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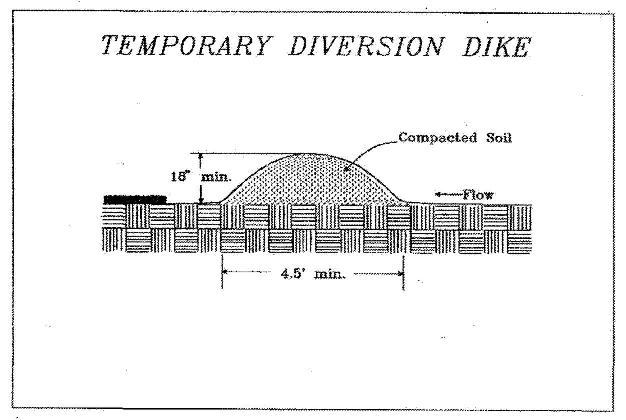
Height

The minimum allowable height measured from the upslope side of the dike is 18 inches (see Plate 3.09-1).



Source: Va. DSWC — Plate 3.09-1

Side Slopes

1½:1 or flatter, along with a minimum base width of 4.5 feet (see Plate 3.09-1).

Grade

The channel behind the dike shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2%, no stabilization is required. If the slope is greater than 2%, the channel shall be stabilized in accordance with Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL.

Outlet

1. The diverted runoff, if free of sediment, must be released through a stabilized outlet or channel.

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2. Sediment-laden runoff must be diverted and released through a sediment-trapping facility such as a TEMPORARY SEDIMENT TRAP (Std. & Spec. 3.13) or TEMPORARY SEDIMENT BASIN (Std. & Spec. 3.14).

Construction Specifications

1. Temporary diversion dikes must be installed as a first step in the land-disturbing activity and must be functional prior to upslope land disturbance.
2. The dike should be adequately compacted to prevent failure.
3. Temporary or permanent seeding and mulch shall be applied to the dike immediately following its construction.
4. The dike should be located to minimize damages by construction operations and traffic.

Maintenance

The measure shall be inspected after every storm and repairs made to the dike, flow channel, outlet or sediment trapping facility, as necessary. Once every two weeks, whether a storm event has occurred or not, the measure shall be inspected and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

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STD & SPEC 3.18

OUTLET PROTECTION (OP)

Definition

Structurally lined aprons or other acceptable energy dissipating devices placed at the outlets of pipes or paved channel sections.

Purpose

To prevent scour at stormwater outlets, to protect the outlet structure, and to minimize the potential for downstream erosion by reducing the velocity and energy of concentrated stormwater flows.

Conditions Where Practice Applies

Applicable to the outlets of all pipes and engineered channel sections.

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Planning Considerations

The outlets of pipes and structurally lined channels are points of critical erosion potential. Stormwater which is transported through man-made conveyance systems at design capacity generally reaches a velocity which exceeds the capacity of the receiving channel or area to resist erosion. To prevent scour at stormwater outlets, a flow transition structure is needed which will absorb the initial impact of the flow and reduce the flow velocity to a level which will not erode the receiving channel or area.

The most commonly used device for outlet protection is a structurally lined apron. These aprons are generally lined with riprap, grouted riprap or concrete. They are constructed at a zero grade for a distance which is related to the outlet flow rate and the tailwater level. Criteria for designing such an apron are contained in this practice. Sample problems of outlet protection design are contained in Appendix 3.18-a.

Where flow is excessive for the economical use of an apron, excavated stilling basins may be used. Acceptable designs for stilling basins may be found in the following sources:

1. Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular No. 14, U. S. Department of Transportation, Federal Highway Administration (83).
2. Hydraulic Design of Stilling Basins and Energy Dissipators, Engineering Monograph No. 25, U.S. Department of the Interior - Bureau of Reclamation, (74).

   Note: Both of the above are available from the U.S. Government Printing Office.

