

Dec 11th, 1:30 PM - 3:10 PM

A Cross-section of Hydraulic Design Solutions to Address Vertical Profile Constraints at Road Crossing Design Projects

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Garelo, Michael, "A Cross-section of Hydraulic Design Solutions to Address Vertical Profile Constraints at Road Crossing Design Projects" (2018). *International Conference on Engineering and Ecohydrology for Fish Passage*. 16.
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A cross section of hydraulic design solutions to address vertical profile constraints at road crossing design projects

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Session 2-5: Fish Passage Design – Road Crossings II, December 11, 2018

FISH PASSAGE 2018 - INTERNATIONAL CONFERENCE ON RIVER CONNECTIVITY
INCORPORATING THE FIRST SYMPOSIUM ON HYDROPOWER AND FISH MANAGEMENT
DECEMBER 10-14, 2018 | ALBURY, NEW SOUTH WALES (AUSTRALIA)





01 Road Crossing Design Strategies

02 Project Constraints and the Hydraulic Design Method

03 Common Hydraulic Design Solutions

04 Hydraulic Design Solutions Applied at Example Projects



01

Road Crossing Design Strategies

Why is Road Crossing Design Important?

- Importance of Road Crossing Design
 - Provides fish access to habitat located upstream of road crossing impediments
 - Not just a fish passage project - Aquatic Organism Passage (AOP) Design
 - Improves geomorphic and ecological connectivity
 - Focuses on the reduction of long-term maintenance costs for transportation corridors



Road Crossing Design Strategies



Geomorphic and Stream Simulation Design

- Mimics character and natural processes exhibited in the existing creek or river



Hydraulic Design

- Introduces designed elements that target a specific hydraulic outcome

Road Crossing Design Strategies - Comparison

Geomorphic Design

- Simplified design approach
- Mimics hydraulic and fish passage characteristics of adjacent reaches
- Accommodates more effective Aquatic Organism Passage (AOP)
- Higher levels of ecologic and geomorphic continuity
- Generally lower maintenance and long-term costs

Hydraulic Design

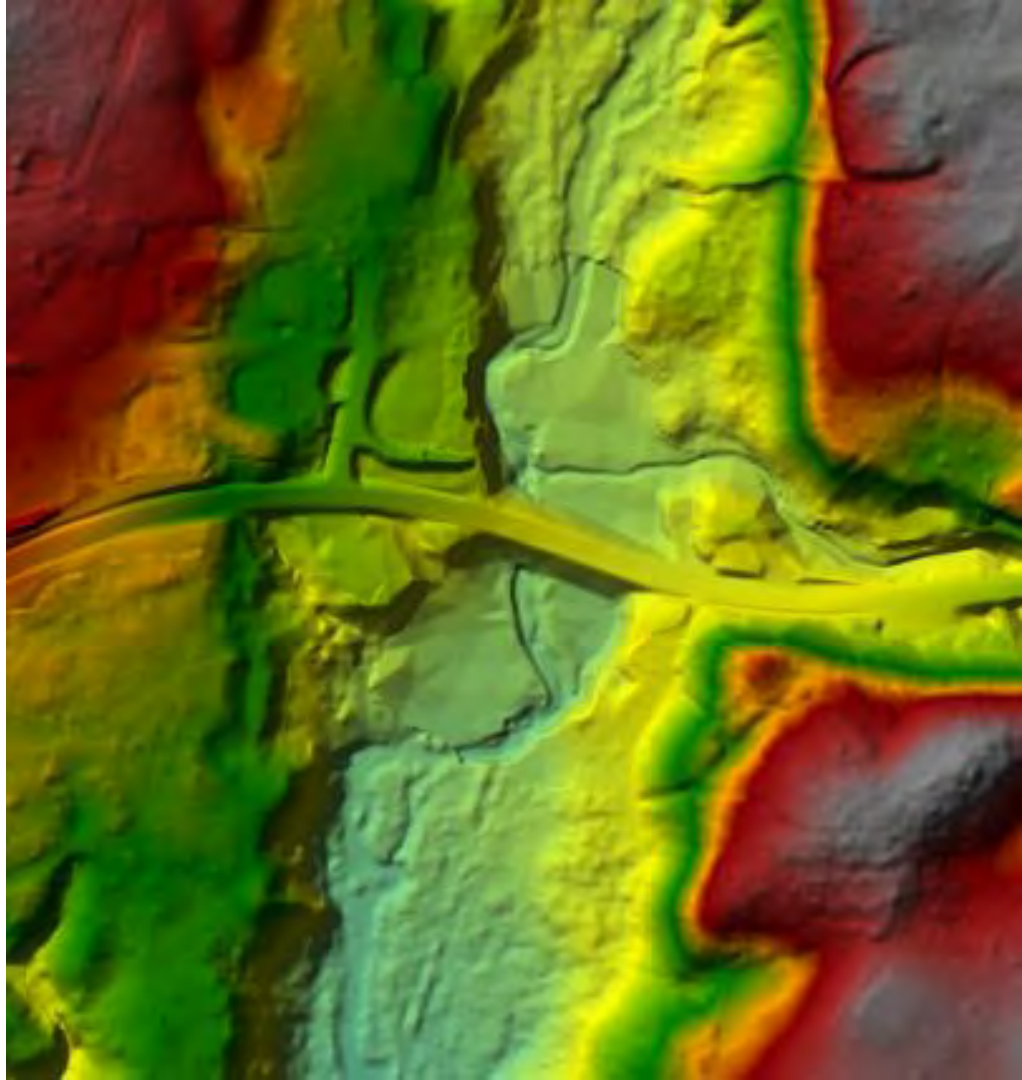
- More complex design approach: 1D, 2D, and 3D models may be used to approximate hydraulic characteristics and bioenergetics.
- Targets a defined set of hydraulic design objectives for select fish species and life stages
- Project elements are designed to accommodate constraints and can limit natural process and continuity.
- Generally higher maintenance and higher long-term costs.



