CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Fish Passage Engineering Research

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Fish Passage Engineering Research Project
Summary of Findings

DRISI Agreement No. 65A0711

November 15, 2023

Upp Creek, MEN 101 – PM48.18 (Willits, CA)

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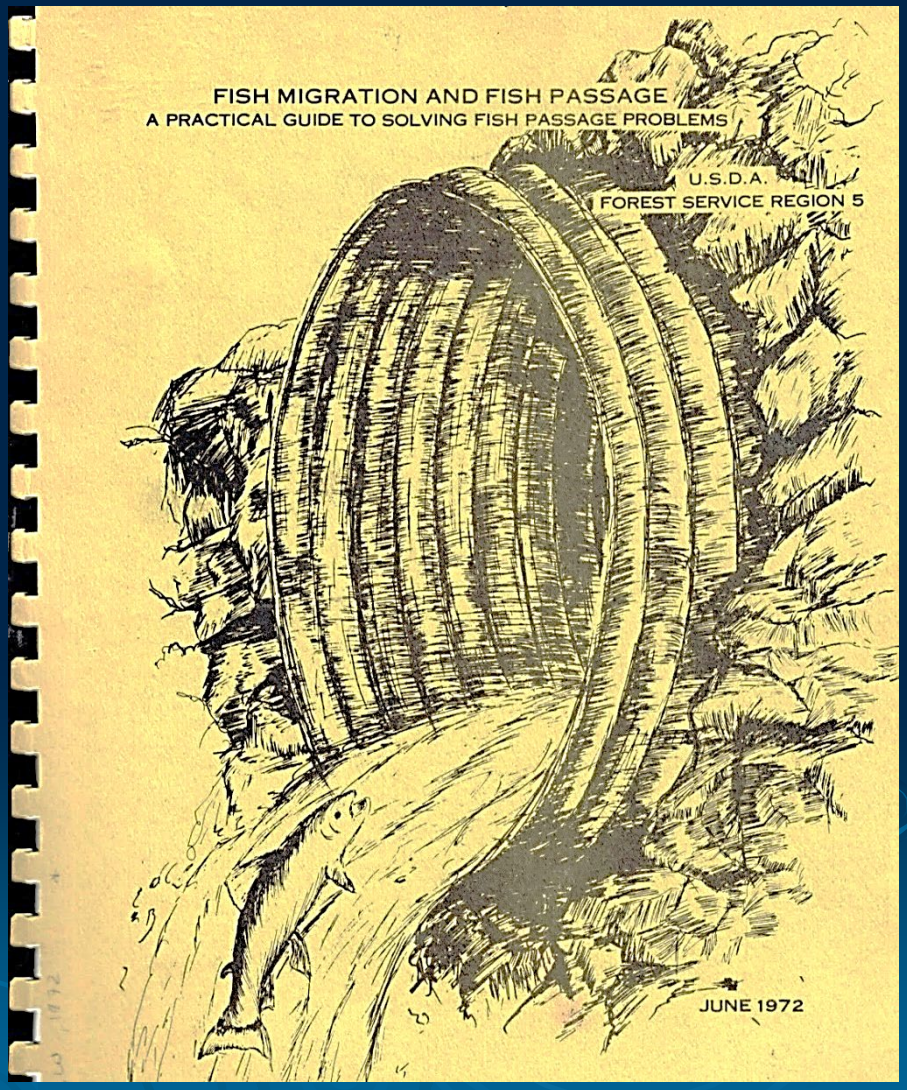
Hydrologic Solutions

Fish Passage at Road-Stream Crossings Not a New Issue

- USFS (1970's & 1980's) "Operation Swim-Up"
- FHWA (1970) "Fish Passage Through Highway Culverts"
- Caltrans D1 (1970) "Passage of Anadromous Fish through Highway Drainage Structures"
- WDFW (1999) "Culverts: A design manual for fish passage at road crossings" – **Stream Simulation**



Caltrans Fish Passage Efforts

California Department of Transportation (Caltrans) District 1 Pilot Fish Passage Assessment Study: Volume 1 – Overall Results

FHWA/CA/EN-2005/02

Margaret M. Lang

Environmental Resources Engineering
Humboldt State University

Final Report For Project:
F 2001 EN 10
Researching State Highway Culverts to Determine Impacts on Threatened and Endangered Salmon

