



PURDUE
UNIVERSITY

Underdrain Construction

Guidelines for
Inspectors and
Contractors

Underdrain Installation

Construction Methods of Underdrains

Although a relatively simple operation, the proper installation of underdrains plays an important role in determining the life of any type of pavement.

The following presentation contains “Points of Emphasis” for construction of underdrains. It is recommended viewing for any INDOT or consultant team involved in a contract that includes this type of work. It is further recommended that, prior to construction, the presentation be viewed jointly by the inspection team and any contractor personnel that will be specifically responsible for constructing underdrains on their project.

Trenching Machine

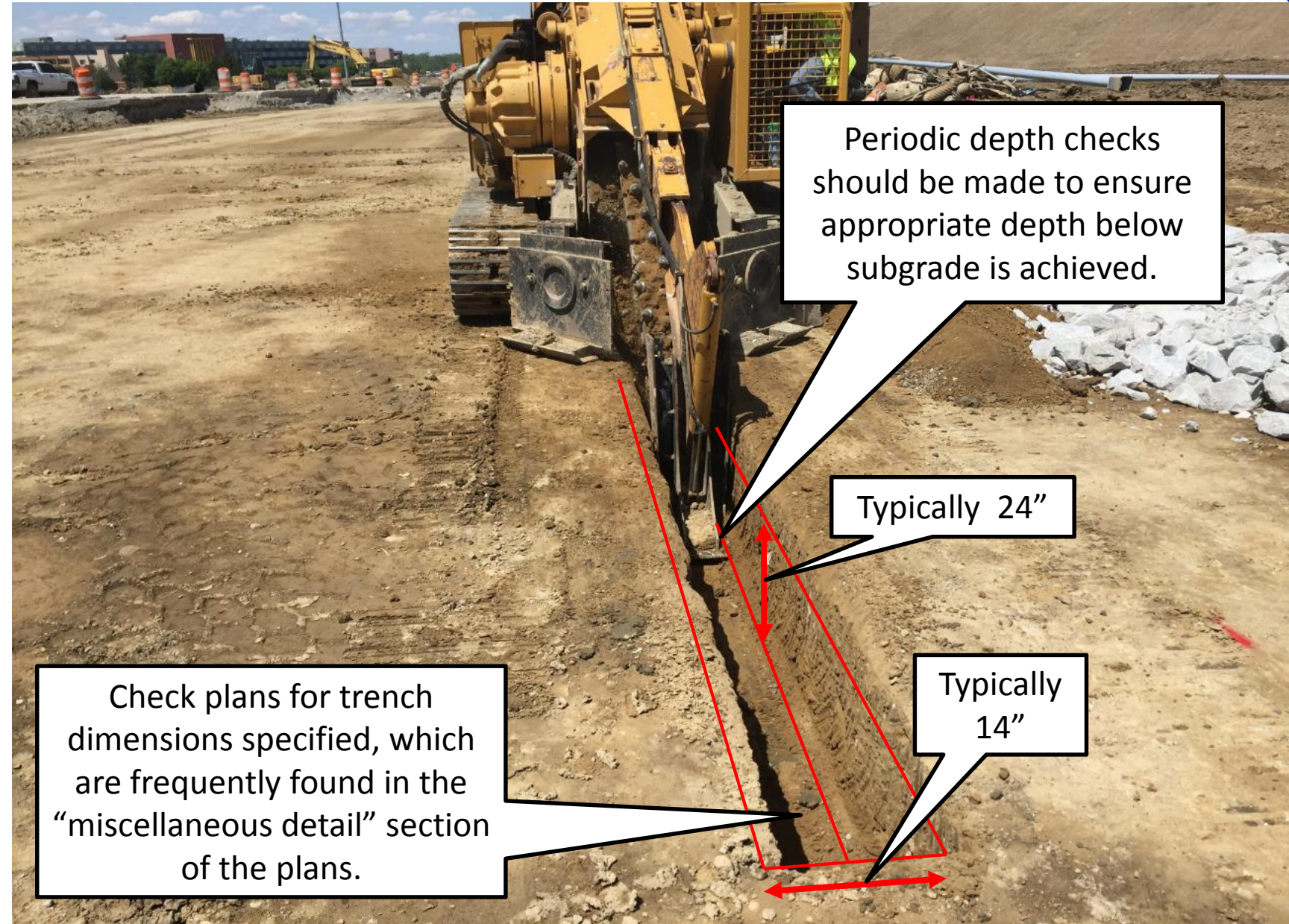
Underdrain Installation



Whether a trencher is used or the material is hand-dug, loose material, including clumps, at the bottom of the trench should either be removed or compacted in order to keep drainage from being compromised.

Trenching Machine

Underdrain Installation



Periodic depth checks should be made to ensure appropriate depth below subgrade is achieved.

Typically 24"

Typically 14"

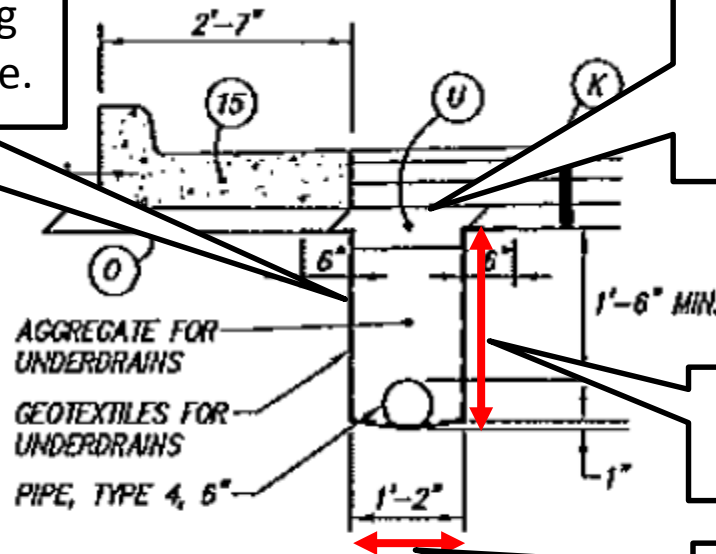
Check plans for trench dimensions specified, which are frequently found in the "miscellaneous detail" section of the plans.

Typical Cross Section

Underdrain Installation

Underdrains prevent water from accumulating under the pavement and causing premature subgrade failure.

Open-graded material placed directly above the underdrain helps move water out from between asphalt layers.



Depth:
24"

Width:
14"

UNDERDRAIN DETAIL
SCALE 1"=2'

Underdrain Tables

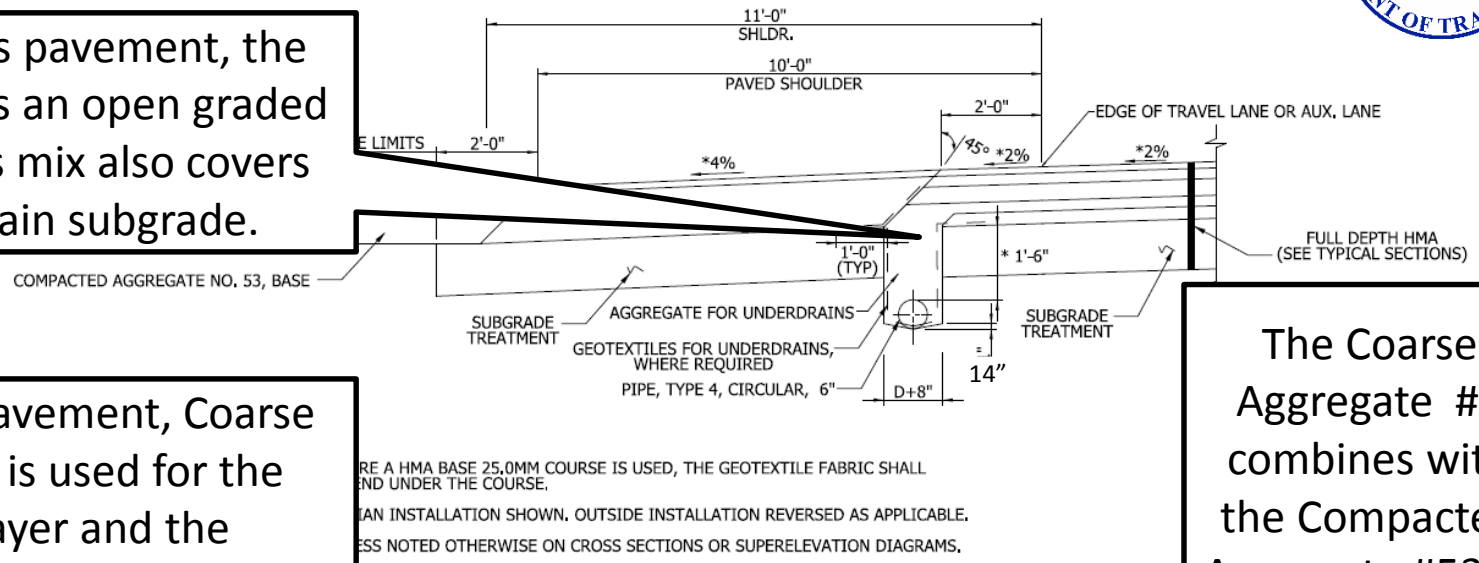
Underdrain Installation



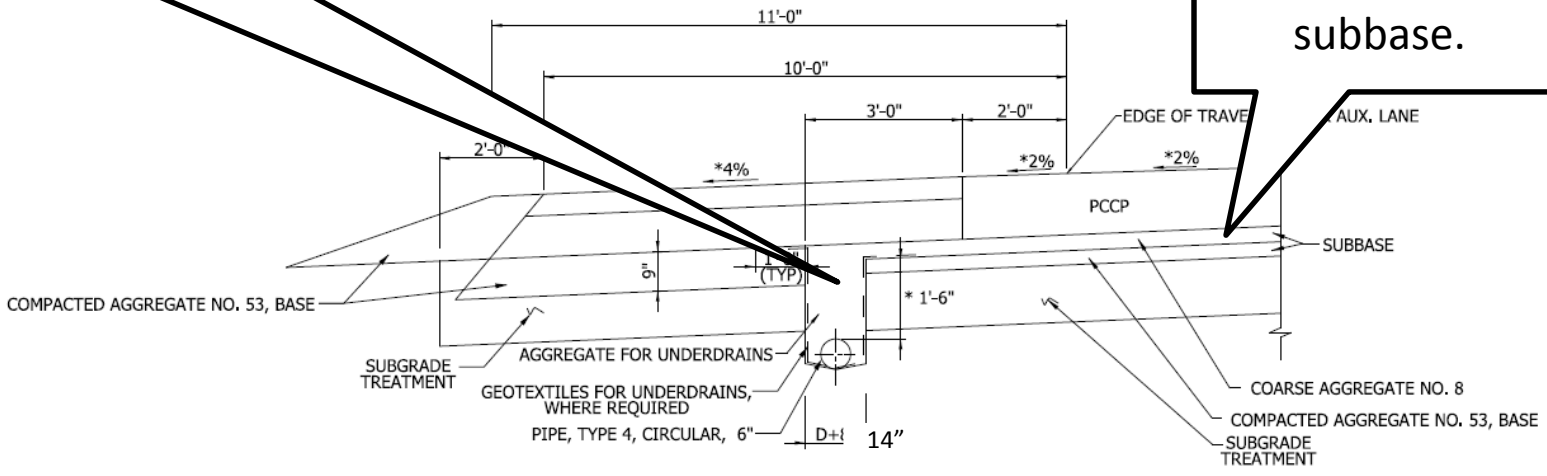
For bituminous pavement, the drainage layer is an open graded HMA mix. This mix also covers the underdrain subgrade.

