USDA FOREST SERVICE

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Stream Simulation Designed Road-Stream Crossings beyond Aquatic Organism Passage

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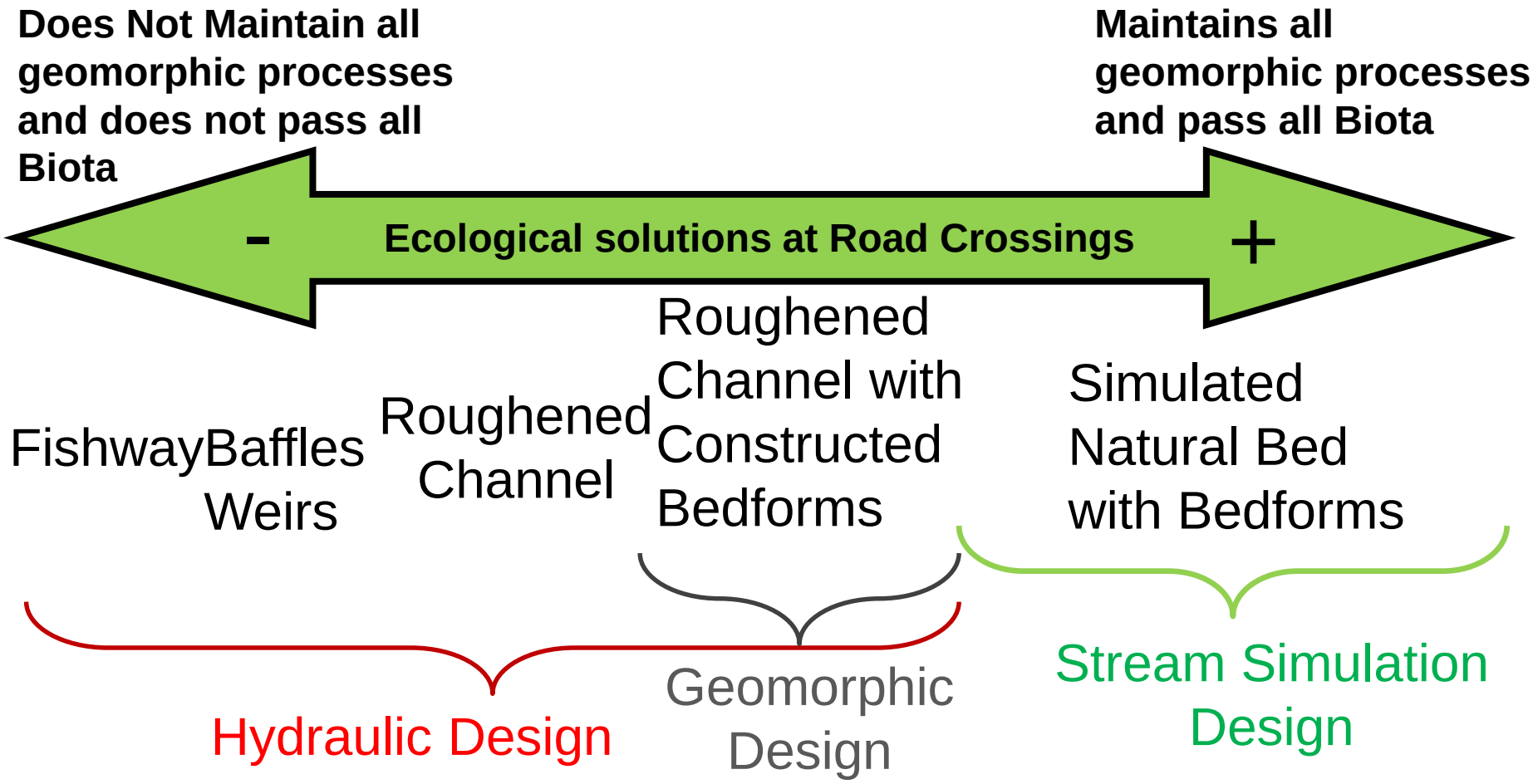
Stream Simulation Designed Road-Stream Crossings beyond Aquatic Organism Passage

What's the Problem?

