Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

OPEN CHANNEL

Code 582

(No.)

DEFINITION

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

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 the construction of open channels or modifications of existing streams or ditches with drainage areas exceeding one (1) mi^2 (1.6 km^2). This standard does not apply to Natural Resources Conservation Service (NRCS) Conservation Practice Standards (CPSs) Codes 362, Diversions; 412, Grassed Waterways; 388, Irrigation Field Ditches; 607, Surface Drain, Field Ditch; or 320, Irrigation Canal or Lateral.

CRITERIA

Use of this standard will comply with all applicable federal, state, and local laws and regulations.

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.

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. Determine the capacity for open channels according to procedures applicable to the purposes of the channel and according to related engineering standards and guidelines in approved references and handbooks. Designs must consider low flows, average flows, frequent storm flows, and high (infrequent) storm flows.

Determine the water surface profile or hydraulic grade line for design flow using guidelines for hydraulic design in NRCS TR-210-25 and/or NRCS NEH, Part 654. Select a Manning's n value for the condition representing an aged channel. Base the selection on the expected vegetation and other factors such as the level of maintenance prescribed in the operation and maintenance plan. Establish the required flow capacity 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. Design conditions cannot result in flood impacts to adjacent properties without addressing through the appropriate authorities.

Cross section. Determine the required channel cross section and grade by the plan objectives, the design capacity, the channel materials, the vegetative establishment program, and the requirements for operation and maintenance. As necessary, provide a minimum depth to allow adequate outlets for subsurface drains, tributary ditches, or streams. In urban areas, consider the design impacts on high-value developments.

Channel stability. A stable channel has the following characteristics:

- The channel neither aggrades nor degrades beyond tolerable limits
- The channel banks do not erode to the extent that an appreciable change in channel cross-section results
- Excessive sediment bars do not develop
- Gullies do not form or enlarge because of the entry of uncontrolled surface flow to the channel

Design all channel construction and modification (including clearing and snagging) to result in a stable channel with reasonable maintenance costs. Use vegetation, riprap, revetments, linings, structures, or other measures if necessary to ensure stability.

Use the methods in NRCS TR-210-25 and/or NRCS NEH, Part 654 to determine the stability of proposed channel improvements.

Bank-full flow is the discharge that fills a channel to an elevation where flow begins to spill onto the active floodplain.

Channels must be stable under conditions existing immediately after construction (as-built condition) and under conditions existing during effective design life (aged condition).

Determine channel stability for discharges under the following conditions:

- As-built condition.—Bank-full flow, design discharge, or 10-year frequency flow, whichever is smallest, but not less than 50 percent of design discharge.
  - The designer may increase the allowable as-built velocity (regardless of type of stability analysis) in the newly constructed channel by a maximum of 20 percent if—
    - The soils at the 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 side slopes.
- Aged condition.—Bank-full 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, determine the Manning's n values according to procedures in Chapter 6 of NRCS TR-210-25. Use caution selecting values greater than 0.025. In channels modified by clearing and snagging, determine the Manning's n value according to the expected channel condition following completion of the work. Guidance is also available in NRCS NEH, Part 654.

Appurtenant structures. Include all structures required for proper functioning of the channel and its laterals, as well as travel ways for operation and maintenance. Minimize the erosion or degradation from inlets and structures needed for entry of surface and subsurface flow into channels. Provide necessary

floodgates, water-level-control devices, bays used in connection with pumping plants and any other appurtenances essential to the functioning of the channels. If needed, use protective structures or treatment at junctions between channels, to ensure stability at these critical locations.

Evaluate the effect of channel work on existing culverts, bridges, buried cables, pipelines, irrigation flumes, inlet structures, surface drainage systems, and subsurface drainage systems.

Assure that culverts and bridges modified or added as part of a channel project meet reasonable standards for the type of structure and have a minimum capacity equal to the design discharge or state agency design requirements, whichever is greater. Increase the capacity of culverts and bridges above the design discharge as necessary to assure the channel and associated floodway meet design capacity.

In natural channels, evaluate the effect of the grade control structure on channel and bank stability. Determine backwater effects and the effects of modification of sediment transport through the reach.

