Appendix I – Water Quality and Hydrology Technical Report

WATER QUALITY AND HYDROLOGY

TECHNICAL REPORT

TRINITY RIVER WATERSHED RESTORATION PROJECT

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PROJECT #63121 (FOREST SERVICE)

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ACS	Aquatic Conservation Strategy
AREMP	Aquatic and Riparian Effectiveness Monitoring Program
BLM	U.S. Bureau of Land Management
BMPs	Best Management Practices
CFR	Code of Federal Regulations
CR	Congressionally Reserved Lands
CVP	Central Valley Project
DOI or USDI	U.S. Department of the Interior
EA	Environmental Assessment
EIS	Environmental Impact Statement
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
GPM	General Protection Measure
HUC	Hydrologic Unit Code
LRMP	Land Resource Management Plan
LSR	Late Seral Reserves
NCIP	Northwest California Integrated Resource Management Plan
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NWFP	Northwest Forest Plan
Project	Trinity River Watershed Restoration Project
Reclamation	U.S. Bureau of Reclamation
Regional Water Board	North Coast Regional Water Quality Control Board
RFO	Redding Field Office
ROD	Record of Decision
RSI	Remote Site Incubation
SLJ	Structured Log Jams
STNF	Shasta-Trinity National Forest
TMC	Trinity Management Council
TMDL	Total Maximum Daily Load
TRRP	Trinity River Restoration Program
TRFES	Trinity River Flow Evaluation Study

USDA	U.S. Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service

Executive Summary

This Technical Report analyzes the effects to the physical attributes of the Trinity River watershed, specifically water quality and hydrology, as a result of activities proposed as part of the Trinity River Watershed Restoration Project (Project). A detailed list of all general protection measures (GPMs), design guidelines, and conservation measures (CMs) by resource are included in Appendix B of the EA. This effects analysis (summarized below) considers both a Proposed Action and a No Action alternative and focuses on the watershed processes, characteristics, and conditions that would be changed with and without implementation of proposed restoration activities.

Table ES - 1. Summary of Project effects to the water quality and hydrology of the Trinity River watershed.

Attributes	Effects Summary
Water Quality	• Ground-disturbing restoration activities would have minor short-term sedimentation and turbidity effects to varying degrees. The duration of most turbidity plumes would be limited to hours or days, though large projects may continue to produce turbidity (though gradually declining) for weeks. Pulses of turbidity would be anticipated as flow is returned to the dewatered or dry channels. Turbidity may also occur during the first storm event following restoration. • Minor short-term increases in stream temperatures due to construction-related disturbance of riparian vegetation along stream channels and work area isolation/dewatering activities. • Long-term minor beneficial effects to water quality because of an increase in sediment storage capacity within Project waterways; a decrease of sediment discharge and roadway runoff as a result of the maintenance and decommissioning of roads; and improvements to water temperatures with installation of instream habitat features, aquatic and riparian habitat enhancements, and improved floodplain connectivity.
Hydrology	• Long-term minor beneficial effects to instream flow in Trinity River tributaries as a result of water conservation activities.

1 Proposed Action

The Trinity River Restoration Program (TRRP) under the Bureau of Reclamation (Reclamation) is the lead agency and the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) are cooperating agencies for the Project, the purpose of which is to improve instream and riparian habitat at a watershed scale and to accelerate the recovery of north coast salmon populations (coho salmon, steelhead, and Chinook salmon), thereby fulfilling tribal trust responsibilities and obligations to local communities as well as recreational and commercial fishing industries (per the Shasta-Trinity National Forest [STNF] Land and Resource Management Plan [LRMP], BLM's Redding Field Office [RFO] Northwest California Integrated Resource Management Plan [NCIP], and state and federal recovery plan goals [NMFS 2014; California Department of Fish and Game 2004]).

The following describes the overall objectives of the Proposed Action:

- Restore and improve instream conditions sufficient to support all life stages of salmonids and other aquatic species.
- Restore upstream and downstream fish passage for all life stages of salmonids.
- Restore continuous paths for wood dispersal, nutrient cycling, sediment transport, and movement of other vegetative material essential for productive aquatic habitat.
- Maintain or restore native plant communities and vegetative structure impacted by invasive plants and pathogens, while rehabilitating eroding streambanks to improve water quality, shade conditions, and large wood recruitment.
- Repair, replace, or remove ineffective instream structures.
- Restore and improve riparian and meadow habitat in order to promote healthy conditions for aquatic and terrestrial wildlife populations.
- Improve late summer/fall base flow conditions through process-based restoration, water conservation improvements, and meadow restoration.

The Proposed Action consists of a suite of instream and riparian restoration activities that are designed to meet the objectives described above. Detailed descriptions of each of the proposed activity categories are included in Chapter 3 of the Project's Environmental Assessment (EA) document. Proposed Activities are grouped into three general categories: instream habitat restoration; upslope habitat restoration; and road maintenance, rehabilitation, and decommissioning activities. The activities proposed under each of these categories are summarized below.

Instream Habitat Restoration:

- Restoration and Enhancement of In-Channel Habitat
- Floodplain Restoration
- Removal or Retrofitting of Fish Passage Barriers, Small Dams, Flood Gates, Pilings and Other In-water Structures
- Water Conservation Projects

- Salmon Carcass Placement
- Remote Site Incubators

Upslope Habitat Restoration:

- Bioengineered Bank Stabilization
- Aquatic, Wetland, Riparian, and Upslope Habitat Enhancement

Road Maintenance, Rehabilitation, and Decommissioning Activities:

- Road Maintenance
- Road Rehabilitation
- Road Decommissioning

The proposed activities would occur within a portion of the Trinity River watershed shown in Figure 1-1 below. Individual restoration actions would take place in and along tributaries of and the mainstem Trinity River (both above and below the Lewiston and Trinity dams) on both private (with permission of the landowner) and public lands (primarily managed by USFS and BLM).

