5.10 Vegetative Buffer Strip

5.10.1 Control Description

The maintenance of new or existing vegetation on the project site can greatly reduce the impact of sediment runoff. Also, buffer strips can impact the number of other sediment removal devices needed during the construction process.

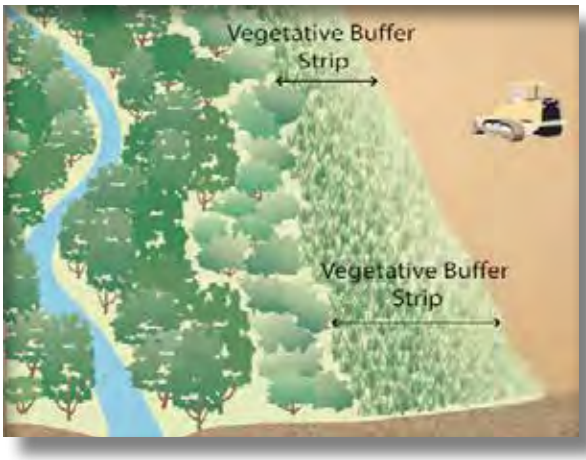
5.10.2 Control Uses and Applicability

Vegetative buffer strips may be used on sites that have an abundance of existing vegetative cover or where good vegetative cover can be established prior to construction activities. This practice is most commonly used next to streams, wetlands or other bodies of water, illustrated in Figures 5-10.1 and Figure 5-10.2.

The following are several factors to keep in mind when using this method:

- Flows shall not be concentrated across the site area. To accomplish this, the use of level spreaders or other methods of dissipating energy that encourage sheet flow and increase functionality should be used (see section 5.13 for additional details).
- Buffer strips are not as effective during winter months and therefore, other practices may be required.
- Disturbance within the vegetative buffer area is not permitted unless infrastructure improvements are made.

Figure 5-10.1
Vegetative Buffer Strip within a Project Site



Courtesy of EPA

Figure 5-10.2
Grass buffer Strip next to Stream

5.10.3 Design Criteria

To ensure a vegetative buffer strip is properly established for use on a project, the following items should be considered:

1. The design width criteria of each buffer area shall be site specific with consideration to the factors of soil types, slope, drainage area, and existing types of vegetation used in the calculation.
2. A vegetative buffer should be used in conjunction with other BMPs in the event there is insufficient buffer.
3. The minimum vegetative buffer width shall be 100 feet. Shorter widths may be approved on a case-by-case basis.
4. For slopes greater than 10 percent, the minimum length is 250 feet. Shorter widths may only be used with the installation of other BMPs .

5. The width of the contributing area shall not exceed 300 feet.

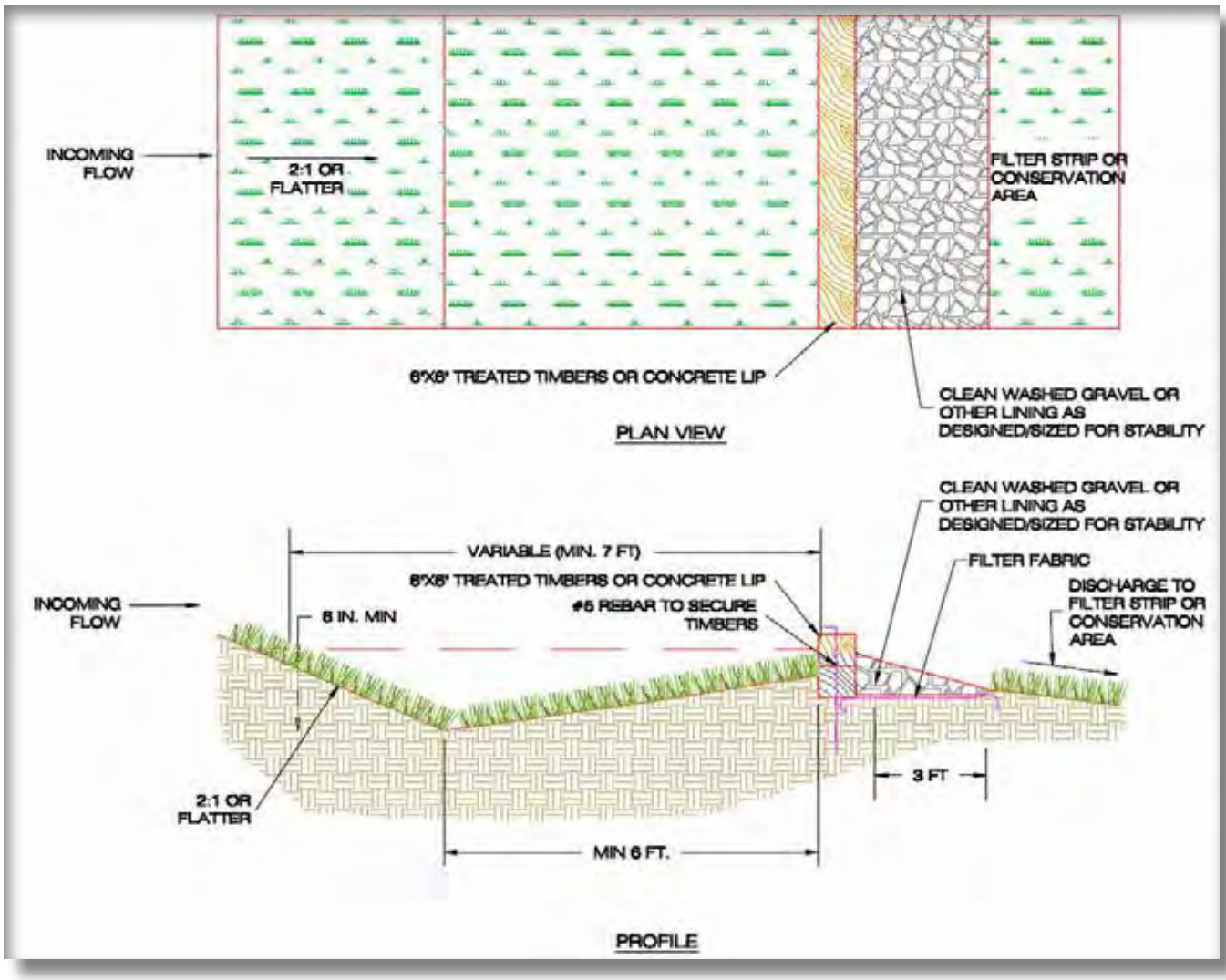
6. Good vegetative cover (greater than 80%) must be established in the proposed buffer area.

