# PROCEDURAL MEMORANDUM

**GENERAL SUBJECT:** Standard Drawings  
**NUMBER:** N/A  
**SPECIFIC SUBJECT:** 2016 Road & Bridge Standards  
**DATE:** July 27, 2016  
**SUPERSEDES:** N/A  
**APPROVED:** B. A. Thrasher, P.E.  
State Location and Design Engineer  
Approved July 27, 2016  

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**EFFECTIVE DATE**  
Effective July 2016, required to be used on all VDOT projects, Tier 1 projects going to Advertisement on November 22, 2016 (Non Federally Eligible), December 13, 2016 (Federally Eligible)  
Tier 2 projects going to Advertisement on February 14, 2017.  

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**PURPOSE**  
Provides standard drawings to be used on VDOT projects and for roadway construction within the right of way of the Commonwealth of Virginia.
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<td>PB-1</td>
<td>INSTALLATION OF PIPE CULVERTS AND STORM SEWERS PIPE ARCH BEDDING AND BACKFILL</td>
<td>106.16</td>
</tr>
<tr>
<td>PB-1</td>
<td>INSTALLATION OF BOX CULVERTS - BEDDING AND BACKFILL</td>
<td>106.17</td>
</tr>
<tr>
<td>PC-1</td>
<td>CONCRETE PIPE - CLASS TABLE FOR HL-93 LIVE LOAD</td>
<td>106.18</td>
</tr>
<tr>
<td>PC-1</td>
<td>CORRUGATED STEEL PIPE - HEIGHT OF COVER TABLE FOR HL-93 LIVE LOAD</td>
<td>106.19</td>
</tr>
<tr>
<td>PC-1</td>
<td>CORRUGATED ALUMINUM ALLOY PIPE - HEIGHT OF COVER TABLE FOR HL-93 LIVE LOAD</td>
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<tr>
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<td>STRUCTURAL PLATE STEEL PIPE - HEIGHT OF COVER TABLE FOR HL-93 LIVE LOAD</td>
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<td>STRUCTURAL PLATE ALUMINUM ALLOY PIPE - HEIGHT OF COVER TABLE FOR HL-93 LIVE LOAD</td>
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<td>106.26</td>
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<td>ALUMINUM SPIRAL RB PIPE - HEIGHT OF COVER TABLE FOR HL-93 LIVE LOAD</td>
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<td>PC-1</td>
<td>STEEL SPIRAL RB PIPE - HEIGHT OF COVER TABLE FOR HL-93 LIVE LOAD</td>
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<tr>
<td>PC-1</td>
<td>CAST IRON PIPE - STRENGTH TABLE FOR HL-93 LIVE LOAD</td>
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<td>PC-1</td>
<td>PLASTIC PIPE - MAXIMUM COVER TABLE FOR HL-93 LIVE LOAD</td>
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<td>PC-1</td>
<td>ALLOWABLE PIPE CRITERIA FOR CULVERTS AND STORM SEWERS</td>
<td>106.31</td>
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<td>ALLOWABLE PIPE CRITERIA FOR CULVERTS AND STORM SEWERS</td>
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<td>PC-1</td>
<td>ALLOWABLE PIPE CRITERIA FOR CULVERTS AND STORM SEWERS</td>
<td>106.33</td>
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<td>PC-1</td>
<td>ALLOWABLE PIPE CRITERIA FOR CULVERTS AND STORM SEWERS</td>
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<td>STANDARD</td>
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<tr>
<td>PP-1</td>
<td>DETAILS FOR BACKFILLING ABANDONED CULVERTS</td>
<td>107.23</td>
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<tr>
<td>UD-1</td>
<td>STANDARD GROUNDWATER UNDERDRAIN</td>
<td>108.01</td>
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<tr>
<td>UD-2</td>
<td>PIPE UNDERDRAIN FOR USE WITH RAISED GRASS MEDIAN STRIPS</td>
<td>108.02</td>
</tr>
<tr>
<td>UD-3</td>
<td>STANDARD SIDEWALK UNDERDRAIN</td>
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<tr>
<td>CD-1</td>
<td>STANDARD COMBINATION UNDERDRAINS (AT LOWER END OF CUTS)</td>
<td>108.04</td>
</tr>
<tr>
<td>CD-2</td>
<td>STANDARD COMBINATION UNDERDRAINS (AT GRADE SAGS AND BRIDGE APPROACHES)</td>
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<tr>
<td>UD-4</td>
<td>STANDARD PAVEMENT EDGEDRAIN</td>
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<td>STANDARD PAVEMENT EDGEDRAIN</td>
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<td>UD-5</td>
<td>PREFabricated Geocomposite Retrofit Pavement Edgedrain</td>
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<td>UD-7</td>
<td>STANDARD Retrofit Edgedrain</td>
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<tr>
<td>PG-2A</td>
<td>STANDARD PAVED DITCHES</td>
<td>109.01</td>
</tr>
<tr>
<td>PG-3</td>
<td>STANDARD RIPRAP AND SLOPE PROTECTION</td>
<td>109.02</td>
</tr>
<tr>
<td>PG-4</td>
<td>STANDARD PAVED FLUME FOR 12&quot; - 24&quot; PIPE CULVERTS</td>
<td>109.03</td>
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<tr>
<td>CP-5</td>
<td>STANDARD PIPE SPILLOUTS</td>
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<td>PG-6A, 6B</td>
<td>STANDARD PRECAST PAVED DITCHES</td>
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<td>PG-7</td>
<td>DITCH FLUME CONNECTOR</td>
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<td>STANDARD SPRING BOX</td>
<td>110.01</td>
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<td>SB-1 PC</td>
<td>PRECAST SPRING BOX</td>
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<td>EC-1, 1A</td>
<td>STANDARD ENERGY DISSIPATOR FOR USE WITH PAVED FLUME</td>
<td>111.01</td>
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<td>EG-1, 1A PC</td>
<td>PRECAST ENERGY DISSIPATOR</td>
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<tr>
<td>PS-2</td>
<td>STANDARD PIPE SPILLOUT FOR 12&quot; - 18&quot; PIPE CULVERTS</td>
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<tr>
<td>PS-3</td>
<td>STANDARD PIPE SPILLOUT FOR 21&quot; - 30&quot; PIPE CULVERTS</td>
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<td>CULVERT OUTLET PROTECTION</td>
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<tr>
<td>EC-2</td>
<td>ROLLED EROSION CONTROL PRODUCT PROTECTIVE COVERING INSTALLATION CRITERIA (TEMPORARY USE)</td>
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<td>ROLLED EROSION CONTROL PRODUCT SOIL STABILIZATION MAT (PERMANENT DITCH INSTALLATION)</td>
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<td>ROLLED EROSION CONTROL PRODUCT SOIL STABILIZATION MAT (CULVERT OUTLET PROTECTION INSTALLATION)</td>
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<td>EC-4</td>
<td>ROCK CHECK DAMS TYPE I AND II</td>
<td>113.05</td>
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<td>EC-5</td>
<td>TEMPORARY SILT BARRIERS SILT FENCE (TYPE A &amp; B)</td>
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<td>TEMPORARY SILT BARRIERS BRUSH BARRIER</td>
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<td>EC-6</td>
<td>INLET PROTECTION (TYPE A)</td>
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<td>INLET PROTECTION (TYPE B)</td>
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<td>INLET PROTECTION (TYPE C)</td>
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<tr>
<td></td>
<td>INLET PROTECTION (TYPE B)</td>
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<td>PAGE</td>
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<td>EC-7</td>
<td>TYPICAL SEDIMENT TRAP</td>
<td>113.11</td>
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<td>EC-8</td>
<td>DEWATERING BASIN</td>
<td>113.12</td>
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<td>EC-9</td>
<td>TEMPORARY DIVERSION DKE</td>
<td>113.13</td>
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<tr>
<td>EC-10</td>
<td>TEMPORARY Berm AND SLOPE DRAIN</td>
<td>113.14</td>
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<tr>
<td>EC-11</td>
<td>STABILIZED CONSTRUCTION ENTRANCE</td>
<td>113.15</td>
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<td>EC-12</td>
<td>TEMPORARY DIVERSION CHANNEL</td>
<td>113.16</td>
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<tr>
<td>EC-13</td>
<td>RIPRAP WERRS: LOW FLOW DIVERSION FOR MULTIPLE LINE CULVERTS</td>
<td>113.17</td>
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<tr>
<td>EC-14</td>
<td>TEMPORARY VEHICULAR WATERCOURSE CROSSING</td>
<td>113.18</td>
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<td>EC-15</td>
<td>SEDIMENT RETENTION ROLL SLOPE INTERRUPTER</td>
<td>113.19</td>
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<tr>
<td>EC-16</td>
<td>TEMPORARY BERM AND SLOPE DRAIN</td>
<td>113.20</td>
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<tr>
<td>SWM-1</td>
<td>STORMWATER MANAGEMENT DRAINAGE STRUCTURE</td>
<td>114.01</td>
</tr>
<tr>
<td></td>
<td>PRECAST STORMWATER MANAGEMENT DRAINAGE STRUCTURE</td>
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<tr>
<td></td>
<td>STORMWATER MANAGEMENT DRAINAGE STRUCTURE - GRATE DETAILS</td>
<td>114.03</td>
</tr>
<tr>
<td>SWM-DR</td>
<td>STORMWATER MANAGEMENT (SWM) DETAILS</td>
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<tr>
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<tr>
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<td>STORMWATER MANAGEMENT (SWM) DETAILS</td>
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</tr>
<tr>
<td></td>
<td>STORMWATER MANAGEMENT (SWM) DETAILS</td>
<td>114.08</td>
</tr>
</tbody>
</table>
NOTES:
1. "H" MAY BE REDUCED UNTIL "X" REACHES A MINIMUM OF 4" WHERE ENDWALL WOULD PROTRUDE ABOVE SHOULDER LINE. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.
2. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
3. ALL CAST IN PLACE CONCRETE TO BE CLASS A3. FOR PRECAST SEE SHEET 101.02.
4. THIS STANDARD TO BE USED WITH STRAIGHT CROSSINGS AND ALL SKews(0° TO 45°).
5. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT.
7. HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.
8. ON SHALLOW FILLS, WHERE ENDWALLS ARE 1' OR LESS BELOW SHOULDER LINE, THE TOP OF THE ENDWALL SHALL BE CONSTRUCTED PARALLEL TO THE GRADE OF THE ROAD.
9. 3/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

ENDWALL FOR CIRCULAR PIPE

<table>
<thead>
<tr>
<th>DIAMETER OF PIPE CULVERT</th>
<th>ENDWALL FOR CIRCULAR PIPE</th>
<th>ENDWALL FOR ELLIPTICAL PIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>0'-6&quot;</td>
<td>23&quot;x14&quot;</td>
</tr>
<tr>
<td>15&quot;</td>
<td>0'-8&quot;</td>
<td>30&quot;x19&quot;</td>
</tr>
<tr>
<td>18&quot;</td>
<td>0'-9&quot;</td>
<td>34&quot;x22&quot;</td>
</tr>
<tr>
<td>21&quot; OR 24&quot;</td>
<td>0'-11&quot;</td>
<td>38&quot;x24&quot;</td>
</tr>
<tr>
<td>27&quot; OR 30&quot;</td>
<td>1'-0&quot;</td>
<td>42&quot;x27&quot;</td>
</tr>
<tr>
<td>33&quot; OR 36&quot;</td>
<td>1'-1&quot;</td>
<td>45&quot;x29&quot;</td>
</tr>
</tbody>
</table>

CUBIC YARDS OF CONCRETE

| CONC. PIPE | 0.241 | 0.492 | 0.697 | 1.319 | 2.067 | 2.947 |
| C.M. PIPE  | 0.257 | 0.521 | 0.739 | 1.398 | 2.198 | 3.145 |

ENDWALL FOR ELLIPTICAL PIPE

<table>
<thead>
<tr>
<th>SIZE OF ELLIPTICAL PIPE CULVERT (SPAN x RISE)</th>
<th>ENDWALL FOR ELLIPTICAL PIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>23&quot;x14&quot;</td>
<td>A 0'-8&quot;</td>
</tr>
<tr>
<td>30&quot;x19&quot;</td>
<td>B 1'-2&quot;</td>
</tr>
<tr>
<td>34&quot;x22&quot;</td>
<td>C 1'-8&quot;</td>
</tr>
<tr>
<td>38&quot;x24&quot;</td>
<td>D 1'-2&quot;</td>
</tr>
<tr>
<td>42&quot;x27&quot;</td>
<td>E 0'-8&quot;</td>
</tr>
<tr>
<td>45&quot;x29&quot;</td>
<td>F 2'-10&quot;</td>
</tr>
<tr>
<td>49&quot;x32&quot;</td>
<td>G 5'-5&quot;</td>
</tr>
<tr>
<td>53&quot;x34&quot;</td>
<td>H 1'-1&quot;</td>
</tr>
</tbody>
</table>

CUBIC YARDS OF CONCRETE

| CONC. PIPE | 0.502 | 0.855 | 1.236 | 1.500 | 1.811 | 2.101 | 2.512 | 2.801 |

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

STANDARD ENDWALL FOR PIPE CULVERTS

12" - 36" CIRCULAR AND 23" x 14" - 53" x 34" ELLIPTICAL PIPES

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
NOTES:
1. CONCRETE TO BE 4000 PSI MINIMUM COMRESSIVE STRENGTH.
2. IF PIPE IS TO BE SKewed THE OPENING WILL BE ADJUSTED TO ACCOMMODATE ANGLES UP TO 45°.
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).
4. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.
5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCE.
6. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE Fill SLOPE, DITCH SLOPE, OR SHOULDER.
7. HEADCOLUMN TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCUR.
8. BEVEL EDGE IS REQUIRED ON THE HEADCOLUMN AT THE INLET END OF THE CULVERT. HEADCOLUMN AT OUTLET END MAY BE EITHER SQUARE EDGE OR BEVELED.
9. 3/8" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

ENDWALL FOR CIRCULAR PIPE

<table>
<thead>
<tr>
<th>DIAMETER OF PIPE CULVERT</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>a</td>
</tr>
<tr>
<td>b</td>
</tr>
</tbody>
</table>

ENDWALL FOR ELLIPTICAL PIPE

<table>
<thead>
<tr>
<th>SIZE OF ELLIPTICAL PIPE CULVERT (SPAN x RISE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S x D</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>a</td>
</tr>
<tr>
<td>b</td>
</tr>
</tbody>
</table>

PRECAST ENDWALL FOR PIPE CULVERTS

12" - 36" CIRCULAR AND 23" x 14" - 53" x 34" ELLIPTICAL PIPES

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
STD. EW-2
STD. EW-2A
2 #4 DEFORMED CRACK CONTROL BARS

NOTES:
1. FOR TABLE OF DIMENSIONS AND VOLUMES FOR CIRCULAR PIPES (STANDARD EW-2) SEE SHEET 2 OF 3.
2. FOR TABLE OF DIMENSIONS AND VOLUMES FOR ELLIPTICAL PIPES (STANDARD EW-2A) SEE SHEET 3 OF 3.
3. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
4. ON SHALLOW FILLS, WHERE ENDWALLS ARE 1 OR LESS BELOW SHOULDER LINE, THE TOP OF THE ENDWALL SHALL BE CONSTRUCTED PARALLEL TO THE GRADE OF ROAD.
5. ALL CAST IN PLACE CONCRETE TO BE CLASS A3.
6. FOR PRECAST SEE SHEETS 101.01 AND 101.07.
7. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.
8. THIS STANDARD TO BE USED WITH STRAIGHT CROSSINGS AND SKEW ANGLES TO 15°.
9. COST OF BARS FOR CRACK CONTROL TO BE INCLUDED IN PRICE PER BID PER CUBIC YARD CONCRETE.
10. BEVEL EDGE IS REQUIRED ON THE HEADWALL AT THE INLET END OF THE CULVERT (WHERE THE FLOW ENTERS THE CULVERT), HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.
11. 3/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.
### TABLE OF DIMENSIONS AND CONCRETE VOLUMES PER ENDWALL FOR 42" - 96" CIRCULAR PIPE CULVERTS

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>42&quot;</th>
<th>48&quot;</th>
<th>54&quot;</th>
<th>60&quot;</th>
<th>66&quot;</th>
<th>72&quot;</th>
<th>78&quot;</th>
<th>84&quot;</th>
<th>90&quot;</th>
<th>96&quot;</th>
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<tbody>
<tr>
<td>A</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>1'-6&quot;</td>
<td>A</td>
</tr>
<tr>
<td>B</td>
<td>4'-9/16&quot;</td>
<td>5'-4&quot;</td>
<td>5'-10/16&quot;</td>
<td>6'-5&quot;</td>
<td>6'-11/16&quot;</td>
<td>7'-6&quot;</td>
<td>8'-0/16&quot;</td>
<td>8'-7&quot;</td>
<td>9'-2/16&quot;</td>
<td>9'-9/16&quot;</td>
<td>B</td>
</tr>
<tr>
<td>C</td>
<td>3'-3/8&quot;</td>
<td>3'-9&quot;</td>
<td>4'-2/8&quot;</td>
<td>4'-7&quot;</td>
<td>5'-0&quot;</td>
<td>5'-5/8&quot;</td>
<td>5'-11&quot;</td>
<td>6'-4/8&quot;</td>
<td>6'-9/8&quot;</td>
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<td>0'-9/8&quot;</td>
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<td>F</td>
</tr>
<tr>
<td>G</td>
<td>4'-4&quot;</td>
<td>4'-10&quot;</td>
<td>5'-4&quot;</td>
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<td>1'-2&quot;</td>
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<td>1'-6&quot;</td>
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<td>I</td>
<td>1'-11&quot;</td>
<td>2'-0&quot;</td>
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<td>J</td>
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#### FOR 1/2:1 FILL SLOPE

|-----------------------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|

#### FOR 2:1 FILL SLOPE

|-----------------------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|

#### FOR 1/2:1 AND 2:1 FILL SLOPES

| a | 0'-4/8" | 0'-5" | 0'-5/8" | 0'-6'/8" | 0'-7" | 0'-7'/8" | 0'-8'/8" | 0'-8'/8" | 0'-9'/8" | 0'-10" |
| b | 0'-3/8" | 0'-4" | 0'-4'/8" | 0'-5'/8" | 0'-5'/8" | 0'-6'/8" | 0'-6'/8" | 0'-7" | 0'-7'/8" | 0'-8" |

*For all dimensions not shown, see values listed above for 1/2:1 fill slope.*
# Table of Dimensions and Concrete Volumes per Endwall for Elliptical Pipe Culverts

## Size of Elliptical Pipe Culverts (Span x Rise)

<table>
<thead>
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<th>Dimension</th>
<th>60 x 38</th>
<th>68 x 43</th>
<th>76 x 48</th>
<th>83 x 53</th>
<th>91 x 58</th>
<th>98 x 63</th>
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## Cubic Yards Concrete

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## Cubic Yards Concrete

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## Cubic Yards Concrete

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<tr>
<td>b</td>
<td>0'-5&quot;</td>
</tr>
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</table>

For all dimensions not shown, see values listed above for 1/2:1 fill slopes.
**NOTES:**

1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.
2. IF PIPE IS TO BE SKEWED, THE OPENING WILL BE ADJUSTED TO ACCOMMODATE ANGLES UP TO 15°.
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).
4. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.
5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCES.
6. IN NO CASE SHALL TOP OF ENDWALL PROTRUDE ABOVE SLOPE, DITCH SLOPE, OR SHOULDER.
7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCUR.
9. HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.
10. 3/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

**DIMENSIONS**

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<tr>
<th>D</th>
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<th>W</th>
<th>L</th>
<th>a</th>
<th>b</th>
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<td>19'-1&quot;</td>
<td>0'-7&quot;</td>
<td>0'-5½&quot;</td>
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**REFERENCE SPECIFICATION**

105 302

**FRONT ELEVATION**

#4 BARS @ 6" EACH WAY, EACH FACE

**SECTION A-A**

CONCRETE INSERTS & ¾" LAG BOLTS

**DETAIL A**

SHAPE TO BE BEVELED WITH MORTAR

**DETAIL B**

SHAPE TO BE BEVELED WITH MORTAR

**PRECAST ENDWALL FOR PIPE CULVERTS**

42" - 96" CIRCULAR PIPE

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
NOTES:
1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.
2. IF PIPE IS TO BE SKewed, THE OPENING WILL BE ADJUSTED TO ACCOMMODATE ANGLES UP TO 15°.
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).
4. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.
5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCES.
6. IN NO CASE SHALL TOP OF ENDWALL PROTRUDE ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.
7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCURS.
9. HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.
10. $\frac{3}{4}$” CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

<table>
<thead>
<tr>
<th>PIPE ID</th>
<th>H</th>
<th>W</th>
<th>1/2-1 SLOPE</th>
<th>2:1 SLOPE</th>
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<th>b</th>
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<td>5”-6”</td>
<td>7”-11”</td>
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<td>8”-10”</td>
<td>0”-6 1/4”</td>
<td>0”-5”</td>
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<td>68”x43”</td>
<td>5”-6”</td>
<td>8”-10”</td>
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<td>8”-10”</td>
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<td>0”-5 1/2”</td>
</tr>
<tr>
<td>78”x48”</td>
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<td>9”-11”</td>
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<tr>
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</tbody>
</table>

STANDARD ENDWALL FOR PIPE CULVERTS
60” x 38” - 106” x 68” ELLIPTICAL PIPES

Virginia Department of Transportation

2016 ROAD & BRIDGE STANDARDS
1. ALL DETAILS AND DIMENSIONS NOT SHOWN ARE THE SAME AS STANDARD EW-2. FOR TABLES OF DIMENSIONS AND VOLUMES SEE SHEET 2 OF 2. FOR DETAILS OF BEVEL REFER TO STANDARD EW-1, APP SHEET 101.02.

2. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.

3. ALL CAST IN PLACE CONCRETE TO BE CLASS A3. FOR PRECAST SEE SHEET 101.10.

4. COST OF BARS FOR CRACK CONTROL TO BE INCLUDED IN PRICE BID PER CUBIC YARD CONCRETE.

5. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALLS OCCUR.


7. HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.

8. ON SHALLOW FILLS, WHERE ENDWALLS ARE 1' OR LESS BELOW SHOULD LINE, THE TOP OF THE ENDWALL SHALL BE CONSTRUCTED PARALLEL TO THE GRADE OF THE ROAD.

9. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.

10. 3⁄8" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

**STANDARD ENDWALLS FOR PIPE CULVERTS**

42" - 96" CIRCULAR PIPES WITH 30° AND 45° SKEW

**NOTES:**

**DIMENSIONS FOR BEVEL ON HEADWALL**

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<tr>
<th>PIPE ID.</th>
<th>a</th>
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<tbody>
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<td>0' - 4&quot;</td>
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<tr>
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</tr>
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<td>60&quot;</td>
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</tr>
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<td>66&quot;</td>
<td>0' - 7&quot;</td>
<td>0' - 5 1/2&quot;</td>
</tr>
<tr>
<td>72&quot;</td>
<td>0' - 7 1/2&quot;</td>
<td>0' - 6&quot;</td>
</tr>
<tr>
<td>78&quot;</td>
<td>0' - 8&quot;</td>
<td>0' - 6 1/2&quot;</td>
</tr>
<tr>
<td>84&quot;</td>
<td>0' - 8 1/2&quot;</td>
<td>0' - 7&quot;</td>
</tr>
<tr>
<td>90&quot;</td>
<td>0' - 9&quot;</td>
<td>0' - 7 1/2&quot;</td>
</tr>
<tr>
<td>96&quot;</td>
<td>0' - 10&quot;</td>
<td>0' - 8&quot;</td>
</tr>
</tbody>
</table>

**SECTION C-C**

**SECTION B-B**

**SECTION A-A**
### TABLE OF DIMENSIONS AND CONCRETE VOLUMES PER ENDWALL

#### FOR 1½:1 FILL SLOPE

<table>
<thead>
<tr>
<th>Dimension</th>
<th>42&quot;</th>
<th>48&quot;</th>
<th>54&quot;</th>
<th>60&quot;</th>
<th>66&quot;</th>
<th>72&quot;</th>
<th>78&quot;</th>
<th>84&quot;</th>
<th>90&quot;</th>
<th>96&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 30</td>
<td>4&quot;-1/2&quot;</td>
<td>4&quot;-3/4&quot;</td>
<td>4-1/2&quot;</td>
<td>4-3/4&quot;</td>
<td>5&quot;-1/2&quot;</td>
<td>5-1/2&quot;</td>
<td>6&quot;-1/2&quot;</td>
<td>6-1/2&quot;</td>
<td>7&quot;-1/2&quot;</td>
<td>7-1/2&quot;</td>
</tr>
<tr>
<td>J 30</td>
<td>5-3/4&quot;</td>
<td>6-1/4&quot;</td>
<td>6-3/4&quot;</td>
<td>7-1/4&quot;</td>
<td>7-3/4&quot;</td>
<td>8&quot;-1/4&quot;</td>
<td>8-1/4&quot;</td>
<td>9&quot;-1/4&quot;</td>
<td>9-1/4&quot;</td>
<td>10-1/4&quot;</td>
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#### FOR 2½:1 FILL SLOPE

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<th>Dimension</th>
<th>42&quot;</th>
<th>48&quot;</th>
<th>54&quot;</th>
<th>60&quot;</th>
<th>66&quot;</th>
<th>72&quot;</th>
<th>78&quot;</th>
<th>84&quot;</th>
<th>90&quot;</th>
<th>96&quot;</th>
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</thead>
<tbody>
<tr>
<td>D 30</td>
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<td>4&quot;-3/4&quot;</td>
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<td>5-1/2&quot;</td>
<td>6&quot;-1/2&quot;</td>
<td>6-1/2&quot;</td>
<td>7&quot;-1/2&quot;</td>
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<tr>
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<td>6-3/4&quot;</td>
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<td>9&quot;-1/4&quot;</td>
<td>9-1/4&quot;</td>
<td>10-1/4&quot;</td>
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</tbody>
</table>

### STANDARD ENDWALLS FOR PIPE CULVERTS

**42" - 96" CIRCULAR PIPES WITH 30° AND 45° SKEW**

*Virginia Department of Transportation*

**Road and Bridge Standards**

**Revision Date:** 101.09

**Sheet 2 of 2**
CONCRETE TO BE 4000 PSI MINIMUM COMpressive STRENGTH.

REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).

PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.

DIMENSIONS SHOWN ARE MINIMUM, ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCES.

IN NO CASE SHALL TOP OF ENDWALL PROTRUDE ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.

HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCUR.


HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.

3/8" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

CONCRETE INSERTS & 3/8" LAG SCREW, 2 PER SIDE, MAX. SPACING 30°.

PLAN VIEW

ELEVATION VIEW

DETAIL A

DETAIL B

PRECAST ENDWALL FOR PIPE CULVERTS

42" - 96" CIRCULAR PIPES WITH 30° AND 45° SKEW

2016 ROAD & BRIDGE STANDARDS

W VDOT

ROAD AND BRIDGE STANDARDS

SHEET 1 OF 1 REVISION DATE

101.10

2016 ROAD & BRIDGE STANDARDS

SPECIFICATION REFERENCE

105

302

2016 ROAD & BRIDGE STANDARDS
### NOTES:
1. In no case shall top of endwall project above fill slope, ditch slope, ditch slope, or shoulder.
2. This item may be precast or cast in place.
3. All cast in place concrete to be Class A3. For precast see sheet 101.12.
4. This standard to be used with straight crossings and skew angles to 15°.
5. Headwall to be beveled in all areas except where a conflict with invert or wingwalls occur.

### FOR CONCRETE PIPE

<table>
<thead>
<tr>
<th>D</th>
<th>S</th>
<th>G</th>
<th>L</th>
<th>Cubic Yards Concrete One Double Endwall</th>
<th>Increase for Each Additional Pipe</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>1'-10&quot;</td>
<td>2'-0&quot;</td>
<td>5'-10&quot;</td>
<td>0.329</td>
<td>0.088</td>
<td>0'-1/4&quot;</td>
<td>0'-1&quot;</td>
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<tr>
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<td>2'-3&quot;</td>
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<td>0.179</td>
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<td>0'-1/4&quot;</td>
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<tr>
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<td>3'-0&quot;</td>
<td>8'-8&quot;</td>
<td>0.941</td>
<td>0.244</td>
<td>0'-2&quot;</td>
<td>0'-1/2&quot;</td>
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<tr>
<td>21&quot; OR 24&quot;</td>
<td>3'-6&quot;</td>
<td>4'-0&quot;</td>
<td>11'-6&quot;</td>
<td>1.763</td>
<td>0.444</td>
<td>0'-2/4&quot;</td>
<td>0'-2&quot;</td>
</tr>
<tr>
<td>27&quot; OR 30&quot;</td>
<td>5'-0&quot;</td>
<td>14'-4&quot;</td>
<td>2.730</td>
<td>0.663</td>
<td>0'-3/4&quot;</td>
<td>0'-2/2&quot;</td>
<td></td>
</tr>
<tr>
<td>33&quot; OR 36&quot;</td>
<td>5'-2&quot;</td>
<td>6'-0&quot;</td>
<td>17'-2&quot;</td>
<td>3.854</td>
<td>0.907</td>
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<td>0'-3&quot;</td>
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### FOR CORRUGATED METAL PIPE

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<th>L</th>
<th>Cubic Yards Concrete One Double Endwall</th>
<th>Increase for Each Additional Pipe</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
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<tr>
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<td>1'-1'/4&quot;</td>
<td>2'-6&quot;</td>
<td>6'-1'/4&quot;</td>
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<td>0.175</td>
<td>0'-1'/4&quot;</td>
<td>0'-1'/4&quot;</td>
</tr>
<tr>
<td>18&quot;</td>
<td>2'-4&quot;</td>
<td>3'-0&quot;</td>
<td>8'-4&quot;</td>
<td>0.980</td>
<td>0.241</td>
<td>0'-2&quot;</td>
<td>0'-1'/2&quot;</td>
</tr>
<tr>
<td>24&quot;</td>
<td>3'-1&quot;</td>
<td>4'-0&quot;</td>
<td>11'-1&quot;</td>
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<td>0.442</td>
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<tr>
<td>27&quot; OR 30&quot;</td>
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<td>13'-10&quot;</td>
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<td>0'-3/4&quot;</td>
<td>0'-2'/2&quot;</td>
<td></td>
</tr>
<tr>
<td>36&quot;</td>
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<td>8'-0&quot;</td>
<td>16'-7&quot;</td>
<td>4.076</td>
<td>0.931</td>
<td>0'-3'/4&quot;</td>
<td>0'-3&quot;</td>
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</tbody>
</table>

---

**STANDARD ENDWALL FOR MULTIPLE PIPE CULVERTS**

12" - 36" CIRCULAR PIPES

VIRGINIA DEPARTMENT OF TRANSPORTATION

---

2016 ROAD & BRIDGE STANDARDS
NOTES:

1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.

2. IF PIPE IS TO BE SKewed THE OPENING WILL BE ADJUSTED TO ACCOMMODATE ANGLES UP TO 15°.

3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).

4. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.

5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCE.

6. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.

7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCUR.

8. BEVEL EDGE IS REQUIRED ON THE HEADWALL AT THE INLET END OF THE CULVERT (WHERE THE FLOW ENTERS THE CULVERT). HEADWALL AT OUTLET END MAY BE EITHER SQUARE EDGE OR BEVELED.

9. 3/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.
1. Quantities given are for one endwall. Please refer to standard EW-1, Sheet 101.01 for all dimensions not given in tables.

2. For details of bevel see standard EW-2, 2A, Sheet 101.03.

3. This item may be precast or cast in place.

4. On shallow fills, where endwalls are 1' or less below shoulder line, the top of the endwall shall be constructed parallel to the grade of road.

5. All cast in place concrete to be class A3. For precast see Sheet 101.15.

6. In no case shall top of endwall project above fill slope, ditch slope, or shoulder.

7. This standard to be used with skew angles from 15° to 37° 30'.

8. Headwall to be beveled in all areas except where a conflict with invert and wingwalls occur.

9. Bevel edge is required on the headwall at the inlet end of the culvert (where the flow enters the culvert). Headwall at the outlet end of the culvert may be either square edge or bevel edge.

10. \( \frac{3}{8} \)" chamfer may be provided on all edges at manufacturer's option.

**NOTES:**

**FOR CONCRETE PIPE**

<table>
<thead>
<tr>
<th>D</th>
<th>G</th>
<th>S</th>
<th>S(_{30})</th>
<th>L(_{30})</th>
<th>Concrete in one double endwall cubic yds.</th>
<th>Increase for each additional pipe cubic yds.</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>2'-0&quot;</td>
<td>1'-10&quot;</td>
<td>2'-1/2&quot;</td>
<td>6'-1/4&quot;</td>
<td>0.338</td>
<td>0.101</td>
<td>0'-1/4&quot;</td>
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<td>2'-3&quot;</td>
<td>2'-7/8&quot;</td>
<td>7'-7/8&quot;</td>
<td>0.668</td>
<td>0.207</td>
<td>0'-13/4&quot;</td>
<td>0'-1/4&quot;</td>
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<tr>
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<td>3'-1&quot;</td>
<td>9'-1&quot;</td>
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<td>0.283</td>
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<td>0'-1/4&quot;</td>
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<tr>
<td>21&quot; OR 24&quot;</td>
<td>4'-0&quot;</td>
<td>3'-6&quot;</td>
<td>4'-0/2&quot;</td>
<td>12'-0/2&quot;</td>
<td>1.794</td>
<td>0.512</td>
<td>0'-21/4&quot;</td>
<td>0'-1&quot;</td>
</tr>
<tr>
<td>27&quot; OR 30&quot;</td>
<td>5'-0&quot;</td>
<td>4'-4&quot;</td>
<td>5'-0/2&quot;</td>
<td>15'-0/2&quot;</td>
<td>2.769</td>
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<td>0'-31/4&quot;</td>
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</tr>
<tr>
<td>33&quot; OR 36&quot;</td>
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<td>5'-2&quot;</td>
<td>5'-11/16&quot;</td>
<td>17'-11/16&quot;</td>
<td>3.895</td>
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**FOR CORRUGATED METAL PIPE**

<table>
<thead>
<tr>
<th>D</th>
<th>G</th>
<th>S</th>
<th>S(_{30})</th>
<th>L(_{30})</th>
<th>Concrete in one double endwall cubic yds.</th>
<th>Increase for each additional pipe cubic yds.</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>2'-0&quot;</td>
<td>1'-7&quot;</td>
<td>1'-10&quot;</td>
<td>5'-10&quot;</td>
<td>0.354</td>
<td>0.100</td>
<td>0'-1/4&quot;</td>
<td>0'-1&quot;</td>
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<td>2'-11/4&quot;</td>
<td>2'-3/4&quot;</td>
<td>7'-3/4&quot;</td>
<td>0.714</td>
<td>0.201</td>
<td>0'-1/4&quot;</td>
<td>0'-1/4&quot;</td>
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<tr>
<td>18&quot;</td>
<td>3'-0&quot;</td>
<td>2'-4&quot;</td>
<td>2'-8/8&quot;</td>
<td>8'-8/8&quot;</td>
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<td>0'-1/4&quot;</td>
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<tr>
<td>24&quot;</td>
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<td>3'-6/8&quot;</td>
<td>11'-6/8&quot;</td>
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<td>0'-2&quot;</td>
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<tr>
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<td>3'-10&quot;</td>
<td>4'-5/8&quot;</td>
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<td>0'-21/4&quot;</td>
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<td>5'-3/4&quot;</td>
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</table>

**STANDARD ENDWALLS FOR MULTIPLE PIPE CULVERTS**

12" - 36" CIRCULAR PIPES WITH 30° SKEW

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**REVISION DATE**

2016 ROAD & BRIDGE STANDARDS
NOTES:
1. QUANTITIES GIVEN ARE FOR ONE ENDWALL. PLEASE REFER TO STANDARD EW-1, SHEET 101.01 FOR ALL DIMENSIONS NOT GIVEN IN TABLES.
2. FOR DETAILS OF BEVEL SEE STANDARD EW-2, 2A, SHEET 101.03.
3. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
4. ON SHALLOW FILLS, WHERE ENDWALLS ARE 1' OR LESS BELOW SHOULDER LINE, THE TOP OF THE ENDWALL SHALL BE CONSTRUCTED PARALLEL TO THE GRADE OF ROAD.
5. ALL CAST IN PLACE CONCRETE TO BE CLASS A3. FOR PRECAST SEE SHEET 101.16.
6. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE SLOPE, DITCH SLOPE, OR SHOULDER.
7. THIS STANDARD TO BE USED WITH SKEW ANGLES ABOVE FILL SLOPE.
8. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT AND WINGWALLS OCCUR.
10. 3/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER’S OPTION.

FOR CONCRETE PIPE

<table>
<thead>
<tr>
<th>D</th>
<th>G</th>
<th>S</th>
<th>S45</th>
<th>L45</th>
<th>CONCRETE IN ONE DOUBLE ENDWALL CUBIC YDS.</th>
<th>INCREASE FOR EACH ADDITIONAL PIPE CUBIC YDS.</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>2'-0&quot;</td>
<td>1'-10&quot;</td>
<td>2'-7/8&quot;</td>
<td>6'-7/8&quot;</td>
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<td>0'-7/8&quot;</td>
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<tr>
<td>15&quot;</td>
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<td>6'-2/8&quot;</td>
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FOR CORRUGATED METAL PIPE

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<th>G</th>
<th>S</th>
<th>S45</th>
<th>L45</th>
<th>CONCRETE IN ONE DOUBLE ENDWALL CUBIC YDS.</th>
<th>INCREASE FOR EACH ADDITIONAL PIPE CUBIC YDS.</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
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<td>2'-2/2&quot;</td>
<td>6'-2/2&quot;</td>
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<td>0.122</td>
<td>0'-1/2&quot;</td>
<td>0'-1&quot;</td>
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<td>3'-3/16&quot;</td>
<td>9'-3/16&quot;</td>
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</tr>
<tr>
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<td>3'-1&quot;</td>
<td>4'-4/16&quot;</td>
<td>12'-4/16&quot;</td>
<td>1.956</td>
<td>0.625</td>
<td>0'-2/2&quot;</td>
<td>0'-2&quot;</td>
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<tr>
<td>27&quot; OR 30&quot;</td>
<td>5'-0&quot;</td>
<td>3'-10&quot;</td>
<td>5'-5&quot;</td>
<td>15'-5&quot;</td>
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<td>0.948</td>
<td>0'-3/4&quot;</td>
<td>0'-2/2&quot;</td>
</tr>
<tr>
<td>36&quot;</td>
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<td>4'-7&quot;</td>
<td>6'-5/8&quot;</td>
<td>18'-5/8&quot;</td>
<td>4.280</td>
<td>1.316</td>
<td>0'-3/4&quot;</td>
<td>0'-3&quot;</td>
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</table>

12" - 36" CIRCULAR PIPES WITH 45° SKEW
NOTES:
1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.
2. IF PIPE IS TO SKewed THE OPENING WILL BE ADJUSTED TO ACCOMMODATE ANGLES OF 15° TO 37° 30'..
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).
4. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.
5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCE.
6. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.
7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCUR.
8. BEVEL EDGE IS REQUIRED ON THE HEADWALL AT THE INLET END OF THE CULVERT (WHERE THE FLOW ENTERS THE CULVERT). HEADWALL AT OUTLET END MAY BE EITHER SQUARE EDGE OR BEVELED.
9. \( \frac{3}{4} \)" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

PRECAST ENDWALL FOR MULTIPLE PIPE CULVERTS

12" - 36" CIRCULAR PIPES WITH 30° SKEW

VIRGINIA DEPARTMENT OF TRANSPORTATION

<table>
<thead>
<tr>
<th>SPECIFICATION REFERENCE</th>
<th>ROAD AND BRIDGE STANDARDS</th>
<th>REVISION DATE</th>
<th>SHEET 1 OF 1</th>
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<tr>
<td>105</td>
<td>2016 ROAD &amp; BRIDGE STANDARDS</td>
<td>101.15</td>
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NOTES:

1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.

2. IF PIPE IS TO BE SKEWED THE OPENING WILL BE ADJUSTED TO ACCOMMODATE ANGLES OF 37°-30° TO 45°.

3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).

4. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.

5. DIMENSIONS SHOWN ARE MINIMUM, ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCE.

6. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.

7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINDWALL OCCURS.

8. BEVEL EDGE IS REQUIRED ON THE HEADWALL AT THE INLET END OF THE CULVERT (WHERE THE FLOW ENTERS THE CULVERT). HEADWALL AT OUTLET END MAY BE EITHER SQUARE EDGE OR BEVELED.

9. ¾" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.
## Notes:
1. Quantities given are for one endwall.
2. Please refer to standard EW-2, sheet 101.04, for all dimensions not given in tables.
3. This item may be precast or cast in place.
4. On shallow fills, where endwalls are 1' or less below shoulder line, the top of the endwall shall be constructed parallel to the grade of road.
5. All cast in place concrete to be class A3, for precast see sheet 101.18.
6. In no case shall top of endwall project above fill slope, ditch slope, or shoulder.
7. This standard to be used with straight crossings and skew angles to 15°.
8. Cost of bars for crack control to be included in price per bid per cubic yard concrete.
9. Headwall to be beveled in all areas except where a conflict with invert and wingwalls occur.
10. Bevel edge is required on the headwall at the inlet end of the culvert (where the flow enters the culvert). Headwall at the outlet end of the culvert may be either square edge or bevel edge.
11. $\frac{3}{4}''$ chamfer may be provided on all edges at manufacturer's option.

### For Concrete Pipe

<table>
<thead>
<tr>
<th>D</th>
<th>S</th>
<th>T</th>
<th>Fill Slope 1/4</th>
<th>Fill Slope 2:1</th>
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<tr>
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<td>18'-10''</td>
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<tr>
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<td>20'-2''</td>
<td>25.115</td>
<td>6.920</td>
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<tr>
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### For Corrugated Metal Pipe

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<td>1.279</td>
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<td>48''</td>
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<td>10'-3/4''</td>
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<td>1.616</td>
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<tr>
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<td>11'-3/4''</td>
<td>8.228</td>
<td>2.104</td>
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<tr>
<td>60''</td>
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<td>12'-6/4''</td>
<td>10.319</td>
<td>2.677</td>
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<tr>
<td>66''</td>
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<td>13'-9/4''</td>
<td>12.751</td>
<td>3.261</td>
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<td>15'-0''</td>
<td>15.673</td>
<td>4.068</td>
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<td>16'-3/4''</td>
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<td>5.805</td>
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</table>

### Standard Endwalls for Multiple Pipe Culverts

42'' - 96'' Circular Pipes

**Virginia Department of Transportation**
PRECAST ENDWALLS FOR MULTIPLE PIPE CULVERTS

FOR CONCRETE OR CORRUGATED METAL PIPE

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<th>L 2:1 SLOPE</th>
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<td>6'-7½&quot;</td>
<td>8'-8&quot;</td>
</tr>
<tr>
<td>48&quot;</td>
<td>6'-0&quot;</td>
<td>13'-10&quot;</td>
<td>10'-10&quot;</td>
<td>7'-0&quot;</td>
<td>9'-10&quot;</td>
</tr>
<tr>
<td>54&quot;</td>
<td>6'-6&quot;</td>
<td>15'-2&quot;</td>
<td>7'-8&quot;</td>
<td>8'-4½&quot;</td>
<td>11'-0&quot;</td>
</tr>
<tr>
<td>60&quot;</td>
<td>7'-0&quot;</td>
<td>16'-6&quot;</td>
<td>8'-6&quot;</td>
<td>9'-3&quot;</td>
<td>12'-1½&quot;</td>
</tr>
<tr>
<td>66&quot;</td>
<td>7'-7&quot;</td>
<td>17'-10&quot;</td>
<td>9'-4&quot;</td>
<td>10'-1½&quot;</td>
<td>13'-3½&quot;</td>
</tr>
<tr>
<td>72&quot;</td>
<td>8'-2&quot;</td>
<td>19'-2&quot;</td>
<td>10'-2&quot;</td>
<td>11'-0&quot;</td>
<td>14'-5½&quot;</td>
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<tr>
<td>78&quot;</td>
<td>8'-6½&quot;</td>
<td>20'-8&quot;</td>
<td>11'-0&quot;</td>
<td>11'-10&quot;</td>
<td>15'-7&quot;</td>
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<td>21'-10&quot;</td>
<td>11'-10&quot;</td>
<td>12'-6½&quot;</td>
<td>16'-9&quot;</td>
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<tr>
<td>90&quot;</td>
<td>9'-11&quot;</td>
<td>23'-5&quot;</td>
<td>12'-9&quot;</td>
<td>13'-7&quot;</td>
<td>17'-11&quot;</td>
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<td>96&quot;</td>
<td>10'-7&quot;</td>
<td>25'-0&quot;</td>
<td>13'-7&quot;</td>
<td>14'-6&quot;</td>
<td>19'-0&quot;</td>
</tr>
</tbody>
</table>

NOTES:
1. CONCRETE TO BE 4000 PSI MINIMUM COMpressive STRENGTH.
2. IF PIPE IS TO BE SKEWED, THE OPENING WILL BE ADJUSTED TO ACCOMMODATE ANGLES UP TO 15°.
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).
4. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.
5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER’S TOLERANCES.
6. IN NO CASE SHALL TOP OF ENDWALL PROTRUDE ABOVE RIPPLE SLOPE, DITCH SLOPE, OR SHOULDER.
7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCUR.
8. BEVEL EDGE AS REQUIRED ON THE HEADWALL AT THE INLET END OF THE CULVERT WHERE THE FLOW ENTERS THE CULVERT.
9. HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.
10. 3/8" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER’S OPTION.
## Standard Endwall for Multiple Pipe Culverts

### For Concrete Pipe or Corrugated Metal Pipe

#### Fill Slope 1/2:1

<table>
<thead>
<tr>
<th>D</th>
<th>S</th>
<th>S_{30}</th>
<th>T_{30}</th>
<th>Concrete in One Double Endwall Cubic Yards</th>
<th>Increase for Each Additional Pipe Cubic Yds.</th>
<th>Concrete in One Double Endwall Cubic Yds</th>
<th>Increase for Each Additional Pipe Cubic Yds.</th>
</tr>
</thead>
<tbody>
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<td>42&quot;</td>
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<td>6'-11/4&quot;</td>
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<td>7'-10 1/4&quot;</td>
<td>12'-6 1/4&quot;</td>
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<td>1,836</td>
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<td>10'-0&quot;</td>
<td>9'-3 1/4&quot;</td>
<td>15'-2&quot;</td>
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<td>3,001</td>
<td>11,640</td>
<td>2,971</td>
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<td>12'-0&quot;</td>
<td>9'-9 3/4&quot;</td>
<td>17'-1/2&quot;</td>
<td>12,663</td>
<td>3,729</td>
<td>14,450</td>
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<tr>
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<td>11'-8 1/4&quot;</td>
<td>18'-8&quot;</td>
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<td>4,552</td>
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<th>Increase for Each Additional Pipe Cubic Yds.</th>
<th>Concrete in One Double Endwall Cubic Yds</th>
<th>Increase for Each Additional Pipe Cubic Yds.</th>
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### Notes:
1. Quantities given are for one endwall.
2. Please refer to standard EW-2S, sheets 101.08 and 101.09, ro all dimensions not given in tables.
3. This item may be precast or cast in place.
4. On shallow fills where endwalls are 10 inches below shoulder line, the top of the endwall shall be constructed parallel to the grade of road.
5. All cast in place concrete to be class C3. For precast see sheet 101.21.
6. In no case shall top of endwall project above fill slope, ditch slope, or shoulder.
7. This standard to be used with skew angles from 15° to 37°30′.
8. Cost of bars for crack control to be included in price per bid per cubic yard concrete.
9. Headwall to be beveled in all areas except where a conflict with invert and wingwalls occur.
10. Bevel edge is required on the headwall at the inlet end of the culvert (where the flow enters the culvert). Headwall at the outlet end of the culvert may be either square edge or bevel edge.
11. Chamfer may be provided on all edges at manufacturer's option.

### Specifications Reference

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**Virginia Department of Transportation**

**2016 Road & Bridge Standards**
## Front View

### For Concrete Pipe

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<tbody>
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<td></td>
<td>Concrete in One Double Endwall Cubic Yards</td>
<td>Increase for Each Additional Pipe Cubic Yards</td>
</tr>
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<td>9.789</td>
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<td>19'-3 1/4&quot;</td>
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<td>36.640</td>
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### For Corrugated Metal Pipe

<table>
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<th>D</th>
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<th>Fill Slope 1/2:1</th>
<th>Fill Slope 2:1</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>Concrete in One Double Endwall Cubic Yds.</td>
<td>Increase for Each Additional Pipe Cubic Yds.</td>
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<td>54&quot;</td>
<td>7'-8&quot;</td>
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<td>17'-2 1/2&quot;</td>
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<td>2.949</td>
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<td>8'-6&quot;</td>
<td>12'-0 1/4&quot;</td>
<td>19'-2 1/2&quot;</td>
<td>12.944</td>
<td>3.755</td>
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<td>9'-4&quot;</td>
<td>13'-2 1/2&quot;</td>
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<td>10'-2&quot;</td>
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<td>19.287</td>
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<td>24'-2&quot;</td>
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<td>30'-4 1/4&quot;</td>
<td>39.499</td>
<td>11.815</td>
</tr>
</tbody>
</table>

## Notes:
1. Quantities given are for one endwall.
2. Please refer to standard EW-25, Sheet 101.08 and 101.09, for all dimensions not given in tables.
3. This item may be precast or cast in place.
4. On shallow fills, where endwalls are 1' or less below shoulder line, the top of the endwall shall be constructed parallel to the grade of road.
5. All cast in place concrete to be class A3. For precast see sheet 101.21.
6. In no case shall top of endwall project above fill slope, ditch slope, or shoulder.
7. This standard to be used with skew angles from 37°30' to 45°.
8. Cost of bars for crack control to be included in price bid per cubic yard concrete.
9. Headwall to be beveled in all areas except where a conflict with invert and wingwalls occur.
10. Bevel edge is required on the headwall at the inlet end of the culvert (where the flow enters the culvert). Headwall at the outlet end of the culvert may be either square edge or bevel edge.
11. For details of headwall bevel see standard EW-25, sheets 101.08 and 101.09.
12. 3/4" chamfer may be provided on all edges at manufacturer's option.

## Standard Endwalls for Multiple Pipe Culverts

42" - 96" Circular Pipe with 45° Skew

Virginia Department of Transportation

Specification Reference: 105, 302
1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.

2. FOR DETAILS OF HEADWALL BEVEL SEE STANDARD EW-25PC, SHEET 101.10.

3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).

4. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.

5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCES.

6. IN NO CASE SHALL TOP OF ENDWALL PROTRUDE ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.

7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCURS.


9. HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.

10. ¥/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.
NOTES:
1. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
2. ON SHALLOW FILLS, WHERE ENDWALLS ARE 1' OR LESS BELOW SHOULD LINE, THE TOP OF THE ENDWALL SHALL BE CONSTRUCTED PARALLEL TO THE GRADE OF ROAD.
3. ALL CAST IN PLACE CONCRETE TO BE CLASS A3. FOR PRECAST SEE SHEET 101.23.
4. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.
5. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT AND WINGWALLS OCCUR.
6. BEVEL EDGE IS REQUIRED ON THE HEADWALL AT THE INLET END OF THE CULVERT (WHERE THE FLOW ENTERS THE CULVERT), HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVELED EDGE.
7. 3/4'' CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

### CORRUGATED METAL PIPE

<table>
<thead>
<tr>
<th>NOMINAL DIAMETERS OF PIPE ARCH</th>
<th>DIMENSIONS FOR ONE SINGLE ENDWALL</th>
<th>CUBIC YARDS CONCRETE FOR 1 ENDWALL</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAN</td>
<td>RISE</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>17''</td>
<td>13''</td>
<td>0'-6''</td>
<td>0'-11''</td>
<td>1'-4''</td>
</tr>
<tr>
<td>21''</td>
<td>15''</td>
<td>0'-6''</td>
<td>0'-11''</td>
<td>1'-4''</td>
</tr>
<tr>
<td>24''</td>
<td>18''</td>
<td>0'-8''</td>
<td>1'-1/2''</td>
<td>1'-7''</td>
</tr>
<tr>
<td>28''</td>
<td>22''</td>
<td>0'-9''</td>
<td>1'-3''</td>
<td>1'-9''</td>
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<tr>
<td>35''</td>
<td>25''</td>
<td>0'-11''</td>
<td>1'-9''</td>
<td>2'-2''</td>
</tr>
<tr>
<td>42''</td>
<td>29''</td>
<td>1'-0''</td>
<td>1'-9''</td>
<td>2'-6''</td>
</tr>
<tr>
<td>49''</td>
<td>33''</td>
<td>1'-0''</td>
<td>1'-9''</td>
<td>2'-6''</td>
</tr>
<tr>
<td>49''</td>
<td>35''</td>
<td>1'-0''</td>
<td>1'-9''</td>
<td>2'-6''</td>
</tr>
<tr>
<td>57''</td>
<td>38''</td>
<td>1'-0''</td>
<td>2'-9''</td>
<td>0'-9''</td>
</tr>
<tr>
<td>57''</td>
<td>41''</td>
<td>1'-0''</td>
<td>2'-9''</td>
<td>0'-9''</td>
</tr>
</tbody>
</table>

*3'' x 1'' AND 5'' x 1'' CORRUGATION DIMENSIONS.
NOTES:
1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.
2. IF PIPE IS TO BE SKewed THE OPENING WILL BE ADJUSTED TO ACCOMMODATE.
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).
4. PIPE ARCH OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.
5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER’S TOLERANCE.
6. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, OR SHOULDER.
7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCUR.
8. BEVEL EDGE IS REQUIRED ON THE HEADWALL AT THE INLET END OF THE CULVERT HEADWALL AT OUTLET END MAY BE EITHER SQUARE EDGE OR BEVELED.
9. ¾” CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER’S OPTION.

PRECAST ENDWALLS FOR PIPE ARCHES
13” - 38” RISE

PRECAST ENDWALL DIMENSIONS

<table>
<thead>
<tr>
<th>SPAN</th>
<th>RISE</th>
<th>H</th>
<th>L</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>17”</td>
<td>13”</td>
<td>1'-8&quot;</td>
<td>4'-0&quot;</td>
<td>0'-2&quot;</td>
<td>0'-11/2&quot;</td>
</tr>
<tr>
<td>27”</td>
<td>13”</td>
<td>1'-10&quot;</td>
<td>5'-0&quot;</td>
<td>0'-21/2&quot;</td>
<td>0'-11/2&quot;</td>
</tr>
<tr>
<td>24”</td>
<td>18”</td>
<td>2'-4&quot;</td>
<td>6'-0&quot;</td>
<td>0'-3&quot;</td>
<td>0'-2&quot;</td>
</tr>
<tr>
<td>28”</td>
<td>20”</td>
<td>2'-6&quot;</td>
<td>7'-0&quot;</td>
<td>0'-3&quot;</td>
<td>0'-2&quot;</td>
</tr>
<tr>
<td>35”</td>
<td>24”</td>
<td>2'-10&quot;</td>
<td>8'-0&quot;</td>
<td>0'-4&quot;</td>
<td>0'-21/2&quot;</td>
</tr>
<tr>
<td>*40”</td>
<td>31”</td>
<td>3'-3&quot;</td>
<td>10'-0&quot;</td>
<td>0'-41/2&quot;</td>
<td>0'-3&quot;</td>
</tr>
</tbody>
</table>
| 47”  | 33”   | 3'-7"| 12'-0"| 0'-51/2"| 0'-33/4"
| *49” | 33”   | 3'-7"| 12'-0"| 0'-51/2"| 0'-33/4"
| *53” | 41”   | 4'-0"| 13'-0"| 0'-6"| 0'-4"
| 57”  | 38”   |      |      |      |      |

*DIMENSIONS FOR 3” x 1” AND 5” x 1” CORRUGATIONS
**NOTES:**

1. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
2. REFER TO STANDARD EW-9, SHEET 101.22, FOR ALL DIMENSIONS NOT GIVEN IN TABLE.
3. ON SHALLOW FILLS, WHERE ENDWALLS ARE 1' OR LESS BELOW SHOULDER LINE, THE TOP OF THE ENDWALL SHALL BE CONSTRUCTED PARALLEL TO THE GRADE OF ROAD.
4. ALL CAST IN PLACE CONCRETE TO BE CLASS A3.
5. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE, OR SHOULDER.
6. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT AND WINGWALLS OCCUR.
8. 3/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.
NOTES:
1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.
2. IF PIPE IS TO BE SKEWED THE OPENING WILL BE ADJUSTED TO ACCOMMODATE.
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM A-615 (REINFORCING BARS).
4. PIPE ARCH OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 4 INCHES 
   AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.
5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH 
   MANUFACTURER'S TOLERANCE.
6. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, OR SHOULDER.
7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH 
   INVERT OR WINNOW OCCUR.
8. BEVELED EDGE IS REQUIRED ON THE HEADWALL AT THE INLET END OF THE CULVERT 
   HEADWALL AT OUTLET END MAY BE EITHER SQUARE EDGE OR BEVELED.
9. 3/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.

**DIMENSIONS FOR 3" X 1" AND 5" X 1" CORRUGATION**

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**PRECAST ENDWALLS FOR MULTIPLE PIPE ARCHES**

13" - 38" RISE

VIRGINIA DEPARTMENT OF TRANSPORTATION

---

PRECAST ENDWALL DIMENSIONS

<table>
<thead>
<tr>
<th>S</th>
<th>D</th>
<th>M</th>
<th>G</th>
<th>L</th>
<th>H</th>
<th>G</th>
<th>D</th>
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<td>17&quot;</td>
<td>13&quot;</td>
<td>2'-6&quot;</td>
<td>2'-2&quot;</td>
<td>6'-10&quot;</td>
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<td>15'-2&quot;</td>
<td>3'-7&quot;</td>
<td>0'-41/2&quot;</td>
<td>0'-3&quot;</td>
</tr>
<tr>
<td>46&quot;</td>
<td>36&quot;</td>
<td>5'-7&quot;</td>
<td>6'-0&quot;</td>
<td>17'-7&quot;</td>
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<td>0'-31/2&quot;</td>
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<td>38&quot;</td>
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<td>6'-11&quot;</td>
<td>20'-4&quot;</td>
<td>4'-4&quot;</td>
<td>0'-6&quot;</td>
<td>0'-4&quot;</td>
</tr>
</tbody>
</table>
NOTES:
1. THIS ITEM MAY BE PRECAST OR CAST IN PLACE. ALL CAST CONCRETE TO BE CLASS A3, FOR PRECAST USE 4000 PSI MINIMUM. REINFORCING STEEL TO HAVE A MINIMUM 1/2" COVER.
2. FOR TABULATION OF DIMENSIONS AND QUANTITIES SEE SHEET 3 OF 3.
3. ALL PIPE FOR GRATE, STRUCTURAL TUBING, AND RELATED HARDWARE TO BE GALVANIZED.
4. STANDARD EW-11 TO BE INSTALLED SO THE GRATE CONFIGURATION IS ALWAYS PERPENDICULAR TO THE EDGE OF THE SHOULDER.
5. SLOPE AS SPECIFIED ON TYPICAL SECTION.
6. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03" NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY OUTSIDE OF STRUCTURE.
7. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALL OCCUR.
9. HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.
10. 1/4" CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER'S OPTION.
11. IN NO CASE SHALL THE TOP OF THE ENDWALL PROJECT ABOVE FILL SLOPE, DITCH SLOPE OR SHOULDER.
**NOTICES FOR PIPE TO BE FORMED IN CONCRETE SO THAT PIPE WILL FIT SNUG BUT CAN BE REMOVED.**

**DETAIL B**

**DETAIL A**

**SECTION A-A**

**CENTER SUPPORT**

**CENTER SUPPORT (ELEVATION)**

**PIECE ENDWALL WITH LOAD-CARRYING GRATE**

12" - 60" CIRCULAR PIPES
### 4:1 SLOPE

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>H</th>
<th>L</th>
<th>W</th>
<th>T</th>
<th>PIPE O.D.</th>
<th>NO. PIPES</th>
<th>L₂</th>
<th>L₃</th>
<th>L₄</th>
<th>L₅</th>
<th>NO CENTER SUPPORT REQUIRED</th>
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<tbody>
<tr>
<td>12&quot;</td>
<td>1'-10&quot;</td>
<td>7'-4&quot;</td>
<td>2'-0&quot;</td>
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<td>3/4&quot;</td>
<td>1</td>
<td>8'-6&quot;/8&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15&quot; or 18&quot;</td>
<td>2'-0&quot;/2&quot;</td>
<td>9'-6&quot;</td>
<td>2'-0&quot;</td>
<td>8&quot;</td>
<td>3/4&quot;</td>
<td>1</td>
<td>10'-6&quot;/8&quot;</td>
<td></td>
<td></td>
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<td>21&quot; or 24&quot;</td>
<td>2'-11&quot;</td>
<td>11'-8&quot;</td>
<td>3'-0&quot;</td>
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<td>4&quot;</td>
<td>2</td>
<td>13'-6&quot;/8&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27&quot; or 30&quot;</td>
<td>3'-0&quot;/2&quot;</td>
<td>13'-10&quot;</td>
<td>3'-0&quot;</td>
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<td>4&quot;</td>
<td>2</td>
<td>15'-6&quot;/8&quot;</td>
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<tr>
<td>33&quot; or 36&quot;</td>
<td>4'-0&quot;/2&quot;</td>
<td>16'-0&quot;</td>
<td>4'-0&quot;</td>
<td>8&quot;</td>
<td>4'/2&quot;</td>
<td>3</td>
<td>17'-6&quot;/8&quot;</td>
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<td>18'-2&quot;</td>
<td>4'-0&quot;</td>
<td>12&quot;</td>
<td>4'/2&quot;</td>
<td>3</td>
<td>19'-8'/2&quot;</td>
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<tr>
<td>48&quot;</td>
<td>5'-1&quot;</td>
<td>20'-4&quot;</td>
<td>5'-0&quot;</td>
<td>12&quot;</td>
<td>4'/2&quot;</td>
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<td>22'-2'/2&quot;</td>
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<td>4'/2&quot;</td>
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<td>4</td>
<td>26'-8'/2&quot;</td>
<td>14'-11&quot;</td>
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### 6:1 SLOPE

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>H</th>
<th>L</th>
<th>W</th>
<th>T</th>
<th>PIPE O.D.</th>
<th>NO. PIPES</th>
<th>L₂</th>
<th>L₃</th>
<th>L₄</th>
<th>L₅</th>
<th>NO CENTER SUPPORT REQUIRED</th>
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<tbody>
<tr>
<td>12&quot;</td>
<td>1'-10&quot;</td>
<td>11'-0&quot;</td>
<td>2'-0&quot;</td>
<td>8&quot;</td>
<td>3'/2&quot;</td>
<td>1</td>
<td>12'-6&quot;/8&quot;</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>15&quot; or 18&quot;</td>
<td>2'-4'/2&quot;</td>
<td>14'-3&quot;</td>
<td>2'-0&quot;</td>
<td>8&quot;</td>
<td>4&quot;</td>
<td>1</td>
<td>15'-6&quot;/8&quot;</td>
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<tr>
<td>21&quot; or 24&quot;</td>
<td>2'-11&quot;</td>
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<td>3'-0&quot;</td>
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<td>4&quot;</td>
<td>2</td>
<td>18'-6&quot;/8&quot;</td>
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</tr>
<tr>
<td>27&quot; or 30&quot;</td>
<td>3'-8'/2&quot;</td>
<td>20'-9&quot;</td>
<td>3'-0&quot;</td>
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<td>3</td>
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<td>17'-4'/2&quot;</td>
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<tr>
<td>33&quot; or 36&quot;</td>
<td>4'-0&quot;/2&quot;</td>
<td>24'-0&quot;</td>
<td>4'-0&quot;</td>
<td>8&quot;</td>
<td>4'/2&quot;</td>
<td>3</td>
<td>24'-3'/2&quot;</td>
<td>17'-4'/2&quot;</td>
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<tr>
<td>42&quot;</td>
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<td>54&quot;</td>
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<td>6'-0&quot;</td>
<td>12&quot;</td>
<td>4'/2&quot;</td>
<td>4</td>
<td>35'-3'/2&quot;</td>
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<td>18'-4'/2&quot;</td>
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### APPROXIMATE QUANTITIES

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<th>PIPE SIZE</th>
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<th>CONC. PIPE</th>
<th>C.M. PIPE</th>
<th>IBS.</th>
<th>REINFORCED STEEL</th>
<th>CONCRETE CUBIC YARDS</th>
<th>CONC. PIPE</th>
<th>C.M. PIPE</th>
<th>IBS.</th>
<th>REINFORCED STEEL</th>
<th>CONCRETE CUBIC YARDS</th>
<th>CONC. PIPE</th>
<th>C.M. PIPE</th>
<th>IBS.</th>
<th>REINFORCED STEEL</th>
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</table>
PIPE ENDWALL WITH LOAD-CARRYING GRATE

12” - 24” CIRCULAR PIPES

NOTES:

1. IN NO CASE SHALL TOP OF ENDWALL PROJECT ABOVE FILL SLOPE, DITCH, SLOPE, OR SHOULDERS.

2. CLASS A3 CONCRETE TO BE USED IF CAST IN PLACE, 4000 PSF PRECAST.

3. REINFORCING STEEL TO HAVE A MINIMUM 1/2” CONCRETE COVER. SEE SHEET 2 OF 2.

4. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.

5. BOTTOM OF STRUCTURE TO BE ON THE SAME GRADE AS DRAINAGE DITCH.

6. 1/4” CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER’S OPTION.

7. HEADWALL TO BE CHEWED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINGWALLS OCCUR.


9. THE NUMBER OF GRATE SECTIONS TO BE USED FOR EACH EW-11A IS BASED ON THE LENGTH "C" SEE QUANTITIES CHART ON SHEET 2 OF 2.
**DIMENSIONS**

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
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<th>B</th>
<th>C</th>
<th>a</th>
<th>b</th>
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<tbody>
<tr>
<td>12&quot;</td>
<td>11'-4&quot;</td>
<td>2'-1&quot;</td>
<td>10'-7/8&quot;</td>
<td>0'-1/4&quot;</td>
<td>0'-1&quot;</td>
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<td>15&quot;</td>
<td>14'-8&quot;</td>
<td>2'-5&quot;</td>
<td>14'-0&quot;</td>
<td>0'-13/4&quot;</td>
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<td>21'-6/2&quot;</td>
<td>0'-2/2&quot;</td>
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**APPROXIMATE QUANTITIES**

<table>
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<tr>
<th>PIPE SIZE</th>
<th>NO. OF GRATE SECTIONS</th>
<th>CONCRETE CUBIC YARDS</th>
<th>LBS. REINF. STEEL</th>
<th>LENGTH TO BE CUT FROM 1 GRATE</th>
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<td>12&quot;</td>
<td>3</td>
<td>1.127</td>
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<td>119</td>
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<td>4</td>
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<td>1.547</td>
<td>161</td>
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<td>18&quot;</td>
<td>5</td>
<td>1.856</td>
<td>1.877</td>
<td>201</td>
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<tr>
<td>21&quot; OR 24&quot;</td>
<td>6</td>
<td>2.567</td>
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<td>276</td>
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*GRATES WILL BE 3/8" SHORT.*

**SCHEDULE OF REINFORCING STEEL**

<table>
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<tr>
<th>PIPE SIZE</th>
<th>BARS A</th>
<th>BARS B</th>
<th>BARS C</th>
<th>BARS D</th>
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<tr>
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<td>LENGTH</td>
<td>NO. SPA.</td>
<td>LENGTH</td>
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<td>26</td>
</tr>
<tr>
<td>21&quot; OR 24&quot;</td>
<td>5</td>
<td>8&quot;</td>
<td>4</td>
<td>33</td>
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**BENDING DIAGRAM**

**APPROXIMATE WEIGHT OF GRATE**

<table>
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<tr>
<th>TYPE</th>
<th>LBS.</th>
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<tbody>
<tr>
<td>2&quot; DIA BAR</td>
<td>158.55</td>
</tr>
<tr>
<td>NO. 14 BILLET STEEL BAR</td>
<td>123.64</td>
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**PIPE ENDWALL WITH LOAD-CARRYING GRATE**

12" - 24" CIRCULAR PIPES

VIRGINIA DEPARTMENT OF TRANSPORTATION

| SHEET 2 OF 2 | REVISION DATE | 101.30 |

2016 ROAD & BRIDGE STANDARDS
**FOOTING DETAIL**

1. CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH. IF PIPE IS TO BE SKewed, THE OPENING WILL BE ADJUSTED TO ACCOMMODATE REINFORCING STEEL IN ACCORDANCE WITH ASTM A615 (REINFORCING BARS).

2. PIPE DIMENSIONS SHOWN ARE MINIMUM. ACTUAL DIMENSIONS MAY VARY WITH MANUFACTURER.

3. BOTTOM OF STRUCTURE TO BE ON THE SAME GRADE AS DRAINAGE DITCH.

4. FOR DETAILS OF GRATE AND NUMBER OF GRATES REQUIRED SEE EW-9A.

5. $\frac{3}{4}''$ CHAMFER MAY BE PROVIDED ON ALL EDGES AT MANUFACTURER’S OPTION.

6. HEADWALL TO BE BEVELED IN ALL AREAS EXCEPT WHERE A CONFLICT WITH INVERT OR WINDWALLS OCCUR.


8. HEADWALL AT THE OUTLET END OF THE CULVERT MAY BE EITHER SQUARE EDGE OR BEVEL EDGE.

9. PIPE OPENINGS IN PRECAST DRAINAGE UNITS SHALL NOT EXCEED 1/4 INCHES AT ANY GIVEN POINT BETWEEN THE PIPE AND THE PRECAST UNIT.

---

**SPECIFICATION REFERENCE**

105
233
302

**ROAD AND BRIDGE STANDARDS**

**2016 ROAD & BRIDGE STANDARDS**
NOTES:

1. TYPICAL ENDWALL TO BE PLACED AT THE ENDS OF ALL UNDERDRAIN OUTLETS, BARRING LOCATIONS WHERE UNDERDRAIN IS TIED INTO OTHER DRAINAGE STRUCTURES. ENDWALL TO BE INSTALLED PERPENDICULAR TO ROADWAY AND FLUSH WITH THE SLOPE.

2. OUTLET PIPES SHALL BE RIGID NONPERFORATED, SMOOTH-BORE PIPE, MEETING THE REQUIREMENTS OF 70 PSI TESTED ACCORDING TO ASTM 2412.

3. EXPANDED STEEL MESH (FLATTENED) SHALL HAVE OPENINGS OF APPROX. 1/4" X 1" AND WEIGH APPROX. 0.02 LBS. PER SQ. FT. MESH SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A-123. THE MESH SHALL EXTEND A MINIMUM OF 1" ABOVE THE O.D. OF THE PIPE, AND IS A BARRIER FOR RODENTS, ETC. THE SLOT FOR THE STEEL MESH IS TO BE CONSTRUCTED SO THAT THE MESH CAN BE REMOVED FOR CLEANOUT PURPOSES.

4. THIS ITEM MAY BE PRECAST OR CAST IN PLACE. CAST IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI MIN.). PRECAST CONCRETE IS TO BE CLASS A4 (4000 PSI MIN.).

5. STEEL POSTS SHALL BE GALVANIZED IN ACCORDANCE WITH THE ROAD AND BRIDGE SPECIFICATIONS. ALUMINUM MARKER PLATES SHALL BE ASTM B209 ALLOY 6061-T6 OR 5052-H38IF. SHEETING FOR WHITE BACKGROUND AND BLACK LETTERS SHALL CONFORM TO SECTION 701 OF THE ROAD AND BRIDGE SPECIFICATIONS.

6. MARKER SHALL BE PLACED AT ALL EW-12 INSTALLATIONS WITH 2 INCH LETTERS PLACED VERTICALLY DESIGNATING UNDERDRAINS WITH "UD" AND CROSSDRAINS WITH "CD".

7. MARKER WILL BE PAID FOR IN ACCORDANCE WITH SECTION 501 OF THE ROAD AND BRIDGE SPECIFICATIONS.
END-SECTION 12" - 60" PIPE

CONCRETE TO BE 4000 PSI MINIMUM

PLAN

SECTION X-X

END VIEW

END SECTION DIMENSIONS

<table>
<thead>
<tr>
<th>PIPE DIAMETER</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<td>2’-0”</td>
<td>4’-0”</td>
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<td>2’-7”</td>
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<td>3’-3”</td>
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LENGTH OF PIPE

SHOULDER

CULVERT

SLOPE DETAIL

NOTES:
PIPE LENGTHS SHOWN ON PLANS ARE BASED ON END-SECTION DESIGN SHOWN ON THE LEFT. IF THE CONTRACTOR ELECTS TO USE THE ALTERNATE DESIGN SHOWN ON THE RIGHT, LENGTHS WILL BE REDUCED BY THE DIFFERENCE IN DIMENSION "D".

FLARED END SECTION
12" - 60" CONCRETE PIPE CULVERTS

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
### Alternate Connections

#### Typical Cross-Section

- **Elevation**
- **Plan**
- **Sketch**

### Sheet Thickness

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<th>PIPE DIAMETER</th>
<th>SHEET THICKNESS</th>
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### Dimensions

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<td>87&quot;</td>
<td>114&quot;</td>
<td>36&quot;</td>
</tr>
</tbody>
</table>

### Notes:

1. Toe plate to be punched to match holes in skirt lip. 1/4" galvanized bolts to be furnished. Length of toe plate is W + 10" for 12" to 30" diameter pipe and W + 22" for 36" to 60" diameter pipe.
2. Skirt section 12" to 30" diameter pipe to be made in one piece.
3. Skirt section for 36" to 54" diameter pipe may be made from two sheets joined by riveting or bolting on center line. 60" may be constructed in 3 pieces.
4. Connector section, corner plate and toe plate to be same sheet thickness as skirt.
5. End-section and fittings are to be steel for use with steel pipe.
6. End-section and fittings are to be aluminum alloy for use with aluminum alloy pipe.
7. Either the steel or aluminum end-section detailed may be used for plastic pipe sizes shown in STD. PC-1.
8. Where flared end-section are to be used with asphalt coated and paved metal pipe, end sections do not need to be coated or paved.
NOTES
1. TOE PLATE TO BE PUNCHED TO MATCH HOLES IN SKIRT LIP.
2. ¾" GALVANIZED BOLTS TO BE FURNISHED; LENGTH OF TOE PLATE IS W + 10" WITH RISE OF 13" TO 23" INCLUDED AND W + 18" MIN. WITH RISE OF 33" TO 47" INCLUDED.
3. SKIRT SECTION WITH RISE OF 13" TO 24" INCLUDED TO BE MADE IN ONE PIECE.
4. SKIRT SECTION WITH RISE OF 29" TO 38" INCLUDED MAY BE MADE FROM TWO SHEETS JOINED BY RIVETING OR BOLTING ON CENTER LINE.
5. SKIRT SECTION WITH RISE OF 43" TO 47" INCLUDED MAY BE MADE FROM THREE SHEETS JOINED BY RIVETING OR BOLTING AT EQUAL DISTANCES FROM CENTER LINE.
6. CONNECTOR SECTION, CORNER PLATE AND TOE PLATE TO BE SAME SHEET THICKNESS AS SKIRT AND SAME TYPE OF MATERIAL AS CULVERT.
7. WHERE FLARED END - SECTIONS ARE TO BE USED WITH ASPHALT COATED AND PAVED METAL PIPE, END SECTIONS DO NOT NEED TO BE COATED OR PAVED.
8. *INDICATES PIPE ARCHES FOR WHICH DIMENSIONS FOR EITHER CORRUGATION MAY BE USED WITHIN FILL HEIGHT LIMITATIONS.

<table>
<thead>
<tr>
<th>Pipe-Arch Dimensions</th>
<th>3&quot; x 1&quot; and 5&quot; x 1&quot; Corrugations</th>
<th>2 1/2&quot; x 1/2&quot; Corrugations</th>
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<tr>
<td>SPAN</td>
<td>RISE</td>
<td>SHEET THICKNESS</td>
</tr>
<tr>
<td>17&quot;</td>
<td>13&quot;</td>
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<tr>
<td>66&quot;</td>
<td>51&quot;</td>
<td>.079&quot;</td>
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Flared End-Section
13" - 47" Rise Metal Pipe Arches
Virginia Department of Transportation
# GENERAL NOTES - PRECAST

Precast structures will conform to Section 302 of the specifications. The manufacturer will have the option of selecting the combination of precast units to complete a structure unless otherwise noted on the plans.

The "H" (linear feet for manholes) dimension shown on the standards and specified on the plans will be measured from the invert of the outfall pipe to the top of the masonry structure. Plan "H" dimensions are approximate only for estimating purposes and the actual dimensions shall be determined by the contractor from field conditions.

In the event the invert of the outfall pipe is higher than the bottom of the structure, the invert of the structure shall be shaped with cement mortar to prevent standing or ponding of water in the structure. This will apply to all structures meeting this condition and is not to be confused with standard IS-1. The cost for invert shaping shall be included in the price bid for the structure.

When specified on the plans, the invert is to be shaped in accordance with standard IS-1. The cost of furnishing and placing all materials incidental to the shaping is to be included in the price bid for the structure.

All precast structures to be constructed with 4000 PSI minimum concrete.

Steps in accordance with standard ST-1 are to be provided in all manholes and in all drop inlets with an "H" dimension of 4'-0" or greater.

3" diameter weep holes will be required in precast structure's located adjacent to the pavement to drain the subbase. Placement of weep holes in the precast unit will be determined by the proximity of the structure to the subbase. Weep holes may also be required in other structures when called for on the plans or directed by the engineer.

Weep holes will have 12" x 12" plastic hardware cloth, 1/2" mesh or galvanized steel wire, minimum wire diameter 0.03", number 4 mesh hardware cloth anchored firmly to outside of structure.

Precast units located adjacent to cast-in-place concrete items, such as flumes, ditches, gutters, and sidewalks shall be connected to the adjacent unit by means of No. 4 smooth steel dowels spaced on approximately 12" centers throughout the contact length and extending at least 4" into both the precast unit to receive the dowels, they shall not exceed 1/2" diameter.

The standard safety slab (SL-1) is to be used only when specified in the plans. On the drainage summary sheet and/or the drainage description, refer to standard SL-1 for safety slab information.

1/4" chamfer may be provided on all edges at manufacturer's option.
#4 BARS @ 4" C-C

#4 DIAGONAL BAR

ALL CORNERS TYPICAL

4'-10" DIAMETER

12 #5 BARS
5' LONG
(63 LBS.)

1800 LBS. (WITHOUT GRATE)

NOTES:
1. SEE GENERAL NOTES PRECAST FOR ADDITIONAL DETAILS.
2. CONCRETE TO BE 4000 PSI MINIMUM.
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM C-478, ASTM A-497 (WIRE FABRIC) AND ASTM A-615 (REINFORCING BARS).
4. CONCRETE COVER AND GRATE ARE TO BE FURNISHED AS A SINGLE UNIT.
5. SEE STANDARD DI-1, 1A FOR DETAILS OF FRAME AND GRATE.
6. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL DIMENSIONS MAY VARY WITH MANUFACTURER.

RECOMMENDED MINIMUM HEIGHT CHART

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>H DIMENSION</th>
<th>CORR. METAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>2'-6&quot;</td>
<td>2'-5&quot;</td>
</tr>
<tr>
<td>15&quot;</td>
<td>2'-9/4&quot;</td>
<td>2'-8&quot;</td>
</tr>
<tr>
<td>18&quot;</td>
<td>3'-0&quot;</td>
<td>3'-11&quot;</td>
</tr>
<tr>
<td>21&quot;</td>
<td>3'-3/4&quot;</td>
<td>3'-2&quot;</td>
</tr>
<tr>
<td>24&quot;</td>
<td>3'-7&quot;</td>
<td>3'-5&quot;</td>
</tr>
</tbody>
</table>

NOTES:
1. TONGUE AND GROOVE JOINT TO BE OF FABRICATOR'S DESIGN MEETING THE APPROVAL OF THE ENGINEER. JOINTS ARE TO BE SEALED WITH MORTAR, OR O-RING GASKETS OR BUTYL RUBBER.
2. ALTERNATE JOINT DETAILS APPLY TO ALL PRECAST UNITS.

ALTERNATE JOINT DETAILS
LOCATION OF HOLE TO VARY WITH TYPE OF INLET CONSTRUCTED. HOLE MAY BE SHIFTED RIGHT, LEFT OR CENTERED.

STANDARD DI-2 COLLAR & GRATE

L 2½” x 2½” x ¼” GALV.

Dowel throat section to chamber if cast separately or provide alternate VDOT approved method of interlock.

SLOT LENGTH "L" VARIES 20'-0" MAX.

NOTES
1. SEE GENERAL NOTES - PRECAST FOR ADDITIONAL DETAILS.
2. CONCRETE TO BE 4000 PSI MINIMUM.
3. REINFORCING STEEL IN ACCORDANCE WITH ASTM-615.
4. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL DIMENSIONS MAY VARY WITH MANUFACTURER.
5. FOR DETAILS OF FRAME AND GRATE SEE STANDARD DI-2A, B, C.
6. VERTICAL REINFORCING BARS TO BE CONTINUOUS THROUGH JOINT.
7. STANDARD ST-1 STEPS NOT REQUIRED IN THIS TOP UNIT.

PLAN

SECTION A-A

SECTION B-B (CG-6 CURB AND GUTTER)

ALTERNATE SECTION B-B (FOR USE WITH CG-7 CURB AND GUTTER)

RECOMMENDED MINIMUM HEIGHT CHART

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>&quot;H&quot; DIMENSION (CONCRETE PIPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>4'-8&quot;</td>
</tr>
<tr>
<td>15&quot;</td>
<td>4'-11½&quot;</td>
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<tr>
<td>18&quot;</td>
<td>5'-2½&quot;</td>
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<td>33&quot;</td>
<td>6'-20½&quot;</td>
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<td>36&quot;</td>
<td>7'-0&quot;</td>
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<tr>
<td>42&quot;</td>
<td>7'-7½&quot;</td>
</tr>
<tr>
<td>48&quot;</td>
<td>8'-2&quot;</td>
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</table>

VERTICAL REINFORCING BARS TO BE CONTINUOUS THROUGH JOINT.

STANDARD PRECAST TOP UNITS

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
T-DI-3.4
Curb Drop Inlet Throat Section

NOTES:
1. See General Notes - Precast for additional details.
2. Concrete to be 4000 psi minimum compressive strength.
3. Reinforcing steel in accordance with ASTM A-615 for reinforcing bars.
4. Reinforcing in accordance with ASTM A-185 for welded wire mesh.
5. Dimensions shown are minimum. Actual dimensions may vary with manufacturer.
6. This unit may be used with all standard DI-3 & DI-4 curb drop inlets.
7. Each face block shall have 2 or more loops (+3 bars) cast in face as shown. These loops may be used for lift and for tying in the poured in place gutter section. Face blocks are to be sealed with grout or polysulfide sealer.
8. Standard ST-1 steps not required in this top unit.

Recommended Minimum Height Chart

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<tr>
<th>Pipe Size</th>
<th>2&quot;-10&quot;</th>
<th>3&quot;-15/4&quot;</th>
<th>3&quot;-3/4&quot;</th>
<th>3&quot;-3 1/4&quot;</th>
<th>3&quot;-3 1/4&quot;</th>
<th>3&quot;-6&quot;</th>
<th>3&quot;-9&quot;</th>
<th>4&quot;-0 1/4&quot;</th>
<th>4&quot;-3 1/4&quot;</th>
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<tbody>
<tr>
<td>DI-3A,B,C, D, &amp; F</td>
<td>6&quot;</td>
<td>8&quot;</td>
<td>10&quot;</td>
<td>12&quot;</td>
<td>15&quot;</td>
<td>18&quot;</td>
<td>21&quot;</td>
<td>DI-3A,B,C, D, &amp; F</td>
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<tr>
<td>36&quot; Base Unit</td>
<td>6&quot;</td>
<td>3&quot;-9&quot;</td>
<td>3&quot;-15/4&quot;</td>
<td>3&quot;-3 1/4&quot;</td>
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<td>48&quot; Base Unit</td>
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<td>3&quot;-9&quot;</td>
<td>3&quot;-15/4&quot;</td>
<td>3&quot;-3 1/4&quot;</td>
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<td>3&quot;-9&quot;</td>
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Typical Minimum Bar Reinforcement

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<td>W-20</td>
<td>4-4</td>
<td>W-20</td>
<td>4-4</td>
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Typical Minimum Welded Wire Reinforcement

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<th>W-20</th>
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<tr>
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<td>W-20</td>
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<td>W-20</td>
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2016 Road & Bridge Standards

Virginia Department of Transportation

Specification Reference

105
233
302
STANDARD PRECAST TOP UNITS

ISOMETRIC
CURB DROP INLET THROAT SECTION
ALTERNATE DESIGN

PLAN

BACK VIEW

END VIEW

NOTES:
1. 2" x 4" NOTCH MAY BE FORMED WITH STRAIGHT SIDES, TAPERED
   SIDES OR TAPERED SIDES WITH RADIUS.
2. ALL DETAILS NOT SHOWN TO BE IN ACCORDANCE
   WITH SHEET 1 OF 2.

NOTE:
DOWEL HOLES PROVIDED TO PREVENT SETTLEMENT OF
ADJACENT CONCRETE.

ALTERNATE DETAIL FOR FACE BLOCK
(NOSE TYPE B)

ALTERNATE NOSE
DETAIL A

ALTERNATE DETAIL B

(VFOR USE WITH MOUNTABLE CURB)
SECTION A-A

SECTION B-B

L2½" x 2½" x ¼"
WELD

WELD

2" DIAMETER BAR @ 10.68 LBS./FT.
OR 14 BILLET STEEL BAR @ 7.65 LBS./FT. (ASTM A615, GRADE 60).

1/4" x 4" STUD SHEAR CONNECTOR

NOTES:

1. SEE GENERAL NOTES-PRECAST FOR ADDITIONAL DETAILS.
2. CONCRETE SHALL BE 4000 PSI MINIMUM.
3. REINFORCING STEEL SHALL BE IN ACCORDANCE WITH ASTM-A 615.
4. CONCRETE COVER AND GRATE ARE TO BE FURNISHED AS A SINGLE UNIT.
5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL DIMENSIONS MAY VARY WITH MANUFACTURER.
6. GRATE BARS ARE TO BE INSTALLED SO THEY WILL BE ALIGNED PARALLEL TO THE DITCH FLOW.
7. WHERE DITCH SLOPES DO NOT MATCH THOSE OF INLET COVER, THE AREA ADJACENT TO THE INLET IS TO BE GRADED TO PROVIDE A SMOOTH TRANSITION.
8. DI-5 IS TO BE UTILIZED IN LOCATIONS NOT NORMALLY SUBJECT TO TRAFFIC.
GRATE A BAR SPACING CHART

<table>
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<tr>
<th>GRATE TYPE</th>
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<tr>
<td>A I</td>
<td>1 1/2&quot;</td>
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<tr>
<td>B</td>
<td>3&quot;</td>
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<tr>
<td>A II</td>
<td>1&quot;</td>
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NOTES:
1. SEE GENERAL NOTES-PRECAST FOR ADDITIONAL DETAILS.
2. CONCRETE COVER AND GRATE ARE TO BE FURNISHED AS A SINGLE UNIT. OUTSIDE DIMENSIONS OF GRATE ARE TO BE 3'-4" X 2'-11 1/4" (GRATE A) OR 3'-4" X 2'-11 1/2" (GRATE B).
3. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL DIMENSIONS MAY VARY WITH MANUFACTURER.
4. GRATE A IS TO BE UTILIZED IN LOCATIONS NOT NORMALLY SUBJECT TO TRAFFIC.
5. GRATE B IS TO BE UTILIZED IN LOCATIONS NORMALLY SUBJECT TO TRAFFIC.
6. ALTERNATE METHODS OF ANCHORING ANGLE IRON WILL BE ACCEPTABLE IF APPROVED BY THE ENGINEER.
7. GRATE AND COLLAR ARE TO BE GALVANIZED AFTER FABRICATION.
8. JOINTS BETWEEN CONCRETE COVER AND GUTTERS (WHEN REQUIRED) ARE TO BE DOWELED, KEYED, OR OTHER VDOT APPROVED METHODS.
9. CONCRETE SHALL BE 4000 PSI MINIMUM.
10. REINFORCING STEEL SHALL BE IN ACCORDANCE WITH ASTM A-615.
11. GRATE BARS ARE TO BE INSTALLED SO THEY WILL BE AlIGNED PARALLEL TO THE DITCH FLOW.
12. SEE STANDARD DI-7, 7A, 7B FOR DETAILS OF GUTTER, METHOD OF PLACEMENT, ALTERNATE METHODS OF CONSTRUCTION.
NOTCH, DOWELS, KEYS OR OTHER VDOT APPROVED MEANS OF PROVIDING POSITIVE INTERLOCK ARE TO BE INCLUDED IN FLAT SLAB TOPS USED IN CONJUNCTION WITH CURB DROP INLETS.

