Upper Conner Creek Rehabilitation Site
Existing Conditions Report

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1 PURPOSE AND BACKGROUND

An overarching goal for the Trinity River Restoration Program (TRRP) is to restore, enhance, and conserve natural production of anadromous fisheries, native plant communities, and associated wildlife resources of the Trinity River basin in sufficient quantity and quality to ensure long-term sustainability. The TRRP seeks to accomplish this goal by increasing habitat quantity and complexity while also restoring fluvial processes that create and maintain habitat. Restoration tools include managed flow releases, coarse sediment additions, fine sediment reductions, and channel rehabilitation projects. TRRP is beginning the design process for a channel rehabilitation project at the Upper Conner Creek Rehabilitation Site (project site) located near Junction City, California. The purpose of this report is to describe the existing conditions of the project site to inform the design process.

1.1 Statutory Mandate

In December 2000, the Secretary of the Interior signed a Record of Decision (ROD; USDOI 2000) for the Trinity River Mainstem Fishery Restoration Final Environmental Impact Statement/Report. This decision recognized that restoration and maintenance of the Trinity River's fishery resources require rehabilitating the river itself and restoring the dynamic geomorphic processes that maintain an aquatic ecosystem. Consequently, the ROD included five components to ensure long-term restoration and maintenance of the Trinity River (USDOI 2000):

1. Variable annual instream flows ranging from 369,000 acre-feet in Critically Dry years to 815,000 acre-feet in Extremely Wet years.
2. Physical channel rehabilitation, including removal of riparian berms and establishment of side channel habitat.
3. Sediment management, including the supplementation of spawning gravels below Lewiston Dam and reduction in fine sediments that degrade fish habitats.
4. Watershed restoration projects to reduce fine sediment production in the Trinity Basin and its subsequent delivery to the Trinity River.
5. Infrastructure improvements or modifications, including rebuilding or fortifying bridges and addressing other structures affected by peak instream flow releases provided the by ROD.

> *The ROD represents the culmination of over two decades of efforts aimed at understanding the necessary instream flow and physical habitat restoration requirements in order to restore the Trinity River anadromous fishery. Statutory requirements since 1955, based in large part upon the federal governments' trust obligation to the Hoopa Valley and Yurok Tribes, require the restoration and maintenance of the Trinity River anadromous fishery resources to pre-dam levels. It is clear that restoration must provide for a meaningful fishery, not only for the Tribes, but also for the commercial, sport, and recreational fisherman. These important resources represent both tribal trust and public treasures from which all should benefit –to restore the faith of tribal beneficiaries and to improve the economic well-being of the Trinity Basin and the North Coast as a whole. (USDOI 2000 page 8).*

The ROD directed the Trinity River Restoration Program (TRRP) to implement the restoration strategy outlined in the ROD within an Adaptive Environmental Assessment and Management (AEAM) framework. The channel rehabilitation efforts focus on the 40-mile Restoration Reach of the mainstem Trinity River between Lewiston Dam and the North Fork Trinity River and include the project site described in this report.

2 SITE CHARACTERISTICS

The characteristics of the Upper Conner Creek Rehabilitation Site will determine the site constraints and opportunities of the project, which will guide the design process. This section of the report goes over the geographic setting; the historical context; the project site environmental study limit (ESL); land ownership, cultural resources, mining claims, and recreational uses within the ESL; and the existing infrastructure at the project site.

2.1 Site Description and Location

Located in the Klamath Mountains of northern California, the Trinity River is a partially confined, semi-alluvial river, and is the largest tributary to the Klamath River. The Trinity River has complex geology and a long history of human impacts. Dredge and hydraulic mining operations on the mainstem channel, tributaries, floodplains, and valley walls occurred during the 19th and early 20th centuries. Industrial logging operations throughout the watershed began in earnest during the 1950s, and flow regulation began with the completion of Lewiston and Trinity Dams in 1964.

The Trinity River is 180 miles long with total watershed area of approximately 2,960 mi^2. Roughly one quarter of the watershed is located above Lewiston Dam. The watershed is predominately mountainous and forested. The climate is Mediterranean with hot dry summers and cool wet winters. Precipitation averages 30–79 inches per year with 80 percent of the precipitation occurring between November and March. The high elevation northern tributaries experience snowmelt-dominated hydrology, while the southern tributaries are predominately rainfall-dominated. The largest magnitude floods on the Trinity River are generated by rain-on-snow events and had peaks as high as 100,000 cfs at Lewiston (USFWS and HVT 1999).

The project site is located approximately 1.5 miles west of Junction City, CA below the Canyon Creek confluence within the North Fork Reach (RM 79.3 to RM 72.2) of the mainstem Trinity River (Figure 1). The project site includes approximately 84 acres and spans 1.2 miles of river between River Mile (RM) 77.2 and RM 78.4 (Figure 2). The project site is approximately 35 miles downstream of the Lewiston Dam, between the previously constructed Hocker Flat (RM 78.4) and Conner Creek (RM 77.2) restoration sites.

2.2 Environmental Study Limit and Land Ownership

The 2019 Upper Conner Creek Environmental Study Limit (ESL) covers approximately 84 acres of private and federal lands. Approximately 61 percent is federally owned by the Bureau of Land Management (BLM), with the remaining 39 percent being privately owned (Figure 2). During the environmental permitting process, TRRP generally includes all properties within 300 ft of ESL boundaries. The Trinity County assessor parcel map was downloaded from the Trinity County website to obtain approximate property boundaries. A total of 27 private parcels occur within the 300 ft buffer expansion area (Figure 2). Prior to work being done at the project site, a California licensed surveyor will be contracted by the TRRP to clarify public and private boundaries within the project site ESL and 300 ft buffer.

The Upper Conner Creek ESL has evolved over time based on changing project objectives, lessons learned from previous rehabilitation designs, and access considerations. The Upper Conner Creek ESL was created in 2007; it was later extended upstream to include untreated portions of the 2005 Hocker Flat Rehabilitation Site and extended downstream to include a planted floodplain at the 2006 Conner Creek Rehabilitation Site that has had lower-than-expected success (Figure 3). The 2019 ESL accommodates new design elements including tree removal for habitat use, contractor use, sediment processing, spoils areas, and access to treatment areas within the project site. ESL data are maintained on TRRP’s Online Data Portal and can be downloaded from http://www.odp.trrp.net/library.

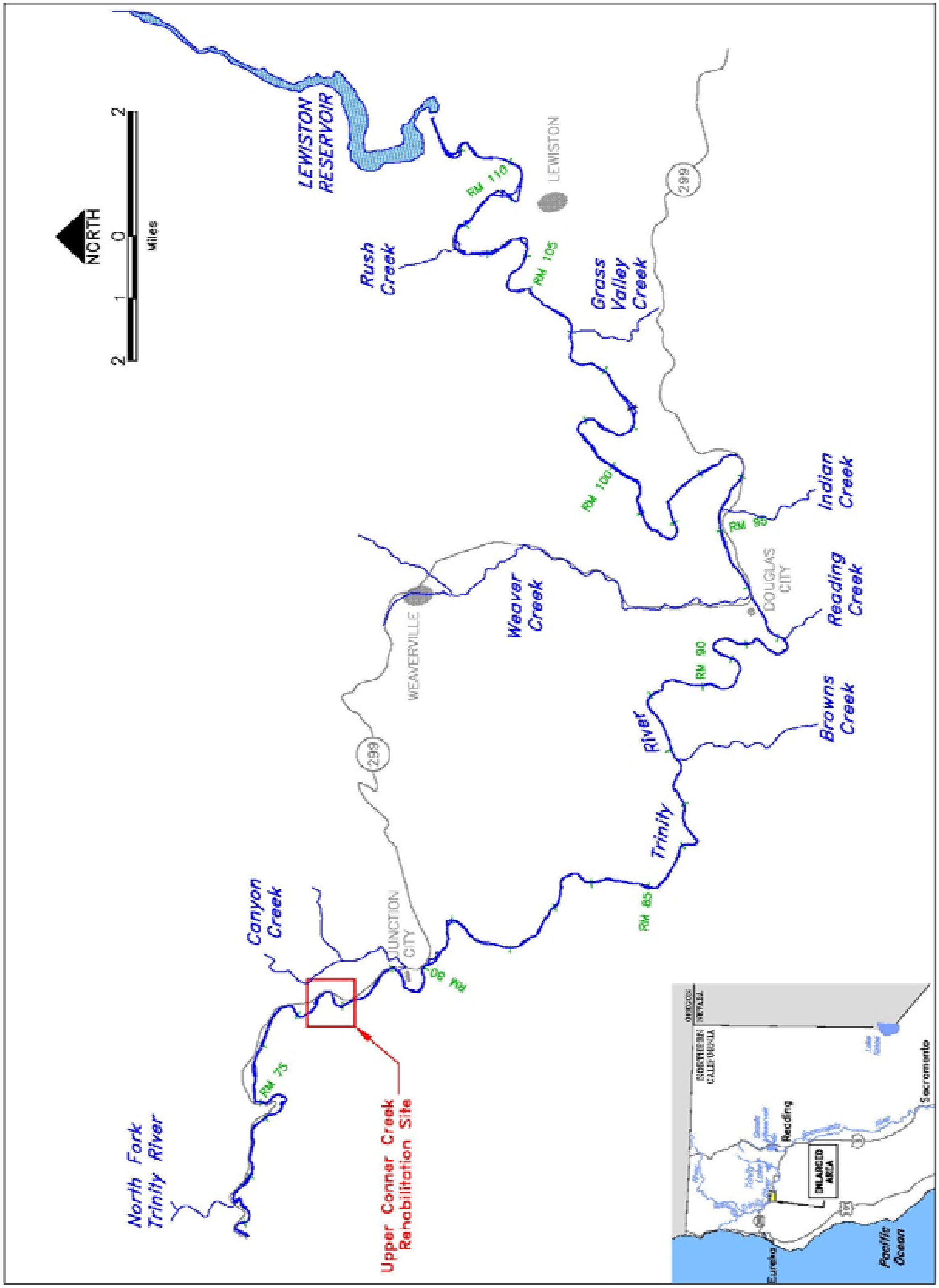


Figure 1. Location of the Upper Conner Creek Rehabilitation Site within the Restoration Reach of the Trinity River.

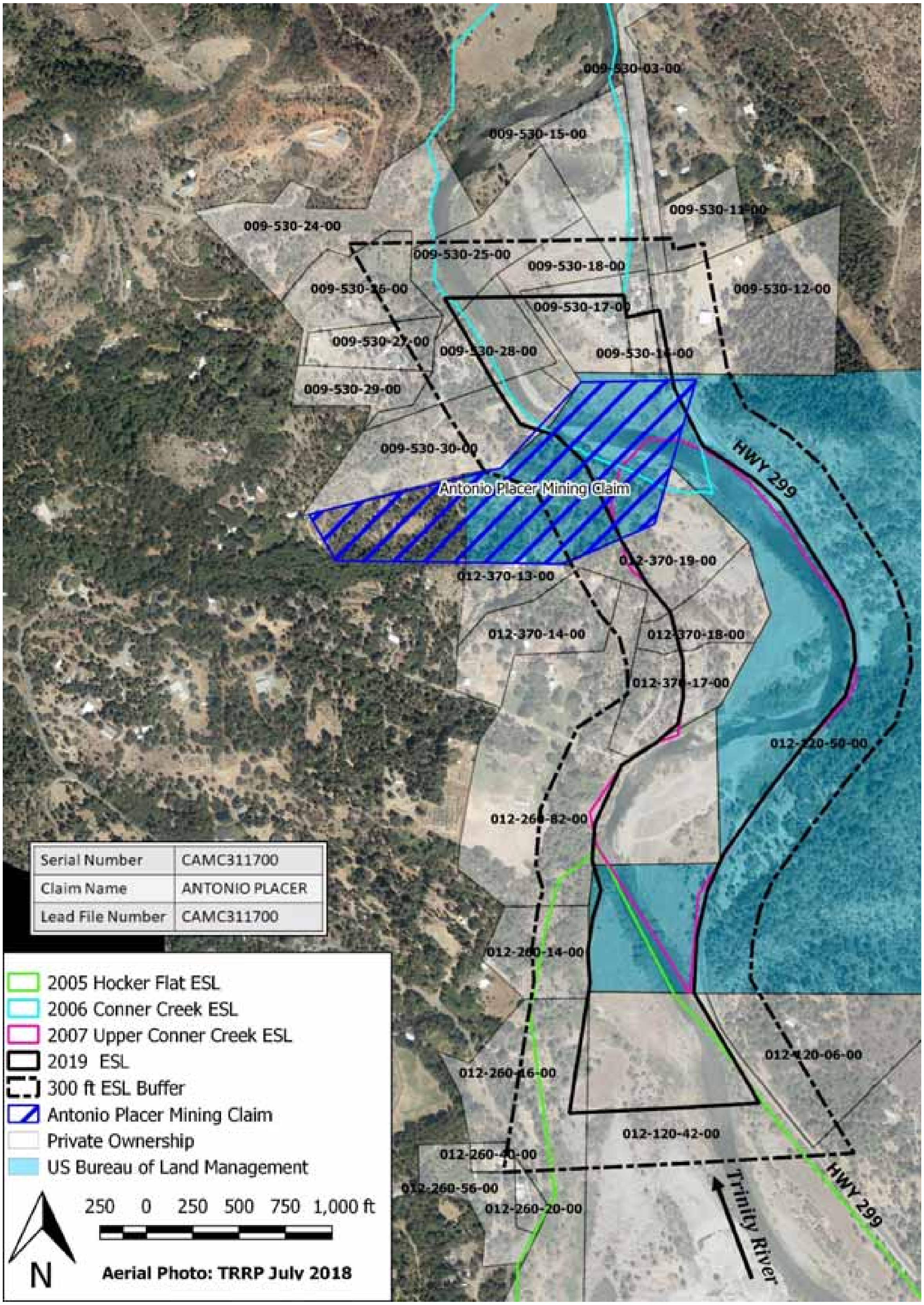


Figure 2. Parcel boundaries, land ownership, and current environmental study limits of the Upper Conner Creek project site.

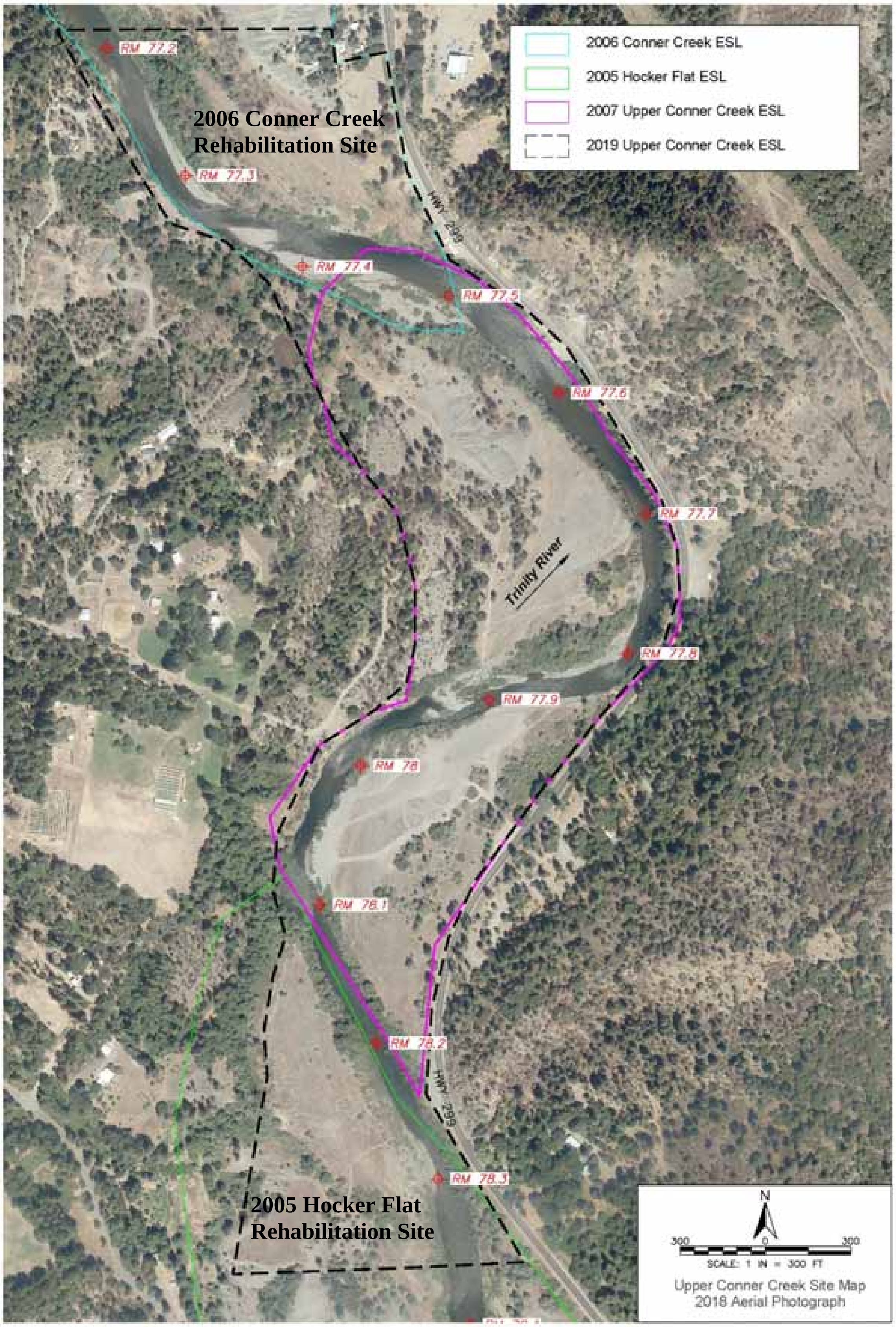


Figure 3. Upper Conner Creek Rehabilitation Site.

2.3 Cultural Resources, Mining Claims, and Recreation

Cultural resources describe historical artifacts that may exist in the project site, including historic mining artifacts and tribal artifacts. Existing cultural resources, mining claims, and recreational uses of the project site were gathered through academic studies of the region and information available through the TRRP. This section summarizes the available information.

2.3.1 Cultural Resources

Bailey (2008) and AECOM (2013) provide the general historical context and background for cultural resources between Lewiston Dam and the North Fork Trinity River; these documents are the primary source of information presented in this section. These documents provide the starting point for more detailed site surveys and research conducted within the project site ESL. Cultural resources surveys have not yet been conducted at the project site.

The cultural history of impacts to the Trinity River exists in the legacy of placer gold mining that occurred in three notable waves from 1848 to the 1960s. Although there were certainly negative impacts to the river during the simple placer gold mining era (1848–1860s), the large-scale impacts to the river occurred during the hydraulic mining and dredge mining eras. Historians disagree on the exact time that hydraulic mining began in earnest in the county, but it is agreed that operations began sometime in the 1860s to 1870s (Bailey 2008). The onset of hydraulic mining in the Trinity River watershed resulted in immense amounts of coarse sediment being flushed into the river. Construction of mining infrastructure resulted in large-scale deforestation within the watershed; this caused additional erosion of mountainsides and increased silt buildup in the Trinity River and its tributaries. Debris from hydraulic mining also caused damage to bridges, roads, and property throughout Trinity County. Remnants of hydraulic mining operations, such as cables and pieces of old equipment, are scattered throughout the river corridor and may be present at the project site.

By the early 1900s, hydraulic mining within the Trinity River corridor had been largely replaced by the onset of dredge mining. This form of mining had a major impact on the Trinity River, as much of the river valley alluvium was turned over during this period of mining. These impacts are still highly visible today as dredge mining tailings distributed along the river corridor throughout the valley; these impacts are particularly evident along the restoration reaches identified by the TRRP, including Upper Conner Creek.

Another important cultural resource that must be considered in regard to the restoration project is tribal artifacts. Due to the past history of dredger mining in the Trinity River basin, historic sites within the river corridor are not distinct and information regarding tribal historical sites within the valley is sparse. However, it is known that throughout history, the Trinity River basin was the home of many Native American tribes, including the Yurok, Hoopa, Chimariko, and Wintu tribes. As such, there is potential for historic tribal artifacts to be present within the Upper Conner Creek ESL.

2.3.2 Mining Claims

The Antonio Placer Mining Claim (Serial #: CAMC311700) is the only active mining claim within the project ESL (Figure 2). The mining claim covers approximately 20 acres on both the left and right bank of the river at the downstream end of the project ESL.

2.3.3 Recreation–River Access

The BLM river access map for the area indicates that one boat ramp is located within the project site at the Junction City Campground (Figure 4). The Junction City Campground is 1.5 miles west of Junction City, along Highway 299, and is open to the public from May through November. The public boat ramp is located on upstream legacy bar (see Figure 3) within the project site. The bar is a mixture of BLM land and private property; however, the boat launch is located on BLM-owned portion of the bar. All public managed lands within the site are open for temporary use (day and overnight use) by the public.

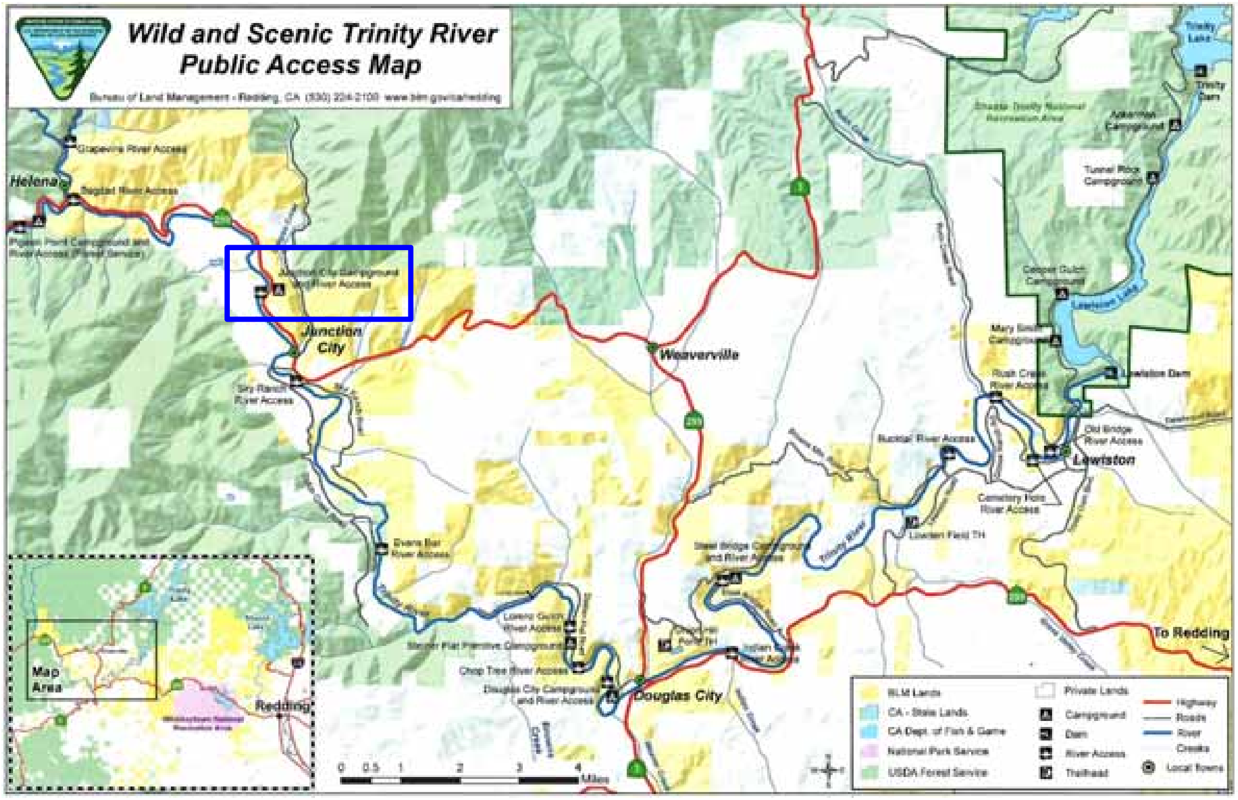


Figure 4. BLM river access map with the location of the Upper Conner Creek Rehabilitation Site highlighted (blue). The Junction City Campground river access is located within the project site.

2.4 Infrastructure

Existing infrastructure within the project site ESL includes State Highway 299, riprap along much of the right bank (Figure 5), culverts and concrete walls along the highway (Figure 6), concrete crib walls (Figure 7), and some private roads that provide river access on the left bank. Electric transmission lines and power poles exist within the project site ESL; a transmission line crosses the river at RM 77.45 (Figure 8). Existing utility lines and poles within the project site ESL shall be protected in place or relocated prior to construction activities.

Figure 5. Riprap along the right bank from RM 77.5 to RM 77.8.

Figure 6. Existing wall with culvert used for Highway 299 drainage (outlined in black).

Figure 7. Concrete crib wall on river right along Highway 299.

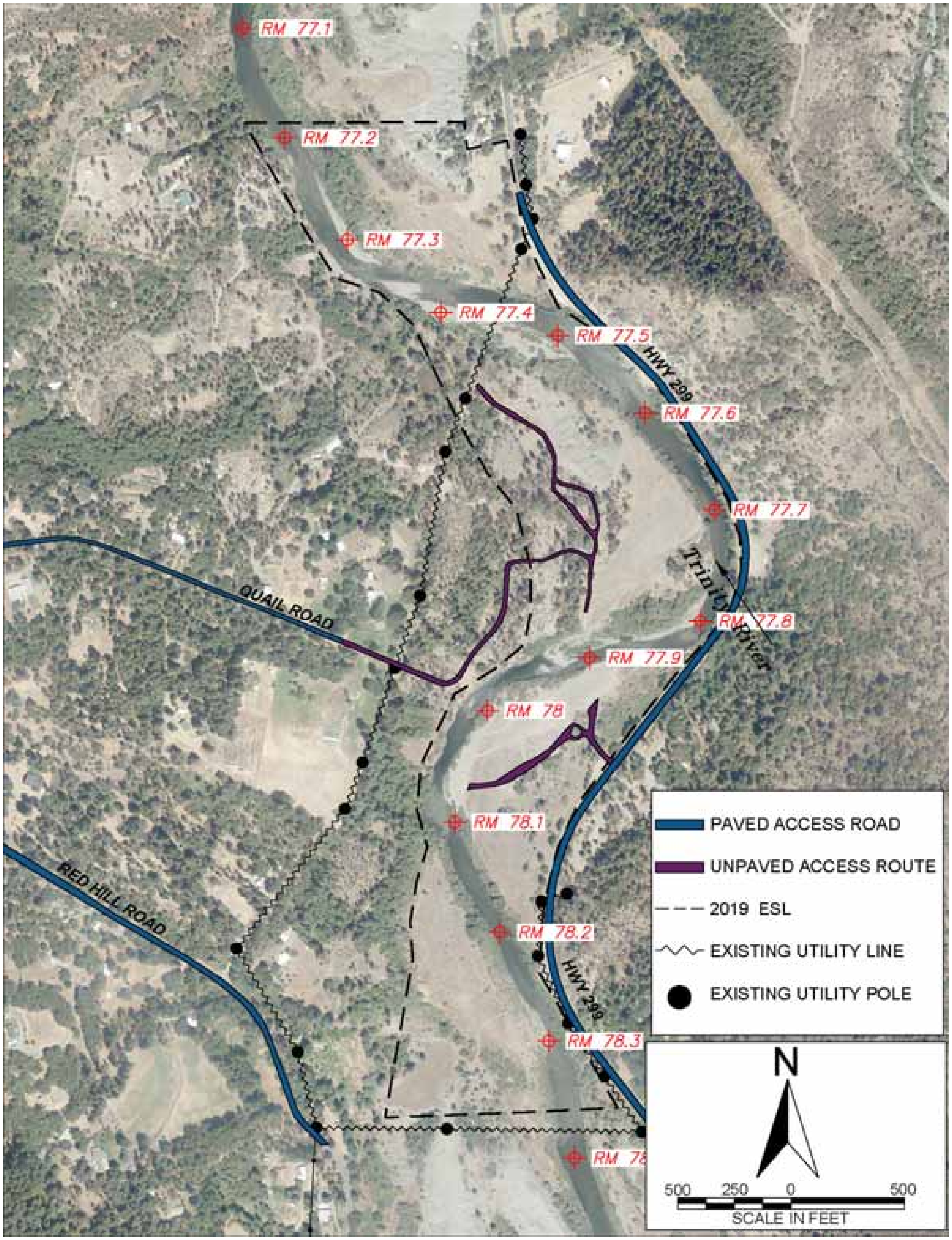


Figure 8. Existing infrastructure within and near the Upper Conner Creek project site.

3 PHYSICAL CHARACTERISTICS

Physical characteristics of the project site are important to consider, as they will guide the opportunities, constraints, and project designs. Physical characteristics discussed in this section are the geologic conditions, the hydrologic setting, the existing hydraulics of the project site, the channel geomorphology, and the restoration history.

3.1 Regional Geology

The information presented in this section is adopted from the Upper Junction City Valley Existing Conditions Report (Yurok Tribal Fisheries et al. 2015). Due to the close proximity of the project site to the Upper Junction City Valley (approximately 2 miles downstream), the same regional geological description presented in Yurok Tribal Fisheries et al. (2015) applies.

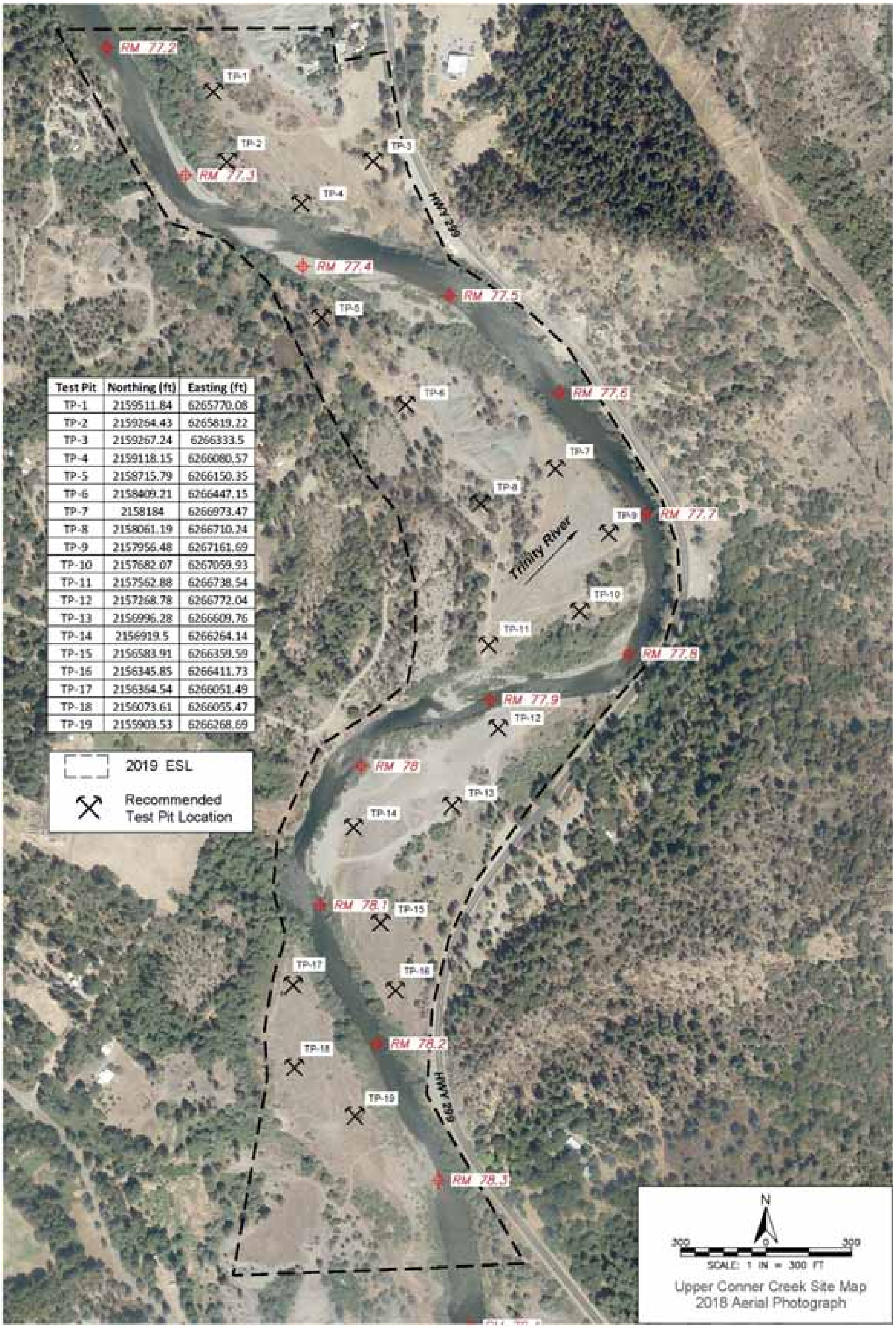
The Trinity River watershed above the South Fork Trinity River confluence lies within the Klamath Mountains geologic province, which is composed of accreted oceanic floor interspersed with igneous plutons and volcanic deposits. The Klamath Mountains formed as allochthonous masses of subducting oceanic plate and nearshore accretionary wedge material collided with, and were welded to, the overriding North American Plate. Primary rock types of the Klamath Mountains province are divided into four separate terranes (or “belts”), with the oldest rocks lying to the east and becoming progressively younger westward. The terranes dip gently eastward and are separated by thrust faults.

Irwin (2003) identified seven separate accretionary episodes that occurred from approximately 440 to 120 million years ago. During the Central Metamorphic accretionary episode, subducting oceanic rocks were dynamically metamorphosed to schist along the suture zone beneath the overriding Trinity and Eastern Klamath terranes to the east (Barrow and Metcalf 2006). Today these rocks are exposed along the Trinity River corridor and provide structural controls that influence the Trinity River through the Upper Conner Creek project site. Specific rock types include the Salmon Hornblende Schist and the Abrams Mica Schist, both belonging to the Central Metamorphic Terrane (CMT), and the Broken Formation of the North Fork Terrane (NFT), which generally defines the eastern edge of the river corridor.

The Trinity River’s corridor and course near the project site are strongly influenced in several ways by various CMT and NFT geologic structures. First, the Trinity River corridor between the Carr Creek confluence (RM 86.3) and Valdor Gulch (RM 74.7) parallels and borders the north-trending Siskiyou fault and accretionary contact between the CMT and NFT. The Trinity River at the Carr Creek confluence is turned north/northwest by a combination of: (1) the Siskiyou fault and NFT–CMT contact zone, (2) the north-trending contact between the Abrams Mica Schist and the Salmon Hornblende Schist formations of the CMT, (3) a large historic landslide originating from the NFT and to a lesser extent by (4) the Salmon Hornblende Schist’s foliation, and (5) planar orientation of the grains and minerals of a metamorphic rock (Bates and Jackson 1987). Second, the river has incised into the CMT bedrock, resulting in a series of alluvium-covered bedrock terraces and a shallow bedrock channel. The alluvium-covered bedrock terraces formed during cycles of river incision and planation generated during periods of tectonic uplift and during base level lowering. Extensive hydraulic mining subsequently removed or rearranged the terrace, exposing the bedrock (see Section 2.3.1). The exposed bedrock terraces and resistant bedrock outcrops create obstructions that deflect the river (e.g., Junction City boat launch pool and pools along Highway 299 downstream of the Junction City Campground) and dictate the arrangement of the alluvial morphology (Lisle 1986). Lastly, the geologic structure, rock type, and tectonic history play a role in the landscape evolution (e.g., landslides, tributary size, and topographic elevation) of the watershed and tributaries in the vicinity of the project site.

