

VIRGINIA DEPARTMENT OF TRANSPORTATION

LOCATION AND DESIGN DIVISION

DRAINAGE DESIGN MEMORANDUM

GENERAL SUBJECT: DRAINAGE DESCRIPTIONS	NUMBER: DDM 2.1 ¹
SPECIFIC SUBJECT: BASIC DRAINAGE DESCRIPTION FORMATS FOR HYDRAULIC PLAN ITEMS	DATE: July 31, 2009
	SUPERSEDES*: IIM-LD-01 (D) 223, Road Design Manual, HDA 02- 02, HDA-02-03, DDM1
ADMINISTRATOR APPROVAL: <i>Stephen D. Kindy, P.E.</i> State Hydraulics Engineer	

* - The information noted in this DDM supplants only specified individual items contained in the listed memorandums.

INSTRUCTIONS

- Descriptions for hydraulic items shall be written in accordance with these instructional guidelines. General examples of basic drainage descriptions are shown for illustrative purposes. These examples are intended to assist the Drainage Designer in the consistent application of VDOT procedures and practices. The numerical values utilized in the descriptions are for illustration only. These examples are reflective of the VDOT Road and Bridge Standards.

PLAN MEASUREMENTS

- The length of culverts and storm sewer pipe shall be shown to the nearest one foot.
- Invert elevations for culverts and appurtenances shall be shown to the nearest 0.1 foot.
- Invert elevations for storm sewer pipe and appurtenances shall be shown to the nearest 0.01 foot.

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DDM2 – Drainage Descriptions

- Linear footage of manholes and heights of junction boxes and drop inlets shall be shown to the nearest 0.1 foot.
 - The design height of cover for culverts and storm sewer pipe shall be shown to the nearest one foot.
 - The skew angle for culverts shall be shown to the nearest 5 degree increment.
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PIPE LENGTHS

- The actual scaled/measured value should be shown.
- Pipe lengths are typically determined based on the horizontal plan view distance between the ends of the pipe segment. Where pipes are specified to be laid on steep slopes, such as the outlet pipe from a shoulder slot inlet, the length of the pipe should be determined based on the length measured along the incline.
- The location of the ends of a segment of drainage pipe will vary depending on the type of terminal structure specified. The ends of the pipe should be established based on the following:
 - For terminal structures such as drop inlets, manholes, junction boxes, etc., the end of the pipe should be established based on the point at which the exterior walls of the pipe intersect the interior wall of the terminal structure. An exception to this would be where a terminal structure would have a base unit with an internal dimension less than the external dimension of the pipe. In this case the end of the pipe should be established based on that point at which the interior walls of the pipe intersect the interior wall of the terminal structure.
 - Where endwalls are specified as terminal structures, the end of the pipe and the location of the face of the endwall should be established based on that point at which the embankment slope intersects the interior wall at the crown (top) of the pipe.
 - Where end-sections are specified as terminal structures, the point at which the embankment slope intersects the exterior wall at the top of the end-section (at its full height) should be determined. Dimension “C” noted in the appropriate table on the Standard Drawings for ES-1, ES-1A or ES-2 (as applicable) should be subtracted from this point to establish the location (and pay line) for the end of pipe.
 - Where the pipe projects beyond the embankment with no type of terminal treatment specified, the end of the pipe should be established based on that point at which the embankment slope intersects the flow line (invert) of the pipe.

