NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND

(No.)
CODE 378

DEFINITION

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by constructing a dam are referred to as embankment ponds, and those constructed by excavating a pit 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 spillway elevation is 3 ft or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, crop and orchard spraying, and other related uses, and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater flow will maintain an adequate supply of water in the pond. The quality of water shall be suitable for the intended use.

The topography and soils of the site shall permit storage of water at a depth and volume that 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 - EMBANKMENT AND EXCAVATED PONDS

A cutoff of relatively impervious material shall be provided under the dam if necessary. 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 horizontal to 1 vertical.

Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage will 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 drains; (2) reservoir blanketing; or (3) a combination of these measures.

In an excavated pond, provisions shall be made for a principal and auxiliary spillway if necessary.

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 full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillway. The diameter of the pipe shall not be less than 4 in. If the pipe conduit diameter is 10 in or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

Pipe conduits under or through the dam shall meet the following requirements. The pipe shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, caulking, or welding.

For dams 20 ft or less in effective height, acceptable pipe materials are cast-iron, steel, corrugated steel or aluminum, concrete, plastic, vitrified clay with rubber gaskets, and cast-in-place reinforced concrete. Concrete and vitrified clay pipe shall be laid in concrete bedding. Plastic pipe that will be exposed to direct sunlight shall be made of ultraviolet-resistant materials or protected by coating or shielding, or provisions for replacement shall be made as necessary. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture either material.

For dams more than 20 ft in effective height, conduits shall be plastic, reinforced concrete, cast-in-place reinforced concrete, corrugated steel or aluminum, or welded steel pipe. The maximum height of fill over any principal spillway steel or aluminum pipe must not exceed 25 ft.

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

- Uniformly spread to a height that does not exceed 3 ft, with the top graded to a continuous slope away from the pond.
- 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 ft from the edge of the pond.
- Shaped to a designed form that blends visually with the landscape.
- Used for low embankment and leveling.
- Hauled away.
- It will be placed in such a manner that the flow of the natural drainage way is not restricted.

Refer to Standards and Specifications for Spoil Spreading (572), for additional requirements.

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 ft for one-way traffic and 26 ft for two-way traffic. Guardrails and other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority.

Table 1

Minimum top width for dams

Total height of embankment	Minimum Top width
-ft -	- ft -
15 or less	10
15 - 25	12
25 - 35	14
35 or more	15

The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical.

The side slopes of the settled dam shall be designed no steeper than 3:1 on the upstream side and no steeper than 2:1 on the downstream side. All slopes must be designed to be stable, even if flatter side slopes are required.

Side slopes of excavated ponds shall be stable and shall not be steeper than 2 horizontal to 1 vertical.

If needed to protect side slopes from erosion, special measures, such as berms, rock riprap, sand-gravel, soil cement, or vegetation, shall be provided (Technical Releases 56 and 69).

The minimum elevation of the top of the settled embankment shall be 1 ft 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 ft for all dams having more than a 20-acre drainage area or more than 20 ft in effective height.

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 10 percent, except where detailed soil testing and laboratory analyses show that a lesser amount is adequate.

The crest elevation shall be no less than 0.5 ft below the crest of the auxiliary spillway for dams having a drainage area of 20 acres or less, and no less than 1 ft for those having a drainage area of more than 20 acres.

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

Pipe shall be watertight. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle, if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet. To ensure adequate life of the structure, protective coatings of asphalt or vinyl on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe shall be considered in areas that have a history of pipe corrosion or where the saturated soil resistivity is less than 4,000 ohms-cm, or where soil pH is lower than 5.

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.

Practice Standard 430-FF provides criteria for cathodic protection of welded steel pipe.

Tables 2 and 3 show the SDR, schedule or gauge for certain pipe to meet the requirements. In addition to the pipe presented, other pipe may be used if the strength and other requirements of the standard are met. Procedures to calculate deflection are presented in WNTC Technical Notes No. 19, "A Procedure for Deflection Analysis of ABE or PVC Pipe Used for Embankment or Structural Drain," and No. 22, "Procedure for Determining Flexible Pipe Deflection Due to External Loading."

Table 2

Acceptable PVC pipe for use in earth dams[1]

Nominal pipe size	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe
In		ft
4 or less	Schedule 40	15

	Schedule 80	20
	SDR 26	10
6,8,10,12	Schedule 40	10
	Schedule 80	15
	SDR 26	10

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

Table 3

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

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

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

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

2 Riveted or helical fabrication.

3 Not permitted.

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

- The effective height of dam is more than 15 ft.
- The conduit is of smooth pipe larger than 8 in. in diameter or corrugated pipe larger than 12 in. in diameter and the pipe is buried more than three feet.

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

The drain is to consist of sand, meeting fine concrete aggregate requirements (at least 15% passing the No. 40 sieve but no more than 10% passing the No. 100 sieve). If unusual soil conditions exist, a special design analysis shall be made.

The drain shall be a minimum of 2 ft thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 in. beneath the conduit invert. The drain diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam.

The drain outlet shall be at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe to where it exits the embankment. The drain fill will be protected from surface erosion.

