ROBINSON CREEK BRIDGE REPLACEMENT ON LAMBERT LANE

Natural Environment Study

Boonville, Mendocino County, California

Section 2, Township 13N, Range 14W

Boonville, CA Quadrangle

District 1

Bridge No. 10C0146

BRLO-5910(099)

March 2019

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Natural Environment Study

Section 2, Township 13N, Range 14W
Boonville, CA Quadrangle
Caltrans District 1

Federal Project Number BLO-5910(099)

Prepared By: Melissa Murphy Date: 7/8/19

Melissa Murphy, Senior Biologist
(530) 332-9909
Gallaway Enterprises
117 Meyers Street, Suite 120
Chico CA 95938

Approved By: Howard N. Dashiell Date: 7/8/19

Howard Dashiell, Director of Transportation
(707) 463-4363
County of Mendocino Department of Transportation
340 Lake Mendocino Drive
Ukiah, CA 95482

Approved By: Christa Unger Date: 7/9/19

Christa Unger, Environmental Planner/Biologist
California Department of Transportation
District 1

Approved By: Julie Gust (Acting for:) Date: 7/9/19

Brandon Larsen, Sr. Environmental Planner
Caltrans Office of Local Assistance
District 1

Summary

Mendocino County (County) and the California Department of Transportation (Caltrans) are proposing to replace the Robinson Creek Bridge on Lambert Lane. The Robinson Creek Bridge Replacement on Lambert Lane Project (Bridge No. 10C0146) (Project) is located in the town of Boonville, California on the western edge of the Anderson Valley. Lambert Lane is the only public road access in and out of a residential and agricultural area. The existing bridge has been designated as functionally obsolete and scour critical by Caltrans, qualifying it for rehabilitation or replacement under the federal Highway Bridge Program (HBP). In winter of 2015, a retaining wall on the upstream side of the west approach washed out and collapsed into the creek causing the County to place revetment to prevent continued scouring and erosion. During the winter of 2016/2017 scour further undermined the eastern abutment footing. Under current conditions, the failed retaining wall and associated riprap creates a 3-foot water surface drop, which classifies the current conditions as a barrier to adult and juvenile steelhead based on California Department of Fish and Wildlife (CDFW) fish passage assessment guidelines (CDFG, 2002). The purpose of the Project is to replace the deficient bridge with a reliable structure to provide a safe crossing that meets current standards. Channel restoration will also take place as part of the Project and will include removing the collapsed retaining wall which will restore fish passage to the upstream reaches of Robinson Creek, protecting portions of the embankment slopes from erosion with hybrid RSP revetment, channel grading to remove abrupt hydraulic changes, adding point bars along portions of the creek banks, and planting willows and trees (MLA 2018). Construction will take place from June 1 through October 31 when Robinson Creek does not contain flowing water.

Land within the Biological Study Area (BSA) is characterized as barren, urban, riverine, annual grassland, valley-foothill riparian and valley oak woodland habitats. Special-status species that have the potential to occur within the BSA include the state Species of Special Concern (SSC) western pond turtle (*Actinemys marmorata*) and Navarro roach (*Lavinia symmetricus navarroensis*), the state candidate for listing as threatened foothill yellow-legged frog (FYLF, *Rana boylii*), the federally threatened northern California (NC) steelhead Distinct Population Segment (DPS) (*Oncorhynchus mykiss irideus*), tree roosting bat species protected by the California Fish and Game Code (CFGC), and a variety of bird and raptor species protected by the Migratory Bird Treaty Act. In addition, Robinson Creek is designated as critical habitat for the NC steelhead DPS.

With the implementation of avoidance and minimization measures including construction timing, the Project will not impact western pond turtle, Navarro roach, FYLF, roosting bats, or nesting birds and will have no effect on the NC steelhead DPS. Channel restoration, may affect, but is not likely to adversely affect NC steelhead DPS critical habitat because the Project will result in a net increase of accessible critical habitat and enhance existing habitat within the BSA. Approximately 77 linear feet (0.042 acres) of temporary impacts and 63 linear feet (0.004 acres) of permanent impacts to NC steelhead critical habitat within the BSA are proposed; however, the removal of the existing fish barrier upstream of the bridge will restore fish passage to 0.146 acres of NC steelhead critical habitat within the BSA. The Project falls within an area mapped by National Marine Fisheries Service (NMFS) as potentially containing Essential Fish Habitat (EFH) for California Coastal Chinook salmon Evolutionarily Significant Unit (ESU) (*Oncorhynchus tshawytscha*) and Central California Coast Coho salmon ESU (*Oncorhynchus kisutch*); however these species are not known to occur within Robinson Creek; therefore, the Project will have no effect on EFH.

The Project will result in 0.10 acres of temporary and 0.09 acres of permanent impacts to jurisdictional waters of the U.S. (WOTUS). This Project is self-mitigating as both temporary and permanent impacts will have a net benefit to WOTUS; therefore, the purchase of credits at a U.S. Army Corps of Engineers (Corps) approved mitigation bank or payment to a Corps approved in-lieu fund, will not be required. Impacts will be the result of restoration activities including removing the failed retaining wall and associated RSP from the creek, streambank stabilization through hybrid RSP revetment, vegetation of created point bars, and habitat enhancement. A Regional Water Quality Control Board (RWQCB) §401 Water Quality Certification permit, a California Department of Fish and Wildlife (CDFW) §1602 Streambed Alteration Agreement, and a Corps Nationwide §404 permit shall be obtained for the project.

Table of Contents

List of Figures

List of Tables

List of Appendices

List of Abbreviated Terms

BSA	Biological Study Area
BMP	Best Management Practices
CC	California Coastal
CCC	Central California Coast
Cal-IPC	California Invasive Plant Council
Caltrans	California Department of Transportation
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFGC	California Fish and Game Code
CIDH	Cast-In-Drilled-Hole
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
Corps	United States Army Corps of Engineers
County	Mendocino County
CRPR	California Rare Plant Rank
CWA	Clean Water Act
DBH	Diameter at Breast Height
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
GIS	Geographic Information System
HBP	Highway Bridge Program
IPaC	Information for Planning and Conservation
LWD	Large Woody Debris

MBTA	Migratory Bird Treaty Act
MLA	Michael Love & Associates, Inc.
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NC	Northern California
NEPA	National Environmental Quality Act
NES	Natural Environmental Study
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
OHWM	Ordinary High Water Mark
RPW	Relatively Permanent Water
RSP	Rock Slope Protection
RWQCB	Regional Water Quality Control Board
SSC	State Species of Special Concern
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WOTUS	Waters of the United States

1 Introduction

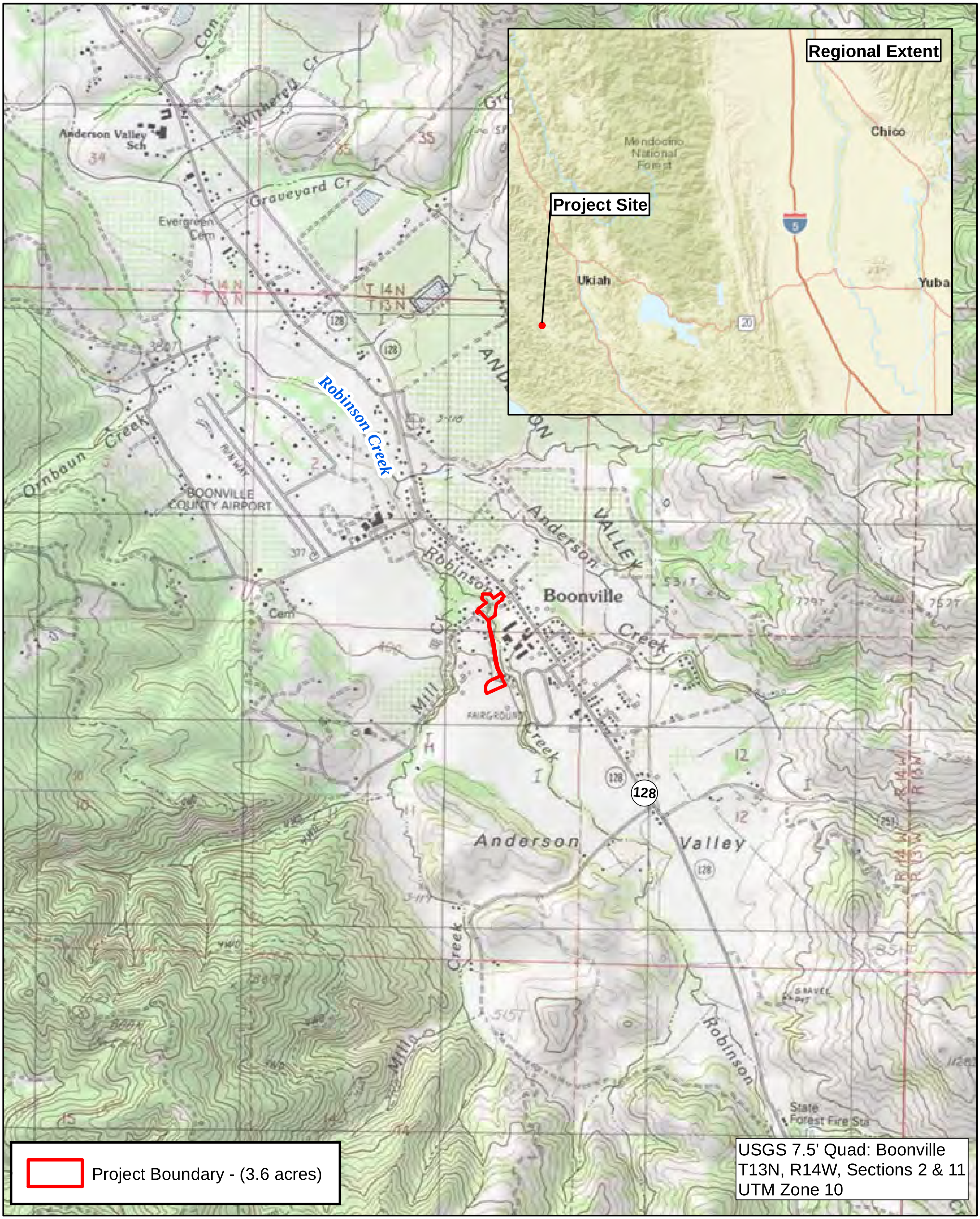
The purpose of Robinson Creek Bridge Replacement on Lambert Lane Project (Bridge No. 10C0146) (Project) is to replace the existing Robinson Creek Bridge on Lambert Lane to provide the public with a safe, reliable crossing and improve traffic operations (**Figure 1: Regional Location Map, Figure 2: Project Location Map**). This project is needed because the existing bridge has been designated as functionally obsolete and scour critical by Caltrans, due to the undermining of the spread footing foundations and collapse of a retaining wall. The purpose of this Natural Environment Study (NES) is to evaluate potential Project impacts to special-status species and their habitats within the project vicinity.

Project History

The Project is located in the town of Boonville, California on the western edge of the Anderson Valley (**Figure 1**). The existing bridge was constructed on Lambert Lane over Robinson Creek in 1954. Lambert Lane is the only public road access in and out of a residential and agricultural area. The existing 32-foot long single span bridge is comprised of a concrete deck slab supported on tall closed strutted abutments founded on spread footings. The existing bridge has been designated as functionally obsolete and scour critical by Caltrans, qualifying it for rehabilitation or replacement under the federal Highway Bridge Program. In winter of 2015, a retaining wall on the upstream side of the west approach washed out and collapsed into the creek causing the County to place revetment to prevent continued scouring and erosion. In the winter of 2016/2017, scour further undermined the eastern abutment footing along its entire length and reinforcing steel is exposed. The purpose of the Project is to replace the deficient, unstable bridge with a reliable structure to provide a safe crossing that meets current standards. The Project is funded through the Highway Bridge Program (HBP) with matching funds from Federal Toll Credits. Caltrans will be the lead agency for National Environmental Policy Act (NEPA) compliance through delegation from the Federal Highway Administration (FHWA) and the County, the owner of the Project, will be the lead agency for California Environmental Quality Act (CEQA) compliance.

<u>FISH PASSAGE</u>

A fish passage assessment of stream crossings was conducted by Ross Taylor and Associates (Taylor 2001). Because the Lambert Lane bridge is a channel spanning crossing, it was considered to provide unimpeded fish passage and was not included in the assessment. However, under current conditions, the failed retaining wall and associated riprap creates a



NORTH
1:24,000
0 1,000 2,000 Feet
Data Sources: ESRI, USGS, Quincy Engineering

Robinson Creek Bridge Replacement Project
Regional Location
Figure 1

gallaway ENTERPRISES
GE: #15-130 Map Date: 01/31/19

1:2,200
0 50 100 Feet
NORTH
Data Sources: ESRI, DigitalGLobe 10/31/17, USGS, Quincy Engineering

Robinson Creek Bridge Replacement Project
Project Location
Figure 2

gallaway ENTERPRISES

GE: #15-130 Map Date: 01/30/19

3-foot water surface drop, which classifies the current conditions as a barrier to adult and juvenile steelhead based on California Department of Fish and Wildlife fish passage assessment guidelines (CDFG, 2002). Channel restoration designs for the site should satisfy current fish passage standards, as described in CDFG (2009) and NMFS (2001) guidelines.

GEOMORPHIC CHANNEL CONDITIONS

Changing geomorphic conditions within Robinson Creek and downstream Anderson Creek have been noted for decades. Channel incision (lowering of the channel bed) and channel bank erosion along Robinson Creek was noted as a significant source of sediment production within the 1998 Navarro River Watershed Restoration Plan. Incision has caused scour and undermining of bridge foundations, leading to the replacement of the Highway 128 crossing of Anderson Creek immediately upstream of the confluence of Robinson Creek and replacement of the Mountain View Road bridge crossing over Robinson Creek, downstream of Lambert Lane. Also, channel widening associated with incision processes has caused severe bank erosion threatening adjoining structures and resulting in loss of mature riparian vegetation throughout lower Robinson Creek.

The Mendocino County Resource Conservation District (RCD) and the Mendocino County Water Agency conducted studies of channel conditions to characterize the ongoing channel adjustments in Robinson Creek, focusing on the reach from the confluence with Anderson Creek to the Mendocino County Fair Grounds upstream of Lambert Lane. This included conducting profile surveys of the channel thalweg and surveys of channel cross sections in 2005 to document the channel morphology. Florsheim (2006) prepared a baseline assessment of bio-geomorphic conditions within lower Robison Creek for the RCD, and identified channel incision as the dominant process causing the observed channel instabilities. Follow-up monitoring surveys of the lower Robinson Creek channel thalweg were conducted in 2008, which found the channel showed signs of aggradation near the confluence with Anderson Creek, but also showed signs of incision within a reach between Mountain View Road and Lambert Lane bridge crossings (Florsheim, 2008). These findings were further described in a 2013 peer-reviewed publication (Florsheim et al., 2013). The RCD provided the original data from the 2005 and 2008 county surveys to MLA to compare to current channel conditions at the Lambert Lane bridge replacement Project.

Project Description

BIOLOGICAL STUDY AREA

The Biological Study Area (BSA) is the area in which biological surveys are conducted and where all construction and staging will occur (**Figure 3: Biological Study Area**). The BSA for this Project encompasses the bridge construction and stream restoration zone as well as the potential off-site staging area located at the County Fairgrounds. The BSA is a total of 3.6 acres.

PROPOSED PROJECT

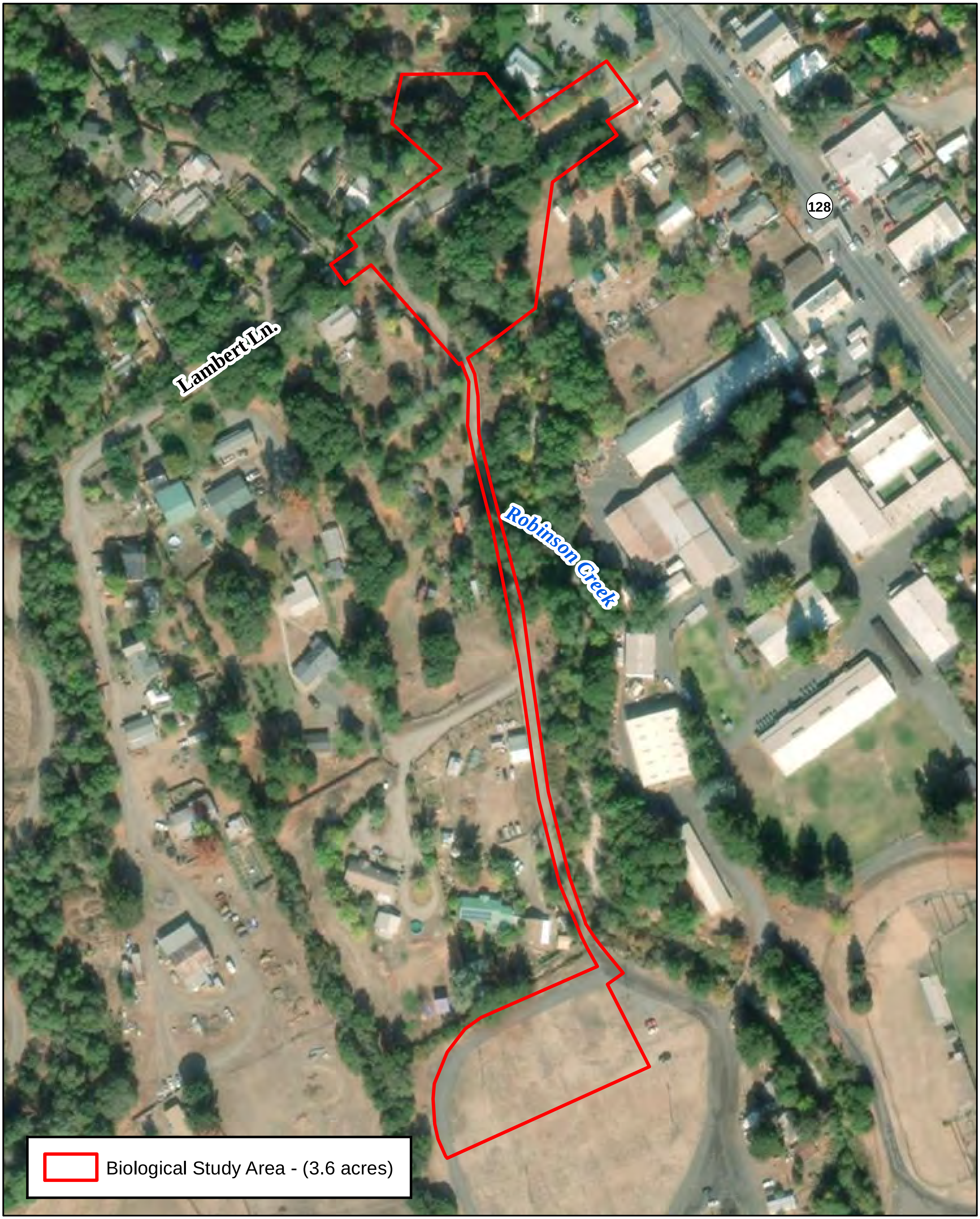
The proposed Project will replace the existing Robinson Creek Bridge on Lambert Lane, approximately 400 feet west of State Route (SR) 128 (**Figure 2**). The existing structure is 32 feet long and 26 feet wide with closed strutted abutments founded on spread footings on erodible alluvial material. This bridge has a history of scour issues and a scour hole that has undermined the integrity of the easterly bridge abutment. There are deficiencies in the bridge width, superstructure and substructure conditions. The replacement bridge will have 9-foot lanes and 5-foot shoulders in each direction resulting in a wider structure which meets safety standards.

In addition to the bridge replacement, portions of the stream channel upstream and downstream of the bridge will be stabilized according to the Robinson Creek Channel Design for the Lambert Lane Bridge Replacement Project prepared by Michael Love & Associates, Inc. (MLA).

CONSTRUCTION METHODS AND ACCESS

The preferred construction method will be to build a replacement bridge on the existing alignment and providing a temporary detour. Based on Lambert Lane being the only public road access to approximately 30 parcels, it is necessary to keep at least one lane of traffic open during construction. Due to the instability of the existing bridge, a temporary bridge is proposed to be erected offset from the existing bridge to pass traffic around bridge construction operations within the Project site and avoid a road closure. This temporary bridge will either be a Bailey Bridge sourced from Mendocino County or a Contractor furnished temporary bridge structure.

A long span steel plate girder bridge will be constructed within the existing bridge alignment and can be fabricated in shorter lengths to facilitate transport and then assembled on-site (**Figure 4**). This bridge option will have a shorter construction time and will minimize impacts to the creek since it does not require falsework in the creek. Additionally, this long span bridge option provides the ability to improve the alignment of the creek to minimize future potential



1:2,200
0 100 200 Feet
NORTH
Data Sources: ESRI, Quincy Engineering, DigitalGlobe 10/31/17

Robinson Creek Bridge Replacement Project
Biological Study Area
Figure 3

gallaway ENTERPRISES

GE: #15-130 Map Date: 01/31/19

scour issues by increasing the channel opening and providing a softer and more gradual turn of the creek. Weathering steel will be utilized to minimize future maintenance efforts and costs. Significant changes to the vertical profile are not anticipated as the existing and replacement bridge option provide adequate hydraulic freeboard. The structure depth will be 4 feet 9 inches.

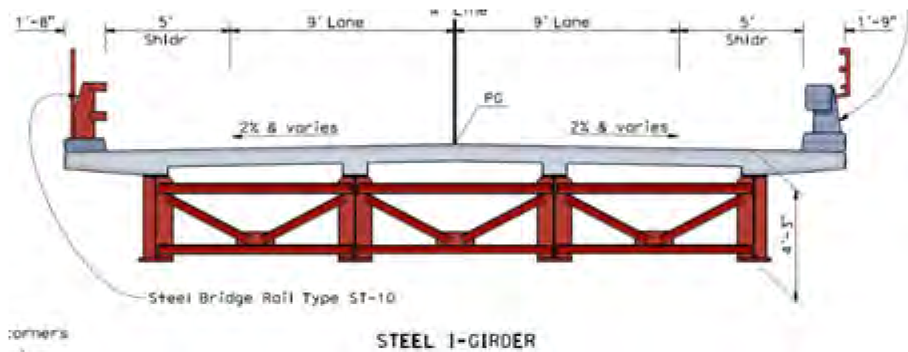


Figure 4. Long Span Prefabricated Steel Plate Girder Bridge Design Cross-Section

Deep foundation systems, drilled piles, will be required due to the presence of unconsolidated channel alluvium substrate. Pile type is Cast-In-Drilled-Hole (CIDH) piles. The foundation type for the retaining walls will be the same as for bridge abutments. It is anticipated that temporary shoring will be required during bridge construction.

Geomorphic Channel Conditions Within the Project Area and the Proposed Bridge Structure

Lambert Lane crosses Robinson Creek approximately 2,860 linear feet upstream of the confluence with Anderson Creek and 500 feet west of State Route SR128. The existing bridge crossing is at the inflection of a tight meander bend and the channel alignment has been constrained by the roadway embankment. The proposed replacement bridge has a free span of approximately 91 feet, while the existing bridge span is only 32 feet. The increased span is in-part intended to facilitate an improved alignment with the channel by decreasing the sharpness of the meander bend. A constraint to realigning the channel was the preservation of large established trees along the right bank upstream and downstream of the crossing, including an 8-foot diameter heritage oak tree close to the existing right bank of the channel upstream of the bridge. The proposed alignment moves the approach channel further to the right (looking downstream) and has a sinuosity of 1.2 (valley length to channel length).

Stream Channel Restoration Geomorphic Characterization

It is proposed that portions of the embankment slopes will be protected from erosion with RSP and that willow plantings will also be included as part of bank protection and restoration. Channel grading will minimize abrupt hydraulic constrictions and areas of focused high velocities (**Figure 5**). The proposed riprap revetments upstream and downstream of the bridge crossing are to be vegetated with live willow cuttings following Caltrans "hybrid revetment" design. Further, this Project will include removing the rubble and reconfiguring the RSP that covers the creek bottom, restoring the channel to a more natural condition and restoring fish passage to sections of Robinson Creek above the failed retaining wall. Channel restoration designs for the site will satisfy current fish passage standards, as described in CDFG (2009) and NMFS (2001) guidelines (**Appendix A: Robinson Creek Channel Design Report**).

The proposed stream channel component of the replacement crossing was designed using the stream simulation approach outlined in Part XII of the California Salmonid Stream Habitat Restoration Manual (CDFG, 2009) and by the USFS (2008). The stream simulation approach is a geomorphically-based approach that requires a channel-spanning crossing structure with adequate capacity to convey the 100-year flow. The channel grading should seamlessly connect with the upstream and downstream channel profiles and the streambed should be composed of native material that is as mobile as bed material within the adjacent channel reaches. The approach relies on using the adjacent stream channel as a geomorphic reference for design of the crossing and channel bed.

The channel configuration and extent of grading was influenced by the goal of preserving trees. The first design consideration was to minimize the removal of larger oak and bay trees. Planting the RSP with willow stakes and site revegetation is intended to offset temporary loses, as willows grow quickly. Project designers considered reusing the larger trees in the channel for fish habitat and identified several locations where large woody debris (LWD) could be incorporated to offset temporal losses to steelhead habitat. Removed trees could be located along the inside bend in the upstream right bank between station 29+60 and 31+100, or downstream left bank around station 28+00. At the downstream end of the RSP, LWD could be utilized to provide flow deflection or bank protection for the bend immediately downstream of the project. Additional consideration for including LWD in the restored stream will be made the final design.

Hybrid Revetment Design

Incorporating vegetation into the streambank revetment has the beneficial effects of improving stream ecology, increasing soil strength and providing flow resistance, although it can be unpredictable over the long term (Caltrans 2014). Established vegetation will provide

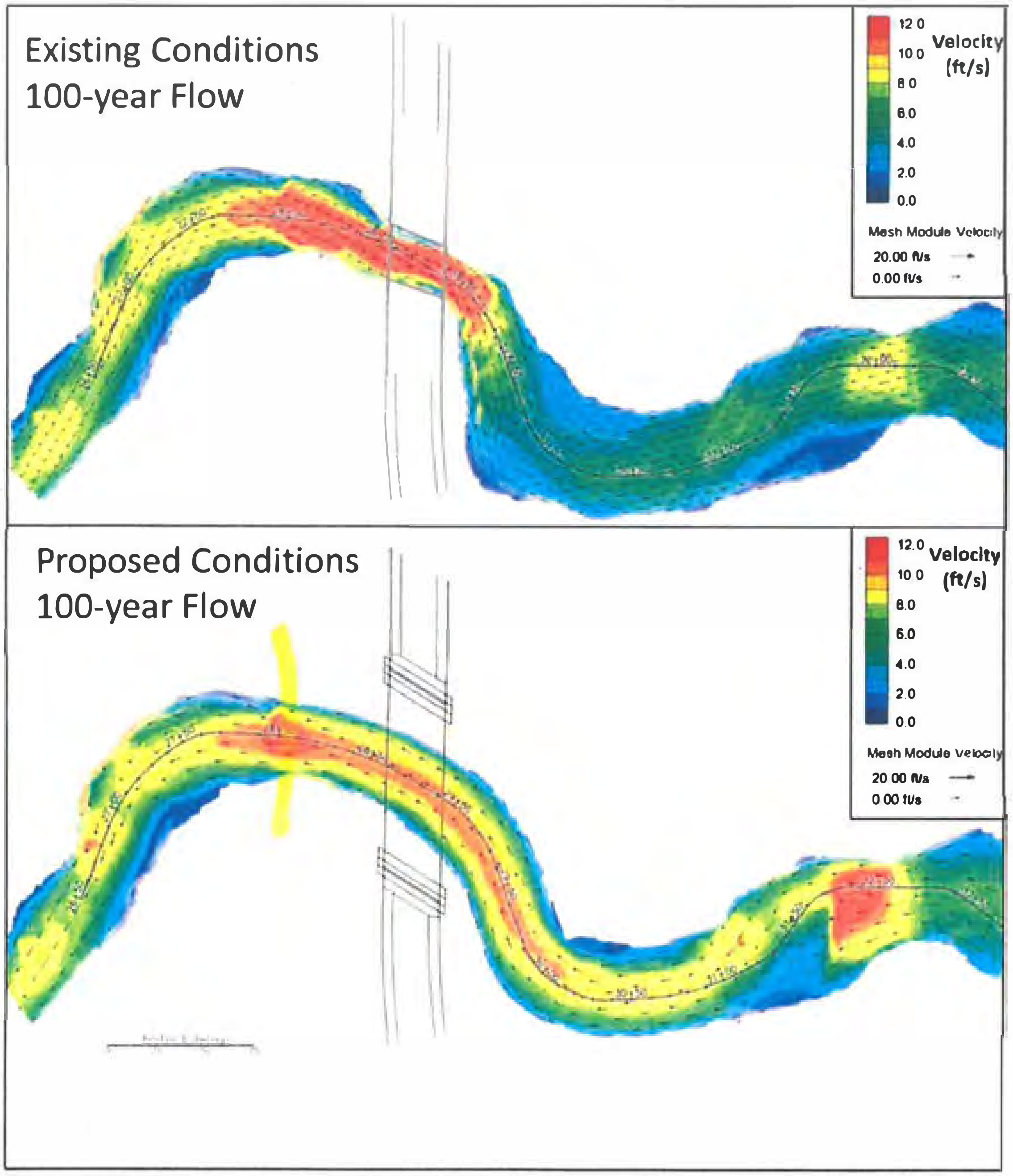


Figure 5. Predicted water velocities associated with the 100-year flow of 1,750 cfs for existing and proposed.

cover, shade the channel and provide nutrients to the stream. As root systems establish, they can support the banks by providing resistance to scour and bind the soils and rock placed along the bank.

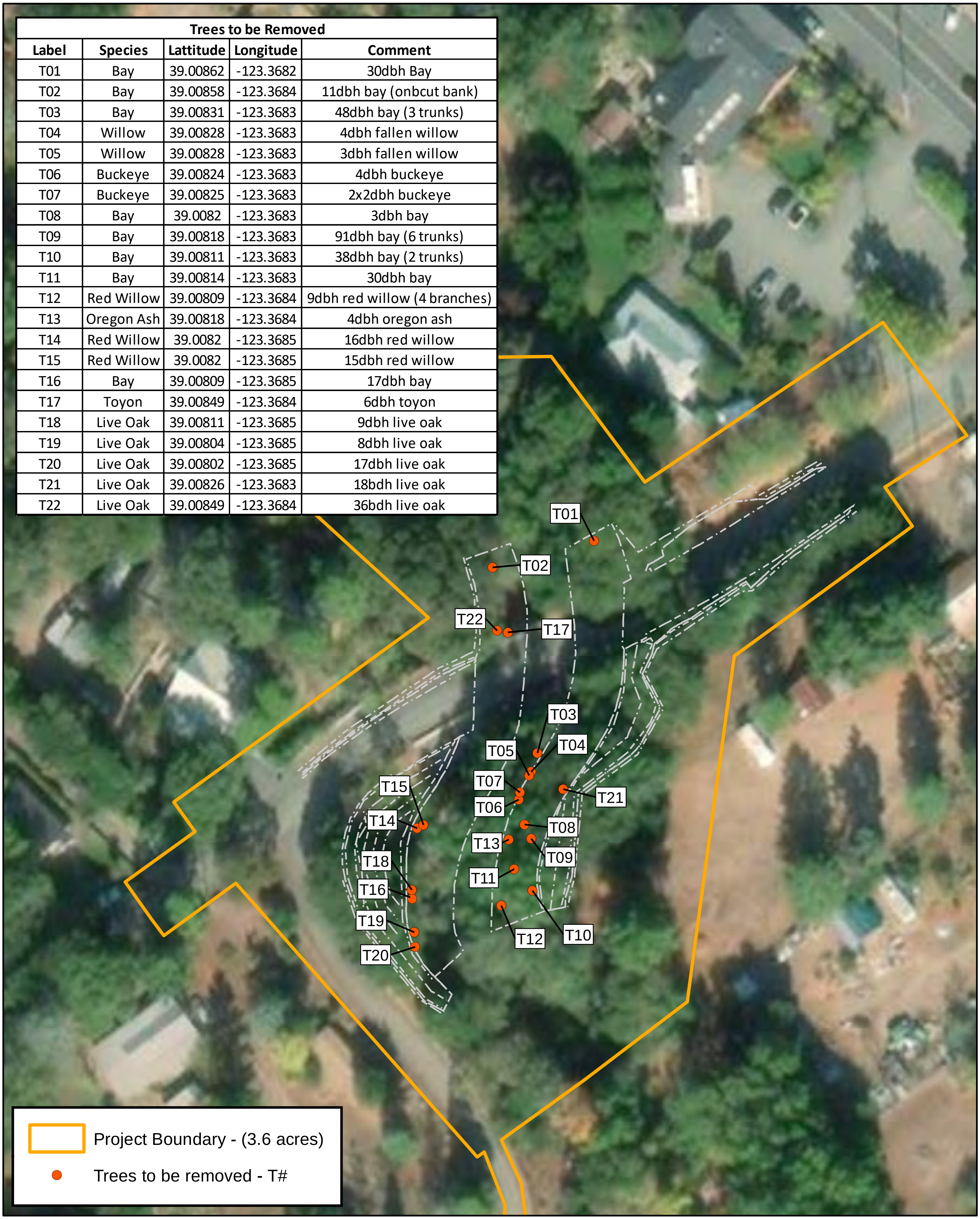
Caltrans has developed recommendations for the use of a "hybrid revetment" that incorporates vegetation into rock slope protection to provide the benefits of stream side vegetation while managing its uncertainties. The intent is to balance the engineering benefit of armoring a bank while promoting ecological processes. The hybrid RSP design consists of the standard RSP design as described above, with the addition of live willow staking that penetrates the rock layers and allows rooting into the native bank soils. Species most commonly used as live stakes are native willow and cottonwood trees. Plantings are placed either vertical or perpendicular to the slope face and must be long enough to extend through to the subbase and into moist soil. Placement of live stakes is done in conjunction with rock placement. To provide protection to the live stakes during rock placement, cuttings should be placed into perforated cardboard tubes that are embedded into the subgrade and extend through the layered RSP. Cardboard is preferred as it can degrade over time and not hinder the growth of the cuttings. Growing medium is placed within the cardboard tubes to provide direct soil contact. Additionally, voids within the placed riprap should be filled with salvaged soil to further promote root growth within the layered RSP.

For Robinson Creek, it is assumed cutting shall be made from native willow species. Stakes may need to be as long as 12 feet and should be placed vertically to maximize their rooting depth, with the butt of the live stake at or near summer groundwater levels. The willow plantings will start at bankfull, 2.3 feet above the finished channel bed, and extend up the RSP revetment. To ensure good establishment, the live stakes should be irrigated for a minimum of two seasons.

Based on the proposed channel grading, 22 trees will be removed (**Figure 6**). In addition to the plantings contained within the hybrid RSP revetment, native vegetation would be planted on the graded point bars on the inside of the channel bends. This vegetation should include native riparian tree species, as well as understory plants. In addition to the planting areas close to the channel, the Project will create a terrace behind the RSP adjacent to the road embankment at the southern bridge approach. This terrace will be used to plant upland tree species, such as native oaks.

Channel incision, channel bank erosion, and channel widening associated with incision processes has caused severe bank erosion, resulting in loss of mature riparian vegetation throughout lower Robinson Creek. Though the riparian trees to be removed as a result of

Trees to be Removed				
Label	Species	Lattitude	Longitude	Comment
T01	Bay	39.00862	-123.3682	30dbh Bay
T02	Bay	39.00858	-123.3684	11dbh bay (onbcut bank)
T03	Bay	39.00831	-123.3683	48dbh bay (3 trunks)
T04	Willow	39.00828	-123.3683	4dbh fallen willow
T05	Willow	39.00828	-123.3683	3dbh fallen willow
T06	Buckeye	39.00824	-123.3683	4dbh buckeye
T07	Buckeye	39.00825	-123.3683	2x2dbh buckeye
T08	Bay	39.0082	-123.3683	3dbh bay
T09	Bay	39.00818	-123.3683	91dbh bay (6 trunks)
T10	Bay	39.00811	-123.3683	38dbh bay (2 trunks)
T11	Bay	39.00814	-123.3683	30dbh bay
T12	Red Willow	39.00809	-123.3684	9dbh red willow (4 branches)
T13	Oregon Ash	39.00818	-123.3684	4dbh oregon ash
T14	Red Willow	39.0082	-123.3685	16dbh red willow
T15	Red Willow	39.0082	-123.3685	15dbh red willow
T16	Bay	39.00809	-123.3685	17dbh bay
T17	Toyon	39.00849	-123.3684	6dbh toyon
T18	Live Oak	39.00811	-123.3685	9dbh live oak
T19	Live Oak	39.00804	-123.3685	8dbh live oak
T20	Live Oak	39.00802	-123.3685	17dbh live oak
T21	Live Oak	39.00826	-123.3683	18bdh live oak
T22	Live Oak	39.00849	-123.3684	36bdh live oak



1:800
0 50 100 Feet
NORTH
Data Sources: ESRI, DigitalGLobe 10/31/17, USGS, Quincy Engineering

Robinson Creek Bridge Replacement Project
Trees to be Removed
Figure 6

gallaway ENTERPRISES

GE: #15-130 Map Date: 05/20/19

the Project are likely important components of NC steelhead critical habitat, current conditions have degraded the overall quality of the critical habitat. The Project proponent proposes to replant up to 355 trees, at a 16:1 ratio, in an effort to restore the creek and mitigate potential impacts to NC steelhead critical habitat. Robinson Creek and its associated riparian vegetation will be restored to a net benefit to NC steelhead and NC steelhead critical habitat. Where feasible LWD will be considered at specific locations within the Project to improve conditions for NC steelhead and offset temporary habitat loss.

The following are the preliminary estimates of trees to be replanted. Upon final design, a qualified landscape architect or botanist should be consulted to determine spacing and placement, species types, and any other factors appropriate to the site.

Planted RSP (3,010 sf):
Willow/cottonwood at 5 feet on center = 125 trees
Channel bank and low terrace (1,823 sf):
Native riparian and understory at 3 feet on center = 220 trees
Upper Terrace (725 sf)
Native upland trees, such as oaks = 5-10 trees

A quantity estimate of both temporary fill materials and permanent features required for construction within Robinson Creek in the BSA is presented in **Table 1**.

Table 1. Impacts to Waters of the United States

Type of impact	Acreage of impact
Temporary Impacts – Access and Bridge Demolition/Construction	0.10 acres
Permanent Impacts – Hybrid RSP Revetment and Stream Restoration	0.09 acres

STAGING AREAS, RIGHTS OF WAY, AND UTILITIES

The Project staging areas will include portions of the closed roadway at each end of the bridge and the area just southeast of the bridge. If this area is unavailable or not sufficient in size, there is an alternative area off-site at the County Fairgrounds that can also serve as a staging area. Right-of-Way including slope easements, temporary construction easements, permanent maintenance easements, and permanent acquisitions will be required. There are existing overhead electrical and telephone utilities that will need to be relocated. Additionally, there is a storm water concrete pipe that outfalls into the creek that will need to be relocated. Coordination will begin early with PG&E.

CONSTRUCTION EQUIPMENT AND SCHEDULE

It is anticipated that excavators, dozers, cranes, pavers, dump trucks, concrete trucks, concrete pumps, and pile drilling equipment will be required. Construction is anticipated to begin in June 1, 2021 and run through October 31, 2021 when the creek is anticipated to be dry or not flowing.

2 Study Methods

The biological and botanical surveys were conducted by Gallaway Enterprises after consulting the United States Fish and Wildlife Services (USFWS) Information for Planning and Conservation (IPaC) species list, National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) species list, NOAA NMFS Essential Fish Habitat (EFH) mapper database, CDFW Natural Diversity Database (CNDDB) search and the California Native Plant Societies (CNPS) list of rare and endangered plants gathered for the BSA (**Appendix B: Species Lists**). Additionally, a map was obtained from the CNDDB Geographic Information System (GIS) database, which provided general locations of species that had recorded CNDDB occurrences within a five (5) mile radius of the Project location (**Figure 7: CNDDB Occurrences**). Based on the results of the species lists and CNDDB map, appropriate biological and botanical surveys were conducted.

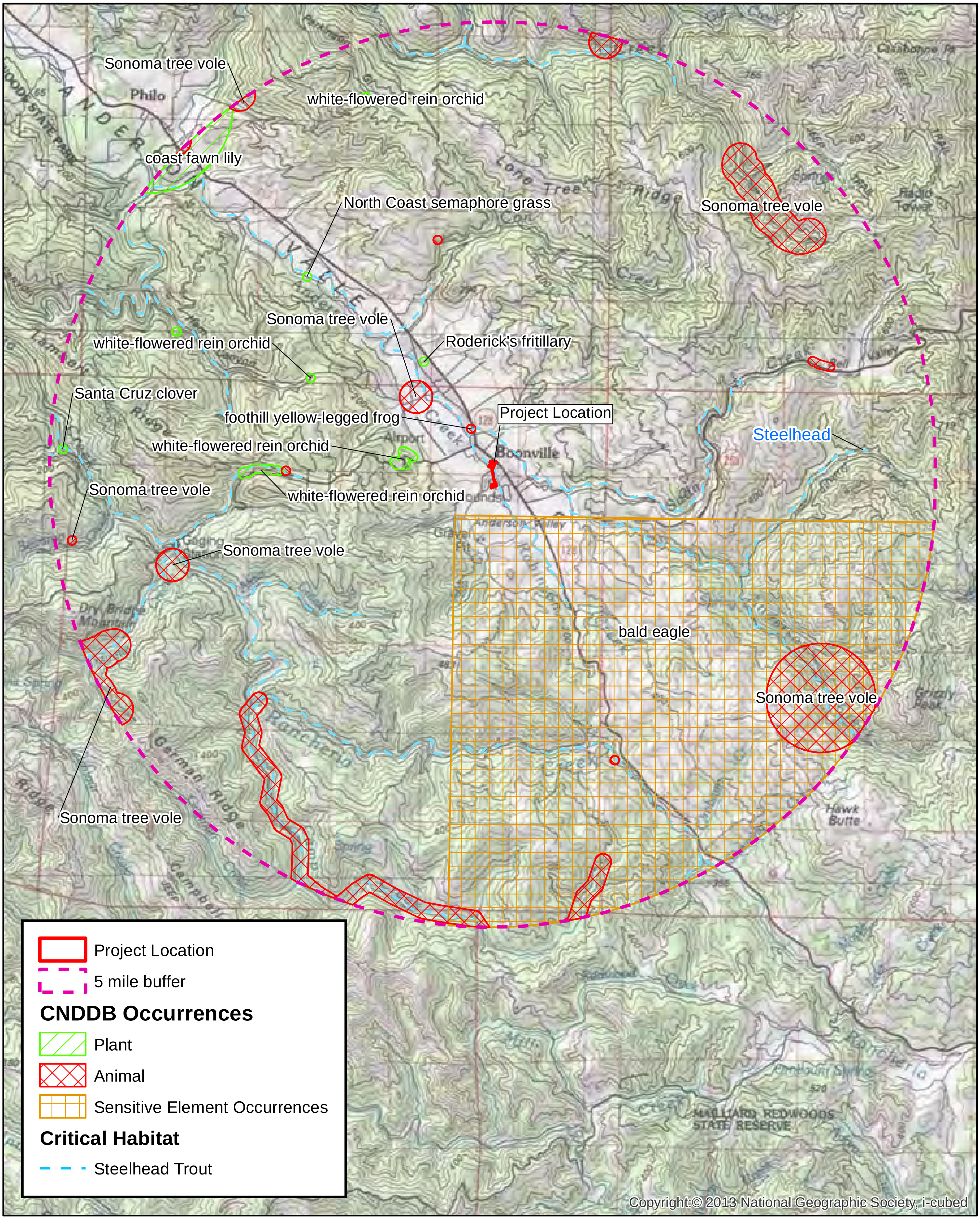
Regulatory Requirements

The following describes federal, state, and local environmental laws and policies that are relevant to the CEQA review process and to this NES.

Federal

Federal Endangered Species Act

The United States Congress passed the Federal Endangered Species Act (ESA) in 1973 to protect species that are endangered or threatened with extinction. The ESA is intended to operate in conjunction with the NEPA to help protect the ecosystems upon which endangered and threatened species depend. The ESA makes it unlawful to “take” a listed animal without a permit. Take is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct.” Through regulations, the term “harm” is defined as “an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.”



NORTH

1:90,000
0 2,500 5,000 Feet

Data Sources: ESRI, USGS, USFWS
CNDDB, Quincy Engineering

Robinson Creek Bridge Replacement Project
CNDDB and Critical Habitat
Figure 7

gallaway ENTERPRISES

GE: #15-130 Map Date: 01/31/19

Migratory Bird Treaty Act

The MBTA (16 USC §703) prohibits the killing of migratory birds or the destruction of their occupied nests and eggs except in accordance with regulations prescribed by the USFWS. The bird species covered by the MBTA includes nearly all of those that breed in North America, excluding introduced (i.e. exotic) species (50 Code of Federal Regulations §10.13). Activities that involve the removal of vegetation including trees, shrubs, grasses, and forbs or ground disturbance has the potential to affect bird species protected by the MBTA.

Waters of the United States, Clean Water Act, Section 404

The Corps and the U.S. Environmental Protection Agency (EPA) regulate the discharge of dredged or fill material into jurisdictional waters of the United States, under the Clean Water Act (CWA, §404). The term “waters of the United States” (WOTUS) is an encompassing term that includes “wetlands” and “other waters.” Wetlands have been defined for regulatory purposes as follows: “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3, 40 CFR 230.3). Wetlands generally include swamps, marshes, bogs, and similar areas.” other waters of the United States are seasonal or perennial water bodies, including lakes, stream channels, drainages, ponds, and other surface water features, that exhibit an ordinary high-water mark but lack positive indicators for one or more of the three wetland parameters (i.e., hydrophytic vegetation, hydric soil, and wetland hydrology) (33 CFR 328.4).

The Corps may issue either individual permits on a case-by-case basis or general permits on a program level. General permits are pre-authorized and are issued to cover similar activities that are expected to cause only minimal adverse environmental effects. Nationwide permits are general permits issued to cover particular fill activities. All nationwide permits have general conditions that must be met for the permits to apply to a particular Project, as well as specific conditions that apply to each nationwide permit.

Executive Orders 13112; Prevention and Control of Invasive Species

On February 3, 1999, Executive Order 13112 was signed establishing the National Invasive Species Council. Executive Order 11312 directs all federal agencies to prevent and control introductions of invasive nonnative species in a cost-effective and environmentally sound manner to minimize their economic, ecological, and human health impacts. Executive Order 11312 established a national Invasive Species Council made up of federal agencies and departments and a supporting Invasive Species Advisory Committee composed of state, local, and private entities. The Invasive Species Council and Advisory Committee oversees and facilitates implementation of the Executive Order, including preparation of a National Invasive Species Management Plan.

Section two (2) of the Executive Order states:

(a) Each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, (1) identify such actions; (2) subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them; and (3) not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

(b) Federal agencies shall pursue the duties set forth in this section in consultation with the Invasive Species Council, consistent with the Invasive Species Management Plan and in cooperation with stakeholders, as appropriate, and, as approved by the Department of State, when Federal agencies are working with international organizations and foreign nations.

The Magnuson-Stevens Act

The Magnuson-Stevens Act (MSA) was signed in 1996 and mandates the use of annual catch limits and accountability measures to end overfishing, provide widespread market-based fishery management through limited access privilege programs, and calls for increased international cooperation. The fish off the coasts of the United States, the highly migratory species of the high seas, the species which dwell on or in the Continental Shelf appertaining to the United States, and the anadromous species which spawn in United States Rivers or estuaries, constitute valuable and renewable natural resources and they and their habitats are protected under the MSA. A national program for the conservation and management of the fishery resources of the United States is necessary to prevent overfishing, to rebuild overfished stocks, to insure conservation, to facilitate long-term protection of EFH, and to realize the full potential of the Nation's fishery resources.

Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The EFH guidelines further interpret the EFH definition as:

- “Waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate.
- “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- “necessary” means the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem.
- and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

Activities proposed to occur in EFH areas do not automatically require consultation. Consultations are triggered only when the proposed action may adversely affect EFH, and then, only Federal actions require consultation. States are not required to consult. However, if NOAAs National Marine Fisheries Service (NMFS) receives information on a State action that may adversely affect EFH, NMFS is required to provide EFH conservation recommendations to the State agency. States are not required to initiate consultation with NMFS nor respond to its recommendations (NOAAs National Marine Fisheries Service 2011).

State of California

California Endangered Species Act

The California Endangered Species Act (CESA) is similar to the ESA, but pertains to state-listed endangered and threatened species. The CESA requires state agencies to consult with the California Department of Fish and Wildlife (CDFW) when preparing documents to comply with the CEQA. The purpose is to ensure that the actions of the lead agency do not jeopardize the continued existence of a listed species or result in the destruction, or adverse modification of habitat essential to the continued existence of those species. In addition to formal listing under the federal and state endangered species acts, “species of special concern” receive consideration by CDFW. Species of special concern are those whose numbers, reproductive success, or habitat may be threatened.

California Environmental Quality Act Guidelines §15380

Although threatened and endangered species are protected by specific federal and state statutes, CEQA Guidelines §15380(d) provides that a species not listed on the federal or state list of protected species may be considered rare or endangered if the species can be shown to meet certain specified criteria. These criteria have been modeled based on the definition in the ESA and the section of the California Fish and Game Code (CFGC) dealing with rare, threatened, and endangered plants and animals. The CEQA Guidelines (§15380) allows a public agency to undertake a review to determine if a significant effect on species that have not yet been listed by either the USFWS or CDFW (e.g. candidate species, species of concern) would occur. Thus, CEQA provides an agency with the ability to protect a species from a Project’s potential impacts until the respective government agencies have an opportunity to designate the species as protected, if warranted.

Clean Water Act, Section 401

The CWA (§401) requires water quality certification and authorization for placement of dredged or fill material in wetlands and other waters of the United States. In accordance with the CWA (§401), criteria for allowable discharges into surface waters have been developed by the State Water Resources Control Board, Division of Water Quality. The resulting requirements are used as criteria in granting National Pollutant Discharge Elimination System (NPDES) permits or waivers, which are obtained through the Regional Water Quality Control Board (RWQCB) per the CWA (§402). Any activity or facility that will discharge waste (such as soils from construction) into surface waters, or from which waste may be discharged, must obtain an NPDES permit or waiver from the RWQCB. The RWQCB evaluates an NPDES permit application to determine whether the proposed discharge is consistent with the adopted water quality objectives of the basin plan.

California Fish and Game Code

The CFGC (§3503.5) states that it is "unlawful to take, possess, or destroy any birds in the order Falconiformes (hawks, eagles, and falcons) or Strigiformes or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto." Take includes the disturbance of an active nest resulting in the abandonment or loss of young. The CFGC (§3503) also states that "it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto."

Rare and Endangered Plants

The CNPS maintains a list of plant species native to California with low population numbers, limited distribution, or otherwise threatened with extinction. This information is published in the Inventory of Rare and Endangered Vascular Plants of California. Potential impacts to populations of CNPS-ranked plants receive consideration under CEQA review. The CNPS California Rare Plant Rank (CRPR) categorizes plants as the following:

- Rank 1A: Plants presumed extinct in California;
- Rank 1B: Plants rare, threatened, or endangered in California or elsewhere;
- Rank 2: Plants rare, threatened, or endangered in California, but more numerous elsewhere;
- Rank 3: Plants about which we need more information; and
- Rank 4: Plants of limited distribution.

The California Native Plant Protection Act (CFGC §1900-1913) prohibits the taking, possessing, or sale within the state of any plants with a state designation of rare, threatened, or endangered as defined by CDFW. An exception to this prohibition allows landowners, under specific circumstances, to take listed plant species, provided that the owners first notify CDFW and give the agency at least 10 days to retrieve (and presumably replant) the plants before they are destroyed. Fish and Game Code §1913 exempts from the 'take' prohibition 'the removal of endangered or rare native plants from a canal, lateral ditch, building site, or road, or other right of way.'

Studies Required

Gallaway Enterprises conducted biological and botanical habitat assessments and a protocol-level rare plant survey within the BSA. Biological and botanical surveys were conducted following review of the USFWS IPaC report, CNDDB Rarefind 5 report, CNPS list, and the CNDDB occurrence map (**Figure 7**). The United States Geological Survey (USGS) “Boonville” 7.5 minute quadrangle in which the Project is located were used to derive the agency species lists **(Appendix B: Species Lists)**. Based on the results of the species lists, Gallaway Enterprises conducted a general habitat assessment and protocol level rare plant botanical survey to identify any rare, endangered, threatened, or sensitive species and their habitats that may have the potential to occur within the BSA.

Personnel and Survey Dates

The biological evaluation and rare plant botanical survey was conducted on June 29, 2018 by Gallaway Enterprises biologist, Melissa Murphy, and senior botanist and certified arborist, Elena Gregg. The purpose of the biological evaluation and rare plant botanical survey is to determine if suitable habitat occurs within the property for special-status species and if special-status species are present. Methods for each survey are described below.

Ms. Murphy has over eight years of experience surveying at the protocol and general level for listed reptiles and amphibians including foothill yellow-legged frog, giant garter snake (GGS), and California red-legged frog. Ms. Murphy has experience surveying for yellow billed cuckoo, foothill yellow-legged frog, PIT tagging reptiles, assisting in de-watering activities including fish relocation, surveying for nesting birds and raptors, capturing and banding waterfowl, and conducting habitat assessments for listed species. Ms. Murphy has installed bird and bat exclusion at a myriad of projects and works under Gallaway Enterprises’ CDFW Scientific Collecting Permit as a Principal Investigator.

Mrs. Gregg has over twelve years of professional experience conducting rare plant surveys, wetland delineations, and habitat assessments in California. She has a working knowledge of CNPS, CDFW, and USFWS survey protocols and holds a CDFW collection permit for listed plant species. Through her extensive field experience in a wide array of habitats and eco-regions in northern California, Mrs. Gregg has gained knowledge of locally invasive plants species and noxious weeds.

BIOLOGICAL HABITAT ASSESSMENT

The biological evaluation was conducted by walking the entire BSA and identifying specific habitat types and elements. If habitat was observed for special-status species it was then evaluated for quality based on vegetation composition and structure, physical features (e.g. water, soils), micro-climate, surrounding area, presence of predatory species and available resources (e.g. prey items, nesting substrates). Biological species observed within the BSA are listed in **Appendix C**.

BOTANICAL HABITAT ASSESSMENT

A botanical habitat assessment was conducted on June 29, 2018 by senior botanist Elena Gregg to assess potential for special-status plant species to occur within the BSA. The assessment was conducted by walking in all accessible areas of the BSA and noting the habitat elements present (e.g. soils, geology, hydrology, topography, aspect, elevation, etc.) and vegetation communities present. If present, natural and man-made disturbance patches were noted as well as the successional stage of vegetation within the BSA. Botanical species observed within the BSA during this field visit are listed in **Appendix C**.

PROTOCOL-LEVEL RARE PLANT SURVEY

The protocol-level rare plant survey was conducted on June 29, 2018 by senior botanist Elena Gregg following the initial botanical habitat assessment during the appropriate blooming period for the four (4) special-status plant species that were identified as having potential to occur within the BSA. The survey was conducted in accordance with the CDFW March 2018, *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Sensitive Natural Communities*. All accessible areas within the Project site were surveyed on foot. A Trimble Geo Explorer 6000 Series GPS Receiver was on hand to record any special-status plant occurrences observed. A list of plant species observed during the protocol-level survey is included as **Appendix C**.

Agency Coordination and Professional Contacts

On February 13, 2019, Gallaway Enterprises spoke with CDFW Environmental Scientist and fish specialist, Scott Harris, regarding the potential for northern California steelhead DPS, California coastal Chinook salmon ESU, and Central California Coast Coho salmon ESU to occur within Robinson Creek.

Limitations That May Influence Results

There were no limitations that may influence results of the habitat assessment and site assessment.

3 Results: Environmental Setting

Description of the Existing Biological and Physical Conditions

The Project site is positioned within the narrow Anderson Valley in the northern California coastal mountain range. The BSA consists of an approximately 3.6-acre survey area including the area surrounding the Lambert Lane bridge over Robinson Creek within the town of Boonville, Mendocino County, CA. The BSA is surrounded by a mix of rural residential homes and urban habitats. The Project is located within the Boonville USGS Quadrangle, Section 2, Township 13N, Range 14W.

Study Area

Within the BSA, vegetation communities are highly disturbed. All construction related activities will be restricted to the limits of the BSA; therefore, habitat assessments and surveys were restricted to the area within the BSA.

Physical Conditions

The survey area ranges in elevation from 382 to 405 feet above sea level and is sloped between 0-9 percent. Soils within the survey area are loams and sandy loams with a deep restrictive layer located more than 80 inches deep. The average annual precipitation is 37.88 inches and the average temperature is 58.55° F (WRCC 2019) in the region where the survey area is located. Based on the current CWA definition of WOTUS, there is one tributary feature that meets the criteria to be considered a jurisdictional WOTUS within the BSA (**Appendix D**).

Biological Conditions in the Biological Study Area

The BSA consists of existing asphalt roadway, concrete bridge, gravel road shoulder, a mixed species tree canopy and patches of disturbed annual grassland. The existing roadway, concrete bridge and gravel road shoulder are characterized as barren habitat and are not considered habitat for any special-status species. Vegetated habitat types present within the BSA are described below based on Mayer and Laudenslayer’s *A Guide to Wildlife Habitats of California* (1988).

Valley Oak Woodland

Along the tops of the banks of Robinson Creek, the majority of the vegetation was dominated by a dense tree canopy consisting of valley oaks (*Quercus lobata*) and live oak (*Quercus wislizeni*), a shrub layer of California bay-laurel (*Umbellularia californica*) and an understory dominated by Himalayan blackberry, periwinkle (*Vinca major*), English ivy (*Hedera helix*), poison oak (*Toxicodendron diversilobum*) and upland herbaceous species.

VALLEY FOOTHILL RIPARIAN

Below the ordinary high water mark (OHWM) of Robinson Creek, there is a narrow corridor of valley foothill riparian habitat. Vegetation along the edges of the creek bed and on the steep banks of the creek include arroyo willow (Salix lasiolepis), Himalayan blackberry, and the occasional Oregon ash (Fraxinus latifolia). The strip of valley foothill riparian habitat that occurs within the limits of Robinson Creek and the transition from this habitat type to adjacent valley oak woodland and urban habitat is abrupt. Valley foothill riparian habitats provide food, water, migration, and dispersal corridors for fish species and escape, nesting, and thermal cover for an abundance of other wildlife species. Within the Action Area, this habitat type is extremely narrow and occurs in close proximity to residential homes, which greatly reduces the potential habitat benefits it can provide.

RIVERINE

Riverine habitat occurs within Robinson Creek in the BSA. Robinson Creek exhibits intermittent flow patterns and typically has a dry period starting in the early summer through fall. The channel morphology is characterized as gravel/cobble bedded pool and riffle with fairly shallow residual pool depths under the bridge. The banks of the creek were generally steep and channelized. Robinson Creek meanders tightly through the BSA with a series of s-curves causing an extensive bank failure and resulting large wood jam from mature trees sloughing into the creek. Upstream of the Robinson Creek bridge the partially failed retaining walls and road embankment is on the outside of a right bend within the channel. On the inside of the bend there is a depositional bar that appears to have formed relatively recently (since construction of the bridge), likely in-part due to backwater affects from the abrupt turn in the channel as it approaches the bridge. The bar appears to have sharpened the radius of the channel bend and pushed the channel thalweg up against the retaining wall along the road embankment and against the nearly vertical bank upstream of the retaining wall, where riprap has been placed, creating a 3-foot water surface drop which classifies the current conditions as a barrier to adult and juvenile steelhead based on the CDFW fish passage assessment guidelines (CDFG, 2002). Western toad (*Anaxyrus boreas*) tadpoles and juveniles were observed in areas where small isolated pools remained in the channel during the June field visit.

ANNUAL GRASSLAND

Disturbed annual grassland habitat occurs as small patches of openings amongst the tree canopy within the area around the bridge and is the dominant habitat type in the proposed offsite staging area. Vegetation within these annual grassland portions of the survey area was primarily composed of perennial rye-grass (*Festuca perennis*), wall hare barley (*Hordeum murinum*), hawkbit (*Leontodon saxatilis*), smooth cat's-ear (*Hypochaeris glabra*), English plantain (*Plantago lanceolata*), and yellow star-thistle (*Centaurea solstitialis*). Wildlife species use grassland habitat for foraging but require some other habitat characteristic such as rocky out crops, cliffs, caves or ponds in order to find shelter and cover for escapement. Common species that are found breeding in this habitat when it is healthy include a variety of ground nesting avian species and small mammals (Mayer and Laudenslayer 1988).

URBAN

Urban habitat is present adjacent to the bridge site which is composed of residential homes and associated landscaping. This environment can present a mosaic of vegetation including primarily ornamental landscaping but can incorporate native tree species. Generalist and invasive species often occupy urban habitat such as common raven (*Corvus corax*), house sparrow (*Passer domesticus*), scrub jays (*Aphelocoma californica*) and brewers blackbirds (*Euphagus cyanocephalus*) as well as small to medium mammals (e.g., raccoon, opossum, striped skunk) (Mayer and Laudenslayer 1988).

BARREN

Within the BSA, the roadways and bridge structure present are characterized as barren habitat. Barren habitat is defined by the absence of vegetation. The barren habitat within the Project consists primarily of asphalt, concrete and gravel. Barren habitat types generally provide low quality of habitat for wildlife.

Regional Species and Habitats and Natural Communities of Concern

The following special-status species were identified under the USFWS IPaC, CNDDB, NMFS and the CNPS species lists (**Appendix B: Species Lists**) as having potential to occur within the USGS "Boonville" 7.5 minute and surrounding quadrangles. Species that have the potential to occur within the BSA are based on suitable habitat within the BSA, including elevation thresholds, CNDDB occurrences within a five-mile radius of the BSA, and observations made during biological surveys and habitat assessment, thus not all species listed within the various species lists in **Appendix B** are included in **Table 2**. A summary of special-status species and their potential to occur within the BSA is provided in **Table 2**.

Table 2. Federal and State Listed and Candidate Species Potentially Occurring or Known to Occur in the Robinson Creek at Lambert Lane BSA.

Common Name	Scientific Name	Status	General Habitat Description	Habitat Present/ Absent	Potential to Occur/Rationale
PLANTS					
Burke's goldfields	*Lasthenia burkei*	FE/CNPS 1B.1	Vernal pools and swales. (April-Jun)	A	No vernal pools or swales present in the BSA and not observed during the field survey. The Project will have no effect on this species.
Coast fawn lily	*Erythronium revolutum*	CNPS 2B.2	Bogs, fens, and mesic streambanks. (Mar-Jul)	A	Not observed within the BSA during the field survey.
Contra Costa goldfields	*Lasthenia conjugens*	FE	Vernal pools. (Mar-Jun)	A	No suitable habitat present in the BSA. The Project will have no effect on this species.
Great burnet	*Sangisorba officinalis*	CNPS 2B.2	Rocky serpentine seeps, bogs, seasonal wetlands, sometimes stream banks. (Jul-Oct)	A	No suitable rocky or seep habitat present in the BSA.
North Coast semaphore grass	*Pleuropogon hooverianus*	CNPS 1B.1	Shady, wet grassy areas and freshwater marshes on forest floor. (Apr-Jun)	A	No suitable wet habitat present and not observed within the BSA during the field survey.
Roderick's fritillary	*Fritillaria roderickii*	CNPS 1B.1	Coastal grassy slopes and mesas. (Mar-May)	A	No suitable habitat present within the BSA.
Santa Cruz clover	*Trifolium buckwestiorum*	CNPS 1B.1	Present in gravelly margins and moist grassland, sometimes in gravel roads and ditches. (Apr-Oct)	A	No suitable gravelly habitat present and not observed within the BSA during the field survey.

