

Pond Building:

A Guide to Planning, Constructing, and Maintaining Recreational Ponds

Introduction

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, and fire fighting.

The purpose of this publication 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.

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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 just 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 having 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 make-up and topography of the pond 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 persons 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. The Alabama Line Location Center (1-800-292-8525) can also locate all utility lines. Avoid sites under power lines. The wires may be within reach of a fishing rod held by someone fishing on the pond.

Figure 1. Pond Construction Process

Ponds, like any body of water, attract people so that 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 may do. While Alabama currently has no state 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 find 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. Life-saving 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 limestone areas of Alabama are especially hazardous 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 wetted. 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 have had with farm ponds in the immediate vicinity.

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 earthfill for a dam. A good site usually is 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 in order 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 aboveground 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 for each surface acre of water. At the opposite extreme, 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.

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 much of the microscopic plant and animal life that form the base of the food chain for fish, thus lowering pond productivity. Fish 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.

In order 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. Unvegetated watersheds should be avoided 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 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.

Wetland Restrictions

Good 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 hydrophytic vegetation. 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 construction of the pond. Federal wetland programs such as Section 404 of the Clean Water Act and Swampbuster provisions of the Food Security Act may apply to private landowners who construct ponds in areas considered to be wetlands. Always check with the U.S. Army Corps of Engineers 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 type and amount), locating an alternative pond site without significant wetlands may be the best alternative. That way, paperwork and possible litigation can be avoided and, 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 a contrast or 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, provide shade

on summer days, and help blend the pond into the surrounding landscape. However, a pond completely surrounded by trees 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.

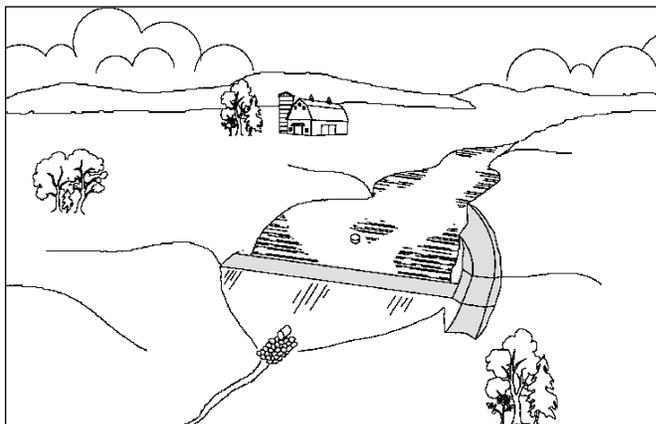


Figure 2. Embankment pond (not to scale)

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 due to competition from wild fish, the introduction of fish diseases, and the inability to effectively fertilize the pond due to excessive outflow.

Excavated Ponds

Excavated, or “dug,” ponds are constructed almost entirely below original ground level (Figure 3). This construction method is usually used only for construction of small ponds (generally less than ½ 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 the pond 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.

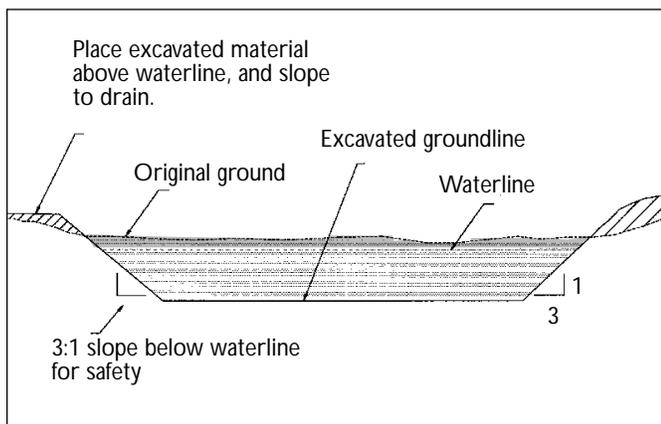


Figure 3. Typical section of an excavated pond (not to scale)

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 due to the absence of a watershed. Per-acre construction costs of levee ponds generally fall between those of watershed and excavated ponds.

