,000,000, depending on the program
- http://www.habitat.noaa.gov/restoration/

U.S. Fish and Wildlife Service – National Fish Passage Program

- What: The U.S. Fish and Wildlife Service's National Fish Passage Program is a non-regulatory program that provides funding and technical assistance toward removing or bypassing barriers to fish movement. Contact your regional FWS partner about the program and funding.
- http://www.fws.gov/fisheries/whatwedo/nfpp/nfpp.html

U.S. Fish and Wildlife Service – Partners for Fish and Wildlife Program

- What: The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program offers technical and financial assistance to private (non-federal) landowners to voluntarily restore wetlands and other fish and wildlife habitats on their land. Restoration projects include reestablishing fish passage for migratory fish by removing barriers (dams) to movement.
- http://www.fws.gov/partners/

National Fish Habitat Partnership

- What: The National Fish Habitat Partnership is associated with fish habitat partnerships across the country that implement strategic conservation to improve aquatic habitat, raise public awareness, and prioritize the use of federal, state and local funds for fish habitat conservation. The partnerships often fund on-the-ground restoration projects.
- http://fishhabitat.org/news

National Fish and Wildlife Foundation

- What: The National Fish and Wildlife Foundation operates grant programs that award matching funds to projects that: address priority actions promoting fish and wildlife conservation and the habitats on which they depend; work proactively to involve other conservation and community interests; leverage available funding; and evaluate project outcomes.
- Funding Range: $10,000 to $150,000
- http://www.nfwf.org/

Natural Resources Conservation Service – Environmental Quality Incentives Program (EQIP)

- What: EQIP provides financial and technical assistance to agricultural producers in order to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation or improved or created wildlife habitat.
- Funding Range: Up to $450,000
- http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

Natural Resources Conservation Service – Watershed and Flood Prevention Operations Program

- What: Funding and/or technical assistance may be available through the Watershed Flood Protection Program or Watershed Surveys and Planning Program.
- http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/

U.S. Army Corps of Engineers – Aquatic Ecosystem Restoration

- What: Section 206 of the Water Resources Development Act of 1996 authorized the Army Corps to plan, design, and build projects to restore aquatic ecosystems for fish and wildlife. Funds from this program can be utilized to remove low head dams as a way to improve water quality and fish and wildlife habitat. Individual Army Corps regional offices will have more information on this program.
- Funding Range: Up to $10 million
- http://planning.usace.army.mil/toolbox/guidance.cfm?Option=BL&BL=EcosystemRestoration&Type=None&Sort=Default

State Funding Sources

Interested project proponents should consult with state agency staff on potential funding. While some states may have dedicated funding sources specifically for dam removal, most do not. However, some states may have funds available resulting from the settlement of environmental enforcement cases brought by the state, and are contributed by the violator in lieu of a penalty. While not an option for every project, this funding source may be able to support studies and design as well as construction. When available these funds are often distributed as grants.

Local Funding Sources

The most likely source of local funds is money that has been allocated by a town to address structural and safety problems with a specific, town-owned dam. Such funding is usually only available if it is approved by a town vote at a regular or special town meeting. In some cases, a town may be able to provide in-kind services from their highway department to assist with construction. These can be important matching funds.

Private Funding Sources

Many private foundations provide funding for environmental restoration projects. In addition, groups like Trout Unlimited, The Nature Conservancy, and American Rivers may have access to funding sources or have good relationships with potential funders. Private funding can be important match for federal grants.

Great Works Dam removal, Penobscot River, Maine
Photo By: Penobscot River Restoration Trust

Additional Funding References

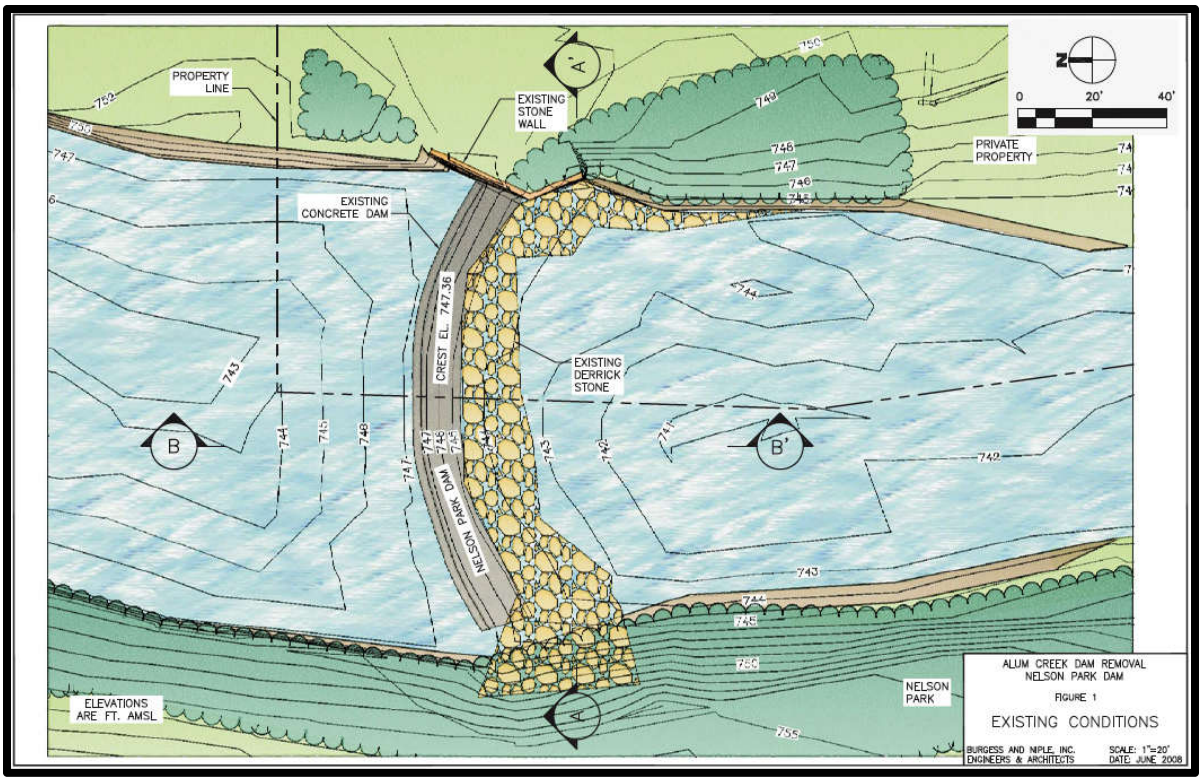
EPA Catalog of Funding Sources for Watershed Protection
http://water.epa.gov/aboutow/owow/funding.cfm

