United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

STREAM CROSSING

CODE 578

(no)

DEFINITION

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

PURPOSE

This practice is applied to:

- Improve water quality by reducing sediment, nutrient, or organic loading to a stream
- Reduce streambank and streambed erosion

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where:

- An intermittent or perennial watercourse (stream) exists.
- Controlled access from one side of the stream to the other side is necessary to reduce or eliminate environmental degradation.
- Soils, geology, fluvial geomorphology, and topography are suitable for construction of a stream crossing.

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.

The landowner/contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Do not create a passage barrier where aquatic species are present and using the stream

NRCS reviews and periodically updates conservation practice standards. To obtain the current version of this standard, contact your Natural Resources Conservation Service State office or visit the Field Office Technical Guide online by going to the NRCS website at https://www.nrcs.usda.gov/ and type FOTG in the search field.

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Location
Locate stream crossings in areas where the streambed is stable or where it can be stabilized (see Alabama NRCS Conservation Practice Standard (CPS), Channel Bed Stabilization, Code 584); and Title 210, National Engineering Handbook (NEH) Part 650, Chapter 16, "Streambank and Shoreline Protection"). 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. Avoid wetland areas.

Avoid the use of or minimize the number of stream crossings through evaluation of alternative trail or travel-way locations, and land user operations. Where feasible, use existing roads. Discourage livestock loafing in the stream by locating crossings, where possible, out of shady riparian areas or by including gates in the design. Minimize shade by selectively removing trees and pruning limbs where appropriate.

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 an access road, design the crossing in accordance with the Alabama NRCS CPS Access Road (Code 560) and Title 210, National Engineering Manual (NEM), Part 536 "Structural Engineering." Where high rates of erosion of the adjacent roadways that slope towards the crossing threaten to deliver an excessive amount of sediment to the drainage, install measures to minimize erosion of the roadside ditch, road surface, and/or cut slopes.

Width
Provide an adequate travel-way width for the intended use. Make "livestock- only" crossings no less than 6 feet wide. Provide multi-use stream crossings with travel-ways no less than 10 feet wide and no more than 20 feet wide. Width is measured from the upstream end to the downstream end of the stream crossing, not including the side slopes.

Side Slopes
Make all side slope cuts and fills stable for the channel materials involved. Make the side slopes of cuts or fills in soil materials no steeper than 2.5 horizontal to 1 vertical (2.5:1). 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. 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. Use the Alabama NRCS CPSs Diversion (Code 362), Structure for Water Control (Code 587), Lined Waterway or Outlet (Code 468), or Grade Stabilization Structure (Code 410) as needed. 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 (Riprap and Aggregate)
Use only rock that is sound, durable, and able to withstand exposure to air, water, and

freezing and thawing. Use rock of sufficient size and density to resist mobilization by design flood flows. Use appropriate rock sizes that will accommodate the intended traffic without causing injury to livestock or people, or damage to vehicles using the crossing. For a rock crossing utilized by livestock, use a hoof contact zone of suitable crushed aggregate or an alternative surfacing method over the rock. In some cases, the hoof contact material may not be stable for the maximum stream velocities and should be considered a sacrificial material that may need to be replaced from time to time.

Riprap materials must meet the requirements of the current Alabama Department of Transportation (ALDOT) Standard Specifications for Highway Constructions, Section 814, Riprap Materials.

Crushed aggregate must meet ALDOT crushed stone gradation requirements for sizes 5, 56, 57, 6, 67, 68, and 610, and Types A or B crushed aggregate base, and other similar products approved by an engineer. Gradation requirements are shown in Table 1.

Geotextile
Install non-woven needle-punched geotextile fabric under all rock or aggregate treatment areas. Turn the outer edge upward and extend edges to the surface. The minimum requirements for geotextile fabric are as follows:

REQUIREMENTS FOR NON-WOVEN GEOTEXTILE

Property	Test Method	Minimum
Grab Tensile Strength	Grab Test ASTM D 4632	157 lb.
Puncture	ASTM D 6241	309 lb.

