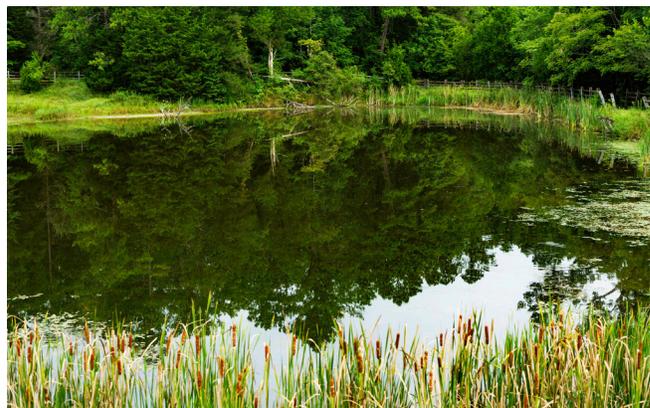


# Pond Building: A Guide to Planning, Constructing & Maintaining Recreational Ponds

► A properly located, well-constructed pond can be a beautiful addition to a landscape. Ponds provide owners with excellent recreational activities such as fishing, swimming, and wildlife viewing as well as potential water sources for livestock watering, irrigation, geothermal home heating/cooling, and firefighting.

The purpose of this document is to provide prospective pond owners with the basic information needed to understand the process involved in establishing and maintaining a quality pond (figure 1). The information is intended to enable landowners to avoid costly mistakes, to communicate more effectively with pond contractors, and to be successful at building and maintaining the best possible pond.



**Pond Construction Process**

**Selecting a Pond Site**

- Safety Considerations
- Soils
- Geology and Topography
- Water Sources
- Wetland Restrictions

**Landscape Planning**

- Type of Pond
- Pond Size and Design
- Water Control Structures

**Pond Construction**

- Permits and Site Survey
- Hiring a Contractor
- Site Preparation

**Establishing Vegetation**

**Pond Maintenance**

Figure 1. The pond construction process.



## Selecting a Pond Site

The process of choosing a pond site is at least as important, if not more so, than the actual construction process. Selecting a pond site involves more than arbitrarily deciding to “put it over yonder,” just as building a pond involves more than just “digging a hole.” Unfortunately, many sites are not suitable for ponds. Minor problems may be correctable at some sites; other sites are doomed for failure no matter how well the pond is constructed. To have a reasonable chance of a good pond, the prospective pond owner should be aware of the basic criteria necessary for a site to be suitable for pond construction. These criteria include the safety of the location, the water-holding capacity of the soil in the pond, the geologic makeup and topography of the site, and the characteristics of the watershed or drainage area.

## Pond Safety

During the planning stages, do not overlook the possibility of dam failure and the resulting damage from the sudden release of water. If possible, do not locate your pond where failure of the dam could cause loss of life; injury to people or livestock; damage to residences, industrial buildings, railroads, or highways; or interrupted use of public utilities. If the only suitable pond site presents one or more of these hazards, hire an engineer experienced in pond design to reduce the possibility of failure from improper design or construction.

Be sure that no buried pipelines or cables cross the proposed pond site. They could be broken or punctured by the excavating equipment, which can result not only in damage to the utility but also in injury to the operator of the equipment. If it is necessary to use a site crossed by pipelines or cable, you must notify the utility company before starting construction and obtain permission to dig. Before beginning any construction, it is always wise to contact the local utilities and appropriate government offices to determine if any underground lines or pipes cross the site. This will also reduce the chance that the pond might violate right-of-way agreements. Avoid sites under power lines. The wires may be within reach of a fishing rod held by someone fishing on the pond.

Ponds, like any body of water, attract people so there is always a chance of injury or drowning. No matter what the purpose of the pond, you can never tell what a small child passing by might do. While individual states or local governments may not have laws governing the design, construction, or operation of a pond, you may be liable in the case of injury or death resulting from use of your pond whether you authorized such use or not. This is particularly important if you intend to open your pond to the public and charge a fee for its use. You may realize that you will need to protect yourself with liability insurance coverage.

If the pond is to be used for swimming, guards must be installed over pipe openings. All undesirable trees, stumps, brush, rubbish, junk, and fences that might be hazardous to boats or swimmers should be removed. Mark safe swimming areas, and place warning signs at all danger points. Lifesaving devices should be properly located to facilitate rescue operations should the need arise.

## Soils in the Pond

The composition of soils in Alabama is highly variable. Soils range from almost pure sands in the Coastal Plain to heavy clays in the Black Belt. Variation in soil texture can vary with depth and can change drastically over short distances. The suitability of a pond site depends on the ability of the soils in the reservoir area to hold water. The soil should contain a layer that is impervious and thick enough (usually a 2-foot minimum) to prevent excessive seepage. Soils made of clay or silty clay are excellent for ponds; sandy clays are usually satisfactory. Coarse-textured sands and sand-gravel mixtures do not hold water well and are unsuitable for ponds.

If there is poor soil over a portion of the pond bottom, you can sometimes make it impervious by importing and compacting a good-quality clay soil or by incorporating bentonite clay into the pond bottom. However, sealing pond bottoms can be very expensive (see **Leaky Ponds**). If soils are determined to be questionable, choosing a secondary pond site with good soils may be the best alternative.

The soil profile under the proposed dam is also very important to the ultimate success of the water-holding ability of the pond. Over time, the ponded water can seep beneath the constructed dam. Therefore, the dam and its foundation must be sealed with impervious soil material to prevent seepage beneath the dam (see **Cutoff Trench and Dam Core**).

### Tip to Remember

The importance of careful site selection and proper construction cannot be overemphasized as means of keeping seepage losses to a minimum. Cutting corners in these areas will often come back to haunt the pond owner. The use of after-the-fact seepage reduction methods ranks as only a distant second choice when compared to doing it right the first time.

## Geology

Some areas with limestone deposits, such as the Tennessee Valley and Wiregrass region of Alabama, are especially problematic as pond sites. There may be invisible crevices, sinkholes, or caverns in the limestone below the surface soil. Building in these sites may result in a badly leaking pond. In addition, many soils in these areas are granular and remain highly permeable even when wet. Pond sites in limestone areas should be thoroughly investigated using both geologic and laboratory analyses before the construction of a pond is planned. Although there are no guarantees, a good indication of the suitability of a pond site in one of these areas (or any area) is the degree of success others in the immediate vicinity have had with farm ponds.

## Topography

The topography, or lay of the land, determines the ultimate construction cost of the pond more than any other single factor. For economic reasons, try to locate the pond where the largest storage volume can be obtained with the least amount of earth fill for a dam.

A good site is usually one where a dam can be built between two ridges crossing a narrow section of a valley that is immediately downstream of a broad section of valley. This permits a large area to be flooded. Such sites also minimize the area of shallow water in the pond, which can be undesirable.

People inexperienced in pond design and construction sometimes think that ponds are always excavated to store water. In reality, excavated ponds are the most expensive to construct per volume of water stored. Therefore, always consider a site where the water is stored above ground behind a small earthen dam.

## **Watershed/Drainage Area**

For ponds in which surface runoff is the main source of water, the contributing drainage area, or watershed, must be large enough to fill and maintain adequate water in the pond during droughts. However, the drainage area should not be so large that expensive overflow structures are needed to bypass excess runoff during storms.

Some characteristics of a watershed that directly affect the yield of water are the slope of the land, soil infiltration, and plant cover. These interrelated factors are variable and site specific. There are no set rules for determining the exact size watershed needed to fill and maintain a given size pond. However, there are some rules of thumb that can be used. For example, some watersheds containing mostly pasture with heavy clay soils may need only 5 acres of land while a sandy watershed in a wooded area may need 30 acres or more of land to contribute runoff for each surface acre of ponded water. A good rule of thumb is to have about 15 acres of watershed for every pond surface acre.

