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

Location Hydraulic Study Report

Prepared for:

Prepared by:

June 2021

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Submitted to:
Mendocino County Department of Transportation

This report has been prepared by or under the supervision of the following Registered Engineer. The Registered Civil Engineer attests to the technical information contained herein and has judged the qualifications of any technical specialists providing engineering data upon which recommendations, conclusions, and decisions are based.

Kazuya Tsurushita, P.E.
Registered Civil Engineer

6/8/2021
Date

June 2021

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Executive Summary

The County of Mendocino (County), in cooperation with the California Department of Transportation (Caltrans), proposes to replace the functionally obsolete and scour critical Lambert Lane Bridge (Bridge No. 10C0146) at Robinson Creek in order to restore service and reduce future maintenance costs. The Robinson Creek Bridge Replacement on Lambert Lane Project (Project) will replace the scour critical bridge and improve traffic operations by widening the bridge to provide 9-foot (ft) lanes and 5-ft shoulders in each direction, as well as replace all traffic safety features to meet current standards. The existing bridge is located in the Town of Boonville in Mendocino County. The existing Lambert Lane Bridge is located approximately 0.1 miles (mi) west of the intersection of Lambert Lane and State Route (SR) 128. The Town of Boonville is located approximately 13.1 mi southwest of the City of Ukiah, Mendocino County, California.

The Project includes development and approval of an Environmental Document, development of a Project Report, development of Plans, Specification, and Estimates (PS&E), and acquiring the necessary right-of-way to construct the Project. Funding for this Project will be provided by the Highway Bridge Program (HBP) with matching funds from Federal Toll Credits. The County will be responsible for ensuring California Environmental Quality Act compliance, and Caltrans will be the lead agency for compliance with the National Environmental Policy Act.

The existing Lambert Lane Bridge over Robinson Creek was constructed in 1954. The existing 32-ft-long, single-span reinforced concrete bridge structure is supported on tall, closed, strutted abutments founded on spread footings on top of erodible alluvial channel material. The current bridge superstructure is approximately 26-ft-wide including a concrete curb and timber railing on each side. The clear-width on the bridge is approximately 24 ft with two 12-ft lanes. The existing approach roadway is also approximately 24-ft-wide with two 12-ft lanes.

The *Project Report* (Quincy Engineering Inc., 2018) recommended replacement of the existing bridge with a new steel girder bridge on the existing alignment with a temporary detour for public traffic. The proposed steel girder bridge would be a 96-ft-long, 31.33-ft-wide, single-span steel girder bridge over Robinson Creek, which would be much longer than the existing bridge. The proposed bridge would have a longer span than the existing bridge to increase the channel opening, which would provide a more gradual turn of the creek when compared to the existing two 90-degree turns upstream and downstream of the existing bridge. The longer bridge would also allow the faces of the proposed bridge abutments to be elevated above the 100-year flood profile of Robinson Creek at the Project location.

The purpose of this study is to examine and analyze the existing base (100-year) floodplain within the Project limits; to document any potential impacts to or encroachments upon the floodplain; and to recommend any avoidance, minimization, or mitigation measures that may be required.

The Project site is located within Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Map Number 06045C1663F for Mendocino County, California and Incorporated Areas. According to this FIRM, the Project site is located in the Special Flood Hazard Area (SFHA) Zone A, which represents areas subject to flooding by the 100-year flood event determined by approximate methods where base flood elevations are not shown. At the Project site, the 100-year flood width is approximately 280 ft when measured along the centerline of Lambert Lane. The areas outside of the limits of the SFHA Zone A is classified as areas outside of the 500-year floodplain. Per Title 44, Code of Federal Regulations, Part 60.3 (44 CFR 60.3C), encroachments within mapped base floodplains (where a floodway has not been designated) must demonstrate that the proposed development will not increase the base flood water surface elevation (WSE) more than 1 foot.

The design flow of Robinson Creek for the design of the proposed bridge was based on a rainfall/runoff model using United States Army Corps of Engineers' (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) software following the SCS unit hydrograph method. The 100-year design flow for Robinson Creek was estimated to be 1,750 cubic feet per second (cfs).

The hydraulics of the existing and proposed conditions were analyzed using the Hydrologic Engineering Center's River Analysis System (HEC-RAS) Version 5.0.7. The hydraulic model was developed using the channel survey data, proposed channel grading, and bridge general plans provided by Quincy Engineering, Inc. and existing bridge information included in the Caltrans' Bridge Inspection Report (BIR).

The outputs from the existing and proposed condition hydraulic model showed both the existing and proposed bridge would be open to the traffic during the 100-year storm event, and the existing and proposed channels would both have sufficient capacity to convey the 100-year flow. Based on the hydraulic model, the proposed single-span bridge with a softer and more gradual turn of the creek alignment would have a 100-year flood profile lower than the existing condition, except at the river station approximately 65 feet downstream of the existing bridge centerline. The Project would remove the existing retaining wall that fell into the creek that is obstructing the exiting flood flow and would lower the 100-year flood profile of Robinson Creek upstream of the proposed bridge. Although the WSEs would increase locally in the proposed condition, those increases in the WSEs would be less than 1 ft for the 100-year flow, which would adhere to the requirements of 44 CFR 60.3C. The existing and proposed 100-year WSEs in the Project vicinity are summarized in the following table.

100-Year Water Surface Elevation Summary

River Station (Existing Condition)	Location/ Distance from Existing Bridge Centerline	100-year WSE		WSE Change
		Existing (ft NAVD 88)	Proposed (ft NAVD 88)	(ft)
673	Model Upstream Limit 450 ft Upstream	382.01	381.35	-0.66
533	310 ft Upstream	381.29	380.04	-1.25
375	153 ft Upstream	380.45	377.93	-2.52
284	Upstream of Collapsed Retaining Wall	379.46	n/a[1]	n/a[1]
256	Downstream of Collapsed Retaining Wall	375.56	n/a[1]	n/a[1]
221	Lambert Lane Bridge Upstream Face[2]	374.96	374.54	n/a[2]
221	Lambert Lane Bridge Downstream Face[2]	374.05	374.03	n/a[2]
200	22 ft Downstream	373.94	373.74	-0.20
156	65 ft Downstream	373.53	373.64	0.11
124	97 ft Downstream	373.62	373.60	-0.02

Notes:
1. Project proposes proposed bridge with a softer and more gradual turn of the creek alignment. Proposed condition hydraulic model does not include channel cross-sections representing upstream/downstream of the collapsed retaining wall.
2. The proposed bridge is wider than the existing bridge. Therefore, the upstream/downstream faces of the existing and proposed bridges are not in the same location.
3. NAVD 88 = North American Vertical Datum of 1988.

The risk associated with the Project was assessed by evaluating whether the Project would result in changes to land use, changes in impervious surface, and added fill within the 100-year floodplain. The qualitative impacts resulting from the Project were assessed by analyzing the hydraulics using HEC-RAS to compare the existing and proposed conditions.

Due to the nature of the work, the Project would not result in an overall change in land use within the watershed. The new widened bridge would result in added impervious areas. When compared to the overall watershed of Robinson Creek at Project location (approximately 4.0 square miles), the widening of the paved area from approximately 24 ft to 31.33 ft would be insignificant and would not significantly increase the peak 100-year flow of Robinson Creek. The realignment of the existing creek within the Project limits would result in a fill inside the existing FEMA SFHA. The hydraulic models of the existing and proposed conditions indicate there would be a local increase in the flood profile downstream of the proposed bridge from the Project, but it would lower the flood profile further upstream, and the 100-year flood flow would be conveyed inside the main channel of Robinson Creek at the Project location. The proposed action would not significantly modify the characteristics of the existing 100-year floodplain and would comply with the requirements of 44 CFR 60.3C. The risk associated with the Project is considered to be low.

Potential short-term adverse effects to the natural and beneficial floodplain values include, temporary loss of vegetation from bridge construction, softening of creek alignment, and potential impacts to the habitat of Northern California steelhead, Central California Coast Coho salmon, foothill yellow-legged frog, migratory birds and raptors, and colonial roosting bats. Temporary environmental impacts resulting from construction activities for the proposed Project can be minimized with standard measures such as revegetation, best management practices, seasonal work restrictions, implementation of erosion control measures, and other activities that meet the requirements of the Project permit conditions. The impacts that cannot be avoided or minimized will be mitigated, which would be discussed in-detail in the Environmental Document for this Project.

Based on the results from the hydraulic analysis of the existing and proposed conditions, the 100-year flow is contained in the main channel of Robinson Creek. Lambert Lane would be open to the traffic during the 100-year storm event.

The County will coordinate with local, state, and federal water resources and floodplain management agencies as necessary during all aspects of the proposed Project. The following regulatory permits and approvals would be required when the Project enters into the final design and construction phases: 1602 Streambed Alteration Agreement from the California Department of Fish and Wildlife (CDFW), a Section 404 Nationwide Permit from the USACE, and a 401 Water Quality Certification from the Regional Water Quality Control Board. In addition, Project may require 2081 Incidental Take Permit from CDFW.

Acronyms

ADT	average daily traffic
BIR	Bridge Inspection Report
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CDFW	California Department of Fish and Wildlife
County	County of Mendocino
CFR	Code of Federal Regulations
CN	Curve Number
DWR	Department of Water Resources
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
HEC-HMS	Hydrologic Engineering Center's Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HSG	Hydrologic Soil Group
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NAVD 88	North American Vertical Datum of 1988
NRCS	Natural Resources Conservation Service
SCS	Soil Conservation Service
SFHA	Special Flood Hazard Area
SR	State Route
TR-55	Technical Release 55
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
WSE	Water Surface Elevation

LOCATION HYDRAULIC STUDY FORM

Dist. 1 Co. MEN Rte. Lambert Lane
Project ID B1302 Federal-Aid Project Number: BRLO-5910(099)

Floodplain Description:

1. Description of Proposal *(include any physical barriers i.e. concrete barriers, sound walls, etc. and design elements to minimize floodplain impacts)*

Project is proposing to replace the existing Lambert Lane Bridge over Robinson Creek in Town of Boonville, Mendocino County, California. The existing bridge is approximately 32-ft-long, 26-ft-wide, clear-span bridge. The existing functionally obsolete and scour critical bridge is proposed to be replaced with 96-ft-long, 31.33-ft-wide, single-span steel girder bridge placed on the same alignment as the proposed bridge. The channel would be widened to conform to the lengthened bridge and creek alignment would be modified to smooth the existing 90-degree turns upstream and downstream of the existing bridge.

2. ADT: Current 379 (2013) Projected 390 (2040)

3. Hydraulic Data:

Base Flood Q_{100}= 1,750 CFS WSE_{100}= 374.96 ft NAVD 88 (Existing)
374.54 ft NAVD 88 (Proposed)

The flood of record, if greater than Q100:
Q= n/a CFS WSE= n/a

Overtopping flood
Q= n/a CFS WSE= n/a

Are NFIP maps and studies available? NO ____ YES ✓

4. Is the highway location alternative within a regulatory floodway?
NO ✓ YES ____

5. Attach map with flood limits outlined showing all buildings or other improvements within the base floodplain.

Potential Q100 backwater damages:

		NO	YES
A.	Residences?		✓
B.	Other Bldgs?		✓
C.	Crops?	✓	
D.	Natural and beneficial Floodplain values?		✓

"Natural and beneficial flood-plain values" shall include but are not limited to fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge.

6. Type of Traffic:

	NO	YES
A. Emergency supply or evacuation route?		✓
B. Emergency vehicle access?		✓
C. Practicable detour available?	✓	
D. School bus or mail route?		✓

LOCATION HYDRAULIC STUDY FORM cont.

Dist.___1___ Co.___MEN___ Rte.___Lambert Lane___
Project ID___B1302___ Federal-Aid Project Number: ___BRLO-5910(099)___

7. Estimated duration of traffic interruption for 100-year event hours:___n/a___

8. Estimated value of Q100 flood damages (if any) – moderate risk level.

A.	Roadway	$___n/a___
B	Property	$___n/a___
	Total	$___n/a___

9. Assessment of Level of Risk Low___✓___
Moderate______
High______

For High Risk projects, during design phase, additional Design Study Risk Analysis may be necessary to determine design alternative.

PREPARED BY:

Signature:
I certify that I have conducted a Location Hydraulic Study consistent with 23 CFR 650 and that the information summarized in items numbers 3, 4, 5, 7, and 9 of this form is accurate.

______________________ *Date* ______________
District Hydraulic Engineer *(capital and 'on' system projects)*

______________________ *Date* ___6/8/2021___
Local Agency/Consulting Hydraulic Engineer *(local assistance projects)*

Is there any longitudinal encroachment, significant encroachment, or any support of incompatible Floodplain development? NO___✓___YES______

If yes, provide evaluation and discussion of practicability of alternatives in accordance with 23 CFR 650.113

Information developed to comply with the Federal requirement for the Location Hydraulic Study shall be retained in the project files.

I certify that item numbers 1, 2, 6 and 8 of this Location Hydraulic Study Form are accurate and will ensure that Final PS&E reflects the information and recommendations of said report:

______________________ *Date* ______________
District Project Engineer *(capital and 'on' system projects)*

______________________ *Date* 6/10/2021
Local Agency Project Engineer *(local assistance projects)*

LOCATION HYDRAULIC STUDY FORM cont.

Dist. 1 Co. MEN Rte. Lambert Lane
Project ID B1302 Federal-Aid Project Number: BRLO-5910(099)

CONCURRED BY:

I have reviewed the quality and adequacy of the floodplain submittal consistent with the attached checklist, and concur that the submittal is adequate to meet the mandates of 23 CFR 650.

____________________ *Date* __________

District Project Manager *(capital and 'on'-system projects)*

____________________ *Date* 6/16/21

Local Agency Project Manager *(Local Assistance projects)*

Russell Hansen *Date* 6/1/2022

District Local Assistance Engineer *(or District Hydraulic Branch for very complex projects or when required expertise is unavailable. Note: District Hydraulic Branch review of local assistance projects shall be based on reasonableness and concurrence with the information provided).*

I concur that the natural and beneficial floodplain values are consistent with the results of other studies prepared pursuant to 23 CFR 771, and that the NEPA document or determination includes environmental mitigation consistent with the Floodplain analysis.

Darrell Cardiff *Date* 6/2/22

District Senior Environmental Planner *(or Designee)*

Note: If a significant floodplain encroachment is identified as a result of floodplains studies, FHWA will need to approve the encroachment and concur in the Only Practicable Alternative Finding.

SUMMARY FLOODPLAIN ENCROACHMENT REPORT

Dist. 1 Co. MEN Rte. Lambert Lane
K.P. Federal-Aid Project Number *(Local Assistance)* BRLO-5910(099)
Project No.: B1302 Bridge No. 10C0146

Limits:
The limit of the construction is approximately 360-ft-long when measured along Lambert Lane. The Project proposes to replace the existing bridge with a longer and wider bridge on the same alignment, and also proposes channel grading to soften the existing 90-degree turns on the creek located upstream and downstream of the existing bridge crossing.

Floodplain Description:
The Project site is located within FEMA FIRM for Mendocino County, California and Incorporated Areas, Map Number 06045C1663F. According to this FIRM, the Project site is located in the Special Flood Hazard Area (SFHA) Zone A, which represents areas subject to flooding by the 100-year flood event determined by approximate methods where base flood elevations are not shown. At the Project site, the 100-year flood width is approximately 280 ft when measured along the centerline of Lambert Lane.

		No	**Yes**
1.	Is the proposed action a longitudinal encroachment of the base floodplain?	✓	
2.	Are the risks associated with the implementation of the proposed action significant?	✓	
3.	Will the proposed action support probable incompatible floodplain development?	✓	
4.	Are there any significant impacts on natural and beneficial floodplain values?	✓	
5.	Routine construction procedures are required to minimize impacts on the floodplain. Are there any special mitigation measures necessary to minimize impacts or restore and preserve natural and beneficial floodplain values? If yes, explain.	✓	
6.	Does the proposed action constitute a significant floodplain encroachment as defined in 23 CFR, Section 650.105(q).	✓	
7.	Are Location Hydraulic Studies that document the above answers on file? If not explain.		✓

SUMMARY FLOODPLAIN ENCROACHMENT REPORT, cont

Dist. 1 Co. MEN Rte. Lambert Lane
K.P. Federal-Aid Project Number *(Local Assistance)* BRLO-5910(099)
Project No.: B1302 Bridge No. 10C0146

PREPARED BY:

______________________ *Date* ______
District Project Engineer *(capital and 'on' system projects)*

______________________ *Date* 6/8/2021
Local Agency/Consulting Hydraulic Engineer *(local assistance projects)*

CONCURRED BY:

______________________ *Date* ______
District Project Manager *(capital and 'on' system projects)*

Russell Hansen
______________________ *Date* 6/1/2022
District Local Assistance Engineer *(Local Assistance projects)*

I concur that impacts to natural and beneficial floodplain values are consistent with the results of other studies prepared pursuant to 23 CFR 771, and that the NEPA document or determination includes environmental mitigation consistent with the Floodplain analysis.

Darrell Cardiff
______________________ *Date* 6/2/22
District Senior Environmental Planner *(or Designee)*

Note: If a significant floodplain encroachment is identified as a result of floodplains studies, FHWA will need to approve the encroachment and concur in the Only Practicable Alternative Finding.

1 GENERAL DESCRIPTION

1.1 Project Description

The County of Mendocino (County), in cooperation with the California Department of Transportation (Caltrans), proposed to replace the Functionally Obsolete and Scour Critical Lambert Lane Bridge (Bridge No. 10C0146) at Robinson Creek in order to improve public safety and reduce future maintenance costs. The existing bridge is located in the Town of Boonville in Mendocino County. The existing Lambert Lane Bridge is located approximately 0.1 miles (mi) west of the intersection of Lambert Lane and State Route (SR) 128. The Town of Boonville is located approximately 13.1 mi southwest of the City of Ukiah, Mendocino County, California. See Figure 1 for the Project Location Map, Figure 2 for the Project Vicinity Map, and Figure 3 for the Project Aerial Map.

The Robinson Creek Bridge Replacement on Lambert Lane Project (Project) includes development and approval of an Environmental Document, development of a Project Report, development of Plans, Specification and Estimates (PS&E) as well as acquiring the necessary right-of-way to construct the Project. Funding for this Project will be provided by the Highway Bridge Program (HBP) with matching funds from Federal Toll Credits. The County will be responsible for California Environmental Quality Act (CEQA) and Caltrans will be the lead agency for the National Environmental Policy Act (NEPA) compliance.

The existing Lambert Lane Bridge, constructed in 1954, is scour critical and out of service. Hydraulic undermining has been documented in the Caltrans' bridge inspection reports (BIR) since 2000. The existing bridge was classified as scour critical in 2013 based on the undermining of the spread footing foundation. In February 2015, a retaining wall on the upstream side of the west roadway approach washed out and collapsed into the creek. As an emergency response, the County placed rock slope protection where the collapse occurred to prevent continued embankment scour, which could have led to a bridge wash out and closure of Lambert Lane. In the winter storms of 2016/2017, scour further undermined the eastern abutment footing and full height of the abutment stem. Reinforcing steel is exposed as the base of the crack, while the abutment stem concrete is spalling and crushing near the top of the crack. These are the signs that the abutment became overstressed with forces it was not designed to experience and was approaching an ultimate failure mode by bending between wingwalls. As an emergency response, the County pumped concrete underneath the undermined footing to re-establish bearing for the abutment and to prevent further erosion underneath the abutment. In March 2019, the eastern abutment failed due to scour of the foundation and the bridge was closed. A Bailey bridge was placed over and along the same alignment as a temporary measure.

The Project will replace the out-of-service bridge and improve traffic operations by widening the bridge to provide 9-feet (ft) lanes and 5-ft shoulders in each direction and replace all traffic safety features to meet current standards. Rehabilitation and widening of the existing bridge is cost prohibitive and is not considered feasible.

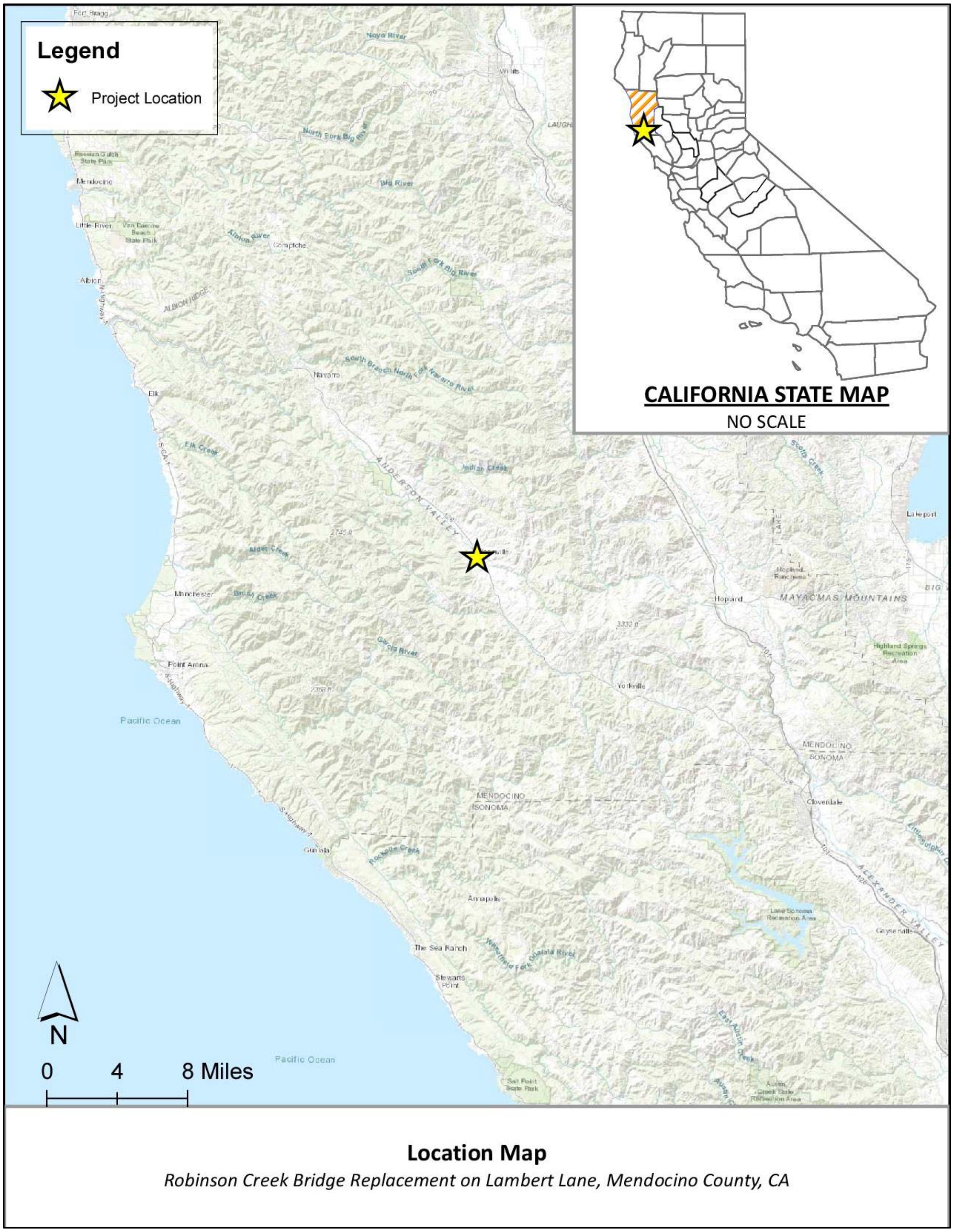
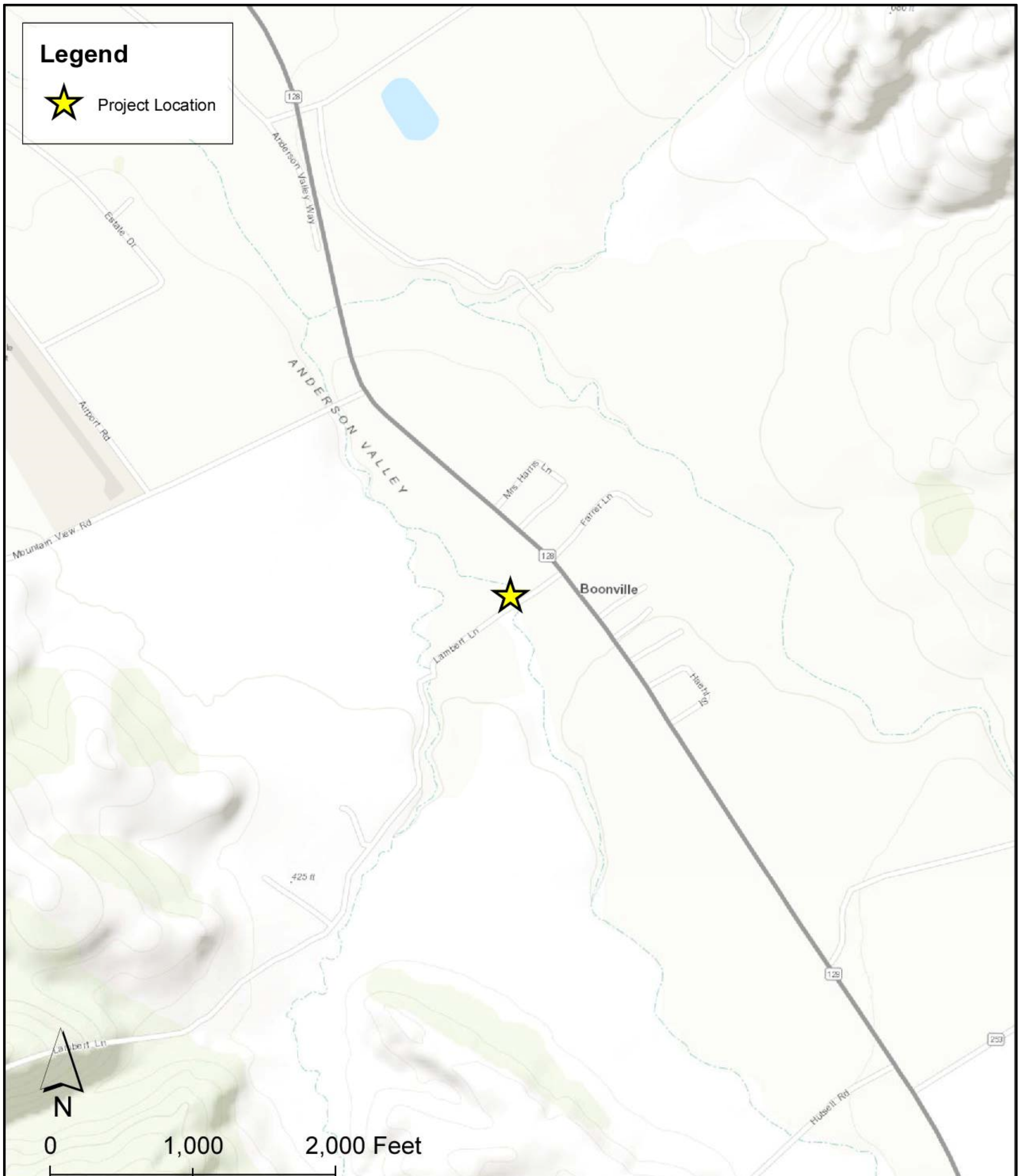


Figure 1. Project Location Map

Source: United States Geological Survey (USGS) and Environmental Systems Research Institute (ESRI) (2021)



Vicinity Map

Robinson Creek Bridge Replacement on Lambert Lane, Mendocino County, CA

Figure 2. Project Vicinity Map

Source: USGS and ESRI (2021)

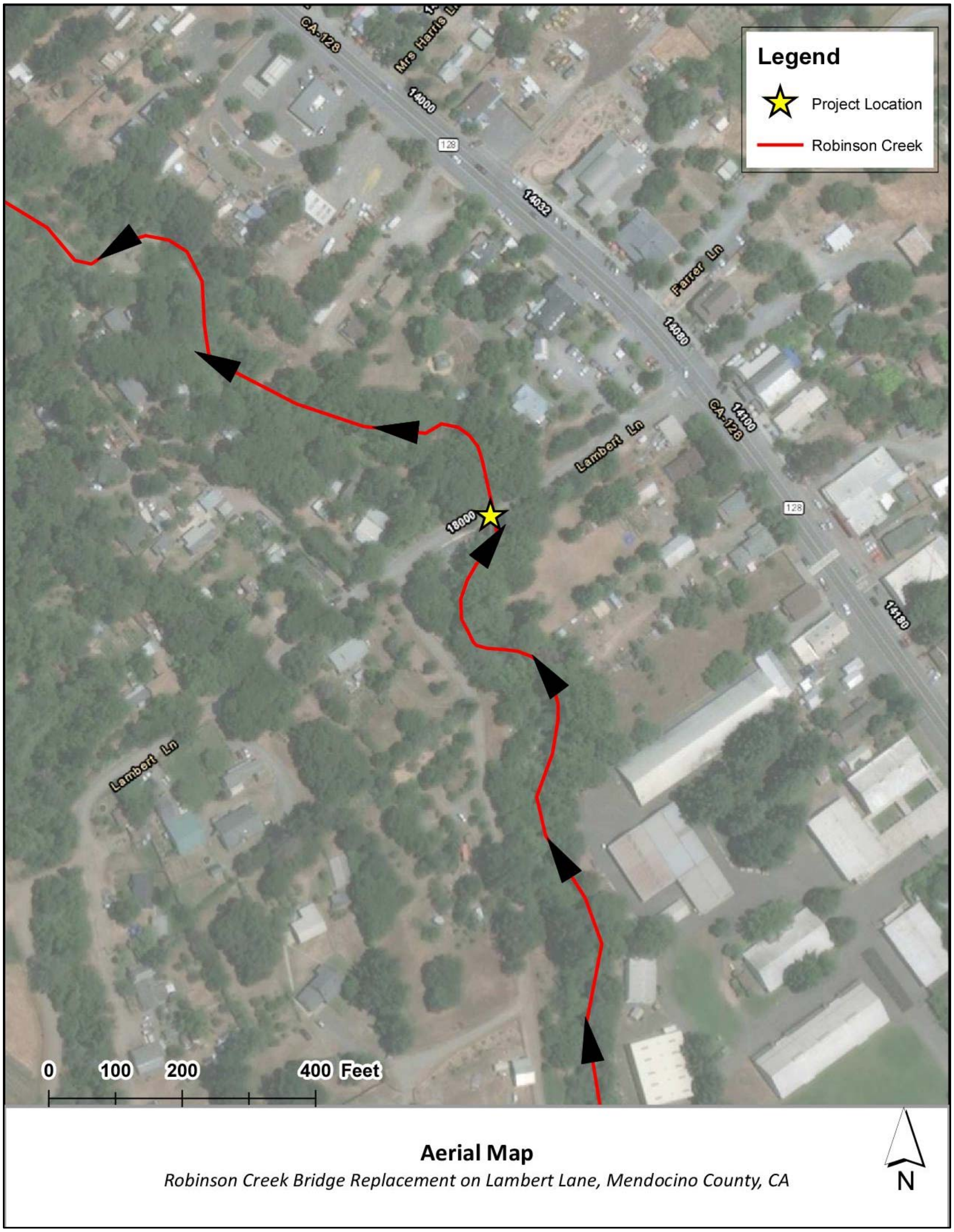


Figure 3. Project Aerial Map

Source: ESRI (2021)

1.2 Existing Bridge

The existing Lambert Lane Bridge over Robinson Creek was constructed in 1954. The existing 32-ft-long, single-span reinforced concrete bridge structure located approximately 0.1 mi west of the SR 128 intersection is supported on tall closed strutted abutments founded on spread footings on top of erodible alluvial material (see Figure 4, Photo 1, and Photo 2). The current bridge superstructure is approximately 26-ft-wide, including a concrete curb and timber railing on each side. The clear-width on the bridge is approximately 24-ft with two, 12-ft lanes. The existing approach roadway is also approximately 24-ft-wide with two, 12-ft lanes.