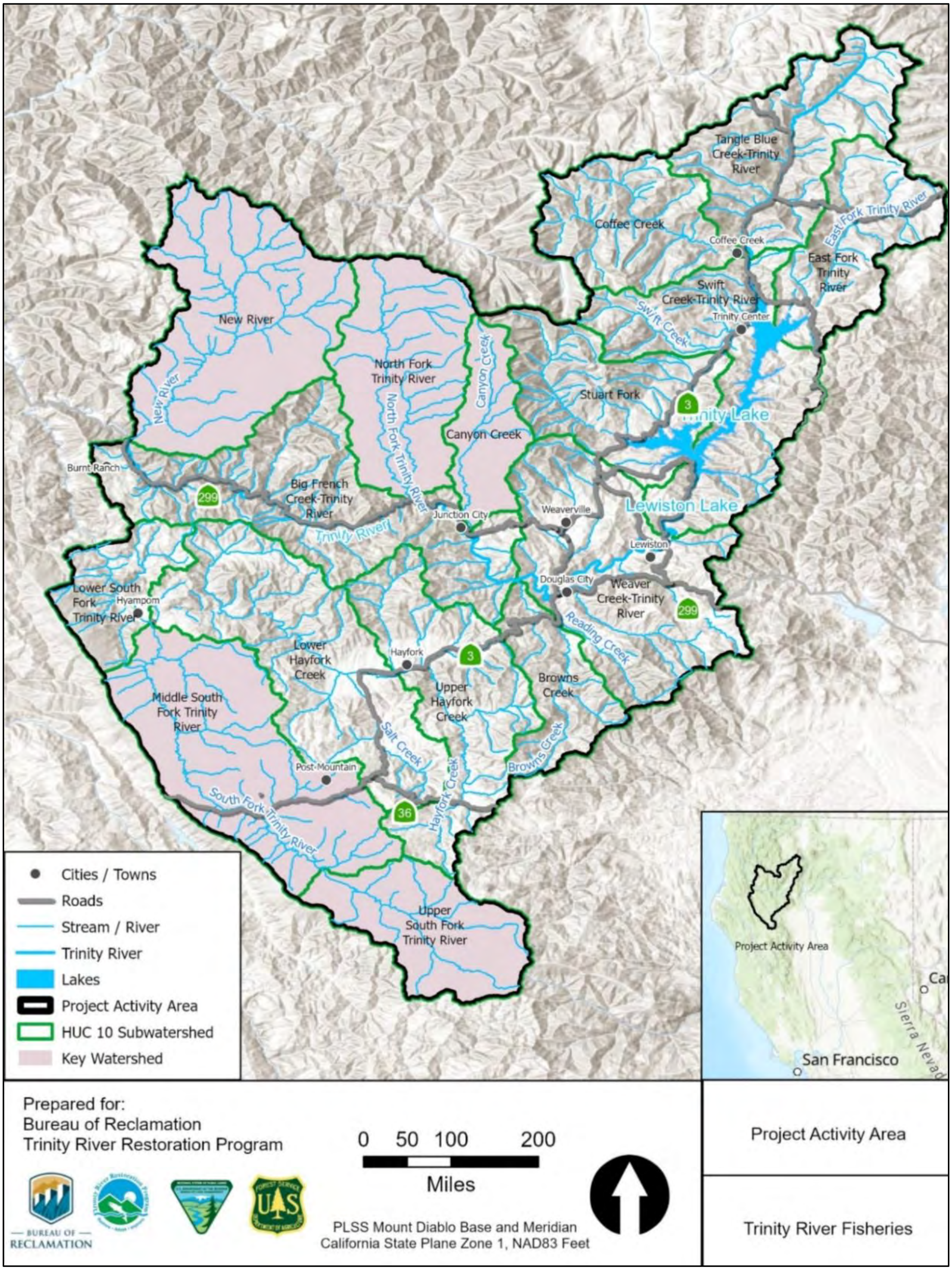

Figure 1-1. Project Activity Area (including Key Watersheds)

Key watersheds (further described below) within the restoration activity area include North Fork Trinity River, South Fork Trinity River, Canyon Creek, and New River. These watersheds are particularly important because of the instream habitat that they provide for aquatic species. Within these watersheds, new roads are prohibited in roadless areas, and a no net increase of roads outside roadless areas is enforced by the USFS with the intent of preventing further habitat degradation.

For the EA, including this technical report, effects analyses were performed for each of the hydrological unit code 10 (HUC 10) watersheds. See Table 1-1 below for watersheds included in the Project activity area.

Table 1-1. HUC 10 Watersheds within the Trinity River Basin.

Subregion (HUC 4)	Basin (HUC 6)	Subbasin (HUC 8)	Watershed (HUC 10)	HUC 10 Number	Acres in Project Activity Area
Klamath-Northern California Coastal 1801	Northern California Coastal 180102	Trinity California 18010211	Big French Creek-Trinity River[1]	1801021111	153,325
			Browns Creek	1801021106	47,110
			Canyon Creek[4]	1801021108	41,033
			Coffee Creek	1801021101	74,835
			East Fork Trinity River	1801021103	74,335
			Horse Linto Creek-Trinity River[2]	1801021112	0
			New River[4]	1801021110	149,597
			North Fork Trinity River[4]	1801021109	97,483
			Stuart Fork	1801021104	88,264
			Swift Creek-Trinity River	1801021105	121,055
			Tangle Blue Creek-Trinity River	1801021102	101,393
			Weaver Creek	1801021107	142,030
		South Fork Trinity 18010212	Lower South Fork Trinity River[3,4]	1801021205	44,229
			Lower Hayfork Creek	1801021203	142,161
			Upper Hayfork Creek	1801021202	105,697
			Middle South Fork Trinity River[4]	1801021204	145,776
			Upper South Fork Trinity River[4]	1801021201	73,634

1. A portion of Big French Creek is excluded from the Project activity area, namely the Sharber Creek HUC 12 subwatershed, because it is in the Six Rivers National Forest.
2. Horse Linto Creek is located in the Six Rivers National Forest and is not included in the Project activity area.
3. A portion of Lower South Fork Trinity River is excluded from the Project activity area, namely Grouse, Mingo, and Old Campbell Creeks (HUC 12 subwatersheds), because they are located in the Six Rivers National Forest.
4. ACS Key Watersheds

2 Environmental Setting

The Trinity River basin is 2,861 square miles and is the largest tributary to the Klamath River. From Lewiston Dam, the Trinity River flows westward for 112 miles then enters the Klamath River near the town of Weitchpec, California. The Trinity River passes through Trinity and Humboldt counties and the Hoopa Valley (Hoopa Tribe) and Yurok Indian Reservations. The Klamath River flows northwesterly for approximately 40 miles from its confluence with the Trinity River before entering the Pacific Ocean near Requa, California.

The Trinity River originates in the rugged Salmon-Trinity Mountains of northern California in the northeast corner of Trinity County, California. It is located within two different geologic provinces, the inland Klamath Mountain and Coast Range provinces. Plate tectonics processes took a relatively thin oceanic plate and collided with a thicker, more buoyant continental crust, uplifting and deforming it to produce today's complex landscape. The Coast Range Province, which consists primarily of the Franciscan Assemblage and the South Fork Mountain Schist which is composed of generally unstable rocks of sedimentary and volcanic origin. The majority of the Trinity River basin lies within the Klamath Mountain Province to the east, formed by older metamorphic and igneous intrusive or plutonic rocks. Large granitic intrusions exist in the headwaters of Grass Valley Creek and along Rush and Weaver creeks, all originating in the Trinity Alps. Highly erodible slopes in these tributaries are a chronic source of fine sediment to the Trinity River system.

