DRAFT RECOVERY PLAN ◦ JULY 2022

Elk River Watershed Stewardship Program: Sediment Remediation and Habitat Rehabilitation Recovery Plan

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Cover photo: Aerial view of the Elk River Valley looking up the valley toward the southeast.

Acknowledgements

In 2012, our Project Team of California Trout, Northern Hydrology and Engineering, Stillwater Sciences, other scientists and landowners, and several dedicated Regional Water Board staff scientists began an arduous but essential environmental remediation process focused on the Elk River, in Humboldt Bay, CA. This process has included several rounds of fundraising, technical planning, and extensive outreach and communications with private landowners; a program of field data collection and detailed technical analyses; many, many meetings among our Project Team and with a breadth of technical and academic experts; and numerous written documents – including several technical reports, newsletters, and presentations.

Throughout this decade we've also relied heavily on the support and collaboration of a very patient and generous community of landowners and stakeholders in the Elk River watershed. We are deeply grateful to all these folks who have donated their time, historical recollections, photographs, and access to their properties so we could explore and learn about the river, watershed, and social setting. We cannot thank you all enough for your commitment to the Elk River Stewardship Program.

And even though there is still more essential "planning" to do, we believe we are ready to begin implementing the *Vision* and the *Actions* that are described in this Report. After 170 years of cumulative landscape changes in Elk River, we hope the next decade brings long-awaited improvements to the lives of residents, to the Elk River, and to the fish, wildlife, and natural landscape in this watershed.

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1 ELK RIVER STEWARDSHIP PROGRAM

1.1 Introduction

The Elk River watershed is currently the focus of intensive efforts to resolve very complex land use and water quality impairment issues. These efforts are codified in the Upper Elk River Sediment TMDL Action Plan adopted by the North Coast Regional Water Quality Control Board (Regional Water Board or RWB) and implemented by the agency using both regulatory and nonregulatory tools, including Waste Discharge Requirements for timber operations in the upper watershed and contract and grant support for the Stewardship Program. These efforts are intended to result in improved erosion control, sediment remediation, and habitat rehabilitation that reduce annual flooding, improve habitat quality, and establish sediment fate and transport characteristics consistent with support of beneficial uses of the Elk River watershed. These efforts rely on science-based assessment and partnerships with local stakeholders. Technical support documents developed to date include: Upper Elk River Technical Analysis for Sediment (Tetra Tech 2015), Elk River Recovery Assessment (CalTrout et al. 2019), and this Sediment Remediation and Habitat Rehabilitation Recovery Plan (CalTrout et al. 2022).

The Elk River Watershed Stewardship Program (Stewardship Program), with CalTrout and a Project Team providing technical capacity and facilitation support, has now become the center of a broad community-based effort to restore beneficial uses of water in Elk River, improve water quality conditions, reduce nuisance flooding, rehabilitate habitat for native salmonids and other aquatic resources, expand riparian habitat, and improve overall ecosystem health in the Elk River.

The purpose of the Stewardship Program is to engage Elk River Stakeholders in a collaborative planning, design, and implementation process that seeks to:

Identify Voluntary Actions and Strategies to:

- ◊ Improve the hydrologic and sediment processes, water quality conditions, and aquatic and riparian habitat functions in Elk River
- ◊ Reduce nuisance flooding and the consequent risks to residents and properties, and improve transportation routes during high water conditions
- ◊ Improve drinking water and agricultural water supplies for residents in Elk River

Ensure that voluntary Actions are prioritized and integrated to:

- ◊ Collectively yield the greatest benefit to residents and natural resources in the Elk River watershed
- ◊ Ensure actions are implemented in a cost-effective manner

Conduct a monitoring and adaptive management program to:

- ◊ Track responses and outcomes of implemented Actions
- ◊ Quantify project benefits and temporary and permanent impacts

The Stewardship Program has been coordinating extensively with watershed residents and other stakeholders throughout 2018-2021 to solicit input and transmit information on Recovery Program activities that are ongoing throughout the watershed. Stakeholders in the Elk River Stewardship Program include several Elk River residential communities along the North Fork and South Fork Elk River and at Elk River Court; the ranching/dairy community and their representative CA Farm Bureau mainly located in the Elk River valley; non-profit conservation and advocacy organizations including CalTrout, Salmon Forever, Environmental Protection Information Center, the Pacific Coast Federation of Fishermen's Association; the Wiyot Tribe; timberland owners; and State and Federal fish and wildlife agencies (Appendix A Elk River Stewardship Program - Final Report (2020)).

This Recovery Plan is the culmination of several years of effort to identify and prioritize feasible Actions and develop a plan to carry out these Actions in an expedient way. Although the progress and continuity of our outreach program conducted with landowners, agencies, and our Technical Advisory Committee in 2018-21 has been disrupted by the COVID-19 pandemic, our Project Team has continued to analyze the efficacy of the proposed remediation Actions, and secured funding to advance several reaches of Elk River into the conceptual design stage. This Recovery Plan presents the results of these ongoing planning, analysis, and design activities, and lays out the technical and regulatory feasibility of implementing these remediation and restoration Actions.

Chapters 1-3 describe the purpose and need for the Recovery Program, including historical and regulatory contexts, and Program objectives. **Chapter 4** (Project Description) describes the proposed remediation and rehabilitation Actions, their anticipated benefits, and their distribution throughout four Planning Areas (PA). These Actions emerged as recommendations from the Elk River Recovery Assessment and were vetted and refined with direct input from private landowners to ensure their voluntary support of these Actions on their properties. **Chapter 5** (Project Evaluation) reports the results of analyses of these actions that were carried out to assess their overall effectiveness and meeting program goals, using our conceptual and hydrodynamic modeling tools to help prioritize actions and ensure the maximum benefit from their implementation. **Chapter 6** (Implementation Framework and Construction Phasing) describes an implementation plan that includes project phasing, construction methods, a proposed implementation timeline and program costs to provide an overall vision for bringing this Recovery Plan to fruition. **Chapter 7** (Regulatory Compliance Strategy) provides a strategy for complying with all required local, state, and federal requirements that are necessary to authorize, permit, and ultimately implement the Recovery Plan. Finally, **Chapter 8** (Monitoring and Evaluating Performance) provides a monitoring and adaptive management framework to evaluate the performance of remediation and habitat actions and track longer-term trends in watershed recovery.

2 CONSERVATION NEED

The Elk River watershed (Figure 2-1), the largest tributary to Humboldt Bay, has been extensively altered over the past 170 years since European-American settlers first arrived in the North Coast region. The watershed was aggressively and rapidly transformed from a mosaic of forest, wetland, and aquatic ecosystems to a working landscape, providing timber resources, agricultural and grazing lands, and rural residential homesteads as part of the rapidly expanding Humboldt County economy and land development process. The logging of old-growth redwoods began as early as the late 1860's, with dramatic changes to logging, yarding and transportation techniques and harvest rates over the ensuing century. According to Tetra Tech (2015), in the 1955-1966 period, harvest rates were calculated at no more than 0.3% in the Elk River watershed. In the 1988-1997 period, the harvest rate jumped to 3.8% in the North Fork, 0.5% in the South Fork, and 2.0% below the forks. As a consequence of this abrupt increase in harvest rates by the Pacific Lumber Co (PALCO), the watershed, its river courses, and Endangered Species Act (ESA)-listed salmon and steelhead were severely degraded, and in the 1990s Elk River became a focal point of environmental activism. In 2008, a bankruptcy court agreed to Mendocino Redwood Company's proposal to reorganize the financially troubled PALCO, acquire its 220,000 Humboldt County land and operate as Humboldt Redwood Company (HRC), including about 22,000 acres in Elk River. According to the NCRWQCB Resolution

R1-2016-0017 adopting the Upper Elk Sediment TMDL Action Plan (https://www.waterboards.ca.gov/northcoast/board_decisions/adopted_orders/pdf/2016/160512-0017_ElkRiverSedimentTMDL.pdf):

> *"Land management activities in the Upper Elk River Watershed caused significant sediment discharge, sedimentation, and aggradation in the impacted reach, which has altered the system's equilibrium in such a manner as to impair beneficial uses and cause nuisance conditions. Further, ongoing sediment mobilization and transport and sediment discharges from current land management activities cause additional aggradation, beneficial use impairment, and worsening nuisance conditions.*

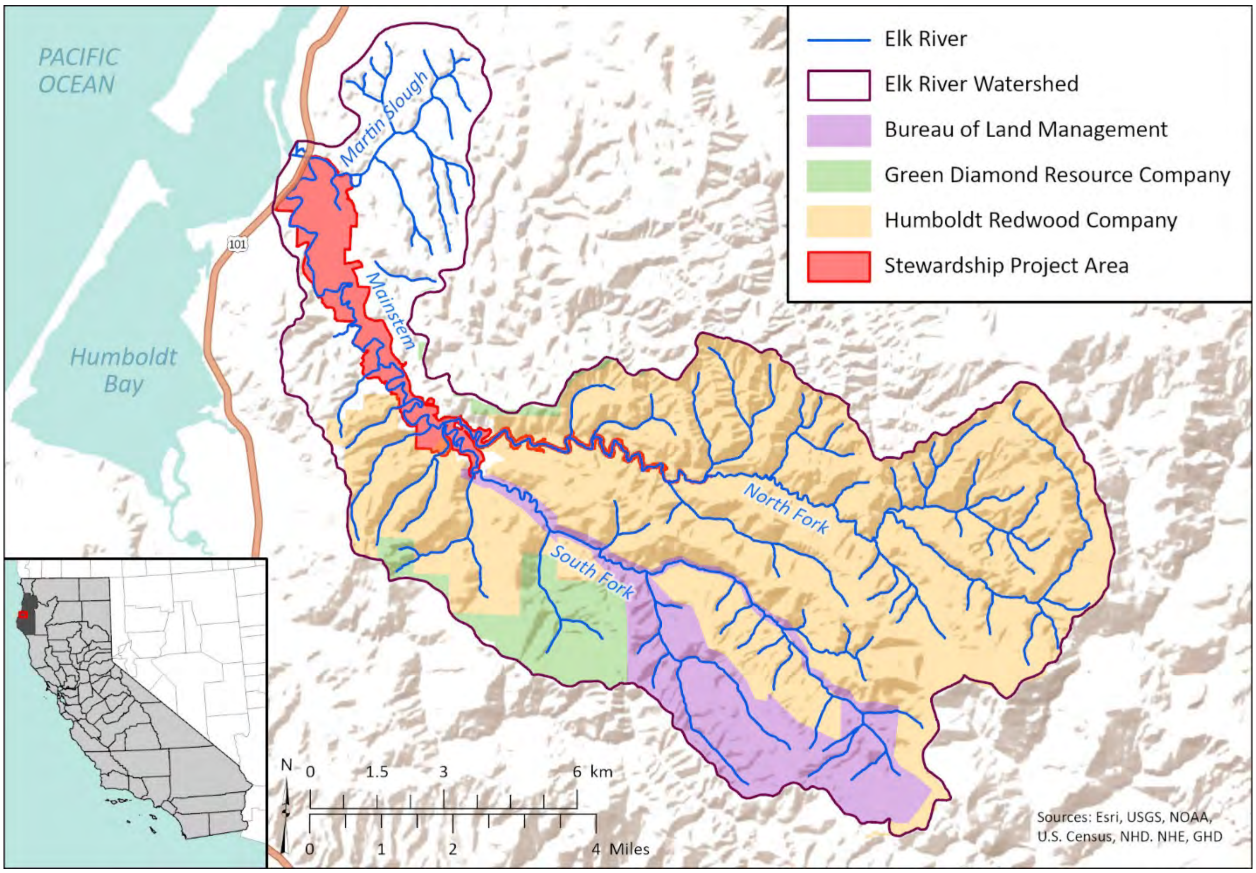

Figure 2-1. The Elk River watershed in Humboldt County, CA, highlighting the extent of the Stewardship Project Area.

Excessive timber harvesting by PALCO in the upper watershed caused extensive sediment pollution in the Elk River, which has resulted in the impairment of water quality beneficial uses and increased frequency of nuisance flooding. The nuisance flooding inundates roads and bridges and prevents residents of the middle portion of Elk River from leaving or returning to their homes or receiving emergency services, when needed, and has caused damage to numerous homes and residences. The sedimentation has also rendered domestic water supplies unpotable. Under order of the Regional Water Board domestic water supplies are trucked into numerous residents in the Elk River community by Humboldt Redwood Company, as successor landowner to PALCO. Also under order, HRC services expensive water filtration systems for other residents.

According to the NCRWQCB R1-2016-0017 Adopting Resolution:

> *"The Regional Water Board has confirmed the water quality impairment due to sediment and sedimentation, confirmed exceedances of sediment-related water quality standards, developed indicators and numeric targets associated with hillslope stability and stream channel recovery, assessed and quantified the sources of sediment, confirmed a linkage between sediment discharges and exceedances of sediment-related water quality standards, established the current sediment loading capacity, and established the sediment load reductions that are necessary to meet water quality standards. Simultaneously, the Regional Water Board has developed a program of implementation for the Upper Elk River watershed that will implement the TMDL, including considerable public outreach and involvement."*

The restoration of beneficial uses that were impaired due to the large-scale watershed degradation that occurred in the 1990s is a daunting and difficult project. Twenty years after the listing of Elk River on the Clean Water Act (CWA) section 303d list of impaired water bodies, the NCRWQCB Basin Plan water quality objectives for sediment, suspended material, settleable material, turbidity, and dissolved oxygen (DO) are still not being met, and numerous Beneficial Uses of water are still adversely impacting the community now, and have been for decades, including municipal [MUN] and agricultural [AGR] water supplies, cold freshwater habitat [COLD], rare, threatened and endangered species [RARE], migration of aquatic organisms [MIGR], spawning, reproduction, and/or early development [SPWN], and water contact recreation [REC-1]. In short, the Elk River is heavily impaired from past industrial logging practices and the current sediment remediation and aquatic habitat rehabilitation needs are enormous.

The Regional Water Board's TMDL Program information can be found at: https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/elk_river/.

The Action Plan for the Upper Elk River Sediment TMDL was adopted by the Regional Water Board in 2016 as an amendment to the Water Quality Control Plan for the North Coast and was subsequently approved by the State Water Resources Control Board in 2017. There are three main components of the Program of Implementation associated with Phase-1 of the TMDL Action Plan, including:

a. **Waste Discharge Requirements (WDR) or waiver of WDRs:** Applicable regulatory programs to reduce sediment loads from new and existing sediment sources on lands in the Upper Elk River Watershed, so as to reduce sediment loading toward the load allocation;
b. **Elk River Recovery Assessment:** A non-regulatory feasibility assessment of sediment remediation and channel restoration activities, which in combination with sediment load reductions, are necessary to improve hydraulic and sediment transport in the Elk River Watershed; and
c. **Watershed Stewardship Program:** A non-regulatory program under which implementation of health and safety projects, remediation and restoration activities, and science and coordinated monitoring serves to support beneficial use enhancement and a trajectory of watershed recovery, including abatement of nuisance flooding and an expansion of sediment loading capacity.

2.1 Geographic Focus

The Elk River is the largest tributary to Humboldt Bay and drains a 58.3 square mile (mi^2) watershed from the Coast Range, traversing across a coastal plain and joining Humboldt Bay just south of the City of Eureka (Figure 2-1). The basin can be divided into four sub-watersheds, including: (1) the North Fork Elk River (22.5 mi^2), (2) the

South Fork Elk River (19.5 mi^2), (3) the Mainstem Elk River downstream of the North Fork and South Fork confluence (mi^2), and (4) the Martin Slough (5.9 mi^2) watershed.
The Elk River TMDL, Recovery Assessment, and Stewardship Program do not include the Martin Slough watershed, though it is included in the CWA 303d listing for sediment impairment. This is because the implementation of the City of Eureka's stormwater program under an NPDES permit issued by the Regional Water Board is expected to be the primary method for controlling sediment sources in Martin Slough. NPDES monitoring requirements will help inform future adaptations to this approach. The Stewardship Program thus spans the entire watershed with exception of Martin Slough. The subject of this Elk River Recovery Plan is a distinct sub-area of the Stewardship Program area, which we refer to as the Stewardship Project Area (Figure 2-1). This Project Area is synonymous with the Elk River Recovery Assessment's modeling footprint and was the focal area for outreach to private landowners. Other areas in the watershed outside the Stewardship Project Area but within the Stewardship Program Area are thus not the subject of this report. This primarily includes the private timber lands in the North Fork above the confluence with Bridge Creek and in the South Fork above the confluence with Tom's Gulch.

Watershed Setting

The Elk River watershed is composed of a steep, forested upper watershed that is actively managed for timber and which makes up the majority of the basin (42 mi^2) and a lower watershed which includes a wide, low gradient alluvial valley bottom and floodplain comprised of rural residential and agricultural land uses. The approximately 12 miles of Mainstem Elk River downstream of the North Fork and South Fork confluence consist of low-gradient, alluvial channel types with a narrow riparian canopy, transitioning to tidally influenced freshwater, brackish, and tidal slough channels.

Like many Northern California coastal watersheds, the Elk River in Humboldt County is an alluvial system. Geology in the Elk River basin is predominantly composed of the Wildcat Group, the Yager terrane, and the Franciscan Complex Central Belt (Ogle, 1953; McLaughlin et al. 2000, Marshall and Mendes 2005). The most extensive geologic unit in the basin is the Wildcat Group, a thick overlap assemblage of poorly indurated marine siltstone and fine-grained sandstone that weathers to granular, non-cohesive, non-plastic clayey silts and clayey sands. Wildcat Group terrain is characterized by steep and dissected topography sculpted by debris sliding and is known for historically high erosion rates associated with headwall swales and inner gorges. The Yager terrane is highly folded and sheared argillite and sandstone turbidites with minor pebbly conglomerate. The sandstone facies commonly form cliffs and exert local base level control where streams have incised through younger, less resistant overlap deposits. The argillite facies are typically deeply weathered, promoting deep-seated flow failures on moderately steep slopes. Franciscan Complex Central Belt is an accretionary mélange enclosing blocks of more coherent sandstone, greenstone, and chert. Large, deep-seated landslides and earthflows are common in the Franciscan Complex Central Belt. Undifferentiated shallow marine and fluvial deposits of middle to late Pleistocene age cap ridges across the western portion of the watershed. The basin is located along the actively uplifting and deforming southern Cascadia Subduction Zone and directly north of the Mendocino triple junction.

For a more detailed description of the Elk River watershed, drainage network, geology, and vegetation cover types, see Tetra Tech (2015) Upper Elk River Technical Analysis for Sediment and the Elk River Recovery Assessment (CalTrout et al. 2019).

Climate Overview

The Elk River watershed has a maritime coastal climate with mild wet winters and a prolonged summer dry season. Mean air temperatures at the coast fluctuate from 48° F in January to 55° F in June. Mean annual precipitation ranges from 39 inches on the coast near Eureka to 60 inches near Kneeland, located 2,657 feet above sea level and approximately 12 miles inland. Roughly 90 percent of the annual precipitation occurs as rainfall between October and April. Intense rainfall over steep topography composed of erodible parent materials results in high sediment yields. Storm events with rainfall intensity exceeding 3 to 4 inches a day are considered capable of initiating landslides (Tetra Tech 2015). Rainfall exceeding 5 inches per day occurred three times between 1941 and 1998 (water years 1950, 1959, and 1997). The 24-hour rainfall total of 6.8 inches on December 27, 2002, caused widespread landslides and flooding (Tetra Tech 2015).

Residential, Agricultural, and Timberland Land Use Overview

The majority (82%) of the mountainous upper Elk River watershed is zoned as timber production zone (TPZ) (Appendix B Land Use Zoning and Williamson Act parcels). Humboldt Redwood Company (HRC) and Green Diamond Resource Company (GDRC) own and manage 75% and 7% of the upper Elk River watershed, respectively. The remaining portions of the upper watershed include the Bureau of Land Management's (BLM) Headwaters Forest Reserve established in 1999 (13%) and a combination of non-industrial timberlands, private residences, and agricultural land uses (5%). The lower Elk River watershed, the alluvial valley that expands downstream of the confluence of the north and south forks, is primarily used for dairy and cattle ranching, and rural residential homesteads. The Martin Slough watershed, which joins Swain Slough and Elk River at the westerly end of the watershed, has mixed agricultural and urban land uses (e.g., a municipal golf course), and additional residential development is anticipated in the coming decades.

The Project involves numerous private properties, as well as public lands, such as the California Department of Fish and Wildlife's (CDFW) Elk River Wildlife Area. Land use and zoning for the Project Area, as well as those parcels currently enrolled in the Williamson Act, are shown in Appendix B. There are 109 separate Assessor Parcel Numbers (APNs) included within the Stewardship Program Area.

2.2 Historical Ecology of Elk River

Our understanding of the historical ecological conditions in Elk River may help guide our identification of recovery Actions as well as predict or anticipate potential outcomes that result from those Actions. Knowledge of the historical ecology of Elk River can thus contribute to and guide our recovery efforts. The interdisciplinary field of *historical ecology* seeks to synthesize diverse historical records to learn how habitats were distributed and ecological functions were maintained within the undisturbed landscape. Unfortunately, a detailed record of the historical ecological conditions in Elk River is not available; there are no written records of Elk River prior to the arrival of European-American settlers in 1850, and during the ensuing decades of rapid settlement the Wiyot people's oral history of the region was not documented, land-use changes were rapid and dramatic, and few records were kept of those changes. Our historical understanding of Elk River can thus only be inferred from a sporadic historical record and from our understanding of general ecological conditions in the north coast and Humboldt Bay region. A description of historical ecological conditions in Elk River prior to 1850 is thus anecdotal.

The Elk River watershed exhibits at least three different zones of historical ecological interest: the forested sub-watersheds, the fluvial mainstem valley, and the tidal marshes and estuarine reaches adjacent to Humboldt Bay. The historical conditions of the first two of these zones are more easily interpreted as extant examples of their ecology still exist. However, the tidal marshes and estuarine reaches of the Elk River were a much more diverse, ecologically rich, and variable landscape, and nearly all of this area was lost to agricultural conversion. Restoration of this area is of paramount importance to the overall function of the Elk River watershed, and required more effort to interpret available information.

The Wiyot People

Before evaluating the ecological setting in Humboldt Bay that existed prior to the arrival of non-indigenous settlers, we must acknowledge the people already inhabiting the region when those settlers arrived. The Wiyot people are the aboriginal inhabitants of Elk River (ikso'ri), and Humboldt Bay (wike'). Wiyot ancestral territory extended from Little River near Trinidad to Bear River Ridge near Scotia, and east to Berry Summit. The region supported a pre-contact Wiyot population estimated at between 1500 and 2000 However, this population declined to approximately 200 after 1860 and to about 100 individuals by 1910, the result of disease, resource depletion, slavery, displacement, and genocide. The Tribe is now 600 members strong and growing (Wiyot Tribe, n.d.).

The first recorded "discovery" of Humboldt Bay by Europeans was in 1806 by Captain Jonathan Winship. Sustained contact began in late 1849 when the Josiah Gregg party of eight explorers journeyed overland from the Trinity River to Humboldt Bay. This party was met by Wiyot headman Ki-we-lat-tah on the day following their arrival at Humboldt Bay. According to LK Wood, Ki-we-lat-tah and his family rowed across the bay to greet the explorers, welcoming them with a feast of clams and providing them with "every means of comfort in his power."

According to Loud (1918): "The Wiyot were preeminently a fisher folk, and no doubt the prehistoric people of this region were the same". Loud acknowledged that "salmon was the chief food fish". Loud's *Ethnogeography and Archaeology of the Wiyot Territory* identified two Wiyot village sites in Elk River (Figure 2-2) both located in the lower valley near Humboldt Bay:

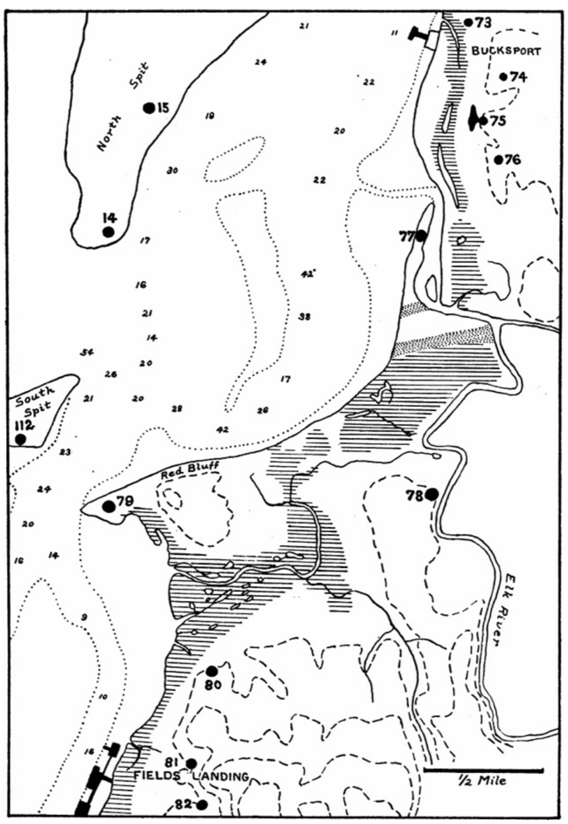

Figure 2-2 Map (Plate 2) from Loud (1918) showing archaeological sites on the central part of Humboldt Bay.

- <u>Site 77</u>: "This village was located at the mouth of Elk River, which had the same name as the village, ikso'ri. According to the United States Coast and Geodetic Survey chart of 1858, the mouth of Elk River was formerly half a mile farther north than at present, with a sandspit between the river and the bay. The village was on this sandspit, which has since been washed away. Old Coonskin, the mauweema [leader or advisor], used to live here part of the time. It appears from the reports of white informants, that there were not more than half a dozen houses, though Dandy Bill said that many people used to live here.

- <u>Site 78:</u> "Situated near the schoolhouse on Elk River, is chiefly of interest because of myths connected with the place. The first people that ever lived made a name for this place, calling it chwanochkok. That was the ''old fashioned name'' which the fathers passed along to their sons… It was used as a camping place where salmon, caught in the river, were dried. The party with L. K. Wood camped here one night.

According to early records, the Elk River was navigable upstream nearly to the confluence of the North Fork and South Fork, a distance of approximately 10.6 river miles or 4.3 miles up the valley, where a trail then led to Kneeland Prairie. According to Save the Redwoods League (2018), the

1854 land surveyor mentions crossing the "Bucksport to Trinity" trail only five years after the beginning of European-American settlement, implying that the trail had been established previously by the Wiyot people (US BLM, 1854 p.212).

Humboldt Bay and Elk River at First Contact

The exploration of Humboldt Bay and its vicinity by European-American settlers is recounted by LK Wood, who was one of the eight original members of the Josiah Gregg Party, recounted in Elliot's 1888 *History of Humboldt County, CA*. The Gregg Party arrived in Humboldt Bay on December 20, 1849 during an arduous, dead-of-winter overland journey from the Trinity River goldfields: "Here commenced an expedition [on 5 November 1849], the marked and prominent features of which were constant and unmitigated toil, hardship, privation, and suffering". The contemporary names for Little River, Mad River, Bucksport, the Eel River, and Van Duzen River (and others) are attributed to the Gregg Party. The explorers' return to San Francisco in February 1850 spurred the onset of a rapid incursion of settlers to Humboldt Bay, forever changing the ecological and social landscape of the region. The narrator LK Wood suffered a brutal attack by a grizzly bear and was fortunate to survive the journey back to "Sonoma Valley"; Josiah Gregg was not so fortunate and succumbed to starvation in the mountains of the Eel River a few days away from Sacramento.

Remarkably, by 1852, the first US Coast Survey map of Humboldt Bay, including the Bayshore and lower reaches of Elk River, had already begun (Figure 2-3). This survey map depicts a low-lying tidal marsh plain extending across the entire width of the lower Elk River Valley (~1.2 miles) and inland as far as the survey map extends (~0.6 miles); there may have been a western fringe of low-elevation sand dune (Laird, Personal Communication) along the bay shore. Extending inland, the floodplains of Elk River were likely "prairie grasslands", a description used by LK Wood (Elliot 1888) for low-lying marsh and open space in other locations along the Humboldt Bay shore. The Gregg Party hunted elk in the lower Elk valley, hence the name. Loud (1918) noted: "The open alluvial plain of the Elk River, therefore, attracted many of the first settlers in the region who established homesteads for farming, dairying and ranching, and who also appreciated the fish-filled river and herds of elk (from Coy 1929)." Along the stream channel, the 1852 map indicates streamside vegetation beginning at approximately 2,000 ft from the Bayshore confluence, roughly as the stream channel bends eastward, away from the bay.

History of Timber Harvesting

The history of timber harvesting in Elk River dates to the earliest European-American settlers who arrived in 1850 and immediately began parceling and claiming land ownership to clear the way for a major era of redwood timber resource extraction. The Tetra Tech report (2015) describes three main eras of logging in Elk River. The first phase of logging of virgin redwood forests began in the late 1850's and peaked around the turn of the century, and involved splash-damming and railroad construction for timber extraction; these methods required considerable reduction in riparian vegetation and instream wood structures to enable rafting logs downstream. The Railroad grade and stream crossings also created hydraulic constrictions in numerous locations across the Elk River floodplain. The town of Falk on the South Fork Elk (Figure 2-3), which operated from 1884 to 1937, epitomized this early era of timber harvest (Clark 2018). The second prominent phase occurred after WWII and involved new technologies for timber harvest – chainsaws, tractors, and logging trucks that notably occurred before significant forest practices rules were established to protect forested watersheds and minimize cumulative effects. The third era of harvest in Elk River occurred in association with Maxxam, Inc. ownership of Pacific Lumber Co, from 1985 through its bankruptcy in 2007. Tetra Tech describes this phase as characterized by an "increase in rate and scale of timber harvest" that was associated with several large storm events that caused large-scale sedimentation.

Figure 2-3. The Falk millpond and splash-dam from c. 1901, located on the South Fork Elk River approximately 3 miles upstream of the North Fork confluence. Photo reprinted by permission.

Based on this timber harvest history, Tetra Tech (2015) reconstructed the sediment loading history associated with post-1955 timber harvest rates (Tetra Tech, Figure 11), which effectively captures the transition from one timber harvest era to the next, culminating in the PALCO period of mismanagement which drives much the necessity for a recovery plan. Since the Humboldt Redwood Company assumed ownership of the upper Elk River watershed, timber harvest rates and silviculture practices have been significantly reformed and are now guided by more stringent forest practice rules and the company's *Habitat Conservation Plan* in place since 1998.

Elk River Bayshore Historical Configuration

Our interpretation of the historical ecology of Elk River is primarily focused on the Elk River valley bottomlands and tidal zone. Above this zone was historically redwood and mixed conifer and deciduous forest; the historical ecology of this zone is less difficult to interpret, has been described elsewhere (e.g., Clark 2018), and continues to be represented within the boundaries of the BLM Headwaters Forest Preserve.

The zone of Elk River valley below the Timber Belt is less easy to interpret. The following description is based on our interpretations of the earliest US Coast Survey maps (e.g., from 1852 and 1858), our understanding of contemporary vegetation species and patterns relative to tidal elevations, and the few brief written records describing the lower Elk River Valley.

There appears to have been three zones of habitat forming a gradient from the Humboldt Bayshore inland to the southeast – a dune and tidal marsh zone, open prairie grasslands, and the wooded "timber belt". These zones are described in the following section.

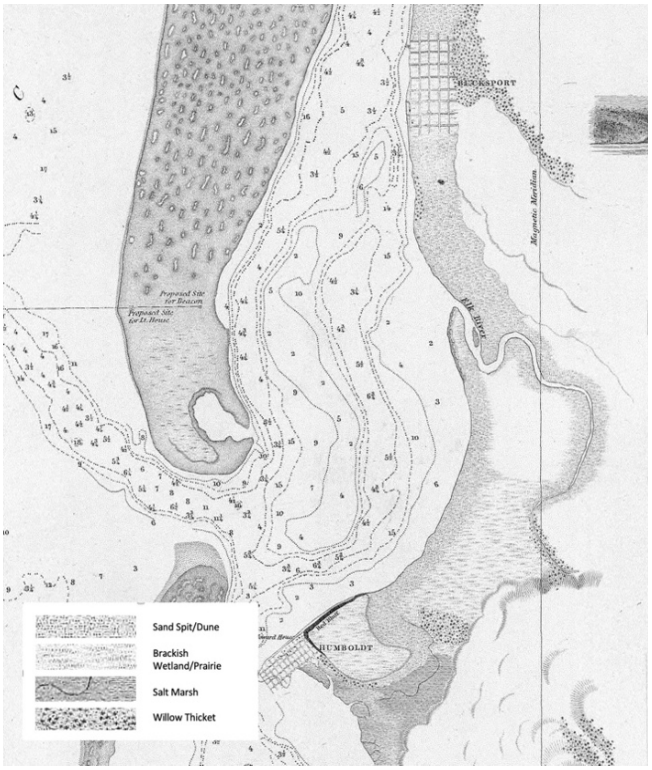

Figure 2-4. US Coast Survey 1852 Map of Humboldt Bay entrance and vicinity, including the lower reach of Elk River.

Sand Dune/Tidal Marsh Areas

The western-most edge of the Elk River valley borders Humboldt Bay along approximately a 2-mile shoreline, extending from Red Bluff (now called Buhne Point) northward past the Elk River spit, and faces the harbor entrance. This western shoreline was bordered by a beachfront, behind which was a low elevation dune complex extending inland a few hundred feet, similar to the condition currently found along the Elk River spit. The Gregg explorers encountered the Wiyot maomea Kiwelatte in December 1849 inhabiting the Elk River spit in what was apparently a permanent village site, so the spit's elevation was presumably above the maximum tide elevations (< 9–10 ft).