Common Name	Scientific Name	Status	General Habitat Description	Habitat Present/ Absent	Potential to Occur/Rationale
Showy Indian clover	*Trifolium amoenum*	FE/CNPS 1B.1	Usually occurs in wetlands within valley grassland and wetland-riparian communities. (Apr-June)	A	No suitable habitat present and not observed during protocol level survey. The Project will have no effect on this species.
White-flowered rein orchid	*Piperia candida*	CNPS 1B.2	Sometimes serpentinite soils, forest duff, mossy banks, rock outcrops. (May-Sep)	A	Not observed within the BSA during the field survey.
INVERTEBRATES					
There are no regulated invertebrates with the potential to occur in the BSA.					
FISH					
Central California Coast Coho salmon ESU	*Oncorhynchus kisutch*	FE/SE	Streams and small freshwater tributaries during juvenile stages, spawning habitat includes gravel substrate.	A	Robinson Creek is intermittent and dries completely during the summer months. CNDDB observations between 1990 and 2016 show that there have been no observations of CCC Coho in Robinson Creek (Christy 2016). In addition, an extensive review of peer reviewed literature and citizen sightings conducted by CDFW showed only one equivocal record of CCC Coho occurring within Robinson Creek within the last 50 years (pers. comm Scott Harris, CDFW Environmental Scientist.). The

Common Name	Scientific Name	Status	General Habitat Description	Habitat Present/ Absent	Potential to Occur/Rationale
					Project will have no effect on this species.
California Coastal Chinook salmon ESU	*Oncorhynchus tshawytscha*	FT	Freshwater rivers, streams, and tributaries during the juvenile stages, prefers deep, large streams.	A	Robinson Creek is intermittent and dries completely during the summer months. In addition, an extensive review of peer reviewed literature and citizen sightings conducted by CDFW showed no occurrences of CC Chinook salmon occurring within Robinson Creek within the last 50 years (pers. comm Scott Harris, CDFW Environmental Scientist, Gavette 2014). The Project will have no effect on this species.
Navarro roach	*Lavinia symmetricus navarroensis*	SSC	Predominately found in small warm streams but are capable of thriving in larger colder streams with diverse conditions.	HP	Creek provides habitat when flowing.
Northern California steelhead DPS	*Oncorhynchus mykiss iridius*	FT	Wintering habitat includes streams with deep low-velocity pools while spawning habitat includes gravel substrates free of excessive silt.	CH/HP	Robinson Creek is designated critical habitat for this species, but only provides habitat when water is present during winter and spring. In addition, the current site conditions of the failed retaining wall and associated riprap

Common Name	Scientific Name	Status	General Habitat Description	Habitat Present/ Absent	Potential to Occur/Rationale
					immediately upstream of the bridge are considered a barrier to adult and juvenile steelhead. Through the implementation of avoidance and minimization measures the Project will have no effect on NC steelhead DPS.
Tidewater goby	*Eucyclogobius newberryi*	FE	Shallow water bodies characterized by brackish water with low to moderate salinity.	A	The creek present has no tidal influence and does not provide suitable habitat. The Project will have no effect on this species.
REPTILES & AMPHIBIANS					
California red-legged frog	*Rana draytonii*	FT/ SSC	Inhabits quiet pools of streams, marshes, and occasionally ponds.	A	There were no California red-legged frogs observed during the site visit. There are no CNDDB occurrences within 5 miles of the BSA, and no hydrologic connection to known populations. The Project will have no effect on this species.
Foothill yellow-legged frog	*Rana boylii*	SC	Frequents rocky streams and rivers with rocky substrate and open, sunny banks, in forests, chaparral, and	HP	Creek only provides habitat when water is present during winter and spring.

Common Name	Scientific Name	Status	General Habitat Description	Habitat Present/ Absent	Potential to Occur/Rationale
			woodlands. Sometimes found in isolated pools, vegetated backwaters, and deep, shaded, spring-fed pools		
Western pond turtle	*Emys marmorata*	SSC	Inhabits permanent streams, marshes, and ponds.	HP	Creek only provides habitat when water is present during winter and spring.
BIRDS					
Bald eagle	*Haliaeetus leucocphealus*	FP	Coast, large lakes and river systems, with open forests with large trees and snags.	A	No nesting habitat within or adjacent to the BSA.
Northern goshawk	*Accipiter gentillis*	SSC	Continuous stands of deciduous or coniferous trees generally above 3000 feet.	A	Nesting habitat is not expected within ¼ mile of the roadway.
Osprey	*Pandion haliaetus*	WL	Associated strictly with large fish-bearing waters, needs large trees, snags, and dead-topped trees in open forests for cover and nesting.	A	Robinson Creek is not a large fish-bearing waterway. There are no known occurrences in the vicinity of the BSA.
Mammals					
Pallid Bat	*Antrozous pallidus*	SSC	Open dry habitats at lower elevations	HP	Mature trees with sloughing bark and/or cavities provide suitable day roosting habitat

Common Name	Scientific Name	Status	General Habitat Description	Habitat Present/ Absent	Potential to Occur/Rationale
					within the BSA.
Sonoma tree vole	*Arborimus pomo*	SSC	Old-growth Douglas-fir forest and dense forests with Douglas fir, grand fir, hemlock or spruce.	A	Only a few small Douglas fir trees present, BSA is in a highly populated area and is in a valley with open grassland/ agricultural land.
Townsend's big-eared bat	*Corynorhinus townsendii*	SSC	Roosts in mines and open caverns.	A	There are no mines or open caverns within the BSA; therefore, no suitable day roosting habitat present.
Code Designations					
Absent [A] - no habitat present and no further work needed. Habitat Present [HP] -habitat is, or may be present. The species may be present. Present [P] - the species is present. Critical Habitat [CH] - project footprint is located within a designated critical habitat unit, but does not necessarily mean that appropriate habitat is present. Status: Federal Endangered (FE); Federal Threatened (FT); Federal Candidate (FC), Federal Species of Concern (FSC); State Endangered (SE); State Threatened (ST); Fully Protected (FP); State Rare (SR); State Candidate (SC), State Species of Special Concern (SSC); State Watch List (WL); California Native Plant Society (CNPS); Sensitive Natural Community (SNC)					

4 Results: Biological Resources, Discussion of Impacts and Mitigation

Habitats and Natural Communities of Special Concern

There are no CDFW designated natural communities of special concern within or adjacent to the BSA.

There is one (1) feature that qualifies as jurisdictional WOTUS within the BSA; Robinson Creek. Project activities will result in permanent impacts to 0.09 acres and temporary impacts to 0.10 acres of WOTUS. Impacts will be the result of channel restoration activities including removing the failed retaining wall and associated RSP from the creek, streambank stabilization through hybrid RSP revetment, vegetation of created point bars, and habitat enhancement. All impacts will have a positive benefit to Robinson Creek and water quality in general. A Draft Delineation of WOTUS Map is included as **Appendix D**.

Special-Status Plant Species

A protocol-level botanical survey was conducted on June 29, 2018 for a total of 13 of the special-status plant species identified on the USFWS, CNPS, and CNDDB lists which have a blooming period that overlapped with the survey date. No special-status plant species were observed during the protocol-level survey. Further, a habitat assessment was conducted within the BSA on June 29, 2018 for all remaining special-status plant species identified on the CNPS and CNDDB lists. Due to the lack of vernal, marsh or seep wetland habitat and volcanic, rocky or serpentine soils, none of these special-status plant species were determined to have potential to occur within the BSA. As such, the Project is not expected to have any effect on special-status plant species.

Special-Status Animal Species Occurrences

NORTHERN CALIFORNIA STEELHEAD

The northern California (NC) steelhead Distinct Population Segment (DPS) is considered threatened under the federal ESA. They rely on streams, rivers, estuaries and marine habitat during their lifecycle. Because young steelhead spend a significant portion of their lives in rivers and streams, they are particularly susceptible to human induced changes to water quality and habitat threats. Steelhead spawn in streams and rivers, steelhead rear in freshwater for 1 to 4 years before migrating downstream through estuaries to the open ocean. Steelhead spend 1 to 5 years at sea before returning to natal streams or rivers. Steelhead do not always die after spawning, but will again migrate through estuaries to the ocean.

Survey Results

The stretch of Robinson Creek that occurs in the BSA contains suitable habitat for northern California steelhead and Robinson Creek has been designated as critical habitat for NC steelhead (**Figure 8: Steelhead Critical Habitat**). However, during the June site visit, Robinson Creek was dry with the exception of a few small shallow pools. As such, Robinson Creek only contains suitable habitat for northern California steelhead when there is flowing water present in the creek in the winter and spring months.

Project Impacts

Construction activities will occur in Robinson Creek. However, all construction activities will occur during the dry season when Robinson Creek is no longer flowing; therefore, the Project will have no effect on the NC steelhead DPS.

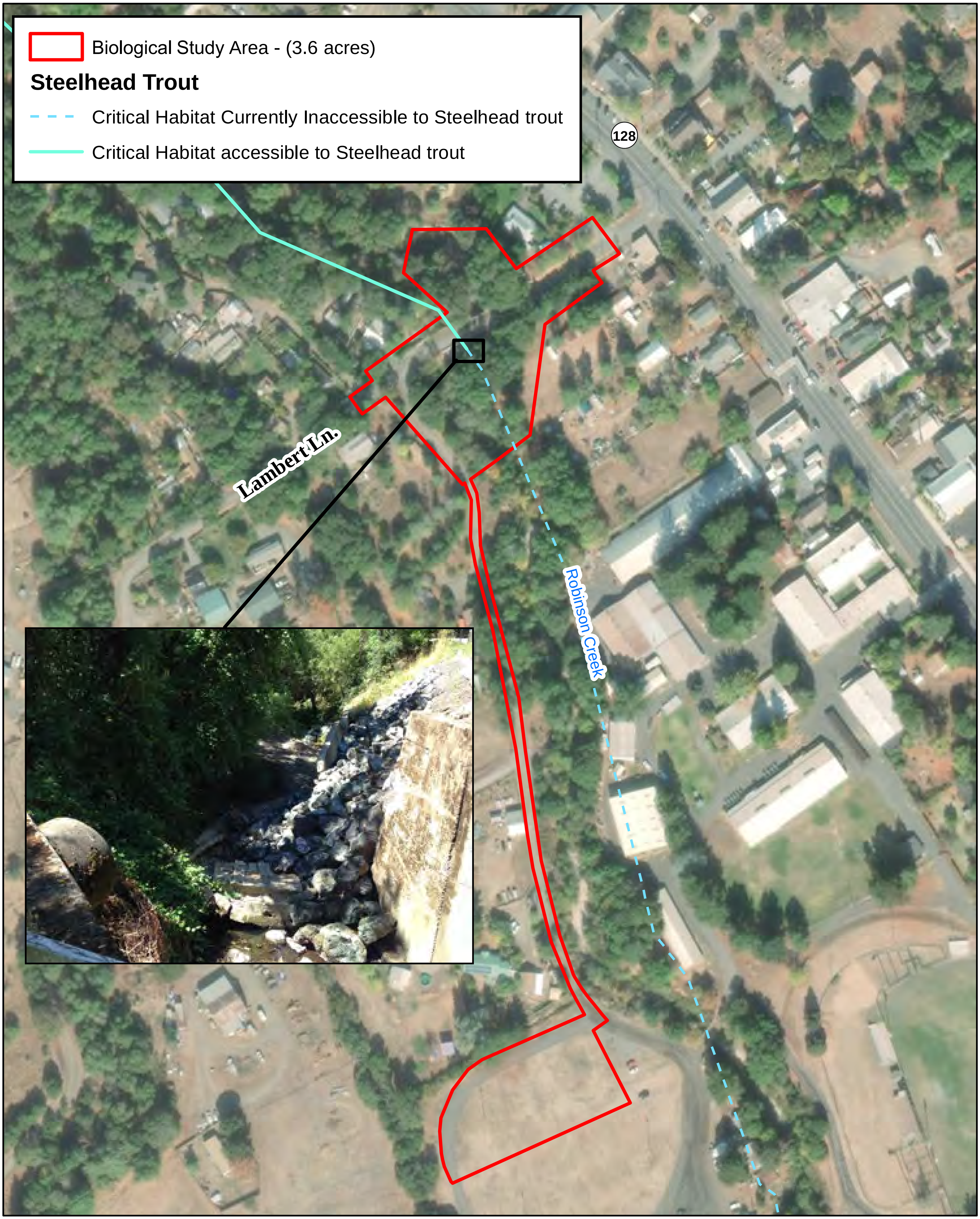
Avoidance and Minimization Efforts

While there will be no direct impacts to steelhead, there is suitable steelhead habitat present within the BSA which will likely be impacted by construction activities. The following recommendations, when implemented, will avoid and minimize impact to this species:

- Construction should begin when there is no flow.
- The existing rubble from the failed retaining wall and RSP will be removed and the channel will be revegetated and restored to a more natural condition to promote fish passage.
- Where feasible, LWD will be incorporated to offset temporal losses to habitat.

Compensatory Mitigation

No compensatory mitigation will be required since the implementation of the avoidance and minimization measures discussed above will ensure that the Project will have no effect on NC steelhead.



1:2,500
0 150 300 Feet
NORTH
Data Sources: ESRI, USFWS, DigitalGlobe
10/31/2017, Quincy Engineering

Robinson Creek Bridge Replacement Project
Steelhead Critical Habitat
Figure 8

gallaway ENTERPRISES

GE: #15-130 Map Date: 03/07/19

Cumulative Impacts

There are no foreseeable new actions that have potential to threaten steelhead within the BSA or contribute to cumulative effects on steelhead.

NORTHERN CALIFORNIA STEELHEAD CRITICAL HABITAT

Survey Results

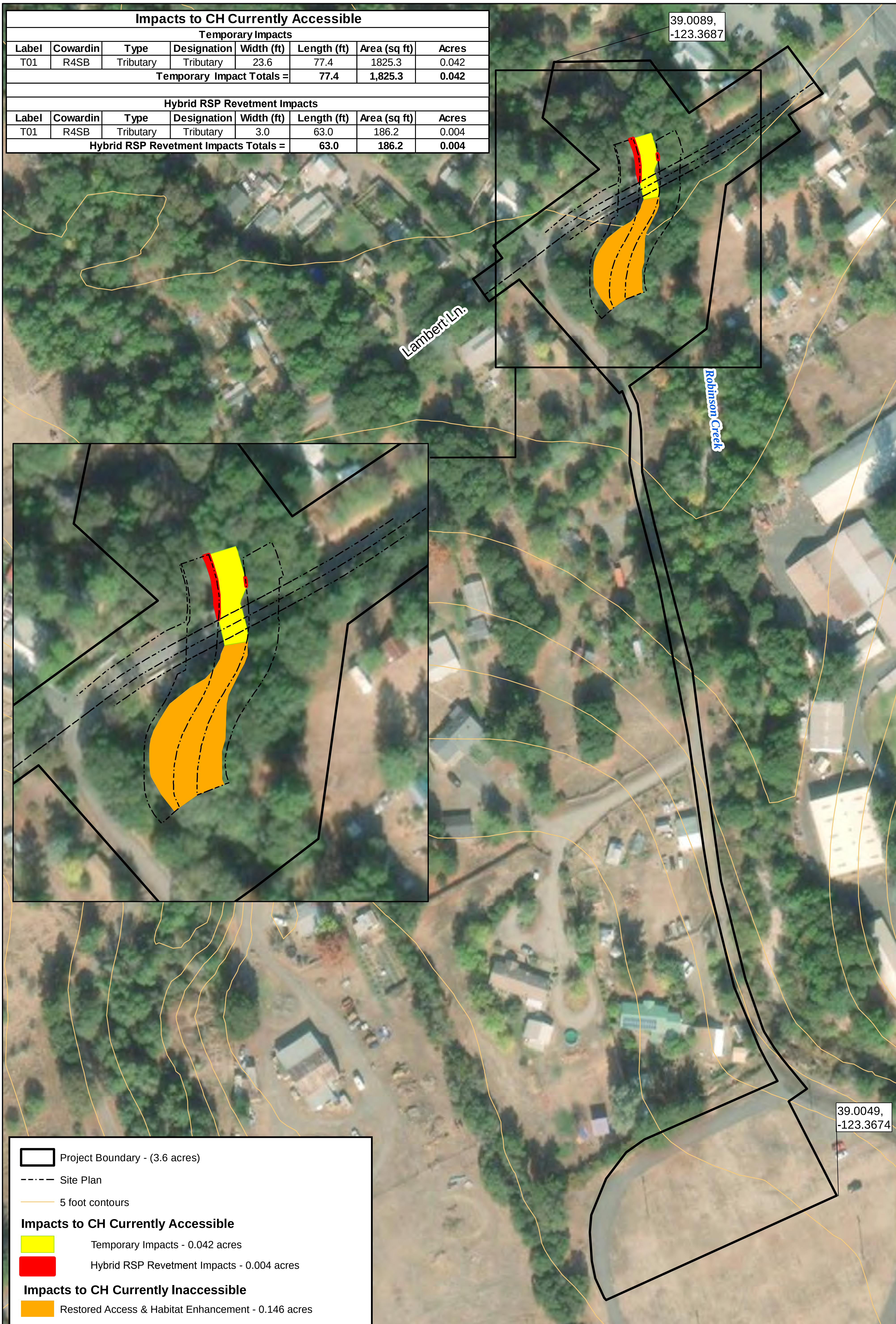
Robinson Creek within the BSA is designated as critical habitat for NC steelhead (**Figure 8**). When water is present in Robinson Creek, the following Primary Constituent Elements (PCEs) are present within the BSA:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

Project Impacts

The Project may affect but is not likely to adversely affect NC steelhead critical habitat. Critical habitat for NC steelhead will be affected by the proposed action through stream restoration activities and the placement of RSP within the creek with live willow staking that penetrates the rock layers and allows rooting into the native bank soils. The intent of the hybrid RSP revetment is to balance the engineering benefit of armoring a bank while promoting ecological processes. Proposed hybrid RSP revetment within the portions of Robinson Creek currently accessible to NC steelhead will result in approximately 63 linear feet (0.004 acres) of permanent impacts and temporary impacts of 77.4 linear feet (0.042) acres to the stream (**Figure 9: Impacts to NC Steelhead Critical Habitat**).

Currently, Robinson Creek is inaccessible to NC steelhead upstream of the existing failed retaining wall (**Figure 8**). Removal of the failed retaining wall and RSP within the creek



Impacts to CH Currently Accessible

Temporary Impacts

Label	Cowardin	Type	Designation	Width (ft)	Length (ft)	Area (sq ft)	Acres
T01	R4SB	Tributary	Tributary	23.6	77.4	1825.3	0.042
			Temporary Impact Totals =		**77.4**	**1,825.3**	**0.042**

Hybrid RSP Revetment Impacts

Label	Cowardin	Type	Designation	Width (ft)	Length (ft)	Area (sq ft)	Acres
T01	R4SB	Tributary	Tributary	3.0	63.0	186.2	0.004
			Hybrid RSP Revetment Impacts Totals =		**63.0**	**186.2**	**0.004**

Data Sources: ESRI, DigitalGlobe 10/31/17, USGS, Quincy Engineering

Robinson Creek Bridge Replacement Project
Impacts to NC Steelhead Critical Habitat
Figure 9

gallaway ENTERPRISES

GE: #15-130 Map Date: 03/12/19

bottom will restore fish passage and access for steelhead to 0.146 acres of critical habitat within the BSA (**Figure 9**). In addition to the removal of the fish barrier, channel grading will minimize abrupt hydraulic constrictions and areas of focused high velocities. Where feasible LWD will be incorporated into the final design to improve conditions for NC steelhead and offset temporary habitat loss.

Avoidance and Minimization Efforts

While there will be no direct impacts to steelhead, there is suitable steelhead habitat present within the BSA which will likely be impacted by construction activities. The following recommendations, when implemented, will avoid and minimize impact to this species:

- Construction should begin when there is no flow, typically June 1 through October 31.
- The existing rubble from the failed retaining wall and RSP will be removed from the creek channel and the channel will be restored to a more natural condition to promote fish passage.
- In addition to the willow plantings contained within the hybrid RSP revetment, native vegetation will be planted on the graded point bars on the inside of the channel bends. This vegetation should include native riparian tree species, as well as understory plants.
- The Project will create a terrace behind the RSP adjacent to the road embankment at the southern bridge approach. This terrace will be used to plant upland tree species, such as native oaks.
- Where feasible, LWD will be incorporated to offset temporal losses to habitat.

Compensatory Mitigation

No compensatory mitigation will be required since there will be a net increase in accessible critical habitat through stream restoration and removal of the existing fish barrier.

Cumulative Impacts

There are no foreseeable new actions that have potential to threaten northern California steelhead critical habitat within the BSA or contribute to cumulative effects on steelhead or their critical habitat.

NAVARRO ROACH

Navarro roach are capable of adapting to varying habitats from coastal streams to mountain foothill streams. They are predominately found in small warm streams but are capable of thriving in larger colder streams with diverse conditions. They may actually occupy several different habitat types within a single drainage. Extreme tolerance includes temperatures ranging from 30-35ºC and dissolved oxygen levels as low as 1-2 ppm. In-stream location may vary depending on geography and predators. When Navarro roach share water with Sacramento pikeminnows, roach will stick to the stream margins, whereas in the absence of these piscivorous fish roach may venture into deeper pools. Navarro roach are omnivorous and diet may depend on stream size and food availability. In smaller rivers roach feed mostly on filamentous algae, supplementing their diet with crustaceans and insects. In larger rivers these fish may focus on a diet of aquatic insects year round. The growth and development of Navarro roach is largely seasonally dependent. Most growth occurs during the summer months and roach may grow 20-40 mm in a year. Most fish of this species reach sexual maturity at age 2-3 and rarely live beyond three years total. Spawning occurs in March through early July, and timing is temperature dependent. Navarro roach breed in gravel beds or riffles where groups of females lay eggs on and into the substrate. One or two males follow each female closely to fertilize the groups of eggs. Each female may produce 250-2,000 eggs per year depending on body size. The eggs hatch in 2-3 days, but the larvae remain in the protection of the gravel substrate before emerging to swim (CalFish 2018).

Survey Results

The stretch of Robinson Creek that occurs in the BSA contains suitable habitat for Navarro roach; however, during the June site visit, Robinson Creek was dry with the exception of a few small shallow, isolated pools. As such, Robinson Creek only contains suitable habitat for Navarro roach when there is flowing water present in the creek in the winter and spring months.

Project Impacts

Construction activities will occur in Robinson Creek. Channel restoration activities will result in a net increase in both enhanced fish habitat and improved fish passage throughout the BSA. To ensure no direct impacts to Navarro roach from the proposed Project, the following avoidance and minimization measures will be implemented.

Avoidance and Minimization Efforts

The following recommendations, when implemented, will avoid and minimize impact to this species:

- Construction should begin when there is no flow, typically June 1 through October 31.
- The existing rubble from the failed retaining wall and RSP will be removed from the creek channel and the channel will be restored to a more natural condition to promote fish passage.
- In addition to the willow plantings contained within the hybrid RSP revetment, native vegetation will be planted on the graded point bars on the inside of the channel bends. This vegetation should include native riparian tree species, as well as understory plants.
- The Project will create a terrace behind the RSP adjacent to the road embankment at the southern bridge approach. This terrace will be used to plant upland tree species, such as native oaks.
- Where feasible, LWD will be incorporated to offset temporal losses to habitat.

Compensatory Mitigation

No compensatory mitigation will be required since the implementation of the avoidance and minimization measures discussed above will ensure that no impacts to Navarro roach will occur.

Cumulative Impacts

There are no foreseeable new actions that have potential to threaten Navarro roach within the BSA or contribute to cumulative effects on Navarro roach.

CALIFORNIA RED-LEGGED FROG

California Red-Legged Frog (CRLF) (*Rana draytonii*) is federally threatened and is a species of special concern in California. The CRLF is the largest native frog in California, with adults obtaining a length of 3 to 5 inches. Adult CRLF have prominent dorsolateral folds, dark spots, a bright red dorsum, and a well-defined stripe running along the upper lip. This species is primarily aquatic and most active during the night occupying perennial water sources such as streams, springs, lakes, marshes, natural and manmade ponds, and ephemeral drainages. During the breeding season, which typically runs from November through April, males call to females from the margins of ponds and slow streams (Jennings et al. 1992). Mating most commonly occurs in February or March, but can vary depending on seasonal climatic patterns. The female lays a jellylike mass of 2,000 to 5,000 reddish brown eggs in the water attached to emergent vegetation, twigs, or other structure. The resulting tadpoles, which likely feed on algae, typically require about 3 weeks to hatch, and another 11 to 20 weeks to metamorphose into juvenile frogs. Metamorphosis, therefore, typically occurs from July to September, although some tadpoles have been observed to delay metamorphosis until the following March or April. Adults are predominantly nocturnal, while juveniles can be active at any time of day.

Survey Results

There were no life stages of California red-legged frog observed during the site visit and there are no known occurrences of CRLF within 5 miles of the BSA. Also, during the June site visit, Robinson Creek was dry with the exception of a few small shallow pools. As such, Robinson Creek does not contain the necessary hydrologic regime required by CRLF for year-round occupancy.

Project Impacts

Due to the intermittent nature of Robinson Creek, there is no suitable habitat for CRLF within the BSA. Further, all construction activities will be conducted when the creek is dry. As such, the Project will have no effect on CRLF.

Avoidance and Minimization Efforts

While CRLF are not expected to occur within the BSA, the following recommendations, when implemented, will ensure complete avoidance of impacts to this species:

- Construction should begin when there is no flow.

Compensatory Mitigation

No compensatory mitigation will be required since the implementation of the avoidance and minimization measures discussed above will ensure that no impacts to CRLF will occur.

Cumulative Impacts

There are no foreseeable new actions that have potential to threaten CRLF within the BSA or contribute to cumulative effects on CRLF.

FOOTHILL YELLOW-LEGGED FROG

Foothill Yellow-Legged Frog (FYLF) (*Rana boylii*) is a state candidate for listing as threatened and a species of special concern. It is a gray to olive colored frog with occasional mottling or spots, and lacks a dorsolateral folk common in California Red-Legged Frog or eye strip common in Northern Pacific tree frogs (*Pseudacris regilla*). The FYLF range includes the coast ranges of Oregon south to Los Angeles County, in northern California west of the Cascade crest, and along the west side of the Sierra Nevada range as far south as Kern County. The FYLF has been found in a variety of habitats. Those habitats that have been found most suitable based on the majority of occurrences include a running perennial water source such as rocky rivers and step rocky tributaries. They have also been found in ephemeral streams, intermittent streams, and perennial ponds. Boulders and large cobble play an important role in the FYLF habitat and life history. FYLFs utilize boulders and large cobble in streams for areas of refuge from predators, basking, depositing eggs and cover during periods of inactivity such as over wintering or cold weather. Breeding season begins at the end of the spring flood season, which can be between March and May depending on local conditions. Breeding and egg laying occur in streams with running water and do not occur in ponds or lakes which are common for most ranids (true frogs). Current threats facing FYLF are primarily due to invasive and exotic predators such as the bullfrog (*Rana catesbeiana*) and centrarchid fish. Other threats include degradation of habitat, hydroelectric development, urban development, agriculture, and timber harvests (Zeiner, D.C. et al. 1990).

Survey Results

The stretch of Robinson Creek that occurs in the BSA contains suitable habitat for FYLF and there is a known CNDDB occurrence of FYLF approximately 0.5 miles downstream of the BSA (Occurrence # 467) within Anderson Creek near its confluence with Rancheria Creek. This occurrence was last observed in 2004 at the Highway 128 bridge over Anderson Creek. However, during the June site visit, Robinson Creek was dry with the exception of a few small shallow, isolated pools. As such, Robinson Creek only contains suitable habitat for FYLF when there is flowing water present in the creek in the winter and spring months.

Project Impacts

Construction activities will occur in Robinson Creek, and have the potential to affect FYLF habitat. To ensure no impacts to FYLF occur due to the proposed Project, the following avoidance and minimization measures will be implemented.

Avoidance and Minimization Efforts

While there are no observed populations in within the BSA this season, there is suitable FYLF habitat present within the BSA which will likely be impacted by construction activities. The following recommendations, when implemented, will avoid and minimize impact to this species:

- Construction should begin when there is no flow, typically June 1 through October 31.
- A qualified biologist shall conduct a preconstruction survey to determine presence of FYLF within seven days prior to the start of in-channel work. If a population is found on the premises, CDFW will be contacted to relocate the individuals to suitable habitat outside of the BSA.
- Contractor shall not use plastic monofilament netting which can entrap the FYLF.
- The existing rubble from the failed retaining wall and RSP will be removed from the creek channel and the channel will be restored to a more natural condition.
- In addition to the willow plantings contained within the hybrid RSP revetment, native vegetation will be planted on the graded point bars on the inside of the channel bends. This vegetation should include native riparian tree species, as well as understory plants.
- The Project will create a terrace behind the RSP adjacent to the road embankment at the southern bridge approach. This terrace will be used to plant upland tree species, such as native oaks.

Compensatory Mitigation

No compensatory mitigation will be required since the implementation of the avoidance and minimization measures discussed above will ensure that no impacts to FYLF will occur and channel restoration will have a beneficial affect on FYLF habitat.

Cumulative Impacts

There are no foreseeable new actions that have potential to threaten FYLF within the BSA or contribute to cumulative effects on FYLF.

WESTERN POND TURTLE

The western pond turtle (*Actinemys marmorata*) is a species of special concern in California. Western pond turtles are drab darkish colored turtles with a yellowish to cream colored head. They range from the Washington Puget Sound to the California Sacramento Valley. Suitable aquatic habitats include slow moving to stagnant water, such as back waters and ponded areas of rivers and creeks, semi-permanent to permanent ponds and irrigation ditches. Preferred habitats include features such as hydrophytic vegetation, for foraging and cover, and basking areas to regulate body temperature. In early spring through early summer, female turtles begin to move over land in search for nesting sites. Eggs are laid on the banks of slow moving streams. The female digs a hole approximately four inches deep and lays up to eleven eggs. Afterwards the eggs are covered with sediment and are left to incubate under the warm soils. Eggs are typically laid between March and August (Zeiner, D.C etal. 1990). Current threats facing the western pond turtle include loss of suitable aquatic habitats due to rapid changes in water regimes and removal of hydrophytic vegetation.

Survey Results

The stretch of Robinson Creek that occurs in the BSA contains suitable habitat for western pond turtles. However, during the June site visit, Robinson Creek was dry with the exception of a few small shallow pools. As such, Robinson Creek only contains suitable habitat for western pond turtles when there is flowing water present in the creek in the winter and spring months. Given the steep banks and abundance of cobble substrate there is no potential for western pond turtle nests to occur within the BSA.

Project Impacts

The Project has potential to impact western pond turtles through activities that may disturb western pond turtle habitat. There will be no impacts to western pond turtles with the implementation of avoidance and minimization measures.

Avoidance and Minimization Efforts

The following are recommended avoidance and minimization measures recommended in order to avoid and minimize potential impacts to western pond turtles.

- A qualified biologist shall conduct a preconstruction survey to determine presence of western pond turtle immediately prior to the start of in-channel work. If found, western pond turtles will be relocated to suitable habitat outside of the BSA by a qualified biologist.

- If a western pond turtle is observed within the Project site, then personnel shall stop work within a 50 foot radius of the sighting and notify the biologist or resident engineer (RE). Work shall not resume within the 50 foot radius buffer until the western pond turtle has left the Project site on its own volition or has been relocated by the qualified biologist.

Compensatory Mitigation

No compensatory mitigation will be required since the implementation of the avoidance and minimization measures discussed above will ensure that no impacts to western pond turtles will occur.

Cumulative Impacts

There are no foreseeable new actions that have potential to threaten western pond turtles within the BSA or contribute to cumulative effects on western pond turtles.

MIGRATORY BIRDS AND RAPTORS

Nesting birds are protected under the MBTA (16 USC 703) and the CFGC (3503). The MBTA (16 USC §703) prohibits the killing of migratory birds or the destruction of their occupied nests and eggs except in accordance with regulations prescribed by the USFWS. The bird species covered by the MBTA includes nearly all of those that breed in North America, excluding introduced (i.e. exotic) species (50 Code of Federal Regulations §10.13). Activities that involve the removal of vegetation including trees, shrubs, grasses, and forbs or ground disturbance has the potential to affect bird species protected by the MBTA.

The CFGC (§3503.5) states that it is “unlawful to take, possess, or destroy any birds in the order Falconiformes (hawks, eagles, and falcons) or Strigiformes (all owls except barn owls) or to take, possess, or destroy the nest or eggs of any such bird except as otherwise provided by this code or any regulation adopted pursuant thereto.” Take includes the disturbance of an active nest resulting in the abandonment or loss of young. The CFGC (§3503) also states that “it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto.”

Survey Results

No active nests of any migratory bird or raptor species were observed during the biologist's field visit, however, the BSA contains vegetation and habitat that have the potential to support nesting migratory birds and raptors. Construction is proposed to occur outside of the avian nesting season, thus minimizing impacts to all avian bird species. A pre-construction survey is recommended if construction is delayed into the avian breeding season (February 1 – August 31) to determine potential locations of active avian species nests within or in close proximity of the BSA.

Project Impacts

With the implementation of avoidance and minimization measures specified above there will be no impacts to avian species of special concern or avian species protected under the MBTA and CFGC.

Avoidance and Minimization Efforts

To avoid impacts to avian species of special concern or avian species protected under the MBTA and the CFGC, the following avoidance and minimization measures are recommended.

<u>The following are avoidance and minimization measures for California avian species of special concern and species protected under the MBTA and the CFGC.</u>

- Any vegetation removal and/or ground disturbance activities should take place during the avian non-breeding season (September 1 – January 31).

- If construction is to begin within the avian breeding season (February 1 – August 31) then a migratory bird and raptor survey shall be conducted within the BSA by a qualified biologist. A qualified biologist shall:

    - Conduct a protocol level survey for all birds protected by the MBTA and CFGC within seven (7) days prior to construction activities, and map all nests located within 200 feet of construction areas;

    - Develop buffer zones around active nests as recommended by a qualified biologist. Construction activity shall be prohibited within the buffer zones until the young have fledged or the nest fails. Nests shall be monitored at least once per week and a report submitted to the County monthly.

  - o If construction activities stop for more than ten (10) days then another migratory bird and raptor survey shall be conducted within seven (7) days prior to the continuation of construction activities.

- All staging and construction activity will be limited to designated areas within the BSA and designated routes for construction equipment shall be established in order to limit disturbance to the surrounding area.

Compensatory Mitigation

There will be no compensatory mitigation necessary for Project activities in regards to avian species of special concern or avian species protected under the MBTA and CFGC.

Cumulative Impacts

There are no foreseeable new actions that have potential to threaten migratory birds within the BSA or contribute to cumulative effects on migratory bird species.

<u>BATS</u>

Pallid bats are designated as a CDFW SSC. Pallid bats roost alone, in small groups (2 to 20 bats), or gregariously (100s of individuals). Day and night roosts include crevices in rocky outcrops and cliffs, caves, mines, trees (e.g., basal hollows of coast redwoods and giant sequoias, bole cavities of oaks, exfoliating Ponderosa pine and valley oak bark, deciduous trees in riparian areas, and fruit trees in orchards), and various human structures such as bridges (especially wooden and concrete girder designs), barns, porches, bat boxes, and human-occupied as well as vacant buildings. Roosts generally have unobstructed entrances/exits, and are high above the ground, warm, and inaccessible to terrestrial predators. However, this species has also been found roosting on or near the ground under burlap sacks, stone piles, rags, and baseboards. Lewis 1996 found that pallid bats have low roost fidelity and both pregnant and lactating pallid bats changed roosts an average of once every 1.4 days throughout the summer. Overwintering roosts have relatively cool, stable temperatures and are located in protected structures beneath the forest canopy or on the ground, out of direct sunlight. In other parts of the species' range, males and females have been found hibernating alone or in small groups, wedged deeply into narrow fissures in mines, caves, and buildings. At low latitudes, outdoor winter activity has been reported at temperatures between –5 and 10 °C.

Survey Results

During the field survey there was no evidence of bats roosting within the bridge structure. However, the mature oak trees surrounding the creek within the BSA have suitable habitat elements (e.g. cavities, peeling bark) that may provide suitable day roost habitat for pallid bats.

Project Impacts

Construction timing is proposed from June 1 to October 31 which falls within the bat maternity season (April-August).

Avoidance and Minimization Efforts

If trees containing suitable bat habitat (i.e. sloughing bark, activities, or crevices) are removed between March 15 and August 31, a qualified biologist will conduct a preconstruction survey for roosting bats within seven days prior to tree removal. The survey will focus on suitable habitat to determine the absence or presence of roosting bats and type of roost within the tree. If the pre-construction survey determines that bats are not using the trees onsite as day roosts, then tree removal can proceed as planned.

If the tree is being utilized as a day roost and the qualified biologist determines that it is a maternity roost, then removal of the tree will be postponed until consultation with CDFW occurs. If the roost is not a maternity roost or if tree removal occurs during the winter months (i.e. October 16 – February 14), then the following phased removal of the occupied tree will be implemented:

- Day 1: All unoccupied roosting habitat (e.g. crevices, sloughing bark, cavities) should be removed or altered to make it less desirable for roosting. All portions of the tree that do not contain suitable habitat can be removed while avoiding occupied habitat.

- Day 2: All remaining portion of the tree including suitable roosting habitat can be removed.

A qualified biologist shall be onsite during tree removal activities if bats are detected.

Compensatory Mitigation

No compensatory mitigation necessary or required.

Cumulative Impacts

There are no foreseeable new actions that have potential to threaten bats within the BSA or contribute to cumulative effects on bats.

5 Conclusions and Regulatory Determinations

Federal Endangered Species Act Consultation Summary

The USFWS was contacted in March 2019 for a list of endangered, threatened, sensitive and rare species, and their habitats within the BSA. The list was later referenced to determine appropriate biological and botanical surveys and potential species occurrence within the BSA. With the implementation of avoidance and minimization measures, the Project will have no effect on federally listed species. The Project may affect, but is not likely to adversely affect NC steelhead DPS critical habitat; however, the Project will both enhance steelhead habitat and restore fish passage to 0.146 acres of critical habitat within the BSA (**Figure 9**).

Essential Fish Habitat Consultation Summary

Robinson Creek within the BSA falls within the Big-Navarro-Garcia Hydrologic Unit, which is mapped as EFH for all Chinook and Coho salmon species. California Coastal Chinook salmon Coho salmon Evolutionarily Significant Unit (ESU) and Central California Coast (CCC) Coho salmon ESU are the Chinook and Coho salmon species that are known to occur in nearby streams that support salmonids.

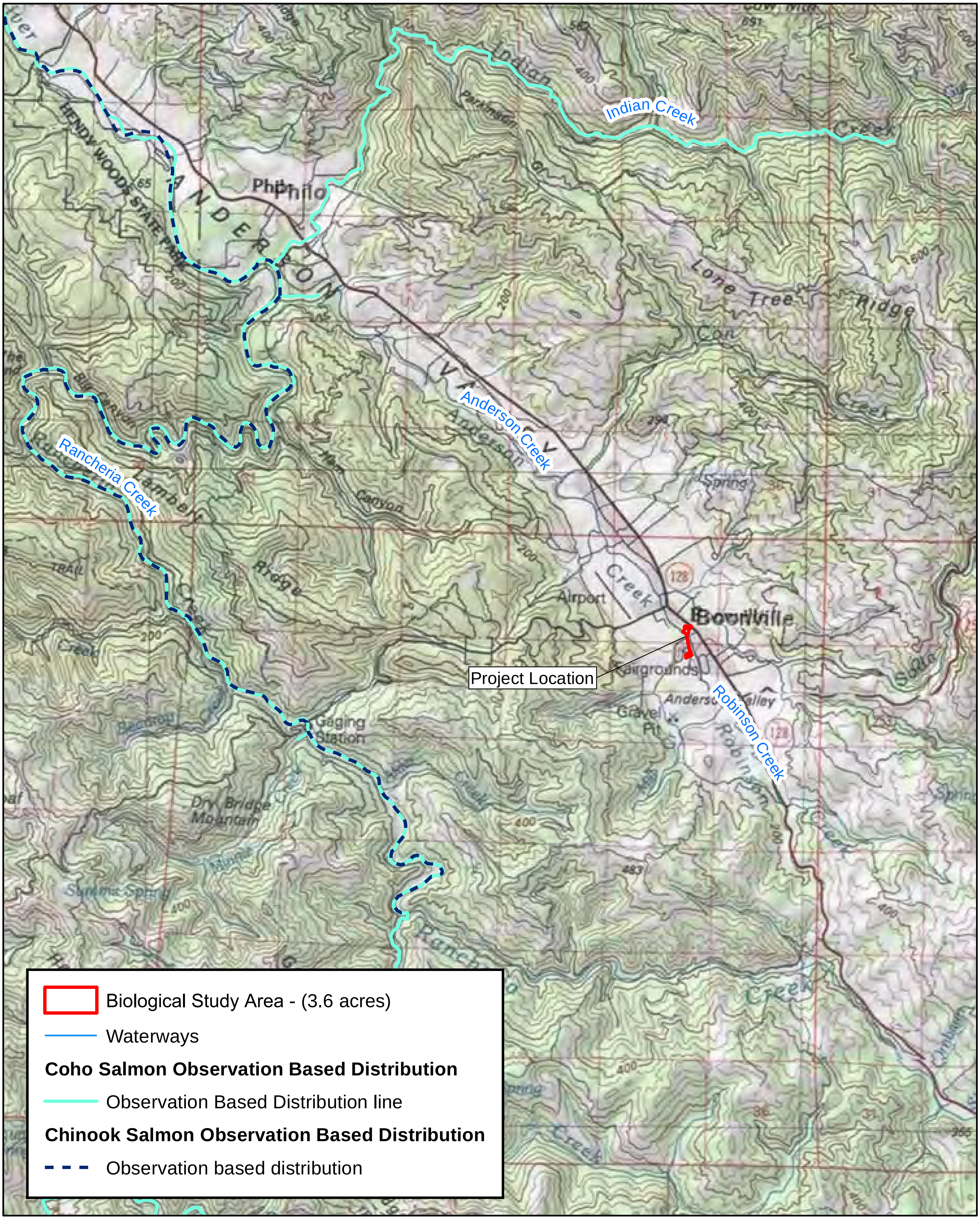
Robinson Creek is intermittent and dries completely during the summer months. CNDDB observations between 1990 and 2016 show that there have been no observations of CCC Coho in Robinson Creek (**Figure 10: Chinook and Coho Salmon Observation Based Distribution**). In addition, an extensive review of peer reviewed literature and citizen sightings conducted by CDFW indicated no occurrences of CC Chinook and only one equivocal occurrence of CCC Coho occurring within Robinson Creek within the last 50 years (pers. comm. Scott Harris, CDFW). There is no evidence or documentation that indicates that Robinson Creek was within the historical distribution of CCC Coho or CC Chinook salmon. The proposed Project will have no effect on these species.

Due to the fact that these species do not occur within Robinson Creek and the lack of evidence of historical distribution within the BSA, Robinson Creek does not meet the definition of necessary waters for Chinook and Coho salmon species and is not EFH. There will be no effect to EFH as a result of Project activities.

There will be no effects to EFH as a result of Project activities.

California Endangered Species Act Consultation Summary

The CDFW was contacted in March 2019 for a list of endangered, threatened, sensitive and rare species, and their habitats within the BSA. The list was later referenced to determine



NORTH
1:75,000
0 0.5 1 Miles
Data Sources: ESRI, USFWS, USGS, Quincy Engineering

Robinson Creek Bridge Replacement Project
Chinook and Coho Salmon Observation Based Distribution
Figure 10

gallaway ENTERPRISES
GE: #15-130 Map Date: 03/06/19

appropriate biological and botanical surveys and potential species occurrence within the BSA. With the implementation of avoidance and minimization measures, the Project is expected to have no effect on state listed species.

Wetlands and Other Waters Coordination Summary

Gallaway Enterprises conducted a Delineation of WOTUS within the BSA.

The BSA was surveyed on-foot by Gallaway Enterprises staff on June 29, 2018 to identify potentially jurisdictional features. The surveys involved an examination of botanical resources, soils, hydrological features, and determination of wetland characteristics based on the United States Army Corps of Engineers Wetlands Delineation Manual (1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (2008). The boundaries of non-tidal, non-wetland waters, when present, were delineated at the OHWM as defined in 33 Code of Federal Regulations (CFR) 328.3 and further described in the U.S. Army Corps of Engineers *Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (2008). The OHWM represents the limit of Corps jurisdiction over non-tidal waters (e.g., streams and ponds) in the absence of adjacent wetlands (33 CFR 328.04) (Curtis, et. al. 2011).

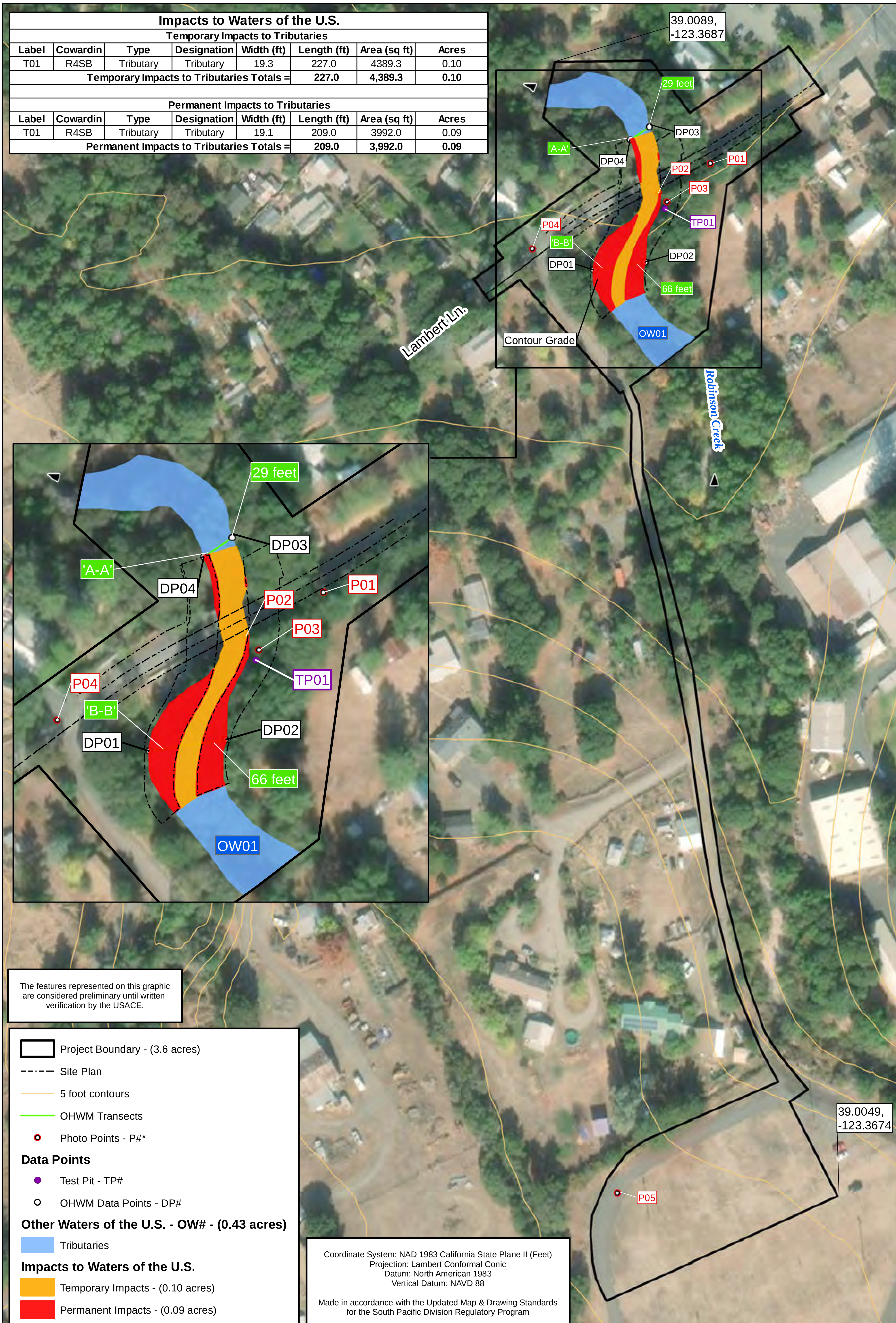
The one tributary was identified within the BSA. No wetlands were determined to be present. The one tributary will be impacted by the Project activities. As such, a RWQCB §401 Water Quality Certification permit and a Corps Nationwide §404 14 permit are necessary. The Project will result in 0.10 acres of temporary and 0.09 acres of permanent impacts to jurisdictional WOTUS (**Figure 11: Impacts to Waters of the US**). This Project is self-mitigating as both temporary and permanent impacts will have a net benefit to WOTUS; therefore, the purchase of credits at a U.S. Army Corps of Engineers (Corps) approved mitigation bank or payment to a Corps approved in-lieu fund, will not be required. Impacts will be the result of restoration activities including removing the failed retaining wall and associated RSP from the creek, streambank stabilization through hybrid RSP revetment, vegetation of created point bars, and habitat enhancement.

Invasive Species

Many non-native plant species occur in California’s natural lands. Some of these non-natives have become naturalized and are relatively benign; however, there are a number of these non-natives that are considered highly invasive. The non-native plants that are considered

Impacts to Waters of the U.S.

Label	Cowardin	Type	Designation	Width (ft)	Length (ft)	Area (sq ft)	Acres
Temporary Impacts to Tributaries							
T01	R4SB	Tributary	Tributary	19.3	227.0	4389.3	0.10
Temporary Impacts to Tributaries Totals =					**227.0**	**4,389.3**	**0.10**
Permanent Impacts to Tributaries							
T01	R4SB	Tributary	Tributary	19.1	209.0	3992.0	0.09
Permanent Impacts to Tributaries Totals =					**209.0**	**3,992.0**	**0.09**



The features represented on this graphic are considered preliminary until written verification by the USACE.

Project Boundary - (3.6 acres)

Site Plan

5 foot contours

OHWM Transects

Photo Points - P#*

Data Points

Test Pit - TP#

OHWM Data Points - DP#

Other Waters of the U.S. - OW# - (0.43 acres)

Tributaries

Impacts to Waters of the U.S.

Temporary Impacts - (0.10 acres)

Permanent Impacts - (0.09 acres)

Coordinate System: NAD 1983 California State Plane II (Feet)
Projection: Lambert Conformal Conic
Datum: North American 1983
Vertical Datum: NAVD 88

Made in accordance with the Updated Map & Drawing Standards for the South Pacific Division Regulatory Program

NORTH 1:1,325 1 inch = 110 feet
0 55 110 Feet

Data Sources: ESRI, DigitalGlobe 10/31/17, USGS, Quincy Engineering

Robinson Creek Bridge Replacement Project
Impacts to Waters of the U.S.
Figure 11

gallaway ENTERPRISES

GE: #15-130 Map Date: 02/13/19

invasive are tracked and ranked by their invasiveness by the United States Department of Agricultural (USDA) Natural Resource Conservation Service (NRCS) and the California Invasive Plant Council (Cal-IPC). Within the BSA, 15 invasive plant species were observed that are included on the USDA and/or Cal-IPC invasive and noxious weed plant list as having a moderate or higher degree of invasiveness in California **(Table 3)**.

Table 3. Invasive Plant Species Identified within the BSA

Scientific Name	Common Name	CAL-IPC	USDA California State
Ailanthus altissima	Tree-of-heaven	Moderate	N/A
Avena barbata	Wild Oats	Moderate	N/A
Bromus diandrus	Ripgut brome	Moderate	N/A
Bromus madritensis ssp. rubens	Red brome	High	N/A
Cynodon dactylon	Bermuda grass	Moderate	CW
Cynosurus echinatus	Hedgehog dogtail	Moderate	N/A
Festuca myuros	Rat-tail fescue	Moderate	N/A
Festuca perennis	Italian ryegrass	Moderate	N/A
Hedera helix	English ivy	High	N/A
Hordeum murinum	Wall hare barley	Moderate	N/A
Lythrum hyssopifolia	Hyssop loosestrife	Moderate	N/A
Mentha pulegium	Pennyroyal	Moderate	N/A
Rubus armeniacus	Himalayan blackberry	High	N/A
Torilis arvensis	Hedge-parsley	Moderate	N/A
Vinca major	Periwinkle	Moderate	N/A

CODE DESIGNATIONS
Moderate – Ecological impacts are substantial, but not sever; moderate to high rates of dispersal but establishment dependent on ecological disturbance; limited to widespread distribution. **High** – Ecological impacts severe; moderate to high rates of dispersal and establishment; widely distributed. **CW** = C List (noxious weeds)

It is recommended that general best management practices (BMP) be implemented prior and during construction activities as recommended under the Cal-IPC Preventing the Spread of Invasive Plants: Best Management Practices for Transportation and Utility Corridors (2012). The following are the recommended general BMP's under Cal-IPC:

- Schedule activities to minimize potential for introduction and spread of invasive plants.
- Designate specific areas for cleaning tools, vehicles, equipment, clothing and gear.
- Designate waste disposal areas for invasive plant materials, and contain invasive plant material during transport.
- Plan travel routes to avoid areas infested with invasive plants.
- Clean tools, equipment, and vehicles before transporting materials and before entering and leaving worksites.
- Clean clothing, footwear and gear before leaving infested areas.
- Prepare worksites to limit the introduction and spread of invasive plants.
- Minimize soil and vegetation disturbance.

Other

Nesting Migratory Birds and Raptors

Migratory birds have the potential to nest within the BSA. No active nests of any migratory bird or raptor species were observed during the biologist's field visit, however, the BSA contains vegetation and habitat that have the potential to support nesting migratory birds and raptors. Construction is proposed to occur outside of the avian nesting season, thus minimizing impacts to all avian bird species. A pre-construction survey should be conducted in the event that construction is delayed into the avian breeding season (February 1 – August 31) to determine potential locations of active avian species nests and to identify the need for establishing buffer zones around nests. With the implementation of avoidance and minimization measures, the Project will have no effect on migratory birds and raptors.

Sudden Oak Death Syndrome

Best Management Practices should be employed to prevent the spread of Sudden Oak Death Syndrome (SOD) and other plant pathogens related to the disposal of vegetation being removed by the Project. The following are the recommended BMPs for prevention of the spread of SOD.

Sudden Oak Death Construction BMPs:

- Ensure all equipment is clean and free of any mud, duff, or vegetation prior to entering or leaving the project site.
- If any known host species are planned for removal within the Project, all branches will be chipped and the chips spread and kept on-site and the trunks be cut into firewood for burning.
- Avoid using watering trucks in areas around host species.
- Avoid trimming any vegetation of host species during wet conditions.
- Clean and properly sanitize all cutting tools (i.e., chainsaws, hand saws, axes, mauls, etc.).

Sudden Oak Death Revegetation BMPs:

- Limit the amount of host species used as re-planting stock.
- Do not plant acorns or other seeds collected from areas known to be infested with SOD.
- Do not import soil, mulch, duff, or other organic material from areas known to be infested with SOD.

- Inspect all nursery stock for signs of infection or cankers.
- Mulch replanted area with no more than 4 inches of clean coarse bark and avoid mulching directly around trunk collar.

6 References

California Department of Fish and Game (CDFG). 2002. Culvert criteria for fish passage. Appendix A in California Salmonid Stream Habitat Restoration Manual 3rd edition. California Department of Fish and Game. CALTRANS. 2000. California Bank and Shoreline Protection Design. State of California Department of Transportation Final Report No. FHWA-CA-TL-95-10. Third Edition.

CDFG. 2009. Parts IX-XII: Fish passage design and implementation. In the California Salmonid Stream Habitat Restoration Manual. California Department of Fish and Game.

California Department of Fish and Wildlife (CDFW) 2019 California Natural Diversity Database (CNDDB), Rarefind version 5. United States Geological Survey (USGS) “Boonville” 7.5 minute quadrangle.

California Native Plant Society, Rare Plant Program. 2019. Inventory of Rare and Endangered Plants of California (online edition, v8-03 0.39). Website http://www.rareplants.cnps.org [accessed 05 March 2019].

Christy, Tom. "Coho Distribution [ds326]." 14 July 2016. Biogeographic Information and Observation System (BIOS). CDFW. 6 March 2019, http://bios.dfg.ca.gov

Florsheim, J. and Circuit Rider Productions, Inc. 2006. Baseline bio-geomorphic assessment of Robinson Creek, Mendocino County, California. Prepared for Mendocino County Resource Conservation District. 404 pages.

Florsheim, J. 2008. RE: Robinson Creek Survey Update. Memorandum to Mendocino County Water Agency and Mendocino County Resource Conservation District.

Florsheim, J., A. Chin, K, Gaffney, D., Slota. 2013. Thresholds of stability in incised "Anthropocene" landscapes. Journal of Anthropocene. Vol. 2., P27-41.

Gavette, Charleen. "Chinook Salmon California Coastal Distribution, 2005 [ds981]." 9 January 2014. Biogeographic Information and Observation System (BIOS). CDFW. 6 March 2019, http://bios.dfg.ca.gov

Keiser, Kate. "Spotted Owl Observations [ds704]." 28 February 2019. Biogeographic Information and Observation System (BIOS). CDFW. 5 March 2019, http://bios.dfg.ca.gov

Mayer, K.E. and Laudenslayer, W.F. 1988. A Guide to Wildlife Habitats of California. State of California, Resources Agency, Department of Fish and Game. Sacramento, CA. 166 pp.

National Marine Fisheries Service. 2001. Guidelines for salmonid passage at stream crossings. NOAA Fisheries, NMFS SW Region.

NMFS. 2016. Coastal Multispecies Recovery Plan. National Marine Fisheries Service, West Coast Region, Santa Rosa, California.

Taylor, R. 2001. Final Report: Coastal Mendocino County Culvert Inventory and Fish Passage Evaluation. 73 pages.

U.S. Fish and Wildlife Service. 2002. Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*). U.S. Fish and Wildlife Service, Portland, Oregon. viii + 173 pp.

U.S. Fish and Wildlife Service. 2005. Recovery Plan for the Tidewater Goby (*Eucyclogobius newberryi*). U.S. Fish and Wildlife Service, Portland, Oregon. vi + 199 pp.

Stone, Steve. "Steelhead DPS, Central California Coast [ds806]." 26 April 2013. Biogeographic Information and Observation System (BIOS). CDFW. 6 March 2019, http://bios.dfg.ca.gov

Western Regional Climate Center (WRCC). 2019. Local Climate Data 2008 Summary. Online access.

FEDERAL REGISTER

70 FR 52488-52627. Endangered and threatened Species; Designation of Critical Habitat for Seven Evolutionary Significant Units of Pacific Salmon and Steelhead in California. NMFS, NOAA and Commerce. (September 2, 2005) Volume 70.

79 FR 48560. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Western Distinct Population Segment of the Yellow-Billed Cuckoo; Proposed Rule. USFWS. (August 15, 2014) Volume 79.

PERSONAL COMMUNICATIONS

Harris, Scott. February 13, 2019. Personal Communications. Environmental Scientist. California Department of Fish and Wildlife. Region 1.

Appendix A – Robinson Creek Channel Design Report

Robinson Creek Bridge Replacement on Lambert Lane,
Mendocino California

Robinson Creek Channel Design Report for the Lambert Lane Bridge Replacement Project

Federal-Aid Project No. BLO-5910(099)

Mendocino County Project No. B1302

Existing Bridge No. 10C0146

Prepared for:

Quincy Engineering
and
County of Mendocino Department of Public Works

Prepared by:

Michael Love & Associates
Hydrologic Solutions
PO Box 4477 • Arcata, CA 95518 • (707) 822-2411

March 2019

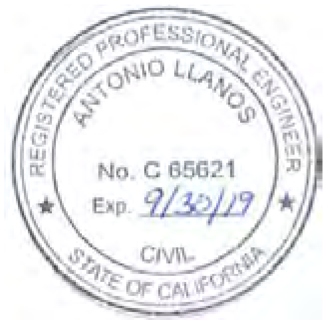
Robinson Creek Channel Design Report for the Lambert Lane Bridge Replacement Project

Prepared for:

County of Mendocino Department of Public Works

Quincy Engineering

Prepared by:



Antonio Llanos, P.E.
Project Engineer
License No. C65621
Michael Love & Associates, Inc.
llanos@h2odesigns.com • (707) 826-2411 x2

Michael Love P.E.
Principal Engineer
License No. C71681
Michael Love & Associates, Inc.
mlove@h2odesigns.com • (707) 826-2411 x1

March 2019

Cover Photo: Oak tree recently fallen into Robinson Creek upstream of Lambert Lane following bank erosion.

Table of Contents

Appendices

1 INTRODUCTION

1.1 Purpose of Report

The purpose of this report is to summarize the channel design for a bridge replacement project on Lambert Lane at Robinson Creek, a tributary to Anderson Creek, in the unincorporated community of Boonville, Mendocino County, California. The bridge replacement designs are being developed by Quincy Engineering for the county and is intended to replace an obsolete and scour critical bridge.

1.2 Project Background

The County of Mendocino and the California Department of Transportation (Caltrans), are planning to replace Lambert Lane Bridge at Robinson Creek (Bridge No. 10C0146). Lambert Lane crosses Robinson Creek approximately 2,860 linear feet upstream of the confluence with Anderson Creek and 500 feet west of State Route SR128 (Figure 1). The contributing drainage area at the bridge crossing is approximately 4.0 square miles. The bridge has been labelled functionally obsolete and is scour critical. Originally built in 1954, the existing 32-foot long single span bridge is supported on concrete abutments founded on spread footings which were placed on the alluvial channel material. Caltrans has noted hydraulic undermining of the abutments since the year 2000. In February 2015 a retaining wall along the roadway embankment on the upstream side of the western bridge approach collapsed, falling across the stream channel. This created a flow obstruction that further increased scour of the bridge foundation. As an emergency measure the county placed riprap at the base of the roadway and later pumped concrete underneath the undermined footing and formed a concrete skirt in front of the exposed footing, as seen in Figure 2.

Previous work has been conducted by Quincy Engineering in partnership with County of Mendocino Department of Public Works, including a Bridge Design Hydraulic Study (2018) and Project Report (2018). These works provide the basis for design of the proposed bridge replacement. Michael Love & Associates, Inc. (MLA) has been contracted to develop the geomorphic design and stabilization measures for the stream channel within the bridge replacement project reach, which is described within this report.

1.3 Fisheries Habitat and Fish Passage

Robinson Creek is a tributary to Anderson Creek within the Navarro River watershed. Robinson Creek is designated as critical habitat for Northern California steelhead, which is federally listed as a threatened species. Streamflows within Robinson Creek are intermittent, with the channel drying by early summer. These conditions suggest that the habitat available in lower Robinson Creek is primarily suitable for spawning and over-winter rearing for steelhead.

A fish passage assessment of stream crossings was conducted by RTA (2001). Because the Lambert Lane bridge is a channel spanning crossing, it was considered to provide unimpeded fish passage and was not included in the assessment. However, under current conditions, the failed retaining wall and associated riprap creates a 3-foot water surface drop, which classifies the current conditions as a barrier to adult and juvenile steelhead based on California Department of Fish and Wildlife fish passage assessment guidelines (CDFG, 2002). Channel restoration designs for the site should satisfy current fish passage standards, as described in CDFG (2009) and NMFS (2001).

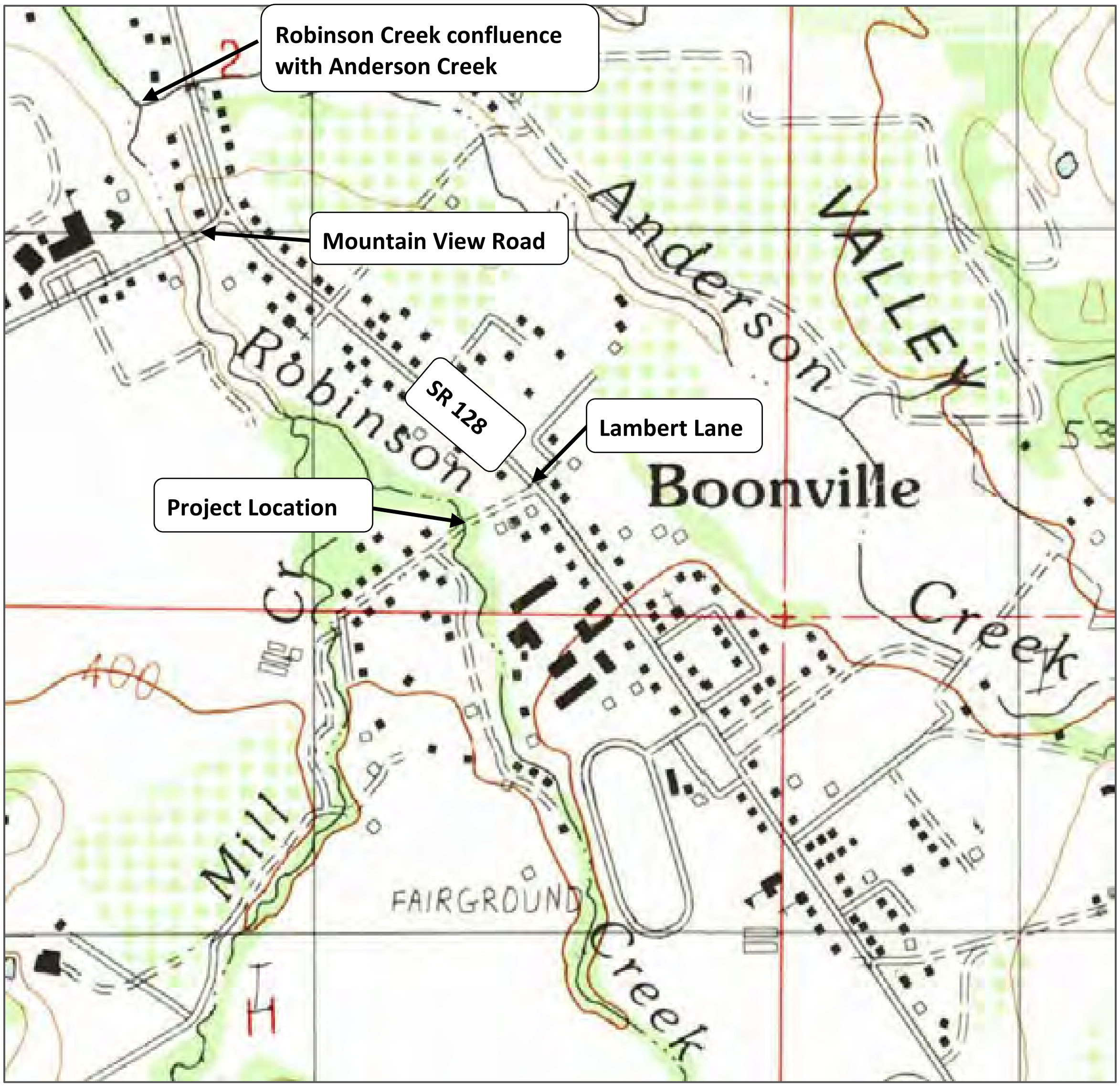


Figure 1. Project location for bridge replacement on Lambert Lane at Robinson Creek, Boonville, Mendocino County, California.