The River Network list of Funding Sources
http://www.rivernetwork.org/resource-library/11

Step 5: Develop a Preliminary Design Plan

The preliminary design phase provides concept-level plans and quantitative information from environmental and engineering assessments necessary to make final decisions on the project design. Preliminary design work can be extensive or minimal depending on the breadth of work identified during initial reconnaissance. In the simplest cases, preliminary design and final design are completed as one phase. For more complex projects, this work is done in a separate Preliminary Design Phase so that project partners and the dam owner can make decisions in consultation with regulators about the project's approach before proceeding to final design.

Depending on the size and complexity of the project, preliminary design can cost from $10,000 to more than $100,000.



Example engineering design plan sheet, Nelson Park Dam removal, Alum Creek, Ohio
Photo By: Ohio Department of Natural Resources, Division of Soil and Water Resources

Step 5A: Selecting Effective Consultants

Preliminary design work is typically completed by environmental consultants, and the choice of the consulting team is critical to project success. Because dams are in dynamic riverine environments, and multidisciplinary issues such as sediment management, habitat restoration, and infrastructure protection must be addressed, a **multidisciplinary consulting team** is needed.

There is always more to a dam removal project than just removing a concrete structure. At a minimum, the consulting team must have expertise in engineering, ecology, and fluvial

geomorphology. This combination of skills is very rare in traditional engineering firms. *Therefore, traditional engineering firms that lack some of these skills should expect to subcontract with a firm with specific river restoration experience*. An effective consulting team can greatly smooth the process, as regulators expect to see an understanding of all of these multidisciplinary issues in the analysis and design. American Rivers has competitively pre-qualified **a list of consultants and consultant teams** that fit these criteria and can share that list upon request.

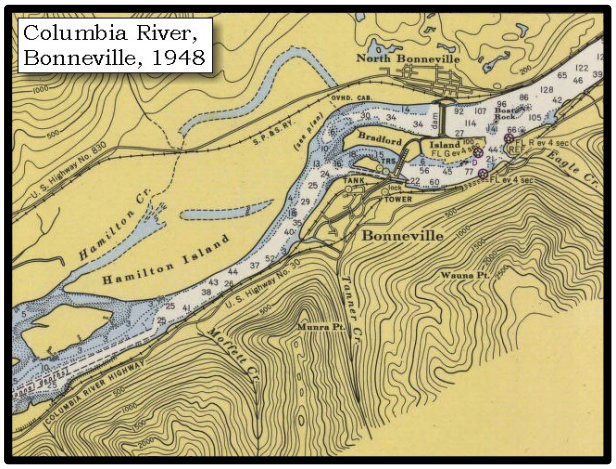
Step 5B: Scoping the Study

The preliminary design study typically includes analyses necessary to develop alternatives for removing the structure, protecting infrastructure, restoring instream and riparian habitat, and managing sediment. While every case is site-specific, below are some general items that are frequently included in the scope of work. Note that **not every step is necessary for every project** and a site-specific evaluation must be completed:

1) **Data Collection**

   Collect and synthesize all available existing data on the dam, the river, and the surrounding landscape. This could include:

   a. Existing maps and plans, including:
      i. As-builts (plans that show how the original dam was constructed)
      ii. Dam dimensions and year built
      iii. Dam materials, operations, and maintenance history
   b. Past dam inspections and dam safety reports
   c. FEMA Flood Insurance Studies (FIS)
   d. Aerial photos
   e. Historic maps
   f. Fisheries data
   g. Planning department reports
   h. Utilities mapping, including water lines, power lines, sewer lines, and other infrastructure that could be impacted by heavy machinery in the area
   i. USGS gauge data



Bonneville Dam Historic Map
Photo By: NOAA Archives

2) Survey and Base Mapping

A site survey is usually necessary to create a base map and provide information needed to assess hydraulics and sediment management. In order to completely survey the site, the surveying team must get in the water! The surveying should include:

a. Cross sections of the river and adjacent land in the impoundment, downstream, and upstream

b. A survey of the deepest part of the stream through the impoundment, downstream, and upstream (longitudinal profile)

c. A survey of the depth of soft sediment throughout the impoundment (depth of refusal) – this can be done in tandem with the cross sections and longitudinal profile

d. Delineate and survey the resource areas that will be affected as required for state and federal permits, including wetland boundaries and ordinary high and low water lines

3) Hydrology and Hydraulics Assessment (H&H)

Hydrology involves assessing the magnitude and frequency of flows in the river. Hydraulics involves assessing the velocity, scour potential, and depths of these flows. Assessing both is necessary for determining potential impacts to surrounding infrastructure and changes in flood levels. If there are issues that might prevent aquatic species passage, such as a bedrock waterfall, an H&H assessment can help determine if certain species can swim through the site.

4) Sediment Assessment and Management Planning

Sedimentation behind Savage Rapids Dam, Rogue River, Oregon
Photo By: U.S. Bureau of Reclamation

Quantitatively assess sediment quality and quantity. Complete a due diligence study to identify potential contaminants; use this to inform a sediment sampling and testing plan. Develop a conceptual plan to manage sediment movement and any contaminated sediment. Fundamental to this analysis is determining what portion of the sediment will transport downstream as a result of different management approaches. The consulting team must know how to complete this type of analysis, and having the necessary background in sediment management is integral in the decision of who to hire for the work.

