Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

POND

CODE 378

(no)

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DEFINITION

A pond is a water impoundment made by constructing an embankment, by excavating a dugout, or by a combination of both.

In this standard, NRCS defines ponds constructed by the first method as embankment ponds, and those constructed by the second method 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 above the lowest original ground along the centerline of the embankment.

PURPOSE

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

- A pond stores water for livestock, fish and wildlife, recreation, fire control, erosion control, flow detention, and other uses such as improving water quality

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all excavated ponds. It also applies to embankment ponds that meet all of the criteria for low-hazard dams as listed below:

- The 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.

CRITERIA

General Criteria Applicable to All Purposes

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

The landowner is responsible for acquiring land rights from adjoining landowners for any permanent or temporary storage created by the planned structure. The landowner shall obtain permits to comply with applicable federal and state laws and regulations. See Iowa Administrative Code (IAC), Environmental Protection [567], Chapter 73, Section 567-73.3(455B) for IDNR water storage and construction permit thresholds and criteria. See IAC Section 567.73.2(455B) for “Height of Dam” definition.

NRCS reviews and periodically updates conservation practice standards. To obtain the current version of this standard, contact your Natural Resources Conservation Service State office or visit the Field Office Technical Guide online by going to the NRCS website at https://www.nrcs.usda.gov/ and type FOTG in the search field.
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The designer shall complete Form IA-ENG-40 for inventory dams and submit the form to the State Conservation Engineer upon completion of construction. The thresholds that have been established for dam and reservoir sizes to be included in the inventory of NRCS assisted dams may be found in Table 8.

Table 8. National Inventory of Dams Criteria

Table 8. National Inventory of Dams Criteria[1]

NRCS Form IA-ENG-40 shall be completed and submitted to the State Conservation Engineer when any of the following conditions are met: a. The dam is classified as Significant or High hazard, b. Overall height > 6 Feet, and storage capacity ≥ 50 Acre-Feet, or c. Overall height ≥ 25 Feet, and storage capacity ≥ 15 Acre-Feet d. All dams with an overall height of 35 feet or more. e. All project detention type structures regardless of size or hazard class.

[1] The National Inventory of Dams is in accordance with §520.21(f), National Engineering Manual (NEM) and is part of the NRCS program for dam safety.

Ponds are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

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 criteria 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. Design sediment storage capacity that is equal to the expected life of the structure or 35 years, whichever is greater, unless periodic sediment removal is provided for in the Operation and Maintenance Plan.

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. Runoff water from barnyards, feedlots, septic tanks, barn drains, or other sources of contamination shall be diverted so as not to flow into ponds to be used for drinking water supply, livestock water supply, fish and wildlife, or recreation.

Reservoir
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, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

The minimum surface area of ponds to be used for fish production shall be 0.5 acre. The pond must provide at least 8 feet of water under at least 25% of the surface area at the principal spillway elevation except in the northern 2 tiers of counties where the minimum depth under at least 25% of the surface area shall be 10 feet.

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Cultural resources
Evaluate the 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.

Criteria Applicable to 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 (ASTM D2487). General relationships between the Unified Classification System and the USDA Textual Classification can be found in Engineering Field Handbook, Chapter 4, Figure 4-7.

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 to prevent seepage and be deep enough to extend into a relatively impervious layer if practical. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations, but not less than 8 feet. Side slopes shall not be steeper than 1 ½ horizontal to 1 vertical.

Seepage control
Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create undesired wet areas downstream, (3) embankment stability requires seepage control, or (4) special problems require drainage for a stable dam.

Control seepage by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

Top width
The minimum top width for dams is shown in Table 1. If the top of dam 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 25 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 (feet)	Top width (feet)
Less than 15.0	10
15.1 – 25.0	12
25.1 – 35.0	14
35.1 or more	See TR60*

*NRCS Technical Release 60, Earth Dams and Reservoirs

**Total height is the vertical distance between the settled top of the dam and the lowest elevation at the downstream toe.

Side slopes
All slopes must be designed to be stable. Constructed embankment side slopes shall not be steeper than 3 horizontal to 1 vertical (3:1) on both the upstream and downstream sides, except for embankments built entirely of glacial till soil on foundations of glacial till soil, which may have side slopes not steeper than 2½:1.

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These general criteria shall apply unless a flatter slope ratio is indicated by slope stability analysis. Downstream or upstream berms can be used to help achieve stable embankment sections.

