

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD  
NEW JERSEY**

**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:

1. Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.
2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the

cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.

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

**GENERAL CRITERIA APPLICABLE TO ALL PONDS**

**Laws and regulations.** All federal, state and local requirements shall be addressed in the design. The criteria contained in this standard apply to all agricultural ponds except where more stringent criteria are established by federal, state, or local regulations. Ponds may be subject to the provisions of the New Jersey Flood Hazard Area Control Act Rules where embankments raise the water level less than 5 feet in height as measured from the downstream toe-of-dam to the auxiliary spillway crest or top of dam where no auxiliary spillway is required. Ponds with embankments that raise the water level 5 feet or greater in height may be designed in conformance with the criteria contained in this standard where:

1. drainage area is less than 320 acres,
2. the pond serves an agricultural use, meaning an impoundment for fish and wildlife, fire control, livestock watering, or crop production, and
3. design and construction are under NRCS supervision.

All other ponds shall be designed in accordance with the more stringent criteria contained in the New Jersey State Dam Safety Standards.

**Vegetation.** 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. Ponds where the ratio of drainage area to normal pool area is greater than 100 will normally have excessive sedimentation unless the drainage area is flat or has good cover. 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. If surface water is the only source of water the ratio of drainage area to normal pool area should be at least 10. 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.

## 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. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments at least to the normal water line 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 minimum depth of 3 feet, unless bedrock is encountered, and 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
<i>Feet</i>	<i>feet</i>
Less than 10	6
10 – 14.9	8
15 – 19.9	10
20 – 24.9	12
25 – 34.9	14
35 or more	15

**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). Ponds with surface areas greater than 5 acres will have wave erosion protection. Ponds with surface areas greater than 2 acres will have erosion protection if not protected from wind by hills, woods, or other features that block the wind. Smaller ponds may require protection against wave action if exposed or constructed from erosive materials.

**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 following conditions are met:

1. The drainage area is 10 acres or less, there is no spring or seep flow, and the auxiliary spillway exit channel is stable from the pond to the downstream receiving channel.

2. The drainage area is 10 acres or less, there is spring or seep flow, the auxiliary spillway channel is stable from the pond to the downstream receiving channel, and a trickle tube of sufficient capacity is installed in accordance with Chapter 11 of the Engineering Field Handbook.

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. Pipes with hood inlets that are designed for pressure flow shall have sufficient head measured between the inlet invert and the auxiliary spillway crest to prime the pipe. For smooth wall pipe the minimum head to prime the pipe is 1.4 times the pipe diameter; for corrugated pipe the minimum head is 1.8 times the pipe diameter.

For dams that raise the water height by five feet or more measured from the downstream toe-of-dam to the auxiliary spillway crest, the minimum pipe diameter is 18 inches. For dams that raise the water height less than five feet, 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.

The minimum capacity of the principal spillway shall be determined for a design storm of the frequency and duration shown in Table 2.

**Table 2. Minimum principal spillway capacity for agricultural ponds**

Drainage area (Ac.)	Raised water height <sup>1</sup> (Ft.)	Storage times height <sup>2</sup>	Minimum design storm	
			Frequency (Years)	Minimum duration (Hours)
320 or less	< than 35	< 300	1	24
320 or less	< than 35	300-3000	2	24
> than 320	< than 5	< 300	1	24
> than 320	< than 5	300-3000	2	24
> than 320	5 or >	All	25	24

1. Measured from lowest point along downstream toe-of-dam to the auxiliary spillway crest or, in the absence of an auxiliary spillway, the top-of-dam.

2. As defined under "Conditions Where Practice Applies".

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.

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.

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.

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 shall be provided for replacement as necessary.

All materials used in construction of the principal spillway including riser, trash rack, anti-vortex device, conduit, anti-seepage collars, fasteners, and any other appurtenances shall be fabricated from compatible materials or otherwise coated or protected to resist galvanic corrosion.

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

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

1. The effective height of dam is greater than 15 feet.
2. The conduit is of smooth pipe larger than 8 inches in diameter.
3. The conduit is of corrugated 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 a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the outside pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drainage diaphragm shall be located immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the cutoff is upstream of the centerline.