The 1852 USCS map is the earliest depiction of the lower Elk River valley. Produced by the US Navy and US Coast Survey under the command of Lieutenant James Alden, this map shows a mosaic of different wetlands and plant types occupying the lower Elk River tidal zone; four different vegetation patterns were sketched which we interpret as (1) beach and sand dune, (2) salt marsh, (3) brackish wetland and prairie, and (4) deciduous alder and willow forest (Figure 2-4). This earliest sketch of the Elk River channel alignment resembles the present-day configuration of Elk River, flowing northwestward along the southern edge of the valley; turning abruptly and meandering north, traversing the entire width of the valley parallel to the shoreline, and making several sharp meanders; then turning westward into the bay. This configuration depicted a marsh plain between the dunes and the Elk River channel.

The 1852 map is less detailed than the 1858 map, which shows a network of slough channels and a prominent salt marsh area south of Red Bluff with a large slough channel extending northward nearly connected to Elk River (Figure 2-5). There appears to be a very subtle drainage divide between this southward-draining slough channel and the northward-draining Elk River; the first road alignment hugged the backside of the dunes and then wove through the salt marsh, apparently taking advantage of slightly higher elevations. The 1858 map shows several such areas of higher ground within this salt marsh plain, possibly representing sand dunes and occasionally bordered by patches of deciduous willow thicket. Loud also shows "Marsh" as a shaded area to the west of Elk River (Figure 2-2), with broken areas of non-marsh between the Elk River tidal marsh and Buhne Slough to the south. One would expect fluvial sediments from Elk River to have created and maintained natural levees along the stream channels, and contributed to a somewhat higher elevation marsh plain. The topography along the Bayshore was thus likely quite variable, characterized by slough channels and tidal marsh surfaces, sand dunes, and natural hummocks and levees, with patchy deciduous vegetation intermixed.

Prairie Grasslands.

Inland from the Elk River, the ground surface gained in elevation and transitioned to brackish marsh and prairie, with patches of alder and willow forest. The early USCS maps do not extend far enough inland to depict vegetation cover types past approximately the head of tide, but both the 1852 and 1858 USCS maps show willow and alder forest becoming prominent as Elk River extends further up the valley.

If one believes the configuration of vegetation depicted in the 1858 map, the northern half of the lower Elk River valley was primarily open prairie while the southern half was primarily mixed deciduous forest – Alder and Willow. It's not unreasonable that Elk herds would have grazed and helped keep open these Prairies. The Gregg Party noted open prairies at numerous locations along their pathway from Arcata to the point where Fort Humboldt was established, and then on to Humboldt Point (Buhne Point). While camped on Humboldt Point, the Gregg Party noted: "The evening we arrived here [at Humboldt Point], some of the Party went out on the slope of prairie, to the east of our camp, and killed an Elk…". This sloped prairie was likely the southern half of Humboldt Hill, shown as unforested in the 1852 sketch showing the view of Red Bluff and the Humboldt Bay entrance (Figure 2-6).

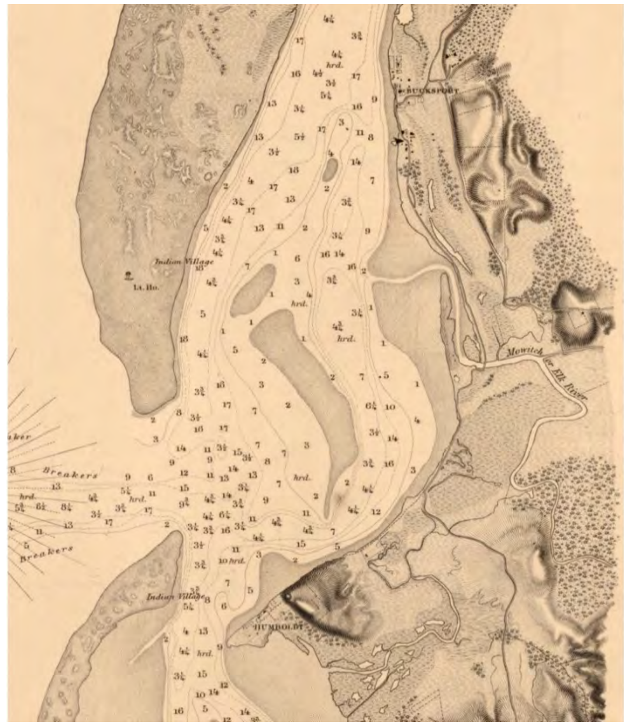

Figure 2-5. US Coast Survey 1858 Map of Humboldt Bay entrance and vicinity, including the lower reach of Elk River.

Loud (1918 pg. 230) also described prairies in the vicinity of Humboldt Bay, which were likely maintained as open grasslands by the Wiyot people:

> *"Within the forests, at all elevations from sea level to the top of the ridges, there were small open patches, known locally as "prairies," producing grass, ferns, and various small plants. These prairies are too numerous to mention in detail. … Most of these patches if left to themselves would doubtless soon have produced forests, but the Indians were accustomed to burn them annually so as to gather various seeds, especially a species of sunflower, probably Wyethia longicaulis. The statement from Professor Jepson that "there is today more wooded area in Humboldt County than when the white man came over a half century since," was confirmed by reports made to the writer that some of the old prairies had come up to young growth of forests. These prairies were of incalculable value to the Indians, not alone for their vegetable products, but also for the game found upon them. A sharp contrast is drawn between the animal life in the forests and on these prairies….".*

Figure 2-6. Sketch from the US Coast Survey 1852 Map of the view looking east toward the hills directly behind the Humboldt Bay harbor entrance, and Red Bluff in the foreground. Elk River valley is to the north of Humboldt Hill.

Redwood/Timber Belt

We reviewed the *Field Notes* (Volume R35) from the original 1854 Plat Map Survey, which recorded vegetation types the surveyors encountered at several locations in the lower Elk River valley, including at section corners and stream/slough channel crossings. These vegetation observation points were plotted on the 1854 Map (Figure 2-7). Notably, all vegetation observations along the southern boundary of Sections 9 & 10 indicate spruce, fir, and conifer. These observations are consistent with other references, including Lentell (1914), which describe the westward extent of the "redwood timber belt" extending down Elk River valley. Below this timber belt and westward to the laterally crossing Elk River, is a mix of Alder, Alder and Willow, Salt Slough, and Prairie.

Figure 2-7. Survey notes of vegetation types encountered at stream crossings and section corners recorded from the 1858 US Coast Survey.

Historical Alignment of Elk River

During development of the Elk River Recovery Assessment, our Project Team evaluated the historical alignment of the Elk River. The 1854 US Survey General Township Plat Map shows a straighter channel alignment, and when this map was georeferenced and the stream channel was digitized, the result was that the NF-SF confluence was a mile upstream (east) from its current location. This concept that Elk River may have been straighter historically and that the Elk River may have been an "anastomosing channel" along the valley bottomlands (i.e., with two or more mainstem channels) was considered. These concepts were explored using historical survey maps and surveyor notes, and based on the best available evidence, were not validated. We concluded that the early (e.g., 1854) mapping of the creek alignment was a rudimentary depiction of channel conditions. When the "historical" channel alignment was overlain onto contemporary topography, the 1854 stream alignment would have cut through the hillside and not followed the valley bottom, which is implausible. Given the crude level of mapping conducted in 1854, we also concluded the map did not accurately depict the position of the confluence of the North and South Fork.

Regarding the sinuosity of the Elk River in the fluvial valley reaches, we located the 1894 "Herrick" map of the Elk River, which appears to be the earliest survey of the river above the fluvial-tidal transition. This map (Figure 2-8) shown side-by-side with the contemporary Elk River planform location shows a single, sinuous mainstem channel approximately in its current configuration. Based on this evidence, we concluded that the mainstem Elk River channel was historically a single-thread channel and the current planform location is likely the historical location in approximately 1850 when major development in the Elk River began.

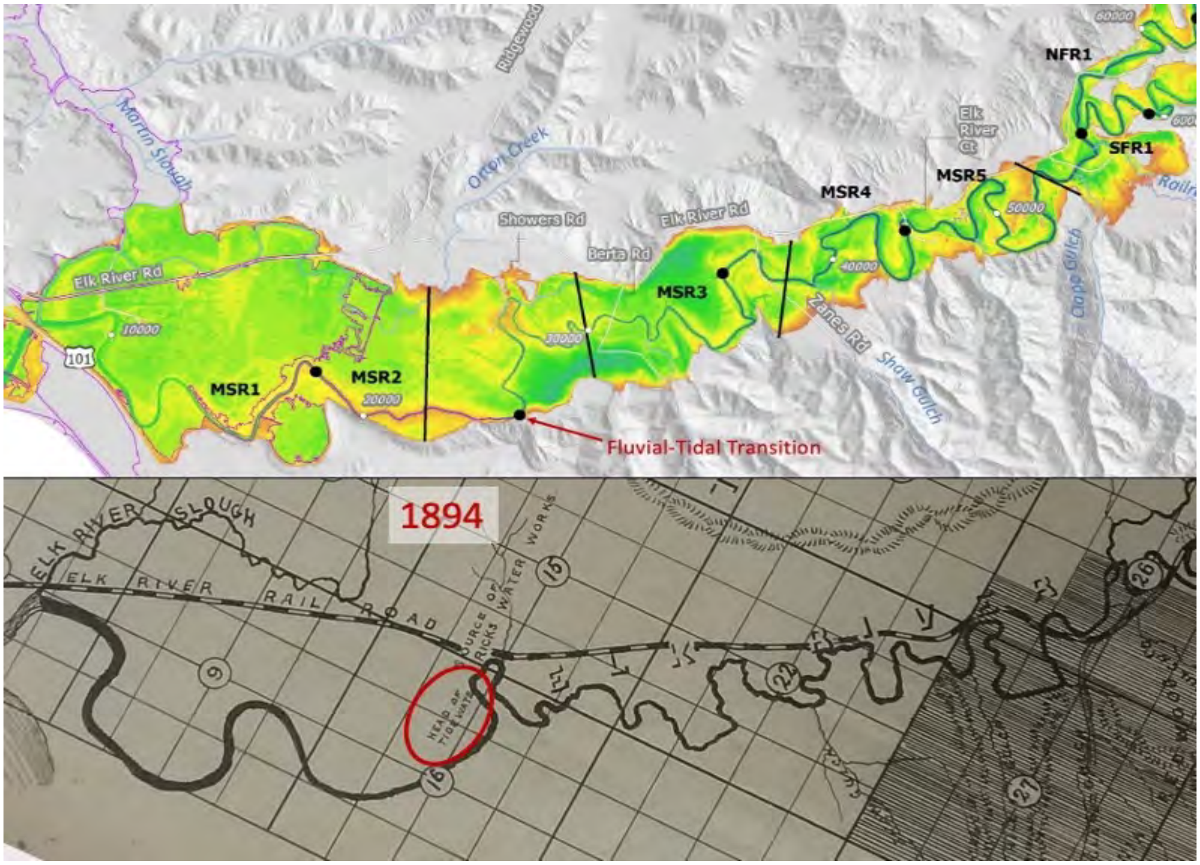

Figure 2-8 Planform configuration of the Elk River from the 1894 Survey Map, showing the Elk River in the approximately identical location as a contemporary map.

Summary

Since the beginning of European-American settlement of the Humboldt Bay region in the 1850s, the condition and function of the Elk River and its floodplain (including coastal marsh habitat) have been influenced by land use (farming, ranching, and timber), and urbanization and infrastructure encroachment (roads, bridges, and houses). Levees and dikes were constructed to create and maintain valley bottomlands suitable for farming and ranching, and roads and railroads were built to access agricultural lands and early timber operations. As a result, much of the pre-existing wetlands and coastal marsh habitat was converted to farmlands. The hardening of the landscape over time has reduced the bay coastline's ability to attenuate high tides, instead forcing these tides upriver. Stabilization of the bay mouth by constructing jetties on the north and south spits hardened the entrance of the bay and resulted in the erosion of much of what is referred to as Red Bluff (Buhne Point). Sediments eroded from Red Bluff subsequently deposited at the mouth of the Elk River causing Elk River Slough to turn north and lengthen prior to entering the bay.

The ecological effects of logging and diking and draining tidelands to accommodate agricultural use are emotional, historical, social, and cultural issues. Accommodating the right to manage natural resources on private property while protecting the public trust and respecting private property rights is an important aspect of the Elk River Stewardship Program.

2.3 Overview of Current Watershed Conditions

In response to the degraded Elk River conditions, and to establish a foundation of sound technical information to inform restoration and management decisions, the Regional Water Board commissioned several detailed technical studies during the period spanning 2014 through 2018. Those studies include the Upper Elk River Technical Analysis for Sediment (Tetra Tech, 2015) and Elk River Recovery Assessment (CalTrout et al. 2019). The Tetra Tech report was primarily oriented toward support of the Regional Water Board's adoption of the TMDL Action Plan, which established regulatory and nonregulatory implementation components for recovery of beneficial uses. The Elk River Recovery Assessment, conducted from 2014 through 2018 by the Stewardship Project Team, is a named component of the TMDL Action Plan and was oriented toward a voluntary (non-regulatory) sediment remediation program, and developed two critical tools to understand the Elk River watershed and its impairment: (1) a conceptual model of hydrologic and geomorphic processes that summarized the current conditions in the Elk River watershed, and (2) a hydrodynamic and sediment transport model (HST model) to predict system response under a range of hypothetical management scenarios. Integration of the conceptual model and HST model provides a framework for identifying appropriate recovery strategies and analyzing and predicting responses to proposed strategies and actions.

The Elk River Recovery Assessment stratified the 19.2-mile Stewardship Program Area into eleven study reaches, each with relatively homogenous fluvial geomorphic forms and processes, including five Mainstem Reaches (MSR 1-5), four North Fork Reaches (NFR 1-4), and two South Fork Reaches (SFR 1-2). These reaches were studied in detail and described in the Recovery Assessment (CalTrout et al. 2019). For subsequent planning purposes within this Recovery Plan and moving toward implementation, these geomorphic reaches have been lumped into four broad **Planning Areas** (Figure 2-9) as follows:

- Tidal and Lower Valley Reaches (Mainstem Reaches 1 and 2)
- Fluvial Mainstem Reaches to Historic RR Xing (Mainstem Reaches 3, 4, and most of 5)
- Upper Mainstem, North Fork, and South Fork (the upper portion of Mainstem Reach 5, North Fork Reach 1, and South Fork Reaches 1 and 2)
- Upper North Fork Reaches (North Fork Reaches 2, 3, and 4)

Sedimentation and Water Quality

The channels and floodplains in the Elk River Project Area have been extensively altered over the past 170 years in response to numerous factors, including agricultural land conversion, timber harvesting, and construction of roads and railroad lines; increases in sediment loading; and changes in riparian vegetation and wood load. A key conclusion from the Elk River Recovery Assessment (CalTrout et al. 2019), summarized the sedimentation problem as follows:

> *The Elk River crossed a threshold during the latter part of the twentieth century, when accelerated timber harvest and road building in the upper watershed coincided with large storm events, leading to large increases in channel aggradation in lowermost reaches of the North Fork, South Fork, and the upper reach of the Mainstem Elk River. Hydraulic constrictions in Mainstem Reach 5 (from the North Fork-South Fork confluence downstream to Elk River Court) and associated backwatering of adjacent upstream reaches were further exacerbated by infrastructure (i.e., roads, bridges, and the railroad grade) and the planting of a densely stocked redwood plantation on the adjacent floodplain. The resulting channel aggradation created a feedback loop that reduced channel conveyance capacity, slowed flow velocities, and limited sediment transport rates. Aggraded fine sediment deposits have subsequently promoted vegetation growth on the channel bed, which increases hydraulic resistance, anchors sediment deposits, and further limits sediment routing and sorting.*

Chapter 3 of the Elk River Recovery Assessment *Conceptual Model of Existing Hydrogeomorphic Processes* synthesizes the geomorphic and hydraulic (i.e., hydrogeomorphic) functions within the Elk River channel and floodplain based on existing and historical information. The Recovery Assessment report can be found here: https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/elk_river/pdf/190516/ERRA%20Framework%20Final%20compiled_031419.pdf

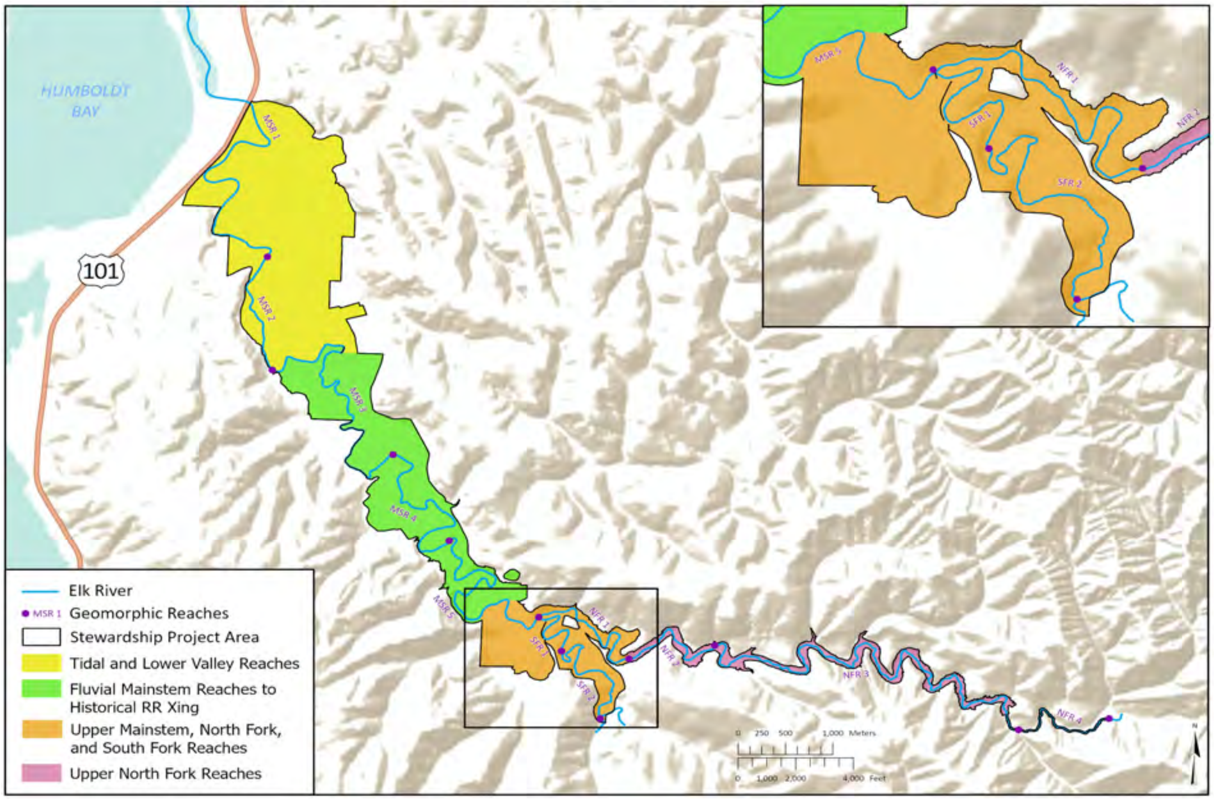

Figure 2-9. Location of the Elk River Watershed Stewardship Program and Planning Areas.

In short, the Elk River channel in the North Fork, South Fork, and Mainstem Reach 5 is heavily aggraded by fine sediment, causing severe water quality and habitat impairment, disrupting domestic water supplies, and threatening the residential communities in these reaches with nuisance flooding of homes, roadways, and bridges (Figure 2-10).

Downstream of MSR 5, the channel becomes less entrenched and natural levees (caused by sediment dropping out adjacent to the channel) separate the bankfull channel from adjacent large, deep flood basins. Compared to other reaches of the Elk River, floodplains in MSR 3-4 (from Elk River Court downstream to Showers Road) convey a large proportion of the total water and sediment flux during storm events. Floodplain sediment storage in these reaches is an important component of the annual sediment budget. Elevated floodplain topography around the fluvial-tidal transition near Showers Road and other confining features create another large-scale hydraulic control that backwaters upstream areas during high flows.

The mainstem Elk River through the downstream two reaches (MSR1-2) is a tidal slough channel partially confined by levees and adjoined by historical and existing but disconnected tidal wetlands. A dense network of relict slough channels throughout the floodplain in this area indicates a once extensive tidal estuary prior to nineteenth century agricultural conversion.

Timber landowners in the upper watershed (HRC, GDRC) and the BLM have been implementing sediment load reduction efforts for many years and will continue to do so through implementation of the Regional Water Board's WDR's and through BLM's implementation of its land management plans. BLM will be subject to the Regional Water Board's Federal Lands Permit which has provisions regulating timber harvest activities and grazing. HRC and GDRC operate timber management activities that are regulated under watershed specific WDR's to reduce road and management related sediment discharge. However, managed timberlands in the Elk River still yield higher quantities of sediment than undisturbed lands in the Elk River despite rigorous implementation of best management practices (Tetra Tech 2015). In addition to sediment derived from historical logging practices, large volumes of sediment were deposited and stored in tributary and mainstem channels during the 1988–1997 time-period (Tetra Tech 2015). This "legacy sediment" will continue to deliver high sediment loads to the Stewardship Program Area for the foreseeable future. Sediment control efforts implemented either voluntarily or through regulatory programs will likely continue throughout the upper watershed's timberlands, with the assumption that, with proper timber management and stewardship, sediment loads will eventually begin to decline.

Nuisance Flooding

A direct consequence of the severe sediment aggradation condition in Elk River channels is the loss of capacity of these channel reaches within the Stewardship Program Area to convey flood flows during winter storm events. The Elk River Recovery Assessment (CalTrout et al. 2019) estimated that the average channel bed elevation had increased by more than 4 ft at the North Fork bridge, and by more than 6 ft at three mainstem bridges for which data were available (Steel Bridge, Zanes Road, and Berta Road). The hydrodynamic model indicated an average loss of more than forty percent of the cross-section area of the typical bankfull channel.

The change in channel capacity has resulted in a condition the State Water Resources Control Board has labeled a nuisance condition, and combined with the finding from the Recovery Assessment that sediment aggradation and consequent nuisance flooding will continue to worsen without intervention, this condition warrants remediation. Numerous homes along the North Fork, the South Fork, and the upper Mainstem at Elk River Court are at risk of flooding and several homes have been flooded in past storm events. Several bridges and roadways including the North Fork Bridge, the Elk River "Flood Curve", the Elk River Court Bridge, Zanes and Berta roads and bridges are all prone to flooding more frequently than during the period prior to major sediment aggradation (Figures 2-11 and 2-12). All four of these bridges and roadways provide the only vehicular access to residential areas, and thus when flooded prevent people from getting to and from their homes.

In addition, tidal flooding (unrelated to the sediment and nuisance flooding condition) has been increasing in the lower reach of Elk River (MSR 1) in recent years, likely the consequence of advancing sea level rise in the Humboldt Bay vicinity (NHE 2015) as well as the result of aging and poorly maintained dikes, levees, and drainage infrastructure (culverts and tide gates). Several formerly productive agricultural properties in the lower estuary have been reclaimed by sea water leakage and are converting back to salt marsh (Figures 2-12 E–F).

Fish Populations

Elk River provides critical habitat for several species of historically abundant anadromous salmonids, including Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*O. tshawytscha*), steelhead (*O. mykiss*), and Coastal Cutthroat Trout (*O. clarkii*). These three species (Chinook, Coho, and steelhead) are currently listed as threatened under the Federal Endangered Species Act (ESA); Coho are listed by the California ESA.

Salmonids in Elk River depend on properly functioning stream channels and floodplains; a mature riparian vegetation corridor contributing allochthonous materials, terrestrial invertebrates, and shade; large wood that forms complex in-channel habitat features; cold, clear, and well-oxygenated water; and a healthy stream-estuary ecotone where natal and non-natal migratory fish can transition between freshwater and saltwater. In addition to their freshwater habitat requirements, native salmonids in Elk River depend on diverse life history strategies (including several different juvenile rearing and outmigration pathways) to maintain resilient and abundant populations in temporally variable environments (Schindler et al. 2010, Wallace et al. 2015). Leaving their natal spawning habitat at different times allows fry and juvenile salmonids to interface with a mosaic of non-natal rearing habitats.

Timber harvest and road building in the upper watershed, ranching and residential development in the middle and lower watershed, and other land uses over the past 170 years have cumulatively impaired water quality, causing high turbidity and suspended sediment concentrations, elevated water temperatures, and low dissolved oxygen, and have degraded stream channels and floodplains that provide critical spawning and rearing habitats for salmonids (Regional Water Board 2013, 2016; NMFS 2014, 2016; Tetra Tech 2015). Large inputs of fine sediment during the 1980s and 1990s accelerated water quality and habitat degradation in Elk River. In turn, habitat degradation has significantly reduced juvenile and adult salmonid abundance in Elk River (NMFS 2014, 2016), and may be impairing critical life history pathways that are essential to the recovery of these species.

The direct and cumulative effects of sediment aggradation, the severe alteration to channel and floodplain structure that contributes to winter and summer rearing habitat, the degraded water quality conditions (e.g., turbidity, suspended sediment, temperature, and DO), and landscape-scale alterations from human land uses have left the Elk River watershed and its salmonid populations significantly impaired and at risk. Salmonids currently struggle to survive and persist at nearly every life-stage in many reaches of the Elk River Stewardship Program Area. Adult spawning appears impaired by sediment aggradation in many locations in upper reaches of the North Fork Elk River, South Fork Elk River, and a few tributaries, but does not appear to limit fry production in the watershed at current rearing habitat capacities. Juvenile rearing habitat may be a key limiting factor and is likely saturated at low densities. Stream reaches providing non-natal juvenile rearing habitat in the lower forks, the Mainstem Elk River, and the estuary are degraded by sediment aggradation and by acute and chronic turbidity and high suspended sediment concentrations during the winter. Temperature and dissolved oxygen are likely impaired during the lowest summer and fall low-flow conditions in the confined mainstem and lower forks reaches (Figures 2-13).

Elk River Southern Oregon/Northern California Coast Coho (SONCC) coho salmon are an important part of the larger Humboldt Bay Tributaries population (NMFS 2014), which is listed as a "Core, Functionally Independent Population" at moderate risk of extinction. Core populations are those chosen by NMFS to meet population viability criteria, i.e., the highest priority for recovery. For Humboldt Bay coho salmon populations, the key limiting stresses are impaired estuary and mainstem function, and lack of floodplain and channel structure. The Humboldt Bay Coastal Chinook population is listed as an "Independent, Essential Population" (NMFS 2016) for which the key threats to extinction were: reduced habitat complexity, riparian removal, sedimentation, degradation of water quality, instream wood removal, and poor estuarine habitats. The Humboldt Bay North Coast Steelhead population has similar high priority recovery potential, and faces habitat threats similar to coho and Chinook salmon populations.

Prior to human disturbances, Elk River supported abundant salmonid populations (CDFG 1994; Weitkamp et al. 1995; HBWAC 2005; NMFS 2014, 2016), and could do so once again. The upper watershed, tributaries, and mainstem Elk River provide exceptional potential for restoring salmonid spawning and rearing habitat. Increasing life-history diversity by restoring non-natal rearing habitat in middle and lower Elk River, and in the stream-estuary ecotone, would improve long-term population stability. Restoration of the stream-estuary ecotone provides dual benefits of winter habitat refugia during winter, as well as productive habitat for smolt emigrants on their way to the ocean in spring.

In addition to salmon and steelhead, Elk River provides habitat for many other native fish and aquatic organisms which are also likely impaired by habitat alteration. Pacific lamprey (*Entosphenus tridentatus*) is native to Elk River; the tidal reaches of Elk River likely also provide habitat for the federally endangered tidewater goby (*Eucyclogobius newberryi*). Humboldt Bay, and by extension lower reaches of Elk River, may also provide nursery habitat for green sturgeon (*Acipenser medirostris*).

Riparian and Wetland Habitats

The Elk River corridor includes the river's instream aquatic habitat, its floodplain, and the riparian vegetation and wetlands habitats growing along the riverbanks. Historically most of the valley was likely densely forested with a mosaic of mixed conifer and hardwood trees forming a riparian canopy, with an understory of woody and herbaceous plants. Redwoods, spruce, willows and alders likely dominated the riparian forest. In addition to these dense, multi-story riparian forests, the presence of low-lying floodplain basins proximal to the fluvial reaches, that were morphologically separated from the stream channel by natural levees, formed palustrine emergent wetlands. Open grasslands or prairies, described in Loud (1918) were likely maintained in the lower valley, fringing the tidal zone. Finally, extensive tidal wetlands existed in the lower Elk River valley in a gradient from freshwater to brackish to salt marsh, with a narrow strip of coastal dune habitat along the shoreline of Humboldt Bay.

Land-use practices have significantly altered the composition of channel and floodplain vegetation, and in many locations have constrained vegetation to a narrow strip along the channel banks or edge of the floodplain. Most of Elk River's floodplain vegetation was removed by the late-19th century and has generally remained open agricultural lands for the past century. Riparian habitat is generally currently confined to a thin strip, as narrow as one tree-canopy width, along the riverbanks and in scattered patches.

The heavily aggraded channel conditions have promoted the encroachment of dense live woody vegetation within the channel bed and banks, significantly affecting channel capacity, hydraulics, geomorphology, and sediment transport. Fresh sediment deposits within the channel are quickly colonized by non-native and invasive plant species. This condition has become a nuisance, contributing to a feedback cycle by facilitating more sediment deposition, further degrading aquatic and riparian habitat. Although the riparian species present are native to Elk River, the presence of high stem densities of live woody species rooted within the channel bed and banks is detrimental to aquatic habitat and riverine function.

These riparian and wetland habitats undoubtedly provided unique and productive habitats for a myriad of native birds, waterfowl, amphibians, and other wildlife species, all of which have been profoundly diminished by past and current land uses.

Available Background Studies

Technical studies that support Elk River recovery planning include:

- Elk River Hydrodynamic and Sediment Transport Modeling Pilot Project (Northern Hydrology and Engineering and Stillwater Sciences, 2013)
- Martin Slough Enhancement Project, Eureka, CA Basis of Design Report (Mike Love and Associates and GHD, 2015)
- Upper Elk River: Technical Analysis for Sediment (Tetra Tech, Inc., 2015)

- Elk River Recovery Assessment: Recovery Framework (CalTrout, Stillwater Sciences, and Northern Hydrology and Engineering, 2019)
- Elk River Sediment Remediation Pilot Implementation Projects: Basis of Revised 65% Draft Engineering Designs (Northern Hydrology and Engineering and Stillwater Sciences, 2019)
- South Fork Elk River 10% Design Report (Northern Hydrology and Engineering and Stillwater Science)
- Elk River Estuary Mainstem Reaches (MSR) 1-2 10% Design Report (Northern Hydrology and Engineering and Stillwater Sciences, in preparation)

Future Study Needs

Multiple new technical studies will be required to support regulatory compliance requirements and the development of engineering designs and construction plans, including:

- Topographic surveys including collection of terrestrial LiDAR data and ground-based topographic and bathymetric surveys.
- Geotechnical and soils investigations
- Wetland and upland delineations and Ordinary High Water Mark determinations
- Botanical Investigations
- Wildlife Resources Evaluation
- Habitat Conversion Analysis
- Agricultural Conversion Analysis
- Surveys for special status plants, Sensitive Natural Communities, and Environmentally Sensitive Habitat Areas
- Biological Assessments for endangered species consultations
- Cultural and historic resource investigations

A note about units – we've chosen to not uniformly adhere to one numeric unit system in this document, either metric or standard. Instead, we have chosen units for each variable that are most intuitive, commonly used, or most easily understood within our profession. In addition, right and left banks of the river are referenced looking in the downstream direction.

Figure 2-10 A–F. Photographs of Elk River showing the sedimentation conditions at various locations in the Stewardship Program Area. A: Tom's Gulch, tributary to the South Fork Elk, with a sand-bedded channel in a sediment source tributary. B: The North Fork Elk River near the South Fork confluence showing slough sedge colonizing a sediment-embedded riffle. C–D: The South Fork Elk River at the BLM Headwaters Reserve parking area, after a March 2019 storm triggered a landslide on BLM property. E: Mainstem Elk River in MSR 5 showing extensive sediment storage in a highly simplified channel. F: Mainstem Elk River in MSR 4 with a large willow growing from the channel bed in fine sediment deposits.

Figure 2-11 A–E. Photographs of Elk River showing nuisance flooding conditions at various locations in the Stewardship Program Area. A-B: Elk River Road "Flood Curve" adjacent to the North Fork Elk River (visible at far right of Photo B before/after a typical winter flood event; road inundation prevents ingress/egress for numerous residents. C: Floodplain inundation in MSR 4 near homes and across roadways. D: Inundation of Elk River Court during a winter flood, with the only ingress/egress bridge in the distance. E: Showers Road in MSR 2; juvenile salmonids entrained in floodwaters in this location would have no route back to mainstem habitats.

Figure 2-12 A–F. Photographs of Elk River showing nuisance flooding conditions at various locations in the Stewardship Program Area. A-B: Flooding of Berta Road which is the only ingress/egress for numerous residents. C-D: Common floodplain inundation in Elk River MSR 2 (C) and MSR 3 (D); most floodwater that leaves the channel in these reaches fill deep flood basins and do not drain back to the mainstem, potentially causing fish stranding. E: Tidal inundation on the CDFW Elk River Wildlife Area caused by unmaintained drainage structures and threatening neighboring agricultural lands. F: Tidal inundation from Swain Slough onto Pine Hills Road and adjacent formerly productive agricultural lands.