3.1.1 Site-Specific Geotechnical Investigations

Site-specific geotechnical investigations will be conducted by the TRRP for the Upper Conner Creek Rehabilitation project. Geotechnical investigations will identify bedrock contacts, identify the depth to groundwater throughout the project site, and document the subsurface stratigraphy (e.g., material type and composition), all of which inform the project. Proposed test pit locations, recommended by McBain Associates, for the project site are shown in Figure 9; actual test pit locations will be determined by the TRRP in collaboration with the HVT design team.



Test Pit	Northing (ft)	Easting (ft)
TP-1	2159511.84	6265770.08
TP-2	2159264.43	6265819.22
TP-3	2159267.24	6266333.5
TP-4	2159118.15	6266080.57
TP-5	2158715.79	6266150.35
TP-6	2158409.21	6266447.15
TP-7	2158184	6266973.47
TP-8	2158061.19	6266710.24
TP-9	2157956.48	6267161.69
TP-10	2157682.07	6267059.93
TP-11	2157562.88	6266738.54
TP-12	2157268.78	6266772.04
TP-13	2156996.28	6266609.76
TP-14	2156919.5	6266264.14
TP-15	2156583.91	6266359.59
TP-16	2156345.85	6266411.73
TP-17	2156364.54	6266051.49
TP-18	2156073.61	6266055.47
TP-19	2155903.53	6266268.69

Figure 9. Recommended test pit locations.

3.2 Hydrology

The Trinity River basin exhibits a rainfall-dominant hydrology in the lower watershed and a spring snowmelt-dominated hydrology in the upper watershed; however, both hydrograph components are regulated by the Trinity and Lewiston Dams except for rainfall-dominated tributaries downstream of Lewiston Dam. The long-term average annual inflow into the Trinity Dam is 1.25 million acre-feet, much of which is stored by Trinity Lake, which has a storage capacity of 2.4 million acre-feet or approximately two full years of average annual inflow (Reclamation 2017).

Trinity and Lewiston dams were constructed as part of the Trinity River Division of the Central Valley Project in the 1960s to create a trans-basin diversion that supplies water from the Trinity River to the Sacramento River. This system began regulating and diverting flows in 1963, with diversion accounting for up to 90 percent of the long-term average annual basin runoff. This virtually eliminated floods and reduced daily flows to a constant 150 cfs year-round through the 1980s (USFWS and HVT 1999). Flow diversions have gradually been reduced since the early 1980s in response to a variety of environmental legislations, including the ROD signed in 2000. Since 2005, flow diversions account for slightly more than half of the long-term average annual runoff. As part of the ongoing restoration efforts, the remainder of the water is released as environmental flows, which include spring high flow releases intended to emulate snowmelt runoff, route sediment downstream, and create and maintain a dynamic channel. The magnitude of these high flow releases varies by water year type, with the largest being capped at 11,000 cfs during Extremely Wet water years (Reclamation 2000). In recent years, adaptive management of the annual hydrograph has resulted in release peaks of 10,000 cfs or more, even during Normal water years.

Contemporary hydrology for the Upper Conner Creek project site streamflow is best represented by the Trinity River above NF Trinity River near Helena USGS gaging station (11526400), approximately four miles downstream of the project site at RM 73.3. Conner Creek, a small tributary with a basin area of 4.8 mi^2, enters the project site just downstream of RM 77.2 and is the only major tributary between the gaging station and the project site. The hydrology at the project site is a mix of dam releases and tributary accretion from several major upstream tributaries. Estimates for the summer baseflow, winter baseflow, and bankfull discharge for the North Fork Reach, as stated in the Channel Design Guide (USFWS and HVT 2011), are provided in Table 1.

Table 1. Hydrologic parameters for the North Fork Reach of the Trinity River as stated in the Channel Design Guide Table 6-5 (HVT et al. 2011).

Description	Flow (cfs)
Summer baseflow + Accretion	498
Winter baseflow	771
Bankfull discharge	9,188

3.2.1 Flow Duration

The duration of flows during different water year types is important to understand when designing a site to interact with and benefit a specific species. For Upper Conner Creek, the winter salmonid rearing period (January 1–April 30) is most critical, and the black cottonwood seed dispersal period (April 19–July 3) is also important. Flow duration curves provide valuable insights into the inundation of potential salmonid and seedling habitat on the floodplains and periods of time for cottonwood seed establishment. The 14-day and 21-day flow duration curves are particularly useful for examining salmon rearing habitat and seed establishment potential and provide flow thresholds for floodplain design. Upper Conner Creek flow duration curves, for each water year type, were prepared using data (WY2005 to WY2019) from the Trinity River Above NF Trinity River gage (Figure 10 through Figure 14).

The median flow (50% exceedance probability flow) for 14-day and 21-day duration during the winter rearing period was determined for all water year types (Table 2). These flows are important as they provide a duration that is sufficient for juvenile salmonids and macroinvertebrates to access inundated floodplains and make use of the habitat value of these features which have been noted to provide faster growth rates than river habitats (Jeffres et al. 2008).

Table 2. Median flows for 14-day and 21-day flow duration curves during the winter juvenile salmonid rearing period (January 1–April 30) by water year type (WY2005 to WY2019).

Water Year Type	14-Day Duration (cfs)	21-Day Duration (cfs)
Extremely Wet	1,780	1,620
Wet	1,010	959
Normal	995	835
Dry	667	639
Critically Dry	491	478

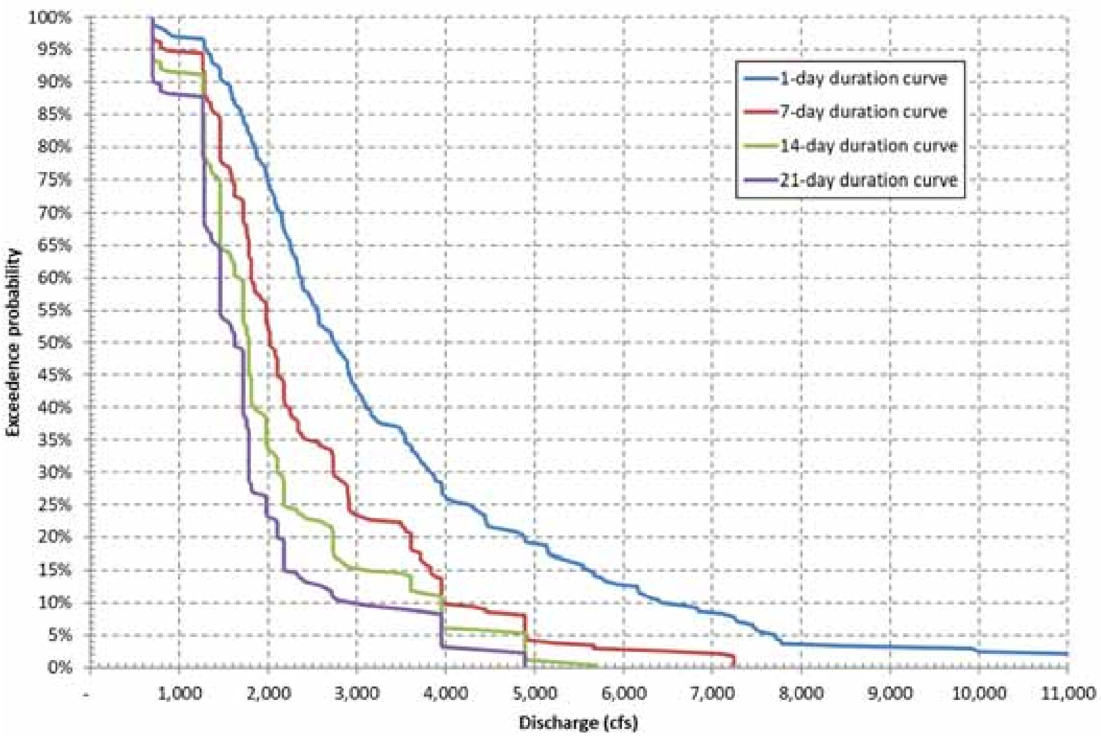


Figure 10. Flow duration curves for Extremely Wet water years (n=2) for winter rearing: January–April 30.

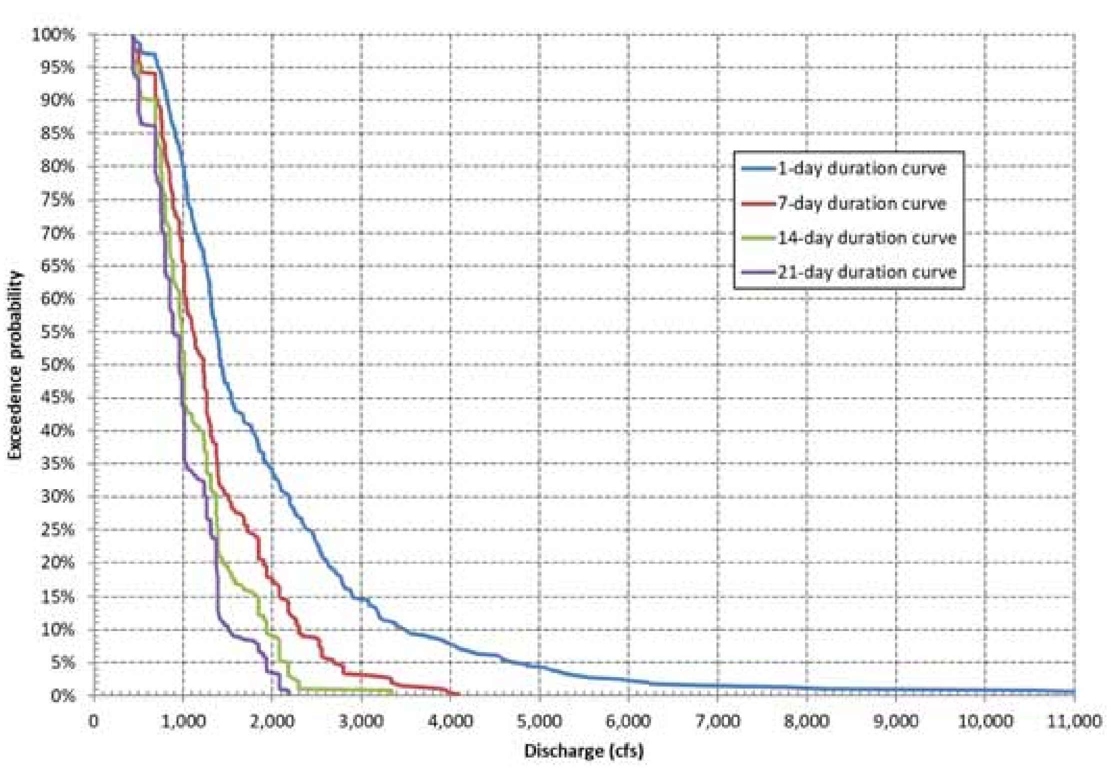


Figure 11. Flow duration curves for Wet water years (n=3.5) for winter rearing: January 1–April 30.

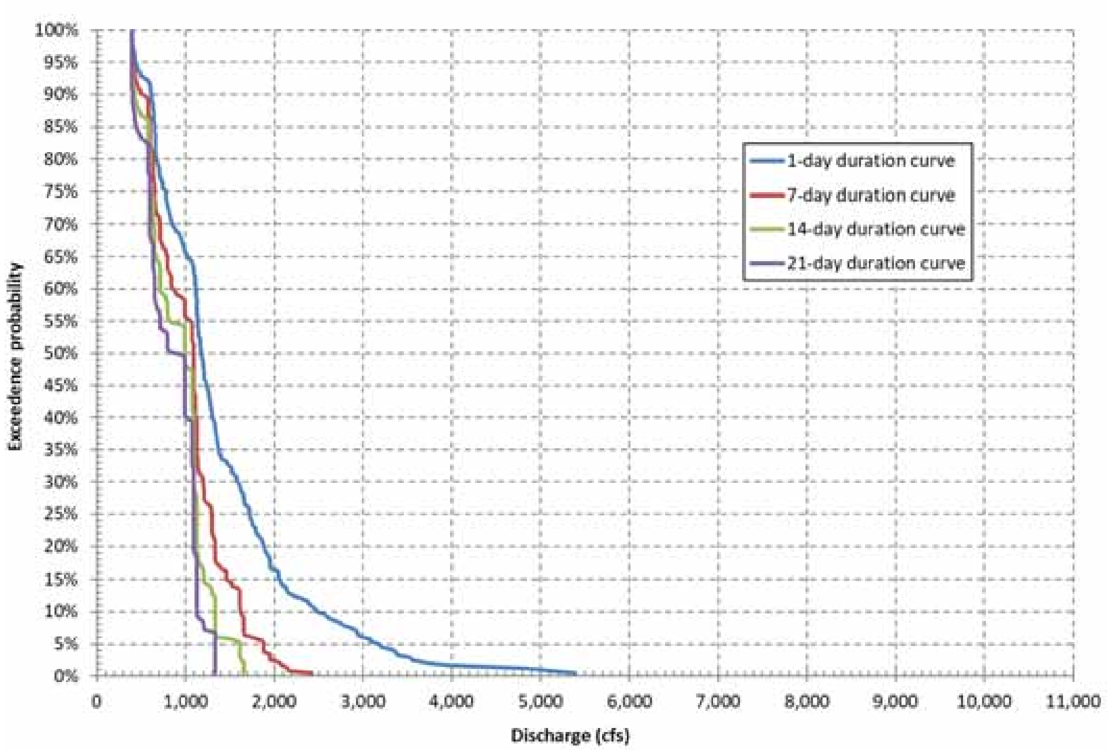


Figure 12. Flow duration curves for Normal water years (n=2) for winter rearing: January 1–April 30.

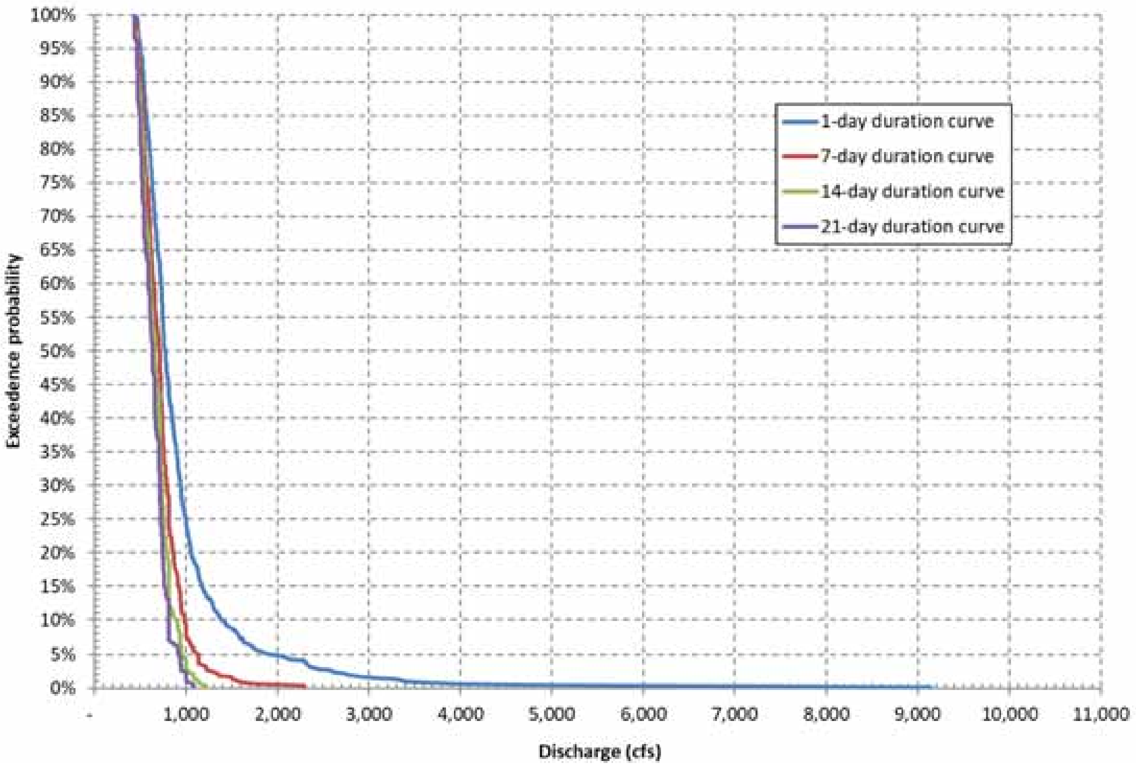


Figure 13. Flow duration curves for Dry water years (n=5) for winter rearing: January 1–April 30.

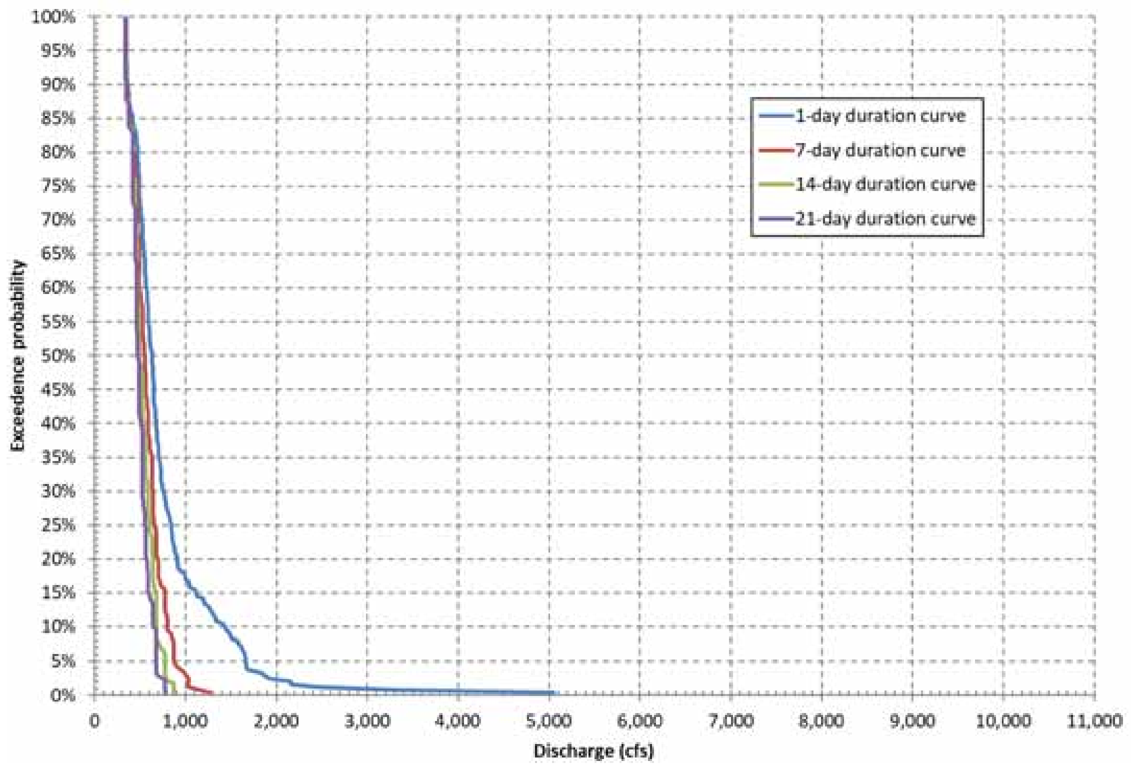


Figure 14. Flow duration curves for Critically Dry water years (n=2) for winter rearing: January 1–April 30.

3.2.2 100-Year Flood Evaluation

The 100-year floodway within the project site is based on the 2016 FEMA Flood Insurance Rate Maps that cover the project site (Figure 15 and Figure 16; FEMA 2016). Structures within the Special Flood Hazard Areas include private property on both sides of the river and the Junction City Campground.

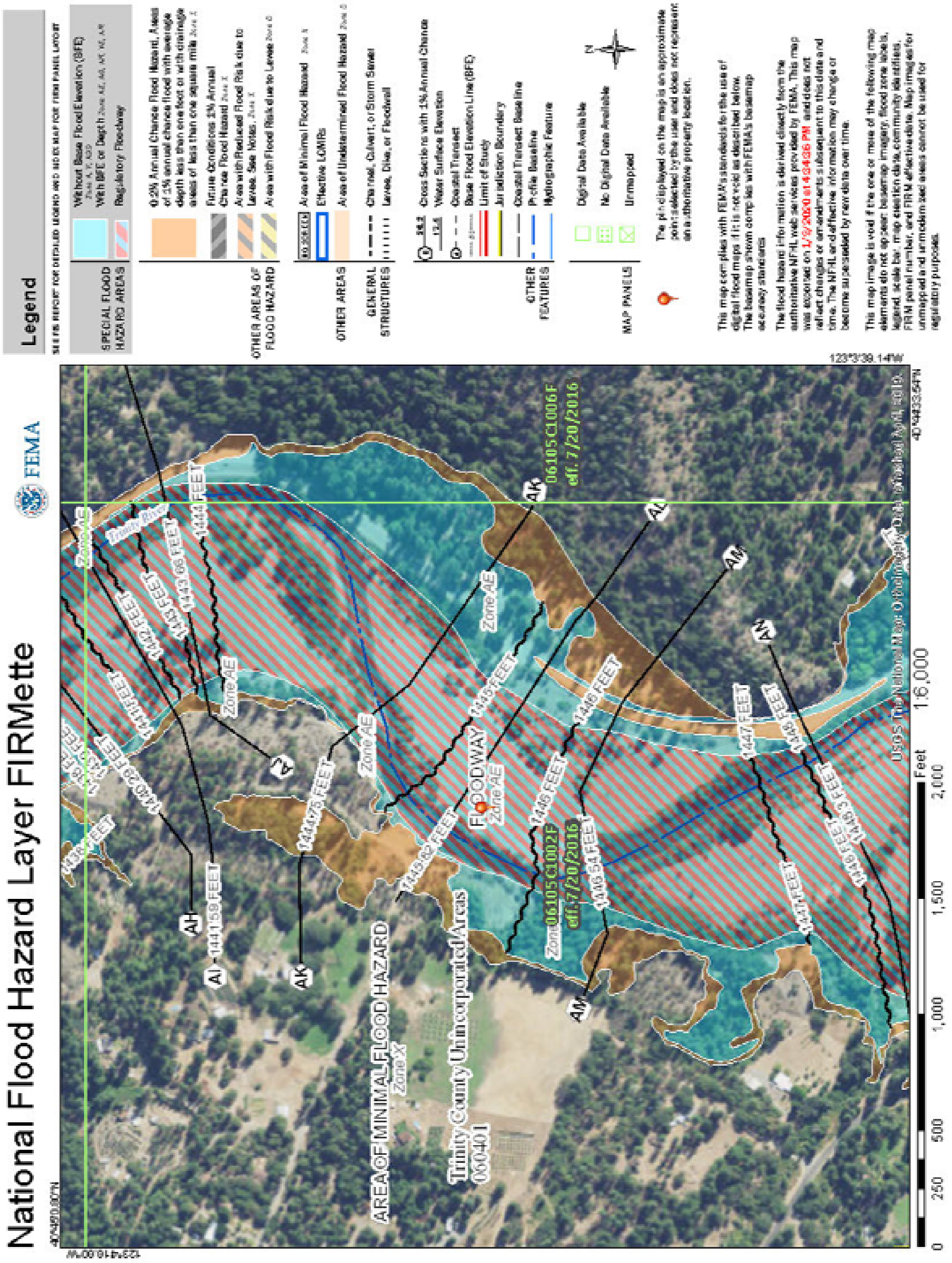


Figure 15. FEMA flood map for the upstream portion of the Upper Conner Creek project site (FEMA 2016).

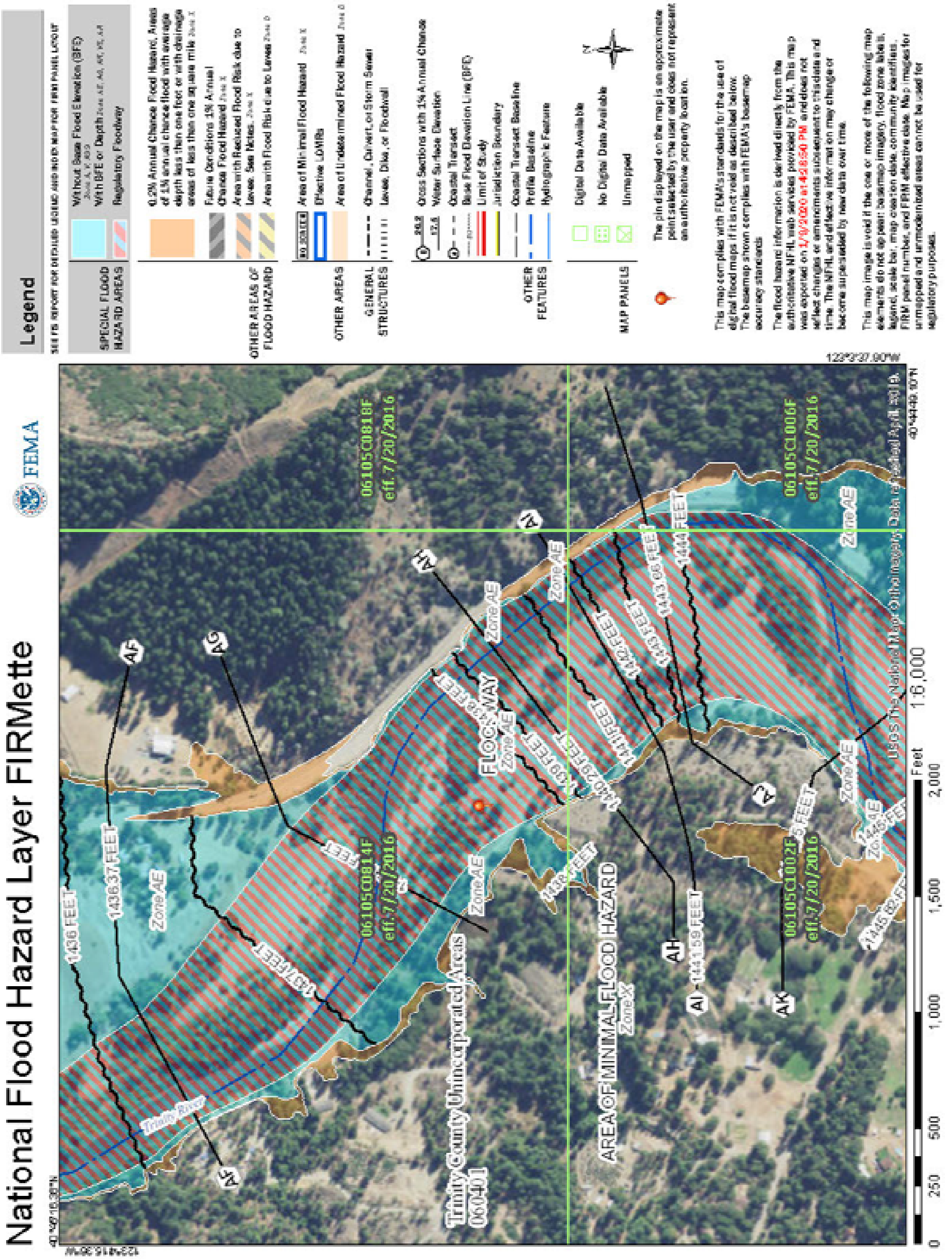


Figure 16. FEMA flood map for the downstream portion of the Upper Conner Creek project site (FEMA 2016).

3.3 Existing Conditions Hydraulic Modeling

Hydraulic modeling was used as part of the Existing Conditions Report to predict the spatial patterns of depth, velocity, and shear stress through the project site, which are used to predict existing carrying capacity for various life stages of salmonids. The Upper Conner Creek model was based on 2016 Trinity River topography and bathymetry that was updated with 2019 survey data, estimates of channel and floodplain roughness, and the outlet water surface elevation for a given streamflow. Existing conditions hydraulic modeling utilized two-dimensional (2-D) HEC-RAS (RAS 2-D), which is included in HEC-RAS v. 5.0.7 (USACE 2017). A hydraulic model of existing site conditions was developed in RAS 2-D as a basis for evaluating hydraulic features in the design, assessing fish habitat, and developing grain size distribution recommendations for certain design features.

3.3.1 Topographical Data and Terrain Development

The existing topography was built from terrestrial LiDAR and sonar data, collected in 2016 by Graham Matthews Associates, and supplemental surveys, conducted in November 2019, of dynamic features that were formed after the 2016 bathymetric surveys. Significant topographical changes at RM 77.3, RM 77.9, and RM 78.0 resulting from winter flood peaks in water year (WY) 2019 (21,000 cfs at “the above NF Trinity River” gage) were observed during an initial site visit in October 2019. Features that were surveyed during the November 2019 supplemental surveys include the downstream riffle and bar at RM 77.3, the bar–riffle complex at RM 77.9, and the bar at RM 78.0. Point data from these surveys were imported to Civil 3D and refined using breaklines, daylighting edges, and surface boundaries to create surfaces for these features (Figure 17, Figure 18).

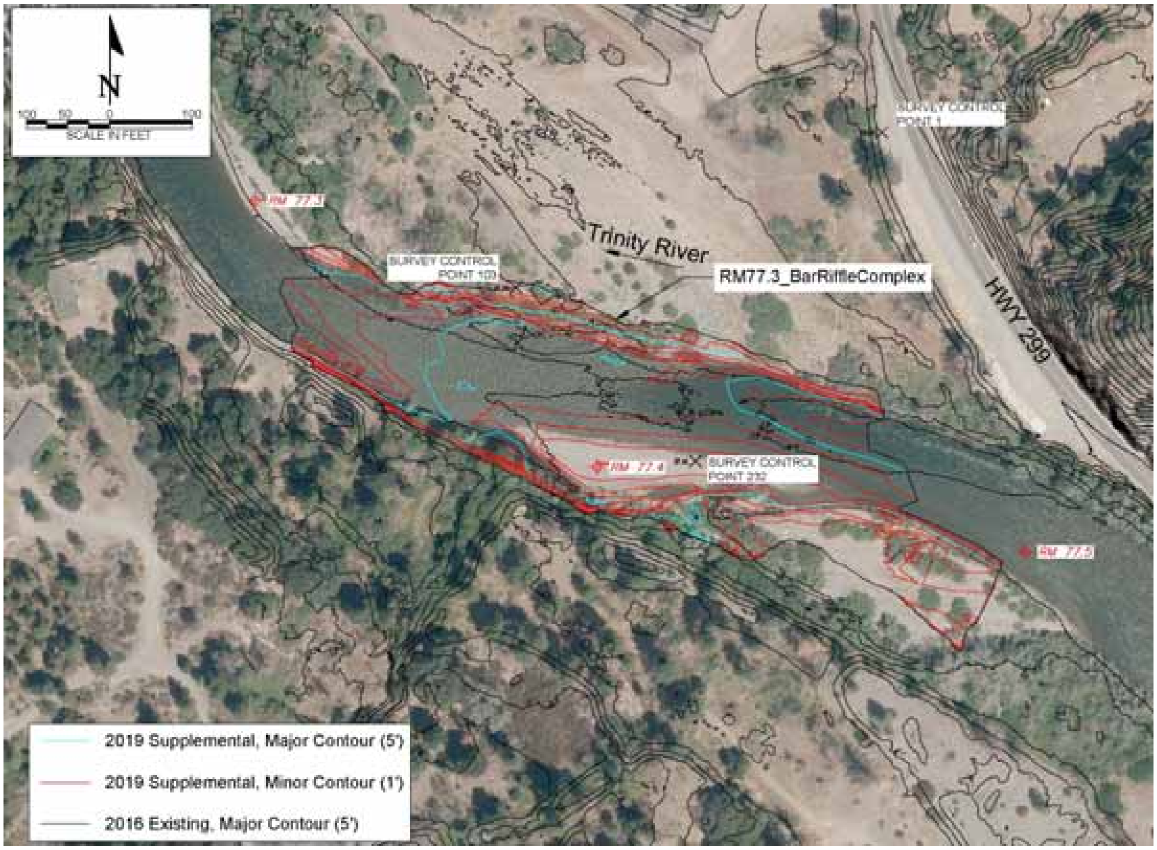


Figure 17. 2019 topographic supplemental survey for the evolved bar–riffle complex at RM 77.3.

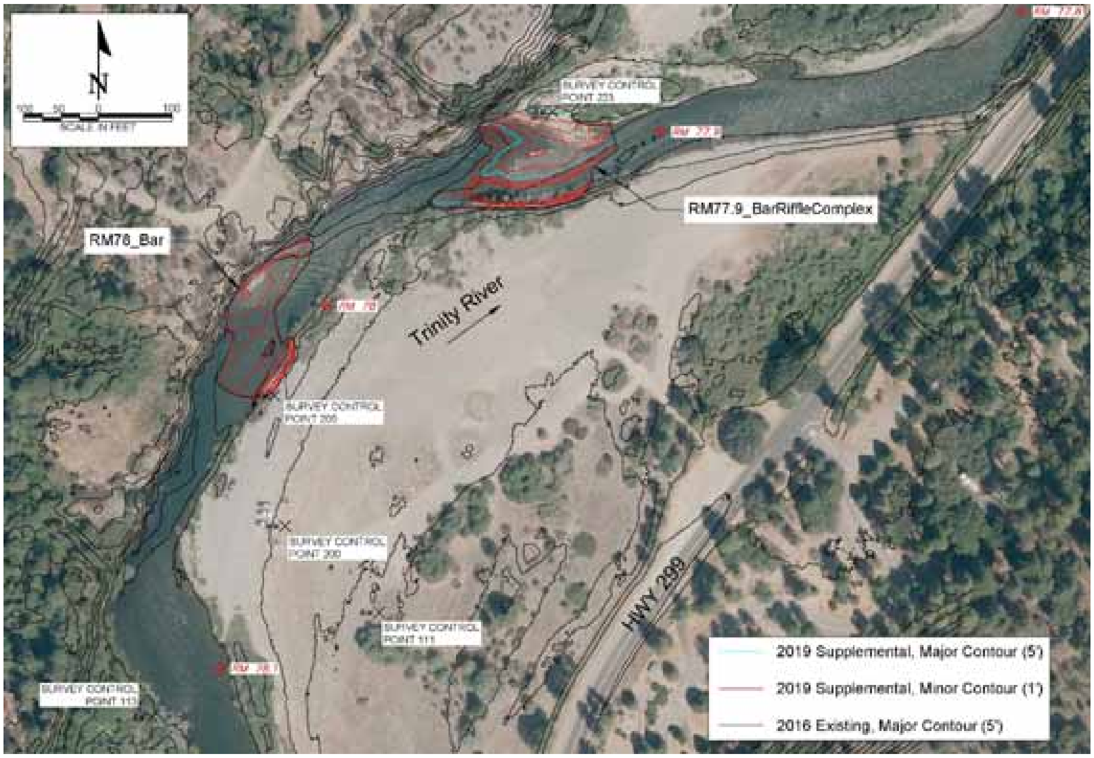


Figure 18. 2019 topographic supplemental survey for the evolved bar-riffle complexes at RM 77.9 and RM 78.0.

These surfaces were combined with 2016 LiDAR data to make a single updated 2019 existing condition digital terrain model (DTM) using Civil 3D, and were imported as a terrain surface into RAS 2-D. The 2-D flow area was drawn around the project site, and the downstream end of the model domain was aligned with cross section 77.24 from the Department of Water Resources (DWR) 2016 hydraulic 1-D model (Reclamation 2016a). The upstream boundary was established at a location sufficiently upstream of the project site such that water surface elevations associated with design features would not be impacted by the upstream boundary condition. The lateral extent of the model domain was set to encompass the estimated 100-year flood area.

