

**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 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 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.

**Scope**

This standard establishes the minimum acceptable quality for the design and construction of ponds if:

1. Failure of the dam will not result in loss of life; in 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 emergency spillway. The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

3. The effective height of the dam is 35 feet or less, and the dam is hazard class (a).

**Conditions where practice applies**

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

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

**Reservoir area.** 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.

**Design criteria for embankment ponds**

**Foundation cutoff.** 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

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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 creates 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.

**Earth 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.

**Table 1.-- Minimum top width for dams**

Total height of embankment	Top width
<i>ft</i>	<i>ft</i>
10 – 15	8
15 – 20	10
20 – 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, 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.

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

The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the emergency spillway flowing at design depth. The minimum difference in elevation between the crest of the emergency 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 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 5 percent, 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 mechanical spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

The crest elevation shall not be less than 0.5 ft below the crest of the emergency 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.

When design discharge of the principal spillway is considered in calculating peak outflow through the emergency 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 emergency spillways. 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 emergency 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 by welding.

For dams 20 ft. or less in effective height, acceptable pipe materials are cast-iron, steel, corrugated steel or aluminum, asbestos-cement, concrete plastic, vitrified clay with rubber

gaskets, and cast-in-place reinforced concrete. Asbestos-cement, concrete, and vitrified clay pipe shall be laid in a concrete bedding. Plastic pipe that will be exposed to direct sunlight shall be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

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. 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. Protective coatings of asbestos-bonded, asphalt coated, or vinyl coating on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe should be provided in areas that have a history of pipe corrosion, or where the saturated soil resistivity less than 4000 ohms-cm or soil pH is lower than 5.

Specifications in tables 2 and 3 are to be followed for polyvinyl chloride (PVC), steel, and aluminum pipe.

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.

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 ft.
2. The conduit is of smooth pipe larger than 8 in. in diameter.
3. The conduit is of corrugated pipe larger than 12 in. in diameter.

Table 2 – Acceptable PVC pipe for use in earth dams<sup>1</sup>

Nominal pipe size	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe
<i>in.</i>		<i>ft.</i>
4 or smaller	Schedule 40	15
	Schedule 80	20
	SDR26	10
6, 8, 10, 12	Schedule 40	10
	Schedule 80	15
	SDR 26	10

<sup>1</sup>Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM-D-1785 or ASTM-D-2241.

Table 3 – Minimum gauge for corrugated metal pipe [2-2/3-in x 1/2-in corrugations]<sup>1</sup>

Fill Height (ft)	Minimum gauge for steel pipe with diameter (in) of --				Minimum thickness (in) of aluminum pipe <sup>2</sup> with diameter (in) of --			
	21 and less	24	30	36 42 48	21 and less	24	30	36
1-15	16	16	16	14 12 10	0.06	0.075	0.075	
15-20	16	16	16	14 12 10	.075	.105	.105	
	16	16	14	12 10 10	.105	.135		<sup>3</sup>

<sup>1</sup>Pipe with 6-, 8-, and 10-in. diameters has 1½ in. x 1/4-in corrugations.

<sup>2</sup>Riveted or helical fabrication.

<sup>3</sup>Not permitted.

Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep 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 feet 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 drainage diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam.

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

When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible with pipe materials. The anti-seep collar(s) shall increase by 15% the seepage path along the pipe.

Closed conduit spillways designed for pressure flow must have adequate antivortex 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 1¼ in.

**Emergency spillways.** Emergency spillways convey large flood flows safely past earth embankments.

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

The emergency 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 emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Emergency spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed emergency 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 feet, the emergency spillway shall have a bottom width of not less than 10 feet.

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

**Structural emergency spillways.** If chutes or drops are used for principal spillways or principal emergency spillways, they shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices and the National Engineering Handbook -- Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 4, less any reduction creditable to conduit discharge and detention storage.

**Visual resource design.** 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 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.

### Design criteria for excavated ponds

**Runoff.** Provisions shall be made for a pipe and emergency spillway, if necessary. Runoff flow patterns shall be considered when locating the pit and placing the spoil (see table 4).