For concrete pavement, Coarse Aggregate #8 is used for the drainage layer and the underdrain aggregate.

The Coarse Aggregate #8 combines with the Compacted Aggregate #53 to form the subbase.



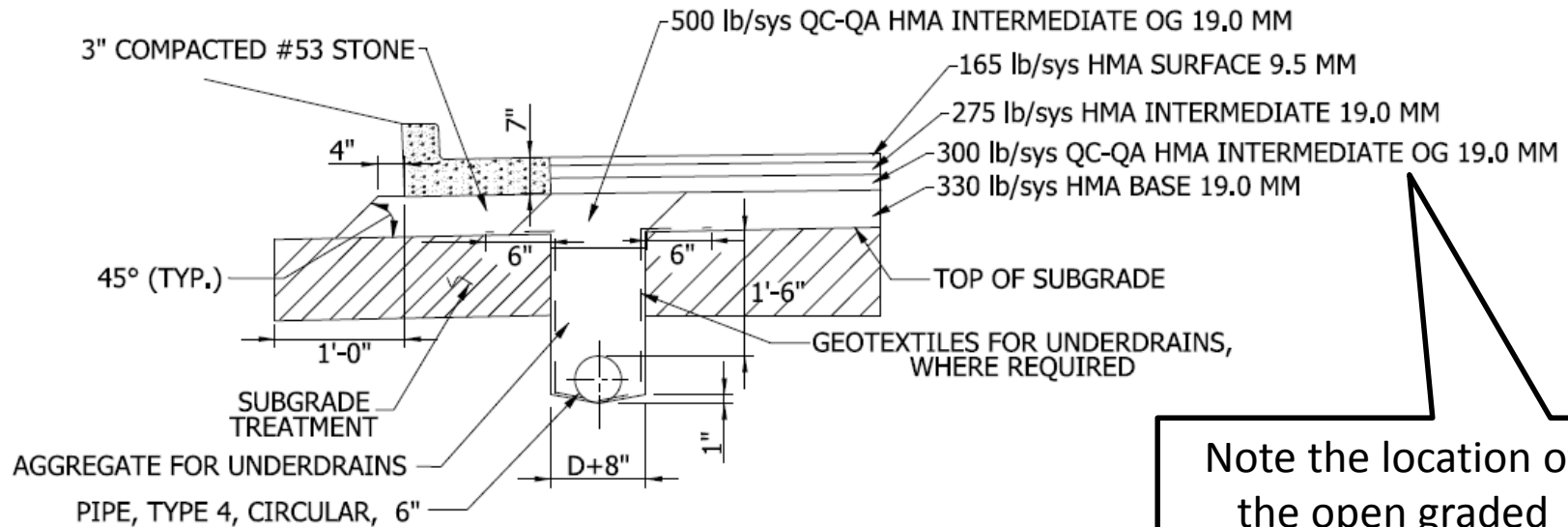
UNDERDRAIN DETAIL FOR H.M.A. MAINLINE



UNDERDRAIN DETAIL FOR PCCP MAINLINE

Underdrain Tables

Underdrain Installation



UNDERDRAIN DETAIL FOR CURB AND GUTTER

Note the location of the open graded material within the layers of a typical HMA mix.

Underdrain Tables

Underdrain Installation

Outlet elevation essentially determines the offset. Once the outlet elevation is staked, be sure it is in a location that is practical.

Outlet Stations

Outlet Elevations

UNDERDRAIN TABLE

OUTLET PIPE

OUTLET PROTECTORS

LINE / Station	LFT	LFT	(syd)	(cys)	(Tons)	%	Flow Underdrain	Outlet (Y/N)	Connect to Structure	Structure	Invert Elevation	45 Degree Elbows Required (ft)	Outlet Pipe LFT	Outlet Station	Outlet Elevation	Outlet at Outlet Protector No.	Ditch Flow Line Elevation at Outlet Protector	Connect Outlet Pipes to Structure No.	Structure Invert Elevation	Borrow for Structure Backfill (cys)	HMA for Underdrains (tons)	Outlet Protector No.	Outlet Protector Type	Location				Remarks					
																								Outside Left	Median Left	Median Right	Outside Right						
LINE "A-SWR"	30+50.00	28+50.00	400.0	88.0	36.0		743.32	N				2	40	28+50.00	736.00		728.39					27	1								X		
	34+50.00	30+50.00	400.0	88.0	36.0		759.49	N				2	40	30+50.00	743.00		738.00					28	1								X		
	38+50.00	34+50.00	400.0	88.0	36.0		759.49	N				2	29	34+50.00	759.00		745.66					29	1								X		
	41+07.52	40+14.77	92.8	20.4	8.3		787.47	N				2	52	39+00.02	784.00		761.64					30	1								X		
LINE "A-SWRL RT"	25+58.18	24+35.64	150.5	33.1	13.5		787.18	N				2	46	24+35.64	784.00		761.64					32	1								X		
	24+35.64	22+70.00	165.6	36.4	14.9		785.01	N				2	19	22+70.00	779.00		765.67					31	1								X		
	28+72.00	24+35.64	236.4	52.0	21.3		786.61	N				2	18	24+35.64	784.00		761.64					32	1								X		
	904+00.00	904+00.00						Y					10	904+00.00	739.90		734.00					33	1		X						Connect to Existing Field Verify Elevations		
	909+45.00	910+23.00						Y	2331	737.28	1	82	910+23.00	737.57																	X	Connect to Existing Field Verify Elevations	
	909+45.00	909+57.00						Y	2312	740.00	1	13	909+57.00	741.40																	X	Connect to Existing Field Verify Elevations	
	922+66.00	919+07.00						Y			2	360																			X	Remove 72' Ex. & Connect Field Verify Elevations	
	927+48.00	927+72.00						Y			1	40	927+72.00	768.38			768.30					35	1								X	Remove 37' Ex. & Connect Field Verify Elevations	
	933+70.00	931+63.00						Y			2	184																			X	Remove 10' Ex. & Connect Field Verify Elevations	
	936+20.00	935+20.00						Y			2	5	931+63.00	778.40			776.80															X	Connect to Existing Field Verify Elevations
	938+00.00	938+00.00						Y			1	22	938+00.00	784.67			780.50															X	Connect to Existing Field Verify Elevations
	941+25.00	941+25.00						Y			20		941+25.00	786.55			786.05															X	Connect to Existing Field Verify Elevations
	944+25.00	944+25.00						Y					22.00	944+25.00	789.00																	X	Connect to Existing Field Verify Elevations
Sheet Totals			0	1848	406	167	0						(ft)	1007							(cys)	0	(tons)	0	(each)	13							

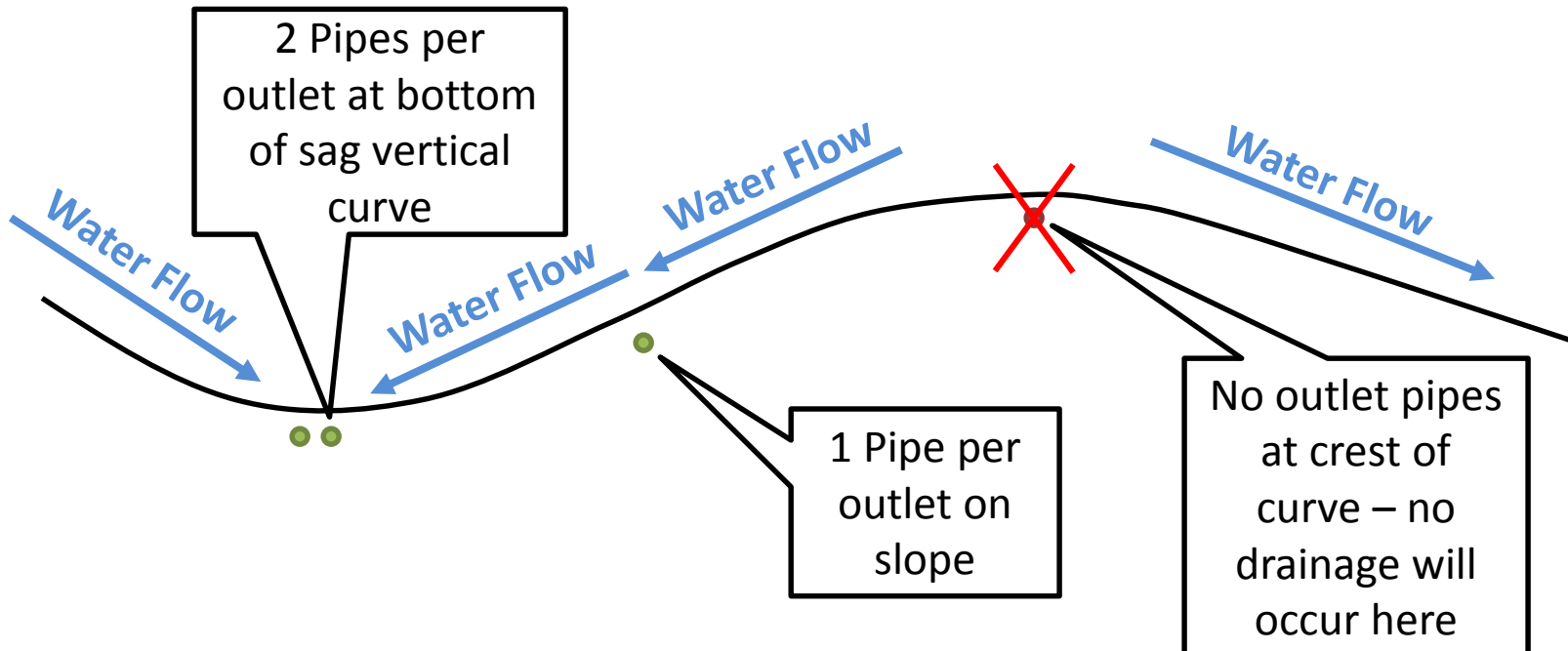
Underdrain table provides useful information regarding material quantities, locations, and instructions. Be sure to check planned outlet locations to determine if they make sense.

