Massachusetts Department of Transportation Stream Crossing Handbook

Northeastern Transportation & Wildlife Conference

Monday September 12, 2016

Tim Dexter, MassDOT
David Nyman, Comprehensive Environmental Inc.

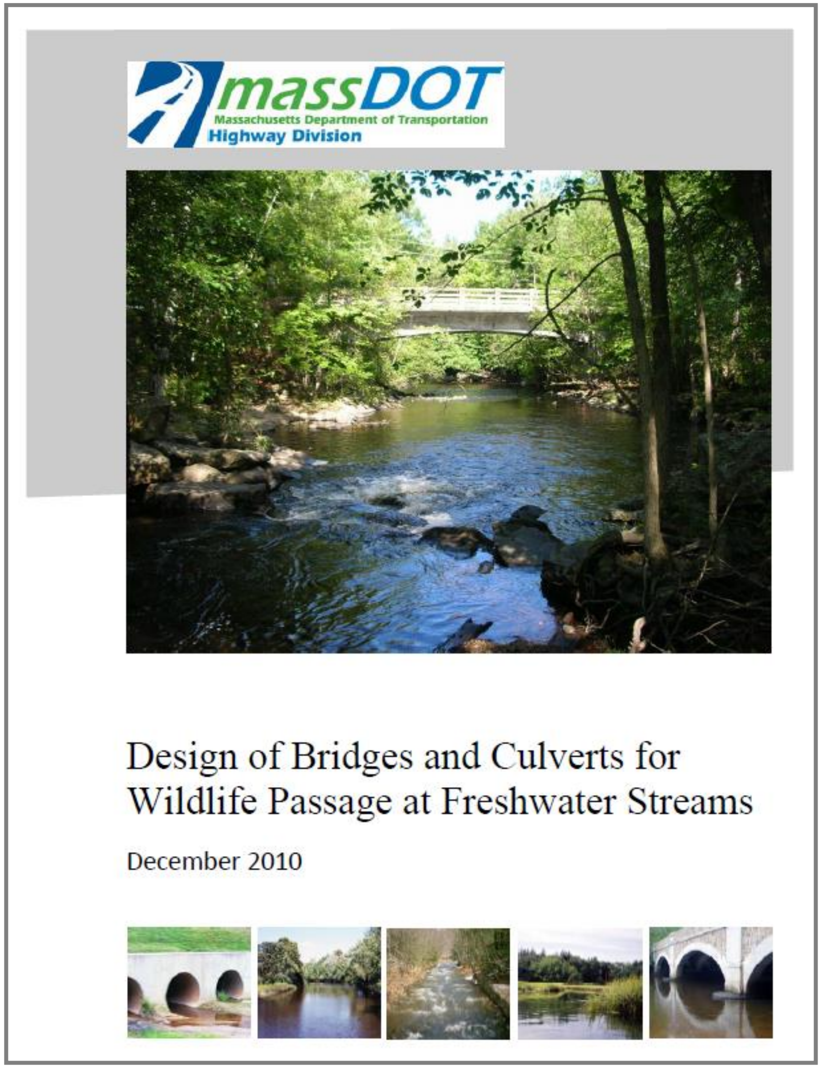
Aquatic & Terrestrial Organism Passage

Aquatic & Terrestrial Organism Passage

Evolution of MassDOT Stream Crossing Handbook

Originally published 2010

- Philosophical & conceptual



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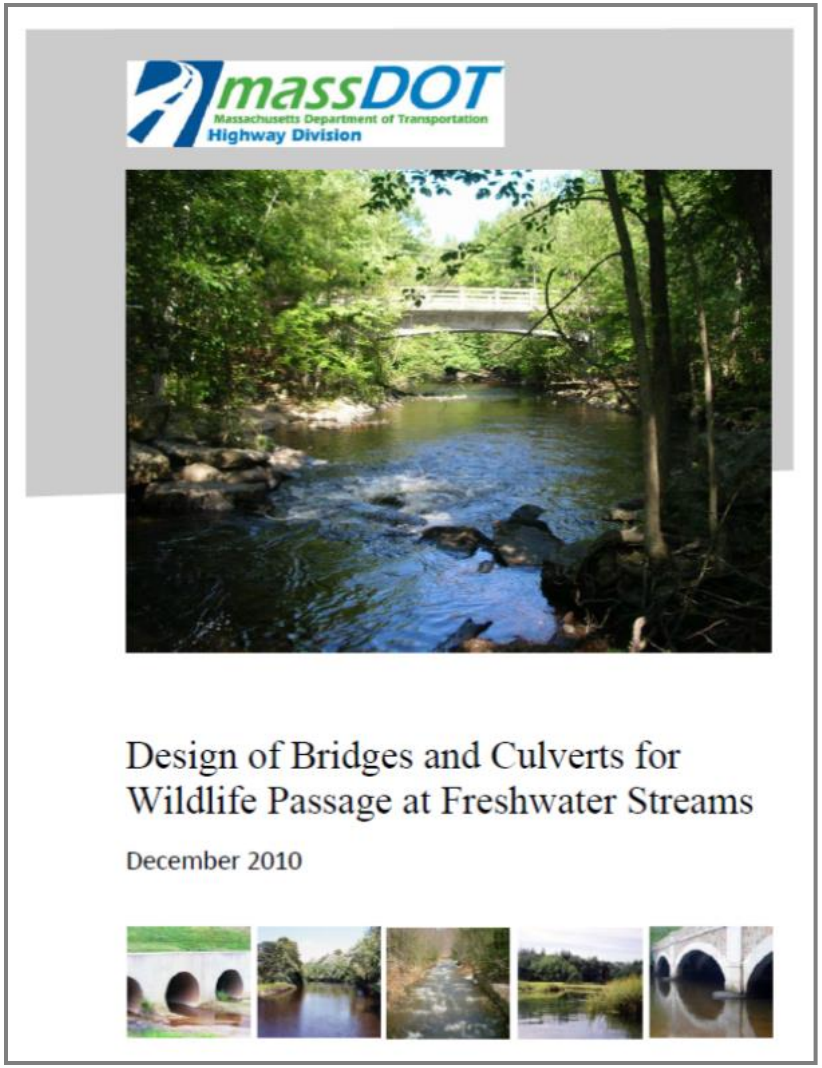

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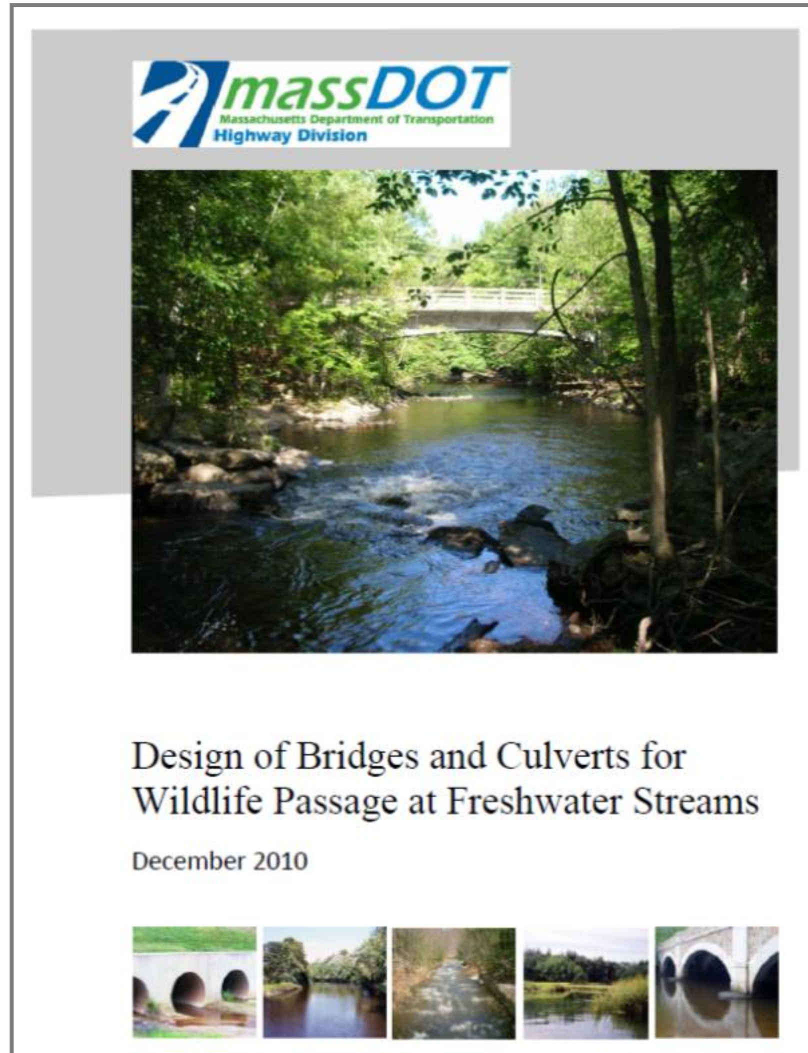
- Justified fish & wildlife passage to DOT engineers & consultants



