Pond Design & Management

Publication by

Fairfield Soil & Water Conservation District

Common pond weeds and algae pictures and information are used from the Texas Cooperative Extension at *http://aquaplant.tamu.edu/database/index/plant_id_floating_plants.htm*

Revised 04/12

Q. Do I need a permit to build a pond?
A. Sec. 1521.06 of the Ohio Revised Code governs construction permits for dams, dikes and levees. To obtain information on these laws, you should contact the Ohio Department of Natural Resources—Division of Water.

Q. Should I plant or maintain trees around my pond?
A. Any shrubbery or trees should be kept back from the water line and should never be planted on the dam itself. Falling leaves cause water to turn brackish when they decompose, using up oxygen needed by the fish. Trees are also a favorite place for animals to burrow near. Decayed roots leave potential channels for water to travel through the dam.

GLOSSARY OF TERMS

Borrow: Soil excavated from the surrounding area to build the dam.

Core trench: Excavated trench into original ground along the center line of the dam to a depth necessary to cutoff previous layers which could cause the water to travel under the dam.

Riparian rights: Rights a person has in the use of water when owning land adjacent to a stream or river.

Test holes: Pits usually dug with a backhoe to evaluate the soil to determine its capacity to hold water and determine levels of previous layers.

Triploid: Having an extra chromosome, which inhibits reproduction.

Watershed: This is the area that will drain toward the pond when it rains.

pH: A measure of the acidity or alkalinity of a solution. 7 = neutral solution, < 7 is acidic, and > 7 is alkaline.

Perennial: Lasting or active through the year.

Moraine: Debris, as boulders or stones, deposited by a glacier.

Outwash: Material carried from a glacier by meltwater and laid down in stratified deposits.

Acre-feet: The volume of water that will cover an area of 1 acre to a depth of 1 foot.

Sheepsfoot roller: A large roller drum with protruding "feet" or knobs, typically pulled behind a tractor.

MOST FREQUENTLY ASKED QUESTIONS

Q. What does the average pond cost?
A. Each site must be evaluated on its own. A qualified contractor or consultant can provide an accurate cost estimate.

Q. Does the government stock private ponds?
A. No. A list of fish hatcheries can be obtained at the Ohio Department of Natural Resources—Division of Wildlife (*www.ohiodnr.com/wildlife*). Fish are also available from traveling trucks from May through September at several farm product stores in the county. We have a list of local stops during the summer season.

Q. I've had a fish kill. Can anyone tell what caused it?
A. There are many reasons why there can be a sudden fish kill. Disease, parasites, chemicals, and extreme weather changes can result in fish kills. The first three listed may require laboratory analysis. The weather can also play a part. As the water temperature increases in the spring, the water on top becomes warmer than the water at the bottom. Cold water is heavier, thus a sudden and hard, cold rain can cause the water on top to become colder than the water on the bottom. This will cause the water in the pond to clip over, taking the oxygen laden water to the bottom. This water will become clouded when it is stirred up in this manner. Since the fish stay in the upper reaches, they become starved for oxygen. Usually it will kill the larger fish first.

Q. How do I control the weeds and algae in my pond?
A. Many weed and algae problems can be eliminated with proper construction practices. Water less than four feet deep tends to encourage weed growth. Reducing the amount of shallow water in the pond will reduce the amount of weed and algae control needed. Spring fed ponds may require additional maintenance because the water is very clear allowing more sunlight to penetrate, which promotes weed growth. Chemicals control most weed problems. Information on these products and their proper use can be obtained from local chemical dealers. Proper ID is the key to controlling nuisance vegetation. Don't guess what the problem vegetation is. ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

Another method for controlling pond weeds is the use of the triploid white amur. This grass eating carp cannot reproduce and will consume leafy and floating pond weeds and algae. They can grow up to five feet in length and can weigh up to 50 pounds. For more information, contact the Ohio Department of Natural Resources—Division of Wildlife. This fish typically cost $11-12 each.

INTRODUCTION

The Fairfield Soil and Water Conservation District (SWCD) has assembled this warm-water pond brochure to assist interested landowners in becoming aware of the elements involved in the design of a pond. Whether it is for recreational use, livestock watering, or fire protection, good judgment and common sense are essential in applying the design criteria that makes a successful pond in Fairfield County.

We will touch on areas of concern and briefly define some of the terms used in pond construction. Our purpose is to provide landowners with some background to begin the process. It is important when considering building a successful pond that you take the necessary steps to protect the health and property of the people of Ohio. If you are not well versed in the design of a pond, you should contact a qualified private engineer, consultant, or contractor knowledgeable in this field.

A glossary of terms used is located in the back of this guide for your convenience.

WARM-WATER PONDS

Warm-water ponds provide many hours of good fishing and pleasant recreation on farm or suburban property. Warm-water ponds can also provide related recreation benefits such as boating, swimming, picnicking, and water for wildlife. Largemouth bass, bluegill, redear sunfish, channel catfish, and bait fish are best suited to these ponds.

Managing a pond for fishing requires more than building, stocking, and fishing the pond. Fish production is influenced greatly by such natural water qualities as temperature, oxygen, acidity or alkalinity (pH of 6.5 to 9.0 is satisfactory for reproduction and growth), and water clarity. The amount of water that flows through the pond is also important.

Most warm-water ponds reach summer temperatures of 75 to 82 degrees Fahrenheit. Bass, bluegill, channel catfish and sunfish are warm -water fish and grow well in these temperatures.

A cool-water pond is one in which summer temperatures rise to 70 degrees but seldom above 80 degrees. Although spring-fed ponds often may have lower water temperatures, without aeration they may lack adequate oxygen levels near the bottom to support trout, yellow perch, or walleye. These fish species seldom survive in Ohio ponds.

TYPES OF PONDS

There are generally two types of ponds: excavated and embankment. Excavated ponds are built by digging a hole in the ground to impound water. Embankment ponds require the construction of a dam to impound the water.

Excavated ponds are typically built in flatter areas where the water table is within a few feet of the surface of the ground. Excavated ponds are usually limited in size and capacity by the construction techniques and equipment used to build them. There is typically excess soil material (spoil) that must be used or disposed of off-site.

