8-4-96

Bois D Arc HOA
Architectural Committee
Pond Specification/Maintenance Policies

Permit: Fort Bend County Engineer

Excavation ponds only. No embankment ponds due to sensitive drainage in the area

LOCATION

All pond area to be behind the 100 ft building line.
Ex: 100 ft from front property line.

DESIGN *

Depth: 7 ft min.. (5ft for fish, 2 ft for evaporation)
Slope: 4 ft slope for every 1 ft depth
Bottom Length: 44 ft min.
Bottom Width: 34 ft min.
* Reference "Soil Considerations in Pond Construction" page 44

MAINTENANCE

Grass around pond to be maintained to a maximum height of 8 inches.
Water level to be maintained to a minimum of 5 ft.
Stock pond with top feeding fish such as Gambusia minnows to reduce mosquito breeding.
After construction, immediately seed banks with Common Hull Bermuda to avoid erosion.

SUGGESTIONS

Excavated ponds should have careful consideration to soil. Bore test holes at intervals over the proposed area to determine type of material present. Should pours material such as sand be present, construct a clay blanket 1 ft deep and compress to prevent seepage.

SOIL CONSIDERATIONS IN POND CONSTRUCTION

B.L. Harris*

Selection of the location for a pond is of major importance in reducing time, labor, and expense involved in construction and maintenance. Careful planning initially, with full consideration of the types of soil materials involved, will pay huge dividends and save countless frustrations. A considerable amount of information is available about soils, most of which is free-of-charge from public agencies. Understanding soil properties and knowing where to find information is important to anyone interested in pond construction or renovation.

POND TYPES

Ponds can be classified in two groups—embankment ponds and excavated ponds. Embankment ponds impound water primarily above the ground level. This type of pond is best suited to sloping locations. Surface water is usually relied on to fill these ponds.

Excavated ponds are dug into the soil so that water is impounded primarily below ground level. Such ponds normally are constructed on relatively flat lands where embankment ponds would be impractical. Either surface water or ground water seepage fills the excavated reservoir.

Pumped water can be used as a primary or supplemental source of water for either pond type. However, because of the expenses involved, it is usually best to choose a site where pumping can be minimized if not avoided altogether.

Successful construction of either type of pond depends on the capability of the soils in the reservoir area to hold water and to provide stable sideslopes and dams. Sites must be carefully selected.

SOIL CONSIDERATIONS FOR EMBANKMENTS

Ratings of soils for embankments usually are made on the basis of soil mixtures to a dept of about 5 feet. Unsuitable material beneath the dam or embankment is generally discovered during the necessary on-site geologic investigations.

Problem soil characteristics for embankments include:

a. Ice—This is not considered a major restrictive feature in Texas, but is included here for completeness. In some areas of the U.S., it is of major importance.

b. Thin soil—This restriction relates to the difficulty of obtaining sufficient soil material to form the embankment, as well as to problems encountered with the operation of equipment.

c. Seepage—This characteristic is a major consideration throughout most of the state. Seepage affects the stability of the embankment, as well as the safety of people and structures downstream. Seepage, in this case, does not refer to loss of water through the bottom pond, but to that moving through the embankment.

d. Piping—This term describes a characteristic of soils with relatively high contents of silts and/or very find sands. When these materials become saturated they tend to flow, which results in mass wasting either at the surface or in tunnels through the embankment. Entire embankments may be lost due to this process.

e. Excess humus—Soils which contain an excess of organic matter do not compact well, thus create an unstable embankment. Excess grass, leaves, stumps or like material likewise, should be keep out of the embankment.

f. Compaction problems—Soil materials which do not compact to maximum density, for whatever reason, will not form a stable and usable embankment. Compaction is necessary to reduce the permeability of the embankment and to prevent settling problems following construction. Organic materials, poorly graded soils or other similar materials may cause problems. Rocks and stones also may interfere. Soil should have a favorable moisture content for compaction—not too wet and not too dry.

g. Large stones—Stones present a problem for equipment during construction and also lead to poor compaction. Because of the cost of removing stones, soils containing many large stones are rated as having severe limitations.

h. Ponding and wetness—Soils which retain excess moisture create problems in constructing embankments. Adequate compaction is usually impossible to obtain under such conditions, and trafficability is greatly reduced. There also may be other equipment problems.

