CONSERVATION PRACTICE STANDARD

POND

(No.)

CODE 378

DEFINITION

A water impoundment made by constructing an 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 the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, 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 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 in 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 is the upper limit.
3. The effective height of the dam is 35 feet or less, and the dam is hazard class (a), as defined in NRCS Technical Release 60.
4. The pond is within the limits of a PA-DEP Class C, Category 3 structure, as defined by PA Code, Title 25, Chapter 105.

Ponds which exceed any of the above limits shall be designed and constructed in accordance with TR-60.

CRITERIA

Design Criteria Applicable To All Ponds

All federal, State and local requirements shall be addressed in the design.

A protective cover of vegetation shall be established on all exposed areas of embankments, spillways and borrow areas as climatic conditions allow, according to the guidelines in conservation practice standard 342, Critical Area Planting.

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway. The area upon which the embankment and reservoir are to be placed shall consist of material that has sufficient bearing strength to support the body of water without excessive consolidation or subsidence.

Drainage area. The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater will provide an adequate supply of water for the intended purpose unless an alternate water source exists to serve this purpose. The quality shall be suitable for the water's intended use.

Reservoir area. The topography and geology of the site shall permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable. Water elevations in the reservoir shall not cause flooding or impede the removal of water from property of adjacent landowners unless appropriate easements are obtained.

Design Criteria For Embankment Ponds

Geological Investigations. Pits, trenches, borings, review of existing data or other suitable means of investigation shall be conducted to characterize materials within the embankment foundation, auxiliary spillway and borrow areas. Soil materials shall be classified using the Unified Soil Classification System.

Foundation. In-situ material under a dam which is not adequate to support the embankment load without excessive consolidation, including but not limited to topsoil, shall be excavated, or otherwise treated to provide adequate bearing capacity. Weathered rock which is permeable and/or susceptible to sliding may also need to be removed to provide a stable foundation.

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

Borrow. Borrow areas must be located and used so that pervious materials which could cause the pond to leak are not exposed. It may be necessary to obtain part or all of the borrow materials from outside the pool area. Test pits in the pool area which penetrate through relatively impervious layers into more pervious formations should be carefully backfilled to prevent leakage. Borrow areas must be finished so they are suitable for the planned use after construction is completed.

Embankment seepage control. Unless site specific conditions and analyses indicate otherwise, the phreatic surface shall be assumed to pass through the embankment at a slope of 4 horizontal to 1 vertical from the 10-year frequency water surface elevation toward the downstream embankment toe.

Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create unacceptably wet conditions downstream, (3) such control 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, and/or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Top Width. The minimum top width for a dam is shown in table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority. For dams with a design height

Table 1. Minimum top width for dams

Design height of embankment (Feet)	Top width (Feet)
< 10	6
10 – 14.9	8
15 – 19.9	10
20 – 24.9	12
25 – 34.9	14
≥ 35	15

(as defined below) of less than 20 feet, maintenance considerations or construction equipment limitations may require increased top widths from the minimums shown in Table 1.

Side Slopes. The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required. Downstream or upstream berms can be used to help achieve stable embankment sections.

Slope Protection. If needed to protect the slopes of the dam from erosion, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (Technical Releases 56, “A guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments” and 69, “Riprap for Slope Protection Against Wave Action” contain design guidance).

Bypass ponds must be designed so that flood flows from the adjacent stream do not erode the downstream embankment slope. When velocities in the bypassed stream exceed safe limits for earthfill, rock riprap or other suitable protection must be provided on the downstream embankment slope up to the design flow depth. The minimum design frequency for evaluating flows in the bypassed stream is a 25-year, 24-hour duration event. Bypass ponds must not restrict or alter the flow characteristics of the stream such that adjacent landowners are adversely affected.

Freeboard. The minimum elevation of the top of the settled embankment, i.e. to the design height, shall be 1 foot above the water surface in the reservoir with the auxiliary spillway flowing at design depth. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam shall be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height.

Settlement. The constructed height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent of the design height of the dam, except where detailed soil testing and laboratory analyses or experience in the area show that a lesser amount is adequate.

Principal spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of lined spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

For dams with a drainage area of 20 acres or less, the principal spillway crest elevation shall not be less than 0.5 feet below the auxiliary spillway crest elevation. For dams with a drainage area over 20 acres, this difference shall not be less than 1.0 feet. Dams with a drainage area greater than 100 acres shall provide a combination of storage and principal spillway discharge to detain runoff from the 10-year frequency, 24-hour storm event below the auxiliary spillway crest.

When the 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 design discharge will be generated in the conduit before there is discharge through the auxiliary spillway.