What are the Passage Objectives & Constraints Relative to Design Method



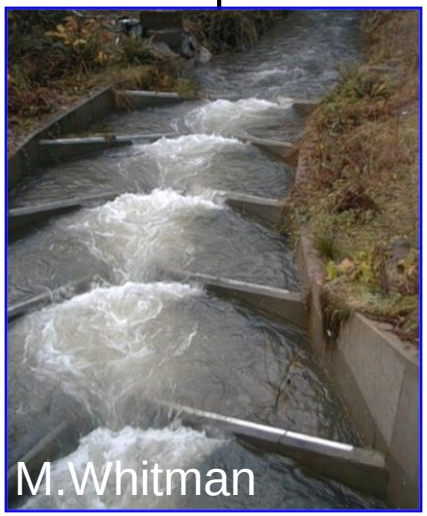
Hydraulic Design Weir / Baffles

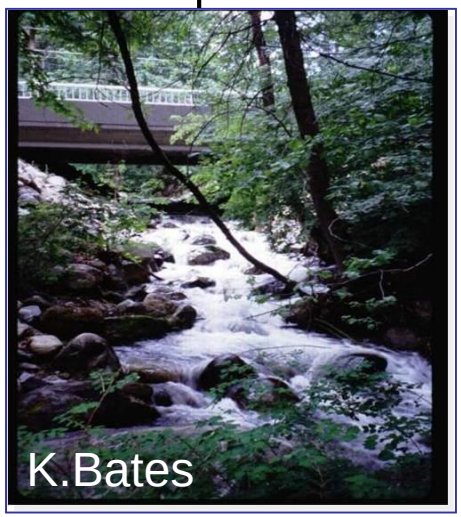
Stream Simulation

- Ecological solutions at Road Crossings +

Pass target species for a life stage

Hydraulic Design Fishway





Geomorphic Design

Pass all species

National USFS AOP "Policy"

"Protect and Restore the Physical, Biological and Chemical integrity of the nations waters" (Intent of the Clean Water Act)

Primary Design Priority:

- Aquatic organism passage and ecological connectivity is the goal and the first design priority for crossing streams that provide habitat for aquatic life.

Other Design Considerations:

- Minimizing the consequences of plugging and overtopping, including the ability to prevent stream diversion.
- Sufficient hydraulic capacity, including the requirement that headwater depth does not cause pressurized flow at the maximum flood.
- Maximize benefits while minimizing life cycle cost.

Road-Stream Crossing Design Methods

- **Stream Simulation Design:** Bridge, arch, or embedded culvert designs providing stream simulation. The USDA Forest Service stream simulation design guidelines should be used when possible.

- **Geomorphic-based Channel Design:** Reconnects the upstream and downstream channel while meeting most fish and other aquatic organism movement and habitat needs.

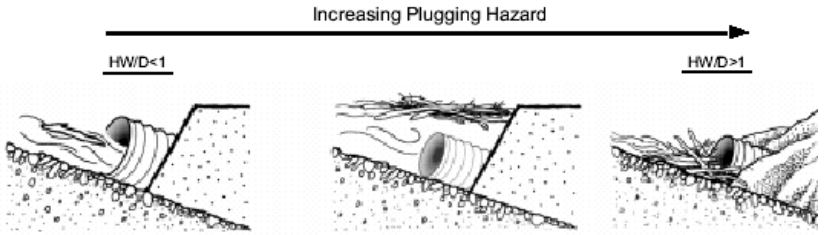
- **Hydraulic Design:** Designs based primarily on hydraulic capacity should be limited to low stream gradients, where the structure is constantly partially submerged. Baffled culverts or structures designed with a fishway are discouraged and should be used as a last resort, especially if they also hinder terrestrial organism passage.

