A Nature Based Solution at Road-Stream Crossings: Free Flowing and Flood Resilient

Forest Service
Stream Simulation Design Methodology

USDA Forest Service U.S. DEPARTMENT OF AGRICULTURE

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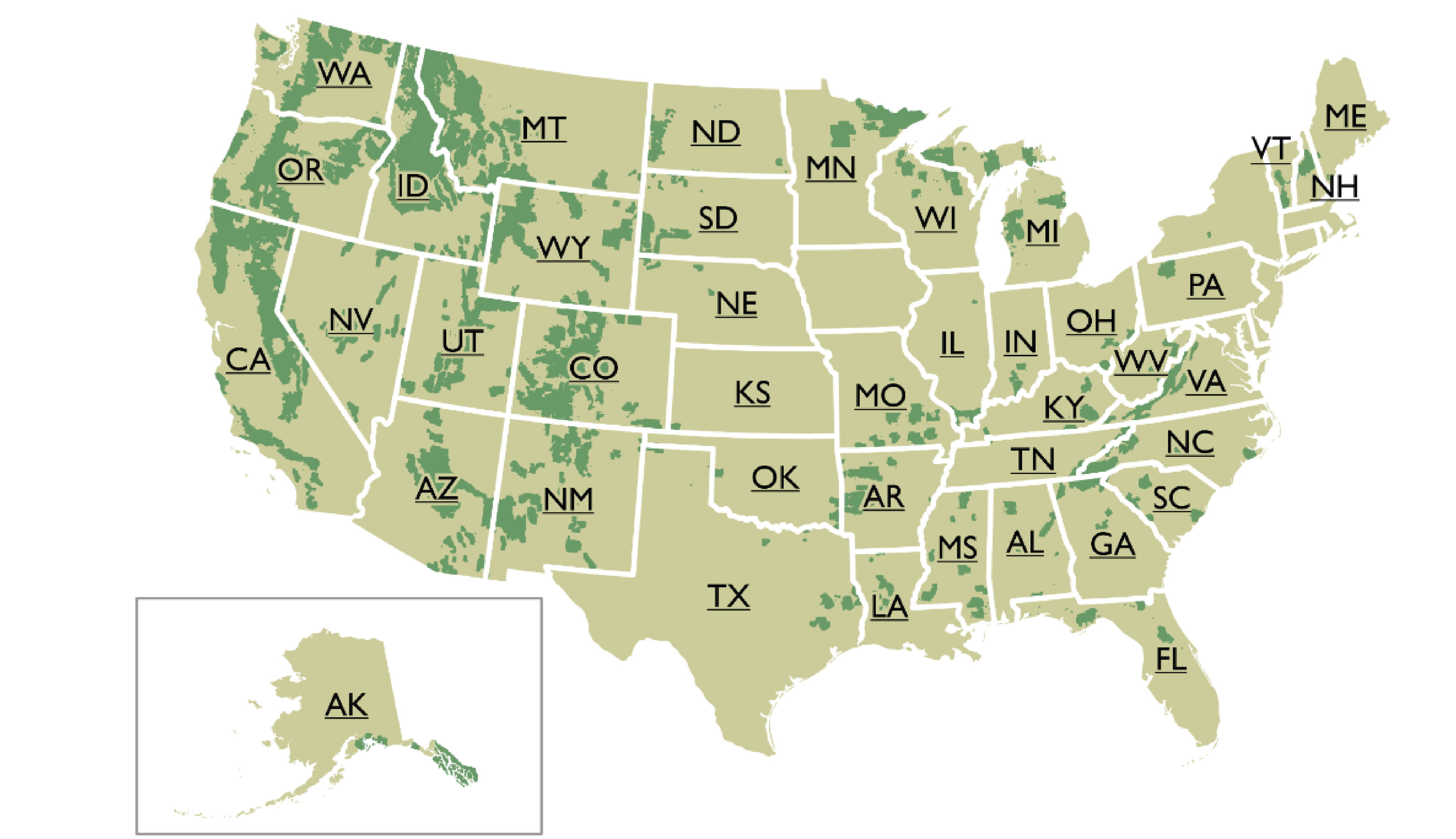


