

## **Appendix 5-B**

### **Manning n Values, Entrance Loss Coefficients, and Culvert Design Form**

**Revised September 2026**

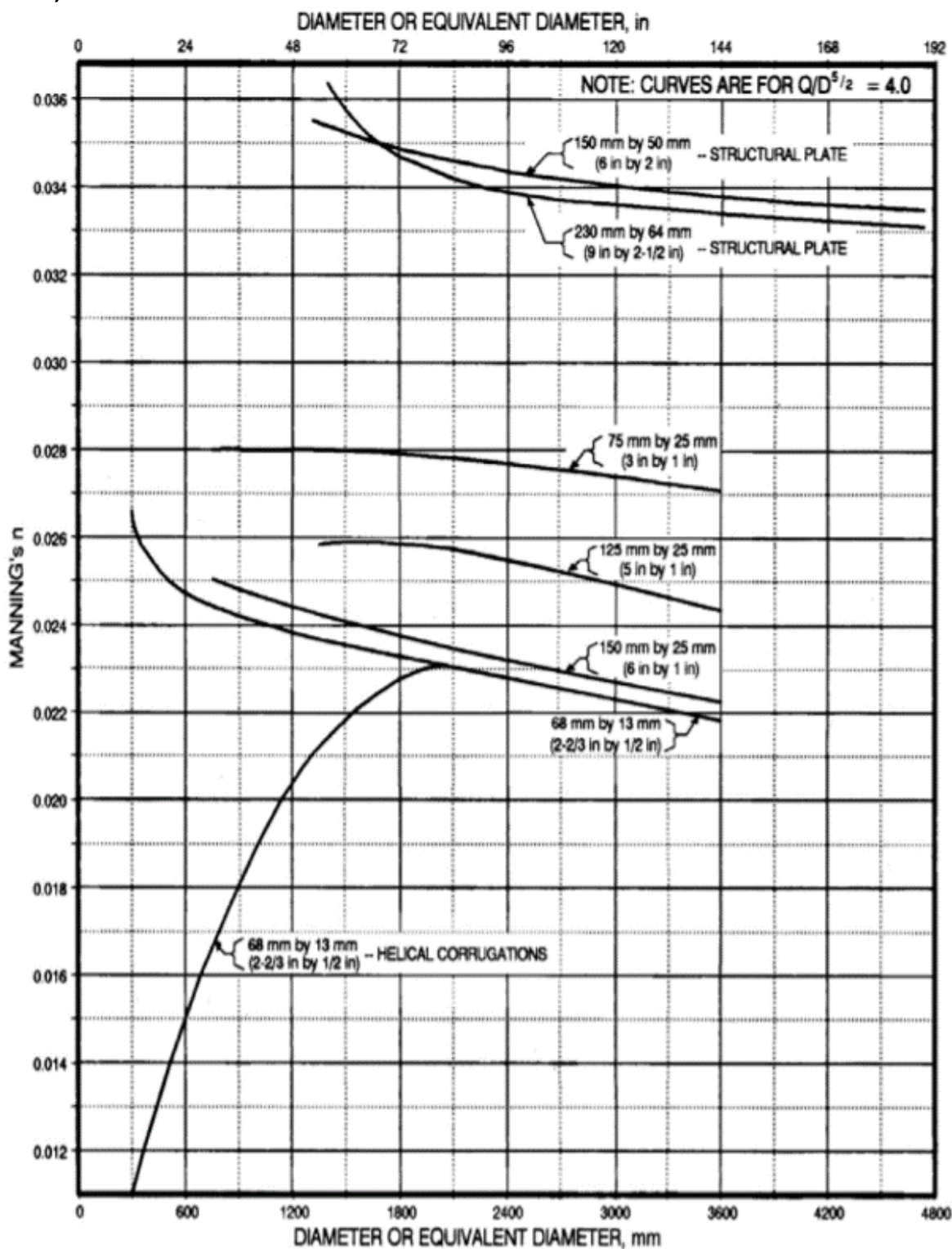
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**Table 5-B-1. Recommended Manning's n Values**

| <b>Type of Conduit</b>                                                                                                                    | <b>Wall Description</b>                     | <b>MDOT Manning Design Value</b> |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|----------------------------------|
| Concrete Pipe                                                                                                                             | Smooth                                      | 0.012                            |
| Concrete Box                                                                                                                              | Smooth                                      | 0.012                            |
| Corrugated Metal Pipe, Pipe-Arch and Box<br>(For Annular and Helical corrugations, refer to 5-B-3: Manning's "n" varies with barrel size) | 2 2/3-inch by 1/2-inch corrugations Annular | 0.027                            |
|                                                                                                                                           | 2 2/3-inch by 1/2-inch corrugations Helical | 0.012-0.024                      |
|                                                                                                                                           | 6-inch by 1-inch corrugations Helical       | 0.025                            |
|                                                                                                                                           | 5-inch by 1-inch corrugations               | 0.026                            |
|                                                                                                                                           | 3-inch by 1-inch corrugations               | 0.028                            |
|                                                                                                                                           | 6-inch by 2-inch structural plate           | 0.035                            |
|                                                                                                                                           | 9-inch by 2.5-inch structural plate         | 0.037                            |
| Spiral Rib Metal                                                                                                                          | Smooth                                      | 0.013                            |
| Corrugated Polyethylene                                                                                                                   | Smooth                                      | 0.013                            |
| Corrugated Polyethylene                                                                                                                   | Corrugated                                  | 0.025                            |
| Polyvinyl Chloride (PVC)                                                                                                                  | Smooth                                      | 0.012                            |
| Cured-in-Place Pipe (CIPP)                                                                                                                | Smooth                                      | 0.015                            |