Site Assessments

Remediated 65 barriers and opened 920 miles of stream habitat

2020 Fish Passage Annual Legislative Report (October 2021)

Caltrans

Report to the Legislature

2021

Full Span Structures

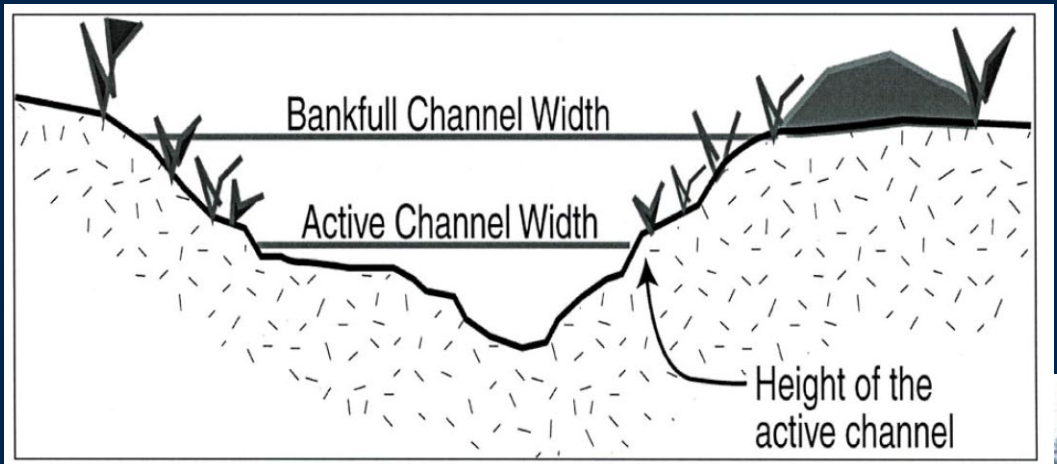
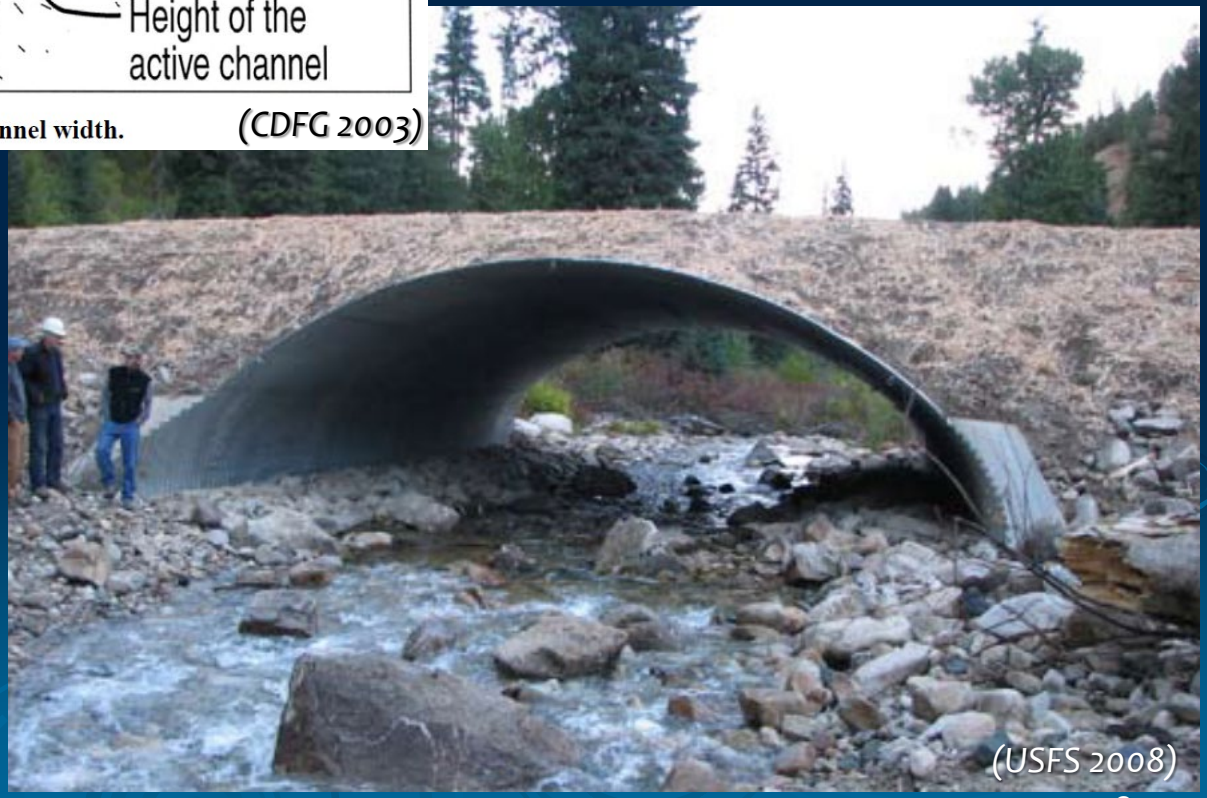


Figure IX-3. Active channel width versus bankfull channel width. *(CDFG 2003)*

Crossing structures with spans that exceed the bankfull channel width

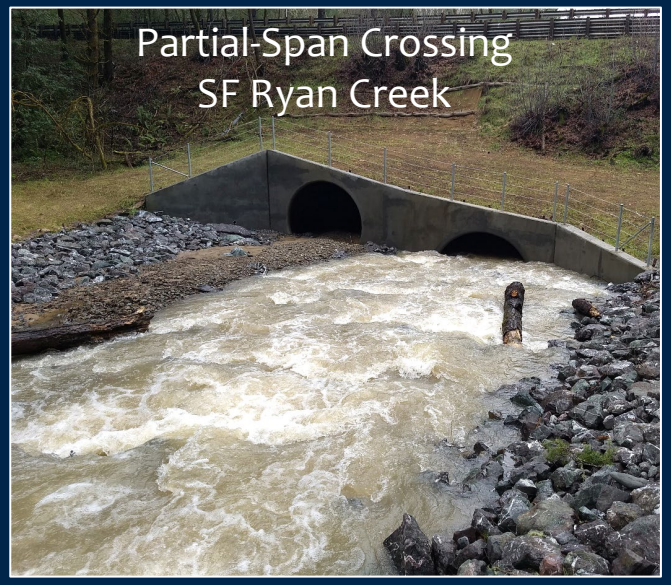


(USFS 2008)

Fish Passage Study Objectives

Evaluate the performance of recent Caltrans fish passage remediation projects:

- Compare performance of full-span solutions to partial-span and retrofit solutions
- Identify project elements that worked well for all sites
- Highlight causes and lessons learned from project elements that have underperformed
- Make recommendations based on project findings



Location Study Sites

- 15 Study Sites, located in Districts 1 and 2
- All study sites visited and received "qualitative assessment"
- 9 study sites received full survey and follow-up analysis