The Trinity River is an important water source for irrigation, hydroelectricity generation, and provides important habitat for threatened and endangered salmonid species. River channels are formed and maintained by the dynamic interaction of three primary components: sediment of various size classes, varying quantities and ages of vegetation, and varying amounts of water. Complex interactions between these three components define the geomorphic environment and provide a diversity of physical structures (TRRP 2007). This complexity provides a variety of riverine and riparian habitats that can be used by different species under a range of flows.

2.1 Water Quality

The Proposed Action is subject to compliance with the Basin Plan (North Coast RWQCB 2011). The beneficial uses for the Trinity River are outlined in Table 2-1 of the Basin Plan. In addition to municipal and domestic water supply, the beneficial uses affected by the water quality of the Trinity River are primarily those associated with supporting high-quality habitat for fish. Recreation (contact and non-contact) is another important beneficial use potentially affected by various water quality parameters (e.g., sediment and temperature). The Basin Plan identifies both numeric and narrative water quality objectives for the Trinity River.

Every six years the Regional Water Board evaluates water quality information and identifies waterbodies that do not meet water quality standards and are not supporting their beneficial uses. Those waters are placed on a list of impaired water bodies that identifies the pollutant or stressor causing impairment and establishes a schedule for developing a control plan to address the impairment (North Coast RWQCB 2024). The Trinity River basin is listed as impaired for several parameters as summarized in Table 2-1 below.

Section 3.4 of the Trinity River Mainstem Fishery Restoration EIS/EIR (USDI 2000) summarizes the water quality objectives for each of the categories that have been established by the Regional Water Board to protect designated beneficial uses. The 2000 Environmental Impact Statement/Environmental Impact Report (EIS/EIR) also provides a comprehensive discussion of water quality parameters that influence water quality in the 40-mile reach of the Trinity River below Lewiston Dam with respect to the Lower Klamath watershed and the Central Valley.

The discussion below focuses on sedimentation and temperature because these are the parameters that the Proposed Action could affect.

Table 2-1. Impaired Waterbodies within the Trinity River basin.

Waterbody Name	Listing Extent	Parameter
Lower Trinity River HA[1]	Entire waterbody except: (1) the New River and its tributaries, (2) Big French Creek and its tributaries, (3) the North Fork Trinity River and its tributaries, including the East Fork North Fork Trinity River and its tributaries, and (4) Manzanita Creek and its tributaries.	Sedimentation/ Siltation
Middle Trinity River HA	Entire waterbody	Sedimentation/Siltation
South Fork Trinity HA	Entire waterbody	Sedimentation/Siltation Temperature
Trinity Lake (was Claire Engle Lake)	Entire waterbody	Mercury
Upper Trinity River HA	Entire waterbody except the Stuart Fork and its tributaries	Sedimentation/ Siltation
Upper Trinity HA, Trinity River, East Fork Trinity River	Entire waterbody	Mercury Sedimentation/Siltation

1. HA: Hydrologic Area is a major subdivision of a hydrologic unit utilized by the Regional Water Board in analyzing water quality within waterbodies. Best described as major tributaries of a river, large valley groundwater basin, or a component of a stream or desert basin group.

2.1.1 Suspended Sediment and Turbidity

The Trinity River was added to the Environmental Protection Agency's (EPA's) list of impaired rivers in 1992, under the provisions of Section 303(d) of the Clean Water Act, in response to the State of California's determination that the river's water quality standards were not being met due to excessive sediment. In 1998, the EPA established a Total Maximum Daily Load (TMDL; EPA 1998) for sediment in the South Fork Trinity River and Hayfork Creek. In 2001, another sediment TMDL (EPA 1998) was issued for the Trinity River. The Regional Water Board has continued to identify the Trinity River as impaired in subsequent listing cycles.

The primary concern with too much or too little sediment transport within the river is the effect it has on aquatic habitat that supports fish species, including anadromous salmonids. Too much fine sediment in the river and spawning gravels could be smothered; too little sediment in the water and sediment transport decreases to a level where habitat complexity decreases which can also have adverse effects to aquatic fish and wildlife species.

TRRP now reports that Record of Decision (ROD) flows have mobilized the excessive fine sediment from the stretch of river below the dams may now experience a deficit of fine sediment in this area (Buxton 2021). The primary issue now is that sediment inputs from upstream areas get trapped on the upstream end of the dams. This has contributed to the degraded sediment conditions within the Trinity River mainstem below the dams. The Trinity River now typically runs clear with background turbidity levels in the range of 0 to 1 nephelometric turbidity units (NTU) during low-flow conditions (300 to 450 cfs).

2.1.2 Temperature

Water temperature is one of the most important variables affecting salmonids and other aquatic organisms (Carter 2005). Temperature influences feeding rates and growth, metabolism, development, timing of migration, spawning and rearing, and the availability of food. Water temperatures in the Trinity River are primarily influenced by dam releases, flows, and distance downstream from the Lewiston Dam. TRRP, in collaboration with Reclamation and other decision makers, has been using flow management practices to meet specific temperature management targets, and temperature monitoring data have been collected as part of the Adaptive Environmental Assessment and Management (AEAM) process since 2002.

Since the construction of the Trinity River Division (TRD), discharges from Lewiston Dam have had a significant effect on water temperatures in the Trinity River downstream. Reservoir releases from Lewiston Dam have altered the natural temperature regime, making the river warmer in the winter and colder in the summer than under pre-dam conditions. Depending on the water year type and time of year, this effect diminishes to varying degrees with distance from Lewiston Dam.

Reclamation has worked to meet water temperature objectives and targets for protecting adult salmonids upstream of the North Fork Trinity River (adult holding targets) and out-migrating juvenile salmonids throughout the mainstem river, as measured at Weitchpec (outmigration targets), since the inception of TRRP in 2000. The adult holding temperature targets (Table 2-2) are implemented as part of the Basin Plan and WRO 90-05 and compliance is monitored by the Regional Water Board.

Table 2-2. Basin Plan and WRO 90-05 Temperature Objectives.

Location Measured	Dates	Target or Range
Douglas City	July 1 – September 14	≤60°F (15.5°C)
Douglas City	September 15 – 30	≤56°F (13.3°C)
North Fork Trinity River	October 1 – December 31	≤56°F (13.3°C)

In recent years, there have been studies indicating lower temperatures would be beneficial for coho survival. Recent studies (Martin et al. 2017; Anderson et al. 2022) have found that even the survival of Chinook salmon eggs, which are not as sensitive as coho salmon eggs, decreases rapidly as water temperatures increase above 53.5 °F (11.9°C) under natural spawning conditions. In 2022, TRRP recommended that Reclamation manage instream temperatures to less than 50°F (10°C) between October 1 and December 31, to support the survival of both Chinook salmon and coho salmon eggs in alignment with updated fisheries research.