Map of National Forest Lands

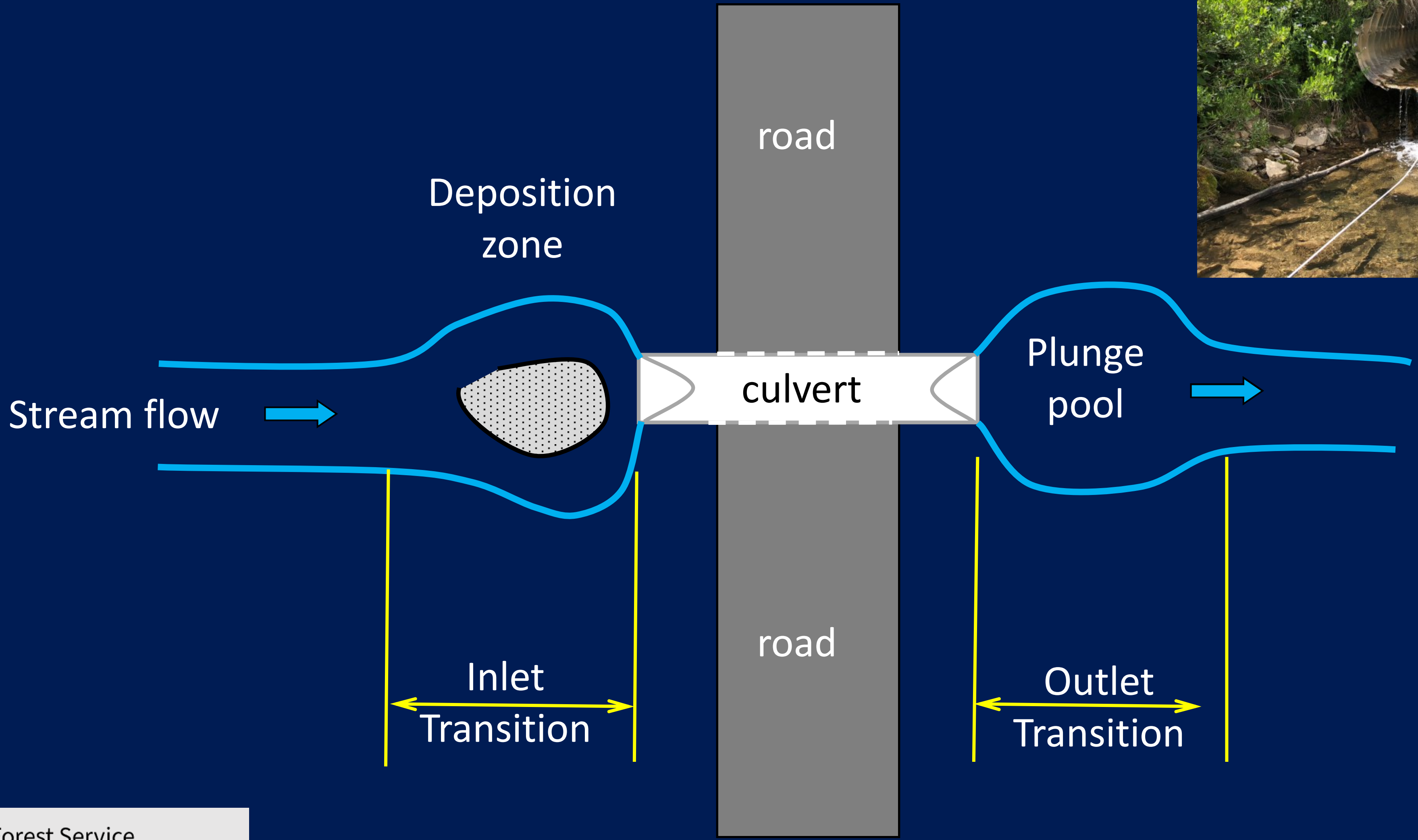
Forest Service Statistics:

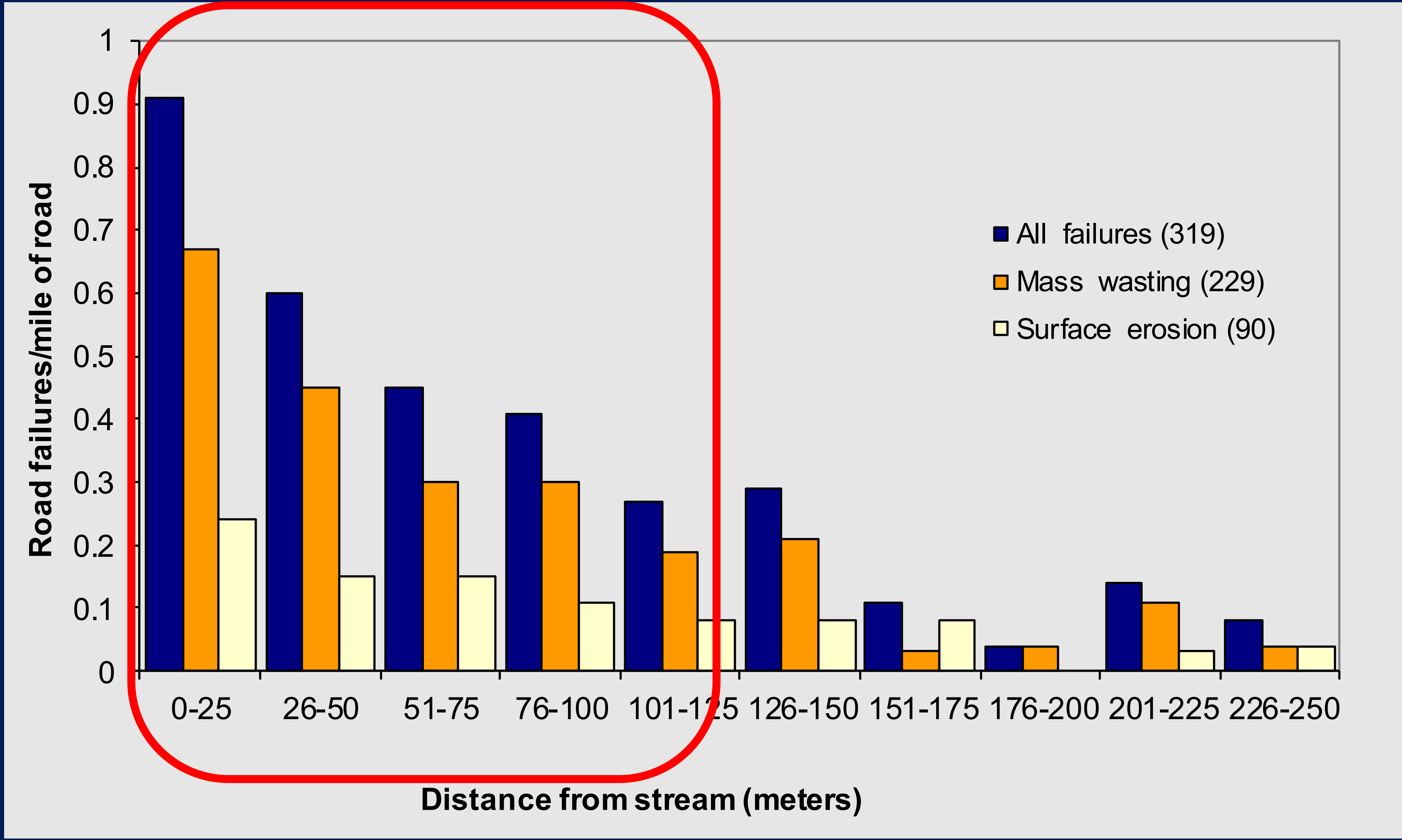
597,700 km of System Roads

357,056 km of Perennial Streams

≈65,000 road-stream & road-river crossings

Anatomy of an undersized culvert





Reference Link

Primary Cause of Species Decline

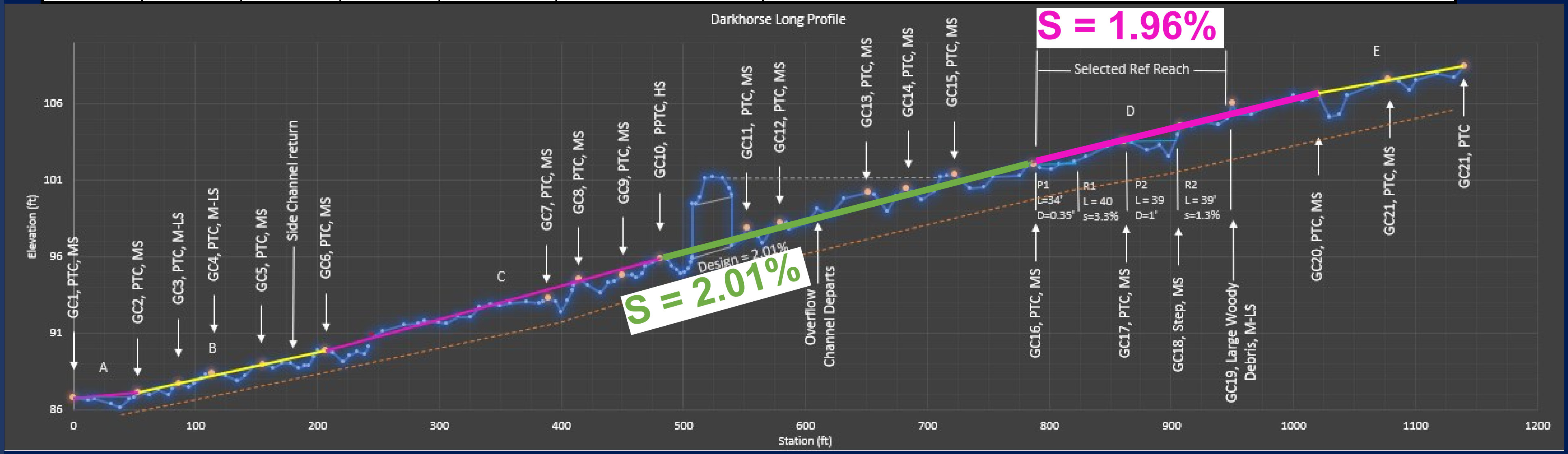
Fragmentation and isolation

The Stream Simulation Methodology Process:

Analyze the longitudinal profile of the stream to find a **REFERENCE REACH.**

The REFERENCE REACH gradient closely matches the **DESIGN PROFILE**.

Segment	Length	Slope	% Diff	# of GC	Pool Depths	Notes
A	53	0.70%	188.3589	1	0.65	Too flat
B	154	1.78%	13.14346	5	0.39, 0.27, 0.46, 0.33	Potential Ref Reach - Low banks/large floodplain
C	274	2.18%	7.762258	3	0.77, 0.87, 0.9	Potential Ref Reach - Sinuous & entrenched with side channel
Culvert	306	2.01%				Culvert is a poor location; alluvial fan. Recommend relocating the road.
D	233	1.96%	2.635832	5	0.35, 0.98	Selected Ref Reach below woody debris before channel type changes
E	120	1.49%	34.95454	3	1.47, 0.8	Flat & differenct Channel Type



DESIGN PROFILE: ties downstream to upstream through the crossing using stable features in the stream.