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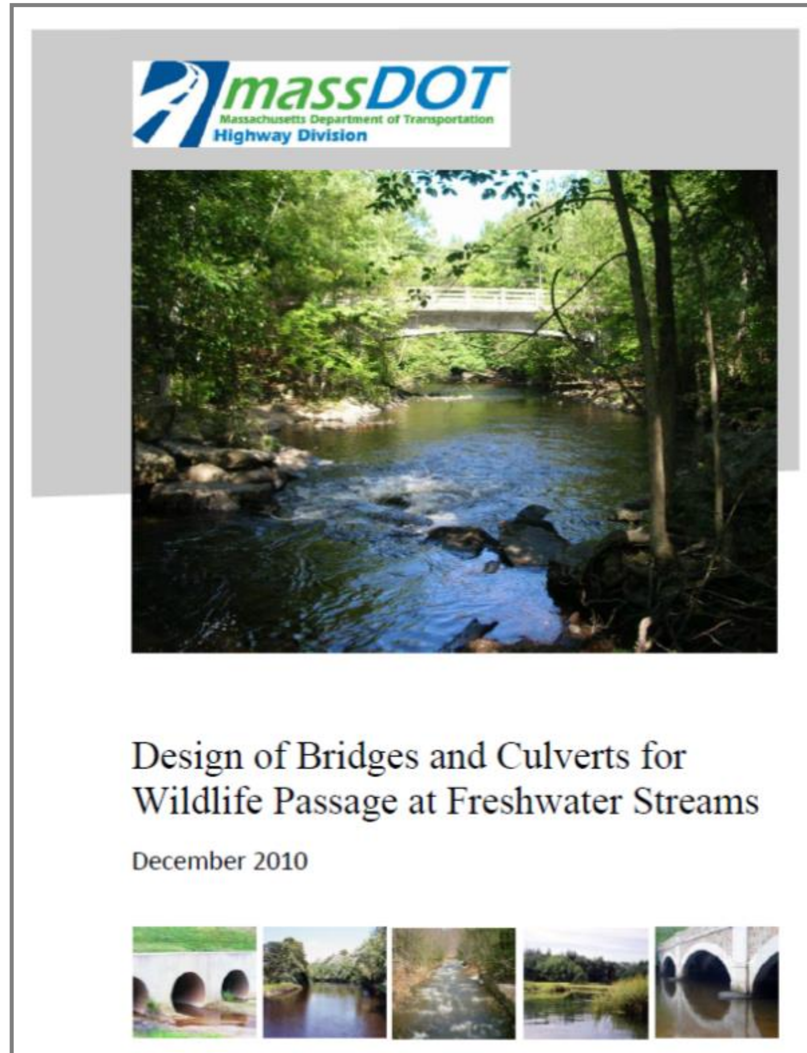
- Recommended design approaches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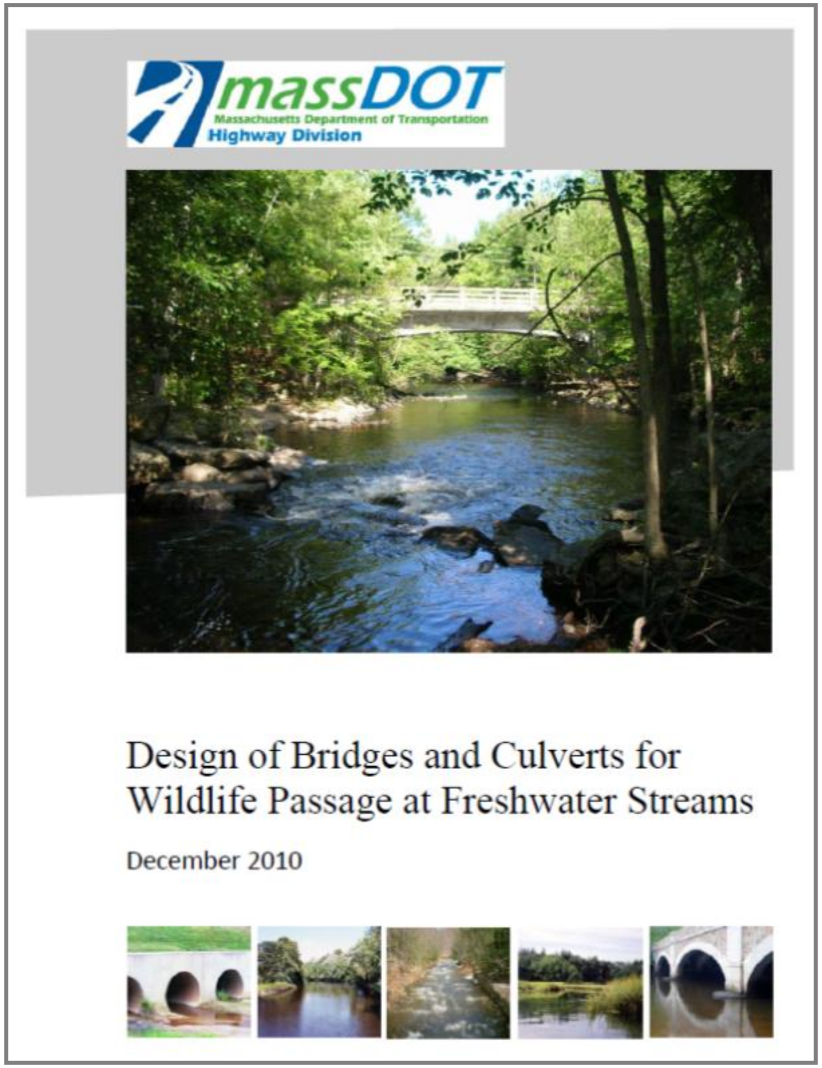
Design of Bridges and Culverts for Wildlife Passage at Freshwater Streams

December 2010

Evolution of MassDOT Stream Crossing Handbook

New handbook (2017)

- Technical & practical



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New handbook (2017)

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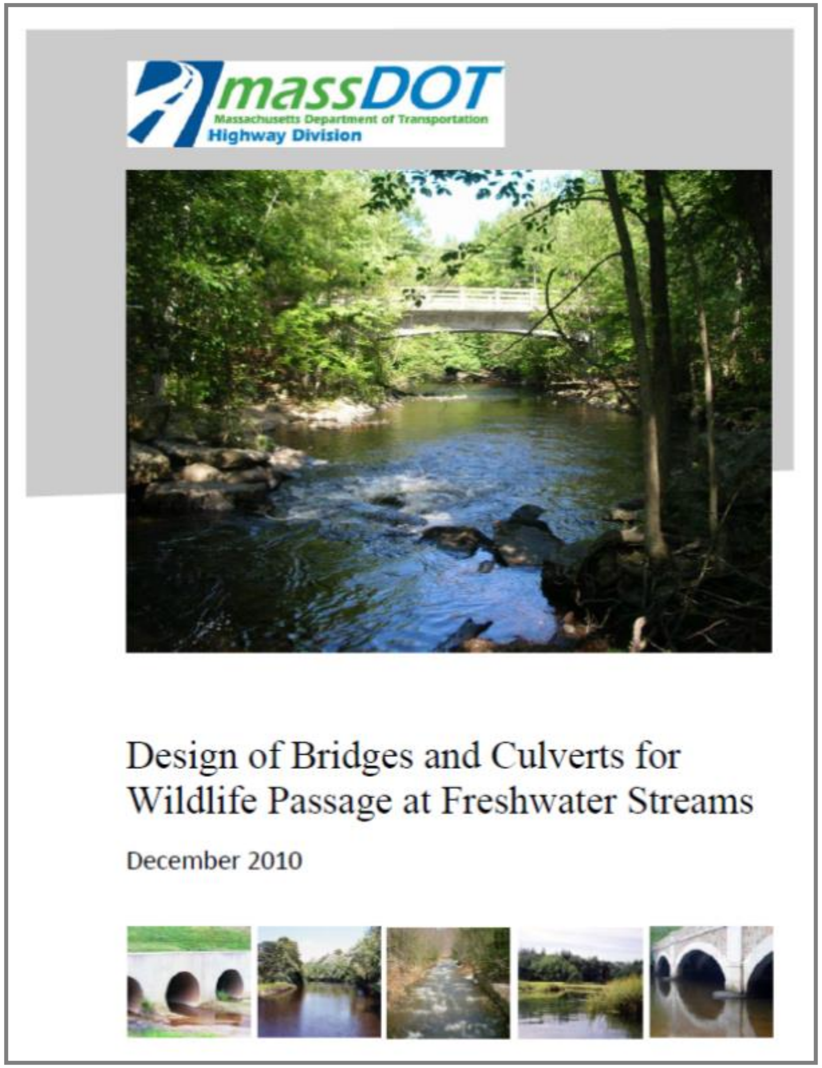
- Response to new stream crossing regulations



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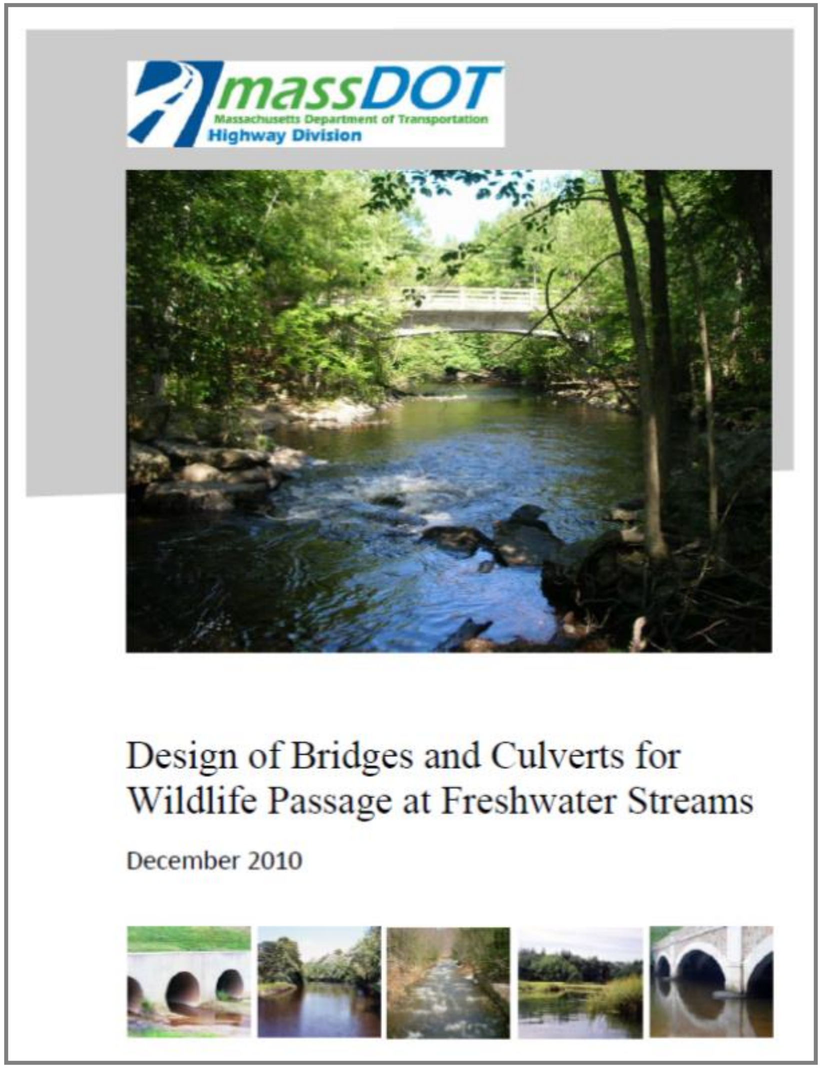

