## Definition

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

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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STORM DRAIN INLET PROTECTION

STD & SPEC 3.07



# Definition

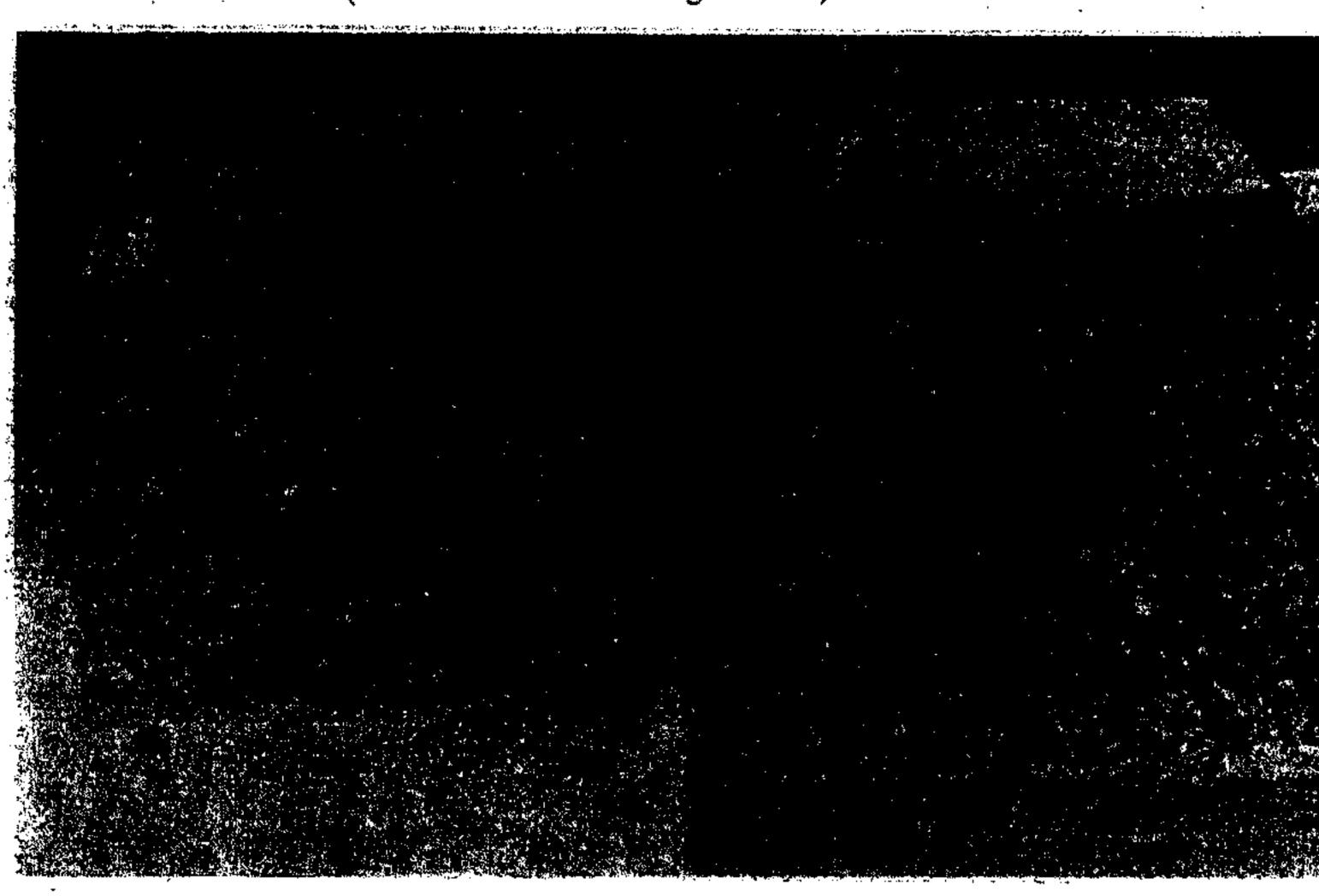
A sediment filter or an excavated impounding area around a storm drain drop inlet or curb

## Purpose

To prevent sediment from entering storm drainage systems prior to permanent stabilization of the disturbed area.

## Conditions Where Practice Applies

Where storm drain inlets are to be made operational before permanent stabilization of the corresponding disturbed drainage area. Different types of structures are applicable to different conditions (see Plates 3.07-1 through 3.07-8).