Figure 2-13 A-F. Photographs of Elk River showing habitat conditions and fish barriers at various locations in the Stewardship Program Area. A: Good quality aquatic habitat persists in the South Fork Elk River above the Stewardship Program Area. B: Riparian habitat on the South Fork Elk River at Save the Redwoods League property, illustrating the typical single tree-width riparian zone found along most reaches of the Elk River. C: Instream habitat in the NF Elk during dissolved oxygen data collection on 7/21/21; summer DO's dip as low as 1-2 mg/L (actual DO measured at this site: 6/11/21: 6.52 mg/L; 7/21/21: 4.75 mg/L; 9/9/21: 0.9 mg/L). D: recovering tidal marsh habitat at the CDFW Elk River Wildlife Area. E-F: Unmaintained and impassable tide gates and culverts are located within and surrounding the CDFW Wildlife Area.

3 Conservation Outcomes

The purpose of the Elk River Stewardship Program and this resultant Recovery Plan is not to propose to restore the Elk River to a pristine condition and bring back the historic abundance of salmon and steelhead populations. Given its past and current land uses and land ownership, that outcome is not feasible nor is it proposed as an outcome of this Recovery Plan. The Elk River is a working landscape, and the stewardship program is not proposing major land-use changes.

The Elk River Stewardship Program has pro-actively pursued two primary outcomes: (1) identify individual Actions that landowners would voluntarily support to be implemented on their private properties, then (2) assess the individual and cumulative benefit to the Elk River's recovery and water quality beneficial uses that would result from implementing these Actions. These *Actions* were derived from the previous phases of technical studies, and now guide our program goals and objectives to be forward-looking, to seek their immediate implementation in order to improve the health of the watershed and the lives of the people who live, work, and recreate there.

This Stewardship Program and Recovery Plan strive to set the Elk River on a trajectory of recovery and to restore the capacity for the stream ecosystem (within the Stewardship Program Area) to eventually maintain itself, and to make Elk River more resilient to future conditions - climate change, sea level rise, and land uses. This includes a state of dynamic equilibrium in sediment supply, transport, and storage; a natural riverine flood regime that doesn't interfere with Elk River residential communities; and a thriving ecosystem that provides suitable habitat for native fish, vegetation, birds, and wildlife species. This conceptual vision is the foundation for more detailed, reach-specific goals and objectives, which serve as targets to which implementation strategies can be tailored.

The purpose of this plan is therefore to provide a concise blueprint of the strategies and resources required to achieve our desired conservation outcomes, identify the resources necessary to meet our conservation goals, and to guide our program toward the most informed and important conservation investments.

Goals and Objectives are essential for guiding the development and implementation of restoration efforts. Because objectives are also used to measure progress and evaluate success as part of a project monitoring and adaptive management program, objectives should be measurable or lead to direct and tangible outcomes. Here we define our Program Goal and set of Objectives for the Elk River Recovery Plan.

3.1 Program and Project Goals

The Elk River Recovery Plan's GOAL is to:

Develop and implement a suite of voluntary Actions within the Elk River Stewardship Program Area, that are supported by landowners, regulatory agencies, and other stakeholders, and that will:

1. **Remediate the impacts of legacy fine sediment deposited in the Elk River channel (North Fork, South Fork, Mainstem).**
2. **Reduce the risk and occurrence of nuisance flooding in Elk River.**
3. **Promote aquatic and riparian habitat remediation and the recovery of threatened salmon and steelhead populations.**

Together, this goal is intended to put the Elk River on a trajectory of recovery of impaired water quality beneficial uses throughout much of the lower watershed. Beneficial uses of the Elk River that are the focus of this Program include municipal and agricultural water supplies; cold freshwater habitat; rare, threatened, and endangered species; migration of aquatic organisms; spawning, reproduction, and/or early development; and water contact recreation. This Recovery Program will balance flood protection and natural resource enhancement and provide a feasible environmental compliance approach for implementation of the recovery Actions.

3.2 Objectives

Program objectives are listed below. Key objectives by reach are summarized in Table 3-1.

- Coordinate and communicate directly with watershed residents, resource and permitting agency staff, and other stakeholders to solicit input and garner voluntary support for the Recovery Program and proposed Actions.
- Identify technical design and implementation approaches that are feasible, fundable, and broadly supported by landowners and permitting agencies; temporary impacts should be balanced to achieve long-term net benefits to public trust resources and ecosystem functions.
- Improve the living conditions of Elk River residents currently affected by frequent nuisance flooding (and the consequent risks and inconveniences) and impaired water quality.
- Protect and restore sensitive habitats and natural communities, special status fish species and critical habitat, sensitive and protected wetland and riparian plant species, and other statutorily protected areas.
- Establish a river-wide coordinated monitoring and adaptive management program to enable evaluation of remediation actions; track trends in water quality, habitat characteristics, and recovery of protected species; and provide timely reporting of information.
- Increase Coastal Resiliency to buffer the threat of sea level rise to tidal marshes, aquatic habitat, and working agricultural lands in the lower reaches of Elk River.
- Restore a balance in ecological function so that eventually Elk River will function without ongoing maintenance and management.
- Reduce, and where feasible eliminate, invasive, non-native vegetation as well as native vegetation encroaching unnaturally into the river channel.
- Demonstrate that the Project does not raise the 100-yr flood level above existing conditions.
- Ensure regular communication with interested stakeholders through multiple means for the purpose of increasing awareness of plans, projects, and changing watershed conditions, including flood conditions.

Table 3-1 Summary of Stewardship Program Objectives by Reach.

Focus	Objective	Planning Area 1	Planning Area 2	Planning Area 3	Planning Area 4
Ecological	Maintain existing tidal inundation and expand tidal prism where feasible, to restore natural tidal marsh and estuarine functions; and restore seasonal freshwater wetlands, ponds, and aquatic habitats, to increase resiliency of native fish and wildlife species dependent on these habitats.	X			
Ecological	Restore and maintain a natural riverine and riparian corridor along Elk River, with natural flood-flow and sediment regimes, seasonal freshwater wetlands, ponds, and aquatic habitats, and buffered protection from agricultural land uses, to increase resiliency of native fish and wildlife species dependent on these habitats.		X		
Ecological	Restore a natural form and function to the river channel, including deep pools and gravelly riffles, connectivity to floodplain benches, natural rates of sediment aggradation, and medium-to-large log jams that provide geomorphic and habitat functions.			X	X
Land Use	Protect the productivity and long-term sustainability of existing forestry and agricultural operations; protect existing rural residential land uses; and provide access to potable domestic and agricultural water supplies.	X	X	X	X
Water Quality	Protect and restore water quality from impairment by suspended sediment and turbidity, water temperature, dissolved oxygen, and coliform bacteria (impairment = anthropogenic alteration from natural water quality regimes).	X	X	X	X
Floodplain	Improve channel/floodplain connectivity during winter flooding, promote natural sedimentation processes, and minimize/avoid stranding of juvenile salmon and steelhead.	X		X	X
Habitat	Restore high quality winter and summer rearing habitat for juvenile salmon and steelhead, within tidal creeks and slough channels, in off-channel freshwater ponds, and in the mainstem Elk River.	X	X	X	
Nuisance Flooding	Reduce nuisance flooding (e.g., of roadways, residential and agricultural infrastructure) by restoring channel conveyance capacity, maintaining and improving floodplain flow pathways, and upgrading drainage infrastructure (culverts, tide gates, bridges, etc.).		X	X	
Sediment	Create low-elevation off-channel habitat and sediment trapping features, to reduce the supply of fine sediment from mainstem and high priority tributaries into downstream mainstem reaches; consider periodic mechanical removal of captured sediment to maintain storage capacity.			X	X
Vegetation	Restore and maintain healthy and mature vegetation assemblages, including a mosaic of native riparian hardwood and conifer species; manage and prevent/suppress vegetation growth within the stream channel.	X	X	X	X

3.3 Technical and Regulatory Constraints, and Landowner Participation

Throughout the technical study and planning process, our Project Team has worked in consultation with regulatory agencies and technical experts to identify planning issues and technical constraints at both the landscape and reach scale, as well as within the social network of Elk River. This process helps identify limitations and information necessary to integrate ecological, social, and economic values. Technical and non-technical constraints identified include:

- Private property (maintaining property owners' desired land management practices)
- Infrastructure (roads, bridges, structures, utilities)
- Geologic features
- Wetland impacts
- Land use conflicts, particularly on agricultural lands
- Cultural resource impacts
- Regulatory and legal issues (such as permitting requirements and liability)
- Funding constraints and Project Team capacity.

Many of these constraints will be evaluated during development of engineering design plans and permit applications leading to implementation of the proposed Recovery Plan, and these constraints may have the potential to alter specific aspects of the Recovery Plan or may require future decisions to resolve. Our commitment is to be transparent and outwardly informative during the progression of objectives to design plans to implementation Actions.

All proposed Recovery Plan actions are located on private property, except for parcels in the tidal reach owned and managed by CDFW at the Elk River Wildlife Area. To implement the Recovery Plan, the Regional Water Board and grant recipients will need to obtain *Access and Maintenance Agreements* with landowners to complete special studies and engineering designs, and to construct, monitor, and maintain the project Actions. Landowners may also be required to participate as co-applicant on permit applications; we anticipate very little or no direct monetary costs to landowners.

3.4 Conservation Outcomes

To reach the goals and objectives outlined above will require a significant investment of time, money, patience, and perseverance. A successful outcome would result in a watershed that can provide its residents with a source of safe and reliable drinking water; considerable reduction in the risks and consequences of nuisance flooding; an ecological condition that is on a trajectory of more rapid recovery and self-maintenance, and a recalculation of the Upper Elk River Sediment TMDL with reduced regulatory controls that account for improved assimilative capacity for sediment.

This Recovery Plan represents an important milestone for the Stewardship Program, and an important step toward the implementation of remediation and rehabilitation Actions.

4 Project Description

4.1 General Enhancement and Restoration Actions

As an outcome of the Elk River Recovery Assessment (CalTrout et al. 2019), the Project Team provided a preliminary set of recommended actions that, when combined, describe the Framework for recovery of beneficial uses, improved water quality, and reduced nuisance flooding in the Elk River. These actions were described in the Recovery Assessment report, presented at several public meetings, reviewed by a Technical Advisory Committee of academic and technical experts, and discussed extensively throughout 2019 and 2020 at numerous individual and group meetings with Elk River property owners, timberland owners, and resource agencies (Appendix A). The categories of Actions being proposed are summarized in the following report section. Utilizing the HST Model developed under the ERRA and described in the Recovery Assessment, this set of Actions, initially referred to as the *Preferred Remediation and Restoration Strategy*, has undergone additional HST modeling and analysis to better understand and demonstrate the efficacy of individual and cumulative Actions (presented in Section 5). The resulting refined set of Proposed Actions will be implemented as part of the proposed Project and include the following:

A. Sediment Load Reduction from Upper Watershed
B. Sediment Remediation of In-channel Aggradation
C. Aquatic Habitat Restoration
D. Floodplain Connectivity and Recontouring
E. Non-Native and Invasive Vegetation Removal (In-Channel and Floodplain)
F. Riparian Habitat Restoration
G. Tidal and Freshwater Wetland Restoration
H. Sediment Re-Use on Floodplains
I. Community Health and Safety Measures
J. Infrastructure Modifications
K. Monitoring and Adaptive Management

A. Sediment Load Reduction from Upper Watershed

To reduce sediment mobilization, transport, and re-deposition of legacy sediments from the upper watershed and tributaries, and protect the downstream investment in sediment remediation, sediment trapping is the most immediate and effective means available. Sediment trapping can be accomplished by creating localized geomorphic features, such as in-channel sediment detention basins or low-elevation floodplain surfaces that reduce the velocity of water containing high suspended sediment concentrations and allow sediment to settle out of suspension. Sediment deposited in winter when concentrations are high can be periodically removed during the low-flow season to maintain the sediment trapping capacity of the site. Trapping sediment before it is delivered to downstream reaches of the Elk River will help reduce the rate of in-channel sediment aggradation, and significantly improve water quality conditions if implemented at the appropriate scale and locations. In addition, sediment detention basins can be designed in some cases to mimic natural salmonid habitat features and provide valuable winter juvenile salmonid rearing habitat. Finally, other in-channel habitat features, such as large log structures, can also aid in scouring and mobilizing sediment, raising water elevations, and increasing the rates of sediment deposition on floodplains.

Sediment detention features will vary in size and configuration depending on the site-specific setting and objectives, and range in the half to two-acre size range. In general, these features will be excavated adjacent to the

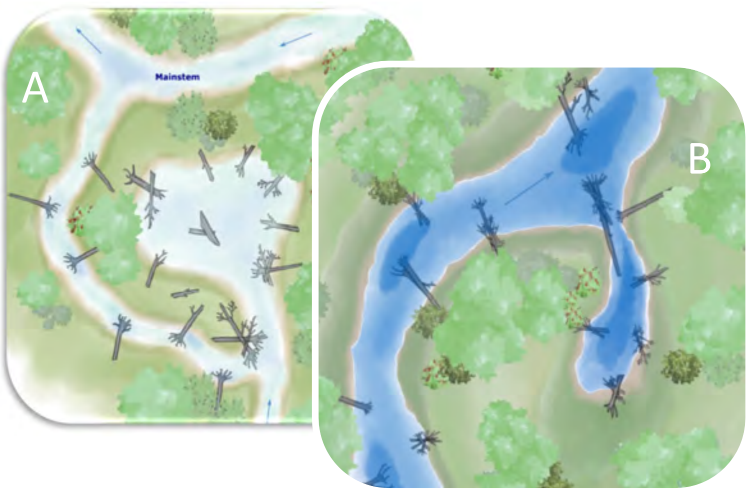

Figure 4-1. Conceptual examples of sediment detention and trapping design features intended to reduce sediment delivery to downstream reaches. A: off-channel sediment detention basin at a tributary confluence. B: off-channel alcove.

channel to mimic natural floodplain benches and depressions that are inundated more frequently than surrounding floodplains. Flow may enter these features directly from out-of-bank flow or by backwatering depending on the site-specific design configuration. Berms will not be used to confine the features, but design contours may be incorporated into sediment detention features to direct sediment-laden flow pathways. In some locations with access and/or designed to receive higher sediment loads, sediment may be removed periodically (e.g., annually or water year dependent) to maintain the sediment storage capacity. These sediment basins may also provide suitable off-channel juvenile rearing habitat for salmonids, and thus fish may be present during the construction season when sediment removal is scheduled. Sediment detention features that incorporate long-term maintenance objectives would have sediment re-use sites identified, with specified capacity to support long-term maintenance.

B. In-channel Sediment Remediation

A primary outcome of the Elk River Recovery Assessment was to document the extensive impairment to the channel bed and banks, the sediment composition, water quality, and aquatic habitat that resulted from large-scale sediment aggradation in Elk River. Currently the Elk River channel bed and banks within the Project Area are covered by deep sediment accumulations that are masked by a thin veneer of poorly functioning aquatic and riparian habitat. Mechanical sediment remediation is expected to be the most expedient and effective approach to minimize nuisance flooding and recover some beneficial uses and improve water quality. Mechanical sediment remediation would enlarge the channel width and increase depth of pools to increase cross-section dimensions that convey flood flows at rates and magnitudes similar to conditions that existed prior to the rapid sediment aggradation that occurred in the late 1980's and 1990s, but maintain thalweg elevations and connectivity to floodplains similar to current conditions.

Channel rehabilitation through mechanical sediment remediation also entails (a) management of in-channel vegetation that has rooted extensively in deposited sediments, (b) recontouring of the channel to form a more natural riffle-pool morphology and maintain connectivity to inset benches, side-channel and off-channel features and floodplains, and (c) addition of large wood habitat features to provide juvenile salmonid habitat and hydraulic forces required to scour and maintain pools. A key consideration for the phasing of implementation as well as the flood conveyance capacity is whether the channel is both widened and deepened: widening the channel requires removal of undesirable native and invasive non-native vegetation that has rooted in fine sediment deposits, whereas deepening the channel results in a more entrenched channel that is less connected to the floodplain. Our channel rehabilitation approach of widening the channel and deepening pools, but maintaining the thalweg profile elevations, will reduce the overall volume (source) of legacy sediment available for downstream transport and thus accelerates the recovery of channel form and function, while maintaining floodplain connectivity.

Mechanical sediment remediation will likely rely on the use of heavy equipment (excavators and dump trucks) and/or suction dredging equipment to remove sediment from the channel and transport it to nearby sediment re-use sites. Dewatering and fish relocation would be required (see Section 6.6). Channel banks that have become overly steepened through successive years of sediment aggradation can be "laid back" at a gentler cross section slope, with large logs and log structures inserted, to create slow-water winter habitat for juvenile salmonids. Mechanical sediment remediation will cause temporary disturbance to aquatic and riparian habitats, as well as the fish and wildlife species that rely on those habitats, and thus should be implemented in multiple phases over a timespan of several years. Voluntary landowner cooperation will be essential to implement this action.

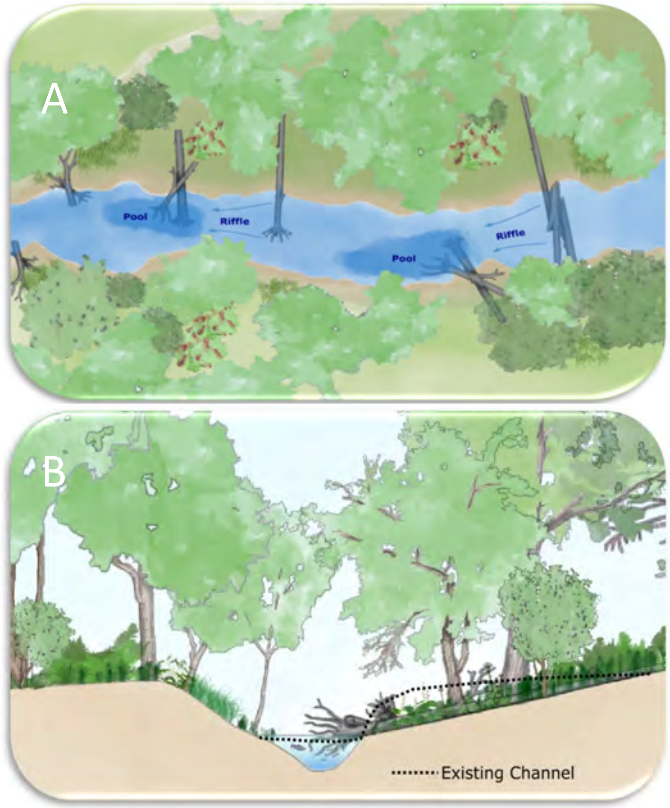

Figure 4-2. Conceptual examples of in-channel sediment remediation Actions intended to reduce legacy sediment storage volume and enhance instream habitat. A: Pool deepening. B: Pool deepening combined with bank recontouring.

C. Floodplain Connectivity and Recontouring

Floodplain rehabilitation and modification includes (a) re-grading and removal of deposited sediment, such as natural levees formed along the stream channel banks in selected locations, and side channels that have filled and become disconnected, (b) creation of meander cut-offs to improve flood flow routing during high flows, and (c) creation or rehabilitation of localized off-channel or backwater features that could provide sediment settling and storage and/or aquatic habitat benefits.

In the stream-estuary ecotone (reaches MSR 1-2), floodplain modification is proposed through enhancement of existing flood-flow pathways, construction of new flow pathways, and abandoning of non-functional drainage ditches and unmaintained infrastructure to route flood flows across floodplains and into "receiving" tidal marsh areas. Flood-flow pathways are intended to be broad and shallow swales, natural features that are inundated during moderate winter flood flows. In addition to routing floodplain flows, these flood-flow pathways (shallow swales) will serve to reduce the risk of stranding of juvenile salmonids during winter by routing flow and salmonids toward high-quality winter rearing habitat in the Elk River Wildlife Area and in Swain Slough. In general, these floodplain swales are proposed to replace the existing drainage infrastructure (see Infrastructure Modification section) with more natural features.

Along the fluvial mainstem reaches of Elk River (MSR 3-5), and in the South Fork Elk numerous floodplain modification features are proposed. These high flow path enhancement features entail mechanical excavation to lower the floodplain elevation and increase/maintain the frequency of inundation. These high flow path features include low elevation connector swales (meander cut-offs), floodplain benches within the bankfull channel, and

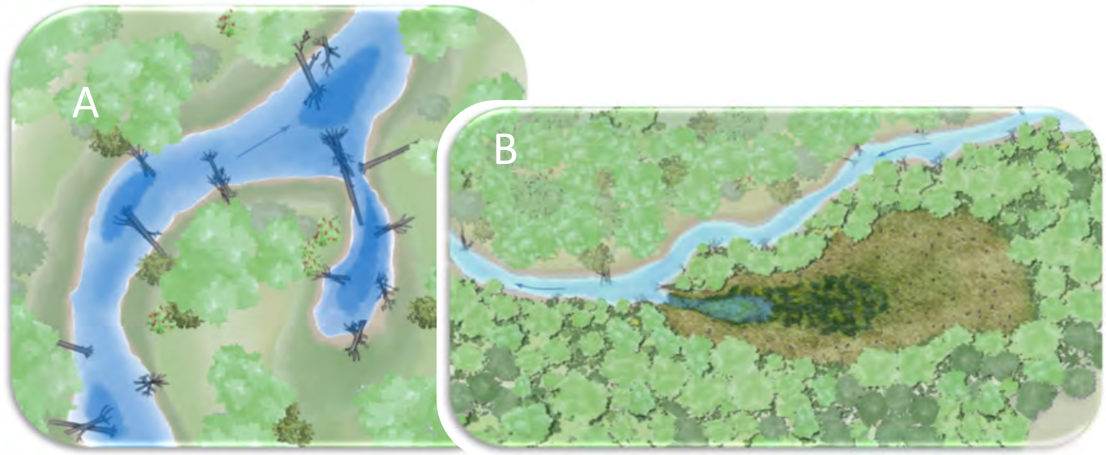

Figure 4-3. Conceptual examples of floodplain recontouring to enhance floodplain connectivity. A: Off-channel alcove feature. B: Enhanced seasonal wetland feature.

creation or enhancement of side channels. In addition to these specific high flow path features, areas on the floodplain that are elevated and cause constriction and contribute to backwatering, such as the abandoned railroad grade, are proposed for removal to improve floodplain flow continuity.

D. Aquatic Habitat Restoration

Land uses over the past century and a half have cumulatively impaired water quality (i.e., causing high turbidity and suspended sediment concentrations, elevated water temperatures, and low dissolved oxygen) and have degraded stream channels and floodplains that provide critical spawning and rearing habitats for salmonids. Large inputs of fine sediment during the 1980s and 1990s accelerated habitat degradation in Elk River. Juvenile salmonid rearing habitat is impaired in many reaches of the forks and tributaries due to sediment aggradation and associated loss of pool habitat, reduction of large wood storage, channel simplification, and lack of habitat complexity. Fine sediment aggradation has buried or embedded riffle substrates, likely reducing benthic invertebrate productivity and diminishing food resources during critical spring and summer rearing seasons. Pool depths and volumes are also significantly reduced, diminishing the overall habitat carrying capacity and habitat quality.

The volume of large in-channel wood has been reduced throughout these reaches, with smaller and less-persistent hardwood species (willow and alder) providing most of the current volume. Consequently, habitat complexity is significantly diminished. In addition, a large proportion of the current wood volume is deposited above the winter baseflow water surface and does not provide habitat benefits.

Much of the in-channel sediment deposits are colonized by dense beds of slough sedge (*Carex obnupta*). During the winter rearing season, more frequent flooding across road surfaces and pastures may also contribute to stranding mortality. Poor water quality resulting from acute and chronic high suspended sediment concentrations and turbidity levels impair fish health and feeding success. In the stream-estuary ecotone of Elk River, the historically extensive tidal marsh lands are currently used for cattle and dairy ranching. Remaining habitat is impaired by sediment aggradation, flood control, and tide gates that reduce the tidal prism and impair migration into and out of sloughs and off-channel areas.

Concurrent with the implementation of the channel and floodplain restoration actions described above, additional complementary actions will be implemented to enhance aquatic habitat in Elk River. These actions, while not entirely resulting from sediment impairment, will nevertheless contribute to improving habitat conditions for listed salmon and steelhead.

Habitat enhancement focuses on improving winter and spring rearing habitat for juvenile and pre-smolt life stages. Actions to improve winter rearing habitat conditions will also benefit rearing conditions during the summer low-flow season, summarized below. Dewatering and fish relocation would be required (see Section 6.6).

- Rehabilitate pool habitat by mechanical excavation of excess stored sediment, increasing pool surface area and residual pool depth, and increasing pool frequency along the length of restored reaches.
- Create complex juvenile and adult salmonid habitat through the addition of numerous large wood structures, increased large wood volume, and number of key pieces stored in-channel, emphasizing whole trees and large logs where feasible. Individual logs and log structures should extend from the channel thalweg in pools up the banks to connect to floodplain surfaces, to create slow-water winter habitat for juvenile salmonids and continuity in slow-water habitat over a range of streamflows.
- Maintain and promote the expansion of riparian habitat area and vegetation diversity, by: (1) expanding the riparian corridor width to a minimum 100 ft from top of stream banks, and wider where feasible, (2) increasing tree and plant species diversity through selective thinning and removal of dense hardwood trees and understory shrubs, (3) through planting of conifer species, and (4) removal of invasive and non-native plant species.
- Construct complex, multi-elevation floodplain benches to create off-channel habitat available over a range of flows during winter baseflows, winter floods, and spring recession.
- Construct off-channel ponds and backwater features that are connected to surface flow only during high flow events, especially in the less confined valley reaches (MSR2 to MSR4).
- Improve channel and floodplain connectivity for fish movement into and out of existing topographically low floodplain areas. Rehabilitate drainage structures to improve fish passage and enhance access during the winter months.

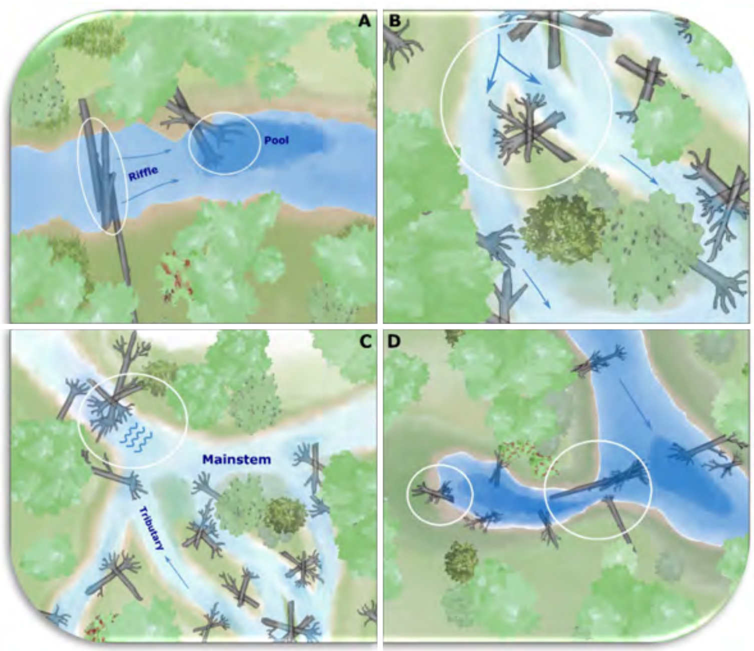

Figure 4-4. Planview of design options for installation of large wood features to enhance instream and off-channel aquatic habitat. A: Wood placement on riffles and pools combined with pool deepening through sediment removal will improve slow-water habitat for summer and winter rearing. B: Placement of wood at key geomorphic features provides habitat diversity. C: Wood jams placed to create hydraulic controls increases water depths and reduces water velocities in adjacent off-channel features. D: Wood placed in backwater features helps scour and maintain connectivity and provide habitat structural diversity.

Tributary confluences are high priority areas for habitat rehabilitation because the lower reaches of tributaries may provide lower suspended sediment concentrations or lower water velocities during winter floods and thus act as temporary habitat refugia from poorer mainstem conditions. Several tributary confluences will be proposed for rehabilitation to remove excess stored sediment and reconstruct habitat by deepening pools and adding large wood structures. The tributary confluence at Shaw's Gulch is proposed to serve as a sediment management area to trap excess sediment delivered from the tributary watershed during high flows.

E. Non-Native Vegetation Removal

Invasive non-native plants are prevalent in many locations along the Elk River riparian corridor, the most common of which include: (1) large stands of Himalayan blackberry located mainly along the margins of pastures and encroached into streamside riparian vegetation, and (2) scattered outbreaks of common ivy mostly growing in well-shaded areas and growing up and into larger riparian trees. Cotoneaster has been observed on the South Fork Elk River. Pampas grass is present along roadsides and occasionally encroach into riparian habitat; spartina is found in tidal marshes along slough channels and on tidal wetland surfaces.

These non-native plant species will be treated (suppressed and/or removed) in combination with restoration and enhancement of native riparian and wetland vegetation, described in the following sections. Non-native vegetation control will include developing an invasive weed management strategy, mapping to assess the scale of the problem and level of effort for control, prioritizing areas for phased management, and inclusion of best management practices during access, maintenance, construction activities.

F. Riparian Habitat Restoration

Riparian habitat within the Project area consists of native riparian trees, shrubs, and herbaceous species, including relatively young age-classes of native hardwood species (willow, alder, bigleaf maple, and elderberry) forming a tree canopy, with a dense understory of various willow species, native and non-native blackberries, stinging nettle, elderberry, and other native species. Land-use practices have significantly altered channel and floodplain vegetation composition, and in many locations has constrained vegetation to a narrow strip along the channel banks or edge of the floodplain. The heavily aggraded channel conditions in many reaches of the Elk River have allowed dense riparian shrubs, bramble, willow, and a wetland sedge to establish on the channel bed and banks, significantly affecting channel hydraulics, geomorphology, and sediment transport. While these species are native to Elk River, their presence rooted within the channel bed and banks in high stem densities is detrimental to aquatic habitat and riverine function and is highly undesirable.

To ameliorate the effects of flooding and to vastly improve the function of native riparian vegetation long the Elk River, the riparian corridor will be treated in selected locations to remove non-native invasive plants and encroaching undesirable native trees and plants, and revegetate with native species to encourage more mature age-classes of trees with a higher proportion of large and maturing hardwood and conifer species. The goal is to improve species composition, structure, and function of the riparian ecosystem over the long-term, in specific reaches. The undesirable dense shrubs and willow thickets that have colonized along the channel banks and bed and the sedge that is growing on the in-channel stored sediment deposits will be selectively thinned or removed. High-value larger riparian trees will be retained. Conifer species will be planted along the banks and channel to enhance tree species diversity, slowly increase shade to the stream and understory vegetation, and eventually provide mature trees for natural recruitment of large wood into the stream channel. Long-term vegetation management of the Elk River riparian corridor is proposed with a focus on increasing native conifer and hardwood trees and native understory species. The management for large trees will help to control the existing dense shrubs, bramble, willow, and sedge that currently occupy the channel bank toes and bed over the long-term.

The Project will prioritize expanding the riparian vegetation along the Elk River to the maximum extent feasible, focusing on reaches and properties where landowners are voluntarily willing to allow thinning or removal of non-native vegetation, expansion of the riparian corridor width, and tree planting to achieve a mixed forest structure composed of a conifer and riparian hardwood canopy and herbaceous understory. In the Lower Valley and Tidal Reaches the Elk River Wildlife Area provides ideal opportunities for planting wetland and riparian species. Along MSR-3, three landowners are amendable to riparian vegetation enhancement on their private properties. On the South Fork Elk River, several landowners are supportive of riparian habitat enhancement, and particularly on the Save the Redwoods League property there are extensive areas of pasture that are proposed to be planted with mixed riparian hardwood and conifer species to greatly expand riparian habitat in this reach.

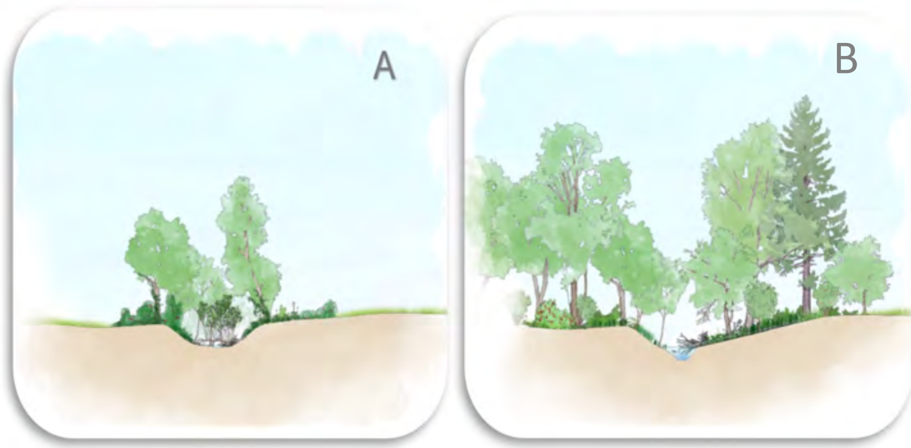

Figure 4-5. Cross section views showing typical stream channel before and after proposed in-channel wood management Actions to (A) remove undesirable hardwood trees (mainly willows) growing in the stream channel to enhance instream habitat, and (B) replant trees on floodplains to expand and enhance riparian habitat.