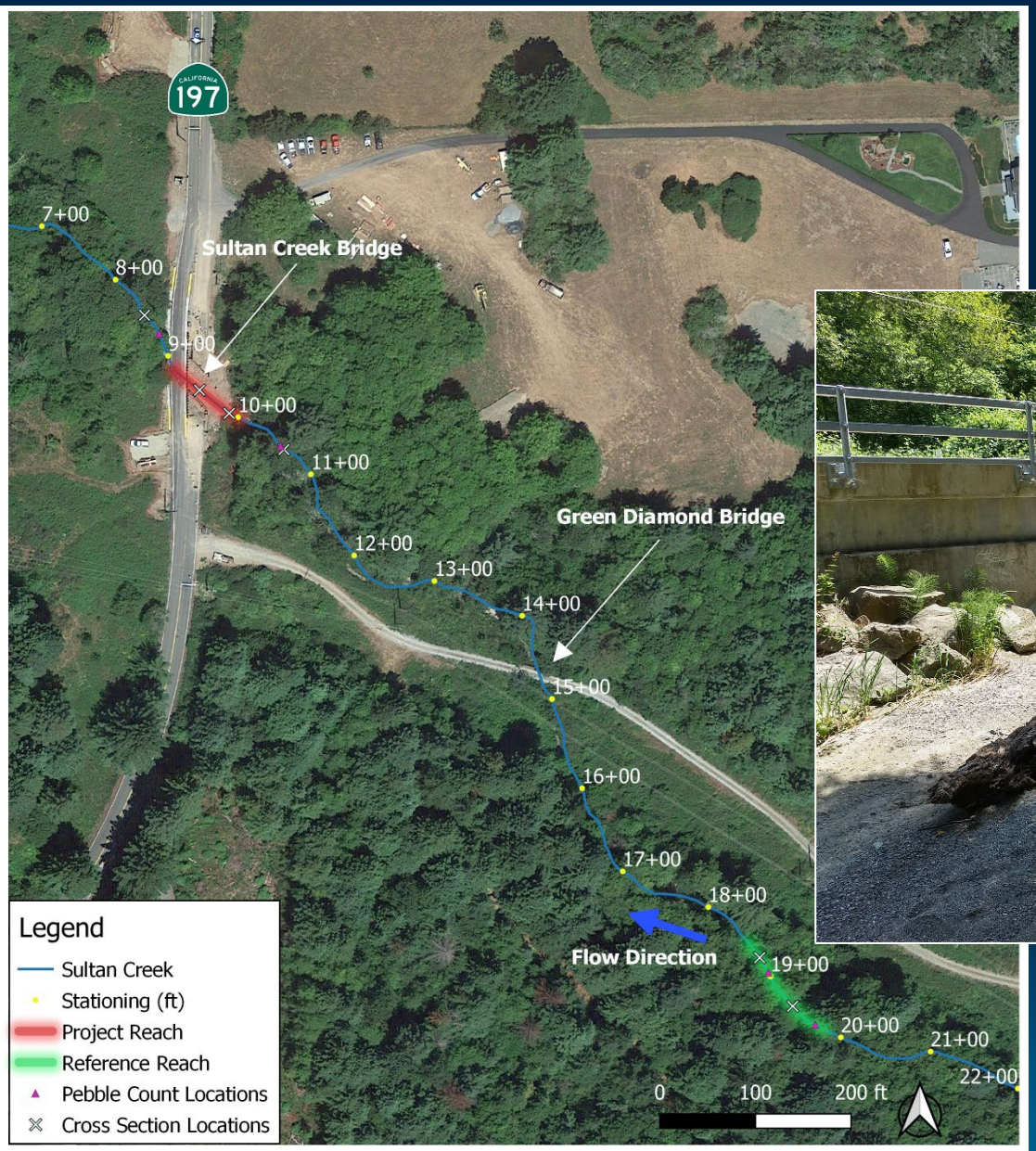
Field Survey Activities

1. Longitudinal thalweg profiles
2. Channel cross sections
3. Measured channel widths
4. Pebble counts

Analysis

1. Thalweg profile interpretation
2. Compare natural channel widths to project structure & channel widths
3. Evaluate similarity of bed material at crossing to natural channel