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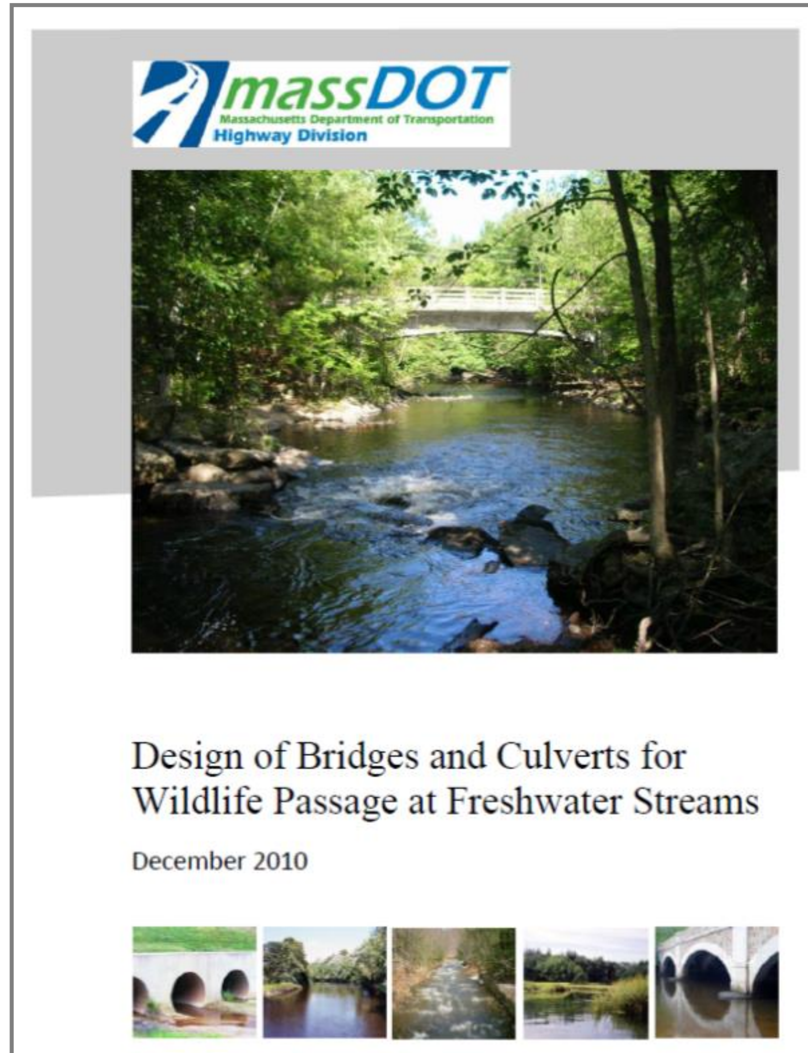
- Technical & practical
- Response to new stream crossing regulations
- Technical guidance for municipalities
- New, cost effective technology



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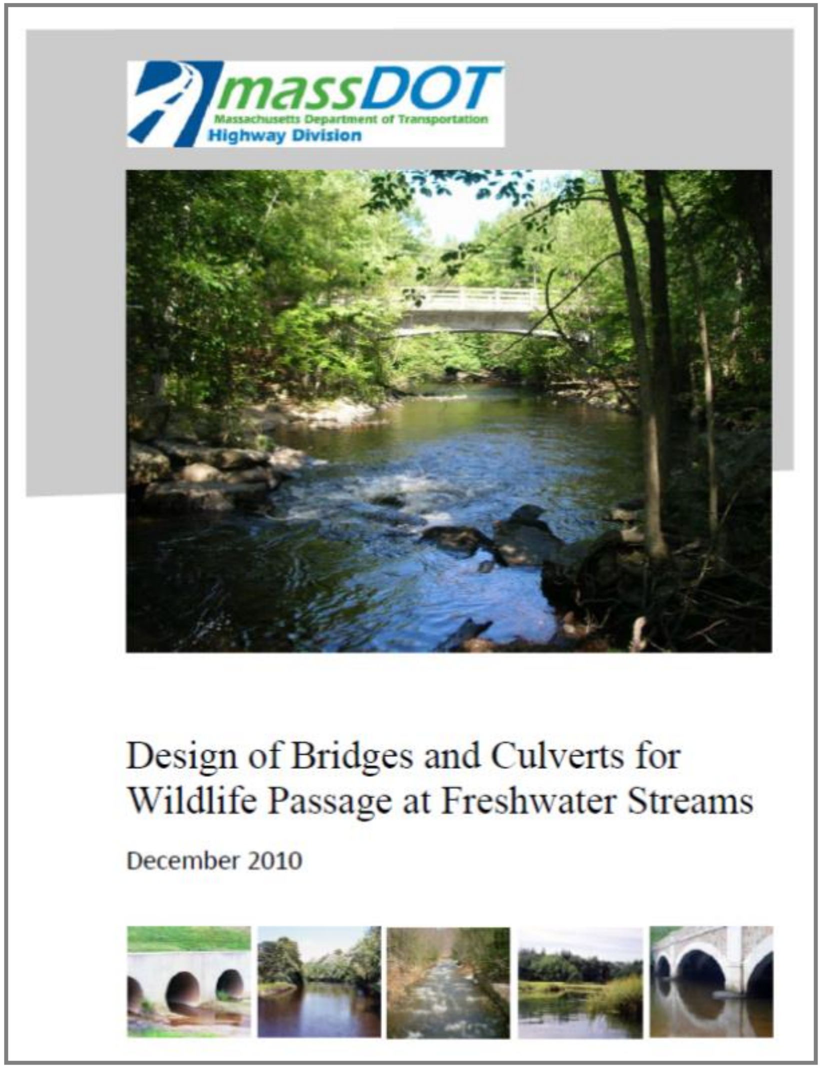
<u>New handbook (2017)</u>

- Technical & practical
- Response to new stream crossing regulations
- Technical guidance for municipalities
- New, cost effective technology
- Design plan templates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December 2010

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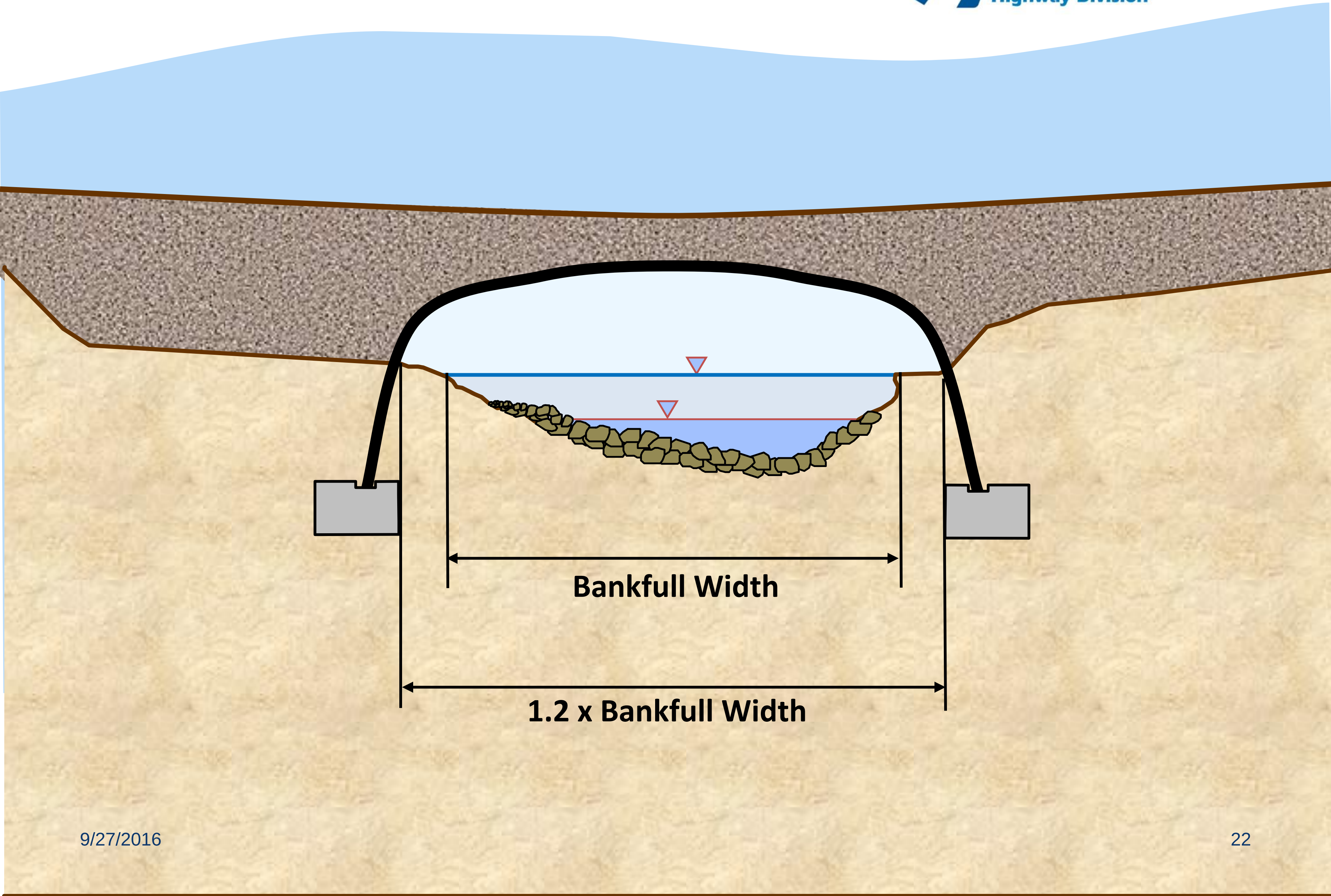
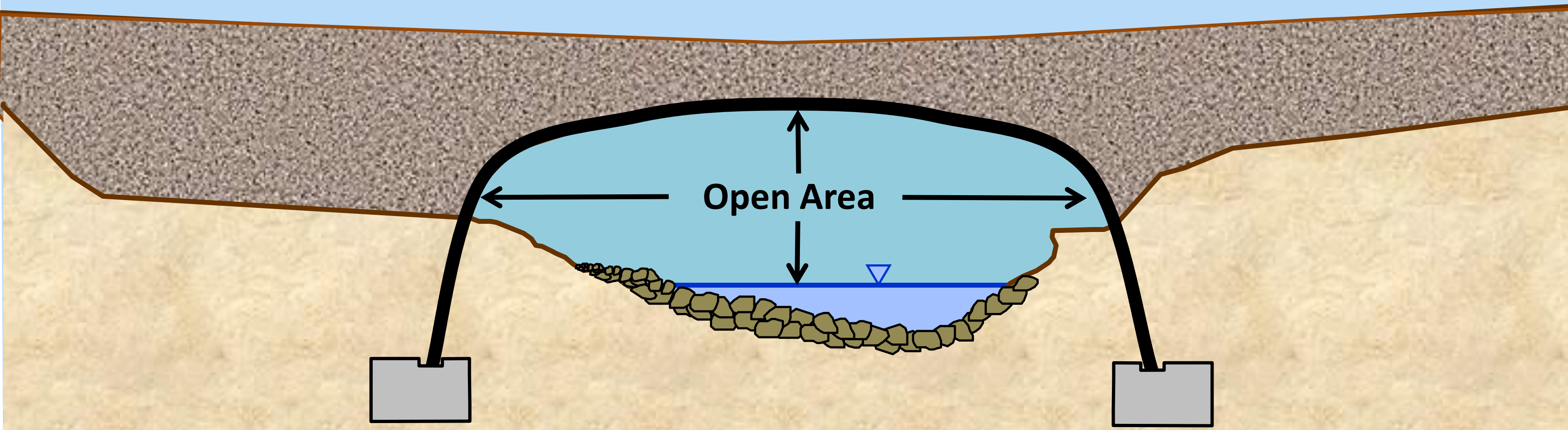
Stream Crossing Standards