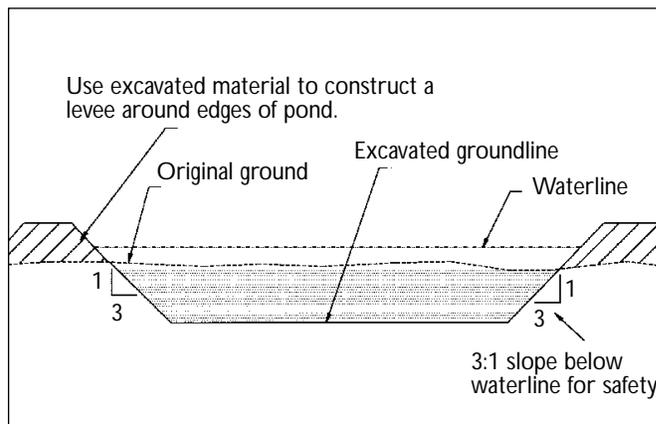


Figure 4. Typical section of a levee pond (not to scale)

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 hill side 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.

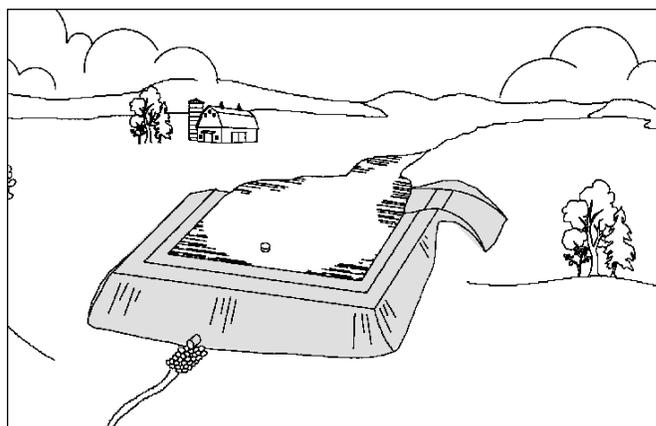


Figure 5. Combination watershed-levee pond (not to scale)

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.

For small ponds, the Natural Resources Conservation Service (NRCS) in Alabama may provide free planning, design, and construction assistance to private landowners in the state. The NRCS has been the recognized expert in this area for over 60 years. However, due to workload and workforce, the NRCS in some counties may only provide

limited assistance on ponds. Private consultants (professional engineers) are available to provide this assistance for a fee.

Pond Sizing

The size of an embankment pond should be relative to the size of the watershed (drainage area) contributing runoff to the site. Ponds with too little watershed will have difficulty filling up and remaining full during drought conditions, and ponds with too much watershed require expensive water control structures and are difficult to manage (see **Watershed/Drainage Area**).

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. The minimum recommended depth of water for ponds in Alabama is 6 to 7 feet. Greater minimum depths are needed for ponds in which a permanent or year-round water supply is essential, such as for irrigation or fire fighting, 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.

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.

Ponds should have a minimum average depth of 3 to 4 feet throughout the year to maintain a healthy fish population. For more information on managing ponds for fishing, see Extension Circulars ANR-577, "Management of Recreational Fish Ponds in Alabama," and ANR-826, "Management of Recreational Catfish Ponds in Alabama."

Pond Shaping

Usually, some simple techniques can be used during planning and construction to shape the pond so that it blends with the surrounding topography and landscape. For example, additional earthfill can be placed on the back slope and abutments of the dam to achieve landform transition. This technique will keep the dam from being such a prominent feature in the landscape. Borrow material needed to construct the dam can also be salvaged along the shoreline of the pond to help deepen the water along the edge as well as provide a more pleasing curvilinear shoreline.

Water Control Structures

Each pond site is unique and therefore requires an individualized design. The hydrology of the watershed must be determined to get an accurate account of different storm runoffs. A smaller-magnitude storm is used to design the pipe overflow system (principal spillway), and a larger-magnitude storm is used to design the emergency spillway that allows the runoff from that storm to safely bypass the dam. This larger storm also establishes the top-of-dam elevation that includes 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). Future conditions must also be considered when designing the pond. For example, changes in a watershed, such as clear-cutting or urbanization, can significantly change the volume and rate of runoff produced by the storms.