Embankment ponds are built where the ground is more sloping and water concentrates in a watercourse, draw, or stream. A dam across the watercourse is needed to hold the water. Provisions must be made during the planning and construction phase to allow excess water to safely pass the dam during periods of heavy rainfall. This typically involves putting a pipe through the dam (principal spillway) to pass the usual amounts of rainfall and water run-off. To protect against storms, an emergency spillway should be built on one end of the dam to safely take the excess water past the dam without eroding the dam.

Ponds in Ohio should have a minimum depth of water. It is generally recommended to have a minimum depth of 8 feet over about 1/3 of the pond area. It may be necessary to have a deeper pond if the primary purpose is for irrigation or fish management. Many uses such as fire protection require that there may be a certain minimum volume of water in the pond.

Sago pondweed is a perennial plant that arises from thickly matted rhizomes and has no floating leaves. The stems are thin, long and highly branching with leaves very thin and filament-like, about 1/16 of an inch wide and 2 to over 12 inches long tapering to a point. The leaves grow in thick layers and originate from a sheath. The fruit is nut-like 1/8 to 1/4 inches long and 1/10 to 1/8 inches wide.

Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.). After aquatic plants die, their decomposition by bacteria and fungi provides food (called "detritus") for many aquatic invertebrates. Sago pondweed is an excellent food for waterfowl which eat both the fruits and the tubers.

Curly-leafed pondweed is a perennial plant that is native to Europe and gets it name from the rippled or wavy nature of its submerged leaves. The leaves are alternate, oblong 3/4 to 4 inches long and 1/4 to 1/2 inch wide. Mature leaves are toothed with a distinct midrib with paired parallel lateral veins, nearly translucent. Stems are flattened and branching. Fruits are seldom found, they reproduce from small "burr-like" vegetative structures that form at the base of some leaves. Curly-leafed pondweed can be an aggressive invader that can cover large portions of ponds.

Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.). After aquatic plants die, their decomposition by bacteria and fungi provides food (called "detritus") for many aquatic invertebrates. Since fruits are not usually present on curly-leafed pondweed, it has little food value to wildlife. It is a non-native plant and should not be spread.

Filamentous algae are single algae cells that form long visible chains, threads, or filaments. These filaments intertwine forming a mat that resembles wet wool. Filamentous algae starts growing along the bottom in shallow water or attaches to structures in the water (like rocks or other aquatic plants). Often filamentous algae floats to the surface forming large mats, which are commonly referred to as "pond scums". There are many species of filamentous algae and often more than one species will be present at the same time in the pond.

Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates (i.e. bugs, worms, etc.). These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.). After aquatic plants die, their decomposition by bacteria and fungi provides food (called "detritus") for many aquatic invertebrates. Filamentous algae has no known direct food value to wildlife.

Planktonic algae are floating microscopic plants that are normal and essential inhabitants of sunlit surface waters. There are literally millions of floating planktonic algae, and they color pond water shades of green, blue-green, brown or variations in between. Planktonic algae that color the water is often called a "bloom" or "algae bloom". Many species of algae are involved in algae blooms and these species change over time based on temperature, light, nutrients, and other factors.

Planktonic algae blooms are considered desirable as the beginning of the pond food chain. In fact, fertilization programs are often used to promote algae blooms and thereby support a larger fish population. Planktonic algae is desirable for shading the pond bottom (in areas over 2 feet deep). This shading suppresses the establishment of rooted aquatic plants. However, too much planktonic algae can cause oxygen depletions and fish kills.

Chara is often called muskgrass or skunkweed because of its foul, musty almost garlic-like odor. Chara is a gray-green branched multicellular algae that is often confused with submerged flowering plants. However, Chara has no flower, will not extend above the water surface, and often has a "grainy" or "crunchy" texture. Chara has cylindrical, whorled branches with 6 to 16 branchlets around each node.

Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.). After aquatic plants die, their decomposition by bacteria and fungi provides food. Chara is consumed by many species of ducks.

SITE SELECTION

Initially, you need to evaluate the location by looking at the size of the watershed, the quality of water that can be expected, the area needed for construction, and the downstream effects.

A watershed ranging from 10 to 30 acres is typically necessary to keep a one-acre pond full. Damming a stream can be difficult to manage. It is costly and can result in excess sediment with larger watersheds entering the pond. Undesirable fish species may enter ponds constructed on a flowing stream and federal and state permits are required to dam a stream.

With increased urban development, water quality in the watershed of the pond must be considered. Good vegetated land with properly working septic systems is acceptable. The area needed for the construction of a pond must include not only the pool area, but the area needed for borrow material and the area needed for the dam. The total area must be included in the overall plan for your property along with the location for your septic system, underground utilities, house site, and other recreational areas.

Riparian rights should also be considered before damming perennial streams. There are state laws governing the construction of certain sized ponds. Each individual should be aware of these laws. Information on this can be obtained from the Ohio Department of Natural Resources—Division of Water (ODNR-DOW) *www.ohiodnr.com/water*.

The diversity of terrain and soil types found in Fairfield County make site selection a critical element in the process of building a pond. All of Fairfield County is covered by glacial moraines and outwash except for the south and southeast part of the county. The soils in this area contain a higher clay content. South and southeast of Lancaster is the unglaciated plateau. These soils consist mainly of sandstone, siltstone, and shale along with glacial outwash materials in the valleys.

Soil Evaluation

Surface soil appearances are not representative of the conditions necessary to impound water. The Fairfield County soil survey can be used in the preliminary investigation of the site. However, each site needs to be evaluated to a depth greater than that provided by the survey.

It is essential to do a soil evaluation before investing money in building a pond. Knowing what soils are on-site and their limitations will allow you to determine expected costs and possible methods to overcome any obstacles posed by poor soils. Contact the Fairfield Soil and Water Conservation District for assistance with soil information or for a soil survey CD.

Soils in the watershed have a major influence on the amount of water that reaches the pond. Soils have different characteristics that affect the infiltration of water and the growth of plants.

Soil type also affects the feasibility and cost of building a pond. Soils that are too rocky, sandy, or silty are not favorable for pond construction. Typically the costs of building a pond increase as the soils become less favorable. Clay soils are generally needed for embankment ponds.

A backhoe is typically used to dig test holes. This provides the subsurface information needed to determine such things as pond and core trench depth. A soil specialist will recognize soil layers that would allow the pond water level to fluctuate. An engineer can determine the suitability and quantity of material available for construction.