Stream Crossing Standards

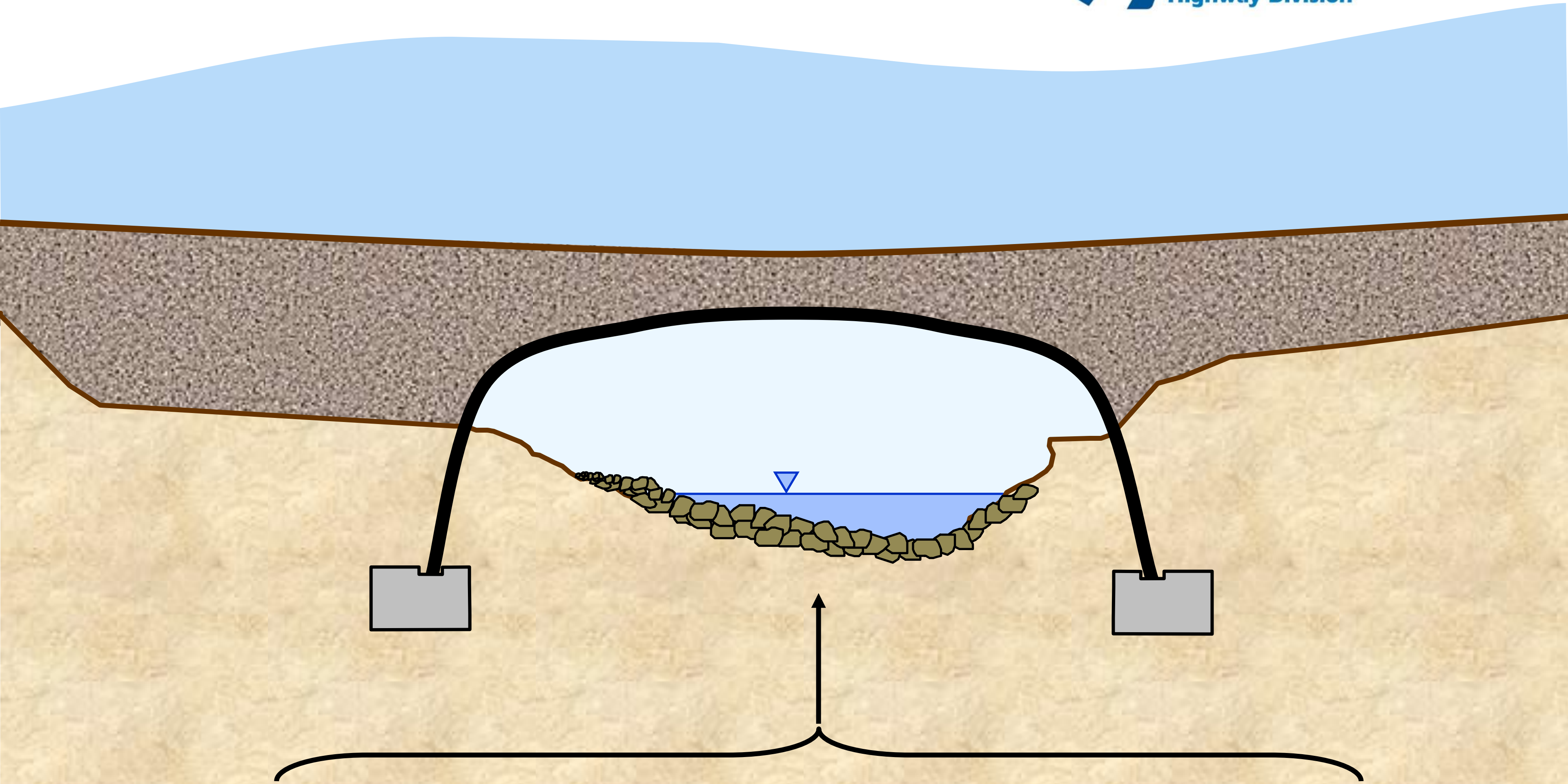


$$\frac{\text{Open Area (m}^2\text{)}}{\text{Structure Length (m)}} = \text{Openness Ratio (m)}$$

Openness Ratio (m) ≥ 0.25m for General Standards

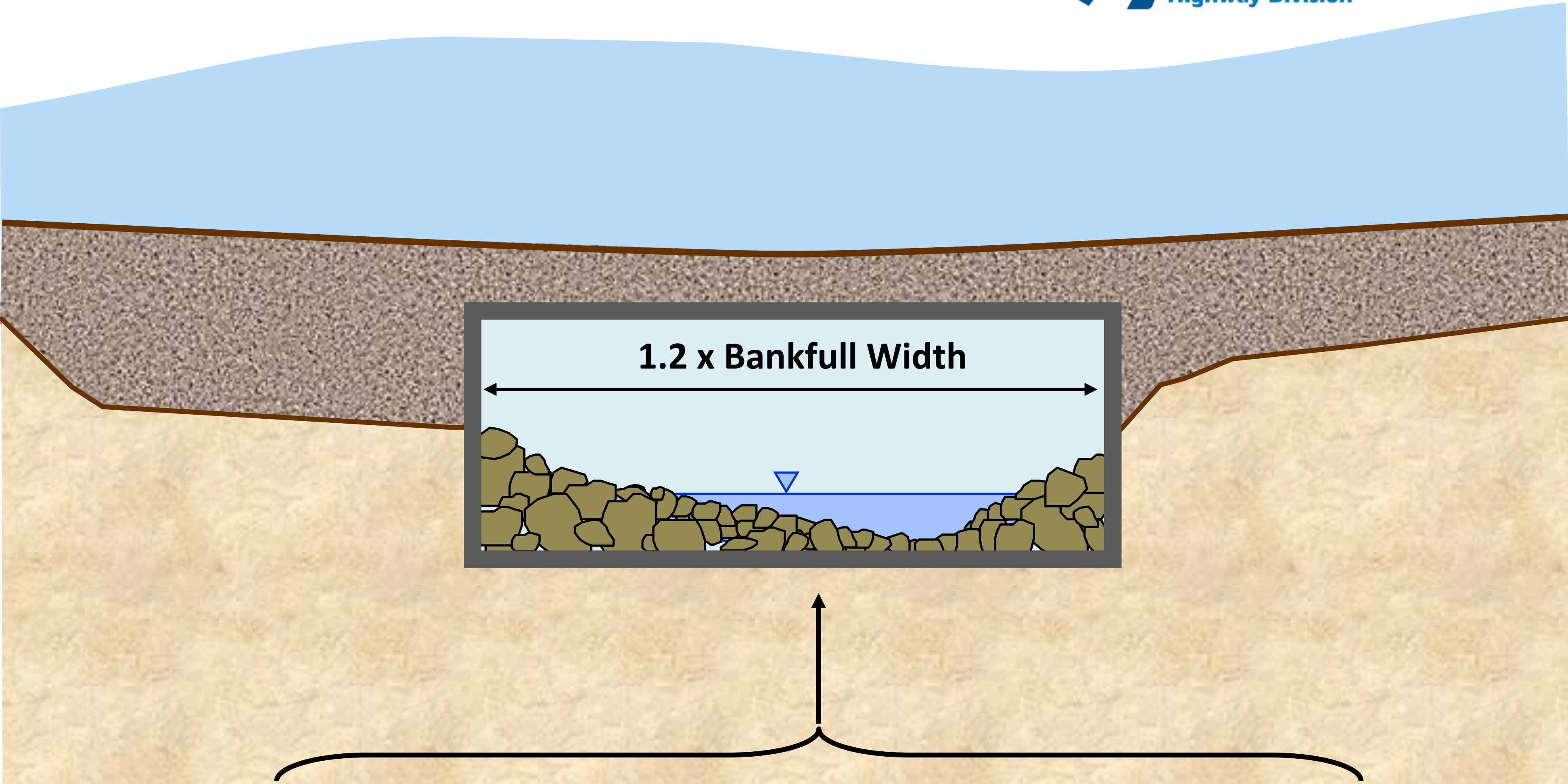
≥ 0.50m to 0.75m for Optimum Standards

Stream Crossing 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.

Stream Crossing Standards



Provide for bed material comparable to natural channel and that results in depths and velocities at a variety of flows.