5.10.4 Materials

Native plants or new vegetative cover based on the permanent seeding chart (Table 5-4.2, page 5-6) shall be permitted for use in the buffer strip.

5.10.5 Maintenance

Vegetative buffer strips shall be inspected at least once per week and after any rain event of 0.5 inches or greater during the duration of the project. If the buffer strip is consistently eroded or the cover decreases below 80%, additional BMP devices to slow erosive velocities shall be required.



Detail 5-10.1
Buffer Strip with Level Spreader

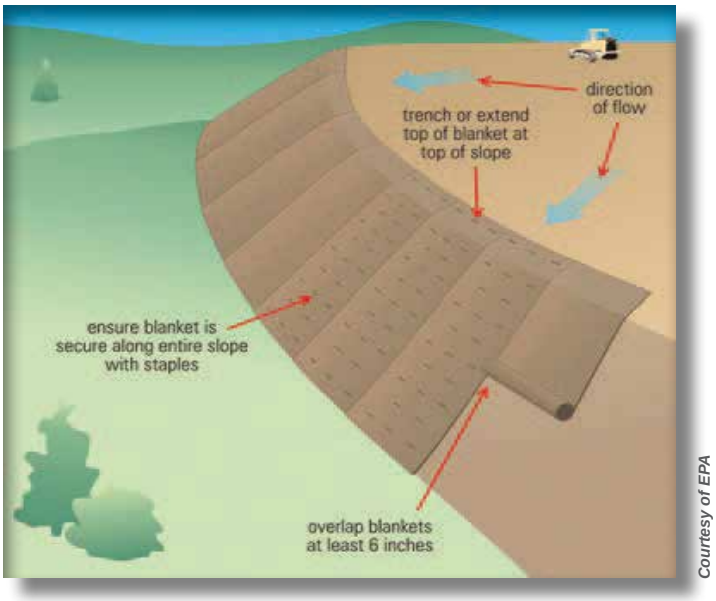
5.11 Erosion Control Matting

5.11.1 Control Description

Erosion control matting generally consists of manufactured blankets, netting and three dimensional products that are made from a varied selection of natural and man-made products.

5.11.2 Control Uses and Applicability

Erosion control matting may be used as a direct replacement for straw or hay mulch and will provide better protection to the slope. Other typical applications of this matting are on steep slopes, Figure 5-11-1 and in low and medium velocity channels to establish vegetative cover, see Figure 5-11.2.



Courtesy of EPA

Figure 5-11.1
Permanent Erosion Control Matting placement on Hillside

Temporary matting can be used in areas where long-term protection is not warranted due to the biodegradable nature of this matting. Permanent matting shall be used in areas where the long-term protection of an area is required. Ultraviolet (UV) stabilized netting materials shall be used in the fabrication of this type of matting.

Figure 5-11.2
Permanent Erosion Control Matting placement in Drainage Ditch

5.11.3 Design Criteria

To provide proper installation of erosion control matting on a project, the following criteria should be followed:

1. A large variety of erosion control matting are available. For many of these products, the manufacturers provide design software and design assistance for selecting the appropriate material. All material used shall be accompanied by the calculations used to select the choice matting. The Erosion Control Technology Council (ECTC) is an organization that represents suppliers and manufacturers of Erosion Control Matting (www.ectc.org) and can be used as a guide to help with the selection of this material.
2. Erosion control matting used for channel lining shall be designed to handle a 10 year storm event, for installation guideline, see Detail 5-11.1 on (page 5-28).

3. Erosion control matting shall always be installed per manufacturer recommendations and standards. Detail 5-11.2 on (page 5-29) provides additional design information.

5.11.4 Materials

Erosion control matting is typically comprised of a wide variety of materials including coconut fiber, hay, straw wood excelsior, jute, nylon, polypropylene, and PVC.

No netting material that has potential to leach contaminants into stream water shall be used.

5.11.5 Maintenance

All matting shall be inspected at least once per week and after any rain event of 0.5 inches or greater during the duration of the project. Should any matting be damaged, a repair or replacement of that particular area must occur immediately. The use of additional staples may become necessary to stabilize the matting sections should it begin to lift around the edges.

Figures 5-11.3 and 5-11.4 show examples of erosion control blanket installations.