3.3.2 Manning's Roughness

Roughness polygons were developed by digitizing the existing features within the project site. The model recognizes three distinct feature types: active channel, floodplain, and vegetated areas (Figure 19). Floodplain and vegetation roughness values were held constant for all flows at n = 0.055 and n = 0.070, respectively. The active channel roughness values were calibrated using high-flow (8,500 cfs) and low-flow (380 cfs) scenarios. Roughness values for the active channel were plotted against flow and a negative logarithmic curve was fit to the data to determine appropriate roughness values (Figure 20, Table 3). The negative logarithmic curve matches trends seen in roughness–flow rating curves for other gravel-bedded rivers (Hicks and Mason 1991). The rest of the modeling domain received a default roughness value of n = 0.06.

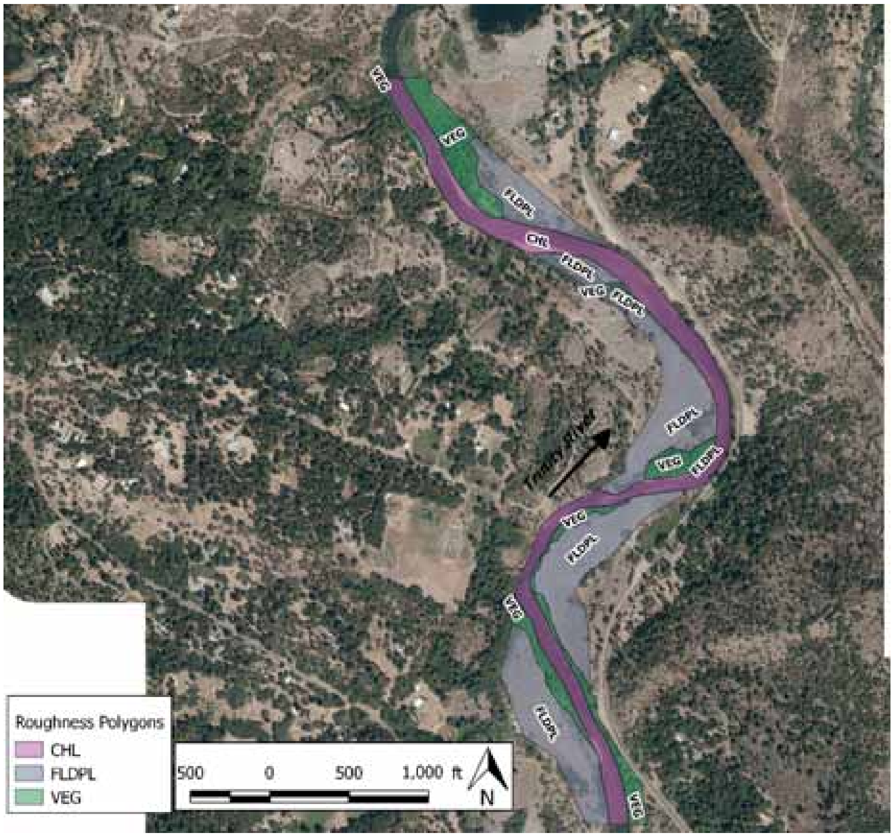


Figure 19. Roughness polygons used to develop the Land Cover file for the hydraulic model. CHL = channel, FLDPL = floodplain, VEG = vegetation.

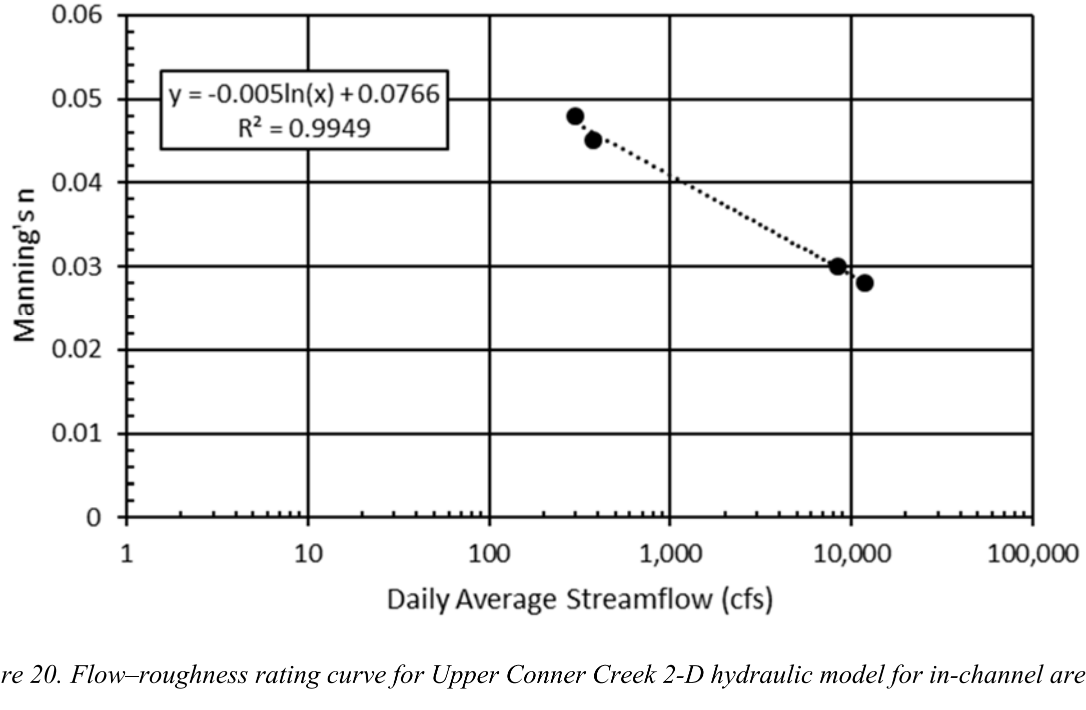


Figure 20. Flow–roughness rating curve for Upper Conner Creek 2-D hydraulic model for in-channel areas.

Table 3. Manning's roughness values and modeled streamflows for habitat–flow model runs.

	Manning's *n*		
Flow (cfs)	**In-channel**	**Floodplain**	**Vegetation**
380	0.045	0.055	0.070
450	0.046	0.055	0.070
700	0.044	0.055	0.070
950	0.042	0.055	0.070
1,000	0.042	0.055	0.070
1,250	0.041	0.055	0.070
1,500	0.040	0.055	0.070
2,000	0.039	0.055	0.070
2,500	0.037	0.055	0.070
3,500	0.036	0.055	0.070
6,000	0.033	0.055	0.070
8,500	0.031	0.055	0.070
11,000	0.030	0.055	0.070

3.3.3 Boundary Conditions

The model includes an upstream boundary condition and a downstream boundary condition. The upstream boundary condition was set as a steady-state flow hydrograph representing each flow of interest. The downstream boundary condition was set as a stage–discharge rating curve taken from the DWR 2016 1-D model cross section that lines up with the downstream boundary of the modeling domain (RM 77.24). The range of flows modeled is provided in Table 3.

3.3.4 Calculation Mesh

The calculation mesh was generated by discretizing the entire modeling domain into a 10-ft by 10-ft grid. The active channel was further refined to a 5-ft by 5-ft grid. Breaklines were incorporated throughout the modeling domain to line grid faces up with important topographical features, including bank slopes and geomorphic feature faces. Breaklines were also used to help guide flow through the resurveyed features at RM 78.0 and RM 77.9 (Figure 21).

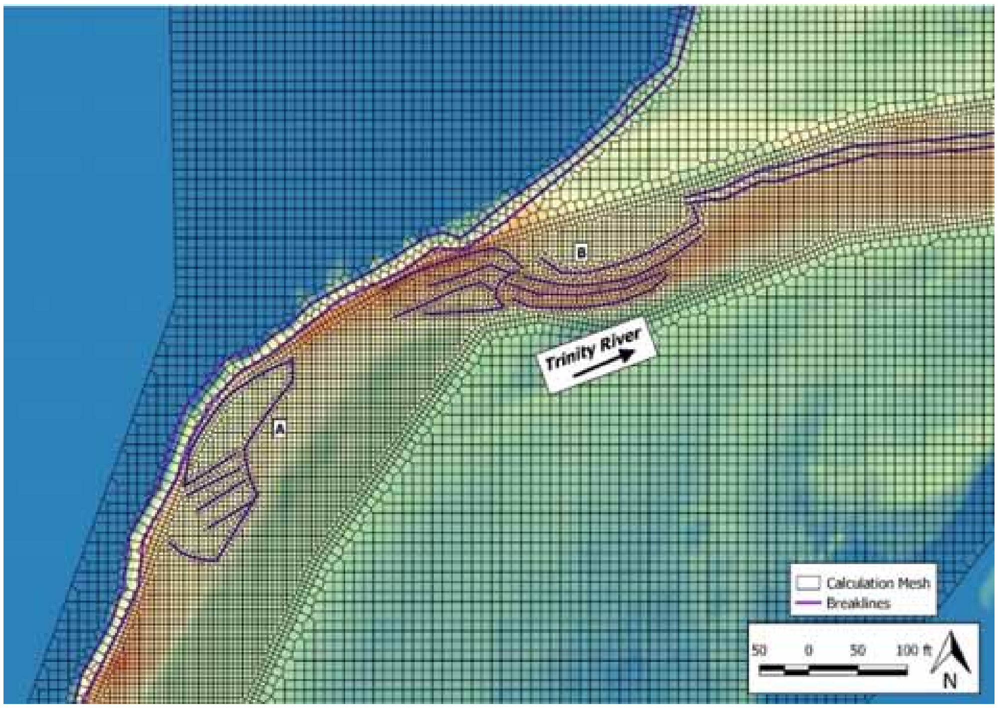


Figure 21. Calculation mesh and breaklines used to refine cell areas, capture grade breaks, and orient cell faces along flow paths using updated 2019 topography at RM 78.0 (A) and RM 77.9 (B).

3.3.5 Calibration

The model was calibrated using three sources of measured water surface elevation (WSE) data including: (1) WSEs collected by HVT on May 20, 2019, during flows ranging from 8,310 cfs to 8,550 cfs; (2) edge of water data extracted from the 2016 terrestrial LiDAR data at a flow of 380 cfs; and (3) WSEs collected during the November 10, 2019, field effort at a flow of 360 cfs. High-flow (8,500 cfs) model runs were calibrated using the data collected by HVT on May 20, 201*(Figure 22, Table 4). Results were analyzed using average error, maximum over-prediction, maximum under-prediction, and root mean square error. Low-flow (380 cfs) model runs were calibrated using a mixture of the edge of water data extracted from the 2016 LiDAR surface and WSE data collected during the November 2019 field effort (Figure 23, Table 4). Use of the combined dataset was necessary due to topographic changes that occurred as a result of high winter flows in WY 2019 (21,000 cfs at the “Above NF Trinity River” gage).

Model results for the high-flow scenario (8,500 cfs) showed a close match to measured data throughout the project site (Figure 22). Model results for the low-flow scenario (380 cfs) were more complex to examine due to geomorphic changes in the project site (Figure 23). Statistics used to examine the high-flow results compared modeled and measured WSEs over the entire reach. Low-flow results compared modeled WSE to the LiDAR-extracted WSEs in areas of the site that were not updated with 2019 topography. In areas that were updated, modeled WSEs were compared to WSE measurements surveyed during the 2019 field effort (Table 4). Overall, the WSE results in the low-flow scenario matched well with 2016 LiDAR-extracted WSE data in the non-updated areas of the project site. Areas that were updated with 2019 topography did not match well with the 2016 data due to bed topography changes that have occurred between 2016 and 2019. However, these areas generally matched well with WSE data collected in November 2019 (Figure 23). WSE model results, and the 2016 terrestrial LiDAR-extracted WSE data in the Hocker Flat portion of the site were both greater than the 2019 WSE data collected in the area, indicating that this portion of the channel has incised since 2016. McBain Associates will request that the TRRP update the LiDAR and bathymetry of the reach prior to construction.

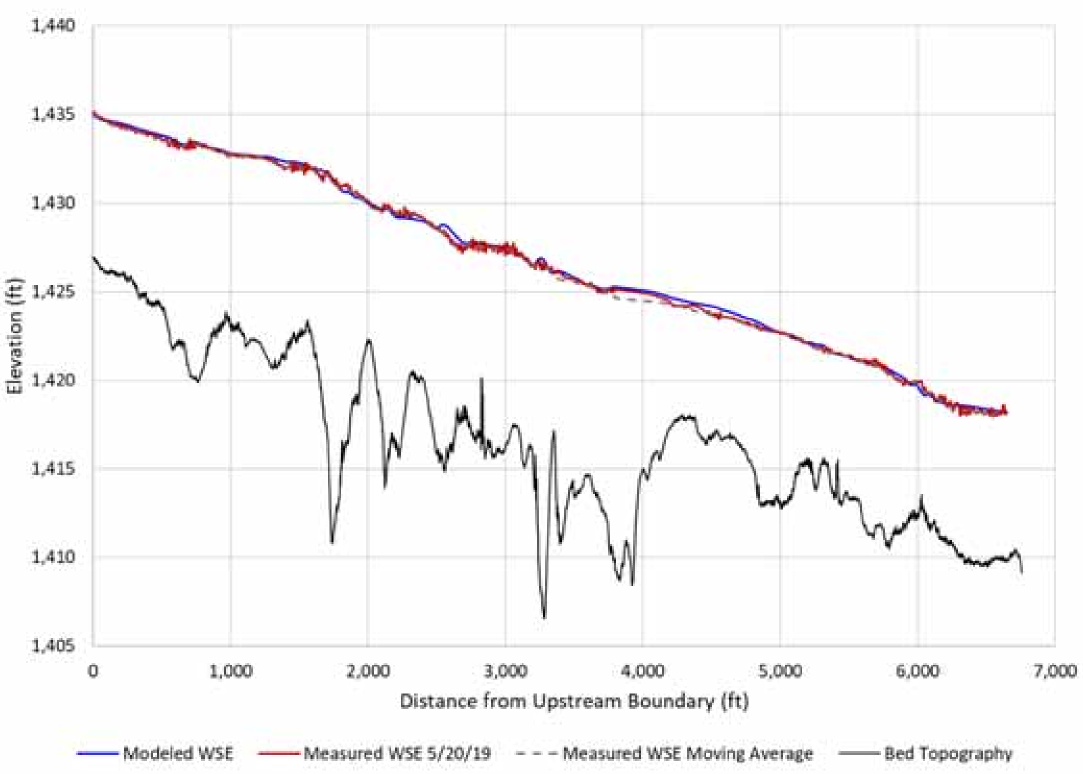


Figure 22. Modeling results for the high-flow scenario (8,500 cfs).

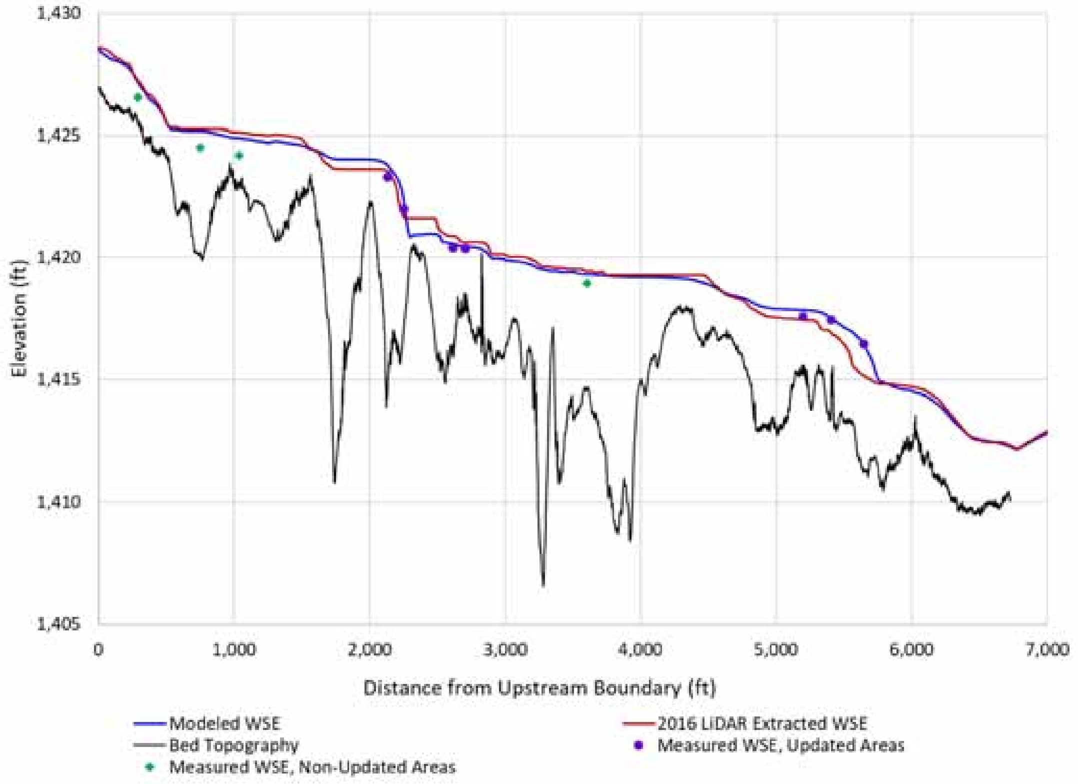


Figure 23. Modeling results for the low-flow scenario (380 cfs). Measured WSE (11/10/2019) diamond markers indicate measured WSEs that are not associated with updated topographic features.

Table 4. Fitness statistics for the high-flow (8,500 cfs) and low-flow (380 cfs) scenarios of the Upper Conner Creek 2-D hydraulic model.

Scenario	Over-prediction	Under-prediction	RMSE
High-flow	0.69 ft	0.67 ft	0.19 ft
Low-flow, 2016 LiDAR-Extracted WSE	0.39 ft	0.32 ft	0.17 ft
Low-flow, Nov 2019 WSE	0.52 ft	0.05 ft	0.07 ft

3.3.6 Results

The calibrated 2-D model was run for flows ranging from 380 cfs to 11,000 cfs (Table 3). Depth, velocity, and shear stress rasters for each flow were saved for further analysis. These three results help describe the condition of the river channel in relation to habitat and geomorphic function. Depth and velocity results are used in juvenile rearing carrying capacity modeling as discussed in Section 4.2.2. Shear stress allows for estimates of grain mobility in the channel at the different flows as discussed in Section 3.4.2.

Resulting velocity outputs for the 450 cfs and 6,000 cfs model runs were indicative of a linear channel with lower velocities along both banks (Figure 24 and Figure 25). Under 6,000 cfs, velocity refugia for fry and juvenile salmonids were limited to channel margins, floodplains, and side channels. Flow depth and shear stress were also evaluated for existing conditions at key flow thresholds (Figure 26 to Figure 29). Depths were greatest at points of contact with bedrock throughout the project reach. High shear stress localities varied with flow, with shear being highest at the bar at RM 78.0 during lower flows of 450 cfs. At 6,000 cfs, shear was highest at the vegetated apex of the first large point bar and at the upper portion of the bar at the bar-riffle complex at RM 77.9.

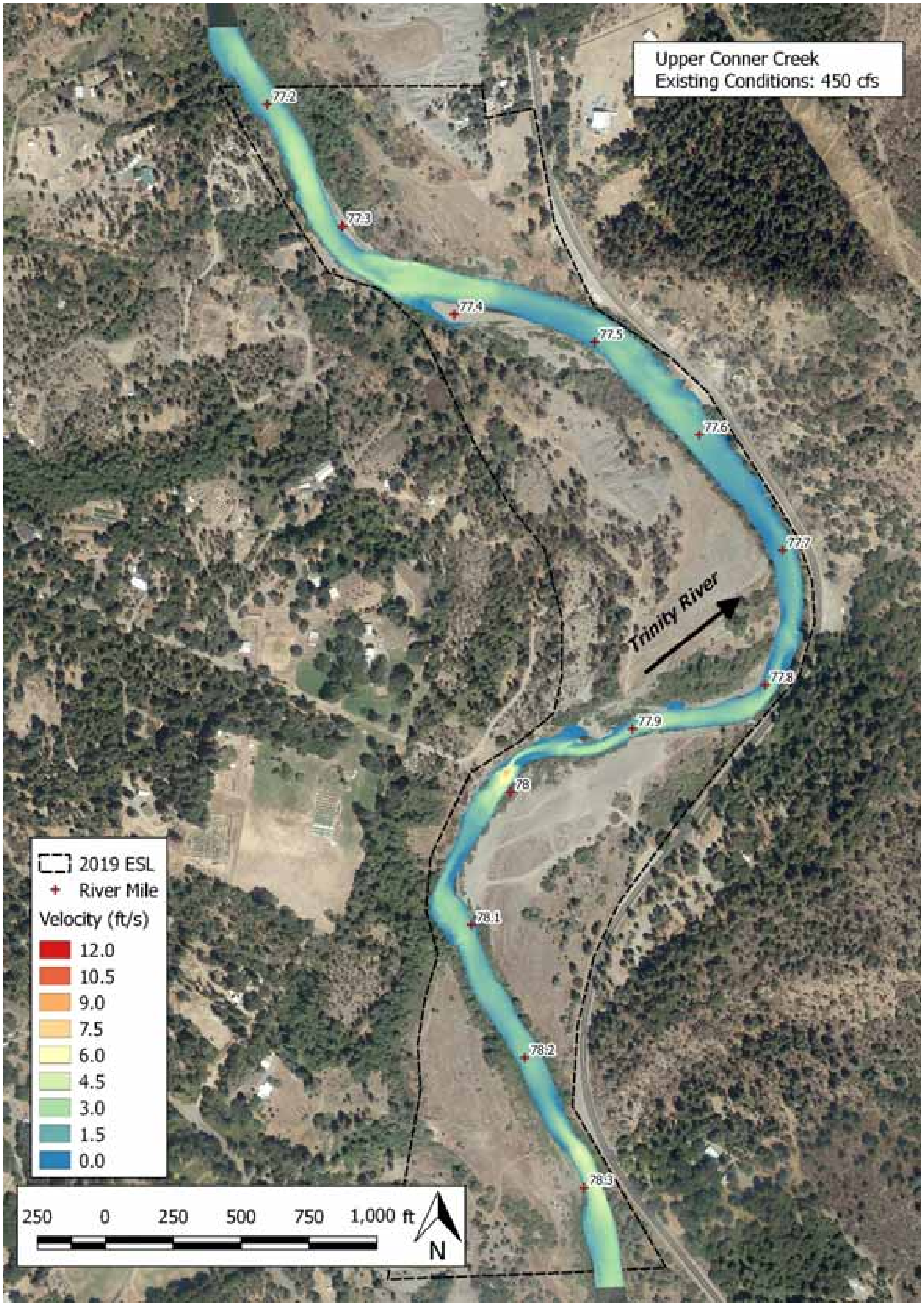


Figure 24. Computed velocity distribution for Upper Conner Creek existing conditions at 450 cfs.

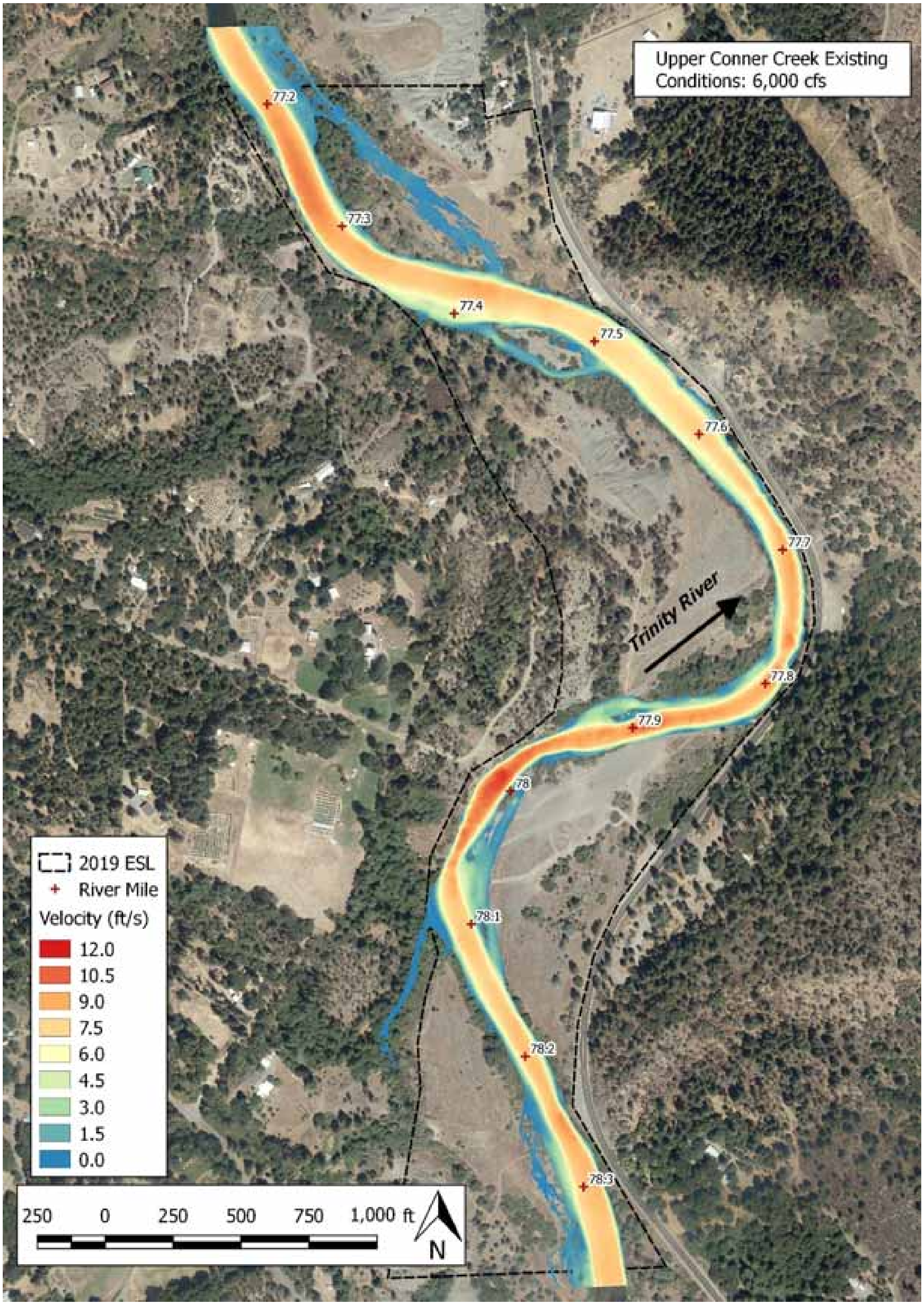


Figure 25. Computed velocity distribution for Upper Conner Creek existing conditions at 6,000 cfs.

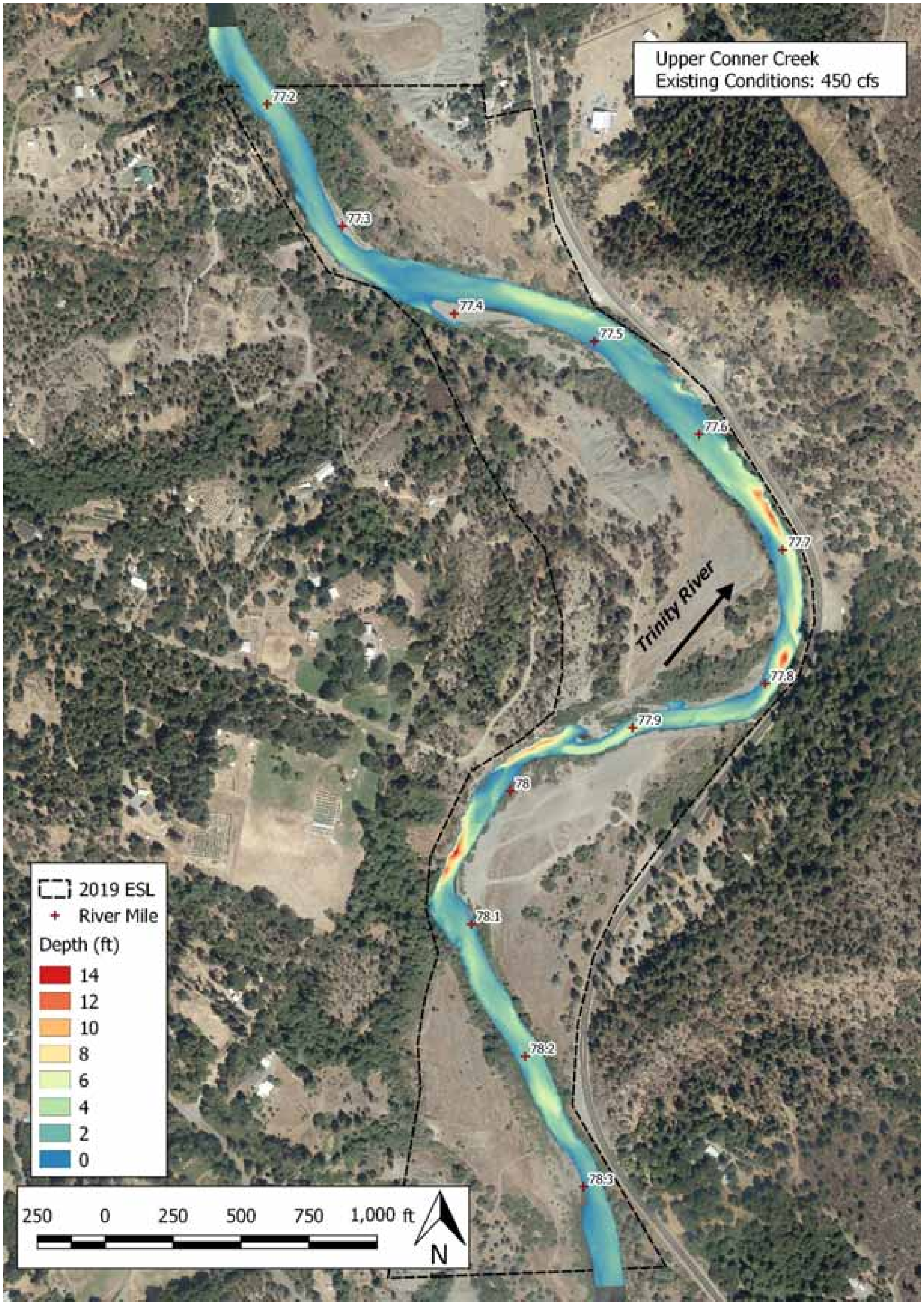


Figure 26. Computed depth distribution for Upper Conner Creek existing conditions at 450 cfs.

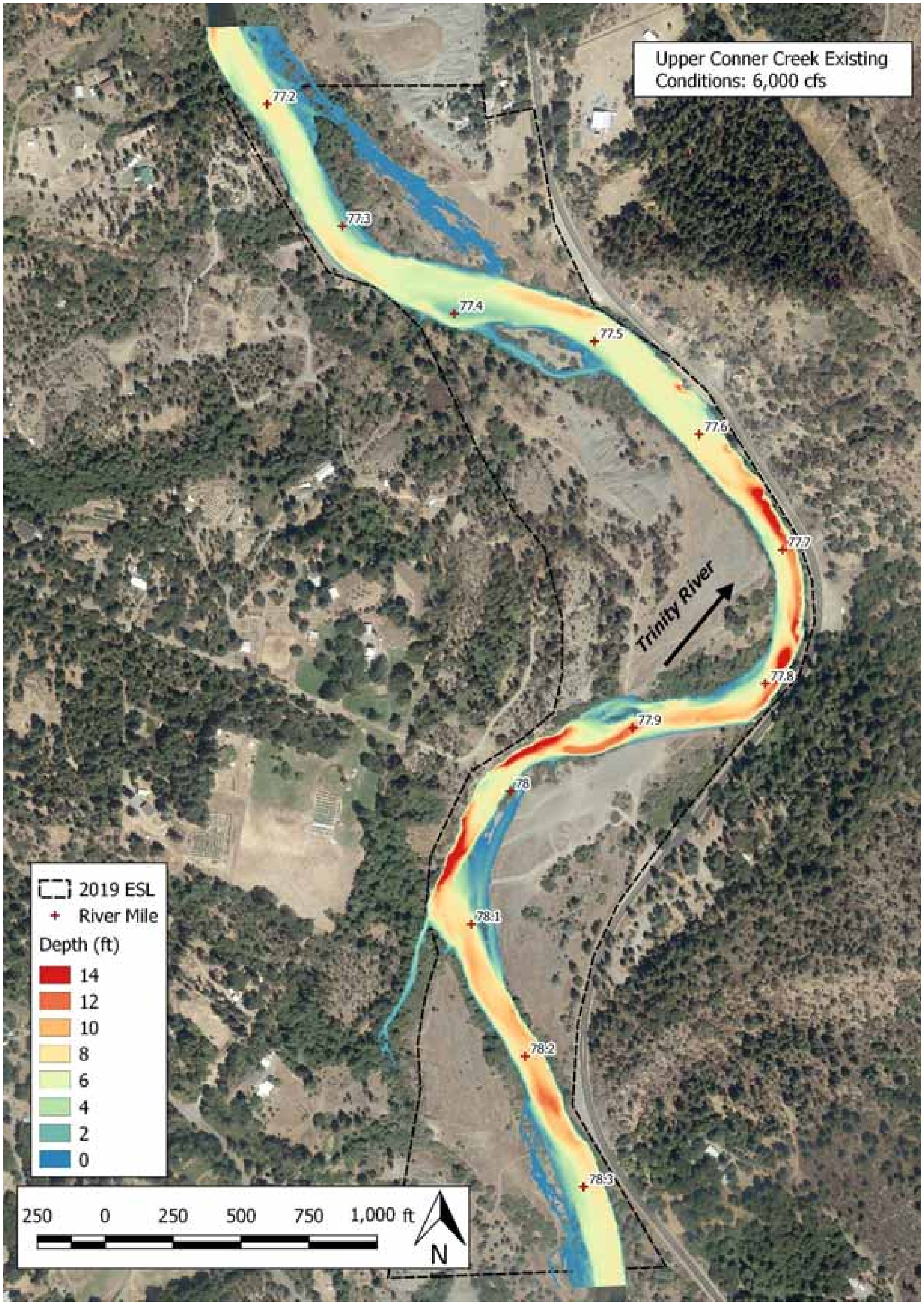


Figure 27. Computed depth distribution for Upper Conner Creek existing conditions at 6,000 cfs.

