NATURAL RESOURCES CONSERVATION SERVICE
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, 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 ponds where:

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.

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.

The effective height of the dam is 35 feet or less.

General 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.

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. Anticipated sediment yield from the watershed shall be considered in determining the storage volume of the pond and the inlet elevation of the principal spillway.

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 cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary to reduce seepage through the foundation. A cutoff trench shall be provided on all structures with a fill height greater than or equal to 12 feet. The cutoff trench shall be excavated to a minimum depth of 4 feet below the existing ground level. If bedrock is encountered in the 4 feet, the cutoff trench need only remove any weathered bedrock. The most impervious material available shall be used as backfill in the core trench. 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.

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) 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, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Embankment. 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 less than 20 feet in height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 1.

Table 1. Minimum top width for dams

Total height of embankment	Top width
feet	*feet*
Less than 10	6
10 – 14.9	8
15 – 19.9	10
20 – 24.9	12
25 – 34.9	14
35 or more	15

The definition of total height of the dam or embankment in Table 1 is the difference in elevation between the designed top of dam (after settlement) and the low point on the centerline.

For ponds with a permanent pool area of 2 acres or more, protection shall be provided across the earth fill at normal pool elevation (elevation of the inlet of the mechanical spillway) on the upstream side of the earth fill extending to the abutments. This protection may be: (1) a berm having a width of at least 5 feet; or (2) other suitable slope protection such as riprap.

The area on which a dam is to be placed shall consist of material that has sufficient bearing strength to support the dam without excessive consolidation.

On structures with drop inlets, the riser shall be protected from damage by ice or floating debris by one of the following options: (1) a berm at least 5 feet wide or other suitable slope protection, such as rock riprap, shall be constructed across the earth fill at the normal pool elevation (elevation of the mechanical spillway) on the upstream side of the earth fill extending to the abutments; or (2) a semi-circular berm extending not less than 5 feet from the riser inlet shall be installed. A berm (full or semi-circular) should be considered with hood inlets for ice protection where the permanent pool level is maintained at the hood inlet elevation. The junction between the earth fill and abutments will normally carry runoff from berms and adjacent areas and shall be shaped and vegetated to minimize erosion.

Organic soils shall not be used for embankment materials unless approved by the State Conservation Engineer. If organic soils are used to build fills, the embankment should be covered with 4 to 6 inches of mineral soil whenever possible to prevent the fill from burning or decomposing rapidly.

Embankments comprised entirely of sandy soils shall not be used for fill heights in excess of 7 feet unless approved by the State Conservation Engineer. If it is necessary to use sandy soils, they will be evaluated on their permeability and piping characteristics. Frequently it is possible to mix some clay with the sandy soil; however, properly designed zoned fills are acceptable.

Borrow may be taken from the pool area provided a natural relatively impervious blanket of 1 foot for each 5 feet of water depth is maintained. Borrow pits upstream from an embankment will be located so that the minimum width between the toe of the embankment and the edge of an excavated borrow area will be equal to twice the maximum height of the dam. For drainage area less than 20 acres, borrow may be excavated from the pool adjacent to the fill, but not lower than the upstream toe of the fill. Generally borrow below a dam in the valley bottom is not recommended, but if necessary, shall be at least a distance of five times the height from the downstream toe.

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 TR-69, “Riprap for Slope Protection Against Wave Action” contain design guidance).

Freeboard. The minimum elevation of the top of the settled embankment 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 design 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 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.

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

Pipe conduits designed for pressure flow must have adequate anti-vortex devices. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

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

If the pipe conduit diameter 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 total height may also be cast iron or unreinforced concrete. Connections of plastic pipe to less flexible pipes or structures must be designed to avoid stress concentrations that could rupture the plastic.

The maximum height of fill over any principal spillway steel or aluminum pipe must not exceed 25 ft.

Pipe conduits shall be designed and installed to withstand all external and internal loads without yielding, buckling, or cracking. 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.

The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material. Connections of flexible pipe to rigid pipe or other structures shall be designed to accommodate differential movements and stress concentrations.

The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe.

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.

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.

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.

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.

Table 2. Acceptable PVC pipe for use in earth dams[1]

Nominal pipe size	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe
in		*ft*
4 or less	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6,8,10,12	Schedule 40	10
	Schedule 80	15
	SDR 26	10

[1]Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM-D-1785 or ASTM-D-2241.

