CHAPTER 10: TEMPORARY DRAINAGE DESIGN

10. TEMPORARY DRAINAGE DESIGN

10.1 PURPOSE

The primary purposes for designing temporary drainage are to:

- Minimize travel lane flooding
- Prevent damage to property adjacent to a project during construction
- Facilitate construction activities by temporarily rerouting or altering drainage conveyances

The information covered in this chapter offers practical considerations and solutions to physical conditions that affect drainage efficiency at roadway construction sites. This is intended for the drainage system engineer and designer and indirectly for other technical personnel. Proper use of this information includes ongoing communication and collaboration with engineers responsible for roadways, structures, and traffic control plans.

10.2 CRITERIA

Consult the *Drainage Manual* for hydraulic and hydrologic criteria that apply to the design of temporary drainage systems. Specifically, refer to Section 2.2 in the *Drainage Manual* for design frequencies at temporary roadside and median ditches, swales, and side drains. Refer to Section 3.3 in the *Drainage Manual* under “General Design” for design frequencies of temporary storm drain systems. Refer to Section 4.3.2 in the *Drainage Manual* for design frequencies at temporary culverts, bridge culverts, and bridges.

Some drainage situations are much more common in temporary conditions than in permanent conditions. For example, in temporary MOT scenarios, a temporary traffic lane ultimately will become a paved shoulder; thus, the shoulder area, proposed to carry spread in the permanent condition, now has traffic flowing with little room before being confined by a barrier wall. Thus, stormwater may pool along the temporary barrier wall or curbing near an inside high-speed lane.

Be aware that criteria can be different for permanent and temporary conditions on the same section of roadway, primarily because the two conditions can have differing design speeds. Consult Section 3.9 of the *Drainage Manual* to determine spread criteria.

10.3 METHOD

Carefully consider the temporary conditions that could arise during the construction or rehabilitation of a permanent transportation facility. Safety of travelers and workers, cost of construction, and the time required to complete construction tasks all are affected adversely when temporary drainage is not adequately addressed during design. You can reduce construction delays resulting from inclement weather conditions by creating a well-designed temporary drainage system. Further, unsafe traveling conditions and construction delays increase the cost of projects. Provide temporary drainage features where and when they are needed.

Design temporary drainage for construction sites with emphasis on the following:

(1) Drain detours efficiently, whether on existing streets or temporary lanes.

(2) Prevent drainage problems caused by construction staging. Examine detour designs in the light of construction staging to determine whether construction activities might divert or trap water and compromise safety and efficiency.

(3) Provide details for box culvert extensions that require a temporary rerouting of water away from work areas.

(4) Provide emergency relief that will convey storm events without substantial risk of flooding travel lanes.

10.4 DETOURS

The term “detour” is defined in FDM 240. Detours may be either located on existing streets or constructed with temporary paved or graded lanes. Design the drainage for detours on existing streets by using the existing street drainage system while preventing overtaxing of the system on those streets. When temporary lanes or roads must be constructed, provide design for temporary drainage systems.

10.4.1 On Existing Streets

Concentrate on construction site ingress and egress points when designing drainage for detours routed over existing streets or roads. Ensure that the construction site does not divert drainage onto the detour route in excess of the capacity of the existing street drainage systems. Conversely, ingress and egress locations cannot be allowed to divert excessive water onto the travel lanes or to accommodate surface drainage that causes erosion of the construction site.

10.4.2 Constructed Detours

Refer to Figures 10.5-1 and 10.5-2. When constructing detours, provide designs for temporary drainage systems that prevent stormwater from pooling or backing up on lanes where traffic will travel. Detour lanes, whether constructed in a median or off an outside edge of pavement, often are built on fill that can disrupt the flow of stormwater unless you design temporary measures to carry the water through or around the fill area.

Include directional flow arrows in the plans when a swale is used between fill for a temporary road and fill for a permanent road. See Figure 10.5-1.

Consider every temporary low area created when a detour road interrupts a proposed ditch gradient as a possible location for temporary drainage structures.

Temporary detours sometimes have vertical curvature or gradients that are independent of the main project. Be careful not to overlook these areas when locating temporary drainage structures. See the temporary pipe shown in Figure 10.5-1.

