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

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

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 desired for livestock, people, and /or equipment. This practice is limited to streams with a top of bank capacity of less than 1000 cfs.

CRITERIA

General Criteria Applicable to all Purposes

Stability. When undercutting is possible, cutoff walls shall be provided at the stream crossing perimeter. 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.

Location. Stream crossings shall be located 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. Avoid sites where channel grade or alignment changes abruptly, excessive seepage or instability is evident, overfalls exist, or large tributaries enter the stream. Wetland areas shall be avoided if at all possible.

Crossings shall be constructed in such a manner that accelerated erosion will not occur. Where necessary, diversions with a stable outlet will be provided. Stream crossings shall be installed perpendicular to the direction of stream flow where possible.

Where possible, locate crossings out of shady riparian areas to discourage cattle loafing time in the stream.

Stream crossings shall provide a way for normal passage of water, fish and other aquatic animals within the channel during all seasons of the year. Evaluate potential impacts on Threatened and Endangered Species by referring to guidance contained in Section II of the FOTG.

Access Roads. 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. Where the stream crossing is installed as part of a roadway, the crossing shall be in accordance with Oklahoma Conservation Practice Standard 560, Access Road.

Width. The stream crossing shall provide an adequate travel-way width for the intended use. A multi-use stream crossing shall have a travel-way no less than 10 feet wide. "Livestock only" crossings shall be no less than 6 feet wide. Width shall be measured

from the upstream end to the downstream end of the stream crossing and shall not include the side slopes.

Side Slopes. All cuts and fills for the stream crossing shall have side slopes that are stable for the soil involved. Side slopes of earth cuts or fills shall be no steeper than 2 horizontal to 1 vertical. Rock cuts or fills shall be no steeper than 1.5 horizontal to 1 vertical. The side slopes shall make a gradual transition from the existing channel side slopes to the ramp slope.

Stream Approaches. Approaches to the stream crossing shall blend with existing site conditions where possible, and shall not be steeper than 5 horizontal to 1 vertical. Unless the foundation geology is otherwise acceptable, the approaches shall be stable, have a gradual ascent or descent grade to blend to the existing channel slope, and be underlain with suitable material, as necessary, to withstand repeated and long term use. The minimum width of the approaches shall be equal to the width of the crossing surface.

Surface runoff shall be diverted around the approaches to prevent erosion of the approaches. Roadside ditches shall be directed into a diversion or away from the crossing surface.

Ramp Slopes. The ramp for the crossing shall extend 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.

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

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

All fencing shall be designed and constructed in accordance with Oklahoma Conservation Practice Standard 382, Fence.

Vegetation. All areas to be vegetated shall be planted as soon as practical after construction according to Oklahoma Conservation Practice Standard 342, Critical Area Planting. Where maintaining vegetative cover is necessary but not possible, Oklahoma Conservation Practice Standard 561, Heavy Use Area Protection shall be used to provide adequate surface protection.

Specific Criteria for Lining Materials

Surfacing material shall be designed for the intended use, and to withstand design flows and other conditions.

Stability. All stream crossings shall be designed 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. Protective linings shall extend to the water surface elevation predicted for the design storm (minimum 10-year, 24-hour).

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

Blanket Material. Blanket material shall consist of hoof contact material, surfacing material, geotextile, sand bedding, and/or sand and gravel mixture.

When specified, blanket material shall be installed on the excavated surface of the ford including access slopes and toe trenches and shall extend across the bottom of the stream and at least up to the 10-year, 24-hour peak discharge elevation.

Sand bedding shall consist of a maximum 3-inch layer of concrete sand meeting ASTM C-33 standards.

Sand and gravel mixture 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.

Rock. All rock shall be chosen to withstand exposure to air, water, freezing and thawing. When rock is used, it shall be sufficiently large

and dense or contained so that it is not mobilized by design flood flows.

Rock used for riprap shall be durable and stable for the design conditions using NRCS design criteria for rock riprap.

