STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

DRAINAGE HANDBOOK
TEMPORARY DRAINAGE DESIGN

OFFICE OF DESIGN, DRAINAGE SECTION October 2001
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TABLE OF CONTENTS

Temporary Drainage Design

Section 1 Purpose

The primary purposes for designing temporary drainage are minimizing travel lane flooding, preventing damage to property adjacent to the project during construction, and facilitating construction activities by temporarily rerouting or altering drainage conveyances.

This Handbook is a practical consideration of problems associated with drainage at roadway construction sites. The Handbook speaks directly to the drainage system designer and indirectly to other technical personnel. Use this Handbook properly by communicating with and sharing information with engineers responsible for roadway, structures, and traffic control plans. The Handbook covers problematic physical conditions that affect drainage efficiency at work-sites and offers possible solutions.

Section 2 Criteria

Consult the **FDOT Drainage Manua**l for hydraulic and hydrologic criteria that apply to the design of temporary drainage systems. Specifically, refer to **Table 2.2** in the Manual for design frequencies at temporary roadside and median ditches, swales, and side drains. Refer to **Table 3.3** in the **Manual** under “General Design” for design frequencies at temporary storm drain systems. Refer to Table 4.3 in the Manual for design frequencies at temporary cross-drains.

Some conditions are much more common in temporary conditions than in permanent. For example, water may pool along temporary barrier wall or curbing near an inside high-speed lane. In that situation, attempt to limit spread so that 8’ of the high-speed lane remains open.

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 **Chapter 3** of the **Manual** to determine spread criteria.

Section 3 Method

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

Design temporary drainage for construction sites with emphasis as follows:

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

Section 4 Detours

This Handbook uses the term “detour” as it is defined in the **State of Florida Standard Specifications, Sections 102-1.3 and 102-4**. 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.

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 streets. 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

4.2 Constructed Detours

Refer to **Figures 1 and 2**. When detours are to be constructed, provide designs for temporary drainage systems that prevent storm water from pooling or backing up on lanes where traffic is maintained. Detour lanes, whether constructed in a median or off an outside edge of pavement, are often built on fill that can disrupt the flow of storm water, unless temporary measures are taken 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 1**.

Consider every temporary low 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 certain that these areas are not overlooked when locating temporary drainage structures. See the temporary pipe shown in **Figure 1**.

Section 5 Construction of the Proposed Facility

Provide a design for temporary drainage of construction features like milled lanes, drop-offs between lanes, turnout construction and construction operations for new side-drain, cross-drain and box-culverts. Examine areas where traffic control items, especially temporary barrier walls, might pond water. Where box-culverts must be extended, provide details for any required temporary dewatering.

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 where lanes are added to the median side of a divided highway, or to the high side of a section in superelevation.

When this curbing effect can't be avoided by 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 3, 4 and 5**.

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

5.2 Turnouts

The construction of turnouts can cause water to pond in the turnout area and subsequently flood adjacent lanes on the roadway. Include details in the plans for the placement of 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-collecting lows and erosion.

5.3 Temporary Drains and Curb Inlets

Provide a note in the plans requiring **'temporary drains for subgrade and base'** at inlets in accordance with **Standard Index 201**, 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.

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 to be extended, divert this water away from work areas for the duration of required work. Refer to **figures 6 through 10** for examples of details for inclusion in plans. Include details and notes in the plans that provide, as 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.

5.5 Temporary Barrier Wall

The temporary barrier wall most commonly used on Department projects is the **Precast Concrete Temporary Barrier Wall** detailed in **Standard Index 415**. The concrete units are available in two configurations; one has two 6” drainage slots and the other has one 31” drainage slot. Units with 31” slots are superior for drainage purposes. The units with 6” slots can cause excessive spread in travel lanes and should be allowed only on the high side of a roadway cross-section.

Perform spread calculations for temporary precast concrete barrier wall, based on 4” per hour rainfall, using equations and information shown in **Tables 1, 2 and 3**.

Another type of approved temporary barrier **wall is the water-filled, steel-reinforced polyethylene** barrier detailed in **Standard Index 416**. The water filled barrier can be drained and moved to new locations by two men. The water filled barrier is available with saddles, which raise the base of the wall unit above the ground. Saddles should be required for locations where spread in travel lanes could be a problem. Without the saddles, the water filled barrier has no slot for drainage.