Common Pond Weeds and Algae

Watermeal is a very tiny (less than 1 millimeter) light green free-floating, rootless plant. In fact, watermeals are the smallest seed-bearing plants in the world. Watermeal tend to grow in dense colonies in quiet water, undisturbed by wave action. Often watermeal will be associated with colonies of duckweeds. Watermeal can be an aggressive invader of ponds and are often found mixed in with duckweeds or mosquito fern. If colonies cover the surface of the water, then oxygen depletions and fish kills can occur. These plants should be controlled before they cover the entire surface of the pond.

Dense colonies of watermeal often can completely cover the surface of a pond and will cause dissolved oxygen depletions and fish kills These colonies will also eliminate submerged plants by blocking sunlight penetration. Watermeal is not known as an important food but many ducks may consume it and often transport it to other bodies of water.

Common duckweed is a very small light green free-floating, seed bearing plant. Duckweed has 1 to 3 leaves, or fronds, of 1/16 to 1/8 inch in length. A single root (or root-hair) protrudes from each frond. Duckweeds tend to grow in dense colonies in quiet water, undisturbed by wave action. Often more than one species of duckweed will be associated together in these colonies. Duckweeds can be aggressive invaders of ponds and are often found mixed in with mosquito fern or watermeal. If colonies cover the surface of the water, then oxygen depletions and fish kills can occur. These plants should be controlled before they cover the entire surface of the pond.

Duckweed colonies provide habitat for micro invertebrates, but if duckweed completely covers the surface of a pond for an extended period it will cause oxygen depletions. These colonies will also eliminate submerged plants by blocking sunlight penetration. Many kinds of ducks consume duckweed and often transport it to other bodies of water.

Elodea is a rooted multi-branched perennial plant but can survive and grow as floating fragments. The dark green blade-like leaves (3/5 inch long and 1/5 inch wide) are in whorls of three with finely toothed margins. The flowers of Elodea have three white petals with a waxy coating that makes them float.

Submerged portions of all aquatic plants provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.). After aquatic plants die, their decomposition by bacteria and fungi provides food (called "detritus") for many aquatic invertebrates. Elodea has no known direct food value to wildlife but is used extensively by insects and invertebrates.

actively growing plant will kill the leaves but not the root system. Aquathol-K is effective for nearly all submerged plants except coontail and watermilfoil. For these two plant species, Reward is a better option. A third herbicide called Sonar, or Avast, is also very effective. It is sold in pint or quart containers. The active ingredient is fluridone. This is the only aquatic herbicide on the market that has a timed-release; it also has a systemic mode of action. Although the cost is much more than Aquathol-K or Reward, it can control weed growth for more than one season in many ponds. Remember to treat early before submerged aquatic plants become too dense. Apply herbicide control to only half of the pond at one time, then wait 7-10 days before treating the other half to prevent oxygen problems. Grass carp are effective at controlling these aquatic plants in most cases. The usual stocking rate is 4 to 6 fish per surface acre of water. More is not better! These fish can consume every plant in the pond if stocked at too high a rate.

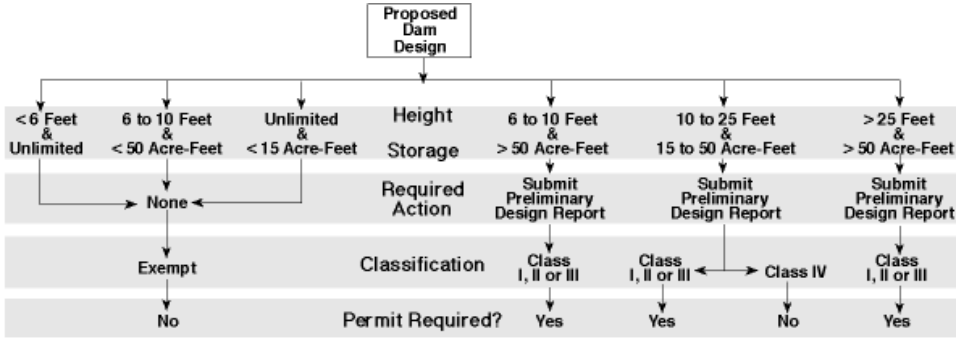
Free-floating Plants

This group of plants are one of the worst problems. Watermeal and duckweed often grow the best in older ponds with many years of accumulated nutrients and little circulation or wind movement. These two plants appear as tiny green granules (watermeal), or as slightly larger green plants about the size of a match head with a visible white root attached underneath (duckweed). When we see these two plants in large numbers, the pond with the problem is often over 30 years old. There is really only one treatment option that is effective, which is Sonar or Avast. The best sequence is applying half of a full treatment dose with a non-ionic surfactant to attach the chemical to the tiny plants on the pond surface. Wait for a week and apply the other half of the needed treatment without a surfactant. In this way both the floating plants on the surface are controlled, as well as the plants forming near the bottom.

DESIGN AND PERMITS

Section 1521.06 of the Ohio Revised Code requires that individuals or government agencies wishing to build a dam first obtain a construction permit from ODNR-DOW. This law protects life, health, and property from damages due to improper design or construction. However, there are dams exempt from the permit process.

Diagram of Construction Permit Determination



"**Height**" means the vertical dimension of a dam as measured from the natural stream bed or watercourse at the downstream or outside toe of a dam to the top of the dam.

"**Storage**" means the total volume impounded when the pool level is at the top of the dam immediately before it is overtopped.

"Classification"

Class I - If the danger of probable loss of human life or serious damage to homes, high-value industrial or commercial properties, or major public utilities exists, the dam shall be placed in Class I. Dams having a storage volume greater than 5000 acre-feet or a height greater than 60 feet shall be placed in Class I.

Class II - If a possible health hazard or probable loss of high value property or damage to major highways, railroads, or other public utilities exists, but loss of human life is not anticipated, the dam shall be placed in Class II. Dams having a storage volume greater than 500 acre-feet or a height greater than 40 feet shall be placed in Class II.

Class III - If property losses are restricted mainly to rural lands and buildings and local roads, and no loss of human life or hazard to human health is anticipated, the dam shall be placed in Class III. Dams having a height greater than 25 feet or a storage volume of greater than 50 acre-feet shall be placed in Class III.