Hydraulic Designs Can Require

- More complex hydraulic and hydrodynamic modeling using more sophisticated software,
- Strict compliance with known design guidelines under the purview of government agencies
- Agreement on design criteria for target species behavior and biology (example: swimming and leaping capability)
- Scour analysis and countermeasures
- More detailed flood conveyance and flood damage mitigation analysis

...a lot more time, effort, and detailed analysis...





02 Project Constraints and the Hydraulic Design Method

Common Constraints Experienced at Road Crossing Projects

- Property ownership and right-of-way boundaries,
- Upstream or downstream structures,
- Geologic features,
- Retaining walls,
- Buildings and structures,
- Road and rail embankments,
- Utilities (UG and OH),
- Funding,
- Others....



Project Constraints Influence the Use of Hydraulic Design Strategies

- Constraints introduce planform and profile irregularities not characteristic of a stream's form and function
- Hydraulic forces become unbalanced with regard to conveyance or bed composition
- If not addressed, un-intentional channel adjustments and instability will occur
- Measures to counter, stabilize, and/or fix streambeds in place require a more complex hydraulic design approach



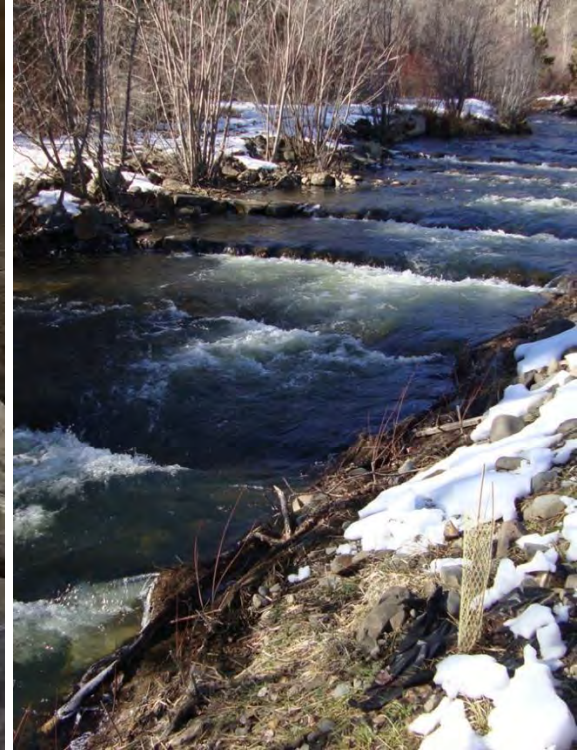
Example of Project with Multiple Constraining Factors