LOCATION, SIZE AND SHAPE OF HOLE MAY VARY DEPENDING ON THE TYPE OF STRUCTURE.

CONCRETE TAPER UNIT

ECCENTRIC TAPER UNIT

NOTES:

1. SEE GENERAL NOTES FOR ADDITIONAL INFORMATION ON WEEP HOLES, STEP REQUIREMENTS, "H" (LIN. FT. FOR MANHOLE) DIMENSION, ETC.

2. ALL SPACER UNITS, FLAT SLAB TOPS, AND TAPER UNITS ARE TO BE IN ACCORDANCE WITH THE REQUIREMENTS OF AASHTO M199.

3. CONCRETE SHALL BE 4000 PSI.

4. FOR STEP DETAILS SEE STANDARD ST-1.

5. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL DIMENSIONS MAY VARY WITH MANUFACTURER.

6. SPACER UNITS SHOWN HEREON ARE ALSO KNOWN AS "GRADE RINGS" OR ADJUSTMENT RINGS.

7. WHEN SPACER UNITS ARE REQUIRED, "H" IS TO BE MEASURED FROM THE TOP OF THE UPPERMOST SPACER.

8. SPACER UNIT IS TO BE DOWELED OR MORTARED TO TAPER UNIT OR FLAT SLAB TOP.
NOTES:

1. SEE GENERAL NOTES FOR ADDITIONAL INFORMATION ON WEEP HOLES, STEP REQUIREMENTS, "H" (LIN. FT. FOR MANHOLES) DIMENSIONS, ETC.

2. ALL REDUCER AND RISER UNITS ARE TO BE IN ACCORDANCE WITH THE REQUIREMENTS OF AASHTO M199.

3. CONCRETE SHALL BE 4000 PSI.

4. WHERE OPENINGS ARE REQUIRED FOR PIPE, THEY SHALL BE FORMED, DRILLED, OR NEATLY CUT AS APPROVED BY THE ENGINEER. THE CONTRACTOR SHALL FURNISH THE FABRICATOR WITH THE ANGLES BETWEEN CENTER LINES, THE INVERT ELEVATIONS, AND THE SIZE OF ALL PIPES TO ENTER THE MANHOLE.

5. FOR STEP DETAILS SEE STANDARD ST-1.

6. DIMENSIONS SHOWN ARE MINIMUM. ACTUAL DIMENSIONS MAY VARY WITH MANUFACTURER.

7. "D" IS NOMINAL DIAMETER.

8. WHEN USING R-2 FLAT SLAB, HEIGHT OF STRUCTURE FROM THE SLAB UP TO THE FINISHED GRADE ELEVATION IS LIMITED TO A MAXIMUM OF 25'.

9. TONGUE AND GROOVE JOINT TO BE OF FABRICATOR'S DESIGN MEETING THE APPROVAL OF THE ENGINEER. JOINTS ARE TO BE SEALED WITH MORTAR, O-RING GASKETS, OR BUTYL RUBBER.
NOTES:

1. See General Notes for additional information on weep holes, step requirements, "H" (lin. ft. for manholes) dimensions, etc.

2. All base units are to be in accordance with the requirements of AASHTO M199.

3. Concrete shall be 4000 psi.

4. Where openings are required for pipe, they shall be formed, drilled, or neatly cut as approved by the Engineer. The contractor shall furnish the fabricator with the angles between center lines, the invert elevations, and the size of all pipes to enter the manhole. Holes are to be a minimum of 4" to a maximum of 8" larger than the outside diameter of the proposed pipe.

5. Dimensions shown are minimum. Actual dimensions may vary with manufacturer.

6. "D" is nominal diameter.

7. In the event the invert of the outfall pipe is higher than the bottom of the structure, the invert of the structure shall be shaped with cement mortar to prevent standing or ponding of water in the structure.

8. Tongue and groove joint are to be of fabricator's design meeting VDOT approval. Joints are to be sealed with mortar, O-ring gaskets, or butyl rubber.

<table>
<thead>
<tr>
<th>DIMENSIONS</th>
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<tbody>
<tr>
<td><strong>D</strong></td>
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<td>60&quot;</td>
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<td>96&quot;</td>
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<tr>
<td>108&quot;</td>
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<tr>
<td>120&quot;</td>
</tr>
<tr>
<td>126&quot;</td>
</tr>
<tr>
<td>144&quot;</td>
</tr>
</tbody>
</table>

* Depth "H" of 36" diameter base unit restricted to 4'-0" maximum.

** One through pipe only. (One pipe entering and one pipe exiting structure)
NOTES:

1. SEE GENERAL NOTES FOR ADDITIONAL INFORMATION ON WEEP HOLES, STEP REQUIREMENTS, "H" DIMENSION, ETC.
2. THE TEE UNIT IS TO BE PRECAST FOR DELIVERY TO THE CONSTRUCTION SITE AS A COMPLETE UNIT.
   ALTERNATE DESIGNS MEETING THE APPROVAL OF THE ENGINEER MAY BE SUBSTITUTED FOR THAT SHOWN HEREON.
3. THE PRECAST BASE SECTION IS TO CONFORM TO THE REQUIREMENTS OF AASHTO M170.
4. THE PRECAST RISER SECTION IS TO CONFORM TO THE REQUIREMENTS OF AASHTO M199,
   EXCEPT THAT MINIMUM WALL THICKNESS IS TO BE 3/8".
5. THE BASE SECTION IS TO BE THE SAME CLASS AND STRENGTH AS THE ADJOINING PIPE CULVERT AND THE TONGUE
   AND GROOVE JOINTS ARE TO BE OF AN IDENTICAL DESIGN.
6. CONCENTRIC RISER SECTION MAY BE SUBSTITUTED WHEN APPROVED BY THE ENGINEER.
7. OTHER MANUFACTURER’S DESIGNS FOR REDUCER SECTION MAY BE SUBSTITUTED WHEN APPROVED BY THE ENGINEER.
8. REDUCER SECTIONS WITH PIPE CROWNS OR CENTER LINES MATCHED ARE AVAILABLE IN ADDITION TO THE MATCHED
   INVERTS SHOWN HEREON.
9. WELD AND SPLICE LONGITUDINAL AND CIRCUMFERENTIAL STEEL OF RISER AND BASE SECTIONS TO MAINTAIN
   CONTINUITY OF REINFORCEMENT.
10. HAND OR PNEUMATICALLY PLACE MORTAR AND SHAPE INTO COLLAR.
11. RISER SECTION PAID AS STANDARD DROP INLET OR LIN. FT. MANHOLE DEPENDING ON USE OF STRUCTURE.

STANDARD PRECAST BASE UNITS

MAX. DEPTH (H) 25’

VIRGINIA DEPARTMENT OF TRANSPORTATION
TRANSVERSE SECTION

LONGITUDINAL SECTION

NOTES:

1. OTHER STANDARD GRATES OR DROP INLET THROAT SECTIONS MAY BE SUBSTITUTED WHEN SPECIFIED ON PLANS.

2. RISER SECTION PAID AS STANDARD DROP INLET OR LIN. FT. OF MANHOLE DEPENDING ON USE OF STRUCTURE.


4. WHEN REQUIRED, CONNECTION BETWEEN DROP INLET RISER AND TEE UNIT MAY BE BOLTED OR RIVETED.
**NOTES**

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS, FOR DEPTH GREATER THAN 10' USE STANDARD DI-1A.

2. THE "H" DIMENSION SHOWN ON THE PLANS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.

3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.


5. STEPS ARE TO BE PROVIDED WHEN H IS 4'-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.

6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.

7. #4 X 8" SMOOTH DOWELS AT APPROXIMATELY 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTTING CONCRETE TO PREVENT SETTLEMENT. IN LIEU OF DOWELS A 2"X4" NOTCH MAY BE PROVIDED. SEE STANDARD T-DI-3, 4 FOR ALTERNATE DESIGN.

8. 3" DIAMETER WEEP HOLE WITH 12"X12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03", NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.

9. CAST IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.

10. ANY ALTERNATE METHODS OF ANCHORAGE MEETING THE APPROVAL OF THE ENGINEER MAY BE SUBSTITUTED FOR THE CAST IRON LUGS SHOWN HEREON.

11. DUMP NO WASTE DRAINS TO WATERSWAYS LETTERING IS REQUIRED ON ALL DI-1 GRATES. LOCATION OF LETTERING MAY VARY BY MANUFACTURER.

**STANDARD DROP INLET**

12" - 24" PIPE: MAXIMUM DEPTH (H) = 10'
NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS. MAXIMUM DEPTH (H) TO BE 20', FOR DEPTHS LESS THAN 10' USE STANDARD DI-1.

2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.

3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.


5. STEPS ARE REQUIRED. FOR DETAILS SEE ST'D. ST-1.

6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.

7. # 4 X 8" SMOOTH DOWELS AT APPROXIMATELY 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTTING CONCRETE TO PREVENT SETTLEMENT. IN LIEU OF DOWELS A 2" X 4" NOTCH MAY BE PROVIDED. SEE STANDARD T-DI-3, 4 FOR ALTERNATE DESIGN.

8. 3" DIAMETER WEEP HOLE WITH 12"X12" PLASTIC HARDWARE CLOTH ¼" MESH OR GALVANIZED STEEL WIREF. MINIMUM WIRE DIAMETER 0.03". NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.

9. ALL REINFORCING STEEL SHALL HAVE A MIN. COVER OF 2".

10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".

11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.

12. ALL SPLICES IN BARS V TO BE A MINIMUM OF 40 DIAMETERS (20')

13. IF OPTIONAL CONSTRUCTION JOINT IS USED, IT IS TO BE KEYED.

14. FOR DETAILS AND DIMENSIONS, ETC. OF GRATE AND STEEL OR CAST IRON COLLAR SEE STANDARD DI-1.

REINFORCING STEEL SCHEDULE

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<td>BARS V</td>
<td>#4 40 H + 4&quot;</td>
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APPROXIMATE QUANTITIES FOR MINIMUM (H) DEPTH

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INCREMENTS TO BE ADDED FOR EACH ADDITIONAL FOOT OF DEPTH (H):

0.465 CY. YDS. OF CONCRETE
58.7 LBS. OF REINFORCING STEEL
STANDARD CURB DROP INLET

12" - 24" PIPE: MAXIMUM DEPTH (H) = 9'

VIRGINIA DEPARTMENT OF TRANSPORTATION

DI-2A, 2B, 2C

PLAN VIEW

3" DIAMETER WEEP HOLE SEE NOTE 8

GALVANIZED MC 6 X 12

BACK OF SIDEWALK

FACE OF CURB

EXPANSION JOINT

CRACK CONTROL JOINT

SECTION B-B

SLOPE OF APPROACH SURFACE

WELDED SURFACE

BARS A-1 @ 10" C-C
BARS B @ 8" C-C
BARS C @ 6" C-C
BARS E

SECTION D-D

SECTION E-E

SECTION C-C

\[ \Delta \text{DECREASE TO 1" WHEN INLET IS USED WITH MEDIANS.} \]

BARS A-1 @ 10" C-C
BARS B-1 @ 6" C-C
BARS E

BARS A @ 10" C-C
BARS B @ 8" C-C
BARS C @ 6" C-C
BARS F

WELD ALL 1/4" X 4" STUD SHEAR CONNECTOR TO COLLAR.

DI-2A

FOR USE ON GRADES

MIN. H = PIPE DIA. - 2" - 6"
MAX. H = DIA. - 6"

5" X 1/2" BENT PLATES

WEEPHOLE SEE NOTE 8

STEPS SEE NOTE 5

FOR STEP DETAILS SEE STD. ST-1.

SECTION A-A

NOSE DETAILS

TYPE A NOSE DETAIL SHALL BE USED WITH CG-7 STANDARD.

TYPE B NOSE DETAIL SHALL BE USED WITH CG-6 STANDARD.

GALVANIZED PLATE FOR TYPE A TO BE BENT ON AN ANGLE OF 6" 30' AND IS TO BE ANCHORED WITH 1/4" X 4" STUD SHEAR CONNECTORS WELDED TO BENT PLATE AT 2" C-C.

NOSE DETAILS

TYPE A

NOSE DETAILS

TYPE B

SPECIFICATION REFERENCE

2016 ROAD & BRIDGE STANDARDS
### TABLE OF QUANTITIES

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### NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.

2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.

3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.


5. STEPS ARE TO BE PROVIDED WHEN H IS 4'-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.

6. * 4 X 8" SMOOTH DOWELS AT APPROXIMATELY 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO DRAIN SUBBASE MATERIAL. DOWELS SHALL BE 12" LONG. ALL OTHER HARDWARE FOR DOWELS MUST BE PROVIDED BY CONTRACTOR.

7. THE CEMENT MIXTURE FOR CONCRETE OF TP-2 SHALL BE USED.

8. 3" DIAMETER WEEP HOLE TO BE LOCATED 3'-0" FROM STRUCTURE AND EMBEDDING TO BE WITHIN A 6" DIAMETER OF WEEP HOLE. ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.

9. ALL REINFORCING STEEL SHALL HAVE A MINIMUM COVER OF 2".

10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".

11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.

12. LENGTH OF SLOT (L) WILL, IN EVERY CASE, BE SHOWN ON PLANS.

13. THIS STANDARD IS INTENDED FOR USE IN CURB AND GUTTER SITUATIONS ONLY.

14. STANDARD INLETS MAY BE CONSTRUCTED WITH CONCRETE BLOCKS IN ACCORDANCE WITH THE DETAILS SHOWN ON STANDARD DRAWING DI-1.

15. THIS AREA MAY BE EARTHEN, IN WHICH CASE THE EARTHEN JOINTS WILL APPLY ONLY TO CURB AND GUTTER.

16. CONCRETE QUANTITIES SHOWN ARE FOR DEPTH (H) OF 5'-2" WITHOUT PIPES. THE AMOUNT DISPLACED BY PIPES MUST BE DEDUCTED TO OBTAIN TRU QUANTITIES FOR INLETS OF DIFFERENT DEPTHS. ADD OR SUBTRACT 0.28 CUBIC YARDS OF CONCRETE FOR EACH FOOT.

17. LENGTH OF ANCHOR IRON AS SHOWN ON SHEET 15" TO BE CUT AT 4'-0" LBS./FT.

18. * DENOTES LENGTH OF ONE (1) BAR.

19. ALL REINFORCING BARS TO BE #5.

20. GRADE TO BE INSTALLED SO SLOTS WILL DIRECT WATER TOWARD THE INLET THREAT.

21. MINIMUM HEIGHT = PIPE DIA. + 2'-8" WHEN PIRES ARE LOCATED UNDER EXTENDED SLOT OF INLET.

22. DUMP NO WASTE DRAINS TO WATERWAYS. LETTERING IS REQUIRED ON ALL DI-2 GRATES. LOCATION OF LETTERING MAY VARY BY MANUFACTURER.

**STANDARD CURB DROP INLET**

| 12" - 24" PIPE: MAXIMUM DEPTH (H) = 9' |

**DETAIL A**

**SECTION F-F**

**ROAD AND BRIDGE STANDARDS**

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**2016 ROAD & BRIDGE STANDARDS**
NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.
   MAXIMUM DEPTH (H) TO BE 20’. FOR DEPTHS
   LESS THAN 9’ USE STANDARD DI-2A, 2B OR 2C.

2. THE “H” DIMENSION SHOWN ON THE STANDARDS
   AND SPECIFIED ON THE PLANS WILL BE MEASURED
   FROM THE INVERT OF THE OUTFALL PIPE TO THE
   TOP OF THE STRUCTURE. PLAN “H” DIMENSIONS
   ARE APPROXIMATE ONLY FOR ESTIMATING
   PURPOSES AND THE ACTUAL DIMENSIONS SHALL
   BE DETERMINED BY THE CONTRACTOR FROM FIELD
   CONDITIONS.

3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO
   BE SHAPED IN ACCORDANCE WITH STANDARD IS-1.
   THE COST OF FURNISHING AND PLACING ALL
   MATERIALS INCIDENTAL TO THE SHAPING IS TO BE
   INCLUDED IN THE BID PRICE FOR THE STRUCTURE.

4. IN THE EVENT THE INVERT OF THE OUTFALL PIPE
   IS HIGHER THAN THE BOTTOM OF THE STRUCTURE,
   THE INVERT OF THE STRUCTURE SHALL BE SHAPED
   WITH CEMENT MORTAR TO PREVENT SETTLEING OR
   PONDING OF WATER IN THE STRUCTURE. THE COST
   OF FURNISHING AND PLACING ALL MATERIALS
   INCIDENTAL TO THE SHAPING IS TO BE INCLUDED
   IN THE BID PRICE FOR THE STRUCTURE.

5. STEPS ARE TO BE PROVIDED, DETAILS SEE
   STANDARD ST-1.

6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.

7. #4 X 8” SMOOTH DOWELS AT APPROXIMATELY 12”
   C-C TO BE PLACED IN ALL AREAS ADJACENT TO
   ADDING CONCRETE TO PREVENT SETTLEMENT.
   IN LIEU OF DOWELS A 2” X 4” NOTCH MAY BE
   PROVIDED, SEE STANDARD T-DI-3, 4 FOR
   ALTERNATE DESIGN.

8. 3” DIAMETER WEEP HOLE IS TO BE LOCATED TO
   DRAIN SUBBASE MATERIAL, WEEP HOLE WITH 12”
   X 12” PLASTIC HARDWARE CLOTH 1/4” MESH OR
   GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER
   0.03”, NUMBER 4 MESH HARDWARE CLOTH
   FASTENED TO THE OUTSIDE OF THE
   STRUCTURE.

9. ALL REINFORCING STEEL SHALL HAVE A MIN. COVER
   OF 2”.

10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL
    OPENINGS BY 2”.

11. CAST-IN-PLACE CONCRETE IS TO BE CLASS A3
    (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.

12. LENGTH OF SLOT (L) WILL, IN EVERY CASE, BE
    SHOWN ON PLANS.

13. THIS STANDARD IS INTENDED FOR USE IN CURB
    AND GUTTER SITUATIONS ONLY.

14. IF OPTIONAL CONSTRUCTION JOINT IS USED IT IS
    TO BE KEYED. ALL SPLICES IN BARS V TO BE
    A MINIMUM OF 40 DIAMETERS (20’).

15. FOR PLAN VIEW OF INLET SEE STANDARD DI-2A,
    2B, 2C.

16. FOR DESCRIPTION AND LOCATION OF DIMENSION L
    SEE SHEET 104.03.

17. FOR NUMBER OF BARS A-F REQUIRED AND LENGTHS
    SEE SHEET 104.04.

18. QUANTITIES SHOWN ARE FOR MINIMUM INLETS OF
    EACH TYPE, FOR INLETS OF GREATER DEPTHS
    (H) OR LONGER SLOTS (L) INCREMENTS SHOWN
    PER FOOT MUST BE ADDED. THE AMOUNT OF
    CONCRETE, AND STEEL DISPLACED BY PIPES MUST
    BE DEDUCTED TO OBTAIN TRUE QUANTITIES.

19. FOR DETAILS AND DIMENSIONS OF CURB, SLOT, BEAM,
    COLLAR AND GRATE, DROPPED GUTTER LINE, AND
    REINFORCING AND STRUCTURAL STEEL NOT
    DETAILED SEE STANDARD DI-2A.

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### NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.
2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE.
3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.
5. STEPS ARE TO BE PROVIDED WHEN H IS 4'-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.
6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.
7. #4 X 8" SMOOTH DOWELS AT APPROXIMATELY 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTTING CONCRETE TO PREVENT SETTLEMENT. IN LIEU OF DOWELS A 2" X 4" NOTCH MAY BE PROVIDED. SEE STANDARD T-DI-3, 4 FOR ALTERNATE DESIGN.
8. 3" DIAMETER WEEP HOLE TO BE LOCATED IN CURB SUBBASE MATERIAL, WEEP HOLE ALONG 12"X12" PLASTIC HARDWARE CLOTH 1/4" MESH OR CALVANIZED STEEL WIRE. MINIMUM WIRE DIA. 0.03". NUMBER 6 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.
9. ALL REINFORCING STEEL SHALL HAVE A MINIMUM COVER OF 2" OF CONCRETE.
10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".
11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.
12. LENGTH OF SLOT (L) WILL, IN EVERY CASE, BE SHOWN ON PLANS.
13. THIS STANDARD IS INTENDED FOR USE IN CURB AND GUTTER SITUATIONS ONLY.
14. STANDARD INLETS MAY BE CONSTRUCTED WITH CONCRETE BLOCKS IN ACCORDANCE WITH THE DETAILS SHOWN ON STANDARD DRAWING DI-MB.
15. THIS AREA MAY BE EARTHEN, IN WHICH CASE THE EXPANSION JOINTS WILL APPLY ONLY TO CURB AND GUTTER.
16. CONCRETE QUANTITIES SHOWN ARE FOR DEPTH (H) OF 5'-0" WITHOUT PIPES, THE AMOUNT DISPLACED BY PIPES MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES FOR INLETS OF DIFFERENT DEPTHS. ADD OR SUBTRACT 0.63 CUBIC YARDS OF CONCRETE FOR EACH FOOT OF DEPTH.
17. LENGTH OF ANGLE IRON AS SHOWN ON SHEET 1 OF 2 IS TO BE L+16" AT 4.10 LBS./FT.
18. *DENOTES LENGTH OF ONE (1) BAR.
19. ALL REINFORCING BARS TO BE #5.
20. GRADE TO BE USED IS 5000 M.P.S.I. NUMBER 6 MESH HARDWARE CLOTH ANCHORED "A" 4'-0"."
NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.

2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.

3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.


5. STEPS ARE TO BE PROVIDED WHEN H IS 4"-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.

6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.

7. * 4" X 8" SMOOTH DOWELS AT APPROPRIATELY 12"-O-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTTING CONCRETE TO PREVENT SETTLE OF CONCRETE. IN LIEU OF DOWELS A 2" X 4" NOTCH MAY BE PROVIDED. SEE STANDARD T-DI-3, 4 FOR ALTERNATE DESIGN.

8. 3" DIAMETER WEEP HOLE TO BE LOCATED TO DRAIN SUBBASE MATERIAL. WEEP HOLE SHALL BE PLACED 12" DEEP. PLASTIC MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03" NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.

9. ALL REINFORCING STEEL SHALL HAVE A MIN. COVER OF 2".

10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".

11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI), PRECAST CONCRETE IS TO BE 4000 PSI.

12. LENGTH OF SLOT (L) WILL IN EVERY CASE, BE SHOWN ON PLANS.

13. THIS STANDARD IS INTENDED FOR USE IN CURB AND GUTTER SITUATIONS ONLY.

14. IF OPTIONAL CONSTRUCTION JOINT IS USED IT IS TO BE KEYED. ALL SPLICES IN BARS V TO BE A MINIMUM OF 40D (20"").

15. FOR PLAN VIEW OF INLET SEE STANDARD DI-2D, 2E, 2F.

16. PROVIDE SAFETY SLABS WHEN SPECIFIED ON THE PLANS.

17. FOR DESCRIPTION AND LOCATION OF DIMENSION L SEE SHEET 104.06.

18. FOR NUMBER OF BARS A-M REQUIRED AND LENGTHS SEE SHEET 104.07.

19. QUANTITIES SHOWN ARE FOR MIN INLETS OF EACH TYPE. FOR INLETS OF GREATER DEPTH (H) OR LARGER SLOTS (L), INCREMENTS SHOWN PER FOOT MUST BE ADDED. THE AMOUNT OF CONCRETE AND STEEL DISPLAYED MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES.

20. FOR DETAILS AND DIMENSIONS OF CURB, SLOT, BEAM, COLLAR AND DRAKE, DROPPED GUTTER LINE, AND REINFORCING AND STRUCTURAL STEEL NOT DETAILED SEE STANDARD DI-2D.

21. INLET MAY BE USED WITH LARGER LONGITUDINAL PIPE (72" MAXIMUM) PROVIDED HORIZONTAL CLEARANCE BETWEEN ADJACENT PIPES IS ADEQUATE.

STANDARD CURB DROP INLET

30" - 48" PIPE: DEPTH (H) - 9" TO 20"

Virginia Department of Transportation

2016 ROAD & BRIDGE STANDARDS
PLAN

SECTION A-A

SECTION B-B

FRONT ELEVATION
(Gutter Removed)

NOSE DETAILS

DETAIL WHEN USED
ADJACENT TO CURB
WITHOUT GUTTER

STANDARD CURB DROP INLET
12" - 30" PIPE: MAXIMUM DEPTH (H) • 8'

FOR USE ON GRADES

FOR USE IN SAGS
BOTH SIDES TO BE SYMMETRICAL

DI-3A, 3B, 3C

KEYED CONST. JOINT
BARS D

BARS F

BAR C

BAR F

BAR A

FACE OF CURB

CRACK CONTROL JOINT

5\(\times\)\(\frac{3}{4}\)" BENT PLATE

\(\frac{3}{4}\)" R

TYPE A

\(\frac{3}{4}\)" X 4" STUD SHEAR CONNECTOR WELDED TO ANGLE IRON AT 2' C-C.

DI-3A

L

H

FOR DETAILS OF INLET FRAME & COVER
SEE STANDARD IC-2.

BACK OF SIDEWALK

EXPANSION JOINT

EXPANSION JOINT

EXIST. OR PROP. SIDEWALK

SEE NOTE 15

BARS G

BARS D

CRACK CONTROL JOINT

BARS B

BARS A

BARS C

BARS F

BARS E

BARS G

DIAMETER WEEP MOLD

3" DIAMETER

WEEP MOLD

DI-3B

L

FLOW

FOR USE ON GRADES

DI-3C

L

FLOW

FOR USE IN SAGS
BOTH SIDES TO BE SYMMETRICAL

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

SPECIFICATION REFERENCE

233

302
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<td>8.25</td>
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<td></td>
<td>20'</td>
<td>9.17</td>
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**Notes:**

1. Depth of inlet (H) to be shown on plans.
2. The "H" dimension shown on the standards and specified on the plans will be measured from the invert of the outfall pipe to the top of the structure. Plan "H" dimensions are approximate only for estimating purposes and the actual dimensions shall be determined by the contractor from field conditions.
3. When specified on the plans the invert is to be shaped in accordance with Standard 13-1. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.
4. In the event the invert of the outfall pipe is higher than the bottom of the structure, the invert of the structure shall be shaped with cement mortar to prevent standing or ponding of water in the structure. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.
5. Steps are to be provided when H is 4'-0" or greater. For details see Standard 1-1.
6. This item may be precast or cast-in-place.
7. *4 X 8" smooth dowels at approximately 12" C-C to be placed in all areas adjacent to abutting concrete to prevent settlement.
8. 3" Diameter weep hole to be located to drain subbase material. Weep hole with 1" x 12" plastic hardware cloth 1/4" mesh or galvanized steel, minimum wire diameter 0.03", number 4 mesh hardware cloth anchored firmly to the outside of the structure.
9. All reinforcing steel shall have a min. cover of 2".
10. All reinforcing steel to be cut clear of all openings by 2".
11. Cast-in-place concrete is to be class A3 (3000 PSI). Precast concrete is to be 3000 PSI.
12. Length of slot (L) will, in every case, be shown on plans.
13. If inlet is constructed in median curb or with integral curb, gutter is to be omitted (see details).
14. Standard inlets may be constructed with concrete blocks in accordance with the details shown on standard drawing DI-3B.
15. This area may be earthen, in which case the expansion joints will apply only to curb and gutter.
16. Concrete quantities shown are for depth (H) of 5'-2" without pipes. The amount displaced by pipes must be deducted to obtain true quantities. For inlets of different depths add or subtract 0.32 cubic yards of concrete for each foot of depth.
17. Length of angle iron as shown on sheet 1 of 2 is to be L + 10" at 4.10 lbs./ft.
18. * Denotes length of one (1) bar.
19. All reinforcing bars to be #5.
20. When inlet is used in 4'-0" median, back of inlet is to be shaped to conform to proposed curb.

---

**Standard Curb Drop Inlet**

12" - 30" Pipe: Maximum Depth (H) - 8'

Virginia Department of Transportation

2016 Road & Bridge Standards

**Revision Date:** 104.10

**Sheet 2 of 2**
NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS. MINIMUM DEPTH (H) TO BE 8'-0". MAXIMUM DEPTH TO BE 20'-0". FOR INLETS LESS THAN 8' USE STANDARD DI-3A, 3B, 3C.

2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.

3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHOWN IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.


5. STEPS ARE REQUIRED. FOR DETAILS SEE STANDARD ST-1.

6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.

7. 4 X 8' SMOOTH DOWELS AT APPROXIMATELY 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABRUTING CONCRETE TO PREVENT SETTLEMENT. IN LIEU OF DOWELS A 2" X 4" NOTCH MAY BE PROVIDED. SEE STANDARD T-DI-3, 4 FOR ALTERNATE DESIGN.

8. 3" DIAMETER WEEP HOLE TO BE LOCATED TO DRAIN SUBBASE MATERIAL. WEEP HOLE WITH 12"X12" PLASTIC HARDWARE CLOTH /4" MESH OR GALVANIZED STEEL WIRE. MINIMUM DIAMETER 0.03". NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.

9. ALL REINFORCING STEEL SHALL HAVE A MIN. COVER OF 2".

10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".

11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.

12. LENGTH OF SLOT (L) WILL, IN EVERY CASE, BE SHOWN ON PLANS.

13. WHEN INLET IS USED IN 4' MEDIAN BACK OF INLET IS TO BE SHAPED TO CONFORM WITH PROPOSED CURB.

14. IF OPTIONAL CONSTRUCTION JOINT IS USED IT IS TO BE KEYED. ALL SPLICES IN BARS V TO BE A MINIMUM OF 40 DIAMETERS (20°).

15. FOR PLAN VIEW OF INLET SEE STANDARD DI-3A, 3B, 3C.

16. QUANTITIES SHOWN ARE FOR MINIMUM INLETS OF EACH TYPE. FOR INLETS OF GREATER DEPTH (H) OR LONGER SLOT (L) INCREMENTS SHOWN PER FOOT MUST BE ADDED. THE AMOUNT OF CONCRETE AND STEEL DISCARDED BY PIPES MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES.

17. FOR NUMBER OF BARS A-G REQUIRED AND LENGTHS SEE SHEET 104.10.

18. FOR DESCRIPTION AND LOCATION OF DIMENSION L SEE SHEET 104.09.

19. FOR ALL DETAILS, DIMENSIONS, AND REINFORCING STEEL ABOVE THIS LINE SEE STANDARD DI-3A, 3B, 3C.

---

SCHEDULE OF REINFORCING STEEL

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APPROXIMATE QUANTITIES FOR MINIMUM 8' DEPTH INLET

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INCREMENTS TO BE ADDED FOR EACH ADDITIONAL FOOT OF DEPTH (H) AND/OR SLOT LENGTH (L)

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STANDARD CURB DROP INLET

12" - 30" PIPE: DEPTH (H) 8' TO 20'

---

2016 ROAD & BRIDGE STANDARDS
2016 ROAD & BRIDGE STANDARDS
### TABLE OF QUANTITIES

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**NOTES**

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.
2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE.
3. THE "L" DIMENSIONS ARE APPROXIMATE ONLY.
4. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD 101. THE COST OF FURNISHING A AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.
5. STEPS ARE TO BE PROVIDED WHEN H IS 4'-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.
6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.
7. *4 X 8" SMOOTH DOWELS AT APPROXIMATELY 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTTING CONCRETE TO PREVENT SETTLEMENT.
8. 3" DIAMETER WEEP HOLE TO BE LOCATED TO DRAIN SUBBASE MATERIAL. WEEP HOLE WITH 12"X12" PLASTIC HARDWARE CLOTH 1/2" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.035" NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.
9. ALL REINFORCING STEEL SHALL HAVE A MIN. COVER OF 2".
10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".
11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.
12. LENGTH OF SLOT (L) WILL, IN EVERY CASE, BE SHOWN ON PLANS.
13. IF INLET IS CONSTRUCTED IN MEDIAN CURB OR WITH INTEGRAL CURB, GUTTER IS TO BE OMITTED (SEE DETAIL).
14. STANDARD INLETS MAY BE CONSTRUCTED WITH CONCRETE BLOCKS IN ACCORDANCE WITH THE DETAILS SHOWN ON STANDARD DRAWING DI-MB.
15. THIS AREA MAY BE EARTHEN IN WHICH CASE THE EXPANSION JOINTS WILL APPLY ONLY TO CURB AND GUTTER.
16. CONCRETE QUANTITIES SHOWN ARE FOR DEPTH (H) OF 5'-2" WITHOUT PIPES. THE AMOUNT DISPLACED BY PIPES MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES. FOR INLETS OF DIFFERENT DEPTHS ADD OR SUBTRACT 0.44 CUBIC YARDS OF CONCRETE FOR EACH FOOT OF DEPTH.
17. LENGTH OF ANGLE IRON AS SHOWN ON SHEET 1 OF 2 IS TO BE 1'-16" AT 4.10 LBS./FT.
18. X DENOTES LENGTH OF ONE (1) BAR.
19. ALL REINFORCING BARS TO BE #5.

### STANDARD CURB DROP INLET (WITH UTILITY SPACE)

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<thead>
<tr>
<th>SHEET 2 OF 2</th>
<th>SPECIFICATION REFERENCE</th>
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<td>REV. 104.13</td>
<td>223 2016 ROAD &amp; BRIDGE STANDARDS</td>
</tr>
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</table>
1. Depth of Inlet (H) to be shown on Plans. Minimum Depth (H) to be 2'-0", maximum depth to be 20'-0", for Inlets less than 8' use Standard DI-30, 3E, 3F.

2. The "H" dimension shown on the Standards and specified on the Plans will be measured from the invert of the outfall pipe to the top of the structure. Plan "H" dimensions are approximate only for estimating purposes and the actual dimensions shall be determined by the contractor from field conditions.

3. When specified on the Plans the invert is to be shaped in accordance with Standard RS-1. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.

4. In the event the invert of the outfall pipe is higher than the bottom of the structure, the invert of the structure shall be shaped with cement mortar to prevent standing or ponding of water in the structure. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.

5. Steps are required. For details see Standard ST-1.

6. This item may be precast or cast-in-place.

7. 4 x 8" smooth dowels at approximately 12" C-C to be placed in all areas adjacent to abutting concrete to prevent settlement. In lieu of dowels a 2" x 4" notch may be provided. See Standard T-DI-3, 4 for alternate design.

8. 3" diameter weep hole to be located to drain subbase material. Weep hole with 12"x12" plastic hardware cloth 1/4" mesh or galvanized steel wire, minimum wire diameter 0.03", number 4 mesh hardware cloth anchored firmly to the outside of the structure.

9. All reinforcing steel shall have a min. cover of 2".

10. All reinforcing steel to be cut clear of all openings by 2".

11. Cast-in-place concrete is to be Class A3 (3000 psi) precast concrete is to be 4000 psi.

12. Length of slot (L) will, in every case, be shown on Plans.

13. This Standard is intended for use in curb and gutter situations only.

14. If optional construction joint is used it is to be keyed. All splices in bars V to be a minimum of 40 diameter (20"").

15. For plan view of inlet see Standard DI-30, 3E, 3F.

16. Concrete quantities shown are for minimum inlets of each type. For inlet of greater depth (H) or longer slots (L) increments shown per foot must be added. The amount displaced by pipes must be deducted to obtain true quantities.

17. For all details, dimensions, and reinforcing steel above this line see Standard DI-30, 3E, 3F.

18. Provide safety slabs when specified on the plans.

19. For description and location of dimension L see Sheet 104.12.

20. For number of bars A-H required and lengths see Sheet 104.13.

### Approximate Quantities for Minimum B' Depth Inlet

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<p>| Increments to be added for each additional foot of Depth (H) and/or Slot Length (L) |
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STANDARD CURB DROP INLET
36" - 48" PIPE: MAXIMUM DEPTH (H) - 8'

FOR DETAILS OF INLET FRAME & COVER SEE STANDARD IC-2.

EXPANSION JOINT
EXISITNG PB PROPOSED CURB DROP INLET

PLAN VIEW

SECTION A-A
NOSE DETAILS
SECTION B-B
DETAIL WHEN USED ADJACENT TO CURB
WITHOUT GUTTER

REFERENCE SPECIFICATION

DI-4A, 4B, 4C
ROAD AND BRIDGE STANDARDS
SHEET 1 OF 2

104.15
04/19

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

2016 ROAD & BRIDGE STANDARDS
### TABLE OF QUANTITIES

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### NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.
2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE.
3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.
5. STEPS ARE TO BE PROVIDED WHEN H IS 4'-0" OR GREATER, FOR DETAILS SEE STANDARD ST-1.
6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.
7. # 4 x 8" SMOOTH DOWELS AT APPROXIMATELY 12" C-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTTING CONCRETE TO PREVENT SETTLEMENT.
8. 3" DIAMETER WEEP HOLE TO BE LOCATED AT DRAIN SUBBASE MATERIAL WEEP HOLE WITH 12"X22" PLASTIC HARDWARE CLOTH /4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03". NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.
9. ALL REINFORCING STEEL SHALL HAVE A MIN. COVER OF 2".
10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".
11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.
12. LENGTH OF SLOT (L) WILL IN EVERY CASE, BE SHOWN ON PLANS.
13. IF INLET IS CONSTRUCTED IN MEDIAN CURB OR WITH INTEGRAL CURB, GUTTER IS TO BE OMITTED (SEE DETAIL).
14. STANDARD INLETS MAY BE CONSTRUCTED WITH CONCRETE BLOCKS IN ACCORDANCE WITH THE DETAILS SHOWN ON STANDARD DRAWING D-MB.
15. THIS AREA MAY BE EARTHEN IN WHICH CASE THE EXPANSION Joints WILL APPLY ONLY TO CURB AND GUTTER.
16. CONCRETE QUANTITIES SHOWN ARE FOR DEPTH (H) OF 6'-0" WITHOUT PIPES. THE AMOUNT DISPLACED BY PIPES MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES. FOR INLETS OF DIFFERENT DEPTHS ADD OR SUBTRACT 0.49 CUBIC YARDS OF CONCRETE FOR EACH FOOT OF DEPTH.
17. LENGTH OF ANGLE IRON AS SHOWN ON SHEET 1 OF 2 IS TO BE L+16" AT 4.10 LBS./ FT.:
18. * DENOTES LENGTH OF ONE (1) BAR.
19. ALL REINFORCING BARS TO BE #5.
1. Depth of inlet (H) to be shown on plans. Minimum depth (H) to be 8'-0". Maximum depth to be 20'-0". For inlets less than 8' use standard Di-4A, 4B, and 4C.

2. The "H" dimension shown on the standards and specified on the plans will be measured from the invert of the outfall pipe to the top of the structure. The invert of the structure is the top of the structure. The actual dimensions shall be determined by the contractor from field conditions.

3. When specified on the plans the invert is to be shaped in accordance with standard IS-1. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.

4. In the event the invert of the outfall pipe is higher than the bottom of the structure, the invert of the structure shall be shaped with cement mortar to prevent standing water or ponding of water in the structure. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.

5. Steps are to be provided. For details see standard ST-1.

6. This item may be precast or cast-in-place.

7. #4 x 8" smooth dowels at approximately 12" c-c to be placed in all areas adjacent to abutting concrete to prevent settlement. In lieu of dowels a 2" x 4" notch may be provided. See standard T-D-3, 4 for alternate design.

8. 3" diameter weep hole to be located in subbase material. Weep hole with 12"x12" plastic hardware cloth 1/4" mesh or galvanized steel wire, minimum wire diameter 0.03". Number 4 mesh hardware cloth anchored firmly to the outside of the structure.

9. All reinforcing steel shall have a min. cover of 2".

10. All reinforcing steel to be cut clear of all openings by 2".

11. Cast-in-place concrete is to be class A3 (3000 PSI). Precast concrete is to be 4000 PSI.

12. Length of slot (L) will, in every case, be shown on plans.

13. If inlet is constructed in median curb or with integral curb, gutter is to be omitted (see detail with standard Di-4A, 4B, 4C).

14. If optional construction joint is used it is to be keyed. All splices in bars V to be a minimum of 40 diameters (20")

15. For plan view of inlet see standard Di-4A, 4B, 4C.

16. Quantities shown are for minimum inlets of each type. For inlets of greater depth (H) or longer slot (L) increments shown per foot must be added. The amount of concrete and steel displaced by pipes must be deducted to obtain true quantities.

17. For number of bars A-H required and length see table of quantities for standard Di-4A, 4B, 4C.

18. For description and location of dimension L see sheet standard Di-4A, 4B, 4C.

19. For all details, dimensions and reinforcing steel above this line, see standard Di-4A, 4B, and 4C.

20. Provide safety slabs when specified on the plans.
### TABLE OF QUANTITIES

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<th>TYPE</th>
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</table>

### NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.
2. THE "H" DIMENSION SHOWN IN THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS.
3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.
4. IN THE EVENT THE INVERT OF THE OUTFALL PIPE IS HIGHER THAN THE BOTTOM OF THE STRUCTURE THE INVERT OF THE STRUCTURE SHALL BE SHAPED WITH CEMENT MORTAR TO PREVENT STANDING OR PONDI NG OF WATER IN THE STRUCTURE. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.
5. STEPS ARE TO BE PROVIDED WHEN H IS 4'-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.
6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.
7. #4 X 8" SMOOTH DOWELS AT APPROXIMATELY 12" O-C TO BE PLACED IN ALL AREAS ADJACENT TO ABUTTING CONCRETE TO PREVENT SETTLEMENT. IN LIEU OF DOWELS A 2" X 4" NOTCH MAY BE PROVIDED. SEE STANDARD T-DI-3-4 FOR ALTERNATE DESIGN.
8. 3" DIAMETER WOOL HOLE TO BE LOCATED TO DRAIN SUBBASE MATERIAL. WOOL HOLE WITH 12"X24" PLASTIC HARDWARE CLOTH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03". NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.
9. ALL REINFORCING STEEL SHALL HAVE A MIN. COVER OF 2".
10. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".
11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.
12. THIS STANDARD IS INTENDED FOR USE IN CURB AND GUTTER SITUATIONS ONLY.
13. IF INLET IS CONSTRUCTED IN MEDIAN CURB OR WITH INTEGRAL CURB, GUTTER IS TO BE OMITTED (SEE DETAIL).
14. STANDARD INLETS MAY BE CONSTRUCTED WITH CONCRETE BLOCKS IN ACCORDANCE WITH THE DETAILS SHOWN ON STANDARD DRAWING DM-86.
15. THIS AREA MAY BE EARTHEN, IN WHICH CASE THE EXPANSION JOINTS WILL APPLY ONLY TO CURB AND GUTTER.
16. CONCRETE QUANTITIES SHOWN ARE FOR DEPTH (H) OF 0'-2" WITHOUT PIPES. THE AMOUNT DISPLACED BY PIPES MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES. FOR INLETS OF DIFFERENT DEPTHS ADD OR SUBTRACT 0.28 CUBIC YARDS OF CONCRETE FOR EACH FOOT OF DEPTH.
17. LENGTH OF ANGLE IRON AS SHOWN ON SHEET 1 OF 2 IS TO BE L+1'-0" AT 4.10 LBS./FT.
18. * DENOTES LENGTH OF ONE (1) BAR.
19. ALL REINFORCING BARS TO BE #5.
20. INLET MAY BE USED WITH LARGER LONGITUDINAL PIPES (60" MAXIMUM) PROVIDED UTILITY SPACE CLEARANCE IS NOT NEEDED. HORIZONTAL CLEARANCE BETWEEN ADJACENT PIPES IS ADEQUATE AND MINIMUM HEIGHT (H) EQUALS PIPE DIAMETER PLUS 3 FEET.
NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.
   MINIMUM DEPTH (H) TO BE 8'-0". MAXIMUM
   DEPTH TO BE 16'-0" FOR INLETS LESS THAN
   8' USE STANDARD DI-40, 4E, AND 4F.
2. THE "H" DIMENSION SHOWN ON THE STANDARDS
   AND SPECIFIED ON THE PLANS WILL BE
   MEASURED FROM THE INVERT OF THE OUTFALL
   PIPE TO THE TOP OF THE STRUCTURE.
   PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY
   FOR ESTIMATING PURPOSES AND THE ACTUAL
   DIMENSIONS SHALL BE DETERMINED BY THE
   CONTRACTOR FROM FIELD CONDITIONS.
3. WHEN SPECIFIED ON THE PLANS THE INVERT IS
   TO BE SHAPED IN ACCORDANCE WITH STANDARD
   IS THE COST OF FURNISHING AND PLACING ALL
   MATERIALS INCIDENTAL TO THE SHAPING IS TO BE
   INCLUDED IN THE BID PRICE FOR THE STRUCTURE.
4. IN THE EVENT THE INVERT OF THE OUTFALL
   PIPE IS HIGHER THAN THE BOTTOM OF THE
   STRUCTURE, THE INVERT OF THE STRUCTURE
   SHALL BE SHAPED WITH CEMENT MORTAR TO
   PROVIDE THE STANDING OF WATER IN THE
   STRUCTURE. THE COST OF FURNISHING AND
   PLACING ALL MATERIALS INCIDENTAL TO
   THE SHAPING IS TO BE INCLUDED IN THE BID
   PRICE FOR THE STRUCTURE.
5. STEPS ARE TO BE PROVIDED. SEE DETAILS FOR
   STANDARD 5T-1.
6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.
7. #4 X 8" SMOOTH DOWELS AT APPROXIMATELY
   12" C-C TO BE PlACED IN ALL AREAS ADJACENT
   TO ABUTTING CONCRETE TO PROVIDE
   SETTLEMENT. IN LIEU OF DOWELS A 2" X 4"
   NOTCH MAY BE PROVIDED. SEE STANDARD
   T-DT-5, 4 FOR ALTERNATE DESIGN.
8. 3" DIAMETER WEEP HOLE TO BE LOCATED TO
   DRAIN SUBBASE MATERIAL. WEEP HOLE WITH
   12" ELASTIC HARDWARE CLOTH 1/2" MESH
   OR GALVANIZED STEEL WIRE. MINIMUM WALL
   DIAMETER 0.03". NUMBER 4 MESH HARDWARE
   CLOTH ANCHORED 1" OUTSIDE THE STRUCTURE.
9. ALL REINFORCING STEEL SHALL HAVE A MIN.
   COVER OF 2".
10. ALL REINFORCING STEEL TO BE CUT CLEAR OF
    ALL OPENINGS BY 2".
11. CAST-IN PLACE CONCRETE IS TO BE CLASS A3
    (3000 PSI). PRECAST CONCRETE IS TO BE
    4000 PSI.
12. LENGTH OF SLOT (L) WILL, IN EVERY CASE, BE
    SHOWN ON PLANS.
13. IF INLET IS COnSTRUCTED IN MEDIAN CURB OR
    WITH INTEGRAL CURB GUTTER IS TO BE
    OMITTED (SEE DETAIL WITH STANDARD DI-
    40, 4E, 4F).
14. IF OPTIONAL CONSTRUCTION J oINT IS USED IT IS
    TO BE KEYED. ALL SPLICES IN BARS V TO BE
    A MINIMUM OF 40 DIAMETER (20")
15. FOR PLAN VIEW OF INLET SEE STANDARD DI-40,
    4E, 4F.
16. CONCRETE QUANTITIES SHOWN ARE FOR DEPTH
    (H) OF 5'-2" WITHOUT PIPES. THE AMOUNT
    DISPLACED BY PIPES MUST BE DEDUCTED TO
    OBTAIN TRUE QUANTITIES. FOR INLETS OF
    DIFFERENT DEPTHS ADD OR SUBTRACT 0.29
    CUBIC YARDS OF CONCRETE FOR EACH FOOT
    OF DEPTH.
17. FOR NUMBER OF BARS A-H REQUIRED AND
    LENGTH SEE TABLE OF QUANTITIES FOR
    STANDARD DI-40, 4E, 4F.
18. FOR DESCRIPTION AND LOCATION OF DIMENSION
    L SEE SHEET STANDARD DI-40, 4E, 4F.
19. FOR ALL DETAILS, DIMENSIONS AND REINFORCING
    STEEL ABOVE THIS LINE, SEE STANDARD DI-40,
    4E, AND 4F.
20. INLET MAY BE USED WITH LARGER
    LONGITUDINAL PIPE (72" MAXIMUM). PROVIDED
    UTILITY SPACE CLEARANCE IS NOT NEEDED,
    HORIZONTAL CLEARANCE BETWEEN ADJACENT
    PIPES IS ADEQUATE AND MINIMUM HEIGHT (H)
    EQUALS PIPE DIAMETER PLUS 3 FEET.
21. PROVIDE SAFETY SLABS WHEN SPECIFIED ON
    THE PLANS.

APPENDIX QUANTITIES FOR
MINIMUM 8' DEPTH INLET

<table>
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<th>TYPE</th>
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<th>REINFORCING STEEL</th>
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<td></td>
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<tr>
<td>BARS J</td>
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<td>BARS V</td>
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INCREMENTS TO BE ADDED
FOR EACH ADDITIONAL FOOT
OF DEPTH (H) AND/OR SLOT LENGTH (L)

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STANDARD CURB DROP INLET (WITH UTILITY SPACE)

36" - 48" PIPE: DEPTH (H) 8' TO 16'

ROAD AND BRIDGE STANDARDS

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.

2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR FROM FIELD CONDITIONS. MAXIMUM DEPTH (H) TO BE 12'-0".

3. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD 1-1 THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICING FOR THE STRUCTURE.


5. STEPS ARE TO BE PROVIDED WHEN H IS 4'-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.

6. REINFORCED CONCRETE FOOTING MAY BE PRECAST OR CAST-IN-PLACE. TWO LIFTING HOOKS OF FABRICATORS DESIGN TO BE PROVIDED IN PRECAST FOOTING.

7. 4" DEPTH AGGREGATE #56, #78, OR #8 X 6" WIDTH.

8. 3" DIAMETER WEEP HOLE WITH 12"X12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.33 NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.

9. THE TYPE OF INLET (PRECAST OR CAST IN PLACE), DETAILED HEREON, TO BE CONSTRUCTED, WILL BE AT THE OPTION OF THE CONTRACTOR.


11. CAST-IN-PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.

12. CONCRETE QUANTITIES SHOWN ARE FOR INDICATED DEPTH (H) WITHOUT PIPES. THE AMOUNT DISPLACED BY PIPES MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES. FOR INLETS OF DIFFERENT DEPTHS ADD OR SUBTRACT THE APPROPRIATE CUBIC YARDS OF CONCRETE FOR EACH FOOT OF DEPTH.

13. PAVED DITCHES ARE TO BE TRANSITIONED TO MEET INLET GUTTER AS SHOWN IN STANDARD PG-2A.

14. PROVIDE SAFETY SLABS WHEN SPECIFIED ON THE PLANS.

---

**Notations (Cont.)**

15. **DI-7**—NO GUTTER

   **DI-7A**—SINGLE GUTTER WHEN DROP INLET IS ON A GRADE.

   **DI-7B**—DOUBLE GUTTER WHEN DROP INLET IS IN A SAG BETWEEN TWO GRADIES.

16. FOR DETAILS OF PRECAST DI-7 NOT SHOWN HEREON SEE PRECAST UNIT ASSEMBLY DIAGRAM, PAGE 103.01. FOR PRECAST GENERAL NOTES PAGE 103.02 AND FOR APPLICABLE PRECAST BASE, RISER AND TOP DETAILS, PAGES 103.07 THRU 103.12.

17. GRATE BARS TO BE PARALLEL TO DITCH FLOW.

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**Recommended Minimum Height Chart**

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<td>2'-9/&quot;</td>
<td>2'-8/&quot;</td>
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<tr>
<td>42&quot;</td>
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**Concrete Cover**

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</table>

INCREMENT PER FOOT OF ADDITIONAL DEPTH (H) \( \frac{1}{2} = 0.362 \text{ CU. YDS. (12" - 36" PIPE)} \)

\[ \frac{1}{2} = 0.410 \text{ CU. YDS. (42" PIPE)} \]
DETAILS OF CONCRETE COVER AND GRATE

NOTES

1. GRATE A IS TO BE UTILIZED IN LOCATIONS NOT NORMALLY SUBJECT TO TRAFFIC.
2. GRATE B IS TO BE UTILIZED IN LOCATIONS NORMALLY SUBJECT TO TRAFFIC.
3. FOR DETAILS OF LOAD CARRYING GRATE (GRATE B), SEE T-DI-7, SHEET 103.08.
4. CONCRETE COVER AND GRATE ARE TO BE FURNISHED AS A SINGLE UNIT, OUTSIDE DIMENSIONS OF GRATE TO BE 3'-4" X 2'-11/2" (GRATE A) OR 3'-4" X 2'-11/2" (GRATE B).
5. ALTERNATE METHODS OF ANCHORAGE ANGLE IRON WILL BE ACCEPTABLE IF APPROVED BY THE ENGINEER.
6. GRATE AND COLLAR ARE TO BE GALVANIZED.
7. CONCRETE COVER MAY BE PRECAST OR CAST IN PLACE.
8. CONCRETE TO BE CLASS A3 IF CAST IN PLACE. 4000 PSI IF PRECAST.
9. GRATE BARS TO BE PARALLEL TO DITCH FLOW.

BAR SPACING CHART

<table>
<thead>
<tr>
<th>BARS (12 REQUIRED)</th>
<th>5X5-0&quot; BARS</th>
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APPROXIMATE QUANTITIES

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<tr>
<th>CONCRETE CLASS A3</th>
<th>0.423 C.Y.</th>
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<tr>
<td>STEEL</td>
<td>63 LBS.</td>
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SECTION A-A

SEE NOTE 3

DETAIL A

1/2" X 4"

LOTH SHEAR CONNECTOR

L2X2"X2/3" X/3"

SECTION B-B

GRATE A:

GRATE TYPE | MAXIMUM DIMENSION |
--- | --- |
I | 1" |
II | 2" |
III | 3" |

APPROXIMATE QUANTITIES FOR ONE CURTAIN WALL, MEASURED FROM BOTTOM OF GUTTER

<table>
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<tr>
<th>CONCRETE CLASS A3</th>
<th>0.241 CU. YDS.</th>
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APPROXIMATE QUANTITIES

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<th>CONCRETE CLASS A3</th>
<th>Di-7</th>
<th>Di-7A</th>
<th>Di-7B</th>
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<tbody>
<tr>
<td>(CU. YDS.)</td>
<td>NONE</td>
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STANDARD MEDIAN DROP INLET

12" TO 42" PIPE

VIRGINIA DEPARTMENT OF TRANSPORTATION

LONGITUDINAL SECTION

WHEN INLET IS LOCATED ABOVE NORMAL DITCH GRADE

SEE NOTE 8.
1. APRON IS TO BE CONSTRUCTED TO A DEPTH OF 1'-0" ON BACK SLOPE SIDE OF INLET (DI-7). ON ROADWAY SIDE, THE DEPTH IS TO BE 1'-0" OR TO THE SHOULDER ELEVATION, WHICHERVER IS LESSER.

2. ALTERNATE METHODS OF ANCHORING ANGLE IRON WILL BE ACCEPTABLE IF APPROVED BY THE ENGINEER.

3. COLLAR AND GRATE ARE TO BE GALVANIZED IN ACCORDANCE WITH THE SPECIFICATIONS.

4. OUTSIDE DIMENSIONS OF GRATE ARE TO BE 3'-4" X 2'-11 ¼".

5. ALL CONCRETE IS TO BE CLASS A3.

6. NORMAL DITCH IS TO BE TRANSITIONED TO TIE SMOOTHLY INTO GUTTER. DITCH GRADE IS TO BE ADJUSTED AS NECESSARY TO MEET GRADE ELEVATION.

7. QUANTITIES SHOWN ARE BASED ON DEPTH H =5'-0".

8. THE AMOUNT OF CONCRETE DISPLACED BY PIPES MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES. FOR EACH FOOT OF DIFFERENCE IN DEPTH H ADD OR SUBTRACT INCREMENT AS SHOWN.

9. SEE STANDARD DI-7, DI-7A AND DI-7B FOR DETAILS AND DIMENSIONS NOT SHOWN HEREON.

10. GRATE BARS ARE TO BE INSTALLED SO THEY WILL BE ALIGNED PARALLEL TO THE DITCH FLOW.

APPROXIMATE QUANTITIES

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<th>CLASS A3 CONCRETE</th>
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<td>CU. YDS.</td>
<td>LBS.</td>
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<tr>
<td>4.091</td>
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INCREMENT PER FOOT OF DEPTH (H) = 0.362 CU. YDS. CONCRETE TO BE ADDED WHEN DOUBLE GUTTER IS REQ'D. = 1.112 CU. YDS.
**NOTES**

1. PRECAST PIPE PLUG SHALL BE SET IN FRESH MORTAR.

2. PRECAST PLUG SHALL CONFORM TO PIPE MANUFACTURER'S JOINT DESIGN AND SHALL HAVE A MINIMUM THICKNESS NOT LESS THAN PIPE WALL THICKNESS.

3. THIS INLET IS TO BE USED ONLY IN LOCATIONS NOT SUBJECT TO TRAFFIC.

4. FRAME IS TO BE SECURELY MORTARED TO TEE SECTION.

5. FRAME AND GRATE SHALL BE GRAY IRON, ASTM A48, CLASS 30S.

6. THE PRECAST TEE UNIT IS TO CONFORM TO THE REQUIREMENTS OF AASHTO M170 FOR 15" CLASS III REINFORCED CONCRETE PIPE.


---

**15" PIPE TEE SECTION DROP INLET**

**SECTION A-A FRAME**

**SECTION A-A GRATE**

**SECTION C-C**

**SECTION B-B**

**PLAN**

**FRAME PLAN**

**PART PLAN FRAME & GRATE**

**BOTTOM VIEW**

**LOCKING BAR**

**DI-9**

**CONTINUOUS PIPE OR PRECAST PLUG AS REQ'D ON PLANS**

**15" PLAN OR REINFORCED CONCR. PIPE AS REQUIRED ON PLANS.**

**LOCKING BAR SLOTS**

**1" BAR STOP**

**OFFSET**

**SYMBOL**

**DIAMETER**

**NOTE**

**SPECIFICATION REFERENCE** 2233 302
CONCRETE MEDIAN BARRIER DROP INLET (WITH MB-7D)

12" - 36" PIPE: DEPTH (H) = 20'-0" MAX.

FOR DIMENSIONS AND QUANTITIES AND NOTES NOT SHOWN SEE SHEET 2 OF 2.

NOTE 5

STEPS. SEE NOTE 7.

WEEP HOLE. SEE DETAIL "A"

FOR USE ON GRADES

WASHINGTON MC 6X12X3'-8"

GALV. MC 6X12X3'-8"

GALV. WITH ½"X4" STUD SHEAR CONNECTORS @ 2'-0" C-C MAX

APPROACH PAVEMENT ELEVATION

WARPED PAVEMENT

APPROACH PAVEMENT ELEVATION

WARPED PAVEMENT

FOR USE IN SAGS.

BOTH SIDES TO BE SYMMETRICAL.
## Table of Quantities

### Reinforcing Steel

<table>
<thead>
<tr>
<th>TYPE I CONCRETE</th>
<th>BARS A</th>
<th>BARS B</th>
<th>BARS E</th>
<th>BARS H</th>
<th>BARS U-1</th>
<th>BARS U-2</th>
<th>BARS V</th>
<th>BARS V-1</th>
<th>BARS V-2</th>
<th>BARS V-3</th>
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<td>5-2</td>
<td>456</td>
<td>490</td>
</tr>
</tbody>
</table>

### Notes

1. Depth of inlet (H) to be shown on plans.
2. The "H" dimension shown on the standards and specified on the plans will be measured from the invert of the outfall pipe to the top of the structure.
3. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for structure.
4. In the event the invert of the outfall pipe is higher than the bottom of the structure, the invert of the structure shall be shaped with cement mortar to prevent standing or ponding of water into the structure. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.
5. Steps are to be provided when H is 4-0" or greater. For details see standard ST-1.
6. This item may be precast or cast-in-place.
7. 3" diameter weep hole to be located to drain subbase material. Weep hole to be located with 12"x12" plastic hardware cloth 1/4" mesh or galvanized steel wire, minimum wire diameter 0.03". Number 4 mesh hardware cloth anchored firmly to the outside of the structure.
8. All reinforcing steel shall have a min. cover of 2".
9. All reinforcing steel to be cut clear of all openings by 2".
10. Cast-in place concrete is to be class A3 (3000 psi), precast concrete is to be 4000 psi.
11. Length of slot (L) will, in every case, be shown on plans.
12. Concrete quantities shown are for depth (H) of 3-0" without pipes. The amount displaced by pipes must be deducted to obtain true quantities for inlets of different depths or subtract 0.36 cubic yards per foot of depth, and 0.5 lbs. of reinforcing steel.
13. Length of angle iron as shown on sheet 1 of 2 is to be 1+16" at 4.10 lbs./ft.
14. * denotes length of one (1) bar.
15. Grate to be installed so slots will direct water toward the inlet throat. Grate must be reversible (right hand grate is shown).
16. Provide safety slabs when specified on plans.
17. For details and dimensions not shown for median barrier see standard MB-70.
18. Quantities include MB-70.

### Summary

**Concrete Median Barrier Drop Inlet (With MB-70)**

12" - 36" pipe: Depth (H)=20'-0" Max.

Virginia Department of Transportation

Specification Reference

<table>
<thead>
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<th>Sheet</th>
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<td>233</td>
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2016 ROAD & BRIDGE STANDARDS
LIMITS OF PAY LINE

ST'D. DI-1 COLLAR & GRATE

WARPED PAVEMENT

PLAN VIEW

PLAN

MC 6X12X3'-2"

GALVANIZED

COLLAR DETAIL

1/4"X4" STUD SHEAR CONNECTOR

SECTIONS

SECTION A-A

SECTIONS

SECTION B-B

SECTION C-C

SECTION D-D

CONCRETE MEDIAN BARRIER DROP INLET (WITH MB-8A)

12" - 24" PIPE: DEPTH (H) - 20' MAX

Virginia Department of Transportation

2016 ROAD & BRIDGE STANDARDS

SPECIFICATION

REFERENCE

233

302

ROAD AND BRIDGE STANDARDS

REVISION DATE

SHEET 1 OF 2

104.28
**2016 ROAD & BRIDGE STANDARDS**

**CONCRETE BARRIER DROP INLET (WITH MB-8A)**

*12" - 24" PIPE: DEPTH (H) - 20' MAX.*

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**TYPE I & III INLET**

**REINFORCING STEEL**

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<tr>
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<th>LENGTH</th>
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<tbody>
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<td>A</td>
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<td>8</td>
<td>2'-2&quot;</td>
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<tr>
<td>A-1</td>
<td>#4</td>
<td>2xL</td>
<td>4'-0&quot;</td>
<td>12</td>
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<td>A-2</td>
<td>#4</td>
<td>2xH</td>
<td>4'-0&quot;</td>
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**TYPE II INLET**

**REINFORCING STEEL**

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<td>#4</td>
<td>L</td>
<td>1'-1&quot;</td>
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<td>H</td>
<td>#5</td>
<td>4xH</td>
<td>1'-6&quot;</td>
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<tr>
<td>H1</td>
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<td>3'-2&quot;</td>
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<td>V</td>
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<tr>
<td>F</td>
<td>#5</td>
<td>SEE NOTE 3</td>
<td>1'-0&quot;</td>
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</tr>
</tbody>
</table>

**NOTES**

1. VARIES GREATER THAN 0' TO 18" MAX. TYPE II CHAMBER, 4" TO 3' MAX. TYPE I CHAMBER.
2. FOR DETAILS AND DIMENSIONS NOT SHOWN FOR MEDIAN BARRIER, SEE STANDARD MB-8A.
3. GALVANIZED MC-6 X 12 IS TO BE WELDED UNDER THE COLLAR AND EXTENDED INTO SIDEWALLS TO WITHIN 2" OF OUTSIDE FACE.
4. ALL REINFORCING BARS ARE TO BE GRADE 60 STEEL WITH MIN. OF 5/8" CONCRETE COVER. ANY BAR IN CONFLICT WITH PIPE SHELL AND/OR TOP SLAB OPENING ARE TO BE FIELD CUT TO PROVIDE THE REQUIRED COVER.
5. DO NOT LOCATE STANDARD ST-1 STEPS ON CHAMBER WALLS THAT HAVE PIPES WHEN POSSIBLE.
6. 8 DOWELS REQUIRED FOR DI-10L MIN. L = 7'-0", ADD 2 DOWELS FOR EACH ADDITIONAL FOOT.
7. 12 BARS A REQUIRED FOR DI-10L.
8. LENGTH OF BARS A, DI-10L = \( \frac{L - (2'-6")}{2} \)
9. DO NOT USE WITH DI-10J.
10. USE 6 BARS F FOR DI-10L TYPE I.
11. DO NOT USE WITH TYPE III.
12. ADD 4 ADDITIONAL BARS FOR EACH EXTRA FOOT OF DEPTH.
13. USE 12 BARS F FOR DI-10L TYPE II.
14. 24 BARS A ARE REQUIRED FOR DI-10L.
15. DO NOT USE WITH DI-10J.
16. A MINIMUM 22" FOOTING DEPTH IS REQUIRED FOR FORMING THE INLET SLOT. SEE PLANS FOR LENGTH "Ld".
17. REFER TO PLANS FOR STRUCTURE LOCATIONS, DATA AND DIMENSIONS.
18. REFER TO PLANS FOR LOCATIONS OF PIPES AND INVERTS.
19. FOR TYPE III, COST OF ACCOMMODATION OF INLET THROAT IS TO BE INCLUDED IN COST OF WALL BARRIER.
20. FOR TYPE III, SEE WALL PLANS FOR WALL FOOTING DETAILS.

**PRICE FOR THE STRUCTURE.**
CONCRETE GUTTER (SLAT REMOVED)  

PLAN

CONCRETE GUTTER FOR DI-12A ONLY

E.W., E.F.

6" C-C

STEP. SEE NOTE 5.

3" - 0"

H - VARIABLE (SEE NOTE 19)

H - MIN. DEPTH IN PLACE

MAX. DEPTH, UNLIMITED, 60" MINIMUM DIAMETER.

SECTION

CAST IN PLACE

NOTES

2. DEPTH OF INLET (H) AND LENGTH (L) TO BE SHOWN ON PLANS.

3. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE.

4. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD 1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.


6. STEPS ARE TO BE PROVIDED WHEN H IS 4" - 0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.

7. CHAMBER MAY BE PRECAST. SEE STANDARD 105.70 FOR DETAILS.

8. # 4 DOWELS 12" LONG SPACED AT 12" C-C ALL SIDES.

9. FOOTING MAY BE ROUND OR SQUARE IN SHAPE. KEY IS TO BE 1" DEEP X WALL THICKNESS 1/2".

10. ALL REINFORCING STEEL SHALL HAVE A MIN. COVER OF 2".

11. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".

12. CAST-IN-PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.

13. ALL REINFORCING BARS TO BE #4.

14. GRATE BARS TO BE INSTALLED SO THEY WILL BE ALIGNED PARALLEL TO DITCH FLOW.

15. FOR DETAILS OF CONCRETE SLOT COLLAR AND GRATE AND METHOD OF PLACING APPROACH GUTTER SEE SHEET 2 OF 3.

16. PAVED DITCHES ARE TO BE TRANSITIONED TO MEET INLET GUTTER AS SHOWN IN STD. PG-2A.

17. QUANTITIES SHOWN ARE FOR INLETS WITHOUT PIPES. PIPE DISPLACEMENTS MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES. SEE SHEET 3 OF 3 FOR QUANTITIES.

18. PROVIDE SAFETY SLABS WHEN SPECIFIED ON THE PLANS.

19. SEE TABULATION CHART ON SHEET 3 OF 3 FOR MINIMUM DEPTH (H).

20. 10" THICK SLAB FOR PIPE SIZES 60" TO 72" IN DIAMETER.

21. THE TYPE OF INLET DETAILED HEREOF TO BE CONSTRUCTED WILL BE AT THE OPTION OF THE CONTRACTOR.

22. DI-12 NO GUTTER. DI-12A PERIPHERAL GUTTER.

MULTILGATE DROP INLET
FOR PIPE SIZES 12" TO 72"

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION REFERENCE

ROAD AND BRIDGE STANDARDS

233 302

REVISION DATE SHEET 1 OF 3

2016 ROAD & BRIDGE STANDARDS
SECTION A-A
CONCRETE GUTTER TO BE 10:1 SLOPE
STEEPEST DESIRABLE SLOPE 3:1
FRAME ANCHOR
BARS V @ 3'-8" C-C
BARS H @ 2'-0" C-C

SECTION B-B
(CHAMBER NOT SHOWN)
(SLOT MAY BE CAST IN PLACE OR PRECAST)
GUTTER DETAIL WILL BE REQUIRED ON PLANS.

NOTES:
1. TYPE I AND TYPE II GRATES SHALL NOT BE LOCATED WITHIN THE LIMITS OF ANY PEDESTRIAN ACCESS ROUTE, SUCH AS A SIDEWALK, SHARED USE PATH, OR PEDESTRIAN CROSSING (MARKED OR UNMARKED).
2. TYPE I GRATE: LIMITED ACCESS AND RURAL UNLIMITED ACCESS
3. TYPE II GRATE: URBAN AREAS
4. SEE GRATE DIMENSION TABLE FOR SIZE AND NUMBER OF GRATE OPENINGS REQUIRED FOR TYPE I AND TYPE II GRATE.
5. PAVED DITCHES ARE TO BE TRANSITIONED TO MEET INLET GUTTER AS SHOWN IN STANDARD PG-2A.
6. 3" DIAMETER WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH ¼" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.03", NUMBER 4 MESH HARDWARE CLOTH ANCHORED 6" OUTSIDE OF STRUCTURE.
7. IF NORMAL DITCH GRADE IS TOO FLAT TO ALLOW FOR ADJUSTED GRADE TO INLET, A SPECIAL GUTTER DETAIL WILL BE REQUIRED ON PLANS.
8. GRATE BARS TO BE PARALLEL TO DITCH FLOW.
9. DI-12 AND DI-12A ARE NOT TO BE UTILIZED IN LOCATIONS NORMALLY SUBJECT TO TRAFFIC.
10. DUMP NO WASTE DRAINS TO WATERWAYS LETTERING IS REQUIRED ON ALL DI-12 GRATES. LOCATION OF LETTERING MAY VARY BY MANUFACTURER.

GRATE DIMENSIONS

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<th>BAR THICKNESS (2)</th>
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MULTIGRATE DROP INLET
FOR PIPE SIZES 12" TO 72"

VIRGINIA DEPARTMENT OF TRANSPORTATION
### Cast in Place Chamber

<table>
<thead>
<tr>
<th>Pipe Sizes</th>
<th>Minimum Depth H (See Note 3)</th>
<th>Reinforcing Steel Lbs.</th>
<th>Concrete Cu. Yds.</th>
<th>Chamber Dimensions</th>
<th>Concrete Chamber Increments Per Foot (See Note 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot; TO 24&quot;</td>
<td>4'-2&quot;</td>
<td>20.5</td>
<td>1.20</td>
<td>2'-8&quot; 3'-8&quot;</td>
<td>.37</td>
</tr>
<tr>
<td>27&quot; TO 36&quot;</td>
<td>5'-6 1/4&quot;</td>
<td>30.33</td>
<td>2.14</td>
<td>3'-8&quot; 4'-0&quot;</td>
<td>.43</td>
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<tr>
<td>42&quot; TO 54&quot;</td>
<td>6'-10 1/2&quot;</td>
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<td>5'-5&quot; 6'-5&quot;</td>
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<tr>
<td>60&quot; TO 72&quot;</td>
<td>8'-6&quot;</td>
<td>277.32</td>
<td>7.65</td>
<td>7'-2&quot; 7'-2&quot;</td>
<td>.69</td>
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### Brick and Block Chamber

<table>
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<tr>
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<tbody>
<tr>
<td>8&quot;</td>
<td>0'-10&quot;</td>
<td>185</td>
<td>227</td>
<td>330</td>
</tr>
<tr>
<td>12&quot;</td>
<td>10'-16&quot;</td>
<td>250</td>
<td>341</td>
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<td>16&quot;</td>
<td>16'-25&quot;</td>
<td>330</td>
<td>454</td>
<td>660</td>
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### Block Chamber Increments Per Ft.

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<tbody>
<tr>
<td>5&quot;</td>
<td>0'-12&quot;</td>
<td>10</td>
<td>14</td>
<td>20</td>
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<tr>
<td>10&quot;</td>
<td>12'-25&quot;</td>
<td>20</td>
<td>28</td>
<td>40</td>
</tr>
</tbody>
</table>

### Notes
1. For each additional foot in depth the increment shown must be multiplied by the additional depth in feet and added to the concrete total.
2. Approximate quantities are shown for bidding purposes only; items are not to be bid separately. To obtain the total approximate concrete quantities for each inlet, the chamber slot and gutter (gutter to be used with DI-12A only) quantities must be added together.
3. Minimum depths shown are for the smallest pipe size in each series. Minimum depth H = pipe diameter + pipe wall thickness + 3".
4. For approximate quantities for DI-12A add 0.36 cu. yds. of Class A3 concrete to DI-12 quantities for concrete gutter. Quantity shown is for a minimum slot length of 3'-8".
5. DI-12A concrete gutter increment: add 0.07 cu. yds. Class A3 concrete for each additional foot of slot length greater than minimum 3'-8".
6. Dowels are to be provided for the joint between the concrete gutter and slot. The cost of dowels are to be included in the cubic yard cost for concrete.
7. Slot may be precast or cast in place.
8. L = length rounded for plan use.

### Approximate Quantities - DI-12 Only

<table>
<thead>
<tr>
<th>Slot 4&quot; to 14&quot; (See Note 8)</th>
</tr>
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<tbody>
<tr>
<td>L</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>3&quot;</td>
</tr>
<tr>
<td>3'-8&quot;</td>
</tr>
<tr>
<td>7'-8&quot;</td>
</tr>
<tr>
<td>9'-8¾&quot;</td>
</tr>
<tr>
<td>11'-8&quot;</td>
</tr>
<tr>
<td>13'-8¾&quot;</td>
</tr>
</tbody>
</table>
1. Depth of inlet (H) to be shown on plans. For depth greater than 6'-6", use STD.  
2. The "H" dimension shown on the standards and specified on the plans will be measured from the invert of the outfall pipe to the top of the structure. Plan "H" dimensions are approximate only for estimating purposes and the actual dimensions shall be determined by the contractor from field conditions.  
3. When specified on the plans theinvert is to be shaped in accordance with standard IS-1. The cost of furnishing and placing all materials incident to the shaping is to be included in the bid price for the structure.  
4. In the event the invert of the outfall pipe is higher than the bottom of the structure, the invert of the structure shall be shaped with cement mortar to prevent standing or ponding of water in the structure. The cost of furnishing and placing all materials incident to the shaping is to be included in the bid price for the structure.  
5. Steps are to be provided when H is 4'-0" or greater. For details see Standard ST-1.  
6. This item may be precast or cast-in-place.  
7. #4 dowels 12" long, 12" C-C to be placed in all areas adjacent to abutting concrete to prevent settlement.  
8. 3" diameter weep hole 12"x12" plastic hardware cloth 1/4" mesh or galvanized steel wire, minimum wire diameter 0.03". Number 4 mesh hardware cloth anchored firmly to the outside of the structure.  
9. All reinforcing steel shall have a min. cover of 2".  
10. All reinforcing steel to be cut clear of all openings by 2".  
11. Cast-in place concrete is to be class A3 (3000 psi). Precast concrete is to be 4000 psi.  
12. Length of slot (L) will in every case, be shown on plans.  
13. All reinforcing bars to be #4.  
14. DI-12C concrete gutter increment: add 0.07 cu. yds class A3 concrete for each additional foot of slot length greater than minimum 3'-6".  
15. Grate bars to be installed so they will be aligned parallel to the ditch flow.  
16. If normal ditch grade is too flat to allow for adjusted grade to inlet, a special gutter detail will be required on plans.  
17. DI-12B --- NO GUTTER  
18. Paved ditches are to be transitioned to meet inlet gutter as shown in Standard PG-2A.  
19. Quantities shown are for inlets without pipes. Pipe displacements must be deducted to obtain true quantities.  
20. Paved transition where required on plans, transition is to be shaped to conform to rounded concrete gutter of DI-12C.  
21. Type I grate: limited access and rural unlimited access.  
22. Type II grate: urban areas.  
23. L = length rounded for plan use.  
24. DI-12C: for approx. quantities for DI-12C, add 0.36 cu. yds. of class A3 concrete to DI-12B quantities for concrete gutter. Quantity shown is for a minimum slot length of 3'-6". For other lengths see concrete gutter increment below.  
25. DI-12B and DI-12C are not to be utilized in locations normally subject to traffic.  
26. Dump no waste drains to waterways lettering is required on all DI-12 grate locations of lettering may vary by manufacturer.  
27. Type I and Type II grates shall not be located within the limits of any pedestrian access route, such as a sidewalk, shared use path, or pedestrian crossing (marked or unmarked).
NOTES

1. THIS UNIT MAY BE PRECAST OR CAST IN PLACE. CAST IN PLACE CONCRETE IS TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE 4000 PSI.

2. ALL REINFORCING STEEL IS TO BE GRADE 60.

3. PIPES ARE TO BE PLACED ON THE DOWN GRADE OR LOWER END OF INLET.

4. PRECAST UNITS MUST BE FURNISHED WITH PIPES PLACED TO THE RIGHT OR LEFT ACCORDING TO THE FLOW DOWN GRADE, WHEN FACING THE INLET FROM THE CENTER OF THE ROAD.

5. WHEN THIS INLET IS USED IN A SAG LOCATION EITHER A RIGHT HAND OR A LEFT HAND UNIT MAY BE USED.

6. BACKFILL IS TO BE PLACED AND COMPACTED IN ACCORDANCE WITH SECTION 303 OF THE ROAD AND BRIDGE SPECIFICATIONS.


8. STANDARD CG-3 CONCRETE CURB SHALL BE PLACED FROM THE END OF THE INLET TO THE BEGINNING OF THE BRIDGE TERMINAL WALL. ASPHALT CONCRETE CURB BACK UP MATERIAL SHALL BE PLACED BEHIND CG-3 AS SHOWN IN SECTION C-C. THE COST OF CG-3 CURB AND ASPHALT CONCRETE CURB BACK UP MATERIAL SHALL BE PAID FOR SEPARATELY FROM THE DI-13 STRUCTURE.


10. FOR DETAILS OF SLOT INLET AND PIPE INSTALLATION, SEE SECTION B-B ON SHEET 2 OF 2.
NOTES

1. SEE SHEET 1 OF 2 (104.35) OF ROAD AND BRIDGE STANDARDS FOR ADDITIONAL DESIGN AND PLACING INFORMATION.

2. TOP CAP IS TO BE FABRICATED FROM A-36 STEEL PLATE 1/4" THICK.
   ALL JOINTS ARE TO BE WELDED USING 3/8" FILLET WELDS AND THE COMPLETE UNIT IS TO BE GALVANIZED.

3. GUARDRAIL MUST BE FLUSH WITH THE FACE OF CURB.

SHOULDER SLOT INLET

VIRGINIA DEPARTMENT OF TRANSPORTATION
METHOD I

1. CORRUGATED TWO PIECE COUPLING BANDS AND 2 ANCHOR GUY SCREWS (INSTALLED 6" FROM THE STRUCTURE) ARE REQUIRED FOR EACH DI-13 STRUCTURE INSTALLATION. (SEE DI-13 STANDARD)

2. ANCHOR GUY SCREWS WILL HAVE THE FOLLOWING DIMENSIONS:
   \( \frac{\pi}{4} \)" ROD DIAMETER X 5'-6" LENGTH, WITH A 6" DIAMETER HELIX. THE ANCHOR GUY SCREWS AND COUPLING BANDS WILL BE GALVANIZED IN ACCORDANCE WITH SECTION 233 OF THE SPECIFICATIONS.

3. REQUIRED 15" CORRUGATED PIPE. SEE PLAN FOR LINEAR FOOT QUANTITIES. THE LINEAR FOOT COST FOR THE PIPE WILL INCLUDE FURNISHING AND PLACING COUPLINGS AND ANCHOR GUYS.

4. CORRUGATED POLYETHYLENE PIPE MAY BE USED AS AN ALTERNATE ONLY IF GALVANIZED METAL COUPLING BANDS ARE USED AND CAN BE SECURED TO THE PIPE AND REQUIRED ANCHOR GUY SCREWS. THE METHOD WILL REQUIRE A SUBMITTAL TO THE ENGINEER FOR REVIEW AND APPROVAL PRIOR TO INSTALLATION.

5. THE 15" CORRUGATED PIPE WILL BE TERMINATED AT THE TOE OF FALL SLOPE WITH AN APPROPRIATE END TREATMENT. FOR SLOPES STEEPER THAN 3:1 (MAX. 1.5:1) THE 15" PIPE WILL BE TERMINATED IN ACCORDANCE WITH METHOD I FOR SLOPES 3:1 AND FLATTER THE PIPE MAY BE TERMINATED IN ACCORDANCE WITH METHOD II INSTEAD OF METHOD I. (SEE PLANS FOR REQUIRED TYPE OF STRUCTURE).

6. PIPE BEDDING SHALL NOT BE USED.

METHOD II

7. TERMINATE PIPE WITH A STANDARD ES-2 END WALL OR OTHER DRAINAGE STRUCTURE AS DETAILED IN THE PLANS OR DIRECTED BY THE ENGINEER. FOR PIPE LENGTHS 50 FT. AND LONGER MEASURED FROM THE BACK OF DI-13 INLET, COUPLING BANDS WITH ANCHOR GUYS ARE TO BE USED AT 25' C-C MAXIMUM SPACING.

8. WHEN THE SPACING OF THE LOWEST COUPLING FALLS CLOSER THAN 25 FT. TO THE RECEIVING STRUCTURE AT THE TOE OF SLOPE, THAT DISTANCE IS TO BE ADDED TO THE LAST FULL 25' SPACE AND THE COUPLING IS TO BE SPACED MID-WAY OF THE COMBINED DISTANCE.

9. IF A PRECAST STRUCTURE IS USED THE PIPE WILL BE CONNECTED TO THE WALL IN ACCORDANCE WITH SECTION 302 OF THE SPECIFICATIONS.

METHOD II:

10. TERMINATE PIPE WITH A STANDARD ES-2 END SECTION ANCHORED WITH COUPLING BAND AND ANCHOR GUYS. FOR PIPE LENGTHS 50 FT. AND LONGER MEASURED FROM THE BACK OF DI-13 INLET, COUPLING BANDS WITH ANCHOR GUYS ARE TO BE USED AT 25' C-C MAXIMUM SPACING.

NOTES:

1. PIPE BEDDING SHALL NOT BE USED.
Concrete Median Barrier Drop Inlet

12”-36” Pipe: Depth (H) 20’-0” Max.

Virginia Department of Transportation

2016 Road & Bridge Standards
### TABLE OF QUANTITIES

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CONCRETE</th>
<th>REINFORCING STEEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TYPE I</td>
<td>TYPE II</td>
</tr>
<tr>
<td></td>
<td>CUB. YDS.</td>
<td>CUB. YDS.</td>
</tr>
<tr>
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<td>NO. LN.</td>
</tr>
<tr>
<td>3</td>
<td>2.23</td>
<td>2.20</td>
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#### NOTES

1. DEPTH OF INLET (H) TO BE SHOWN ON PLANS.
2. THE "H" DIMENSION SHOWN ON THE STANDARDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE.
3. WHEN SPECIFIED ON THE PLANS THE INERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.
5. STEPS ARE TO BE PROVIDED WHEN H IS 4"-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.
6. THIS ITEM MAY BE PRECAST OR CAST-IN-PLACE.
7. 3" DIAMETER WEEP HOLE TO BE LOCATED TO DRAIN SUBBASE MATERIAL. WEEP HOLE WITH 12"X12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE MINSIMUM WIRE DIAMETER 0.03" NUMBER 4 MESH HARDWARE CLOTH ANCHORED TO THE OUTSIDE OF THE STRUCTURE.
8. ALL REINFORCING STEEL SHALL HAVE A MINIMUM COVER OF 2".
9. ALL REINFORCING STEEL TO BE CUT CLEAR OF ALL OPENINGS BY 2".
10. CAST-IN PLACE CONCRETE IS TO BE CLASS A OR B, PRECAST CONCRETE IS TO BE 4000 PSI.
11. LENGTH OF SLOT (L) WILL, IN EVERY CASE, BE SHOWN ON PLANS.
12. CONCRETE QUANTITIES SHOWN ARE FOR DEPTH (H) OF 3'-0" WITH PIPES, THE AMOUNT DISPLACED BY PIPES MUST BE DEDUCTED TO OBTAIN TRUE QUANTITIES. FOR INLETS OF DIFFERENT DEPTHS ADD OR SUBTRCT 0.36 CUBIC YARDS OF CONCRETE FOR EACH FOOT OF DEPTH AND 84 LBS. OF REINFORCING STEEL.
13. LENGTH OF ANGLE IRON AS SHOWN ON SHEET 1 OF 2 IS TO BE L+16" AT 4.10 LBS./FT.
14. * DENOTES LENGTH OF ONE (1) BAR.
15. GRAVE TO BE INSTALLED SO SLOTS WILL DIRECT WATER TOWARD THE INLET THREAT. GRAVE MUST BE REVERSIBLE (RIGHT HAND GRAVE IS SHOWN).
16. PROVIDE SAFETY SLABS WHEN SPECIFIED ON THE PLANS.
17. FOR DETAILS AND DIMENSIONS NOT SHOWN FOR MEDIAN BARRIER SEE STANDARD MB-12.
18. QUANTITIES INCLUDE MB-12.
**Type I & II Inlet**

**Reinforcing Steel**

<table>
<thead>
<tr>
<th>Mark</th>
<th>Size</th>
<th>No.</th>
<th>Length</th>
<th>Space</th>
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<tbody>
<tr>
<td>A</td>
<td>#4</td>
<td>8</td>
<td>L - 2'-6&quot;</td>
<td>see note 7</td>
</tr>
<tr>
<td>A</td>
<td>#4</td>
<td>8</td>
<td>L - 2'-6&quot;</td>
<td>see note 8</td>
</tr>
</tbody>
</table>

**Notes**

1. Varies greater than: 0" to 18" max. Type I chamber.
2. For details and dimensions not shown for median barrier, see standard MB-13.
3. Galvanized MC-6 X 12 is to be welded under the collar and extended into sidewalls within 2" of outside face.
4. All reinforcing bars are to be grade 60 steel with min. of 1/2" concrete cover. Any bars in conflict with pipe shell and/or top slab opening are to be field cut to provide the required cover.
5. Do not locate standard ST-1 steps on chamber walls that have pipes when possible.
6. 8 dowels required for DI-14E, min. L = 7'-0". Add 2 dowels for each additional foot.
7. 12 bars A required for DI-14F.
8. Length of bars A, DI-14E = \( \frac{L - (2'-6'')}{2} \)
9. Do not use with DI-14D.
10. Use 6 bars F for DI-14F, type I.
11. Do not use with Type II.
12. Add 4 additional bars for each extra foot of depth.
13. Use 12 bars F for DI-14F, type II.
14. 24 bars A are required for DI-14F.
15. A minimum 22" footing depth is required for forming the inlet slot. See plans for length "L".
16. Refer to plans for structure locations, data, and dimensions.
17. Refer to plans for locations of pipes and inverters.
18. For Type III, cost of accommodation of inlet throat is to be included in cost of wall barrier.
19. For Type III, see wall plans for wall footing details.
20. 3" diameter weep hole with 12"x12" plastic hardware cloth, 1/4" mesh, hardware cloth anchored firmly to the outside of the structure.
21. Type I denotes inlet with single throat and chamber.
22. Galvanized pipe size is 24" diameter.
23. Concrete median barrier (all wall) shall have delineators installed on barrier wall oriented towards oncoming traffic at approximately 25° above the roadway.
24. Provide safety slabs when specified on the plans.
25. When specified on the plans, the invert is to be shaped in accordance with standard IS-1. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.
EXPANSION JOINT

CRACK CONTROL JOINT

BACK OF SIDEWALK

EXISTING OR PROPOSED SIDEWALK

CAST IN PLACE SUBBASE

CONCRETE BLOCK

CAST IN PLACE

2" X CAST IN PLACE CONCRETE BLOCK 10"

STANDARD IS-1

2" X CAST IN PLACE CONCRETE BLOCK

B

A

8" 4 DOWEL 16" C-C

SEE NOTE 3

PLAN

SECTION A-A

1. CONCRETE BLOCK IS TO BE EITHER 8" X 8" X 16" OR 8" X 8" X 12" (NOMINAL DIMENSION) SOLID CONCRETE MASONRY BLOCK MEETING THE REQUIREMENTS OF ASTM C-139.