The 107-acre redwood tree plantation located on the floodplain in MSR 5, from the North Fork Elk River and South Fork Elk River confluence downstream to Elk River Court, is a unique vegetation feature along Elk River. Prior to being planted in dense rows of redwood, this floodplain surface was open pasture used for cattle grazing. Historically it was likely a redwood forest with mixed riparian vegetation along the stream channel. The increase in the hydraulic roughness associated with the redwood tree plantation (planted in 1979–82) contributes to increased backwater flood levels in the North Fork, South Fork, and MSR 5. The redwood plantation is proposed to be thinned at selected areas across the floodplain and along the channel in the MSR5 reach. Some areas may be converted back to open space. Riparian hardwoods may also be replanted along the channel corridor to increase native species and habitat diversity. This action would enhance the riparian forest quality, reduce vegetative roughness along the channel and floodplain, contribute allochthonous materials to the channel, and provide large wood for recruitment to support geomorphic and habitat function.

Revegetation will seek to take advantage of proposed topographic variability to support the restoration and enhancement of diverse vegetation zones. In addition, vegetation planting will be designed to provide wildlife habitat and shade to the stream channel for the benefit of cooler water temperatures. The revegetation strategy will also seek to reduce the risk of colonization by non-native invasive species such as reed canary grass and dense-flowered cordgrass by planting fast-growing native species at competitive densities, and/or managing Spartina for a few years until native vegetation is established.

G. Tidal and Freshwater Wetland Restoration

The following areas will be a focus of estuary and wetland enhancement:

- Elk River Wildlife Area (California Department of Fish and Wildlife)

- Swain Slough
- Private property south of Pine Hill Road and west of Elk River Road
- Mainstem Elk River (MSR 1)
- South Fork Elk River at Save the Redwoods League property
- North Fork Elk River at Wrigley property

The 99-acre Elk River Wildlife Area is proposed for enhancement by deepening, widening, and reconnecting former slough channels and existing and constructed wetlands. The enlarged slough channels will be sized to accommodate increased tidal exchange resulting from infrastructure modifications (levee modification, improved tide gates, etc.), as well as conveyance of upstream flood flows. A mix of seasonal freshwater wetlands and tidal wetlands are proposed within the Elk River Wildlife Area. The variation in habitats will be achieved using relatively small changes in topography to produce different inundation patterns and support a variety of vegetation types across the landscape.

Swain Slough is proposed to be extended approximately 1.3 miles from the existing terminus located at a tide gate under Elk River Road. The extension will occupy its former (historic) alignment, where feasible, except for a short realignment to avoid a home. A small intermittent tributary and a portion of winter floodplain flows will be directed toward the upstream end of Swain Slough. Saline water will be confined within the Swain Slough channel by either lateral berms or a muted tide gate. Several infrastructure modifications will be necessary to extend Swain Slough (see Infrastructure Modification section).

A new channel and wetland complex is proposed for construction on private property north of Pine Hill Road and west of Elk River Road. During winter floods, Pine Hill Road is frequently overtopped, and water flows through, and over, undersized drainage infrastructure and floodplains on this property. To reduce flooding over the road, and route flood flows into the new wetland complex, a culvert would be placed under Pine Hill Road to allow flood flows to enter the property with more regularity. High flows would exit the wetland complex to either Swain Slough or directly to Elk River. The intent is to maintain freshwater wetlands as non-natal juvenile salmonid rearing habitat during winter.

The mainstem of Elk River through MSR 1 is expected to widen and deepen over time as a result of increased tidal exchange from estuary enhancements proposed as part of the Recovery Strategy, and estuary enhancement projects that have been recently implemented or are in the planning phases, including the Martin Slough Enhancement Project and the City of Eureka Elk River wetland restoration project on the downstream side of Hwy 101. Recommendations for further enhancement include eelgrass planting and creation of areas of mudflat between the Elk River channel and the tidal marshes within the Elk River Wildlife Area. These actions will be considered during the next phase of project design and analysis.

The North Fork and South Fork Elk River also provide opportunities for wetland enhancement or restoration. On the South Fork Elk, Save the Redwoods League owns 77 acres of undeveloped lands adjacent to the South Fork and are supportive of restoring and maintaining seasonal wetland habitat on floodplains that were former pasture lands. These areas are proposed to be planted with a mosaic of wetland and riparian plant species, with some areas maintained as open meadow (grassland) habitat. A single off-channel wetland feature is proposed for the North Fork at the downstream end of the Wrigley Orchard property. The objective of this feature is to provide suitable off-channel juvenile rearing habitat for salmonids as well as a potential site for off-channels sediment deposition.

H. Sediment Re-Use on Floodplains

Recovery actions such as channel rehabilitation and slough channel restoration require excavation of sediment. Beneficial uses for reuse of the sediment will be strongly prioritized within the Project Area. Off-site sediment disposal will be avoided, if possible, although some sediment may be hauled off-site if adequate sediment reuse space is not available within our Project Area. Sediment reuse areas will be examined in more detail during the analysis phase. All fill areas will be revegetated to support existing land uses or plans for future land uses. The strategy for sediment reuse will differ in and out of coastal zone. Potential sediment reuse within the stream-estuary ecotone reaches include:

- Creating intentional flow paths that reduce fish stranding in agricultural areas and direct them toward high quality habitats,
- Allowing maximum tidal inundation to enhanced marshes by limiting inundation on adjacent agricultural lands by raising the ground elevation of the agricultural lands,
- Creating off-set berms to allow for the expansion of slough channels adjacent to agricultural lands,
- Maintaining, repairing, or raising existing dikes to support enhancement actions,
- Raising of targeted areas of tidal marshes to help keep pace with sea-level rise and diversify habitats,
- Spreading material across agricultural lands (outside the coastal zone) to improve agricultural productivity,
- Targeted areas identified by landowners to protect infrastructures (e.g., associated with raising a house or improving water quality from dairy operations),
- Targeted filling of drainage ditches to reduce mortality risk of salmonids, and
- Placement in upland areas, above the 100-year flood.

I. Community Health and Safety Measures

Community health and safety issues include degradation and loss of domestic and agricultural water supply, and flooding of private and public infrastructure. Formation of a Health and Safety Workgroup was envisioned under the Upper Elk River Sediment Total Maximum Daily Load (TMDL) as a part of the Stewardship Program to develop the health and safety measures that could result in improved public access to clean water and protection from excess flooding. Regional Water Board staff have begun one-on-one interviews with Elk River residents to hear the observations, concerns, and proposed solutions of local residents. The initial focus is on owners and residents of properties within the 100-year flood zone. The Regional Water Board will be identifying the public resources available to address these pressing issues and reinvigorate the Health and Safety Workgroup to develop a Health and Safety Plan. The schedule for such a plan is still to be determined.

<u>Nuisance Flooding</u>. One of the major Project actions is to reduce nuisance flooding in the middle reaches of Elk River (SFR 1-2, NFR 1-2, MSR 5 and Elk River Courts) to significantly reduce or eliminate the threat of flooding to residents in Elk River. Currently, frequent nuisance flooding affects Showers Road, Berta Road, Zanes Road, Elk River Court, and Elk River Road Flood Curve located near the North Fork Bridge. Actions to alleviate the threat of flooding include removal of sediment from the channel to increase channel conveyance capacity, enhancement of floodplains to move storm water flow through the floodplain, management of undesirable native and non-native invasive vegetation growing within the stream channel, and raising bridges and roads to reduce flood inundation frequencies. In some locations where sediment remediation or modification of public infrastructure (e.g., roads or bridges) are not sufficient, modifications to private property (e.g., raising homes above projected flood heights) may be the most efficacious solution. Health and safety assessment and planning is ongoing, ramping up with the support of the Regional Water Board's Humboldt Bay Steward, and involving other agencies with authority relative to drinking water, public infrastructure, and flood protection. The community would also benefit from safety

contingency planning to raise awareness of risks and thresholds for when precautionary actions are necessary. As above, the Regional Water Board will be reinvigorating the Health and Safety Workgroup as a forum for identifying solutions and funding opportunities, and providing more consistent outreach on these topics.

Domestic Water Supplies. The second community service that needs to be at the forefront of solutions for Elk River is implementation of a long-term solution to providing healthy and reliable drinking water supplies to residents in the middle reaches of Elk River. One solution would be to provide community drinking water services to Elk River residents. Currently the Humboldt Community Services District boundary extends a portion of the way up the Elk River Valley, nearly to Berta Road. This services boundary could presumably be extended farther up the valley. Alternatively, a separate community water system could be created to service the local Elk River community, for example similar to the Westhaven Community Services District. These topics will be discussed soon within the reinvigorated Health and Safety Workgroup.

On-Site Septic Systems. In addition to flood risks and issues with domestic water supplies, residential sites along the North Fork and South Fork all have on-site septic systems. Very little is known about the potential risk of flooding and the effect on water quality from flooding of residential septic systems in Elk River. Long-term solutions for these conditions may also be needed. As appropriate, the Health and Safety Workgroup can take up this issue, as well.

J. Infrastructure Modifications

Numerous enhancement opportunities are associated with infrastructure modifications. The conversion of the former estuary and mainstem valley to agricultural land over a century ago largely relied on altering the tidal hydrology and drainage patterns through the construction of levees, tide gates, drainage ditches, culverts and roads. Many of these features have slowly deteriorated over the past decades without regular maintenance, and in combination with early effects of sea level rise at the western end of the valley, many of these structures no longer provide the tidal protection and winter flood-flow drainage functions for which they were designed and constructed. In short, the saltwater and freshwater drainage infrastructure in the Elk River valley no longer functions adequately for the protection of much of the agricultural working lands nor for the recovery of natural resources (e.g., wetlands and salmonid habitat).

The road alignments and historic railroad alignment are also an impediment to restoration in some locations and infrastructure upgrades are needed. Elk River Road parallels the mainstem Elk River and is subject to flooding in several locations; Pine Hills Road to the east of Elk River Road also is prone to flooding at high tides; and to the west of Elk River Road inhibits down-valley drainage during winter storm events. Berta Road traverses the entire valley bottom and floods repeatedly during the winter, and poses a safety risk to residential automobile traffic. Zanes Road has a similar configuration to Berta Road but floods less frequently. Elk River Court is prone to flooding during winter high flows. Finally, the Elk River Road "Flood Curve" that parallels the lower 3,000 ft of the North Fork Elk River is a well-documented flood hazard that inhibits ingress and egress during winter floods to approximately 25 Elk River residents who live upstream of the Flood Curve. The North Fork Bridge at the upstream end of the Flood Curve has been assessed by Humboldt County and identified as a priority for bridge replacement. The abandoned railroad infrastructure has been left in place in many locations and is proposed under this Recovery Plan to be removed. In that case, the railroad grade fill prism would be regraded where it impairs or inhibits natural flooding patterns.

Along the North Fork and South Fork Elk River there are a subset of homes that are known to be at risk of flooding. The *Flood Elevation Estimates for the Lower Elk River , Humboldt County* Technical Memorandum prepared by Northern

Hydrology and Engineering (2020) identified the "1% Chance" or 100-year flood boundary for Elk River, and noted that "several residential structures that currently flood are mapped outside of the FEMA flood hazard zone, and it also became evident, based on conversations with landowners, that the current extent, depth, and risk associated with extreme flood events in the Elk River…may not be fully understood or appreciated." The 100-year inundation extent predicted from the HST model was used to identify those residential structures currently at risk, and includes at least one structure on the South Fork, eight structures on the North Fork, and 12 structures along the upper mainstem Elk River. The Regional Water Board has prioritized interviews with the owners and residents of these properties to flesh out the full suite of observations, concerns, and possible solutions.

4.2 Summary of Proposed Actions by Planning Area

The following sections describe the detailed and specific Actions that are proposed as part of the Stewardship Project, for each of the four Planning Areas. These Actions were initially derived from the set of recommended Actions in the Elk River Recovery Assessment and were then vetted with private landowners to determine which actions they voluntarily supported on their properties. Some Actions have been modified or eliminated since the first set of Actions were identified and presented to the public in 2019. The Actions described here and presented in the associated figures are a fundamental part of this Recovery Plan and cumulatively represent the suite of Actions proposed for implementation, including the environmental benefits that can be achieved.

Planning Area 1: Tidal and Lower Valley Reaches (MSR 1-2) (Figure 4-6)

The lower Elk River Valley and Tidal Reaches Planning Area has considerable potential for tidal marsh and salmonid habitat restoration and is a primary focus of the Elk River Recovery Plan. Currently the lower Elk River tidal channel is generally confined by constructed levees, which transition to a combination of natural sediment levees topped with some constructed levees. This reach is surrounded by the CDFW Elk River Wildlife Area and offers significant restoration potential relative to other properties in the reach, which must also balance agricultural productivity.

The primary restoration emphasis in the tidal reaches is to restore natural tidal and fluvial drainage patterns in the lower river, by upgrading and replacing aged drainage infrastructure (tide gates, culverts), reducing or removing levees and a relict railroad grade, restoring tidal sloughs and tidal creek channel connectivity to the mainstem channel, and lightly recontouring portions of the floodplain with hummocks and swales to guide winter flood-flows across the floodplain and back into the slough channel network. Construction of off-channel ponds on the Elk River Wildlife Area, connected to Elk River, will provide high quality, winter freshwater rearing habitat for coho salmon. Removal of levees would considerably expand tidal inundation and improve marsh habitat, allow better access for salmonids to off-channel habitat, and improve drainage in the lower valley during winter floods. However, removal of levees and/or modification to other drainage infrastructure could affect surrounding agricultural lands, and those actions will be constrained by the need to protect private property and current agricultural land uses.

At the southern end of the tidal reaches, at the downstream end of MSR 3, the project would reshape the natural and constructed levees on the right bank of Elk River to allow floodwaters to flow onto the floodplain and into constructed swales. These constructed floodplain swales would provide connected flow paths for aquatic species, to enable fish to find their way back to connected channels and habitat.

On the east side of the valley, paralleling Elk River Road (ERR), Swain Slough is leveed up to the Elk River Road tide gate. Above this tide gate the slough is heavily aggraded and choked with vegetation. This portion of Swain

Slough (above ERR) should be dredged of sediment and vegetation and extended an additional 1.3 miles up the valley and the tide gate modified to allow tidal inundation into the restored tidal channel and allow flood flows to drain through Swain Slough. Several tributary creeks will be reconnected to Swain Slough to improve drainage in this reach. Restoring the easterly extent of Swain Slough, in combination with the constructed floodplain swales, would reduce the potential for juvenile salmonid stranding in winter when floodwaters spill onto the lower Elk River floodplain.

Finally, this lower tidal and estuary Planning Area defined as MSR 1-2 has considerable potential for expansion of tidal marsh and riparian vegetation. Currently the Elk River Wildlife Area has limited areas of high quality brackish and salt marsh vegetation, and these native wetland plant types and habitats should be expanded across the property. Working with the CDFW Lands Program, relict farm buildings, drainage culverts and tide gates, and internal levees should be removed. Portions of Elk River will require vegetation management to reduce encroachment of willow thickets in the channel. These proposed actions would improve flood conveyance, and would be offset with wetland and riparian vegetation planting along Elk River and Swain Slough where feasible and within private landowner constraints.

Drainage ditches that route flow toward the Elk River channel through culverts likely result in stranding risk for juvenile salmonids. These drainage ditches would be realigned to convey water down the valley through a series of swales (following the footprint of relict/historic swales where possible), toward the entry points of Swain Slough and the Elk River Wildlife Area. The former drainage ditches would be modified through a combination of plugging, partially, or completely filling, as appropriate. such that they are no longer a stranding risk to salmonids.

Estuary expansion opportunities are available at the Elk River Wildlife Area, just upstream of Hwy 101 through modifying levees and tide gates along the stream channel. The estuary enhancement area on the western side Elk River has two breaches, which allow tidal inundation. Additional modification of the levee system would improve connectivity with the main channel and deliver more sediment to the marsh, which would help the marsh surface elevations keep pace with sea level rise. The estuary enhancement area on the eastern side Elk River is constrained by levees and includes two tide gates. One tide gate is damaged and allows limited tidal inundation upstream. The second tide gate is functional, but is undersized, and thus does not adequately drain flood flows from the Elk River that accumulate behind the tide gate. Collectively, these tide gates and levee system both limit the tidal inundation of the former marsh plain and slow the natural drainage of the upstream floodplain. Actions proposed in this area include modification of the levees and tide gates to increase the tidal exchange within the enhancement area and improve the natural drainage patterns during flood flows. Tide waters would be confined to the enhancement area by a combination of actions that may include strategic placement of sediment on adjacent agricultural lands (see sediment reuse section), tide gates, or limited modification of the levees.

Flood flows that bypass the upstream entrance to the Elk River Wildlife Area and continue through the lower agricultural areas would be able to enter the Elk River Wildlife Area through additional tide gates proposed along the eastern property boundary of the Elk River Wildlife Area, as well as pass under Pine Hill Road through the proposed culvert discussed above. Flood-flows that pass through the culvert would be routed through a newly constructed channel that would link two off-channel ponds and would exit to the mainstem Elk River just upstream of the confluence with Swain Slough. The railroad grade would either be partially removed, or a culvert installed through the grade to connect the wetland ponds.

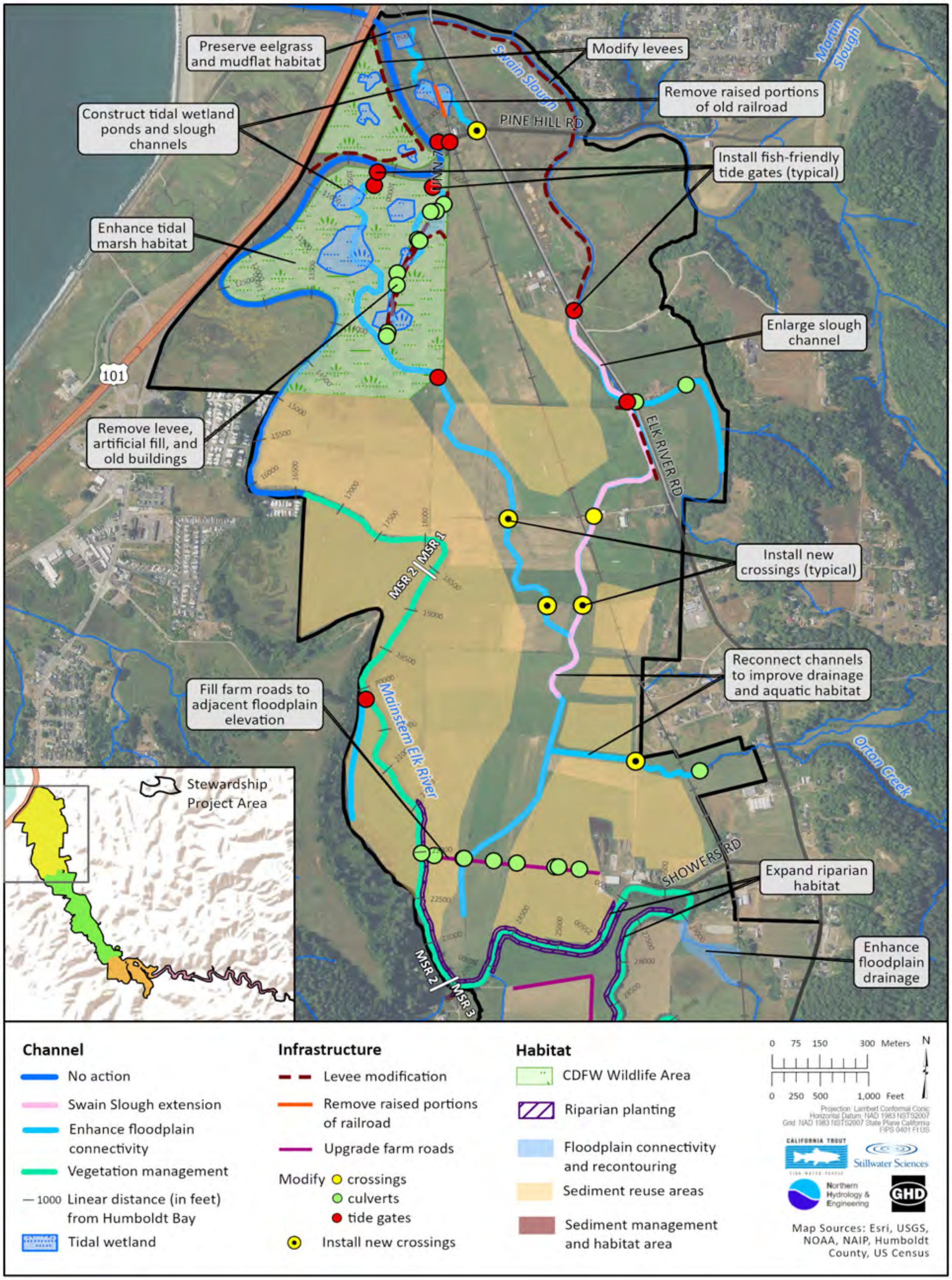

Figure 4-6. Proposed sediment remediation and habitat rehabilitation Actions for the Tidal and Lower Valley Reaches of Elk River.

On the east side of Elk River Road, the western levee along Swain Slough has been partially breached in at least two locations, allowing high tides to inundate portions of the property. The extension of Swain Slough and associated increase in tidal prism would further exacerbate these vulnerable areas of the levee system by extending the duration of high tides. Repair of this levee system, or other alternatives, will be necessary to implement the Swain Slough enhancement actions.

Planning Area 2: Fluvial Mainstem Reaches up to Historic RR Xing (MSR 3-5) (Figure 4-7)

The primary focus in the valley Mainstem Reaches is the protection of existing agricultural lands, and thus the footprint of proposed enhancement and restoration actions in these reaches is much smaller due to landowner constraints. There are several large ranching and dairy operations in this portion of the valley and landowners are generally adapted to flooding and sediment conditions and are thus generally supportive of maintaining existing channel conditions. The channel is heavily degraded by fine sediment aggradation and vegetation encroachment into the channel. Removal of invasive and encroaching (native and non-native) vegetation is proposed where feasible and where impacts can be minimized. Only the upper portion of MSR 4 is proposed for sediment remediation. Several floodplain swales are proposed in this upper reach to improve winter flood flow conditions.

At the lower end of MSR 3 just upstream of Showers Road and the Alexandre Dairy, the sharp meander bend causes a significant hydraulic constriction, which contributes to more frequent flooding of dairy and road infrastructure.

Downstream of Berta Road, landowners are supportive of expanding the width of the riparian vegetation corridor along the Elk River, which will cumulatively provide several acres of riparian habitat restoration.

As mentioned above, Berta Road floods repeatedly during winter storms, and poses a safety risk to residential automobile traffic, and Zanes Road is similar to Berta Road but floods less frequently. The Recovery Assessment proposed channel enlargement and vegetation management in this reach, but only vegetation management is currently proposed at these locations to reduce the frequency of flooding, because there is not consistent or strong support from landowners for channel enlargement.

In the MSR-4 reach above Zanes Road, Shaw Gulch is a significant contributor of fine sediment to Elk River. Sediment aggradation in the tributary has impacted land uses and the landowner is supportive of constructing an off-channel habitat feature that would also aid in reducing sediment contribution to the mainstem channel. Perennial flow from Shaw Gulch would potentially support summer rearing habitat in this feature. Several high flow enhancement features are proposed in MSR-4 upstream of Shaw Gulch to connect meander bends and facilitate increased flood conveyance in winter. These features can also be designed to provide off-channel habitat refugia for juvenile salmonids.

Nuisance flooding occurs along Elk River Road in this reach, and threatens several homes located along the road. One home near the intersection of Elk River Court has already been raised on its foundation but is still at risk of continued flooding.

Within MSR 3-4, there are at least five tributary channels where the confluence connectivity should be improved, to facilitate better winter flow conveyance and in one location to trap excess sediment from the western hillside.

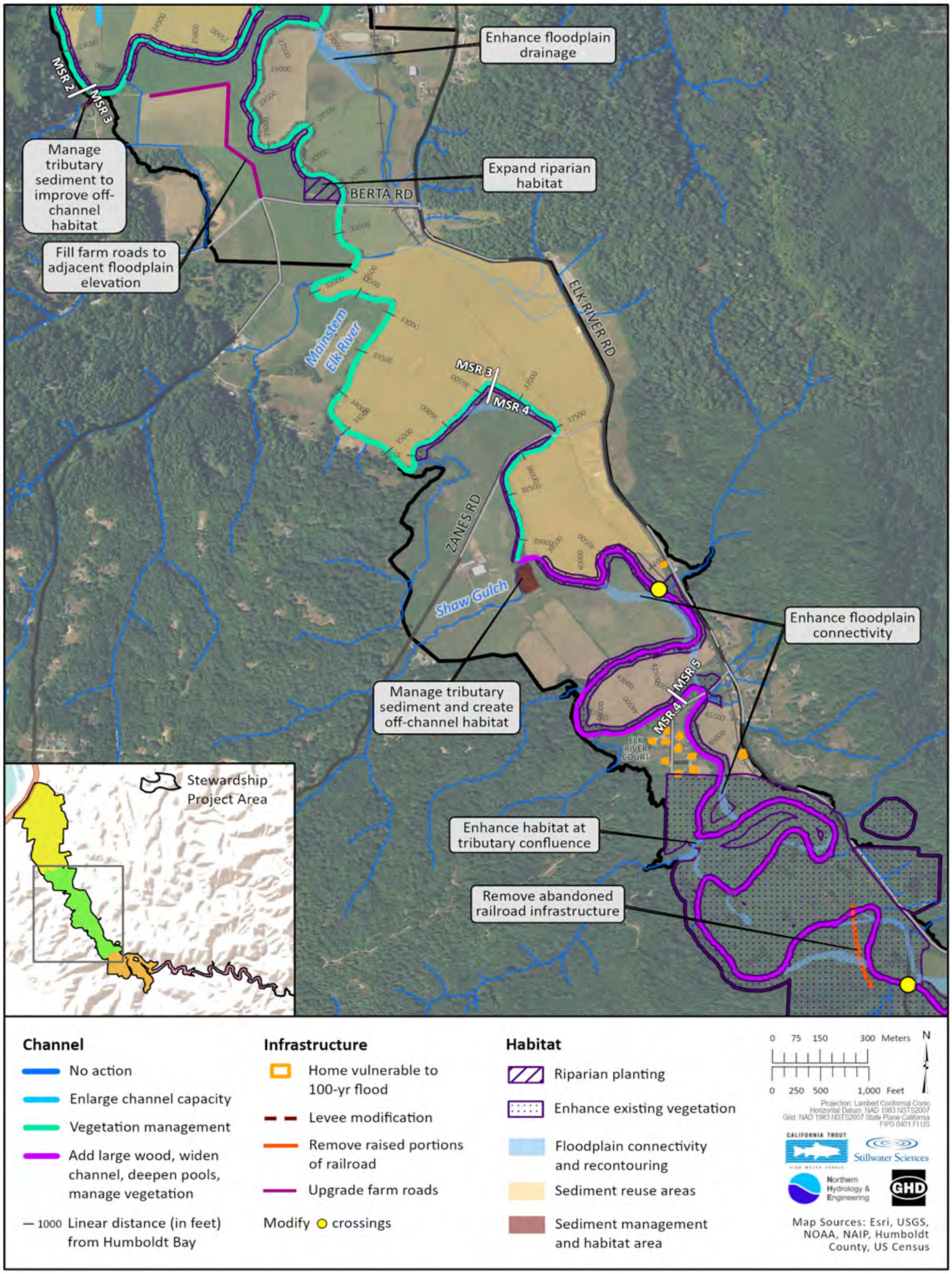

Figure 4-7. Proposed sediment remediation and habitat rehabilitation Actions for the Fluvial Mainstem Reaches of Elk River.

At the downstream end of MSR 5, private homes are at risk from flooding in the Elk River Court residential subdivision and along the adjacent section of Elk River Road. The combination of sediment aggradation, a tight Elk River meander bend, invasive vegetation (native and non-native) encroachment into the channel, and potential constriction caused by the Elk River Court bridge have significantly increased the risk of flooding in this reach. There are 12 residences in this sub-division. Actions proposed in this portion of MSR 5 are designed to reduce nuisance flooding and include channel widening and removal of invasive riparian vegetation (native and non-native). Bridge replacement should be considered but requires additional study. Excavation of deep pools and placement of large wood structures would improve winter and summer juvenile rearing habitat in this reach.

Upstream of the Elk River Court subdivision, there is a sharp transition from the rural residential neighborhood to a dense redwood forest plantation. The redwood plantation occupies roughly 3,100 feet of the valley bottom and ends just shy of the confluence of the North Fork and South Fork Elk River. The channel length through the plantation is 8,700 feet. The mainstem channel and floodplain in this reach offers a unique opportunity for forest, riparian, and aquatic habitat restoration. The infrastructure in the redwood plantation is limited to the Elk River Timber Bridge (Steel Bridge), the old railroad grade that once extended up the South Fork Elk River to the historic town of Falk, and a defunct log footbridge.

Currently the 120-acre redwood plantation is a single-species forest environment, composed of windrows of same-age redwood trees, and a 1-2 ft accumulation of redwood needles and branches on the forest floor. There is little understory vegetation. During winter flood events when Elk River spills onto the floodplain, the plantation provides significant hydraulic roughness, which is exacerbated by the movement of duff into piles, which further increases roughness and backwatering, and consequently higher flood water elevations. Redwood trees in this plantation have not recruited into the mainstem channel, and only sparse riparian vegetation is growing along the channel and the fringe of the floodplain. Very few large-wood habitat structures exist within the channel, most pools are filled with sediment, and excess sediment has aggraded along the toe of the channel banks.

Three main restoration actions are proposed for the mainstem reach within the redwood plantation reach (in MSR-5): (1) redwood tree removal and forest thinning in the plantation to create uneven aged stand structure with patches of open space within the plantation, (2) replanting of native understory and riparian vegetation in within the forest stands and in the newly created open space areas, and (3) channel widening and deepening, removal of invasive riparian vegetation (native and non-native) within the channel, and placement of large wood structures to improve aquatic habitat.

To treat the floodplain within the redwood plantation, redwood trees are proposed to be thinned through the implementation of a phased Non-Industrial Timber Management Plan (NTMP) to promote a healthier uneven-age forest stand structure and reduce the extent of the monotypic tree plantation. Within the thinned forest canopy, some areas should be revegetated with native vegetation in the understory, and other areas converted to open space. Several swales should be sculpted across the floodplain connecting meander bends, to allow flood flow access to the floodplain at lower flood recurrence intervals, improve down-valley flood flow conveyance, and reduce hydraulic backwatering. These swales should be revegetated with native wetland and riparian plant species; riparian revegetation would emphasize increasing tree and understory species diversity. Open spaces may be used for other agricultural purposes.

Restoration in the mainstem Elk River channel is proposed to improve flood flow conveyance and to create high quality salmonid habitat. The channel cross section should be widened in numerous locations, especially where constrictions occur, to increase the conveyance capacity of the channel and reduce the volume of stored sediment.

Sediment should also be excavated from the channel bed to reduce the amount of sediment stored in the channel. Sediment removal actions would restore deep pools for salmonid rearing habitat and expand winter rearing habitat. Invasive vegetation such as willows and alders that have rooted in the channeled should be removed, and this undesirable woody material replaced by redwood tree structures (whole trees with root-wads harvested from the plantation) constructed to create wood habitat within the mainstem channel. Sediment should also be excavated from the un-named west-side tributary above its confluence with the Elk River and from Clapp Gulch to reduce the amount of sediment stored in the tributary channels and to improve off-channel juvenile rearing habitat.

All relict infrastructure is proposed to be removed within MSR 5, including the Steel Bridge, the relict railroad grade and crossing, and the relict log footbridge.

Planning Area 3: Upper Mainstem, North Fork, and South Fork (MSR 5, NFR 1, SFR 1-2) (Figure 4-8)

The South Fork Reaches (SFR) 1 and 2 extend from the confluence with the North Fork upstream approximately 10,000 ft to the Tom's Gulch confluence (Figure 4-8). SFR 1-2 includes seven residential properties with river frontage (only one of which is at risk from flooding). This reach has moderate sediment aggradation and channel confinement, and very few deep pools or large wood structures providing habitat for salmonids.

Restoration actions proposed for Planning Area 3 are designed to maintain or increase the connectivity of winter flood flows to the surrounding floodplain and to greatly enhance instream habitat by reducing the density of invasive vegetation growing within the low-flow channel and replacing this woody material with higher quality and more durable large wood habitat structures. Only the lower-most 2,500 ft of the South Fork is proposed for sediment remediation through channel widening; the channel in this reach should be widened to increase channel conveyance and reduce constriction and backwatering in this reach. In combination with other actions proposed further downstream in MSR 5, this action would alleviate some risk of flooding to the private residence (Figure 4-8). The Health and Safety Plan should consider the value of raising this home on its foundation to further reduce the risk of flooding. Construction of deep pools is proposed in this reach, where feasible and opportune, to enhance winter salmonid rearing habitat.

Several off-channel habitat features are proposed in this reach, including lower-elevation floodplain benches, backwater alcoves, and secondary high-flow or split channels. These features are intended to provide greater channel capacity and slower water velocity areas for winter habitat refugia during high flows. Excavation of these features would also serve as sediment remediation. The entire reach would be enhanced through addition of large numbers of conifer logs, placed individually or in log structures. Logs would provide multiple functions, including encouraging channel scour and sorting of the channel bed sediment, providing instream habitat and pool scour to enhance summer rearing habitat and for velocity refugia during winter high flows. The large wood would also increase roughness and maintain or increase hydraulic connectivity to floodplains. For ideal habitat function, large logs with intact rootwads should be placed into the low-flow channel and extent up the bank to provide slow-water habitat over a range of streamflows.

