NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

STREAM CROSSING

(No.)

CODE 578

DEFINITION

A stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles.

PURPOSE

- Provide access to another land unit.
- Improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream.
- Reduce streambank and streambed erosion.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where an intermittent or perennial watercourse exists and a ford, bridge, or culvert type crossing is needed. This practice is limited to streams with a bankfull flow of less than 1,000 cfs.

CRITERIA

General Criteria Applicable to all Purposes

Apply this standard in accordance with all local, State, Tribal, and Federal regulations, including flood plain regulations and flowage easements.

Identify significant cultural resources or threatened or endangered species that could be affected by the implementation of the practice.

Bankfull flow is the discharge that fills a stream channel up to the elevation at which flow begins to spill onto the floodplain.

Location. Locate stream crossings in areas where the streambed is stable (not predicted to degrade within 10 years or the design life, whichever is greater) or where grade control can be provided to create a stable condition. Do not place crossings where channel grade or alignment changes abruptly, excessive seepage or instability is evident, overfalls exist (evidence of incision and bed instability), where large tributaries enter the stream, or within 300 feet of known spawning areas of listed species. Wetland areas shall be avoided if at all possible.

Discourage livestock loafing in the stream by locating crossings, where possible, out of shady riparian areas or by including gates in the design.

Install stream crossings perpendicular to the direction of stream flow where possible. Fully consider the natural lateral migration pattern of the stream in the design. Avoid skews on all but the smallest streams.

Access Roads. Where the stream crossing is installed as part of a roadway, size the crossing according to Oklahoma NRCS Conservation Practice Standard, Access Road (560).

Width. Provide an adequate travel-way width for the intended use, as measured from the upstream end to the downstream end of the stream crossing, not including the side slopes. Make a multi-use stream crossing no less than 10 feet wide. Make "livestock only" crossings no less than 6 feet wide and no more than 30 feet wide.

Side Slopes. Make all side slope cuts and fills for the stream crossing side slopes stable for the material involved. Make the side slopes of cuts or fills in soil materials no steeper than 2 horizontal to 1 vertical (2:1). Make rock cuts or fills no steeper than 1.5 horizontal to 1 vertical (1.5:1).

Stream Approaches. Blend approaches to the stream crossing with existing site conditions, where possible. Use streambank soil bioengineering practices as appropriate and feasible. Make the approaches stable, with gradual ascent and descent grades which are not steeper than 5 horizontal to 1 vertical (5:1), and of suitable material to withstand repeated and long term use. Make the minimum width of the approaches equal to the width of the crossing surface.

Divert surface runoff around the approaches to prevent erosion. Direct roadside ditches into a diversion or away from the crossing surface.

Configure the crossing approaches (gradient and curves) to properly accommodate the length and turning radii of vehicles using the crossing.

Rock. All rock must be able to withstand exposure to air, water, freezing, and thawing. Use rock of sufficient size and density to resist mobilization by design flood flows.

Use appropriate rock sizes to accommodate the intended traffic without damage to the livestock, people, or vehicles using the crossing.

Use rock for riprap that is durable and stable for the design conditions using NRCS design criteria for rock riprap.

Fencing. Areas adjacent to the stream crossing shall be permanently fenced or otherwise excluded as needed to manage livestock access to the crossing.

Install cross-stream fencing at fords, with breakaway wire, swinging floodgates, hanging electrified chain or other devices to allow the passage of floodwater debris during high flows.

Design and construct all fencing in accordance with Oklahoma NRCS Conservation Practice Standard, Fence (382).

Vegetation. Plant all areas to be vegetated as soon as practical after construction. If completion does not coincide with appropriate planting dates for permanent cover, use a cover of temporary vegetation to protect the site until permanent cover can be established. Native or functioning-as-native plant species are preferred. Use NRCS Conservation Practice Standard, Critical Area Planting, Code 342, where vegetation is unlikely to become established by natural regeneration, or where acceleration of the recovery of vegetation is desired.

In areas where the vegetation may not survive, use Oklahoma NRCS Conservation Practice Standard, Heavy Use Area Protection (561).