5) Infrastructure Protection

Evaluate whether utilities, bridges, culverts, retaining walls, and any other surrounding infrastructure could be damaged by removing the dam. Develop a preliminary plan for removing, moving, stabilizing, or avoiding any infrastructure that is at risk. This step requires involving parties with a good understanding of hydrology, hydraulics, and structural engineering.

6) Species Protection

Working with state and federal biologists, determine if any measures are necessary to protect species at the site, particularly threatened and endangered species. Consider whether species could suffer long-term harm from the project. Most dam removals will have short-term impacts, but will ultimately result in long-term benefits. Where necessary, develop plans to relocate species or otherwise protect species of concern.

7) Site-Specific Issues

There are many additional site-specific issues that may need to be evaluated during the preliminary design phase on a case-by-case basis. These could include:

a. Assessment of replacing the current uses of the dam and impoundment
b. Invasive species management
c. Active channel and riparian habitat restoration beyond just removing the dam
d. Historic/archaeological assessment of the dam and surrounding area
e. Photo renderings of project alternatives if desired for community work (see section on community issues)
f. Recreation plan for parks, river walks, boating/fishing access

***Phragmites australis*, an invasive plant in many places**
Photo By: Darkone

8) Preliminary Structure Removal Plan

The final approach for removing the structure will be completed during the engineering design, but several issues should be considered during the preliminary phase as they can have a significant effect on the scope of the design. These include:

a. The condition of the dam structure for safety concerns, potential demolition approaches, and whether there are usable gates or removable boards that can be used during the dam removal
b. Access to the site for construction equipment and staging areas
c. Site limitations, such as utilities or topographic constraints

9) Pre-Project Monitoring

The analysis done during the preliminary design can provide the baseline for post-project monitoring if the preliminary design analysis is done with monitoring in mind. See the section on 'project monitoring' for more information.

10) Permit Identification

Determine which federal, state, and local permits will be required by assessing whether the project approach will exceed permitting thresholds. Complete the resource area and other calculations necessary to fill out those permits.

11) Technical Memorandum

A Technical Memorandum on the Preliminary Design should describe the above analysis and provide a recommended approach for each issue. Depending on the challenges of the site, the technical memorandum could be very brief, providing rationale for the engineering design.

12) Conceptual Drawings

Develop concept-level drawings of design alternatives for removing structures and restoring the site. These concept-level drawings are often referred to as "10%" or "30%" design drawings.

13) Cost Estimate

Develop cost estimates to bring the recommended approach to completion, including costs of final design, permitting, construction and construction oversight. At this point in the process until the engineering design has been finalized, the cost estimate will be considered a 'probable cost' based on the consulting team's best judgment and past experience.

Before dam removal in 2013 on Cox Creek in Albany, Oregon
Photo By: Calapooia Watershed Council

American Rivers can provide assistance with identifying issues to assess. The table below provides example tasks for a more complex project that you might consider for your project's work plan. Note that not all of these tasks may be necessary for your project, and some additional tasks may be needed, depending upon the logistics of your specific project.

Example Project Tasks for a Work Plan

Hiring Project Engineer (your organization's staff)
Create and conduct hiring process including: forming Interview Committee, Request for Proposals/Quotes (RFP/RFQ) to hire engineering firm, selection criteria, etc.
Create Scope of Work (SOW) and timeline for all project staff and/or contractors
Education and Outreach (your organization's staff)
Create Memorandum of Understanding (MOU) with dam's owner(s) that outlines roles and responsibilities for the project participants
Create outreach strategy
Conduct outreach to affected stakeholders (2-6 meetings)
On-going communication with your group (watershed council, federal/state partners, other)
Participate in public meetings with affected stakeholders (2-6 meetings)
Build consensus on preferred alternative
Education and Outreach (Project Engineer)
Participate in public meetings with affected stakeholders (2-6 meetings)
Technical Assistance (your organization's staff)
Build Technical Team and facilitate Technical Team meetings (4 to 6 depending on project complexity)
Collect background site data
On-going communication with agency staff
Technical Assistance (Project Engineer)
Participate in Technical Team meetings (4 to 6 depending on project complexity) and incorporate feedback from these meetings into project design, timeline, etc.
Collect background site data
Create a hydrologic model of the system
Conduct topographic and bathymetric site survey (including longitudinal profile)
Collect current discharge data (may require instrumentation of the river)
Conduct pebble counts
Conduct sediment sampling
Conduct geomorphic survey
Collect discharge data from historic records
Analyze collected data
Create reports, maps, and alternatives analysis of site options for maintaining or removing the dam
Develop preferred alternative to the 30% design level
Develop preferred alternative to the 60% design level to submit for permits
Prepare permit applications and all necessary accompanying data
Prepare 90% design for final permit agency review

Prepare 100% design
Prepare bid and specification documents and distribute to potential contractors
Manage bid process to select project contractor(s) for project implementation
Provide construction oversight
Provide any required site monitoring during construction (typically water quality sampling)
Prepare as-builts upon project completion
Prepare final reports for funding agencies
Technical Assistance (may require other contracted services if your engineering firm does not have this expertise)
Conduct seismic refraction study
Conduct archaeology survey (per State Historic Preservation Office (SHPO) standards)
Conduct wetlands inventory

Note— Table above adapted from: Hoffert-Hay, D. 2008. *Small Dam Removal in Oregon: A Guide for Project Managers*. Oregon Watershed Enhancement Board.

More information on the types of decision-making that go into designing a dam removal project can be found in our guide— *Exploring Dam Removal*.

Before (above) and after (right)
West Henniker Dam removal
Contoocook River, New Hampshire

Step 6: Finalize Your Engineering Design

The final design plans are the culmination of the preliminary design data collection, project approach decision-making, stakeholder input, and regulator input. Engineering design plans and specifications should be completed in sufficient detail that a contractor could take the plans and complete the work.

Just as with preliminary studies, the design team must be interdisciplinary to appropriately design all aspects of the project (see discussion in the preliminary design section on selecting effective consultants).