If the drainage area is too small in relation to the pond size, the pond may not adequately fill, or the water level may drop too low during extended periods of hot, dry weather. Shallow water contributes to excessive aquatic weed problems and potentially to fish kills from low dissolved oxygen when average depth is less than 3 feet.

Ponds with excessive drainage areas can be difficult to manage for fish production. They tend to be muddy, silt-in rapidly, and have erosion problems in the spillway area. Runoff from oversized drainage areas can flush out the nutrients and much of the microscopic plant and animal life (the plankton) that form the base of the food chain for fish, thus lowering pond productivity. Fish,

particularly grass carp if present, may also leave the pond during overflow from heavy rains. Contamination of ponds with wild fish from either upstream or downstream sources is more likely when watershed size is excessive.

To avoid potential pollution of pond water, select a location where drainage from farmsteads, feedlots, sewage lines, dumps, industrial and urban sites, and other similar areas does not reach the pond.

For the planned depth and capacity of a pond to be maintained, the inflow must be reasonably free of silt from an eroding watershed. The best protection is adequate erosion control on the contributing drainage area. Land under permanent cover of trees or grasses is the most desirable drainage area. If such land is not available, treat the watershed with proper conservation practices to control erosion before constructing the pond.

## **Water Sources and Quality**

The three sources of water for filling ponds are rainfall runoff, groundwater, and surface water, each of which has advantages and disadvantages.

### **Rainfall Runoff**

The primary source of water for embankment ponds is rainfall runoff from the drainage or watershed area surrounding the pond. Rainfall runoff can be an excellent free source of water, depending on the physical and chemical characteristics of the watershed. The best runoff water source for ponds is a watershed containing undisturbed, well-vegetated cover such as timberland or grassland. Avoid unvegetated watersheds because of the potential for excessive muddiness and premature siltation of the pond. Watersheds containing concentrated livestock feeding areas or overfertilized pastures can result in problems due to excessive nutrients and other contaminants entering the pond. Watersheds with cropland receiving regular pesticide applications are of concern because of the potential for pond contamination from runoff or spray drift. Ponds receiving runoff from cropland should have a good buffer zone of grass or sod between the cropland and the pond to serve as a filter for potential soil erosion and pesticide runoff.

### **Groundwater**

Groundwater pumped from wells, where available, can serve as either a primary water source for a levee or excavated pond or as a supplementary source to ponds with inadequate watersheds or excessive seepage.

Advantages of well water include the absence of wild fish and, generally, good water quality. Disadvantages include construction cost and maintenance, potential inadequate water yield, and pumping costs.

## Surface Water

Surface water from nearby springs, streams, rivers, or reservoirs that have good water quality can be used as a pond water source. Water pumped from these sources should be filtered to remove wild fish, fish eggs, and larvae. However, it is difficult to prevent wild fish from contaminating a pond that is supplied by surface water. Withdrawal of water from a public source such as a permanent stream or reservoir may require a permit, and the amount of water may be limited depending on state or federal regulations.

## Wetland Restrictions

Potential pond sites in Alabama will sometimes include land areas classified as wetlands. Wetlands include marshes, swamps, and shallow areas that pool water seasonally and support wetland-type plants, such as bulrush, cattails, cypress trees, and other plants associated with wet soils. Wetlands are among the most biologically productive natural ecosystems in the world. They provide many benefits including food and habitat for fish and wildlife, flood protection, natural products for human use, water quality improvement, and opportunities for recreation, education, and research.

If wetlands are present on a pond site, they must be identified before beginning construction of the pond. Federal wetland provisions under the Clean Water Act and the no-net-loss of wetlands policy do apply to private landowners who are considering constructing ponds in areas considered to be wetlands. Always check with the U. S. Army Corps of Engineers (USACE) or the USDA Natural Resources Conservation Service (NRCS) before construction to determine which specific law or regulation may apply to you. In some cases, it may be necessary to obtain a permit or additional planning assistance.

If wetlands are present (depending on the assessment by the USACE), locating an alternative pond site without significant wetlands may be the best alternative. That way, paperwork, cost of mitigation, and possible litigation can be avoided. Most importantly, the wetland and its benefits to the environment will be preserved.

## Landscape Planning

Water adds variety to a landscape and further enhances its quality. Reflections in water attract the eye and help create contrast or a focal point in the landscape. A pond visible from a home, patio, or entrance road increases the attractiveness of the landscape and often improves land value. Good landscape design techniques include consideration of size, site visibility, relationship to the surrounding landscape and use patterns, and shoreline configuration.

Where possible, locate the pond (or the house) so that the major sight line crosses the longest dimension of water surface. The pond should be placed so that a viewer will see the water first before noticing the dam, pipe inlet, or spillway. Often, minor changes in the dam alignment and spillway location can shift these elements out of view and reduce their prominence.

When feasible, locate the pond so that some existing trees and shrubs remain along part of the shoreline. Shoreline trees and shrubs add interest by casting reflections on the water, providing shade on summer days, and helping blend the pond into the surrounding landscape. A pond completely surrounded by trees, however, will appear smaller than a pond the same size without trees or with few trees. Ponds constructed in woods should have the cleared limits irregularly shaped to provide a natural-appearing edge and open area. Further transition with vegetated surroundings can be accomplished by feathering clearing edges. Density and height of vegetation can be increased progressively from the water's edge to the undisturbed vegetation. The shape of a pond should complement its surroundings. Irregular shapes with smooth, flowing shorelines are generally more compatible with the lines of countryside landscape.

## Types of Ponds

### Embankment Ponds

The most common type of pond in Alabama is the embankment pond, also called watershed pond or hill pond (figure 2). A watershed is the drainage area around the pond within which rainfall drains toward the pond. A dam or embankment is constructed in a depression between two hills and serves to impound water in a basin area on the upstream side of the dam. This type of pond is best suited for areas with slightly to moderately rolling topography.

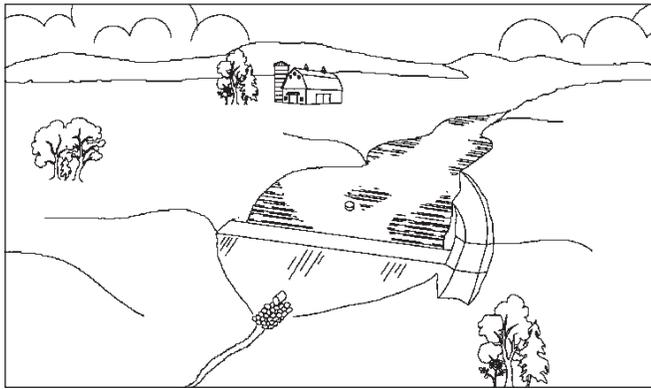


Figure 2. Embankment pond (not to scale).

Embankment ponds usually depend on rainfall runoff to fill and then maintain water levels. Pond size, shape, and depth are limited by the topography of the site and the size of the watershed draining to the pond. Generally, the steeper the slope of the pond site, the smaller the pond that can be constructed. Well-sited embankment ponds generally require the least amount of earthmoving per acre of water impounded compared to other types of ponds. Because construction costs are based largely on the amount of earthmoving, an embankment pond is generally the least expensive type of pond per surface acre of water to construct.

Building a dam across a large, permanent stream is not a recommended practice for constructing a pond. Following heavy rainfall, streams often carry large amounts of suspended sediments that will settle out in the pond and severely shorten its useful life. Ponds fed by large streams can be difficult to manage for fishing because of competition from wild fish, the introduction of fish diseases, and the inability to effectively fertilize the pond because of excessive outflow.

## Excavated Ponds

Excavated, or dug, ponds are constructed almost entirely below the original ground level (figure 3). This construction method is usually used only for construction of small ponds (generally less than  $\frac{1}{2}$  acre) because of the large amount of earthmoving required in relation to the size of the pond. Excavated ponds may require an external water source to fill and maintain if springs, groundwater, or runoff are not sufficient. An excavated pond is usually the most expensive type of pond to construct on a per-acre basis.