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1992

1992

#### 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:

- Hydraulic Design of Energy Dissipators for Culverts and Channels, Hydraulic Engineering Circular No. 14, U. S. Department of Transportation, Federal Highway
- 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 limings 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

(Sec Plate 3.18-1)

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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Planning Considerations

Storm sewers 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

To avoid these problems, it is necessary to prevent sediment from entering the system at the

This practice contains several types of inlet filters and traps which have different

applications dependent upon site conditions and type of inlet. Other innovative techniques

for accomplishing the same purpose are encouraged, but only after specific plans and details

Care should be taken when choosing a specific type of inlet protection. Field experience.

has shown that inlet protection which causes excessive ponding in an area of high.

construction activity may become so inconvenient that it is removed or bypassed, thus

transmitting sediment-laden flows unchecked. In such situations, a structure with an

The following inlet protection devices are for drainage areas of one acre or less. Runoff

from larger disturbed areas should be routed to a TEMPORARY SEDIMENT TRAP (Std.

The best way to prevent sediment from entering the storm sewer system is to stabilize the

Stone is utilized as the chief ponding/filtering agent in most of the inlet protection types

described in this specification. The various types of "coarse aggregates" which are depicted

are able to filter out sediment mainly through slowing down flows directed to the inlet by

creating an increased flow path for the stormwater (through void space in the respective

stone). The stone filtering medium by no means slows stormwater flowrate as does filter

cloth and therefore cannot provide the same degree of filter efficiency when smaller silt and

excessive ponding in busy areas adjacent to stormwater inlets is in many cases unacceptable.

Fortunately, in most instances, inlet protection utilizing stone should not be the sole control

measure. At the time that storm sewer inlet and associated appurtances become

operational, areas adjacent to the structures are most likely at final grade or will not be

altered for extended periods; this is the time when TEMPORARY SEEDING (Std. & Spec.

3.31) and other appropriate controls should be implemented to enhance sediment-loss

a greater degree of sediment removal can be obtained. As an option, filter cloth can be

mitigation. In addition, by varying stone sizes used in the construction of inlet protection,

used with the stone in these devices to further enhance sediment removal. Notably, the

potential inconvenience of excessive ponding must be examined with these choices,

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clay particles are introduced into stormwater flows. However, as mentioned earlier,

are submitted to and approved by the appropriate Plan-Approving Authority.

& Spec. 3.13) or a TEMPORARY SEDIMENT BASIN (Std. & Spec. 3.14).

site as quickly as possible, preventing erosion and stopping sediment at its source.

adequate overflow mechanism should be utilized.

- that is why stone must be utilized with many installations.

especially the latter.

sediment loading, the storm sewer itself may clog and lose a major portion of its capacity.

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Design Criteria The drainage area shall be no greater than 1 acre.

The inlet protection device shall be constructed in a manner that will facilitate cleanout and disposal of trapped sediment and minimize interference with construction

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

Apron length: The apron length shall be determined from the curves according to

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

If the pipe discharges onto a flat area with no defined channel, the width of the

have a width equal to the pipe diameter plus the length of the apron.

equal to the pipe diameter plus 0.4 times the length of the apron.

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

Side slopes: If the pipe discharges into a well-defined channel, the side slopes of the

Alignment: The apron shall be located so there are not bends in the horizontal

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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The upstream end of the apron, adjacent to the pipe, shall have a width three

For a Minimum Tailwater Condition, the downstream end of the apron shall

For a Maximum Tailwater Condition, the downstream end shall have a width

into a defined channel.

the tailwater condition:

end of the apron.

Minimum Tailwater - Use Plate 3.18-3.

Maximum Tailwater - Use Plate 3.18-4.

times the diameter of the outlet pipe.

channel shall not be steeper than 2:1 (horizontal: vertical).

apron shall be determined as follows:

- 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.
- Design criteria more specific to each particular inlet protection device will be found on Plates 3.07-1 through 3.07-8.
- For the inlet protection devices which utilize stone as the chief ponding/filtering medium, a range of stone sizes is offered; VDOT #3, #357, or #5 Coarse Aggregate should be used. The designer/plan reviewer should attempt to get the greatest amount of filtering action possible (by using smaller-sized stone), while not creating significant ponding problems.
- In all designs which utilize stone with a wire-mesh support as a filtering mechanism, the stone can be completely wrapped with the wire mesh to improve stability and provide easier cleaning.
- Filter Fabric may be added to any of the devices which utilize "coarse aggregate" stone to significantly enhance sediment removal. The fabric, which must meet the physical requirements noted for "extra strength" found in Table 3.05-B, should be secured between the stone and the inlet (on wire-mesh if it is present). As a result of the significant increase in filter efficiency provided by the fabric, a larger range of stone sizes (VDOT #1, #2 or #3 Coarse Aggregate) may be utilized with such a configuration. The larger stone will help keep larger sediment masses from clogging the cloth. Notably, significant ponding may occur at the inlet if filter cloth is utilized in this manner.