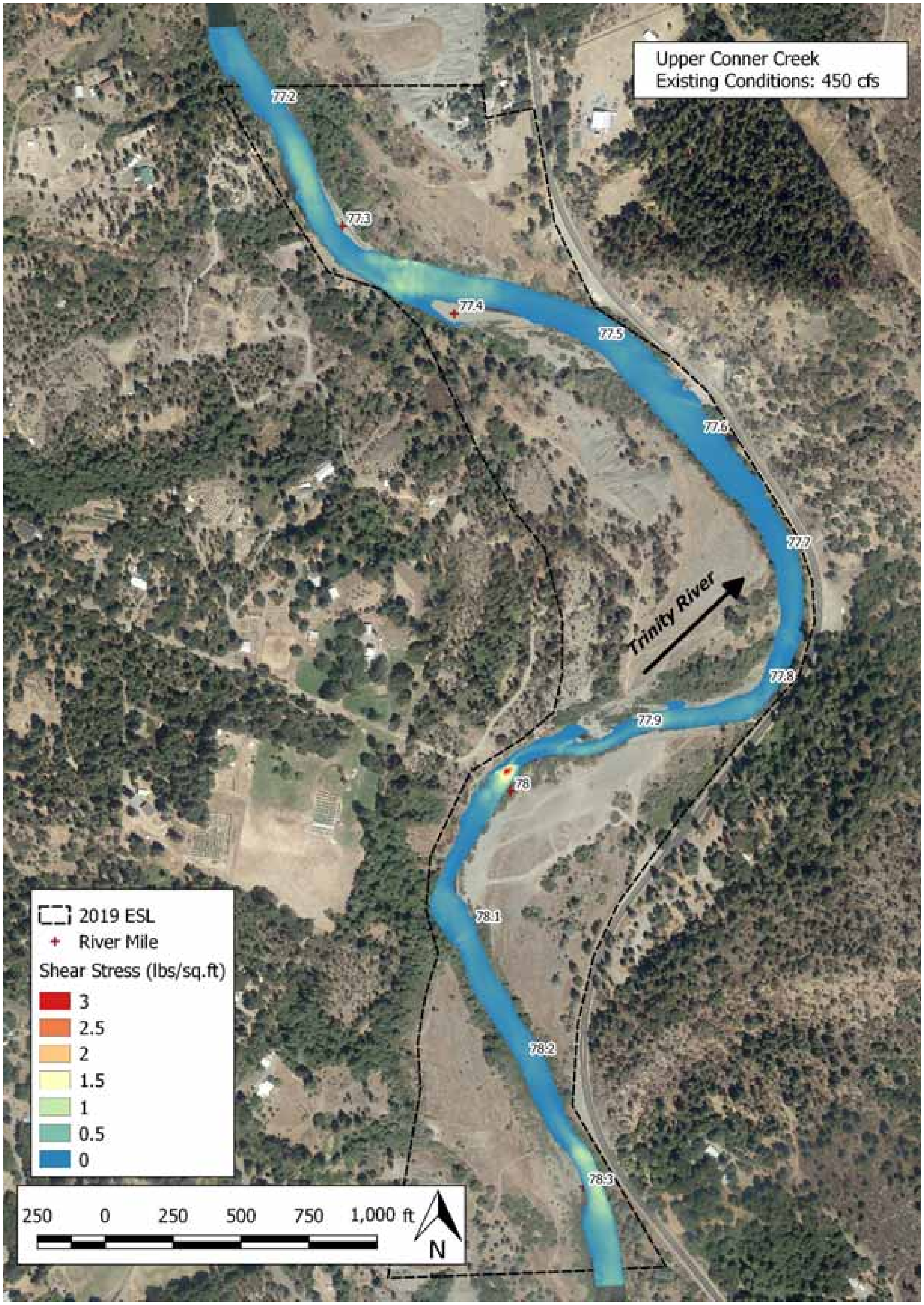


Figure 28. Computed shear stress distribution for Upper Conner Creek existing conditions at 450 cfs.

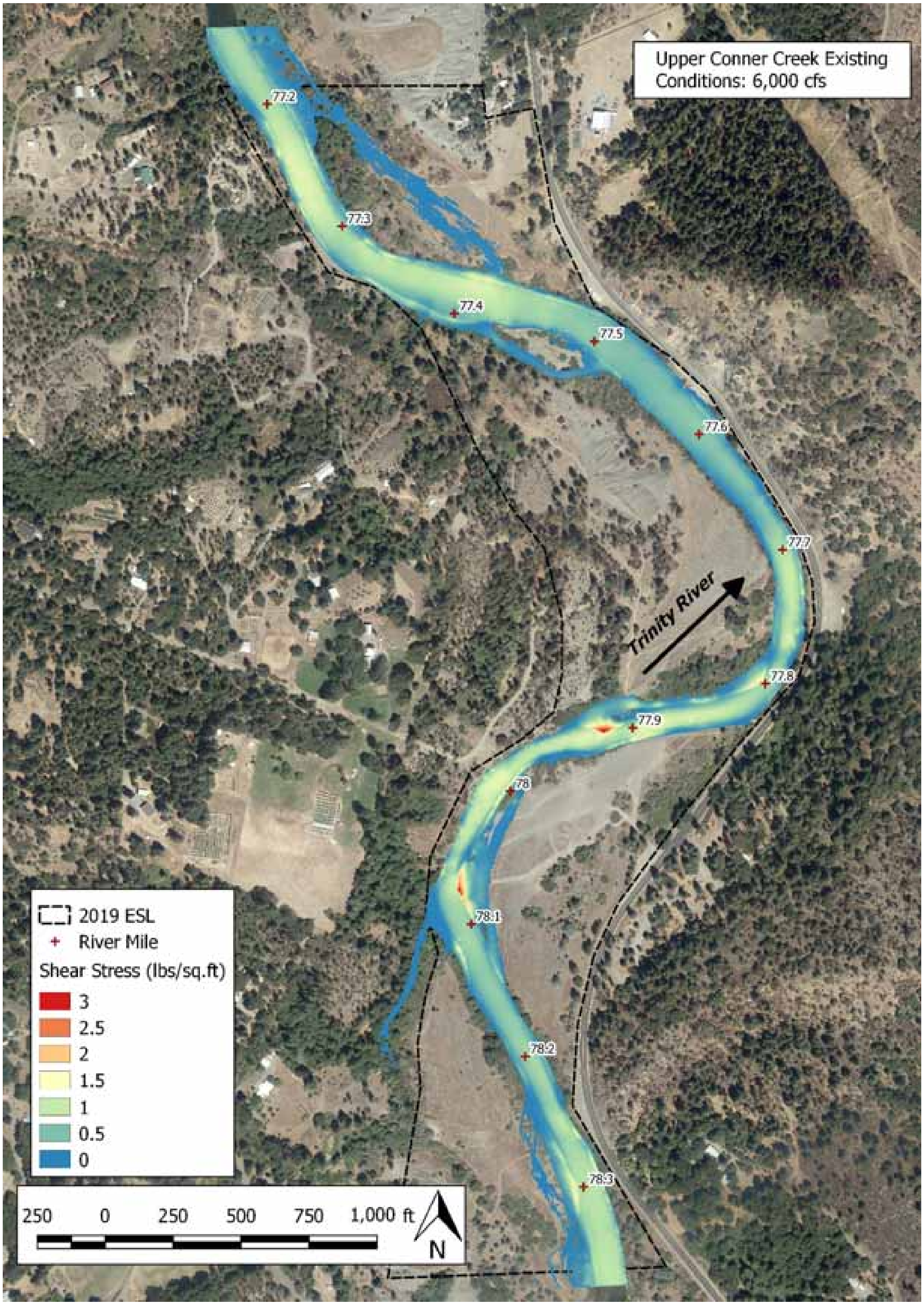


Figure 29. Computed shear stress distribution for Upper Conner Creek existing conditions at 6,000 cfs.

3.4 Channel Morphology

This section of the report describes the historic planform evolution of the channel based on available historical imagery, the current geomorphic conditions, and large wood distribution at the project site.

3.4.1 Planform Evolution (1944–2018)

Historical change in the channel morphology of the project site was assessed using aerial photos from 1944, 1960, 1965, 1997, and 2018. The geomorphology of the project site was heavily influenced by hydraulic and dredge mining, as shown in the 1944 aerial imagery (Figure 30). The 1944 aerial imagery shows a large volume of mining tailings flanking much of the river. The river flowed straight through the project site, past a large lateral bar on river left at RM 77.9 until encountering bedrock at RM 77.6, at which point it takes a sharp left (radius of curvature = 250 ft). The river then flowed through a short meander (meander wavelength = 800 ft) past two point bars at RM 77.6 and at RM 77.5.

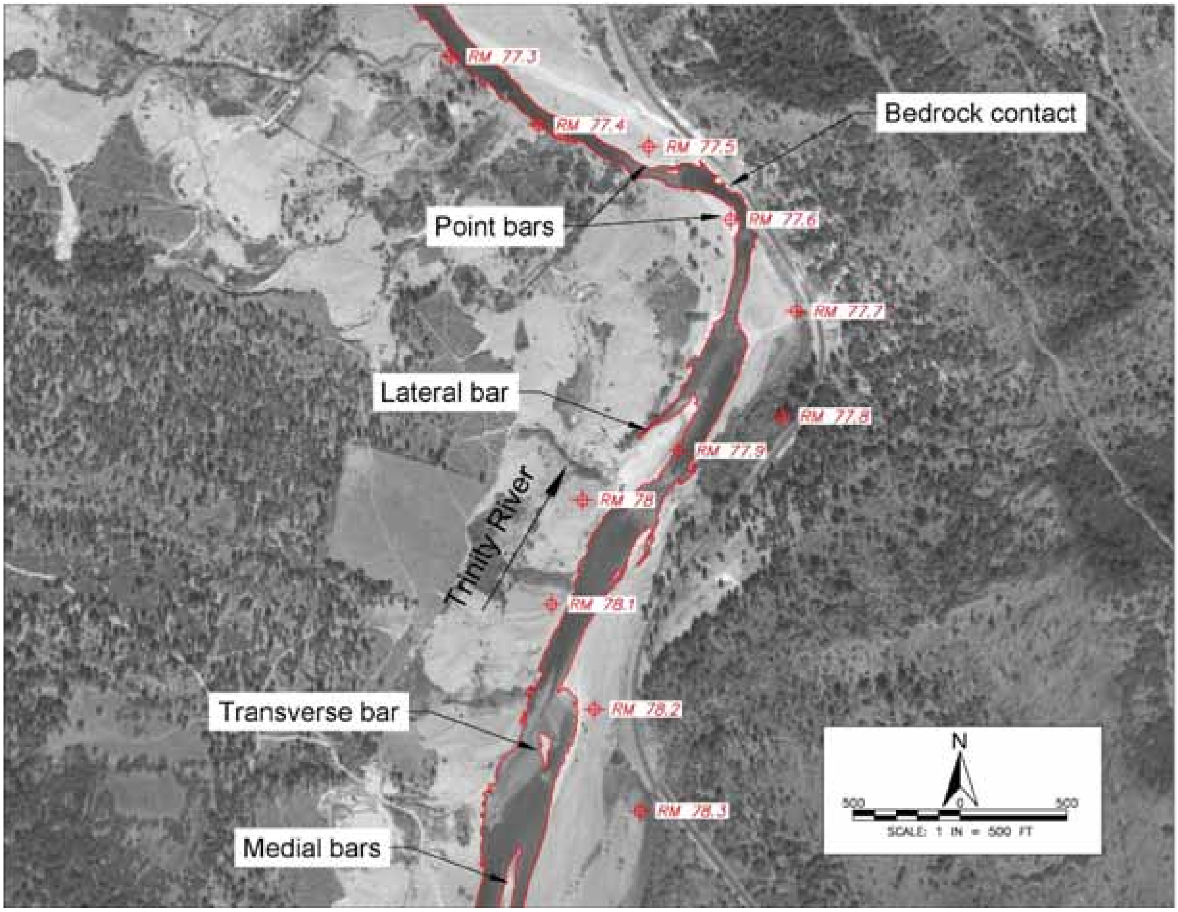


Figure 30. Dredger tailings created an unnaturally straight channel morphology at the Upper Conner Creek site, as shown in aerial imagery from 1944.

The largest observed geomorphic change within the project site occurred as a result of the 1955 flood, which reworked the river valley within the project site and realigned the mainstem channel to a planform configuration resembling its current configuration (Figure 31). The 1944 alignment was abandoned, and a new meandering planform became established. This was likely due to high flow and high sediment load interactions with bedrock outcroppings at RM 78.1 and RM 77.6. Both point bar surfaces were clear of vegetation in 1960, indicating flows between 1955 and 1960 were high enough to scour away any colonizing vegetation. A small side channel exists between the left bank and a small lateral bar at RM 77.5.

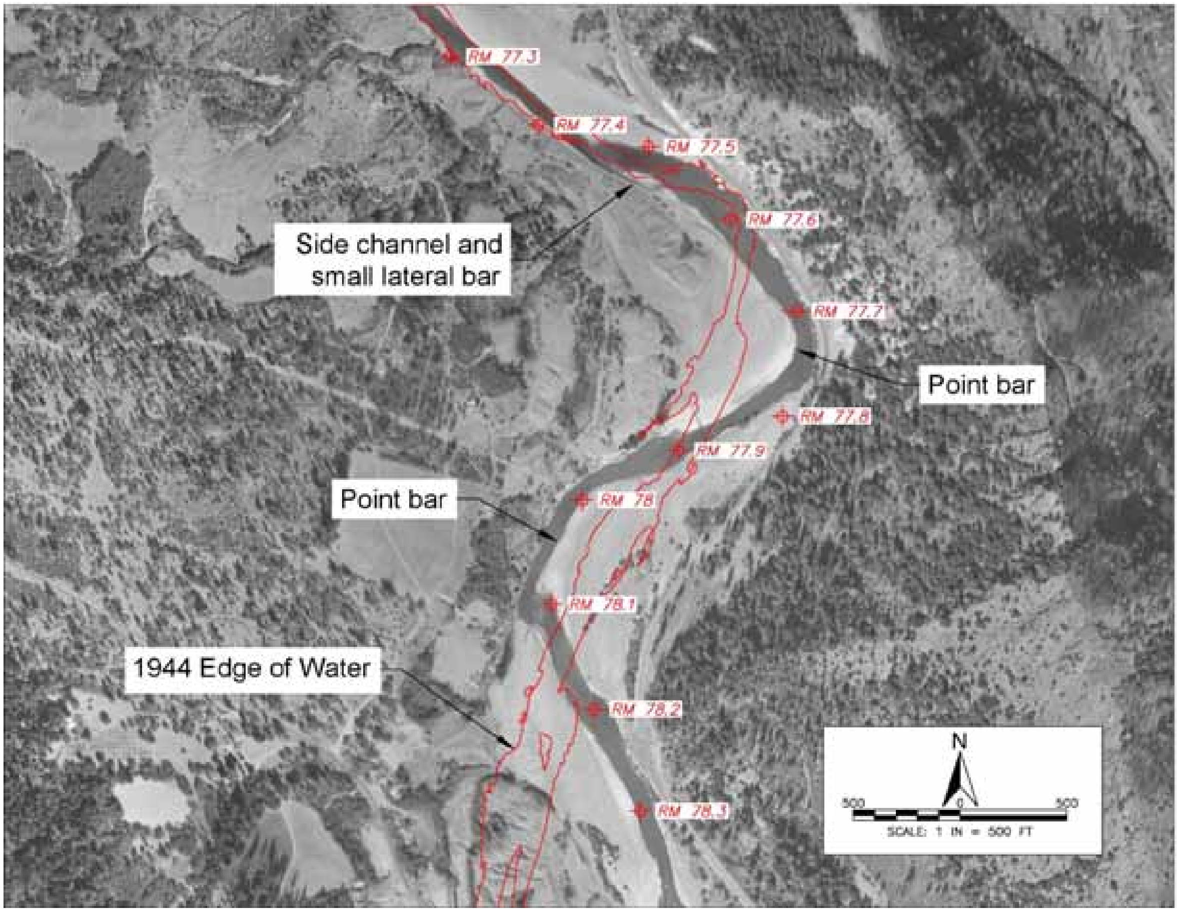


Figure 31. Massive realignment of the planform geometry resulting from the 1955 flood, as shown in the aerial imagery from 1960.

Following the 1955 flood and the completion of the Trinity and Lewiston dams in 1964, geomorphic changes within the project site were subtle compared to those generated by the 1955 flood, even with the occurrence of a 100-year flood in December 1964. Between 1960 and 1965, there were no major changes to the planform configuration (Figure 32). The lateral bar at RM 77.5 shifted slightly upstream and increased in length, the channel continued to migrate towards the left bank from RM 77.3 to RM 77.4, and the riffle at RM 78.1 continued to evolve. The side channel was not fully inundated in the 1965 aerial imagery but likely still flowed during higher flows, as indicated by later imagery.

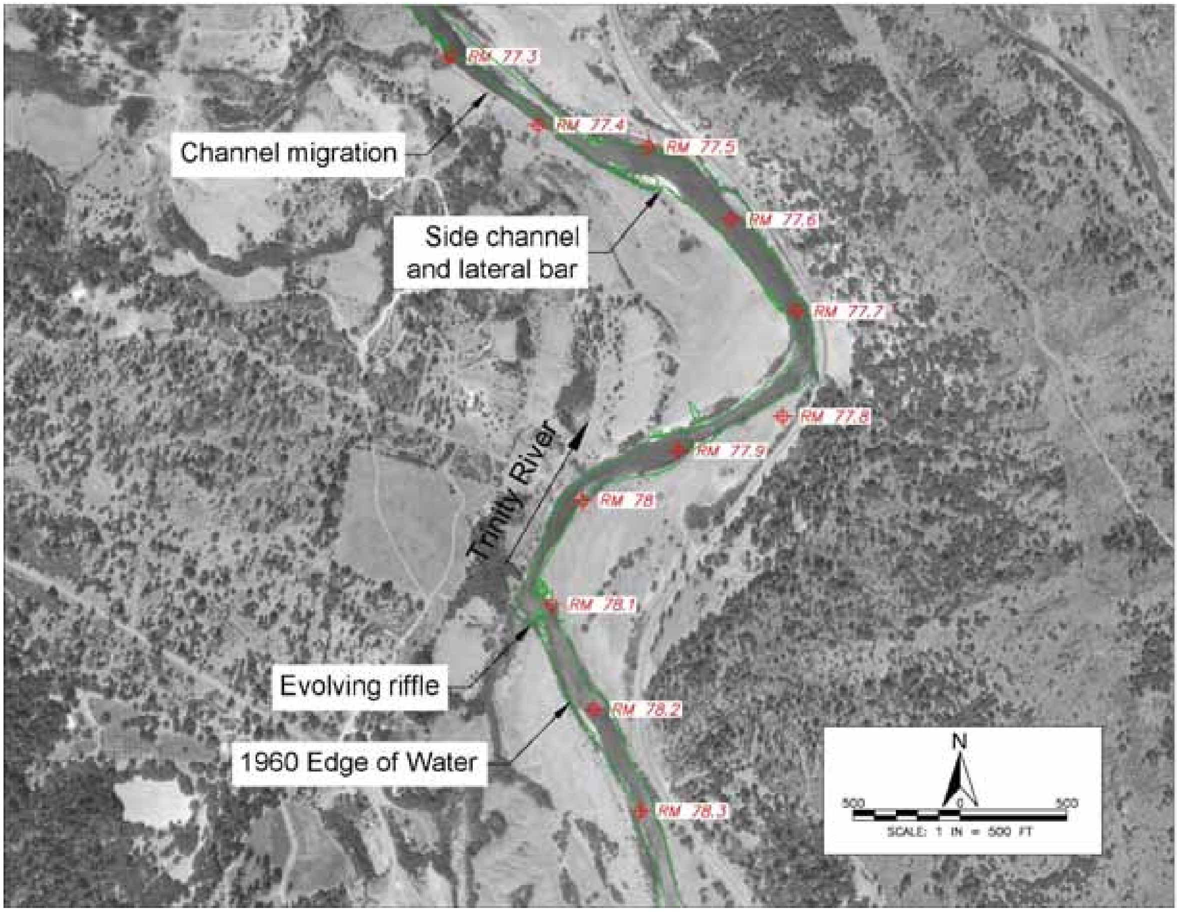


Figure 32. No major changes in planform configuration have occurred since 1960. There is some channel migration occurring at the downstream end of the site, as shown in aerial imagery from 1965.

Since 1965, little change has occurred in the planform of the reach, other than minor lateral migration toward the right bank occurred between RM 77.7 and RM 77.9. The most significant geomorphic changes occurred at the lateral bar just upstream of RM 77.4 following the 1997 flood, which was 25-year flood event with a flow of approximately 35,000 cfs. The side channel between the bank and lateral bar was scoured and increased in width from 15 ft to 40 ft (Figure 33). Since 1965, the main channel continued to migrate toward the left bank from RM 77.3 to RM 77.4. Lastly, a transverse bar developed from the lateral bar just upstream of RM 77.4 to the opposite bank and showed a highly complex assemblage of bar forms that appeared to be compounded by dredger tailing accumulations (Figure 33). The complex planform associated with the bar assemblage became simplified in the following decades (2000 – 2018).

With the onset of flow regulation following the completion of the Trinity and Lewiston dams in 1964, riparian encroachment became a common process on geomorphic features throughout the Trinity River corridor, and this is apparent in the 1997 imagery (Figure 33). Vegetated berms formed along the large point bars within the project site, isolating the historic floodplain and point bars. Small point bars formed at RM 77.8 and RM 78.0 near the apex of the historic, now isolated, point bars.

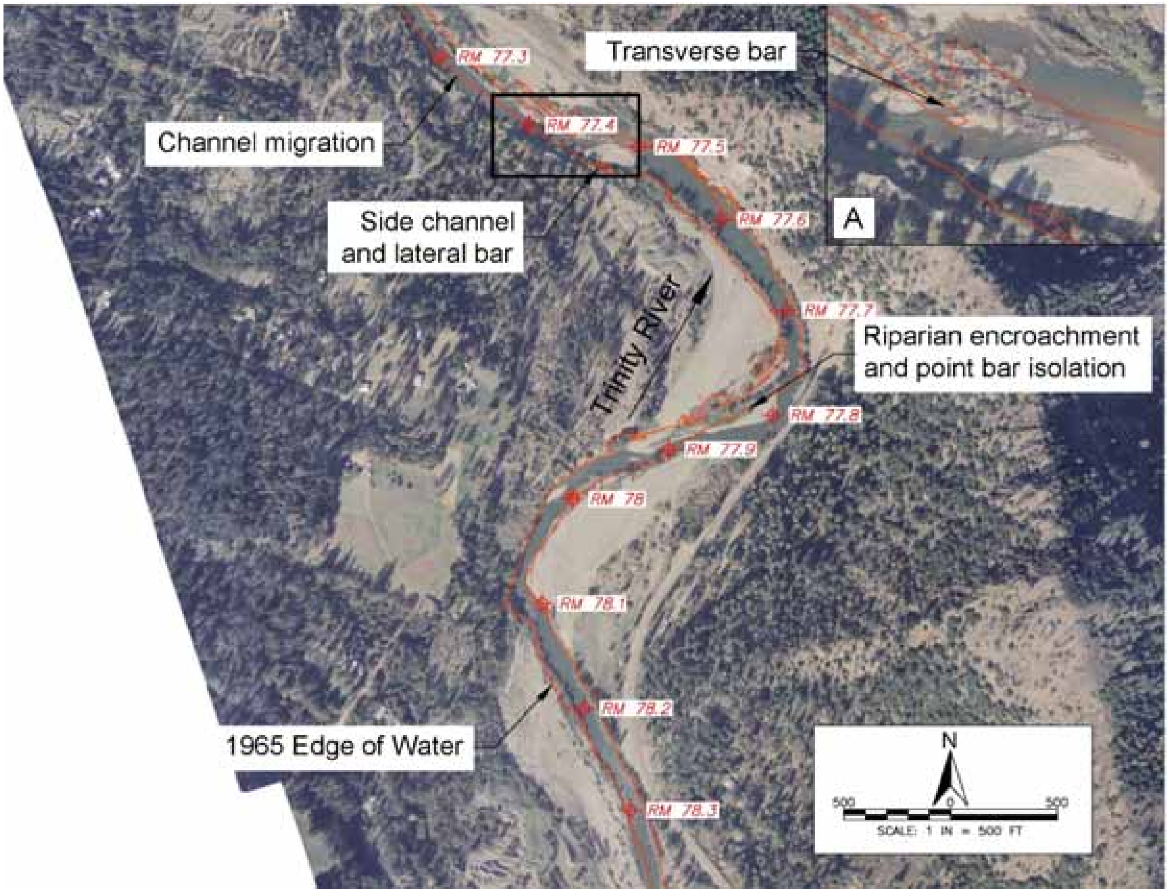


Figure 33. Riparian bars have formed along the legacy point bars following completion of Trinity Dam in 1964, isolating the features, as shown in aerial imagery from 1997. (A) Lateral bar near RM 77.4, showing scour and widening of the side channel.

Since 1997, the width of the side channel at the lateral bar near RM 77.4 has become vegetated as the right bank continues to erode and the left bank bar continues to grow (Figure 34). The side channel is not active during summer baseflows and exists as an alcove at the downstream end of the bar, as seen in the 2019 aerial imagery. The bar-riffle complex upstream of RM 77.9 has continued to develop and the lateral bar at RM 77.4 has grown. There has been little channel migration since 1997, as evidenced by the 1997 edge-of-water depicted in the 2019 photo (Figure 34).

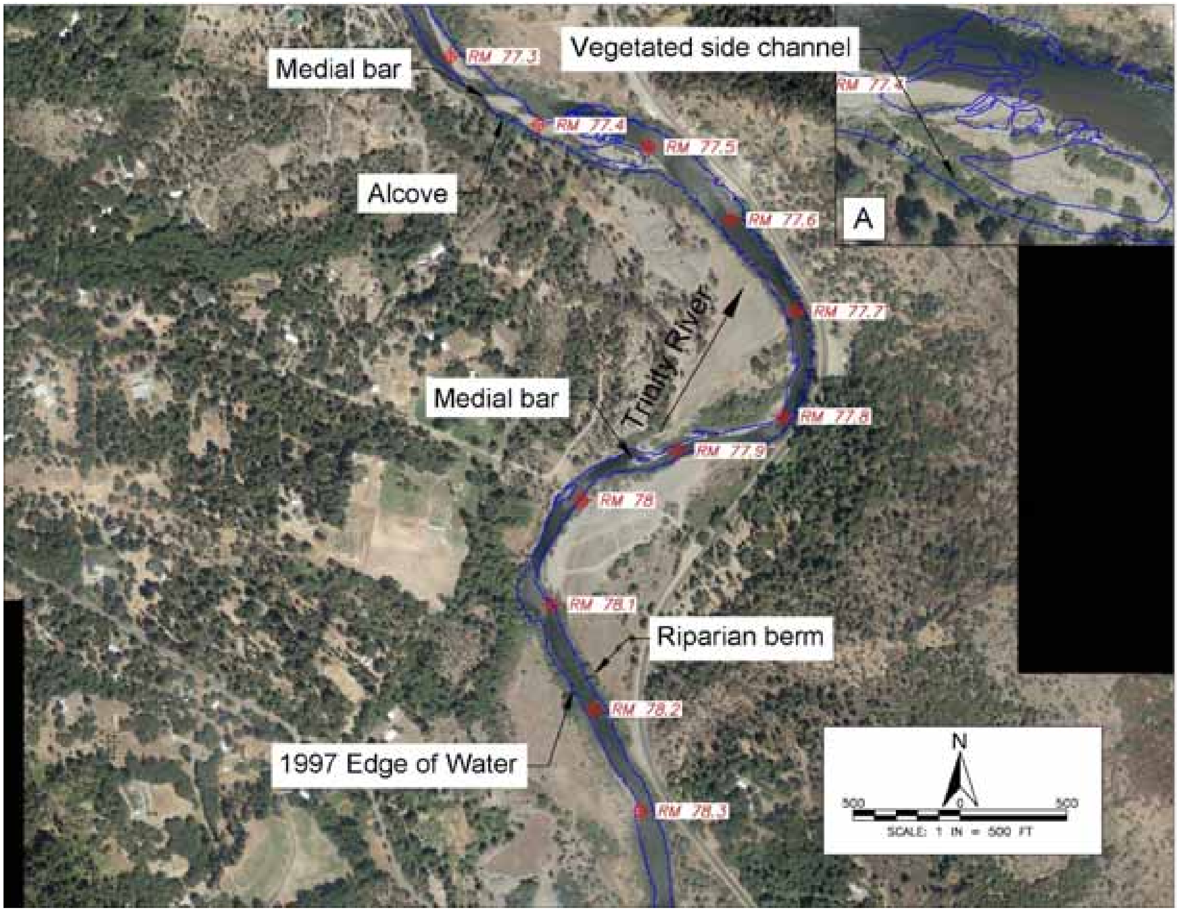


Figure 34. The complex transverse bar (A) at RM 77.4 has simplified since 1997, as shown in aerial imagery from 2018.

3.4.2 Current Geomorphic Conditions

Current geomorphic conditions of the project site were assessed using a combination of information gathered during a site visit by the HVT design team in October 2019, 2019 imagery, and data collected by MA and HVT staff during the November 2019 field effort. Data collected during the November 2019 field effort included: channel topography, pebble counts of bars and riffles, and cross section topography at 8 of 13 historic cross sections within the project site (Figure 35). Subsequent numerical analyses and hydraulic modeling used this newly collected data.

3.4.2.1 2019 Aerial Imagery

From the 2019 aerial imagery, three meander wavelengths were identified within the project site. The downstream meander has a wavelength of 1,710 ft, a sinuosity of 1.09, and a downstream and upstream radius of curvature of 585 ft and 720 ft, respectively (Figure 35). The middle meander has a wavelength of 1,960 ft, a sinuosity of 1.25, and a downstream and upstream radius of curvature of 485 ft and 612 ft, respectively. The upstream meander has a wavelength of 2,585 ft, a sinuosity of 1.03, and a downstream and upstream radius of curvature of 2,533 ft and 1,514 ft, respectively. The upstream and downstream portions of the reach lacking bedrock control have straightened meanders, while the middle portion of the reach encompasses one large meander wavelength controlled by bedrock.

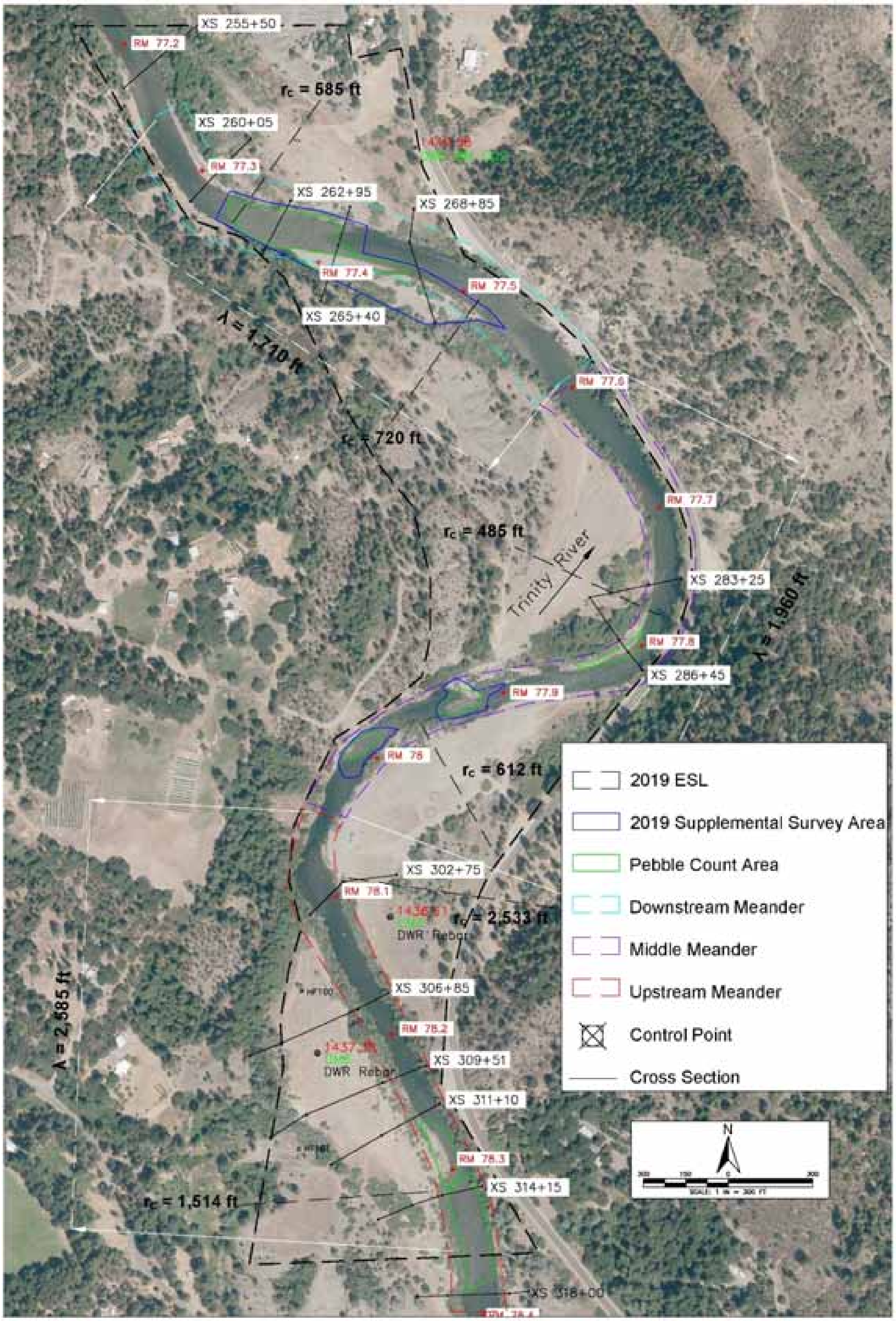


Figure 35. Existing cross sections, pebble count locations, and 2019 topographic survey locations.

3.4.2.2 Geomorphic Change Detection Analysis

Topographic evolution for the WY 2012–2019 period was assessed using Geomorphic Change Detection (GCD) software applied to the 2012 and 2019 DTMs. The GCD analysis was used to infer changes in sediment storage and channel evolution associated with spring ROD flow releases and naturally occurring winter peak flow events between WY 2012 and WY 2019. Only two of the eight annual peaks (2012 and 2018) occurred during spring flow release periods; the remainder were naturally occurring tributary accreted winter peak flows (Table 5).

Table 5. Annual instantaneous peak streamflow for water years 2012–2019 at USGS 11526400, Trinity River above North Fork Trinity Near Helena, CA.

Water Year	Peak Date	Annual Instantaneous Peak Streamflow (cfs)
2012	5/9/2012	6,990**
2013	12/2/2013	9,360
2014	3/10/2014	4,680
2015	2/7/2015	13,000
2016	1/17/2016	13,100
2017	2/9/2017	16,500
2018	4/7/2018	6,380**
2019	2/27/2019	20,800*

* Provisional data

**Peak from Lewiston Dam release

The DTMs were developed by TRRP and GMA (2017) from topographic ground survey data, bathymetric data, and LiDAR data, and updated by MA with additional 2019 topography as described in Section 3.3.1. The analysis was confined to the active channel and some near-channel areas where scour/fill were field-verified. Heavily vegetated areas, most floodplains, riprap banks, and tailings piles were not included. The trimmed, active channel DTMs were sampled to 1 ft raster digital elevation models (DEMs) and exported to ArcGIS format for GCD analysis (Wheaton 2008). A minimum level of detection (MinLOD) of ± 1.0 ft was applied to the analysis to filter out topographic uncertainty due to survey methods (prism pole tilt, grain size variation, LiDAR inaccuracies in heavily vegetated areas, etc.). If a feature registered change above the ± 1.0 ft threshold, then the change was considered to be "real" change.

A DEM of Difference (DoD) is presented graphically in Figure 36. Geomorphic responses to peak streamflows exceeding 20,000 cfs illustrate contemporary trends in channel evolution at Upper Conner Creek. These responses include:

- Riparian berm development near RM 78.3 and 78.1;
- Bank and riffle scour near RM 78.0;
- Bar development and side channel filling at the final bend below RM 77.5, and
- Bank scour and channel migration toward the right bank near RM 77.4.