2.2 Hydrology

California's Mediterranean climate brings challenges with cool, wet winters and hot, dry summers significantly increasing risks of wildfires. All other regions in the United States have precipitation year-round occurring heaviest in the spring and summer. Annual precipitation over the Trinity River watershed averages 57 inches (1,400 mm). Precipitation ranges from 37 inches (940 mm) in lowlands around Weaverville and Hayfork, to as high as 85 inches (2,200 mm) in mountain ranges closer to the coast. The high rainfall rates combined with rugged geography results in rapid runoff and a high risk of flooding during winter storms. Large volumes of rock and sediment carried by floods are spread along the rivers forming wide alluvial channels.

The Trinity River is predominantly a rain-fed river below Lewiston and Trinity dams. The highest flows occur between December and April. Large intense Pacific storms (often referred to as the Pineapple Express) frequently strike California's north coast causing rapid runoff events and flooding. Little to no precipitation occurs in summer (August through October) and very low flow and warm waters limit available fisheries habitat during this time. The primary source of summer flow is groundwater base flow and snowmelt (when snowfall persists at higher elevations).

Historically, the Trinity River functioned as a dynamic river reach that provided quality spawning and rearing habitat for anadromous fish. Gold was found by settlers at Reading Bar near Douglas City in 1848 and by 1849 the Gold Rush was in full swing. The mining practices and water diversions that were constructed wreaked havoc in Northern California, including the Trinity River basin. Roads were built to access gold rapidly. The steep rugged terrain and complex geology of the region did not impede development. The construction of Trinity Dam (California's 3rd largest reservoir holding 2.4 million acre-feet [MAF]) began in 1956 and was finished in 1960 as part of the Central Valley Project (CVP) to divert water to the Sacramento River Basin. Lewiston Dam was completed in 1963 as the afterbay of the Trinity Power Plant. These Trinity River components of the CVP form the TRD.

After the establishment of the TRD, flow regulation on the Trinity River eliminated nearly all high flows adequate to form and maintain the alluvial river, and reduced scour by winter floods downstream of Lewiston (USFWS and HVT 1999). At times (starting in 1964), 90% of the Trinity River flow was diverted to the Sacramento River basin, also contributing to the decline of Chinook salmon, coho salmon, and steelhead (NMFS 2014). To address these precipitous declines, numerous pieces of legislation and a decades-long study led to the completion of the Trinity River Flow Evaluation Study (TRFES) by USFWS and HVT (1999) and the subsequent Trinity River FEIS and ROD. Following the signing of the ROD, the Department of the Interior (DOI) established the TRRP and opened Reclamation's TRRP office in 2002 to coordinate and oversee the restoration of fish and wildlife populations of the Trinity River affected by dam construction and related diversions. The TRRP is mandated by Congress to restore anadromous fisheries to pre-dam levels and implements variable annual instream flows ("ROD releases") to improve habitat-forming flows within the Trinity River. ROD releases from Lewiston Dam are determined by the TRRP through the recommendations of the Trinity Management Council (TMC). In addition, today, flow diversion from the Trinity River basin to the Sacramento River basin has been adjusted so that about 50% of flows are kept in the Trinity River system downstream of the dams.

Until recently, TRRP flow management resulted in most of the annual water volume being released after April 15 with a baseflow of 300 cubic feet per second (cfs) for seven months of the year (October to April) when streams in the region experience their largest and most variable flow events. During the first half of the water year (October 1 to April 15), the flow regime released approximately 20% of the entire water year's total flow. Without the operation of Trinity and Lewiston dams, approximately 50% of the total flow during the water year would occur between October 1 and April 15. However, starting in water year 2024, the TMC approved the TRRP-recommended winter variable flows and implementation of this program is underway. This program aims to mimic a more natural flow regime in support of the anadromous fisheries in the Trinity River. Undammed tributaries to the Trinity River naturally flow higher during winter storm events and as high-elevation snowpack melts in early spring.

2.3 Aquatic Conservation Strategy

The Northwest Forest Plan (NWFP) developed an aquatic conservation strategy (ACS) with the primary objective of maintaining and restoring degraded habitats and ecosystem health at watershed and landscape scales. While promoting enhanced species distribution, diversity, and complexity of watershed-level features and processes to which aquatic and riparian species are uniquely adapted. This approach seeks to prevent further habitat degradation and restore habitat over broad landscapes as opposed to implementing individual projects or focusing on small watersheds. The objectives and components of the ACS are described further below.

2.3.1 ACS Components

- **Key Watersheds** (See Figure 1-1 and Table 2-1 above) – Four key watersheds within the Project activity area are the North Fork Trinity River, South Fork Trinity River, Canyon Creek, and the New River. New roads are prohibited in roadless areas, and a no net increase of roads outside roadless areas is enforced. USFS manages four primary tier key watersheds in the upper Trinity River watershed, primarily associated with the Trinity Alps Wilderness Area.
- **Watershed Analysis** – This process is used by BLM and USFS to summarize the existing characteristics of the watershed and is discussed more below.
- **Riparian Reserves** – These areas include all permanently flowing and intermittent streams, lakes, and wetland areas that are greater than one acre. Riparian reserves are commonly considered to as a buffer zone around stream courses.
- **Watershed Restoration** – Restoration activities have been implemented as part of the NWFP over time and the results of which are monitored by the Aquatic and Riparian Effectiveness Monitoring Program (AREMP). Some of this program's results related to water quality are discussed below.

2.3.2 Watershed Analysis

Per NWFP guidance, many watersheds in the Trinity River Basin were assessed utilizing the *Ecosystem Analysis at the Watershed Scale, Federal Guide for Watershed Analysis* (Regional Interagency Executive Committee and Intergovernmental Advisory Committee 1995). A watershed analysis describes not only the general location, local setting, and communities within; but also the climate, geomorphology, geology, soils, historic value, recreation uses, forest plan management direction, and goals for future restoration.

Watershed analysis/assessment reports[1] have been prepared for watersheds within the Project activity area and are in the process of being updated to reflect changed conditions such as wildfire and watershed restoration. These are listed below.

Trinity River (18010211):

- Big French Creek (2017/2010)
- Burnt Ranch and Soldier Creek (2009)
- Upper Trinity River (Trinity River, Coffee Creek, East Fork Trinity River, Stuart Fork, Trinity Reservoir; 2005)
- Weaverville (Weaver and Rush creeks 2005)
- North Fork Trinity River, East Fork North Fork Trinity River, and Canyon Creek (2003)
- Mainstem Trinity River (1995)
- South Fork Trinity River (18010212):
- Eltapom Creek and Corral Creek (2017)
- Hyampom Watershed (2011)

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[1] "Watershed Analysis/Assessment Reports" can be found at: https://www.fs.usda.gov/main/stnf/landmanagement/planning

- Big Creek (2008)
- Hidden Valley, Plummer Creek and Rattlesnake Creek (2001)
- Middle Hayfork and Salt Creek (2000)
- Upper South Fork Trinity River - Happy Camp Creek (1999)
- East Fork/Smoky Creek (1998)
- Upper Hayfork Creek (1998)
- Lower Hayfork (1996)
- Butter Creek (1994)

By its nature, this Project is a comprehensive ecosystem restoration project intended to restore the physical processes and biological resources of the Trinity River watershed. The scope and scale of this Project promotes activities for restoration of ecological processes and functions that are expected to be consistent with the ACS. As project activities would be accomplished at the watershed scale, resource specialists completed their analysis using a conservative approach, analyzing all areas where proposed project activities would be feasible and appropriate. The intent of the Proposed Action is to enhance habitat function in the watershed, increasing its resilience to a increased average temperatures, precipitation extremes, and wildfires, while restoring and conserving anadromous fish habitat, and ultimately meeting ACS goals and objectives.

