



Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

POND

CODE 378

(no)

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

This practice is used to accomplish one or more of the following purposes:

- 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 (class a) hazard ponds (dams) 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 is the upper limit.
3. The effective height of the dam is 35 feet or less.

Dams exceeding the limitations listed above and any significant (class b) hazard or high (class c) hazard dams as defined in National Engineering Manual (NEM) Part 520 will meet or exceed the requirements of Technical Release No. 60, Earth Dams and Reservoirs.

(Note: Hazard class designations a, b, and c are being phased out and replaced with low, significant, and high.)

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 ground water 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 intended use of the water.

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.

CRITERIA

General Criteria Applicable to All Purposes

Laws, rules, and regulations

This practice shall conform to all federal, state, and local laws, rules, and regulations. Laws, rules, and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands or other waters of the U.S., preservation of cultural resources, development of a breach inundation area map, and endangered species.

The owner is responsible for securing necessary permits, complying with all laws and regulations, and meeting legal requirements applicable to the installation and operation and maintenance of the pond and associated structures. The owner is also responsible for any upgrades to the dam required by changes to the hazard classification due to development in the breach inundation area.

Dams that are 25 feet high or taller or dams that are 6 feet high or taller and impound 50 acre- feet or more of water at the elevation of the top of dam are required by Kansas Statutes Annotated (K.S.A.) 82a-301 to 305a (Stream Obstruction Act) to be approved and permitted by the Chief Engineer of the Kansas Department of Agriculture, Division of Water Resources (DWR).

The total height of the dam (embankment) is the difference in elevation in feet between the top of the dam and the lowest elevation at the downstream toe of the dam.

Owners of dams where the annual diversion and beneficial use are more than 15 acre-feet or dams having a total water volume of more than 15 acre-feet are required by K.S.A. 82a-728 of the Kansas Water Appropriation Act to obtain a permit to appropriate water from the Chief Engineer of DWR.

Dams that impound 50 acre-feet of water or less for which tax reduction benefits are requested are required by K.S.A. 82a-406 of the Kansas Water Storage Law to be approved by the Chief Engineer of DWR.

Permitted dams must meet the requirements of this standard, the requirements of DWR's rules and regulations, and K.S.A. 82a-301 to 305a. The latest versions of the rules and regulations and K.S.A.s can be obtained at the website <http://accesskansas.org/kda/dwr>.

Vegetation and fencing

The exposed surfaces of the embankment, auxiliary spillway, outlet channel, borrow area, spoil, and other disturbed areas adjacent to the reservoir area shall be seeded. Seedbed preparation, seeding, fertilizing, and mulching shall comply with Conservation Practice Standard 342, Critical Area Planting.

Fencing shall be installed as required for the protection of vegetation, special vegetative plantings, vegetative wave erosion protection, and for safety considerations. Fencing shall comply with Conservation Practice Standard 382, Fencing. Fishponds with reservoir areas of less than 2 acres will have the reservoir area, dam, and auxiliary spillway fenced as required to exclude livestock.

Design criteria for embankment ponds

Pond size, depth, and spacing

Ponds shall provide storage capacity for the planned consumptive uses and the sediment yield estimated for the life of the structure. The volume of this capacity shall not exceed the mean annual runoff from the drainage area.

Spacing of stockwater facilities within a pasture should not exceed 1 mile apart on gentle relief or ½ mile on rough relief for adequate distribution of grazing. Except where there is a significant difference in water quality, the required distribution of water may be provided by springs, wells, flowing streams, or ponds.

Fishponds - The minimum reservoir area shall be ½ acre. The depth over ¼ of the reservoir area shall be at least 8 feet for spring-fed ponds and 10 feet where surface runoff is the primary source of water. Not more than 20 percent of the reservoir area will have a water depth less than 2 feet.

Depth along the shoreline for 2/3 the distance from the dam to the upper end of the reservoir shall be at least 3 feet. Side slopes for this portion of the shoreline shall be 3 horizontal to 1 vertical (3:1) unless soil characteristics or special design considerations dictate otherwise. The bottom of the reservoir area shall be left in an irregular, rough condition with ridges, drop-offs, ledges, boulders, stumps, etc. Consult the pond booklet entitled "Producing Fish and Wildlife from Kansas Ponds" for further considerations.