How Structures Fail

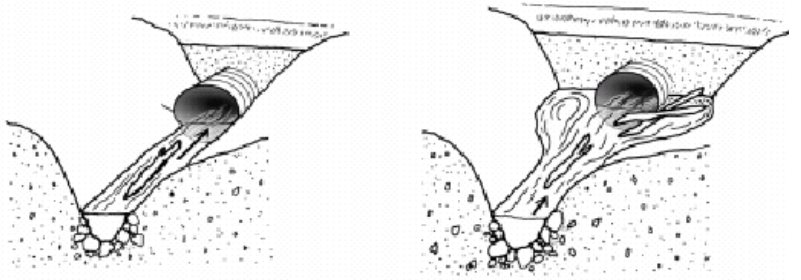
- Hydraulic capacity exceeded
- Sediment “Slug”
- Debris flow (wood, etc.)

Why Structures Fail

- Undersized hydraulic capacity
- Abrupt transitions
- Poor vertical alignment with channel
- Poor stream to structure geometry
- Poor geomorphic location or design not accounting for diversion potential

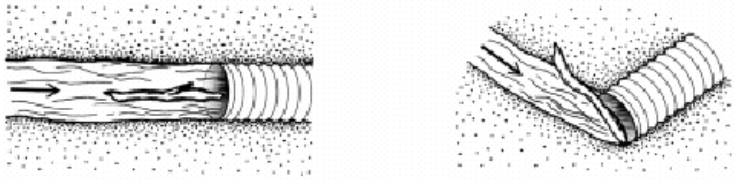


Undersized hydraulic capacity



Abrupt transitions adjacent to structure

Poor design profile (vertical alignment)