An envelope of drain fill material shall extend continuously along the pipe from the drainage diaphragm to where it exits at the downstream toe of the dam. 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. Collar material shall be compatible with pipe materials. 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. 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.

**Outlet Protection for Pipe Conduit.** Conduits larger than 18 inches in diameter shall have outlet protection to control scour. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable

devices to provide a safe outlet include the Saint Anthony Falls stilling basin, impact basin, rip-rap lined aprons or scour holes.

**Other Outlets.** A pipe with a suitable valve or other suitable device shall be provided to drain the pool area. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function. All pipe conduits used as drains must meet the same requirements as the pipe conduit for the principal spillway.

**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<sup>2</sup> 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 3, 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. The maximum permissible velocity in the exit channel shall be 4 feet per second where only sparse vegetative cover can be expected and maintained, and 6 feet per second where

excellent vegetative cover can be expected and maintained.

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 but no steeper than 2 foot horizontal to 1 foot vertical. 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 a distance of at least 25 feet. The inlet channel may be curved to fit existing topography. The exit channel shall be straight for at least 50 feet downstream of the control section. The grade of the exit channel of a constructed auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities. The design flow should be contained in the exit channel without use of dikes. If a dike is necessary, it shall have at least 2:1 side slopes, a top width of 8 feet, and height to contain the design flow.

**Table 3. Minimum auxiliary spillway capacity for agricultural ponds**

Drainage area (Ac.)	Raised water height <sup>1</sup> (Ft.)	Storage (Ac-Ft)	Minimum design storm	
			Frequency (Years)	Minimum duration (Hours)
20 or less	20 or less	< than 50	10	24
20 or less	> than 20	< than 50	25	24
20 to 320	20 or less	< than 50	25	24
20 to 320	> than 20	< than 50	50	24
320 or <	All	50 or >	50	24
> than 320	< than 5	All	50	24
> than 320	5 or >	All	100	24

1. Measured from the lowest point on the downstream toe-of-dam to the auxiliary spillway crest or, in the absence of an auxiliary spillway, the top-of-dam.

**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 2, less any reduction creditable to conduit discharge and detention storage.

**Fish Ladders.** All dams constructed in streams that are runways for migratory fish shall have a fish ladder or other approved structure to permit fish to pass the dam in either direction.

**Renewable Energy.** Renewable energy systems shall meet applicable design criteria in NRCS and/or industry standards, and shall be in accordance with manufacturer's recommendations. Hydropower systems shall be designed, operated, and maintained in accordance with the Microhydropower Handbook, Sections 4 and 5, as appropriate.

#### CRITERIA FOR EXCAVATED PONDS

**Runoff.** Provisions shall be made where needed for a principal spillway, auxiliary spillway and embankment in accordance with the embankment pond criteria. 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 two horizontal to one vertical above normal water level and 1.5 horizontal to one vertical below normal water level. 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 five horizontal to one vertical.

**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.

For excavated ponds in flood plain areas, excavated material will be disposed of in accordance with New Jersey Flood Hazard Area Control Act Rules.

### CONSIDERATIONS

**Safety.** Consider the need for fencing, flattening of sloped areas, or signage that warns of hazards or restricts access.

**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

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

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

history and list of project contracts. Part two shall include the operation and maintenance instructions and a schedule for maintenance. Inspections shall be performed annually, every four years by a licensed professional engineer, and by the owner or operator in intervening years.

## **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. The plan shall provide for yearly inspections by the owner or operator for the life of the structure. As a minimum, inspections shall include the following items plus any unique items:

- Condition of trash rack, riser, and water control gates including debris accumulation or deterioration.
- Alignment and condition of principal spillway conduit and pipe joints.
- Condition of embankment including settlement, cracking, sloughing, wave erosion or rutting; adequacy of vegetative cover; and rodent borrows.
- Downstream slope and toe for signs of seepage.
- Condition of auxiliary spillway including adequacy of vegetative cover, signs of erosion or obstructions such as debris, woody vegetation, etc.
- Stability of outlet areas.

An operation and maintenance manual shall be prepared for a structure classified as a dam in accordance with the NJ Dam Safety Standards. The manual shall have two parts. Part one shall include an introduction, project description, project authorizations, project