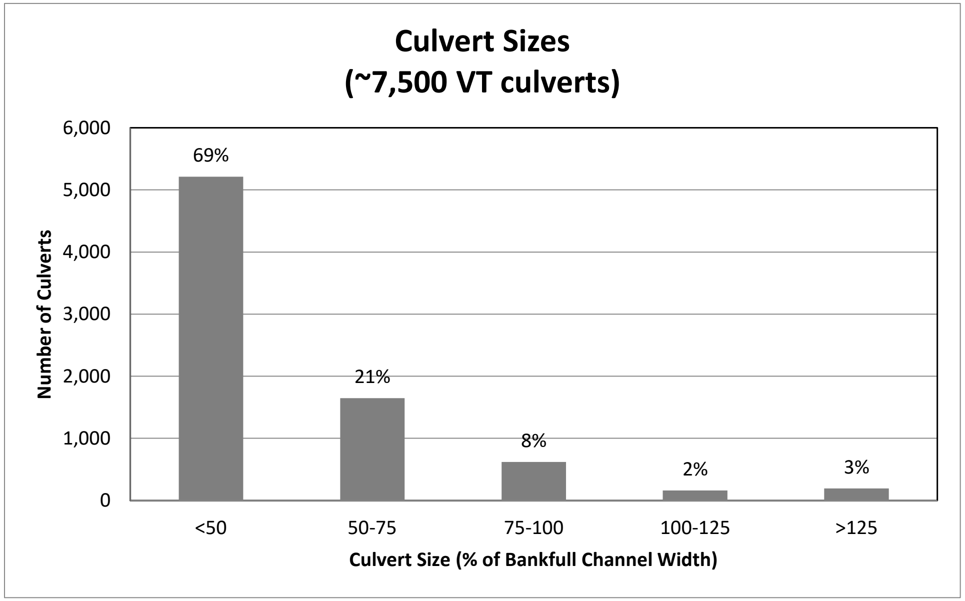
The Geomorphic-Engineering Approach to Designing Bridges and Culverts