**Side slopes.** Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical.

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

**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 so that 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. Hauled away.

Table 4 – Minimum spillway capacity

Drainage area	Effective height of dam <sup>1</sup>	Storage	Minimum design storm <sup>2</sup>	
			Frequency	Minimum duration
acre	ft	acre-ft	yr	hr
20 or less	20 or less	Less than 50	10	24
20 or less	More than 20	Less than 50	25	24
More than 20	20 or less	Less than 50	25	24
All others			50	24

<sup>1</sup>As defined under "Scope."

<sup>2</sup>Select rain distribution based on climatological region.

### 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.

## POND STANDARD

Design Criteria for Embankment Ponds – In addition to the National Standard, the minimum hydrologic design for dams greater than 6 feet effective height with more than 50 ac-ft of storage or dams greater than 25 feet effective height and with more than 15 ac-ft of storage shall be as follows:

Principal Spillway Storm\* – 2.5 to 3.0 inches of rainfall per 24 hr.

(See Figure 1).

Emergency Spillway Storm – 50 year 24 hour frequency

(See Figure 2).

Freeboard Storm – 100 year 24 hour frequency

(See Figure 3).

\*Principal spillway criteria does not apply to ponds whose drainage area is essentially the same as the surface area (e.g. commercial fish ponds).

A trickle tube shall be required for all ponds with a drainage area greater than 5 acres. The crest elevation of the trickle tube shall be no less than 0.5 feet below the crest of the emergency spillway for dams having a drainage area of 20 acres or less, and no less than 1 foot for those having a drainage area of more than 20 acres. The minimum trickle tube size for a pond is shown in Table 1. All trickle tubes shall have a trash guard to prevent the conduit from clogging.

TABLE 1 – Minimum Trickle Tube Size\*

Drainage Area Acres	Siphon		Drop Inlet**		Downstream Riser Inches
	SSP & PVC Inches	PVC & SSP, Inches	CMP Inches		
5 – 10	4	8 x 6	10 x 8		6
11 – 20	4	8 x 6	10 x 8		8
21 – 50	6	8 x 6	12 x 8		10
51 – 100	8	10 x 8	15 x 10		12
101 – 175	10	15 x 10	18 x 12		***
176 – 300	12	18 x 12	21 x 15		***

\*Applies to dams less than 6 feet effective height with more than 50 ac-ft of storage and dams less than 25 feet effective height with less than 50 ac-ft of storage.

\*\*Riser diameter X barrel diameter.

\*\*\*Special design required.

Freeboard – The minimum freeboard for ponds having a surface exposure (fetch) of 1000 feet or less shall be as required by the National Standard.

Additional freeboard shall be provided, to contain waves, for ponds having longer surface exposure (fetch) by addition of the following amounts to the applicable freeboard given above:

<u>Fetch</u> (feet)	<u>Freeboard</u> (feet)
1001 – 1250	0.2
1251 – 1500	0.4
1501 – 1750	0.6
1751 – 2000	0.8
over 2000	increase proportionally

Wave Erosion Protection – When the surface exposure (fetch) of the pond exceeds 1,000 feet the upstream face of the dam shall be protected from wave damage by one of the following methods:

1. At least an 8-foot wide berm located approximately 1.0 foot above the planned waterline.
2. A 4-foot bank of structural material such as precast perforated concrete block, riprap or broken concrete extending to an elevation at least 2 feet below and 2 feet above the planned waterline.
3. Increase the width through the dam at the planned waterline at least 4 feet. This increase in width may be obtained by increasing the top width or freeboard, or by flattening the side slopes.
4. Soil cement.
5. Planting vegetation of the right character and height on properly constructed berms (Ref. TR-56).

The assistance and approval of the state office is required when use of soil cement, concrete blocks or vegetation is planned for protection of the upstream face of the dam.