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i. Excess sodium or other salts—Soils with high levels of sodium or other salts may be easily dispersed, highly erosive, and susceptible to piping. Salts also create severe problems in establishing vegetation on the embankment and cause corrosion of metal structures. Resultant water quality also may be poor.

SOIL CONSIDERATIONS FOR POND RESERVOIR AREAS

The pond reservoir area is that area which holds the water behind an embankment or in an excavated pit. For this use, soils generally are rated on their properties within the upper 60 inches. Soils are evaluated as to their permeability against seepage losses without regard to cutoff trenches or other features that may be installed under the pond embankment.

Important soil characteristics for pond reservoir areas include (Table 1):

a. Permeability—This term describes the potential for loss of water by seepage downward or laterally.
b. Coarse-textured layer—Even though the overall permeability of the soil material may be low, the occurrence of a thin, highly permeable layer such as a sand or gravel lense may cause serious seepage problems.
c. Cemented pan—Such restrictive layers frequently interfere with equipment usage, reservoir excavations, and compaction. Cemented pans frequently overlie more permeable materials and, once fractured, commonly become a source of continuing seepage losses.
d. Bedrock—Hard rock can be a severe problem, particularly in the use of construction equipment. Fractured bedrock is very difficult to seal against seepage losses.
e. Slope—Steep slopes present many problems. If the slope is perpendicular to the embankment, the storage capacity of the reservoir area will be reduced greatly. Steep slopes also causes excessive runoff during heavy rainstorm, which can create safety problems. Equipment usage may be restricted.
f. Marl/gypsum—These relatively soluble soil materials frequently cause both water quality problems and seepage losses.

SOIL CONSIDERATIONS FOR AQUIFER-FED EXCAVATED PONDS

The ponds are created by excavating a pit which intersects an aquifer. Therefore, underground water is the primary source of water to fill such ponds. Important characteristics of aquifer-fed excavated ponds are (Table 2):

a. Water depth—The depth to the aquifer water is an important consideration. Where water is too deep to be intersected easily or is unreliable, severe limitations exist. Perched water tables frequently result in an unreliable wate source.
b. Permeability—The refill rate for aquifer-fed ponds is directly related to the permeability of the soil. Permeability may be so slow that inflow outpaces evaporation and consumption. However, permeability of the basin must be adequate to prevent excess seepage losses.
c. Salinity—Highly saline water may be toxic to fish and restrict other uses accordingly.
d. Stones—The occurrence of large stones hampers the use of equipment for excavation or embankment or dike construction.
e. Bedrock—The dept of bedrock is an important concern because of its limitations for equipment use.
f. Stability—In some cases, the soil may be so unstable that the bank caves and pit depth cannot be maintained.

SEEPAGE CONTROL

When ponds lose water because of excessive seepage, it is usually because a poor site with high soil permeability has been selected. However, seepage losses can be ameliorated in several ways, such as:

a. Compaction—Compaction is a particularly effective technique of reducing seepage, especially where the soil being compacted is well-graded, (that is, it contains all particle sized from small gravel to find sands, silts and clays). This is also an inexpensive method of pond sealing. This practice involves mixing the soil to a depth of 8 to 10 inches with a disk, rototiller or similar equipment, removing rocks, roots limbs and stumps, and then compacting the loosened soil with a sheep's foot roller or similar equipment.
b. Clay blankets—When a pond has been constructed in relatively coarse-grained soils, clay can be layered over the soil and compacted to reduce seepage losses. The blanket should cover the entire impoundment basin. The thickness of the blanket is determined by the depth of the water anticipated and the characteristics of the material used for the blanket.
c. Bentonite—This is a special type fo clay which swells greatly when wet. This material is used to blanket the impoundment basin. The rate of application depends upon the nature of the soil being covered and the depth of the water anticipated.
d. Chemical additives—There are various kinds of chemicals designed to breakdown aggregates and disperse clay particles, thus sealing the ponds. Such treatments are effective primarily for medium to fine-textured soils.