## Construction Specifications

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- Silt Fence Drop Inlet Protection
- Silt Fence shall conform to the construction specifications for "extra strength" found in Table 3.05-B and shall be cut from a continuous roll to avoid joints.
- For stakes, use 2 x 4-inch wood (preferred) or equivalent metal with a minimum length of 3 feet.

3.18

- Space stakes evenly around the perimeter of the inlet a maximum of 3-feet apart, and securely drive them into the ground, approximately 18-inches deep (see Plate 3.07-1).
- To provide needed stability to the installation, frame with 2 x 4-inch wood strips around the crest of the overflow area at a maximum of 13 feet above the drop inlet crest.
- Place the bottom 12 inches of the fabric in a trench (see Plate 3.07-1) and backfill the trench with 12 inches of compacted soil.
- Fasten fabric securely by staples or wire to the stakes and frame. Joints must be overlapped to the next stake.
- It may be necessary to build a temporary dike on the downslope side of the structure to prevent bypass flow.

## Gravel and Wire Mesh Drop Inlet Sediment Filter

- Wire mesh shall be laid over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Wire mesh with 1/2-inch openings shall be used. If more than one strip of mesh is necessary, the strips shall be overlapped.
- Coarse aggregate shall be placed over the wire mesh as indicated on Plate 3.07-2. The depth of stone shall be at least 12 inches over the entire inlet opening. The stone shall extend beyond the inlet opening at least 18 inches
- If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stones must be pulled away from the inlet, cleaned and/or replaced.

Note: This filtering device has no overflow mechanism; therefore, ponding is likely especially if sediment is not removed regularly. This type of device must never be used where overflow may endanger an exposed fill slope. Consideration should also be given to the possible effects of ponding on traffic movement, nearby structures, working areas, adjacent property, etc.

## Block and Gravel Drop Inlet Sediment Filter

Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, with the ends of adjacent blocks abutting. The height of the barrier can be varied, depending on design needs, by stacking combinations of 4-inch, 8-inch and 12-inch wide blocks. The barrier of blocks shall be at least 12-inches high and no greater than 24-inches high.

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PIPE OUTLET CONDITIONS PLAN VIEW 0 % ----FILTER CLOTH KEY IN 6"-9": RECOMMENDED FOR ENTIRE PERIMETER 3d, (MIN.) PIPE OUTLET TO WELL 0 % -----SECTION A-A FILTER CLOTH KEY IN 6"-9"; RECOMMENDED FOR ENTIRE PERIMETER

NOTES: 1. APRON LINING MAY BE RIPRAP, GROUTED RIPRAP, GABION

USING PLATES 3.18-3 AND 3.18-4.

2. La IS THE LENGTH OF THE RIPRAP APRON AS CALCULATED

3. d = 1.5 TIMES THE MAXIMUM STONE DIAMETER, BUT, NOT

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Source: Va. DSWC

Plate 3.18-1

TIDEWATER

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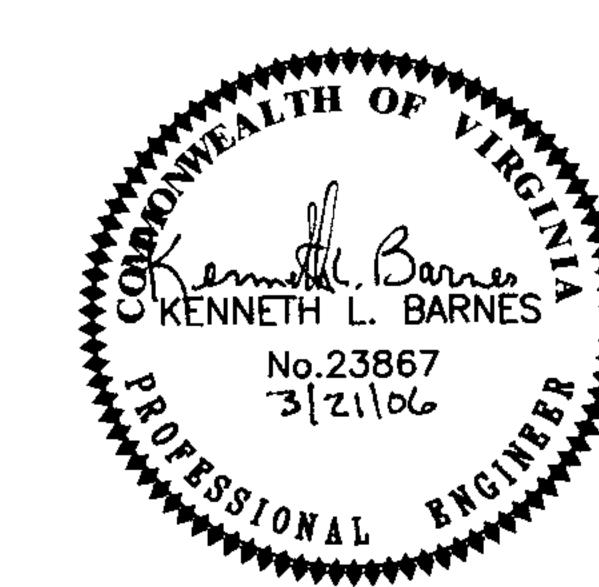
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