STREAM CROSSING RULES
Env-Wt Part 900

Application from the DOT Perspective

NHPWA Annual Meeting
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Bureau of Environment
Stream Team

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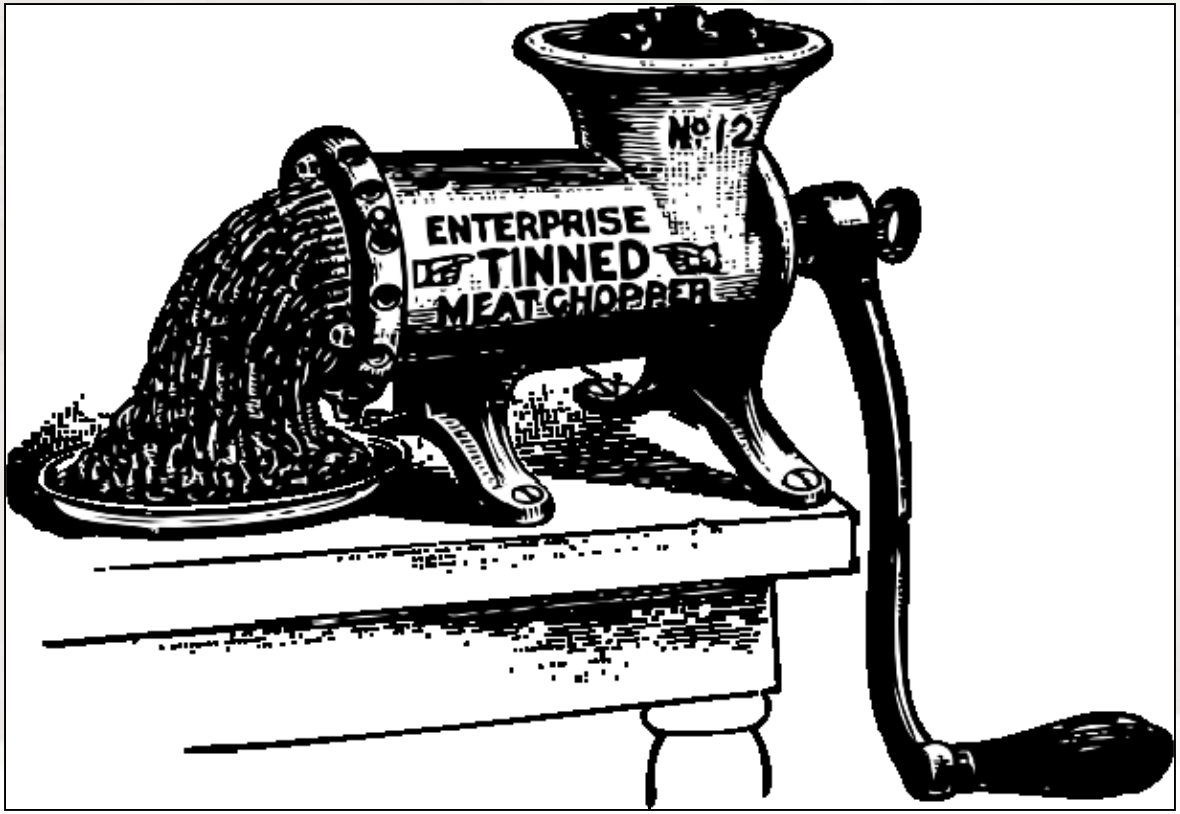
Presentation Outline

1. Origin of the Rules and Introduction
2. Specifics on the Stream Crossing Rules
3. DOT Implementation
4. Sample DOT Projects
5. Questions

New Hampshire DOT Department of Transportation

Origin of the Rules and Introduction



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History

Process began in 2006

Army Corps of Engineers directive

NH Stream Crossing Guidelines

Rules Workgroup

Rules effective May 12, 2010

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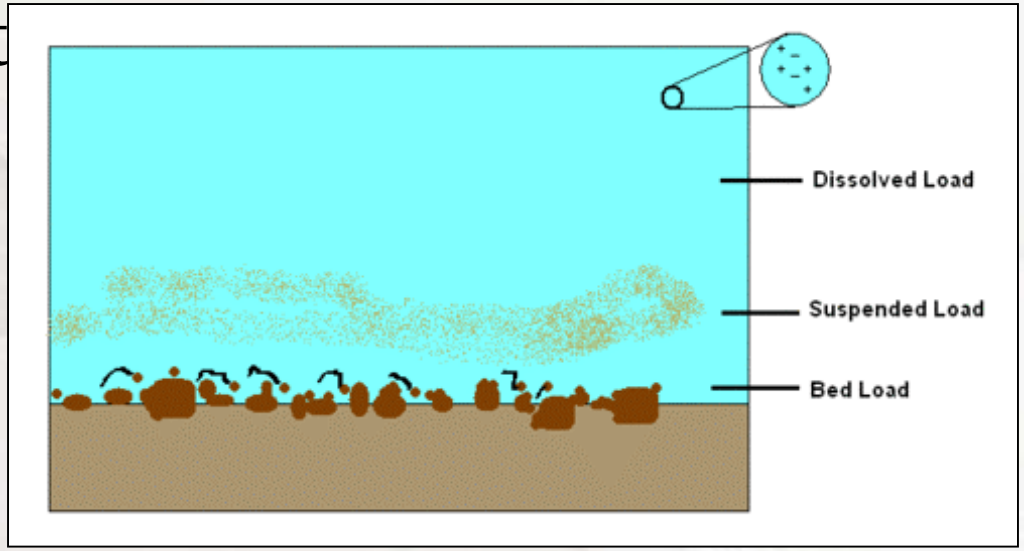
Why Stream Crossing Rules?

Nationwide movement

Rivers move water, sediment, debris and are home to aquatic organisms



Move from hydraulic-only designs to designs that accommodate sediment transport

Estimated 17,000 culverts in NH (3,000 active dams (approx.))

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Purpose of Rules

Enhance public safety by establishing standards to:

Lessen the risk of blockages/flooding/wash-outs

Preserve the functions and values of existing streams

Restore stream channels to a more natural state

Improve aquatic organism (AO) passage

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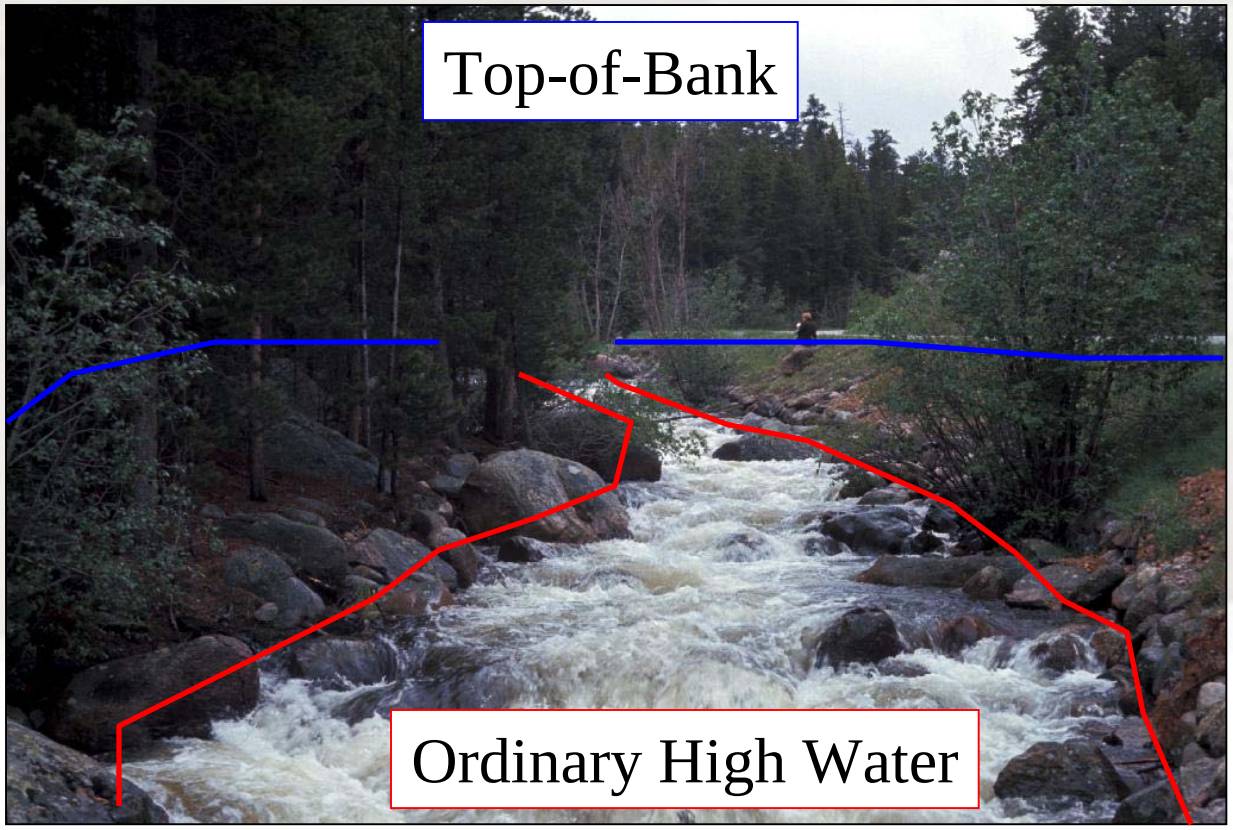
DES Jurisdiction (No Change)