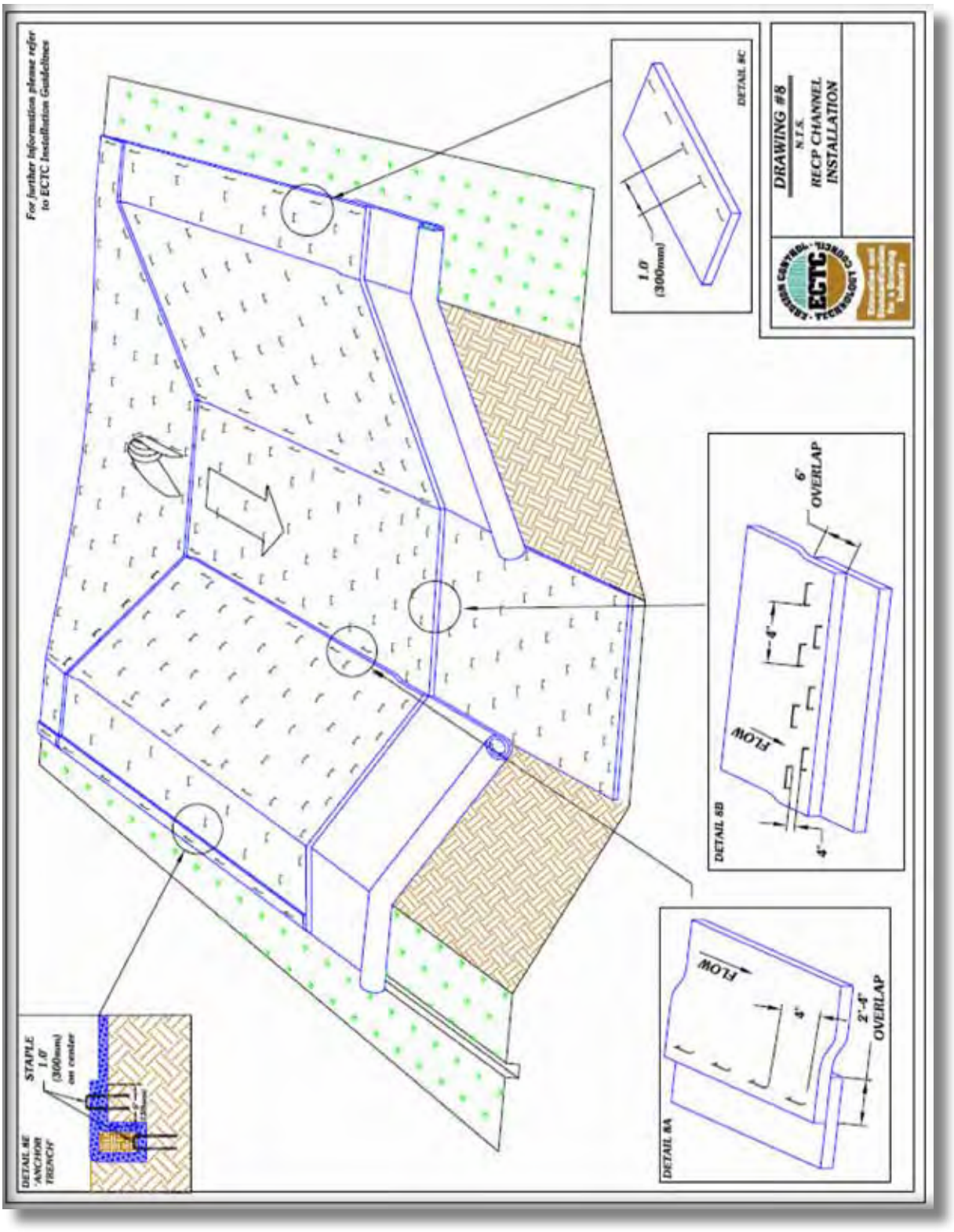
Courtesy of ECTC

Figure 5-11.3
Erosion Blanket properly installed in Channel

Courtesy of ECTC

Figure 5-11.4
Hillside placement of Erosion Blanket

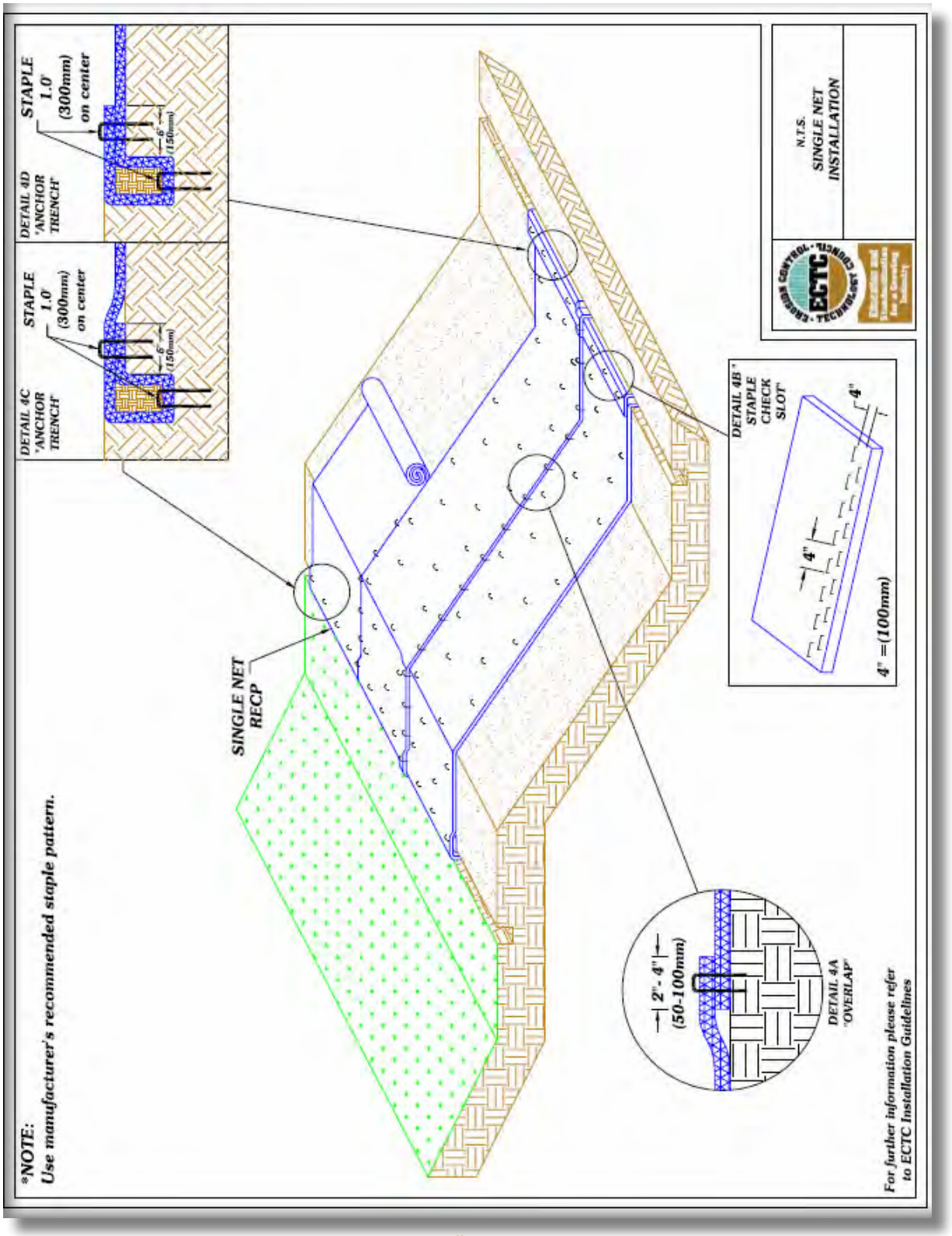
Courtesy of ECTC



Detail 5-11.1
Channel installation

Erosion Control Matting

Courtesy of ECTC



Detail 5-11.2
Erosion Control installation on Hillside

5.12 Outlet Protection

5.12.1 Control Description

Pipe outlets are known points of high erosion due to the high velocities typically experienced at the outfall. To mitigate the potential of erosion at the pipe outlet, adequately designed energy dissipation must be used. There are several types of man-made and natural devices which can be used to dissipate energy, riprap being the most common, in Figure 5-12-1. New man-made energy dissipating devices are also available, such as articulated concrete block, Figure 5.12.2.