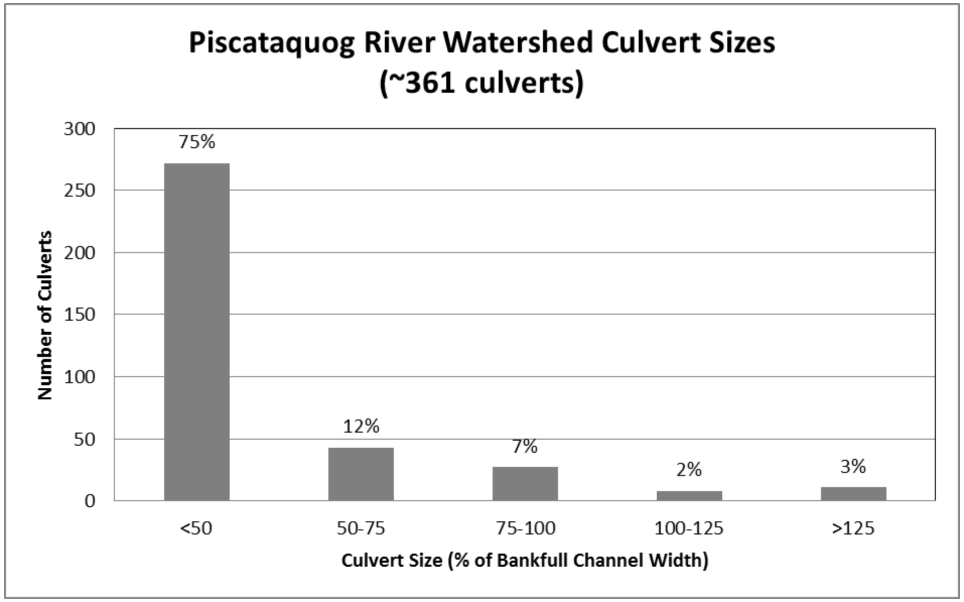
Presented By

Roy Schiff

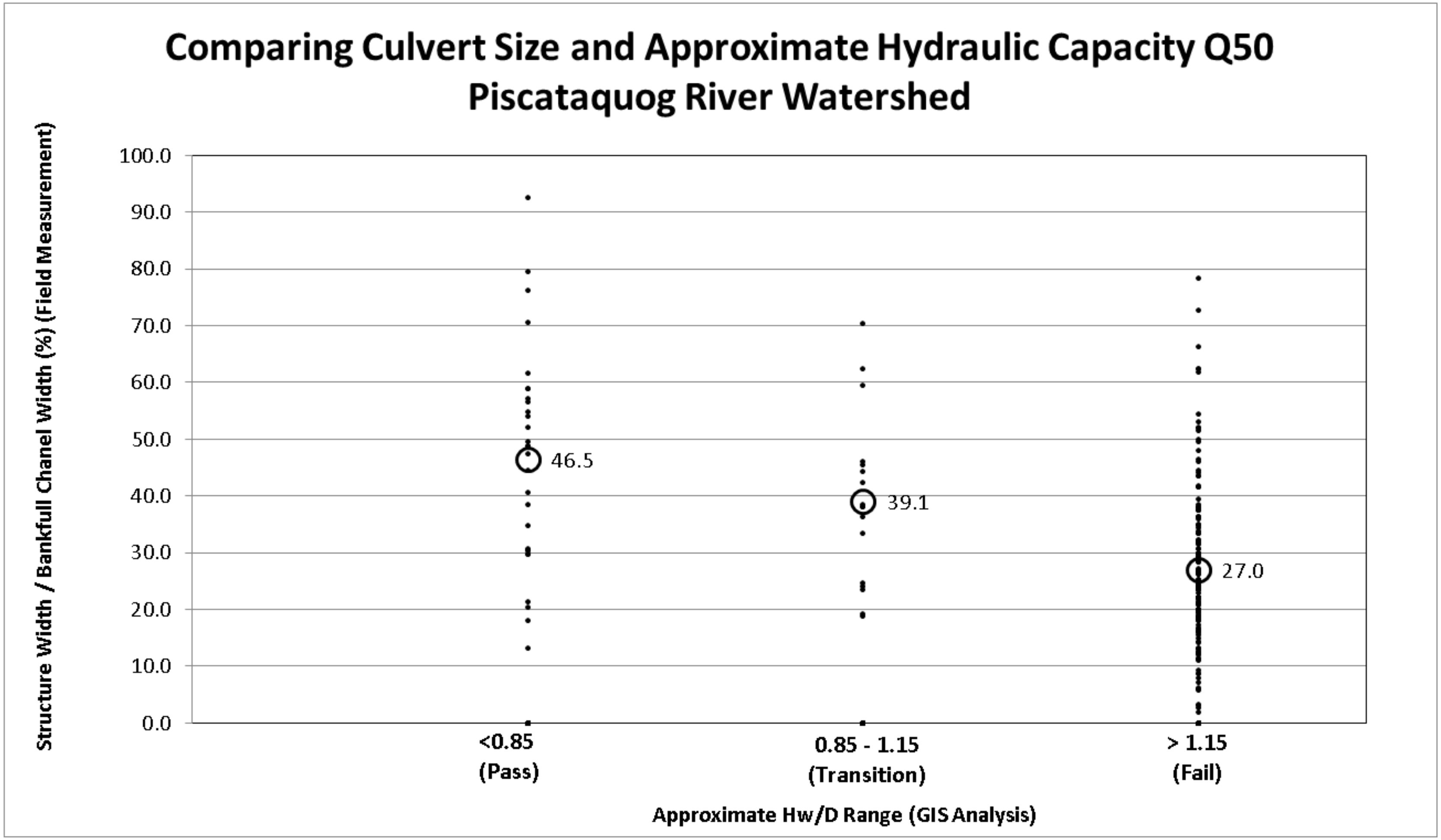
MILONE & MACBROOM

Undersized Culverts

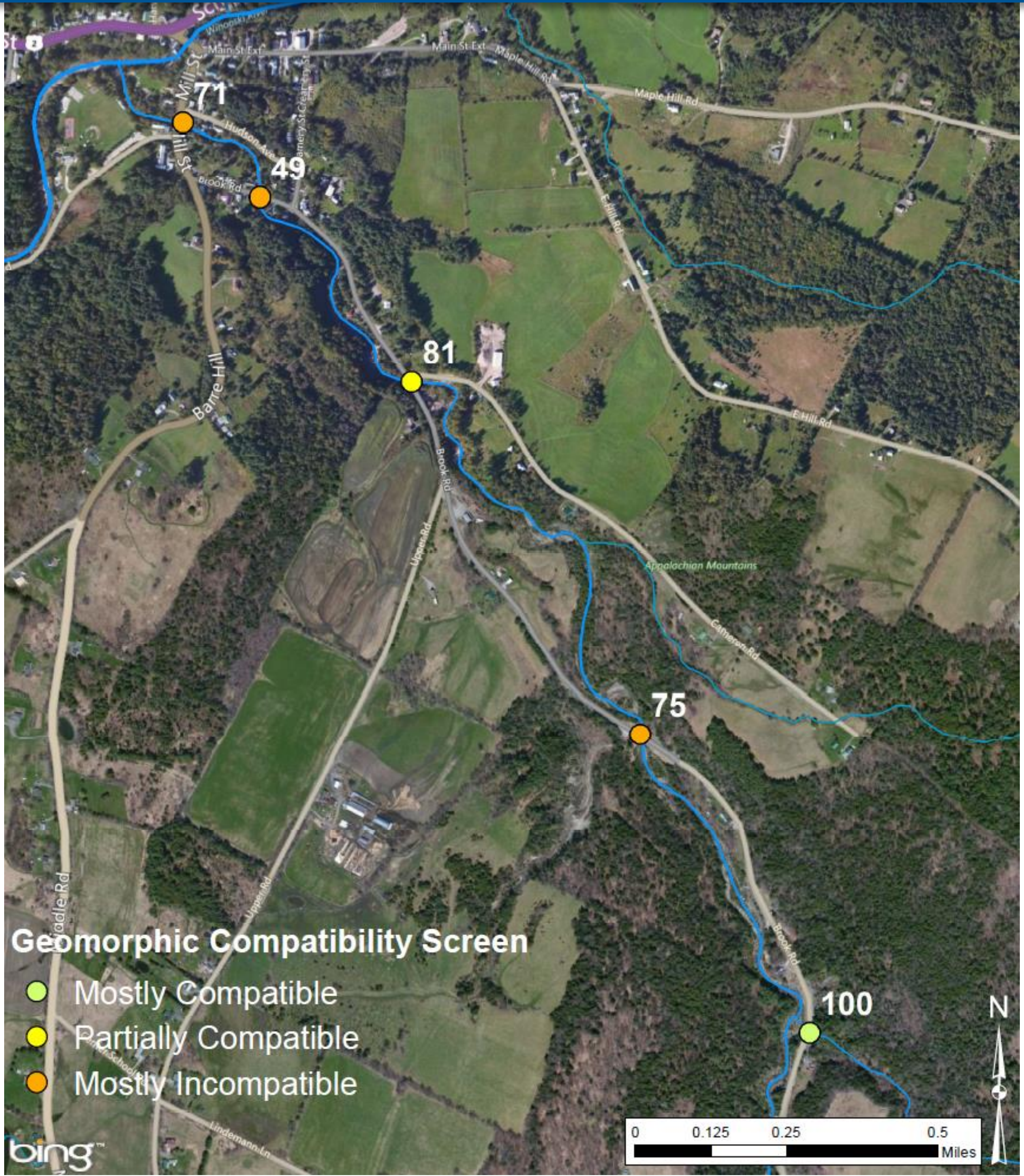




