

Open Channel

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, or other water management purposes.

Conditions Where Practice Applies: This practice applies to open channel construction or modification of existing channels.

It also 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.

Planning Considerations

Water Quantity:

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

Water Quality: The following effects on water quality will be considered:

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

2. Effects of the use of chemicals during vegetation control.
3. Effects of changes in channel vegetation on downstream water temperature.
4. Potential for temporary and long-term effects on the visual quality of downstream waters.

Design Criteria

General: SCS Technical Release No. 25 "Design of Open Channels" contains methods of design applicable to this practice.

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 should 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 modification shall not be changed to the extent that the stability of the channel or laterals thereto is endangered. Appendix B may be used for estimating the runoff expected from a drainage area. Other

guides which may be used include Chapter 2 of the Soil Conservation Service Engineering Field Handbook and SCS Technical Release 55.

Capacity: The capacity for open channels shall be determined according to the purposes to be served. For uniform channels, Manning's equation may be used to determine capacity. 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. For non-uniform channels the procedure contained in Technical Release 25 may be used.

Channel Cross Section: The required channel cross section and grade are determined by the design capacity, the materials in which the channel is to be constructed, and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams. Developments through which the channel is to be constructed must be considered in design of the channel section.

Design side slopes shall not be steeper than those shown below.

<u>Material</u>	<u>Side Slope</u>
Sand or silt with clay binder	2:1
Heavy clay or silty clay	1 1/2:1
Gravel, clean	2:1
Sand, clean	1:1
Solid rock	1/4:1
Loose rock or cemented gravel (cut)	1:1

Side slopes steeper than that shown will require mechanical streambank protection unless the existing streambank is stable and will not be disturbed nor the channel bottom deepened.

Alignment: The alignment of new channels must be such that there will be no sharp curves. The minimum radius of curvature will be as shown below unless shown stable for the criteria and procedure contained in Technical Release No. 25.

<u>Water Surface Width (feet)</u>	<u>Minimum Radius (feet)</u>	<u>Approximate Degree of Curve (Degrees)</u>
15 or less	400	14
15 to 35	600	10
35 or more	800	7

Channels outside the range of the above table and which are not stable using the procedures contained in Technical Release No. 25 will require special treatment. Sharp curves are needed in some locations to facilitate land use in the adjacent areas. Where this is necessary, streambanks should be protected in accordance with the standard for Streambank Protection.

Channel Stability: Characteristics of a stable channel are:

1. It neither aggrades or degrades beyond tolerable limits.
2. The channel banks do not erode to the extent that the channel cross section is changed appreciably.

3. Excessive erosion does not occur around culverts and bridges or elsewhere.
4. Excessive sediment bars do not develop.
5. Gullies do not form or enlarge due to the entry of uncontrolled surface flow to the channel.

All channel construction and improvement shall be in accordance with a design which can be expected to result in a stable channel which can be maintained at reasonable cost.

Drainage Area 640 Acres or Less:

Design velocities shall not exceed those listed below without special protective measures (i.e. streambank protection and/or stream channel stabilization). The material of the channel bed and bank being the most limiting will govern.

Bed and Bank Materials	Allowable Velocity ft/sec
Fine clean sands (SW, SP)	1.5
Silty sand (SM)	2.0
Coarse clean sand (SW, SP)	2.5
Alluvial silt, noncolloidal (ML)	2.5
Alluvial silt, colloidal (MH)	3.0
Clayey sand (SC)	3.0
Lean to moderately cohesive clay (CL)	3.0
Silty gravel (GM)	3.5
Fine clean gravel (GW, GP)	4.0
Clayey gravel (GC)	4.5
Stiff clay (CH)	4.5
Coarse clean gravel (GW, GP)	5.0
Cobbles and boulders	6.0
Weathered shale and hardpan	6.0

Drainage Area Exceeds 640 Acres:

Channels with drainage areas greater than 640 acres shall be checked for stability under both aged and as built conditions as outlined below.

Aged condition — The channel shall be designed to be stable for an aged condition. The average velocity or tractive force shall be determined for both the design flow and bankfull flow. The channel shall be stable for both of these determinations when checked with the allowable limits contained in Technical Release No. 25. The "n" value for this calculation shall be based on the expected kind and density of vegetation and assuming good maintenance. In no case is it necessary to check channel stability for discharges greater than that from the 100-year frequency storm. The discharge used in stability analyses of channels having a controlled inflow shall be their design flow.

As built condition — The channel shall be designed to be stable under conditions existing immediately after construction. The average velocity or tractive force shall be determined for either the expected flow from a 10-year frequency storm on the watershed, or the bankfull flow. The channel shall be stable for either situation. The calculations need not be made for both conditions if the first situation checked is satisfactory.

The "n" value for the newly constructed channel shall be used. The "n" values of newly constructed channels in fine-grained soils and sands shall not exceed 0.025.

Bankfull flow is defined as the flow in the channel which creates a water surface that is at or near normal ground elevation for a significant length of a channel reach. Excessive channel depth created by cut through high ground, such as might result from realignment of the channel, should not be considered in determinations of bankfull flow.

The allowable velocity in the newly constructed channel may be increased by a maximum of 20 percent to reflect the effects of vegetation to be established under the following conditions:

1. The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion controlling vegetation.
2. The species and method of establishment of erosion controlling vegetation adaptable to the area are known and have been proven satisfactory.
3. The channel design includes detailed plans for establishment of vegetation on the channel side slopes.

Appurtenant Structures: The channel design shall include all structures required for proper functioning of the channel and its laterals, as well as travel ways 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. If needed, protective structures or treatment shall be used at junctions between channels to insure stability at these critical locations.

The effect of channel work on existing culverts, bridges, buried cables, pipelines, 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.

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.

Specifications

Measures and construction methods that protect fish and wildlife values shall be incorporated as needed and practical. Special attention will be given to protecting and maintaining key shade, food, and den trees and to stabilization of disturbed areas.

Removal of any trees and brush required will be done in such a manner as to avoid damage to other trees and property.

Channels shall be excavated to the line and grades shown on the drawings. The excavated surfaces shall be reasonably smooth. Excavation shall be done in a manner which will not restrict flow in existing channels.

Material excavated from the channel shall be disposed of in the locations and in the manner shown on the drawings. In reaches involving realignment of existing channels, the upstream ends of segments of the old channel that are cut off by the new alignment shall be filled to ground level unless otherwise specified.

Spoil will be placed in a manner to maintain the stability of the streambanks and with consideration of the existing and future land use of the adjacent area.

All combustible refuse shall be burned or buried or disposed in such a way as to have the least detrimental effect on the environment. When buried, all roots, brush, stumps, stones, and similar material shall be placed a minimum of 18-inches

below the elevation of the finished grade. All work shall be done in such a manner that erosion and air and water pollution will be minimized and held within legal limits. This shall be done by:

1. Placing spoil in a location to prevent its sloughing or washing into the channel or water course.
2. Keeping chemicals, fuel, lubricants, sewage and waste materials out of channel and drainage ways.
3. Limiting the use of excavating equipment to areas outside the channel and drainage ways except to those few times when no other alternative is possible.
4. Establish vegetation on all disturbed areas as soon as possible after exposure or disturbance, especially channel banks.
5. Fell trees away from stream and keep slash out of water courses.