5.12.2 Control Uses and Applicability

The use of outlet protection shall occur at all culvert outlets and pipe conduits coming from sediment basins and stormwater ponds throughout the project area.

5.12.3 Design Criteria

Riprap outlet protection design criteria shall be based on the methods used by the WVDOH. The cross section in Details 5-12.1 shows the typical section details for outlet protection used for channel flow. These details are a courtesy of the WVDOH Standard Drawings Volume 1 - Drainage Manual at http://www.transportation.wv.gov/highways/engineering/StandardDetails/Vol1/2000SD1.pdf

Figure 5-12.1
Outlet Protection at Pipe Wing wall

Figure 5-12.2
Outlet Protection using Articulated Concrete Block

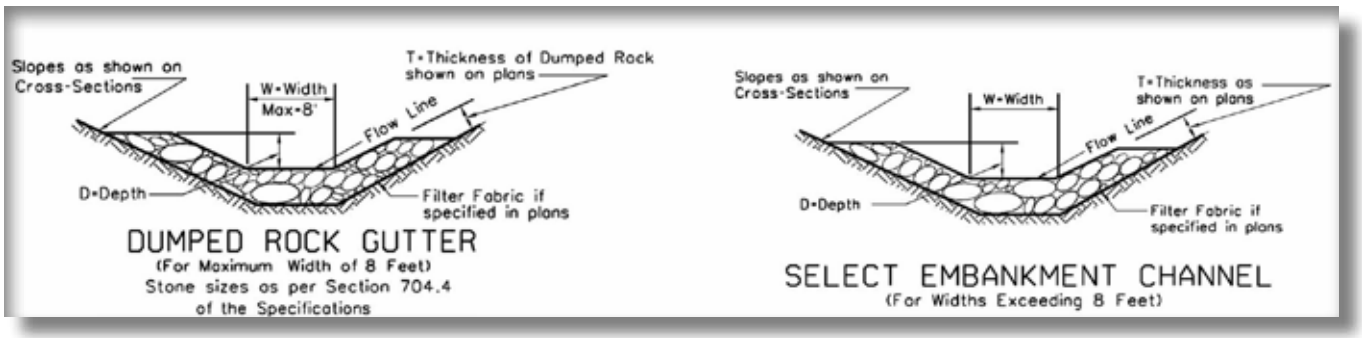
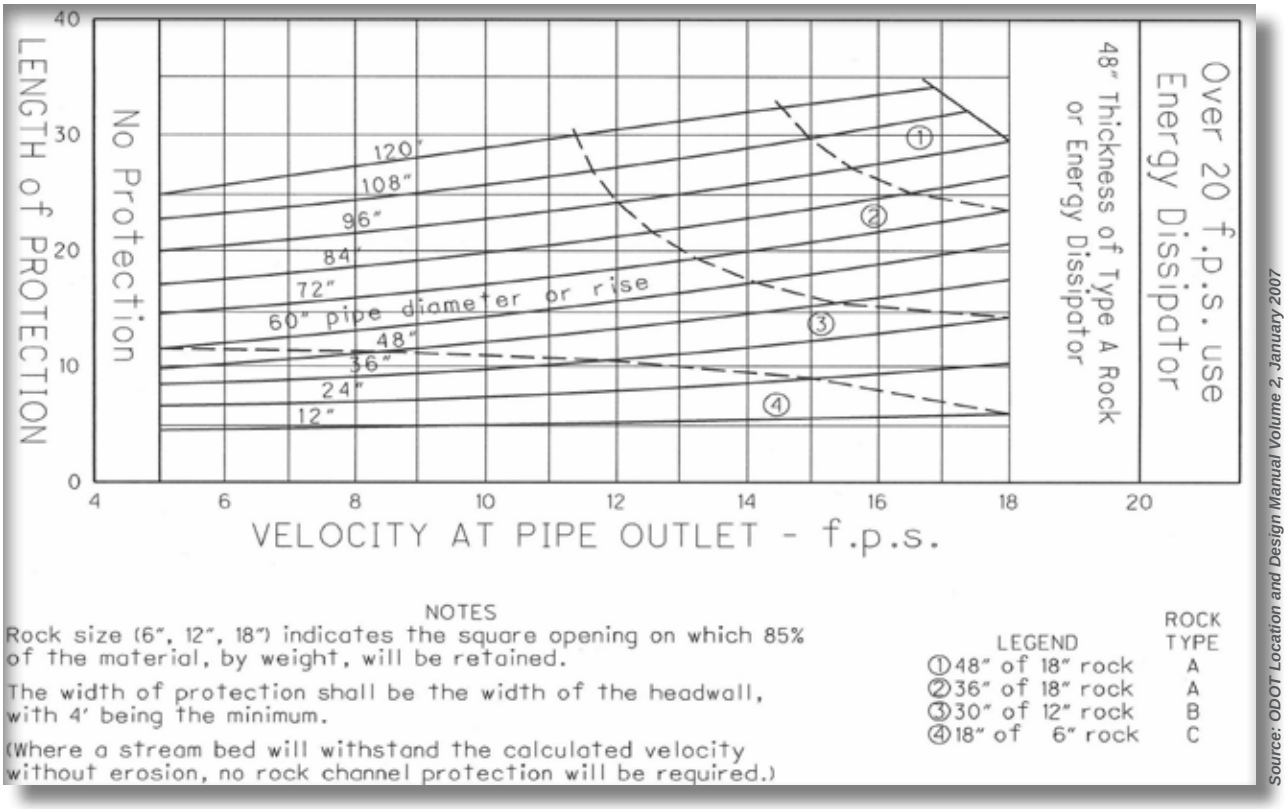