From Top-of-Bank to Top-of-Bank and everything in between

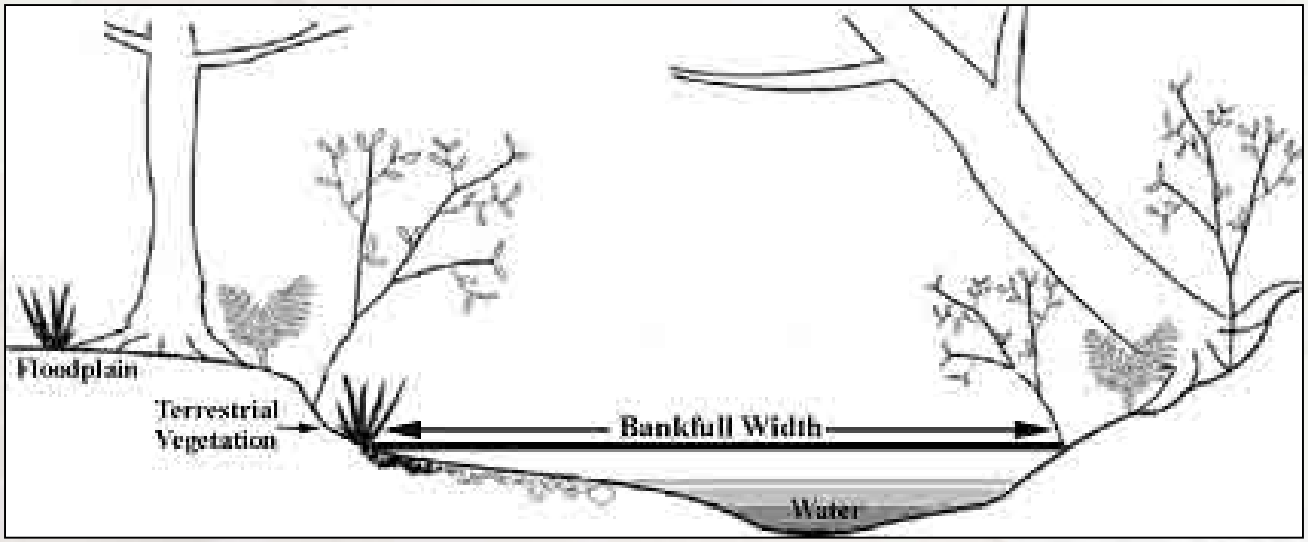


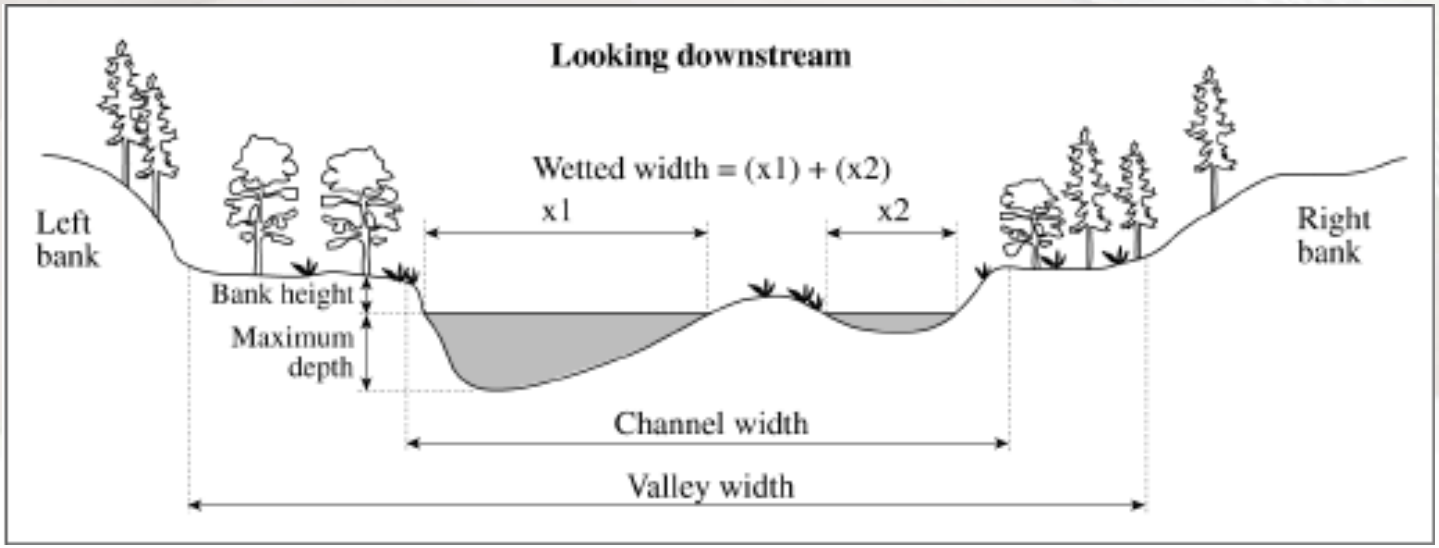
Bankfull Stage

"The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels."
(Dunne & Leopold 1978)

The incipient elevation where flooding into a floodplain begins.

