



WATERSHED
FACT PACK

SMALL DAM REMOVAL

IN PENNSYLVANIA

Free-Flowing Watershed Restoration



BEFORE

AFTER



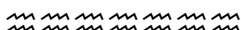
GOOD HOPE DAM removed from
Conodoguinet Creek in Cumberland County in November 2001.

Small Dam Removal in Pennsylvania: Free-Flowing Watershed Restoration



This fact pack was produced by the Pennsylvania Organization for Watersheds and Rivers (POWR) in cooperation with the Mid-Atlantic Field Office of American Rivers. Sara Nicholas from American Rivers authored the document.

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Introduction

There are an estimated 75,000 dams larger than 6 feet in the United States today, and many thousands of smaller dams. With the most stream miles anywhere in the continental United States, Pennsylvania has its share of dams – 3,200 at last count. Many of these dams were built more than 100 years ago on small rivers and creeks to supply power for gristmills. Others were built to provide water for drinking and irrigation, flood protection, hydroelectric power, and recreation. Most of these dams are small, and many of them no longer serve the purpose for which they were built.

As old mills are torn down or stop regular operation, the dams to which they are connected continue to lie across rivers and creeks, blocking the movement of fish and other aquatic species, degrading water quality, and altering the flow of sediment and nutrients critical for stream health. Old dams can also create safety hazards to downstream communities when they fail, to upstream communities when they back up flood waters, and to visitors who fall off of them or boaters and canoeists who go over them and get caught in dangerous hydraulic currents. While some dams continue to serve important functions, many dams in Pennsylvania are good candidates for removal.

This fact pack is designed for watershed organizations, citizen groups, municipalities, and others interested in restoring the many benefits of a free-flowing river or creek through dam removal. While change can be very hard to accomplish and accept – many people love dams for the way they look and sound or simply have gotten used to them being there for many years – the benefits of dam removal are often worth the effort. In this fact pack, we walk you through the ABCs of community dam removal, from the early planning and research stages, through permitting, fundraising, hiring qualified contractors to do the removal, and, the kind of hands-on monitoring and restoration projects in which citizen groups can get involved following dam removal.

While removing a dam is not always possible for various reasons, we will give you some information and guidance on how to make that decision and how to go about the process of removing a dam when it is appropriate.

Examples of Small Dams

Mill Dams

Mill dams, many over 100 years old, dot the landscape of Pennsylvania along creeks and rivers. Most of these dams no longer serve any purpose; only a handful of working mill dams are left in the Commonwealth. These small dams, known as run-of-river dams, run the entire width of the creek and, at normal flows, have water running continuously over the top of the dam. They do not provide flood storage and, therefore, no flood control. In some instances they can actually exacerbate flooding upstream of the dam.

Detter's Mill Dam



This low-head mill dam on west Conowago Creek in York County was slated for removal in late 2002.

Water Supply Dams

These dams are used by water supply companies, industry, or agriculture to pump and pipe water out of the impoundment for local or distant uses. Many water supply dams in Pennsylvania serve municipalities and townships in providing a source of drinking water to their communities. These dams are generally larger than mill dams, some rising 50 or 60 feet high, and generally have an outlet or water control structure at the base to regulate levels in the impoundment and flows into the creek below. Unless water supply dams are failing to meet state drinking water standards, failing structurally, or rendered obsolete by an alternative source of water supply, they are not often candidates for removals.

Hydroelectric Dams

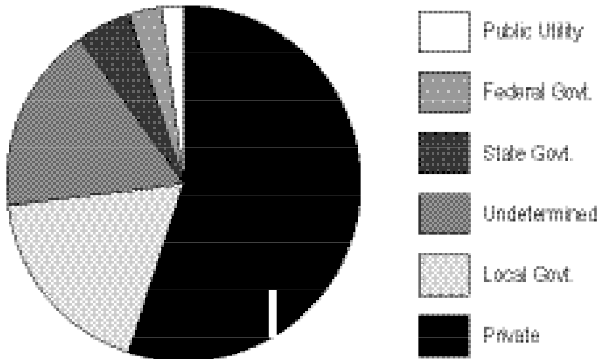
Small hydroelectric dams are found throughout the Commonwealth on streams of all sizes. In addition to the well-known large hydroelectric dams on the mainstem Susquehanna river, there are many smaller dams that once powered small river communities by generating electricity through early turbines. In some cases, these dams were built originally to power grist mills and retrofitted for hydroelectric generation, but in others they were built as early as 1900 to generate electricity. Non-federal dams currently generating hydroelectricity are regulated by the Federal Energy Regulatory Commission and are subject to their maintenance and operation requirements. These dams are required by law to be re-licensed every 30-50 years.

Recreational Dams

Some 33 percent of all dams nationwide now serve primarily recreational purposes. These include mill dams where mill use has given way to “lake” recreation, fishing and boating, as well as dams built explicitly for recreational purposes.

When is Dam Removal Appropriate?

