NATURALRESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE DITCH AND CANAL LINING, FLEXIBLE MEMBRANE

(Ft.)
CODE 428 B

DEFINITION

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

PURPOSE

- Improve management of irrigation water
- Maintain water quality
- Prevent erosion
- Prevent water-logging of land
- Reduce water loss

CONDITIONS WHERE PRACTICE APPLIES

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

The available water supply shall be sufficient to make irrigation practical for the crops to be grown and the irrigation methods to be used.

Lined ditches and canals shall either be located where they are not susceptible to damage from side drainage flooding or they shall be protected from such damage. Flexible membrane liners must be protected from external water pressure that could cause the liner to bulge and possibly fail.

CRITERIA

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

- Capacity shall be sufficient to deliver the water needed for irrigation to meet the design peak consumptive use of the crops in the area served.
- Capacity shall be sufficient to provide an adequate flow rate for all methods of irrigation and crops planned.

Canals and laterals lined with flexible membranes must be designed with sufficient capacity to carry the required flows under the maximum probable retardance conditions.

When computing capacity, the Manning's "*n*" value shall be selected according to the material from which the canal or lateral is constructed, taking into account alignment, aging, hydraulic radius, potential weed and moss buildup, and other restrictions.

Velocity. The minimum expected Manning's "*n*" value, for the selected flexible membrane liner, shall be used when evaluating designs for maximum allowable velocity.

The water velocity in the ditch where water is to be delivered onto the field shall be sufficiently low to permit operation of the planned takeout structure or device.

When soil material is used as a protective cover over a flexible membrane liner, the velocity in canals or ditches shall not exceed the non-erosive velocity for the protective soil material or the material through which the canal or ditch passes, whichever is less. Local information on velocity limits for specific soils may be used, if available, otherwise stability limits shall be based on the tractive stress design approach as discussed in USDA - ARS (Agricultural Research Service) Agriculture Handbook Number 667 - "Stability Design of Grassed-Lined Open Channels" or other comparable channel stability criteria.

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 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 mini-

mum freeboard for any lined ditch or canal shall be 0.25 feet of lining above the designed water surface. This minimum freeboard requirement is based on the assumption that the finished channel bottom and top-of-ditch elevations will vary no more than 0.1 foot (ft) from the design elevations. If a construction deviation greater than 0.1 ft is permitted, the minimum freeboard shall be increased.

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 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 varies according to the type of takeout structure or device used and the amount of water to be delivered. A minimum head of 0.5 feet shall be provided.

Side slopes. Canals and ditches with buried membrane linings must be constructed with stable side slopes. Slope requirements vary according to the type of cover material, but the side slopes shall not be steeper than 3 horizontal to 1 vertical (3H: 1V).

The side slopes for canals and ditches with exposed membrane linings will be limited by the type and configuration of material, fastening techniques, sound engineering practices, and the manufacturer's recommendations.

Subgrade. Flexible membranes shall be placed on a relatively smooth and firm surface. The top 6 in. of the subgrade shall be free of organic material, particles larger than 3/8-inch in size, angular particles, other sharp objects, or anything else that could damage the liner.

If the subgrade does not meet these criteria, a 6 in. layer of soil free of particles larger than 3/8-in., angular particles, and other sharp objects or medium weight (at least 8 ounces per square yard) non-woven geotextile material shall be used beneath the liner. Increasing the liner thickness, by an amount approved by the State Conservation Engineer, may substitute for this requirement.

Anchor trenches and Cutoffs. All flexible membrane liners require adequate anchoring. Anchor trenches along the ditch and cutoffs at the beginning and ending of the flexible membrane liner are a proven method to secure the flexible membrane liner from uplift or tearing. Additional cutoffs shall be considered at appropriate intervals.

Anchor trenches are used to secure the flexible membrane liner along both sides of the ditch. They are generally at least one foot deep and six inches wide. The anchor trench is located at the top of the embankment and at least one foot from the inside edge of the ditch. One edge of the liner is laid in the bottom of the first trench and up the side of the trench towards the ditch. Soil is place on the liner in this first trench and consolidated to the original top of embankment. The flexible membrane liner is placed loosely in and across the ditch and into the second anchor trench located on the opposite side of the ditch. The flexible membrane liner is allowed to conform to the shape of the ditch and the second trench and any wrinkles are removed. The flexible membrane liner in the second anchor trench is then covered with soil and consolidated to the original top of embankment.

Cutoffs are essentially anchor trenches that are cut perpendicular to the direction of normal water flow. They are designed to intercept water that may be flowing under the liner and confine this renegade water to a short section of ditch. Culvert crossings and check gate locations are logical locations for cutoffs. Cutoffs can also be made from the liner material and filled with soil or plain concrete.

Other anchoring and cutoff methods must be approved by the State Conservation Engineer.

Covered liners. Any manufactured material shall have sufficient ultraviolet protection, either inherent in the material or by covering, to prevent deterioration.

When flexible membrane liners are to be covered, they shall be protected by an earth or an earth and gravel covering not less than 12 inches thick. The covering must extend not less than 6 in. above the top edge of the lining.

The material in the bottom 3 in. of soil cover shall be non-angular particles and no larger than 3/8-in. Lining in the bottom of a ditch or canal may need to be thicker, as per manufacturer recommendations.

Livestock must be excluded from the ditch.

Membrane thickness. The required flexible membrane thickness depends on the expected sub-grade conditions, the hydrostatic forces that will be acting on the flexible membrane, and the susceptibility of the lining to damage during or after installation. Minimum flexible membrane thickness, installed under ideal conditions, is shown in **Table 1.**

Table 1
Minimum nominal thickness of flexible membrane liners

Material	Minimum Liner Thickness (mil)
Poly Vinyl Chloride (PVC) (1)	20
Geo-synthetic Clay Liner (GCL) (1)	0.75 lb/sq ft‡ of sodium bentonite
Ethylene Propylene Diene Terpolymer (EPDM)	45
EPDM (reinforced)	45
Polyurethane/geotextile composite	45
High Density Polyethylene (HDPE)	40
Linear Low Density Polyethylene (LLDPE)	40
Polypropylene (PP) (reinforced)	36
Bituminous geomembrane	120

(1) Minimum cover thickness – 12 inches of soil

Related structures. Construction drawings shall provide for adequate inlets, outlets, turnouts, checks, crossings, and related structures needed for successful conservation irrigation. These structures must be installed in such a way as to not damage or impair the effectiveness of the lining.

CONSIDERATIONS

Effect on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, and deep percolation of dissolved substances to the groundwater.

Effects on downstream flows or aquifers that would affect other water uses or users.

Potential changes in vegetation located next to the conveyance because of the reduction of leakage from the system.

Abrasion by sediment on the liner or the erosion on the protective cover over the liner.

Effects of wetlands and other wildlife habitats.

Effects on the visual quality of water resources.

DRAWINGS AND SPECIFICATIONS

Drawings and specifications for installing flexible membrane irrigation ditch and canal lining shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be developed for flexible membrane ditch and canal linings. The plan should document needed actions to ensure that practices perform adequately throughout their expected life.

O&M requirements shall be determined as part of the design. Any requirements should be documented as brief statements in the plans, specifications, the conservation plan narrative, or as a separate O&M plan. Typical O&M may include sediment/debris removal, patching of tears, replacing of deteriorated linings, reanchoring edges, or resealing seams.