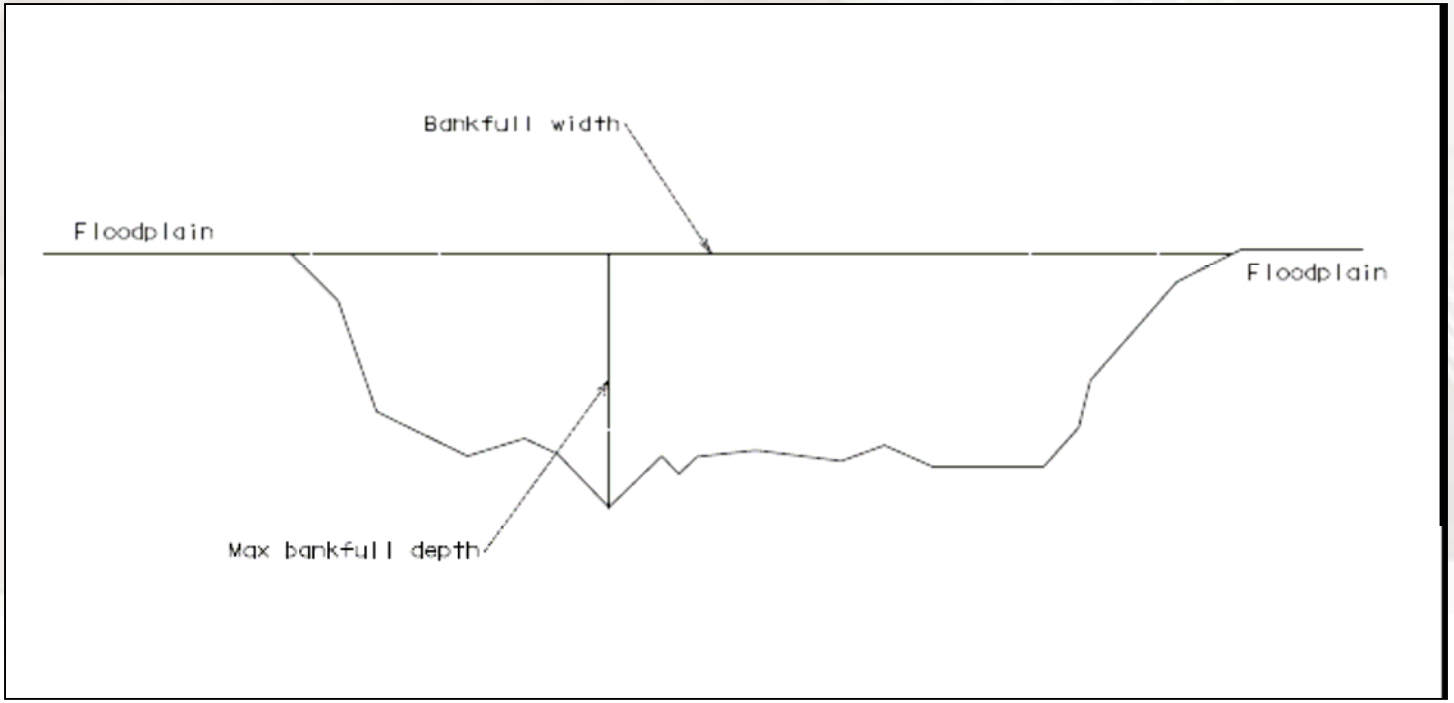
Bankfull Stage



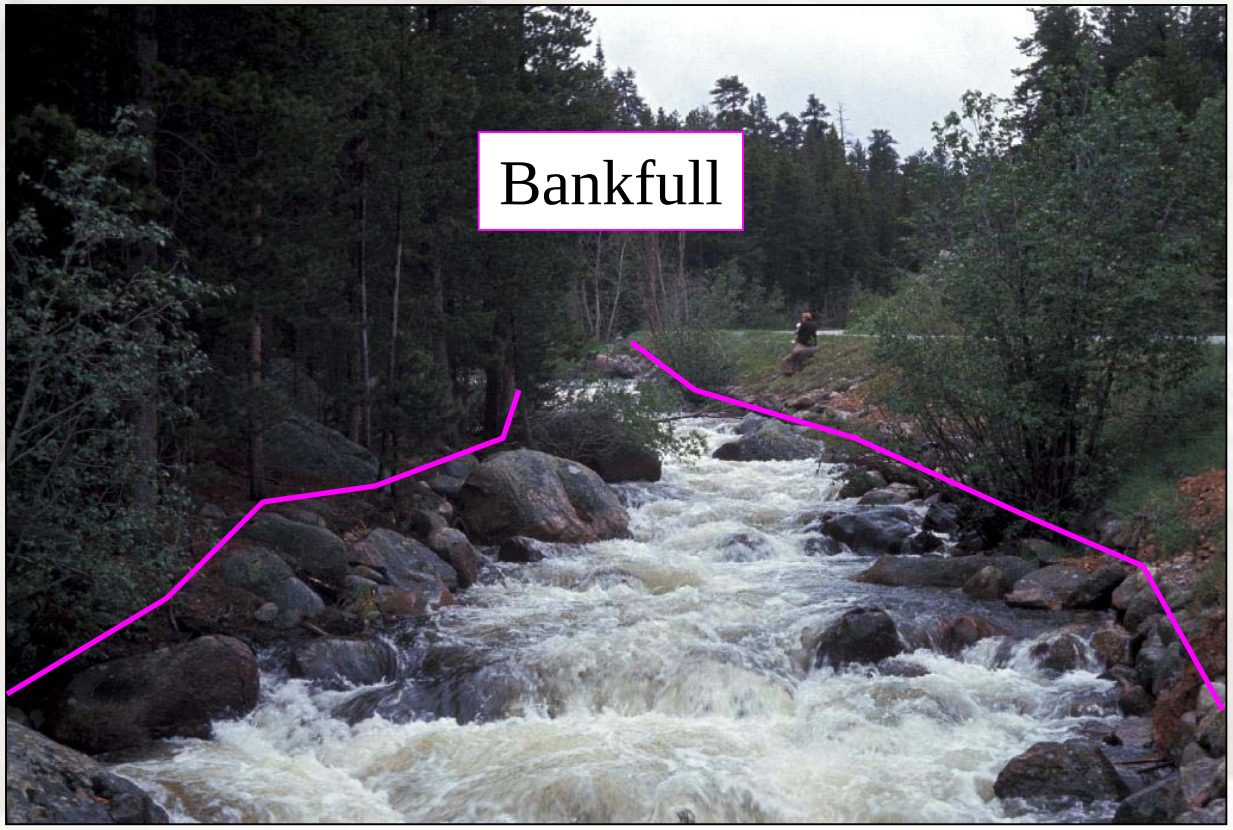


Bankfull Stage

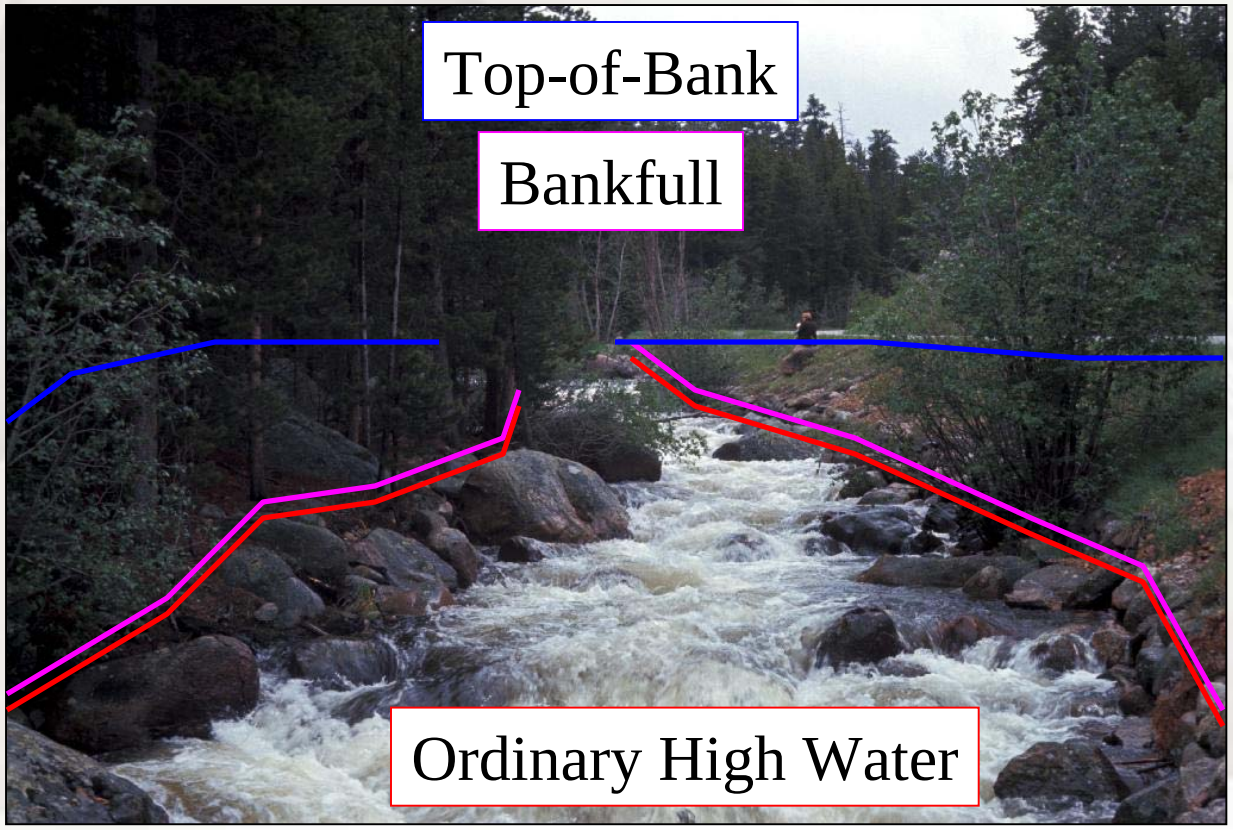
Rivers form their banks and channel at the bankfull stage about every 1.5 years



Bankfull Stage



Bankfull Stage



Bankfull Stage

Normal Flow

Bankfull Flow

Specifics of the Stream Crossing Rules

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Rules apply to “watercourses”

A ‘watercourse’ is a surface water that:

Develops and maintains a defined channel, with evidence of sediment transport, and

Is greater than 75’ in length, or is any length and connected to a wetland or other surface water at either end

Rules do NOT apply, if…

The crossing is located in a drainage swale, or ephemeral stream (only wet when it rains)

The crossing qualifies for Routine Roadway Maintenance

Rules do NOT apply, if…

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Department of Transportation

As a matter of fact…

SB21 amended RSA 482-A:3,IV(b) so that…

Man-made nontidal drainage ditches
roadside and railroad ditches
detention basins
ponds and wetlands constructed to convey,
treat, or control stormwater and runoff
erosional features caused by human activity

…may be maintained, repaired, replaced, or modified as necessary **without** a permit from DES.

You cannot impact any other jurisdictional area

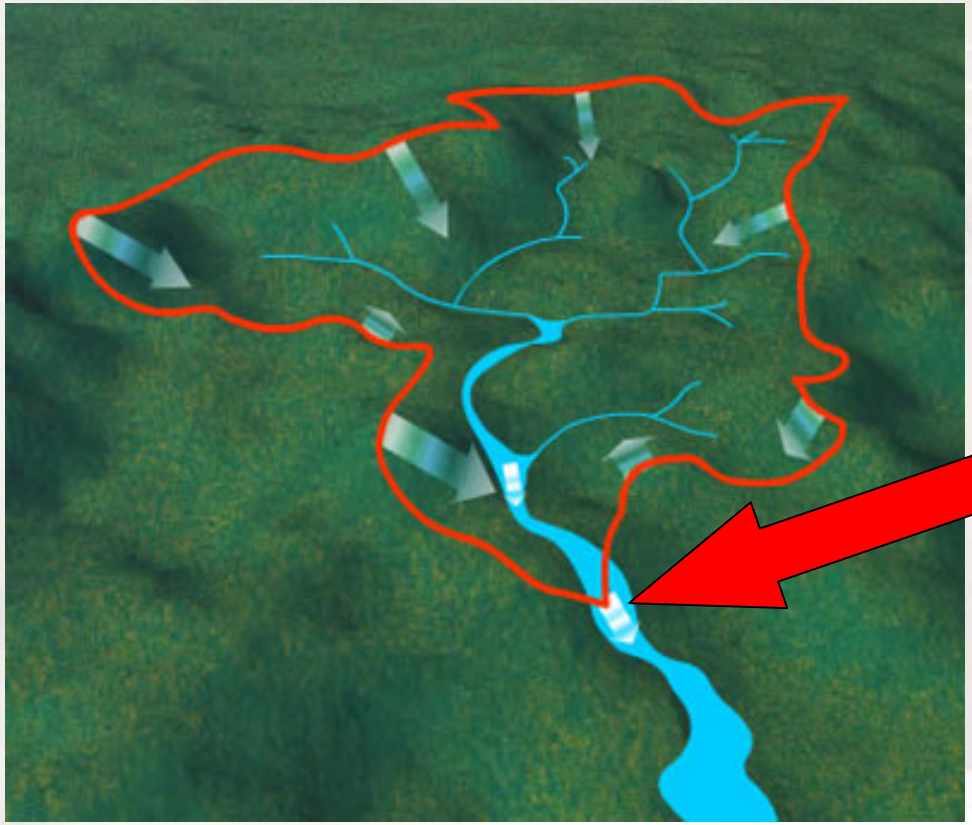
How do the stream rules apply?

General Design Considerations

All stream crossings shall:

- Allow the movement of sediment & AO
- Not increase freq. of flooding;
- Maintain existing low flows;
- Preserve/ restore watercourse connectivity;
- Not cause water quality degradation
- Not cause scour or aggradation

Tiers Based System: Contributing Watershed



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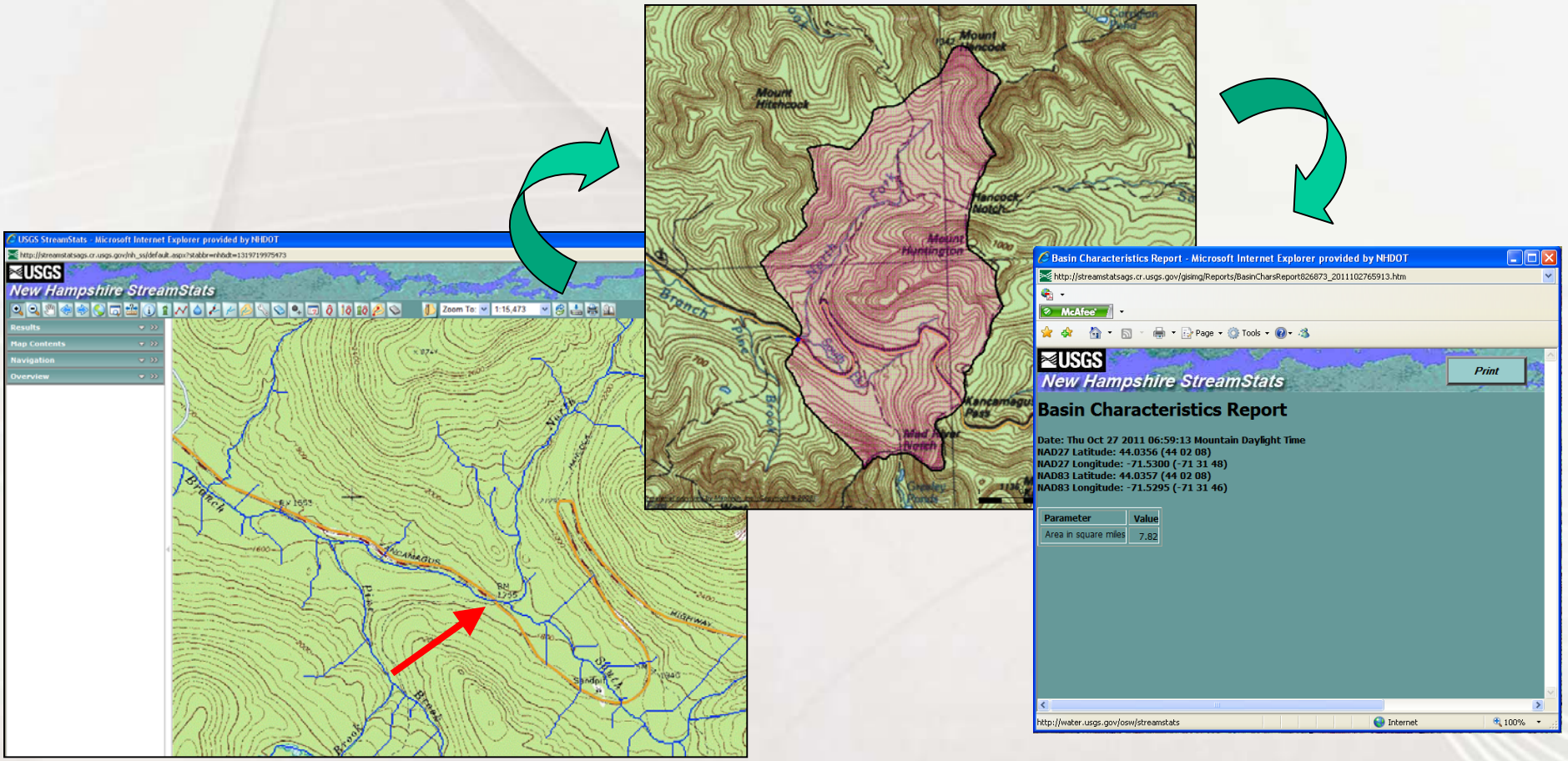
USGS StreamStats



http://water.usgs.gov/osw/streamstats/new_hampshire.html

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Tier 1

Contributing watershed less than 201 acres

Meet general design considerations

Accommodate 50-yr storm or other applicable reg.