03

Common Hydraulic Design Solutions



Roughened Channels and Rock Ramps

Rock Weirs and Log Weirs



Rock Riffles and Rock Slope Protection



Hydraulic Training Structures Engineered Wood Structures



Technical Fish Ladders

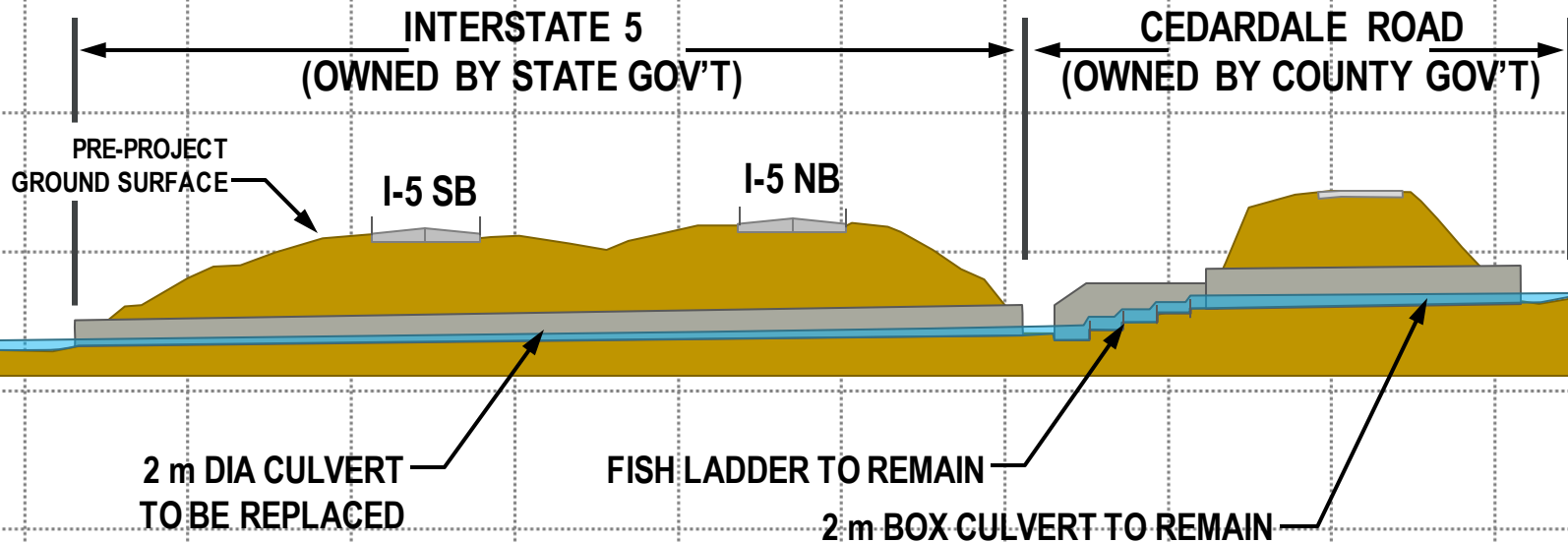




Culvert Retrofits and Hydraulic Baffles



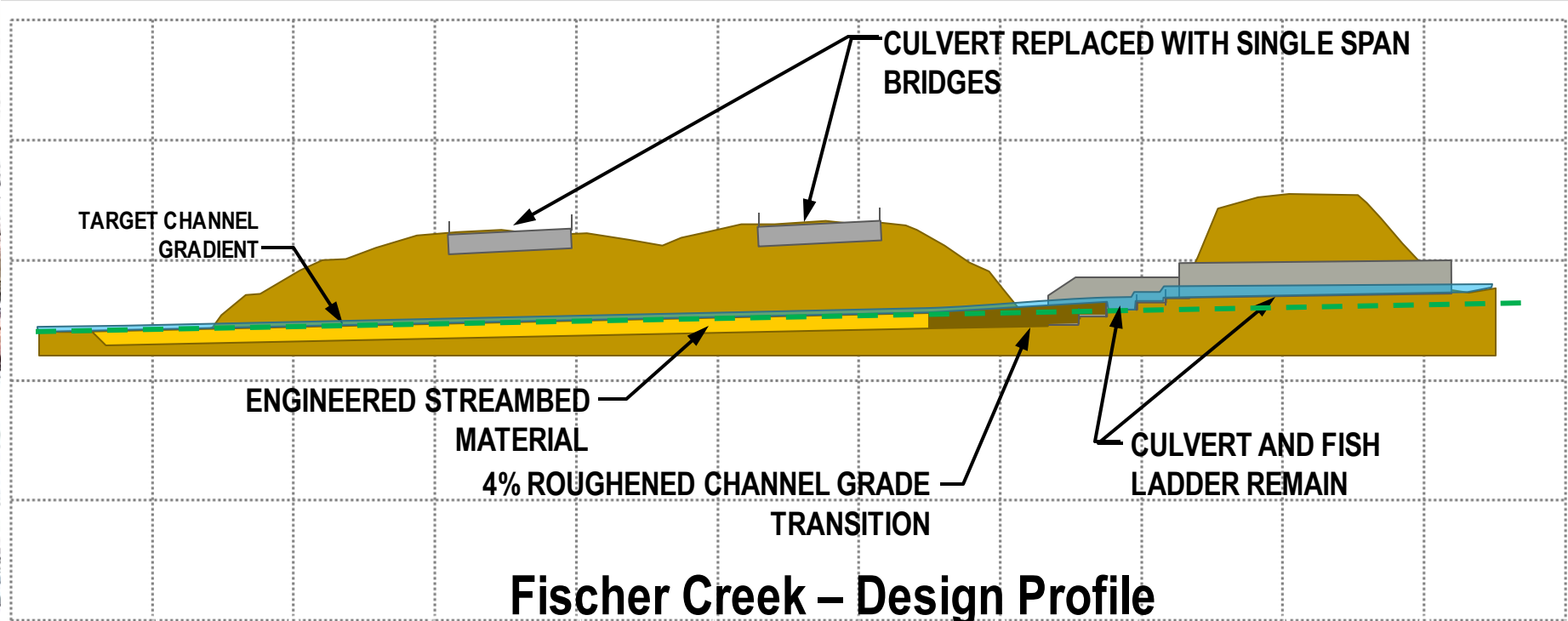
04 Hydraulic Design Solutions Applied at Example Projects