When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar to be measured perpendicular to the pipe but not more than 25 feet. They shall be equally spaced along the conduit. The distance from the pipe inlet or riser to the first collar shall not exceed the spacing between anti-seep collars. The minimum projection of the anti-seep collar shall be 2 feet. Collar material shall be compatible with pipe materials. The anti-seep collar(s) shall increase by 15% the seepage path along the pipe.

Additional criteria for special designs of drainage diaphragms is contained in TR-60, "Earth Dams and Reservoirs," and Soil Mechanics Note 1.

Closed conduit spillways designed for pressure flow must have adequate anti-vortex devices.

To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

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.

Supply pipes through the dam to watering troughs and other appurtenances shall have an inside diameter of not less than 1-1/4 in.

Auxiliary spillways convey large flood flows safely past earth embankments.

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

Peak rates of discharge shall be computed by methods outlined in the publication:

Peak Rates of Discharge for Small Watersheds, Chapter 2 (Revised 10/73 for New Mexico and updated 2/85) of the Engineering Field Manual for Conservation Practices.

The spillway may be either natural or excavated. Hydraulic design shall be determined from Chart 4-N-16495. The critical velocity, Vc, shall not exceed 8 feet per second. This velocity may be exceeded when the spillway is excavated into massive rock.

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.

TABLE 4

Minimum Spillway Capacity

Drainage Area (acres)	Total Height (feet)	Pool Capacity (acre-feet)	Auxiliary Spillway (Min. Capacity)
20 or less	20 or less	10 or less	10 yr. 24 hr.*
20 or less	Over 20	10 or less	25 yr. 24 hr.*
Over 20	20 or less	10 or less	25 yr. 24 hr.*
Over 20	Over 20	10 or less	50 yr. 24 hr.*
All others		More than 10	50 yr. 24 hr.*
All others		50	24

* Freeboard must be added to spillway depths, as calculated above, to determine height of dam. However, if a freeboard hydrograph storm equal to 100 yr. 6 hr. + .12 (PMP-100 yr. 6 hr.) is used, routed or unrouted, to determine spillway depths, no freeboard is added to calculate height of dam.

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. The side slopes shall be stable for the material in which

the spillway is to be constructed. For dams having an effective height exceeding 20 ft, the auxiliary spillway shall have a bottom width of not less than 10 ft.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed auxiliary spillway shall fall within the range established by discharge requirements and permissible velocities.

If chutes or drops are used for principal or auxiliary spillways, they shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices, the National Engineering Handbook-Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways.

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

If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

All stock-watering facilities will ordinarily be spaced on rangeland to provide a travel distance of .75 to 1.0 mile on level or rolling topography. Patterns of fencing, natural barriers, and very rough, mountainous terrain may increase the number of watering places needed. See National Range Handbook 803.3

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 4 horizontal to 1 vertical.

All stock water ponds shall have a minimum effective depth of 12.0 feet over a minimum area of 200 square feet. A minimum depth of 7.0 feet will be acceptable where physical factors such as rock, gravel, or sand make it impracticable to complete the structure as designed.

When ponds are to be developed as a wetland, wildlife habitat, or fish habitat, please refer to Standards and Specifications for Commercial Fish Ponds (397), Practice Wildlife Wetland Habitat Management (644), Wetland Restoration (657), Wetland Creation (658), or Wetland enhancement (659), as appropriate. Pond design, which deviates from these standards, will be approved in writing by the area engineer and state biologist. Written approval will be noted directly on the pond design so as to indicate the modification.

For sites where water temperature and quality are anticipated to meet the requirements of trout, refer to N.M. Animal Guide – Pond Management for Rainbow Trout.

For sites where water temperatures and quality are anticipated to meet the requirements of warm water fish (WWF) species (largemouth bass, bluegill sunfish, redear sunfish, channel catfish or minnow), refer to NM Animal Guides – Pond Management for Largemouth Bass and Bluegill Sunfish; Pond Management for Channel Catfish.

Where site potential exist for developing shallow wetlands in and around the pond borders, and the landowner decides to incorporate wetland wildlife habitat into the pond, the pond will be designed and constructed to reflect this feature. Construct the basic pond to meet the design criteria for the selected type of fish production. Design additional shallow water areas to have a water depth of less than 3 feet and side slopes flatter than 3:1.

For sites where water temperature and quality are anticipated to meet the requirements of trout, refer to N.M. Animal Guide – Pond Management for Rainbow Trout.

For ponds to be managed for fishing by the periodic stocking of trout fingerlings, which will be dependent upon naturally produced food and have a production objective of 50-100 pounds of trout per surface acre:

- Water source may or may not supply a continuous flow through.
- The pond will be at least 0.25 surface acre at anticipated seasonal low water level.

Where water sources are of superior temperature and quality or supply a reliable sustained flow, construct the trout pond with an average depth of at least 6 feet over at least 25 percent of the surface area at anticipated seasonal low water level.

Where water sources are of good quality and temperature or the supply is unreliable, construct a trout pond with an average depth of at least 10 feet over at least 25 percent of the surface area at anticipated seasonal low water level.