Any type of structure (culvert/bridge);

Construct during low flow

Use BMPs during construction

Tier 1

Repair/rehabilitation available (explained later)

Compensatory mitigation not required, unless the general design considerations cannot be met, pursuant to the repair/rehabilitation section

Tier 2

Contributing watershed from 201 ac - 639 ac

Specific design criteria (explained later)

Span structure (bridge), embedded pipe arch. open bottom culvert, embedded closed culvert

Stream simulation

Tier 2

In-kind replacement available (explained later)

Alternative design available (explained later)

Repair/rehabilitation available (explained later)

Plans stamped by a Professional Engineer

Construct during low flow

Use BMPs

Tier 2

Compensatory mitigation not required for:

- Crossings that meet specific design criteria
- Repair/rehabilitated
- In-kind replacements

Tier 3

Contributing watershed greater than 639 ac

Designated river corridor (1/4 mile)

Impairments

- Benthic macroinvertebrate index
- Fish assemblage index
- Habitat assessments
- Stream channel stability

Tier 3

100-year floodplain

Natural Heritage Bureau (NHB) record

Prime wetland or buffer

*Tier 3 Kick out
(impairments, NHB record or 100-year floodplain)

Tier 3

Span structure (bridge), or open bottom culvert

Stream simulation

Alternative design available

Plans stamped by a Professional Engineer

Construct during low flow

Use BMPs

Tier 3

Compensatory mitigation not required for

Self-mitigating crossing
Conforms to NH Stream Crossing Guidelines

Tier 2 & Tier 3 Design Criteria

NH Stream Crossing Guidelines

Water depth and flow in crossing same as natural channel

Vegetated banks on both sides of the watercourse for wildlife passage

Preserve natural alignment and grade of stream for natural flow and access to floodplain

Tier 2 & Tier 3 Design Criteria

Accommodate 100-year flood so that:

No increase in flood stages for abutters

Sediment transport not negatively affected

Simulate a natural stream channel

Tier 1 & Tier 2 Repair/Rehabilitation

Can only be repaired/rehabilitated if the crossing does not have a history of causing or contributing to flooding

Concrete repair, slip lining, cured-in-place lining, concrete invert lining

Slipline shall only occur once

Tier 1 & Tier 2
In-Kind Replacement

Can only be repaired/rehabilitated if the crossing does not have a history of causing or contributing to flooding

Replacement is same size as existing or an upgrade (closed bottom culvert to an open bottom culvert)

Meet general design considerations

Not diminish hydraulic capacity

Not diminish aquatic organism passage, OR

Tier 1 & Tier 2
In-Kind Replacement

Replacement does not adversely affect stream channel, or stream bank stability; and

Not cause an increase in flooding or overtopping of banks

Could require compensatory mitigation

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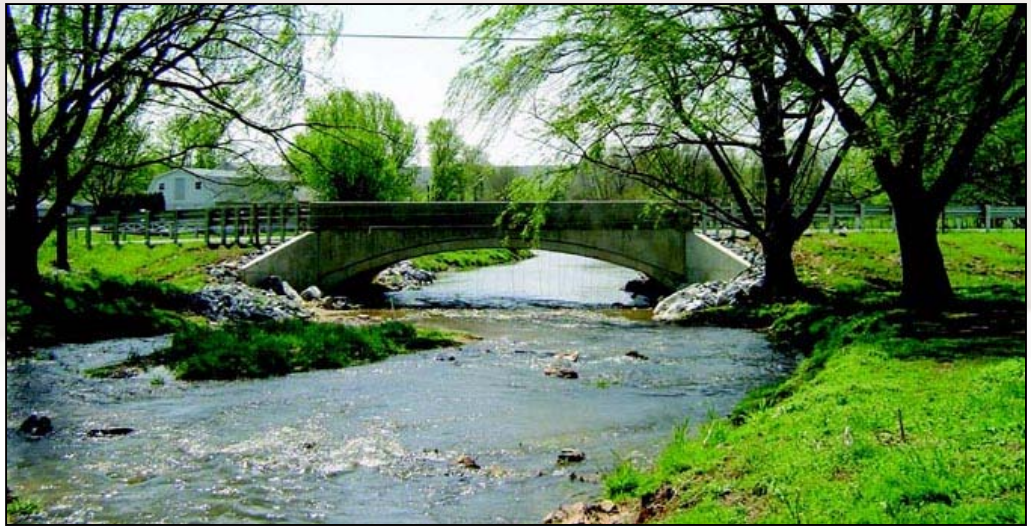
Replacing Tier 3 Crossings

Comply with design criteria for Tier 2 & Tier 3 crossings

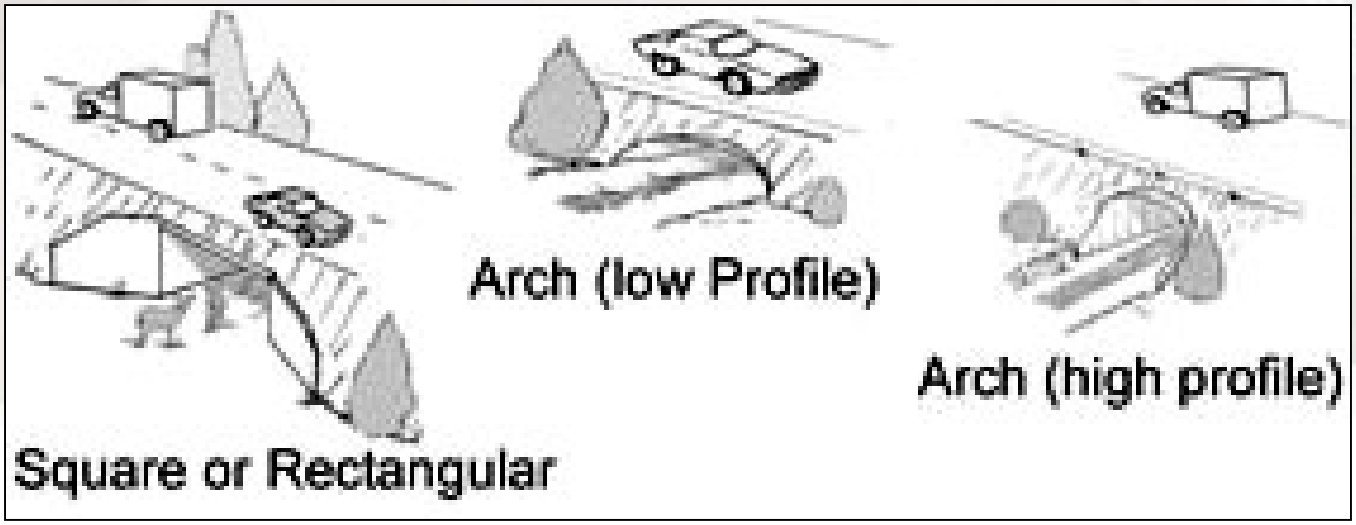
Alternative design allowed



Alternative Designs

If installing the structure required by rule is not "practicable," propose an alternative

Written request accompanied by a "technical report"



Alternative Designs

New/replacement Tier 2 & Tier 3 Crossings

Technical report demonstrates that adhering to the rules is not practicable

Meets specific design criteria to “maximum extent practicable”

Meets general design considerations

Alternative Designs

New/replacement Tier 1 Crossing

Technical report demonstrates that adhering to the rules is not practicable

Meets general design considerations to “maximum extent practicable”

Practicable

“Practicable means available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.” (Env-Wt 101.73)