Fischer Creek - Pre Project Conditions

Fischer Creek - Pre Project Conditions





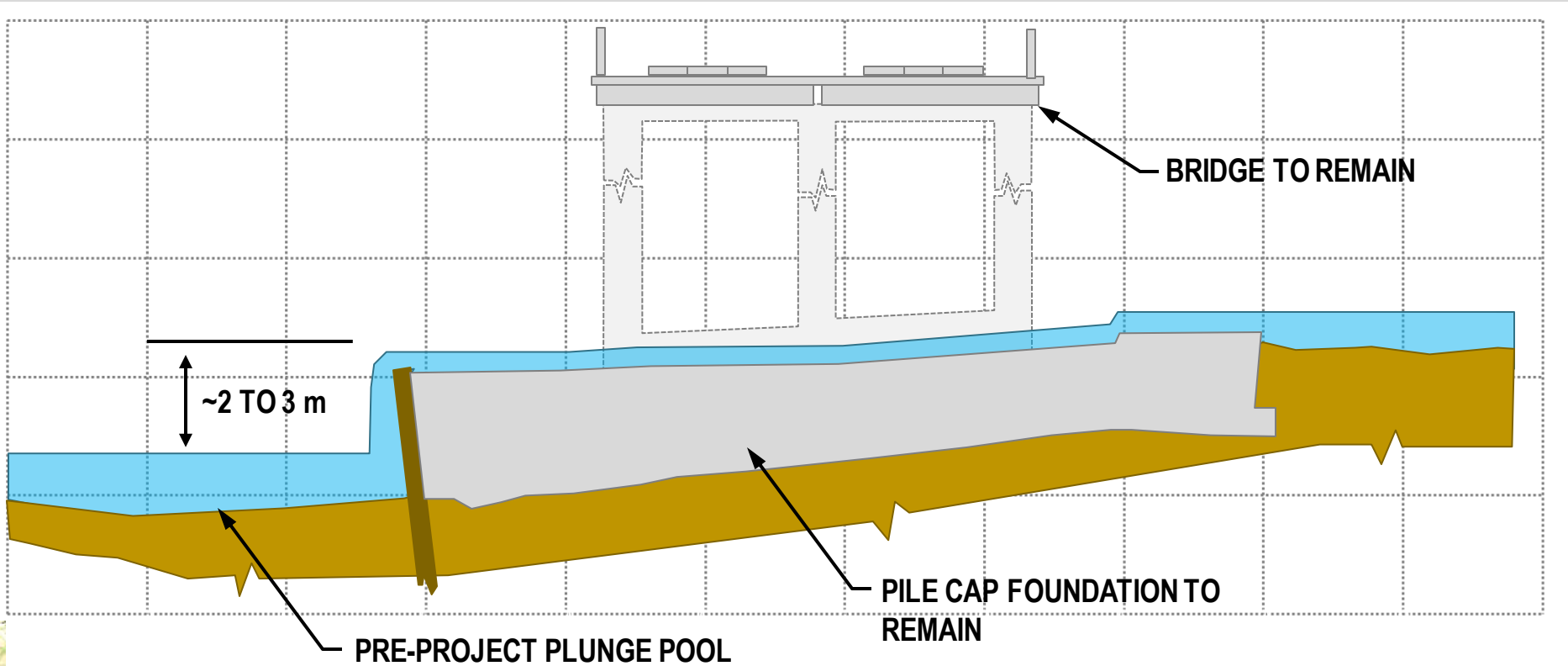


Fischer Creek – Post Project Conditions



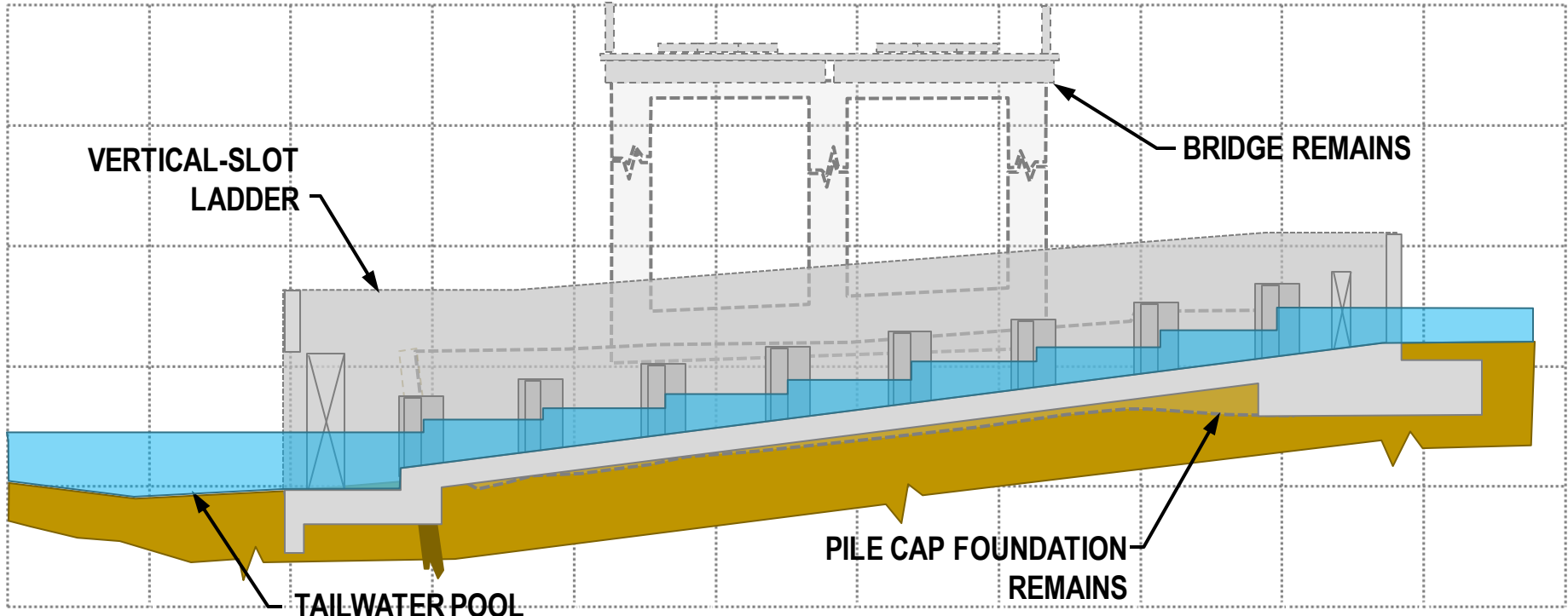