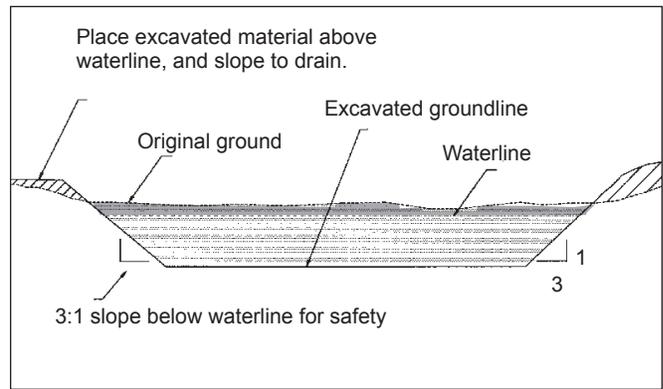


Figure 3. Typical section of an excavated pond (not to scale).

## Levee Ponds

Suitable for flat or nearly flat land, levee ponds are only partially excavated. Earth from what is to be the basin area of the pond is removed and used to construct the sides, or levees, of the pond that impound the water (figure 4). The water level in a levee pond is higher than the original ground level. Water depth is usually similar throughout the pond and is regulated by the height of the outlet pipes and constructed levees. An externally pumped water source, such as a well or creek, will be necessary to fill and maintain this type of pond because of the absence of a watershed. Per-acre construction costs of levee ponds generally fall between those of watershed and excavated ponds.

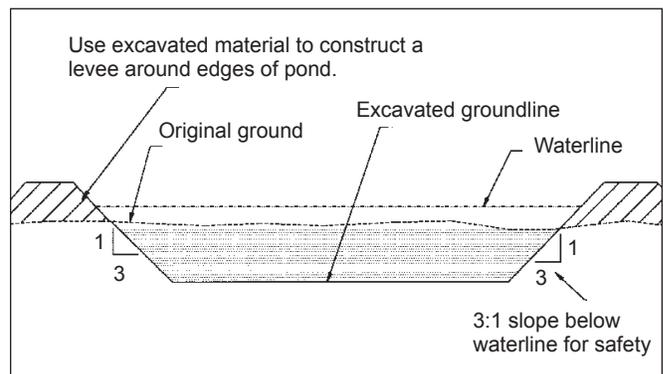


Figure 4. Typical section of a levee pond (not to scale).

## Combination Watershed-Levee Ponds

An example of a combination watershed-levee pond would be a two- or three-sided levee pond that connects to an existing hill to form its other side (figure 5). Depending on the site, the hillside of the pond can provide a significant amount of watershed runoff to the pond, thus reducing and, in some cases, eliminating the need for pumping water to fill and maintain the pond.

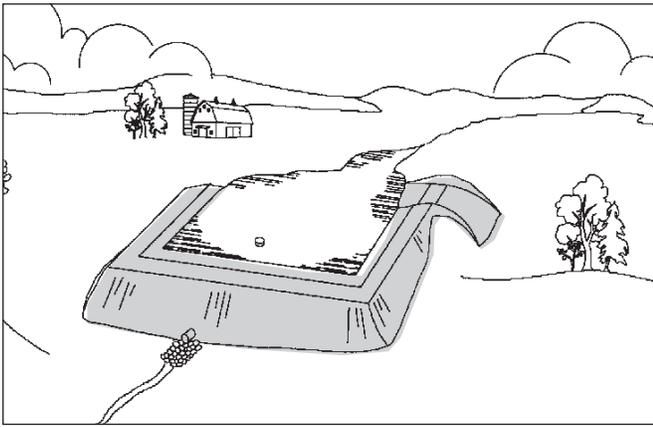


Figure 5. Combination watershed-levee pond (not to scale).

## Pond Design and Layout

### Technical Assistance

Proper construction of a pond must be preceded by proper planning and design. The major considerations to be determined in planning and designing a pond are the size and shape of the pond and the water control structures required.

The Natural Resources Conservation Service (NRCS) can provide advice and information to help private landowners wishing to construct a pond. The NRCS provides guidance for wetland determination, soil maps, uses of ponds for farm needs, and basic design consideration. Private consultants (professional engineers) are available for a fee to provide more detailed planning and land surveys.

### Pond Depth and Volume

To ensure a permanent water supply, the water in the pond must be deep enough to meet the intended use requirements and to offset probable seepage and evaporation losses. Ponds should have a minimum average depth of 6 to 8 feet with water at least 4 feet in depth at an easily fishable distance from the shore. Greater minimum depths are needed for ponds in which a permanent or year-round water supply is essential, such as for irrigation or firefighting, or where seepage is more than normal. Most typical farm ponds in Alabama have 10 to 15 feet of water at the dam.

The estimated capacity, or volume, of the pond can be determined by multiplying the surface area of the pond in acres by 0.4 times the maximum water depth in feet measured at the dam. For example, a pond with a surface area of 3.2 acres and a depth of 12.5 feet at the dam has an approximate capacity of 16 acre feet

( $0.4 \times 3.2 \times 12.5 = 16$  acre feet); (1 acre-foot = 325,851 gallons). An exact capacity of the pond can be obtained only through detailed surveys and calculations.

Ponds should have a minimum average depth of 6 to 8 feet with water at least 4 feet in depth at an easily fishable distance from the shore. For more information on managing ponds for fishing, see Extension publication ANR-0577, "Management of Recreational Fish Ponds in Alabama."

### Tip to Remember

*Fish are stocked based on pond surface acreage, not depth. A pond that maintains an average depth of 15 feet produces no more fish than a pond maintaining a 6-foot average depth.*

## Water Control Structures

There are two water control structures (spillways) that must be designed and sized appropriately to make sure that water can safely drain from the pond during routine and heavy rainfall events. The primary spillway is usually a pipe system (standpipe, siphon system, or a pipe at the waterline through the top of the dam) that is sized to carry all but the very heaviest rainfall. The emergency spillway is normally a lower section of the dam with an open channel designed to carry the water around and away from the base of the dam during high water events. Predicted large storm events, the slope of the watershed, the type of vegetation, and soils all play a role in the design of a safe dam including the top-of-dam elevation and adequate freeboard, which is the distance between the designed flow of the emergency spillway and the top of the dam, usually about 1 foot (figure 6).

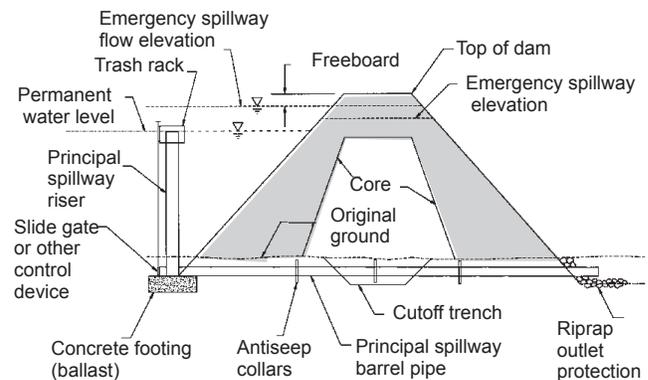
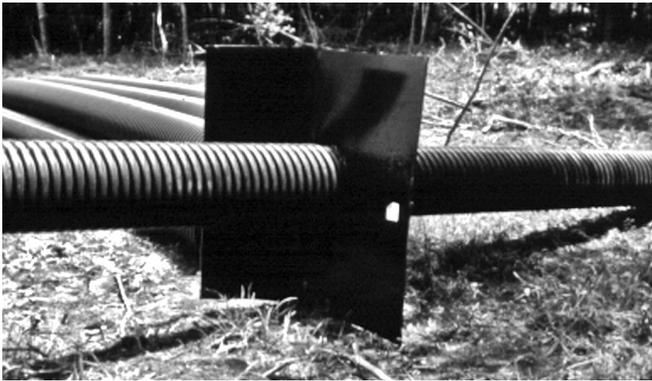


Figure 6. Typical cross section of dam along center line of principal spillway (not to scale).