DOT Implementation

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Information at Crossing

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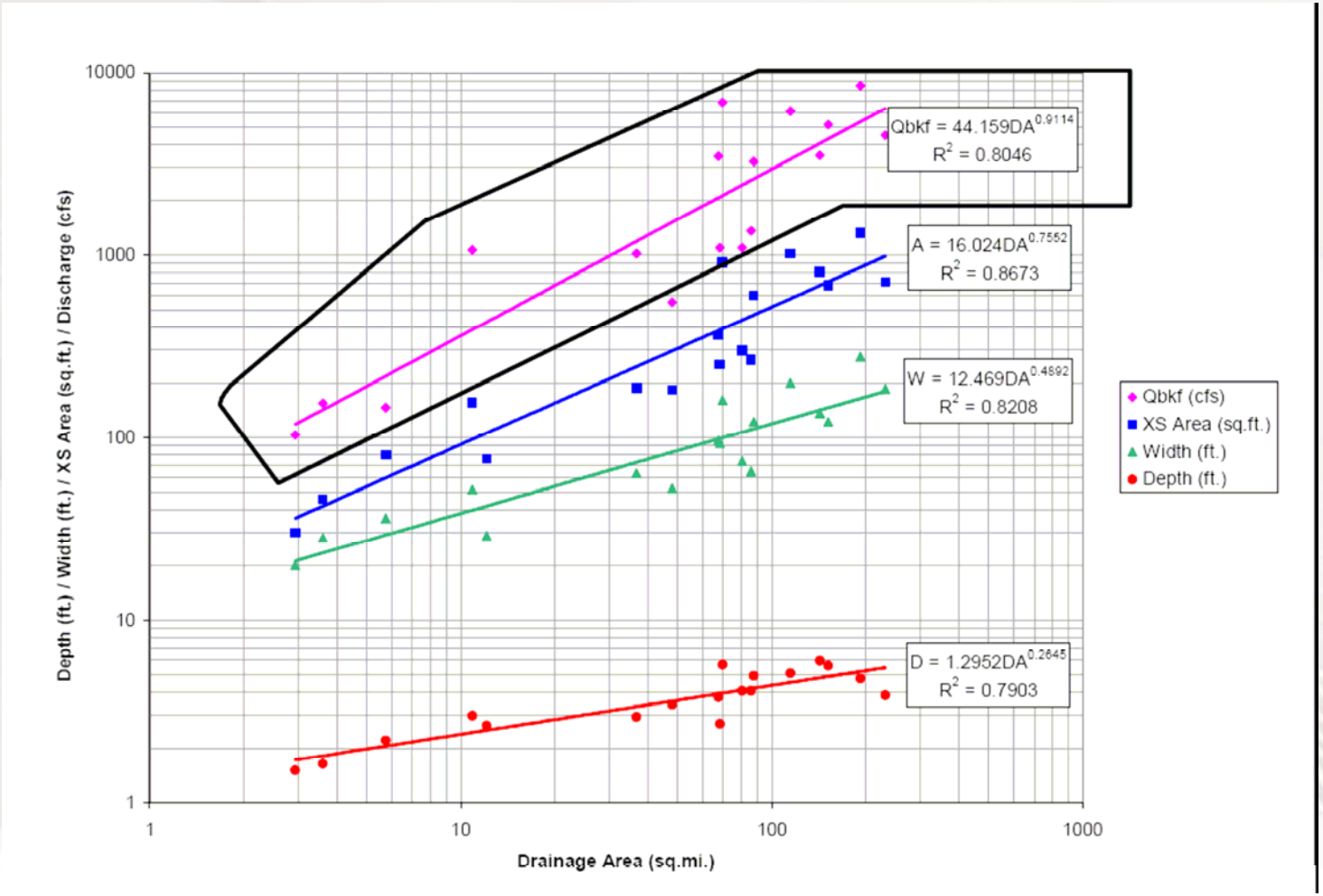
Estimating Bankfull Conditions

Flow
Area
Width
Depth



2005 Regional Hydraulic Geometry Curves (provisional)

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Reference Reach

Bankfull width & bankfull depth

Entrenchment ratio

Sinuosity

Floodprone width

Longitudinal profile

Cross sections

Pebble count

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Reference Reach

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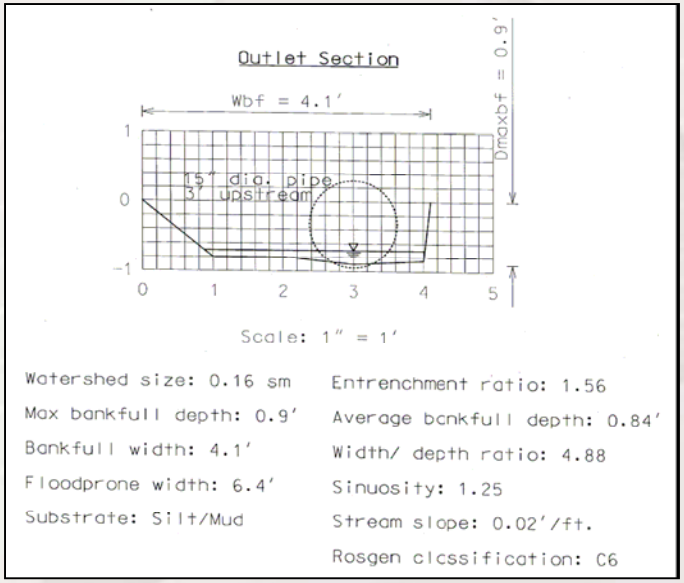
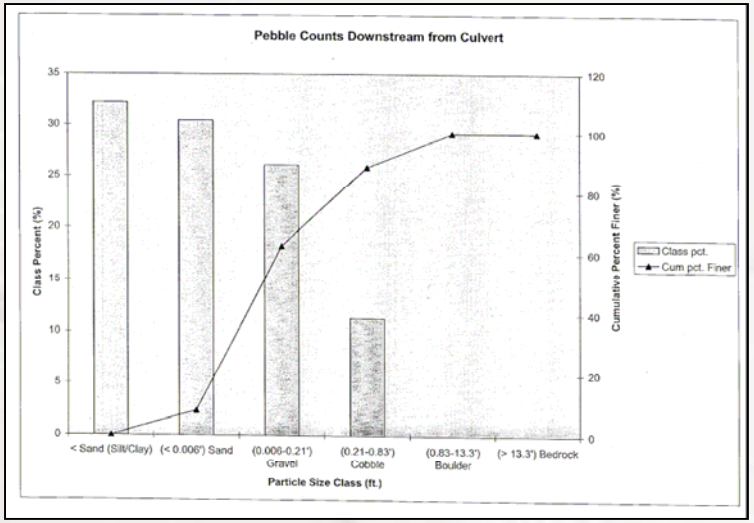
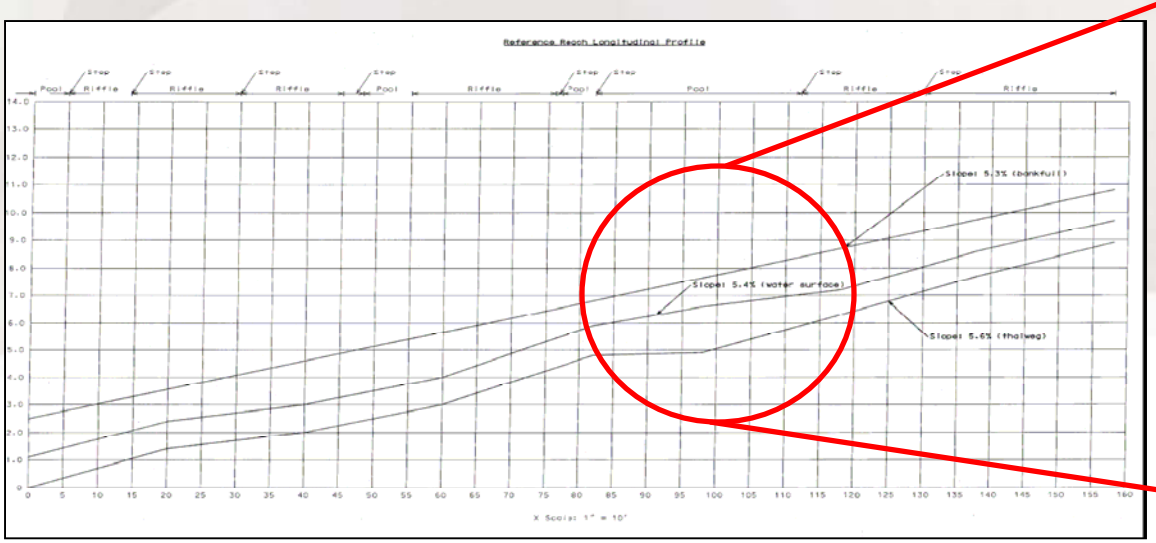
Fluvial Geomorphic Report

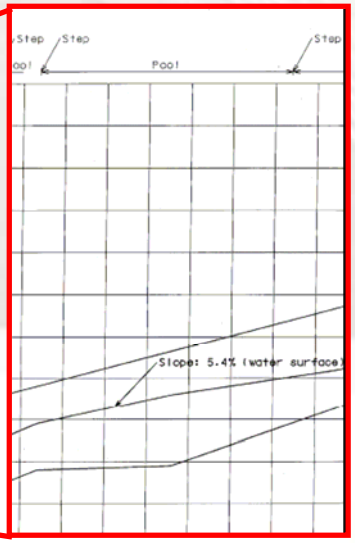


Watershed size: 0.16 sm
Max bankfull depth: 0.9'
Bankfull width: 4.1'
Floodprone width: 6.4'
Substrate: Silt/Mud

Entrenchment ratio: 1.56
Average bankfull depth: 0.84'
Width/ depth ratio: 4.88
Sinuosity: 1.25
Stream slope: 0.02'/ft.
Rosgen classification: C6







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Engineering / Hydraulics

Drainage calculations
- Drainage area
- Soil type
- 25-year, 50-year, 100-year flows

Hydraulic calculations
- Headwater
- Outlet water velocity

When is a Fluvial Geomorphic Assessment Required?

New Tier 2 Crossings

Tier 2 repair/rehabilitation where there is a flooding history

Tier 2 replacement where there is a flooding history

All new/replacement Tier 3 Crossings

Rehabilitation/Modification of Tier 2 & Tier 3 Crossings

Rules are silent on rehabilitation of Tier 3 crossings and modifications to Tiers 1, 2 & 3 crossings

Repair/rehabilitation of Tier 3 crossings need to comply with the General Design Considerations insofar as possible

Modifications use Alternative Design process

New Hampshire DOT Department of Transportation

Rehabilitation/Modification of Tier 2 & Tier 3 Crossings

Redefine “replacement” or add a definition for “upgrade or improvement”

Define “modification”

Adopt rules for “modification of existing crossings,” and “rehabilitation of Tier 3 crossings.”

Information Required for Stream Crossing Application

Dewatering system
- Flow estimates
- Diversion dam and sump locations
- Backwater prevention methods
- Sediment treatment plan

Erosion and pollution controls

Construction Sequence

*Not available at the time of application

Information Required for Stream Crossing Application

Contractor-prepared and –submitted SWPPP

Conditioned permits subject to review and approval by DES

DOT working toward supplying this information in advance for project development

How Long Does It Take?

Conditions

Personnel

Detail of data

How Long Does It Take?

For an average wadable Tier 2/3 stream…

3 hrs. to complete pre-survey review
24 hrs. to survey crossing & reference reach
10 hrs. to crunch & input data into CAD/D
3 hrs. to generate a report for Design
Does not include hydraulic/drainage calculations

Pebble Counts

Nothing from NH Stream Crossing Guidelines

Wolman Pebble Count

Cross Section Analysis

Wetted Perimeter Cross-Section Analysis

Pebble Counts

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What Does “Accommodate” Mean?