The existing bridge was accepted into the HBP for a replacement scoped project in 2014. The concrete slab structure is exhibiting minor cracks and light efflorescence on the bridge soffit. The concrete abutments have multiple cracks in various locations. The spread footings are exposed and have high regions of undermining. The retaining wall on the south (upstream) side of the western abutment (Abutment 1) has been undermined and collapsed into the creek in February 2015 (see Photo 3 and Photo 4). As an emergency response to prevent washout of the bridge, the County placed rock slope protection of top of the collapsed retaining wall (see Photo 5).

In the winter of 2016/2017, the eastern abutment (Abutment 2) became completely undermined (see Photo 6). This abutment lost bearing beneath the footing and became only supported by the wingwalls on each edge of the existing bridge. As a result, structural crack developed in the complete height of the abutment stem with reinforcing steel yielding at the base of the footing and concrete spalling and crushing at the top of the stem. This response indicates a substantial overstress of the abutment to a load path it was not designed to facilitate. As an emergency response to prevent potential collapse of the bridge, the County pumped concrete underneath the undermined abutment footing to re-establish bearing and defer further undermining of this foundation (see Photo 7).

In March 2019, the eastern abutment experienced failure due to high flows. The left (upstream) wingwall was displaced, and severe cracking of the face of the abutment, left wingwall, and foundation are present (see Photos 8-10). The bridge was closed and a temporary Bailey bridge was installed.

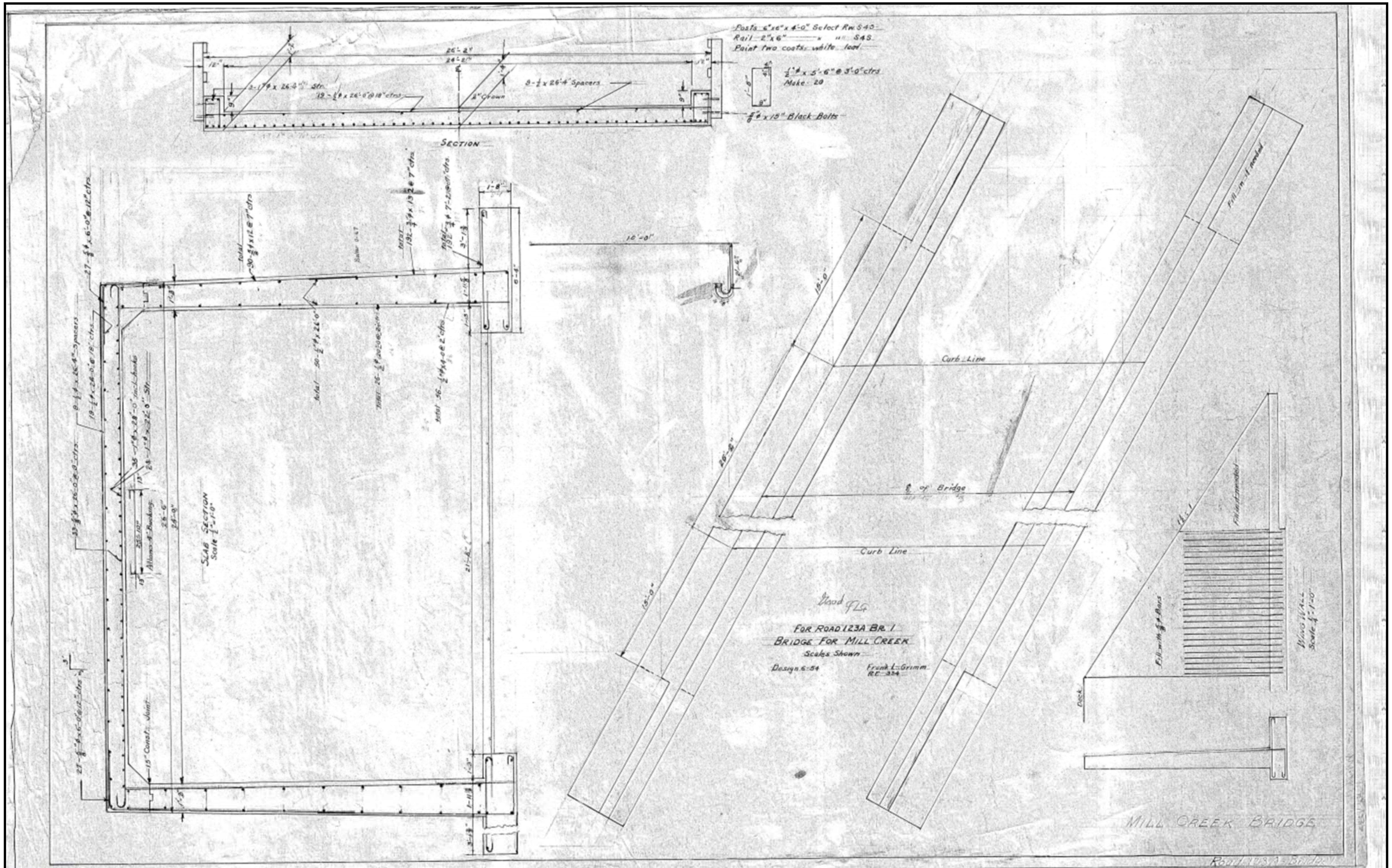


Figure 4. Existing Bridge As-Builts

Source: Caltrans

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Photo 1. Existing Bridge Upstream Face (May 11, 2016)

Source: Caltrans

Photo 2. Existing Bridge Downstream Face (May 11, 2016)

Source: Caltrans

Photo 3. Collapsed Retaining Wall, Viewing from Overbank Area (May 11, 2016)
Source: Caltrans

Photo 4. Collapsed Retaining Wall, View from Bottom of Channel (May 11, 2016)
Source: Caltrans

Photo 5. Existing Retaining Wall of Bridge Upstream (May 11, 2016)

Source: Caltrans

Photo 6. Undermined Footing of Abutment 2 (Eastern Abutment) (Sept 27, 2017)

Source: Caltrans

Photo 7. Scour Repair at Abutment 2 (Sept 27, 2017)

Source: Caltrans

Photo 8. Abutment 2 Failure, Downstream Face (May 20, 2019)

Source: Caltrans

Photo 9. Abutment 2 Offset Wingwall, Downstream Side (May 20, 2019)

Source: Caltrans

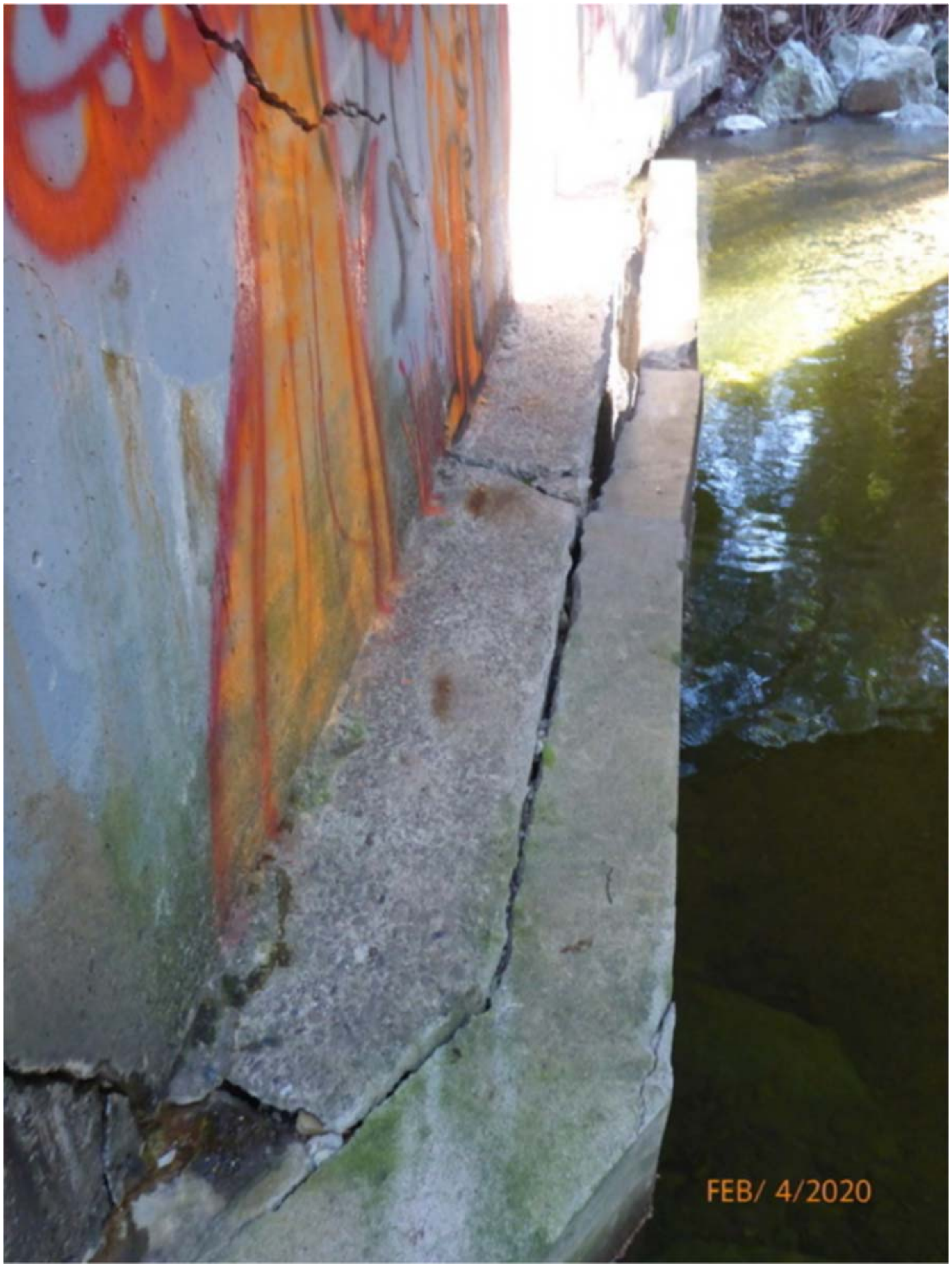

Photo 10. Abutment 2 Foundation, Facing Upstream (Feb 4, 2020)

Source: Caltrans

1.3 Proposed Bridge

The *Project Report* for this Project dated March 2018, prepared by Quincy Engineering Inc., recommended replacement of the existing bridge with a new steel girder bridge on the existing alignment with temporary detour for public traffic. The bridge general plan is shown in Figure 5. The proposed steel girder bridge would be a 96-ft-long, 31.33-ft-wide single-span bridge over Robinson Creek.

The proposed bridge would have a longer span than the existing bridge to increase the channel opening, which would provide a softer and more gradual turn of the creek when compared to the existing two 90-degree turns at the Project location. The longer bridge would also allow the faces of the proposed bridge abutment elevated above the 100-year flood profile of Robinson Creek at the Project location.

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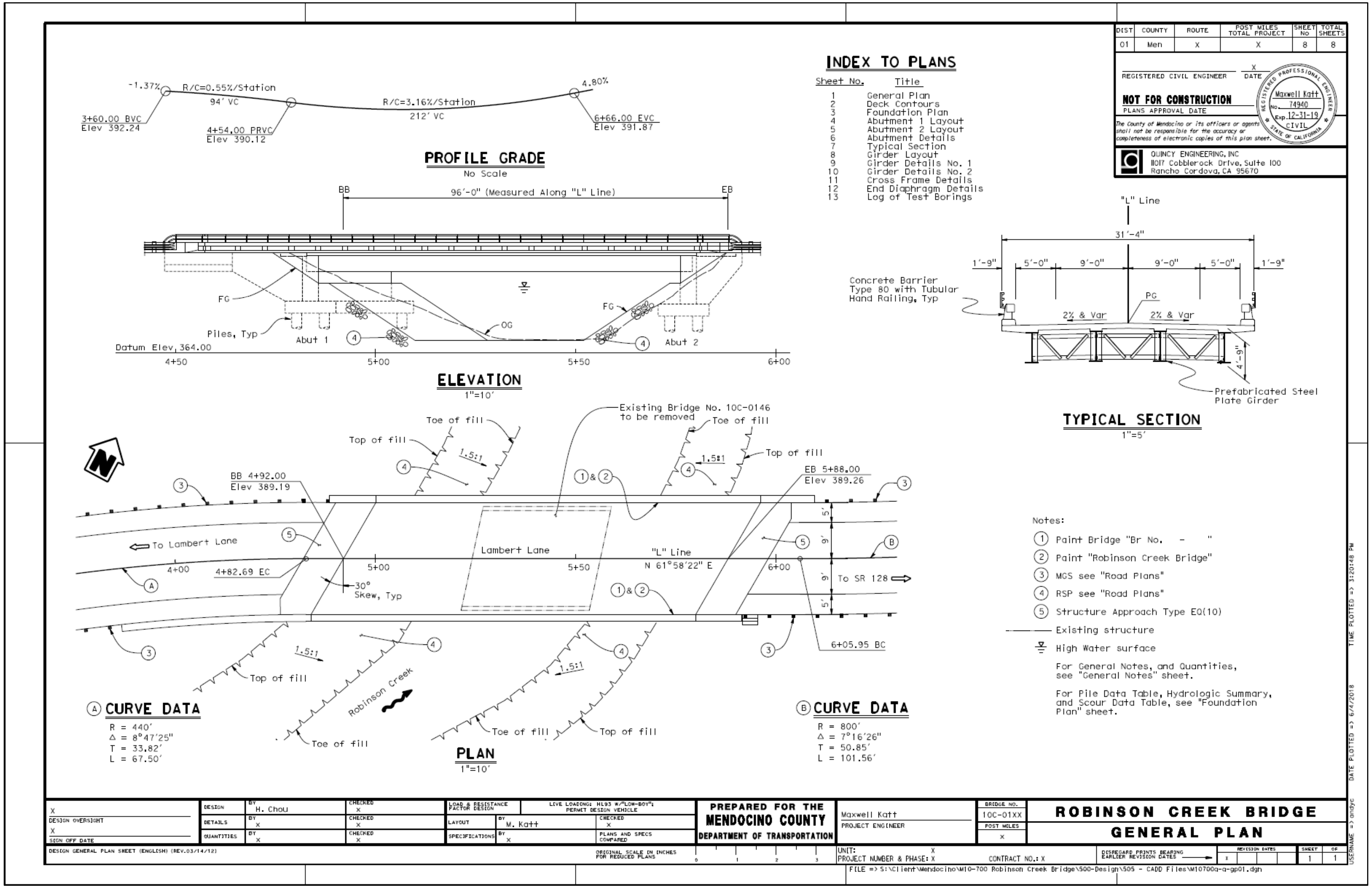

Figure 5. Proposed Bridge General Plan

Source: Quincy Engineering, Inc. (2021)

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1.4 Regulatory Setting

1.4.1 Executive Order 11988 (Floodplain Management, 1977)

Executive Order 11988 (Floodplain Management) directs all federal agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Requirements for compliance are outlined in Title 23, Code of Federal Regulations, Part 650, Subpart A (23 CFR 650A) titled "Location and Hydraulic Design of Encroachment on Floodplains" (2017).

If the preferred alternative involves significant encroachment onto the floodplain, the final environmental document (final Environmental Impact Statement or finding of no significant impact) must include:

- The reasons why the proposed action must be located in the floodplain,
- The alternatives considered and why they were not practicable, and
- A statement indicating whether the action conforms to applicable state or local floodplain protection standards.

1.4.2 California's National Flood Insurance Program

The Federal Emergency Management Agency (FEMA) is the nationwide administrator of the National Flood Insurance Program (NFIP), which is a program that was established by the National Flood Insurance Act of 1968 to protect lives and property, and to reduce the financial burden of providing disaster assistance. Under the NFIP, FEMA has the lead responsibility for flood hazard assessment and mitigation, and it offers federally backed flood insurance to homeowners, renters, and business owners in communities that choose to participate in the program. FEMA has adopted the 100-year floodplain as the base flood standard for the NFIP. FEMA is also concerned with construction that would be within a 500-year floodplain for proposed projects that are considered "critical actions," which are defined as any activities where even a slight chance of flooding is too great. FEMA issues the Flood Insurance Rate Maps (FIRM) for communities that participate in the NFIP. These FIRMs present delineations of flood hazard zones.

In California, nearly all of the state's flood-prone communities participate in the NFIP, which is locally administered by the California Department of Water Resources' (DWR) Division of Flood Management. Under California's NFIP, communities have a mutual agreement with the State and federal governments to regulate floodplain development according to certain criteria and standards, which are further detailed in the NFIP.

1.4.3 Mendocino County Floodplain Data

As part of the NFIP, typically, each county (or community) has a Flood Insurance Study (FIS), which is used to locally develop FIRMs and base flood elevations. The FEMA Flood Insurance Study for Mendocino County, California and Incorporated Areas last revised in July 18, 2017 and the FEMA Flood Insurance Rate Map 06045C1663F dated June 2, 2011, was reviewed for this Project (see Appendix A).

1.5 Design Standards

1.5.1 FEMA Standards

FEMA standards are employed for design, construction, and regulation to reduce flood loss and to protect resources. Two types of standards are often employed: design criteria and performance standards.

One design criteria or specified standard dictates that a provision, practice, requirement, or limit be met (e.g., using the 1% flood and establishing floodway boundaries so as not to cause more than a 1-ft increase in flood stages).

A performance standard dictates that a goal is to be achieved, leaving it to the individual application as to how to achieve the goal (e.g., providing protection to the regulatory flood, keeping post-development stormwater runoff the same as pre-development, or maintaining the present quantity and quality of water in a wetland).

The 1% annual-chance-flood and floodplain have been adopted as a common design and regulatory standard in the United States. The NFIP adopted it in the early 1970s, and it was adopted as a standard for use by all federal agencies with the issuance of Executive Order 11988. States or local agencies are free to impose a more stringent standard within their jurisdiction.

1.5.2 Hydraulic Design Criteria

1.5.2.1 FHWA Standards

The Federal Highway Administration (FHWA) criterion refers to the California Amendments to American Association of State Highway and Transportation Officials *Load and Resistance Factor Design (LRFD) Bridge Design Specifications* (2014), which indicates the proposed bridge profile should provide adequate freeboard to pass anticipated drift for the 50-year design flood, to pass the 100-year base flood without freeboard, or the flood of record without freeboard, whichever is greater.

1.5.2.2 Caltrans Standards

The Caltrans criteria for the hydraulic design of bridges is that they be designed to pass the 2% probability of annual exceedance flow (50-year design discharge) with adequate freeboard to pass anticipated drift, and the 1% probability of annual exceedance flow (100-year design discharge, or base flood) without freeboard.

1.5.2.3 Mendocino County Standards

According to the County of Mendocino's *Road and Development Standards* approved in August 14, 2008, bridges that span major and secondary open channels and are existing, planned or projected at the time of channel design, shall have a minimum clearance of 1.0

ft from soffit to design water surface, and shall cause no encroachment on the specified minimum freeboard in the upstream channel or waterway. This design standard was assumed to be also applicable for the design of the new bridge spanning over the existing major and secondary open channels.

A major waterway is defined as a watershed with a drainage area at least 4 square miles (sq mi) in size, and is designed for an average recurrence interval of 100 years. A secondary waterway is defined as a watershed with a drainage area between 1 and 4 sq mi, and is designed for an average recurrence interval of 25 years. The watershed area of Robinson Creek at Project location is approximately 4.0 sq mi (see Section 2.2), and was assumed to be a major waterway.

1.6 Traffic

According to the 2017 Caltrans BIR, the bridge is functionally classified as a local rural road. According to Mendocino County, the average daily traffic (ADT) was 379 vehicles per day in 2013, and the future ADT projected for the year 2040 is 390 vehicles per day. The existing bridge is used as an emergency supply or evacuation route, emergency vehicle access route as well as a school bus or mail route. It is expected that the proposed replacement bridge will maintain these traffic uses.

The 2017 Caltrans BIR says detour length is 199 km (124 mi). The only possible detour route without a temporary bridge would be though the County fairgrounds, which is not a practical detour. A Bailey bridge would be used to provide temporary detour across Robinson Creek during the construction of the new bridge structure.

1.7 Vertical Datum

The Project references the North American Vertical Datum of 1988 (NAVD 88).

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2 AFFECTED ENVIRONMENT

2.1 Geographic Location

The existing bridge is located at 39°00’28” North latitude and 123°22’04” West longitude, in the Town of Boonville within Anderson Valley in southern Mendocino County (Caltrans, 2017). The existing bridge is carrying Lambert Lane and is located approximately 0.1 mi west of the intersection of Lambert Lane and SR 128 in the Town of Boonville. The Town of Boonville is located approximately 13.1 miles southwest of the City of Ukiah, Mendocino County, California.

2.2 Watershed Description

Robinson Creek drains a watershed area of approximately 4.0 sq mi at the Project Location (see Figure 6 and Appendix B for USGS StreamStats data). Adjacent watersheds are Mill Creek to the west and Anderson Creek to the east. The Rancheria Creek watershed is located adjacent to the southern watershed boundaries of Mill and Robinson creeks. The confluence of Robinson Creek and Mill Creek is located approximately 1,000 ft downstream of Lambert Lane, and the confluence of Robinson Creek and Anderson Creek is located approximately 0.5 mi downstream of Lambert Lane. Anderson Creek is a tributary of Navarro River, which outfalls into Pacific Ocean approximately 24.6 mi northwest of the Project site.

2.3 Land Use

The aerial imagery of the watershed shows land uses within the Robinson Creek watershed is mostly undeveloped (see Figure 6). Developed areas within the watershed are limited to the Town of Boonville. According to the Mendocino County’s County Zoning Map, the zones assigned inside the watershed of Robinson Creek at the Project location is residential and agricultural within the Town of Boonville (see Appendix C for Mendocino County zoning map). Outside of Boonville, assigned zones are rangeland and timberland production.

2.4 FEMA Floodplains

The Project site is located within FEMA FIRM for Mendocino County, California and Incorporated Areas, Map Number 06045C1663F. According to this FIRM, the Project site is located in the Special Flood Hazard Area (SFHA) Zone A, which represents areas subject to flooding by the 100-year flood event determined by approximate methods where base flood elevations are not shown. At the Project site, the 100-year flood width is approximately 280 ft when measured along the centerline of Lambert Lane (see Figure 7 and Appendix A for FEMA FIRM).

Per Title 44, Code of Federal Regulations, Part 60.3, Subpart C (44 CFR 60.3C), encroachments within mapped base floodplains (where a floodway has not been designated) must demonstrate that the proposed development will not increase the base flood water surface elevation (WSE) more than 1 ft.

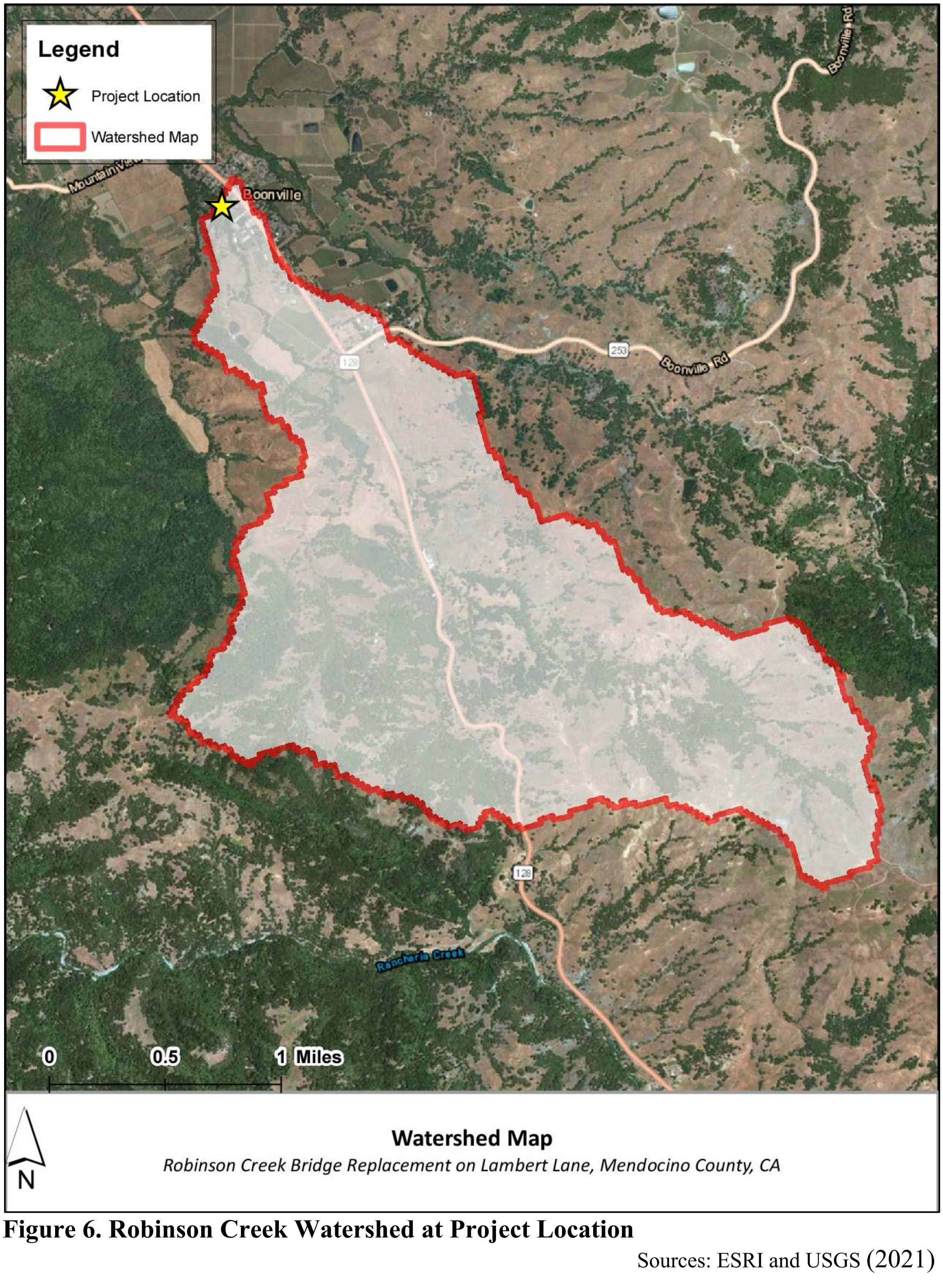

Figure 6. Robinson Creek Watershed at Project Location

Sources: ESRI and USGS (2021)

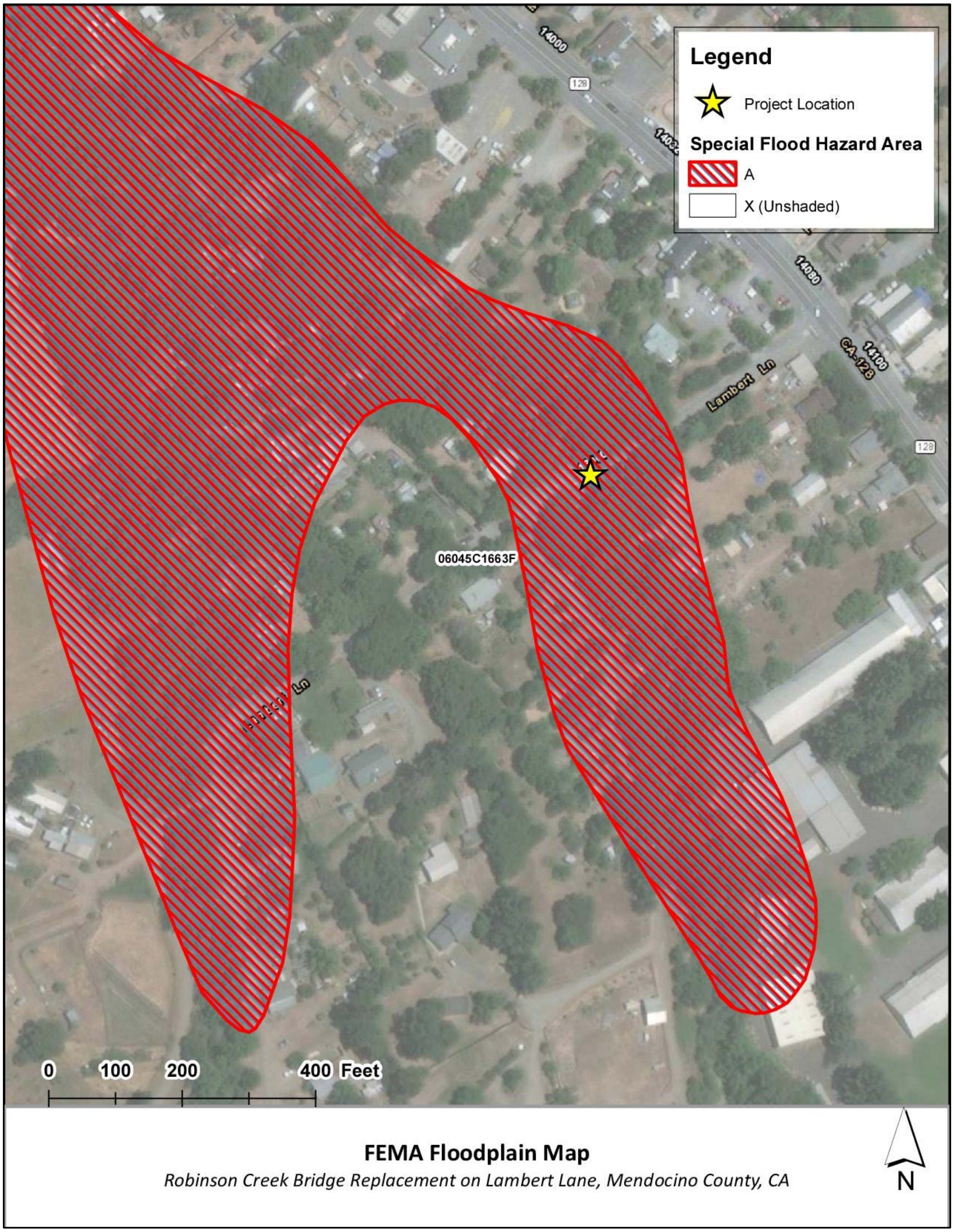

Figure 7. FEMA Floodplain Map at Project Location

Sources: FEMA and ESRI (2021)

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3 HYDROLOGY AND HYDRAULICS

3.1 Hydrologic Assessment

3.1.1 Hydrologic Design Sources and Methods

WRECO evaluated the hydrology at the Project site using the following hydrologic design methods:

1. United States Geological Survey Regional Regression Equations
2. Development of rainfall/runoff model using United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS)

3.1.2 Design Discharge Summary

3.1.2.1 USGS Regional Regression

This method follows the equations outlined in Caltrans' *Highway Design Manual* (2020) Section 819.2C. The equation used is based on the location of the Project within the North Coast region (Region 1). Flood-frequency equations were developed by the USGS and based on analysis of data from gaging stations. California is divided into six regions; the Project site is within the North Coast region. These flood-frequency equations are generally used to estimate stream flow for ungaged sites that are not affected by substantial urban development and are natural (unregulated) streams.