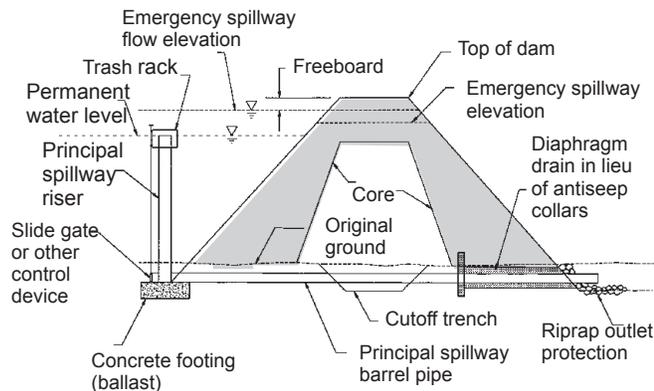
## Principal Spillway

The principal spillway through the dam designed to control runoff from routine rainfall has several key components. The most common design is a standpipe with a barrel through the base of the dam. This system has the advantage of allowing control of the water height for repair or complete restoration by opening a valve at the bottom of the standpipe. Previously, NRCS recommended installing an antiseep collar around the barrel to ensure that water from the pond does not leak between the outside surface of the barrel pipe and the earthfill of the dam (figure 7).

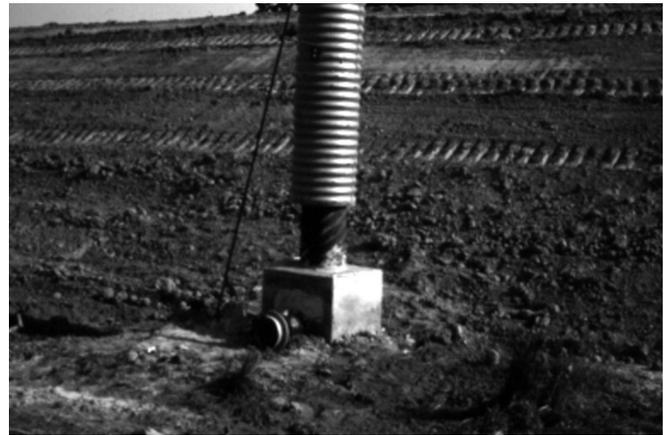


**Figure 7.** While we recommend smooth steel, PVC, or aluminum for the barrel through the dam and not the corrugated pipe shown here, this picture does show the anti-seep collar designed to reduce leakage around the pipe.

Achieving good compaction of the earthfill around the barrel pipe is extremely important. This area is often the weakest portion of the earthfill and where many dams develop leaks. The current recommendation of NRCS as an alternative to antiseep collars is a filter and drainage diaphragm that can be installed around the barrel pipe (figure 8). This system collects seepage and channels it through the dam without eroding the area around the barrel pipe. Contact your local NRCS office for detailed information on the design and installation of a filter and diaphragm seepage control system.



**Figure 8.** Typical cross section of dam along centerline of principal spillway (not to scale).



**Figure 9.** Principal spillway showing barrel pipe connected to riser pipe with concrete counterweight attached to base of riser to counteract buoyancy.

The vertical pipe attached to the barrel pipe at the upstream side of the dam is called the riser (figure 9). The riser pipe must be adequately sized to deliver water to the barrel pipe and is usually 1½ to 2 pipe sizes larger than the barrel pipe. A trash rack must be placed on the riser pipe to keep floating debris from clogging the pipe system. A sleeve-type trash rack can be used for deepwater release to help improve the pond water quality. Keep in mind that the riser pipe has a tendency to float. Attach a concrete counterweight of the appropriate size to the base of the riser to counteract buoyancy.

As an alternative to the conventional barrel and riser principal spillway system, a siphon pipe spillway can also be used (figure 10). The siphon should be considered for older ponds that are being renovated and that require a new principal spillway system. The siphon spillway is formed in the shape of an inverted V over the dam and positioned so that the crest of the siphon is at the normal water surface elevation. Siphoning action begins when the air in the siphon tube has been exhausted. An air vent is provided to break the siphon action when the pond surface is drawn down to the normal water surface elevation. The siphon system must be periodically checked and maintained since a plugged air vent could cause the pond to drain. The system can be designed with a simple open vent so that a siphon never forms unless the vent is closed with a valve to permit lowering the water for maintenance. While the siphon system has the advantage of not having a barrel through the bottom of the dam, the disadvantage is that the pond cannot be completely drained and maintained dry by opening a valve. Once the siphon is broken when the pond is lowered, the pond begins to refill.

The principal spillway pipe system should be constructed of smooth steel or PVC piping. Aluminum pipe can be used, but it is typically too expensive for most recreational pond applications. If PVC is used and exposed to sunlight, it should be painted to prevent degradation due to ultraviolet light.

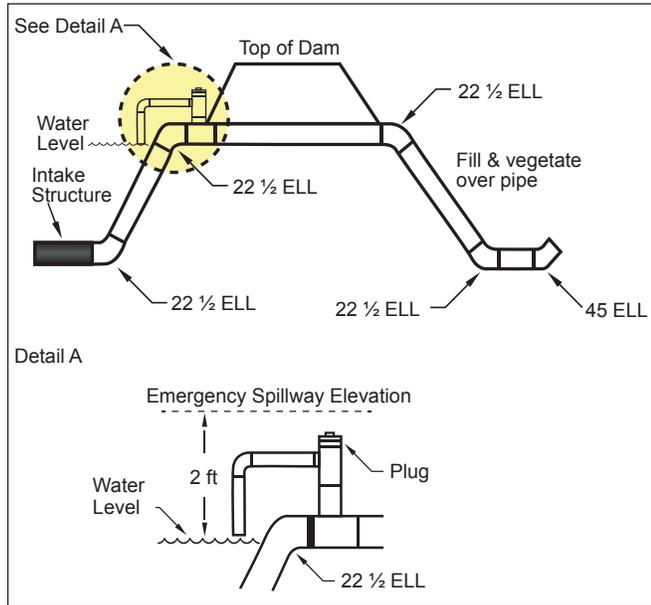


Figure 10. Siphon system. Outlet should be 4 feet lower than intake structure.

### Emergency Spillway

The emergency spillway for the pond is designed so runoff from larger storms can be carried safely around the dam (see figure 2). The spillway is generally located on one end of the dam in undisturbed soil and should be well vegetated with grass to reduce erosion. No trees or shrubs should be planted or allowed to grow in the spillway. The spillway should also be kept clear of structures as well. Should fencing be necessary to control livestock through the spillway, it must be routinely cleaned to prevent the buildup of debris. The only structure recommended to be built across the spillway is a grass carp barrier to help retain these fish in the pond during high water events (figure 11).

### Sizing Water Control Structures

Typical barrel pipe sizes range from 4 to 30 inches in diameter, and riser pipes range from 6 to 48 inches in diameter. Emergency spillways can be anywhere from 10 to 50 feet wide or wider. The actual size of the principal spillway pipes and the emergency spillway width and elevation should be determined using approved design techniques and by qualified individuals. Improperly designed spillways could create an unsafe dam and place undue liability on the owner.



Figure 11. See Extension publication ANR-0452, Using Grass Carp to Control Weeds in Alabama Ponds, for design of a grass carp barriers.

### Livestock Watering Access

Water from a pond is often used as a primary source of drinking water for livestock. However, the practice of allowing cattle unrestricted access to a pond has detrimental effects on the pond water quality, the health of the cattle, and the vegetative cover on the dam and shoreline. Cattle should be fenced out of the pond and off the dam. Limited access for cattle at a planned location (watering ramp) can be provided; however, the best alternative is to fence cattle entirely out of the pond and provide water by gravity flow or pump into a trough or tank.