Design Criteria

The design of structurally lined aprons at the outlets of pipes and paved channel sections applies to the immediate area or reach below the pipe or channel and does not apply to continuous rock linings of channels or streams (See STORMWATER CONVEYANCE CHANNEL, Std. & Spec. 3.17). Notably, pipe or channel outlets at the top of cut slopes or on slopes steeper than 10% should not be protected using just outlet protection as a result of the reconcentration and large velocity of flow encountered as the flow leaves the structural apron. Outlet protection shall be designed according to the following criteria:

Pipe Outlets

(See Plate 3.18-1)

1. Tailwater depth: The depth of tailwater immediately below the pipe outlet must be determined for the design capacity of the pipe. Manning's Equation may be used to determine tailwater depth (see Chapter 5, Engineering Calculations). If the tailwater depth is less than half the diameter of the outlet pipe, it shall be classified as a

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Minimum Tailwater Condition. If the tailwater depth is greater than half the pipe diameter, it shall be classified as a Maximum Tailwater Condition. Pipes which outlet onto flat areas with no defined channel may be assumed to have a Minimum Tailwater Condition. Notably, in most cases where post-development stormwater runoff has been concentrated or increased, MS #19 will be satisfied only by outfall into a defined channel.

2. Apron length: The apron length shall be determined from the curves according to the tailwater condition:

   Minimum Tailwater - Use Plate 3.18-3.
   Maximum Tailwater - Use Plate 3.18-4.

3. Apron width: When the pipe discharges directly into a well-defined channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tailwater depth or to the top of the bank (whichever is less).

   If the pipe discharges onto a flat area with no defined channel, the width of the apron shall be determined as follows:

   a. The upstream end of the apron, adjacent to the pipe, shall have a width three times the diameter of the outlet pipe.
   b. For a Minimum Tailwater Condition, the downstream end of the apron shall have a width equal to the pipe diameter plus the length of the apron.
   c. For a Maximum Tailwater Condition, the downstream end shall have a width equal to the pipe diameter plus 0.4 times the length of the apron.

4. Bottom grade: The apron shall be constructed with no slope along its length (0.0% grade). The invert elevation of the downstream end of the apron shall be equal to the elevation of the invert of the receiving channel. There shall be no overfall at the end of the apron.
5. Side slopes: If the pipe discharges into a well-defined channel, the side slopes of the channel shall not be steeper than 2:1 (horizontal: vertical).
6. Alignment: The apron shall be located so there are not bends in the horizontal alignment.
7. Materials: The apron may be lined with riprap, grouted riprap, concrete, or gabion baskets. The median sized stone for riprap shall be determined from the curves in Appendix 3.18-a (Plates 3.18-3 and 3.18-4) according to the tailwater condition. The gradation, quality and placement of riprap shall conform to Std. & Spec. 3.19, RIPRAP.

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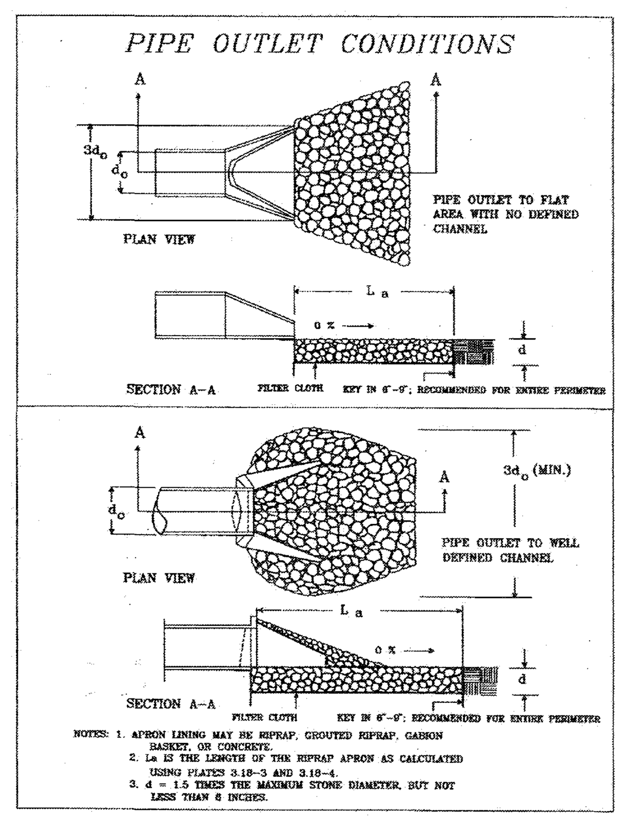

Source: Va. DSWC — Plate 3.18-1

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8. Filter cloth: In all cases, filter cloth shall be placed between the riprap and the underlying soil to prevent soil movement into and through the riprap. The material must meet or exceed the physical properties for filter cloth found in Std. & Spec. 3.19, RIPRAP. See Plate 3.18-1 for orientation details.