Fischer Creek – Completed Project

El Jaro Creek Crossing at San Julian Ranch Pre-Project Conditions





**El Jaro Creek Crossing at San Julian Ranch
Pre-Project Conditions**



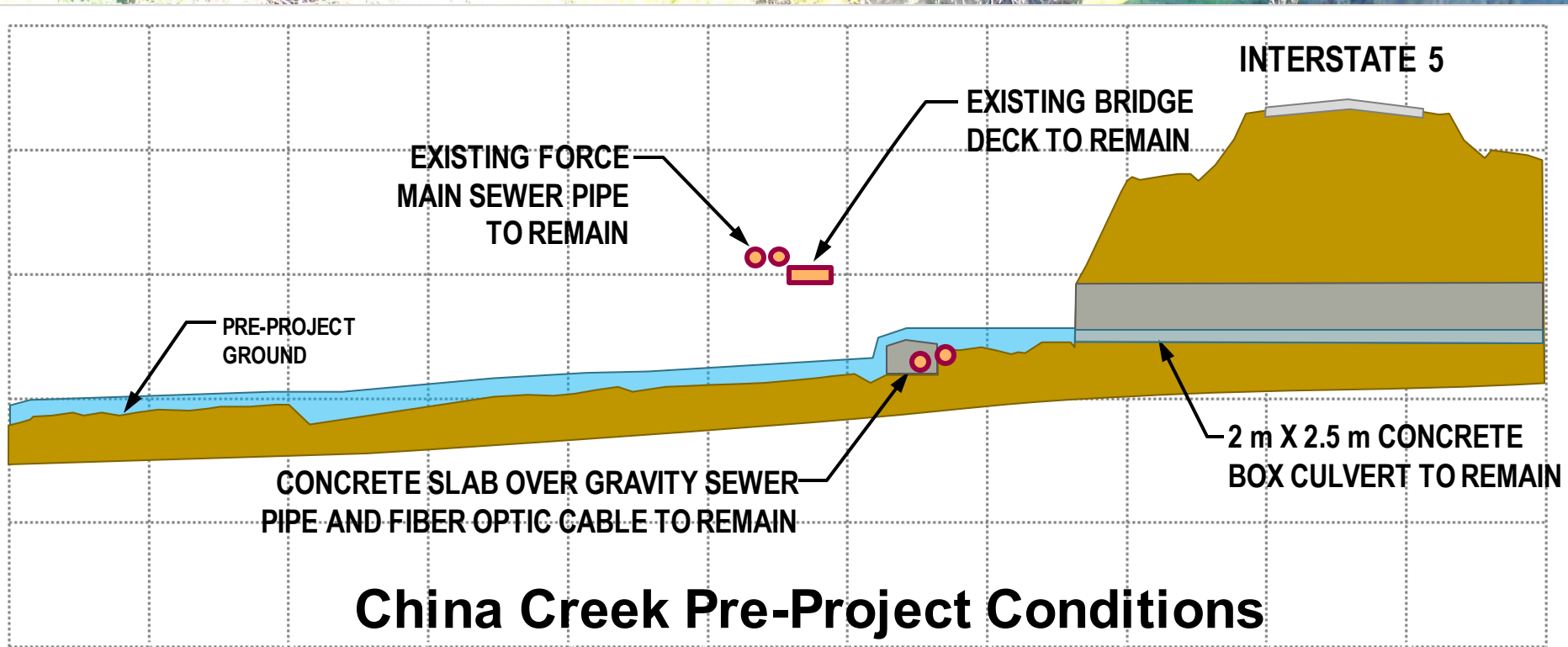