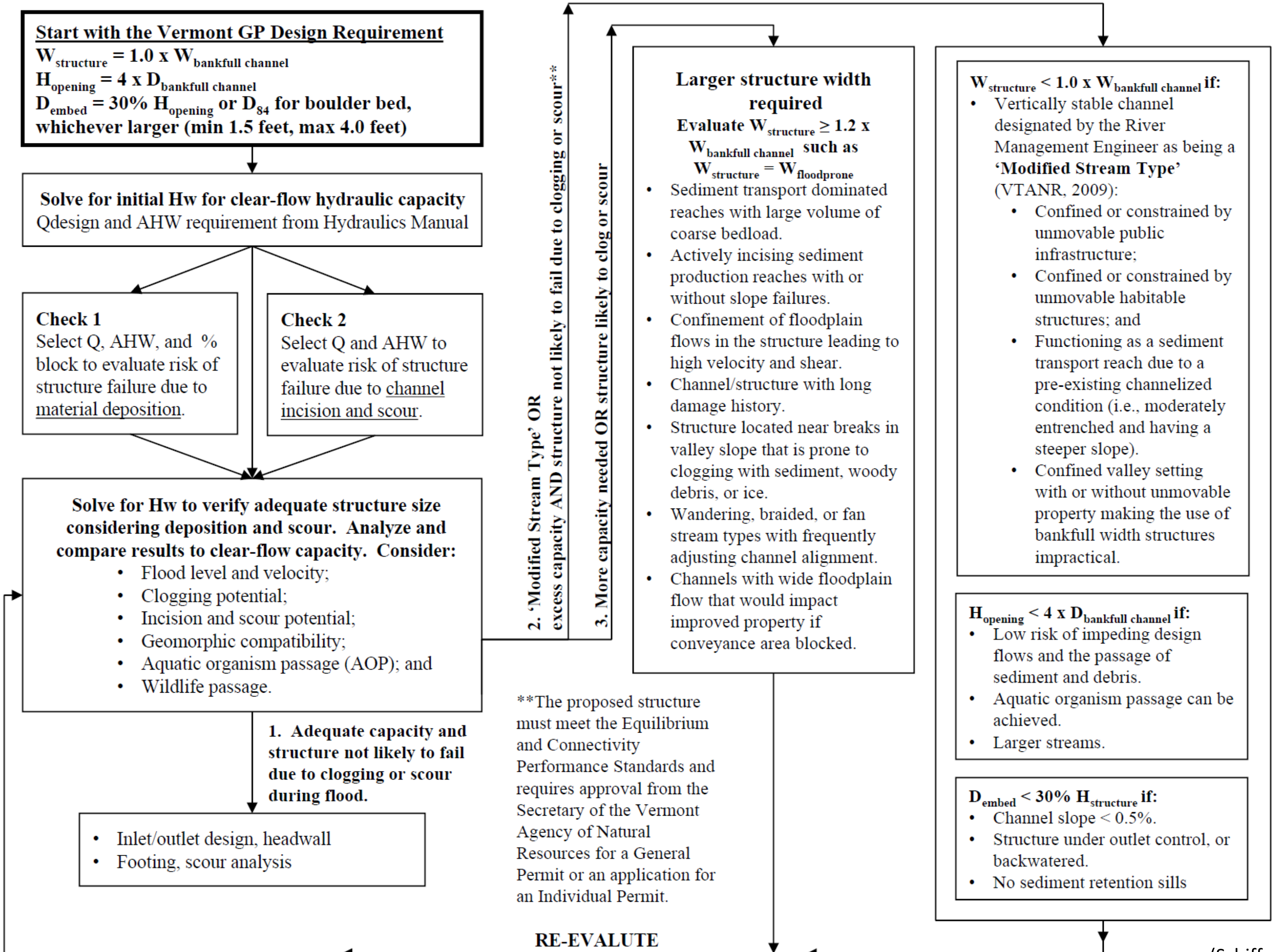
Undersized Culverts



Undersized Bridges

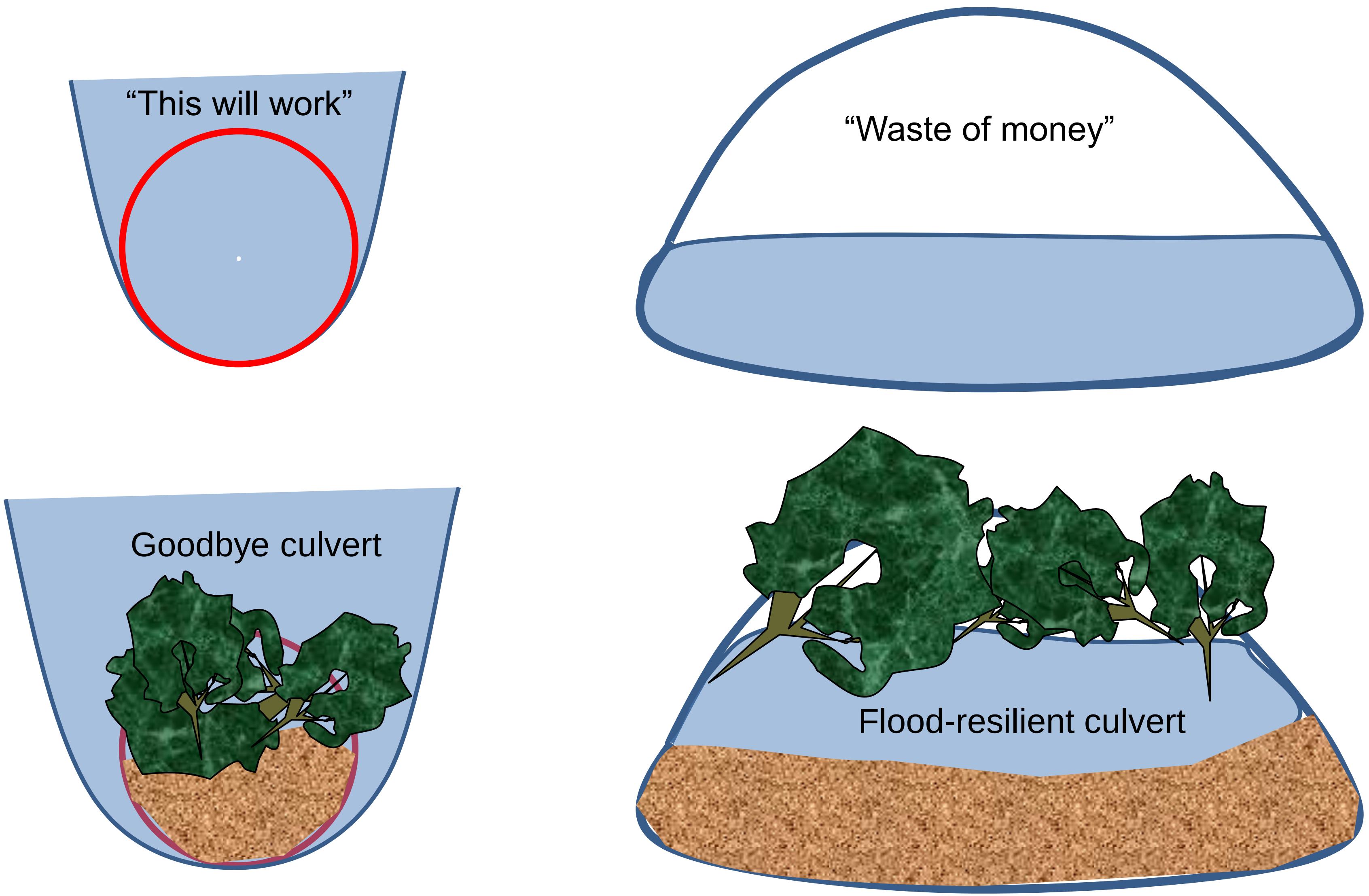


Geomorphic-Engineering Design

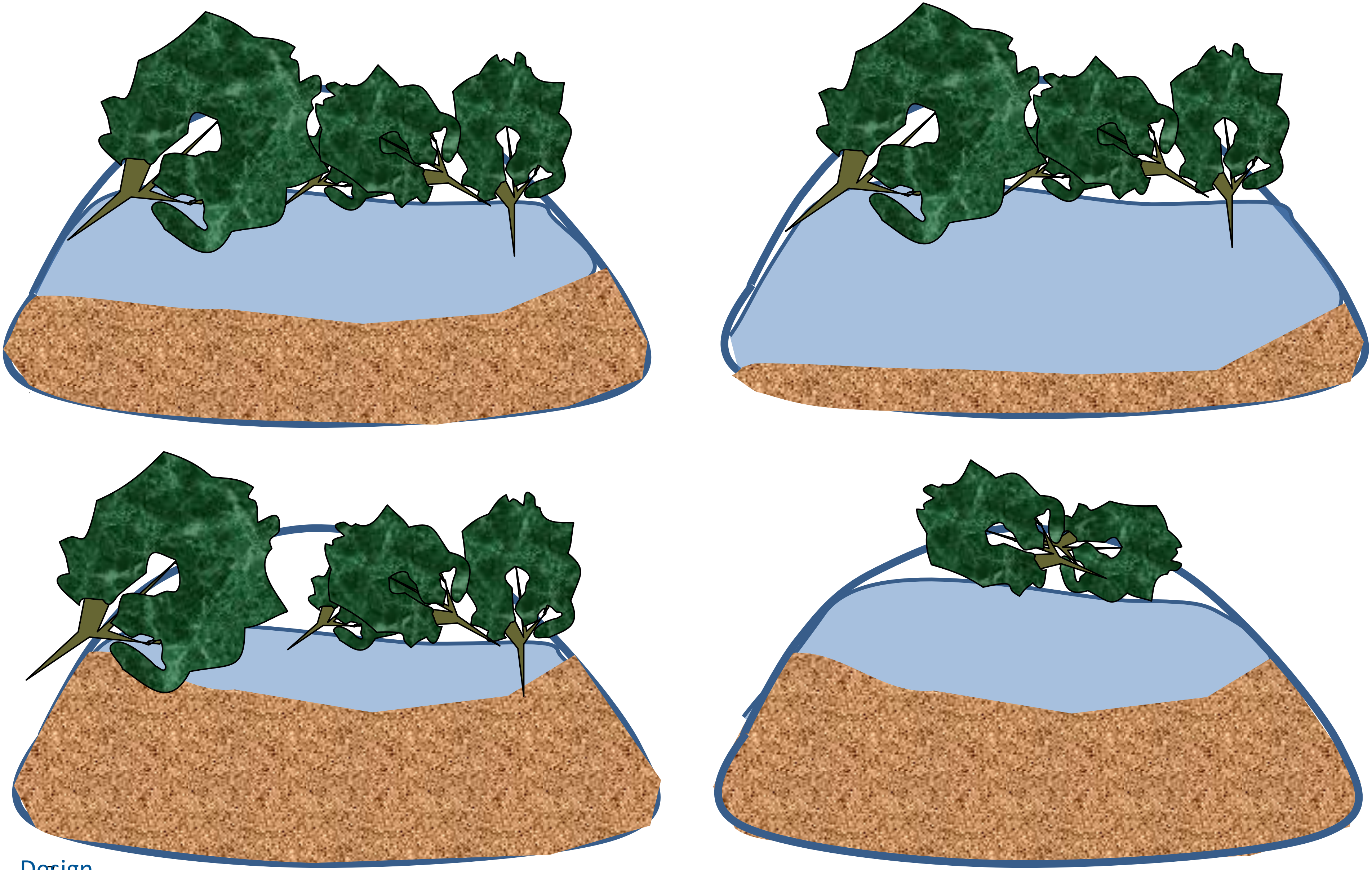