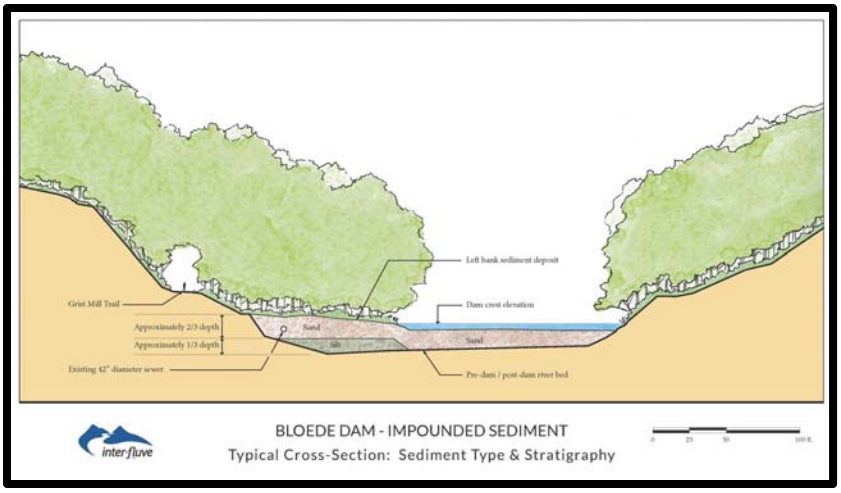
The design typically includes a set of drawings (the design plan), a set of detailed specifications, and a technical memorandum describing the analysis and approach. Final engineering design can cost between $10,000 and $100,000, depending on the size and complexity of the project.

Engineering Design Considerations

1) Engineering Design Plan

The design drawings should show plans for dam removal, sediment management, and channel restoration plans as necessary to reflect the project complexity. Plan sheets typically include base maps and drawings of:

a. Existing site conditions
b. Staging areas and access
c. Removal plan
d. Dewatering plan (sometimes completed by the contractor)
e. Delineation of resource areas
f. Proposed plan view
g. Proposed cross sections
h. Proposed longitudinal profile
i. Erosion prevention and sediment control practices
j. Infrastructure replacement/protection
k. Habitat feature installation schematics



Example cross-section from Bloede Dam
Patapsco River, Maryland

2) Project Specifications

The project specifications provide details on the construction work that will be completed. In the simplest cases, project specifications can be included directly on the design plans. Typically specifications detail:

a. Construction equipment needs
b. Material specifications and quantities
c. Project sequencing
d. Staging area treatment
e. Site access route treatment
f. Dewatering
g. Other site-specific details such as planting plans, traffic control, infrastructure protection, etc.

3) Technical Memorandum

The technical memorandum describes the analysis that went into the design and details the rationale behind the project approach. If a technical memorandum was completed during the preliminary design, this document may be nearly identical with revisions that were completed in the final design.

4) Cost Estimate

The design team should develop an itemized cost estimate based on the design and specifications. At this stage, the cost estimate is considered an Engineer's Opinion of Probable Cost based on the project specifications, until contractors bid on the project.

Bear Run Dam removal, Pennsylvania
Photo By: Terra Dawn Photography

Notes on Key Design Issues

While this handbook is not intended as a guide to the scientific and engineering aspects of dam removal, some key points to consider in the design include:

- The entire vertical extent of the dam structure should be removed from the stream. Rivers are dynamic systems and any solid concrete structure that is left in the bed of a river can eventually become a barrier again as river flows cause scour on the downstream side over time. In some cases, side abutments are left in place to preserve a historical remnant of the structure. In these cases, the hydraulics should be modeled to ensure that the remaining abutments do not create a constriction and ultimately scour and cause high flow velocities.

- To effectively restore habitat, simulate the surrounding stream or other nearby healthy streams to the extent possible. For example, if the stream channel upstream of the impoundment has a slight slope and the channel downstream of the dam has a slight slope, then as a general rule, the restored channel through the removed dam should not have a steep slope. This will allow whatever species that make use of the more natural sections of the stream to also make use of the restored sections.

- Remember, good habitat is messy! Aquatic species need a range of complex habitats at different times in the season and for different life stages. Only be "neat and clean" where it is necessary for infrastructure protection. Otherwise, vegetate the site extensively and provide varying in-stream habitats such as adding wood in the stream or providing variation on the stream bed.

- Slowly draining the impoundment during dam removal:
    - Reduces the release of sediment downstream
    - Allows the bed of the impoundment and stream to drain and stabilize
    - Prevents a "wall of water" from crashing downstream and damaging both infrastructure and habitat

  This can be accomplished by gradually removing boards from the control structure; slowly opening a low-level outlet if one exists; or by cutting incremental breaches into the dam structure and letting the water level lower after each increment.

- Carefully consider the need to proactively revegetate land that is exposed by the dam removal. While the environment can be extremely effective at growing vegetation, often the first species that take root in exposed land are non-native or invasive species.

Step 7: Help Your Community Learn About Your Project

Many towns developed around sites that provided waterpower for mills, and dams have been a central part of these communities since their earliest days. Some are historic and scenic structures, and decisions surrounding dams often raise strong feelings of sense of place, connection to the landscape, and nostalgia for the way things have always been. Many impoundments are used for recreation or simply provide a pleasing view for adjacent landowners. In some cases, communities will strongly oppose the notion of dam removal. In other cases, the community will have no interest in the dam at all. In still other cases, the surrounding community may support improved water quality and the return of fish runs and riverine recreational opportunities. Whatever the case, the importance of working with the local community should not be underestimated.

Community outreach event
Petersburg, Virginia

Community interest in the site should be assessed in the early stages of project conception. Based on this initial assessment, project proponents should develop a plan for community presentations and participation.

Step 7A: Public Participation

There are two primary ways to involve the community in dam removal projects: through mandatory regulatory hearings and through proactive public participation. If the community has an interest in the dam, then proactive approaches are critical to help the community through the change that is occurring in the landscape. Having **community members as active proponents** of a dam removal will help ease the fear of change, will help create new community norms, and will smooth local decision making.