10.5 CONSTRUCTION OF THE PROPOSED FACILITY

Provide a design for temporary drainage of construction features, such as milled lanes, drop-offs between lanes, turnout construction, and construction operations for new side drains, cross drains, and box culverts. Examine areas where traffic control items, especially temporary barrier walls, might cause water to pond.

10.5.1 Milling and Drop-Offs

A drainage problem can occur where the natural sheet flow across the roadway surface is curbed by an adjacent lane; this problem will be most evident in sag vertical curves where curbed water is directed to the low point and then flows in concentrated form across an adjacent lane. The best way to avoid this is to schedule construction phasing so that an adjacent lane does not curb natural sheet flow across the roadway surface. It is difficult to avoid this curbing effect when adding lanes to the median side of a divided highway, or to the high side of a section in super-elevation.

Where you cannot avoid this curbing effect with construction phasing, provide temporary measures to prevent flooding of adjacent travel lanes. Sandbags or temporary asphalt curb can be effective in directing runoff away from travel lanes. Prevent overtopping flow at drop-offs by calling for sandbags or temporary asphalt curb to be placed along the drop-off to force water away from travel lanes. Refer to Figures 10.5-3, 10.5-4 and 10.5-5.

If the speed limit in a work zone is 45 mph or less, you can use intermittent transverse saw-cuts in travel lanes to allow water to flow through the travel area without overtopping.

10.5.2 Driveways

Constructing driveways can cause water to pond in the turnout area and subsequently flood adjacent lanes on the roadway. Include details in the plans for placing sandbags or temporary asphalt curb along outside edges of pavement adjacent to turnout construction to prevent water in the turnout site from flowing across the travel lanes. Provide details for temporary flumes and inlets, where needed, to direct water at turnout sites into the storm drain system, thus preventing water from collecting in low areas and/or causing erosion.

10.5.3 Temporary Drains and Curb Inlets

In accordance with Standard Plans, Index 425-001, provide a note in the plans requiring “temporary drains for subgrade and base” at inlets, or include a similar detail in the plans. Either detail will require construction of temporary drains for water that is trapped on base and subsequent paving layers around inlets during construction.

10.5.4 Box-Culvert Extensions

Furnish a temporary drainage design that will provide dry work areas for box culvert extensions during common storms and provide flood protection during severe storms. When standing or flowing water occupies box culverts that are to be extended, divert this water away from work areas for the duration of required work. Refer to Figures 10.5-6 through 10.5-10 for examples of details for inclusion in plans. Include details and notes in the plans that provide, at a minimum, the following information:

1. Provide sizes for diversion pipes that are to be inserted into existing box culverts.
2. Show the configuration requirements for sandbagging.
3. Include measures for stabilization and erosion control.
4. List any items that must be removed prior to final grading.
5. List descriptions and quantities for items not included in the cost of the structure.

10.5.5 Temporary Barrier Wall

The temporary barrier wall most commonly used on Department projects is the Type K Temporary Concrete Barrier System detailed in Standard Plans, Index 102-110. The concrete units are configured with two 27-inch drainage slots.

When needed, perform spread calculations for temporary precast concrete barrier wall, based on rainfall of four inches per hour.

10.5.5.1 Flow under Temporary Barrier Walls

For barrier walls placed on a longitudinal grade, an approach to calculating spread that is similar to the approach used for curb inlets is summarized as follows.

1. Determine the flow approaching the slot.
2. Assume normal depth of flow at the slot and use the modified Manning's Equation for shallow channel flow to determine the spread and associated depth of flow (y) at the edge of the barrier wall.

$$Q = \left(\frac{0.56}{n}\right) Sx^{5/3} SL^{1/2} T^{8/3}$$

where:
Q = Gutter flow rate, in ft^3/sec
n = Manning's roughness coefficient (see Table B-2, Appendix B)
Sx = Pavement cross slope, in ft/ft
SL = Longitudinal slope, in ft/ft
T = Spread, in ft