Diagram 5-12.1
Outlet Protection for Channel Flow.



Detail 5-12.3
Outlet Protection Sizing Design

1. Diagram 5-12.3 shall be used to find the design length, riprap thickness and size based upon velocity and pipe size. If using a pipe size is used that is not listed, use the next pipe size up from the given pipe.
2. Table 5-12.1 presents the acceptable velocity for certain soil types (courtesy of AASHTO Model Drainage Manual, 1991 Edition).

Table 5-12.1: Allowable Velocities for Soil Type

Soil Texture	Allowable Velocities (ft/s)
Fine Sand and Sandy Loam	2.5
Silt Soils	3
Silt or Clayey gravel and sand	3.5
Clayey Soils	4.0
Clay, Fine Grave	5.0
Cobbles	5.5
Shale	6.0

3. Man-made energy dissipater devices are considered on a case-by-case basis and shall be installed per manufacturer recommendations. The velocity and flow volume are to be verified to be within the manufacturer recommended standards prior to use on a project.

5.12.4 Materials

Aggregate and riprap sizes are specified in the WVDOH Specifications Section 704.4.

5.12.5 Maintenance

All outlet protection devices shall be inspected at least once per week and after any rain event of 0.5 inches or greater during the duration of the project. Should any devices be damaged, a repair or replacement of that particular area is to occur immediately.

Figures 5-12.3 show examples of alterative installation of outlet protection.

Figure 5-12.3
Outlet Protection using Articulated Concrete Block

5.13 Level Spreaders

5.13.1 Control Description

Level spreaders are used to dissipate concentrated flows in order to reduce the erosive velocity prior to exiting the project site or entering a vegetative buffer area.

5.13.2 Control Uses and Applicability

Level spreaders, illustrated in Figure 5-13.1, are typically used at the end of a diversion ditch or channel to convert concentrated flow to sheet flow.

They can be used in both temporary and permanent applications.

Figure 5-13.1
Example of a Level Spreader

5.13.3 Design Criteria

To ensure the proper installation of level spreaders, illustrated in Figure 5-13.2, the guidelines shall be followed. See Detail 5-13.1 (page 5-34) for guidelines.