Plotting and Interpretation of Longitudinal Profiles



Combined LiDAR/Surveyed Longitudinal Channel Profiles

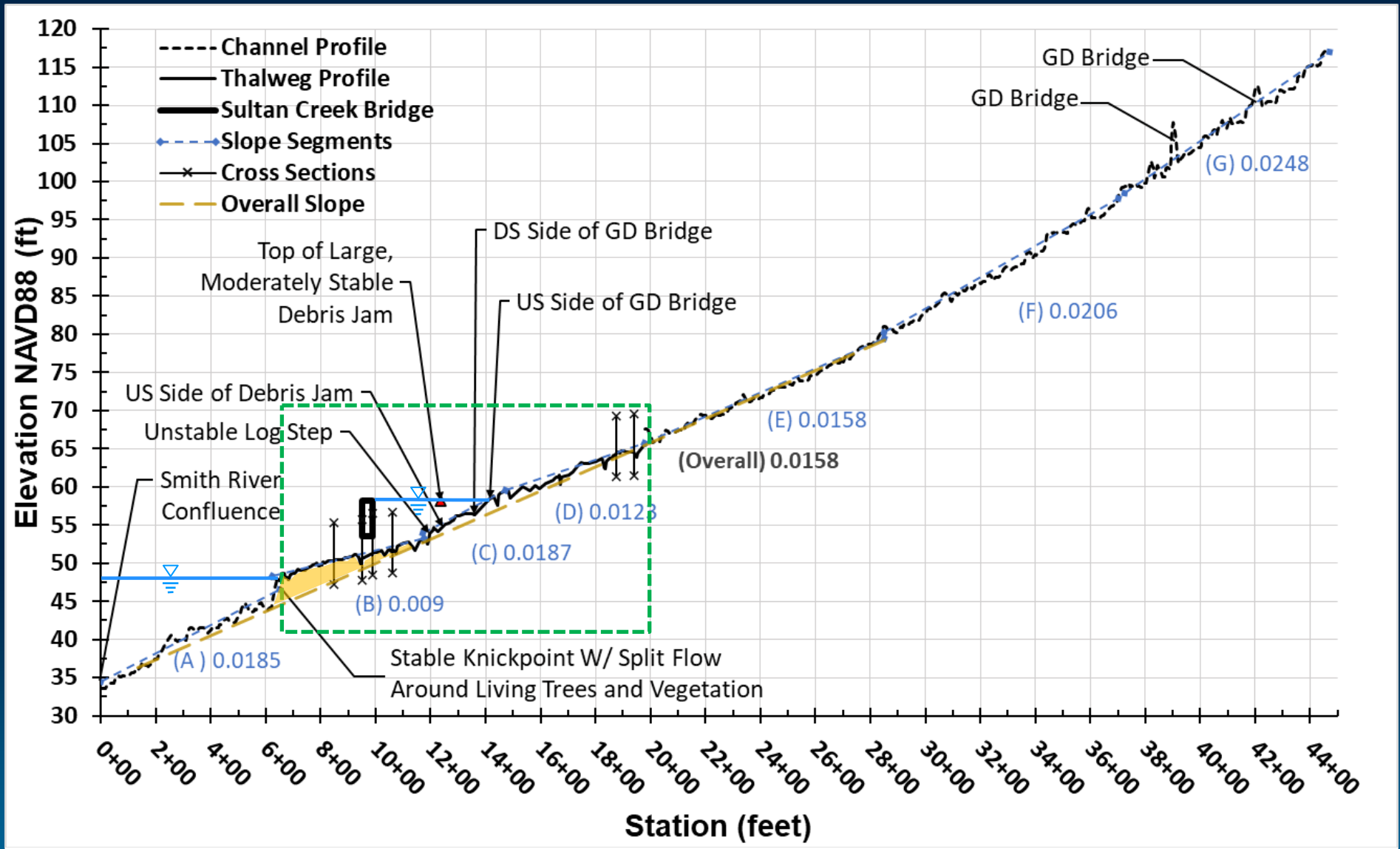


FIGURE 2-3. CHANNEL PROFILE THROUGH PROJECT REACH GENERATED FROM COMBINED LIDAR DEM AND GROUND SURVEY POINTS, WITH CHANNEL SLOPE SEGMENTS DEFINED.