Borrow area in the pool within 6 vertical feet of the permanent water elevation shall have a minimum side slope of 2½:1. All other borrow areas below crest shall have a minimum side slope of 1½:1.

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 Release 56, “A guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments” and Technical Release 69, “Riprap for Slope Protection Against Wave Action” contain design guidance).

Design the berm on small dams to meet or exceed the following limits:

- When the pond surface area is 1 acre or less the berm may be omitted.
- When the pond surface area is greater than 1 acre but less than or equal to 2 acres extend the berm around the inlet for a distance of not less than 10 feet.
- When the pond surface area is greater than 2 acres design the berm 8 feet in width or wider at the normal pool elevation to dampen out wave action. Extend the berm across the earthfill to the abutments. The berm may be constructed as much as 6 inches above the permanent pool elevation to allow for settlement.
- When the pond surface area is greater than 6 acres design a sloping berm in accordance with Technical Release 56, “A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments”.
- Rock riprap or other structural measures shall be used for dams where vegetation will not provide effective protection, for multiple-purpose dams, and for dams with fluctuating normal water levels. Rock riprap shall extend at least 1 foot above the maximum wave height and at least 3 feet below normal pool elevation.

When a downstream berm is needed on the downstream slope for slope stability, as an erosion control measure, or as a crossing, it shall be not less than 10 feet in width (measured on the horizontal projection). Downstream slopes may be flattened in lieu of berms. Berms may be built level or drain back towards the fill and laterally to safe outlets.

Freeboard
Design a minimum of 1.0 foot of freeboard between the maximum water surface elevation of the design auxiliary spillway storm and the top of the settled embankment. Design a minimum 2.0 feet of elevation difference between the crest of the auxiliary spillway and the top of the settled embankment. See the “Auxiliary Spillways” section for design criteria when the pond has no auxiliary spillway.

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 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. A mechanical spillway shall be provided for all ponds with a drainage area of 20 acres or more.

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.

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

Provide an antivortex device for a pipe conduit designed for pressure flow. Design the inlet and outlet to function 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 spillway. The diameter of the principal spillway pipe shall not be less than 4 inches. See Table 2 for additional limits on pipe diameter. 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.

				Minimum Design Frequency[2] (24-hour Duration Storm)	
Drainage Area(acres)	MinimumPipeDiameter(inches)	Effective Fill1 Height(feet)	Storage1 (acre-feet)	Principal Spillway(year)	AuxiliarySpillway(year)
0-20	4	0-20	Less than 50	———	10
0-20	4	20-35	Less than 50	2	25
20-80	6	0-20	Less than 50	5	25
20-80	6	20-35	Less than 50	5	50
80-250	10	0-20	Less than 50	10	25
80-250	10	20-35	Less than 50	10	50
All Others	15	0-35	All	25	50

[1] Defined under "Conditions where Practice Applies." Except if there is no auxiliary spillway, Storage is to the top of dam elevation.

[2] If the structure requires an IDNR permit, more restrictive criteria may apply. See IDNR Technical Bulletin 16.

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.

The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 165, or 16 gage as appropriate for the particular pipe material. Pipe strength shall not be less than that of the grades indicated in Table 3 for plastic pipe and in Table 4 for corrugated aluminum and galvanized steel pipe.

If the maximum height of fill will exceed the limits of Table 3 or Table 4 for flexible pipe, or if rigid pipe conduit is specified, design and install the pipe conduits to withstand all external and internal loads without yielding, buckling, or cracking. 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. For additional design guidance, refer to NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits. Rigid pipe shall be designed for a positive projecting condition.

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.

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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.

The outlet section shall be a minimum of 20 feet long with a minimum of 8 feet overhang downstream from the centerline of prop or from the intersection of the flow line of the pipe and design fill slope when no prop is used. The pipe shall project beyond the toe of the fill in all cases. The slope of the propped outlet should be within the limits shown in Table 5.

The invert of the pipe at the outlet end shall be a minimum of 1 foot above a constructed channel or gully bottom. In situations where sediment accumulation in outlet channels may be a problem the outlet shall be raised or a chute or slotted flume outlet used. A slotted flume may be used on metal pipe conduits.

Chute outlets should be used when downstream sedimentation is expected, downstream gully banks may be sloped at a later date, or outlet submergence may occur from downstream works of improvement.

Chute outlets for concrete pipe conduits will be constructed of reinforced concrete and shall meet the requirements for outlets for chute spillways.