Class IV - If property losses are restricted mainly to the dam and rural lands, and no loss of human life or hazard to health is anticipated, dams which are 25 feet or less in height or have a total storage volume less than 50 acre-feet shall be placed in Class IV.

Please be advised that the disturbance of continuous flow, intermittent flow and ephemeral stream channels and wetlands in Fairfield County need the approval of multiple agencies. If your proposed pond or lake includes the construction of dikes and dams, culvert placement, the movement of the stream channel or fill and dredge operations of a "stream" as mentioned above, you must obtain all necessary permits.

These permits can be lengthy and expensive and require the approval and review of other agencies for threatened or endangered species. You are often required to provide professional engineering calculations or professional analysis of streams and wetlands. Fairfield Soil and Water Conservation District is not the permitting authority for these permits. To receive further information please contact the following:

Ohio EPA Central District Office
Division of Surface Water, Suite 700
Columbus, OH 43215
Phone: (614) 728-3844
Fax: (614) 728-3898

The United States Army Corps of Engineers
502 8th Street
Huntington, WV 25701
Phone: (304) 399-5210
Fax: (304) 399-5085

The Ohio Department of Natural Resources, Dam Safety
Division of Water
Dam Safety Program
2045 Morse Road, Bldg. B-2
Columbus, OH 43229-6693
Phone: (614) 265-6731

Pond owners often get frustrated when they apply control chemicals too early and don't see the results that they expected. These plants are best treated after July 4 when the uptake of herbicides down to the roots is greatest. There are two types of herbicides that are effective in controlling these persistent plants. Reward (diquat dibromide) and Rodeo (glyphosate). Reward is a contact herbicide and controls only the parts of the plant that it touches. Because Reward does not travel through the plant to the roots, annual application is probably required to kill the problem growth. Rodeo is a systemic herbicide, it will travel through the plant to kill the roots and any green growth that you see. Because Rodeo has a better effect, it is usually more expensive than Reward. Both chemicals are sold by the gallon.

For both of these herbicides, an ounce per gallon of a non-ionic surfactant should be applied to help "stick" the treatment chemical to the plant leaf. Surfactants are usually less than $5 per pint.

Other options for these emergent weeds include pulling out new growth (if you have a strong back) and frequent cutting of the new growth. Both of these options will eventually rob the root system of the energy needed to survive the winter. One last note on these plant types; they are not eaten by grass carp. You will hear many claims to the contrary, but this is not the case.

Submerged Plants

These are the most common cause for frustration by pond owners. There are many species of submerged plants that cause headaches and proper identification is needed to control them. For example, there are 6 or 7 species of pondweed in Ohio, and 5 to 8 different types of other plant species that are common nuisances. If you cannot identify the plant that is causing you problems, please call to request a field visit or bring a sample of the plant in water into the Fairfield SWCD office for identification.

Once the plant has been identified, there are three herbicides that are most effective. Although other treatment options exist, the three discussed have the best track record of killing the nuisance plant growth without causing other problems (i.e. fish kills). For most pondweeds, Aquathol-K in liquid or granular form is very effective. This product is used in a tank or 1-3 gallon hand sprayer without any surfactant. It is a contact herbicide, so the chemical touching the

VEGETATION CONTROL

For starters, we need to identify what is growing in your pond. In the space here it is not possible to show examples of every plant that might be causing you problems. Instead, let's break them down into a few general types.

Algae

Algae is often among the first types of problem vegetation to begin growing in many ponds. This will start to grow soon after ice-out, or generally in late February as the days start to lengthen. Algae starts to grow in contact with the pond bottom, where most of the phosphorus that enters the pond settles out. Algae is a form of colonial one-cell plants that grow in long chains. Two of the more common types in ponds are Pithophera and Spirogyra. They are commonly a problem in shallow areas of ponds that are less than 4 feet deep. One of the best ways to keep algae from getting out of control is early treatment. Copper in granular or liquid forms is toxic to algae. Treating a pond early (late March or early April) will help you keep ahead of the algae. Trade names for liquid copper sulfate or chelated copper products include AlgaePro or Cutrine Plus. These are usually sold in one or 2.5 gallon containers. Granular copper sulfate products are sold under many trade names in two to five pound bags. When using the liquid or granular copper products, remember to apply them early in the day on a sunny day if possible. During these conditions, algae is most active and will take up more of the copper. If you have lots of floating mats of algae on the surface of your pond, try raking some of it out. This will make the chemical more effective, as it won't be tied up on these floating mats. As temperatures rise, use caution in applying any chemical. Treating only half of the pond at a time will help to prevent any oxygen problems.

Emergent Plants

Emergent plants are those such as cattails that begin beneath the water surface and grow above the water level, frequently in large numbers. These include cattails, water lilies, arrowhead or bulrushes. Most of these plants have their peak growth in Ohio before July. After that they are simply sending as much energy as they can down to the roots, which are often 1.5 to 2.5 inches in diameter.

POND COMPONENTS

If you are considering building a pond or having someone build a pond for you, it is important to be aware of the necessary components of a good pond design. The information provided here is simplified to help you understand the features of a pond. The principal spillway for small ponds is usually a pipe made of steel, concrete, or plastic. Its purpose is to control the water level of the pond. It is designed to handle the volume of run-off from low intensity rainfalls. Examples are shown below and on the following page.

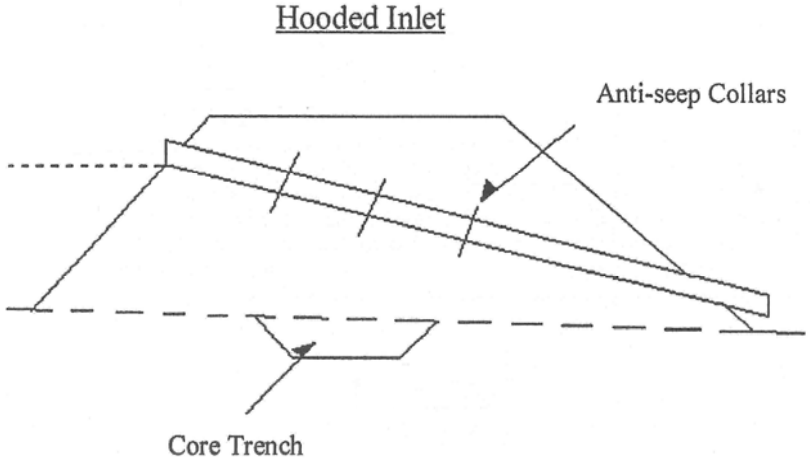
The emergency spillway is a vegetated earthen pathway usually around the side of the dam. It allows for large volumes of storm run-off to pass safely. It is an important feature and should be constructed along with the principal spillway.

