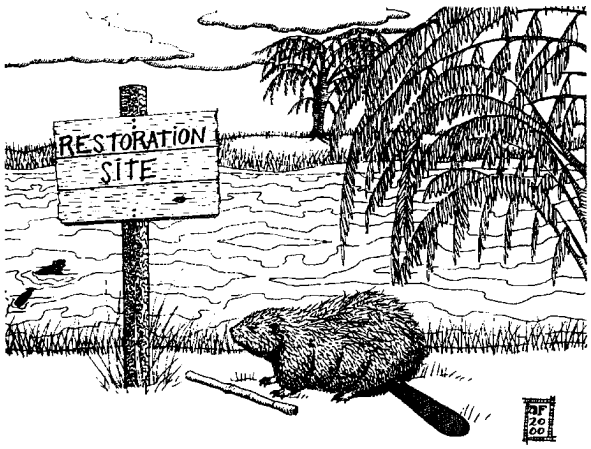
Control of Beaver Flooding at Restoration Projects

PURPOSE: This technical note describes alternatives to control undesirable flooding caused by beavers at wetland restoration projects.



BACKGROUND: Beaver dams are a natural part of the North American landscape, and in some situations beavers have been deliberately re-introduced to augment the restoration process. In other cases, however, beaver damming can cause flooding that is detrimental to restoration project objectives. This unwanted flooding caused by beavers can often be prevented or controlled by structures designed to: 1) prevent the damming of water control structures, spillways, and road culverts, 2) regulate water levels upstream of a beaver dam, and 3) both prevent damming and regulate water levels. This technical note describes various alternatives that can be applied separately or in combination to accomplish these objectives.

EXCLUSION SYSTEMS TO BLOCK DAMMING OF WATER CONTROL STRUCTURES, SPILLWAYS, AND CULVERTS: Grills, grates, and small mesh devices are often installed to protect the upstream openings of culverts: however, they usually require frequent cleaning since they are easily dammed by beavers (D'Eon 1995). The options described below generally provide more effective, lower maintenance alternatives.

Beaver Deceiver. A beaver deceiver (Figure 1) is a fence that discourages damming due to its unnatural shape and large perimeter (Lisle 1999). Deceivers are usually trapezoidal, but may be pentagonal or form long rectangles at narrow flowages. Fences are constructed of braced cedar posts and 6-gauge, wide mesh fencing. Although heavy-duty metal posts could also be used, wooden posts appear to be more resistant to ice damage and vandalism. The bottom of the fence should fit tightly against the streambed. If a deceiver is built in a flowage with a soft or uneven bottom, beavers can be discouraged from digging underneath by placing strips of fencing secured with concrete blocks in an "L" pattern, facing outward around the perimeter.

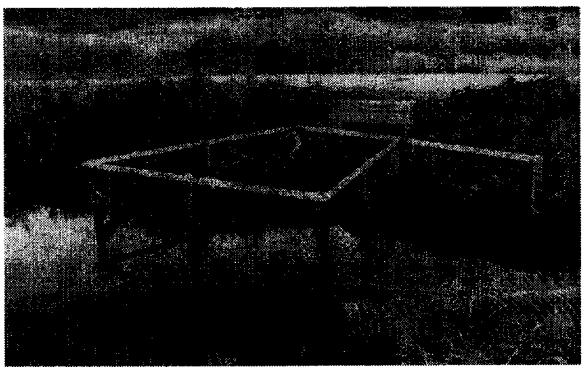


Figure 1. Beaver Deceiver

Figure 2. Pre-dam installed at culvert intake

Pre-dam. Pre-dams (Figure 2) are short semicircular, circular, or rectangular fences that divert the beavers' attention away from an inlet water control box, an overflow, or a culvert to the fence (Brown and Brown 1999). These devices are also called beaver fences, deepwater fences, and diversion dams. Unlike beaver deceivers, which function by preventing damming, pre-dams are intended to be dammed.

Pre-dams are constructed of heavy gauge 5- or 6-in. square wire mesh, supported by steel fence posts. Six-inch mesh concrete reinforcement wire is often used, because it is readily available in 100-ft-long, 5-ft-wide rolls, or 5- by 10-ft sheets, and the larger mesh size allows for less obstruction of water flow and debris accumulation than 5-in. mesh. An occasional beaver, however, will become stuck in the 6-inch mesh; beaver entrapment is less apt to occur with the smaller mesh. The fence should extend about 2 ft above the water level or a cover should be added to discourage climbing beavers. To further protect the water control structure, beaver sticks and other debris can be placed against the fence to encourage the beavers to dam the fence instead of the water control structure. For culvert installations, a minimum radius of 7 ft is recommended for an 18-in. culvert with a correspondingly larger radius for a larger culvert. At sites that are adjacent to high traffic roads or have steep banks, it is advisable to leave a 10- to 12-in. opening, or similarly sized passageway along a 5-ft-long "wing" at one side of a pre-dam or beaver deceiver to allow wildlife passage.