(Schiff et al., 2014)

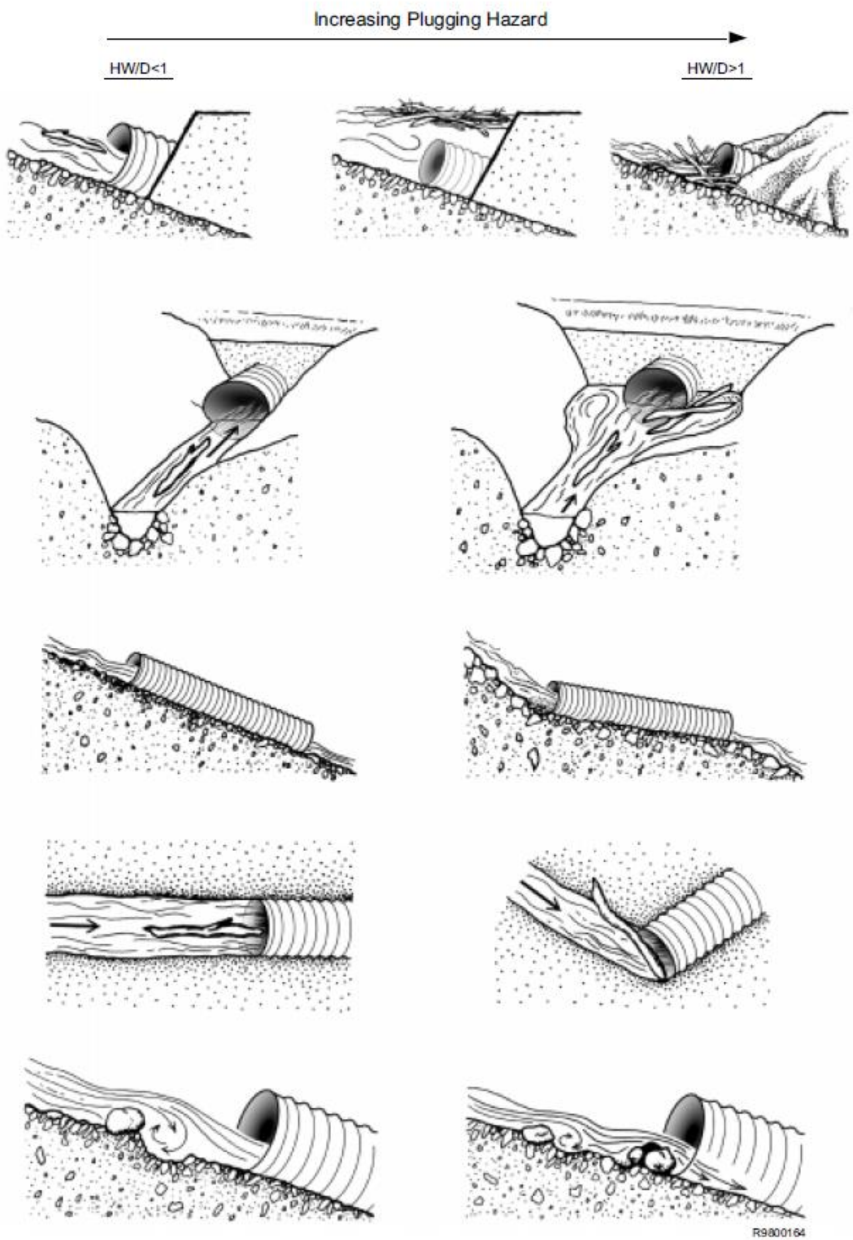
Design – Clear Flow v Reality



Design – What is true structure capacity?



Assessment – Large Wood



(Furniss et al., 1998)