SKEW ANGLE OF CULVERTS

- The angle of skew shown on the plans for a drainage culvert is the acute angle formed by the centerline of the structure and a line drawn perpendicular to the roadway baseline that the culvert crosses. Where the culvert crosses more than one roadway baseline and where the baselines at the opposite ends of the structure are not parallel, an angle of skew for each end of the structure shall be shown in the description and in the summaries.
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STRUCTURE NUMBERS

- A numbering system is to be used to identify all proposed drainage items on the plans and those existing items to be modified or adjusted with the proposed construction (Exception – Projects with minimal drainage items that will use a Streamline Summary). A two number designation is to be used. The first number will identify the number of the plan sheet that contains the item and the second number will designate the assigned item number (e.g., Structure 4-20 is item number 20 on plan sheet 4; Structure 11B-2 is item number 2 on sheet 11B).
 - Culverts shall be identified by a single designation (e.g., 15-9).
 - For storm drain systems, the structures (inlets, manholes, junction boxes, etc.) shall be individually numbered. The pipe connecting two such structures shall be identified as from point to point (e.g., 4-6 to 4-7 is the pipe between structures 4-6 and 4-7).
 - The structure designation numbers are to be shown within ellipses. The descriptions are to be shown, space permitting, on the corresponding plan sheet. If all of the descriptions cannot be shown on the plan sheet, a separate drainage description sheet should be provided.
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PROTECTIVE COATINGS

- Where a protective coating is required for culverts, storm sewers and concrete structures exposed to the normal ebb and flow of tidal water or a corrosive environment, the Drainage Designer should include the following notation in the drainage description for the specified structures:

Pipe or structure is to have protective coating applied in accordance with Section 404 of the VDOT Road and Bridge Specifications.

PIPE DESCRIPTIONS

- Each description should list the categories of information, as may be appropriate in the following order:
 - All data pertaining to the pipe or culvert barrel (length, size, skew, cover, inverts)
 - The type of end treatment (including erosion control protection)
 - The recommended foundation data and minor structure excavation quantities
- The “Design Height of Cover” must be shown for each pipe description on the plans (including pipes under entrances) and on the Drainage Summary. This allows the Contractor to determine the proper strength, sheet thickness, or class of pipe from VDOT’s* Road and Bridge Standard PC-1 drawings applicable to a particular location. When specifying less than the standard minimum cover on concrete pipe, a reference to Drainage General Note D-14 should be included in the description for the structure.
- In those cases where the Materials Division’s Subsurface Investigation Report indicates a soft, yielding or otherwise unsuitable foundation material, the description would include the recommended excavation and backfill information and be noted as follows:

*Excavate 20” below bottom of culvert and backfill with Bedding Material
Aggregate #25 or 26
200 Cu. Yds. Minor Structure Excavation
100 Tons Bedding Material Aggregate #25 or 26*

- The specified bedding material quantity should be that required for backfilling the unsuitable material excavation below the normal 4 inches of bedding material and within the vertical limits shown in the Road and Bridge Standard PC-1 drawings.
- The specified minor structure excavation quantity should be measured from the top of the existing ground surface or bottom of the normal roadway excavation limit, whichever is lower, to the bottom of the foundation trench and within the vertical limits shown in the Road and Bridge Standard PC-1 drawings.

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- The quantities specified for minor structure excavation and bedding material should include that required for endwalls, wingwalls, or other appurtenances. This quantity is based on the ratio of the plan area of the endwalls, wingwalls, or other appurtenances to the plan area of the culvert or pipe barrel. (See DDM3)
 - The strength, thickness, gage, class of pipe or method of bedding will not be noted on the plans except in those cases where, for specific reasons, VDOT's Road and Bridge Standards PC-1 and PB-1 Tables will not govern.
 - Pipe fittings such as tees, wyes, reducers, etc. are paid for as linear feet of pipe based on the largest dimension. Therefore, such items should be included in the description of the larger size pipe and their length included in the total length of that pipe segment.
 - In instances where a culvert must be countersunk to comply with environmental requirements a notation should also be included in the drainage description indicating that the invert elevations reflect countersinking, e.g., "The invert elevations noted reflect a minimum of "*" countersinking." (where "*" is either 3" or 6" as required for the culvert's size.) This will clearly communicate to the field personnel that the proposed invert elevations are intentionally set lower than the streambed. The fact that the culvert is to be countersunk should also be included in the remarks column of the Drainage Summary.
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TYPICAL CULVERT DESCRIPTIONS