Annotating and Interpreting Surveyed Channel Profiles

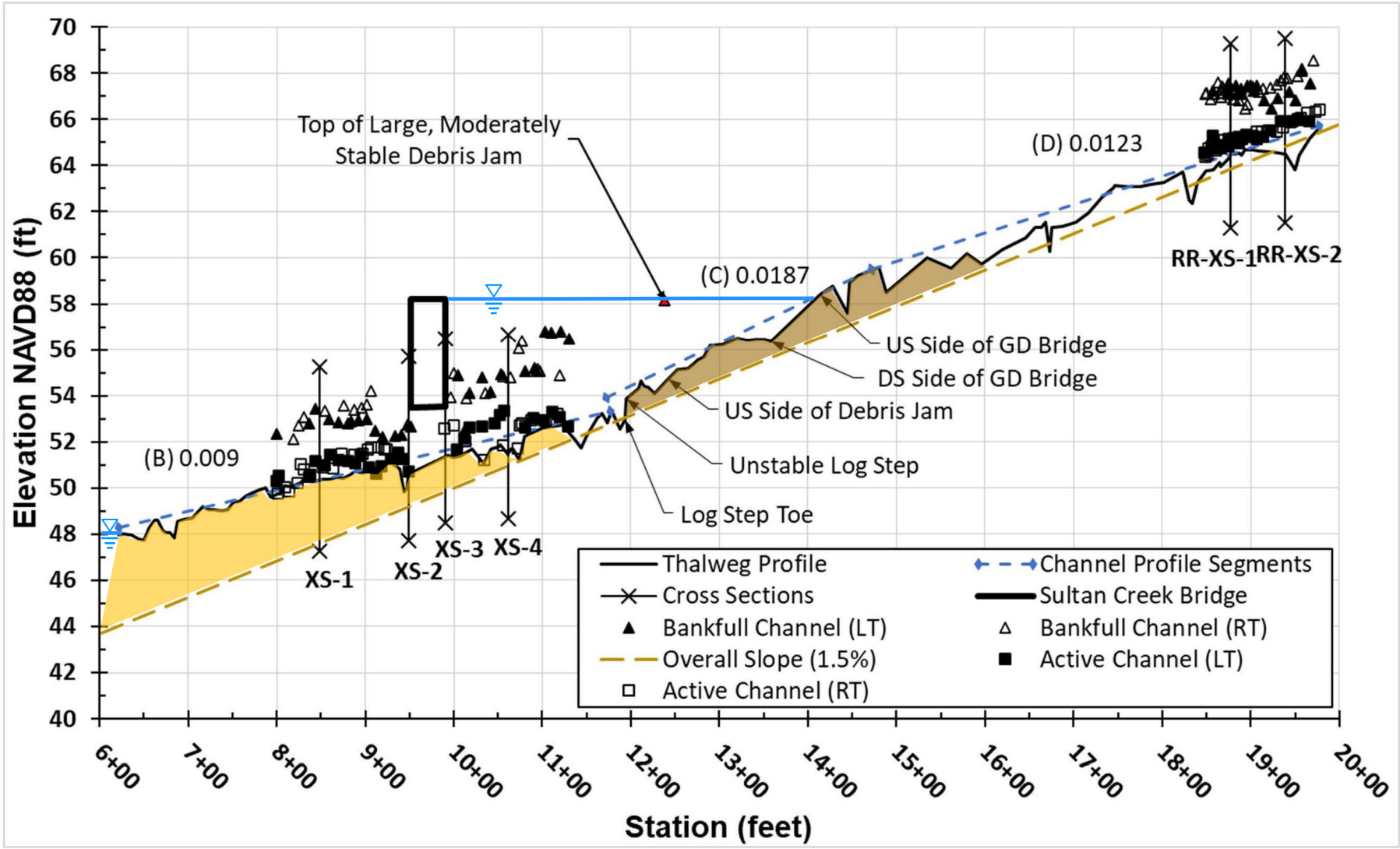
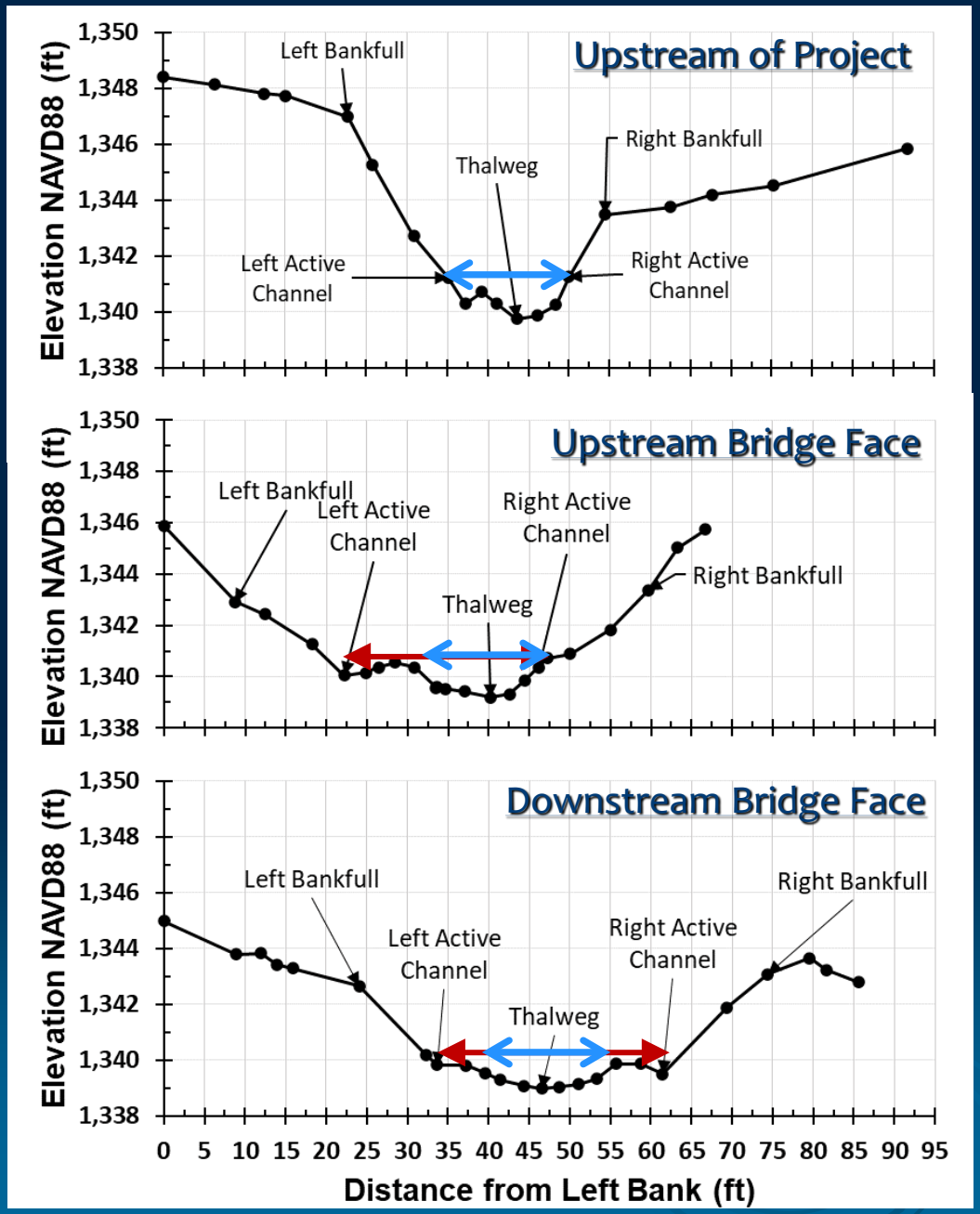


FIGURE 2-4. 2019 SURVEYED THALWEG PROFILE ALONG CHANNEL CENTERLINE ALIGNMENT, WITH DEFINED SLOPE SEGMENTS. LOCATION AND IDENTIFICATION OF CHANNEL CROSS SECTIONS DENOTED.

Comparison of Channel Geometry (Upp Creek)



Upstream Channel

Downstream Bridge Face

What Worked – Full Span Bridges

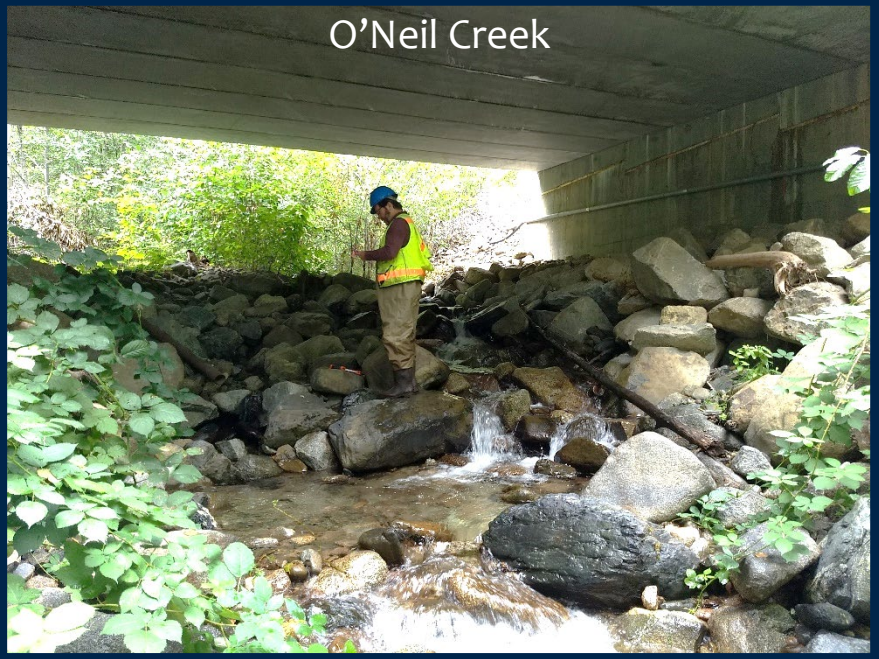
Nearly all crossings replaced with full-span bridges performed well