Recognize who has the ultimate decision on whether a dam will be removed, as this will affect the dynamics of community discussions. Discussions about private property need to be managed differently than discussions about publicly-owned dams. In some cases, public participation is needed to develop community consensus about a project. In other cases, public participation will be planned to provide input to decision-makers. In still other cases, public participation will be designed to simply keep the community informed. It is important to determine upfront what role the public will play in the process and relay that role to the public to maintain reasonable expectations.

In towns with a **conservation commission**, reaching out to that body can be a good first step to engage the local community. Ideally, members of the conservation commission can serve as members of the project team by participating in planning meetings and other aspects of the

project. The commission can also host public meetings in the local community, serving as a bridge between project proponents and local residents.

Step 7B: Public Visioning

A sense of loss is inherent in the notion of dam removal: an object is being removed. But dam removal projects can also bring a great deal of gain in terms of new recreation opportunities, restored ecosystem health, and a renewed connection to a free-flowing river. With some creative community visioning, the fear of loss can be turned into a sense of gain.

1) **Renderings**

   Renderings can take the form of drawings or digitally-altered photographs showing "before" and "after" images of the site. They can help the community gain a better vision for how the restored river will look when a dam is removed. Renderings have been successfully used in situations where there is apprehension about the "look" of the restored river or where different removal options are being considered.

2) **Framing Effective Messages**

   While many river advocates care deeply about the river and the fish and wildlife it supports, for others these are small concerns. The perception of an idea such as dam removal is more important than the actual science that backs it up. It is important to think about the perceived benefits of dam removal for your audience. For many communities, public safety and the financial burden of failing infrastructure present a strong economic argument, while in other places social or recreational interests may be important. It is also important that community visioning is led by someone from the community and not by state or federal agency staff who will be perceived as outsiders. Agency partners can provide valuable scientific backup and support, including producing renderings and talking about alternatives, but **local leadership** is critical to effective community discussions.

3) **Getting Started on Community Outreach**

   A good initial exercise in planning a community outreach strategy is to write down **perceived benefits and barriers** as viewed by the community so that they can be adequately addressed. Barriers might include the perceived loss of property values, the loss of a pond and recreational amenity, or simply fear of change. With every loss, there can be a real or perceived gain, such as increased fishing opportunities or increased recreational opportunities in the form of a new walking trail through the old impoundment. Using **examples and case studies from other communities** can also help spread understanding that dam removal is becoming a common approach.

Step 8: Obtaining Your Dam Removal Permits

Local, state, and federal agencies have authority over dams, dam removal, and ecological restoration. As a result, **multiple permits are often required** to remove a dam. Each permit has a regulatory threshold that specifies whether it is required for a specific project. Not all permits may be required at all dam removals depending on site-specific actions. Usually the more thoroughly prepared the design and permit application, the less time it takes to receive approval. In some cases, regulators may require additional analysis during the permitting process.

Project permitting costs vary widely depending on project complexity. If the work is entirely completed by consultants, including completing paperwork, filing forms, and attending hearings, meetings, and site visits, permitting can cost between $5,000 and $50,000 depending on site-specific permit requirements. The proponent can realize significant cost savings by handling the filings and any hearings.

Savage Rapids Dam removal, Rogue River, Oregon
Photo By: U.S. Bureau of Reclamation

General Recommendations

- Consult with and work cooperatively with regulatory agencies early in the permitting process
- Plan sufficient time to complete all the necessary consultations and regulatory processes, typically 3 to 6 months.

Permits That You <u>Likely</u>[1] Need to Obtain Include:

Clean Water Act (CWA), Section 404 Permit

- **Agency:** U.S. Army Corps of Engineers
- **Covers:** Discharge of dredged or fill material into navigable waters of the U.S. at specified disposal sites
- **Notes:** 2 possible avenues different designations of Section 404 permits
  - Nationwide Permit (NWP)
    - Timeline: Typically 60 days
  - Individual Permit (IP) (also referred to as "Standard Permit")
    - Timeline: Typically 120 days
  - One form for both avenues
  - Army Corps decides which avenue applies to your project, based on your scope of work and expected impacts to the aquatic environment
  - Most dam removal projects will receive an IP.
-

[1] Note that some of these permits are combined in certain states. Check with your state to find out the exact permits and approvals you will need to complete your project.

- This permit application may trigger the following activities depending on project specifics:
    - Biological Assessment
    - Biological Opinion
    - Programmatic Consultations
    - Endangered Species Act Consultation
    - Magnuson-Stevens Act Essential Fish Habitat (EFH) Consultation
    - National Environmental Policy Act (NEPA) Review
    - Sediment Evaluation Framework (SEF) Review

Nationwide Permit #27, Aquatic Habitat Restoration, Establishment, and Enhancement Activities

- **Agency:** U.S. Army Corps of Engineers
- **Notes:** Army Corps may issue NWP27 if your project's impact to the aquatic environment is anticipated to be "no more than minimal"
- Only used in some states
- No additional permit application required; determination made from CWA 404 Permit Application
- Being issued this permit provides a big advantage when it comes to the type of data and supporting information you are requested to provide.

Rivers and Harbors Act, Section 10 Permit

- **Agency:** U.S. Army Corps of Engineers
- **Notes:** This permit will only apply if the project in question will obstruct or alter a navigable waterway of the United States.

Clean Water Act (CWA), Section 401 Water Quality Certification

- **Agency:** Environmental Protection Agency/State
- **Notes:** A federal agency cannot issue a permit or license for an activity that may result in a discharge to waters of the U.S. until the state or tribe where the discharge would originate has granted or waived §401 certification.
- Decision is based on the proposed project's compliance with EPA-approved water quality standards, and to ensure that the activity leading to the discharge will comply with applicable effluent limitations guidelines, new source performance standards, toxic pollutant restrictions, and other appropriate requirements of state or tribal laws.

National Historic Preservation Act, Section 106 (Consultation)

- **Agency:** State (or Tribal) Historic Preservation Office (SHPO)
- **Notes:** Federal agencies are required to take into account the effects of their undertakings on historic properties. This consultation addresses those obligations.