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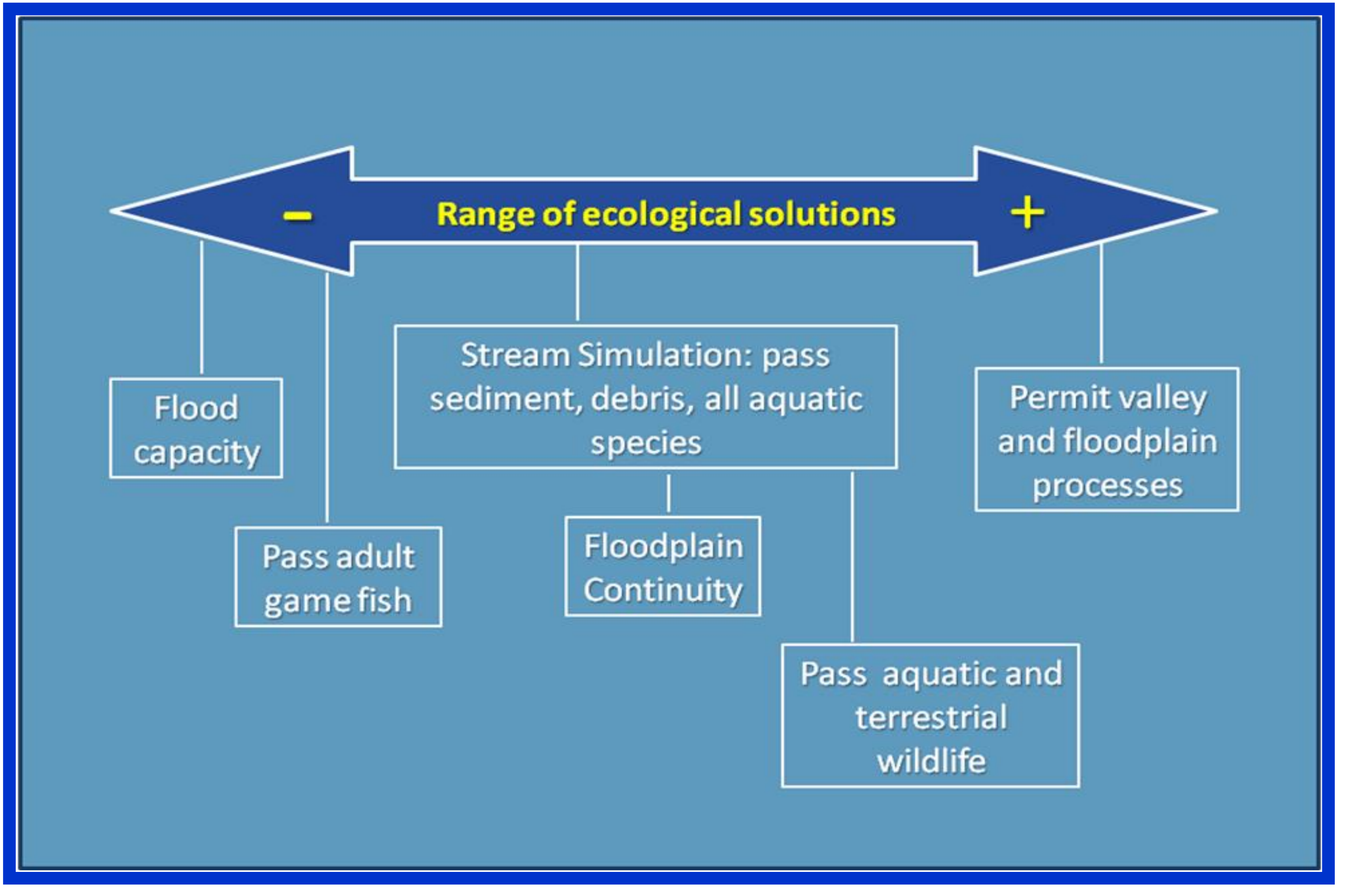
Range of Design Solutions



Adapted from Gubernick, Culvert Summit 2006

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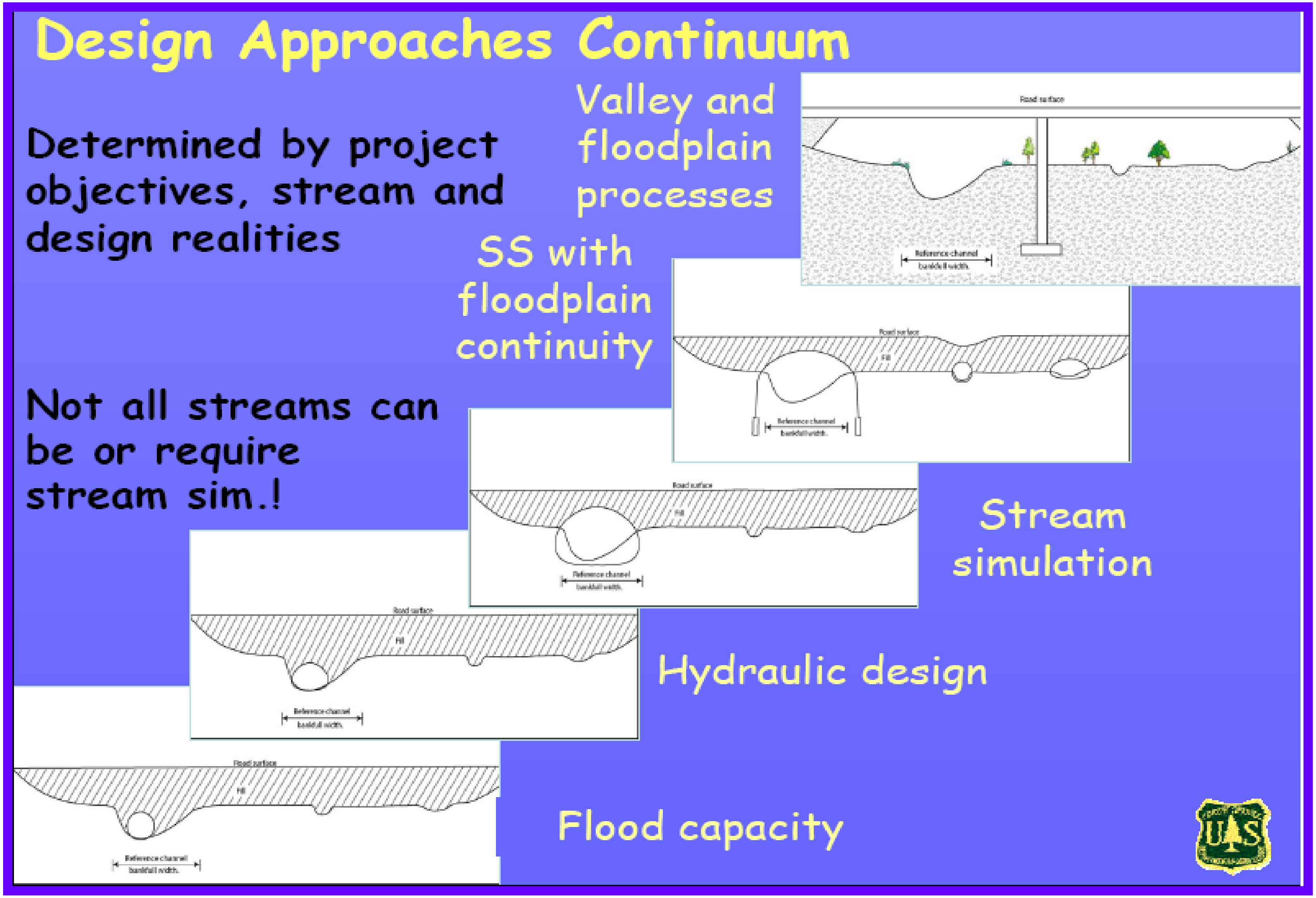

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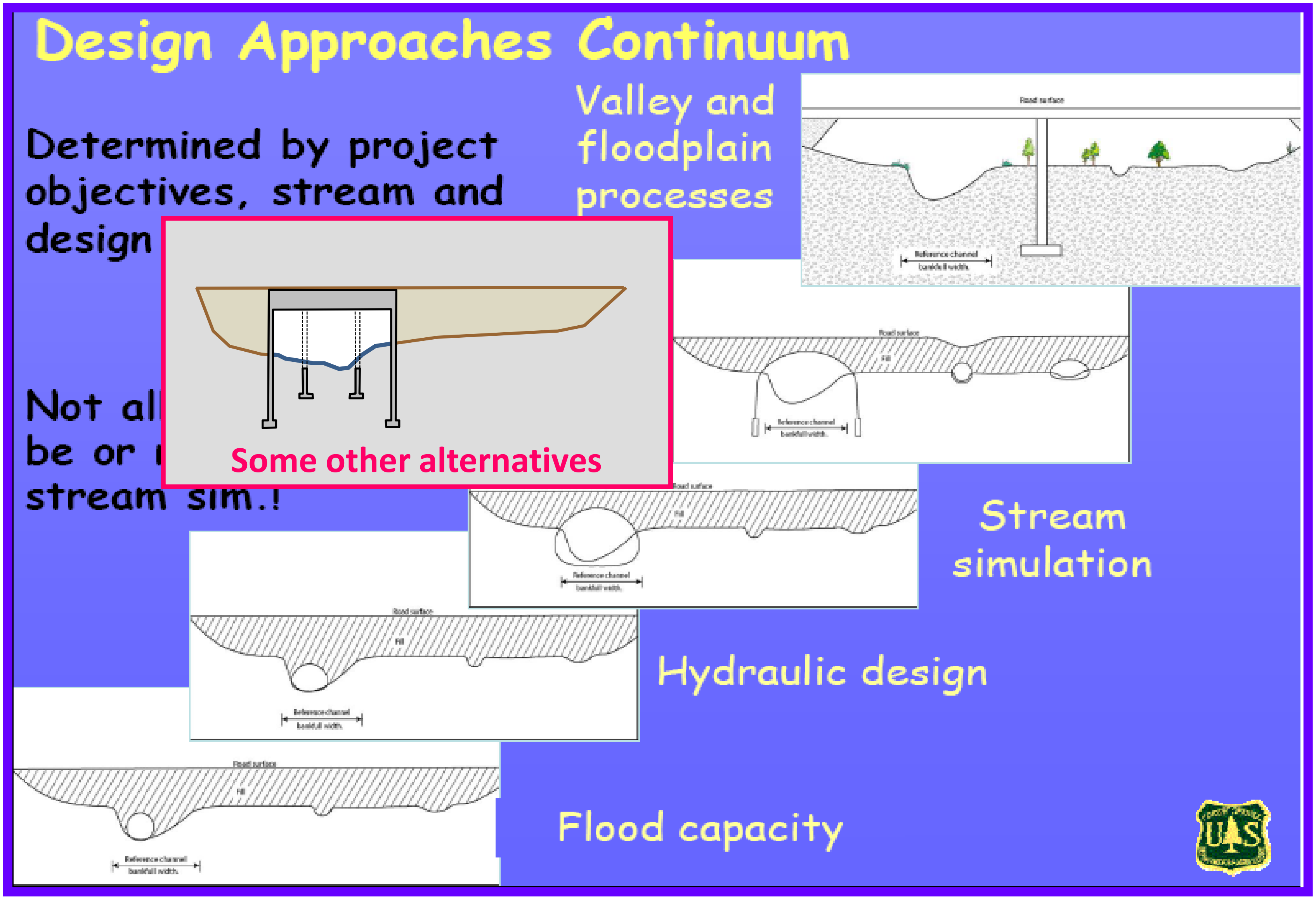