5.5.1 Flow Under Temporary Barrier Walls

The equations in **Tables 2 and 3** can be used as part of the calculation of spread next to temporary barrier walls. For barrier walls placed on a longitudinal grade, an approach to calculating spread, which is similar to the approach used for curb inlets, is summarized as follows. **Table 4** gives spread values for typical pavement widths and slopes.

1. Determine the flow approaching the slot.
2. Assume normal depth of flow at the slot and use the modified Manning's formula 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 (CFS)
n = Manning's roughness coefficient. (See **TABLE 1** below)
Sx = Pavement Cross Slope, (ft / ft)
SL = Longitudinal Slope, (ft / ft)
T = Spread, (ft)

TABLE 1: Manning's 'n' Values for Street and Pavement Gutters

Type of Gutter or Pavement	Manning's n
Concrete gutter, troweled finish	0.012
Asphalt pavement: Smooth texture Rough texture [1]	 0.013 0.016
Concrete gutter with asphalt pavement: Smooth texture asphalt Rough texture asphalt	 0.013 0.015
Concrete pavement: Float Finish Broom Finish [2]	 0.014 0.016
For gutters with small slope, where sediment may accumulate, increase above values of 'n' by	0.002

Reference: FHWA HEC-22
(1) The Department's friction course is rough texture asphalt.
(2) The Department's standard is brush (broom) finish for concrete curb. [Specification Section 520]

3. Using the depth of flow (y) at the edge of the barrier wall, determine the flow through the slot using the equation from **Table 3**. We suggest that the slot flow be reduced to 75% of the equation value to account for 25% 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 one through five for the length of barrier wall or until equilibrium.

For sag vertical curves, a more complicated approach is likely. 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 2: Flow through Barrier Wall Slots (Sump conditions): $Q=a_1y+a_2y^2+a_3y^3$

Equation is based on Ponded Water Upstream of the Slot

Slot Length (Index 415)		**Applicable range Of depth of flow (y)**		**a_1**		**a_2**		**a_3**	
mm	**in**	**m**	**ft**	**SI**	**English**	**SI**	**English**	**SI**	**English**
150	6	0 – 0.180	0 – 0.6	0.041	0.44	0.11	0.35	-0.57	-0.57
790	31	0 – 0.070	0 – 0.23	0.196	2.11	-5.03	-16.51	83.0*	83.0
790	31	0.070– 0.180	0.23 – 0.6	0.415	4.47	-1.97	-6.47	4.43	4.43

*The original report has a typographical error showing this value as 3.0.

TABLE 3 Flow through Barrier Wall Slots (On Longitudinal Grade): $Q=b_1+b_2y$
Equation is based on Water Flowing Longitudinally along the Wall

Slot Length (Index 415)		Applicable range Of depth of flow (y)		b_1		b_2	
mm	**in**	**m**	**ft**	**SI**	**English**	**SI**	**English**
150	6	0.013–0.163	0.042-0.54	-4.5×10^{-4}	-0.016	0.0375	0.404
790	31	0 – 0.070	0 – 0.33	0.0	0.0	0.114	1.23

Notes for Tables 2 and 3

1. Q= Flow through the slot.
2. y = Depth of flow at the edge of the barrier wall.
3. In English units, use y in feet to find Q in cubic feet per second.
4. In SI units, use y in meters to find Q in cubic meters per second.

