Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

OPEN CHANNEL

CODE 582

(ft)

DEFINITION

An open channel is a natural or artificial in which water flows with a free surface.

PURPOSE

This practice is used to accomplish the following purpose–

- Construct, improve, or restore an open channel to convey water required for flood prevention, drainage, wildlife habitat protection or enhancement, or other authorized water management purpose

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to all earth channel construction or modification. Design criteria for channel stability and maintenance of floodwater diversions, or surface drain, main or lateral, having a drainage area in excess of one square mile will be in accord with this standard for open channels. It does not apply to Indiana (IN) Field Office Technical Guide (FOTG) Standards (362) Diversion, (412) Grassed Waterway, or (607) Surface Drain, Field Ditch.

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 excavating or other channel work does not cause significant erosion, flooding, or sedimentation.

CRITERIA

General Criteria Applicable to All Purposes

Use of this standard requires compliance with all applicable federal, state, and local laws and regulations.

Native plant species will be used whenever possible. Known invasive species will not be used.

Use NRCS Engineering Technical Releases (TR), 210-25, Design of Open Channels; NRCS National Engineering Handbook (NEH), Part 653, Stream Corridor Restoration: Principles, Processes, and Practices; and NRCS NEH, Part 654, Stream Restoration Design, as applicable in surveys, planning, site investigations, and design of channel work.

In selecting the location and design of channels, careful consideration will 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.

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

Do not modify the horizontal or vertical alignment of a channel to the extent of endangering the stability of the channel or its laterals.

Capacity
The capacity for open channels will 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 will be determined according to guidelines for hydraulic design in NRCS TR-210-25 and/or NRCS NEH, Part 654. The Manning's "n" value for aged channels will 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 or protection, and economic feasibility.

Channels or channel systems in an urban area level of protection will be designed so that the water surface elevation attained during the passing of the runoff from a 100-year frequency, 24-hour duration storm will be such that all floors of living units or commercially used buildings will be free from water. Streets will remain useable during runoff from a 10-year return frequency of 24-hour duration storm.

Cross section
The required channel cross section and grade will 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 to 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.

Side slopes will be 2:1 or flatter, stable, and be designed based on site conditions. Side slopes steeper than 2:1 may be used only if justified by unusual site conditions.

Channel stability
Characteristics of a stable channel are:

- The channel neither aggrades nor degrades beyond tolerable limits.
- The channel banks do not erode to the extent that the channel cross section is changed appreciably.
- Excessive sediment bars do not develop.
- 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) will 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 will be used if necessary to ensure stability.

The method applicable to site conditions in NRCS TR-210-25 and/or NRCS NEH, Part 654will be used to determine the stability of proposed channel improvements.

Bankfull flow is the flow in a channel that creates a water surface at or near the normal ground elevation, or the tops of dikes or continuous spoil banks that confine the flow for a significant length of a channel reach.

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 will be determined for discharges under these conditions as follows:

- As-built conditon-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:
  - The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation.
  - Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known.
  - The channel design includes detailed plans for establishing vegetation on the channel site slopes.
- 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 feet/second or less.

For newly constructed channels in fine-grained soils and sands, the Manning's "n" values will be determined according to procedures in Chapter 6 of NRCS TR-210-25, and will not exceed 0.025. The "n" value for channels to be modified by clearing and snagging only will be determined by reaches according to the expected channel condition upon completion of the work.

Appurtenant structures
The channel design will 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 will be included in the channel design. The design also will 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 will 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 will be evaluated to determine the need for modification or replacement.

Culverts
Culverts and bridges that are modified or added as part of channel projects will meet reasonable standards for the type of structure and will 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 will be disposed of in a manner that will:

- Not confine or direct flows so as to cause instability when the discharge is greater than the bankfull flow.
- 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.

- Not hinder the development of travel ways for maintenance.
- Leave the right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses.
- Direct water accumulating on or behind spoil areas to protected outlets.
- Maintain or improve the visual quality of the site to the extent feasible.

Vegetation of channel
Establish vegetation on all channel slopes, berms, spoil, and other disturbed areas according to IN FOTG Standard (342) Critical Area Planting.

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.

Additional Criteria for Conversion to Two-Stage Ditch
Where an existing agricultural drainage ditch will be converted to a two-stage ditch (wider ditch with benches), additional criteria apply.

Two-stage ditches will not be constructed along ditches with established trees unless approved by Indiana NRCS. These are areas where more than six trees of 3-inch DBH (diameter at breast height) must be removed within a 100-foot length of ditch.

The low flow channel and vegetation below the bench elevation will not be disturbed unless determined needed by the NRCS engineer to outlet an upstream component.

Total bench width of the two-stage ditch will be between 2 and 4 times the existing low channel flow (bank) width. Total bench width is preferred to be evenly split between the two sides, but can be distributed unevenly, or on one side only. One-sided construction will only be used if needed to avoid protected or inhibitory areas (such as but not limited to trees, wetlands and/or cultural resources).

