**NATURAL RESOURCES CONSERVATION SERVICE**

**VIRGINIA CONSERVATION PRACTICE STANDARD**

# OPEN CHANNEL

**(ft)**

**CODE 582**

## DEFINITION

Constructing or improving a channel either natural or artificial, in which water flows with a free surface.

## PURPOSE

To provide discharge capacity required for flood prevention, drainage, other authorized water management purposes, or any combination of these purposes.

## CONDITIONS WHERE PRACTICE APPLIES

This standard applies to construction of new earth channels or modification of existing earth channels.

This standard applies to the Virginia Conservation Practice Standard *Surface Drainage, Main or Lateral (Code 608)* where the drainage area is in excess of 1 $mi^2$.

This standard does not apply to Virginia Conservation Practice Standards *Diversion (Code 362), Grassed Waterway (Code 412)* or *Surface Drainage, Field Ditch (Code 607).*

This standard does not apply to localized reaches of stream that should be treated by using Virginia Conservation Practice Standard *Streambank and Shoreline Protection (Code 580)* or *Channel Stabilization* (*Code 584*).

This standard applies where stability requirements can be met, where the impact of the proposed construction on water quality, fish and wildlife habitat, forest resources, and quality of the landscape is evaluated and the techniques and measures necessary to overcome the undesirable effects are made part of any planned work, where an adequate outlet for the modified channel reach is available for discharge by gravity flow or pumping, and where excavation or other channel work does not cause significant erosion, flooding, or sedimentation.

## DESIGN CRITERIA

Measures shall be designed and installed according to a site-specific plan that is in compliance with all federal, state, and local laws and regulations. The landowner or operator shall be responsible for obtaining and complying with all applicable permits.

**Plan.** Channel construction or modification shall be according to an approved plan prepared for the site. TR-25 shall be used in surveys, planning, and site investigations for channel work. Design criteria in TR-25 shall be followed, using the procedure best adapted to site conditions.

In selecting the location and design of channels, careful consideration shall be given to minimizing water pollution, damage to fish and wildlife habitat, and to protecting forest resources and the quality of the landscape. In considering requirements for construction and operation and maintenance, selected woody plants must be preserved. The overall landscape character, prominent views, and fish and wildlife habitat requirements must be considered.

Planned measures necessary to mitigate unavoidable losses to fish or wildlife habitat shall be included in the project. The quality of the landscape shall be maintained by both the location of channel works and plantings, as appropriate.

The alignment of channels undergoing

modifications shall not be changed to the extent that the stability of the channel or laterals thereto is endangered.

**Capacity.** The capacity for open channels shall be determined according to procedures applicable to the purposes to be served and according to related engineering standards and guidelines in handbooks. The water surface profile or hydraulic gradeline for design flow shall be determined according to guidelines for hydraulic design in TR-25. The n value for aged channels shall be based on the expected vegetation, along with other retardance factors, considering the level of maintenance prescribed in the operation and maintenance plan prepared with the owners or sponsors. The required capacity may be established by considering volume-duration removal rates, peak flow, or a combination of the two, as determined by the topography, purpose of the channel, desired level of protection, and economic feasibility.

**Cross section.** The required channel cross section and grade shall be determined by the plan objectives, the design capacity, the materials in which the channel is to be constructed, the vegetative establishment program, and the requirements for operation and maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams. Urban and other high-value developments through which the channel is to be constructed must be considered in the design of the channel section.

**Channel stability.** Characteristics of a stable channel are:

1. The channel neither aggrades nor degrades beyond tolerable limits.

2. The channel banks do not erode to the extent that the channel cross section is changed appreciably.

3. Excessive sediment bars do not develop.

4. Gullies do not form or enlarge because of the entry of uncontrolled surface flow to the channel.

All channel construction and modification (including clearing and snagging) shall be according to a design that can be expected to result in a stable channel that can be maintained at reasonable cost. Vegetation, riprap, revetments, linings, structures, or other measures shall be used if necessary to ensure stability.

The method applicable to site channel in TR-25 shall be used in determining the stability of proposed channel improvements.

Channels must be stable under conditions existing immediately after construction (as-built condition) and under conditions existing during effective design life (aged condition). Channel stability shall be determined for discharges under these conditions as follows:

1. As-built condition – Bankfull flow, design discharge, or 10-year frequency flow, whichever is smallest, but not less than 50 percent of design discharge.

   The allowable as-built velocity (regardless of type of stability analysis) in the newly constructed channel may be increased by a maximum of 20 percent if:

   a) The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation,

   b) Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known, and

   c) The channel design includes detailed plans for establishing vegetation on the channel side slopes.

2. Aged condition – Bankfull flow or design discharge, whichever is larger, except that it is not necessary to check stability for discharge greater than the 100-year frequency.

Stability checks that are flow related are not required if the velocity is 2 ft/s (0.6 m/s) or less.

For newly constructed channels in fine-grained soils and sands, the n values shall be determined according to procedures in chapter 6 of TR-25, and shall not exceed 0.025. The n value for channels to be modified by clearing and snagging only shall be determined by reaches according to the expected channel condition upon completion of the work.

**Appurtenant structures.** The channel design shall include all structures required for proper

functioning of the channel and its laterals, as well as travelways for operation and maintenance. Inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the channel design. The design also shall provide for necessary flood gates, water-level-control devices, bays used in connection with pumping plants, and any other appurtenances essential to the functioning of channels and contributing to attainment of the purposes for which they are built. If needed, protective structures or treatment shall be used at junctions between channels to ensure stability at these critical locations.