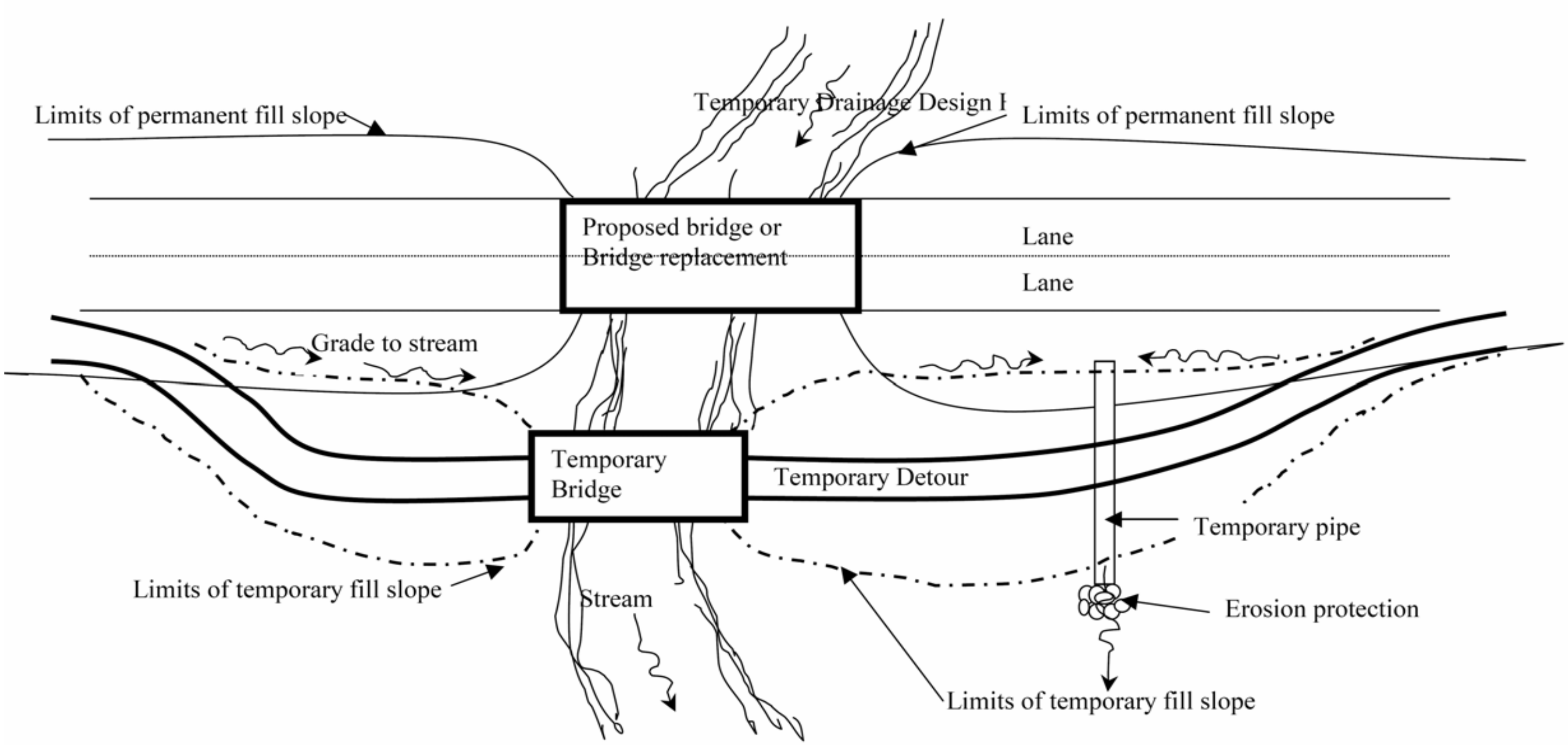
TABLE 4: Spread at Temporary Barrier Walls (31") Slots
Based on Equation for Table 3

PAVEMENT WIDTH	CROSS SLOPE	LONGITUDINAL SLOPE = 0.3%	LONGITUDINAL SLOPE = 1%	LONGITUDINAL SLOPE = 3%
	FT/FT	Spread (ft)	Spread (ft)	Spread (ft)
12'	0.01	2.7	2.1	1.8
	0.02	1.8	1.4	1.1
	0.03	1.4	1.1	0.9
24'	0.01	3.5	2.8	2.7 (60')
	0.02	2.3	1.8	1.5
	0.03	1.8	1.4	1.1
36'	0.01	4.1	4.1 (75')	4.1 (160')
	0.02	2.6	2.1	2.0 (60')
	0.03	2.1	1.6	1.4

Notes for Table 4

1. For most of the slopes and pavement widths in **Table 4**, the slots accept all the water coming to them (i.e. no bypass). The spread values for these slopes and pavement widths are based on Manning's formula for the triangular flow section next to the wall.
2. Where noted by a number in parentheses (xx'), the slots do not accept all the water coming to them and bypass flow exists. The spread values for these situations exist where the flow from the pavement (between adjacent slots) equals the flow through the downstream slot and the bypass flow does not change for successive slots. The number in parentheses is the distance to reach 95% of this equilibrium spread value.