- Span the floodprone width, supporting uninterrupted geomorphic processes
- Able to accommodate most anticipated and unanticipated channel adjustments
- Most fish passage deficiencies that arise can be addressed without replacing the bridge crossing

Little Mill Creek Full-Span Bridge

What Worked
Full Span Bridges


Fort Goff Creek


O'Neil Creek


Dunn Creek

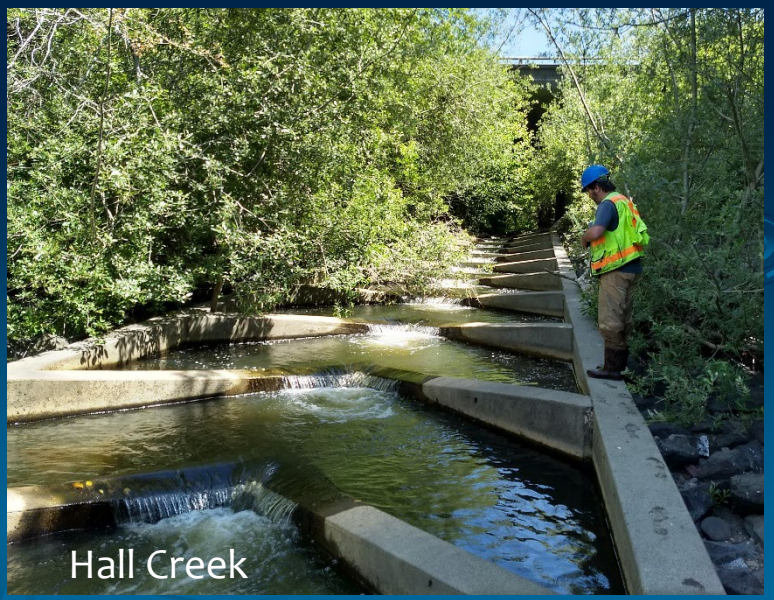

Yank Creek

What Worked
Fish Baffles and Fishway Retrofit Designs

- 4 study sites retrofitted with fishways/baffles
- All appeared to be constructed and functioning as intended, meeting passage criteria
- All retrofits were in crossing structures with adequate width


Peacock Creek


Cedar Creek


Hall Creek

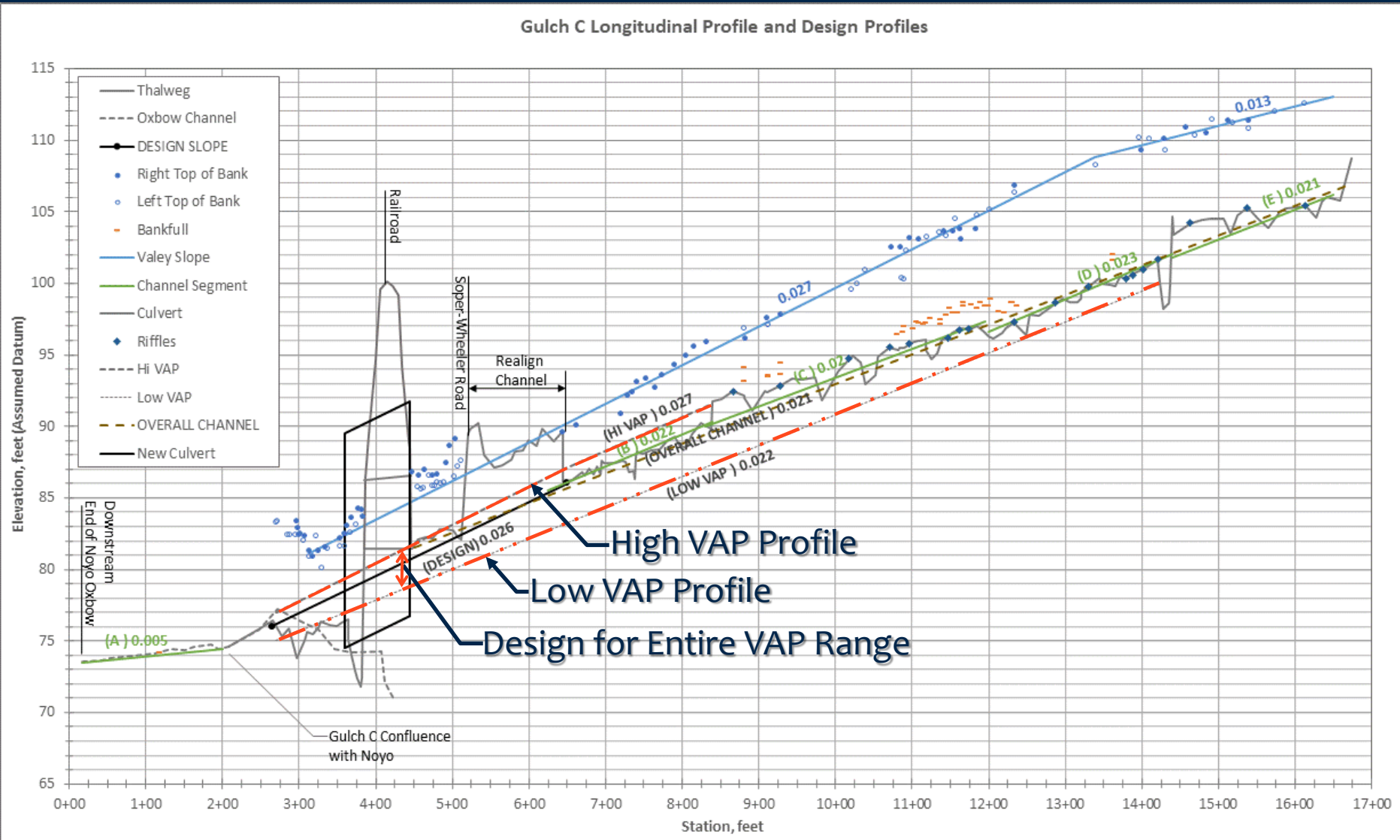
Lessons Learned
Post-Project Channel Profile Adjustments