You <u>Might Also</u> Need Other State-Specific Permits or Approvals Related to:

- Federal Energy Regulatory Commission (FERC) Review for hydropower dams
- Construction Near Wetlands and Waterways
- General Construction Activity
- Sediment and Stormwater Management and Erosion Control
- Dam Safety
- Highway or Transportation Related Issues
- Forest Conservation
- Historic Preservation
- Site Access

This list of resources only includes primary federal and state permits you may need for your dam removal project. In addition, depending on the location of the dam in question and the scope of the restoration design, you will want to look into county or municipality permitting requirements.

Ashland Mill Dam
Ashland Creek, Oregon

Step 9: Completing Your Project

The background work is done, the project design is completed, the community is on board, and you have obtained permits for the construction work. The culmination of months of hard work has arrived. You are ready to remove a dam. Congratulations!

Harvell Dam removal
Appomattox River, Petersburg, Virginia

Construction is most commonly bid out to qualified contractors. In some cases, town departments of public works or partnering corporations have qualified personnel and the appropriate equipment to complete some or all of the work. Ensure that all of your contractors are licensed, bonded, and insured in accordance with the regulations in your state.

While the design plans should have a level of detail that allows the production engineers to complete the project, the designer should still be present on-site during construction to oversee the process. You never know what unforeseen circumstances might arise when you are working on rivers. There are very few contractors that have experience with habitat restoration projects and many of the nuances of infrastructure protection and habitat construction must be relayed on-site during construction.

Construction can cost from about $30,000 upwards. For some lessons learned regarding construction of dam removal projects, see The Aspen Institute's *Dam Removal: A New Option for a New Century*.

Step 10: Monitoring Your Project

Monitoring project results is an important, but often overlooked step in the dam removal process. There are two types of monitoring that occur at dam removals. The first is project evaluation to determine if the engineering design was constructed properly and that the project is performing successfully in terms of infrastructure and public safety concerns. The second is environmental monitoring to determine if the project is meeting habitat goals over the long-term.

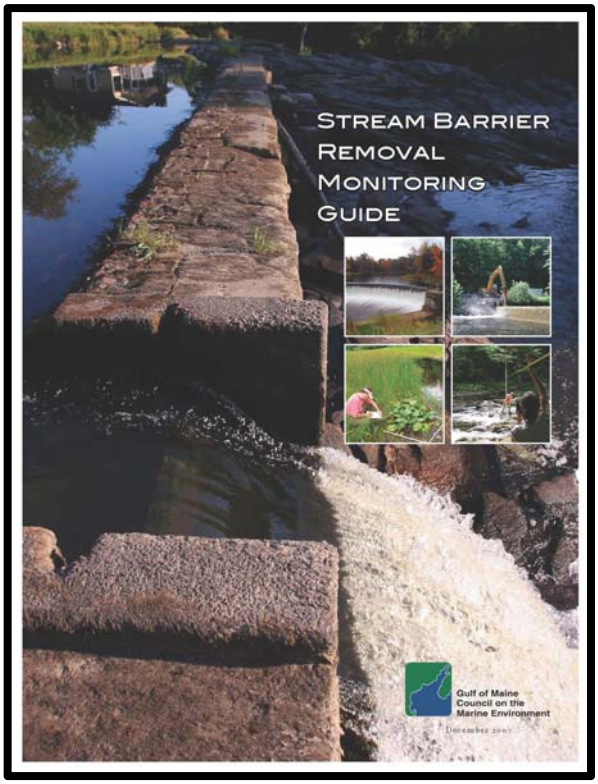
Step 10A: Project Evaluation

The contractor and construction manager should complete a project evaluation immediately following project completion. However, the project proponent should also complete regular project inspections of the site. The proponent can develop a checklist of issues to inspect with the assistance of the project design team. The checklist might include a visual assessment of vegetation growth, erosion, and scour around infrastructure, such as pipes, retaining walls, and abutments.

Step 10B: Environmental Monitoring

Environmental monitoring involves evaluating changes in ecological, hydrologic, and geomorphic parameters to gauge project success and lend insight to future projects. A monitoring plan should be developed during the project development phase, as most monitoring parameters must be pre-measured prior to project implementation in order to establish pre-project baseline conditions. Trained personnel from universities, environmental consulting firms, or scientific staff from various non-profits can complete environmental monitoring activities. In some cases, state agencies can provide assistance with project monitoring, such as by evaluating fish populations before and after dam removal.

Note that it is important to document baseline factors before barrier removal in order to have a basis for comparison post-construction.



Potentially Useful Monitoring-Related Resources

Stream Barrier Removal Monitoring Guide

- Who: Gulf of Maine Council on the Marine Environment
- What: This guide recommends seven critical monitoring parameters and outlines methods for each parameter. It also provides data sheets, equipment lists, etc.
- Year: 2007
- www.gulfofmaine.org/streambarrierremoval/

Fish Passage Barrier Removal Performance Measures and Monitoring Worksheet

- Who: NOAA Restoration Center
- What: Monitoring guidance and a worksheet to track completion of project goals
- Year: 2010
- http://www.habitat.noaa.gov/partners/toolkits/restoration_center_toolkits/forms_and_guidance_documents/ori_monitoring_sheet_w_guidance.pdf


NOAA Restoration Center

Fish Passage Barrier Removal Performance Measures and Monitoring Worksheet

A General Info

B Project Timing

C Available Habitat

D Site "Passability"

PRE-IMPLEMENTATION

POST-IMPLEMENTATION

It is important to consider the monitoring needs in the context of the size and scope of the project and not develop a monitoring plan that is overly ambitious. The most basic approach to project monitoring is to develop photo stations to photograph the site from the same location repeatedly over time. In addition, there are a number of parameters that can be monitored to track the ecological success of a project, and they fall in some broad categories:

1) **Ecological Response**
   a. Evaluate changes in fish, macroinvertebrate, and other aquatic species distributions and abundance.
   b. Evaluate vegetation regrowth in exposed lands, particularly assessing invasive and exotic species.

2) **River Channel Response**
   a. Evaluate sediment movement, erosion, and habitat structure by surveying channel structure and analyzing bed material samples.