The minimum spillway capacities for class (A) dams having a product of storage times the effective height of the dam of less than 3000 and an effective height of 35 feet or less shall meet the requirements of Table 4.

Table 4 assumes an emergency spillway in good condition. A good spillway is one which will support vegetation (or is otherwise protected) and has exit slopes which lie within the ranges as defined in Minnesota Engineering Technical Note 1 or EFH, Exhibit 11-2, Tables 3A-3B. A poor emergency spillway is one which will likely sustain damage from an appreciable flow but will protect the principal spillway structure and embankment during the passage of a single design storm. Structures with a poor emergency spillway must increase the principal spillway design storm in Table 4 by one frequency level. (In other words, a site with a good emergency spillway may have a 10 year frequency design storm. If that same site has a poor emergency spillway, a 25-year design storm must be used.)

Table 3. Minimum gage for corrugated metal pipe [2-2/3-in x ½-in corrugations][1]

Fill	Minimum gauge for steel pipe with diameter (in) of ——					
height (ft)	21 and less	24	30	36	42	48
1 - 15	16	16	16	14	12	10
15 - 20	16	16	16	14	12	10
20 - 25	16	16	14	12	10	10

Fill	Minimum thickness (in) of aluminum pipe[2] with diameter (in) of ——			
height (ft)	21 and less	24	30	36
1 - 15	0.06	0.06	0.075	0.075
15 - 20	0.06	0.075	0.105	0.105
20 - 25	0.06	0.105	0.135	----[3]

1 Pipe with 6-, 8-, and 10-inch diameters has 1-1/2 in x ¼-inch corrugations.

2 Riveted or helical fabrication.

3 Not permitted.

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:

- The effective height of dam is greater than 15 feet.
- The conduit is of smooth pipe larger than 8 inches in diameter.
- 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.

Drainage Diaphragm. 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 located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam, but downstream of the centerline of the dam if the cutoff is upstream of the centerline. 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, with these exceptions:

1. The vertical extension upward need be no higher than the maximum potential reservoir water level, or closer than 2 feet perpendicular to the embankment design surface.
2. The horizontal extension need be no further than 5 ft beyond the sides and slopes of any excavation made to install the conduit.
3. The vertical extension downward may be terminated at the surface of bedrock when it occurs within the 18” distance. Additional control of general seepage through an upper zone of weathered bedrock may be needed.

The drainage diaphragm shall be outletted at the embankment downstream toe using a drain backfill envelope continuously along the pipe to where it exits the embankment. Drain fill shall be protected from surface erosion.

Table 4. Minimum spillway capacity

			Minimum principal spillway design storm[2]		Minimum emergency spillway design storm[2]	
Drainage area	Effective height of dam[1]	Maximum Storage	Frequency	Minimum duration	Frequency	Minimum duration
acre	*ft*	*ac-ft*	*yr*	*hr*	*yr*	*hr*
20 or less	0-20	50	*	24	10	24
20 or less	20-35	50	2	24	25	24
20-80	0-20	50	5	24	25	24
20-80	20-35	50	5	24	50	24
80-250	0-20	50	10	24	25	24
80-250	20-35	50	10	24	50	24
All others	0-35	any	25	24	50	24

1. As defined under "Scope."

2. Select rain distribution based on climatological region.

* A principal spillway is required on all embankment ponds except where the drainage area is less than 20 acres AND there is no spring flow or base flow AND the emergency spillway is in good condition. A trickle tube is required if the site has no principal spillway.

Freeboard is the difference in elevation between the water surface in the vegetative spillway during the passage of the emergency spillway design storm and the top of settled fill. The minimum freeboard shall be 1.0 foot.

Anti-seep Collars. When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. 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. The anti-seep collar(s) shall increase by at least 15 percent the seepage path along the pipe.

Trash Guard. 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.

Other Outlets. 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.

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 safe 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 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.

Table 5. Permissible Velocities for Vegetated Spillways*

Erosion Resistant Soils***

Permissible velocity in ft/sec**	Exit Channel slope 0 - 5 %	Exit Channel slope 5-10 %
Buffalo grass, Kentucky blue grass, Smooth bromegrass, Reed canarygrass	7	6
Sod-forming grass legume mixtures	5	4
Big bluestem Native grass mixtures	3.5	3.5

Easily Eroded Soils

Permissible velocity in ft/sec**	Exit Channel slope 0 - 5 %	Exit Channel slope 5 - 10 %
Buffalo grass, Kentucky blue grass, Smooth bromegrass, Reed canarygrass	5	4
Sod-forming grass legume mixtures	4	3
Big bluestem Native grass mixtures	2.5	2.5

* Refer to NRCS TP-61 or EFH Exhibit 11-2, Table 1

** Increase values 10% when the anticipated average use of the spillway is not more frequent than once in 50 years or 25 percent when the anticipated average use is not more frequent than once in 100 years.