Chute outlets for monolithic conduits will meet the same criteria as outlined for chute spillways in Conservation Practice Standard 410, Grade Stabilization Structure. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet.

Corrosion Protection
Provide protective coatings for all steel pipe and couplings 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.

Ultaviolet Protection
Use ultraviolet-resistant materials for all plastic pipe or provide coating or shielding to protect plastic pipe exposed to direct sunlight.

Table 3. Acceptable PVC pipe for use in earthen dams

Nominal Pipe Size (inches)	Pipe Material	Maximum Depth of Fill OverPipe (feet)
4, 6, 8, 10, 12	ASTM D2241 SDR 26	13
4, 6, 8, 10, 12	ASTM D2241 SDR 21	17
4, 6, 8, 10, 12	ASTM D2241 SDR 17	24
10, 12	ASTM D1785 Schedule 40	8
6, 8	ASTM D1785 Schedule 40	13
4	ASTM D1785 Schedule 40	20
10,12	ASTM D1785 Schedule 80	20
6,8	ASTM D1785 Schedule 80	24
4	ASTM D1785 Schedule 80	25
4, 6, 8, 10, 12	AWWA C900 Class 165	13
4, 6, 8, 10, 12	AWWA C900 Class 235	18
4, 6, 8, 10, 12	AWWA C900 Class 305	25

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Table 4. Minimum gage for corrugated metal pipe (CMP)

2 2/3 inch x 1/2 inch corrugations[1]

Fill Height Above Pipe (feet)	Steel Pipe Nominal Diameter (in) of:						Aluminum Pipe[2] Nominal Diameter (in) of:			
	<21	24	30	36	42	48	<21	24	30	36
1-15	16	16	16	14	12	10	16	16	14	14
15-20	16	16	16	14	12	10	16	16	12	12
20-25	16	16	14	12	10	10	16	12	10	------[3]

3 inch x 1 inch corrugations[4]

	Steel Pipe with Nominal Diameter (in) of:										
	36	42	48	54	60	66	72	78	84	90	96
1-15	16	16	16	16	16	16	16	14	12	12	10
15-20	16	16	16	16	14	14	14	12	10	8	------[3]
20-25	16	16	14	12	10	8	8	8	------[3]	------[3]	------[3]

[1] Pipe with 6, 8, and 10 inch diameters has 1½ x ¼ inch corrugations

[2] Riveted or helical fabrication

[3] Not permitted

[4] n = 0.027

Table 5. Allowable slope of cantilever outlet

Diameter (in)	Minimum	Maximum
4-15	2%	20%
16-24	2%	12%
26-48	2%	7%
Over 48	2%	4%

Cathodic Protection

Provide cathodic protection 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 the original design and installation did not include cathodic protection, consider establishing electrical continuity in the form of joint-bridging straps on pipes that have protective coatings. Add cathodic protection later if monitoring indicates the need.

See National Engineering Handbook (NEH), Part 650 (Engineering Field Handbook), Chapter 6, Structures, for additional criteria for cathodic protection of welded steel pipe.

Seepage control along pipes

Provide a filter diaphragm for closed conduit structures when both of the following conditions exist:

- The effective height of the dam is 15 feet or greater, and
- The effective storage of the dam (total storage to the auxiliary spillway crest) is 50 acre-feet or more.

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Seepage along pipes not meeting the above height and storage criteria shall be controlled by use of either a filter diaphragm or anti-seep collars.

Filter Diaphragm
Design the filter diaphragm in accordance with the requirements of NEH, Part 628, Chapter 45, Filter Diaphragms. Locate the filter diaphragm immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the foundation cutoff is upstream of the centerline or if there is no cutoff trench. The minimum earthfill cover shall be 2 feet. See Chapter 45, Appendix A, section titled, "Location of the conduit referenced to centerline of the embankment" for more specific guidance for the location of the filter diaphragm.

The filter diaphragm shall be a minimum of 2 feet thick and extend in all directions a minimum of two times the outside pipe diameter from the surface of the pipe. Ensure the filter diaphragm functions both as a filter for adjacent base soils and a drain for seepage that it intercepts. The filter diaphragm shall consist of sand meeting the requirements of ASTM C-33 for fine aggregate when the embankment base soils are in Category 2. Category 2 includes base soils having between 40 and 85 percent finer than the #200 sieve (after regrading the #4 sieve). If unusual soil conditions exist such that this material may not meet the required filter or capacity requirements, a special design analysis shall meet the requirements of NEH Part 628, Chapter 45, Filter Diaphragms, Section 628.4503(d), Filter and Drain Gradation.

