Minnesota Guide for Stream Connectivity and Aquatic Organism Passage Through Culverts

Matt Herick, Jessica Kozarek – UMN St. Anthony Falls Laboratory
Christian Lenhart, John Nieber – UMN Dept. of Bioproducts and Biosystems Engineering
Nicki Bartelt – MN Dept of Transportation
Peter Leete – DNR – MnDOT Liaison

Next 15 minutes

- Need for guidance
- Development of this guide
- What is in the guide?
- How will it be used? Benefits?
- Implementation
What is the need to design for AOP?

**DNR Public Waters**

**Mn Statute: 103G.245 (Work in Public Water)**

Effect on Environment and Mitigation

- A public-waters-work permit may be issued only if the project will involve a minimum encroachment, change, or damage to the environment, particularly the ecology of the waterway.
- If a major change in the resource is justified, public waters work permits must include provisions to compensate for the detrimental aspects of the change.

**Mn Rules: 6115.0230: (Bridge and Culvert criteria)**

- The structure provides for game fish movement, unless the structure is intended to impede rough fish movement or the stream has negligible fisheries value.

---

**Past AOP designs and guidance**

“... provides for game fish movement ...”

**Easier said than done....**

- Design for 2 fps for 2yr event (fish swimming ability)
- MESBOAC (principles of fluvial geomorphology)

MESBOAC stands for:
- Match culvert width to bankfull stream width.
- Extend culvert length through the side slope toe of the road.
- Set culvert slope the same as stream slope.
- Bury the culvert.
- Offset multiple culverts.
- Align the culvert with the stream channel.
- Consider headcuts and cutoffs.
Why was a Minnesota AOP Design Guide needed?

**Goal:** Improve culvert design to accommodate fish passage and improve stream connectivity through culverts at road-stream crossings. To balance ecological and transportation needs.

- More efficient culvert design and permitting process.
- Frequency of similar designs will improve contractors familiarity with them (lowering construction costs?).
- Avoidance of detrimental designs to the natural environment and/or roadway.
- Increased ecological connectivity.

**In short:** Consistency

Potential problems if only hydraulic design parameters are considered

Undersized -> perched, erosion or scour
Too wide -> rapid shallow flow, sediment aggradation
Stream connectivity

A structure comprehensively designed to convey surface water, sediment, debris, and resident aquatic organisms.
Synthesize national and Minnesota research into a guidance document tailored to Minnesota

Find Reports here: http://dotapp7.dot.state.mn.us/projectPages/pages/homepage.jsf

ST. ANTHONY FALLS LABORATORY

Who influenced guide development?

UMN Research Team

- Matt Hernick & Jessica Kozarek, St. Anthony Falls Laboratory,
- Chris Lenhart & John Nieber, Department of Bioproducts & Biosystems Engineering.

Technical Advisory Team

- MnDOT (Petra Dewall & Nicole Bartelt, MnDOT Bridge Hydraulics)
- DNR (Brian Nerbë, Stream Habitat Program, Peter Leete, Hydrologist)
- USFS (Bob Gubernick, Watershed Restoration Geologist)

External Review Panel

- Tom Wilson, Erickson Engineering
- Pete Sarberg, Widseth, Smith & Nolting
- Chris Katapodis, Katapodis Hydraulics
- Luther Aadlund, DNR River Ecologist
- Julie Aadlund, DNR Area Hydrologist
- Kristian Blann, Freshwater Ecologist, The Nature Conservancy
- Scott Jackson, UMass, North Atlantic Connectivity Cooperative
- Matt Diebel, WiDNR, Research Scientist

67 Survey respondents ->

ST. ANTHONY FALLS LABORATORY
Topics addressed in the guide

Design Approaches. Written in regulatory context for both DNR and MnDOT.

Design Methods. Provides multiple methods and best practices that incorporate AOP and waterway connectivity.

Site Assessment and Analysis tools. Consistent tools for gathering characteristics, energy dissipation needs, hydraulic analysis, AOP, and sediment transport.

Options. Selection charts and corresponding information.

More Options. Multiple barrels, floodplain culverts, grade control, retrofits and other considerations (such as cost).

USGS, FHWA, Embedded, Bridge, etc

http://www.fsl.orst.edu/geowater/FX3/help/7_Culvert_Basics/Embedded_Culverts.htm
Seven best practices (design elements) based on stream characteristics can be summarized as follows:

1-4. Design the culvert to be similar to the stream channel (reference reach), matching bankfull width, alignment, flow depth, and slope.

5-6. Provide a continuous sediment bed. Roughness similar to the channel and maintain sediment transport and debris passage.

7. Design for public safety, longevity, and resilience.

Key to future success of the guide

Common Terminology
- Receded culvert
- Embedded culvert
- Offset culvert
- Floodplain culvert
- Bankfull width, etc.

Survey methodology

Consistency
When and where to use the guide?

When will it be used?
Published January 2019.

For MnDOT projects - upcoming Early Notification Memo (ENM) comments, and next iteration of the DNR General Permit to MnDOT for Bridge and Culvert work (GP2004-0001), and its accompanying Best Practices Manual...

Where will it be utilized?
Statewide. The guide is applicable for culvert proposals on Public Waters in regards to game fish passage and/or rare species movement.

DNR Area Managers and County Engineers may also refer to it on county and local road systems.

Remember,

• This is a GUIDE synthesizing a lot of information on culvert design for AOP, tailored to Minnesota.
• Supplement culvert design practices (not replace)
• Appropriate approaches will differ based on site characteristics, project goals.
Confused yet?

Training development in progress!

• 6 live sessions, spaced throughout the state
• Will include both in-class and field work sessions, anticipated 1.5-2 day class
• Develop on-line module
• Audience: MnDOT Hydraulic Design Engineers, City and County Engineers, Consultant Engineers, Regulatory staff, other resource agency partners
• FREE for attendees (funding provided by MnDOT)

Tentative 2020 Training Dates and Locations

June 2-4 – MnDOT Arden Hills
July 14-16 – Carlton County
Aug 11-13 – MnDOT Bemidji
Sept 15-17 – MnDOT St Cloud
Sep 29-Oct 1 – MnDOT Mankato
Oct 6-8 – MnDOT Arden Hills
Thank you!

Matt Hernick, PE
Associate Engineer
St. Anthony Falls Laboratory

612-624-3930
hern0122@umn.edu

http://www.dot.state.mn.us/research/reports/2019/201902.pdf