2.3.3 Effectiveness Monitoring Results

Displayed below are monitoring results specific to sedimentation provided by of the Aquatic and Riparian Effectiveness Monitoring Program (AREMP, Dunham et al. 2023) that show a decrease in annual fine sediment in sampled subwatersheds within Late Seral Reserve (LSR), Matrix, and Congressional Reserve (CR) forest stands over time.

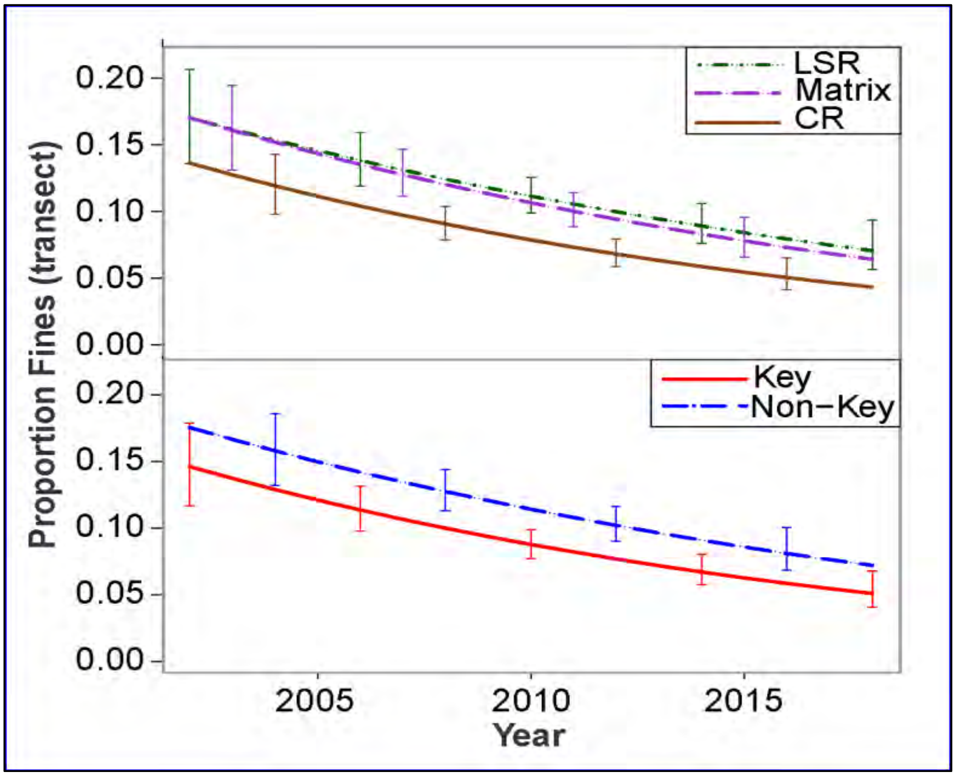

Figure 2-1. Trends in Proportion of Instream Fine Sediments from Transect-based Sampling for the 2002-2018 Time Period by Key and Non-Key Watershed in LSR, Matrix, and CR forest stands (Dunham et al. 2023).

These results indicate that aquatic habitat conditions are improving, in terms of fine sediment deposits, within both actively managed matrix lands as well as within reserves since the Northwest Forest Plan (NWFP) was initially developed. This and other indicators of the long-term benefits of watershed restoration activities are being monitored over time. The Project would be a continuation of these restoration efforts and was developed using the ACS objectives that would benefit populations of native cold-water fishes throughout their life cycles (Beechie et al. 2013, Bisson et al. 2009).

3 Environmental Consequences

Key considerations for the analysis of potential Project effects to the Trinity River basin include the current state of the watershed and the scope and nature of Project activities. This analysis looks at short- and long-term effects to the Trinity River basin. Short-term effects to waterways as a result of construction impacts are commonly related to ground disturbance with the floodplains, streambeds, or streambanks. Long-term effects are caused by the action and are later in time or farther removed in distance. Long-term effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

As previously mentioned, individual restoration actions would take place in and along tributaries of and the mainstem Trinity River (both above and below the Lewiston and Trinity dams) on both private and public lands. Key watersheds within the restoration activity area include North Fork Trinity River, South Fork Trinity River, Canyon Creek, and New River. Through coordination between TRRP, BLM, and USFS, it was determined that an effects analysis performed at the HUC 10 watershed scale would be sufficient to adequately characterize Project effects. Therefore, 16 HUC 10 watersheds are analyzed in this report. See Table 1-1 for HUC 10 names and acreages and Figure 1-1 for an overview map.

For the effects analysis related to hydrology and water quality as a result of the Project, the intensity of effects is described using the following terms:

- Negligible: Effects would not be measurable and have no perceptible consequences.
- Minor: Effects are detectable but are small and localized.
- Moderate: Effects are detectable, can be measured, and cover a larger area (e.g., a tributary stream).
- Major: Effects are easily measured, regional, and at the HUC 10 watershed-scale.

3.1 Affected Environment

The more ground disturbance and terrestrial habitat alteration there is within a watershed, the greater the potential there is for ongoing water quality issues. In addition, the more ground disturbance there is, the greater the opportunity there is for reducing and controlling disturbance footprints, restoring soil compaction, controlling surface runoff, promoting ground cover and reducing erosion potential. Therefore, HUC 10 watersheds have been characterized in Table 3-1 below by disturbance data compiled by the USFS. This information shows which HUC 10 watersheds have been subject to alteration and also where there is the most net benefit to be gained by addressing these issues. Disturbance concerns used to characterize each watershed include the following:

- High road/trail density (>5 miles/sq mi). Linear features, particularly roads, are one of the biggest disturbances known for being chronic sources of erosion and sedimentation.
- Wildfires that burn a significant portion of a watershed (>20%) at high and moderate severities often destroy existing vegetation and the protective soil groundcover. High intensity wildfires can cause hydrophobic soils that increase overland flow and can cause significant erosion. Severe wildfire effects can damage a watershed for decades.
- High percentage of the watershed that has been harvested over an extended period of time (1950's to the present). Watersheds with 50% or more of the drainage area harvested likely have compacted soils that interfere with drainage patterns and plant growth.
- Powerlines have similar erosion and sedimentation impacts as roads. They are often a source of disturbance in a watershed that get used as roadways or trails for recreation and hunting.

