

**NATURAL RESOURCES CONSERVATION SERVICE**  
**CONSERVATION PRACTICE STANDARD**  
**IRRIGATION WATER CONVEYANCE**  
**NONREINFORCED CONCRETE DITCH AND CANAL LINING**  
**(Ft)**  
**CODE 428A**

**DEFINITION**

A fixed lining of impervious material installed in an existing or newly constructed irrigation field ditch, irrigation canal, or lateral.

**PURPOSES**

To prevent waterlogging of land, to maintain water quality, to prevent erosion, and to reduce water loss.

**CRITERIA**

**General.** This standard applies to linings made of nonreinforced Portland cement concrete that are cast in place in a preformed ditch or canal section. It does not include linings of pneumatically applied mortar.

This standard is restricted to installations in ditches or canals that have a bottom width not greater than 6 feet, a design capacity not greater than 100 ft<sup>3</sup>/s and a maximum velocity of 15 ft/s.

Ditches and canals to be lined shall serve as integral parts of an irrigation water distribution or conveyance system that has been designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries for the area served shall be sufficient to make irrigation practical for the crops to be grown

and the irrigation water application methods to be used.

Lined ditches and canals shall be located where they are not susceptible to damage from side drainage flooding, or they shall be protected from such damage.

Linings shall be installed only in well-drained soils or on sites where subgrade drainage facilities are installed with or before the lining. Linings shall not be installed on sites susceptible to severe frost heave or on sites where experience has indicated that the sulfate salt concentration in the soil causes rapid concrete deterioration. On sites where sulfate concentrations exist, concrete linings may be used only if they are made using special sulfate-resistant cement as follows:

**Capacity.** The design capacity for lined ditches and canals shall be based on the following, whichever is greatest.

1. Capacity shall be enough to deliver the water needed for irrigation to meet the design peak consumptive use of the crops in the area served.
2. Capacity shall be enough to provide an adequate irrigation system for all methods of irrigation planned for use in the area served.

The capacity shall be computed with

Mannings Formula using a roughness coefficient “n” of not less than 0.015.

### Types of Cement Required for Concrete Exposed to Sulfate Attack

Percentage water-soluble Sulfate (as SO <sub>4</sub> ) in soil samples	Sulfate (as SO <sub>4</sub> ) in water samples, PPM	Cement type
0.00 to 0.10	0 to 150	I or IP
0.10 to 0.20	150 to 1,500	II, II w/Class F pozzolan <sup>1</sup> or IP (MS) <sup>1</sup>
0.20 to 2.0	1,500 to 10,000	V, V w/Class F pozzolan <sup>2</sup> , II w/Class F pozzolan <sup>2</sup> , or IP (MS) <sup>2</sup>
2.0 or more	10,000 or more	V plus Class F pozzolan <sup>2</sup>

<sup>1</sup>R factor less than 1.5 for substituted or blended cement.

<sup>2</sup>R factor less than 0.75 for substituted or blended cement, where  $R = (CaO-5)/Fe_2O_3$

**Velocity.** To avoid unstable surge flows, restrict a design velocity in excess of 1.7 times the critical velocity to straight reaches that discharge into a section or structure designed to reduce the velocity to less than critical velocity and avoid the velocity range of 0.7 to 1.3 times the critical velocity. The maximum velocity in these straight reaches shall be 15 ft/s. The velocity in ditch reaches from which water is to be delivered onto the field through turnouts, siphon tubes, or to similar means shall be less than super-critical and sufficiently slow to permit operation of the planned takeout structure or device.

**Freeboard.** The required freeboard varies according to the size of the ditch or canal,

the velocity of the water, the horizontal and vertical alignment, the amount of the storm or waste water that may be intercepted, and the change in the water surface elevation that may occur when any control structure is operating. The minimum freeboard for any lined ditch or canal shall be 3 inches above the designed water surface. If a construction deviation greater than 0.1 feet is permitted for the constructed lining elevation, the minimum freeboard shall be increased accordingly.

More freeboard shall be provided if required by slope velocity, depth of flow, alignment, obstruction, curves, and other site conditions.

**Water surface elevations.** All lined ditches and canals shall be designed so that the water surface elevations at field takeout points are high enough to provide the required flow onto the field surface. If ditch checks or other control structures are to be used to provide the necessary head, the backwater effect must be considered in computing freeboard requirements. The required elevation of the water surface varies with the type of takeout structure or device used and the amount of water to be delivered through each. A minimum head of 4 inches shall be provided.

**Lining thickness.** The thickness of canal linings must be consider the location, canal size, velocity, subgrade conditions, method of construction, operation, and climate of the site. The minimum thickness for nonreinforced concrete linings in rectangular sections shall be 3-1/2 inches. For trapezoidal or parabolic sections, the minimum thickness shall be 2-1/2 inches for design velocities of less than 12 feet per second and 3 inches for design velocities of 12 to 15 feet per second.