Paved Channel Outlets

(See Plate 3.18-2)

1. The flow velocity at the outlet of paved channels flowing at design capacity must not exceed the permissible velocity of the receiving channel (see Tables 3.18-A and 3.18-B)
2. The end of the paved channel shall merge smoothly with the receiving channel section. There shall be no overfall at the end of the paved section. Where the bottom width of the paved channel is narrower than the bottom width of the receiving channel, a transition section shall be provided The maximum side divergence of the transition shall be 1 in 3F where;

$$F = \frac{V}{\sqrt{gd}}$$

where,

F = Froude number
V = Velocity at beginning of transition (ft./sec.)
d = depth of flow at beginning of transition (ft.)
g = 32.2 ft./sec.^{2}

3. Bends or curves in the horizontal alignment at the transition are not allowed unless the Froude number (F) is 1.0 or less, or the section is specifically designed for turbulent flow.

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STD & SPEC 3.08

CULVERT INLET PROTECTION (CIP)

Definition

A sediment filter located at the inlet to storm sewer culverts.

Purposes

1. To prevent sediment from entering, accumulating in and being transferred by a culvert and associated drainage system prior to permanent stabilization of a disturbed project area.
2. To provide erosion control at culvert inlets during the phase of a project where elevation and drainage patterns change, causing original control measures to be ineffective or in need of removal.

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Maintenance

1. The structure shall be inspected after each rain and repairs made as needed.
2. Aggregate shall be replaced or cleaned when inspection reveals that clogged voids are causing ponding problems which interfere with on-site construction.
3. Sediment shall be removed and the impoundment restored to its original dimensions when sediment has accumulated to one-half the design depth. Removed sediment shall be deposited in a suitable area and in such a manner that it will not erode and cause sedimentation problems.
4. Temporary structures shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.

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Conditions Where Practice Applies

Where culvert and associated drainage system is to be made operational prior to permanent stabilization of the disturbed drainage area. Different types of structures are applicable to different conditions (see Plates 3.08-1 and 3.08-2).

Planning Considerations

When construction on a project reaches a stage where culverts and other storm sewer appurtenances are installed and many areas are brought to a desired grade, the erosion control measures used in the early stages normally need to be modified or may need to be removed altogether. At that time, there is a need to provide protection at the points where runoff will leave the area via culverts and drop or curb inlets.

Similar to drop and curb inlets, culverts which are made operational prior to stabilization of the associated drainage areas can convey large amounts of sediment to natural drainageways. In case of extreme sediment loading, the pipe or pipe system itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the culvert by using one of the methods noted in this section.

General Guidelines (All Types)

1. The inlet protection device shall be constructed in a manner that will facilitate clean-out and disposal of trapped sediment and minimize interference with construction activities.
2. The inlet protection devices shall be constructed in such a manner that any resultant ponding of stormwater will not cause excessive inconvenience or damage to adjacent areas or structures.
3. Design criteria more specific to each particular inlet protection device will be found in Plates 3.08-1 through 3.08-2.

Design Criteria

1. Silt Fence Culvert Inlet Protection
   a. No formal design is required.
   b. Silt fence culvert inlet protection has an expected maximum usable life of three months.
   c. The maximum area draining to this practice shall not exceed one acre.

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2. Culvert Inlet Sediment Trap
   a. Runoff storage requirements shall be in accordance with information outlined under Std. & Spec. 3.13, TEMPORARY SEDIMENT TRAP.
   b. Culvert inlet sediment traps have a maximum expected useful life of 18 months.
   c. The maximum area draining to this practice shall not exceed 3 acres.