Fencing
Exclude livestock access to the crossing through the use of fence and gates, as needed. Install cross- stream fencing at fords, with breakaway wire, swinging floodgates, hanging electrified chain, or other devices to allow the passage of floodwater and large woody material during high flows. Design and construct all fencing in accordance with the Alabama CPS Fence (Code 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 Alabama 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 Alabama NRCS Conservation Practice Standard, Heavy Use Area Protection, Code 561.

Criteria Applicable to Bridge Crossings
Design bridges in a manner that is consistent with sound engineering principles and adequate for the use, type of road, or class of vehicle. Refer to 210-NEM, Part 536. Design bridges with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics and pass the design flow without causing erosion or overtopping of the structure. Design bridges to fully span the stream, passing at least the bank full flow where the design flow is not dictated by regulation. (Bank full flow is the discharge that

fills a stream channel up to the elevation at which flow begins to spill onto the floodplain.)

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

For all bridge crossings, perform a geologic subsurface investigation that is in sufficient detail and analysis to support the design. Describe the soil material observed, subgrade conditions, bearing capacity, and depth to bedrock; and any geologic conditions or hazards that needs to be addressed in the design, construction, or operation of the bridge Refer to 210- NEM, Part 531, “Geology.”

Follow requirements in 210-NEM, Part 536 on acceptable bridge materials and necessary safety measures.

Vehicle and livestock 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), or according to Design Guide AL#1, BRIDGES FOR LIVESTOCK AND AGRICULTURAL EQUIPMENT.

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

Acceptable bridge materials include concrete, steel, and wood.

Criteria Applicable to Culvert Crossings

Design culverts in a manner that is consistent with sound engineering principles and adequate for the use, type of road, or class of vehicle. Design culvert flow associated with road culverts to meet the criteria in Alabama NRCS Conservation Practice Standard, Access Road, Code 560. The design flow for culverts not associated with a road will be the 2-year, 24- hour storm discharge, or bank full flow, whichever is greater. Design culverts with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics.

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.

Aadequately protect crossings so that out-of-bank flows safely bypass without damaging the structure or eroding the streambanks or the crossing fill.

Place at least one culvert pipe with its entire length set 6 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.

Compacted fill will be used to form the culvert crossing. Place compacted fill over the culvert at a minimum depth equal to one-half the diameter of the culvert, or 24 inches, whichever is greater.

Build up compacted fill over the culvert so that any stream overflow will cross the road at a point away from the culvert. Protect compacted fill and pipe outlet from erosion if needed with riprap. Provide a total thickness of at least 18 inches of riprap.

A concrete headwall or grouted riprap may be required in cases of severe erosive forces.

Top driving surfaces over culverts with non-woven geotextile and a minimum 6 inches of ALDOT No. 1 coarse aggregate or other suitable materials.

Acceptable culvert materials include concrete, corrugated metal, corrugated plastic, new or used high quality steel, and any other materials that meet the requirements of Alabama NRCS Conservation Practice Standard, Structure for Water Control, Code 587.

Criteria Applicable to Ford Crossings

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. Ford crossings will only be used in streams with a bank height of 5 feet or less. Bank heights above 5 feet must be approved by the State Conservation Engineer. Do not place ford crossings immediately downstream from a pipe or culvert because of potential damage from localized high-velocity flows.

Use a culvert crossing or curbed bridge if the stream crossing is to have frequent or daily use, such as in a dairy operation.

Ensure that the cross-sectional area of the crossing is equal to or greater than the natural channel cross- sectional area. To the extent possible, design the top surface of the ford crossing to follow contours of the streambed. Slope the crossing toward the center of stream to provide a thalweg (low-flow) channel.

Recess the subgrade of the stream crossing so that the constructed surface of the crossing is at or below the original surface of the streambed.

Provide cutoff walls at the upstream and downstream edges of ford-type stream crossings to protect against undercutting. Evaluate the need for water depth signage.

Where riprap stone is used for ford-type stream crossings for livestock, use a hoof contact zone of small crushed aggregate over the rock. Cover the entire rock surface with crushed limestone, rock screenings, crusher run, or similar materials. Generally, 4 inches of hoof contact zone is necessary. This material does not have to meet any velocity criteria. This layer is expected to be replaced periodically by the landowner as livestock traffic or runoff events erode the surface material.