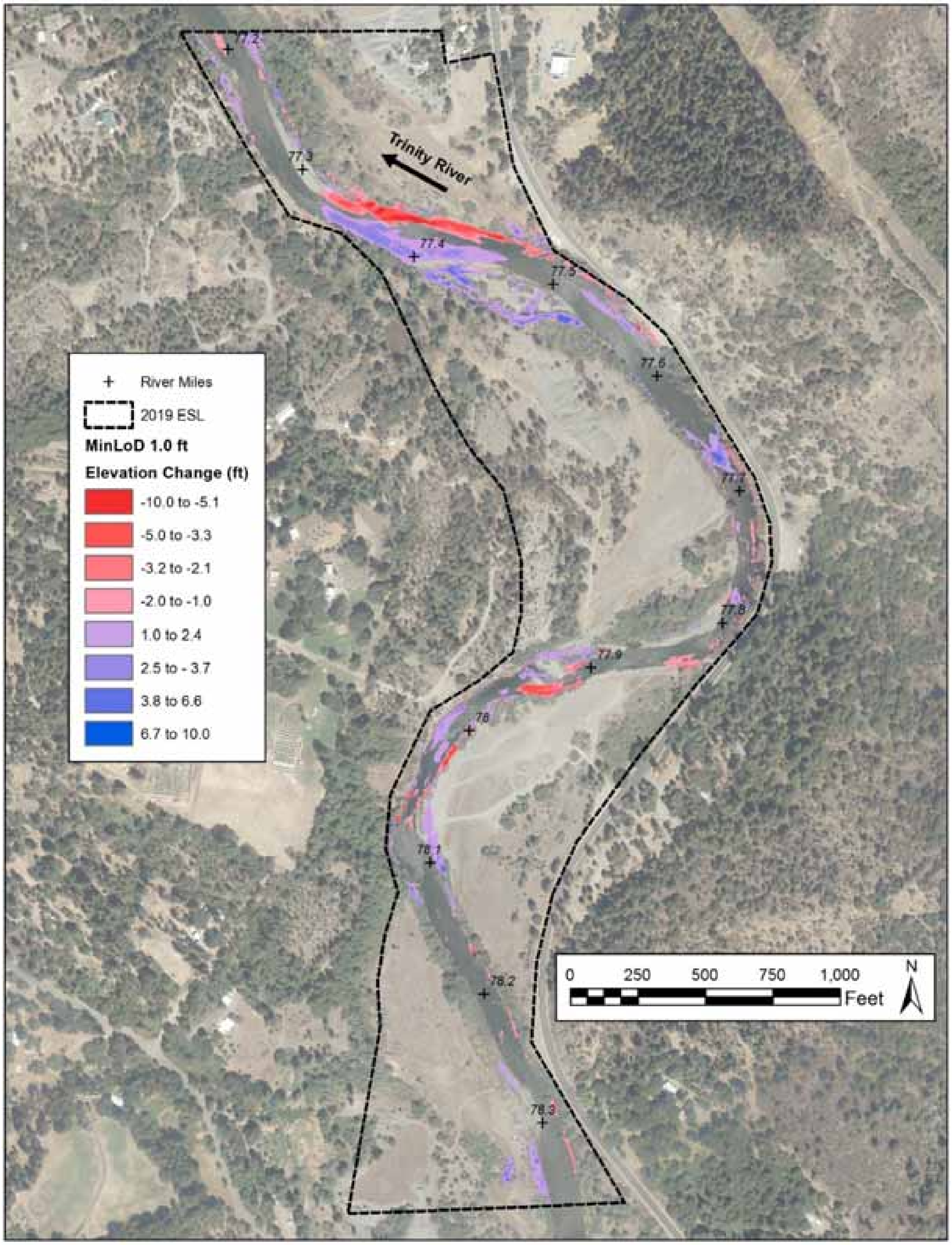


Figure 36. The DEM of difference for the Upper Conner Creek project site, 2012 vs. 2019

The GCD analysis output includes estimates of erosion, deposition, and net volumetric change between 2012 and 2019 DEMs. Topographic differences were computed for each 0.1-mile segment within the project site, though the first segment is shorter at 0.05 miles. Table 6 details the scour and fill estimates shown in Figure 36. The first two columns in Table 6 provide erosion and deposition volumes by segment. The third column, Total Volume of Difference, is the sum of erosion and deposition, describing “total turnover,” a measure of dynamism. The final column in Table 6 describes the net change by segment: zero would infer equilibrium, negative values indicate deficit (scour or erosion) and positive values indicate surplus (fill or aggradation). The positive values for segments 78.35, 78.2 and 78.1 were primarily driven by riparian berm development (and by some bar growth in segment 78.1). The negative values in segments 78.0 and 77.9 indicated bank and riffle erosion. Segment 77.8 showed very little change while segments 77.7 to 77.5 indicated well over 3,000 cubic yards (yd^3) of fill, describing bar growth and channel filling along the inside of the final bend. In segment 77.4, scour along the right bank exceeded deposition along the inside of the bend, resulting in 176 yd^3 net erosion. The final segment, with 631 yd^3 net deposition, exhibited berm growth along the right bank and bar growth along the left bank along the inside of a very subtle bend.

Table 6. Results of 2012–2019 Upper Conner Creek topographic differencing volumetric analysis. River Mile is the upstream boundary of each computational segment.

River Segment	Total Volume of Erosion (yd³)	Total Volume of Deposition (yd³)	Total Net Volume Difference (yd³)
78.35	98	711	613
78.3	184	143	–41
78.2	106	376	269
78.1	642	1,034	391
78.0	991	768	–223
77.9	365	118	–246
77.8	318	280	–38
77.7	185	914	728
77.6	335	1,134	799
77.5	1,771	3,333	1,562
77.4	2,519	2,343	–176
77.3	209	840	631
Total	**7,724**	**11,992**	**4,268**

3.4.2.3 Cross Sections

Thirteen known monumented cross sections occur within the study area, eight of which were resurveyed in November 2019 (Figure 35).These cross sections were chosen to provide a general look across the entire project site in both dynamic and static areas. Data sources for these historic sections include: (1) pre-project monitoring, (2) post-construction surveys, and (3) GRTS panel monitoring; data was collected by HVTF and MA staff. Survey dates go back as far as 1999, but different cross sections were surveyed at different times, so not all dates appear on each cross section. All eight cross sections are presented in Appendix A and four representative sections are discussed here.

The upstream-most cross section (314+15) was the only section showing the modeled 6,000 cfs water surface elevation accessing floodplain surfaces (Figure 37). The cross sections in the upper portion of the project site (314+15, 306+85, 302+75) showed modest change along the channel-bed between 2006 and 2019 (Figure 37, Figure 38). However, they did reveal significant riparian berm development 4 to 5 ft in height along the left bank of 314+15 (Figure 37) and the right bank of 302+75. The aggradation along the left bank of 302+75 was a sand bar which was associated with the high-flow channel return which enters the mainstem immediately upstream. The 2 ft of bed scour between the 2005 and 2019 ground surfaces shown in Figure 38 (XS 302+75) does not appear in the DEM of difference (Figure 36) because it occurred prior to the GCD analysis period (2012–2019).

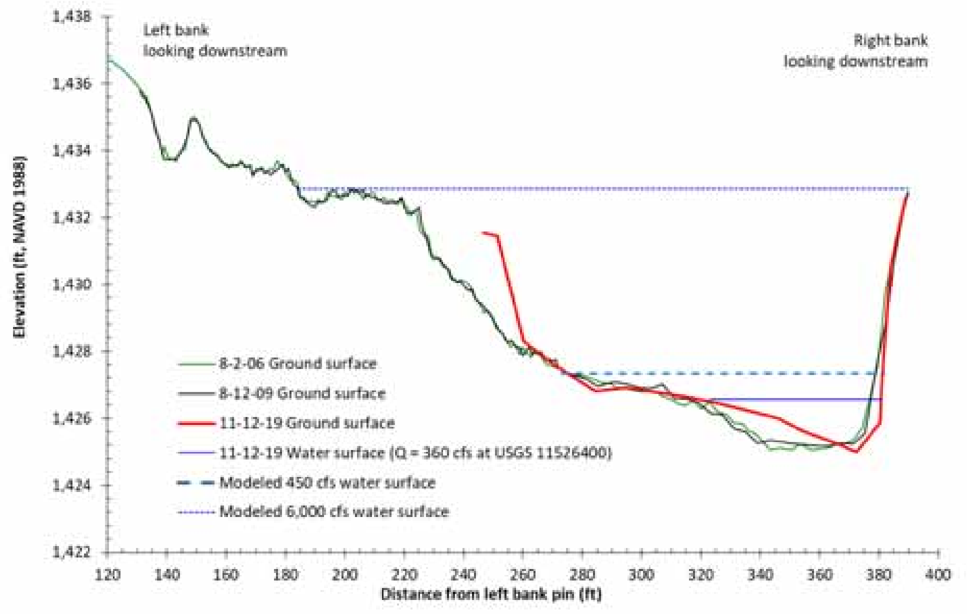


Figure 37. Trinity River, Upper Conner Creek, cross section 314+15 showing the development of a riparian berm on the left bank and slight channel migration towards the right bank.

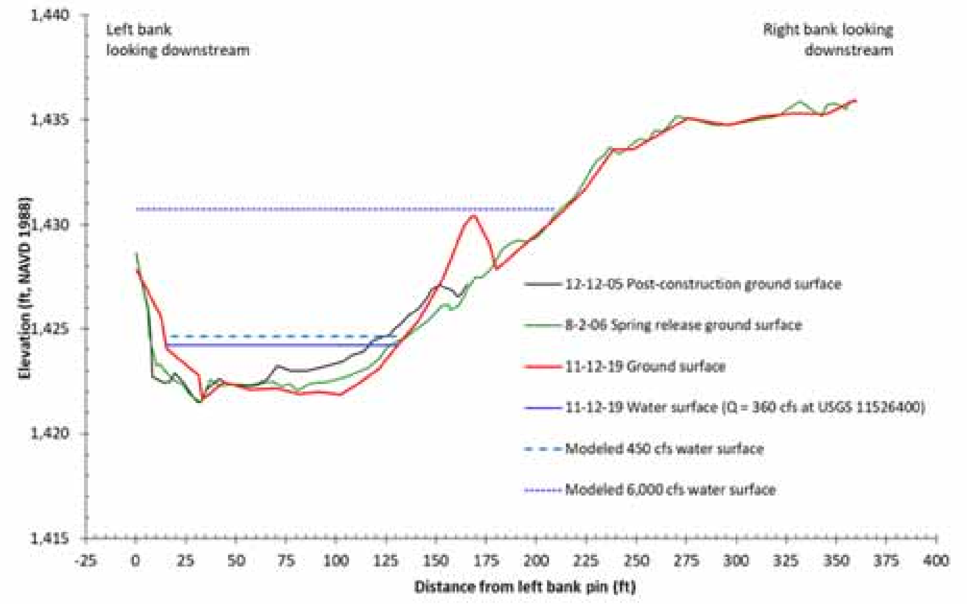


Figure 38. Trinity River, Upper Conner Creek, cross section 302+75 showing riparian berm development along the right bank.

In the middle of the project site (RM 78.0 to 77.7), the vegetated sandy banks opposite resistant structures are eroding. The right bank above and below RM 78.0 (adjacent to a bedrock cliff) is actively eroding and although these areas were not picked up by cross sections, they showed up as “hot spots” in the DoD (Figure 36). Just downstream at RM 77.4, over 10 feet of bank retreat has occurred since 2011 at cross section 283+25 adjacent to the Highway 299 riprap bank revetment Figure 39).

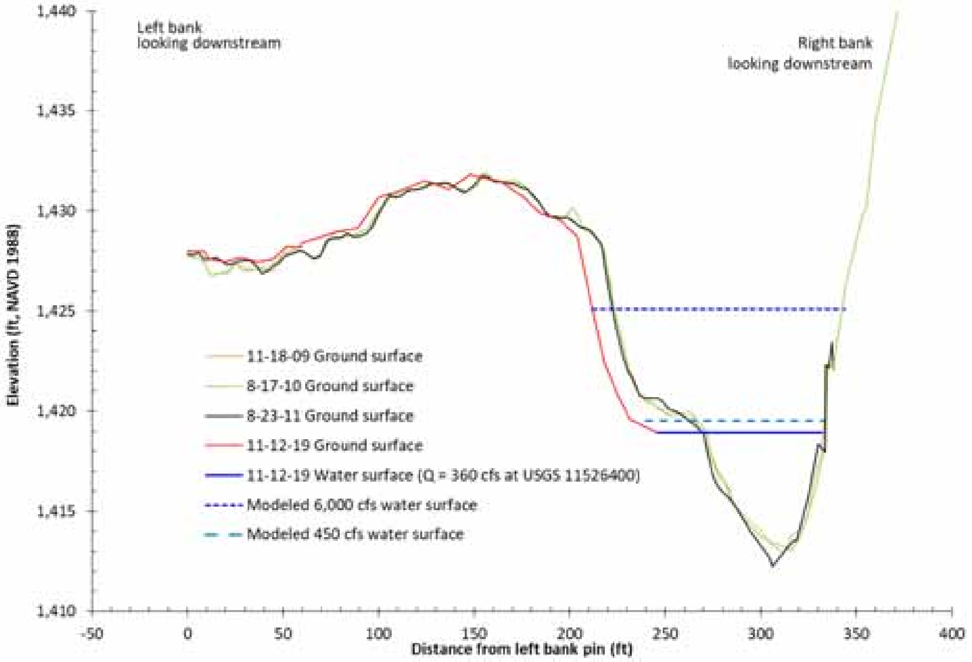


Figure 39. Trinity River, Upper Conner Creek, cross section 265+40 showing channel widening and erosion of the left bank.

The downstream portion of the project site below RM 77.6 is the most dynamic area within the Upper Conner Creek ESL. Bar growth along the inside of the bend (left bank), forces flow against the right bank, causing lateral erosion and channel migration toward the right art cross section 265+40 (Figure 40). Where the active channel was located along the left side of the channel in 2009, a gravel bar 5 ft deep has formed. As the channel has migrated to the right, it has cut through and removed a 10-ft tall confining berm. The contemporary channel bed is 2-ft higher than it was in 2009 (Figure 40). In the cross section plot, channel capacity appears lower than it was in 2009 but the modeled 6,000 cfs still does not overtop the bank to access the floodplain. The dynamism implied by the cross section changes in Figure 40 corresponds to the high values of net volume of difference at segment 77.5 in Table 6.

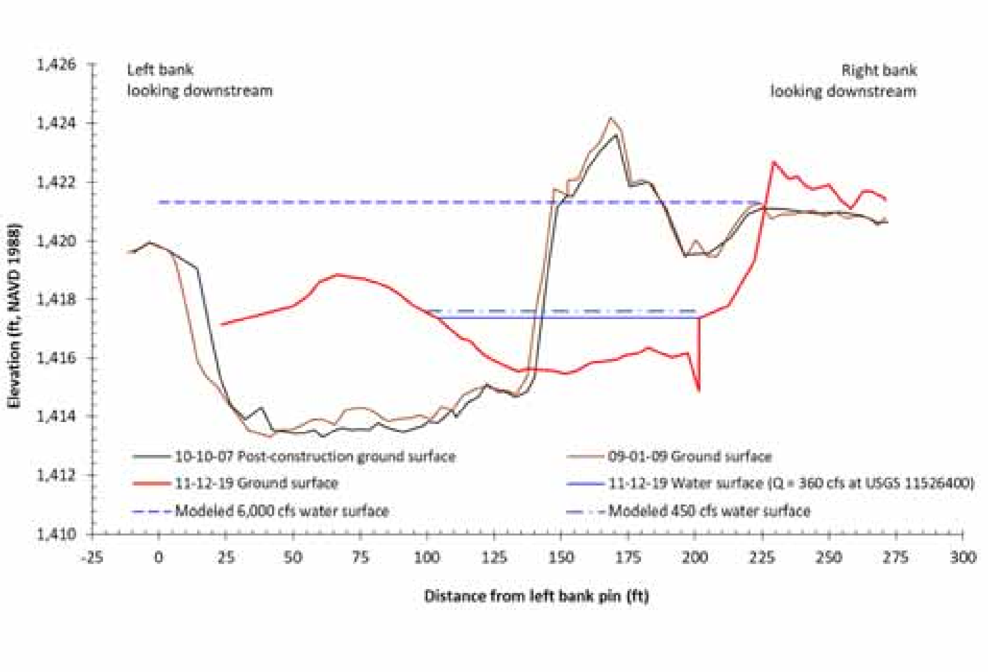


Figure 40. Trinity River, Upper Conner Creek, cross section 265+40 show channel deposition and migration towards the right bank.

3.4.2.4 Grain Size and Bed Mobility

Assessing the grain size distribution of bed surface sediments provides (1) information for developing roughness values required in hydraulic modeling and (2) an understanding of what type of bed texture currently exists and persists in bars and riffles. Substrate mapping of the D_{84} (the grain size for which 84 percent of the bed surface has a smaller intermediate axis) was conducted by Alvarez et al. (2015a) during summer 2014. Alvarez et al. (2015a) generated estimates of D_{84} grain size using ocular estimates during snorkel surveys and then generated rasters of estimated D_{84} (Figure 41). Ocular estimates were compared daily to measured D_{84} values to calibrate observers' estimates and to improve the accuracy of the data. MA conducted pebble counts within seven distinct facies in November 2019 to account for any changes in bed texture in response to flows that occurred since the mapping effort in 2014 (Table 5). Polygons representing those facies are presented in Figure 41. D_{84} values are presented in inches.

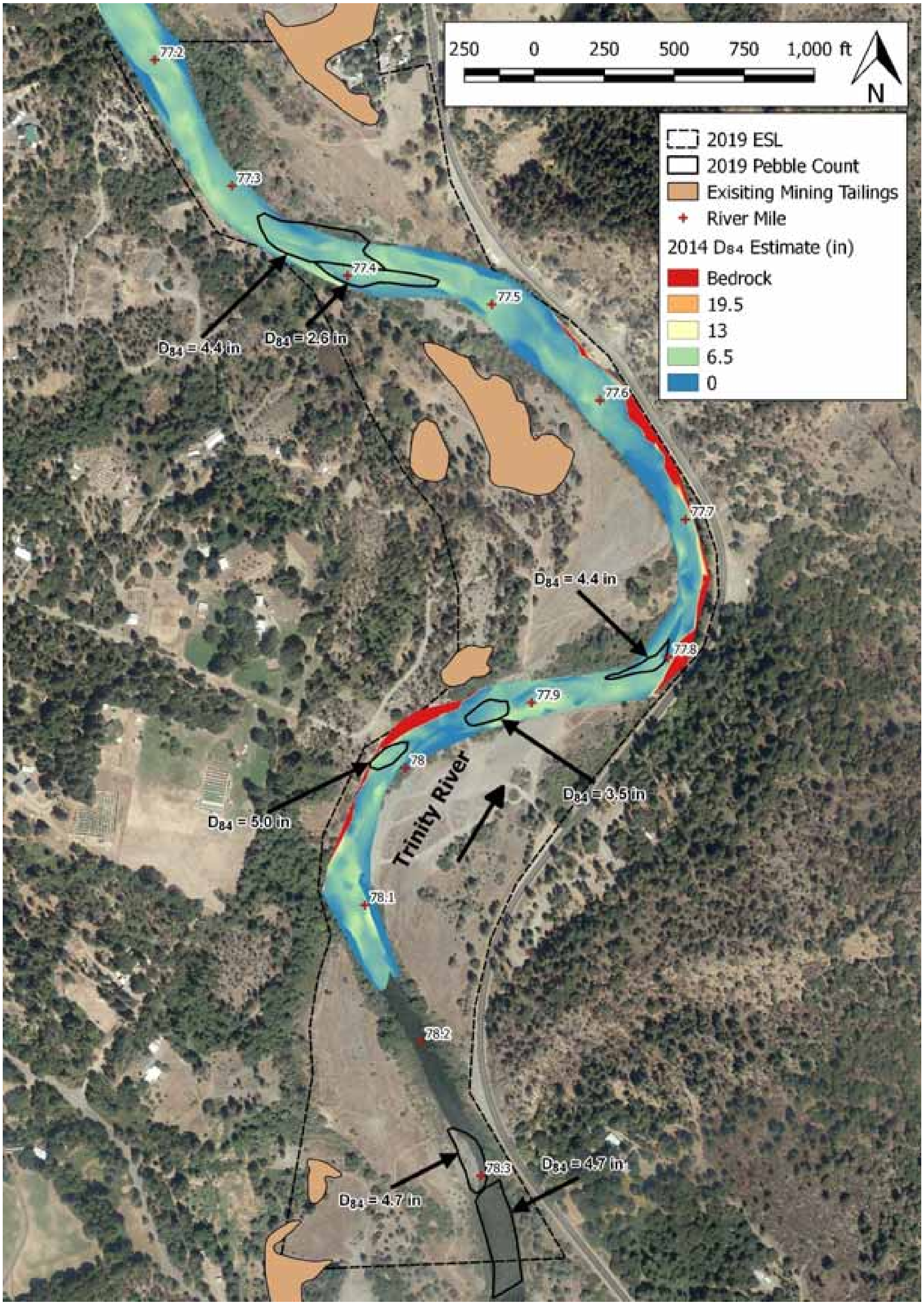


Figure 41. Substrate map of Upper Conner Creek showing pebble count locations and D_{84}, in inches.

Coarse sediment mobility was calculated using shear stress results from the 2019 existing conditions hydraulic model (Section 3.3.6). The mobile particle size of the project site was estimated using Equation 1 below. Mobility by particle size within the project site was examined for flows of 450 cfs (Figure 42) and 6,000 cfs (Figure 43) to provide information for a low-flow and high-flow condition. For a modeled flow of 450 cfs, results predict a mobile particle size class less than 6-inches through the majority of the project reach. The exception is at the chute near the bar feature at RM78 that predicts mobility of 12-inch particles. Predictions of 6-in to 12-in particles being mobilized at a flow of 450 cfs is unrealistic. These predicted values are due to shallow riffles with high velocities approaching or exceeding critical flow. For a flow of 6,000 cfs, large grain particles are mobilized along channel margins, at the apex of meander bends, and the bar-riffle complex at RM77.9. The mobile size class is reduced at the RM78 bar during higher flows due to less flow constriction. Areas predicting large grainsize mobility (12-inch) in Figure 43 occur at locations where Manning's roughness transitions between channel and floodplain values; higher roughness values in the vegetation/floodplain polygons (See Figure 19) resulted in high shear stress predictions which are directly proportional to the higher mobile grain size predictions in Figure 43.

$$D_{84} = \frac{\tau}{g(\rho_s - \rho)\tau_{cr}^*} \qquad (1)$$

where:

τ_{cr}^* = dimensionless critical shear stress; 0.02 used for analysis of D_{84}
τ = shear stress (lbs/ft^2)
g = gravitational constant (ft/s^2)
ρ_s = sediment density (slug/ft^3); 5.43 slug/ft^3 for Trinity River sediment
ρ = water density (slug/ft^3)
D_{84} = 84th percentile particle diameter (ft)

3.4.1 Large Wood

Large wood surveys were conducted in November 2017 and November 2019 (Figure 44) with the November 2017 survey focused on large accumulations of wood in a single location know as wood jams. Large wood is distributed throughout the Upper Conner Creek site primarily along the riverbanks above the 450 cfs WSE. There is a higher density of pieces at both the upstream and downstream ends of the project site, with a large wood jam amongst the burned cottonwood grove at the downstream end of the site. The higher density of large wood is likely due to wood placement during channel rehabilitation activities at Hocker Flat in 2005 and Conner Creek in 2006.

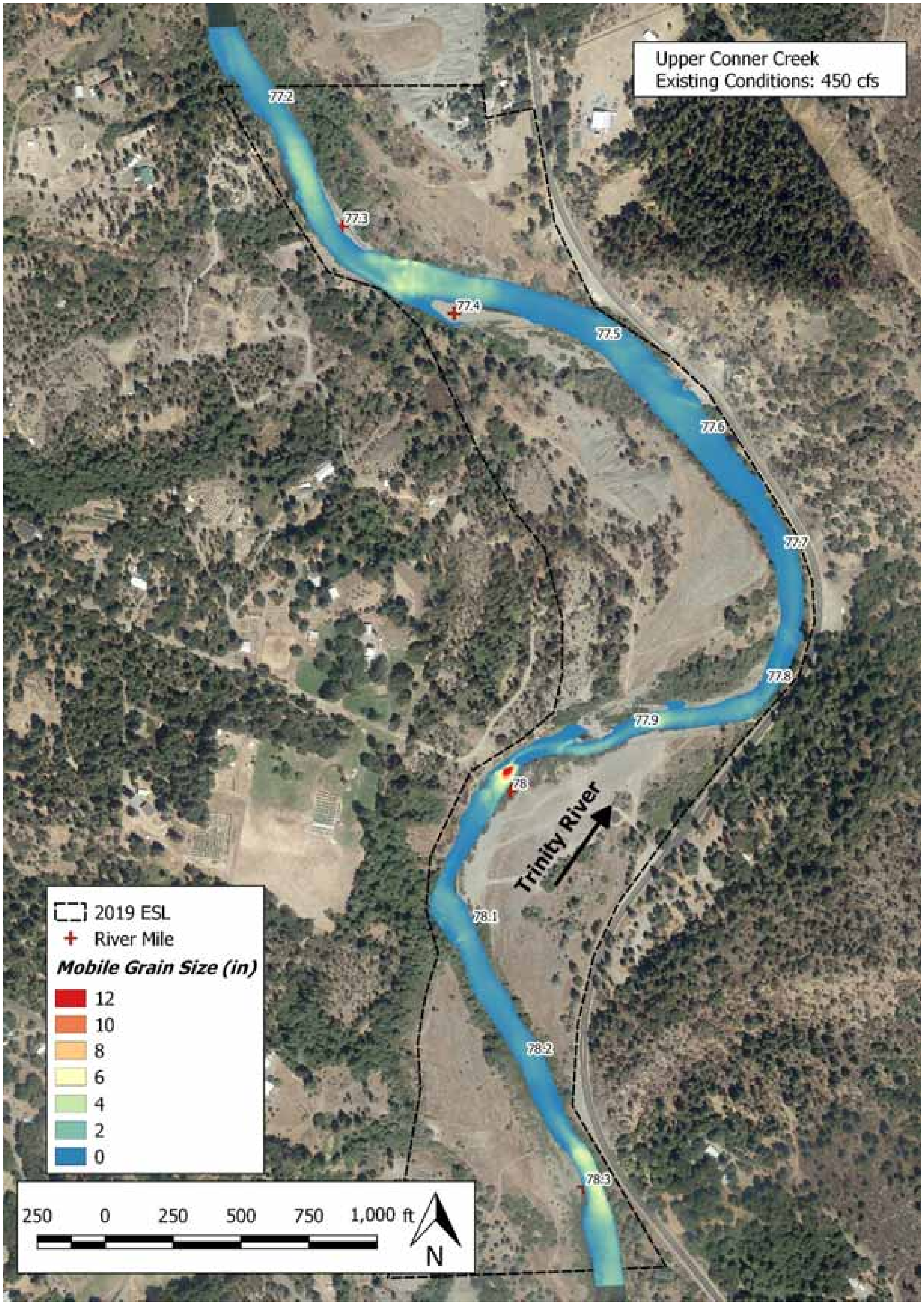


Figure 42. Predicted mobile particle grain size classes for Upper Conner Creek existing conditions at 450 cfs.

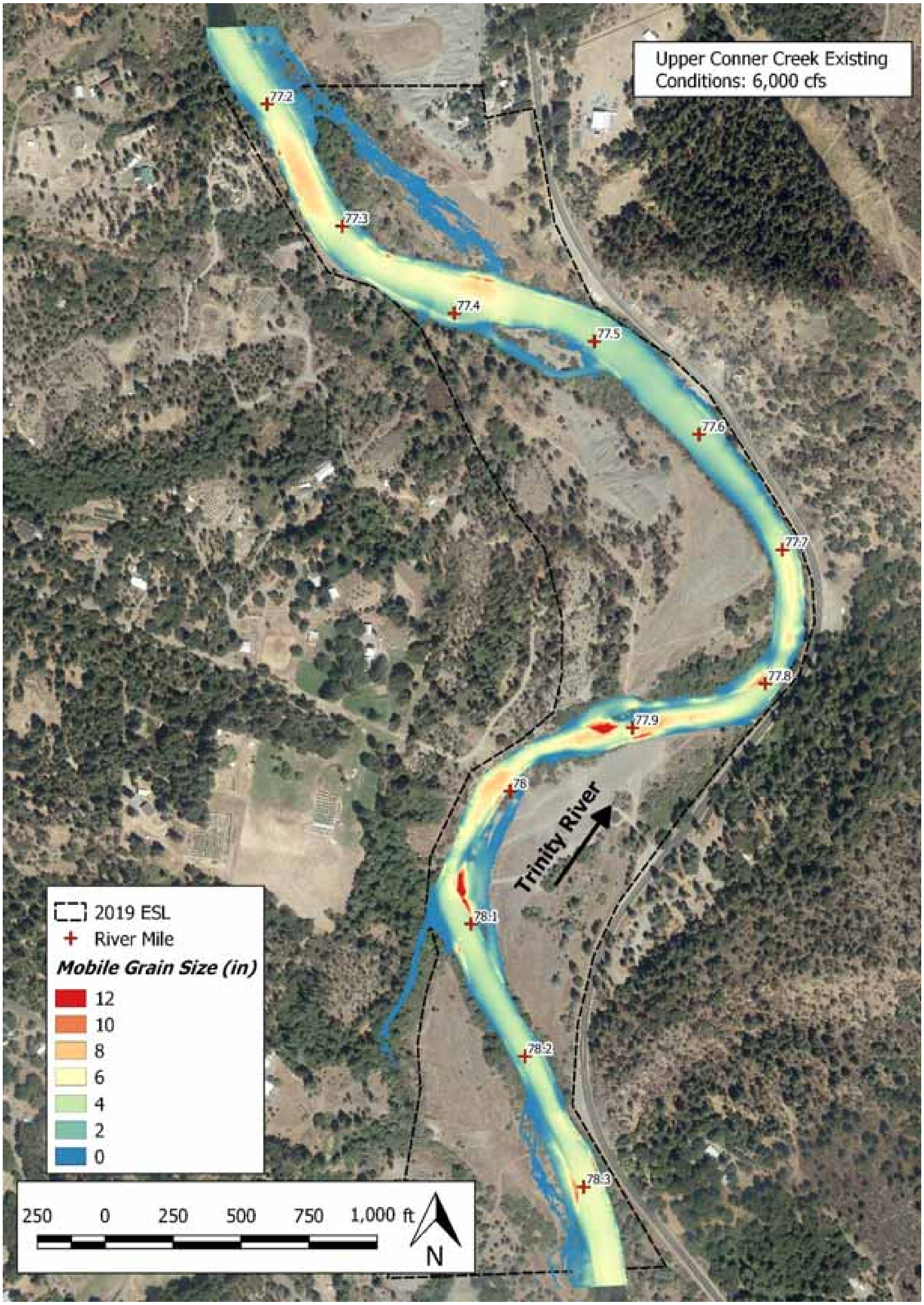


Figure 43. Predicted mobile particle grain size classes for Upper Conner Creek existing conditions at 6,000 cfs.

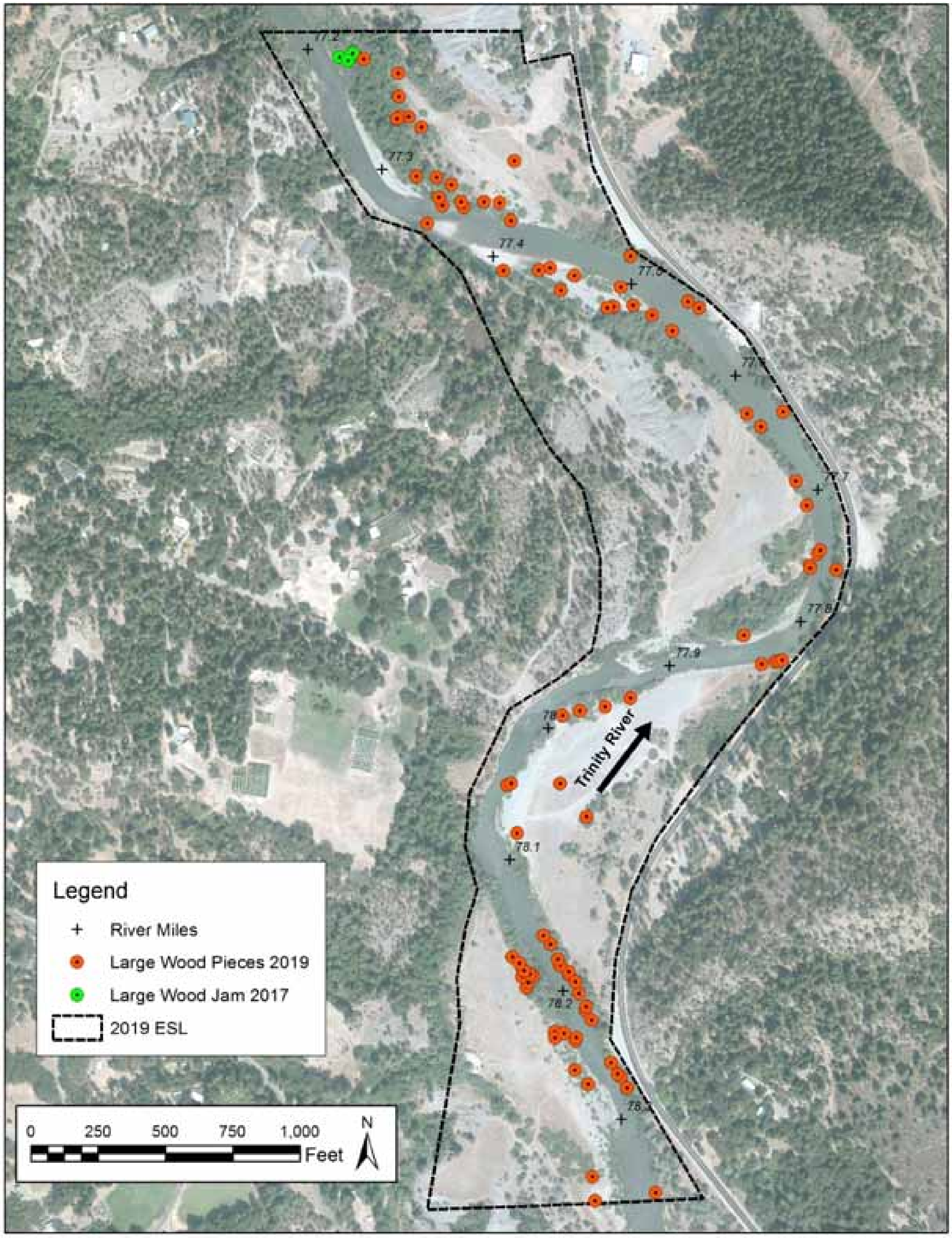


Figure 44. Existing large wood within the Upper Conner Creek project site.

3.5 Restoration History

Two restoration efforts have occurred at the upstream and downstream end of the 2019 Upper Conner Creek ESL: the Hocker Flat Channel Rehabilitation Site constructed in 2005 and the Conner Creek Channel Rehabilitation Site constructed in 2006. Both efforts included off-channel restoration activities, including riparian berm removal, feathered edge construction, and floodplain lowering. The 2006 Conner Creek floodplains were designed to inundate at 450 cfs and 6,000 cfs (Figure 45). The floodplains at Hocker Flat were designed to inundate at a flow of 6,000 cfs (Figure 46).