- These descriptions allow the Contractor the option of utilizing any of the pipe materials specified in the Allowable Pipe Type Table for a particular location. If there is only one type of allowable culvert material, the type of pipe material should be specified in the description (e.g., 100'-48" Conc. Pipe Req'd.).
- (2-3) 100'-48" Pipe Req'd. (6' Cover)(20°Skew)
Inv.(In) 435.0 Inv.(Out) 434.0
2 St'd. EW-2 Req'd.
21 Cu. Yds. St'd EC-1 Class 1 Req'd. Lt. Type B Installation
378 Cu. Yds. Minor Structure Excavation
- (2-5) 100'-24" Pipe Req'd. (3'Cover)
Inv.(In) 435.0 Inv.(Out) 434.0
1 St'd. ES-1 or 2 Req'd. Lt.
1 St'd. EW-11 Req'd. Rt. 4:1 Slope

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CONCRETE PIPE ON RADIUS

- Concrete pipe may be installed on a radius using the open joint method or using the bevel pipe method with or without open joints. Concrete pipe that is installed on a radius using the open joint method is standard pipe and should not be specified as concrete radial pipe. See DDM1 for the minimum radius for each method for various pipe sizes.
 - OPEN JOINT METHOD
 - (2-3) 100'-48" Pipe Req'd. (6' Cover)
(530' Radius with open joints – using 8' pipe joint lengths)
Joints are to be opened a maximum of 25% of the spigot or tongue length.
Inv.(In) 435.0 Inv.(Out) 434.0
2 St'd. EW-2 Req'd.
21 Cu. Yds. St'd EC-1 Class 1 Req'd. Type B Installation*
378 Cu. Yds. Minor Structure Excavation
 - BEVEL PIPE METHOD
 - (3-1) 100'-48" Conc. Radial Pipe Req'd. (6' Cover)
(120' Radius – using 8' pipe joint lengths with full bevel)
Inv.(In) 435.0 Inv.(Out) 434.0
2 St'd. EW-2 Req'd. Lt.
21 Cu. Yds. St'd EC-1 Class 1 Req'd. Type B Installation
378 Cu. Yds. Minor Structure Excavation
 - BEVEL PIPE WITH OPEN JOINT METHOD
 - (6-7) 100'-48" Conc. Radial Pipe Req'd. (6' Cover)
(95' Radius with open joints – using 8' pipe joint lengths with full bevel)
Joints are to be opened a maximum of 25% of the spigot or tongue length.
Inv.(In) 435.0 Inv.(Out) 434.0
2 St'd. EW-2 Req'd.
21 Cu. Yds. St'd EC-1 Class 1 Req'd. Type B Installation
378 Cu. Yds. Minor Structure Excavation

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JACKED PIPE

- (5-6) 80'-48" Jacked Conc. Pipe Req'd. (25' Cover)
Inv.(In) 197.6 Inv.(Out) 197.0
2 St'd. EW-2 Req'd.
21 Cu. Yds. St'd EC-1 Class 1 Req'd. Type B Installation*
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MULTIPLE PIPE INSTALLATION

- (8-9) 300'-48" Pipe Req'd. (7' Cover)
(Triple Line – 100' each line)
Inv.(In) 164.8 Inv.(Out) 164.1
2 St'd. EW-7 Req'd.
41 Cu. Yds. St'd EC-1 Class 1 Req'd. Type B Installation
1,134 Cu. Yds. Minor Structure Excavation
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EXISTING PIPE EXTENSION

- The vertical and horizontal alignment of the pipe extension should duplicate that of the existing pipe. The type of pipe specified for the extension should be the same as the existing pipe. The cover specified should be the maximum that occurs along the entire run of pipe, including the existing section.
- (2-3) Existing Pipe To Be Extended with 50'-36" Corrugated Steel Pipe Req'd.
(7' Cover)
Inv.(In) 435.0 Inv.(Out) 434.0
1 St'd. EW-1 Req'd.
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STORM SEWER PIPE