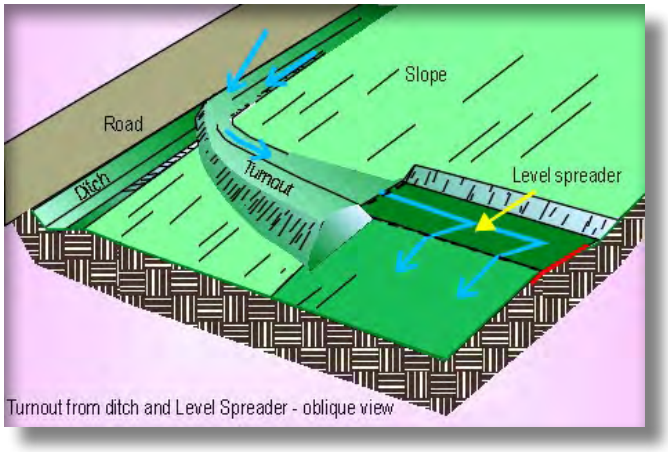


Figure 5-13.2
Installation of Level Spreader

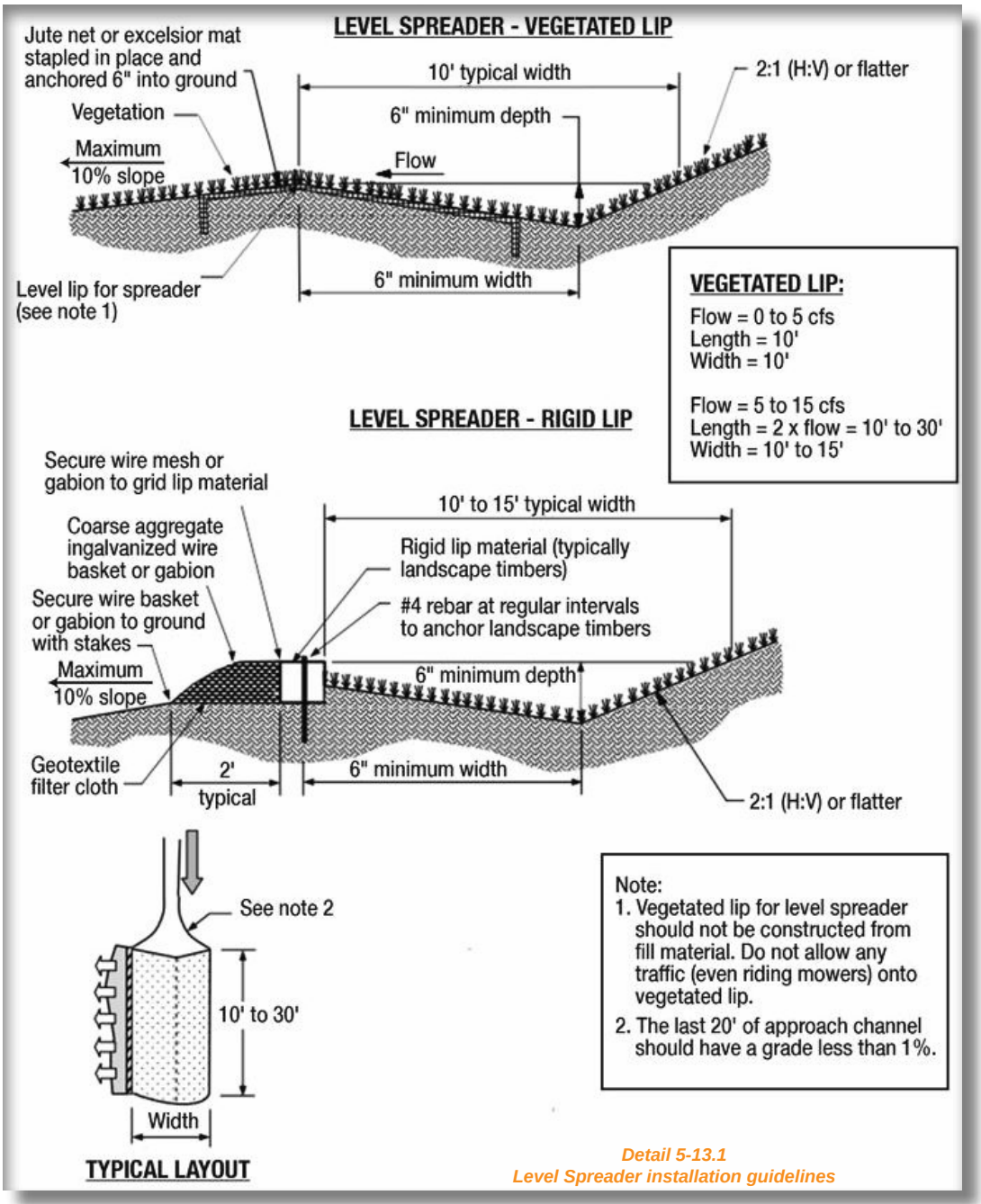
1. Level spreaders must be constructed on undisturbed soil.
2. Outlet slopes must be well vegetated with slopes less than 10% for spreaders to be effective.
3. The outflow lip shall be installed level to ensure even flow distribution and stabilized using stone or matting.
4. The device shall be designed to dissipate 0.25 cubic feet per second (cfs) per linear foot of spreader for the peak discharge of the 10-year.
5. If the level spreader is a permanent structure, its design must be approved by the City on a case-by-case basis.
6. Level spreaders shall be monitored often to ensure no erosion channels are forming.
7. The spreader entrance shall be shaped to ensure the runoff enters directly into the zero (0) percent slope channel.
8. A 20 ft transition section between the diversion channel and the spreader shall be required.
9. For stone stabilization, a minimum of two (2) inches thick cover on a layer of filter fabric is required. After placement, the stone shall be covered with a galvanized wire mesh and stapled to secure the material in place.

5.13.4 Materials

On-site soil shall be used whenever possible to assist with installation of the spreaders. The cover of stone shall consist of AASHTO #1, #2, or #3 stone throughout the project at all spreader locations.

5.13.5 Maintenance

All level spreaders shall be inspected at least once per week and after any rain event of 0.5 inches or greater during the duration of the project. Should any section be damaged, a repair or replacement of that particular section or areas of channelization are to occur immediately. Traffic shall be prevented over or on the spreaders to ensure a flat grade is maintained.



Detail 5-13.1
Level Spreader installation guidelines

Courtesy of Stormwater ONE, LLC.

5.14 Sediment Traps

5.14.1 Control Description

A sediment trap is an excavated stormwater storage device used for short term sediment control to trap and store sediment as well as to reduce the velocity of flow. The sediment trap shall be stabilized by seeding and mulching whenever possible with the addition of a rip-rap stabilized outlet.

5.14.2 Control Uses and Applicability

Sediment traps, illustrated in Figures 5-14.1 and 5-14.2, are to be used as a temporary or permanent outlets, at the bottom of temporary diversions or channels, at the inlet of culverts under roadways, and above stormwater inlets that receive sediment runoff. If the drainage area does not exceed five (5) acres, a sediment trap is sufficient for stormwater storage, However, drainage areas greater than five (5) acres require the use of a sediment pond.

Figure 5-14.1
Sediment Trap

Figure 5-14.2
Sediment Traps in series

5.14.3 Design Criteria

To ensure the sediment traps are properly designed and constructed, use the following guidelines below and also see Table 5-14.1, (page 5-36) and Detail 5-14.1 on (page 5-37)

1. The sediment trap shall have a storage volume of 3,600 cubic feet per acre of drainage area.
2. Half of the sediment trap volume (1,800 of min.) shall be used for wet storage while the other half is used for dry storage.
3. The sediment trap embankment must not exceed five (5) feet in height.
4. Inside slopes of the sediment trap shall have a maximum slope of 2:1 and outside slopes shall have a maximum slope of 3:1.
5. The sediment trap outlet shall be a minimum of four (4) feet wide or two (2) feet plus two (2) feet for each addition acre of drainage i.e. 12' for 5 acres.
6. The sediment trap shall have two (2) times the length as the width.
7. A stabilized pipe or weir outlet shall be present for every trap on the project.
8. If a pipe is used for outlet, it shall be installed in six (6) inch lifts with a minimum of two (2) feet of cover over the pipe if there is traffic is prevalent in the vicinity.

9. Riser structures used shall be designed to prevent flotation.
10. The stone outlet shall have a thickness of one (1) foot of a combination of one (1) to one and one half (1 ½) inch stone and two (2) to eight (8) inch rip rap.
11. The crest of the outlet must be at least one (1) foot lower than the top of the sediment trap.
12. An overflow should be installed to direct water toward the nearest channel if the primary discharge flow becomes obstructed.
13. For ease in cleaning and site safety, the maximum depth of the wet storage shall not exceed four (4) feet.