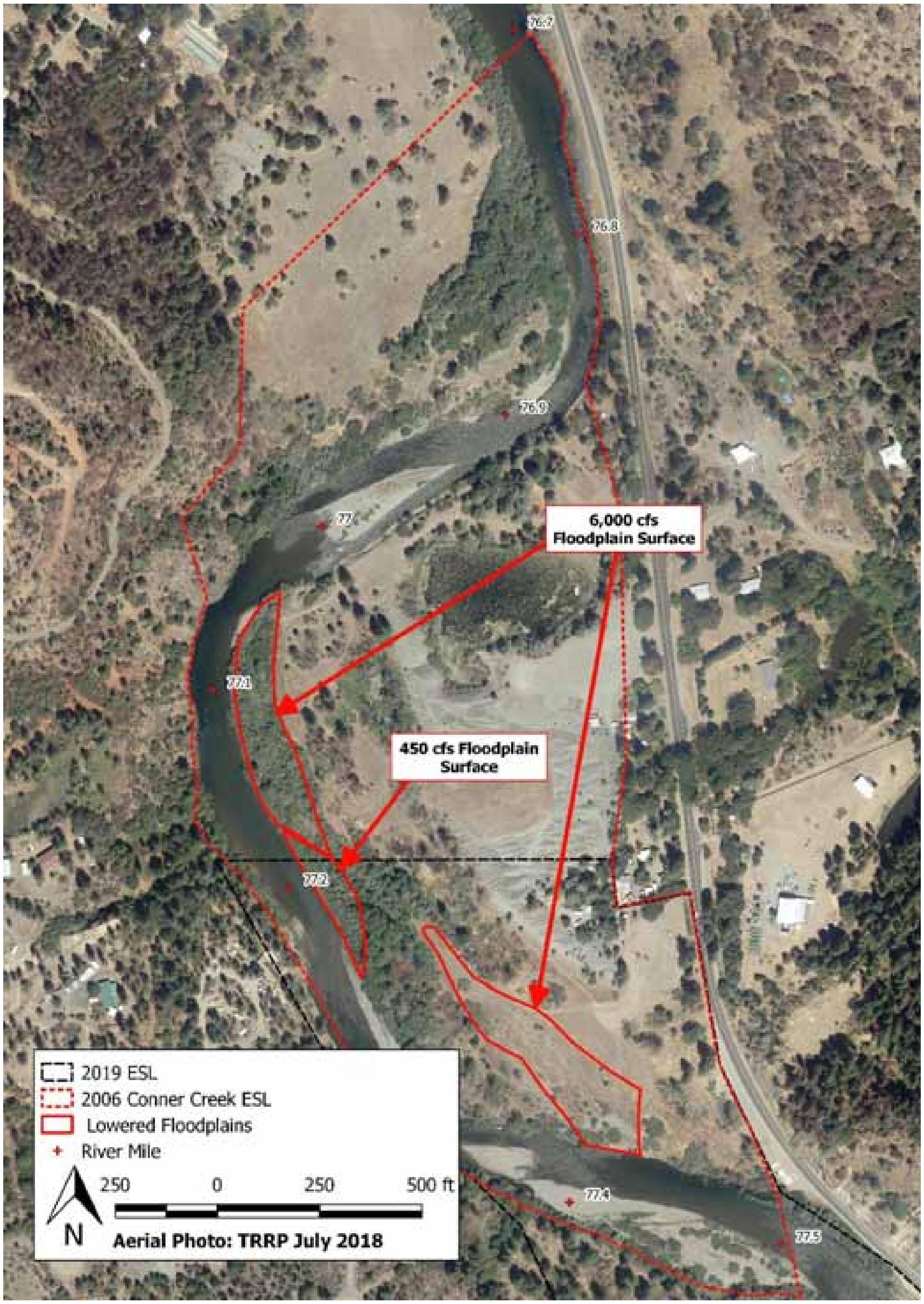


Figure 45. 2006 Conner Creek restoration floodplain lowering and bank rehabilitation.

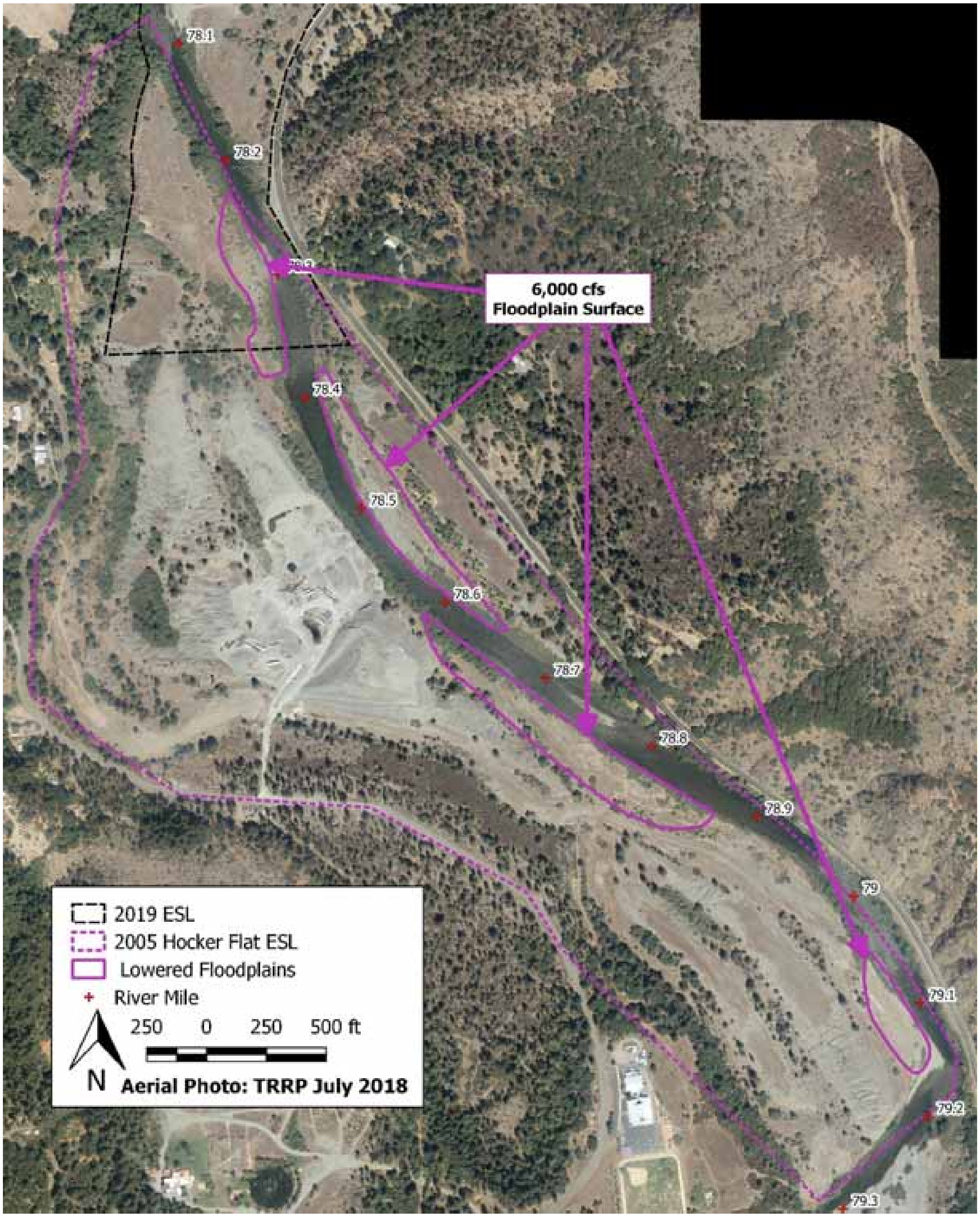


Figure 46. 2005 Hocker Flat restoration floodplain lowering and riparian berm removal.

4 EXISTING BIOLOGICAL RESOURCES

Biological resources include vegetation, fish, wildlife, and the habitats where they live. They are intrinsically valuable and provide additional aesthetic, economic, cultural, and recreational benefits to society. Types of biological resources include terrestrial and aquatic plant and animal species, game and non-game species, special status species that receive protection under federal and/or state law, and sensitive natural and/or critical habitats (Appendix B). It is beyond the scope of this document to describe or catalog all of the biological resources at the Upper Conner Creek project site; instead the following discussion focuses on general categories: vegetation (including sensitive natural communities), fisheries, and special status wildlife species (including foothill yellow-legged frog and western pond turtle).

4.1 Existing Vegetation

Since 2003, a map showing vegetated and unvegetated land cover types has been developed every five years between Lewiston and the North Fork of the Trinity River (IAP 2009). The 2018 map was used to describe existing vegetation conditions with the Upper Conner Creek ESL. Vegetated and unvegetated areas within the Upper Conner Creek ESL were mapped using E-cognition software and field verified. The high-resolution riparian and adjacent upland vegetation map (Figure 47) served as the basis for quantifying existing vegetation patch size, patch or cover type, and overall corridor diversity within the project site ESL.

Riparian, wetland, and upland areas were quantified within the Upper Conner Creek ESL. Riparian vegetation was mapped within the project site ESL in the field on 2018 ortho-photographs. E-cognition software was used to conduct image segmentation, which partitioned the 2018 image into distinct regions. Each distinct region included pixels with similar spectral attributes. A scale of 1:150 was used to determine the size of the distinct regions or “rough objects.” Object training assigned a land cover type attribute to each distinct region based on the field-based 2013 map and a nearest neighbor classification. Depending on the classification, rough objects were merged and smoothed. The minimum mapping unit criterion of 150 pixels (i.e., 75 ft^2) was applied to the objects and those smaller than 150 pixels deleted. Following field verification, the data were exported into a shapefile and imported into ArcGIS for additional smoothing and reduction of polygon vertices. Polygon topology was built, and the final data were exported to a shapefile. The aerial extent of mapped polygons was summed by land cover types within the project site ESL following the protocol described in the *Riparian Vegetation Revegetation and Recovery Plan* (TRRP 2013).

The Upper Conner Creek ESL covers 84.2 acres (Figure 47, Table 7). There were no mapped cover classes within the project ESL that were dominated by obligate wetland plants (i.e. jurisdictional wetlands); however, this does not mean that Jurisdictional Waters of the U.S. are not present in the mapped area. Narrowleaf willow dominated mature riparian vegetation within the project ESL (13.3% of the ESL), with white alder (4.3% of the ESL) and cottonwood cover types (3.4% of the ESL collectively) present to a lesser extent. In the Upper Conner Creek ESL, cover classes that were dominated by invasive non-native plants were primarily composed of yellow star-thistle (9.7% of the ESL), non-native grassland (8.5% of the ESL), and Himalaya blackberry (1.0% of the ESL). Upland vegetation within the project ESL was composed of patches of ponderosa pine (8.8% of the ESL), foothill pine (2.1% of the ESL), and whiteleaf manzanita (2.3% of the ESL). Dredger tailings cover 5.5% of the Upper Conner Creek ESL. Additional human disturbance-related cover types make up 1.0% of the project ESL.

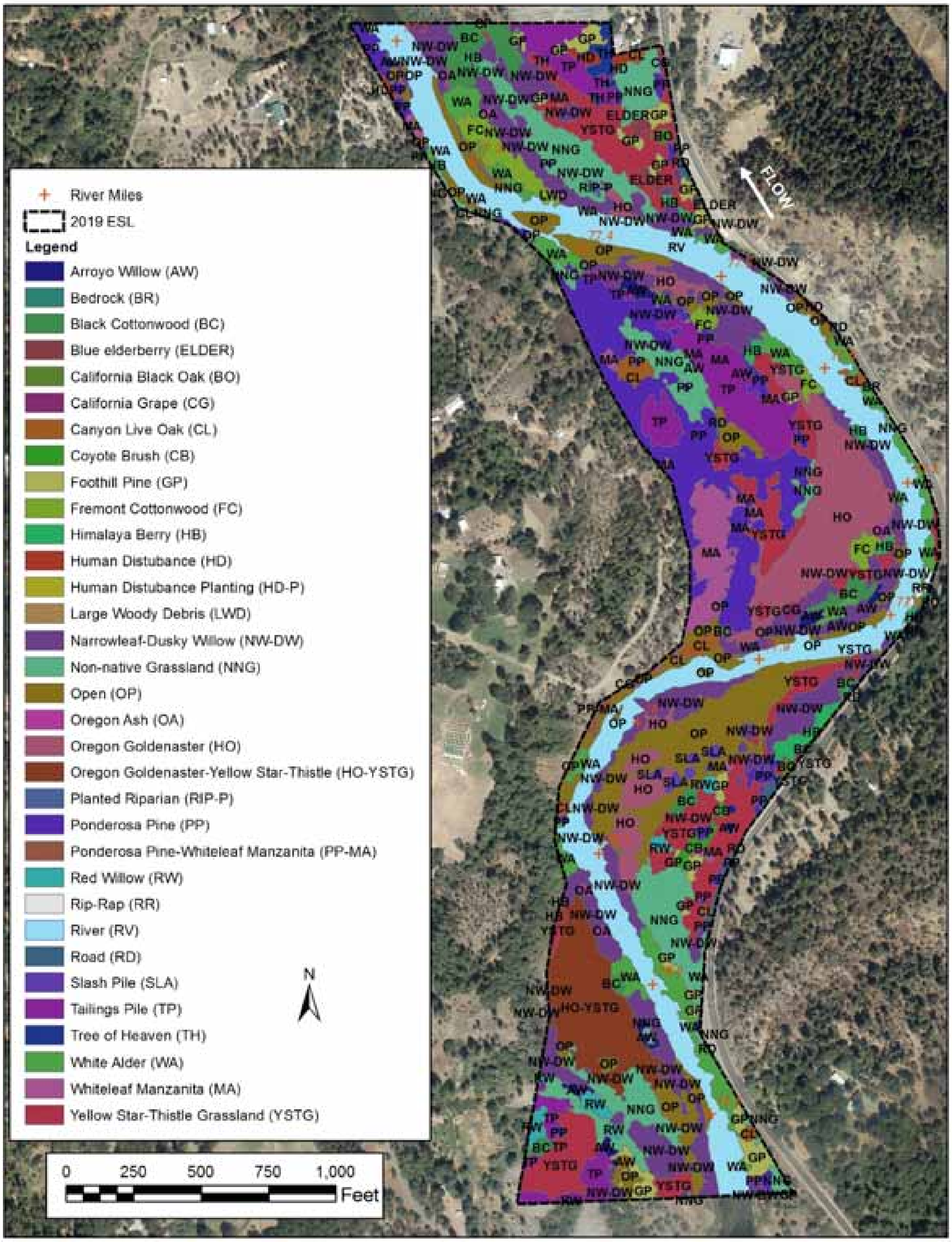


Figure 47. Existing vegetated and unvegetated cover types within the Upper Conner Creek ESL based on analysis of the 2018 aerial photo and 2019 field verification.

Table 7. Area of 24 vegetated and 9 unvegetated cover types within the Upper Conner Creek ESL. Cover types in red are dominated by non-native species. When applicable, the California Department of Fish and Wildlife rarity rank is provided.

Cover Type	Vegetation Alliance	CDFW Sensitive Community/ Rarity Rank	Area (ac)
Arroyo Willow	*Salix lasiolepis* Shrubland Alliance Arroyo willow thickets	Yes G3 S3	0.63
Bedrock	no corresponding Alliance	N/A	0.02
Black Cottonwood	*Populus trichocarpa* Forest Alliance Black cottonwood forest	Yes G5 S3	1.59
Blue Elderberry	*Sambucus nigra* Shrubland Alliance Blue elderberry stands	Yes G3 S3	0.19
California Black Oak	*Quercus kelloggii* Forest Alliance California black oak forest	Yes G4 S4	0.12
California Grape	*Vitis arizonica–Vitis girdiana* Shrubland Alliance Wild grape shrubland	Yes G3 S3	0.16
Canyon Live Oak	*Quercus chrysolepis* Forest Alliance Canyon live oak forest	No G5 S5	0.73
Coyote Brush	*Baccharis pilularis* Alliance Coyote brush scrub	Yes G5 S5	0.22
Foothill Pine	*Pinus sabiniana* Woodland Alliance Foothill pine woodland	Yes G4 S4	1.78
Fremont Cottonwood	*Populus fremontii–Fraxinus velutina–Salix gooddingii* Forest Alliance Fremont cottonwood forest	Yes G4 S3.2	1.31
Himalaya Berry	*Rubus armeniacus–Sesbania punicea–Ficus carica* Shrubland Semi-Natural Alliance Himalayan blackberry–rattlebox–edible fig riparian scrub	No Not rated	0.88
Human Disturbance	no corresponding Alliance	N/A	0.26
Human Disturbance Planting	no corresponding Alliance	No None	0.00
Large Woody Debris	no corresponding Alliance	N/A	0.03
Narrowleaf–Dusky Willow	*Salix exigua* Shrubland Alliance Sandbar willow thickets	Yes G5/S4.2	11.21
Non-native Grassland	several corresponding alliances	No None	7.16
Open	no corresponding Alliance	N/A	8.13
Oregon Ash	*Fraxinus latifolia* Forest Alliance Oregon ash groves	Yes G4 S3.2	0.17
Oregon Goldenaster	*Heterotheca (oregona, sessiliflora)* Herbaceous Alliance Goldenaster patches	Yes G3 S3	6.01
Oregon Goldenaster–Yellow Star-Thistle	no corresponding Alliance	No None	3.45

Cover Type	**Vegetation Alliance**	**CDFW Sensitive Community/ Rarity Rank**	**Area (ac)**
Planted Riparian	no corresponding Alliance	No None	0.04
Ponderosa Pine	*Pinus ponderosa* Forest Alliance Ponderosa pine forest	Yes G5 S4	7.39
Ponderosa Pine–Whiteleaf Manzanita	*Pinus ponderosa* Forest Alliance Ponderosa pine forest	Yes G5 S4	0.10
Red Willow	*Salix gooddingii–Salix laevigata Woodland Alliance* Gooding's willow–red willow riparian woodland	Yes G4 S3	0.60
Riprap	no corresponding Alliance	N/A	0.08
River	no corresponding Alliance	N/A	12.52
Road	no corresponding Alliance	N/A	0.51
Slash Pile	no corresponding Alliance	N/A	0.25
Tailings Pile	no corresponding Alliance	N/A	4.59
Tree of Heaven	*Eucalyptus* spp.*–Ailanthus altissima–Robinia pseudoacacia* Woodland Semi-Natural Alliance Eucalyptus–Tree of Heaven–black locust groves	No Not ranked	0.35
White Alder	*Alnus rhombifolia* Forest Alliance White alder groves	Yes G4 S4	3.65
Whiteleaf Manzanita	*Arctostaphylos viscida* Shrubland Alliance Whiteleaf manzanita chaparral	Yes G4 S4	1.90
Yellow Star-thistle Grassland	*Centaurea (solstitialis, melitensis)* Herbaceous Semi-Natural Alliance Yellow star-thistle fields	No Not ranked	8.17
Total			84.23

4.1.1 Height Above River Analysis

Mapped vegetation patterns were related to the height they established above the summer 450 cfs water surface to evaluate the interrelationship of vegetation growing within the project site and the physical and hydrologic environments that support it. The relationships between existing vegetation and ground surface height above the summer water surface elevation (450 cfs) were used to: (1) explain existing vegetation patterns, (2) provide design criteria that would facilitate wetland and riparian vegetation types, (3) inform the development of physical designs, and (4) ensure that revegetated plant materials will be installed in locations that reflect where they naturally grow on the landscape.

Groundwater within the Trinity River riparian corridor is seasonally and temporally variable, and the ground surface topography is also highly variable within the project ESL. Riparian and wetland vegetation persist in locations where groundwater is shallow, whether created by drainage from the valley wall or tributaries, or due to lower elevation ground surfaces.

Given suitable hydrology and soils, riparian vegetation generally establishes within a fixed distance (i.e., height) from the shallow groundwater table. In many river systems with coarse substrates, groundwater can be approximated by the water surface in the adjacent stream, and the height above the stream water surface elevation can be used as a surrogate for the height above the groundwater table. A groundwater DEM, or “height above river” model, can be created using measured groundwater depths and HEC-RAS modeling output. By subtracting the groundwater DEM from the existing ground DEM, a new detrended DEM (dtDEM) can be created that shows ground height above groundwater. A topographic map showing the ground surface height above groundwater can be used for:

- Evaluating the elevation distribution of individual vegetation cover types above the groundwater to define vegetation zones, and
- Evaluating the extent of and location where proposed physical designs modify existing ground surface elevations and the vegetation types the proposed designs may increase/decrease.

The difference between the Trinity River 450 cfs water surface elevation determined from HEC-RAS model and the updated 2019 Upper Conner Creek topography was used to construct a dtDEM showing the existing topography height above the 450 cfs water surface (Figure 48). The 450 cfs water surface was laterally extended using HEC-RAS model output and cross sections to construct a 450 cfs water surface DEM. The 450 cfs DEM points were subtracted from individual ground surface points to construct the dtDEM. Elevation values are in feet and are negative for the riverbed bathymetry (i.e., water depth).

To be truly representative of a depth to groundwater, the actual groundwater elevation corresponding to the streamflow water surface elevation should ideally be used to construct a height above river model. The existing conditions dtDEM used a simple planar projection of the 450 cfs WSE, since no current groundwater data were available at this site. The relationship between vegetation and the ground height above 450 cfs water surface may oversimplify the relationship of shallow groundwater because the simple flat planar projection of the river’s wetted edge at 450 cfs water may not portray the actual groundwater conditions at a given location. However, this method presents a reasonable approximation for describing existing conditions and developing revegetation designs.

The relationships between vegetated and unvegetated cover types and the existing conditions 450 cfs dtDEM were evaluated. Cover types mapped in 2014 were overlaid on the 450 cfs dtDEM. An analysis was conducted to identify the minimum and maximum elevations associated with each cover type and calculate the median and standard deviations of dtDEM pixel values within each cover type polygon. Box whisker charts were prepared using detrended elevation range, 25th and 75th percentiles, and median. Cover types were ranked from smallest median value (lowest elevation) to largest median value (highest elevation) and vegetation zones were qualitatively assigned loosely based on asymptotes in ascending means.

The project site includes areas that are close to groundwater and areas that are high above it (Figure 49). Mapped vegetation types dominated by wetland and mesic species tended to grow on lower ground elevations above 450 cfs streamflow elevation. The relationship between existing vegetation patterns and the height above the 450 cfs water surface dtDEM was used to identify ground surface elevations that would generally support different vegetation zones. Mapped cover types sorted themselves out as a function of height above the 450 cfs water surface. Five habitat zones were defined (Figure 49; Table 8).

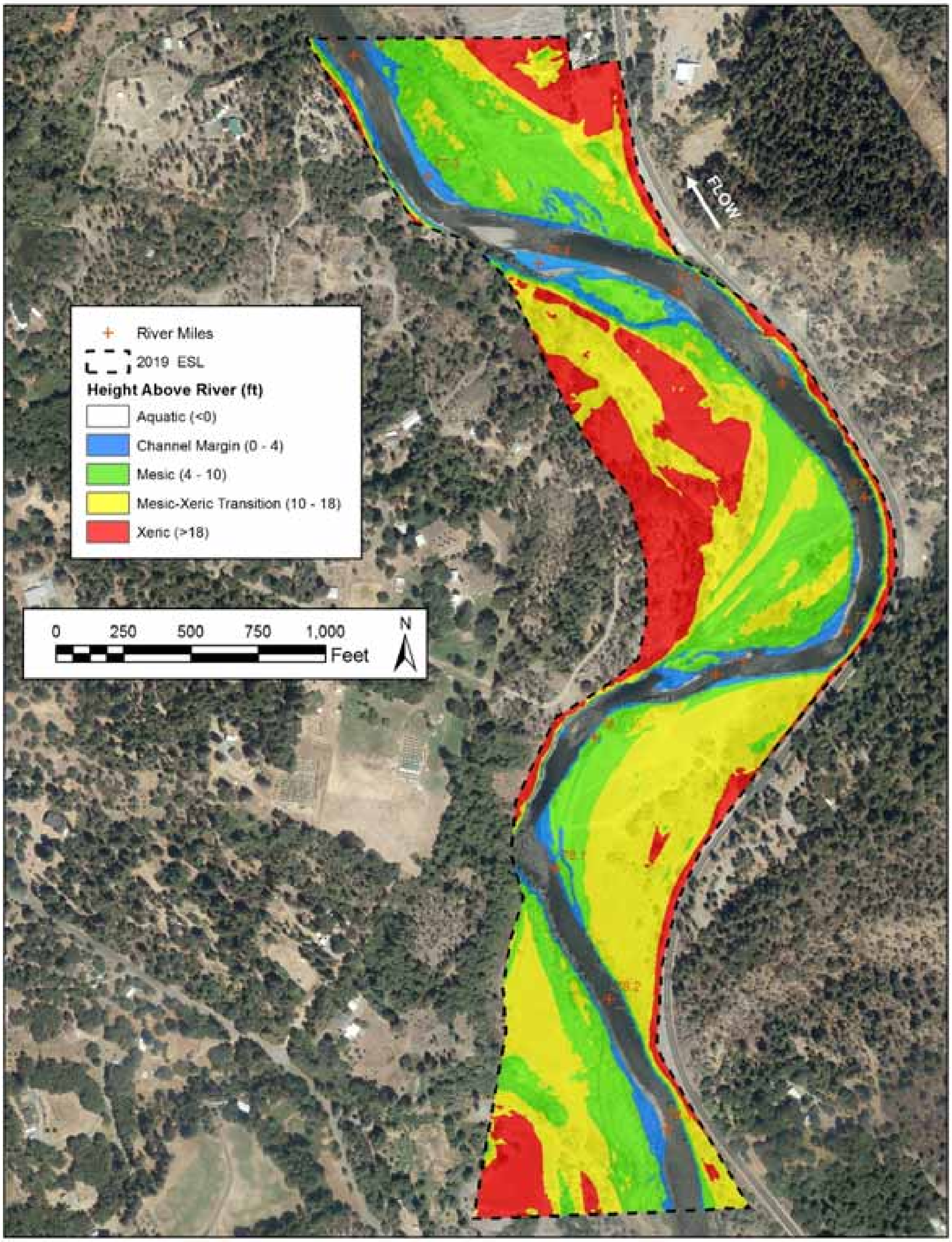


Figure 48. Upper Conner Creek rehabilitation site existing detrended Digital Elevation Model (dtDEM) showing the existing topography height above the modeled 450 cfs water surface.

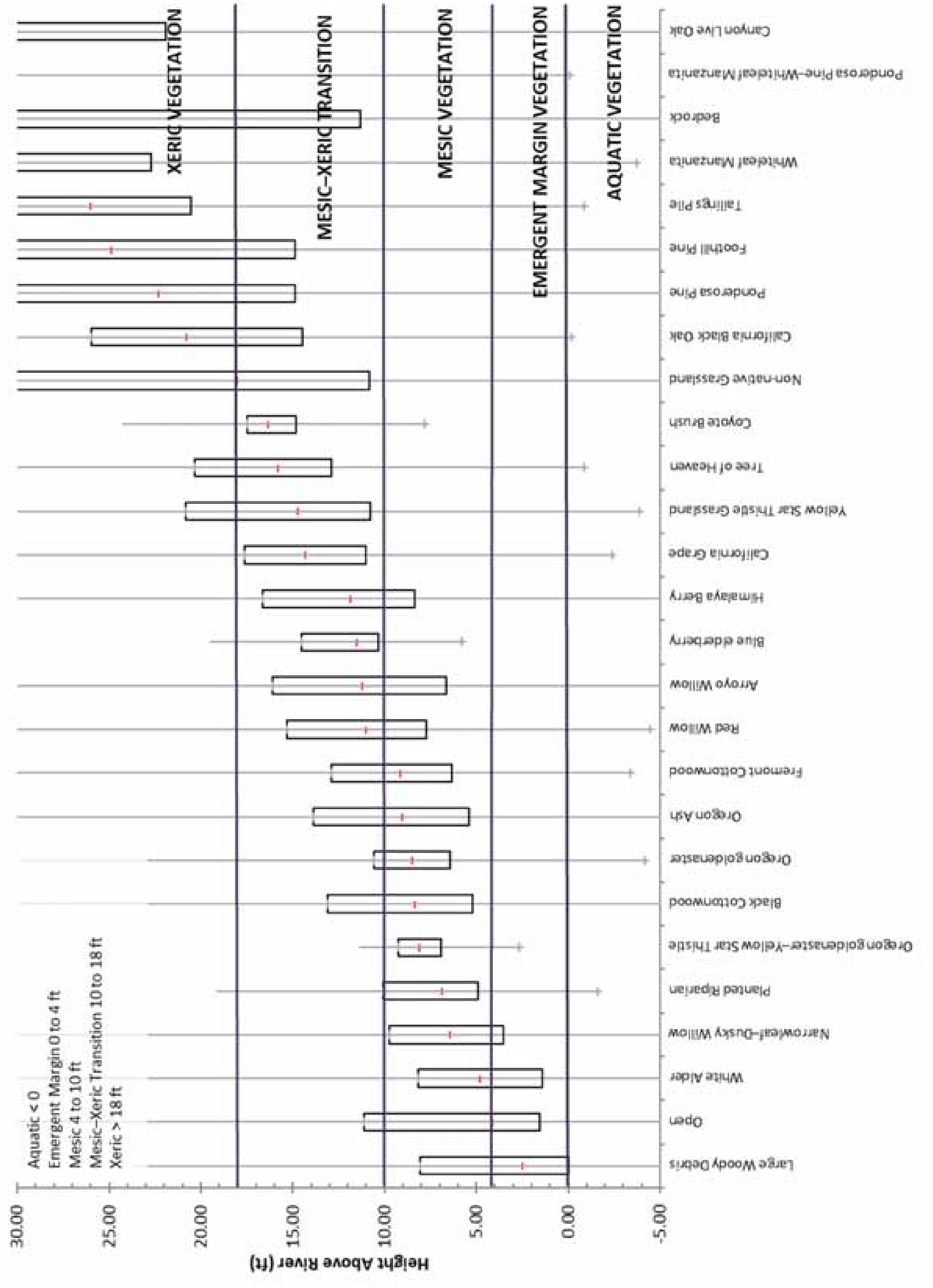


Figure 49. Box plots illustrating the median height and range of heights above water for mapped cover types. The red dot is the median elevation of the cover type. The box is defined by the 25th and 75th percentiles, and the grey lines show the range in data between minimum and maximum height above 450 cfs values. The height in the chart is truncated to 30 ft. Additional xeric cover types occurred more than 30 ft above the groundwater surface and are not shown.

Table 8. Five habitat zones defined using the height above 450 cfs water surface analysis.

Vegetation Zone	Height above 450 cfs Water Surface Elevation	Description
Aquatic (Open Water)	< 0 ft	This zone is in constant contact with water through direct inundation
Emergent Margin (Wetland)	0 to 4 ft	This zone is in constant contact with water either through capillarity or direct inundation
Mesic (Riparian)	4 to 10 ft	This zone is frequently in contact with water through capillarity or direct inundation
Mesic–Xeric Transition (Transition)	10 to 18 ft	This zone is infrequently in contact with water through capillarity or direct inundation
Xeric (Upland)	> 18 ft	This zone is rarely if ever in contact with water through capillarity or direct inundation

The five habitat zones within the 84.2-acre project site ESL were not equally distributed. The aquatic habitat zone covered 14.3 acres within the project site (17.0% of the ESL; Table 9). The topographic area associated with the emergent margin zone was 5.6 acres (6.6% of the ESL; Table 9). The topographic area associated with the mesic zone was 22.3 acres (26.5% of the ESL; Table 9). The topographic area associated with the mesic–xeric transition zone was 26.4 acres (31.4% of the ESL; Table 9).The topographic area associated with the xeric zone was 15.6 acres (18.5% of ESL; Table 9).

Habitat zones are topographic and defined using general vegetation trends. The habitat zones were used to associated habitat preferences to vegetated cover types. Cover types that were typical of each habitat zone were determined using the median value of each vegetated cover type. For example black cottonwood has a detrended median value of 8.3 ft. The median value for black cottonwood falls within the mesic habitat zone even though the black cottonwood elevation range shows them growing at higher elevation associated with the xeric zone and lower elevation associated with the emergent zone than the median value. Black cottonwood patches regardless of the elevation they grow are always considered mesic. The 1.58 acres that are associated with black cottonwood are assigned to the mesic zone. When all cover types that are associated with each habitat zone are summed it is possible that summed vegetation area could have a larger cover area value than the topography that is associated with the habitat zone itself. Native vegetation covered 30.1 acres within the mesic and mesic–xeric transition zones (35.8% of the area; Table 10).

Table 9. Area of the five habitat zones at Upper Conner Creek ESL.

Habitat Zone	Acres	Percent of Project Site
Aquatic	14.3	17.0%
Emergent Margin	5.6	6.6%
Mesic	22.3	26.5%
Mesic–Xeric Transition	26.4	31.4%
Xeric	15.6	18.5%
Grand Total	84.2	100.0%

Table 10. Area of existing native vegetation cover types within the five habitat zones at Upper Conner Creek ESL. Open, non-native vegetation, and human disturbance-related cover types have been excluded.

Habitat Zone	Acres of Native Vegetation	Percent of Project Site with Native Vegetation Cover
Aquatic	0.0	0%
Emergent Margin	0.0	0%
Mesic	27.4	32.6%
Mesic–Xeric Transition	2.7	3.2%
Xeric	12.0	14.3%
Total	**42.2**	**50%**

4.1.2 Sensitive Natural Communities

Sixteen mapped vegetated cover types within the Upper Conner Creek ESL are California Department of Fish and Wildlife (CDFW) listed sensitive natural communities (Table 7). Sensitive natural communities are vegetation types that are rare or limited distribution globally or regionally, and are ranked according to their global and statewide rarity (Table 11). Sensitive natural community rankings were obtained from the list of California Sensitive Natural Communities published by the California Department of Fish and Wildlife (CDFW 2019). Sensitive natural communities occur within the mesic, mesic–xeric transition, and xeric zones.

Table 11. Global and state rarity rankings for sensitive natural communities in California.

Global Ranks
G1 = Fewer than 6 viable occurrences of the vegetation type worldwide and/or < 2,000 acres
G2 = 6–20 viable occurrences of the vegetation type worldwide and/or > 2,000–10,000 acres
G3 = 21–100 viable occurrences of the vegetation type worldwide and/or > 10,000–50,000 acres
G4 = Greater than 100 viable occurrences of the vegetation type worldwide and/or > 50,000 acres
G5 = Vegetation type is demonstrably secure due to worldwide abundance
State Ranks
S1 = Fewer than 6 viable occurrences of the vegetation type statewide and/or < 2,000 acres
S2 = 6–20 viable occurrences of the vegetation type statewide and/or > 2,000–10,000 acres
S3 = 21–100 viable occurrences of the vegetation type statewide and/or > 10,000–50,000 acres
S4 = Greater than 100 viable occurrences of the vegetation type statewide and/or > 50,000 acres
S5 = Vegetation type is demonstrably secure due to statewide abundance
Threat Rank
0.1 = Seriously threatened (over 80% of occurrences threatened/high degree and immediacy of threat)
0.2 = Moderately threatened (20–80% of occurrences threatened/moderate degree and immediacy of threat)
0.3 = Not very threatened in California (< 20% of occurrences threatened/low degree and immediacy of threat or no current threats known)

Woody plants associated with terrestrial freshwater habitats dominated the mesic zone. Mesic vegetation grows along the margins of the mainstem Trinity River, tributaries, ponded water associated with dredger tailing swales and freshwater bodies (both perennial and seasonal) between 4 and 10 ft above the 450 cfs water surface. Riparian woodlands are most often dominated by wet facultative wetland indicator species (Lichvar et al. 2016). Seven cover types occur within this zone. Six of the cover types were sensitive natural communities: black cottonwood forest (*Populus trichocarpa* Forest Alliance), Fremont cottonwood forest (*Populus fremontii* Forest Alliance), Narrowleaf–dusky willow thickets (*Salix exigua* shrubland Alliance), White alder forest (*Alnus rhombifolia* Forest Alliance), Oregon goldenaster patches (*Heterotheca oregona, H. sessiliflora*) Herbaceous Alliance), and Oregon ash groves (*Fraxinus latifolia* Forest Alliance).