2. DETAILS ABOVE APPLY TO STANDARD DRAWINGS 3A THROUGH 3F AND 4A THROUGH 4F.

3. X EQUALS INTERIOR DIMENSION OF STANDARD DROP INLET SPECIFIED ON PLANS.

4. PARTIAL BLOCK BRICK OR MORTAR MAY BE USED TO ADJUST TOP TO CURB ELEVATION.

5. REINFORCED CONCRETE FOOTING MAY BE PRECAST OR CAST IN PLACE. LIFTING HOOKS OF FABRICATORS DESIGN ARE TO BE PROVIDED IN PRECAST FOOTING.

6. MAXIMUM DEPTH ALLOWABLE FOR CONCRETE BLOCK CONSTRUCTION IS TO BE 8 FEET.

7. MORTAR JOINTS ON INTERIOR SURFACES ARE TO BE FINISHED FLUSH AND MAY BE LEFT EXTRUDED ON EXTERIOR FACES.

8. THE "H" DIMENSION SHOWN ON THE STDS AND SPECIFIED ON THE PLANS WILL BE MEASURED FROM THE INVERT OF THE OUTFALL PIPE TO THE TOP OF THE STRUCTURE. PLAN "H" DIMENSIONS ARE APPROXIMATE ONLY FOR ESTIMATING PURPOSES AND THE ACTUAL DIMENSIONS SHALL BE DETERMINED BY THE CONTRACTOR BY FIELD CONDITIONS.

9. WHEN SPECIFIED ON THE PLANS THE INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD PLAN IS-1. THE COST OF FURNISHING AND PLACING ALL MATERIALS INCIDENTAL TO THE SHAPING IS TO BE INCLUDED IN THE BID PRICE FOR THE STRUCTURE.

10. 3" DIAMETER WEEP HOLE SHALL BE LOCATED TO DRAIN SUBBASE MATERIAL. WEEP HOLE WITH 12" X 12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE MINIMUM WIRE DIAMETER 0.03", NUMBER 4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO THE OUTSIDE OF THE STRUCTURE.

11. ALL DETAILS AND DIMENSIONS OF THE PORTION OF THE INLET DESIGNATED "CAST-IN-PLACE" ARE TO BE IN STRICT ACCORDANCE WITH THE STD. DRAWING SPECIFIED ON THE PLANS. THIS WILL INCLUDE ALL DETAILS, NOTES, DETAILS OF FRAME AND COVER, GUTTER, AND ANGLE IRON. ALL REINF. STEEL WILL REMAIN AS DETAILED WITH THE FOLLOWING EXCEPTIONS:

A) THE VERTICAL LEG OF BARS C WILL BE ELIMINATED.

B) BARS C WILL BE ELIMINATED AND REPLACED WITH DOWELS SHOWN HEREON.


13. STEPS ARE TO BE PROVIDED WHEN H IS 4'-0" OR GREATER. FOR DETAILS SEE STANDARD ST-1.

NOTES

CONSTRUCTION METHOD FOR CONCRETE MASONRY BLOCK CURB DROP INLET

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION REFERENCE

302

ROAD AND BRIDGE STANDARDS

REVISION DATE

104.42

SHEET 1 OF 1

2016 ROAD & BRIDGE STANDARDS
NOTES

1. THE LETTERS V.D.O.T. ARE OPTIONAL IF USED THE LETTERS ARE TO BE CAST IN THE DEPRESSION IN TOP OF THE COVER 1" WIDE AND RAISED 1/4" MGH AS SHOWN.

2. THE DUMP NO WASTE DRAINS TO WATERWAYS LETTERING IS REQUIRED ON ALL IC-2 COVERS. LOCATION OF LETTERING MAY VARY BY MANUFACTURER.
INLET FRAME

SECTION L

INLET COVER

DETAIL A

NOTES

1. STRUCTURAL COMPONENTS SHALL CONFORM TO AASHTO M222.

2. FRAME AND COVER SHALL HAVE A CONTINUOUS FLASH FIT.

3. DUMP NO WASTE DRAINS TO WATERWAYS LETTERING IS REQUIRED ON ALL IC-2 COVERS. LOCATION OF LETTERING MAY VARY BY MANUFACTURER.
1. CONCRETE 4000 PSI

2. SUPPLIER MAY FURNISH 1/4" STEEL FOR 10 GA.


4. DUMP NO WASTE DRAINS TO WATERWAYS LETTERING IS REQUIRED ON ALL IC-2 COVERS. LOCATION OF LETTERING MAY VARY BY MANUFACTURER.
**MANHOLE FOR 12" - 48" PIPE CULVERTS**

**Virginia Department of Transportation**

**TABLE OF QUANTITIES**

<table>
<thead>
<tr>
<th>DEPTH (Ft)</th>
<th>BRICK (T)</th>
<th>CONCRETE MANHOLE (Cu Yd)</th>
<th>CONCRETE MINUS MANHOLE (Cu Yd)</th>
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<tbody>
<tr>
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<td>0.785</td>
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<tr>
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**INCREMENTS:**

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<th>INCREMENT (Ft)</th>
<th>BRICK (T)</th>
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<th>CONCRETE MINUS MANHOLE (Cu Yd)</th>
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<td>-</td>
<td>-</td>
<td>0.582</td>
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**Notes:**

1. Quantities shown are for manhole without pipes; the amount displaced by pipes must be deducted to obtain true quantities.
2. A base thickness of 9" was used in computing concrete quantities.
3. Increments to be added for each additional foot of depth.
4. Materials may be brick, concrete or approved concrete manhole block.
5. If blocks are used the minimum thickness of same is to be 5"; other thicknesses are to conform to wall thickness shown for concrete.
6. All concrete to be class A3.
7. When specified on plans the invert is to be shaped in accordance with Standard IS-1. The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.

**See standard SL-1 for applicability of safety slabs.**

**Standard MH-1 Frame & Cover**

**Note:**

The top of masonry is to be left sufficiently low to permit proper adjustment of cover and frame to grade by the use of mortar or brick as directed by the engineer.

**Flat slab top as detailed on Standard T-MH-2 may be substituted for tapered section when approved by the engineer.**

**Invert is to be shaped in accordance with Standard IS-1.**

**The cost of furnishing and placing all materials incidental to the shaping is to be included in the bid price for the structure.**
SECTION A-A

SECTION B-B

FRAME AND COVER SHALL BE RATED FOR TRAFFIC CONDITIONS. APPROXIMATE WEIGHT

CAST IRON

FRAME 239 ± 12 LBS.
COVER 137 ± 7 LBS.
SECTION A-A

FRAME SECTION AT MID POINT

SECTION A-A

APPROXIMATE WEIGHT

CAST IRON

COVER 137 ± 7 LBS.
FRAME 235 ± 12 LBS.

FRAME 235 ± 12 LBS.

NOTES:

THE LETTERS V.D.O.T. ARE OPTIONAL, IF USED THE LETTERS ARE TO BE CAST IN THE DEPRESSION IN TOP OF COVER 1" WIDE AND RAISED ⅜" HIGH AS SHOWN.

COVER 1" WIDE AND RAISED ... HIGH

CAST IN THE DEPRESSION IN TOP OF

THE LETTERS V.D.O.T. ARE OPTIONAL,

FINISHED DIMENSION

FINISHED DIMENSION

FRUIT RE Semi UPTON 2016 ROAD & BRIDGE STANDARDS

THIS STANDARD VOIDED APRIL 2020

VIRTUAL DEPARTMENT OF TRANSPORTATION

STANDARD MANHOLE FRAME AND COVER

2016 ROAD & BRIDGE STANDARDS

ROAD AND BRIDGE STANDARDS

REVISION DATE SHEET 3 OF 5

VOID APRIL 2020

STANDARD MANHOLE FRAME AND COVER

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
FRAME AND COVER SHALL BE RATED FOR TRAFFIC CONDITIONS.

APPROXIMATE WEIGHT

CAST IRON

FRAME 235 ± 12 LBS.
COVER 130 ± 7 LBS.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

STANDARD MANHOLE FRAME AND COVER

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

REVISION DATE
04/20

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

224
302
STANDARD MANHOLE FRAME AND COVER

NONSKID ALUMINUM OXIDE IMPREGNATED STEEL PLATE 3/16" THICK
NEOPRENE FOAM BOND
STEEL PLATE 1/8" THICK MATERIAL AASHTO M222
1/4" x 3/4" HR FLAT BAR (WELDED TO COVER ONLY)

LETTERING OPTIONAL
SEE DETAIL A

SECTION C
MANHOLE FRAME

NOTES:
STRUCTURAL COMPONENTS SHALL CONFORM TO AASHTO M222.
FRAME AND COVER SHALL HAVE A CONTINUOUS FLUSH FIT.
STANDARD MANHOLE FRAME AND COVER

VIRGINIA DEPARTMENT OF TRANSPORTATION

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

2016 ROAD & BRIDGE STANDARDS

224
302
FOR DETAILS OF ALL COMPONENT PARTS AND "GENERAL NOTES- Precast" SEE SHEETS 103.01-103.11
METHOD OF TREATMENT IN DROP INLETS

SECTION A-A

SHAPE TO ELEVATION OF MID-POINT OF LARGEST PIPE.

SHAPE TO CONTOUR OF PIPE

SLOPE TO DRAIN TO INVERT OF OUTLET PIPE

METHOD OF TREATMENT IN MANHOLES

SECTION B-B

SLOPE TO DRAIN TO INVERT OF OUTLET PIPE

TRANSITION BETWEEN PIPE DIAMETERS WHEN DIFFERENT SIZES OF PIPES ARE ENCOUNTERED.

NOTES:
SHAPING OF MANHOLE AND INLET INVERTS IN ACCORDANCE WITH THIS DRAWING IS TO APPLY TO THOSE STRUCTURES SPECIFIED ON PLANS OR WHERE INVERT OF PIPE IS ABOVE INVERT OF STRUCTURE.

MANHOLE OR DROP INLET IS TO BE FORMED AND CONSTRUCTED IN ACCORDANCE WITH APPLICABLE STANDARD OR SPECIAL DRAWING. THE INVERT SHAPING AS DETAILED HEREON IS TO CONSIST OF A PORTLAND CEMENT CONCRETE MIX CONFORMING TO CLASS A3 OR CLASS C1, EXCEPT THAT 25% OF COARSE AGGREGATE MAY BE UP TO 4" IN DIAMETER AND CONSIST OF STONE, BROKEN BRICK, BROKEN CONCRETE OR BROKEN CONCRETE BLOCK. THE SURFACE SHALL BE LEFT SMOOTH BY MEANS OF HAND TROWELLING. NONE OF THE COARSE AGGREGATE SHALL REMAIN EXPOSED.

DETAILS OF INVERT SHAPING AS SHOWN HEREON ARE FOR EXAMPLE PURPOSES ONLY. EACH MANHOLE OR DROP INLET IS TO BE SHAPED INDIVIDUALLY TO BEST FIT THE PARTICULAR INLET AND OUTLET CONFIGURATION AND FLOW LINES.
#4, Grade 60, reinforcing rod encased in a corrosion resistant rubber or other material approved by the engineer. (Dimension may vary with manufacturer’s design)

NO. 6 GALVANIZED STEEL STEP

TYPICAL SECTION

NOTES:

Steps will be required in all structures with a depth of 4'-0" or greater unless otherwise noted on the plans.

All steps shall protrude 4 1/2" from inside face of structure wall.

Maximum step spacing to be 16" C-C.

Steps shall withstand a minimum force of 300 pounds when extended 4 1/2" from the face of the support.

Steps are to be vertically aligned and uniformly spaced for the entire depth of any structure.

In precast units steps may be cast in place, mortared into holes provided by the fabricator, or driven.

Steps differing in dimensions, configuration, or materials from those shown may also be used provided they meet the minimum requirements shown hereon and the contractor has furnished the engineer with details and certified test reports of the proposed substitute and has received written approval from the engineer for the use of such steps.

All steps installed shall be provided with slip-resistant surfaces such as but not limited to, corrugated knurled, or dimpled surfaces.

Aluminum steps shall be fabricated in accordance with ASTM B223, Alloy 6065-T6.

That portion of the step encased in masonry shall be uniformly coated with a bituminous, solvent type, asbestos filled aluminum pigmented coating conforming to Federal specification TC-C-00498A.

STANDARD STEP

VIRGINIA DEPARTMENT OF TRANSPORTATION
NOTES:
1. ALL REINFORCING STEEL TO BE #6 BARS WITH A MINIMUM 1/2" CLEARANCE.
2. ANY REINFORCING BARS IN CONFLICT WITH PIPE SHELLS ARE TO BE CUT A MINIMUM OF 1/2" FROM PIPE.
4. PRECAST CHAMBERS OF THE BOLT TOGETHER TYPE MAY BE SUBSTITUTED WHEN APPROVED ON AN INDIVIDUAL BASIS.
5. ALL CONCRETE TO BE CLASS A3 IF CAST IN PLACE, 4000 PSI IF PRECAST.
6. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
7. ELIMINATE DOWELS WHEN PRECAST TYPE A TOWER IS ELECTED.
8. WHEN SPECIFIED ON PLANS INVERT IS TO BE SHAPED IN ACCORDANCE WITH STANDARD IS-1. THE MATERIALS INCIDENTAL TO THE SHAPING ARE NOT TO BE MEASURED OR PAID SEPARATELY BUT THE COST OF SAME IS TO BE INCLUDED IN THE PRICE BID PER CUBIC YARD OF JUNCTION BOX CONCRETE.
### Junction Box Details for Anguler Connections of 48" - 72" Pipe Culverts

**Pipe Size**

<table>
<thead>
<tr>
<th>Type A: &quot;W&quot;</th>
<th>4&quot; - 10&quot;</th>
<th>5&quot; - 6&quot;</th>
<th>6&quot; - 7&quot;</th>
<th>7&quot; - 8&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIM. D:</td>
<td>6.47</td>
<td>5.26</td>
<td>5.96</td>
<td>7.77</td>
</tr>
<tr>
<td>CONC. YDS:</td>
<td>2086</td>
<td>1794</td>
<td>2360</td>
<td>2230</td>
</tr>
<tr>
<td>LBS. REINF.</td>
<td>3.88</td>
<td>4.30</td>
<td>4.50</td>
<td>4.99</td>
</tr>
<tr>
<td>STRUCT. STEEL</td>
<td>8.34</td>
<td>8.34</td>
<td>8.34</td>
<td>8.34</td>
</tr>
</tbody>
</table>

**Type C: "W" | 2" - 6" | 3" - 4" | 4" - 6" |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DIM. D:</td>
<td>6.19</td>
<td>5.58</td>
<td>4.92</td>
</tr>
<tr>
<td>CONC. YDS:</td>
<td>1865</td>
<td>1744</td>
<td>1744</td>
</tr>
<tr>
<td>LBS. REINF.</td>
<td>8.34</td>
<td>8.34</td>
<td>8.34</td>
</tr>
<tr>
<td>STRUCT. STEEL</td>
<td>8.34</td>
<td>8.34</td>
<td>8.34</td>
</tr>
</tbody>
</table>

**Specifications Reference**

- 105
- 233
- 302

**NOTES:**

Where pipes enter the chamber on a skew, pipe walls are to be extended, if required, into the chamber a sufficient distance to maintain a minimum uncut length of 2' in a 6' pipe section.

Quantities shown are for chamber without pipes. Pipe displacement of concrete and steel must be deducted to obtain true quantities. See Sheet 4 of 4.

Chamber and tower quantities for concrete and reinforcing steel must be added to obtain totals.

<table>
<thead>
<tr>
<th>&quot;W&quot;</th>
<th>STRUCT. STEEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot;-0&quot;</td>
<td>30 Lbs.</td>
</tr>
<tr>
<td>3&quot;-0&quot;</td>
<td>40 Lbs.</td>
</tr>
<tr>
<td>4&quot;-0&quot;</td>
<td>50 Lbs.</td>
</tr>
</tbody>
</table>

**Road and Bridge Standards**

**Revision Date:** 106.11
DETAILS OF TOWERS

TYPE A
TO BE USED WHEN VERTICAL DISTANCE BETWEEN GRADE AND INVERT OF PIPE IS PIPE DIAMETER PLUS 5'-4" OR GREATER (SEE NOTE 3).

WALL THICKNESS TO BE 6" TO A DEPTH OF 10' AND 8" OVER 10'.

SECTION A-A

PLAN

NOTES:
1. PRECAST UNITS IN ACCORDANCE WITH STANDARD MH-2 MAY BE SUBSTITUTED FOR TYPE A TOWER SHOWN. IF SUBSTITUTED, PAYMENT WILL BE MADE AT THE CONTRACT UNIT PRICE FOR CONCRETE AND STEEL BASED ON THE THEORETICAL QUANTITIES THAT WOULD HAVE BEEN REQUIRED TO BUILD THE TYPE A TOWER.
2. SEE STANDARD SL-1 FOR APPLICABILITY OF SAFETY SLABS.
3. INCREASE INDICATED DIMENSION BY ONE FOOT FOR USE WITH 72" DIAMETER PIPE.
4. CHAMBER AND TOWER QUANTITIES FOR CONCRETE AND REINFORCING STEEL MUST BE ADDED TO OBTAIN TOTALS.

TYPE B
TO BE USED WHEN VERTICAL DISTANCE BETWEEN GRADE AND INVERT OF PIPE IS PIPE DIAMETER PLUS 3'-2" TO 5'-4" (SEE NOTE 3).

SECTION A-A

PLAN

QUANTITIES FOR TOWER **

<table>
<thead>
<tr>
<th></th>
<th>TYPE A</th>
<th>TYPE B</th>
<th>TYPE C</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONCRETE</td>
<td>0.643 C.Y.</td>
<td>0.325 C.Y.</td>
<td>—</td>
</tr>
<tr>
<td>INCREMENT PER FOOT 0.262 TO 10' DEPTH</td>
<td>0.259</td>
<td>0.145</td>
<td></td>
</tr>
<tr>
<td>REINFORCING STEEL</td>
<td>—</td>
<td>62 LBS.</td>
<td>—</td>
</tr>
</tbody>
</table>

** QUANTITIES SHOWN ARE FOR MINIMUM TOWERS OF EACH TYPE. FOR TOWERS ABOVE MINIMUM HEIGHT INCREASES SHOWN PER FOOT MUST BE ADDED.
## Displacement Quantities for Pipe Openings

(To Be Used With Std. JB-1 Junction Box)

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Pipe Class</th>
<th>0°</th>
<th>15°</th>
<th>30°</th>
<th>45°</th>
<th>Reinf. Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cu Yards</td>
<td>Cu Yards</td>
<td>Cu Yards</td>
<td>Cu Yards</td>
<td>Lbs.</td>
</tr>
<tr>
<td>12&quot;</td>
<td>III, IV, V</td>
<td>.035</td>
<td>.036</td>
<td>.040</td>
<td>.050</td>
<td>17.67</td>
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<tr>
<td>12&quot;</td>
<td>CM</td>
<td>.019</td>
<td>.020</td>
<td>.022</td>
<td>.027</td>
<td>11.06</td>
</tr>
<tr>
<td>15&quot;</td>
<td>III, IV, V</td>
<td>.050</td>
<td>.052</td>
<td>.058</td>
<td>.071</td>
<td>24.88</td>
</tr>
<tr>
<td>15&quot;</td>
<td>CM</td>
<td>.030</td>
<td>.031</td>
<td>.034</td>
<td>.042</td>
<td>15.93</td>
</tr>
<tr>
<td>18&quot;</td>
<td>III, IV, V</td>
<td>.069</td>
<td>.072</td>
<td>.080</td>
<td>.099</td>
<td>33.23</td>
</tr>
<tr>
<td>18&quot;</td>
<td>CM</td>
<td>.043</td>
<td>.044</td>
<td>.049</td>
<td>.061</td>
<td>21.68</td>
</tr>
<tr>
<td>24&quot;</td>
<td>III, IV, V</td>
<td>.118</td>
<td>.122</td>
<td>.137</td>
<td>.168</td>
<td>53.53</td>
</tr>
<tr>
<td>24&quot;</td>
<td>CM</td>
<td>.076</td>
<td>.078</td>
<td>.087</td>
<td>.108</td>
<td>35.83</td>
</tr>
<tr>
<td>30&quot;</td>
<td>III, IV, V</td>
<td>.179</td>
<td>.186</td>
<td>.208</td>
<td>.256</td>
<td>78.64</td>
</tr>
<tr>
<td>30&quot;</td>
<td>CM</td>
<td>.118</td>
<td>.122</td>
<td>.137</td>
<td>.168</td>
<td>53.53</td>
</tr>
<tr>
<td>36&quot;</td>
<td>III, IV, V</td>
<td>.254</td>
<td>.263</td>
<td>.294</td>
<td>.362</td>
<td>108.76</td>
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<tr>
<td>36&quot;</td>
<td>CM</td>
<td>.170</td>
<td>.176</td>
<td>.197</td>
<td>.242</td>
<td>74.76</td>
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<tr>
<td>42&quot;</td>
<td>III, IV, V</td>
<td>.341</td>
<td>.353</td>
<td>.395</td>
<td>.486</td>
<td>143.33</td>
</tr>
<tr>
<td>42&quot;</td>
<td>CM</td>
<td>.231</td>
<td>.240</td>
<td>.268</td>
<td>.330</td>
<td>99.53</td>
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<tr>
<td>48&quot;</td>
<td>III, IV, V</td>
<td>.441</td>
<td>.457</td>
<td>.511</td>
<td>.629</td>
<td>182.90</td>
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<tr>
<td>48&quot;</td>
<td>CM</td>
<td>.302</td>
<td>.313</td>
<td>.350</td>
<td>.431</td>
<td>127.85</td>
</tr>
<tr>
<td>54&quot;</td>
<td>III, IV</td>
<td>.554</td>
<td>.574</td>
<td>.642</td>
<td>.789</td>
<td>227.29</td>
</tr>
<tr>
<td>54&quot;</td>
<td>V</td>
<td>.580</td>
<td>.600</td>
<td>.672</td>
<td>.826</td>
<td>237.42</td>
</tr>
<tr>
<td>54&quot;</td>
<td>CM</td>
<td>.382</td>
<td>.396</td>
<td>.443</td>
<td>.545</td>
<td>159.70</td>
</tr>
<tr>
<td>60&quot;</td>
<td>III, IV</td>
<td>.679</td>
<td>.704</td>
<td>.787</td>
<td>.965</td>
<td>276.49</td>
</tr>
<tr>
<td>60&quot;</td>
<td>V</td>
<td>.708</td>
<td>.734</td>
<td>.821</td>
<td>1.009</td>
<td>287.85</td>
</tr>
<tr>
<td>60&quot;</td>
<td>CM</td>
<td>.472</td>
<td>.481</td>
<td>.551</td>
<td>.673</td>
<td>195.09</td>
</tr>
<tr>
<td>66&quot;</td>
<td>III, IV</td>
<td>.818</td>
<td>.847</td>
<td>.948</td>
<td>1.166</td>
<td>330.50</td>
</tr>
<tr>
<td>66&quot;</td>
<td>V</td>
<td>.849</td>
<td>.880</td>
<td>.985</td>
<td>1.211</td>
<td>342.70</td>
</tr>
<tr>
<td>66&quot;</td>
<td>CM</td>
<td>.571</td>
<td>.591</td>
<td>.662</td>
<td>.814</td>
<td>234.02</td>
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<tr>
<td>72&quot;</td>
<td>III, IV</td>
<td>.969</td>
<td>1.004</td>
<td>1.123</td>
<td>1.382</td>
<td>389.34</td>
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<tr>
<td>72&quot;</td>
<td>V</td>
<td>1.003</td>
<td>1.040</td>
<td>1.183</td>
<td>1.431</td>
<td>402.58</td>
</tr>
<tr>
<td>72&quot;</td>
<td>CM</td>
<td>.679</td>
<td>.704</td>
<td>.787</td>
<td>.969</td>
<td>276.49</td>
</tr>
</tbody>
</table>
NOTES:

1. THE STANDARD SAFETY SLAB (SL-1) IS TO BE USED ONLY WHEN SPECIFIED IN THE PLANS ON THE DRAINAGE SUMMARY SHEET AND/OR THE DRAINAGE DESCRIPTION FOR MANHOLES, JUNCTION BOXES, AND DROP INLETS WITH HEIGHTS GREATER THAN 12 FEET. THE SPACING OF ADJACENT SAFETY SLABS SHALL BE 8” TO 12” WITH NO SAFETY SLAB LOCATED WITHIN 6 FEET OF THE TOP OR BOTTOM OF THE STRUCTURE. SAFETY SLABS SHALL NOT BE LOCATED BELOW ANY INLET PIPE OF 30” DIAMETER OR GREATER.

2. THE COST OF THE SL-1 IS INCLUDED IN THE COST OF THE STRUCTURE.

3. ACCESS OPENINGS ARE TO BE STAGGERED FROM ONE SIDE OF STRUCTURE TO THE OTHER WHERE APPLICABLE. STEPS ARE TO BE STAGGERED ACCORDINGLY.

4. SAFETY SLAB MAY BE CAST-IN-PLACE OR PRECAST, CAST-IN-PLACE CONCRETE TO BE CLASS A3 (3000 PSI). PRECAST CONCRETE IS TO BE A4 (4000 PSI). REINFORCING STEEL TO BE IN ACCORDANCE WITH AASHTO M31.

5. ACCESS OPENINGS MAY BE 30” DIAMETER OR 30” SQUARE. WHEN STRUCTURE WIDTH IS LESS THAN 30” THE ACCESS OPENING SHALL BE RECTANGULAR (STRUCTURE WIDTH BY 30” LONG).

SEE CAST IN PLACE DRAWINGS FOR FURTHER DETAILS.

TYPICAL PRECAST UNIT.
NOTES

1. BEDDING MATERIAL IS TO BE AGGREGATE SIZE 25 OR 26. IF FOUNDATION HAS STANDING OR RUNNING WATER PRESENT, THEN AGGREGATE NO. 57 SHALL BE USED FOR THE DEPTH SPECIFIED ON THE PLANS OR AS DIRECTED BY THE ENGINEER, CAPPED WITH 4 INCHES OF AGGREGATE NO. 25 OR 26.

2. WIDTH OF BEDDING MATERIAL SHALL EXTEND A MINIMUM OF 6" BEYOND THE BASE OF THE STRUCTURE ON ALL SIDES.

3. HEIGHT OF STRUCTURE (H) IS MEASURED FROM THE INVERT OF THE STRUCTURE TO THE TOP OF THE FRAME AND COVER OR CONCRETE DEPENDING ON STRUCTURE TYPE. SEE APPLICABLE DRAINAGE STRUCTURE STANDARD FOR DETAIL.

BEDDING THICKNESS TABLE

<table>
<thead>
<tr>
<th>FOUNDATION TYPE</th>
<th>BEDDING THICKNESS (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL EARTH</td>
<td>4&quot; FOR H &lt; 10'</td>
</tr>
<tr>
<td></td>
<td>6&quot; FOR H &gt; 10'</td>
</tr>
<tr>
<td>ROCK</td>
<td>1&quot; PER FOOT OF H, MAX. 8&quot;</td>
</tr>
</tbody>
</table>

SOFT & YIELDING

AS SPECIFIED ON THE PLANS OR AS DIRECTED BY THE ENGINEER
GENERAL
1. METHOD "A" PIPE BEDDING SHALL BE USED FOR ALL TYPES OF PIPE CULVERTS WITHIN THE
   APPLICABLE HEIGHT OF COVER RANGE NOTED IN THE STANDARD PC-1 TABLES UNLESS
   OTHERWISE NOTED ON THE PLANS.
2. H = HEIGHT OF COVER MEASURED FROM TOP OF CULVERT TO FINISHED GRADE.
3. b = EXCAVATION DEPTH AS SHOWN ON PLANS OR TO FIRM BEARING SOIL.

CIRCULAR PIPE
1. D = OUTSIDE DIAMETER OF PIPE.
2. d = INSIDE DIAMETER OF PIPE.
3. X = WIDTH OF CLASS I BACKFILL MATERIAL BEYOND THE EXTREMITY OF THE PIPE.
   X = 12" WHERE d IS LESS THAN 36".
   X = 18" WHERE d IS 36" AND GREATER.
4. WHERE DIRECTED BY THE ENGINEER BEDDING MATERIAL MAY BE ELIMINATED FOR
   NORMAL EARTH FOUNDATIONS UNDER ROUTINE ENTRANCE PIPE (EXCEPT PLASTIC PIPE)
   30" AND LESS IN DIAMETER WITH HEIGHT OF COVER 15" OR LESS.
5. REGULAR BACKFILL MATERIAL MAY BE USED IN LIEU OF CLASS I BACKFILL MATERIAL FOR
   ALL FOUNDATION TYPES FOR ROUTINE ENTRANCE PIPE (EXCEPT PLASTIC PIPE) 30" AND
   LESS IN DIAMETER WITH HEIGHT OF COVER 15" OR LESS.
6. BEDDING MATERIAL AND CLASS I BACKFILL MATERIAL MAY BE ELIMINATED FOR SHOULDER
   SLOT INLET (D-13) OUTLET PIPES INSTALLATIONS.

ELLIPtical PIPE
1. S₁ = OUTSIDE SPAN DIMENSION OF PIPE.
2. S₂ = INSIDE SPAN DIMENSION OF PIPE.
3. R = OUTSIDE RISE DIMENSION OF PIPE.
4. X = WIDTH OF CLASS I BACKFILL MATERIAL BEYOND THE EXTREMITY OF THE PIPE.
   X = 12" WHERE S₂ IS LESS THAN 36".
   X = 18" WHERE S₂ IS 36" AND GREATER.
5. WHERE DIRECTED BY THE ENGINEER BEDDING MATERIAL MAY BE ELIMINATED FOR
   NORMAL EARTH FOUNDATIONS UNDER ROUTINE ENTRANCE PIPE WHERE S₂ IS 38" OR
   LESS AND HEIGHT OF COVER 15" OR LESS.
6. REGULAR BACKFILL MATERIAL MAY BE USED IN LIEU OF CLASS I BACKFILL MATERIAL FOR
   ALL FOUNDATION TYPES FOR ROUTINE ENTRANCE PIPE WHERE S₂ IS 38" OR LESS AND
   HEIGHT OF COVER 15" OR LESS.

PIPE ARCH
1. S = SPAN DIMENSION OF PIPE.
2. R = RISE DIMENSION OF PIPE.
3. B = SEE PC-1 TABLE FOR APPLICABLE PIPE MATERIAL.
4. X = WIDTH OF CLASS I BACKFILL MATERIAL BEYOND THE EXTREMITY OF THE PIPE.
   X = 12" WHERE S₂ IS LESS THAN 36".
   X = 18" WHERE S₂ IS 36" AND GREATER.
5. WHERE DIRECTED BY THE ENGINEER BEDDING MATERIAL MAY BE ELIMINATED FOR
   NORMAL EARTH FOUNDATIONS UNDER ROUTINE ENTRANCE PIPE WHERE S₂ IS 35" OR
   LESS AND HEIGHT OF COVER 15" OR LESS.
6. REGULAR BACKFILL MATERIAL MAY BE USED IN LIEU OF CLASS I BACKFILL MATERIAL FOR
   ALL FOUNDATION TYPES FOR ROUTINE ENTRANCE PIPE WHERE S IS 35" OR LESS AND
   HEIGHT OF COVER 15" OR LESS.
NO PROJECTION OF PIPE ABOVE GROUND LINE

Pipe Projection Above Ground Line

Normal Earth Foundation

Rock Foundation

Foundation Soft, Yielding, or Otherwise Unsuitable Material

Notes:

For General Notes on Pipe Bedding, See Installation of Pipe Culverts and Storm Sewers General Notes on Sheet 107.00.

Crushed Glass Conforming to the Size Requirements for Crusher Run Aggregate Size 25 and 25 may be used in place of Class II Backfill.

Bedding Material in Accordance with Section 302 of the Road and Bridge Specifications.

Regular Backfill Material in Accordance with Section 302 of the Road and Bridge Specifications.

For All Other Pipe Regular Backfill Material in Accordance with Section 302 of the Road and Bridge Specifications.

For Plastic Pipe:

6" Minimum Class I Backfill Material Placed Directly Over Pipe and 6" Regular Backfill Material, or 12" of Class II Backfill Material in Accordance with Section 302 of the Road and Bridge Specifications.
NO PROJECTION OF PIPE ABOVE GROUND LINE

NORMAL EARTH FOUNDATION

TOP OF FILL

GROUND LINE

R + 12"

R / 2

MIN. 1/10 R

S1

S2

BEDDING MATERIAL

EARTH

NORMAL EARTH FOUNDATION

ROCK FOUNDATION

TOP OF FILL

GROUND LINE

R + 12"

R / 2

MIN. 1/10 R

1/2" PER 1' OF H MIN. 8" MAX. 24"

S1

S2

BEDDING MATERIAL

ROCK OR UNYIELDING SOIL

NORMAL EARTH FOUNDATION

ROCK FOUNDATION

GROUND LINE

R + 12"

R / 2

MIN. 1/10 R

1/2" PER 1' OF H MIN. 8" MAX. 24"

S1

S2

BEDDING MATERIAL

ROCK OR UNYIELDING SOIL

FOUNDATION SOFT, YIELDING, OR OTHERWISE UNSUITABLE MATERIAL

PIECE PROJECTION ABOVE GROUND LINE

NORMAL EARTH FOUNDATION

TOP OF FILL

GROUND LINE

R + 12"

R / 2

MIN. 1/10 R

S1

S2

BEDDING MATERIAL

EARTH

NORMAL EARTH FOUNDATION

ROCK FOUNDATION

GROUND LINE

R + 12"

R / 2

MIN. 1/10 R

1/2" PER 1' OF H MIN. 8" MAX. 24"

S1

S2

BEDDING MATERIAL

ROCK OR UNYIELDING SOIL

NORMAL EARTH FOUNDATION

ROCK FOUNDATION

GROUND LINE

R + 12"

R / 2

MIN. 1/10 R

1/2" PER 1' OF H MIN. 8" MAX. 24"

S1

S2

BEDDING MATERIAL

ROCK OR UNYIELDING SOIL

FOUNDATION SOFT, YIELDING, OR OTHERWISE UNSUITABLE MATERIAL

NOTES:

FOR GENERAL NOTES ON PIPE BEDDING SEE INSTALLATION OF PIPE CULVERTS AND STORM SEWERS GENERAL NOTES ON SHEET 107.00.

CRUSHED GLASS CONFORMING TO THE SIZE REQUIREMENTS FOR CRUSHER RUN AGGREGATE SIZE 25 AND 26 MAY BE USED IN PLACE OF CLASS I BACKFILL.

SPECIFICATION REFERENCE

302

303

ELLIP. PIPE BEDDING AND BACKFILL - METHOD "A"

VDOT

ROAD AND BRIDGE STANDARDS

REVISION DATE

10/09

SHEET 2 OF 4

107.02

2016 ROAD & BRIDGE STANDARDS
NO PROJECTION OF PIPE ARCH ABOVE GROUND LINE

NORMAL EARTH FOUNDATION

ROCK FOUNDATION

FOUNDATION SOFT, YIELDING, OR OTHERWISE UNSUITABLE MATERIAL

PIPE ARCH PROJECTION ABOVE GROUND LINE

NORMAL EARTH FOUNDATION

ROCK FOUNDATION

FOUNDATION SOFT, YIELDING, OR OTHERWISE UNSUITABLE MATERIAL

NOTE:

FOR GENERAL NOTES ON PIPE BEDDING, SEE INSTALLATION OF PIPE CULVERTS AND STORM SEWERS GENERAL NOTES ON SHEET 107.00.

CRUSHED GLASS CONFORMING TO THE SIZE REQUIREMENTS FOR CRUSHER RUN AGGREGATE SIZE 25 AND 26 MAY BE USED IN PLACE OF CLASS I BACKFILL.

BEDDING MATERIAL IN ACCORDANCE WITH SECTION 302 OF THE ROAD AND BRIDGE SPECIFICATIONS.

CLASS I BACKFILL MATERIAL IN ACCORDANCE WITH SECTION 302 OF THE ROAD AND BRIDGE SPECIFICATIONS.

REGULAR BACKFILL MATERIAL IN ACCORDANCE WITH SECTION 302 OF THE ROAD AND BRIDGE SPECIFICATIONS.

EMBANKMENT
H - HEIGHT OF COVER MEASURED FROM TOP OF CULVERT TO FINISHED GRADE.

FOR NORMAL EARTH FOUNDATION:
FOR PRECAST AND CAST IN PLACE BOX CULVERT b = 6".

FOR ROCK FOUNDATION:
FOR PRECAST BOX CULVERT b = 1/4" PER 12" OF H - 8" MIN., 24" MAX.
FOR CAST IN PLACE BOX CULVERT b= DEPTH AS SHOWN ON PLANS OR WHERE NO BEDDING IS SPECIFIED BOTTOM SLAB TO BE KEYED INTO EXISTING ROCK FOUNDATION.
FOR SOFT, YIELDING OR OTHERWISE UNSUITABLE FOUNDATION:
FOR PRECAST AND CAST IN PLACE BOX CULVERT
b = DEPTH AS SHOWN ON PLANS OR TO FIRM BEARING SOIL.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

INSTALLATION OF BOX CULVERT BEDDING AND BACKFILL - METHOD "A"

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION REFERENCE: 302
303

REVISED DATE: 07/16
SHEET 4 OF 4
107.04
**NOTES:**

1. Cover heights indicated in tables are for finished construction. The cover heights were retained to match former cover heights based on allowable stress design. Cover heights were not re-calculated using LRFD.

2. To protect pipe during construction, minimum cover heights of cover prior to allowing construction traffic to cross installation are to be 1/2 diameter or 30", whichever is greater. The cover shall extend the full length of the pipe. The approach fill ramp is to extend a minimum of (diameter + 36") on each side of the pipe or to the intersection with a cut.

3. Standard minimum finished height of cover for all pipes, except those under entrances, shall be 2.0' or 1/2 diameter, whichever is greater. In cases in which these cover heights cannot be achieved, a minimum finished cover height of 1.0' will be allowed only if all possible means to obtain the standard value have been exhausted. The minimum finished height of cover for pipes under entrances is 9".

4. Crushing strength (pounds per linear foot ultimate strength) per ASTM C76:
   - 3000 lbs for Class IV pipe
   - 3750 lbs for Class V pipe

5. For height of cover greater than that shown for Class V, a special design concrete pipe is required.

6. Nonreinforced pipe to be used only under entrances and lower functional classification (LFC) roadways (see Sheet 17 of 18).

7. See standard PB-1 for pipe bedding and backfill requirements.

8. Pipe with less than the standard minimum cover is to be minimum class III reinforced.

### Height of Cover Table for HL-93 Live Load

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Area</th>
<th>Maximum Height of Cover in Feet</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.8</td>
<td>14' (1800)</td>
<td>14'</td>
</tr>
<tr>
<td>15</td>
<td>1.2</td>
<td>14' (2125)</td>
<td>14'</td>
</tr>
<tr>
<td>18</td>
<td>1.8</td>
<td>14' (2400)</td>
<td>14'</td>
</tr>
<tr>
<td>21</td>
<td>2.4</td>
<td>13' (2700)</td>
<td>13'</td>
</tr>
<tr>
<td>24</td>
<td>3.1</td>
<td>13' (3000)</td>
<td>13'</td>
</tr>
<tr>
<td>27</td>
<td>4.0</td>
<td>14' (2125)</td>
<td>14'</td>
</tr>
<tr>
<td>30</td>
<td>4.9</td>
<td>14' (2400)</td>
<td>14'</td>
</tr>
<tr>
<td>33</td>
<td>5.9</td>
<td>14' (2700)</td>
<td>14'</td>
</tr>
<tr>
<td>36</td>
<td>7.1</td>
<td>14' (3000)</td>
<td>14'</td>
</tr>
<tr>
<td>42</td>
<td>9.6</td>
<td>13' (3000)</td>
<td>13'</td>
</tr>
<tr>
<td>48</td>
<td>12.6</td>
<td>13' (3300)</td>
<td>13'</td>
</tr>
<tr>
<td>54</td>
<td>15.9</td>
<td>12' (3600)</td>
<td>12'</td>
</tr>
<tr>
<td>60</td>
<td>19.6</td>
<td>12' (3900)</td>
<td>12'</td>
</tr>
<tr>
<td>66</td>
<td>23.8</td>
<td>12' (4200)</td>
<td>12'</td>
</tr>
<tr>
<td>72</td>
<td>28.3</td>
<td>12' (4500)</td>
<td>12'</td>
</tr>
<tr>
<td>78</td>
<td>33.2</td>
<td>12' (4800)</td>
<td>12'</td>
</tr>
<tr>
<td>84</td>
<td>38.5</td>
<td>12' (5100)</td>
<td>12'</td>
</tr>
<tr>
<td>90</td>
<td>44.4</td>
<td>12' (5400)</td>
<td>12'</td>
</tr>
<tr>
<td>96</td>
<td>50.3</td>
<td>12' (5700)</td>
<td>12'</td>
</tr>
<tr>
<td>102</td>
<td>56.7</td>
<td>12' (6000)</td>
<td>12'</td>
</tr>
<tr>
<td>108</td>
<td>63.6</td>
<td>12' (6300)</td>
<td>12'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Area</th>
<th>Maximum Height of Cover in Feet</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.8</td>
<td>14' (1800)</td>
<td>14'</td>
</tr>
<tr>
<td>15</td>
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</tr>
<tr>
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<td>4.0</td>
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<td>14'</td>
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<td>4.9</td>
<td>14' (2400)</td>
<td>14'</td>
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<td>7.1</td>
<td>14' (3000)</td>
<td>14'</td>
</tr>
<tr>
<td>42</td>
<td>9.6</td>
<td>13' (3000)</td>
<td>13'</td>
</tr>
<tr>
<td>48</td>
<td>12.6</td>
<td>13' (3300)</td>
<td>13'</td>
</tr>
<tr>
<td>54</td>
<td>15.9</td>
<td>12' (3600)</td>
<td>12'</td>
</tr>
<tr>
<td>60</td>
<td>19.6</td>
<td>12' (3900)</td>
<td>12'</td>
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<tr>
<td>66</td>
<td>23.8</td>
<td>12' (4200)</td>
<td>12'</td>
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<td>72</td>
<td>28.3</td>
<td>12' (4500)</td>
<td>12'</td>
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<tr>
<td>78</td>
<td>33.2</td>
<td>12' (4800)</td>
<td>12'</td>
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<tr>
<td>84</td>
<td>38.5</td>
<td>12' (5100)</td>
<td>12'</td>
</tr>
<tr>
<td>90</td>
<td>44.4</td>
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<td>12'</td>
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<tr>
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<td>50.3</td>
<td>12' (5700)</td>
<td>12'</td>
</tr>
<tr>
<td>102</td>
<td>56.7</td>
<td>12' (6000)</td>
<td>12'</td>
</tr>
<tr>
<td>108</td>
<td>63.6</td>
<td>12' (6300)</td>
<td>12'</td>
</tr>
</tbody>
</table>
## Height of Cover Tables for HL-93 Live Load

### Reinforced Elliptical Concrete Pipe

**Horizontal Installation**

<table>
<thead>
<tr>
<th>Equivalent Round Size Inches</th>
<th>Span x Rise Inches</th>
<th>Max. Height of Cover in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HE - III</td>
</tr>
<tr>
<td>18</td>
<td>23 x 14</td>
<td>13'</td>
</tr>
<tr>
<td>24</td>
<td>30 x 19</td>
<td>13'</td>
</tr>
<tr>
<td>27</td>
<td>34 x 22</td>
<td>13'</td>
</tr>
<tr>
<td>30</td>
<td>38 x 24</td>
<td>13'</td>
</tr>
<tr>
<td>33</td>
<td>42 x 27</td>
<td>13'</td>
</tr>
<tr>
<td>36</td>
<td>45 x 29</td>
<td>13'</td>
</tr>
<tr>
<td>39</td>
<td>49 x 32</td>
<td>13'</td>
</tr>
<tr>
<td>42</td>
<td>53 x 34</td>
<td>13'</td>
</tr>
<tr>
<td>48</td>
<td>60 x 38</td>
<td>13'</td>
</tr>
<tr>
<td>54</td>
<td>68 x 43</td>
<td>13'</td>
</tr>
<tr>
<td>60</td>
<td>76 x 48</td>
<td>13'</td>
</tr>
<tr>
<td>66</td>
<td>83 x 53</td>
<td>13'</td>
</tr>
<tr>
<td>72</td>
<td>91 x 58</td>
<td>13'</td>
</tr>
<tr>
<td>78</td>
<td>98 x 63</td>
<td>13'</td>
</tr>
<tr>
<td>84</td>
<td>106 x 68</td>
<td>13'</td>
</tr>
</tbody>
</table>

**Vertical Installation**

<table>
<thead>
<tr>
<th>Span x Rise Inches</th>
<th>Max. Height of Cover in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HE - III</td>
</tr>
<tr>
<td>29 x 45</td>
<td>13</td>
</tr>
<tr>
<td>32 x 49</td>
<td>13</td>
</tr>
<tr>
<td>34 x 53</td>
<td>13</td>
</tr>
<tr>
<td>38 x 60</td>
<td>13</td>
</tr>
<tr>
<td>43 x 68</td>
<td>13</td>
</tr>
<tr>
<td>48 x 76</td>
<td>13</td>
</tr>
<tr>
<td>53 x 83</td>
<td>13</td>
</tr>
<tr>
<td>58 x 91</td>
<td>13</td>
</tr>
<tr>
<td>63 x 98</td>
<td>13</td>
</tr>
<tr>
<td>68 x 106</td>
<td>13</td>
</tr>
</tbody>
</table>

### Notes:

1. Cover heights indicated in tables are for finished construction. The cover heights were retained to match former cover heights based on allowable stress design. Cover heights were not recalculated using LRFD.

2. To protect pipe during construction, minimum heights of cover prior to allowing construction traffic to cross installation are to be 1/2 span or 3', whichever is greater. The cover shall extend the full length of the pipe. The approach fill ramp is to extend a minimum of 10'(span + 36") on each side of the pipe or to the intersection with a cut.

3. Standard minimum finished height of cover for all pipes shall be 2.0' or 1/2 span, whichever is greater. In cases in which these cover heights cannot be achieved, an absolute minimum finished cover height of 1.0' will be allowed only if all possible means to obtain the standard value have been exhausted. Minimum finished height of cover for pipe under entrances is 9".

4. See Standard PB-1 for pipe bedding and backfill requirements.
NOTE:
1. COVER HEIGHTS INDICATED IN TABLES ARE FOR FINISHED CONSTRUCTION, USING AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS AND ASSUMING 25% METAL LOSS AT END OF DESIGN LIFE.
2. TO PROTECT PIPE DURING CONSTRUCTION, MINIMUM HEIGHT OF COVER TO BE IN ACCORDANCE WITH TABLE PRIOR TO ALLOWING CONSTRUCTION TRAFFIC TO CROSS INSTALLATION. THE COVER SHALL EXTEND THE FULL LENGTH OF THE PIPE. THE APPROACH FILL RAMP & TO EXTEND A MINIMUM OF 15 DIAMETERS ON EACH SIDE OF THE PIPE OR THE INTERSECTION WITH A CUT.
3. STANDARD MINIMUM FINISHED HEIGHT OF COVER FOR ALL PIPES, EXCEPT UNDER ENTRANCES, SHALL BE 2 2/3" OR 1/2" DIAMETER, WHICHER IS GREATER, WILL BE ALLOWED ONLY IF ALL POSSIBLE MEANS TO OBTAIN THE STANDARD VALUE HAVE BEEN EXHAUSTED. THE MINIMUM FINISHED HEIGHT OF COVER FOR PIPES UNDER ENTRANCES IS 9" FOR PIPE DIAMETERS LESS THAN OR EQUAL TO 24" AND 12" OR 1/2" DIAMETER, WHICHER IS GREATER, FOR PIPE DIAMETERS GREATER THAN 24", WHERE A POLYMER COATED PIPE WILL BE USED AND THE SURFACE OVER THE TOP OF THE PIPE WILL BE ASPHALT, CLASS I BACKFILL MATERIAL IS TO BE PLACED UP TO A MINIMUM OF 6" ABOVE THE TOP OF THE PIPE.
4. SEE STANDARD PB-1 FOR PIPE BEDDING AND BACKFILL REQUIREMENTS.
### Table A: Corrugated Aluminum Alloy Pipe - 3" x 1" Corrugations

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Area SQ. FT.</th>
<th>Maximum Height of Cover in Feet</th>
<th>Minimum Sheet Thickness for Entrance Pipes with Less Than 1 FT. Cover (Gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>0.8</td>
<td>141 176 247 318 389 16</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1.2</td>
<td>112 141 197 254 311 16</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>1.8</td>
<td>93 117 164 212 259 16</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>2.4</td>
<td>80 100 140 181 221 16</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>3.1</td>
<td>69 87 123 158 193 16</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>4.0</td>
<td>77 109 140 172 14</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>4.9</td>
<td>69 98 126 154 14</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>5.9</td>
<td>63 88 114 140 14</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>7.1</td>
<td>57 81 105 128 14</td>
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</tr>
<tr>
<td>42</td>
<td>9.6</td>
<td>69 89 109 109 12</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>12.6</td>
<td>60 78 95 12</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>15.9</td>
<td>53 69 84 12</td>
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<td>60</td>
<td>19.6</td>
<td>61 75 10</td>
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<tr>
<td>66</td>
<td>23.8</td>
<td>68 8</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>28.3</td>
<td>62 8</td>
<td></td>
</tr>
</tbody>
</table>

### Notes:
1. Cover heights indicated in tables are for finished construction, using AASHTO LRFD Bridge Design Specifications and assuming 25% metal loss at end of design life.
2. To protect pipe during construction, minimum height of cover to be in accordance with Table A prior to allowing construction traffic to cross installation. The cover shall extend the full length of the pipe. The approach fill ramp is to extend a minimum of 20 diameters on each side of the pipe or the intersection with a cut.
3. Standard minimum finished height of cover for all pipes, except those under entrances, shall be 2.0' or ½ diameter, whichever is greater. In cases in which these cover heights cannot be achieved, an absolute minimum finished cover height of 1.0' or ½ diameter, whichever is greater, will be allowed only if all possible means to obtain the standard value have been exhausted. The minimum finished height of cover for pipes under entrances is 0' for pipe diameters equal to or less than 18" and 12" or ½ diameter, whichever is greater, for pipe diameters greater than 18'.
4. See standard PB-1 for pipe bedding and backfill requirements.
### MINIMUM SHEET THICKNESS AND DESIGN DATA

<table>
<thead>
<tr>
<th>PIPE ARCH DIMENSION</th>
<th>NOMINAL SIZE SPAN - RISE INCHES</th>
<th>EQUIVALENT PIPE DIAMETER INCHES</th>
<th>AREA SQ. FT.</th>
<th>B INCHES</th>
<th>Rc INCHES</th>
<th>MINIMUM SHEET THICKNESS REQUIRED INCHES (GAUGE)</th>
<th>MAXIMUM COVER HEIGHT N FEET</th>
<th>MAXIMUM CORNER PRESSURE</th>
<th>MINIMUM SHEET THICKNESS FOR EACH SIDE OF THE PIPE, OR TO THE INTERSECTION WITH A CUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 x 13</td>
<td>15</td>
<td>1.1</td>
<td>5¼</td>
<td>3</td>
<td>0.064 (16)</td>
<td>11</td>
<td>17</td>
<td>2</td>
<td>2/3&quot; x 1½&quot; CORRUGATIONS</td>
</tr>
<tr>
<td>21 x 15</td>
<td>18</td>
<td>1.6</td>
<td>6</td>
<td>3</td>
<td>0.064 (16)</td>
<td>9</td>
<td>14</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>24 x 18</td>
<td>21</td>
<td>2.2</td>
<td>7¼</td>
<td>3</td>
<td>0.064 (16)</td>
<td>8</td>
<td>12</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>28 x 20</td>
<td>24</td>
<td>2.8</td>
<td>8</td>
<td>3</td>
<td>0.064 (16)</td>
<td>7</td>
<td>10</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>35 x 24</td>
<td>30</td>
<td>4.4</td>
<td>9½</td>
<td>3</td>
<td>0.064 (16)</td>
<td>5</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>42 x 29</td>
<td>36</td>
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<td>3½</td>
<td>0.064 (16)</td>
<td>5</td>
<td>8</td>
<td>2</td>
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<td>49 x 33</td>
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<td>2</td>
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<td>57 x 38</td>
<td>48</td>
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<td>13½</td>
<td>5</td>
<td>0.109 (12)</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>64 x 43</td>
<td>54</td>
<td>14.3</td>
<td>15</td>
<td>6</td>
<td>0.109 (12)</td>
<td>6</td>
<td>9</td>
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</tr>
<tr>
<td>71 x 47</td>
<td>60</td>
<td>17.6</td>
<td>16½</td>
<td>7</td>
<td>0.138 (10)</td>
<td>6</td>
<td>9</td>
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<td>77 x 52</td>
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<td>8</td>
<td>0.168 (8)</td>
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<td></td>
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<td>25.3</td>
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<td>9</td>
<td>0.168 (8)</td>
<td>7</td>
<td>10</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

#### 3" x 1" AND 5" x 1" CORRUGATIONS

<table>
<thead>
<tr>
<th>NOMINAL SIZE SPAN - RISE INCHES</th>
<th>4.0 x 4.0</th>
<th>4.5 x 4.5</th>
<th>5.0 x 5.0</th>
<th>5.5 x 5.5</th>
<th>6.0 x 6.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>EQUIVALENT PIPE DIAMETER INCHES</td>
<td>18.0</td>
<td>19.5</td>
<td>21.0</td>
<td>22.5</td>
<td>24.0</td>
</tr>
<tr>
<td>AREA SQ. FT.</td>
<td>6.0</td>
<td>6.8</td>
<td>7.6</td>
<td>8.4</td>
<td>9.2</td>
</tr>
<tr>
<td>B INCHES</td>
<td>2½</td>
<td>2¾</td>
<td>3¼</td>
<td>3½</td>
<td>4¼</td>
</tr>
<tr>
<td>Rc INCHES</td>
<td>3</td>
<td>3½</td>
<td>4</td>
<td>4½</td>
<td>5</td>
</tr>
<tr>
<td>MINIMUM SHEET THICKNESS REQUIRED INCHES (GAUGE)</td>
<td>0.109 (12)</td>
<td>0.109 (12)</td>
<td>0.109 (12)</td>
<td>0.109 (12)</td>
<td>0.109 (12)</td>
</tr>
<tr>
<td>MAXIMUM COVER HEIGHT N FEET</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>MAXIMUM CORNER PRESSURE</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>MINIMUM SHEET THICKNESS FOR EACH SIDE OF THE PIPE, OR TO THE INTERSECTION WITH A CUT</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

### NOTES:

1. COVER HEIGHTS INDICATED IN TABLES ARE FOR FINISHED CONSTRUCTION. HOCUS Pocus VDOT ALLOWABLE STRESS DESIGN TABLES. COVER HEIGHTS WERE NOT recalculated using LRFD.

2. TO PROTECT PIPE DURING CONSTRUCTION, MINIMUM HEIGHT OF COVER TO BE IN ACCORDANCE WITH TABLE A PRIOR TO ALLOWING CONSTRUCTION TRAFFIC TO CROSST. INSTALLATION. THE COVER SHALL EXTEND THE FULL LENGTH OF THE PIPE ARCH. THE APPROACH FILL RAMP IS TO EXTEND A MINIMUM OF 10" HEIGHT + ½" SPAN ON EACH SIDE OF THE PIPE, OR TO THE INTERSECTION WITH A CUT.

3. STANDARD MINIMUM FINISHED HEIGHT OF COVER FOR ALL PIPE SHALL BE 20" OR ½" SPAN, WHICHER IS GREATER. IN CASES IN WHICH THESE COVER HEIGHTS CANNOT BE ACHIEVED, AN ABSOLUTE MINIMUM FINISHED COVER HEIGHT OF 10" OR ½" SPAN, WHICHER IS GREATER, WILL BE ALLOWED ONLY IF ALL POSSIBLE MEANS TO OBTAIN THE STANDARD VALUE HAVE BEEN EXHAUSTED. WHERE POLYMER COATED PIPE WILL BE USED AND THE SURFACE OVER THE TOP OF THE PIPE WILL BE ASPHALT, CLASS 1 BACKFILL MATERIAL IS TO BE PLACED UP TO A MINIMUM OF 6" ABOVE THE TOP OF THE PIPE.

4. SEE STANDARD PB-1 FOR PIPE BEDDING AND BACKFILL REQUIREMENTS.

5. THE MAXIMUM HEIGHT OF COVER SHOWN IN THE TABLES IS BASED ON A SOIL MODULUS OF 700 PSI. ALL OTHER DESIGN CRITERIA ARE IN ACCORDANCE WITH THE AASHTO SPECIFICATIONS AND VDOT MODIFICATIONS FOR SOIL CORRUGATED METAL STRUCTURE INTERACTION SYSTEMS.

6. WHEN DESIGN HEIGHT OF COVER REQUIRES THE USE OF THIS CATEGORY OF PIPE, FOUNDATION AND BACKFILL MUST BE APPROVED BY THE ENGINEER.

7. SPAN OF PIPE ARCHES IS MEASURED "B" INCHES ABOVE THE INVERT. SEE DIAGRAM BELOW FOR ILLUSTRATION OF "B" DIMENSION.

### TABLE A

<table>
<thead>
<tr>
<th>PIPE ARCH SPAN</th>
<th>MINIMUM COVER HEIGHT DURING CONSTRUCTION (SEE NOTE 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17&quot; TO 35&quot;</td>
<td>18&quot;</td>
</tr>
<tr>
<td>42&quot; AND ABOVE</td>
<td>½ SPAN</td>
</tr>
</tbody>
</table>

---

**CORRUGATED STEEL PIPE ARCH**

**HEIGHT OF COVER TABLE FOR HL-93 LIVE LOAD**

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**REVISION DATE**

07/16

**SPECIFICATION REFERENCE**

232

302
### MINIMUM SHEET THICKNESS AND DESIGN DATA

<table>
<thead>
<tr>
<th>NOMINAL SIZE SPAN-RISE INCHES</th>
<th>PIPE ARCH DIMENSION</th>
<th>AREA SQ. FT.</th>
<th>B INCHES (SEE NOTE 9)</th>
<th>Rc INCHES</th>
<th>MINIMUM SHEET THICKNESS REQUIRED INCHES (GAUGE)</th>
<th>MAXIMUM COVER HEIGHT IN FEET</th>
<th>MAXIMUM CORNER PRESSURE 4000 LBS./SQ. FT.</th>
<th>6000 LBS./SQ. FT. (SEE NOTE 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 x 13</td>
<td>15</td>
<td>1.1</td>
<td>4 3/8</td>
<td>3</td>
<td>0.060 (16)</td>
<td>11</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>21 x 15</td>
<td>18</td>
<td>1.6</td>
<td>4 3/8</td>
<td>3</td>
<td>0.060 (16)</td>
<td>9</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>24 x 18</td>
<td>21</td>
<td>2.2</td>
<td>5 3/8</td>
<td>3</td>
<td>0.060 (16)</td>
<td>8</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>28 x 20</td>
<td>24</td>
<td>2.8</td>
<td>6 3/8</td>
<td>3</td>
<td>0.075 (14)</td>
<td>7</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>35 x 24</td>
<td>30</td>
<td>4.4</td>
<td>8 3/8</td>
<td>3</td>
<td>0.075 (14)</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>42 x 29</td>
<td>36</td>
<td>6.4</td>
<td>9 3/8</td>
<td>3 1/2</td>
<td>0.105 (12)</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>49 x 33</td>
<td>42</td>
<td>8.7</td>
<td>11 3/8</td>
<td>4</td>
<td>0.105 (12)</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>57 x 38</td>
<td>48</td>
<td>11.4</td>
<td>13 3/8</td>
<td>5</td>
<td>0.135 (10)</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>64 x 43</td>
<td>54</td>
<td>14.3</td>
<td>14 3/8</td>
<td>6</td>
<td>0.135 (10)</td>
<td>6</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>71 x 47</td>
<td>60</td>
<td>17.6</td>
<td>16 3/8</td>
<td>7</td>
<td>0.164 (8)</td>
<td>6</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>40 x 31</td>
<td>36</td>
<td>6.4</td>
<td>—</td>
<td>5</td>
<td>0.060 (16)</td>
<td>8</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>46 x 36</td>
<td>42</td>
<td>8.7</td>
<td>—</td>
<td>6</td>
<td>0.060 (16)</td>
<td>8</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>53 x 41</td>
<td>48</td>
<td>11.4</td>
<td>15 3/8</td>
<td>7</td>
<td>0.060 (16)</td>
<td>8</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>60 x 46</td>
<td>54</td>
<td>14.3</td>
<td>20 3/8</td>
<td>8</td>
<td>0.075 (14)</td>
<td>8</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>66 x 51</td>
<td>60</td>
<td>17.6</td>
<td>22 3/8</td>
<td>9</td>
<td>0.075 (14)</td>
<td>8</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>73 x 55</td>
<td>66</td>
<td>22.0</td>
<td>25 3/8</td>
<td>12</td>
<td>0.105 (12)</td>
<td>11</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>81 x 59</td>
<td>72</td>
<td>25.0</td>
<td>23 3/8</td>
<td>14</td>
<td>0.105 (12)</td>
<td>11</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>87 x 63</td>
<td>78</td>
<td>31.0</td>
<td>25 3/8</td>
<td>14</td>
<td>0.135 (10)</td>
<td>10</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>95 x 67</td>
<td>84</td>
<td>35.0</td>
<td>27 3/8</td>
<td>16</td>
<td>0.135 (10)</td>
<td>11</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>103 x 71</td>
<td>90</td>
<td>40.0</td>
<td>29 3/8</td>
<td>16</td>
<td>0.164 (8)</td>
<td>10</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>112 x 75</td>
<td>96</td>
<td>46.0</td>
<td>31 3/8</td>
<td>18</td>
<td>0.164 (8)</td>
<td>10</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>117 x 79</td>
<td>102</td>
<td>52.0</td>
<td>33 3/8</td>
<td>18</td>
<td>0.164 (8)</td>
<td>10</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

*Indicates pipe arches for which dimensions for either corrugation may be used within height of cover limitations.

### NOTES:

1. Cover heights indicated in tables are for finished construction which match former VDOT allowable stress design tables. Cover heights were not recalculated using LRFD.

2. To protect pipe during construction, minimum height of cover to be in accordance with table A prior to allowing construction traffic to cross installation. The cover shall extend the full length of the pipe arch. The approach fill ramp is to extend a minimum of 10 (height + 1/2 span) on each side of the structure or to the intersection with a cut.

3. Standard minimum finished height of cover for all pipes shall be 20" or 1/2 span, whichever is greater. In cases in which these cover heights cannot be achieved, an absolute minimum finished cover height of 1'0" or 1/2 span, whichever is greater, will be allowed only if all possible means to obtain the standard value have been exhausted.

4. See Standard PB-1 for pipe bedding and backfill requirements.

5. The maximum height of cover shown in the tables is based on a soil modulus of 700 psi. All other design criteria are in accordance with the AASHTO specifications and VDOT modifications for soil corrugated metal structure interaction systems.

6. When design height of cover requires the use of this category of pipe bedding foundation and backfill must be approved by the engineer.

7. Lapped longitudinal seams shall be staggered so as to alternate on each side of the center of arch top by approximately 15 percent of the periphery.

8. A tolerance of plus, or minus, 1" is permissible for dimensions of span, rise, and corner radius.

9. Span of pipe arches is measured "B" inches above the invert. See diagram below for illustration of "B" dimension.

### Table A

<table>
<thead>
<tr>
<th>PIPE DIAMETER</th>
<th>MINIMUM COVER HEIGHT DURING CONSTRUCTION (SEE NOTE 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17&quot; to 35&quot;</td>
<td>18&quot;</td>
</tr>
<tr>
<td>42&quot; and ABOVE</td>
<td>1/2 SPAN</td>
</tr>
</tbody>
</table>

### Diagram

![Diagram of pipe arch dimensions and cover limitations.](image-url)
### Structural Plate Steel Pipe - 6" x 2" Corrugations

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Area</th>
<th>Maximum Height of Cover in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sheet Thickness in Inches (Gauge)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.11 (12)</td>
</tr>
<tr>
<td>60</td>
<td>20</td>
<td>91</td>
</tr>
<tr>
<td>66</td>
<td>24</td>
<td>83</td>
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<td>64</td>
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<td>90</td>
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<td>114</td>
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<td>156</td>
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<td>192</td>
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<td>284</td>
<td>31</td>
</tr>
<tr>
<td>240</td>
<td>314</td>
<td>34</td>
</tr>
</tbody>
</table>

### Notes:
1. Cover heights indicated in Table are for finished construction, using AASHTO LRFD Bridge Design Specifications and assuming 25% metal loss at end of design life.
2. To protect pipe during construction minimum height of cover prior to allowing construction traffic to cross installation is to be 1/2 diameter. This cover shall extend the full length of the pipe. The approach fill ramp is to extend a minimum of 10 (Diameter + 36") on each side of the pipe or to the intersection with a cut.
3. Standard minimum finished height of cover for all pipes shall be 2.0 or 1.0 diameter, whichever is greater. In cases in which these cover heights cannot be achieved, an absolute minimum finished cover height of 1.0 or 1.0 diameter will be allowed only if all possible means to obtain the standard value have been exhausted.
4. Structural plate pipe dimensions are to inside crest and are subject to manufacturing tolerances.
5. See Standard PB-1 for bedding and backfill requirements.
NOTES:
1. COVER HEIGHTS INDICATED IN TABLE ARE FOR FINISHED CONSTRUCTION, USING AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS AND ASSUMING 25% METAL LOSS AT END OF DESIGN LIFE.
2. TO PROTECT PIPE DURING CONSTRUCTION, MINIMUM HEIGHT OF COVER PRIOR TO ALLOWING CONSTRUCTION TRAFFIC TO CROSS INSTALLATION SHALL BE 1/2 DIAMETER. THIS COVER SHALL EXTEND THE FULL LENGTH OF THE PIPE. THE APPROACH FILL RAMP IS TO EXTEND A MINIMUM OF 10(DIAMETER 36") ON EACH SIDE OF THE PIPE OR TO THE INTERSECTION WITH A CUT.
3. STANDARD MINIMUM FINISHED HEIGHT OF COVER FOR ALL PIPES SHALL BE 2.0' OR 1/2 DIAMETER, WHICHER IS GREATER. IN CASES IN WHICH THESE COVER HEIGHTS CANNOT BE ACHIEVED, AND ABSOLUTE MINIMUM FINISHED COVER HEIGHT OF 1.0' OR 1/4 DIAMETER, WHICHER IS GREATER, WILL BE ALLOWED ONLY IF ALL POSSIBLE MEANS TO OBTAIN THE STANDARD VALUE HAVE BEEN EXHAUSTED.
4. SEE STANDARD PB-1 FOR PIPE BEDDING AND BACKFILL REQUIREMENTS.
5. STEEL BOLTS ONLY TO BE USED. BOLTS ARE 3/4" DIAMETER HIGH STRENGTH TO MEET CURRENT AASHTO DESIGNATION M-164 AND GALVANIZED TO MEET CURRENT ASTM DESIGNATION A-394. BOLTS ARE TO BE LOCATED IN THE VALLEY AND CREST OF EACH CORRUGATION IN DOUBLE ROWS SPACED 1½" APART.

### TABLE: STRUCTURAL PLATE ALUMINUM ALLOY PIPE

<table>
<thead>
<tr>
<th>PIPE DIAMETER</th>
<th>AREA SQ. FT.</th>
<th>MAXIMUM HEIGHT OF COVER IN FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SHEET THICKNESS IN INCHES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>60</td>
<td>20</td>
<td>59</td>
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<td>66</td>
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<td>114</td>
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<td>120</td>
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<td>144</td>
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<td>156</td>
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<tr>
<td>228</td>
<td>284</td>
<td>33</td>
</tr>
</tbody>
</table>
### Minimum Thickness—Structural Plate Steel Pipe Arches

#### 6" x 2" Corrugations

<table>
<thead>
<tr>
<th>Span Width</th>
<th>Nominal Size</th>
<th>B (inches)</th>
<th>Rise (inches)</th>
<th>Minimum Sheet Thickness (inches)</th>
<th>Minimum Sheet Thickness Required</th>
<th>Maximum Allowable Cover Height in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>6'-1&quot;</td>
<td>4'-7'</td>
<td>22</td>
<td>21.0</td>
<td>18</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>6'-4&quot;</td>
<td>4'-9&quot;</td>
<td>24</td>
<td>20.5</td>
<td>18</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>6'-9&quot;</td>
<td>4'-11&quot;</td>
<td>26</td>
<td>22.0</td>
<td>18</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>7'-0&quot;</td>
<td>5'-1&quot;</td>
<td>28</td>
<td>21.4</td>
<td>18</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>7'-3&quot;</td>
<td>5'-3&quot;</td>
<td>31</td>
<td>20.8</td>
<td>18</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>7'-8&quot;</td>
<td>5'-5&quot;</td>
<td>33</td>
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### Notes:

1. Cover heights indicated in tables are for finished construction which match former VDOT allowable stress design tables. Cover heights were not recalculated using LRFD.

2. To protect pipe during construction, minimum height of cover prior to allowing construction traffic to cross installation shall be 1/2 span. The cover shall extend the full length of the pipe arch. The approach fill ramp is to extend a minimum of 10 ft (height + 1/2 span) on each side of the structure, or to the intersection with a cut.

3. Standard minimum finished height of cover for all pipes shall be 2.0' or 1/2 span, whichever is greater. In cases in which these cover heights cannot be achieved, an absolute minimum finished cover height of 1.0' or 1/4 span, whichever is greater, will be allowed only if all possible means to obtain the standard value have been exhausted.

4. See standard PB-1 for pipe bedding and backfill requirements.

5. The maximum height of cover shown in the tables is based on a soil modulus of 700 psi. All other design criteria are in accordance with the AASHTO specifications and VDOT modifications for soil corrugated metal structure interaction systems.

6. When design height of cover requires the use of this category of pipe, bedding and backfill must be approved by the engineer.

7. Structural plate pipe-arch dimensions are to inside of crest and are subject to manufacturing tolerances.

8. Span of pipe arches is measured 9" inches above the invert. See diagram below for illustration of "B" dimension.
### Minimum Thickness - Structural Plate Steel Pipe Arches

#### 6" x 2" Corrugations

<table>
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<tr>
<th>Span (ft)</th>
<th>Rise (in)</th>
<th>Area (sq. ft)</th>
<th>B (inches)</th>
<th>Rc (inches)</th>
<th>Minimum Sheet Thickness Required (Gauge)</th>
<th>Maximum Allowable Cover Height in Feet (4000 Lbs./sq. ft.)</th>
<th>Maximum Corner Pressure (6000 Lbs./sq. ft.)</th>
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* (See Note 6)

#### Notes:
1. Cover heights indicated in tables are for finished construction which match former VDOT allowable stress design tables. Cover heights were not recalculated using LRFD.
2. To protect pipe during construction, minimum height of cover prior to allowing construction traffic to cross installation shall be 1/2 span. The cover shall extend the full length of the pipe arch. The approach fill ramp is to extend a minimum of (1/2 height + 1/2 span) on each side of the structure or to the intersection with a cut.
3. Standard minimum finished height of cover for all pipes shall be 1/4 span. In cases in which this cover height cannot be achieved, an absolute minimum finished cover height of 1/4 span will be allowed only if all possible means to obtain the standard value have been exhausted.
4. See Standard PB-1 for pipe bedding and backfill requirements.
5. Structural plate pipe-arch dimensions are to inside of crest and are subject to manufacturing tolerances.
6. When design height of cover requires the use of this category or pipe, bedding and backfill must be approved by the engineer.
7. The maximum height of cover shown in the tables is based on a soil modulus of 700 psi. All other design criteria are in accordance with the AASHTO specifications and VDOT modifications for soil corrugated metal structure interaction systems.
8. Span of pipe arches is measured "B" inches above the invert (See diagram below for illustration of "B" dimension).

#### Structural Plate Steel Pipe Arch

**Height of Cover Table for HL-93 Live Load**

[Diagram of a pipe arch with labels for R, B, and Rc]
### Structural Plate Aluminum Alloy Pipe Arches

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<th>RISE</th>
<th>CORNER RADIUS (INCHES)</th>
<th>AREA</th>
<th>MAXIMUM COVER HEIGHT IN FEET</th>
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**NOTES:**

1. COVER HEIGHTS INDICATED IN TABLES ARE FOR FINISHED CONSTRUCTION WHICH MATCH FORMER VDOT ALLOWABLE STRESS DESIGN TABLES. COVER HEIGHTS WERE NOT RE-CALCULATED USING LFD.

2. TO PROTECT PIPE DURING CONSTRUCTION. MINIMUM HEIGHT OF COVER PRIOR TO ALLOWING CONSTRUCTION TRAFFIC TO CROSS INSTALLATION TO BE 1/2 SPAN. THE COVER SHALL EXTEND THE FULL LENGTH OF THE PIPE ARCH. THE APPROACH FILL RAMP IS TO EXTEND A MINIMUM OF TO 8" SPAN ON EACH SIDE OF THE PIPE, OR TO THE INTERSECTION WITH A CUT.

3. STANDARD MINIMUM FINISHED HEIGHT OF COVER FOR ALL PIPES SHALL BE 2.0" OR 1/2 SPAN, WHICHEVER IS GREATER. IN CASES IN WHICH THESE COVER HEIGHTS CANNOT BE ACHIEVED, AN ABSOLUTE MINIMUM FINISHED COVER HEIGHT OF 1.0" OR 1/2 SPAN, WHICHEVER IS GREATER, WILL BE ALLOWED ONLY IF ALL POSSIBLE MEANS TO OBTAIN THE STANDARD VALUE HAVE BEEN EXHAUSTED.

4. SEE STANDARD PB-1 FOR BEDDING AND BACKFILL REQUIREMENTS.

5. THE MAXIMUM HEIGHT OF COVER SHOWN IN THE TABLES IS BASED ON A SOIL MODULUS OF 700 psi. ALL OTHER DESIGN CRITERIA ARE IN ACCORDANCE WITH THE ASHTO SPECIFICATIONS AND VDOT MODIFICATIONS FOR SOIL CORRUGATED METAL STRUCTURE INTERACTION SYSTEMS.

6. WHEN DESIGN HEIGHT OF COVER REQUIRES THE USE OF THIS CATEGORY OF PIPE, BEDDING AND BACKFILL MUST BE APPROVED BY THE ENGINEER.

7. BOLTS ARE 1/2" DIAMETER, HIGH STRENGTH TO MEET CURRENT A.S.T.M. DESIGNATION M-164 AND GALVANIZED TO MEET CURRENT A.S.T.M. DESIGNATION A-994. BOLTS ARE TO BE LOCATED IN THE VALLEY AND CREST OF EACH CORRUGATION IN DOUBLE ROWS SPACED 1 1/4" APART.

8. STRUCTURAL PLATE PIPE-ARCH DIMENSIONS ARE TO INSIDE CREST AND ARE SUBJECT TO MANUFACTURING TOLERANCES.

9. SPAN OF PIPE ARCHES ARE INSIDE 9" INCHES ABOVE THE INVERT. SEE DIAGRAM BELOW FOR ILLUSTRATION OF "B" DIMENSION.
## ALUMINUM SPIRAL RIB PIPE 3/4" WIDE x 3/4" DEEP RIBS SPACED @ 7 1/2"

<table>
<thead>
<tr>
<th>PIPE DIAMETER INCHES</th>
<th>AREA SQ. FT.</th>
<th>MAXIMUM HEIGHT OF COVER IN FEET</th>
<th>SHEET THICKNESS IN INCHES (GAUGE)</th>
<th>MINIMUM SHEET THICKNESS FOR ENTRANCE PIPES WITH LESS THAN 1 FT. COVER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.06 (16)</td>
<td>0.075 (14)</td>
<td>0.105 (12)</td>
</tr>
<tr>
<td>12</td>
<td>0.8</td>
<td>75</td>
<td>103</td>
<td>166</td>
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<tr>
<td>15</td>
<td>1.2</td>
<td>59</td>
<td>82</td>
<td>133</td>
</tr>
<tr>
<td>18</td>
<td>1.8</td>
<td>49</td>
<td>68</td>
<td>110</td>
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<tr>
<td>21</td>
<td>2.4</td>
<td>42</td>
<td>58</td>
<td>94</td>
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<tr>
<td>24</td>
<td>3.1</td>
<td>36</td>
<td>50</td>
<td>82</td>
</tr>
<tr>
<td>27</td>
<td>4.0</td>
<td>32</td>
<td>44</td>
<td>73</td>
</tr>
<tr>
<td>30</td>
<td>4.9</td>
<td>28</td>
<td>40</td>
<td>65</td>
</tr>
<tr>
<td>36</td>
<td>7.1</td>
<td>23</td>
<td>33</td>
<td>54</td>
</tr>
<tr>
<td>42</td>
<td>9.6</td>
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<td>27</td>
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<td>48</td>
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<td>39</td>
</tr>
<tr>
<td>54</td>
<td>16.0</td>
<td>13</td>
<td>20</td>
<td>35</td>
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<tr>
<td>60</td>
<td>19.6</td>
<td>11</td>
<td>17</td>
<td>31</td>
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<tr>
<td>66</td>
<td>23.8</td>
<td>9</td>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td>72</td>
<td>28.3</td>
<td>7</td>
<td>13</td>
<td>25</td>
</tr>
</tbody>
</table>

### NOTES:

1. **Cover Heights Indicated in Table are for Finished Construction**, using AASHTO LRFD Bridge Design Specifications and assuming 25% Metal Loss at End of Design Life.

2. *To Protect Pipe During Construction, Minimum Height of Cover to be in Accordance with Table A Prior to Allowing Construction Traffic to Cross Installation. The Cover Shall Extend the Full Length of the Pipe. The Approach Fill Ramp is to Extend a Minimum of 20 Diameters on Each Side of the Pipe, or to the Intersection with a Cut.

3. **Minimum Finished Height of Cover for All Pipes, Excluding Those Under Entrances, Shall Be 20" or 1/2 Diameter, whichever is greater. In cases in which these cover heights cannot be achieved, an Absolute Minimum Finished Cover Height of 10" or 1/4 Diameter, whichever is greater, will be allowed only if all possible means to obtain the standard value have been exhausted. The Minimum Finished Height of Cover for Pipes Under Entrances is 9" for Pipe Diameters Less Than or Equal to 18" or 1/2 Diameter, whichever is greater, for Pipe Diameters Greater Than 18".

4. **See Standard PB-1 for Pipe Bedding and Backfill Requirements.**

### Table A

<table>
<thead>
<tr>
<th>PIPE DIAMETER</th>
<th>MINIMUM COVER HEIGHT DURING CONSTRUCTION (SEE NOTE 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot; TO 27&quot;</td>
<td>18&quot;</td>
</tr>
<tr>
<td>30&quot; AND OVER</td>
<td>EQUAL TO DIAMETER</td>
</tr>
</tbody>
</table>
# Steel Spiral Rib Pipe ¾" Wide x ⅜" Ribs Spaced @ 7½"

<table>
<thead>
<tr>
<th>Pipe Diameter Inches</th>
<th>Area Sq. Ft.</th>
<th>Maximum Height of Cover in Feet</th>
<th>Sheet Thickness in Inches (Gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.064 (16)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.079 (14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.109 (12)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.138 (10)</td>
</tr>
<tr>
<td>16</td>
<td>1.8</td>
<td>101</td>
<td>142</td>
</tr>
<tr>
<td>21</td>
<td>2.4</td>
<td>86</td>
<td>121</td>
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<tr>
<td>24</td>
<td>3.1</td>
<td>75</td>
<td>106</td>
</tr>
<tr>
<td>27</td>
<td>4.0</td>
<td>67</td>
<td>94</td>
</tr>
<tr>
<td>30</td>
<td>4.9</td>
<td>60</td>
<td>84</td>
</tr>
<tr>
<td>36</td>
<td>7.1</td>
<td>49</td>
<td>70</td>
</tr>
<tr>
<td>42</td>
<td>9.6</td>
<td>42</td>
<td>59</td>
</tr>
<tr>
<td>48</td>
<td>12.6</td>
<td>36</td>
<td>51</td>
</tr>
<tr>
<td>54</td>
<td>16.0</td>
<td>45</td>
<td>77</td>
</tr>
<tr>
<td>60</td>
<td>19.6</td>
<td>40</td>
<td>69</td>
</tr>
<tr>
<td>66</td>
<td>23.8</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>72</td>
<td>28.3</td>
<td>57</td>
<td>84</td>
</tr>
<tr>
<td>78</td>
<td>33.2</td>
<td>52</td>
<td>77</td>
</tr>
<tr>
<td>84</td>
<td>38.6</td>
<td></td>
<td>71</td>
</tr>
<tr>
<td>90</td>
<td>44.17</td>
<td></td>
<td>66</td>
</tr>
</tbody>
</table>

## Notes:

1. Cover heights indicated in Table are for finished construction, using AASHTO LRFD Bridge Design Specifications and assuming 25% metal loss at end of design life.

2. To protect pipe during construction, minimum height of cover to be in accordance with Table A prior to allowing construction traffic to cross installation. The cover shall extend the full length of the pipe. The approach fill is to extend a minimum of 15 diameters on each side of the pipe or to the intersection with the cut.

3. Minimum finished height of cover for all pipes, except those under entrances, shall be 2.0" or ¾" diameter, whichever is greater. In cases in which these cover heights cannot be achieved, an absolute minimum finished cover height of 10" or ¾" diameter, whichever is greater, will be allowed only if all possible means to obtain the standard value have been exhausted. The minimum finished height of cover for pipes under entrances is 9" for pipe diameters less than or equal to 24" and 12" or ¾" diameter, whichever is greater, for pipe diameters greater than 24", where polymer coated pipe will be used and the surface over the top of the pipe will be asphalt, class I backfill material is to be placed up to a minimum of 6" above the top of the pipe.

4. See Standard PB-1 for pipe bedding and backfill requirements.

5. A maximum height of cover table for Steel Spiral Rib with ¾" wide x ⅜" deep ribs spaced at 1½" is available upon request.

## Table A

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Minimum Cover Height During Construction (See Note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot; to 30&quot;</td>
<td>18&quot;</td>
</tr>
<tr>
<td>36&quot; and Above</td>
<td>⅜&quot; Diameter</td>
</tr>
</tbody>
</table>

---

**STEEL SPIRAL RIB PIPE**

**HEIGHT OF COVER TABLE FOR HL-93 LIVE LOAD**

Virginia Department of Transportation

A copy of the original sealed and signed standard drawing is on file in the central office.
CAST IRON PIPE CULVERT DESIGNATION

<table>
<thead>
<tr>
<th>DIAMETER INCHES</th>
<th>AREA SQ. FT.</th>
<th>MAXIMUM HEIGHT OF COVER IN FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 (2)</td>
<td>0.8</td>
<td>STANDARD PIPE</td>
</tr>
<tr>
<td>15 (3)</td>
<td>1.2</td>
<td>HEAVY PIPE</td>
</tr>
<tr>
<td>16 (2) (4)</td>
<td>1.4</td>
<td>EXTRA HEAVY PIPE</td>
</tr>
<tr>
<td>18 (1)</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>24 (1)</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>30 (1)</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>36 (1)</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>42 (2)</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>48 (2)</td>
<td>12.6</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. PIPE MAY BE SMOOTH CAST IRON, CORRUGATED CAST IRON, OR RIBBED CAST IRON.
2. PIPE TO BE SMOOTH CAST IRON ONLY.
3. PIPE TO BE CORRUGATED CAST IRON OR RIBBED CAST IRON.
4. MAY BE SUBSTITUTED FOR 15" PIPE CULVERT AT NO INCREASE IN PRICE BID FOR 15" PIPE, WHERE APPROVED BY THE ENGINEER.

COVER HEIGHTS INDICATED IN TABLES ARE FOR FINISHED CONSTRUCTION WHICH MATCH FORMER VDOT ALLOWABLE STRESS DESIGN TABLES. COVER HEIGHTS WERE NOT RE-CALCULATED USING LRFD.

TO PROTECT PIPE DURING CONSTRUCTION, MINIMUM HEIGHT OF COVER PRIOR TO ALLOWING CONSTRUCTION TRAFFIC TO CROSS INSTALLATION IS TO BE 24". THIS COVER IS TO EXTEND THE FULL LENGTH OF THE PIPE CULVERT. THE APPROACH FILL RAMP IS TO EXTEND A MINIMUM OF 10 (DIAMETER 36") ON EACH SIDE OF THE CULVERT, OR TO THE INTERSECTION WITH A CUT.

MINIMUM FINISHED HEIGHT OF COVER TO BE 24", EXCEPT PIPE UNDER ENTRANCES AND MEDIAN CROSSOVERS WHERE A 9" MINIMUM WILL BE PERMITTED.

SEE STANDARD PB-1 FOR PIPE BEDDING AND BACKFILL REQUIREMENTS.
### Polyethylene Corrugated Pipe (PE)

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Area SQ. FT.</th>
<th>Maximum Height of Cover Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type C</td>
<td>Type S</td>
</tr>
<tr>
<td>12</td>
<td>0.8</td>
<td>23</td>
</tr>
<tr>
<td>15</td>
<td>1.2</td>
<td>23</td>
</tr>
<tr>
<td>18</td>
<td>1.8</td>
<td>19</td>
</tr>
<tr>
<td>24</td>
<td>3.1</td>
<td>16</td>
</tr>
<tr>
<td>30</td>
<td>4.9</td>
<td>13</td>
</tr>
<tr>
<td>36</td>
<td>7.1</td>
<td>12</td>
</tr>
<tr>
<td>42</td>
<td>9.6</td>
<td>10</td>
</tr>
<tr>
<td>48</td>
<td>12.6</td>
<td>10</td>
</tr>
<tr>
<td>54</td>
<td>15.9</td>
<td>10</td>
</tr>
<tr>
<td>60</td>
<td>19.6</td>
<td>10</td>
</tr>
</tbody>
</table>

### Polyvinylchloride Profile Wall Pipe (PVC)

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Area SQ. FT.</th>
<th>Maximum Height of Cover Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>1.7</td>
<td>41</td>
</tr>
<tr>
<td>21</td>
<td>2.3</td>
<td>40</td>
</tr>
<tr>
<td>24</td>
<td>3.0</td>
<td>37</td>
</tr>
<tr>
<td>30</td>
<td>4.7</td>
<td>34</td>
</tr>
<tr>
<td>36</td>
<td>6.9</td>
<td>34</td>
</tr>
</tbody>
</table>

### Polypropylene Pipe (PP)

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Area SQ. FT.</th>
<th>Maximum Height of Cover Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type S</td>
<td>Type D</td>
</tr>
<tr>
<td>12</td>
<td>0.8</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>1.2</td>
<td>24</td>
</tr>
<tr>
<td>18</td>
<td>1.8</td>
<td>24</td>
</tr>
<tr>
<td>24</td>
<td>3.1</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>4.9</td>
<td>16</td>
</tr>
<tr>
<td>36</td>
<td>7.1</td>
<td>14</td>
</tr>
<tr>
<td>42</td>
<td>9.6</td>
<td>14</td>
</tr>
<tr>
<td>48</td>
<td>12.6</td>
<td>13</td>
</tr>
<tr>
<td>60</td>
<td>19.6</td>
<td>12</td>
</tr>
</tbody>
</table>

### Notes:

1. Cover heights indicated in tables are for finished construction, using AASHTO LRFD Bridge Design Specifications.

2. To protect pipe during construction, minimum height of cover to be in accordance with Table A prior to allowing construction traffic to cross installation. The cover shall extend the full length of the pipe. The approach fill is to extend a minimum of 1C(Diameter + 1/2 Diameter) on each side of the pipe or to the intersection with a cut.

3. Standard minimum finished height of cover for all pipes, except those under entrances, shall be 2.0' or 7/16 Diameter whichever is greater. For 12' through 48' diameter pipe installations where the cover heights cannot be achieved, an absolute minimum finished cover height of 1.0' will be allowed only if all possible means to obtain the standard value have been exhausted. The minimum finished height of cover for pipes under entrances is 9" for pipe diameters less than or equal to 24", and 12" for pipe diameters greater than 24", where the surface over the top of the pipe will be asphalt, a minimum of 6" of Class I backfill material is to be placed between the top of the pipe and the bottom of the asphalt.