The inlets and outlets shall be structurally sound, made of materials compatible with the pipe, and designed to function satisfactorily for the full range of flow and hydraulic head anticipated. The riser size for pipe drops shall be such that flow is either weir-control or pipe-control; orifice-control at the riser crest is unacceptable. The riser shall be analyzed for flotation assuming all orifices and pipes are plugged. The factor of safety against flotation shall be 1.2 or greater.

Pipe conduits designed for pressure flow must have adequate anti-vortex devices. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser unless the watershed does not contain trash or debris that could clog the conduit. Openings through trash guards shall be no larger than one-half of the conduit diameter.

The capacity of the principal spillway shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillway(s). The diameter of a principal spillway pipe shall not be less than 4 inches.

If the diameter of a principal spillway conduit is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

Pipe conduits shall be ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (pre-cast or site-cast), or plastic. Pipe conduits through dams of less than 20 feet design height may also be cast iron or unreinforced concrete.

Pipe conduits shall be designed and installed to withstand all external and internal loads without yielding, buckling, or cracking to a degree which will reduce the design capacity or allow seepage. Rigid pipe shall be designed for a positive projecting condition. Flexible pipe shall be designed for a maximum deflection of 5 percent. 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. Different reductions in modulus may be appropriate for other plastic pipe materials.

Specifications in Tables 2 and 3 are to be followed for polyvinyl chloride (PVC) and corrugated metal pipe. For sizes and materials (e.g. PE, ABS) not shown in those tables, the Modified Spangler equation shall be used to determine the appropriate pipe strength which allow no greater than five percent pipe wall deflection. Reinforced concrete pipe and welded steel pipe shall be designed in accordance with TR-60.

Pipe conduits used solely as a supply pipe through the dam for watering troughs and other appurtenances shall not be less than 1-1/4 inches in diameter. Supply pipes shall be galvanized steel or other material identified above for pipe conduits. All valves should be located at or upstream of the dam centerline. Any valves and pipes located downstream of the dam centerline shall have adequate frost protection.

All pipe conduits shall be designed and installed to be water tight by means of couplings, gaskets, caulking, waterstops, or welding. Joints shall be designed to remain watertight under all internal and external loading including pipe elongation due to foundation settlement. Connections of flexible pipe to rigid pipe or other structures shall be designed to accommodate differential movements and stress concentrations.

Pipe conduits shall have a concrete cradle or bedding if needed to provide improved support for the pipe to reduce or limit structural loading on pipe to allowable levels.

Pipe 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 pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment shall be controlled by use of a drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.

The drainage diaphragm shall function both as a filter for adjacent base soils and a drain for seepage that it intercepts. The drainage diaphragm shall consist of sand meeting the requirements of ASTM C-33, for fine aggregate. If unusual soil conditions exist such that this material may not meet the required filter or capacity requirements, a special design analysis shall be made.

The drainage diaphragm shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the outside pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the cutoff is upstream of the centerline. If a chimney drain is part of the embankment, the diaphragm may be included in that drain.

The drainage diaphragm shall be outletted at the embankment downstream toe using a drain

Table 2. Acceptable PVC Pipe for use in Ponds

Nominal pipe size (Inches)	Schedule or Standard Dimension Ratio (SDR) [1/]	Maximum Depth of Fill Over Pipe (Feet)
4 or smaller	SDR 26	10
	Schedule 40	15
	Schedule 80	20
6 – 24	SDR 26	10
	Schedule 40	10
	Schedule 80	15

[1/] PVC 1120 or 1220, conforming to ASTM D1785 or D2241

Table 3. Minimum Gauge for CM pipe for use in ponds

Fill Height (Feet)	Minimum Gauge [1/] for Steel Pipe with Diameter of (Inches) : (2-2/3 inches x ½ inch corrugations) [3/]						Minimum Thickness (Inches) of Aluminum Pipe [2/] with Diameter of (Inches) : (2-2/3 inches x ½ inch corrugations) [3/]			
	≤ 21	24	30	36	42	48	≤ 21	24	30	36
1 -15	16	16	16	14	12	10	0.06	0.06	0.075	0.075
16 – 20	16	16	16	14	12	10	0.06	0.075	0.105	0.105
21 - 25	16	16	14	12	10	10	0.06	0.105	0.135	[4/]

[1/] Gauge for diameters shown may be reduced to 16 when corrugations are 3 inches x 1 inch.

[3/] Pipe with 6-, 8-, and 10-inch diameters has 1½ -inch x ¼-inch corrugations.

[2/] Riveted or helical fabrication.

[3/] Pipe with 6-, 8-, and 10-inch diameters has 1½ -inch x ¼-inch corrugations.