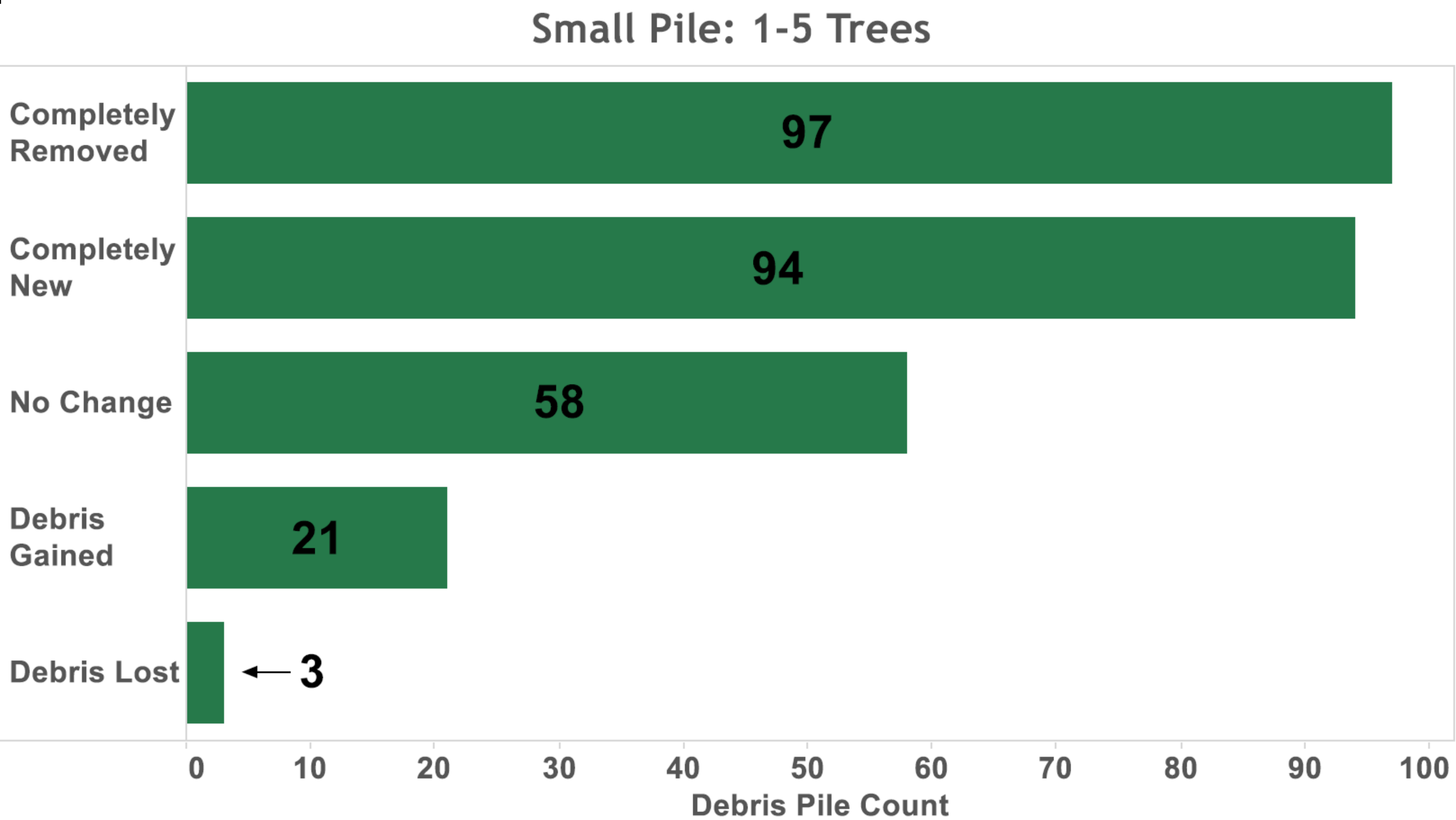
Large Wood at Bridges

Great Brook
Brook Road in Plainfield, VT
7/19/2015
Photo taken by B. Towbin

Great Brook
Brook Road in Plainfield, VT
5/27/2011
Photo taken by G. Springston

UVM Large Woody Debris Study

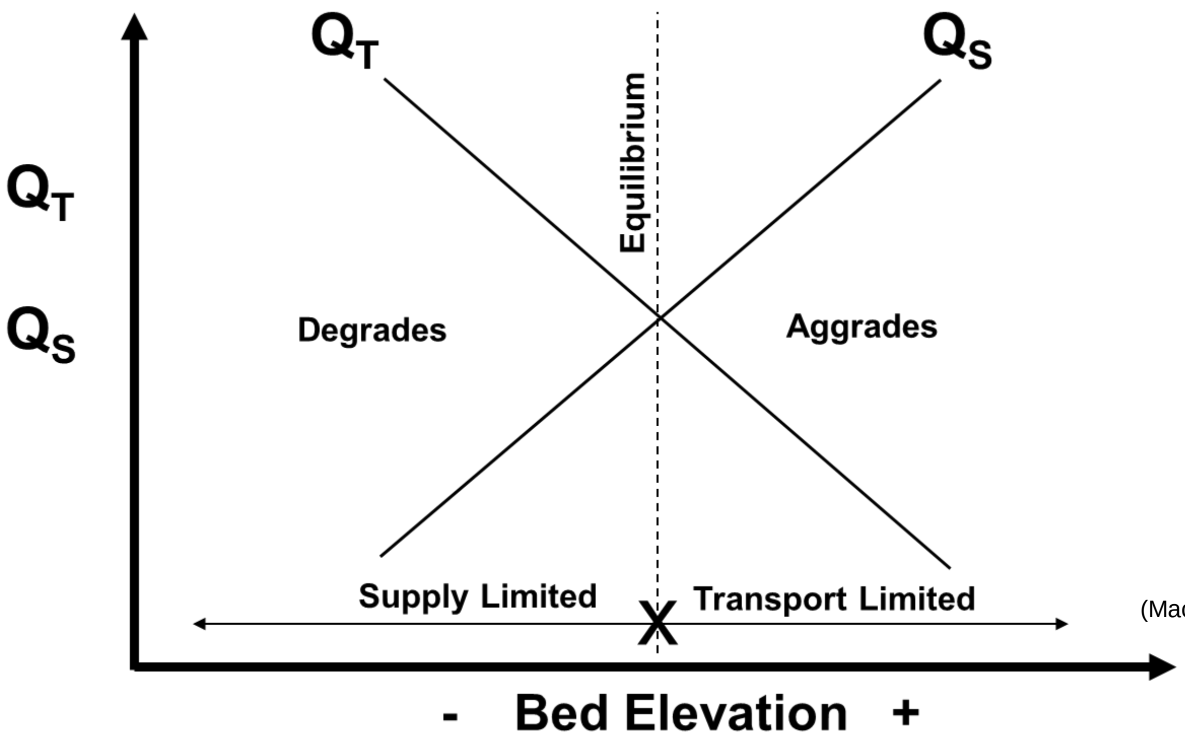
UVM Large Woody Debris Study



(O'Neil-Dunne and Ahles, 2015)

Sediment Transport

- Equilibrium: Load ≅ Transport
- Deposition: Supply > Transport
- Erosion: Transport > Supply
- Local Scour: Bridges, bends, contractions



(MacBroom, 1998)

Identify Sediment Sources

Fulmer Creek
German Flatts, NY
(M. Carabetta, 2013)

Roaring Branch
Bennington, VT
(MMI, 2011)

Assessment and Design Overview

Independent Variables (Assessment)

- Physical Site Constraints
- Valley / Channel Slope
- Existing Channel and Floodplain Dimensions
- Confinement
- Flow
- Stream Power ($\Omega = \gamma QS$)
- Channel Pattern, Alignment, and Dynamics
- Floodplain Connectivity
    - Entrenchment
    - Incision
- Sediment and Large Wood
- Channel Evolution

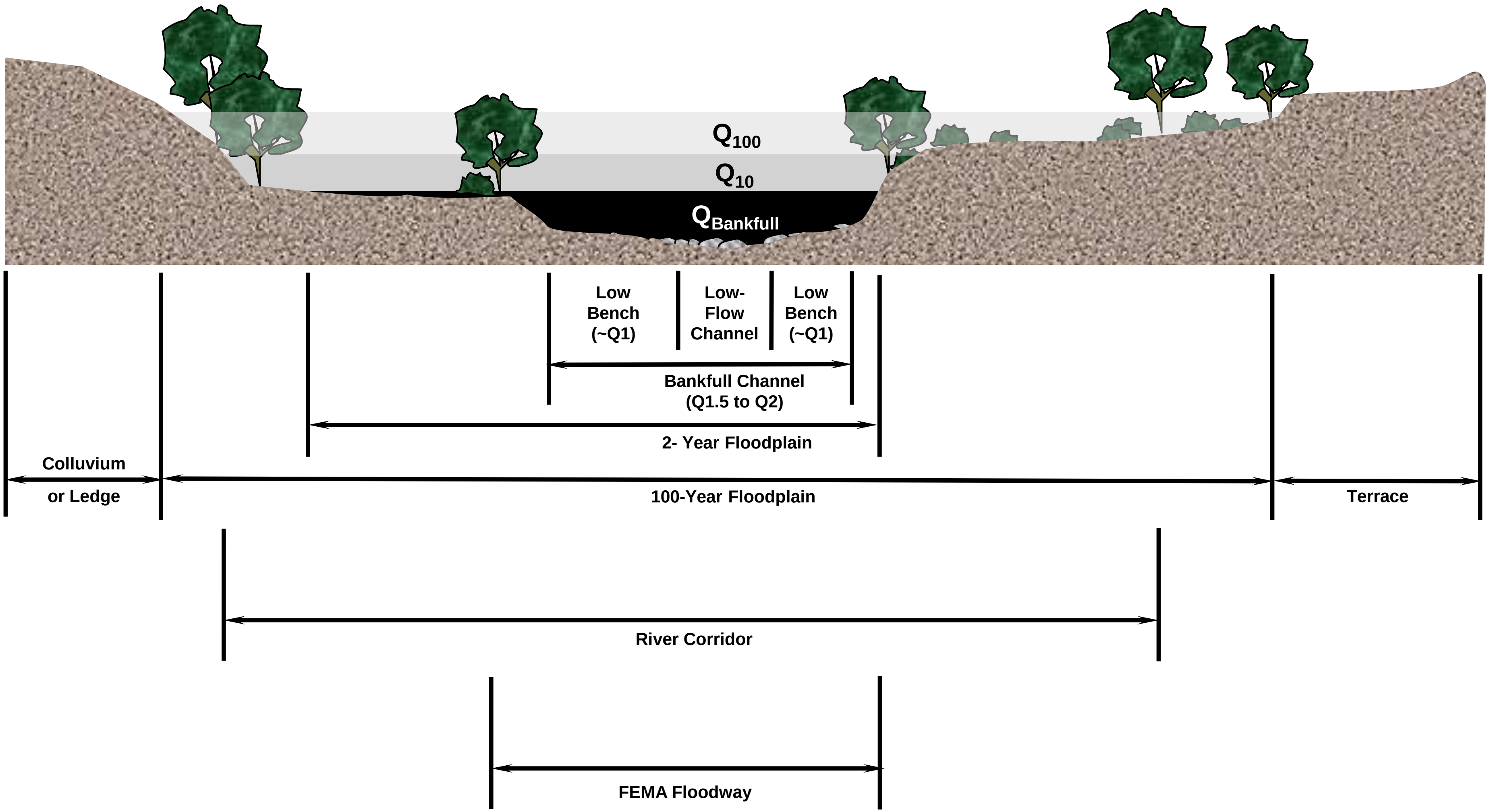
Increasing complexity and variables that may drop out of basic assessment during quick emergency repairs.