If a watering ramp is provided, cattle should have access to the pond only at the ramp location, with a walking surface protected with geotextile filter fabric covered with crushed stone (figure 12). This will allow the cattle access to the pond without miring in mud to get to the water. Any potential shade around the watering ramp should be eliminated to keep cattle from loafing in or near the pond.

A watering trough below a fenced pond has proven to be one of the best livestock watering systems (figure 13). A trough or tank is placed downstream of the dam and connected to the pond water by a 1½-inch plastic pipe. The intake in the pond should have a strainer and

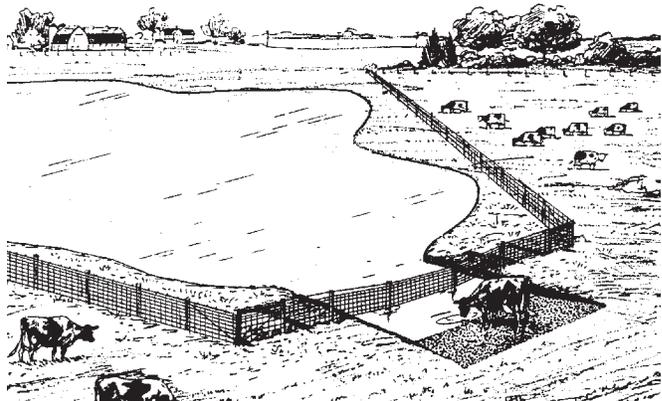


Figure 12. Livestock watering with limited access to watering ramp..

be located to ensure a supply of water during drought conditions. The outlet in the trough should be equipped with a valve to control the water supply. The area around the trough should be protected from erosion using either concrete or geotextile filter fabric and crushed stone. If the water cannot be supplied by gravity feed, a small pump may be needed to supply water to the system. These pumps can be electrical with power supplied from the power grid or remotely with solar panels. The water can also be pumped mechanically using windmills or a pasture pump where power is provided by the livestock's pushing a diaphragm with their muzzles.

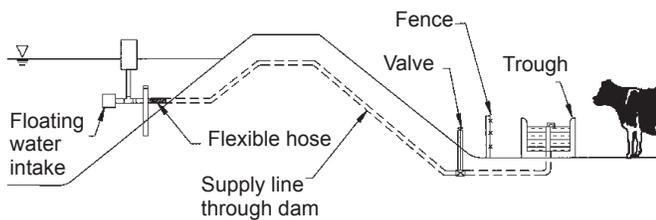


Figure 13. Livestock watering with no access to pond (not to scale).

## Pond Construction

### Permit Requirements

The owner must obtain any required permits before hiring a contractor. If wetlands are involved, a permit may be required from the Corps of Engineers (see **Wetland Restrictions**). Pond sites that involve a total of 5 or more acres of land disturbance during construction require a National Pollution Discharge Elimination System (NPDES) permit issued from the Alabama Department of Environmental Management. This permit requires that a best management practices (BMP) plan be developed and implemented to control erosion during construction and also requires that the BMPs be monitored to ensure that they are working properly. Even if the site is smaller than 5 acres, the landowner and contractor should make a conscious effort to control erosion during construction. A simple way to do this is to perform no construction activities in the pool area until after the dam is near completion. This minimizes land disturbance and creates a basin to trap the sediment produced in the pool area. In all cases, vegetation should be established to control erosion as soon as possible after construction.

### Hiring a Contractor

Unless you have the necessary equipment, you will need to hire a contractor to build the pond. A list of pond contractors can sometimes be obtained at your local NRCS office. You may wish to receive bids from

several contractors to be sure you are getting the best quality job done at the lowest cost. It is always best to talk with others who have had ponds built by the contractor in your area. Ask for references from your prospective contractor before finally contracting your construction project.

### Tip to Remember

*Construction work of the quality and standards desired will not result unless there is a clear understanding between the owner and the contractor of all the requirements for the job.*

Before contracting, have a set of plans and specifications prepared. The plans should show all elevations and dimensions of the dam and emergency spillway; the dimensions and extent of the cutoff trench and other areas requiring backfill; and the location, dimensions, and elevations of the principal spillway, bank contours, and other planned structures. The plan should also include a list of the quantity and kind of building materials required.

The specifications should give all the information not shown on the plans that is necessary to define what is to be done, prescribe how the work is to be done if such direction is required, specify the quality of material and workmanship required, and define the method of measurement and the unit of payment for the various items of work that constitute the whole job.

Construction work of the quality and standards desired will not result unless there is a clear understanding between the owner and the contractor of all the requirements for the job. For these reasons, good plans and specifications should be prepared for all ponds for which an owner awards a contract.

While the local Soil and Water Conservation District and the NRCS professionals may provide input and some review of pond construction plans, private consultants and construction engineers should prepare the plans and specifications. Of course, the final responsibility of ensuring that the job is constructed according to plans and specifications is the owner's.

### Construction Costs

The cost of constructing a pond can be highly variable. On a per-acre basis, small ponds are generally more expensive than larger ponds. The largest single factor controlling the cost of constructing a pond is the amount

of earthmoving required. Other costs such as clearing, site preparation, pipe, concrete, and seeding and mulching are often only incidental compared to the earthmoving cost.

The best way to contract the work of building the pond is to have individual unit prices and pre-agreed-upon costs for every item to be completed in the construction of the pond. Some pond owners elect to “lump sum” the job. That is, the contractor gives them one price for the entire completed job. This is fine unless changes in construction are required, and, in which case, modifications to the work are difficult to price. Some contractors may want to do all or portions of the work on an hourly basis. This could prove to be expensive since the pond owner has no control over the time required to do the work.

The cost of installing a pond can sometimes be cost-shared through government programs if the pond actually reduces downstream water pollution or is used as a source of water for livestock. Check with the local Soil and Water Conservation District Office and the NRCS for potential cost-share money.

### Site Preparation

The contractor must prepare the surface of the soil on which the earthen dam will be constructed, the emergency spillway location, and any borrow locations before beginning the earthmoving operations. Site preparation involves clearing trees from the area, removing stumps and roots, and removing any type of organic material. This may even include the removal of some organic soil if present. Trees, stumps, and roots should never be buried at a location that will eventually be underneath the earthen dam. Most contractors can burn the cleared material and bury the unburned remains at a location that will not affect the dam. The pool area of the pond should also be cleared. If



Figure 14. Initial clearing for base of pond dam and cutoff trench.



Figure 15. Excavation of cutoff trench below base of pond dam.

a structure for fishing is planned for the pond, some stumps can be left. Any debris that could easily float should be removed because floating debris can clog the principal spillway pipe system and threaten the safety of the dam.

### Cutoff Trench and Dam Core

Potential seepage underneath a dam must be prevented to avoid excessive water loss and possible failure of the dam. To prevent excessive seepage, a cutoff trench should be excavated at least 12 inches into impervious material beneath the dam (see figures 6, 14, 15). The trench is generally excavated along the center line of the dam and extends up each abutment of the dam as far as there is any previous material that might allow seepage. The bottom of the trench should be no less than 8 feet wide and the sides no steeper than 1:1. The old channel underneath the dam should also be cleaned out using the same procedures as those for excavating the cutoff.

Trench excavation can be hazardous work. Cave-ins can occur if the walls of the trench are not sloped. Often, the depths shown on the plans for the cutoff trench are only approximate; therefore, an on-site inspection should be made before the trench is backfilled. If there is a cutoff trench near any existing or former stream bed or waterway, the trench must be deeper and wider so that all stones, gravel, sand, sediment, stumps, roots, organic matter, and any other objectionable material that could interfere with proper bonding of the earthfill and foundation can be removed.