Many of the project designs failed to recognize or anticipate:

1. Post-project channel incision/bed lowering
2. Influence of adjacent river on channel dynamics
3. Local aggradation deposited upstream of pre-project crossing

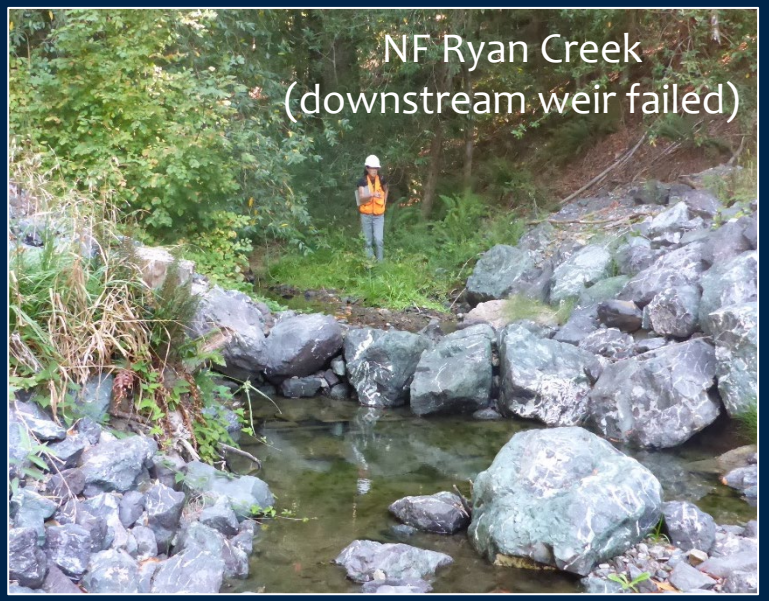
Defining the Vertical Adjustment Potential (VAP)

Long-Term Aggradation/Degradation



Lessons Learned
Construction and Performance of Rock Grade Control

1. Rock weirs only type of rock-based grade control used at study sites
2. One or more rock weirs failed at 7 of 8 study sites
3. Various causes of failure from both design and construction
4. Constructed drop heights over rock weirs varied substantially from design



Lessons Learned
Over-widened Channels through Project Reach

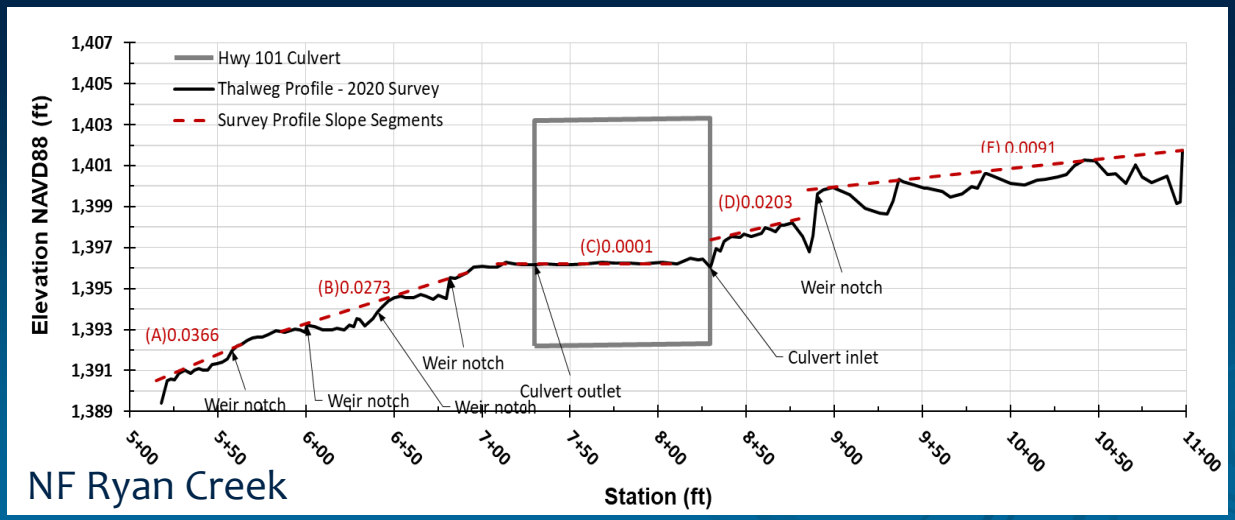
Channel width through crossing excessively wide compared to adjacent natural channel

- Lack of streambanks to create confinement
- Produces shallower flow depths than in adjacent natural channel
- Likely creating low-flow barriers to fish movement

Lessons Learned
Lack of Channel Slope and Bedforms inside Long Culverts

- Culverts narrower than upstream bankfull channel
- Streambed profile flattened through embedded culverts
- No bed features (pools/riffles) resulting in shallow flow conditions
- Lack the "profile controls" that influences natural channel grade