Design an outlet to the filter diaphragm to improve filter diaphragm performance. The filter diaphragm outlet may be terminated at the embankment downstream toe using a drain backfill envelope continuously along the pipe to where it exits the embankment, or it may be terminated at foundation/embankment drains as long as they have capacity to carry the design discharge of the filter diaphragm. When the end of the outlet is at the downstream toe, the design may incorporate geotextile as a separator to provide transition between coarse filters and riprap at the toe of the dam. Protect the outlet from surface erosion and animal intrusion. Design the outlet size according to NEH Part 628, Chapter 45, "Filter Diaphragms", Appendix C.

Anti-seep Collars
When anti-seep collars are used in lieu of a 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 the seepage path along the pipe by at least 15 percent.

The number of anti-seep collars required can be determined by the formula:

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$$N = \frac{L}{7(V - D)}$$

Where: L = Length of pipe lying within the saturated zone in feet.
V = Vertical height of the anti-seep collar in feet.
D = Outside diameter of the principal spillway conduit or outside height of a monolithic conduit in feet.

The length of pipe lying within the saturated zone (L) is interpreted as follows:

MLRA 107: The distance from the inlet or downstream face of the riser to the centerline of the embankment drainage system or to the downstream toe if no embankment drainage system is planned.

Remainder of State: The distance from the inlet or the downstream face of the riser to the downstream edge of the top plus 60% of the distance from the downstream edge of the top to the downstream toe.

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.

If an auxiliary spillway cannot be provided, design the principal spillway and any associated temporary storage for 50-year–24-hour runoff and provide at least 2.0 feet of freeboard. This requires approval of the state conservation engineer.

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 ft2 or more, and
- 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 2, 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

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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.

A constructed auxiliary spillway consists of an inlet channel, a control section, and an exit channel. Design the auxiliary spillway with a trapezoidal cross section. Locate the auxiliary spillway in undisturbed or compacted earth or in-situ rock. Design for stable side slopes for the material in which the spillway is to be constructed. Design a minimum bottom width of 10 feet for dams having an effective height of 20 feet or more.

Design a level inlet channel upstream from the control section for a minimum distance of 30 feet. If necessary, curve the inlet channel upstream of the level section to fit existing topography.

Design the grade of the exit channel of a constructed auxiliary spillway within the range of 1% to 10% unless a routing of the auxiliary spillway storm satisfies discharge and tractive stress requirements.

Design a straight exit channel that extends beyond the downstream toe of the dam. If curvature of the exit channel is required, it shall be beyond the downstream toe of the dam. Where necessary a dike will be constructed along the exit channel. The dike shall have a minimum top width of 8 feet, side slopes no steeper than 2½:1, and sufficient height throughout the length of the dike. The dike and exit channel shall extend a sufficient distance downstream to prevent spillway discharge from damaging the main fill. The maximum permissible velocities for auxiliary spillways can be found in Table 6. Additional design guidance may be found in NEH, Part 628, Chapter 50, Earth Spillway Design.

Table 6. Permissible velocities for vegetated spillways

Vegetation	Permissible Velocity (feet/second)			
	Erosion Resistant Soils[1] Slope of Exit Channel		Easily Erodible Soils[2] Slope of Exit Channel	
	0 - 4.9%	5.0 – 9.9%	0 - 4.9%	5.0 – 9.9%
Smooth Bromegrass	8.75	7.5	6.25	5.0
Tall Fescue	8.75	7.5	6.25	5.0
Sod-forming grass-legume mix	6.25	5.0	5.0	3.75

[1] Erodibility will be determined by the texture of the soil horizon that is exposed after construction. Erosion resistant soil textures are loam, sandy loam, loamy sand, clay loam, sandy clay loam, and clay.

[2] Easily erodible soil textures are silt, silt loam, fine sandy loam, loamy fine sand, silty clay loam, and silty clay.

Structural auxiliary spillways

When used for principal spillways or auxiliary spillways, design chute spillways or drop spillways according to the principles set forth in NEH, Part 650, Engineering Field Handbook; and NEH, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. Design a structural spillway with the minimum capacity required to pass the peak flow expected from a total design storm of the frequency and duration shown in Table 2, less any reduction creditable to the conduit discharge and detention storage. When the drainage area is greater than 900 acres or the vertical drop is greater than 10 feet, design a structural spillway with the minimum capacity required to pass the peak flow expected from a 100 year-24 hour total design storm.