Underdrain Tables

Underdrain Installation

Field conditions must be checked to make sure of the following:

- Outlets must be placed at the sags of vertical curves
- Two outlet pipes must be placed at the sags of vertical curves to accommodate water draining from two different directions
- Appropriateness of locations on the slope (offset)

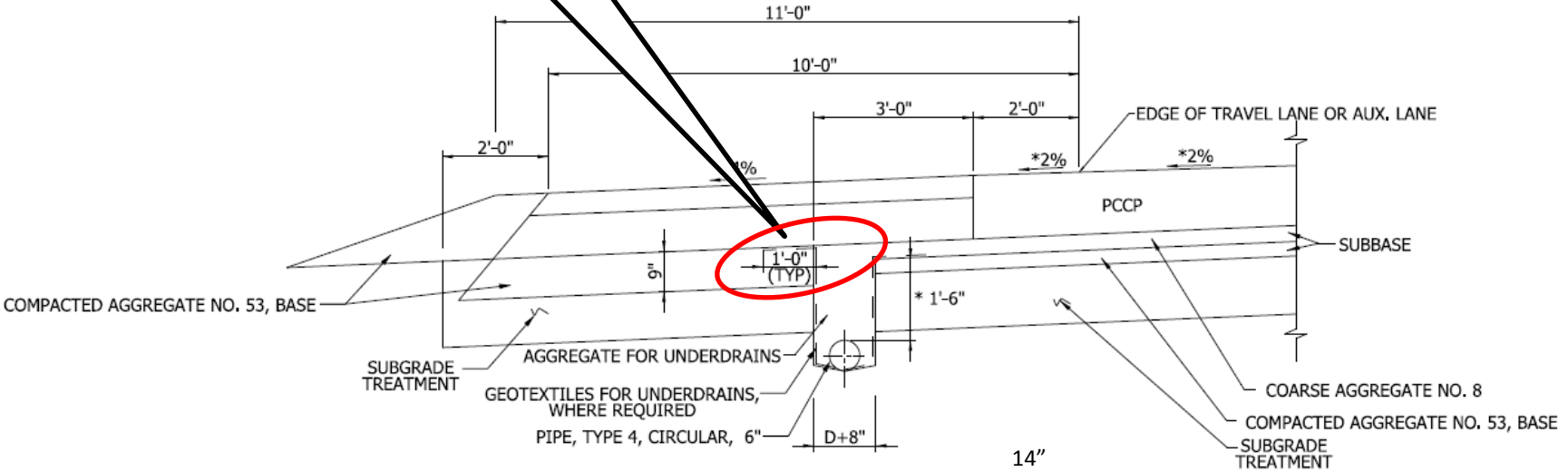
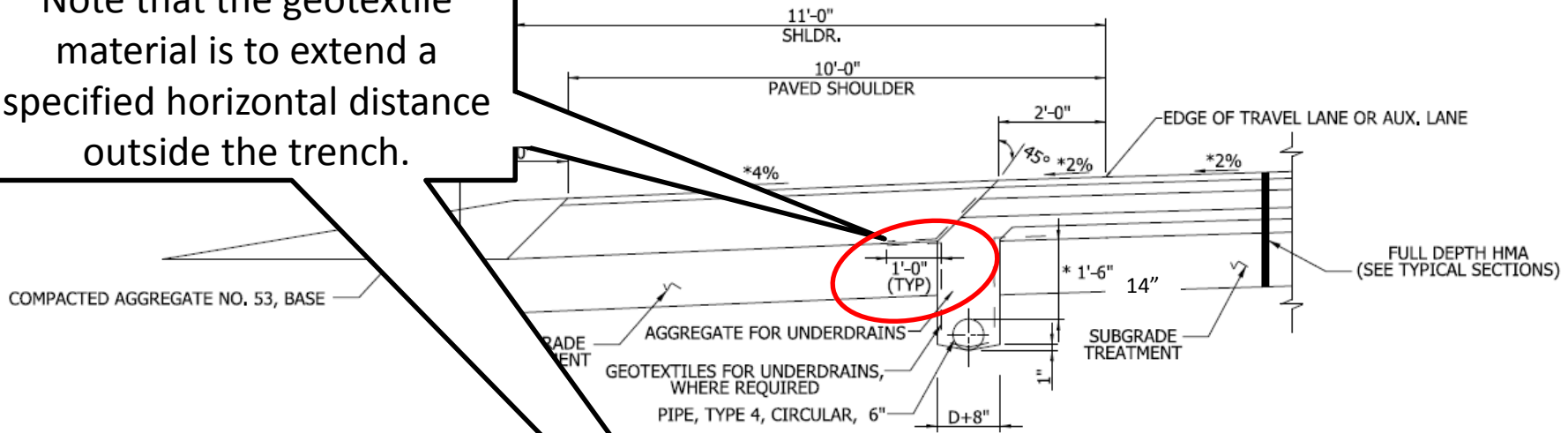


Underdrain Tables

Underdrain Installation



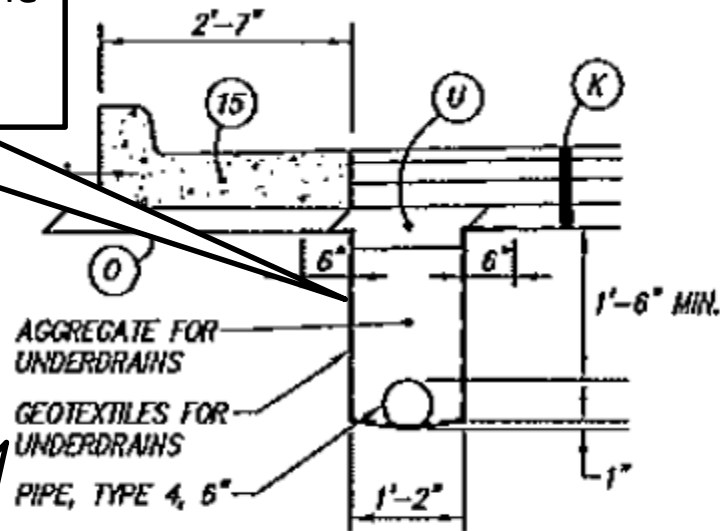
Note that the geotextile material is to extend a specified horizontal distance outside the trench.



UNDERDRAIN DETAIL FOR PCCP MAINLINE

Typical Cross Section Underdrain Installation

Geotextile material will be specified by the plans to line the trench.



AGGREGATE FOR
UNDERDRAINS

GEOTEXTILES FOR
UNDERDRAINS

PIPE, TYPE 4, 6"

UNDERDRAIN DETAIL

SCALE 1"=2'

Geotextile material is used to prevent "fines" from the surrounding soil from contaminating the aggregate backfill and hindering drainage.

Typical Cross Section

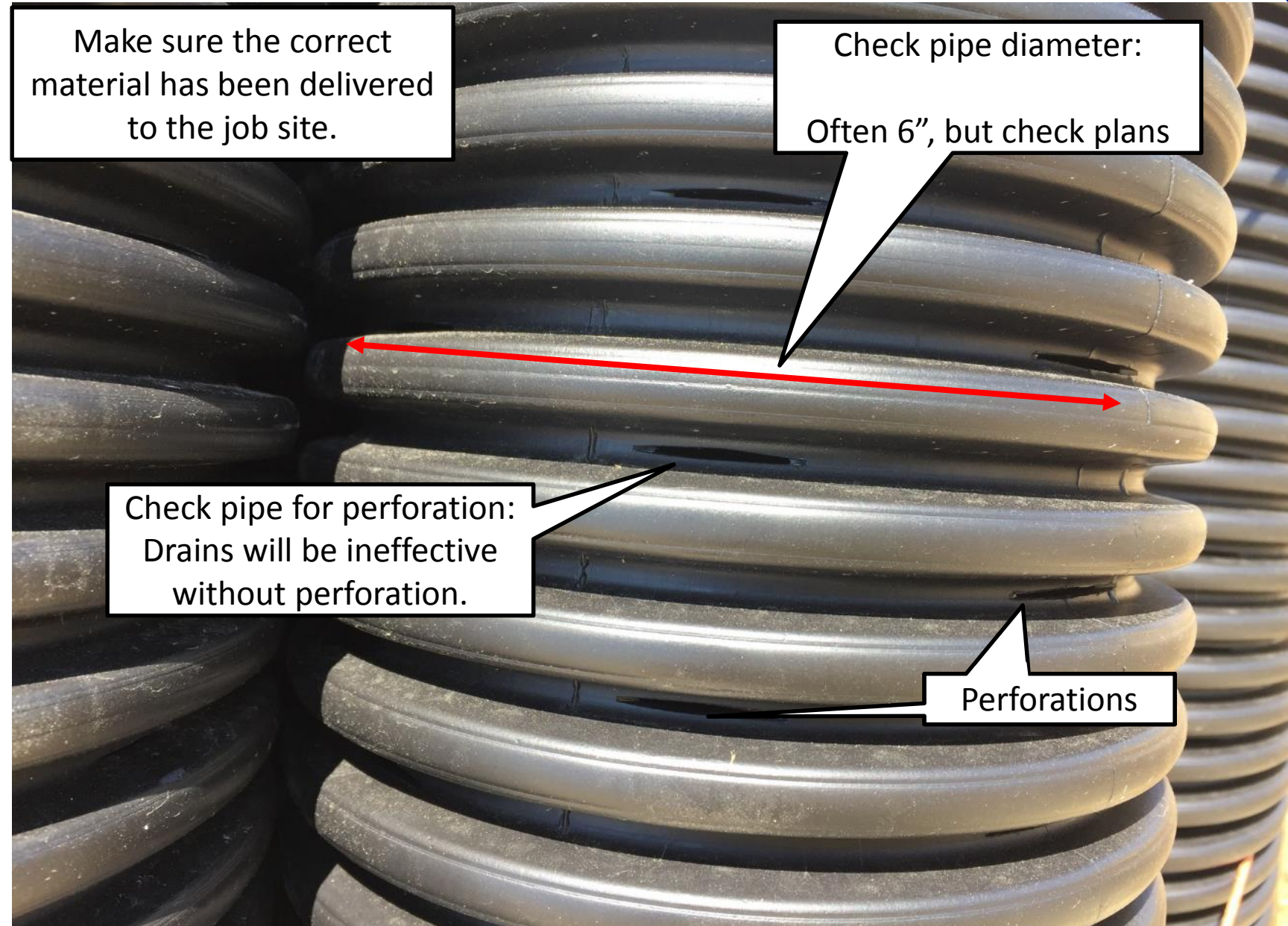
Underdrain Installation

Make sure the correct material has been delivered to the job site.