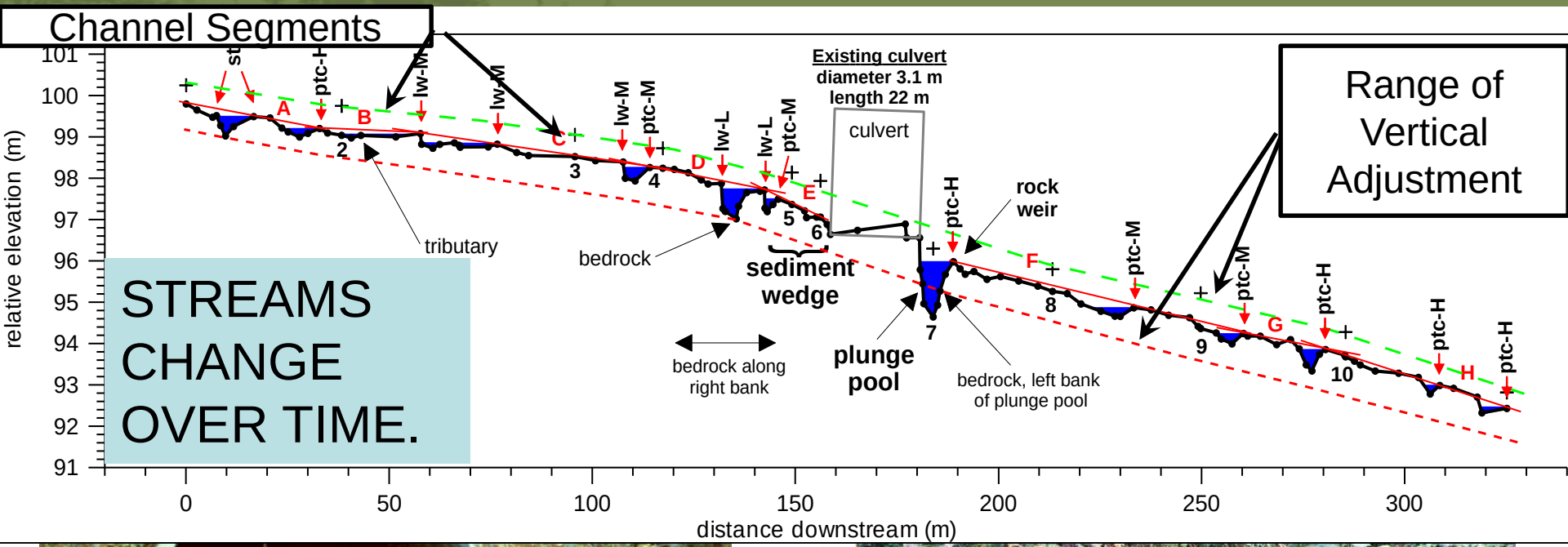


Poor horizontal alignment

Furniss et al 1998

What are the Site & Geomorphic Conditions Relevant to Choosing the Design Method

- **Is the channel stable or incising? How much will it change over time**
- **How much Elevation differential exists (Inlet to Outlet)?**
- **Are there road impounded wetlands upstream or other features that must be maintained?**
- **Are you on an alluvial fan or is the area prone to debris flows?**
- **Is woody debris a problem?**
- **Is there high bed load transport?**


Channel Segments
Existing culvert
diameter 3.1 m
length 22 m
culvert
Range of Vertical Adjustment
STREAMS CHANGE OVER TIME.
tributary
bedrock
sediment wedge
rock weir
bedrock along right bank
plunge pool
bedrock, left bank of plunge pool
relative elevation (m)
distance downstream (m)
A
B
C
D
E
F
G
H
1
2
3
4
5
6
7
8
9
10


1979
T.Sylte


1998
T.Sylte

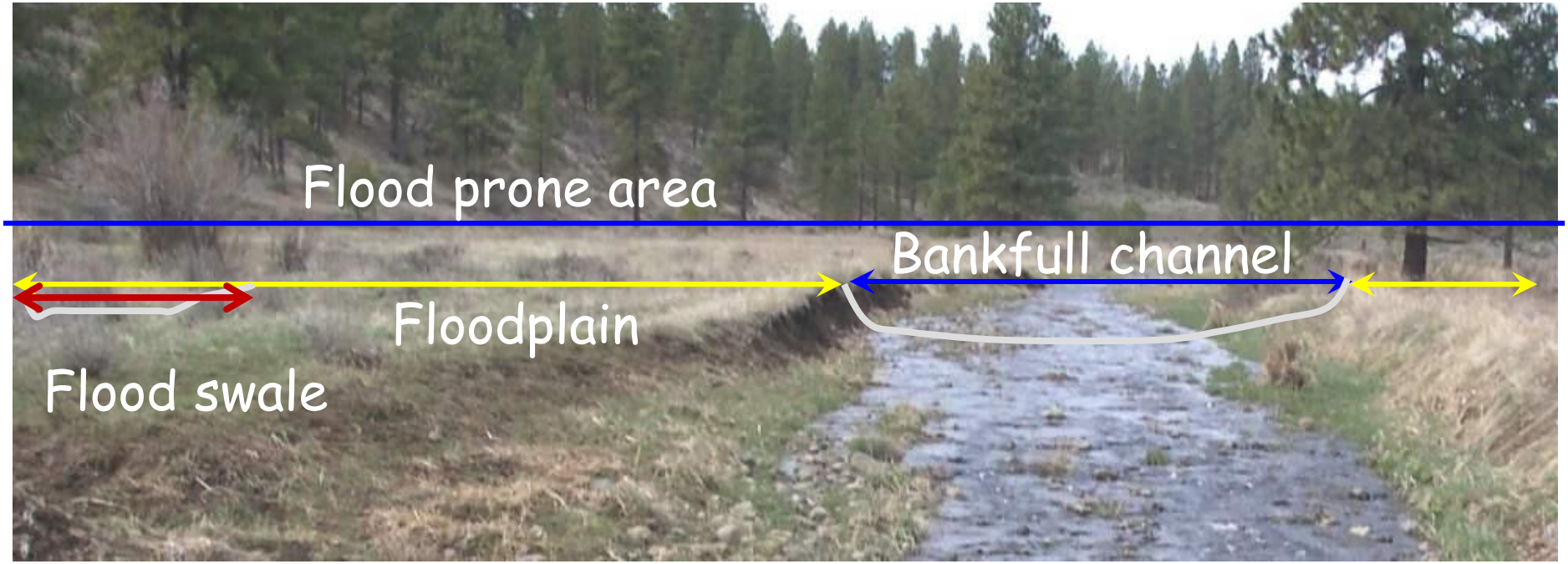
Stream Simulation Design

- Geomorphic and ecologically-based approach
- Mimics natural channel structure, sediment characteristics, water velocity & depths, and resting areas for aquatic organisms

