Aquatic & Terrestrial Organism Passage
Aquatic & Terrestrial Organism Passage
Evolution of MassDOT Stream Crossing Handbook

Originally published 2010
• Philosophical & conceptual
Evolution of MassDOT Stream Crossing Handbook

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- Response to stream crossing standards (recommendations)
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- Justified fish & wildlife passage to DOT engineers & consultants
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• Recommended design approaches
Evolution of MassDOT Stream Crossing Handbook

New handbook (2017)
• Technical & practical
Evolution of MassDOT Stream Crossing Handbook

New handbook (2017)

- Technical & practical

- Response to new stream crossing regulations
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- Technical guidance for municipalities
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• Technical guidance for municipalities

• New, cost effective technology

• Design plan templates
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1. Introduction
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2. Rationale for Crossing Design for Wildlife Passage
   MA River and Stream Crossing Standards
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3. Regulatory Context and MassDOT Compliance
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Stream Crossing Standards

Open Area (m$^2$) / Structure Length (m) = Openness Ratio (m)

Openness Ratio (m) ≥ 0.25m for General Standards
≥ 0.50m to 0.75m for Optimum Standards
Preserve existing stream bed (preferred); or if necessary, provide for bed material comparable to natural channel and that results in depths and velocities at a variety of flows.
Provide for bed material comparable to natural channel and that results in depths and velocities at a variety of flows.
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Range of Design Solutions

- Range of ecological solutions

- Flood capacity
  - Pass adult game fish

Stream Simulation: pass sediment, debris, all aquatic species

Floodplain Continuity

- Permit valley and floodplain processes
  - Pass aquatic and terrestrial wildlife

Adapted from Gubernick, Culvert Summit 2006
Range of Design Solutions

Design Approaches Continuum

Determined by project objectives, stream and design realities

Valley and floodplain processes

SS with floodplain continuity

Not all streams can be or require stream sim.

Stream simulation

Hydraulic design

Flood capacity

Adapted from Gubernick, Culvert Summit 2006
Range of Design Solutions

Design Approaches Continuum

Determined by project objectives, stream and design

Valley and floodplain processes

Not all alternatives be or need stream sim!

Some other alternatives

Stream simulation

Hydraulic design

Flood capacity

Adapted from Gubernick, Culvert Summit 2006
Range of Design Solutions

Design Approaches Continuum

Determined by project objectives, stream and design

Valley and floodplain processes

Not all solutions will be or need to be stream sim.!

Some other alternatives

Flood capacity

Some other alternatives

Adapted from Gubernick, Culvert Summit 2006
Stream Crossing Design Approaches:
Order of Preference:

1. Valley Span
2. Stream Span (preserve existing stream)
3. Stream Span with stream simulation
4. Bridge Replacement - Retain Abutments
   a. Cut retained abutments below streambed
   b. Cut retained abutments at bank elevation
Stream Crossing Design Approaches: Order of Preference: (continued)

5. Full Span Embedded Multi-Box Culvert
6. Embedded Culvert (less than full span)
7. No-Slope Culvert
8. Fish Passage Hydraulic Design
   a. Roughened Channel
   b. Baffles or other fishway modifications
9. Flow Conveyance Design
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Site Constraints

- Flood profile impacts
- Other hydrologic constraints
- Potential head-cutting
- Bank stability
- In-stream and wetlands habitat
- Extent of habitat fragmentation
- Engineering design constraints (e.g. geotechnical, structural)
- Property and infrastructure impacts
- Costs
Before replacement
Completed replacement: embedded culvert
(< bankfull width to meet site constraints)
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# Municipal Bridge Projects

## MGL Chapter 85 Section 35 Review Process

**NOTE:** Design Requirements to be used depend on the Category of the Proposed Structure and not on the Category of the Existing Structure.

### Note:
- If the Proposed Structure is a Non-BRI Bridge Structure (span ≤ 10 feet), a Chapter 85 review is not required.
- If the Proposed Structure is a BRI Bridge Structure (10 feet < span ≤ 20 feet), the following requirements apply:

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Hydraulic Design</th>
<th>Geotechnical Design</th>
<th>Structural Design</th>
<th>Construction Details</th>
<th>Design Review Submittals</th>
<th>Other Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local Road</strong></td>
<td>- <a href="#">Hydraulic report per Bridge Manual</a> except as noted below.</td>
<td>- Geotechnical Report per Bridge Manual (except as noted below). At least one boring to refusal below bottom of footing or pile tip for every 50 feet of elevation or planet width. If rock is encountered, a 10-foot core is recommended.</td>
<td>- Design in accordance with AASHTO LRFD for HL-93 Design Loading.</td>
<td>- Need not follow MassDOT Bridge Manual construction details.</td>
<td>- Geotechnical Report (if over water)</td>
<td>- Evaluation of structure from a Cultural Resources standpoint.</td>
</tr>
<tr>
<td></td>
<td>- Less than 2 feet of freeboard.</td>
<td></td>
<td>- Bridge Manual DL and LL load distribution procedure if applicable. Geotextile AASHTO Guide Specifications for 300A requirements.</td>
<td></td>
<td>- No bridge ratings or barriers and transitions; those used must be credit listed to either NCHRP 100 or MAG. Test Level 2 minimum if roadway speed ≤ 45 mph, minimum Test Level 3 if roadway speed &gt; 45 mph. Provisional ratings and barriers if pedestrians are allowed on bridge.</td>
<td>- Consider Stream Crossing Standards requirements.</td>
</tr>
<tr>
<td></td>
<td>- Check Scour freq.: 50 years.</td>
<td></td>
<td></td>
<td></td>
<td>- Evaluation of structure from a Cultural Resources standpoint.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Must be scourable after Design Scour Event but not necessarily available for use.</td>
<td></td>
<td></td>
<td></td>
<td>- Evaluation of structure from a Cultural Resources standpoint.</td>
<td></td>
</tr>
<tr>
<td><strong>State or US Numbered Route</strong></td>
<td>- <a href="#">Hydraulic report per Bridge Manual</a> except as noted below. Provide 2 feet of freeboard.</td>
<td>- Geotechnical Report per Bridge Manual (except as noted below). Perform a Design Scour program in accordance with Bridge Manual Part I, Section 1.2.</td>
<td>- Design in accordance with AASHTO LRFD for HL-93 Design Loading. Bridge Manual DL and LL load distribution procedure if applicable.</td>
<td>- If a pre-fabricated structure designed by fabricator, submit fabricated design calculations and shop drawings of final structure.</td>
<td>- Geotechnical Report (if over water). Evaluate structure from a Cultural Resources standpoint.</td>
<td>- Evaluation of structure from a Cultural Resources standpoint.</td>
</tr>
<tr>
<td></td>
<td>- Flood frequency: 25-year Design Scour freq.: 100 years.</td>
<td></td>
<td></td>
<td></td>
<td>- Evaluation of structure from a Cultural Resources standpoint.</td>
<td>- Consider Stream Crossing Standards requirements.</td>
</tr>
<tr>
<td></td>
<td>- Check Scour freq.: 100 years.</td>
<td></td>
<td></td>
<td></td>
<td>- Consider “no risk” guidelines for NRP regulatory floodways.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Must be scourable and available for limited use after the Design Scour Event.</td>
<td></td>
<td></td>
<td></td>
<td>- Consider Complete Streets guidelines.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Flood frequency: 50-year Design Scour freq.: 100 years.</td>
<td></td>
<td></td>
<td></td>
<td>- Evaluation of structure from a Cultural Resources standpoint.</td>
<td>- Consider Stream Crossing Standards requirements.</td>
</tr>
<tr>
<td></td>
<td>- Check Scour freq.: 200 years.</td>
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<td>- Consider “no risk” guidelines for NRP regulatory floodways.</td>
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<td></td>
</tr>
</tbody>
</table>

Note: The following NHS routes: Eisenhower Interstates, Other NHS Routes and STRAAM/IBRT Routes and Connectors, are considered Critical/Essential in that they are the primary routes for emergency use during and after an emergency or natural event. Structures on NHS routes must be available for limited use after such an event. See MassDOT Bridge Manual for more information on these requirements. A map of NHS Routes in Massachusetts is available on the following website:

Standard-compliant design examples
Standard-compliant design examples
Standard-compliant design examples

Comprehensive Environmental Inc.
Standard-compliant design examples
Embedded Precast Concrete Pipe
Standard-compliant design examples
Standard-compliant design examples
Precast Concrete 3-Sided Box Culvert – Pavement on Structure

TOP OF PAVEMENT

APPROACH SLAB TYP.

1 C.Y. CRUSHED STONE TYP.

11.00'

PROPOSED 24” NATURAL STREAMBED MATERIAL

36” MODIFIED ROCKFILL OVER CRUSHED STONE TO BE PLACED AT EXISTING CHANNEL ELEV.

12” CRUSHED ¾ STONE OVER SMOOTHLY GRADED MATERIAL
Standard-compliant design examples
Standard-compliant design examples
Precast Concrete Arch

- 100-Year Flood: EL = 122.81
- 75-Year Flood: EL = 122.48
- Observed Stream: EL = 123.00
- Precast Reinforced Concrete Arch
- Natural Streambed Material
- Streambed Elev 119.5
- 12-Inch Diameter Timber Piles
- Steel Sheet Piles along inner walls of spread footing, inside culvert and in front of wing walls.
- Void between pile cap and steel sheet piles to be filled with 4000 PSI concrete
Comprehensive Environmental Inc.

Standard-compliant design examples
Standard-compliant design examples
QUESTIONS?

Tim Dexter
Wildlife Biologist / Wetlands Scientist
MassDOT Highway Division
timothy.dexter@state.ma.us
(857) 368-8794

David C. Nyman, P.E.
Senior Engineer
Comprehensive Environmental Inc.
dnyman@ceiengineers.com
(508) 281-5178