Tier 1 stream crossing shall **accommodate** the greater of the 50-year frequency flood or other applicable standard

Tier 2/3 stream crossing shall **accommodate** the 100-year frequency flood

Accommodate does **NOT** mean “pass through the structure without headwater conditions.”

What Does Accommodate Mean?

It means you know where the flood water will go, and your design has taken it into consideration…

Roadside ditches
Backwater onto adjacent land
Over the road (which has been hardened)
Overflow culvert
Floodplain culvert
Under or through the structure

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What Does Accommodate Mean?

New Hampshire DOT
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Vegetated Banks

Tier 2 & 3 crossings shall provide… *"a vegetated bank on both sides of the watercourse to allow for wildlife passage."*

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Vegetated Banks

Tier 2 & 3 crossings shall provide… *"a vegetated bank on both sides of the watercourse to allow for wildlife passage."*

Saltwater Systems

Academic community, Dr. Ballestero, UNH, indicated rules for freshwater only

DES applies rules to saltwater systems

DOT Stream Crossing Projects

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Swanzey Bridge 150/056 (Tier 3 Modification)

Swanzey Bridge 150/056

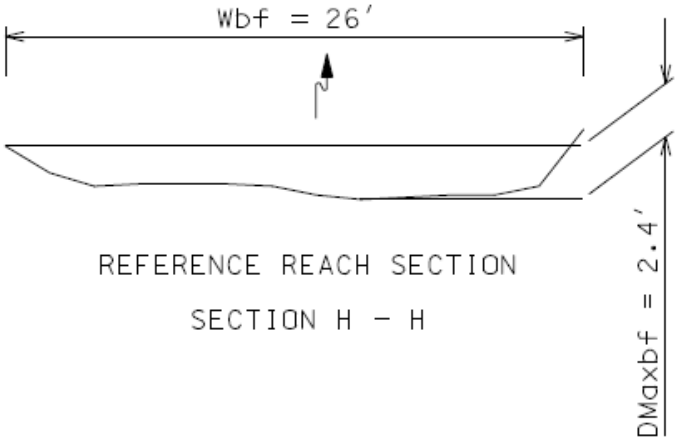
Existing Tier 3 concrete slab bridge, 25’ wide

Watershed: 5,500 ac (8.6 sm)

Project to widen bridge to facilitate rehabilitation (traffic control)

Swanzey Bridge 150/056

REFERENCE REACH



REFERENCE REACH SECTION

SECTION H - H

Rosgen Classification: E5b
(slope slightly off)

Section	Max Dbf	Wbf
H-H	2.4'	26.0

Slope: 0.057

Wfpa: 438' (estimated)

Entrenchment Ratio: 17.5

Sinuosity: 1.5 (2,500 lf/1,660 lf)

Width/Depth Ratio: 8.4 (27.8/3.3)

Dist. from lt. bank	Depth
0'	0'
2'	-1.2'
4'	-1.8'
6'	-1.7'
8'	-1.7'
10'	-1.7'
12'	-1.8'
14'	-2.2'
16'	-2.4'
18'	-2.3'
20'	-2.4'
22'	-2.4'
24'	-2.0'
26'	+0.8'

Swanzey Bridge 150/056

Specifics (reference reach):

Field Collected	Calculated (for info.)
W_{bf} = 26.0’	W_{bf} = 35.7’
D_{maxbf} = 2.4’	D_{maxbf} = 2.3’

Technical report (qualitative), no fluvial geomorphic assessment required

Alternative design

Wakefield, Farnham Brook
(Flooding History vs. No Flooding History)

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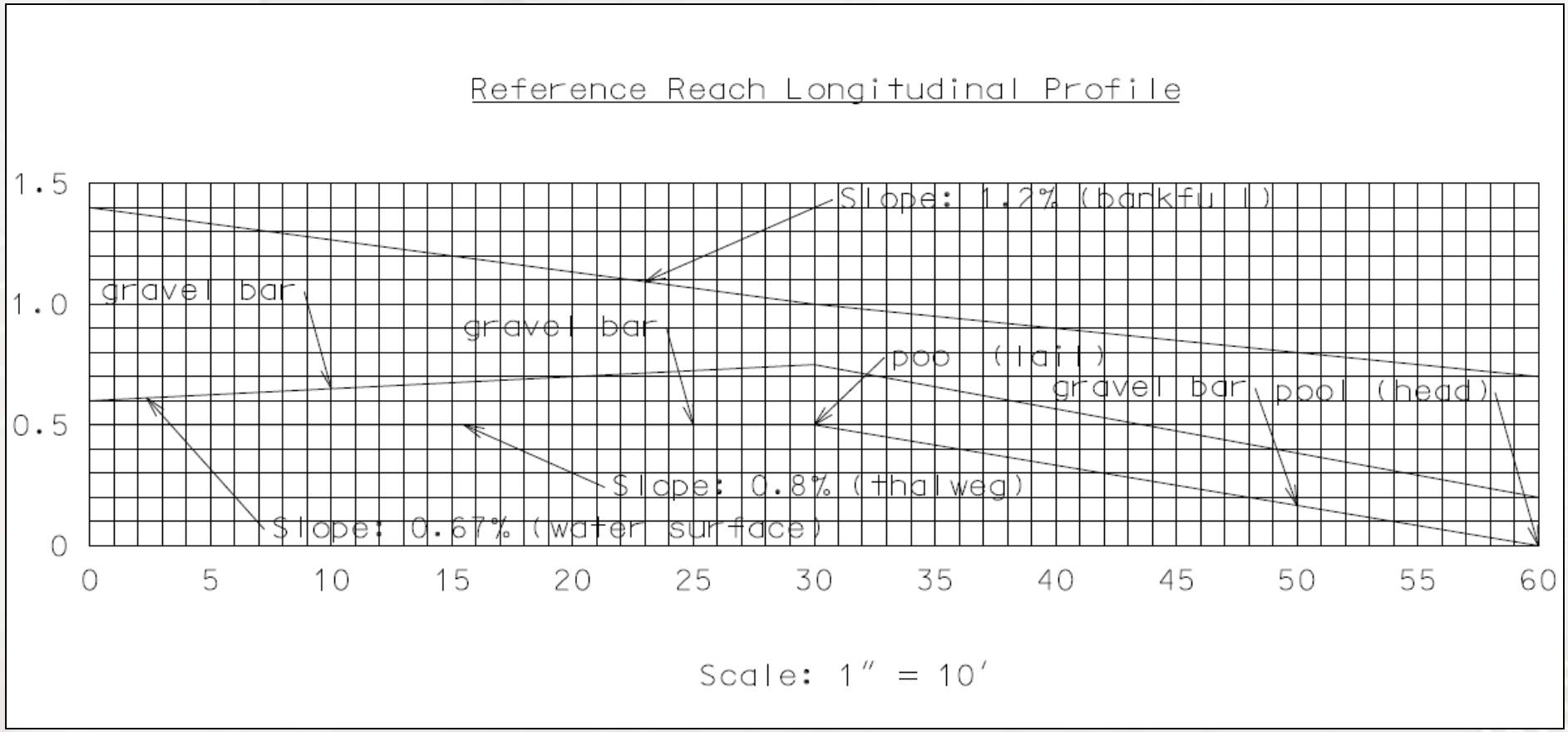
Wakefield, Farnham Brook

Existing Tier 2 concrete box culvert 3’ H x 6’ W

Project proposed to replace the culvert

No flooding history

Wakefield, Farnham Brook



Wakefield, Farnham Brook

At Crossing:

<u>Field Collected</u>

W_{bf} = 16.2’

D_{maxbf} = 3.3’

Reference reach:

<u>Field Collected</u>

W_{bf} = 8.9’

D_{maxbf} = 0.7’

<u>Calculated (for info.)</u>

W_{bf} = 12.4’

D_{maxbf} = 1.3’

Wakefield, Farnham Brook

"In-kind replacement or upgrade"
Proposed 3' X 8' box (embedded 1')

However, <u>if there were a flooding history</u>:
Stream Crossing Design Guidelines

Span: 1.2 X W_{bf} + 2' or 14-foot span, or open bottomed or embedded culvert based on reference reach…essentially **A BRIDGE**

Stratham, Jewell Hill Brook (Saltwater Stream Crossing)

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Stratham, Jewell Hill Brook

Existing 42’L x 66” dia. Tier 3 pipe arch

Tidal river

Stratham, Jewell Hill Brook

Crossing outlet:

Field Collected

W_{bf} = 24.8’

D_{maxbf} = 4.0’

Reference reach:

Field Collected

W_{bf} = 25.4’

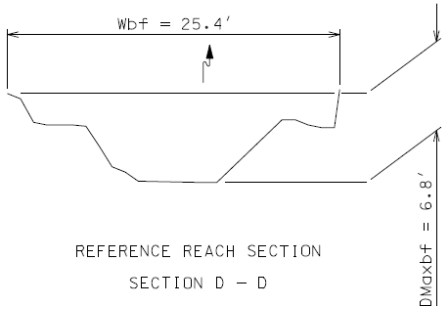
D_{maxbf} = 6.8’

Calculated (for info.)