3) **Water Quality Response**
   a. Evaluate changes in water quality, including such parameters as water temperature, dissolved oxygen, and suspended solids.

4) **Hydraulic Response**
   a. Evaluate changes in flow velocities as it impacts aquatic species movement and recreational boating safety in the river.

Frequently Asked Questions

What will the restored river look like?

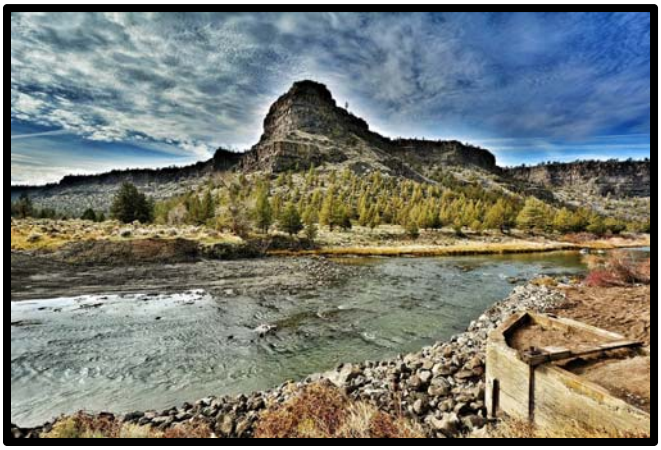
The river channel that re-forms or is actively restored after a dam is removed will ultimately be a similar size and shape as the river upstream and downstream of the former impoundment. Sometimes the general shape of the old river channel can be seen in underwater patterns if you look at an aerial photograph of the impoundment. Some dams were built to increase the water level in a natural lake or pond and that natural lake will be restored after dam removal. Changes to the landscape will be more or less dramatic depending on the size of the structure, its purpose, and the size and shape of the impoundment. Renderings showing what the restored river channel will look like can help the community to understand likely post-project conditions.

Will there be an increase in flooding?

Only a small percentage of dams provide flood control benefits and those dams were expressly built for that purpose. Most dams do not significantly affect or control downstream flooding and therefore their removal will not cause a significant change in flooding downstream. In some cases, dam removal can decrease flooding upstream of the dam, and can eliminate a downstream hazard by removing the potential for a catastrophic breach of the structure.

Can the dam be used for hydropower production instead of being removed?

Retrofitting existing small dams to generate electricity is usually not economical. With few exceptions, good sites for hydropower development were developed decades ago, so the sites that remain are hampered by limited generating capacity and the cost of development, operation, and maintenance. Even with economic incentives to develop renewable energy sources, the economics of many dam sites remain marginal. The cost of repairs to an existing dam to meet current safety standards can be prohibitive, in addition to the cost of the new infrastructure necessary for energy production. In most cases, the community, public safety, economic, and ecological value of removing the dam will outweigh the societal benefits provided by the relatively small amount of energy.



Former Stearns Dam Site
Crooked River, Oregon
Photo By: River Design Group

How long will it take the impoundment to revegetate?

Depending on the time of year, revegetation of the sediment behind a dam begins within weeks of exposure to sunlight. It is important to keep an eye on invasive plants such as purple loosestrife and Japanese knotweed during the first growing season, so that native plants can grow and out-compete unwanted species.

What happens to the fish and wildlife that were in the impoundment?

Dams create artificial habitat by impounding water and altering river function. Impoundments trap sediment and create stagnant conditions with warmer water than the rest of the river system. Generally, much of the wildlife that uses an impoundment such as birds and turtles will quickly adapt to restored river conditions. Rivers typically provide more habitat variety and conditions for native species. Fish will be able to move upstream and make use of the full river for their life cycle. The restored river may also help bring back cold water fisheries, such as trout, and will allow anadromous fish, such as Atlantic salmon, to use the river for spawning. While the fishery will certainly change, a greater variety of fish and fishing opportunities is likely to result.

What about all the sediment behind the dam?

One of the first steps in designing a dam removal is to assess the quality and amount of sediment behind a dam. If the sediment is contaminated, precautions will be necessary for removal and disposal or in-situ capping. Dredging of sediment is not always necessary during a dam removal and not all sediment that was trapped by the dam will flush downstream during removal. Typically a combined approach is taken of removing some sediment and stabilizing the rest through active revegetation and bioengineering. Sediment impacts below the dam are generally temporary and the river quickly readjusts to its new configuration. Bioengineering and stream channel reconstruction can help stabilize sediments in the former impoundment.

Will there be wetland impacts?

The wetland habitat behind a dam will change when the dam is removed. Depending on the surrounding topography, deep water marsh may become shallow marsh or wet meadow. Habitats such as red maple swamp may return. Rivers are also wetlands, and riparian areas have important habitat functions. While the total wetland area may change, the function of the natural ecosystem will be improved. Usually wetlands above a dam are not self-sustaining (they are sustained by a human-made structure that must be maintained) and will gradually fill with sediment over time.

What if the owner just breaches the dam?

A dam owner may be required by the Dam Safety Office to open the gates, breach, or lower the dam for safety reasons. This action removes the pressure from impounded water on the structure to prevent a catastrophic failure. Many dam owners may not have the financial means to fully remove a structure and will leave the structure in the stream. Open gates can clog with debris and water can re-impound behind the structure creating an unstable habitat and safety concerns. Breached structures can also continue to be passage barriers to fish, especially at low flows, and do not allow for full channel recovery above the dam. A better option is to fully remove the vertical extent of the structure and fully restore the channel and its banks as a natural system.