Table 5-14.1: Sediment Trap Size

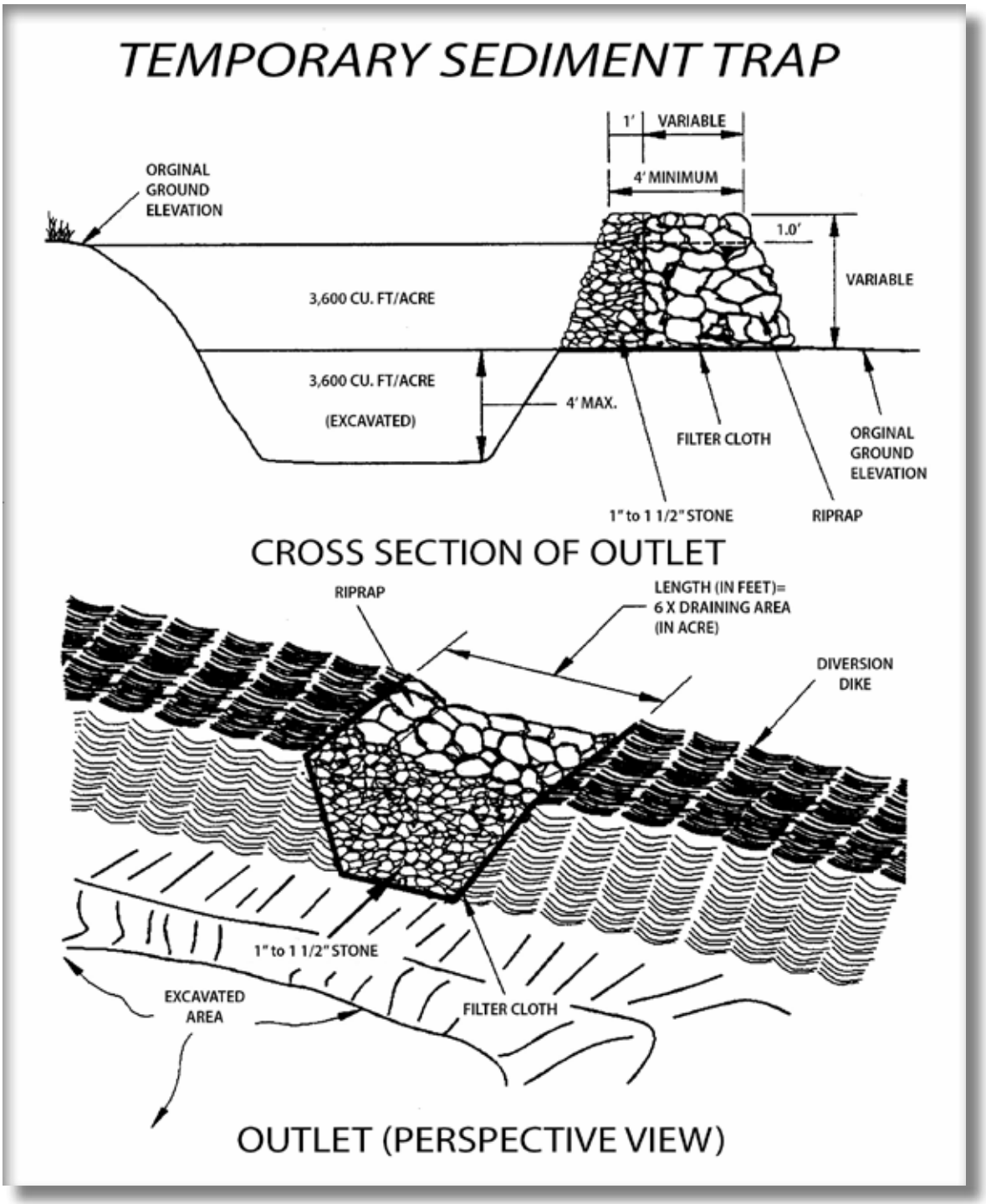
Maximum Drainage Area (Acres)	Minimum Size Outlet Diameter (inches)	Minimum Size Riser Diameter (inches)
1	12	15
2	15	18
3	18	21
4	21	24
5	21	27

5.14.4 Materials

On site soil shall be used whenever possible in the design and construction of sediment traps. The use of cohesive and compactible soil is required.

5.14.5 Maintenance

The sediment trap shall be inspected at least once per week and after any rain event of 0.5 inches or greater during the duration of the project. Should any section of the sediment trap become damaged, a repair of that particular area must occur immediately. The sediment trap shall be cleaned out prior to the wet storage volume being reduced by half.



Detail 5-14.1
Temporary Sediment Trap

5.15 Sediment Ponds

5.15.1 Control Description

Sediment ponds or basins are earthen structures designed to remove sediment from construction stormwater runoff. Typically these structures are dewatered by either an engineer designed riser or a skimmer system and are often converted from a temporary sediment removal system to a permanent stormwater facility after construction has been completed.

5.15.2 Control Uses and Applicability

Sediment ponds or basins are applicable to projects containing drainage areas between five (5) to 100 acres. These ponds or basins shall be located in an area convenient for cleaning and where runoff from the site will naturally occur when possible. In addition, the ponds or basins should be constructed in a location that will minimally impact the construction activities of the project. See Figures 5-15.1, 5-15.2 and 5-15.3 for examples of sediment ponds.

Structures with a height of 25 feet or greater, measured from the crest to downstream toe and with a storage volume of more than 15 acre-feet, are subject to the West Virginia Dam Safety Act and permitting requirements under that program.

5.15.3 Design Criteria

To ensure the sediment ponds or basins are properly designed and constructed see Detail 5-15.1 (page 5-40), the followings guidelines shall be adhered to:

1. Sediment ponds or basins are required to dewater the dry storage volume in no less than 48 hours for proper sediment removal but may not exceed 72 hours.
2. Sediment ponds or basins shall be designed to have a primary dewatering device to carry a 2-year storm and provide overflow to safely

Figure 5-15.1
2 Stage Sediment pond with Forebay and overflow

Figure 5-15.2
Sediment Pond Outlet with trash protection

Figure 5-15.3
Sediment pond with silt fence filters

pass the 25-year storm with one (1) foot of free board. The 100-year storm shall be able to safely pass out of the sediment pond without damage to the embankment.