**El Jaro Creek Crossing at San Julian Ranch
Design Profile**



**El Jaro Creek Crossing at San Julian Ranch
Completed Project**



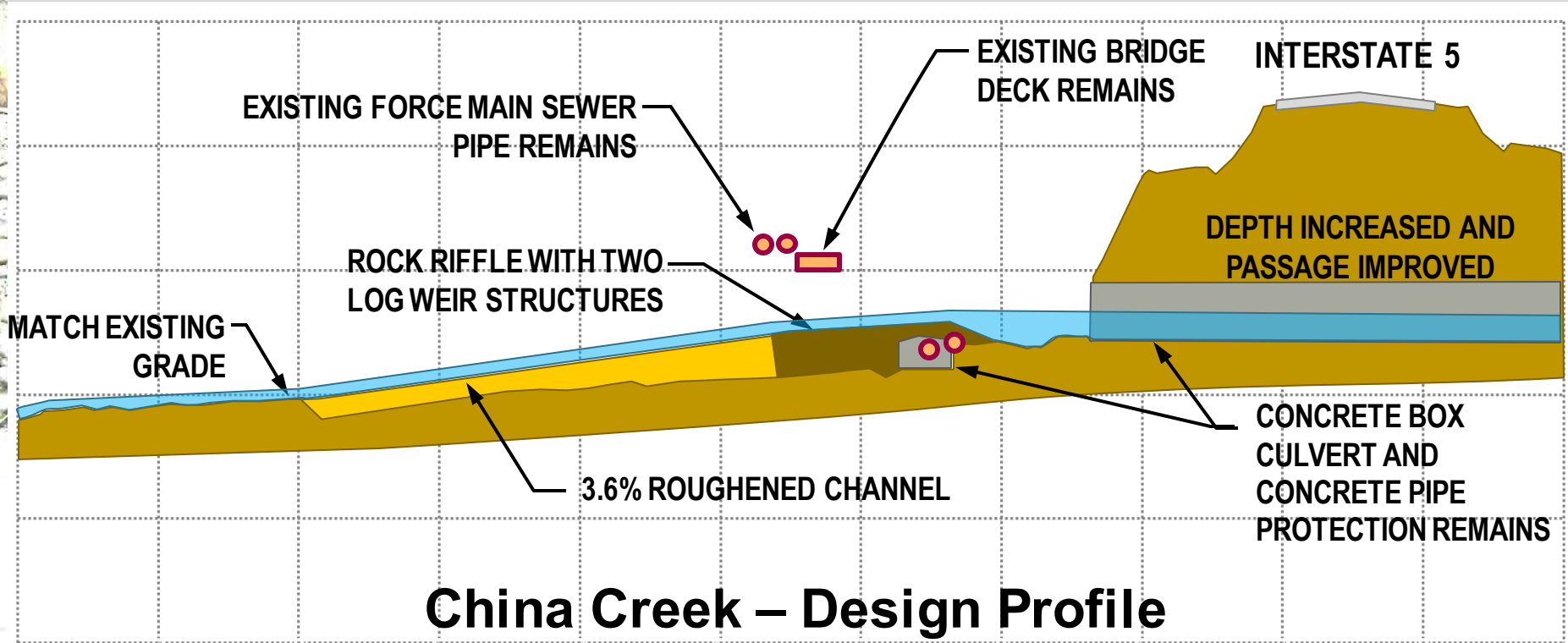
**El Jaro Creek Crossing at San Julian Ranch
Completed Project**