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. 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 1:1. Excavation deeper than 5 feet shall conform to Occupational Safety and Health Administration (OSHA) requirements.

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 ensure 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 1-way traffic and 26 feet for 2-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.

Side slopes

The upstream and downstream side slopes of the settled embankments shall not be less than 3:1 and 2½:1, respectively. 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.

Table 1 - Minimum top width for dams

Total Height of Embankment (feet)	Top Width (feet)
Less than 20	10
20 to less than 25	12
25 to less than 35	14
35 or more	15

Note: For this standard, the maximum effective height of the dam is 35 feet.

Slope protection

The necessity to protect the face of the embankment from wave erosion is dependent on specific site conditions and shall be a design consideration for each dam.

Normally, dams that face the prevailing wind and have an unshielded fetch of 500 feet or more require erosion 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 Release No. 56, A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments, and Technical Release No. 69, Riprap for Slope Protection Against Wave Action, contain design guidance. Also refer to the Kansas Supplement to Chapter 11 of National Engineering Handbook (NEH) Part 650, *Engineering Field Handbook*.

Consideration shall be given to using wave erosion measures other than berms or flatter slopes on fishponds to maintain an upstream slope of 3:1 insofar as possible.

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, except as modified by Table 6 for dams on roads. 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 ponds not subject to DWR approval. Ponds subject to DWR approval shall conform to the applicable rules and regulations.

Settlement

The design height of the dam shall be increased by the amount needed to ensure 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. The allowance for settlement will be based on centerline height. For DWR-approved dams, follow criteria in the applicable rules and regulations.

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 auxiliary spillway. This second exception is limited to dams storing 50 acre-feet or less at top of dam elevation.

Dams not specifically requiring a pipe conduit because of the favorable auxiliary spillway conditions listed above but subject to periods of long, continuous flow from snowmelt, springs, etc., may use a trickle tube to control this flow. Such a pipe shall have a crest elevation at least 1 foot below the auxiliary spillway crest and a 6- inch minimum diameter.

Crest elevation of inlet - The crest elevation of the inlet shall be set below the crest elevation of the auxiliary spillway a vertical distance that meets all of the following:

1. Full pipe flow is generated before there is flow through the auxiliary spillway.
2. Accommodate the runoff, based upon Antecedent Moisture Condition II, from a rainfall of 2-year frequency, 24-hour duration, without auxiliary spillway flow.

Size - The capacity of the pipe conduit shall be adequate to discharge long duration, continuous, or frequent flows without flow through the auxiliary spillway. Flood routing through the principal spillway conduit may be used to determine the crest elevation of the auxiliary spillway. However, for DWR-approved dams, follow criteria contained in the applicable rules and regulations.

The principal spillway conduit shall:

1. Provide capacity to release the 2-year frequency detention storage volume in 72 hours or less
2. Be 6 inches or greater in diameter if a hooded or canopy inlet is used
3. Have a barrel 8 inches or greater in diameter if a drop inlet is used

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.

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 (precast or sitecast), or plastic. Pipe conduits through dams of less than 20 feet total 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. Rigid pipe shall be designed for a positive projecting condition. Flexible pipe strength shall not be less than necessary to support the design load with a maximum deflection of 5 percent. The modulus of elasticity for polyvinyl chloride (PVC) pipe shall be assumed as 1/3 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. Refer to NEH Part 636, *Structural Engineering*, Chapter 52, for details of design procedures.

Refer to Tables 2, 3, and 4 for minimum pipe thickness details and maximum allowable earthfill over pipes. Connections of flexible pipe to rigid pipe or other structures shall be designed to accommodate differential movements and stress concentrations.

All pipe conduits shall be designed and installed to be watertight 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.

All plastic pipe that requires joints shall use gaskets in the couplings for conduits with more than 10 feet of earthfill cover. Solvent weld connections are not permitted. Joints for corrugated plastic pipes shall be installed as recommended by the manufacturer.

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.