From the top of the reach at Tom's Gulch, there is no flood risk to infrastructure; therefore, there is maximum opportunity for significant habitat enhancement. One landowner, Save the Redwoods League, owns a significant portion of this reach, and is in the process of transferring ownership to the Bureau of Land Management. Both the current and future landowners of this property are supportive of extensive expansion of riparian vegetation in this reach. Approximately 60 acres of floodplain are therefore proposed for planting with a mix of riparian hardwood and conifer species, with a diverse understory of herbaceous plants. The planting strategy would target creation of a mosaic of terrestrial, riparian, and seasonal wetland habitat types. The bridge crossing should be modified or replaced to eliminate the in-channel bridge piers, improving flood conveyance and passage of large wood.

A large sediment management feature is proposed at the mouth of Tom's Gulch, to trap sediment and reduce the downstream transport of some portion of the sediment load coming from this tributary. Tetra Tech (2015) determined that Tom's Gulch has the highest sediment loading rate of any sub-watershed in the Upper Elk River watershed, nearly twice the average sub-watershed sediment loading. So, capturing and controlling sediment produced in Tom's Gulch could have a strong influence on sedimentation downstream. Two design alternatives are being considered for this site, one with, and one without ongoing sediment management and maintenance.

The North Fork Reach extends from the confluence with the South Fork upstream approximately 10,660 feet and includes 11 residential properties with river frontage (eight of which are at risk from flooding). The stream channel in this reach is heavily aggraded with fine sediment and choked with native and non-native invasive vegetation growing within the stream channel and on aggraded stream banks. This reach provides very poor aquatic habitat, and the riparian vegetation consists mostly of willow and alder trees, with sparse conifers present. The Elk River Road "flood curve" is a prominent nuisance flooding location, becoming inundated at low winter peak flows, and when flooded, prevents residents from traveling to and from their homes. No other transportation route is available to these residents when the flood curve is flooded.

The primary restoration focus proposed in this reach is to widen the channel to reduce the amount of stored sediment and remove native and non-native invasive vegetation from the channel, both of which are intended to increase channel conveyance capacity and reduce nuisance flooding. In suitable locations, excess sediment should be excavated from pools and large wood structures constructed to improve juvenile salmonid rearing habitat. Several floodplain benches and off-channel habitat features are proposed on parcels with willing landowners. Where feasible, the streamside riparian community should be expanded and/or planted with more diverse vegetation species to offset the vegetation removed from within the channel.

Protection of housing and road infrastructure is a critical component of the Stewardship Program in the NFR 1. The Elk River Road flood curve is proposed to be elevated to reduce the frequency of flood inundation, and the adjoining North Fork bridge (aka "concrete bridge") to be replaced with a higher elevation bridge that spans the channel and allows for wood passage. Raising homes in this reach that are vulnerable to flooding should be considered, pending the property owner's interest and the outcome of health and safety planning. See Appendix C & D North Fork and South Fork Elk River Conceptual and Engineering Design Documents.

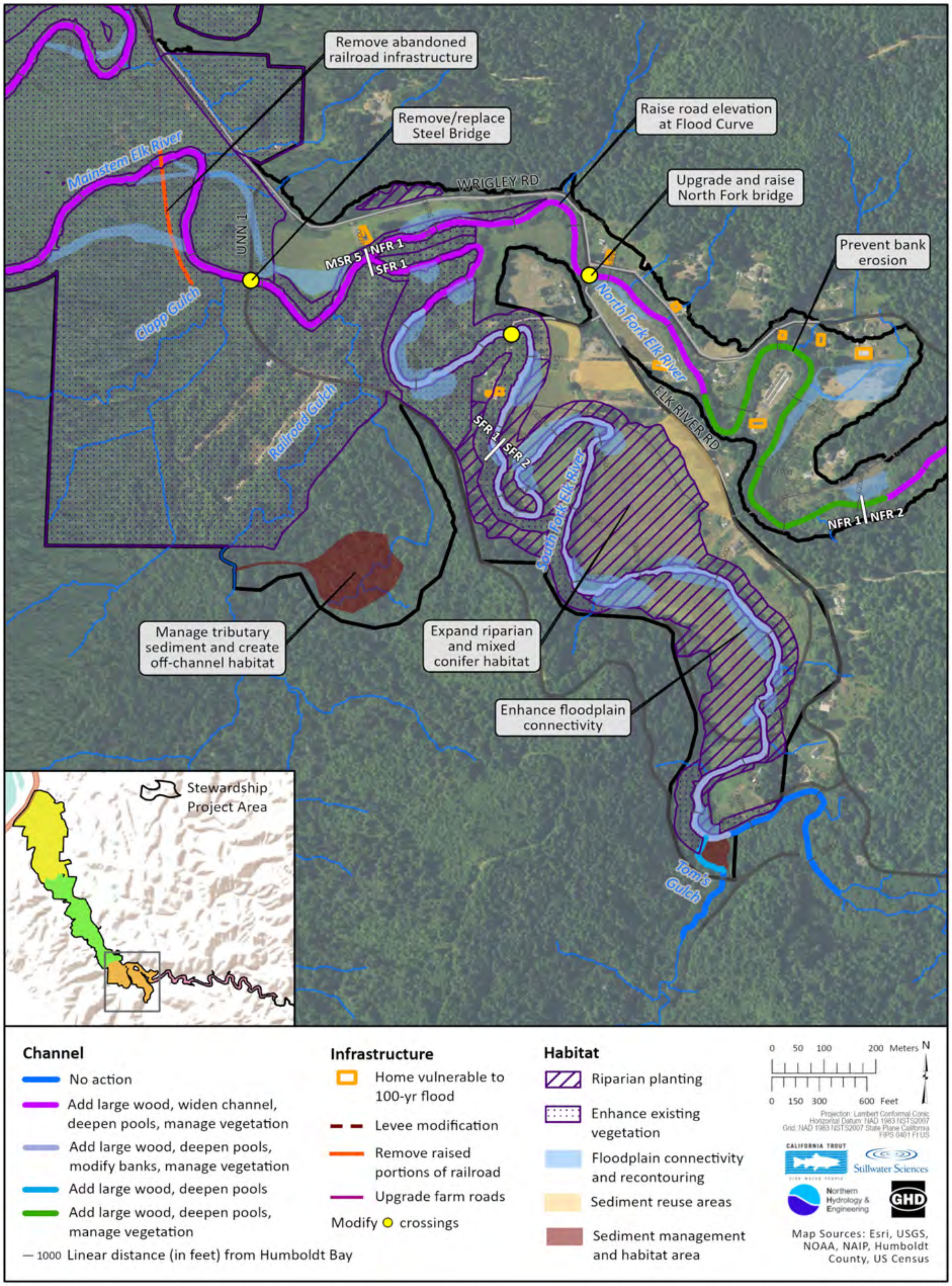

Figure 4-8. Proposed sediment remediation and habitat rehabilitation Actions for the North Fork, South Fork, and Upper Mainstem reaches of Elk River.

Planning Area 4: Upper North Fork Reaches (NFR 2-4)

Humboldt Redwood Company ownership on the North Fork Elk River marks the transition from Planning Area 3 to Planning Area 4. Downstream of the HRC property boundary there are 8 residential parcels along Wrigley Road. On HRC ownership in NFR 2, the recommended treatment for the lower-most 1,800 ft (from Sta. 62000 to 63800) is to widen the channel and deepen pools to reduce excess sediment, remove invasive vegetation growing within the channel and on aggraded streambanks, and add large wood to improve habitat for juvenile salmonids. Above this transitional reach, a buffer area of no treatment is proposed for approximately 1,050 ft below the HRC stream gauge and 1,750 ft upstream of the gage, to protect long-term data collection and gauge maintenance. Upstream of this buffer reach to Dunlap Gulch, Humboldt Redwood Company is proposing and currently designing the addition of large wood structures to enhance aquatic habitat. This large wood infusion is combined with the proposed removal of one mile of gravel road that lies partially within the riparian zone along the north bank of the North Fork, and removal of 17 road crossings to reduce sediment inputs along this reach (Figure 4-9). An off-channel habitat and sediment management feature was recently installed at the confluence of Bridge Creek by HRC, and a similar feature is being considered at the confluence of Dunlap Gulch.

Extending farther up the North Fork Elk River on Humboldt Redwood Company property, the two upper-most geomorphic reaches on the North Fork (NFR 3-4) up to Bridge Creek begin the transition from lower-gradient channels into slightly steeper, and coarser-bed channels. There is no development along these reaches, other than the Elk River Boy Scouts Camp. The aggradation from legacy sediment stored in-channel is diminished and instream habitat progressively improves moving upstream through these reaches. The proposed enhancement and restoration actions in NFR 3-4 are to add large wood structures that improve salmonid spawning and rearing habitat, benefit local floodplain connectivity, increase overall habitat complexity including shelter, and manage sediment from tributaries where feasible. Confluences of tributaries with the mainstem North Fork also provide good opportunity for habitat enhancement to create refugial areas during winter high flows.

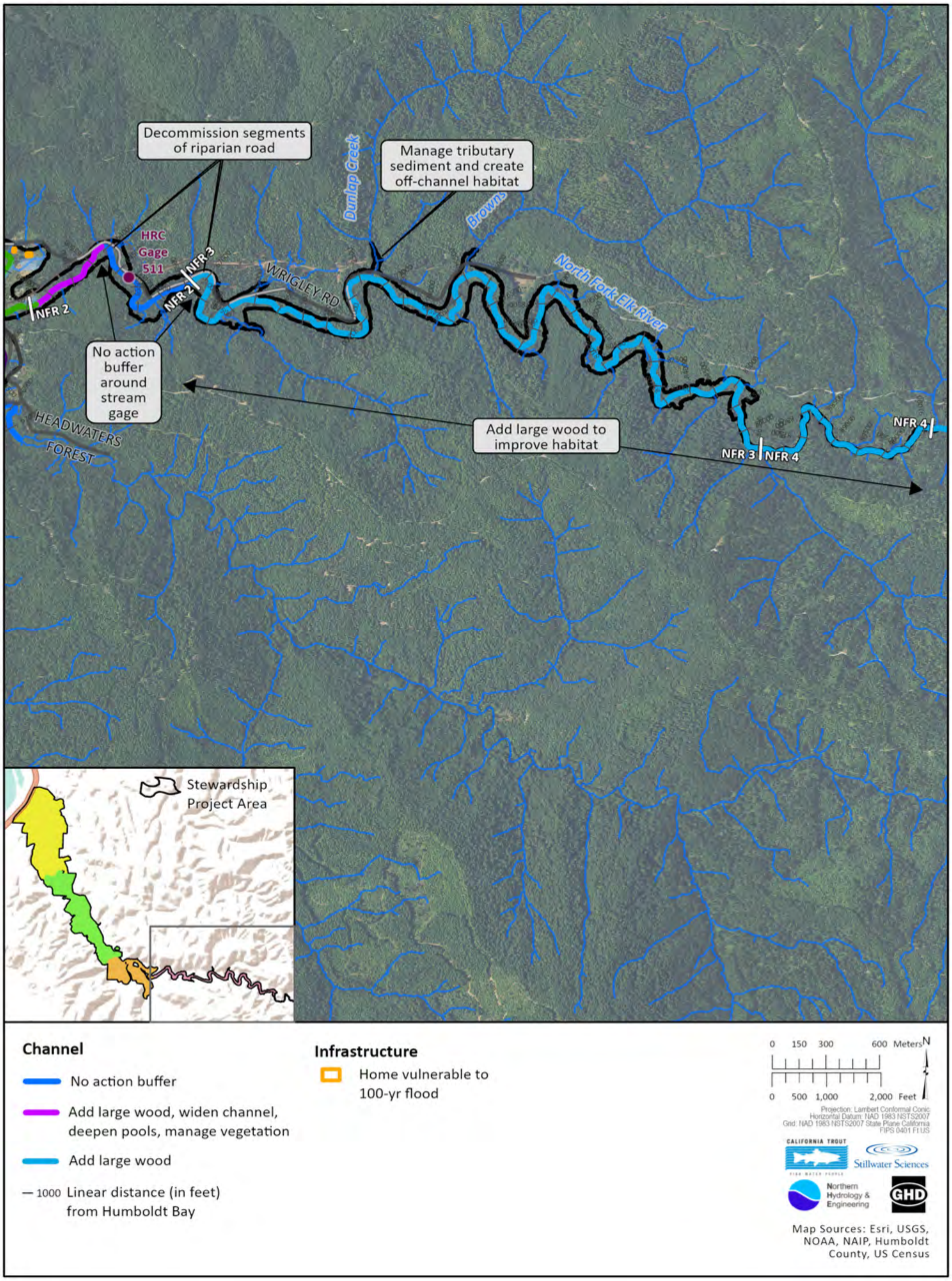

Figure 4-9. Proposed sediment remediation and habitat rehabilitation Actions for the Upper North Fork Reaches of Elk River.

5 STEWARDSHIP PROJECT MODEL EVALUATION

An unsteady, multi-dimensional hydraulic and sediment transport model (HST model) was used to evaluate the impact of the proposed Stewardship Project (Project) on flooding and sediment storage compared to existing conditions. The model includes most of the Project actions discussed in Section 4.2 and shown in Figures 4.6 to 4.9 including in-channel sediment remediation, floodplain connectivity and re-contouring, aquatic habitat restoration actions, non-native vegetation removal, riparian habitat restoration, tidal and freshwater restoration, sediment re-use on floodplains, and selected infrastructure modification (e.g., tide gate modifications). Actions that had insufficient information to include in the model, would not affect model results, or could not be included due to model grid resolution include:

- Culverts (PA-1)
- New crossings (PA-1)
- Preserve eelgrass and mudflat habitat (PA-1)
- Filling of farm roads (PA-2)
- Sediment management at tributaries (PA-2, PA-3, PA-4)
- Road elevation changes at the flood curve (PA-3)
- North Fork bridge changes (PA-3)
- Decommission segments of road (PA-4)

Modelling the full Stewardship Project area for flow up to the 100-year flow requires a relatively coarse model grid. Since high flows were the focus of the model development in previous studies (NHE 2020), fine scale drainage features/ditches were deemed unnecessary and were not included in the model. The coarse grid affects the ability of the model to accurately predict inundation extents of actions that are narrower than the model grid cells. For instance, the preliminary design of the Swain Slough extension is 50-70 ft in width; however, the model grid cells in this area are more than 100 feet. Therefore, the width of the Swain Slough extension inundation extent is over-estimated but is representative in terms of length and longitudinal connectivity. Similarly, PA-1 has a highly dissected network of drainage ditches, and these were composited into a singular drainage feature for the purposes of this study. The representation of finer scale actions in the South Fork are also limited due to the model grid size. More refined representations of target inundation extents for the South Fork can be found in Appendix D (Table 3-3).

In general, out of bank flows occur most frequently in the lower part of the watershed (Planning Area 1 and 2; Figures 5-8 to Figure 5-9). Return flows to the channel from the floodplain tend to be limited by elevated natural sediment levees relative the lower adjacent floodplains. These levees form naturally in this area. In some areas of Planning Area 2, the natural levees have been artificially raised to reduce overbank flows, but that is an exception rather than a rule. In Planning Area 1, artificial levee construction on top of the natural levees is more common and continuous artificial levees occur around and within the Elk River Wildlife Area and downstream properties, as well as along Swain Slough.

The model, which was developed as part of the Elk River Recovery Assessment (CalTrout et al. 2019) was used to simulate flows from Water Year (WY) 2003-2015. To support the analysis needed in the Recovery Plan, the hydraulic portion of the HST model (CalTrout et al. 2019) was expanded to include steady state flows up to the 100-year flood. This expanded hydraulic model is referred to as HST-EXP (NHE 2020).

The following section provides a description of the modeled predictions relative to flooding and sedimentation that are expected to result from implementation of the proposed Project. In summary, the model predicts that implementation of the proposed Project will provide some reduction in frequent flooding and sedimentation throughout the Program area but will not fully resolve flooding and sedimentation issues to the pre-1980's condition. The Project substantially decreases the 100-year water surface elevations in much of the Stewardship Program Area (PA-2 to PA-4), and has no effect on the 100-year water surface elevations in most of PA-1. Localized increases in water surface elevations are the result of fill placement which will be re-distributed in later design phases to address those localized increases. These findings indicate that in addition to implementation of the proposed Project, there is 1) continued need for sediment source reductions in the upper watershed and 2) need for engineered solutions to the health and safety issues that result from continued localized flooding and sedimentation (e.g., improved water supply, road and bridge improvements, and mitigations for private homes and other infrastructure). The proposed Project will not increase 100-year water surface elevations.

5.1 Flood Analysis

Steady-state and unsteady model runs were conducted to compare existing and Project conditions. The HST-EXP steady-state model (NHE 2020) was used to model selected design flows that are relevant to salmonid winter rearing habitat, vegetation zonation, frequent flooding that may be associated with nuisance flooding, and large floods relevant for development and infrastructure. The steady-state analysis provides a snapshot of the water surface elevation and inundation extents at a given design flow. The design flows include 10% exceedance flow, which is a flow that is exceeded 10% of the time. This is the lowest flow used to evaluate salmonid winter habitat; lower flows will be evaluated at during later designs stages as more refined modeling tools are developed. The four higher flows are expressed in terms of recurrence interval or probability of a flow occurring or being exceeded in a given year. The 1.053-year flow, has a 95% probability of occurring, the 1.11-year flow has a 90% probability, 1.25-year flow has an 80% probability, 1.5-year has a 66.7% probability, and 2-yearflow has a 50% chance of occurring. These are all relatively frequent flows and create unique conditions in the channel that have different functions to support the complex aquatic and terrestrial species. In the Elk River, there is a broad range of flows that trigger out of bank flows that vary substantially along the length of the channel and create nuisance flood conditions. The large, less frequent flood 100-year flow has a 1% probability of occurring in a given year and is commonly used for infrastructure design, is the basis for the National Flood Insurance Program, and regulations are commonly in place to limit the changes a Project can have on the 100-year water surface elevation.

The unsteady HST-EXP model was used to simulates 13-years of measured flows from (WY 2003-2015). These model runs provide information on the frequency of inundation during the 13-year simulation period at key locations within the watershed (e.g., roads).

As described in Chapter 3, a primary project goal is to reduce the risk and occurrence of nuisance flooding in Elk River to a rate more comparable to conditions prior to massive sedimentation that substantially altered the river hydraulics (pre-1980's). However, there are several factors that prohibit a full return to pre-1980's conditions including changes in management practices of vegetation and in-stream wood to protect in-stream habitat and on-going climate change which will continue to incrementally alter flood frequencies and increase the delivery of sediment.

California Water Code §13050 defines nuisance to mean anything which meets the following requirements:

- Is injurious to the health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.
- Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted in individuals may be unequal.
- Occurs during, or as a result of, the treatment or disposal of waste.

A numerical definition of nuisance flooding was not defined for this project. Flooding is defined in the model as any inundation that occurs, which is specified as 1 inch or more in the model. This criterion provides a standardized method of comparing the Project to existing conditions, but over-estimates the occurrence of nuisance flooding in some cases. In support of health and safety planning, future model scenarios could be funded with more specific inundation criteria defined. For instance, a certain depth of flooding constitutes a "nuisance" may be different for safe passage on a road versus the depth of water that may cause damage to property or affect agricultural uses.

Road Flooding

The frequency of flooding at roads was predicted for measured flows from WY2003 to WY2015 (Figure 5-1) for existing and Project conditions. As described in California Trout (2019), the highest frequency of flooding currently occurs at Berta Road, followed by Showers Road, Elk River Road at the Flood Curve, Elk River Court and Zanes Road. The Project would result in significant declines in the frequency of inundation over the model period for all roadways after implementation. The model predicts the greatest reduction in post-implementation flood frequency for Showers Road and Elk River Courts (94% and 95% respectively). Flood frequency after Project implementation is expected to decrease by 82% on Zanes Road, by 74% along the Elk River Road flood curve, and by 65% along Berta Road (Figure 5-1).

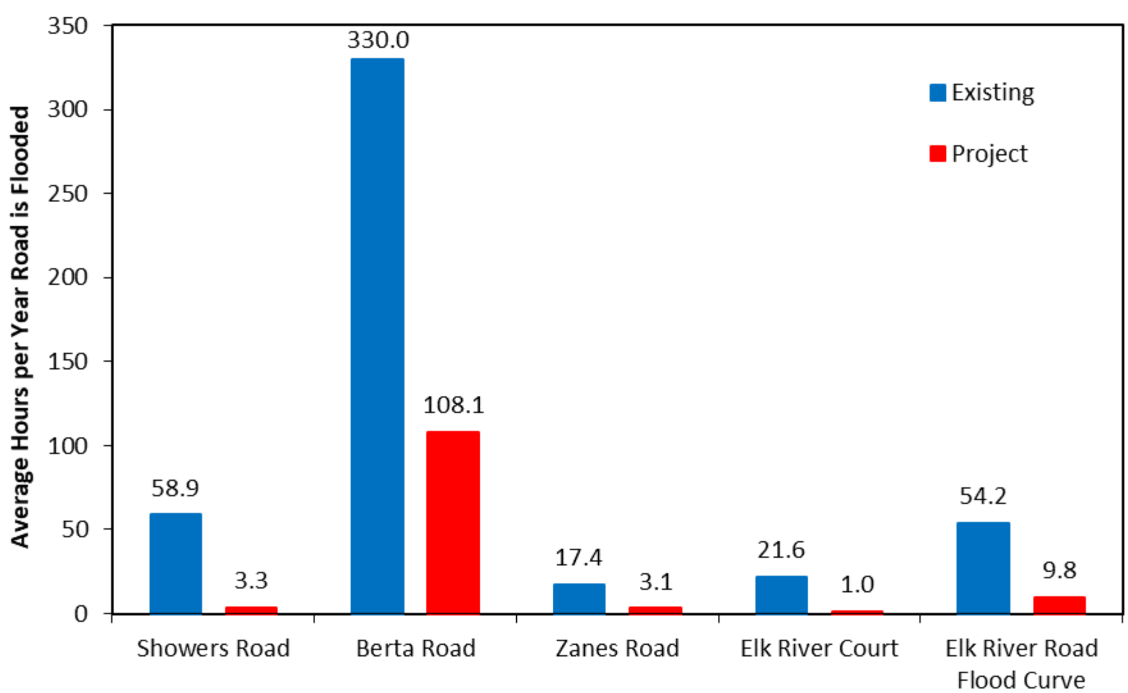

Figure 5-1. Average number of hours per year of road flooding WY 2003-2015 under existing and Project conditions.

Currently, roads are subject to flooding during frequent flows with increasing flooding extent and depth during more extreme floods; all but one small section of roadway that is inundated at the 100-year flow experiences some flooding by the 2-year flow (Figure 5-2 and Figure 5-3). All roadways that cross the river (Berta Road, Zanes Road, Elk River Court, and Elk River Road at North Fork Bridge) are inundated by the 2-year flow. Elk River Road, which hugs the east valley wall at a higher elevation than the adjacent floodplain, becomes inundated at several lower lying locations. Areas of roadway inundation expand and deepen with design flows greater than the 2-year flow.

The Project is predicted to decreases the length of road inundation at the 2-year and 100-year flood throughout the project area and eliminates some road inundation at the 2-year flow. Elk River Court and Wrigley Road are not predicted to be flooded following Project implementation at the 2-year flow. The Project largely eliminates the road inundation identified in Planning Area 4. Inundation of Zanes Road is limited to the west side of the bridge, while Berta Road and Elk River Road at the Flood Curve remain inundated at the 2-year flow. Modeling shows inundation along a section of Elk River Road just upstream of the Pine Hill Road intersection; however, this inundation may be an artifact of the model's simplified representation of the tides. The model, which is steady state, assumes that the tidal boundary condition remains high during the entire simulation. Of course, the tide rises and falls every six hours, allowing for periodic drainage and substantial lowering of water surface elevations.

100-year Flood Risk to Homes

Houses currently within the 100-year flood zone were identified from air photos. These homes may remain dry if the floor elevations are above the 100-year water surface elevation, even if the property surrounding them is inundated. Although the Project is predicted to alter the 100-year water surface elevations significantly in some areas of the Project (Figure 5-4 - Figure 5-7), all identified houses, save one, are predicted to remain vulnerable to the 100-year flow. The easternmost home identified in Planning Area 3 on Wrigley Road is the only structure that is within the 100-yr flood extent under existing conditions but outside of it under Project conditions.

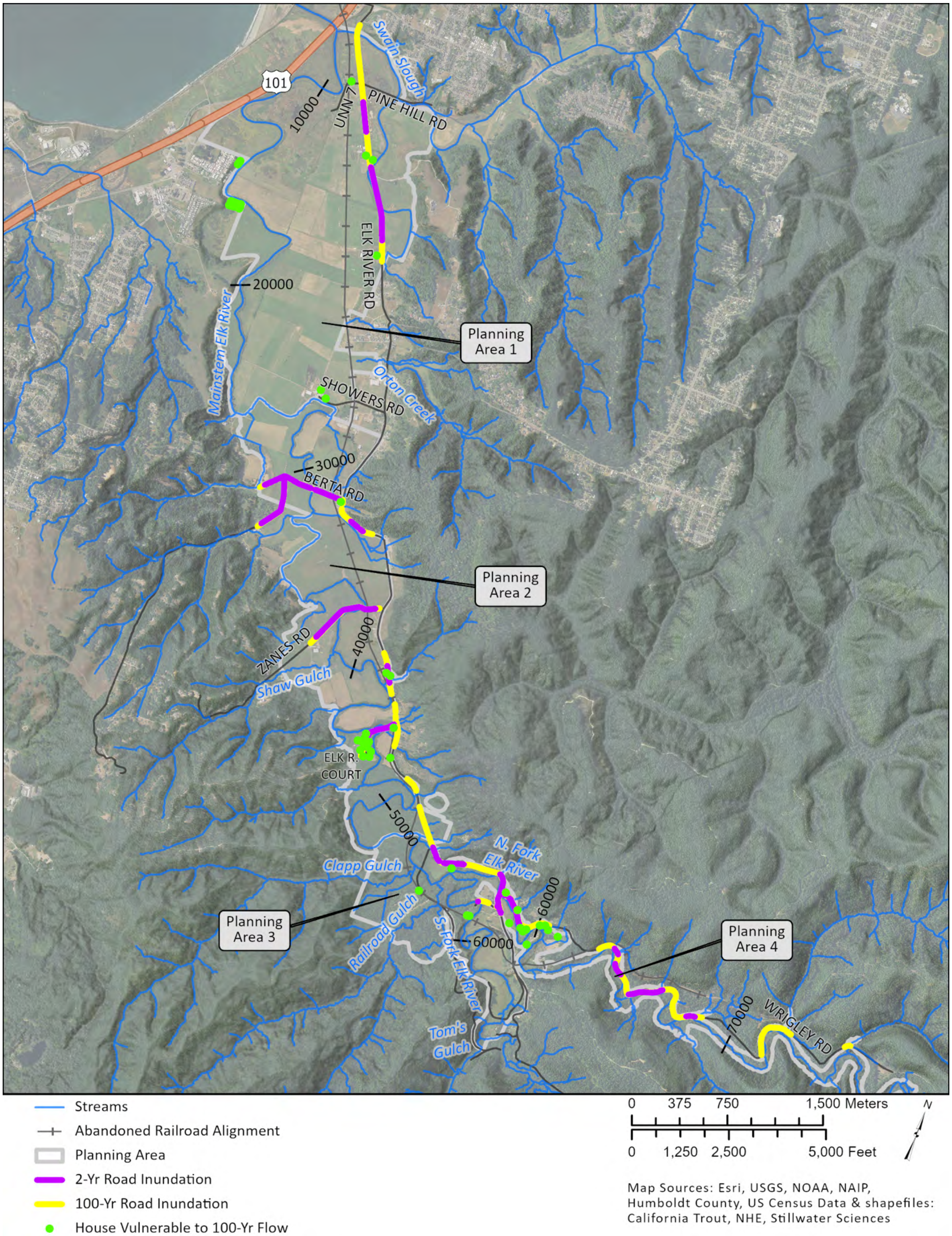

Figure 5-2. Predicted Road inundation at the 2-year and 100-year flow under existing conditions.

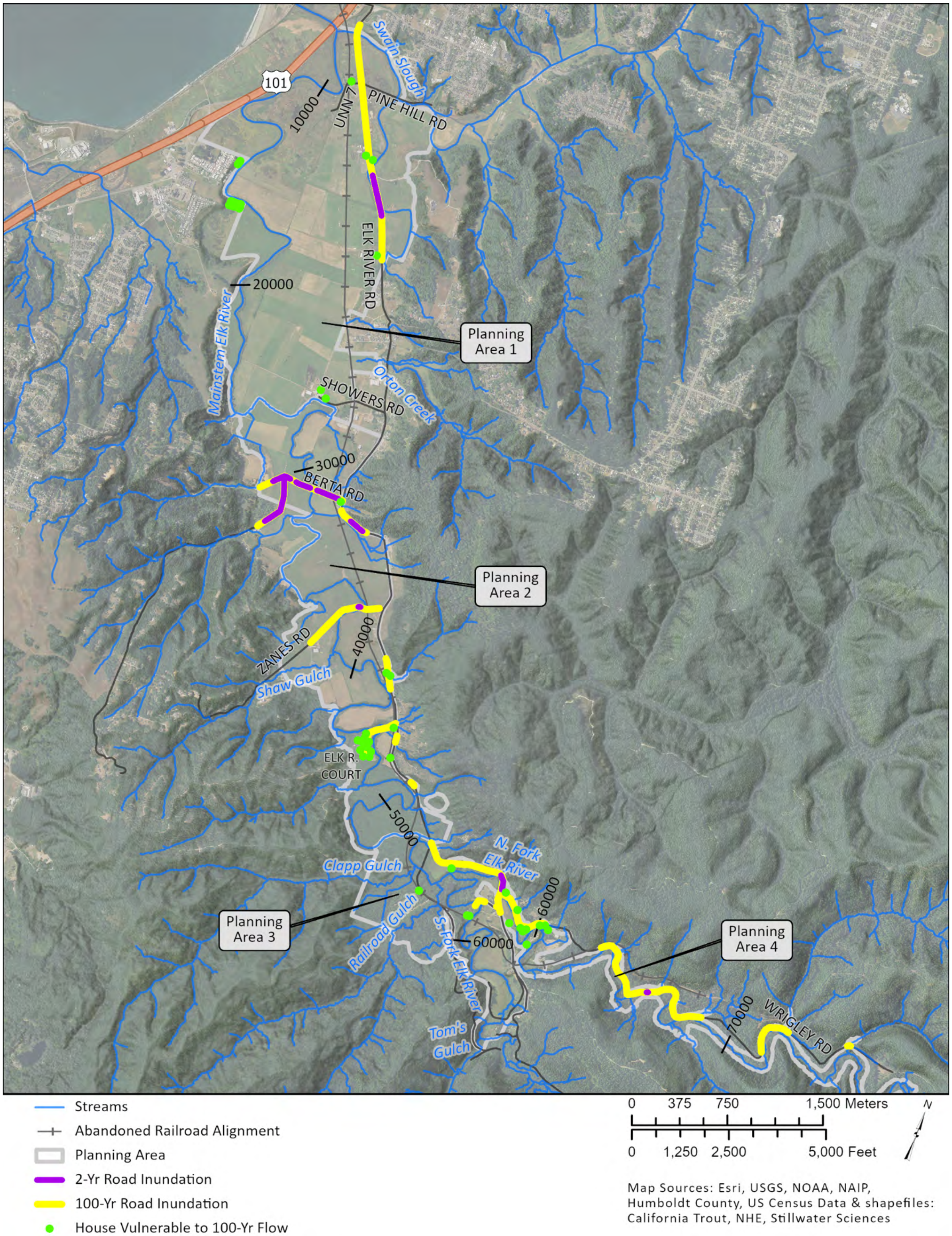

Figure 5-3. Predicted Road inundation at the 2-year and 100-year flow for Project conditions.

100-year Water Surface Elevation in Planning Areas 1-4

The Project generally decreases the 100-year water surface elevation in PA-2 to PA-4 and has no effect in PA-1 (Figure 5-4 to Figure 5-9. A few isolated areas show an increase in water levels which is due to the initial placement of excavated sediment on the floodplain. The placed fill will be re-distributed in later design phases to ensure the Project does not increase 100-year water surface elevations.

Project actions do not affect 100-year water surfaces elevations over most of Planning Area 1 (Figure 5-4). However, there are a few areas where some change is predicted. Near the swale that connects overbank flows to Swain Slough (Sta 24,000), water levels drop less than 1 foot relative to existing conditions. Project water surface elevations increase relative to existing conditions near Showers Road, likely due to the patterns of fill placement in this area. Modifications to fill placement will be made to ensure that water levels do not rise in this area.

Water surface elevations at the 100-year flow decline relative to existing conditions over most of Planning Area 2, with the largest drops in water levels occurring at the upstream end of Planning Area 2 (>2 foot) (Figure 5-5). No change in water level is observed immediately downstream of Zanes Road, and an isolated area of increased water surface elevation occurs downstream of Zanes Road (<1 foot). This rise in water surface elevations is also related to placement of fill, which will be altered in the next phase of designs to ensure that water levels do not rise at this location.

Water surface elevations at the 100-year flow in Planning Area 3 decline 2-4 feet throughout the area with Project implementation (Figure 5-6). The largest changes in water surface elevations are in the downstream end of Planning Area 3. These considerable declines in water surface elevations occur in one of the most flood prone areas of Elk River Road (flood curve) which is a critically important access route for access for both residents in the North Fork and South Fork.