Check pipe diameter:
Often 6", but check plans

Check pipe for perforation:
Drains will be ineffective without perforation.

Perforations



Geotextile Material

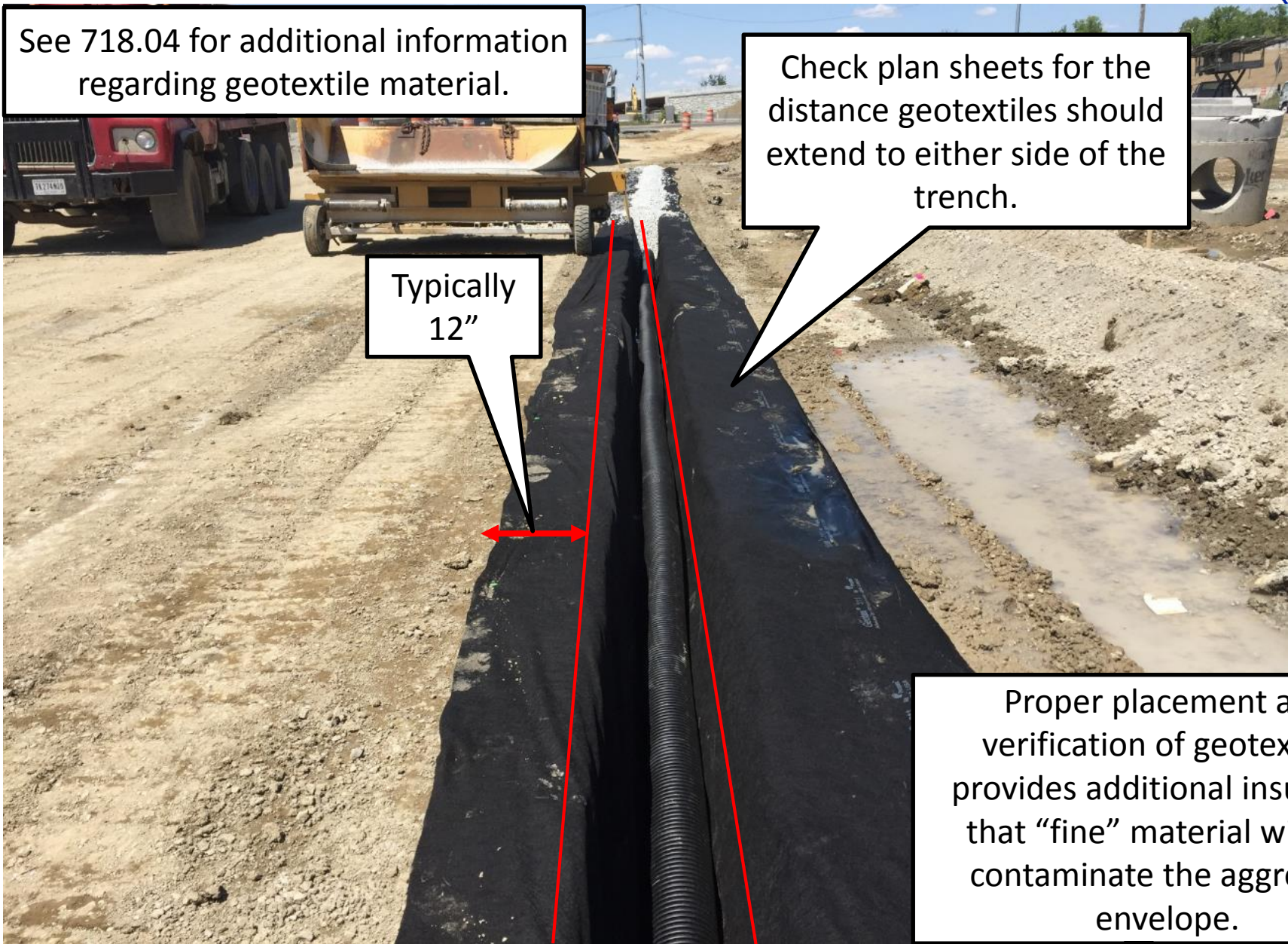
Underdrain Installation

See 718.04 for additional information regarding geotextile material.

Check plan sheets for the distance geotextiles should extend to either side of the trench.

Typically
12"

Proper placement and verification of geotextiles provides additional insurance that "fine" material will not contaminate the aggregate envelope.



Geotextile Material

Underdrain Installation



Fabric Pin

The upstream roll should overlap the downstream roll when placing a subsequent roll of material within a long run. This overlap should be a minimum of 1 foot, as per 718.04.

Pin the fabric as shown here to keep the fabric in place during paving

Aggregate Fill

Underdrain Installation



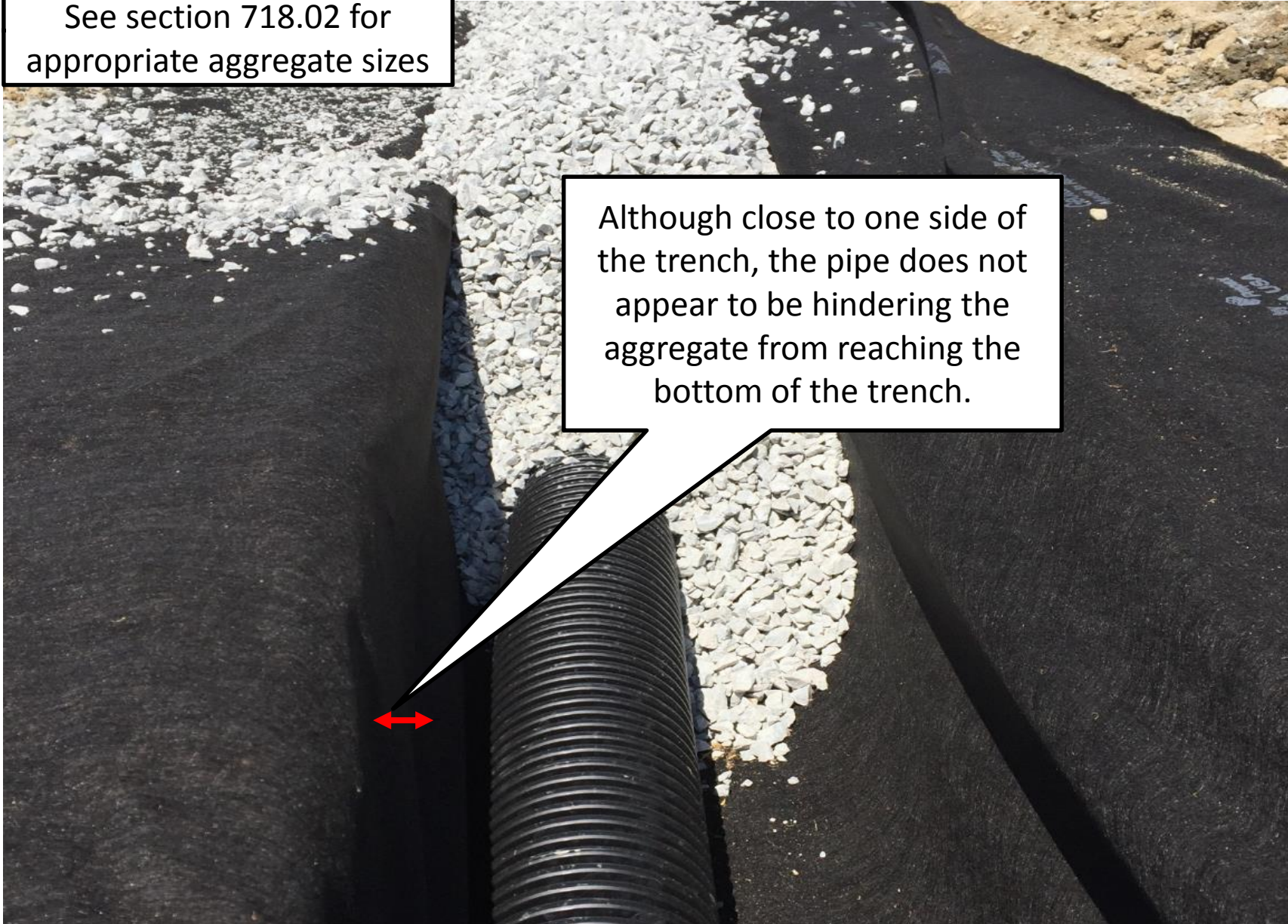
Aggregate should easily fall to both sides of the pipe.

Aggregate Fill

Underdrain Installation


See section 718.02 for appropriate aggregate sizes

Although close to one side of the trench, the pipe does not appear to be hindering the aggregate from reaching the bottom of the trench.



Aggregate Fill

Underdrain Installation



Aggregate should be removed from the fabric after placement

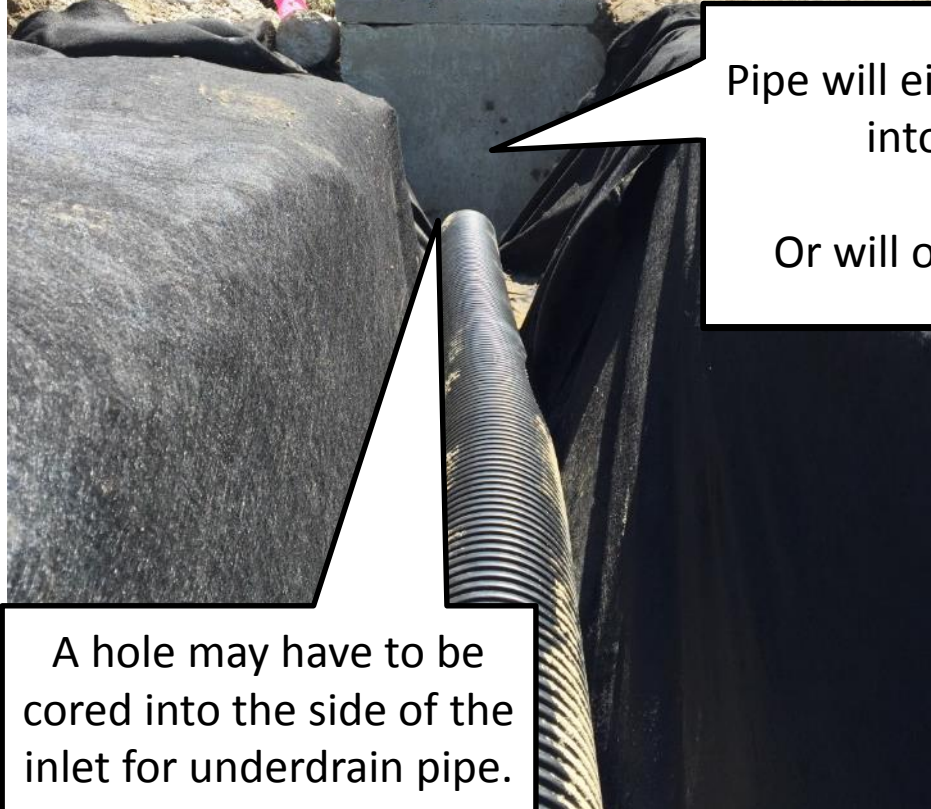
Fabric Pin

Pipe Outlets

Underdrain Installation



Recurring Plan Detail 718-R-639d contains important information about the various aspects of outletting an underdrain.