Figure 2. Current condition of the channel at the Lambert Lane Bridge, with (a) riprap placed along roadway embankment at location of collapsed retaining wall and (b) a new concrete skirt along the undermined footing.

1.4 Previous Studies of Geomorphic Channel Conditions

Changing geomorphic conditions within Robinson Creek and downstream Anderson Creek have been noted for decades. Channel incision (lowering of the channel bed) and channel bank erosion along Robinson Creek was noted as a significant source of sediment production within the 1998 Navarro River Watershed Restoration Plan. Incision has caused scour and undermining of bridge foundations, leading to the replacement of the Highway 128 crossing of Anderson Creek immediately upstream of the confluence of Robinson Creek and replacement of the Mountain View Road bridge crossing over Robinson Creek, downstream of Lambert Lane. Also, channel widening associated with incision processes has caused severe bank erosion threatening adjoining structures and resulting in loss of mature riparian vegetation throughout lower Robinson Creek,

The Mendocino County Resource Conservation District (RCD) and the Mendocino County Water Agency conducted studies of channel conditions to characterize the ongoing channel adjustments in Robinson Creek, focusing on the reach from the confluence with Anderson Creek to the Mendocino County Fair Grounds upstream of Lambert Lane. This included conducting profile surveys of the channel thalweg and surveys of channel cross sections in 2005 to document the channel morphology. Florsheim (2006) prepared a baseline assessment of bio-geomorphic conditions within lower Robison Creek for the RCD, and identified channel incision as the dominant process causing the observed channel instabilities. Follow-up monitoring surveys of the lower Robinson Creek channel thalweg were conducted in 2008, which found the channel showed signs of aggradation near the confluence with Anderson Creek, but also showed signs of incision within a reach between Mountain View Road and Lambert Lane bridge crossings (Florsheim, 2008). These findings were further described in a 2013 peer-reviewed publication (Florsheim et al., 2013). The RCD provided the original data from the 2005 and 2008 county surveys to MLA to compare to current channel conditions at the Lambert Lane bridge replacement project.

1.5 Channel Restoration Design Approach

Development of the channel restoration design for the bridge replacement project involved:

- Reviewing previous geomorphic studies and data for Robinson Creek,
- Characterizing existing geomorphic processes related to previously noted channel incision and widening that may influence the project channel reach
- Identifying the design channel profile and estimate the potential range in variability of the channel bed elevation resulting from future incision or aggradation processes
- Identifying appropriate channel dimension based on a characterization of a stream reference reach
- Identifying appropriate bank treatments based on hydraulic forces acting on the streambanks within the project reach

Channel design followed stream simulation methodology from USFS (2008) and bank stabilization measures from Caltrans design documents, as referenced within this report. The channel design is intended to provide geomorphically stable channel geometry while protecting the roadway embankment and vulnerable streambanks with hybrid RSP revetments where required due to risk of scour and lateral channel migration.

2 STREAM CHANNEL GEOMORPHIC CHARACTERIZATION

The proposed stream channel component of the replacement crossing was designed using the stream simulation approach outlined in Part XII of the California Salmonid Stream Habitat Restoration Manual (CDFG, 2009) and by the USFS (2008). The stream simulation approach is a geomorphically-based approach that requires a channel-spanning crossing structure with adequate capacity to convey the 100-year flow. The channel grading should seamlessly connect with the upstream and downstream channel profiles and the streambed should be composed of native material that is as mobile as bed material within the adjacent channel reaches. The approach relies on using the adjacent stream channel as a geomorphic reference for design of the crossing and channel bed.

2.1 Field Activities

2.1.1 Lower Robinson Creek Reconnaissance and Observations

On September 12, 2018 staff from MLA walked Robinson Creek stream channel from the confluence with Anderson Creek to the bridge crossing at the Mendocino County Fair Grounds. In general, the channel appeared to be relatively stable vertically, with no obvious knickpoints. The channel morphology is characterized as gravel/cobble bedded pool and riffle with fairly shallow residual pool depths. Primary features forcing the channel morphology and pool scour appear to be channel constrictions, flow obstructions and wood recruitment from bank failures.

From upstream to downstream the channel widens, and the terraces that form the valley floor get higher above the channel bed, with heights ranging from 15 to 25 feet increasing in the downstream direction. Active bank erosion sites are located at numerous locations throughout lower Robinson Creek. Indicators suggest that the channel incision process noted by Florsheim (2006 and 2008) has slowed or stopped and the channel is actively widening due to the oversteepened banks created by incision. Several locations were recently treated for bank erosion, which involved use of both large rock and vegetation treatments (live willow stakes).

2.1.2 Geomorphic Site Surveys

On September 12 and 13, 2018 staff from MLA conducted a geomorphic survey of the stream channel extending 500 feet downstream and 1,182 feet upstream of Lambert Lane using a Trimble S7 robotic total station. The survey datum was State Plane Zone 2 in the horizontal and NAVD88 in the vertical based on survey control established by SHN for the project. At the time of the survey the channel was dry.

The geomorphic survey consisted of a longitudinal profile of the channel thalweg extending a total distance of 1,682 feet. The profile includes breaks in slope, such as riffle crests and pool bottoms. In addition to the thalweg, the margins of the actively scoured channel bed were surveyed. In potential reference reaches, persistent inset benches above the bankfull channel bed were also surveyed. Downstream of Lambert Lane the bases of several streamside heritage bay trees were also surveyed as indicators of historical incision.

A series of five channel cross sections were surveyed upstream and four downstream of Lambert Lane for use in developing reference reach channel geometry and to extend the project hydraulic model further upstream and downstream beyond the topographic survey limits provided by SHN. Cross sections noted geomorphic features, including active channel margins, bankfull indicators, and tops of inset benches.

Pebble counts were conducted at three locations upstream of Lambert Lane to characterize the bedload gradation that will be delivered to the project reach. A potential reference reach was identified and field sketches were prepared. An annotated map of the assessed channel reach is provided in Figure 3 showing the location of the reference reach, surveyed cross sections (XS) and pebble counts (PC), along with noted locations of active bank erosion and bank armoring. Additional geomorphic field data is provided in Appendix B.

2.2 Comparison of 2005, 2008, 2016, and 2018 Channel Profiles

The RCD provided the original spreadsheets containing the 2005 and 2008 channel thalweg survey conducted by the county. The county's profiles begin at station 0+00 at the confluence with Anderson Creek. The elevation data, which was in vertical datum NAVD29 was converted to NAVD88 by adding 2.971 feet to the surveyed elevations. The MLA 2018 thalweg was then overlaid onto the previous surveys along with the 2016 project survey by SHN, as shown in Figure 4.

Comparison of the profiles found them to be relatively consistent through time. As noted by Florsheim (2008), some channel aggradation was observed between 2005 and 2008 in the lower 300 feet of Robinson Creek and at the confluence with Anderson Creek, suggesting that incision originating from downstream has ceased. Also, comparing the 2005 to 2008 profiles shows some lowering of the channel bed between stations 16+00 and 21+00. This reach is located at the confluence of Mill Creek, and has recently experienced extreme channel bank erosion and widening, causing the channel bed to lose confinement. This appears to be the cause of the localized lowering of the stream profile within this reach, and does not appear to be due to headward migrating incision.

The overall slope of the channel is relatively constant from the Mountain View Road bridge crossing to the bridge at the County Fair Grounds, averaging approximately 1.19%. Plotting the overall profile highlights a 500-foot section of locally aggraded channel upstream of Lambert Lane extending from station 30+00 to 35+00. Field inspection of this reach suggests the aggradation is caused in whole or in part by backwater affects created by sharp channel bends associated with the Lambert Lane bridge approach. Between 2008 and 2016 additional sediment aggradation has occurred closer to the bridge crossing as a result of a flow obstruction created by the collapsed retaining wall and associated riprap.

2.3 Local Scour and Aggradation downstream of Lambert Lane

Under the bridge, the right (looking downstream) footing has experienced significant local scour caused in part by flow plunging over the failed retaining wall being directed into the footing. In 2018 the scour depth along the right footing had increased to 5 feet, partially undermining the recent interim repair.

Immediately downstream of the bridge there is a tight left bend in the channel. The bank along the outside of the bend located on the property of the Boonville Hotel is oversteepened and actively eroding (Figure 5). The resulting bank failures have toppled numerous mature trees into the channel, creating a large wood jam near station 28+00. This bank failure started in 2012 with the loss of a heritage oak tree (personal communication, Linda MacElwee, RCD), but became more extensive during the winter of 2017. Between the 2016 and 2018 surveys, the height of the channel bed upstream of the large wood jam aggraded approximately 1.6 feet.

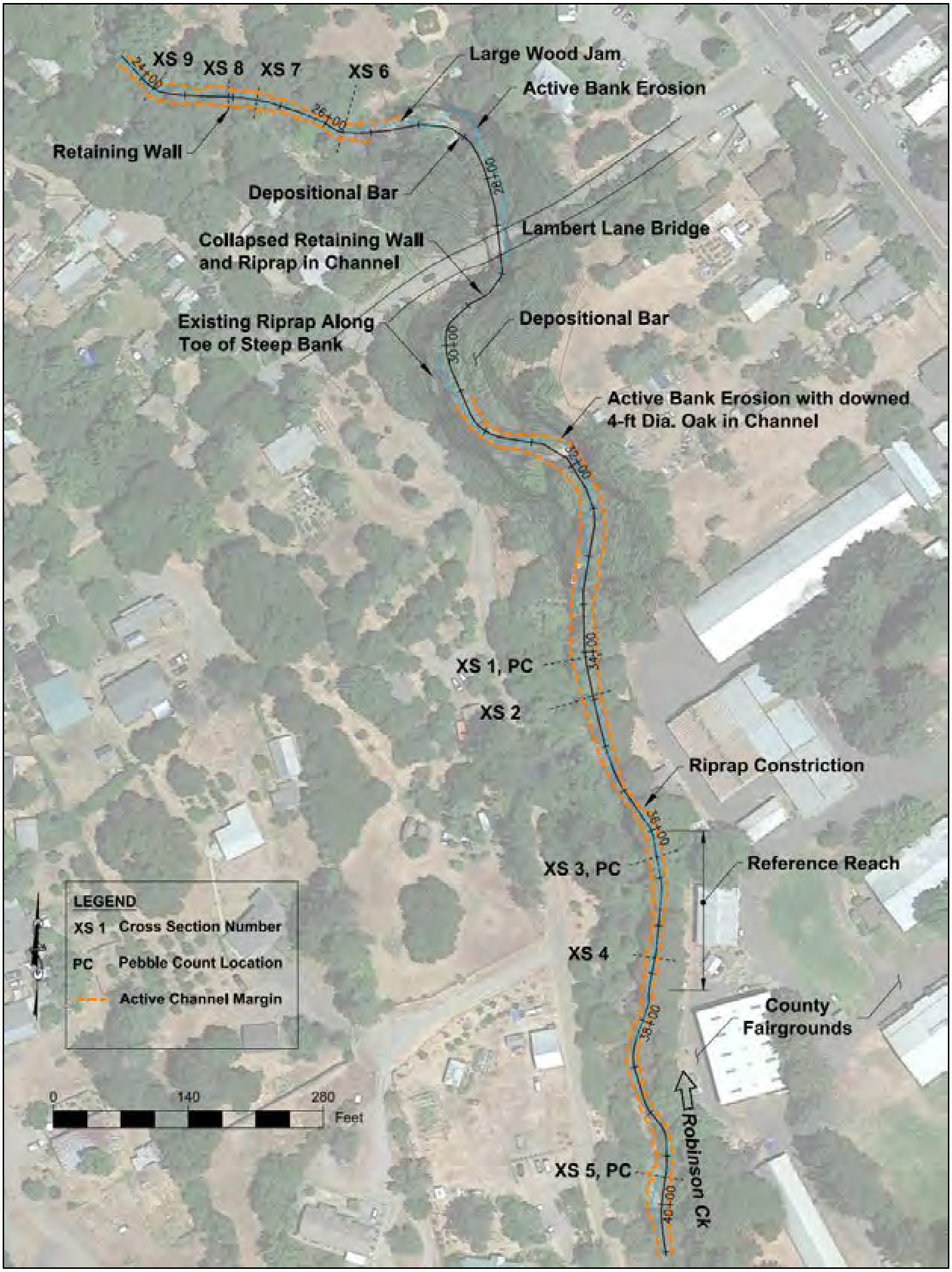


Figure 3. Robinson Creek plan view extents of the geomorphic survey of the channel.

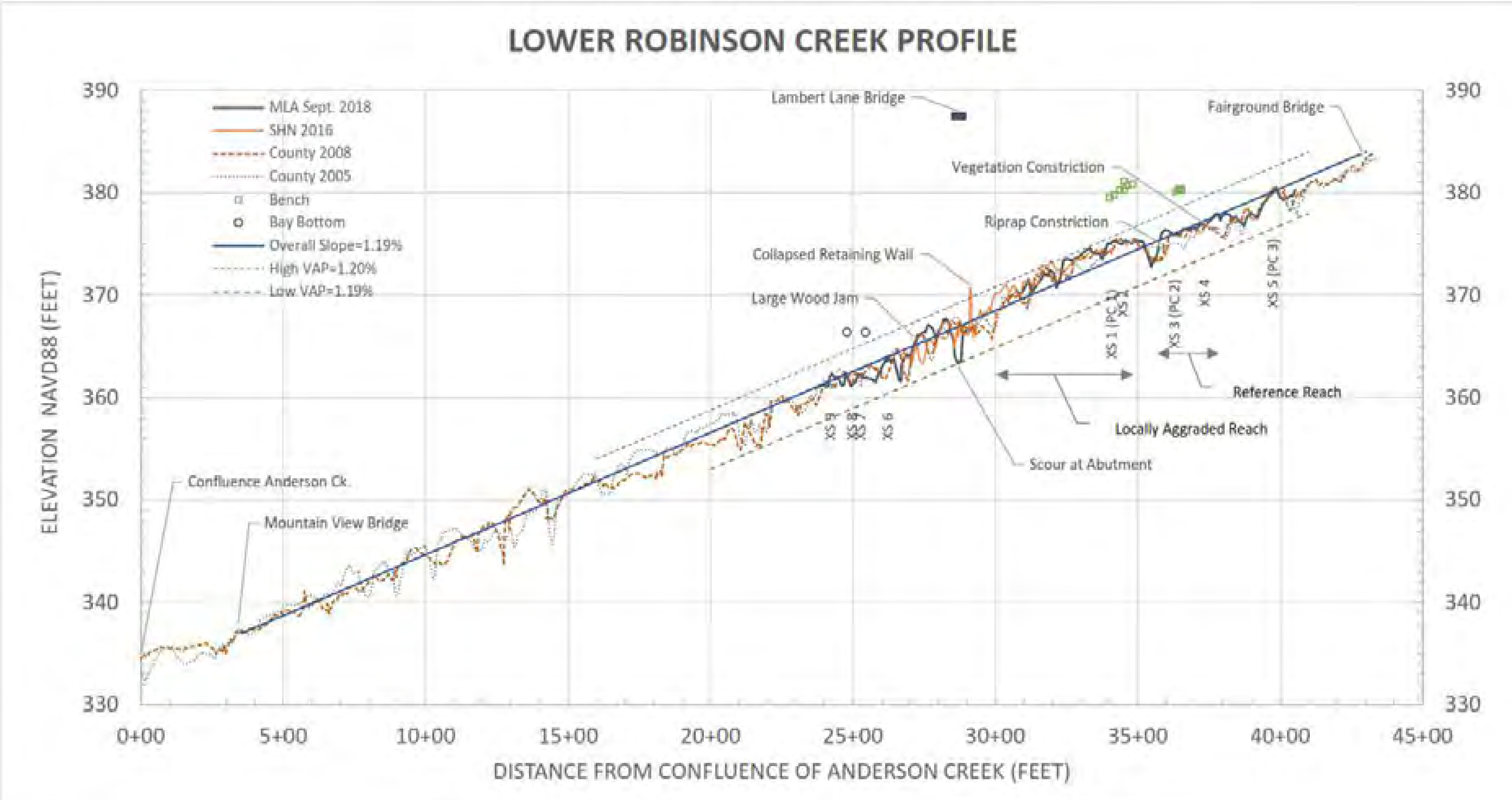


Figure 4. Channel thalweg profile showing the MLA survey (2018), SHN survey (2016), and County surveys from 2008 and 2005. Estimated overall channel profile and high and low vertical adjustment potential (VAP) profiles through the project reach are also shown.

Figure 5. Looking downstream at the active bank failure and local sediment aggradation upstream of large wood jam, 150 feet downstream of the Lambert Lane bridge (near station 27+50).

2.4 Stream Sinuosity

The channel has moderate sinuosity from upstream of Mountain View Road to approximately station 27+00. Beginning at station 27+00 to approximately 33+00 the channel sinuosity increases substantially, with the Lambert Lane crossing located within the most sinuous section of this reach (Figure 3). The Lambert Lane bridge crossing is located on an s-curve within the channel. The bridge is at the beginning of a tight meander towards the left. Downstream this meander continues bending left, causing the extensive bank failure and resulting large wood jam previously described.

Upstream of the Lambert Lane bridge the partially failed retaining walls and road embankment is on the outside of a right bend within the channel. On the inside of the bend there is a depositional bar that appears to have formed relatively recently (since construction of the bridge), likely in-part due to backwater affects from the abrupt turn in the channel as it approaches the bridge. The bar appears to have sharpened the radius of the channel bend and pushed the channel thalweg up against the retaining wall along the road embankment and against the nearly vertical bank upstream of the retaining wall, where riprap has been placed.

Farther upstream there is another meander bend near station 32+00. The bank along the outside of the bend is oversteepened and actively eroding, and caused a 4-foot diameter oak tree to topple into the channel. Upstream of this bend the channel is relatively straight, with low sinuosity.

2.5 Discussion of Geomorphic Conditions

The lower reach of Robinson Creek does not appear to be incising since the 2005 survey, and has transitioned to the widening stage of channel development, as described by Schumm et al. (1984). This is expressed by the frequent bank failure and in-channel deposition. Localized aggradation was observed upstream of the crossing, caused by the sharp bend and obstructed flow at the bridge and from a large wood jam downstream of the bridge that resulted from bank failure at the bend immediately downstream of the crossing.

Pools were generally shallow, however deeper pools observed in the profile were usually forced by constrictions from riprap placement and flow obstructions from wood jams resulting from bank failure. The dominant bed material can be characterized as very coarse gravel with a large percentage of cobble. The bed material has minimal embeddedness, suggesting it is frequently mobilized.

2.6 Overall Slope and Channel Vertical Adjustment Potential (VAP)

Developing stream crossing and bank revetment designs requires consideration of the degree that the channel bed may aggrade or degrade (incise). This is accomplished through geomorphic interpretation of the channel thalweg profile, documented historical channel adjustments, and field observations of channel features, including depth of pools, location of riffle crests, height of banks, longevity of wood controls, and potential for increases or decreases in coarse sediment loads. Through this process, low and high "vertical adjustment potential" (VAP) profiles are plotted following methods outlined in Part XII of the California Salmonid Stream Habitat Restoration Manual (CDFW, 2009) and in USFS (2008).

The outcome of the channel VAP evaluation is the low and high VAP profiles and the current stable channel profile through the project reach. These VAP profiles define the estimated bounds of vertical channel adjustment that may occur in the project reach over the next several decades. The channel VAP profiles are based on both quantitative and qualitative evaluations with uncertainty inherent in their nature, which should be considered when developing engineering designs. The VAP profiles do not consider local scour, which is accounted for using other methods, but rather are based on reach scale aggradation or degradation potential.

2.6.1 Estimated Low Vertical Adjustment Potential (VAP) Profile

The low VAP profile is typically used as part of the overall scour analysis for setting the bottom of bridge footings and bank revetments. The estimated low VAP profile is shown on Figure 5 and Figure 6. This was estimated based on the interpretation that the channel incision process has slowed or stopped, with no substantial vertical adjustment between 2005 and 2018. Additionally, the channel bed of Anderson Creek at the confluence with Robinson Creek appears to be stable or aggrading. Therefore, the lowest points along the channel profile between station 20+00 and 43+00 were used to estimate the low VAP profile. The resulting profile has a slope equal to the overall slope of 1.19%, but is offset approximately 4 feet lower in elevation.

2.6.2 Estimated High Vertical Adjustment Potential (VAP) Profile

The high VAP profile is typically used to evaluate hydraulic conditions if the channel aggrades. This is applied when setting the top elevation for bank revetments and setting the soffit elevations for road-stream crossings. For the project reach, the high VAP profile was based in part on the likelihood that upstream locally aggraded sediments, as seen in Figure 5, will be released in response to a new larger bridge crossing and less abrupt channel bends. This sediment release could temporarily aggrade the channel within the project reach. Additionally, long-term aggradation could occur due to ongoing bank erosion and widening, leading to an overall increase in sediment supply. Therefore, the high VAP profile was set based on the current elevation of the aggraded channel reach, placing it approximately 2 feet higher than the overall channel profile as shown in Figure 6. The result is an estimated 6-foot range in potential channel bed elevations within the project reach during the next several decades.

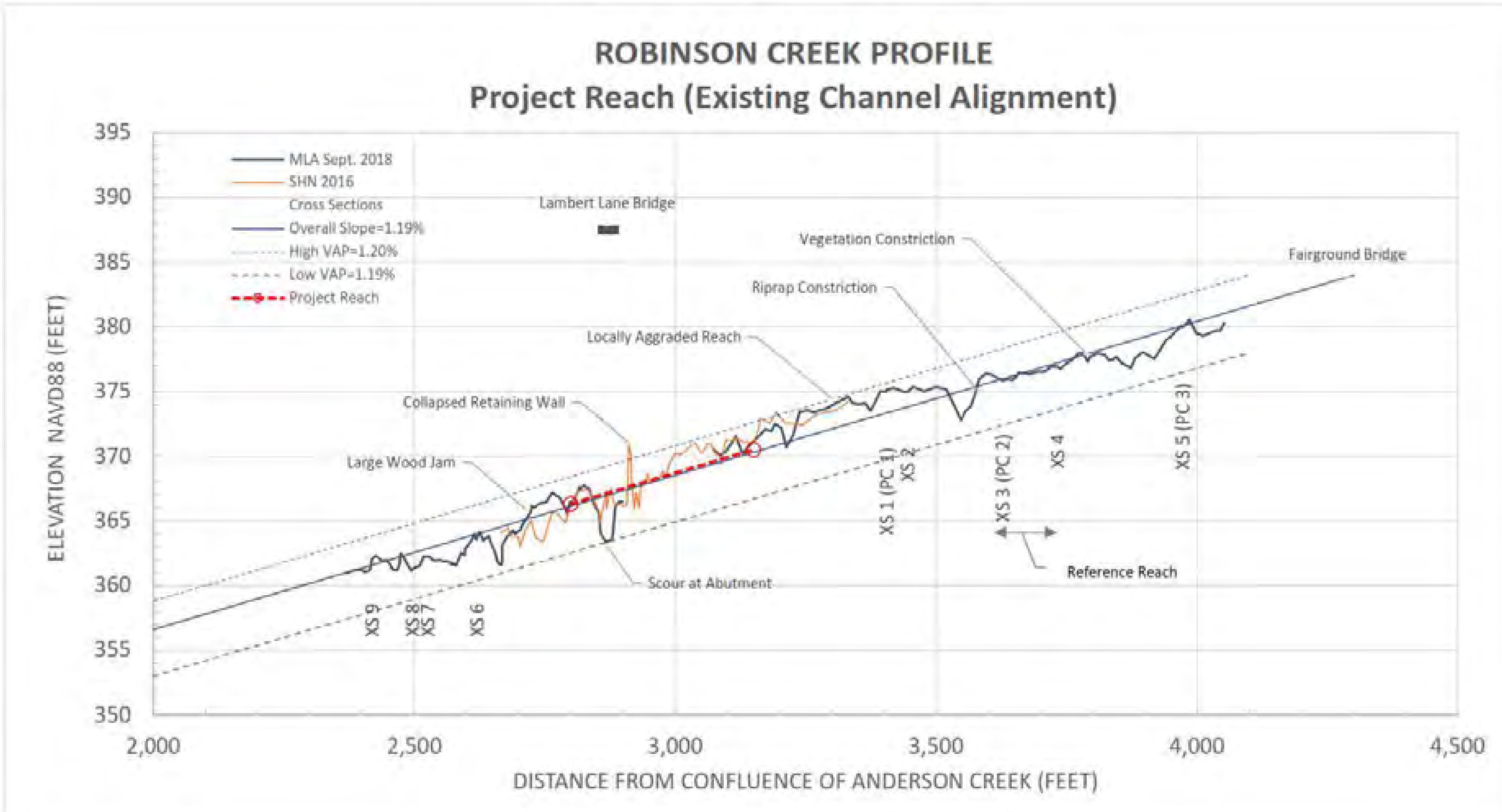


Figure 6: Robinson Creek channel thalweg profile upstream and downstream of the existing bridge crossing at Lambert Lane. Also plotted are the overall channel slope based on the entire lower Robinson Creek profile, the current project extents, and the low and high vertical adjustment potential (VAP) profiles for the project.

2.7 Hydrology

The contributing watershed area at the Lambert Lane crossing is approximately 4.0 square miles and is characterized by second growth forests in the steeper headwaters that drain into the agricultural land of Anderson Valley. The estimated mean annual precipitation for the watershed is 44.2 inches per year (USGS, 2018). A summary of basin statistics is provided in Appendix C.

The Draft Bridge Design Hydraulic Study Report by WRECO (2018) included estimates of the 50-year and 100-year return period flows calculated using two methods: the USGS North Coast regression equations (Gotvald et al. 2012) and the USACE rainfall-runoff model, HEC-HMS. WRECO (2018) selected the HEC-HMS 50- and 100-year flows of 1,340 and 1,750 cubic feet per second (cfs) for design of the Robinson Creek Bridge Replacement Project.

The USGS regression equations provide estimates of peak flows for return periods as low as the 2-year flow. Frequently occurring peak flows with return periods of 1.2 to 2.5 years are often the "channel forming flows" that convey the most sediment through time (Wollman & Miller, 1960; Leopold, 2005). There is also often a break in slope and change in vegetation within the channel cross section associated with the stream stage at the channel forming flow, which is referred to as "bankfull". Therefore, to evaluate the channel hydraulic geometry, peak flows with these return periods were estimated by extrapolating the flows from the USGS regression using a log-linear regression. The estimated peak flows for the various return periods are provided in Table 1.

2.8 Representative Channel Geometry

Nine channel cross sections were surveyed as part of the geomorphic assessment and used to measure active channel width, bankfull width, and bankfull depth. In addition to these sections, the survey captured the left and right margins of the active channel bed and heights of inset benches above the thalweg. Averages of active channel width, bankfull width, and bankfull depth were computed and are provide Table 2. The typical bankfull depth and width was 2.3 feet and 25 feet, respectively. These values were used to determine the appropriate dimensions for the channel within the project reach.

2.9 Reference Reach Selection and Characterization

The reference reach is a selected section of channel that serves as a template for design of the project channel. The reference reach should have a similar drainage area and slope as the project reach and appear geomorphically stable. Ideally, it would also have a similar planform sinuosity as the project reach. Three reaches were surveyed and assessed for use as a reference reach for channel design. The reach containing cross sections (XS) 3 and 4 was selected, although it is relatively straight compared to the project reach (Figure 3). This reference reach is upstream of the aggraded sediment from the bridge crossing and has a slope that is close to the overall channel slope of 1.19% at the project site (Figure 4 and Figure 6). Cross sections, a pebble count of the bed material was conducted and site sketch prepared for the reference reach.

Table 1: Estimated peak flows for various return periods in Robinson Creek at Lambert Lane. Extrapolated values are indicated with (*).

Return Period of Peak Flow	Peak Flows Robinson Creek at Lambert Lane: North Coast Regional Regression Equations	Peak Flows Robinson Creek at Lambert Lane: HEC-HMS (from WRECO, 2018)
1.01-Year	77 cfs*	
1.2-Year	126 cfs*	
1.5-Year	187 cfs*	
2-Year	264 cfs	
5-Year	517 cfs	
10-Year	700 cfs	
25-Year	943 cfs	
50-Year	1,130 cfs	1,340 cfs
100-Year	1,320 cfs	1,750 cfs

Table 2: Measured channel dimensions upstream and downstream of the Lambert Lane crossing. The selected Reference Reach is indicated with (*).

Cross Section Location		Active Channel Width (ft)	Bankfull Width (ft)	Bankfull Depth (ft)
Upstream of Lambert Lane				
XS 1	STA 34+05	26.2	29.9	2.2
XS 2	STA 34+45	19.5	25	2.7 / 2.3
XS 3*	STA 36+27	15.4	21.4	2.4
XS 4*	STA 37+33	13.3	24.8	2.2
XS 5	STA 39+72	24.8	31.7	2.1
	Average:	**19.8**	**26.6**	**2.3**
Downstream of Lambert Lane				
XS 9	STA 24+20	17	23.7	1.8 / 2.1
XS 8	STA 24+95	18.1	19.6	
XS 7	STA25+25	19.7	25	2.3
XS 6	STA 26+20	19.6	28.8	2.6
	Average:	**18.6**	**24.3**	**2.2**

2.9.1 Description

The reference reach has an average actively scoured bottom width of 14.4 feet and average bankfull width and depth of 23.1 feet and 2.3 feet, respectively. The reach has an inset floodplain bench running along its entire left side of the channel (looking downstream), as seen in Figure 7. This bench is consistently about 3.8 feet above the channel thalweg. There is also a discontinuous floodplain bench on the right side of the channel that is slightly lower in height. Cross section 3 is on the outside of a left bend in the reference reach. The thalweg is against the right bank, on the outside of the bend, and there is a gentle upward sloping point bar within the actively scoured channel (Figure 8).

The floodplain benches do not appear to be formed through deposition from overbank flows in the stream. Instead, they may be remnants of the historical channel bed prior to an incision event, as suggested by Florsheim (2006). As such, their inundation may not coincide to frequently occurring flows.

Figure 7. Looking upstream at selected reference reach, with typical channel cross section and location of inset floodplain bench noted.

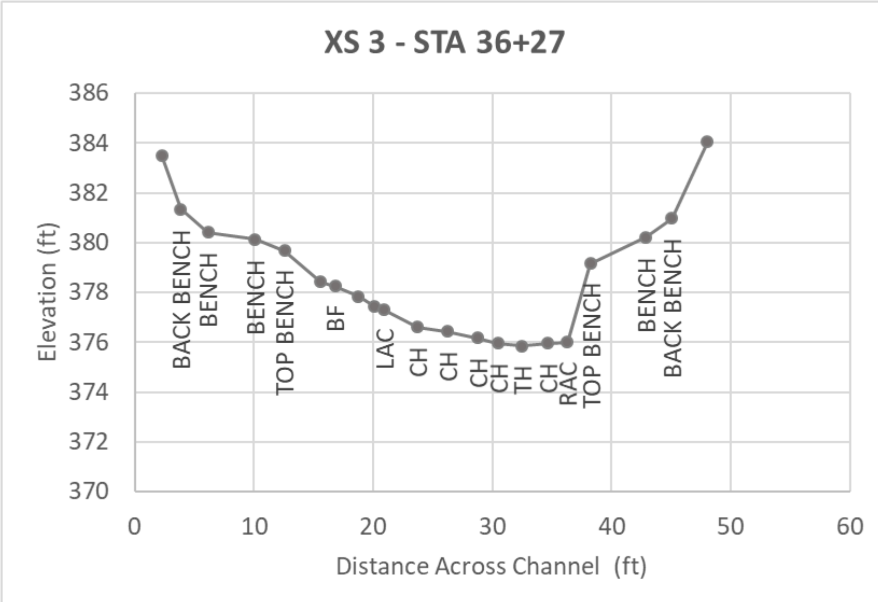


Figure 8. Reference reach cross sections, looking downstream, with typical bench geometry. Where LAC and RAC are left and right sides of active channel, BF is bankfull, and TH is thalweg.

2.9.2 Streambed Material

Pebble counts of the surface streambed material were conducted at three locations upstream of the Lambert Lane crossing to characterize the sediment size (Figure 9). Pebble count (PC) 1 was the furthest downstream and well within the influence of the existing bridge and failed retaining wall. It had substantially finer material than the other two pebble counts. PC-2 was within the reference reach. The median particle size within this reach was very coarse gravel (64 mm) and the D84 was medium cobble (128 mm).

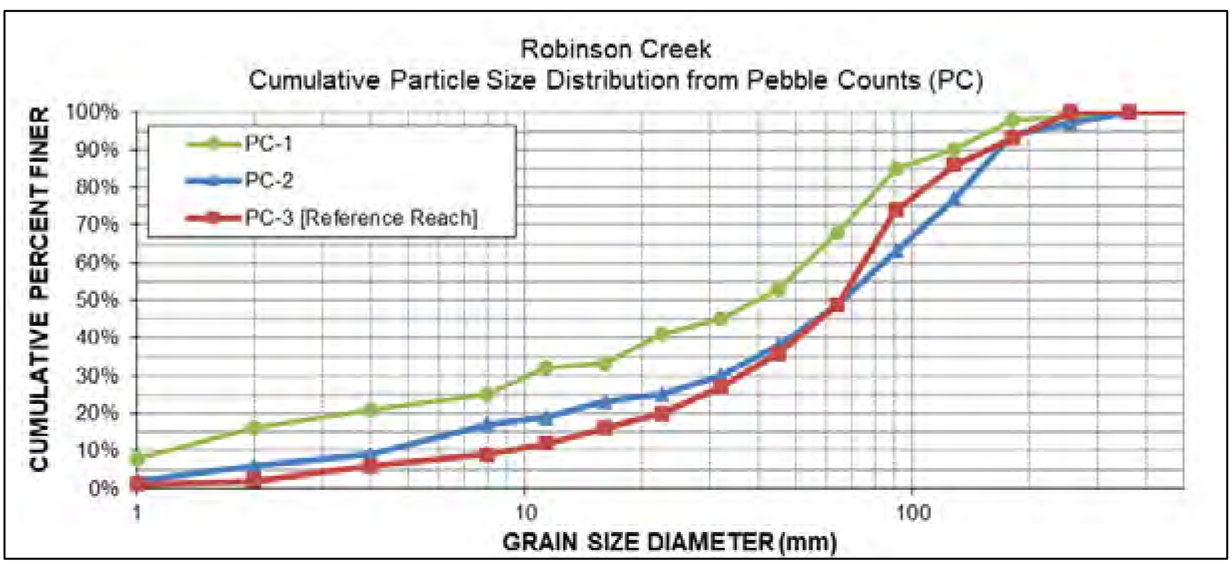


Figure 9. Gradation of streambed material from pebble counts in Robinson Creek upstream of Lambert Lane. PC-1 is closest to the bridge crossing.

2.9.3 Bankfull Capacity and Shear Stress in Reference Reach

The nine cross sections surveyed as part of the geomorphic assessment were added to the existing conditions HEC-RAS steady-state 1-D model (Appendix D) that was prepared by WRECO (2018). This model was then used to evaluate channel flow conveyance relative to geomorphic features within the reference reach, including bankfull flow. Model roughness coefficients for existing conditions matched the WRECO model, which is discussed in Section 4.1.1.

Water levels for cross section 3 within the reference reach are shown in Figure 10. Results indicate that the field indicators for bankfull correspond approximately with the 1.2-year flow. The right bench elevation becomes inundated at the 2-year return flow while the left bench inundates between a 2-year and 5-year flow. The infrequency of flows inundating the benches supports that they are likely due to recent incision within the reach. As previously noted, field evidence suggests the benches are remnants of the historical channel bed prior to an incision event.

Water velocity and channel shear stress for flows with 1- to 5-year return periods is shown in Figure 11. At 1.2-year bankfull flow of 126 cfs the cross-sectional average channel velocity is 3.9 ft/s and shear stress is 0.76 lb/ft^2. Bankfull flow is typically associated with initiation of bedload movement. Using a dimensionless Shields parameter of 0.052 for very coarse gravel (Julien, 1998), the median particle size, the estimated critical shear stress to initiate movement ranges between 0.54 and 1.12 lb/ft^2. This falls within the model-estimated shear stress at the 1.2-year flow, supporting the observed bankfull estimate.

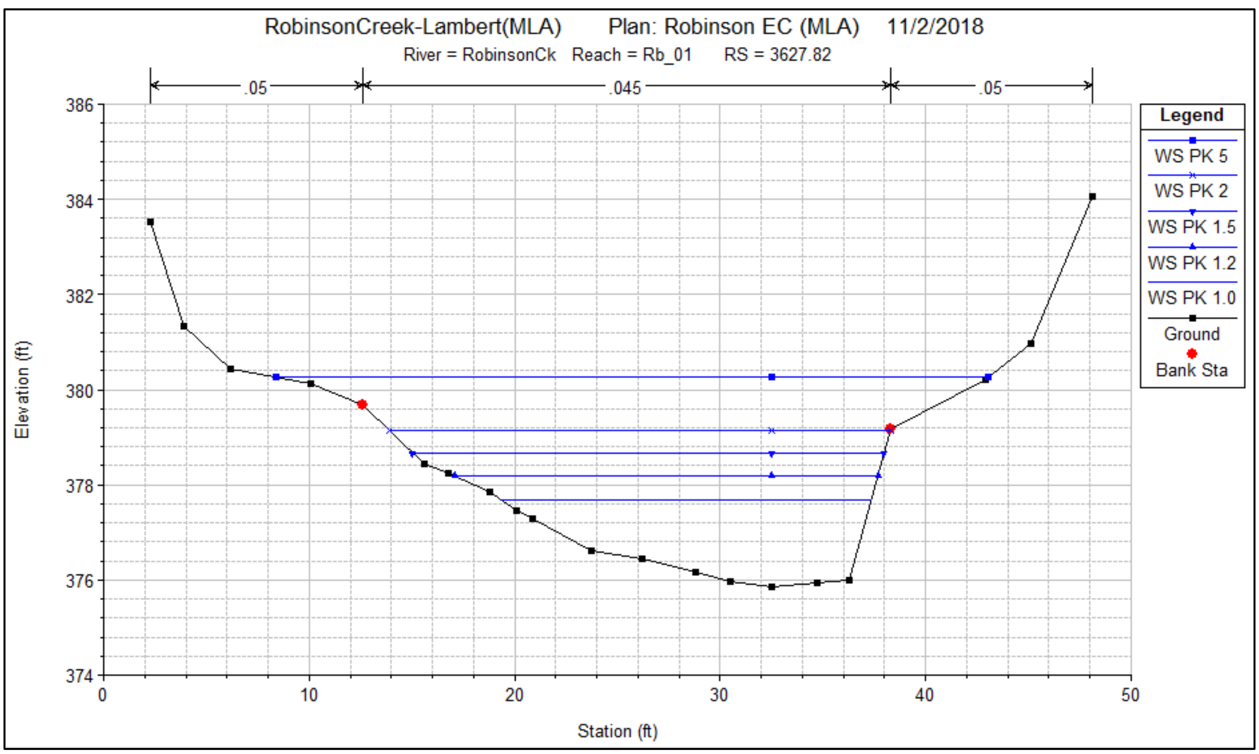


Figure 10. Existing condition HEC-RAS model results for the cross section XS3 in the selected reference reach. The bankfull field indicators correspond to the 1.2-year return flow and the benches inundate between a 2-year and 5 -year flow.

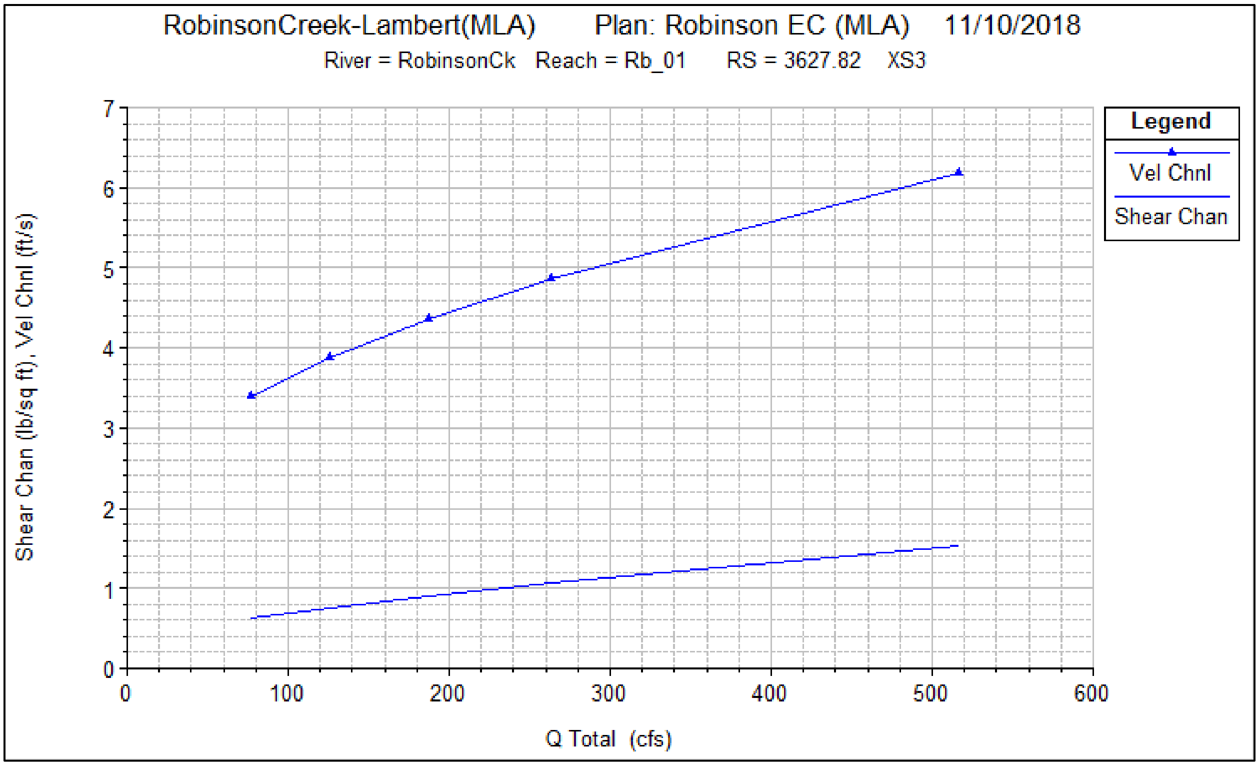


Figure 11. Water velocities and channel shear stress for cross section XS3 between the 1.01-year flow (77 cfs) and 5-year flow (517 cfs).

3 DESIGN CHANNEL LAYOUT AND GRADING

The channel design involved developing the appropriate channel profile and dimensions and then determining the appropriate bank protection measures and revegetation approach. Drawings for the channel restoration plan are provided in Appendix A.

3.1 Design Planform

The existing bridge crossing is at the inflection of a tight meander bend and the channel alignment has been constrained by the roadway embankment. The proposed replacement bridge has a free span of approximately 91 feet, while the existing bridge span is only 32 feet. The increased span is in-part intended to facilitate an improved alignment with the channel by decreasing the sharpness of the meander bend. A constraint to realigning the channel was the preservation of large established trees along the right bank upstream and downstream of the crossing, including an 8-foot diameter heritage oak tree close to the existing right bank of the channel near station 29+60.

The proposed alignment moves the approach channel further to the right (looking downstream) and has a sinuosity of 1.2 (valley length to channel length).

The outside of the bends will need to be protected from scour. Additionally, local toe scour along the outside of the bends must be considered as part of the design.

3.2 Design Profile

The design profile for the stream channel was developed based on the current overall channel profile. Figure 6 show the proposed channel profile with a slope of 1.4%, which is slightly steeper than the overall profile of 1.19%. This is due to the shortening of the channel length by approximately 28 feet by reducing the sharpness of the meander bends. The steeper profile allows for the channel slope to relax as it releases the stored sediment from upstream.

3.3 Release of Upstream Aggraded Sediments

At the upstream limits of the project, upstream of the crossing, the graded channel will steepen to match the existing streambed. At this location the channel has aggraded as much as 1.8 feet due to the failed retaining wall across the channel and the flow constrictions created by the bridge. An estimated 220 cubic yards of sediment is anticipated to be released during the adjustment period. During the adjustment period these sediments will be released during high flows and may temporarily deposit within the project reach or within the channel bend downstream of the bridge.

3.4 Design Cross Sections

Nearly the entire project reach is on one of two bends. The design channel cross section shape and dimensions were based on the reference reach, which includes cross section XS3 on a bend. A narrower bottom width of 11.5 feet and an anticipated actively scoured channel width of 15 feet is proposed to accommodate a point bar and bench on the inside of the bend (Figure 12). Although bench width will vary and is expected to adjust with time, for design purposes a bench height of 3.8 feet and a side slope of 5:1 (H:V) was selected based on reference reach observations. Bank side slopes between 1.5:1 and 2:1 are proposed for the outside of the bends and for the slope at the back of the benches.

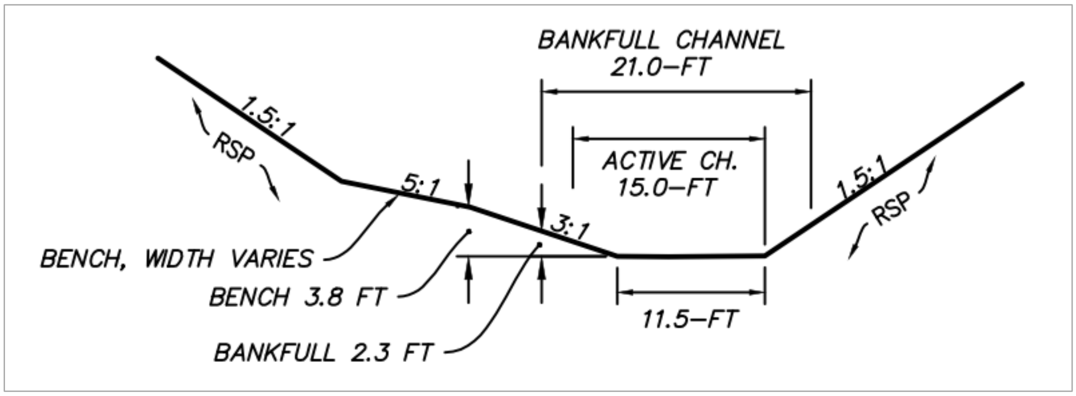


Figure 12. Typical channel geometry under the bridge for Robinson Creek at Lambert Lane Bridge replacement.

3.5 Streambed Material

The existing channel bed upstream and downstream of the culvert's influence is composed of cobbles, gravels, and fines. It is expected that native stream bed material would be stockpiled and reused in reconstruction of the channel bed and point bars. The coarser material within the project reach that more closely matches the gradation of PC3 in Figure 9 should be high-graded for this use. Finer sediments salvaged during excavation should be used for forming the point bars above bankfull elevation that are slated for planting.

3.6 Proposed Channel Grading

The approximate 350-foot long proposed channel was graded as a surface in AutoCAD Civil 3D. The final grading was developed through an iterative process guided in part by results from both the 1D and 2D steady state hydraulic models of proposed conditions. The grading is shown in Appendix A.

Channel grading upstream of the proposed bridge involved maintaining the existing mature trees along the right bank while minimizing the sharpness of the meander bend. The proposed point bar on the right side of the channel blends with the existing bench that supports these large trees between 29+60 and 31+40. The left bank downstream of 30+90 will be a vegetated riprap revetment intended to protect the roadway embankment from scour and erosion while guiding the flow around the sweeping bend.

As the channel approaches the bridge the channel bends towards the left. At the cross-over near station 29+60 the point bar transitions from the right bank to the left bank. Grading in the cross-over focused on maintaining flow conveyance areas similar to upstream and downstream to avoid a channel constriction. Downstream of the cross-over a vegetated riprap revetment will be required along both banks upstream of the bridge.

A point bar is maintained along the left bank as the channel bends to the left under the bridge between station 28+00 and 29+60. Riprap revetments will be placed against the bridge abutments. The riprap along the right bank is on the outside of the bend, and subject to high velocities and local scour.

Downstream of the bridge the left bank grading transitions to match the existing steep ground. Along the right bank the grading ties-out immediately upstream of an existing exposed root mass from a large oak tree along the bank.

4 HYDRAULIC ANALYSIS OF DESIGN CHANNEL

4.1 HEC-RAS One-Dimensional Hydraulic Analyses

The one-dimensional steady-state hydraulic model developed by WRECO (2018) using the HEC-RAS software (USACE, 2010) was updated for existing conditions. A separate HEC-RAS model was developed for the proposed channel grading associated with the bridge replacement. The model was used to evaluate existing hydraulic geometry of cross sections within the reference reach (see section 2.9.3) and proposed hydraulic conveyance associated with the 100-year flow for sizing riprap as part of rock slope protection (RSP) revetments.

4.1.1 Existing Conditions HEC-RAS Model Development

The WRECO (2018) existing conditions HEC-RAS model for the Lambert Lane bridge replacement project was derived from the project topographic surface provided by SHN. The model reach was 673 feet with 19 cross sections. The bridge routine was utilized for the existing crossing and an inline weir was used to simulate the collapsed concrete wall that is currently obstructing flow. Table 3 lists the Manning's roughness coefficients used in the existing and proposed conditions model.

Table 3. Roughness coefficients used for existing and proposed condition hydraulic modelling. Adapted from WRECO (2018).

Channel Description	Manning's Roughness Coefficient (n)
Concrete Retaining Wall	0.020
Low Flow Channel, Downstream of Existing/ Proposed Bridge Structure	0.040
Low Flow Channel	0.045
Channel Bank with Rock Slope Protection (no vegetation)	0.050
Channel Bank Hybrid Rock Slope Protection with Mature Vegetation (willow)*	0.100
Overbank Area with Modest Vegetation	0.050 to 0.080
Overbank Area with Dense Vegetation	0.100

MLA utilized the HEC-RAS model leaving it unchanged with the exception of extending the model length upstream and downstream by adding the nine MLA surveyed cross sections, all of which were located beyond of the existing model boundaries. Additionally, channel river stationing was adjusting to correspond to match the distance from the confluence with Anderson Creek, and therefore match the geomorphic analyses presented in Section 2. The updated existing conditions model extends a length of 1,564 feet.

The model was executed in mixed mode. Existing conditions HEC-RAS results are provided in Appendix D.

4.1.2 Proposed Conditions HEC-RAS Model Development

The proposed model domain extends 1,536 feet along Robinson Creek through the project area. A total of 26 cross sections were used to create the model. Eight of the cross sections were derived from the geomorphic channel sections surveyed by MLA, and the remaining cross sections were sampled from the proposed condition surface developed by MLA for the channel restoration design as shown in Appendix A

Model geometry was developed for as-built conditions. The proposed riprap revetments upstream and downstream of the bridge crossing are to be vegetated with live willow cuttings following Caltrans "hybrid revetment" design. Initially, the riprap revetment will have a relatively low Manning's roughness of 0.050. This value was determined based on the additive Manning's n method, as recommended in Caltrans (2014) *Hybrid Streambank Revetments: Vegetated Rock Slope Protection* manual. This will result in the highest water velocities impinging on the riprap, and should be used for sizing the riprap. Mature vegetation conditions following growth of the willow plantings was evaluated using the two-dimensional model and a Manning's n of 0.100, as presented in Section 4.2.

Based on observed conditions and using the additive Manning's n method, the Manning's roughness coefficient for the channel was set at 0.045 for the main channel between the specified bank markers. For overbank areas, the Manning's roughness coefficient of 0.07 was assigned to simulate the hydraulic obstructions created by brush and moderately dense vegetation along the channel and 0.05 for areas with vegetated RSP. Calculation of Manning's n is provided in Appendix D. Bank markers were placed to provide average channel velocity within the main channel, including all proposed RSP bank treatments. The proposed bridge was not included in the model for channel design, as the clearance and freeboard are well above the proposed design water surface and the concrete abutments do not encroach on the channel area.

The model was run for the 50- and 100-year return flows of 1,320 and 1,760 cfs respectively. To account for potential channel aggradation and to check the design height of RSP, the high VAP condition was also modeled. This was done by applying a fixed sediment elevation by adding 2 feet to the proposed channel bed elevations.

Proposed conditions HEC-RAS was executed in mixed mode. Results are presented in Appendix D.

4.1.3 Results for Existing Conditions

The existing conditions model results were primarily used to evaluate hydraulic geometry, channel capacity, and channel shear stresses within the reference reach. This is discussed in section 2.9.3.

4.1.4 Results for Proposed Conditions

The HEC-RAS water surface profiles for the proposed condition is provided in Figure 13. The 100-year water surface at the bridge face is at elevation 374.67, which is greater than 9 feet below the bottom of the proposed bridge deck. Average channel velocities at the 100-year flow are generally between 7 and 9 ft/s in the channel at the bridge crossing, but spike to 11.6 ft/s at the downstream limit of the project (Figure 14). This is located immediately upstream of an expansion in the channel cross section associated with the downstream bank failure. The expansion causes a local drawdown in the water surface and spike in water velocities at 28+06.

4.1.5 Results for High VAP Profile Conditions

Flow conveyance for the high VAP profile condition was evaluated with the proposed conditions HEC-RAS model. This was accomplished by adding two feet of "sediment fill" to the bottom of each channel cross section. Results from this analysis were used to estimate water surfaces associated with the 50- and 100-year flows with high VAP profile conditions (Figure 15). The high VAP 100-year water surface at the bridge face is at elevation 375.50, which is 0.83 feet higher than under design conditions.

4.2 SRH Two-Dimensional Hydraulic Analysis

A two-dimensional model of existing and proposed conditions was developed using the USBR/FHWA Sedimentation River Hydraulics (SRH-2D) model (Bureau of Reclamation, 2008). The SRH-2D model is widely used for applications similar to this project. It provides good flexibility in creating and editing the two-dimensional mesh and provides good computational stability.

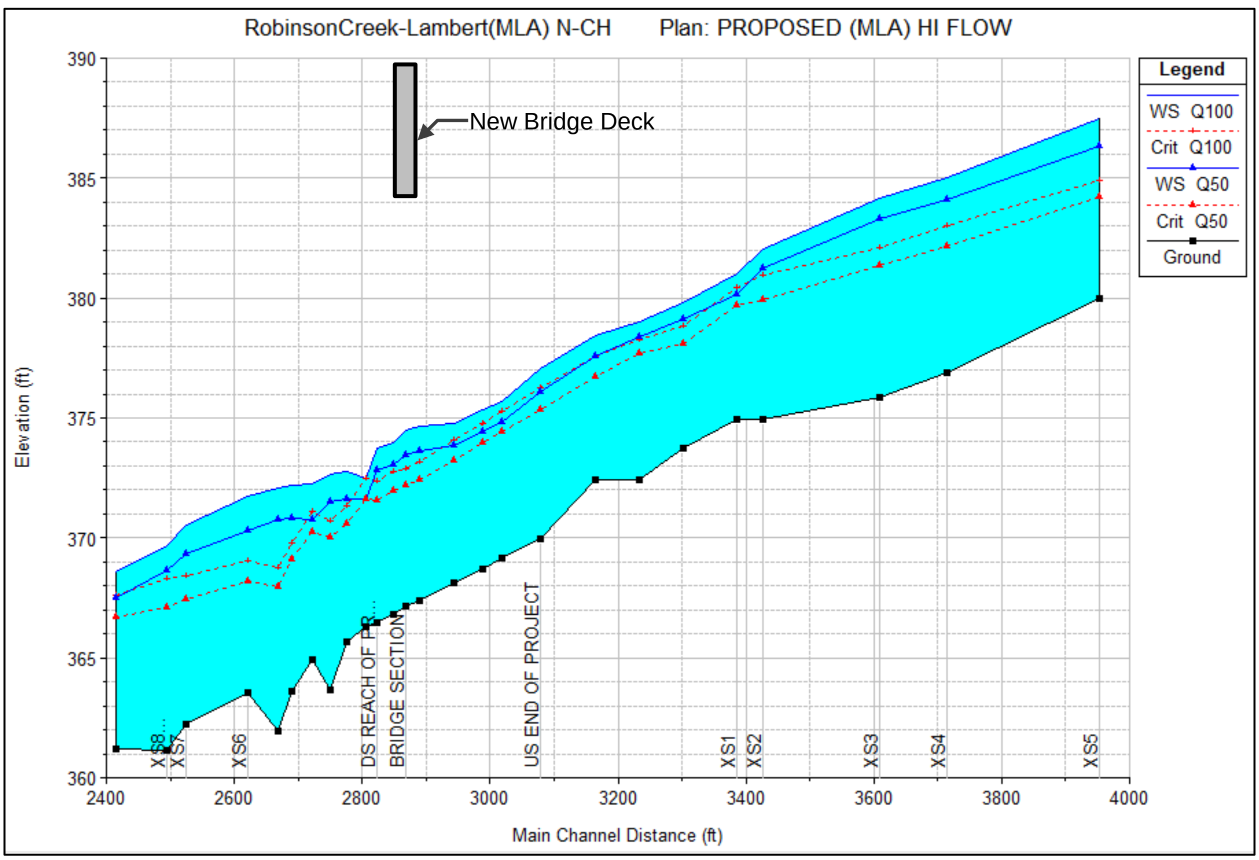


Figure 13. HEC-RAS proposed conditions water surface profiles of the 50- and 100-year flows in Robinson Creek at Lambert Lane Crossing.

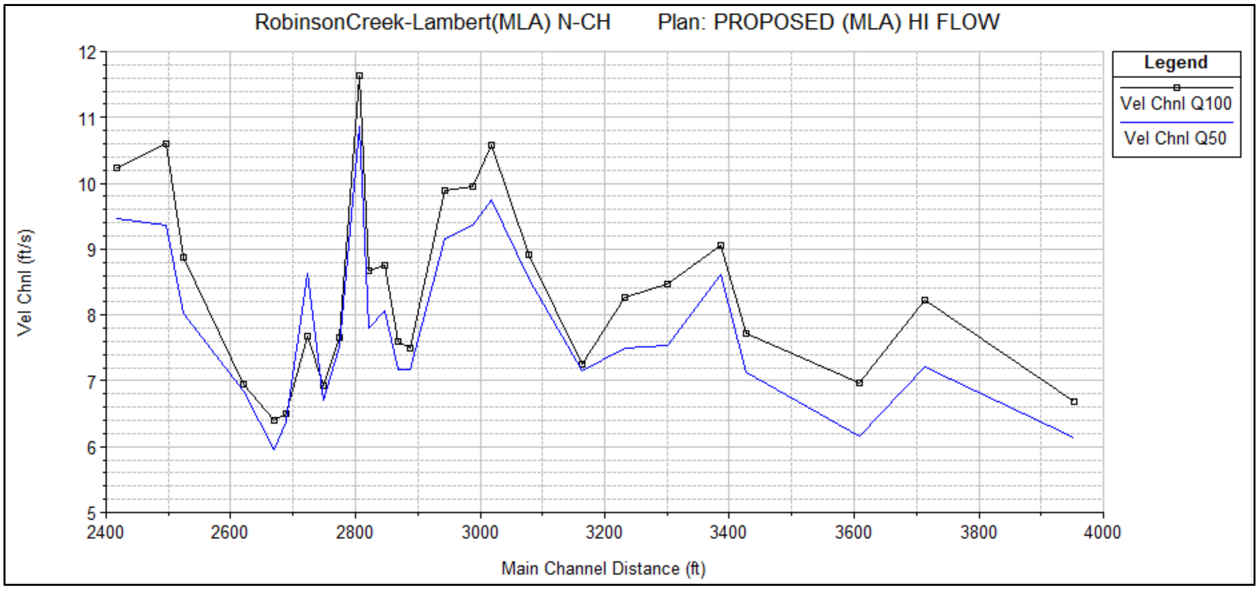


Figure 14. HEC-RAS proposed conditions channel velocity profiles for the 50- and 100-year flows in Robinson Creek at Lambert Lane Crossing.

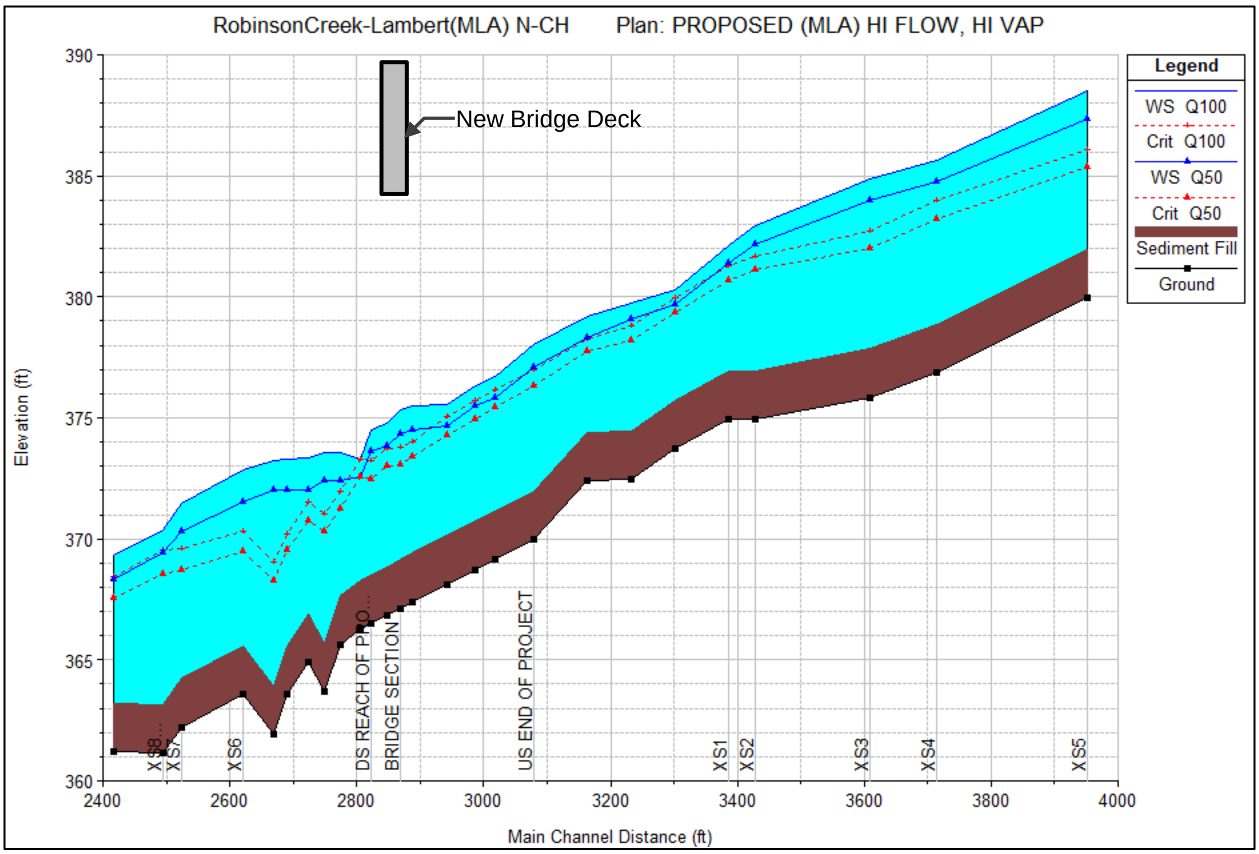


Figure 15. HEC-RAS high VAP conditions (2 feet of aggradation) with water surface profiles for the 50- and 100-year flows in Robinson Creek at Lambert Lane Crossing.

This analysis using SRH-2D focused on both bankfull flows and 100-year flow conditions, and was used to identify areas with high shear stress and velocities. These results were used to refine the channel grading to minimize abrupt hydraulic constrictions and areas of focused high velocities. The results were also used to set the top elevation for the RSP revetments. This was selected rather than the one-dimensional HEC-RAS model because of SRH-2D's ability to calculate super-elevation of flows along the outside of channel bends.