Allowance For Settlement – The design height of the dam shall be increased by the amount needed to insure that the design top elevation will be maintained after all settlement has taken place. This increase shall be as follows:

<u>Dams constructed with</u>	<u>Allowance in percent</u>
Bulldozers	10
Draglines	20*
Carryalls and scrapers	5

\*Use of draglines alone is not permissible for dams with maximum fill heights exceeding 10 feet.

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Actual allowance for settlement (in excess of the minimum listed) shall be determined by the technician for the individual site based on soil type, moisture conditions, contractor and experience in the area.

Downstream Riser – A downstream riser, with a maximum diameter of 12 inches, may be used where the static head does not exceed 16 feet (the difference in elevation between the riser crest and the centerline of the horizontal barrel). The downstream riser shall be braced, and its base suitably protected against splash erosion.

#### Ponds Constructed Primarily for Game Fish Production

Where ponds are to be constructed primarily for game fish production, they shall be located so that the drainage area will produce adequate runoff; however, peak outflow shall be small enough to limit the design spillway flow to 6 inches in depth. Design spillway flow depth may be increased when a trickle tube is used. The trickle tube shall be set a minimum of 1 foot below the crest of the emergency spillway for dams having a drainage area of 20 acres or less and shall be set a minimum of 1.5 feet below the crest of the emergency spillway for dams having a drainage area of more than 20 acres. The trickle tubes shall be sized to decrease the use of the emergency spillway. The landowner should be informed that fish stock may be lost during storms causing high spillway flow depth. Trickle tubes should remove water from the bottom and not the surface of the pond storage area. Shallow water edges should be deepened to provide an 18 to 36 inch water depth. See Standards and Specifications – 399 (Fishpond Management), Land Management Guide, Biology Job Sheets and Technical Notes on fisheries for biological recommendations, and Landscape Architecture Note 4.