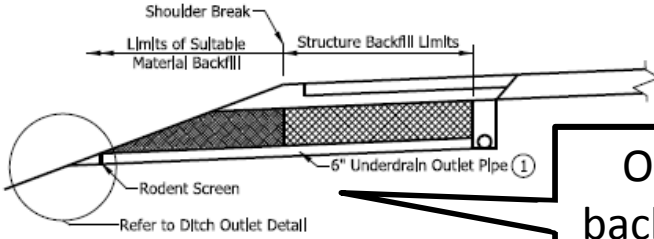
Pipe will either connect directly into a storm inlet
Or will outlet onto a slope.

A hole may have to be cored into the side of the inlet for underdrain pipe.



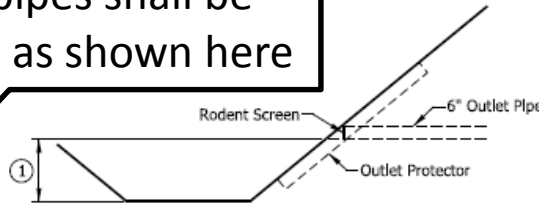
Pipe Outlets

Underdrain Installation

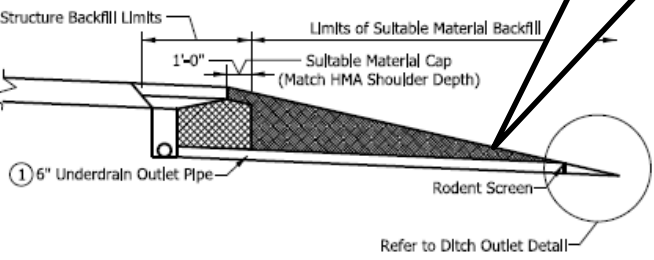


OUTSIDE SHOULDER INSTALLATION

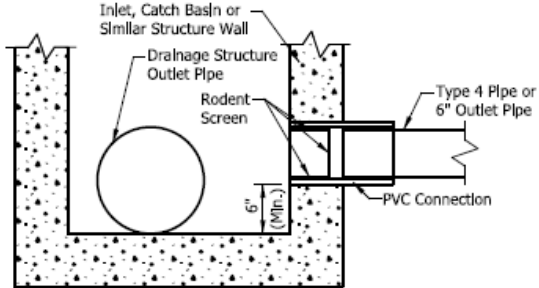
Outlet pipes shall be backfilled as shown here



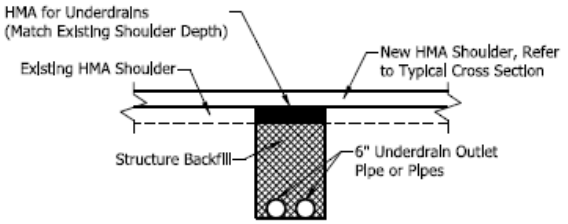
DITCH OUTLET DETAIL



MEDIAN SHOULDER INSTALLATION



DRAINAGE STRUCTURE OUTLET DETAIL



RETROFIT UNDERDRAIN OUTLET DETAIL (UNDER PAVED SHOULDER)

NOTE:

- ① If underdrain outlet pipe elevations are not shown on Underdrain Table, the minimum outlet pipe slope shall be 0.3%. The minimum freeboard between the outlet pipe outfall and the ditch line shall be 1'-0" for median ditches and 2'-0" for side ditches.

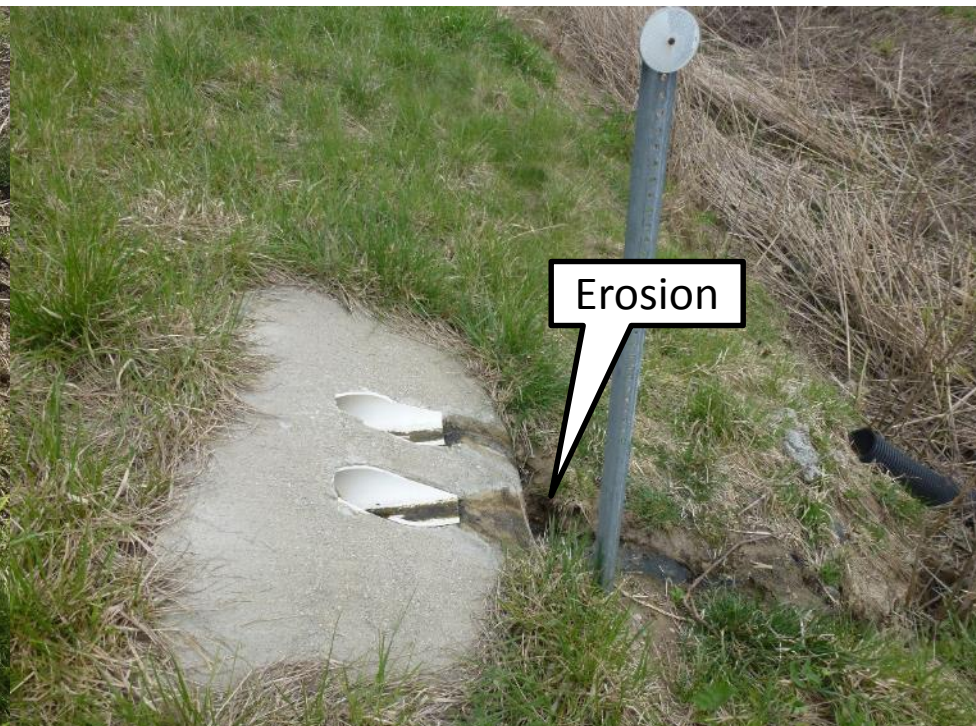
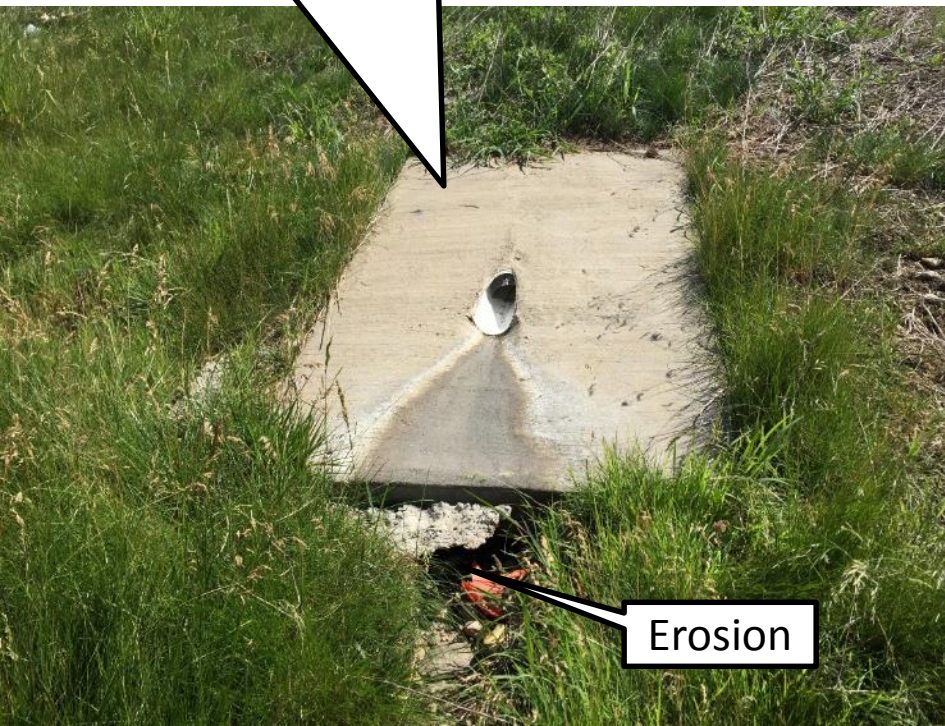
E 718-R-639d 3 of 7

Eff. for Lettings On or After 07-01-16

Pipe Outlets: Slope Outlet Underdrain Installation

When out-letting to a slope, outlet protectors are used.

It is a good idea to run the pipe as far down the slope as possible in order to avoid situations like this.