Simulated high gradient channel
Mitkof Island, AK.Tongass NF

TYPICAL LOW GRADIENT CHANNEL

How do the Different Design Methods Fit the Channel

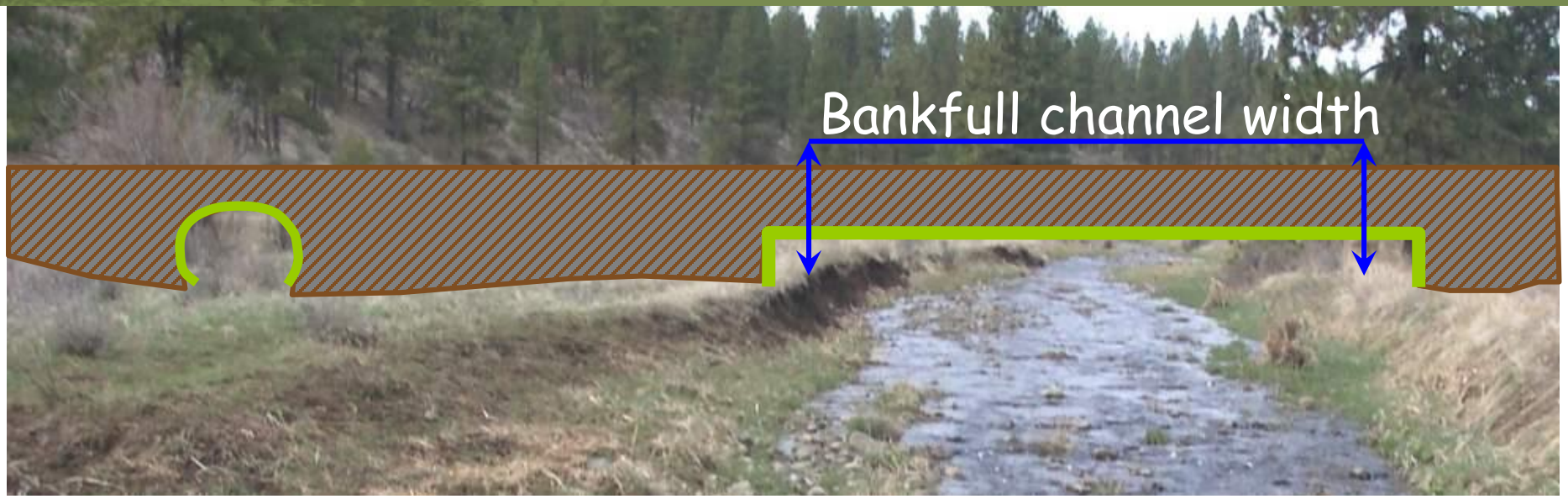


Natural channel with

- Bankfull channel
- Flood plain
- Ecological processes

Hydraulic Design Method
Perspective View on a Road Crossing Site

- Typically constrict the natural channel
- Rigid structure in dynamic environment