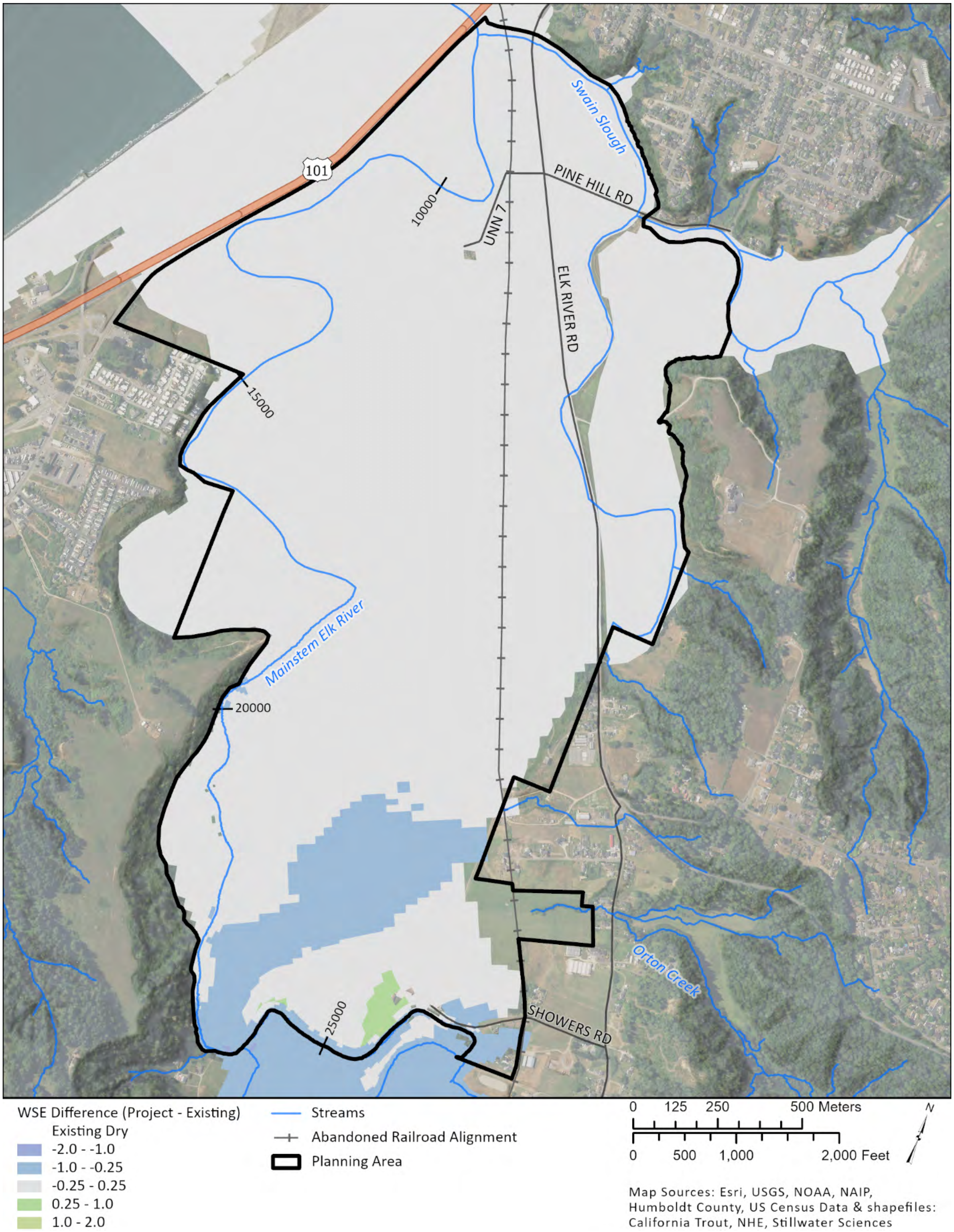

Figure 5-4.Predicted difference in water surface elevation at the 100-year flow in Planning Area 1.

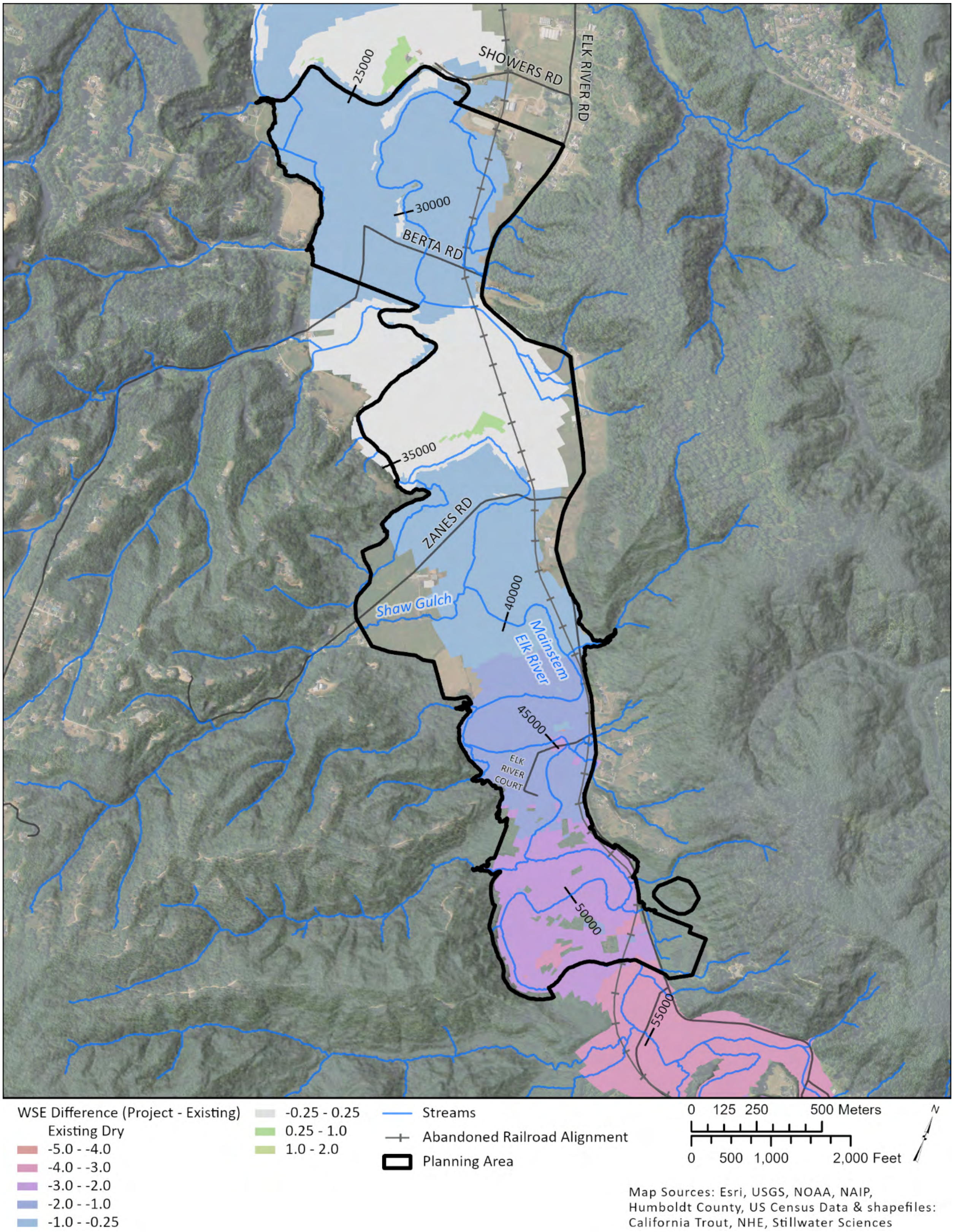

Figure 5-5.Predicted difference in water surface elevation at the 100-year flow in Planning Area 2.

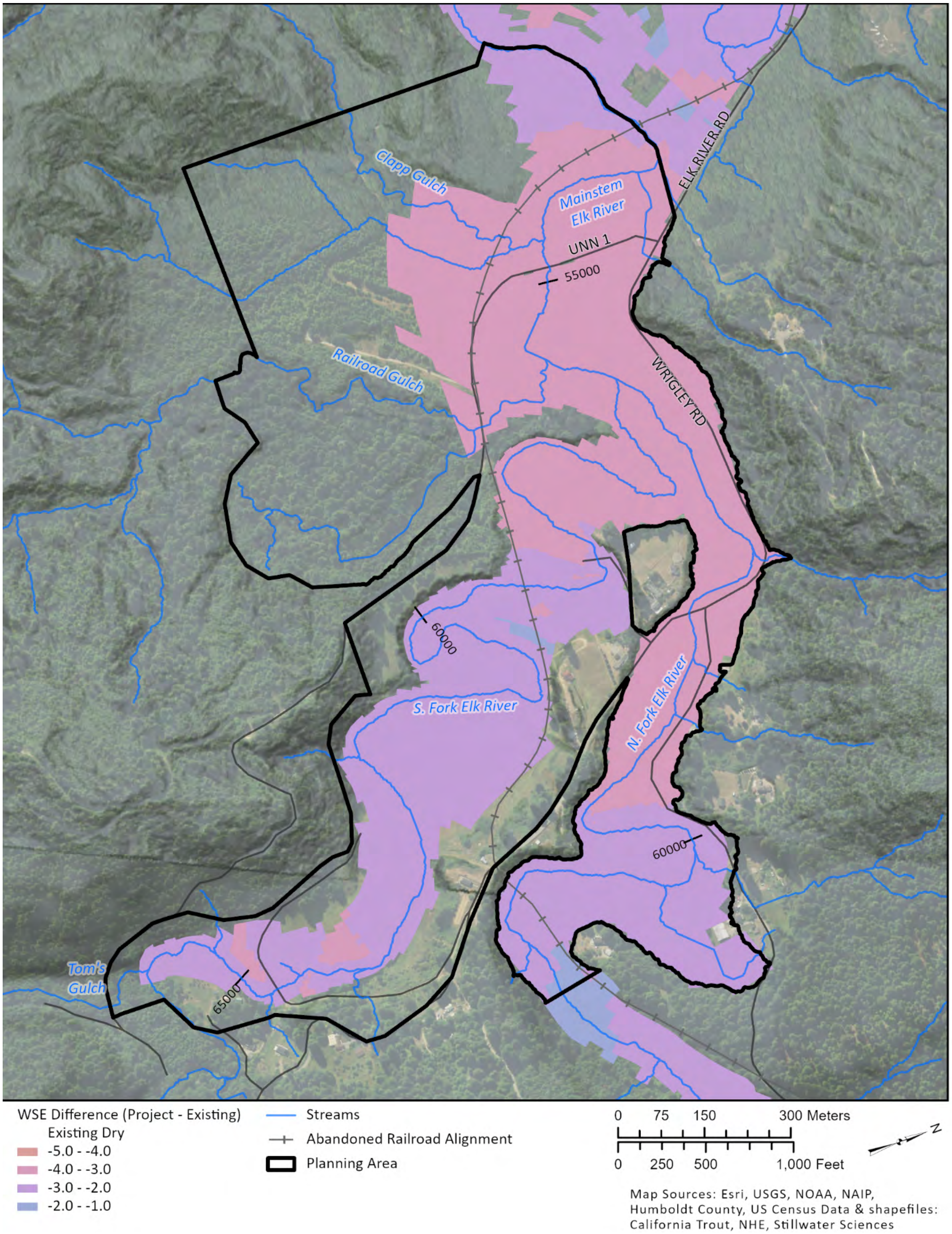

Figure 5-6.Predicted difference in water surface elevation at the 100-year flow in Planning Area 3.

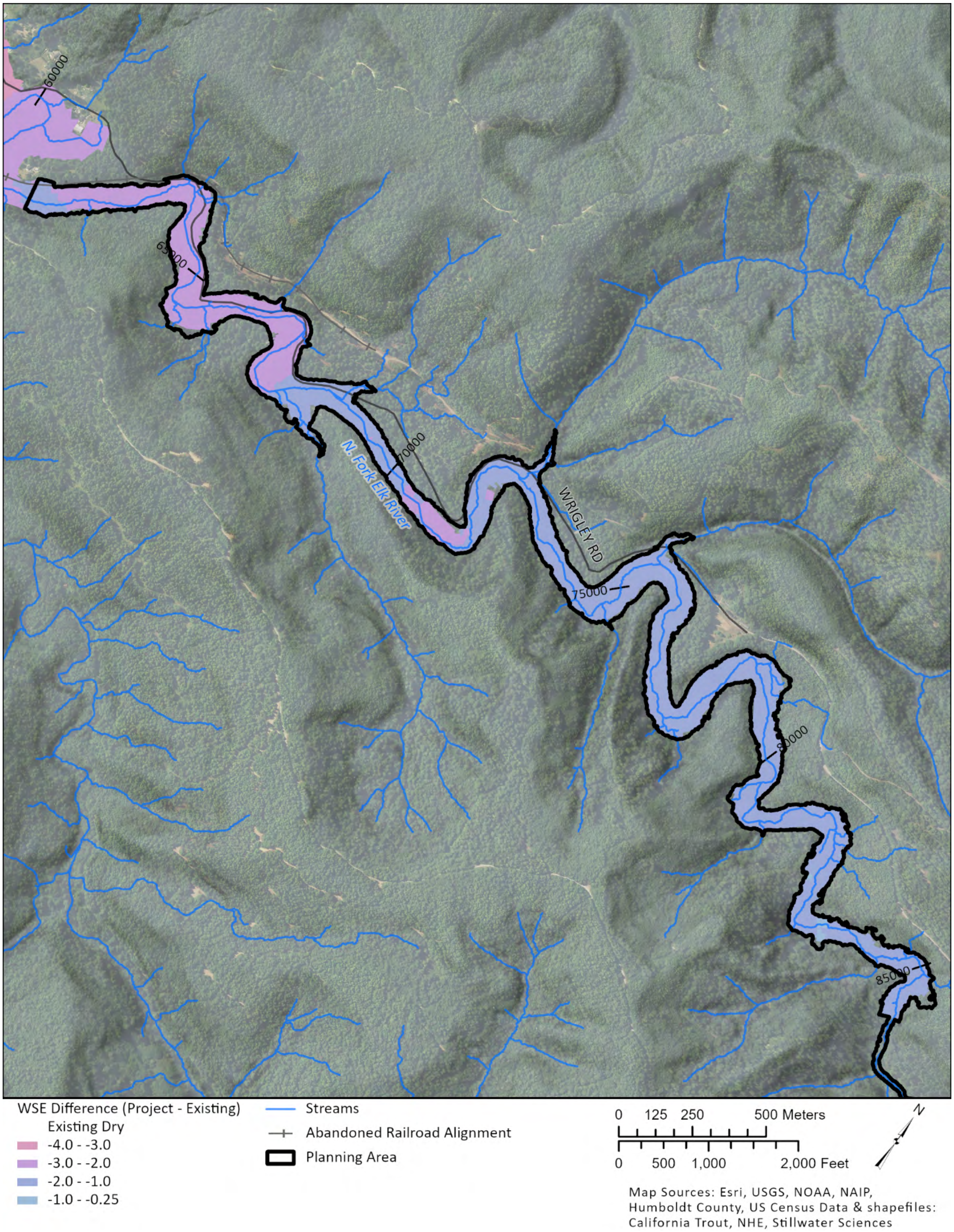

Figure 5-7. Predicted difference in water surface elevation at the 100-year flow in Planning Area 4.

Design Flows for Evaluation of Habitat and Nuisance Flooding

10% Exceedance Flow

The 10% exceedance flow is the lowest flow modeled. The Project aims to increase the amount of low-velocity off-channel alcoves and backwater areas at this flow. For both existing and Project conditions, inundation at the 10% exceedance is confined to the channel, alcoves, and tidal marshes (Figure 5-8). Under existing and Project conditions, out of bank flows at the 10% exceedance flow are driven by tides in the Elk River Wildlife Area and on properties adjacent to Swain Slough. Inundation of these properties under existing conditions should be limited by levees and tide gates, but many structures and portions of levees are in disrepair and allow substantial inundation onto the adjacent pastures. The modeled Project assumes repairs to failed infrastructure (tide gates and levee breaches) resulting in less inundation along Swain Slough. However, other possible alternatives may lead to a removal of these structures (tide gates and levee), which would increase inundation, rather than reduce it as shown. These alternatives are being considered in the 10% design phase.

Near Showers Road and immediately downstream of Zanes Road, isolated, low elevation areas of the floodplain adjacent to the channel are inundated and function as backwater areas or alcoves under existing conditions. The Project reduces inundation of these areas due to lower water surface elevations, except in areas that are specifically expanded by Project actions. The reduction of inundation of alcoves and backwater areas is counter to Project objectives. Therefore, additional Project actions will be identified to address this deficit such as lowering existing alcoves and backwater areas to achieve target inundation or strategically placing wood to increase water surface elevation in the vicinity of existing alcoves or backwater areas in the next design phase. It is worth noting that some inundation of these types of actions are not predicted by the model due to the coarse model grid size. Examples of actions and associated inundation extents that were developed in an area with more advanced planning (South Fork Elk River) are shown in Appendix D (Table 3-4).

1.053-year Flow

Floodplain inundation varies substantially in the watershed at the 1.053-year flow. Currently, widespread inundation occurs downstream of Zanes Road leading to frequent flooding of Berta Road. Upstream of Zanes Road, only isolated low elevation areas adjacent to the channel are inundated. Under Project conditions, out of bank flows do not occur at the 1.053-year event. The floodplain downstream of Showers Road is dry except for the areas along Swain Slough and the new channel the routes water into the Elk River Wildlife Areas (Figure 5-8).

1.25-year Flow

Currently, the 1.25-year flow results in widespread flooding in Planning Areas 1 and 2 and isolated out of bank flows occur in the upper mainstem and forks (Planning Area 3). Inundation extents are limited to the lower elevation portions of the floodplain adjacent to the channel in the forks. Elk River Road at the flood curve is inundated by the 1.25-year flow. Downstream of Zanes Road, the entire valley is inundated except for floodplains on the west side of the river in Planning Area 1. Implementation of the Project would significantly reduce the footprint of the inundation downstream of Zanes Road, except for properties west of Elk River in Planning Area 1. Increased inundation of these properties is not intended and will be addressed in later design phases. The project reduces out of bank flows in upstream planning areas, except for locations associated with project actions that intentionally lower the ground surface to locally increase inundation to improve habitat. Under Project conditions, Elk River Flood Curve is not inundated at the 1.25-year flow.

1.5-year and 2-year Flow

Currently, out of bank flows occur throughout the Stewardship area at the 1.5-year and 2-year flow; however, the extent of floodplain inundation varies. The Project would expand inundation on the west side of Elk River (Sta. 16,000-20,000) and previously inundated areas in Planning Area 1. Between Showers Road and Sta. 33000 (between Berta Road and Zanes Road), inundation extents at the 1.5-year and 2-year flow are similar to existing conditions. Upstream of Sta. 33000, Project floodplain inundation extents are much narrower than existing conditions, due to lower water levels, but all design floodplain swales are inundated by the 1.5-2-year flow (Figure 5-9, Figure 5-10). The Project would not improve flooding across Zanes Road and Elk River Courts at this flow. Flooding on Elk River Road upstream of Zanes Road would continue to occur in isolated locations.

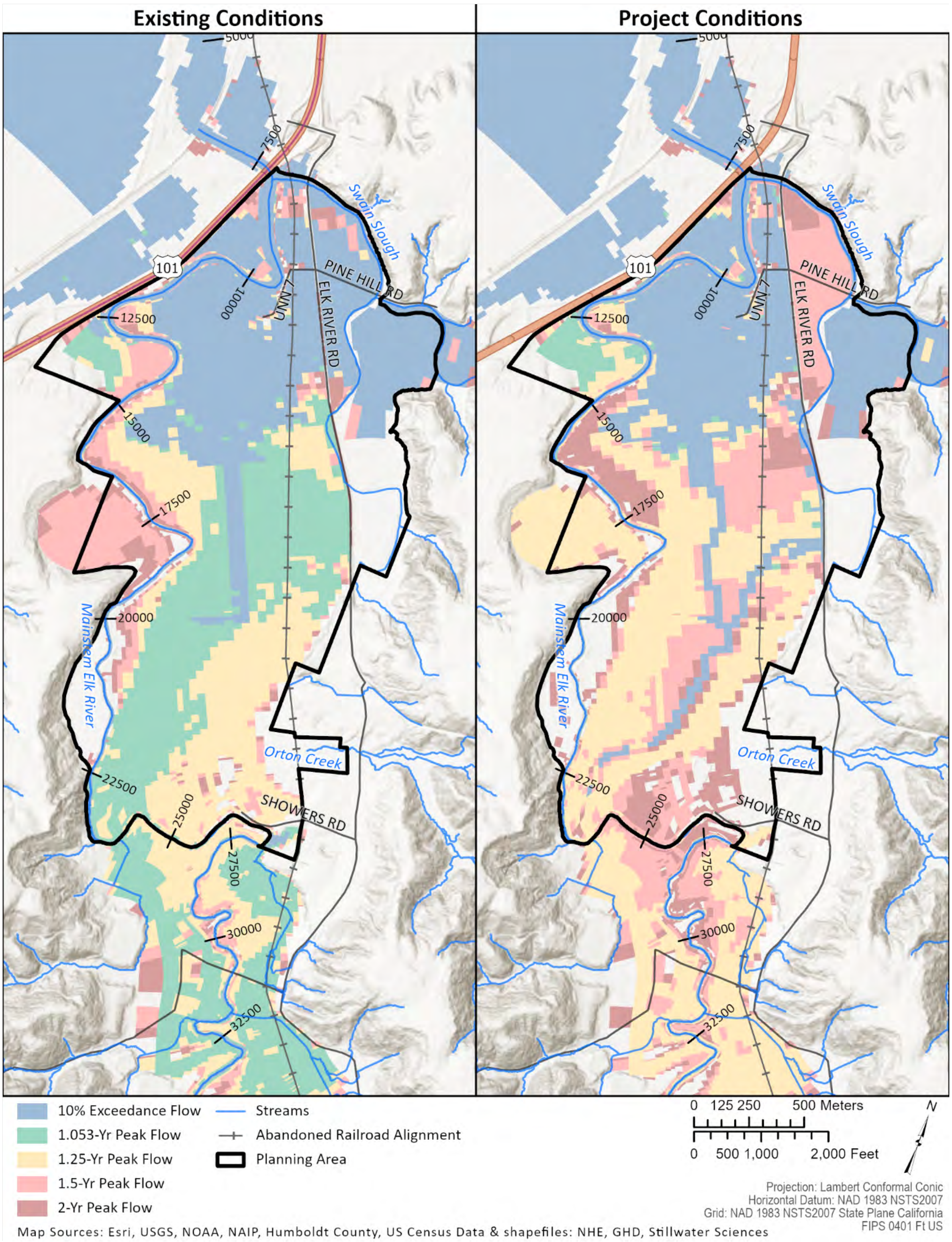

Figure 5-8. Inundation for existing and project conditions for flows up to the 2-year flow in Planning Area 1.

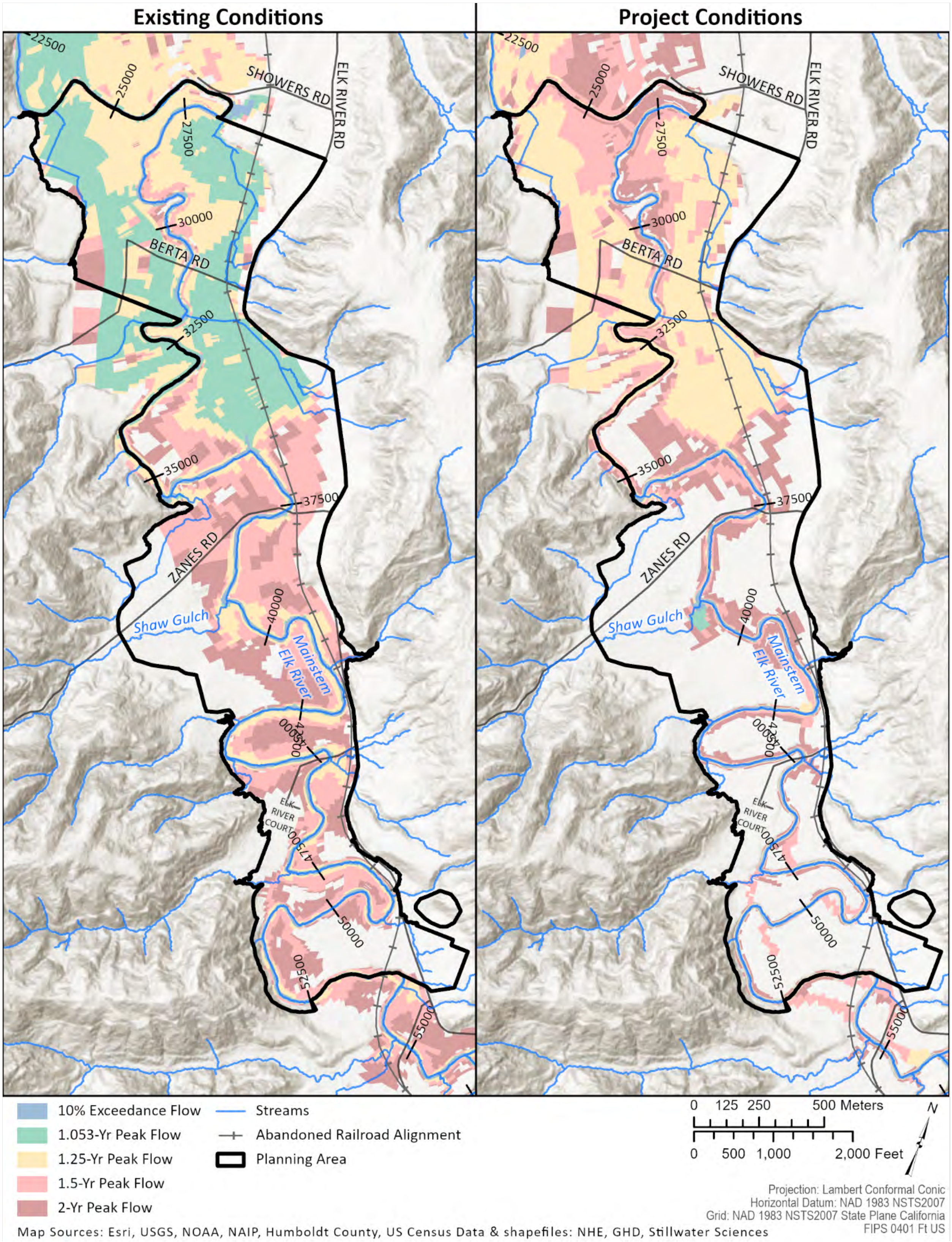

Figure 5-9. Inundation for existing and project conditions for flows up to the 2-year flow in Planning Area 2.

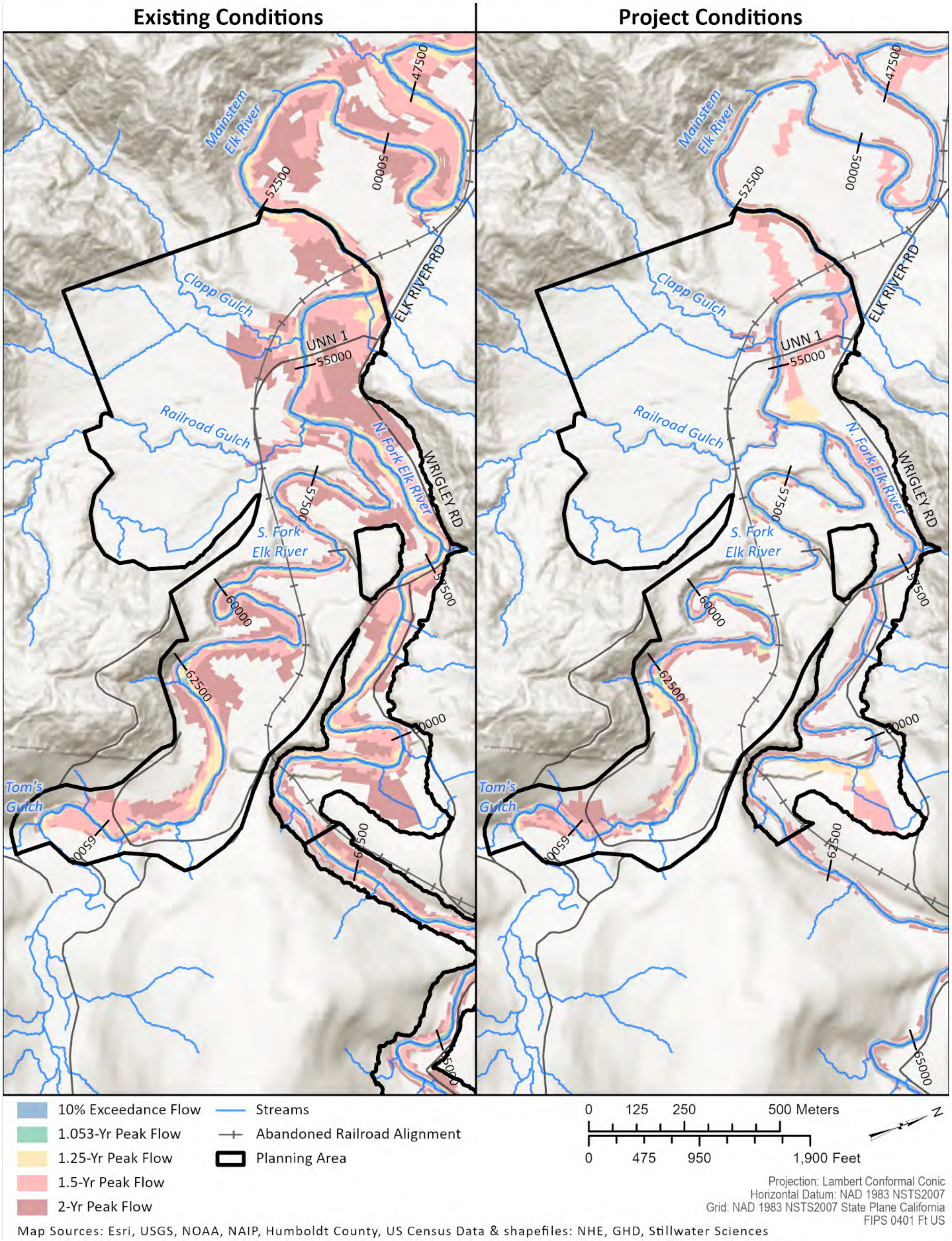

Figure 5-10. Inundation for existing and project conditions for flows up to the 2-year flow in Planning Area 3.

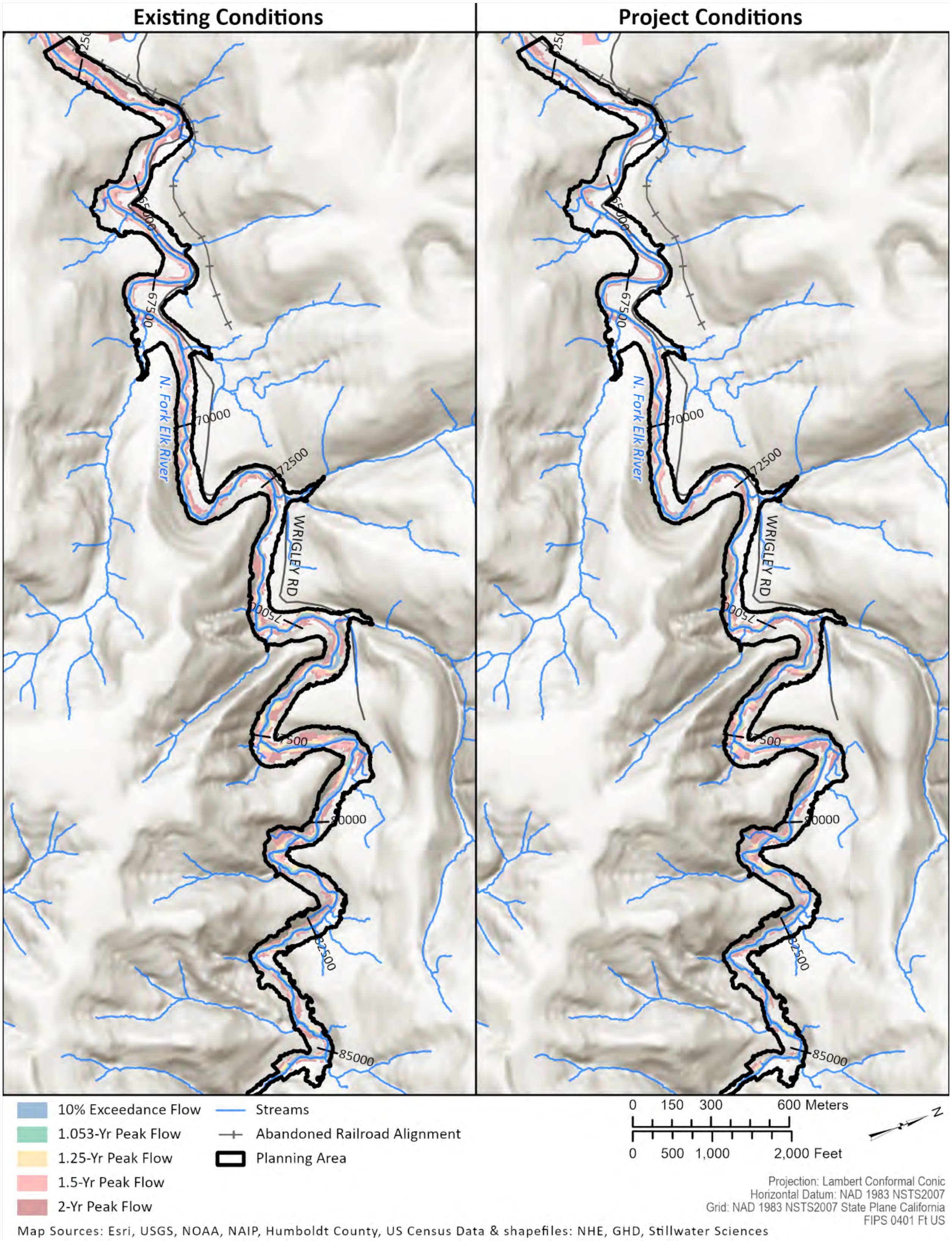

Figure 5-11. Inundation for existing and project conditions for flows up to the 2-year flow in Planning Area 4.