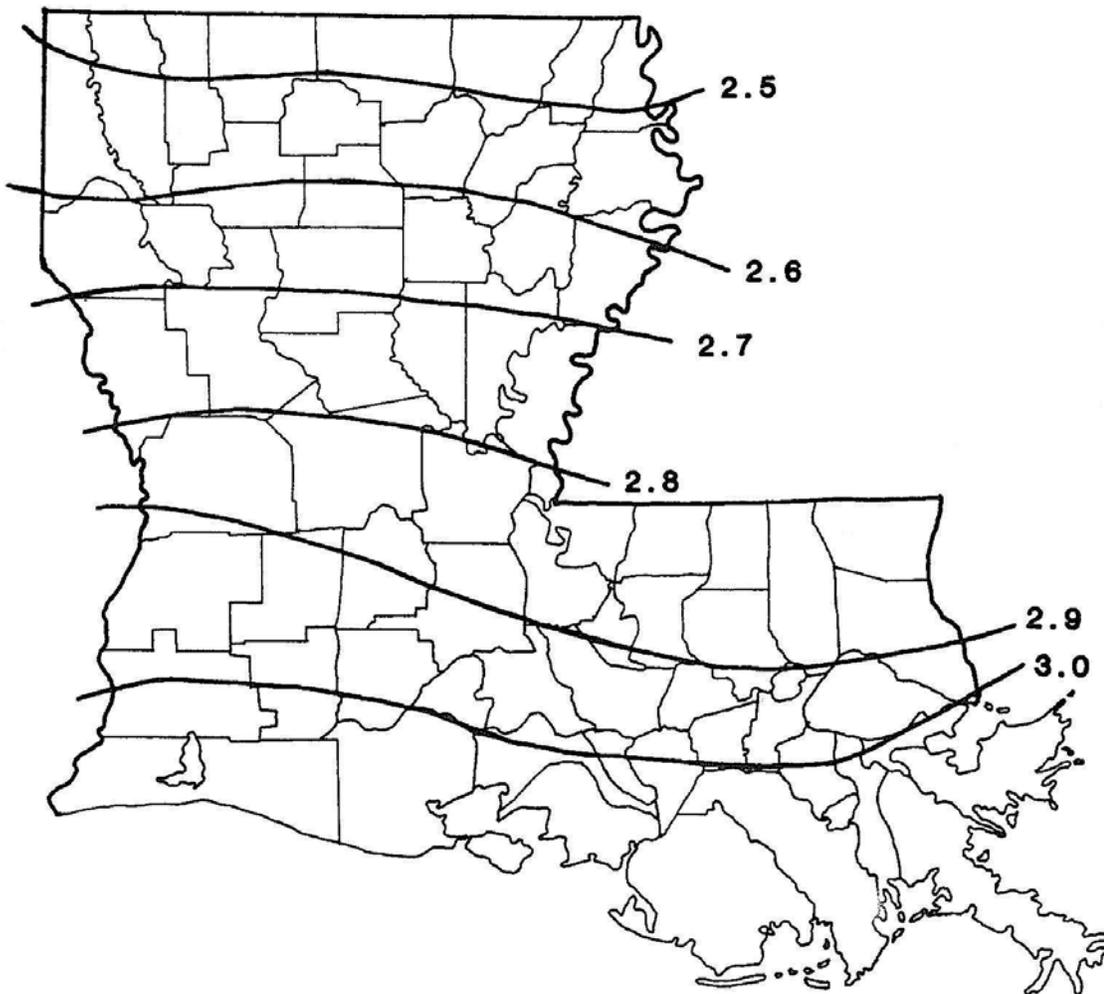
## Design Criteria

### Minimum Size

The minimum size excavated pond shall have 2,400 square feet of surface area, with a minimum top width of 40 feet. It is desirable that twenty percent of the surface area shall be 6 feet deep. However, a minimum of 16 percent of the surface area shall be 6 feet deep, except where the depth is limited to less than 6 feet by a permeable stratum and no other source of water is practicable. See Standard and Specifications 399 (Fishpond Management), Land Management Guide, Biology Job Sheets and Technical Notes on fisheries for biological recommendations.

**FIGURE 1**

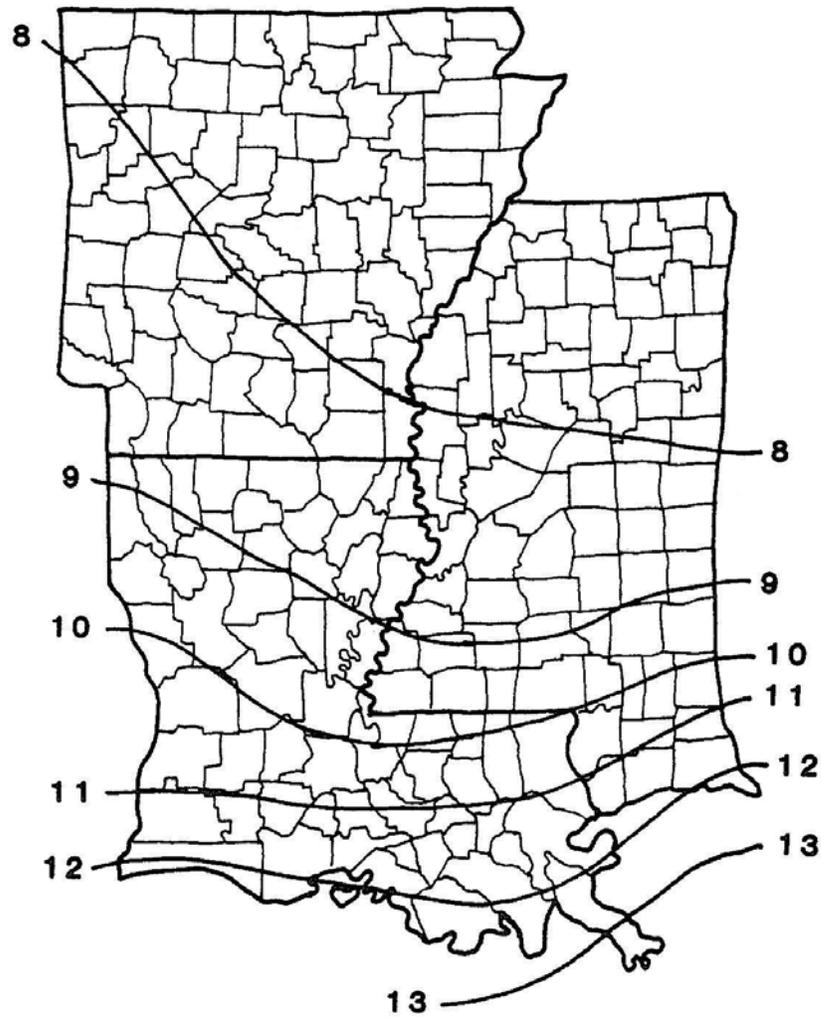
**PRINCIPAL SPILLWAY DESIGN RAINFALL (INCHES)**