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- galvanized, aluminized, or coal-tar enamel (as appropriate) for the pipe type. Plastic pipe that will be exposed to direct sunlight should be ultraviolet-resistant and protected with a coating or shielding. Unprotected pipe shall be repaired or replaced as specified in the operation and maintenance plan.

Table 2 - Smooth PVC 1/ and PE 2/ pipe 3/

Nominal Pipe Size (inches)	Schedule, Standard Dimension Ratio (SDR), Standard Inside Dimension Ratio (SIDR), or Dimension Ratio (DR)	Maximum Depth of Fill over Pipe (feet)
PVC 1½, 2 ^{4/}	SDR 26	16
	SDR 21	23
	Schedule 40 or Schedule 80	40
PE 1½, 2 ^{4/}	SIDR 11.5	15
	SDR 11 or DR 11 or SIDR 9	19
	SDR 9 or DR 9	33
4 ^{4/}	SDR 26	16
	SDR 21	23
	Schedule 40	28
	Schedule 80	40
6 to 15	DR 25 or SDR 26	16
	SDR 21	23
	DR 18	31
16 to 24	DR 25	17
	DR 18	31
^{1/} Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to American Society for Testing and Materials (ASTM) D 1785 or ASTM D 2241 or American Water Works Association (AWWA) C 900 or C 905 ^{2/} Polyethylene pipe, PE 3408, conforming to ASTM D 2239 or D 3035 ^{3/} Based on NEH Part 636, <i>Structural Engineering</i> , Chapter 52 with values of E' = 400 psi, 5% deflection, a soil unit weight of 120 pcf, and a 16,000-pound wheel load for allowable deflection ^{4/} Limited to water supply lines		

Table 3 - Corrugated metal pipe 1/ 2/

Pipe Diameter (inches)	Steel with 1½ Inches x ¼ Inch Corrugation			Steel with 2⅔ Inches x ½ Inch Corrugation			Aluminum with 1½ Inches x ¼ Inch Corrugation			Aluminum with 2⅔ Inches x ½ Inch Corrugation		
	Gage	Thickness (inches)	Fill ^{3/} (feet)	Gage	Thickness (inches)	Fill ^{3/} (feet)	Gage	Thickness (inches)	Fill ^{3/} (feet)	Gage	Thickness (inches)	Fill ^{3/} (feet)
6 to 10	16	0.064	30	—	—	—	16	0.060	30	—	—	—
12 to 60	—	—	—	16	0.064	30	—	—	—	16	0.060	25
66 to 72	—	—	—	16	0.064	30	—	—	—	16	0.060	14

^{1/} Riveted or helical fabrication manufactured in accordance with ASTM A 796 or B 790

^{2/} Based on NEH Part 636, Chapter 52, with a soil stiffness factor of 0.22 and a 16,000-pound wheel load for allowable thrust - For steel pipe, E = 30,000,000 psi, yield strength = 33,000 psi, and tensile strength = 45,000 psi; for aluminum pipe, E = 10,000,000 psi, yield strength = 24,000 psi, and tensile strength = 34,000 psi

^{3/} Maximum depth of fill over pipe

Table 4 - Corrugated PVC 1/ and PE 2/ pipe with smooth interior 3/

Nominal Pipe Size (inches)	Pipe Type, Reference Specification, and Ring Stiffness Constant (RSC) or Pipe Stiffness (PS)	Maximum Depth of Fill over Pipe (feet)
4 to 36	Dual Wall PVC, ASTM F 949, PS = 46	12
4 to 12	Dual Wall PE, AASHTO M 252 and M 294, PS = 50	12
15, 18, 24, or 30	Dual Wall PE, AASHTO M 252 and M 294, PS = 28-42	11
36, 42, or 48	Dual Wall PE, AASHTO M 252 and M 294, PS = 18-22	10
18, 24, or 30	Dual Wall PE, ASTM F 894 RSC = 40	10
36, 42, or 48	Dual Wall PE, ASTM F 894 RSC = 40	9

^{1/} Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM F 949

^{2/} Polyethylene pipe conforming to ASTM F 894 or American Association of State Highway Transportation Officials (AASHTO) M 252 or M 294 - PE pipe is limited to applications with less than 25 feet of head (10.8 psi).