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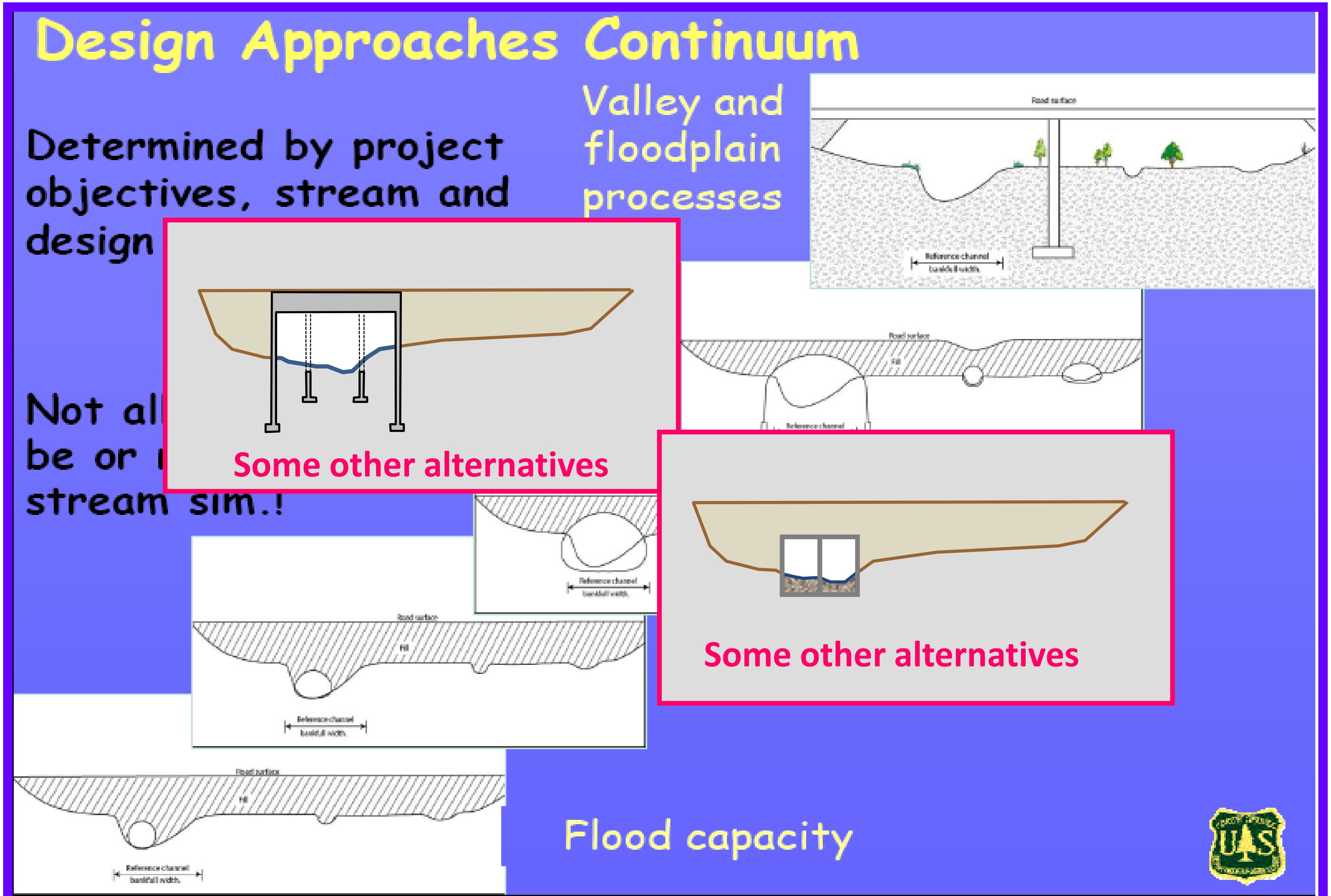

Adapted from Gubernick, Culvert Summit 2006

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

Before replacement

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Completed replacement: embedded culvert
(< bankfull width to meet site constraints)

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February 2013

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Chapter 85 Review

massDOT Massachusetts Department of Transportation Highway Division

Municipal Bridge Projects

MGL Chapter 85 Section 35 Review Process

Design Requirements and Submittals for Bridge Replacement Projects and Superstructure Replacement Projects

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

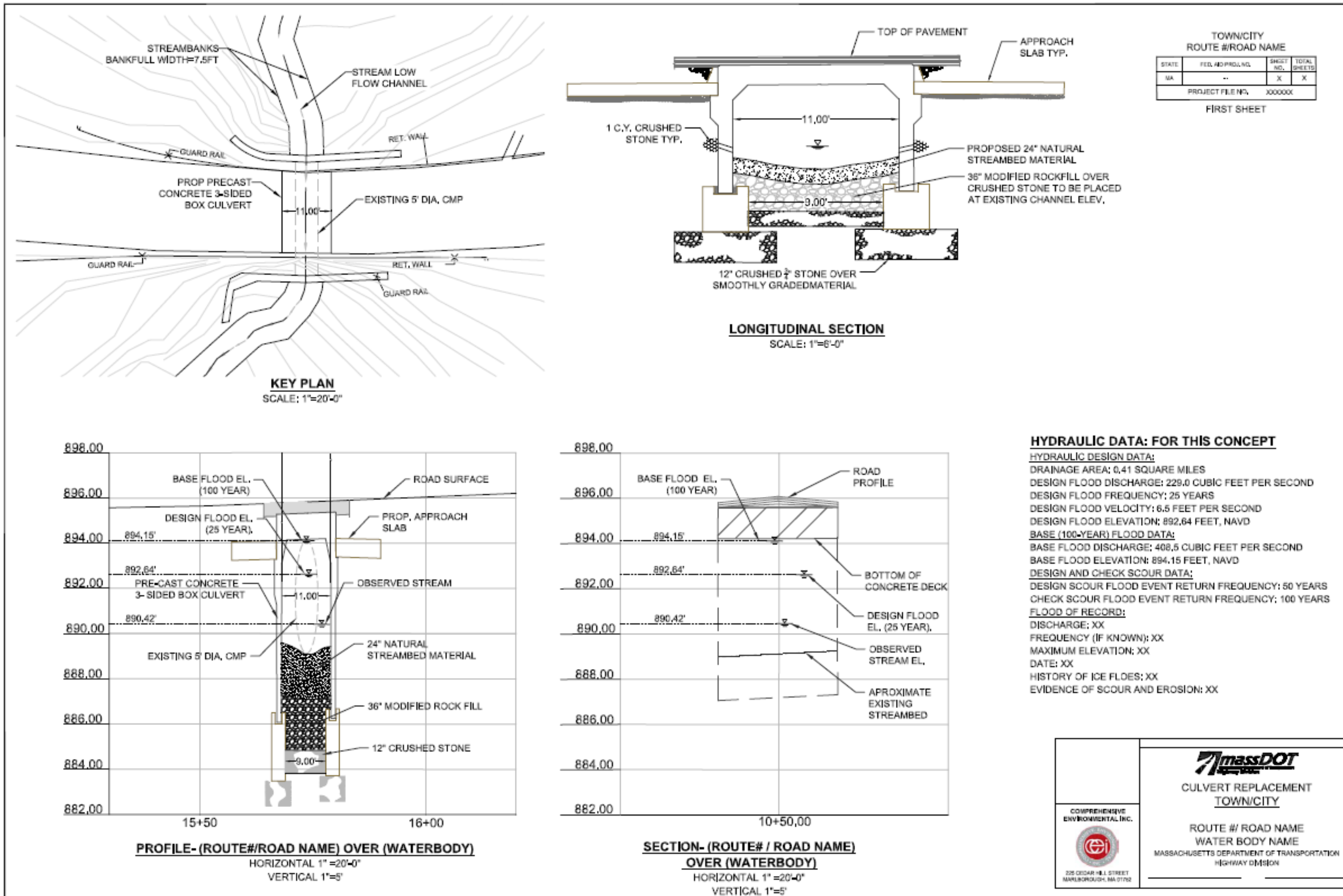
Note: If the Proposed Structure is a Non-BRI Bridge Structure (span ≤ 10 feet), a Chapter 85 review is not required

If the Proposed Structure is a BRI Bridge Structure (10 feet < span ≤ 20 feet)