The dam must be constructed of compacted soil with adequate clay content. A thick, dense stand of grass is important to stabilize the dam and prevent erosion.

A beach area is an important safety feature. It provides an area of shallow water that will allow someone to get out of the water safely.

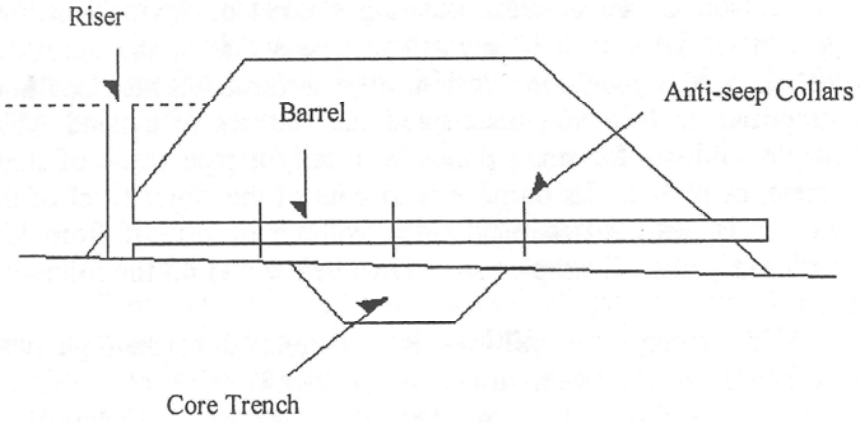
Typical Principal Spillway Pipe Designs

(small and medium watershed ponds, ponds with a lot of storage between pipe and emergency)



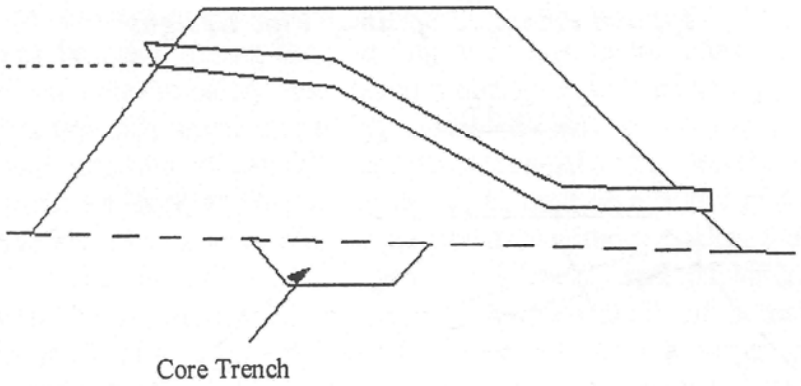
Barrel and Riser

(medium and larger watershed ponds, excavated ponds)



Trickle Tube

(Less than 10-acre watershed)



FISH STOCKING

A common feature in building a pond is to create an environment for fish that will sustain them through the winter. This can be done by making at least 25 percent of the area of the pond eight feet deep or more. Bass, bluegill, and channel catfish are the most desirable species for warm-water ponds in this area. You should know the surface area of your pond when buying fish stock for a newly constructed pond.

Stocking Recommendations for Ohio Ponds

FINGERLINGS: (3-5 inches)	100 large mouth bass per acre 300 bluegill or redear sunfish per acre
IF LARGER FISH STOCKED	4 - 6 inch bass => 50 per acre 2 - 4 inch bluegill => 150—200 per acre
FATHEAD MINNOW:	500 per acre minimum Usual cost approx. $7 - $8 with around 200 minnows per pound

Optional Stocking Sequence

FIRST YEAR:	minnows and bass
SECOND YEAR:	bluegill, redear sunfish, and catfish
THIRD YEAR:	channel catfish, grass carp, etc.