Figure 1. Typical Two-sided Two-stage Ditch

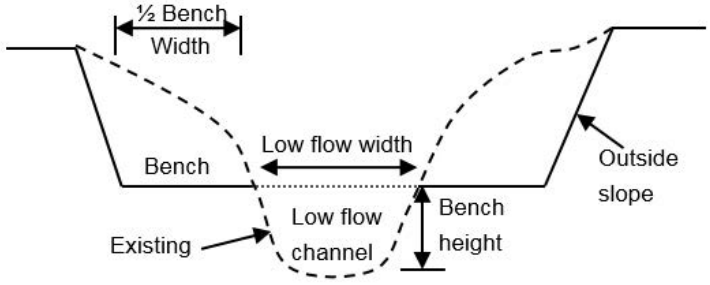

Figure 1. Typical Two-sided Two-stage Ditch

Bench height will be determined by regional curve method or other accepted runoff method to size the low flow channel to carry between 0.5 and 1-year, 24 hour storms or by approximating elevation of natural bench formations.

Outside bank slopes will be 2:1 or flatter. Erosion control blanket will be used where conditions are not suitable for rapid vegetative establishment.

If possible, existing drainage tile outlets will be repaired and outlet onto the newly created bench. Riprap or other erosion protection method will be installed at outlets to protect bench. Where a tile must outlet into the low channel, appropriate cover must be maintained according to IN FOTG Standard (606) Subsurface Drainage and IN FOTG Standard (620) Underground Outlet.

Existing structures or other appurtenances will be reconstructed as necessary to fit the new ditch configuration.

All bench and bank areas will be seeded and mulched according to IN FOTG Standards (342) Critical Area Planting and (484) Mulching. All disturbed areas outside of top of bank will be seeded to the appropriate NRCS standard, planted to crop within 15 days or temporary seeded if to be planted to a crop at a later time.

CONSIDERATIONS

General Considerations

The considerations section contains information that is optional to the planner.

Special attention will be given to maintaining and improving visual resources and habitat for fish and wildlife where applicable.

Effects on water quantity and quality will be considered. Concentrating the flow in an open channel may reduce the opportunity of infiltration, increasing runoff. The amount of increase will depend on the extent that surface flows were spread before collection in the channel and the permeability of the soils in the floodplain. Open channels may result in a negligible to major decrease in the ground water recharge quantity.

Open channels will have minor long term impact on surface water quality. This standard specifically requires that water quality impacts be evaluated, and measures taken to overcome any impacts determined. There may be increased erosion and sediment yield from the channel and surrounding areas during and immediately after construction. These should be minimal after the first period of use and establishment of vegetation. Component practices constructed as part of an open channel will significantly reduce soil erosion and improve water quality. There may also be a minor increase in the transport of soluble pesticides from the site due to chemicals used for vegetation control in or along the open channel. The amount of any pesticide leaving the site in surface flow will depend on the type and amount of pesticide used, soil characteristics, and precipitation patterns at the time of pesticide use.

An increase in temperature may occur due to increased water surface areas subject to solar radiation, especially if associated with decreased vegetative canopy.

There may be minor changes in ground water quality, which result from the infiltration of small amounts of soluble pesticides used to control vegetation in and along open channels.

Consideration will be given to the use of construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, buffers, etc.

Consider rerouting tile drainage outlets entering a two-stage ditch to outlet on top of the bench and onto a riprap pad.

Where phosphorus is of particular concern in a two-stage ditch, refer to the Agricultural Waste Management Field Handbook, Table 6-6 for plant uptake values of alternative plantings. Where practical, remove biomass and sedimentation annually.

Consider limiting construction to late summer to allow establishment of appropriate vegetation.

Maintenance access

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

A travel way will be provided along the channel and on each side of large channels if necessary for use of maintenance equipment. Travel ways must be adequate for movement and operation of equipment required for maintenance of the channel. The travel way 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 travel way. The travel way, including access points, must blend into the topography, the landscape, and adjacent land uses.

PLANS AND SPECIFICATIONS

Plans and specifications will be prepared for the practice site. Plans will include at a minimum:

- Plan view
- Profile
- Cross section (typical or other)
- Location of spoil
- Seeding rates, dates and establishment procedure
- Safety Features, as applicable

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. The minimum requirements to be addressed in the operation and maintenance plan are:

- Do not graze protected area during vegetative establishment and when soil conditions are wet.
- Fertilize to maintain a vigorous vegetative cover. Caution should be used with fertilization to maintain water quality.
- Mulch, spray or chop out undesirable vegetation periodically to prevent growth of large woody stemmed weeds, water plants such as cattails or trees (such as willows) which impede flow.
- Promptly repair eroded areas.
- Remove silt and sediment accumulations in the channel cross-section as soon as practical to prevent buildup and growth of undesirable vegetation.
- Reestablish vegetative cover immediately where scour erosion has removed established seeding.
- Keep inlets to side drainage structures open.
- Keep subsurface drain outlet pipes open and protected. Maintain animal guards in proper operation.
- Periodically inspect area for signs of undermining or instability and, if any are observed, take immediate action to protect from further damage.

REFERENCES

USDA Natural Resources Conservation Service. Engineering Technical Releases, TR-210-25, Design of Open Channels. Washington, DC.

USDA Natural Resources Conservation Service. National Engineering Handbook (NEH), Part 653, Stream Corridor Restoration: Principles, Processes, and Practices. Washington, DC.

USDA Natural Resources Conservation Service. NEH, Part 654, Stream Restoration Design. Washington, DC.