On July 18, 2012, the USGS issued *Methods for Determining Magnitude and Frequency of Floods in California, Based on Data through Water Year 2006* (Gotvald et. al. 2012), which contains updated regional flood-frequency equations and revised the boundaries of the six unique regions within California. These equations are based on annual peak flow data through water year 2006 for 771 streamflow-gaging stations in California that have 10 or more years of data. The updated equations were used in support of the Project's hydrologic analysis.

The regional regression equations were developed for the North Coast region using data from sites with a wide range of basin characteristics: drainage areas, ranging from 0.04 to 3,200 sq mi and mean annual precipitation ranging from 20 to 125 inches (Gotvald et al. 2012).

$$Q_{100} = 48.5(DRNAREA)^{0.866}(PRECIP)^{0.556}$$

Q_x	= peak discharge for a storm event with a return period of x years, cubic feet per second (cfs)
DRNAREA	= drainage area, sq mi
PRECIP	= mean annual precipitation, in.

With a drainage area of 4.0 sq mi (obtained from StreamStats) and a mean annual precipitation of 44.2 in. (obtained from StreamStats), the 100-year discharge is 1,320 cubic ft per second (cfs).

3.1.2.2 HEC-HMS

The rainfall/runoff model estimated the 100-year recurrence interval design discharges. The rainfall/runoff model simulates the rainfall/runoff process and generates discharge hydrographs. The input parameters were estimated following the procedures in Technical Release 55 (TR-55), the *Urban Hydrology for Small Watersheds Manual* (Natural Resources Conservation Service [NRCS], 1986), A guide to *Hydrologic Analysis Using Soil Conservation Service* (SCS) *Methods* (McCuen, 1982), and Chapter 810 from Caltrans' *Highway Design Manual* (2020). Some of the factors that will affect the runoff at the Project site include the watershed basin size, the slopes and elevations of the basin, the land uses, and the soils.

As stated in Section 2.2, Robinson Creek at the Project site drains a watershed area of approximately 4.0 sq mi. For the hydrologic analysis, the watershed was modeled as one basin. The watershed delineation is shown in Figure 6. The watershed basin was modeled using the SCS curve number (CN) loss method and the SCS unit hydrograph transform method.

The SCS runoff CN is based on the cover type, hydrologic condition of that cover, and the hydrologic soil group (HSG). Cover types are typically selected based on aerial photographs and land use maps. The hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff. For this Project, the land use zoning from Mendocino County's County Zoning Map (as described in Section 2.3) and aerial imagery were used to determine the land uses for the Project's watershed basin.

The HSGs of the watershed were researched using the NRCS online *Web Soil Survey* (2021); see Appendix D for a map of the HSGs underlying the Project's watershed. Infiltration rates and runoff potentials are indicated by the soil's HSG. Soils may be assigned to one of four groups (A, B, C, or D). Group A has high infiltration rates (low runoff potential) and consists mainly of deep, well-drained to excessively drained sands or gravel sands. On the other end of the spectrum, Group D has very slow infiltration rates (high runoff potential) and consists chiefly of clays that have a high shrink-swell potential or soils with a clay or a nearly impervious layer near the surface. The soils underlying the Project's watershed are predominantly categorized as HSG C and D. HSG C and D soils have a slow infiltration rate and high runoff potential.

Based on the land use and the HSGs, a composite runoff CN value was estimated to represent the basin. In the hydrologic model, the rainfall is converted to runoff by using a CN, which is based on the watershed's soils, plant covert type and treatment, amount of impervious area, interception, and surface storage. The initial abstraction is the part of rainfall that occurs before direct stormwater runoff begins, and consists of interception, initial infiltration, surface depression storage, evapotranspiration, and other factors. The composite CN was approximately 63.7, and the initial abstraction was approximately 1.14.

The lag time was estimated using the time of concentration method identified in the Caltrans *Highway Design Manual* (2020), then converted the time of concentration to lag time using the factor of 0.6 using the definition of lag time as provided by the NRCS. The lag time was estimated to be approximately 47 minutes.

The precipitation depth was obtained from the National Oceanic and Atmospheric Administration's (NOAA) Atlas 14 website for California Precipitation Frequency Data using the longitude and latitude of the approximate centroid of the watershed basin. Based on the rainfall distribution map from the NRCS, the Project is within rainfall distribution Type IA. The Project precipitation depths are shown in Appendix E. The estimated peak discharge for the 100-year design storm event was approximately 1,750 cfs.

3.1.3 Selected Design Discharges

The regional regression equations were developed for the North Coast region using data from sites with a wide range of basin characteristics: drainage areas ranging from 0.04 to 3,200 sq mi and mean annual precipitation ranging from 20 to 125 inches (Gotvald et al. 2012). Both the rainfall/runoff model and the USGS regional regression equation methods yielded similar results. The peak flow estimated using rainfall/runoff model with the HEC-HMS software is more conservative than the peak flow estimated using the USGS regional regression equations. Therefore, peak flow estimated using the rainfall/runoff model was selected to perform hydraulic analysis of the existing and proposed conditions.

3.2 Hydraulic Assessment

3.2.1 Design Tools

The hydraulic analyses were performed for the existing and proposed conditions using the USACE's Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling software, Version 5.0.7.

3.2.2 Cross-Section Data

The channel cross sections in the hydraulic model of existing and proposed conditions included in the HEC-RAS model was developed using the existing channel survey data provided by Quincy Engineering Inc. on 2016 and proposed channel grading data provided by Quincy Engineering Inc. on 2018. The survey data referenced North American Datum of 1983, California Zone II as horizontal datum and NAVD 88 as vertical datum. The cross section naming convention is by river station (RS), with the cross section number increasing in the upstream direction. The upstream and downstream cross sections for the existing and proposed condition hydraulic model are at the same location, but the river reach lengths are different because of the channel regrading proposed by the Project.

The limits of the channel cross sections for the existing and proposed conditions imported into the HEC-RAS model is shown in Figure 8. The existing condition hydraulic model has river reach length of 673 ft and 19 cross sections. The proposed condition hydraulic model has river reach length of 659 ft and 15 cross sections. The conform points are RS 156 on downstream of the Lambert Lane Bridge and RS 375/362 (Existing/Proposed) on upstream of the Lambert Lane Bridge.

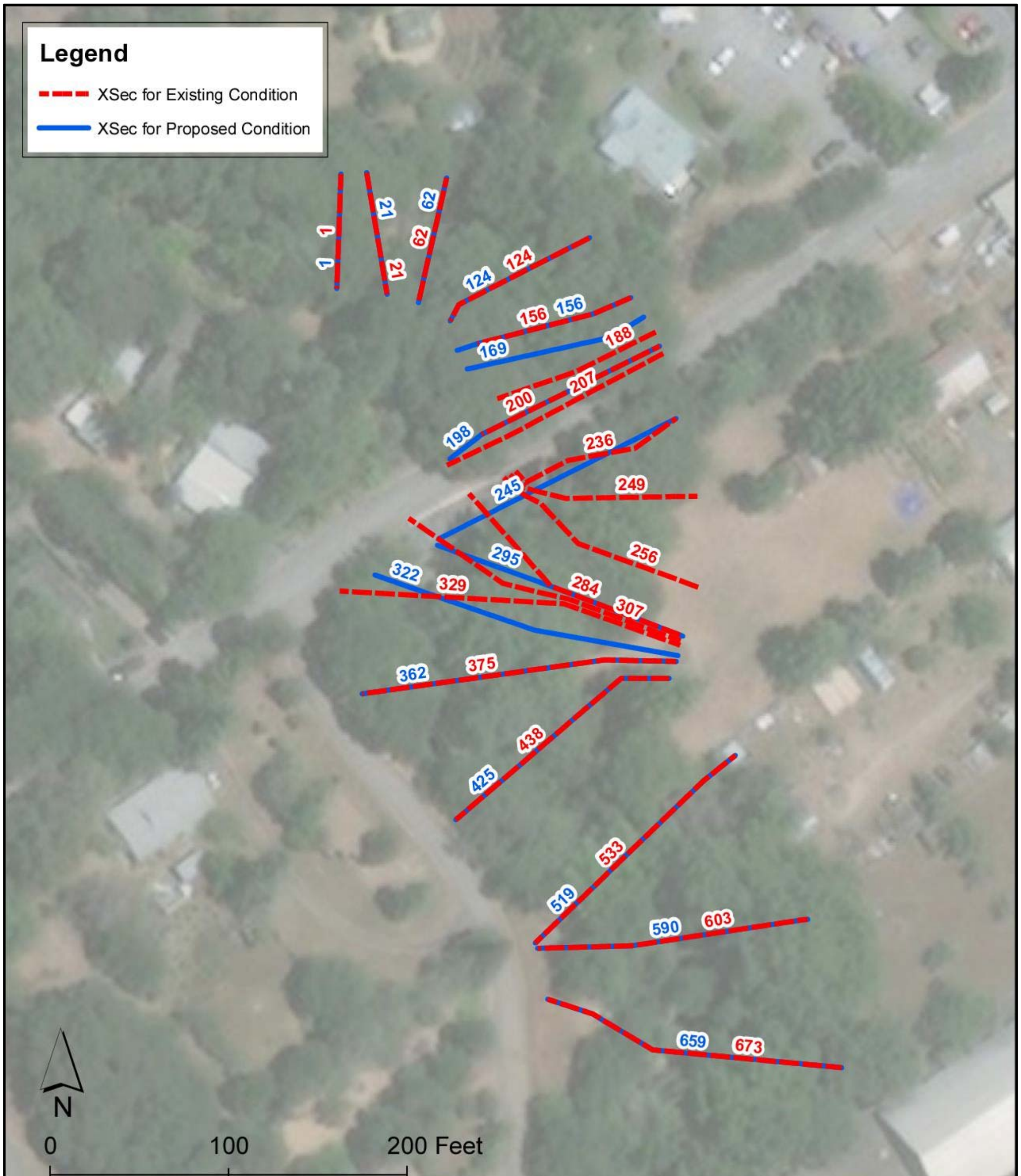
3.2.3 Modeled Hydraulic Structures

The HEC-RAS model of Robinson Creek at the Project location includes the existing and proposed Lambert Lane bridges. The input parameters for the existing bridge were based on the bridge as-builts included in the Caltrans' BIR (2020). The input parameters for the proposed bridge were based on the bridge general plans provided by Quincy Engineering Inc.

The collapsed retaining wall upstream of the existing bridge was represented in the existing condition hydraulic model as an in-stream weir. The input parameters were based on a topographic survey done in 2016 and field visit notes. The proposed condition model does not include the collapsed retaining wall because it would be removed as part of the channel realignment.

3.2.4 Model Boundary Conditions

A normal depth slope of 0.016 ft/ft was used as the downstream reach boundary condition and it was based on the survey of Robinson Creek downstream of the Lambert Lane Bridge.



HEC-RAS Channel Cross Sections

Robinson Creek Bridge Replacement on Lambert Lane, Mendocino County, CA

Figure 8. HEC-RAS Model Cross-Section Locations

Source: ESRI (2021)

3.2.5 Manning's Roughness Coefficients

Manning's roughness coefficients were used in the hydraulic model to estimate energy losses in the flow due to friction. Manning's roughness coefficient selected for the existing and proposed condition models varied from 0.020 to 0.100 and are summarized in Table 1. These values were selected based on the Project Team's field visit on May 11, 2016.

Table 1. Manning's Roughness Coefficient in the Hydraulic Model

Type of Channel/ Overbank Area	Manning's Roughness Coefficient
Concrete Retaining Wall (Only for Existing Condition)	0.020
Low Flow Channel, Below Existing/Proposed Bridge Structure	0.040
Low Flow Channel	0.045
Channel Bank Slope with Rock Slope Protection	0.050
Overbank Area with Modest Vegetation	0.050 to 0.070
Overbank Area with Dense Vegetation	0.100

3.2.6 Expansion and Contraction Coefficients

Expansion and contraction coefficients were used in the hydraulic model to represent energy losses in the channel. An expansion coefficient of 0.3 and a contraction coefficient of 0.1 were used to represent the channel in the vicinity of the Project. These values represent a channel with a gradual transition between cross sections. The expansion and contraction coefficients used in the vicinity of the bridges were 0.5 and 0.3, respectively. These values represent the flow interference caused by the bridges and retaining wall in the existing condition.

3.2.7 Water Surface Elevations

The 100-year WSEs in the vicinity of the existing and proposed Lambert Lane Bridge are summarized in Table 2. The cross-sectional view of the existing and proposed bridges in the hydraulic model, looking downstream, are presented in Figure 9 and Figure 10. The 100-year flood profile of Robinson Creek in the Project vicinity is presented in Figure 11. The detailed hydraulic analysis outputs for the existing and proposed conditions are included in Appendix F and Appendix G, respectively.

The results from hydraulic analysis indicate that the proposed Project would locally increase the 100-year WSE of Robinson Creek downstream of the Lambert Lane Bridge. The increase in flood profile of approximately 0.11 ft is because the proposed Project would fill the existing scour hole formed on upstream and downstream faces of the existing bridge (see Figure 11). The removal of the collapsed retaining wall and channel regrading would lower the 100-year flood profile upstream of the proposed Lambert Lane

Bridge. It would also remove the hydraulic jump on the downstream of the collapsed retaining wall, which would lower the flow velocity on the upstream face of the existing Lambert Lane Bridge.

Table 2. Summary of 100-year Water Surface Elevations

River Station (Existing Condition)	Location/ Distance from Existing Bridge Centerline	100-year WSE		WSE Change (ft)
		Existing (ft NAVD 88)	Proposed (ft NAVD 88)	
673	Model Upstream Limit 450 ft Upstream	382.01	381.35	-0.66
533	310 ft Upstream	381.29	380.04	-1.25
375	153 ft Upstream	380.45	377.93	-2.52
284	Upstream of Collapsed Retaining Wall	379.46	n/a[1]	n/a[1]
256	Downstream of Collapsed Retaining Wall	375.56	n/a[1]	n/a[1]
221	Lambert Lane Bridge Upstream Face[2]	374.96	374.54	n/a[2]
221	Lambert Lane Bridge Downstream Face[2]	374.05	374.03	n/a[2]
200	22 ft Downstream	373.94	373.74	-0.20
156	65 ft Downstream	373.53	373.64	0.11
124	97 ft Downstream	373.62	373.60	-0.02

Notes:
1. Project proposes a bridge with a softer and more gradual turn of the creek alignment. The proposed condition hydraulic model does not include channel cross-sections representing upstream/downstream conditions and/or effects of the collapsed retaining wall.
2. The proposed bridge is wider than the existing bridge. Therefore, the upstream/downstream faces of the existing and proposed bridges are not in the same location.
3. NAVD 88 = North American Vertical Datum of 1988.

As shown in Figure 9 and Figure 10, both existing and proposed bridge would have sufficient freeboard during the 100-year storm event. Lambert Lane would be open to traffic during the 100-year storm event.

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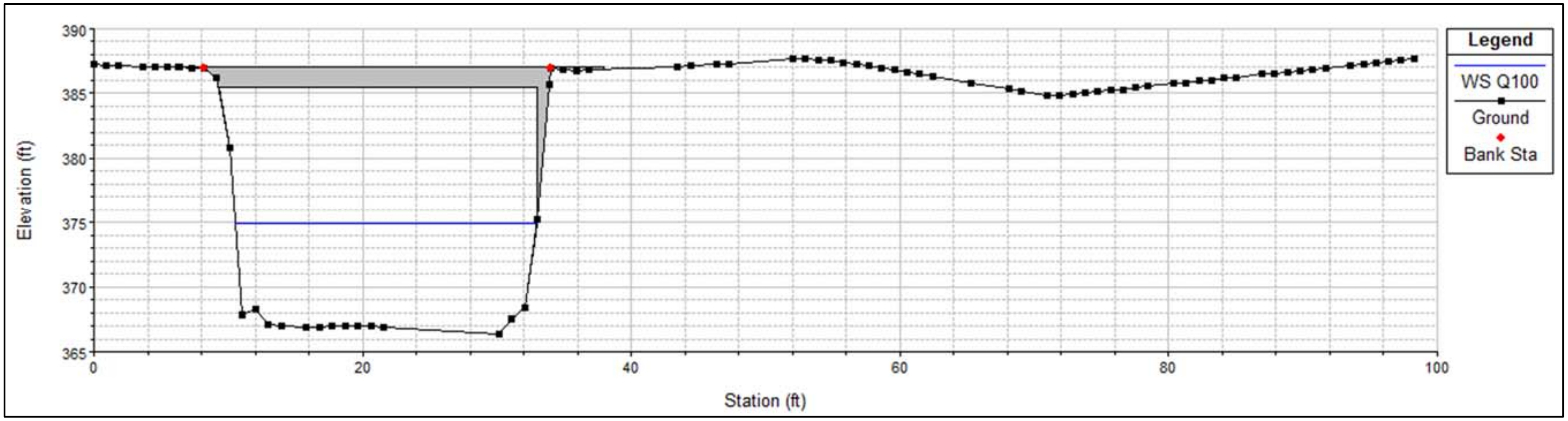

Figure 9. Existing Lambert Lane Bridge, Looking Downstream

Source: HEC-RAS (2021)

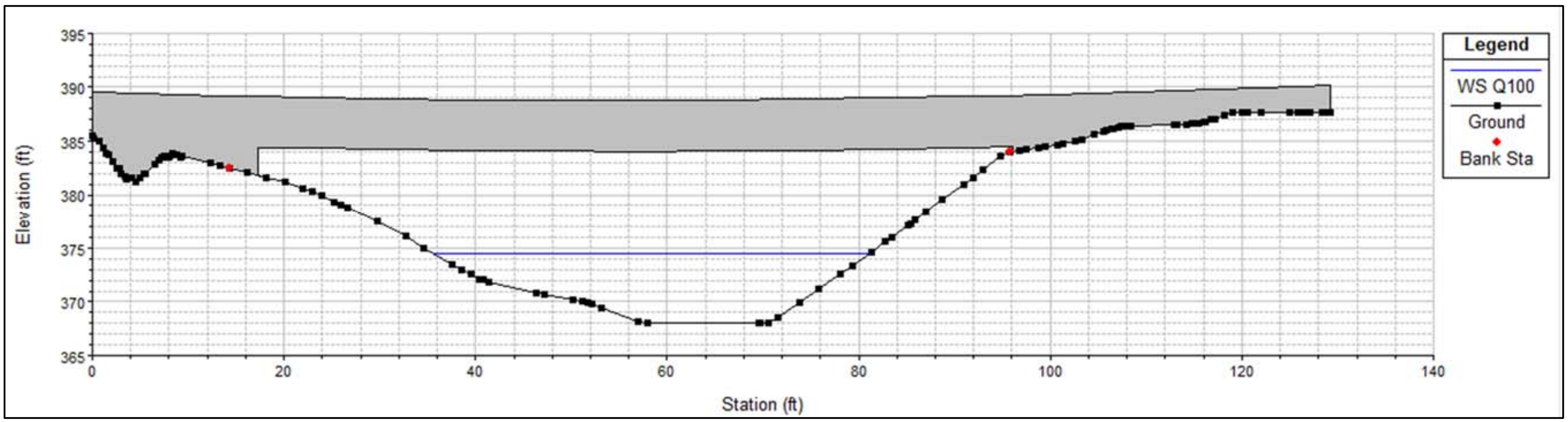

Figure 10. Proposed Lambert Lane Bridge, Looking Downstream

Source: HEC-RAS (2021)

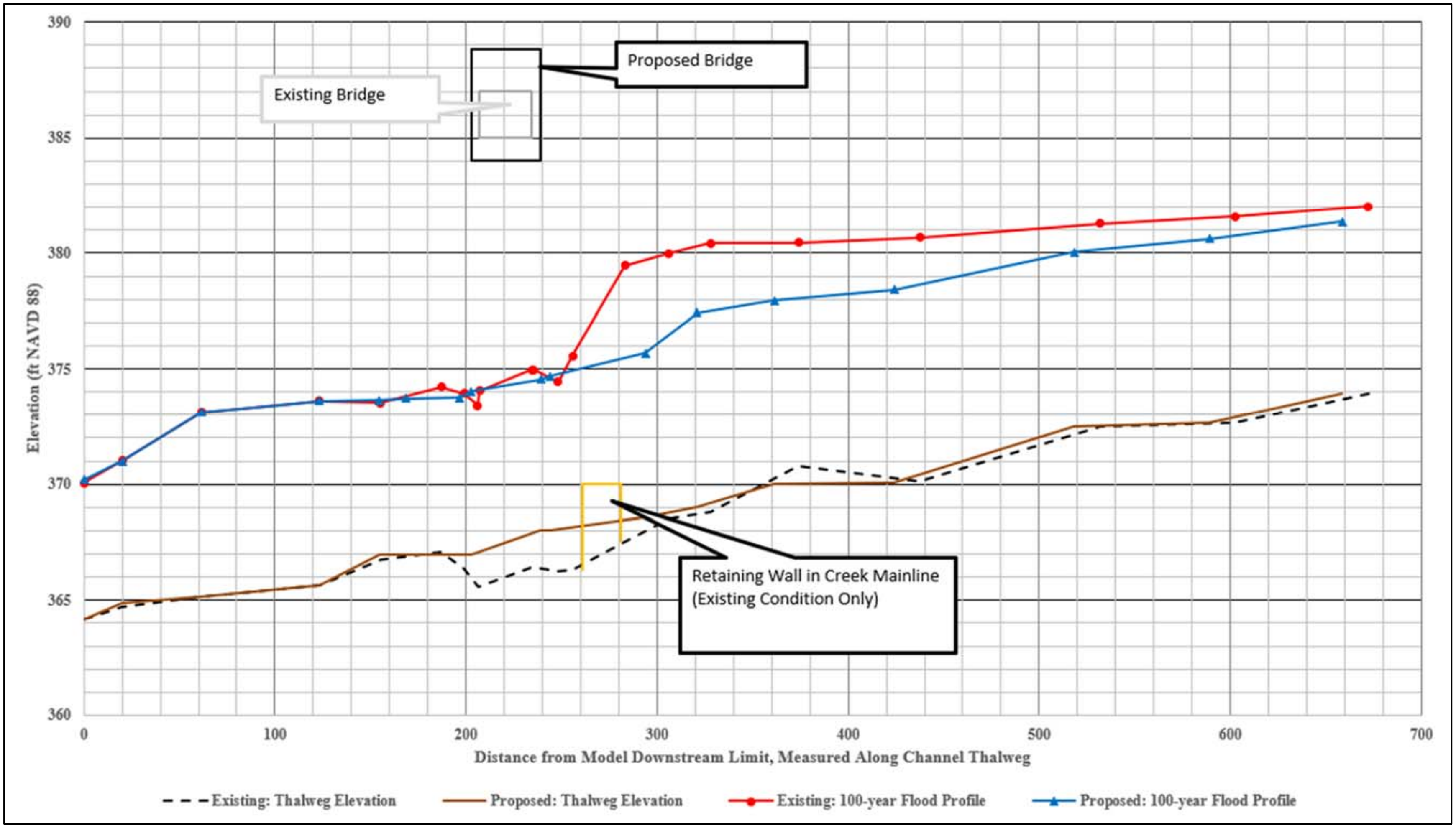

Figure 11. 100-year Flood Profile of Robinson Creek at Project Location

Note: channel alignment for proposed condition is shorter at the bridge crossing. The five upstream-most cross sections for the existing and proposed conditions are located in same location, as shown in Figure 7.

Source: WRECO (2021)

4 PROJECT EVALUATION

Executive Order 11988 requires federal agencies to avoid to the maximum extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development, wherever there is a practicable alternative. This section analyzes the impacts associated with this Project.

4.1 Risk Associated with the Proposed Action

As defined by the FHWA, risk shall mean the consequences associated with the probability of flooding attributable to an encroachment. It shall include the potential for property loss and hazard to life during the service life of the bridge and roadway.

The potential risk associated with the implementation of the proposed action includes, but is not limited to: 1) change in land use, 2) change in impervious surface area, 3) fill inside the floodplain, or 4) change in the 100-year WSE. The measures to minimize the potential floodplain impacts associated with the action are summarized in Section 5.

4.1.1 Change in Land Use

The Project proposes the removal of existing bridge structure and replacing it with longer and wider bridge following the same alignment. With the exception of the bridge, associated widening of the bridge approach area, and changes in the creek alignment from curve softening, changes in the land use in the Project vicinity are not expected to occur from the proposed Project.

4.1.2 Change in Impervious Surface Area

The replacement of existing bridge with longer and wider bridge would slightly increase the impervious surface area within the watershed of Robinson Creek. However, widening of impervious surface at the bridge and bridge approach from approximately 24 ft to approximately 31.33 ft would be insignificant compared to the watershed of Robinson Creek at the Project location (approximately 4.0 sq mi).

4.1.3 Fill Inside the Floodplain

The existing FEMA SFHA Zone A at the Project location is approximately 280 ft, and the proposed construction activities inside FEMA SFHA Zone A includes removal/replacement of bridge and softening of the creek alignment. The Project will introduce fill within the FEMA SFHA Zone A associated with the realignment of the channel. However, the proposed bridge abutments will be designed to clear-span the creek and the faces of the abutments will be beyond the limits of the 100-year floodplain, as shown in the hydraulic analysis. This is an improvement compared to the existing condition, where the existing bridge abutments are within the 100-year floodplain.

4.1.4 Change in the 100-Year Water Surface Elevation

The results of the steady-state hydraulic modeling indicated that the proposed replacement of the bridge and channel grading would slightly increase the flood profile at the downstream bridge opening by approximately 0.9 ft or less, but would lower the 100-year flood profile of Robinson Creek upstream of the proposed Lambert Lane Bridge. At the upstream limit of the hydraulic model located approximately 450 ft upstream of the existing Lambert Lane Bridge, the Project would lower the 100-year flood profile by approximately 0.66 ft. The 100-year flow would be conveyed in the main channel of Robinson Creek in the Project vicinity for both existing and proposed conditions. The proposed action would not significantly modify the characteristics of the existing 100-year floodplain and would comply with the requirements of 44 CFR 60.3C.

4.2 Summary of Potential Encroachments

The Federal Highway Administration (FHWA) defines a significant encroachment as a highway encroachment, and any direct support of likely base floodplain development that would involve one or more of the following construction or flood-related impacts: 1) significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community’s only evacuation route, 2) a significant risk, or 3) a significant adverse impact on the natural and beneficial floodplain values (FHWA, 1994). The following sections discuss the potential impacts to the floodplain that may result from the proposed action. The risk associated with implementation of the action is discussed in Section 4.1.

4.2.1 Potential Traffic Interruptions for the Base Flood

The existing and proposed bridge would be open during the 100-year storm event, as both existing and proposed bridge would have sufficient freeboard during the 100-year storm event to meet the FHWA, Caltrans, and Mendocino County design standards.

4.2.2 Potential Impacts on Natural and Beneficial Floodplain Values

Natural and beneficial floodplain values include, but are not limited to: fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge.