SRH-2D is a mesh-based model that solves the standard St. Venant's equations for gradually varying flow using finite-volume methods. The flexible mesh elements can be a combination of rectangular and triangular elements that vary in shape and size to accurately reflect the topography of the model domain. The model outputs include depth of flow, depth averaged velocity vectors (x and y direction), and shear stress for each wetted element in the mesh.

4.2.1 SRH2-D Model Development

The model domain for the Lambert Lane bridge replacement project included the 720 feet of surveyed channel that encompasses the project area as shown in Appendix E. The model domain extended on both sides of the channel up to the top of banks. The channel was modeled with flexible triangular elements with 3-foot sides, except where additional detail was necessary. The elevations of the element nodes were derived from the project's digital terrain model (DTM). For existing conditions, the DTM developed from the topographic surveys by SHN was used. For the existing and proposed conditions model, the SHN DTM was extend further downstream based on MLA survey points to include the entire bend in the channel and associated bank failure behind the Booneville Hotel. For proposed conditions the design surface was merged with the existing conditions DTM.

Manning's roughness coefficients were assigned to each mesh element. SRH-2D does not use contraction and expansion or eddy viscosity coefficients as part of the computations. Therefore, contraction and expansion losses need to be incorporated into the Manning's roughness values. Manning's roughness values were taken from Table 3. This includes a value of 0.100 for the hybrid RSP with mature vegetation and 0.08 for the riparian planting areas on the inside of the meander bends. These roughness values were calculated using methods recommended in Caltrans (2014), and as provided in Appendix E.

The downstream boundary condition was set based on HEC-RAS water surface elevations for cross section XS6, which is located at the downstream end of the SHR-2D model domain for both existing and proposed conditions.

4.2.2 SRH-2D Results

The SRH-2D results are provide in Appendix E. Figure 16 compares the water velocities and vectors for existing and proposed conditions. Existing condition results illustrate the channel constriction created by the existing bridge opening, with water velocity under the existing bridge exceeding 11 ft/s. The constriction raises water levels upstream of the bridge, creating slower velocities and widening the area of inundation during the 100-year flow.

In comparison, the proposed condition velocities are reduced under the bridge and the flow area remains relatively constant throughout the project reach. The highest velocities are at the upstream limit of the project grading, near station 31+50. This is the location that a small headcut is expected to occur as upstream stored sediments are released and transported downstream.

Downstream of the bridge crossing the proposed condition velocity distribution against the existing bank failure remain effectively unchanged from existing conditions. There is an area of high velocities at station 28+00, immediately downstream of the project grading. This is caused by an existing large oak tree on the bank, with its root mass protruding into the channel. Under existing conditions this is masked by the extremely high velocities discharging from under the bridge.

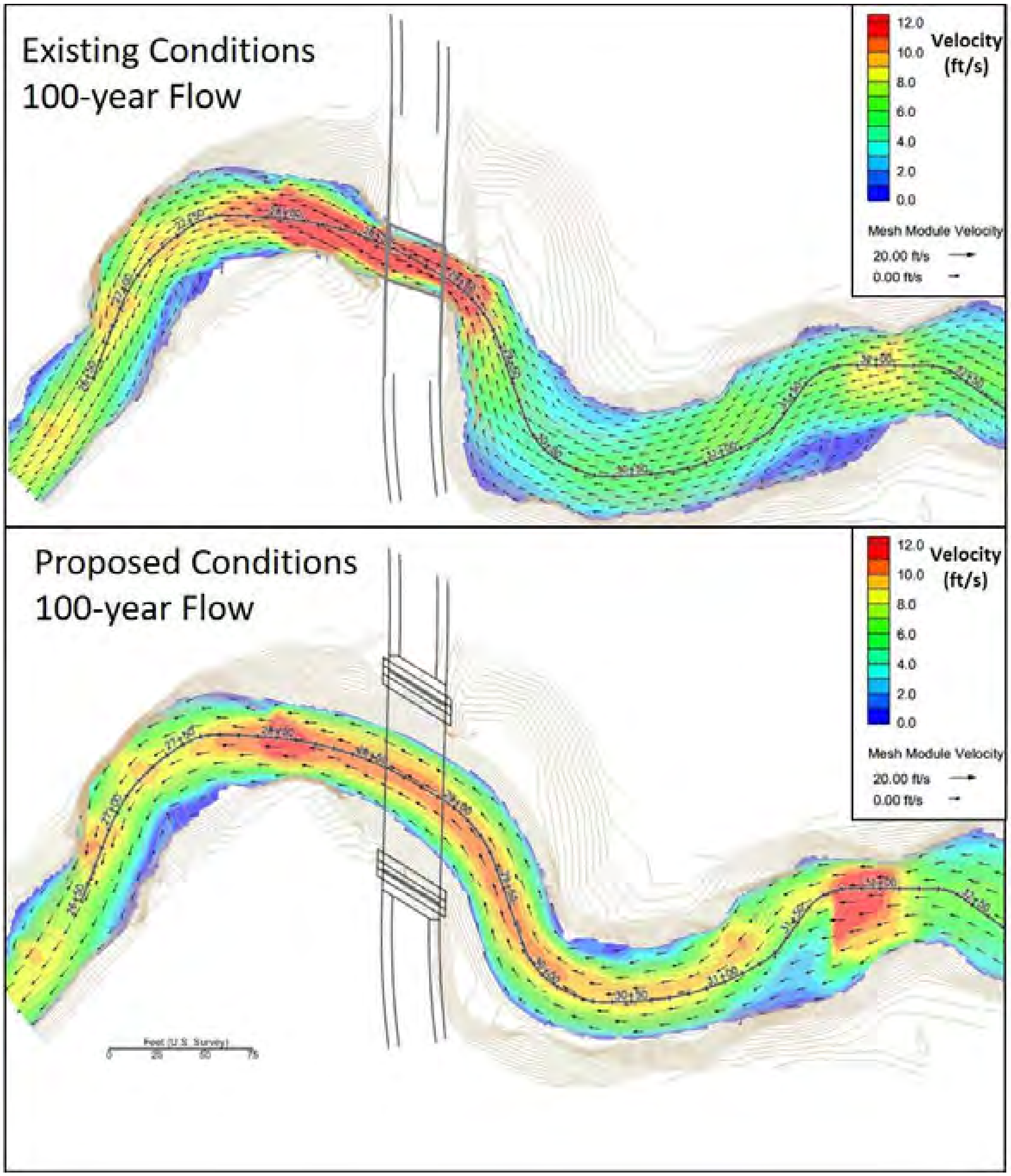


Figure 16. SRH-2D predicted water velocities associated with the 100-year flow of 1,750 cfs for existing and proposed.

5 DESIGN OF CHANNEL BANK REVETMENTS

Due to high water velocities within the channel and the steep side slopes required for the streambanks in the vicinity of the roadway and bridge, rock slope protection (RSP) will be necessary to form a stable streambank revetment. To provide channel shade and additional roughness along the streambanks to slow velocities, a *hybrid revetment* design consisting of vegetated RSP will be used following design guidance given in Caltrans Design Information Bulletin No. 87-01 (Caltrans, 2014). This uses standard guidelines for RSP sizing, thickness, and layering as described in the California Bank and Shore Rock Slope Protection Design manual (Caltrans, 2000).

5.1 RSP Sizing

RSP was sized for the 100-year flow condition of 1,760 cfs with as-built vegetation conditions. Three methods were used and results were compared: California Bank and Shore Protection Design, equation 1(Caltrans, 2000), and USACE (1994) equation 3-3 and equation 3-5. The three methods yield a wide range in size class for RSP and are summarized in Appendix F. The USACE equation 3-3 resulted in the most conservative (i.e. largest rock class) and was selected based on professional judgement.

The USACE equation 3-3 for determining RSP size for channel bottom and side slopes uses depth averaged channel velocity. Velocity and depth for key locations in the project site were derived from the proposed conditions HEC-RAS model (post construction "as-built" conditions). This method is applicable to side slopes of 1.5H:1V or flatter. RSP placed along the outside of channel bends will experience increased forces from impinging flows. This method accounts for bendways using the ratio of the centerline radius of the bend to wetted width of the channel. In addition to velocity and side slope, this method is sensitive to the unit weight of stone, which generally varies from 150 to 175 pounds per cubic foot. For this application a unit weight (γ_s) of 165 pounds per cubic foot was used.

A minimum safety factor of 1.1 is recommended by USACE. For the Robinson Creek channel design, a safety factor of 2.0 has been applied due to the sharp meander, potential for impact from large floating debris, and risk to vital infrastructure.

Equation 3-3 yields a representative stone size for the D_{30}, for which 30 percent of the gradation is finer by weight and length. To determine the D_{50}, a relationship is presented that is based on the ratio of D_{84} to D_{15} that defines the gradation of material. Standardized gradations range from 1.4 to 2.2, where a higher ratio indicates a wider range of material size. A ratio of D_{84}/D_{15} of 1.6 was used for this analysis, which is consistent with Caltrans specifications for larger rock size classes.

Calculated stable rock sizes for streambank revetments in the project reach are provided in Table 4. Weights are calculated assuming a spherical shape for the rock and a unit weight of 165 lbs/ft^3. Caltrans RSP classes are named by the D_{50} (median rock diameter). Table 4 lists the Caltrans RSP size classes and the corresponding FHWA classification that are closest to the stable D_{50} rock size for the specified location.

Computations for RSP sizing are presented in Appendix F.

Table 4. Calculated stable rock sizes for RSP along channel banks and applicable Caltrans and FHWA RSP size class. Sizing based on USACE (1994) equation 3-3.

Station	Location	Side Slope (H:V)	Stable Rock Size (D_{50})		
			Diameter (ft)	Weight (lbs)	Size Class FHWA (Caltrans)
30+78	Left Bank Approaching Bend	1.5:1	1.7	424	V (¼ Ton)
30+18	Left Bank Approaching Bend	1.5:1	2.6	1,518	VIII (1 Ton)
29+87	Lower Left Bank at Bend Apex	1.5:1	2.9	2,107	VIII (1 Ton)
	Upper Left Bank at Bend Apex	2:1	2.2	920	VII (½ Ton)
29+42	Both Banks at Bridge Approach	1.5:1	2.2	920	VII (½ Ton)
28+89	Right Bank, Upstream Bridge Face	1.5:1	1.3	190	IV (Light)
28+68	Right Bank Under Bridge	1.5:1	1.4	237	IV (Light)
28+48	Both Banks, Downstream Bridge Face	1.5:1	1.6	354	V (¼ Ton)

5.2 RSP Layers and Thickness

RSP should be placed in a layer with a thickness sufficient to remain stable and provide maximum protection against erosive forces. Rock that interlocks and minimizes voids will help ensure the stability of the RSP layer. Design equations are based on a minimum thickness of $1*D_{100}$, the maximum size in the size class. Caltrans methods for RSP design call for use of "California Layered RSP" (Caltrans, 2000), where up to three layers of rock make up the total RSP thickness. The design follows filtration theory where, from the inside to the outside, each layer is progressively larger so an inner layer will not pass through the voids of the next layer. The total RSP thickness is made up of a backing, inner and outside layer. In some cases, an inner layer is not required.

Caltrans standard RSP size classes are divided into two construction methods. Method "A" is for larger rock that is individually placed and Method "B" is for smaller rock where dumping is acceptable. Using the stable rock sizes calculated for locations given in Table 4, the RSP size class layers and thickness were developed following Caltrans (2000), and are provided in Table 5.

Standard Caltrans design includes RSP fabric at the interface of the native slope and the backing class. However in lieu of RSP fabric, the hybrid revetment uses a gravel filter to better support vegetation plantings. A Universal Gravel Filter Gradation is appropriate for the proposed RSP revetments. It consists of 6-inch minus gravel. For slopes steeper than 2.5H:1V rounded river-run material is not recommended for the gravel filter layer.

Table 5. RSP size class and thickness by station and location.

Station and Location	Side Slope (H:V)	Outer Layer		Backing Layer	
		RSP Class	Thickness (ft)	RSP Class	Thickness (ft)
<u>28+15 to 29+60</u> Under Bridge Both Banks	1.5:1	½ TON	3.4	Backing No. 1	1.8
<u>29+60 to 30+30</u> Outside Bend Lower Left Bank	1.5:1	1 TON	4.3	Light	2.5
Outside Bend Upper Left Bank	2:1	½ TON	3.4	Backing No. 1	1.8
<u>30+30 to 30+90</u> Upstream Approach Left Bank	1.5:1	¼ TON	3.3	Backing No.1	1.8

5.3 Toe Scour Analysis

Toe scour and undermining of RSP along streambanks is a common cause of failure. The proposed channel within the project reach will have a natural substrate bottom and includes two substantial meander bends. In meandering channels flow is impinged along the outside bend, increasing velocities and scour forces. In high flows the channel bed scours and then refills during the receding limb of the hydrograph. Toe protection can be provided by extending the toe of the RSP to a depth below the expected scour depth.

Caltrans (2014) and USACE (1998) reference methods developed in *Toe Scour Estimation in Stabilized Bendways* (Maynord 1996) as a way of predicting potential scour depth. The empirical equations were developed by synthesizing laboratory and field data for scour at bank toes around stream bends. The primary variables are the average depth in the main channel upstream of the bend, depth at the bend and centerline radius of the main channel bend. The depth of scour is the difference of the computed depth in the bend and the maximum depth as predicted by Equation 16.

Based on the radius of the channel bends a factor of safety of 1.19 was used, implying that 2% of measured scour could be 5% deeper (approximately 0.5 feet) than the predicted scour depth.

The scour analysis indicated that the toe of the RSP should be placed to a minimum depth of 3.0 feet below the channel bed. This scour depth is added to the depth the channel may degrade based on the low vertical adjustment potential (VAP) profile, which is approximately 4 feet lower than the design channel bed. This places the toe of the RSP a minimum of 7 feet below the design channel bed.

5.4 Design Height of RSP

Caltrans recommends the water depth during 50-year return flow for the design height of the RSP. Additional freeboard can be added to the design height based on site conditions and professional judgment. Additional consideration should be given to the potential for super-elevation at bends and the possibility of channel aggradation. In this case, results from the 2D model at the 100-year flow, which represents the matured vegetation condition of the hybrid RSP revetment was used to define the design water surface with super elevation at the bends. The final design height of the RSP was then modified by adding the difference of the proposed water surface and the high VAP water surface as predicted by the HEC RAS model to account for potential aggradation.

Cross sections 30+78, 29+87 and 28+88 are on the straight section approaching the bend, on the right bend, and on the left bend at the bridge face. These locations represent the highest potential for scour and super elevation and were used to determine the design height of the RSP design. Table 6 lists the SHR-2D water surface at the hybrid riprap banks on the outside of the bends. The increase in water surface elevation at the high VAP conditions as compared to design conditions is based on the HEC-RAS results. This difference is added to the SRH-2D water surface elevation to arrive at the design elevation for the top of the RSP.

Table 6. Summary RSP top elevation based on 100-year water surface elevations (WSE) for proposed conditions with mature vegetation from 2D modelling plus increase in WSE due at high VAP profile due to potential aggradation.

Station and Location	SRH-2D WSE along Bank (feet)	Increase in WSE at High VAP	Design Elevation for RSP Top (feet)
28+88 Upstream Bridge Face	375.5	0.8 feet	**376.3**
29+87 Outside of Left Bend	377.3	1.0 feet	**378.3**
30+78 Straight Section Upstream of Bends	378.0	1.0 feet	**379.0**

5.5 Hybrid Revetment Design- Vegetated RSP

Incorporating vegetation into the streambank revetment has the beneficial effects of improving stream ecology, increasing soil strength and providing flow resistance, although it can be unpredictable over the long term (Caltrans 2014). Established vegetation will provide cover, shade the channel and provide nutrients to the stream. As root systems establish, they can support the banks by providing resistance to scour and bind the soils and rock placed along the bank.

Caltrans has developed recommendations for the use of a "hybrid revetment" that incorporates vegetation into rock slope protection to provide the benefits of stream side vegetation while managing its uncertainties. The intent is to balance the engineering benefit of armoring a bank while promoting ecological processes.

The hybrid RSP design consists of the standard RSP design as described above, with the addition of live willow staking that penetrates the rock layers and allows rooting into the native bank soils. Species most commonly used as live stakes are native willow and cottonwood trees. Plantings are placed either vertical or perpendicular to the slope face and must be long enough to extend through to the subbase and into most soil. Placement of live stakes is done in conjunction with rock placement. To provide protection to the live stakes during rock placement, cuttings should be placed into perforated cardboard tubes that are embedded into the subgrade and extend through the layered RSP (Figure 17). Cardboard is preferred as it can degrade over time and not hinder the growth of the cuttings. Growing medium is placed within the cardboard tubes to provide direct soil contact. Additionally, voids within the placed riprap should be filled with salvaged soil to further promote root growth within the layered RSP.

For Robinson Creek, it is assumed cutting shall be made from native willow species. Stakes may need to be as long as 12 feet and should be placed vertically to maximize their rooting depth, with the butt of the live stake at or near summer groundwater levels. The willow plantings will start at bankfull, 2.3 feet above the finished channel bed, and extend up the RSP revetment. To ensure good establishment, the live stakes should be irrigated for a minimum of two seasons.

Preliminary spacing of live willow stakes is assumed to be 5 feet on-center. Prior to final design a qualified landscape architect or botanist should be retained to provide recommendations for lateral spacing, live willow stake diameter range, embedment depths into subgrade and type of soil backfill for the tubes. They should also provide provisions for harvesting and storage of cutting stock and irrigation design.

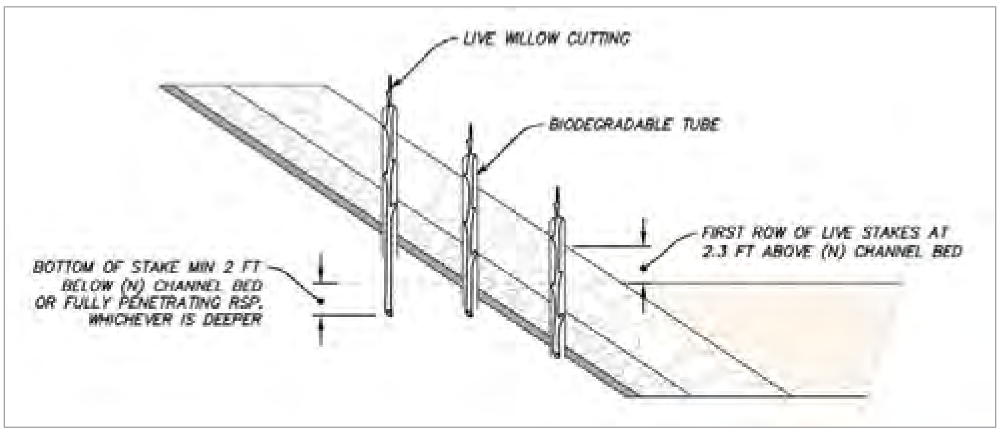


Figure 17. Typical live stake placement for hybrid RSP revetment.

5.6 RSP Design Sections

Three typical design sections were developed for the RSP bankline protection for the project (Figure 18):

1. Under the Bridge (Station 28+15 to 28+60)
2. Apex of the bend and along the roadway and bridge approach (Station 28+60 to 30+30)
3. Upstream edge of project at approach to bend Station (30+30 to 30+90)

Section 1 has 1.5:1 side slope and is located along the bend under the bridge. This reach has ½ Ton RSP (Class VII) application on both banks. The right bank is the outside bend and the left bank is the inside bend where a bench is expected to form in the wider channel. Roughly half of the RSP on the right bank will be outside the cover of the bridge deck and should utilize the Hybrid RSP discussed above.

Section 2 is located at the apex of the bend along the bridge approach currently protected by the retaining wall and RSP. The left bank will have 1-Ton RSP (Class VIII) application with a 1.5:1 slope at the toe and ½-ton RSP (Class VII) at a 2:1 slope along the upper bank. This reach should utilize Hybrid RSP. Compacted native backfill behind the RSP layers will be required where the new bank is pulled away from the existing road embankment. Above the RSP application backfill and planting should be applied to meet the existing ground.

Section 3 is located at the upstream end of the project reach and is the approach to the first bend. ¼-ton RSP (Class V) will be applied to the left bank at a 1.5:1 side slope and blend into the native bank. Hybrid RSP should be utilized. Existing RSP along this reach should be reused as practical.

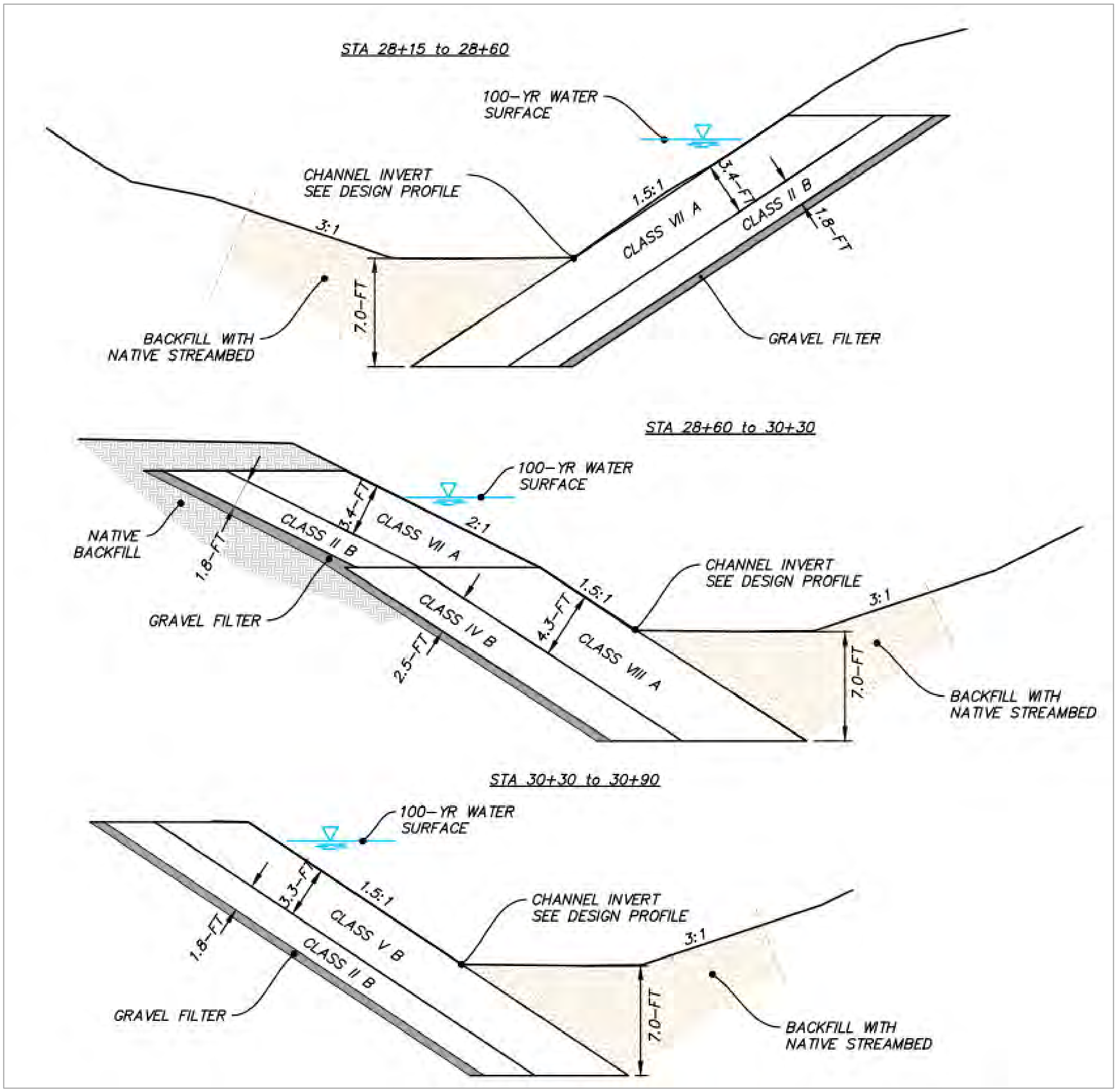


Figure 18. Typical sections for RSP placement along design channel on Robinson Creek at Lambert Lane.

5.7 Tree Removal and Additional Streamside Planting Areas

Based on the proposed channel grading shown in Appendix A, several trees will be removed. This includes a 30-inch tree (DBH) close to the bridge face, a 16-inch tree near the existing retaining wall, and an 8-inch and two 4-inch trees on the right bank. The species of these trees is not known, but if any are willows, they should be considered for use as live stakes for the hybrid revetment.

In addition to the plantings contained within the hybrid RSP revetment, native vegetation would be planted on the graded point bars on the inside of the channel bends. This includes on the right bank between station 29+50 and 31+10, and on the left bank immediately upstream and downstream of the bridge crossing. This vegetation should include native riparian tree species, as well as understory plants. Irrigation will likely be required for a minimum of two years to ensure survival.

In addition to the planting areas close to the channel, the project will create a terrace behind the RSP adjacent to the road embankment at the southern bridge approach. This terrace could be used to plant upland tree species, such as native oak trees. Prior to final design a qualified landscape architect or botanist should be retained to develop a planting plan.

5.8 Recommendation for Treatment of the downstream Bank Failure

The stream channel design allows for release of the stored sediments from the upstream channel. In total, approximately 220 cubic yards of streambed sediments may be released and transport downstream during this channel adjustment period. This is a relatively small amount of sediment for this stream. However, this released sediment has the potential to deposit between high flow events within the project reach and immediately downstream. Deposition could exacerbate the existing bank erosion downstream of the bridge, behind the Boonville Hotel. Given the condition of this failing bank, proximity of structures on top of this bank, and potential for channel adjustments associated with this project, efforts should be made to treat the bank failure using standard bioengineering bank revetment practices prior to, or in conjunction with, the Lambert Lane bridge replacement. The Mendocino County Resource Conservation District (RCD) has lead bank repairs using similar approaches in other location in lower Robinson Creek, and should be engaged about the potential to lead repair efforts for this bank failure.

6 REFERENCES

Bureau of Reclamation. 2008. SRH-2D Theory and User's Manual version 2.0, Lai, Y.G. Technical Service Center, Denver, CO.

CDFG. 2009. Parts IX-XII: Fish passage design and implementation. In the California Salmonid Stream Habitat Restoration Manual. California Department of Fish and Game.

CDFG. 2002. Culvert criteria for fish passage. Appendix A in California Salmonid Stream Habitat Restoration Manual 3rd edition. California Department of Fish and Game. CALTRANS. 2000. California Bank and Shoreline Protection Design. State of California Department of Transportation Final Report No. FHWA-CA-TL-95-10. Third Edition.

Caltrans. 2014. Hybrid Streambank Revetments: Vegetated Rock Slope Protection. State of California Department of Transportation Design Information Bulletin. DIB 87-0.1

Entrix, Inc. 1998. Navarro Watershed Restoration Plan.

Florsheim, J., A. Chin, K., Gaffney, D., Slota. 2013. Thresholds of stability in incised "Anthropocene" landscapes. J. of Anthropocene. Vol. 2., P27-41.

Florsheim, J. 2008. RE: Robinson Creek Survey Update. Memorandum to Mendocino County Water Agency and Mendocino Count y Resource Conservation District.

Florsheim, J. and Circuit Rider Productions, Inc. 2006. Baseline bio-geomorphic assessment of Robinson Creek, Mendocino County, California. Prepared for Mendocino County Resource Conservation District. 404 pages.

Gotvald, A. J., Barth, N. A., Veilleux, A.G., and Parrett, Charles. 2012. Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 pp.

Julien, P.Y. 1998. Erosion and Sedimentation. Cambridge University Press, Cambridge, UK.

Leopold. L. 2005. A View of the River. The President and Fellows of Harvard College. 298 pp.

Maynord, S.T. (1996). Toe-Scour Estimation in Stabilized Bendways. ASCE Journal of Hydraulic Engineering, August 1996.

NMFS. 2001. Guidelines for salmonid passage at stream crossings. NOAA Fisheries, NMFS SW Region.

Quincy Engineering (2018). Project Report. Lambert Lane Bridge at Robinson Creek Center of town in Boonville, CA. Prepared for County of Mendocino Department of Public Works.

Schumm, S.A.; Harvey, M.; Watson, C. 1984. Incised Channels: Morphology, Dynamics, and Control; Water Resources Publications: Littleton, CO, USA.

Taylor, R. 2001. Final Report: Coastal Mendocino County Culvert Inventory and Fish Passage Evaluation. 73 pages.

USACE. 1994. Hydraulic Design of Flood Control Channels 1110-2-1601. U.S. Army Corps of Engineers, Washington D.C.

USACE 1998. User's Manual for CHANLPRO, PC Program for Channel Protection Design. Technical Report CHL-98-20.

USACE. 2010. HEC-RAS, River Analysis System User's Manual. Hydraulic Reference Manual: Version 4.1, U.S. Army Corps of Engineers, Hydrologic Engineering Center.

USFS. 2008. Stream simulation: An Ecological Approach to Road Stream Crossings. USDA United States Forest Service National Technology and Development Program, San Dimas, CA.

USGS. 2012. The StreamStats Program. http://water.usgs.gov/osw/streamstats/california.html. Data accessed December, 2017.

WRECO. 2018. Draft Bridge Design Hydraulic Study Report. Robinson Creek Bridge Replacement on Lambert Lane, Mendocino County, California. Federal Aid Project No. BRLO-5910(099), Mendocino County Project No. B1302, Existing Bridge No. 10C0146

Wolman, M. G., and Miller, J. P. (1960. Magnitude and frequency of forces in geomorphic processes. Journal of Geology 68, 54-7 4.

Appendix A – Design Drawings

Appendix B - Geomorphic Field Data

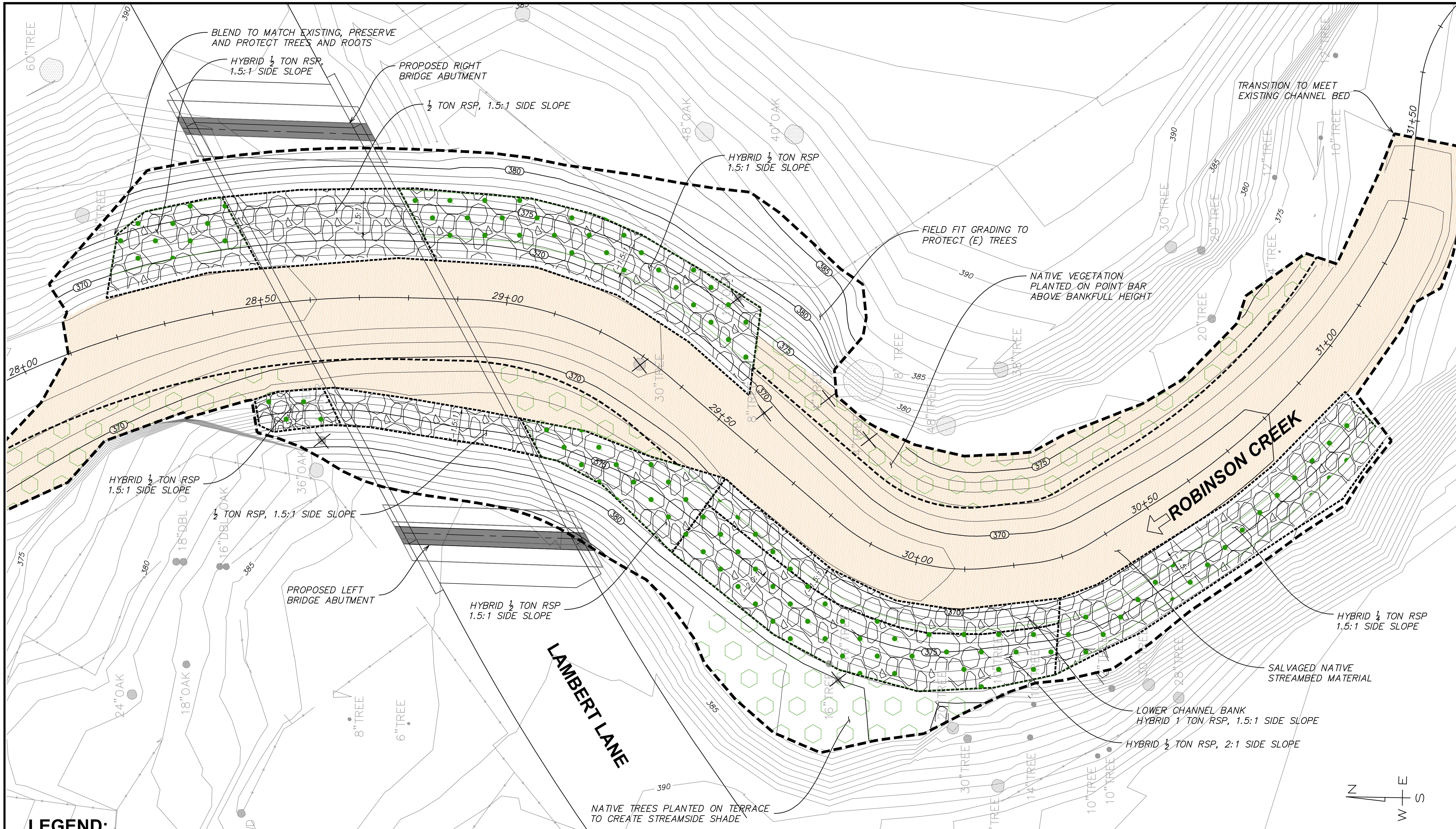
Appendix C – Hydrology

Appendix D - HEC RAS Results

Appendix E - SMS Results

Appendix F – Rock Slope Protection Design

Appendix A – Design Drawings



LEGEND:

- ROCK SLOPE PROTECTION (RSP)
- NATIVE STREAMBED MATERIAL
- HYBRID RSP (VEGETATED)
- VEGETATION TREATMENT

1 CHANNEL RESTORATION PLAN

LAYOUT

Michael Love & Associates, Inc.
PO Box 4477 • Arcata, CA 95518 • (707) 822-2411

DRAFT

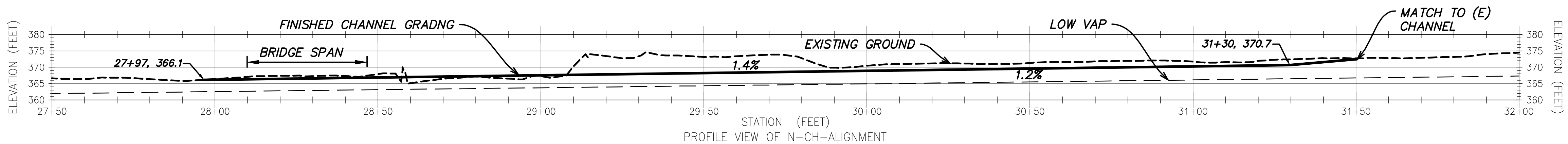
30% DESIGN SUBMITTAL

VERIFY SCALE — THIS BAR IS ONE INCH LONG AT FULL SCALE

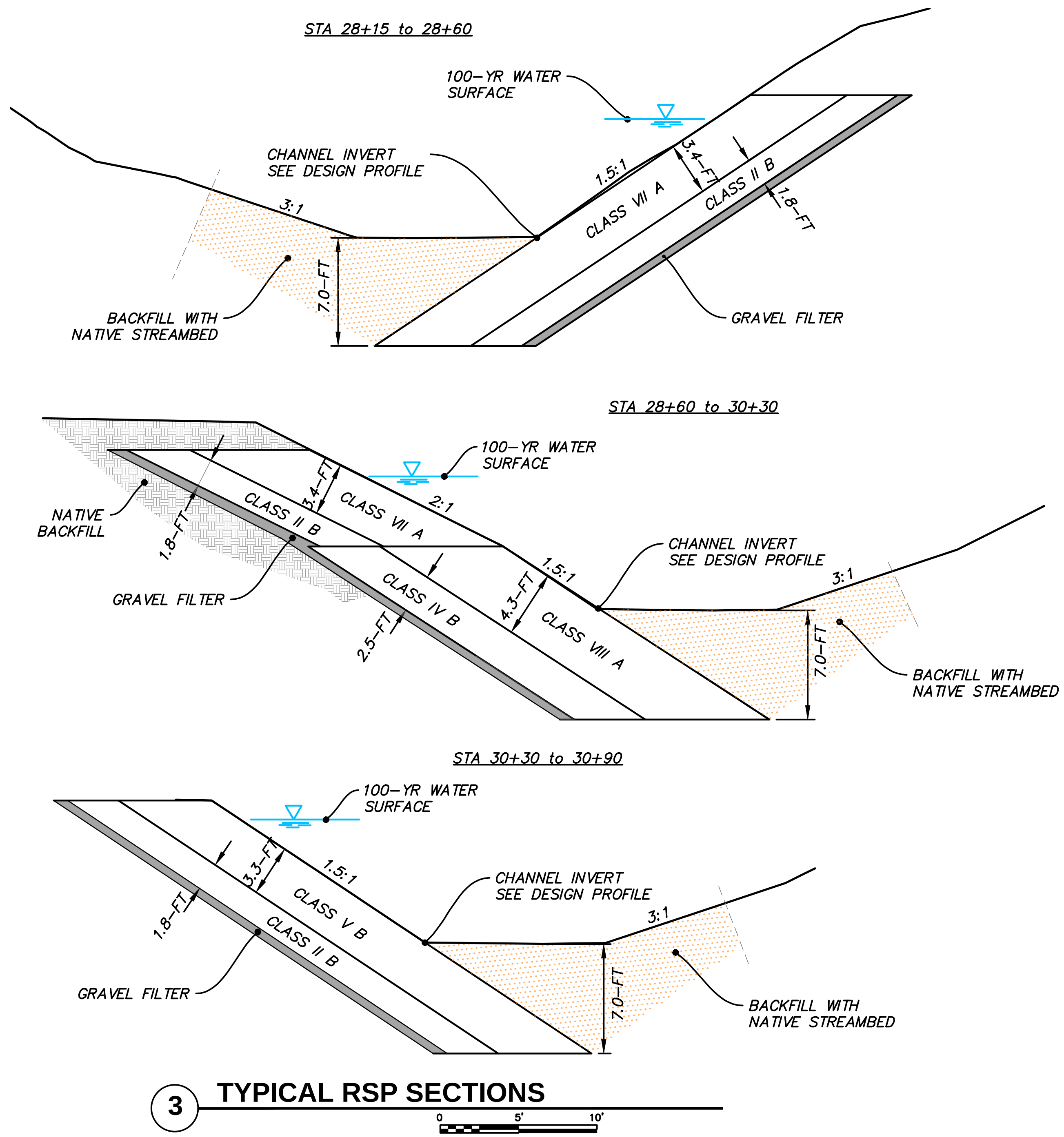
MENDOCINO COUNTY DEPARTMENT OF TRANSPORTATION
ROBINSON CREEK AT LAMBERT LANE
BOONEVILLE, CA

CHANNEL RESTORATION PLAN

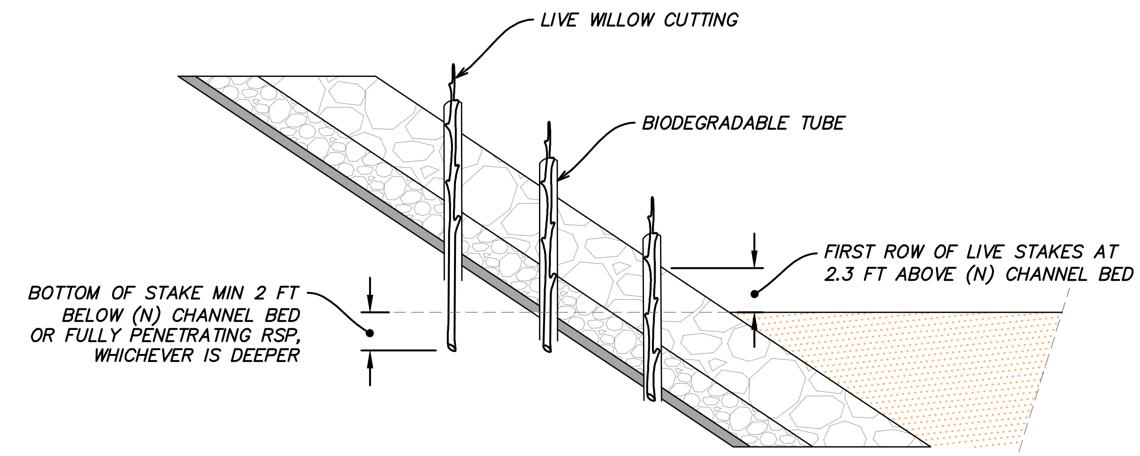
DATE	OCT. 2018
SUBMITTAL	30% DESIGN
DESIGN	AL, ML
DRAWN	LLANOS
SHEET	1 of 2



2 CHANNEL PROFILE



3 TYPICAL RSP SECTIONS



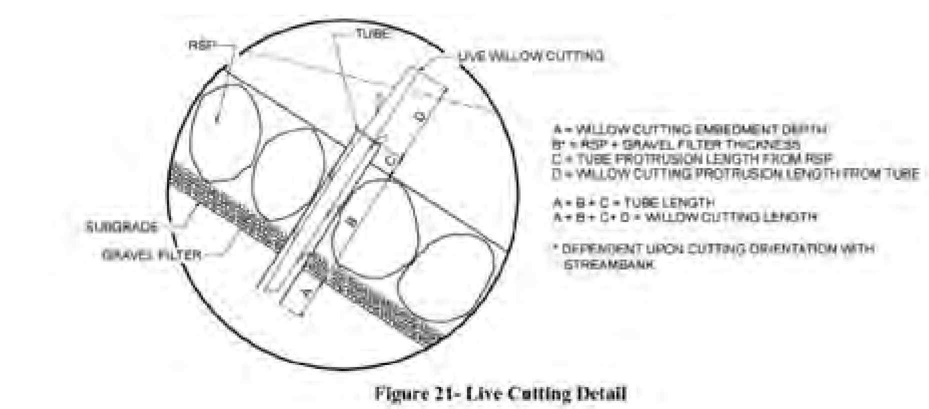
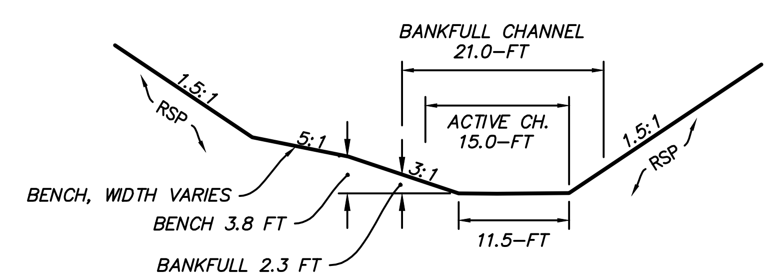


Figure 21- Live Cutting Detail

4 HYBRID RSP DETAIL
NTS



5 TYPICAL SECTION UNDER BRIDGE
NTS

Michael Love & Associates, Inc.
PO Box 4477• Arcata, CA 95518 • (707) 822-2411

DRAFT
30% DESIGN SUBMITTAL

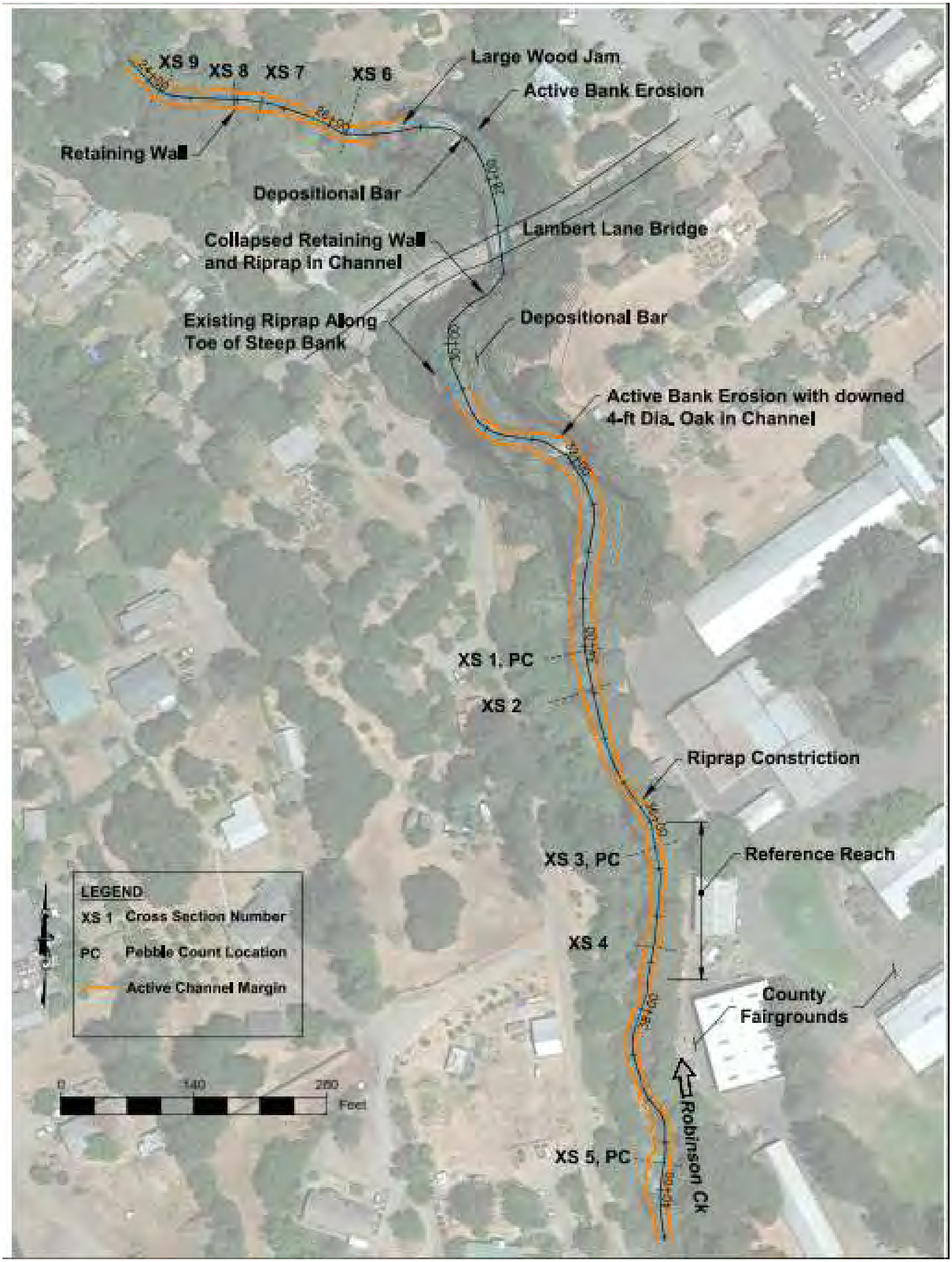
VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

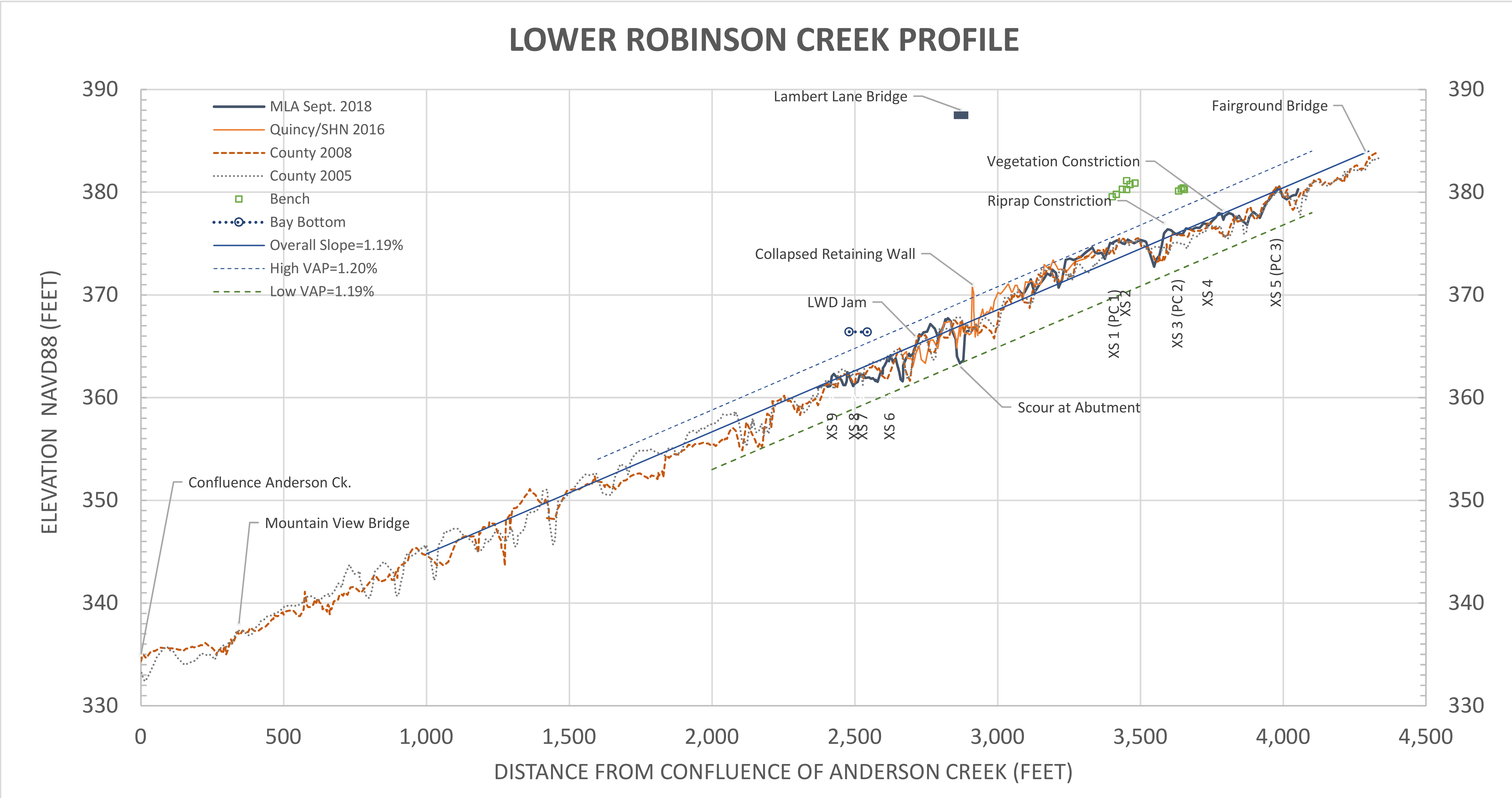
MENDOCINO COUNTY DEPARTMENT OF TRANSPORTATION
ROBINSON CREEK AT LAMBERT LANE
BOONEVILLE, CA

CHANNEL PROFILE AND TYPICAL RSP REVETMENT

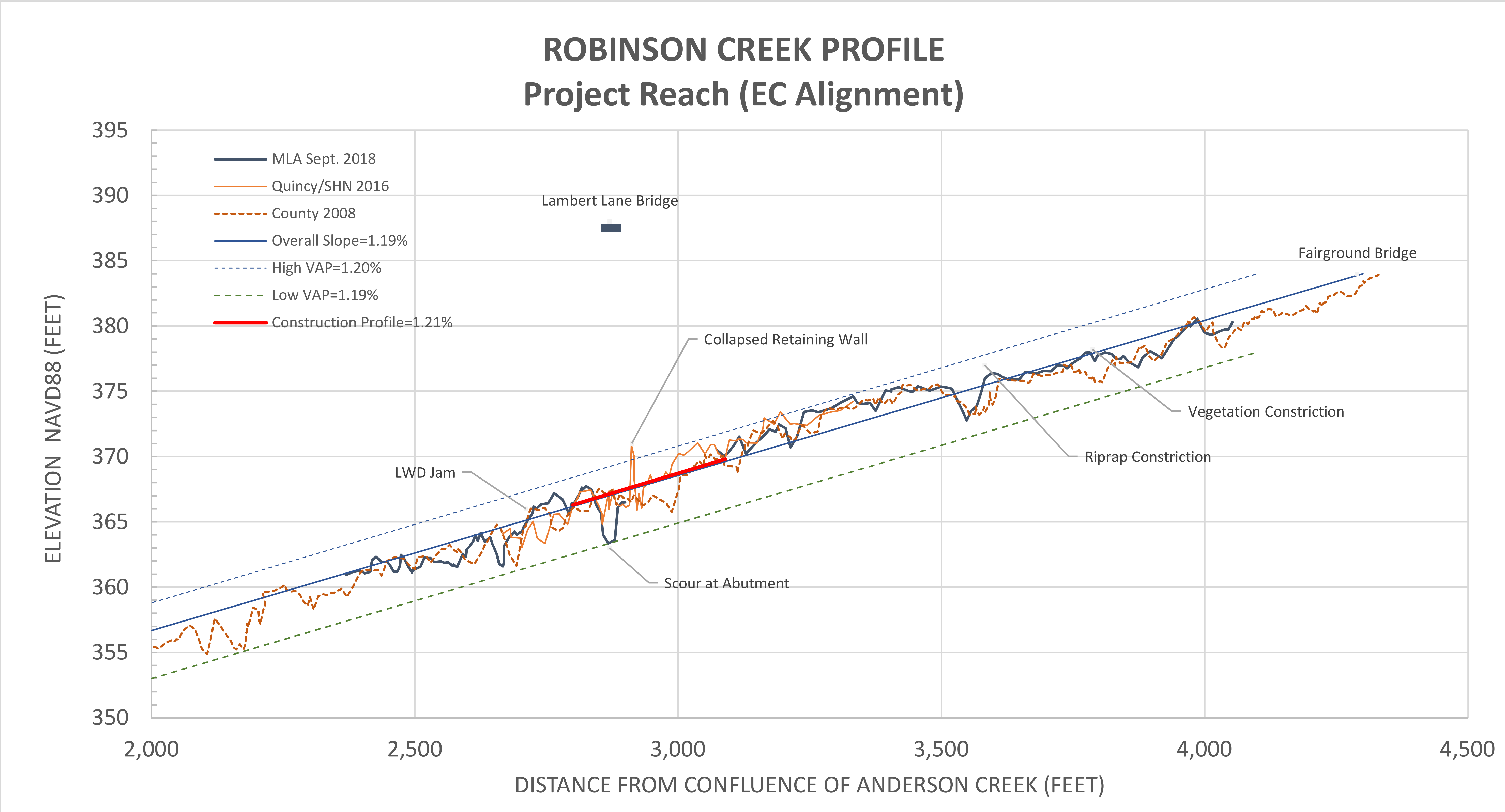
DATE	OCT. 2018
SUBMITTAL	30% DESIGN
DESIGN	AL, ML
DRAWN	LLANOS
SHEET	2 of 2

Appendix B - Geomorphic Field Data


XS 9
XS 8
XS 7
XS 6
Large Wood Jam
Active Bank Erosion
Retaining Wall
Depositional Bar
Lambert Lane Bridge
Collapsed Retaining Wall
and Riprap in Channel
Existing Riprap Along
Toe of Steep Bank
Depositional Bar
Active Bank Erosion with downed
4-ft Dia. Oak in Channel
XS 1, PC
XS 2
Riprap Constriction
XS 3, PC
Reference Reach
XS 4
County
Fairgrounds
Robinson Ck
XS 5, PC
LEGEND
XS 1 Cross Section Number
PC Pebble Count Location
Active Channel Margin
0
140
280
Feet



LOWER ROBINSON CREEK PROFILE
MLA Sept. 2018
Quincy/SHN 2016
County 2008
County 2005
Bench
Bay Bottom
Overall Slope=1.19%
High VAP=1.20%
Low VAP=1.19%
Lambert Lane Bridge
Fairground Bridge
Vegetation Constriction
Riprap Constriction
Collapsed Retaining Wall
LWD Jam
Scour at Abutment
Confluence Anderson Ck.
Mountain View Bridge
XS 1 (PC 1)
XS 2
XS 3 (PC 2)
XS 4
XS 5 (PC 3)
XS 9
XS 8
XS 7
XS 6
ELEVATION NAVD88 (FEET)
DISTANCE FROM CONFLUENCE OF ANDERSON CREEK (FEET)
390
380
370
360
350
340
330
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500


ROBINSON CREEK PROFILE
Project Reach (EC Alignment)
MLA Sept. 2018
Quincy/SHN 2016
County 2008
Overall Slope=1.19%
High VAP=1.20%
Low VAP=1.19%
Construction Profile=1.21%
Lambert Lane Bridge
Fairground Bridge
Collapsed Retaining Wall
LWD Jam
Scour at Abutment
Vegetation Constriction
Riprap Constriction
ELEVATION NAVD88 (FEET)
DISTANCE FROM CONFLUENCE OF ANDERSON CREEK (FEET)
395
390
385
380
375
370
365
360
355
350
2,000
2,500
3,000
3,500
4,000
4,500

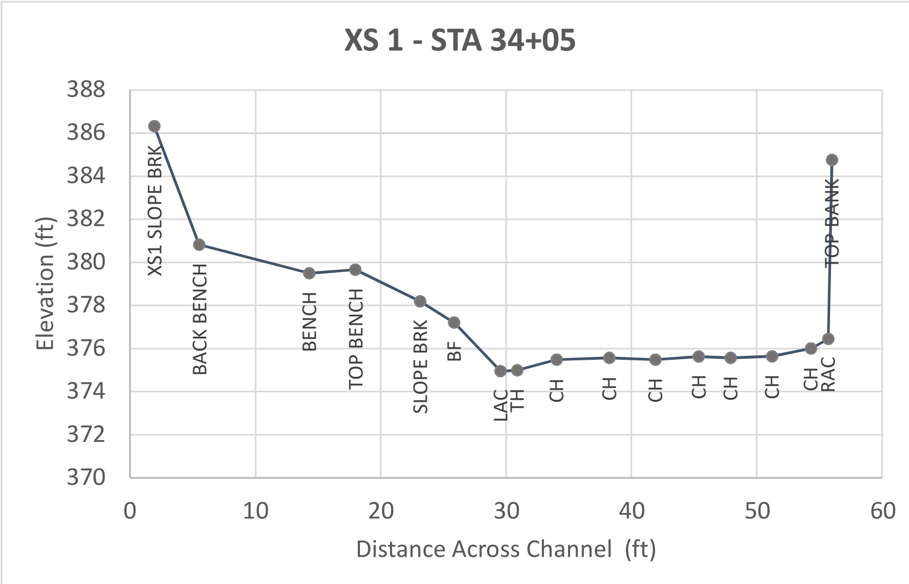
Robinson Creek Geomorphic Survey

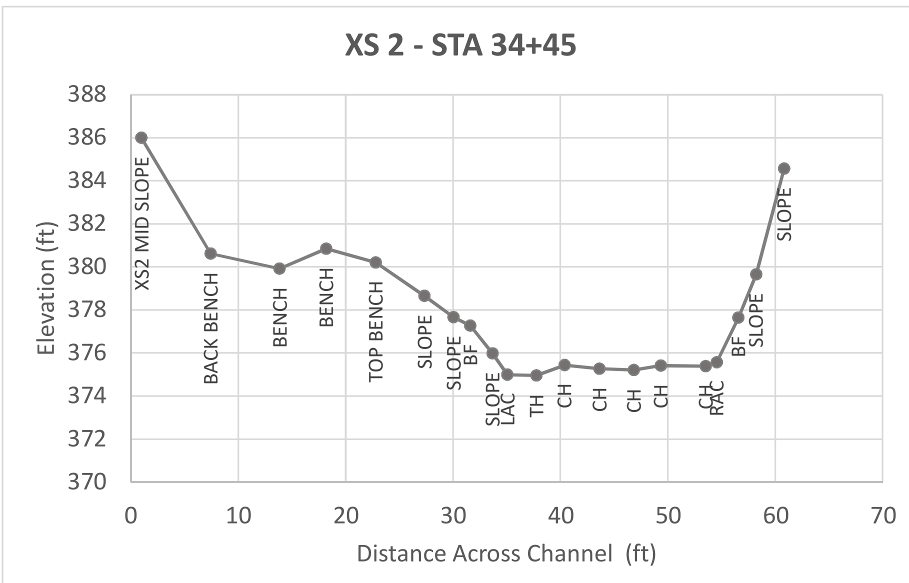
Spetember 12, 2018

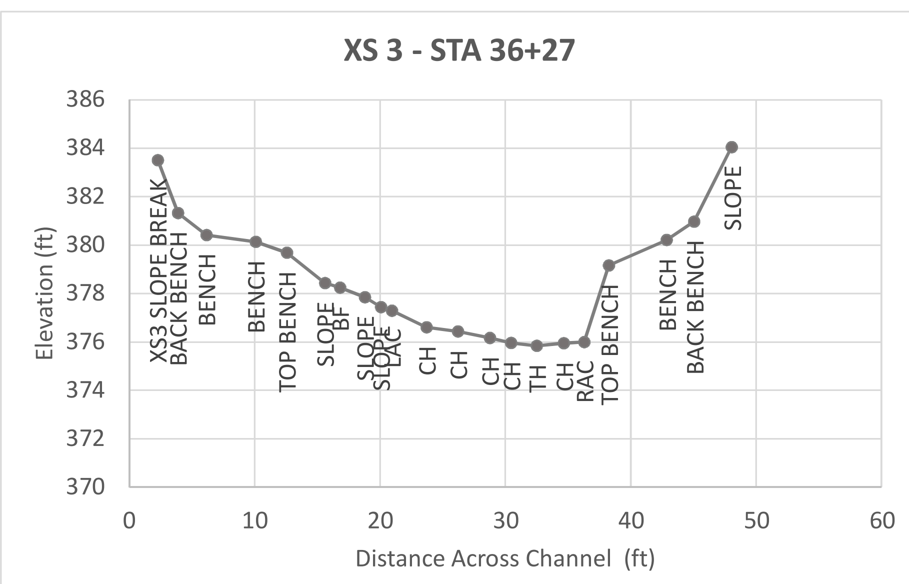
Cross Section Data

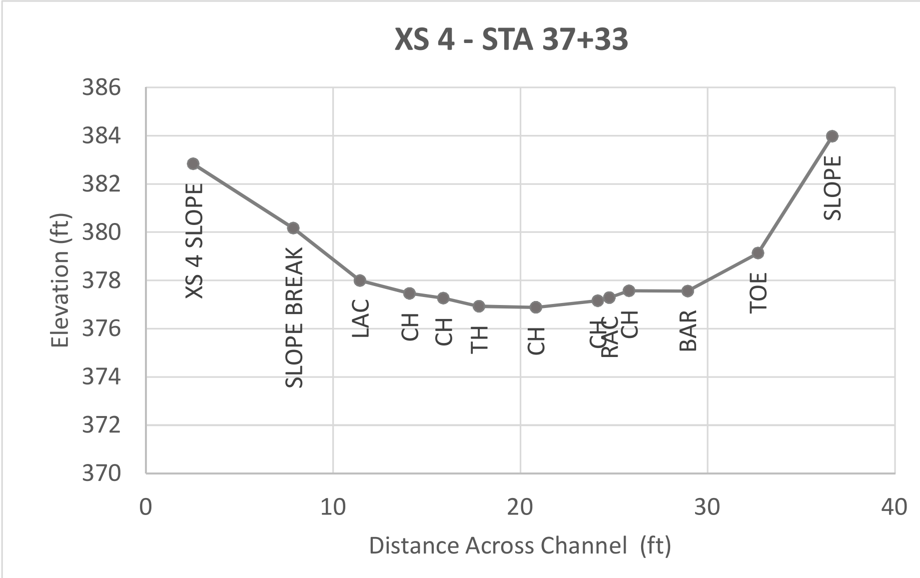
Upstream of Lambert Lane					
Cross Section Location		**BF Width (ft)**	**BF Depth (ft)**		**AC Width (ft)**
XS 1	STA 34+05	29.9	2.2		26.2
XS 2	STA 34+45	25.0	2.7	2.3	19.5
XS 3	STA 36+27	21.4	2.4		15.4
XS 4	STA 37+33	24.8	2.2		13.3
XS 5	STA 39+72	31.7	2.1		24.8
	Average:	**26.6**	**2.3**		**19.8**

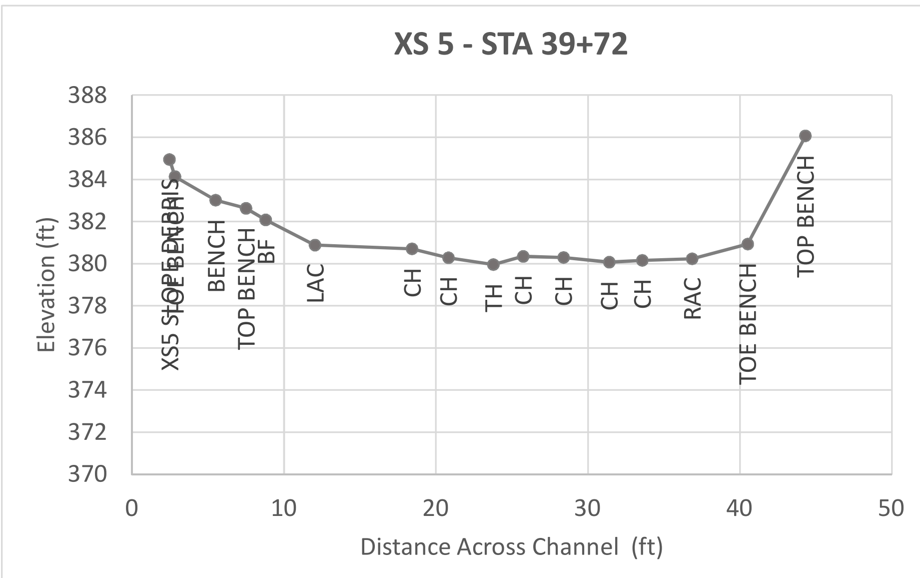
Downstream of Lambert Lane					
Cross Section Location		**BF Width (ft)**	**BF Depth (ft)**		**AC Width (ft)**
XS 9	STA 24+20	23.7	1.8	2.1	17.0
XS 8	STA 24+95	19.6			18.1
XS 7	STA25+25	25.0	2.3		19.7
XS 6	STA 26+20	28.8	2.6		19.6
	Average:	**24.3**	**2.2**		**18.6**