Where vegetation is used as part of the lining material for the crossing, as with erosion control or turf reinforced matting, limit use of the crossing until adequate vegetation has been established.

Specific Criteria for Bridge Crossings

Bridge designs must be approved by the Oklahoma State Conservation Engineer.

Design bridges in a manner that is consistent with sound engineering principles and adequate for the use, type of road, or class of vehicle. Design bridges with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics. Design bridges to fully span the stream, passing at least the bankfull flow where the design flow is not dictated by regulation.

Adequately protect bridges protected so that out-of-bank flows safely bypass without damaging the structure or eroding the streambanks.

Vehicle and pedestrian bridges must be designed in accordance with the current American Association of State Highway and Transportation Officials Load and Resistance Factor Design (LRFD) bridge design specifications (AASHTO, 2010).

Evaluate the need for safety measures such as guardrails and reflectors at bridge crossings.

Acceptable bridge materials include concrete, steel, and wood.

Specific Criteria for Culvert Crossings

Culvert designs must be approved by the Oklahoma State Conservation Engineer.

Design culverts in a manner that is consistent with sound engineering principles and adequate for the use, type of road, or class of vehicle. For culverts associated with a road, culvert design flow shall meet the criteria in the Oklahoma NRCS Conservation Practice Standard, Access Road (560). The design flow for culverts not associated with a road will be the 2-year, 24-hour storm discharge, or bankfull flow, whichever is less. Design culverts with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics. Additional guidance is provided in NRCS NEH 653, Stream Corridor Restoration: Principles, Processes, and Practices.

Design culverts to minimize habitat fragmentation and to minimize barriers to aquatic organism movement.

Do not use culverts where large flows of sediment or large woody material are expected, or where the channel gradient exceeds 6 percent (100 horizontal to 6 vertical).

Evaluate the need for safety measures such as guardrails at culvert crossings.

Crossings shall be adequately protected so that out-of-bank flows safely bypass without damaging the structure or eroding the streambanks or the crossing fill.

At least one culvert pipe shall be placed with its entire length set six inches below the existing stream bottom. Additional culverts may be used at various elevations to maintain terrace or floodplain hydraulics and water surface elevations.

Make the barrel length of the culvert adequate to extend the full width of the crossing, including side slopes, and inlet or outlet extensions.

Acceptable culvert materials include concrete, corrugated metal, corrugated plastic, new or used high quality steel, and any other materials approved by the Oklahoma State Conservation Engineer for the appropriate design conditions.

Specific Criteria for Ford Crossings

The following criteria apply to all ford crossings:

Design surfacing material for the intended use, and to withstand design flows and other conditions.

Design all stream crossings to prevent mobilization of the stream crossing lining during a peak flow from the design storm (minimum 10-year, 24-hour) and to limit degradation or other impacts to the existing stream channel. Extend protective linings at least up to the bankfull flow elevation.

Make the cross-sectional area of the crossing equal to or greater than the natural channel cross-sectional area. Make a portion of the crossing depressed at or below the average stream bottom elevation when needed to keep base flows or low flows concentrated.

Match ford shape to the channel cross-section to the extent possible.

Provide cutoff walls at the upstream and downstream edges of ford-type stream crossings when needed to protect against undercutting. The minimum depth of the cutoff wall is 2-feet, measured from natural ground, and the minimum width of the cutoff wall is 1 foot. The depth of cutoff walls shall be sufficient for the type of soil in the streambed.

Evaluate the need for water depth signage at ford crossings.

To the extent possible, the top surface of the ford crossing shall follow the contours of the stream bottom but in no case shall the top surface of the ford crossing be higher than 0.5 foot above the original stream bottom at the upstream edge of the ford crossing.

Make the downstream edge of the ford crossing with a low-flow hydraulic drop less than 0.5 foot above the original stream bottom.

Extend the ramps treated with surfacing material from the stream crossing surface elevation to the existing top of bank elevation. Ramp slopes shall be not be steeper than 3:1 for livestock crossings and 5:1 for vehicle crossings.