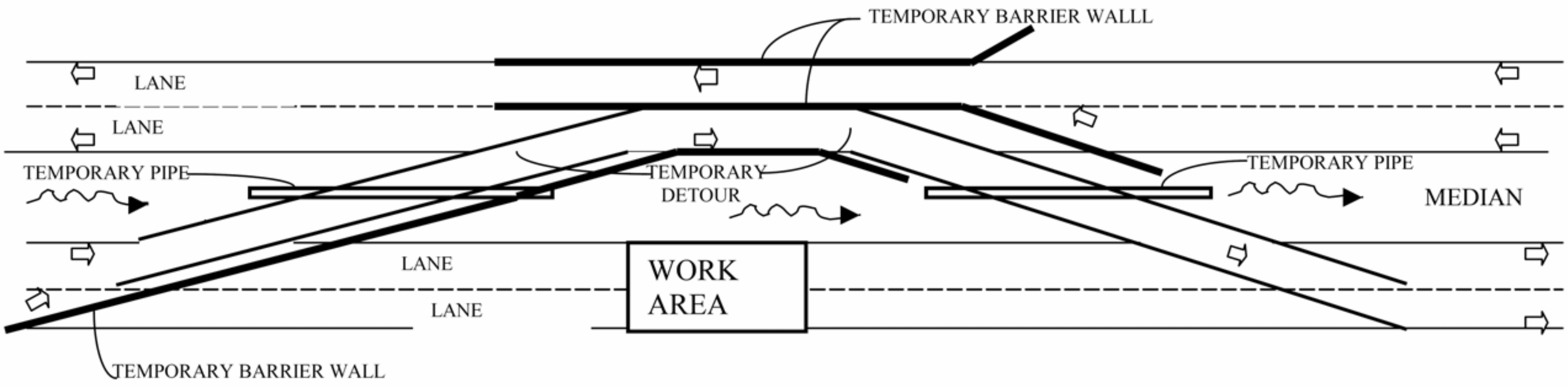
The above values are based on:
* Manning's n for pavement = 0.016
* Intensity = 4 iph
* Rational Runoff Coefficient = 0.95
* 25% blockage applied to the slot equations



TEMPORARY DETOUR AND BRIDGE

1. Prevent water from being trapped in the area where the limits of temporary fill overlaps 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, care must be taken 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. A contractor should not be forced to handle it. The temporary pipe shown in **Figure 1** is a possible scenario.

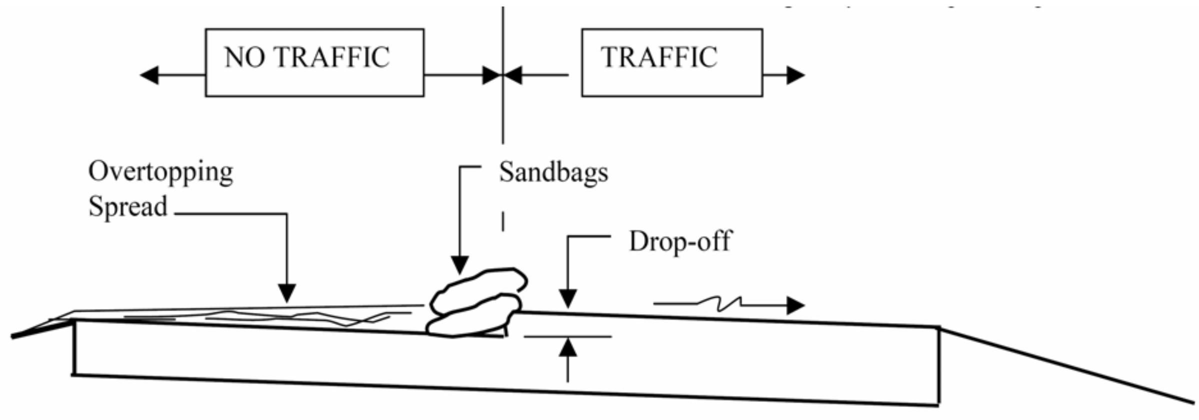
Figure 1



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 the flow approaching barrier wall slots based on average rainfall of 4 inches per hour. Calculate spread using the method defined as “Flow Under Temporary Barrier Walls” (See **Tables 1 through 4**). Prepare a design for temporary conditions that meets the requirements of the **FDOT Drainage Manual** and this Handbook.
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 located 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.