[4/] Not permitted.

envelope continuously along the pipe to where it exits the embankment. Drainfill shall be protected from surface erosion. When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. The anti-seep collar(s) shall increase by at least 15 percent the seepage path along the pipe. Collars should be equally spaced along that portion of the pipe within potentially saturated fill. Maximum spacing shall be approximately 14 times the minimum projection of the collar, measured perpendicular to the pipe but not more than 25 feet. The minimum spacing shall be 10 feet. Collar material shall be compatible with pipe materials.

Outlets. The outlet end of a principal spillway conduit shall extend downstream to a channel with a stable grade or to a point where the resulting scour hole will not endanger the downstream slope of the embankment. Designed, armored scour basins are required where erosive outlet channel conditions exist.

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 stilling basin or an impact basin may be used to provide a safe outlet.

A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Corrosion Protection. All steel pipe and couplings shall have protective coatings in areas that have traditionally experienced pipe corrosion, or in embankments with saturated soil resistivity less than 4000 ohms-cm or soil pH less than 5. Protective coatings shall be asphalt, polymer over galvanizing, aluminized coating or coal tar enamel as appropriate for the pipe type. Plastic pipe that will be exposed to direct sunlight shall be ultraviolet-resistant and protected with a coating or shielding, or provisions provided for replacement as necessary

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.

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

An auxiliary spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway: a conduit with a cross-sectional area of 3 ft^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed auxiliary spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

The auxiliary spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days’ drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the auxiliary spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Auxiliary spillways shall provide for passing the design flow at a non-erosive velocity to a point downstream where the dam will not be endangered.

Constructed auxiliary spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth or in-situ rock. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 feet, the auxiliary spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The minimum length of the level section shall be 10 feet for drainage areas of 20 acres or less, and 20 feet for drainage areas

Table 4. Minimum auxiliary spillway capacity

Type of Pond [1/]	Drainage Area (Acres)	Effective Height (Feet)	Minimum Design Storm
DEP permit not required [2/]	< 20	≤ 15	10-yr, 24-hr
DEP permit not required	<20	>15	25-yr, 24-hr
DEP permit not required	20 to 100	≤ 35	50-yr, 24-hr
DEP permit required	≤100	≤ 35	50-yr, 24-hr
DEP permit required	> 100	≤ 35	100-yr, 24-hr

[1/] DEP permit required (per Code Section 105.3) where drainage area exceeds 100 acres, *or* maximum storage depth exceeds 15 feet, *or* the maximum impounding capacity exceeds 50 acre-feet.

[2/] Exception to [1/] : DEP permit is not required for ponds with no contributory drainage area, the maximum storage depth is 15 feet or less, and the maximum impounding capacity is 50 acre-feet or less. DEP defines maximum storage depth and maximum impounding capacity from the lowest upstream embankment toe to the top of dam.

greater than 20 acres. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities. The exit channel must be perpendicular to the control section, and should be straight and confine the flow to a down-stream point where it will not damage the embankment.

Structural auxiliary spillways. If chutes or drops are used for principal spillways or auxiliary spillways, they shall be designed according to the principles set forth in the Part 650, Engineering Field Handbook and the National Engineering Handbook, 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 a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

Design Criteria For Wetland Restoration/Creation Ponds

For low embankment ponds, used to restore or create wetlands (CP 657 or CP 658, respectively), and that meet the conditions below for their appropriate category, the following criteria may be applied. In addition, all criteria for embankment ponds relative to top width, seepage control, and principal spillways are applicable.

CATEGORY I:

1. Conditions – all must apply
   a. Design height is less than three feet.

b. Drainage area is less than 100 acres.

c. Total storage to the top of the embankment is less than 50 acre-feet.

d. No downstream hazards.

2. Minimum design criteria

a. Principal spillway sized according to Table 5.

b. The design height set 0.5 feet above the principal spillway crest.

c. Where conditions allow, use the entire crest of the embankment as the auxiliary spillway. However, the embankment length, in feet, used as the auxiliary spillway, shall be at least equal to two times (2x) the drainage area, in acres, but not less than 50 feet. The embankment must have a downstream slope of 6:1 or flatter, and be thoroughly compacted and vegetated.

d. If the above requirements cannot be met, an auxiliary spillway shall be sized as defined for Category II or III.

Table 5. Criteria for principal spillways in Category I – III ponds [1/].

Drainage Area (Acres) [2/]	Minimum Riser Diameter (Inches) [3/]	Minimum Box-type Inlet Width x Depth (Inches) [4/]	Minimum Barrel Diameter (Inches) [3/]
0 – 10	6	8 x 10	4
11 – 20	8	14 x 16	6
21 – 50	12 [2/]	24 x 28	8
51 – 75	24 [2/]	n/a	12
75 – 99	36 [2/]	n/a	18

[1/] Smaller, inline structures may be used for water-level control only, in addition to a principal spillway with a riser/inlet and barrel meeting Table 5 criteria.