Construction Specifications

1. Silt Fence Culvert Inlet Protection
   a. The height of the silt fence (in front of the culvert opening) shall be a minimum of 16 inches and shall not exceed 34 inches.
   b. Extra strength filter fabric with a maximum spacing of stakes of 3 feet shall be used to construct the measure.
   c. The placement of silt fence should be approximately 6 feet from the culvert in the direction of incoming flow, creating a "horseshoe" shape as shown in Plate 3.08-1.
   d. If silt fence cannot be installed properly or the flow and/or velocity of flow to the culvert protection is excessive and may breach the structure, the stone combination noted in Plate 3.08-1 should be utilized.
2. Culvert Inlet Sediment Trap
   a. Geometry of the design will be a "horseshoe" shape around the culvert inlet (see Plate 3.08-2).
   b. The toe of riprap (composing the sediment filter dam) shall be no closer than 24" from the culvert opening in order to provide an acceptable emergency outlet for flows from larger storm events.
   c. All other "Construction Specifications" found within Std. & Spec. 3.13, TEMPORARY SEDIMENT TRAP, also apply to this practice.
   e. The proper installation of the culvert inlet sediment trap is a viable substitute for the installation of the TEMPORARY SEDIMENT TRAP.

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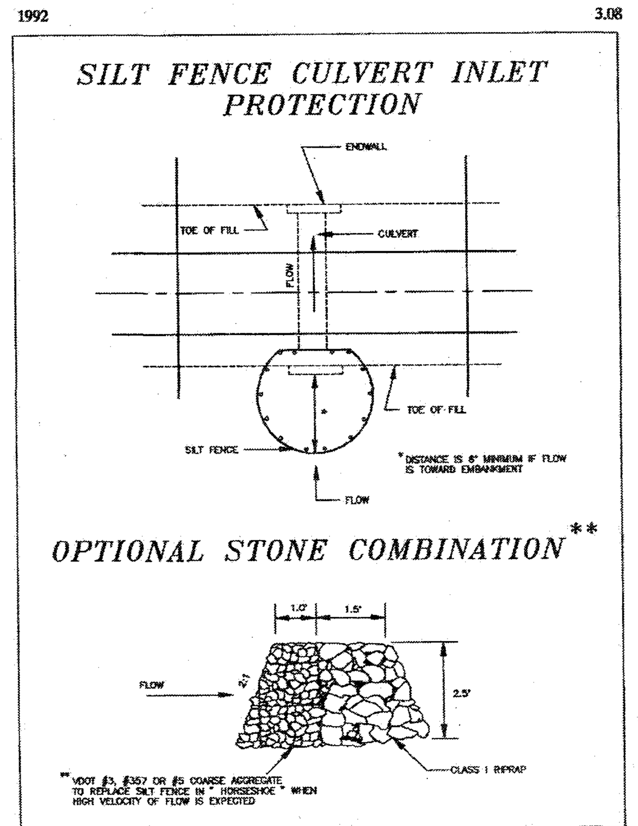

Source: Adapted from VDOT Standard Sheets and Va. DSWC — Plate 3.08-1

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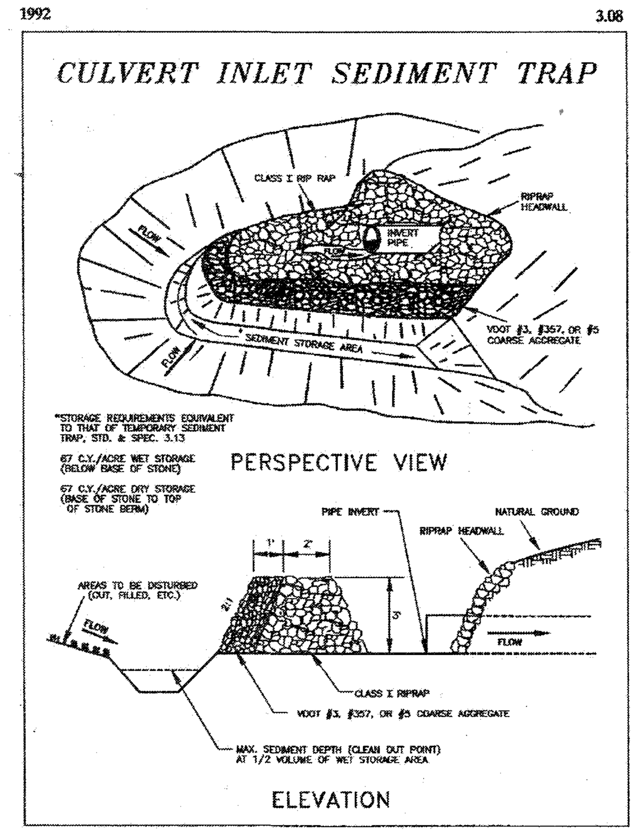

