UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

POND

(No.)

Code 378

DEFINITION

A water impoundment made by constructing a dam or embankment, or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as Embankment Ponds and those constructed by the second method are referred to as Excavated Ponds. Ponds constructed by both the excavation and embankment methods are classified as Embankment Ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 ft. or more.

PURPOSE

To provide water for livestock, fish and wildlife, aquaculture, recreation, fire control, crop and orchard irrigation, develop renewable energy systems, and other related uses and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of low hazard (class "a") ponds where:

1. Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or interruption of the use or service of public utilities.

2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume in acre-feet in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam becomes the upper limit.

3. The effective height of the dam is 35 ft. or less.

This practice applies where the water resource, topography, soils, and geology are suitable for construction and maintenance of a water supply sufficient for the intended purpose. National Engineering Manual, Part AL 501 requires the use of form AL-ENG-27 or AL-ENG-27A and an operations and maintenance (O&M) plan on all earth fill ponds.

Site Conditions

Site conditions shall be such that runoff from the design storm (Table 5) can be safely passed through:

1. natural or constructed auxiliary spillway,

2. combination of a principal spillway and an auxiliary spillway,

3. principal spillway designed to pass the auxiliary spillway design storm flow with a minimum 10-ft. wide auxiliary spillway, or

4. principal spillway designed to pass the 10-yr., 24-hr. storm for levee type ponds with embankments that exclude outside runoff.

Drainage Area

The drainage area above the pond must be protected against erosion to the extent that expected normal sedimentation will not shorten the planned effective life of the structure.

The drainage area shall be large enough so that surface runoff, together with groundwater flow will maintain an adequate supply of water in the pond

unless the owner supplements by pumping. The area must be free of sources of pollution or contamination so that the water will be suitable for its intended purpose.

Reservoir Area

The topography and soils of the site shall permit storage of water at a depth and volume that insures a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. The pond supported by surface runoff shall have soils impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

CRITERIA

Embankment Ponds

Definitions. The designed height of the dam is defined as being the vertical distance between the lowest normal ground point along the centerline of the dam and the top of dam.

Prevailing wind in Alabama is generally NW to SE; however, localized conditions may be different.

Site Investigation. Field soil borings will be made in the embankment foundation, auxiliary spillway, and any borrow locations. Borings for the embankment are usually along the centerline and used to determine if an adequate cutoff can be constructed. Borings in the auxiliary spillway and borrow areas are used to determine the adequacy of material to be used in the cutoff and embankment. All soil borings will be recorded using the appropriate engineering forms. Soil materials shall be classified using the Unified Soil Classification System.

Foundation Cutoff. A cutoff of relatively impervious material shall be provided under the dam. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and shall extend into a relatively impervious layer (minimum 1 ft.) or provide for a stable dam when combined with seepage control. The cutoff trench shall have a minimum bottom width of 8 ft. and be adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical.

Seepage Control. Seepage control is to be included if: (1) pervious layers are not intercepted by the cutoff, (2) seepage could create swamping downstream, (3) it is needed to insure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment filters and drains, (2) reservoir blanketing, or (3) a combination of these measures.

Earth Embankment. The minimum top width for a dam is shown in Table 1. Guard rails or other safety measures shall be used in public road situations and shall meet the requirements of the Alabama Department of Transportation Specifications.

Side Slopes. The combined upstream and downstream side slopes of the settled embankments shall not be less than that shown in Table 2 and the front slope shall not be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required.

Wave Protection. Where needed to protect the face of the dam, special wave protection measures such as berms, rock riprap, sand-gravel, soil cement or special water tolerant vegetation (maidencane, switchgrass, sandbar willows, and rice cutgrass) will be provided (see Technical Release 56 or 69). When the location of the pond exposes the dam to prevailing winds, and fetch length is greater than 1320 ft., the upstream slope shall be protected from wave damage as a minimum by one of the following methods:

1. Place an 8-ft. wide berm approximately 1 ft. above the designed waterline.

2. Place a blanket of riprap 2 ft. thick at the designed waterline, the upper limit of this blanket being 2 ft. above and the lower limit being 1 ft. below the waterline.

3. Increase the width through the dam at the designed waterline at least 4 ft. by flattening the side slopes.

4. Plant water tolerant vegetation of the right character and height on properly constructed berms. When vegetation is recommended for wave erosion protection, the vegetation should be capable of enduring short durations of

inundation without serious damage and should be sod formers or bunch-type plants.

Freeboard. The minimum freeboard depth used to establish the top of the settled embankment shall be 1 ft. above the water surface elevation of the reservoir with the auxiliary spillway flowing at design depth. This minimum may be more according to the prevailing wind fetch length (Table 5, Note 7). The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of dam shall be 2 ft. for all dams having more than a 20-acre drainage area or more than 20 ft. in effective height. For dams having less than 20 acres drainage area and 20 ft. effective height, the minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam will be at least 1 ft. or more according to the prevailing wind fetch length.

For levee type embankment ponds that exclude outside drainage area and have a principal spillway designed to handle the 10-yr., 24-hr. direct rainfall, the minimum difference in elevation between the settled top of dam and the permanent water elevation shall be based on the prevailing wind fetch length (Table 5, Note 7). In no case shall the difference be less than 1 foot.