Summary

The Project significantly reduces flooding at these frequent flows. In the upper reaches (above Elk River Court), the channel was deeply entrenched into older river terraces and inundation of the adjacent terraces was infrequent. This less frequent pattern of flooding supported land uses that were different that the lower valley bottom. The sediment impacts upstream of Elk River Court resulted in more frequent and widespread flooding. The proposed Project has the largest reduction in flooding extent in these areas (Figure 5-9 and Figure 5-10).

Downstream, of Zanes Road, the pre-1980 flood inundation of the valley bottom was more frequent and widespread. The sedimentation impact altered the frequency of flooding but has a less noticeable impact on floodplain inundation extents. The proposed Project shows significant reductions in flood frequency of floodplains and roadways, particularly at Berta Road (Figure 5-1 and Figure 5-9), but floodplain inundation extent remains similar in PA-2 (Figure 5-9). In PA-1, the inundation extent is narrower as a result of the creation of the floodplain corridor which provides more confinement of floodplain flows and directs those flows into the ERWA and Swain Slough extension. This improved floodplain corridor is expected to reduce fish mortality.

5.2 Sediment Storage and Concentration

The Elk River channel has on-going impacts as a result of high sediment loads that result in severe water quality and habitat impairment, disrupting domestic water supplies, and threatening the residential communities with nuisance flooding of homes, property, roadways, and bridges. The HST-model (CalTrout, 2019) was used to estimate the effect of the Project on suspended sediment concentrations in the channel and sediment storage within the channel and floodplains. The largest storm on record (WY 2003) was modeled was used to estimate the response of the system to Project implementation. Refer to California Trout et al. (2019) for details on model development and calibration. The results of this analysis demonstrate the effect of the Project on addressing these key impairments in the watershed.

Sediment Storage

With Project implementation, the total volume of sediment stored in the entire Stewardship area changes by less than 0.5%, with slightly less sediment stored under existing conditions. However, the Project generally shifts sediment deposition from upstream planning reaches to downstream planning reaches. The upstream planning areas have a 20-24% reduction in total sediment storage, while Planning Area 2 has an increase of 11% and Planning Area 1 increases by 29%.

Sediment Storage in Channel

Excessive fine sediment deposition in the stream channel can impair channel conditions and worsen flooding. The general patterns of sediment deposition in the channel for Project and existing conditions are similar, with the highest rates of in-channel sediment storage occurring in upstream Planning Areas (3 and 4) and much lower in-channel sediment storage in Planning Areas 1 and 2 (Table 5-1). The Project has lower in- channel storage compared to existing conditions in PA 2-4. In PA-1, more sediment is stored in the channel; however, this could be a benefit to the estuary as sediments deposited in the estuarine channel may be redistributed to local tidal marsh plains during subsequent high tides. The re-distribution of sediment to the marsh plains is beneficial by building the marsh plain elevation which in turn, increases coastal resilience.

Sediment Storage in Floodplain

Currently, sediment storage in the floodplain is highest in PA- 2, which has low elevation floodplains and long durations of flow inundation, followed by PA-3 and PA-1 (Table 5-1). The Project decreases sediment storage in the floodplain in PA-3, due to reduced inundation, and increases sediment storage in the floodplain in PA- 1 and PA-2. Thus, for Project conditions, sediment storage is highest in PA- 2, followed by PA- 1 (tidal reaches) and PA-3. Increases in sediment storage in the floodplain and tidal marshes in PA- 1 are generally beneficial as these areas are the most vulnerable to climate change and sea-level rise.

Table 5-1. Change in channel and floodplain sediment storage between existing and Project conditions.

	Existing Sediment Storage (CY/1000 ft length)		Project Sediment Storage (CY/1000 ft length)		Difference in Sediment Storage (CY/1000 ft length)	
	Channel	Floodplain*	Channel	Floodplain*	Channel	Floodplain*
Planning Area 1	0.11	11	0.20	14	0.09	3.1
Planning Area 2	0.53	15	0.40	17	-0.13	2.0
Planning Area 3	2.9	13	2.7	8.9	-0.23	-4.3
Planning Area 4	1.7	2.7	1.4	2.1	-0.33	-0.55
Planning Area 1-4	1.2	9.5	1.1	9.9	-0.15	0.37

*Floodplain length is calculated along the valley axis.

Suspended Sediment Concentrations

Suspended sediment concentrations (SSC) were predicted for existing and Project conditions for the 2003 storm using the HST-model. Discharge, water surface elevation, total suspended sediment concentration, and suspended sediment concentrations of three size classes were extracted at 10 locations along the Elk River to evaluate the impact of the Project on suspended sediment concentration.

The Project produces slightly higher SSC throughout the Stewardship area (Appendix E). This result is due to the consistently higher capacity to transport sediment and less sediment deposition occurring in the channel in Planning Areas 2-4. The fully tidal station (Figure 5-12) shows the largest changes in the finest size class (clay to coarse silt) with some increase in transport occurring in the coarse silt to fine sand size class. In the fluvial portion of the Elk River mainstem, this pattern shifts such that the Project produces similar concentrations of the fine size class (clay to coarse silt) and increases in the larger size classes (coarse to fine sand and fine sand to medium sand) (Figure 5-13 to 5-21). The increases in transport of these larger grain sizes reflects a higher transport capacity and higher likelihood of increasing the complexity of the channel bed.

Summary

The Project redistributes sediment from upstream, which is generally beneficial. Excessive sediment has created impaired conditions in the channel and floodplains and exacerbates nuisance flooding. In downstream reaches (PA-1), sediment is a resource and deposition on the low elevation agricultural lands and tidal marshes will reduce impacts due to climate change and sea level rise. Unfortunately, the Project does not improve suspended sediment concentrations. The translation of sediments from upstream to downstream increases sediment in the water column. These findings indicate that in addition to implementation of the proposed Project, there is a continued need for sediment source reductions in the upper watershed.

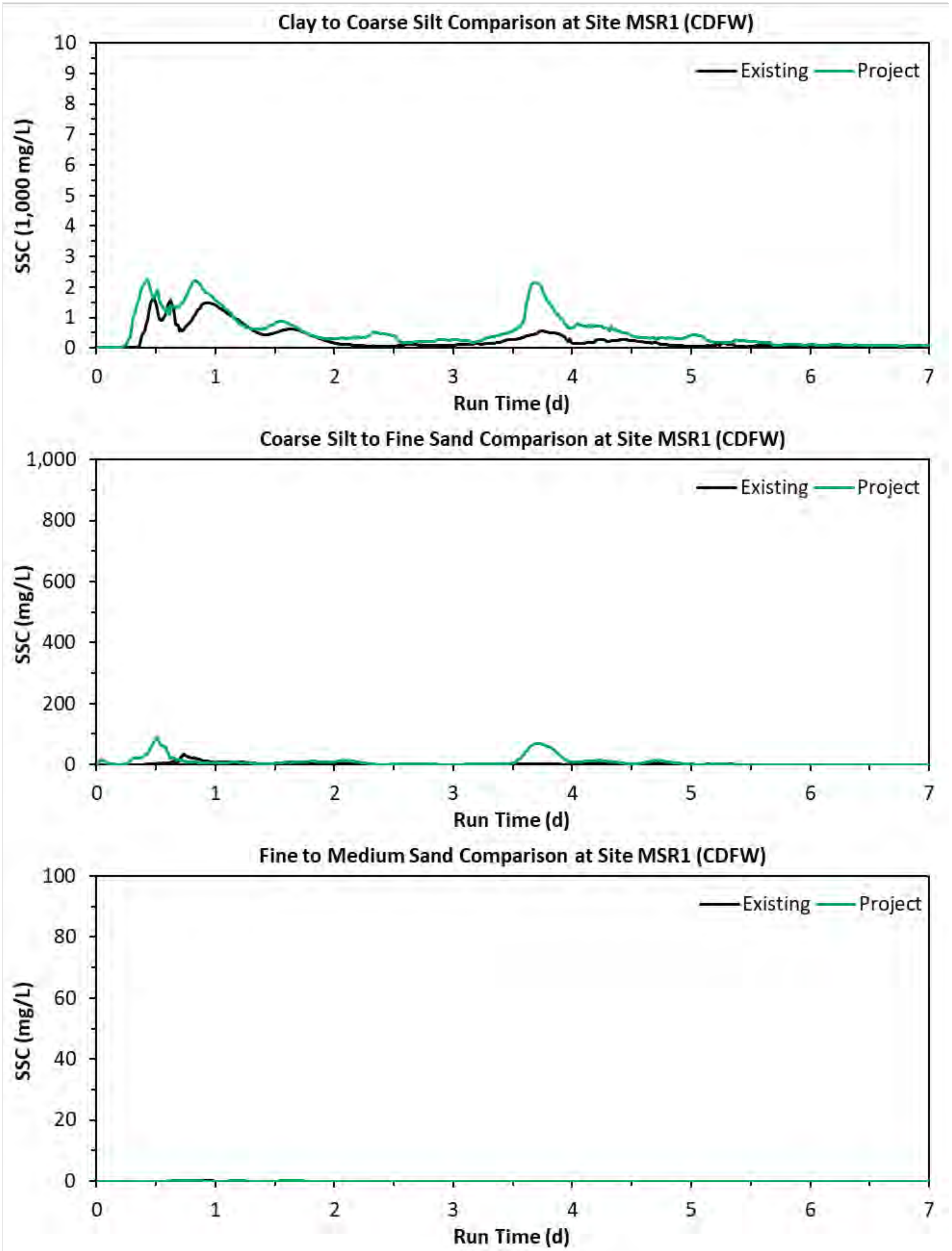

Figure 5-12. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 1 in mainstem Elk River (middle site).

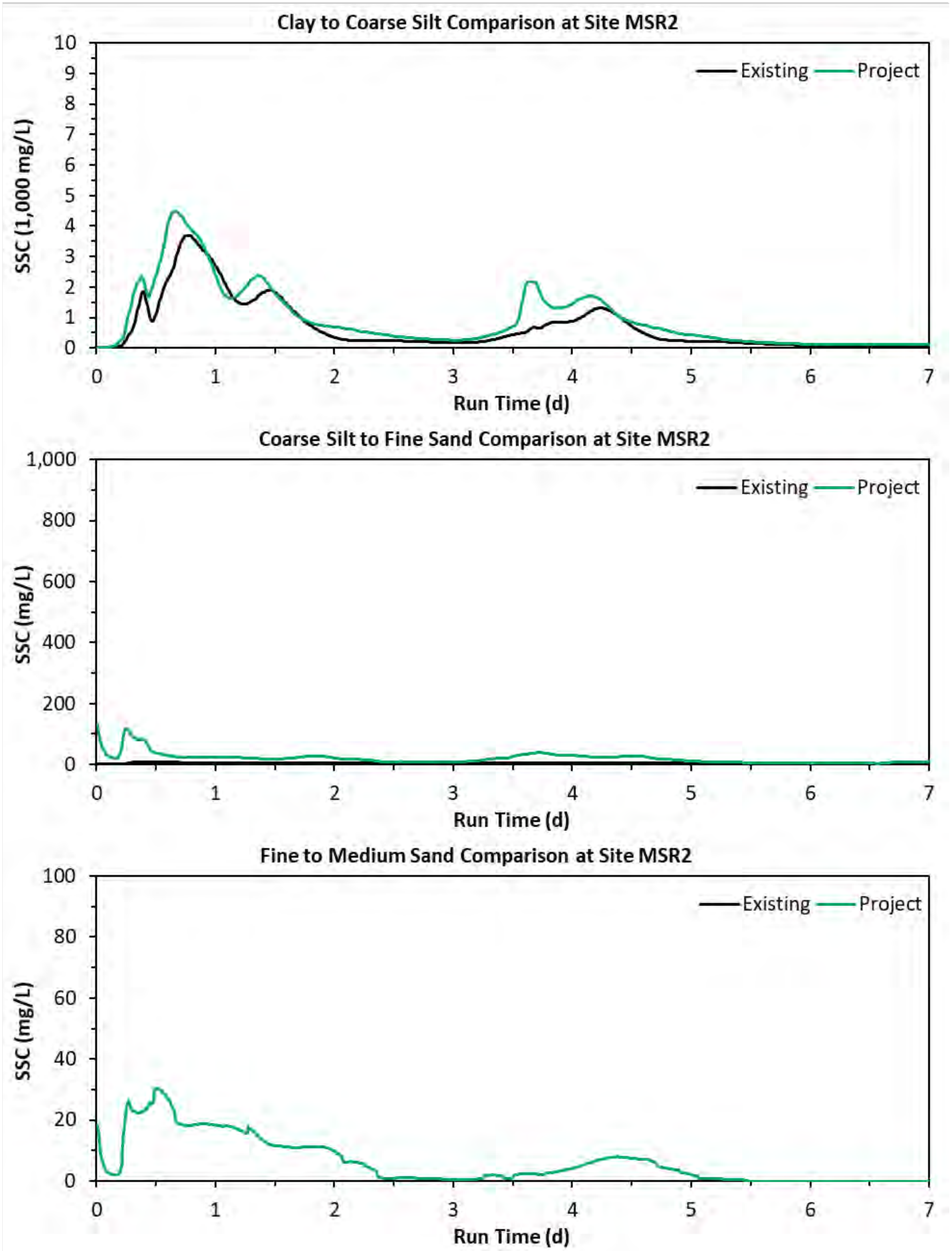

Figure 5-13. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 1 in mainstem Elk River (upper site).

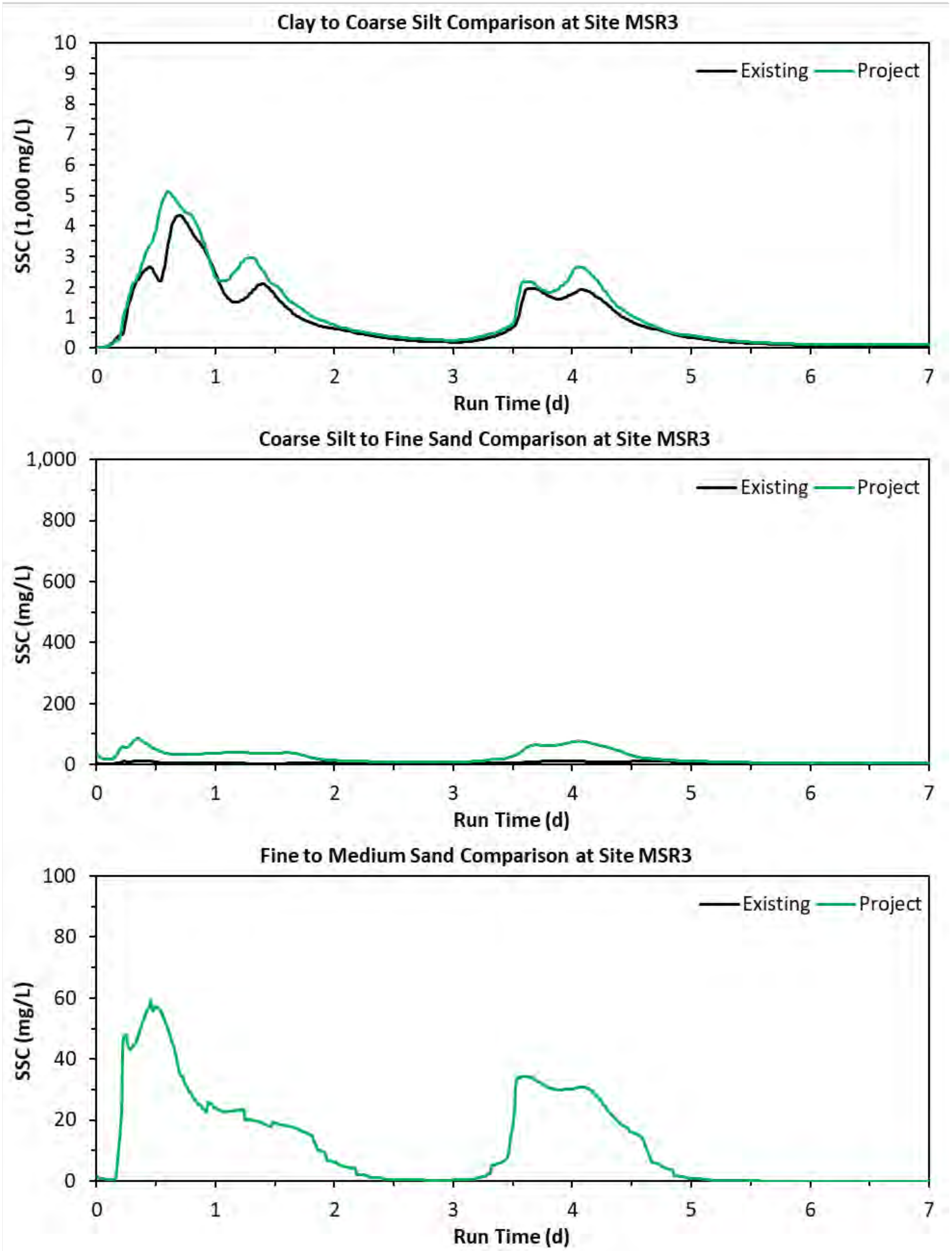

Figure 5-14. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 2 in mainstem Elk River (lower site).

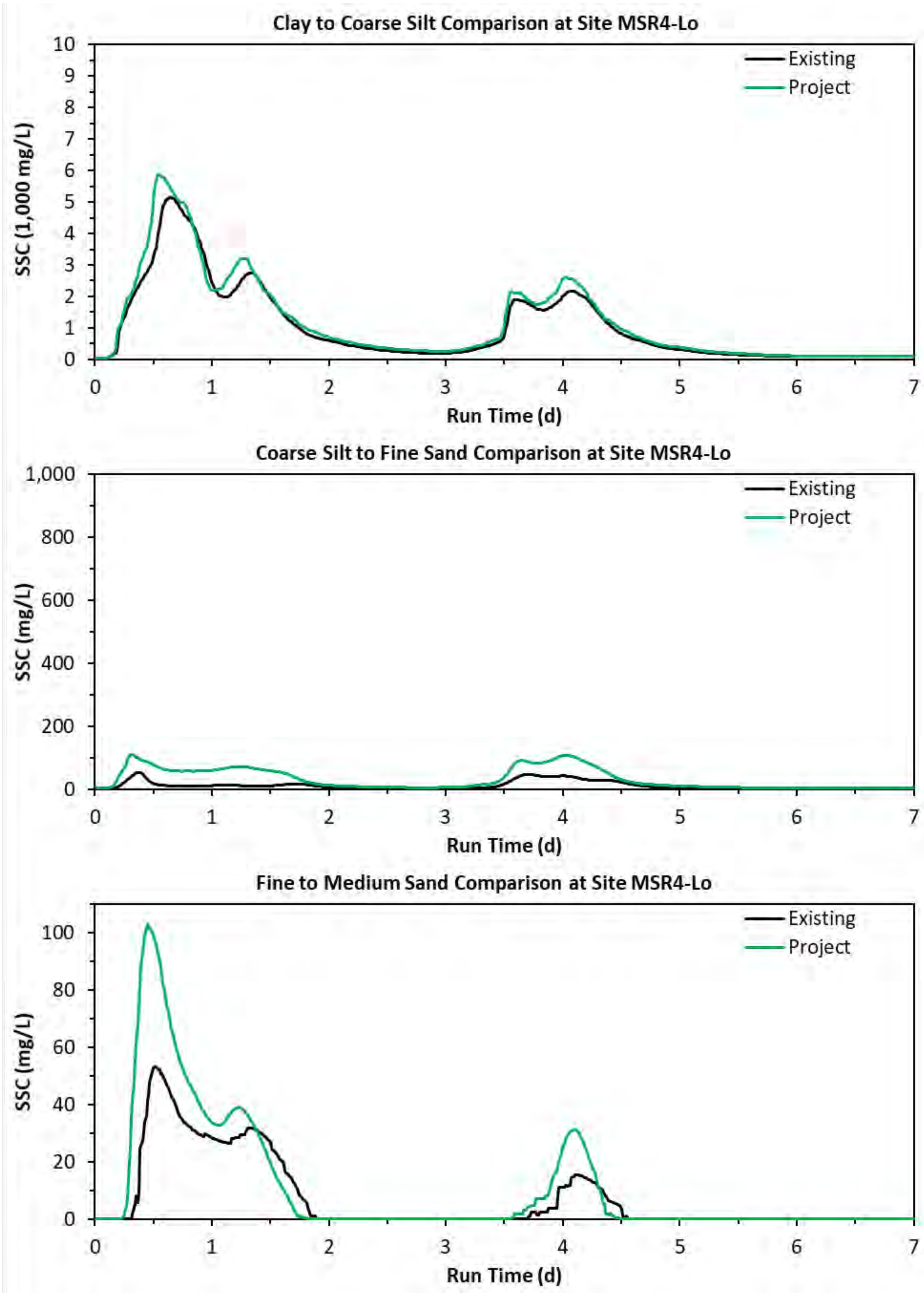

Figure 5-15. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 2 in mainstem Elk River (middle site).

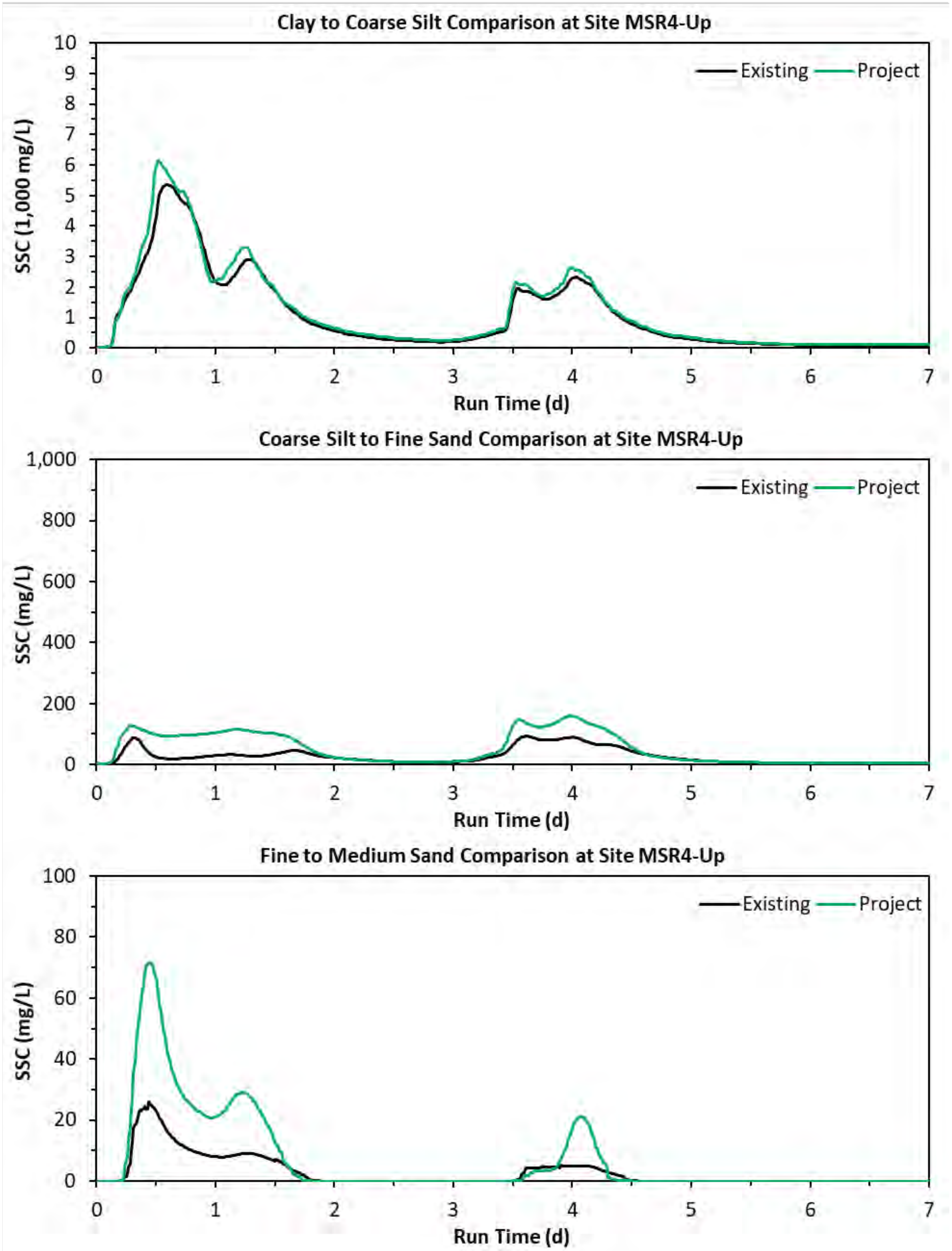

Figure 5-16. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 2 in mainstem Elk River (upstream site).

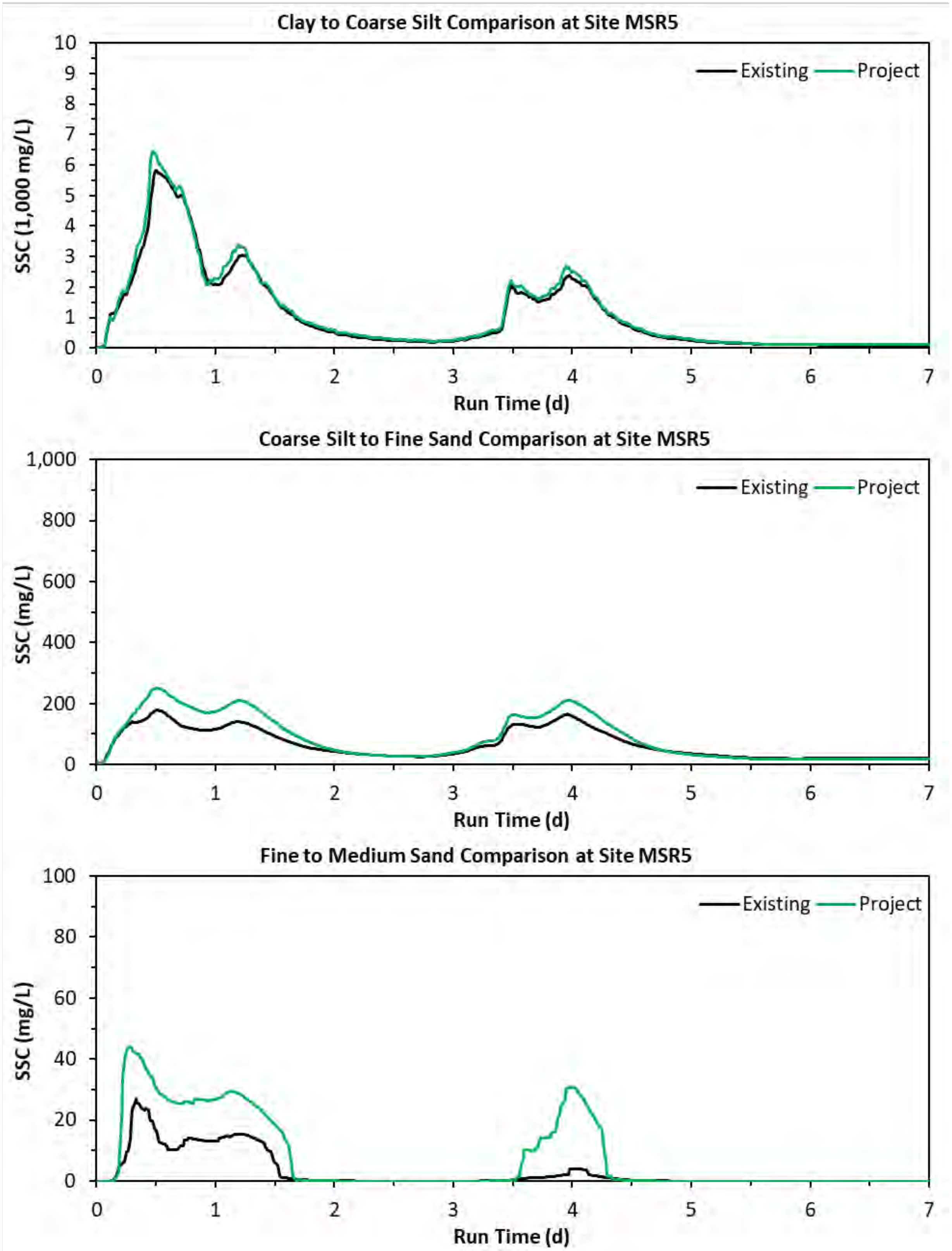

Figure 5-17. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 3 in mainstem Elk River.

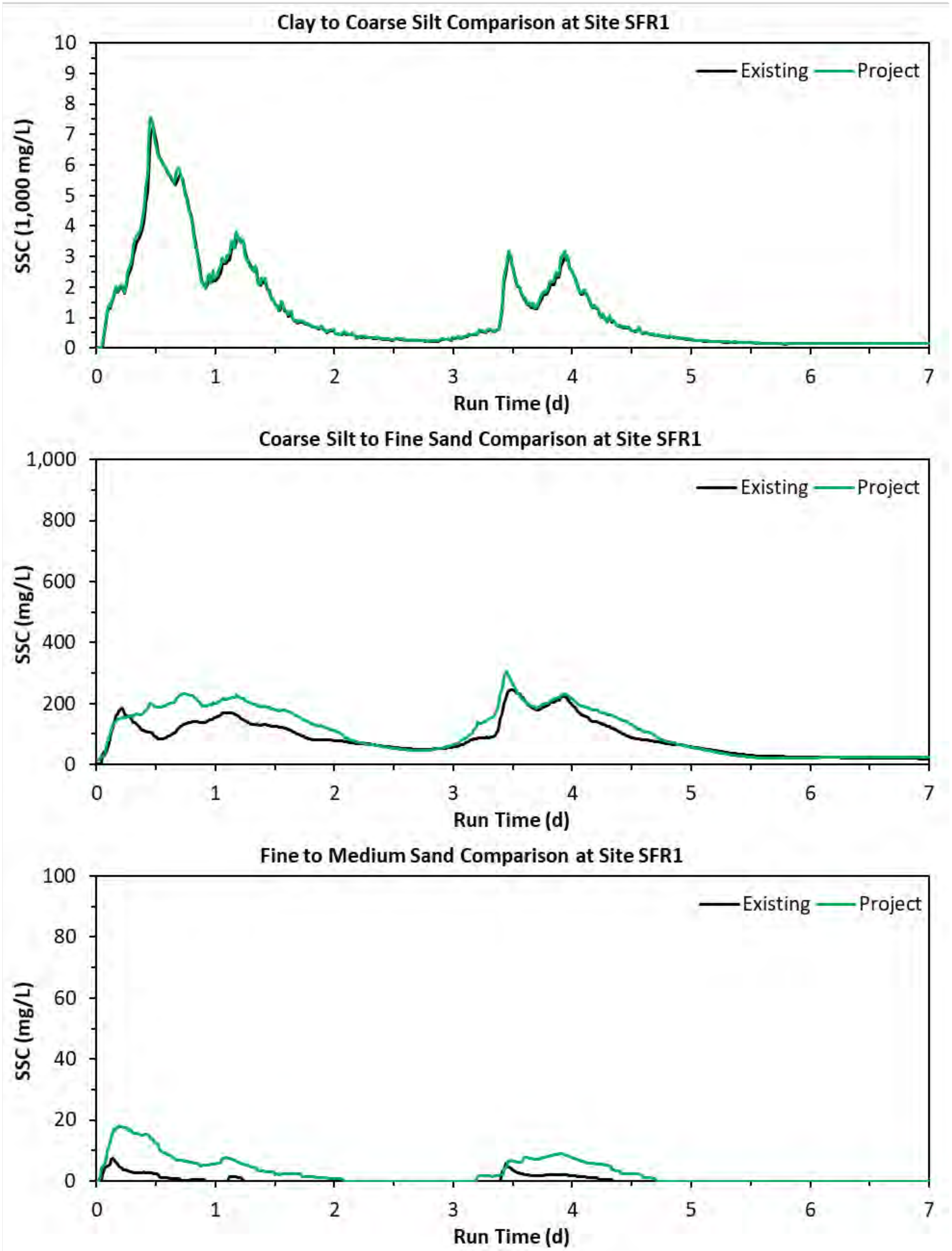

Figure 5-18. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 3, in South Fork Elk River (downstream site).