1. Based on GRADIENT of thalweg

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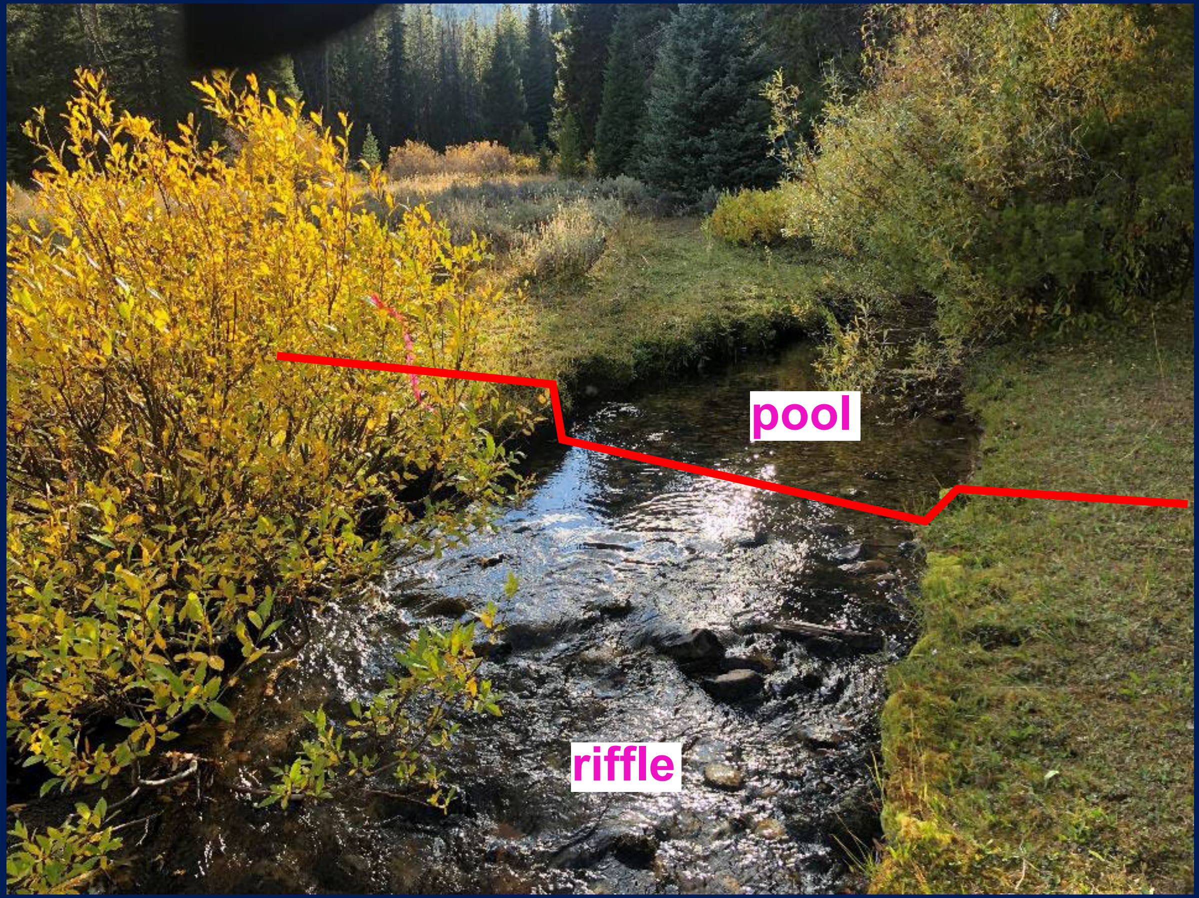
The Stream Simulation Methodology Process:

2. Copy the REFERENCE REACH

- ✓ Cross Sections
  - Bankfull width
  - Floodprone width
  - Bank Height
- ✓ Stream Features
  - Pool-forming features (bends, steps, constriction)
  - Pool lengths & Depths
  - Riffle lengths
- ✓ Streambed Material



The Stream Simulation Methodology Process:

3. Select a structure to fit the stream width plus banklines connecting downstream to upstream.

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*Verify design flood stage; no pressurized pipes