Table 3-1. Watershed Conditions Summary in Project Activity Area.

HUC 10 Watershed Name	Acres in Project Activity Area	Total Number of HUC 14 Drainages	HUC 14's with High Road/Trail Density	HUC 14's with >20% High or Moderate Burn Severity	HUC 14's with >50% Harvested	Power-lines
Big French Creek-Trinity River[1]	153,325	16	0	10	0	9
Browns Creek	47,110	6	3	1	4	3
Canyon Creek[2]	41,033	12	1	7	2	7
Coffee Creek	74,835	11	0	0	0	1
East Fork Trinity River	74,335	11	5	1	5	0
New River[2]	149,597	21	0	4	0	0
North Fork Trinity River[2]	97,483	14	0	2	0	3
Stuart Fork	88,264	15	5	1	2	8
Swift Creek-Trinity River	121,055	5	1	0	1	1
Tangle Blue Creek-Trinity River	101,393	16	2	0	1	4
Weaver Creek	142,030	7	4	0	1	7
Lower South Fork Trinity River[2,3]	44,229	7	1	5	0	6
Lower Hayfork Creek	142,161	14	4	12	0	6
Upper Hayfork Creek	105,697	21	10	13	3	14
Middle South Fork Trinity River[2]	145,776	15	5	0	0	6
Upper South Fork Trinity River[2]	73,634	12	1	3	0	0

1. A portion of Big French Creek is excluded from the Project activity area, namely the Sharber Creek HUC 12 subwatershed, because it is in the Six Rivers National Forest.
2. ACS Key Watersheds
3. A portion of Lower South Fork Trinity River is excluded from the Project activity area, namely Grouse, Mingo, and Old Campbell Creeks (HUC 12 subwatersheds), because they are located in the Six Rivers National Forest.

3.2 Effects to Water Quality and Hydrology

The Proposed Action has been specifically designed to improve riparian and aquatic habitat conditions, aligning with ACS objectives, and promote the enhancement and restoration of watershed within the Trinity River basin more rapidly than would occur if the No Action alternative was selected. If the No Action alternative was selected, it is likely that similar restoration projects would be implemented over time in the basin; however, these projects would take longer to plan and permit compared to the Proposed Action alternative, so improvements to hydrology and water quality would be realized more slowly within the Project activity area.

3.2.1 Water Quality

Construction activities would affect water quality, specifically sedimentation, turbidity, and potentially temperature. Another concern would be chemical contamination related to potential fuel and fluid leaks from heavy equipment or contaminated sediment being released with the removal of instream structures. However, the probability of such an uncontrolled event is low with the implementation of the best management practices (BMPs) provided in Appendix B of the EA. Therefore, chemical contamination will not be discussed further in this document.

3.2.1.1 Sedimentation and Turbidity

Many of the proposed activities are designed and would be implemented to restore more natural watershed processes that influence the production, transport, and deposition of sediments throughout watersheds and their stream and river networks. Project restoration activities would have short-term adverse effects on water quality to varying degrees; however, in the long-term the implementation of multiple restoration activities across the basin would be expected to improve instream sediment and turbidity conditions overall.

Project restoration activities involving construction with heavy machinery and earthmoving create the greatest potential for sediment and turbidity concerns. Restoration and Enhancement of In-Channel Habitat; Floodplain Restoration; Removal or Retrofitting of Fish Passage Barriers, Small Dams, Flood Gates, Pilings and Other In-water Structures; Water Conservation Projects; Bioengineered Bank Stabilization; and Road Maintenance, Rehabilitation, and Decommissioning Activities would be those most likely to produce short-term construction-related sedimentation and turbidity impacts. The duration of most turbidity plumes would be limited to hours or days, though large projects may continue to produce turbidity (though gradually declining) for weeks. Actions in other activity categories have minor, if any, construction components.

Table 3-2. Sedimentation and Turbidity Effects Summary by Restoration Activity

Activity Category	Sedimentation and Turbidity Construction-Related Effects
Restoration and Enhancement of In-Channel Habitat	• Exposing, or reactivating existing off- or side-channels by removing fill plugs, would mobilize site or stream-reach sediment and increase turbidity either during initial water flows or during the first high flows. • Resulting sediment plumes would be most concentrated within, and immediately downstream of, the immediate action area during construction activities. For most actions, these plumes would extend no more than a few hundred feet. • Instream log and boulder placements would require the use of heavy equipment in riparian areas and stream channels. Sediment delivery to streams would occur when excavators disturb streambanks as they travel access routes between existing roads where materials are staged and the channels where the materials are placed. The volume of soil displaced would be small (less than two cubic yards) per access route.
Floodplain Restoration	• Short-term inputs of sediment would result from ground disturbance such as removal of levees, berms, and dikes; opening of side channels; stream channel reconstruction; and other activities that occur inside the bankfull channel.
Removal or Retrofitting of Fish Passage Barriers, Small Dams, Flood Gates, Pilings and Other In-water Structures	• Removing large instream structures would potentially cause the release of sediment stored over time behind the structure. As the structures are notched or removed, an immediate increase in suspended sediment and turbidity would be anticipated. Downstream habitats would likely be degraded for a short period of time. • The removal of fish passage barriers that had also restricted natural hydrologic flows would restore a more natural and functional hydrologic condition, which would be expected to increase transport of sediment downstream.
Water Conservation Projects	• Water conservation projects would adversely impact water quality in the short-term where heavy equipment is used in and along streams in the course of removing improving or consolidating water diversions, fish screens, or other associated structures. In the long-term, more flow would remain in streams resulting in improved sediment transport conditions.

Activity Category	Sedimentation and Turbidity Construction-Related Effects
Bioengineered Bank Stabilization	• After the installation of bioengineered bank stabilization techniques, the first few higher-flow events of the rainy season would result in increased turbidity and sediment transport. This volume of action-related soil or sediment transport, however, would represent a small fraction of the sediment that naturally moves through and deposits in a stream reach in any one season.
Road Maintenance, Rehabilitation, and Decommissioning Activities	• There may be a slight increase in short-term sediment delivery by these actions if immediately adjacent to waterways, but for most actions, heavy equipment operation would be far enough from streams that catchment and avoidance and minimization measures would be effective in preventing the majority of sedimentation impacts. • Removing culverts and their associated fill and replacing undersized culverts with culverts and bridges of sizes to accommodate high flows could mobilize sediment for deposition downstream, which would increase sediment and turbidity in the short-term (days to weeks). The size of the stream and culvert being removed or replaced would correspond to the amount of sediment potentially mobilized. Larger culverts would generally produce more sediment than small culverts. • If non-fish-bearing culverts are replaced, these are generally smaller than fish-passage culverts so the volume of material moving downstream beyond the culverts would also be smaller (i.e., a few cubic yards per pipe).