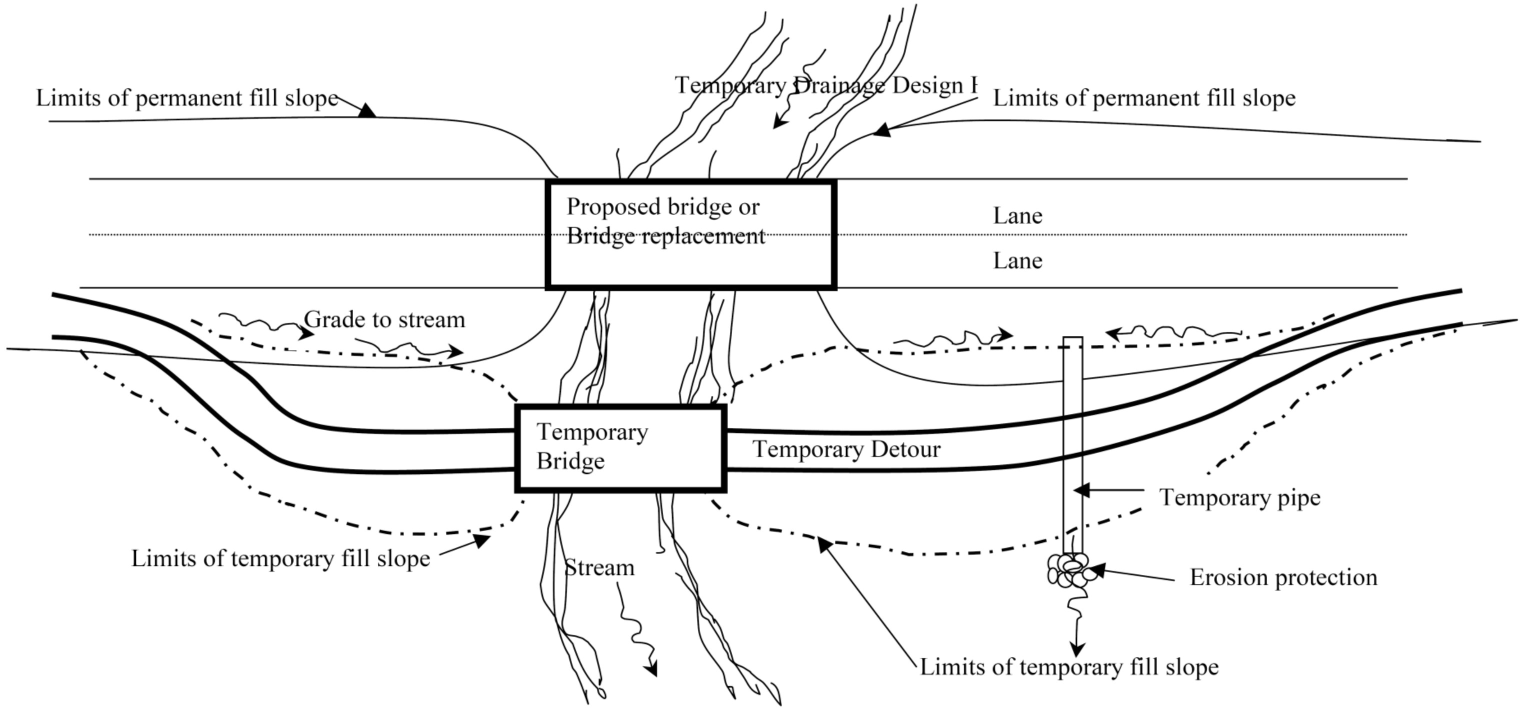
3. Using the depth of flow (y) at the edge of the barrier wall, determine the flow through the slot using the capture equations in HEC 22, and assuming that the two 27-inch slots operate independently. The Department suggests that the slot flow be reduced to 75 percent of the equation value to account for 25 percent blockage.
4. Subtract the flow through the slot from the flow approaching the slot to determine the flow bypassing the slot.
5. Add the bypass flow to the surface runoff for the next slot.
6. Repeat steps 1 through 5 for the length of the barrier wall or until equilibrium is achieved.

Table 10.5-1 provides the spread values for several pavement widths and slopes using the approach described above.

For sag vertical curves, you will likely need a more complicated approach. Several items change with changing (y) values. As the depth of ponding increases, the length of roadway draining directly (not including the bypass from approach grades) to the ponded area increases, as does the number of slots that operate in sump condition.