Dependent Variables (Design)

- Structure Slope / Channel Profile
- Structure Width and Height / Capacity
- Hydraulics
- Scour
- Sediment in Structure
    - Natural
    - Embedded
    - Streambed Fill in Structure
- AOP
- Structure Design

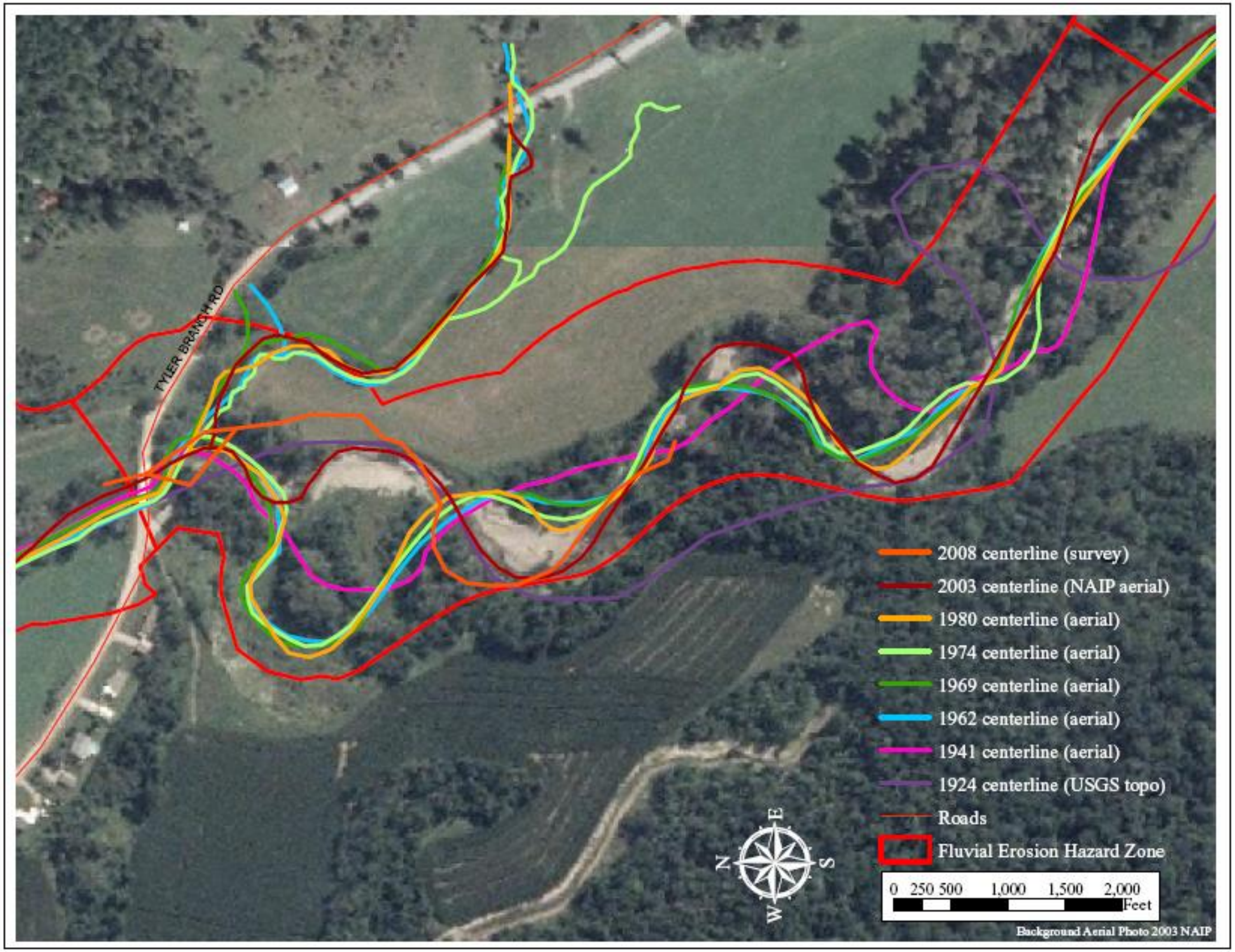
(MMI, 2016)