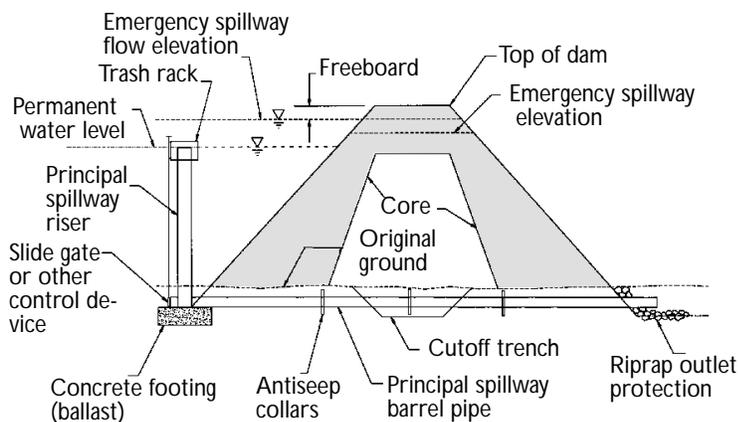


Figure 6. Typical cross section of dam along centerline of principal spillway (not to scale)

Principal Spillway

The principal spillway through the dam is designed to control runoff from a smaller-design storm and has several key components. The pipe through the dam, often referred to as the barrel pipe, should have an antiseep collar(s) installed on the outside 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. Pipe being prepared for installation through dam (barrel pipe) with antiseep collar attached

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 the majority of dams fail. As an alternative to antiseep collars, a filter and drainage diaphragm 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.

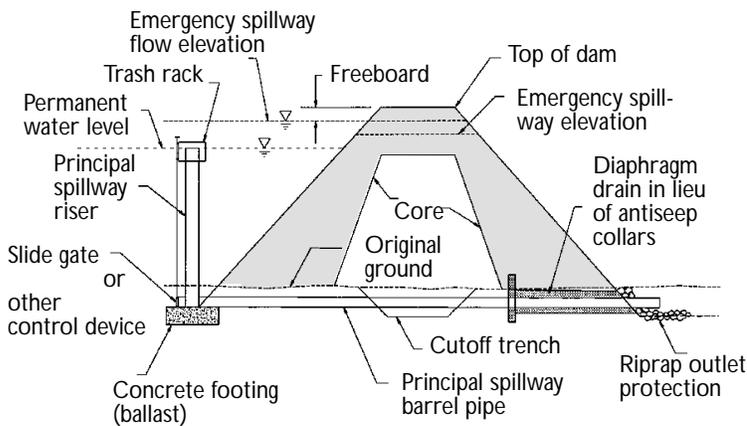


Figure 8. Typical cross section of dam along centerline of principal spillway (not to scale)



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 deep-water 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. The siphon should be considered for older ponds that are being renovated and require a new principal spillway system. The siphon spillway is a closed conduit system 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 principal spillway pipe system can be constructed of many different kinds of materials including steel, corrugated metal, and various types of plastic. If plastic is used, protection from ultra-violet light must be provided, and the outlet of the pipe must be protected from damage by fire.

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. 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.

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.

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 (see **Limiting Livestock Access**). 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 into a trough below the pond.

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 10).

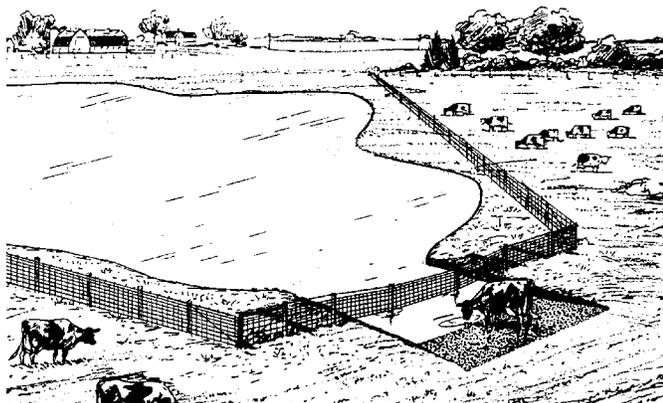


Figure 10. Livestock watering with limited access to watering ramp

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 11). 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 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. A pasture pump may be needed if water cannot be supplied by gravity. This device requires no electricity. The power is provided by the livestock's pushing a diaphragm with their muzzles to pump the water.

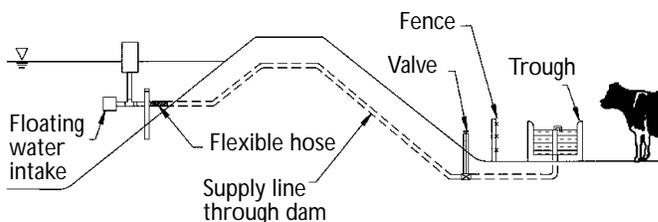


Figure 11. Livestock watering with no access to pond (not to scale)

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

Tip to Remember

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

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.