Pipe Outlets: Slope Outlet Underdrain Installation



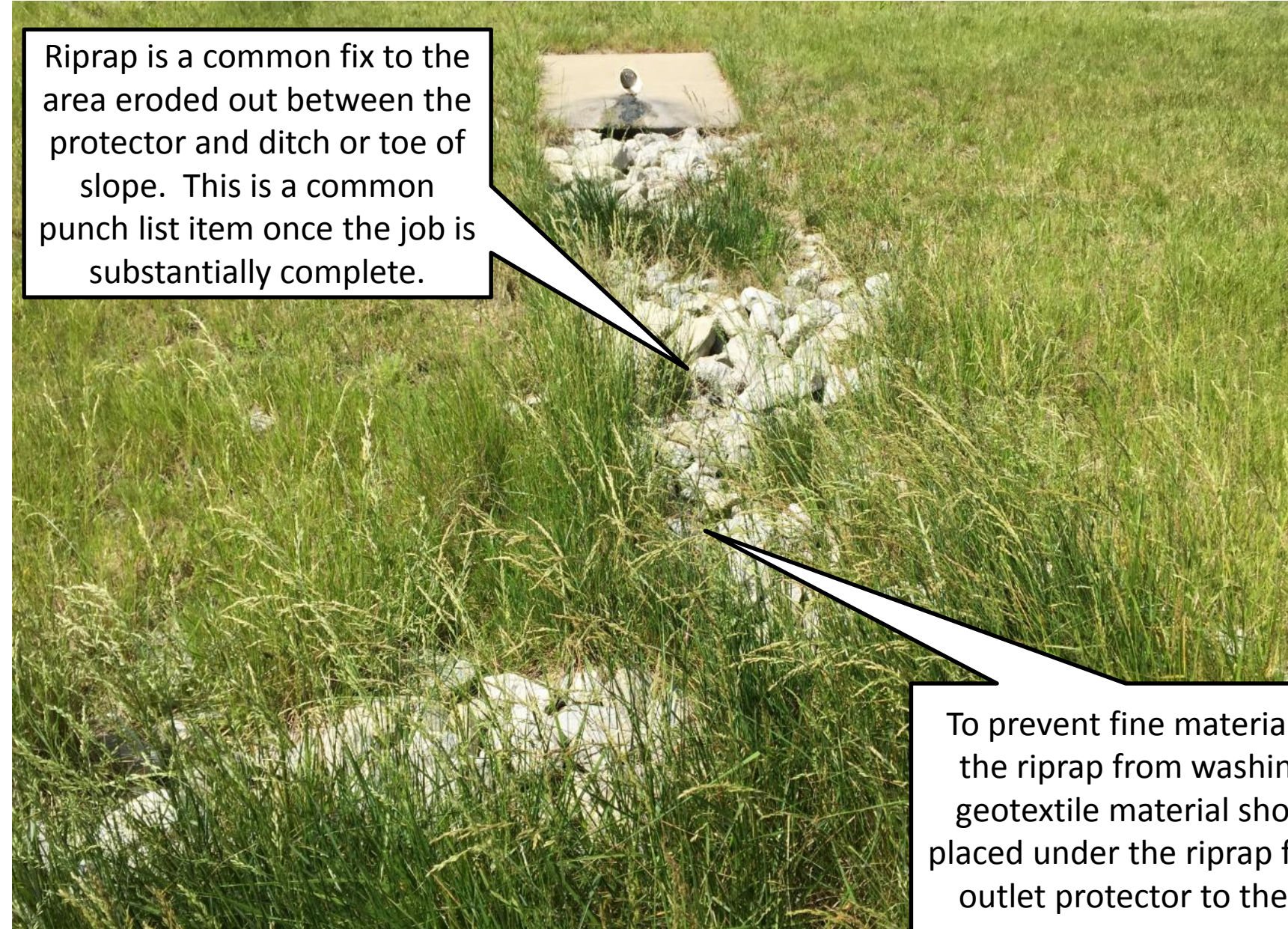
In many cases, it is not a matter of “if” the slope below the protector will wash out, but “when”. Although 718-R-639d indicates the placement of sod immediately below the protector, erosion will typically occur just below the limits of the sod.

It is not uncommon to place a strip of sod on either side of the protector to prevent erosion alongside the protector. However, unless good sod notches are cut, the slope will erode between the sod and the seeded area.

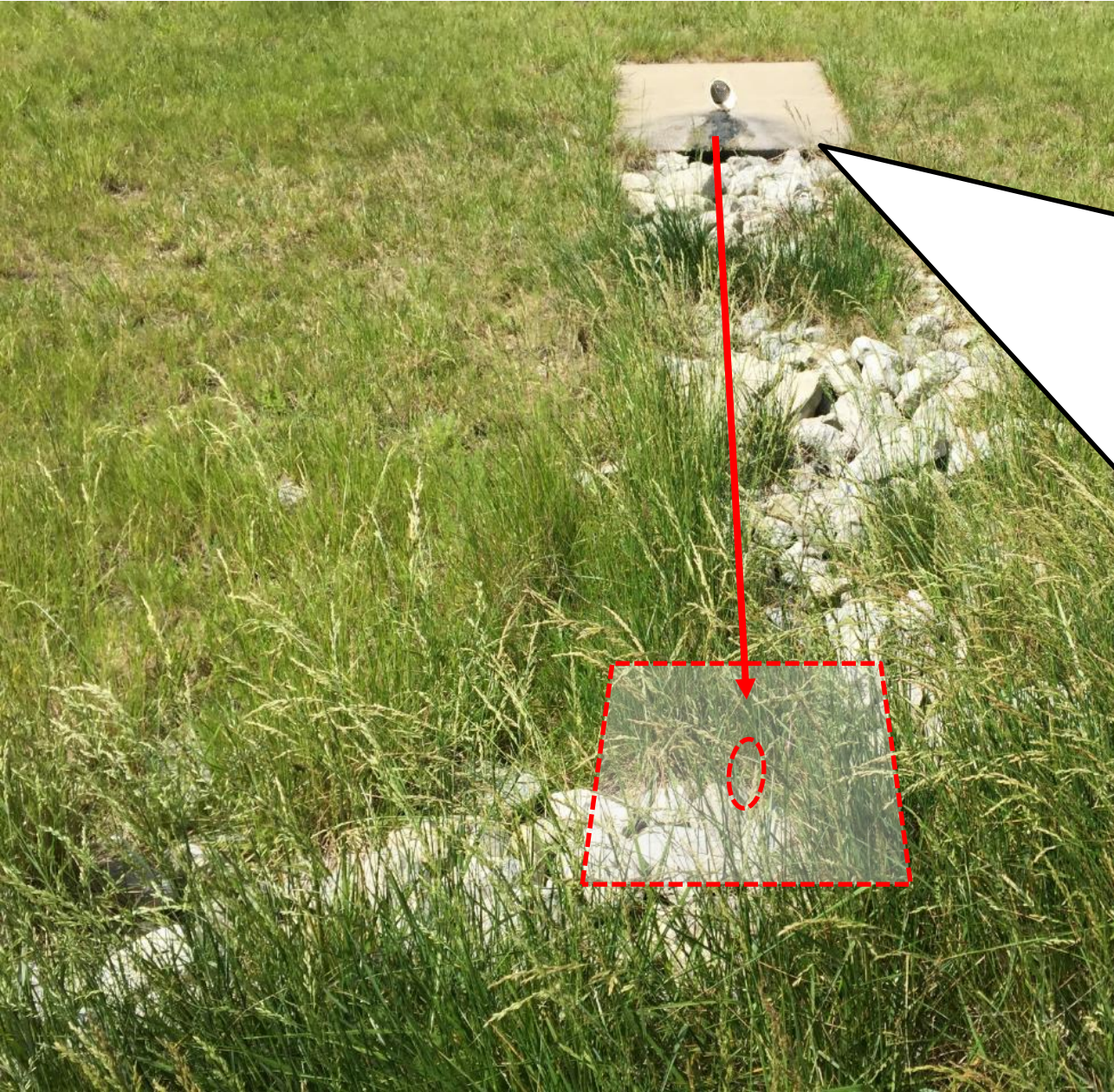
Pipe Outlets: Slope Outlet Underdrain Installation

Riprap is a common fix to the area eroded out between the protector and ditch or toe of slope. This is a common punch list item once the job is substantially complete.

To prevent fine material under the riprap from washing out, geotextile material should be placed under the riprap from the outlet protector to the ditch.



Pipe Outlets: Slope Outlet Underdrain Installation



To avoid spending money on riprap or even remobilizing a contractor's crew, consider extending the outlet pipe further down the slope and constructing the protector closer to the ditch line. A small amount of riprap can then be placed as a matter of course between the protector and the ditch line. Although pipe cost will increase, the cost to repair any eroded area by the contractor or by an INDOT maintenance crew is avoided in the future. See 718-R-639d (3 of 7, Note 1) for parameters regarding protector placement.

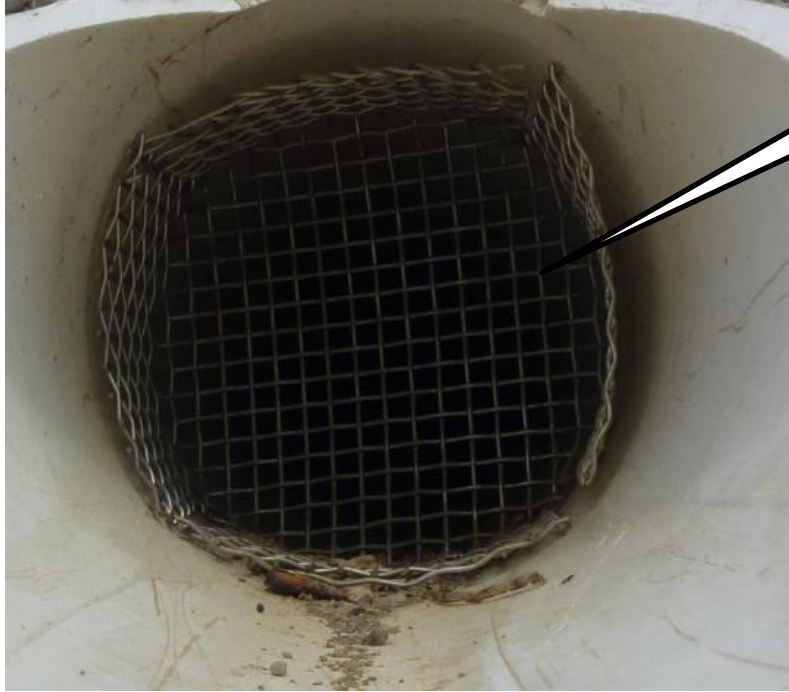
Pipe Outlets: Slope Outlet Underdrain Installation