W_{bf} = 14.2’

D_{maxbf} = 1.4’

REFERENCE REACH



REFERENCE REACH SECTION

SECTION D – D

Section	Max Dbf	Wbf
D–D	6.8'	25.4'

Slope: less than 0.2

Wfpa: 500' (estimated)

Entrenchment Ratio: 19.7 (500/25.4)

Sinuosity: 2.09 (5,739 lf/2,746 lf)

Width/Depth Ratio: 7.26 (25.4/3.5)

Dominant channel material: muck

Rosgen Classification: E6

Dist. from lt. bank	Depth
1'	-0.4'
2'	-2.2'
3'	-2.4'
4'	-2.4'
5'	-2.4'
6'	-2.5'
7'	-4.0'
8'	-5.6'
9'	-6.0'
10'	-6.7'
15'	-6.8'
16'	-6.8'
21'	-2.0'
22'	-2.0'
23'	-2.4'
24'	-2.6'
25'	-2.6'

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Stratham, Jewell Hill Brook

Proposed 40’ L X 8’ dia. plastic pipe embedded 18”

Waiver of stream crossing rules included
NH Coastal Program (DES) suggested that rules should not apply to tidal streams

Alternative Design

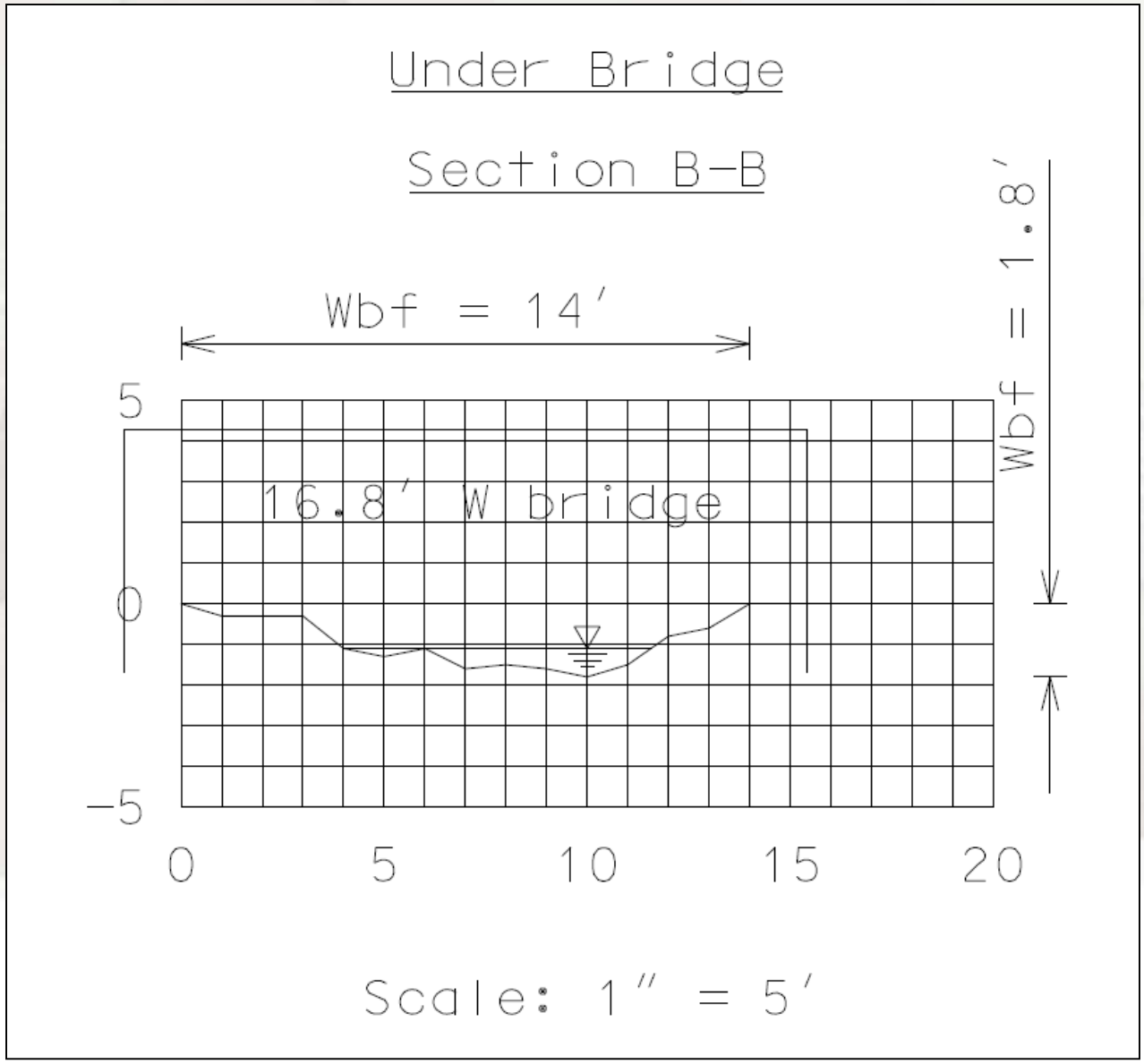
Pinkham's Grant, Ellis River (Watershed Size Estimate)

Pinkham's Grant, Ellis River

Existing 16.8' span Tier 2 bridge

No flooding history

Pinkham's Grant, Ellis River



Pinkham's Grant, Ellis River

Crossing outlet:

<u>Field Collected</u>

W_{bf} = 14.7'

D_{maxbf} = 1.8'

Reference reach

<u>Field Collected</u>

W_{bf} = 23.9'

D_{maxbf} = 2.2'

<u>Calculated (for info.)</u>

W_{bf} = 10.4'

D_{maxbf} = 1.2'

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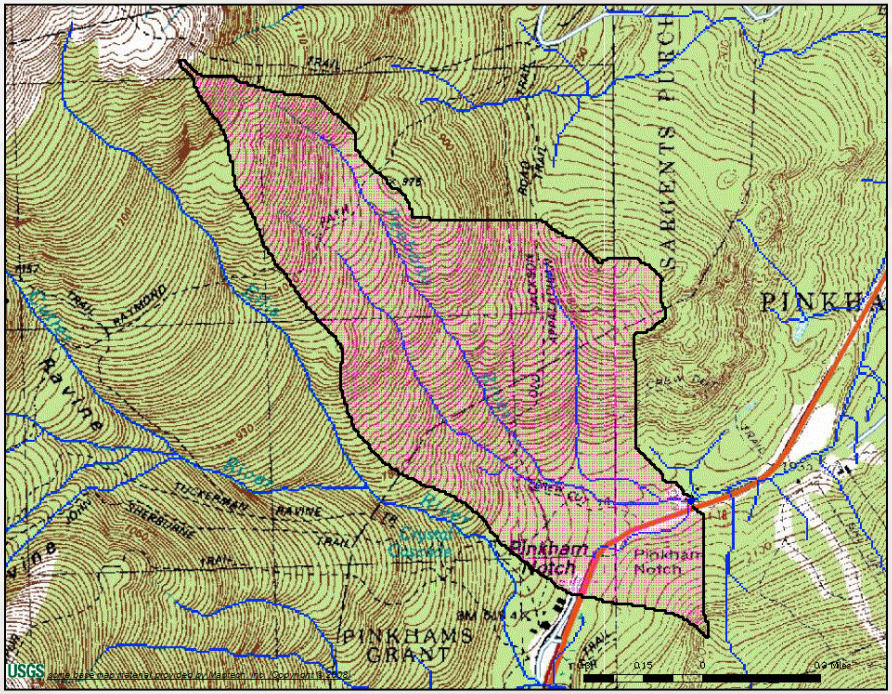
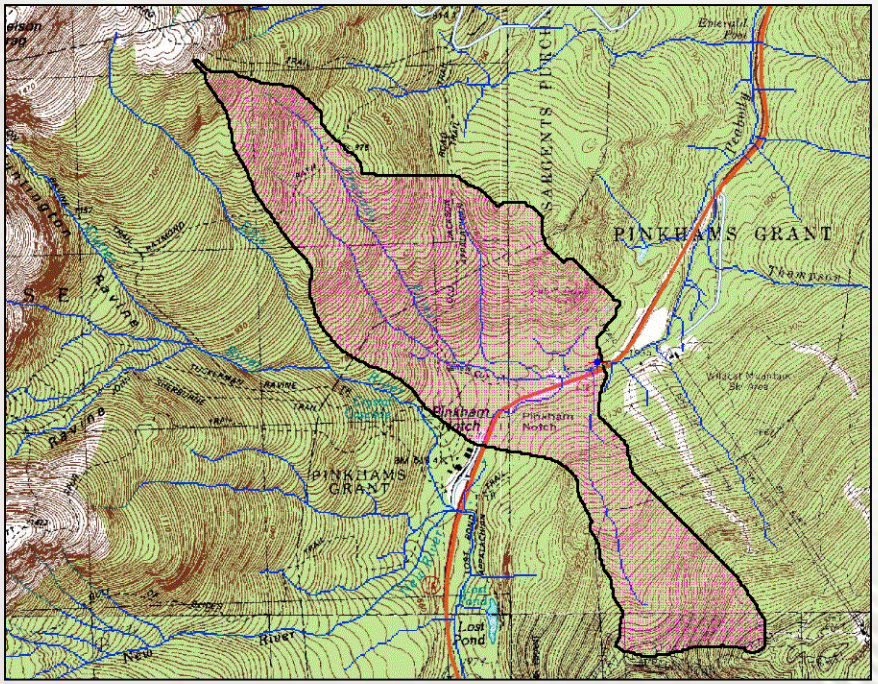
Pinkham's Grant, Ellis River





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Pinkham's Grant, Ellis River

Proposed 20' span bridge

Replacement / upgrade of existing Tier 2

Fully compliant with rules

Courtesy of AEWC

Pinkham's Grant, Ellis River

Under construction now

Courtesy of AEWC

North Hampton, Winnicut River (Wide Channel w/ Vegetation)

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North Hampton, Winnicut River