4. See Standard PB-1 for pipe bedding and backfill requirements.

5. Large culverts shall be designed by an engineer, registered in the commonwealth of Virginia, and shall be designed in accordance with the requirements of Volume V, Part 2 of the Manual of the Structure and Bridge Division. A large culvert is any culvert that will become part of the structure and bridge inventory. The geometric definition of these structures is provided in the current version of VDOT's IM-5&6-27.

### Pipe Type Definitions:

- **Type C** - Single Wall Pipe (Corrugated Wall Only)
- **Type S** - Double Wall Pipe (Corrugated Wall With Smooth Inner Wall)
- **Type D** - Triple Wall Pipe (Corrugated Wall Between Smooth Inner and Outer Wall)

### Table A

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Minimum Cover Height During Construction (See Note 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot; to 30&quot;</td>
<td>18&quot;</td>
</tr>
<tr>
<td>36&quot; and Above</td>
<td>1/2 Diameter</td>
</tr>
</tbody>
</table>
### TABLE A - ALLOWABLE TYPE OF PIPE CULVERT

For roadways that are constructed, funded or will ultimately be maintained by VDOT.

<table>
<thead>
<tr>
<th>Functional Classification of Roads System Under Which Pipe is to be Installed</th>
<th>Entrance Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Functional Class - HFC</td>
<td>Lower Functional Class - LFC</td>
</tr>
<tr>
<td>75-Year Design Life</td>
<td>50-Year Design Life</td>
</tr>
<tr>
<td>Rural Principal Arterial, Urban Principal Arterial, Rural Minor Arterial, Rural Collector Roads, Urban Collector Streets, Subdivision Streets with an ADT Greater Than 4000</td>
<td>Rural Local Roads, Urban Local Streets, Subdivision Streets with an ADT Less Than or Equal to 4000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Allowable Pipe Culverts</th>
<th>Statewide</th>
<th>Location Shown in Table B</th>
<th>Statewide</th>
<th>Location Shown in Table B</th>
<th>Statewide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes 1 &amp; 2</td>
<td>Notes except locations shown in Table B</td>
<td>Notes except locations shown in Table B</td>
<td>Notes except locations shown in Table B</td>
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<td></td>
</tr>
<tr>
<td>Concrete</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum Coated Type 2 Corrugated Steel</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Note 3</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Polymer Coated (10/10) Corrugated Steel</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Note 3</td>
<td></td>
<td></td>
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<tr>
<td>Uncorroded Galvanized Corrugated Steel</td>
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<tr>
<td>Notes 3 &amp; 4</td>
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<td></td>
<td></td>
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<tr>
<td>Galvanized Steel Structural Plate</td>
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<td></td>
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<tr>
<td>Note 3</td>
<td></td>
<td></td>
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<tr>
<td>Galvanized Steel Structural Plate with Thickened Invert</td>
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<td>Note 3, 5</td>
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<tr>
<td>Corrugated Aluminum Alloy</td>
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<tr>
<td>Note 3</td>
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<tr>
<td>Corrugated Aluminum Alloy Structural Plate</td>
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<tr>
<td>Note 3</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Polyvinylchloride (PVC) Profile Wall Pipe (Smooth Interior)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyethylene (PE) Corrugated Type C</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Polyethylene (PE) Corrugated Type S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polypropylene (PP) Type D or S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. Allowable types of pipes for a specific area are to conform to the criteria shown in tables A, A1, B, and C. Any deviation must be approved by the state location and design engineer and the district materials engineer.
2. See height of cover tables for minimum and maximum cover limitations for each type of pipe.
3. See table C for minimum and maximum pH, resistivity, and velocity limitations for metal pipes. See table D for required gauge of metal pipe.
4. Use only under entrances where the pipe size is less than or equal to 30” diameter (or equivalent) and the height of cover is less than or equal to 15’ and as an outlet pipe for standard DI-13 shoulder slot inlets.
5. Bottom and corner plates shall be 2 gauge steps thicker.

---

### NOTES:

- Allowable types of pipes for a specific area are to conform to the criteria shown in tables A, A1, B, and C. Any deviation must be approved by the state location and design engineer and the district materials engineer.
- See height of cover tables for minimum and maximum cover limitations for each type of pipe.
- See table C for minimum and maximum pH, resistivity, and velocity limitations for metal pipes. See table D for required gauge of metal pipe.
- Use only under entrances where the pipe size is less than or equal to 30” diameter (or equivalent) and the height of cover is less than or equal to 15’ and as an outlet pipe for standard DI-13 shoulder slot inlets.
- Bottom and corner plates shall be 2 gauge steps thicker.
### Table A1 - Allowable Type of Storm Sewer Pipe

<table>
<thead>
<tr>
<th>Pipe Type</th>
<th>Higher Functional Class - HFC</th>
<th>Lower Functional Class - LFC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>75 - Year Design Life</td>
<td>50 - Year Design Life</td>
</tr>
<tr>
<td></td>
<td>Rural Principal Arterial, Urban Principal Arterial, Rural Minor Arterial, Urban Minor Arterial</td>
<td>Rural Local Roads, Urban Local Streets, Subdivision Streets with an ADT greater than 4000</td>
</tr>
</tbody>
</table>

#### Notes:
- **Note 1**: Allowable pipe except locations shown in Table B.
- **Note 2**: Allowable pipe criteria for culverts.
- **Note 3**: Statewide except locations shown in Table B.
- **Note 4**: Location shown in Table B.
- **Note 5**: PVC profile wall pipe (smooth interior).
- **Note 6**: Polyethylene (PE) corrugated type S.
- **Note 7**: Polypropylene (PP) type D or S.

### Table C - Allowable Pipe Criteria for Culvert and Storm Sewers

<table>
<thead>
<tr>
<th>Pipe Type</th>
<th>Allowable pH Range (See Note 6)</th>
<th>Allowable Resistivity Range (Ohms-cm)</th>
<th>Allowable Velocity (FPS)</th>
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</thead>
<tbody>
<tr>
<td>Uncoated Galvanized Steel</td>
<td>6.0 - 10.0</td>
<td>2000 - 10000</td>
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<td>Galvanized Steel Structural Plate</td>
<td>6.0 - 9.0</td>
<td>2000 - 10000</td>
<td>5</td>
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<tr>
<td>Calvanized Steel Structural Plate</td>
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<td>2000 - 10000</td>
<td>5</td>
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<td>Aluminum Coated Type 2</td>
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<td>Corrugated Aluminum Alloy</td>
<td>4.0 - 9.0</td>
<td>1500 - 2000</td>
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<tr>
<td>Corrugated Aluminum Alloy</td>
<td>4.0 - 9.0</td>
<td>1500 - 2000</td>
<td>5</td>
</tr>
<tr>
<td>Polyethylene (PE) Corrugated Type S</td>
<td>4.0 - 9.0</td>
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<tr>
<td>Polyethylene (PE) Corrugated Type S</td>
<td>4.0 - 9.0</td>
<td>750 - 1000</td>
<td>10</td>
</tr>
<tr>
<td>Polypropylene (PP) Type D or S</td>
<td>4.0 - 9.0</td>
<td>750 - 1000</td>
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</tr>
</tbody>
</table>

### Notes:
1. Allowable types of pipes for a specific area are to conform to the criteria shown in Tables A, A1, B, and C. Any deviation must be approved by the state location and design engineer and the district materials engineer.
2. See height of cover tables for minimum and maximum cover limitations for each type of pipe.
3. See Table C for minimum and maximum pH, resistivity, and velocity for metal pipes. See Table D for required gauge of metal pipe.
4. Allowable water velocity in pipe where abrasive bedload is present or anticipated. Maximum velocity based on 10 year design discharge (Q).
5. pH values apply to both the in-situ soil and water. The lesser of the two values shall apply.
6. pH of soil - AASHTO T289.
7. Large culverts shall be designed by an engineer registered in the Commonwealth of Virginia, and shall be designed in accordance with the requirements of Volume V, Part 2 of the manual of the structure and bridge division. A large culvert is any culvert that will become part of the structure and bridge inventory. The geometric definition of these structures is provided in the current version of VDOT's IM-5M-27.
### TABLE D - REQUIRED METAL GAUGE THICKNESS (AFTER ABRASION CONSIDERATIONS)

#### TABLE D FOR GALVANIZED STEEL 50-YEAR DESIGN LIFE

<table>
<thead>
<tr>
<th>pH</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>5000</th>
<th>6000</th>
<th>7000</th>
<th>8000</th>
<th>&gt;9000</th>
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<tbody>
<tr>
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#### TABLE D FOR GALVANIZED STEEL 75-YEAR DESIGN LIFE

<table>
<thead>
<tr>
<th>pH</th>
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<th>4000-5000</th>
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#### TABLE D FOR ALUMINUM COATED TYPE 2, ALUMINUM ALLOY, AND POLYMER-COATED STEEL 50-YEAR DESIGN LIFE

<table>
<thead>
<tr>
<th>pH</th>
<th>1500</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>5000</th>
<th>6000</th>
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#### TABLE D FOR ALUMINUM COATED TYPE 2, ALUMINUM ALLOY, AND POLYMER-COATED STEEL 75-YEAR DESIGN LIFE

<table>
<thead>
<tr>
<th>pH</th>
<th>1500</th>
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</tbody>
</table>

**NOTES:**

1. LEVEL 3 ABRASION IS MAXIMUM FOR POLYMER-COATED STEEL PIPE AND GALVANIZED STEEL PLATE WITH THICKENED INVERT.
2. LEVEL 2 ABRASION IS MAXIMUM FOR REST OF METAL PIPES.
4. BASED ON pH AND RESISTIVITY REQUIREMENTS THE GAUGE OF PIPE MAY NEED TO BE INCREASED AS NOTED IN THESE TABLES TO ATTAIN THE REQUIRED DESIGN LIFE.

**SPECIFICATION REFERENCE**

232 302

A COPY OF THE ORIGINAL SEALED AND SIGNED STANDARD DRAWING IS ON FILE IN THE CENTRAL OFFICE

**ALLOWABLE PIPE CRITERIA FOR CULVERT AND STORM SEWERS**

VIRGINIA DEPARTMENT OF TRANSPORTATION
SECTION OF CONCRETE PIPE PLUG

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>CUBIC YARDS BACKFILL PER LINEAR FOOT</th>
<th>CUBIC YARDS PER EACH CONC. PLUG</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>0.029</td>
<td>0.013</td>
</tr>
<tr>
<td>18&quot;</td>
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<td>0.029</td>
</tr>
<tr>
<td>24&quot;</td>
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<td>0.048</td>
</tr>
<tr>
<td>30&quot;</td>
<td>0.091</td>
<td>0.066</td>
</tr>
<tr>
<td>36&quot;</td>
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</tr>
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<td>0.159</td>
<td>0.111</td>
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<td>108&quot;</td>
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<td>0.440</td>
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</tbody>
</table>

NOTES:

- Backfill is to be flowable backfill in accordance with Section 249 of the Specifications and is to be paid as cubic yards of flowable backfill.

- For placement of structures, see roadway plan sheets.

- Concrete brick may be used in lieu of clay brick. Jumbo brick will be permitted.

- Precast Notes:
  - Concrete to be 4000 P. S. I. min. compressive strength.
  - Concrete and reinforcing steel shall be in accordance with AASHTO M170.
  - Detail shown for precast plug is representative only; other manufacturer's design will be acceptable upon approval by the engineer.
SELECT MATERIAL OR STABILIZED SUBGRADE MATERIAL IF SPECIFIED

#57 AGGREGATE, #8 AGGREGATE OR CRUSHED GLASS MEETING #8 GRADATION REQUIREMENTS.

Paved Shoulder Section

Without Paved Shoulder

Longitudinal Perforated Pipe

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>Crushing Strength</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth Wall PVC</td>
<td>1.53 W.T. 6&quot; Nominal Diameter</td>
<td></td>
</tr>
<tr>
<td>Corrugated PE</td>
<td>1.53 W.T. 6&quot; Nominal Diameter</td>
<td>AASHTO M-252</td>
</tr>
</tbody>
</table>

Non-Perforated Outlet Pipe

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>Crushing Strength</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth Wall PVC</td>
<td>1.53 W.T. 6&quot; Nominal Diameter</td>
<td></td>
</tr>
<tr>
<td>Smooth Wall PE</td>
<td>70 PSI XX XI</td>
<td></td>
</tr>
</tbody>
</table>

※ WALL THICKNESS (MIN) - INCHES
※※※ TESTED ACCORDING TO ASTM D-2412 AT 3% DEFLECTION.

NOTES:

1. WHEN THE LONGITUDINAL PIPE CONNECTS DIRECTLY INTO A DRAINAGE STRUCTURE (DROP INLET, MANHOLE, ETC.), NON-PERFORATED OUTLET PIPES ARE NOT REQUIRED.
2. INVERT ELEVATION AT OUTLET END OF OUTLET PIPE TO BE A MINIMUM OF 1'-0" ABOVE INVERT ELEVATION OF RECEIVING DRAINAGE DITCH OR STRUCTURE.
3. ALL CONNECTIONS (ELBOWS, WYES, ETC.) WITHIN PAY LIMITS FOR OUTLET PIPE ARE TO BE OF THE SAME CRUSHING STRENGTH AS THE OUTLET PIPE.
4. OUTLET PIPE ARE TO BE INSTALLED ON 2% MIN. (3% DESIRABLE) GRADE.
5. THE NORMAL DEPTH OF UNDERDRAIN IS TO BE 4'-0" BELOW THE NEAR EDGE OF PAVEMENT AS SHOWN. THE LONGITUDINAL GRADE OF THE UNDERDRAIN SHALL FOLLOW THAT OF THE ROADWAY WITH A MINIMUM GRAD OF 0.2 %.
6. WHERE THE BOTTOM OF SELECT MATERIAL IS GREATER THAN 4'-0" BELOW THE PAVEMENT, THE BOTTOM OF THE UNDERDRAIN IS TO BE COINCIDENT WITH THE BOTTOM OF SELECT MATERIAL AND THE TRENCH DEPTH AND BACKFILL QUANTITY INCREASED ACCORDINGLY.
7. WHEN USED WITH STABILIZED OPEN-GRADED DRAINAGE LAYER, THE BOTTOM OF THE CURB AND GUTTER SHALL BE CONSTRUCTED PARALLEL TO THE SLOPE OF SUBBASE COURSES OUT TO THE DEPTH OF THE PAVEMENT.
8. OUTLET PIPE TO BE SECURELY CONNECTED TO EW-12 OR OTHER DRAINAGE STRUCTURE.
9. ▼ DENOTES WATER TABLE.
10. OUTLET PIPE CONFIGURATION TO PROVIDE FOR PASSAGE OF INSPECTION CAMERA WITH 2½" I.D. HEAD.

Standard Groundwater Underdrain

Virginia Department of Transportation
**LONGITUDINAL PERFORATED PIPE**

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>Crushing Strength</th>
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<tbody>
<tr>
<td>Smooth Wall PVC</td>
<td>0.153 W.T.</td>
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<tr>
<td>Corrugated PE</td>
<td>AASHTO M-252</td>
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</table>

**NON-PERFORATED OUTLET PIPE**

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>Crushing Strength</th>
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</thead>
<tbody>
<tr>
<td>Smooth Wall PVC</td>
<td>0.153 W.T.</td>
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<tr>
<td>Smooth Wall PE</td>
<td>70 PSI</td>
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</tbody>
</table>

**Notes:**

1. When the longitudinal pipe connects directly into a drainage structure (drop inlet, manhole, etc.), non-perforated outlet pipes are not required.

2. Invert elevation at outlet end of outlet pipe to be a minimum of 1'-0" above invert elevation of receiving drainage ditch or structure. All connections (elbows, wyes, etc.) within pay limits for outlet pipe are to be of the same crushing strength as the outlet pipe.

3. Outlet pipe are to be installed on 2% min. (3% desirable) grade and located at a maximum of 500' apart.

4. Outlet pipe to be securely connected to EW-12 or other drainage structure.

5. When underdrain must traverse under crossover locations, non-perforated outlet pipe only is to be used under crossover pavement.

6. When the longitudinal pipe connects directly into a drainage structure (drop inlet, manhole, etc.), non-perforated outlet pipes are not required.

7. Invert elevation at outlet end of outlet pipe to be a minimum of 1'-0" above invert elevation of receiving drainage ditch or structure. All connections (elbows, wyes, etc.) within pay limits for outlet pipe are to be of the same crushing strength as the outlet pipe.

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2016 ROAD & BRIDGE STANDARDS

NOTES:
1. WHEN THE LONGITUDINAL PIPE CONNECTS DIRECTLY INTO A DRAINAGE STRUCTURE (DROP INLET, MANHOLE, ETC.), NON-PERFORATED OUTLET PIPES ARE NOT REQUIRED.
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4. OUTLET PIPE TO BE INSTALLED ON 2% MIN. (3% DESIRABLE) GRADE.
5. OUTLET PIPE TO BE SECURELY CONNECTED TO EW-12 OR OTHER DRAINAGE STRUCTURE.
6. SIDEWALK UNDERDRAIN IS TO BE USED WHEN THE SIDEWALK LONGITUDINAL GRADIENT IS 3% OR MORE AND WHEN THE UNDERLYING SOIL HAS A 3% OR MORE PASSING THE NO. 200 SIEVE, AND HAS A PI OF 13 OR LESS, AND THE AREA HAS A HISTORY OF SIDEWALK UNDERMINING.
7. SIDEWALK UNDERDRAINS SHOULD BE TIED INTO THE STORM SEWER SYSTEM AT POINTS APPROXIMATELY A CITY BLOCK APART. UNDERDRAIN RUNS MUST NOT EXCEED 1,000 FEET IN LENGTH WITHOUT DISCHARGING INTO THE STORM DRAIN SYSTEM OR INTO AN OPEN DRAIN.
8. WITHIN THE LIMITS OF A COMMERCIAL ENTRANCE, NON-PERFORATED PIPE SHALL BE UTILIZED IN LIEU OF PERFORATED PIPE.

LONGITUDINAL PERFORATED PIPE

<table>
<thead>
<tr>
<th>TYPE OF PIPE</th>
<th>CRUSHING STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMOOTH WALL PVC</td>
<td>0.153</td>
</tr>
<tr>
<td>CORRUGATED PE</td>
<td>AASHTO M-252</td>
</tr>
</tbody>
</table>

NON-PERFORATED PIPE FOR USE UNDER COMMERCIAL ENTRANCES AND FOR OUTLETS

<table>
<thead>
<tr>
<th>TYPE OF PIPE</th>
<th>CRUSHING STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMOOTH WALL PVC</td>
<td>0.153</td>
</tr>
<tr>
<td>SMOOTH WALL PE</td>
<td>70 PSI</td>
</tr>
</tbody>
</table>

WALL THICKNESS (MIN) - INCHES

X X X TESTED ACCORDING TO ASTM D-2412 AT 5% DEFLECTION.

STANDARD SIDEWALK UNDERDRAIN

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION REFERENCE

ROAD AND BRIDGE STANDARDS

REVISION DATE

SHEET 1 OF 1

108.03

2016 ROAD & BRIDGE STANDARDS
GENERAL NOTES

1. UNLESS SPECIFICALLY INDICATED, CROSSDRAIN WILL NOT BE LOCATED AT THIS POINT WHEN BOTH SUBBASE AND SUBGRADE ARE STABILIZED.

2. TRENCH SHALL BE FILLED WITH AGGREGATE AND THROUGHLY HAND TAMPERED TO INSURE COMPACTNESS.

3. OUTLET PIPE SHALL BEGIN AT THE EDGE OF THE TRAVEL LANE PAVEMENT AND SHALL BE PLACED ON A GRADE PARALLEL TO THE SHOULDER SLOPE 2% MIN. (3% DESIRABLE) GRADE.

4. ON CURB AND GUTTER SECTIONS, WHERE IT IS IMPOSSIBLE TO OTHERWISE PROVIDE OUTLETS FOR CROSSDRAINS, THEY ARE TO BE LOCATED 50 FT. AS TO DRAIN INTO DROP INLETS OR MANHOLES.

5. ON SUPERELEVATED SECTIONS, TRENCH IS TO BE UNDER ENTIRE PAVEMENT AREA WITH OUTLET PIPE ON LOW SIDE ONLY.

6. INVERT ELEVATION AT OUTLET END OF OUTLET PIPE TO BE A MINIMUM OF 1'-0" ABOVE INVERT ELEVATION OF RECEIVING DRAINAGE DITCH OR STRUCTURE.

7. ALL CONNECTIONS (ELBOWS, WYES, ETC.) WITHIN PAY LIMITS FOR OUTLET PIPE ARE TO BE OF THE SAME CRUSHING STRENGTH AS THE OUTLET PIPE.

8. OUTLET PIPE TO BE SECURELY CONNECTED TO EW-12 OR OTHER DRAINAGE STRUCTURE.

STANDARD CROSSDRAIN

(AT LOWER END OF CUTS)

VIRGINIA DEPARTMENT OF TRANSPORTATION

ROAD AND BRIDGE STANDARDS

SHEET 1 OF 1

REVISION DATE 07/16

2016 ROAD & BRIDGE STANDARDS

2016 ROAD & BRIDGE STANDARDS
CROSSDRAIN CD-2 ON FILLS
CENTER LINE SECTION
(WITH TYPE 1 SELECT MATERIAL)

TRENCH PLACEMENT

P AVEMENT SURFACE & BASE
SUBBASE
SELECT MATERIAL TYPE I OR II

#57 AGGREGATE, #8 AGGREGATE OR CRUSHED
GLASS MEETING #8 GRADATION REQUIREMENTS.

OR

P AVEMENT SURFACE & BASE
SUBBASE OR CEMENT STABILIZED SUBBASE
SELECT MATERIAL TYPE II OR SUBGRADE
(CEMENT OR LIME STABILIZED)

#57 AGGREGATE, #8 AGGREGATE OR CRUSHED
GLASS MEETING #8 GRADATION REQUIREMENTS.

GENERAL NOTES

1. TRENCH SHALL BE FILLED WITH AGGREGATE AND THOROUGHLY HAND TAMPOED TO INSURE COMPACTNESS.

2. OUTLET PIPE SHALL BEGIN AT THE EDGE OF THE TRAVEL LANE PAVEMENT AND SHALL BE PLACED ON A GRADE PARALLEL TO THE SHOULDER SLOPE 2 % MIN. (3 % DESIRABLE) GRADE.

3. ON CURB AND GUTTER SECTIONS, WHERE IT IS IMPOSSIBLE TO OTHERWISE PROVIDE OUTLETS FOR CROSSDRAINS, THEY ARE TO BE LOCATED SO AS TO DRAIN INTO DROP INLETS OR MANHOLES.

4. ON SUPERELEVATED SECTIONS, TRENCH IS TO BE UNDER ENTIRE PAVEMENT AREA WITH OUTLET PIPE ON LOW SIDE ONLY.

5. INVERT ELEVATION AT OUTLET END OF OUTLET PIPE TO BE A MINIMUM OF 1'-0" ABOVE INVERT ELEVATION OF RECEIVING DRAINAGE DITCH OR STRUCTURE.

6. ALL CONNECTIONS (ELBOWS, WYES, ETC.) WITHIN PAY LIMITS FOR OUTLET PIPE ARE TO BE OF THE SAME CRUSHING STRENGTH AS THE OUTLET PIPE.

7. OUTLET PIPE TO BE SECURELY CONNECTED TO EW-12 OR OTHER DRAINAGE STRUCTURE.

PLAN VIEW SHOWING PLACEMENT OF CD-2 CROSSDRAIN

NON-PERFORATED OUTLET PIPE

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<th>TYPE OF PIPE</th>
<th>CRUSHING STRENGTH</th>
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<td>W.T. 6&quot; NOM. DIAMETER</td>
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* WALL THICKNESS (MIN) - INCHES
*** TESTED ACCORDING TO ASTM D-2412 AT 5% DEFLECTION.

STANDARD CROSSDRAIN

(AT GRADE SAGS AND BRIDGE APPROACHES)
STANDARD PAVEMENT EDGEDRAIN

UP TO ELBOW PIPE IS PERFORATED

45° ELBOW CONNECTION

PIPE-LESS AGGREGATE TRENCH WITH DRAINAGE FABRIC

PRIMARY DIRECTION OF WATER FLOW

NON PERFORATED OUTLET PIPE (TYPICAL)

45° ELBOW CONNECTION

45° WYE CONNECTION

PAY LIMITS FOR OUTLET PIPE TO BEGIN WITH 45° ELBOW

1'-0" MAX.

EW-12 (TYPICAL)

OUTLET PIPE

NO SCALE

2016 ROAD & BRIDGE STANDARDS
LONGITUDINAL PERFORATED PIPE

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<th>TYPE OF PIPE</th>
<th>CRUSHING STRENGTH</th>
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<tr>
<td>SMOOTH WALL PVC</td>
<td>.103</td>
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<tr>
<td>CORRUGATED PE</td>
<td>AASHTO M-252</td>
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NON-PERFORATED OUTLET PIPE FOR USE UNDER COMMERCIAL ENTRANCES AND FOR OUTLETS

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</tr>
<tr>
<td>SMOOTH WALL PE</td>
<td>70 PSI</td>
</tr>
</tbody>
</table>

* WALL THICKNESS (MIN) - INCHES

**TESTED ACCORDING TO ASTM D-2412 AT 5% DEFLECTION.

NOTES:

1. 4" MINIMUM, PROVIDED ATTAINING MINIMUM 4" OF AGGREGATE ON TOP OF PIPE

2. WHEN THE LONGITUDINAL PIPE CONNECTS DIRECTLY INTO A DRAINAGE STRUCTURE (DROP INLET, MANHOLE, ECT.), NON-PERFORATED OUTLET PIPES ARE NOT REQUIRED.

3. INVERT ELEVATION AT OUTLET END OF OUTLET PIPE TO BE A MINIMUM OF 1'-0" ABOVE INVERT ELEVATION OF RECEIVING DRAINAGE DITCH OR STRUCTURE.

4. ALL CONNECTIONS (ELBOWS, WYES, ETC.) WITHIN PAY LIMITS FOR OUTLET PIPE ARE TO BE OF THE SAME CRUSHING STRENGTH AS THE OUTLET PIPE.

5. OUTLET PIPES ARE TO BE INSTALLED ON 2% MIN. (3% DESIRABLE) GRADE AND LOCATED EVERY 350'-MAXIMUM OR AS NOTED ON PLANS.

6. OUTLET PIPE TO BE SECURELY CONNECTED TO EW-12 OR OTHER DRAINAGE STRUCTURE.

7. WITHIN THE LIMITS OF A COMMERCIAL ENTRANCE, NON-PERFORATED PIPE SHALL BE UTILIZED IN LIEU OF PERFORATED PIPE.

8. THE LENGTH OF PIPE BETWEEN THE WYE CONNECTION AND THE EW-12 SHALL BE LIMITED TO NO MORE THAN 1'-0" TO PERMIT CAMERA INSPECTION OF THE MAN LINE IN EITHER DIRECTION.

9. IN SITUATIONS WHEN FULL DEPTH OF STABILIZED OPEN-GRATED MATERIAL CANNOT BE MAINTAINED UNDER CURB AND GUTTER, NO. 21B AGGREGATE SHALL BE USED UNDER CURB AND GUTTER.

STANDARD PAVEMENT EDGEDRAIN

VIRGINIA DEPARTMENT OF TRANSPORTATION
UNPAVED SHOULDER SECTION

- **Type of Pipe**: Smooth Wall PVC, Smooth Wall PE, Corrugated Aluminum
- **Wall Thickness (Min)**: 0.103
- **Tested According to**: ASTM D-2412 at 5% Deflection

PAVED SHOULDER SECTION

- **Type of Pipe**: Smooth Wall PVC, Smooth Wall PE, Corrugated Aluminum
- **Wall Thickness (Min)**: 0.103
- **Tested According to**: ASTM D-2412 at 5% Deflection

CURB AND GUTTER SECTION

- **Type of Pipe**: Smooth Wall PVC, Smooth Wall PE, Corrugated Aluminum
- **Wall Thickness (Min)**: 0.103
- **Tested According to**: ASTM D-2412 at 5% Deflection

**Notes:**

1. Invert elevation at outlet end of outlet pipe to be a minimum of 1'-0" above invert elevation of receiving drainage ditch or structure.
2. All connections (elbows, wyes, etc.) to outlet pipe shall be as recommended and supplied by the Edgedrain manufacturer.
3. Outlet pipes shall be installed on 2% min. (3% desirable) grade and located every 350'-max. or as noted on plans.
4. Outlet pipe to be securely connected to EW-12 or other drainage structure.
5. UD-5 Inspection ports shall be located where specified on the plans.

**Edgedrain Connection to Outlet Pipe**

- **Non-Perforated Outlet Pipe**
- **Crushing Strength**
  - Corrugated Aluminum: 0.048
  - Smooth Wall PVC: 0.153
  - Smooth Wall PE: 70 PSI

**Specification Reference**

- 240
- 501
- 701
NOTES:
1. 4" minimum, provided attaining minimum 4" of aggregate on top of pipe.
2. Where the longitudinal perforated pipe aligns with a drainage structure (drop inlet, manhole, etc.), a non-perforated outlet pipe is not required. Instead, the perforated pipe is to be connected directly to the drainage structure. Where the longitudinal perforated pipe is continuous, it shall be connected to each side of the drainage structure.
3. Invert elevation at outlet end of outlet pipe to be a minimum of 1'-0" above invert elevation of receiving drainage ditch or structure.
4. All connections (elbows, wyes, etc.) within pay limits for outlet pipe are to be of the same crushing strength as the outlet pipe.
5. Outlet pipes are to be installed on 2% min. (3% desirable) grade and located every 350' maximum or as noted on plans.
6. Outlet pipe to be securely connected to EW-12 or other drainage structure.
7. Within the limits of a commercial entrance, non-perforated pipe shall be utilized in lieu of perforated pipe.
8. The length of pipe between the WYE connection and the EW-12 shall be limited to no more than 1'-0" to permit camera inspection of the main line in either direction.
9. Existing asphalt shoulder to be sawed to achieve a smooth joint.

LONGITUDINAL PERFORATED PIPE

<table>
<thead>
<tr>
<th>TYPE OF PIPE</th>
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</tr>
</thead>
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<td>SMOOTH WALL PVC</td>
<td>0.103</td>
</tr>
<tr>
<td>CORRUGATED PE</td>
<td>AASHTO M-252</td>
</tr>
</tbody>
</table>

NON-PERFORATED OUTLET PIPE FOR USE UNDER COMMERCIAL ENTRANCES AND FOR OUTLETS

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<tr>
<th>TYPE OF PIPE</th>
<th>CRUSHING STRENGTH (W.T. 4&quot; NOM. DIAMETER)</th>
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</thead>
<tbody>
<tr>
<td>SMOOTH WALL PVC</td>
<td>0.103</td>
</tr>
<tr>
<td>SMOOTH WALL PE</td>
<td>70 PSI XXXX</td>
</tr>
</tbody>
</table>

XXX WALL THICKNESS (MIN) - INCHES

XXX TESTED ACCORDING TO ASTM D-2412 AT 5% DEFLECTION.
THIS PAGE INTENTIONALLY LEFT BLANK
**MINIMUM THICKNESS "T"**

<table>
<thead>
<tr>
<th>RIP RAP CLASS</th>
<th>MINIMUM &quot;T&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS A</td>
<td>20&quot;</td>
</tr>
<tr>
<td>CLASS I</td>
<td>26&quot;</td>
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<tr>
<td>CLASS II</td>
<td>38&quot;</td>
</tr>
<tr>
<td>CLASS III</td>
<td>53&quot;</td>
</tr>
</tbody>
</table>

**NOTES:**

- Rip rap bedding material
- Geotextile fabric to be provided under all riprap installations class A, class I and class II unless otherwise noted on the plans or directed by the engineer.
- Riprap installations of class III shall have an intermediate aggregate bedding layer(s) as specified on the plans based on geotechnical recommendations.
- See typical section shown on plans for side slope, bottom width and depth of channel and riprap thickness.

**TYPE I**
Riprap ditch protection

**TYPE II**
Riprap slope protection
WELDED WIRE FABRIC 6 X 6 - W2.1 X W2.1

CLASS A3 CONCRETE

BAR F

CURTAIN WALL

WELDED WIRE FABRIC

BAR G

CURTAIN WALL

JOINT

SECTION A-A

*10'-0" C-C MAXIMUM TYPICAL SPACING BETWEEN ANCHOR LUGS. ANCHOR LUG IS TO BE A MAXIMUM OF 2' FROM END OF CHANNEL.

SECTION B-B

SECTION C-C

STANDARD PAVED FLUME FOR 12" - 24" PIPE

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

APPROXIMATE QUANTITIES

<table>
<thead>
<tr>
<th>CLASS A3 CONCRETE</th>
<th>REINFORCING STEEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CU. YDS.</td>
</tr>
<tr>
<td>ANCHOR LUG</td>
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</tr>
<tr>
<td>1/2:1</td>
<td>0.0216</td>
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<td>CURTAIN WALL</td>
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<tr>
<td>1/2:1</td>
<td>0.100</td>
</tr>
<tr>
<td>JOINT</td>
<td>2:1</td>
</tr>
<tr>
<td>1/2:1</td>
<td>—</td>
</tr>
</tbody>
</table>

0.425 SQUARE YARDS SURFACE AREA PER LINEAR FOOT OF FLUME.

NOTE:
DOWELS TO BE LOCATED AT ALL REQUIRED JOINTS.
K VALUE = 128
FOR DETAILS OF PIPE SPILLOUTS FOR 12"-24" CULVERTS, SEE STANDARD DRAWINGS PS-2 AND PS-3.
## STANDARD PAVED DITCHES

**CONC. THICKNESS** | **D** | **1'** | **2'** | **3'** | **4'** | **5'** | **6'** | **7'** | **8'** | **9'** | **10'** |
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
4" | 0.425 | 0.536 | 0.648 | 0.759 | 0.870 | 0.981 | 1.092 | 1.203 | 1.314 | 1.425 |
5" | 0.740 | 0.851 | 0.962 | 1.073 | 1.184 | 1.295 | 1.406 | 1.517 | 1.629 | 1.740 |
6" | 1.054 | 1.165 | 1.276 | 1.387 | 1.498 | 1.609 | 1.721 | 1.832 | 1.943 | 2.054 |
7" | 1.368 | 1.479 | 1.590 | 1.702 | 1.813 | 1.924 | 2.035 | 2.146 | 2.257 | 2.368 |
8" | 1.682 | 1.794 | 1.905 | 2.016 | 2.127 | 2.238 | 2.349 | 2.460 | 2.571 | 2.682 |
9" | 1.997 | 2.108 | 2.219 | 2.330 | 2.441 | 2.552 | 2.663 | 2.774 | 2.886 | 2.997 |
10" | 2.311 | 2.422 | 2.533 | 2.644 | 2.755 | 2.866 | 2.977 | 3.089 | 3.200 | 3.31 |
6" | 0.512 | 0.623 | 0.734 | 0.845 | 0.956 | 1.067 | 1.178 | 1.290 | 1.401 | 1.512 |
7" | 0.812 | 0.923 | 1.035 | 1.146 | 1.257 | 1.368 | 1.479 | 1.590 | 1.702 | 1.813 |
8" | 1.114 | 1.225 | 1.336 | 1.447 | 1.558 | 1.669 | 1.780 | 1.891 | 2.002 | 2.113 |
9" | 1.416 | 1.527 | 1.638 | 1.749 | 1.860 | 1.971 | 2.082 | 2.193 | 2.304 | 2.415 |
10" | 1.718 | 1.829 | 1.940 | 2.051 | 2.162 | 2.273 | 2.384 | 2.495 | 2.606 | 2.717 |
6" | 0.515 | 0.626 | 0.737 | 0.848 | 0.959 | 1.070 | 1.181 | 1.292 | 1.403 | 1.514 |
7" | 0.815 | 0.926 | 1.037 | 1.148 | 1.259 | 1.370 | 1.481 | 1.592 | 1.703 | 1.814 |
8" | 1.117 | 1.228 | 1.339 | 1.450 | 1.561 | 1.672 | 1.783 | 1.894 | 2.005 | 2.116 |
9" | 1.419 | 1.530 | 1.641 | 1.752 | 1.863 | 1.974 | 2.085 | 2.196 | 2.307 | 2.418 |
10" | 1.721 | 1.832 | 1.943 | 2.054 | 2.165 | 2.276 | 2.387 | 2.498 | 2.609 | 2.720 |

**NOTES:**
- Depth (D) and Width (W) to be as shown on plans.
- Weep holes are to be provided on all channels where W is equal to or greater than 4" and D is equal to or greater than 2".
- Weep hole with 12" x 12" plastic hardware cloth, 1/4" mesh or galvanized steel wire diameter 0.03 inch, number 4 mesh, hardware cloth anchored firmly to the bottom of the channel.

**SECTION A-A**

- Concrete to be Class A3
- Expansion joint spacing 90° maximum
- 4" x 6" dowels smooth bars 12" C-C located at all joints
- Curtain wall to be located at the beginning and end of all channels and on the lower end of each expansion joint.

**ELEVATION**
**CONCRETE VEE DITCH**

ALL CONCRETE TO BE #4 400 P.S.I.
LIFTING DEVICES OF THE FABRICATOR'S DESIGN ARE TO BE FURNISHED WHEN REQUIRED.

**Basis of Payment**
To be square yards of surface measure which is to include furnishing and placing concrete slabs and mortaring joints.

**Pipe Drain Ditch Liner**

Pipe sections may be used in roadside ditches, median ditches, slope drains, and flumes with the exception of 1/2 round sections which are restricted to slope drains and flumes only.

When pipe drain ditch liner is substituted for standard PG-2A or 4 specified on the plans, the contractor must select a "K" value shown herein that is equal to or greater than the "K" value for the type at standard paved ditch shown below.

"K" is the conveyance factor as calculated by the Manning's formula for flow in open channels.

Pipe drain ditch liners are to be constructed from sections of concrete pipe, regular reinforced concrete pipe, bituminized fiber pipe, corrugated aluminum pipe, or corrugated steel pipe. Non-reinforced sections may be used for concrete pipe sizes 24" or less.

Joints to be of standard manufacturer's design for regular concrete pipe and may be lapped, butted with a collar, or bell and spigot for bituminized fiber pipe. Joints for corrugated metal pipe may be bolted or riveted. All joints to be sealed to insure a watertight bond.

Bituminized fiber and corrugated metal pipe to be anchored with 1" x 4" x 30" pressure preservative treated stakes placed at all joints with intermediate spacing not to exceed 10 feet. #4 x 30" hooked deformed bars may be substituted if approved by the engineer.

Concrete and corrugated metal pipe sections are to be as specified in standard PC-1. Specifications for minimum height of fill. Bituminous fiber pipe shall conform to section 240 of the specifications, and is limited to sizes 24" or less.

**Pipe Drain Ditch Liner**

For use on slopes and flumes only.

Pipe sections are to be as specified in standard PC-1 and specifications for minimum height of fill. Bituminous fiber pipe shall conform to section 240 of the specifications, and is limited to sizes 24" or less.

Inlet end of pipe drain ditch liner installation is to be protected with asphalt or concrete treatment as directed by the engineer to prevent undercutting.

Cost of protection to be included in price bid for linear feet of pipe drain ditch liner.

At the option of the fabricator, concrete pipe may be grooved for splitting.

Lifting devices of fabricator's design are to be furnished when required. Pipe sections are to be as specified in pipe standard PC-1 for minimum height of fill.

---

**Concrete and Pipe Specifications**

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>D</th>
<th>W</th>
<th>K Smooth</th>
<th>K C.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12&quot;</td>
<td>6&quot; 1'-0&quot;</td>
<td>15</td>
<td>10</td>
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</tr>
<tr>
<td>15&quot;</td>
<td>7¾&quot; 1'-3&quot;</td>
<td>28</td>
<td>17</td>
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<td>18&quot;</td>
<td>9&quot; 1'-6&quot;</td>
<td>46</td>
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<tr>
<td>21&quot;</td>
<td>10½&quot; 1'-9&quot;</td>
<td>69</td>
<td>43</td>
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<td>7½&quot; 2'-2&quot;</td>
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<tr>
<td>36&quot;</td>
<td>9&quot; 2'-7½&quot;</td>
<td>79</td>
<td>49</td>
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<tr>
<td>42&quot;</td>
<td>10½&quot; 3'-5½&quot;</td>
<td>118</td>
<td>74</td>
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<tr>
<td>48&quot;</td>
<td>1'-0&quot; 3'-5½&quot;</td>
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<tr>
<td>54&quot;</td>
<td>1½'-0&quot; 3'-10½&quot;</td>
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<td>3'-0&quot; 4'-3½&quot;</td>
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<td>8½&quot; 3'-6½&quot;</td>
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</table>

**Concrete and Pipe Specifications**

Pipe sections are to be as specified in standard PC-1 for minimum height of fill.
DITCH FLUME CONNECTOR

REINFORCING STEEL SCHEDULE

<table>
<thead>
<tr>
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<td>H</td>
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<td>5'-3&quot;</td>
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<td>B3 S.F.</td>
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BENDING DIAGRAM

APPROXIMATE QUANTITIES

- REINFORCING STEEL: 132.9 LBS.
- CLASS A3 CONC.: 1.7 CU. YDS.

CURTAIN WALL TO BE LOCATED AT BEGINNING AND END OF ALL FLUMES AND ON THE LOWER END OF EACH JOINT.

PRICE BID PER EACH TO INCLUDE DOWELS, WELDED WIRE FABRIC, REINFORCING STEEL, ANCHOR LUGS AND CURTAIN WALL, AND CLASS A-3 CONC.

FIELD CUT BARS V1 & BARS H2 TO CLEAR OPENING FOR STD. PG-5

DATE: 2016 ROAD & BRIDGE STANDARDS

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION REFERENCE: 502
**STANDARD SPRING BOX**

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**SPECIFICATION REFERENCE**

105  
232  
302

---

**REINFORCING STEEL**

<table>
<thead>
<tr>
<th>HEIGHT OF FILL</th>
<th>SIZE (L)</th>
<th>TOP SLAB (D)</th>
<th>SIDEWALLS (W)</th>
<th>FOOTING WIDTH (F)</th>
<th>NO. REQ'D.</th>
<th>LENGTH</th>
<th>SIZE</th>
<th>SPACING C-C</th>
<th>CU. YDS. CONC.</th>
<th>REINF. STEEL LBS.</th>
<th>INCREMENT CU. YDS.</th>
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<td>0.053</td>
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* QUANTITIES SHOWN ARE BASED ON A 8" DEPTH OF FOOTING, ADD INCREMENTAL QUANTITY FOR EACH ADDITIONAL 1" OF DEPTH.

---

**NOTES:**

- ALL CONCRETE TO BE CLASS A3 IF CAST IN PLACE. FOR PRECAST SEE SHEET 110.02.
- CONCRETE QUANTITIES SHOWN ARE BASED ON A 12" DUCTILE IRON WATER LINE. IF OTHER SIZE OR TYPE OF PIPE IS USED QUANTITIES ARE TO BE ADJUSTED ACCORDINGLY.
- COST OF WIRE MESH SHIELD AT OUTFALL END OF PIPE IS TO BE INCLUDED IN PRICE BID FOR PIPE.
- THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
- CONTRACTOR IS TO PROVIDE OPENING FOR PIPE AND FLEXIBLE CONNECTOR BY CORING OR CAST-IN-PLACE SLEEVE WITH WATER STOP COLLAR.

PIPE(S) SHALL BE CONNECTED TO SPRING BOX WITH A FLEXIBLE BOOT MEETING ASTM SPECIFICATION C-923. COST OF FLEXIBLE CONNECTION TO BE INCLUDED IN BID PRICE FOR SPRING BOX. BOOT SHALL BE MADE FROM NEOPRENE RUBBER AND HAVE A 3/16" MINIMUM WALL THICKNESS THROUGHOUT. THE INTERNAL EXPANSION BAND TO SECURE THE BOOT IN PLACE SHALL CONFORM TO ALUMINUM MATERIAL SPECIFICATION 1061.  THE EXTERNAL BAND TO CLAMP AND SEAL THE BOOT TO THE PIPE SHALL BE STAINLESS STEEL-CORROSION RESISTANT CONFORMING TO ASTM SPECIFICATION A-187. THE OPENING TO RECEIVE THE FLEXIBLE CONNECTION SHALL BE CORE DRILLED AND IS TO BE CONSTRUCTED TO ALLOW FOR LATERAL AND VERTICAL MOVEMENT, AS WELL AS ANGULAR ADJUSTMENT THRU 20 DEGREES. ALL FIELD INSTALLATION OF PIPE TO SPRING BOX USING FLEXIBLE BOOT SHALL BE COMPLETED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND SPECIFICATIONS.
CONCRETE TO BE 4000 PSI MINIMUM COMPRESSIVE STRENGTH.

REINFORCING STEEL IN ACCORDANCE WITH A.S.T.M. A-615 (REINFORCING BARS).

PIPE(S) SHALL BE CONNECTED TO SPRING BOX WITH A FLEXIBLE BOOT MEETING ASTM SPECIFICATION C-923. COST OF FLEXIBLE CONNECTION TO BE INCLUDED IN BID PRICE FOR SPRING BOX. BOOT SHALL BE MADE FROM NEOPRENE RUBBER AND HAVE A 0.75" MINIMUM WALL THICKNESS THROUGHOUT. THE INTERNAL EXPANSION BAND TO SECURE THE BOOT IN PLACE SHALL CONFORM TO ALUMINUM MATERIAL SPECIFICATION 6061-T6. THE EXTERNAL BAND TO CLAMP AND SEAL THE BOOT TO THE PIPE SHALL BE STAINLESS STEEL-CORROSION RESISTANT CONFORMING TO ASTM SPECIFICATION A-167. THE OPENING TO RECEIVE THE FLEXIBLE CONNECTION SHALL BE CORE DRILLED AND IS TO BE CONSTRUCTED TO ALLOW FOR LATERAL AND VERTICAL MOVEMENT, AS WELL AS ANGULAR ADJUSTMENT THRU 20 DEGREES.

ALL FIELD INSTALLATION OF PIPE TO SPRING BOX USING FLEXIBLE BOOT SHALL BE COMPLETED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND SPECIFICATIONS.

DIMENSIONS SHOWN ARE MINIMUM. ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCES.
FOR DETAILS OF SAFETY GRATE
SEE STD. EG-1

1. CONCRETE STRENGTH 4000 PSI MINIMUM.
2. REINFORCING SHALL CONFORM TO A.S.T.M. A615, GRADE 40.
3. ALL UNITS SHALL BE FOR A 2:1 SLOPE UNLESS SPECIALLY ORDERED.
4. DOWEL HOLES PROVIDED TO PREVENT SETTLEMENT OF ADJACENT CONCRETE.
5. DIMENSIONS SHOWN FOR CONCRETE THICKNESS ARE MINIMUM.
ACTUAL MEASUREMENTS MAY VARY WITH MANUFACTURER'S TOLERANCES.

PRECAST ENERGY DISSIPATOR

EG-1 PC-ENERGY DISSIPATOR (WITHOUT GRATE)
EG-1A PC-ENERGY DISSIPATOR (WITH GRATE)

HOLE AS REQUIRED

SECTION A-A

#3 BARS @ 12" C-C MAX.

SECTION B-B

#3 BARS @ 12" C-C
PIPE SPILLOUT
PLATE VIEW

SCHEDULE OF REINFORCING STEEL

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<th>SIZE</th>
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<tr>
<td>L</td>
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<td>3&quot;</td>
<td>12&quot;</td>
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† QUANTITIES BASED ON 18" PIPE.

APPROXIMATE QUANTITIES

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<tr>
<th>CLASS AS CONCRETE STEEL</th>
<th>REINFORCING STEEL</th>
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<tr>
<td>CUBIC YARDS</td>
<td>LBS.</td>
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<tr>
<td>PIPE</td>
<td>2/1</td>
</tr>
<tr>
<td>SPILLOUT</td>
<td>1/2</td>
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NOTE:
DOWELS TO BE LOCATED AT ALL REQUIRED JOINTS.

FOR DETAIL OF DOWELS SEE STANDARD PG-4 COST OF DOWELS TO BE INCLUDED WITH STD. PG-4.

FOR DETAILS OF CURTAIN WALL SEE STD. PG-4.

SECTION B-B

SECTION C-C
1. For multiple line installations, dimension S is to govern the protection outside the channel width (W).

2. On any installation requiring culvert outlet protection where no endwall or endsection is specified on the plans, construction is to be in accordance with detail 2 shown above.

3. Geotextile fabric to be installed under class A1, I, and I materials in accordance with the specifications.

4. S = Diameter of circular culvert or span for box, elliptical or arch culvert. H = Diameter of circular culvert or rise/height for box, elliptical or arch culvert.

* Use typical section shown on plans for side slope, bottom width and depth of channel or match existing ditch or natural ground.

### Culvert Outlet Protection

**Virginia Department of Transportation**

<table>
<thead>
<tr>
<th>Type of Outlet Protection Material</th>
<th>Maximum Outlet Velocity (for Design Storm)</th>
<th>Minimum &quot;T&quot; (inches)</th>
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<tr>
<td>Class A1 Class A1 Dry Riprap</td>
<td>8 fps</td>
<td>18</td>
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<tr>
<td>Class I Class I Dry Riprap</td>
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<tr>
<td>Class II Class II Dry Riprap</td>
<td>19 fps</td>
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<th>Outlet Protection Minimum Length (L)</th>
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<tr>
<td>Type A Installation</td>
</tr>
<tr>
<td>Type B Installation</td>
</tr>
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</table>
**GENERAL NOTES:**

1. **CUT OR FILL SLOPE INSTALLATION**
   - Width of material may vary from minimum dimension by increments of 4 or 5 feet.
   - "T-TOP" staples or other manufacturer's design approved by the engineer may be substituted for the staples shown.
   - Gage wire No. 11 minimum.
   - No. 11 min. gage wire.

2. **DITCH INSTALLATION**
   - Lap joint 2" min.
   - Edge and end joints to be overlapped 2" minimum.
   - Staples formed from No. 8 steel wire 8" staple minimum length for sandy soil, 6" staple minimum length for other soil.

3. **TERMINAL FOLD**
   - Terminal fold 2" min.

4. **CHECK SLOT**
   - Check slot 4".
   - Combines third row of staples from each strip in lap with alternate spacing.
   - 9" max.

5. **JUNCTION SLOT**
   - Junction slot 1" to 2".
   - 1" to 2".
   - Staples to be buried 6" to 12".

6. **ANCHOR SLOT**
   - Anchor slot 6" max.
   - Joints may be eliminated when slope is less than 4:1.

7. **STAPLING DIAGRAM**
   - Staples formed from No. 8 steel wire 8" staple minimum length for sandy soil, 6" staple minimum length for other soil.

8. **NOTES:**
   - Approximate 200 staples required per 4' x 225' roll.
   - Anchor slots, junction slots, and check slots to be buried 6" to 12" and variable.
   - Max. spacing C-C check slots.
   - 100' slope 4% or less 50' slope steeper than 4%.

9. **EC-2 MATERIALS TYPES 1, 2, 3, OR 4.**
   - Width of material may vary from minimum dimension by increments of 4 or 5 feet.

10. **Rut Depth**
    - Center row may be eliminated when slope is less than 4:1.

11. **PER 4' X 225' ROLL.**
    - Approximate 200 staples required per 4' x 225' roll.

12. **FOR SOURCES OF APPROVED MATERIAL SEE VDOT'S APPROVED PRODUCTS LIST FOR EC-2 MATERIALS TYPES 1, 2, 3, OR 4.**

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.
TYPICAL INSTALLATION AT END OF PIPE

ROLLED EROSION CONTROL PRODUCT MAY BE USED IN CONJUNCTION WITH STANDARD EC-1 EROSION CONTROL STONE AT OUTLET END OF PIPE.

STAKING DETAIL

3' OVERLAP BETWEEN ROLLS

STAKES OR PINS 3'O.C.

CHECK SLOT 25'O.C.

NOTES:

1. STAKES SHALL BE WOOD OR METAL AS RECOMMENDED BY THE MANUFACTURER AND SHALL BE A MINIMUM OF 12" IN LENGTH. IN SANDY SOILS METAL STAKES A MINIMUM OF 18" IN LENGTH SHALL BE USED.

2. ALL EC-3 MATERIALS ARE TO BE IN ACCORDANCE WITH THE APPROVED PRODUCTS LIST.

3. EC-3 MATERIAL SHOULD BE INSTALLED TO THE SHOULDER BREAK POINT OR EXISTING GROUND THEN EMBEDDED 6". MATERIAL ON BOTH SIDES OF THE DITCH SHALL BE INSTALLED TO THE SAME ELEVATIONS.

4. IF MORE THAN 3 LINES OF MATERIAL ARE REQUIRED PARALLEL TO THE CENTER LINE OF THE DITCH, MATERIAL SHALL BE INSTALLED PERPENDICULAR TO THE CENTER LINE OF THE DITCH, STARTING AT THE LOWEST ELEVATION OF THE DITCH.

5. FOR SOURCES OF APPROVED MATERIALS SEE VDOT'S APPROVED PRODUCTS LIST FOR STD. EC-3, TYPES 1, 2, AND 3.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

ROLLED EROSION CONTROL PRODUCT
SOIL STABILIZATION MAT
(PERMANANT DITCH INSTALLATION )

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
NOTES:

1. FOR MULTIPLE LINE INSTALLATIONS, DIMENSION S IS TO GOVERN THE PROTECTION OUTSIDE THE CHANNEL WIDTH (W).

2. ON ANY INSTALLATION REQUIRING CULVERT OUTLET PROTECTION WHERE NO ENDWALL OR ENDSECTION IS SPECIFIED ON THE PLANS, CONSTRUCTION IS TO BE IN ACCORDANCE WITH DETAIL 2 SHOWN ABOVE.

3. EC-3 TYPE 3 SHALL BE USED FOR CULVERT OUTLET PROTECTION WHERE THE OUTLET VELOCITY IS 6 FPS OR LESS FOR THE DESIGN STORM AND THE TOTAL HYDRAULIC OPENING IS LESS THAN 7 SQUARE FEET. IF THE TOTAL HYDRAULIC OPENING IS 7 SQUARE FEET OR GREATER, OR THE DESIGN STORM OUTLET VELOCITY IS GREATER THAN 6 FPS USE STANDARD EC-1.

4. S = DIAMETER OF CIRCULAR CULVERT OR SPAN FOR BOX, ELLIPTICAL OR ARCH CULVERT.

H = DIAMETER OF CIRCULAR CULVERT OR RISE/HEIGHT FOR BOX, ELLIPTICAL OR ARCH CULVERT.

* USE TYPICAL SECTION SHOWN ON PLANS FOR SIDE SLOPE, BOTTOM WIDTH AND DEPTH OF CHANNEL OR MATCH EXISTING DITCH OR NATURAL GROUND.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.
NOTES:

1. SLOPE SURFACE SHALL BE SMOOTH AND FREE OF ROCKS, LUMPS OF DIRT, GRASS, AND STICKS. MAT SHALL BE PLACED FLAT ON SURFACE FOR PROPER SOIL CONTACT.

2. STAKES SHALL BE WOOD OR METAL AS RECOMMENDED BY THE MANUFACTURER AND SHALL BE A MINIMUM OF 18 INCHES IN LENGTH.

3. EC-3 MATERIALS SHALL BE IN ACCORDANCE WITH THE APPROVED PRODUCT LIST.

4. SOURCES OF APPROVED MATERIALS SEE VDOT’S APPROVED PRODUCTS LIST FOR STD. EC-3, TYPE 3 MATERIALS.

5. SLOPES SHALL BE SEEDED IMMEDIATELY PRIOR TO INSTALLATION OF STD. EC-3 TYPE 3 MATERIAL.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.
**Typical Detail for Rock Check Dam Type I**

- **Section A-A**
  - **Front Elevation**
  - **Typical Detail for Rock Check Dam Type II**
  - **Section A-A**
  - **Front Elevation**

**Suggested Rock Check Dam Spacing**

- **L = H/S WHERE:**
  - **H** = Height of Dam Crest in Feet
  - **S** = Channel Slope in FT/FT
  - **L** = Check Dam Spacing in Feet; the distance such that points A and B are of equal elevation

**Notes:**

1. Rock check dams that are designated on the plans as a stormwater management (SWM) item are to be left in place as a permanent installation.
2. Where drainage areas exceed 1 acre or ditch grade exceeds 3%, a temporary sediment forebay shall be installed with minimum dimensions of 12" depth, 2' width and 6' length.
3. If a check dam is located inside clear zone and adjacent to a travelway, slope facing on coming traffic is to be 6:1 and maximum H is to be 12".
4. Check dam shall not be used for locations in live stream.

**Check Dam (Rock) Ty. I, Item Code 27410, Each**

**Check Dam (Rock) Ty. II, Item Code 27415, Each**

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**Road and Bridge Standards**

**Virginia Department of Transportation**

**2016 Road & Bridge Standards**

A copy of the original sealed and signed drawing is on file in the central office.

**Specification Reference**

107
303
NOTES
1. TYPE A SILT FENCE WILL HAVE WOODEN POSTS AND IS LIMITED TO FILL HEIGHTS OF 20 FEET OR LESS. TYPE B SILT FENCE WILL HAVE STEEL POSTS AND MUST BE USED WHERE THE FILL HEIGHT EXCEEDS 20 FEET.
2. WOODEN POSTS SHALL BE OAK AND HAVE NOMINAL DIMENSIONS OF 2" BY 2". STEEL POSTS SHALL HAVE A MINIMUM WEIGHT OF 1.25 POUNDS PER LINEAR FOOT.
3. ALL POSTS SHALL BE DRIVEN 24" MIN. INTO THE GROUND AND SHALL EXTEND 6" ABOVE THE FILTER FABRIC.
4. GEOTEXTILE FABRIC SHALL BE EMBEDDED 12" INTO THE GROUND (6" VERTICALLY AND 6" HORIZONTALLY ALONG THE BOTTOM OF TRENCH) AS SHOWN IN DETAILS.
5. SLICING IS AN APPROVED ALTERNATIVE TO TRENCHING FOR ANCHORING THE GEOTEXTILE FABRIC INTO THE GROUND. SLICING SHALL BE ACCOMPLISHED IN ACCORDANCE WITH SECTION 303 OF THE ROAD AND BRIDGE SPECIFICATIONS.
6. WHEN TWO SEPARATE SECTIONS OF GEOTEXTILE FABRIC ADJOIN EACH OTHER, THEY SHALL OVERLAP BY 6" AND BE DOUBLE FOLDED.
7. GEOTEXTILE FABRIC SHALL BE FASTENED SECURELY TO THE POSTS AT BOTH THE TOP AND VERTICAL MIDPOINT OF THE GEOTEXTILE FABRIC.
8. WHEN THE DISTANCE FROM THE TOE OF THE FILL TO THE SILT FENCE IS NOT PROVIDED IN THE PLANS A MINIMUM OF 5 FEET WILL BE USED.
9. MATERIALS FOR ALL SILT FENCE SHALL CONFORM TO THE REQUIREMENTS OF SECTION 242 OF THE VDOT ROAD & BRIDGE SPECIFICATIONS.
10. THE GEOTEXTILE FABRIC FOR SILT FENCE SHALL BE FROM THE VDOT MATERIALS APPROVED LIST 63.
SILT BARRIERS
TYPICAL DETAIL FOR BRUSH BARRIER
(TO BE USED AT ALL APPLICABLE LOCATIONS)

NOTES:
1. BRUSH BARRIERS SHALL BE CONSTRUCTED AT LOCATION SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER. BRUSH SHALL BE FILED AGAINST EXISTING TREES TO PREVENT MOVEMENT OF BARRIER. BRUSH SHALL BE FILED AS TIGHTLY AS POSSIBLE AND WEIGHTED DOWN BY UNMERCHANTABLE LOGS.

2. GEOTEXTILE FABRIC CONFORMING TO THE ROAD AND BRIDGE SPECIFICATIONS SHALL BE INSTALLED AS DETAILED ABOVE. GEOTEXTILE FABRIC MAY ALSO BE ATTACHED TO EXISTING FENCES WHEN SPECIFIED ON THE PLANS OR DIRECTED BY THE ENGINEER.

3. NO BRUSH WILL BE DESTROYED OR REMOVED FROM THE PROJECT UNTIL ALL BRUSH SILT BARRIERS ARE IN PLACE AND HAVE BEEN INSPECTED AND APPROVED BY THE ENGINEER.

4. DIMENSIONS SHOWN ARE APPROXIMATE ONLY.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

TEMPORARY SILT BARRIERS
BRUSH BARRIER
VIRGINIA DEPARTMENT OF TRANSPORTATION

EC-5
NOTES
1. POSTS AND TOP RAIL SHALL BE A NOMINAL 2" X 4" NO. 2 SOUTHERN PINE, AND POSTS SHALL BE DRIVEN 24" MINIMUM IN THE GROUND.
2. END OF FILTER BARRIER TO BE EMBEDDED INTO AGGREGATE.
3. IF A DROP INLET IS LOCATED IN A SAG IN THE DITCH GRADE, A CHECK DAM IS REQUIRED FOR EACH SIDE OF THE INLET THAT RECEIVES DITCH FLOW.
4. WHERE DRAINAGE AREAS EXCEED ONE ACRE OR DITCH GRADE EXCEEDS 3%, A TEMPORARY SEDIMENT FOREBAY SHALL BE INSTALLED IN ACCORDANCE WITH THE EC-4 STANDARD.
5. WHEN REQUIRED SEE STANDARD EC-4 FOR DETAILS OF ROCK CHECK DAM AND SEDIMENT FORBAY.
6. SILT FENCE GEOTEXTILE IN ACCORDANCE WITH SECTION 245 OF THE ROAD AND BRIDGE SPECIFICATIONS.
7. ONLY SEDIMENT RETENTION ROLL PRODUCTS WITH A MINIMUM 18" DIAMETER LISTED ON THE VDOT APPROVED PRODUCTS LIST MAY BE USED FOR TYPE A INLET PROTECTION.
8. ALL STAKES SHALL BE DRIVEN 24" MIN. INTO THE GROUND AND SHALL EXTEND 8" ABOVE THE SEDIMENT RETENTION ROLL; WOODEN STAKES SHALL BE OAK AND HAVE NOMINAL DIMENSIONS OF 2" BY 2"; STEEL STAKES SHALL HAVE A MINIMUM WEIGHT OF 1.33 POUNDS PER LINEAR FOOT.

INLET PROTECTION (TYPE A) ITEM CODE 27451 EACH

9. SEDIMENT SHALL BE REMOVED FROM INLET PROTECTION WHEN IT HAS ACCUMULATED TO ONE- HALF THE EXPOSED HEIGHT OF THE STRUCTURE AND PAVED FOR AS SEDIMENT REMOVAL PER CUBIC YARD.
10. STACKING SEDIMENT RETENTION ROLLS TO MEET THE REQUIRED INLET PROTECTION HEIGHT IS NOT PERMITTED.
11. SEDIMENT RETENTION ROLLS SHALL BE EMBEDDED INTO THE DITCH 2' EXCEPT WHEN PLACED OVER STANDARD EC-2 OR EC-3 LINED DITCH.
12. SEDIMENT RETENTION ROLLS AND STAKES USED FOR INLET PROTECTION APPLICATIONS SHALL BE REMOVED AFTER STABILIZATION IS COMPLETE.
13. GEOTEXTILE PRODUCTS DESIGNED TO BE INSERTED INTO OR ANCHORED TO THE TOP OF GRATE INLETS, AND ARE FOUND ON VDOT'S EC-4 APPROVED PRODUCT LIST, MAY BE SUBSTITUTED FOR THE DROP INLET PROTECTION DEVICES DETAILED IN THIS STANDARD.
**SPECIFIC APPLICATION**

This method of inlet protection is applicable at curb inlets where an overflow capability is necessary to prevent excessive ponding in front of the structure.

**INLET PROTECTION (TYPE B)**

**NOTES:**

1. Inlet protection using sediment retention rolls shall be constructed with compost filter socks or sediment tubes.
2. Only sediment retention roll products with a minimum 8" diameter listed on the VDOT approved products list may be used for Type B inlet protection.
3. Sediment shall be removed from inlet protection when it has accumulated to one-half the exposed height of the structure and paid for as sediment removal per cubic yard.
4. Stacking sediment retention rolls to meet the required inlet protection height is not permitted.
5. Sediment retention rolls and stakes used for inlet protection applications shall be removed after stabilization is complete.
6. Geotextile products designed to be inserted into or anchored to grates or slots of curb inlets, and are found on VDOT's EC-6 approved products list, may be substituted for the drop inlet protection devices detailed in this standard.
7. Sediment retention roll will be anchored with a 50 pound sandbag on each end or in accordance with manufacturers installation instructions.

**INLET PROTECTION (TYPE B), ITEM CODE 27461 EACH**

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

**REFERENCE**

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<th>2016 ROAD &amp; BRIDGE STANDARDS</th>
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<td>INLET PROTECTION (TYPE B)</td>
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<td>REVISION DATE</td>
<td>VIRGINIA DEPARTMENT OF TRANSPORTATION</td>
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</tr>
</tbody>
</table>
TYPICAL DETAIL FOR INSTALLATION OF TEMPORARY SILT FENCE/CHECK DAM AT CULVERT

NOTES:
1. FOR FILL HEIGHT OF 20' OR LESS, TYPE A SILT FENCE MAY BE USED.
   FOR FILL HEIGHT GREATER THAN 20', TYPE B SILT FENCE IS REQUIRED.
2. ROCK CHECK DAM IS TO BE CONSTRUCTED IN ACCORDANCE WITH THE ROAD AND BRIDGE SPECIFICATIONS, AND STANDARD EC-4 OR EC-16 AS DETERMINED BY THE ENGINEER.
3. SILT FENCE IS TO BE INSTALLED IN ACCORDANCE WITH THE ROAD AND BRIDGE SPECIFICATIONS, AND STANDARD EC-5.

* INSTALLATION DETAIL ONLY - ROCK CHECK DAMS AND SILT FENCE TO BE PAID FOR IN ACCORDANCE WITH THE ROAD AND BRIDGE SPECIFICATIONS.
NOTES:

1. CHECK DAM IS SHOWN FOR ILLUSTRATION ONLY AND IS NOT INCLUDED IN PAYMENT FOR SEDIMENT TRAP.

2. THE SEDIMENT STORAGE VOLUME SHALL BE 134 CUBIC YARDS/ACRE OF TOTAL CONTRIBUTING DRAINAGE AREA AND SHALL CONSIST OF HALF IN THE FORM OF WET STORAGE AND HALF IN THE FORM OF DRY STORAGE.

3. SEE PLANS FOR DIMENSIONS AND ELEVATIONS.
NOTES:

1. Dewatering basin size shall be determined by the formula 16 X GAL./MIN. OF PUMP - CU. FT. OF STORAGE CAPACITY.

2. This work shall consist of the construction of a dewatering basin for the purpose of receiving sediment-laden water pumped from a construction site to allow for filtration before it reenter the waterway. Pumping into these basins shall cease when the flow from the basin becomes sediment-laden.

3. Surface water flow shall be diverted around this device.

4. The outfall from the basin(s) shall have a stabilized conveyance to receiving waters.

5. Once the dewatering basin becomes filled to half of the storage capacity, accumulated sediment shall be removed and disposed of in an approved disposal area outside of the 100-year floodplain unless otherwise approved on the plans.

6. Sediment control devices are to remain in place until all disturbed areas are stabilized and the engineer approves their removal. Ground contours shall be returned to their original condition unless specifically approved otherwise by the engineer.

7. Synthetic products that have been approved for use on VDOT projects and found on VDOT's Spel List may be used in lieu of this design. However, VDOT will only compensate the contractor up to the bid price per each at each site.
TEMPORARY DIVERSION DIKE

NOTE:
1. THE CHANNEL CREATED BEHIND THE DIKE SHALL HAVE A POSTIVE GRADE TO A STABILIZED OUTLET. THE CHANNEL SHALL BE STABILIZED, AS NECESSARY, TO PREVENT EROSION.

2. TEMPORARY DIVERSION DIKE WILL BE MEASURED AND PAID FOR IN ACCORDANCE WITH SECTION 303 OF THE SPECIFICATIONS.
TEMPORARY BERM & SLOPE DRAIN

PROFILE

SECTION A-A

PROFILE

ALTERNATE ENTRANCE TREATMENT

PLAN VIEW

NOTES

1. SLOPE DRAIN SHALL BE SECURELY STAKED TO THE SLOPE, AT 10' OR LESS INTERVALS.
2. THE SLOPE DRAIN SECTIONS SHALL BE SECURELY FASTENED TOGETHER AND HAVE WATER TIGHT FITTINGS.

SIZE OF SLOPE DRAIN

<table>
<thead>
<tr>
<th>MAXIMUM DRAINAGE AREA (ACRES)</th>
<th>MINIMUM PIPE DIAMETER, D (IN.)</th>
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<tbody>
<tr>
<td>0.5</td>
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EARTHEN BERM
EARTHEN BERM SHALL BE INSTALLED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS OR AS DIRECTED BY THE ENGINEER.

COMPACTED SOIL

FLOW
MINIMUM REQUIREMENTS FOR STABILIZED CONSTRUCTION ENTRANCE

6" MINIMUM DEPTH *1 COARSE AGGREGATE, WITH MINIMUM 10' CLOSEST TO ROADWAY CAPPED WITH 4" MINIMUM DEPTH
*68 OR #78 AGGREGATE, AS DIRECTED BY THE ENGINEER.

1. SURFACE WATER SHALL BE PIPED UNDER THE CONSTRUCTION ENTRANCE. IF PIPING IS IMPractical, a MOUNTABLE BERM WITH 5:1 SLOPES WILL BE PERMITTED.

2. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT OF WAY. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHT OF WAY SHALL BE REMOVED IMMEDIATELY.

3. WHEELS SHALL BE CLEANED TO REMOVE SEDIMENT PRIOR TO ENTRANCE ONTO PUBLIC RIGHT OF WAY. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH STONE AND WHICH DRAINS INTO AN APPROVED SEDIMENT TRAPPING DEVICE.

4. PERIODIC INSPECTION AND NEEDED MAINTENANCE SHALL BE PROVIDED AFTER HEAVY USE AND EACH RAIN.
TEMPORARY DIVERSION CHANNEL

SILT FENCE REQUIRED

STREET DIVERSION

TYPICAL SECTION
TEMPORARY DIVERSION CHANNEL
AND ACCEPTABLE LININGS

STREAM DIVERSION
GENERAL NOTES

SLOPES
MAXIMUM STEEPNESS OF SIDE SLOPES SHALL BE 1:1, DEPTH AND GRADE MAY BE VARIABLE DEPENDENT ON SITE CONDITIONS, BUT SHALL BE SUFFICIENT TO ENSURE CONTINUOUS FLOW OF WATER IN THE DIVERSION.

EXCAVATION
NO EXCAVATED MATERIAL SHALL BE STORED OR STOCKPILED NEXT TO THE DIVERSION OR IN SUCH A MANNER THAT SFPATION OF THE STREAM COULD OCCUR.

PIPE CULVERTS
PIPE CULVERT(S) MAY BE USED TO DIVERT A STREAM PROVIDED THEY ARE PROPERLY SIZED TO SAFELY CARRY THE FLOW OF A TWO YEAR EVENT. UNDERSIZED PIPE(S) SHALL BE USED FOR NO LONGER THAN 72 HOURS PRIOR TO SUBSEQUENT FILL OF 75% OR MORE OF THE CULVERT'S DRAINAGE STRUCTURE(S) FOR WHICH THE DIVERSION WAS BUILT. PRIOR TO USING THE HIGHER CLASS OF LINING THAN THAT SPECIFIED ON THE PLANS, NO ADDITIONAL COMPENSATION WILL BE ALLOWED FOR USING THE HIGHER CLASS.

STREET DIVERSION LINERS SHALL NOT BE MIXED WITH STREAM DIVERSION WEIGHTS. WEIGHTS MAY ALSO BE NEEDED ALONG THE STREAM DIVERSION'S LENGTH.

STREAM DIVERSION LINERS SHALL BE ENTRAINED AT THE TOP OF THE DIVERSION SLOPES (SLOPE BREAKS) WITH A LINE OF SILT FENCE. SILT FENCE REQUIRED.

STREAM DIVERSION LINERS SHALL BE OVERLAPPED WHEN A SINGLE OR CONTINUOUS LAYER LINER IS NOT AVAILABLE OR IS IMPractical, OVERLAPS SHALL BE PLACED SUCH THAT CONTINUOUS FLOW OF THE STREAM IS MAINTAINED. AN UPSTREAM SECTION SHALL OVERLAP A DOWNSTREAM SECTION BY A MINIMUM OF 18". OVERLAPS ALONG THE CROSS-SECTION SHALL BE MADE SUCH THAT A LINER IS PLACED IN THE STREAM DIVERSION BOTTOM FIRST AND ADDITIONAL PIECES OF LINER ON THE SLOPES OVERLAP THE BOTTOM PIECE BY A MINIMUM OF 18".

GENERAL
THE DOWNTOWN PLUG SHALL BE REMOVED PRIOR TO THEUPSTREM PLUG WHEN A STREAM DIVERSION IS USED FOR THE TRANSPORT OF WATER.

NON-ERODIBLE MATERIALS, INCLUDING BUT NOT LIMITED TO: STONE, CONCRETE BARRIERS, SANDBAGS, PLASTIC, OR SHEET PILING SHALL BE USED BOTH TO DIVERT THE STREAMS AWAY FROM THEIR ORIGINAL CHANNELS AND TO PREVENT OR REDUCE WATER BACKUP INTO A CONSTRUCTION AREA.

STREUMS MAY BE DIVERGED THROUGH AN EXISTING OR INCOMPLETE STRUCTURE PROVIDED THEY WILL NOT PERMITS A DISTURBED AREA TO COME INTO CONTACT WITH WET CONCRETE, AND/OR BECOME PARTIALLY OR FULLY IMPROVED, SILTED, OR OTHERWISE CONTAMINATED.

STREAMS MAY BE DIVERGED THROUGH AN EXISTING OR INCOMPLETE STRUCTURE PROVIDED THEY WILL NOT PERMITS A DISTURBED AREA TO COME INTO CONTACT WITH WET CONCRETE, AND/OR BECOME PARTIALLY OR FULLY IMPROVED, SILTED, OR OTHERWISE CONTAMINATED.

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STREAMS MAY BE DIVERGED THROUGH AN EXISTING OR INCOMPLETE STRUCTURE PROVIDED THEY WILL NOT PERMITS A DISTURBED AREA TO COME INTO CONTACT WITH WET CONCRETE, AND/OR BECOME PARTIALLY OR FULLY IMPROVED, SILTED, OR OTHERWISE CONTAMINATED.
**RIPRAP WEIRS**

LOW FLOW DIVERSION FOR MULTIPLE LINE CULVERT INSTALLATIONS

VIRGINIA DEPARTMENT OF TRANSPORTATION

**NOTES:**

1. THE TOP WIDTH OF THE WEIR IS VARIABLE AND IS TO BE ADJUSTED AS NEEDED TO DIRECT THE LOW FLOW TO THE BARREL(S) DESIGNATED ON THE PLANS.

2. FOR SKewed ENDWALLS, RIPRAP WEIR SIDES ARE TO BE CONSTRUCTED PARALLEL WITH PIPE SKEW.

3. REFER TO APPLICABLE ENDWALL STANDARD DRAWING FOR DIMENSIONS NOT SHOWN HEREIN

4. BASIS OF PAYMENT: TO BE PAID FOR AS SQ.YDS. OR TONS OF DRY RIPRAP CLASS I

**LEGEND**

- 6" MINIMUM OR ½ P.
- DIMENSION VARIeS ACCORDING TO PIPE SIZE, SKEW AND ENDWALL DIMENSIONS
- DEPTH OF FOUNDATION TO BE VARIABLE ACCORDING TO SITE CONSTRAINTS OR AS DIRECTED BY THE ENGINEER
- THE PROPOSED HEIGHT OF THE RIPRAP WEIR FROM THE EXISTING STREAM BED TO THE TOP OF WEIR, IS TO BE SPECIFIED ON THE ROADWAY PLANS.
- "X" DIMENSION (HEIGHT OF WEIR ABOVE STREAM BED) CAN BE A MINIMUM OF 6" OR ANY VARIABLE DIMENSION TO A MAXIMUM OF 12".

**PLAN VIEW**

(ENDWALL WITHOUT WINGS)

**END VIEW**

EXISTING STREAM BED

CULVERTS COUNTERSUNK 6" MIN.

BELOW EXISTING STREAM BED

**TYPICAL SECTION A-A**

EXISTING STREAM BED ELEVATION

6" MIN

12" MAX

6" MIN

12" MAX

**REFERENCES:**

107 303

2016 ROAD & BRIDGE STANDARDS
NOTES:
1. THE CULVERT(S) SHALL BE SIZED TO CONVEY THE FLOW OF A TWO YEAR STORM EVENT. THE ELEVATION OF THE TWO YEAR EVENT SHALL BE AT OR BELOW THE LOWEST SURFACE ELEVATION OF THE CROSSING. THE REQUIRED HYDRAULIC OPENINGS SHOULD BE DETERMINED USING THE APPROPRIATE HYDROLOGIC/HYDRAULIC DESIGN TECHNIQUES. A TEMPORARY VEHICULAR WATERCOURSE CROSSING SHOULD ONLY BE UTILIZED WHERE THE DRAINAGE AREA IS NO GREATER THAN 1 SQUARE MILE. THE DEPTH OF STONE COVER OVER THE CULVERT(S) SHALL BE IN ACCORDANCE WITH STANDARD PC-1.

2. AN ALTERNATIVE TEMPORARY VEHICULAR WATERCOURSE CROSSING DESIGN MAY BE USED PROVIDED IT IS SUBMITTED TO THE ENGINEER FOR REVIEW AND APPROVAL IN ACCORDANCE WITH ROAD AND BRIDGE SPECIFICATIONS SECTIONS 105 AND 107.
1. THE STANDARD FOR SEDIMENT RETENTION ROLLS (SRR) SHALL INCLUDE COMPOST FILTER SOCKS AND SEDIMENT TUBES, UNLESS SPECIFICALLY NOTED.

2. SRR SHALL BE INSTALLED PARALLEL TO THE SLOPE ALONG THE GROUND CONTOUR. SRR SHALL NOT BE INSTALLED WITHIN 10' OF THE TOE OF THE SLOPE. SRR SHALL NOT BE USED IN STREAMS.

3. COMPOST FILTER SOCKS USED IN SLOPE APPLICATIONS MAY REMAIN IN PLACE TO BIODEGRADE. SEDIMENT TUBES SHALL BE REMOVED FROM THE SLOPES AFTER STABILIZATION IS COMPLETE. THIS MAY BE ACCOMPLISHED BY CUTTING THE TUBE OPEN AND SPREADING THE SEDIMENT ON THE SITE. ALL NON-BIODEGRADABLE MATERIAL AND STAKES SHALL BE REMOVED.

4. ONLY SRR PRODUCTS LISTED ON THE VDOT APPROVED PRODUCTS LIST MAY BE USED.

5. SEDIMENT RETENTION ROLLS (SRR) USED FOR SLOPE APPLICATIONS WILL BE PAID IN ACCORDANCE WITH SECTION 603 OF THE SPECIFICATIONS.

6. PAYMENT SHALL INCLUDE ALL MATERIALS AND LABOR NECESSARY FOR INSTALLATION, MAINTENANCE AND REMOVAL.

7. SEDIMENT SHALL BE REMOVED FROM BEHIND THE SRR WHEN IT HAS ACCUMULATED TO ONE-HALF THE EXPOSED HEIGHT OF THE STRUCTURE AND PAID FOR AS SEDIMENT REMOVAL PER CUBIC YARD.

8. SRR SHALL BE INSTALLED WITH WOODEN STAKES (MIN. 1.5" X 1.5" ACTUAL). THE STAKE SHALL BE EMBEDDED A MINIMUM OF 2'.

9. IF MORE THAN ONE SRR IS PLACED IN A ROW IN A SLOPE APPLICATION, THE TUBES SHALL BE OVERLAPPED A MINIMUM OF 24" TO PREVENT FLOW AND SEDIMENT FROM PASSING THROUGH THE JOINT.

10. SRR SHALL NOT BE USED ON PAVEMENT, ROCKY SOILS, OR AT ANY OTHER LOCATION WHERE THE STAKES CANNOT BE DRIVEN TO THE REQUIRED DEPTH.
1. Temporary check dams shall be constructed with sediment retention rolls (SRR) which include compost filter socks and sediment tubes, unless specifically noted.

2. Compost filter socks used in temporary check dam applications may remain in place to biodegrade. All non-biodegradable material and stakes shall be removed after stabilization is complete.

3. Sediment tubes and stakes used in temporary check dam applications shall be removed after stabilization is complete.
   a. Sediment tubes containing biodegradable materials may be cut open and the fill material spread on the site. All non-biodegradable material shall be removed.
   b. Sediment tubes containing non-biodegradable material shall be removed.

4. Only sediment retention roll products listed on the VDOT approved products list may be used.

5. Sediment retention rolls used for temporary check dams will be paid in accordance with Section 303 of the specifications.

6. Sediment shall be removed from behind the temporary check dam when it has accumulated to one-half the exposed height of the structure and paid for as sediment removal per cubic yard.

7. All stakes shall be driven 24" min. into the ground and shall extend 6" above the SRR. Wooden stakes shall be oak and have nominal dimensions of 2" by 2". Steel stakes shall have a minimum weight of 1.33 pounds per linear foot.

8. If more than one SRR is used to construct the temporary check dam, the tubes shall be overlapped a minimum of 24" to prevent flow and sediment from passing through the joint.

9. Temporary check dams shall not be used on pavement, rocky soils, or at any other location where the stakes cannot be driven to the required depth.

10. Top of check dam at center of ditch shall be 6" lower than the outer edge intersection with the ditch slope.

11. Temporary check dams are limited to ditch depths of 2' when used in trapezoidal ditches.

12. Sediment retention rolls shall be embedded into the ditch 2" except when placed over standard EC-2 or EC-3 lined ditch.

13. Stacking sediment retention rolls to meet the required temporary check dam height is not permitted.
CAST IN PLACE STORMWATER MANAGEMENT DRAINAGE STRUCTURE

NOTES:
1. COST OF TRASH RACK AND DEBRIS RACK ARE TO BE INCLUDED IN THE BID PRICE FOR THE STORMWATER MANAGEMENT DRAINAGE STRUCTURE.
2. STRUCTURE MAY BE PRECAST OR CAST IN PLACE. SEE SHEET 2 OF 3 FOR DETAILS ON PRECAST STRUCTURE.
3. WEEP HOLES SHALL NOT BE PROVIDED.
4. STEPS ARE TO BE PROVIDED WHEN HEIGHT OF STRUCTURE IS 4'-6" OR GREATER ABOVE INVERT OF OUTLET PIPE. FOR STEP DETAILS SEE STANDARD ST-1.
5. FOR DETAILS ON METAL PLATE, DEBRIS RACK AND TRASH RACK SEE STANDARD SWM-DR.
6. MARK HEIGHT OF STRUCTURE, IN BLACK, WITH 4" HIGH NUMERALS AND 1" WIDE HORIZONTAL STRIPES AT 1 INTERVALS FROM INVERT OF WATER QUALITY ORIFICE (ALL VISIBLE SIDES).
7. THE PERMANENT STORMWATER MANAGEMENT DRAINAGE STRUCTURE, STANDARD SWM-1 MAY BE MODIFIED WHERE THE STORMWATER MANAGEMENT BASIN IS TO BE USED AS A TEMPORARY SEDIMENT BASIN DURING PROJECT CONSTRUCTION. SEE STANDARD SWM-DR, SHEET 1 OF 5, FOR TEMPORARY MODIFICATION DETAILS.
8. THE SIZE OF THE WATER QUALITY ORIFICE SHALL BE SPECIFIED ON THE PLANS. ADDITIONAL OPENINGS IN THE STORMWATER MANAGEMENT DRAINAGE STRUCTURE TO BE PROVIDED WHEN SPECIFIED ON THE PLANS.

PIPE SIZE | 12" | 15" | 18" | 24" | 30" | 36" | 42"
--- | --- | --- | --- | --- | --- | --- | ---
MINIMUM DEPTH H | 5'-0" | 5'-3/4" | 5'-6/2" | 6'-1" | 6'-7/4" | 7'-2" | 7'-8/2"
CU. YDS. CONCRETE | 2.665 | 2.773 | 2.878 | 3.078 | 3.624 | 3.437 | 3.598
INCREMENT PER FOOT OF ADDITIONAL DEPTH "H" - 0.461 CU. YDS.
NOTES:

1. COST OF TRASH RACK AND DEBRIS RACK ARE TO BE INCLUDED IN THE PRICE BID FOR THE STORMWATER MANAGEMENT DRAINAGE STRUCTURE.

2. STRUCTURE MAY BE PRECAST OR CAST IN PLACE. SEE SHEET 1 OF 3 FOR DETAILS ON CAST IN PLACE STRUCTURE.

3. WEEP HOLES SHALL NOT BE PROVIDED. ANY LIFT HOLES SHALL BE PLUGGED.

4. STEPS ARE TO BE PROVIDED WHEN HEIGHT OF STRUCTURE IS 4'-0" OR GREATER ABOVE INVERT OF OUTLET PIPE. FOR STEP DETAILS SEE STANDARD ST-1.

5. SEE STANDARD SWM-DR FOR DETAILS ON PLATE, DEBRIS RACK AND TRASH RACK.

6. MARK HEIGHT OF STRUCTURE IN BLACK, WITH 4" HIGH NUMERALS AND 1" WIDE HORIZONTAL STRIPES AT 1'-INTERVALS FROM INVERT OF WATER QUALITY ORIFICE (ALL VISIBLE SIDES).

7. THE PERMANENT STORMWATER MANAGEMENT DRAINAGE STRUCTURE, STANDARD SWM-1 MAY BE MODIFIED WHERE THE STORMWATER MANAGEMENT BASIN IS TO BE USED AS A TEMPORARY SEDIMENT BASIN DURING PROJECT CONSTRUCTION. SEE STANDARD SWM-DR, SHEET 1 OF 5 FOR TEMPORARY MODIFICATION DETAILS.

8. THE SIZE OF THE WATER QUALITY ORIFICE SHALL BE SPECIFIED ON THE PLANS. ADDITIONAL OPENINGS IN THE STORMWATER MANAGEMENT DRAINAGE STRUCTURE TO BE PROVIDED WHEN SPECIFIED ON THE PLANS.
NOTES:
1. THESE DETAILS ARE TO BE USED TO MODIFY THE PERMANENT STORMWATER MANAGEMENT DRAINAGE Structure WHERE THE STORMWATER MANAGEMENT BASIN IS TO BE USED FOR A TEMPORARY SEDIMENT BASIN DURING PROJECT CONSTRUCTION.
2. GRADE STORMWATER MANAGEMENT BASIN AS SHOWN IN PLANS.
3. ALL OPENINGS (IF ANY) IN SIDE OF STRUCTURE (OTHER THAN PERMANENT WATER QUALITY ORIFICE) ARE TO BE COVERED WITH SOLID METAL PLATES WHILE THE BASIN IS BEING USED FOR SEDIMENT CONTROL.
4. DEWATERING DEVICE AND COMPONENTS AND TEMPORARY METAL PLATES (IF ANY), AS SHOWN IN THE DETAIL, ARE TO BE REMOVED AND PERMANENT STEEL PLATE WITH WATER QUALITY ORIFICE IS TO BE INSTALLED WHEN BASIN IS NO LONGER NEEDED FOR SEDIMENT CONTROL.
5. SIMILAR DEVICE MAY ALSO BE USED ON OTHER STORMWATER MANAGEMENT DRAINAGE STRUCTURES.
6. COST OF TEMPORARY DEWATERING DEVICE AND TEMPORARY METAL PLATES (IF ANY) SHALL BE INCLUDED IN THE BID PRICE FOR STORMWATER MANAGEMENT DRAINAGE STRUCTURE.
7. THE TEMPORARY 8" DIA. POLYETHYLENE DRAINAGE TUBING IS TO BE SOLID FOR THE LENGTH BELOW WET STORAGE ELEVATION AND IS TO BE PERFORATED ABOVE THE WET STORAGE ELEVATION. THE COUPLING IS TO BE WATERTIGHT.
1. COST OF DEBRIS RACK, METAL PLATE, AND DEBRIS RACK HOLDER TO BE INCLUDED IN THE BID PRICE FOR THE SWM DRAINAGE STRUCTURE.

2. DEBRIS RACK MAY BE FABRICATED FROM WELDED 3/8" DIAMETER BARS OR 1/2" THICK HIGH DENSITY POLYETHYLENE. METAL COMPONENTS OF DEBRIS RACK MUST NOT BE GALVANIZED.