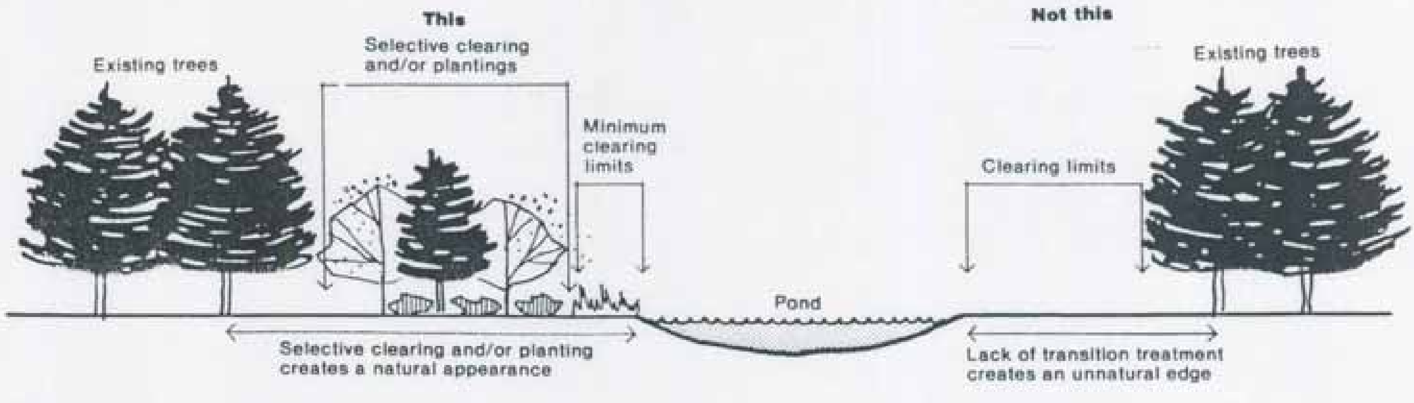

Figure 30. Feathering vegetation at the pond's edge makes a natural transition with existing vegetation.

Install barrels and antiseep collars and tamp the selected backfill material around the entire trickle tube structure before placing the earthfill for the dam. The same procedure applies to all other pipes or conduits.

Excavating the Earth Spillway. The completed spillway excavation should conform as closely as possible to the lines, grades, bottom width, and side slopes shown on the plans and staked on the site. Leave the channel bottom transversely level to prevent meandering and the resultant scour within the channel during periods of low flow. If it becomes necessary to fill low places or depressions in the channel bottom caused by undercutting the established grade, fill them to the established grade by placing suitable material in 8-inch layers and compacting each layer under good moisture conditions.

Building the Dam. Clear the dam and spillway area of trees, brush, stumps, boulders, sod, and rubbish. The sod and topsoil can be stockpiled and used later to cover the dam and spillway (fig. 32 p. 42). This will help when vegetation is established. Get suitable fill material from previously selected borrow areas and from sites of planned excavation. The material should be free of sod, roots, stones more than 6 inches in diameter, and any material that could prevent the desired degree of compaction. Do not use frozen material or place fill material on frozen foundations.

Selected backfill material should be placed in the core trench and around pipes and antiseep collars. The material should be compacted by hand tamping or manually directed power tampers. Begin placing fill material at the lowest point and bring it up in horizontal layers approximately 8 inches thick. Do not place fill in standing water. If the material can be formed into a firm ball that sticks together, the moisture content is adequate for compaction. Laboratory tests of the fill material and field testing of the soil for moisture and compaction may be necessary for large ponds or special conditions.

If the material varies in texture and gradation, use the more impervious (clay) material in the core trench, center, and upstream parts of the dam.

Construction equipment can be used to pack fill in an ordinary pond. Equipment with rubber tires can be routed so each layer is covered by a tire track. For dams over 20 feet high, special equipment such as sheepsfoot rollers should be used.