Large mouth bass

Redear sunfish

Bluegill

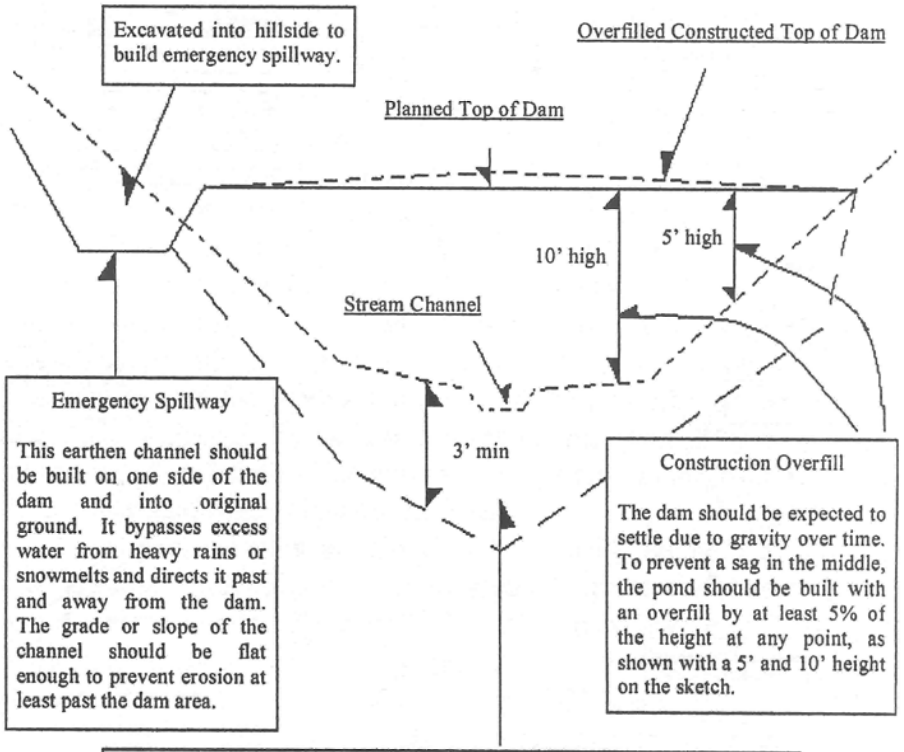
Grass carp

Channel catfish

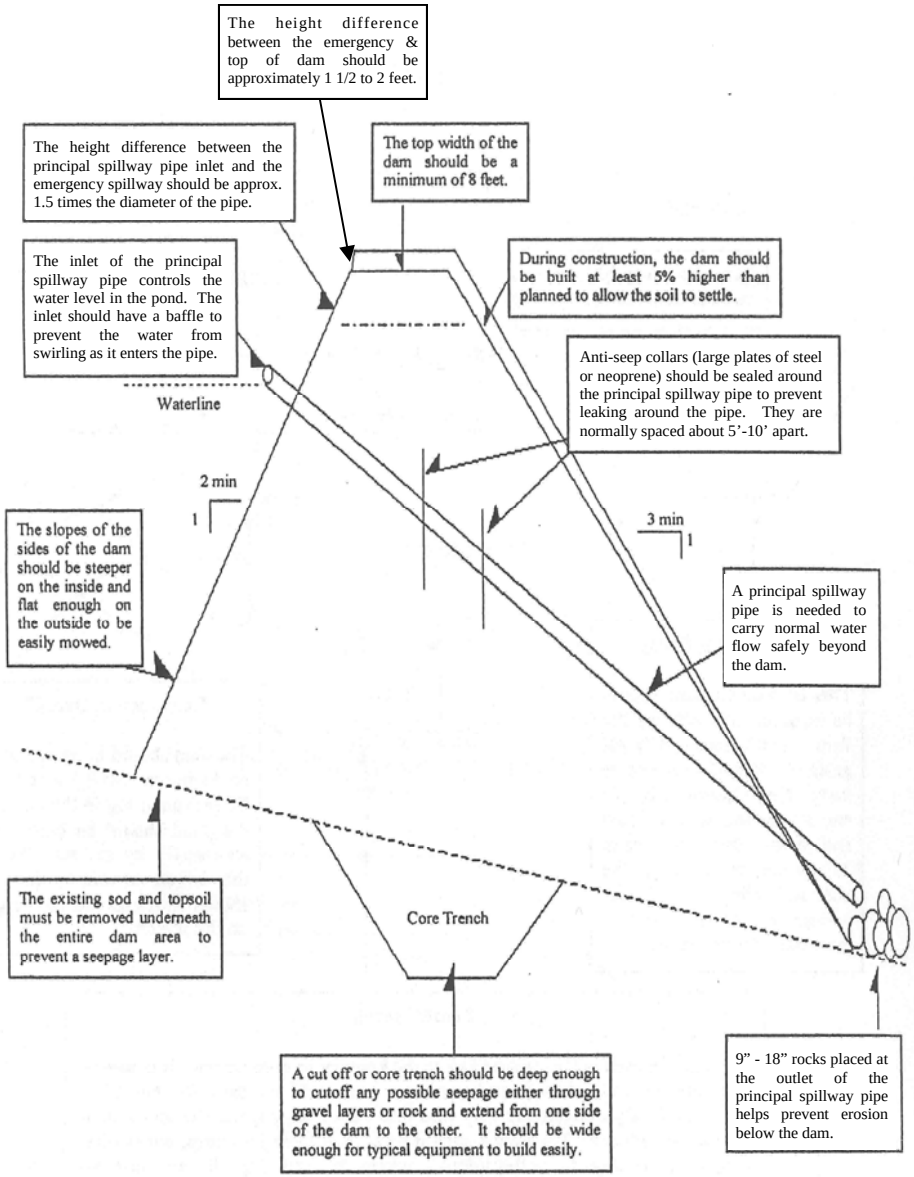
AERATION

Dissolved oxygen is the single most important water quality parameter in lakes and ponds. All fish and most other aquatic organisms depend on dissolved oxygen for life. The minimum amount of dissolved oxygen required for fish to survive is 5 parts per million (ppm). Nearly all Ohio ponds under normal circumstances have oxygen levels that exceed this amount. Under natural conditions, plant life and surface diffusion from the air produce oxygen. This is distributed in the water by wind currents and by diffusion. These processes are adequate to satisfy the oxygen demands of the fish and other organisms under normal conditions. The exception might be an extremely hot, still summer day or prolonged ice and snow cover on top of a pond during the winter. Older ponds (over 30 years old) are much more susceptible to summer and winter oxygen problems because of the amount of accumulated organic matter on the bottom that uses up oxygen as it decays. This situation can lead to oxygen reductions in deeper water and fish kills can occur.

Aeration equipment can be purchased from fish and pond equipment suppliers to help overcome oxygen problems, especially in older ponds. Having a bottom-diffuser type aeration unit will keep the pond from stratifying during the warmer months. This allows the fish to have adequate oxygen levels from the top of the pond to the bottom. In general, the older a pond is, the more it will benefit from supplemental aeration. The most efficient systems use a bottom diffuser in one or two locations powered by an air compressor on shore. Compressors and diffusers are sized according to how large and deep the pond is. Most compressors are between 1/3 and 1 horsepower (hp). Power requirements for a 1 hp pump would increase electric costs for the pond owner by approximately $72 per month, assuming 10 cents per kilowatt hour, 1/2 hp would be $36 per month and 1/3 hp would be $24 per month. Approximate costs for an aeration system vary between $800 and $1,500 for a typical system.