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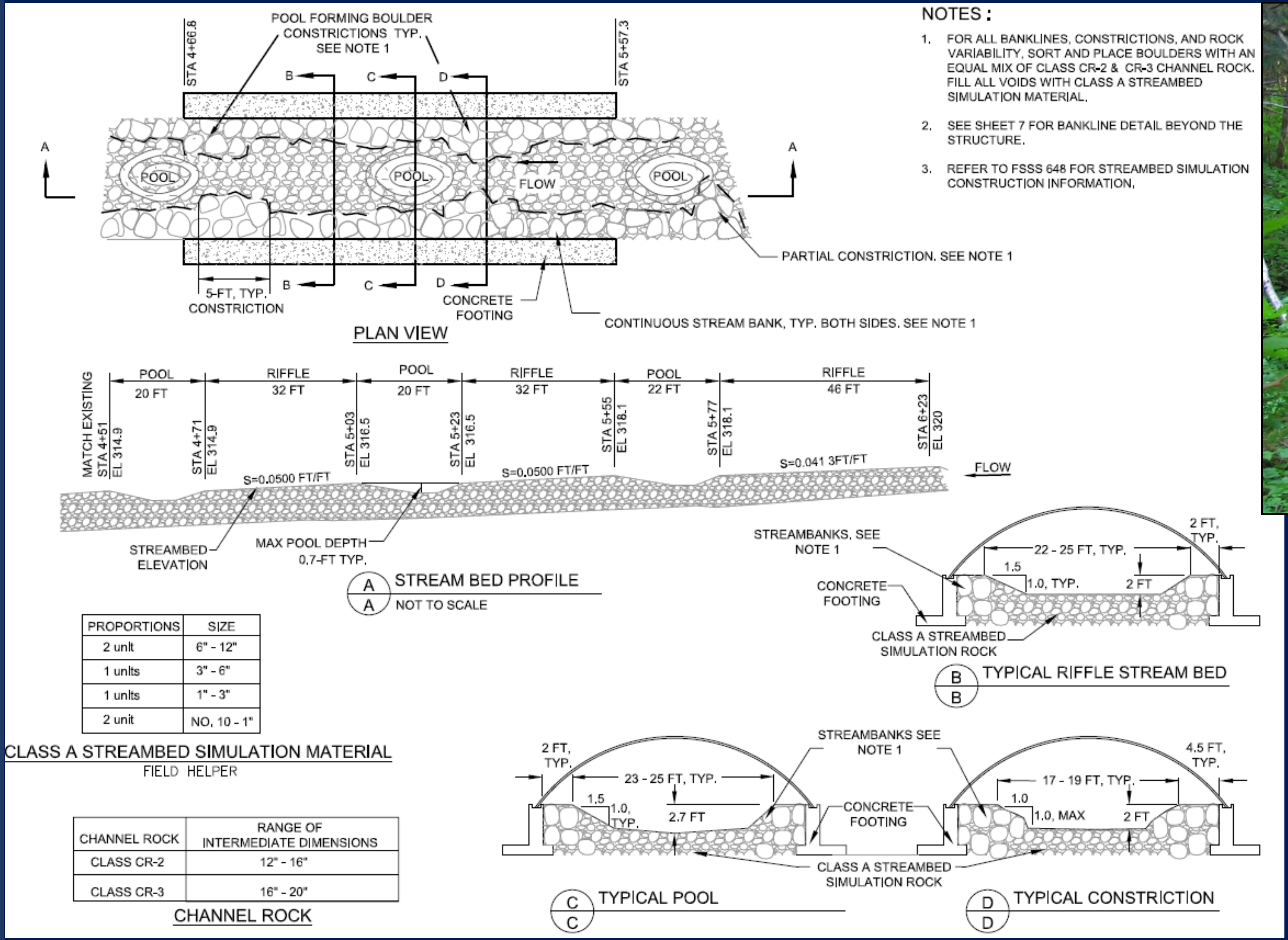
The Stream Simulation Methodology Process:



4. Create Construction Drawings

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Stream Simulation Outcomes

- Replicates the natural channel
- Provides passage for aquatics & terrestrials
- Facilitate the natural process to, minimize maintenance, reduce failure liability, & reduce future resource damage