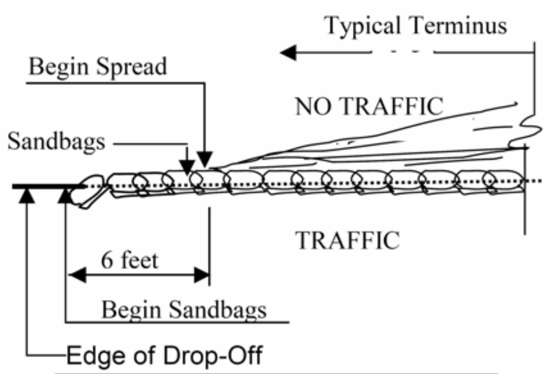
Figure 2



SECTION SHOWING SANDBAGGING TO PREVENT OVERTOPPING

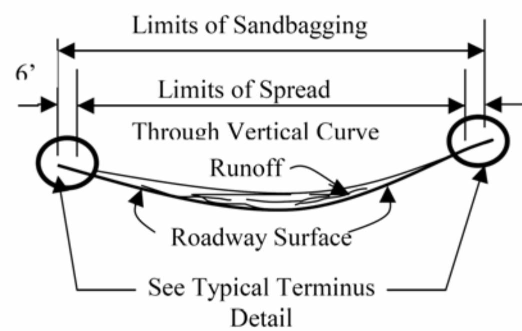
1. Place one row of sandbags, two bags deep, adjacent to drop-offs where overtopping spread may occur and where the down-slope lanes must be used to maintain traffic.
2. When possible, avoid this situation by phasing milling and pavement lifts so that the exposed sides of drop-offs face down-slope.
3. 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 3



TYPICAL TERMINUS
Detail for Sandbagging
To Prevent Overtopping
At Drop-Offs
Plan View