Use blanket material that consists of hoof contact material, surfacing material, geotextile, sand bedding, and/or sand and gravel mixture. When specified, install blanket material on the excavated surface of the ford including access slopes and toe trenches, and extend blanket material across the bottom of the stream and at least up to the 10-year, 24-hour peak discharge elevation or bankfull flow elevation, whichever is less. Install a maximum 3-inch layer of concrete sand that meets ASTM C-33 standards for a sand bedding. Sand and gravel mixture bedding shall be pit run with 50 to 85% by weight passing a No. 4 sieve. The maximum gravel size shall be 3 inches. No more than 5% by weight shall pass a No. 200 sieve.

Concrete Fords. Use concrete ford crossings only where the foundation of the stream crossing is determined to have adequate bearing strength.

Use concrete with a minimum compressive strength of 3,000 psi at 28 days, with a ratio of water to cementitious materials of 0.50 or less. Use coarse aggregate of 0.75 to 1 inch nominal size. If designed for freezing conditions, use concrete with 4 to 8 percent air-entrainment.

Use a minimum thickness of 5 inches of placed concrete. Pour the concrete slab on a minimum 4-inch thick gravel base, unless the foundation is otherwise acceptable.

Use a minimum thickness of 5 inches of placed concrete with a minimum reinforcement of 6-inch by 6-inch, 6 gauge welded wire fabric. Pour the concrete slab on a minimum 4-inch thick blanket material base, unless the foundation is otherwise acceptable. For vehicle crossings, the concrete shall be placed over a minimum 4-inch thick layer of compacted sand bedding underlain by firm, native mineral soil material.

When heavy equipment loads are anticipated, the concrete slab shall be designed using an appropriate procedure as described in American Concrete Institute, ACI 360, Design of Slabs on Grade.

Construct toe-walls at the upstream and downstream ends of the crossing. Make the toe-walls a minimum of 6 inches thick and 18 inches deep. Extend the toe-walls in the stream approaches to the bankfull flow elevation.

Precast concrete panels may be used in lieu of cast-in-place concrete slabs. To the extent possible, the panels shall follow the contours of the stream bottom in order to avoid potential problems with sediment accumulation. Use concrete units that have adequate reinforcement for transportation and placement.

Fiber Reinforced Concrete (FRC) may be specified in addition to or in lieu of 6-inch by 6-inch, 10 X 10 gauge (6 X 6 – W 1.4 X 1.4) welded wire fabric to control shrinkage cracks for slabs where vehicle, tractor, or other heavy point loads are not anticipated or if approved by an engineer.

Rock Fords and the Use of Geosynthetics. Coarse aggregate or crushed rock ford crossings are often used in steep areas subject to flash flooding and where normal flow is shallow or intermittent. When the site has a soft or unstable subgrade, use geotextiles in the design of rock ford crossings.

Use durable geosynthetic materials and install them according to the manufacturer's recommendations, including the use of staples, clips, and anchor pins.

Where used, install nonwoven geotextile material on the excavated surface including access slopes and toe trenches, and extend it across the bottom of the stream and up to the bankfull flow elevation. Cover the geotextile material with at least 6 inches of crushed rock.

Manufactured erosion control matting must be rated for the design conditions expected. Where needed, install an approved plastic (PE) three-dimensional cellular containment grid to hold rocks in place. Use minimum 6-inch deep geocells, if geocells are used.

Design all rock ford stream crossings to remain stable for the bankfull flow. Compute channel velocities and choose rock size using procedures in NEH630; NEH654 TS14N; and EFH Chapter 16 (NEH650), Appendix 16A, or other procedures approved by the State Conservation Engineer.

Where rock is used for ford crossings for livestock, use a hoof contact zone or alternative surfacing method over the rock.

CONSIDERATIONS

Avoid or minimize the use of or number of stream crossings, when possible, through evaluation of alternative trail or travel-way locations. Assess landuser operations to consolidate and minimize the number of crossings. Where feasible, use existing roads.

Ford crossings have the least detrimental impact on water quality when crossing is infrequent. Ford crossings are adapted for crossing wide, shallow watercourses with firm streambeds.