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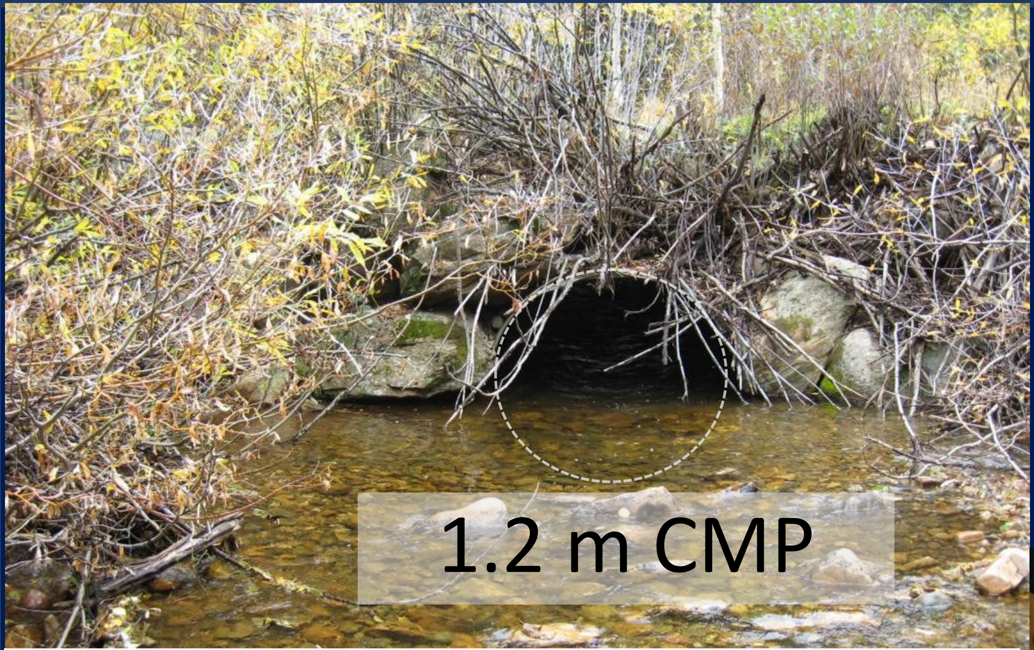
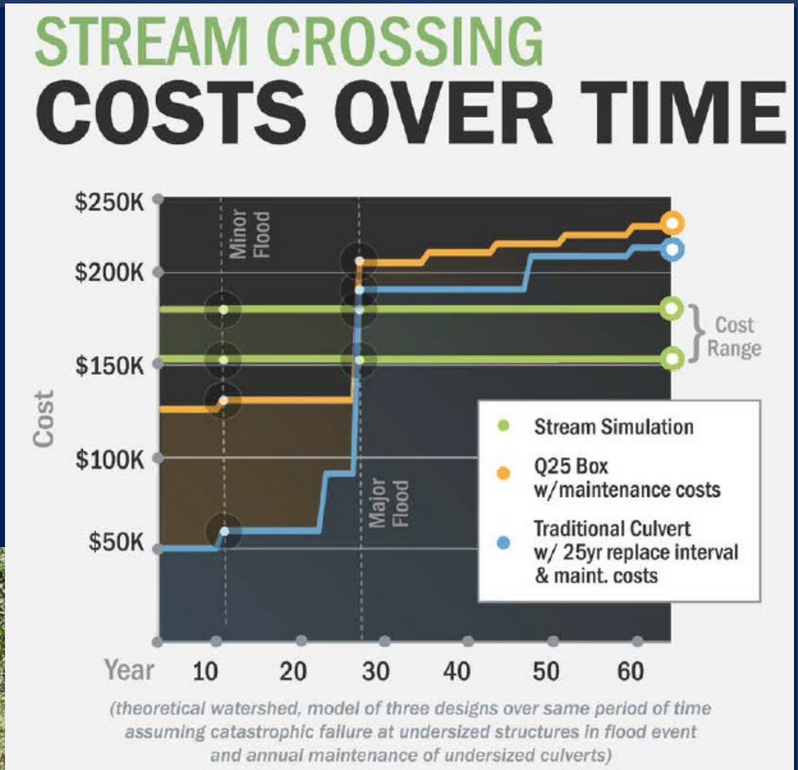


Comparison	Hydraulic Design	Geomorphic Design
Design Life (not including failure)	25 – 50 yrs	75 – 100 yrs
Maintenance	Seasonal	0 - minimal
Ecologic & Economic	Fractured Habitats, Sediment Loads	Unimpeded Access



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Publication Link

FEATURE

Flood Effects on Road–Stream Crossing Infrastructure: Economic and Ecological Benefits of Stream Simulation Designs

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Efecto de las inundaciones en la infraestructura de pasadizos fluviales: beneficios económicos y ecológicos de los diseños de simulación de arroyos

RESUMEN: *el diseño de simulación de arroyos es un enfoque geomórfico, de ingeniería y con consideraciones ecosistémicas en el que se crean pasadizos erigiendo un canal natural y dinámico entre arroyos a través de estructuras de paso similares en dimensiones y características al canal natural adyacente, permitiendo así el paso irrestricto de organismos acuáticos, debris y agua durante distintas condiciones de flujo, incluyendo inundaciones. Se llevó a cabo un caso de estudio retrospectivo acerca de los éxitos y fracasos de la construcción de pasadizos entre arroyos en la parte alta de la cuenca del Río Blanco y el parque Nacional Montaña Verde, en Vermont, justo después de las inundaciones sucedidas tras el paso de la tormenta tropical Irene, en agosto de 2011. El daño fue en gran parte evitado en dos pasadizos donde se implementó el diseño de simulación de arroyos, no así en distintos pasadizos que fueron construidos mediante el diseño hidráulico tradicional, en los que el daño fue extensivo. El análisis de costos sugiere que incrementos relativamente pequeños en la inversión inicial, destinados a implementar un diseño de simulación de arroyos, dan como resultado considerables beneficios sociales y económicos. Se presentan recomendaciones que podrán ayudar tanto a las agencias como los participantes genuinamente interesados en el tema, a mejorar los pasadizos fluviales mediante un incremento en la coordinación que promueva las metodologías del diseño de simulación de arroyos, aumento de los fondos y la flexibilidad de las*