China Creek Pre-Project Conditions



**China Creek
Pre-Project Conditions**

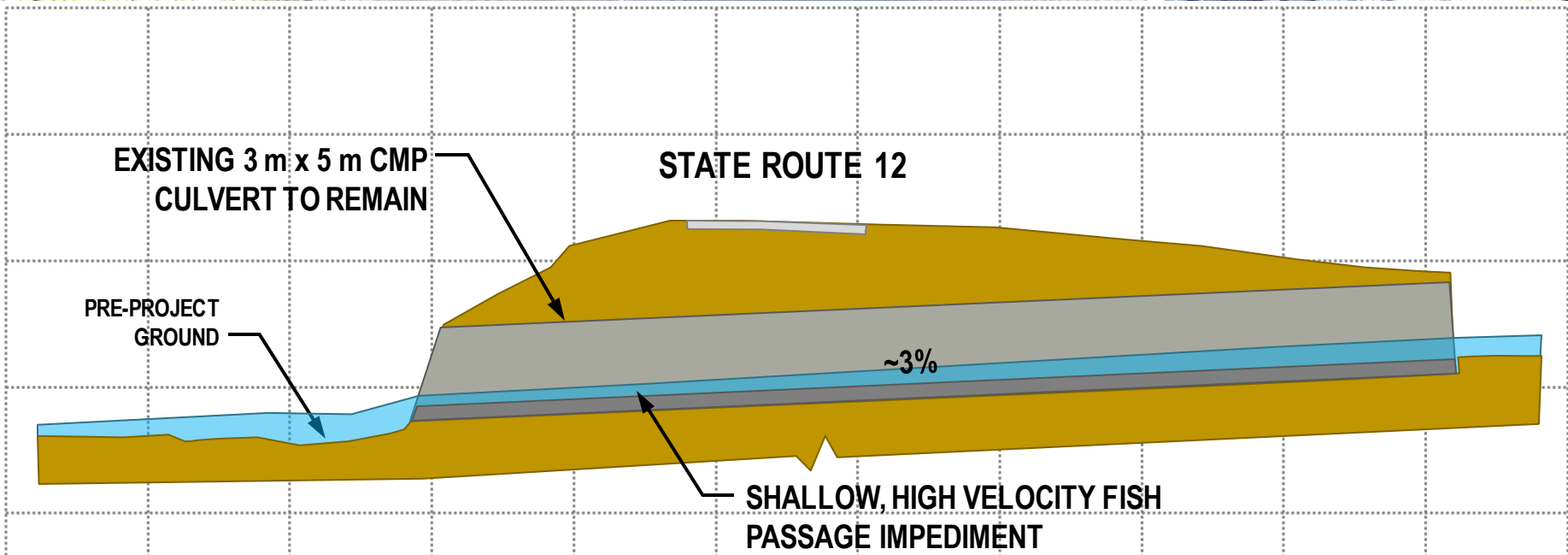




China Creek – Completed Project



**China Creek
Completed Project**



Big Meadow Creek Culvert Pre-Project Conditions



Big Meadow Creek Culvert Pre-Project Conditions

**EXISTING 3 m x 5 m CMP
CULVERT REMAINS**

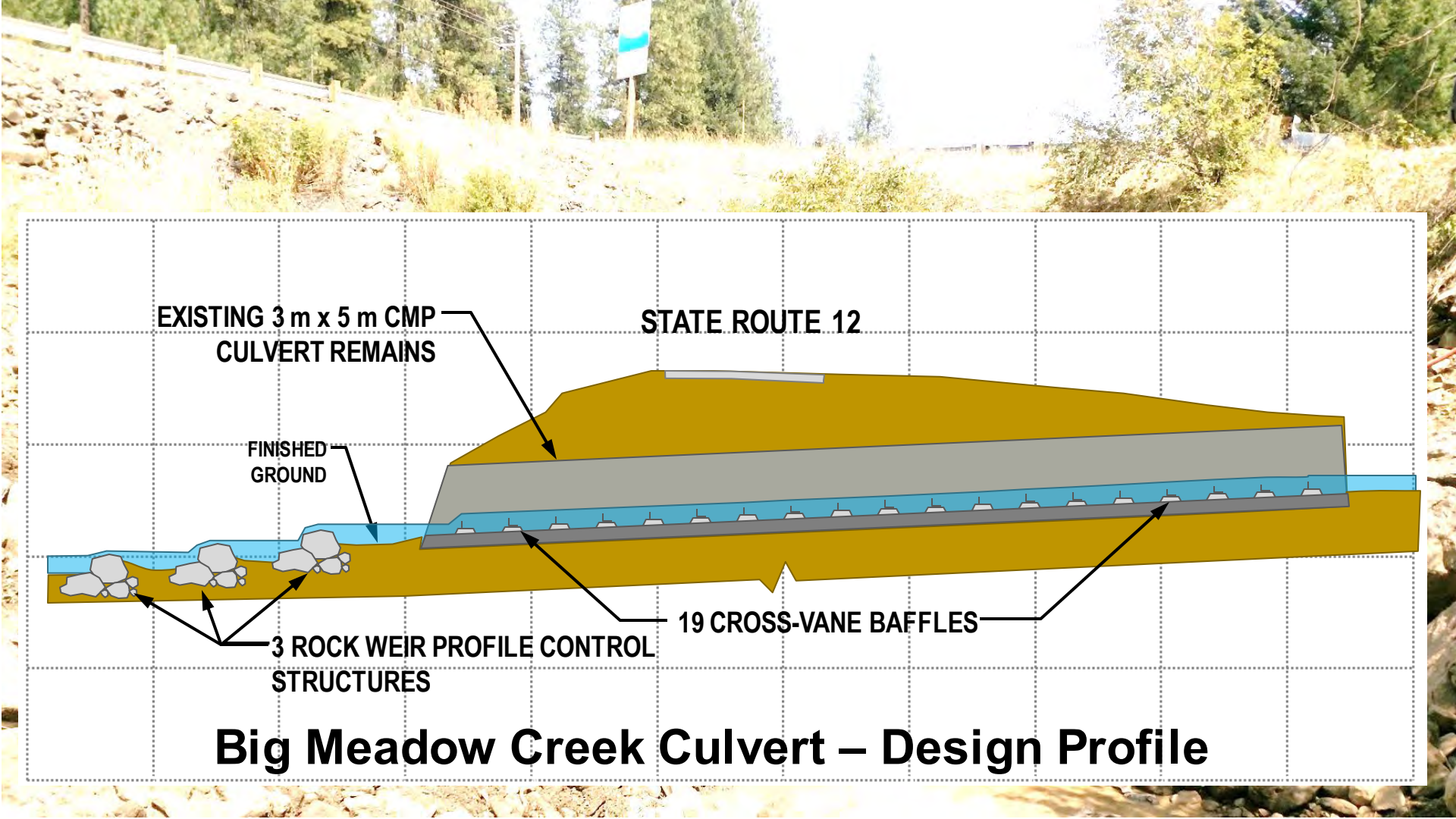
STATE ROUTE 12

**FINISHED
GROUND**

**3 ROCK WEIR PROFILE CONTROL
STRUCTURES**

19 CROSS-VANE BAFFLES

Big Meadow Creek Culvert – Design Profile





Big Meadow Creek Culvert - Pre Project Conditions



Big Meadow Culvert Retrofit Completed Project

Conclusions

- Road crossing design projects often experience constraints that necessitate the use of more complex hydraulic design techniques and methods
- Hydraulic design strategies often require more effort and more complex calculation tools to improve certainty of hydraulic performance
- There are common design elements and features that can be used to stabilize channel gradients in Road Crossing projects



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