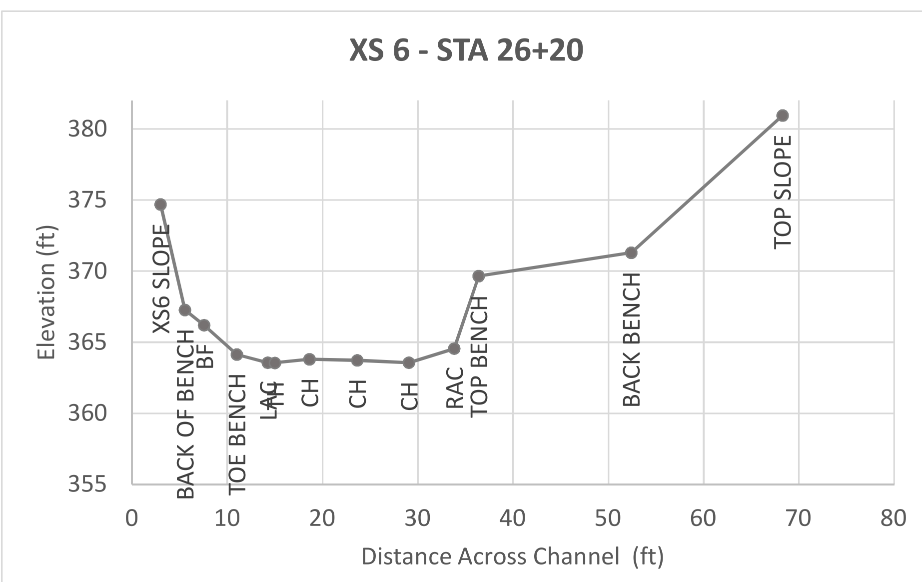

XS 1 - STA 34+05
Elevation (ft)
Distance Across Channel (ft)
XS1 SLOPE BRK
BACK BENCH
BENCH
TOP BENCH
SLOPE BRK
BF
LAC
TH
CH
RAC
TOP BANK

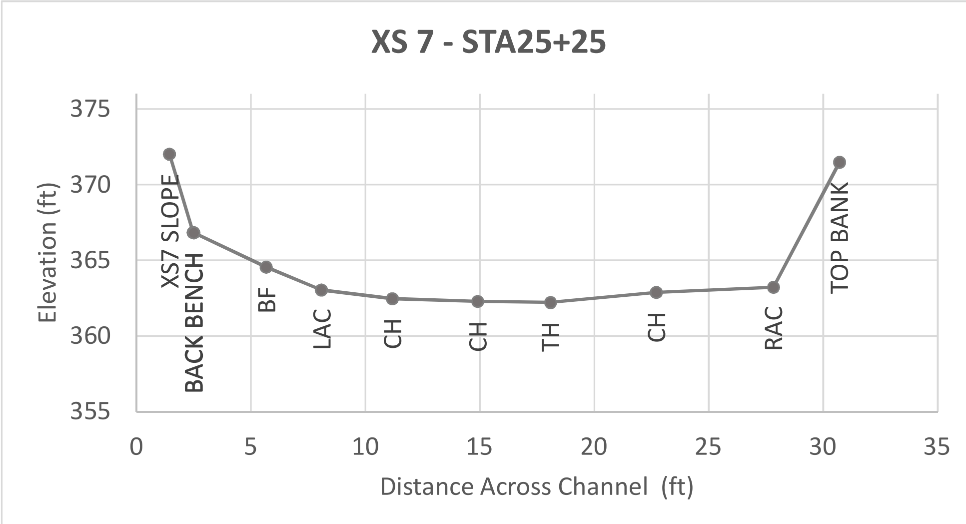

XS 2 - STA 34+45
Elevation (ft)
Distance Across Channel (ft)
XS2 MID SLOPE
BACK BENCH
BENCH
TOP BENCH
SLOPE
BF
LAC
TH
CH
RAC

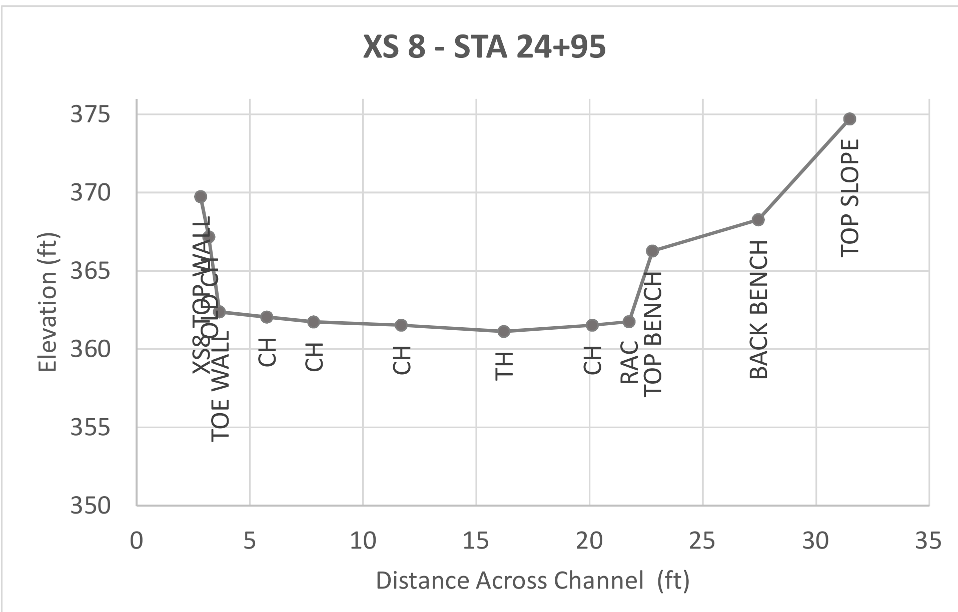

XS 3 - STA 36+27
Elevation (ft)
Distance Across Channel (ft)
XS3 SLOPE BREAK
BACK BENCH
BENCH
TOP BENCH
SLOPE
BF
LAC
CH
TH
RAC

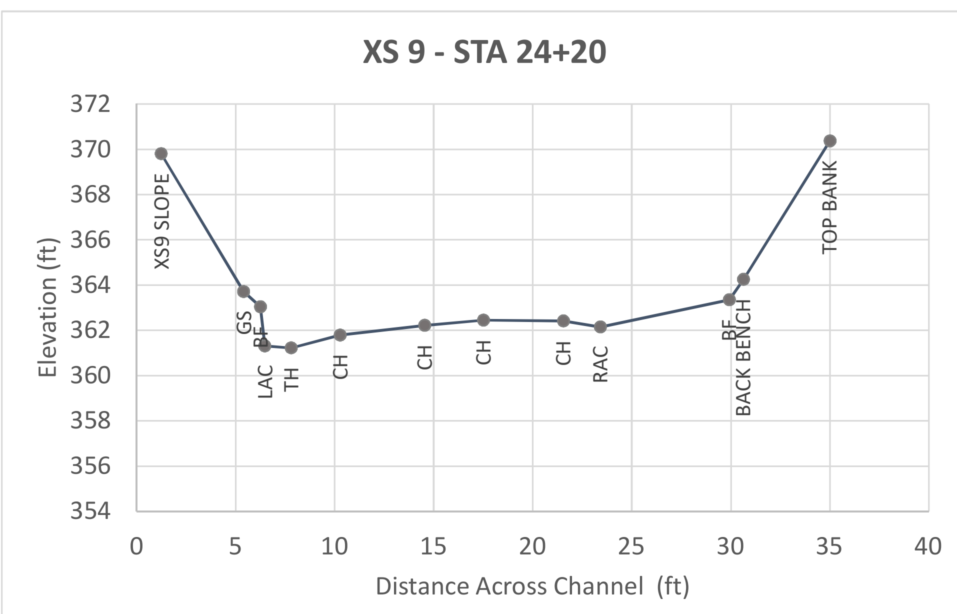

XS 4 - STA 37+33
Elevation (ft)
Distance Across Channel (ft)
XS 4 SLOPE
SLOPE BREAK
LAC
CH
CH
TH
CH
CH
RAC
CH
BAR
TOE
SLOPE

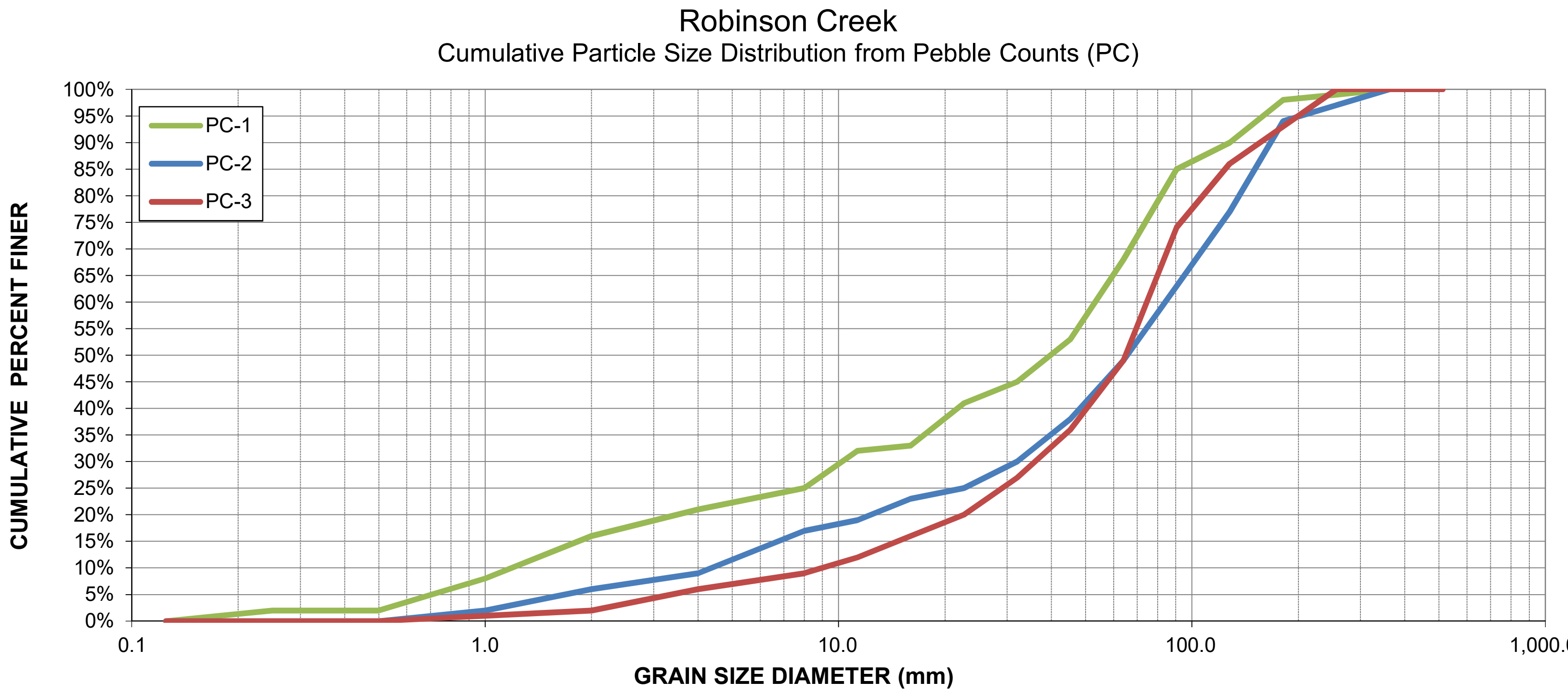

XS 5 - STA 39+72
Elevation (ft)
Distance Across Channel (ft)
BENCH
TOP BENCH
BF
LAC
CH
CH
TH
CH
CH
CH
CH
RAC
TOE BENCH
TOP BENCH


XS 6 - STA 26+20
Elevation (ft)
Distance Across Channel (ft)
XS6 SLOPE
BACK OF BENCH
BF
TOE BENCH
CH
CH
CH
RAC
TOP BENCH
BACK BENCH
TOP SLOPE

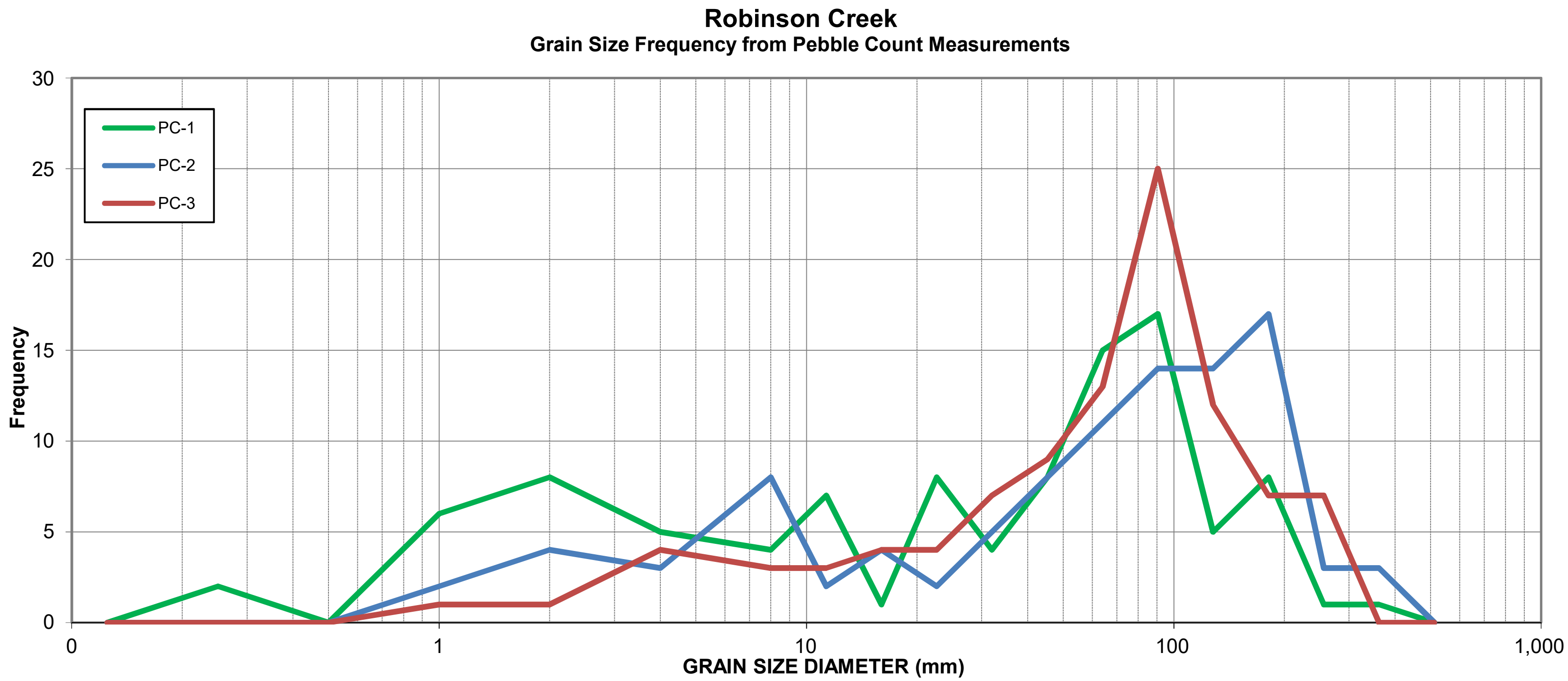

XS 7 - STA25+25
Elevation (ft)
Distance Across Channel (ft)
XS7 SLOPE
BACK BENCH
BF
LAC
CH
CH
TH
CH
RAC
TOP BANK
375
370
365
360
355
0
5
10
15
20
25
30
35


XS 8 - STA 24+95
Elevation (ft)
Distance Across Channel (ft)
XS8 TOP WALL
OLD CH
TOE WALL
CH
CH
CH
TH
CH
RAC
TOP BENCH
BACK BENCH
TOP SLOPE
375
370
365
360
355
350
0
5
10
15
20
25
30
35


XS 9 - STA 24+20
Elevation (ft)
Distance Across Channel (ft)
XS9 SLOPE
GS
BF
LAC
TH
CH
CH
CH
CH
RAC
BF
BACK BENCH
TOP BANK
372
370
368
366
364
362
360
358
356
354
0
5
10
15
20
25
30
35
40



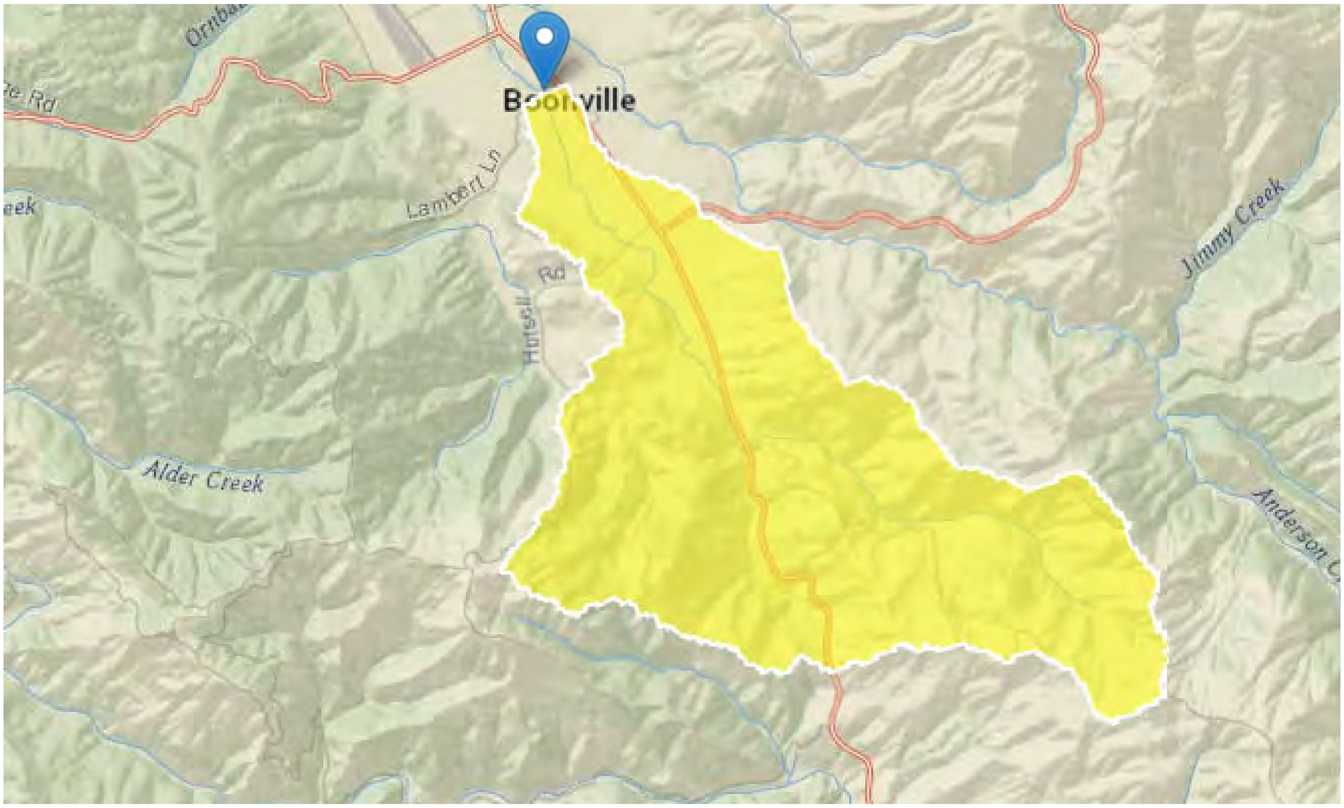
Robinson Creek
Cumulative Particle Size Distribution from Pebble Counts (PC)
PC-1
PC-2
PC-3
CUMULATIVE PERCENT FINER
GRAIN SIZE DIAMETER (mm)
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
0.1
1.0
10.0
100.0
1,000.0


Robinson Creek
Grain Size Frequency from Pebble Count Measurements
PC-1
PC-2
PC-3
Frequency
30
25
20
15
10
5
0
0
1
10
100
1,000
GRAIN SIZE DIAMETER (mm)

Appendix C – Hydrology

Robinson Creek at Lambert Lane Boonville, CA

Region ID: CA
Workspace ID: CA20180907194531373000
Clicked Point (Latitude, Longitude): 39.00833, -123.36844
Time: 2018-09-07 12:45:47 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BASINPERIM	Perimeter of the drainage basin as defined in SIR 2004-5262	14.2	thousand feet
BSLDEM30M	Mean basin slope computed from 30 m DEM	23.2	percent
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	-2314707.3	feet
CENTROIDY	Basin centroid vertical (y) location in state plane units	2108387.3	feet

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	4	square miles
EL6000	Percent of area above 6000 ft		percent
ELEV	Mean Basin Elevation	881	feet
ELEVMAX	Maximum basin elevation		feet
FOREST	Percentage of area covered by forest	18.5	percent
JANMAXTMP	Mean Maximum January Temperature	56.41	degrees F
JANMINTMP	Mean Minimum January Temperature	37.58	degrees F
LAKEAREA	Percentage of Lakes and Ponds		percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24		percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset		percent
LFPLENGTH	Length of longest flow path		miles
MINBELEV	Minimum basin elevation		feet
OUTLETELEV	Elevation of the stream outlet in thousands of feet above NAVD88.	375	feet
PRECIP	Mean Annual Precipitation	44.2	inches
RELIEF	Maximum - minimum elevation		feet
RELRELF	Basin relief divided by basin perimeter		feet per mi

Peak-Flow Statistics Parameters [2012 5113 Region 1 North Coast]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	4	square miles	0.04	3200
PRECIP	Mean Annual Precipitation	44.2	inches	20	125

Peak-Flow Statistics Flow Report [2012 5113 Region 1 North Coast]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	264	ft^3/s	108	645	58.6
5 Year Peak Flood	517	ft^3/s	247	1080	47.4
10 Year Peak Flood	700	ft^3/s	347	1410	44.2
25 Year Peak Flood	943	ft^3/s	482	1850	42.7
50 Year Peak Flood	1130	ft^3/s	576	2220	42.7
100 Year Peak Flood	1320	ft^3/s	659	2660	44.3
200 Year Peak Flood	1510	ft^3/s	748	3040	44.4
500 Year Peak Flood	1760	ft^3/s	851	3630	46

Peak-Flow Statistics Citations

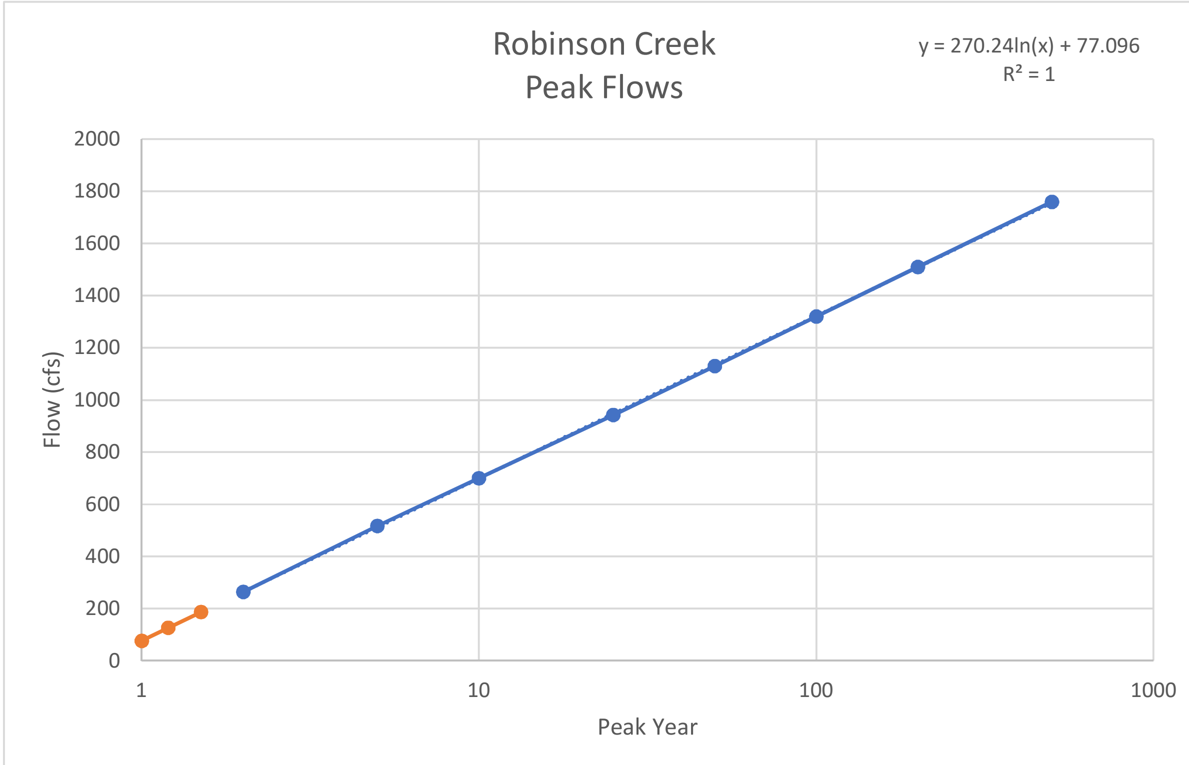
Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles,2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl. (http://pubs.usgs.gov/sir/2012/5113/)

Application Version: 4.2.1

Flood Frequency

Robinson Creek at Lambert Lane

	DA (sq mi)=	4
	PK (year)	Q (cfs)
Extrapolated	1	77
	1.2	126
	1.5	187
Streamstats	2	264
	5	517
	10	700
	25	943
	50	1130
	100	1320
	200	1510
	500	1760



Appendix D - HEC RAS Results

Manning's Roughness Calculations

Robinson Creek at Lambert Lane

CALTRANS. 2014. Hybrid Streambank Revetments: Vegetated Rock Slope Protection. State of California Department of Transportation Design Information Bulletin. DIB 87-0.1

$$n_c = (n_0+n_1+n_2+n_3+n_4)\, m_5$$

n_c= main channel effective roughness value

Post Project "As-Built Conditon"

<u>Hybrid RSP revetment after construction with newly planted vegetation</u>

Main Channnel Bed and Bank Surface Material	Reevaluated n_o=	0.028	Coarse Rock
Channel Degree of Irregularity	Reevaluated n_1=	0.005	Slightly Eroded banks or bed
Channel Cross Section Variation	n_2=	0.005	Thalweg Alternates sides
Main Channel Relative Effect of Obstructions	n_3=	0.000	No obstructions
Main Channel Vegetation Density	Reevaluated n_4=	0.005	Low vegetation Denisty
Channel Degree of Meandering	m_5=	1.000	Sinuosity of 1.2

n_c= 0.043

Post Project "Full Grow Out Conditon"

<u>Hybrid RSP revetment with mature vegetation</u>

Main Channnel Bed and Bank Surface Material	Reevaluated n_o=	0.028	Coarse Rock
Channel Degree of Irregularity	Reevaluated n_1=	0.000	SmoothBanks
Channel Cross Section Variation	n_2=	0.005	Thalweg Alternates sides
Main Channel Relative Effect of Obstructions	n_3=	0.010	Obstruction <15% of XS from debris
Main Channel Vegetation Density	Reevaluated n_4=	0.065	Dense Willows
Channel Degree of Meandering	m_5=	1.000	Sinuosity of 1.2

n_c= 0.108

<u>Channel Bed</u>

Main Channnel Bed and Bank Surface Material	Reevaluated n_o=	0.028	Coarse Rock
Channel Degree of Irregularity	Reevaluated n_1=	0.000	SmoothBanks
Channel Cross Section Variation	n_2=	0.005	Thalweg Alternates sides
Main Channel Relative Effect of Obstructions	n_3=	0.010	Obstruction <15% of XS from debris
Main Channel Vegetation Density	Reevaluated n_4=	0.000	No vegetationin Channel
Channel Degree of Meandering	m_5=	1.000	Sinuosity of 1.2

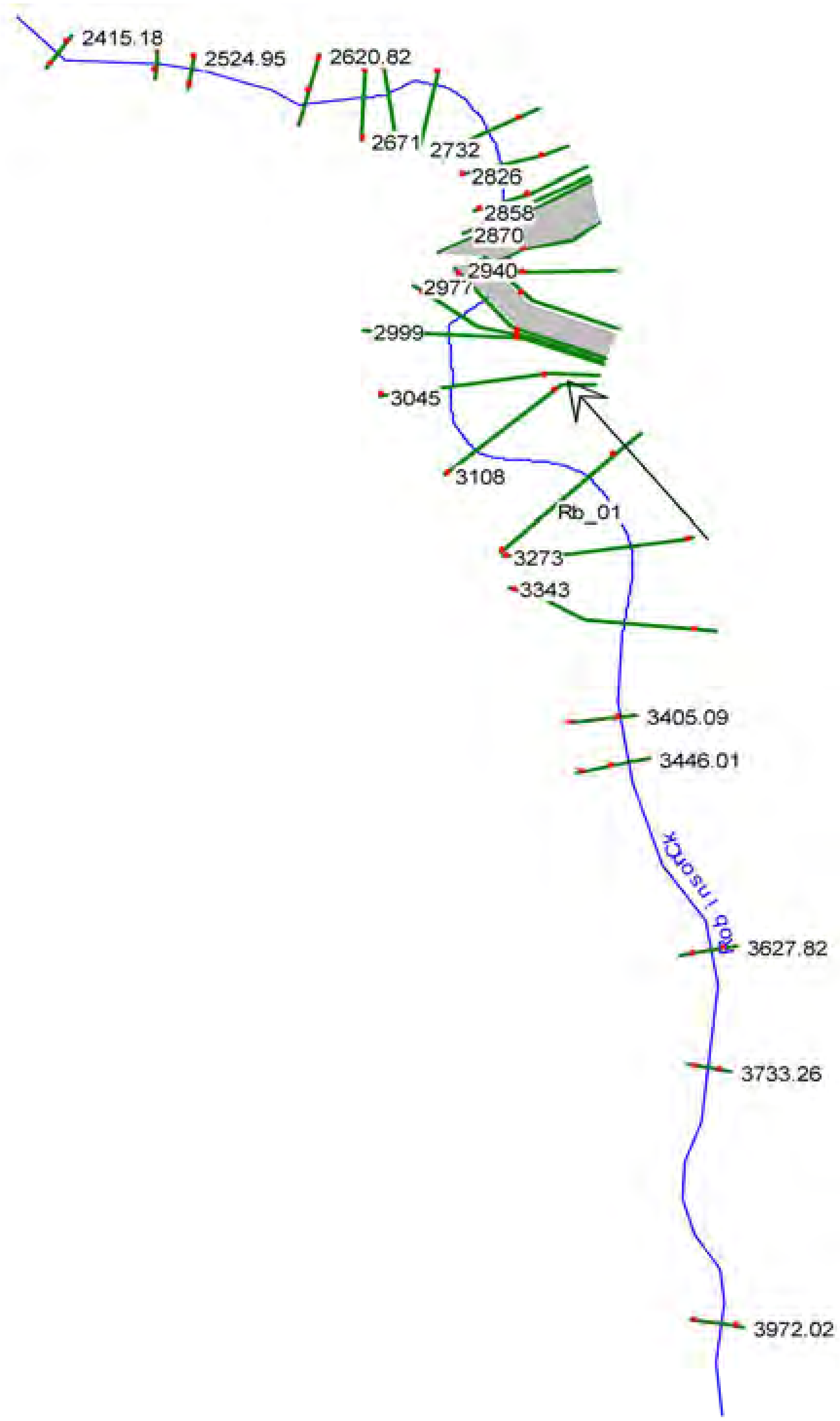
n_c= 0.043

<u>Native Planting Areas</u>

Main Channnel Bed and Bank Surface Material	Reevaluated n_o=	0.02	Earth and sand
Channel Degree of Irregularity	Reevaluated n_1=	0.005	Slightly eroded banks
Channel Cross Section Variation	n_2=	0.005	Thalweg Alternates sides
Main Channel Relative Effect of Obstructions	n_3=	0.010	Obstruction <15% of XS from debris
Main Channel Vegetation Density	Reevaluated n_4=	0.040	Native Trees with wide spacing
Channel Degree of Meandering	m_5=	1.000	Sinuosity of 1.2

n_c= 0.08

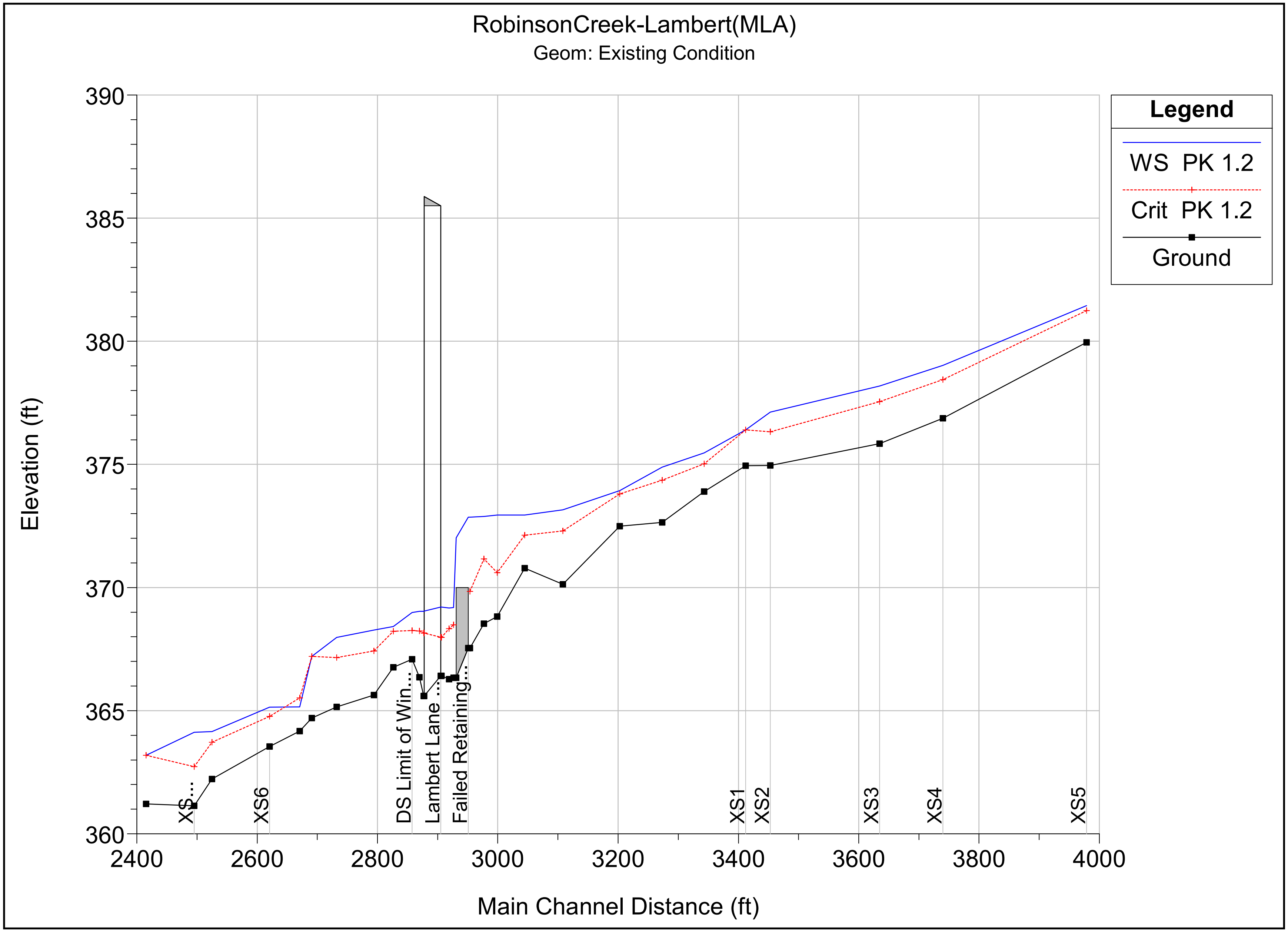
Robinson Creek at Lambert Lane Bridge
HEC-RAS Reults for Existing Channel



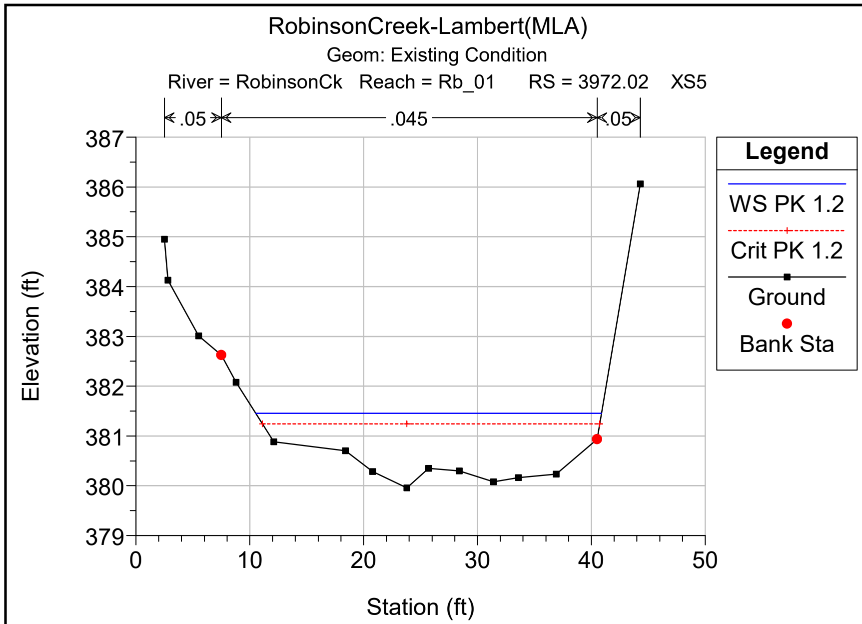
Robinson Creek at Lambert Lane Bridge
HEC-RAS Reults for Existing Channel

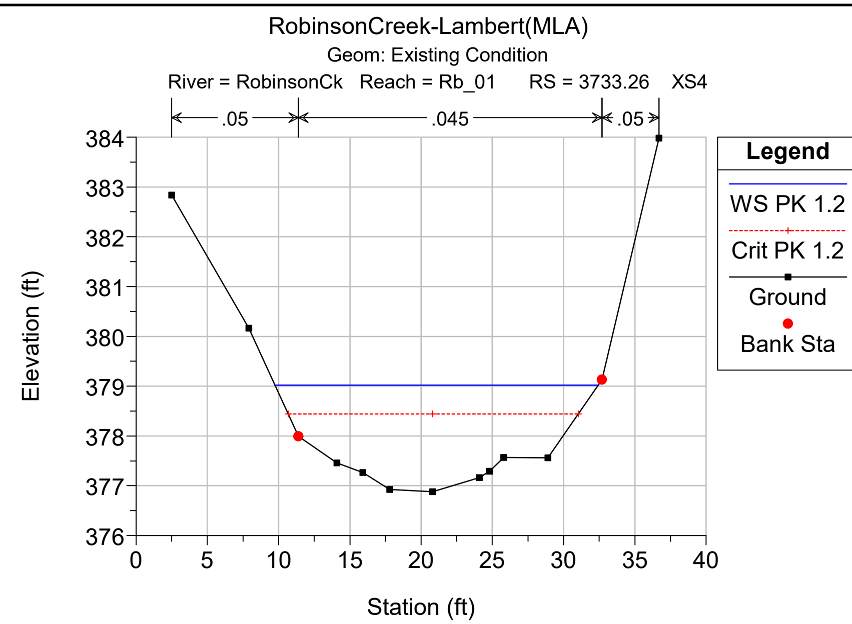
Profile = Q1.2
Q Total (cfs) = 126

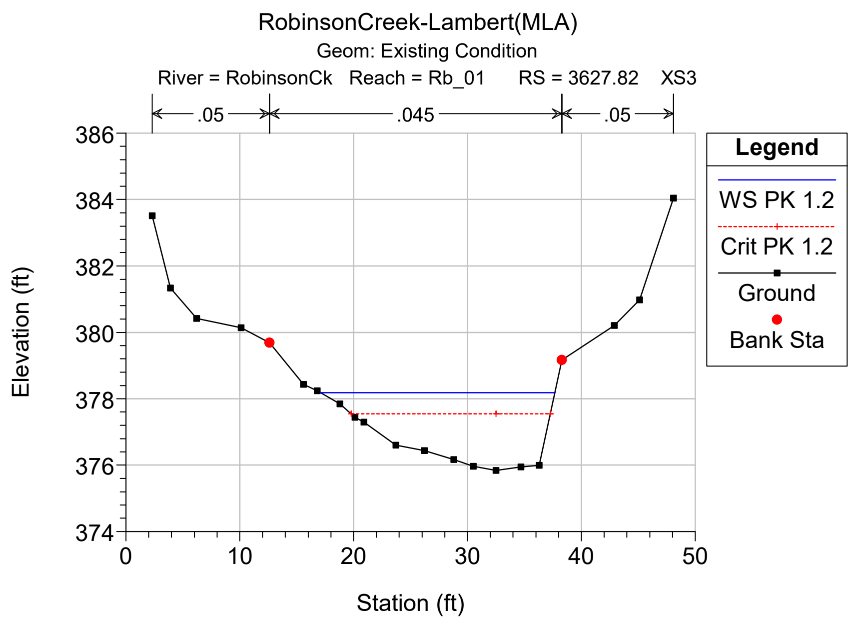
River Sta	Description	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Depth of Flow (ft)
3972.02		379.96	381.45	381.24	381.72	0.015676	4.15	30.47	30.36	0.73	1.49
3733.26		376.88	379.02	378.44	379.24	0.007335	3.77	33.94	22.7	0.53	2.14
3627.82		375.85	378.19	377.55	378.42	0.008272	3.89	32.43	20.59	0.55	2.34
3446.01		374.96	377.12	376.33	377.27	0.004788	3.1	40.59	24.26	0.42	2.16
3405.09		374.95	376.4	376.4	376.83	0.032602	5.26	23.95	28.35	1.01	1.45
3343.00		373.90	375.46	375.02	375.65	0.008308	3.44	36.65	29.42	0.54	1.56
3273.00		372.65	374.89	374.36	375.09	0.007769	3.57	35.3	25.33	0.53	2.24
3203.00		372.49	373.93	373.8	374.24	0.020368	4.43	28.41	30.74	0.81	1.44
3108.00		370.13	373.15	372.3	373.32	0.005267	3.32	37.92	21.7	0.44	3.02
3045.00		370.79	372.94	372.13	373.04	0.003381	2.51	50.25	32.94	0.36	2.15
2999.00		368.82	372.95	370.6	372.97	0.000435	1.29	98.02	36.87	0.14	4.13
2977.00		368.53	372.88	371.16	372.95	0.001988	2.08	60.5	24.36	0.23	4.35
2954.00		367.54	372.85	369.84	372.92	0.000951	2.03	62.09	17.01	0.19	5.31
2940.00	Inl Struct										0.00
2926.00		366.34	369.19	368.48	369.56	0.010128	4.94	25.53	11.87	0.59	2.85
2919.00		366.28	369.17	368.33	369.45	0.007328	4.24	29.71	14.3	0.52	2.89
2906.00		366.41	369.21	367.98	369.32	0.002047	2.68	47.01	21.23	0.32	2.80
2891.00	Bridge										0.00
2877.00		365.60	369.04	368.16	369.21	0.003938	3.38	37.3	20.63	0.44	3.44
2870.00		366.36	369.03	368.24	369.16	0.004169	2.88	43.78	26.39	0.39	2.67
2858.00		367.09	368.98	368.25	369.11	0.004583	2.79	45.1	31.55	0.41	1.89
2826.00		366.76	368.42	368.23	368.78	0.018333	4.79	26.28	22.98	0.79	1.66
2794.00		365.63	368.27	367.43	368.39	0.006085	2.78	45.28	31.93	0.41	2.64
2732.00		365.15	367.97	367.16	368.09	0.004037	2.69	46.82	30.13	0.38	2.82
2691.00		364.70	367.21	367.21	367.68	0.034574	5.5	22.9	25.35	1.02	2.51
2671.00		364.17	365.15	365.52	366.35	0.149476	8.78	14.36	24.97	2.04	0.98
2620.82		363.55	365.15	364.77	365.39	0.010655	3.95	31.91	24.78	0.61	
2524.95		362.23	364.15	363.71	364.41	0.009677	4.08	30.98	21.79	0.6	
2495.47		361.13	364.12	362.73	364.23	0.002547	2.72	46.38	18.76	0.3	
2415.18		361.22	363.19	363.19	363.69	0.034012	5.69	22.14	22.91	1.02	

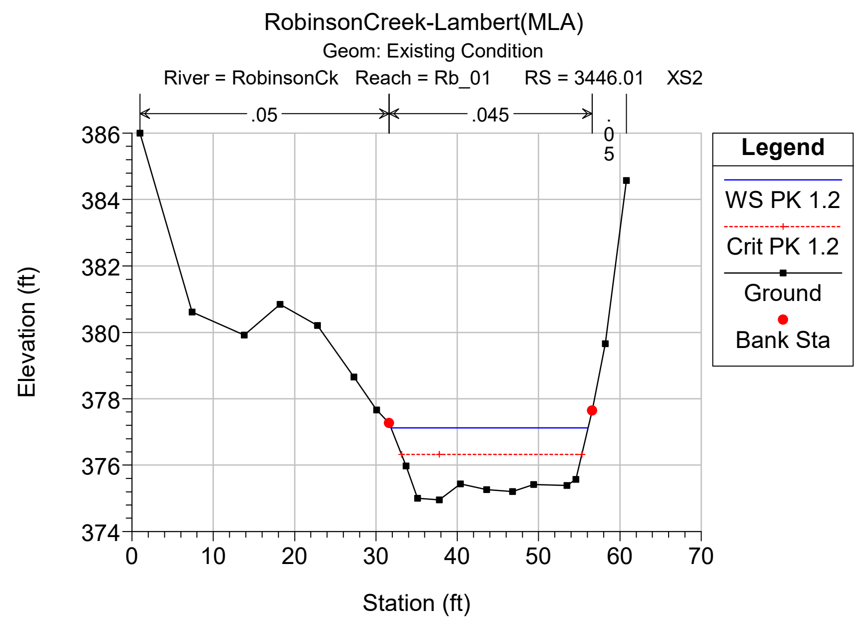


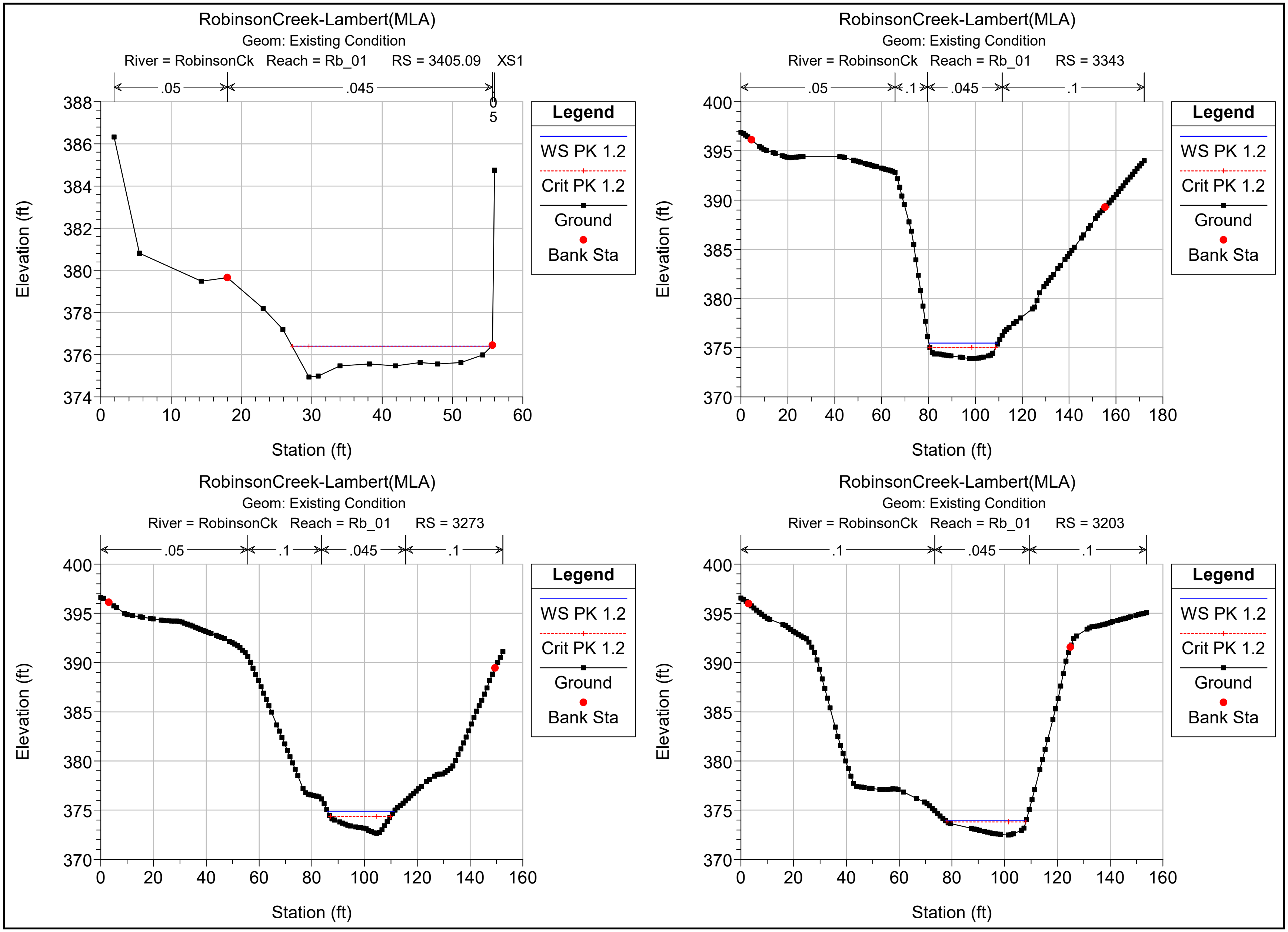
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
Legend
WS PK 1.2
Crit PK 1.2
Ground
Elevation (ft)
Main Channel Distance (ft)
390
385
380
375
370
365
360
2400
2600
2800
3000
3200
3400
3600
3800
4000
XS...
XS6
DS Limit of Win...
Lambert Lane ...
Failed Retaining...
XS1
XS2
XS3
XS4
XS5

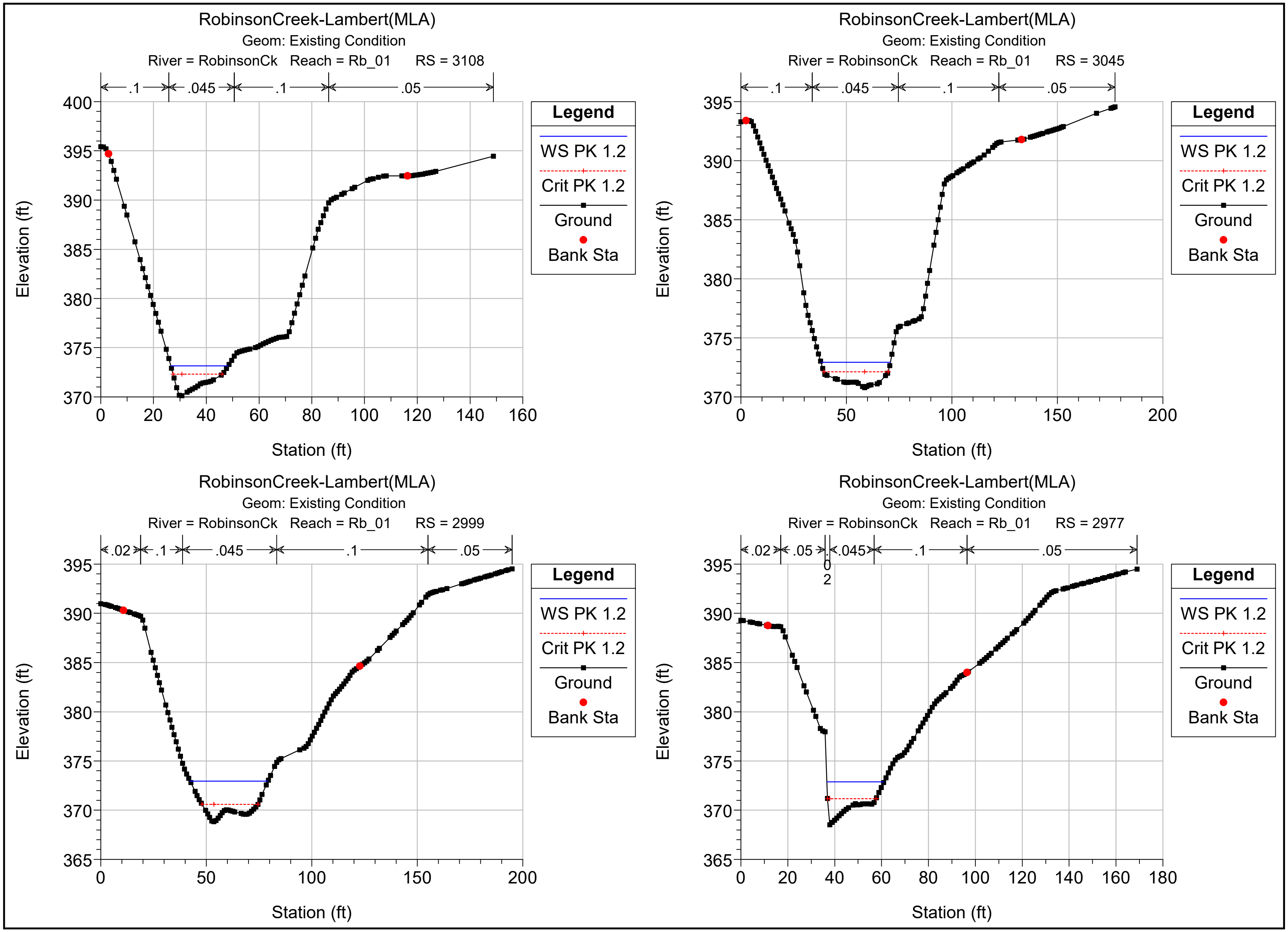

RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3972.02 XS5
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta

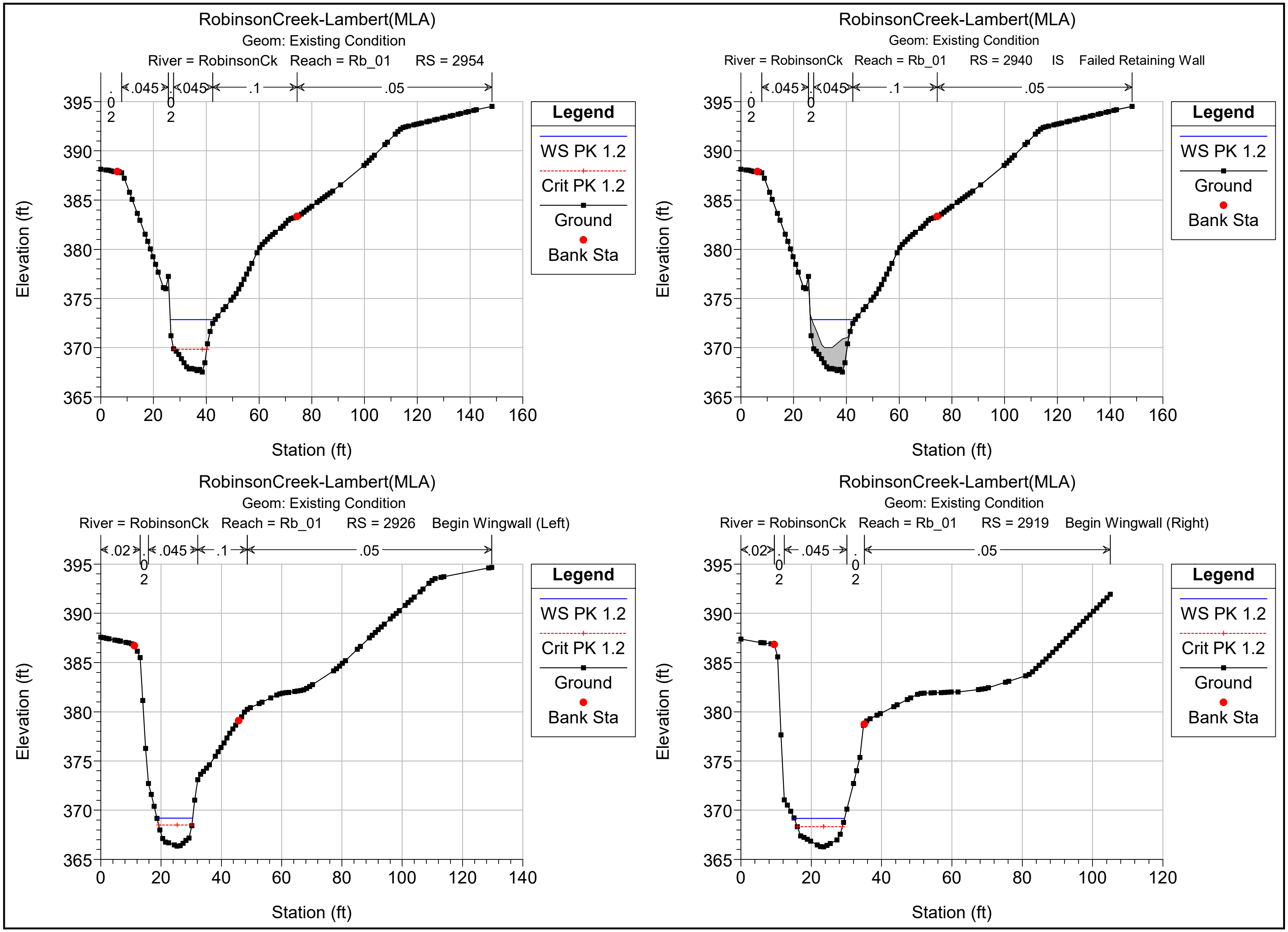

RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3733.26 XS4
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta


RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3627.82 XS3
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta

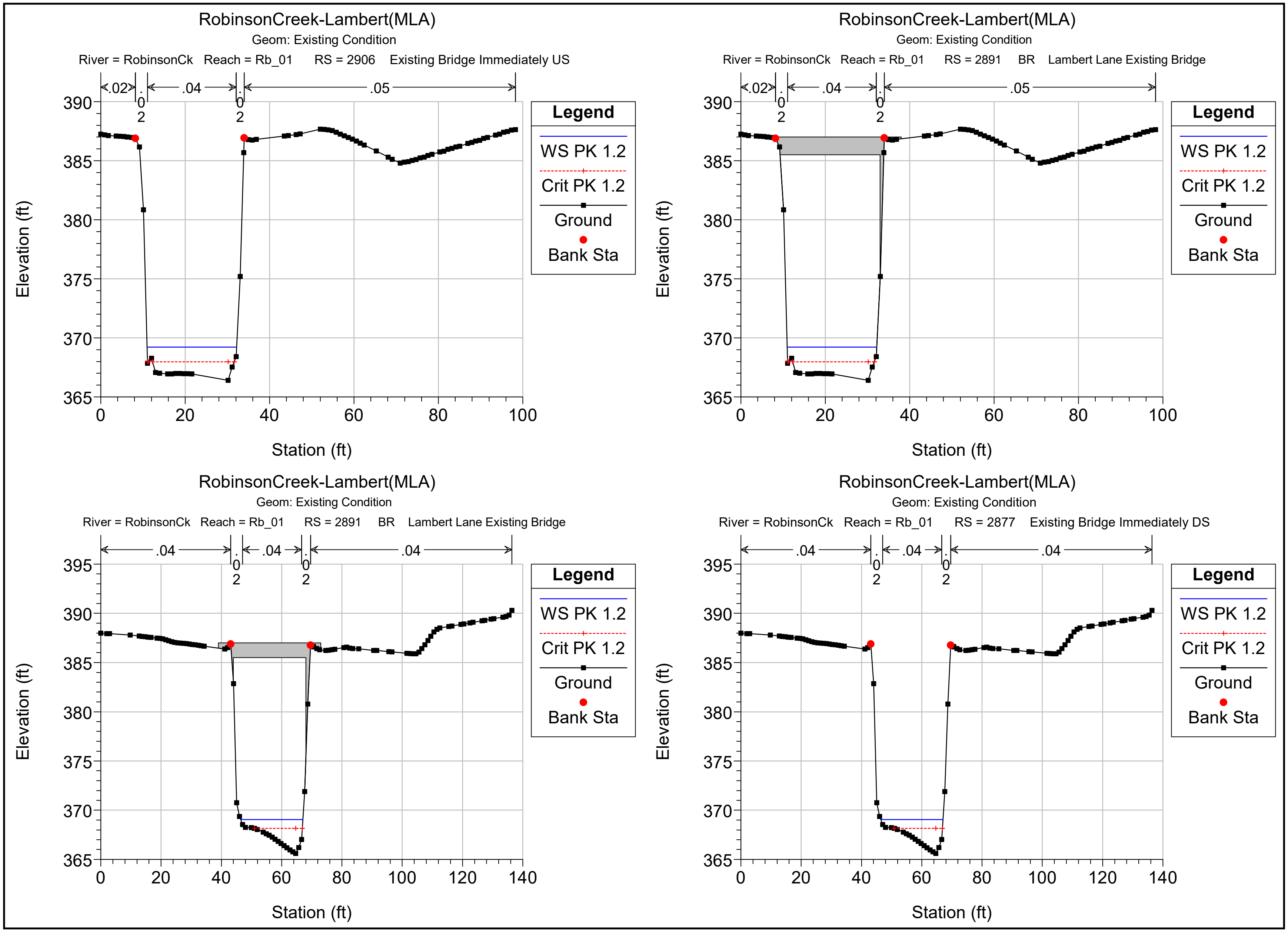

RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3446.01 XS2
.05
.045
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta


RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3405.09 XS1
.05
.045
0
5
Elevation (ft)
388
386
384
382
380
378
376
374
0
10
20
30
40
50
60
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3343
.05
.1
.045
.1
Elevation (ft)
400
395
390
385
380
375
370
0
20
40
60
80
100
120
140
160
180
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3273
.05
.1
.045
.1
Elevation (ft)
400
395
390
385
380
375
370
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3203
.1
.045
.1
Elevation (ft)
400
395
390
385
380
375
370
0
20
40
60
80
100
120
140
160
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta

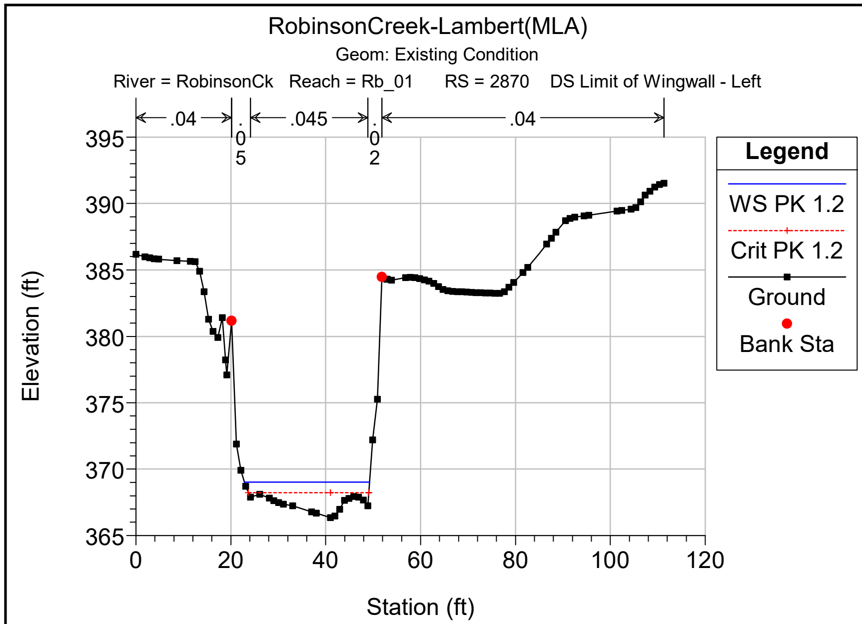

RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3108
.1 .045 .1 .05
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 3045
.1 .045 .1 .05
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2999
.02 .1 .045 .1 .05
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2977
.02 .05 0 2 .045 .1 .05
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta

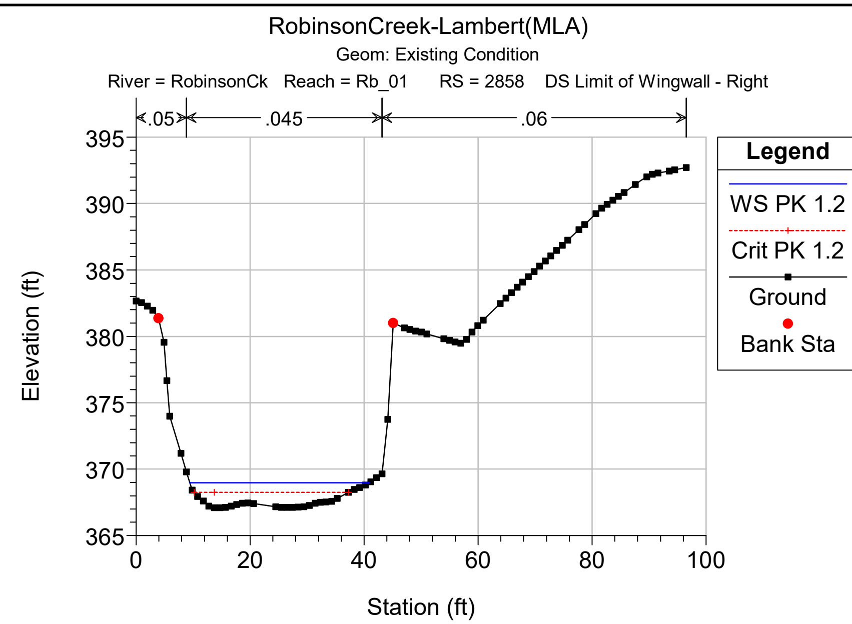


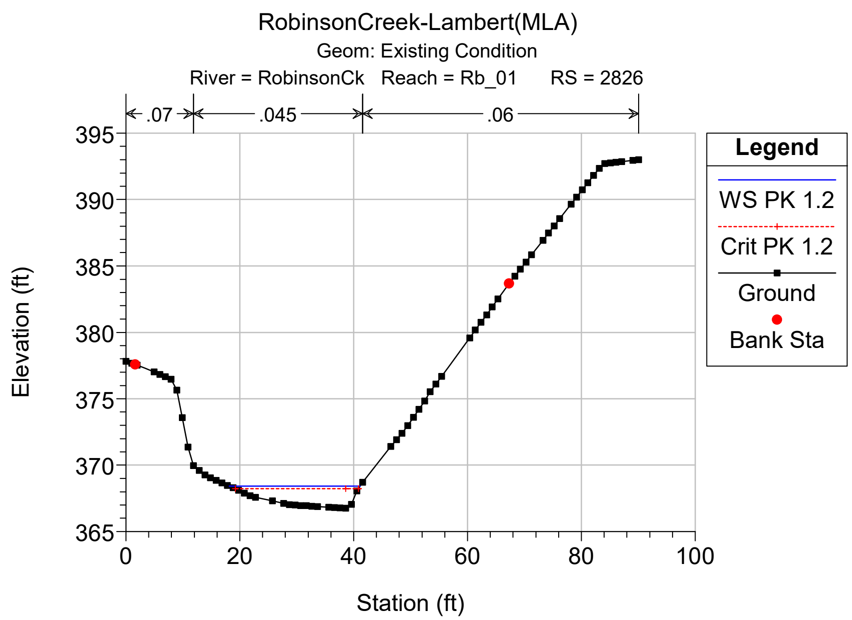
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2954
.045 .045 .1 .05
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2940 IS Failed Retaining Wall
.045 .045 .1 .05
Legend
WS PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2926 Begin Wingwall (Left)
.02 .045 .1 .05
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2919 Begin Wingwall (Right)
.02 .045 .05
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)

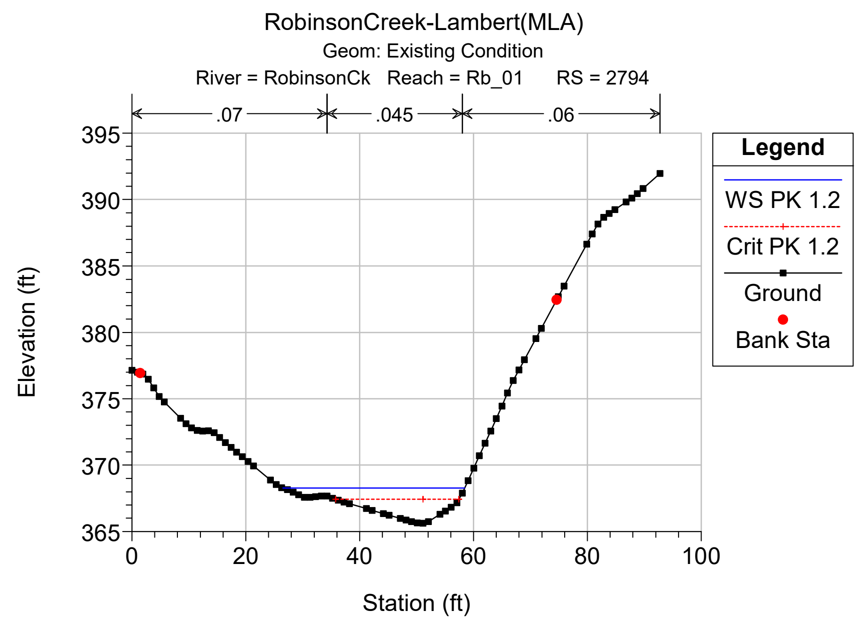


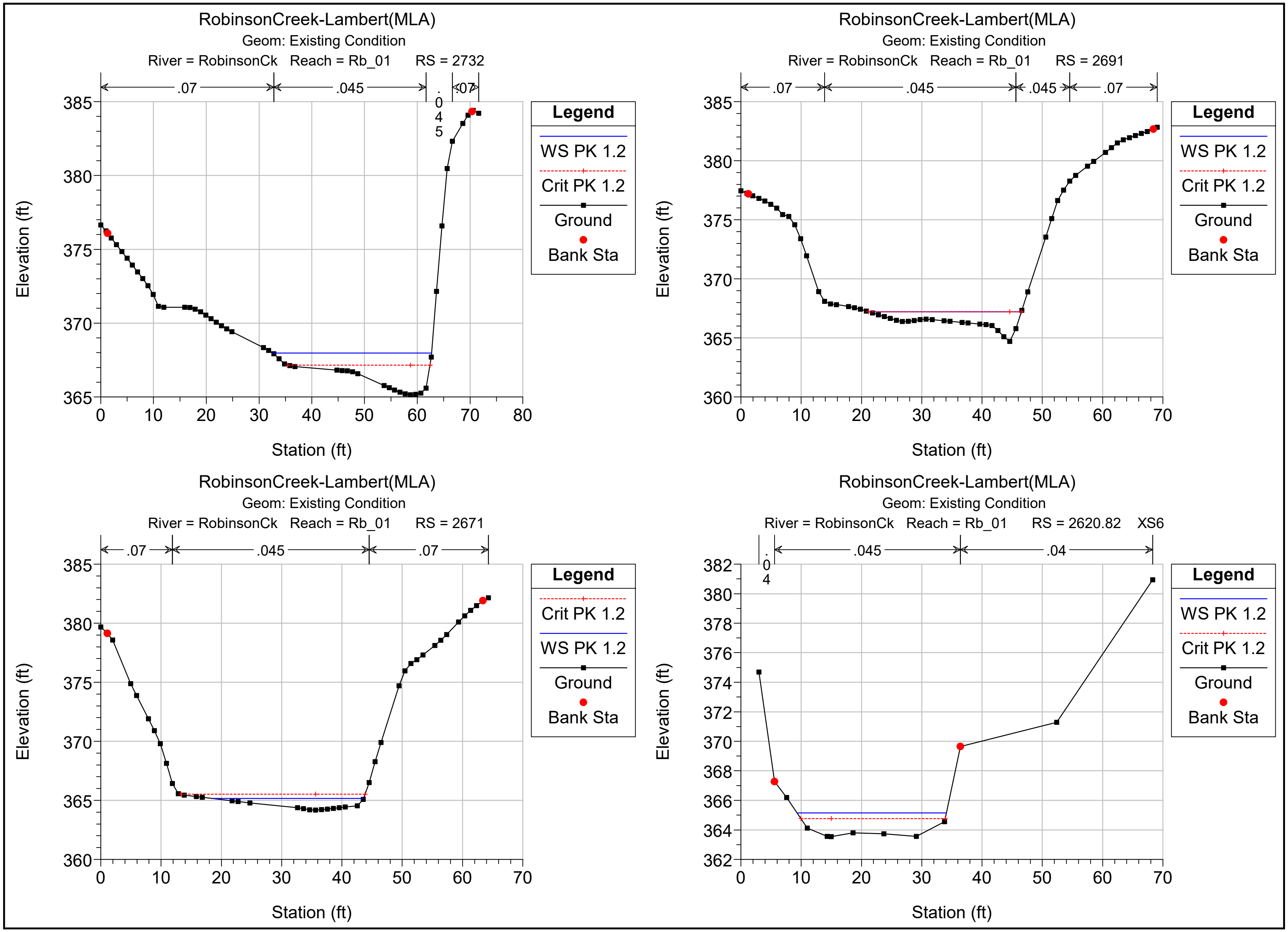
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2906 Existing Bridge Immediately US
.02
.04
.05
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2891 BR Lambert Lane Existing Bridge
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2891 BR Lambert Lane Existing Bridge
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2877 Existing Bridge Immediately DS
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)

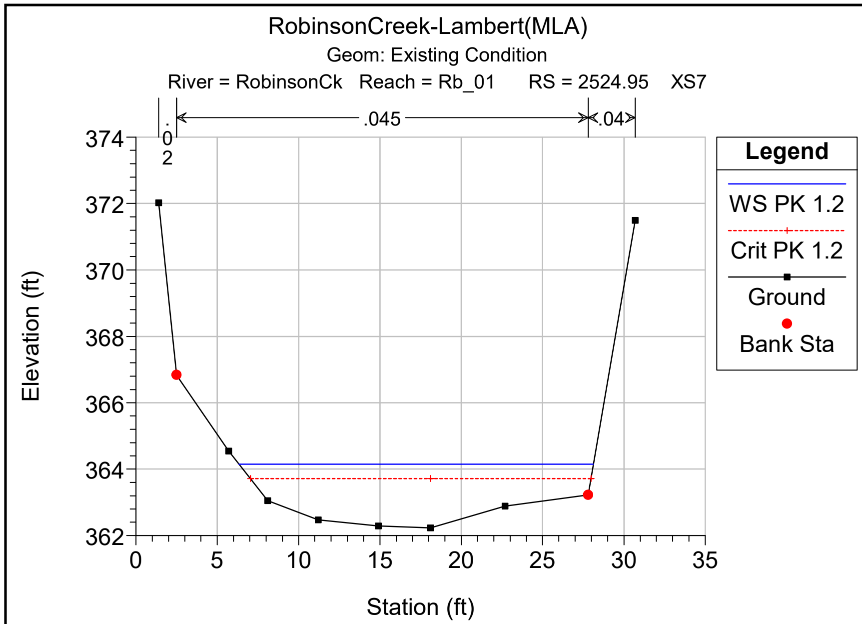

RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2870 DS Limit of Wingwall - Left
.04
.05
.045
.02
.04
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta


RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2858 DS Limit of Wingwall - Right
.05
.045
.06
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta

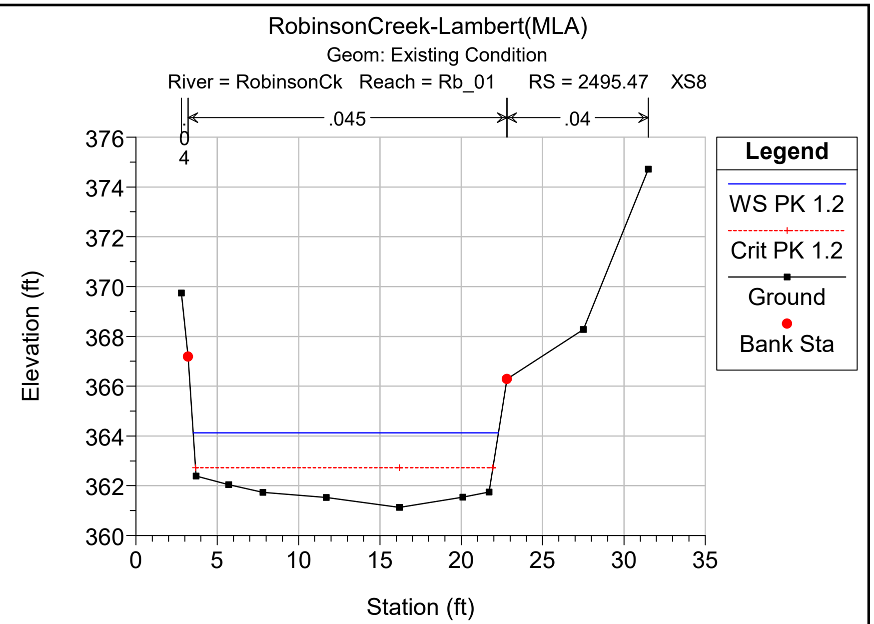

RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2826
.07
.045
.06
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta


RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2794
.07
.045
.06
Elevation (ft)
Station (ft)
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta

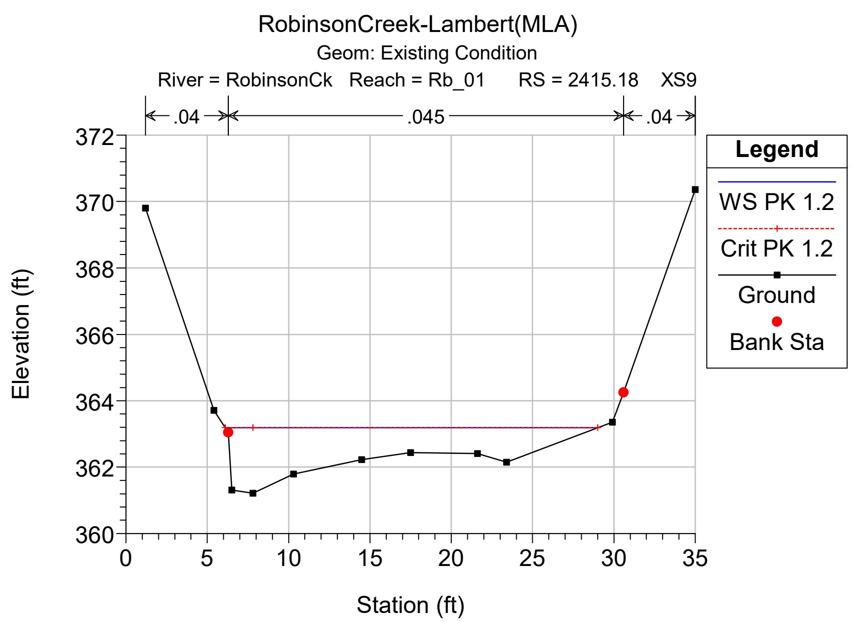

RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2732
.07
.045
.045
.07
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2691
.07
.045
.045
.07
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2671
.07
.045
.07
Legend
Crit PK 1.2
WS PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2620.82 XS6
.04
.045
.04
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)



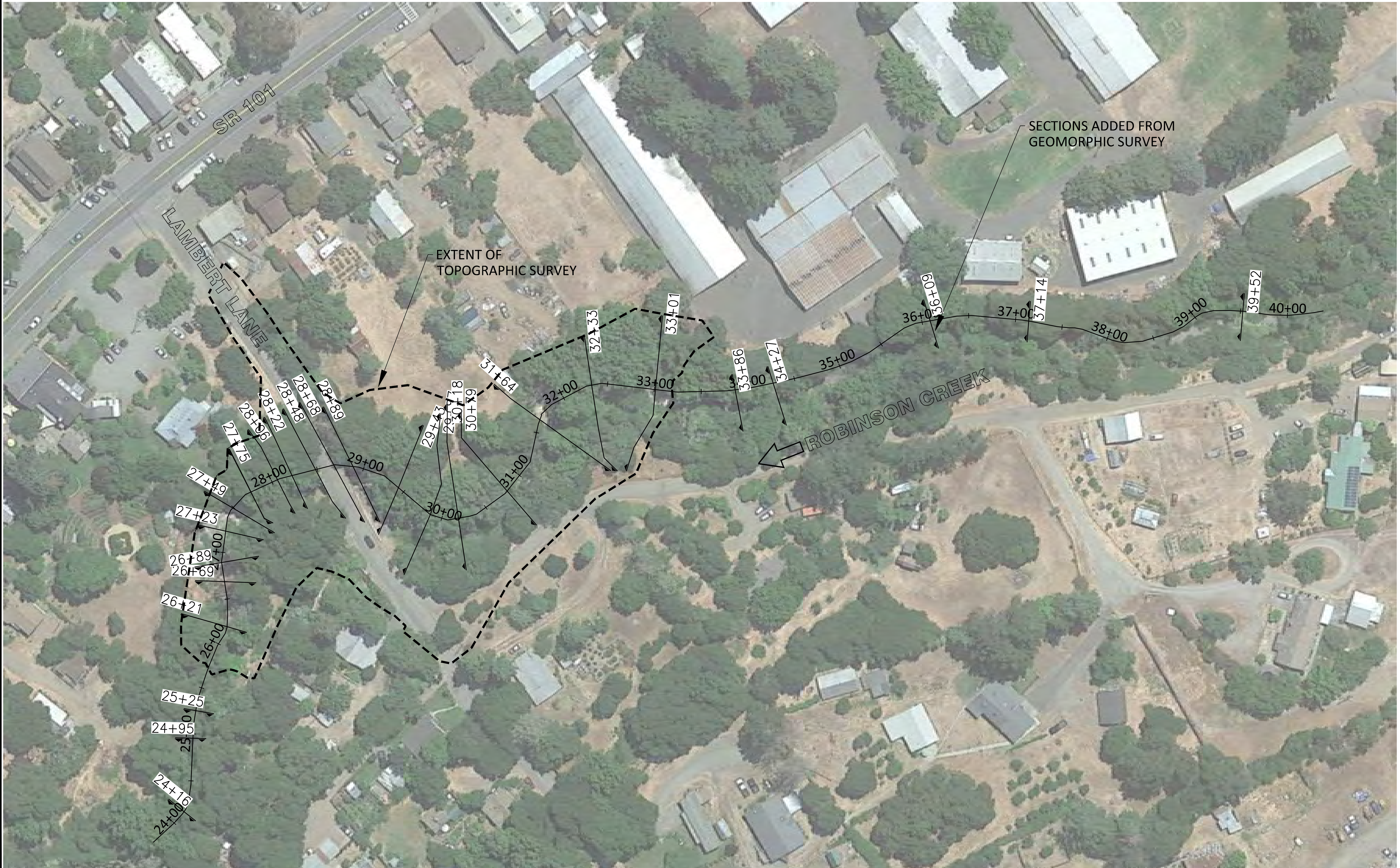
RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2524.95 XS7
.045
.04
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)



RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2495.47 XS8
.045
.04
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)



RobinsonCreek-Lambert(MLA)
Geom: Existing Condition
River = RobinsonCk Reach = Rb_01 RS = 2415.18 XS9
.04
.045
.04
Legend
WS PK 1.2
Crit PK 1.2
Ground
Bank Sta
Elevation (ft)
Station (ft)



Michael Love & Associates, Inc.
PO Box 4477• Arcata, CA 95518 • (707) 822-2411

VERIFY SCALE

THIS BAR IS ONE INCH LONG AT FULL SCALE

MENDOCINO COUNTY DEPARTMENT OF TRANSPORTATION
ROBINSON CREEK AT LAMBERT LANE
BOONEVILLE, CA

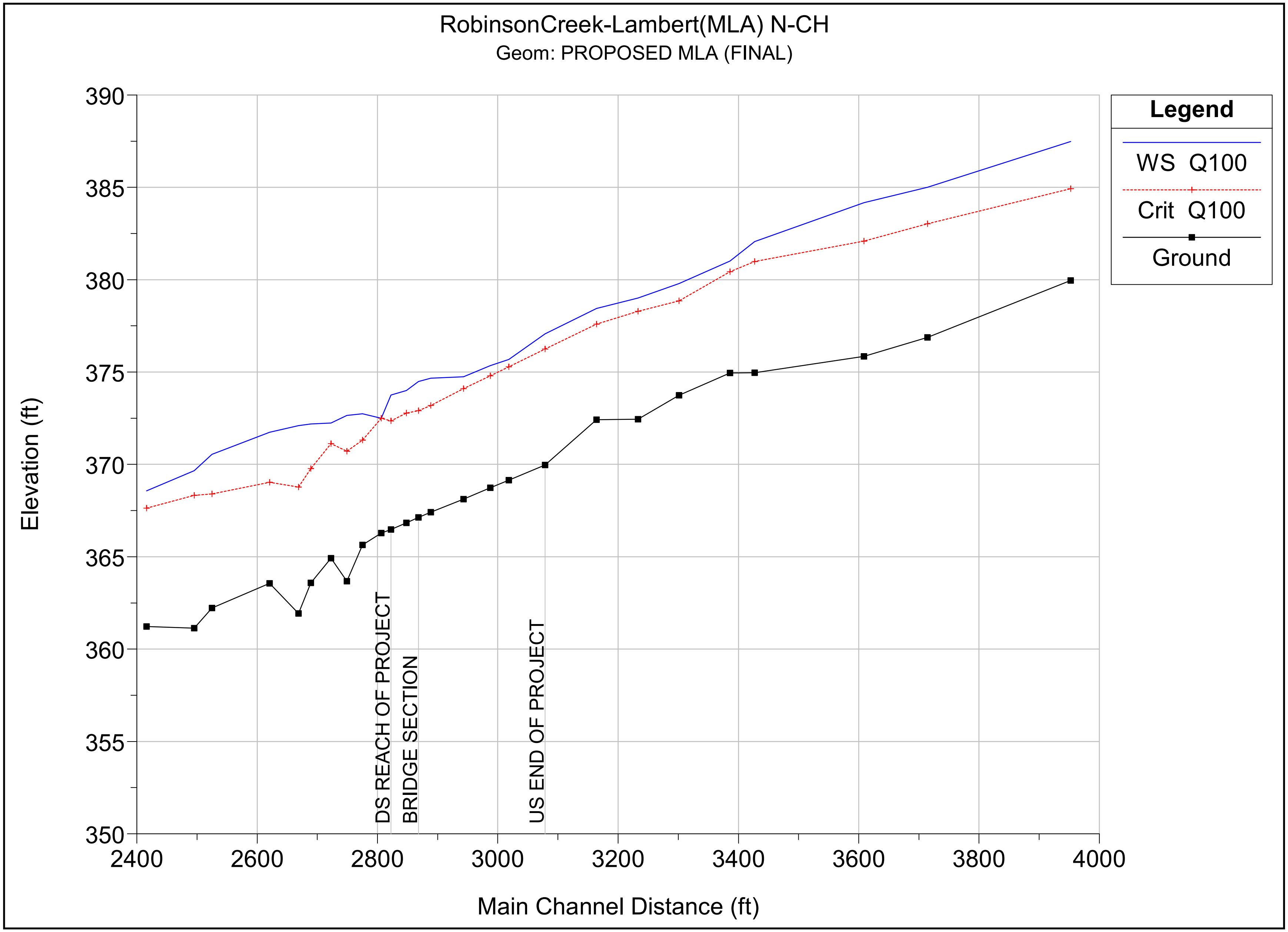
HEC-RAS LAYOUT ROBINSON CREEK AT LAMBERT LANE

DATE	OCT. 2018
SUBMITTAL	30% DESIGN
DESIGN	AL, ML
DRAWN	LLANOS
SHEET	1

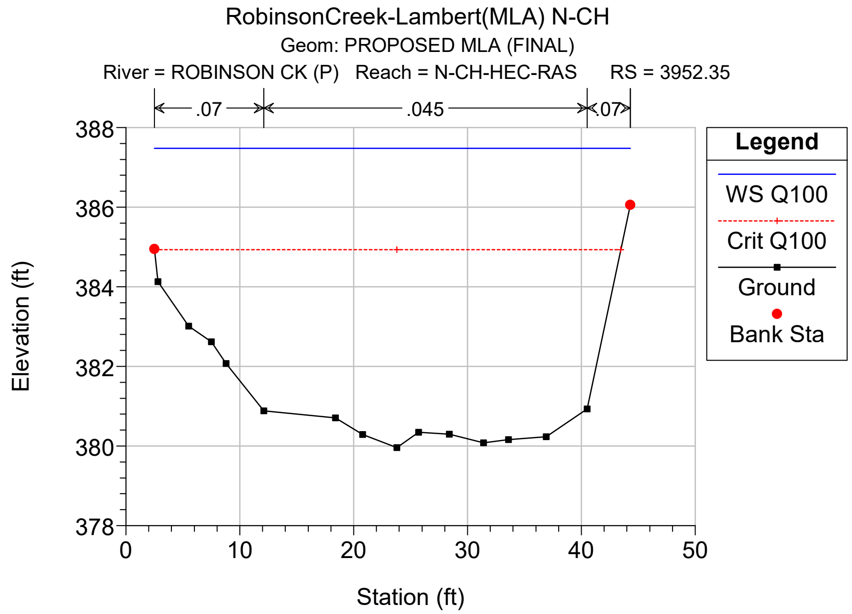
Robinson Creek at Lambert Lane Bridge
HEC-RAS Reults for Design Channel (Proposed As-Built Condition)

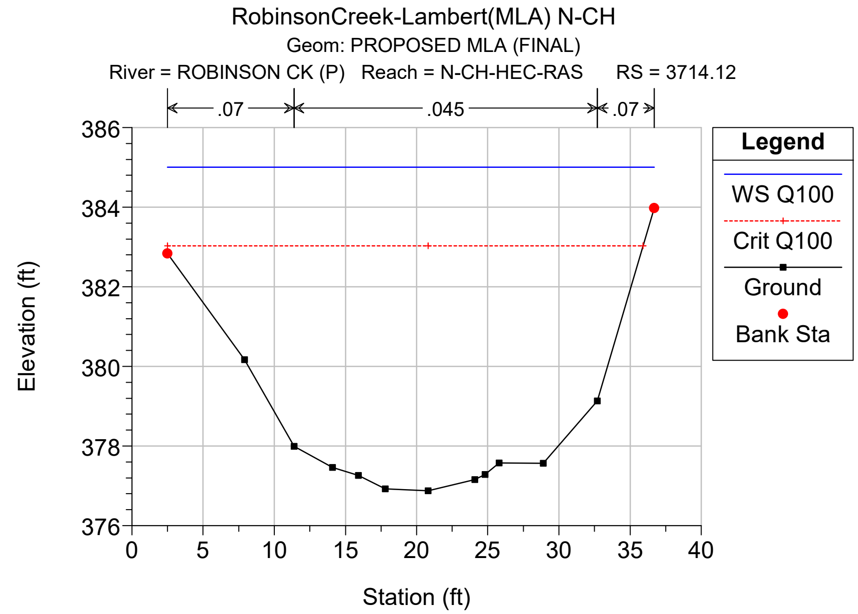
Profile = Q100
Q Total (cfs) = 1,760

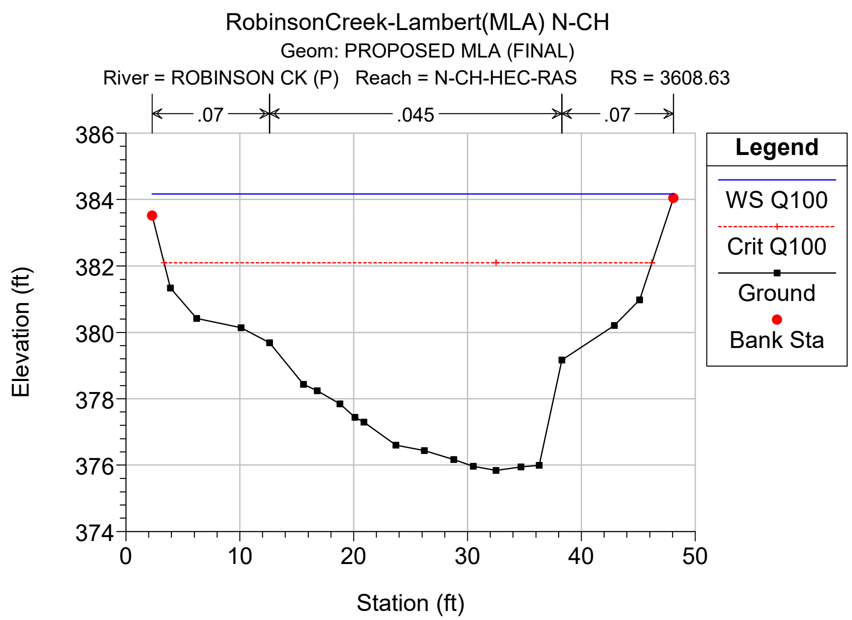
River Sta	Description	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Depth of Flow (ft)
3952.35		379.96	387.48	384.93	388.17	0.006924	6.68	263.43	41.80	0.47	7.52
3714.12		376.88	385.00	383.03	386.05	0.011365	8.23	213.86	34.20	0.58	8.12
3608.63		375.85	384.17	382.09	384.92	0.008643	6.96	252.81	45.80	0.52	8.32
3427.12		374.96	382.06	380.98	382.99	0.013182	7.72	227.87	53.80	0.66	7.10
3386.15		374.95	381.02	380.44	382.29	0.020321	9.07	194.13	50.49	0.81	6.07
3301.22		373.74	379.79	378.85	380.91	0.012553	8.46	208.02	49.57	0.73	6.05
3233.01		372.45	379.00	378.29	380.07	0.011627	8.28	212.65	57.82	0.76	6.55
3164.24		372.42	378.44	377.59	379.26	0.009792	7.25	242.67	68.26	0.68	6.02
3078.81	US end of project	369.97	377.07	376.24	378.30	0.011808	8.92	197.40	45.57	0.75	7.10
3018.21		369.15	375.68	375.29	377.42	0.016042	10.59	166.23	38.06	0.89	6.53
2987.41		368.73	375.35	374.79	376.89	0.01461	9.96	176.73	41.87	0.85	6.62
2942.93		368.12	374.75	374.10	376.26	0.013406	9.88	178.11	39.73	0.82	6.63
2888.75	Bridge Face (US)	367.41	374.67	373.20	375.54	0.007424	7.49	235.09	51.38	0.62	7.26
2868.05	Bridge Section	367.13	374.48	372.91	375.38	0.00736	7.60	231.43	48.48	0.61	7.35
2848.11	Bridge Face (DS)	366.84	374.00	372.78	375.18	0.009867	8.75	201.23	41.70	0.70	7.16
2822.41		366.48	373.76	372.36	374.92	0.010132	8.66	203.13	38.14	0.66	7.28
2806.19	DS end of Project	366.28	372.50	372.50	374.60	0.021263	11.64	151.19	36.45	1.01	6.22
2775.13		365.64	372.74	371.31	373.66	0.008911	7.67	229.61	52.66	0.65	7.10
2749.18		363.68	372.65	370.72	373.40	0.00719	6.92	254.23	56.57	0.58	8.97
2722.84		364.92	372.24	371.12	373.15	0.010407	7.68	229.21	54.22	0.66	7.32
2689.3		363.59	372.19	369.78	372.84	0.005003	6.50	270.60	46.42	0.47	8.60
2668.74		361.93	372.11	368.78	372.74	0.004179	6.41	274.74	39.96	0.43	10.18
2620.59		363.56	371.74	369.03	372.49	0.006006	6.95	253.14	47.14	0.53	8.18
2524.84		362.23	370.54	368.40	371.77	0.008566	8.87	198.38	28.65	0.59	8.31
2495.34		361.13	369.66	368.32	371.40	0.013519	10.60	166.07	25.55	0.73	8.53
2416.06		361.22	368.57	367.63	370.20	0.016003	10.23	172.02	31.66	0.77	7.35

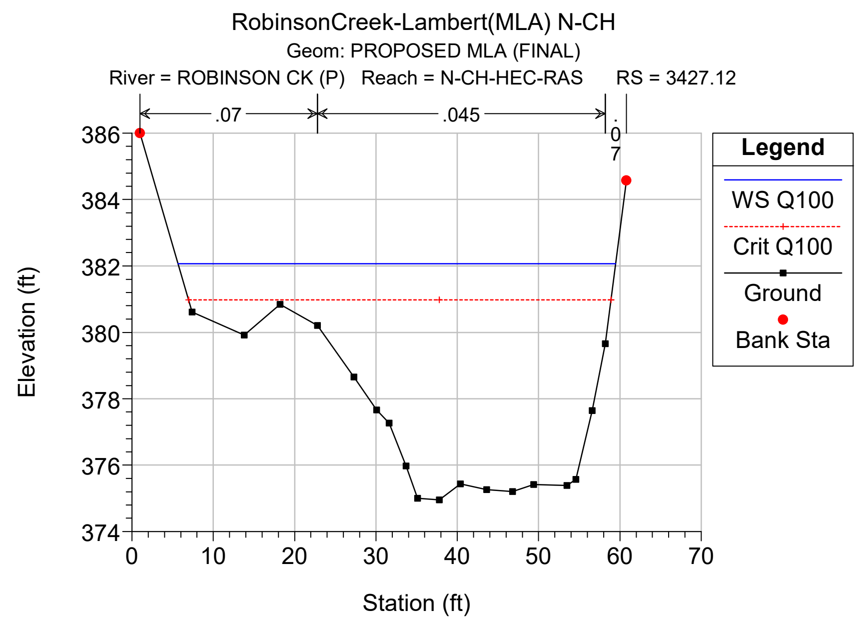


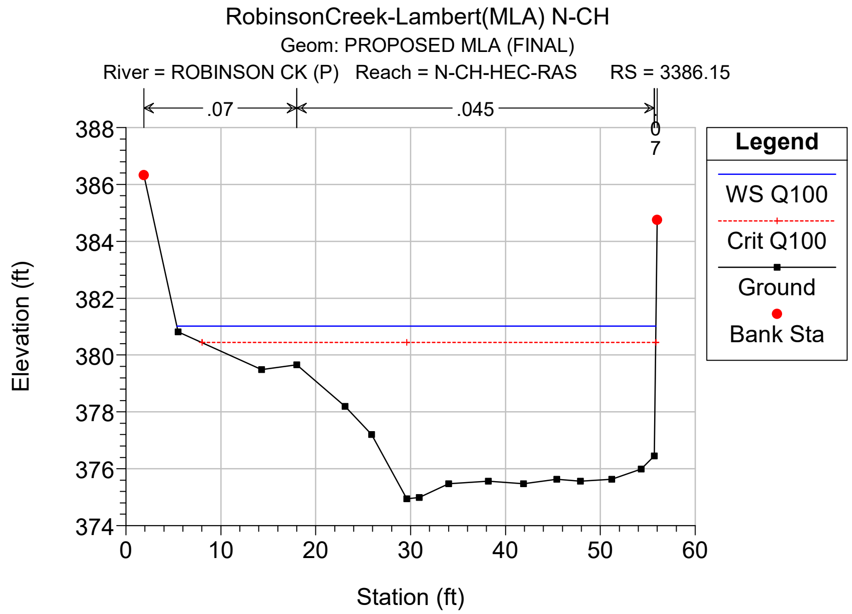
RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
Legend
WS Q100
Crit Q100
Ground
Elevation (ft)
Main Channel Distance (ft)
390
385
380
375
370
365
360
355
350
2400
2600
2800
3000
3200
3400
3600
3800
4000
DS REACH OF PROJECT
BRIDGE SECTION
US END OF PROJECT

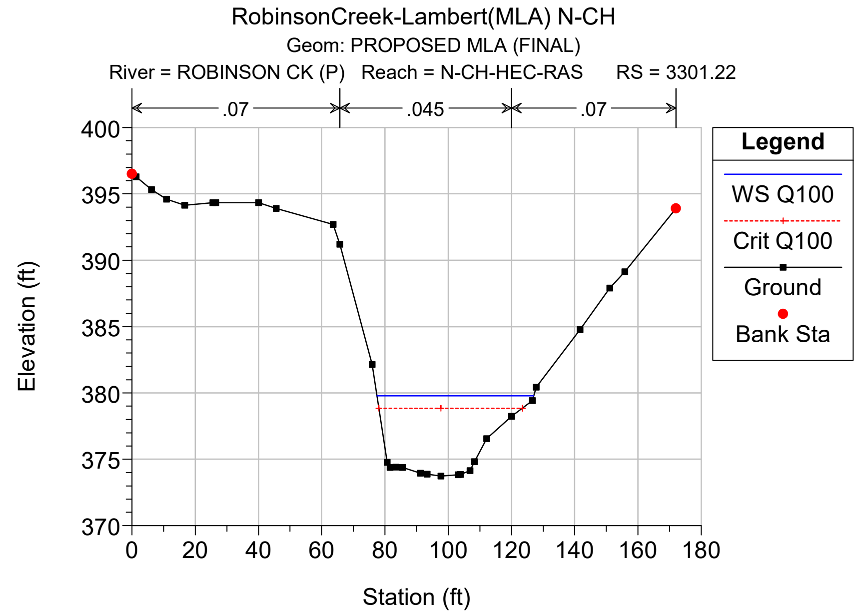

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3952.35
.07
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

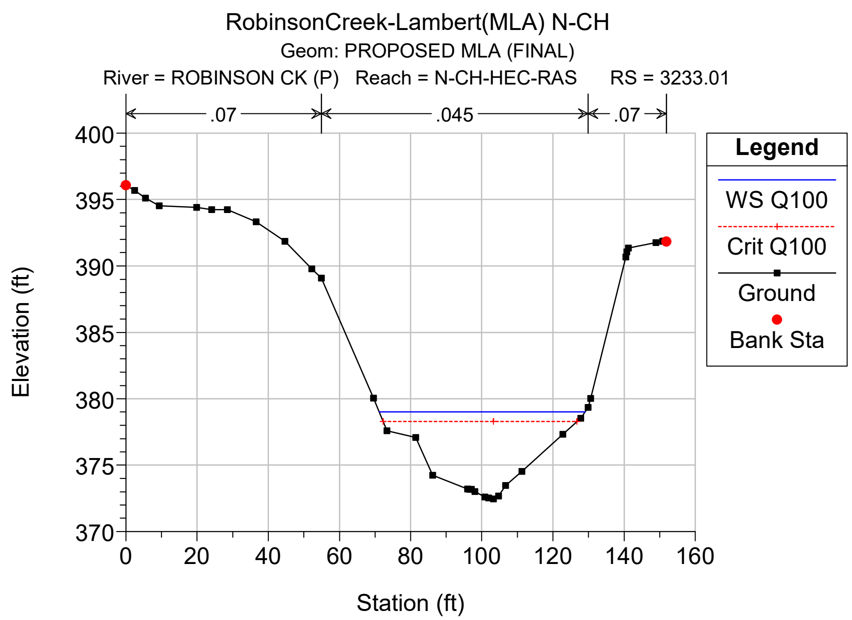

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3714.12
.07
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

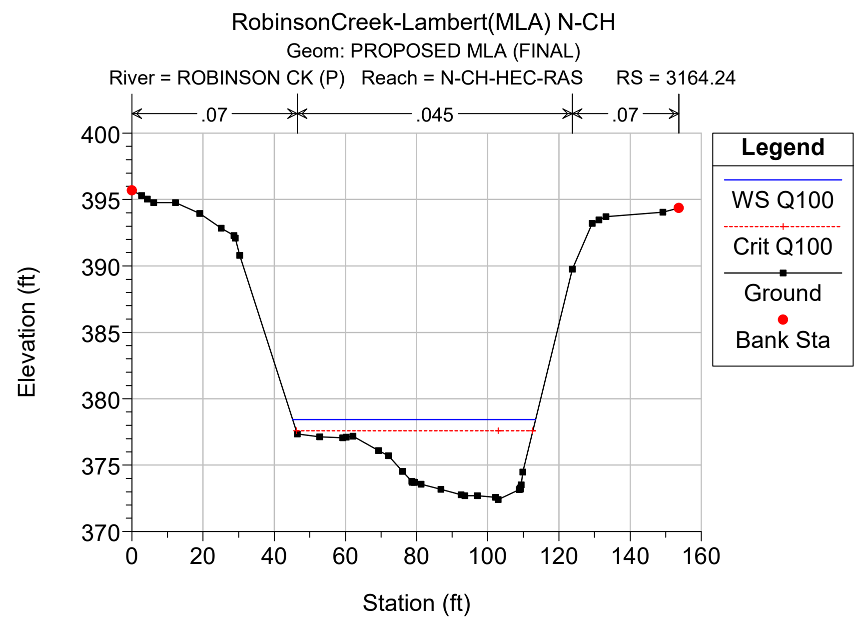

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3608.63
.07
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

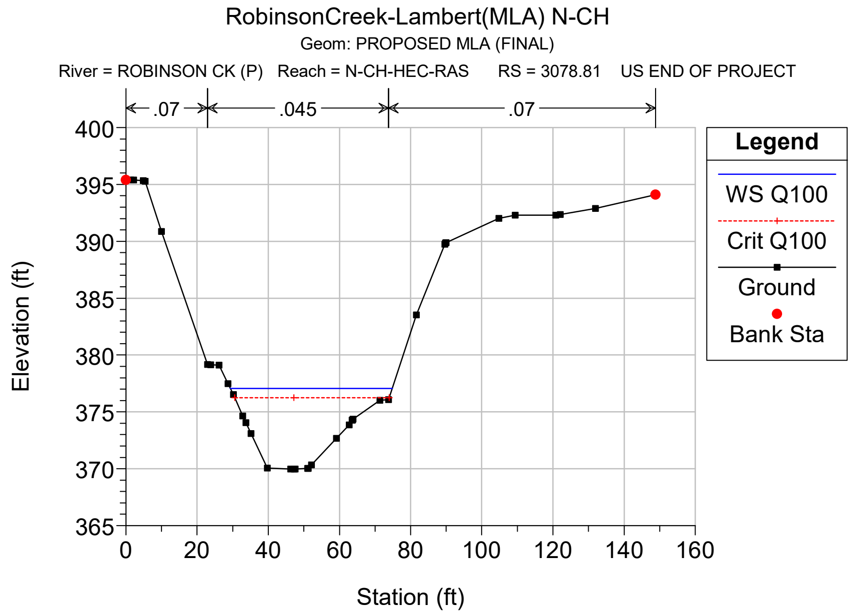

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3427.12
.07
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

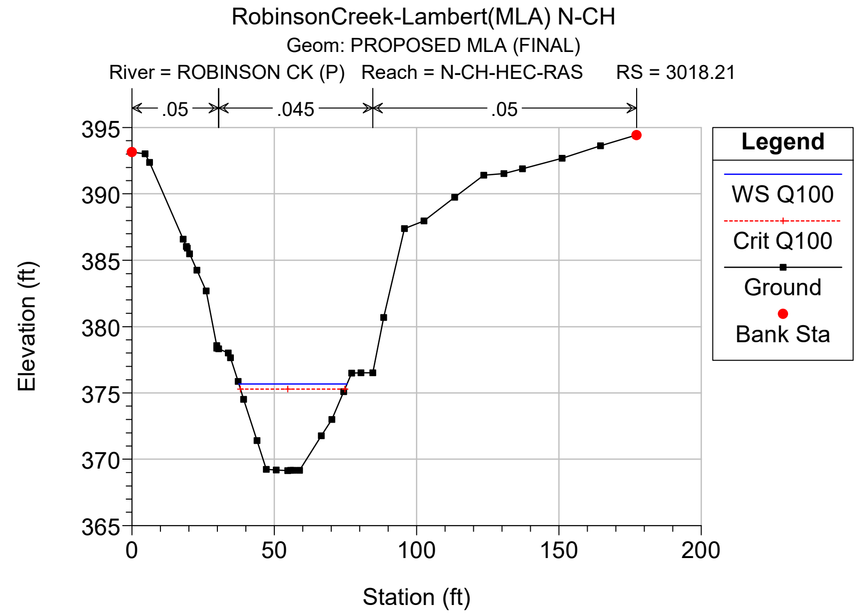

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3386.15
.07
.045
0
7
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
388
386
384
382
380
378
376
374
0
10
20
30
40
50
60

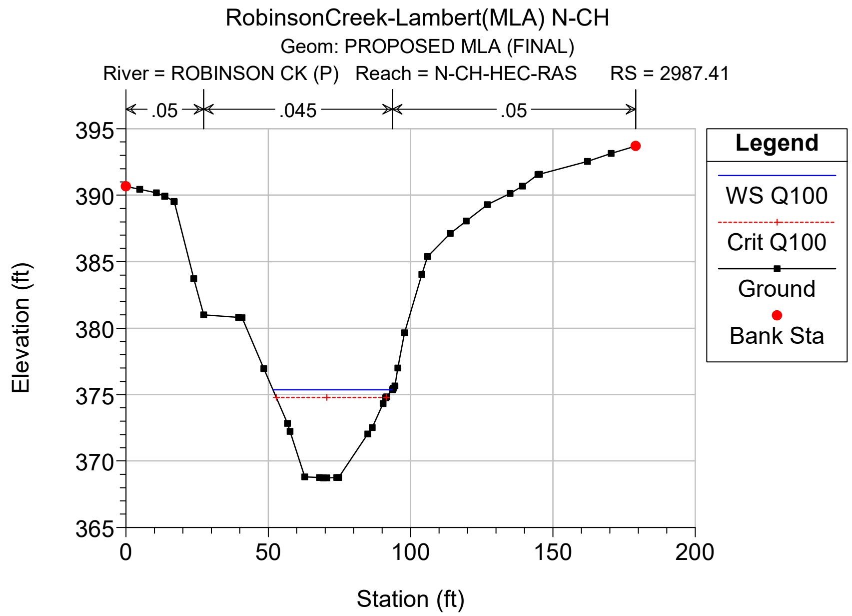

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3301.22
.07
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
400
395
390
385
380
375
370
0
20
40
60
80
100
120
140
160
180

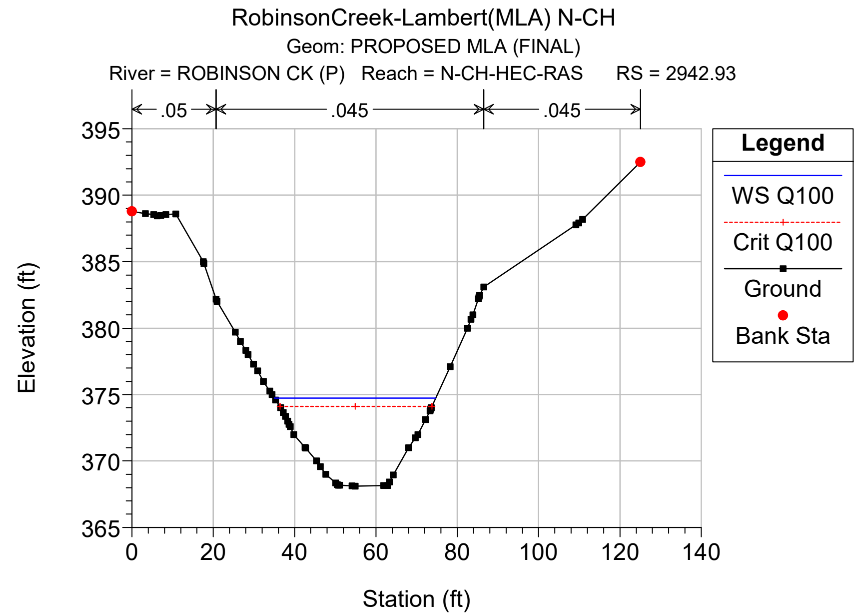

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3233.01
.07
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
400
395
390
385
380
375
370
0
20
40
60
80
100
120
140
160

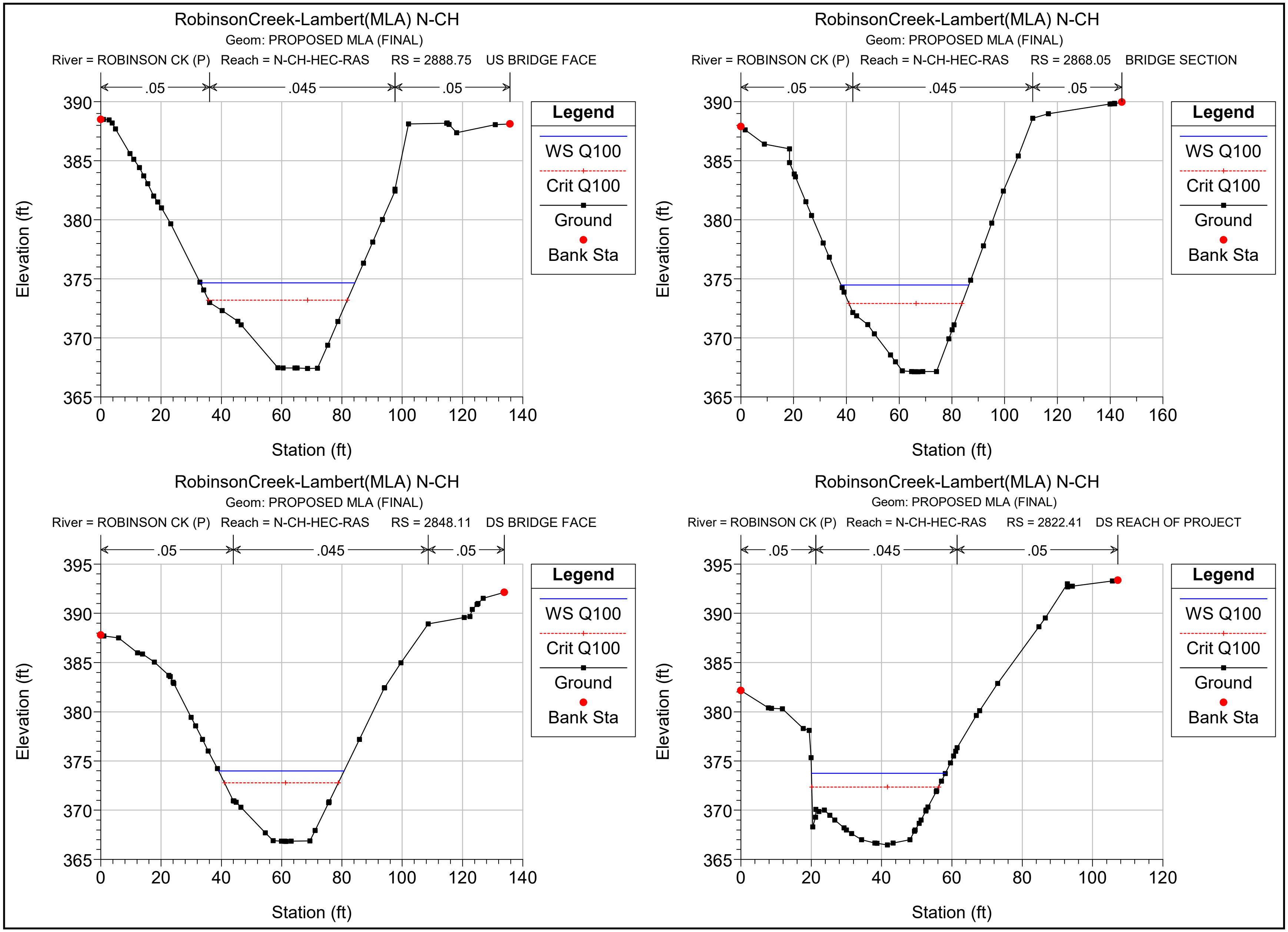

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3164.24
.07
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
400
395
390
385
380
375
370
0
20
40
60
80
100
120
140
160

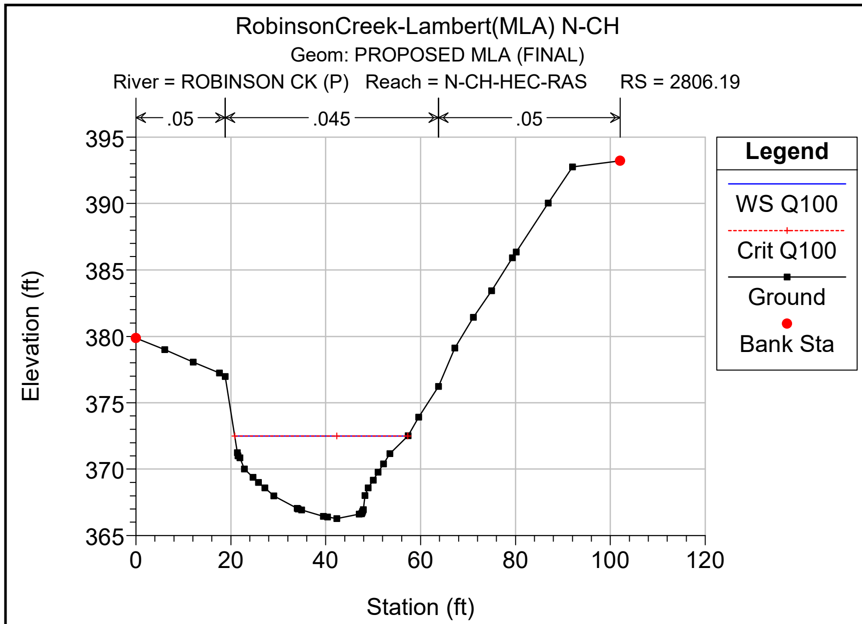

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3078.81 US END OF PROJECT
.07
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

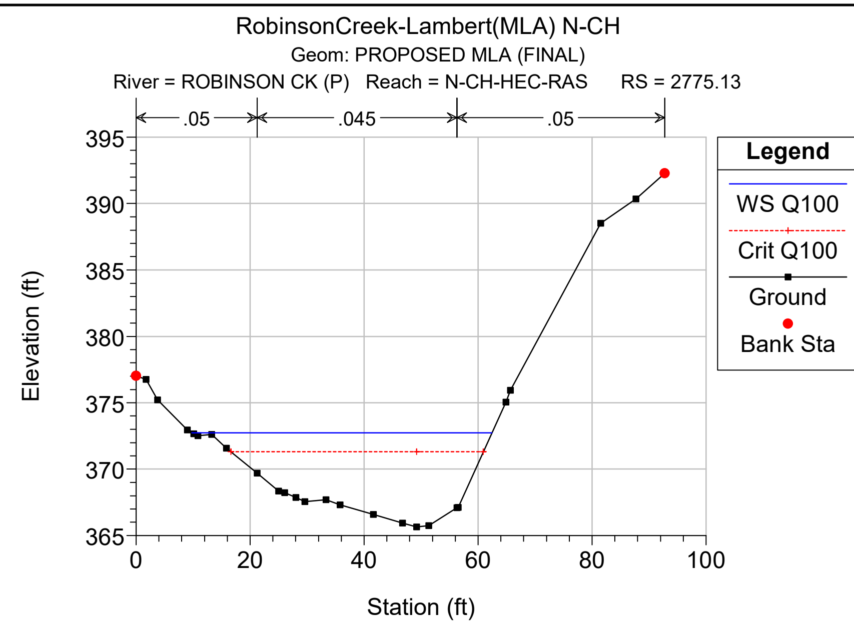

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3018.21
.05
.045
.05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

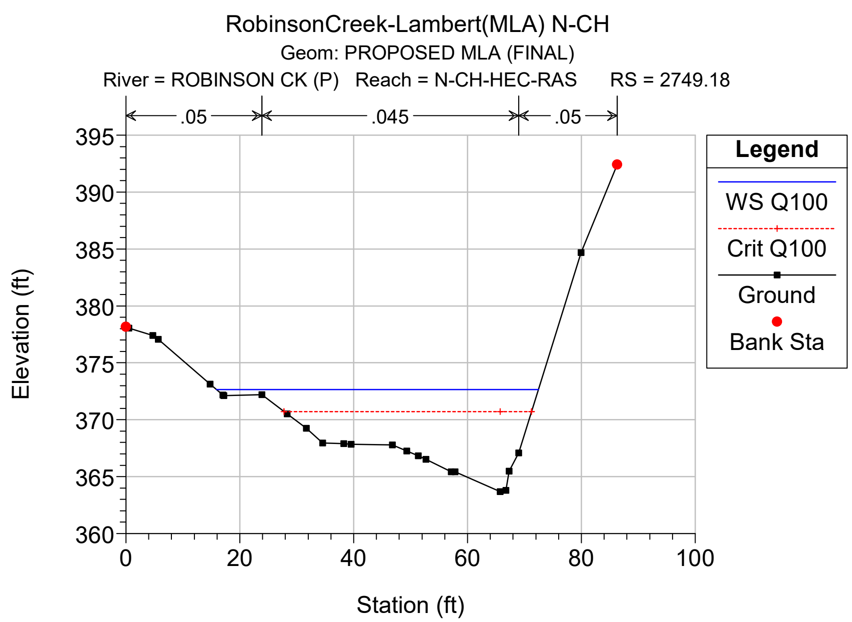

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2987.41
.05
.045
.05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

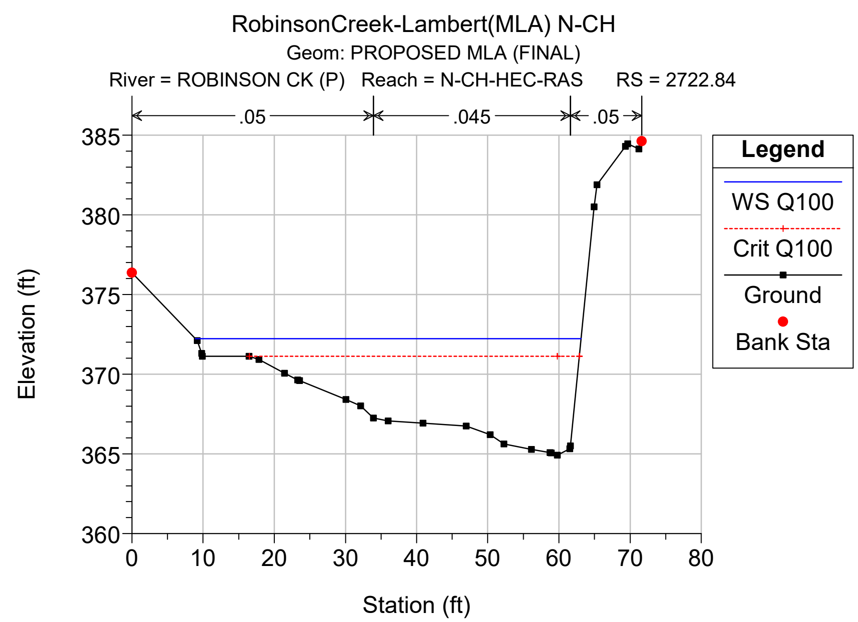

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2942.93
.05
.045
.045
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

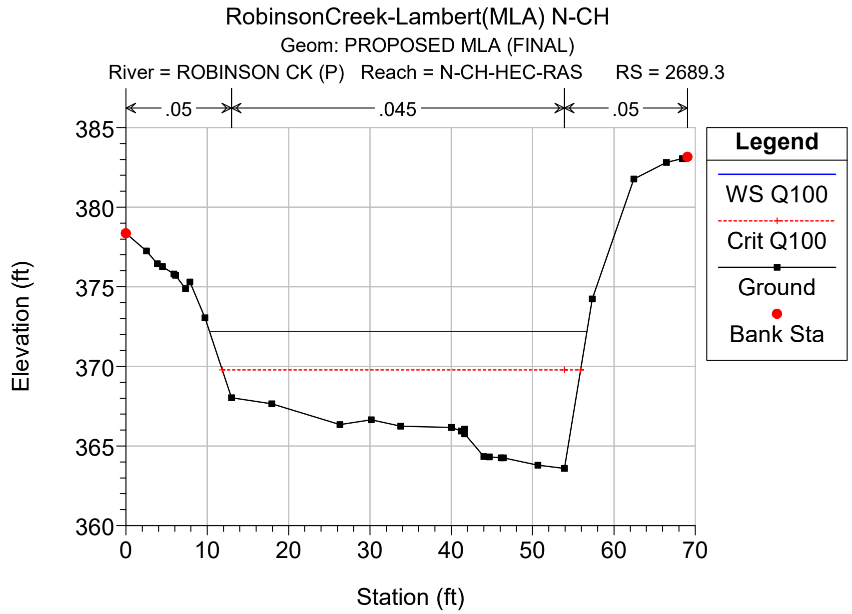

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2888.75 US BRIDGE FACE
.05 .045 .05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2868.05 BRIDGE SECTION
.05 .045 .05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2848.11 DS BRIDGE FACE
.05 .045 .05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2822.41 DS REACH OF PROJECT
.05 .045 .05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

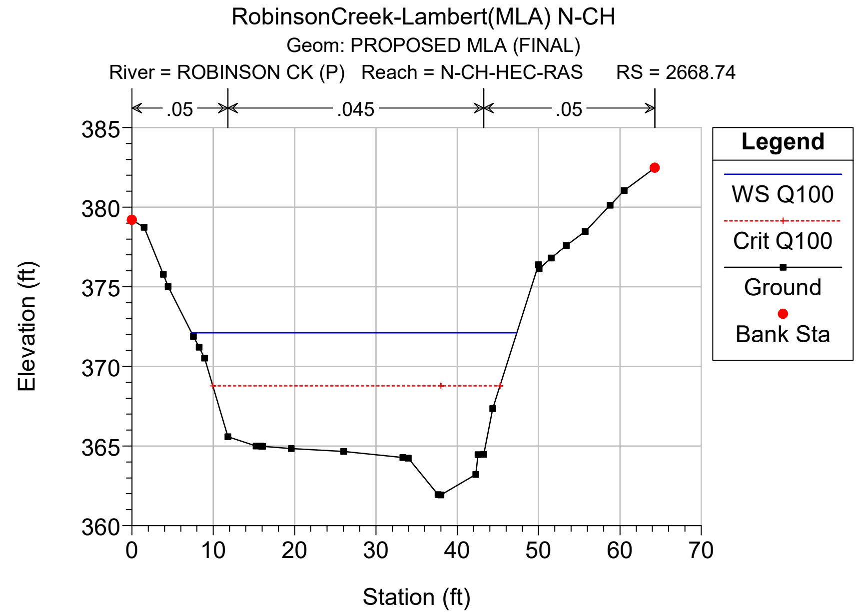

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P)   Reach = N-CH-HEC-RAS   RS = 2806.19
.05
.045
.05
Elevation (ft)
Station (ft)
395
390
385
380
375
370
365
0
20
40
60
80
100
120
Legend
WS Q100
Crit Q100
Ground
Bank Sta

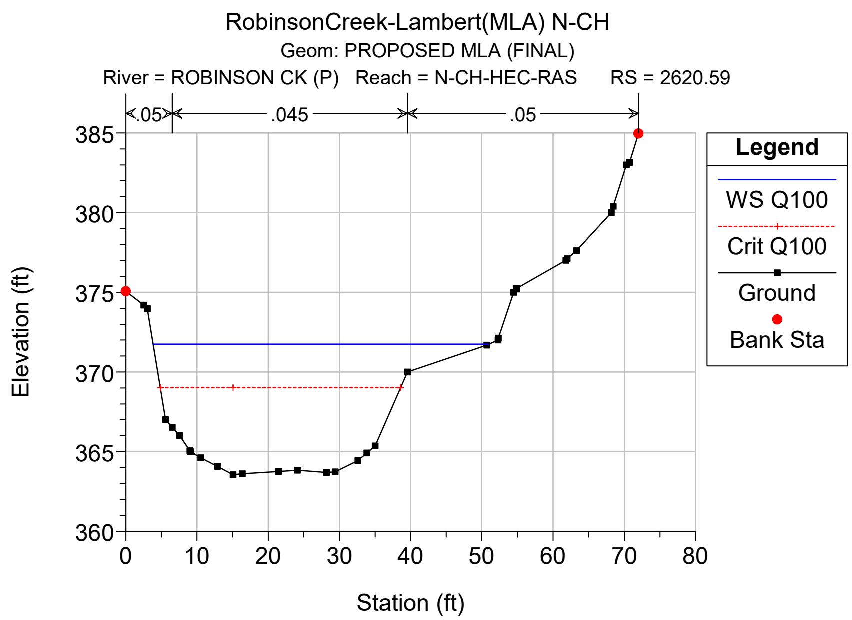

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P)   Reach = N-CH-HEC-RAS   RS = 2775.13
.05
.045
.05
Elevation (ft)
Station (ft)
395
390
385
380
375
370
365
0
20
40
60
80
100
Legend
WS Q100
Crit Q100
Ground
Bank Sta