Settlement. The design height of the dam shall be increased by the amount needed to insure that after settlement has taken place, the constructed height of dam will equal or exceed the design height. This increase shall not be less than 5 percent of the height of the dam, except where detailed soil testing and laboratory analysis shows a lesser amount is adequate.

Compaction. Proper compaction of earth fill is critical for ensuring the stability and impermeability of the dam. The following procedures are the minimum requirements for fill placement and compaction:

- The maximum uncompacted layer thickness shall be 8 inches.
- For dams having an effective height less than 20 feet compaction shall be accomplished by traversing every point on each layer a minimum of 3 times with construction/earth moving equipment having lugged pneumatic tires.
- For dams having an effective height of 20 feet and greater compaction shall be accomplished by use of a “sheepfoot” or tamping type roller. Each layer shall be rolled a minimum of 6 times, or until the feet “walk out” of the layer.

Where strict control of earth fill placement is deemed necessary, soil moisture and density may be specified and tested in accordance with procedures in ASTM Standard D 698.

Principal Spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam except where a rock, concrete or other type mechanical spillways are used or where the rate and duration of flow can be safely handled by a vegetated or earth spillway without erosion. Water level control pipe systems with short risers or a hood inlet in a box may be used in renovation of excavated or embankment ponds where installation of a pipe through the base of the dam is not practical. Siphon systems may be used in new ponds or in renovation of existing ponds.

Storm Storage. The principal spillway crest elevation shall be no less than 0.5 ft. below the crest of the auxiliary spillway for dams having a drainage area of 20 acres or less and no less than 1 ft. for dams having a drainage area of more than 20 acres.

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the auxiliary spillway except where the pipe is enlarged because of drawdown requirements. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

Pipe Conduit Size. The capacity of the pipe conduit shall be adequate to discharge long duration, continuous, or frequent flows without discharge through the auxiliary spillway. The diameter of the pipe conduit will not be less than 4 inches. If the pipe conduit diameter is 10 in. or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway. Watershed runoff and peak rates will be determined using methods outlined in National Engineering Handbook (NEH), Part 650, Engineering Field Handbook, Chapter 2, Estimating Runoff and Peak Discharges., Pipe size will be determined according to procedures in

NEH, Part 650, Chapter 11, Ponds and Reservoirs. Approved computer programs, such as WINPOND may be used to select the size of pipe conduit and riser.

Requirements of Pipe Conduits Under or Through the Dam. The pipe shall be capable of withstanding the external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The modulus of elasticity for PVC pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity. Rigid pipe shall be designed for a positive projecting condition. The inlets and outlets shall be structurally sound and made from materials compatible with those of the pipe. All pipe and joints are to be made watertight by the use of glued couplings, gaskets, or welding. Total pipe length will include a minimum of 6 ft. added to extend beyond the downstream toe and 4 ft. added to extend beyond the upstream toe.

For dams 20 ft. or less in total height, acceptable pipe materials are ductile iron, welded steel, corrugated steel or aluminum, reinforced concrete, plastic, and pre-cast and site-cast reinforced concrete. Concrete pipe shall be laid in concrete bedding. Plastic pipe that will be exposed to direct sunlight should be protected by coating or shielding; or provisions made as necessary for replacement. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

For dams more than 20 ft. in total height, conduits shall be reinforced concrete pipe, cast-in-place reinforced concrete, corrugated steel or aluminum, or welded steel pipe. The maximum height of fill over any principal spillway, corrugated steel pipe or aluminum pipe will not exceed 25 feet. Refer to Tables 3 and 4 in this standard.

A drain pipe with a suitable valve or other device shall be provided where needed for proper pond management or required by local or State law. The pipe conduit may be used as a drain when so located as to accomplish this function. Supply lines to watering troughs and other appurtenances shall have a minimum inside diameter of 1.25 inches. A watering trough when needed will be used and placed below embankment and excavated ponds. Drainage diaphragm requirements shall apply to supply lines also.

Joint and Appurtenances. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls (SAF) stilling basin or an impact basin may be used to provide a safe outlet. Protective coatings of asphalt or vinyl on galvanized corrugated metal pipe, or coal tar enamel paint on welded steel pipe should be provided in areas that have a history of pipe corrosion, or where the saturated soil resistivity is less than 4,000 ohms-cm, or where the soil pH is lower than 5.

Specifications in Tables 3 and 4 are to be followed for polyvinyl chloride (PVC), polyethylene, steel, and aluminum pipe.

Cathodic Protection. Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

Seepage Control. Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 feet.

2. The conduit is of smooth pipe larger than 8 inches in diameter.

3. The conduit is of corrugated metal pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm.

Diaphragm Drain. The drain is to consist of sand, meeting fine concrete aggregate requirements in ASTM C-33 (at least 15% passing the No. 40 sieve

but no more than 10% passing the No. 100 sieve). If unusual soil conditions exist, a special design analysis shall be made.

The drain shall be a minimum of 2-ft. thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18-in. beneath the conduit invert.

The drain diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam. Guidance for design and installation of diaphragm drains is available in NEH, Part 628, Dams, Chapter 45.