The proposed action would result in environmental impacts from the removal of the existing bridge structure and construction of the new bridge. Potential short-term adverse effects during the construction of the new bridge to the natural and beneficial floodplain values include: 1) the loss of vegetation during construction activity and softening of creek alignment at the proposed bridge crossing; and 2) temporary disturbance of wildlife and aquatic habitat. Permanent potential impacts include changes to the alignment of the Robinson Creek in the vicinity of the proposed Lambert Lane Bridge.

The Project location is critical habitat for Northern California steelhead and Central California Coast Coho salmon. In addition, the following species have the potential to occur in the Project location: western pond turtle, Navarro roach, foothill yellow-legged frog, migratory birds and raptors, and colonial roosting bats.

Recommendations detailed in the *Natural Environment Study* (Gallaway Enterprises, 2020) and *Biological Opinion* (NOAA National Marine Fisheries Service, 2021) will avoid and minimize impact to the above-mentioned species. No compensatory mitigation will be required.

4.2.3 Support of Probable Incompatible Floodplain Development

As defined by the FHWA, the support of incompatible base floodplain development will encourage, allow, serve, or otherwise facilitate incompatible base floodplain development, such as commercial development or urban growth.

The Project is proposing to replace the existing structurally deficient bridge in the same alignment as the existing bridge. The Project is not proposing to create a new access route to developed or undeveloped lands within the limits of the FEMA SFHA. The Project would not trigger incompatible floodplain development of the areas within the existing Robinson Creek floodplain.

4.2.4 Longitudinal Encroachments

As defined by the FHWA, a longitudinal encroachment is an action within the limits of the base floodplain that is longitudinal to the normal direction of the floodplain.

A longitudinal encroachment is "[a]n encroachment that is parallel to the direction of flow. Example: A highway that runs along the edge of a river is usually considered a longitudinal encroachment." The requirement for consideration of avoidance alternatives must be included in a Location Hydraulic Study by including an evaluation and a discussion of the practicability of alternatives to any significant encroachment or any support of incompatible floodplain development.

The alignment of the proposed bridge is not parallel to the direction of flow in Robinson Creek and therefore, the proposed action would not be a longitudinal encroachment to the existing floodplain.

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5 AVOIDANCE, MINIMIZATION, AND/OR MITIGATION MEASURES

5.1 Minimize Floodplain Impacts

The proposed Project would not change the overall land use within the Project watershed of Robinson Creek, would not significantly increase impervious area, and would not result in significant fill inside the existing FEMA SFHA. Based on the results from the hydraulic analysis, the proposed Project would not significantly modify the 100-year flood profile and extents of the 100-year floodplain. Therefore, Project would have minimal impacts to the floodplain.

5.2 Restore and Preserve Natural and Beneficial Floodplain Values

Temporary environmental impacts could be minimized with measures, such as best management practices, seasonal construction work restrictions, revegetation, establishing a boundary for work around sensitive habitat, implementing dust, erosion, and sedimentation control measures, and other activities that are part of the Project's permit conditions. Avoidance and minimization efforts are detailed in the *Natural Environment Study* and *Biological Opinion*. No additional compensatory mitigation is required.

5.3 Alternatives to Significant Encroachments

According to the hydraulic analyses of the existing and proposed bridge conditions, the 100-year flood profile and extents of the 100-year flood would not change significantly as a result of the proposed action. There would be no significant encroachments at the Project location. Therefore, alternatives to the significant encroachments were not analyzed.

5.4 Alternatives to Longitudinal Encroachments

The proposed Project would not be a longitudinal encroachment to the existing floodplain and therefore, alternatives to longitudinal encroachments were not analyzed.

5.5 Coordination with Local, State, and Federal Water Resources and Floodplain Management Agencies

The County will coordinate with local, state, and federal water resources and floodplain management agencies as necessary during all aspects of the proposed Project. The following regulatory permits and approvals would be required when the Project enters into the final design and construction phases: 1602 Streambed Alteration Agreement from the California Department of Fish and Wildlife (CDFW), a Section 404 Nationwide Permit from the USACE, and a 401 Water Quality Certification from the Regional Water Quality Control Board. In addition, Project may require 2081 Incidental Take Permit from CDFW.

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6 REFERENCES

California Department of Transportation. (2017). *Memo to Designers 16-1 Hydraulic Design for Structures over Waterways*. <https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/memotodesigner/f0006651-mtd-16-1-final.pdf> (Last accessed: May 18, 2021).

California Department of Transportation. (2019). *California Amendments to the AASHTO LRFD Bridge Design Specifications (Eighth Edition).* <https://dot.ca.gov/programs/engineering-services/manuals/lrfd-ca-amendments-8th-edition> (Last accessed: May 18, 2021).

California Department of Transportation. (2011). *California Amendments to the AASHTO LRFD Bridge Design Specifications (Fourth Edition).*

California Department of Transportation. (2020). *Highway Design Manual*. U.S. Customary Units. (Seventh Edition). <https://dot.ca.gov/programs/design/manual-highway-design-manual-hdm> (Last accessed: May 18, 2021).

Federal Emergency Management Agency. (2011). *Flood Insurance Rate Map* for Mendocino County, California and Incorporated Areas. Map Number 06045C1663F. Panel 1663 of 2100.

Federal Emergency Management Agency. (2017). *Flood Insurance Study* for Mendocino County, California and Incorporated Areas. Flood Insurance Study Number 06045CV001B.

Federal Emergency Management Agency. (2006). National Training and Education – Emergency Management Institute. "Chapter 13: Regulatory and Design Standards for Reducing Losses." *Floodplain Management – An Integrated Approach.*

Federal Highway Administration. (2004). *Code of Federal Regulations*. Title 23 – Highways. Sub-chapter G – Engineering and Traffic Operations. Part 650 – Bridges, Structures, and Hydraulics.

Federal Highway Administration. (1994). "Location and Hydraulic Design of Encroachment on Flood Plains." *Federal-Aid Policy Guide*. Title 23, Code of Federal Regulations, Part 650, Subpart A (23 CFR 650A December 7, 1994, Transmittal 12. <http://www.fhwa.dot.gov/legsregs/directives/fapg/cfr0650a.htm>

Federal Highway Administration. (1979). DOT Order 5650.2 - Floodplain Management and Protection. <http://www.fhwa.dot.gov/engineering/hydraulics/policymemo/order56502.pdf> (Last accessed: July 15, 2016)

Gallaway Enterprises. (December 2020). *Natural Environmental Study*. Prepared for California Department of Transportation.

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, C. (2012). *Methods for Determining Magnitude and Frequency of Floods in California, Based on Data through Water Year 2006.* USGS Scientific Investigation Report 2011-5113.

Quincy Engineering. (March 2018). *Project Report, On Route: Lambert Lane Bridge at Robinson Creek Center of Town in Boonville CA, B1302*

Mendocino County (August 14, 2008). Road and Development Standards.

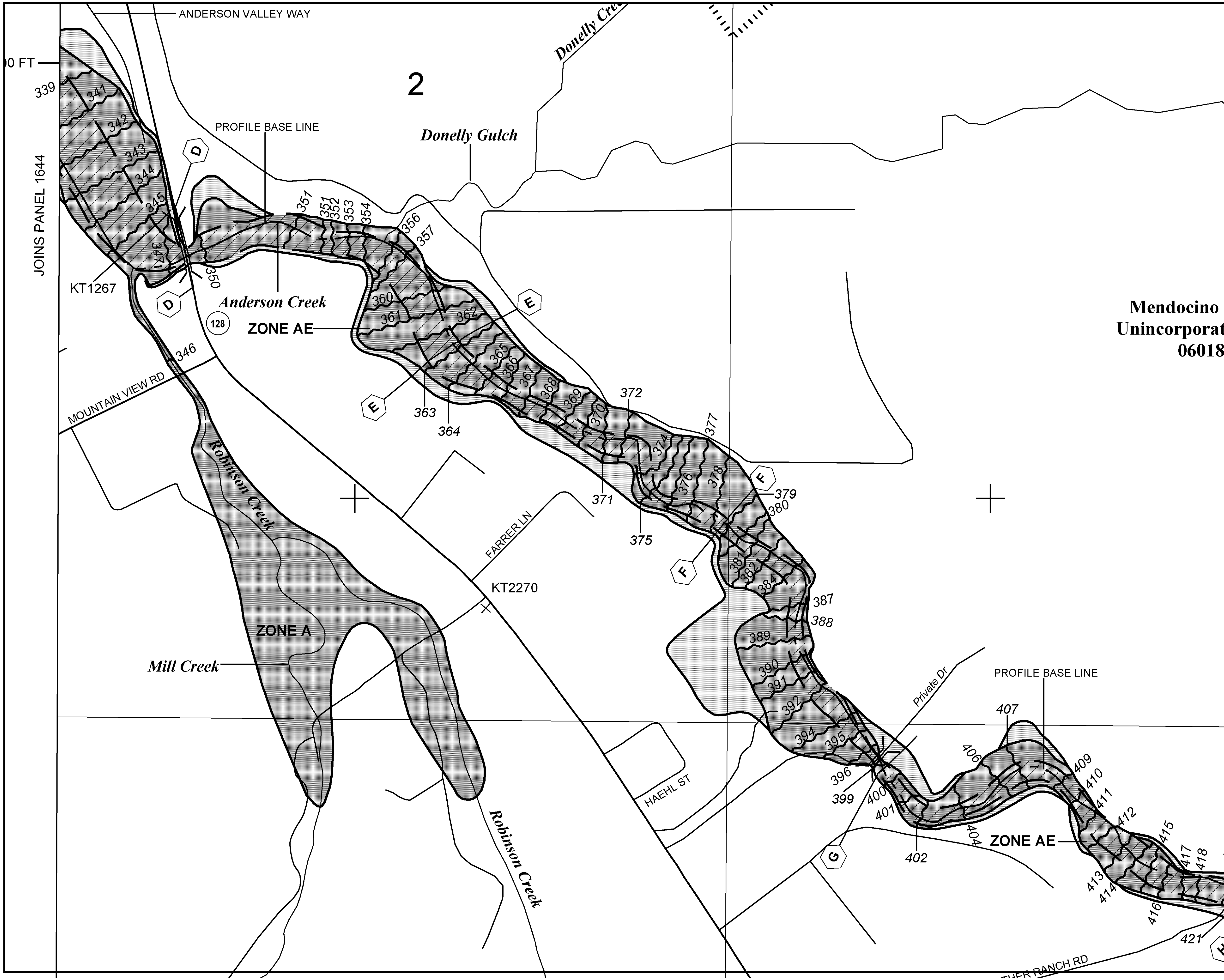
NOAA National Marine Fisheries Service, West Coast Region. *Endangered Species Act Section 7(a)(2) Biological Opinion*. Prepared for California Department of Transportation.

United States Army Corps of Engineers - Hydrologic Engineering Center. (2019). River Analysis System. HEC-RAS. (Version 5.0.7) [Computer software]. May 2021. Available from: https://www.hec.usace.army.mil/software/hec-ras/download.aspx

United States Geological Survey. (2001). *California: Seamless USGS Topographic Maps (CDROM, Version 2.6.8, 2001, Part Number: 113-100-004*). National Geographic Holdings, Inc.

U.S. Government Publishing Office. (April 1, 2020). Code of Federal Regulations Title 23 Highways. Chapter I - Federal Highway Administration, Department Of Transportation. Subchapter G - Engineering and Traffic Operations. Part 650 - Bridges, Structures, and Hydraulics. <https://www.govinfo.gov/content/pkg/CFR-2020-title23-vol1/pdf/CFR-2020-title23-vol1-part650.pdf> (Last accessed: May 18, 2021)

Appendix A Federal Emergency Management Agency Flood Insurance Rate Maps



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1663F

FIRM

FLOOD INSURANCE RATE MAP

MENDOCINO COUNTY, CALIFORNIA

AND INCORPORATED AREAS

PANEL 1663 OF 2100

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MENDOCINO COUNTY	060183	1663	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

U.S. DEPARTMENT OF HOMELAND SECURITY

MAP NUMBER
06045C1663F

EFFECTIVE DATE
JUNE 2, 2011

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

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Appendix B USGS StreamStats

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StreamStats Version 3 Beta

Basin Characteristics Ungaged Site Report

Date: Tues Aug 25, 2015 3:31:10 PM GMT-7
NAD 1983 Latitude: 39.0086 (39 00 31)
NAD 1983 Longitude: -123.3684 (-123 22 07)

Label	Value	Units	Definition
DRNAREA	4	square miles	Area that drains to a point on a stream
RELIEF	1597	feet	Maximum - minimum elevation
ELEVMAX	1967	feet	Maximum basin elevation
MINBELEV	371	feet	Minimum basin elevation
LAKEAREA	0	percent	Percentage of Lakes and Ponds
EL6000	0	percent	Percent of area above 6000 ft
OUTLETELEV	374	feet	Elevation of the stream outlet in thousands of feet above NAVD88.
BASINPERIM	14.4	miles	Perimeter of the drainage basin as defined in SIR 2004-5262
RELRELF	111	feet per mi	Basin relief divided by basin perimeter
ELEV	881	feet	Mean Basin Elevation
BSLDEM30M	23.2	percent	Mean basin slope computed from 30 m DEM
FOREST	18.5	percent	Percentage of area covered by forest
LC11IMP	1.1	percent	Percentage of impervious area determined from NLCD 2011 impervious dataset
PRECIP	44.2	inches	Mean Annual Precipitation
JANMAXTMP	56.41	degrees F	Mean Maximum January Temperature
JANMINTMP	37.58	degrees F	Mean Minimum January Temperature
ALTIND	0.73	thousand feet	Altitude Index
LC11DEV	8.8	percent	Percentage of land-use from NLCD 2011 classes 21-24
LFPLENGTH	5	miles	Length of longest flow path

StreamStats Version 3 Beta

Flow Statistics Ungaged Site Report

Date: Tues Aug 25, 2015 3:30:08 PM GMT-7
Site Location: California
NAD 1983 Latitude: 39.0086 (39 00 31)
NAD 1983 Longitude: -123.3684 (-123 22 07)
Drainage Area: 4 mi2

Peak-Flow Basin Characteristics			
100% 2012 5113 Region 1 North Coast (4 mi2)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	4	0.04	3200
Mean Annual Precipitation (inches)	44.2	20	125

Peak-Flow Statistics						
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
PK2	264	ft3/s	59		108	645
PK5	517	ft3/s	47		247	1080
PK10	700	ft3/s	44		347	1410
PK25	943	ft3/s	43		482	1850
PK50	1130	ft3/s	43		576	2220
PK100	1320	ft3/s	44		659	2660
PK200	1510	ft3/s	44		748	3040
PK500	1760	ft3/s	46		851	3630

#http://pubs.usgs.gov/sir/2012/5113/#

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.

Appendix C Mendocino County Zoning Map

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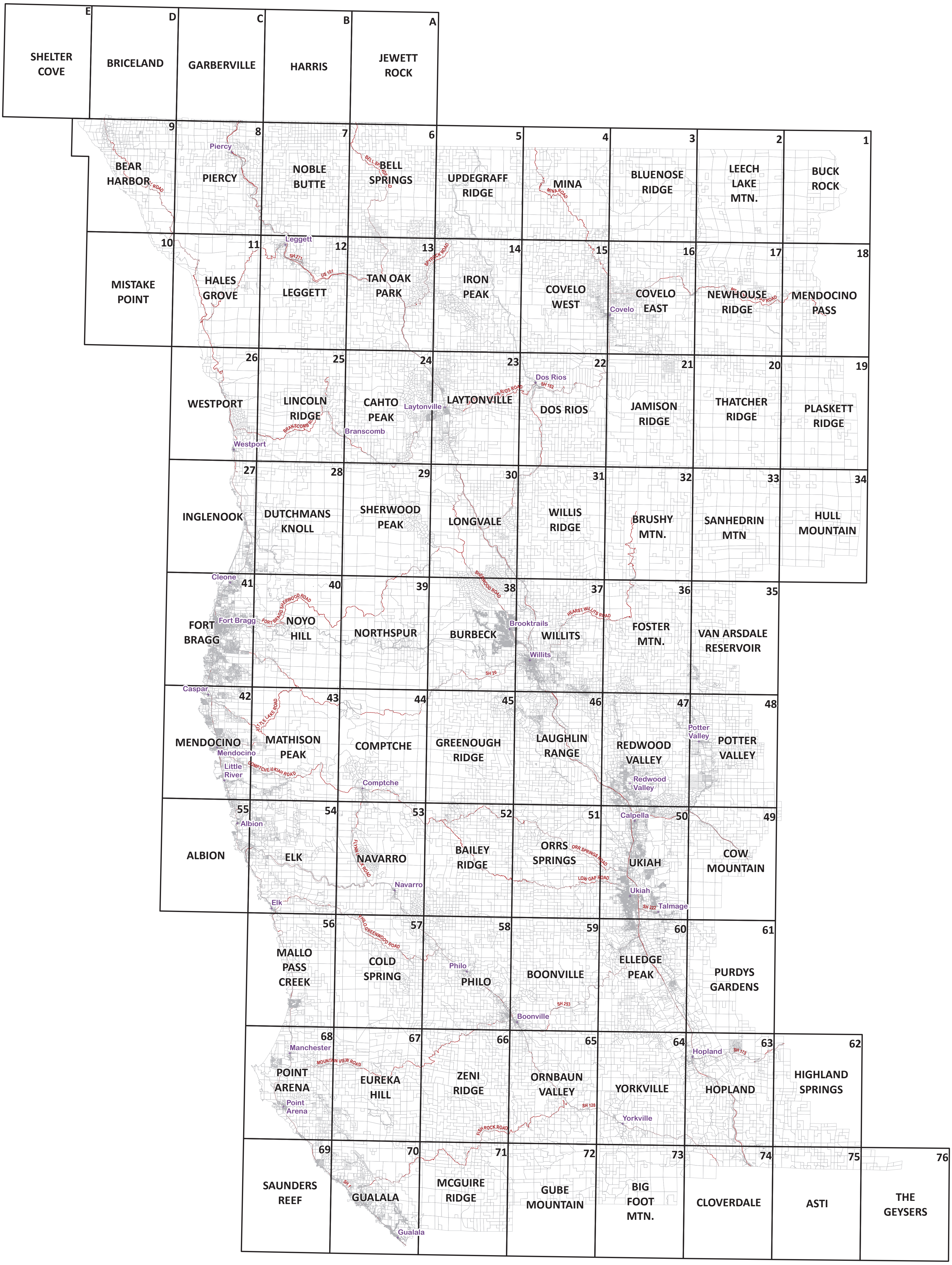
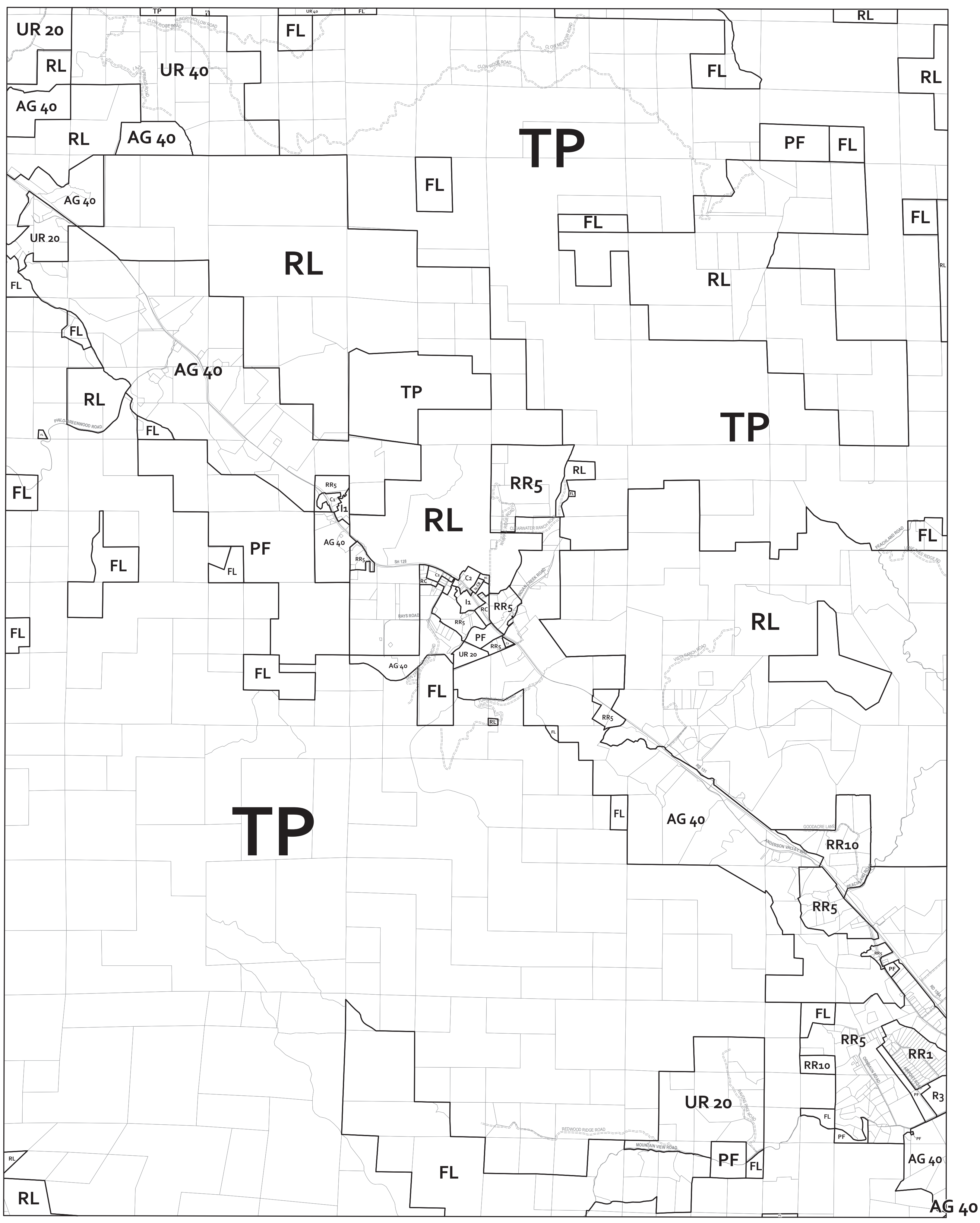
USGS QUAD MAP INDEX for MENDOCINO COUNTY



Map produced by the Mendocino County Department of Planning & Building Services, May, 2013
This map is provided as a visual display of county information, and as such may be subject to change, correction or revision without notice.
Assessors parcel data current November, 2011. All spatial data is approximate.
Reasonable effort has been made to ensure the accuracy of the map and data provided, however errors and omissions may still exist.
Do not make a business decision based on this map without first consulting the appropriate agency.

THIS MAP AND ASSOCIATED DATA ARE PROVIDED WITHOUT WARRANTY OF ANY KIND.

ZONING DISPLAY MAP



0 0.5 1 2 Miles

0 1,000 2,000 4,000 6,000 8,000 Feet

1 in = 2,000 ft

ABBREVIATION KEY

ZONING DISPLAY MAP

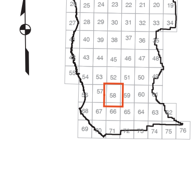
PRODUCED 2018
MENDOCINO COUNTY
PLANNING & BLDG. SVCS.
THIS IS NOT AN ADOPTED MAP
FOR DISPLAY PURPOSES ONLY
Print Date: 5/8/2018

AG	Agricultural Lands
AG-CR	Agricultural (Contract Rezone)
AV	Airport District
C	Coastal Commercial
C-PD	Coastal Commercial (Planned Development)
C1	Inland Limited Commercial
C1-CR	Inland Limited Commercial (Contract Rezone)
C2	Inland General Commercial
C2-CR	Inland General Commercial (Contract Rezone)
C2-IS	Inland General Commercial (Isolated Service)
FL	Forestland
FV	Fishing Village
I	Coastal Industrial
I1	Inland Limited Industrial
I1-CR	Inland Limited Industrial (Contract Rezone)
I2	Inland General Industrial
OS	Open Space
OS-CR	Open Space (Contract Rezone)
PI	Pinoleville Industrial
PF	Public Facility
PF-PD	Public Facility (Planned Development)
RC	Rural Community
RC-CR	Rural Community (Contract Rezone)
RL	Rangeland
RL-PD	Rangeland (Planned Development)
SR	Suburban Residential
TP	Timberland Production
UR	Upland Residential
UR-CR	Upland Residential (Contract Rezone)
UR-PD	Upland Residential (Planned Development)
R1	Single Family Residential
R2	Two Family Residential
R3	Multi Family Residential
RMR	Remote Residential
RMR-DL	Remote Residential (Development Limitation)
RMR-PD	Remote Residential (Planned Development)
RR	Rural Residential
RR-CR	Rural Residential (Contract Rezone)
RR-DL	Rural Residential (Development Limitation)
RR-PD	Rural Residential (Planned Development)
RR-PD-DL	Rural Residential (Planned Development Limitation)
RV	Rural Village
MC	Mendocino Commercial
MFL	Mendocino Forestland
MMU	Mendocino Mixed-Use
MOS	Mendocino Open Space
MPF	Mendocino Public Facility
MRM	Mendocino Multi-Family Residential
MRR	Mendocino Rural Residential
MSR	Mendocino Suburban Residential
MTR	Mendocino Town Residential
GPD	Gualala Planned Development
GVMU	Gualala Village Mixed Use
GHMU	Gualala Highway Mixed Use
GI	Gualala Industrial
RR_ [RR_]	Variable Density Zone (see note below)

Zoning designations shown in [brackets] (coastal zone only) indicate 'variable density zones'. Per county code Sec. 3.8-10 In order to be developed to the smaller parcel size, areas indicated on the map as having a variable density zoning classification shall be required to be served by a public water system which utilizes surface waters, and which does not impact upon the ground water resource, or by completion of a hydrological study which supports those greater densities.

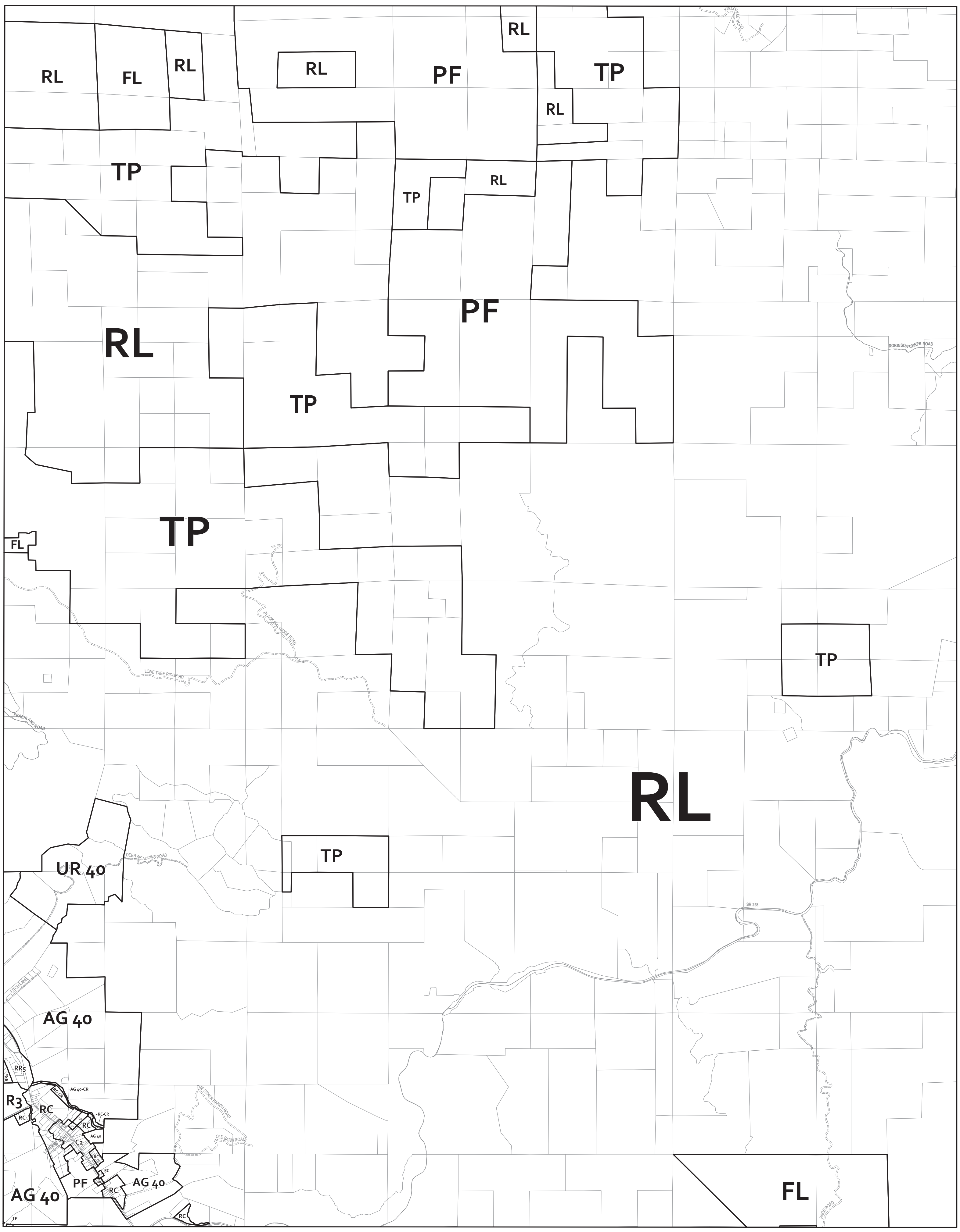
PHILO

USGS QUADRANGLE BASE



SHEET 59

ZONING DISPLAY MAP



0 0.5 1 2 Miles

0 1,000 2,000 4,000 6,000 8,000 Feet

1 in = 2,000 ft

ABBREVIATION KEY

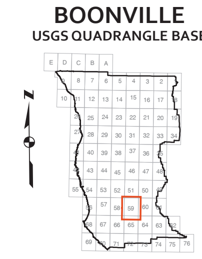
AG	Agricultural Lands	**I1-CR**	Inland Limited Industrial (Contract Rezone)	**UR-CR**	Upland Residential (Contract Rezone)	**MC**	Mendocino Commercial
AG-CR	Agricultural (Contract Rezone)	**I2**	Inland General Industrial	**UR-PD**	Upland Residential (Planned Development)	**MFL**	Mendocino Forestland
AV	Airport District	**OS**	Open Space	**R1**	Single Family Residential	**MMU**	Mendocino Mixed-Use
C	Coastal Commercial	**OS-CR**	Open Space (Contract Rezone)	**R2**	Two Family Residential	**MOS**	Mendocino Open Space
C-PD	Coastal Commercial (Planned Development)	**PI**	Pinoleville Industrial	**R3**	Multi Family Residential	**MPF**	Mendocino Public Facility
C1	Inland Limited Commercial	**PF**	Public Facility	**RMR**	Remote Residential	**MRM**	Mendocino Multi-Family Residential
C1-CR	Inland Limited Commercial (Contract Rezone)	**PF-PD**	Public Facility (Planned Development)	**RMR-DL**	Remote Residential (Development Limitation)	**MRR**	Mendocino Rural Residential
C2	Inland General Commercial	**RC**	Rural Community	**RMR-PD**	Remote Residential (Planned Development)	**MSR**	Mendocino Suburban Residential
C2-CR	Inland General Commercial (Contract Rezone)	**RC-CR**	Rural Community (Contract Rezone)	**RR**	Rural Residential	**MTR**	Mendocino Town Residential
C2-IS	Inland General Commercial (Isolated Service)	**RL**	Rangeland	**RR-CR**	Rural Residential (Contract Rezone)	**GPD**	Gualala Planned Development
FL	Forestland	**RL-PD**	Rangeland (Planned Development)	**RR-DL**	Rural Residential (Development Limitation)	**GVMU**	Gualala Village Mixed Use
FV	Fishing Village	**SR**	Suburban Residential	**RR-PD**	Rural Residential (Planned Development)	**GHMU**	Gualala Highway Mixed Use
I	Coastal Industrial	**TP**	Timberland Production	**RR-PD-DL**	Rural Residential (Planned Development Limitation)	**GI**	Gualala Industrial
I1	Inland Limited Industrial	**UR**	Upland Residential	**RV**	Rural Village	**RR_ [RR_]**	Variable Density Zone (see note below)

Zoning designations shown in [brackets] (coastal zone only) indicate 'variable density zones'. Per county code Sec. 3.8-10 In order to be developed to the smaller parcel size, areas indicated on the map as having a variable density zoning classification shall be required to be served by a public water system which utilizes surface waters, and which does not impact upon the ground water resource, or by completion of a hydrological study which supports those greater densities.