If the level of backed-up water is not important, no additional work is needed except for periodic maintenance checks. More often, however, pre-dams are used in combination with drain pipes in order to control water levels upstream.

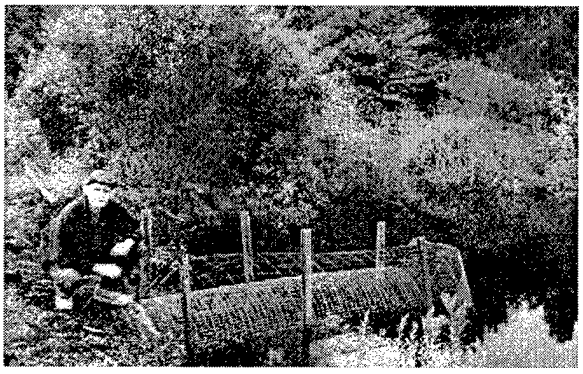


Figure 3. Beaver baffler

Beaver Baffler. A beaver baffler (Figure 3) is an inexpensive cylindrical flow device constructed from multiple layers of wide mesh wire. This system excludes beavers from a culvert opening or dam breach while allowing free flow of water (Brown and Brown 1999). The likelihood of beaver clogging is reduced by spreading the water intake over a large area. A basic baffler consists of two 15-ft-long, concentric cylinders of concrete reinforcing wire, including an inner cylinder that fits inside the culvert and an outer cylinder that is a foot larger in diameter. Bafflers for culverts of 4-ft-diameter or larger require additional support, such as hoops of 3/8-in. concrete rebar, or 3/4-in. PVC flexible plastic pipe inside the outer cylinder at 4-ft intervals. Bafflers are built in 5-ft sections using form wire or pig rings to hold each cylinder together, and the sections are connected onsite.

In areas where snowplowing can flatten the baffler's culvert end, the 5-ft section of the inner cylinder at the culvert is covered with 1- by 2-in. mesh fencing to prevent beavers from stuffing the inner tube with debris. Three feet of clearance is preferable below the baffler to the streambed.

For culverts of different diameters, the length of 5-ft-wide concrete reinforcing wire and light wire fencing needed can be calculated as follows: $C = 3.14 \times D$, where C (circumference) is the amount needed to make each 5-ft-long cylindrical section, and D is the diameter of the cylinder needed.

Similar devices are also available ready-made. For example, a Beaver Stop is constructed of heavy gauge, durable wire and provides protection for both culvert inlets and outlets.

Culvert Outlet Installations. Protecting the downstream outlet of culverts is essential for the long-term success of an installation. Otherwise, beavers will eventually enter the culvert outlet and dam inside it. It is desirable to exclude beavers from culverts, because removing a dam from within a culvert can be difficult and dangerous. Caution is also advised when removing a dam in front of a culvert.

Such dams can be prevented by installing 5-in. mesh wire fencing that is held in place with two fence posts at culvert outlets. A 10- to 12-in. opening should be left for wildlife passage in high-traffic areas or at road embankments with steep slopes. Dam boards may also be installed at culvert outlets to control the water level upstream and to preserve part of the upstream wetland (Figure 4). A 2-in.-thick board can be secured to the outlet of a small culvert with fence posts, or a sheet of plywood can be used at the outlet of larger culverts. Dam boards are removed during flood periods or at important fish migration times. The boards also quiet the noisy flow through metal culverts that can stimulate beaver activity.

