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 square mile. This standard does not apply to WI Natural Resources Conservation Service (NRCS) Conservation Practice Standards (WI NRCS CPS), Diversion (Code 362); Grassed Waterways (Code 412); Irrigation Field Ditches (Code 388); Surface Drain, Field Ditch (Code 607); or Irrigation Canal or Lateral (Code 320).

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

Design and install measures according to a site-specific plan in accordance with all local, State, Tribal, and Federal laws and regulations. Apply measures that are compatible with improvements planned or being carried out by others.

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.

Soils investigation, sampling, and associated lab testing must be adequate to document a stable channel design.

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

The open channel shall not impede the passage of aquatic organisms.

Capacity. The capacity for open channels will be determined 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.

The water surface profile or hydraulic grade line for design flow will be determined using 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 and other factors such as the level of maintenance prescribed in the operation and maintenance plan. 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.

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 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.

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 a reasonable cost. Vegetation, riprap, revetments, linings, structures, or other measures, if necessary, to ensure stability.

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

Bank-full 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 the following conditions:

- As-built condition - Bank-full flow, design discharge, or the flow from a 10-year frequency, 24-hour duration rainfall, 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 by may be increased 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 greater, except that it is not necessary to check stability for discharge greater than the 100-year frequency, 24-hour duration rainfall.

Stability checks that are flow related are not required if the velocity is 2 feet per 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. In channels modified by clearing and snagging, determine the Manning's "n" value according to the expected channel condition following 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. 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 to determine the need for modification or replacement.

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. The capacity of some culverts and bridges may need to be increased above the design discharge.

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

- Not confine or direct flows so as to 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.
- Not adversely impact wetlands.

Vegetation of channel. Establish vegetation on all channel slopes, berms, spoil, and other disturbed areas according to WI NRCS CPS, Critical Area Planting (Code 342); or Streambank and Shoreline Protection (Code 580). Native plant species will be used whenever possible.

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.

Cultural resources. Evaluate the impact of cultural resources in the project area. Project designs shall include conservation and stabilization of archaeological, historic, structural, and traditional cultural properties.

Additional Criteria for Conversion to Two-Stage Ditch

An existing agricultural drainage ditch may be converted to a two-stage ditch (wider ditch with benches), using this additional criteria. The typical cross section of a two-stage ditch is shown in Figure 1.

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).

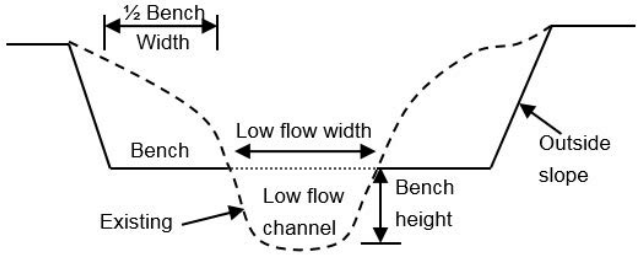

Figure 1. Typical Two-sided Two-stage Ditch

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 WI NRCS CPS Subsurface Drainage (Code 606) and Underground Outlet (Code 620).

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 WI NRCS CPS Critical Area Planting (Code 342) and Mulching (Code 484). 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

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 re-vegetation.

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

Water 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.
- Phosphorus discharge from the biomass accumulation above the low-flow channel.

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.

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:

- A plan view of the layout of the channel and appurtenant features.
- Typical profiles and cross sections of the channel and flood plain, as needed.
- Appurtenant features as needed.
- Structural drawings, as needed.
- Requirements for vegetative establishment and/or mulching, as needed.
- Safety features.
- Site-specific construction and material requirements.
- Spoil disposal requirements.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator.

As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, channel surfaces, safety components and significant appurtenances.
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reaches pre-determined elevations.
- Periodic removal of undesirable trees, brush, and invasive species.
- Maintenance of vegetative protection and immediate seeding or replanting of damaged areas, as needed.

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.