Stream Simulation Design Method Perspective View on a Road Crossing Site

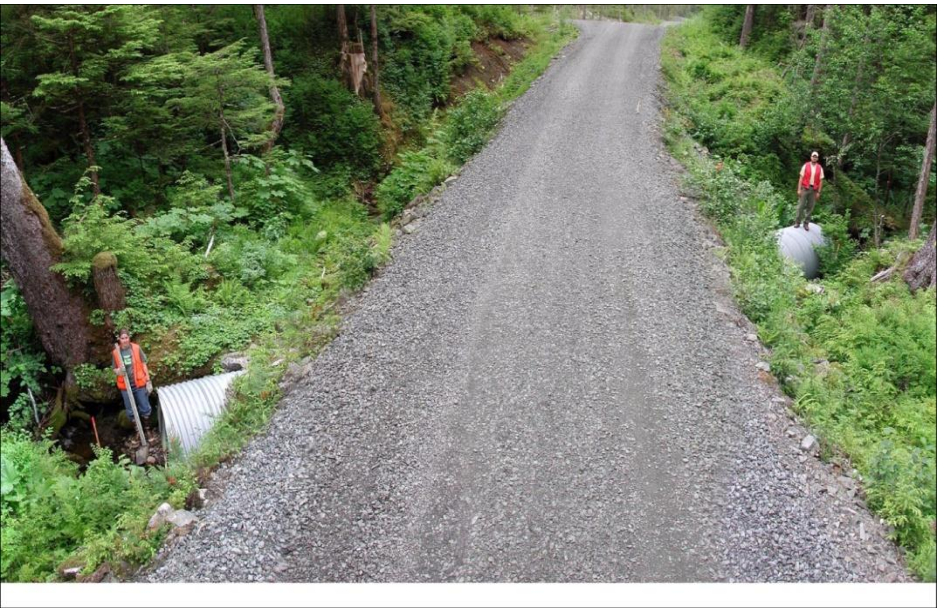
- No constriction the natural channel bankfull width
- Accounts for floodplain conveyance, most geomorphic processes, and all aquatic passage needs
- Flexible design to account for long term changes in bed elevations

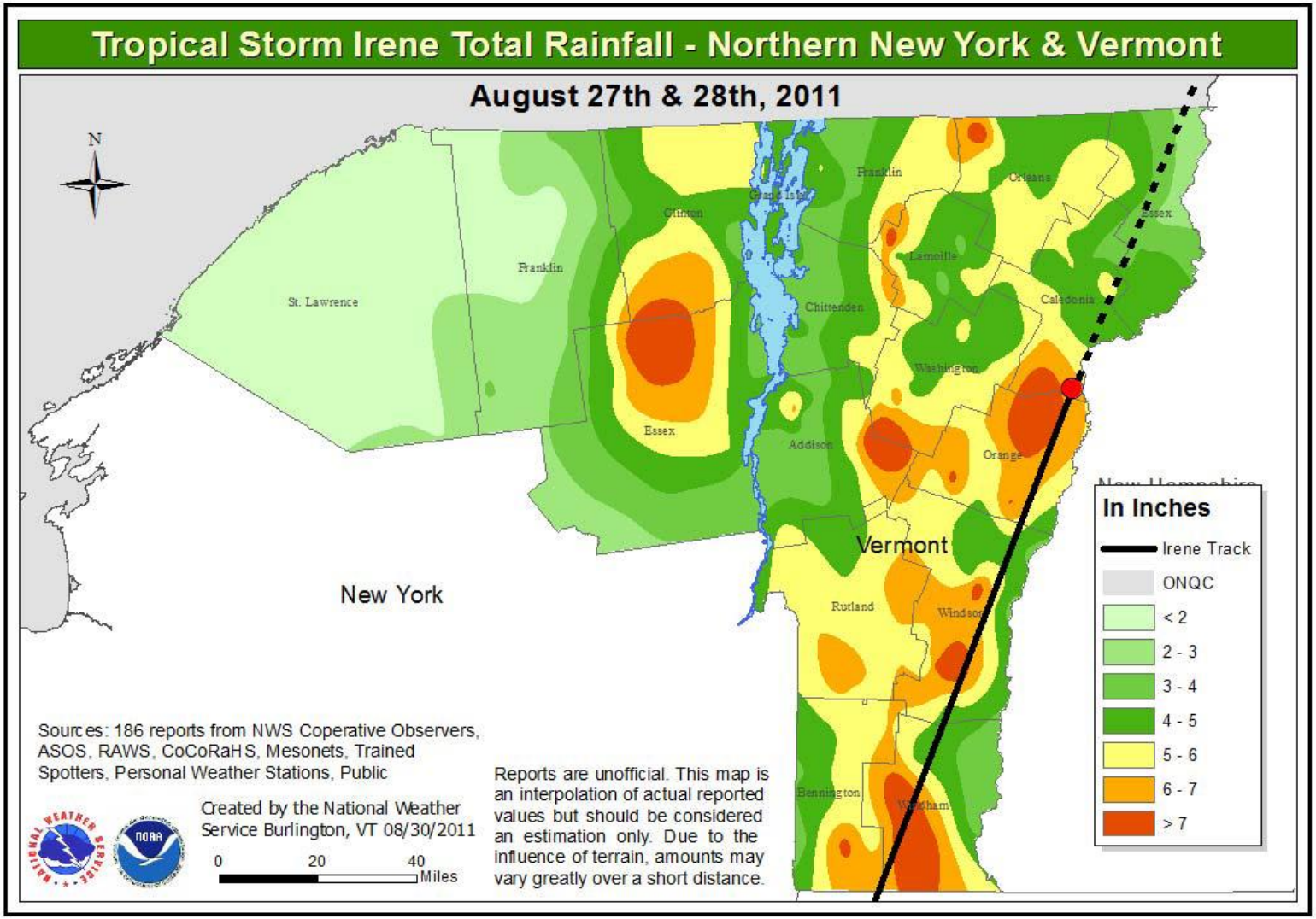
Stream Simulation Design Method Perspective View on a Road Crossing Site