ZONING DISPLAY MAP

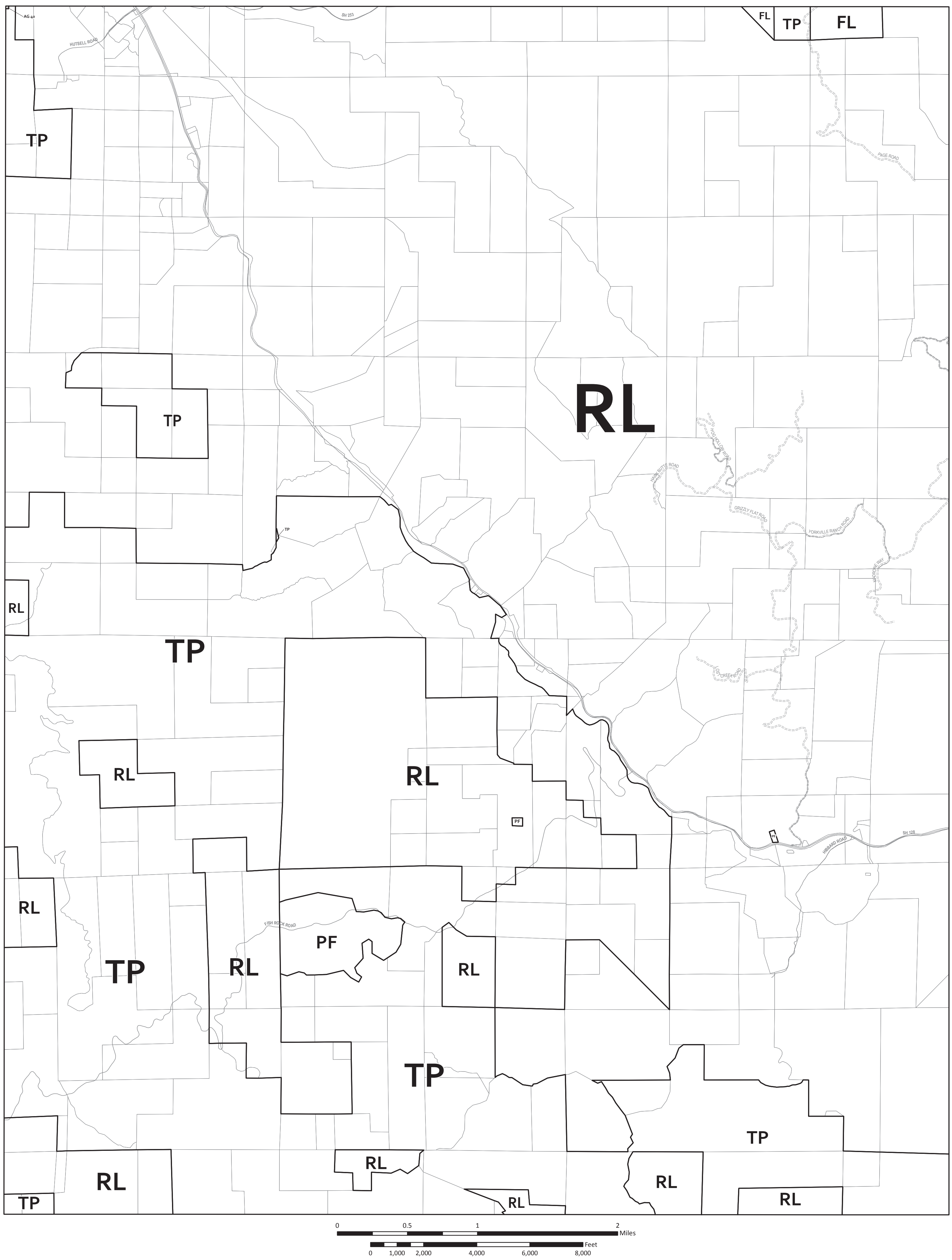
PRODUCED 2013
MENDOCINO COUNTY
PLANNING & BLDG. SVCS.
THIS IS NOT AN ADOPTED MAP
FOR DISPLAY PURPOSES ONLY
Print Date: 6/6/2013

BOONVILLE
USGS QUADRANGLE BASE



SHEET 65

ZONING DISPLAY MAP



ABBREVIATION KEY

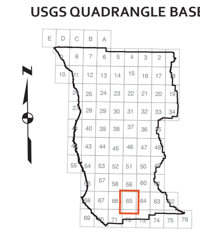
ZONING DISPLAY MAP

PRODUCED 2013
MENDOCINO COUNTY
PLANNING & BLDG. SVCS.
THIS IS NOT AN ADOPTED MAP
FOR DISPLAY PURPOSES ONLY
Print Date: 6/6/2013

AG	Agricultural Lands	**I1-CR**	Inland Limited Industrial (Contract Rezone)	**UR-CR**	Upland Residential (Contract Rezone)	**MC**	Mendocino Commercial
AG-CR	Agricultural (Contract Rezone)	**I2**	Inland General Industrial	**UR-PD**	Upland Residential (Planned Development)	**MFL**	Mendocino Forestland
AV	Airport District	**OS**	Open Space	**R1**	Single Family Residential	**MMU**	Mendocino Mixed-Use
C	Coastal Commercial	**OS-CR**	Open Space (Contract Rezone)	**R2**	Two Family Residential	**MOS**	Mendocino Open Space
C-PD	Coastal Commercial (Planned Development)	**PI**	Pinoleville Industrial	**R3**	Multi Family Residential	**MPF**	Mendocino Public Facility
C1	Inland Limited Commercial	**PF**	Public Facility	**RMR**	Remote Residential	**MRM**	Mendocino Multi-Family Residential
C1-CR	Inland Limited Commercial (Contract Rezone)	**PF-PD**	Public Facility (Planned Development)	**RMR-DL**	Remote Residential (Development Limitation)	**MRR**	Mendocino Rural Residential
C2	Inland General Commercial	**RC**	Rural Community	**RMR-PD**	Remote Residential (Planned Development)	**MSR**	Mendocino Suburban Residential
C2-CR	Inland General Commercial (Contract Rezone)	**RC-CR**	Rural Community (Contract Rezone)	**RR**	Rural Residential	**MTR**	Mendocino Town Residential
C2-IS	Inland General Commercial (Isolated Service)	**RL**	Rangeland	**RR-CR**	Rural Residential (Contract Rezone)	**GPD**	Gualala Planned Development
FL	Forestland	**RL-PD**	Rangeland (Planned Development)	**RR-DL**	Rural Residential (Development Limitation)	**GVMU**	Gualala Village Mixed Use
FV	Fishing Village	**SR**	Suburban Residential	**RR-PD**	Rural Residential (Planned Development)	**GHMU**	Gualala Highway Mixed Use
I	Coastal Industrial	**TP**	Timberland Production	**RR-PD-DL**	Rural Residential (Planned Development Limitation)	**GI**	Gualala Industrial
I1	Inland Limited Industrial	**UR**	Upland Residential	**RV**	Rural Village	**RR_ [RR_]**	Variable Density Zone (see note below)

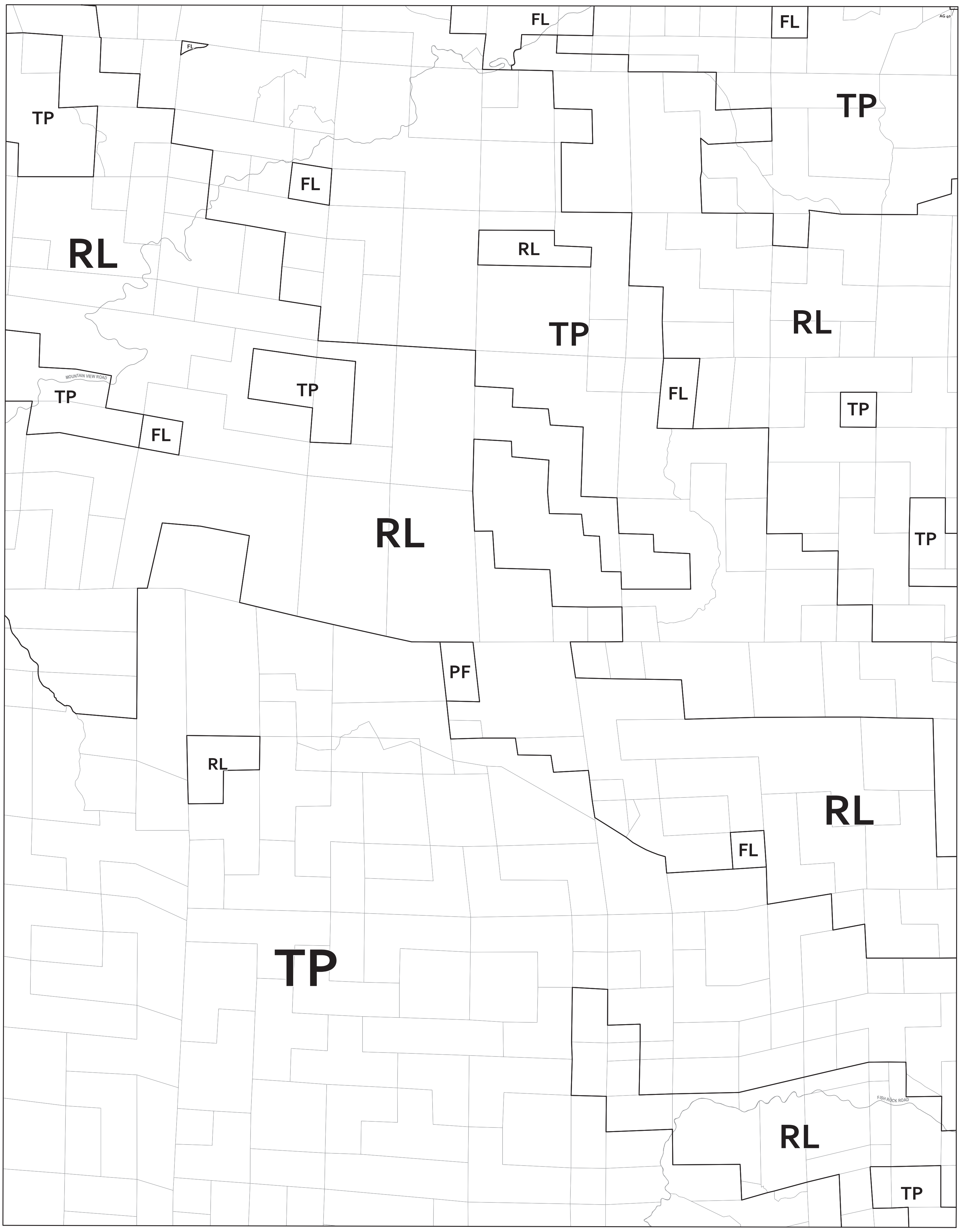
Zoning designations shown in [brackets] (coastal zone only) indicate 'variable density zones'. Per county code Sec. 3.8-10 In order to be developed to the smaller parcel size, areas indicated on the map as having a variable density zoning classification shall be required to be served by a public water system which utilizes surface waters, and which does not impact upon the ground water resource, or by completion of a hydrological study which supports those greater densities.

ORNBAUN VALLEY
USGS QUADRANGLE BASE



SHEET 66

ZONING DISPLAY MAP



0 0.5 1 2 Miles

0 1,000 2,000 4,000 6,000 8,000 Feet

1 in = 2,000 ft

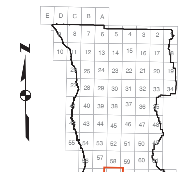
ABBREVIATION KEY

ZONING DISPLAY MAP

PRODUCED 2013
MENDOCINO COUNTY
PLANNING & BLDG. SVCS.
THIS IS NOT AN ADOPTED MAP
FOR DISPLAY PURPOSES ONLY
Print Date: 6/10/2013

AG Agricultural Lands
AG-CR Agricultural (Contract Rezone)
AV Airport District
C Coastal Commercial
C-PD Coastal Commercial (Planned Development)
C1 Inland Limited Commercial
C1-CR Inland Limited Commercial (Contract Rezone)
C2 Inland General Commercial
C2-CR Inland General Commercial (Contract Rezone)
C2-IS Inland General Commercial (Isolated Service)
FL Forestland
FV Fishing Village
I Coastal Industrial
I1 Inland Limited Industrial
I1-CR Inland Limited Industrial (Contract Rezone)
I2 Inland General Industrial
OS Open Space
OS-CR Open Space (Contract Rezone)
PI Pinoleville Industrial
PF Public Facility
PF-PD Public Facility (Planned Development)
RC Rural Community
RC-CR Rural Community (Contract Rezone)
RL Rangeland
RL-PD Rangeland (Planned Development)
SR Suburban Residential
TP Timberland Production
UR Upland Residential
UR-CR Upland Residential (Contract Rezone)
UR-PD Upland Residential (Planned Development)
R1 Single Family Residential
R2 Two Family Residential
R3 Multi Family Residential
RMR Remote Residential
RMR-DL Remote Residential (Development Limitation)
RMR-PD Remote Residential (Planned Development)
RR Rural Residential
RR-CR Rural Residential (Contract Rezone)
RR-DL Rural Residential (Development Limitation)
RR-PD Rural Residential (Planned Development)
RR-PD-DL Rural Residential (Planned Development Limitation)
RV Rural Village
MC Mendocino Commercial
MFL Mendocino Forestland
MMU Mendocino Mixed-Use
MOS Mendocino Open Space
MPF Mendocino Public Facility
MRM Mendocino Multi-Family Residential
MRR Mendocino Rural Residential
MSR Mendocino Suburban Residential
MTR Mendocino Town Residential
GPD Gualala Planned Development
GVMU Gualala Village Mixed Use
GHMU Gualala Highway Mixed Use
GI Gualala Industrial
RR_ [RR_] Variable Density Zone (see note below)

ZENI RIDGE
USGS QUADRANGLE BASE



Zoning designations shown in [brackets] (coastal zone only) indicate 'variable density zones'. Per county code Sec. 3.8-10 In order to be developed to the smaller parcel size, areas indicated on the map as having a variable density zoning classification shall be required to be served by a public water system which utilizes surface waters, and which does not impact upon the ground water resource, or by completion of a hydrological study which supports those greater densities.

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Appendix D USDA Web Soil Survey

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United States
Department of
Agriculture

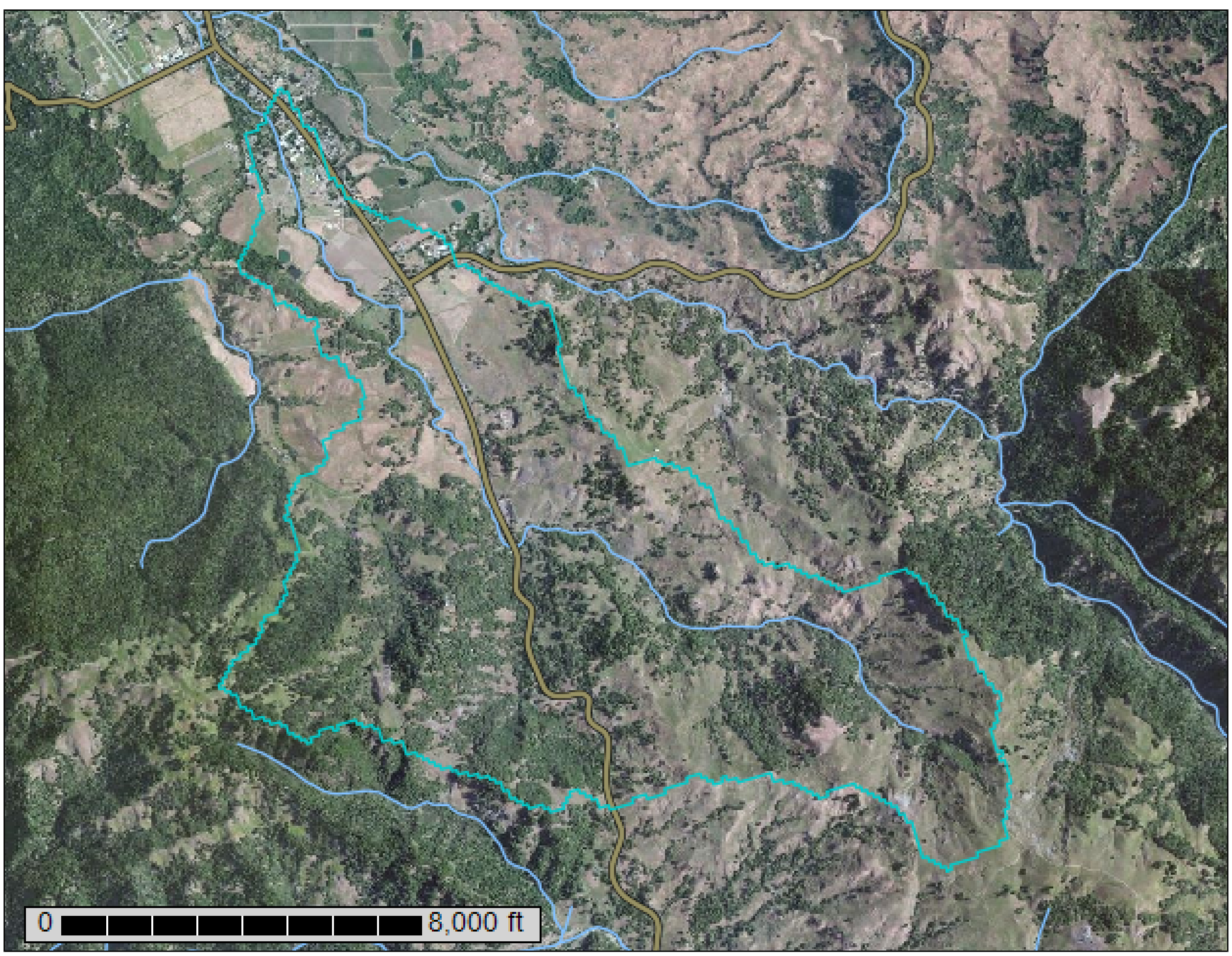
NRCS

Natural
Resources
Conservation
Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Mendocino County, Western Part, California



September 23, 2016

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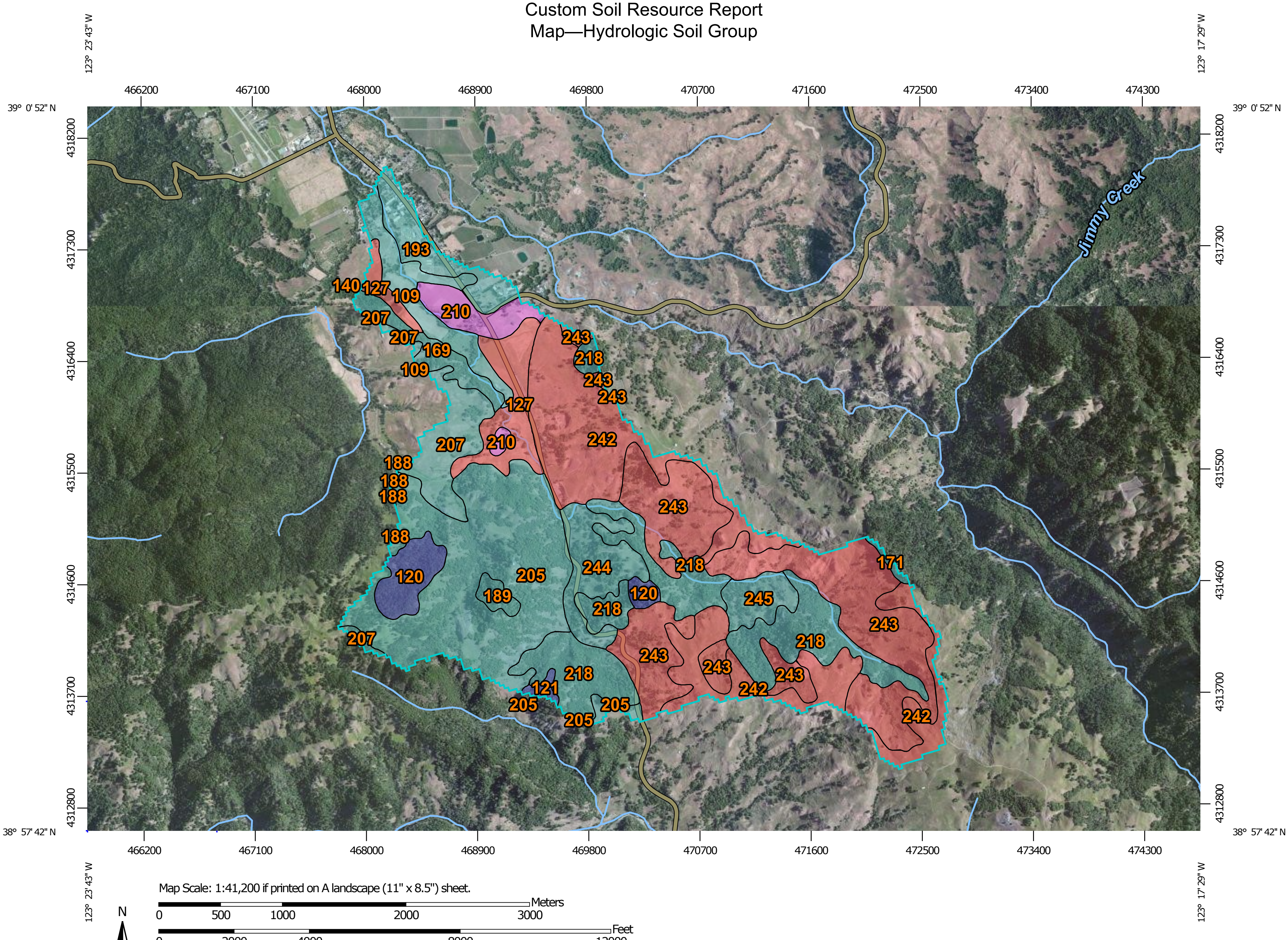
Custom Soil Resource Report
Map—Hydrologic Soil Group



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Mendocino County, Western Part, California
Survey Area Data: Version 10, Sep 30, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 16, 2010—Aug 14, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Mendocino County, Western Part, California (CA694)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
109	Boontling loam, 2 to 9 percent slopes	C	92.0	3.6%
120	Casabonne-Wohly complex, 30 to 50 percent slopes	B	70.5	2.8%
121	Casabonne-Wohly-Pardaloe complex, 50 to 75 percent slopes	B	8.4	0.3%
127	Cole loam, 0 to 5 percent slopes	D	113.0	4.4%
140	Feliz loam, 0 to 5 percent slopes	B	0.0	0.0%
169	Hopland-Witherell-Squawrock complex, 30 to 50 percent slopes	C	53.3	2.1%
171	Hopland-Wohly complex, 50 to 75 percent slopes	C	5.2	0.2%
188	Ornbaun-Zeni complex, 30 to 50 percent slopes	B	1.1	0.0%
189	Ornbaun-Zeni complex, 50 to 75 percent slopes	C	16.8	0.7%
193	Pinole loam, 2 to 9 percent slopes	C	81.2	3.2%
205	Squawrock-Garcia-Witherell complex, 15 to 50 percent slopes	C	484.7	19.1%
207	Squawrock-Witherell complex, 15 to 50 percent slopes	C	108.9	4.3%
210	Talmage gravelly loam, 0 to 2 percent slopes	A	63.2	2.5%
218	Updegraff-Hopland-Woodin complex, 30 to 50 percent slopes	C	344.1	13.5%
242	Yorkville-Squawrock-Witherell complex, 15 to 30 percent slopes	D	423.1	16.6%
243	Yorkville-Squawrock-Witherell complex, 30 to 50 percent slopes	D	524.0	20.6%
244	Yorkville-Yorktree-Squawrock complex, 15 to 30 percent slopes	C	103.0	4.1%
245	Yorkville-Yorktree-Squawrock complex, 30 to 50 percent slopes	C	50.0	2.0%
Totals for Area of Interest			**2,542.4**	**100.0%**