The drain shall be outletted at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe to where it exits the embankment. Protect the drain outlet erosion by use of a properly designed filter system and riprap.

Trash Guards. An approved type of trashrack sleeve (minimum length 24 in.) or wildlife sleeve shall be installed at the riser inlet on all drainage area embankment ponds to prevent the conduit from clogging. Levee ponds will have a trashrack or be screened to prevent fish from escaping and prevent wild trash fish from entering the pond through the pipe. The minimum quality of material used shall be 16 gage and shall be protected by asphalt coating, galvanizing, or water durable paint. Trash guards of PVC or polyethylene are acceptable if size and thickness are adequate. Barrels or plastic buckets are not acceptable. All hardware used for mounting shall be of equal or compatible material.

Anti-vortex. Closed conduit spillways designed for pressure flow are to have adequate antivortex devices.

Outlet Protection. Barrel pipes 12 in. or larger and siphon pipes are to have outlet protection.

Hood Inlet. A hood inlet may be used when installed in the dam abutment with any size of pipe barrel. The section of pipe on which the hood is installed must be at least 12-ft. long and be of steel, aluminum, concrete, PVC, or bituminous coated corrugated metal. The hood shall be on top of the pipe and project three-fourths of the diameter of the pipe. The vertical distance between the invert of the pipe and control section of the auxiliary spillway shall be no less than 1.5 times the diameter of the pipe.

Siphon Spillway. A siphon pipe spillway is a closed conduit system formed in the shape of an inverted "V", positioned so that the invert of the bend (CREST) of the upper passageway is at normal water surface elevation. The initial discharge of the siphon, as the reservoir level rises above normal, is similar to flow over a weir. Siphoning action begins after the air in the siphon pipe has been exhausted, usually at a depth over the crest equal to about 1/3 the pipe diameter. An air vent is provided to break the siphoning action when the reservoir water surface is drawn down to normal pool elevation. Because of the negative pressure that exists within the siphon when flowing full, the pipe joints must be air tight and the pipe must be sufficiently rigid to withstand the collapsing forces. Welded steel or plastic pipe with glued joints should be used. Pipe joints using rubber gasketed joints may not be sufficiently airtight to function properly in a siphon system.

The following minimum criteria shall apply to siphon spillway systems, in addition to other applicable criteria listed elsewhere in this standard: The total lift of the siphon will be limited to a maximum of 20 feet. A 2-in. diameter vent pipe will be used on siphon pipes up through 8-in. and a 4-in. diameter vent pipe will be used for siphons 10-in. through 16-in. diameters. Pipe used for siphons shall be smooth steel or smooth plastic pipe with a minimum wall thickness equivalent to Schedule 40 or SDR 26. The siphon will have an elbow on the downstream end or will be submerged during flow to completely seal the end of the pipe. If an elbow is used, it will have a 1/4-in. to 3/8-in. weep hole drilled in the bottom of the elbow to insure that water does not freeze in the pipe and possibly prevent the siphon from functioning. The pipe will be buried through the dam and the downstream section of the pipe will be buried or will have adequate anchors and restraints to prevent thrust forces and vibrations from breaking the pipe. The vent pipe will be protected by a perforated pipe sleeve to prevent floating debris from clogging the vent. The total area of the perforations in the vent pipe sleeve should equal at least four times the vent pipe area. The inlet to the siphon shall have a perforated section which will exclude trash, turtles, fish, etc. The perforated inlet section must have an open area equivalent to at least two times the cross sectional area of the siphon pipe.

Auxiliary Spillway. Auxiliary spillways convey large flood flows safely past earth embankments and have historically been referred to as "Emergency Spillways".

An auxiliary spillway shall be provided for all dams to safely pass the design storm runoff around the dam. Auxiliary spillways shall pass the design flow at a safe velocity to a point downstream where the dam will not be endangered. Where spillways are constructed in earth, they shall be vegetated. Earthen portions of a spillway constructed in rock shall be vegetated. All embankment ponds will have a minimum 10-ft. wide spillway, except levee-type embankment ponds which exclude outside drainage area. These type levee ponds are not required to have an auxiliary spillway if the principal spillway is designed to handle a 10-yr., 24-hr. rainfall.

Excavated spillways shall consist of an inlet channel, a control section, and an exit channel.

Inlet Channel. The inlet channel is that portion upstream from the control section. It shall have a uniform negative grade toward the pond with a minimum slope of 0.5 percent or enough grade to achieve adequate drainage. The alignment of the inlet channel may be curved to fit existing topography.

Control Section. The control section shall be constructed level at designed grade with a minimum length of 25 feet.

Exit Channel. The exit channel, that portion downstream from the control section, shall be straight in alignment for a distance of 50 ft., if possible, and its centerline shall be perpendicular to the control section. The grade of the exit channel shall fall within the range established by discharge requirements and maximum permissible velocities. The exit channel shall terminate at a point where the design flow may be discharged without erosion or damage to the earth embankment. Refer to NEH, Part 650, Chapter 11.

Capacity. The minimum capacity of the natural or constructed earth spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 5 less any reduction creditable to conduit discharge and detention storage.