Site Surveys and Layout

Certain information for the potential pond site must be obtained through engineering surveys. At a minimum, information collected should include surveys for the proposed earthen dam location, emergency spillway location, and shoreline for the pond. Any soils investigation should be documented and referenced to the site survey. The information gathered from the field surveys will then be used by the designer to calculate the elevations and earthfill quantities associated with the construction of the dam. Just prior to construction, the site survey and design information is used to precisely lay out the earthen dam and emergency spillway for 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 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 possible cost. It is always best to talk with others who have had ponds built. Ask for references from your prospective contractor before finally contracting your construction project.

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 of all the requirements for the job between the owner and the contractor. For these reasons, good plans and specifications should be prepared for all ponds for which an owner awards a contract.

The local Soil and Water Conservation District, the NRCS, and private consultants (professional engineers) can assist in preparing the plans and specifications. These people can also provide assistance during the construction phase; however, the primary responsibility to ensure 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. Small ponds can easily range from \$10,000 to \$20,000 per acre or more, while larger ponds (10 acres or more) can range from \$1,000 to \$5,000 per acre or possibly even less for ideal sites. 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, 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.

Construction Equipment

The contractor will need adequate equipment to construct the pond. A list of available equipment may include a bulldozer, self-loading scraper, backhoe, farm tractor and implements, sheepsfoot or tamping roller, and manually directed power tampers. Welding equipment will be needed for steel principal spillway systems.

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 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, 12, 13). The trench is generally excavated along the centerline of the dam and extends up each abutment of the dam as far as



Figure 12. Initial clearing for base of pond dam and cutoff trench



Figure 13. Excavation of cutoff trench below base of pond dam

there is any pervious 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 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 clayey material.

Soil Moisture/Compaction

The two main elements of good compaction are compactive effort and soil moisture. The dam must be built gradually in thin layers (6 to 8 inches), and heavy equipment and/or sheepsfoot rollers should be used to ensure that the soil receives adequate compactive effort (Figure 14). 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 compactive effort.

During the construction process, the dam should be slightly overbuilt (about 5 percent) to allow for settlement, which will occur over time.



Figure 14. Using sheep's foot roller to compact earthfill

The dam should also have at least 3 (horizontal) to 1 (vertical) side slopes that are easy to maintain and a top width of 12 to 16 feet if the top of the dam is to be used for a farm road.

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 and antiseep collars. 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 15). 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.



Figure 15. Seed new pond embankments to establish vegetative cover and reduce erosion.

The prepared soil can then be seeded, sprigged, or sodded with the appropriate grasses. Depending on the season following construction, a cool-season groundcover can be planted in the fall, followed by overseeding in the spring with a warm-season grass. Check with your county Extension office for best grass types and planting dates for your area.

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.

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 ponds should be cut down if they are less than 6 inches in diameter. There is some question as to whether or not larger-diameter trees should be cut. One school of thought says to cut all trees on dams, while another recommends leaving the larger trees (over 6 inches in diameter) because if cut, the deteriorating roots of the bigger trees may leave large voids in the dam. Regardless, don't let trees grow on a new pond dam, and remove any smaller trees found on older pond dams.

Limiting Livestock Access

Cattle are detrimental to ponds and should not have uncontrolled access to the pond. Uncontrolled livestock access will cause damage to dams and banks and substantially shorten the life of a pond. Cattle damage ponds by trampling edges, exposing soil of pond banks through overgrazing, and muddying the pond through wading (Figure 16). The physical trampling of pond edges and erosion from overgrazing will cause premature siltation and shallowing of the edges. Shallowing of pond edges promotes aquatic weed growth. Cattle wading in the pond causes excessive muddiness, which lowers pond productivity and can lead to conditions of low dissolved oxygen and a resulting fish kill. An excessive quantity of manure in the pond can result in excess fertility and possible fish kills due to low dissolved oxygen.



Figure 16. Cattle should not be allowed unrestricted access to ponds.

Ponds can serve the purpose of stock watering without allowing direct animal access to the pond. A watering line can be installed through the dam during construction to provide water to a trough below the dam. Gravity-flow waterlines can also be installed over the dam of existing ponds (See **Livestock Watering Access**). For information on installing livestock watering devices, contact your local NRCS office.

Muskrat and Beaver Control

Musk rats and beavers are burrowing animals that cause extensive damage to pond structures. Their burrowing activities damage ponds by weakening and eventually caving in pond banks and dams. 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. Musk rats can be trapped during the season or at other times by special permission from a local Conservation Officer of the Alabama Department of Conservation and Natural Resources. There is no closed season on beaver in Alabama.