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Appendix E NOAA Atlas 14

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NOAA Atlas 14, Volume 6, Version 2
Location name: Boonville, California, USA*
Latitude: 38.9842°, Longitude: -123.3503°
Elevation: 511.12 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.140 (0.125-0.159)	0.172 (0.152-0.195)	0.213 (0.188-0.243)	0.247 (0.217-0.286)	0.295 (0.248-0.355)	0.332 (0.272-0.410)	0.371 (0.295-0.471)	0.412 (0.316-0.541)	0.469 (0.342-0.648)	0.513 (0.360-0.739)
10-min	0.201 (0.178-0.228)	0.246 (0.218-0.280)	0.305 (0.270-0.349)	0.355 (0.310-0.409)	0.423 (0.355-0.508)	0.476 (0.390-0.588)	0.532 (0.422-0.676)	0.590 (0.453-0.776)	0.672 (0.491-0.929)	0.735 (0.515-1.06)
15-min	0.243 (0.216-0.276)	0.297 (0.264-0.339)	0.369 (0.327-0.422)	0.429 (0.375-0.495)	0.511 (0.429-0.615)	0.576 (0.471-0.710)	0.643 (0.511-0.817)	0.714 (0.548-0.938)	0.812 (0.593-1.12)	0.889 (0.623-1.28)
30-min	0.342 (0.304-0.389)	0.419 (0.371-0.477)	0.520 (0.460-0.594)	0.604 (0.529-0.697)	0.720 (0.604-0.866)	0.811 (0.664-1.00)	0.905 (0.719-1.15)	1.00 (0.772-1.32)	1.14 (0.835-1.58)	1.25 (0.878-1.80)
60-min	0.504 (0.448-0.573)	0.617 (0.547-0.703)	0.767 (0.678-0.876)	0.890 (0.779-1.03)	1.06 (0.891-1.28)	1.20 (0.978-1.48)	1.33 (1.06-1.70)	1.48 (1.14-1.95)	1.69 (1.23-2.33)	1.85 (1.29-2.66)
2-hr	0.774 (0.688-0.880)	0.939 (0.833-1.07)	1.15 (1.02-1.31)	1.32 (1.16-1.52)	1.55 (1.30-1.86)	1.72 (1.41-2.12)	1.90 (1.51-2.41)	2.07 (1.59-2.73)	2.31 (1.69-3.20)	2.50 (1.75-3.60)
3-hr	1.01 (0.898-1.15)	1.22 (1.08-1.39)	1.49 (1.31-1.70)	1.70 (1.49-1.96)	1.98 (1.66-2.38)	2.19 (1.79-2.70)	2.40 (1.90-3.04)	2.61 (2.00-3.43)	2.89 (2.11-4.00)	3.10 (2.18-4.47)
6-hr	1.58 (1.40-1.80)	1.90 (1.69-2.17)	2.31 (2.04-2.63)	2.62 (2.29-3.03)	3.04 (2.55-3.65)	3.34 (2.74-4.13)	3.65 (2.90-4.63)	3.95 (3.03-5.19)	4.34 (3.17-6.00)	4.64 (3.25-6.68)
12-hr	2.33 (2.07-2.65)	2.85 (2.53-3.25)	3.51 (3.10-4.01)	4.02 (3.52-4.64)	4.69 (3.94-5.64)	5.18 (4.24-6.39)	5.66 (4.50-7.20)	6.14 (4.72-8.08)	6.76 (4.94-9.35)	7.23 (5.07-10.4)
24-hr	3.35 (3.01-3.80)	4.21 (3.78-4.78)	5.28 (4.73-6.02)	6.12 (5.44-7.03)	7.22 (6.21-8.56)	8.03 (6.77-9.72)	8.82 (7.26-10.9)	9.61 (7.70-12.2)	10.6 (8.19-14.1)	11.4 (8.49-15.6)
2-day	4.42 (3.98-5.02)	5.57 (5.00-6.33)	7.03 (6.29-8.01)	8.17 (7.26-9.39)	9.68 (8.33-11.5)	10.8 (9.10-13.1)	11.9 (9.80-14.8)	13.0 (10.4-16.6)	14.5 (11.1-19.2)	15.5 (11.6-21.3)
3-day	5.19 (4.67-5.90)	6.55 (5.88-7.44)	8.26 (7.40-9.41)	9.62 (8.54-11.0)	11.4 (9.81-13.5)	12.7 (10.7-15.4)	14.1 (11.6-17.4)	15.4 (12.3-19.6)	17.1 (13.2-22.7)	18.4 (13.7-25.2)
4-day	5.84 (5.25-6.63)	7.38 (6.62-8.39)	9.32 (8.35-10.6)	10.8 (9.64-12.5)	12.9 (11.1-15.2)	14.3 (12.1-17.4)	15.8 (13.0-19.6)	17.3 (13.8-22.0)	19.2 (14.8-25.4)	20.6 (15.3-28.2)
7-day	7.28 (6.54-8.26)	9.24 (8.29-10.5)	11.7 (10.4-13.3)	13.6 (12.0-15.6)	16.0 (13.7-19.0)	17.7 (15.0-21.5)	19.4 (16.0-24.1)	21.1 (16.9-26.9)	23.3 (17.9-30.9)	24.9 (18.5-34.1)
10-day	8.36 (7.52-9.50)	10.7 (9.56-12.1)	13.5 (12.0-15.3)	15.6 (13.9-17.9)	18.3 (15.8-21.7)	20.3 (17.1-24.6)	22.2 (18.3-27.5)	24.0 (19.2-30.6)	26.3 (20.3-34.9)	28.0 (20.9-38.4)
20-day	11.2 (10.0-12.7)	14.3 (12.8-16.2)	18.0 (16.2-20.6)	20.9 (18.5-24.0)	24.4 (21.0-28.9)	26.9 (22.6-32.5)	29.2 (24.0-36.2)	31.4 (25.2-40.0)	34.2 (26.3-45.3)	36.2 (26.9-49.6)
30-day	13.5 (12.2-15.4)	17.3 (15.5-19.6)	21.8 (19.5-24.8)	25.1 (22.3-28.8)	29.2 (25.1-34.7)	32.1 (27.0-38.8)	34.8 (28.6-43.1)	37.3 (29.9-47.5)	40.4 (31.1-53.6)	42.7 (31.8-58.5)
45-day	17.0 (15.3-19.3)	21.7 (19.5-24.6)	27.1 (24.3-30.9)	31.1 (27.7-35.8)	36.1 (31.0-42.8)	39.5 (33.3-47.8)	42.6 (35.1-52.8)	45.6 (36.5-58.0)	49.2 (37.9-65.2)	51.7 (38.5-70.9)
60-day	20.2 (18.1-22.9)	25.5 (22.9-29.0)	31.7 (28.4-36.1)	36.3 (32.2-41.6)	41.8 (35.9-49.6)	45.6 (38.4-55.2)	49.1 (40.4-60.8)	52.4 (42.0-66.7)	56.3 (43.4-74.7)	59.1 (44.0-81.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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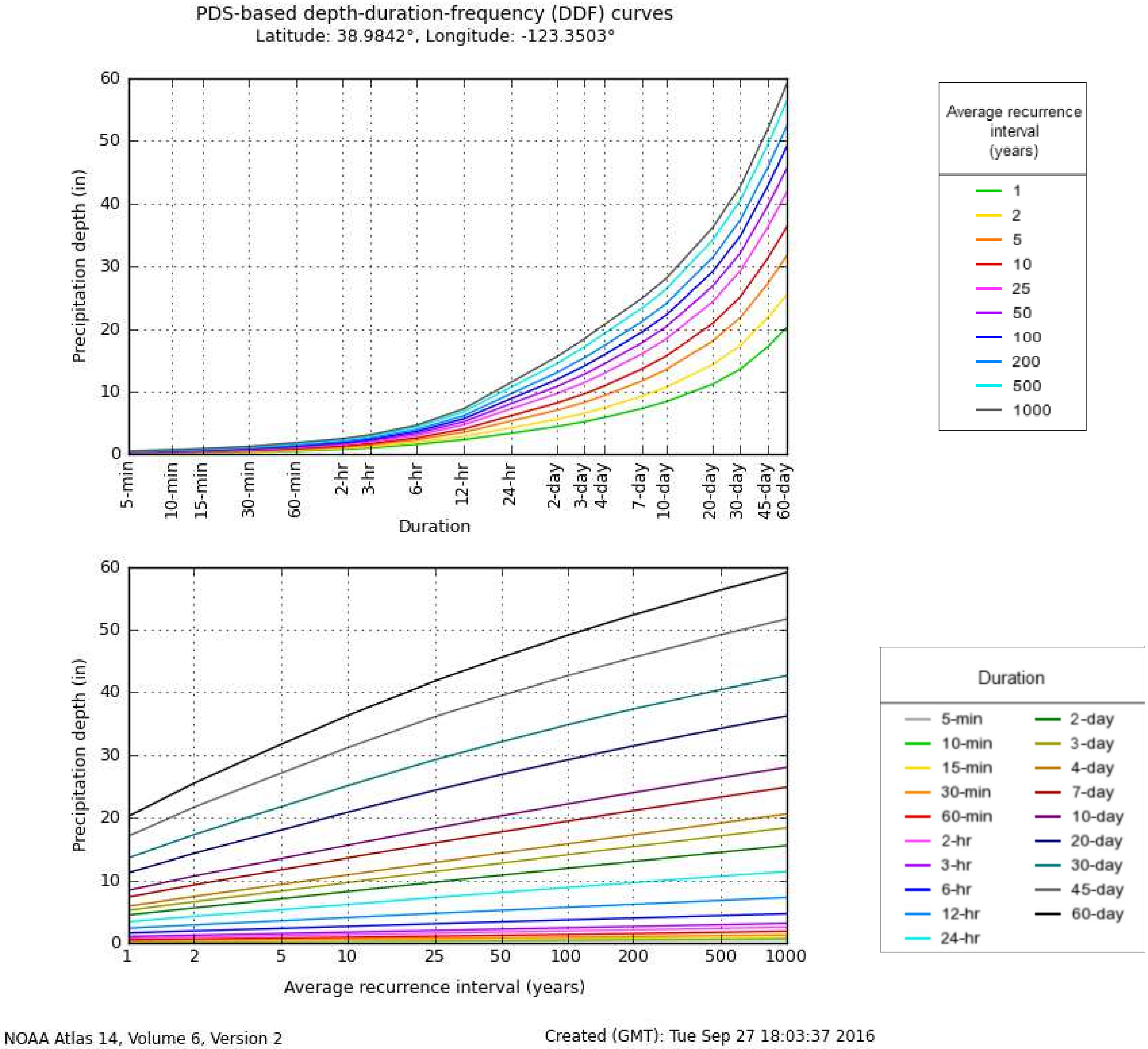
PF graphical



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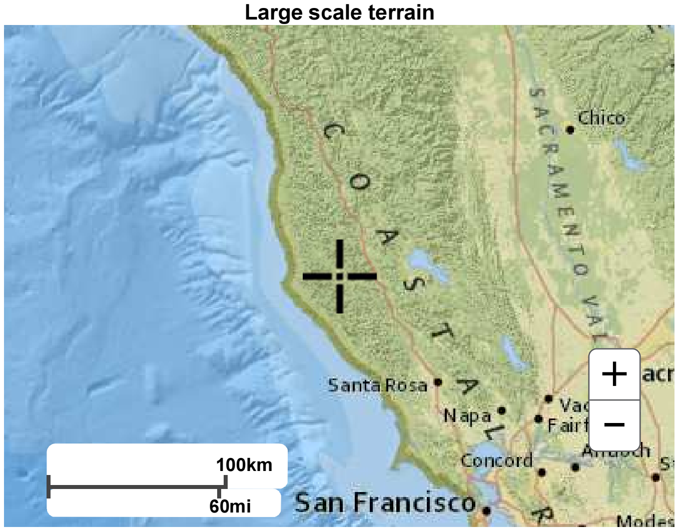
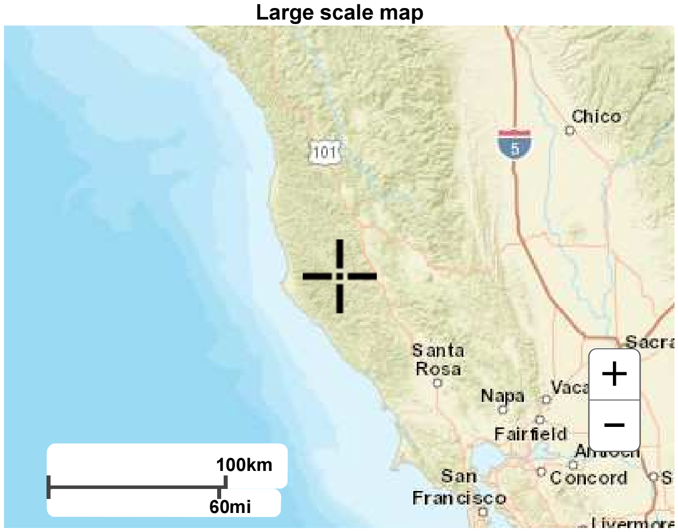
Maps & aerials

Small scale terrain

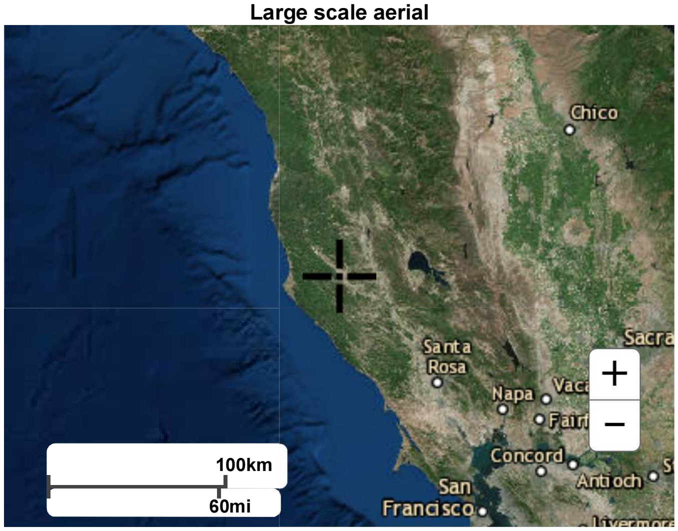
Large scale terrain



Large scale map



Large scale aerial



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National Weather Service
National Water Center
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Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Appendix F Hydraulic Analysis, Existing Condition

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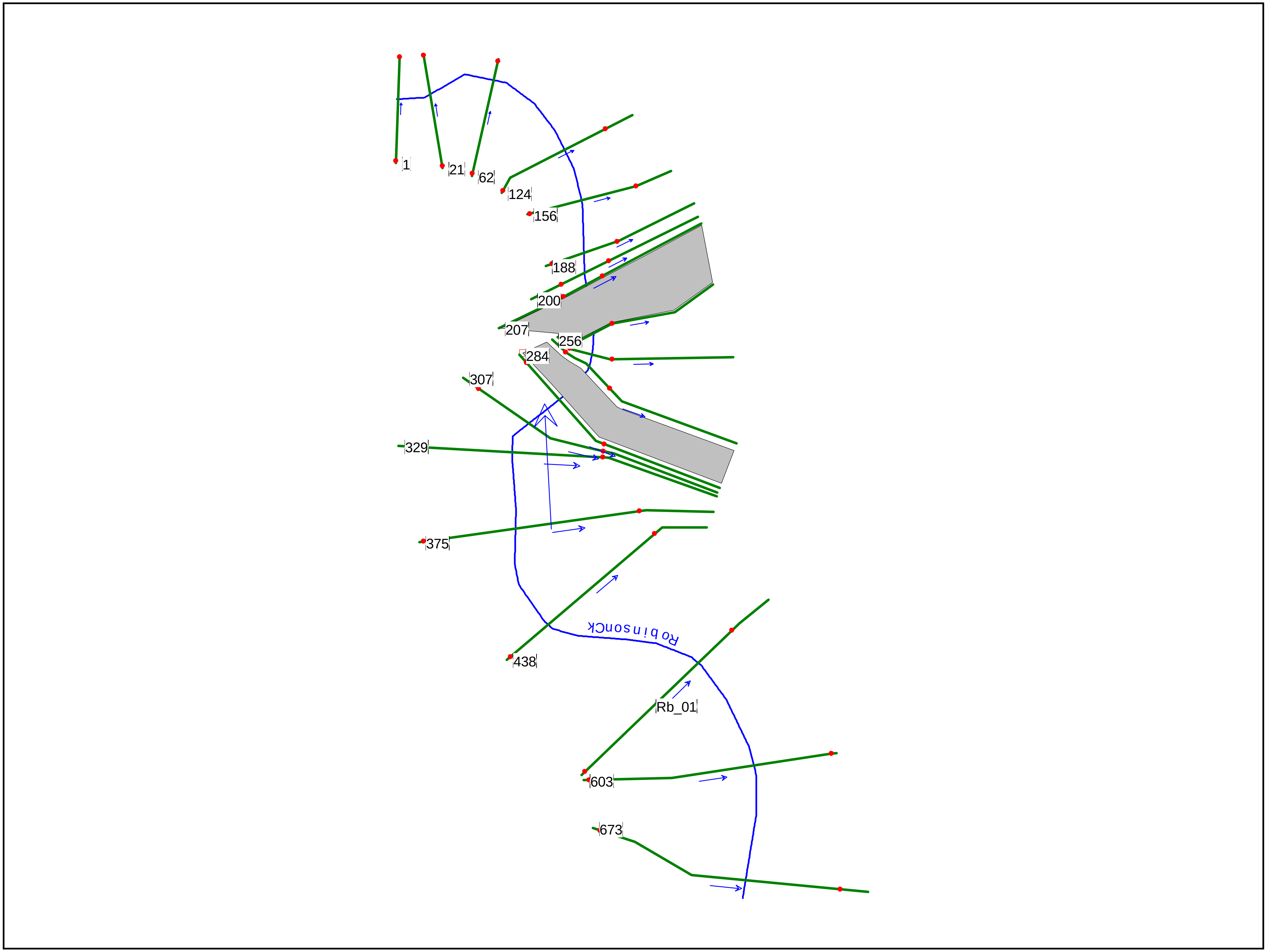
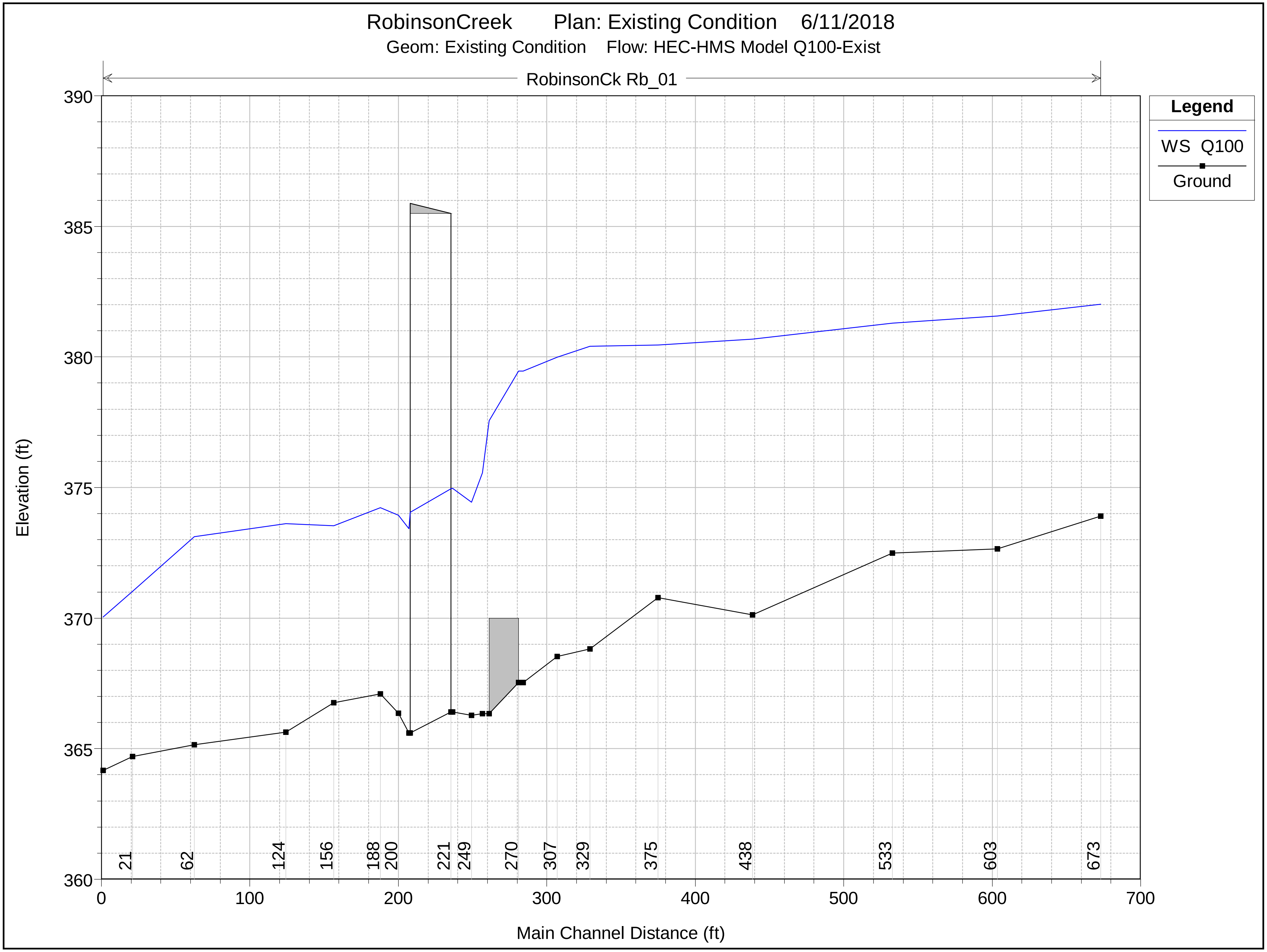

1
21
62
124
156
188
200
207
256
284
307
329
375
438
RobinsonCk
Rb_01
603
673

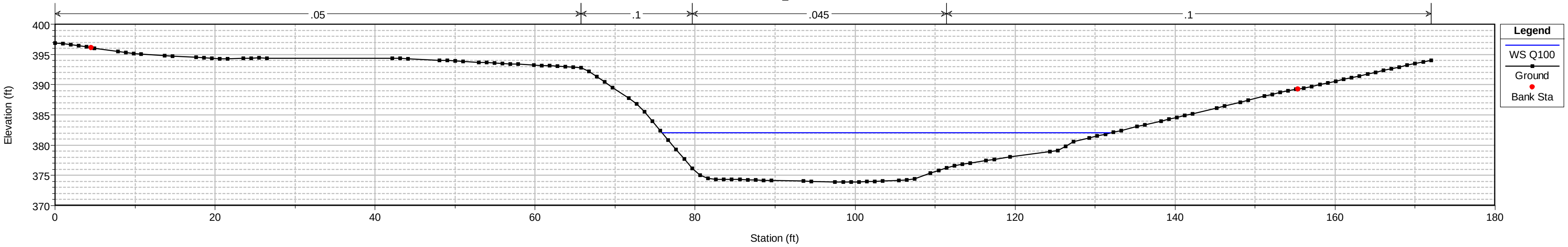


RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
RobinsonCk Rb_01
Legend
WS Q100
Ground
Elevation (ft)
Main Channel Distance (ft)
390
385
380
375
370
365
360
0
100
200
300
400
500
600
700
21
62
124
156
188
200
221
249
270
307
329
375
438
533
603
673

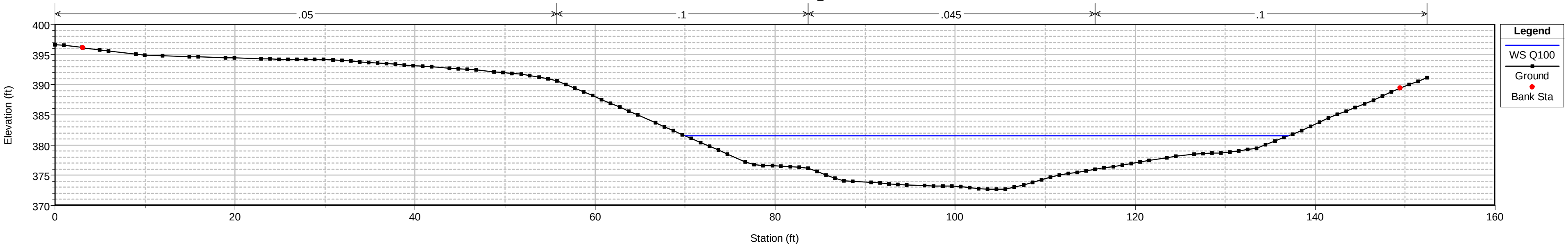
HEC-RAS Plan: Existing River: RobinsonCk Reach: Rb_01 Profile: Q100

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Rb_01	673	1750.00	373.90	382.01		382.48	0.007933	5.45	321.01	56.02	0.40
Rb_01	603	1750.00	372.65	381.57		381.93	0.006960	4.81	363.64	67.10	0.36
Rb_01	533	1750.00	372.49	381.29		381.52	0.004125	3.83	456.48	77.31	0.28
Rb_01	438	1750.00	370.13	380.68		381.03	0.006244	4.76	367.76	57.29	0.33
Rb_01	375	1750.00	370.79	380.45		380.73	0.003234	4.24	412.34	60.83	0.29
Rb_01	329	1750.00	368.82	380.41		380.58	0.002010	3.29	531.82	76.17	0.22
Rb_01	307	1750.00	368.53	379.98		380.47	0.007405	5.61	312.09	49.29	0.39
Rb_01	284	1750.00	367.54	379.46	376.31	380.24	0.011306	7.05	248.29	39.40	0.49
Rb_01	270	Inl Struct									
Rb_01	256	1750.00	366.34	375.56	375.56	378.39	0.041057	13.50	129.59	23.05	1.00
Rb_01	249	1750.00	366.28	374.44	374.35	377.35	0.017728	13.68	127.96	21.41	0.99
Rb_01	236	1750.00	366.41	374.97	372.93	376.56	0.006389	10.13	172.82	22.47	0.64
Rb_01	221 BR U	1750.00	366.41	374.96	372.95	376.56	0.006415	10.14	172.58	22.46	0.64
Rb_01	221 BR D	1750.00	365.60	374.05	373.21	376.18	0.009265	11.73	149.24	23.09	0.81
Rb_01	207	1750.00	365.60	373.42	373.20	376.04	0.012668	12.97	134.91	22.97	0.94
Rb_01	200	1750.00	366.36	373.94		375.37	0.009630	9.60	182.30	29.52	0.68
Rb_01	188	1750.00	367.09	374.23		375.11	0.006420	7.49	233.78	38.36	0.53
Rb_01	156	1750.00	366.76	373.53		374.73	0.012427	8.78	199.24	40.45	0.70
Rb_01	124	1750.00	365.63	373.62		374.24	0.008144	6.33	276.55	55.79	0.50
Rb_01	62	1750.00	365.15	373.12		373.74	0.007946	6.34	276.21	56.15	0.50
Rb_01	21	1750.00	364.70	371.02	371.02	373.06	0.024514	11.47	152.64	37.44	1.00
Rb_01	1	1750.00	364.17	370.05	369.25	371.53	0.016009	9.77	179.17	36.94	0.78

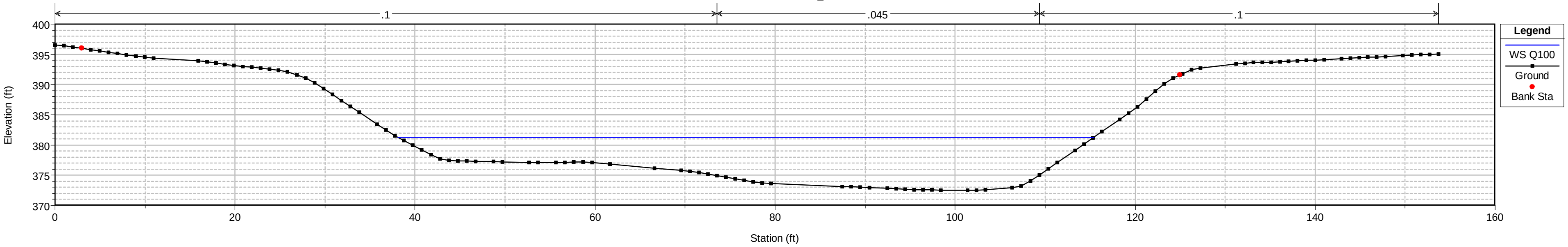
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 673 Model US Limit



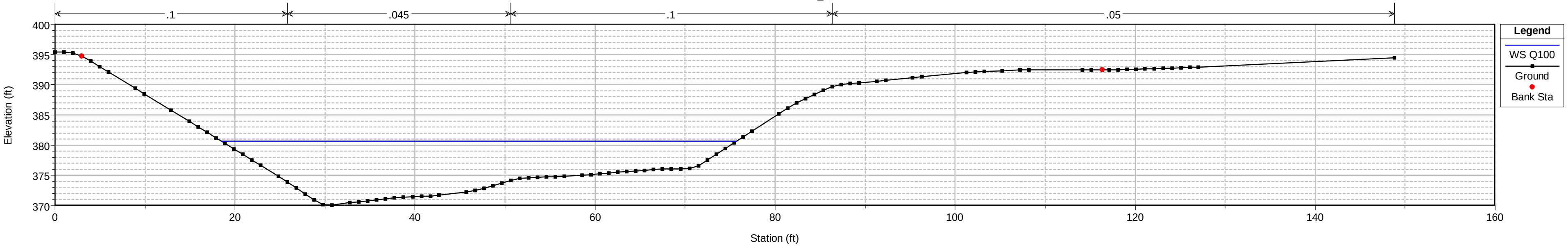
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 603

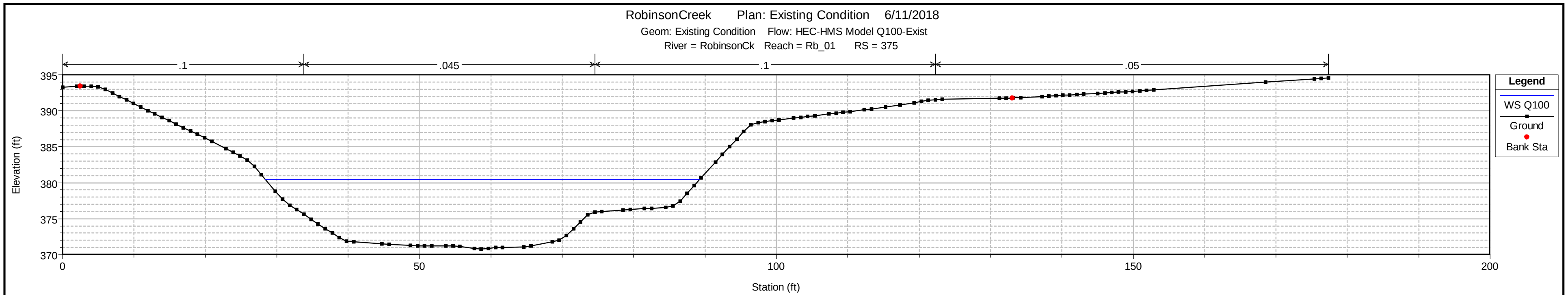


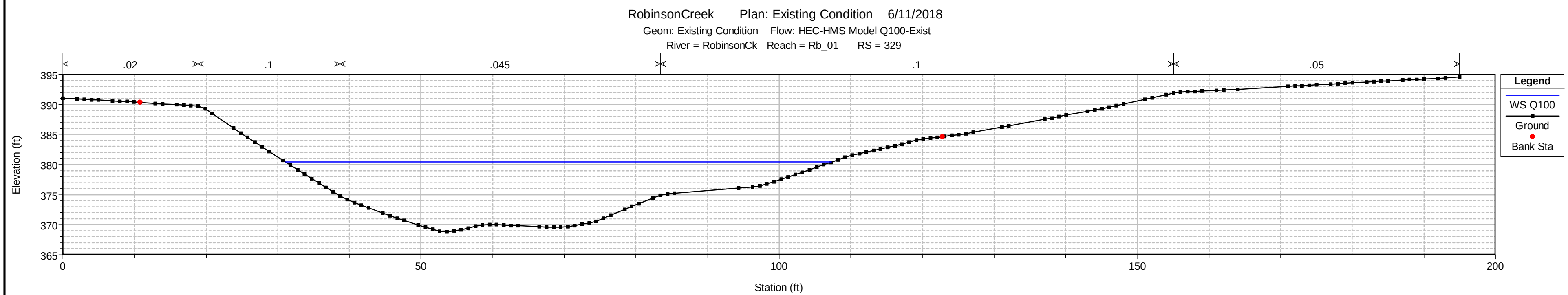
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 533