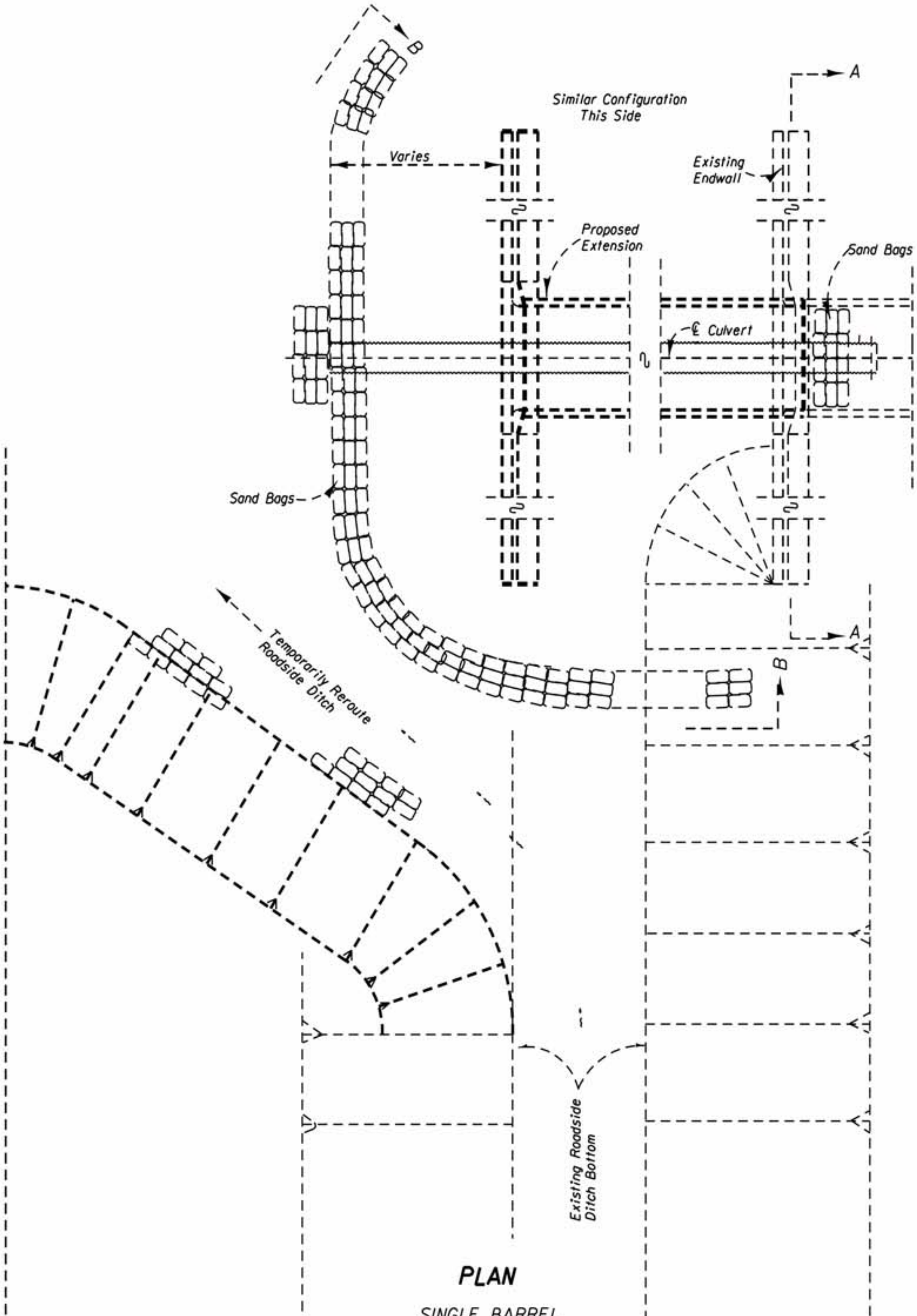
Figure 4



LIMITS OF SANDBAGGING
For Prevention Of Overtopping
At Drop-Offs along Vertical Curves

Profile View

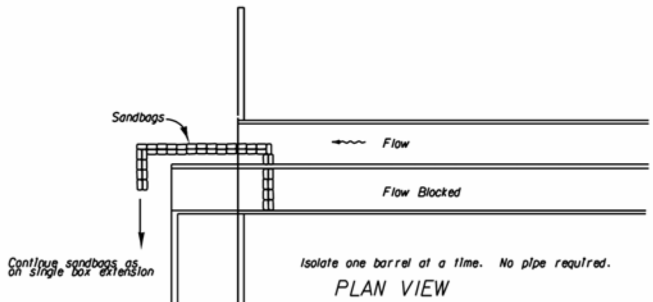
Figure 5



TEMPORARY DRAINAGE AT
BOX CULVERT EXTENSION

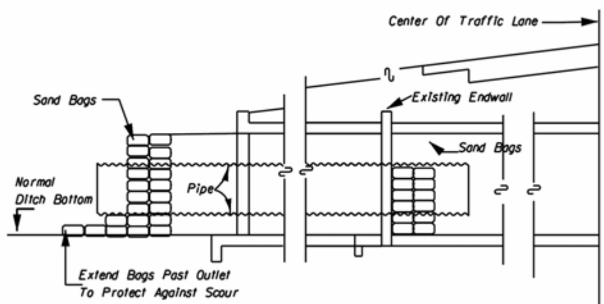
For treatment of multiple barrel culvert see Figure 7

Figure 6



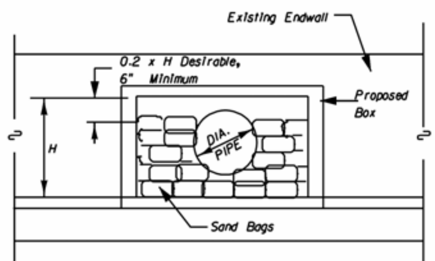
TEMPORARY DRAINAGE FOR EXTENSION OF DOUBLE BARREL BOX-CULVERTS

Figure 7



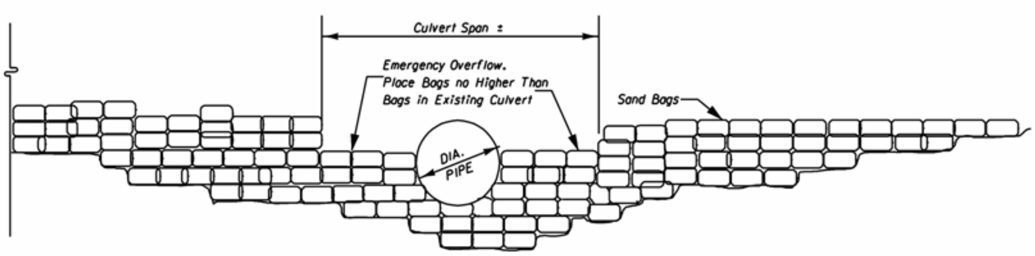
SECTION NORMAL TO CULVERT
SINGLE BARREL

Figure 8



SECTION AA
SINGLE BARREL

Figure 9



SECTION BB
SINGLE BARREL

Figure 10