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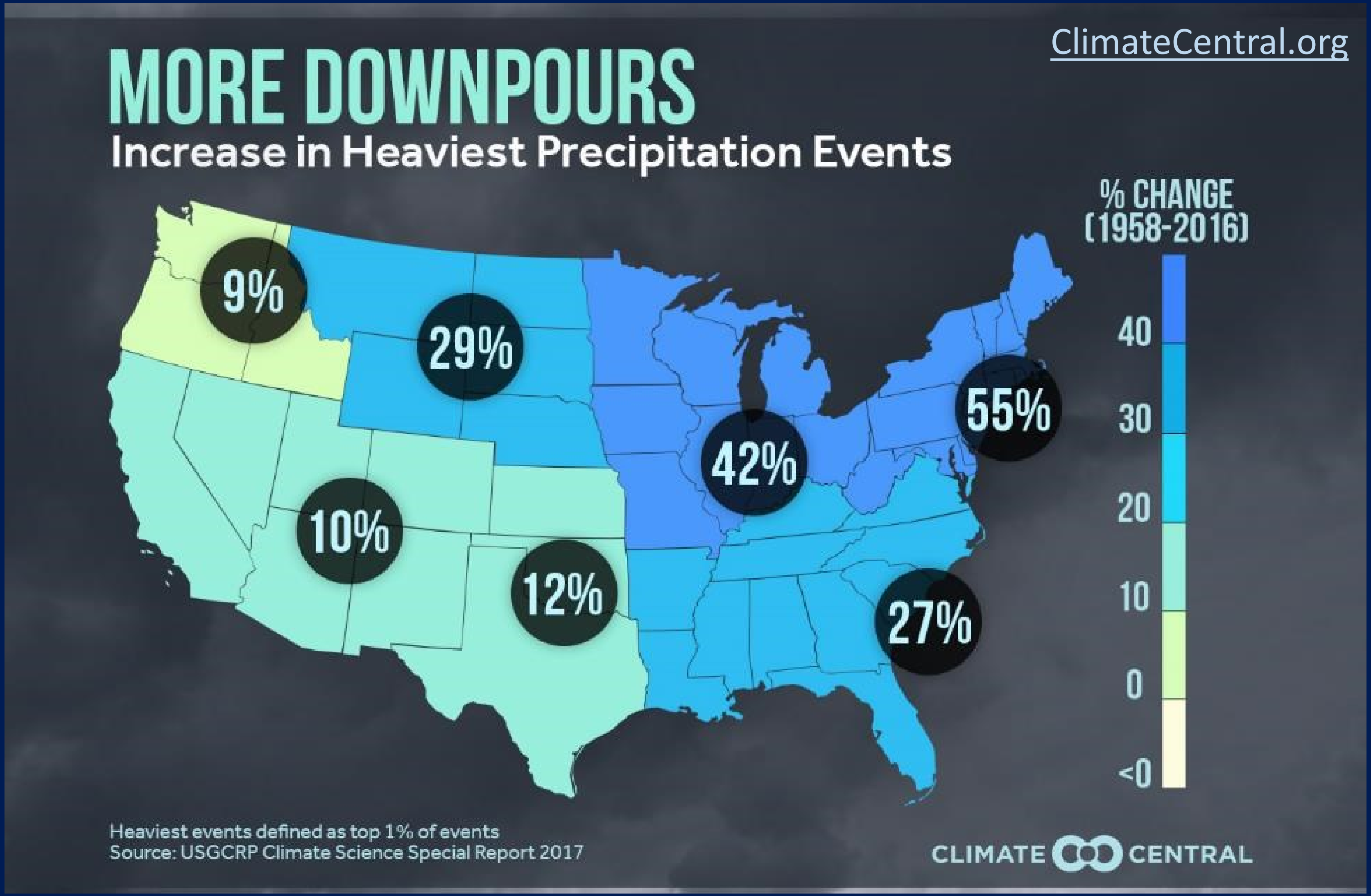
Climate Change Research for the U.S.



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With climate change, extreme flooding is becoming more common.

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Thank You
Free Flow 2024

STREAM SIMULATION: An Ecological Approach To Providing Passage for Aquatic Organisms at Road-Stream Crossings

by

Forest Service Stream-Simulation Working Group

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