Before backfilling operations are attempted, pump any accumulated water from the cutoff trench. The trench should be damp (not wet) and lightly scarified before the



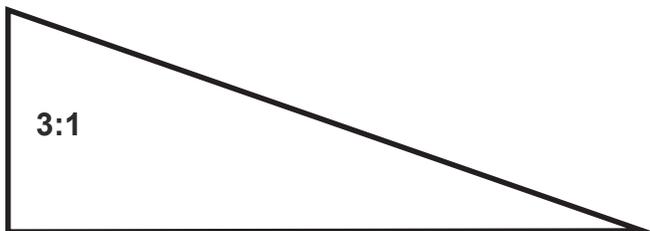
Figure 16. Using sheep's foot roller to compact earthfill.

first layer of fill material is placed in the core. The core of the dam is the interior portion of the dam from the bottom of the cutoff trench to the top of the dam and is compacted with the best available clay material.

### Soil Moisture/Compaction

Good compaction requires that the soil be moist and the compactors and rollers be adequate. The dam must be built gradually in thin layers (6 to 8 inches), and heavy equipment and/or sheep's foot rollers should be used to ensure that the soil receives adequate compacting effort (figure 16). The moisture content of the soil must be monitored. Soil that is either too dry or too wet will not properly compact, regardless of the compacting effort.

During the construction process, the dam should be slightly overbuilt (about 5 percent) to allow for settlement, which will occur over time. The dam should also have at least 3:1 (horizontal to vertical) side slopes that are easy to maintain, and a top width of at least 16 feet if the top of the dam is to be used for vehicle traffic.



### Principal Spillway

Good compaction of the earthfill around the barrel pipe is extremely important. The fill should be compacted using manually directed power tampers to ensure good compaction against the pipe. Manual compaction should continue around the barrel pipe until at least 2 feet of

material is over the pipe. Extreme care should be taken with the compaction around the barrel pipe since this area is often the weakest portion of the earthfill and where the majority of dams fail.

If the pond site has continuously flowing water due to an excessively large watershed or spring, a diversion ditch may be needed to divert the water away from the installation of the barrel pipe. Once the earthfill is 2 or more feet over the barrel pipe, the stream can flow through the pipe to complete construction of the dam.

A valve is often attached to the end of the barrel pipe in the pond to allow the pond to be occasionally drained for maintenance purposes. A stem is attached to the valve to allow operation from above the water surface (see Figure 6).

### Emergency Spillway

The emergency spillway for the pond is constructed on one end of the dam in undisturbed soil, is transversely level to prevent meandering of water, and should be established and maintained with a good stand of grass. The flow through the emergency spillway should be shallow, slow, and uniform to minimize the possibility of the spillway eroding and causing failure of the dam. Likewise, the natural ground where the emergency spillway empties should not erode and, thereby, cause damage to the spillway. The spillway must also convey the water safely to the valley below the dam without damaging the downstream slope of the dam (see figure 2).

### Establishing Vegetation

The final step in good pond construction, and one of the most important, is to establish good vegetative cover over all exposed areas around the pond (figure 17). Too often, pond owners forget this critical step and quickly discover that the pond dam and banks are suffering from severe erosion and siltation. Ideally, topsoil should be set aside during the initial site preparation for construction. Following construction, the stockpiled topsoil should be spread, limed (if needed), and fertilized. The prepared soil can then be seeded, sprigged, or sodded with the appropriate grasses and sod-forming legumes. Depending on the season following construction, a cool-season groundcover can be planted in the fall, followed by overseeding in the spring with warm-season varieties. Check with your county Extension office for best ground covers and planting dates for your area.



**Figure 17.** Seed new pond embankments to establish vegetative cover and reduce erosion.

## Pond Maintenance

### Dam and Spillway Maintenance

Once a pond is completed, the dam and spillways require some maintenance. Vegetation on the dam must be mowed and occasionally fertilized. Trees should not be allowed to grow on the dam or in the emergency spillway. Any erosion or scour in the emergency spillway should be immediately repaired and revegetated. The trash rack should have debris removed from it periodically. The spillway pipes should be inspected and the valve checked annually for proper operation.

### Controlling Vegetation on Pond Banks and Dams

Pond bank vegetation should not be allowed to grow uncontrolled. Vegetation such as cattails, willows, reeds, and sedges are acceptable in limited areas and amounts if desired, but excessive shoreline vegetation will limit access to pond banks and hinder fishing, swimming, and other activities. Thick vegetation on banks also provides habitat for muskrats and beavers, which can cause severe damage to ponds (see **Muskrat and Beaver Control**).

Woody vegetation should not be allowed to grow on dams. Tree roots can eventually penetrate the core of the dam and cause excessive pond seepage. Trees that have been allowed to grow on older dams should be cut down if they are less than 8 inches in diameter at chest height. Larger trees should be left in place unless the owner or contractor has the equipment and expertise to remove the root ball of a large tree. Large diseased or

dying trees on the dam should be removed by a qualified contractor or arborist who will remove the root ball and fill the void with compacted clay. If a large tree on a dam blows over during a storm, the tearing out of the roots could compromise the dam.

## Muskrat and Beaver Control

Muskrats and beavers are burrowing animals that can cause extensive damage to pond structures. Their burrowing activities damage ponds by weakening and eventually caving in pond banks and dams. Beavers also can stop up pipe spillways and build dams across emergency side spillways and diversion ditches. Beavers can damage valuable timber as well. Keeping pond banks neatly mowed and trimmed will help discourage muskrats and beavers by removing desirable habitat. However, many ponds have chronic problems with these animals. Trapping or shooting (where safe) are the usual means of removing muskrats and beavers. Muskrats can be trapped during the season or at other times by special permission from a local conservation office of the Alabama Department of Conservation and Natural Resources. There is no closed season on beaver in Alabama. For more information see Extension publication ANR-0630, "Beaver Control in Alabama."

## Deepening Pond Edges

Proper pond design and construction are the first and most important steps in preventing aquatic weed problems. Shallow water areas are more likely to develop aquatic weed infestations. Pond edges should slope off quickly (2:1 to 3:1) quickly reaching 3 feet of depth. Ponds should be designed and constructed so that there is no more than 20 percent of the pond 2 feet in depth or less.

Ideally, pond edges should be deepened during the initial construction phase. However, it is possible to correct existing ponds with shallow edges by lowering the pond level in mid-September (after fish spawning) and allowing the edges to dry enough to permit machinery into the pond area. Three methods of pond edge deepening are illustrated in figures 18, 19, 20, and 21.

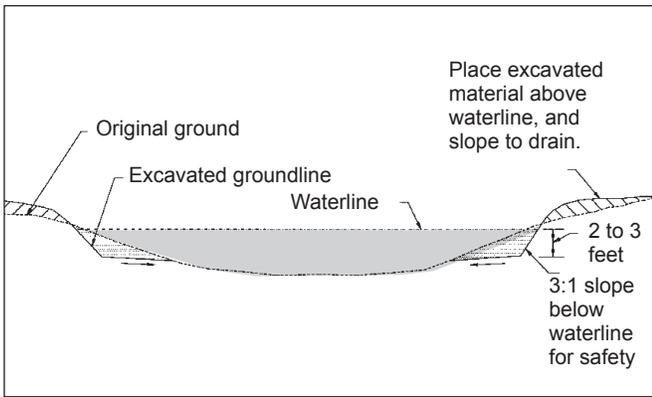


Figure 18. Method 1: Digging edges deeper and placing soil on outside edge of pond (not to scale).

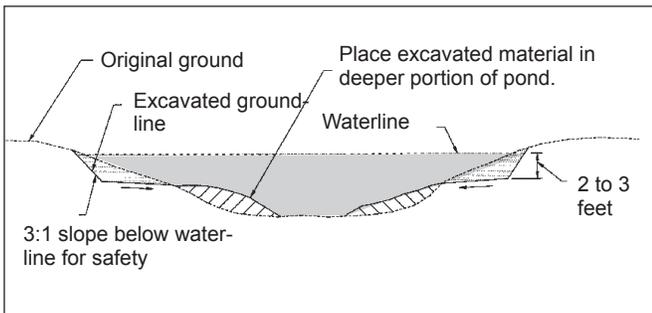


Figure 19. Method 2: Digging edges deeper and placing soil in deeper portions of pond (not to scale).