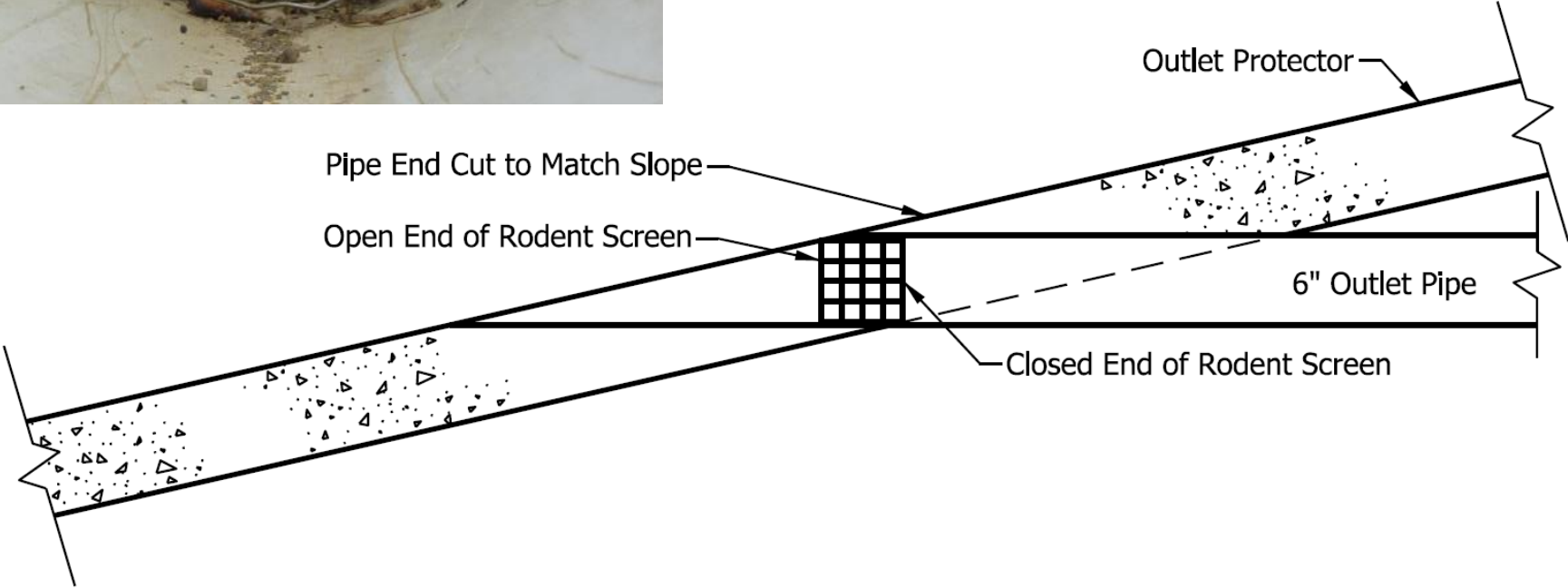
Here, the outlet protector was constructed close to the bottom of the slope. Any future repair of erosion below the protector can be performed easily and without heavy equipment.

Pipe Outlets: Rodent Screen

Underdrain Installation



Proper
Installation

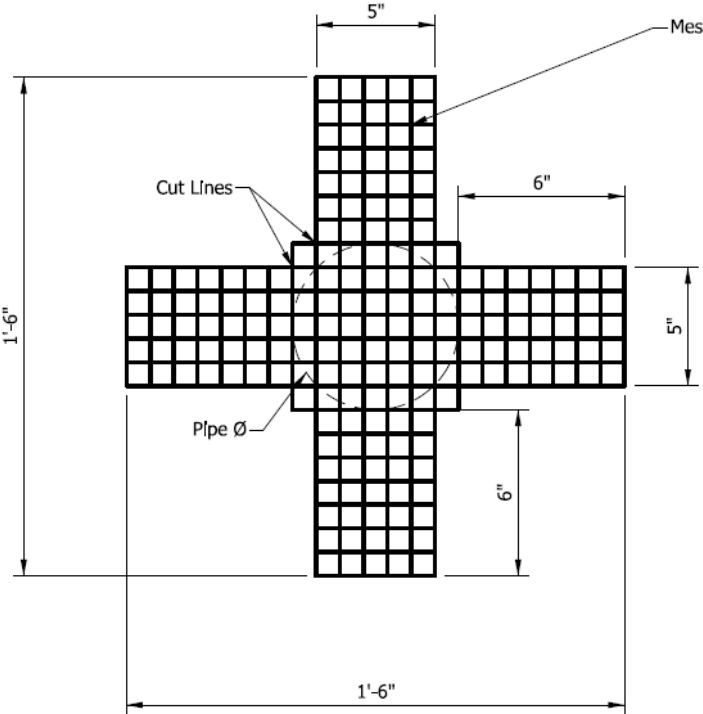


Pipe Outlets: Rodent Screen

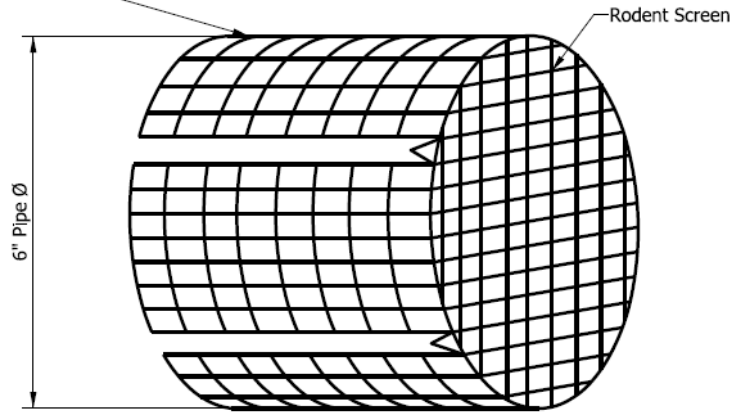
Underdrain Installation



Incorrect
Installation

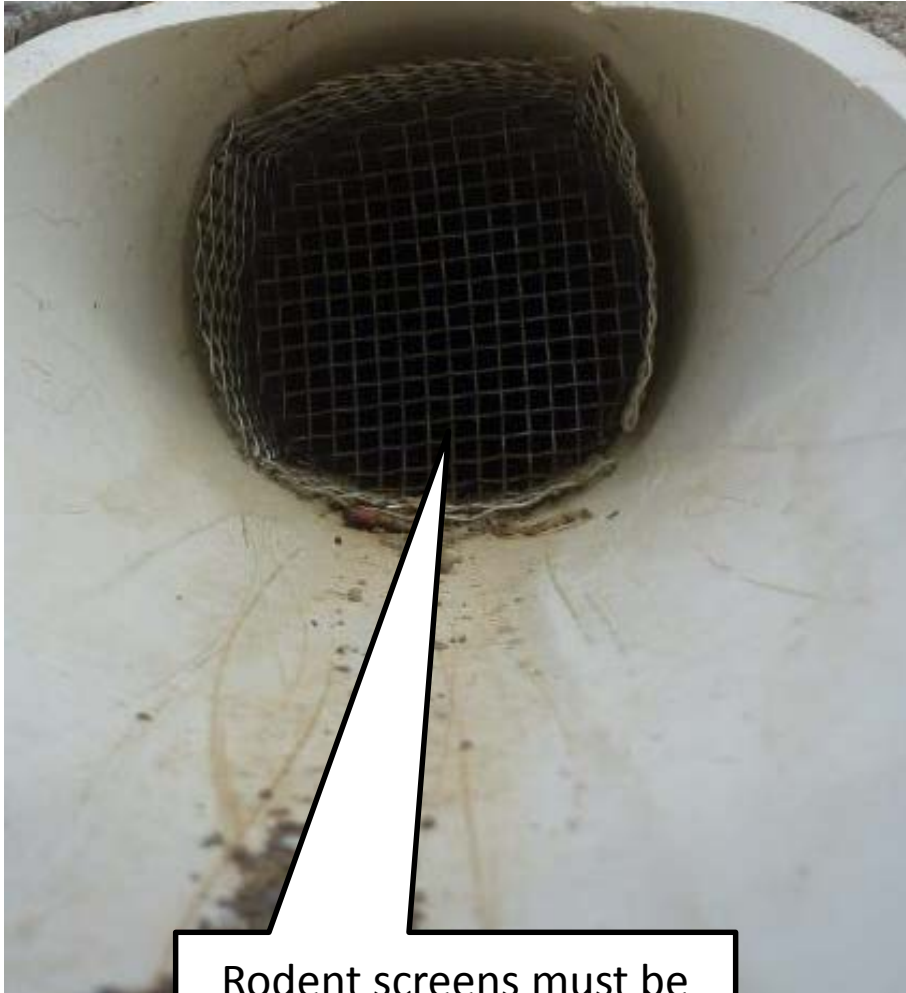


Mesh Size = 3 Openings per 1"
Wire Ø = 0.072"

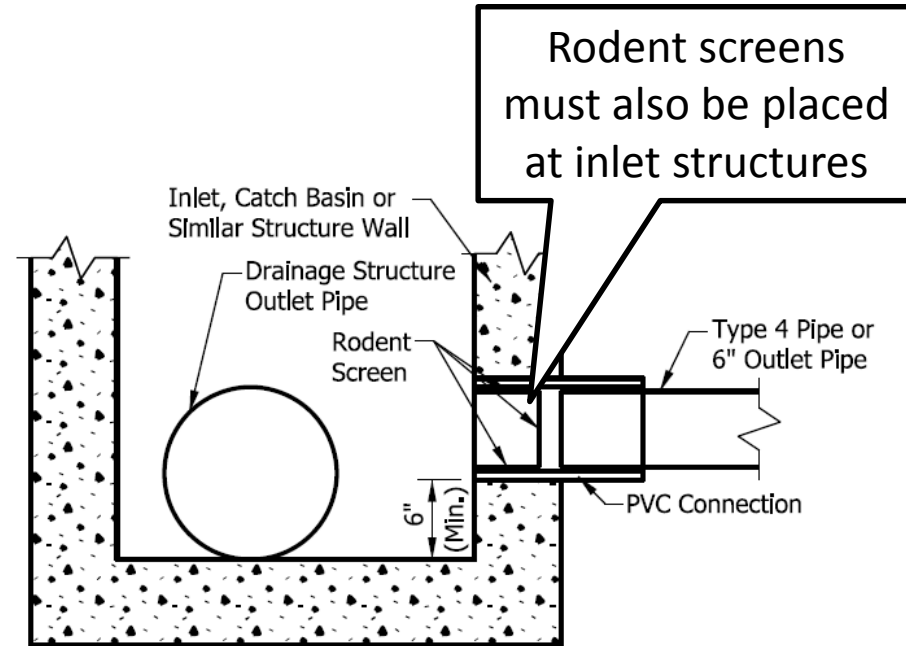


Pipe Outlets: Rodent Screen

Underdrain Installation



Rodent screens must be placed on all outlet pipes



DRAINAGE STRUCTURE OUTLET DETAIL

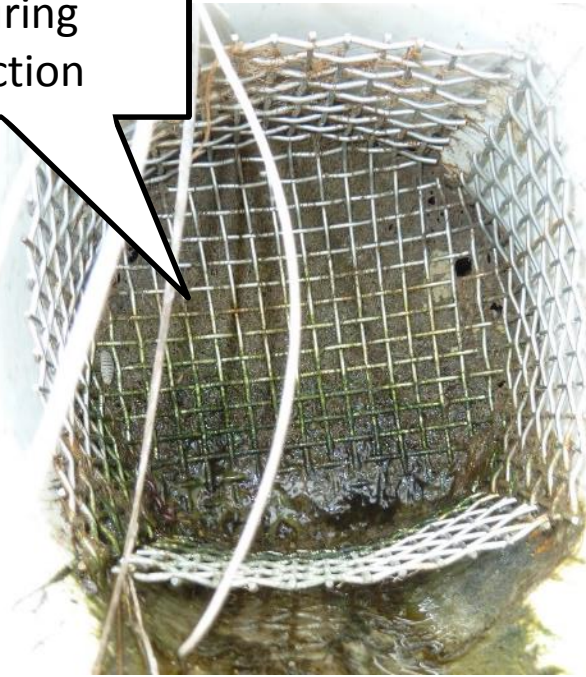
See 718-R-639d (3 and 7 of 7) for more information on rodent screens.