Disposal of spoil. Dispose of spoil material from clearing, grubbing, and channel excavation in a manner that will—

- Not modify flows or cause channel instability when the discharge is greater than the bank-full flow.
- Provide for the free flow of water between the channel and floodplain unless the presences of continuous dikes establish the basis for the valley routing and water surface profile.
- Not hinder the development of travel ways for maintenance.
- Leave the right-of-way in the best condition for 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 CPS Codes 342, Critical Area Planting; or 580, Streambank and Shoreline Protection.

Cultural resources. Consider existence of cultural resources in the project area and any project impacts on such resources. Consider conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.

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.

The total bench width of the two-stage ditch will be between 2 and 4 times the existing low channel flow (bank) width. Split the bench width evenly on each side of the low flow channel unless it is necessary to distribute the bench width unevenly, or provide the entire width on one side only. One-sided construction will only be used if it is necessary to avoid protected or inhibitory areas (such as but not limited to trees, wetlands and/or cultural resources).

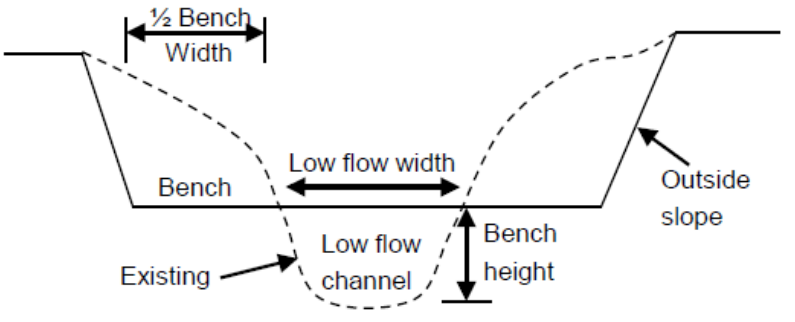

Figure 1. Typical Two-sided Two-stage Ditch

The bench height will be determined by using regional curves or other accepted methods to size the low flow channel to carry between 1 and 2-year, 24 hour storms or by approximating the 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 methods will be installed at outlets to protect the bench. Existing structures or other appurtenances will be reconstructed as necessary to fit the new ditch configuration. Underground outlets and other appurtenances shall meet the requirements of conservation practice standards Subsurface Drainage (606), Underground Outlet (620), or other practices as appropriate.

All bench and bank areas will be seeded according to conservation practice standard Critical Area Planting (342) and mulched or blanketed. All disturbed areas outside of top of bank will be seeded to the appropriate NRCS standard, planted to crop within 30 days or temporary seeded if the areas is to be planted to a crop at a later time.

CONSIDERATIONS

Visual resource design. Carefully consider the visual design of channels in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of channels, excavated material, and plantings are to relate visually to their surroundings and to their function.

Fish and wildlife. This practice may influence important fish and wildlife habitats such as streams, creeks, riparian areas, floodplains, and wetlands. Evaluate aquatic organism passage concerns (e.g., velocity, depth, slope, air entrainment, screening, etc.) to enhance positive impacts and minimize negative impacts.

Select project location and construction methods that minimize the impacts to existing fish and wildlife habitat.

Include measures necessary to mitigate unavoidable losses to fish or wildlife habitat in the design. Maintain the quality of the landscape by both the location of channel works and plantings, as appropriate.

Vegetation. Stockpile topsoil for placement on disturbed areas to facilitate revegetation.

Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

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

Water quantity and quality. Consider the effects of—

- Erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that runoff carries.
- Short-term and construction-related effects of this practice on the quality of downstream watercourses.
- Wetlands and water-related wildlife habitats.
- Increasing runoff. Concentrating the flow in an open channel may reduce the opportunity of infiltration.
- Ground water recharge.
- Infiltration of small amounts of soluble pesticides used to control vegetation in and along open channels, which may affect ground water quality.

Two-stage Ditch. 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.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to this standard.

As a minimum, include the following items:

- Plan View
- Profile
- Cross section (typical or other)
- Location of spoil
- Seeding rates, dates, and establishment procedure

OPERATION AND MAINTENANCE

Plan. Prepare an operation and maintenance plan for the operator for each channel system. Minimum requirements for operation, maintenance, and the 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. Travel ways 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 travel way shall be provided 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.

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.

A maintenance program will be established by the landowner/user to maintain capacity and vegetative cover. Item to consider 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.
- Reestabilsh 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.

PLANNING CONSIDERATIONS FOR QUANTITY AND QUALITY

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.

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.