3. DEBRIS RACK TO BE HINGED AS SHOWN OR CONTRACTOR MAY SUBSTITUTE A COMPARABLE DESIGN AS APPROVED BY THE ENGINEER.

4. THE LOCATION OF THE DEBRIS RACK HOLDER MAY BE ADJUSTED FOR VARIABLE CONDITIONS. WHEN HOLDER BOLT IS LOCATED ON THE METAL PLATE THE 1/4" DIA BOLT LENGTH IS TO BE REDUCED 1/4" LG AND WELDED TO THE PLATE. DEBRIS RACK HOLDER AND ALL HARDWARE IS TO BE GALVANIZED.

STORMWATER MANAGEMENT (SWM) DETAILS
DEBRIS RACK, METAL PLATE, WATER QUALITY ORIFICE, CONCRETE CRADLE
(FOR SWM DRAINAGE STRUCTURES, SWM RISER PIPES AND SWM DAMS)

SPECIFICATION REFERENCE
302
ROAD AND BRIDGE STANDARDS
REVISION DATE
114.05
**STORMWATER MANAGEMENT (SWM) DETAILS**

**DEBRIS RACK, METAL PLATE, WATER QUALITY ORIFICE, CONCRETE CRADLE**

(for SWM drainage structures, SWM riser pipes and SWM dams)

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

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<tr>
<th>PIPE SIZE INCHES</th>
<th>CRADLE BOTTOM WIDTH (INCHES)</th>
<th>CRADLE HEIGHT (INCHES)</th>
<th>CRADLE TOP WIDTH (INCHES)</th>
<th>INCREMENT, IN CUBIC YARDS, PER LINEAR FOOT OF PIPE</th>
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Concrete shall be class A3 but not less than 6".

**CONCRETE CRADLE IS TO BE INSTALLED UNDER THE ENTIRE LENGTH OF CULVERT AT EACH STORMWATER MANAGEMENT BASIN.**

**CONCRETE CRADLE IS TO BE PAID FOR AS MISCELLANEOUS CONCRETE AND SUMMARIZED IN CUBIC YARDS FOR EACH PIPE LOCATION.**
**STORMWATER MANAGEMENT DETAILS TRASH RACK FOR SWM DRAINAGE STRUCTURES**

**NOTES:**

1. All metal trash racks 36" in diameter and larger or with a total weight of 75 lbs or greater shall have a hinged, lockable access door with a minimum 2' x 2' clear opening.

2. All high density polyethylene trash racks 48" in diameter and larger shall have a hinged, lockable access door with a minimum 2' x 2' clear opening.

3. Anti-vortex plate is to be used when specified on the plans. Cost of furnishing and placing the anti-vortex plate is to be included in the bid price for the structure.

**SPECIFICATION REFERENCE**

302

**ROAD AND BRIDGE STANDARDS**

**REVISION DATE**

07/16

**SHEET 4 OF 5**

**VIRGINIA DEPARTMENT OF TRANSPORTATION**
NOTE:
A HINGED, LOCKABLE ACCESS DOOR WITH A MINIMUM 2' x 2' CLEAR OPENING, SHALL BE PROVIDED ON ALL TRASH RACKS.

HIGH DENSITY POLYETHYLENE
APPROX. WT. (LBS.)  95

METAL (STEEL)
APPROX. WT. (LBS.)  188

1/4" DIA. X 6" LG. ADHESIVE BOLTS W/FLAT WASHERS AND SELF LOCKING NUTS TYPICAL 8 PLACES-EQUALLY SPACED ON AN "E" DIA. B.C.
SECTION 200

CURBS, MEDIANS & ENTRANCE GUTTERS
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<td>CONCRETE MEDIAN CURB</td>
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<td>STANDARD ENTRANCE GUTTER (FOR USE WITH UNPAVED SPACE BETWEEN CURB AND GUTTER)</td>
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<td>CG-9D</td>
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<td>CG-12 DETECTABLE WARNING SURFACE, (TYPE MEDIAN AND REFUGE ISLAND APPLICATIONS)</td>
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<td>CG-12 DETECTABLE WARNING SURFACE (METHOD OF INSTALLING DETECTABLE WARNINGS ON A RADIUS)</td>
<td>204.07</td>
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</tbody>
</table>
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NOTES:

1. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
2. CONCRETE TO BE CLASS A3 IF CAST IN PLACE, 4000 PSI IF PRECAST.
3. CURB HAVING A RADIUS OF 300 FEET OR LESS (ALONG FACE OF CURB) WILL BE PAID FOR AS RADIAL CURB.
4. THE DEPTH OF CURB MAY BE REDUCED AS MUCH AS 3" (15" DEPTH) OR INCREASED AS MUCH AS 3" (21" DEPTH) IN ORDER THAT THE BOTTOM OF CURB WILL COINCIDE WITH THE TOP OF A COURSE OF THE PAVEMENT SUBSTRUCTURE. OTHERWISE, THE DEPTH IS TO BE 18" AS SHOWN. NO ADJUSTMENT IN THE PRICE BID IS TO BE MADE FOR A DECREASE OR AN INCREASE IN DEPTH.
5. CG-2 IS TO BE USED ON ROADWAYS MEETING THE REQUIREMENTS FOR CG-6 AS SHOWN IN APPENDIX A OF THE VDOT ROAD DESIGN MANUAL, IN THE SECTION ON GS URBAN STANDARDS.

ACCEPTABLE ALTERNATIVE IF CURB IS EXTRUDED

STANDARD 6" CURB

VIRGINIA DEPARTMENT OF TRANSPORTATION
NOTES:

1. This item may be precast or cast in place.

2. Concrete to be class A3 if cast in place, 4000 PSI if precast.

3. Curb having a radius of 300 feet or less (along face of curb) will be paid for as radial curb.

4. The depth of curb may be reduced as much as 3" (13" depth) or increased as much as 3" (19" depth) in order that the bottom of the curb will coincide with the top of a course of the pavement substructure. Otherwise, the depth is to be 16" as shown. No adjustment in the price bid is to be made for a decrease or an increase in depth.

5. CG-3 is to be used on roadways meeting the requirements for CG-7 as shown in Appendix A of the VDOT Road Design Manual in the section on GS Urban Standards.

6. When this standard is to be tied into existing barrier curb, the transition is to be made within 10' or the change in standards can be made at regular openings.
NOTES:

1. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.

2. CONCRETE TO BE CLASS A3 IF CAST IN PLACE, 4000 PSI IF PRECAST.

3. COMBINATION CURB & GUTTER HAVING A RADIUS OF 300 FEET OR LESS (ALONG FACE OF CURB) SHALL BE PAID FOR AS RADIAL COMBINATION CURB & GUTTER.

4. FOR USE WITH STABILIZED OPEN-GRADED DRAINAGE LAYER, THE BOTTOM OF THE CURB & GUTTER SHALL BE CONSTRUCTED PARALLEL TO THE SLOPE OF SUBBASE COURSES AND TO THE DEPTH OF THE PAVEMENT.

5. ALLOWABLE CRITERIA FOR THE USE OF CG-6 IS BASED ON ROADWAY CLASSIFICATION AND DESIGN SPEED AS SHOWN IN APPENDIX A OF THE ROAD DESIGN MANUAL IN THE SECTION ON GS URBAN STANDARDS.

COMBINATION 6" CURB AND GUTTER

THIS AREA MAY BE CONCRETE AT THE OPTION OF THE CONTRACTOR

THE BOTTOM OF THE CURB AND GUTTER MAY BE CONSTRUCTED PARALLEL TO THE SLOPE OF SUBBASE COURSES PROVIDED A MINIMUM DEPTH OF 7" IS MAINTAINED.
NOTES:
1. THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
2. CONCRETE TO BE CLASS A3 IF CAST IN PLACE, 4000 PSI IF PRECAST.
3. COMBINATION CURB & GUTTER HAVING A RADIUS OF 300 FEET OR LESS (ALONG FACE OF CURB) SHALL BE PAID FOR AS RADIAL COMBINATION CURB & GUTTER.
4. FOR USE WITH STABILIZED OPEN-GRADED DRAINAGE LAYER, THE BOTTOM OF THE CURB AND GUTTER SHALL BE CONSTRUCTED PARALLEL TO THE SLOPE OF SUBBASE COURSES AND TO THE DEPTH OF THE PAVEMENT.
5. ALLOWABLE CRITERIA FOR THE USE OF CG-7 IS BASED ON ROADWAY CLASSIFICATION AND DESIGN SPEED AS SHOWN IN APPENDIX A OF THE VDOT ROAD DESIGN MANUAL IN THE SECTION ON URBAN GS STANDARDS.
6. WHEN THIS STANDARD IS TO BE TIED INTO EXISTING BARRIER CURB, THE TRANSITION IS TO BE MADE WITHIN 10' OR THE CHANGE IN STANDARDS CAN BE MADE AT REGULAR OPENINGS.
7. WHEN COMBINATION MOUNTABLE CURB AND GUTTER IS USED, THE STANDARD ENTRANCE GUTTERS OR STANDARD CONNECTION FOR STREET INTERSECTIONS ARE TO HAVE THE MOUNTABLE CURB CONFIGURATION INCORPORATED.

THIS AREA MAY BE CONCRETE AT THE OPTION OF THE CONTRACTOR

THE BOTTOM OF THE CURB AND GUTTER MAY BE CONSTRUCTED PARALLEL TO THE SLOPE OF SUBBASE COURSES PROVIDED A MIN. DEPTH OF 7" IS MAINTAINED.
RIGID PAVEMENT

BACKFILL

RIGID PAVEMENT

FLEXIBLE PAVEMENT OR RIGID BASE WITH ASPHALT SURFACE

SHOULDER STABILIZATION AS SHOWN ON PLANS.

ASPHALT CURB

ASPHALT MEDIAN

ASPHALT MEDIAN

ASPHALT CONCRETE CURB AND MEDIAN

(VIRGINIA DEPARTMENT OF TRANSPORTATION)

ASPHALT TOP FOR MEDIAN TO BE SAME MIX AS CURB.

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
NOTES

1. **STANDARD MC-3B** requires the paved shoulder to extend to the back of curb.
2. Paved shoulder widths to be in accordance with the plans, VDOT policy, or as directed by the engineer.
3. The paved shoulder and the extended paved shoulder shall be placed simultaneously.
4. Face of guardrail shall be aligned with face of the curb.
5. Distance from the face of rail to the hinge point in accordance with the guardrail standard used.
6. MC-3B curb not permitted within the limits of any guardrail terminal.

**STANDARD GUARDRAIL & MC-3B ASPHALT CURB INSTALLATION**

To calculate the asphalt backup material:

1. Multiply the length of MC-3B by the end area which results in cubic feet.
2. Multiply cubic feet by 0.0733 tons / cubic foot which results in tons of asphalt concrete backup material.

A copy of the original sealed and signed drawing is on file in the central office.

ASPHALT CONCRETE CURB

(ASPHALT BACKUP MATERIAL INSTALLATION)

Virginia Department of Transportation

2016 ROAD & BRIDGE STANDARDS
ASPHALT PAVING UNDER GUARDRAIL
(FOR USE WHERE ASPHALT CURB IS NOT REQUIRED)

NOTES:
1. CONSTRUCTED WITH THE SAME MATERIAL AND TO THE SAME DEPTH AS THE ROADWAY PAVED SHOULDER.
2. CONSTRUCTED WITH THE SAME ASPHALT MATERIALS AS THE PAVED SHOULDER FROM THE FACE OF RAIL TO THE SHOULDER HINGE POINT AT FOLLOWING DEPTHS:
   ALLOWABLE DEPTHS OF ASPHALT MATERIAL
   SM-9.5A OR SM-12.5D 1.5"
   IM-19.0A OR IM-19.0D 2"
3. MAXIMUM ALLOWABLE DEPTH FOR PAVING UNDER GUARDRAIL IS 2 INCHES.
4. DISTANCE FROM THE FACE OF RAIL TO THE HINGE POINT IN ACCORDANCE WITH THE GUARDRAIL STANDARD USED.
5. SEE GUARDRAIL OR GUARDRAIL TERMINAL STANDARD FOR INSTALLATION AND SITE PREPARATION REQUIREMENTS.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

ASPHALT PAVING UNDER GUARDRAIL

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
CONCRETE MEDIAN CURB

WHEN ROADWAY DESIGN MEETS THE CRITERIA FOR CG-7 AS SHOWN IN APPENDIX A OF THE ROAD DESIGN MANUAL IN THE SECTION ON GS URBAN STANDARDS, MEDIAN CURB IS TO BE IN ACCORDANCE WITH CG-3.

THE DEPTH OF CURB MAY BE REDUCED AS MUCH AS 3" (15" DEPTH) OR INCREASED AS MUCH AS 3" (21" DEPTH) IN ORDER THAT THE BOTTOM OF CURB WILL COINCIDE WITH THE TOP OF A COURSE OF THE PAVEMENT SUBSTRUCTURE. OTHERWISE, THE DEPTH IS TO BE 18" AS SHOWN. NO ADJUSTMENT IN THE PRICE BID IS TO BE MADE FOR A DECREASE OR AN INCREASE IN DEPTH.

INTEGRAL

THE DEPTH OF CURB MAY BE REDUCED AS MUCH AS 3" (15" DEPTH) OR INCREASED AS MUCH AS 3" (21" DEPTH) IN ORDER THAT THE BOTTOM OF CURB WILL COINCIDE WITH THE TOP OF A COURSE OF THE PAVEMENT SUBSTRUCTURE. OTHERWISE, THE DEPTH IS TO BE 18" AS SHOWN. NO ADJUSTMENT IN THE PRICE BID IS TO BE MADE FOR A DECREASE OR AN INCREASE IN DEPTH.

INDEPENDENT

THE DEPTH OF CURB MAY BE REDUCED AS MUCH AS 3" (15" DEPTH) OR INCREASED AS MUCH AS 3" (21" DEPTH) IN ORDER THAT THE BOTTOM OF CURB WILL COINCIDE WITH THE TOP OF A COURSE OF THE PAVEMENT SUBSTRUCTURE. OTHERWISE, THE DEPTH IS TO BE 18" AS SHOWN. NO ADJUSTMENT IN THE PRICE BID IS TO BE MADE FOR A DECREASE OR AN INCREASE IN DEPTH.
NOTES:
(1) THOROUGHLY COMPACTED AREA TO CONSIST OF THE FOLLOWING:
IN FILLS - REGULAR FILL MATERIAL
IN CUTS - UNDISTURBED EARTH AND REGULAR FILL MATERIAL AS REQUIRED.

SUGGESTED CONSTRUCTION METHOD IF TOP SLAB IS Poured SEPARATELY
2" R

ALTERNATE CONSTRUCTION METHOD IF TOP SLAB IS Poured SEPARATELY
2" R

WHEN ROADWAY DESIGN MEETS THE CRITERIA FOR CG-7 AS SHOWN IN APPENDIX A OF THE ROAD DESIGN MANUAL, MEDIAN CURB IS TO BE IN ACCORDANCE WITH STANDARD CG-3.
• THE DEPTH OF CURB MAY BE REDUCED AS MUCH AS 3" (9" DEPTH) OR INCREASED AS MUCH AS 3" (15" DEPTH) IN ORDER THAT THE BOTTOM OF CURB WILL COINCIDE WITH THE TOP OF A COURSE OF THE PAVEMENT STRUCTURE. OTHERWISE, THE DEPTH IS TO BE 12" AS SHOWN. NO ADJUSTMENT IN THE PRICE BID IS TO BE MADE FOR A DECREASE OR AN INCREASE IN DEPTH.

ALTERNATE WITH EXTRUDED CURB

WHEN MEDIAN WIDTH IS 3 FEET OR GREATER, A LONGITUDINAL CONTRACTION JOINT SHALL BE PROVIDED ALONG ξ OF MEDIAN STRIP.

CIRCULAR NOSE

NON-SYMMETRICAL NOSE

ADDITIONAL HOLES OF ADEQUATE SIZE TO BE PROVIDED FOR SIGN POSTS, DELINEATOR POSTS, ETC. AS SHOWN ON THE PLANS OR DIRECTED BY THE ENGINEER.

SPECIFICATION REFERENCE
502

VIRGINIA DEPARTMENT OF TRANSPORTATION

ROAD AND BRIDGE STANDARDS

REVISION DATE SHEET 1 OF 1
202.03

2016 ROAD & BRIDGE STANDARDS
STANDARD RAISED GRASS MEDIAN STRIPS

FOR DETAILS OF INTEGRAL CURB
SEE STANDARD MC-1 OR CG-3

WHEN ROADSIDE DESIGN MEETS THE
CRITERIA FOR CG-7 AS SHOWN IN
APPENDIX A OF THE ROAD DESIGN
MANUAL IN SECTION ON GS
STANDARDS, MEDIAN CURB IS TO
BE IN ACCORDANCE WITH CG-3

FOR DETAILS OF INDEPENDENT CURB
SEE STANDARD MC-1 OR CG-3

HALF SECTION WITH PROP. CONCRETE
OR FLEXIBLE PAVEMENT

HALF SECTION WITH PROP. CONCRETE
OR FLEXIBLE PAVEMENT

FOR DETAILS OF INDEPENDENT CURB
SEE STANDARD MC-1 OR CG-3

HALF SECTION WITH EXISTING FLEXIBLE PAVEMENT

HALF SECTION WITH EXIST. FLEXIBLE BASE
WITH ASPHALT TOP

PAVEMENT UNDER MEDIAN TO BE REMOVED

1/4"" SLOPE
2" TOP SOIL
(1)

1/4"" SLOPE
2" TOP SOIL
(1)

1/4"" SLOPE
2" TOP SOIL
(1)

1/4"" SLOPE
2" TOP SOIL
(1)

1/4"" SLOPE
2" TOP SOIL
(2)

1/4"" SLOPE
2" TOP SOIL
(2)

EXIST. FLEXIBLE PAVEMENT
2" ASPHALT CONCRETE TYPE SM-9.5 A OR D
FOR DETAILS OF INTEGRAL CURB
SEE STANDARD MC-1 OR CG-3

HALF SECTION WITH PROPOSED CONCRETE PAVEMENT

2" ASPHALT CONCRETE TYPE SM-9.5 A OR D
FOR DETAILS OF INDEPENDENT CURB
SEE STANDARD MC-1 OR CG-3

HALF SECTION WITH PROP. CONCRETE OR FLEXIBLE PAVEMENT

2" ASPHALT CONCRETE TYPE SM-9.5 A OR D
FOR DETAILS OF INDEPENDENT CURB
SEE STANDARD MC-1 OR CG-3

HALF SECTION WITH EXISTING FLEXIBLE PAVEMENT

2" ASPHALT CONCRETE TYPE SM-9.5 A OR D
FOR DETAILS OF INDEPENDENT CURB
SEE STANDARD MC-1 OR CG-3

HALF SECTION WITH EXISTING FLEXIBLE PAVEMENT

WHEN ROADWAY DESIGN MEETS THE CRITERIA FOR CG-7 AS SHOWN IN APPENDIX A OF THE ROADWAY DESIGN MANUAL IN SECTION ON GS STANDARDS, MEDIUM CURB IS TO BE IN ACCORDANCE WITH CG-3

(1) THOROUGHLY COMPACTED AREA TO CONSIST OF THE FOLLOWING:
IN FILLS - REGULAR FILL MATERIAL IN CUTS - UNDISTURBED EARTH AND REGULAR FILL MATERIAL, AS REQUIRED.
(2) THOROUGHLY COMPACTED AREA TO CONSIST OF REGULAR FILL MATERIAL.

NOTE: THE ASPHALT CONCRETE SURFACE SLAB IS TO CONFORM TO THE CURRENT ROAD & BRIDGE SPECIFICATIONS FOR SM-9.5 A OR D MATERIAL EXCEPT THAT THE MINIMUM BITUMEN CONTENT IS TO BE 6.5%
STANDARD ENTRANCE GUTTER WITH FLARED OPENING

FOR USE ACROSS SIDEWALK

1. FOR SIDEWALK, CURB AND GUTTER - BUILT CONCURRENTLY.
2. FOR INITIAL CURB AND GUTTER ONLY.
3. FOR INITIAL SIDEWALK ONLY - 7" SIDEWALK TO BE DIPPED.
4. FOR PEDESTRIAN ACCESS ROUTE - MINIMUM 4'-0" TRAVERSABLE WIDTH IS REQUIRED WITH A MAXIMUM 2% CROSS SLOPE.
5. FOR CURB AND GUTTER ONLY - AFTER INITIAL SIDEWALK.
6. FOR CURB AND SIDEWALK ONLY - WITHOUT GUTTER.
7. INDICATES POINT OF GRADE CHANGE.

WHEN USED IN CONJUNCTION WITH STANDARD CG-3 OR CG-7, THE CURB FACE ON THIS STANDARD IS TO BE ADJUSTED TO MATCH THE MOUNTABLE CURB CONFIGURATION.

REFERENCE: 502
PEDESTRIAN ACCESS ROUTE DETAILS WITH & WITHOUT UPAVED SPACE

ADDITIONAL RIGHT-OF-WAY IS REQUIRED IF THE LIMITS OF PEDESTRIAN ACCESS ROUTE EXTEND BEYOND EXISTING OR PROPOSED VDOT RIGHT-OF-WAY.

PEDESTRIAN ACCESS ROUTES PROVIDE A CONTINUOUS UNOBSCECTED, STABLE, FIRM AND SLIP RESISTANT PATH CONNECTING ALL ACCESSIBLE ELEMENTS OF A FACILITY THAT CAN BE APPROACHED, ENTERED AND USED BY PEDESTRIANS.

* IF PEDESTRIAN ACCESS ROUTES ARE BEING PROVIDED, A MINIMUM 4' TRAVERSABLE WIDTH IS REQUIRED WITH A MAX. 2% CROSS SLOPE.

WHEN USED IN CONJUNCTION WITH STANDARD CG-3 OR CG-7, THE CURB FACE ON THIS STANDARD IS TO BE ADJUSTED TO MATCH THE MOUNTABLE CURB CONFIGURATION.

LIMITS OF PEDESTRIAN ACCESS ROUTE EXTEND BEYOND EXISTING OR PROPOSED VDOT RIGHT-OF-WAY.

SECTION A-A

STANDARD ENTRANCE GUTTER

SECTION B-B

SECTION C-C

SECTION D-D

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
GENERAL NOTES

1. When used in conjunction with standard CG-3 or CG-7, the curb face on this standard is to be adjusted to match the mountable curb configuration.

2. See standard CG-12 for curb ramp design to be used with this standard.

3. Mainline pavement shall be constructed to the R/W line (except any subgrade stabilization required for mainline pavement which can be omitted in the entrance.)

4. Radial curb or combination curb and gutter shall not be constructed beyond the R/W line except for replacement purposes.

ENTRANCE NOTES

5. When the entrance radii cannot accommodate the turning requirements of anticipated heavy truck traffic, the depth for sidewalk & curb ramps within the limits of the radii should be increased to 7" (see CG-13)

6. Plans are to indicate when construction of a flow line is required to provide positive drainage across the entrance.

7. The desirable and maximum entrance grade changes (%) are listed in the allowable entrance grade table. These values are not applicable to street connections.

INTERSECTION NOTES

8. When CG-11 is used for street connections, the connection must be designed in accordance with AASHTO policy and the applicable requirements of the VDOT Road Design Manual, including stopping sight distance and V value requirements.

9. Optional flowline may require warping of a portion of gutter to provide positive drainage across the intersection.

ALLOWABLE ENTRANCE GRADE CHANGES

<table>
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<tr>
<th>ENTRANCE VOLUME</th>
<th>GRADE CHANGE (%)</th>
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<tr>
<td></td>
<td>DESIRABLE</td>
</tr>
<tr>
<td>HIGH</td>
<td>MORE THAN 1500 VPD</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>500-1500 VPD</td>
</tr>
<tr>
<td>LOW</td>
<td>LESS THAN 500 VPD</td>
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</tbody>
</table>

Note: Allowable entrance grade table is not applicable to street connections.
EXPANSION JOINT

WIDTH OF ENTRANCE

A

D

C

B

6"

EXPANSION JOINT

MAIN ROADWAY

FLOW LINE

PAY LINE

CG-12 DETECTABLE WARNING (W=2')

PERMISSIBLE CONSTRUCTION JOINT

EXPANSION JOINT

SECTION A-A

FACE OF CURB
NORMAL GUTTER

CLASS A3 CONC.

6" AGGREGATE BASE
TYPE I SIZE 21B

5' - 0"

LIMITS OF CG-13

EXPANSION JOINT

LIMITS OF CG-13

5 X 8" BARS @ 12" C-C
MIN. CONC. COVER 1/2"

PERMISSIBLE CONSTRUCTION JOINT

1 1/2" MINIMUM CONCRETE COVER

SECTION B-B

SECTION C-C

SECTION D-D

PERMISSIBLE CONSTRUCTION JOINT

2'-0"

5 X 8" BARS @ 12" C-C
PERMISSIBLE CONSTRUCTION JOINT

2'-0"

6" AGGREGATE BASE
TYPE I SIZE 21B

PERMISSIBLE CONSTRUCTION JOINT

2'-0"

6" AGGREGATE BASE
TYPE I SIZE 21B

PERMISSIBLE CONSTRUCTION JOINT

2'-0"

6" AGGREGATE BASE
TYPE I SIZE 21B

PEDESTRIAN ACCESS ROUTE DETAIL

ADDITIONAL RIGHT-OFF-WAY IS REQUIRED IF THE LIMITS OF PEDESTRIAN ACCESS ROUTE EX EXTEND BEYOND EXISTING OR PROPOSED VDOT RIGHT-OFF-WAY.

PEDESTRIAN ACCESS ROUTES PROVIDE A CONTINUOUS UNOBSTRUCTED, STABLE, FIRM AND SLIP RESISTANT PATH CONNECTING ALL ACCESSIBLE ELEMENTS OF A FACILITY THAT CAN BE APPROACHED, ENTERED AND USED BY PEDESTRIANS. IF ACCESS ROUTE IS ADJACENT TO BACK OF CURB, MINIMUM WIDTH SHOULD BE 6'.

IF PEDESTRIAN ACCESS ROUTES ARE BEING PROVIDED, A MINIMUM 4' TRAVERSABLE WIDTH IS REQUIRED WITH MAX. 2% CROSS SLOPE.

NOTE:

1. PROPOSED 7" SIDEWALK IS TO BE Poured MONOLITHICALLY WITH ENTRANCE OR BY USING PERMISSIBLE CONSTRUCTION JOINT WITH REQUIRED BARS.

2. PROPOSED 7" SIDEWALK TO BE CLASS A-3 CONCRETE.

3. REQUIRED BARS ARE TO BE NO. 5X8" PLACED 1 CENTER TO CENTER ALONG BACK OF CURB, MID-DEPTH OF SIDEWALK. MINIMUM CONCRETE COVER 1/2".

4. ALL DETAILS AND DIMENSIONS NOT SHOWN ARE THE SAME AS STANDARD CG-9D.

5. THIS DESIGN MAY ALSO BE APPLIED TO OTHER ENTRANCE STANDARDS AS THE NEED ARISES.

6. WHEN USED IN CONJUNCTION WITH STANDARD CG-3 OR CG-7, THE CURB FACE ON THIS STANDARD IS TO BE ADJUSTED TO MATCH THE MOUNTABLE CURB CONFIGURATION.

7. SEE STANDARD CG-12 FOR DETECTABLE WARNING DETAILS.

COMMERCIAL ENTRANCE
(HEAVY TRUCK TRAFFIC ANTICIPATED)
GENERAL NOTES:

1. The detectable warning shall be provided by truncated domes.

2. All detectable warning surface products shall meet the requirements of Section 504 of the specifications for CG-12 detectable warning surface. Detectable warning surface products used shall be from the materials approved product list number 72.

3. Sloping sides of curb ramp may be poured monolithically with ramp floor or by using permissible construction joint with required bars.

4. Required bars are to be No. 5 x 8” placed “center to center” along both sides of the ramp floor, mid-depth of ramp floor. Minimum concrete cover 1/4”.

5. Roadway curb / curb and gutter slope transitions adjacent to curb ramps are included in payment for curb / curb and gutter.

6. Curb ramps are required for sidewalks and shared use paths. The width of the curb ramp shall match sidewalk width. When curb ramps are used in conjunction with a shared use path, the minimum width shall be the width of the shared use path.

7. Detectable warnings shall extend the full width of the curb ramp landing floor.

8. Curb ramps will be installed and located within pedestrian crosswalks as shown on plans or as directed by the engineer. Curb ramps should not be located behind vehicle stop lines, light poles, fire hydrants, drop inlets, etc.

9. Ramps may be placed on radial or tangential sections provided that the curb opening is placed within the limits of the crosswalk and that the slope at the connection of the curb opening is perpendicular to the curb.

10. Detectable warning surface panels shall be installed flush with the back of curb.

11. Where curb ramps intersect a radial section of curb at entrances or street connections, the detectable warning surface shall have a factory radius or be field-modified as recommended by the manufacturer to match the back of curb. See CG-12-INS Pages 204.06 and 204.07 for methods of installing detectable warnings on a radius.

NOTE: COMPONENTS OF CURB RAMPS CONSIST OF THE FOLLOWING:

HYDRAULIC CEMENT SIDEWALK (DEPTH IN INCHES, AREA IN SQUARE YARDS)
CURB WHEN REQUIRED (CG-2 OR CG-3 IN LINEAR FEET)
DETECTABLE WARNING SURFACE (AREA IN SQUARE YARDS)

EACH OF THE ABOVE ITEMS IS A SEPARATE PAY ITEM AND SHOULD BE SUMMARIZED FOR EACH CURB CUT RAMP.

GENERAL NOTES:

TRUNCATED DOME DETAIL

TRUNCATED DOME

16"-2.4" C-C

1.6"-2.4" C-C

50%-65% OF BASE DIAMETER

TOP DIAMETER

BASE DIAMETER

DEFECTABLE WARNING SURFACE INSTALLED ON A RADIUS

AVOID THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

2016 ROAD & BRIDGE STANDARDS
**NOTES:**

1. For general notes on the detectable warning surface, see Sheet 1 of 5.
2. This design to be used for construction that incorporates wider sidewalk, landing (4' wide) required at top of curb ramp. Minimum curb ramp length 8 feet for new construction.
3. Gutter pan shall be a maximum slope of 20:1 at the ramp opening.
4. Diagonal placement is not permitted.
NOTES:
1. FOR GENERAL NOTES ON THE DETECTABLE WARNING SURFACE, SEE SHEET 1 OF 5.
2. THE REQUIRED LENGTH OF A PARALLEL RAMP IS LIMITED TO 15 FEET, REGARDLESS OF THE SLOPE.
3. GUTTER PAN SHALL BE A MAXIMUM SLOPE OF 20:1 AT THE RAMP OPENING.
4. DIAGONAL PLACEMENT IS NOT PERMITTED.

<table>
<thead>
<tr>
<th>ROADWAY GRADE IN PERCENT</th>
<th>MINIMUM RAMP LENGTH IN FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4&quot; CURB</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
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<td>5</td>
<td>10</td>
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<tr>
<td>6</td>
<td>14</td>
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**NOTES:**

1. FOR GENERAL NOTES ON THE DETECTABLE WARNING SURFACE, SEE SHEET 1 OF 5.
2. THE SELECTION OF CURB TYPE AND THE CONFIGURATION OF THE BUFFER STRIP MAY VARY TO MEET EXISTING FIELD CONDITIONS AND ROADWAY GEOMETRICS PROVIDING THE DIMENSIONS AND SLOPES ARE AS NOTED.
3. THIS COMBINED (PARALLEL & PERPENDICULAR) DESIGN CAN BE USED WITH ADJOINING BUFFER STRIP. LANDING AT BOTTOM OF TWO SLOPING SIDES WITH 5' X 5' MIN. DIMENSIONS. THE SHORT PERPENDICULAR RUN TO THE STREET CAN BE PROTECTED BY A LANDSCAPED SETBACK OR CONNECTED TO THE SIDEWALK WITH A WARPED SURFACE.
4. GUTTER PAN SHALL BE A MAXIMUM SLOPE OF 20:1 AT THE RAMP OPENING.
5. DIAGONAL PLACEMENT IS NOT PERMITTED.
1. FOR GENERAL NOTES ON THE DETECTABLE WARNING SURFACE, SEE SHEET 1 OF 5.
2. CURB SHALL BE SHAPED TO MATCH THE FACE OF ROADWAY CURB.
3. SEE ROADWAY PLANS FOR MEDIAN AND REFUGE ISLAND DIMENSIONS
4. RAMPS AND CUT THROUGH'S SHALL BE ALIGNED WITH CROSSWALKS.
5. THE RAMPS AND CUT THROUGH’S SHALL BE INSTALLED AND PAID FOR AS 4" HYDRAULIC CEMENT CONCRETE SIDEWALK IN ACCORDANCE WITH SECTION 504 OF THE ROAD & BRIDGE SPECIFICATIONS. EXCAVATION OF MATERIAL FOR THE INSTALLATION OF THE SIDEWALK SHALL BE INCLUDED IN THE PRICE BID FOR 4" HYDRAULIC CEMENT CONCRETE SIDEWALK.
6. CUT THROUGH'S LESS THAN 6' IN WIDTH SHALL NOT HAVE DETECTABLE WARNINGS INSTALLED.

NOTES:

SECTION A-A

SECTION B-B

SECTION C-C

SECTION D-D

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
**CG-12 DETECTABLE WARNING SURFACE**

**TYPICAL INSTALLATION FOR SHARED-USE PATH WITH SHOULDER**

1. The offset of the detectable warning panel at the landing center is 2" maximum with a 0" offset at each end. Offsets greater than 2" are not permitted and require the detectable warning panels to be cut to match the back of curb radius.

2. Joints between detectable warning panels shall be factory edges. Cut sides of panels are not permitted to abut adjacent panels.

3. Alignment of domes on adjacent panels that will be modified to fit a radius shall be maintained when field modifying detectable warning panels.

4. Partial detectable warning domes that are the result of cutting panels should be ground flush with the panel surface.

5. Gaps between adjacent detectable warning panels are not permitted.

6. See plans for crosswalk markings, turning areas, route widths, grade changes and ramp configurations.

---

**TYPICAL INSTALLATION ON RADIUS**

*(Sidewalks or shared use paths)*

---

**REFERENCES**

- **SPECIFICATION REFERENCE**: 105, 502, 504
- **NEW 04/19**
- **A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.**
NOTES

1. Locations where the detectable warning cannot be installed with a maximum 2" offset from the back of curb shall have a radius to match radius of the curb. Detectable warning panels shall have a factory radius or if approved by the engineer may be field modified as recommended by the manufacturer to match the back of curb.

2. Joints between detectable warning panels shall be factory edges. Cut sides of panels are not permitted to abut adjacent panels.

3. Alignment of domes on adjacent panels that will be modified to fit a radius shall be maintained when field modifying detectable warning panels.

4. Detectable warning panel sizes shown are for example purposes. Other panel sizes may be used in order to maintain consistent alignment of the domes for each curb ramp location.

5. Blended transition curb ramps are for alteration situations where standard directional curb ramps are not feasible due to site constraints. Blended transition curb ramps are not permitted for new construction.

6. Partial detectable warning domes that are the result of cutting panels should be ground flush with the panel surface.

7. Gaps between adjacent detectable warning panels are not permitted.

8. See plans for crosswalk markings, turning areas, route widths, grade changes, and ramp configurations.
SECTION 300

PAVEMENT ITEMS
INDEX OF SHEETS
SECTION 300-PAVEMENT ITEMS
VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

STANDARD | TITLE |
--- | --- |
PR-2 | PLAIN AND REINFORCED CONCRETE PAVEMENT SHOWING REINFORCEMENT, LONGITUDINAL AND TRANSVERSE JOINTS |
PR-3 | 8" CONTINUOUSLY REINFORCED CONCRETE PAVEMENT (FOR USE WITH BAR OR WIRE MESH REINFORCEMENT) |
PR-4 | 9" CONTINUOUSLY REINFORCED CONCRETE PAVEMENT (LEAVE OUT JOINT DETAIL) |
PR-5 | 9" CONTINUOUSLY REINFORCED CONCRETE PAVEMENT 14 FOOT TRAVEL LANE |
PR-6 | 10" CONTINUOUSLY REINFORCED CONCRETE PAVEMENT 14 FOOT TRAVEL LANE |
PR-7 | 11" CONTINUOUSLY REINFORCED CONCRETE PAVEMENT 14 FOOT TRAVEL LANE |
PR-8 | 12" CONTINUOUSLY REINFORCED CONCRETE PAVEMENT 14 FOOT TRAVEL LANE |
PR-9 | 13" CONTINUOUSLY REINFORCED CONCRETE PAVEMENT 14 FOOT TRAVEL LANE |
XJ-1 | BRIDGE APPROACH EXPANSION JOINT (INSTALLATION CRITERIA) |
WP-2 | PAVEMENT WIDENING |
RS-1 | CONTINUOUS GROOVE SHOULDER RUMBLE STRIPS |
RS-2 | CENTERLINE RUMBLE STRIPS |
RS-3 | EDGE LINE RUMBLE STRIPS |
RS-4 | EDGE LINE SHOULDER RUMBLE STRIPS |
RS-5 | SHOULDER EDGE RUMBLE STRIPS |
ACOT-1 | ASPHALT CONCRETE OVERLAY TRANSITIONS
THIS PAGE INTENTIONALLY LEFT BLANK
PLAIN AND REINFORCED CONCRETE PAVEMENT
(SHOWING REINFORCEMENT, LONGITUDINAL AND TRANSVERSE JOINTS)

STEEL FABRIC REINFORCEMENT: Steel fabric reinforcement shall consist of members rigidly attached at all joints or points of intersection except as noted below. Longitudinal members shall be of No. 2 gage wire spaced at 6" on centers. Traverse members shall be No. 4 gage wire spaced at 12" on centers. (Wire reinforcement steel institute designation 6 x 12 - W5.5 x W4).

The widths of steel fabric sheets shall be 4" less than the width of the slab. The number of sheets allowable between contraction joints or between contraction and expansion joints shall not exceed 3.

All members, longitudinal or transverse, shall be so cut that the projecting ends will extend not less than 1" nor more than 11" from the joints or points of intersection of the fabric members.

When it is necessary to lap steel fabric reinforcement, the minimum amount of lap shall be equivalent to the spacing of the wires parallel to the lap.

Other types of mesh reinforcement may be used on written permission of the engineer. The width of sheets and other general requirements, which apply, shall be the same as for steel fabric reinforcement.

Dowels at contraction joints may be placed in the full thickness of pavement by mechanical device in lieu of dowel baskets.

X-RINGED STEEL REINFORCEMENT MAY BE USED IN LIEU OF ROAD SHEETS.

EXPANSION AND CONTRACTION JOINTS:

CONSTRUCTION JOINTS IN BOTH PLAN AND REINFORCED PAVEMENT SHALL HAVE THE SAME LOAD TRANSFER DEVICES AS NOTED FOR CONTRACTION JOINTS IN REINFORCED PAVEMENT.

CONTRACTION JOINTS OF THE TYPE SPECIFIED ON SHEET 2 SHALL BE SPACED AT 30 FOOT INTERVALS FOR REINFORCED CONCRETE PAVEMENT AND AT 15 FOOT INTERVALS FOR PLAIN CONCRETE PAVEMENT UNLESS OTHERWISE NOTED ON JOINT LAYOUTS IN PLANS.

ADJACENT TO ROAD STRUCTURES: Concrete street intersections, or R&A grade x-ings, bridge approach expansion joints and/or transverse expansion joints are to be placed as shown on sheet 2 of 3. Other expansion joints are to be used as specified on plans.

If asphalt concrete is to be applied, all transverse joints are to be sawed, but not widen, except at the end of a days run and when interruptions occur in the concrete operations of more than 30 minutes duration. In these cases, butt construction joints are to be used.

PAVED SHOULDERS: When asphalt concrete paved shoulders are to be used adjacent to either plain or reinforced cement concrete pavement, the edge of the concrete slab is to be painted, to its full depth, with asphaltic material, either CRS-2 or RS-250 as directed by the engineer.

LONGITUDINAL JOINTS: The contractor will be permitted to construct the concrete pavement in dual lanes simultaneously, where the sum of the lane widths does not exceed 20 feet, provided a satisfactory and true longitudinal dummy groove joint is obtained. This is to be done by the use of an approved forming strip or by sawing, at the contractor's option, where lanes are poured separately. The hook bolts or tie bolts shall be in accordance with the details shown on sheet 2. Where both lanes are poured simultaneously, tie bars shall be as detailed on Sheet 2. The maximum width of pavement that may be constructed without a longitudinal joint is 14'-0". For widths greater than 14 feet, the longitudinal joint shall be in the center. No other deviations are to be allowed unless shown on joint layout, plans, or directed by the engineer.

METHOD OF FINISHING AT EXPANSION JOINTS: A protective gap or installation shield of 1/4" steel shall be placed over the top of the expansion joint filler. The finishing machine shall then be allowed to pass over the joint, leaving it as shown in Figure 1, sheet 2. Prior to the initial set the shield shall be removed and a rectangular bar 1/4" less in width than the preformed filler placed on top of the filler. The concrete squeeze finished adjacent to it as shown in Figure 2, and the edges rounded with hand tools, using the bar as a guide. The bar shall then be withdrawn, leaving a joint gap of the same width as the filler.

LONGITUDINAL JOINTS: FOR PAVEMENT CROWN SLOPE, THICKNESS - "T", LANE WIDTH - "W", SEE TYPICAL SECTIONS IN PLANS.

PLAN OF TWO LANES OF CONCRETE PAVEMENT

LONGITUDINAL SECTION A-A

TYPICAL CROSS SECTION CONCRETE PAVEMENT

REINFORCED

CONTRACTION JOINT

LONGITUDINAL JOINT

CONSTRUCTION JOINT

CONTRACTION JOINT

MIN. 5/8" PLAN DOWELS 1/4" DIA HOOK BOLTS OR #5 X 2'-6" DEFORMED TIE BARS @ 30" C-C

MIN. 5/8" PLAN DOWELS 18" LONG @ 12" C-C

EXPANSION JOINT

NOTE: JOINTS OF THE CONCRETE PAVEMENT ARE TO BE SHOWN ALONG WITH THE COMPLETED FORMS OR WHERE FINISHED AS SHOWN BY THE CONTRACTOR, PROVIDING THAT THEY ARE WITHIN THE LIMITS SPECIFIED ON SHEET 2.

PR-2

ROAD AND BRIDGE STANDARDS

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION REFERENCE

316

REVISED DATE

301.01
GENERAL NOTES

ALTERNATE PREFORMED SEALANTS HAVING A CROSS-SECTIONAL AREA COMPARABLE TO TYPE A (CONTRACTION JOINTS) AND TYPE D (EXPANSION JOINTS) AND MEETING THE APPROVAL OF THE ENGINEER MAY BE SUBSTITUTED.

OTHER TYPES OF JOINT MATERIAL ARE TO BE IN ACCORDANCE WITH THE SPECIFICATIONS.

ALL DETAILS NOT SHOWN HEREON TO BE IN ACCORDANCE WITH STANDARDS PR-2, SHEET 2 OF 5.

ALL CONTRACTION JOINTS TO BE SAWED IN CONFORMANCE WITH DETAIL TO THE LEFT, EXCEPT THAT WHERE GRAVEL AGGREGATE IS USED IN THE CONCRETE, THE JOINT MAY BE PREPARED BY FORMING 1/4" OR LESS OF THE WIDTH, FOR THE DEPTH SHOWN WITH NON-METALLIC OR REMOVABLE MATERIAL FOLLOWED BY SAWING TO COMPLETE THE JOINT TO THE REQUIRED WIDTH AND DEPTH.

FOR DETAILS OF TRANSVERSE CONSTRUCTION JOINT, SEE BELOW.

SEALANTS FOR TRANSVERSE CONTRACTION JOINTS

SEALANTS FOR TRANSVERSE EXPANSION JOINTS

FOUR 15" SLAB LENGTHS (PLAIN)

FOR 30" SLAB LENGTHS (REINFORCED)

WIDEN TOP OF GROOVE TO 3/4" x 1/2" & SEAL WITH HOT Poured ELASTOMERIC SEALANT IF ASPHALT TOP IS NOT USED

METHODS OF WIDENING CONCRETE PAVEMENT

PLAIN AND REINFORCED CONCRETE PAVEMENT SHOWING REINFORCEMENT, LONGITUDINAL AND TRANSVERSE JOINTS

VIRGINIA DEPARTMENT OF TRANSPORTATION

ROAD AND BRIDGE STANDARDS

REVISION DATE SHEET 3 OF 5

301.03
SIDE ELEVATION A - A CONTRACTION JOINT

SIDE FRAME DETAIL

NOTES:

1. ENTIRE BAR TO BE LUBRICATED.

2. STAKING PINS, A MINIMUM SIX PER ASSEMBLY, THREE TO EACH SIDE.

3. EXPANSION AND CONTRACTION JOINTS: THE DEVICE FOR SUPPORTING DOWELS AT EXPANSION AND CONTRACTION JOINTS SHALL BE SO CONSTRUCTED THAT IT WILL HOLD THE DOWELS FIRMLY IN POSITION, PARALLEL TO THE SURFACE AND CENTERLINE OF THE SLAB.

4. NO MEMBERS SHALL BE PLACED SO THAT THEY WILL INTERFERE WITH THE FREE FLOW OF CONCRETE BETWEEN THE DOWELS.

5. ASSEMBLY AND WELDING OF ALL MEMBERS SHALL BE SUCH AS TO INSURE A GOOD WORKMANLIKE JOB, WITH ALL JOINTS TRUE AND SQUARE.

6. ASSEMBLIES WHICH HAVE BECOME WARPED OR DAMAGED IN TRANSIT OR STORAGE SO THEY WILL NOT CONFORM TO THE SUBGRADE SHALL NOT BE USED.

7. A SAMPLE OF THE SUPPORTING DEVICE SHALL BE SUBMITTED FOR APPROVAL PRIOR TO THE FILLING OF JOB ORDERS.

PERSPECTIVE VIEW
2016 ROAD & BRIDGE STANDARDS

STANDARD LOAD TRANSFER ASSEMBLY
EXPANSION JOINT

NOTES:
1. DOWEL BAR TO BE MIN. LENGTH OF 18". IF BAR IS NOT CENTERED THE LONG SIDE SHALL BE THE FREE END. SEE STANDARD PR-2.
2. ENTIRE BAR TO BE LUBRICATED.
3. STAKING PINS, A MINIMUM SIX PER ASSEMBLY, THREE TO EACH SIDE.
4. EXPANSION AND CONTRACTION JOINTS; THE DEVICE FOR SUPPORTING DOWELS AT EXPANSION AND CONTRACTION JOINTS SHALL BE SO CONSTRUCTED THAT IT WILL HOLD THE DOWELS FIRMLY IN POSITION, PARALLEL TO THE SURFACE AND CENTER-LINE OF THE SLAB.
5. NO MEMBERS SHALL BE PLACED SO THAT THEY WILL INTERFERE WITH THE FREE FLOW OF CONCRETE BETWEEN DOWELS.
6. ASSEMBLY AND WELDING OF ALL MEMBERS SHALL BE SUCH AS TO INSURE A GOOD WORKMANLIKE JOB, WITH ALL JOINTS TRUE AND SQUARE.
7. ASSEMBLIES WHICH HAVE BECOME WARPED OR DAMAGED IN TRANSIT OR STORAGE SO THEY WILL NOT CONFORM TO THE SUBGRADE SHALL NOT BE USED.
8. A SAMPLE OF THE SUPPORTING DEVICE SHALL BE SUBMITTED FOR APPROVAL PRIOR TO THE FILLING OF JOB ORDERS.

SPECIFICATION REFERENCE
ROAD AND BRIDGE STANDARDS
REVISION DATE
SHEET 5 OF 5
301.05

2016 ROAD & BRIDGE STANDARDS
**SECTION B-B DOUBLE LAP METHOD**

**SECTION C-C PLAN-RAMP & MAIN LINE CONNECTION**

**SECTION A-A**

Transverse construction joint bars are to be placed in the same horizontal plane as 5 longitudinal bars.

**8" THICK CONTINUOUSLY REINFORCED CONC. PAVE. (STEEL BAR REINFORCEMENT)**

**NOTE:** Hook bolts or tie bars are to be placed in the same horizontal plane as 5 longitudinal bars.

5 longitudinal bars are to be lapped and tied in the same horizontal plane.

For 36' width pavement use single 12' lanes with 2 longitudinal construction joints or 12' and 24' lanes with one longitudinal construction joint and one grooved longitudinal joint. Transverse bars shall not extend through longitudinal construction joints, but shall extend full length (23' 9") for grooved longitudinal joints.

Smooth surface to be steel troweled 8" in from the edge of pavement every 500 feet, and station number stamped into it.

The date is to be shown in a similar manner at the beginning of each day's pour. Both outside edges of divided highway to be stamped, one edge of undivided highways where feasible (travel lane).

A copy of the original sealed and signed drawing is on file in the central office.

2016 ROAD & BRIDGE STANDARDS
**LEAVE OUT JOINT**

FOR USE WITH STEEL BAR REINFORCEMENT

* 4 TRANSVERSE (GRADE 60) BARS @ 36" C.C.

TRANSVERSE CONSTRUCTION JOINT

* 5 LONGITUDINAL BARS @ 6" C.C.

LONGITUDINAL JOINT

EXTRA * 5 (GRADE 60) BARS (21' LONG) SHALL BE SPACED AT 12" C.C.

8" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

(LEAVE OUT JOINT DETAIL)

Virginia Department of Transportation

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

2016 ROAD & BRIDGE STANDARDS
5 TRANSVERSE BARS

4" ± 1"

NO LAP WITHIN 3' BEHIND CONSTRUCTION JOINT

LONGITUDINAL CONJ. WITH 36' PAVEMENT

SECTION A-A

NO LAP WITHIN 8' AHEAD OF CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT

LONGITUDINAL STEEL

TO CONTINUE THROUGH JOINT

END LAPS OF BARS

TO BE STAGGERED

ON ANGLE OF 45°

DESIRABLE, 30° MIN.

PLAN VIEW

6 BARS

6'-0" LONG

(Grade 60)

7/12

CHAIRS AT 48" C.C.

NO LAP WITHIN 3' BEHIND

CONSTRUCTION JOINT

6 CHAIRS PER 12' LANE @ 2'-2"

(Grade 60)

SECTION A-A

TRANSVERSE CONSTRUCTION JOINT

LONGITUDINAL STEEL

TO CONTINUE THROUGH JOINT

END LAPS OF BARS

TO BE STAGGERED

ON ANGLE OF 45°

DESIRABLE, 30° MIN.

PLAN VIEW

EXTRA BAR METHOD

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

(Steel Bar Reinforcement)

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS. NO LAP WITHIN 3' BEHIND CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS.

7/12

CHAIRS AT 48" C.C.

NO LAP WITHIN 8' AHEAD OF CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT

LONGITUDINAL STEEL

TO CONTINUE THROUGH JOINT

END LAPS OF BARS

TO BE STAGGERED

ON ANGLE OF 45°

DESIRABLE, 30° MIN.

PLAN VIEW

EXTRA BAR METHOD

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

(Steel Bar Reinforcement)

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9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

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TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS.

7/12

CHAIRS AT 48" C.C.

NO LAP WITHIN 8' AHEAD OF CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT

LONGITUDINAL STEEL

TO CONTINUE THROUGH JOINT

END LAPS OF BARS

TO BE STAGGERED

ON ANGLE OF 45°

DESIRABLE, 30° MIN.

PLAN VIEW

EXTRA BAR METHOD

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

(Steel Bar Reinforcement)

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS. NO LAP WITHIN 3' BEHIND CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS.

7/12

CHAIRS AT 48" C.C.

NO LAP WITHIN 8' AHEAD OF CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT

LONGITUDINAL STEEL

TO CONTINUE THROUGH JOINT

END LAPS OF BARS

TO BE STAGGERED

ON ANGLE OF 45°

DESIRABLE, 30° MIN.

PLAN VIEW

EXTRA BAR METHOD

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

(Steel Bar Reinforcement)

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS. NO LAP WITHIN 3' BEHIND CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS.

7/12

CHAIRS AT 48" C.C.

NO LAP WITHIN 8' AHEAD OF CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT

LONGITUDINAL STEEL

TO CONTINUE THROUGH JOINT

END LAPS OF BARS

TO BE STAGGERED

ON ANGLE OF 45°

DESIRABLE, 30° MIN.

PLAN VIEW

EXTRA BAR METHOD

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

(Steel Bar Reinforcement)

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS. NO LAP WITHIN 3' BEHIND CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS.

7/12

CHAIRS AT 48" C.C.

NO LAP WITHIN 8' AHEAD OF CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT

LONGITUDINAL STEEL

TO CONTINUE THROUGH JOINT

END LAPS OF BARS

TO BE STAGGERED

ON ANGLE OF 45°

DESIRABLE, 30° MIN.

PLAN VIEW

EXTRA BAR METHOD

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

(Steel Bar Reinforcement)

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS. NO LAP WITHIN 3' BEHIND CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS 6 LONGITUDINAL BARS.

7/12

CHAIRS AT 48" C.C.

NO LAP WITHIN 8' AHEAD OF CONSTRUCTION JOINT

TRANVERSE CONSTRUCTION JOINT

LONGITUDINAL STEEL

TO CONTINUE THROUGH JOINT

END LAPS OF BARS

TO BE STAGGERED

ON ANGLE OF 45°

DESIRABLE, 30° MIN.
CONCRETE FOR LUG ANCHORS SHALL BE POURED AGAINST COMPACTED SUBGRADE. CONCRETE FOR LUGS AND ANCHOR SLAB MAY BE POURED MONOLITHICALLY OR POURED USING RAISED KEY CONSTRUCTION JOINT METHOD.

ADEQUATE CONSOLIDATION OF CONCRETE IN LUGS WILL BE OBTAINED WITHOUT DISPLACING Longitudinal Continuous Steel, BY THE USE OF INTERNAL VIBRATION.

WHEN LESS THAN FULL WIDTH LUG AND PAVEMENT SLAB IS PLACED, THE #5 TRANSVERSE STEEL IN THE LUGS SHALL BE EXTENDED, LAPPED AND SPLED AT LEAST 25 DIAMETERS.

SECTION B-B
ANCHOR SLAB TYPE I
(FOR USE ADJACENT TO PLAIN CONCRETE PAVEMENT)

CONSTRUCTION JOINT
PAY LINE CONVENTIONAL PAVEMENT
LONGITUDINAL JT.
PAVEMENT BAR OR WIRE MESH REINF.
TROWEL FINISH & BOND BREAKER
PAY LINES ANCHOR SLAB
INCL SUB SLAB AND PAVEMENT SLAB

SECTION A-A
ANCHOR SLAB TYPE II
(FOR USE ADJACENT TO PLAIN CONCRETE PAVEMENT)

DENOTES 1" EXPANSION JOINT MATERIAL (POLYSTYRENE OR EQUIVALENT)

9" THICK CONTINUOUSLY REINFORCED CONCRETE PAVEMENT
(FOR USE WITH BAR REINFORCEMENT ONLY)

VIRGINIA DEPARTMENT OF TRANSPORTATION

WF BEAM (WEIGHT AND DIMENSIONS)

<table>
<thead>
<tr>
<th>CRCP THICKNESS</th>
<th>EMBEDMENT IN &quot;SUB SLAB&quot;</th>
<th>WF BEAM SIZE</th>
<th>FLANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>14 X 61</td>
<td>10&quot;</td>
</tr>
<tr>
<td>9&quot;</td>
<td></td>
<td>10&quot; X 3/4&quot;</td>
<td>3/8&quot;</td>
</tr>
</tbody>
</table>

NOTES:
CONCRETE SHOULD BE ADEQUATELY VIBRATED UNDER BEAM FLANGE TO ELIMINATE HONEYCOMB.
2" MIN. CONCRETE COVER FOR STEEL IN SUB-SLAB.
WELDED 1/4" STEEL PLATE AT BOTH ENDS OF WF BEAM TO SEAL ENDS.

NOTE: FOR DOWEL & JOINT DETAILS SEE DETAIL OF TRANSVERSE EXPANSION JOINT PR-2

DETAIL-RAISED KEY CONSTRUCTION JOINT
STEEL BAR REINFORCEMENT ONLY

LEAVE OUT JOINT

1 5"

TRANSVERSE CONSTRUCTION JOINT

YIELD BARS

7" 

10'-0" MIN.

5 TRANSVERSE BARS (GRADE 60)

@ 48" C-C

EXTRA 6 (GRADE 60) BARS (21' LONG) SHALL BE SPACED AT 15" C-C.

6 LONGITUDINAL BARS @ 7/4" C-C

LONGITUDINAL

LEAVE OUT JOINT

STEEL BAR REINFORCEMENT ONLY

* LONGITUDINAL STEEL TO CONTINUE THROUGH JOINT.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.

(LEAVE OUT JOINT DETAIL)

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
9" THICK CONTINUOUSLY REINFORCED CONC. PAVE.  
(14 FOOT TRAVEL LANE)
NOTES:
1. HOOK BOLTS OR TIE BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS THE #5 TRANSVERSE BARS. WHERE NECESSARY, ADJUST THE LOCATION OF THE HOOK BOLTS OR TIE BARS TO A 2½" MINIMUM CLEARANCE BETWEEN HOOK BOLTS OR TIE BARS AND TRANSVERSE BARS.

2. TRANSVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS THE #6 LONGITUDINAL BARS.

3. #6 LONGITUDINAL BARS ARE TO BE LAPPED AND TIED IN THE SAME HORIZONTAL PLANE.

4. FOR THE 38 FOOT WIDTH PAVEMENT USE SINGLE 12 FOOT LANES WITH 12 FOOT LONGITUDINAL CONSTRUCTION JOINTS OR 12 FOOT AND 14 FOOT LANES WITH ONE LONGITUDINAL CONSTRUCTION JOINT AND ONE SAW CUT OR TAPE INSERT LONGITUDINAL JOINT. TRANSVERSE BARS SHALL NOT EXTEND THROUGH LONGITUDINAL CONSTRUCTION JOINTS. BUT SHALL EXTEND FULL LENGTH (25'-0") FOR SAW CUT OR TAPE INSERT LONGITUDINAL JOINT.

5. SMOOTH SURFACE TO BE STEEL TROWELED 8" IN FROM EDGE OF PAVEMENT EVERY 500 FT. AND THE STATION NUMBER STAMPED INTO IT AS SHOWN BELOW. THE DATE IS TO BE SHOWN IN A SIMILAR MANNER AT THE BEGINNING OF EACH DAY'S POUR. BOTH OUTSIDE EDGES OF DIVIDED HIGHWAY IS TO BE STAMPED. ONE EDGE OF UNDIVIDED HIGHWAY WHERE FEASIBLE (TRAVEL LANE).

6. DOUBLE LAP REQUIREMENT (40") AND THE EXTRA BAR METHOD APPLY ONLY TO LAPS FALLING WITHIN AN AREA OF 10 FEET BEYOND THE CONSTRUCTION JOINT.

7. CONCRETE FOR LUG ANCHORS SHALL BE Poured AGAINST COMPACTED SUBGRADE. CONCRETE FOR LUGS AND ANCHOR SLAB MAY BE Poured MANUALLY OR Poured USING RAISED KEY CONSTRUCTION JOINT METHOD. ADEQUATE CONSOLIDATION OF CONCRETE IN LUGS WILL BE OBTAINED WITHOUT DISPLACING LONGITUDINAL CONTINUOUS STEEL BY THE USE OF INTERNAL VIBRATION. WHEN LESS THAN FULL WIDTH LUG AND PAVEMENT SLAB IS PLACED, THE #5 TRANSVERSE STEEL IN THE LUGS MUST BE EXTENDED, LAPPED AND SPACED AT LEAST 25 DIAMETERS.

8. LONGITUDINAL STEEL TO CONTINUE THROUGH JOINT. EXTRA #6 BARS 20'-LONG SHALL BE SPACED AT 13½" C-C.

9. CONCRETE SHOULD BE ADEQUATELY VIbrATED UNDER BEAN FLANGE TO ELIMINATE HONEYCOMBS.

10. IN CONDITIONS OF SOFT CLAY UNDERLYING SOILS (AASHTO SOIL CLASSIFICATION OF GROUP A-1, A-2, A-3, A-4, OR A-7) INCLUSIVE OF SUBGROUPS (PER AASHTO MATERIALS SPECIFICATIONS M 145), AN ANCHOR SLAB TYPE I UTILIZING 3 ANCHOR LUGS (ANCHOR SLAB LENGTH = 85") OR AN ANCHOR SLAB TYPE II SHALL BE USED. REINFORCEMENT STEEL SIZE AND SPACING WILL BE THE SAME AS THE CONTINUOUS CONCRETE PAVEMENT.

11. WELD STEEL END PLATE TO BOTH ENDS OF WF BEAM TO SEAL ENDS. WELD SHEAR CONNECTORS TO WEB AND FLANGE OF WF BEAM.

12. 2 INCH MINIMUM CONCRETE COVER FOR STEEL IN SUB-SLABS.

13. WIDE FLANGE BEAM TO BE TREATED WITH CORROSION INHIBITOR PER SECTION 407 OF THE ROAD AND BRIDGE SPECIFICATIONS.

14. ALL REINFORCED BARS SHALL BE GRADE 60 STEEL.

15. THE USE OF TUBE FEEDING TO PLACE REINFORCEMENT IN PLASTIC CONCRETE WILL NOT BE ALLOWED.
NOTES:
1. Hook bolts or tie bars are to be placed in the same horizontal plane as the #5 transverse bars. Where necessary, adjust the location of the hook bolts or tie bars to a 2½" minimum clearance between hook bolts or tie bars and transverse bars.
2. Transverse construction joint bars are to be placed in the same horizontal plane as the #6 longitudinal bars.
3. #6 longitudinal bars are to be lapped and tied in the same horizontal plane.
4. For the 38 ft. width pavement use single 12 foot lanes with two longitudinal construction joints or 12 ft. and 14 ft. lanes with one longitudinal construction joint and one saw cut or tape insert longitudinal joint. Transverse bars shall not extend through longitudinal construction joints, but shall extend full length (25'-6") for saw cut or tape insert longitudinal joint.
5. Smooth surface to be steel troweled 8" in from edge of pavement every 500 ft. and the station number stamped into it as shown below. The date is to be shown in a similar manner at the beginning of each day. Both outside edges of divided highway is to be stamped. One edge of undivided highway where feasible (travel lane).
6. Double lap requirement (40") and the extra bar method apply only to laps falling within an area of 10’ beyond the construction joint.
7. Concrete for lug anchors shall be poured against compacted subgrade. Concrete for lugs and anchor slabs may be poured monolithically or poured using raised key construction joint method. Adequate consolidation of concrete in lugs will be obtained without displacing longitudinal continuous steel by the use of internal vibration. When less than full width lug and pavement slab is placed, the #5 transverse steel in the lugs shall be extended, lapped and spliced at least 25 dia.
8. Longitudinal steel to continue through joint. Extra #6 bars 20’ long shall be spaced at 13½” C-C.
9. Concrete should be adequately vibrated under beam flange to eliminate honeycombs.
10. In conditions of soft clay underlying soils (AASHTO soil classification of Group A-4, A-5, A-6, or A-7) inclusive of subgroups (per AASHTO materials specifications M 145), an anchor slab type I utilizing 5 anchor lugs (anchor slab length - 85") or an anchor slab type II shall be used. Reinforcement steel size and spacing will be the same as the continuous concrete pavement.
11. In conditions of granular underlying soils only (AASHTO soil classification of Group A-1, A-2, or A-3) inclusive of subgroups (per AASHTO materials specifications M 145), an anchor slab type II utilizing 3 anchor lugs (anchor slab length - 5") or an anchor slab type II may be used. Reinforcement steel size and spacing will be the same as the continuous concrete pavement.
12. Weld steel end plate to both ends of WF beam to seal ends. Weld shear connectors to web and flange of WF beam.
13. 2 inch minimum concrete cover for steel in sub-slabs.
14. Wide flange beam to be treated with corrosion inhibitor per section 407 of the Road and Bridge Specifications.
15. All reinforced bars shall be grade 60 steel.
16. The use of tube feeding to place reinforcement in plastic concrete will not be allowed.
NOTES:

1. HOOK BOLTS OR TIE BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS THE #6 TRANSVERSE BARS, WHERE NECESSARY. ADJUST THE LOCATION OF THE HOOK BOLTS OR TIE BARS TO A 2½" MINIMUM CLEARANCE BETWEEN HOOK BOLTS OR TIE BARS AND TRANSVERSE BARS.

2. TRANSVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS THE #6 LONGITUDINAL BARS.

3. #6 LONGITUDINAL BARS ARE TO BE LAPPED AND TIED IN THE SAME HORIZONTAL PLANE.

4. FOR THE 38 FOOT WIDTH PAVEMENT USE SINGLE 12 FOOT LANES WITH TWO LONGITUDINAL CONSTRUCTION JOINTS OR 12 FOOT AND 14 FOOT LANES WITH ONE LONGITUDINAL CONSTRUCTION JOINT AND ONE SAW CUT OR TAPE INSERT LONGITUDINAL JOINT. TRANSVERSE BARS SHALL NOT EXTEND THROUGH LONGITUDINAL CONSTRUCTION JOINTS, BUT SHALL EXTEND FULL LENGTH (25'-6") FOR SAW CUT OR TAPE INSERT LONGITUDINAL JOINT.

5. SMOOTH SURFACE TO BE STEEL TROWELED 8" IN FROM EDGE OF PAVEMENT EVERY 500 FT., AND THE STATION NUMBER STamped INTO IT AS SHOWN BELOW. THE DATE IS TO BE SHOWN IN A SIMILAR MANNER AT THE BEGINNING OF EACH DAYS POUR. BOTH OUTSIDE EDGES OF DIVIDED HIGHWAY ARE TO BE STAMPED, ONE EDGE OF UNDIVIDED HIGHWAY WHERE FEASIBLE (TRAVEL LANE).

6. DOUBLE LAP REQUIREMENT (40") AND THE EXTRA BAR METHOD APPLY ONLY TO LAPS FALLING WITHIN AN AREA OF 10' BEYOND THE CONSTRUCTION JOINT.

7. CONCRETE FOR LUG ANCHORS SHALL BE POURED AGAINST COMPACTED SUBGRADE. CONCRETE FOR LUGS AND ANCHOR SLAB MAY BE POURED MONOLITHICALLY OR POURED USING RAISED KEY CONSTRUCTION JOINT METHOD. ADEQUATE CONSOLIDATION OF CONCRETE IN LUGS WILL BE OBTAINED WITHOUT DISPLACING LONGITUDINAL CONTINUOUS STEEL BY THE USE OF INTERNAL VIBRATION. WHEN LESS THAN FULL WIDTH LUG AND PAVEMENT SLAB IS PLACED, THE #5 TRANSVERSE STEEL IN THE LUGS WILL BE EXTENDED, LAPPED AND SPliced AT LEAST 25 DIAMETERS.

8. LONGITUDINAL STEEL TO CONTINUE THROUGH JOINT. EXTRA #6 BARS 20' LONG SHALL BE SPACED AT 13½" C-C.

9. CONCRETE SHOULD BE ADEQUATELY VIBRATED UNDER BEAM FLANGE TO ELIMINATE HONEYCOMBS.

10. IN CONDITIONS OF SOFT CLAY UNDERLYING SOILS (AASHTO SOIL CLASSIFICATION OF GROUP A-4, A-5, A-6, OR A-7) INCLUSIVE OF SUBGROUPS (PER AASHTO MATERIALS SPECIFICATIONS M 145), AN ANCHOR SLAB TYPE II UTILIZING 5 ANCHOR LUGS (ANCHOR SLAB LENGTH = 85") OR AN ANCHOR SLAB TYPE II SHALL BE USED. REINFORCEMENT STEEL SIZE AND SPACING WILL BE THE SAME AS THE CONTINUOUS CONCRETE PAVEMENT.

IN CONDITIONS OF GRANULAR UNDERLYING SOILS ONLY (AASHTO SOIL CLASSIFICATION OF GROUP A-1, A-2, OR A-3) INCLUSIVE OF SUBGROUPS (PER AASHTO MATERIALS SPECIFICATIONS M 145), AN ANCHOR SLAB TYPE II UTILIZING 3 ANCHOR LUGS (ANCHOR SLAB LENGTH = 55") OR AN ANCHOR SLAB TYPE II MAY BE USED. REINFORCEMENT STEEL SIZE AND SPACING WILL BE THE SAME AS THE CONTINUOUS CONCRETE PAVEMENT.

11. WELD STEEL END PLATE TO BOTH ENDS OF WF BEAM TO SEAL ENDS. WELD SHEAR CONNECTORS TO WEB AND FLANGE OF WF BEAM.

12. 2 INCH MINIMUM CONCRETE COVER FOR STEEL IN SUB-SLABS.

13. WIDE FLANGE BEAM TO BE TREATED WITH CORROSION INHIBITOR PER SECTION 407 OF THE ROAD AND BRIDGE SPECIFICATIONS.

14. ALL REINFORCED BARS SHALL BE GRADE 60 STEEL.

15. THE USE OF TUBE FEEDING TO PLACE REINFORCEMENT IN PLASTIC CONCRETE WILL NOT BE ALLOWED.
NOTES:
1. HOOK BOLTS OR TIE BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS #5 TRANSVERSE BARS. WHERE NECESSARY, ADJUST THE LOCATION OF THE HOOK BOLTS OR TIE BARS TO A 2½" MIN. CLEARANCE BETWEEN HOOK BOLTS OR TIE BARS AND TRANSVERSE BARS.
2. TRANSVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS THE #7 LONGITUDINAL BARS.
3. #7 LONGITUDINAL BARS ARE TO BE LAPPED AND TIED IN THE SAME HORIZONTAL PLANE.
4. FOR THE 38 FOOT WIDTH PAVEMENT USE SINGLE 12 FOOT LANES WITH TWO LONGITUDINAL CONSTRUCTION JOINTS OR 12 FOOT AND 14 FOOT LANES WITH ONE LONGITUDINAL CONSTRUCTION JOINT AND ONE SAW CUT OR TAPE INSERT LONGITUDINAL JOINT. TRANSVERSE BARS SHALL NOT EXTEND THROUGH LONGITUDINAL CONSTRUCTION JOINTS, BUT SHALL EXTEND FULL LENGTH (25'-6") FOR SAW CUT OR TAPE INSERT LONGITUDINAL JOINT.
5. SMOOTH SURFACE TO BE STEEL TROWELED 8" FROM EDGE OF PAVEMENT EVERY 500 FT. AND THE STATION NUMBER STAMPED INTO IT AS SHOWN BELOW. THE DATE IS TO BE SHOWN IN A SIMILAR MANNER AT THE BEGINNING OF EACH DAYS FOUR. BOTH OUTSIDE EDGES OF DIVIDED HIGHWAY ARE TO BE STAMPED. ONE EDGE OF UNDIVIDED HIGHWAY WHERE FEASIBLE (TRAVEL LANE).
6. DOUBLE LAP REQUIREMENT (40") AND THE EXTRA BAR METHOD APPLY ONLY TO LAPS FALLING WITHIN AN AREA OF 10' BEYOND THE CONSTRUCTION JOINT.
7. CONCRETE FOR LUG ANCHORS SHALL BE Poured AGAINST COMPACTED SUBGRADE. CONCRETE FOR LUGS AND ANCHOR SLAB MAY BE POURED MONOLITHICALLY OR USING RAISED KEY CONSTRUCTION JOINT METHOD. ADEQUATE CONSOLIDATION OF CONCRETE IN LUGS WILL BE OBTAINED WITHOUT DISPLACING LONGITUDINAL CONTINUOUS STEEL. BY THE USE OF INTERNAL VIBRATION. WHEN LESS THAN FULL WIDTH LUG AND PAVEMENT SLAB IS PLACED, THE #5 TRANSVERSE STEEL IN THE LUGS SHALL BE EXTENDED, LAPPED AND SPACED AT LEAST 25 DIAMETERS.
8. LONGITUDINAL STEEL TO CONTINUE THROUGH JOINT. EXTRA #6 BARS 20' LONG SHALL BE SPACED AT 13½" C-C.
9. CONCRETE SHOULD BE ADEQUATELY VIBRATED UNDER BEAM FLANGE TO ELIMINATE HONEYCOMBS.
10. IN CONDITIONS OF SOFT CLAY UNDERLYING SOILS (AASHTO SOIL CLASSIFICATION OF GROUP A-4, A-5, A-6, OR A-7) INCLUSIVE OF SUBGROUPS (PER AASHTO MATERIALS SPECIFICATIONS M 145), AN ANCHOR SLAB TYPE I UTILIZING 5 ANCHOR LUGS (ANCHOR SLAB LENGTH = 83") OR AN ANCHOR SLAB TYPE II SHALL BE USED. REINFORCEMENT STEEL SIZE AND SPACING WILL BE THE SAME AS THE CONTINUOUS CONCRETE PAVEMENT.
11. IN CONDITIONS OF GRANULAR UNDERLYING SOILS ONLY (AASHTO SOIL CLASSIFICATION OF GROUP A-1, A-2, OR A-3) INCLUSIVE OF SUBGROUPS (PER AASHTO MATERIALS SPECIFICATIONS M 145), AN ANCHOR SLAB TYPE I UTILIZING 3 ANCHOR LUGS (ANCHOR SLAB LENGTH = 55") OR AN ANCHOR SLAB TYPE II MAY BE USED. REINFORCEMENT STEEL SIZE AND SPACING WILL BE THE SAME AS THE CONTINUOUS CONCRETE PAVEMENT.
12. 2 INCH MINIMUM CONCRETE COVER FOR STEEL IN SUB-SLABS.
13. WIDE FLANGE BEAM TO BE TREATED WITH CORROSION INHIBITOR PER SECTION 407 OF THE ROAD AND BRIDGE SPECIFICATIONS.
14. ALL REINFORCED BARS SHALL BE GRADE 60 STEEL.
15. THE USE OF TUBE FEEDING TO PLACE REINFORCEMENT IN PLASTIC CONCRETE WILL NOT BE ALLOWED.
NOTES:
1. HOOK BOLTS OR TIE BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS #5 TRANSVERSE BARS, WHERE NECESSARY, ADJUST THE LOCATION OF THE HOOK BOLTS OR TIE BARS TO A 2/2" MIN. CLEARANCE BETWEEN HOOK BOLTS OR TIE BARS AND TRANSVERSE BARS.
2. TRANSVERSE CONSTRUCTION JOINT BARS ARE TO BE PLACED IN THE SAME HORIZONTAL PLANE AS THE #7 LONGITUDINAL BARS.
3. #7 LONGITUDINAL BARS ARE TO BE LAPPED AND TIED IN THE SAME HORIZONTAL PLANE.
4. FOR THE 38 FOOT WIDTH PAVEMENT USE SINGLE 12 FOOT LANES WITH TWO LONGITUDINAL CONSTRUCTION JOINTS OR 12 FOOT AND 14 FOOT LANES WITH ONE LONGITUDINAL CONSTRUCTION JOINT AND ONE SAW CUT OR TAPE INSERT LONGITUDINAL JOINT. TRANSVERSE BARS SHALL NOT EXTEND THROUGH LONGITUDINAL CONSTRUCTION JOINTS, BUT SHALL EXTEND FULL LENGTH (25'-6") FOR SAW CUT OR TAPE INSERT LONGITUDINAL JOINT.
5. SMOOTH SURFACE TO BE STEEL TROWELED 9" FROM EDGE OF PAVEMENT EVERY 500 FT. AND THE STATION NUMBER STAMPED INTO IT AS SHOWN BELOW. THE DATE IS TO BE SHOWN IN A SIMILAR MANNER AT THE BEGINNING OF EACH DAYS POUR. BOTH OUTSIDE EDGES OF DIVIDED HIGHWAY ARE TO BE STAMPED. ONE EDGE OF UNDIVIDED HIGHWAY WHERE FEASIBLE (TRAVEL LANE).
6. DOUBLE LAP REQUIREMENT (40") AND THE EXTRA BAR METHOD APPLY ONLY TO LAPS FALLING WITHIN AN AREA OF 10" BEYOND THE CONSTRUCTION JOINT.
7. CONCRETE FOR LUG ANCHORS SHALL BE Poured AGAINST COMPACTED SUBGRADE. CONCRETE FOR LUGS AND ANCHOR SLAB MAY BE Poured MONOLITHICALLY OR USING RAISED KEY CONSTRUCTION JOINT METHOD. ADEQUATE CONSOLIDATION OF CONCRETE IN LUGS WILL BE OBTAINED WITHOUT DISPLACING LONGITUDINAL CONTINUOUS STEEL, BY THE USE OF INTERNAL VIBRATION, WHEN LESS THAN FULL WIDTH LUG AND PAVEMENT SLAB IS PLACED. THE #5 TRANSVERSE STEEL IN THE LUGS SHALL BE EXTENDED, LAPPED AND SPACED AT LEAST 25 DIAMETERS.
8. LONGITUDINAL STEEL TO CONTINUE THROUGH JOINT. EXTRA #6 BARS 20' LONG SHALL BE SPACED AT 13½" C-C.
9. CONCRETE SHOULD BE ADEQUATELY VIBRATED UNDER BEAM FLANGE TO ELIMINATE HONEYCOMBS.
10. IN CONDITIONS OF SOFT CLAY UNDERLYING SOILS (AASHTO SOIL CLASSIFICATION OF GROUP A-4, A-5, A-6, OR A-7) INCLUSIVE OF SUBGROUPS (PER AASHTO MATERIALS SPECIFICATIONS M 145), AN ANCHOR SLAB TYPE I UTILIZING 5 ANCHOR LUGS (ANCHOR SLAB LENGTH = 30") OR AN ANCHOR SLAB TYPE II SHALL BE USED. REINFORCEMENT STEEL SIZE AND SPACING WILL BE THE SAME AS THE CONTINUOUS CONCRETE PAVEMENT.
11. WELD STEEL END PLATE TO BOTH ENDS OF WF BEAM TO SEAL ENDS. WELD SHEAR CONNECTORS TO WEB AND FLANGE OF WF BEAM.
12. 2 INCH MINIMUM CONCRETE COVER FOR STEEL IN SUB-SLABS.
13. WIDE FLANGE BEAM TO BE TREATED WITH CORROSION INHIBITOR PER SECTION 407 OF THE ROAD AND BRIDGE SPECIFICATIONS.
14. ALL REINFORCED BARS SHALL BE GRADE 60 STEEL.
15. THE USE OF TUBE FEEDING TO PLACE REINFORCEMENT IN PLASTIC CONCRETE WILL NOT BE ALLOWED.

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
SECTION B-B

TOP FACE OF SUB-SLAB TO BE STEEL TROWELED SMOOTH
THE END AWAY FROM THE BRIDGE

PAY LINE

LOW SLUMP CONCRETE
HAND FINISHED IN A
SMOOTH PLANE

SEAL JOINTS WITH
ASPHALT CEMENT

PAINT THESE SURFACES
WITH MINIMUM 1/8" COATING
OF ASPHALT CEMENT

OUTSIDE EDGES OF SLAB TO BE CAST
AGAINST COMPACTED SUBGRADE
WITHOUT FORMS. TOP SLAB EDGE OF
SIDE AWAY FROM BRIDGE TO BE
TOOLED TO PRESENT A ROUND EDGE

SELECT BACKFILL AND/OR SUBBASE
MATERIAL TO DEPTHS SHOWN ON
PLANS FOR NORMAL PAVEMENT

SECTION A-A

APPROXIMATE QUANTITIES

<table>
<thead>
<tr>
<th>PER YARD OF TRANSVERSE MEASURE</th>
<th>MAIN LINE PAVEMENT DEPTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUBIC YARDS CLASS A3 CONCRETE</td>
<td>0.30 0.30</td>
</tr>
<tr>
<td>REINFORCING STEEL LBS.</td>
<td>33.44 33.44</td>
</tr>
<tr>
<td>ASPHALT CONCRETE BMW-25.0 TONS</td>
<td>0.16 0.18</td>
</tr>
<tr>
<td>ASPHALT CONCRETE CONN. SM-9.5A OR D</td>
<td>0.06 0.06</td>
</tr>
<tr>
<td>SQ. YARDS CONCRETE PAVEMENT **</td>
<td>0.51 0.52</td>
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</tbody>
</table>

** BEVELED PORTION OF PAVEMENT SLAB HAS BEEN CONVERTED TO EQUIVALENT DESIGN DEPTH OF MAIN LINE PAVEMENT.

BRIDGE APPROACH EXPANSION JOINT

(FOR WIDENING OR MAINTENANCE OF EXISTING XJ-1 ONLY)

VIRGINIA DEPARTMENT OF TRANSPORTATION

SCHEDULE OF REINFORCING STEEL

<table>
<thead>
<tr>
<th>MARK</th>
<th>SIZE</th>
<th>SPACING C-C</th>
<th>LENGTH</th>
<th>NO. REQ'D.</th>
<th>WEIGHT/FT. TRANSVERSE MEASURE LBS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>12&quot;</td>
<td>4'-0&quot;</td>
<td>(W)</td>
<td>4.172</td>
</tr>
<tr>
<td>A1</td>
<td>5</td>
<td>12&quot;</td>
<td>3'-0&quot;</td>
<td>(W)</td>
<td>3.129</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>6&quot;</td>
<td>W-4&quot;</td>
<td>5</td>
<td>5.215</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>6&quot;</td>
<td>7'-8&quot;</td>
<td>(W12)</td>
<td>10.240</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>6&quot;</td>
<td>W-4&quot;</td>
<td>16</td>
<td>10.888</td>
</tr>
</tbody>
</table>

ASPHALT CONCRETE BASE COURSE
TYPE BM-25.0
6" WIDE 8" PAVEMENT
7" WITH 9" EXPANSION

2" ASPHALT CONCRETE TYPE
SM-9.5A OR D

NOTES:
CONCRETE IN SUBSLAB TO BE CLASS A3.
BARS A, A1, B TO BE PLACED AS SHOWN WHETHER PLAIN OR REINFORCED CONCRETE PAVEMENT IS USED.
PORTIONS OF BARS A AND A1, WHICH ARE OUTSIDE OF THE INDICATED PAY LINES ARE INCLUDED IN PRICE BID FOR COMPLETE JOINT.

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WITH BRIDGE APPROACH SLAB
90° REINF. CONC. PAVEMENT
(3 RDWY SLABS) *
75° PLAIN CONC. PAVEMENT
(5 RDWY SLABS) *

WITHOUT BRIDGE APPROACH SLAB
90° REINF. CONC. PAVEMENT
(3 RDWY SLABS) *
75° PLAIN CONC. PAVEMENT
(5 RDWY SLABS) *

PLAN
* DENOTES DESIRABLE VALUES, PAVEMENT TYPE (PLAIN OR REINFORCED) TO BE DETERMINED BY THE MATERIALS DIVISION.
NOTE:
BRIDGE APPROACH EXPANSION JOINT INCLUDING SUB-SLAB IS TO TERMINATE AT EDGE OF THROUGH PAVEMENT.

USED WITH CONCRETE BASE WITH ASPHALT CONCRETE SURFACE

USED ADJACENT TO RAISED MEDIAN

USED ADJACENT TO CURB OR COMBINATION CURB AND GUTTER

NOTES:
ALL CONSTRUCTION FEATURES TO BE IN ACCORDANCE WITH SHEET 1 OF 2.
IF CONCRETE PAVEMENT IS USED ADJACENT TO CONCRETE PAVEMENT WITH ASPHALT CONCRETE SURFACE, THE JOINT IS TO CONTINUE ACROSS ENTIRE WIDTH IN ACCORDANCE WITH SHEET 1 OF 2 AND VIEW A.
IF CONCRETE PAVEMENT IS USED ADJACENT TO FLEXIBLE PAVEMENT THE JOINT IS TO EXTEND THROUGH RIGID PAVEMENT ONLY.
NOTES:

1. ASPHALT PAVEMENT WIDENING SHALL HAVE A PAVEMENT DESIGN IN ACCORDANCE WITH CURRENT VDOT PROCEDURES AND BE APPROVED BY THE ENGINEER.

2. THE PAVEMENT DESIGN FOR ASPHALT PAVEMENT WIDENING SHALL MEET OR EXCEED THE DEPTHS AND TYPES OF THE LAYERS OF EXISTING PAVEMENT. SUBSURFACE DRAINAGE OF THE EXISTING AND PROPOSED PAVEMENT SHALL BE ADDRESSED IN THE PAVEMENT DESIGN.

3. A MINIMUM OF THREE CORES SHALL BE TAKEN ALONG THE CENTER OF THE ADJACENT TRAVEL LANE TO DETERMINE THE TYPE AND THICKNESS OF EXISTING PAVEMENT LAYERS. THESE CORES SHALL BE SPACED NO MORE THAN 500 FEET APART.

4. THE ADJACENT TRAVEL LANE SHALL BE MILLED A MINIMUM DEPTH OF 1 1/2 INCHES AND REPLACED WITH AN ASPHALT SURFACE COURSE TO MATCH THE PROPOSED PAVEMENT WIDENING SURFACE COURSE, UNLESS WAIVED BY THE ENGINEER.

5. THE ENGINEER MAY REQUIRE THE MILLING DEPTH OF THE EXISTING PAVEMENT TO BE ADJUSTED TO ACHIEVE AN ACCEPTABLE PAVEMENT CROSS-SLOPE AND EFFECTIVE SURFACE DRAINAGE.

6. EXISTING PAVEMENT MARKINGS AND MARKERS WITHIN THE PROJECT LIMITS SHALL BE RESTORED SUBJECT TO THE APPROVAL OF THE ENGINEER.

7. FINAL TRANSVERSE PAVEMENT TIE-IN SHALL CONFORM TO THE REQUIREMENTS OF SECTION 315 OF THE SPECIFICATIONS EXCEPT THAT ALL JOINTS AT TIE-IN LOCATIONS SHALL BE TESTED USING A 10 FOOT STRAIGHTEDGE IN ACCORDANCE WITH THE REQUIREMENTS OF SECTION 315 OF THE SPECIFICATIONS.
NOTES

1. Rumble strips shall be milled-in continuously following the plans or as directed by the engineer.

2. Rumble strips shall be installed on mainline shoulders only, unless directed by the regional traffic engineer for ramps.

3. Rumble strips shall not be placed within limits of bridge drainage aprons or special design shoulder slot inlets.

4. All material milled to form the rumble strip shall be thoroughly removed, disposed of in a location approved by the engineer, and swept clean of dust.

5. Milling into existing and new pavements shall be in accordance with VDOT specifications, supplemental specifications and special provisions. Overspray of liquid asphalt coating (emulsion) shall not extend more than 2 inches beyond the width of groove and/or shall not come in contact with pavement markings.

6. Rumble strips shall not be placed within 25 feet of any median break crossover or acceleration/deceleration lane taper or within the gore area.

7. Pavement markings and markers shall be placed at times and locations in accordance with the current VDOT standards, contract documents, the Virginia supplement to the MUTCD, and as directed by the engineer.

8. Outside edge line shall be placed 2 inches from the pavement joint and median edge line shall be placed 1 inch from the pavement joint, unless approved by the engineer. The pavement joint shall be within the shoulder unless approved by the engineer.

SPECIFICATION REFERENCE

A COPY OF THE ORIGINAL SEALED AND SIGNED STANDARD DRAWING IS ON FILE IN THE CENTRAL OFFICE

CONTINUOUS GROOVE SHOULDER RUMBLE STRIPS

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
NOTES

1. CENTER LINE RUMBLE STRIPES SHALL BE WILLED-IN CONTINUOUSLY FOLLOWING THE PLANS OR AS DIRECTED BY THE ENGINEER.

2. CENTER LINE RUMBLE STRIPES SHALL NOT BE INSTALLED ON SUBDIVISION STREETS OR IN NARROW UMARKED ROAD SECTIONS WITHOUT PAVEMENT MARKINGS.

3. CENTER LINE RUMBLE STRIPES SHALL NOT BE INSTALLED IN PASSING ZONES EXCEPT WHEN SPECIFIED WITH 12 OR 24 INCH SPACING IN THE CONTRACT DOCUMENTS OR AS DIRECTED BY THE REGIONAL TRAFFIC ENGINEER.

4. CENTER LINE RUMBLE STRIPES SHALL NOT BE INSTALLED WITHIN THE LIMITS OF BRIDGES DRAINAGE APRONS, RAIL GRADE CROSSINGS, MARKED CROSSWALKS OR CENTER TWO-WAY TURN LANES, UNLESS DIRECTED BY THE ENGINEER.

5. CENTER LINE RUMBLE STRIPES SHALL NOT BE PLACED WITHIN 25 FEET OF ANY PUBLIC ROADWAY OR COMMERCIAL DRIVEWAY TAPER OR TURN RADIUS.


7. ALL MATERIAL WILLED TO FORM THE RUMBLE STRIPE SHALL BE THOROUGHLY REMOVED, DISPOSED OF IN A LOCATION APPROVED BY THE ENGINEER, AND SWEPT CLEAN OF DUST.