Excavated Ponds

Excavated ponds are the simplest to build in relatively flat terrain. Because their capacity is obtained almost solely by excavation, their practical size is limited. They are best suited to locations

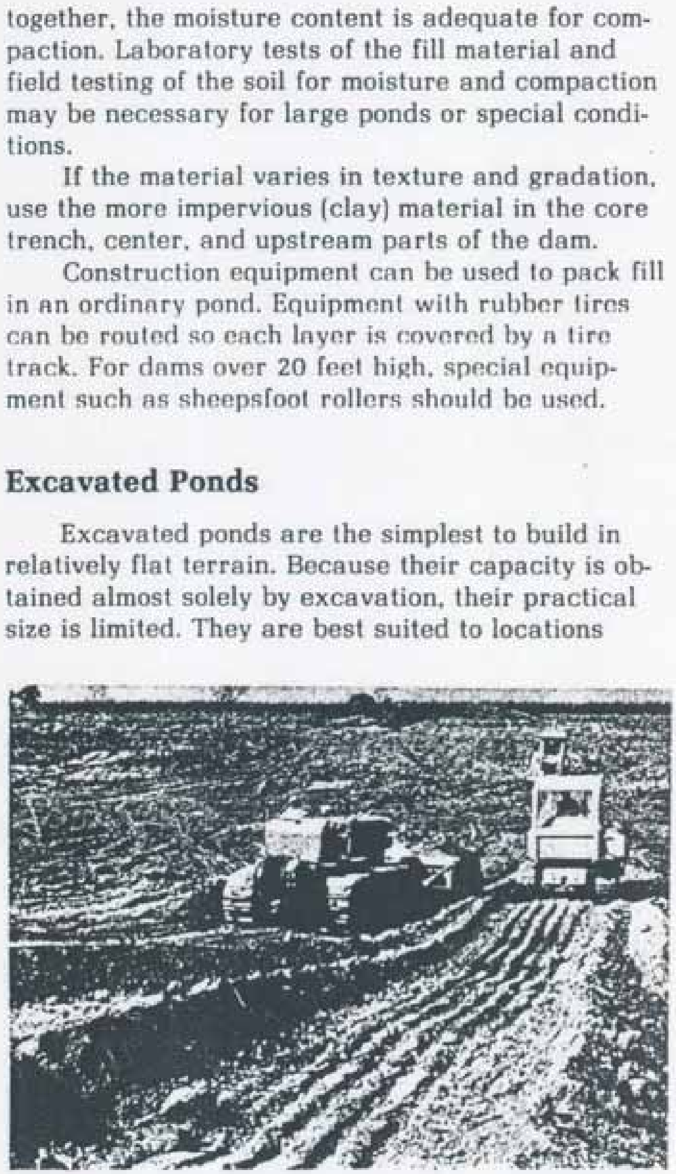

Figure 31. A pond in early stages of construction.

where the demand for water is small. Since excavated ponds can be built to expose a minimum water surface area in proportion to their volume, they are advantageous in places where evaporation losses are high and water is scarce. The ease with which they can be constructed, their compactness, their relative safety from flood-flow damage, and their low maintenance requirements make them popular in many sections of the country.

There are two kinds of excavated ponds. One is fed by surface runoff and the other is fed by groundwater aquifers, usually layers of sand and gravel. Some ponds may be fed from both of these sources.

The general location of an excavated pond depends largely on the purpose or purposes for which the water is to be used and on other factors discussed previously in this handbook. The specific location is often influenced by topography.

Excavated ponds fed by surface runoff can be located in almost any kind of topography. They are, however, most satisfactory and most commonly used in areas of comparatively flat but well-drained terrain. A pond can be located in a broad natural drainageway or to one side of a drainageway if the runoff can be diverted into the pond. The low point of a natural depression is often a good location. After the pond is filled, excess runoff escapes through regular drainageways.

Excavated ponds fed by ground-water aquifers can be located only in areas of flat or nearly flat topography. If possible, they should be located where the permanent water table is within a few feet of the surface.