Like any decision a group or an individual makes, the appropriate choice in dam removal usually hinges on whether the pros outweigh the cons. There are many stakeholders in the decision to remove or retain a dam, from the owner of the dam to the local, state, and federal agencies that make permit decisions, to the community in which the dam is located, to recreational users of the river. In Pennsylvania, the dam owner has a strong say in whether a dam stays or goes. Mirroring the national trend, more than half of all dams in Pennsylvania are privately owned – and are almost never removed without the consent of the owner.



Dam owners also have responsibilities under state law. The Pennsylvania Department of Environmental Protection (DEP) requires dam owners to maintain their dams so that they do not present a safety hazard to the community. Dam owners are required to check their dams periodically for cracks or other signs of structural weakness. Dam owners can also be required to repair their dams to ensure their safety. This can be very expensive, running more than a half-million dollars to restore even a modest-sized dam.

The Pennsylvania Fish and Boat Commission (PFBC) can require dam owners to provide a way for migratory fish to pass their dam. PFBC can also require dam owners to make their dams passable to canoeists and other river users. Dam owners across Pennsylvania are periodically notified by mail by these two state agencies about their responsibilities as dam owners.

Below are some of the arguments used for removing and for keeping dams. Each dam site has a unique set of environmental, economic, and social circumstances that makes every decision different.

Benefits of Removal

- restores free-flowing river conditions
- allows passage of migratory fish and other aquatic species
- improves water quality in the impoundment and downstream
- reduces upstream flooding
- reduces hazard of catastrophic dam failure
- reduces risk of drownings and landowner liability
- improves conditions for recreational uses like canoeing and fishing
- restores habitat in and downstream of the impoundment area favoring native species
- requires no future structural repair costs or maintenance
- usually less expensive than dam repair or fish ladders

Dam Safety Sign



Most dams in PA are required by law to post these warning signs above dams to protect people and boaters from the hazards dams present.

Costs of Removal

- eliminates current uses of the dam and impoundment areas
- alters the current composition of fish and aquatic habitat in the impoundment area
- can eliminate recreational uses such as power boats
- removes a piece of “history”
- may allow the migration of unwanted “nuisance” species like sea lamprey

Ecological Arguments

As noted above, most of the ecological benefits to a stream or river come from removing a dam, not replacing it. Rivers are born to run, and the many plant and animal species that have evolved with rivers depend on the free-flowing movement of water, nutrients, and sediments. Dams create an impounded section of a river or stream that functions more like a lake, which can favor species such as ducks, geese, and carp, but often at the expense of native species, including wading birds and trout. Waters trapped behind dams heat up causing unnaturally high temperatures, build up nutrients such as nitrogen and phosphate that promote plant growth, and produce plants such as algae that rob the water of its oxygen, hurting fish and other wildlife that depend on oxygenated waters. Dams also change the river bottom, making it less hospitable to the macroinvertebrates on which fish feed (e.g., caddis fly nymphs) and building up sediments that cover gravel where fish lay their eggs. One of the only documented ecological benefits of dams is the ability of a dam to prevent the upstream spread of invasive exotic species, and, in some instances, the ability of a dam to prevent the downstream dispersal of toxic sediments that may exist in the impoundment.

Smith Dam



Smith Dam Impoundment



Smith Dam on Trindle Springs Run, a limestone trout stream in Cumberland County, has sediment build-up and poor water quality in its impoundment.

Economic Arguments

Whether removing a dam is a good idea financially depends on the current uses of the dam and impoundment. Hydroelectric dams can generate an income stream for their owners and provide power for communities, although in some cases hydroelectric dams may not be generating enough power or income to justify their ongoing maintenance and repair costs – or to justify the damage inflicted on the river. Dams that provide flood management, water supply, or recreational benefits may justify the expense of repair and maintenance – a decision that needs to be made by the owner and others impacted by the dam.

What is very often true, however, is that the removal of a dam is less expensive than repairing or replacing a dam. The River Alliance of Wisconsin estimates that dam repair is generally 3 to 5 times as expensive as dam removal. Dam removal is also usually cheaper than other forms of fish passage, such as fish ladders or rock ramps. Further, a restored river can often bring additional revenue into a community through increased recreational opportunities or from a revitalization of downtown areas resulting from dam removal.

Social Arguments

In dam removal, social arguments can cut both ways. Those who favor dam removal stress the social benefits of reducing a known safety hazard. Allowing recreational users such as anglers and canoeists easier travel up and down a river or stream may be another benefit. Anglers who fish on foot may prefer a free flowing stream to an impounded one, and those who favor native stream fish such as trout may also benefit from dam removal.

On the other hand, recreational power boaters may lose deep water for their boats when a dam and its impoundment are removed. Fishermen who prefer largemouth bass, sunfish,

and other deeper-water species may also lose opportunities with dam removal. Communities that see a dam as a piece of their history, or their civic identity, may feel a loss with dam removal. Aesthetic arguments can also go both ways. Some people see dams and their impoundments as beautiful and “natural,” while others prefer the look of a free-flowing stream without human alterations. As always, beauty is in the eye of the beholder.