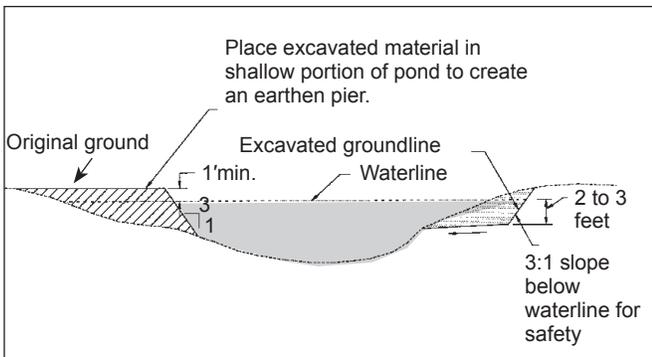


Figure 20. Method 3: Digging edges deeper and using soil to make earthen fishing piers (not to scale).

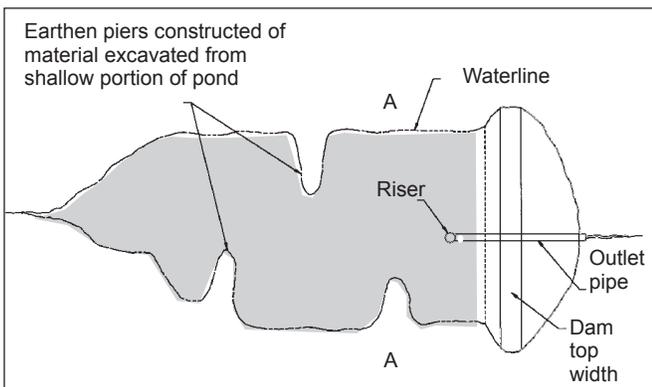


Figure 21. Method 3: Plan view of pond with earthen piers (not to scale).

## Leaky Ponds

Excessive seepage is a common pond problem in many areas. Most severe seepage problems can be traced back to two fundamental causes: a poor site and/or improper pond construction practices. A poor site may be one in which either the soils are too permeable to hold water and/or the underlying geology is not conducive to holding water. Risky geological structure includes underlying cavernous limestone prone to develop sinkholes or exposed rock areas in the pond bottom around which water might channel beneath the pond. Seepage rates can vary considerably for ponds, depending on the dominant soil type. However, properly constructed ponds on good sites will have low seepage rates. Table 1 lists relative seepage rates plus average summertime evaporation in the southeast to show typical water level drop (assuming no added water from rainfall, runoff, groundwater, or other sources).

Table 1. Seepage Rates Showing Potential Summer Water Level Drop

	Seepage Rate	+ Evaporation*	= Pond Water Level Drop**
Low	<1.4	+ 1.0	= <2.4
Medium	1.4 to 2.75	+ 1.0	= 2.4 to 3.75
High	>2.75	+ 1.0	= >3.75

\*Evaporation averages about 1 inch per week (June–September).

\*\*Assuming no water entering pond

Units shown in inches per week

Ponds that leak excessively can be difficult and expensive to fix after the pond is constructed. However, because of water needs, ignorance, or other reasons, ponds are often built on marginal sites and under less-than-ideal conditions. When excessive seepage occurs, there are several methods available for attempting to reduce seepage to a tolerable level.

Improper pond construction techniques are often the cause of excessive seepage. As discussed previously under **Pond Construction**, most embankment ponds require a cutoff and core trench compacted with a good-quality clayey material along the centerline of the dam and extending down into impervious material. Failure to properly install the core trench can result in excessive seepage through the base of the dam. This problem can sometimes be corrected through draining the pond and installing a new core trench in front of the dam.

Proper soil moisture is very important for obtaining optimum compaction during the construction phase. Ponds constructed with soil either too dry or too wet can result in excess seepage due to poor compaction. Generally, the soil is too dry if it can't be molded in your hand and too wet if it adheres to the construction equipment or is obviously saturated. There are several methods and materials that can be used to seal leaking ponds, including compaction, clay blankets, bentonite, chemical dispersing agents, and pond liners.

## Compaction

Sealing by compaction is one of the least expensive sealing methods. This method can work on pond sites containing soils of a wide range of particle sizes and some clay (at least 10 percent) and silt to make a seal. The procedure involves clearing the pond area of all trees and stumps and filling any remaining holes with good-quality clayey soil. The top 8 to 10 inches of soil should be disked and then all rocks and tree roots removed. The soil is then compacted under proper moisture conditions with four to six passes of a sheepsfoot roller (see figure 15). The compacted layer should be no less than 8 inches thick for water depths of 10 feet or less. In areas where the water will exceed 10 feet in depth, compact two or more layers, not exceeding a thickness of 8 inches per layer.

## Clay Blankets

If the clay content of the soil in the pond area is not sufficient to make a good seal, laying down a clay blanket may be an option worth considering. Ideally, good-quality material containing at least 20 percent clay should be obtained from a borrow area near the pond site to minimize hauling costs.

Preparing the pond area for a clay blanket is the same as preparing the area for the compaction method. The material should be spread in layers 6 to 8 inches thick and compacted as previously described. A blanket thickness of 12 inches is sufficient for water up to 10 feet deep. Add 2 inches of thickness for each foot of water over 10 feet. Clay blankets should be protected from cracking due to drying or freezing and thawing.

Protection can be provided by spreading a 12- to 18-inch cover of gravel between the anticipated high and low water levels of the pond. The quantity of soil needed to form a clay blanket can be substantial. A 1-foot-thick blanket spread over 1 acre requires more than 1,600 cubic yards of clay.

## Bentonite

Bentonite is a type of fine-grained clay that absorbs water and swells from 8 to 20 times its original volume and is available either as sodium or calcium bentonite. Sodium bentonite swells to a much greater extent than calcium bentonite and, therefore, should be the form used to seal ponds. Before spreading bentonite, prepare the pond area in the same manner as for the compaction method. When used as a pond sealer in a dry pond, bentonite is mixed into the top 6 inches of soil and then compacted and saturated. When saturated, the bentonite particles expand to fill the pores between the soil particles. Soil moisture in the treatment area should be near optimum for good compaction. If the area is too wet, postpone treatment until conditions improve. If the area is too dry, sprinkle water over the area to moisten it.

Bentonite can also be added to the pond water over the suspected area of the leak, but it is not as effective when applied in this manner. The granular form is more effective than the powder form because when sprinkled on the pond surface, the granules tend to sink to the bottom before becoming saturated with water.

Application rates for bentonite range from 1 to 3 pounds per square foot, depending on the soil type. Bentonite will shrink and crack when dry and is not recommended for ponds in which the water level fluctuates widely through draining or excessive evaporation. Before filling the pond with water, protect treated pond areas from drying by mulching with hay during the final compaction stage.

Bentonite can be expensive to use, and, as with any pond-sealing method, there are no guarantees that it will stop the leak. With most ponds, whole-pond treatments are not practical. Treatment efforts should be concentrated around the suspected problem areas.

## Chemical Dispersing Agents

Some fine-grained clay soils will seep excessively because the clay particles are arranged in an open honeycomb structure. Certain chemicals, known as dispersing agents, can have the effect of rearranging the clay particles, causing the open structure to collapse. Treatments with dispersing agents are effective only in soils containing more than 50 percent of fine-grained material (silt and clay finer than 0.074 millimeters in diameter) and at least 15 percent of clay finer than 0.002 millimeters in diameter. Chemical treatment is not effective in coarse-grained soils.