Note 1: The values indicated in this table are recommended Manning's n design values. Actual field values for older pipelines vary depending on the effects of abrasion, corrosion, deflection, and joint conditions. Concrete pipe with poor joints and deteriorated walls has n values of 0.014 to 0.018. Corrugated metal pipe with joint and wall problems has higher n values and may experience shape changes that could adversely affect the general hydraulic characteristics of the culvert.

Figure 5-B-1. Manning's "n" Diameter for Corrugated Metal Conduits (FHWA HDS 5, 2012)



**Table 5-B-2. Entrance Loss Coefficients - Outlet Control, Full or Partly Full**

$$H_e = K_e (V^2/2g)$$

| Type of Structure and Design of Entrance                       | Coefficient $K_e$ |
|----------------------------------------------------------------|-------------------|
| Standard Commercial Ends .....                                 | 0.5               |
| Safety Slope Ends.....                                         | 0.7               |
| <b>Pipe, Concrete</b>                                          |                   |
| Mitered to conform to fill slope.....                          | 0.7               |
| * End-Section conforming to fill slope .....                   | 0.5               |
| Projecting from fill, sq. cut end .....                        | 0.5               |
| Headwall or headwall and wingwalls                             |                   |
| Square-edge.....                                               | 0.5               |
| Rounded (radius = 1/12D) .....                                 | 0.2               |
| Socket end of pipe (groove-end) .....                          | 0.2               |
| Projecting from fill, socket end (groove-end) .....            | 0.2               |
| Beveled edges, 33.7° or 45° bevels .....                       | 0.2               |
| Side- or slope-tapered inlet .....                             | 0.2               |
| <b>Pipe, or Pipe-Arch, Corrugated Metal</b>                    |                   |
| Projecting from fill (no headwall) .....                       | 0.9               |
| Mitered to conform to fill slope, paved or unpaved slope ..... | 0.7               |
| Headwall or headwall and wingwalls square-edge .....           | 0.5               |
| * End-section conforming to fill slope.....                    | 0.5               |
| Beveled edges, 33.7° or 45° bevels .....                       | 0.2               |
| Side- or slope-tapered inlet .....                             | 0.2               |
| <b>Box, Reinforced Concrete</b>                                |                   |
| Wingwalls parallel (extension of sides)                        |                   |
| Square-edged at crown .....                                    | 0.7               |
| Wingwalls at 10° to 25° or 30° to 75° to barrel                |                   |
| Square-edged at crown .....                                    | 0.5               |
| Headwall parallel to embankment (no wingwalls)                 |                   |
| Square-edged on 3 edges .....                                  | 0.5               |
| Rounded on 3 edges to radius of 1/12 barrel                    |                   |
| dimension, or beveled edges on 3 sides .....                   | 0.2               |
| Wingwalls at 30° to 75° to barrel                              |                   |
| Crown edge rounded to radius of 1/12 barrel                    |                   |
| dimension, or beveled top edge .....                           | 0.2               |
| Side- or slope-tapered inlet .....                             | 0.2               |

\* Note: "End Section conforming to fill slope," made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests, they are equivalent in operation to a headwall in **inlet** and **outlet** control. Some end section designs that incorporate a **closed** taper have superior hydraulic performance. These latter sections are designed using the information given for the beveled inlet.

Figure 5-B-2. Culvert Design Form (FHWA HDS 5, 2012)

|                |  |                      |  |                                |  |
|----------------|--|----------------------|--|--------------------------------|--|
| PROJECT: _____ |  | STATION: _____       |  | <b>CULVERT DESIGN FORM</b>     |  |
|                |  | SHEET _____ OF _____ |  | DESIGNER / DATE: _____ / _____ |  |
|                |  |                      |  | REVIEWER / DATE: _____ / _____ |  |