Dam Profile
Not to Scale



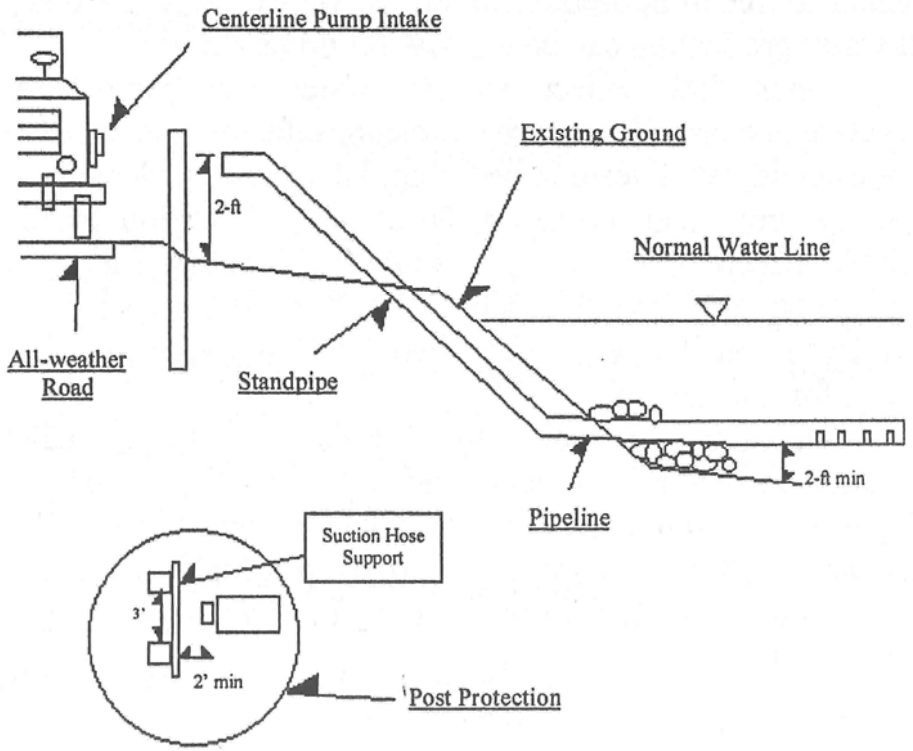
Dam Cross Section
Not to Scale

FIRE PROTECTION

The dry fire hydrant is an excellent way to extract water from a pond. In many areas of the state, fire insurance rates have been reduced by having a network of these structures in the rural community.

Frequent concerns about dry hydrants are that they will destroy the fish and ruin the aesthetics of the pond. The use of a hydrant to put out a house fire will not impact the fish or wildlife population, nor will you see much difference in the water level. Recommended water depth is 8' minimum. A minimum of 30,000 gallons (1.1 acre-inches) of pumpable impoundment water or a minimum pump flow rate of 250 gpm without interruption for 2 hours is considered a dependable water supply. The site must be easily accessible for fire equipment.

Contact your local fire department or the Fairfield Soil and Water Conservation District for details on installing a dry hydrant systems.



Normally the liner is covered with 12 inches of soil to anchor the material and to guard it from ultraviolet light and any herbicides or other chemicals used in the pond at a later date. This soil cover can be troublesome on side slopes due to sloughing. Vandalism can be an issue as well. If the liner is punctured, the seal is broken and the pond water level will begin to fluctuate. Biodegradation of organic matter in the subsurface layer of soil or a rising water table can cause upward movement of gases which can expel the air from soil voids. If either of these problems are likely to occur based on your site conditions, the installation of a geotextile material sufficient to handle the estimated flows would be required to release the gases.

Alternative Water Sources for Rural Areas

Clean water can be taken for granted. Homeowners not served by public water systems generally turn to drilled wells as a potential source of household water. However, there are areas where well water production can be too low for domestic use.

Ponds that collect surface water can provide a good alternative and provide a source of clean, safe, and inexpensive water for livestock watering, lawns and gardens, swimming pools, or any other home or farm use. Optimum water quality is found at a depth of 12" to 36" regardless of total pond depth.

Managing the pond for weeds and algae, maintaining vegetation in the drainage area, and restricting the use of chemicals and pesticides within the watershed can protect the quality of the pond water. It is also important to consult state and local health departments to get the current regulations when planning a pond water system.

Pond Safety

Ponds can be enjoyed by everyone. Unfortunately, ponds are often the sites of accidents and drowning. Liability may increase for non-posted, non-fenced ponds. Making your pond as safe as possible should be a priority for every pond owner.

- Restrict entry to your pond to keep out uninvited guests.
- Keep rescue devices near your pond and readily accessible.
- Remove submerged safety hazards.
- Mark safe swimming areas with floats.
- Have your pond tested for any suspected contamination.
- Assure that guests and family members know how to swim.
- NEVER SWIM ALONE!

Construction Notes

POND AREA IN ACRES

LENGTH - FEET

WIDTH Feet	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
100	0.230	0.344	0.459	0.574	0.689	0.803	0.918	1.03	1.15	1.26	1.38	1.49	1.61	1.72	1.84	1.95	2.07	2.18	2.30
150	0.344	0.517	0.689	0.861	1.03	1.21	1.38	1.43	1.72	1.89	2.07	2.24	2.41	2.58	2.75	2.93	3.10	3.27	3.44
200	0.459	0.689	0.918	1.15	1.38	1.61	1.84	2.07	2.30	2.53	2.75	2.98	3.21	3.44	3.67	3.90	4.13	4.36	4.59
250	0.574	0.861	1.15	1.43	1.72	2.01	2.30	2.58	2.87	3.16	3.44	3.73	4.02	4.30	4.59	4.88	5.17	5.45	5.74
300	0.689	1.03	1.38	1.72	2.07	2.41	2.75	3.10	3.44	3.79	4.13	4.48	4.82	5.17	5.51	5.85	6.20	6.54	6.89
350	0.803	1.21	1.61	2.01	2.41	2.81	3.21	3.62	4.02	4.49	4.82	5.22	5.62	6.03	6.43	6.83	7.23	7.63	8.03
400	0.918	1.38	1.84	2.30	2.75	3.21	3.67	4.13	4.59	5.05	5.51	5.97	6.43	6.89	7.35	7.81	8.26	8.72	9.18
450	1.03	1.43	2.07	2.58	3.10	3.62	4.13	4.65	5.17	5.68	6.20	6.71	7.12	7.75	8.26	8.78	9.30	9.81	10.3
500	1.15	1.72	2.30	2.87	3.44	4.02	4.59	5.17	5.74	6.31	6.89	7.46	8.03	8.61	9.18	9.76	10.3	10.9	11.5
550	1.26	1.89	2.53	3.16	3.79	4.42	5.05	5.68	6.31	6.94	7.58	8.21	8.84	9.47	10.1	10.7	11.4	12.0	12.6
600	1.38	2.07	2.75	3.44	4.13	4.82	5.51	6.20	6.89	7.58	8.26	8.95	9.64	10.3	11.0	11.7	12.4	13.1	13.8
650	1.49	2.24	2.98	3.73	4.48	5.22	5.97	6.71	7.46	8.21	8.95	9.70	10.4	11.2	11.9	12.7	13.4	14.2	14.9
700	1.61	2.41	3.21	4.02	4.82	5.62	6.43	7.12	8.03	8.84	9.64	10.4	11.2	12.0	12.9	13.7	14.5	15.3	16.1
750	1.72	2.58	3.44	4.30	5.17	6.03	6.89	7.75	8.61	9.5	10.3	11.2	12.0	12.9	13.8	14.6	15.5	16.4	17.2
800	1.84	2.75	3.67	4.59	5.51	6.43	7.35	8.26	9.18	10.1	11.0	11.9	12.9	13.8	14.7	15.6	16.5	17.4	18.4
850	1.95	2.93	3.90	4.88	5.85	6.83	7.81	8.78	9.76	10.7	11.7	12.7	13.7	14.6	15.6	16.5	17.6	18.5	19.5
900	2.07	3.10	4.13	5.17	6.20	7.23	8.26	9.30	10.3	11.4	12.4	13.4	14.5	15.5	16.5	17.6	18.6	19.6	20.7
950	2.18	3.27	4.36	5.45	6.54	7.63	8.72	9.81	10.9	12.0	13.1	14.2	15.3	16.4	17.4	18.5	19.6	20.7	21.8
1000	2.30	3.44	4.59	5.74	6.89	8.03	9.18	10.3	11.5	12.6	13.8	14.9	16.1	17.2	18.4	19.5	20.7	21.8	23.06