Soils

If an excavated pond is to be fed by surface runoff, enough impervious soil at the site is essential to avoid excess seepage losses. Sites where fine-textured clays and silty clays extend well below the proposed pond depth are most desirable. Sites where sandy clays extend to adequate depths usually are satisfactory. Avoid sites where soils are porous or are underlain by strata of coarse-textured sands or sand-gravel mixtures unless you are prepared to bear the expense of an artificial lining. Avoid soils underlain by limestone containing crevices, sinks, or channels.

The performance of nearby ponds that are fed by runoff and in a similar soil is a good indicator of the suitability of a proposed site. Supplement such observations of existing ponds by boring enough test holes at intervals over the proposed pond site to determine accurately the kind of material there. You can get some indication of permeability by filling the test holes with water. The seepage indicates what to expect of a pond excavated in the same kind of material.

If an excavated pond is to be fed from a water-bearing sand or a sand-gravel layer, the layer must be at a depth that can be reached practically and economically by the excavating equipment. This depth seldom exceeds 20 feet. The water-bearing layer must be thick enough and permeable enough to yield water at a rate that satisfies the maximum expected demand for water and overcomes evaporation losses.

Thoroughly investigate sites proposed for aquifer-fed excavated ponds. Bore test holes at intervals over the site to determine the existence and physical characteristics of the water-bearing material. The water level in the test holes indicates the normal water level in the completed pond. The vertical distance between this level and the ground surface determines the volume of overburden or excavation needed that does not contribute to the usable pond capacity but may increase the construction

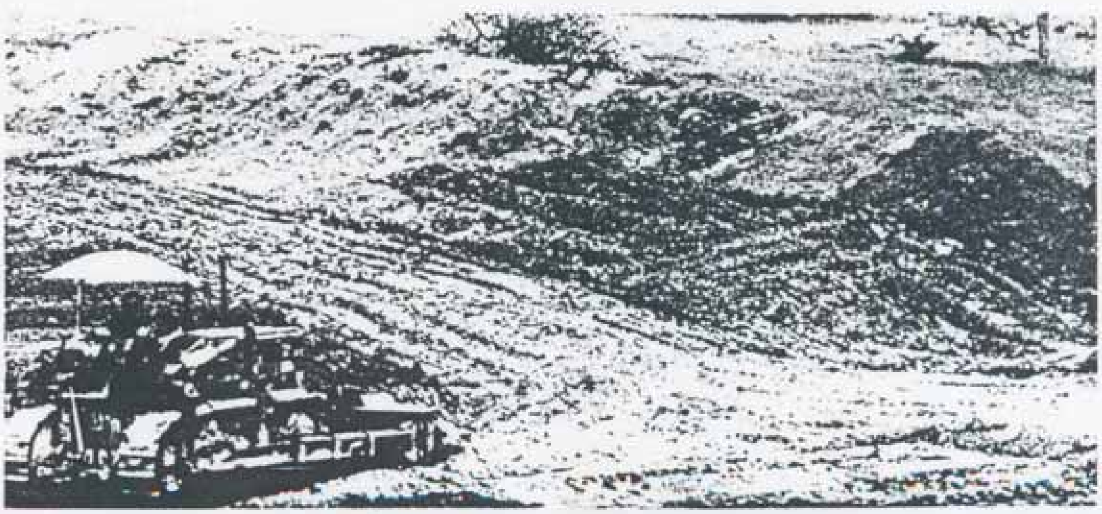

Figure 32. Sod and topsoil are stockpiled for later use.

cost considerably. From an economic standpoint, this vertical distance between water level and ground surface generally should not exceed 6 feet.

Check the rate at which the water rises in the test holes. A rapid rate of rise indicates a high-yielding aquifer. If water is removed from the pond at a rapid rate, as for irrigation, the water can be expected to return to its normal level within a short time after removal has ceased. A slow rate of rise in the test holes indicates a low-yielding aquifer and a slow rate of recovery in the pond. Check the test hole during drier seasons of the year to avoid being misled by a high water table that is only temporary.

Spillway and Inlet Requirements

If you locate an excavated pond fed by surface runoff on sloping terrain, you can use a part of the excavated material for a small low dam around the lower end and sides of the pond to increase its capacity. You need an earth spillway to pass excess storm runoff around the small dam. Follow the procedures for planning the spillway and provide protection against erosion as discussed on page 41.