Woody and herbaceous plants associated with higher floodplain surfaces and low terraces between 10 and 18 ft above the 450 cfs water surface dominate the mesic–xeric transition zone. Nine cover types occur within the mesic–xeric transition zone. Cover types in this zone were most often dominated by facultative and facultative upland indicator species (Lichvar et al. 2016). Five of the cover types mapped in the mesic–xeric transition zone are sensitive natural communities: red willow riparian woodland (*Salix gooddingii–Salix laevigata* Woodland Alliance), arroyo willow thickets (*Salix lasiolepis* Shrubland Alliance), blue elderberry stands (*Sambucus nigra* Shrubland Alliance), wild grape shrubland (*Vitis arizonica–Vitis girdiana* Shrubland Alliance), and coyote brush scrub (*Baccharis pilularis* Shrubland Alliance).

Oaks and conifers dominate the xeric zone. Vegetation alliances associated with the xeric zone are not inundated for long periods of time, if at all. The xeric zone occurs at elevations greater than 18 ft above the 450 cfs water surface. Vegetated cover types associated with the xeric zone may have some wetland indicator species, but many of the plants associated with these cover types were facultative upland or upland plants (Lichvar et al. 2016). Six cover types occur within this habitat, and all of them were sensitive natural communities: California black oak forest (*Quercus kelloggii* Forest Alliance), ponderosa pine forest (*Pinus ponderosa* Forest Alliance), foothill pine woodland (*Pinus sabiniana* Woodland Alliance), whiteleaf manzanita chaparral (*Arctostaphylos viscida* Shrubland Alliance), ponderosa pine–whiteleaf manzanita forest (Ponderosa pine Forest Alliance), and canyon live oak forest (*Quercus chrysolepis* Forest Alliance).

4.1.3 Existing Vegetation to Avoid

Mesic and emergent vegetation, sensitive natural communities, and vegetation with high quality structural and habitat value should be included in designs and avoid disturbance during construction activities. The location and extent of existing mesic and emergent vegetation and sensitive natural communities were identified using the 2019 land cover map which served as a basis for vegetation that should be avoided and preserved. James Lee, the former TRRP Riparian ecologist, conducted a foot survey during summer 2019 and identified vegetation with high structural or habitat value within the Upper Conner Creek ESL. A GIS layer was prepared from the foot survey and a map was developed that also included the mesic and emergent vegetation, and sensitive natural communities (Figure 50). Areas identified for preservation typically had several scales of spatial and temporal vegetation variability, including plant density, plant age, species richness, and cover. Existing vegetation that was identified for avoidance or preservation included areas with:

- Multiple age classes of cottonwood, white alder, red willow, Oregon ash, California black oak, ponderosa pine, and foothill pine;
- A high degree of vertical heterogeneity within patches with a fairly homogenous overstory species composition (shrubs next to trees; habitat roughness);
- Patches of riparian vegetation that are initiating, establishing, mature, and/or senescent growing above the 450 cfs water surface;
- Female cottonwood trees for seed sources post-construction;
- Large patch interiors;
- Large trees along the channel that provide shaded river cover (especially along the southern bank);

- Widest riparian vegetation;
- Increased upland ecotone complexity; and
- The highest potential to introduce large wood with sufficient height and diameter, with the ability to affect local channel complexity (key piece or larger size) and induce substantial geomorphic changes during moderate to large flood events (greater than a 5-yr recurrence interval).

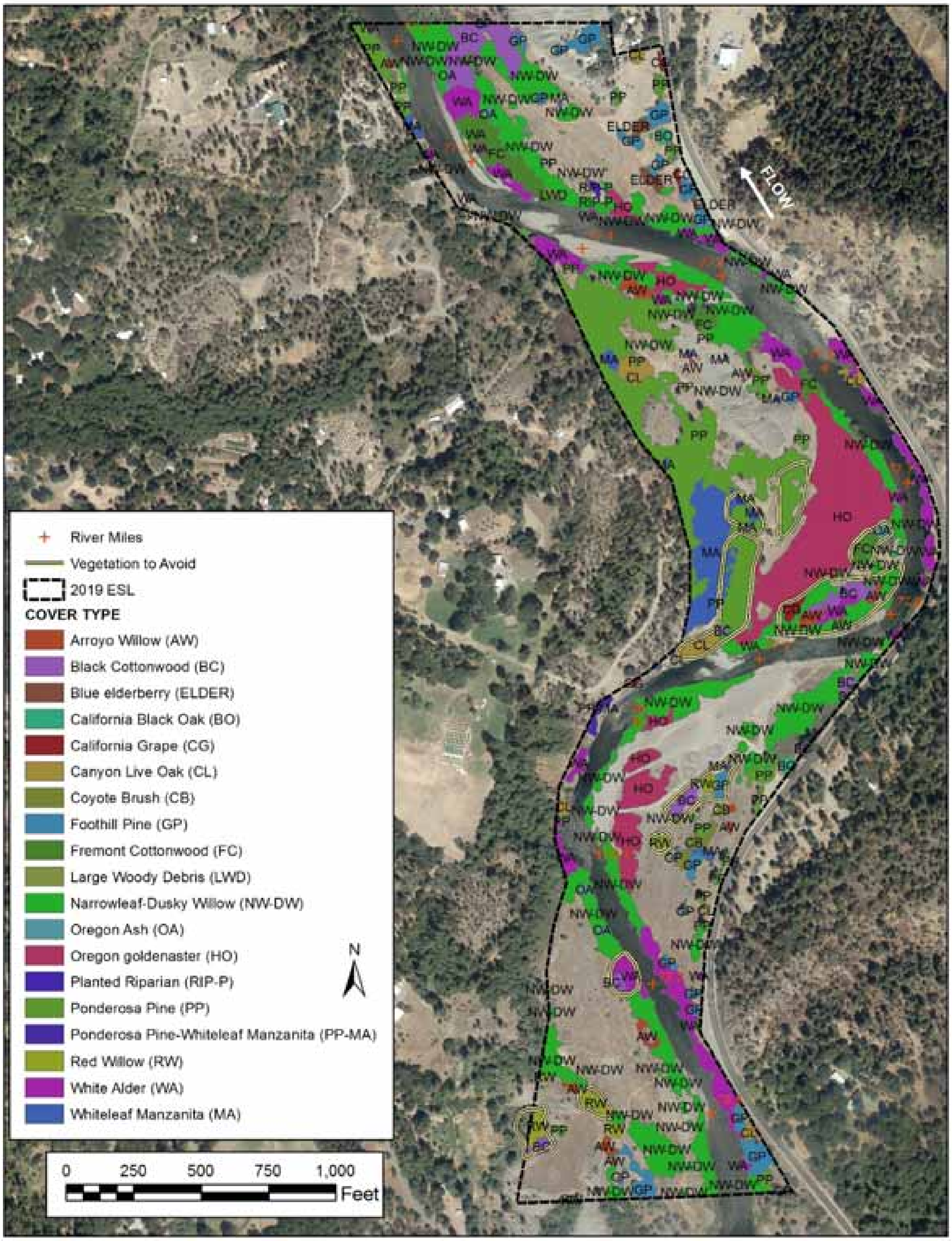


Figure 50. CDFW sensitive natural communities and native vegetation areas identified by James Lee that should be avoided during project implementation.

4.1.4 Non-Native Plants

Non-native vegetation is composed of non-native plant species that grow in patches that outcompete native riparian and aquatic vegetation and reduce habitat quality and structural complexity. Non-native invasive plants within and near the Upper Conner Creek project site were identified and a GIS layer prepared (Table 12, Figure 51). Non-native species identified for removal in the project ESL area may occur in large patches (e.g., Himalaya berry) or as isolated individuals (e.g., Tree of Heaven). Many non-native semi-woody and herbaceous plant species grow in the project ESL and occur within mapped patches of vegetation (e.g., Himalaya berry) or are so ubiquitous as to be beyond removal during construction (e.g., non-native annual grasses and sweetclover).

Table 12. Observed non-native invasive plant species in or near the Upper Conner Creek ESL and the associated California Invasive Plant Council (Cal-IPC) invasion threat level. The table is prioritized by order of invasiveness.

Cal-IPC Threat	**Scientific Name**	**Common Name**	**Habit**	**USFWS Hydric Code**
High	*Bromus madritensis* ssp. *rubens*	foxtail chess	Grass	UPL
	Bromus tectorum	cheat grass	Grass	N/A
	Centaurea solstitialis	yellow star-thistle	Herb	N/A
	Cytisus scoparius	Scotch broom	Shrub	N/A
	Elymus caput-medusae	medusahead	Grass	N/A
	Lepidium latifolium	pepperweed	Herb	FACW
	Myriophyllum aquaticum	parrot's feather	Aq Herb	OBL
	Rubus armeniacus	Himalaya berry	Shrub	FAC+
Moderate	*Ailanthus altissima*	Tree of Heaven	Tree	FACU
	Avena barbata	slender wild oat	Grass	N/A
	Avena fatua	wild oat	Grass	N/A
	Brassica nigra	black mustard	Herb	N/A
	Cirsium vulgare	Bull thistle	Herb	FAC
	Conium maculatum	poison hemlock	Herb	FAC
	Cynodon dactylon	Bermuda grass	Grass	FACU
	Cynosurus echinatus	hedgehog dogtail	Grass	N/A
	Dipsacus fullonum	wild teasel	Herb	FACW–
	Festuca arundinacea	tall fescue	Grass	FAC–
	Festuca myuros	annual fescue	Grass	FACU
	Festuca perennis	perennial ryegrass	Grass	FAC
	Ficus carica	fig	Tree	?
	Hirschfeldia incana	tumblemustard	Herb	UPL
	Holcus lanatus	velvet grass	Grass	FAC

Cal-IPC Threat	Scientific Name	Common Name	Habit	USFWS Hydric Code
	Hypericum perforatum ssp. *perforatum*	St. John's wort	Herb	N/A
	Leucanthemum vulgare	Shasta daisy	Herb	NI
	Linaria dalmatica	dalmatian toadflax	Herb	N/A
	Mentha pulegium	pennyroyal	Herb	OBL
	Phalaris aquatica	Harding grass	Grass	FAC
	Potamogeton crispus	crispate-leaved pondweed	Aq Herb	OBL
	Rumex acetosella	sheep-sorrel	Herb	FAC–
	Tanacetum vulgare	common tansy	Herb	N/A
	Vinca minor	periwinkle	Vine	N/A
Limited	*Agrostis stolonifera*	bent grass	Grass	FACW
	Anthoxanthum odoratum	sweet vernal grass	grass	?
	Bromus hordeaceus	soft chess	Grass	FACU–
	Dactylis glomerata	orchard grass	Grass	FACU
	Erodium cicutarium	redstem stork's bill	Herb	N/A
	Hypochaeris radicata	rough cat's-ear	Herb	FACU
	Marrubium vulgare	horehound	Herb	FACU
	Myosotis latifolia	forget-me-not	Herb	N/A
	Plantago lanceolata	English plantain	Herb	FAC–
	Poa pratensis ssp. *pratensis*	Kentucky bluegrass	Grass	FAC
	Polypogon monspeliensis	annual beard grass	Grass	FACW+
	Robinia pseudoacacia	black locust	Tree	FACU
	Rumex crispus	curly dock	Herb	FACW–
	Saponaria officinalis	soapwort	Herb	FACU
	Tribulus terrestris	puncture vine	Herb	N/A
	Trifolium hirtum	rose clover	Herb	N/A
	Verbascum thapsus	common mullein	Herb	NI
Watch	*Buddleja davidii*	butterfly bush	Shrub	?
	Catalpa bignonioides	Catalpa	Tree	UPL
	Convolvulus arvensis	bindweed	Herb	N/A
	Cyperus esculentus	yellow nutsedge	Em Herb	FACW
	Elymus pontica ssp. *pontica*	tall wheatgrass	Grass	N/A
	Mentha × piperita	peppermint	Herb	OBL
	Mentha arvensis	wild mint	Herb	FACW
	Mentha spicata	spearmint	Herb	OBL
	Poa annua	annual bluegrass	Grass	FAC
	Poa bulbosa	bulbous bluegrass	Grass	N/A
	Populus alba	white poplar	Tree	N/A

Cal-IPC Threat	Scientific Name	Common Name	Habit	USFWS Hydric Code
	Rosa rubiginosa	sweet-briar	Shrub	FACU
	Rubus laciniatus	cutleaf blackberry	Shrub	FAC+
	Sorghum halepense	Johnsongrass	Grass	FACU
	Symphytum × uplandicum	Russian comfrey	Herb	N/A
	Verbascum blattaria	moth mullein	Herb	FACU

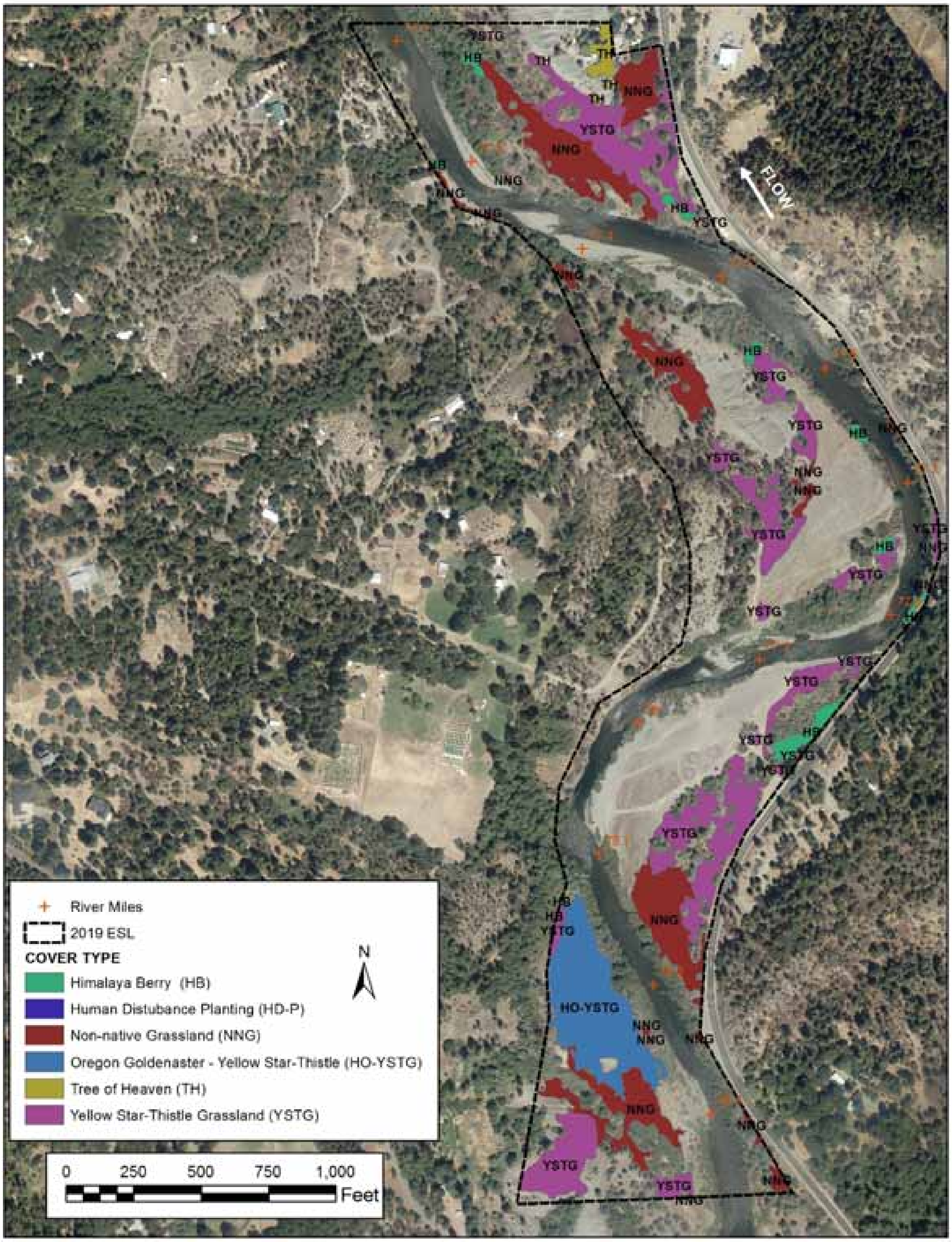


Figure 51. Non-native and invasive plants that should be identified for removal during construction.

4.2 Fisheries

This section of the report covers existing spawning habitat, juvenile rearing habitat, and adult holding habitat within the Upper Conner Creek ESL. The juvenile rearing habitat and adult holding habitat analyses are specific to Chinook salmon (*Oncorhynchus tshawytscha*), while spawning surveys considered multiple types of salmon, as species-type was not specified in the redd data. This section also reports on the potential for lamprey and freshwater mussels within the project site, as these are species that are monitored by the TRRP.

4.2.1 Adult Salmonid Spawning Habitat

Salmonids spawn within the project site, although the number of surveyed redds varies year to year (USFWS spawning survey data 2010–2017, Figure 52). The surveys show a high density of spawning occurring around River Mile 77.5 and this area will be considered during design development.

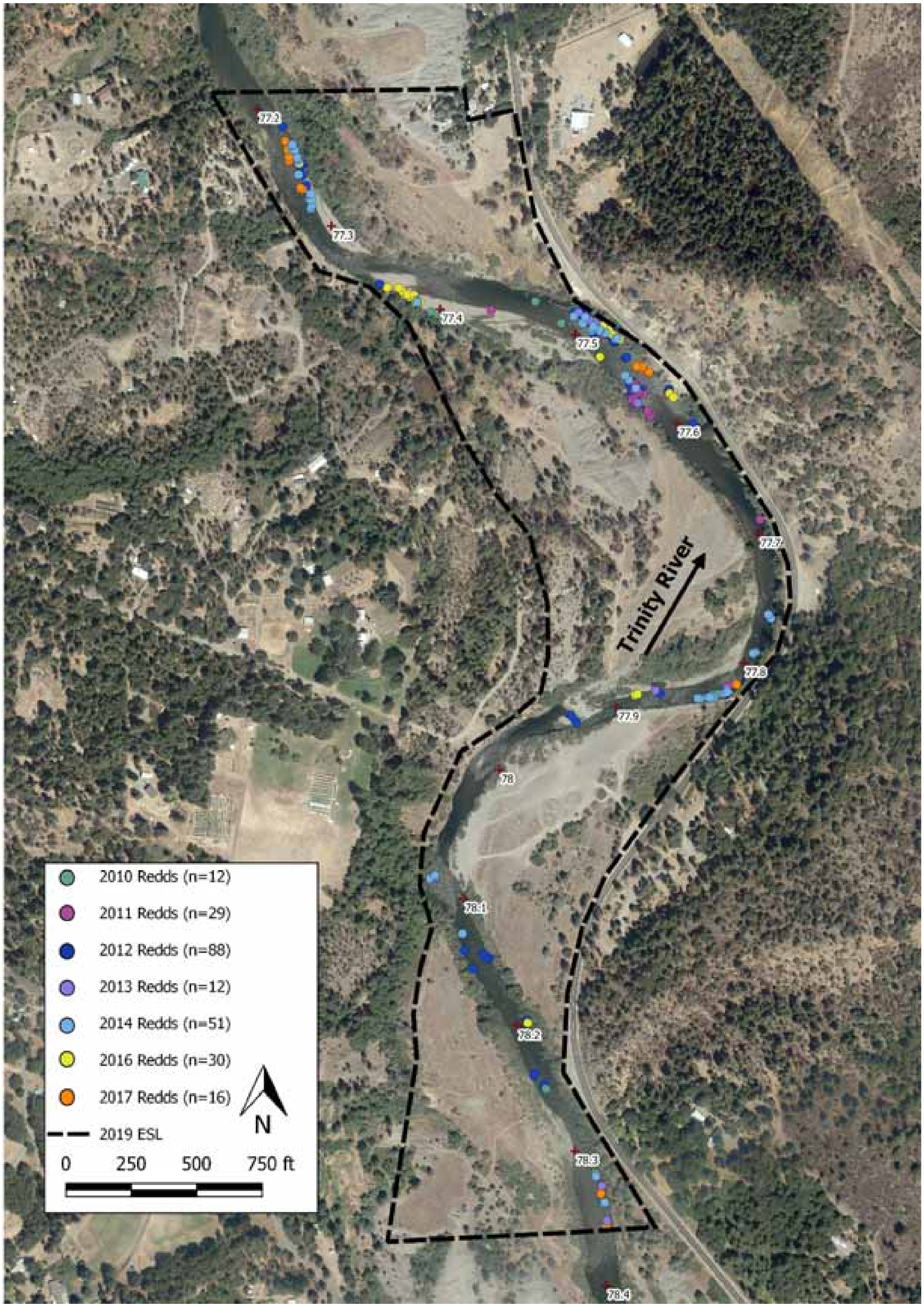


Figure 52. Salmonid redd locations within the Upper Conner Creek project site (USFWS spawning survey data 2010–2017).

4.2.2 Juvenile Chinook Salmon CarryingCapacity Estimates

Estimates of carrying capacity for Chinook Salmon were also made using an N-mixture model developed specifically for the Trinity River (Som et al. 2018). An R function was used to determine N-mixture-based capacity estimates using depth, velocity and distance to cover at each flow (Som et al. 2018). Results indicated that capacity for both fry and parr life stages increase with increases in flow (Figure 53, Table 13).

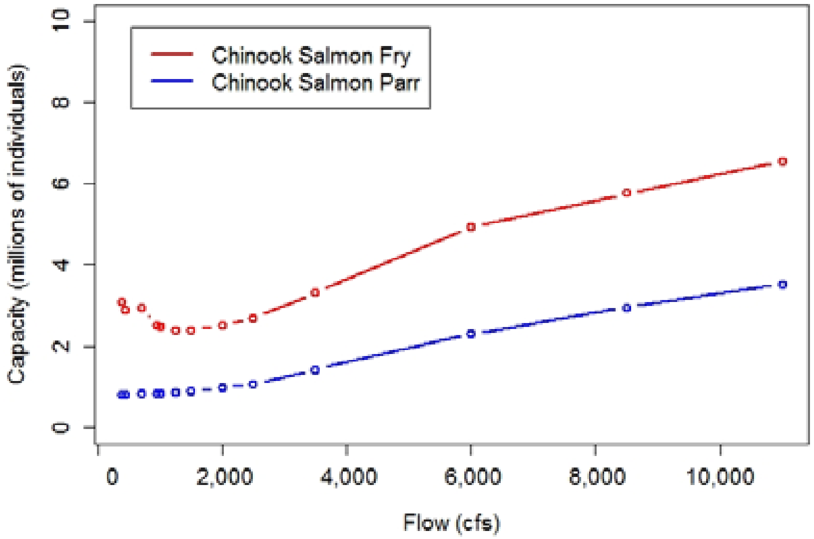


Figure 53. Capacity for Chinook Salmon fry and parr life stages under existing conditions at the Upper Conner Creek project site.

Table 13. Capacity for Chinook Salmon fry and parr life stages under existing conditions at the Upper Conner Creek project site.

Chinook Salmon Life Stage	**Capacity (millions of individuals) at Specified Flow**												
	380 cfs	**450 cfs**	**700 cfs**	**950 cfs**	**1,000 cfs**	**1,250 cfs**	**1,500 cfs**	**2,000 cfs**	**2,500 cfs**	**3,500 cfs**	**6,000 cfs**	**8,500 cfs**	**11,000 cfs**
Fry	3.08	2.89	2.95	2.50	2.47	2.40	2.40	2.52	2.69	3.32	4.93	5.76	6.57
Parr	0.80	0.81	0.85	0.83	0.84	0.87	0.89	0.98	1.07	1.42	2.30	2.96	3.53

4.2.3 Adult Chinook Salmon Holding Habitat

When not migrating or spawning, adult Chinook salmon spend time in deep pools. These pools, termed “holding habitat,” provide cover, cooler water temperatures, and reduced velocities. There are few available published sources that characterize holding habitat for adult Chinook Salmon, though it is generally understood that “deeper is better.” Raleigh et al (1986) described prime adult holding pools greater than 16.4 ft wide and greater than 6.6 ft in depth. NOAA (NMFS 2014) describes holding habitat for adult winter-run Chinook Salmon as generally greater than 5 ft. Moyle (2002) described adult spring-run Chinook Salmon preference for pools deeper than 6.6 ft. Although depth is the primary parameter discussed in much of the literature, other factors like water velocity, stream aspect, hillshade effects, and overhead cover may influence the quality of deep water for holding adult Chinook Salmon. NOAA (2014) noted that pools utilized by adult Chinook Salmon contain some form of cover and have velocities ranging from 0.5 to 2.0 ft/sec.

There are six pools within the Upper Conner Creek ESL (Table 14, Figure 54). Five of the six pools within the project site were assessed by Gaeuman and Krause (2013) and occur near the bedrock banks of the channel (Pool 121 to Pool 125, Figure 54). Pool 120 is an area of converging flow at the downstream boundary of Hocker Flat. Surveys conducted in 2009 and 2010 by Gaeuman and Krause (2013) showed that, within the project site, some pools are aggrading and some are deepening. An analysis of the pools using the 2019 existing conditions hydraulic model with the 2019 topography and a flow of 450 cfs was conducted to compare the existing pool depths. For pools deeper than 6.6 ft, existing pool were compared to values presented in Gaeuman and Krause (2013), in which the maximum depth and 75th percentile depths were examined. Maximum depth examines the deepest portion of each pool and change in this parameter provides insight into changes at the deepest locations since 2010. The 75th percentile depth parameter examines the broader range of depths in each pool and changes in this parameter provide insight on how the depth distribution of the pool has changed since 2010.

Pool 120 has scoured by approximately 0.5 ft since the 2011 surveys, although the results presented in Gaeuman and Krause (2013) show that Pool 120 did not have depths of 6.6 ft even during the 2011 surveys. Pool 121 showed evidence of scour since 2011, with the maximum depth of the pool increasing by approximately 3.5 ft. Pool 122 also showed aggradation; although the maximum depth did not change by much, the 75th percentile depth aggraded by just under 2 ft. Pool 123 showed slight scour of the maximum depth, but aggradation of approximately 0.8 ft for the 75th percentile depth. Pool 124 showed a decrease of 0.8 ft in the maximum depth but an increase of approximately 0.5 ft in the 75th percentile depth. Pool 125 is aggrading and showed a decrease in the maximum depth of 1.2 ft and a decrease in the 75th percentile depth of 2 ft. Results from the analysis shows that some pools within the project site are aggrading while others are scouring.

Table 14. Pool depths within the Upper Conner Creek project site. Measurements from 2009–2010 were from Gaueman and Krause (2013) and 2019 depths were based on modeling results from the 2019 existing conditions hydraulic model.

		Maximum Depth (ft)			**75th Percentile Depth (ft)**		
Pool Designation	**Number**	**2009–2010**	**2019**	**Change**	**2009–2010**	**2019**	**Change**
RM78.25	120	5.43	5.93	–0.50	4.36	4.92	–0.56
JC Campground 1	121	10.53	14.17	–3.64	7.69	7.96	–0.27
JC Campground 2	122	11.66	11.04	+0.62	9.28	7.48	+1.80
Upper Conner 1	123	12.88	13.01	–0.13	8.91	8.10	+0.81
Upper Conner 2	124	9.68	8.87	+0.81	6.32	6.89	–0.57
Upper Conner 3	125	14.19	12.64	+1.55	9.42	7.45	+1.97

Figure 54. Adult Chinook Salmon holding pool locations based on 2019 existing condition hydraulic model results. Pool numbering matches Gaeuman and Krause (2013).

4.2.4 Lamprey Ammocoete Distribution

The distribution of Pacific lamprey (*Entosphenus tridentatus*) ammocoetes was documented between Dutch Creek (RM 86.5) and Oregon Gulch (RM 81.0) during data collection efforts in January 2015 (Alvarez et al. 2015b); however, there is sparse literature regarding the distribution of ammocoetes within the Upper Conner Creek ESL. The 2015 surveys found ammocoetes throughout the study reach in varying abundance; the data package is available through the TRRP Data Portal. Available information, specific to river segments within the 2019 ESL, noted large areas of ammocoete holding habitat, which consists of low velocities, fine sediments, and depositional areas, near RM 78.1 (Goodman et al. 2009).

4.2.5 Freshwater Mussel Distribution

The distribution of freshwater mussel beds in the Trinity River was surveyed between Evan's Bar (RM 85.1) and Oregon Gulch (RM 81.0) during data collection efforts in November 2014 (Alvarez et al. 2015c). Mussel beds were observed throughout the study reach in varying abundance; the data package is available through the TRRP Data Portal. There is a lack of literature documenting freshwater mussel beds within the Upper Conner Creek ESL; however, freshwater mussels shells were observed by McBain Associates staff during a site visit in November 2019.

4.3 Amphibians and Reptiles

The ecosystem approach adopted by the ROD is intended to benefits salmonids, native vegetation, and other wildlife populations that inhabit the riverine ecosystem. Two species of note are the foothill yellow-legged frog (*Rana boylii*) and the western pond turtle (*Actinemys marmorata*), both of which are listed as California Species of Concern (Snover and Adams 2016).

4.3.1 Foothill Yellow Legged Frog

The foothill yellow-legged frog (FYLF), once widespread across California, has experienced significant declines across its range. In its 2019 status review of the species, CDFW split the state population into six clades representing different regions within the state. Five of the six clades are now listed as 'threatened" under the California Endangered Species Act (CESA); however, the North Coast clade, to which Trinity River *R. boylii* belong, remained as a "Species of Special Concern" (Jennings and Hayes 1994, Thomson et al. 2016) and is currently in review for federal listing under the 1973 Endangered Species Act (ESA; United States Code [USC], Title 16, Sections 1531 and others). Primary threats to the species include alteration of flow and thermal regimes and other habitat degradation associated with dams, changes in land use, disease, and invasive species pressure (Kupferberg et al. 2013, Adams et al. 2017).

The FYLF has evolved strategies to time reproduction with hydrograph cycles to minimize scour and desiccation risks to eggs while maximizing development time for offspring. In the Mediterranean climate of California, seasonal patterns are somewhat predictable, but the annual variability in hydrograph shape and timing means the frogs do not always get it right; in some years they succeed, and in others they fail. Individual frogs decide when to initiate breeding based on a suite of environmental cues (Wheeler and Welsh Jr. 2008, Lind et al. 2016). Downstream of dams, components of the hydrograph may be decoupled from natural environmental cues, hampering the frogs' ability make the best choice of when and where to oviposit (Lind et al. 2016). On the Trinity River, breeding typically ranges from April through July, depending on water year type, hydrograph timing, distance from Lewiston Dam, and water temperature. Breeding in side channels can occur prior to breeding in the mainstem river.

FYLF surveys in the upper 40-mi of the Trinity River have been conducted by TRRP with data available from 2013 to 2016. Foothill yellow legged frogs were observed in adult, juvenile, larval, and egg-mass life stages within the project site during 2013 and 2016 surveys. Observations were focused around the geomorphically dynamic bars near RM 77.3 and RM 77.9 (Figure 55).

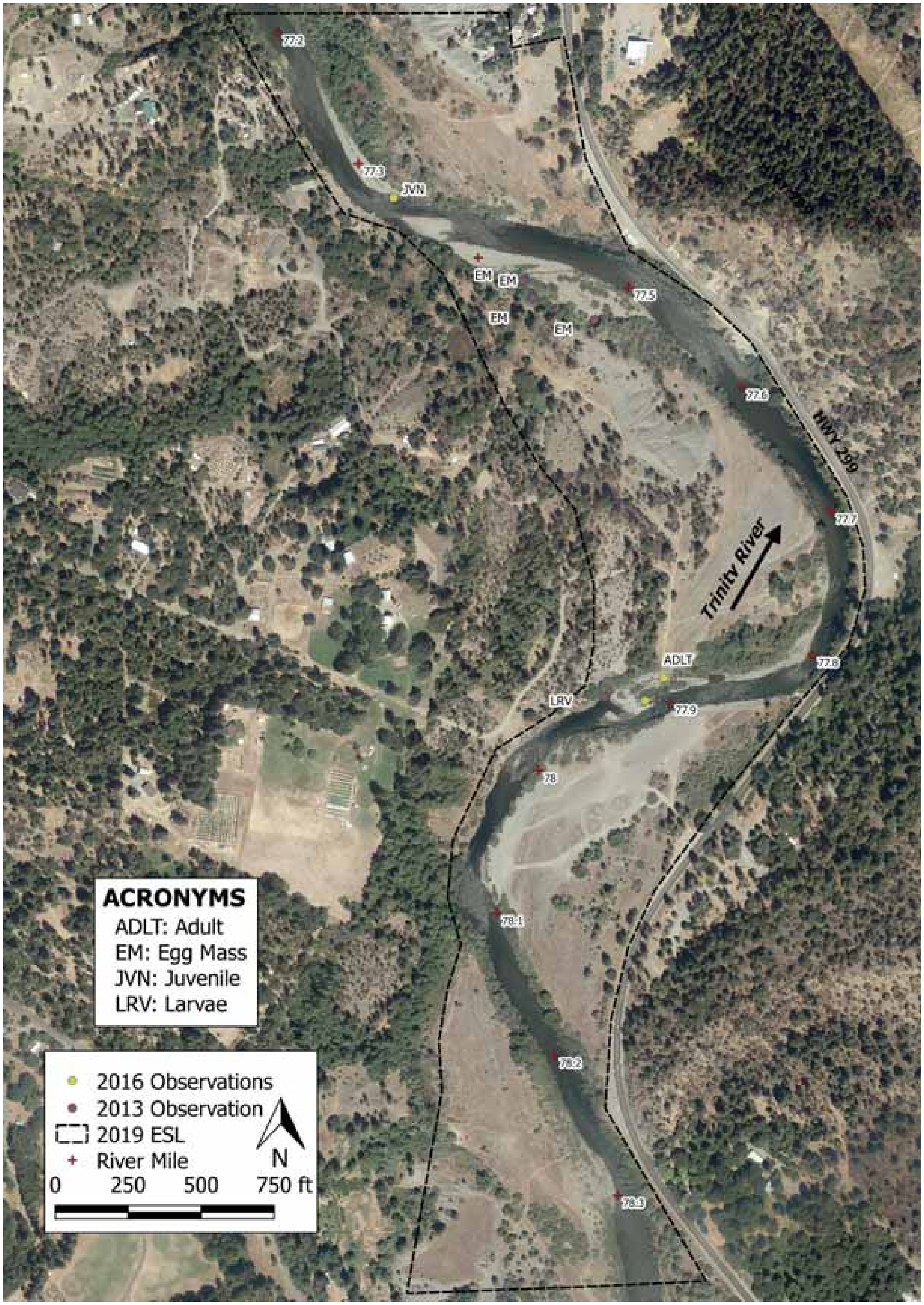


Figure 55. Foothill yellow-legged frog observations within the project site.

4.3.2 Western Pond Turtle

Western pond turtles are widespread along the Pacific Slope of North America and are the only native turtles to California. Though once abundant in suitable habitats across the state, their populations are in decline throughout their historic range due to habitat loss from urbanization and agriculture, water diversions in many of their native waterways, and increased competition from non-native species (Ashton et al. 2011). Mark and recapture along with modeling efforts conducted in Ashton et al. (2011) estimated a population of 220 adult turtles along the mainstem Trinity River between the North Fork confluence and Lewiston Dam though exact reaches turtle captures occurred were not specified. Based on data in the USGS western pond turtle database, an adult turtle was observed within the Upper Conner Creek ESL in 2014 and 2015, while no adult turtles were observed within the ESL during 2016 survey (USGS 2017).