In the long-term, the Project restoration activities proposed would have several beneficial long-term effects. These are summarized below.

Adding channel roughness, such as boulders, structured log jams (SLJs), and loose wood placements, would increase the sediment storage capability within Project waterways. One or more of these added instream habitat features could capture tens to hundreds of cubic yards of sediment and wood that would otherwise be lost through annual stream flows in the absence of placed structures.

Restoring floodplain connections by decommissioning roads and removing their associated culverts and cross-drains, paired with floodplain restoration activities, would increase sediment storage within its reconnected floodplain. Studies indicate that road decommissioning would reduce human-caused sediment to streams. One study (Black et al. 2017) noted an 80% reduction in sediment delivery to streams in National Forests in the Pacific Northwest, Northern, and Intermountain Forest Service Regions.

Newly constructed meandering stream channels established through channel reconstruction or relocation would be more sinuous than the relatively channelized stream that they replace. This would allow for an increase in sediment sorting and storage and would restore natural aquatic habitat forming processes.

3.2.1.2 Temperature

The Proposed Action could cause short-term increases in stream temperature due to construction-related disturbance of riparian vegetation along stream channels and work area isolation/dewatering activities. Restoration and Enhancement of In-Channel Habitat; Floodplain Restoration; Removal or Retrofitting of Fish Passage Barriers, Small Dams, Flood Gates, Pilings and Other In-water Structures; Water Conservation Projects; Bioengineered Bank Stabilization; and Road Maintenance, Rehabilitation, and Decommissioning Activities would be those most likely to produce short-term construction-related temperature impacts due to riparian vegetation disturbance and work area isolation/dewatering activities. However, severe short-term water temperature impacts on aquatic life are not expected given the limited geographic scope of these activities, the limited effects within site-specific restoration activity areas, and the fact that site-specific projects would be dispersed in time and space within the watershed.

However, in the long-term, the Proposed Action is anticipated to have minor beneficial effects to water temperatures throughout the Project activity area. These effects, specific to restoration activity category, are described in Table 3-3 below.

Table 3-3. Temperature Long-Term Effects Summary by Restoration Activity.

Activity Category	Long-Term Temperature Effects
Restoration and Enhancement of In-Channel Habitat	• Improving instream habitat complexity through placement of SLJs, boulders, and loose wood can provide shade within the stream channel and may cool water temperatures. • Improving aquatic habitat across the floodplain would improve surface- and ground-water interactions and increase temperature heterogeneity within the floodplain, having long-term water temperature benefits (IMST 2004). • Following construction, riparian areas would be restored with native plants. Depending on the size of the channel and the size class of the plants that can be established in a certain area, taller plants (shrubs and trees) would provide shade, which would have a beneficial long-term effect on water temperatures.
Floodplain Restoration	• Improving aquatic habitat across the floodplain would improve surface- and ground-water interactions and increase temperature heterogeneity within the floodplain, having long-term water temperature benefits (IMST 2004). • Following construction, riparian areas would be restored with native plants. Depending on the size of the channel and the size class of the plants that can be established in a certain area, taller plants (shrubs and trees) would provide shade, which would have a beneficial long-term effect on water temperatures.
Removal or Retrofitting of Fish Passage Barriers, Small Dams, Flood Gates, Pilings and Other In-water Structures	• Morphological changes to downstream aquatic habitat that would occur as a result of improved more natural sediment transport by instream structure removals would create habitat features conducive to cooler water temperatures. • Following construction, riparian areas would be restored with native plants. Depending on the size of the channel and the size class of the plants that can be established in a certain area, taller plants (shrubs and trees) can provide shade, which would have a beneficial long-term effect on water temperatures.
Water Conservation Projects	• Water conservation projects would be designed to retain continuity of flow and to reduce summer water temperatures. • Following minor streambank activities, riparian areas would be restored with native plants, which would have a beneficial long-term effect on water temperatures.
Bioengineered Bank Stabilization	• Using bioengineering techniques, streambanks would be restored with native plants. Depending on the size of the channel and the size class of the plants that can be established in a certain area, taller plants (shrubs and trees) would provide shade, which would have a beneficial long-term effect on water temperatures.

Activity Category	Long-Term Temperature Effects
Road Maintenance, Rehabilitation, and Decommissioning Activities	• Any removal of road fill from floodplain areas that reconnects floodplain areas would increase overbank flooding and bank storage and sediment stored upstream of removed culverts would mobilize and deposit downstream creating habitat features conducive to cooler water temperatures. • Any riparian areas disturbed during this work would be restored with native plants. Depending on proximity to the stream channel and the size class of the plants that can be established in a certain area, taller plants (shrubs and trees) would provide shade, which would have a beneficial long-term effect on water temperatures.

3.2.2 Hydrology

The majority of the Project restoration activities would alter the geomorphology of stream channels and the conditions of the bed, bank, and floodplain through which water flows; however, would not affect the volume of water flowing through that stream reach. However, the "Water Conservation Project" activity category is intended to increase instream flow in the long-term and thereby improve aquatic habitat. Across the Trinity River basin, water use and associated infrastructure warrant improvement and efficiency upgrades to ensure that instream flows are available for fish and wildlife species and associated habitat. Particularly, wherever there are stream diversions along tributary streams that continue to withdraw water when streamflows are at low-flow conditions water conservation systems are warranted and would be proposed under this restoration activity category.

Many of these water conservation projects, particularly in small tributaries higher in the subwatersheds, could increase instream flows considerably, depending on the size of stream from which water had originally been diverted. These efforts would have minor beneficial effects to hydrology throughout the Trinity River basin. Effects to hydrology in the Trinity River mainstem would likely be negligible since flow is managed with the Trinity and Lewiston dams.

4 Regional Effects

Regional effects include the short- and long-term impacts of the Project together with the past, present, and future actions of other projects. This analysis looks at other actions that have affected or could affect the same resources as action alternatives, in this case, watershed resources. The effects of past actions are reflected in the descriptions of current existing conditions. Lands in the vicinity of the Project activity area include USFS-, BLM-, and privately-owned land.

4.1 Flow Management

As previously mentioned, flows are highly managed on the Trinity River mainstem. ROD flows are released from the Lewiston Dam to mimic natural Trinity River flows and interact with downstream areas to enhance conditions for all life stages of fish and wildlife. However, about 50% of Trinity River flows are still diverted to the Sacramento River basin. Lower flows cause degradation of aquatic habitat within the Trinity River due to loss of deep-water habitats and a limited ability to maintain water temperatures required for cold-water fish survival. Over time, much of the mainstem between Lewiston and the North Fork Trinity River confluence has been confined to a narrow channel bordered by dense riparian berms. TRRP, upon the recommendations of the TMC, continues to strive toward managing flows in the river to support aquatic habitat downstream of the dams.