Individual rock fragments shall be dense, sound and free from cracks, seams, and other defects conducive to accelerated weathering. Only angular to subrounded rock shall be used. The least dimension of an individual rock fragment shall be not less than one-third the greatest dimension of the fragment.

Concrete. Concrete shall have a minimum compressive strength of 3,000 psi at 28 days.

Precast concrete panels may be used in lieu of cast-in-place concrete slabs. Precast concrete units shall comply with ACI 525 or 533, or as otherwise acceptable for local conditions.

Fiber Reinforced Concrete. 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.

Fibrillated polypropylene fibers of ¾ inch to 1½ inch in length shall be used at a minimum rate of 1.5 pounds per cubic yard of concrete.

Concrete mix design shall produce 3000-psi concrete in 28 days. Use only approved 7-day concrete cure.

Geosynthetic. All geosynthetic material shall be suitably durable and shall be installed in accordance with the manufacturer's recommendations, including the use of staples, clips and anchor pins.

Where used, nonwoven geotextile material shall be installed on the excavated surface including access slopes and toe trenches and shall extend across the bottom of the stream and at least up to the 10-year, 24-hour peak discharge elevation.

Manufactured erosion control matting must be rated for the design conditions expected.

Specific Criteria for Culvert and Bridge Crossings

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

Design of culverts and bridges shall be consistent with sound engineering principles and shall be adequate for the use, type of road, or class of vehicle. Culverts and bridges shall have sufficient capacity to convey the design flow without appreciably altering the stream flow characteristics. Crossings shall be protected so that out-of-bank flows safely bypass the crossing without structure or streambank damage, or erosion of the crossing fill.

Culverts. Culverts shall be sized to handle at least the bankfull flow or the peak runoff from the 2-year, 24-hour storm event, whichever is less. Additional guidance is provided in NRCS NEH 653, Stream Corridor Restoration: Principles, Processes, and Practices.

At least one culvert pipe shall be placed on or below grade with the existing stream bottom. Additional culverts may be used at various elevations to maintain terrace or floodplain hydraulics.

The length of the culvert shall be adequate to extend the full width of the crossing, including side slopes, and using pipe length guidance provided in Oklahoma Conservation Practice Standard 378, Pond.

Acceptable culvert materials include corrugated metal, new or high quality used steel and other materials approved by the engineer for the appropriate design conditions.

Bridges. Acceptable bridge materials include concrete, steel, and wood.

Specific Criteria for Ford Crossings

A ford crossing does not restrict the cross-sectional area of the designed channel to less than the natural channel cross-sectional area.

A portion of the ford crossing shall be depressed at or below the average stream bottom elevation when needed to keep base flows or low flows concentrated.

The finished top surface of the ford type stream crossing in the bottom of the watercourse shall be no higher than the original stream bottom at the upstream edge of the ford crossing. If the downstream edge of

the ford crossing is above the original stream bottom, the ford crossing shall be stabilized in accordance with Conservation Practice Standard 584, Stream Channel Stabilization.

If the design rock size in a ford-type crossing is inappropriate for the design livestock unit, a hoof contact zone shall be designed and installed or an alternative surfacing method used to minimize the maintenance requirements of a hoof contact zone.

Concrete Fords. Concrete ford crossings shall be used only where the foundation of the stream crossing is determined to have adequate bearing strength.

Concrete ford crossings shall have a minimum thickness of placed concrete of 5 inches with minimum reinforcement of 6-inch by 6-inch, 6 gauge welded wire fabric. The concrete slab shall be poured 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.

Geocell and/or Rock Ford Crossings. Rock ford crossings with geotextile shall be used when the site has a soft or unstable subgrade.

Ford crossings made of stabilizing material such as rock riprap are often used in steep areas subject to flash flooding, where normal flow is shallow or intermittent.

The geotextile material shall be covered with at least 6 inches of crushed rock.

At minimum, all stream crossings shall be designed to remain stable during the 10-year, 24-hour peak discharge.