Ponds excavated in areas of flat terrain usually require prepared spillways. If surface runoff must enter an excavated pond through a channel or ditch rather than through a broad shallow drainageway, the overfall from the ditch bottom to the bottom of the pond can create a serious erosion problem unless the ditch is protected. Scouring can occur in the side slope of the pond and for a considerable distance upstream in the ditch. The resulting sediment tends to reduce the depth and capacity of the pond. Protect by placing one or more lengths of rigid pipe in the ditch and extend them over the side slope of the excavation. The extended part of the pipe or pipes can be either cantilevered or supported with timbers. The diameter of the pipe or pipes depends on the peak rate of runoff that can be expected from a 10-year frequency storm. If you need more than one pipe inlet, the combined capacity should equal or exceed the estimated peak rate of runoff.

Figure 33. A pond may be excavated in a geometric form, then graded to create a more natural configuration.

Pipe diameter[1] (inches)	Pond inflow Q (ft^3/sec)
15	0 to 6
18	6 to 9
21	9 to 13
24	13 to 18
30	18 to 30
36	30 to 46
42	46 to 67
48	67 to 92
54	92 to 122
60	122 to 158

[1]Based on a free outlet and a minimum pipe slope of 1.0 percent with the water level 0.5 foot above the top of the pipe at the upstream end.

In areas where a considerable amount of silt is carried by the inflowing water, you should provide a desilting area or filter strip in the drainageway immediately above the pond to remove the silt before it enters the pond. This area or strip should be as wide as or somewhat wider than the pond and 100 feet or more long. After you prepare a seedbed, fertilize and seed the area to adapted perennial grasses. As the water flows through the grass, the silt settles out and the water entering the pond is relatively silt free.

Planning the Pond

Although excavated ponds can be built to almost any shape desired, a rectangle is commonly used in relatively flat terrain. The rectangular shape is popular because it is simple to build and can be adapted to all kinds of excavating equipment.

The rectangular shape should not be used, however, where the resulting straight lines would be in sharp contrast to surrounding landscape patterns. A pond can be excavated in a rectangular form and the edge shaped later with a blade scraper to create an irregular configuration (fig. 33).

The capacity of an excavated pond fed by surface runoff is determined largely by the purpose or purposes for which water is needed and by the amount of inflow that can be expected in a given period. The required capacity of an excavated pond fed by an underground water-bearing layer is difficult to determine because the rate of inflow into the pond can seldom be estimated accurately. For this reason, the pond should be built so that it can be enlarged if the original capacity proves inadequate.

Selecting the Dimensions. The dimensions selected for an excavated pond depend on the required capacity. Of the three dimensions of a pond, the most important is depth. All excavated ponds should have a depth equal to or greater than the minimum required for the specific location. If an excavated pond is fed from ground water, it should be deep enough to reach well into the water-bearing material. The maximum depth usually is determined by the kind of material excavated and the type of equipment used.

The type and size of the excavating equipment can limit the width of an excavated pond. For example, if a dragline excavator is used, the length of the boom usually determines the maximum width of excavation that can be made with proper placement of the waste material.

The minimum length of the pond is determined by the required pond capacity.

The side slopes are generally no steeper than the natural angle of repose of the material being excavated in order to prevent sloughing. This angle varies with different soils, but for most ponds the side slopes are 4:1 or ~~flatter~~ (fig. 34).

If the pond is to be used for watering livestock, provide a ramp with a flat slope (4:1 or flatter) for access. Regardless of the intended use of the water, these flat slopes are necessary if certain types of excavating equipment are used. Tractor-pulled wheeled scrapers and bulldozers require a flat slope to move material from the bottom of the excavation.

Estimating the Volume. After you have selected the dimensions and side slopes of the pond, estimate the volume of excavation required. This estimate determines the cost of the pond and is a basis for inviting bids and for making payment if the work is to be done by a contractor.