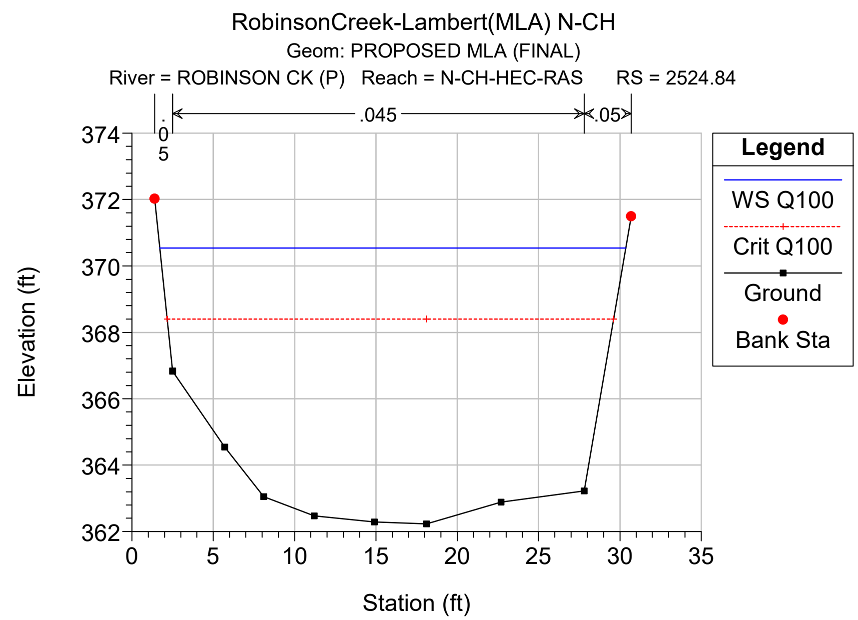

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P)   Reach = N-CH-HEC-RAS   RS = 2749.18
.05
.045
.05
Elevation (ft)
Station (ft)
395
390
385
380
375
370
365
360
0
20
40
60
80
100
Legend
WS Q100
Crit Q100
Ground
Bank Sta

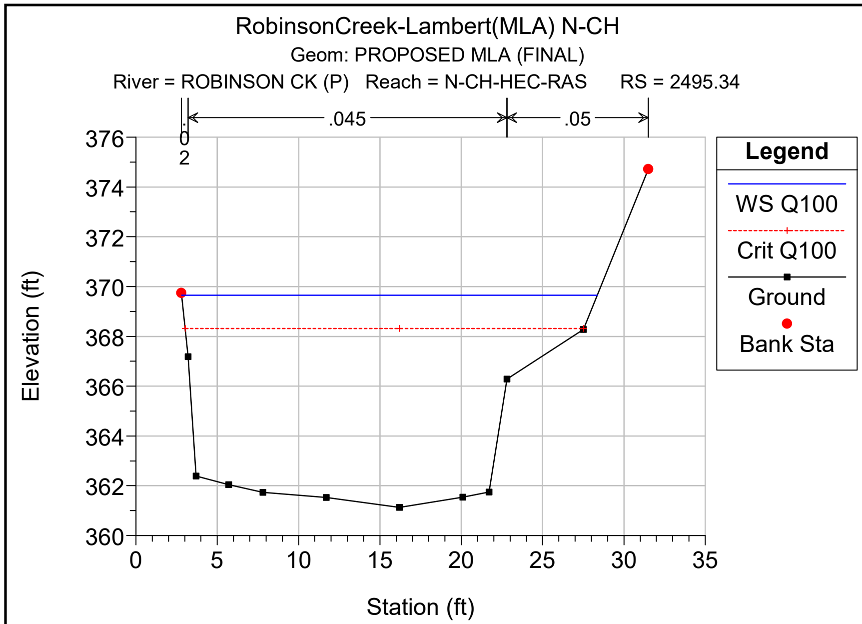

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P)   Reach = N-CH-HEC-RAS   RS = 2722.84
.05
.045
.05
Elevation (ft)
Station (ft)
385
380
375
370
365
360
0
10
20
30
40
50
60
70
80
Legend
WS Q100
Crit Q100
Ground
Bank Sta

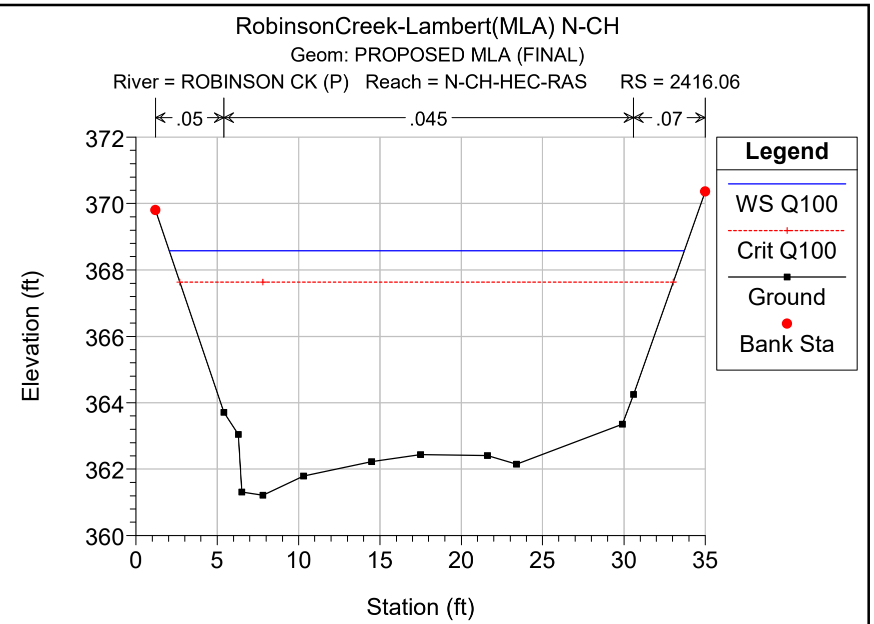

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2689.3
.05
.045
.05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
0
10
20
30
40
50
60
70


RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2668.74
.05
.045
.05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
0
10
20
30
40
50
60
70


RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2620.59
.05
.045
.05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
0
10
20
30
40
50
60
70
80


RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2524.84
.05
.045
.05
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
374
372
370
368
366
364
362
0
5
10
15
20
25
30
35

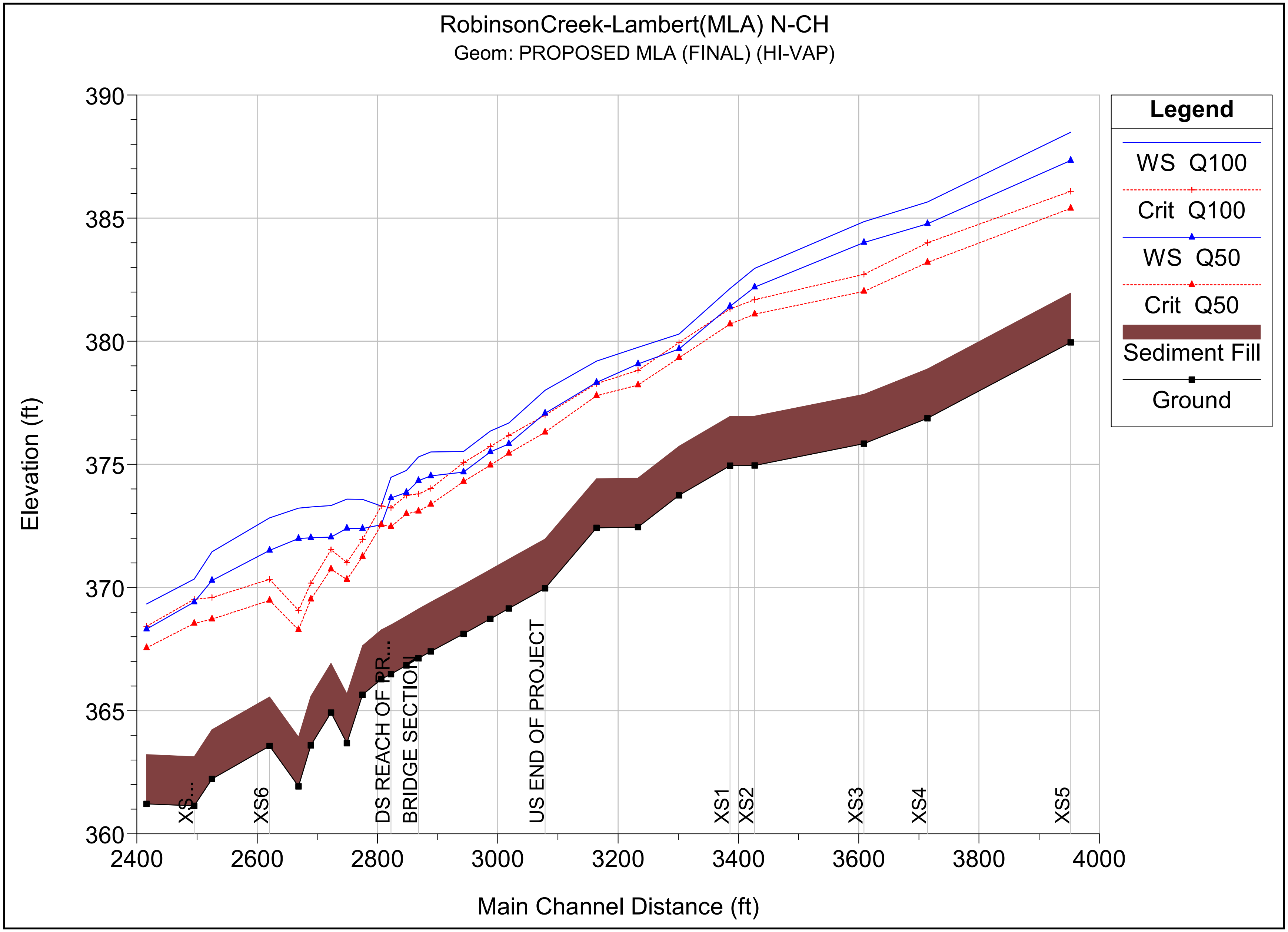

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2495.34
.045
.05
0
2
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

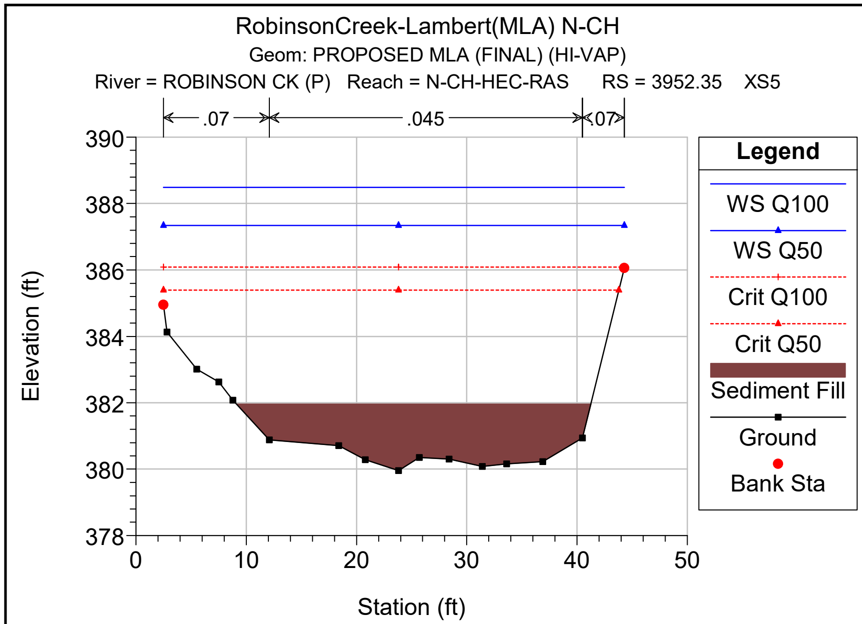

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2416.06
.05
.045
.07
Legend
WS Q100
Crit Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)

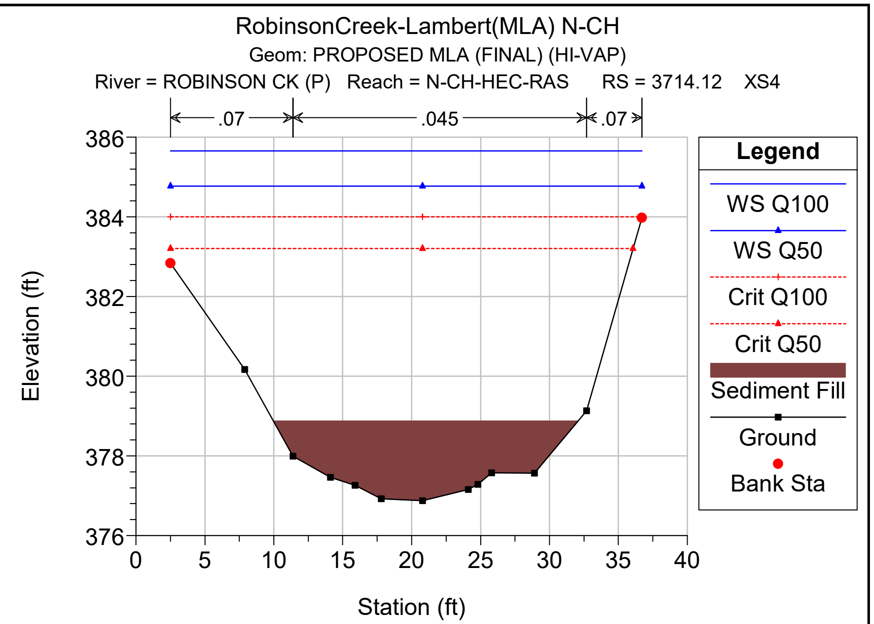
Robinson Creek at Lambert Lane Bridge
HEC-RAS Reults fo High VAP Channel (Proposed As-Built Condition)

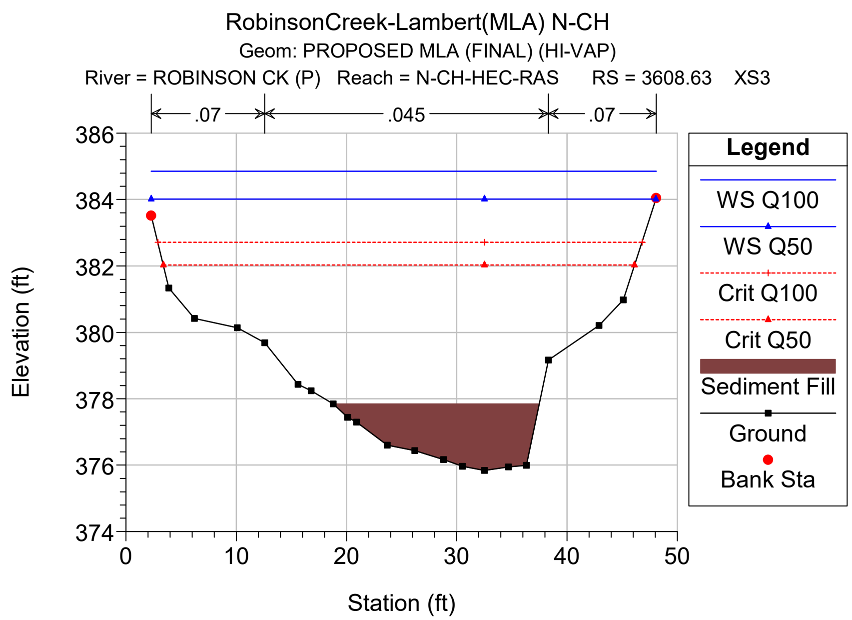
Profile = Q100
Q Total (cfs) = 1,760

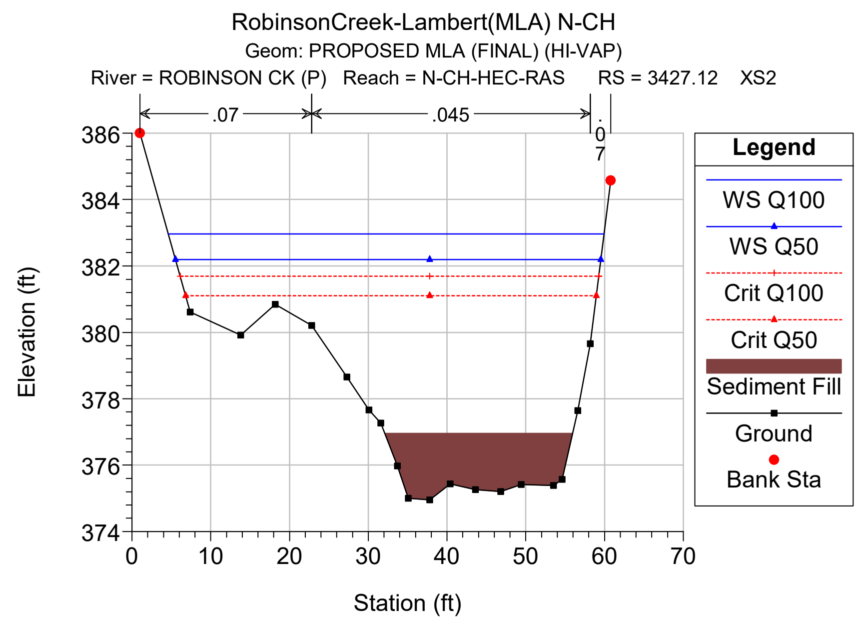
River Sta	Description	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Depth of Flow (ft)
3952.35		381.96	388.49	386.09	389.2	0.01	6.79	259.35	41.80	0.48	6.53
3714.12		378.88	385.66	384.00	386.8	0.01	8.56	205.54	34.20	0.62	6.78
3608.63		377.85	384.85	382.72	385.58	0.01	6.81	258.36	45.80	0.51	7.00
3427.12		376.96	382.96	381.69	383.8	0.01	7.32	240.44	55.34	0.62	6.00
3386.15		376.95	382.14	381.31	383.21	0.02	8.32	211.61	51.27	0.72	5.19
3301.22		375.74	380.29	379.95	381.7	0.02	9.51	185.15	50.46	0.87	4.55
3233.01		374.45	379.75	378.82	380.66	0.01	7.64	230.44	60.27	0.69	5.30
3164.24		374.42	379.20	378.28	379.97	0.01	7.07	248.91	69.86	0.66	4.78
3078.81	US end of project	371.97	378.01	377.00	379.1	0.01	8.36	210.51	48.04	0.70	6.04
3018.21		371.15	376.68	376.18	378.24	0.02	10.01	175.85	48.70	0.93	5.53
2987.41		370.73	376.35	375.73	377.71	0.01	9.35	188.20	45.39	0.81	5.62
2942.93		370.12	375.53	375.07	377.07	0.01	9.96	176.78	42.57	0.86	5.41
2888.75	Bridge Face (US)	369.41	375.50	374.02	376.31	0.01	7.23	243.53	54.44	0.60	6.09
2868.05	Bridge Section	369.13	375.30	373.80	376.16	0.01	7.42	237.23	51.39	0.61	6.17
2848.11	Bridge Face (DS)	368.84	374.76	373.75	375.95	0.01	8.77	200.61	44.18	0.73	5.92
2822.41		368.48	374.48	373.24	375.67	0.01	8.77	200.60	39.16	0.68	6.00
2806.19	DS end of Project	368.28	373.31	373.31	375.35	0.02	11.46	153.61	38.17	1.01	5.03
2775.13		367.64	373.58	371.95	374.36	0.01	7.08	248.52	55.79	0.59	5.94
2749.18		365.68	373.59	371.02	374.14	0.00	5.93	296.81	59.33	0.47	7.91
2722.84		366.92	373.33	371.53	373.99	0.01	6.52	269.97	56.81	0.53	6.41
2689.3		365.59	373.27	370.18	373.79	0.00	5.80	303.69	47.52	0.40	7.68
2668.74		363.93	373.22	369.07	373.72	0.00	5.67	310.66	41.77	0.37	9.29
2620.59		365.56	372.83	370.33	373.51	0.01	6.63	265.45	49.42	0.50	7.27
2524.84		364.23	371.46	369.60	372.76	0.01	9.16	192.09	29.17	0.63	7.23
2495.34		363.13	370.34	369.53	372.33	0.02	11.30	155.76	25.99	0.81	7.21
2416.06		363.22	369.33	368.43	370.93	0.02	10.14	173.58	32.73	0.78	6.11

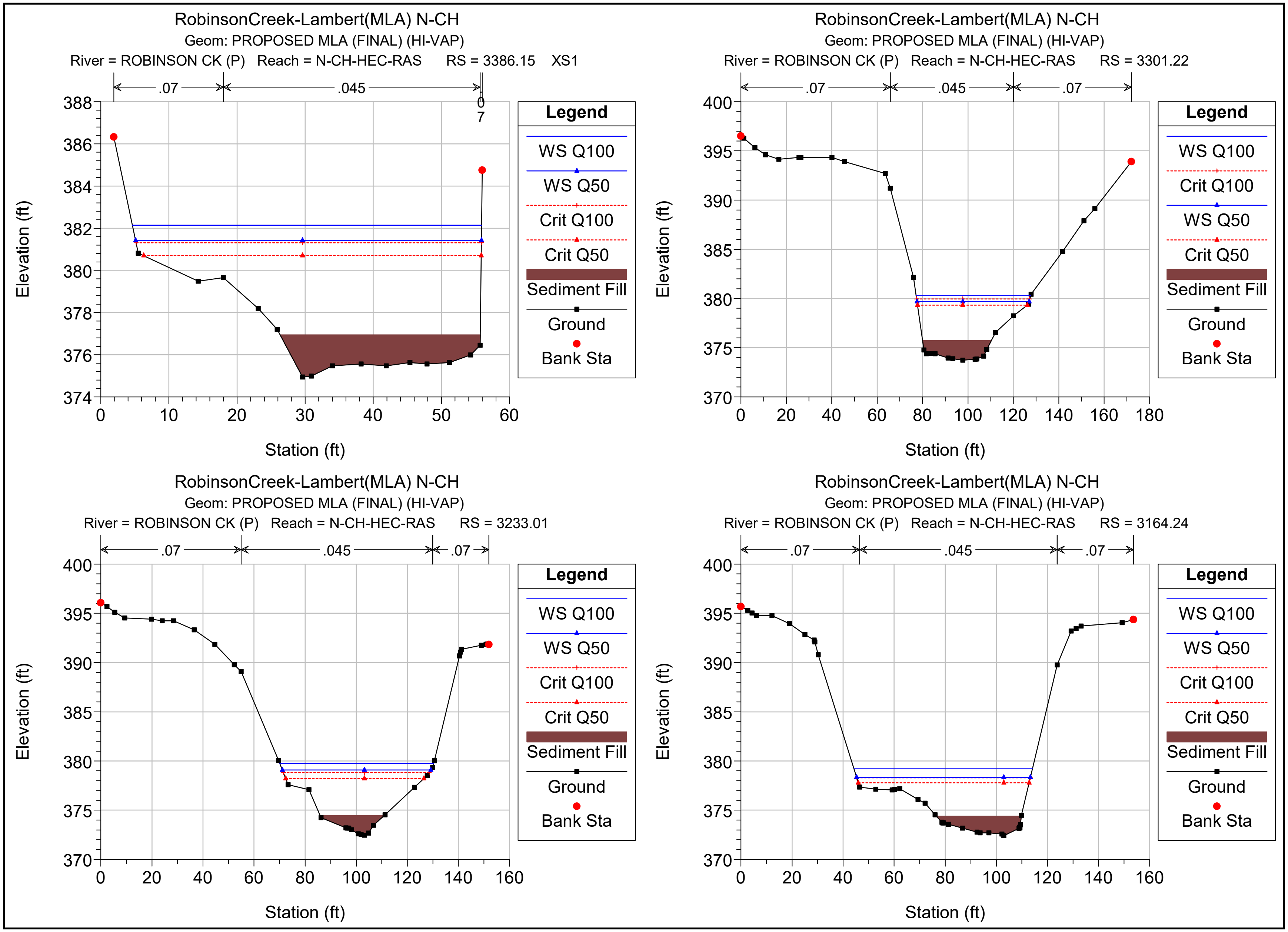

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
Elevation (ft)
Main Channel Distance (ft)
390
385
380
375
370
365
360
2400
2600
2800
3000
3200
3400
3600
3800
4000
Legend
WS Q100
Crit Q100
WS Q50
Crit Q50
Sediment Fill
Ground
XS...
XS6
DS REACH OF PR...
BRIDGE SECTION
US END OF PROJECT
XS1
XS2
XS3
XS4
XS5

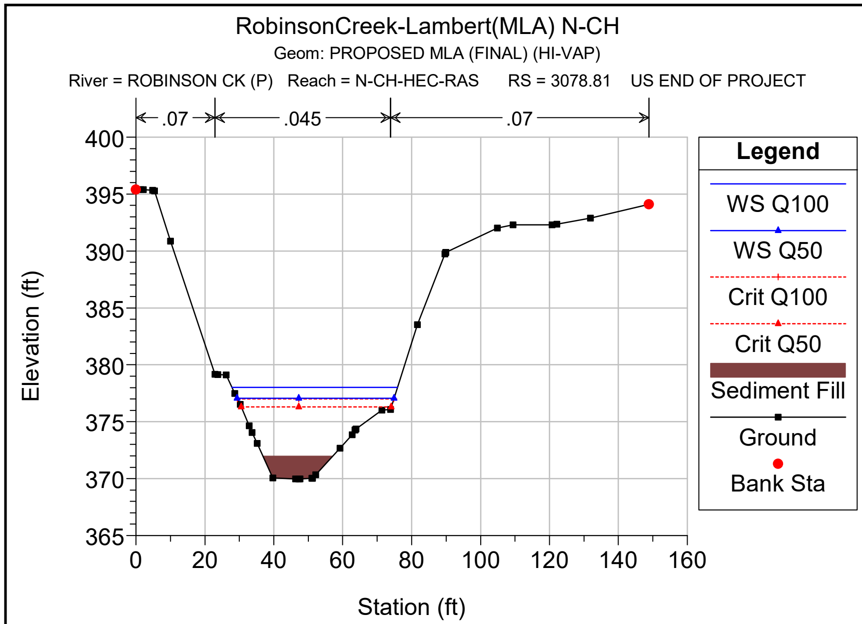

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3952.35 XS5
.07
.045
.07
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

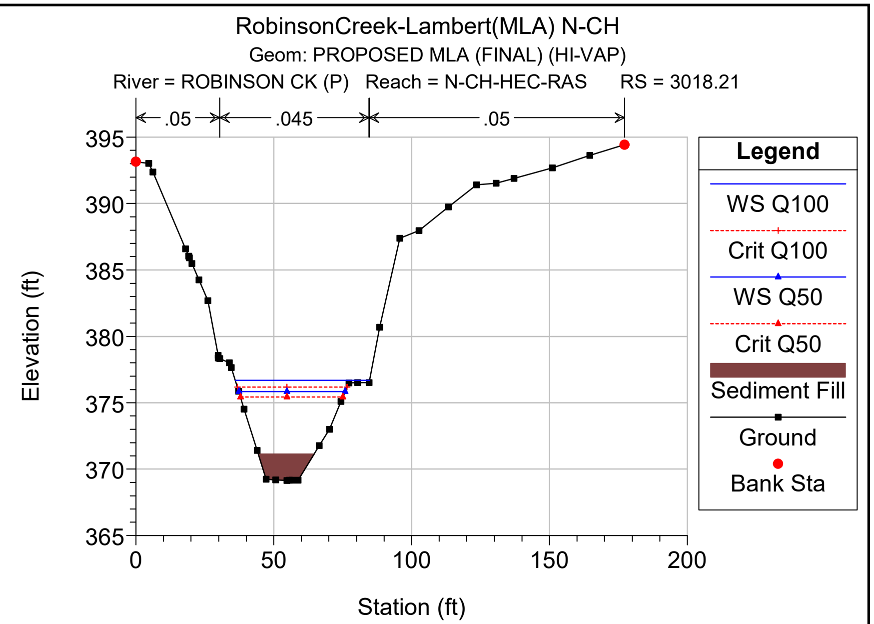

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3714.12 XS4
.07
.045
.07
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

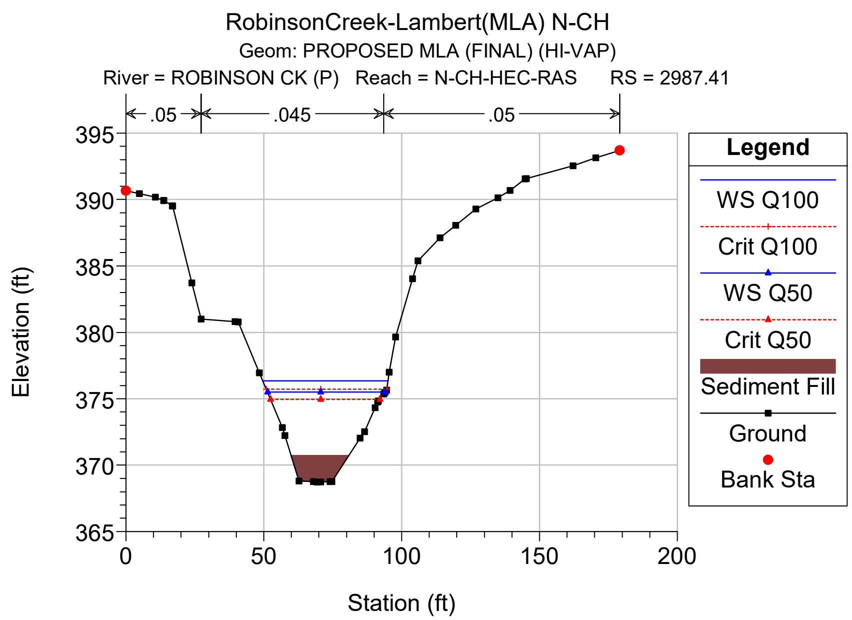

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3608.63 XS3
.07
.045
.07
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

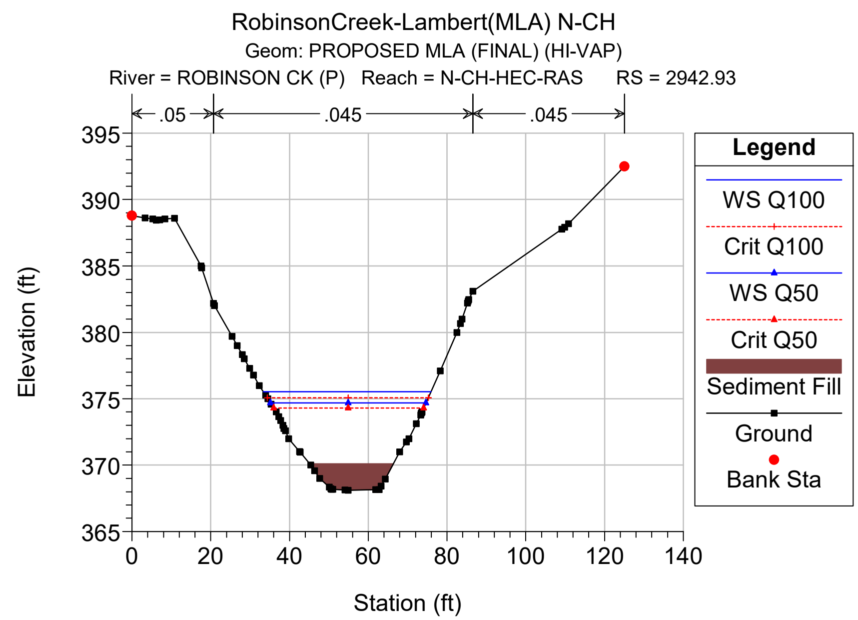

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3427.12 XS2
.07
.045
.07
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

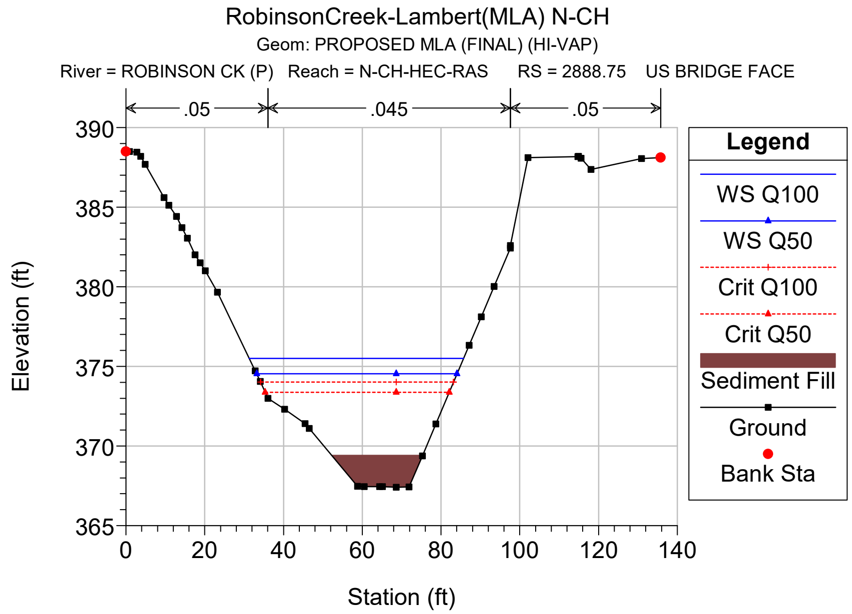

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3386.15 XS1
.07
.045
0
7
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3301.22
.07
.045
.07
Legend
WS Q100
Crit Q100
WS Q50
Crit Q50
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3233.01
.07
.045
.07
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)
RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3164.24
.07
.045
.07
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta
Elevation (ft)
Station (ft)

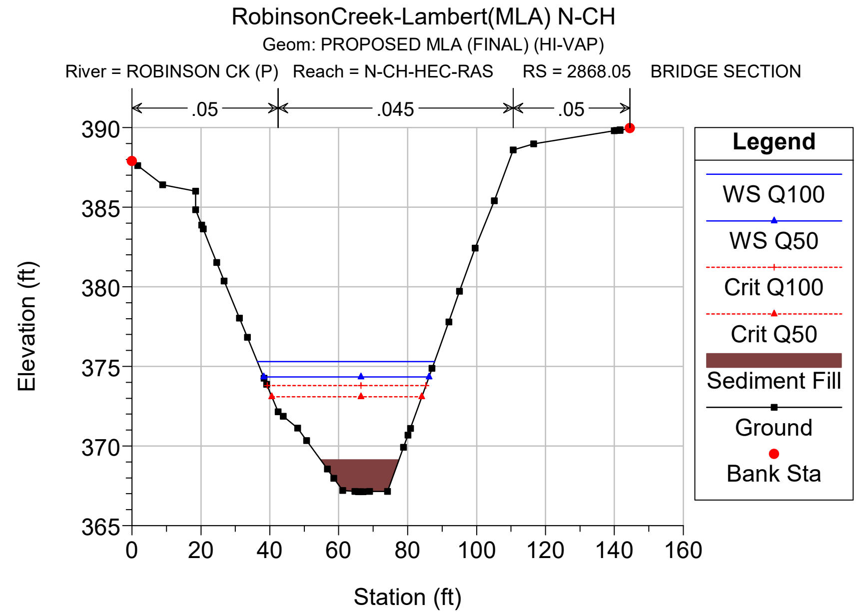

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3078.81 US END OF PROJECT
.07
.045
.07
Elevation (ft)
Station (ft)
400
395
390
385
380
375
370
365
0
20
40
60
80
100
120
140
160
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

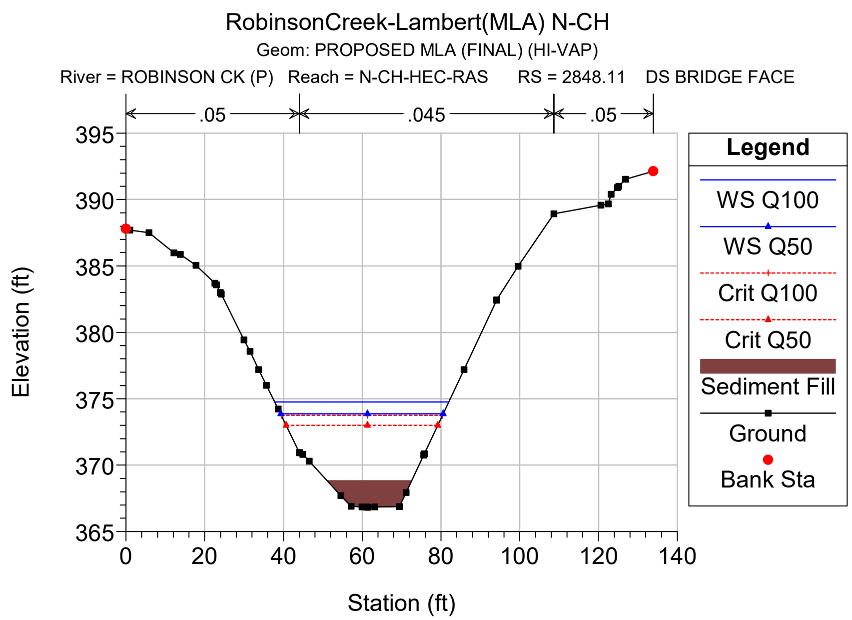

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 3018.21
.05
.045
.05
Elevation (ft)
Station (ft)
395
390
385
380
375
370
365
0
50
100
150
200
Legend
WS Q100
Crit Q100
WS Q50
Crit Q50
Sediment Fill
Ground
Bank Sta

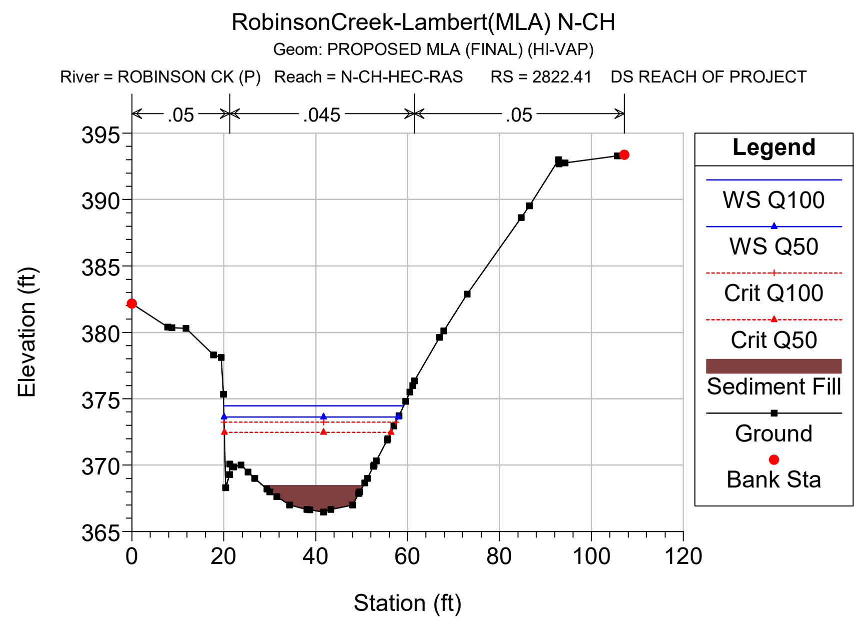

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2987.41
.05
.045
.05
Elevation (ft)
Station (ft)
395
390
385
380
375
370
365
0
50
100
150
200
Legend
WS Q100
Crit Q100
WS Q50
Crit Q50
Sediment Fill
Ground
Bank Sta

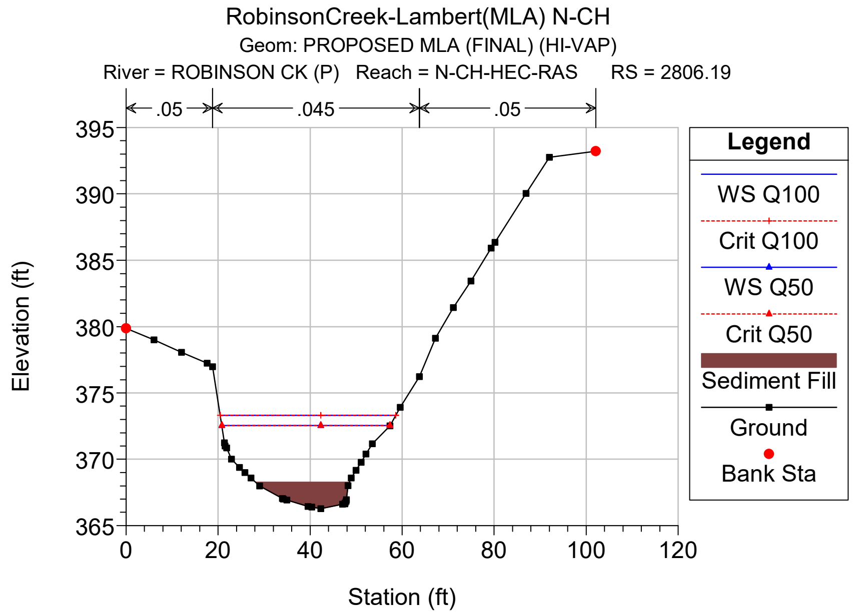

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2942.93
.05
.045
.045
Elevation (ft)
Station (ft)
395
390
385
380
375
370
365
0
20
40
60
80
100
120
140
Legend
WS Q100
Crit Q100
WS Q50
Crit Q50
Sediment Fill
Ground
Bank Sta

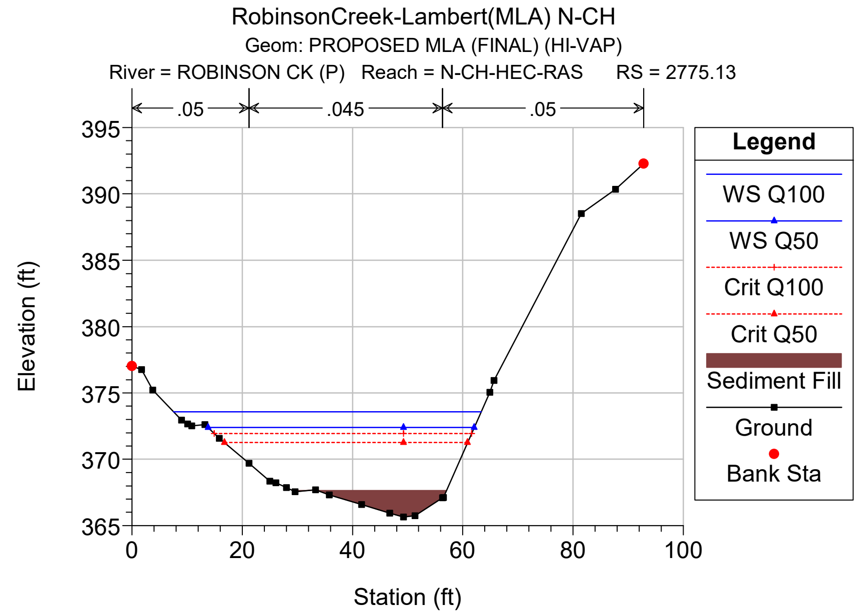

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2888.75 US BRIDGE FACE
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

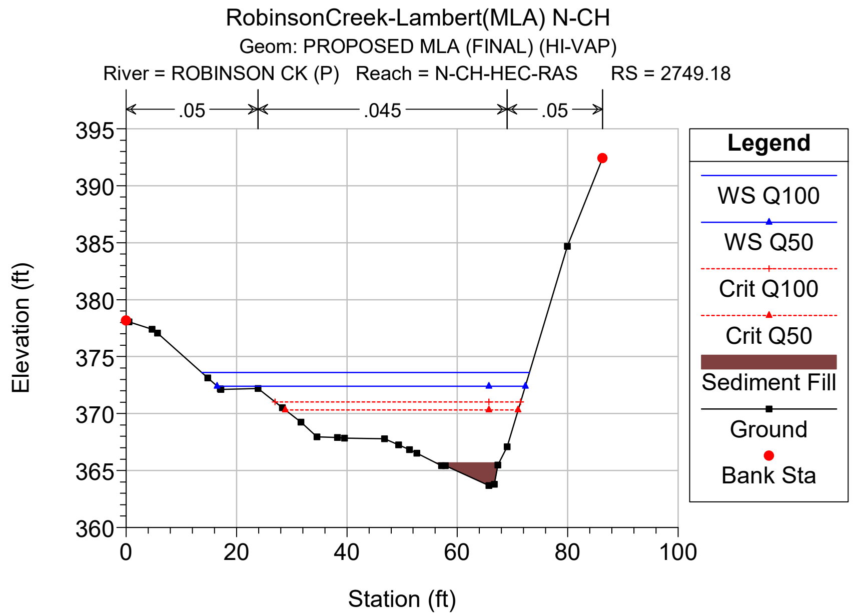

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2868.05 BRIDGE SECTION
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

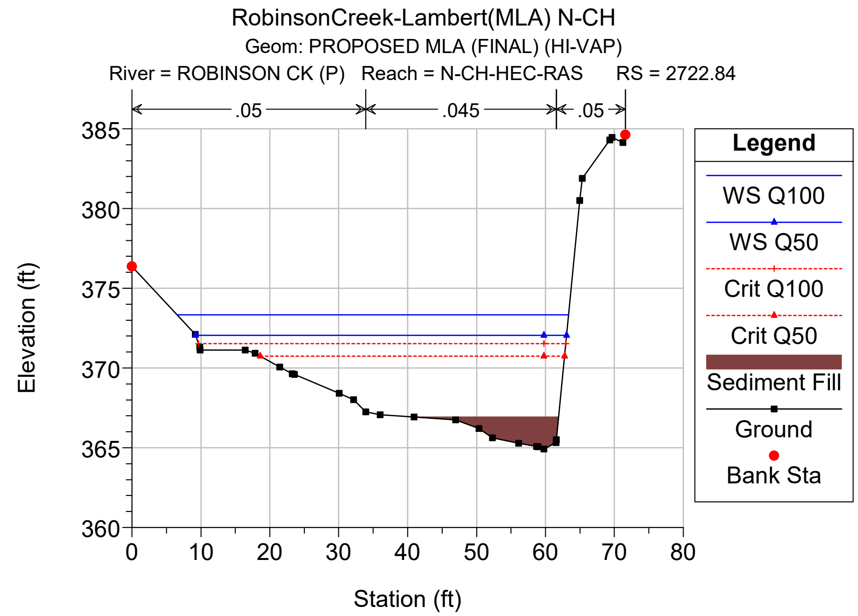

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2848.11 DS BRIDGE FACE
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

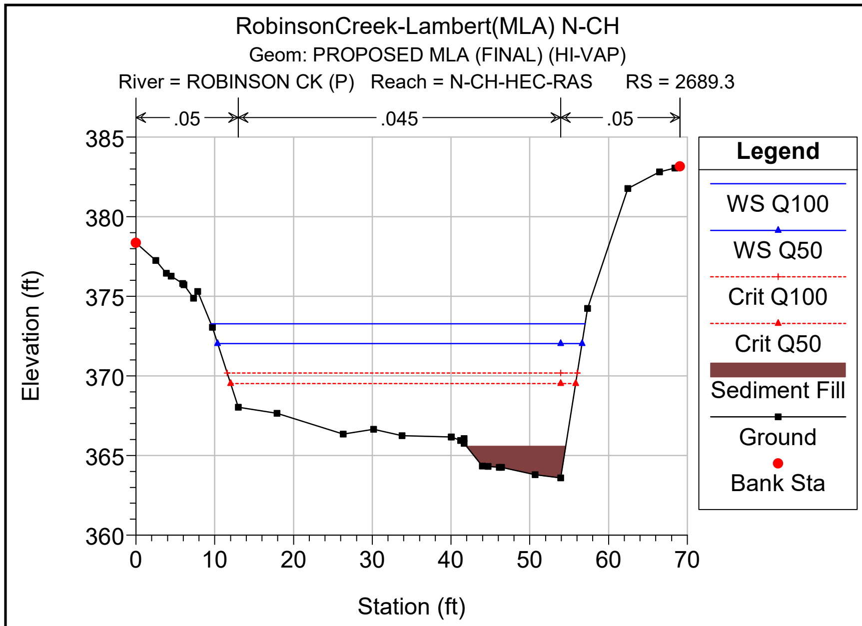

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2822.41 DS REACH OF PROJECT
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

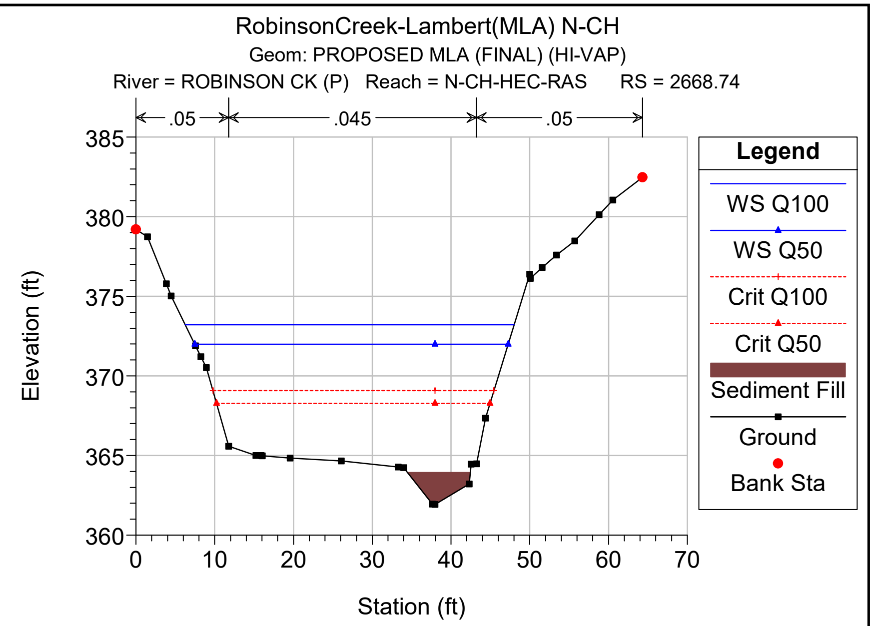

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2806.19
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
Crit Q100
WS Q50
Crit Q50
Sediment Fill
Ground
Bank Sta

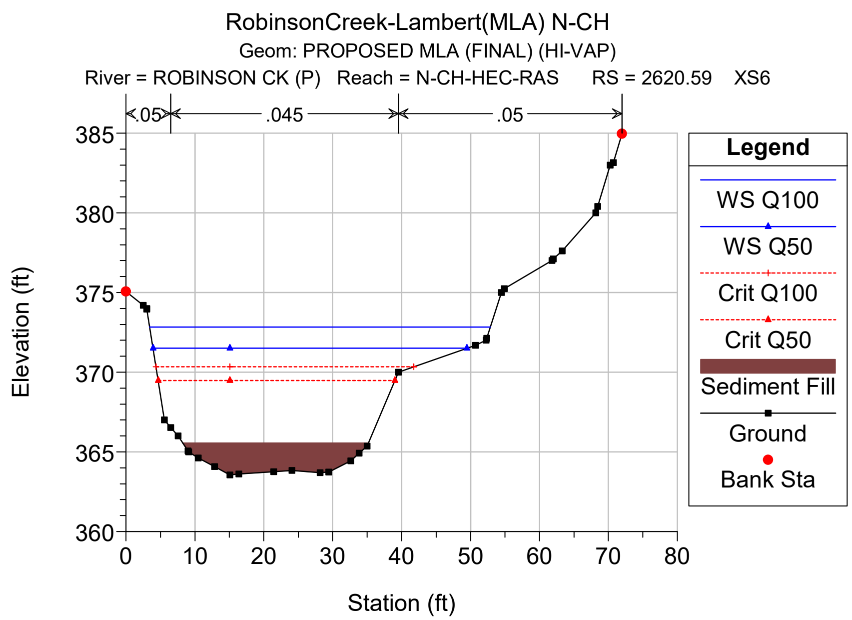

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2775.13
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

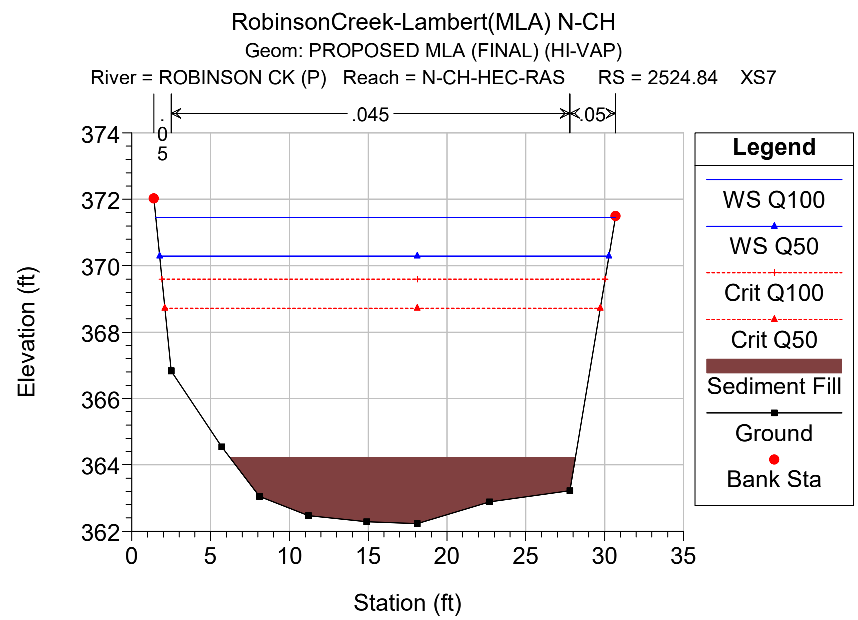

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2749.18
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

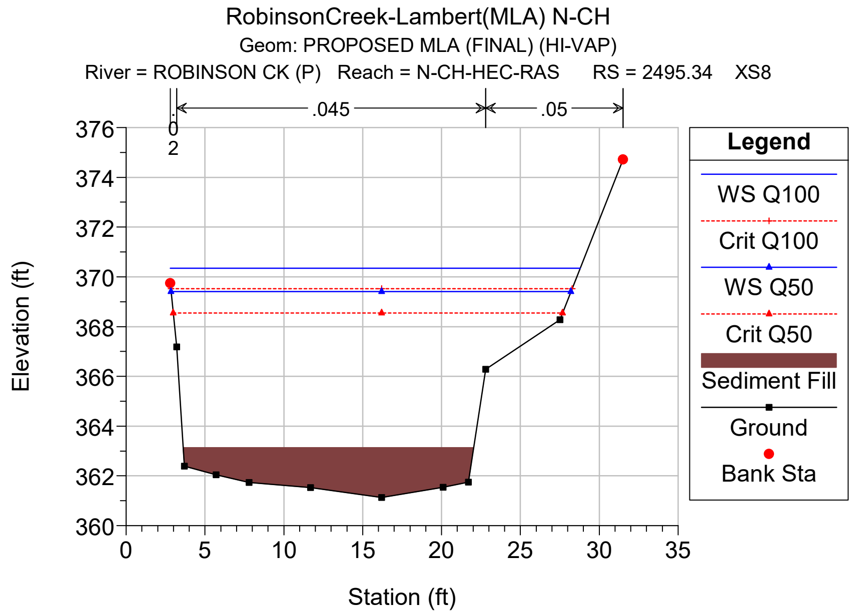

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2722.84
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

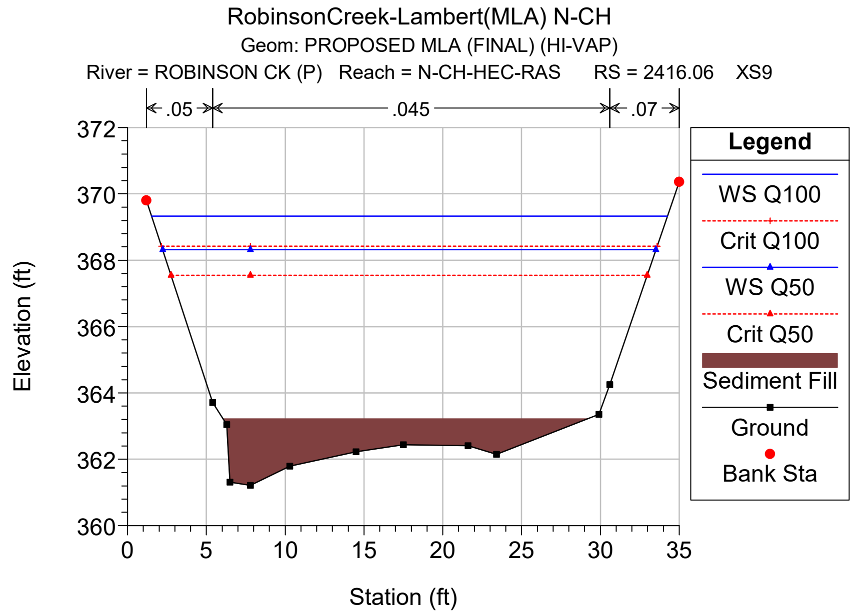

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2689.3
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta


RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2668.74
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta


RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2620.59 XS6
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta

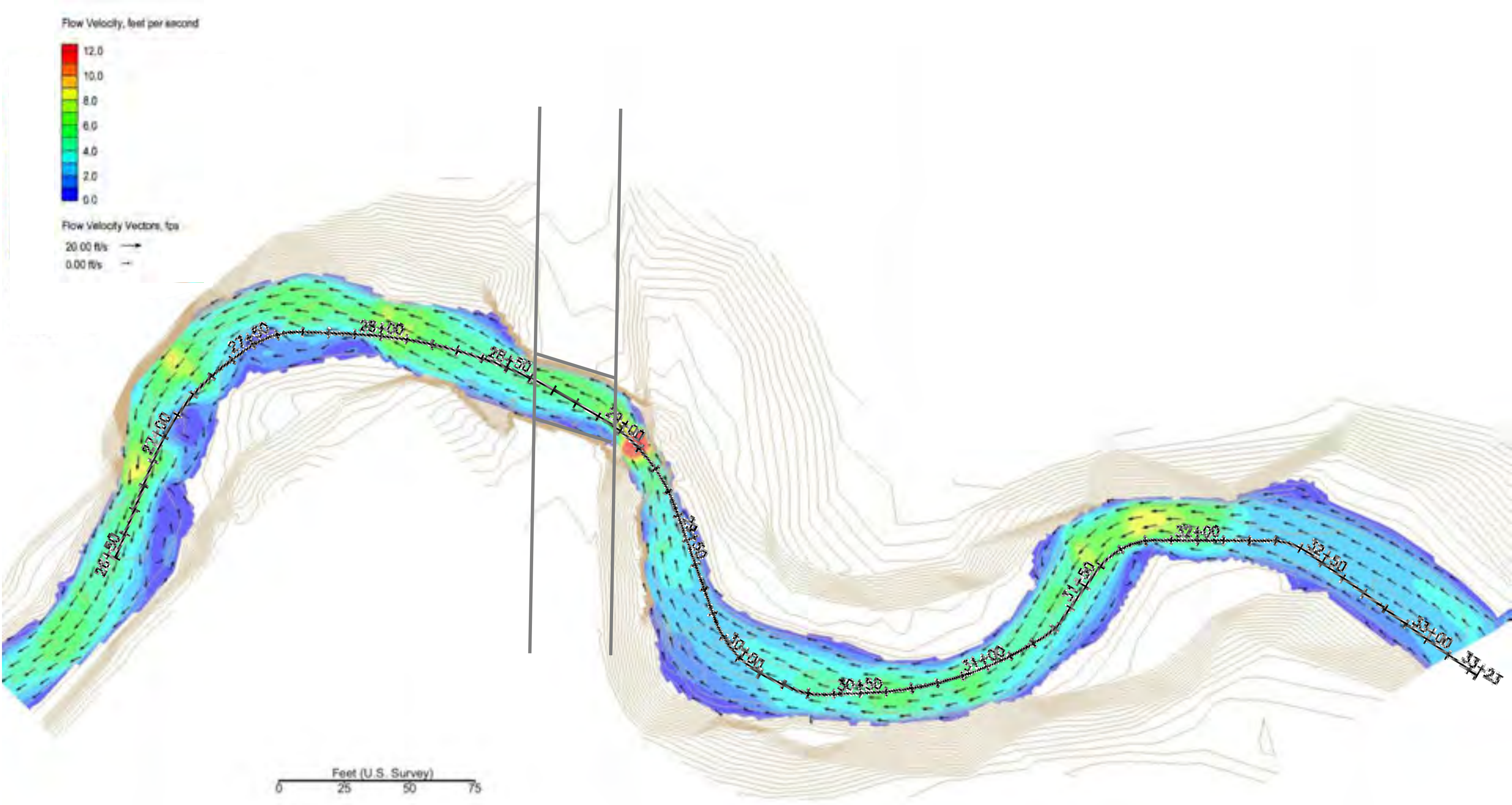

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2524.84 XS7
.045
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q50
Crit Q100
Crit Q50
Sediment Fill
Ground
Bank Sta


RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2495.34 XS8
.045
.05
0
2
376
374
372
370
368
366
364
362
360
0 5 10 15 20 25 30 35
Elevation (ft)
Station (ft)
Legend
WS Q100
Crit Q100
WS Q50
Crit Q50
Sediment Fill
Ground
Bank Sta

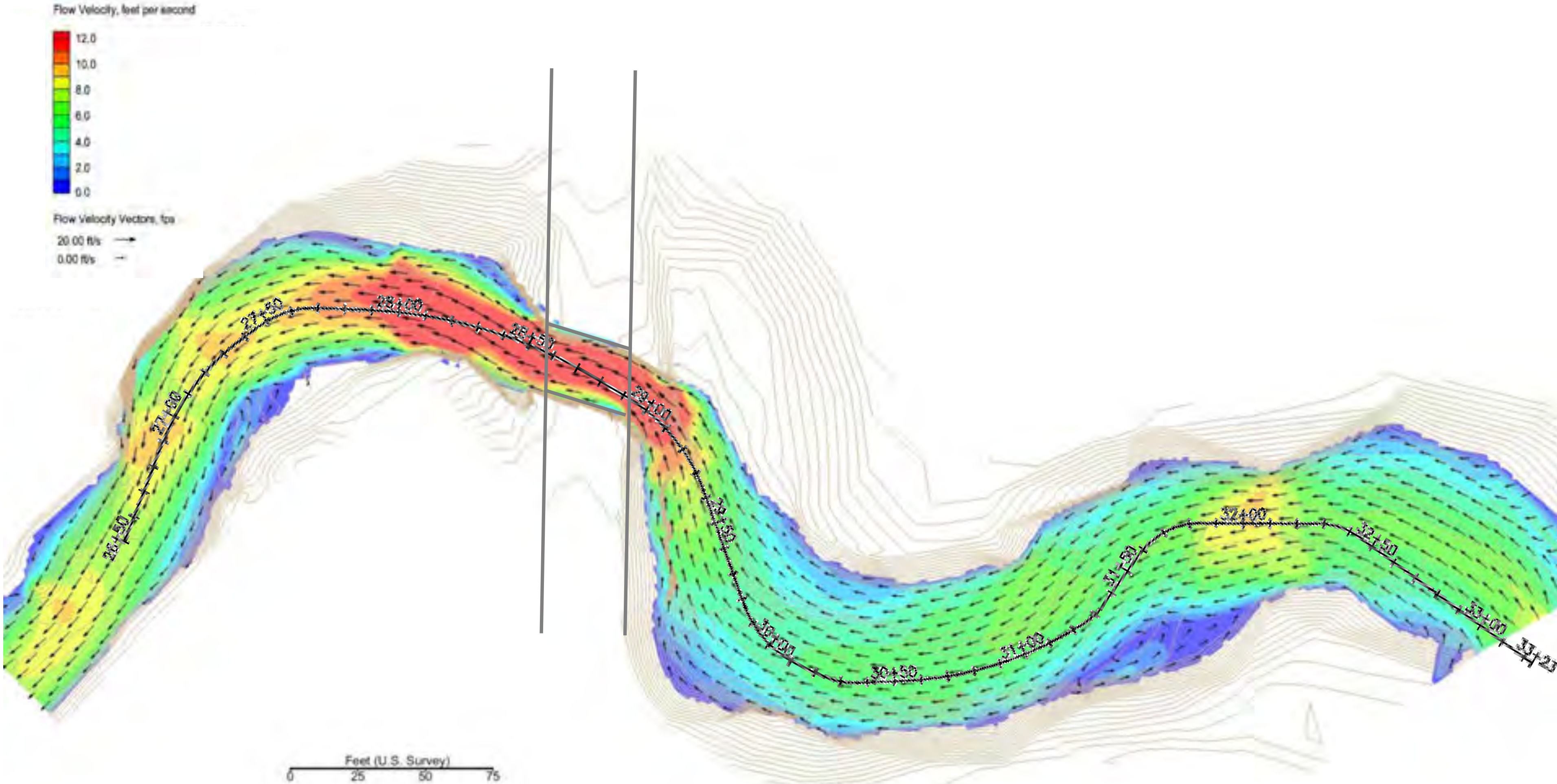

RobinsonCreek-Lambert(MLA) N-CH
Geom: PROPOSED MLA (FINAL) (HI-VAP)
River = ROBINSON CK (P) Reach = N-CH-HEC-RAS RS = 2416.06 XS9
.05
.045
.07
372
370
368
366
364
362
360
0 5 10 15 20 25 30 35
Elevation (ft)
Station (ft)
Legend
WS Q100
Crit Q100
WS Q50
Crit Q50
Sediment Fill
Ground
Bank Sta