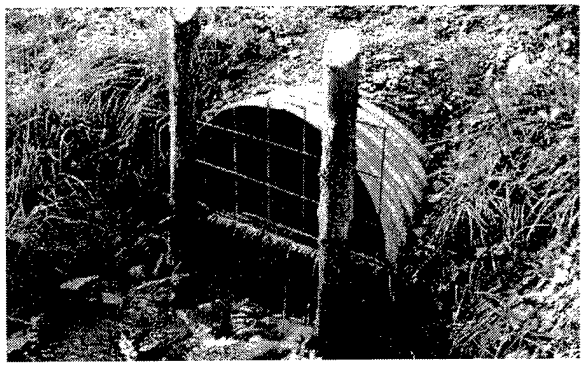


Figure 4. Dam board on culvert outlet

PIPE SYSTEMS DESIGNED TO REGULATE WATER LEVELS

PVC Drain Pipes. Drain pipe systems may be installed at culvert openings, concrete water control inlets, or within beaver dams to regulate upstream water levels. An estimate of the size of the drainage basin is useful in determining the number and size of pipes required. The upstream water level will be determined by the highest point of the pipe. PVC pipes are desirable because beavers will not damage them by gnawing. Solid or perforated PVC pipes or black corrugated polyethylene (flex) pipes can be used. White PVC pipes can be sanded and painted with splotches of black paint prior to installation in order to make them less conspicuous (Lisle 1999), both for aesthetic reasons and to decrease possible vandalism. Wide spacing of pipes at their intakes is used for the same reasons and also helps to discourage beaver damming. Corrugated metal pipes may cause problems, because the noisy water flow through them stimulates beaver damming activity.

Perforated PVC pipes may be inserted through the notched riser boards of an inlet concrete control box. This method was used at a restored wetland at the Patuxent Research Refuge in Laurel, Maryland. H-shaped supports for pipes can be made of two metal fence posts with two shorter metal lengths wired above and below the pipe to secure it. Since PVC cement can deteriorate in flowages, 10-ft pipe sections should be connected with shingle nails or screws. Cutting 2- by 6-in. slots, using every other hole, in a 10-ft section that will be upstream will improve the flow in a 20-ft PVC perforated pipe.

Some form of protection at the intake will be necessary to prevent beaver clogging. Perforated pipes can be capped at the intake or a protective 3-ft-diam roll of 5- or 6-in. mesh fencing, closed at the upstream end, can be added to prevent blockages (see "A Step by Step Guide to Solving Beaver Problems" (The Fund for Animals 1999)). Elbows can be added to both ends of non-perforated pipes. Pipes should be slanted slightly downward from the control box or culvert to ensure that their inlets are underwater. This reduces the sound of flowing water that can stimulate damming. At least 3 ft of clearance from a pipe to the pond bottom is preferable, especially if the substrate is soft. Pipes can be cleaned with a telescoping rod of the type used to clean chimneys.

Figure 5. Clemson leveler intake pipe

Clemson Beaver Pond Leveler. A Clemson leveler intake (Figure 5) is a section of perforated drain pipe that is protected by a cylindrical wire cage to prevent beaver clogging. This device is a well-proven, low-maintenance apparatus for the control of beaver flooding. Ducks Unlimited Canada has installed 95 Clemson levelers at restored marshes and dams in the Atlantic region since 1992, and none have been plugged by beavers.

Levelers can be ordered ready-made, or built from plans. The standard Clemson leveler is constructed with a 10-in. inlet and an 8-in. outlet pipe. If a larger drainage capacity is needed, levelers can be built with larger diameter pipes, a few levelers can be used in combination, or alternatives without pipes, such as a beaver deceiver or a beaver baffler can be installed.

A Clemson leveler intake can be attached directly to a conduit that penetrates a dike, or the riser boards of a concrete control box may be notched to receive the Clemson leveler intake. Water levels can be further regulated by adding a standpipe to the leveler pipeline, either within a concrete control box, or at the pipe outlet downstream of the dike. A standpipe can be attached via a lubricated elbow that can be tilted, or different lengths of standpipes can be used to control the water level upstream. An exposed standpipe should be rocked to prevent scour around the bottom. It is also advisable to construct a 15- to 20-ft-long emergency spillway with the lowest end about 3 in. higher than the top of the leveler's standpipe.

Wooden Pipes. Long, rectangular wooden pipes have been installed in dams for many years to control water levels in beaver wetlands (Laramie 1985). The pipes are constructed with 1- by 12-in. boards on three sides and coarse mesh on the bottom (Figure 6). The pipes are built in 12-ft sections, and are best assembled on site, since they are heavy. Although wooden pipes may be more aesthetically pleasing than PVC pipes, they can be damaged by beaver gnawing. To discourage this, the downstream ends can be buried in the dam during installation. Small mesh wire fencing can also be applied for protection. It is recommended that the pipes be checked monthly.