|                                                                                                                                                                                                                                                                        |            |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| <b>HYDROLOGICAL DATA</b>                                                                                                                                                                                                                                               |            |         | <p style="text-align: center;">ROADWAY ELEVATION: _____ ( )</p> <p style="text-align: center;">EL<sub>ha</sub>: _____ ( )</p> <p style="text-align: center;">EL<sub>d</sub>: _____ ( ) S<sub>o</sub>: _____</p> <p style="text-align: center;">ORIGINAL STREAM BED</p> <p style="text-align: center;">EL<sub>i</sub>: _____ ( ) T S = S<sub>o</sub> - T/L<sub>o</sub></p> <p style="text-align: center;">S = _____</p> <p style="text-align: center;">L<sub>o</sub> = _____</p> <p style="text-align: right;">EL<sub>o</sub>: _____ ( )</p> |  |  |
| <input type="checkbox"/> METHOD: _____<br><input type="checkbox"/> DRAINAGE AREA: _____ <input type="checkbox"/> STREAM SLOPE: _____<br><input type="checkbox"/> CHANNEL SHAPE: _____<br><input type="checkbox"/> ROUTING: _____ <input type="checkbox"/> OTHER: _____ |            |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |
| <b>DESIGN FLOWS/TAIWATER</b>                                                                                                                                                                                                                                           |            |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |
| R.I. (YEARS)                                                                                                                                                                                                                                                           | FLOW (cfs) | TW (ft) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |
| _____                                                                                                                                                                                                                                                                  | _____      | _____   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |
| _____                                                                                                                                                                                                                                                                  | _____      | _____   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |

| <b>CULVERT DESCRIPTION:</b>        |                    |                           | <b>HEADWATER CALCULATIONS</b> |                 |       |                      |                |                |                        |                    |                |       |                      | Control Headwater Elevation | Outlet Velocity | Comments |  |
|------------------------------------|--------------------|---------------------------|-------------------------------|-----------------|-------|----------------------|----------------|----------------|------------------------|--------------------|----------------|-------|----------------------|-----------------------------|-----------------|----------|--|
| MATERIAL - SHAPE - SIZE - ENTRANCE | Total Flow Q (cfs) | Flow Per Barrel Q / N (1) | INLET CONTROL                 |                 |       |                      | OUTLET CONTROL |                |                        |                    |                |       |                      |                             |                 |          |  |
|                                    |                    |                           | HW/D (2)                      | HW <sub>i</sub> | T (3) | EL <sub>hi</sub> (4) | TW (5)         | d <sub>c</sub> | d <sub>c</sub> + D / 2 | h <sub>o</sub> (6) | k <sub>e</sub> | H (7) | EL <sub>ho</sub> (8) |                             |                 |          |  |
|                                    |                    |                           |                               |                 |       |                      |                |                |                        |                    |                |       |                      |                             |                 |          |  |
|                                    |                    |                           |                               |                 |       |                      |                |                |                        |                    |                |       |                      |                             |                 |          |  |
|                                    |                    |                           |                               |                 |       |                      |                |                |                        |                    |                |       |                      |                             |                 |          |  |
|                                    |                    |                           |                               |                 |       |                      |                |                |                        |                    |                |       |                      |                             |                 |          |  |
|                                    |                    |                           |                               |                 |       |                      |                |                |                        |                    |                |       |                      |                             |                 |          |  |

|                                                                                       |                                                                                            |                                                                                                                                                              |
|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TECHNICAL FOOTNOTES:</b>                                                           |                                                                                            |                                                                                                                                                              |
| (1) USE Q/NB FOR BOX CULVERTS                                                         | (4) EL <sub>hi</sub> = HW <sub>i</sub> + EL <sub>i</sub> (INVERT OF INLET CONTROL SECTION) | (6) h <sub>o</sub> = TW or (d <sub>c</sub> + D) / 2 (WHICHEVER IS GREATER)                                                                                   |
| (2) HW <sub>i</sub> / D = HW / D OR HW <sub>i</sub> / D FROM DESIGN CHARTS            | (5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL                               | (7) H = [1 + k <sub>e</sub> + (K <sub>u</sub> n <sup>2</sup> L) / R <sup>1.33</sup> ] v <sup>2</sup> / 2g WHERE K <sub>u</sub> = 19.63 (29 IN ENGLISH UNITS) |
| (3) T = HW - (EL <sub>hi</sub> - EL <sub>o</sub> )<br>T IS ZERO FOR CULVERTS ON GRADE |                                                                                            | (8) EL <sub>ho</sub> = EL <sub>o</sub> + H + h <sub>o</sub>                                                                                                  |

|                                                                                                                                                                                                                              |                               |                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
| <b>SUBSCRIPT DEFINITIONS:</b>                                                                                                                                                                                                | <b>COMMENTS / DISCUSSION:</b> | <b>CULVERT BARREL SELECTED:</b>                                                       |
| a. APPROXIMATE<br>f. CULVERT FACE<br>ha. ALLOWABLE HEADWATER<br>hi. HEADWATER IN INLET CONTROL<br>ho. HEADWATER IN OUTLET CONTROL<br>i. INLET CONTROL SECTION<br>o. OUTLET<br>sf. STREAMBED AT CULVERT FACE<br>tw. TAILWATER |                               | SIZE: _____<br><br>SHAPE: _____<br><br>MATERIAL: _____ n _____<br><br>ENTRANCE: _____ |