Upper Merion Township dam on Gulph Mill



This dam on Gulph Mill in Upper Merion Township outside of Philadelphia is valued by the community for its history and its appearance.

Technical and Engineering Issues

There are entire books written on the technical and engineering issues associated with dam removal, but, for the purpose of this fact pack, communities should take a few things into consideration:

- **Structural integrity of the dam is important.** Periodic reviews by a qualified engineer or public dam safety official can determine the structural integrity of the dam. As a rule, the less structurally sound a dam is, the more hazardous it is and the more expensive it will be to repair it. Pennsylvania’s DEP Dam Safety Division requires an inspection of its regulated dams every 5 years and includes a report of the findings in each dam’s file, which is available for public review.
- **Context is everything.** Removal of a small dam on a stream in the middle of a forest will have a completely different set of considerations than a large urban water supply dam located in a community. Dams with dense residential development along the impounded area and heavy recreational infrastructure investments (e.g., decks, boat docks, boat ramps) will likely present more challenges in a removal effort than a situation where the dam owner owns all of the land along the impoundment or where there is limited development or infrastructure along the impoundment. In general, when more stakeholders are invested in a particular dam, more issues are likely to arise during an effort to remove the dam.

- **Sediment can be key to dam removal.** Dams trap sediments behind them; run-of-river mill dams tend to trap less sediment than other types of dams because sediment is often washed over the dam during storm events. If sediments are contaminated, in great volume, or composed of small, fine particles that may inundate downstream habitat, removal can become more complicated and more expensive. Sediment analysis is essential before any removal effort – and depending on the dam in question the analysis may need to be extensive. This service is usually done by a contractor or the state and can cost anywhere from a few hundred dollars for a very small dam with little potential for contaminated sediments to tens of thousands of dollars for larger dams or those in an urban setting.

Good Hope Dam



Sediments accumulate behind low-head dams like this one at Good Hope Dam in Cumberland County.

- **Alternatives to dams exist for many economic or social uses.** Even dams that do provide some function, such as water supply for irrigation, may be appropriate for removal if an alternative technology can replace the services the dam provides.
- **Look for other infrastructure.** Dams affect not only the stretch of stream on which they are placed, but also can also affect significant downstream and upstream reaches. Dam owners and/or communities, with the help of engineers, need to consider the impacts of dam removal on nearby roads and highways, bridge abutments, utility lines, buildings, downstream communities, streambank stability, and other factors.

Getting Involved

Many dam removals in Pennsylvania and other states are limited interactions between the dam owner and the permitting agencies. However, there may be opportunities for positive local involvement in removal efforts, especially as communities begin to understand the benefits associated with dam removal. Citizen groups, like a watershed association, can be very effective at educating nearby residents on the benefits of conservation activities such as dam removal. As local stakeholders, members of watershed groups are often better positioned to speak to the community than regional or national groups or state and federal agencies. Citizen groups are critical to spreading the word about the positive

aspects of dam removal to their own community. POWR's fact pack entitled *Communicating Your Message: Tool for Building Partnerships and Sharing Your Watershed Success Stories* explains the importance of highlighting your work and describes easy strategies for telling others about the benefits of local activities. (See the back cover for information on this and other fact packs.)

A terrific resource that walks community groups through aspects of the dam removal process is *Dam Removal: A Citizen's Guide to Restoring Rivers*, published by Trout Unlimited and the River Alliance of Wisconsin. Here is a short summary of the ways groups can get involved as a public proponent of dam removal. Remember, the most effective proponents do their homework ahead of time!

DAM REMOVAL RESOURCES

- ✓ *Exploring Dam Removal: A Decision-making Guide*
(American Rivers and Trout Unlimited)

- ✓ *Dam Removal Success Stories* report
(American Rivers, Friends of the Earth, and Trout Unlimited)

- ✓ *Paying for Dam Removal: A Guide to Selected Funding Sources*
(American Rivers)

- ✓ *Taking a Second Look: Communities and Dam Removal* (video)
(American Rivers, Trout Unlimited, and others)

- ✓ *The Ecology of Dam Removal: A Summary of the Benefits and Impacts*
(American Rivers)

- ✓ *Permitting Issues Related to Dam Removal*
(American Rivers)

- ✓ *Dam Removal Bibliography*
(American Rivers)

- ✓ *Small Dam Removal: A Review of Potential Economic Benefits*
(Trout Unlimited)

- ✓ *Dam Removal: A Citizen's Guide to Restoring Rivers*
(River Alliance of Wisconsin and Trout Unlimited)

Addressing Public or Individual Concerns

Find out what the community thinks about the idea of removing a dam. For example, conduct a formal or informal survey. If there is already a community buzz about a proposed dam removal – word on the street, letters to the editor – keep a log of who supports and opposes the removal. Keep in mind that sometimes the loudest voices do not represent the majority of residents. Look for motives. And look for the other point of view. Prepare to address each concern that arises with good information and solid data.