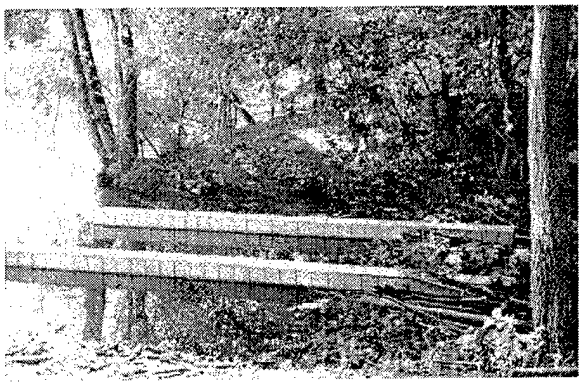


Figure 6. Wooden pipes installed in a beaver dam

COMBINATION SYSTEMS: Pipe and fence systems are often installed in combination to prevent beavers from damming an overflow and to regulate the water level upstream.

If a single pipe is used, it is placed in the fence where the depth of the flowage is greatest, and it is secured at the desired water level. The highest point in the pipe determines the upstream water level. Pipe lengths can be connected with a PVC elbow to fit a curved flowage, and several pipes can be spaced over a pre-dam to discourage beaver plugging. When PVC pipes are added to a pre-dam, the system is called an "exclosure" (see "Outwitting Maine's Busy Beavers" (Maine Department of Inland Fisheries and Wildlife 1995)).

A variation of this method has been used at Canada's Gatineau Park for many years. To prevent road culverts from being blocked and to control water levels, completely enclosed triangular cages (Figure 7) are used as part of a fence and pipe system. The cages are constructed of galvanized 5-in.-square wire mesh on a 5-ft-high galvanized metal frame. Circular or rectangular cages can also be used, although less debris accumulates with the triangular shape. Corrugated polyethylene (flex) pipes have been found to be preferable over PVC pipes. Although flex pipes over 6 in. in diameter may float, they can be perforated at the top along their length to let air escape and then wired to concrete blocks (use two concrete blocks per 20-ft length) or fence posts to keep them underwater. This gives a more aesthetic installation and provides protection from ice movements. Flex pipes should be buried in dams to discourage gnawing, or they can be wrapped with welded, galvanized, small mesh fencing. Unlike PVC pipes that end at the dam, flex pipes should extend several feet over the dam for best results.

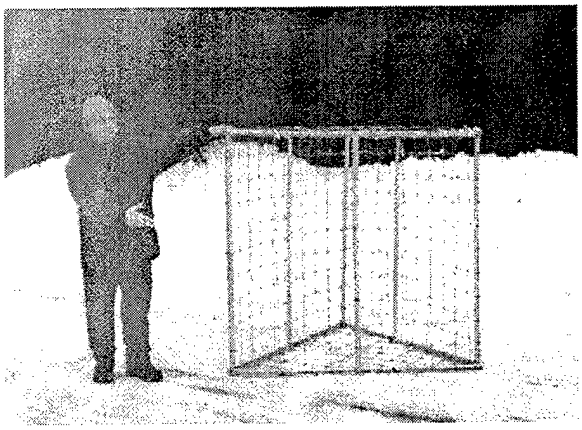


Figure 7. Triangular cage used as part of a fence and pipe system at Gatineau Park

This cage and pipe system works well even when the water depth is shallow, since additional flex pipe lengths can be added in order to place the cage in water that is at least 3 ft deep. As further insurance at problem sites, a 5-ft-long, one-layer cylinder of wide mesh fencing can be inserted partway into the culvert. The upstream end of the roll is closed with more mesh and secured with fence posts. Such rolls are removed prior to freeze-up in areas subject to ice damage and reinstalled in the spring.

APPLICABILITY: The methods described above may be installed at water control structures, culverts, spillways, and within beaver dams themselves. Although most of these techniques may be applied in a variety of situations, some methods are more suitable than others for a particular application. This section provides some suggestions for the installation and use of these techniques. Additional information may be obtained from the sources listed in Table 1, as well as those citations listed in the references.

Water control structures built within a dike are sometimes used to manipulate water levels in wetland restoration projects. For all dikes, a 3 to 1 slope and fencing or large riprap placed on the upstream slope discourage burrowing by beavers and other semi-aquatic mammals. Anti-seep collars, which can protect the pipelines of both inlet and in-line water control structures from washing out, are available ready-made, or can be constructed from a 3/4-in. plywood sheet.

