CULVERT SIZING POLICY
Merril E. Dougherty, PE
Indiana Department of Transportation

The Goal for Policy is a Clear Understanding!
Design Storm Frequency

INDOT Considers Four Criteria:

1. **Downstream Channel Capacity**
2. **Backwater**
3. **Outlet Velocity**
4. **Roadway Serviceability**

<table>
<thead>
<tr>
<th>Functional Classification</th>
<th>Allowable Backwater</th>
<th>Roadway Serviceability</th>
<th>Allowable Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>$Q_{30}$</td>
<td>$Q_{100}$</td>
<td>$Q_{50}$</td>
</tr>
<tr>
<td>Multilane Non-Freeways</td>
<td>$Q_{10}$</td>
<td>$Q_{50}$</td>
<td>$Q_{30}$</td>
</tr>
<tr>
<td>Two-Lane Facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AADT ≥ 3000</td>
<td>$Q_{10}$</td>
<td>$Q_{50}$</td>
<td>$Q_{30}$</td>
</tr>
<tr>
<td>3000 &gt; AADT ≥ 1000</td>
<td>$Q_{10}$</td>
<td>$Q_{50}$</td>
<td>$Q_{30}$</td>
</tr>
<tr>
<td>AADT &lt; 1000</td>
<td>$Q_{10}$</td>
<td>$Q_{10}$</td>
<td>$Q_{30}$</td>
</tr>
</tbody>
</table>

*Note: The design storm frequency for culvert extension structures is identical to those for new culvert structures. Traffic volumes are for a 20-year projection.*
**Design Criteria**

*Downstream Channel Adequacy*

**Design Considerations:**

- Check the stream for at least ¼ mile downstream
- Check the next three crossings, if within one mile
- Low lying structures within 300 feet upstream or ¼ mile downstream?
- Does the project add drainage area to the stream?
- Are overland flows concentrated?
- Is water brought to the stream more quickly than in the existing condition?

---

**Design Criteria**

*Downstream Channel Adequacy*

What to do if the Downstream Channel is inadequate?

**First:** Try to detain water!

But if not, perhaps improve the downstream channel...

In any case, contact INDOT Hydraulics!
Allowable Backwater
New Alignment

- 40mm Maximum Backwater
- Special Cases:
  - Backwater Dissipates 40mm or Less at R/W
  - Backwater is Contained in the Channel
    • Remember to Check Outlet Velocity!

Allowable Backwater
Replacing an Existing Culvert

- Match or Reduce Existing Backwater
- Exception:
  - Existing Backwater Exceeds 300mm
Allowable Backwater
Other Constraints

- Grade of Adjacent Driveways
- Finished Floor Elevation of Adjacent Buildings
- Elevation of Surrounding Crop Land
Roadway Serviceability

- For a Q100 Design Storm
  - 0.6m Below Edge of Pavement
- For Design Storms Less Than Q100
  - Headwater Can Not Exceed Edge of Pavement

Maximum Outlet Velocity

- Revetment Riprap $\leq 2 \text{ m/s}$
- Class 1 Riprap $> 2 \text{ m/s} < 3 \text{ m/s}$
- Class 2 Riprap $\geq 3 \text{ m/s} \leq 4 \text{ m/s}$
- Energy Dissipator $> 4 \text{ m/s}$

- See Chapter 34
Minimum Outlet Velocity

- Typical Minimum Outlet Velocity
  - 0.9 m/s

Do Not Consider Storage at the Culvert

"Get rid of them?! On the contrary, Mr. Westford. Because the geese have begun to nest here, your pool has been declared a protected wetland, requiring that no human activity take place within 150 feet."
Priority System

- Trial 1 - Single Circular Pipe
- Trial 2 - Single Deformed Pipe
- Trial 3 - Single Specialty Structure
- Trial 4 - Multiple Circular Pipes
- Trial 5 - Multiple Deformed Pipes
- Trial 6 - Multiple Specialty Structures

Pipe Culvert Interior Designation

- Smooth Interior - Manning’s n = 0.012
- Corrugated Interior - Manning’s n = 0.024
Minimum Culvert Size

<table>
<thead>
<tr>
<th>Structure Application</th>
<th>Minimum Circular Pipe Size</th>
<th>Minimum Deformed Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driveway Culvert</td>
<td>375 mm</td>
<td>0.10 m²</td>
</tr>
<tr>
<td>Mainline/Public Road Approach Culvert (2 lanes)</td>
<td>375 mm</td>
<td>0.10 m²</td>
</tr>
<tr>
<td>Mainline/Public Road Approach Culvert (3 + Lanes)</td>
<td>900 mm</td>
<td>0.60 m²</td>
</tr>
</tbody>
</table>

Culvert Extension Process

- Match Existing Culvert Size and Type
- Perform Appropriate Hydraulic Analysis
Approved Design Methods

Computer Method
- FHWA Program HY-8

Hand Method
- Nomographs From FHWA Publication HDS #5 “Hydraulic Design of Highway Culverts”
- Available as a Printed Manual and on CD ROM

Design Responsibility

“Small Structure Replacement”
- Consultant Will Furnish Plots and Documents
- INDOT Hydraulics Will Size The Culvert

All Other Types of Projects
- Consultant Will Size the Culvert(s)
- INDOT Hydraulics Will Review Computations
Where Do I Get More Information?

- INDOT Design Manual
  Part IV  Hydrology and Hydraulics
- FHWA Hydraulics Home Page
  - Hydraulics Engineering Publication List
  - Hydraulics Engineering Software Reference List
  - www.fhwa.dot.gov/engineering/hydraulics

MAJOR MOVES!

- More Money Equals More Projects
  - $150 Million Next Two Years for Local Transportation Projects
  - INDOT Will Be Doubling the Current Construction Budget of $800 Million
- Proper Drainage is Essential
  - Pavement Life
  - Road Serviceability
Questions

www.fhwa.dot.gov/engineering/hydraulics