Understanding and Documenting Conflicting Uses

In most situations, there are two sides to every issue. If boaters are worried about losing their deep water, there may be other boaters like kayakers who find the dam impeding their recreation. For anglers who favor lake species like largemouth bass, there may be others who would prefer trout or smallmouth bass that would benefit from the removal. If downstream residents are concerned about increased flooding with dam removal, look again at the type of dam. Most small dams do not provide any flood protection at all; rather, they may exacerbate flooding upstream. This information can help educate removal opponents and proponents alike.

Good Hope Dam



Anglers found plenty of fish following removal of Good Hope Dam in 2001.

Property Values

Often community members that have riverfront property express the concern that the loss of a dam and its impoundment will automatically reduce their property values. In truth, there is very little factual information available on this issue to point either way. A study done on this issue over a ten-year period following a removal in Wisconsin shows that property values stayed the same following the removal, although there was a slight decline in property values of homes located several blocks from the impoundment because these residents lost their “lake” view. And remember, while many people would pay more to be on a lake, even an artificial one, many others prefer the sights and sounds of a free-flowing stream and are willing to pay for that, too. Also keep in mind that dam removal may create “new” upland for owners who abut the impoundment area, and the exposure of this land will have economic ramifications as well. For a good discussion of property values and dam removal, see Trout Unlimited’s *Small Dam Removal: A Review of Potential Economic Benefits*.

Mudflats to Mosquitoes – Health and Aesthetic Concerns

Misinformation often rules the day in many communities when it comes to the subject of dam removal. Many residents automatically assume there will be exposed mudflats, virtually no river or stream left, and breeding mosquitoes following a dam removal. Often, the best way to envision how the area impounded by a dam will look once it is removed is to examine the river immediately downstream of the impoundment. Over time, the vegetation, channel width, and water depth of the restored section of river is likely to resemble the stretch of river downstream.

Good Hope Dam



Natural revegetation from buried seedbank and nearby plant colonization often occurs following dam removal on newly exposed lands.

As the river restores itself, there may be an intermediate stage of meandering sediment bars and weedy vegetation, but over time the stream will usually stabilize on its own and the vegetation will mature into trees and woody shrubs. Tree planting can jump-start this process, and, for streams that have serious erosion or other problems, substantial in-stream restoration may be required following the removal to help stabilize the stream. The design contractor should address this need prior to removal.

As for mosquitoes, they favor standing (still) water over moving water. Dam removal turns a stagnant system into a free-flowing system, which works against mosquitoes. Better oxygenated waters following dam removal attract different bugs, which provide food for trout and other riverine species.

Another good way to address aesthetic concerns is to schedule a stream clean-up shortly after the removal. Residents may fear that lower water will expose tires, appliances, or other junk that may have been dumped into the impoundment. A clean-up is a positive and effective way to improve the look of the newly restored stream segment.

Fear of Change

This factor is one of the most important any community grapples with when contemplating a dam removal. Because most people do not like change, there is not a simple way to deal with this issue. However, one thing that can help is to provide the community with a picture or a vision of how the post-removal stream and environs will look. The video *Taking a Second Look* does a good job of showing how various post-removal rivers look. American Rivers, PFBC, and DEP can all provide before-and-after photos of comparable stream systems in Pennsylvania and offer technical assistance in assessing how the post-

removal system will look and function. Another point to consider is that when dams were built, they created major changes to the stream and the community – changes that may not have always been welcomed by the community, again due to a fear of change. Finally, dams have a finite life span; they are not meant to be in place forever.

Finding Allies

It may become obvious quickly who the opponents are of a dam removal. People with a vested interest in keeping the status quo will often fight hard to retain a dam, even if its costs out-weigh its benefits – both economically and ecologically. Those who would benefit from removal may be less vocal, or not yet realize how they would benefit. Finding potential allies and partners in your watershed can significantly help with the removal process. The following groups or organizations may be good places to start:

- watershed associations
- fishing groups, particularly trout, shad, and striped bass enthusiasts
- canoeists and kayakers
- hiking clubs
- bird-watching clubs
- the dam owner, especially if there are safety and liability concerns
- township officials, particularly if there are safety concerns
- high school, college, and university outdoor and ecology clubs

Dam on Octoraro Creek



Dams can be an obstacle to people as well as fish, like these kayakers hung up on a dam on Octoraro Creek.

Public Hearings

If a public hearing is scheduled for a dam removal by a permitting agency such as the DEP or PFBC, it presents a good opportunity to share valuable information and to voice support for a dam removal. Expect some community opposition to the removal – there almost always is someone against this change. Recruit allies to come to the meeting and show support in numbers. If the owner is willing to remove the dam and the permitting agencies are willing to allow the removal, there is not much a community can do to stop the effort short of purchasing the dam and paying for its repair. This opportunity is sometimes offered by DEP, but it is rarely acted on by a community due to the associated costs. Dam purchase and repair is simply too expensive for most residents to afford, and many residents drop their opposition once they are required to pay for a service that was no charge to them in the past. You can request a permitting agency to hold a public hearing, or, as a

community group, you can work with your township or municipality to schedule one yourself. Again, make sure you have done your homework ahead of time, and get some assistance. And remember that even in contentious dam removals, it is important for all community members to have an opportunity share their concerns and have their voices heard.