Types of water control structures commonly used to control water levels in wetland restoration projects include concrete boxes with riser boards, PVC structures with PVC stop logs, and conduits that pass through dikes. These types of structures can be protected from damming with a Clemson leveler, a pre-dam, or a pipe and fence system. As an example, a pipe and fence system was installed at the Patane-Simpson wetland restoration in Canastota, New York, to protect a PVC inlet control structure. Options to protect the conduit intake for an inline structure include a pre-dam, a cage to protect the inlet, or a Clemson leveler intake. Pre-dams, beaver deceivers, and beaver bafflers are widely used to protect the openings of culverts and spillways.

Table 1
Sources of Additional Information on Control of Beaver Flooding

Ready-made water level control devices:

Beaver Stop. (Literature and video available), Canada Culvert, P.O. Box 39, Bolton, Ontario, Canada ONL7E 5T1, phone: 1-800-565-1152.

Clemson Beaver Pond Leveler. (Four-page description and order form), MINNCOR Industries, 1450 Energy Park Dr., Suite 48LL, St. Paul, MN 55108-5219, phone: 1-800-646-6267.

Inlet and Inline Water Level Control Structures. Agri Drain Corp., P.O. Box 458, Adair, IA 50002, phone: 1-800-232-4742

Videos:

"Outwitting Maine's Busy Beavers." (1995). Maine Dept. of Inland Fisheries and Wildlife, Public Information Div., 284 State St., State House Station 41, Augusta, ME 043333, phone: 207-287-5244.

"The Beaver Pond Leveler." (1991). Clemson University Communications Center, 83 Poole Agricultural Center, Clemson, S.C. 29634, phone: 864-656-5134.

"A Step by Step Guide to Solving Beaver Problems." (1999). The Fund for Animals, 850 Sligo Ave., Suite LL2, Silver Springs, MD 20910, phone: 888-405-FUND.

Sometimes it may be desirable to install a water level control device within the beaver dam itself. A Clemson leveler, a beaver baffler or Beaver Stop, or a pipe system with a protected inlet, can be installed in beaver dams to control upstream water levels. Longer lengths, however, may be required in dam installations as compared to pre-dams. For example, two or three 20-ft lengths of flex pipe are often needed for a dam pipe and triangular cage installation.

This approach will necessitate breaching the dam in order to complete the installation. A potato hook, four-prong cultivator, or the fire-fighting tool called a pulaski, can be used to breach the dam. For a single pipe installation, place the pipe where the water depth upstream is greatest, and consider that the highest point in the pipe will determine the water level. If two or more pipes are needed in a wide flowage, they can be spaced along the dam to discourage beaver damming. Once a pipe is installed it can be advisable to plug the outlet until the beavers dam over the pipe. Then remove the plug.

Since beavers are nocturnal, breaching a dam in the early morning may allow time for the flow to subside before installing pipes. If the impoundment is very large, it may take more than a day for the water level to stabilize. As a temporary measure to prevent beavers from repairing the dam, a single strand of electric fencing can be strung about 4 in. above water level across the opening, or attached to a floating board frame. The battery pack power source can be locked in a box to prevent vandalism.

At larger impoundments, the dam breaking could cause problems with excessive silt and flooding downstream as well as a loss of other wetland benefits. Therefore, it may sometimes be desirable to stabilize a beaver dam. This can be done by driving fence posts through the dam, planting vegetation on it, and bringing branches and other dam construction materials to the site for the beavers to utilize. When a dam must be breached, waiting until mid to late summer, when water levels are generally lower, can help prevent large pulses of silt and other debris.

POINTS OF CONTACT: For additional information, contact the program manager of the Wetlands Regulatory Assistance Program, Dr. Russell F. Theriot (601)-634-2733, *Russell.F.Theriot@erdc.usace.army.mil*). This technical note should be cited as follows:

> Brown, S., Shafer, D., and Anderson, S. (2001). "Control of beaver flooding at restoration projects," *WRAP Technical Notes Collection* (ERDC TN-WRAP-01-01), U.S. Army Engineer Research and Development Center, Vicksburg, MS. *www.wes.army.mil/el/wrap*

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D'Eon, R., et al. (1995). *The Beaver Handbook: A Guide to Understanding and Coping with Beaver Activity*, Northeast Science & Technology Field Guide FG-006, NEST, Timmins, Ontario, Canada.

Laramie, H. (1985). *Beavers and Their Control* (wooden pipe information, reprinted in 1997), The Univ. of New Hampshire Cooperative Extension Forestry Information Center, 131 Main St., Nesmith Hall, Durham, NH 03824-3597, phone: 603-862-4861.

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