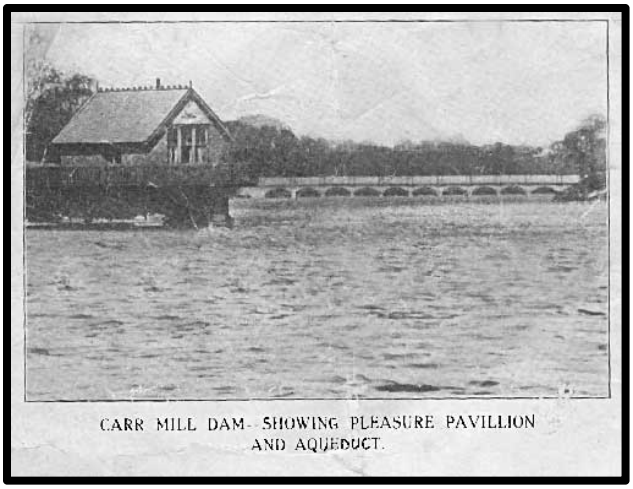
North River Dam is breached
Colrain, Massachusetts
Photo By: Massachusetts Department of Energy and Environmental Affairs

Who will own the exposed land?

Because many dams were constructed by mill owners centuries ago, sorting out property ownership is not an easy task. A mill owner may have owned a dam and/or mill pond miles from the mill itself, and deeds for the dam may not always be attached to surrounding properties. Deeds and titles for the specific dam and/or legislative acts that provide for creating reservoirs will often show who owns the impoundment and the land under the water, and often this might be the municipality, especially if it is a municipally-owned dam. Whether or not abutters have rights to the newly exposed land is something that would have to be sorted out on a case-by-case basis.

What about property values?

While the loss of one type of recreational and scenic resource may decrease value to some, to others, the restored river, improved water quality, and added open space increases the value of the site. Preliminary studies are showing that property values in some cases may actually increase long-term following dam removal, but every case is site-specific.



CARR MILL DAM- SHOWING PLEASURE PAVILLION AND AQUEDUCT.

Is the dam historic?

Some dams and their associated mills provide examples of early industrial history. Some community members will feel an attachment to dams for their historic significance, while others will feel that the true history is a free flowing river. Any project that receives federal funding or requires a federal permit will be required to evaluate the history of the site. Historic mitigation has been done at many dam removals, often by taking historic grade photographs, installing interpretive signage, preserving associated mill buildings, or by leaving a component of the dam.

Is there money available to help remove the dam?

There are several sources of federal and other funding available for dam removal, depending on the amount and type of habitat being restored. Rivers are a public resource, so there are many parties interested in habitat restoration.

Additional Resources

Restoring America's Rivers: Preparing for the Future

- Media Type: Video
- Produced by: American Rivers
- Year: 2010
- http://www.americanrivers.org/newsroom/resources/restoring-americas-rivers-preparing-for-the-future/

Dam Removal and Historic Preservation: Reconciling Dual Objective

- Media Type: Written Report
- Authored By: American Rivers and National Park Service
- Year: 2008
- http://www.americanrivers.org/newsroom/resources/dam-removal-and-historic-preservation-reconciling-dual-objective/

Dam Safety: Protecting Communities and Ecosystems from Dam Failure

- Media Type: Written Report
- Authored By: American Rivers
- Year: 2006
- http://www.americanrivers.org/newsroom/resources/dam-safety-protecting-communities-and-ecosystems-from-dam-failure/

Exploring Dam Removal: A Decision Making Guide

- Media Type: Written Report
- Co-authored By: American Rivers and Trout Unlimited
- Year: 2002
- http://www.americanrivers.org/newsroom/resources/exploring-dam-removal-a-decision-making-guide/

The Ecology of Dam Removal: A Summary of Benefits and Impacts

- Media Type: Written Report
- Authored By: American Rivers
- Year: 2002
- http://www.americanrivers.org/newsroom/resources/ecology-of-dam-removal/

Dam Removal: Science and Decision Making

- Media Type: Written Report
- Authored By: The H. John Heinz III Center for Science, Economics, and the Environment
- Year: 2002
- http://water.epa.gov/polwaste/nps/upload/Dam_removal_full_report.pdf

Dam Removal: A New Option for a New Century

- Media Type: Written Report
- Authored By: The Aspen Institute
- Year: 2002
- http://www.aspeninstitute.org/sites/default/files/content/docs/ee/damremovaloption.pdf

Dam Removal Research: Status and Prospects

- Media Type: Written Report
- Authored By: William L. Graf, editor. The H. John Heinz III Center for Science, Economics, and the Environment
- Year: 2002
- http://heinzhome.heinzctrinfo.net/Major_Reports_files/Dam%20Removal%20Research%20Status%20and%20Prospects.pdf

Taking a Second Look: Communities and Dam Removal

- Media Type: Video
- Produced By: Trout Unlimited and American Rivers
- Year: 2000
- http://www.americanrivers.org/newsroom/resources/taking-a-second-look/

Dam Removal: A Citizen's Guide to Restoring Rivers

- Media Type: Written Report
- Co-Authored By: Rivers Alliance of Wisconsin and Trout Unlimited
- Year: 2000
- http://www.wisconsinrivers.org/images/Documents/Dams/Dam%20Removal%20-%20A%20Citizens%20Guide%20to%20Saving%20Rivers.pdf

Dam Removal Success Stories: Restoring Rivers Through Selective Removal of Dams that Don't Make Sense

- Media Type: Written Report
- Co-Authored By: American Rivers, Friends of the Earth, and Trout Unlimited
- Year: 1999
- http://www.americanrivers.org/newsroom/resources/dam-removal-success-stories/

Clearinghouse for Dam Removal Information (CDRI)

- Media Type: Web Database
- What: Provides a wealth of additional information and project examples from around the country
- Run By: University of California and California State University
- http://wrca.library.ucr.edu/CDRI/

American Rivers has a vision of a nation of clean, healthy rivers that sustain and connect us
Photo By: William Gray

American Rivers
1101 14th Street, NW
Suite 1400
Washington, D.C. 20005
AmericanRivers.org/initiatives/dams/

American Rivers
Rivers Connect Us®

About American Rivers

American Rivers protects wild rivers, restores damaged rivers, and conserves clean water for people and nature. Since 1973, American Rivers has protected and restored more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and an annual *America's Most Endangered Rivers*® campaign.

Rivers connect us to each other, nature, and future generations. Find your connections at AmericanRivers.org, Facebook.com/AmericanRivers, and Twitter.com/AmericanRivers.