Key Stages in a Dam Removal Effort

So you have weighed the potential pros and cons of dam removal and want to move forward with determining whether dam removal is appropriate for your river. Below are the key stages that will help guide you through exploring whether or not it makes sense to remove your community's dam and, if so, the key steps to help ensure a successful outcome to dam removal.

KEY AGENCY CONTACTS

COUNTY

PA Association of Conservation Districts; (717) 545-8878 ; www.pacd.org

STATE

PA Department of Environmental Protection - Division of Dam Safety; (717) 787-8568; www.dep.state.pa.us (directLINK "dam safety")

PA Fish and Boat Commission

Scott Carney, Bureau of Fisheries; (814) 355-4837; rscarney@state.pa.us

PA Historical and Museum Commission

(717) 787-3362; inquiries are assigned to staff on the basis of county; www.phmc.state.pa.us

FEDERAL

Federal Energy Regulatory Commission; www.ferc.gov

U.S. Army Corps of Engineers; www.lrp.usace.army.mil

U.S. Fish and Wildlife Service

For permit review information, contact Jennifer Kagel at the FWS Ecological Services office in State College at (814) 234-4090. For information on fish passage, operation of the Susquehanna River hydroelectric dam fish lifts, or American shad, contact Richard St. Pierre in Harrisburg at (717) 705-7838. For information on fish and fish passage in the Delaware River drainage, contact the Delaware River Fisheries Coordinator at (302) 653-9152. www.fws.gov

U.S. Geologic Survey; www.usgs.gov

National Park Service – Rivers, Trails, and Conservation Assistance Program
www.ncrc.nps.gov/programs/rtca

National Oceanic and Atmospheric Administration

For assistance in the Mid-Atlantic Region, contact Rich Takacs at the NOAA Restoration Center in Annapolis, Maryland at (410) 267-5672; rich.takacs@noaa.gov

Coastal Zone Management Act

Administered by the DEP in Pennsylvania, CZMA provides technical assistance and funding assistance for projects within the coastal zone along the Delaware River and Lake Erie. Contact Jim Tabor at the Office for River Basin Cooperation; (717) 772-5626; etabor@state.pa.us

NON-PROFIT ASSISTANCE

TECHNICAL ASSISTANCE

- ➔ **American Rivers;** (717) 232-8355; www.americanrivers.org

RESTORATION

- ➔ **Alliance for the Chesapeake Bay;** (717) 737-8622; www.acb-online.org
- ➔ **Trout Unlimited;** (800) 834-2419; www.tu.org
- ➔ **Chesapeake Bay Foundation;** (717) 234-5550; www.savethebay.org

MONITORING

- ➔ **Consortium for Scientific Assistance to Watersheds;** pa.water.usgs.gov/csaw/
- ➔ **Keystone Watershed Monitoring Network;** (717) 234-7910;
www.pawatersheds.org/kwn.asp
- ➔ **Academy of Natural Resources;** Richard Horwitz; (215) 405-5081
www.acnatsci.org

GENERAL INQUIRIES

- ➔ **Pennsylvania Organization for Watersheds and Rivers;** (717) 234-7910;
www.pawatersheds.org
- ➔ **River Alliance of Wisconsin;** (608) 257-2424;
www.wisconsinrivers.org/index.html
- ➔ **Hydropower Reform Coalition;** (202) 347-7550; www.hydroreform.org

Determine who owns the dam.

If you are not the dam owner or do not know who the dam owner is, there are a few tools available to help you determine ownership. If the dam has a known name or you can pinpoint it on a map (longitude and latitude help, but are not essential) you can check with the DEP - Division of Dam Safety, which keeps records on all regulated dams in the Commonwealth. These records usually list the owner. Another option is to go to your township or city planning and zoning office and look up the dam location on a tax map, which lists lots by owner and size. You can also learn what other owners' properties adjoin the impoundment.

Determine what, if any, ongoing functions the dam provides.

First, consult the files at DEP to see if they contain current information on dam functions. Smaller dams may not be on file at DEP Dam Safety, so you may have to do some sleuthing yourself. If the dam is a mill dam and the mill no longer exists at the site, or if the mill is still

Iron Bridge Dam



This old mill on Conestoga Creek in Lancaster County no longer has a working millwheel.

there but does not have a working millwheel or mill race, the dam is probably not serving any economic purpose. For hydroelectric dams, the Federal Energy Regulatory Commission (FERC) – the agency that regulates non-federal hydropower dams in the U.S. – has information on, among other things, ownership, output generated, and years left on the hydro license. The easiest way to find this information is to contact the Hydropower Reform Coalition.