Clearing

The first step in the construction of a pond is clearing the area of brush, roots, vegetation and other unsuitable materials. Care must be taken to assure that all tree roots are removed under the dam. Topsoil is stockpiled for later use on the front of the dam to encourage vegetative growth. Clearing should also include the area that will be under water.

Dam Layout

Once the site is cleared, the centerline of the dam is laid out. The core trench will be constructed along this centerline by removing at least 3' depth of material the width of the excavation equipment used. If questionable soils are noted, excavate below that material and re-compact with suitable clay. Otherwise see compaction for replacement of the removed material. This will ensure that water will not leak under the dam. Also measure your 3:1 or flatter back slope to ensure the toe is far enough from any property line to meet your local zoning.

Compaction

Proper compaction is important to block seepage and prevent dam failure. Earth fill material should have an appropriate clay and moisture content. The moisture content of the fill prior to compaction must be suitable to form a handheld ball that does not break apart. Compacted earth fill required to build the dam and core trench should be placed in uniform layers with a maximum pre-compacted thickness of 6".

Each layer of fill should be uniformly tracked by a minimum of 4 passes with a sheepsfoot roller having a minimum compaction of 200 psi. The "feet" of the roller should have contact with the previously compacted layer. The dam should be built to the full design height with compacted layers. Once built, place 6"-12" of topsoil over the dam and disturbed areas to be seeded to establish good grass cover.

Spillways

The pond must allow water to bypass safely. A typical pond has two structures called a principal spillway and emergency spillway; however, they can be combined in some cases. The principal spillway is the main structure usually in the form of a pipe. The pipe size is determined by the amount of runoff, drainage area, pipe material, pipe slope through the dam and how much storage area can be backed up behind the dam. The principal spillway should pass the 2-year or routed 2-year storm event quantity. Anti-seep collars should be placed on the pipe to prevent leaking. Around the pipe be should hand compacted until mechanical means can assure uniform compaction.

The secondary structure is the emergency spillway. It directs excess flow to a safe outlet during large rains. The emergency is typically notched out near the edge of the dam and never on filled material. This will be a wide flat area at least 1 to 2 feet lower than the top of dam. The emergency spillway should be designed to handle either the 10-year or 25-year storm quantity (depending on size of pond) minus the quantity of water the principal spillway is accepting. It should be planted with high velocity and water tolerant grass such as turf type or tall fescue to form a dense sod.

Use and Maintenance

All ponds require maintenance for proper operation. The landowner should check the inlet of the principal spillway pipe regularly and remove the debris that collects around the pipe. The outlet of the pipe should be checked for erosion. The dam should be checked regularly for signs of seepage, especially along the edges, bottom or toe of the dam, and along the principal spillway pipe. The owner should inspect the dam for any signs of excess settlement, including slips on the inside or outside face of the dam. Remove any woody vegetation over the principal spillways and control invasive plant growth. Maintain the shape and height of the dam. Problems to look for in the emergency spillway include sparse vegetation, small rills or gullies, and debris buildup. If any of these problems are found they should be corrected as soon as possible.

The landowner should ensure that all safety equipment and signs are in working order and properly maintained. Any docks, rafts, or boats should be inspected regularly for safety. If a safety or privacy fence was built, it should be properly maintained to keep its original function. Pond dams and spillways should be protected from trampling by livestock with adequate fencing.

Beavers, muskrats, and other wildlife are attracted to ponds. If not properly controlled, beavers and muskrats can threaten the structural integrity of the dam by burrowing or plugging up the principal spillway pipe. Wildlife should not be allowed to impair the proper functioning of a pond and its related structures.

One of the most common maintenance problems is unwanted vegetation both in and around the pond. For weed control in the pond, contact the Fairfield Soil and Water Conservation District. The first step in control of nuisance vegetation around the pond begins with proper construction. The pond's bottom should slope a minimum of 3 to 1 from the pond edge to minimize the area of shallow water. Many older ponds have trees growing on the backside of the dam. Their roots act like small pipes through the dam and allow water to slowly leak past the dam. Annual mowing of the dam and spillway keeps unwanted woody vegetation out of these areas. The pond should be built with slopes that allow access for mowing. Typically, the steepest slope that is safe to mow is 3 to 1.

Pond Liners

There are two alternatives for holding water on a site where the soil is too permeable to hold water naturally. The first option is to import clay from another site and incorporate it into the pond bottom before the pond fills with water. Bentonite clay that is available in 40 pound bags is another option. Clay products are cheaper and easier to install than textile liners. Both excavated clay and bentonite should be mixed with existing soil and compacted with heavy equipment, such as a sheepsfoot roller.

If clay is not available or practical to use, textile liners are another option for sealing ponds. These liners may be made of polyethylene, PVC or rubber. When using these products make sure that the thickness (mils) of the material is suitable for pond use. A minimum number of mils would likely exceed 5. These liners can be custom ordered but are not generally an option for larger ponds because of the cost of the materials.