8. MILLING INTO EXISTING AND NEW PAVEMENTS SHALL BE IN ACCORDANCE WITH VDOT SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS. OVERSPRAY OF LIQUID ASPHALT COATING (EMULSION) SHALL NOT EXTEND MORE THAN 2 INCHES BEYOND THE WIDTH OF GROOVE AND/OR SHALL NOT COME IN CONTACT WITH PAVEMENT MARKINGS.

9. TEMPORARY PAVEMENT MARKINGS OR MARKERS SHALL BE INSTALLED IF PERMANENT MARKINGS CANNOT BE INSTALLED IN ACCORDANCE WITH THE CURRENT VDOT STANDARDS, CONTRACT DOCUMENTS, VIRGINIA SUPPLEMENT TO THE MUTCD, AND AS DIRECTED BY THE ENGINEER.

10. PAVEMENT MARKINGS AND MARKERS SHALL BE PLACED AT TIMES AND LOCATIONS IN ACCORDANCE WITH THE CURRENT VDOT STANDARDS, CONTRACT DOCUMENTS, VIRGINIA SUPPLEMENT TO THE MUTCD, AND AS DIRECTED BY THE ENGINEER.

11. WHEN SPECIFIED ON THE PLANS OR DIRECTED BY THE ENGINEER, RAISED PAVEMENT MARKERS SHALL BE INSTALLED WITH THE CENTER LINE RUMBLE STRIPES IN ACCORDANCE WITH STANDARD PM-8 FOR THE TYPE OF INSTALLATION SPECIFIED.

12. TWO CONSECUTIVE GROOVES FOR THE CENTER LINE RUMBLE STRIPES SHALL BE OMITTED AT THE LOCATION OF THE TYPE C OR D SINGLE RAISED PAVEMENT MARKER TO FACILITATE INSTALLATION.
RS-4 MEDIAN, SECTION VIEW A-A
(SHOULDER WIDTH GREATER THAN 1'-0"

RS-4 OUTSIDE, SECTION VIEW A-A
(SHOULDER WIDTH GREATER THAN 1'-0"

NOTES
1. EDGE LINE RUMBLE STRIPE GROOVES ON THE OUTSIDE RIGHT SHOULDER SHALL BE MILLED-N WITH INTERMITTENT PATTERN OF 45 FEET OF GROOVES FOLLOWED BY A 15-FOOT GAP AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER.

2. EDGE LINE RUMBLE STRIPE GROOVES ON THE MEDIAN SHOULDER OF DIVIDED HIGHWAYS SHALL BE MILLED-N CONTINUOUSLY AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER.

3. EDGE LINE RUMBLE STRIPES SHALL BE INSTALLED ON MAINLINE SHOULDERS ONLY, UNLESS DIRECTED BY THE REGIONAL TRAFFIC ENGINEER FOR RAMPS.

4. EDGE LINE RUMBLE STRIPES SHALL NOT BE INSTALLED WITHIN THE LIMITS OF BRIDGES DRAINAGE APRONS, RAIL GRADE CROSSINGS, OR MARKED CROSSWALKS UNLESS DIRECTED BY THE ENGINEER.

5. EDGE LINE RUMBLE STRIPES SHALL NOT BE PLACED WITHIN 25 FEET OF ANY PUBLIC ROADS, COMMERCIAL DRIVEWAY, MEDIUM BREAK CROSSOVER TAPER OR TURN RADIUS TURN LANE OR ACCELERATION / DECELERATION LANE TAPER OR, WITHIN THE GORE AREA.

6. ALL MATERIAL MILLED TO FORM THE RUMBLE STRIPES SHALL BE THOROUGHLY REMOVED, DISPOSED OF IN A LOCATION APPROVED BY THE ENGINEER, AND SWEEP CLEAN OF DUST.

7. MILLING INTO EXISTING AND NEW PAVEMENTS SHALL BE IN ACCORDANCE WITH VDOT SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS. LIQUID ASPHALT COATING (EMULSION) ONSURSPRAY SHALL NOT EXTEND MORE THAN 2 INCHES BEYOND THE WIDTH OF GROOVE AND/OR SHALL NOT COME IN CONTACT WITH PAVEMENT MARKINGS.

8. TEMPORARY PAVEMENT MARKINGS OR MARKERS SHALL BE INSTALLED IF "PERMANENT MARKINGS CANNOT BE INSTALLED IN ACCORDANCE WITH THE LIMITS SPECIFIED IN SECTION 704 OF THE SPECIFICATIONS AND AT THE DIRECTION OF THE ENGINEER.

9. PAVEMENT MARKINGS AND MARKERS SHALL BE PLACED AT TIME AND LOCATIONS IN ACCORDANCE WITH THE CURRENT VDOT STANDARDS, CONTRACT DOCUMENTS, VIRGINIA SUPPLEMENT TO THE MUTCD, AND AS DIRECTED BY THE ENGINEER.
RS-5 MEDIAN, SECTION VIEW

RS-5 OUTSIDE, SECTION VIEW A-A
(Shoulder width greater than or equal to 5'-6"

PLAN VIEW
PUBLIC ROADWAY OR COMMERCIAL ENTRANCE

NOTES

1. Shoulder rumble strip grooves on the outside right shoulder shall be milled-in with intermittent pattern of 45 feet of grooves followed by a 15-foot gap as shown on the plans or as directed by the engineer.

2. Shoulder rumble strip grooves on the median shoulder of divided highways shall be milled-in continuously as shown on the plans or as directed by the engineer.

3. Shoulder rumble strips shall be installed on mainline shoulders only, unless directed by the regional traffic engineer for ramps.

4. Shoulder rumble strips shall not be installed within the limits of bridges drainage aprons, rail grade crossings, or marked crosswalks, unless directed by the engineer.

5. Shoulder rumble strips shall not be placed within 25 feet of any public roadway commercial driveway, median break crossover taper or turn radius; turn lane taper or acceleration/deceleration lane; or, within the gore area.

6. All material milled to form the rumble strip shall be thoroughly removed, disposed of in a location approved by the engineer, and swept clean of dust.

7. Milling into existing and new pavements shall be in accordance with VDOT specifications, supplemental specifications and special provisions. Liquid asphalt coating (emulsion) overspray shall not extend more than 2 inches beyond the width of groove and/or shall not come in contact with pavement markings.

8. Pavement markings and raised markers shall be placed at times and locations in accordance with the current VDOT standards, contract documents, the Virginia Supplement to the MUTCD, and as directed by the engineer.

9. Outside edge line shall be placed 2 inches from the pavement joint and median edge line shall be placed 1 inch from the pavement joint, unless approved by the engineer. The pavement joint shall be within the shoulder unless approved by the engineer.

A COPY OF THE ORIGINAL SEALED AND SIGNED STANDARD DRAWING IS ON FILE IN THE CENTRAL OFFICE

EDGE LINE SHOULDER RUMBLE STRIPS

VIRGINIA DEPARTMENT OF TRANSPORTATION

ROAD AND BRIDGE STANDARDS

SHEET 1 OF 1
07/16
304.04

SPECIFICATION REFERENCE

310
315

2016 ROAD & BRIDGE STANDARDS
RS-6 OUTSIDE, SECTION VIEW A-A
(SHOULDER WIDTH GREATER THAN 1'-6'"

NOTES

1. SHOULDER EDGE RUMBLE STRIP GROOVES ON THE OUTSIDE RIGHT SHOULDER SHALL BE Milled-IN WITH INTERMITTENT PATTERN OF 45 FEET OF GROOVES FOLLOWED BY A .15-FOOT GAP AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER.

2. SHOULDER RUMBLE STRIP/STRIPE GROOVES ON THE MEDIAN SHOULDER OF DIVIDED HIGHWAYS SHALL BE Milled-IN CONTINUOUSLY AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER.

3. SHOULDER EDGE RUMBLE STRIPS SHALL BE INSTALLED ON MAINLINE SHOULDERS ONLY, UNLESS DIRECTED BY REGIONAL TRAFFIC ENGINEER FOR RAMPS.

4. SHOULDER EDGE RUMBLE STRIPS SHALL NOT BE INSTALLED WITHIN THE LIMITS OF BRIDGES DRAINAGE APRONS, RAIL GRADE CROSSINGS, OR MARKED CROSSWALKS, UNLESS DIRECTED BY THE ENGINEER.

5. SHOULDER EDGE RUMBLE STRIPS SHALL NOT BE Placed WITHIN 25 FEET OF ANY PUBLIC ROADWAY, COMMERCIAL DRIVEWAY, MEDIAN BREAK CROSSOVER TAPER OR TURN RADIUS; TURN LANE TAPER OR ACCELERATION/DECELERATION LANE; OR, WITHIN THE GORE AREA.

6. ALL MATERIAL Milled TO FORM THE RUMBLE STRIP SHALL BE THOROUGHLY REMOVED, DISPOSED OF IN A LOCATION APPROVED BY THE ENGINEER, AND SWEEP CLEAN OF DUST.

7. MILLING INTO EXISTING AND NEW PAVEMENTS SHALL BE IN ACCORDANCE WITH VDOT SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS AND SPECIAL PROVISIONS; LIQUID ASPHALT COATING (EMULSION) OVERSPLAY SHALL NOT EXTEND MORE THAN 2 INCHES BEYOND THE WIDTH OF GROOVE AND/OR SHALL NOT COME IN CONTACT WITH PAVEMENT MARKINGS.

8. PAVEMENT MARKINGS AND RAISED MARKERS SHALL BE PLaced AT TIMES AND LOCATIONS IN ACCORDANCE WITH THE CURRENT VDOT STANDARDS, CONTRACT DOCUMENTS, THE VIRGINIA SUPPLEMENT TO THE MUTCD, AND AS DIRECTED BY THE ENGINEER.

9. OUTSIDE EDGE LINE SHALL BE Placed 2 INCHES FROM THE PAVEMENT JOINT, UNLESS APPROVED BY THE ENGINEER. THE PAVEMENT JOINT SHALL BE WITHIN THE SHOULDER UNLESS APPROVED BY THE ENGINEER.
NOTES

1. Tie-in requirements to intersecting roads or streets shall be in accordance with the contract documents or at the direction of the Engineer.

2. Existing pavement surface shall be planed to transition the top course of the asphalt concrete overlay. Any sub-course termination may be notched into the existing pavement or blended with the next course of pavement.

3. When there is a special provision for rideability included in the contract, a distance of 100 feet (0.02 of a mile), measured from the line of the tie-in will be exempted from pay adjustment.

4. Transition shall begin/end at the project limits, at bridge approach slab/abutment (or an intermediate point determined by the Engineer), and a minimum of 75 feet from a vertical plane of the nearest outer face of the bridge overpass.

5. No overlay or milling shall be permitted on the bridge deck without the prior written approval of the District Bridge Engineer.

<table>
<thead>
<tr>
<th>Transition Rate</th>
<th>Posted Speed MPH</th>
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<tbody>
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<td>20 25 35 40 45 50</td>
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**Temporary Wedge Detail**

Temporary pavement wedge shall be constructed of surface mix asphalt a minimum of 3 feet in length for every inch of depth of pavement milling.

**Transition Geometry**

- Single Course Overlay Transition Geometry
- Two Course Overlay Transition Geometry
- Three Course Overlay Transition Geometry

**Specifications Reference**

A copy of the original sealed and signed drawing is on file in the Central Office.

210
315
510
515

2016 ROAD & BRIDGE STANDARDS

VIRGINIA DEPARTMENT OF TRANSPORTATION

AASHTO 1
305.01
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SECTION 400

RETAINING WALLS
<table>
<thead>
<tr>
<th>STANDARD</th>
<th>TITLE</th>
<th>PAGE</th>
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<tbody>
<tr>
<td>RW-2</td>
<td>CONCRETE GRAVITY RETAINING WALLS - LEVEL BACKFILL</td>
<td>401.01</td>
</tr>
<tr>
<td>RW-3</td>
<td>CONCRETE GRAVITY RETAINING WALLS INFINITE SURCHARGE AND DECK SURCHARGE - LOADED</td>
<td>401.02</td>
</tr>
<tr>
<td>RW-2, 3</td>
<td>SUGGESTED RUSTICATION TREATMENTS FOR RETAINING WALLS</td>
<td>401.03</td>
</tr>
<tr>
<td>CW-1</td>
<td>STANDARD REINFORCED CONCRETE CRIB WALL</td>
<td>402.01</td>
</tr>
<tr>
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<td>STANDARD REINFORCED CONCRETE CRIB WALL</td>
<td>402.02</td>
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**CONCRETE GRAVITY RETAINING WALL - LEVEL BACKFILL**

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

<table>
<thead>
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<th>ROAD AND BRIDGE STANDARDS</th>
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<td>506</td>
<td>401.01</td>
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**TABLE**

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<tr>
<th>HEIGHT OF WALL &quot;H&quot; IN FEET</th>
<th>THICKNESS AT TOP &quot;A&quot; IN FEET</th>
<th>THICKNESS AT BASE B-.4H</th>
<th>COMPRESSION AT TOE LBS. PER SQ. FT.</th>
<th>AREA OF SECTION SQ. FT.</th>
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<td>1709</td>
<td>8.13</td>
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<tr>
<td>6</td>
<td>&quot;</td>
<td>2'-4¾&quot;</td>
<td>2049</td>
<td>10.83</td>
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<tr>
<td>7</td>
<td>&quot;</td>
<td>2'-9¼&quot;</td>
<td>2385</td>
<td>13.93</td>
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<td>&quot;</td>
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<td>&quot;</td>
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</tr>
<tr>
<td>12</td>
<td>&quot;</td>
<td>4'-9¾&quot;</td>
<td>4050</td>
<td>35.43</td>
</tr>
<tr>
<td>13</td>
<td>&quot;</td>
<td>5'-2¾&quot;</td>
<td>4381</td>
<td>40.93</td>
</tr>
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<td>4712</td>
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<tr>
<td>15</td>
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<td>6'-0&quot;</td>
<td>5043</td>
<td>53.13</td>
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**SAFE BEARING CAPACITY OF SOIL**

- ROCK MINIMUM ................................................................. 10,000 - 20,000 LBS. PER SQ. FT.
- GRAVEL AND COARSE SAND, WELL CEMENTED .......................... 16,000 - 20,000 LBS. PER SQ. FT.
- CLAY IN THICK BEDS, ALWAYS DRY .................................... 12,000 - 16,000 LBS. PER SQ. FT.
- CLAY IN THICK BEDS, MODERATELY DRY ................................. 8,000 - 12,000 LBS. PER SQ. FT.
- CLAY, SOFT ........................................................................ 2,000 - 4,000 LBS. PER SQ. FT.
- SAND, DRY, COMPACT, AND WELL CEMENTED ........................ 8,000 - 12,000 LBS. PER SQ. FT.
- SAND, CLEAN, DRY ............................................................. 4,000 - 8,000 LBS. PER SQ. FT.
- ALLUVIAL SOILS, ETC ......................................................... 1,000 - 2,000 LBS. PER SQ. FT.

**H - HEIGHT IN FT.**

**BASE = 4/10 H**

**EARTH = 100 LBS.**

**CONCRETE = 150 LBS.**

**ANGLE OF REPPOSE = 1/2:1**

**POROUS BACKFILL @ 100 LBS./CU. FT.**

**#78 OR #8 AGGREGATE OR CRUSHED GLASS MEETING #78 OR #8 GRADATION REQUIREMENTS**

**3" DRAIN PIPE 8' APART**

**WEB HOLE WITH 12"x12" PLASTIC HARDWARE CLOTH 1/4" MESH OR GALVANIZED STEEL WIRE, MINIMUM WIRE DIAMETER 0.035" #4 MESH HARDWARE CLOTH ANCHORED FIRMLY TO OUTSIDE OF STRUCTURE.**

**NOTE:**

IF COMPRESSION AT TOE EXCEEDS SAFE BEARING CAPACITY OF SOIL, A SPECIAL FOOTING IS TO BE USED.

DEPTH OF WALL IN GROUND DETERMINED BY CONDITIONS, TO BE NOT LESS THAN 1'-6".
**CONCRETE GRAVITY RETAINING WALLS**

**INFINITE SURCHARGE AND DECK SURCHARGE - LOADED**

**JOINT EXPANSION**

SEE DETAIL

**WATERSTOP MATERIAL. DIMENSIONS SHOWN ARE ABSOLUTE MINIMUM.**

* WATER STOPS TO BE ELASTOMERIC OR OTHER APPROVED

**TOE OF WALL**

**CONTRACTION**

**JOINT FILLER**

**PREMOLDED**

**JOINT**

**PAINTED WITH ASPHALT**

**4"X6" WATERSTOP**

**WATERSTOP**

**NOTE:**

**DEPTH OF WALL IN GROUND DETERMINED BY CONDITIONS. TO BE NOT LESS THAN 1'-6".**

**NOTE:**

**SAFE BEARING CAPACITY OF SOIL**

<table>
<thead>
<tr>
<th>ROCK MINIMUM</th>
<th>10,000 - 20,000 LBS. PER SQ. FT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLAY IN THICK BEDS, ALWAYS DRY</td>
<td>12,000 - 16,000 LBS. PER SQ. FT.</td>
</tr>
<tr>
<td>CLAY IN THICK BEDS, MODERATELY DRY</td>
<td>8,000 - 12,000 LBS. PER SQ. FT.</td>
</tr>
<tr>
<td>CLAY, SOFT</td>
<td>2,000 - 4,000 LBS. PER SQ. FT.</td>
</tr>
<tr>
<td>SAND, DRY, COMPACT, AND WELL CEMENTED</td>
<td>8,000 - 12,000 LBS. PER SQ. FT.</td>
</tr>
<tr>
<td>ALLUVIAL SOILS, ETC</td>
<td>1,000 - 2,000 LBS. PER SQ. FT.</td>
</tr>
</tbody>
</table>

**NOTE:**

**IF COMPRESSION AT TOE EXCEEDS SAFE BEARING CAPACITY OF SOIL, A SPECIAL FOOTING IS TO BE USED.**

**HEIGHT OF WALL**

<table>
<thead>
<tr>
<th>HEIGHT OF WALL</th>
<th>&quot;H&quot; IN FEET</th>
</tr>
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<tbody>
<tr>
<td>3</td>
<td>1'-0&quot;</td>
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<tr>
<td>4</td>
<td>1'-0&quot;</td>
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<tr>
<td>5</td>
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<tr>
<td>7</td>
<td>1'-0&quot;</td>
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<td>1'-0&quot;</td>
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<tr>
<td>9</td>
<td>1'-0&quot;</td>
</tr>
<tr>
<td>10</td>
<td>1'-0&quot;</td>
</tr>
<tr>
<td>11</td>
<td>1'-1 1/4&quot;</td>
</tr>
<tr>
<td>12</td>
<td>1'-2 3/8&quot;</td>
</tr>
<tr>
<td>13</td>
<td>1'-3 5/8&quot;</td>
</tr>
<tr>
<td>14</td>
<td>1'-4 3/4&quot;</td>
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<tr>
<td>15</td>
<td>1'-6&quot;</td>
</tr>
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</table>

**THICKNESS AT TOP "A" IN FEET**

<table>
<thead>
<tr>
<th>THICKNESS AT TOP &quot;A&quot; IN FEET</th>
<th>1'-9 3/8&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>THICKNESS AT BASE B=6H</td>
<td>2'-4 7/8&quot;</td>
</tr>
<tr>
<td>COMPRESSION AT TOE A IN FEET</td>
<td>3'-0&quot;</td>
</tr>
<tr>
<td>AREA OF SECTION SQ. FT.</td>
<td>4'-2 1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>4'-9 1/8&quot;</td>
</tr>
<tr>
<td></td>
<td>5'-4 3/8&quot;</td>
</tr>
<tr>
<td></td>
<td>6'-0&quot;</td>
</tr>
<tr>
<td></td>
<td>6'-7'/4&quot;</td>
</tr>
<tr>
<td></td>
<td>7'-2 1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>7'-9&quot;</td>
</tr>
<tr>
<td></td>
<td>8'-4 3/4&quot;</td>
</tr>
<tr>
<td></td>
<td>9'-0&quot;</td>
</tr>
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</table>

**BATTER 1/2 PER FOOT**

<table>
<thead>
<tr>
<th>BATTER 1/2 PER FOOT</th>
<th>A = 1/8 BASE, WITH MIN. OF 1'.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>EARTH = 100 LBS.</td>
</tr>
<tr>
<td></td>
<td>CONCRETE = 150 LBS.</td>
</tr>
</tbody>
</table>

**WEEP HOLE WITH 12"X12" PLASTIC**

**HARDWARE CLOTH 1/4 MESH OR**

**OR GALVANIZED STEEL WIRE, MINIMUM**

**WIRE DIAMETER 0.03", NUMBER 4**

**MESH HARDWARE CLOTH ANCHORED FIRMLY TO OUTSIDE OF STRUCTURE.**
SUGGESTED RUSTICATION TREATMENTS FOR RETAINING WALLS

VERTICAL GROOVE

RANDOM BOARD RUSTICATION

NOTES:

RUSTIC TREATMENTS FOR STANDARD RW-2 AND RW-3 CONCRETE GRAVITY RETAINING WALLS ARE TO BE CONSIDERED WHERE LARGE AREAS ARE SUBJECT TO VIEWING BY GENERAL PUBLIC. AS A GENERAL GUIDELINE THE USE OF SUCH TREATMENT WILL BE CONSIDERED ON WALLS WHERE THE HEIGHT IS 3’ OR GREATER.

THE SELECTION OF THE PROPOSED TREATMENT SHOULD BE MADE AT THE FIELD INSPECTION REVIEW AND PARTICULAR ATTENTION GIVEN IF THE PROPOSED WALL TIES INTO A BRIDGE ABUTMENT TO INSURE THAT BOTH HAVE THE SAME TREATMENT.

IF ENVIRONMENTAL CONSIDERATIONS DICTATE, OTHER TYPES OF TREATMENTS CAN BE USED.
WALL SECTION "A"

WALL SECTION "B"

WALL SECTION "C"

WALL SECTION "D"

FOR TABLES OF QUANTITIES AND DETAILS OF HEADERS, STRETCHERS & ETC. SEE SHEET 2 OF 2.

NOTES:
SURFACE DRAINAGE SHOULD NOT BE PERMITTED TO FLOW DIRECTLY AGAINST THE FACE OF THE CRIbbing. ALL WALLS ARE TO BE SEPARATED INTO 96" SECTIONS, UNLESS OTHERWISE NOTED ON PLANS OR DIRECTED BY THE ENGINEER, BY THE PROVISION OF DOUBLE ROWS OF HEADERS. IN USING THESE TYPICAL SECTIONS FOR DESIGNING WALLS OF INTERMEDIATE HEIGHT, THE DRAWING SHOULD BE READ FROM THE TOP DOWN UNTIL THE DESIRED HEIGHT IS REACHED.
### 5"X10" HEADERS

<table>
<thead>
<tr>
<th>UNIT</th>
<th>WEIGHT</th>
<th>CU. FT.</th>
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<tbody>
<tr>
<td>5&quot;X8&quot;X4'-0&quot; HEADER</td>
<td>235#</td>
<td>1.48</td>
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<tr>
<td>5&quot;X8&quot;X6'-0&quot; HEADER</td>
<td>325#</td>
<td>2.04</td>
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<tr>
<td>5&quot;X10&quot;X6'-0&quot; HEADER</td>
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<tr>
<td>5&quot;X10&quot;X8'-0&quot; HEADER</td>
<td>515#</td>
<td>3.24</td>
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<tr>
<td>6&quot;X6&quot;X6'-0&quot; STRETCHER</td>
<td>240#</td>
<td>1.50</td>
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<tr>
<td>6&quot;X8&quot;X6'-0&quot; HEADER</td>
<td>320#</td>
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<tr>
<td>5&quot;X10&quot;X10&quot; BLOCK</td>
<td>50#</td>
<td>0.33</td>
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### CRIBBING

Cribbing is to be placed on a foundation of firm bearing material meeting the approval of the engineer.

This foundation is to be at least 3' below the surface of the ground, beyond all danger of frost, unless on solid rock.

For details not shown on this sheet, see sheet 1 of 2.

Blocks shall be set in mortar.

### NOTES:

- All reinforcing to be No. 3 bars placed 1" clear from surface of concrete.
- Bars to be held in position by chairs having non-corrosive tips.
- Class A-5 concrete to be used except maximum size aggregate to be No. 7.
SECTION 500

GUARDRAIL, MEDIAN BARRIER, FENCING & MARKERS
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<td>STANDARD W-BEAM GUARDRAIL HARDWARE</td>
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<tr>
<td></td>
<td>STANDARD THREE BEAM GUARDRAIL HARDWARE</td>
<td>501.03</td>
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<tr>
<td>GR-2, 2A</td>
<td>STANDARD BLOCKED-OUT W-BEAM GUARDRAIL (STRONG POST SYSTEM)</td>
<td>501.04</td>
</tr>
<tr>
<td></td>
<td>STANDARD BLOCKED-OUT W-BEAM GUARDRAIL (STRONG POST SYSTEM) POST AND BLOCKOUT DETAILS</td>
<td>501.09</td>
</tr>
<tr>
<td>GR-3</td>
<td>CABLE GUARDRAILS</td>
<td>501.05</td>
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**INDEX OF SHEETS**

**SECTION 500 - GUARDRAIL, BARRIER AND FENCE**
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SECTION THRU RAIL ELEMENT AND W BEAM BACK-UP PLATE

DETAIL OF SPLICE JOINT

SLOTTED HOLE

DETAIL OF BUTTON HEAD BOLT AND RECESS NUT (GUARDRAIL BOLT)

NOTES:
ALL HARDWARE IS TO BE GALVANIZED IN ACCORDANCE WITH THE SPECIFICATIONS.
THE GUARDRAIL AND MEDIAN BARRIER COMPONENTS DEPICTED IN ARTBA TECHNICAL BULLETIN NUMBER 268B MAY BE SUBSTITUTED IF INTERCHANGEABLE WITH THE STANDARDS FOR GUARDRAIL (GR) OR MEDIAN BARRIER (MB) AND APPROVED BY THE ENGINEER.
NOTE:
LAP IN DIRECTION OF
TRAFFIC AT SPlice JOINT.

2 1/4" POST BOLT SLOT
1 1/4"

SPlice BOLT SLOT 3/8" X 1/4"

2 1/4" X 2 1/2" POST BOLT SLOT (OPTIONAL)
1 1/4"

BEND AND HOLE ONLY
RECO'D. TO MODIFY
CONNECTOR FOR USE
IN GR-7.

THE GUARDRAIL MEDIAN BARRIER COMPONENTS
DEPICTED IN A.R.T.B.A. TECHNICAL BULLETIN
NUMBER 268B MAY BE SUBSTITUITED IF INTER-
CHANGEABLE WITH THE STANDARDS FOR
GUARDRAIL (GR) OR MEDIAN BARRIER (MB) AND
APPROVED BY THE ENGINEER.

* STANDARD DIMENSIONS OF 12 1/2", 24" AND 30" ARE SUGGESTED.

W BEAM END SECTION (BUFFER)

W BEAM END SECTION (FLARED)

W BEAM END SECTION (ROUNDED)
SECTION THRU THRIE BEAM RAIL ELEMENT

NOTES:

THE GUARDRAIL AND MEDIAN BARRIER COMPONENTS DEPICTED IN ARTBA TECHNICAL BULLETIN NUMBER 288B MAY BE SUBSTITUTED IF INTERCHANGEABLE WITH THE STANDARDS FOR GUARDRAIL (GR) OR MEDIAN BARRIER (MB) AND APPROVED BY THE ENGINEER.

LAP IN DIRECTION OF TRAFFIC

DISTANCE BETWEEN POST SLOTS AND THE SUM OF POST BOLT SLOT CENTERS TO BE DESIGNATED.

SPlice DETAIL

TRANSITION SECTION DETAIL
(W-BEAM TO THRIE BEAM)
**GR-2, 2A**

*27\(\frac{3}{4}\)" MIN - 28\(\frac{3}{4}\)" MAX RAIL HEIGHT*

**NOTES:**

Guardrail locations shown on plans are approximate only and can be adjusted during construction if and as directed by the engineer.

For details of post and blockouts see SHEET NO. 501.05.

For details of rail element, rail splice joint, and associated hardware see SHEET NO. 501.01 and 501.02.

Rail elements are furnished shop curved for radii between 3 feet and 150 feet.

All guardrail posts shall be set plumb. Post shall not be set with a variation of more than \(\frac{1}{8}\)" per foot from vertical. W-beam, blockouts, and posts shall be set and aligned without alteration or force, as per Section 505 of the specifications.

All GR-2 and GR-2A rail shall be maintained at a height of 27\(\frac{3}{4}\)" MIN - 28\(\frac{3}{4}\)" MAX as measured per standard GR-ins.

All W-beam rails shall be lapped in the direction of vehicular travel for the finished roadway.

The optional GR-2A methods of nesting the rail or use of an additional rail on the back of the post for standard GR-2A shall be approved by the engineer prior to installation.

**FLARE RATES**

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<th>FLARE RATE</th>
<th>BEYOND SHY LINE</th>
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<td>MPH</td>
<td>FLARE LINE LS</td>
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<tr>
<td>70</td>
<td>9'</td>
<td>30:1</td>
<td>15:1</td>
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<tr>
<td>60</td>
<td>8'</td>
<td>26:1</td>
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<td>6.5'</td>
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<td>30</td>
<td>4'</td>
<td>13:1</td>
<td>7:1</td>
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* Suggested maximum flare rate for semi-rigid barrier systems.
6x8 WOOD POST

The CRT post is for use with the standard GR-10 type III or where specified by the engineer in the plans.

6" WIDE BLOCKOUT

Post may be hot rolled or welded.

4" WIDE BLOCKOUT

Optional hole to facilitate galvanizing.

STEEL POST

The CRT post is for use with the standard GR-10 type III or where specified by the engineer in the plans.

FOR USE WHEN REPAIRING DAMAGED GUARDRAIL CONTAINING STEEL BLOCKOUTS.

BLOCKOUT FOR MAINTENANCE REPAIR ONLY

GUARDRAIL INSTALLATION SITES REQUIRING LONGER GUARDRAIL POSTS

NOTES:
1. All bolts, nuts, washers, and other steel items are to be galvanized.
2. Alternate type posts and blockout may be interchanged on any one project with the restriction that the same type of post and blockout must be used in any single run of guardrail.
3. For details of guardrail element splice joint, hardware, etc., see sheet nos. 501.01 and 501.02.
4. Drive nail on both sides within 2" of the top or bottom of blockout after ½" x 18 bolt is installed.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

STANDARD BLOCKED-OUT W-BEAM GUARDRAIL (STRONG POST SYSTEM, POST AND BLOCKOUT DETAILS)

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

ROAD AND BRIDGE STANDARDS

REVISION DATE 08/14
SHEET 2 OF 2

501.05
TERMINAL TREATMENT FOR W-BEAM GUARDRAIL

NOTES:


2. MAXIMUM DISTANCE BETWEEN BOTTOM OF THE LOWER W-BEAM RAIL AND GROUND LINE IS 18". WHEN DOUBBLE RAIL IS REQ'D., TAPER BOTH W-BEAM RAILS TO MAINTAIN THE 18" DISTANCE FROM THE GROUND.

3. BOTH W-BEAM RAILS TO BE 1'-0" BELOW FINISHED GRADE AT POST #1 (8'-0" OFFSET).

4. A 8'-0" LONG POST MUST BE USED WHEN UPPER AND LOWER W-BEAM RAILS ARE REQUIRED. FROM THE BEGINNING OF THE LOWER RAIL THROUGH POST #3.

5. STANDARD GR-6 TERMINAL TREATMENT MAY BE USED AT THE RUN-ON END OF DIVIDED HIGHWAYS (LEFT AND RIGHT OF TRAFFIC) AND AT THE RUN-ON AND RUN-OFF ENDS ON UNDIVIDED HIGHWAYS.

6. ALL POST SPACING 6'-3" C-C UNLESS OTHERWISE NOTED. THE POST MAY BE W6 X 8.5 STEEL OR 6X8 WOOD EXCEPT THE LAST 3 TERMINAL POSTS MUST BE W6 X 8.5 STEEL.

7. FOR SECTIONS D-D & E-E, AND END ANCHORAGE DETAILS SEE SHEET 501.10.

8. ALL TERMINAL RUN-ON OR RUN-OFF INSTALLATIONS SHALL BE INSTALLED WITH RAILS LAPPED IN THE DIRECTION OF ADJACENT TRAFFIC.


A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

SPECIFICATION REFERENCE

221 505

TERMINAL TREATMENT FOR W-BEAM GUARDRAIL

2016 ROAD & BRIDGE STANDARDS
DETAIL A
END ANCHORAGE

DETAIL B
END ANCHORAGE (POST)

DETAIL C
END ANCHORAGE (CONCRETE)

DETAIL D
1/2" THICK STEEL PLATE

NOTE:
1. 1/2" STEEL PLATE MAY BE WELDED OR BOLTED TO POST. IF PLATE IS BOLTED TO POST USE 4 - 5/8" X 1/2" LG. HEX HEAD BOLTS W/ HEX NUTS. IF PLATE IS WELDED TO POST DO NOT DRILL 1/2" HOLES IN PLATE OR IN POST FLANGES.
2. CONCRETE END ANCHORAGE MAY BE USED IN PLACE OF STEEL POST AT 8'-0" OFFSET.

DETAIL E
1/4" THICK SQUARE WASHER

DETAIL F
SOLID ROCK CUT INSTALLATION

TERMINAL TREATMENT FOR W-BEAM GUARDRAIL

NOTE:
1. PLACE OF STEEL POST AT 8'-0" OFFSET. CONCRETE END ANCHORAGE MAY BE USED IN DRILL 3/8" HOLES IN PLATE OR IN POST FLANGES.
2. IF PLATE IS WELDED TO POST DO NOT DRILL 1/2" HOLES IN PLATE OR IN POST FLANGES.

SECTION D-D
SECTION E-E

NOTE:
SEE DETAIL D
SEE DETAIL A
SEE DETAIL B
SEE DETAIL C
SEE DETAIL E
SEE DETAIL F

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

Virginia Department of Transportation

Road and Bridge Standards
Sheet 2 of 2
Revision Date 7/12

2016 Road & Bridge Standards

Specification Reference

221
505

2016 Road & Bridge Standards
NOTES:
1. GUARDRAIL TERMINAL, STD. GR-7 SHALL BE FROM VDOT'S APPROVED PRODUCTS LIST.

2. ALL TERMINALS SHALL BE INSTALLED ACCORDING TO THE MANUFACTURER'S INSTALLATION INSTRUCTIONS AND THE FOLLOWING VDOT REQUIREMENTS:
   A. ALL STANDARD GR-7 TERMINALS SHALL BE INSTALLED WITH A 4 FT. OFFSET.
   B. YELLOW 8" X 36" REFLECTIVE SHEETING, IN ACCORDANCE WITH VDOT SPECIFICATIONS, SHOULD BE APPLIED TO TERMINALS EMPLOYING W-BEAM END SECTIONS. FOR TERMINALS EMPLOYING IMPACT (EXTRUDER) HEADS, AMBER (YELLOW) REFLECTIVE SHEETING WITH BLACK DIAGONAL STRIPES SHOULD BE APPLIED TO THE FULL AREA INSIDE THE IMPACT HEAD WITH THE DIRECTION OF THE BLACK DIAGONAL STRIPES CONFORMING TO CURRENT MUTCD APPLICATION FOR TYPE 3 OBJECT MARKERS (OM-3).
   C. DO NOT CHANGE THE LAPPING OF TERMINAL FOR ANY INSTALLATIONS. INSTALL AS SHOWN BELOW REGARDLESS OF ADJACENT TRAFFIC DIRECTION.
   D. HEIGHT MEASURED AT TOP OF W-BEAM IS 27¾" MIN. - 28¾" MAX.

3. IF THE NECESSARY CLEAR RUNOUT AREA FOR THE GR-7 TERMINAL CANNOT BE OBTAINED, CONSIDER ALTERNATIVE TERMINAL OPTIONS.

4. THIS DRAWING IS REPRESENTATIONAL ONLY. DETAILS, DIMENSIONS, QUANTITIES, AND OTHER INFORMATION NOT SHOWN WILL VARY FOR EACH MANUFACTURER. SEE INDIVIDUAL MANUFACTURER'S PLANS FOR THIS INFORMATION.
Offsets are measured from a tangential line extended from the end of the standard section of guardrail.

Flared terminal placement on inside of curve - less than 3000 ft. radius

If the offset is less than the standard section offset, the offset will be held at the standard section offset.

Flared end terminal (4' flare)
NOTES:
1. The cross slope of the grade approaching the guardrail terminal and adjacent to for its full length must be 10:1. If the existing grade is flat or is a positive slope due to the super-elevation of the roadway pavement, the min. offset from behind the post to the hinge point, as shown, is required.

2. The area immediately behind and beyond the terminal should be traversable (3:1 or flatter) and free from fixed objects. If the clear run out is not attainable, this area should at least be similar in character to the upstream un-shielded roadside areas.

3. For new construction, reconstruction, and 3R work, the 10:1 slope grading must extend a minimum of 5'-0" behind the end post.

4. For proprietary guardrail terminals, the manufacturer's site preparation requirements take precedence over this standard.

SITE PREPARATION REQUIREMENTS FOR GR-7

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

GUARDRAIL TERMINAL INSTALLATION SITE PREPARATION REQUIREMENTS FOR GR-7

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

GR-7

SPECIFICATION REFERENCE
221
505

REVISION DATE
01/14

SHEET 3 OF 3
501.13
TYPICAL INSTALLATION

SQUARE WASHER

GUARDRAIL POST CONNECTION DETAIL

S 3 X 5.7 STEEL POST

W-BEAM GUARDRAIL (WEAK POST SYSTEM)

TL-3 (>45 MPH)

FOR ROCK INSTALLATION, 8" X 24" X 1/8" PLATE IS TO BE ELIMINATED. DRILL OR EXCAVATE HOLE FOR POST, PLACE POST AND BACKFILL WITH CRUSHER RUN AGGREGATE TO LEVEL OF ROCK.

FOR DETAILS OF GUARDRAIL ELEMENT, SPICE JOINT, HARDWARE, ETC. SEE SHEET NO. 501.01.

THE GUARDRAIL AND MEDIAN BARRIER COMPONENTS DEPICTED IN A.R.T.B.A. TECHNICAL BULLETIN NUMBER 268B MAY BE SUBSTITUTED IF INTERCHANGEABLE WITH THE STANDARDS FOR GUARDRAL (GR) OR MEDIAN BARRIER (MB) AND APPROVED BY THE ENGINEER.

POST SPACING ON CURVES

<table>
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<th>PAVEMENT &amp; RADIUS</th>
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<tr>
<td>&gt; 220 FT. R</td>
<td>12' - 6&quot;</td>
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<tr>
<td>219 FT. - 111 FT.</td>
<td>8&quot; - 3&quot;</td>
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<tr>
<td>111 FT. - 76 FT.</td>
<td>4&quot; - 2½&quot;</td>
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<tr>
<td>75 FT. - 50 FT.</td>
<td>3&quot; - 1½&quot;</td>
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<tr>
<td>&lt; 50 FT.</td>
<td>USE NOT RECOMMENDED</td>
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BOLT AND NUT SHALL HAVE 4000 POUNDS MIN. TENSILE STRENGTH

* HEIGHT TOLERANCE = 3/16"
2016 ROAD & BRIDGE STANDARDS

PLAN

ELEVATION

ANCHOR BLOCK DETAILS

W-BEAM END SECTION (FLARED)

#3 BARS

2 SPlice BOLTS AND NUTS

#3 BARS, PLACED AT EACH CORNER VERTICALLY.

8-3/4" x 18" LONG NON-HEADED ANCHOR BOLTS AASHTO M 270M GRADE A36 MATERIAL, WITH DOUBLE NUTS. DO NOT ALLOW BOLTS TO PROTRUDE ABOVE TOP OF RAIL ELEMENT.

1/4" X 3" X 27" STEEL PLATE WITH 8-1" Ø HOLES @ 3" O.C.

END POST SUPPORT ANGLES

L4"X3"X1/4"-8" LONG

STANDARD W-BEAM GUARDRAIL (WEAK POST SYSTEM)

TL-3 (>45 MPH)

GR-8 TYPE II TERMINAL TREATMENT

(LOCK-OFF ANCHORAGE)

2016 ROAD & BRIDGE STANDARDS
NOTES:

1. TANGENT END TERMINAL (GR-9) SHALL BE A VDOT APPROVED PRODUCT MEETING NCHRP 350 OR MASH TESTING CRITERIA. ANY TERMINAL USED FOR THE GR-9 SHALL BE FROM THE VDOT APPROVED PRODUCTS LIST. STANDARD MB-3 TERMINAL OPTIONS ARE INCLUDED WITH THE GR-9 TERMINALS ON THE APPROVED PRODUCTS LIST.

2. ALL TERMINALS SHALL BE INSTALLED ACCORDING TO THE MANUFACTURER'S INSTALLATION INSTRUCTIONS AND THE FOLLOWING VDOT REQUIREMENTS:

   A. ALL STANDARD GR-9 TERMINALS (SIMILAR TO AS SHOWN ABOVE) SHALL BE INSTALLED WITH A 1 FT. OFFSET ACCOMPLISHED WITH A 50:1 FLARE TO PREVENT THE GUARDRAIL TERMINAL HEAD FROM ENCROACHING ON THE SHOULDER FOR 3R WORK WHERE RIGHT OF WAY IS LIMITED, THE OFFSET CAN BE DECREASED AS DIRECTED BY THE ENGINEER.

   B. DIRECTION OF THE REFLECTIVE TAPE ON THE TERMINAL HEAD SHALL CONFORM TO MUTCD APPLICATION FOR DIAGONAL STRIPES ON OBJECT MARKERS AND BRIDGE END PANELS. COLOR OF TAPE SHALL BE AMBER (YELLOW).

   C. DO NOT CHANGE THE LAPPING OF TERMINAL FOR ANY INSTALLATIONS, INSTALL AS SHOWN ABOVE REGARDLESS OF ADJACENT TRAFFIC DIRECTION.

   D. HEIGHT MEASURED AT TOP OF W-BEAM IS 27¾" MIN. - 28¾" MAX.

3. THIS DRAWING IS REPRESENTATIONAL ONLY. DETAILS, DIMENSIONS, QUANTITIES, AND OTHER INFORMATION NOT SHOWN WILL VARY FOR EACH MANUFACTURER. SEE INDIVIDUAL MANUFACTURER'S PLANS FOR THIS INFORMATION.
NOTES:

1. The cross slope of the grade approaching the guardrail terminal, and adjacent to for its full length, must be 10:1. If the existing grade is flat or is a positive slope due to the super-elevation of the roadway pavement, the minimum offset from behind the post to the hinge point, as shown, is required.

2. The area immediately behind and beyond the terminal should be traversable and free from fixed objects. If a clear run out is not attainable this area should at least be similar in character to the upstream unshielded roadside areas.

3. For new construction and reconstruction the 10:1 slope grading must extend a minimum of 5'-0" behind the end post.

4. For 3R work the grading should be as close as possible to the new construction with slope extending a minimum of 2'-0" behind the blocked out post. From the hinge point tie the graded slope into the existing ditch slope to cover the foundation tubes and soil plates without extending this slope beyond the ditch bottom. Use #21B aggregate, or other suitable material as approved by the Engineer, at roadway shoulders.

5. The taper for new construction will be 15:1. For 3R work the minimum allowable taper is 10:1.

6. For proprietary guardrail terminals the manufacturer's site preparation requirements take precedence over this standard.
ONE POST OMITTED

TOP VIEW
FOR DETAILS OF GUARDRAIL POSTS AND
BLOCKOUTS, SEE STANDARD GR-2, 2A.

TABLE OF MAXIMUM
ALLOWABLE STRUCTURE
WIDTHS FOR THIS DESIGN
* A THE MINIMUM ALLOWABLE
DISTANCE BETWEEN CLOSEST
POINT OF POST TO STRUCTURE.

<table>
<thead>
<tr>
<th>TYPE I - ONE POST OMITTED</th>
<th>TYPE II - TWO POST OMITTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>SKEW</td>
<td>MAX. PERPENDICULAR WIDTH (Feet)</td>
</tr>
<tr>
<td>0° 9&quot;</td>
<td>10.5</td>
</tr>
<tr>
<td>5° 9&quot;</td>
<td>10.4</td>
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<tr>
<td>10° 9&quot;</td>
<td>10.2</td>
</tr>
<tr>
<td>15° 9&quot;</td>
<td>10.0</td>
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<tr>
<td>20° 9&quot;</td>
<td>9.6</td>
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<td>25° 9&quot;</td>
<td>9.2</td>
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<tr>
<td>30° 9&quot;</td>
<td>8.8</td>
</tr>
<tr>
<td>35° 9&quot;</td>
<td>8.2</td>
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<tr>
<td>40° 9&quot;</td>
<td>7.6</td>
</tr>
<tr>
<td>45° 9&quot;</td>
<td>7.0</td>
</tr>
</tbody>
</table>

NOTES:
1. THIS SHEET IS APPLICABLE WHEN GUARDRAIL IS REQUIRED AND THE DEPTH OF
   FILL ABOVE THE TOP SLAB OF THE BOX CULVERT IS LESS THAN 4'-0".
2. GUARDRAIL INSTALLATION SHALL BE IN ACCORDANCE WITH SECTION 505 OF THE
   SPECIFICATIONS. MATERIAL REQUIREMENT FOR COMPONENTS SHALL BE IN
   ACCORDANCE WITH SECTION 221 OF THE SPECIFICATIONS.
3. GUARDRAIL POST SPACING SHALL BE IN ACCORDANCE WITH STANDARD GR-2.
4. THIS DISTANCE SHALL BE IN ACCORDANCE WITH VDOT POLICY ON DETERMINING
   THE LENGTH OF NEED FOR GUARDRAIL WITH A MINIMUM DISTANCE AS SHOWN.
5. ALL SPLICES IN NESTED W-BEAM SECTIONS MUST COINCIDE AT A COMMON POINT
   AND BE BOLTED TOGETHER USING ONE SET OF BOLTS AT EACH SPlice.
GUARDRAIL AT LOW-FILL CULVERTS

NOTE: FOR DETAILS OF GUARDRAIL POSTS AND BLOCKOUTS, SEE STANDARD GR-2.

A  THE MINIMUM ALLOWABLE DISTANCE BETWEEN CLOSEST POINT OF POST TO STRUCTURE.

<table>
<thead>
<tr>
<th>SKEW</th>
<th>A x</th>
<th>MAX. PERPENDICULAR WIDTH (FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>9&quot;</td>
<td>23.00</td>
</tr>
<tr>
<td>5°</td>
<td>9&quot;</td>
<td>22.90</td>
</tr>
<tr>
<td>10°</td>
<td>9&quot;</td>
<td>22.60</td>
</tr>
<tr>
<td>15°</td>
<td>9&quot;</td>
<td>22.10</td>
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<tr>
<td>20°</td>
<td>8&quot;</td>
<td>21.40</td>
</tr>
<tr>
<td>25°</td>
<td>6&quot;</td>
<td>20.00</td>
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<tr>
<td>30°</td>
<td>6&quot;</td>
<td>19.60</td>
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<tr>
<td>35°</td>
<td>6&quot;</td>
<td>18.40</td>
</tr>
<tr>
<td>40°</td>
<td>6&quot;</td>
<td>17.10</td>
</tr>
<tr>
<td>45°</td>
<td>6&quot;</td>
<td>15.60</td>
</tr>
</tbody>
</table>

1. THIS SHEET IS APPLICABLE WHEN GUARDRAIL IS REQUIRED AND THE DEPTH OF FILL ABOVE THE TOP SLAB OF THE BOX CULVERT IS LESS THAN 4'-0".
2. GUARDRAIL INSTALLATION SHALL BE IN ACCORDANCE WITH SECTION 505 OF THE SPECIFICATIONS. MATERIAL REQUIREMENT FOR COMPONENTS SHALL BE IN ACCORDANCE WITH SECTION 221 OF THE SPECIFICATIONS.
3. GUARDRAIL POST SPACING SHALL BE IN ACCORDANCE WITH STANDARD GR-2.
4. TWO NESTED W-BEAM GUARDRAILS, SEE TABLE FOR ALLOWABLE WIDTHS (25'-0" MAXIMUM).
5. TWO NESTED W-BEAM GUARDRAILS, CRT WOOD POST 6'-3" SPACING, WITH TWO 6"x8"x14" WOOD OR RECYCLED MATERIAL BLOCKOUTS.
6. ALL SPLICES IN NESTED W-BEAM SECTIONS MUST COINCIDE AT A COMMON POINT AND BE BOLTED TOGETHER USING ONE SET OF BOLTS AT EACH SPLICE.
ALL STRUCTURAL STEEL, INCLUDING BOLTS, NUTS, AND WASHERS SHALL BE GALVANIZED.

TESTS HAVE SHOWN THAT ALTHOUGH THIS RAIL DEFLECTS HORIZONTALLY TWO OR THREE FEET, ADEQUATE VEHICLE CONTAINMENT AND RE-DIRECTION IS ACHIEVED. THE RESULTING MORE GRADUAL DECELERATION THUS PRODUCES A SAFER CONDITION THAN AFFORDED BY OTHER BRIDGE RAILINGS.

DETAILS ON THIS SHEET ARE TO BE USED FOR BOTH STRAIGHT AND WELDED NUTS) WITH HEX NUTS AND WASHERS AS SHOWN. THREADED RODS MAY BE 0.781 MIN. DIAMETER WITH ROLLED THREADS. NUTS SHALL CONFORM TO A307 REQUIREMENTS AND SHALL BE TAPPED OR CHASED AFTER GALVANIZING. BOLTS AND NUTS SHALL HAVE CLASS 2A AND 2B FIT TOLERANCES. BOLTS SHALL BE EMBEDDED 8" INTO THE CONCRETE.

THE GUARDRAIL INSTALLATION SHALL CONFORM TO SECTION 505 OF THE CURRENT VIRGINIA DEPARTMENT OF TRANSPORTATION ROAD AND BRIDGE SPECIFICATIONS.

RAIL POSTS MAY BE VERTICAL OR PERPENDICULAR TO ADJACENT ROADWAY GRADE AND CROSS SLOPE. TOP OF PEDESTAL SHALL BE SLOPED AS NECESSARY FOR PERPENDICULAR INSTALLATION.

DETAILS ON THIS SHEET ARE TO BE USED FOR BOTH STRAIGHT AND SKEWED BOXES.

ANCHOR BOLTS SHALL BE 3/8 - A307 (OR A36 THREADED RODS WITH TACK WELDED NUTS) WITH HEX NUTS AND WASHERS AS SHOWN. THREADED RODS MAY BE 0.781 MIN. DIAMETER WITH ROLLED THREADS. NUTS SHALL CONFORM TO A307 REQUIREMENTS AND SHALL BE TAPPED OR CHASED AFTER GALVANIZING. BOLTS AND NUTS SHALL HAVE CLASS 2A AND 2B FIT TOLERANCES. BOLTS SHALL BE EMBEDDED 8" INTO THE CONCRETE.

TUBULAR GUARD RAIL SHALL BE FURNISHED AND INSTALLED IN 25 FT. SECTIONS. TUBULAR RAIL MEMBER SHALL BE EXTENDED AND CONNECTED TO AT LEAST THE FIRST SOIL EMBEDDED POST AT EACH END OF THE STRUCTURE. MORE SUCH POSTS SHALL BE USED TO UTILIZE 25 FT. STANDARD SECTIONS. APPROACH GUARDRAIL POSTS SHALL BE SPACED AT 6'-3" ADJACENT TO THE TUBULAR RAIL SINCE ITS FLEXIBILITY IS SIMILAR TO THE STANDARD METAL BEAM GUARDRAIL. DO NOT INSTALL ADDITIONAL POSTS AT 3'-1½" CENTERS. FULLY ANCHORED GUARDRAIL MUST BE ATTACHED AT BOTH ENDS OF TUBULAR RAIL.

TESTS HAVE SHOWN THAT ALTHOUGH THIS RAIL DEFLECTS HORIZONTALLY TWO OR THREE FEET, ADEQUATE VEHICLE CONTAINMENT AND RE-DIRECTION IS ACHIEVED. THE RESULTING MORE GRADUAL DECELERATION THUS PRODUCES A SAFER CONDITION THAN AFFORDED BY OTHER BRIDGE RAILINGS.


BR SERIES BARS SHALL BE 5 IN SIZE.

PRECAST BOXES SHALL BE TREATED AS AN EXISTING BOX FOR PEDESTAL INSTALLATION.

THIS UNIT IS ONLY TO BE USED WHEN DESIGN SPEED IS 45 MPH OR LESS.

TESTED - NCHRP 350 TEST LEVEL 2

TUBULAR GUARD RAIL SHALL BE FURNISHED AND INSTALLED IN 25 FT. SECTIONS. TUBULAR RAIL MEMBER SHALL BE EXTENDED AND CONNECTED TO AT LEAST THE FIRST SOIL EMBEDDED POST AT EACH END OF THE STRUCTURE. MORE SUCH POSTS SHALL BE USED TO UTILIZE 25 FT. STANDARD SECTIONS. APPROACH GUARDRAIL POSTS SHALL BE SPACED AT 6'-3" ADJACENT TO THE TUBULAR RAIL SINCE ITS FLEXIBILITY IS SIMILAR TO THE STANDARD METAL BEAM GUARDRAIL. DO NOT INSTALL ADDITIONAL POSTS AT 3'-1½" CENTERS. FULLY ANCHORED GUARDRAIL MUST BE ATTACHED AT BOTH ENDS OF TUBULAR RAIL.

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THIS UNIT IS ONLY TO BE USED WHEN DESIGN SPEED IS 45 MPH OR LESS.

TESTED - NCHRP 350 TEST LEVEL 2
Notes:

Tubular W-beam rail member is to be fabricated from standard 20 nominal W-beam sections. Top and bottom seams shall be butt welded 8" at 12" spacing. Continuous seam welding is also acceptable. Welds shall be chipped and cleaned and the complete 25 ft. tubular member shall be galvanized after fabrication. For tubular rail splice additional post mounting slots are to be made in each member 1'-3" from the standard slots at 6'-3" centers.

8-1/8" splice nuts shall be tack welded to a bent sheet metal positioner as shown. Other suitable positioning methods or devices may be substituted. The completed splice shall have 8 bolts (16 bolts if a tubular rail splice). Each bolt will include a 1/4" x 3" x 1/8" plate washer or a 2 inch diameter washer.

Washer (see note) 16 ga. bent sheet metal positioner for splice nuts (1 required per splice)

Tack weld (typical for all nuts)

Use standard 3/8" W-beam splice nut (typ.)
NEW BRIDGES - ATTACHMENTS
ONE WAY TRAFFIC - RUN-ON, 2-GR-FOA-1, TYPE I
- RUN-OFF, 2-GR-FOA-1, TYPE II
TWO WAY TRAFFIC - RUN-ON, 4-GR-FOA-1, TYPE I
EXISTING BRIDGE ATTACHMENTS AS SHOWN ON PLANS.

W-Beam GUARDRAIL - FIXED OBJECT ATTACHMENT
FOR USE BETWEEN VERTICAL FIXED OBJECTS AND GUARDRAIL (WOOD POSTS)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MATERIAL/SPECIFICATIONS/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5/8&quot; X 18&quot; LONG GUARDRAIL BOLT AND RECESSED NUT</td>
</tr>
<tr>
<td>2</td>
<td>STANDARD 6&quot; X 8&quot; WOOD POST AND BLOCK</td>
</tr>
<tr>
<td>3</td>
<td>STANDARD W-BEAM TERMINAL CONNECTOR</td>
</tr>
<tr>
<td>4</td>
<td>STANDARD W-BEAM RAIL</td>
</tr>
<tr>
<td>5</td>
<td>5/8&quot; X 2&quot; LONG GUARDRAIL BOLT &amp; RECESSED NUT (SEE STD. GR-HDW)</td>
</tr>
<tr>
<td>6</td>
<td>RECTANGULAR PLATE WASHER (SEE STD. GR-HDW)</td>
</tr>
<tr>
<td>7</td>
<td>BENT PLATE RUBRAIL (SEE SHEET 3 OF 3)</td>
</tr>
<tr>
<td>8</td>
<td>C6 X 8.2 RUBRAIL (SEE SHEET 3 OF 3)</td>
</tr>
<tr>
<td>9</td>
<td>WASHER FOR 5/8&quot; BOLT</td>
</tr>
<tr>
<td>10</td>
<td>COMMON NAIL</td>
</tr>
</tbody>
</table>

NOTES:
1. FIXED OBJECTS MAY CONSIST OF BRIDGE RAIL ENDS, ABUTMENTS, PIER, RETAINING WALLS, OR OTHER FLAT SURFACED STRUCTURES WITH A VERTICAL FACE.
2. BRIDGE RAIL ENDS AND BRIDGE PARAPETS MUST BE OF ADEQUATE STRENGTH TO ACCEPT FULL IMPACT LOADING.
3. GUARDRAIL COMPONENTS SHALL BE IN ACCORDANCE WITH VDOT ROAD AND BRIDGE STANDARDS.
4. POSTS 1, 2, 3, 4, AND 5 REQUIRE AN ADDITIONAL HOLE TO ATTACH BLOCKS AND/OR RUBRAIL. RUBRAIL IS NOT BOLTED TO POSTS 2 AND 4.
5. BOTTOM WOOD BLOCKS LOCATED ON POSTS 1 THROUGH 4 ARE CENTER DRILLED AND SECURED WITH 5/8" GUARDRAIL BOLTS (LENGTH AS REQUIRED).
6. APPROPRIATE LENGTH 5/8" DIAMETER ASTM A449 HEX BOLTS WITH WASHERS MUST BE USED WITH THRU DRILLED HOLES AND A 5/8" BEARING PLATE ON THE BACK SIDE OF THE BRIDGE PARAPET OR TERMINAL WALL.
7. DRIVE NAIL WITHIN 2" OF THE TOP OR BOTTOM OF THE BLOCKOUT AFTER 5/8" X 18 BOLT IS INSTALLED.
8. SEE SHEET 3 OF 3 FOR RUBRAIL BLOCKOUT DETAILS.
NEW BRIDGES - ATTACHMENTS
ONE WAY TRAFFIC - RUN-ON, 2-GR-FOA-1, TYPE I
- RUN-OFF, 2-GR-FOA-1, TYPE II
TWO WAY TRAFFIC - RUN-ON, 4-GR-FOA-1, TYPE I

NOTES:
1. FIXED OBJECTS MAY CONSIST OF BRIDGE RAILS, ABUTMENTS, PIERS, RETAINING WALLS, OR OTHER FLAT SURFACED STRUCTURES WITH VERTICAL FACE.
2. BRIDGE RAIL ENDS AND BRIDGE PARAPETS MUST BE OF ADEQUATE STRENGTH TO ACCEPT FULL IMPACT LOADING.
3. GUARDRAIL COMPONENTS SHALL BE IN ACCORDANCE WITH VDOT ROAD AND BRIDGE STANDARDS.
4. POSTS 1, 2, 3, 4, AND 5 REQUIRE AN ADDITIONAL HOLE TO ATTACH BLOCKS AND/OR RUBRAIL. RUBRAIL IS NOT BOLTED TO POSTS 2 AND 4.
5. BOTTOM WOOD BLOCKS LOCATED ON POSTS 1 THROUGH 4 ARE CENTER DRILLED AND SECURED WITH 3⁄4" GUARDRAIL BOLTS (LENGTH AS REQUIRED).
6. APPROPRIATE LENGTH 3⁄4" DIAMETER ASTM A49 HEX BOLTS WITH WASHERS MUST BE USED WITH THRU DRILLED HOLES AND A 3⁄4" BEARING PLATE ON THE BACK SIDE OF THE BRIDGE PARAPET OR TERMINAL WALL.
7. SEE SHEET 3 OF 3 FOR RUBRAIL BLOCKOUT DETAILS.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>MATERIAL/SPECIFICATIONS/NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3⁄4&quot; X 10&quot; LONG GUARDRAIL BOLT &amp; RECESSED NUT</td>
</tr>
<tr>
<td>2</td>
<td>STD. W6X8.5 OR W6X9 STEEL POST</td>
</tr>
<tr>
<td></td>
<td>STD. 6X8X14&quot; LG TREATED PINE BLOCK OR RECYCLED MATERIAL</td>
</tr>
<tr>
<td>3</td>
<td>STANDARD W-BEAM TERMINAL CONNECTOR</td>
</tr>
<tr>
<td>4</td>
<td>STANDARD W-BEAM RAIL</td>
</tr>
<tr>
<td>5</td>
<td>3⁄4&quot; X 2&quot; LONG GUARDRAIL BOLT &amp; RECESSED NUT (SEE STANDARD GR-HDW)</td>
</tr>
<tr>
<td>6</td>
<td>RECTANGULAR PLATE WASHER (SEE STD. GR-HDW)</td>
</tr>
<tr>
<td>7</td>
<td>BENT PLATE RUBRAIL (SEE SHEET 3 OF 3)</td>
</tr>
<tr>
<td>8</td>
<td>C6 X 8.2 RUBRAIL (SEE SHEET 3 OF 3)</td>
</tr>
<tr>
<td>9</td>
<td>W8 X 13 X 7'-6&quot; LONG STEEL POST WITH STANDARD 6&quot; X 8&quot; X 14&quot; LONG TREATED PINE BLOCK OR RECYCLED MATERIAL</td>
</tr>
</tbody>
</table>
ITEM 7 DETAIL

INDICATES EXTRA POST REQ'D. FOR RUN-OFF FIXED OBJECT ATTACHMENT STD. GR-FOA-1 TYPE II

6'-3" 3'-1/2" 3'-1/2"
SPACING STANDARD GUARDRAIL MAX. TYPE II RUN OFF

ONE WAY TRAFFIC

STANDARD W-BEAM TERMINAL CONNECTOR

AS NEEDED TO ATTACH W-BEAM TERMINAL TO CONNECTOR.

ITEM 8 DETAIL

RUBRAIL BLOCKOUT DETAIL

W-BEAM GUARDRAIL - FIXED OBJECT ATTACHMENT
(RUBRAIL AND HARDWARE DETAILS)

W-BEAM GUARDRAIL - FIXED OBJECT ATTACHMENT
(RUBRAIL AND HARDWARE DETAILS)

W-BEAM GUARDRAIL - FIXED OBJECT ATTACHMENT
(RUBRAIL AND HARDWARE DETAILS)

W-BEAM GUARDRAIL - FIXED OBJECT ATTACHMENT
(RUBRAIL AND HARDWARE DETAILS)
**W-Beam Guardrail - Fixed Object Attachment**

For use with Safety Shape - (Steel Posts)

**Notes:**
1. Fixed objects may consist of safety shaped bridge parapets or concrete barriers.
2. Bridge rail ends and bridge parapets must be of adequate strength to accept full impact loading.
3. Guardrail components shall be in accordance with VDOT road and bridge standards.
4. Posts 1, 2, 3, 4, and 5 require an additional hole to attach lower blocks and/or rubrail. Rubrail is not bolted to posts 2 and 4.
5. Bottom wood blocks located on posts 1 through 4 are center drilled and secured with ¾" guardrail bolts. (Length as required).
6. Rubrail must be twisted 35° between sections C-C and D-D. Shop fabrication may be required. Right hand and left hand twists will be necessary.
7. Appropriate length ¾" ASTM A449 Hex bolts with washers must be used with thru drilled holes and a ¾" bearing plate on the back side of the bridge parapet or concrete barrier.
8. See sheet 3 of 3 for rubrail blockout details.

**Material / Specifications / Notes**

<table>
<thead>
<tr>
<th>Item</th>
<th>Material / Specifications / Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STD W6 x 8.5 or W6 x 9 steel post w/ std. 6&quot; x 8&quot; x 14&quot; LG. treated pine block or recycled material</td>
</tr>
<tr>
<td>2</td>
<td>Standard W-Beam Terminal Connector</td>
</tr>
<tr>
<td>3</td>
<td>Standard W-Beam Rail</td>
</tr>
<tr>
<td>4</td>
<td>¾&quot; x 2&quot; long guardrail bolt and recessed nut (see standard GR-HDW)</td>
</tr>
<tr>
<td>5</td>
<td>Rectangular plate washer (see standard GR-HDW)</td>
</tr>
<tr>
<td>6</td>
<td>Bent plate rubrail (see sheet 3 of 3)</td>
</tr>
<tr>
<td>7</td>
<td>C6 x 8.2 rubrail (see sheet 3 of 3)</td>
</tr>
<tr>
<td>8</td>
<td>¾&quot; x 10&quot; long guardrail bolt and recessed nut (see sheet 3 of 3)</td>
</tr>
<tr>
<td>9</td>
<td>Wood blockout for rubrail (see sheet 3 of 3)</td>
</tr>
<tr>
<td>10</td>
<td>W8 x 13 x 7½&quot; LG. steel post with std. 6&quot; x 8&quot; x 14&quot; LG. treated pine block or recycled material</td>
</tr>
</tbody>
</table>
RUBRAIL AND HARDWARE DETAILS

ITEM 7 DETAIL

RUBRAIL BLOCKOUTS
7" X 4" X THICKNESS

STEEL POSTS
RUBRAIL BLOCKOUTS
7" X 4" X THICKNESS

WOOD POSTS
RUBRAIL BLOCKOUTS
7" X 4" X THICKNESS

NOTES:
1. CAN BE FIELD CUT AND BENT USING HEAT.
IF SHOP CUT AND BENT, RIGHT HAND OR LEFT
HAND MUST BE SPECIFIED DEPENDING ON WHICH
SIDE OF THE ROADWAY THE TRANSITION IS USED.

01/14

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

2016 ROAD & BRIDGE STANDARDS

W-Beam Guardrail - Fixed Object Attachment

Rubrail and Hardware Details

Virginia Department of Transportation

2016 Road & Bridge Standards
ITEM 7 DETAIL

NOTES:

1. CAN BE FIELD CUT AND BENT USING HEAT.
   IF SHOP CUT AND BENT, RIGHT HAND OR LEFT HAND
   MUST BE SPECIFIED, DEPENDING ON WHICH SIDE OF
   THE ROADWAY THE TRANSITION IS USED.

ITEM 9 DETAIL

ITEM 8 DETAIL

W BEAM TERMINAL CONNECTOR (MOD.)
1. Holes, where shown, shall be formed with sleeves of 1/2" diameter nominal pipe.

2. Bolt lengths are to be established by the contractor and approved by the Engineer. All bolts are to be 1/4" dia. hex head machine bolts with beveled washers and self-locking nuts.

3. For two-way traffic design, use run-on end transition (type II).

4. Run-off (type I) guardrail to be used only when required for other reasons.

5. Cost of transition to be included in price bid per foot of traffic barrier service concrete.

6. These instructions applicable for temporary installation in construction zones only. Refer to standard GR-FOA for instructions on permanent installation.
DETAILED OF GUARDRAIL AT BRIDGE PIERS USING STANDARD GR-2

DETAILED OF GUARDRAIL AT BRIDGE PIERS USING STANDARD GR-2 & MB-3
WHEN BACK OF GUARDRAIL IS WITHIN REQUIRED CLEAR ZONE

TYPICAL SECTION

GUARDRAIL SHALL BE PLACED SO THAT A HAZARD IS NOT WITHIN THE DEFLECTION LIMIT OF THE GUARDRAIL. THE GUARDRAIL DESIGN AND PLACEMENT SHOWN ABOVE MAY ALSO BE USED FOR SHIELDING AN OVERHEAD SIGN SUPPORT, FIXED OBJECTS OR OTHER TYPES OF ROAD SIDE OBSTRUCTIONS.

X 25° ANGLE OF VEHICLE DEPARTURE.

SECTION E-E

NOTES:
1. DISTANCE "A" MUST BE GREATER THAN REQ'D. CLEAR ZONE.
2. DISTANCE "B" IS LESS THAN REQ'D. CLEAR ZONE.

W-BEAM GUARDRAIL INSTALLATION CRITERIA

ROAD AND BRIDGE STANDARDS

501.34

2016 ROAD & BRIDGE STANDARDS
**DETAIL OF GUARDRAIL AT DUAL BRIDGES**

**NOTES:**

1. IF A CUT SECTION IS CLOSER THAN 200', A STANDARD GR-6 TERMINAL IS PREFERRED.

2. NO GUARDRAIL IS REQUIRED ON RUN-OFF UNLESS NEEDED TO SHIELD A HAZARD WITHIN THE REQUIRED CLEAR ZONE.

3. NO GUARDRAIL IS REQUIRED ON RUN-OFF UNLESS NEEDED TO SHIELD A HAZARD WITHIN THE REQUIRED CLEAR ZONE.

REFER TO SHEET 501.3+ IF BACK OF GUARDRAIL FROM THE OPPOSING LANES IS WITHIN THE REQUIRED CLEAR ZONE.
2016 ROAD & BRIDGE STANDARDS

SECTION A-A

SECTION B-B

SECTION C-C

SECTION D-D

NOTE:
- If ground level or underground fixed object necessitates the elimination of one or more posts, a GR-10 or a special design will be required.

DETAIL OF SPECIAL DESIGN SITUATION
<table>
<thead>
<tr>
<th>X</th>
<th>W-2'</th>
<th>W-3'</th>
<th>W-4'</th>
<th>W-5'</th>
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**NOTE:**
GUARDRAIL INSTALLATION CRITERIA AS SHOWN ON THESE SHEETS IS TO APPLY TO THOSE LOCATIONS WHERE GUARDRAIL HAS TO BE TRANSITIONED FROM THE NORMAL LOCATION.

LENGTH OF TRANSITION (L) IS TO BE IN ACCORDANCE WITH TABLE IV FOR APPLICABLE VALUES OF W OR AS DIRECTED BY THE ENGINEER.

RAIL TERMINAL SECTIONS IN ACCORDANCE WITH STANDARD GR-6, GR-7 OR GR-8 ARE TO BE INSTALLED AT EACH TERMINUS OF GUARDRAIL WHERE SPECIFIED ON PLANS.

ALL LENGTHS (L) ARE APPLIED ALONG FACE OF GUARDRAIL.

OFFSET SHOWS IN TABLES ARE FOR 6'-3" SPACING, FOR 12'-6" SPACING (GR-8) USE EVERY SECOND VALUE OF Y.

INSTALLATION METHODS SHOWN ON THESE SHEETS ARE APPLICABLE TO STANDARD PLANS GR-2, GR-2A AND GR-8.
TRANSITION FROM STRONG POST TO WEAK POST GUARDRAIL

TRANSITION FROM GR-7 & GR-9 TERMINAL TO WEAK POST GUARDRAIL

TRANSITION FROM GR-6, GR-7, OR GR-9 TERMINAL TO WEAK POST GUARDRAIL

TRANSITION FROM WEAK POST MEDIAN BARRIER TO CONCRETE MEDIAN BARRIER

DETAIL A

[COST OF TRANSITION IS TO BE INCLUDED IN PRICE BID FOR STD. MB-5B MEDIAN BARRIER.]
**2016 ROAD & BRIDGE STANDARDS**

**NOTES:**

STANDARD MB-3 POST SPACING IS 6'-3".

FOR DETAILS OF RAIL ELEMENT, RAIL SPLICE JOINT, W BEAM BACK UP PLATE, AND ASSOCIATED HARDWARE SEE SHEET NO. 501.01.

ALTERNATE TYPE POSTS AND BLOCKOUTS MAY BE INTERCHANGED ON ANY ONE PROJECT WITH THE RESTRICTION THAT THE SAME TYPE OF POST AND BLOCKOUT MUST BE USED IN ANY SINGLE RUN OF MEDIAN BARRIER.

ALL HOLES IN POST TO BE ⅜" DIAMETER.

SOUTHERN PINE

**FLARE RATES**

<table>
<thead>
<tr>
<th>DESIGN SPEED</th>
<th>INSIDE SHY LINE</th>
<th>BEYOND SHY LINE</th>
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<td>FLARE RATE</td>
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</tr>
<tr>
<td>30</td>
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<td>7:1</td>
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</table>

* SUGGESTED MAXIMUM FLARE RATE FOR SEMI-RIGID BARRIER SYSTEMS.

**METHOD OF TREATMENT AT BRIDGE PIER OR MEDIAN OBSTRUCTION**

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

**BLOCKED-OUT W-BEAM MEDIAN BARRIER**

**SPECIFICATION REFERENCE**

<table>
<thead>
<tr>
<th>VDOT ROAD AND BRIDGE STANDARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHEET 1 OF 1</td>
</tr>
<tr>
<td>502.01</td>
</tr>
</tbody>
</table>
The guardrail and median barrier components depicted in A.R.T.B.A. Technical Bulletin Number 2686 may be substituted if interchangeable with the standards for guardrail (GR) or median barrier (MB) and approved by the engineer.

The typical installation includes:
- Height tolerance: ±1/8"
- All posts, bolts, nuts and washers are to be galvanized.

For details of guardrail element, hardware, etc., see Sheet No. 501.01.
For details of guardrail splice joint, see Standard GR-8 depicting an NCHRP 350 TL-3 installation.

Standard W-beam median barrier
(weak post system)

TL-3 (>45 MPH)

Virginia Department of Transportation
TRAFFIC

ST'D. MB-5
4 SPACES @ 6'-3"
ST'D. MB-5A

8 SPACES @ 3'-1/2"
ST'D. MB-5B

5 SPACES @ 6'-3"
ST'D. MB-3

MEDIAN OPENING 20'
(TYPICAL)

MEDIAN

TRANSLATION FROM WEAK POST
AS PER STANDARD GR-INS SHEET 8 OF 8

AN APPROVED IMPACT ATTENUATOR
CAT OR BRAKEMASTER

TREATMENT FOR MEDIAN BARRIER CROSS-OVER
2016 ROAD & BRIDGE STANDARDS

**CONCRETE MEDIAN BARRIER**

**NOTES:**

If the contractor elects to use the optional construction joint, transverse joints for crack control and expansion joints are to be provided in both footing and barrier at the same location. Transverse joints are to coincide with joints in adjacent pavement with a maximum spacing of 20 feet C-C. Concrete median barrier may be cast in place or slip-formed. Precast barrier is not permitted for permanent installations. Horizontal reinforcing steel bars are to be separated at all expansion and contraction joints. A 2" concrete cover is required over the ends of the reinforcing steel.

**SPECIFICATION REFERENCE**

105  
502

**ROAD AND BRIDGE STANDARDS**

**REVISION DATE**

7/16

**SHEET 1 OF 1**

**502.04**

2016 ROAD & BRIDGE STANDARDS
NOTES:

1. AT THE OPTION OF THE MANUFACTURER, ADDITIONAL REINFORCING MAY BE ADDED TO THE PRECAST CONCRETE BARRIER FOR HANDLING.
2. CONCRETE SHALL BE 4000 P.S.I. MINIMUM.
3. BARRIER DELINEATOR SIZE, COLOR AND SPACING SHALL BE IN ACCORDANCE WITH THE SPECIFICATIONS.
4. COST OF DELINEATOR SHALL BE INCLUDED IN THE PRICE BID FOR TRAFFIC BARRIER SERVICE.
5. OTHER PRECAST TRAFFIC BARRIER SERVICE CONCRETE DESIGNS THAT HAVE BEEN APPROVED BY VDOT AS AN ACCEPTABLE ALTERNATE TO THE STANDARD DESIGN MAY BE SUBSTITUTED.
6. A 1" RADIUS MAY BE USED AS AN ALTERNATE FOR THE 1/4" CHAMFER.
7. BARRIER DELINEATOR REFLECTIVE SURFACE IN ALL INSTANCES SHALL BE FACING ONCOMING TRAFFIC.
8. BARRIER VERTICAL PANELS SHALL BE SPACED IN ACCORDANCE WITH VIRGINIA WORK AREA PROTECTION MANUAL.

WHEN USING VDOT STANDARD MB-7D PC WITH THE PIN AND LOOP POSITIVE CONNECTION, ALLOW FOR A 6'-0" DYNAMIC DEFLECTION, PROVIDE MIN. 60' OF BARRIER UPSTREAM AND DOWNSTREAM OF WORK ZONE FOR ANCHORAGE.

FOR APPROVED NON-VDOT DESIGNS, REFER TO MANUFACTURER'S INSTALLATION INSTRUCTIONS FOR DEFLECTIONS AND ANCHORAGE.

<table>
<thead>
<tr>
<th>FLARE RATES</th>
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<tbody>
<tr>
<td>DESIGN SPEED</td>
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<tr>
<td>40</td>
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<tr>
<td>30</td>
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</table>

* SUGGESTED MAXIMUM FLARED RATE FOR RIGID BARRIER SYSTEMS.
1. PIN AND CONNECTORS SHALL BE ASTM A36. REINFORCING STEEL BARS SHALL BE ASTM A615 GRADE 60. ONE CONNECTOR PIN ASSEMBLY WITH EACH BARRIER SECTION.

**NOTES:**

- TOP CONNECTOR
- BAR
- WASHER
- NUT
- BOTTOM CONNECTOR

**PLAN OF CONNECTION**

**ELEVATION OF CONNECTION**

**BOTTOM CONNECTOR**

- 5/8" R
- STEEL BAR
- GALVANIZE AFTER FORMING

**TOP CONNECTOR**

- 3/8" R
- STEEL BAR

**PLAIN GALVANIZED STEEL WASHER**

- FOR 1 1/4" PIN

**1/4" HEAVY HEX NUT**

- WHEN THREADED ROD IS USED

**CONNECTOR PIN ASSEMBLY**

- GALVANIZE AFTER FABRICATION

**REFERENCES**

- SPECIFICATION
- ROAD AND BRIDGE STANDARDS

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

**FOR TEMPORARY USE**

**2016 ROAD & BRIDGE STANDARDS**
NOTE:
REINFORCING STEEL BARS SHOWN ARE BASED ON A 20' PANEL LENGTH.

ALL REINFORCING BARS ARE TO BE SIZE #4 GRADE 60 STEEL WITH A MINIMUM 1/2" CONCRETE COVER.

THE TYPICAL JOINT SPACING FOR CONSTRUCTION JOINTS IS 20' AND 80' FOR EXPANSION JOINTS FOR TYPE I & III BARRIERS.

FOR DETAILS OF HOW JOINTS ARE TO BE FORMED & WATER STOP DETAILS SEE STD. RW-3.

TRANSVERSE JOINTS FOR TYPE II BARRIERS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE ROAD AND BRIDGE SPECIFICATIONS EXCEPT NO SCORING OR SAWING WILL BE ALLOWED.

HORIZONTAL REINFORCING STEEL BARS B ARE TO BE SEPARATED AT ALL EXPANSION & CONTRACTION JOINTS. A 2" CONCRETE COVER IS REQUIRED OVER THE ENDS OF REINFORCING STEEL.

PERMISSIBLE CONSTRUCTION JOINT TO BE BONDED IN STRICT ACCORDANCE WITH SECTION 404 OF THE CURRENT VDOT ROAD AND BRIDGE Specs.

TYPE III (GREATER THAN 2'-0" HT. DIFF., MAX. 3'-0")

MEASUREMENT AND PAYMENT

MIDIAN BARRIER MB-8A TYPE I, II OR III WILL BE PAID FOR AT THE CONTRACT UNIT PRICE PER LIN. FOOT, WHICH SHALL BE FULL COMPENSATION FOR FURNISHING AND INSTALLING CLASS A3 CONCRETE, REINFORCING STEEL, POROUS BACKFILL AND ALL TOOLS, LABOR, EQUIPMENT AND INCIDENTALS NECESSARY TO COMPLETE THE WORK.

ANY ADDITIONAL EXCAVATION, BACKFILL WITH SUITABLE MATERIAL AND COMPACTION WORK NECESSARY FOR THE CONCRETE MEDIAN BARRIER INSTALLATION IS TO BE CONSIDERED INCIDENTAL IN THE PRICE BID FOR THE CONCRETE MEDIAN BARRIER.

REINFORCING STEEL SCHEDULE

<table>
<thead>
<tr>
<th>PANEL</th>
<th>NO.</th>
<th>LENGTH</th>
<th>NO.</th>
<th>LENGTH</th>
<th>NO.</th>
<th>LENGTH</th>
<th>NO.</th>
<th>LENGTH</th>
</tr>
</thead>
</table>
| TYPE I | 2   | 19'-8" | 19'-8" | 40 | 1'-0"
| TYPE II | 20 | 4'-0" | 19'-8" | 40 | 1'-0"
| TYPE III | 20 | 4'-0" | 19'-8" | 40 | 1'-0"

CONCRETE MEDIAN BARRIER

TYPE I, II OR III

VIRGINIA DEPARTMENT OF TRANSPORTATION
**CAST IN PLACE CONCRETE MEDIAN BARRIER**

12 FT. TERMINAL SECTION

**NOTES:**
- CONCRETE TO BE CLASS A3.
- FOR USE WHERE THE OPERATING SPEED IS 40 M.P.H. OR LESS.
- LOCATION OF THE BARRIER END SECTIONS TO BE AS NOTED ON PLANS OR AS APPROVED BY THE ENGINEER.
- FOR POSITIVE CONNECTION DETAILS AND DIMENSIONS SEE STANDARD MB-INS.
- ONLY FOR USE OUTSIDE OF CLEAR ZONE.

**M8-9A**

**PLAN VIEW**
- *8x8" DOWELS MAY BE ELIMINATED IF POUR IS MONOLITHIC.*
- CLASS A-3 CONCRETE
- FINISHED GRADE ELEVATION

**ELEVATION VIEW**
- DOWELS
- 4'-0" C-C

**SECTION B-B**
- Optional Construction Joint
- Class C-1 concrete may be used below construction joint if base is poured separately.

**SECTION C-C**
- *8x8" DOWELS, 4'-0" C-C DOWELS MAY BE ELIMINATED IF POUR IS MONOLITHIC
- Finished Grade Elevation
- Min.

**ISOMETRIC VIEW**
- ALTERNATE TOP

**BASE OF PAYMENT**: CONCRETE MEDIAN BARRIER
12' TERMINAL SECTION IS TO BE MEASURED AND PAID FOR IN LIN. FT. STD. MB-70, OR LIN. FT. OF TRAFFIC BARRIER SERVICE CONCRETE.

**REMARKS**: DEPTH OF CONCRETE BASE MAY BE EXTENDED AT THE CONTRACTOR'S OPTION TO COINCIDE WITH BOTTOM OF PAVEMENT COURSE IN WHICH BASE TERMINATES; HOWEVER, THE COST OF ADDITIONAL CONCRETE SHALL BE INCLUDED IN UNIT PRICE BID PER LIN. FT. OF BARRIER.
**Basis of Payment:** Concrete median barrier 12' terminal section is to be measured and paid for in lin. ft. std. MB-7D, or lin. ft. of traffic barrier service concrete.

**Notes:**

- Concrete to be 4000 P.S.I.
- Reinforcing steel to be grade 60.
- All reinforcing is to have a minimum concrete cover of 1/2.".
- For use where the operating speed is 40 m.p.h. or less.
- Location of the barrier end sections to be as noted on plans or as approved by the engineer.
- For positive connection details and dimensions see standard MB-INS.
- Only for use outside of clear zone.

**Precast Concrete Median Barrier**

**12 Ft. Terminal Section**

Virginia Department of Transportation

---

**Specification Reference**

105

**Road and Bridge Standards**

**Revision Date**

502.10

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2016 ROAD & BRIDGE STANDARDS
TRAFFIC BARRIER SERVICE CONCRETE PARAPET
(SINGLE FACE)
(FOR TEMPORARY INSTALLATION ON BRIDGE DECK EXTERIOR)

REINFORCING STEEL SCHEDULE

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<td>2 1/2&quot;</td>
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<td>6</td>
<td>4'-8&quot;</td>
<td>4 1/2&quot;</td>
<td>&quot;</td>
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</table>

BENDING DIAGRAM

DIMENSIONS IN BENDING DIAGRAMS ARE OUT-TO-OUT OF BARS, EXCEPT AS SHOWN.
POUNDS OF REINFORCING STEEL = 202
REINFORCING SCHEDULE BASED ON 12'-0" UNIT LENGTH.

ELEVATION VIEW

UNIT: 1" = 0'-0"
SCALE: 1/8"

PLAN VIEW

UNIT: 1" = 0'-0"
SCALE: 1/8"

ALTERNATE SLOT DETAIL

TOP CONNECTOR
BOTTOM CONNECTOR

TOP Connector
BOTTOM Connector

GALVANIZE AFTER FORMING
NOTE: ENTIRE CONNECTOR MAY BE GALVANIZED.

ELEVATION OF CONNECTION
DETAIL "A" NOTES:

1. BARRIER DELINEATOR TO BE SPACED IN ACCORDANCE WITH SECTION 702, OF THE ROAD AND BRIDGE SPECIFICATIONS AND THE BARRIER VERTICAL PANELS TO BE SPACED IN ACCORDANCE WITH VIRGINIA WORK AREA PROTECTION MANUAL, REFLECTIVE SURFACE, IN ALL Instances, TO BE FACING ONGOING TRAFFIC.

2. CONCRETE 4000 PSI (MIN.). REINFORCING STEEL GRADE 60.


4. COST OF BARRIER DELINEATOR AND BARRIER VERTICAL PANELS TO BE INCLUDED IN PRICE BID PER LINEAR FOOT OF BARRIER SERVICE.

5. WHEN BARRIER IS LOCATED ON VERTICAL AND/OR HORIZONTAL CURVES, THE OPENING AT THE JOINT IS NOT TO EXCEED 1°.

6. DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT.

TRAFFIC BARRIER SERVICE CONCRETE PARAPET
(DOUBLE FACE)

(FOR TEMPORARY INSTALLATION ON BRIDGE DECK EXTERIOR)

SPECIFICATION REFERENCE

105
512

2016 ROAD & BRIDGE STANDARDS
NOTES:

1. BARRIER DELINEATOR IS TO BE SPACED IN ACCORDANCE WITH SECTION 702 OF THE ROAD AND BRIDGE SPECIFICATIONS AND THE BARRIER VERTICAL PANELS ARE TO BE SPACED IN ACCORDANCE WITH THE VIRGINIA WORK AREA PROTECTION MANUAL.

2. REFLECTIVE SURFACE, IN ALL Instances, ARE TO BE FACED ONCOMING TRAFFIC.

3. COST OF BARRIER DELINEATOR AND BARRIER VERTICAL PANELS ARE TO BE INCLUDED IN PRICE BID PER LINEAR FOOT OF BARRIER SERVICE.

4. ANCHOR BOLTS SHALL BE INSTALLED ON TRAFFIC SIDE.

5. CONCRETE 4000 PSI (MIN.)

6. WELDED WIRE FABRIC MAY BE ONE SHEET BENT TO FIT CONFIGURATION OR TWO SEPARATE SHEETS, ONE ON EACH FACE.

7. AFTER REMOVING TEMPORARY BARRIER, CUT 7/8" Ø BOLT OR THREADED ROD AS LOW AS PRACTICAL BELOW ROADWAY SURFACE AND FILL RECESS WITH EPOXY BONDING COMPOUND (DETAIL "A") OR REMOVE 7/8" Ø BOLT OR THREADED ROD AND FILL HOLE WITH GROUT BONDED WITH EPOXY BONDING COMPOUND (DETAIL "A").

8. FOR POSITIVE CONNECTION DETAILS AND DIMENSIONS SEE STANDARD MB-INS.

TRAFFIC BARRIER SERVICE CONCRETE PARAPET (DOUBLE FACE) (FOR TEMPORARY INSTALLATION ON BRIDGE DECK EXTERIOR)

SPECIFICATION REFERENCE

105
512

ROAD AND BRIDGE STANDARDS

REVISION DATE 01/09

SHEET 2 OF 3

502.14

2016 ROAD & BRIDGE STANDARDS
NOTES:
1. STAKING OF STANDARD MB-11A TO ASPHALT CONCRETE PAVEMENT, COMPACTED BASE MATERIAL, CONCRETE PAVEMENT, OR ASPHALT OVER CONCRETE PAVEMENT IS REQUIRED WHEN TRAFFIC BARRIER SERVICE CONCRETE IS PLACED WITHIN THE TWO (2) FOOT OFFSET OF A TRENCHING OPERATION (4' OR GREATER IN DEPTH) OR WHEN DETERMINED BY THE ENGINEER.

2. 2" MIN. FOR ASPHALT CONCRETE, 6" MIN. FOR COMPACTED BASE MATERIAL.