If there is public access, visit the dam site and talk to nearby residents to determine if there are ongoing recreational uses at the impoundment. The presence of a large pipe or working pump at the impoundment may signal its use as an intake for water supply (or the pipe may be an active sewer or gas line). Look for utility crossings, warning signs, and company signs to indicate use and ownership. As in any situation that involves private ownership, make sure to obtain permission before entering private property.

Contact DEP and/or PFBC for assistance.

Both the DEP Division of Dam Safety and the PFBC have significant experience with dam removals, and they often can save you time and effort by participating directly in the process. Eventually, both agencies will need to be brought in for permitting reasons, so it makes sense to involve them early in the process.

Obtain dam owner's consent for removal.

In Pennsylvania, dam removals do not go forward without a willing landowner. If the owner is not already involved in the removal effort, you may want to seek guidance on this step from the agencies or from a nonprofit group like American Rivers about how to approach a landowner and make the best possible case for removal.

Determine whether removal is the best option.

In Pennsylvania, the dam owner, and ultimately the permitting agencies, have the final say in whether or not a dam can be removed. However, it is important that communities have input into the decision, and find some agreement among themselves as to what the best course of action would be. In many cases, particularly where a dam provides recreational opportunities, some residents may feel they are entitled to the dam's current uses in perpetuity. In other cases, residents may not care, or may not be unanimously opposed to a removal. It is important to take the temperature of the affected community and try to reach some agreement on whether removal is warranted or not. This is not always possible, or easy, but it may help forestall bitter feelings down the road that are likely to occur if affected residents have no say. A good resource for working with a community to reach a consensus on the right course of action regarding a dam is included in *Exploring Dam Removal: A Decision-making Guide* (American Rivers and Trout Unlimited). It helps communities examine the pros and cons of a removal as well as alternatives to removal, including no action. In general, the more accurate information made available to the affected public is, the better the decision will be and the better the long-term sentiments will be about that decision.

Design the removal.

In most cases, it makes sense to hire a contractor with experience in designing dam removals. In Pennsylvania, where more than 60 dams have been removed since 1985,

Irving Mill Dam



State, county and federal permitors review site-specific concerns at Irving Mill Dam on Ridley Creek in Delaware County.

there are a growing number of qualified engineering firms with experience in designing and implementing dam removals. American Rivers, DEP, and PFBC can all provide recommendations for contractors by region. The design effort considers several elements, including technical issues in removing the dam; quantity and quality of the sediments behind the dam; impacts to upstream and downstream infrastructure; condition of the streambanks; and a cost estimate for the removal and any restoration required following removal.

Acquire necessary permits.

Once a landowner has agreed to remove a dam and the engineering design is underway, it is time to think about the permits required. Pennsylvania has one of the most streamlined permits for dam removal in the country. DEP issues the state dam removal permit, which for small dams consists of a free, one-page river restoration waiver form. Other agencies that weigh in on the permit review include PFBC, the Pennsylvania Historical and Museum Commission, and the U.S. Fish and Wildlife Service (FWS). In addition to a state permit, the county conservation district in which the dam is located needs to issue an erosion and sedimentation control permit. If the dam is large, if fill placement will be required during the removal process, or if other complications arise, the U.S. Army Corps of Engineers may require a federal permit as well. In Pennsylvania, DEP Dam Safety staff takes the lead in coordinating all of these reviews and permit requirements. The engineering contractor who does the design should also be familiar with these requirements and should be able to offer assistance. When getting started, call DEP early in the process.

HELPFUL FACT SHEETS

- ➔ **American Rivers – FAQ About Dam Removal**
www.amrivers.org
- ➔ **DEP Fact Sheet – Citizens Volunteer Monitoring Program**
www.dep.state.pa.us
(subject/water management/watershed conservation/watershed support)
- ➔ **PFBC Fact Sheet – Dam Safety and Removal Laws in Pennsylvania**
fmenke@fish.state.pa.us
- ➔ **DEP Fact Sheet – Liability and Responsibility of Dam Owners**
www.dep.state.pa.us (directLINK “Dam Safety”)
- ➔ **DEP Fact Sheet – Dam Inspection by Owners**
www.dep.state.pa.us (directLINK “Dam Safety”)
- ➔ **DEP Fact Sheet – Breaching of Dams in Pennsylvania**
(directLINK “Dam Safety”)
- ➔ **PFBC Fact Sheet – Pennsylvania Fish Commission Stream Easements**
PFBC Real Estate Division; (717) 705-7800

Obtain financing.