Aquatic Weed Control

A popular misconception is that fish need vegetation in ponds in order to thrive. In reality, aquatic vegetation is neither necessary nor desirable in most ponds for maintaining a healthy fish population. Aquatic vegetation can interfere with fishing, decrease the quality and quantity of the fish, and make ponds unattractive. Once aquatic vegetation increases in coverage to become a nuisance, it can be considered a weed, which is a plant growing where it is not wanted.

Proper pond design and construction is the first and most important step 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) for the first 2½ feet or more of depth. Ponds should be designed and constructed so that there are no significant shallow areas less than 2½ feet deep.

An excellent biological control agent for many common pond weeds is the grass carp. The grass carp, also called the white amur, is a herbivorous fish that does an excellent job preventing or controlling many submersed aquatic weeds. Stocking three to five grass carp per acre in a new pond will help prevent the establishment of many types of undesirable aquatic plants. In ponds with existing weed problems, up to 20 grass carp per acre can be stocked with no adverse effects on the other fish in the pond. Grass carp are legal to use in Alabama. Pond owners outside Alabama should contact their state fisheries agency regarding grass carp stocking regulations. For more information on grass carp, see Extension Circular ANR-452, "Using Grass Carp for Controlling Weeds in Alabama Ponds."

Deepening Pond Edges

Ponds constructed with inadequate shoreline depth or that have suffered from pond bank erosion will have shallow edges that hinder fishing and promote undesirable growth of submersed and shoreline vegetation. 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 17, 18, 19, and 20.

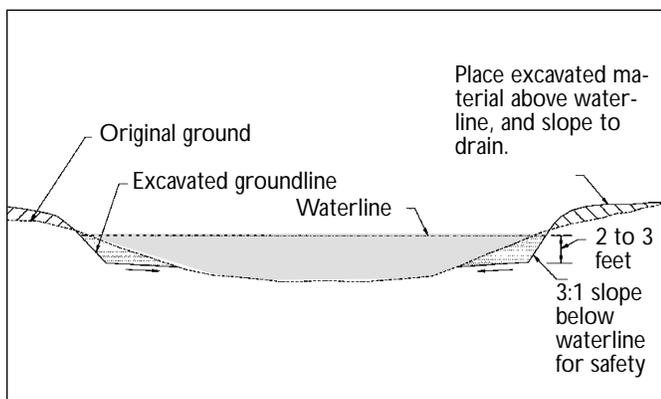


Figure 17. Method 1: Digging edges deeper and placing soil on outside edge of pond (not to scale)

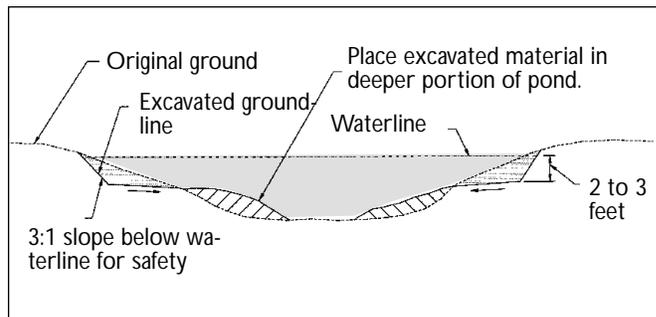


Figure 18. Method 2: Digging edges deeper and placing soil in deeper portions of pond (not to scale)

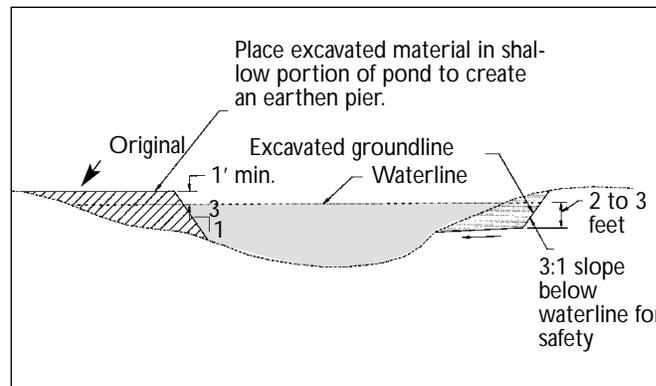


Figure 19. Method 3: Digging edges deeper and using soil to make earthen fishing piers (not to scale)