^{3/} Based on NEH Part 636, Chapter 52 with values of E' = 400 psi, 5% deflection, a soil unit weight of 120 pcf, and a 16,000-pound wheel load for allowable deflection

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.

Barrel slope

The minimum slope shall be 1 percent to provide drainage and allow for settlement. The maximum slope shall not exceed 25 percent. The outlet section of conduits exceeding 15 inches in diameter shall not exceed 7 percent.

Conduit outlet

Pipes shall extend beyond the intersection of the embankment and the grade line of the outlet channel a minimum of 8 feet if the diameter is greater than 12 inches or a minimum of 5 feet if the diameter is 12 inches or less. The conduit invert shall be installed a minimum of 1 foot above the grade line of the outlet channel. If the outlet channel is expected to aggrade, the invert shall be set to provide 1 foot above the grade line after aggrading occurs. Conduit outlet supports are to be installed when the outlet channel may degrade or other unstable conditions are anticipated. The pipe support shall be equivalent to the approved engineering drawings and design information referred to in NEH Part 650 KS650.680. A stilling basin or other suitable energy dissipator (Saint Anthony Falls [SAF] basin or an impact basin) is to be installed when the conduit diameter is 18 inches or larger and for smaller diameters if there is need to dissipate energy before the discharge enters the outlet channel. Riprap or other erosion control materials are to be installed as required for stabilizing the energy dissipator.

Seepage control for pipe conduit

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 consists of smooth pipe larger than 8 inches.
- 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 or anti-seep collars.

Drainage diaphragm

The drainage diaphragm shall function both as a filter for adjacent base soils and as 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 (from outside of the pipe) at least 3 times the outside pipe diameter and vertically downward 18 inches or 1.5 times the outside diameter of the pipe (whichever is more) 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.

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

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 the associated pipe materials. The anti-seep collar shall increase by at least 15 percent the seepage path along the pipe.

The anti-seep collar shall be secured to the pipe by mechanical means to insure the watertight connection. The collar materials and installation shall be equivalent to the approved engineering drawings and design information referred to in NEH Part 650 KS650.680.

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.

Trash guards shall incorporate an anti-vortex device for principal spillway drop inlets designed for pressure flow. Trash guards shall be equivalent to the approved engineering drawings and design information referred to in NEH Part 650 KS650.680.

Conduit inlets

Canopy or hooded inlets may be used for metal or plastic conduits. They should not be used for corrugated PVC or PE conduits unless a special fitting is used and the inlet is formed from smooth wall materials.

A concrete collar or pad around the inlet is recommended for use with corrugated plastic pipe to resist floating.

The canopy or hooded inlets and concrete collars shall be equivalent to the approved engineering drawings and design information referred to in NEH Part 650 KS650.680.

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 laws, rules, and regulations.

Pipes used to drain the pool area are to meet the principal spillway material requirements and seepage control requirements of this standard. These pipes may be a separate installation or incorporated with the principal spillway structure. A valve, cap, or plate must be installed on the drainpipe.

A drainpipe shall be provided for fishponds. The fishpond outlet pipe shall be equivalent to the approved engineering drawings and design information referred to in NEH Part 650 KS650.680.

Water supply pipes

Supply pipes through the dam to watering facilities shall have an inside diameter of not less than 1½ inches. Water supply pipes shall meet the principal spillway material requirements and seepage control requirements of this standard. NEH Part 650 KS650.680 refers to approved engineering drawings and the minimum acceptable design requirements for water supply pipes through dams.

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 square feet 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 5 less any reduction creditable to conduit discharge and detention storage.

Dams located on county or township roads shall have auxiliary spillway proportions based upon daily vehicular traffic as shown in Table 6.

