3.3.2.6 Temporary Stream Crossing

Source: TDEC

Definition and Purpose

A temporary stream crossing may consist of pipes or culverts placed within a flowing stream or watercourse and covered with clean stone or riprap to provide site access for construction vehicles. It can also be a temporary bridge made of wood, steel, or other materials. As the most common type of stream crossing, culverts are cost-effective, readily available, and capable of supporting heavy equipment. Bridges, while less common due to the time and cost to construct, as less intrusive to the stream. Properly designed stream crossings reduce damage to the stream bed, channel, or banks during use; however, they may contribute to erosion during installation and removal.

Appropriate Applications

Temporary stream crossings can be installed where construction traffic cannot be routed around a stream. Culvert crossings are an ideal measure for crossings with heavy machinery, where many crossings occur throughout the workday, and when the channel is too wide for normal bridge construction (VDEQ, 2024). Bridge crossings are ideal in sensitive waterways as bridge construction results in less disturbance to the streambed and banks, as well as the least impediments to aquatic organism passage and flow compared to culverts. Stream crossings may also be used as access for structures in need of repair or that are proposed for repair, such as bridges.

Limitations and Maintenance

Temporary crossing structures are generally used for projects lasting less than one year. Crossings are to be removed once no longer needed. Storms larger than the design event may yield significant damage to the crossing, such as washouts, blockages, overtopping, or loss of materials. For projects longer than two years, a larger design storm may be needed in order to prevent washout of the crossing. If a storm occurs that is beyond the design storm and washes the crossing out, it is the permittee's responsibility to clean up the material, rebuild the crossing, and consider a larger design storm capacity. Larger streams may not be suitable to have temporary culvert crossings due to the amount of drainage area and flow that is draining to that point.

Inspect the crossing after every rainfall and at least twice a week during required inspections. Repair any damage to the crossing as soon as possible. Unstable stream banks may need lining with conventional riprap or appropriate stabilization measures. If the crossing detains and traps sediment, the crossing may require total replacement. It may not be sufficient to clean and properly dispose of the sediment, as the crossing will likely continue to trap sediment.

Installing temporary culvert crossings in jurisdictional waters requires additional permits, such as an ARAP, and therefore, both the conditions of the CGP permit and ARAP must be followed. A Section 404 permit from USACE may also be required. If the proposed crossing is to be completed in a TVA reservoir, a TVA 26a permit may also be necessary. Local permitting may be required in addition to state and federal permitting requirements. Consider the criteria and conditions of the necessary permits during the planning stages of the project and EPSC plans. Temporary culvert(s) may not be permitted in streams with sensitive or endangered aquatic life. Culverts may create hydraulic jumps or fish barriers, thereby preventing passage (see example photograph) if they are not installed correctly. Temporary culverts should only be constructed when necessary, as they create the greatest obstructions to flood flow and aquatic habitat (GSWCC, 2016).

Source: GSWCC (2016)

Planning and Design Considerations

The culverts used for the temporary culvert crossing can vary in shape, size, and material (GSWCC, 2016; VDEQ, 2024). The design of the temporary culvert crossing requires hydrologic and hydraulic analysis to ensure it can safely convey expected flow rates and velocities. This is necessary to compute the ideal number, diameter, and length of pipe.

Include all design specifications in the EPSC plans. Within the ARAP General Permit, there are requirements to embed the culvert in the streambed. Placing the culvert inverts at the same elevation as the streambed is the least impactful option for a temporary crossing. This allows the substrate not to be disturbed and to remain at the same elevation before and after construction.

There are various planning and design considerations to be aware of before constructing temporary culvert crossings. The crossings need to be protected from washout during periods of high flows. This can be achieved by diverting high flows around or over the structures. To limit disturbances and preserve the local ecosystem to the maximum extent possible, implement the following (TDOT):

- Limit the clearing or riparian vegetation as much as possible;
- During installation, divert the flowing water around the structure;
- Design the crossing perpendicular to avoid impeding stream flow;
- Design the crossing to support the maximum anticipated loads and width of equipment such that maintenance burdens are not repeatedly observed;
- Place culverts on the streambed to minimize fish blockages and hydraulic jumps;
- Extend the culverts at least one foot beyond the upstream and downstream toe of placed aggregate; and
- Inspect channel conditions to see if additional or other stream stabilization measures may be necessary.

The culverts need to be sized to convey the peak flow from the designated design storm: either the 2-year, 24-hour, or 5-year, 24-hour, depending on the quality of the stream. Check local regulations if a larger design storm is required. The minimum pipe size suggested is 18 inches (TDOT). The diameter of *circular pipes* can be computed following the reformulated version of Manning's Equation (Eqn 15, Section 3.3.2.4). A single culvert may result in a pipe diameter too large for the channel dimensions. In such cases, Table 3.3.2.6-A provides the equivalency of pipe capacities. For example, a 36-inch pipe has the capacity of three 24-inch pipes. When multiple culverts are desired, they should be separated by one-half the diameter of the culvert or 12 inches, whichever distance is greater.