The volume of excavation required can be estimated with enough accuracy by using the prismoidal formula:

$$V = \frac{(A + 4B + C)}{6} \times \frac{D}{27}$$

where

- V = volume of excavation in cubic yards
- A = area of the excavation at the ground surface in square feet
- B = area of the excavation at the middepth point (1/2 D) in square feet
- C = area of the excavation at the bottom of the pond in square feet
- D = average depth of the pond in square feet
- 27 = factor converting cubic feet to cubic yards

As an example, assume a pond with a depth, D, of 12 feet, a bottom width, W, of 40 feet, and a bottom length, L, of 100 feet as shown in figure 34. The side slope at the ramp end is 4:1 and the remaining slopes are 2:1. The volume of excavation, V, is computed as follows:

$$\begin{aligned} A &= 88 \times 172 &&= 15{,}136 \\ 4B &= 4(64 \times 136) &&= 34{,}816 \\ C &= 40 \times 100 &&= 4{,}000 \\ &(A + 4B + C) &&= 53{,}952 \end{aligned}$$

then

$$V = \frac{53{,}952}{6} \times \frac{12}{27} = 3{,}996 \text{ yd}^3$$

If the normal water level in the pond is at the ground surface, the volume of water that can be stored in the pond is 3,996 cubic yards times 0.00061983, or 2.48 acre-feet. To convert to gallons,

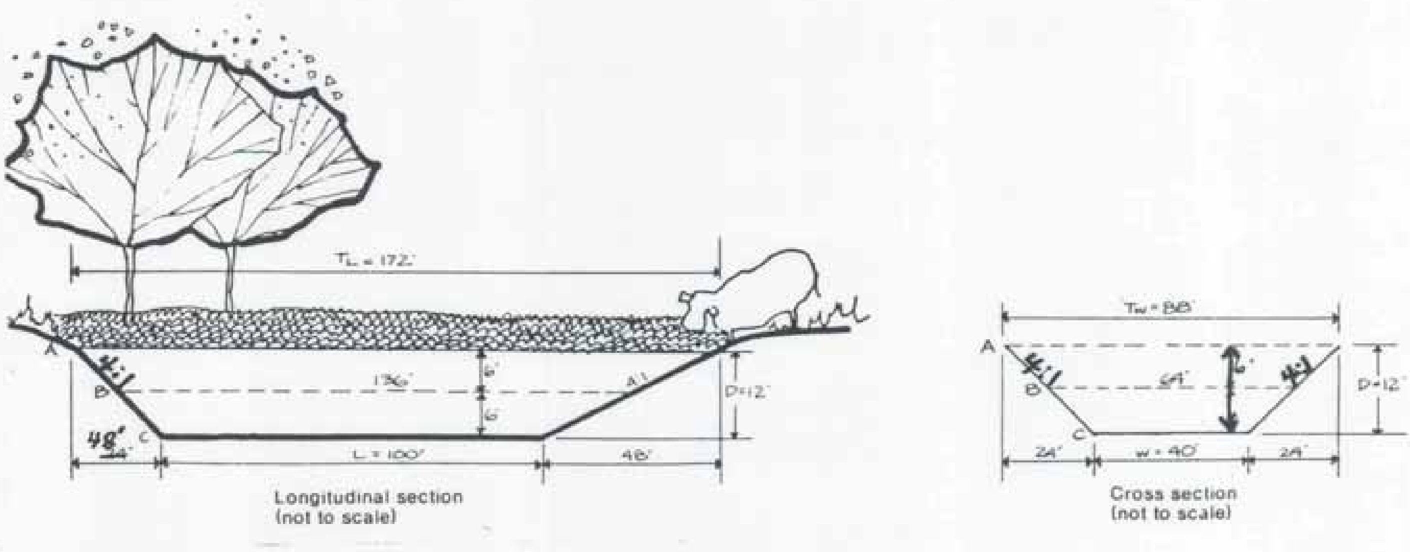

Figure 34. Typical sections of an excavated pond.

able material and compact it thoroughly. Reseed or resod these areas and fertilize as needed. If the upstream face of the earthfill shows signs of serious washing or sloughing because of wave action, install protective devices such as booms or riprap. If there is evidence of seepage through or under the dam, consult an engineer at once so that you can take proper corrective measures before there is any serious damage.