Table 5 - Minimum auxiliary spillway capacity

Drainage Area (acre)	Effective Height of Dam ^{1/} (feet)	Storage (acre-feet)	Minimum Design Storm ^{2/}	
			Frequency (years)	Minimum Duration (hours)
20 or less	20 or less	Less than 50	10	24
20 or less	Over 20	Less than 50	25	24
Over 20		Less than 50	25	24
All others			50	24
1/ As defined under the CONDITIONS WHERE PRACTICE APPLIES section				
2/ Antecedent Moisture Condition II				

Table 6 - Minimum design storms for roadfill dams

Estimated Daily Vehicular Traffic	Minimum Design Storm ^{1/}		Minimum Freeboard ^{2/} (feet)
	Frequency (years)	Minimum Duration (hours)	
0 to 49	50	24	1
50 to 99	50	24	2
100 or more	Auxiliary spillway and freeboard hydrographs from Technical Release No. 60 for low (class a) hazard dams.		
^{1/} Antecedent Moisture Condition II			
^{2/} Above the maximum water surface in the reservoir measured immediately upstream from the level crest section of the auxiliary spillway			

The auxiliary spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start with the water surface at the elevation of the crest of the principal spillway. 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 and no steeper than 3:1 in earth materials. For dams having an effective height exceeding 15 feet, the auxiliary spillway shall have a bottom width of not less than 20 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, but not less than 30 feet for dams subject to DWR approval. 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.

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 NEH Part 650; NEH Section 5, *Hydraulics*; NEH Section 11, *Drop Spillways*; and NEH 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 6 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 (when embankments are part of the excavated pond design) that will meet the capacity requirements of Table 5. 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 against sloughing. Side slopes of 3:1 or flatter are preferable and should be used unless site conditions and/or machinery limitations require steeper slopes. In no case, shall the side slopes be steeper than 2:1.

Where livestock will water directly from the pond, at least 1 end or side shall be constructed with a slope no steeper than 4:1.

Where the pond is for fish production, all side slopes shall be 3:1 or steeper.

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 materials

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. Spoil must not be placed in a manner that will cause erosion, restrict runoff, or limit flood plain capacity. It shall be disposed of in one of the following ways:

Fishpond - Spoil shall be uniformly placed or shaped primarily on the east and/or west sides behind a berm width equal to the depth of the pond but not less than 12 feet. Placement is important for aeration and wind movement.

Other ponds - Spoil shall be handled as follows:

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.

Depth and area

Fishponds - The minimum reservoir area shall be $\frac{1}{2}$ acre. The depth over $\frac{1}{4}$ of the reservoir area shall be at least 8 feet where ground water is the primary source of water and 10 feet for ponds relying on surface runoff.

Other ponds - Where surface runoff is the primary source of water for a pond, the minimum depth from ground level at the outlet shall be 5 feet, and the minimum bottom area at 5 feet of depth shall be 500 square feet. Where ground water is the primary source of water for a pond, the minimum depth shall be 5 feet; and the minimum bottom area shall be 200 square feet. The ground water should provide 2 to 3 feet of useable water during the dry season and the design depth increased as recommended by the investigation.

CONSIDERATIONS

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.

Wetlands

Consider existence of wetlands and/or other water of the U.S. and any project impacts on such resources. Consider sequencing (avoidance, minimizations, partial mitigation) when appropriate.

Fish and wildlife

Consider the following:

- Project location and construction should minimize the impacts to existing fish and wildlife habitat.
- When feasible, structure and diversity should be developed and/or retained such as trees in the upper reaches of the pond and stumps in the pool area. The 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

Consider the following:

- Selection and placement of vegetation to protect all disturbed areas from erosion - Refer to Conservation Practice Standard 342, Critical Area Planting.
- Topsoil stockpiling for placement on disturbed areas to facilitate revegetation.
- Placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

Water quantity

Consider the following:

- 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 the environment (such as wetlands and aquifers) and the social and economic impacts to downstream uses or users.
- Potential for multiple purposes.

Water quality

Consider the following:

- 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.

Hazard classification

The hazard classification of the structure may be affected by potential development in the breach inundation area. Consideration should be given to providing the breach inundation area map to local zoning or planning authorities to limit development in that area. The owner should be informed of the potential costs and liabilities associated with a change in the hazard classification to “significant” or “high.”

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 individuals responsible for operation and maintenance.

REFERENCES

None.