Roadway Type	Hydraulic Design	Geotechnical Design	Structural Design	Construction Details	Design Review Submittals	Other Considerations
Local Road	Hydraulic report per Bridge Manual (except as noted below) Less than 2 feet of freeboard Flood frequency: 10 year Design Scour freq.: 25 year Check Scour freq.: 50 year Must be scour stable after Design Scour Event but not necessarily available for use	Geotechnical Report per Bridge Manual (except as noted below) At least one boring to refusal below bottom of footing or pile tip for every 30 feet of abutment or culvert width. If rock is encountered, a 10 foot core is recommended If superstructure replacement, provide a memo on the adequacy of the substructure to be re-used both from a condition standpoint and load carrying capacity	Design in accordance with AASHTO LRFD for HL-93 Design Loading Bridge Manual DL and LL load distribution procedure if applicable Seismic: AASHTO Guide Specifications for SDC A requirements If a pre-fabricated structure designed by fabricator, submit fabricator design calculations and shop drawings of final structure	Need not follow MassDOT Bridge Manual construction details. If not using standard MassDOT bridge railings or barriers and transitions, those used must be crash tested to either NCHRP 350 or MASH, Test Level 2 minimum if roadway speed ≤ 45 mph, minimum Test Level 3 if roadway speed > 45 mph. Provide 42" railing height if pedestrians are allowed on bridge	Hydraulic Report (if over water) Geotechnical Report (with memo on the adequacy of sub-structure re-use if being re-used) Complete final set of Construction Plans and one set of design calculations checked by a second engineer Shop drawings of pre-fabricated components and fabricator design calculations (if pre-engineered)	Evaluation of structure from a Cultural Resources standpoint Consider Stream Crossing Standards requirements Consider "no rise" guidelines for NFIP regulatory floodways Consider Complete Streets guidelines
State or US Numbered Route	Hydraulic report per Bridge Manual Provide 2 feet of freeboard Flood frequency: 25 year Design Scour freq.: 50 year Check Scour freq.: 100 year Must be scour stable and available for limited use after the Design Scour Event	Geotechnical Report per Bridge Manual Perform a Design Boring program in accordance with Bridge Manual Part I, Section 1.2 If superstructure replacement, evaluate the substructure for re-use considering both condition and load carrying capacity in an addendum to Geotechnical Report	Design in accordance with AASHTO LRFD for HL-93 Design Loading Bridge Manual DL and LL load distribution procedure if applicable Seismic design per Bridge Manual for a 1000 year return period event If a pre-fabricated structure designed by fabricator, submit fabricator design calculations and shop drawings of final structure	If MassDOT standard bridge, follow MassDOT Bridge Manual construction details Use MassDOT bridge railings and barriers and transitions	Hydraulic Report (if over water) Geotechnical Report (with substructure evaluation addendum if re-using substructure) Complete final set of Construction Plans and one set of design calculations checked by a second engineer Shop drawings of pre-fabricated components and fabricator design calculations (if pre-engineered)	Evaluation of structure from a Cultural Resources standpoint Consider Stream Crossing Standards requirements Consider "no rise" guidelines for NFIP regulatory floodways Consider Complete Streets guidelines
National Highway System (NHS) Route (See Note Below)	Hydraulic report per Bridge Manual Provide 2 feet of freeboard Flood frequency: 50 year Design Scour freq.: 100 year Check Scour freq.: 200 year Must be scour stable and available for limited use after the Check Scour Event	Geotechnical Report per Bridge Manual Perform a Design Boring program in accordance with Bridge Manual Part I, Section 1.2 If superstructure replacement, perform a full Preliminary Structures Report per MassDOT Bridge Manual with material sampling	Design in accordance with AASHTO LRFD for HL-93 Design Loading Bridge Manual DL and LL load distribution procedure if applicable Seismic design per Bridge Manual for a 2500 year return period event If a pre-fabricated structure designed by fabricator, submit fabricator design calculations and shop drawings of final structure	If MassDOT standard bridge, follow MassDOT Bridge Manual construction details Use MassDOT bridge railings and barriers and transitions	Hydraulic Report (if over water) Geotechnical Report Preliminary Structures Report (if re-using substructure) Complete final set of Construction Plans and one set of design calculations checked by a second engineer Shop drawings of pre-fabricated components and fabricator design calculations (if pre-engineered)	Evaluation of structure from a Cultural Resources standpoint Consider Stream Crossing Standards requirements Consider "no rise" guidelines for NFIP regulatory floodways Consider Complete Streets guidelines

Note: The following NHS routes: Eisenhower Interstate, Other NHS Routes and STRAHNET 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: http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/

Standard-compliant design examples



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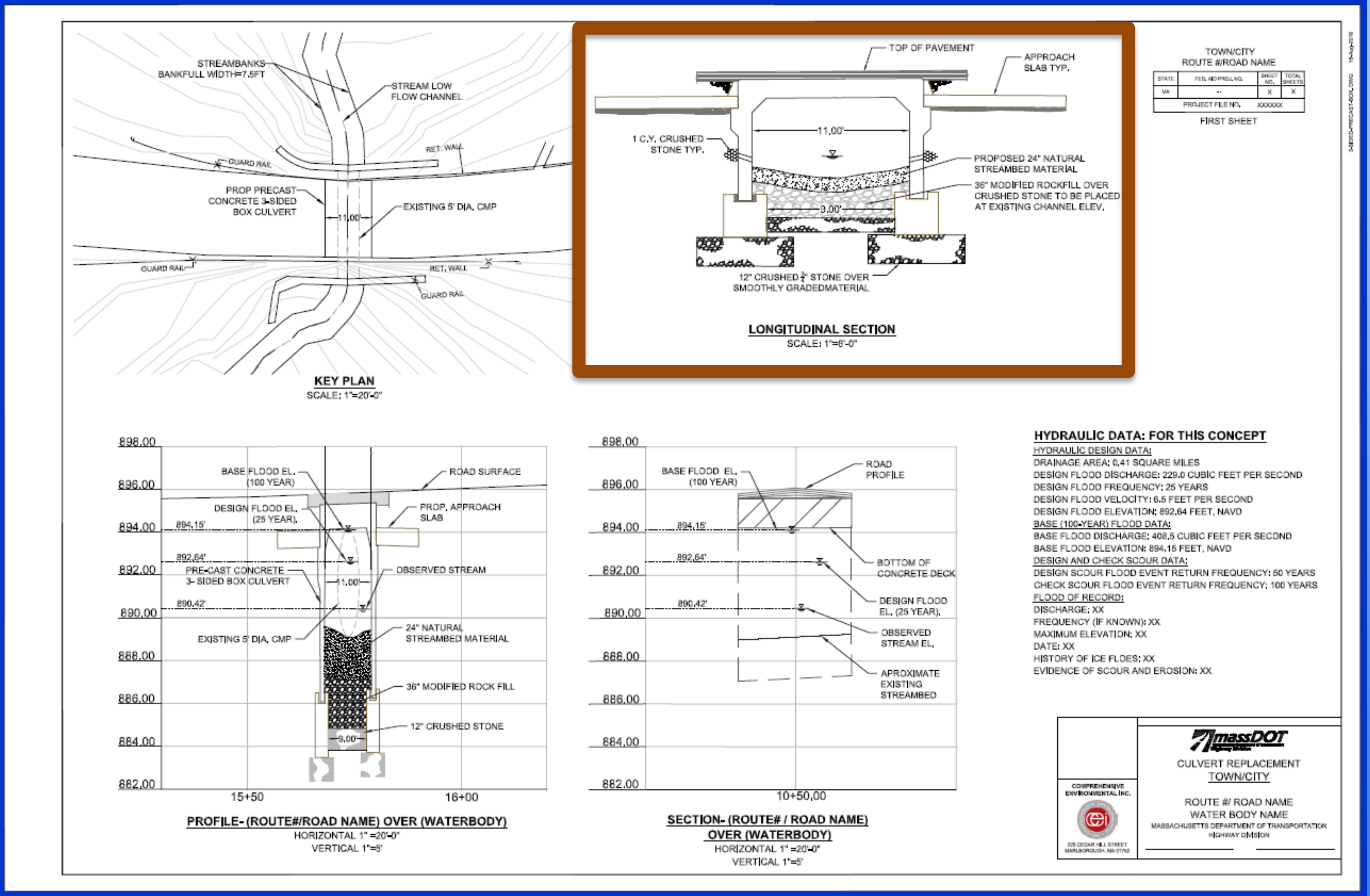


Standard-compliant design examples

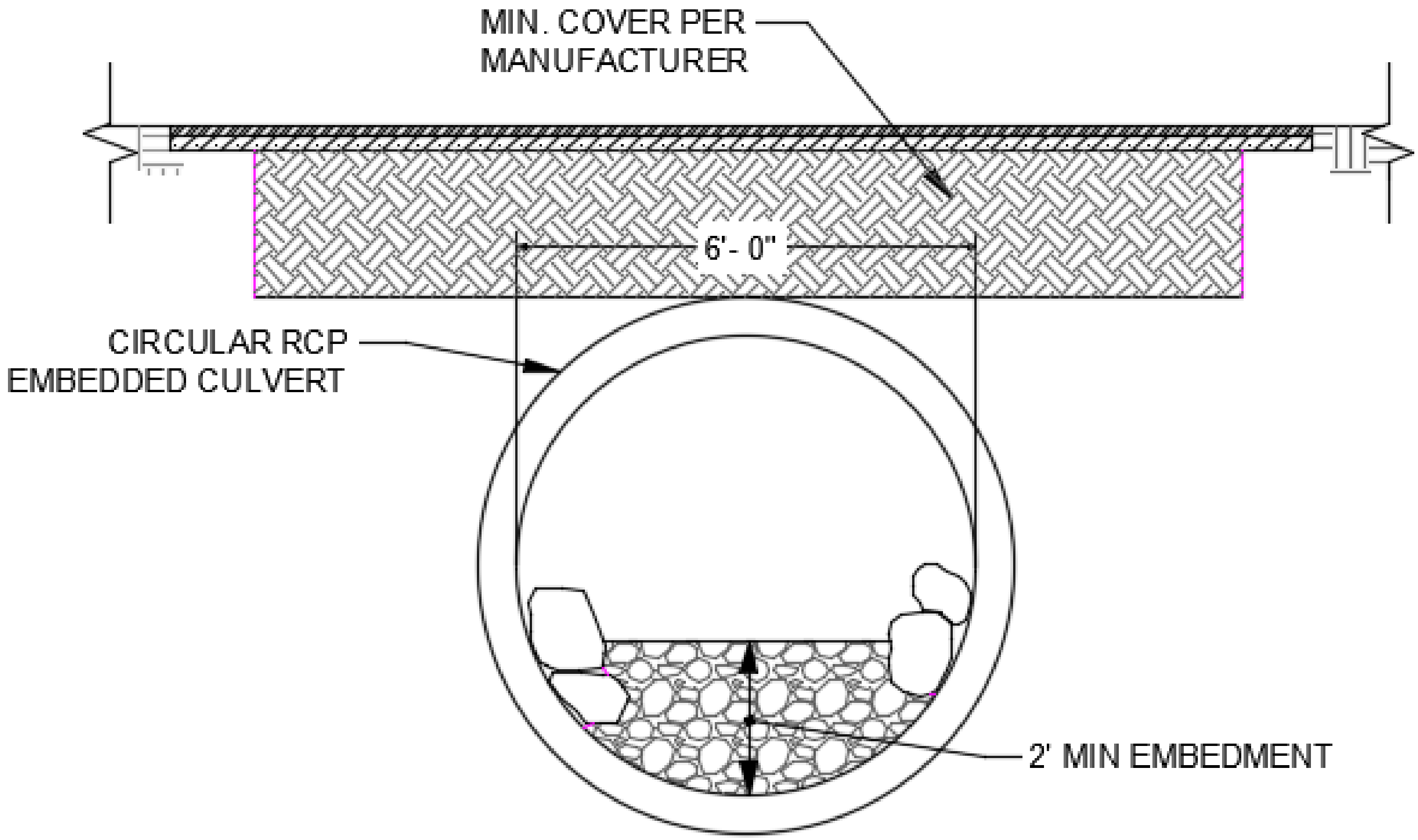
Comprehensive Environmental Inc.