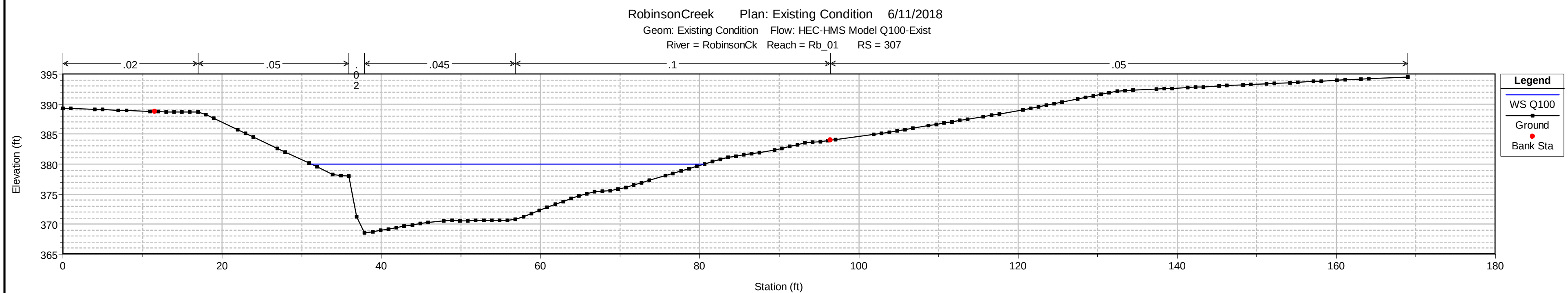


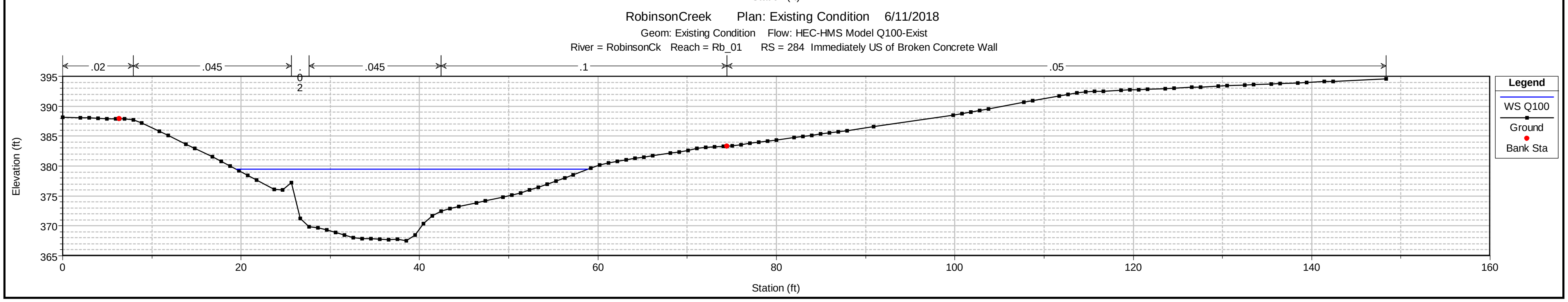
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 438



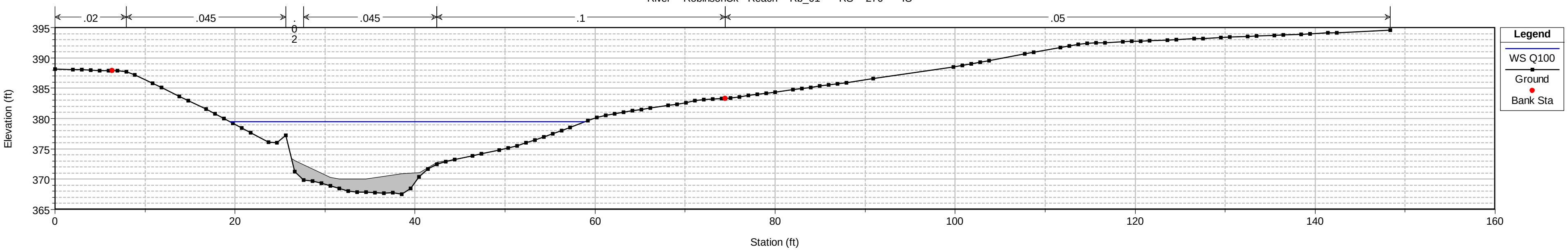

RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 375
.1
.045
.1
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
Ground
Bank Sta


RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 329
.02
.1
.045
.1
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
Ground
Bank Sta

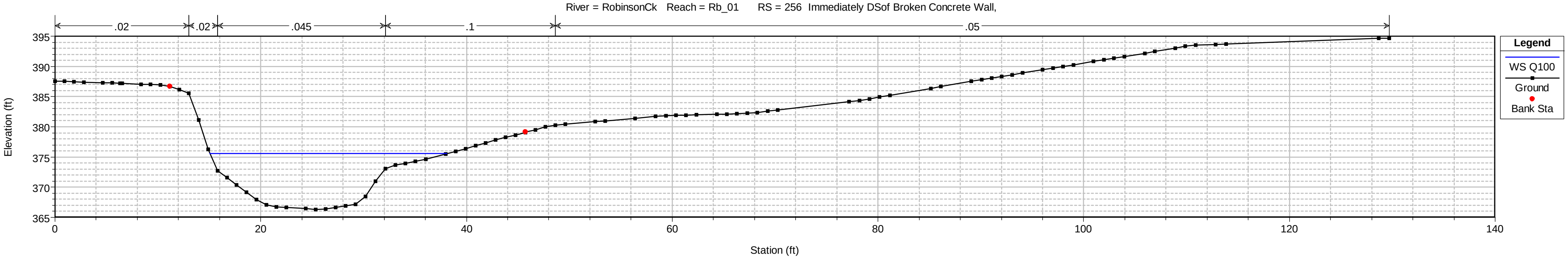

RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 307
.02
.05
0
2
.045
.1
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
Ground
Bank Sta


RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 284 Immediately US of Broken Concrete Wall
.02
.045
0
2
.045
.1
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
Ground
Bank Sta

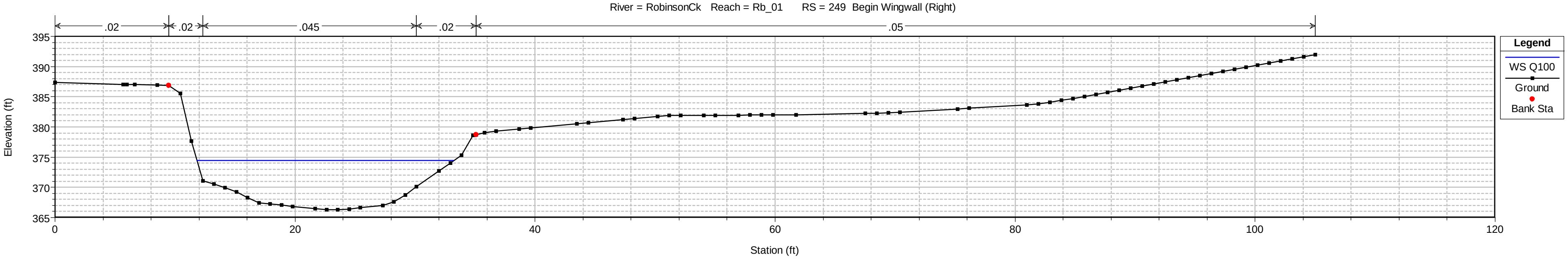
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 270 IS



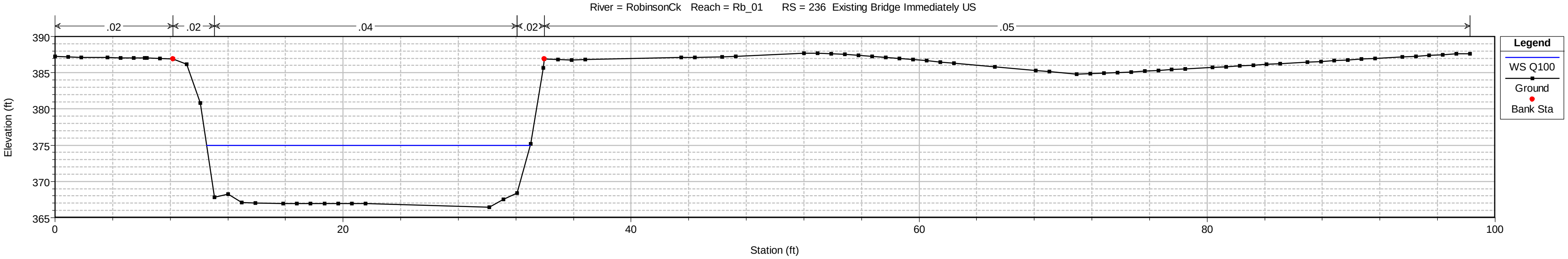
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 256 Immediately DSof Broken Concrete Wall,



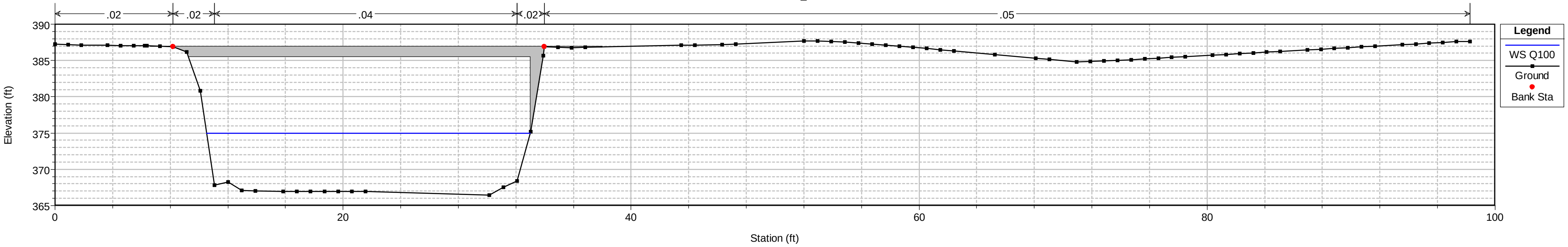
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 249 Begin Wingwall (Right)



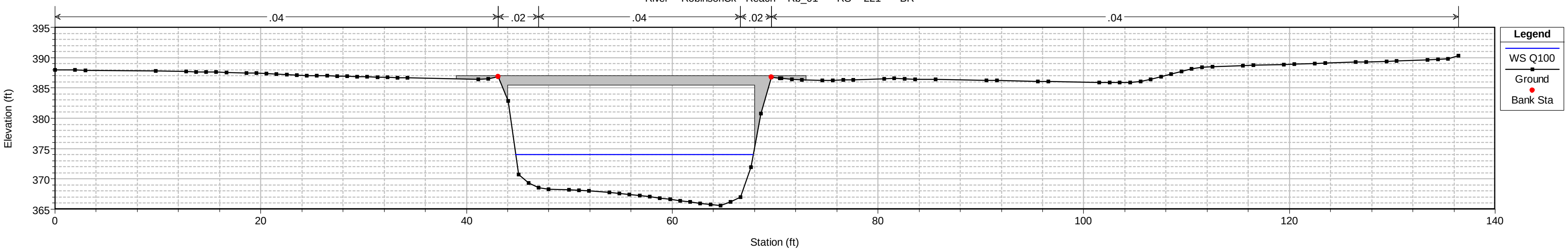
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 236 Existing Bridge Immediately US



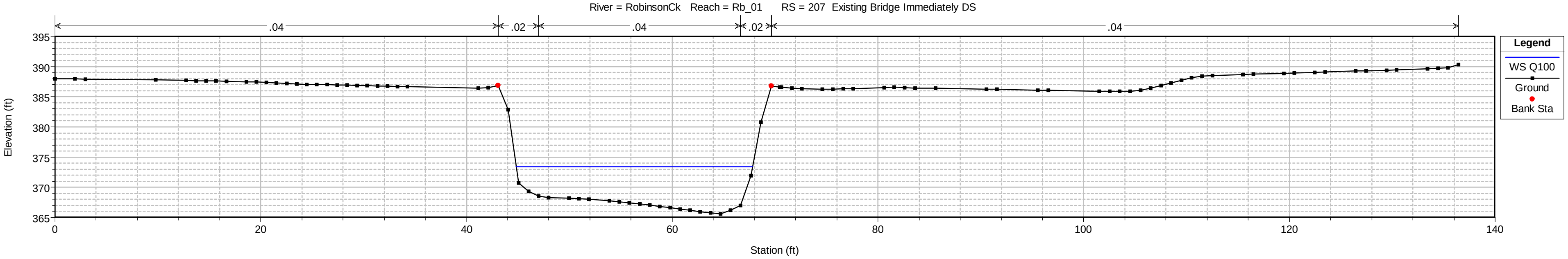
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 221 BR



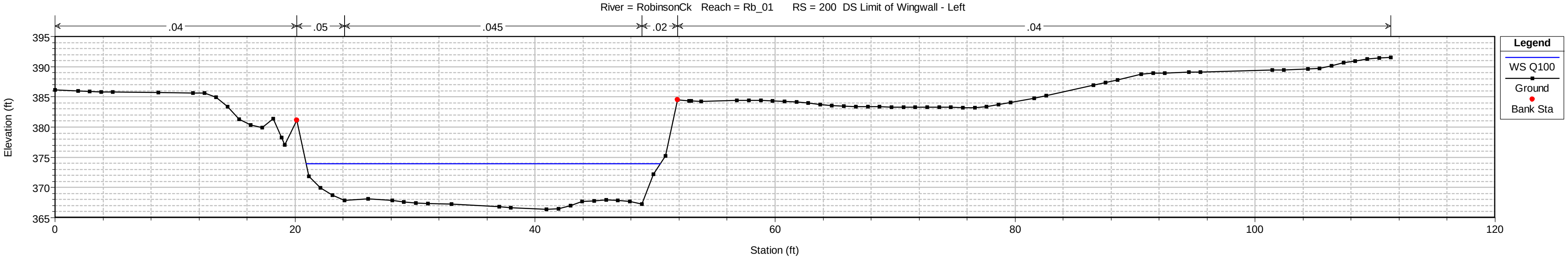
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 221 BR



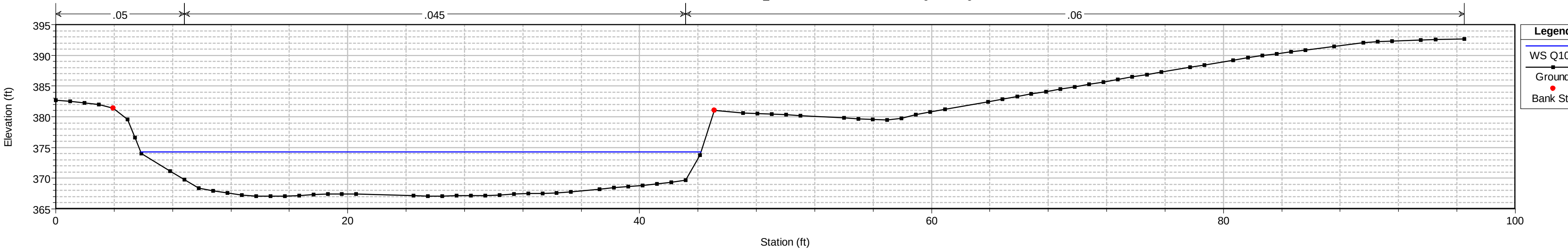
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 207 Existing Bridge Immediately DS



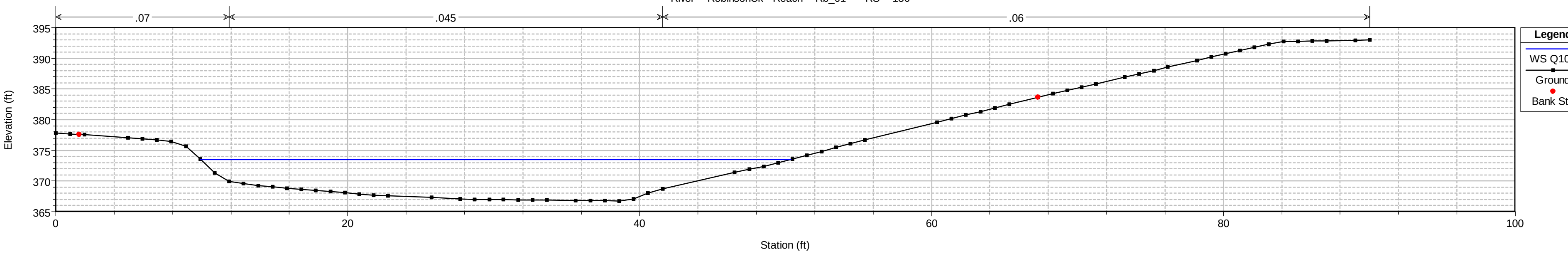
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 200 DS Limit of Wingwall - Left



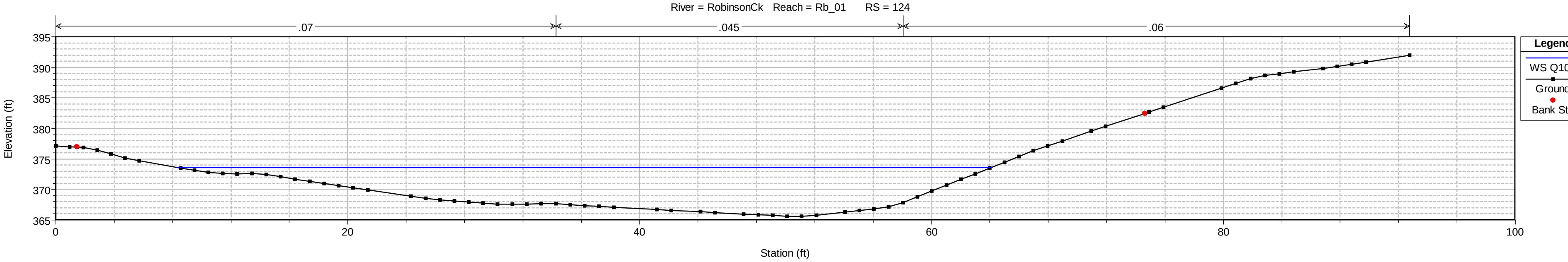
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 188 DS Limit of Wingwall - Right



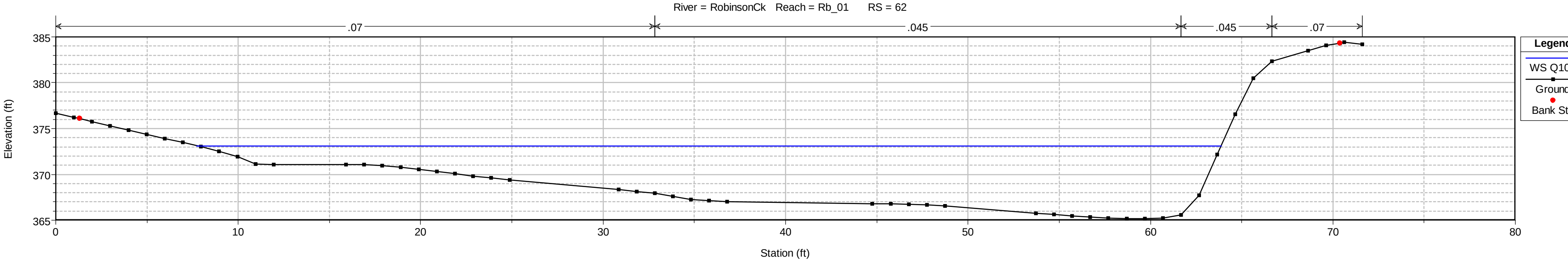
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 156

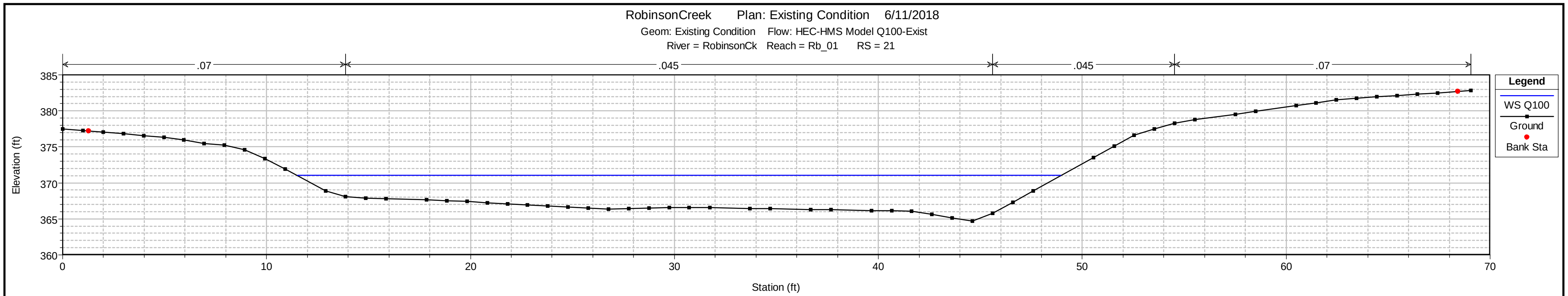


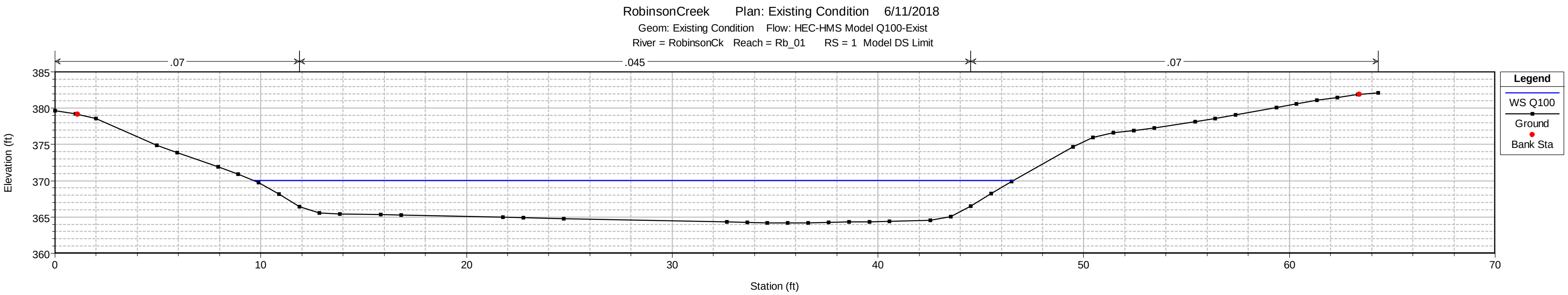
RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 124



RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 62




RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 21
.07
.045
.045
.07
Elevation (ft)
Station (ft)
Legend
WS Q100
Ground
Bank Sta


RobinsonCreek Plan: Existing Condition 6/11/2018
Geom: Existing Condition Flow: HEC-HMS Model Q100-Exist
River = RobinsonCk Reach = Rb_01 RS = 1 Model DS Limit
.07
.045
.07
Elevation (ft)
Station (ft)
Legend
WS Q100
Ground
Bank Sta

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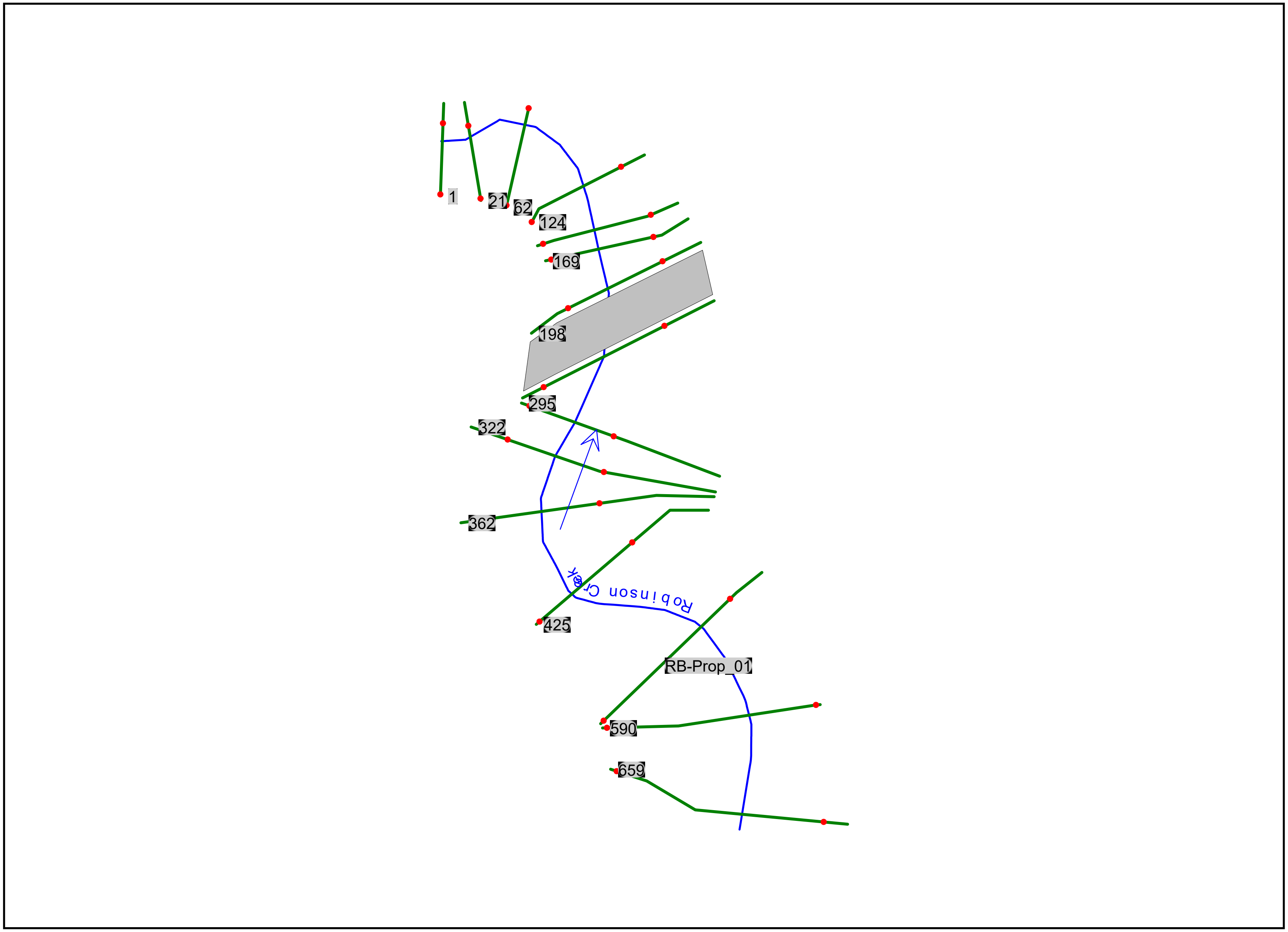
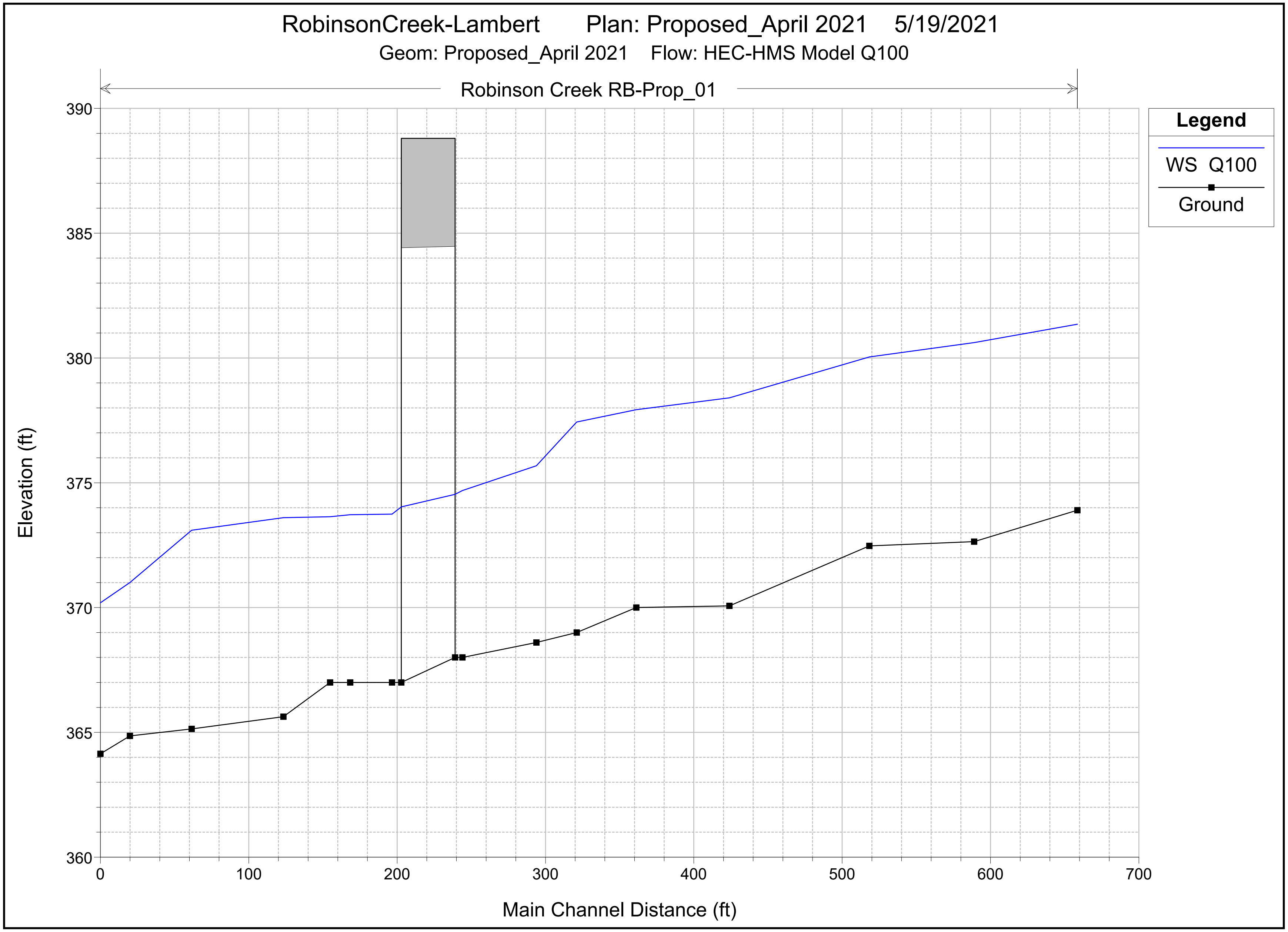
Appendix G Hydraulic Analysis, Proposed Condition