Cross-Section. The spillway shall be excavated in undisturbed earth and have a trapezoidal cross section with side slopes not steeper than three horizontal to one vertical. The side slopes may be vertical when the spillway is excavated in rock.

If a rock auxiliary spillway is to be designed, the table for vegetated spillways excavated in erosion resistant soil found in NEH, Part 650,Chapter 11, is to be used.

Structural Auxiliary Spillways. Chutes or drops, when used for principal spillways or auxiliary spillways, will be designed according to the principles set forth in the NEH, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from the design storm less any reduction creditable to conduit discharge and detention storage.

Reservoir Area. Reservoir areas are to be cleared at least up to the elevation of the lowest ungated principal spillway inlet. Stumps must be cut as close to the ground as possible.

Less clearing may be approved by the state conservation engineer for a specific site if the structure incorporates fish and wildlife features and the sponsor or owner requests that the area not be cleared, or if the cost of clearing is disproportionate to the other costs of the structure and lack of clearing will not interfere with the functioning of the reservoir. If approval is granted, the minimum area cleared must extend the full length of the dam for a distance of 400 ft. upstream from the principal spillway and must include the area upstream from the auxiliary spillway to the extent required for it to function properly.

Excavated Ponds

Runoff. Provisions shall be made for a pipe and auxiliary spillway if necessary. A pipe will be used when flow from springs or from seepage is anticipated to occur for about six months of the year. The pipe will be set a minimum of 6 in. below the crest of the auxiliary spillway. Flow patterns will be considered when locating the pond and placing the spoil.

Site Investigation. Site suitability and design shall be based on adequate investigations and surveys as described in NEH, Part 650, Chapter 11.

Capacity. The storage capacity of excavated ponds shall be such that an adequate supply of water is available for all intended purposes when needed.

Depth. The depth of a pond shall be no less than that required to provide water for the intended purposes. Where site conditions will permit, a minimum depth of 6 ft. shall be provided over at least one-half of the bottom area.

Auxiliary Spillway. Where excavated material is used to construct an embankment, an auxiliary spillway (minimum 10 ft. width) must be installed with a stage and freeboard (minimum 1 ft.) sufficient to insure safety of the dam. If there is two feet of water, or more, impounded against the embankment at the auxiliary spillway elevation, or if the drainage area exceeds 10 acres, the auxiliary spillway shall be designed as for an earthfill pond.

Side Slopes. Side slopes of excavated ponds shall be no flatter than those needed to obtain slope stability and in no event shall they be steeper than 1 horizontal to 1 vertical. Where the pond is to be used for direct watering by livestock, at least one slope shall be 3:1 or flatter. If the pond is used for watering swine, the water will be piped to a trough or a concrete watering ramp installed and the pond shall be fenced to provide protection to the side slopes.

Perimeter Form. When the pond is used for recreation or is located in high public view, the perimeter or edge should be shaped to a curvilinear form.

Inlet Protection. Where surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Placement of Excavated Material. The excavated material shall be placed in one of the following ways:

1. Uniformly spread to a height not exceeding 3 ft. above the designed water elevation, with the top graded on a continuous slope away from the pond.

2. Shape to a design form that blends visually with the landscape.

3. Use for low embankment and leveling.

4. Haul away.

Ponds Constructed Primarily for Aquaculture

Levee type ponds which exclude outside runoff and embankment ponds constructed for fish production shall be designed using the preceding criteria with these added requirements:

1. **Pipe.** A pipe will be required for management purposes. The drain pipe on cut and fill ponds should be placed at the lowest constructed ground elevation.

2. **Shallow Water.** All shallow water edges, where feasible, shall be deepened to provide a minimum depth of 2.5 ft. and preferably 3 ft. of water on slope of 4:1 or steeper. This does not apply to crawfish ponds.

3. **Location of Levee Ponds.** Levee ponds located in the flood plain are to be located so the main drainage of the floodplain shall pass as a minimum the runoff from the 25-yr., 24-hr. storm without significant flooding or damage to utilities and private or public property. It is recommended that 40 to 50 percent of the owner's floodplain area around the channel be left open. Unless flood prone maps are available in each county, designers will make valley and channel section surveys for use in rating and determining flood plain limits of the design storm.

4. **Water Supply.** Levee production and embankment production ponds with small drainage areas should have an adequate water supply available to replenish oxygen losses and for proper pond management. A good rule of thumb is 15 to 25 gallons per minute, per acre of surface area. In addition, provision must be made for emergency aeration during periods of low oxygen.

5. **Water Control Structure.** The riser and deep water release can be designed and installed to control the water level and remove excess water from either the bottom or from different elevations in the pond. The drain pipe must be adequate to completely drain the pond and draw the water down within a three-day period to a seineable depth and be so located as to provide positive uniform drainage from the entire pond area including harvesting basin. A screen should be installed over the valve inlet or outlet pipe to prevent fish loss and to prevent wild trash fish from entering the pond. The riser and

drain facilities when possible should be located in one corner of the embankment area to provide a more desirable seineable harvest area.