Floodplain Dimensions



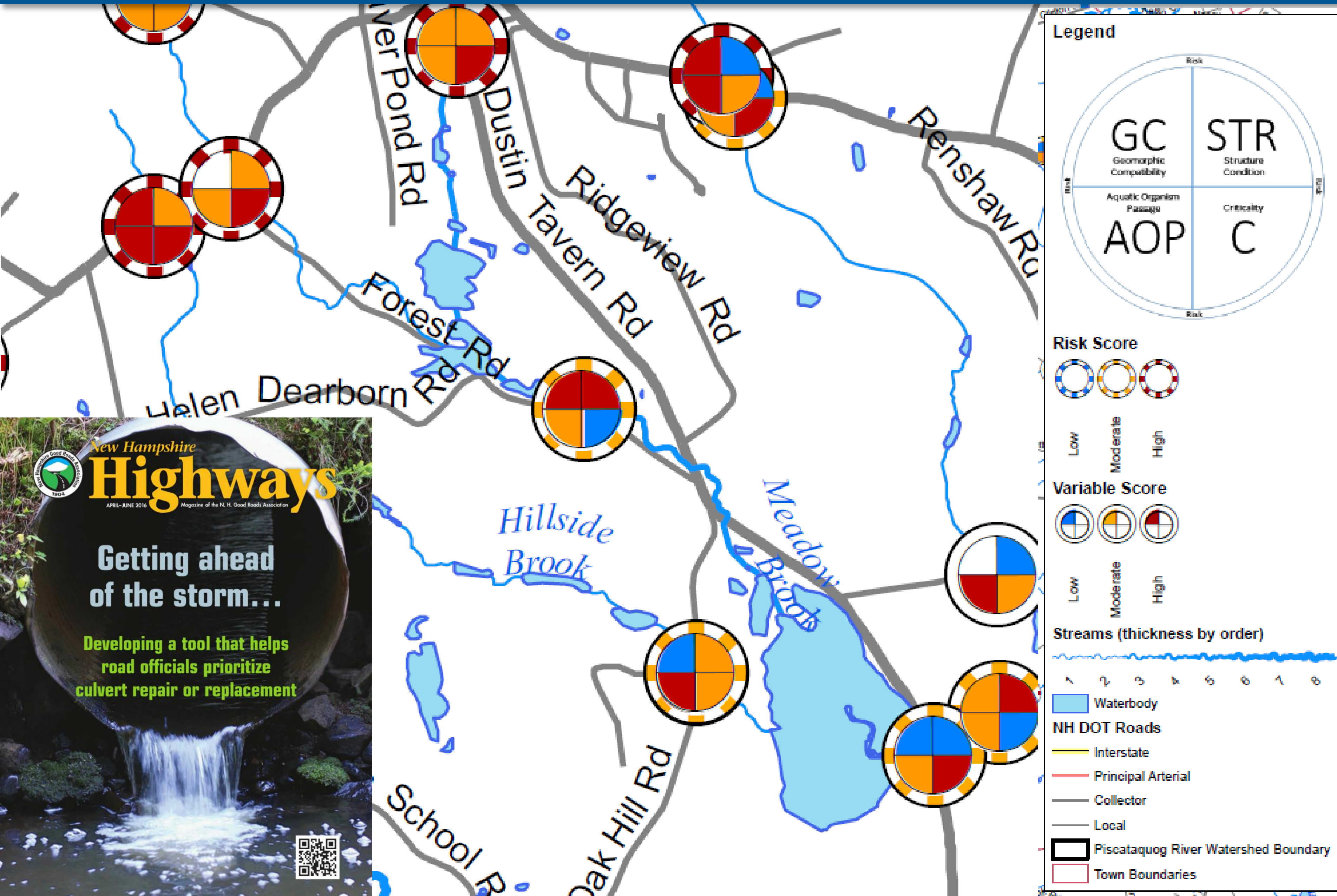
(Adapted from Schiff et al., 2014)

Channel Dynamics



(MMI, 2009)

NH Draft Screen Results



THANK YOU.

Former culvert

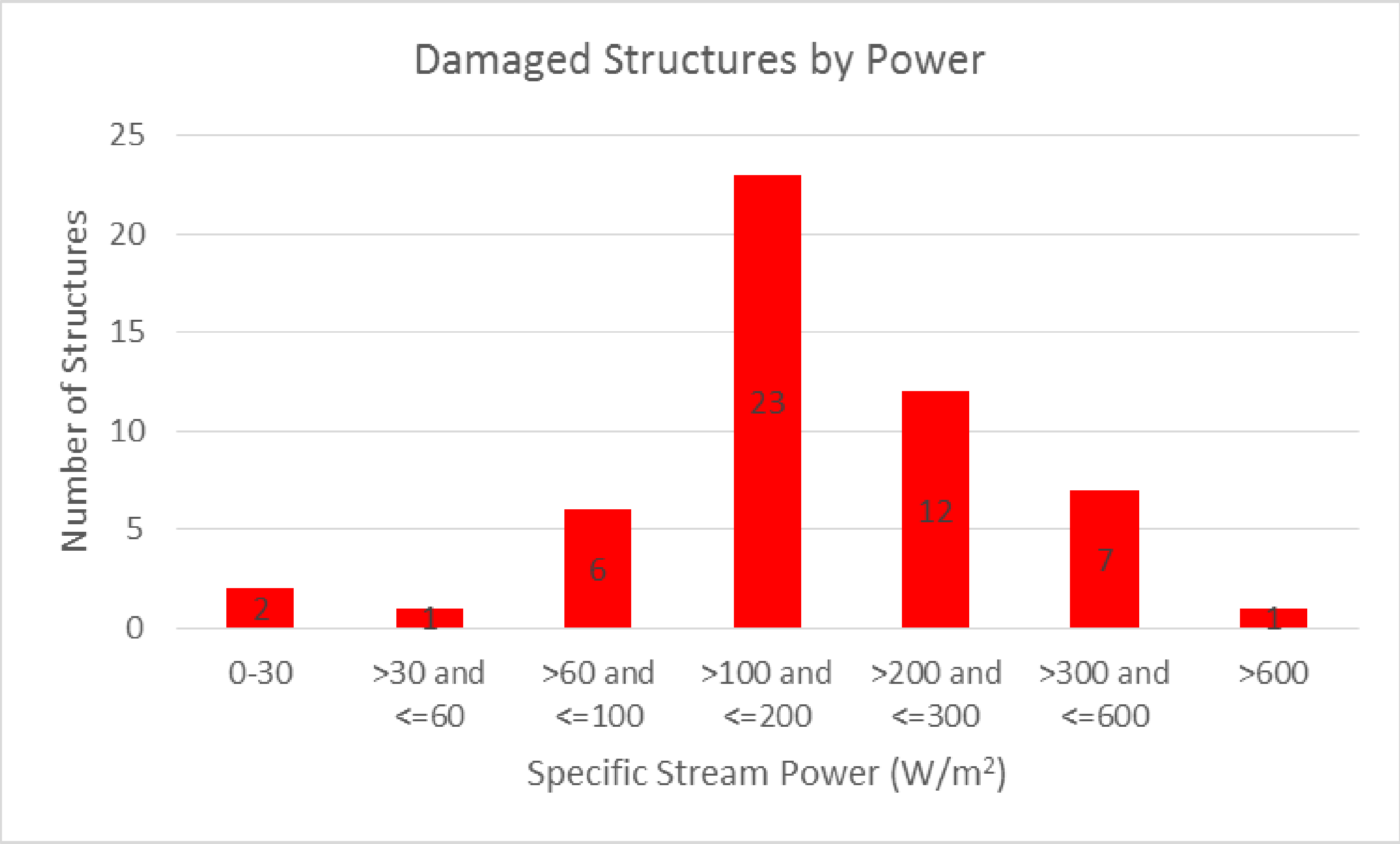
(MMI, 2015)

New culvert

HIGH RESILIENCY = HIGH CONNECTIVITY

EXTRA SLIDES.