To maintain the protective plant cover on the dam and on the earth spillway, mow it frequently and fertilize when needed. Mowing prevents the growth of woody plants where undesirable and helps develop a cover and root system more resistant to runoff. If the plant cover is protected by fencing, keep the fences in good repair.

Keep trickle tubes, trash racks, outlet structures, valves, and watering troughs free of trash at all times.

In some localities burrowing animals such as badgers, gophers, and prairie dogs cause severe damage to dams or spillways. If this damage is not repaired, it may lead to failure of the dam. A heavy layer of sand or gravel on the fill discourages burrowing to some extent. Poultry netting can be used, but in time it rusts out and needs to be replaced.

Keep the water in your pond as clean and unpolluted as possible. Do not permit unnecessary trampling by livestock, particularly hogs. If fencing is not practical, pave the approaches to the pond with small rocks or gravel. Divert drainage from barn lots, feeding yards, bedding grounds, or any other source of contamination away from the pond. Clean water is especially important in ponds used for wildlife and recreation.

In areas where surface water encourages mosquito breeding, stock the pond with topfeeding fish. Gambusia minnows are particularly effective in controlling mosquitoes. In malaria areas, do not keep any aquatic growth or shoreline vegetation and take special precautions in planning, building, and operating the pond. Most states in malaria areas have health regulations covering these precautions and they should be followed.

In some areas, algae and other forms of plant life may become objectionable. They can cause disagreeable tastes or odors, encourage bacterial development, and produce an unsightly appearance.

Pond Safety

Ponds, like any body of water, attract people so that there is always a chance of injury or drowning. You may be planning to build a pond for watering livestock, irrigation, or any of the other purposes discussed in this handbook, but your family and friends may want to picnic beside the pond or use it for fishing, swimming, boating, or ice skating, and you can never tell what a small child passing by may do.

Your pond can become a source of pleasure as well as profit but only if it is safe. To prevent injuries or drownings and to protect yourself financially you can take some of the following steps.

Before Construction

Almost all states have laws on impounding water and on the design, construction, and operation of ponds. In many states small farm ponds are exempt from any such laws. You should become familiar with those that apply in your state and be sure that you or your engineer comply with them.

Find out what your community or state laws are regarding your liability in case of injury or death resulting from use of your pond, whether you authorize 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 insurance.

You should decide how the water is going to be used so that you or your engineer can plan the needed safety measures before construction starts. For example, if the water is to be used for swimming, guards over conduits are required. You may wish to provide for beaches and diving facilities; the latter require a minimum depth of about 10 feet of water.

During Construction

There are other safety measures that your contractor should take during pond construction. Remove all undesirable trees, stumps, and brush. Remove all rubbish, wire, junk machinery, and fences that might be hazardous to boating and swimming. Eliminate sudden dropoffs and deep holes.

After Completion

Mark safe swimming areas and place warning signs at all danger points. Place lifesaving devices such as ring buoys, ropes, planks, or long poles at swimming areas to facilitate rescue operations should the need arise. Place long planks or ladders at ice skating areas for the same reason.

LANDOWNER

PONDS	RECTANGULAR
SIDE SLOPE.................	4.0 : 1
END SLOPE..................	4.0 : 1
POND DEPTH.................	7.0 FT.
TOP LENGTH.................	100.0 FT.
TOP WIDTH..................	90.0 FT.
BOTTOM LENGTH..............	44.0 FT.
BOTTOM WIDTH...............	34.0 FT.
EARTH VOLUME...............	1,225.1 CU.YD.
WATER VOLUME...............	0.8 AC.FT.
WATER VOLUME...............	247418 GALLONS
SURFACE SIZE...............	0.2 ACRES

RECTANGULAR DAMLESS POND VOLUME FORMULA

V = D(At + 4Am + Ab)/162

D	= POND DEPTH	7.0 FT.
At	= AREA OF THE TOP	9000.0 SQ.FT.
4Am	= AREA OF THE MIDDLE	17856.0 SQ.FT.
Ab	= AREA OF THE BOTTOM	1496.0 SQ.FT.

DATE : 05/07/96

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