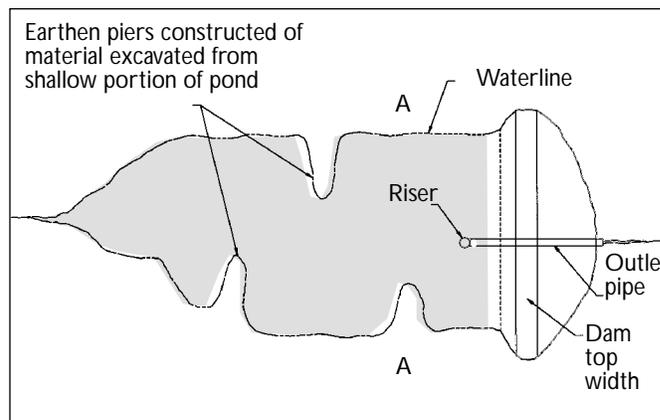


Figure 20. Method 3: Plan view of pond with earthen piers (not to scale)

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 Alabama to show potential water level drop (assuming no added water from rainfall, runoff, groundwater, or other sources).

Table 1. Seepage Rates Showing Potential Water Level Drop

SUMMERTIME POND LEVEL DROP (inches per week)				
	Seepage Rate	+	Evapo- ration*	= 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

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 14). 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 described previously. 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 over 1,600 cubic yards of clay.

Bentonite

Bentonite, available in either powdered or granular form, is a fine-grained clay that absorbs water and swells from 8 to 20 times its original volume. 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 be also 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 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. Even the minimum recommended treatment rate of 1 pound per square foot would require over 20 tons of bentonite at a cost of over \$3,500 per treated acre.

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 millimeter in diameter) and at least 15 percent of clay finer than 0.002 millimeter in diameter. Chemical treatment is not effective in coarse-grained soils.

The most commonly used dispersing agents are the 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 due to the cost of the liner material and installation.

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. Contrary to popular opinion, the addition of structure to a pond will not increase the number of fish in the pond. Fish do not need cover or structure to thrive. The addition of structure simply attracts fish, which enables the angler to fish at a particular spot in the pond where fish concentration is likely to be highest.

Fertilizer Platform

Ponds managed for bass and bluegill fishing are often fertilized to increase fish production (see Extension Circulars ANR-249, "Fertilizing Fish Ponds," and ANR-577, "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 21). Locate the platform in the upper end of the pond in an area that receives good wind and wave action. The platform should be sized to provide 3 to 4 square feet of area for each surface acre of water. One adequately sized platform is sufficient for up to 25 surface acres of water.

Fish Spawning Beds

Fishing for bluegill (bream) during the spring/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 such as water birds, shore birds, song birds, 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 tradeoff is that excessive pond bank vegetation limits fishing access and may attract potential nuisance wildlife such as muskrats and beaver. When making decisions regarding shoreline vegetation management, pond owners can use their best judgment and manage pond bank areas according to their priorities of fishing access, wildlife attraction, and personal aesthetics.

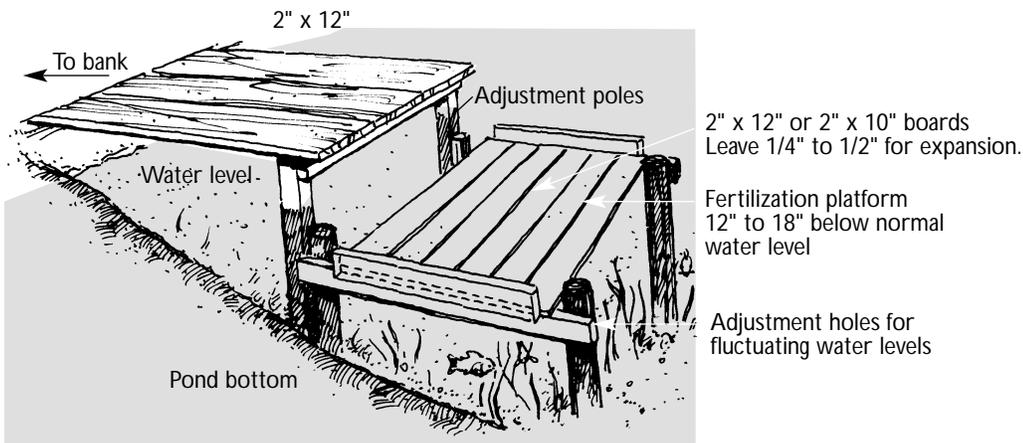


Figure 21. Fertilizer platform



ANR-1114

Chris Hyde, *Extension Aquaculturist*, Department of Fisheries and Allied Aquacultures, Auburn University, and **Perry Oakes**, State Conservation Engineer, USDA Natural Resources Conservation Service, Alabama

For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

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