Although dam removal is generally the least costly way to address a failing or otherwise unwanted dam, removals still cost money. There are no federal programs explicitly designed to address and pay for dam removal. Options vary state-by-state, and region-by-region. In Pennsylvania, some dam removals have been financed through state Growing Greener

funds. Others are privately financed. Some within the Chesapeake Bay Watershed have been funded through U.S. Environmental Protection Agency (EPA) or U.S. FWS Chesapeake Bay Program funds to aid migratory fish species. American Rivers is a good contact to provide fundraising assistance for small dam removals and has a grant program to assist in funding preliminary design work and dam removal for streams that would benefit migratory fish species. The American Rivers publication *Paying for Dam Removal* cites many additional sources of funding in Pennsylvania and nationwide. PFBC can also provide funding assistance and referrals for small dam removal.

POTENTIAL FUNDING SOURCES

FEDERAL FUNDS

National Fish and Wildlife Foundation

(202) 857-0166; www.nfwf.org/

NOAA Community-Based Restoration Program funds

American Rivers, (202) 347-7550; www.rivergrants/americanrivers.org

STATE FUNDS

PA DEP Growing Greener

(717) 705-5400; www.dep.state.pa.us/growgreen/

OVERVIEW OF FUNDING SOURCES

American Rivers publication *Paying for Dam Removal*

www.amrivers.org/damremovaltoolkit/fundingsourcesdamremoval.htm

Removing the dam.

Remember that one of the most important factors in the success of a dam removal is choosing a good contractor. Consult with the permitting agencies to ensure that the contractor you choose has experience and a good track record in dam removal – not just general restoration activities. Dam removal is a relatively recent practice and can have many pitfalls for inexperienced contractors

Once the owner's consent is obtained, the permits are in hand, funds are raised, and a contractor is hired to do the job, removal can

Manatawney Creek



Construction was scheduled to avoid peak fish migration and spawning seasons at Manatawney Creek in Berks County.

proceed. The removal itself is often a fairly quick process. After months (or even years) of working to remove a small dam, the actual removal usually takes just a few days.

Timing is critical when scheduling a removal. Low-flow periods that occur in late fall usually offer the best conditions for a removal because a dam breach during this time will not send as much water downstream as in high-flow periods. It is also easier to get the large equipment usually required to remove a dam (e.g., a backhoe) into the middle of a stream in shallow water conditions. Timing is also important for the aquatic resources involved; shad and other anadromous fish migrate into Pennsylvania waters between early April and late June. Dams on these anadromous streams and rivers should never be scheduled for removal during this period. Streams with naturally reproducing trout populations should not be worked on during late fall, and work in hatchery-stocked trout streams should be avoided in the spring months. Be sure to check with the PFBC when scheduling a removal.

Conduct post-removal activities.

There are many things a community group or municipality can do following the removal of a dam. Active restoration is not always required, particularly for very small dam removals, but removal can present an opportunity to do exciting and creative work along the river. When an impoundment is drained, it exposes submerged lands and can sometimes make many acres available for restoration. Some dam removals have resulted in new parkland,

soccer fields, bike and hiking trails, forested buffers, and other amenities. Trout Unlimited, River Alliance of Wisconsin, and American Rivers produced a video, *Taking a Second Look: Communities and Dam Removal*, which showcases three dam removals and how each community addressed the sites following removal, which may provide some useful examples of restoration.

Woollen Mills



Submerged lands exposed by a dam removal can have many uses, including parks, trails, and soccer fields.

private landowners can help control the revegetation by planting desirable streambank species. The *Forest Buffer Toolkit* from the Alliance for the Chesapeake Bay is a great resource for community groups to learn about revegetating stream banks effectively and inexpensively. The Pennsylvania Department of Conservation and Natural Resources (DCNR) is another good state resource for information about plants.

Monitoring is another opportunity for community groups to get involved in a removal. Good data on a removal's impacts to water quality, aquatic species, and other parameters are important to document in order to help scientists and agencies make better informed decisions about dams and dam removals. Many good resources exist in Pennsylvania to help groups get started on monitoring or to help them specifically on pre- and post-dam removal monitoring. The most useful

Octoraro Creek



Pre-dam removal monitoring for fish on Octoraro Creek on the Chester/Lancaster County line.

monitoring is that which is done before and after a removal to provide a baseline for comparison. Schedule pre-removal monitoring activities well in advance of the removal, and plan to monitor again at least six months to one year after the removal. As of the writing of this fact pack, POWR and American Rivers are leading the development of pre- and post-dam removal volunteer monitoring protocols. The Keystone Watershed Monitoring Network is a clearinghouse for volunteer monitoring information in Pennsylvania.

When Dam Removal is not an Option

Sometimes removal is not an appropriate option for a particular dam. The dam may be providing a valuable public service, the owner might be unwilling to consider removal, or the majority of the community may be against the removal and may be willing to pay for the dam's continued existence. While complete dam removal is most often the best option in terms of restoring a stretch of river, other benefits, such as passage of migratory fish, can be accomplished even if the dam is left in place. The following are a couple of different ways to address fish passage when a dam cannot be removed.