For trout ponds to be managed for fishing by the annual stocking of fingerlings which are to be regularly fed with a production level of commercial fish food and where the production objective is for 1,000 or more pounds per surface acre:

- Water source must supply a reliable sustained flow. The trout pond size and average depth and the planned fish production will be based upon the available volume of flow.
- The minimum surface area of the trout pond will be at least 0.1 acre, with an average depth of at least 6 feet over at least 25 percent of the surface area at anticipated seasonal low water level.

For ponds to be managed to provide fishing for largemouth bass when stocked with bluegill sunfish, redear sunfish, channel catfish, or a species of minnow, and there will be no regular feeding:

- Water sources may or may not supply a continuous flow through.
- Construct the pond to be at least 0.5 acres with an average depth of at least 6 feet over at least 25 percent of the surface area at anticipated seasonal low water level.

For ponds to be managed for channel catfish to provide fishing through annual stocking of fry or fingerlings, and regular feeding with a production level of commercial fish food, and where the production objective is 1,000 or more pounds of channel catfish per surface acre:

- Water sources may or may not supply a continuous flow through. The size, average depth, and planned level of fish production will depend upon the availability and reliability of the water supply.
- The minimum surface area of the pond will be at least 0.1 acre, with an average depth of at least 6 feet over at least 25 percent of the surface area at anticipated seasonal low water level.

CONSIDERATIONS

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

The visual design of ponds shall 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 should 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.

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 the downstream flows or aquifers that could affect other water uses or users.

Effects on the volume of downstream flow to prohibit undesirable environmental, social or economic effects.

Effects on the visual quality of onsite and downstream water resources.

Potential for multiple use.

Effects on erosion and the movement of sediment, pathogens, and soluble and sediment attached substances that are carried by runoff.

Short-term and construction-related effects of this practice on the quality of downstream water courses.

Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.

Effects on wetlands and water-related wildlife habitats.

Effects of water levels on soil nutrient processes such as plant nitrogen use or de-nitrification.

Effects of soil water level control on the salinity of soils, soil water, or downstream water.

Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

When the pond is being utilized for livestock water, consider excluding livestock from the pond and providing separate drinking facilities.

SUMMARY OF RULES FOR ADHERENCE TO STATE LAWS

A dam constructed directly in a watercourse to impound water for livestock purposes does not require a permit from the New Mexico Office of the State Engineer (OSE) provided it impounds no more than 10 acre-feet, both temporary and permanent, regardless of the height of the dam. As used in this standard, temporary storage is that storage between the crest of the auxiliary spillway and the lowest ungated port in the inlet structure of the principal spillway. Permanent storage is that below the lowest ungated port in the inlet structure of the principal spillway.

A permit from OSE is required to build any stock dam, regardless of height or capacity, in the Gila, San Francisco, or San Simon stream systems.

If it is proposed to impound more than 10 acre-feet, both temporary and permanent, in a stock dam, the landowner must file an application with OSE, accompanied by drawings and specifications in the format prescribed by OSE Regulations. The OSE must issue a permit before construction may begin. Further guidance may be obtained from the National Engineering Manual (NEM) Part NM501, Authorizations.

A dam to impound water for livestock purposes that is to be located off stream and requires a man-made diversion works in a watercourse, requires a permit from OSE, prior to the appropriation of water, regardless of the height or capacity of the dam.

An erosion control dam, including grade stabilization structures and/or debris basins may be constructed without a permit from the State Engineer if it complies with the conditions set forth below.

- The reservoir capacity is no more than 10 acre-feet.
- Dam height is less than 10 feet. For permit purposes, dam height is the difference in elevation between design top of dam and the lowest channel elevation along the downstream toe of the dam. Exceptions to this policy and further guidance on erosion control dam approval policies are found in NEM NM501.03.
- An ungated outlet is recommended so that no water is retained in the reservoir.
- The dam is near active erosion or a damaging sediment deposition area

whereby the purpose of the structure is obvious.

- The structure is sized only to accomplish its purpose and is not overbuilt.

- The grade stabilization structure may cause water to be routed from an actively eroding channel, provided the water so routed flows over only the area that would have naturally received from prior to the need for the installation of the structure. The water should be routed in such a manner to prevent continued erosion only, and the flow should be returned substantially undiminished to the watercourse. Nothing should be constructed to spread the water in a manner that could be construed as irrigation of grasslands.

- A debris basin should be constructed solely to retain debris and should not impound or divert water for beneficial use. However, auxiliary spillway flow may be diverted as noted in the above paragraph.

All structures which will retain water for a period of 96 hours or longer must comply with New Mexico Regulations Governing Mosquito Abatement and Control. For the procedures to be followed, refer to GM-190, Part 410, paragraph NM410.21(f).

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

Provisions shall be made as necessary for operations and maintenance requirements and may include a formal plan for larger or more complex designs.

The following actions shall be carried out to ensure the practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), repair, and upkeep.

The pond and all of its components will be inspected periodically, protected, and restored as needed to maintain the intended purpose from adverse impacts such as rodent holes, vehicular traffic, seepage, erosion, or woody vegetation.