Source: North Carolina Sediment Control Commission — Plate 3.08-2

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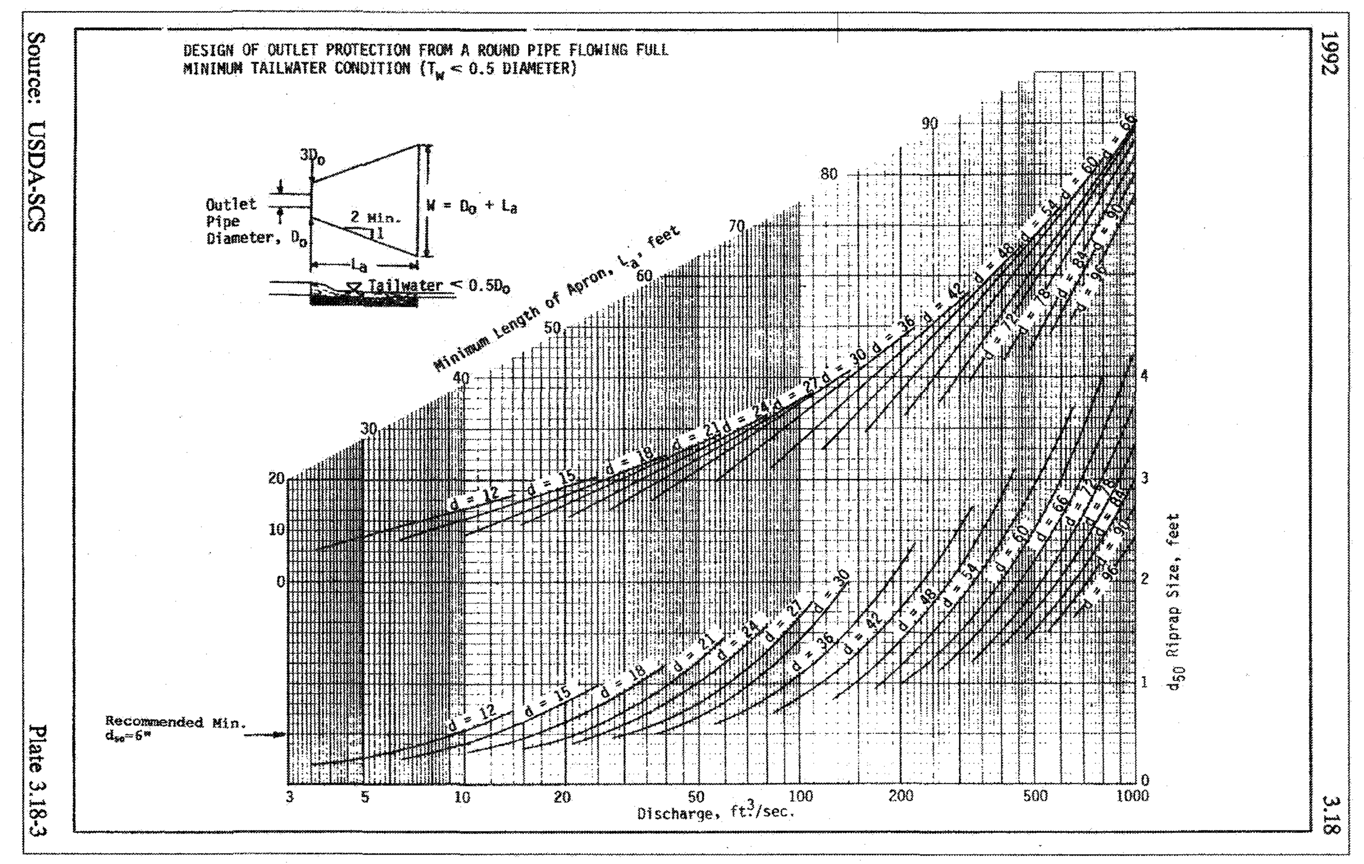

Source: USDA-SCS — Plate 3.18-3 — 1992 — 3.18

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Sheet No. 17 of 25

Date: MAY 4, 2018

Scale: 1" = 20'

Project No.

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