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Criteria for Excavated Ponds

Site Selection
Sufficient soil borings will be taken to determine if the soil is impervious enough to hold water for surface-fed ponds or to establish the presence of adequate groundwater for groundwater-fed ponds. If the soils are shallow and are underlain by gravel or sand the seepage rates may be excessive and another site should be selected.

Capacity and Size Requirements
Design the minimum storage volume of the pit for the average number of livestock expected during the design period when livestock water is a project purpose.

Design the bottom width 10 feet or more and the length 40 feet or more. The minimum bottom area shall be 500 square feet at the designed depth.

Runoff
Provisions shall be made for a pipe and auxiliary spillway, if needed, that will meet the capacity requirements of Table 2. 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 1½:1 nor flatter than 3:1 except where livestock water directly from the pond. If livestock will water directly from the pond, a watering ramp at least 10 feet wide shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than 4:1.

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. Excavated material shall not be placed in a wetland. 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. Shape to a designed form that blends visually with the landscape.
4. Provide for low embankment construction and leveling of surrounding landscape.
5. Haul material offsite.

CONSIDERATIONS

Visual resource design

Carefully consider the visual design of ponds in areas of high public visibility and those associated with recreation. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

Shape the embankment to blend with the natural topography. Shape the edge of the pond so that it is generally curvilinear rather than rectangular. Shape excavated material so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, add islands to provide visual interest and to attract wildlife.

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Fish and Wildlife

Locate and construct ponds to minimize the impacts to existing fish and wildlife habitat.

When feasible, retains structures such as trees in the upper reaches of the pond and stumps in the pool area. Shape upper reaches of the pond to provide shallow areas and wetland habitat.

If operations include stocking fish, use Conservation Practice Standard 399, Fishpond Management.

Vegetation

Stockpile topsoil for placement on disturbed areas to facilitate revegetation.

Consider selecting and placing 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 the environment such as wetlands, aquifers, and social and economic impacts to downstream uses or users.
- Potential for multiple purposes.
- It is generally recommended that the permanent pool volume not exceed the estimated annual runoff.

Water Quality

Consider the effects of:

- Erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that runoff carries.
- Visual quality of onsite and downstream water resources.
- Short-term and construction-related effects of this practice on the quality of downstream water courses.
- Water-level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Wetlands and water-related wildlife habitats.
- Water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- 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.
- Livestock grazing adjacent to the pond. Consider fencing to keep livestock activities out of direct contact with the pond and dam.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to this standard.

The following list of Construction Specifications is intended as a guide to selecting the appropriate specifications for each specific project. The list includes most, but may not contain all of the specifications that are needed for a specific project:

IA-1 Site Preparation

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IA-3 Structure Removal

IA-5 Pollution Control

IA-6 Seeding and Mulching for Protective Cover

IA-11 Removal of Water

IA-21 Excavation

IA-23 Earthfill

IA-24 Drainfill

IA-26 Salvaging and Spreading Topsoil

IA-31 Concrete

IA-45 Plastic (PVC, PE) Pipe

IA-51 Corrugated Metal Pipe Conduits

IA-52 Steel Pipe Conduits

IA-81 Metal Fabrication and Installation

IA-83 Timber Fabrication and Installation

IA-92 Fences

IA-99 Cathodic Protection for Buried Metal Structures

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed and reviewed with the landowner or individual responsible for operation and maintenance. The plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly. As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenances
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reaches predetermined storage elevations if specified
- Periodic removal of trees, brush, and undesirable species
- Periodic inspection of safety components and immediate repair if necessary
- Maintenance of vegetative protection and immediate seeding of bare areas as needed

REFERENCES

American Society for Testing and Materials. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487. West Conshohocken, PA.

USDA NRCS. Engineering Technical Releases, TR-210-60, Earth Dams and Reservoirs. Washington, DC.

USDA NRCS. National Engineering Handbook (NEH), Part 628, Dams. Washington, DC.

USDA NRCS. NEH, Part 633, Soil Engineering. Washington, DC.

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USDA NRCS. NEH, Part 636, Structural Engineering. Washington, DC.

USDA NRCS. NEH, Part 650, Engineering Field Handbook. Washington, DC.

USDA NRCS. National Engineering Manual. Washington, DC.

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