

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE

**PNEUMATICALLY-APPLIED MORTAR (PAM)
DITCH AND CANAL LINING**

(Feet)

CODE 428D CA INTERIM

DEFINITION

A fixed lining of pneumatically-applied mortar installed in an existing or newly-constructed irrigation field ditch, irrigation canal or lateral.

Scope

This standard applies to linings made of non-reinforced pneumatically-applied mortar to a preformed ditch or canal section and does not include cast-in-place concrete. 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 c.f.s., and a maximum velocity of 15 feet-per-second. This standard includes design and construction criteria for shaping or reshaping the ditch section as well as for the lining.

PURPOSES

The principal purposes of ditch and canal linings are to prevent water logging of land, to maintain water quality, to prevent erosion, and to reduce water loss.

CONDITIONS WHERE PRACTICE APPLIES

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 farmer 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 will not be subject to damage from side drainage flooding, or they shall be protected from such damage.

Pneumatically-applied mortar linings shall be installed only in well-drained soils or on sites where subgrade drainage facilities are installed with or before the lining. These linings shall not be installed on sites subject to severe frost heave or on sites where experience has indicated the sulfate salt concentration in the soil causes rapid concrete deterioration.

On sites where the sulfate concentration is more than 0.1 percent, concrete linings may be used only if made with special sulfate-resistant cements as follows:

Sulfate Concentration	Cement Type
More than 0.1%	II or V
More than 0.3%	V

CRITERIA

Capacity Requirements

A lined ditch or canal shall have enough capacity to meet its requirement as a part of the planned irrigation water distribution or conveyance system without danger of overtopping. Design capacity shall be based upon the following, whichever is greater:

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 stream for all methods of irrigation planned for use in the area served.
3. For design purposes, the capacity shall be considered to be equal to the capacity as computed with the Manning Formula using a coefficient of roughness "n" of not less than 0.017

Velocities

To avoid unstable surge flows, design velocities in excess of 1.7 times the critical velocity shall be restricted to straight reaches that discharge into a section or structure designed to reduce the velocity to less than critical velocity. The maximum velocity in these straight reaches shall be 15 feet-per-second. The velocities in ditch reaches from which water is to be delivered onto the field through turnouts, siphon tubes, or similar means shall be less than critical and sufficiently low to permit operation of the planned takeout structure or device.

Freeboard

The required freeboard varies with the size of the ditch or canal, the velocity of the water, the horizontal and vertical alignment, the amount of 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 requirement is based on the assumption that the finished channel bottom elevations will vary no more than 0.1 foot is to be permitted, the minimum freeboard shall be provided as required by slope, velocity, depth of flow, alignment, obstructions, curves, and other site conditions.

Water Surface Elevations

All lined ditches and canals shall be designed so 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 above the field surface will vary 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 pneumatically-applied mortar canal linings must be established from engineering consideration on each job. Location, canal size, velocity, subgrade conditions, method of construction, operation, and climate shall be evaluated in establishing the thickness to be used. The minimum thickness for pneumatically-applied mortar linings in rectangular sections shall be 3 1/2 inches. For trapezoidal or parabolic sections the minimum thickness shall be as shown in Table 1. In no case should rebound be included in the minimum thickness.

Ditch or Canal Side Slopes

Pneumatically-applied mortar linings generally are used in ditches and canals that have either a trapezoidal or parabolic cross section. They may be used in rectangular sections where the vertical sidewall height will be no greater than 1 1/2 feet. Side slopes for pneumatically-applied mortar shall not be steeper than shown below:

Height of Lining	S:S
less than 2 feet	3/4 to 1
more than 2 to 3 feet	1 to 1
more than 3 feet	1 1/4 to 1

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.

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

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

Related Structures

Plans for pneumatically-applied mortar ditch or canal lining installations shall provide for adequate inlets, outlets, turnouts, checks, crossings, and other related structures needed for successful conservation irrigation. These structures may be installed before, during, or after the lining placement. They must be constructed or installed in such a way as to damage or impair the effectiveness of the lining.

Materials

All materials shall meet or exceed the minimum requirements for materials as set forth in the 428D Material Specifications.

CONSIDERATIONS

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, evaporation, deep percolation and ground water recharge.
2. Effects on downstream flow or aquifers that would affect other water uses or users.
3. Potential use for irrigation water management.
4. Potential changes in growth and transpiration for vegetation located next to the conveyance because of the elimination of leakage from the system.

Water Quality

1. Effects of installing the lining on the erosion of the earth conveyance and the movement of sediment and soluble and sediment attached substances carried by water.
2. Effects on the movement of dissolved substances to ground water.
3. Effects on wetlands or water-related wild life habitats.
4. Effects on visual quality of water resources.

Endangered Species Considerations

Determine if installation of this practice with any others proposed will have any effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern or at least not have any

adverse effect on a listed species. If the Environmental Evaluation indicates the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

PLANS AND SPECIFICATIONS

Plans and specifications for installation of non-reinforced pneumatically applied mortar on ditch and canal lining shall be in keeping with this standard and shall described the requirements for application of the practice to achieve its intended purposes.

OPERATION AND MAINTENANCE

An operation and maintenance plan must be prepared by the Designer for use by the owner or other responsible for operating this practice. The plan should provide specific instructions for operating and maintaining the system to insure that it functions properly. It should also provide for periodic inspections and prompt repair or replacement of damage components.

Table 1. Minimum required thickness, pneumatically-applied mortar ditch and canal lining in trapezoidal or parabolic sections.

Design velocity ¹	Climate Area*	
	Warm	Cold
	Minimum Thickness - In.	
Ft. Per Second		
Less than 9.0	1.5	2.0
9.0 to 12.0	2.0	2.5
12.0 to 15.0	2.5	3.0

¹ Velocity in short chute sections shall not be considered as design velocity. * Climate Areas: Warm - Average January temperature is 40°F and above; Cold - Average January temperature is less than 40°F