MA Culvert Vulnerability Screening

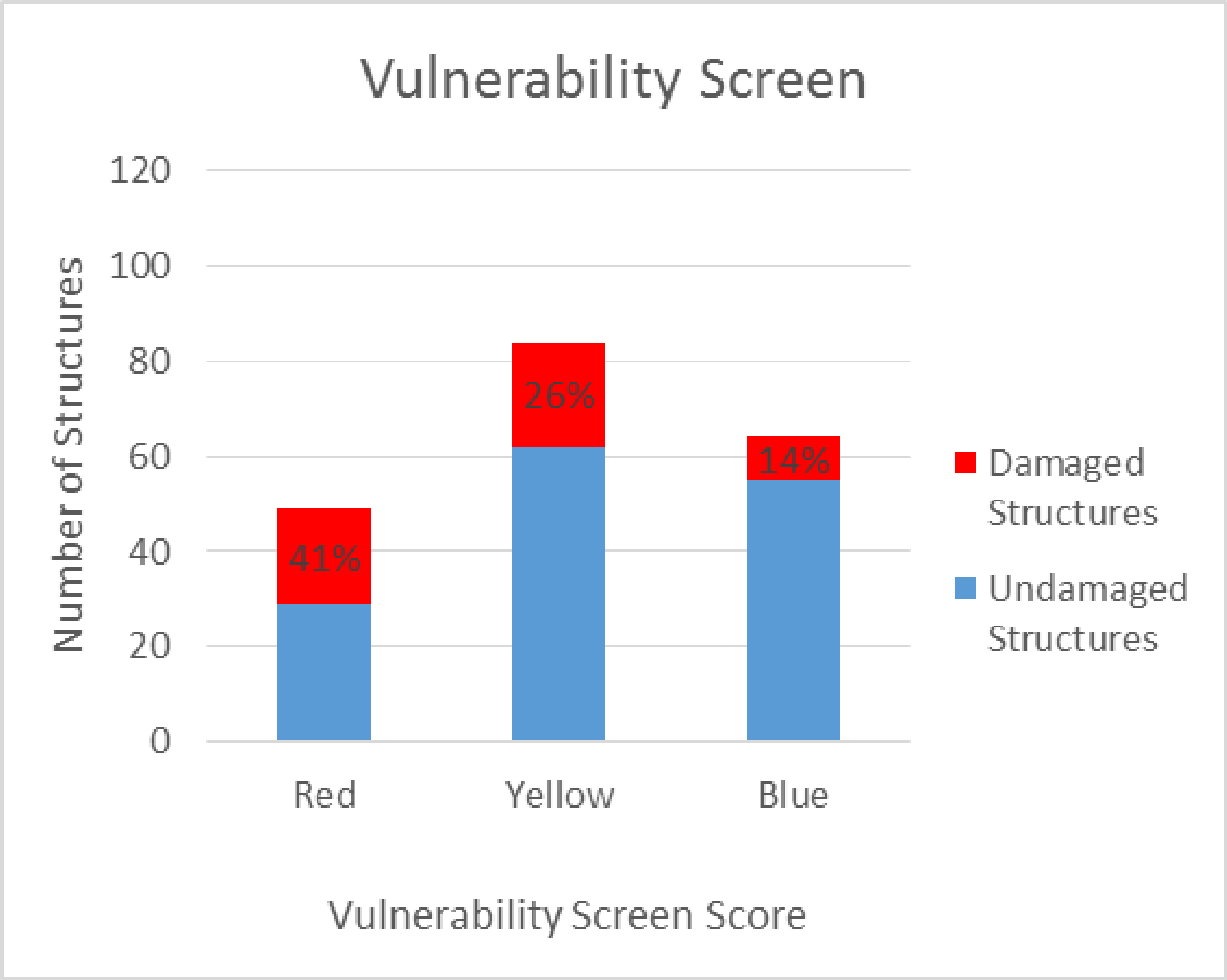


Specific Stream Power versus Bed Resistance

		Dominant Particle Size (Bed Resistance)					
		Silt	Sand	Gravel	Cobble	Boulder	Bedrock
Specific Stream Power (W/m^2)	0-60	3	3	2	3	4	4
	60-100	3	3	0	1	3	3
	100-300	3	2	0	0	2	2
	300+	2	1	0	0	1	2

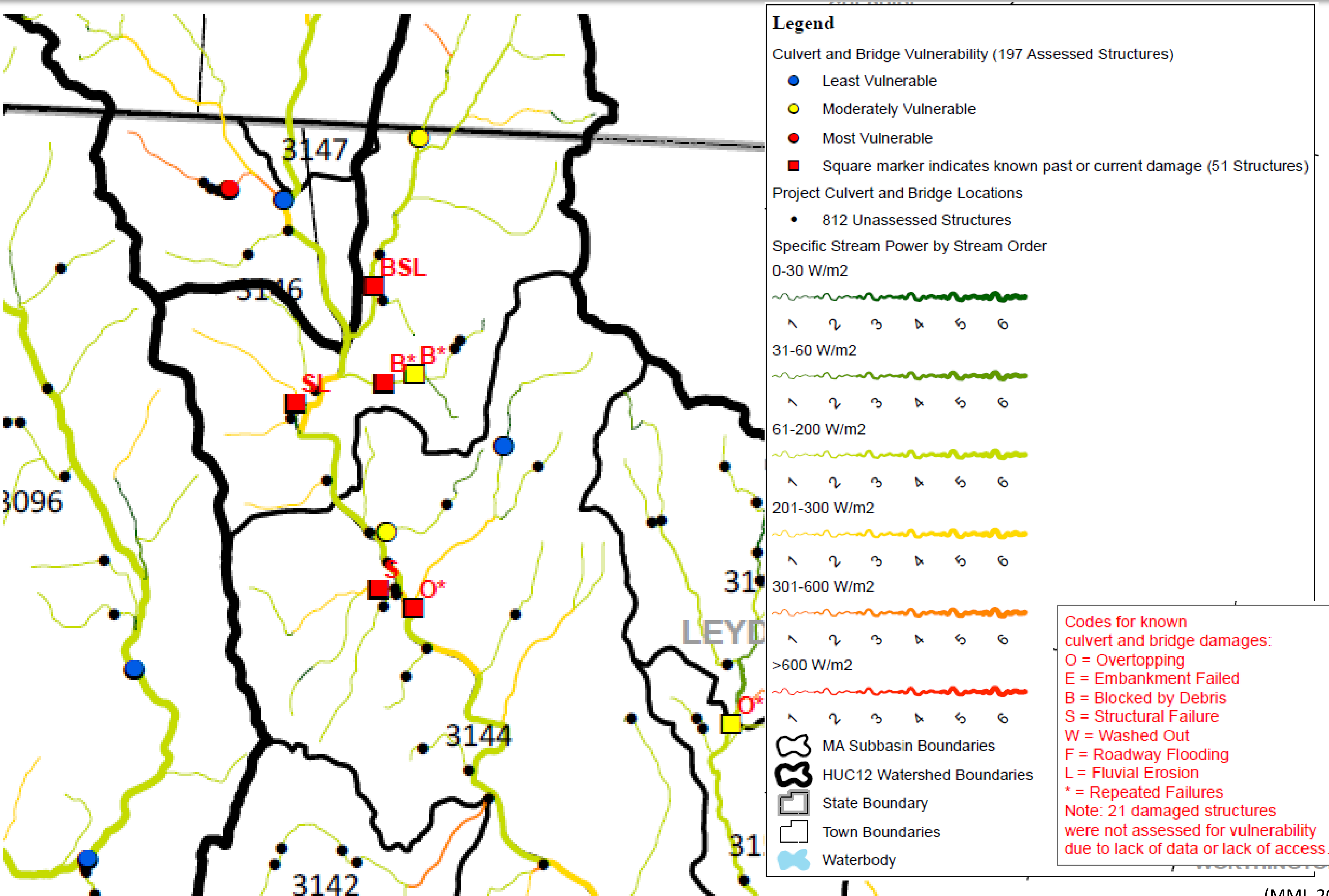
(MMI, 2016)

MA Culvert Vulnerability Screening



(MMI, 2016)

MA Culvert Vulnerability Screening



(MMI, 2016)

Poor Bridge Alignment

Roaring Brook
US Route 4 in Killington, VT
Photo by Lars Gange &
Mansfield Heliflight, August
31, 2011)