[2/] For Category I ponds; if the pool surface area, at the riser crest, is at least 3% of the drainage area, principal spillway size requirements may be reduced by one drainage area level. If the pool surface area, at the riser crest, is at least 6% of the drainage area, principal spillway size requirements may be reduced by two drainage area levels.

For Category II ponds; if the pool surface area, at the riser crest, is at least 5% of the drainage area, principal spillway size requirements may be reduced by one drainage area level.

[3/] For risers and barrels that are plastic or smooth steel. In addition to the approved pipe materials listed in Tables 2 & 3, the following pipes are acceptable for embankments with a design height of less than 6-feet: ASTM F-667, F-894, D-3033, & D-3034 (SDR 35).

[4/] PennDOT precast concrete inlet boxes are recommended.

CATEGORY II:

1. Conditions – all must apply

    a. Effective height is less than 6 feet.

    b. Drainage area is less than 50 acres.

    c. Total storage to the top of the embankment is less than 50 acre-feet.

    d. No downstream hazards.

2. Minimum design criteria

    a. The principal spillway sized according to Table 5.

    b. Auxiliary spillway crest set 0.5 feet above the principal spillway crest. The auxiliary spillway must be excavated into original soil or rock.

    c. The auxiliary spillway sized to carry the 10-year, 24-hour peak discharge using NRCS EFH Exhibit 11-2.1, for Retardance C-D. For sites with good storage conditions, the 10-year peak discharge may be flood routed using TR-55 to reduce the size of the auxiliary spillway.

    d. The design height set a minimum of 1.0 foot above the auxiliary spillway crest or at the design flow level in the auxiliary spillway, whichever is greater.

    e. In lieu of a pipe principal spillway, an auxiliary spillway lined with erosion resistant material (e.g., rock, precast interlocking block) may be used.

CATEGORY III:

1. Conditions – all must apply

    a. Effective height is less than six feet.

    b. Drainage area is between 50 and 99 acres.

    c. Total storage to the top of the embankment is less than 50 acre-feet.

    d. No downstream hazards.

2. Minimum design criteria

    a. The principal spillway sized according to Table 5.

    b. The auxiliary spillway crest set 0.5 feet above the principal spillway crest. The auxiliary spillway must be excavated into original soil or rock.

    c. Auxiliary spillway sized to carry the 25-year, 24-hour peak discharge using NRCS EFH Exhibit 11-2.1, Retardance C-D. For sites with good storage conditions, the 25-year peak discharge may be flood routed using TR-55 to reduce the size of the auxiliary spillway.

    d. The design height set 0.5 feet above the flow level in the auxiliary spillway, but not less than 1.0 above the auxiliary spillway crest.

Design Criteria For Excavated Ponds

For ponds constructed by excavation, the following design criteria shall apply.

Runoff. Provisions shall be made for a pipe and auxiliary spillway, if needed, that will meet the capacity requirements of Table 4. Runoff flow patterns shall be considered when locating the excavated pond and placing the spoil.

Side slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width and stability shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than five horizontal to one vertical. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Excavated material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment construction and leveling of surrounding landscape.
5. Hauled away.

Spillways. If water is to be stored above the natural groundline, the crest of any embankment may serve as an auxiliary spillway using the criteria for Category I above. Otherwise, the auxiliary spillway must meet the requirements of Table 4.

CONSIDERATIONS

Safety. Consideration shall be made for the safety of all visitors to the pond. Measures may include fencing, slope benching. Locking controls, etc. When fencing a structure, the fence shall be located so that it will not interfere with the operation of any spillway.

Visual resource design. The visual design of ponds should be carefully considered in areas of high public visibility and those associated with recreation. 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 may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If compatible with other objectives of the pond, islands may be added for visual interest and to attract wildlife.

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

If fish are to be stocked, consider criteria and guidance in conservation practice standard 399, Fishpond Management.

Vegetation. Stockpiling topsoil for placement on disturbed areas can facilitate revegetation.

Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

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

1. Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that are carried by runoff.
2. Effects on the visual quality of onsite and downstream water resources.
3. Short-term and construction-related effects of this practice on the quality of downstream water courses.
4. Effects of water level control on the temperatures of downstream water to

prevent undesired effects on aquatic and wildlife communities.

5. Effects on wetlands and water-related wildlife habitats.
6. Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.
7. Effects of soil water level control on the salinity of soils, soil water, or downstream water.
8. Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed and reviewed with the landowner or individual responsible for operation and maintenance. As a minimum, this plan shall contain items relating to the structural integrity of the pond and its components (e.g. spillways, pool area, embankment), and to operation of any appurtenances (e.g. gates, valves). The plan should also identify the person(s) to be contacted and emergency actions to be taken in the event if an unusual event such as inoperable gate or dam overtopping.