6. **Spillway Storage.** The principal spillway and storage must be designed for a minimum 5-yr., 24-hr. storm runoff to limit auxiliary spillway operation. A properly designed trashrack or sleeve with screens for the riser will prevent loss of fish from the pond and also prevent trash fish from entering the pond during storm periods. When completing the principal spillway design, check to see if it drains the pond down to the seinable depth within the three-day period as specified in Item 5.

7. **Harvesting Basin.** The pond area for commercial harvested ponds shall be developed with a smooth bottom shaped to drain to the pipe and be free of stumps, snags, and other obstructions. The harvesting basin for small operations shall be constructed, as a minimum, 1/5 the size of the pond and at least 18 in. deep and the bottom and sides shall be smooth and uniform and be free of stumps and snags. When a series of small ponds are constructed together, consideration should be given to developing the harvest basin and drainage facilities adjacent to each other to permit the harvest of fish from two ponds at the same loading locations.

8. **Road System**. An adequate all-weather road system with ramps shall be planned and constructed to provide access to the pond or ponds to facilitate stocking, feeding, and harvesting operations. Gravel, sand, crushed stone, chert, or other similar material should be used on main segments to facilitate all-weather use. Culverts should be installed in low areas along the all-weather road to provide surface drainage. The road around the pond shall be constructed a minimum of 1 ft. above the permanent waterline elevation to accommodate feeding and harvesting of fish.

9. **Top Width and Side Slopes**. The top width of dikes, levees, and dams for ponds used as roads for feeding and harvesting purposes in commercial fish production shall be a minimum of 14 ft., except embankments used for electrical service which shall have a minimum top width of 16 ft. (Refer to Alabama NRCS Conservation Practice Standard, Aquaculture Ponds – Code 397). Side slopes (wet) shall be 3:1 or flatter to facilitate harvest and to minimize damage from wave action. In order to reduce costs on some ponds, the engineer may approve the use of a 2.5:1 slope on the wet side of the dam. Levees or dikes between ponds not used as roads may be designed for minimum top width as shown in Table 1. Where embankments join other embankments or abutments longer radius turns should be used to enable larger trucks to make appropriate turns easier.

10. **Vegetation**. The vegetation plan and operation and maintenance plan will be as outlined in the Plans and Specifications section.

Ponds Constructed Primarily as Shallow Water Impoundments for Wildlife.

Ponds constructed as shallow water impoundments for wildlife shall be designed using the preceding criteria for embankment and excavated ponds with these exceptions:

- Green tree reservoirs shall meet the functional requirements contained in Alabama NRCS Conservation Practice Standard, Wetland Wildlife Habitat Management, Code 644.

- Sites with 6 ft. or less effective height (as defined in this standard) and less than a 5:1 watershed to pond ratio can be designed utilizing Class III dike criteria contained in Alabama NRCS Conservation Practice Standard, Dike, Code 356.

- Where frequent flood flows can bypass on the floodplain and return to the drainage ways without causing erosion or other undesirable conditions, the principal spillway (or other water control structure) may be sized to meet the functional requirements of the impoundment rather than the requirements of Table 5. The requirements for the auxiliary spillway design storm shall remain the same. Where these conditions exist, the riser may be set at no less than 0.5 ft. below the crest of the auxiliary spillway or bypass elevation.

- Ponds located in flood plain areas shall meet the same requirements for flood plain blockage as those identified for aquacultural ponds.

- The area around the embankment shall be cleared so that the distance to the edge of the nearest tree canopy is not closer than 20 ft. to the toe of the embankment.

Renovation of Embankment and Excavated Ponds

Pond clean out shall consist of removal of accumulated silt, debris, bank sloughing, and other material from the reservoir. The purpose of excavated pond renovation is to restore the useful storage capacity and to reduce safety and disease hazards to livestock. Renovation of embankment ponds will be to restore the original storage capacity and water level control pipe and to repair the embankment and the earth spillway.

Renovated ponds used for livestock watering should be fenced and a concrete or riprap watering ramp installed in the pond or a trough installed downstream to maintain water quality and quantity.

Renovation applies to water impoundment reservoirs constructed with or without costsharing funds. It is limited to excavated and small embankment ponds which no longer serve the purpose for which they were originally designed due to damage from erosion, cattle traffic, and sedimentation.

Material Requirements

Pipe materials shall meet the requirements of the reference specification for the type of material used as shown in Table 6.

Corrugated Steel Pipe. Field coupling of pipe sections shall be accomplished by means of coupling bands and watertight gaskets or flange pipe couplings. The band couplers shall be at least 5 corrugations wide for annular corrugated pipe, or 9 in. for spiral corrugated pipe. Minimum gage shall be as shown in Table 4, Minimum Gages, Corrugated Metal Pipe. Protective coatings shall be used as outlined in the section on Joints and Appurtenances, Principal Spillway, and Embankment Pond Criteria.

Smooth Steel Pipe. Good quality, used, smooth-welded steel pipe suitably protected from rust and corrosion may be used.

Used pipe must have a remaining wall thickness at any pitted or rust spot equal to 75% of the equivalent wall thickness of new pipe.

Reinforced Concrete Pipe. New pipe shall be used, shall have flexible watertight joints with rubber gaskets, shall be cambered, and shall be able to withstand the external loadings specified.