Table 10.5-1: Spread at Temporary Barrier Walls (27") Slots

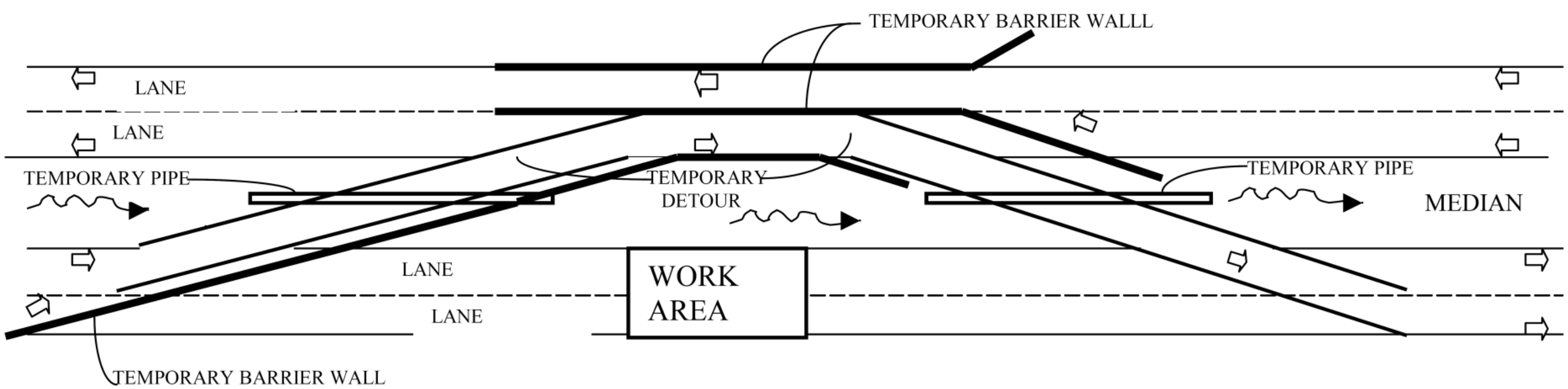
Pavement Width	Cross Slope	Longitudinal Slope = 0.3%	Longitudinal Slope = 1%	Longitudinal Slope = 3%
	ft/ft	Spread (ft)	Spread (ft)	Spread (ft)
12 feet	0.01	3.00	2.39	1.95
	0.02	1.94	1.55	1.26
	0.03	1.51	1.20	0.98
24 feet	0.01	3.74	2.98	2.43
	0.02	2.42	1.93	1.57
	0.03	1.88	1.5	1.22
36 feet	0.01	4.33	3.45	2.81
	0.02	2.8	2.24	1.82
	0.03	2.18	1.74	1.41



TEMPORARY DETOUR AND BRIDGE

1. Prevent water from being trapped in the area where the limits of temporary fill overlap the limits of permanent fill by providing a design for temporary ditches that drain positively to the stream, as shown on the left side of this detail, or provide a design for temporary drains under the detour, as shown on the right.
2. When the grade of a detour road is lower than ditch elevations, take care to avoid any sag in the ditch grade that could collect water until it pops over and spills onto the detour. Find and solve this problem during design. Do not force the contractor to handle it. The temporary pipe shown is a possible scenario.

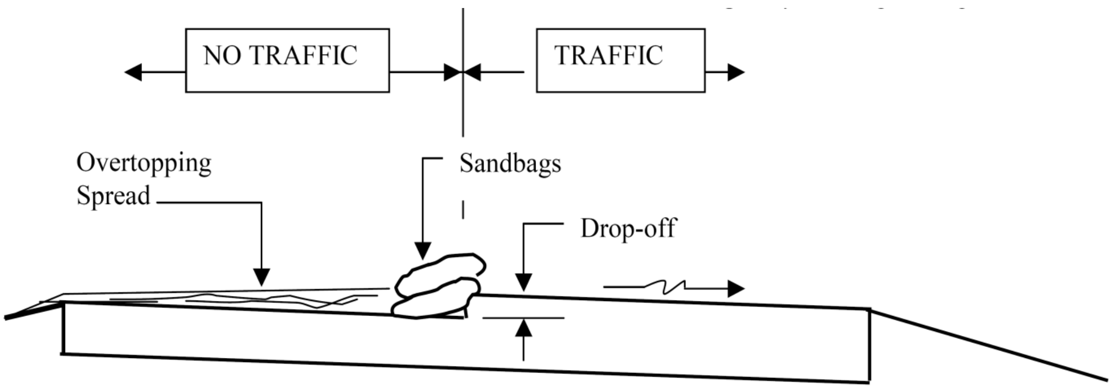
Figure 10.5-1: Temporary Detour and Bridge