Partial Breaches or Notching

A partial breach or notching is sometimes recommended by engineers when removing the entire dam is not feasible. A dam can be integrated structurally into another building – either a mill or an adjacent structure – and its removal could undermine the safety of the adjacent structure. Or, as is the case with a number of dams in Pennsylvania and neighboring New Jersey, a dam is connected to an historic canal wall or similar structure. A partial breach allows part of the dam to be removed while some segment remains. A notch is simply a chunk cut out of the top of a dam, usually in the center section, to allow a portion of the dam through which fish can move. For very small dams, about one to

three feet in height, notching can be a good compromise. Notches can impact the height of the impoundment behind the dam, but obviously not as much as a complete removal or a breach.

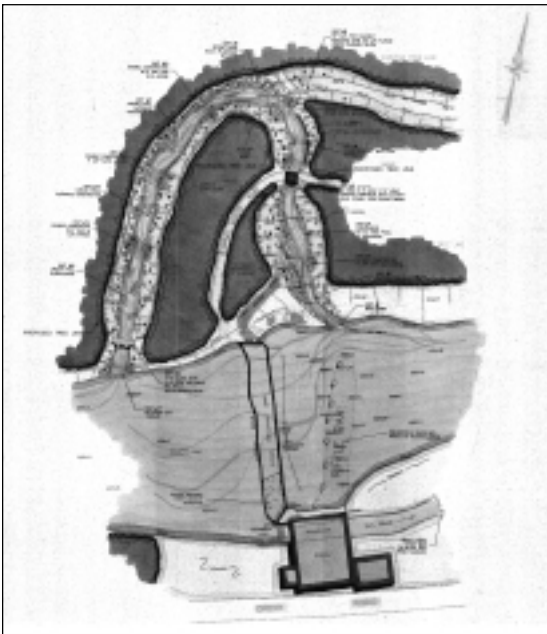
Good engineering is essential to ensure that the remaining dam is structurally sound and safe and that the “hole” created by the breach or notch is large enough to pass fish as well as large enough to not present a safety hazard for boaters. For a community that wants some tangible evidence of the presence of a dam to remain, a partial breach or notch with an historic marker on the remaining segment is sometimes a worthwhile compromise.

However, poorly engineered breaches and notches can create a hydraulic block to fish, where the water flowing through the breach is so strong that most fish species cannot swim through it. While breaching and notching do not provide as complete river restoration as does full dam removal, they can present a good hybrid solution.

Bypass Channels

Sometimes known as “nature-like” fishways, these bypass channels are a new technology in the United States. The first bypass channel proposed for Pennsylvania – one of the first in the U.S. – is to move shad around a historic mill dam on Conodoguinet Creek in southcentral Pennsylvania. A bypass is a small side channel that starts at the base of a dam and travels at a gradual slope until it eventually reconnects to the main stream channel

Heishman Design



This design of a bypass channel will allow American shad and other migratory fish to swim around the dam to reach upstream spawning habitat.

Heishman's Mill Dam



The owner of this mill and low-head dam wants the dam to remain in place, so partners are designing a bypass channel to take fish around the dam.

above the dam. With a control structure at the upstream entrance to regulate the volume of water that flows through it, bypass channels can be designed to allow shad and other species to migrate around the dam. The benefit of a bypass channel is that it can accommodate more than one species, allowing even local aquatic species such as crayfish to migrate up and down the stream. It, too, requires monitoring and maintenance and is not practical for every setting, particularly when there is

development along the banks or where there is no room to dig a new channel. Because bypass channels are a relatively new technology, cost comparisons with fish ladders are not yet known.

Rock Ramps and Rock Veins

Rock ramps and rock veins are a technique involving the regrading of a stream bottom gradually up to the downstream face of the dam to allow fish to swim up and over the dam. For very small dams or partially submerged pipes that block fish from migrating, rock ramps can be successful at passing fish. They also require monitoring and maintenance and can be expensive.

Fish Ladders and Lifts

Fish ladders and lifts have been used extensively in Pennsylvania to allow the migration of American shad and other target migratory species to reach their upstream spawning habitat. Two common types of fish ladders are the Denil fishway, a large concrete box affixed to dams that guide shad through a series of baffles up and over the dam, and an Alaskan Steppass ladder, a smaller and less expensive structure that is designed to pass shad and river herring. While the Denil is

Carlisle Waterworks



This fish ladder, under construction at the Carlisle Waterworks in Cumberland County, will enable shad to move through a series of "baffles" up and over the dam.

documented as successful in passing shad over dams, it is expensive – usually about \$250,000 per ladder – and requires ongoing maintenance and monitoring. It also does not help other species migrate as successfully as shad. The steppass is successful on smaller streams but, again, only allows the passage of certain target species. Good resources on steppass and Denil ladders in Pennsylvania include PFBC and FWS. Fish lifts tend to be very large, expensive structures designed to literally lift hundreds of fish at one time up and over a dam in a lift or elevator. These structures are in place on all four of the mainstem Susquehanna hydroelectric dams and have helped pave the way for the recovery of American shad runs in Pennsylvania. They cost many millions of dollars and are not practical for small dams.



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