3. Sediment ponds or basins are not to be constructed near any stream that would require a Section 404 Permit from the US Army Corp of Engineers without the consent of the City.
4. The basin length to width ratio should be at least than 2:1, with 4:1 being the optimal design.
5. Structures should be created in a wedge shape with the inlet at the narrow end. When possible, the outlet should be lined up with the inlet.
6. The volume design should be at least 3,600 cubic feet per acre as measured from the crest of the principle overflow.
7. Half of the trap volume shall be used for wet storage, while the other half is used for dry storage.
8. Sediment pond features must be designed for a project's anticipated construction life plus two (2) additional years.
9. Detailed dewatering calculations must be submitted to the City for approval.
10. All pipe connections shall be watertight.
11. A watertight anti-seep collar shall be installed around the primary discharge pipe.
12. The over flow (emergency spillway) must have a width of at least eight (8) feet with 3:1 or flatter side slopes and a minimum length of 20 feet. The over flow shall outlet to a defined channel downstream of the sediment pond.
13. Dam top widths must meet maximum requirements shown in Table 5-15.1.

Table 5-15.1: Dam Top Widths

Fill Height	Minimum Top Width
Less Than 10 ft	8.0 ft
10 ft to 15 ft	10.0 ft
16 ft to 25 ft	15.0 ft

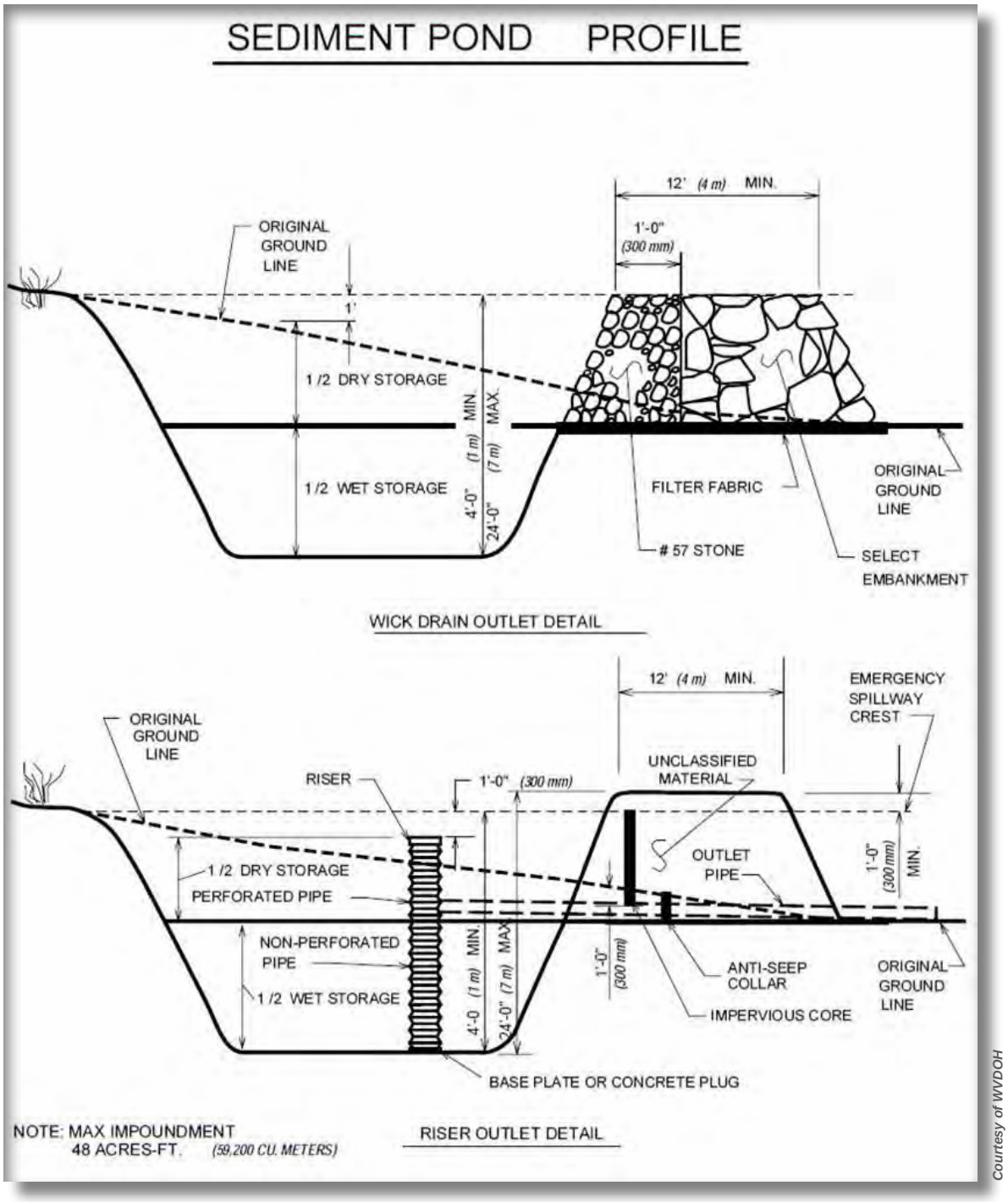
14. The side slopes shall never exceed 2:1 with the total slope of both sides equaling 5:1, e.g. a 2:1 and a 3:1 slope.
15. A minimum of two (2) baffles shall be provided to distribute flow evenly.
16. All sediment ponds must be designed by a Registered Professional Engineer.

5.15.4 Materials

Onsite soil shall be used whenever possible in the design and construction of sediment traps.

5.15.5 Maintenance

The sediment trap shall be inspected at least once per week and after any rain event of 0.5 inches or greater during the duration of the project. Should any section of the trap become damaged, a repair of that particular area must occur immediately. The trap shall be cleaned out prior to the wet storage volume being reduced by half.



Courtesy of WVDOH

Detail 5-15.1
Temporary Sediment Pond