Plastic Pipe. New pipe shall be used and shall conform to requirements in Table 3. The conduits shall be transported, stored, installed, and protected according to manufacturer's recommendations. Smooth lined corrugated plastic tubing pipe conforming to AASHTO M252 or M294 may be used in pond installations provided it is properly bedded and connected with watertight couplings.

Inspection. NRCS personnel shall thoroughly inspect the material and fittings to determine if they meet the requirements of the specifications, test results, and certification from the manufacturer. Although the products may have met standard specifications when tested or at the time of delivery by the supplier, they may have become defective before installation. Inspection by NRCS personnel at the job site is essential to determine the adequacy of the product to be used.

Materials evaluated and found not to meet the requirements of the specifications or found not suitable for the use intended shall not be used. Documentation shall be by a statement made in the Engineering Field Notes on the inspection and acceptance or rejection of the materials.

Pipe Installation Requirements. Pipe conduits shall be installed in a manner that provides uniform support to the pipe and continuous contact between the pipe, soil foundation and backfill. Except where the pipe penetrates drainage zones, earth fill around the pipe shall be of the more plastic soil available on site. The ability of pipe to withstand vertical loads is dependent upon the density of the soil surrounding the sides of the pipe. Manual compaction of soil within the two-foot zone surrounding the pipe is required to ensure that adequate soil density is achieved and to prevent damage to the pipe by construction equipment. Guidance for bedding and backfilling around pipe conduits may be found in NEH Part 650, Chapter 17, and Technical Note

ENG-AL-10. Installation shall be in accordance with the requirements of construction specification CS-EMB-378. Joining pipe sections will be performed in a manner to ensure a watertight connection and in compliance with the manufacturer's recommendations.

The pipe conduit should be cambered to prevent breaking or joint separation as the dam settles. That is, the pipe should be laid essentially level to the centerline of dam, then laid essentially straight to the exit end elevation. Then as, settlement occurs, the pipe grade will flatten and tighten the joints. The amount of camber provided should be equal to or greater than the anticipated settlement along the pipe. The amount of deflection provided at any joint should not exceed the manufacturer's recommendations. Uniform bedding should be used to avoid stress concentrations in the pipe as soil load is applied.

CONSIDERATIONS

Ponds are constructed to improve water quality and they create new surface and groundwater regimes. Generally, peak discharge will be reduced and in many instances reduced to zero during dry periods. There may be increased recharge to the groundwater since most ponds seep and the base flow may extend for a longer period of time.

Properly constructed ponds will trap nutrients, sediment, and pesticides. Therefore, chemical concentrations will normally be higher in the pond area and lower in the downstream channel section. Ponds constructed in pervious soils may cause more leachable substances to be carried into the groundwater. Plans should be made for each site based on site conditions and the desired water quantity and quality needed downstream. Surface water temperature of the pond will increase.

Siphon spillway inlets are placed above the pond bottom and will not completely drain the reservoir. Siphon spillways can be designed to discharge poorer quality water from near the pond bottom thereby improving the quality of water in the reservoir.

Consider the use of anti-seep collars for siphons when poor soils or other conditions unfavorable for fill placement around the pipe exist.

Consider the use of fencing and a heavy use area protected watering ramp for ponds used as a direct source of water for livestock.

Visual Resource Design. The landscape will be considered in planning earthfill ponds to improve the surroundings. Trees and shrubs should not be left within 15 ft. of the dam except at locations above the waterline. The landscape can be improved by leaving desirable trees on the slopes between the auxiliary spillway and the end of the dam. Ponds in areas of high public visibility and those associated with recreation are to receive careful visual design. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material and plantings are to relate visually to their surroundings and to their function.

The embankment can be shaped to blend with the natural topography. The edge of the pond can be shaped so it is generally curvilinear rather than rectangular. Excavated material can be shaped so the final form is smooth, flowing, and fitting to the adjacent landscape rather than appearing as angular geometric mounds. Where feasible, islands or piers can be added for visual interest and wildlife value.

Outlet Protection. Pipe outlet protection should be considered on a case-by-case basis for barrel pipes less than 12 in. diameter.

Regulations Governing the Impounding of Water

To comply with the rules and regulations of the State of Alabama and U.S. Army Corp of Engineers (COE) governing the impounding of water or damming of water courses in Alabama, the following shall apply:

1. The construction of ponds in Alabama may require a National Pollution Discharge Elimination System (NPDES) Permit from the Alabama Department of Environmental Management (ADEM) by the landowner or contractor prior to construction based on the amount of land disturbed and the purpose of the pond.

2. Federal laws designed to protect wetlands and other waters of the U.S. require a permit for construction of some ponds. According to the COE, a 404 Permit determination must be made for ponds that involve more than 0.1 acre of wetland or other waters of the U.S. unless

exempted as part of an established farming operation or otherwise permitted under a nationwide permit.

3. Safety measures such as warning signs, rescue facilities, fencing, etc., will be included in the plans as appropriate to the location and anticipated use of the ponds.

4. Construction operations shall be carried out in such a manner that soil erosion, and air, water, and noise pollution will be minimized and held within legal limits as established by state regulations.