Pipe Outlets: Maintenance

Underdrain Installation



Blockages can occur,
even during
construction



Pipe Outlets: Maintenance

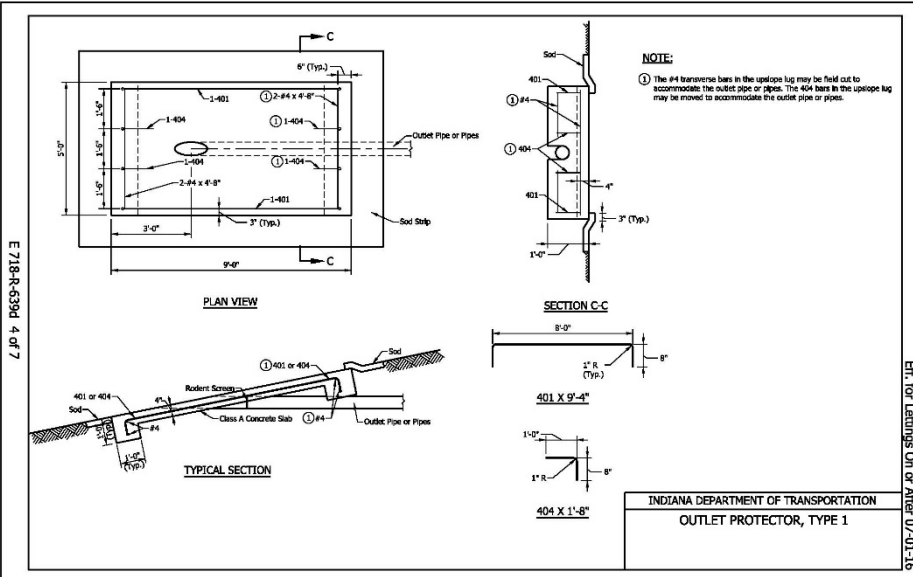
Underdrain Installation

Outlets should be checked occasionally during construction to ensure no blockages have developed. Mulch from seeding operations or recently placed sod that has moved due to heavy rains could lead to outlet blockages. Water back-up from these blockages could have a relatively immediate impact on the life of the highway if not removed in a timely manner.

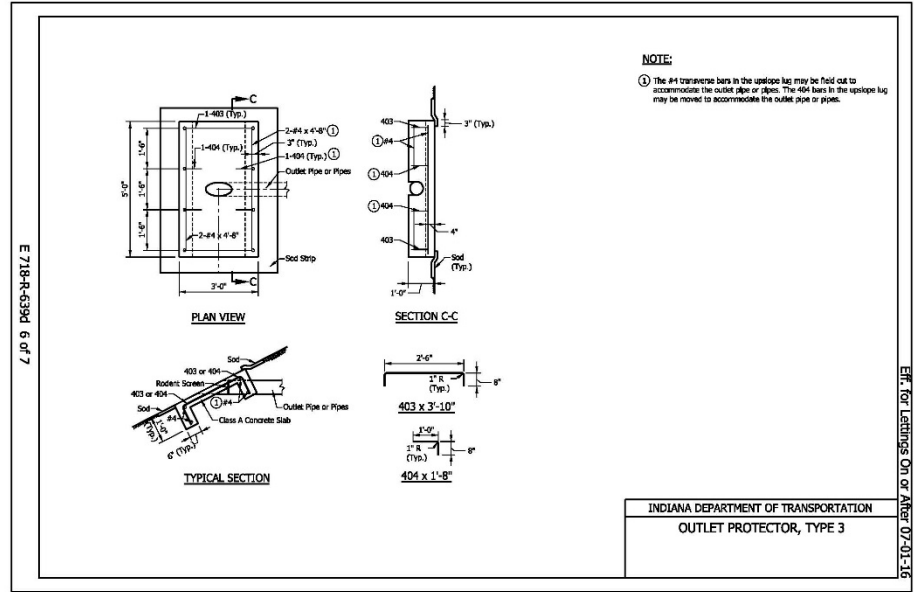
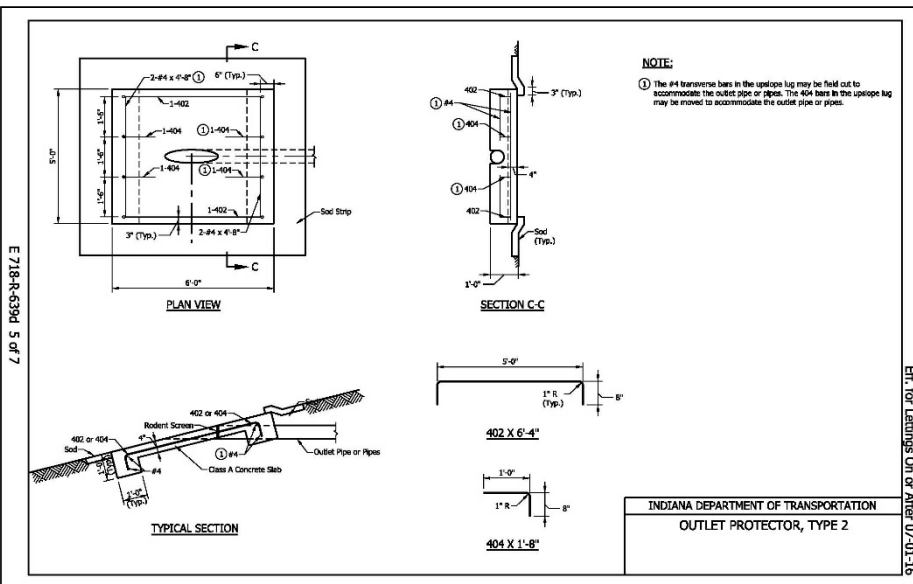
In addition to checking outlets during the course of the project, all outlets should be checked again at the pre-final inspection. If significant time has elapsed between the pre-final and final inspections, they should be checked again.

Pipe Outlet Protectors

Underdrain Installation

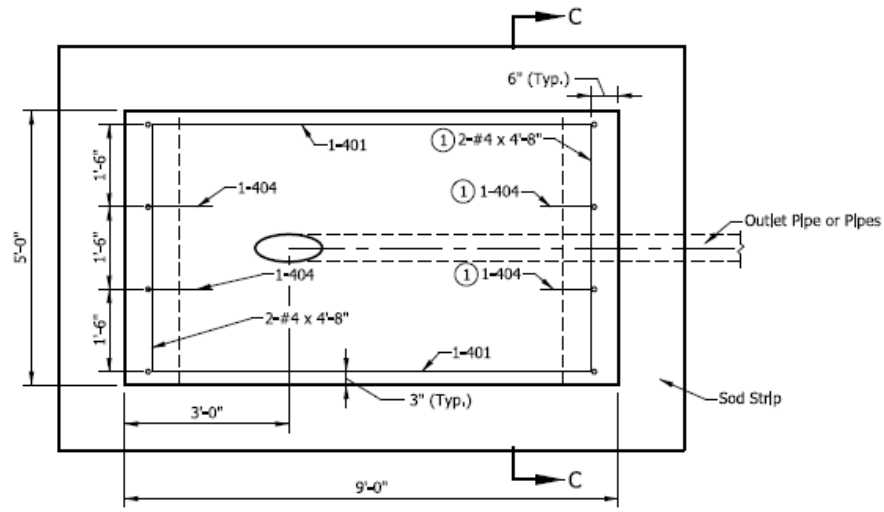


There are 3 different types of outlet protectors. The type for any specific location is shown in the underdrain table. Be sure the type shown makes sense.

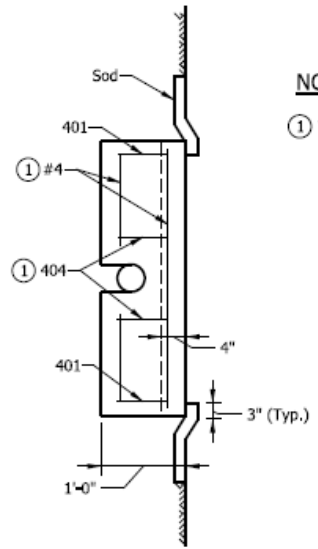


Pipe Outlet Protectors

Underdrain Installation



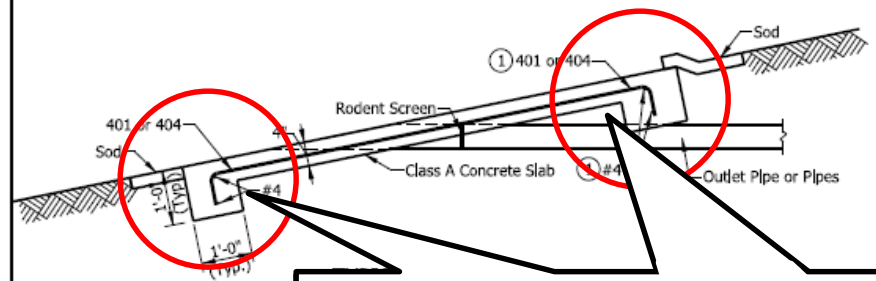
PLAN VIEW



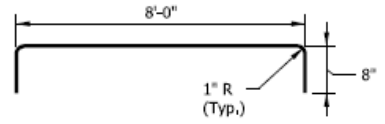
SECTION C-C

NOTE:

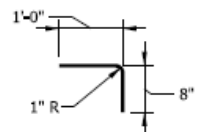
- ① The #4 transverse bars in the upslope lug may be field cut to accommodate the outlet pipe or pipes. The 404 bars in the upslope lug may be moved to accommodate the outlet pipe or pipes.



Proper construction of the lug is critical to keep the outlet protector in place on the slope.



401 X 9'-4"



404 X 1'-8"

INDIANA DEPARTMENT OF TRANSPORTATION
OUTLET PROTECTOR, TYPE 1