**Ditch or canal side slopes.** Side slopes for nonreinforced concrete linings.

Side slopes for usual construction methods shall not be steeper than:

Hand-placed, formed concrete:

Height of lining less than 1-½ feet....Vertical

Hand-placed, screened concrete:

Height of lining less than 2-½ feet....3/4 to 1

Height of lining more than 2-½ feet....1 to 1

Slip form concrete:

Height of lining less than 3 feet....1 to 1

Height of lining more than 3 feet....1 ¼ to 1

Linings generally have either a trapezoidal or parabolic cross section. The sidewall height in rectangular sections shall not exceed 1-1/2 feet.

**Ditch or canal banks.** Ditch and canal banks shall be built up with earth to at least the top edge of the lining. In cut sections, other than in rock, a berm shall be constructed not less than 2 inches above the top of the lining. Banks and berms shall be wide enough to insure stability of fills and to prevent excessive deposition in cut sections.

If the bank or berm is to be used as a roadway, the minimum top width shall be adequate for the purpose.

Outside bank slopes and slopes above the berm elevation in cut sections must be flat enough to insure stability.

**Related structures.** Plans for installing ditch or canal linings shall provide for adequate inlets, outlets, turnouts, checks, crossings, and other related structures needed for successful conservation irrigation. These structures can be installed before, during, or after placement of the lining. They must be constructed or installed in such a way as not to damage the lining or to impair its effectiveness.

**Concrete.** Concrete used in linings shall be proportioned so that it is plastic enough for thorough consolidation and stiff enough to stay in place on the side slopes. The concrete mix shall be have a 28-day compressive strength of 3,000 psi or greater. Ready mix concrete shall meet the requirements of ASTM C 94. The air content shall be in the range of 5 to 7 percent. The use of accelerators or antifreeze compounds shall not be allowed. Aggregates shall conform to ASTM Designation C 33, Specification for Concrete Aggregates.

**Foundation preparation.** The foundation area for all ditch embankments and/or ditch pads shall be cleared of all trees, weeds, sod, loose rock or other materials not suitable for the subgrade. Ditches and canals shall be excavated to the neat lines of the specified cross section and finished with a smooth, firm surface.

**Concrete placement and curing.** All surfaces on which concrete linings are to be placed shall be moist when the concrete is poured. Slip forms and screeding equipment shall be operated so as to place the concrete uniformly across the perimeter of the ditch or canal, with a minimum thickness not less than that specified. Concrete shall not be placed on mud, excessively dry soil, uncompacted fill, ice or frozen subgrade. Concrete linings shall have a smooth and uniform finish and shall be free of honeycomb.

Concrete shall be cured for not less than 5 days by (1) impounding water over the exposed surface, (2) covering with burlap or a similar material that is kept continuously moist, or (3) spraying a concrete sealing compound evenly over all exposed surfaces according to the manufacturer's directions.

If conditions warrant, concrete shall be protected from freezing for at least 3 days

after placement. Concrete damaged by freezing shall be considered defective work and must be removed and replaced.

**Contraction and construction joints.**

Contraction joints, at least ¼ inch wide, shall be cut transversely in the concrete to a depth of about one-third the thickness of the lining at a uniform spacing not greater than 10 feet. Construction joints shall be the butt type formed square with the lining surface and at right angles to the ditch or canal. Contraction and construction joints shall be tooled so that the edges will have a smooth finish.

**Construction operations.** Construction operations shall be done in such a manner that erosion and air and water pollution are minimized and held within legal limits.

**CONSIDERATIONS**

Consider the effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, and deep percolation and ground water recharge.

Consider the effects on downstream flows or aquifers that would affect other water uses or users.

Consider the potential for irrigation water management.

Consider the potential changes in growth and transpiration of vegetation located next to the ditch or lateral because of the elimination of leakage from the system and the effects on wetlands or water-related wildlife habitats.

Consider the effects of installing the lining on the ditch erosion and seepage and the movement of sediment and soluble and sediment-attached substances carried by water and on the movement of dissolved substances to ground water.

Consider the effects on the visual quality of water resources.

**PLANS AND SPECIFICATIONS**

Plans and specifications for installing nonreinforced concrete irrigation ditch and canal linings shall describe the requirements for applying the practice to achieve its intended purpose and include applicable lining cross-sectional shape, grades, thickness, joints and pertinent structures.

**OPERATION AND MAINTENANCE**

Operation and maintenance will include patching of cracks/joints, replacement of earth berms, weed control, etc as needed.

**REFERENCES**

- NRCS Engineering Field Manual,  
Chapter 3