Cultural Resources. Consider existence of cultural resources in the project area and any project impacts on such resources. Consider conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.

Fish and Wildlife. Project location and construction should minimize the impacts to existing fish and wildlife habitat.

When feasible, structures such as trees in the upper reaches of the pond and stumps in the pool area should be retained. Upper reaches of the pond should be shaped to provide shallow areas and wetland habitat.

Water Quantity. Consider effects upon components of the water budget, especially:

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
- Variability of effects caused by seasonal or climatic changes.
- Effects on downstream flows and impacts to environment such as wetlands, aquifers, and; social and economic impacts to downstream uses or users.
- Potential for multiple purposes.

Water Quality

- Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that are carried by runoff.
- Effects on the visual quality of onsite and downstream water resources.
- Short-term and construction-related effects of this practice on the quality of downstream water courses.
- Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Effects on wetlands and water-related wildlife habitats.
- Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- Effects of soil water level control on the salinity of soils, soil water, or downstream water.
- Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

PLANS AND SPECIFICATIONS

Plans and specifications are to be prepared for specific field sites in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. The appropriate Construction Specification for this standard will be used. Plans and specifications include construction plans, drawings, job sheets, construction specifications, vegetation plan, narrative statements in conservation plans or other similar documents.

The site will be protected by perennial vegetation as shown in the Construction Specifications for this practice. A strip of adapted perennial vegetation, at least 50 ft. wide, will be established above all impounded areas that are not already protected by a good sod, woods, or other protective type vegetation. The vegetation plan will include the salvage of surface soil from the site and placement over critical areas. The area will be mulched after seeding.

OPERATION AND MAINTENANCE

An operation and maintenance plan will be made for each structure site and given to the landuser along with the plans and specifications for construction.

When needed, fencing, and watering trough will be provided to protect the pond and vegetation from livestock.

All ponds must be adequately maintained if their purposes are to be realized through the expected life. Special considerations shall be given for maintenance needs during the planning, design, and construction of the pond.

Rills on the slopes of the dam and eroded areas in the earth spillway shall be filled with suitable material, compacted, reseeded, and fertilized as needed. Should the upstream face of the dam wash, due to wave action, protection such as riprap shall be installed. If seepage through or under the dam occurs, proper corrective measures shall be taken.

The vegetative cover of the dam and earth spillway shall be maintained by mowing and fertilizing or burning when needed. Trees can cause leaks and safety hazards and should not be permitted in the embankment or the auxiliary spillway.

Appurtenances such as trickle tubes, trashracks, outlet structure and valves shall be kept free of trash and replaced when needed. If vent pipes on siphon spillway systems are allowed to plug with trash or ice, the siphon action will not be broken and the pond could drain.

REFERENCES

National Engineering Manual
National Engineering Handbook Series, Part 628, Dams, Chapter 45, Filter Diaphragm
National Engineering Handbook Series, Part 650, Engineering Field Handbook, Chapter 2, Estimating Runoff and Peak Discharges; Chapter 11, Ponds and Reservoirs
Alabama NRCS Conservation Practice Standards
- Aquaculture Ponds, Code 397
- Critical Area Planting, Code 342
- Dike, Code 356
- Fence, Code 382
- Heavy Use Area Protection, Code 561
- Subsurface Drains, Code 606
- Wetland Wildlife Habitat Management, Code 644

Alabama Guide Sheets
- Pond Construction – AL 378
- Excavated Pond Development – AL 378A
- Erosion and Sediment Control During Farm Pond Construction - AL 378B
- Embankment Pond Renovation – AL 378C
- Use Exclusion - Livestock - AL 472
- Watering Ramp - AL 561A

Alabama Engineering Technical Note
- ENG-AL-10

OTHER DOCUMENTS

Alabama Engineering Forms
- AL-ENG-2 – Earth Fill Pond Plan
- AL-ENG-3 – Plan of Pond (Farm)
- AL-ENG-4A – Pond Design Data (All Classes of Ponds)
- AL-ENG-5 – Pond Construction Check Data
- AL-ENG-6 – Dug Pond Design Data
- AL-ENG-7 – Plan of Excavated Pond
- AL-ENG-27 – Application for Technical Assistance for the Design of a Dam and Reservoir or Embankment Type Structure
- AL-ENG-27A – Application for Technical Assistance for the Design of a Pond Associated with an Aquaculture Farming Operation
- AL-ENG-34 – Farm Pond (Embankment) Data Sheet

Table 1. Embankment Top Width (Minimum)

Total Height of Dam (Ft.)	Top Width (Ft.)	Top Widths (Farm Roads) (Ft.)	Top Width (Public Road) 1 Way (Ft.)	Top Width (Public Road) 2 Way (Ft.)
less than 10	6	12	16	28
10 to 14.9	8	12	16	28
15 to 19.9	10	12	16	28
20 to 24.9	12	14	16	28
25 to 34.9	14	14	16	28
35	15	16	16	28

Table 2. Side Slope Based on Embankment Material

Embankment Material	Minimum Slopes Horizontal to Vertical Both Slopes*
Clayey Sand (SC), Sandy Clay (CL), Silty Clay (CL), Silty Sand (SM), Clayey Gravel (GC), Silty Gravel (GM)	5 to 1
Silt (ML), Fat Clay (CH), Clayey Silts (MH)	6 to 1
Fine Sand (SM-SP) (Minimum one side 3.5 to 1)	8 to 1

*Dams to be mowed should have 3:1 side slopes or flatter on back side.