*** Cohesive soils with a PI greater than 15.

The allowable velocity to the control section shall not exceed the velocities shown in Table 5. For dams with an effective height greater than 20 feet and a drainage area greater than 20 acres, the exit channel velocity for peak discharge must not exceed Table 5 velocities in the reach where an exit channel failure might cause flow to impinge on the toe of the dam.

Spillways shall have a minimum length of level section upstream from the control section of 30 feet. The centerline of the approach channel upstream of the level section shall be tangent to the centerline of the level section. The shape of the level section shall have the same dimensions (side slope and bottom width) as the outlet section.

An abrupt change in grade may be constructed in lieu of a vertical curve section to achieve the intended purpose of a control section.

The alignment shall be as straight as possible throughout the length of the outlet section. No curvature shall be incorporated for a distance equal to at least one-half the maximum base width of the embankment. The outlet shall be (1) a nearly level channel or flood plain area; or, (2) a bluff type escarpment where outflow can spread uniformly over the escarpment slope.

Outlets where outflow will be concentrated due to gullies or small drainageways shall be avoided or modified to eliminate concentrations of flow.

Where the outlet has or will have seepage problems, appropriate measures shall be installed to maintain a stable outlet and promote good sod producing vegetation.

Seeding and mulching. An adequate cover of grass shall be established on the exposed surfaces of the embankment, borrow areas, and the emergency spillway. In some cases, temporary vegetation or mulching may be used until conditions are right for establishment of permanent vegetation. For seeding specifications, see Standard 342, Critical Area Planting. For mulching specifications, see Standard 484, Mulching.

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.

Criteria for Excavated Ponds

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 shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical.

Minimum size. Excavated ponds receiving their water supply from surface runoff must have a minimum dimension of 10 feet by 10 feet at a depth of 8 feet below the overflow level. Check pond capacity to insure that an adequate supply of water is available for livestock use (see section below). This minimum size requirement does not apply to ponds constructed for wildlife. The criteria in Standard 644, Wildlife Wetland Habitat Management, apply for the minimum size of a wildlife structure. Excavated ponds receiving their water supply from ground water shall have a minimum dimension of 8 feet by 8 feet at a water depth of 4 feet. If the water supply is adequate, criteria on water capacities below do not apply to excavated ponds fed by ground water.

Perimeter form. If the structures are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvilinear.

Seeding. All areas disturbed during construction are to be seeded to an erosion resistant mix specified in the construction documents.

Inlet protection. 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.

CONSIDERATIONS

Water Capacity for all ponds. When used for stock watering purposes, the pond storage capacity should be based upon providing water requirements for livestock estimated on the following basis (Values should be increased for hot summer months.)

1. Cow or horses -- 10 to 12 gallons daily.
2. Heavy milk-producing cows -- 18 to 24 gallons daily.
3. Hogs or sheep - 2.5 to 3 gallons daily.
4. Poultry - 5 to 7 gallons daily per 100 chickens.
5. Provide for a 180 day drought period.
6. When the pond depends upon surface runoff, allow approximately 3 feet for seepage and evaporation.

When the primary purpose is for stock watering, the minimum surface area at normal water level shall be 0.15 acre. At least 0.04 acre surface area at normal water level (25 percent of surface area if practical) shall have a minimum depth of 8 feet. When the underlying material prevents excavation to the 8-foot depth, at least 0.08 acre surface area (50 percent if practicable) shall have a minimum depth of 6 feet.

If livestock are to water directly from the pond, an approach ramp must be constructed with a slope of 4:1 or 5:1. If the pond is fenced, the ramp shall be graveled, paved or otherwise prepared to provide solid footing and shall be at least 16 feet wide. Any permanent system used to pump water from a pond to a tank should be protected from damage by freezing. The intake should have a filter to prevent pipe clogging and the system must be large enough to meet the watering requirements.

Urban applications. Urban sites frequently are a higher risk than rural sites. Consideration should be given to public safety, utility locations, vandalism, and higher property values that may increase damages from a potential overtopping condition.

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 feasible, 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, structure 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.

- 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 de-nitrification.
- 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 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.