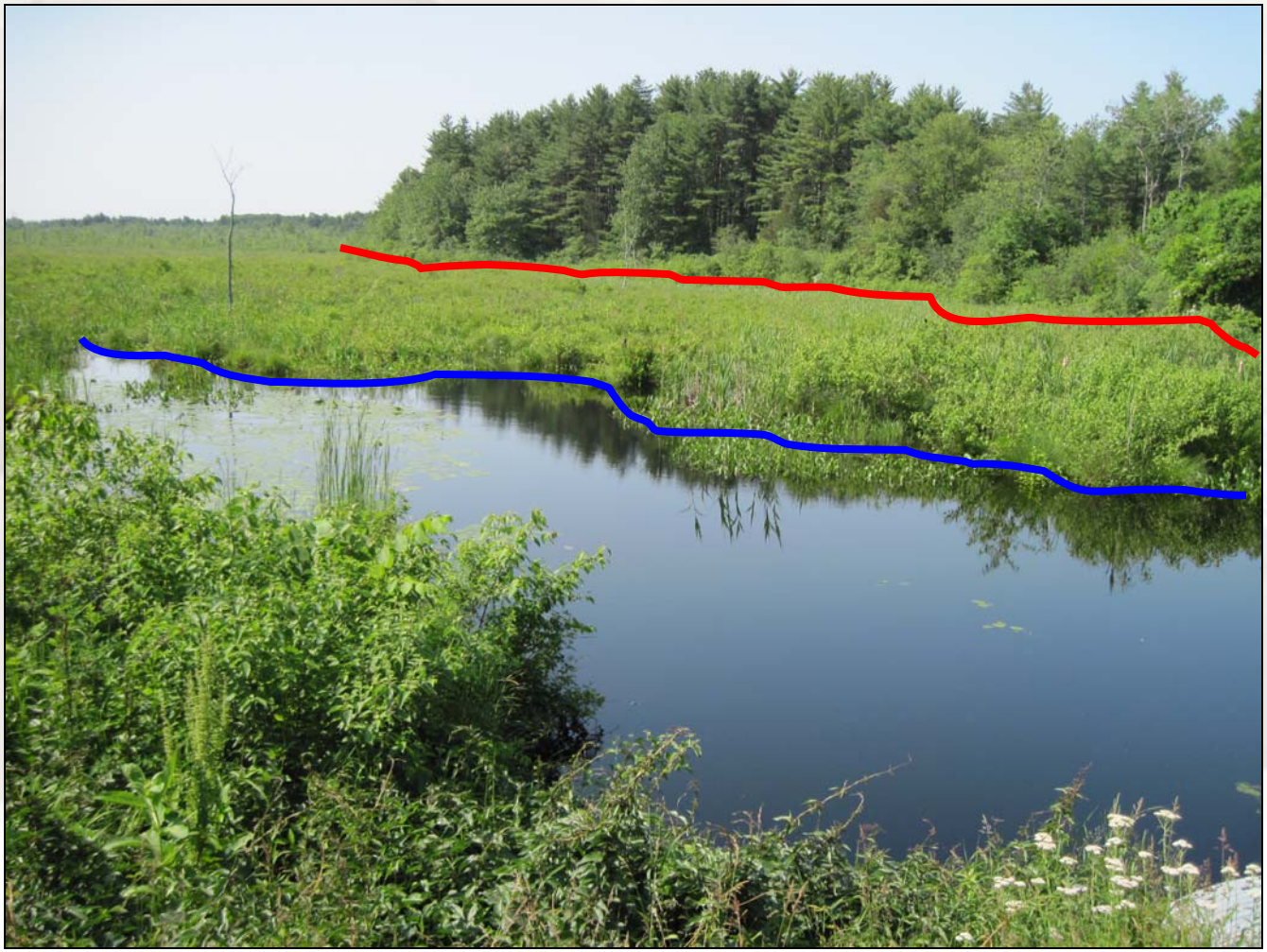
Emergent wetland adjacent to flowing water

Elevation of ground surface at the boundary between the wetland and the open water

Grasses mark decrease in flow velocity of moving water

- Shane Csiki, DES

North Hampton, Winnicut River



Northwood, Narrows Brook (Alternative Reference Reach)

Northwood, Narrows Brook

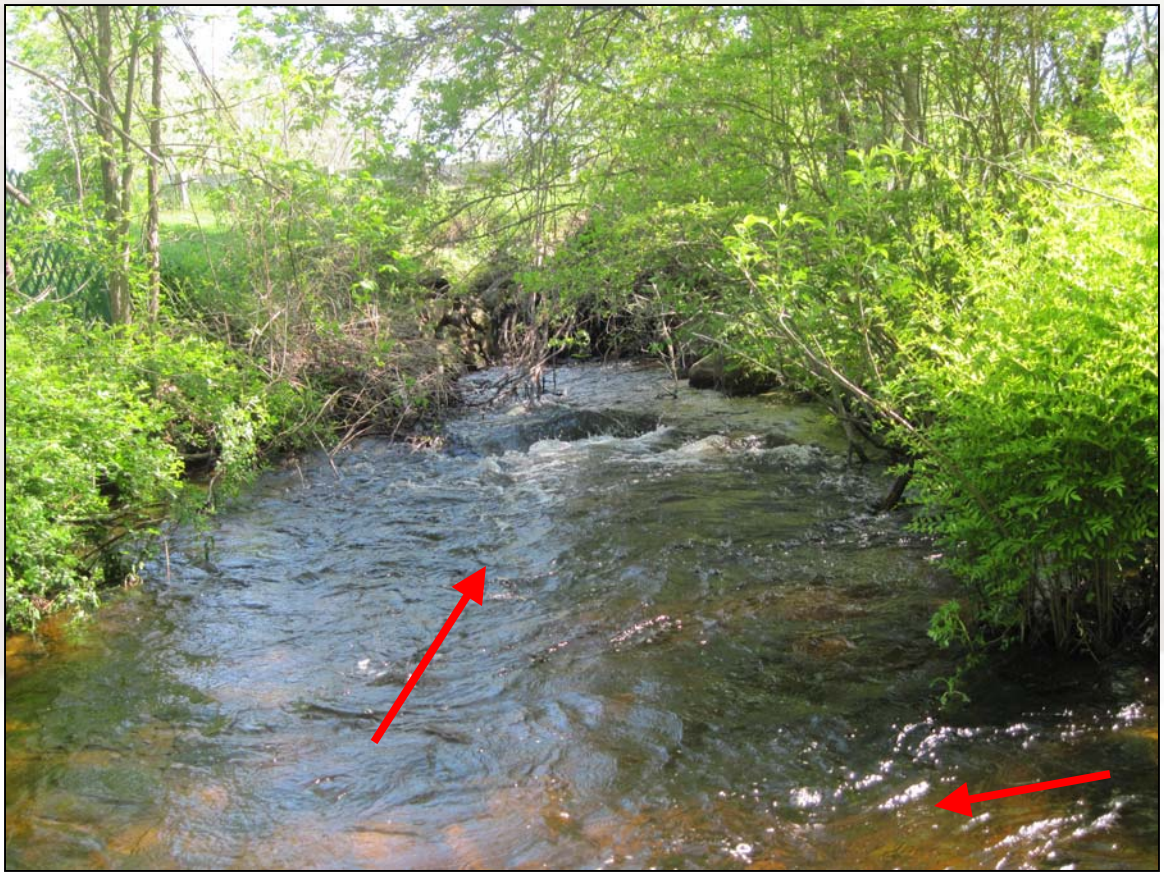
Existing 5’ corrugated metal pipe arch, Tier 3

8 square mile watershed

Calculated Wbf = 36’

Northwood, Narrows Brook

Convergence of two streams (Kelsey Brook and Narrows Brook

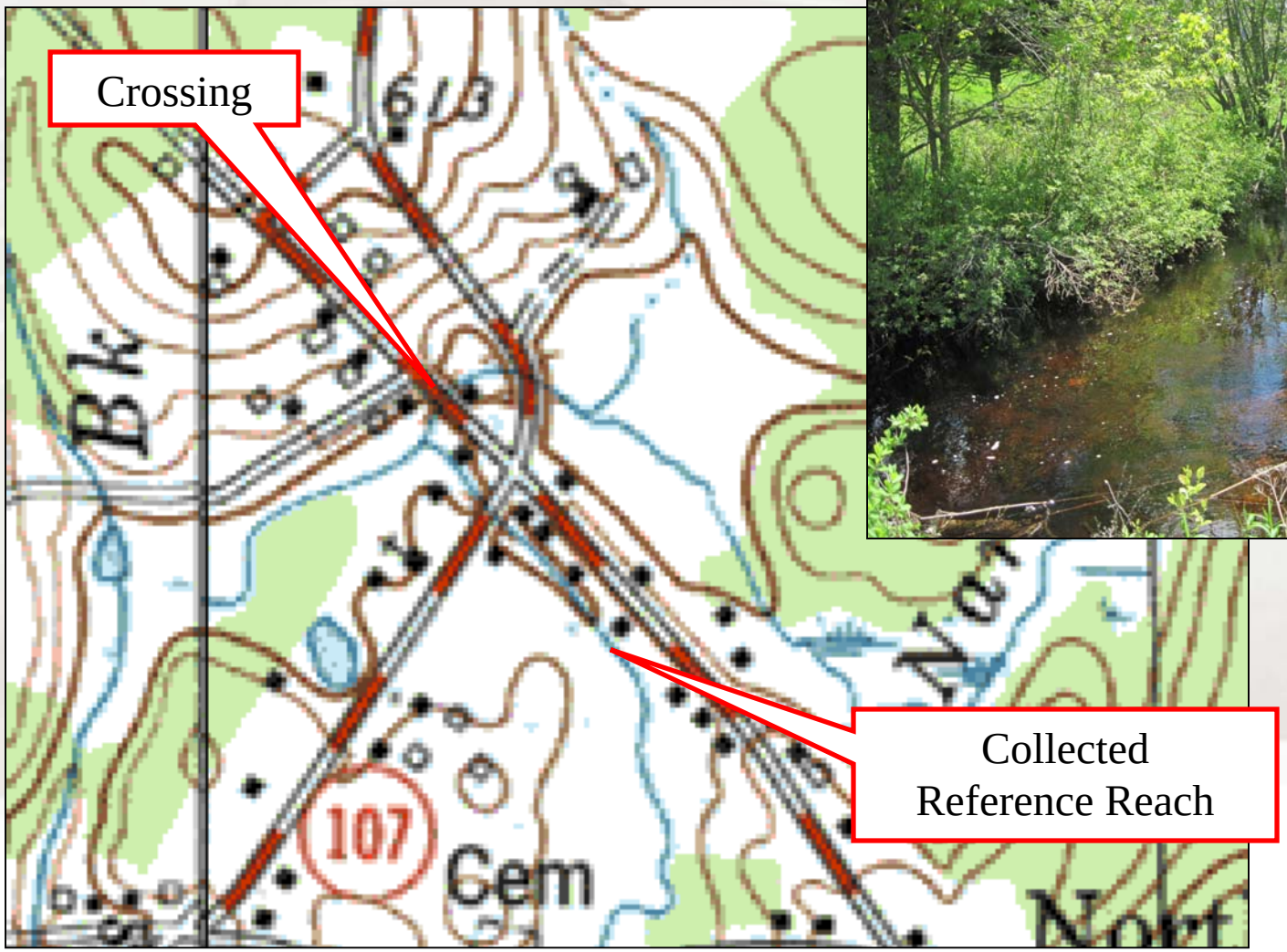


Northwood, Narrows Brook

Upstream reference reach was vastly different than stream at crossing

Northwood, Narrows Brook

Kelsey Brook reference reach



Northwood, Narrows Brook

Similar watershed area

Similar geographic location

Similar topographic location

Similar substrate material

Similar vegetative conditions

Similar stream gradient

To Date…

2-Tier 3 Replacement
2-Tier 3 Repair / modification
3-Tier 2 In-kind replacement / upgrade
1-Tier 1 Repair / rehabilitation
3-Tier 1 In-kind replacement / upgrade
1-Tier 1 Repair / modification

16 Assessments in 2010
13 Assessments in 2011

New Hampshire DOT Department of Transportation

New Hampshire DOT
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