- No constriction the natural channel & floodplain width
- Accounts for floodplain conveyance, all geomorphic processes, and terrestrial & aquatic passage needs
- Flexible design to account for long term changes in bed elevations

What Are The Engineering Constraints Relevant To Choosing The Design Method

- Alignment (Vert. & Horiz.) – Can they be changed?
- Can the road be relocated?
- Are there Right of Way constraints?
- Are utilities present? Can they be relocated?





State wide 1,477 structures were damaged or destroyed

Tropical Storm Irene August 28, 2011

Damage on the GMNF

- 24 Forest Service System Roads (21 miles)
- Estimates repair costs = $6.4+ million
- 11 stream crossing failures
- No stream simulation design failures (3)

Typical Post TS Irene Culvert Failure
Non-Stream Simulation Design

Typical Post TS Irene Culvert Success
Stream Simulation Design

Fort Goff Creek Bridge Project
Klamath National Forest

- **State:** California
- • Removed 15 foot diameter culvert that restricted anadromous fish access in Fort Goff Creek and replaced culvert with a single concrete span bridge.
- • Provided unrestricted access to 1.6 miles of Coho Salmon and Chinook Salmon spawning habitat and 3.4 miles of steelhead trout spawning habitat.
- **Forest Service Contribution:** $10,000
- **Partner Contribution**: $3,490,000
- **Project Costs:** $3,500,000
- **External Partners:**
- California Department of Transportation
- California Dept. of Fish and Wildlife
- US Fish and Wildlife Service
- Pacificorp

Lion Creek Dam Removal Project in Support of AOP
Los Padres National Forest

- **State:** California
- • Removed a 4-foot tall by 25 feet wide check dam that restricted anadromous fish access to Lion Creek, a tributary to the wild and scenic Sespe Creek
- • Collaborative interagency project that provided unrestricted access to 3.7 miles of Southern CA steelhead (SCS) spawning habitat

External Partners:

- National Oceanic & Atmospheric Admin (NOAA)
- California Conservation Corps
- California Department of Fish and Wildlife

Thank you, any questions ?

Before: *shallow, over-widened channel at low water crossing where poor channel habitat retarded upstream fish passage.*

After: *bridge after installation.*

Note: *narrowed stream channel with reconstructed banks for improved aquatic habitat.*