Concrete Fords

Concrete ford crossings will only be approved by the State Conservation Engineer.

Use concrete ford crossings only where the foundation of the stream crossing is determined to have adequate bearing strength. Perform a subsurface investigation that is in sufficient detail and analysis to support the design. Describe the soil material observed, subgrade conditions, bearing capacity, and depth to bedrock. Refer to 210- NEM, Part 531, Subpart B, “Engineering Geology.”

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. Refer to 210- NEM, Part 536 for design criteria.

Dewatering of the site and toe walls is required during placement of the concrete to lessen the potential for segregation and to maintain the proper water/cement ratio. Flowing water will erode concrete that is not sufficiently hardened. The stream must be diverted or retained from flowing over the concrete until the concrete makes its final set, and a minimum of 12 hours after placement of the concrete.

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

Rock Fords and the Use of Geosynthetics

Rock (riprap) 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. Geotextile is not required if the foundation is on rock.

Dewater and excavate the bed of the channel to the necessary depth and width. Install the geotextile material on the excavated surface of the ford and extend it across the bottom of the stream and at least up to the bank full flow elevation.

Cover the geotextile material with at least 8 in. of crushed rock. Use minimum 6-inch deep geocells, if geocells are used. Do not use geocell material if velocities are expected to exceed 5 fps. Use durable geosynthetic materials and install them according to the manufacturer's recommendations, including the use of staples, clips, and anchor pins.

Design all rock ford stream crossings to remain stable for the bank full flow. Compute channel velocities and choose rock size using procedures and guidelines set forth in the appropriate section in 210-NEH,

Part 630, "Hydrology;" 210-NEH, Part 654, Technical Supplement (TS) 14N "Fish Passage and Screening Design;" and 210-NEH 650, Chapter 16, Appendix 16A, "Size Determination for Rock Riprap," or using the Alabama Worksheet for Geotextile and Stone Stream Crossing.

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

The stream crossing must be designed to remain stable during either the bank full event or the peak runoff from a 10-year, 24-hour event, whichever is less. Choose a stone size based on channel velocities computed or measured, from Table 578- 1. When larger stone than D_{50} of

4 in. is used for convenience, the minimum thickness will be: 1.5 x D_{50}.

TABLE 578-1. MAXIMUM VELOCITY AND D_{50} SIZES	
MAXIMUM VELOCITY (FPS)	**D_{50}* (INCHES)**
2.7	**0.5**
3.2	**1.0**
4.3	**2.0**
5.3	**3.0**
6.3	**4.0**
***DIAMETER OF STONE SUCH THAT 50% (BY WEIGHT) OF THE STONES ARE SMALLER.**	

CONSIDERATIONS

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

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 including a well-graded rock riprap apron on the downstream edge of concrete crossings to dissipate flow energy.

Consider all life stages of aquatic organisms in the stream crossing design to accommodate their passage, in accordance with the species' requirements. NRCS aquatic organism passage standards can be found in CPS Aquatic Organism Passage (Code 396). Design criteria are available in 210-NEH, Part 654, TS 14N; Clarkin, Keller, et.al, (2006); and Forest Service stream simulation guidance (USFS, 2008). Also, see Harrelson, et al. (1994), for stream reference site descriptions. 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.

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

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.

For concrete fords, consider using precast concrete panels in lieu of cast-in-place concrete slabs. To the extent possible, the panels must follow the contours of the streambed to avoid potential problems with sediment accumulation. As with the poured-in-place concrete, install a gravel base and toe walls.

- Locate stream crossings to avoid adverse environmental impacts and consider the following:
- Using the “riffle” section of the stream for the proposed crossing, for it is frequently one of the most stable sections of a stream. When riffles are not present, consider using a stable straight reach.
- 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.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for stream crossings in accordance with this standard. Clearly describe the requirements for applying the practice to achieve its intended purpose in the plans and specifications must 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.
- 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.
- Applicable structural details of all components, including reinforcing steel, type of materials, thickness, anchorage requirements, lift thickness, covering.
- Load limits for bridges and culverts.
- 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 or a statement making the contractor responsible for selecting such.
- Location of utilities and notification requirements.
- Additional site-specific considerations.

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.

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