When using manufactured materials, consider widths that correspond to sizes of materials to limit waste.

Evaluate proposed crossing sites for variations in stage and discharge, tidal influence, hydraulics, fluvial geomorphic impacts, sediment transport and flow continuity, groundwater conditions, and movement of woody and organic material. Increase crossing width or span to accommodate transport of large woody material in the flow. Design passage features to account for the known range of variation.

For culvert crossings, consider incorporating natural streambed substrates throughout the culvert length for passage of aquatic organisms (see Bunt and Abt, 2001, for sampling procedures). Natural streambeds provide passage and habitat benefits to many life stage requirements for aquatic organisms and may reduce maintenance costs.

Consider all life stages of aquatic organisms in the stream crossing design to accommodate their passage, in accordance with the species' requirements. Design criteria are available in NEH Part 654, Technical Supplement 14N, Fish Passage and Screening Design; U.S Forest Service low-water design guidance (USFS, 2006); and stream simulation guidance (USFS,2008). Each State also has specific design criteria for culverts and stream crossings (e.g., MassDOT, 2010). See also Harrelson, et al. 1994, for stream reference site descriptions.

Where a stream crossing is installed to remove an existing barrier to the passage of aquatic organisms, consider using Oklahoma NRCS Conservation Practice Standard, Aquatic Organism Passage (396).

Consider relevant aquatic organisms in the design and location of crossings to improve or provide passage for as many different aquatic species and age classes as possible.

Consider the habitat requirements of other aquatic or terrestrial species that may be affected by construction of a stream crossing. For example, a crossing may be designed with features that also promote safe crossing by terrestrial vertebrates.

Ford crossings have the least detrimental impact on water quality when their use is infrequent. Ford crossings are adapted for crossing wide, shallow watercourses with firm streambeds. If the stream crossing is to be used frequently, or daily, as in a dairy operation, a culvert crossing or curbed bridge should be used, rather than a ford crossing.

Locate stream crossings to avoid adverse environmental impacts and consider the following:

- Effects on upstream and downstream flow conditions that could result in increases in erosion, deposition, or flooding. Consider habitat upstream and downstream of the crossing to avoid fragmentation of aquatic and riparian habitats.
- Short-term and construction-related effects on water quality.
- Overall effect on erosion and sedimentation that will be caused by the installation of the crossing and any necessary stream diversion.
- Effects of large woody material on the operation and overall design of the crossing.
- Consider adding a well-graded rock riprap apron on the downstream edge of concrete crossings to dissipate flow energy.
- Ford crossings should not be placed immediately downstream from a pipe or culvert because of potential damage from localized high velocity flows.

Where stream crossings are used, evaluate the need for safety measures such as guardrails at culvert or bridge crossings, or water depth signage at ford crossings.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for stream crossings in keeping with this standard. The plans and specifications must clearly describe the requirements for applying the practice to achieve its intended purpose.

As a minimum, include the following in plans and specifications:

- Location of stream crossing.

- Stream crossing width and length with profile and typical cross sections.
- Design grades or slopes of stream approaches.
- Design flow calculations.
- Thickness, gradation, quantities, and type of rock or stone.
- Type, dimensions, and anchoring requirements of geotextile.
- Thickness, compressive strength, reinforcement and other special requirements for concrete, if used.
- Vegetative requirements that include seed and plant materials to be used, establishment rates, and season of planting.
- Location, type, and extent of fencing required.
- Method of surface water diversion and dewatering during construction.
- Location of utilities and notification requirements.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan and implement it for the life of the practice.

Include the following items in the operation and maintenance plan, as a minimum:

- Inspect the stream crossing, appurtenances, and associated fence after each major storm event and make repairs if needed.
- Remove any accumulation of organic material, woody material, or excess sediment.
- Replace surfacing stone used for livestock crossing as needed.

REFERENCES

Design of Open Channels, Technical Release No. 25, October 1977. U.S. Department of Agriculture, Soil Conservation Service.

NRCS Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection, December 1996. U.S. Department of Agriculture, Natural Resources Conservation Service.

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