5 SUMMARY

The information presented in the Upper Conner Creek Existing Conditions Report will be used to guide the conceptual designs during the basis of design and into the 30% design process. Constraints and opportunities will be identified based on the existing geologic, hydrologic, and biological conditions of the project site. Bedrock outcroppings and existing infrastructure identified in this document will help guide the potential location of alluvial features throughout the project site. The presence of sensitive wildlife species presents the opportunity to design a project that aims to restore habitat for these species along with juvenile salmonids. Overall, these opportunities and constraints will be the guiding factors through the conceptualization and actualization of the Upper Conner Creek Rehabilitation project.

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7 APPENDIX A: CROSS SECTIONS

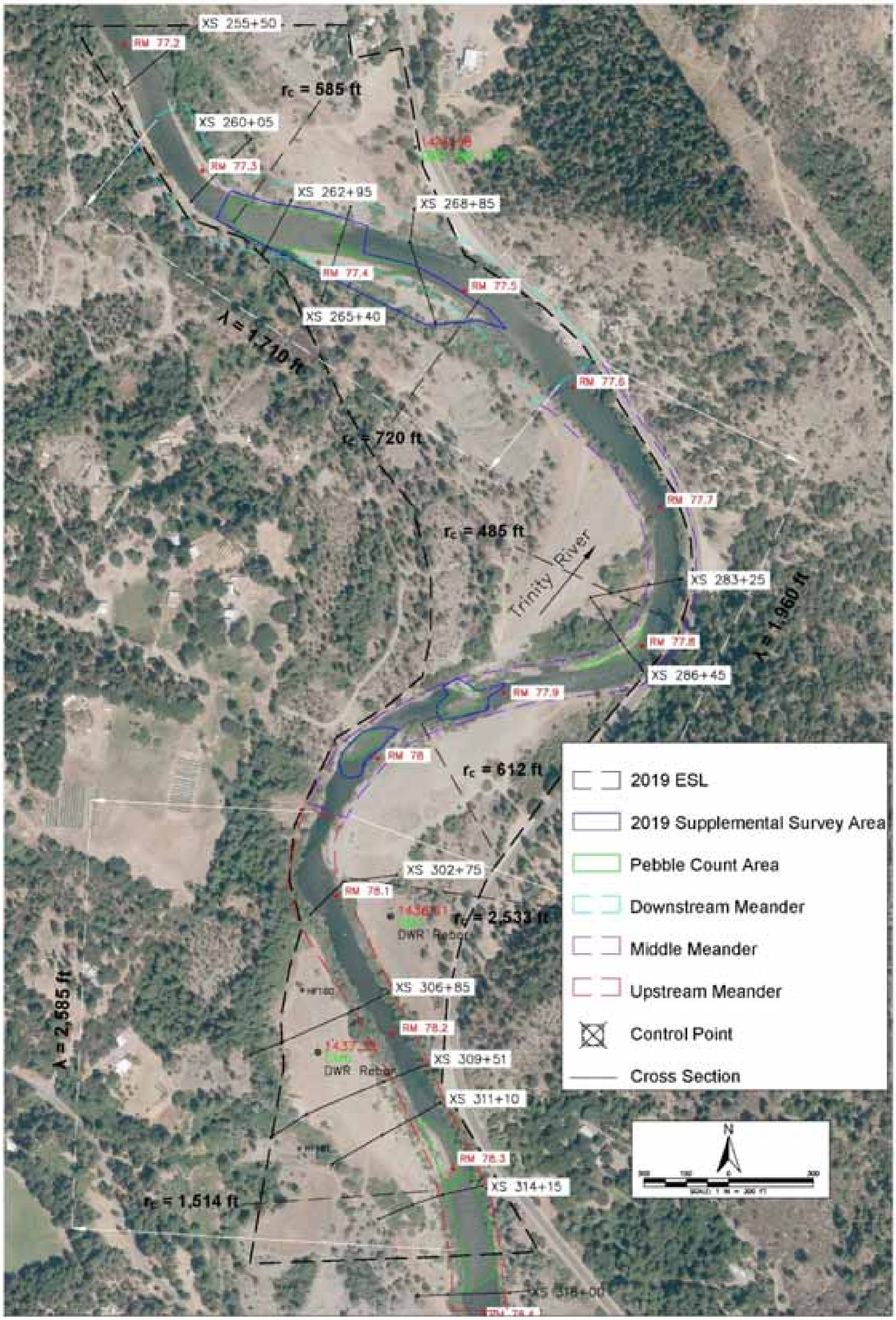

Figure A-1. *Existing cross sections, pebble count locations, and 2019 topographic survey locations.*

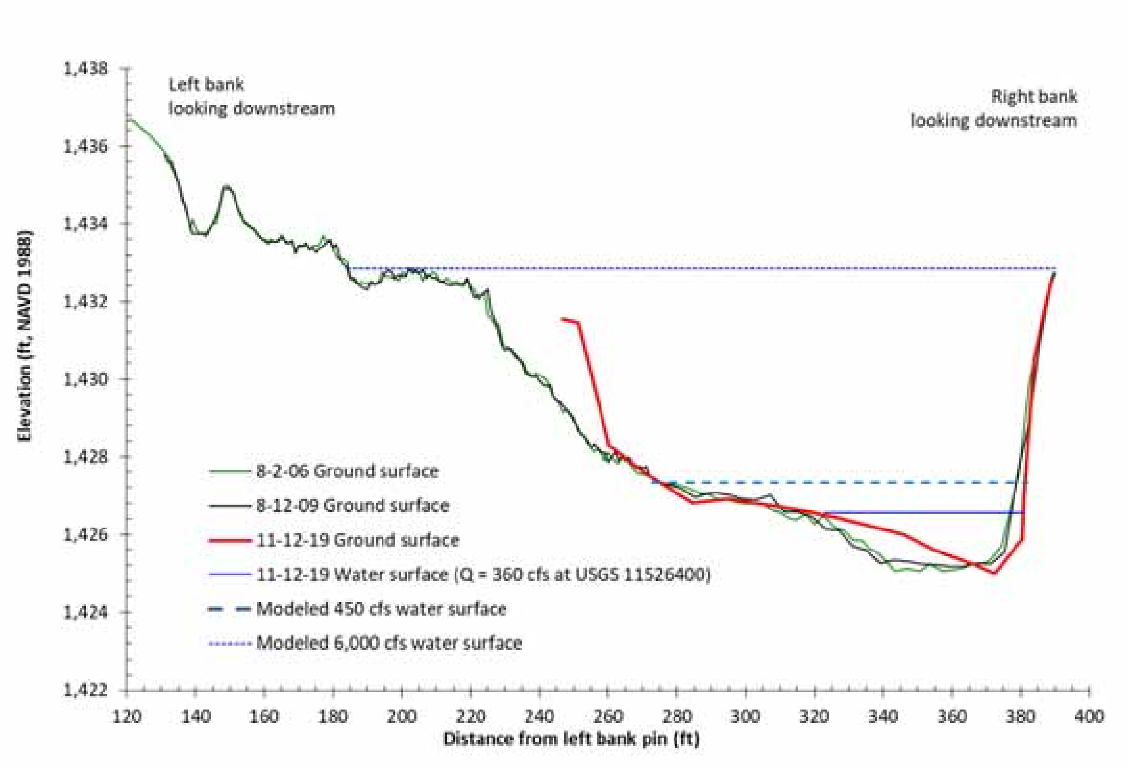

Figure A-2. Trinity River, Upper Conner Creek, Cross Section 314+15.

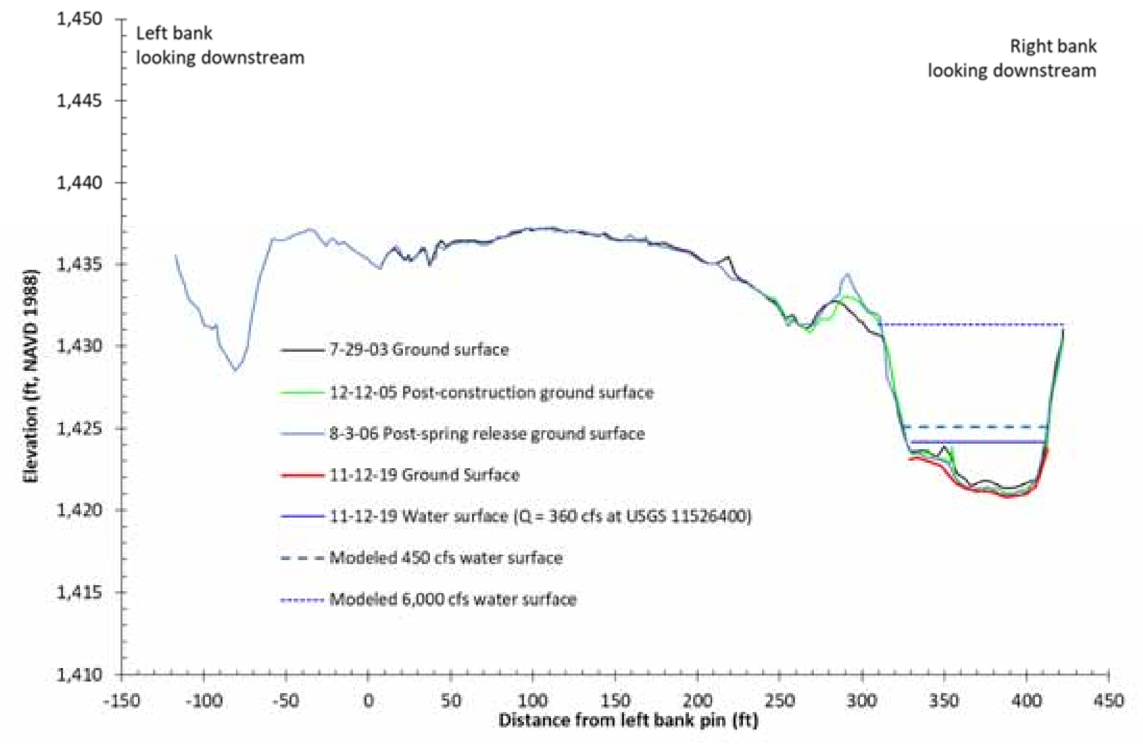

Figure A-3. Trinity River, Upper Conner Creek, Cross Section 306+85.

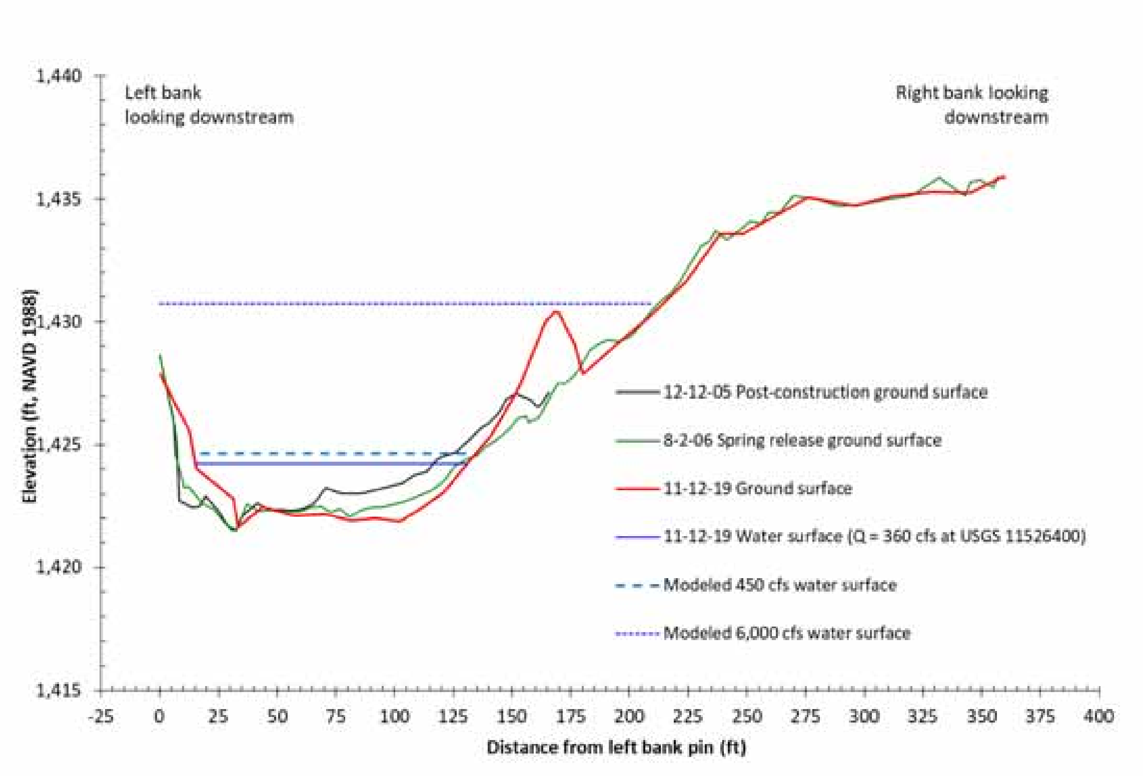

Figure A-4. *Trinity River, Upper Conner Creek, Cross Section 302+75.*

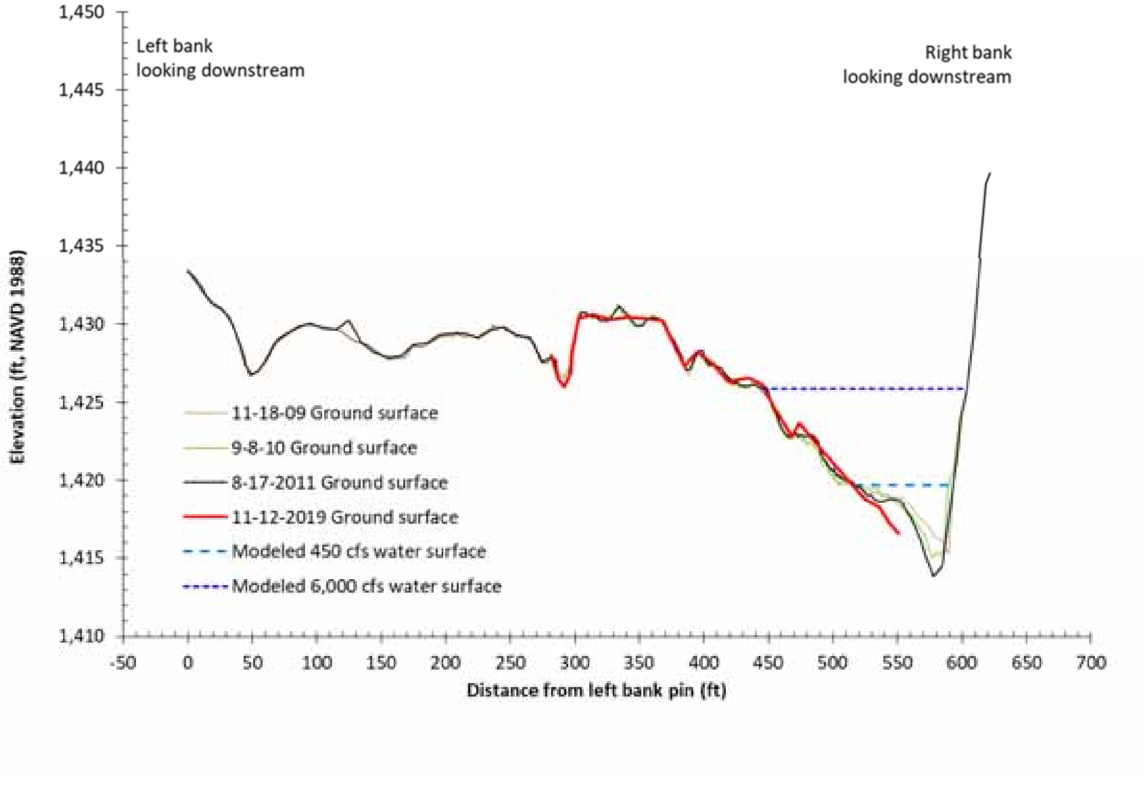

Figure A-5. *Trinity River, Upper Conner Creek, Cross Section 286+45.*

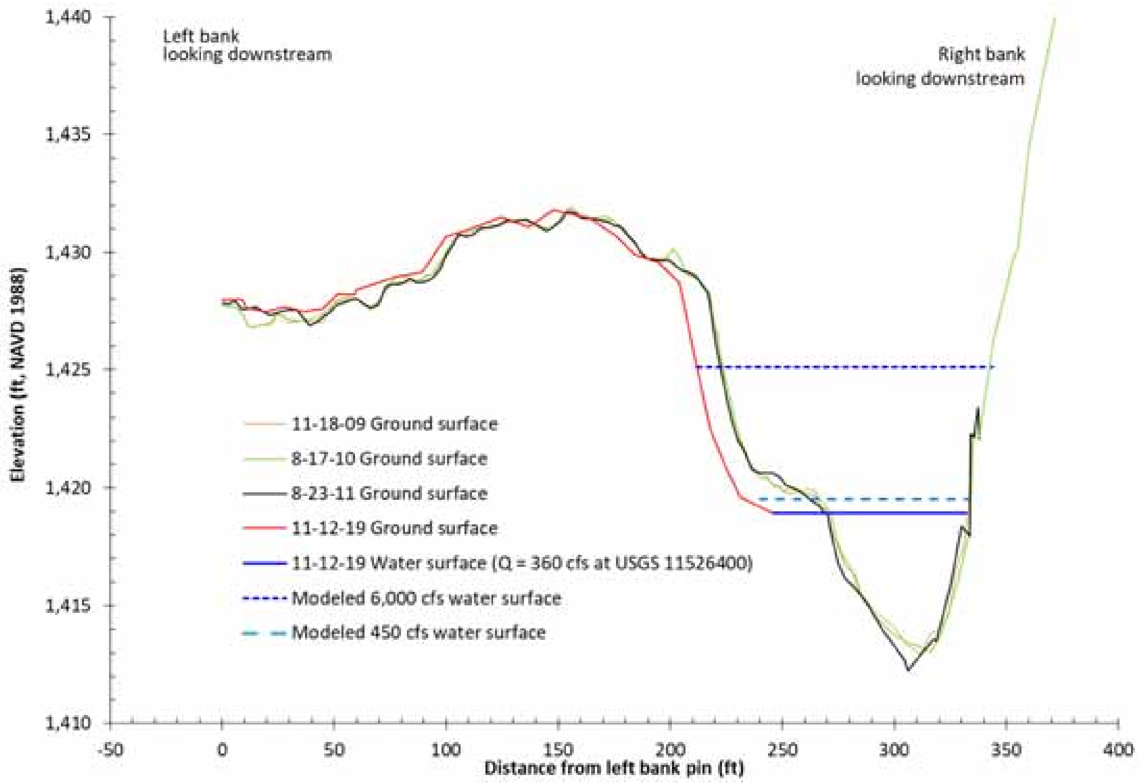

Figure A-6. Trinity River, Upper Conner Creek, Cross Section 283+25.

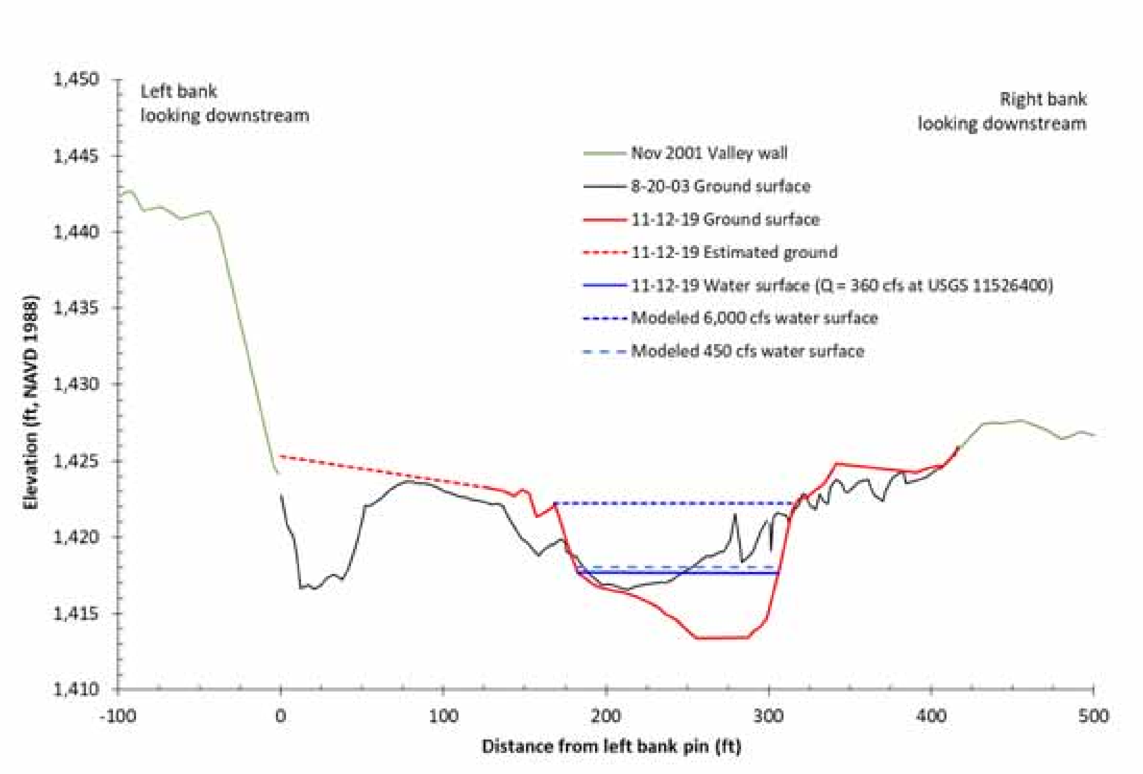

Figure A-7. Trinity River, Upper Conner Creek, Cross Section 268+85.

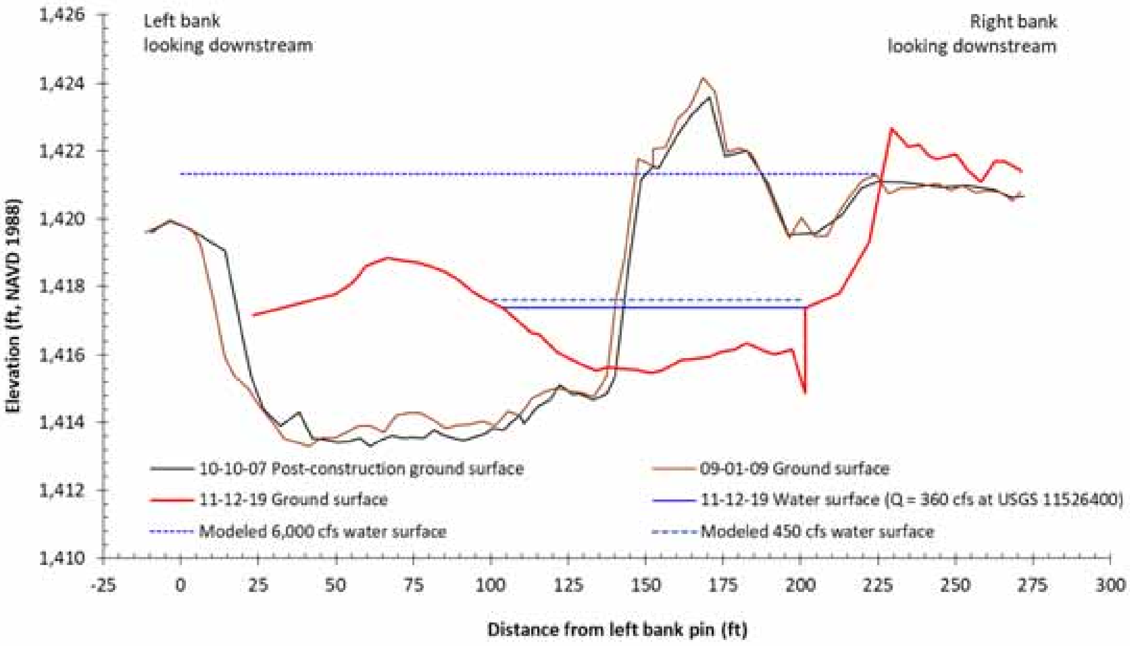

Figure A-8. Trinity River, Upper Conner Creek, Cross Section 265+40.

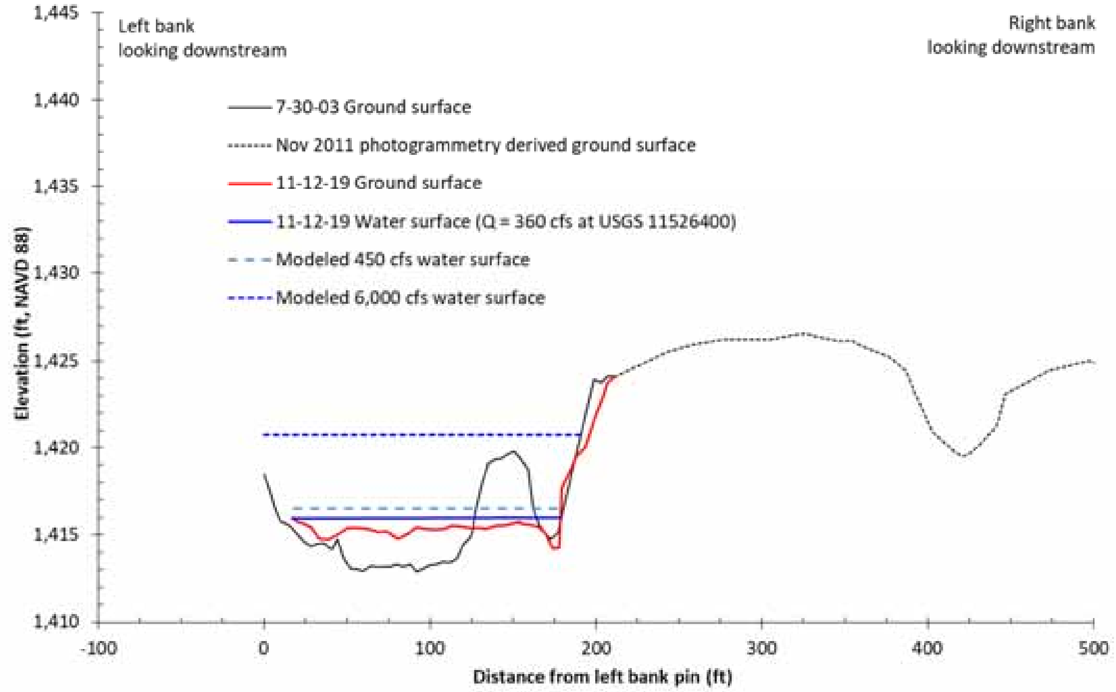

Figure A-9. Trinity River, Upper Conner Creek, Cross Section 262+95.

8 APPENDIX B: SPECIAL STATUS WILDLIFE SPECIES

The Upper Conner Creek ESL exhibits suitable habitat for certain terrestrial and aquatic species of concern. Habitat usage varies seasonally, and surveys of the project ESL are needed to determine current occupation. Twenty-nine special status wildlife species have the potential to occur within the project site ESL (Table B-1), as specified in the 2009 Master EIR for channel rehabilitation and sediment management for the remaining Phase 1 and Phase 2 rehabilitation sites (NCRWQCB and BOR 2009). The list will be updated, and relevant surveys conducted during later design phases.

*Table B-1. Special status wildlife species assessment. Codes: E = Endangered; T = Threatened; D = Delisted; C = Candidate; SC = Species of Special Concern; FP = California Fully Protected Species; * = BLM Sensitive; † = USFS Sensitive (NCRWQCB and BOR 2009).*

Common Name ***Scientific Name***	**Status (Fed/State)**	**General Habitat**	**Comments**
Trinity bristle snail *Monadenia setosa*	Federal: none State: T	Riparian corridors and canyon slopes with dense deciduous understory in Trinity County.	**May be present**. Riparian zones within the project site provide suitable habitat.
California red-legged frog *Rana aurora draytonii*	Federal: T State: SC	Requires aquatic habitat for breeding; also uses a variety of other habitats, including riparian and upland areas.	**Absent**. Sites are not within the current or historic range of this species.
American peregrine falcon *Falco peregrinus anatum*	Federal: D State: E, FP	Forages in many habitats; requires cliffs for nesting.	**Absent as breeder**. Project sites lack suitable nesting habitat, but species may occur as a forager.
Bald eagle *Haliaeetus leucocephalus*	Federal: D State: E	Uncommon to common in riverine and open wetland habitats. Requires large bodies of water or free-flowing rivers with abundant fish for foraging. Nests in large, live trees, usually near water and free from human disturbance.	**May be present**. Suitable nesting habitat is not present at the sites due to lack of dense, large trees and the moderate level of human disturbance. However, the species may forage on the site.
Northern spotted owl *Stix occidentalis caurina*	Federal: T State: none	In northern California, resides in large stands of old growth, multi-layered, mixed conifer, redwood, and Douglas-fir habitats.	**Absent.** Suitable habitat not present within the project site.
Bank swallow *Riparia riparia*	Federal: none State: T	Colonial nesters on vertical banks or cliffs with fine-textured soils near water.	**Absent**. Suitable habitat not present within the project site.
Marbled murrelet *Brachyramphus marmoratus*	Federal: T State: E	Marine subtidal and pelagic habitats; requires dense, mature forests of redwood and Douglas-fir for breeding.	**Absent**. Suitable habitat not present within the project site.
Little willow flycatcher *Empidonax trailii brewsteri*	Federal: † State: E	Rare summer resident in wet meadow and montane riparian habitats at 2,000 to 8,000 feet elevation.	**May be present**. The montane riparian community in the region provides suitable habitat and the species has been observed along the Trinity River corridor.

Common Name ***Scientific Name***	**Status (Fed/State)**	**General Habitat**	**Comments**
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	Federal: C, † State: E	Occurs in cottonwood/willow riparian forest.	**Absent**. Site is not within the currently known range of the species.
California wolverine *Gulo gulo luteus*	Federal: † State: T, FP	A variety of habitats at elevations between 1,600 and 14,200 feet. Most commonly inhabits open terrain above timberline.	**Absent**. Site is not within the currently known range of the species.
Pacific fisher *Martes pennant pacifica*	Federal: C, *, † State: SC	Dens and forages in intermediate to large stands of old-growth forests or mixed stands of old-growth and mature trees with greater than 50% canopy closure. May use riparian corridors for movement.	**Absent as breeder**. This species is not expected to breed on the project site but may use the Trinity River as a travel corridor.
Tailed frog *Ascaphus truei*	Federal: none State: SC	Clear, rocky, swift, cool perennial streams in densely forested habitats.	**Absent**. Suitable habitat not present.
Foothill yellow-legged frog *Rana boylii*	Federal: *, † State: SC	Cool, fast-moving, rocky streams in a variety of habitat.	**Likely present**. Species known to occur in the Trinity River. Verified observations in Upper Conner Creek ESL in 2013 and 2016 (See Section 4.3.1)
Cascades frog *Rana cascadae*	Federal: † State: SC	Open coniferous forests along the sunny, rocky banks of ponds, lakes, streams, and meadow potholes. From 2,600 to 9,000 feet elevation in Cascade and Trinity Mountains.	**Absent**. Project site is below known elevational range of this species.
Western pond turtle *Actinemys marmorata*	Federal: † State: SC	Slow-water aquatic habitat with available basking sites. Requires an upland oviposition site near the aquatic site.	**May be present**. Riverine and riparian habitats along the Trinity River provide suitable habitats. Verified observation of a single adult in the project ESL in 2014 and 2015 (See Section 4.3.2)
Black swift *Cypseloides niger*	Federal: none State: SC	Nests in moist crevices, caves or sea cliffs above the surf, or on cliffs behind or adjacent to waterfalls in deep canyons; forages widely over many habitats.	**Absent as breeder**. The project site does not provide suitable breeding habitat; however, the species may forage over the project site while migrating.
California yellow warbler *Dendroica petechia brewsteri*	Federal: none State: SC	Breeds in riparian woodlands, particularly those dominated by willows and cottonwoods.	**May be present**. Montane riparian habitat along the Trinity River in the project site provides suitable nesting and foraging habitats.

Common Name ***Scientific Name***	**Status (Fed/State)**	**General Habitat**	**Comments**
Golden eagle *Aquila chrysaetos*	Federal: none State: SC, FP	Breeds on cliffs or in large trees or electrical towers, forages in open areas.	**Absent as breeder**. Suitable nesting habitat is absent from the site; however, the species may occur as a forager.
Northern goshawk *Accipiter gentiles*	Federal: † State: SC	Breeds in dense, mature conifer and deciduous forests, interspersed with meadows, other openings and riparian areas; nesting habitat includes north-facing slopes near water.	**May be present**. Woodlands along the Trinity River provide suitable nesting and foraging habitat.
Vaux's swift *Chaetura vauxi*	Federal: none State: SC	Prefers redwood and Douglas-fir habitats; nests in hollow trees and snags, or occasionally in chimneys; forages aerially.	**May be present**. Suitable habitat is present in the project site.
Yellow-breasted chat *Icteria virens*	Federal: none State: SC	Breeds in riparian habitats having dense understory vegetation, such as willow and blackberry.	**May be present**. Montane riparian habitat along the Trinity River in the project site provides suitable nesting and foraging habitat.
Fringed myotis *Myotis thysanodes*	Federal: * State: none	In mesic habitats, roosts in caves, mines, tunnels, and buildings. Roosts typically in valley foothill hardwood and hardwood–conifer habitats, but forages in open early-successional-stage habitats near water. Generally, at 4,000–7,000 ft.	**Absent**. Project site below the known elevational limits of the species.
Long-eared myotis *Myotis evotis*	Federal: * State: none	Found in most habitats but prefers coniferous woodlands. Roosts in buildings, crevices, caves, spaces under bark, and snags. Forages among trees and over brush, usually in close association with water.	**May be present**. Woodlands along the Trinity River corridor provide suitable roosting and foraging habitats.
Oregon snowshoe hare *Lepus americanus klamathensis*	Federal: none State: SC	In California, primarily found in montane riparian habitats and in stands of young conifers interspersed with chaparral. Dense cover is preferred. Primarily occurs in areas with deep winter snow accumulation that persists for several months.	**Absent**. Suitable habitat is not present in the project area.

Common Name ***Scientific Name***	**Status (Fed/State)**	**General Habitat**	**Comments**
Pallid bat *Antrozous pallidus*	Federal: *, † State: SC	Forages over many habitats; roosts in buildings, large oaks or redwoods, rocky outcrops, and rocky crevices in mines and caves.	**May be present**. Suitable habitat is present along the Trinity River corridor.
Ring-tailed cat *Bassariscus astutus*	Federal: none State: FP	Occurs in riparian habitats and brush stands of most forest and shrub habitats. Nests in rock recesses, hollow trees, logs, abandoned burrows, and woodrat nests.	**May be present**. Montane riparian habitat along the Trinity River corridor provides breeding and foraging habitat.
Townsend's western big-eared bat *Corynorhinus townsendii*	Federal: *, † State: SC	Roosts in colonies in cave, mines, bridges, buildings, and hollow trees in a range of habitats. Forages along habitat edges. Habitat must include appropriate roosting, maternity, and hibernacula sites free from human disturbance.	**May be present**. Suitable habitat is present along the Trinity River in the project site.
American marten *Martes americana*	Federal: † State: none	Mature, complex evergreen forests with abundant cavities for denning and nesting and open areas for foraging.	**Absent**. Proper forest habitat not present within the project site.
Yuma myotis *Myotis yumanensis*	Federal: * State: none	Forages over water such as ponds, streams, and stock tanks in open woodlands. Roosts in buildings, caves, mines, abandoned swallow nests, bridges, and rock crevices.	**May be present**. Suitable habitat is present along the Trinity River in the project site.