The most commonly used dispersing agents are sodium polyphosphates, including tetrasodium pyrophosphate (TSPP) and sodium tripolyphosphate (STPP). The dispersants should be finely ground particles. Application rates range from 0.05 to 0.10 pound per square foot. Sodium chloride, which is less effective, is applied at a rate of 0.20 to 0.33 pound per square foot. Soda ash is another chemical that is sometimes used as a dispersing agent at 0.10 to 0.20 pound per square foot. A laboratory analysis is recommended to determine the most effective type and rate of dispersing agent to use.

## Pond Liners

The use of flexible membranes such as high-density polyethylene, vinyl, or butyl rubber is an effective but costly way to reduce excessive seepage losses in recreational ponds. Pond liners such as those used in landfills, lagoon ponds, and other industrial applications are generally impractical for all but the smallest of ponds or ornamental pools because of the cost of the liner material and installation.



Figure 22. Fish attractors serve as habitat for aquatic insects and forage.

## Enhancements

There are a number of things pond owners can do to enhance the usefulness and productivity of their ponds, particularly for fishing and to attract wildlife.

### Fish Attractors

Fish attractors help anglers locate and catch fish. These structures attract fish by providing them cover and serving as habitat for aquatic insects and forage fish upon which the sportfish feed. Common types of fish attractors include evergreen treetops weighted or anchored to the bottom, piles of rocks or cinder blocks, and tied and weighted reefs of discarded tires. The attractors should be placed at relatively shallow depths of 2 to 6 feet where oxygen levels are adequate.

In newly constructed ponds, windrows of trees cleared from the site can be positioned as fish attractors. In ponds fished by boat, fish attractors should be submerged enough so that they don't interfere with boat movement.

The number of fish attractors should not be too numerous because too many will defeat the purpose of trying to concentrate fish where anglers can more easily find them. One to three fish attractors per acre are sufficient. The primary reason to add structure to a pond is to concentrate the fish making them easier to catch. If the fish are easier to catch, anglers should gain greater enjoyment from the pond, be able to better harvest the amount needed for proper management, and assessment with electrofishers will be improved. Brush and other structures can also improve the survival and sustainability of some kinds of forage such as bream and certain minnows.



Figure 23. Electrofishing can help improve pond assessment.

## Fertilizer Platform

Ponds managed for bass and bluegill fish are often fertilized to increase fish production and help control aquatic weeds (see Extension publication ANR-0577, "Management of Recreational Fish Ponds in Alabama"). If a granular form of fertilizer is used, the fertilizer should be suspended away from the pond bottom in 12 to 18 inches of water. One method of suspending the fertilizer is the use of a fertilizer platform (figure 24). The platform should be 3 to 4 square feet. Ideally, install one platform for every 5 to 10 acres of pond."

## Fish Spawning Beds

Fishing for bluegill (bream) during the spring or summer spawn is a favorite activity of many anglers. Shoreline areas can be enhanced to encourage the bluegill to spawn in a particular location where anglers can easily locate them and where fishing access is best. Small gravel (pea gravel) is a preferred substrate for bluegill spawning beds and can be spread in an area of the pond where anglers would like to fish. Spread the pea gravel in a 4- to 6-inch layer in 2 to 6 feet of water. The gravel can be contained within a wooden frame if the area is particularly silty.

## Wildlife

Ponds naturally attract wildlife and can be managed to encourage visits from particular types of animals. Nesting boxes for wood ducks can be placed over the pond. Shoreline vegetation, such as cattails, rushes, and smartweeds, attract many types of wildlife including water birds, shorebirds, songbirds, rabbits, turtles, frogs, and snakes. Shoreline vegetation, though potentially undesirable in excessive amounts, can be allowed to grow in limited areas as long as the pond owner is willing to control its coverage. If shoreline vegetation is allowed to grow, the trade-off is that excessive pond bank vegetation limits fishing access and may attract potential nuisance wildlife, such as muskrats and beaver. Planting food plots and mast-producing trees (although not on the dam!) will attract wildlife with food and water. Incorporating legumes, such as clover in the ground cover and wildflowers in areas that won't be mowed, will attract and support pollinators like honeybees.

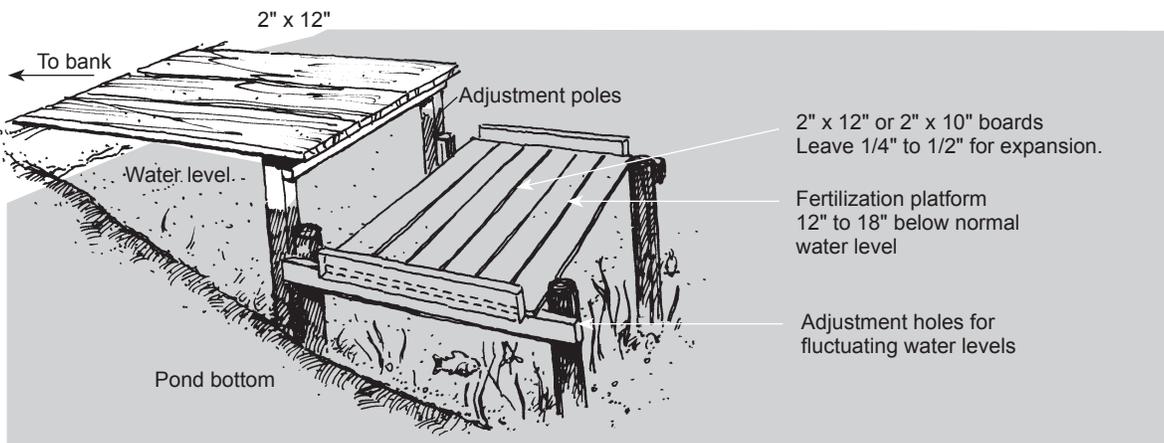


Figure 24. A fertilizer platform can be used to suspend fertilizer.



**Figure 25.** A well-maintained dam with no trees and a roadway along the bank provide convenient access to the pond.

## Accessibility

A well-designed and maintained recreational fishing pond can be accessible to individuals with a wide range of mobility and physical abilities. By considering accessibility and incorporating a few elements of construction and maintenance, your pond can provide enjoyment easily and safely to everyone.

Road access to a pond is important for convenience and maintenance (figure 25). Having a road to the pond and preferably around the entire shoreline allows access for large equipment needed for construction or to bring in lime and mowing equipment. A gravel boat ramp with a consistent slope allows fishing boats, lime barges, and electrofishing boats (if necessary for assessment) access to the pond. Road access also provides a way for individuals with limited mobility to be transported close to the pond.



**Figure 26.** Accessible pier entrance

Construct wide trails with gentle slopes, even and firm surface material, and handrails in steep sections. Trails free of tripping hazards are safer for everyone.

To make fishing piers accessible and safe, start by grading the access trail up to the pier and reachable without having to step up onto the decking. Make the pier wide enough so that anglers can easily pass others who are seated and fishing. Create sections of the pier that are lower (34 inches) for seated anglers and children (figures 27). Lowered railings with extensions for wheelchairs can also be added (figure 28). Providing shade over a portion of the pier or along the shoreline provides refuge from the summer sun (figure 29).



**Figure 27.** A low railing is convenient for seated anglers and children.



**Figure 28.** Lower railings with extensions are convenient for wheelchair access.

Lockable storage at the pond allows extra fishing chairs, fishing equipment, and chemicals, such as fertilizers, to be readily available. Having these supplies stored at the pond helps facilitate maintenance and allows for some impromptu fishing when you stop by the pond and the fish are active.

For more information on pond and fishing structure features and designs compliant with the Americans with Disabilities Act, visit the United States Access Board website at <https://www.access-board.gov/guidelines-and-standards/recreation-facilities/guides/fishing-piers-and-platforms>.



**Figure 29.** A shaded area on a fishing pier provides relief from the summer sun.



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