- Pipe that is considered storm sewer pipe is to be so designated in the plan description.
- (2-3) T0 (3-3) 195'-24" Storm Sewer Pipe Req'd. (11' Cover)
Inv.(In) 15.2 Inv.(Out) 14.5
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BOX CULVERT DESCRIPTIONS

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STANDARD (CAST IN PLACE)

- The standard description should be used where a cast in place structure can be used. However, the specifications allow the Contractor the option of substituting a precast structure with approval of the Engineer.

(4-3) 150'- 6' X 8' Box Culvert Req'd. (25' Cover)(15° Skew)
Inv.(In) 60.0 Inv.(Out) 57.0
St'd. BCS-DT, BCS-30, & BCW-21
4 St'd. Type I Wings Req'd.
75 Cu. Yds. St'd EC-1 Class 1 Req'd. Rt. Type B Installation
527 Cu. Yds. Minor Structure Excavation

PRECAST

- The precast description should be used where a precast structure only is desired.

(4-8) 150'- 6' X 8' Precast Box Culvert Req'd. (25' Cover)(15° Skew)
Inv.(In) 60.0 Inv.(Out) 57.0
2 Headwalls Req'd. (Cost to be included in price bid for linear feet of box culvert) Reference St'ds. BCS-DT & BCS-30
4 Wings Req'd. Reference St'd. BCW-21, Type 1(K)
75 Cu. Yds. St'd EC-1 Class 1 Req'd. Rt. Type B Installation
527 Cu. Yds. Minor Structure Excavation

STRUCTURES

- When specifying precast structures, it is not necessary to identify, in the description, the applicable precast standard base, riser, and top units, unless a particular type of component is desired. The Contractor should, wherever possible, be allowed the option of determining the most economical units to utilize to assemble the desired structure.
- In addition to the standard information, the drainage description should include all information required to properly construct the structure. The description should be clear to the extent that there is no doubt as what is to be done at the location. Some examples of additional information to be included in a description would be:
 - *Connect To Existing 18" Conc. Pipe*
 - *Connect UD-4 TO DI*

- Standard IS-1 Inlet Shaping should be specified for manholes, drop inlets, or junction boxes where the main trunk line of a storm sewer changes direction or pipes of approximately the same size intersect and are carried forward in a single pipe.
 - Standard SL-1 safety slabs shall be specified for manholes, drop inlets, or junction boxes in accordance with the guidance outlined in DDM1 and the standard drawing.
 - All drop inlets (both curb and median), catch basins, junction boxes and other such structures that require a frame and cover or grate at finished ground elevation, shall show the height dimension “H” on the plans and on the Drainage Summary. This dimension is to be measured from the invert elevation to the top of the concrete or masonry structure and is to be shown to the nearest 0.1 foot.
 - Manholes should be shown as the number of linear feet required, measured from the invert to the top of the concrete or masonry structure. The linear feet of manhole specified should not include the height of the frame and cover.
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CURB DROP INLETS

- The standard description assumes cast in place; however, the Contractor is allowed the option to substitute a precast structure.

(3-1) 1 St'd. DI-4D Req'd.
L=8', H=5.2' Inv. 197.6
St'd. IS-1 Req'd.
 - When the required structure height is greater than the maximum allowed for a cast in place structure, or a precast structure is desired, the description would be:

(9-7) 1 St'd. DI-4DD (Precast) Req'd.
L=8', H=25.0' Inv. 197.6
2 St'd. SL-1 Req'd.
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GRATE DROP INLETS

- Descriptions for Standard DI-5, DI-7, and DI-12 series grate drop inlets should specify the type of grate required, i.e., a Type I grate for areas where pedestrian access is unlikely or a Type III (DI-5 & 7) or Type II (DI-12) for pedestrian accessible areas. When a DI-7 inlet is to be located in areas subject to occasional traffic (e.g., shoulders, parking areas, etc.), a load carrying Grate B should be specified.