4.2 Cannabis Farming

In 2018, the State of California legalized the recreational use of cannabis, as well as the cultivation and manufacture of cannabis plants and products. In Trinity and Humboldt counties, there are many cannabis farms which collectively reduce flow volume and increase discharge of waste and pollutants in streams, which adversely affects water quantity and quality in the Project activity area. Presently, there is no watershed-scale evaluation of the effects of cannabis farming on aquatic habitat in the Trinity River or particular streams (NMFS 2020).

4.3 Residential Development

Residential development as a result of human population growth in the Project activity area is expected to remain relatively stable over the next 10 years. Once development and associated infrastructure (e.g., roads/trails, drainages, powerlines, and water development) are established, the effects to the landscape are typically permanent. Anticipated effects on aquatic resources include loss of riparian vegetation, changes to channel morphology and dynamics, altered hydrologic regimes (e.g., increased storm runoff and water diversions), increased sediment loading, and elevated water temperatures where shade-providing canopy is removed (NMFS 2020).

The presence of structures, powerlines, and roads/trails near waterways may lead to the removal of large wood features in order to protect infrastructure from flood impacts. Commonly, around residential areas, there are also effects of home pesticide use, stormwater runoff of automobile-generated pollutants, introductions of invasive plant species to riparian areas, and land clearing activities. These all have adverse effects to water quality. However, the population growth rate in Trinity County decreased by about 11% between 2010 and 2019 (U.S. Census Brueau 2020). This may indicate a trend that could ameliorate or reduce the effects of residential development (NMFS 2020).

4.4 Resource Extraction

Resource-based industries are likely to continue to have an influence on environmental conditions within the Project activity area for the indefinite future. Logging continues to be conducted on both public and private lands throughout the tributaries of the Trinity River, except in Canyon Creek (Reclamation 2019). STNF's vegetation management projects include those for forest health/thinning and fuels reduction. Some mining for gravel, aggregate, and minor precious metals occurs on the Trinity River floodplain and a few tributary watersheds. Mining operations can affect coarse sediment supplies and impair water quality via contaminated and sediment-laden runoff from operations. The lack of protective measures in existing regulatory mechanisms, including land management plans (e.g., State Forest Practice Rules), contributes in varying degrees to ongoing water quality issues including sedimentation associated with poor forestry practices and roadbuilding are particularly chronic problems. However, some resource extraction industries have adopted management practices that reduce many of their most harmful impacts, which were unknown or not commonly used until recently (NMFS 2020). The STNF regularly implements forestry projects using resource protection measures and BMPs to reduce sedimentation into streams and otherwise reduce effects to environmental resources.

4.5 Wildland Fire Control

Control of wildland fires may include the removal or modification of vegetation due to the construction of firebreaks or setting of backfires to control the spread of fire. This removal of vegetation can trigger post-fire landslides as well as create chronic sediment erosion that can adversely affect water quality through sedimentation. In addition, the use of fire retardants may cause chemical contamination, adversely affecting water quality if used in a manner that does not sufficiently protect streams (NMFS 2020).

4.6 Aquatic Habitat Restoration

Since 2009, the TRRP has implemented Trinity River mainstem channel rehabilitation projects at all the Phase 1 channel rehabilitation sites named in the 2000 Master EIR and at nine of the Phase 2 sites. The Deep Gulch and Sheridan sites were constructed in 2017. The Bucktail site, constructed in 2008, was expanded in 2016 to include additional areas. The Dutch Creek project was constructed in 2020. The Chapman Ranch Phase A site was constructed in 2019 and the Phase B site was completed in 2021. The Oregon Gulch project was completed in 2023. These mainstem projects have improved anadromous fish spawning and rearing habitat throughout the extent of the Trinity River.

TRRP continues to add sediment within the 40-mile reach downstream of the Lewiston Dam. In addition, TRRP-managed flows have been implemented yearly since 2004. Ongoing monitoring efforts by TRRP partners continue to document improvements in aquatic habitat use, alluvial processes, and riparian vegetative communities along the mainstem. Continued sediment and wood augmentation projects are intended to improve anadromous fish spawning and rearing habitat in the Trinity River mainstem.

Beyond TRRP's mainstem channel rehabilitation and sediment augmentation projects, there have been several restoration and road sediment reduction projects implemented by various agencies and organizations throughout the Trinity River watershed. While some of these were considered in the 2009 Master EIR, the USFS, Five Counties Salmonid Conservation Program, Northwest Resource Conservation and Development Council, Watershed Research and Training Center, Trinity County Resource Conservation District, Yurok Tribe, Hoopa Valley Tribe, Nor Rel Muk Wintu Nation, and other local nonprofits and governments have been funded for and/or completed additional projects intended to improve watershed conditions, restore aquatic habitat, improve aquatic connectivity, and reduce road-related sediment delivery to streams and rivers. These watershed restoration projects are intended to improve water quantity and quality as well as rearing habitat in the Trinity River watershed.

4.7 Proposed Action

The Project's Proposed Action is an extension of the watershed restoration projects mentioned above. The Project focuses on Trinity River tributaries as well as the mainstem. The objectives of the Proposed Action are as follows:

- Restore and improve instream conditions sufficient to support all life stages of salmonids and other aquatic species.
- Restore upstream and downstream fish passage for all life stages of salmonids.

- Restore continuous paths for wood dispersal, nutrient cycling, sediment transport, and movement of other vegetative material essential for productive aquatic habitat.
- Maintain or restore native plant communities and vegetative structure impacted by invasive plants and pathogens, while rehabilitating eroding streambanks to improve water quality, shade conditions, and large wood recruitment.
- Repair, replace, or remove ineffective instream structures.
- Restore and improve riparian and meadow habitat in order to promote healthy conditions for aquatic and terrestrial wildlife populations.
- Improve late summer/fall base flow conditions through process-based restoration, water conservation improvements, and meadow restoration.

The Project is an effort to streamline design and planning processes, including environmental compliance, for proposed restoration actions across the watershed, thereby increasing the number of restoration actions that can be implemented over time. Ultimately, the Project is anticipated to benefit water quality and quantity within the Trinity River basin. As previously discussed, the proposed restoration activities would have short-term sedimentation and temperature effects; however, in the long-term, the Proposed Action would have beneficial effects water quality and hydrology in terms of an increase in sediment storage capacity within Project waterways; a decrease of sediment discharge and roadway runoff as a result of the maintenance and decommissioning of roads; improvements to water temperatures as a result of installation of instream habitat features, aquatic and riparian habitat enhancements, and improved floodplain connectivity; and an increase in flow volume in tributaries as a result of site-specific water conservation projects. Ultimately, these water quality and hydrology benefits associated with the Proposed Action may serve to offset ongoing impacts associated with flow management, cannabis farming, residential development, resource extraction, and wildland fire control activities.

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