Geocell. Where needed, an approved plastic (PE) three-dimensional cellular containment grid shall be installed to hold rocks in place. The cells shall be at least 6 inches deep.

CONSIDERATIONS

Avoid or minimize stream crossings, when possible, through evaluation of alternative trail or travel way locations.

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.

Stream crossings should be located where adverse environmental impacts will be minimized and considering the following:

- Effects on upstream and downstream flow conditions that could result in increases in erosion, deposition, or flooding.
- Short term and construction-related effects on water quality.
- Effects on fish passage and wildlife habitats.
- Effects on cultural resources.
- Overall effect on erosion and sedimentation that will be caused by the installation of the crossing and any necessary stream diversion.

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

Plans and specifications for stream crossings shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

An operation and maintenance plan shall be developed and implemented for the life of the practice.

The stream crossing, appurtenances, and associated fence should be inspected after each major storm event, with repairs made 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.

NRCS National Engineering Handbook Part 653; Stream Corridor Restoration: Principles, Processes, and Practices; http://www.usda.gov/stream_restoration

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE SPECIFICATIONS

STREAM CROSSING

(No.)

CODE 578

GENERAL SPECIFICATIONS

FOUNDATION PREPARATION

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod, and other objectionable materials.

The complete work shall conform to the lines, grades, and elevations shown on the drawings. The cross-section shall be excavated to the neat lines and grades shown on the plans. No abrupt deviations from design grade or horizontal alignment shall be permitted.

Construction shall be done in such a manner that erosion and air and water pollution are minimized and held within reasonable and legal limits. The completed job shall be workmanlike and present a good appearance.

The topsoil and sod shall be stockpiled during construction and reinstalled upon project completion. All disturbed areas shall be vegetated or otherwise provided with a cover to protect the areas against soil erosion.

Stream Crossings shall be located to minimize excavation. Excavation will be required to allow for the placement of rock or other materials to the grades shown on the plans.

MATERIALS

All materials shall conform to appropriate ASTM specifications.

Hoof Contact Material. Gradation of surfacing riprap for livestock hoof interface is as shown in the following table. If such riprap is smaller than needed for design conditions, the surfacing material will need regular replacement and maintenance, or other design solutions should be sought.

Size of Rock for Livestock Hoof Interface (inches)	% Smaller by Weight
3	100
2-1/2	90-100
2	35-70
1-1/2	0-15
¾	0-5

Rock. Rock may be placed by equipment or by hand. Placement must ensure that rocks are reasonably homogeneous with larger rocks uniformly distributed and in firm contact with one another and smaller rocks filling in the voids.

Geotextile. The geotextile shall be a Class I nonwoven geotextile fabric with a minimum weight of 8 ounces per square yard. The fabric shall also meet the following requirements:

Property	Test Method	Requirement
Tensile Strength	ASTM D4632	180 lb. - min.
Elongation at Failure	ASTM D4632	$\geq$ 50%
Puncture	ASTM D4833	80 lb. - min.
Ultraviolet Light (% residual tensile strength)	ASTM D4355	70 % - min.
Apparent Opening Size (AOS)	ASTM D4751	#40 sieve - max.
Permittivity	ASTM D4491	0.70/sec - min.

Installation shall be in accordance with the manufacturer's recommendations. Geotextile shall be placed with the length perpendicular to the direction of flow. All laps shall be a minimum of 18 inches and installed with the

upper perpendicular length overlapping the lower adjoining segment. Geotextile shall be pinned as recommended by the manufacturer.

Prior to placement of the geotextile, the soil surface shall be prepared reasonably smooth and free of loose rocks, holes, projections, mud or standing water. The geotextile shall not be placed until it can be properly anchored and covered within 48 hours.

In no case shall material be dropped onto an uncovered geotextile from a height greater than 3 feet.

Metal Components. Metal conduits shall be either new or used high quality welded steel, corrugated steel (CMP), on, or other materials approved by the engineer for the appropriate design conditions.