Reference Stream Reach

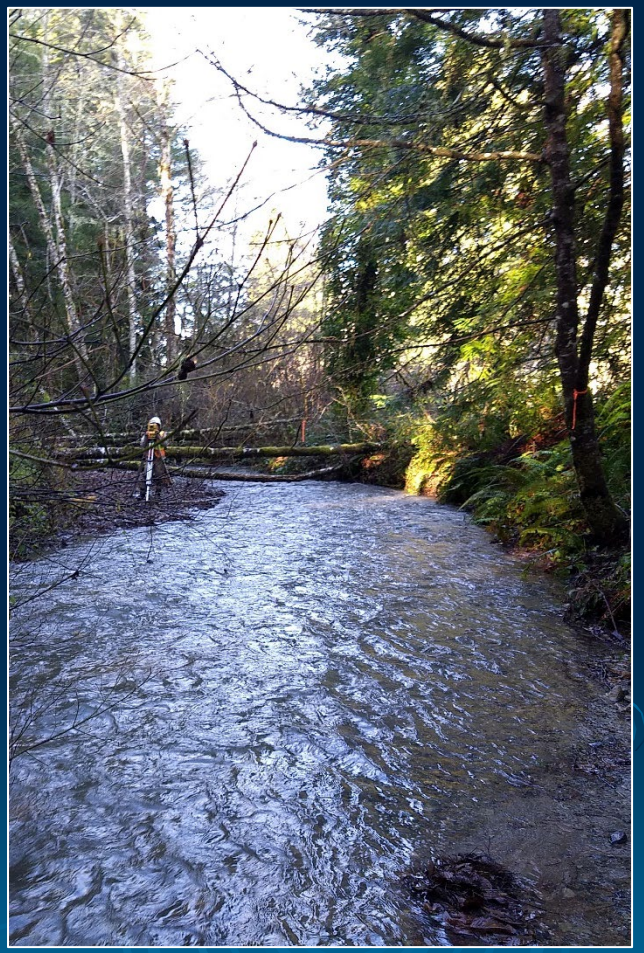


NF Ryan Creek

Primary Recommendation

Institute Geomorphic Site Assessments as a Standard Study for Project Development

- Identifies geomorphic risk factors
  (channel incision, aggradation, lateral migration)
- Determines need for risk mitigation measures
  (grade control, raising road profile, increasing span)
- Establishes geomorphic and fisheries design objectives
- Defines project extents/footprint/**RoW** needs
- Provides a template for channel design based on a reference stream reach
  (profile, channel dimensions, min. crossing span)

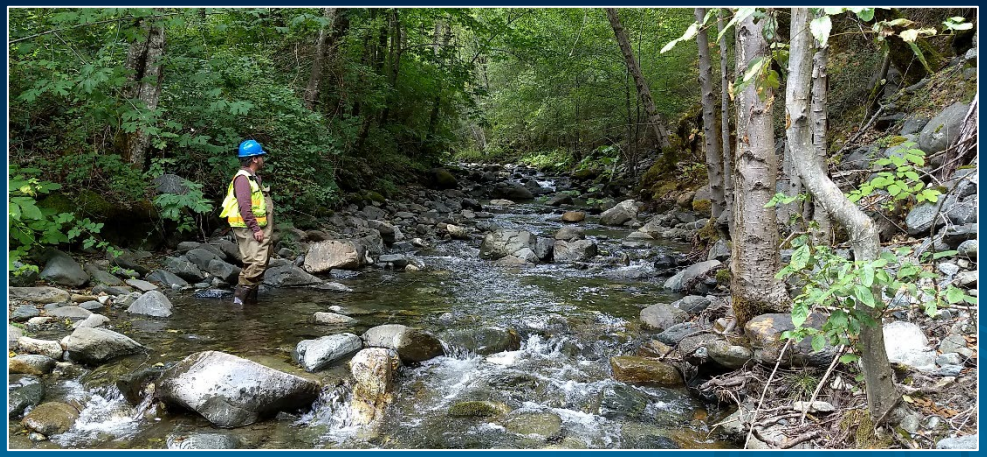


Upstream reference reach for Sultan Creek crossing

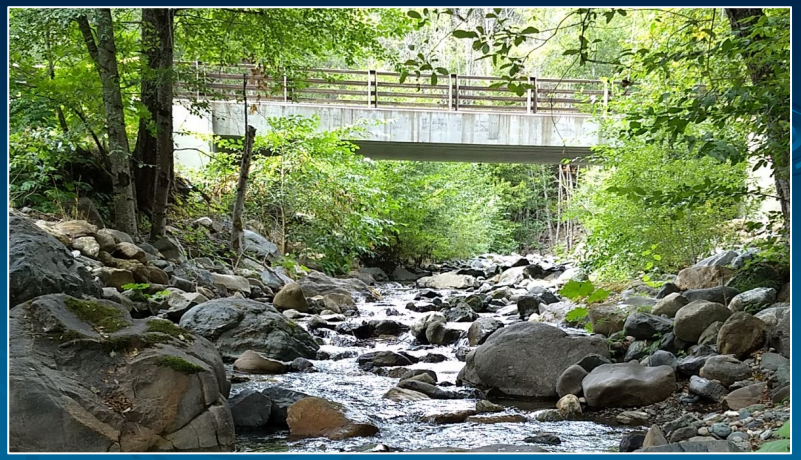
Other Recommendations

- Provide guidance document for conducting geomorphic site assessments
- Provide additional guidance for design and construction of grade control
- Develop Standard Special Provisions for channel construction
- Prepare to make field changes during construction to meet project objectives

Example of a "roughened channel" grade control in a box culvert



Upstream reference reach for the Fort Goff Bridge



Fort Goff Bridge Channel

Discussion