(9-16) 1 St'd. DI-7 Req'd. Grate A Type II Req'd.

DDM2 – Drainage Descriptions

H=5.3' Inv. 23.6

- Descriptions for Standard DI-5 inlets should include the type of cover. The Standard PG-2A cover type most closely matching the ditch configuration should be specified. The height of the structure is measured from the invert to the top of the concrete cover.

(4-5) 1 St'd. DI-5 Req'd. Type I Grate Req'd.
St'd. PG-2A Type E Cover
H=4.8' Inv. 13.6

MANHOLES

- If a cast in place structure only is to be allowed, show only the MH-1 designation. Show only the MH-2 designation if a precast unit only is to be allowed. The option of utilizing cast in place as well as precast manholes should be allowed at all locations except for those where placement is limited due to existing pipelines, utilities, the size of pipe, etc. Most locations should permit the Contractor the option to utilize either and the descriptions should specify both the cast in place and precast standard.

(3-1) 14.6 Lin. Ft. St'd. MH-1 or 2 Req'd.
1 St'd. MH-1 Frame & Cover Req'd.
Inv. 83.4
1 St'd. SL-1 Req'd.

JUNCTION BOXES

(8-3) 1 St'd. JB-1 Req'd.
H=12.8', W=4', D=5'
Type A Tower Req'd.
1 St'd. MH-1 Frame & Cover Req'd.
Inv. 121.4
1 St'd. SL-1 Req'd.

STORMWATER MANAGEMENT STRUCTURES

- In those instances where the stormwater management basin is to be utilized as a temporary sediment basin, the description should be so noted with a reference to Standard SWM-DR for details.

- SWM DRAINAGE STRUCTURE
 - (14-7) 6.7' St'd. SWM-1 Req'd.
Bottom Elev. 23.8
3" Diameter Water Quality Orifice Req'd., Inv. 26.8
10" Diameter Orifice Req'd., Inv. 28.8
See Sheet 2G For Details.

 - STORMWATER MANAGEMENT DAM
 - (11-9) 1 SWM Dam Req'd.
See sheet 2E for details.

 - MANUFACTURED WATER QUALITY STRUCTURES
 - (7-7) 1 Water Quality Structure Req'd.
Top Elevation 26.3
Inv. Pipe (In) 20.3, Inv. Pipe (Out) 20.0
Minimum WQV=2,345 Cu. Ft.
Minimum WQQ=8.5 CFS
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EXISTING STRUCTURES

- “Modify” should be used when a major work effort is required (e.g., connecting or removing pipes, adjusting height more than 1 foot, etc.).
 - (4-11) Modify Existing Drop Inlet
Adjust To Grade. Raise 2.3'
Add DI-3B, L=6' Top.
Proposed Top Elev. 153.6
See Sheet 2K For Details.

- “Adjust” should be used when a minor work effort is required (e.g., adjusting height 1 foot or less).
 - (5-18) Adjust Existing MH
Adjust To Grade. Raise 0.5'
1 St'd. MH-1 Frame & Cover Req'd.
Proposed Top Elev. 234.3

- All work to be performed to modify the structure should be clearly stated in the drainage description. Other such information would be:
 - *Modify To (Accept/Remove) 15" Conc. Pipe*

 - *Connect UD-4 To Structure*

- *Convert Existing DI to Manhole*
- *To Be Cleaned Out*
- The necessary standard items for completing the work should be specified (e.g., precast units, manhole frame and cover, etc.). The structural condition of an existing structure should be field evaluated to determine the suitability for modification. Those structures found to be structurally deficient or in poor condition should be replaced in lieu of being modified. The cost of total replacement versus modification should also be evaluated to make sure the most economical solution is being proposed.