Corrugated steel pipe and corrugated aluminum pipe shall be new material. When CMP pipe is used for culverts, all welded seams shall be wire brushed and painted with two coats of zinc dust-zinc oxide primer or equivalent material.

Unless otherwise specified, CMP culverts shall be helically corrugated and all connectors shall be flanged couplers, Hugger type or equivalent couplers, or annular corrugated band couplers. When the Hugger type or annular corrugated band couplers are to be used, the pipe ends shall be reformed with annular corrugations. Hugger-type couplers shall be installed with o-ring gasket seals, and 18-inch and larger diameter pipe shall have one encircling rod on each side of the joint. Annular corrugated band couplers shall be 12-inch wide bands installed with o-ring or neoprene gasket seal and two encircling rods on each side of the joints. O-ring gaskets for Hugger type couplers shall be 13/16-inch diameter for less than 42-inch diameter pipe and 7/8-inch diameter for 42-inch and larger pipe. O-ring gaskets for annular corrugated couplers shall be 3/8-inch diameter and shall be fabricated from a high-grade rubber compound. They shall be homogeneous, free of blisters, pitting or other imperfections. Neoprene gaskets for annular corrugated couplers shall have a minimum width of 6 inches and a minimum thickness of 3/8 inch.

Aluminized or polymer coatings may be specified in certain circumstances for added protection of the steel structures. If specified, aluminized pipe shall be Aluminum-Coated Type 2 and meet ASTM A-819. Polymer coatings shall be a minimum of 0.01 inches thick (10 mil) and meet ASTM A-762.

Welded steel may be used material so long as it is sound pipe without damaging corrosion pits, does not exceed 36-inch diameter, and has wall thickness equal to or greater than the specified minimum in the standard.

Concrete. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. The mix design and testing of concrete shall be consistent with the size and requirements for the job. Concrete shall be placed to the lines and grades as shown on the plans or as staked in the field.

The type of cement, air entrainment, slump, aggregate, or other properties shall be specified as necessary. Unless otherwise specified, the concrete mix shall produce a strength of not less than 3,000-psi in 28 days.

The concrete shall be delivered to the site and discharged into the forms within 1-1/2 hours after the introduction of the cement to the aggregates, unless a mix design with set retarder is approved for use by the technician. If needed, reinforcing steel shall be placed as indicated on the plans and shall be held securely in place during concrete placement.

Subgrades and forms shall be installed to line and grade, and the forms shall be mortar tight and unyielding as the concrete is placed. The concrete shall be consolidated in the forms as it is placed to insure a tight bond to reinforcing steel and to yield a dense concrete. Concrete shall not be placed when the outside temperature is below 40 degrees or above 90 degrees Fahrenheit.

Concrete placed during cold weather shall be protected from freezing during the curing period. The concrete shall be cured by covering it with burlap, canvas, or other suitable material and kept from drying out for at least 7 days. The concrete may be cured by coating the surface with an approved white-pigmented curing compound.

Slabs shall have a broomed or other non-slip finish.

Fiber Reinforced Concrete. Additional water will not be added to the job mix. Only superplasticizers or low range water reducers

as recommended by the concrete plant shall be added.

Contraction joints shall be installed each 12 feet for 4-inch thick slabs or each 15 feet for 5-inch thick slabs.

Do not used tined (garden) rakes to move or place FRC as the tines disrupt the three-dimensional fibrous distribution.

Wait until all surface water has disappeared from the concrete surface before finishing. Use steel or magnesium trowels or floats. Wood floats may not be used. When hand troweling, trowel only in one direction so that the surface fibers are not raised up.

POLLUTION CONTROL AND PROJECT COMPLETION

Construction operations shall be carried out so that erosion and air and water pollution are minimal. All work shall be conducted in a skillful and workmanlike manner. The completed job shall present a workmanlike appearance.

Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Fencing and cover to control erosion and pollution shall be established as needed. Appropriate safety measures, such as warning signs, rescue facilities, and fencing, shall be provided as needed.