TEMPORARY DETOUR IN MEDIAN

1. Conditions shown here may differ as to location, amount, configuration, direction of flow, etc., with regard to temporary barrier wall, temporary drainage structures, and work area.
2. Calculate spread using the method defined in Section 10.5.5. Prepare a design for temporary conditions that meets the requirements of this chapter and the *Drainage Manual*.
3. Require installation of temporary drainage structures where needed to maintain normal flow through the work area.
4. Where two or more runs of temporary barrier wall are parallel to each other, on or adjacent to a common width of pavement, a temporary slotted drain may be required to hold spread within acceptable limits.

Figure 10.5-2: Temporary Detour in Median



SECTION SHOWING SANDBAGGING TO PREVENT OVERTOPPING

1. Place one row of sandbags, two bags deep, adjacent to drop-offs where overtopping spread may occur and where the down-slope lanes must be used to maintain traffic.
2. When possible, avoid this situation by phasing milling and pavement lifts so that the exposed sides of drop-offs face down-slope.
3. Consider using this detail wherever new pavement lifts must be placed or existing pavement must be milled, and where the exposed edge of a drop-off faces upslope.

Figure 10.5-3: Section Showing Sandbagging to Prevent Overtopping

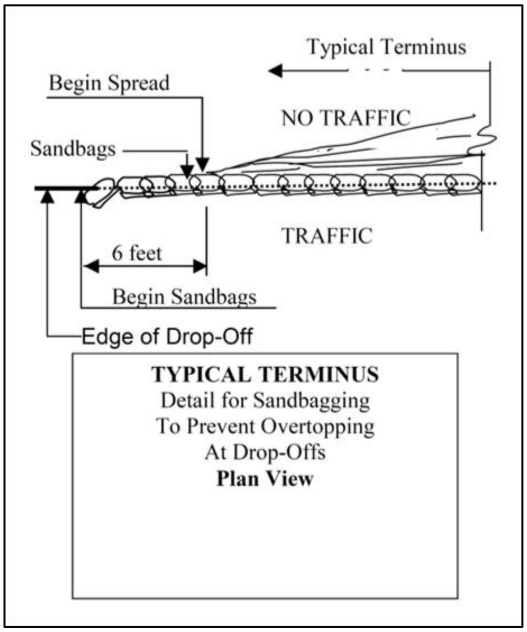


Figure 10.5-4: Typical Terminus

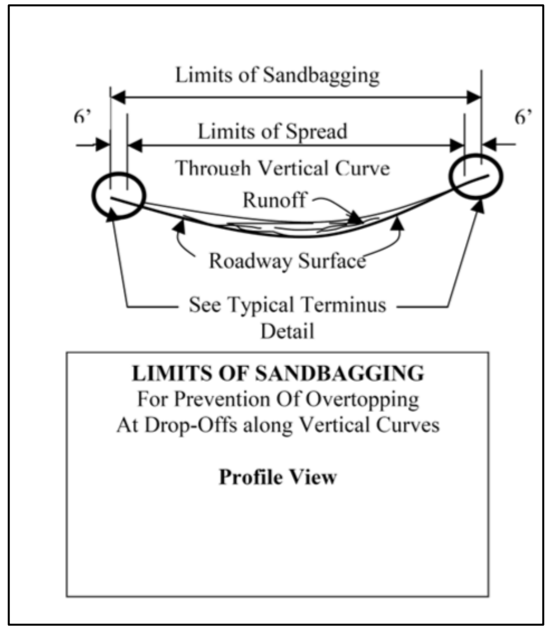


Figure 10.5-5: Limits of Sandbagging

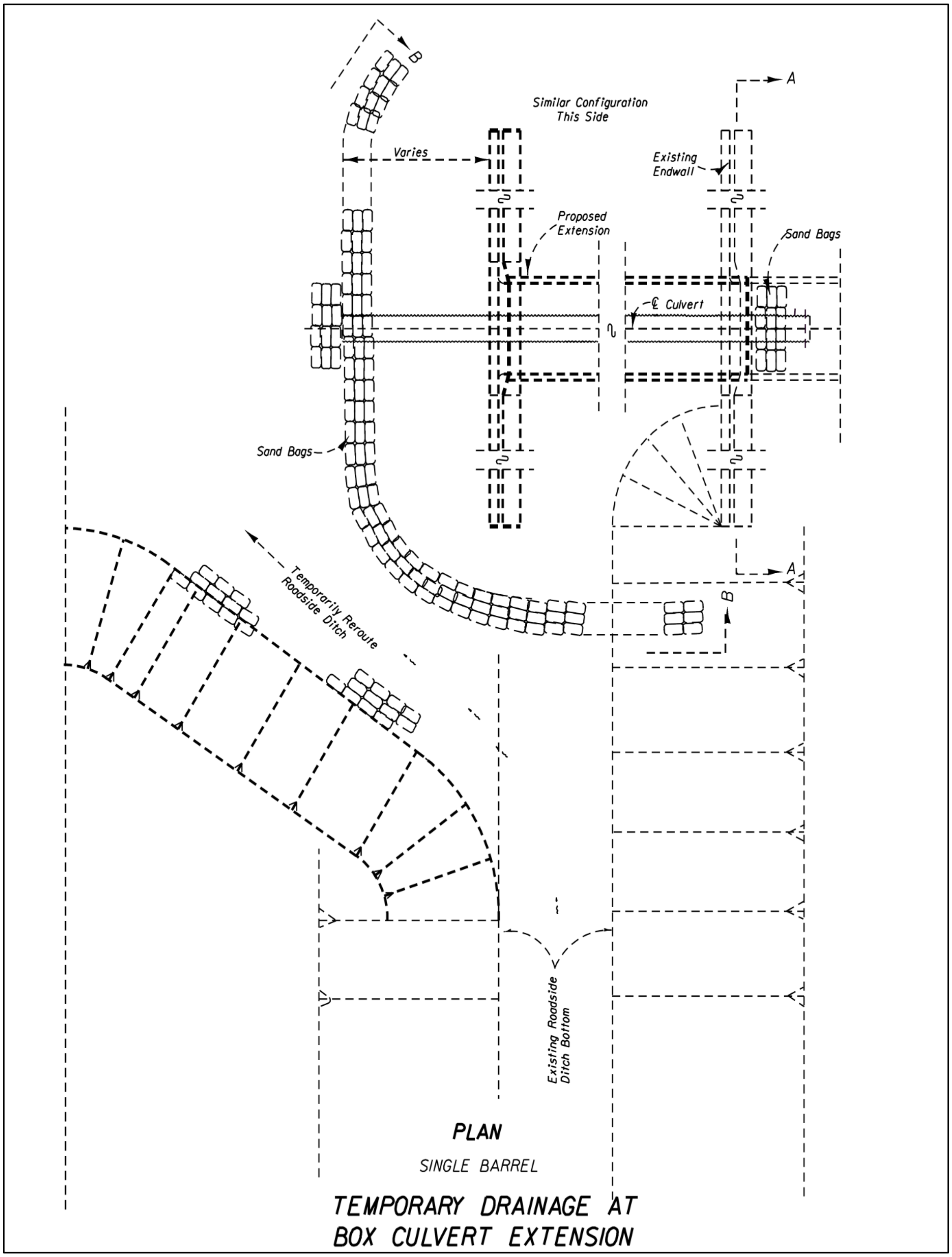


Figure 10.5-6: Temporary Drainage at Box Culvert Extension

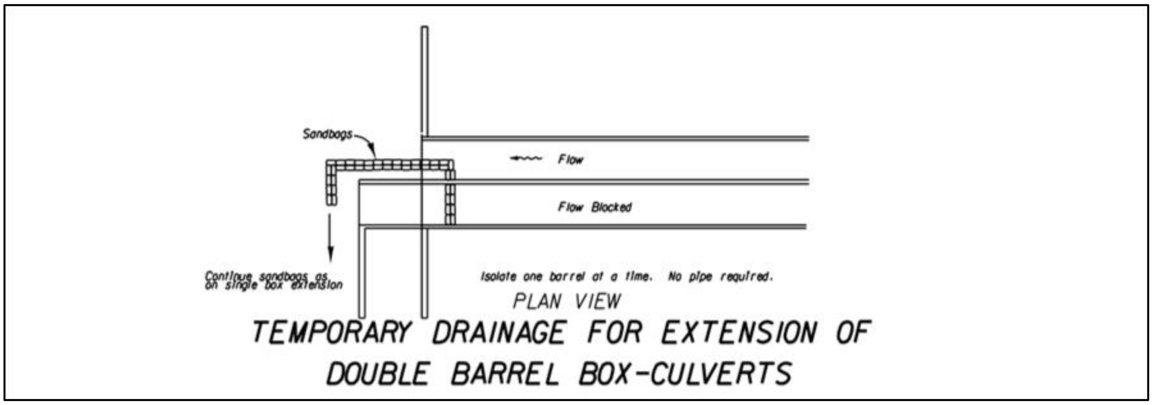


Figure 10.5-7: Temporary Drainage for Extension of Double Barrel Box-Culverts

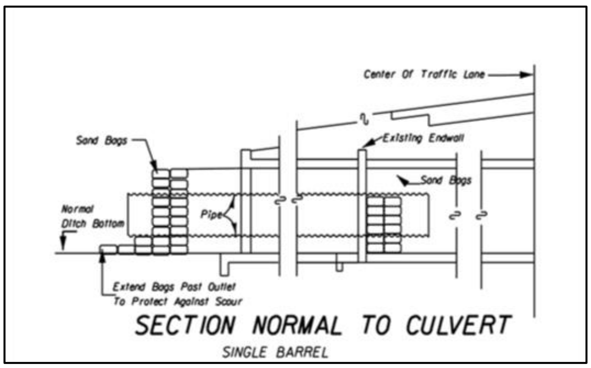


Figure 10.5-8: Section Normal to Culvert (Single Barrel)

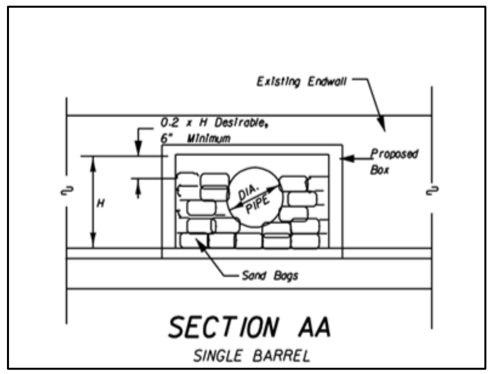


Figure 10.5-9: Section AA (Single Barrel)

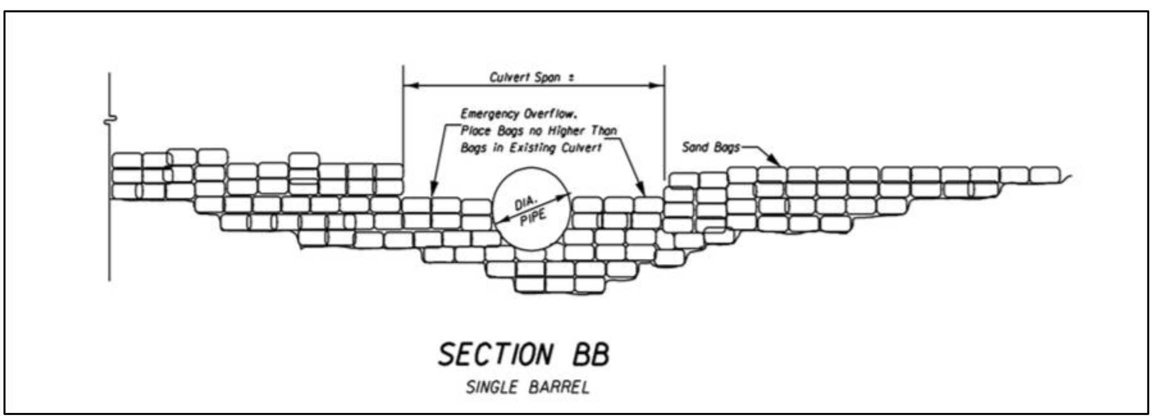


Figure 10.5-10: Section BB (Single Barrel)