The effect of channel work on existing culverts, bridges, buried cables, pipelines, irrigation flumes, and inlet structures for surface and subsurface drainage on the channel and laterals thereto shall be evaluated to determine the need for modification or replacement.

Culverts and bridges that are modified or added as part of channel projects shall meet reasonable standards for the type of structure and shall have a minimum capacity equal to the design discharge or state agency design requirements, whichever is greater. Capacity of some culverts and bridges may need to be increased above the design discharge.

**Disposition of spoil.** Spoil material from clearing, grubbing, and channel excavation shall be disposed of in a manner that will:

1. Not confine or direct flows so as to cause instability when the discharge is greater than the bankfull flow.
2. Provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed.
3. Not hinder the development of travelways for maintenance.
4. Leave the right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses.
5. Direct water accumulating on or behind spoil areas to protected outlets.
6. Maintain or improve the visual quality of the site to the extent feasible.

**Vegetation of channel.** Vegetation shall be established on all channel slopes, berms, spoil, and other disturbed areas according to the Virginia Conservation Practice Standard for *Critical Area Planting (Code 342)*.

## CONSIDERATIONS

### *Quantity*

Effects on components of the water budget, especially on volumes and rates of runoff and infiltration.

### *Quality*

Effects of erosion and the movement of sediment and soluble and sediment-attached substances in runoff during and immediately after construction.

Effects of the use of chemicals during vegetation control.

Effects of changes in channel vegetation on downstream water temperature.

Potential for temporary and long-term effects on the visual quality of downstream waters.

## PLANS AND SPECIFICATIONS

Plans and specifications for constructing open channels shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

Record all required information in an engineer field book, on a plan sheet or design computation sheet, or in another appropriate location.

DESIGN DATA

1. Detailed site investigation report with supporting data including project purpose, flow information, channel materials, source of channel instability (if known), land use upstream and downstream, activities in the watershed impacting the stream, etc. Include photographs.

2. Completed Environmental Evaluation (Form VA-EE-1) and subsequent requirements.
3. Soils investigation.
4. Survey and plot data: profile, cross-sections, topography, as needed.
5. Design computations, including purpose of practice and references used.
6. Plan view of site with existing and planned features, including dimensions, distances, utilities, structures, property boundaries, etc.
7. Standard Cover Sheet (VA-SO-100A).
8. Materials and quantities needed. Identify borrow material and/or spoil area, as needed.
9. Vegetation and/or ground cover requirements.
10. Identification of needed Erosion & Sediment Control measures.
11. Dewatering plan, if needed.
12. Supplemental practices required.
13. Virginia Conservation Practice Specifications (700 Series).
14. Operation and Maintenance Plan.

CHECK DATA

1. As-built survey.
2. As-built plans including dimensions, types and quantities of materials installed, and variations from design. Include justification for variations.
3. Locations of appurtenant practices.
4. Adequacy of vegetation and/or ground cover.
5. Complete as-built section of Cover Sheet.

**OPERATION AND MAINTENANCE**

Operation and Maintenance requirements must be prepared for use by the landowner or operator responsible for operation and maintenance of an open channel system. The plan should provide specific instruction for operating and maintaining the channels to ensure they function properly. It should also provide specific instruction pertaining to the intensity of management activities in the stream channel and riparian area. Where applicable, operation and maintenance plans will describe the anticipated time frame for changes and adjustments in the plan form and profile, and the appropriate operation and maintenance response to these adjustments. Permits and/or consultation may be required for operation and maintenance. Minimum requirement to be address in the operation and maintenance plan are:

1. Prompt repair or replacement of damaged components if necessary.
2. Remove foreign materials and vegetation that are interfering with proper operation only when necessary.
3. Maintain vigorous vegetative growth in riparian areas and for erosion control.
4. Maintain travel-ways for operation and maintenance access.

**Plan.** An operation and maintenance plan must be prepared for each channel system. Minimum requirements for operation, maintenance, and replacement shall be consistent with the design objectives. This includes consideration of fish and wildlife habitat, quality of the landscape, water quality, mitigation features, methods, equipment, costs, stability, function for design life, frequency, and time of year for accomplishing the work. Detailed provisions for operation and maintenance must be made if complex features, such as water-level-control structures and pumping plants, are required.

**Maintenance access.** Travelways for maintenance generally shall be provided as part of all channel work. This requirement may be met by providing reading access points to sections of the channel if this will permit adequate maintenance in conformance with the operation and maintenance plan.

A travelway shall be provided on each side of large channels if necessary for use of maintenance equipment. Travelways must be adequate for movement and operation of equipment required for maintenance of the channel. The travelway may be located adjacent to the channel on a berm or on the spread spoil. In some places the channel itself may be used as the travelway. The travelway, including access points, must blend into the

topography, the landscape, and adjacent land uses.

**Safety.** Open channels can create a safety hazard. Appropriate safety features and devices should be installed to protect people and animals from accidents such as falling or drowning.

**REFERENCES**

USDA-Natural Resources Conservation Service. Electronic Field Office Technical Guide (eFOTG), Section IV [Online]. Available at http://www.nrcs.usda.gov/technical/eFOTG.

USDA-Natural Resources Conservation Service. Technical Release 25, Design of Open Channels. October 1977.

USDA-Natural Resources Conservation Service. Virginia 700 Series Construction Specifications. [On-line]. Available at http://www.nrcs.usda.gov/technical/eFOTG.

Virginia Department of Environmental Quality Office of Wetlands and Water Protection. Joint Permit Application. [Online]. Available at http://www.deq.state.va.us/wetlands/

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