3. DRIVE STAKE HEAD BELOW FACE OF BARRIER TO PREVENT SNAGGING.

4. CONTRACTOR TO VERIFY PAVEMENT STRUCTURE PRIOR TO PLACING STAKES.

CONCRETE MEDIAN BARRIER (TALL WALL)

**MB-12A, B, C**

**BARRIER TAPER FROM 50" TALL F-SHAPE TO A STANDARD MB-7A OR MB-7D BARRIER TO BE ACCOMPLISHED WITHIN THE 6'-0" AS INDICATED.**

**TRANSITION FROM 50" TALL WALL TO 32" JERSEY OR F-SHAPE BARRIER**

**ST'D MB-7D F-SHAPE BARRIER**

**NEW JERSEY OR F-SHAPE BARRIER**

**MB-12A ALTERNATE TOP DESIGN**

**IF BARRIER EXTENSION IS CONSTRUCTED AS A SEPARATE ITEM, ALL JOINTS ARE TO BE CONSTRUCTED AT THE SAME INTERVAL AS CONCRETE BARRIER. ALL VERTICAL BARS ARE #4 AT 24" MAX. SPACING. LENGTH OF DOWELS SHALL BE 20". VERTICAL BARS MAY BE PLACED IN THE CONCRETE OR BONDED INTO DRILLED HOLES IN HARDENED CONCRETE. WHEN HOLES ARE DRILLED NON-SHRINK GROUT SHALL BE USED TO BOND THE BARS IN PLACE.**

**DETAIL B**

**THE ALTERNATE DESIGN OF 1" R MAY ALSO BE USED FOR MB-12A, 12B OR 12C.**

**MB-12A**

**OPTIONAL CONSTRUCTION JOINT, IF Poured IS MONOLITHIC, DOWELS MAY BE ELIMINATED.**

**DEPTCH OF CONCRETE BASE MAY BE EXTENDED AT THE CONTRACTOR'S OPTION TO COINCIDE WITH BOTTOM OF PAVEMENT COURSE IN WHICH BASE TERMINATES; HOWEVER, THE COST OF ADDITIONAL CONCRETE SHALL BE INCLUDED IN UNIT PRICE BID PER LINEAR FT. OF BARRIER.**
NOTES:

If the contractor elects to use the optional construction joint, transverse joints for crack control and expansion joints are to be provided in both footing and barrier at the same location.

Transverse joints are to coincide with joints in adjacent pavement with a maximum spacing of 20 ft. C-C.

Concrete median barrier may be cast in place or slip-formed.

Horizontal reinforcing steel bars are to be separate at all expansion and contraction joints. A 2" concrete cover is required over the ends of the reinforcing steel.

Barrier delineator size, color, and spacing shall be in accordance with the specifications. Cost of delineator shall be included in the price bid for median barrier. Reflective surface of barrier delineator in all instances, shall be facing the oncoming traffic.

Concrete shall be Class A3 if cast in place, 4000 PSF precast.

Depth of concrete base may be extended at the contractor's option to coincide with bottom of pavement course in which base terminates. However, the cost of additional concrete shall be included in unit price bid per linear ft. of barrier.

Weep holes with 12" x 12" plastic hardware cloth 1/4" mesh or galvanized steel wire, diameter 0.03 inch No. 4 mesh hardware cloth anchored firmly to outside of structure.

4" aggregate #68, #78, or #8 or crushed glass meeting #78 or #8 gradation x 6" width when weep holes are provided.

3" diameter weep holes to be provided on 10 centers when barricade is placed behind barrier, unless otherwise approved by the engineer. Locate within lower slope face of barrier to drain to roadway.

Dowels and optional construction joint are to be in accordance with MB-12A.

4" aggregate #68, #78, #8 or crushed glass meeting #78 or #8 gradation requirements.

**Suggested maximum flare rate for rigid barrier systems.**

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NOTE:
REINFORCING STEEL BARS SHOWN ARE BASED ON A 20' PANEL LENGTH.
ALL REINFORCING BARS ARE TO BE SIZE #4 GRADE 60 STEEL
WITH A MINIMUM 1 1/2" CONCRETE COVER.
THE TYPICAL JOINT SPACING FOR CONSTRUCTION JOINTS IS
20' AND 80' FOR EXPANSION JOINTS FOR TYPE II AND III
BARRIERS.
FOR DETAILS OF HOW JOINTS ARE TO BE FORMED & WATER
STOPS SEE STD. RW-3.
TRANSVERSE JOINTS FOR TYPE I BARRIERS SHALL BE CONSTRUCTED
IN ACCORDANCE WITH THE ROAD AND BRIDGE SPECIFICATIONS
EXCEPT NO SCORING OR SAWING WILL BE ALLOWED.
HORIZONTAL REINFORCING STEEL BARS B ARE TO BE SEPARATED
AT ALL EXPANSION & CONTRACTION JOINTS. A 2" CONCRETE COVER
IS REQUIRED OVER THE ENDS OF REINFORCING STEEL.

1) TRANSITIONED TO BE PAID FOR AS MEDIAN BARRIER MB-13
   TYPE II OR III.

2) MAXIMUM FLARE RATE FOR RIGID BARRIER SYSTEMS.

<table>
<thead>
<tr>
<th>DESIGN SPEED</th>
<th>INSIDE SHY LINE</th>
<th>BEYOND SHY LINE</th>
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<tbody>
<tr>
<td>MPH</td>
<td>SHY LINE</td>
<td>FLARE RATE</td>
</tr>
<tr>
<td>70</td>
<td>10'</td>
<td>30 : 1</td>
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<tr>
<td>60</td>
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<td>26 : 1</td>
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<tr>
<td>50</td>
<td>6.5'</td>
<td>21 : 1</td>
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<tr>
<td>40</td>
<td>5'</td>
<td>16 : 1</td>
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<tr>
<td>30</td>
<td>3.5'</td>
<td>13 : 1</td>
</tr>
</tbody>
</table>

CONCRETE MEDIAN BARRIER
TYPE I, II OR III

SECTION A-A
(Foundation not shown)

SECTION B-B
(ST'D. MB-12B)
NOTES:
1. BASIS OF PAYMENT: TRAFFIC BARRIER SERVICE LATERAL SUPPORT WILL BE MEASURED AND PAID FOR IN UNITS OF EACH COMPLETE IN PLACE AND SHALL INCLUDE FURNISHING AND PLACING PRECAST CONCRETE BARRIERS (TBS CONCRETE) AND MAINTENANCE, REMOVAL WHEN NO LONGER NECESSARY, AND ALL MATERIALS, LABOR, TOOLS, EQUIPMENT, AND INCIDENTALS NECESSARY TO COMPLETE THE WORK.

2. FOR POSITIVE CONNECTION DETAILS AND DIMENSIONS SEE STANDARD MB-7D PC.

3. FOR DIMENSIONS NOT SHOWN, REFER TO STD. MB-7D PC AND MB-10A.
NOTES:
1. BASIS OF PAYMENT:
   TRAFFIC BARRIER SERVICE LATERAL SUPPORT
   WILL BE MEASURED AND PAID FOR IN UNITS OF
   EACH COMPLETE IN PLACE AND SHALL INCLUDE
   FURNISHING AND PLACING PRECAST
   CONCRETE BARRIERS (TBSC CONCRETE) AND SAND
   BAGS, MAINTENANCE, REMOVAL WHEN NO LONGER
   NECESSARY, AND ALL MATERIALS, LABOR, TOOLS,
   EQUIPMENTS, AND INCIDENTALS NECESSARY TO
   COMPLETE THE WORK.

2. FOR POSITIVE CONNECTION DETAILS AND
   DIMENSIONS SEE STANDARD MB-7D PC.

3. FOR DIMENSIONS NOT SHOWN, REFER TO STD.
   MB-7D PC AND MB-10A.
GENERAL NOTES - FENCING

FARM FENCE

BARBED WIRE
BARBED WIRE IS TO CONFORM TO ONE OF THE TYPES ALLOWED BY THE SPECIFICATIONS.
UNLESS OTHERWISE NOTED ON PLANS FOUR STRANDS WILL BE PROVIDED.
SPACING OF STRANDS SHOWN IS SUGGESTED ONLY, ANY OTHER SPACING APPROVED BY
THE ENGINEER MAY BE USED.

WOOD POSTS
WOOD POSTS TO BE SQUARE CUT OR ROUND TO THE DIMENSIONS SHOWN ON THE
DRAWINGS.
POSTS TOPS MAY BE FLAT OR CUT AT A 30° ANGLE.
FOR WOVEN WIRE FABRIC, STAPLES ARE TO BE USED AT TOP AND BOTTOM STRANDS AND
AT A MINIMUM OF THREE INTERMEDIATE STRANDS PER POST.
ONE STAPLE PER STRAND IS TO BE USED FOR BARBED WIRE FENCE.
WHERE GATE, CORNER, OR BRACE POSTS FALL IN ROCK OR MARSHY AREAS THEY SHALL
BE SET IN CLASS A3 OR C1 CONCRETE.

METAL POSTS
METAL POSTS ARE TO BE ONE OF THE TYPES SHOWN ON THE STANDARD DRAWINGS AND
CONFORMING TO THE SPECIFICATIONS.
AT EACH CORNER AND STRETCHER POST WIRE FABRIC IS TO BE CUT AND ALL HORIZONTAL
STRANDS SECURELY WRAPPED AROUND POST.
BRACES ON CORNER, STRETCHER AND END POSTS ARE TO BE SECURED 1'-6" FROM TOP
OF POST WITH 1/4" BOLTS.
IN LIEU OF SETTING POSTS IN CONCRETE, MANUFACTURER'S ANCHORING DEVICES MEETING
THE SPECIFICATION REQUIREMENTS MAY BE USED WHEN APPROVED BY THE ENGINEER.

BRACES
MAXIMUM SPACING BETWEEN BRACES TO BE 500'.
CORNER BRACES TO BE PROVIDED WHERE CORNER ANGLE IS 15° OR OVER.
LINE BRACES TO BE PROVIDED WHERE VERTICAL ALIGNMENT CHANGES 15° OR MORE AND
WHERE SPACING REACHES 500'.

MISCELLANEOUS
FENCE IS TO BE LOCATED AS SHOWN ON THE PLANS OR DIRECTED BY THE ENGINEER.
THE SIDE OF THE POST TO WHICH FABRIC IS TO BE ATTACHED WILL BE DETERMINED BY
THE ENGINEER.
FENCE TO BE GROUND IN ACCORDANCE WITH DETAIL SHOWN ON STANDARD FE-6
WHERE REQUIRED.
UNLESS SPECIFIED ON PLANS, THE CONTRACTOR WILL HAVE THE OPTION OF FURNISHING
EITHER METAL OR WOOD POSTS. POSTS TYPES ARE NOT TO BE INTERMIXED ON ANY ONE
INSTALLATION.

CHAIN LINK FENCE

WIRE FABRIC
WIRE FABRIC SHALL HAVE A 2" MESH.

MISCELLANEOUS
IN LIEU OF SETTING POSTS IN CONCRETE, MANUFACTURER'S ANCHORING DEVICES MEETING
THE SPECIFICATION REQUIREMENTS MAY BE USED WHEN APPROVED BY THE ENGINEER.
FOR GATES EXCEEDING 6'-0" IN WIDTH ROLLED FORMED STEEL POST WILL
NOT BE ALLOWED.
CHAIN LINK FENCE TO BE GROUNDED IN ACCORDANCE WITH DETAILS SHOWN
ON STANDARD FE-6, WHERE REQUIRED.
**STANDARD FENCE**

**CHAIN LINK**

**NOTES:**

- See General Notes-Fencing for additional details and instructions.
- A moisture-excluding cap is required on tubular posts.
- Material for cap shall conform to the allowable types for other listed fittings.
- Corner brace - to be used when horizontal alignment changes 15° or more.
- Line brace - to be used when vertical alignment changes 15° or more.
- End/corner posts shall be used with all line and corner braces.
- Braces shall be installed half the height above the ground line of the post when a top rail is used, or two-thirds the height above the ground line when a tension wire is used in lieu of a top rail.
- Chain link fence greater than 6 feet in height shall be submitted to the standards & special design section for approval.

**GROUND LINE**

- Concrete footing
- Line post
- Line post
- Concrete footing
- 10'-0"
- 10'

**ALTERNATE ANCHOR DEVICES**

- May be used in lieu of setting post in concrete. Devices shown are representational only. See General Notes.

**PIPE SIZES O.D.**

- Minimum
- Line post 2.375"
- Line post 2.875"
- Gate post (single swing) w ≤ 6ft. 2.875"
- Gate post (single swing) w > 6ft. 4.000"
- Gate post (double swing) 2.875"
- Brace 1.660"
- Gate frame 1.900"

**REFERENCE SPECIFICATION**

- 503.04
- 2016 Road & Bridge Standards

**SPECIFICATION REFERENCE**

- 242
- 507
**WOOD GATE - WOOD POSTS - WOVEN WIRE**

If gate width exceeds 12', gate post is to be set 3'-6" into ground. Height of gate post above ground depends on type of fence used: 5'-0", woven wire fabric; 4'-6", barbed wire.

**WOOD GATE - WOOD POSTS - BARBED WIRE**

Wood gate frames and center brace to be to the dimensions shown on the drawing except that a 3" width gate can have a min. 1" frame with no center brace.

Gate is to be hot-dipped galvanized or electroplate galvanized in accordance with ASTM A-154 Type GS.

Gate fabric is to be all #11 gauge except top and bottom strands which are to be #9 vertical strands are to be spaced 6" apart.

**MISCELLANEOUS**

If locations of gates are not specified on plans, they are to be erected at the sites designated by the engineer.

Gate hinge and latch assemblies may be of any type meeting the approval of the engineer, except that all hinges are to be of a bolt-through type. All fittings are to be hot-dipped galvanized.

Any combination of gate and fence types meeting the approval of the engineer will be acceptable and is not limited to the examples shown hereon.

Where wood gates posts fall in rock or marshy areas they are to be set in Class A3 or C1 concrete.

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**STANDARD FENCE GATES**

Virginia Department of Transportation

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<table>
<thead>
<tr>
<th>SPECIFICATION REFERENCE</th>
</tr>
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<tbody>
<tr>
<td>242</td>
</tr>
<tr>
<td>507</td>
</tr>
<tr>
<td>236</td>
</tr>
</tbody>
</table>

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2016 Road & Bridge Standards

Revision Date: 503.05
NOTES:

1. GROUNDING ELECTRODE CLAMP

2. GROUNDING CONDUCTOR IS TO BE IN CONTACT WITH HORIZONTAL WIRE OF FENCE BY COMPRESSION CONNECTORS AS SHOWN.

3. GROUNDING ELECTRODE TO BE LOCATED ON POST SIDE OF FENCE AND AS CLOSE AS POSSIBLE TO POST AND FENCE.

4. UNLESS OTHERWISE CALLED FOR IN THE PLANS OR DIRECTED BY THE ENGINEER, FENCE GROUNDING WILL BE REQUIRED FOR METAL FENCES INCLUDING PLASTIC COATED FENCE FABRIC AT THE FOLLOWING LOCATIONS.

5. WHEN HIGH VOLTAGE LINES CROSS ABOVE THE FENCE, GROUNDING SYSTEMS SHALL BE INSTALLED 50' BEYOND THE OVERHEAD CROSSING POINT OF THE OUTER MOST CONDUCTORS OF THE HIGH VOLTAGE LINES.

6. WHEN THE HIGH VOLTAGE LINES ARE PARALLEL TO AND WITHIN 50' HORIZONTALLY OF THE FENCE, GROUNDING SYSTEMS SHALL BE INSTALLED AT 50' INTERVALS ALONG THE PARALLEL SECTIONS OF FENCE AND HIGH VOLTAGE LINES.

7. COST FOR FURNISHING AND PLACING ALL GROUNDING MATERIALS IS TO BE INCLUDED IN PRICE BID PER LINEAR FOOT OF FENCE.

8. DETAILS SHOWN HEREON ARE TO APPLY TO ALL METAL FENCES AND HANDRAILS. FENCES WILL BE GROUNDED ONLY WHEN INDICATED ON THE PLANS OR AS RECOMMENDED BY THE ENGINEER.
4 #3 STEEL RODS
3'-0" LONG

MINIMUM CLEARANCE 1"

GROUND LINE

REINFORCEMENT TO BE #3 STEEL RODS, SECURELY HELD IN CAGES BY SPOT WELDED W. 9 WIRES ATTACHED TO ALL BARS APPROXIMATELY 8" FROM EACH END TO INSURE PROPER PLACING.

CENTER OF BACK OF MONUMENT TO BE CORRECT FOR STATION AND ALIGNMENT.

NOTES:

THE LETTERS "VDOT" ARE TO BE INDENTED IN THE TOP OF EACH RIGHT-OF-WAY MONUMENT.

IN ENTRANCES AND YARDS WHERE THE MONUMENTS WOULD BE UNSIGHTLY, THEY MAY BE SET WITH THE TOP FLUSH WITH THE GROUND.

ALTERNATE METHODS OF PLACING WIRES

WIRES ON ALL 4 SIDES WELDED TO ALL 4 BARS.

WIRES ON 3 SIDES WELDED TO ALL 4 BARS.

ALL LETTERING TO BE 1/2" STANDARD FOUNDRY LETTERS.

GUARD STAKE

HUB TO BE ACCURATELY SET BY SURVEY PARTY.

BEFORE HUB IS DISTURBED IN SETTING MONUMENTS.

FOUR LINER STAKES ARE TO BE SET, SO THAT TWO LINES STRETCHED BETWEEN STAKES WILL INTERSECT EXACTLY OVER TACK IN HUB TOPS OF STAKES TO BE MORE THAN 9" ABOVE GROUND AT MONUMENT.

RIGHT-OF-WAY MONUMENTS

RIGHT-OF-WAY MONUMENTS ARE TO PLACED AT ALL P.C.'S AND P.T.'S AND AT INTERVALS ON TANGENTS SO AS TO BE VISIBLE FROM EACH, BUT NOT MORE THAN 2500' APART, AND AT ALL BREAKS IN THE RIGHT-OF-WAY LINES. IN THE CASE OF SLOPES ACQUIRED AS EASEMENT, THE MONUMENTS ARE TO BE SET ON NORMAL RIGHT-OF-WAY LINES.

RIGHT-OF-WAY MONUMENTS ARE TO BE SET PLUMB.
STANDARD PLAN AND METHOD OF SETTING RIGHT-OF-WAY MONUMENTS

LOCATOR POST TO BE U-TYPE ROLLED RAIL STEEL @ 2 LBS./FT. OR ALUMINUM ALLOY 6063-T6 @ 0.78 LBS./FT. IN ACCORDANCE WITH THE SPECIFICATIONS.

STEEL POSTS TO BE CALVANIZED IN ACCORDANCE TO ASTM A123.

LOCATOR POST AND PIN TO BE SET BY THE SURVEY PARTY AT THE TIME OF ORIGINAL STAKING.

PIN TO BE ACCURATELY SET BY SURVEY PARTY AND CAP PUNCHED TO INDICATE R/W LINE.

NOTES:
RIGHT-OF-WAY MONUMENTS ARE TO BE PLACED AT ALL P.C.'S AND P.T.'S AND AT INTERVALS ON TANGENTS SO AS TO BE VISIBLE FROM EACH, BUT NOT MORE THAN 2500' APART, AND AT ALL BREAKS IN THE RIGHT-OF-WAY LINES. IN THE CASE OF SLOPES ACQUIRED AS EASEMENT, THE MONUMENTS ARE TO BE SET ON NORMAL RIGHT-OF-WAY LINES.
RIGHT-OF-WAY MONUMENTS ARE TO BE SET PLUMB.
1. Design shown is representational only. See manufacturer's drawings for components and installation instructions.

2. Impact attenuator shall be selected from VDOT's provisionally approved MASH list. All units must have successfully passed the MASH 2016 TL-3 testing criteria and deemed reimbursable by FHWA.

3. All steel hardware components shall be galvanized.

4. Impact attenuator manufacturer must furnish details for required anchoring system. For dimensions of unit and concrete foundation see manufacturer's drawings and specifications.

5. Cross slope of the pad shall not exceed a 8% (12:1) slope.

6. Any location where there is reverse direction traffic, a transition panel shall be supplied by the manufacturer and installed in accordance with the manufacturer's drawings and specifications.

7. Due to the varying lengths of proprietary impact attenuators, the designer should allow 30' for the length of the attenuator.

8. Fluorescent prismatic lens yellow sheeting shall be used on the reflective markers. All reflective sheeting is to be in accordance with section 701 of the road and bridge specifications. Stripes shall slope down toward the side of the obstruction on which traffic is to pass.

   Color:
   Field - Yellow (ReflectORIZED)
   Message - Black stripes (Non-ReflectORIZED)

9. Paint chevron stripes and install reflective markers on pavement at the front of the unit for maximum visibility.

10. Measurement and Payment:
Type 1 Impact Attenuator will be measured in units of each complete-in-place. Payment shall be full compensation for furnishing and installing impact attenuator, reflectorized marker, Portland concrete foundation, required backup, transition panel, and all materials, labor, excavation, tools, equipment and any incidentals necessary to complete the work.

   A reinforced concrete foundation is required. Design details are to be furnished by the impact attenuator manufacturer. Minimum compressive strength of concrete shall be 4000 PSI.

   VDOT
   Impact Attenuator
   Type 1 Re-directive Permanent Installation (TL-3 > 40 MPH)
   Virginia Department of Transportation

   MASH 2016

   Item Code 13607 STD. IA-1 Impact Attenu. (TL-3, >40 MPH DES.SP.) Each

   Minimum 8' Clear Area for Attenuator Rearward Motion

   Elevation View

   Standard MB-7D
   Constant Slope Barrier

   Bridge Parapet Terminal Walls

   2016 RD & BRIDGE STANDARDS
PLAN VIEW
(BI-DIRECTIONAL)

* THE MINIMUM DISTANCE SHOWN IS A MINIMUM CLEAR SPACE REQUIRED FOR THE
PROPER OPERATION OF THE IMPACT ATTENUATOR. STANDARD SHOULDER WIDTHS
SHOULD BE DESIGNED AND MAINTAINED IN ACCORDANCE WITH CURRENT VDOT
POLICY.

PLAN VIEW
(UNI-DIRECTIONAL)
SITE PREPARATION REQUIREMENTS FOR IMPACT ATTENUATOR ON A SHOULDER

IMPACT ATTENUATOR

TYPE 1 RE-DIRECTIVE PERMANENT INSTALLATION ( TL-3 ≥ 40 MPH )

VIRGINIA DEPARTMENT OF TRANSPORTATION

REVISION DATE 12/18
SHEET 3 OF 3

105 221 505 512

A COPY OF THE ORIGINAL SEALED AND SIGNED STANDARD DRAWING IS ON FILE IN THE CENTRAL OFFICE

EDGE OF TRAVELED WAY

EDGE OF TRAVELED WAY

SLOPE HINGE POINT

SLOPE HINGE POINT

15:1 TAPER

15:1 TAPER

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

505.03

2016 ROAD & BRIDGE STANDARDS
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NOTES
1. DESIGN SHOWN IS REPRESENTATIONAL ONLY. SEE MANUFACTURER’S DRAWINGS FOR COMPONENTS AND INSTALLATION INSTRUCTIONS.

2. IMPACT ATTENUATOR SHALL BE SELECTED FROM VDOT’S PROVISIONALLY APPROVED MASH LIST. ALL UNITS MUST HAVE SUCCESSFULLY PASSED THE MASH 2016 TL-2 TESTING CRITERIA AND DEEMED REIMBURSABLE BY FHWA.

3. ALL STEEL HARDWARE COMPONENTS SHALL BE GALVANIZED.

4. IMPACT ATTENUATOR MANUFACTURER MUST FURNISH DETAILS FOR REQUIRED ANCHORING SYSTEM. FOR DIMENSIONS OF UNIT AND CONCRETE FOUNDATION SEE MANUFACTURER’S DRAWINGS AND SPECIFICATIONS.

5. CROSS SLOPE OF THE PAD SHALL NOT EXCEED A 8% (12:1) SLOPE.

6. ANY LOCATION WHERE THERE IS REVERSE DIRECTION TRAFFIC, A TRANSITION PANEL SHALL BE SUPPLIED BY THE MANUFACTURER AND INSTALLED IN ACCORDANCE WITH THE MANUFACTURER’S DRAWINGS AND SPECIFICATIONS.

7. DUE TO THE VARYING LENGTHS OF PROPRIETARY IMPACT ATTENUATORS, THE DESIGNER SHOULD ALLOW 15’ FOR THE LENGTH OF THE ATTENUATOR.

8. FLUORESCENT PRISMATIC LENS YELLOW SHEETING SHALL BE USED ON THE REFLECTIVE MARKERS. ALL REFLECTIVE SHEETING IS TO BE IN ACCORDANCE WITH SECTION 701 OF THE ROAD AND BRIDGE SPECIFICATIONS. STRIPES SHALL SLOPE DOWN TOWARD THE SIDE OF THE OBSTRUCTION ON WHICH TRAFFIC IS TO PASS.

COLOR:
FIELD - YELLOW (REFLECTORIZED)
MESSAGE - BLACK STRIPES (NON-REFLECTORIZED)

9. PAINT CHEVRON STRIPES AND INSTALL REFLECTIVE MARKERS ON PAVEMENT AT THE FRONT OF THE UNIT FOR MAXIMUM VISIBILITY.

10. MEASUREMENT AND PAYMENT:
TYPE 1 IMPACT ATTENUATOR WILL BE MEASURED IN UNITS OF EACH COMPLETE-IN-PLACE. PAYMENT SHALL BE FULL COMPENSATION FOR FURNISHING AND INSTALLING IMPACT ATTENUATOR, REFLECTORIZED MARKER, PORTLAND CONCRETE FOUNDATION, REQUIRED BACKUP, TRANSITION PANEL, AND ALL MATERIALS, LABOR, EXCAVATION, TOOLS, EQUIPMENT AND ANY INCIDENTALS NECESSARY TO COMPLETE THE WORK.

11. SEE PAGE 505.03 FOR SITE PREPARATION REQUIREMENTS WHEN IMPACT ATTENUATOR IS INSTALLED ON A SHOULDER.

STRENGTH OF CONCRETE SHALL BE 4000 PSI.

ELEVATION VIEW
ITEM CODE 13606 STD. IA-2 IMPACT ATTEN. (TL-2, < 40 MPH DES.SP.) EACH

A REINFORCED CONCRETE FOUNDATION IS REQUIRED. DESIGN DETAILS ARE TO BE FURNISHED BY THE IMPACT ATTENUATOR MANUFACTURER. MINIMUM COMPRESSIVE STRENGTH OF CONCRETE SHALL BE 4000 PSI.
A PLAN VIEW

TRAFFIC

SECTION A-A

SUB-BASE TO BE COMPACTED UNDER CONC. FOUNDATION

3' MIN.

3' MIN.

VIRGINIA DEPARTMENT OF TRANSPORTATION

IMPACT ATTENUATOR

(UNI-DIRECTIONAL)

3' MIN.

3' MIN.

705.05

REVISION DATE

12/18

MASH 2016

VIRGINIA DEPARTMENT OF TRANSPORTATION

105

505

512

2016 ROAD & BRIDGE STANDARDS

THE MINIMUM DISTANCE SHOWN IS A MINIMUM CLEAR SPACE REQUIRED FOR THE PROPER OPERATION OF THE IMPACT ATTENUATOR. STANDARD SHOULDER WIDTHS SHOULD BE DESIGNED AND MAINTAINED IN ACCORDANCE WITH CURRENT VDOT POLICY.

PLAN VIEW

(BI-DIRECTIONAL)

PLAN VIEW

(UNI-DIRECTIONAL)

TRANSITION PANEL REQUIRED WITH TWO WAY TRAFFIC

TRAFFIC

TRAFFIC

VARIABLE BASED ON MANUFACTURER

VARIABLE BASED ON MANUFACTURER

VARIABLE BASED ON MANUFACTURER

VARIABLE BASED ON MANUFACTURER

VARIABLE 4" MIN.

VARIABLE 4" MIN.

SUB-BASE TO BE COMPACTED UNDER CONC. FOUNDATION

SECTION B-B

CONC. FOUNDATION COMPACTED UNDER SUB-BASE TO BE APPROPRIATE FOR THE ROAD AND BRIDGE STANDARDS
NOTES

1. DESIGN SHOWN IS REPRESENTATIONAL ONLY, SEE MANUFACTURER’S DRAWINGS FOR COMPONENTS AND INSTALLATION INSTRUCTIONS.
2. IMPACT ATTENUATOR SHALL BE SELECTED FROM VDOT’S PROVISIONALLY APPROVED MASH LIST FOR TYPE I RE-DIRECTIVE LOW MAINTENANCE CATEGORY. ALL UNITS MUST HAVE SUCCESSFULLY PASSED MASH 2016 TL-3 TESTING CRITERIA AND BEEN ACCEPTED BY FHWA.
3. ALL STEEL HARDWARE COMPONENTS SHALL BE GALVANIZED.
4. IMPACT ATTENUATOR MANUFACTURER MUST FURNISH DETAILS FOR REQUIRED ANCHORING SYSTEM; FOR DIMENSIONS OF UNIT AND CONCRETE FOUNDATION SEE MANUFACTURER’S DRAWINGS AND SPECIFICATIONS.
5. CROSS SLOPE OF THE PAD SHALL NOT EXCEED A 8% (12:1) SLOPE.
6. ANY LOCATION WHERE THERE IS REVERSE DIRECTION TRAFFIC A TRANSITION PANEL SHALL BE SUPPLIED BY THE MANUFACTURER AND INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS DRAWINGS AND SPECIFICATIONS.
7. DUE TO THE VARYING LENGTHS OF PROPRIETARY IMPACT ATTENUATORS THE DESIGNER SHOULD ALLOW 30’ FOR THE LENGTH OF THE ATTENUATOR.
8. FLUORESCENT PRISMATIC LENS YELLOW SHEETING SHALL BE USED ON THE REFLECTIVE MARKERS. ALL REFLECTIVE SHEETING IS TO BE IN ACCORDANCE WITH SECTION 701 OF THE ROAD AND BRIDGE SPECIFICATIONS. STRIPES SHALL SLOPE DOWN TOWARDS THE SIDE OF THE OBSTRUCTION ON WHICH TRAFFIC IS TO PASS.
   COLOR:
   FIELD - YELLOW (REFLECTORIZED)
   MESSAGE - BLACK STRIPES (NON-REFLECTORIZED)
9. PAINT CHEVRON STRIPES AND INSTALL REFLECTIVE MARKERS ON PAVEMENT AT THE FRONT OF THE UNIT FOR MAXIMUM VISIBILITY.
10. MEASUREMENT AND PAYMENT:
    LOW MAINTENANCE TYPE I IMPACT ATTENUATOR WILL BE MEASURED IN UNITS OF EACH COMPLETE-IN-PLACE. PAYMENT SHALL BE FULL COMPENSATION FOR FURNISHING AND INSTALLING IMPACT ATTENUATOR, REFLECTORIZED MARKER, PORTLAND CONCRETE FOUNDATION, REINFORCING STEEL, REQUIRED BACKUP, TRANSITION PANEL, AND ALL MATERIALS, LABOR, EXCAVATION, TOOLS, EQUIPMENT AND ANY INCIDENTALS NECESSARY TO COMPLETE THE WORK.
11. SEE PAGE 505.03 FOR SITE PREPARATION REQUIREMENTS WHEN IMPACT ATTENUATOR IS INSTALLED ON A SHOULDER.

A REINFORCED CONCRETE FOUNDATION IS REQUIRED, DESIGN DETAILS ARE TO BE FURNISHED BY THE IMPACT ATTENUATOR MANUFACTURER. MINIMUM COMPRESSIVE STRENGTH OF CONCRETE SHALL BE 4000 PSI.

ELEVATION VIEW

ITEM CODE 13603 IMPACT ATTEN. TY. 1 (TL-3, LOW MAINTENANCE) EACH

<table>
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<tr>
<th>SPECIFICATION REFERENCE</th>
<th>A COPY OF THE ORIGINAL SEALED AND SIGNED STANDARD DRAWING IS ON FILE IN THE CENTRAL OFFICE</th>
</tr>
</thead>
</table>
| 105                     |                             | IMPACT ATTENUATOR
| 221                     |                             | LOW MAINTENANCE TYPE 1 RE-DIRECTIVE IMPACT ATTENUATOR (TL-3 > 40 MPH)
| 505                     |                             | VIRGINIA DEPARTMENT OF TRANSPORTATION
| 640                     |                             | MASH 2016

2016 ROAD & BRIDGE STANDARDS
IMPACT ATTENUATOR

LOW MAINTENANCE TYPE 1 RE-DIRECTIVE IMPACT ATTENUATOR

(TL-3 ≥ 40 MPH)

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
SECTION THRU RAIL ELEMENT AND
W BEAM BACK-UP PLATE

DETAIL OF MID-SPAN SPLICE JOINT

LAP IN DIRECTION
OF TRAFFIC

DETAIL OF BUTTON HEAD BOLT AND RECESS NUT
(GUARDRAIL BOLT)

NOTES:
ALL HARDWARE IS TO BE GALVANIZED IN ACCORDANCE WITH THE
SPECIFICATIONS.

L = 1/4" FOR SPLICE BOLT-FULL LENGTH THREADS
L = 2" FOR SPLICE BOLT-FULL LENGTH THREADS ON NESTED W BEAMS.
L = 14" FOR STEEL POST WITH 12" BLOCKOUT BOLT-1/2" MIN. THREADS
L = 18" FOR STEEL POST WITH 16" BLOCKOUT DEPTH BOLT-2" MIN. THREADS
L = 26" FOR STEEL POST WITH 24" BLOCKOUT DEPTH BOLT-2" MIN. THREADS

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

MGS STANDARD GUARDRAIL HARDWARE

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
THREE BEAM TERMINAL CONNECTOR DETAIL

NOTES:
ALL HARDWARE IS TO BE GALVANIZED IN ACCORDANCE WITH THE SPECIFICATIONS.

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

MGS STANDARD GUARDRAIL HARDWARE
THREE BEAM GUARDRAIL HARDWARE
VIRGINIA DEPARTMENT OF TRANSPORTATION
NOTES:
1. Guardrail locations shown on plans are approximate only and can be adjusted during construction if and as directed by the engineer.
2. For details of post and blockouts see sheet no. 506.05.
3. For details of rail element, and associated hardware see sheets 506.01 and 506.02.
4. Rail elements with radius less than or equal to 150 feet shall be shop curved and paid for as radial GR-MGS1, or GR-MGS1A.
5. All GR-MGS1 and GR-MGS1A rail shall be maintained at a height of 30" min - 32" max as measured per standard GR-INS.
6. All guardrail posts shall be set plumb. Post shall not be set with a variation of more than 1/4" per foot from vertical. W-beam, blockouts, and posts shall be set and aligned without alteration or force, as per section 505 of the specifications.

4. All GR-MGS1 and GR-MGS1A rail shall be maintained at a height of 30" min - 32" max as measured per standard GR-INS.

MIDWEST GUARDRAIL SYSTEM
(STANDARD AND REDUCED POST SPACING)

GRADED TO AS PER THE ENGINEER.

FOR DETAILS OF POST AND BLOCKOUTS SEE SHEET NO. 506.05.

FOR DETAILS OF RAIL ELEMENT, AND ASSOCIATED
HARDWARE SEE SHEETS 506.01 AND 506.02.

FLARE RATES

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<th>DESIGN SPEED</th>
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<tr>
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<td>30:1</td>
<td>15:1</td>
</tr>
<tr>
<td>60 MPH</td>
<td>8'</td>
<td>26:1</td>
<td>14:1</td>
</tr>
<tr>
<td>50 MPH</td>
<td>6.5'</td>
<td>21:1</td>
<td>11:1</td>
</tr>
<tr>
<td>40 MPH</td>
<td>5'</td>
<td>16:1</td>
<td>9:1</td>
</tr>
<tr>
<td>30 MPH</td>
<td>4'</td>
<td>13:1</td>
<td>7:1</td>
</tr>
</tbody>
</table>

* SUGGESTED MAXIMUM FLARE RATE FOR SEMI-RIGID BARRIER SYSTEMS.

7. All W-beam rails shall be lapped in the direction of vehicular travel for the finished roadway.
8. Adjusting existing guardrail to meet the MGS1 standard is not permitted.

DESCRIPTION | ITEM CODE | LF |
---|---|---|
GUARDRAIL GR-MGS1 | 13280 | LF |
GUARDRAIL GR-MGS1A | 13281 | LF |
GUARDRAIL RADIAL GR-MGS1 9' POST | 13282 | LF |
GUARDRAIL RADIAL GR-MGS1 | 13283 | LF |
GUARDRAIL RADIAL GR-MGS1A | 13284 | LF |
GUARDRAIL RADIAL GR-MGS1 9' POST | 13285 | LF |
**NOTES:**

1. ALL BOLTS, NUTS, WASHERS, AND OTHER STEEL ITEMS ARE TO BE GALVANIZED.

2. BLOCKOUTS OTHER THAN SHOWN SHALL BE A VDOT APPROVED PRODUCT MEETING MASH TESTING CRITERIA. BLOCKOUTS SHALL BE FROM THE VDOT APPROVED PRODUCTS LIST. APPROVED BLOCKOUTS MAY BE INTERCHANGED ON ANY ONE PROJECT WITH THE RESTRICTION THAT THE SAME TYPE OF BLOCKOUT MUST BE USED IN ANY SINGLE RUN OF GUARDRAIL.

3. WOOD BLOCKOUTS SHALL BE TREATED WITH A WOOD PRESERVATIVE IN ACCORDANCE WITH THE SPECIFICATIONS.

4. DIMENSION MAY VARY PLUS OR MINUS 1/4" DUE TO MANUFACTURING TOLERANCES IN GUARDRAIL COMPONENTS.
NOTES:

1. TANGENT END TERMINAL (GR-MGS2) SHALL BE A VDOT APPROVED PRODUCT MEETING MASH TESTING CRITERIA. ANY TERMINAL USED FOR THE GR-MGS2 SHALL BE FROM THE VDOT APPROVED PRODUCTS LIST.

2. ALL TERMINALS SHALL BE INSTALLED ACCORDING TO THE MANUFACTURER'S INSTALLATION INSTRUCTIONS AND THE FOLLOWING VDOT REQUIREMENTS:
   A. ALL STANDARD GR-MGS2 TERMINALS (SIMILAR TO AS SHOWN ABOVE) SHALL BE INSTALLED WITHOUT AN OFFSET.
   B. INSTALLING GR-MGS2 TERMINAL ON A RADIUS IS NOT PERMITTED.
   C. DIRECTION OF THE REFLECTIVE TAPE ON THE TERMINAL HEAD SHALL CONFORM TO MUTCD APPLICATION FOR DIAGONAL STRIPES ON OBJECT MARKERS AND BRIDGE END PANELS. (SEE NOTE 4)
   D. DO NOT CHANGE THE LAPPING OF TERMINAL FOR ANY INSTALLATIONS, INSTALL AS SHOWN IN THE MANUFACTURER'S INSTALLATION INSTRUCTIONS REGARDLESS OF ADJACENT TRAFFIC DIRECTION. (SEE DETAIL THIS SHEET)
   E. HEIGHT MEASURED AT TOP OF W-BEAM IS 30" MIN. - 32" MAX.

3. THIS DRAWING IS REPRESENTATIONAL ONLY. DETAILS, DIMENSIONS, QUANTITIES, AND OTHER INFORMATION NOT SHOWN WILL VARY FOR EACH MANUFACTURER. SEE INDIVIDUAL MANUFACTURER'S PLANS FOR THIS INFORMATION.

4. FLUORESCENT PRISMATIC LENS YELLOW SHEETING SHALL BE USED ON THE REFLECTIVE MARKERS. ALL REFLECTIVE SHEETING IS TO BE IN ACCORDANCE WITH SECTION 701 OF THE ROAD AND BRIDGE SPECIFICATIONS. STRIPES SHALL SLOPE DOWN TOWARD THE SIDE OF THE OBSTRUCTION ON WHICH TRAFFIC IS TO PASS.

   COLOR:
   FIELD - YELLOW (REFLECTORIZED)
   MESSAGE - BLACK STRIPES (NON-REFLECTORIZED)

   THROUGH ROADWAY MARKER POSITION LEFT OF TRAFFIC
   ITEM CODE 13286 EACH
   THROUGH ROADWAY MARKER POSITION RIGHT OF TRAFFIC

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

MIDWEST GUARDRAIL SYSTEM
(TANGENT END TERMINAL)

VIRGINIA DEPARTMENT OF TRANSPORTATION
**NOTES:**


2. THE AREA IMMEDIATELY BEHIND AND BEYOND THE TERMINAL SHALL BE TRAVERSABLE AND FREE FROM FIXED OBJECTS. IF A CLEAR RUN OUT IS NOT ATTAINABLE THIS AREA SHALL AT LEAST BE SIMILAR IN CHARACTER TO THE UPSTREAM UNSHIELDED ROADSIDE AREAS.

3. FOR NEW CONSTRUCTION AND RECONSTRUCTION, THE 10:1 SLOPE GRADING SHALL EXTEND A MINIMUM OF 6'-0" MEASURED FROM THE FACE OF RAIL.

4. FOR PROPRIETARY GUARDRAIL TERMINALS, THE MANUFACTURER'S SITE PREPARATION REQUIREMENTS TAKE PRECEDENCE OVER THIS STANDARD IF ADDITIONAL GRADING IS REQUIRED.
MIDWEST GUARDRAIL SYSTEM
(TANGENT END TERMINAL)

NOTES:

1. The cross slope of the grade approaching the guardrail terminal, and adjacent to for its full length, must be a maximum of 10:1. If the existing grade is flat or is a positive slope due to the super-elevation of the roadway pavement, the minimum offset from the face of rail to the hinge point, as shown, is required.

2. The area immediately behind and beyond the terminal should be traversable and free from fixed objects. If a clear run out is not attainable this area should at least be similar in character to the upstream unshielded roadside areas.

3. Not for use on interstates, freeways, or new construction, unless approved by the engineer. May be used when specified in the plans for 3R work that cannot conform to the site preparation requirements on page 506.07.

4. For limited applications as described in note 3, the grading should be as close as possible to the site preparation requirements on page 506.07. The slope shall extend a minimum of 4'-0" from the face of rail and grading shall conform to the details above. Use 21B aggregate, or other suitable material as approved by the engineer.

LIMITED USE SITE PREPARATION REQUIREMENTS FOR GR-MGS2

A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.

A. B

REFERENCE SPECIFICATION

505

221
236
505

ROAD AND BRIDGE STANDARDS

9/17

505.08

2016 ROAD & BRIDGE STANDARDS
**NOTES:**
1. USE OF THIS TRAILING END ANCHORAGE IS RESTRICTED TO RUN-OFF CONDITIONS ON DIVIDED HIGHWAYS.
2. STEEL POST, BLOCKOUT, AND SPLICE SHALL BE IN ACCORDANCE WITH THE GR-MGS1 STANDARD AND LOCATED AS SHOWN IN THE DETAILS ABOVE.
3. ALL BOLTS, NUTS, WASHERS, AND OTHER STEEL ITEMS ARE TO BE GALVANIZED.
4. WOOD POSTS SHALL BE TREATED WITH A WOOD PRESERVATIVE IN ACCORDANCE WITH THE SPECIFICATIONS.
1. Height transition from 31" GR-MGS1 to 27\(\frac{3}{4}\)" GR-2 will require a single 25' W-beam with \(\frac{3}{4}\)" x 2\(\frac{1}{2}\)" slotted holes at 3' - 1\(\frac{1}{2}\)" spacing.

2. Posts, blockouts, and splices will be in accordance with the GR-MGS1 standard and located as shown in the details above.

3. Standard 6 foot posts will be used unless otherwise noted on plans.

4. Standard GR-MGS4 transition will be paid for as each complete in place.

5. End terminal will be a VDOT approved product meeting MASH testing criteria.

6. The blockout depth of the GR-MGS4 transition will match the blockout depth of the GR-MGS2 terminal when the terminal ties directly to the GR-MGS4 height transition.

A copy of the original sealed and signed drawing is on file in the central office.

Midwest Guardrail System
(Transition from MGS 31" Height to GR-2 27\(\frac{3}{4}\)" Height)

Virginia Department of Transportation

Specification Reference
271
236
505

Road and Bridge Standards
Revision Date
09/17
Sheet 1 of 1
506.11
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MEASURING GUARDRAIL HEIGHT ON FRONT SLOPE RELATIVE TO SHOULDER HINGE POINT

THE HEIGHT OF THE GUARDRAIL SHALL BE MEASURED AT THE FACE OF CURB.  

THE OPTION TO OFFSET GUARDRAIL FROM THE FACE OF CURB IS APPLICABLE FOR DESIGN SPEEDS OF 45 MPH AND LESS.

MEASURING GUARDRAIL HEIGHT & RAIL OFFSET FROM FACE OF CURB OR CURB & GUTTER APPLICABLE FOR DESIGN SPEEDS OF 45 MPH AND LESS.
**ROADSIDE OBSTRUCTION**

**SECTION A-A**

*TRAFFIC RUN ON OR RUN OFF*

*FOR TWO WAY TRAFFIC, USE 8 POST SPACING DESIGN FROM EACH END OF FIXED OBJECT.*

**SECTION D-D**

**TABLE I**

<table>
<thead>
<tr>
<th>TOTAL SHOULDER WIDTH (S) (PAVED &amp; GRADED)</th>
<th>PAVED SHOULDER WIDTH (PS) (SEE NOTE)</th>
<th>OFFSET FROM EDGE OF TRAVELED WAY TO FACE OF GUARDRAIL (O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18'</td>
<td>12'</td>
<td>14'</td>
</tr>
<tr>
<td>16'</td>
<td>4' or 10'</td>
<td>12'</td>
</tr>
<tr>
<td>14'</td>
<td>4' or 8'</td>
<td>10'</td>
</tr>
<tr>
<td>12'</td>
<td>3', 4', 5', or 6'</td>
<td>8'</td>
</tr>
<tr>
<td>10'</td>
<td>3' or 4'</td>
<td>6'</td>
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<tr>
<td>8'</td>
<td>0 or 2'</td>
<td>4'</td>
</tr>
<tr>
<td>6'</td>
<td>0</td>
<td>2'</td>
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</table>

**TABLE II**

<table>
<thead>
<tr>
<th>TOTAL SHOULDER WIDTH (S) (PAVED &amp; GRADED)</th>
<th>PAVED SHOULDER WIDTH (PS) (SEE NOTE)</th>
<th>OFFSET FROM EDGE OF TRAVELED WAY TO FACE OF GUARDRAIL (O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18'</td>
<td>12'</td>
<td>14'</td>
</tr>
<tr>
<td>16'</td>
<td>6' or 10'</td>
<td>12'</td>
</tr>
<tr>
<td>14'</td>
<td>8'</td>
<td>10'</td>
</tr>
<tr>
<td>12'</td>
<td>4', 5', or 6'</td>
<td>8'</td>
</tr>
<tr>
<td>10'</td>
<td>0 or 4'</td>
<td>6'</td>
</tr>
<tr>
<td>8'</td>
<td>0 or 2'</td>
<td>4'</td>
</tr>
<tr>
<td>6'</td>
<td>0</td>
<td>2'</td>
</tr>
</tbody>
</table>

**NORMAL GUARDRAIL LOCATION**

**MGS W-BEAM GUARDRAIL INSTALLATION CRITERIA**

**DETAIL OF MULTIPLE BLOCK-OUT TO AVOID UNDERGROUND OR LOW PROFILE OBSTRUCTION**

**SPECIFICATION REFERENCE**

1. A COPY OF THE ORIGINAL SEALED AND SIGNED DRAWING IS ON FILE IN THE CENTRAL OFFICE.
2. **ROAD AND BRIDGE STANDARDS**
3. **SHEET 2 OF 4**
4. **REVISION DATE** NEW 02/17
5. **507.02**
TRANSITION FROM WEAK POST (STANDARD GR-8) TO GR-MGS1 GUARDRAIL
MGS W-BEAM GUARDRAIL INSTALLATION CRITERIA

1. LEAVE-OUT ALLOWS FOR PROPER POST ROTATION.
2. DO NOT SHORTEN POST. POST SHALL HAVE FULL EMBEDMENT.
3. INSTALL POST AFTER OPENING IS BACKFILLED AND COMPACTED IN 6" LIFTS.
THREE-BEAM FIXED OBJECT ATTACHMENT
FOR USE WITH VERTICAL FACE TERMINAL WALLS AND MGS GUARDRAIL

1. THREE-BEAM FIXED OBJECT ATTACHMENT IS FOR USE WITH THE CPSR, SSCP, AND KANSAS CORRAL VERTICAL FACE TERMINAL WALLS.

2. 7/8" BOLTS SHALL BE ASTM A325, A449 HEX BOLTS WITH ASTM A663 OR DA OR A194 GR. 2H NUTS. A 3" x 3" x 0.315" ASTM A572 GR. 50 SQUARE PLATE WASHER IS REQUIRED FOR EACH BOLT ON THE BACK SIDE OF THE BRIDGE TERMINAL WALL.

3. NO BOLT PLACED IN LOWER HOLE OF GR-FOA-5 POST 9.


5. SPLICE LOCATION IS DEPENDENT ON THE LENGTH OF W-BEAM RAIL USED. IF 12'-6" RAIL IS USED A SPLICE WILL BE AT THIS LOCATION.

6. STANDARD CG-3 CURB IS REQUIRED FROM POST 11 TO THE TERMINAL WALL.

7. STANDARD CG-3 CURB IS REQUIRED FROM POST 11 TO THE TERMINAL WALL.


9. GUARDRAIL COMPONENTS SHALL BE IN ACCORDANCE WITH VDOT ROAD AND BRIDGE STANDARDS.

10. ALL BOLTS, NUTS, WASHERS, AND OTHER STEEL ITEMS ARE TO BE GALVANIZED.

11. INSTALLATION OF THE FOA-5 ON A RADIUS OR FLARE IS NOT PERMITTED.

12. 4'-0" WIDE GRADING FROM THE FACE OF RAIL TO THE HINGE POINT SHALL EXTEND A MINIMUM OF 3' PAST THE END OF THE TERMINAL WALL TO SUPPORT FOA POSTS.
6''x12''x19'' TREATED WOOD BLOCKOUT
6''x8''x19'' TREATED WOOD BLOCKOUT

A36 SQUARE PLATE WASHER

\( \frac{3}{4}'' \) HOLE

\( \frac{3}{8}'' \) HOLE

\( \frac{3}{8}'' \) HOLE

1'' x 2\( \frac{1}{2}'' \) SLOTTED HOLES AT 1''-6\( \frac{1}{4}'' \) SPACING

13'-6\( \frac{1}{4}'' \)

12'-6''

\( \frac{3}{4}'' \) x 2\( \frac{1}{2}'' \) SLOTTED HOLES AT 1''-6\( \frac{1}{4}'' \) SPACING

STANDARD 12'-6'' THRIE-BEAM SECTION

STEEL POST

STEEL POST

W6x15 STEEL POST 7' LENGTH

W6x9 OR W6x8.5 STEEL POST 6' LENGTH

\( \frac{3}{4}'' \) x 2\( \frac{1}{2}'' \) SLOTTED HOLES AT 1''-6\( \frac{1}{4}'' \) SPACING

STANDARD 6'-3'' THRIE-BEAM SECTION
**NOTES:**

1. The temporary concrete barrier shall be precast by a VDOT approved precast manufacturer. The manufacturer shall submit shop drawings for approval by the standards & special design section. Modifications to this design are not permitted.

2. Barrier shall have a uniform natural concrete finish. The barrier shall not be painted or coated other than markings necessary to identify the manufacturer.

3. The recessed lettering in the top of the barrier containing MASH 2016 along with month and year of manufacture is required for each barrier segment produced.

4. Concrete shall be a minimum of 5,000 psi.

5. All reinforcing steel shall be in accordance with ASTM-A615 Grade 60.

6. All reinforcing steel shall have a minimum cover of 2" unless otherwise shown.

7. Loop bars shall not be used to lift, move, or reposition the barrier.

8. Only one type of temporary barrier is permitted in a run. Mixing temporary concrete barrier with other temporary concrete barriers is not permitted.

9. Other precast temporary concrete barriers shall be from the MASH provisionally approved list. Barriers that have been approved by VDOT on the MASH provisionally approved list may be substituted for this standard.

10. Maximum cross slope for placement of temporary barrier will be 10:1.

11. Barrier delineator size, color and spacing shall be in accordance with the specifications.

12. Barrier delineator reflective surface in all instances shall be facing oncoming traffic.

13. Cost of delineator shall be included in the price bid for temporary concrete barrier.

14. Barrier vertical panels shall be spaced in accordance with VDOT work area protection manual.

---

**SPECIFICATION REFERENCE**

- 105
- 512

---

A copy of the original sealed and signed drawing is on file in the central office.

**TEMPORARY CONCRETE BARRIER**

(MASH FREESTANDING PRECAST PIN AND LOOP FOR TEMPORARY USE)

**ROAD AND BRIDGE STANDARDS**

**REVISION DATE**

New 04/20

**SHEET** 1 OF 3

**509.01**

---

**2016 ROAD & BRIDGE STANDARDS**
FLARE RATES

<table>
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<th>DESIGN SPEED</th>
<th>INSIDE SHY LINE</th>
<th>BEYOND SHY LINE</th>
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<tr>
<td>MPH</td>
<td>FLARE RATE</td>
<td>FLARE RATE</td>
</tr>
<tr>
<td>70</td>
<td>10'</td>
<td>20:1</td>
</tr>
<tr>
<td>60</td>
<td>8'</td>
<td>18:1</td>
</tr>
<tr>
<td>50</td>
<td>6.5'</td>
<td>14:1</td>
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<tr>
<td>40</td>
<td>5'</td>
<td>10:1</td>
</tr>
<tr>
<td>30</td>
<td>3.5</td>
<td>8:1</td>
</tr>
</tbody>
</table>

* FLARE RATES

WHEN USING VDOT STANDARD TCB-1 WITH THE PIN AND LOOP POSITIVE CONNECTION, ALLOW FOR A 6'-8" DYNAMIC DEFLECTION. PROVIDE MIN. 60' OF BARRIER UPSTREAM AND DOWNSTREAM OF WORK ZONE FOR ANCHORAGE. FOR APPROVED NON-VDOT DESIGNS, REFER TO MANUFACTURER'S INSTALLATION INSTRUCTIONS FOR DEFLECTIONS AND ANCHORAGE.

CONNECTOR PIN

REINFORCING STEEL & LOOP BAR SCHEDULE

<table>
<thead>
<tr>
<th>Work</th>
<th>No.</th>
<th>Size</th>
<th>LengthX</th>
<th>Material</th>
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<td>14</td>
<td>7&quot;</td>
<td>5 1/4&quot;</td>
<td>A615 Gr. 60</td>
</tr>
<tr>
<td>ML01</td>
<td>3</td>
<td>5&quot;</td>
<td>12'-2 1/2&quot;</td>
<td>A615 Gr. 60</td>
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<tr>
<td>ML02</td>
<td>6</td>
<td>6&quot;</td>
<td>12'-2 1/2&quot;</td>
<td>A615 Gr. 60</td>
</tr>
<tr>
<td>A1</td>
<td>2</td>
<td>6&quot;</td>
<td>2'-11&quot;</td>
<td>A709 Gr. 70</td>
</tr>
<tr>
<td>B1</td>
<td>2</td>
<td>6&quot;</td>
<td>7'-1&quot;</td>
<td>or A706 Gr. 60</td>
</tr>
<tr>
<td>C1</td>
<td>2</td>
<td>6&quot;</td>
<td>8'-5/8&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Dimensions in bending diagram are out-to-out of bars, except as shown. * DENOTES LENGTH OF ONE (1) BAR.
**Surface Requirements for Barrier Placement**

- **Barrier shall be placed on a paved surface or a compacted aggregate base a minimum of 6" in depth. Placement of barrier on grass, soil, or any non-paved area is not permitted.**

- **Maximum cross slope for barrier placement is 10:1.**

- **1'-0" min. Normal Earth**

- **Existing asphalt concrete pavement, hydraulic cement concrete pavement, or a minimum 6" of 21A or 21B compacted aggregate, 4' width minimum.**

**Barrier Deflection Area**

- **Traffic Side**

- **Area to remain free of equipment, stored materials, and workers.**

- **Dynamic Deflection Area 6'-8".**

**Minimum Work Area and Anchorage**

- **Downstream Barrier Anchorage**
  - Minimum 5 barrier segments

- **Work Area**
  - Minimum 3 barrier segments

- **Upstream Barrier Anchorage**
  - Minimum 5 barrier segments

**Notes:**

1. The space behind the 5 segments of anchorage barrier shall remain free of equipment, stored materials, and workers.

2. Barriers extended on a flare to the roadway clear zone shall have a minimum of 2 barrier segments placed beyond the roadway clear zone at the same flare rate.

**Temporary Concrete Barrier**

- **MASH Freestanding Precast Pin and Loop for Temporary Use**

**Specifications Reference**

- 105
- 512

**A copy of the original sealed and signed drawing is on file in the central office.**

**Virginia Department of Transportation**

2016 Road & Bridge Standards
SECTION 600

MISCELLANEOUS DESIGNS & SIGHT DISTANCE TABLES
<table>
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<th>STANDARD</th>
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<tbody>
<tr>
<td>S-1</td>
<td>STANDARD CONCRETE STEPS FOR 1(\frac{1}{4}):1 SLOPES</td>
<td>601.01</td>
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<tr>
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<td>STANDARD CONCRETE STEPS FOR 1(\frac{1}{4}):1 SLOPES</td>
<td>601.02</td>
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<td>S-2</td>
<td>STANDARD CONCRETE STEPS FOR 2:1 SLOPES</td>
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<td>STANDARD CONCRETE STEPS FOR 2:1 SLOPES</td>
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<tr>
<td>HR-1</td>
<td>STANDARD HANDRAILS (METHOD OF LOCATING AND ERECTING)</td>
<td>601.05</td>
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<tr>
<td>LR-1</td>
<td>MINIMUM DESIGN FOR SMALL BOAT LAUNCHING RAMPS AT PUBLIC LANDINGS</td>
<td>601.06</td>
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<tr>
<td>SP-1</td>
<td>SETTLEMENT PLATE</td>
<td>601.07</td>
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<td>SI-1, 2, 3</td>
<td>STANDARD PLAN FOR SIGN ISLANDS</td>
<td>602.01</td>
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<td>PE-1</td>
<td>STANDARD PRIVATE ENTRANCES</td>
<td>602.02</td>
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<td>CR-1</td>
<td>STANDARD MAINTENANCE CROSSOVER FOR USE ON FREeways</td>
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<td>RFD-1</td>
<td>TURN OUT DETAIL</td>
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<td>G-3</td>
<td>PRECAST CONCRETE CATTLE GUARD</td>
<td>604.01</td>
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<td>G-3A</td>
<td>PRECAST CONCRETE CATTLE GUARD</td>
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<tr>
<td>NG-1</td>
<td>STORAGE FACILITY FOR NUCLEAR GAUGE</td>
<td>605.01</td>
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<tr>
<td>RU-1</td>
<td>METHODS OF UNDERCUTTING ROCK</td>
<td>606.01</td>
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<tr>
<td>SS-1</td>
<td>STANDARD METHOD OF SETTING AND MARKING SLOPE STAKES</td>
<td>607.01</td>
</tr>
<tr>
<td>SD-1</td>
<td>SIGHT DISTANCES ON HORIZONTAL CURVES HEIGHT OF EYE 3.5 FEET; HEIGHT OF OBJECT 2.0 AND 3.5 FEET</td>
<td>608.01</td>
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<td>SIGHT DISTANCE ON HORIZONTAL CURVES HEIGHT OF EYE 3.5 FEET; HEIGHT OF OBJECT 0.5</td>
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<tr>
<td>SD-3</td>
<td>SIGHT DISTANCE ON HORIZONTAL CURVES HEIGHT OF EYE 3.5 FEET; HEIGHT OF OBJECT 0.25 FEET</td>
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<td>SD-4</td>
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<td>SD-5</td>
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<td>608.05</td>
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<td>SIGHT DISTANCES ON CREST VERTICAL CURVES HEIGHT OF EYE 3.5 FEET; HEIGHT OF OBJECT 3.50 FEET</td>
<td>608.06</td>
</tr>
</tbody>
</table>
V = 0.917W + 1.146(W + H) + 0.726(W + H) + 1.336

V - INDICATES TOTAL VOLUME OF STEPS IN CUBIC YARDS.
V1, V2, V3 & V4 - INDICATE ELEMENTARY VOLUMES
USED IN COMPUTING V.
W - INDICATES CLEAR WIDTH OF STEPS, IN FEET, BETWEEN SIDERAILS.
N - INDICATES NUMBER OF STEPS IN INSTALLATION EXCLUSIVE OF LANDING.
L1 - INDICATES LENGTH OF BARS A, IN INCHES. L1 = 13.038N + 8
L2 - INDICATES LENGTH OF BARS B, IN INCHES. L2 = 12W + 9
L3 - INDICATES LENGTH OF BARS C, IN INCHES. L3 = 13.038N + 18
A LANDING IS TO BE PROVIDED WHERE 12 OR MORE STEPS ARE REQUIRED MINIMUM SIZE OF LANDING TO BE W + 1 FOOT X 4 FEET.

THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
CONCRETE TO BE CLASS A3 IF CAST IN PLACE, 4000 PSI IF PRECAST.
FOR OTHER WIDTHS THE APPROPRIATE SPACING OF BARS A IN INCHES WILL BE EQUAL TO 80 + N WITH A MINIMUM SPACING OF 6 INCHES.
REINFORCING BARS TO BE USED IN INSTALLATIONS OF 6 OR MORE STEPS.
FOR TABULATION OF CONCRETE AND STEEL QUANTITIES SEE SHEET 2.

HANDRAIL IS TO BE PROVIDED FOR STEPS HAVING THREE OR MORE RISERS, AND WILL MEET THE FOLLOWING CONDITIONS:
1. ON STEPS LESS THAN 44 INCHES WIDE HAVING BOTH SIDES ENCLODED, AT LEAST ONE HANDRAIL, PREFERABLY ON THE RIGHT SIDE DESCENDING.
2. ON STEPS LESS THAN 44 INCHES WIDE HAVING ONE SIDE OPEN, ONE HANDRAIL ON EACH SIDE.
3. ON STEPS LESS THAN 44 INCHES WIDE HAVING BOTH SIDES OPEN, ONE HANDRAIL ON EACH SIDE.
4. ON STEPS MORE THAN 44 INCHES WIDE BUT LESS THAN 88 INCHES WIDE, ONE HANDRAIL ON EACH SIDE.
5. ON STEPS 88 OR MORE INCHES WIDE, ONE HANDRAIL ON EACH SIDE, AND ONE INTERMEDIATE HANDRAIL LOCATED APPROXIMATELY MIDWAY OF THE WIDTH.

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STANDARD CONCRETE STEPS FOR 1/2:1 SLOPE
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* Increments to be added for each additional foot of width.
N - Indicates number of steps exclusive of landing.
W - Indicates width between sidewalls.

For detail drawings and dimensions of steps see sheet 1 of 2.
V1 = 1,000 CU. FT.
V2 = 0.583 CU. FT.
V3 = 0.750 CU. FT.
V4 = 0.708 CU. FT.

FROM PICTORIAL VIEW IT IS SEEN THAT:
V = \( V_1 + 2V_2(N-1) + V_3(W+1) - 2V_4 \)
\[ \frac{27}{27} \]

SUBSTITUTING VALUES OF ELEMENTARY VOLUMES:
V = 1,000 \( W + 1.186(N-1) + 0.750(W+1) \cdot 1.416 \)
\[ \frac{27}{27} \]

V - INDICATES TOTAL VOLUME OF STEPS IN CUBIC YARDS.
V1, V2, V3 & V4 - INDICATE ELEMENTARY VOLUMES
USED IN COMPUTING V.
W - INDICATES CLEAR WIDTH OF STEPS, IN FEET, BETWEEN
SIDEWALLS.
N - INDICATES NUMBER OF STEPS IN INSTALLATION EXCLUSIVE
OF LANDING.
L1 - INDICATES LENGTH OF BARS A, IN INCHES. L1 = 13.416N + 8”
L2 - INDICATES LENGTH OF BARS B, IN INCHES. L2 = 12W + 9”
L3 - INDICATES LENGTH OF BARS C, IN INCHES. L3 = 13.416N + 18”

A LANDING IS TO BE PROVIDED WHERE 12 OR MORE STEPS ARE REQUIRED.
MINIMUM SIZE OF LANDING TO BE W + 1 FOOT X 4 FEET.

THIS ITEM MAY BE PRECAST OR CAST IN PLACE.
CONCRETE TO BE CLASS A3 IF CAST IN PLACE, 4000 PSI IF PRECAST.
FOR OTHER WIDTHS THE APPROXIMATE SPACING OF BARS A
IN INCHES WILL BE EQUAL TO 80/N WITH A MINIMUM SPACING OF 6”.
REINFORCING BARS TO BE USED IN INSTALLATIONS OF 6 OR MORE STEPS.
FOR TABULATION OF CONCRETE AND STEEL QUANTITIES SEE SHEET 2.

### NUMBER OF BARS A

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HANDRAIL IS TO BE PROVIDED FOR STEPS HAVING THREE OR MORE RISERS, AND WILL MEET THE FOLLOWING CONDITIONS:
1. ON STEPS LESS THAN 44 INCHES WIDE HAVING BOTH SIDES ENCLOSED, AT LEAST ONE HANDRAIL, PREFERABLY ON THE RIGHT SIDE DESCENDING.
2. ON STEPS LESS THAN 44 INCHES WIDE HAVING ONE SIDE OPEN, ONE HANDRAIL ON EACH SIDE.
3. ON STEPS LESS THAN 44 INCHES WIDE HAVING BOTH SIDES OPEN, ONE HANDRAIL ON EACH SIDE.
4. ON STEPS MORE THAN 44 INCHES WIDE BUT LESS THAN 88 INCHES WIDE, ONE HANDRAIL ON EACH SIDE.
5. ON STEPS 88 OR MORE INCHES WIDE, ONE HANDRAIL ON EACH SIDE, AND ONE INTERMEDIATE HANDRAIL LOCATED APPROXIMATELY MIDWAY OF THE WIDTH.
## TABLE OF QUANTITIES

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* Increments to be added for each additional foot of width.

N - Indicates number of steps exclusive of landing.

W - Indicates width between sidewalks.

For detail drawings and dimensions of steps see sheet 1.
**Method of Locating and Erecting**

**HR-1 Type II Pedestrian Railing**
(For use along sidewalks and ramps)

**HR-1 Type III Bicycle Railing**
(For use along shared use paths)

**Notes**
1. The contractor shall submit drawings detailing all aspects of fabrication and installation of railing, including concrete foundations for approval by the engineer prior to installation. Shop drawings shall be signed and sealed by a professional engineer holding a valid license to practice engineering in the Commonwealth of Virginia.

2. All railing components and fasteners shall be galvanized in accordance with the current road and bridge specifications. To achieve a uniform coating on all surfaces, venting and drainage holes for galvanizing shall be included in the shop drawings.

3. All fasteners shall be in accordance with ASTM A307, ASTM A563, and ASTM F844. All anchor bolts shall be in accordance with AASHTO M314, Grade 36.

4. A chemical anchor system from VDOT's approved material list may be used in lieu of cast in place anchors and shall be included in the shop drawings.

5. Posts shall be mitred to match grade of ramps, sidewalks, and steps.

6. Handrails shall match grade of ramps, sidewalks, and steps.

7. All posts and pickets shall be set plumb.

8. Railings shall be grounded and effectively bonded. Grounding materials installation to be in accordance with STD. FE-6.

9. Commercially available railing systems may be used in lieu of designing and fabricating the railing. Documentation from the manufacturer verifying that project requirements are met with the railing system shall be submitted with the installation drawings and approved by the engineer in accordance with Note 1.

10. Handrail to be in accordance with the latest edition of the Virginia Uniform Statewide Building Code.

11. This handrail is to be used only as a protection for pedestrians and should not be placed in any location where it might be subject to any vehicular impact. For vehicular protection, standard guardrail should be used.

**Specifications Reference**

| Specification | 105 | 238 | 504 |

**Virginia Department of Transportation**

**2016 Road & Bridge Standards**

**Rev. Date**
7/11

**Sheet 1 of 1**

**HR-1**
NOTES:
1. THE MINIMUM SLAB WIDTH IS TO BE 16'.
2. SLAB DETAILS ARE TO BE IN ACCORDANCE WITH STANDARD PLAN PR-2 EXCEPT THAT EXPANSION, CONTRACTION, AND LONGITUDINAL JOINTS MAY BE ELIMINATED UNLESS REQUIRED BY THE ENGINEER.
3. STEEL FABRIC SLAB REINFORCEMENT SHALL CONSIST OF MEMBERS RIODLY ATTACHED AT ALL JOINTS OR POINTS OF INTERSECTION AND SHALL HAVE AN EFFECTIVE WEIGHT OF NOT LESS THAN 61 LBS./100 SQ.FT. LONGITUDINAL MEMBERS SHALL BE NO. 1 GAGE WIRE SPACED AT 6" O.C. TRANSVERSE MEMBERS SHALL BE OF NO. 4 GAGE WIRE SPACED AT 12" O.C. ALTERNATE GRADE 60 NO. 4 REBARS 12" O.C EACHWAY CENTERED IN SLAB.
4. SLAB IS TO BE CONSTRUCTED ON EITHER A STRAIGHT GRADE OR WITH VERTICAL CURVES WITH A RATE OF CHANGE PER FOOT OF LESS THAN 2X.
5. THE GRADIENT OF SLAB IS TO BE 12-15%, RAMPS CONSTRUCTED IN SALT WATER WITH THE POSSIBILITY OF LARGER BOATS USING THE RAMP SHOULD BE DESIGNED USING THE LOWER END OF THIS RANGE.
6. ALL REINFORCING STEEL MEMBERS ARE TO HAVE A MINIMUM OF 3" CONCRETE COVER AT EDGES OF SLAB. MESH REINFORCEMENT IS TO BE PLACED 2" FROM TOP OF SLAB.
7. FINAL FINISH OF SLAB IS TO BE OBTAINED BY THE USE OF A STEEL RAKE (WITH TINES BENT AWAY FROM THE DIRECTION OF PULL) DRAWN TRANSVERSALLY TO AXIS OF SLAB (PARALLEL TO WATER LINE).
8. PORTIONS OF SLAB WHICH WILL ULTIMATELY BE BELOW WATER LEVEL ARE TO BE PROTECTED DURING POURING, FINISHING, AND CURING BY THE USE OF COFFERDAMS, CHBS, OR OTHER METHODS MEETING THE APPROVAL OF THE ENGINEER.
9. CLASS 1 DRY RIP RAP TO BE IN ACCORDANCE WITH ROAD AND BRIDGE SPECIFICATIONS.
10. SUITABLE PARKING AREAS FOR VEHICLES AND TRAILER ARE TO BE PROVIDED OFF OF RAMP.
11. RAMP SHOULD BE ANGLED DOWNSTREAM IN RIVER SITUATIONS AT THE DISCRETION OF THE ENGINEER.
12. ON FLOWING RIVER SITUATIONS COURTSEY PIERS ARE NOT DESIRABLE, ON ALL OTHER SITUATIONS A COURTSEY PIER IS DESIRABLE.
13. LAUNCH RAMPS AND PARKING AREAS SHOULD BE FREE OF OVERHEAD OBSTRUCTIONS, ESPECIALLY ELECTRICAL WIRING.
14. THESE FACILITIES SHOULD BE HANDICAPPED ACCESSIBLE TO THE TOP OF BOAT RAMP AND COURTSEY PIER IF PROVIDED.
15. WHERE WAVE OR TIDAL ACTION OCCUR, THE RIP RAP LENGTH ABOVE MEAN HIGH WATER SHALL BE EXTENDED TO DISSIPATE WATER VELOCITIES.

MINIMUM DESIGN FOR SMALL BOAT LAUNCHING RAMPS AT PUBLIC LANDINGS

<table>
<thead>
<tr>
<th>BEND TO FIT GRADE BARS &quot;B&quot;</th>
<th>2'-8&quot;</th>
<th>1'-10&quot;</th>
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<tr>
<td>A</td>
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<td>B</td>
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* NO. OF BARS EQUALS SLAB WIDTH IN FEET.
** SLAB WIDTH MINUS 6"
NOTES:
1. SETTLEMENT PLATES SHALL BE PLACED AS SHOWN ON PLANS OR AS DIRECTED BY THE ENGINEER.
2. ALL WELDED CONNECTIONS BETWEEN BASE PLATE, RISER PIPE, AND FINS SHALL BE IN ACCORDANCE WITH SECTION 407 OF THE SPECIFICATIONS.
3. STEEL PLATE SHALL BE 1/8" THICK AND CONFORM TO ASTM A36.
4. RISER PIPE SHALL BE 1" SCHEDULE 40 (A-53) STEEL PIPE INSTALLED IN 4' SECTIONS AS REQUIRED.
5. CASING IS TO BE SCHEDULE 40 STEEL OR PVC INSTALLED IN 4' SECTIONS AS REQUIRED. THREADED FITTINGS ARE REQUIRED FOR STEEL PIPE, PVC FITTINGS SHALL BE GLUED WITH PVC PIPE CEMENT.
6. A PROTECTIVE CAP IS REQUIRED AT THE TOP OF THE CASING PIPE TO PREVENT DEBRIS FROM ENTERING THE CASING.
7. THE COUPLING MAY BE OMITTED AND THE RISER PIPE WELDED DIRECTLY TO THE BASE PLATE.
**NOTE:**
Concreate is to be class A3 if cast in place, 4000 PSI if precast.

Size of island is to be governed by offsets from pavement edges & as shown on plans.

**SECTION A-A**

**Basis of Payment - Each**

0.5 cu. yds concrete to be class A3 if cast in place, 4000 PSI if precast.

**Note:**
Size of island is to be governed by offsets from pavement edges & as shown on plans.

**12" Square Hole for Sign Post to be Formed at Radius Point.**

**When Sign Island is Installed Over Existing Pavement a Hole for Sign Post is to be Extended to the Subbase.**

**Detail of Standard Sign Island**

**Design of Standard Sign Island**

**Detail of Directional Island Curb**

**Standard Plan for Sign Islands**
TO BE DETERMINED BY THE EXISTING CONDITIONS
AT THE TIME OF CONSTRUCTION

TYPE I - CRUSHER RUN AGGREGATE
TYPE II - CONCRETE
TYPE III - ASPHALT
TYPE IV - ASPHALT COMMERCIAL

NOTES:
1. ALL ENTRANCE GRADES SHALL START BACK OF THE SHOULDER LINE. IF DRAINAGE IS NECESSARY, THE DITCH MAY BE MOVED BACK TO PROVIDE AT LEAST 9" OF COVER OVER PIPE, AS SHOWN IN THE ALTERNATE METHODS FOR PLACING PIPE UNDER ENTRANCES DIAGRAM.
2. ENTRANCE GRADES ARE TO BE SMOOTHLY TIED INTO THE ROADWAY BY ROUNDING AS NECESSARY.
3. 12" OR EXISTING WIDTH WHICHEVER IS GREATER.
4. LENGTHS OF CULVERTS SHOWN ON ROAD PLANS FOR ENTRANCES ARE APPROXIMATE AND SHALL BE ADJUSTED TO OBTAIN ABOVE ROADWAY WIDTHS.
5. ENTRANCES IN FILL TO BE SAME AS ABOVE EXCEPT LOCATION OF CULVERT (WHEN NECESSARY).
EXAMPLES OF ALTERNATE MEDIAN DRAINAGE

These alternatives could be considered in lieu of a pipe underneath the median crossover.

EXISTING CROSS DRAINAGE STRUCTURE

TRAFFIC

DROP INLET

PIPE

DROP INLET

TRAFFIC

DISCHARGE INTO OUTSIDE DITCH SECTION

SKEW THE PIPE IF POSSIBLE TO MOVE-ENDS BEYOND THE CLEAR ZONE OF APPROACH TRAFFIC

PIECE CULVERT IF REQ'D.

SLOPES 10:1 OR FLATTER DESIRABLE

CABLE BARRICADE

20' R (TYPICAL)

6' PAVED SHOULDER

1 CABLE BARRICADE - MEDIAN WIDTH 60' OR LESS.

* 2 CABLE BARRICADES - MEDIAN WIDTH OVER 60'.

* TO BE LOCATED 20' FROM EDGE OF EACH THRU ROADWAY PAVEMENT.

THRU ROADWAY PAVEMENT

PLAN

1 WIDEN PAVED PORTION OF MEDIAN SHOULDER OR 150' TO ACCOMMODATE TURNING VEHICLES.

2 END TREATMENT AS REQUIRED TO MEET PROPOSED SLOPE.

2" DIAMETER HOLE TO BE DRILLED THROUGH WOOD POST

GALVANIZED EYE-BOLT

ATTACH TO BOLT WITH MIN. 9 GAGE GALVANIZED WIRE.

3/4" GALVANIZED CABLE

2" DIAMETER HOLE TO BE DRILLED THROUGH WOOD POST

6" X 6" WOOD POST GRADE NO. 2 SR OR S3 X 5.7 STEEL POST (2 REQ'D. EACH CABLE ASSEMBLY)

SECTION A-A

WOOD POSTS TO BE SALT TREATED OR PRIMED AND PAINTED DARK GREEN.

VARIABLE

PADLOCK TO BE FURNISHED AND INSTALLED BY STATE FORCES UNLESS OTHERWISE SPECIFIED. CONTRACTOR TO TEMPORARILY ATTACH CABLE TO EYE-BOLT WITH MINIMUM 9 GAUGE GALVANIZED WIRE.

**\ SIGN

MATERIAL: 0.080" ALUMINUM ALLOY 6061 - T6

SIZE: 24" X 9"

COLOR COMBINATION: C-1

BORDER WIDTH: 1/4"

MARGIN WIDTH: 1/8"

CORNER RADIUS: 1/4"

LETTER TYPE: L-10 OR L-2

LETTER HEIGHT AND SERIES: 4" - 0

IN ACCORDANCE WITH V.D.O.T. "MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS".

MESSAGE, BOTH SIDES IF ONE CABLE BARRICADE IS USED. 20' MESSAGE, ONE SIDE IF TWO CABLE BARRICADES ARE USED.
NOTES:

1. MAILBOXES SHALL BE OF LIGHT SHEET METAL OR PLASTIC CONSTR.
   CONFORMING TO THE REQUIREMENTS OF THE U.S. POSTAL SERVICE.

2. MAILBOX SUPPORTS SHALL NOT BE SET IN CONCRETE UNLESS THE
   SUPPORT DESIGN HAS BEEN SHOWN TO BE SAFE BY CRASH TESTS
   WHEN SO INSTALLED.

3. POSTS MAY BE 4" X 4" OR 4½" DIAMETER WOOD POST,
   2" DIAMETER STANDARD STRENGTH STEEL PIPE, OR OTHER STEEL
   OR ALUMINUM POST SHAPES OF EQUAL STRENGTHS.

4. THE POST-TO-BOX ATTACHMENT DETAILS SHOULD BE OF SUFFICIENT
   STRENGTH TO PREVENT THE BOX FROM SEPARATING FROM THE
   POST TOP IF THE INSTALLATION IS STRUCK BY A VEHICLE.
   HARDWARE SHOWN IS SUGGESTED ONLY, ALL GUIDELINES AS REQ'D.
   BY THE U.S. POSTAL SERVICE MUST BE FOLLOWED.

* DIMENSIONS VARY ACCORDING TO THE SIZE OF THE MAIL BOX.

STANDARD MAILBOX
### TURNOUT DETAIL

**NOTES:**

1. IF THERE IS A NEED TO PROVIDE FOR INCREASED ACCESS, THE FOLLOWING MAY BE CONSIDERED IN CONJUNCTION WITH THE LOCAL POSTMASTER:
   
   A. PROVIDE A LEVEL CLEAR FLOOR SPACE 30" X 48" CENTERED ON THE BOX FOR EITHER SIDE OR FORWARD APPROACH.
   
   B. PROVIDE AN ACCESSIBLE PASSAGE TO AND FROM THE MAILBOX AND PROJECTION INTO A CIRCULATION ROUTE (NO MORE THAN 4" IF BETWEEN 28" AND 80" AFF) SO THAT THE MAILBOX DOES NOT BECOME A PROTRUDING OBJECT FOR PEDESTRIANS WITH IMPAIRED VISION.

2. STRIVE FOR A 6 FEET MIN.; HOWEVER, IN SOME SITUATIONS THIS MAY NOT BE PRACTICAL. IN THOSE CASES, PROVIDE AS MUCH AS POSSIBLE.

3. IF A TURNOUT IS PROVIDED, THIS MAY REDUCE TO ZERO.

4. BEHIND TRAFFIC-FACE OF CURB.

<table>
<thead>
<tr>
<th>HIGHWAY TYPE AND ADT, (vpd)</th>
<th>WIDTH (W) OF ALL-WEATHER SURFACE TURNOUT OR AVAILABLE SHOULDER AT MAILBOX, (FT.) (SEE NOTE 1)</th>
<th>DISTANCE (X) FROM FACE OF MAILBOX TO BE OFFSET FROM EDGE OF TURNOUT OR USEABLE SHOULDER, (IN.)</th>
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<tbody>
<tr>
<td>RURAL HIGHWAY OVER 10,000</td>
<td>12</td>
<td>MINIMUM 8</td>
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<td>RURAL HIGHWAY OVER 1,500 TO 10,000</td>
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<td>RURAL HIGHWAY 400 TO 1,500</td>
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<td>RURAL HIGHWAY UNDER 400</td>
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<tr>
<td>RESIDENTIAL STREET WITHOUT CURB OR ALL-WEATHER SHOULDER</td>
<td>6</td>
<td>MINIMUM 0</td>
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</table>

**ADT** = AVERAGE DAILY TRAFFIC  vpd = VEHICLES PER DAY

**EDGE OF PAVED TURNOUT**

**EDGE OF PAVED SHOULDER**

**DIRECTION OF TRAVEL**

**EDGE OF TRAVEL WAY**

**WS** = A MINIMUM DESIGN FOR ROADS CARRYING LOW-SPEED TRAFFIC AND FOR LOCAL AND COLLECTOR ROADS.

**HS** = FOR ROADS CARRYING HIGH-SPEED TRAFFIC.

**W** = FOR SUGGESTED WIDTHS, SEE TABLE.

**MAILBOXES** = FOR MAILBOX SPACING AND VARIABLE LENGTH, SEE SHEET 603.01

**X** = 0" - 12" MAILBOX FACE OFFSET. SEE TABLE.
"L" - 10'-0" MIN.

NOTES:
ANY MANUFACTURERS FABRICATION MEETING OR EXCEEDING THE MINIMUM DESIGN REQUIREMENTS DETAILED HEREON WILL BE ACCEPTABLE.
ALL CONCRETE IN PRECAST MEMBERS TO BE 4000 PSI CONCRETE IN FOOTING TO BE CLASS C1 OR CLASS A3 LENGTH TO BE AS SHOWN ON PLANS.

MINIMUM SECTIONAL AREA OF MEMBERS
INTERMEDIATE RAIL — 28 SQ. IN.
SIDE RAIL — 50 SQ. IN.
BEAM — 48 SQ. IN.

PLAN VIEW

SECTION B-B
TYPICAL BEAM SECTION

SECTION A-A

MINIMUM 2 BARS PER BEAM HAVING A MINIMUM TOTAL WEIGHT OF 2.004 LBS. PER FT.

FINISHED GRADE

MINIMUM 2 BARS PER RAIL HAVING A MINIMUM TOTAL WEIGHT OF 1.356 LBS. PER FT.
NOTES:
Any manufacturers fabrication meeting or exceeding the minimum design requirements detailed hereon will be acceptable.
All concrete in precast members to be 4000 psi.

Length to be as shown on plans.
* A rail spacing of 9½" would be allowed provided the space of beams does not exceed 3'.

Minimum sectional area of members

- Intermediate rail: 28 sq. in.
- Side rail: 50 sq. in.
- Beam: 48 sq. in.

Section B-B
Typical beam section

Precast concrete cattle guard
NOTES:

NO SEPARATE PAYMENT WILL BE MADE FOR FURNISHING, INSTALLING AND PROVIDING MAINTENANCE OF THE STORAGE FACILITY FOR NUCLEAR GAUGE AND THE PRICE THEREOF SHALL BE INCLUDED IN THE PRICE BID FOR FIELD OFFICE (TYPE) SPECIFIED, IN ACCORDANCE WITH SECTION 514 OF THE CURRENT ROAD AND BRIDGE SPECIFICATIONS.

A STEEL BOX SHALL BE CONSTRUCTED OF A-36 Sheet Steel 1/4" min. thickness. When welding to frame use 1/8" fillet welds.

ALL FRAME Work IS TO BE A-36 STEEL ANGLE L 2" X 2" X 1/4".

METAL SCREEN SHALL HAVE A MAXIMUM OF 50 SQUARES PER INCH TO A MINIMUM OF 25 SQUARES PER INCH AND BE SPOT WELDED TO INSIDE OF THE BOX OVER VENT OPENINGS.

THE HOOK SHALL BE WELDED TO THE CENTER OF THE TOP. VENT OPENINGS SHALL BE PARTIALLY COVERED EXTERNALLY BY METAL VENT COVERS.

STORAGE UNIT SHALL BE PAINTED INTERNALLY AND EXTERNALLY WITH A ONE COAT ACRYLIC DIRECT TO METAL (DTM) COATING WITH A THICKNESS OF 4-6 MILS (WET MIL THICKNESS). COLOR SHALL BE EQUAL TO FEDERAL STANDARD COLOR NO. 595-17886 (WHITE).

THE DESIGN IS TO BE 4" ID AND MOUNTED AT A 45° ANGLE OVER THE BULB."HASP OPENING IN THE DOOR.

TOP VIEW

DUPLEX GROUNDED RECEPTACLE MOUNTED IN WATER-PROOF WALLBOX, 110 VOLT MALE PLUG WITH GROUND FAULT PROTECTED FROM SOURCE.

LOCK BOX EACH, OPEN ON THE BOTTOM AND TOP.

A STEEL EYE BOLT SHALL BE INSTALLED IN THE FLOOR INSIDE THE CONTAINER TO ACCOMMODATE A LINKED SECURITY CHAIN. THE EYE BOLT MAY BE THROUGH BOLTED OR WELDED TO THE FLOOR AND SHALL HAVE A MINIMUM 1/4" DIAMETER EYE TO ALLOW THE GAUGE TO BE CHAINED AND LOCKED TO THE FLOOR OF THE FACILITY.

STORAGE FACILITY FOR NUCLEAR GAUGE
STANDARD METHODS OF UNDERCUTTING ROCK

NOTE:
APPicable METHOD AS SHOWN HEREIN IS TO BE USED AT SUCH LOCATIONS AS DESIGNATED BY THE ENGINEER.

Rock Cut Sections
In Design A, if cement or lime subgrade stabilization is included in the normal roadway design, it should be eliminated when solid rock is encountered. Where irregular rock outcroppings, boulders, shale or other non-solid rock is encountered, substitute aggregate base or subbase material for the subgrade stabilization on an inch for inch basis using bottom 2" as a leveling course.

In Design B, if cement or lime subgrade stabilization is included in the normal roadway design, it should be eliminated when solid rock, irregular outcroppings, boulders, shale or other non-solid rock is encountered. Substitute aggregate base or subbase material for the stabilization on an inch for inch basis using bottom 2" as a leveling course.

In Design C, if cement stabilization of aggregate base or subbase material is included as an integral part of the pavement structure above subgrade elevation, eliminate the cement when solid rock or irregular rock outcroppings, boulders, shale or other non-solid rock is encountered.

Rock Fill Sections
When a fill section is built using good quality stone at subgrade elevation and 2' or more below subgrade elevation, fill sections shall be handled in the same manner as rock cut sections. Good quality rock in fill sections should be considered the same as solid rock in cut sections shown in Design A. All other rock fill subgrade conditions shall be handled according to Design A, B or C as shown.
SLOPE STAKES ON TANGENTS

The front of the stake shall indicate the cut or fill to the slope intersection (vertical distance A to B), the offset distance (B to C), and the station.

The back of the stake shall indicate the cut or fill at the point where the stake is set (vertical distance A to C), and the distance to the centerline (A to C).

SLOPE STAKES ON CURVES

The front of the stake shall indicate the cut or fill to the slope intersection including superelevation (vertical distance B to C), the offset distance (C to D), and the station.

The back of the stake shall indicate the cut or fill to centerline at the point where the stake is set (vertical distance A to D), the cut or fill where the stake is set, including superelevation (vertical distance B to D), and the distance to centerline (A to D).
LENGTH OF ARC SUBTENDED OR CLEAR SIGHT DISTANCE MEASURED ALONG CENTER LINE OF INSIDE LANE (S)

INTERMEDIATE VALUES OF S AND M NOT LISTED ON GRAPH CAN

MARK EQUAL TO 10' SIGHT DISTANCE (S) AND 1' OF RADIAL DISTANCE (M).