Appendix E - SMS Results

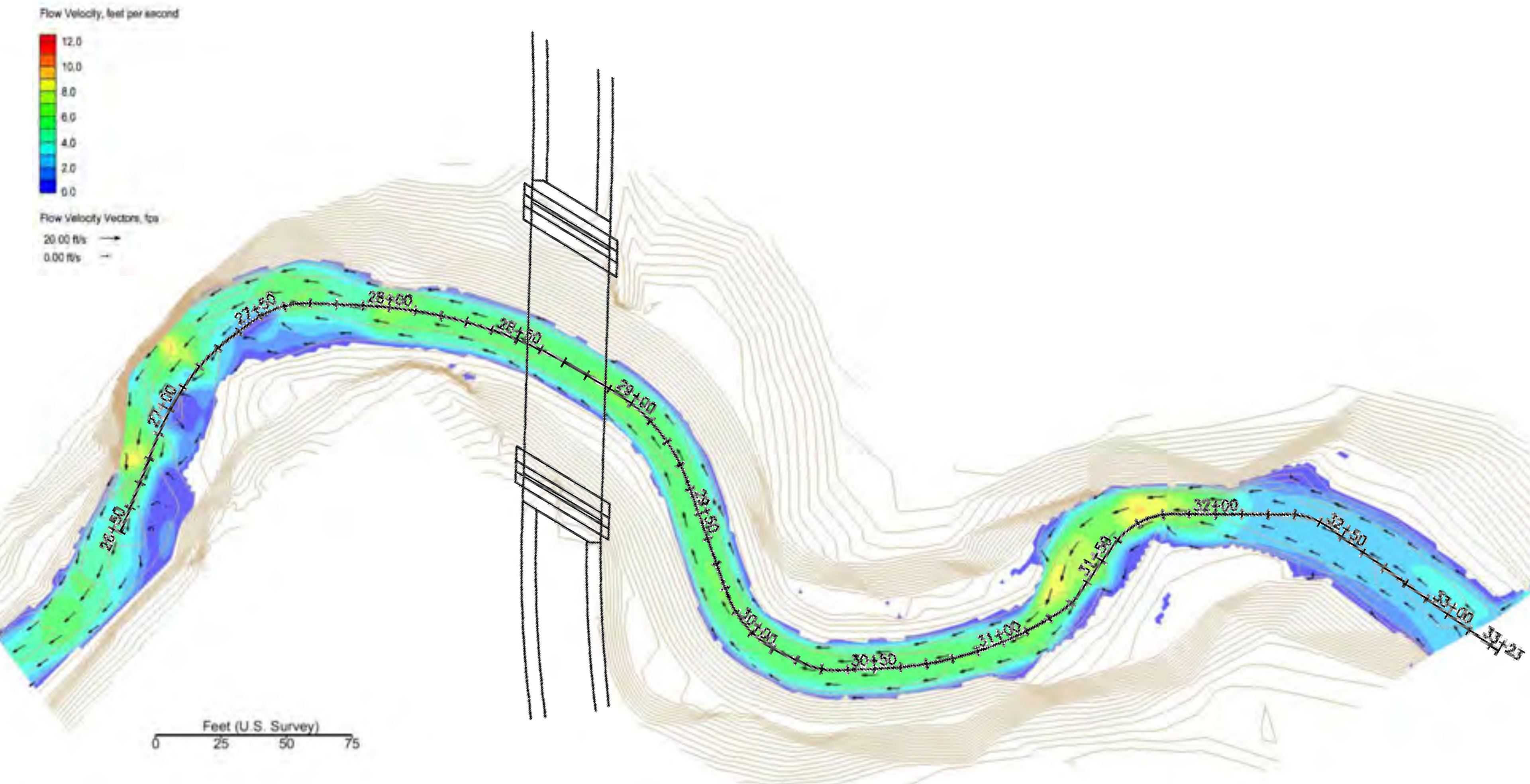
EC 1.5-Year Velocity



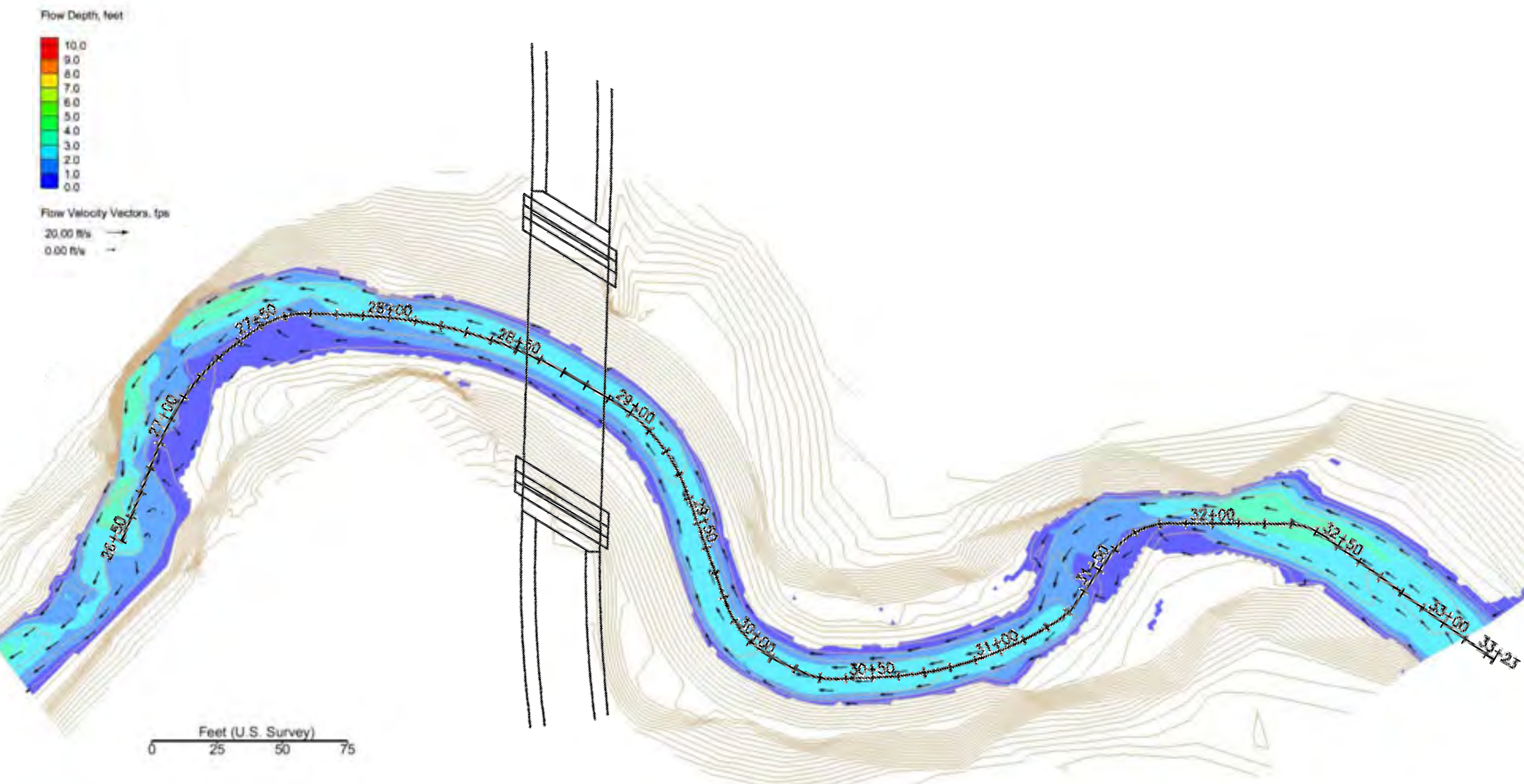
EC 100-year Velocity



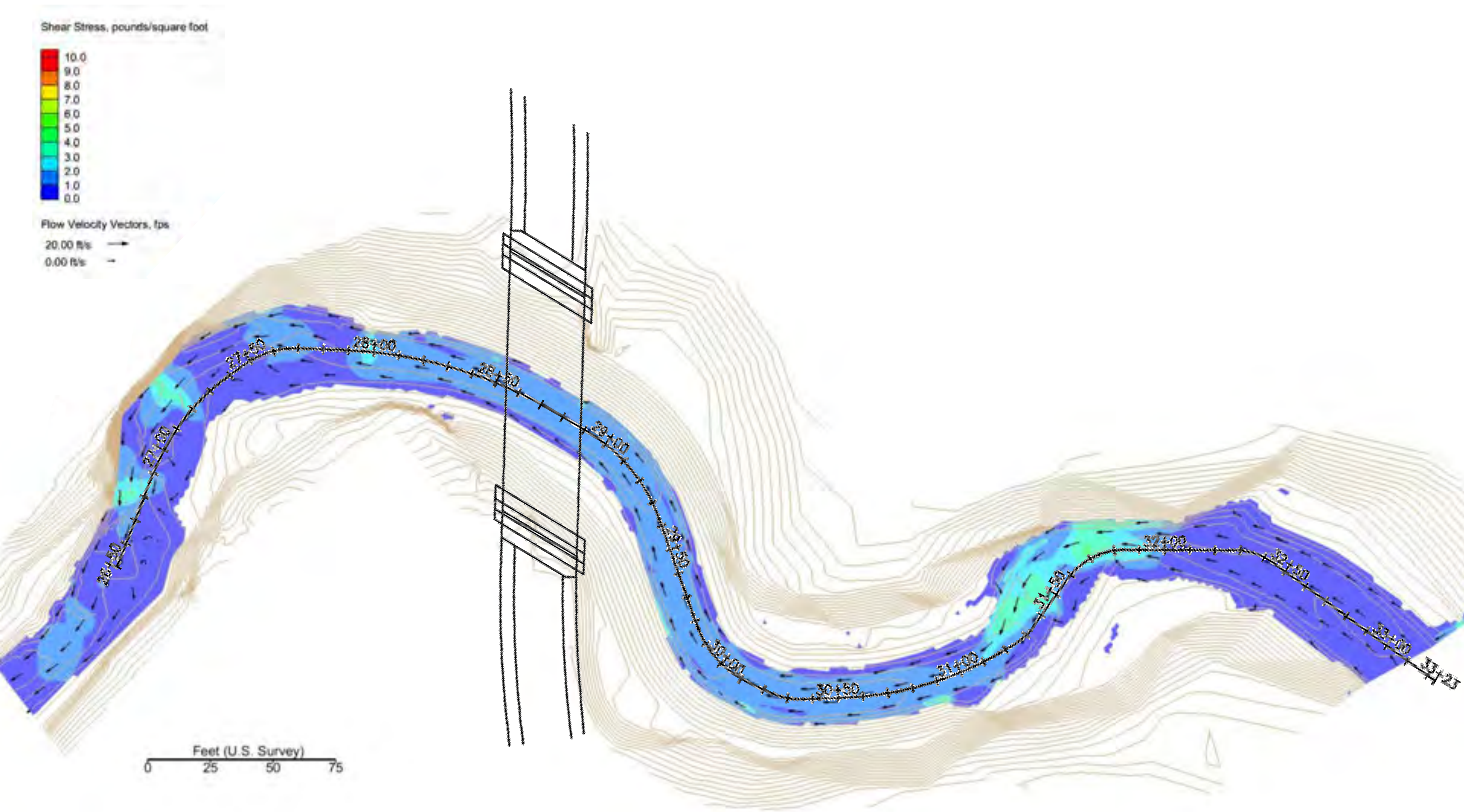
Proposed Conditions 1.5-Year Flow Velocity



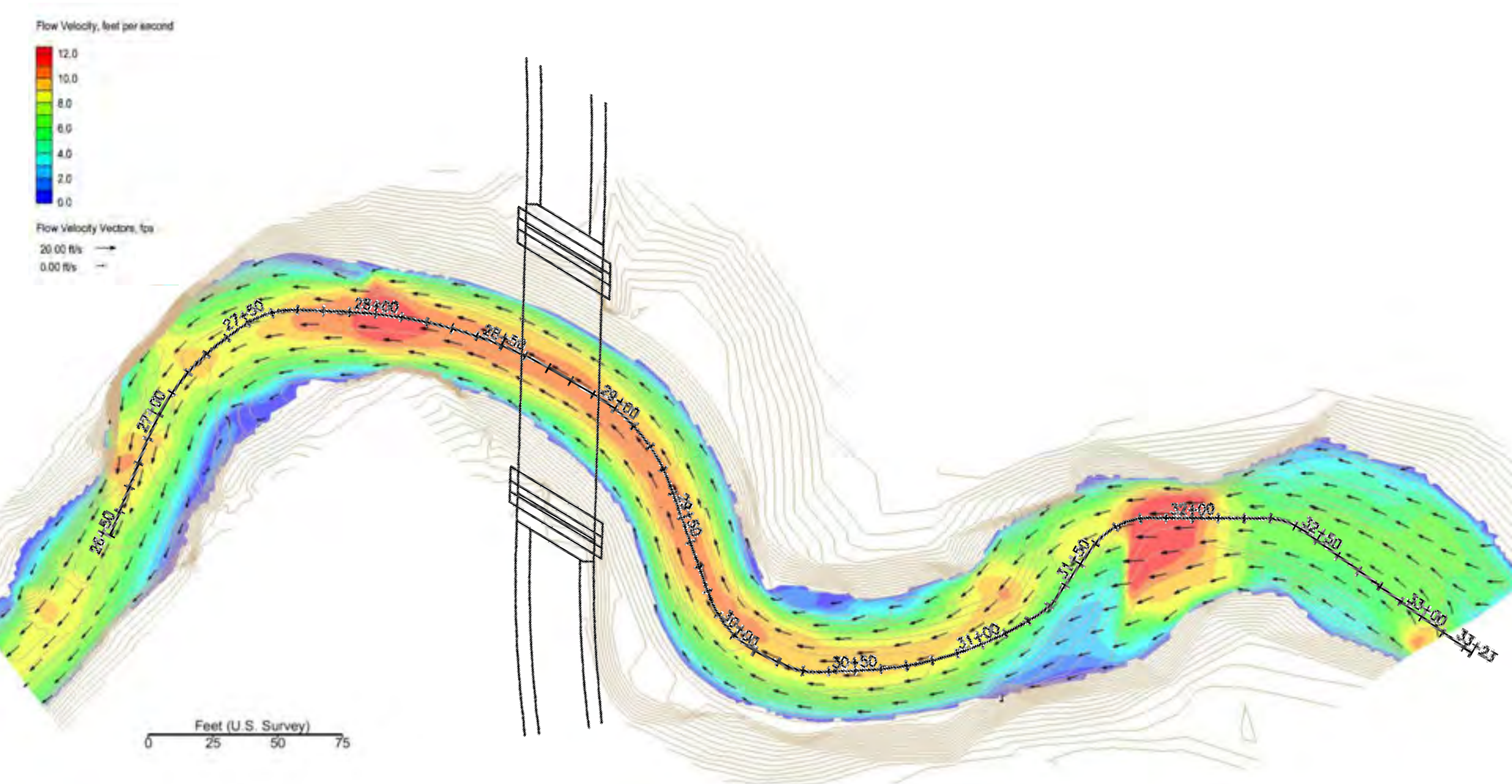
Proposed Conditions 1.5-Year Flow Depth



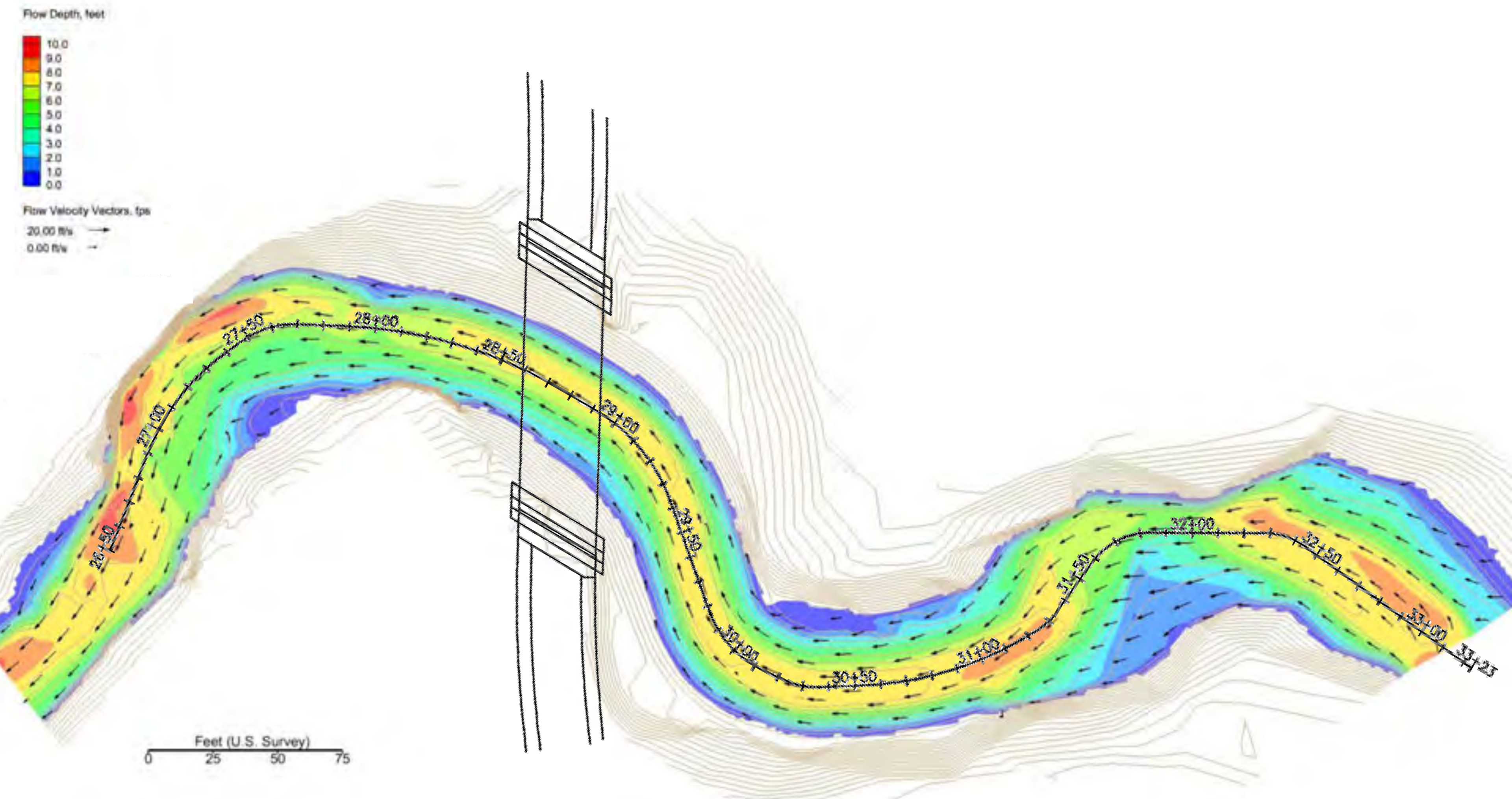
Proposed Conditions 1.5-Year Shear



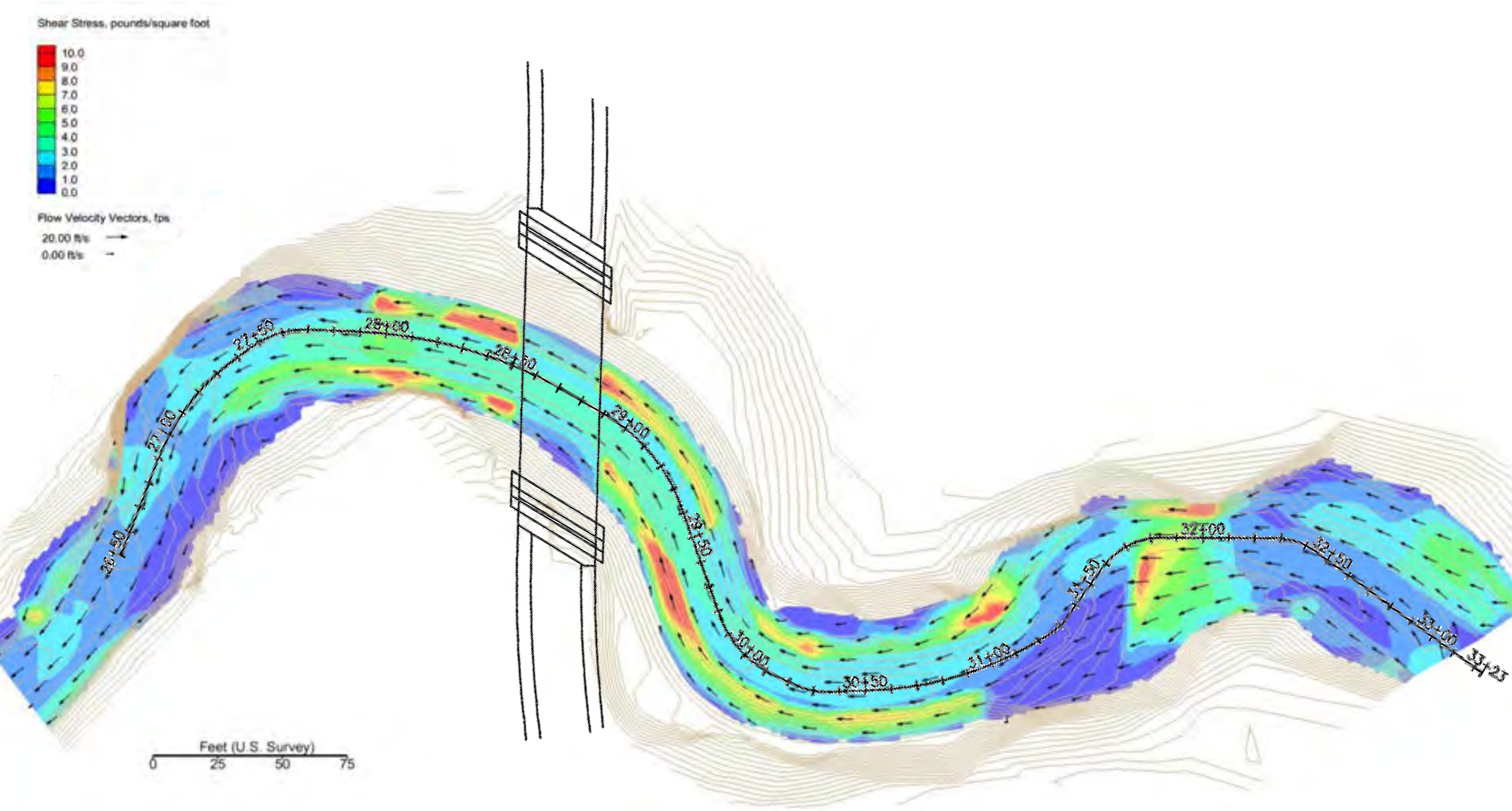
Proposed Conditions 100-Year Flow Velocity



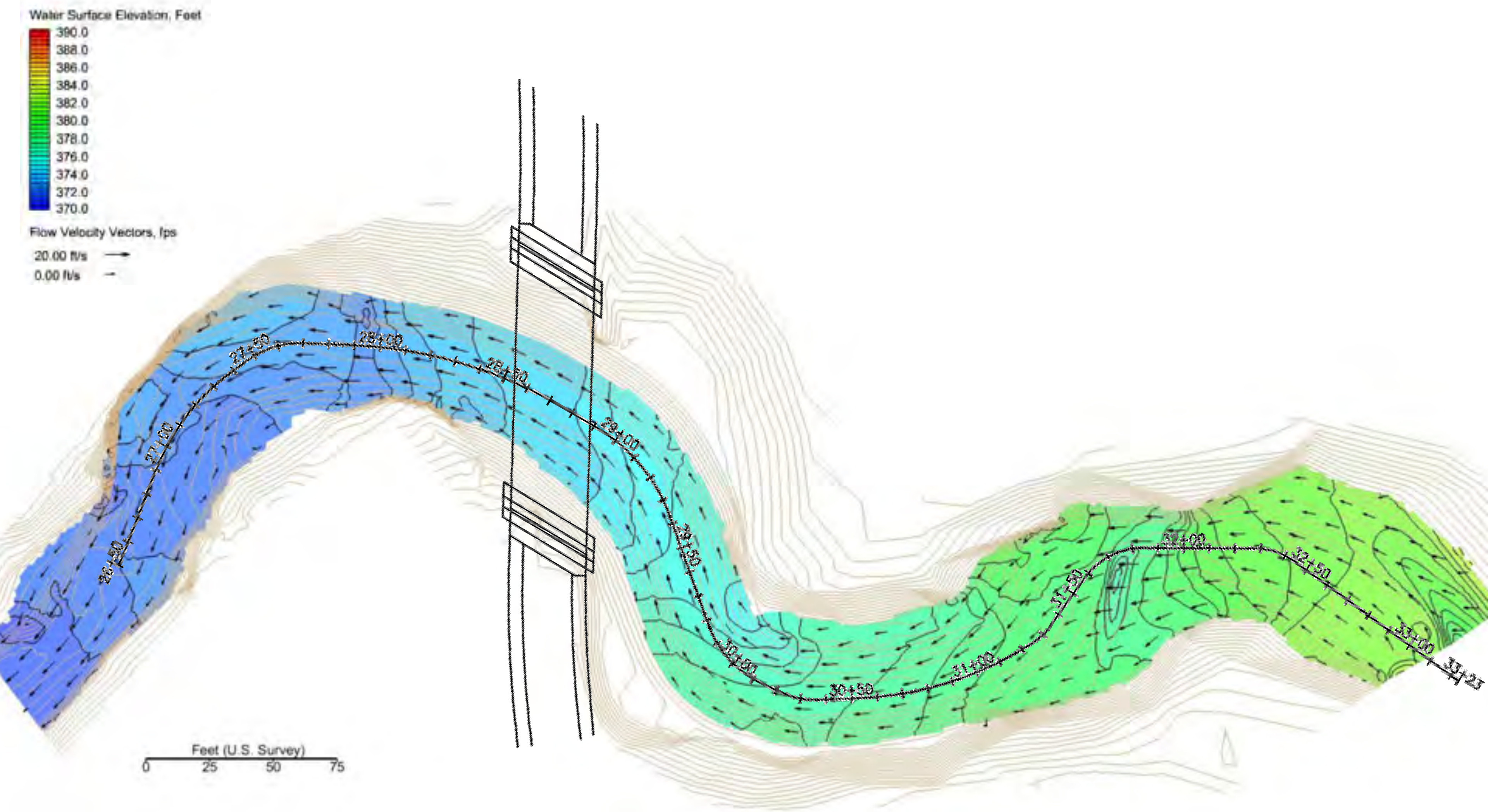
Proposed Conditions 100-Year Flow Depth

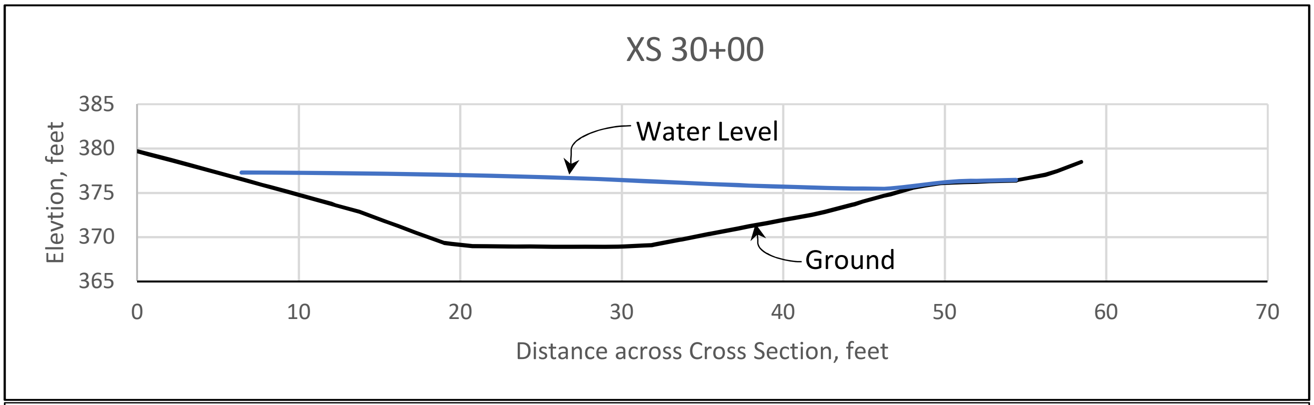


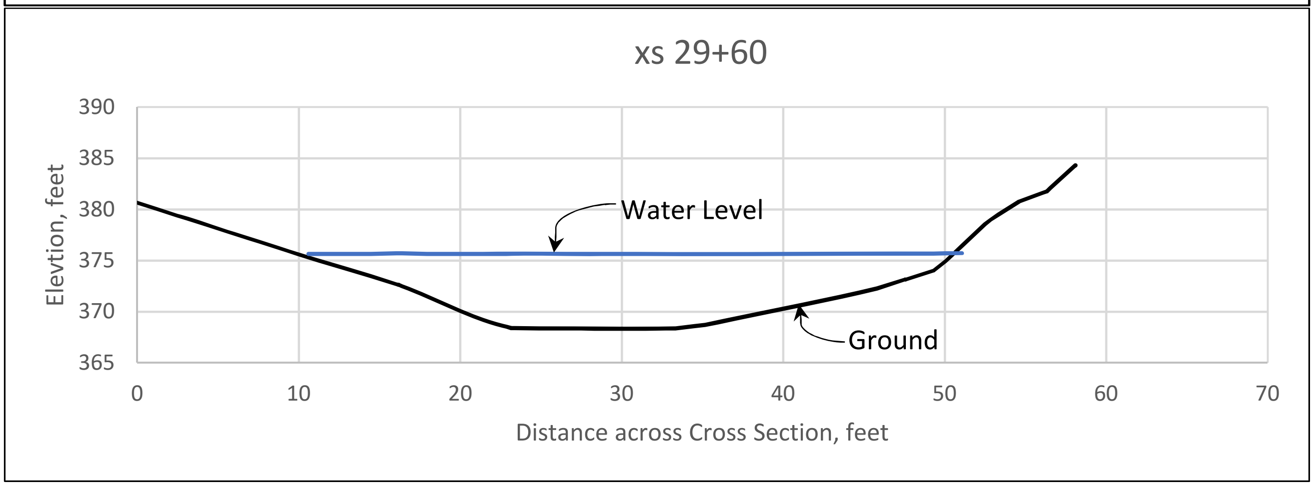
Proposed Conditions 100-Year Shear

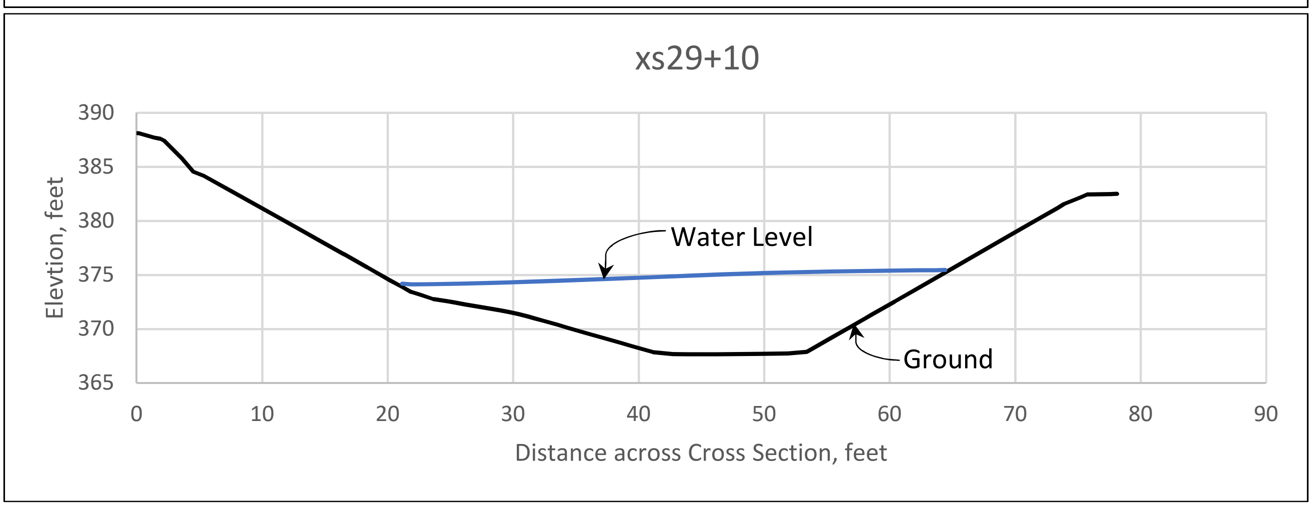


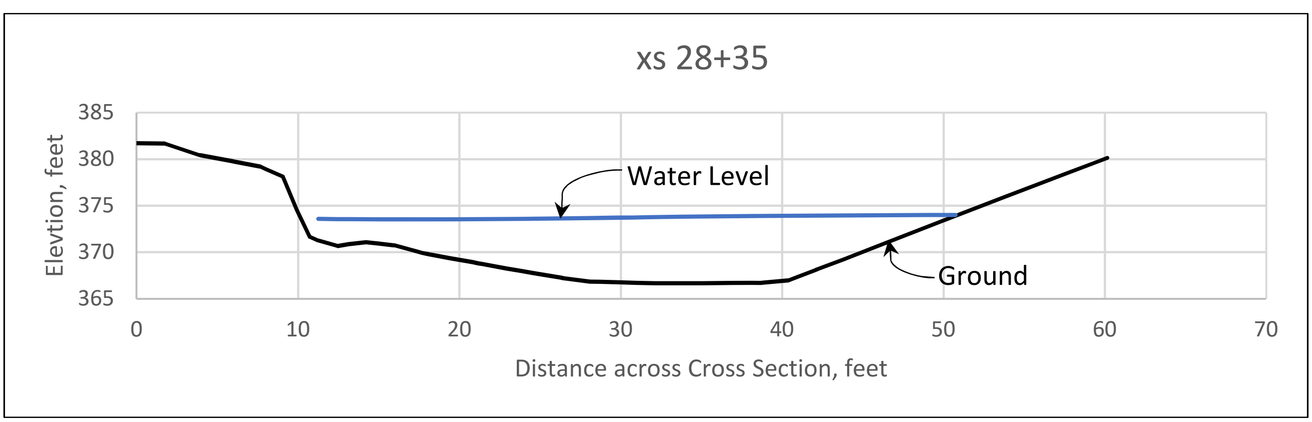
Proposed Conditions 100-Year WSE











100-year water surface elevations predicted by the proposed-condition 2-D modeling at select cross sections.

Appendix F – Rock Slope Protection Design

California Bank and Shore Rock Slope Protection Design

Methods from: CA Dept. of Transportation, Final Report No. FHWA-CA-TL-95-10, Caltrans Study No. F90TL03

$$W = \frac{0.00002}{(SG - 1)^3} \frac{V^6}{SIN^3} \frac{SG}{(r - a)}$$

Solve for:
W = Minimum rock weight which resists forces of flowing water and remains stable on slope of stream or river bank, Pounds

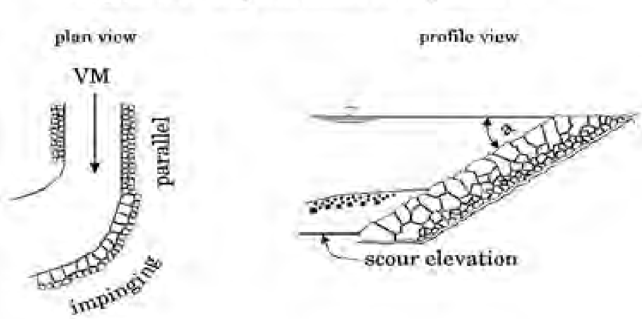
CONSTANTS

Specific Gravity of the rock	SG	2.65
r = 70 Degrees (for randomly placed rubble) [1.22 Rad]	r	1.22
Velocity Multiplier: for Parallel flow =0.67 (2/3), for Impinging flow = 1.33 (4/3)	$V_{Multiplier}$	--

HEC-RAS RIVER STATION:		**30+78**	**30+18**	**29+87**		**29+42**	**28+89**	**28+68**	**28+48**
ROCK PLACEMENT LOCATION:		Approach to Bend Left Bank	Approach to Bend Left Bank	Apex Bend Left Bank		Bridge Approach Both Banks	US Bridge Face Right Bank	Under Bridge Right Bank	DS Bridge Face, Both Banks
INPUT VARIABLES									
Side Slope Correction Factor									
Side Slope	**(h:1v)**	**1.5**	**1.5**	**1.5**	**2.0**	**1.5**	**1.5**	**1.5**	**1.5**
Slope (radians)	a	0.59	0.59	0.59	0.46	0.59	0.59	0.59	0.59
Design Variables									
Velocity to which bank is exposed, (fps)	**V**	**8.92**	**10.59**	**9.96**	**10.59**	**9.88**	**7.49**	**7.60**	**8.75**
Velocity Multiplier	$V_{Multiplier}$	**0.67**	**0.67**	**1.33**	**1.33**	**0.67**	**1.33**	**1.33**	**0.67**
RESULTS									
Rock Size									
Min stable rock size (lbs)	**W**	**3**	**7**	**309**	**285**	**5**	**56**	**61**	**2**

NOTES:
Slope (radians) [1.5:1 =0.59, 2:1=0.46, 3:1 =0.32]

Figure 5-1. Key Variables in Equation 1



Stone Stability Calculation

USACE 1110-2-1601 , 1994. Hydraulic Design of Flood Control Channels, ***<u>Equation 3-3</u>***

Equation for sizing riprap for channel bottom and side slopes

$$D_{30} = S_f C_s C_v C_T d \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right)^{1/2} \frac{V}{\sqrt{K_1 g d}} \right]^{2.5} \qquad (3\text{-}3)$$

$$K_1 = \sqrt{1 - \frac{\sin^2 \theta}{\sin^2 \phi}}$$

and

$$D_{50} = D_{30} (D_{85}/D_{15})^{(1/3)}$$

CONSTANTS

Stability Coef. for Incipient Failure (D85/D15 = 1.7 to 5.2) *0.30 = Angular Rock; 0.375 = Rounded Rock*	Cs	0.30
Vertical Velocity Distribution Coefficient *1.0 = Straight Chnls* *1.283-.2log(R/W) = Outside of Bends* *1.25 = Downstream of Conc. Channels & End of Dikes*	Cv	--
Thickness of Coefficient 1.0 = thickness of 1D100 or 1.5D50 (whichever greater)	Ct	1.0
Gravitational Constant (ft/s^2)	g	32.2
Unit Weight of Water (lb/cf)	γw	62.4
Unit Weight of Sediment or Rock (lb/cf)	γs	165

HEC-RAS RIVER STATION:		30+78	30+18	29+87		29+42	28+89	28+68	28+48
ROCK PLACEMENT LOCATION:		Approach to Bend	Approach to Bend	Apex Bend		Bridge Approach	US Bridge Face	Under Bridge	DS Bridge Face
BANK SIDE:		Left Bank	Left Bank	Left Bank		Both Banks	Right Bank	Right Bank	Both Banks
INPUT VARIABLES									
Side Slope Correction Factor									
Angle of Repose of Riprap (deg) *Normally 40 deg*	ϕ	40	40	40	40	40	40	40	40
Side Slope	**(h:1v)**	**1.5**	**1.5**	**1.5**	**2.0**	**1.5**	**1.5**	**1.5**	**1.5**
Angle of Side Slope with Horizontal (deg) [1.5:1 = 33.7, 2:1=26.6]	Θ	33.7	33.7	33.7	26.6	33.7	33.7	33.7	33.7
Side Slope Correction Factor	K1	0.51	0.51	0.51	0.72	0.51	0.51	0.51	0.51
Design Variables									
Depth-Averaged Local Velocity[1,] (ft/s)	**V**	**8.92**	**10.59**	**9.96**	**10.59**	**9.88**	**7.49**	**7.60**	**8.75**
Centerline Radius of Bend	**R**			**46.7**	**46.7**		**67.0**	**67.0**	
Water Surface Width	**W**			**49.4**	**49.4**		**40.4**	**40.4**	
Velocity Distrubution Coefficient[2]	**Cv**	**1.00**	**1.00**	**1.29**	**1.288**	**1.00**	**1.239**	**1.24**	**1.00**
Local Depth of Flow (ft)	**d**	**7.10**	**6.53**	**6.62**	**6.53**	**6.63**	**7.26**	**7.35**	**7.16**
Safety Factor	**Sf**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**
Rock Gradation									
Gradation Ratio (for Calculating D50)	**D84/D15**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**	**1.6**
RESULTS									
D30 Rock									
Rock Diameter (ft)	**D30**	**1.4**	**2.3**	**2.5**	**1.9**	**1.9**	**1.1**	**1.2**	**1.4**
Weight (lb) [dia. rounded to tenths]	**W30**	**237**	**1,051**	**1,350**	**593**	**593**	**115**	**149**	**237**
D50 Rock									
Rock Diameter (ft)	**D50**	**1.7**	**2.6**	**2.9**	**2.2**	**2.2**	**1.3**	**1.4**	**1.6**
Weight (lb) [dia. rounded to tenths]	**W50**	**424**	**1,518**	**2,107**	**920**	**920**	**190**	**237**	**354**

<u>NOTES</u>:

1. *In straight reaches, V = Vave.*

2. C_V *Velocity Distribution Coefficient*

Cv = 1.283-0.2*LOG(R/W)

Cv = 1.0 for straight reaches

Stone Stability Calculation

USACE 1110-2-1601 , 1994. Hydraulic Design of Flood Control Channels, Equation 3-5

Equation for Sizing Riprap in Steeper Channels for Channel Bottom and Side Slopes

Q100yr:	**1,760**	cfs	
Slope of Bed	**0.013**	ft/ft	
Water Surface Slope:	0.012	ft/ft	*(from HEC RAS)*

$$D_{30} = \frac{1.95\ S^{0.555}\ q^{2/3}}{g^{1/3}}$$

HEC-RAS RIVER STATION:		**30+18**	**29+87**
INPUT VARIABLES			
Unit Discharge:			
Design Flow (cfs):	**Q100yr**	**1,760**	**1,760**
Active Channel Bed (Bottom) Width (ft):	***W***	**11.5**	**11.5**
Unit Discharge of Active Bed (cfs/ft):	***q***	153.04	153.04
Flow Concentration Factor (1.25 or greater for skewed approach flow)		**1**	**1.25**
Gradation Ratio (for Calculating D50)	D84/D15	1.6	1.6
RESULTS			
D30 Rock			
Rock Diameter (ft)	**D30**	**1.6**	**1.8**
Weight (lb) [dia. rounded to tenths]	**W30**	**354**	**504**
D50 Rock			
Rock Diameter (ft)	**D50**	**1.8**	**2.1**
Weight (lb) [dia. rounded to tenths]	**W50**	**504**	**800**

Scour Depth Calculation

USACE CHL-98-20 , 1998. Users's Manual for CHANLPRO, Equation (2)

Equation for estimating scour depth at riprap toe

Ref: Toe-Scour Estimation in Stablized Bendways Maynord (1996a) Equation 16

SF = Safety Factor (see Table 1) **1.19**

Flow Condition 1760 cfs
Return Interval Q100

		US Bend		Bridge Face
HEC-RAS RIVER STATION:		**30+18**	**29+87**	**28+88**
ROCK PLACEMENT LOCATION:		Left Bank	Left Bank	Right Bank
INPUT VARIABLES				
Section Upstream of Bend				
Main Channel Area (sf)	**A**	**197.4**	**197.4**	**178.1**
Main Channel Width (ft)	**W**	**45.5**	**45.5**	**39.7**
Avg depth in crossing upstream of bend (ft)	$\mathbf{D_{mnc}}$	4.3	4.3	4.5
Section at Bend				
Existing water depth in Bend (ft)	**D**	**6.5**	**6.6**	**7.3**
Centerline radius of bend main channel (ft)	**R**	**46.7**	**46.7**	**67.0**
R/W Should be limited from 1.5 to 10. (For R/W< 1.5, use 1.5)	**R/W**	1.03	1.03	1.69
Aspect ratio W/D_{mnc} from 20 to 125 (For W/D_{MNC} < 20, use 20)	$\mathbf{W/D_{mnc}}$	10.47	10.47	8.86
RESULTS				
Max water Depth in Bend (ft)	$\mathbf{D_{mxb}}$	9.48	9.48	9.54
Scour Depth (ft)	$\mathbf{D_{scr}}$	**2.95**	**2.86**	**2.28**
ALTERNATIVE for R/W =1.5, and W/Dmnc=20	D_{mxb}	*9.8*	*9.8*	*10.1*
Scour Depth (ft)	D_{scr}	*3.24*	*3.15*	*2.83*

Notes:

Based on flows with 1 to 5 year return interval or overbank depth less than 20% of channel depth

D_{mnc} should be based on flow in main channel only

SF of 1.14 is recommended by USACE. For 1.14, 5% of the observed data will have a scour depth deeper than the predicted depth. A threshold of 5 percent difference between predicted and observed is used (D/D = 0.95).

Appendix B – Species Lists

United States Fish and Wildlife Service, IPaC

National Marine Fisheries Service

California Department of Fish and Wildlife Natural Diversity Database

California Native Plant Society

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Arcata Fish And Wildlife Office
1655 Heindon Road
Arcata, CA 95521-4573
Phone: (707) 822-7201 Fax: (707) 822-8411

In Reply Refer To: March 06, 2019
Consultation Code: 08EACT00-2019-SLI-0213
Event Code: 08EACT00-2019-E-00481
Project Name: Lambert Lane 2

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Arcata Fish And Wildlife Office
1655 Heindon Road
Arcata, CA 95521-4573
(707) 822-7201

Project Summary

Consultation Code: 08EACT00-2019-SLI-0213

Event Code: 08EACT00-2019-E-00481

Project Name: Lambert Lane 2

Project Type: BRIDGE CONSTRUCTION / MAINTENANCE

Project Description: Revised boundary for Lambert Lane

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/39.006710394937066N123.36810307383504W

Counties: Mendocino, CA

Endangered Species Act Species

There is a total of 8 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Birds

NAME	STATUS
Northern Spotted Owl *Strix occidentalis caurina* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1123	Threatened
Western Snowy Plover *Charadrius nivosus nivosus* Population: Pacific Coast population DPS-U.S.A. (CA, OR, WA), Mexico (within 50 miles of Pacific coast) There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/8035	Threatened
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **proposed** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

Amphibians

NAME	STATUS
California Red-legged Frog *Rana draytonii* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/2891	Threatened

Fishes

NAME	STATUS
Tidewater Goby *Eucyclogobius newberryi* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/57	Endangered

Flowering Plants

NAME	STATUS
Burke's Goldfields *Lasthenia burkei* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4338	Endangered
Contra Costa Goldfields *Lasthenia conjugens* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/7058	Endangered
Showy Indian Clover *Trifolium amoenum* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6459	Endangered

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

Elena Gregg

From:	Elena Gregg
Sent:	Monday, February 11, 2019 1:51 PM
To:	'nmfswcrca.specieslist@noaa.gov'
Subject:	Robinson Creek Bridge Replacement on Lambert Lane, Boonville, CA

Search Results:

Quad Name **Boonville**
Quad Number **39123-A3**

ESA Anadromous Fish

SONCC Coho ESU (T) -	
CCC Coho ESU (E) -	**X**
CC Chinook Salmon ESU (T) -	**X**
CVSR Chinook Salmon ESU (T) -	
SRWR Chinook Salmon ESU (E) -	
NC Steelhead DPS (T) -	**X**
CCC Steelhead DPS (T) -	**X**
SCCC Steelhead DPS (T) -	
SC Steelhead DPS (E) -	
CCV Steelhead DPS (T) -	
Eulachon (T) -	
sDPS Green Sturgeon (T) -	

ESA Anadromous Fish Critical Habitat

SONCC Coho Critical Habitat -	
CCC Coho Critical Habitat -	**X**
CC Chinook Salmon Critical Habitat -	
CVSR Chinook Salmon Critical Habitat -	
SRWR Chinook Salmon Critical Habitat -	
NC Steelhead Critical Habitat -	**X**
CCC Steelhead Critical Habitat -	
SCCC Steelhead Critical Habitat -	
SC Steelhead Critical Habitat -	
CCV Steelhead Critical Habitat -	
Eulachon Critical Habitat -	
sDPS Green Sturgeon Critical Habitat -	

ESA Marine Invertebrates

Range Black Abalone (E) -
Range White Abalone (E) -

ESA Marine Invertebrates Critical Habitat

Black Abalone Critical Habitat -

ESA Sea Turtles

East Pacific Green Sea Turtle (T) -
Olive Ridley Sea Turtle (T/E) -
Leatherback Sea Turtle (E) -
North Pacific Loggerhead Sea Turtle (E) -

ESA Whales

Blue Whale (E) -
Fin Whale (E) -
Humpback Whale (E) -
Southern Resident Killer Whale (E) -
North Pacific Right Whale (E) -
Sei Whale (E) -
Sperm Whale (E) -

ESA Pinnipeds

Guadalupe Fur Seal (T) -
Steller Sea Lion Critical Habitat -

Essential Fish Habitat

Coho EFH - **X**
Chinook Salmon EFH - **X**
Groundfish EFH -
Coastal Pelagics EFH -
Highly Migratory Species EFH -

MMPA Species (See list at left)

ESA and MMPA Cetaceans/Pinnipeds

See list at left and consult the NMFS Long Beach office
562-980-4000

MMPA Cetaceans -
MMPA Pinnipeds -

Agency Name:

FHA/Caltrans District 1

Point-of-Contact:

Elena Gregg
Gallaway Enterprises
117 Meyers Street, Suite 120
Chico, CA 95928
530.332.9909

Elena Gregg
Gallaway Enterprises
530.332.9909

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad IS (Bailey Ridge (3912324) OR Orrs Springs (3912323) OR Ukiah (3912322) OR Philo (3912314) OR Boonville (3912313) OR Elledge Peak (3912312) OR Zeni Ridge (3812384) OR Ornbaun Valley (3812383) OR Yorkville (3812382))

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Accipiter gentilis northern goshawk	ABNKC12060	None	None	G5	S3	SSC
Arborimus pomo Sonoma tree vole	AMAFF23030	None	None	G3	S3	SSC
Arctostaphylos stanfordiana ssp. raichei Raiche's manzanita	PDERI041G2	None	None	G3T2	S2	1B.1
Astragalus agnicidus Humboldt County milk-vetch	PDFAB0F080	None	Endangered	G2	S2	1B.1
Bombus caliginosus obscure bumble bee	IIHYM24380	None	None	G4?	S1S2	
Ceanothus confusus Rincon Ridge ceanothus	PDRHA04220	None	None	G1	S1	1B.1
Corynorhinus townsendii Townsend's big-eared bat	AMACC08010	None	None	G3G4	S2	SSC
Dicamptodon ensatus California giant salamander	AAAAH01020	None	None	G3	S2S3	SSC
Emys marmorata western pond turtle	ARAAD02030	None	None	G3G4	S3	SSC
Erethizon dorsatum North American porcupine	AMAFJ01010	None	None	G5	S3	
Erythronium revolutum coast fawn lily	PMLIL0U0F0	None	None	G4G5	S3	2B.2
Falco peregrinus anatum American peregrine falcon	ABNKD06071	Delisted	Delisted	G4T4	S3S4	FP
Fissidens pauperculus minute pocket moss	NBMUS2W0U0	None	None	G3?	S2	1B.2
Fritillaria roderickii Roderick's fritillary	PMLIL0V0M0	None	Endangered	G1Q	S1	1B.1
Grimmia torenii Toren's grimmia	NBMUS32330	None	None	G2	S2	1B.3
Haliaeetus leucocephalus bald eagle	ABNKC10010	Delisted	Endangered	G5	S3	FP
Harmonia guggolziorum Guggolz's harmonia	PDAST650M0	None	None	G1	S1	1B.1
Helminthoglypta arrosa pomoensis Pomo bronze shoulderband	IMGASC2033	None	None	G2G3T1	S1	
Lasiurus cinereus hoary bat	AMACC05030	None	None	G5	S4	

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Lasthenia burkei Burke's goldfields	PDAST5L010	Endangered	Endangered	G1	S1	1B.1
Limnanthes bakeri Baker's meadowfoam	PDLIM02020	None	Rare	G1	S1	1B.1
Malacothamnus mendocinensis Mendocino bush-mallow	PDMAL0Q0D0	None	None	GXQ	SX	1A
Navarretia leucocephala ssp. bakeri Baker's navarretia	PDPLM0C0E1	None	None	G4T2	S2	1B.1
Oncorhynchus kisutch pop. 4 coho salmon - central California coast ESU	AFCHA02034	Endangered	Endangered	G4	S2?	
Oncorhynchus mykiss irideus pop. 16 steelhead - northern California DPS	AFCHA0209Q	Threatened	None	G5T2T3Q	S2S3	
Pandion haliaetus osprey	ABNKC01010	None	None	G5	S4	WL
Piperia candida white-flowered rein orchid	PMORC1X050	None	None	G3	S3	1B.2
Pleuropogon hooverianus North Coast semaphore grass	PMPOA4Y070	None	Threatened	G2	S2	1B.1
Rana boylii foothill yellow-legged frog	AAABH01050	None	Candidate Threatened	G3	S3	SSC
Streptanthus glandulosus ssp. hoffmanii Hoffman's bristly jewelflower	PDBRA2G0J4	None	None	G4T2	S2	1B.3
Taricha rivularis red-bellied newt	AAAAF02020	None	None	G4	S2	SSC
Trifolium buckwestiorum Santa Cruz clover	PDFAB402W0	None	None	G2	S2	1B.1
Usnea longissima Methuselah's beard lichen	NLLEC5P420	None	None	G4	S4	4.2

Record Count: 33

CNPS California Native Plant Society

Plant List

Inventory of Rare and Endangered Plants

17 matches found. *Click on scientific name for details*

Search Criteria

California Rare Plant Rank is one of [1A, 1B, 2A, 2B], Found in Quads 3912324, 3912323, 3912322, 3912314, 3912313, 3912312, 3812384 3812383 and 3812382;

Modify Search Criteria Export to Excel Modify Columns Modify Sort Display Photos

Scientific Name	Common Name	Family	Lifeform	Blooming Period	CA Rare Plant Rank	State Rank	Global Rank
Arctostaphylos stanfordiana ssp. raichei	Raiche's manzanita	Ericaceae	perennial evergreen shrub	Feb-Apr	1B.1	S2	G3T2
Astragalus agnicidus	Humboldt County milk-vetch	Fabaceae	perennial herb	Apr-Sep	1B.1	S2	G2
Ceanothus confusus	Rincon Ridge ceanothus	Rhamnaceae	perennial evergreen shrub	Feb-Jun	1B.1	S1	G1
Erythronium revolutum	coast fawn lily	Liliaceae	perennial bulbiferous herb	Mar-Jul(Aug)	2B.2	S3	G4G5
Fissidens pauperculus	minute pocket moss	Fissidentaceae	moss		1B.2	S2	G3?
Fritillaria roderickii	Roderick's fritillary	Liliaceae	perennial bulbiferous herb	Mar-May	1B.1	S1	G1Q
Grimmia torenii	Toren's grimmia	Grimmiaceae	moss		1B.3	S2	G2
Harmonia guggolziorum	Guggolz' harmonia	Asteraceae	annual herb	Apr-May	1B.1	S1	G1
Lasthenia burkei	Burke's goldfields	Asteraceae	annual herb	Apr-Jun	1B.1	S1	G1
Limnanthes bakeri	Baker's meadowfoam	Limnanthaceae	annual herb	Apr-May	1B.1	S1	G1
Malacothamnus mendocinensis	Mendocino bush-mallow	Malvaceae	perennial deciduous shrub	May-Jun	1A	SX	GXQ
Navarretia leucocephala ssp. bakeri	Baker's navarretia	Polemoniaceae	annual herb	Apr-Jul	1B.1	S2	G4T2
Piperia candida	white-flowered rein orchid	Orchidaceae	perennial herb	(Mar)May-Sep	1B.2	S3	G3
Pleuropogon hooverianus	North Coast semaphore grass	Poaceae	perennial rhizomatous herb	Apr-Jun	1B.1	S2	G2
Sanguisorba officinalis	great burnet	Rosaceae	perennial rhizomatous herb	Jul-Oct	2B.2	S2	G5?
Streptanthus glandulosus ssp. hoffmanii	Hoffman's bristly jewelflower	Brassicaceae	annual herb	Mar-Jul	1B.3	S2	G4T2
Trifolium buckwestiorum	Santa Cruz clover	Fabaceae	annual herb	Apr-Oct	1B.1	S2	G2

Suggested Citation

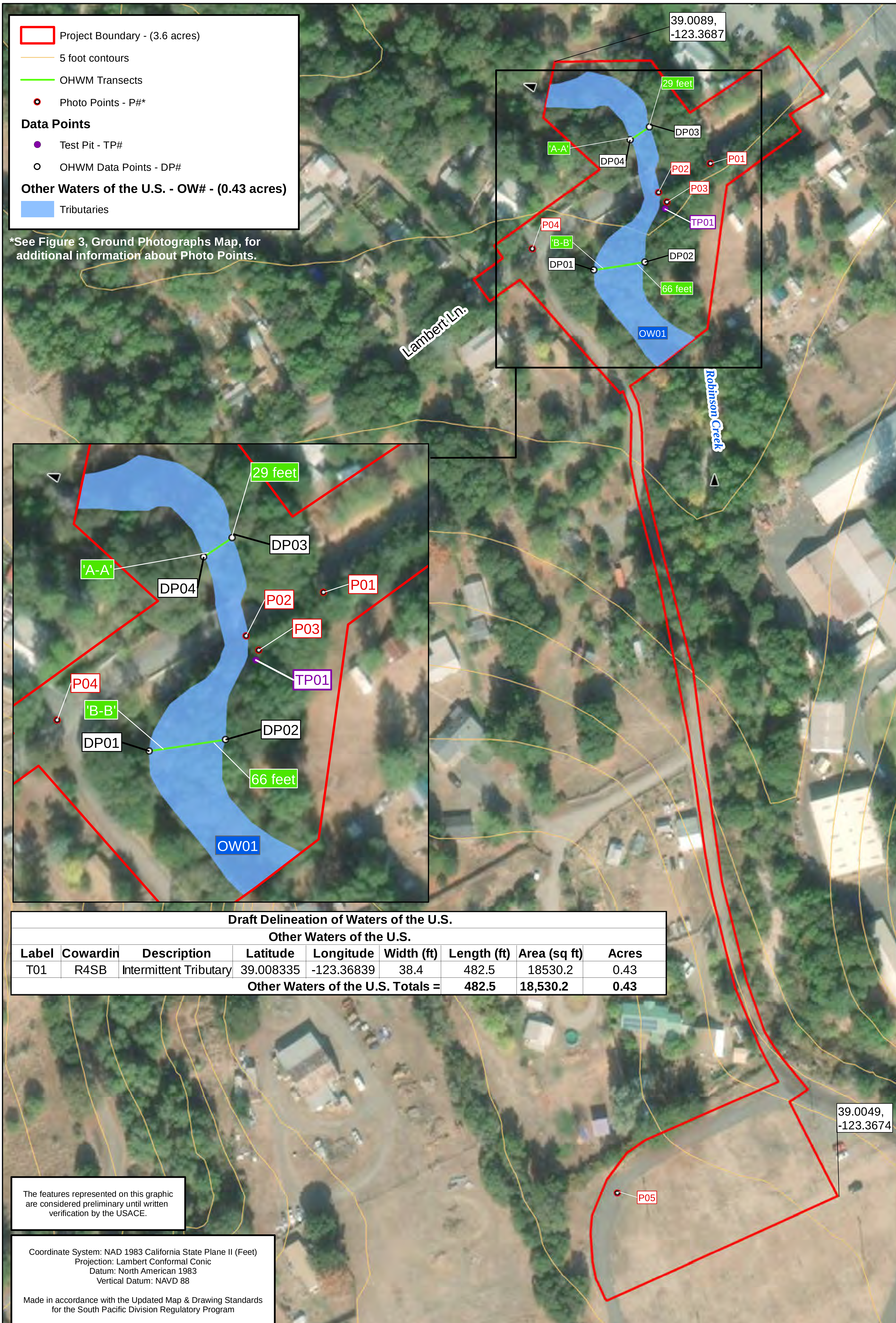
California Native Plant Society, Rare Plant Program. 2019. Inventory of Rare and Endangered Plants of California (online edition, v8-03 0.39). Website http://www.rareplants.cnps.org [accessed 05 March 2019].

Appendix C - Species Observed During Site Visits

Plant Species Observed within theRobinson Creek Bridge on Lambert Lane June 29, 2016	
Scientific Name	**Common Name**
Acmispon americanus	Spanish lotus
Adiantum jordanii	California maidenhair fern
Aesculus californica	California buckeye
Ailanthus altissima	Tree-of-heaven
Aira caryophyllea	Silver hairgrass
Arbutus menziesii	Madrone
Aristida oligantha	Oldfield 3-awn
Artemisia douglasiana	California mugwort
Avena barbata	Wild oats
Brassica sp.	Mustard
Briza maxima	Greater quaking-grass
Briza minor	Lesser quaking-grass
Brodiaea sp.	Brodiaea
Bromus carinatus	California brome
Bromus diandrus	Rip-gut brome
Bromus madritensis ssp. rubens	Red brome
Cerastium glomeratum	Mouse-eared chickweed
Chamaemelum fuscatum	Dusky dog fennel
Chlorogalum pomeridianum var. pomeridianum	Wavyleaf soap-plant
Cynodon dactylon	Bermuda grass
Cynosurus echinatus	Hedgehog dogtail
Daucus pusillus	Rattlesnake weed
Dryopteris arguta	Coastal wood fern
Equisetum arvense	Common horsetail rush
Erigeron bonariensis	South American horseweed
Eschscholzia californica	California poppy
Festuca myuros	Rattail fescue
Festuca perennis	Rye-grass
Fraxinus latifolia	Oregon ash
Gastridium phleoides	Nitgrass
Geranium dissectum	Cut-leaved geranium
Hedera helix	English ivy
Heteromeles arbutifolia	Toyon
Hordeum murinum	Wall hare barley
Juglans hindsii	Black walnut
Lactuca serriola	Prickly lettuce
Leontodon saxatilis	Hawkbit
Lysimachia arvensis	Scarlet pimpernel
Lythrum hyssopifolia	Hyssop loosestrife
Madia gracilis	Slender tarweed
Mentha pulegium	Pennyroyal
Nerium oleander	Oleander
Pentagramma triangularis ssp. triangularis	Gold-backed fern

Scientific Name	Common Name
Phalaris paradoxa	Hood canarygrass
Pinus sp.	Pine
Plantago lanceolata	English plantain
Polygonum aviculare	Prostrate knotweed
Prunus cerasifera	Cherry plum
Pseudotsuga menziesii var. menziesii	Douglas-fir
Quercus lobata	Valley oak
Quercus wislizeni	Live oak
Robinia pseudoacacia	Black locust
Rosa californica	California wild rose
Rubus armeniacus	Himalayan blackberry
Rumex crispus	Curly dock
Rumex pulcher	Fiddle dock
Salix lasiolepis	Arroyo willow
Sequoia sempervirens	Coast redwood
Sherardia arvensis	Field-madder
Sisymbrium officinale	Hedge mustard
Sonchus asper	Sow thistle
Spergularia rubra	Ruby sandspurry
Symphoricarpos albus	Common snowberry
Torilis arvensis	Hedge parsley
Toxicodendron diversilobum	Poison oak
Trifolium sp.	Clover
Umbellularia californica	California bay laurel
Vicia sativa	Garden vetch
Vinca major	Periwinkle
Vitis californica	Wild grape

Appendix D– Draft Delineation of Waters of the US Maps



Draft Delineation of Waters of the U.S.								
Other Waters of the U.S.								
Label	Cowardin	Description	Latitude	Longitude	Width (ft)	Length (ft)	Area (sq ft)	Acres
T01	R4SB	Intermittent Tributary	39.008335	-123.36839	38.4	482.5	18530.2	0.43
Other Waters of the U.S. Totals =						**482.5**	**18,530.2**	**0.43**

NORTH
1:1,325
1 inch = 110 feet
0 55 110 Feet
Data Sources: ESRI, DigitalGlobe 10/31/17, USGS, Quincy Engineering

Robinson Creek Bridge Replacement Project
Draft Delineation of Waters of the U.S.
Figure 4

gallaway ENTERPRISES
GE: #15-130 Map Date: 01/30/19

Appendix E– Project Location Photos

Site Photos Taken June 29, 2018

Lambert Lane intersection looking southeast

Staging area overview looking east

Staging area overview looking southeast

Looking at the underside of the Lambert Lane bridge. No day roosting bat habitat is present.

Standing at the southwest corner of the bridge looking north.

Looking southeast immediately upstream of the bridge at ponded water with algae bloom. The start of the failed retaining wall and RSP that are acting as a fish passage barrier can be seen on the right.

Standing on the northwest corner of the bridge looking west at the failed retaining wall and RSP.

Western toad tadpoles and sub-adults were observed within and adjacent to pools of standing water throughout BSA.

Standing downstream of the bridge looking southeast at the dry creek.