Table 3. Acceptable PVC* and Polyethylene Pipe for Use in Earth Dams

Nominal Pipe Size (inches)	Schedule or Standard Dimension Ratio (SDR)	Maximum Depth of Fill Over Pipe (ft.)
Smooth Wall PVC Pipe**		
4	Sched. 40	15
	Sched. 80	20
	SDR 26	10
6 thru 12	Sched. 40	10
	Sched. 80	15
	SDR 26	10
	SDR 35	5
Corrugated smooth-lined polyethylene and PVC***		
4 thru 18	N-12, A-2000	15
24 thru 36	N-12	10

* Plastic pipe manufactured to conform to ASTM Specifications other than those listed may be used with the maximum fill limits shown in Table 3 provided the pipe meets or exceeds the requirements of the listed pipes for materials, wall thickness, and joint water tightness. Pipe having a wall thickness different from the listed pipes may be used provided the calculated long term deflection for the designed fill height and installation conditions does not exceed 5 percent.

** Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D1785 or ASTM D2241.

*** Polyethylene, Type III, Class C, Category 4 or 5 conforming to ASTM D1248 and D3350 and AASHTO M252 or M294, Type S pipe; PVC, ASTM F949.

Table 4. Minimum Gages - Corrugated Metal Pipe and Smooth Steel Pipe

(2 2/3 in. x 1/2 in. corrugations and 1 1/2 in. x 1/4 in. corrugations)*

	Steel (CMP) Minimum Gage Pipe Diameter (in.)					Aluminum (CMP)** Minimum Thickness (in.) Pipe Diameter (in.)				Smooth Steel Minimum Thickness (in.) Pipe Diameter (in.)		
Total Height Over Pipe (ft.)	6 thru 24	30	36	42	48	6 thru 21	24	30	36	4 thru 21	21 thru 34	34 thru 48
1 - 14	16	16	14	12	10	0.06	0.06	0.075	0.075	0.125 (1/8)	0.188 (3/16)	0.250 (1/4)
15 - 19	16	16	14	12	10	0.06	0.075	0.105	0.105	0.188 (3/16)	0.250 (1/4)	0.250 (1/4)
20 - 25****	16	14	12	10	10	0.06	0.105	0.135	***	0.250 (1/4)	0.312 (5/16)	0.375 (3/8)

* Pipe with 6, 8, and 10-inch diameter has 1 1/2 in. x 1/4 in. corrugations.
** Riveted or helical fabrication
*** Not permitted
**** Steel pipe having fill heights exceeding 25 ft. shall be individually designed.

Table 5. Minimum Hydrologic Criteria for Design of Class I Through V Dams

Job Class[1]	Principal Spillway or Detention Storage Storm (24 hour)	Auxiliary Spillway Design Storm (24 hour)		Freeboard [6] and [7] (minimum)
	years	years [2]	years [3]	ft.
I	0.5 [4]	10	50	1
I	1 [4]	25	50	1
II	2	25	50	1
III [5]	5	50	50	1
IV [5]	10	50	50	1
V	10	50	50	1

1/ See Alabama Engineering Job Approval classification Chart NEM Part 501, Subpart A - Review and Approval.
2/ When effective height and storage is less than 20 ft. and 50 acre-ft. respectively.
3/ When effective height or storage is equal to or more than 20 ft. or 50 acre-ft. respectively.
4/ Crest elevation of the auxiliary spillway is a minimum of 1 foot above permanent pool elevation except (a) may be 0.5 for less than 15 acre D.A., and (b) excavated ponds with spring flow or for water level control. All other Class I ponds use 1-year storm (use 0.5-year storm only on pond with D.A. less than 15 acres).
5/ Where drainage area is less than 20 acres and storage is less than 50 acre-ft., auxiliary spillway design storm may be reduced to 5-year frequency.
6/ Top of dam elevation shall be minimum 2 ft. above auxiliary spillway crest for all dams having drainage areas more than 20 acres or effective height greater than 20 feet.
7/ Prevailing wind freeboard for fetch length shall be: 660 ft. or less, 1.0 ft.; 660 to 1320 ft., 1.5 ft.; and 1320 to 5280 ft., 2 feet. The increases in freeboard meet the requirements of Alabama NRCS Conservation Practice Standard, Commercial Fish Ponds - Code 397 (Table 1).

Table 6. Certification Requirements for New Materials

Type	Reference Specification
Ductile Iron	ANSI/AWWA C151/A21.51, ANSI/AWWA C115/A21.15
Steel Pipe	ASTM A53
Corrugated Steel Pipe	ASTM A760, 762, 885
Corrugated Aluminum Pipe	ASTM B745, 790
Reinforced Concrete	AWWA C300, C301, C302, or ASTM C76 Class II
PVC pipe (1120 or 1220)	ASTM D1785 or ASTM D2241
Polyethylene pipe	ASTM D1248, 3350 ASSHTO M252, 294