SIGHT DISTANCES ON HORIZONTAL CURVES
HEIGHT OF EYE 3.5 FT. : HEIGHT OF OBJECT 2.0 AND 3.5 FT.

* 2.0 FEET STOPPING
3.5 FEET PASSING
LINE OF SIGHT AT MID POINT TO BE 2.0' ABOVE EDGE OF PAVEMENT FOR STOPPING SIGHT DISTANCE, AND 4.0' FOR PASSING SIGHT DISTANCE.
### SIGHT DISTANCE ON VERTICAL CURVES

**HEIGHT OF EYE = 3.5 FEET**  
**HEIGHT OF OBJECT = 0.5 FEET**

**2016 ROAD & BRIDGE STANDARDS**

<table>
<thead>
<tr>
<th>L = LENGTH OF VERTICAL CURVE IN FEET</th>
<th>WHEN S = 664.575 + ( \frac{1}{2} ) A</th>
<th>WHEN S = 36.458 ( \sqrt{\frac{A}{L}} )</th>
<th>S = SIGHT DISTANCE IN FEET</th>
<th>A = ALGEBRAIC GRADE OF CURVE IN PERCENT</th>
<th>A = ALGEBRAIC GRADE OF GRADES IN PERCENT</th>
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## SIGHT DISTANCE ON VERTICAL CURVES

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<th>A = ALGEBRAIC DIFFERENCE IN FEET</th>
<th>L = LENGTH OF VERTICAL CURVE IN FEET</th>
<th>S = SIGHT DISTANCE IN FEET</th>
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**SIGHT DISTANCE ON VERTICAL CURVES**

**HEIGHT OF EYE = 3.5 FEET**

**HEIGHT OF OBJECT = 0.5 FEET**

**VIRGINIA DEPARTMENT OF TRANSPORTATION**

---

**2016 ROAD & BRIDGE STANDARDS**
### 2016 ROAD & BRIDGE STANDARDS

#### SIGHT DISTANCE ON VERTICAL CURVES

**HEIGHT OF EYE = 3.5 FEET**

**HEIGHT OF OBJECT = 4.25 FEET**

**VDOT**

**ROAD AND BRIDGE STANDARDS**

**SHEET 1 OF 2**

**REVISION DATE**

**608.04**

#### WHEN $SLI = \frac{1546.362}{A} + \frac{L}{A}$

| $A$ (AS PERCENT) | $50$ | $100$ | $150$ | $200$ | $250$ | $300$ | $350$ | $400$ | $450$ | $500$ | $550$ | $600$ | $650$ | $700$ | $750$ | $800$ | $850$ | $900$ | $950$ | $1000$ |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0.5              | 301 | 306 | 315 | 320 | 325 | 330 | 335 | 340 | 345 | 350 | 355 | 360 | 365 | 370 | 375 | 380 | 385 | 390 | 395 | 400 | 405 | 410 |
| 1.0              | 200 | 205 | 210 | 215 | 220 | 225 | 230 | 235 | 240 | 245 | 250 | 255 | 260 | 265 | 270 | 275 | 280 | 285 | 290 | 295 | 300 | 305 |
| 1.5              | 100 | 105 | 110 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 165 | 170 | 175 | 180 | 185 | 190 | 195 | 200 | 205 |
| 2.0              | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |

#### WHEN $SLI = \frac{55.612}{\sqrt{L}}$

| $L$ (LENGTH OF VERTICAL CURVE IN FEET) | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 | 950 | 1000 |
|---------------------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0.5                                   | 301| 306| 315| 320| 325| 330| 335| 340| 345| 350| 355| 360| 365| 370| 375| 380| 385| 390| 395| 400| 405| 410|
| 1.0                                   | 200| 205| 210| 215| 220| 225| 230| 235| 240| 245| 250| 255| 260| 265| 270| 275| 280| 285| 290| 295| 300| 305|
| 1.5                                   | 100| 105| 110| 115| 120| 125| 130| 135| 140| 145| 150| 155| 160| 165| 170| 175| 180| 185| 190| 195| 200| 205|
| 2.0                                   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
### SIGHT DISTANCE ON VERTICAL CURVES

**Height of Eye = 3.5 Feet**  
**Height of Object = 4.25 Feet**

**2016 ROAD & BRIDGE STANDARDS**

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<td><strong>S = SIGHT DISTANCE IN FEET</strong></td>
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<td><strong>A = ALGEBRAIC CURVATURE IN FEET</strong></td>
<td>**S = ( \frac{1546.362}{A} + \frac{1}{2} ) when ( S \geq S )</td>
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| **A** | **2000** | **1850** | **1750** | **1700** | **1650** | **1600** | **1550** | **1500** | **1450** | **1400** | **1350** | **1300** | **1250** | **1200** | **1150** | **1100** | **1050** |
|-------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 2.0   | 2000     | 1759     | 1573     | 1350     | 1130     | 929      | 742      | 571      | 415      | 279      | 164      | 94       | 54       | 30       | 18       | 11       | 7        | 4        |
| 2.5   | 3344     | 2879     | 2407     | 1906     | 1451     | 1047     | 760      | 525      | 357      | 223      | 131      | 73       | 39       | 22       | 13       | 8        | 5        | 3        |
| 3.0   | 4327     | 3652     | 2931     | 2178     | 1514     | 1062     | 723      | 430      | 275      | 173      | 103      | 59       | 34       | 19       | 11       | 7        | 5        | 3        |
| 3.5   | 4944     | 4163     | 3263     | 2419     | 1728     | 1214     | 816      | 475      | 300      | 186      | 112      | 64       | 37       | 21       | 13       | 8        | 5        | 3        |
| 4.0   | 5255     | 4434     | 3444     | 2550     | 1825     | 1304     | 905      | 510      | 312      | 188      | 114      | 66       | 38       | 22       | 13       | 8        | 5        | 3        |
| 4.5   | 5357     | 4560     | 3581     | 2656     | 1894     | 1356     | 940      | 535      | 323      | 194      | 118      | 70       | 40       | 23       | 14       | 8        | 5        | 3        |
| 5.0   | 5365     | 4577     | 3608     | 2678     | 1925     | 1378     | 952      | 540      | 323      | 194      | 118      | 70       | 40       | 23       | 14       | 8        | 5        | 3        |
| 5.5   | 5367     | 4578     | 3608     | 2678     | 1925     | 1378     | 952      | 540      | 323      | 194      | 118      | 70       | 40       | 23       | 14       | 8        | 5        | 3        |
| 6.0   | 5367     | 4578     | 3608     | 2678     | 1925     | 1378     | 952      | 540      | 323      | 194      | 118      | 70       | 40       | 23       | 14       | 8        | 5        | 3        |
| 6.5   | 5367     | 4578     | 3608     | 2678     | 1925     | 1378     | 952      | 540      | 323      | 194      | 118      | 70       | 40       | 23       | 14       | 8        | 5        | 3        |

**2016 ROAD & BRIDGE STANDARDS**

**REVISION DATE**  
**608.05**

**SD-3**

**ROAD AND BRIDGE STANDARDS**

**SHEET 2 OF 2**
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**STopping Sight Distance On Crest Vertical Curves**

*Height of Eye = 3.5 Feet*  
*Height of Object = 2.00 Feet*  
*Virginia Department of Transportation*  
*608.06 Road and Bridge Standards*  
*Revision Date*  
*2016 Road & Bridge Standards*
### Stopping Sight Distance on Crest Vertical Curves

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#### Equations

- When $S = \Delta B + \frac{A}{2}$
- $L = \text{length of vertical curve in feet}$
- $S = \text{stopping sight distance in feet}$

#### Notes

- $A$ = algebraic difference of grades in percent
- $S$ = stopping sight distance in feet
- $L$ = length of vertical curve in feet
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<th>WHEN S = \frac{\sqrt{L}}{A}</th>
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**PASSING SIGHT DISTANCE ON CREST VERTICAL CURVES**

HEIGHT OF EYE = 3.5 FEET
HEIGHT OF OBJECT = 3.5 FEET

**2016 ROAD & BRIDGE STANDARDS**
### 2016 ROAD & BRIDGE STANDARDS

#### Passing Sight Distance on Crest Vertical Curves

**Height of Eye = 3.5 Feet**

**Height of Object = 3.5 Feet**

**Virginia Department of Transportation**

**Revision Date:** 608.09

**Road and Bridge Standards**

**Sheet 2 of 2**

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### Passing Sight Distance on Crest Vertical Curves Table

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**Notes:**

1. **SD-5**
2. **Sheet 2 of 2**
3. **Revision Date:** 608.09

---

**Tables and Diagrams:**

- **Table:** Passing Sight Distance on Crest Vertical Curves
- **Diagram:** Curves and Sight Distance Calculations

---

**Definitions:**

- **A**: Algebraic difference in vertical ordinates in feet
- **L**: Length of vertical curve in feet
- **S**: Sight distance in feet

---

**Formulas:**

- **When SXL S = \( 1400 \times A + \frac{L}{2} \)**
- **When SXL S = 52.915 \( \sqrt{\frac{L}{A}} \)**

---

**Additional Information:**

- **2016 ROAD & BRIDGE STANDARDS**
- **Virginia Department of Transportation**
- **Revision Date:** 608.09

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**Contact:**

- **Virginia Department of Transportation**
- **Road and Bridge Standards**

---

**References:**

- **All relevant standards and guidelines**
- **Technical publications related to sight distance and vertical curves**

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**Further Reading:**

- **Sight Distance on Vertical Curves**
- **Vertical Curves in the Design of Highways**
- **Horizontal and Vertical Alignment in Highway Design**
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SECTION 700

GEOMETRIC DESIGNS
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TYPICAL METHODS OF GRADING SIDE SLOPES

NOTES:
SLOPE Rounding (STD. CS-1) TO BE AS DETAILED ABOVE, UNLESS SPECIFICALLY EXCEPTED ON PROJECT TYPICAL SECTION(S).

SEE STANDARD CS-2A FOR SUGGESTED METHODS OF FINISHING SLOPES TO FIT VARIOUS CONDITIONS.

SEE STANDARD CS-2 FOR SUGGESTED METHOD OF TRANSITIONING FROM CUT TO FILL.

ALL SLOPES SHALL BE FINISHED IN ACCORDANCE WITH THIS PLAN AND NOTES HEREON. EXCEPTIONS: LACK OF RIGHT OF WAY, ROCK OUT-CROP, OR WHERE DESIRABLE TO SAVE TREES, SHRUBBAGE, ETC., AS MAY BE DIRECTED BY THE ENGINEER. SHOULD THIS RESULT IN SURPLUS EXCAVATION MATERIAL, SUCH SURPLUS SHALL BE USED AS DIRECTED BY THE ENGINEER, IN LIEU OF BURROW, TO WIDEN FILLS, OR GRADE WITHIN THE RIGHT OF WAY, SHOULD IT RESULT IN INSUFFICIENT EXCAVATION MATERIAL, SUCH MATERIAL SHALL BE OBTAINED AS DIRECTED BY THE ENGINEER.

WHEN FOUND EXPEDIENT, STANDARD DITCH WIDTH AND DEPTH MAY BE INCREASED: THE DISTANCE BETWEEN BOTTOM OF DITCH AND MINIMUM RIGHT OF WAY LINE TO REMAIN AS SHOWN FOR STANDARD DITCH.

IN SHALLOW CUTS, WHERE POSSIBLE, KEEP THE CUT SLOPE, AT LEAST AS STEEP AS THE DITCH SLOPE BY WIDENING THE DITCH, HOLDING THE STANDARD DEPTH.

STD. CS-1: AS DETAILED HEREON WITH CUT SLOPE ROUNDING.
STD. CS-1A: AS DETAILED HEREON EXCEPT THAT CUT SLOPE ROUNDING IS TO BE ELIMINATED.
SUGGESTIONS FOR GRADING SIDE SLOPES AND ROADWAYS TO FIT VARIOUS CONDITIONS

APPLICABLE TO ALL SLOPES AND SLOPE STANDARDS

SUGGESTED DRAINAGE TREATMENT

(AT BEGINNING OF FILLS)

CENTER LINE

EDGE OF PAVEMENT

EDGE OF SHOULDER

TOE OF FILM

TOE OF PEL

CENTER LINE
SUGGESTIONS FOR GRADING SIDE SLOPES AND ROADWAYS TO FIT VARIOUS CONDITIONS

APPLICABLE TO ALL SLOPES AND SLOPE STANDARDS

TIGHT ROCK

FILL OVER ROCK TO SMOOTH SLOPE

EVEN UP R/W BY EXTENDING ROADWAY

WIDEN SHOULDER AND DITCH TO SMOOTH SLOPE

EVEN UP SLOPE BY CUT AND FILL

EXTEND SHOULDER TO SMOOTH UP R/W

CUT AND FILL TO SMOOTH UP R/W

ALTERNATE LINE

REMOVE BERM TO SMOOTH UP R/W

EVEN UP R/W BY FILLING

WHEN BERM IS FOR SHORT DISTANCE
ALTERNATE GRADING LINE MAY BE USED OTHERWISE BERM TO BE DRESSED OFF

CUT THROUGH TO TIE INTO ORIGINAL GROUND

CUT AND FILL TO ELIMINATE BERM

CUT THROUGH TO TIE INTO ORIGINAL GROUND

FILL TO ELIMINATE BERM

CUT AND FILL TO SMOOTH UP R/W

METHOD OF WIDENING FILLS

TYPICAL METHODS OF GRADING SIDE SLOPES

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
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SLOPE Rounding TO BE IN ACCORDANCE WITH ABOVE DETAIL UNLESS SPECIFICALLY EXCEPTED ON PROJECT TYPICAL SECTION(S).
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SEE STANDARD CS-2 FOR SUGGESTED METHOD OF TRANSITIONING FROM CUT TO FILL.
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IN SHALLOW CUTS, WHERE POSSIBLE, KEEP THE CUT SLOPE AT LEAST AS STEEP AS THE Ditch SLOPE BY WIDENING THE Ditch, HOLDING THE STANDARD DEPTH.
MAXIMUM SLOPE RATE SHALL NOT BE CHANGED MORE THAN TWICE IN A CUT.
IF METHOD SHOWN FOR TRANSITIONING FROM 1/2:1 SLOPES AND VICE VERSA, PRODUCES TRANSITIONS TOO SHORT, THEY SHALL BE INCREASED TO 100' IN LENGTH.
WHEN RECOVERABLE AREAS ARE NOT INDICATED ON THE TYPICAL SECTION, THE FILL SLOPE IS TO BE APPLIED TO THE NORMAL SHOULDER WIDTH BREAK POINT.
SEE TYPICAL SECTION FOR DITCH WIDTH.
SEE TYPICAL SECTION FOR RECOVERABLE AREA WIDTH TO BE USED WITH NORMAL FILL SHOULDER WIDTH.
WHEN FOUND EXPEDIENT, STANDARD Ditch WIDTH AND DEPTH MAY BE INCREASED, THE DISTANCE BETWEEN BOTTOM OF Ditch AND MINIMUM OF RIGHT OF WAY LINE TO REMAIN AS SHOWN FOR STANDARD Ditch.
IN CUTS UP 400' IN LENGTH 1/2:1 SLOPES MAY BE CARRIED THROUGH REGARDLESS OF DEPTH, PROVIDED RIGHT OF WAY IS AVAILABLE.

TYPICAL METHODS OF GRADING SIDE SLOPES

VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS
DETAIL A

DETAIL SHOWING BERM DITCH IF SHOWN ON PLANS OR REQ'D BY THE ENGINEER

NOTES:

SLOPE ROUNDING TO BE IN ACCORDANCE WITH ABOVE DETAIL UNLESS SPECIFICALLY EXCEPTED ON PROJECT TYPICAL SECTIONS.

SEE STANDARD CS-2A FOR SUGGESTED METHODS OF FINISHING SLOPES TO FIT VARIOUS CONDITIONS.

SEE STANDARD CS-2 FOR SUGGESTED METHOD OF TRANSITIONING FROM CUT TO FILL.

ALL SLOPES SHALL BE FINISHED IN ACCORDANCE WITH THIS PLAN AND NOTES HEREBY. EXCEPTIONS: LACK OF RIGHT OF WAY, ROCK OUT-CROP, OR WHERE DESIRABLE TO SAVE TREES, SHRUBBERRY, ETC., AS MAY BE DIRECTED BY THE ENGINEER. SHOULD THIS RESULT IN SURPLUS EXCAVATION MATERIAL, SUCH SURPLUS SHALL BE USED AS DIRECTED BY THE ENGINEER, IN LIEU OF BORROW, TO WIDEN FILLS, OR GRADE WITHIN THE RIGHT OF WAY. SHOULD IT RESULT IN INSUFFICIENT EXCAVATION MATERIAL, SUCH MATERIAL SHALL BE OBTAINED AS DIRECTED BY THE ENGINEER.

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WHEN RECOVERABLE AREAS ARE NOT INDICATED ON THE TYPICAL SECTION, THE FILL SLOPE IS TO BE APPLIED TO THE NORMAL SHOULDER WIDTH BREAK POINT.

SEE TYPICAL SECTION FOR TRAVERSABLE DITCH WIDTH AND SLOPE.

SEE TYPICAL SECTION FOR RECOVERABLE AREA WIDTH TO BE USED WITH NORMAL FILL SHOULDER WIDTH.
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SEE STANDARDS CS-2A FOR SUGGESTED METHODS OF FINISHING
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IN SHALLOW CUTS, WHERE POSSIBLE, KEEP THE CUT SLOPE AT
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HOLDING THE STANDARD DEPTH.
IN CUTS UP TO 400' IN LENGTH 1/2:1 SLOPES MAY BE CARRIED
THROUGH REGARDLESS OF DEPTH, PROVIDED RIGHT OF WAY IS
AVAILABLE.
MAXIMUM SLOPE RATE SHALL NOT BE CHANGED MORE THAN TWICE
IN A CUT.
IF METHOD SHOWN FOR TRANSITIONING FROM 1/2:1 TO
1:1 SLOPES AND VICE VERSA PRODUCES TRANSITIONS TOO SHORT,
THEY SHALL BE INCREASED TO 100' IN LENGTH.
WHEN RECOVERABLE AREAS ARE NOT INDICATED ON THE TYPICAL
SECTION, THE FILL SLOPE IS TO BE APPLIED TO THE NORMAL
SHOULDER WIDTH BREAK POINT.
SEE TYPICAL SECTION FOR DITCH WIDTH
SEE TYPICAL SECTION FOR RECOVERABLE AREA WIDTH TO BE
USED WITH NORMAL FILL SHOULDER WIDTH

TYPICAL METHODS OF GRADING SIDE SLOPES

ROAD AND BRIDGE STANDARDS

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATION REFERENCE

2016 ROAD & BRIDGE STANDARDS
TYPICAL METHODS OF GRADING SIDE SLOPES

NOTES:

SLOPE ROUNDING TO BE IN ACCORDANCE WITH ABOVE DETAIL UNLESS SPECIFICALLY EXCEPTED ON PROJECT TYPICAL SECTION(S).

SEE STANDARD CS-2A FOR SUGGESTED METHODS OF FINISHING SLOPES TO FIT VARIOUS CONDITIONS.

SEE STANDARD CS-2 FOR SUGGESTED METHOD OF TRANSITIONING FROM CUT TO FILL.

ALL SLOPES SHALL BE FINISHED IN ACCORDANCE WITH THIS PLAN AND NOTES HEREON. EXCEPTIONS: LACK OF RIGHT OF WAY, ROCK OUT-CROP, OR WHERE DESIRABLE TO SAVE TREES, SHRUBBERY, ETC., AS MAY BE DIRECTED BY THE ENGINEER. SHOULD THIS RESULT IN SURPLUS EXCAVATION MATERIAL, SUCH SURPLUS SHALL BE USED AS DIRECTED BY THE ENGINEER. IN LIEU OF BORROW, TO WIDEN FILLS, OR GRADE WITHIN THE RIGHT OF WAY, SHOULD IT RESULT IN INSUFFICIENT EXCAVATION MATERIAL, SUCH MATERIAL SHALL BE OBTAINED AS DIRECTED BY THE ENGINEER.

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WHEN RECOVERABLE AREAS ARE NOT INDICATED ON THE TYPICAL SECTION, THE FILL SLOPE IS TO BE APPLIED TO NORMAL SHOULDER WIDTH BREAK POINT.

SEE TYPICAL SECTION FOR TRAVERSABLE DITCH WIDTH AND SLOPE.

SEE TYPICAL SECTION FOR RECOVERABLE DITCH WIDTH TO BE USED WITH NORMAL FILL SHOULDER WIDTH.
DETAIL A

DETAIL SHOWING BERM DITCH IF SHOWN ON PLANS OR REQ'D. BY THE ENGINEER

NOTES:
SLOPE Rounding TO BE in ACCORDANCE with ABOVE DETAIL UNLESS SPECIFICALLY EXCEPTED ON PROJECT TYPICAL SECTION(S).
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IN CUTS UP TO 400' IN LENGTH 1/4:1 SLOPES MAY BE CARRIED THROUGH REGARDLESS OF DEPTH, PROVIDED RIGHT OF WAY IS AVAILABLE.
MAXIMUM SLOPE RATE SHALL NOT BE CHANGED MORE THAN TWICE IN A CUT. IF METHOD SHOWN FOR TRANSITIONING FROM 2:1 TO 1/4:1 SLOPES AND VICE VERSA PRODUCES TRANSITIONS TOO SHORT, THEY SHALL BE INCREASED TO 100' IN LENGTH.
SEE TYPICAL SECTIONS FOR RECOVERABLE AREA WIDTH WHEN RECOVERABLE AREAS ARE NOT INDICATED ON THE TYPICAL SECTION, THE FILL SLOPE IS TO BE APPLIED TO THE NORMAL SHOULDER WIDTH BREAK POINT.
SEE TYPICAL SECTION FOR TRAVERSABLE DITCH WIDTH AND SLOPE.
TYPICAL METHODS OF GRADING SIDE SLOPES

SLOPE Rounding TO BE in ACCORDANCE WITH ABOVE DETAIL UNLESS SPECIFICALLY EXCEPTED ON PROJECT TYPICAL SECTION(S).

SEE STANDARD CS-2A FOR SUGGESTED METHODS OF FINISHING SLOPES TO FIT VARIOUS CONDITIONS.

SEE STANDARD CS-2 FOR SUGGESTED METHOD OF TRANSITIONING FROM CUT TO FILL.

ALL SLOPES SHALL BE FINISHED IN ACCORDANCE WITH THIS PLAN AND NOTES HEREIN. EXCETIONS: LACK OF RIGHT OF WAY, ROCK OUT-CROP OR WHERE DESIRABLE TO SAVE TREES, SHRUBBERY, ETC., AS MAY BE DIRECTED BY THE ENGINEER. SHOULD THIS RESULT IN SURPLUS EXCAVATION MATERIAL, SUCH MATERIAL SHALL BE USED AS DIRECTED BY THE ENGINEER. IN LEM OF BORROW, TO WIDEN FILLS, OR GRADE WITHIN THE RIGHT OF WAY, SHOULD IT RESULT IN INSUFFICIENT EXCAVATION MATERIAL, SUCH MATERIAL SHALL BE OBTAINED AS DIRECTED BY THE ENGINEER.

NORMAL GUARDRAIL OFFSET TO BE AS SHOWN FOR DETAILS OF TRANSITIONING SEE STD. OR-INS.

*SEE TYPICAL SECTION FOR RECOVERABLE AREA WIDTH.

Δ SEE PLAN TYPICAL SECTIONS FOR SHOULDER WIDTHS.

REFERENCE SPECIFICATION

Virginia Department of Transportation

TYPICAL METHODS OF GRADING SIDE SLOPES
NOTES:
SLOPE ROUNGING TO BE IN ACCORDANCE WITH ABOVE DETAIL UNLESS SPECIFICALLY EXCEPTED ON PROJECT TYPICAL SECTION(S).
SEE STANDARD CS-2A FOR SUGGESTED METHODS OF FINISHING SLOPES TO FIT VARIOUS CONDITIONS.
SEE STANDARD CS-2 FOR SUGGESTED METHOD OF TRANSITIONING FROM CUT TO FILL.
ALL SLOPES SHALL BE FINISHED IN ACCORDANCE WITH THIS PLAN AND NOTES HEREON. EXCEPTIONS: LACK OF RIGHT OF WAY, ROCK OUT-CROP, OR WHERE DESIRABLE TO SAVE TREES, SHRUBBERY, ETC., AS MAY BE DIRECTED BY THE ENGINEER. SHOULD THIS RESULT IN SURPLUS EXCAVATION MATERIAL, SUCH SURPLUS SHALL BE USED AS DIRECTED BY THE ENGINEER, IN LIEU OF BORROW, TO WIDEN FILLS, OR GRADE WITHIN THE RIGHT OF WAY. SHOULD IT RESULT IN INSUFFICIENT EXCAVATION MATERIAL, SUCH MATERIAL SHALL BE OBTAINED AS DIRECTED BY THE ENGINEER.
WHEN FOUND EXPEDIENT, STANDARD DITCH WIDTH AND DEPTH MAY BE INCREASED; THE DISTANCE BETWEEN BOTTOM OF DITCH AND MINIMUM RIGHT OF WAY LINE TO REMAIN AS SHOWN FOR STANDARD DITCH.
IN SHALLOW CUTS, WHERE POSSIBLE, KEEP THE CUT SLOPE AT LEAST AS STEEP AS THE DITCH SLOPE BY WIDENING THE DITCH, HOLDING THE STANDARD DEPTH.
IN CUTS UP TO 400' IN LENGTH, 1V2:1 SLOPES MAY BE CARRIED THROUGH REGARDLESS OF DEPTH, PROVIDED RIGHT OF WAY IS AVAILABLE.
MAXIMUM SLOPE RATE SHALL NOT BE CHANGED MORE THAN TWICE IN A CUT.
IF METHOD SHOWN FOR TRANSITIONING FROM 1V2:1 TO 1:1 SLOPES AND VICE VERSA PRODUCES TRANSITIONS TOO SHORT, THEY SHALL BE INCREASED TO 100' IN LENGTH.
× SEE TYPICAL SECTION FOR RECOVERABLE AREA WIDTH WHEN RECOVERABLE AREAS ARE NOT INDICATED ON THE TYPICAL SECTION, THE FILL SLOPE IS TO BE APPLIED TO THE NORMAL SHOULDER WIDTH BREAK POINT.
× SEE TYPICAL SECTION FOR TRAVERSABLE DITCH WIDTH AND SLOPE.

TYPICAL METHODS OF GRADING SIDE SLOPES
Typical Methods of Grading Side Slopes

Notes:
- Slope rounding to be as detailed above, unless specifically excepted on project typical section(s).
- See standard CS-2A for suggested methods of finishing slopes to fit various conditions.
- See standard CS-2 for suggested method of transitioning from cut to fill.
- All slopes shall be finished in accordance with this plan and notes hereon. Exceptions: lack of right of way, rock out-crop, or where desirable to save trees, shrubbery, etc., as may be directed by the engineer. Should this result in surplus, such material shall be used as directed by the engineer, in lieu of borrow, to widen fills, or grade within the right of way, should it result in insufficient excavation material, such material shall be obtained as directed by the engineer.
- See typical section for recoverable area width to be used with normal fill shoulder width.
- When recoverable areas are not indicated on the typical section, the fill slope is to be applied to the normal shoulder width break point.
- See typical section for traversable ditch width and slope.
- See standard plan GS-13 for graded median.
- See plan typical sections for shoulder widths.
SECTION  800

TRANSITION  CURVES
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<td>TC-5.11</td>
<td>TRANSITION CURVES - RURAL 45 MPH DESIGN SPEED</td>
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<td>TRANSITION CURVES - RURAL 75 MPH DESIGN SPEED</td>
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<td></td>
<td>TRANSITION CURVES - RURAL 80 MPH DESIGN SPEED</td>
<td>803.44</td>
</tr>
</tbody>
</table>
GENERAL CONDITION

All original cross sections shall be taken from the baseline at stations, plus fifties, and unusual breaks in the ground as on tangent alignment.

Where a part or all of a superelevation transition curve falls on a vertical curve, elevations on the vertical curve should be computed for the positions given on sheet 803.15 for crown transitions, sheet 803.16 for urban projects and sheet 803.17 for rural projects. These elevations and plus fifties should be shown on the plans for the convenience of the survey party in staking out the project. Throughout these sections of the grade, elevations at even stations and plus fifties should be omitted.

Slope stakes should be set at the positions on the transition given on sheets 803.15, 803.16 and 803.17 and ground cross sections taken at these positions omitting the stations and plus fifties throughout the transition. If unusual breaks in the ground occur, additional sections should, of course, be taken. Additional sections should also be taken where location is through rock cut in anticipation of unusual breakage which may occur during construction.

After rough grading has been done, fine grading (blue top) and form stakes should be set at the positions given on sheet 803.15 for crown transitions, sheet 803.16 for urban projects or as given on sheet 803.17 for rural projects.

Final cross sections should, of course, be taken at those positions at which the slope stake sections were taken. Where unusual breakage in rock occurs, and this was not anticipated, additional final sections should be taken and original ground sections interpolated.

Baseline stakes should be set at all p.c.'s, p.t.'s, t.s.'s, s.t.'s, s.c.'s, and c.s.'s in staking out alignment but slope stakes need not be set nor cross sections taken at p.c.'s or p.t.'s except where called for in the accompanying tables. The transition will take its form from the positions given on sheets 803.16 and 803.17.

The right of way shall, in all cases, be referenced from the baseline.

The designer should exercise caution in the use of compound and reverse curves unless topographical or right of way restrictions make their use appropriate. The use of broken-back curves should be avoided except where very unusual topographical or right of way conditions make other alternatives impractical. The use of broken-back curves may require a design exception from the state location and design engineer. See sheets 803.11 thru 803.14 for general information on compound, reverse and broken-back curve information.

A design exception is not required when using values from sheets 803.23 thru 803.44 since these tables were derived within AASHTO guidelines.

Refer to Chapter 4 of AASHTO’s A Policy on Geometric Design of Highways and Streets for information on the use of 18' pavement widths (9' lane widths).

All tangent runout section (Lt) values and superelevation runoff lengths (Lr) listed in the tables have been rounded up to the nearest foot. All Lt values are based on a 2% crown.
### STANDARD SYMBOLS

- **LOCATION**: Alignment on which the proposed right-of-way and construction is based.
- **STANDARD PAVEMENT**: The typical pavement section to be shown on the road plans.
- **P.C.**: Point of beginning of baseline circular curve.
- **P.T.**: Point of ending of baseline circular curve.
- **P.C.C.**: Point of baseline compound curvature.
- **P.R.C.**: Point of baseline reverse curve.
- **T.S.**: Point of change from tangent to transition curve (tangent to spiral).
- **S.C.**: Point of change from transition curve to circular curve (spiral to circular).
- **C.S.**: Point of change from circular curve to transition curve (circular to spiral).
- **S.T.**: Point of change from transition curve to tangent (spiral to tangent).
- **RADIUS**: Radius of baseline circular curve.
- **DV**: Approximate maximum safe speed in miles per hour using standard rate of super-elevation.
- **W** or **PW**: Width of standard pavement.
- **ZT**: Distance from transitioned baseline to edges of transitioned pavement.
- **w**: Maximum total pavement widening.
- **E**: Rate of super-elevation.
- **F**: Safe side friction factor.
- **S**: Amount of super-elevation to be applied to the baseline grade to obtain the elevations of the edges of transitioned pavement.
- **C**: Difference in elevation between baseline (center) and edge of pavement for standard pavement crown.
- **Lr**: Length of transition curve measured along baseline. Where no transition curve is applied, Lr is length of super-elevation runoff section.
- **Lt**: Standard pavement crown transition or tangent runout section.
- **CP**: Chord point (1/10 increments of transition curve).
- **NPC**: Normal pavement crown.

---

**ALL DISTANCES (HORIZONTAL AND VERTICAL) ARE MEASURED IN FEET.**
RURAL CONDITIONS APPLY TO INTERSTATE, ARTERIAL, PRIMARY AND SECONDARY SYSTEMS OR TO ANY OTHER ROAD WITH RURAL TYPE DESIGN AND OPERATING CONDITIONS.

THESE TABLES CONTAIN THE MINIMUM ALLOWABLE SUPERELEVATION, TRANSITION LENGTHS, AND WIDENING CORRECTIONS FOR STANDARD RURAL PAVEMENT WIDTHS THROUGH A RANGE OF DESIGN VELOCITIES CONSIDERED MOST LIKELY TO BE USED IN RURAL HIGHWAY DESIGN.

DEFINITIONS FOR THE STANDARD SYMBOLS USED THROUGHOUT THESE TABLES ARE FOUND ON SHEET 803.02.

FOR MINIMUM DESIGN FACTORS FOR VARIOUS DESIGN SPEEDS FOR RURAL CONDITIONS SEE SHEETS 803.32 THRU 803.44.

ON CURVES WITH NO PAVEMENT WIDENING, PAVEMENT WILL BE SUPERELEVATED BY AN AMOUNT EQUAL TO THE RATE SHOWN IN THE TABLES. SEE SHEET 803.06 FOR A GRAPHICAL ILLUSTRATION OF THE APPLICATION OF THIS CORRECTION.

ON CURVES WITH PAVEMENT WIDENING, WIDENING WILL BE ACHIEVED BY EQUAL WIDENING OF BOTH EDGES OF PAVEMENT OVER THE SUPERELEVATION RUNOFF LENGTH. SEE PAGE 803.05 FOR DETAILS.

WHEN USING COMPOUND OR REVERSE CURVES WITH RURAL CONDITIONS, SEE SHEETS 803.11, 803.12, 803.13, AND 803.14 FOR DETAILS OF TRANSITIONS.

FOR CURVE RADII NOT LISTED IN TABLES, REFER TO SHEET 803.20 TO CALCULATE SUPERELEVATION RUNOFF LENGTH (Lr) AND PAVEMENT WIDENING (w).

Lr AND E SHALL BE SHOWN ON THE PLANS FOR ALL CURVES.

FOR ADDITIONAL GENERAL INSTRUCTIONS (BOTH URBAN AND RURAL) SEE SHEET 803.01.
URBAN CONDITION

URBAN CONDITIONS APPLY TO URBAN STREET SYSTEMS AND ANY OTHER ROAD WITH PRESENT OR FUTURE URBAN STREET OPERATING CONDITIONS.

THESE TABLES CONTAIN THE MINIMUM SUPERELEVATION RATES AND TRANSITION LENGTHS FOR STANDARD URBAN PAVEMENT WIDTHS THROUGH A RANGE OF DESIGN VELOCITIES CONSIDERED MOST LIKELY TO BE USED IN URBAN ROAD DESIGN.

DEFINITIONS FOR THE STANDARD SYMBOLS USED THROUGHOUT THESE TABLES ARE FOUND ON SHEET 803.02.

A TABLE FOR "LOW-SPEED URBAN" DESIGNS IS ON SHEET 803.23 WITH A RANGE OF STANDARD PAVEMENT WIDTHS (W), TRANSITION LENGTHS (Lr), AND RADII OF CURVE WHEN SUPERELEVATED BY AN AMOUNT EQUAL TO THE NORMAL CROWN AND THE APPROXIMATE MAXIMUM SAFE SPEEDS (DV) AFFORDED THEREBY. VALUES IN THIS TABLE CAN BE USED ON STREETS WITH OPERATING SPEEDS LESS THAN OR EQUAL TO 45 MPH. ALSO SHOWN ARE THE APPROXIMATE MAXIMUM SAFE SPEEDS (NC) WITH NO SUPERELEVATION. VALUES FOR (NC) CAN BE USED ON URBAN ARTERIAL, COLLECTOR, AND LOCAL STREETS.

FOR MINIMUM DESIGN FACTORS FOR VARIOUS DESIGN SPEEDS FOR URBAN CONDITIONS SEE SHEETS 803.24 THRU 803.31.


FOR CURVE RADII NOT LISTED IN TABLES REFER TO SHEET 803.20 TO CALCULATE TRANSITION LENGTHS (Lr).

Lr SHALL BE SHOWN ON THE PLANS FOR ALL CURVES.

E SHALL BE SHOWN ON THE PLANS FOR ALL CURVES WITH URBAN STREET CONDITIONS.

FOR ADDITIONAL GENERAL INSTRUCTIONS (BOTH URBAN AND RURAL) SEE SHEET 803.01.
NOTE:
PAVEMENT WIDENING OF RURAL ROADWAYS WILL BE ACHIEVED BY EQUAL WIDENING OF BOTH EDGES OF PAVEMENT OVER THE SUPERELEVATION RUNOFF LENGTH (Lr).

NOTE:
ON THE INSIDE OF CURVE THE STANDARD PAVEMENT CROWN (C) SHALL BE HELD UNTIL IT IS EXCEEDED BY THE TABULATED (S) VALUE, THEN THE (S) VALUES SHALL BE APPLIED.

PLAN OF TRANSITION

PROFILE OF TRANSITION

NOTE: SHORT VERTICAL CURVES SHOULD BE INSERTED BY EYE AT POINTS (P) IF CONSIDERED NECESSARY.

CROSS SECTION THRU TRANSITION

DETAIL FOR TRANSITIONED RURAL CONDITION WITH PAVEMENT WIDENING

2016 ROAD & BRIDGE STANDARDS
NOTE: ON THE INSIDE OF CURVE THE STANDARD PAVEMENT CROWN (C) SHALL BE HELD UNTIL IT IS EXCEEDED BY THE TABULATED RATE OF SUPERELEVATION (E).

SUPERELEVATED BY AN AMOUNT EQUAL TO THE STANDARD PAVEMENT CROWN

SUPERELEVATED BY AN AMOUNT EXCEEDING THE STANDARD PAVEMENT CROWN

\[
C = \frac{W}{2} \cdot \frac{NPC}{100}
\]

\[
S = \frac{W}{2} \cdot \frac{E}{100}
\]
The elevation differential between normal crown and maximum superelevation, relative to the baseline profile.

Additional information may be obtained from a policy on geometric design of highways and streets (AASHTO) book, chapter III - Elements of Design (Superelevation Runoff).

On standard TC-5.11ULS, TC-5.11U, and TC-5.11R (without pavement widening), superelevated curves, position the superelevation runoff section (Lr) two thirds (2/3) on the tangent and one third (1/3) into the curve. Stations and elevations for these transitions will need to be computed for TS, SC, CS, ST and every 25' increment (i.e., 10+00, 10+25, 10+50, 10+75, etc...).
POVET OF FINISHED GRADE

THE PAVEMENT WIDTHS SHOWN IN THE STANDARD TC-5.11 TABLES ON SHEET 803.24 THROUGH 803.44 REPRESENT TWICE THE DISTANCE FROM THE CROWNLINE TO THE EDGE OF PAVEMENT ON THE HIGH SIDE.

THE ELEVATION DIFFERENTIAL BETWEEN NORMAL CROWN AND MAXIMUM SUPERELEVATION, RELATIVE TO THE BASELINE PROFILE.

ADDITIONAL INFORMATION MAY BE OBTAINED FROM A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (AASHTO) BOOK, CHAPTER III - ELEMENTS OF DESIGN (SUPERELEVATION RUNOFF).

PROJECTS IN WHICH LANES MAY BE ADDED IN THE FUTURE IN THE MEDIAN AREA SHOULD BE DESIGNED WITH THE CONSTRUCTION BASELINE AND POINT OF FINISHED GRADE LOCATED IN THE MIDDLE OF THE MEDIAN. SUPERELEVATION IS TO BE ROTATED FROM THIS BASELINE POINT. THIS WILL PREVENT UNEVEN PAVEMENT PROBLEMS WHEN ADDITIONAL LANES ARE ADDED IN THE MEDIAN AREA, SUCH AS CROSSOVER GRADES AS WELL AS THE NEED FOR RETAINING WALLS, MEDIAN BARRIERS AND SPECIAL DESIGN DRAINAGE STRUCTURES. ADDITIONAL RIGHT OF WAY OR EASEMENTS, IN MOST SITUATIONS, WILL NOT BE REQUIRED.
EXAMPLE FOR FOUR LANE ROADWAYS
NOTE:

1. For compound curves on open roadways, the ratio of flatter radius (R1) to the sharper radius (R2) shall not exceed 1.5:1.

2. For compound curves on ramps and at intersections, the ratio of the flatter radius (R2) to the sharper radius (R2) shall not exceed 2:1. Where practical, a desirable maximum ratio of 1.75:1 should be used.

3. Compute straight line widening and superelevation transition from maximum of first curve to maximum of second curve.

4. Refer to Chapter 3 of the AASHTO Green Book for additional compound curve design information.

5. The separate curves that are combined to create the compound curve should be of sufficient length to allow adequate development of the full superelevation on each curve.
1. Compute straight line widening and superelevation transition from maximum of first curve to maximum of second curve.

2. Refer to Chapter 3 of the AASHTO's "Policy on the Geometric Design of Highways and Streets" for additional reverse curve design information.

3. Reverse curves should have a curve length that allows adequate development of the full superelevated section of pavement for each curve.
1. For compound curves on open roadways, the ratio of flatter radius (R1) to the sharper radius (R2) shall not exceed 1.5:1.

2. For compound curves on ramps and at intersections, the ratio of the flatter radius (R1) to the sharper radius (R2) shall not exceed 2:1. Where practical, a desirable maximum ratio of 1.75:1 should be used.

3. Compute super-elevation transition from maximum of first curve to maximum of second curve. Length of compound spiral computed per page 803.20.

4. Refer to Chapter 3 of the AASHTO Green Book for additional compound curve design information.

5. The separate curves that are combined to create the compound curve, should be of sufficient length to allow adequate development of the full super-elevation on each curve.
REVISION DATE
TC-5.11
METHOD OF APPLYING TC-5.11 ON REVERSE CURVES
URBAN & RURAL CONDITIONS W/O PAVEMENT WIDENING

NOTES:
1. Compute superelevation transition from maximum of first curve to maximum of second curve. Length of superelevation runoff \( L_r \) computed per page 803.20.
2. Refer to Chapter 3 of the AASHTO's A Policy on the Geometric Design of Highways and Streets for additional reverse curve design information.
3. The use of spiral transitions for compound and reverse curves on urban roadways should be avoided. However, the engineer does have latitude in the use of spiral transitions if the geometrics are warranted.
4. Reverse curves should have a curve length that allows adequate development of the full superelevated section of pavement for each curve.

Virginia Department of Transportation
2016 ROAD & BRIDGE STANDARDS
## TRANSITION TABLE

<table>
<thead>
<tr>
<th>LENGTH OF TANGENT RUNOUT (Lt)</th>
<th>START/END OF SUPERELEVATION RUNOFF (Lr)</th>
<th>DISTANCE IN FEET FROM START/END OF SUPERELEVATION RUNOFF SECTION (Lr)</th>
<th>NORMAL CROWN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
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<td>20</td>
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</table>

**NOTE:**

The table lists positions on transitions at which slope stakes should be set, construction and final cross-sections taken, fine grading stakes (blue top) set, and form stakes set (concrete pavement only).
## URBAN CONDITIONS
### RURAL CONDITIONS WITHOUT PAVEMENT WIDENING

For use with flexible and concrete pavement. (Lt: positioned 2/3 on tangent, 1/3 on curve)

<table>
<thead>
<tr>
<th>LENGTH OF SUPERELEVATION RUNOFF</th>
<th>END/BEGN TANGENT RUNOUT</th>
<th>DISTANCE IN FEET FROM P.C. OR P.T. ON TANGENT</th>
<th>DISTANCE IN FEET FROM P.C. OR P.T. ON CURVE</th>
<th>FULL SUPER ELEVATION (E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Lr)</td>
<td>(Lt)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>480</td>
<td>320</td>
<td>272</td>
<td>224</td>
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<td>75</td>
<td>59</td>
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</tbody>
</table>

**Note:**
- Table giving positions on curves at which slope stakes should be set.
- Construction and final cross-sections taken, fine grading stakes (blue top) set, and form stakes set (concrete pavement only).
- * Denotes additional staking positions for use with concrete pavement only.
### TABLE 2

**RURAL CONDITIONS WITH PAVEMENT WIDENING**

For use with flexible and concrete pavement.

<table>
<thead>
<tr>
<th>LENGTH OF SUPERELEVATION RUNOFF (Lr)</th>
<th>T.S. OR S.T.</th>
<th>DISTANCE IN FEET FROM T.S. OR S.T. ALONG SPIRAL TRANSITION</th>
<th>S.C. OR C.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>160</td>
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<td>16</td>
<td>32</td>
</tr>
</tbody>
</table>

**NOTE:**

Table giving positions on transition curves at which slope stakes should be set, construction and final cross-sections taken, fine grading stakes (blue top) set, and form stakes set (concrete pavement only).

* Denotes additional staking positions for use with concrete pavement only.
GENERAL DESIGN CONSIDERATIONS

1. WHERE PAVEMENT WIDENING IS REQUIRED, THE APPROPRIATE WIDENING IS ADDED TO THE LANE WIDTH WHEN CALCULATING THE SUPERELEVATION RUNOFF LENGTH (Lr).

2. THE COMPUTED SUPERELEVATION RUNOFF LENGTH (Lr) IS ROUNDED UP TO THE NEAREST FOOT.

3. WHEN THE SUPERELEVATION RUNOFF LENGTH (Lr) IS CALCULATED, IT MUST BE COMPARED WITH THE MINIMUM VALUE LISTED IN THE APPROPRIATE COLUMN ON THE RELATIVE GRADIENT TABLE.

4. TANGENT RUNOUT (Lt) IS ALWAYS ACHIEVED OUTSIDE OF THE SUPERELEVATION RUNOFF SECTION (Lr).

5. NO PAVEMENT WIDENING IS REQUIRED FOR URBAN ROADWAYS.

6. PAVEMENT WIDENING IS APPLIED ONLY WHEN CALCULATED WIDENING (w) IS EQUAL TO OR GREATER THAN 2 FEET. SEE PAGE 803.05 FOR DETAIL.

7. WHEN CALCULATING WIDENING (w) FOR MULTI-LANE RURAL ROADWAYS, WIDENING IS FIRST CALCULATED USING THE SINGLE LANE WIDTH FOR "W".

8. WHEN THE SUPERELEVATION RUNOFF LENGTH (Lr) IS CALCULATED, IT MUST BE EQUAL TO OR GREATER THAN 2 SECONDS OF TRAVEL TIME AT THE ROADWAY'S DESIGN SPEED AS NOTED IN THE RELATIVE GRADIENT TABLE.

9. CALCULATED WIDENING IS ROUNDED UP TO THE NEAREST 0.1 FOOT.

10. CURVES WITH SPIRAL CURVE TRANSITIONS MUST HAVE A MINIMUM SUPERELEVATION RUNOFF LENGTH (Lr) EQUAL TO 2 SECONDS OF TRAVEL TIME AT THE ROADWAY'S DESIGN SPEED AS NOTED IN THE RELATIVE GRADIENT TABLE.

11. THE MINIMUM LENGTH OF CURVE SHOULD EQUAL THE LENGTH OF SUPERELEVATION TRANSITION OR Lt. THIS IS TO ALLOW SUFFICIENT DEVELOPMENT OF THE FULL SUPERELEVATED SECTION OF PAVEMENT WHICH SHOULD BE A MINIMUM LENGTH OF 2/3 THE TRANSITION Lr.

12. REVERSE CURVES SHOULD BE SEPARATED BY A TANGENT OF SUFFICIENT LENGTH TO ALLOW THE FULL Lt AND Lr FOR EACH CURVE. IF THIS IS NOT POSSIBLE A MINIMUM LENGTH OF TANGENT SHOULD ALLOW FOR THE FULL Lt FOR EACH CURVE.

13. REVERSE CURVES THAT MEET AT A PRC SHOULD HAVE A CURVE LENGTH THAT ALLOWS ADEQUATE DEVELOPMENT OF THE FULL SUPERELEVATED SECTION OF PAVEMENT FOR EACH CURVE.

14. THE SEPARATE CURVES THAT ARE COMBINED TO CREATE THE COMPOUND CURVE, SHOULD BE OF SUFFICIENT LENGTH TO ALLOW ADEQUATE DEVELOPMENT OF THE FULL SUPERELEVATION ON EACH CURVE.

MAXIMUM RADIUS FOR USE OF A SPIRAL CURVE TRANSITION

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Maximum Radius (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>203</td>
</tr>
<tr>
<td>25</td>
<td>317</td>
</tr>
<tr>
<td>30</td>
<td>456</td>
</tr>
<tr>
<td>35</td>
<td>620</td>
</tr>
<tr>
<td>40</td>
<td>810</td>
</tr>
<tr>
<td>45</td>
<td>1025</td>
</tr>
<tr>
<td>50</td>
<td>1265</td>
</tr>
<tr>
<td>55</td>
<td>1631</td>
</tr>
<tr>
<td>60</td>
<td>1922</td>
</tr>
<tr>
<td>65</td>
<td>2138</td>
</tr>
<tr>
<td>70</td>
<td>2479</td>
</tr>
<tr>
<td>75</td>
<td>2846</td>
</tr>
<tr>
<td>80</td>
<td>3238</td>
</tr>
</tbody>
</table>

MAXIMUM LENGTH OF SPIRAL

\[ L_{s,\text{max}} = \sqrt{\frac{24}{p_{\text{max}}} R} \]

\[ L_{s,\text{max}} = \text{MAXIMUM LENGTH OF SPIRAL, ft} \]
\[ p_{\text{max}} = \text{MAXIMUM LATERAL OFFSET BETWEEN THE TANGENT AND CIRCULAR CURVE (3.3 ft)} \]
\[ R = \text{RADIUS OF CIRCULAR CURVE, ft} \]
### ADJUSTMENT FACTORS

<table>
<thead>
<tr>
<th>Design Speed ( V_0 ) MPH</th>
<th>12' Lane</th>
<th>16' Lane</th>
<th>18' Lane (2nd Rule)</th>
<th>24' Lane (2nd Rule)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.74</td>
<td>0.84</td>
<td>0.89</td>
<td>0.99</td>
</tr>
<tr>
<td>25</td>
<td>0.70</td>
<td>0.80</td>
<td>0.84</td>
<td>0.93</td>
</tr>
<tr>
<td>30</td>
<td>0.66</td>
<td>0.75</td>
<td>0.80</td>
<td>0.88</td>
</tr>
<tr>
<td>35</td>
<td>0.62</td>
<td>0.71</td>
<td>0.75</td>
<td>0.83</td>
</tr>
<tr>
<td>40</td>
<td>0.58</td>
<td>0.66</td>
<td>0.70</td>
<td>0.77</td>
</tr>
<tr>
<td>45</td>
<td>0.54</td>
<td>0.61</td>
<td>0.65</td>
<td>0.72</td>
</tr>
<tr>
<td>50</td>
<td>0.50</td>
<td>0.57</td>
<td>0.60</td>
<td>0.67</td>
</tr>
<tr>
<td>55</td>
<td>0.47</td>
<td>0.54</td>
<td>0.57</td>
<td>0.63</td>
</tr>
<tr>
<td>60</td>
<td>0.45</td>
<td>0.51</td>
<td>0.54</td>
<td>0.60</td>
</tr>
<tr>
<td>65</td>
<td>0.43</td>
<td>0.49</td>
<td>0.52</td>
<td>0.57</td>
</tr>
<tr>
<td>70</td>
<td>0.40</td>
<td>0.45</td>
<td>0.48</td>
<td>0.53</td>
</tr>
<tr>
<td>75</td>
<td>0.38</td>
<td>0.43</td>
<td>0.46</td>
<td>0.51</td>
</tr>
<tr>
<td>80</td>
<td>0.35</td>
<td>0.39</td>
<td>0.42</td>
<td>0.47</td>
</tr>
</tbody>
</table>

### DEFINITIONS

- **A**: Front overhang of design vehicle from apparent table.
- **bw**: Adjustment factor from table.
- **C**: Lateral clearance of design vehicle from apparent table.
- **E**: Super-elevation rate from apparent table.
- **F**: Calculated width of overhang for design vehicle.
- **L**: Wheelbase of design vehicle from apparent table.
- **Lt**: Length of crown runoff section.
- **Lr**: Length of super-elevation runoff section.
- **Lr** = \( b_w \left( w + \frac{n}{W} \right) \)
- **Lt** = \( \frac{d}{NC} \)
- **M**: Multiple lane factor.
- **N**: Number of lanes.
- **\( n_f \)**: Number of lanes rotated (from tables).
- **\( n_{r} \)**: Number of lanes rotated.
- **\( e_d \)**: Design super-elevation rate, percent.
- **\( e_{nc} \)**: Normal cross slope rate, percent.
- **\( u \)**: Track width of design vehicle from apparent table.
- **\( V_0 \)**: Design velocity.
- **\( w \)**: Calculated widening.
- **\( W \)**: Pavement width.
- **\( W_e \)**: Calculated total curve width.
- **\( W_n \)**: Width of lane.
- **\( Z \)**: Calculated extra width allowance.

### Formulas Used to Calculate Super-elevation Runoff (\( Lr \)) and Crown Runout (\( Lt \))

**No Widening Required**

\[
Lr = b_w \left( W + \frac{n}{W} \right)
\]

**Widening Required**

\[
Lr = b_w C \left( W + \frac{n}{W} \right)
\]

\[
Lr = M \left( W + \frac{n}{W} \right)
\]

**For solved problems using this methodology for \( Lr \), see the examples on page 803.22**

**Note:** An alternate method for multi-lane roadways. For four lane undivided pavements (48'), the \( Lr \) is 1.5 times \( M \). For two lane highways, and for six lane undivided pavements (72'), the \( Lr \) is two times \( M \).
### METHODOLOGIES FOR CALCULATING TC-5.11 VALUES

**REFERENCE SPECIFICATION**

**ROAD AND BRIDGE STANDARDS**

**REVISION DATE**

**SHEET 1 OF 1**

**2016 ROAD & BRIDGE STANDARDS**

## Design Vehicle Dimensions

<table>
<thead>
<tr>
<th>Design Vehicle Type</th>
<th>u Width</th>
<th>A Front Overhang</th>
<th>L</th>
<th>WB-1</th>
<th>WB-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>7</td>
<td>3</td>
<td>11</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>SU-30</td>
<td>8</td>
<td>4</td>
<td>20</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>SU-40</td>
<td>8</td>
<td>4</td>
<td>25</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>S-BUS-36</td>
<td>8</td>
<td>3</td>
<td>12.5</td>
<td>27.5</td>
<td></td>
</tr>
<tr>
<td>WB-62</td>
<td>8.5</td>
<td>4</td>
<td>21.3</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Clearance (C)**

<table>
<thead>
<tr>
<th>Lane Width</th>
<th>Clearance (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 ft</td>
<td>1.5 ft</td>
</tr>
<tr>
<td>10 ft</td>
<td>2 ft</td>
</tr>
<tr>
<td>11 ft</td>
<td>2.5 ft</td>
</tr>
<tr>
<td>12 ft</td>
<td>3 ft</td>
</tr>
<tr>
<td>16 ft</td>
<td>5 ft</td>
</tr>
</tbody>
</table>

**Note:** The "L" value used in calculating "u" will be the greater of the values listed under WB-1 or WB-2 in the table. The "L" value used in calculating simplifies the calculations for other design vehicle dimensions refer to the AASHTO Green Book.

### Formulas Used to Calculate Widening (w)

\[
U = u + R - \sqrt{R^2 - L^2}
\]

\[
F_A = \sqrt{R^2 + A (2L + A) - R}
\]

\[
Z = \frac{V_0}{\sqrt{R}}
\]

\[
W_C = N(U + C + F_A + Z)
\]

\[
W = W_C - 2W_n = 27.08657 - 2(12) = 3.0865 or 3.1
\]

### Design Vehicle SU-40

- **24 ft Pavement Width**
  - \(V_D = 20\) MPH
  - \(R = 200\) FT
  - \(W_n = 12\) FT
  - \(E = 6.1(6.1\% \text{ PER } 803.32)\)
  - \(U = 8.0 + 200 - \sqrt{(200)^2 - (25)^2} = 9.56865\)
  - \(F_A = \sqrt{(200)^2 + 4[2(25) + 4]} = 9.56865\)
  - \(Z = \frac{V_0}{\sqrt{R}} = \frac{20}{\sqrt{200}} = 1.41\)
  - \(W_C = N(U + C + F_A + Z) = 27.08657\)
  - \(w = W_C - 2W_n = 27.08657 - 2(12) = 3.0865 or 3.1\)

### Design Vehicle SU-40

- **20 ft Pavement Width**
  - \(V_D = 35\) MPH
  - \(R = 500\) FT
  - \(W_n = 10\) FT
  - \(E = 3.1(3.1\% \text{ PER } 803.38)\)
  - \(U = 8.0 + 500 - \sqrt{(500)^2 - (25)^2} = 8.62539\)
  - \(F_A = \sqrt{(500)^2 + 4[2(25) + 4]} = 8.62539\)
  - \(Z = \frac{V_0}{\sqrt{R}} = \frac{35}{\sqrt{500}} = 1.57\)
  - \(W_C = N(U + C + F_A + Z) = 23.0367\)
  - \(w = W_C - 2W_n = 23.0367 - 2(10) = 3.0367 or 3.0\)

### Design Vehicle WB-62

- **20 ft Pavement Width**
  - \(V_D = 50\) MPH
  - \(R = 1000\) FT
  - \(W_n = 10\) FT
  - \(E = 7.6(7.6\% \text{ PER } 803.38)\)
  - \(U = 8.0 + 1000 - \sqrt{(1000)^2 - (43)^2} = 9.42492\)
  - \(F_A = \sqrt{(1000)^2 + 4[2(43) + 4]} = 9.42492\)
  - \(Z = \frac{V_0}{\sqrt{R}} = \frac{50}{\sqrt{1000}} = 1.58\)
  - \(W_C = N(U + C + F_A + Z) = 24.5158\)
  - \(w = W_C - 2W_n = 24.5158 - 2(10) = 4.5158 or 4.5\)
**RURAL EXAMPLE**

20 FT PAVEMENT WIDTH
(DESIGN SOFTWARE - 1 LANE AT 10 FT)

\[ V_D = 50 \text{ MPH} \quad R = 1000 \text{ FT} \]
\[ W_n = 10 \text{ FT} \quad rg = 0.50 \]
\[ E = 7.6 \quad (7.6\% \text{ PER 803.38}) \]

\[ U = u + R - \sqrt{R^2 - L^2} \]
\[ U = 8.5 \times 1000 - \sqrt{(1000)^2 - (43)^2} \]
\[ U = 9.42492 \]

\[ F_A = \sqrt{R^2 + A (2L + A) - R} \]
\[ F_A = \sqrt{(1000)^2 + 4(2(19.5) + 4) - 1000} \]
\[ F_A = 0.085996 \]

\[ Z = \frac{(V_D)}{\sqrt{R}} \]
\[ Z = \frac{(50)}{\sqrt{1000}} \]
\[ Z = 1.58 \]

\[ W_C = N (U + C) + F_A + Z \]
\[ W_C = 2(9.42492 + 2) + 0.085996 + 1.58 \]
\[ W_C = 24.5158 \]

\[ w = W_C - 2W_n = 24.5158 - 2(10) = 4.5158 \text{ or } 4.5 \]

\( w>2 \text{ THEREFORE WIDENING IS REQUIRED} \)

\[ Lr = W_n \cdot (W_n + w/2)/rg \cdot b_w \]
\[ Lr = 7.6(12.25)/0.50 \]
\[ Lr = 186.20 \]


**RURAL EXAMPLE**

72 FT PAVEMENT WIDTH
(DESIGN SOFTWARE - 3 LANES AT 12 FT)

\[ V_D = 40 \text{ MPH} \quad R = 500 \text{ FT} \]
\[ W_n = 12 \text{ FT} \quad rg = 0.58 \]
\[ E = 8.0 \quad (8\% \text{ PER PAGE 803.36}) \]

\[ U = u + R - \sqrt{R^2 - L^2} \]
\[ U = 8.5 \times 500 - \sqrt{(500)^2 - (43)^2} \]
\[ U = 10.35243 \]

\[ F_A = \sqrt{R^2 + A (2L + A) - R} \]
\[ F_A = \sqrt{(500)^2 + 4(2(19.5) + 4) - 500} \]
\[ F_A = 1719 \]

\[ Z = \frac{(V_D)}{\sqrt{R}} \]
\[ Z = \frac{(40)}{\sqrt{500}} \]
\[ Z = 1.7885 \]

\[ W_C = 2 (U + C) + F_A + Z \]
\[ W_C = 2(10.35243 + 3) + 1.7885 \]
\[ W_C = 28.6652 \]

\[ w = W_C - 2W_n = 28.6652 - 2(12) = 4.6652 \]

FOR 72' PAVEMENT WIDTH
\[ w = 3(4.6652) = 13.9956 \]

\( w>2 \text{ THEREFORE WIDENING IS REQUIRED} \)

\[ Lr = (E n W_n + w/2)/rg \]
\[ Lr = 7.6(12.25)/0.50 \]
\[ Lr = 186.20 \]


**URBAN EXAMPLES**

24 FT PAVEMENT WIDTH
(DESIGN SOFTWARE - 1 LANE AT 12 FT)

\[ V_D = 40 \text{ MPH} \quad R = 600 \text{ FT} \]
\[ W_n = 12 \text{ FT} \quad rg = 0.58 \]
\[ E = 4.0 \quad (4\% \text{ PER PAGE 803.28}) \]

\[ Lr = W_n \cdot (W_n + w/2)/rg \cdot b_w \]
\[ Lr = 12(12)(4)/0.58 \]
\[ Lr = 151.7317 \]


66 FT PAVEMENT WIDTH
(DESIGN SOFTWARE - 3 LANES AT 11 FT)

\[ V_D = 40 \text{ MPH} \quad R = 1000 \text{ FT} \]
\[ W_n = 11 \text{ FT} \quad rg = 0.58 \]
\[ E = 4.0 \quad (4\% \text{ PER PAGE 803.28}) \]

\[ Lr = W_n \cdot (W_n + w/2)/rg \cdot b_w \]
\[ Lr = 11(3)(4)/0.58 \]
\[ Lr = 151.7241 \]

\[ Lr = M (E W_n + w/2)/rg \]
\[ Lr = 2 (44/0.58) \]
\[ Lr = 151.7241 \]
### MINIMUM RADII AND SUPERELEVATION RUNOFF SECTION LENGTHS (Lr) FOR +2% SUPERELEVATION

<table>
<thead>
<tr>
<th>RADIUS (FEET)</th>
<th>E (%)</th>
<th>f</th>
<th>DV (MPH)</th>
<th>LENGTH OF SUPERELEVATION RUNOFF (Lr) IN FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PAVEMENT WIDTH (W)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24' (10'12'') (1.5'12'') (2'12'') (3'12'')</td>
</tr>
<tr>
<td>&gt; 795</td>
<td>2.0</td>
<td>0.150</td>
<td>45</td>
<td>45 56 67 75 82 90 *</td>
</tr>
<tr>
<td>593</td>
<td>2.0</td>
<td>0.160</td>
<td>40</td>
<td>42 52 63 70 77 84 *</td>
</tr>
<tr>
<td>408</td>
<td>2.0</td>
<td>0.180</td>
<td>35</td>
<td>39 49 59 65 72 78 *</td>
</tr>
<tr>
<td>273</td>
<td>2.0</td>
<td>0.200</td>
<td>30</td>
<td>37 46 55 61 67 74 *</td>
</tr>
<tr>
<td>167</td>
<td>2.0</td>
<td>0.230</td>
<td>25</td>
<td>35 43 52 58 64 69 *</td>
</tr>
<tr>
<td>92</td>
<td>2.0</td>
<td>0.270</td>
<td>20</td>
<td>33 41 49 55 60 66 *</td>
</tr>
</tbody>
</table>

* FOR PAVEMENT WIDTHS GREATER THAN 72 FEET USE Lr VALUES DEVELOPED BY THE DESIGN SOFTWARE.

### MINIMUM RADII FOR DESIGNS UTILIZING -2% SUPERELEVATION NORMAL PAVEMENT CROWN

<table>
<thead>
<tr>
<th>RADIUS (FEET)</th>
<th>f</th>
<th>NC (MPH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 1039</td>
<td>.150</td>
<td>45</td>
</tr>
<tr>
<td>762</td>
<td>.160</td>
<td>40</td>
</tr>
<tr>
<td>510</td>
<td>.180</td>
<td>35</td>
</tr>
<tr>
<td>333</td>
<td>.200</td>
<td>30</td>
</tr>
<tr>
<td>198</td>
<td>.230</td>
<td>25</td>
</tr>
<tr>
<td>107</td>
<td>.270</td>
<td>20</td>
</tr>
</tbody>
</table>
### Design Factors for a Design Speed of 20 MPH (Urban) Using \(e = 4\%\) Max.

<table>
<thead>
<tr>
<th>Radius (feet)</th>
<th>(E) (%)</th>
<th>Pavement Width</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>24 ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 @ 12'</td>
</tr>
<tr>
<td>Lt</td>
<td>Lr</td>
<td>Lt</td>
</tr>
<tr>
<td>1410</td>
<td>NC</td>
<td>0</td>
</tr>
<tr>
<td>960</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>868</td>
<td>2.1</td>
<td>33</td>
</tr>
<tr>
<td>784</td>
<td>2.2</td>
<td>33</td>
</tr>
<tr>
<td>696</td>
<td>2.3</td>
<td>33</td>
</tr>
<tr>
<td>565</td>
<td>2.4</td>
<td>33</td>
</tr>
<tr>
<td>408</td>
<td>2.6</td>
<td>33</td>
</tr>
<tr>
<td>376</td>
<td>2.7</td>
<td>33</td>
</tr>
<tr>
<td>348</td>
<td>2.8</td>
<td>33</td>
</tr>
<tr>
<td>300</td>
<td>2.9</td>
<td>33</td>
</tr>
<tr>
<td>264</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>254</td>
<td>3.1</td>
<td>33</td>
</tr>
<tr>
<td>229</td>
<td>3.2</td>
<td>33</td>
</tr>
<tr>
<td>197</td>
<td>3.3</td>
<td>33</td>
</tr>
<tr>
<td>188</td>
<td>3.4</td>
<td>33</td>
</tr>
<tr>
<td>167</td>
<td>3.5</td>
<td>33</td>
</tr>
<tr>
<td>156</td>
<td>3.6</td>
<td>33</td>
</tr>
<tr>
<td>147</td>
<td>3.7</td>
<td>33</td>
</tr>
<tr>
<td>124</td>
<td>3.8</td>
<td>33</td>
</tr>
<tr>
<td>116</td>
<td>3.9</td>
<td>33</td>
</tr>
<tr>
<td>87</td>
<td>4</td>
<td>33</td>
</tr>
</tbody>
</table>

**NOTE:**

Lt and Lr values in feet.

For pavement widths greater than 72 feet, use Lr values developed by the design software.

The listed radius is the minimum allowable radius for the corresponding \(E, Lt\), and Lr values.

---

**Reference:**

Virginia Department of Transportation

2016 Road & Bridge Standards
## Design Factors for a Design Speed of 25 MPH (Urban) Using E = 4% Max.

<table>
<thead>
<tr>
<th>RADIUS (FEET)</th>
<th>E (%)</th>
<th>PAVEMENT WIDTH</th>
<th>24 FT</th>
<th>36 FT</th>
<th>48 FT</th>
<th>60 FT</th>
<th>66 FT</th>
<th>72 FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2050 NC</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1350 2</td>
<td>35</td>
<td>35</td>
<td>43</td>
<td>43</td>
<td>52</td>
<td>52</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
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<td>103</td>
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**NOTE:**

Li and Lr values in feet.

For pavement widths greater than 72 feet use Lr values developed by the design software.

Listed radius is the minimum allowable radius for the corresponding E, Li, and Lr values.
### Design Factors for a Design Speed of 30 MPH (Urban) Using E= 4% Max.

<table>
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<th>RADIUS (FEET)</th>
<th>E (%)</th>
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</thead>
<tbody>
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<td>24 FT</td>
</tr>
<tr>
<td></td>
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<td>37</td>
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<tr>
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<td>37</td>
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<tr>
<td>1442 2.3</td>
<td>37</td>
<td>42</td>
</tr>
<tr>
<td>1282 2.4</td>
<td>37</td>
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</tr>
<tr>
<td>1134 2.5</td>
<td>37</td>
<td>46</td>
</tr>
<tr>
<td>1013 2.6</td>
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<td>754 2.9</td>
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<tr>
<td>251 4.0</td>
<td>37</td>
<td>73</td>
</tr>
</tbody>
</table>

**NOTE:**
- LI and LR values in feet.
- For pavement widths greater than 72 feet use LR values developed by the design software.
- Listed radius is the minimum allowable radius for the corresponding E, LI, and LR values.
### Design Factors for a Design Speed of 35 MPH (Urban) Using $E \cdot 4\%$ Max.

<table>
<thead>
<tr>
<th>Radius (Feet)</th>
<th>$E$ (2)</th>
<th>Pavement Width</th>
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<tbody>
<tr>
<td></td>
<td>24 Ft</td>
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</tr>
<tr>
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<td>24 Ft</td>
<td>36 Ft</td>
</tr>
<tr>
<td></td>
<td>1 1/2&quot;</td>
<td>1 1/2&quot;</td>
</tr>
</tbody>
</table>

**Design Software Equivalents (Number of Lanes at Lane Width)**

- **Lt** and **Lr** values in feet.
- For pavement widths greater than 72 feet use **Lr** values developed by the design software.
- Listed radius is the minimum allowable radius for the corresponding $E$, **Lt**, and **Lr** values.

---

**Transition Curves - Urban**

35 MPH Design Speed

**Virginia Department of Transportation**

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2016 Road & Bridge Standards
### Design Factors for a Design Speed of 40 MPH (Urban) Using E = 4% Max.

<table>
<thead>
<tr>
<th>Radius (Feet)</th>
<th>E (%)</th>
<th>Pavement Width</th>
<th>Design Software Equivalents (Number of Lanes at Lane Width)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>24 Ft</td>
<td>36 Ft</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 @ 12'</td>
<td>1.5 @ 12'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lt</td>
<td>Lr</td>
</tr>
<tr>
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</table>

**Note:**

- Lt and Lr values in feet.
- For pavement widths greater than 72 feet, use Lr values developed by the design software.
- Listed radius is the minimum allowable radius for the corresponding E, Lt, and Lr values.
### Design Factors for a Design Speed of 45 MPH (Urban) Using E* 4% Max.

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**Note:**
- Lt and Lr values in feet.
- For pavement widths greater than 72 feet use Lr values developed by the design software.
- Listed radius is the minimum allowable radius for the corresponding E, Lt, and Lr values.
### Design Factors for a Design Speed of 50 MPH (Urban) Using $E = 4\%$ Max.

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</table>

**NOTE:**

- Lt and Lr values in feet.
- For pavement widths greater than 72 feet use Lr values developed by the design software.
- Listed radius is the minimum allowable radius for the corresponding E, Lt and Lr values.
<table>
<thead>
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<th>RADIUS (FEET)</th>
<th>E (%)</th>
<th>PAVEMENT WIDTH</th>
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</table>

**NOTE:**
- Lt and Lr values in feet.
- For pavement widths greater than 72 feet use Lr values developed by the design software.
- Listed radius is the minimum allowable radius for the corresponding E, Lt, and Lr values.
### Design Factors for a Design Speed of 20 MPH (Rural) Using E = B/2 Max.

<table>
<thead>
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<th>Radius (ft)</th>
<th>10' 0&quot;</th>
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<th>10' 11&quot;</th>
<th>11' 0&quot;</th>
<th>11' 12&quot;</th>
<th>16' 0&quot;</th>
<th>18' 0&quot;</th>
</tr>
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<tbody>
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**Note:** LL & W values in feet. Listed radius is the minimum allowable radius for the corresponding LL, Lr, and W values. Widening shown is based on a SU-40 design vehicle.
DESI
GN

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4.4
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626
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VIRGINIA DEPARTMENT OF TRANSPORTATION

2016 ROAD & BRIDGE STANDARDS

25 MPH DESIGN SPEED
REVISION DATE

01/13

7.7
7.8
7.9
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WI
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WI
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7.5

NOTE:

7.4

7.3

216

199

7.2

225

209

7
7.1

6.9

251

234

6.8

259

242

6.6
6.7

267

6.5

290
273

6.3
6.4

299

6.2

322
308

6

360

6.1

5.9

376

337

5.8

392

340

5.6
5.7

408

5.5

4.2

690
662

420

4.1

718

5.3

31

4

5.4

74

31

3.9

781
752

446

70
72

31

3.8

807

458

69

31

3.7

830

54

3.6

30

3.5

52

51

49

48

46

44

43

41

40

38

37

35

34

32

31

29

0

Lr

910
30

30

30

30

30

30

30

30

30

30

30

30

30

30

30

29

0

Lt

WI
DTH=20 FT

DESI
GN SOFTW ARE EQUI
VALENTS (NUMBER OF LANES AT LANE W I
DTH)
1 @ 9’

870

3.4

1160

950

2.9

1220

3.3

2.8

1254

3.2

2.7

1290

990

2.6

1400

1008

2.5

1432

3

2.4

1520

3.1

2.3

1580

1056

2.2

1698

1080

2
2.1

1745

NC

2370

RADI
US(FT) E(%)

=25

VELOCI
TY

WI
DTH= 18 FT

DESI
GN FACTORS FOR A DESI
GN SPEED OF 25 MPH (RURAL) USI
NG

2016 ROAD & BRIDGE STANDARDS
TC-5.11

SPECIFICATION

TRANSITION CURVES - RURAL
ROAD AND BRIDGE STANDARDS

SHEET 1 OF 1


## 30 MPH Design Speed - Rural

### Table: Design Factors for a Design Speed of 30 MPH (Rural) Using E = 8% Max.

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<td>E(%) L1   L2 w</td>
<td>E(%) L1   L2 w</td>
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**Note:**
- Lt, L1, and L2 refer to values in feet.
- Listed radius is the minimum allowable radius for the corresponding E (Lt, L1, L2 values).
- Widening shown is based on a SU-40 Design Vehicle.
### Design Factors for a Design Speed of 35 MPH (Rural) Using E-8% Max.

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<th>Width (ft)</th>
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<th>1%</th>
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<th>4%</th>
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**Note:** Values shown are based on a SU-40 design vehicle.
### Design for a Speed of 40 MPH (Rural) Using E = 8% Max.

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ALSO LISTED IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, L1, Lr, and w VALUES.

### Design for a Speed of 40 MPH (Rural) Using E = 8% Max.

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ALSO LISTED IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, L1, Lr, and w VALUES.

### Design for a Speed of 40 MPH (Rural) Using E = 8% Max.

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<th>ROAD VELOCITY</th>
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<th>WIDTH=20 FT</th>
<th>WIDTH=22 FT</th>
<th>WIDTH=24 FT</th>
<th>WIDTH=48 FT</th>
<th>WIDTH=72 FT</th>
<th>INTERCHANGE RAMPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 ' 9&quot;</td>
<td>10 ' 10&quot;</td>
<td>10 ' 11&quot;</td>
<td>10 ' 12&quot;</td>
<td>12 ' 0&quot;</td>
<td>12 ' 12&quot;</td>
<td></td>
</tr>
<tr>
<td>L1, Lr, w</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>L1, Lr, w</td>
</tr>
<tr>
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<td>0</td>
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<td>0</td>
<td>0</td>
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<tr>
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<td>0</td>
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</table>

ALSO LISTED IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, L1, Lr, and w VALUES.

### Design for a Speed of 40 MPH (Rural) Using E = 8% Max.

<table>
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<tr>
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<th>WIDTH=22 FT</th>
<th>WIDTH=24 FT</th>
<th>WIDTH=48 FT</th>
<th>WIDTH=72 FT</th>
<th>INTERCHANGE RAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 ' 9&quot;</td>
<td>10 ' 10&quot;</td>
<td>10 ' 11&quot;</td>
<td>10 ' 12&quot;</td>
<td>12 ' 0&quot;</td>
<td>12 ' 12&quot;</td>
<td></td>
</tr>
<tr>
<td>L1, Lr, w</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L1, Lr, w</td>
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<td>0</td>
<td>0</td>
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<td>Lr</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

ALSO LISTED IS THE MINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, L1, Lr, and w VALUES.
## Design Factors for a Design Speed of 45 MPH (Rural) Using E - 8% Max.

| Design Velocity | Width/20 FT | Width/22 FT | Width/24 FT | Width/26 FT | Width/28 FT | Width/30 FT | Width/32 FT | Width/34 FT | Width/36 FT | Width/38 FT | Width/40 FT | Width/42 FT | Width/44 FT | Width/46 FT | Width/48 FT | Width/50 FT | Width/52 FT | Width/54 FT | Width/56 FT | Width/58 FT | Width/60 FT | Width/62 FT | Width/64 FT | Width/66 FT | Width/68 FT | Width/70 FT | Width/72 FT | Interchange Ramps | Reference |
|-----------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|--------------|-----------|
| 45 MPH Design Speed - Rural |
| Specifications |
| Design Factors |

**NOTE:** Ll, Ll, and w VALUES IN FEET. LMINIMUM ALLOWABLE RADIUS FOR THE CORRESPONDING E, Ll, Ll, and w VALUES. WIDENING ShOWN IS BASED ON A WB-62 DESIGN VEHICLE.
### Transition Curves - Rural

#### 50 MPH Design Speed

<table>
<thead>
<tr>
<th>VDOT Design Factors</th>
<th>Design Speed (MPH)</th>
<th>Radius (ft)</th>
<th>SE</th>
<th>LE</th>
<th>LR</th>
<th>W</th>
<th>Value</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td></td>
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<td>360</td>
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<td>5</td>
<td>7</td>
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<tr>
<td></td>
<td>80</td>
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<td>2</td>
<td>4</td>
<td>6</td>
<td>9</td>
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</tr>
<tr>
<td></td>
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<td>5</td>
<td>8</td>
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<td>180</td>
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<td>4</td>
<td>7</td>
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<td></td>
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<td>144</td>
<td>-</td>
<td>1</td>
<td>3</td>
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<tr>
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<td>120</td>
<td>115</td>
<td>-</td>
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<td>5</td>
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<td>130</td>
<td>92</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>4</td>
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<td>140</td>
<td>73</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
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</tbody>
</table>

Note: Values in feet listed above are the minimum allowable radius for the corresponding E, L, and W values. Values shown are based on a W/R=60-65, VDOT design vehicle.
## Design Factors for a Design Speed of 55 MPH (Rural) Using E = 8% Max.

### Design Speed

<table>
<thead>
<tr>
<th>Design Velocity (MPH)</th>
<th>Width - 32 FT</th>
<th>Width - 24 FT</th>
<th>Width - 18 FT</th>
<th>Width - 12 FT</th>
<th>Width - 6 FT</th>
<th>Interchange Ramps</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

### Transition Curves - Rural

<table>
<thead>
<tr>
<th>Radius (ft)</th>
<th>Design Software Equivalents (Number of Lanes at Lane Width)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 x 7</td>
</tr>
<tr>
<td>2016 ROAD &amp; BRIDGE STANDARDS</td>
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</tr>
<tr>
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</tr>
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<tr>
<td>2</td>
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<td>2.5</td>
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<td>3</td>
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<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4.5</td>
<td>4.5</td>
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<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>6</td>
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<tr>
<td>9.5</td>
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<td>10</td>
<td>10</td>
</tr>
<tr>
<td>10.5</td>
<td>10.5</td>
</tr>
</tbody>
</table>

### Notes

- Values in feet.
- Listed radius is the minimum allowable radius for the corresponding e, l, l', and w values.
- Widening shown is based on a WB-62 design vehicle.
## Design Factors for a Design Speed of 60 MPH (Rural)

### Design Factors for a Design Speed of 60 MPH (Rural)

<table>
<thead>
<tr>
<th>Design Velocity</th>
<th>Width +24 FT</th>
<th>Width +48 FT</th>
<th>Width +72 FT</th>
<th>Interchange Ramps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lt Lr w</td>
<td>Lt Lr w</td>
<td>Lt Lr w</td>
<td>Lt Lr Lr</td>
<td>Lt Lr Lr</td>
</tr>
<tr>
<td>10 ft</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 ft</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16 ft</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18 ft</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Design Software Equivalents (Number of Lanes at Lane Width)

<table>
<thead>
<tr>
<th>Design Software</th>
<th>10 ft</th>
<th>12 ft</th>
<th>16 ft</th>
<th>18 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lt Lr w</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lt Lr w</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lt Lr Lr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Note:
- Lt, Lr, and w values in feet.
- Listed radius is the minimum allowable radius for the corresponding L, Lt, Lr, and w values.
- Widening shown is based on a W-0B design vehicle.

### Transition Curves - Rural

<table>
<thead>
<tr>
<th>Design Speed</th>
<th>Specifications</th>
</tr>
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<tbody>
<tr>
<td>60 MPH</td>
<td>Width 24 ft</td>
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### 2016 Road & Bridge Standards

<table>
<thead>
<tr>
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<th>Road &amp; Bridge Standards</th>
<th>07/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC 5.4.1</td>
<td>2016 Road &amp; Bridge Standards</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Lane Width</th>
<th>Design Velocity</th>
<th>Width +24 FT</th>
<th>Width +48 FT</th>
<th>Width +72 FT</th>
<th>Interchange Ramps</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 ft</td>
<td>Lt Lr w</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 ft</td>
<td>Lt Lr w</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16 ft</td>
<td>Lt Lr Lr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18 ft</td>
<td>Lt Lr Lr</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

### Width +24 FT

<table>
<thead>
<tr>
<th>Design Velocity</th>
<th>Width +48 FT</th>
<th>Width +72 FT</th>
<th>Interchange Ramps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lt Lr w</td>
<td>Lt Lr w</td>
<td>Lt Lr Lr</td>
<td>Lt Lr Lr</td>
</tr>
<tr>
<td>10 ft</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 ft</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16 ft</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18 ft</td>
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### Width +48 FT

<table>
<thead>
<tr>
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<th>Width +72 FT</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Lt Lr Lr</td>
<td>Lt Lr Lr</td>
<td>Lt Lr Lr</td>
</tr>
<tr>
<td>10 ft</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 ft</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16 ft</td>
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<td>0</td>
</tr>
<tr>
<td>18 ft</td>
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<td>0</td>
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### Width +72 FT

<table>
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<th>Interchange Ramps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lt Lr Lr</td>
<td>Lt Lr Lr</td>
</tr>
<tr>
<td>10 ft</td>
<td>0</td>
</tr>
<tr>
<td>12 ft</td>
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</tr>
<tr>
<td>16 ft</td>
<td>0</td>
</tr>
<tr>
<td>18 ft</td>
<td>0</td>
</tr>
</tbody>
</table>

### Interchange Ramps

<table>
<thead>
<tr>
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<th>10 ft</th>
<th>12 ft</th>
<th>16 ft</th>
<th>18 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lt Lr w</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lt Lr w</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Lt Lr Lr</td>
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### Road & Bridge Standards

<table>
<thead>
<tr>
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<th>07/13</th>
</tr>
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<tbody>
<tr>
<td>TC 5.4.1</td>
<td>2016 Road &amp; Bridge Standards</td>
<td></td>
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</tbody>
</table>
### Design Factors for a Design Speed of 65 MPH (Rural) Using E-8% Max.

#### Design Velocity

<table>
<thead>
<tr>
<th>Rad/Sift</th>
<th>Design Velocity</th>
<th>Width-22 FT</th>
<th>Width-24 FT</th>
<th>Width-48 FT</th>
<th>Width-72 FT</th>
<th>Interchange Ramps</th>
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</thead>
<tbody>
<tr>
<td>000</td>
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<td>236</td>
<td>127</td>
<td>64</td>
<td>0</td>
<td>0.0</td>
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<tr>
<td>000</td>
<td>105</td>
<td>236</td>
<td>127</td>
<td>64</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>000</td>
<td>105</td>
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<td>236</td>
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<tr>
<td>000</td>
<td>105</td>
<td>236</td>
<td>127</td>
<td>64</td>
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<tr>
<td>000</td>
<td>105</td>
<td>236</td>
<td>127</td>
<td>64</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### Widening Shown is Based on a WB-62 Design Vehicle.

**Note:** All values in feet. Listed radius is the minimum allowable radius for the corresponding E, LL, Lr, and w values.
### Design Factors for a Design Speed of 70 MPH (Rural) Using E - 8% Max.

#### VOIT

<table>
<thead>
<tr>
<th>Design Velocity (m/s)</th>
<th>Width 12 ft</th>
<th>Width 18 ft</th>
<th>Width 24 ft</th>
<th>Width 36 ft</th>
<th>Width 48 ft</th>
<th>Width 72 ft</th>
<th>Interchange ramps</th>
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<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td><strong>LR</strong></td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>W</strong></td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>10 ft</strong></td>
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<td>60</td>
<td>0</td>
<td>59</td>
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<td>59</td>
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<td>58</td>
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<tr>
<td><strong>14 ft</strong></td>
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<td>0</td>
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<tr>
<td><strong>16 ft</strong></td>
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<td>60</td>
<td>0</td>
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</tr>
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<td>58</td>
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</table>

#### Transition Curves - Rural

<table>
<thead>
<tr>
<th>Design Speed (m/s)</th>
<th>70 MPH</th>
<th>75 MPH</th>
<th>80 MPH</th>
<th>85 MPH</th>
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</thead>
<tbody>
<tr>
<td><strong>12 ft</strong></td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>14 ft</strong></td>
<td>0</td>
<td>0</td>
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#### Road & Bridge Standards

- **Approach Ramps:**
  - Minimum allowable radius for the corresponding E, LT, LR, and W values.
  - Widening shown is based on a 90°-VBE design vehicle.

#### Notes:
- **E:** Values in feet.
- **L:** Listed radius is the minimum allowable radius for the corresponding E, LT, LR, and W values.
- **W:** Widening shown is based on a WB-62 design vehicle.
<table>
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**Note:** Li, Lr, & w values in feet. Listed radius is the minimum allowable radius for the corresponding E, Li, Lr, and w values. Widening shown is based on a WB-62 design vehicle.
### Design Factors for a Design Speed of 80 MPH (Rural) Using E = 8% Max.

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<th>24′ 10″</th>
<th>24′ 12″</th>
<th>28′ 10″</th>
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### Transition Curves - Rural 80 MPH Design Speed

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### Note:
- L, Lr, w values in feet. Listed radius is the minimum allowable radius for the corresponding E, L, Lr, and w values. Widening shown is based on a W-82 design vehicle.
APPENDIX
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**NOTE:**

Bar numbers are based on the number of 1/8 inches included in the nominal diameter of the bar.
PARABOLIC VERTICAL CURVE

C.G. = POINT OF CHANGE OF GRADIENT
C = CENTER CORRECTION
C' = CORRECTION AT ANY GIVEN POINT ON CURVE
D = L/2 = HALF LENGTH OF VERTICAL CURVE
D' = DISTANCE TO POINT WHERE CORRECTION IS REQUIRED FROM BEGINNING OR END OF CURVE
C = \frac{\text{ALG. DIFF. X LENGTH OF CURVE IN STATIONS}}{8}
C' = C \left( \frac{D'}{2} \right)
### Metric Conversion Factors

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<td>MILE (U.S. STATUTE)</td>
<td>METER (m)</td>
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</tbody>
</table>

| AREA             |     |             |
| INCH² (in²)     | METER² (m²) | .0006       |
| FOOT² (ft²)     | METER² (m²) | .0929       |
| YARD² (yd²)     | METER² (m²) | .8361       |
| MILE² (U.S. STATUTE) | METER² (m²) | 2589988.0000 |
| ACRES           | METER² (m²) | 4046.8560   |

| MASS             |     |             |
| TON (SHORT-2000 lbs) | KILOGRAM (kg) | 907.1847   |

| VOLUME           |     |             |
| FOOT³ (ft³)     | METER³ (m³) | .0283       |
| YARD³ (yd³)     | METER³ (m³) | .7645       |
| ACRE-FOOT       | METER³ (m³) | 1233.4820   |
| OUNCE (U.S. LIQUID) | LITER (l)   | .0296       |
| PINT (U.S. LIQUID) | LITER (l)   | .4732       |
| QUART (U.S. LIQUID) | LITER (l)   | .9463       |
| GALLON (U.S. LIQUID) | LITER (l)   | 3.7853      |

| VELOCITY         |     |             |
| FOOT/SECOND     | METER/SECOND (m/s) | .3048       |
| MILE/HOUR (U.S. STATUTE) | METER/SECOND (m/s) | .4470       |
| MILE/HOUR (U.S. STATUTE) | KILOMETER/HOUR | 1.6093      |

| TEMPERATURE      |     |             |
| DEGREE FAHRENHEIT | DEGREE CELSIUS | t°C = (t°F - 32) / 1.8 |

| OTHER COMMONLY USED UNITS |     |             |
| MILLIMETER             | = 0.001 METER |
| CENTIMETER             | = 0.01 METER |
| KILOMETER              | = 1000 METER |
| KILOGRAM               | = 1000 GRAMS |
| MILLILITER             | = 0.001 LITER |