Table 3.3.2.6-A: Number of smaller diameter culverts (top row) required to achieve the same flow capacities as larger diameter culverts (first column). Source: Wisconsin Tubing.

Diameter (in)	18	24	30	36	42	48	54
18	1						
24	2	1					
30	3	2	1				
36	5	3	2	1			
42	7	4	3	2	1		
48	10	5	3	2	2	1	
54	13	7	4	3	2	2	1
60	16	8	5	4	3	2	2
66	20	10	6	4	3	2	2
72	25	12	8	5	4	3	2
84	35	18	11	7	5	4	3


Source: TDEC

Before placement of the pipe culvert(s) and aggregate, place a geotextile fabric on the stream-bed and banks to prevent subgrade sediment migration. Ensure the geotextile covers the streambed and extends a minimum of six inches and a maximum of one foot beyond the end of the culvert and bedding material. Cover the culvert(s) with clean small riprap, such as Class A-1, such that the depth of conventional riprap above the top of the culvert is one-half the diameter of the culvert or 18 inches, whichever is greater. Use a geotextile fabric to separate the Class A-1 riprap from No. 57 stone, which is to be used as the top six inches of the crossing. For sites that are crossing an ETW or waters with unavailable parameters for siltation, use a nine-inch layer of Class A-3 riprap instead of the six inches of 57 stone. Crown the top of the culvert crossing in the center of the crossing above the channel banks and grade down to each approach. Extend the conventional riprap past the top of the bank of each approach to prevent potential erosion. Ensure the top width of the crossing does not exceed 20 feet.

A provision to prevent construction road runoff from entering the stream is necessary. The preferred method for accomplishing this is to provide low approaches that will form "sag" points on either side of the stream channel (TDOT). Direct runoff into these "sag" points in erosion-resistant areas adjacent to the access road. These low approaches will also facilitate the safe passage of flood flows greater than the design flow rate. If possible, construct the "sag" points such that they are no lower than the crown of the temporary culvert. Where "sag" points cannot be constructed, low berms, six inches high with 5H:1V side slopes, may be placed on either side of the channel to divert flows.

The culverts, rock, and geotextile should be removed immediately after construction is finished, and the stream-bed and banks must be stabilized and restored to pre-construction conditions.

Bridges are to be constructed with appropriate stringer and decking materials, such as logs, sawn timber, concrete, or metal, that can safely support anticipated loads. If installing the bridge requires work within the channel, a temporary stream diversion must be implemented, such that construction can be completed in dry working conditions to prevent sedimentation and protect water quality. The bridge should be built at or above the bank elevation to avoid trapping floating debris, with abutments placed on stable, parallel banks. The structure needs to span the entire channel, and additional piers or supports may only be used when the stream exceeds eight feet in width; streams narrower than eight feet should not need to contain in-channel supports. This may require additional permits. Decking and any optional run planks or curbs should be securely fastened to ensure safe equipment passage and to minimize the risk of soil being dislodged into the stream.

Once installed, the bridge needs to be anchored at one end so that it can lift freely in high flows without obstructing the channel, using large trees, boulders, or driven steel anchors as secure tie-points. All disturbed areas should be stabilized, and temporary bridges located on public rights-of-way may need additional permissions. All bridges should be designed by a qualified engineer to ensure adequate structural capacity.

Example Application

-Example courtesy of TDOT-

Given:

A temporary culvert crossing is to be constructed across a stream in Wilson County, TN (Type II rainfall distribution), which has the following characteristics:

- Drainage Area = 120 acres (0.1875 square miles)
- Slope of stream at site = 2.0%
- Channel bottom width = 8 feet
- The channel side slopes are 3.5 feet high at a slope of 1.5H:1V
- Runoff Curve Number CN=75 Wilson County, TN
- Time of Concentration, T_c =1 hour
- Assume no pond and swamp areas, F_p =1.

Determine:

The temporary culvert crossing design for this site and compute the required quantities.

Solution:

Step 1- Determine the design flow rate: The design flow rate should be based on the 2-Year, 24-hour storm. The Rational method may be applicable to estimate the design flow rate based on professional judgement; however, the NRCS method is more appropriate. For a 2-year, 24-hour storm, the rainfall depth, P = 3.64 in. Compute the various variables required in Eqn 10 from Section 2.1.3.

a.) Runoff depth, Q_{CN}, Eqns 1-3 from Section 2.1.1:

$$S = 1000 / CN - 10 = 3.33$$

$$I_a = \lambda \times S;\ \text{assume } \lambda = 0.2$$

$$I_a = 0.2 \times 3.33 = 0.667 \text{ in}$$

$$Q_{CN} = \frac{(P - I_s)^2}{P - I_a + S} = \frac{(3.64 - 0.667)^2}{3.64 - 0.667 + 3.33} = 1.4 \text{ in.}$$

b.) Unit peak discharge, q_u:

$$I_a / P = 0.667 / 3.64 = 0.183$$

$$q_u = 340 \text{ csm/in (Exhibit 4-II or 5-II, NRCS, 1986)}$$

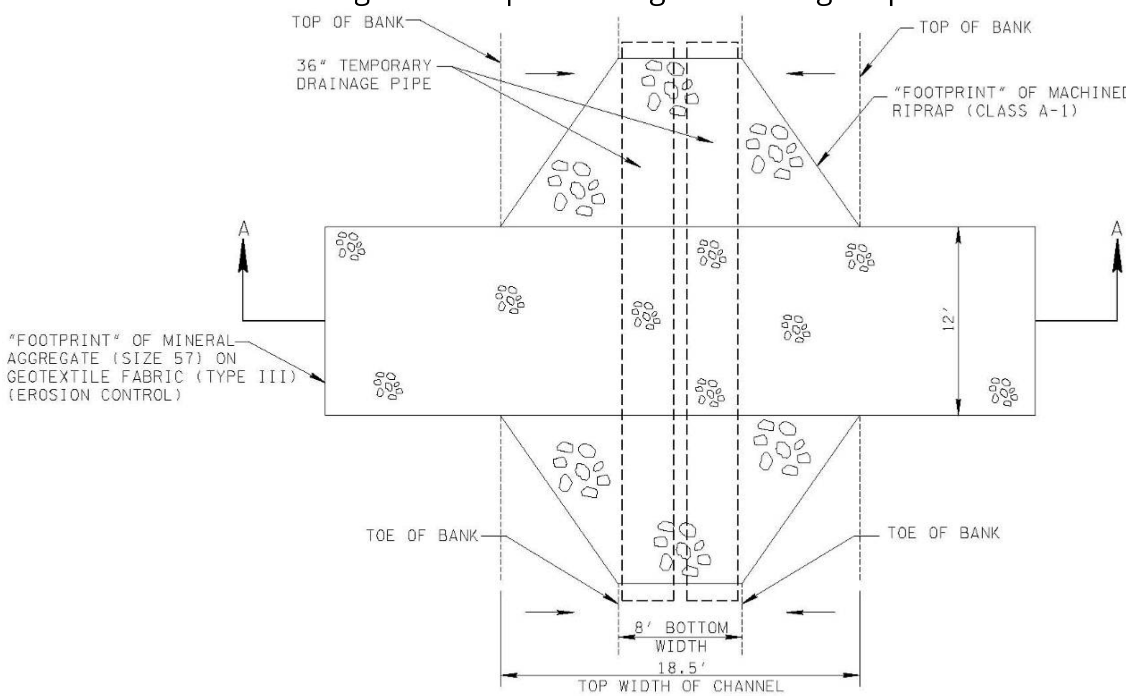
c.) Peak discharge, q_p:

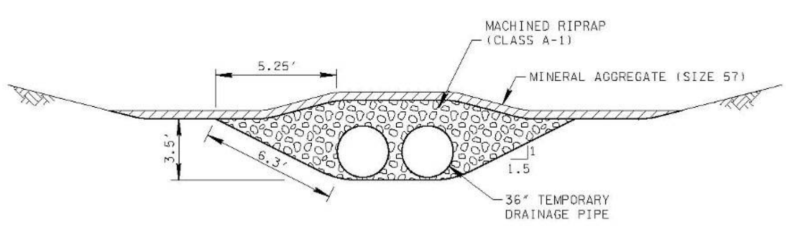
$$q_p = q_u \times A_m \times CN \times F_p = 340 \times 0.1875 \times 1.4 \times 1 = 89.3 \text{ ft}^3\text{/s}$$

Step 2- Select pipe size and number: Using Eqn 15 (Section 3.3.2.4), the diameter pipe (assuming corrugated metal; n = 0.022) required to convey 89.3 cubic feet per second can be calculated:

$$D = 16 \times \left(\frac{q_p \times n}{\sqrt{S}}\right)^{3/8} = 16 \times \left(\frac{89.3 \times 0.022}{\sqrt{0.02}}\right)^{3/8} = 42.9 \text{ inches}$$

Thus, the smallest diameter pipe that can convey 89.3 cubic feet per second of water is 48 inches. However, as indicated on the standard drawing, this pipe would require two feet of cover in addition to six inches of mineral aggregate (size 57). Thus, the total height of this structure would be 6.5 feet, which is judged to be too large to fit into the channel height. As an alternative, twin 36-inch pipes are considered to handle the same flow rate (Table 3.3.2.6-A). The spacing between the pipes should be 1.5 feet for a total width of 7.5 feet, which can be accommodated in the channel bottom. Further, these pipes require 1.5 feet of cover, which, combined with 6 inches of mineral aggregate (size 57), results in a total height of 5.0 feet. This height is judged to be a much better fit compared to the channel height, and twin 36-inch pipes are selected for the crossing. An example drawing of the design is presented.





SECTION A-A

References

GSWCC. (2016). *Manual for Erosion and Sediment Control in Georgia*.
TDOT. *Drainage Manual Ch10*.
VDEQ. (2024). *Virginia Stormwater Management Handbook.*
Wisconsin Tubing. *Flow Capacity of Multiple Culvert Installation*.