Stream Crossing (NO) 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.

CRITERIA

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

Investigate required federal, state, and local permits depending on the jurisdictional authority for the stream, county drain, or inter-county drain. Permits that may apply include, but are not limited to, the following:

1. Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, 1994, P.A. 451. Permits for development of livestock crossings if any of the following occurs:
   A. Dredging or other disruption of stream bottom material;
   B. Filling, including the placement of concrete, gravel, crushed stone, rock, or peastone;
   C. Sloping and shaping of the immediate streambank, and other land alteration within 500 feet of the stream;
   D. Construction of ponds within 500 feet of a lake or stream;
   E. Alteration of wetland areas;
   F. Disruption of flood flows; or
   G. Certain streams classified by state and federal governments as wild and scenic rivers may have additional restrictions.
2. Permit from the County Drain Commissioner, County Drain Board, or Inter-County Drainage Board if crossing is constructed along county drains.

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

Location. Locate stream crossings in areas where the streambed is stable or where it can be stabilized (see NRCS Conservation Practice Standard, Channel Bed Stabilization, Code 584). 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.

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.

Stream crossings shall provide a way for normal passage of water as well as fish and other aquatic organisms within the channel during all seasons of the year. Projects that may impact a threatened or endangered species require consultation with the U.S. Fish and Wildlife Service for Federally-listed species and the Michigan Department of Natural Resources for state-listed species. These agencies will further evaluate the threatened or endangered species impacts of the project and help determine if the project is feasible.

Access Roads. Where the stream crossing is installed as part of a roadway, size the crossing

according to NRCS Conservation Practice Standard, Access Road, Code 560.

Width. Provide an adequate travel-way width for the intended use. A stream crossing used for vehicular traffic shall have a travel-way no less than 16 feet wide and no more than 4 feet wider than the widest vehicle that will be using the crossing. A stream crossing used exclusively for livestock crossing shall be no less than 10 feet wide and no more than 16 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. 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 horizontal to 1 vertical (2H:1V). Make rock cuts or fills no steeper than 1.5 horizontal to 1 vertical (1.5H:1V).

Stream Approaches. Blend approaches to the stream crossing with existing site conditions, where possible. Use streambank stabilization practices as appropriate and feasible. Make the approaches stable, with gradual ascent and descent grades which are not steeper than 4 horizontal to 1 vertical (4H:1V), 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.

Fencing. Control livestock access to the crossing and adjacent areas 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 NRCS Conservation Practice Standard, Fence, Code 382.

Refer to NRCS conservation practice standards: Use Exclusion (472), Prescribed Grazing (528A), Filter Strip (393A), Riparian Herbaceous Cover (390), Riparian Forest Buffer (391), or other practice standards to determine the location of the fence and for the management of the land between streambank and fence.

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 NRCS Conservation Practice Standard, Heavy Use Area Protection, Code 561.

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. 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.

Bankfull 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 culvert or eroding the banks.

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.

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. For culverts associated with a road, culvert design flow shall meet the criteria in 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 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.

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 that meet the requirements of NRCS Conservation Practice Standard, Structure for Water Control, Code 587.

Ford Crossings

The following criteria apply to all ford crossings:

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.

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.

Ford crossings shall be placed over firm, native mineral soil material where the foundation of the stream crossing is determined to have adequate bearing strength. Ford-type stream crossings may not be placed on organic soils unless suitable base, designed in accordance with a foundation analysis, is provided to support the anticipated animal or vehicular traffic loads.

Ramp slope shall be 6H:1V or flatter for livestock only ford crossings. Ramp slope shall be 8H:1V or flatter for ford crossings intended for vehicles.

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. The concrete surface shall be roughened to provide a non-skid surface. Concrete shall comply with the guidance in the current Construction Specification, NRCS-MI-159, *Plain* Concrete.

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. Precast concrete units shall comply with ACI 525 or 533, or as otherwise acceptable for local conditions.

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.

Dewatering of the site and toe-walls is required during placement of the concrete 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 for at least 12 hours after placement of the concrete.

During construction, aquatic species must be removed from the construction area according to State protocols.

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.

Coarse aggregate or crushed rock ford crossings shall be underlaid by non-woven geotextile designated for Stream Crossing & Surface Water Livestock Access Watering Facility in accordance with Construction Specification, NRCS-MI-165, Geotextiles. Coarse aggregate shall be natural stone, crushed rock, or gravel. Where velocity based on flow depth at top of low bank is 3.5 feet per second or less, the coarse aggregate material shall have a minimum D_{100} size of 1.5 inch with less than 5 percent passing the number 200 sieve. Where the velocity based on flow depth at top of low bank exceeds 3.5 feet per second, the size of the coarse aggregate material shall be determined by a site-specific design or alternative stabilizing or surfacing measures such as geocells shall be employed. Where traffic may displace loose aggregate, alternative measures shall be implemented.

Address livestock comfort, as appropriate, when selecting coarse aggregate or alternative surfacing measures. The selected coarse aggregate or alternative surfacing measures shall accommodate access while discouraging the livestock from lingering in the stream crossing. Where rock is used for ford crossings for livestock, use a hoof contact zone or alternative surfacing method over the rock.

The bed of the channel shall be excavated to the necessary depth and width and covered with geotextile material. The geotextile material shall be installed on the excavated surface of the ford and shall extend across the bottom of the stream and at least up to the 10-year, 24-hour peak discharge elevation or to the top of the bank, whichever is lower.

The geotextile material shall be covered with at least 12 inches of coarse aggregate. If using geocells, the cells shall be at least 6 inches deep. 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.

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

CONSIDERATIONS

Consider the potential effects of installation and operation of stream crossings on the cultural, archeological, historic, and economic resources.

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.

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 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.

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.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

Support data documentation requirements are as follows:

- Inventory and evaluation records
  - Assistance notes or special report
- Survey notes, where applicable
  - Design survey
  - Construction layout survey
  - Construction check survey
- Design records
  - Physical data, functional requirements, and site constraints, where applicable
  - Soils/subsurface investigation report, where applicable
- Design and quantity calculations
- Construction drawings/specifications with:
  - Location map
  - "Designed by" and "Checked by" names or initials
  - Approval signature
  - Job class designation
  - Initials from preconstruction conference
  - As-built notes
- Construction inspection records
  - Assistance notes or separate inspection records
  - Construction approval signature
- Record of any variances approved, where applicable
- Record of approvals of in-field changes affecting function and/or job class, where applicable

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be developed for this practice. The O&M plan shall be consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for the design.

REFERENCES

AASHTO, 2010. American Association of State Highway and Transportation Officials Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Customary U.S. Units, 5th Edition, with 2010 edits; ISBN Number: 1-56051-451-0

Bunte, Kristin; Abt, Steven R. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel-and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. Gen. Tech. Rep. RMRS-GTR-74. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 428 p (http://www.fs.fed.us/rm/pubs/rmrs_gtr74.html)

Harrelson, Cheryl C; Rawlins, C. L.; Potyondy, John P, 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p. (http://www.stream.fs.fed.us/publications/PDFs/RM245E.PDF)

MassDOT, 2010. Design of Bridges and Culverts for Wildlife Passage at Freshwater Streams. Massachusetts Department of Transportation, Highway Division. (http://www.mhd.state.ma.us/downloads/projDev/Design_Bridges_Culverts_Wildlife_Passage_122710.pdf)