Standard-compliant design examples


Comprehensive Environmental Inc.


http://www.downeastlakes.org/

Embedded Precast Concrete Pipe



Standard-compliant design examples

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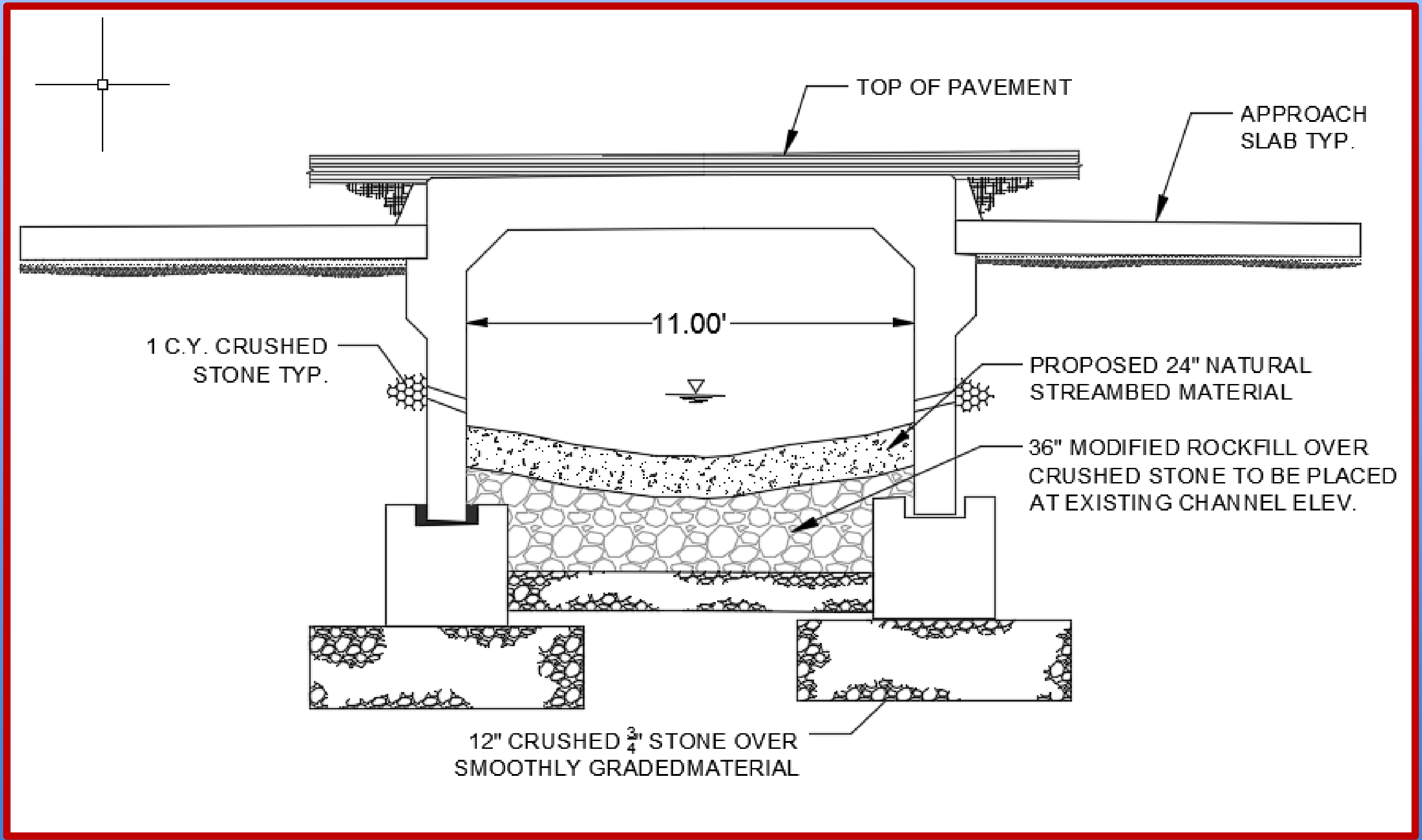
Precast Concrete 3-Sided Box Culvert – Pavement on Structure



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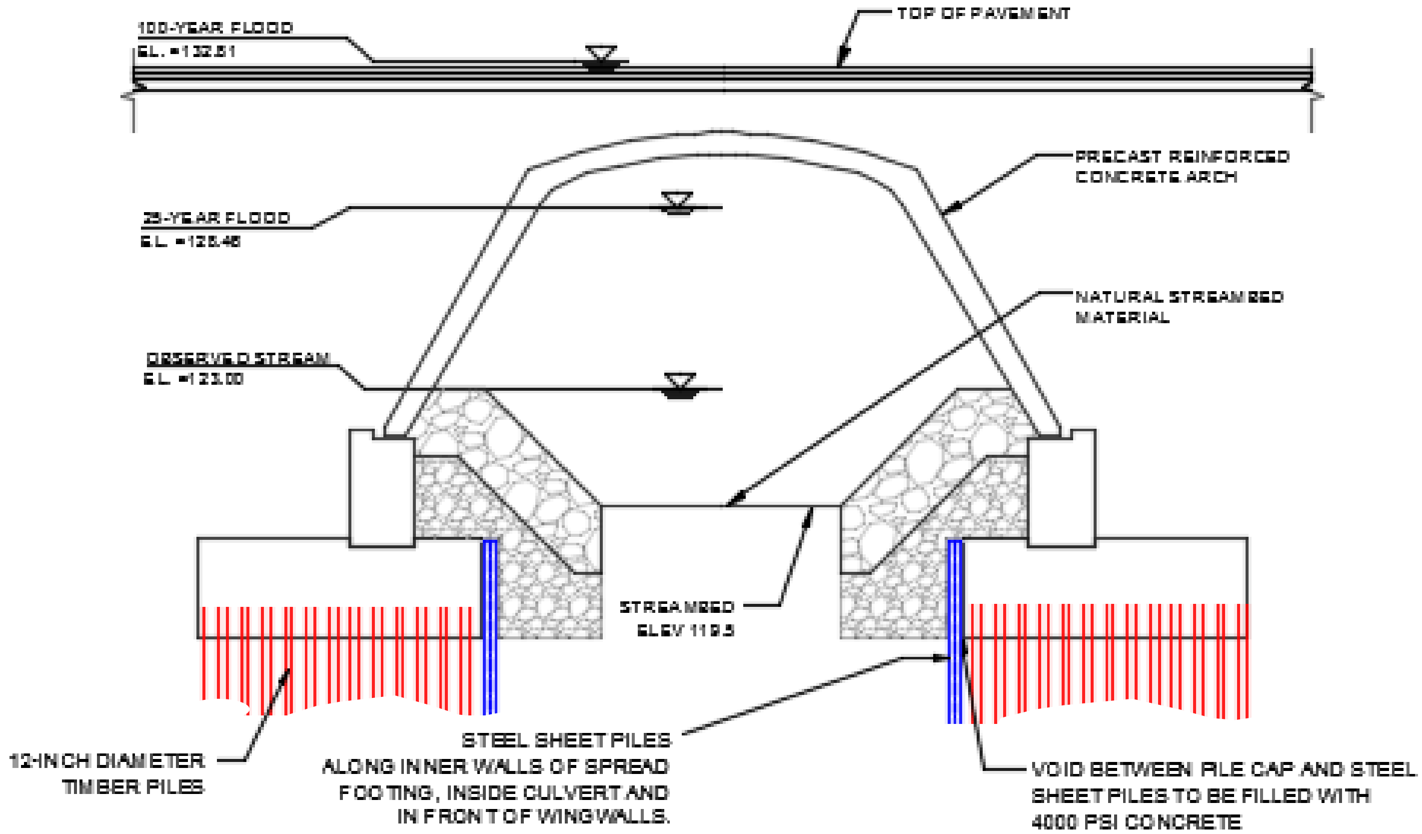
Precast Concrete Arch

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Standard-compliant design examples

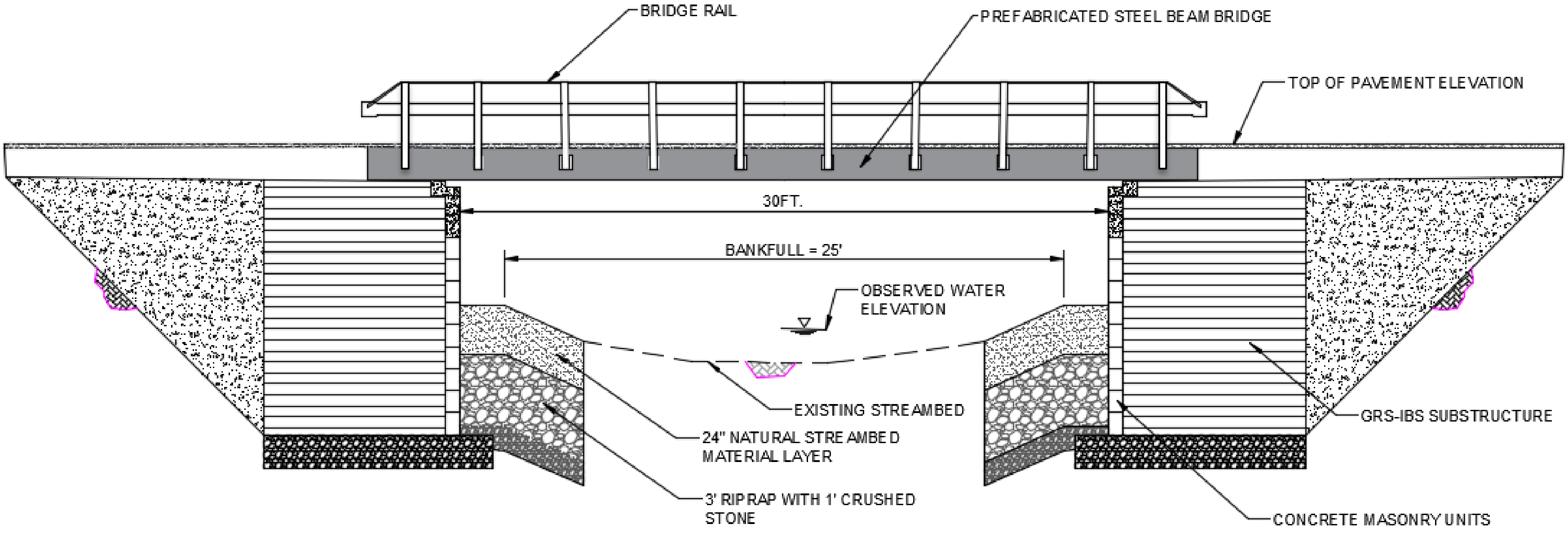

Comprehensive Environmental Inc.


Allan Block Corporation

Standard-compliant design examples

GRS-IBS

Geosynthetic Reinforced Soil – Integrated Bridge System



QUESTIONS?

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