TGH Notice 71 SCS-LA, April 1988

**FIGURE 2**

**50-YEAR 24-HOUR RAINFALL (INCHES)**

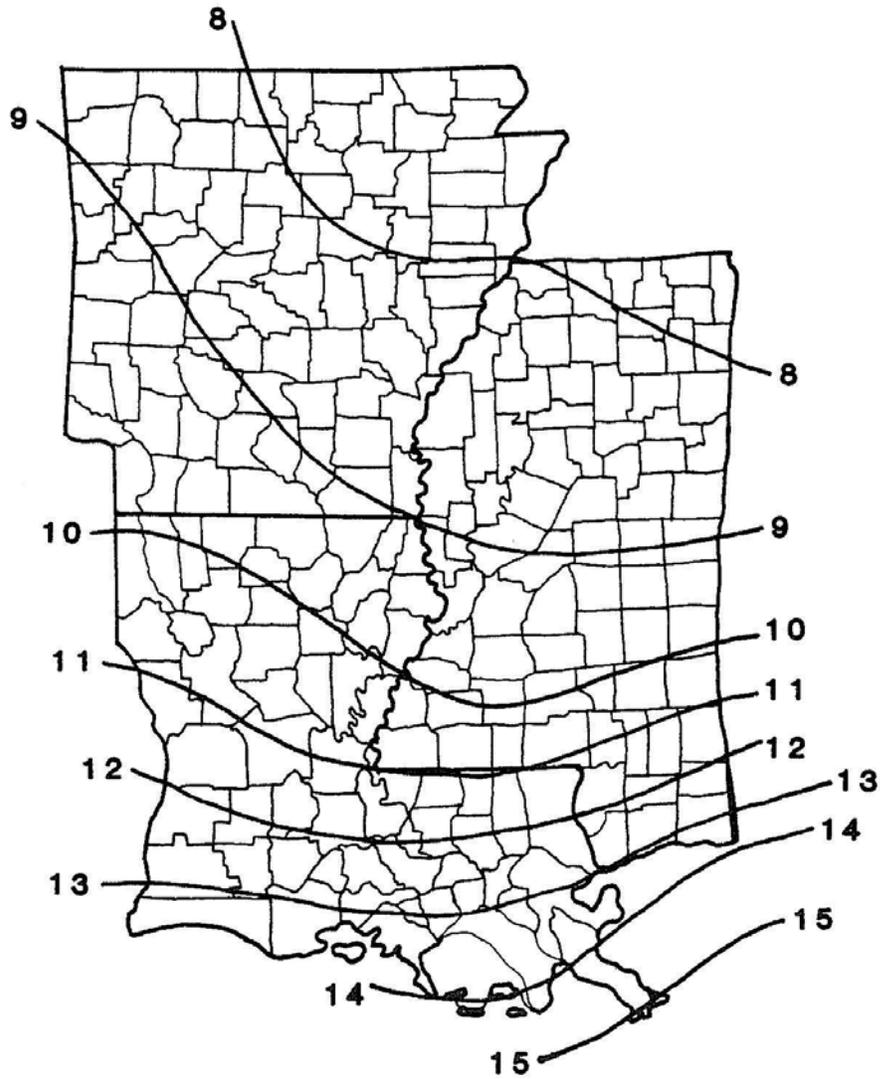


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**FIGURE 3**  
**100-YEAR 24-HOUR RAINFALL (INCHES)**



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