1
21
62
124
169
198
295
322
362
425
Robinson Creek
RB-Prop_01
590
659

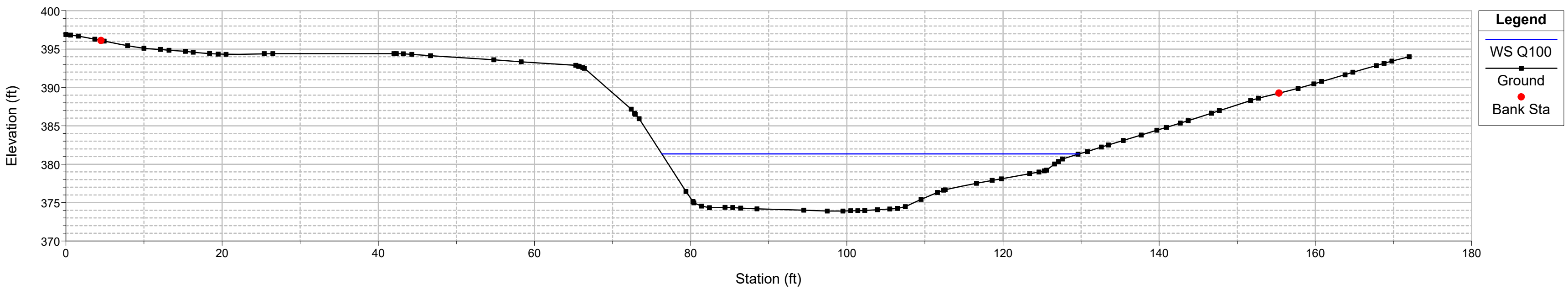


RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
Robinson Creek RB-Prop_01
Legend
WS Q100
Ground
Elevation (ft)
390
385
380
375
370
365
360
0
100
200
300
400
500
600
700
Main Channel Distance (ft)

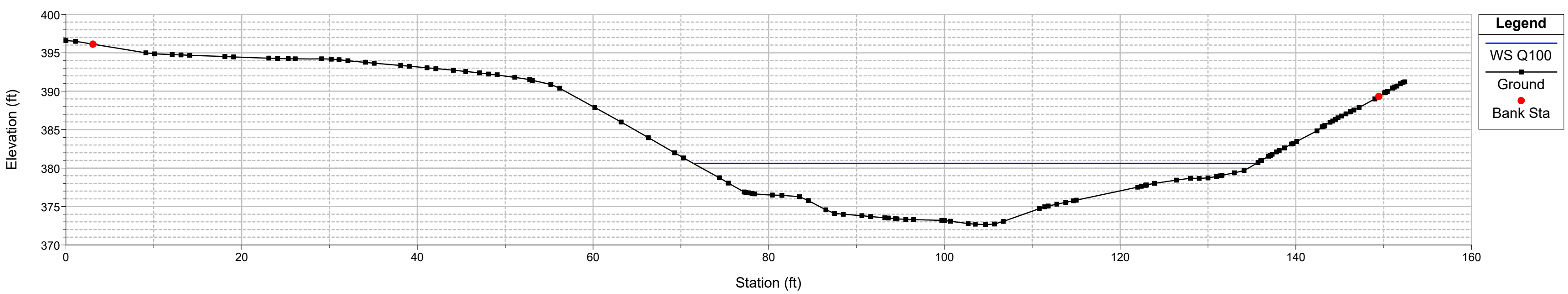
HEC-RAS Plan: proposed april 2021 River: Robinson Creek Reach: RB-Prop_01 Profile: Q100

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
RB-Prop_01	659	Q100	1750.00	373.90	381.35		381.94	0.010564	6.14	285.13	53.45	0.47
RB-Prop_01	590	Q100	1750.00	372.64	380.62		381.14	0.011829	5.80	301.50	64.15	0.47
RB-Prop_01	519	Q100	1750.00	372.47	380.04		380.40	0.008181	4.84	361.69	74.49	0.39
RB-Prop_01	425	Q100	1750.00	370.07	378.40		379.21	0.020131	7.20	243.03	52.42	0.59
RB-Prop_01	362	Q100	1750.00	370.00	377.93		378.55	0.005583	6.34	276.08	56.96	0.51
RB-Prop_01	322	Q100	1750.00	369.00	377.43		378.28	0.006791	7.38	237.03	45.12	0.57
RB-Prop_01	295	Q100	1750.00	368.60	375.68	375.68	377.84	0.022635	11.79	148.45	34.41	1.00
RB-Prop_01	245	Q100	1750.00	368.00	374.69	373.63	375.81	0.010410	8.50	205.99	46.09	0.71
RB-Prop_01	220 BR U	Q100	1750.00	368.00	374.54	373.64	375.74	0.011479	8.79	199.01	45.56	0.74
RB-Prop_01	220 BR D	Q100	1750.00	367.00	374.03	372.91	375.32	0.010258	9.10	192.35	39.11	0.72
RB-Prop_01	198	Q100	1750.00	367.00	373.74		375.19	0.012130	9.66	181.18	38.28	0.78
RB-Prop_01	169	Q100	1750.00	367.00	373.72		374.68	0.007657	7.86	222.65	44.94	0.62
RB-Prop_01	156	Q100	1750.00	367.00	373.64		374.57	0.007504	7.73	226.49	45.42	0.61
RB-Prop_01	124	Q100	1750.00	365.63	373.60		374.23	0.008204	6.34	275.83	55.75	0.50
RB-Prop_01	62	Q100	1750.00	365.14	373.10		373.73	0.008003	6.36	275.23	55.88	0.51
RB-Prop_01	21	Q100	1750.00	364.86	371.00	371.00	373.05	0.024707	11.46	152.64	37.40	1.00
RB-Prop_01	1	Q100	1750.00	364.14	370.19	369.24	371.58	0.016006	9.44	185.32	37.21	0.75

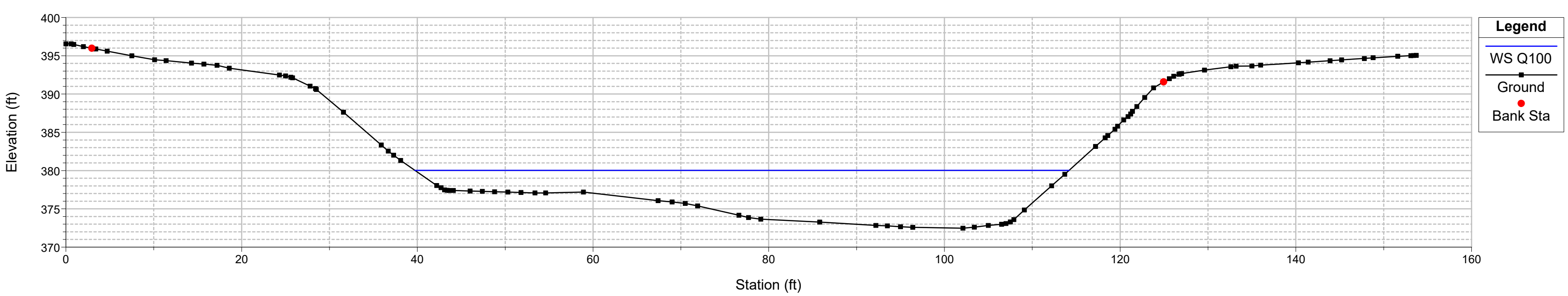
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 659 Model US Limit



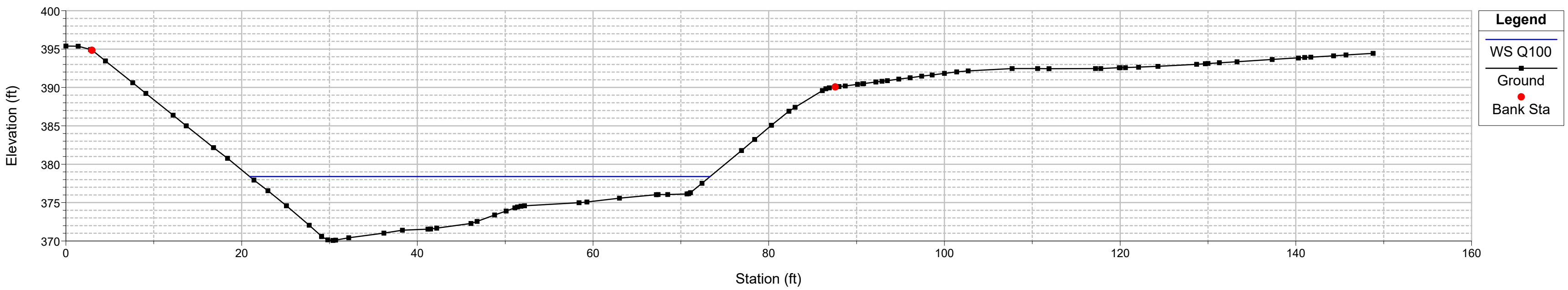
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 590 Exist RS 603



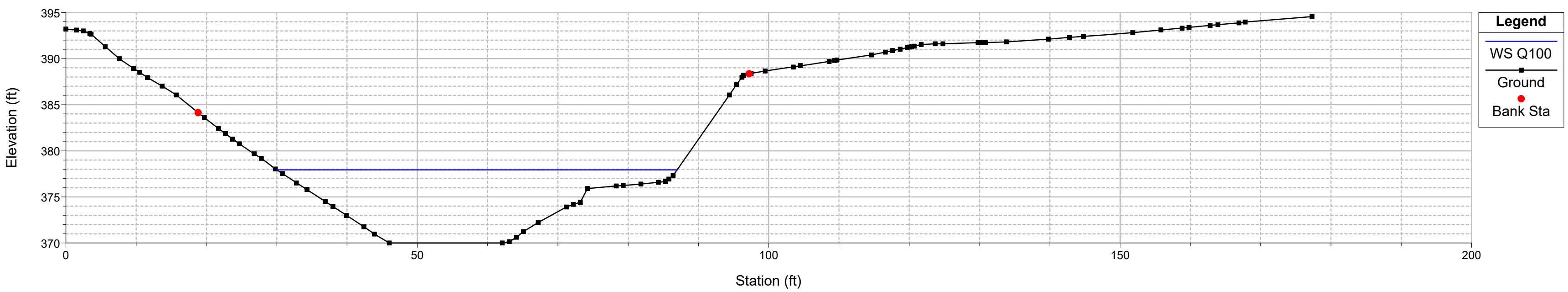
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 519 Exist RS 533



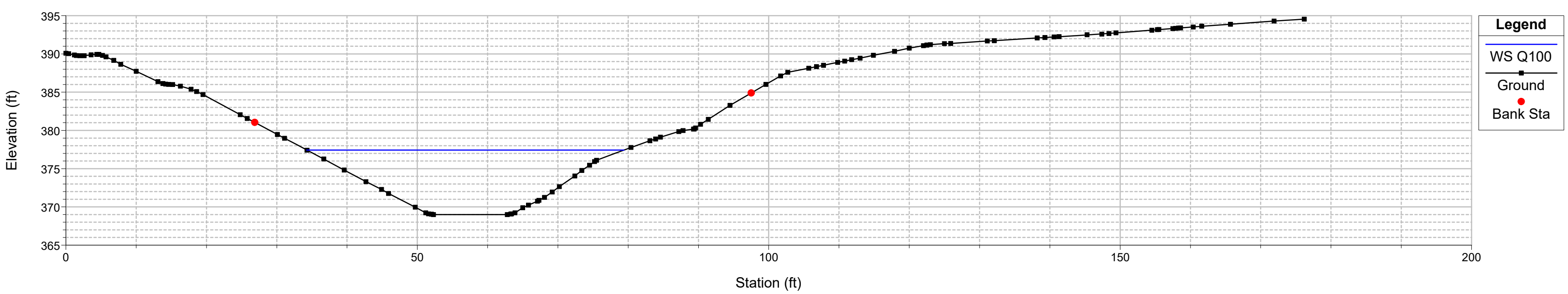
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 425 Exist RS 438



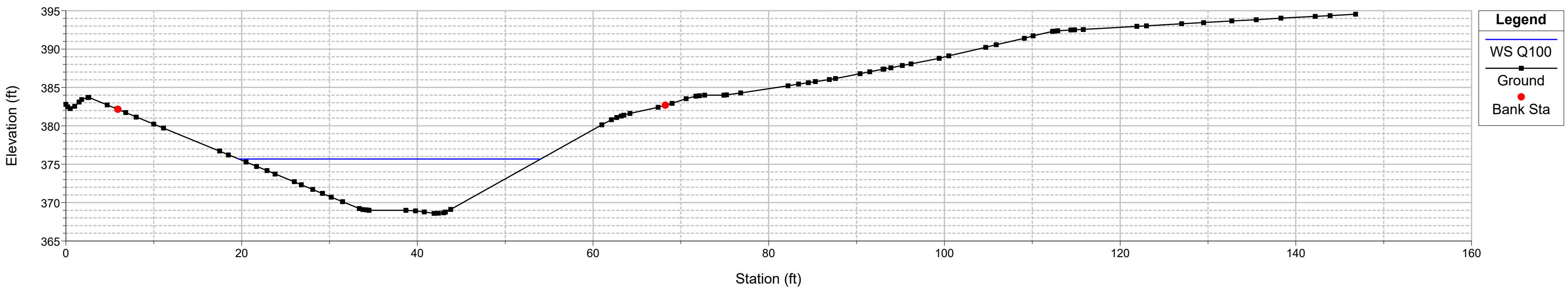
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 362 Proposed Graded Channel



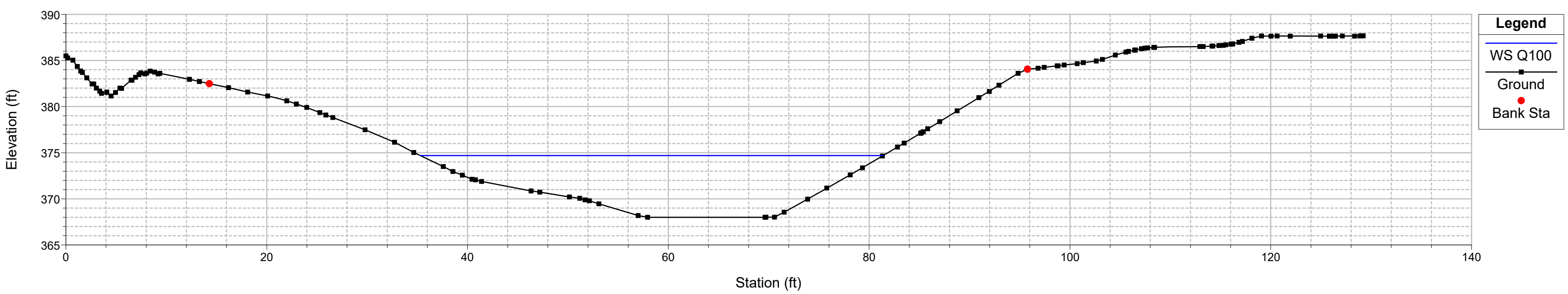
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 322 Proposed Graded Channel



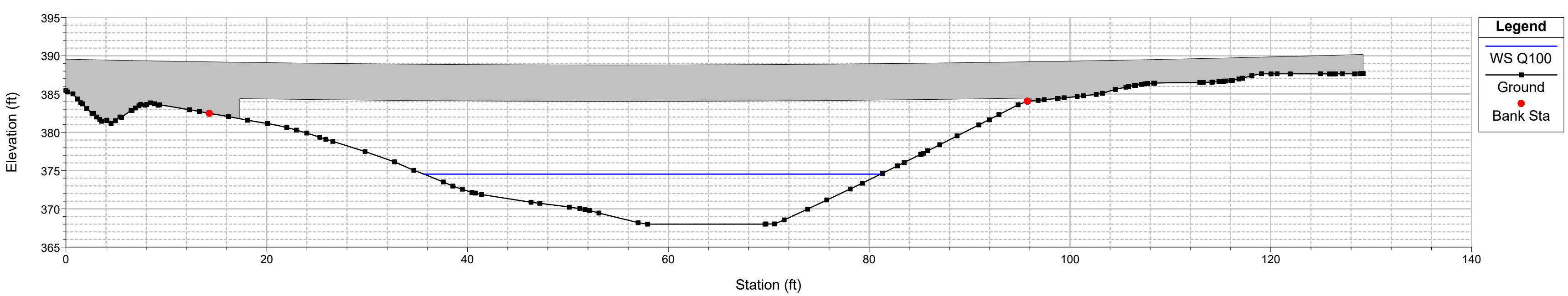
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 295



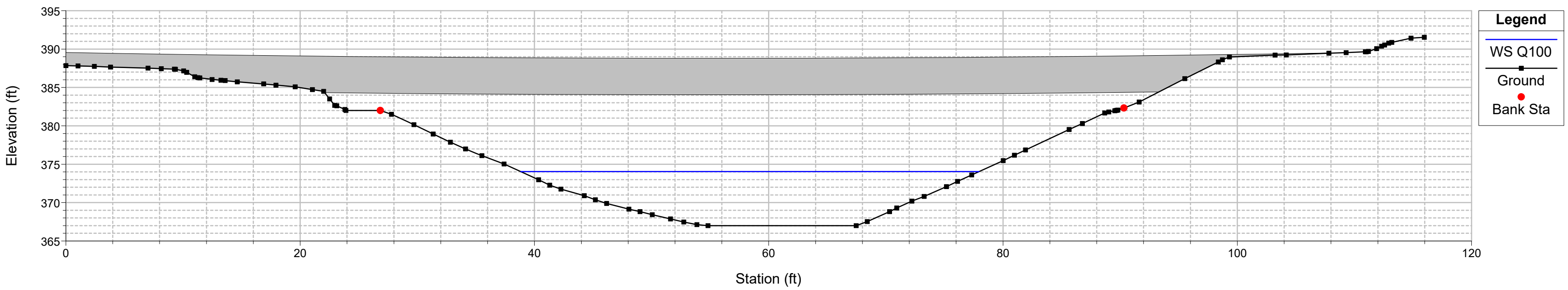
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 245 Upstream of Proposed Bridge



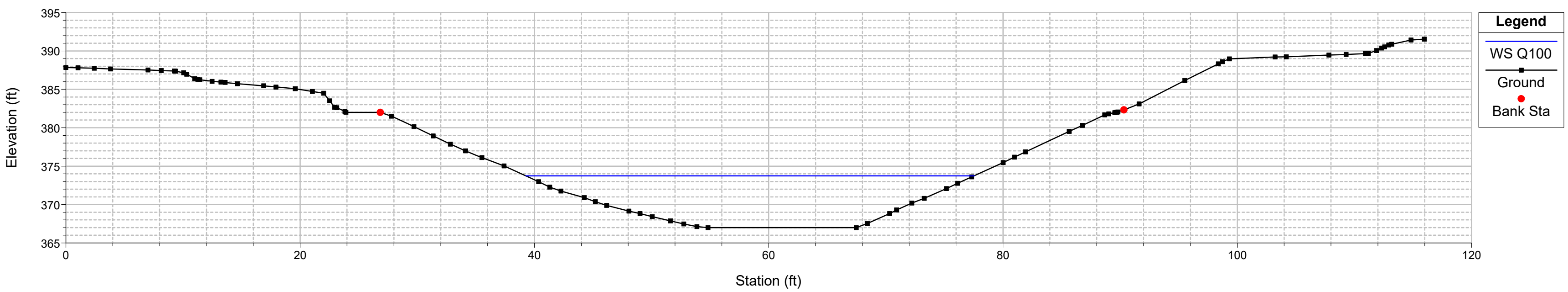
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 220 BR



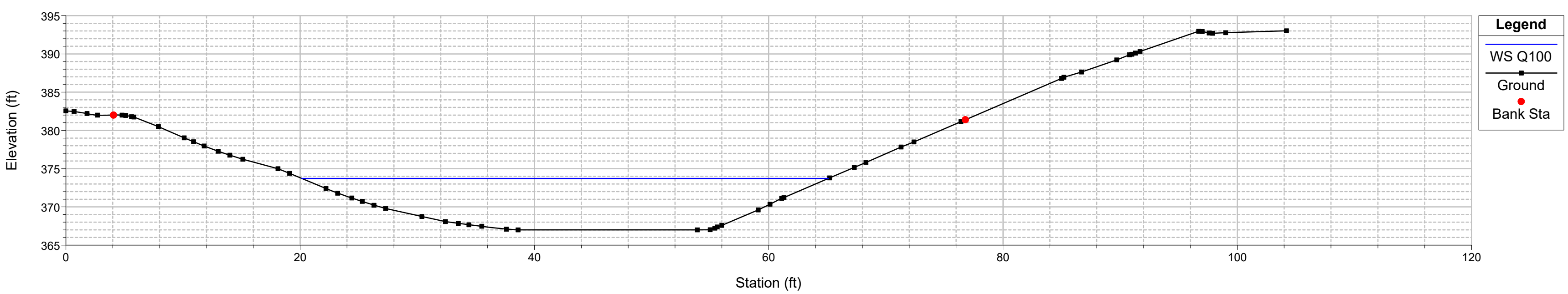
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 220 BR



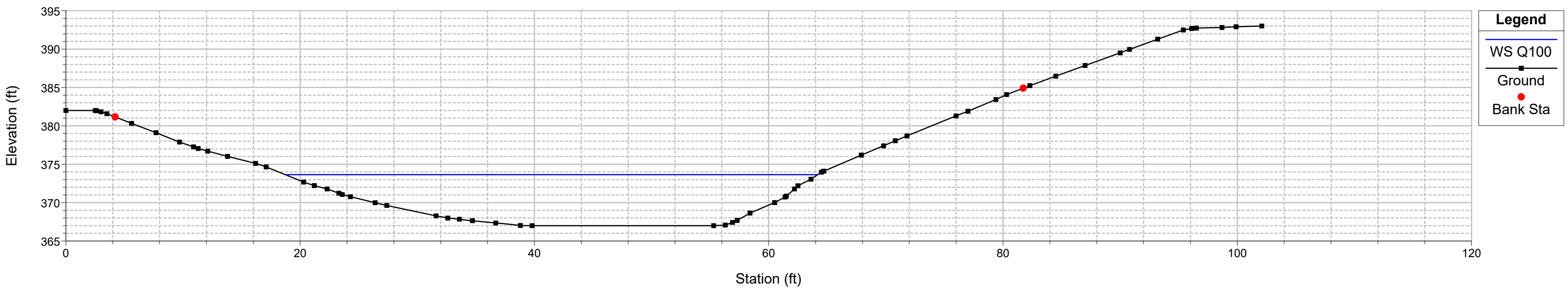
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 198 Downstream of Proposed Bridge



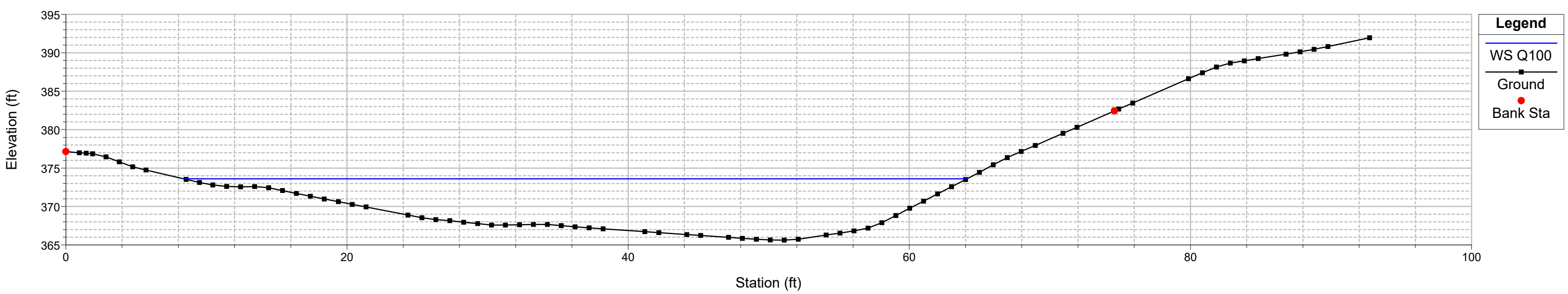
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 169



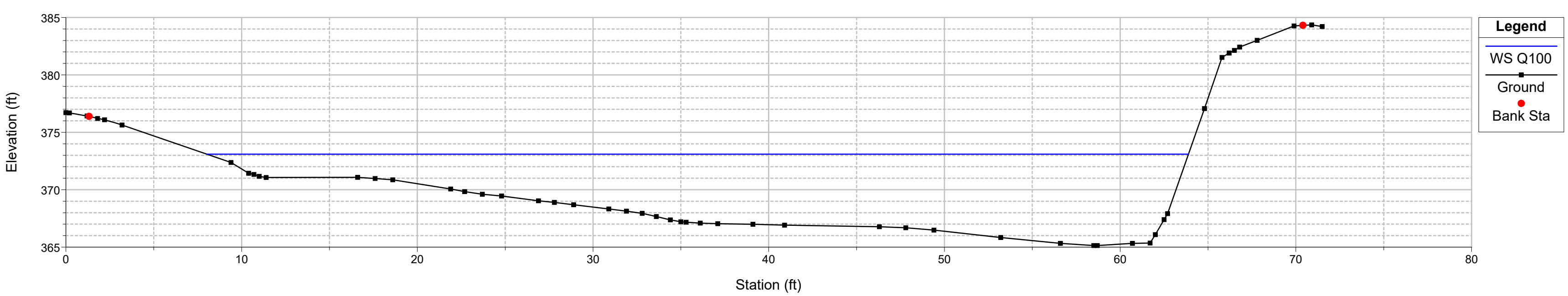
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 156 DS Limit of Proposed Channel Grading

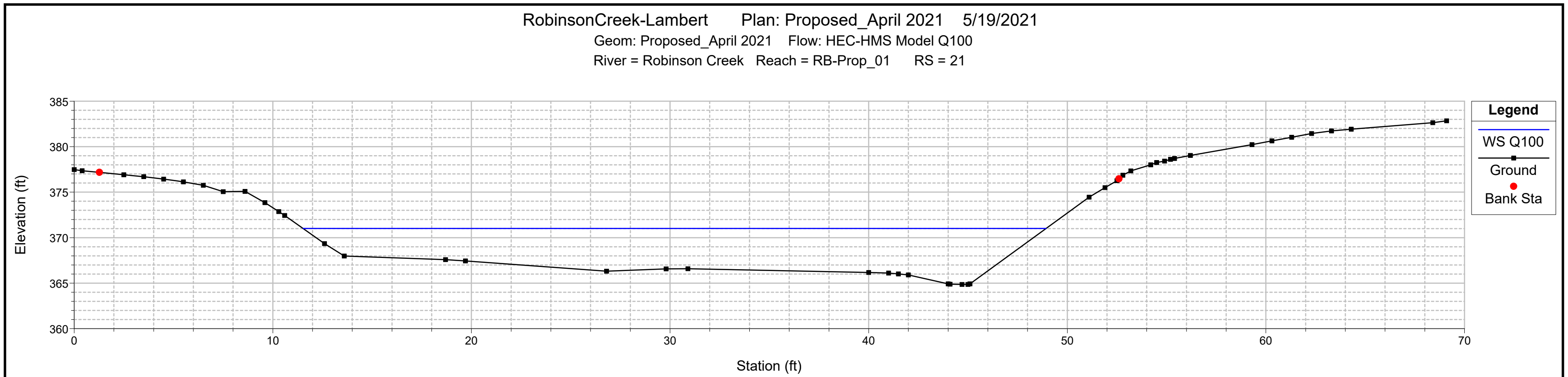


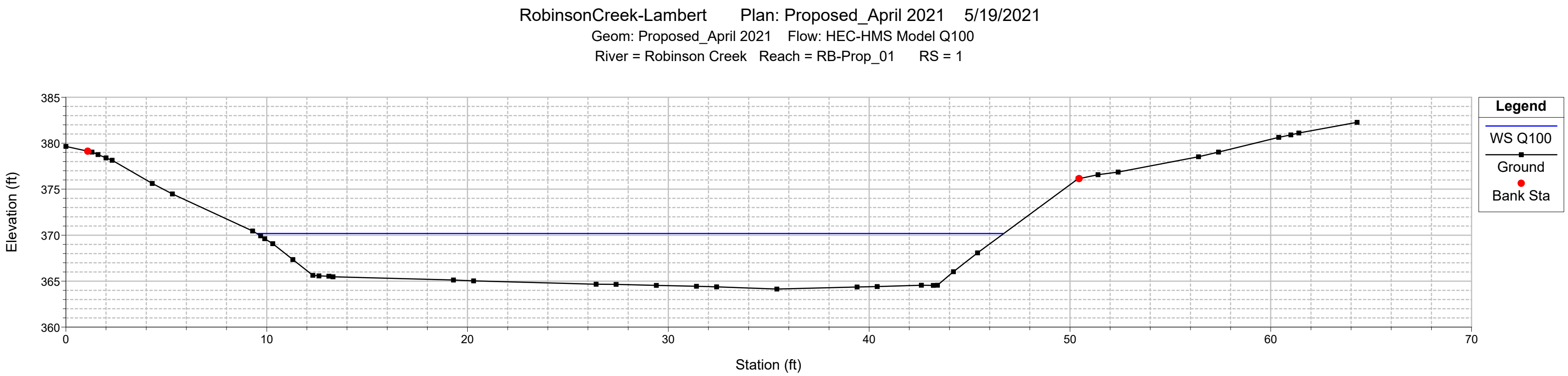
RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 124



RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 62




RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 21
Legend
WS Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
0
10
20
30
40
50
60
70


RobinsonCreek-Lambert Plan: Proposed_April 2021 5/19/2021
Geom: Proposed_April 2021 Flow: HEC-HMS Model Q100
River = Robinson Creek Reach = RB-Prop_01 RS = 1
Legend
WS Q100
Ground
Bank Sta
Elevation (ft)
Station (ft)
385
380
375
370
365
360
0
10
20
30
40
50
60
70

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