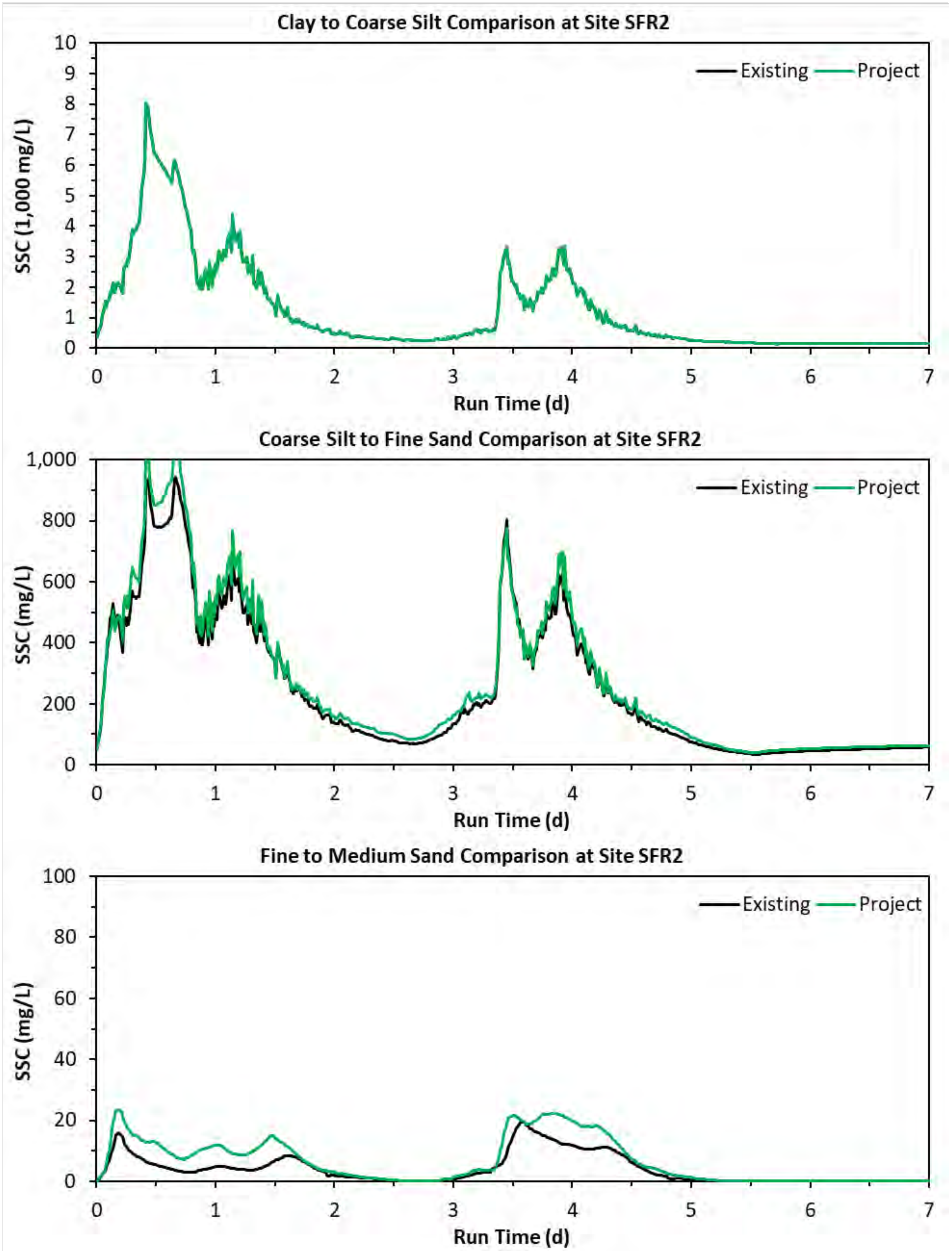

Figure 5-19. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 3 in South Fork Elk River (upstream site).

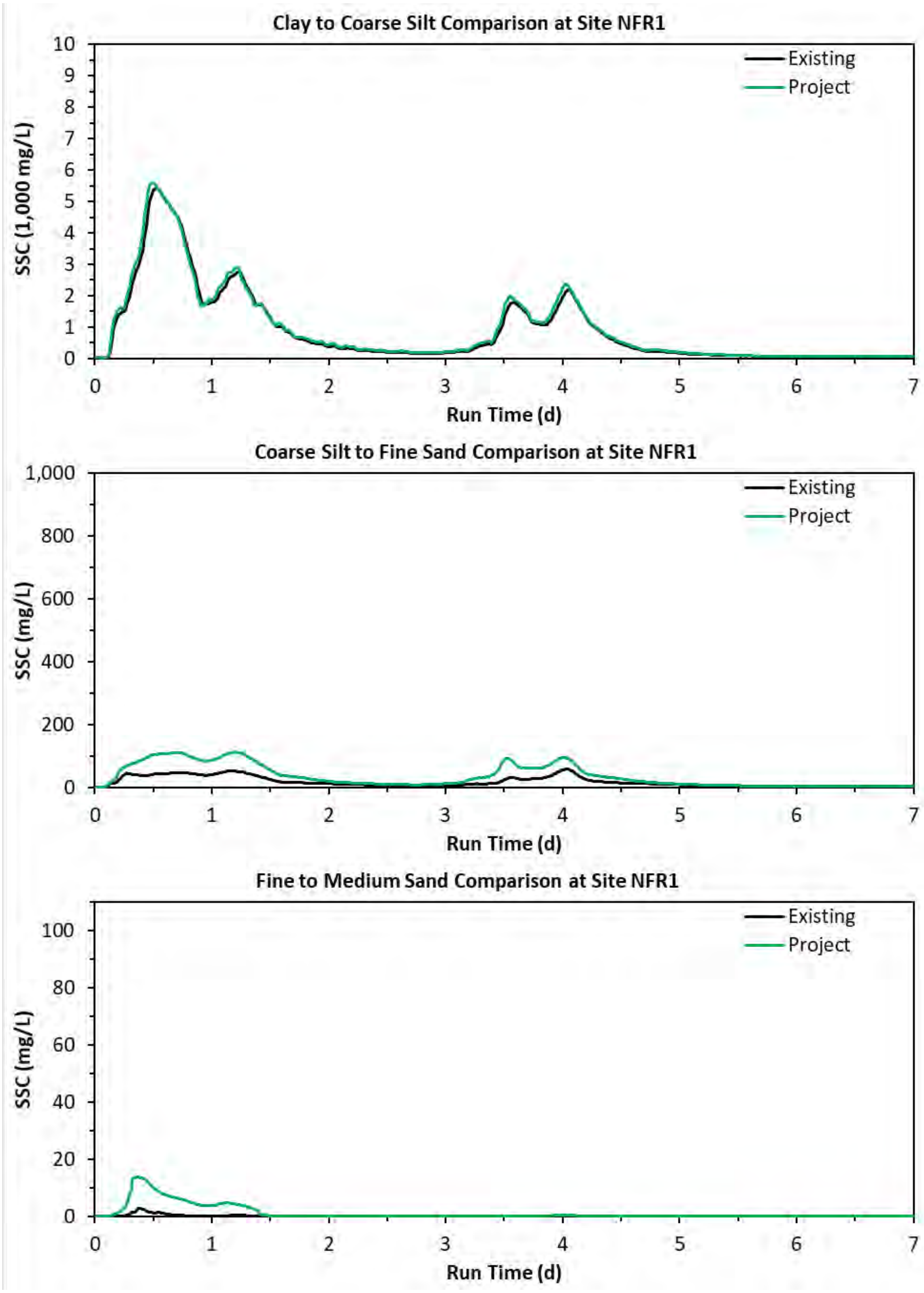

Figure 5-20. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand.in Planning Area 3, North Fork Elk River.

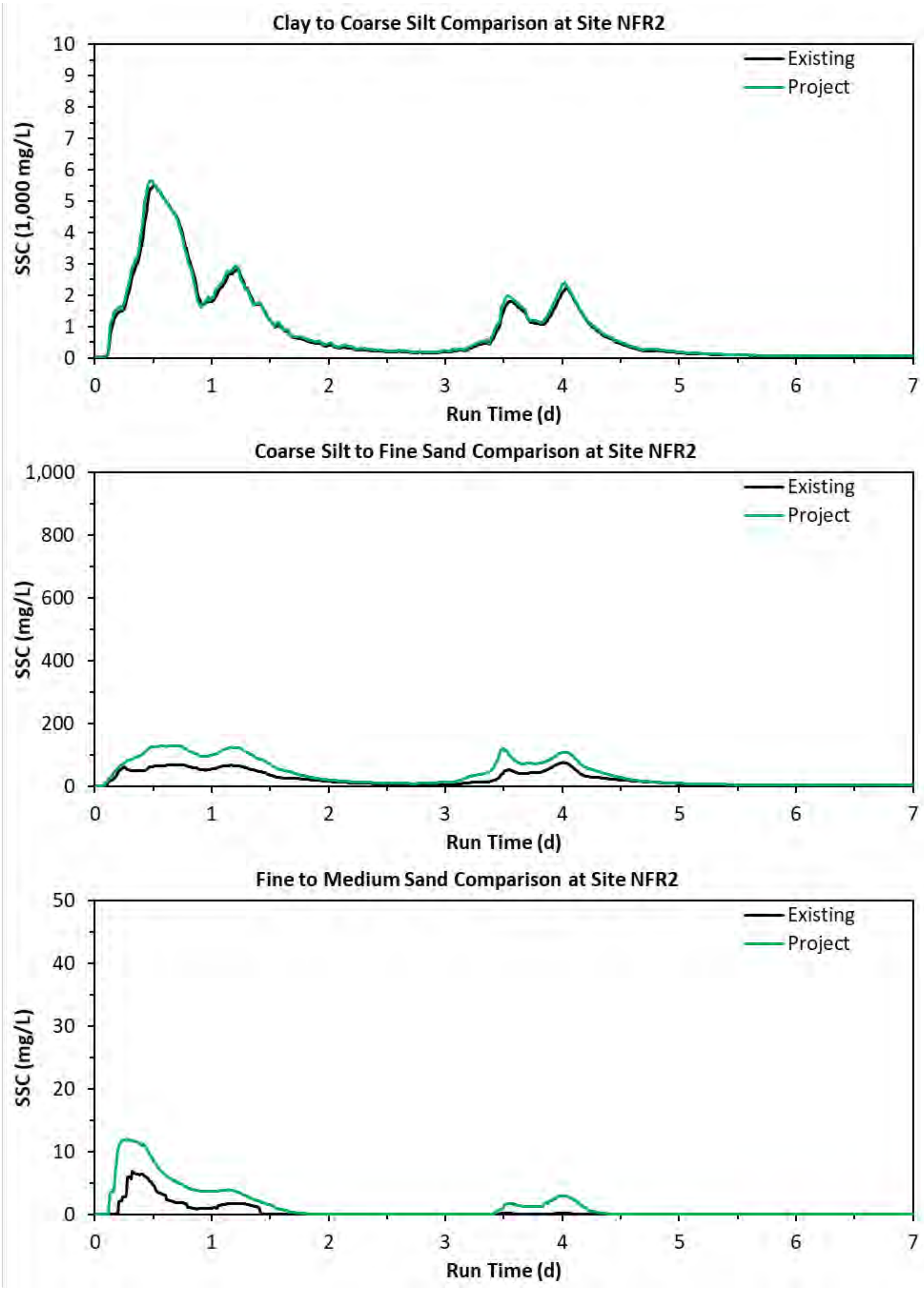

Figure 5-21. SSC for sediment classes of clay to coarse silt, coarse to fine sand, and fine to medium sand in Planning Area 4 (downstream site).

6 Implementation Framework and Construction Phasing

This Elk River Recovery Plan proposes a large-scale and ambitious effort to remediate excess legacy sediment, reduce the consequent nuisance flooding, and rehabilitate aquatic and riparian habitat associated with Elk River. The forthcoming effort required to carry the program through phases of conceptual and engineering design, regulatory compliance, funding and contracting for successive phases of construction, and post-construction maintenance and monitoring, all with landowner and public support will be complex. Regionally there are several recent or contemporaneous examples of phased restoration programs of the scale proposed herein, the best-known of which are the Trinity River Restoration Program, the Salt River Ecosystem Restoration Project, and the Dry Creek Fish Habitat Enhancement Program. These programs and others have several important features that will be essential to the success of the Elk River Program, including:

- A consistent, non-competitive source of annual funding for base program support, annual project construction, and post-construction adaptive management and monitoring.
- Structured leadership from one or more local, state, or federal agencies providing program management and oversight.
- A multi-disciplinary engineering and environmental science design team composed of civil and hydraulic engineers; hydrologists, geomorphologists, and other physical scientists; aquatic, fisheries, and wetland biologists; botanical and riparian vegetation specialists.
- A decision support system that objectively helps prioritize and refine implementation phases and strategies, that is linked to the engineering designs, predictive modeling, and adaptive management framework.
- A regulatory mandate as the primary impetus establishing the program goals and objectives.
- Significant buy-in and support from the affected landowners, associated stakeholders, and the nearby community

This Elk River Stewardship Program has its foundation and impetus in the Regional Water Board's Elk River TMDL Program which has now been adopted into the North Coast Basin Plan by amendment (Resolution No. 2017-0046). Over the past two decades, the Elk River has been listed on the CWA 303d list as sediment impaired, studied intensively to identify causes of sediment impairment, and assessed for potential remediation actions including the Elk River Recovery Assessment (CalTrout et al. 2019) reviewed by a Technical Advisory Committee. Proposed actions described in this report have been analyzed to assess their efficacy and vetted with landowners, resource agencies, and stakeholders in preparation for the implementation phase.

In this section we provide a framework for implementing this program, an estimate of funding resources needed, and an estimated timeline to complete the implementation phases. Post-construction maintenance and monitoring will also be an essential component to this program. This implementation framework is based on two important considerations that guide how we have initially prioritized program phases. These two considerations are:

1. Finding the most direct and streamlined pathway for implementation of project phases that brings relief as soon as possible to landowners in the Elk River, those affected by nuisance flooding, flood risks, and impaired water quality.
2. Providing net ecological benefits to sensitive habitats (e.g., wetland and riparian habitat) and protected species (e.g., salmonids) in advance of temporary impacts to those habitats and species that are an inevitable and unavoidable result of the project construction phases.

In addition to these two primary criteria, a third criterion – landowner willingness to participate is a very important consideration for our implementation planning. Since nearly all lands bordering the Elk River are privately owned, remediation and rehabilitation actions will ultimately be implemented at locations where private landowners have voluntarily granted permission for the work to be completed on their property.

To aid in our implementation planning, the Elk River Stewardship Program Area was partitioned into four Planning Areas that will aid in organizing and executing the engineering design process, completing the regulatory compliance steps at the scale that is recommended by our agency partners (described in Section 7), and for securing project funding in reasonable and manageable sums. These Planning Areas are also hydraulically linked and ecologically relatively homogeneous and have similar land ownership issues that will need to be addressed leading up to project implementation. Finally, these Planning Areas may lend themselves to different grant program funding objectives (e.g., sediment remediation vs estuarine restoration) and can therefore be packaged and presented to different funding programs more holistically.

As described in Section 2.3 above, the four Planning Areas (not presented in any order of priority, but oriented from downstream to upstream) are:

- Planning Area 1: Tidal and Lower Valley Reaches
- Planning Area 2: Fluvial Mainstem Reaches to Historic RR Xing
- Planning Area 3: Upper Mainstem, North Fork, and South Fork,
- Planning Area 4: Upper North Fork Reaches

Each of these Planning Areas is discussed in more detail in the following sections, with a brief description the proposed actions, a summary of the status of planning and design, and implementation strategies and proposed construction phasing. Each Planning Area will eventually encompass several phases of engineering design, regulatory compliance, and construction, with each "phase" of construction spanning one annual construction season. Each seasonal phase of construction will in turn entail numerous project actions and numerous different sites within the defined river reach or floodplain area. For example, the South Fork Elk River within the Stewardship Project Area extends from its confluence with the North Fork for approximately 10,000 ft upstream to the Tom's Gulch confluence. This Reach of the South Fork Elk River will have three phases of construction, implemented in three separate construction seasons, and implementing project actions at numerous different project sites.

Finally, this implementation framework should be considered preliminary and not static; it will remain subject to modification and revision as funding, landowner considerations, and other variables arise. As such, they are represented as "proposed" projects.

6.1 Planning Area 1: Tidal and Lower Valley Reaches

Reach Extents	Mainstem Sta. 7800 (US101) to Sta. 26000 (near Showers Road) Swain Sta. 7800 (US101) to Sta. 17500 (near Zanone Way)
PA1 Channel Lengths	Mainstem = 18,200 ft Swain = 9,700 ft = 27,900 ft (5.3 miles) total channel length
PA-1 Area	857 acres
# Landowners/Parcels	8/35
Construction Phases:	Phases 1-3
Total Sediment Remediation Volume in PA1	267,600 cu yds.

Planning Area Overview (Geographic Extent, Objectives)

Planning Area 1 (PA-1) encompasses the lower-most reaches of the Elk River mainstem at the downstream (north-westerly) end of the Elk River valley. This Planning Area (Figure 4-6) spans approximately 857 acres of former tidal and brackish wetlands, riparian forest, and prairie grasslands, and was historically interspersed with mixed conifer forest stands. The western edge of this Planning Area is bordered by US Highway 101, although this is an artificial boundary; there are additional tidal wetlands on the west side of US 101 owned by the City of Eureka that are hydraulically interconnected with Planning Area 1 but are transected by US 101. Those western-most tidal wetlands are concurrently undergoing restoration planning and design by the City of Eureka and are not part of the Stewardship Program Area.

PA1 is generally bounded to the south-west by the Elk River itself and to the north-east by Swain Slough and Elk River Road. The Elk River – Swain Slough confluence is at the very downstream end of PA1, just upstream of US 101 at Sta. 7800; PA1 extends up the sinuous Elk River to approximately Station 26000 at the Sea Mist Dairy (a total length of 18,200 ft or 3.4 miles). Martin Slough branches off Swain Slough but is not considered part of our Stewardship Area or Recovery Plan. The US 101 Bridge is the only bridge crossing of Elk River in this area; Elk River Road crosses Swain Slough near the downstream end of the slough, and again at Sta. 12500.

This Planning Area is hydraulically and hydrologically inter-connected and is characterized by broad and flat low-elevation marsh plains that are variably protected from tidal inundation by unmaintained earthen dikes, ditches, tide gates and other drainage infrastructure. Protected areas are used for cattle and dairy ranching. Exceptions to the otherwise typical agricultural land uses are the CDFW Wildlife Area, and several parcels at the northwesterly end of the valley in which unmaintained earthen dikes and drainage infrastructure are allowing tidal inundation and land conversion to salt marsh. Numerous rural residential properties are scattered along Elk River Road, generally on upland areas above the 12-15 ft MSL elevation contour. There are eight tide gates operate in this Area, several of which are dysfunctional. The abandoned Elk River railroad grade traverses the agricultural wetlands running up the valley parallel and to the west of Elk River Road.

The primary restoration actions proposed in this Planning Area include (a) maintaining and reconnecting the floodplain and marsh plains to Elk River and tidal slough channels, (b) enhancement of the tidal slough and creek drainage network, and off-channel ponds, to provide seasonally variable freshwater, brackish, and tidal aquatic habitat, (c) vegetation management, minor recontouring of the floodplain, and extension and expansion of Swain Slough further up the valley, to facilitate better flood-flow conveyance, and (d) eradication of non-native vegetation and replacement/enhancement of wetland and riparian vegetation with native plant and tree species. Habitat restoration and infrastructure improvements are proposed for the CDFW Elk River Wildlife Area. Several slough channel enhancements and ponds at the Wildlife Area, the extension of Swain Slough, and reconnection of an abandoned freshwater slough channel connected to Swain Slough will provide aquatic habitat benefits. Wetland and riparian vegetation enhancement, and non-native vegetation removal opportunities are included at numerous locations where landowners are supportive.

Current Status of Planning and Design

Conceptual designs are in development for this entire area, under two grants to CalTrout and our Project Team provided by the State Coastal Conservancy and Wildlife Conservation Board. The terms of these grants run through May 2023. This planning activity includes detailed baseline surveys and inventories of (a) ground topography and water management infrastructure, (b) wetland and upland jurisdictional determination, (c) vegetation types and presence of special status plants, (d) aquatic habitat, and (e) cultural resources assessment. Once baseline surveys are complete, the Project Team will advance the project toward a 10% engineering design level, expected to be completed in early 2023.

The next phases of planning and design for this Planning Area will entail:

- Continue landowner and stakeholder outreach and coordination through the Elk River Stewardship Program, with newsletters, individual meetings with landowners, and public meetings; develop landowner access and maintenance agreements.
- Complete any final baseline studies to fill-in data gaps.
    a. Obtain updated topographic and bathymetric surveys to update topographic surfaces used for analysis and design.
    b. Obtain surveys of federally protected fish, wildlife, and plant species (e.g., tidewater goby, Northern Spotted Owl (NSO), and Western Lily).
- Advance all reaches in PA1 to the 65% engineering and revegetation design level, with robust topographic and hydraulic detail, refined grading plans, aquatic habitat opportunities, and robust revegetation plans, to enable an analysis of the flood routing and habitat restoration benefits of the designs.
- Quantify temporary impacts and environmental benefits from project construction; prepare and submit the SWRCB Statewide Restoration General Order Notice of Intent (NOI) Application to the Regional Water Board for California Environmental Quality Act (CEQA) authorization and to initiate regulatory permit coverage.
    a. Prepare a Mitigation and Monitoring Plan as part of the NOI Application submittal.
- Submit a U.S Army Corps of Engineers (USACE) CWA Section 404 Individual Permit application and initiate Federal ESA Section 7 consultation with NOAA Fisheries to obtain a Biological Opinion for PA1.
    a. Prepare a joint Biological Assessment for three federal Endangered Species Act (ESA) threatened salmonid species and federal ESA endangered tidewater goby.
- Initiate wetland, riparian, and conifer plant propagation for initial project construction phases to begin revegetation implementation in advance of vegetation management and earthworks construction.
- Prepare bid documentation, solicit contractor bids, select contractors for earthworks and revegetation; then, in conjunction with contractors, advance the project designs and construction specifications to 100%.
- Initiate plant nursery cultivation to prepare revegetation materials at the scale needed for annual planting (including wetland, riparian, conifer vegetation)

Implementation Strategy and Construction Phases

This implementation framework proposes three phases of sediment remediation, habitat restoration (instream and riparian habitat), and vegetation management for Planning Area 1.Phase 1 will begin with habitat restoration, earthworks, and infrastructure modifications in the Elk River Wildlife Area and two contiguous private properties (Younger and Prior) that occupy the lowermost portion of the Elk River estuary; this includes the portion of the valley that borders US 101 and extends upstream along the Elk River Slough from US 101 (Sta. 7800) through the Wildlife Area (Sta. 15000) for a total stream reach of 7,200 ft. Actions in this phase include removal of berms, excavation of ponds, rehabilitation of slough channels and drainage network, temporary and/or permanent placement of fill, removal of relict infrastructure (buildings, culverts, pipelines, etc.), eradication of non-native vegetation (Spartina spp., Pampas grass, canary reed grass, etc.), and planting of native wetland and riparian vegetation.

Project Implementation would occur as follows:

<u>Year-1 Fall/Winter Vegetation Management (Nov – Mar)</u>

- identify "save" vegetation to be avoided and remove riparian vegetation at staging and access route locations (this is very minimal).
- plant ~10-15 acres of wetland, riparian, and conifer vegetation (well in excess of vegetation proposed for temporary or permanent removal), targeting planting locations away from the forthcoming construction season's channel and floodplain work.

<u>Year-1 Summer In-Channel Work (Jun – Oct)</u>

- Preserve eel grass and mudflat habitat in Elk River slough from any construction impacts.
- Enhance tidal marsh habitat in CDFW Wildlife Area:
  - Remove left bank levee along western property boundary and remove fill material in the interior of the Wildlife Area.
  - Remove non-native invasive vegetation from wetland surfaces (Spartina spp., Pampas Grass, others).
  - Increase the tidal prism by modifying infrastructure (levee, tide gates), rehabilitate slough channels and drainage network within the tidal marsh interior, excavate relic channel network, and remove artificial fill.
  - Excavate off-channel ponds.
  - Install fish-friendly tide gates to enable fish passage, allow a muted tidal prism into enhanced tidal marsh areas, and control tidal inundation of the enhancement area.
  - Improve levees along Elk River Slough to protect adjacent private agricultural lands.
  - Remove relict infrastructure (old buildings and agricultural appurtenances).
- Improve floodplain connectivity and drainage
  - Place sediment on designated floodplain sediment re-use sites and/or stockpile sediment in adjacent upland areas for subsequent phases of construction.
  - Install culvert under Pine Hill Road to allow improved drainage pathway.
  - Upgrade tide gates to improve fish passage and allow improved drainage pathway back to Elk River Slough.

Phase 2 will complete rehabilitation actions in the Elk River Wildlife Area and across the fluvial floodplain up the main portion of the valley. These actions include a second season of wetland and riparian vegetation planting, floodplain rehabilitation actions from the CDFW Wildlife Area through MSR 2 (Sta. 15000 to 26000), including placement and recontouring of sediment fill material and development of drainage swales connected to the Wildlife Area. There are additional riparian vegetation planting areas along the mainstem Elk River downstream of the Sea Mist Dairy.

<u>Year-2 Fall/Winter Vegetation Management (Nov – Mar)</u>

- Plant native riparian hardwood and conifer vegetation in selected areas along the Elk River mainstem.

<u>Year-2 Summer In-Channel Work (Jun – Oct)</u>

- Conduct vegetation management in the mainstem Elk River.
- Remove non-native invasive vegetation from wetland surfaces (Spartina spp., Pampas Grass, others).
- Place fill in select floodplain areas to create connected flow-paths for aquatic species and improved agricultural productivity.
- Develop swales with defined flood flow paths to reduce potential for fish stranding and increase flow connectivity.

- Modify natural and man-made levees along the Elk River right bank Showers Road to enable flood flow into constructed floodplain swales.
- Modify drainage infrastructure to create fish friendly exchanges between floodplain, main channel, and slough channels.
- Install sediment management feature at left bank tributary near MSR 2/3 boundary.

Phase 3 will focus on the Swain Slough extension and rehabilitation, to provide high quality salmonid rearing habitat and to improve flood and tidal water connection to floodplains. This phase has the largest volume of sediment remediation in this Planning Area; sediment will be excavated from the existing Swain Slough, and from the new segment extension above Elk River Road. Several tide gates on Swain Slough will be upgraded to improve juvenile fish passage.

Year-3 Summer In-Channel Work (Jun – Oct)

- Enhance tidal marsh along the lower portion of Swain Slough:
  - Acquire properties and/or conservation easements with willing landowners.
  - Improve levees along Swain Slough to protect adjacent productive agricultural lands.
  - Modify existing tide gate on Swain Slough/Elk River Road Crossing #1 to allow a muted tidal prism into the restored Swain Slough channel.
  - Extend and deepen Swain Slough through a relic channel along Elk River Road.
  - Modify the existing Swain Slough/Elk River Road Crossing #2 to improve upstream habitat, limit tidal inundation, and enable fish passage into off-channel freshwater habitat.
  - Install new crossings for ranch access.
- Modify drainage infrastructure along Swain Slough.
- Add bridges over Swain Slough on private properties for agricultural uses.
- Remove elevated portions of railroad grade to create connected flow paths.
- Reconnect tributary streamflow into the upstream end of restored Swain Slough.

6.2 Planning Area 2: Fluvial Mainstem Reaches to Historic RR Xing

Reach Extents	Mainstem Sta. 26000 (Showers Road) to Sta. 39200 (Shaw Gulch) Mainstem Sta. 39200 (Shaw Gulch) to Sta. 53000 (ERRR Xing)
PA2 Channel Lengths	Mainstem = 13,200 ft (2.5 mi) Mainstem = 13,800 ft (2.61 mi) = 27,000 ft (5.11 miles) total channel length
PA1 Floodplain Area	556 acres
# Landowners/Parcels	20/27
Construction Phases:	Phases 1-3
Total Sediment Remediation Volume in PA2	135,600 cu yds

Planning Area Overview (Geographic Extent, Objectives)

Planning Area 2 encompasses the majority of the fluvial mainstem Elk River, from the sharp meander bend near Showers Road (Sta. 26000) upstream to the Historic RR Xing (Sta. 53000) just below the confluence of the North and South Forks, a mainstem length of approximately 5.11 miles. (Figure 4-7) The upstream-most 8,600 ft (1.6 mi) of mainstem reach meanders through the "redwood plantation" in MSR-5 before the channel opens into the Elk River Valley, then runs another 3.5 miles through several large tracts of ranching and dairy lands. At the head of the valley below the redwood plantation is the Elk River Court residential subdivision, composed of 17 residential parcels. There is one landowner in the MSR 5 redwood plantation reach, and 8 landowners occupying the ranching lands down the valley. Three bridges cross the Elk River along these 5 miles – at Elk River Court, Zanes Road, and

Berta Road. An unnamed tributary in the redwood plantation reach and Shaw Gulch upstream of Zanes Road are the two primary tributaries in this Planning Area

There are two primary treatment approaches along the fluvial mainstem reaches: in the upper 2.76 miles of the mainstem downstream to Shaw Gulch the proposed actions include sediment remediation to widen the channel and deepen pools, and vegetation management to clear undesirable vegetation rooted in the channel bed. Additionally, riparian revegetation and large wood placement for habitat enhancement are proposed within the redwood plantation reach. In the lower 2.5 miles from Shaw Gulch to Showers Road, vegetation management is the primary action, with some riparian planting proposed near Berta Road. A sediment management feature is proposed at the confluence of Shaw Gulch and the unnamed tributary to reduce sediment inputs from tributaries; off-channel salmonid rearing habitat will be incorporated into the design of these feature, primarily for winter rearing habitat refugia.

Current Status of Planning and Design

The initial phases of planning and design in this Planning Area conducted through the Stewardship program, resulted in the proposed actions described here and in Section 4.2. The next phase of planning and design will initiate in 2022 under a planning grant awarded to CalTrout and our Project Team from the National Fish and Wildlife Foundation (NFWF) National Coastal Resilience Program (NCRP). This planning phase will conduct baseline studies, including (a) survey of channel and floodplain topography and major infrastructure features, (b) riparian vegetation and aquatic habitat mapping, (c) geomorphic and soils assessments, and (d) cultural resources surveys. This information will provide the basis for advancing the proposed actions to a 10% engineering design level. This phase of planning will also assess regulatory constraints and conduct outreach to landowners to begin developing agreements for access and maintenance related to project implementation.

In addition to the design process initiated under the NFWF grant, the private landowner in MSR 5 is considering developing a Non-Industrial Timber Management Plan (NTMP) for the redwood plantation. This planning process would be conducted independently of (i.e., not funded by) the remediation and rehabilitation design process and would provide a CEQA-equivalent level of environmental analysis for timber harvesting within the redwood plantation. The NTMP is the appropriate permitting process for long-term forestry management of the redwood plantation. Timber harvesting within the plantation may eventually create areas suitable for replanting in streamside riparian vegetation that would improve the overall forest and aquatic ecosystems within Planning Area 2. As described in Section 4.2, active management of the redwood plantation is viewed as necessary to reduce floodplain roughness and improve movement of flood flows through this reach. Similarly, there is opportunity for improving riparian habitat and recruiting large wood over time.

Following completion of the NFWF NCRP conceptual design phase, subsequent phases of planning and design for PA2 will include the following steps:

- Continue landowner and stakeholder outreach and coordination through the Elk River Stewardship Program, with newsletters, individual meetings with landowners, and public meetings; develop landowner access and maintenance agreements.
- Complete any final baseline studies to fill-in minor data gaps.
- Advance all reaches in PA2 to the 65% engineering and revegetation design level, with robust topographic and hydraulic detail, refined grading plan, aquatic habitat opportunities, and robust revegetation plan, to enable an analysis of the flood reduction and habitat restoration benefits of the design.

- Quantify temporary impacts and environmental benefits from project construction; prepare and submit the SWRCB Statewide Restoration General Order NOI Application to the Regional Water Board for CEQA authorization and to initiate regulatory permit coverage.
    a. Prepare a Mitigation and Monitoring Plan as part of the NOI Application submittal.
- Submit a USACE CWA Section 404 Individual Permit application and initiate Federal ESA Section 7 consultation with NOAA Fisheries to obtain a Biological Opinion for PA1.
    a. Prepare a joint Biological Assessment for three federal ESA threatened salmonid species and federal ESA endangered tidewater goby.
- Initiate wetland, riparian, and conifer plant propagation for initial project construction phases, to begin revegetation implementation in advance of vegetation management and earthworks construction.
- Prepare bid documentation, solicit contractor bids, select contractors for earthworks and revegetation; then, in conjunction with contractors, advance the project designs and construction specifications to 100%.

Implementation Strategy and Construction Phases

<u>Year-1 Fall/Winter Vegetation Management (Nov – Mar)</u>

Beginning in Fall:

- Remove non-native invasive vegetation from floodplain (English Ivy, Himalaya blackberry, other) within the project area.
- Clear vegetation at staging and access route locations.
- Plant 10-15 acres of wetland, riparian, and conifer vegetation along the PA2 mainstem reaches, to achieve a much higher ratio of planted vegetation relative to vegetation removal; early phases of revegetation should target planting locations away from subsequent channel and floodplain work; later stages of vegetation will revegetate temporary impact areas.

<u>Year-1 Summer Floodplain Sediment Remediation (Jun – Oct)</u>

Beginning in Summer:

- Implement fish removal and relocation, and channel dewatering steps according to stepwise plans described in the Regulatory Compliance Strategy (Section 7.6).
- Once a Notice to Proceed is provided, equipment operation can begin clearing and grubbing to remove rooted vegetation from in-channel, channel banks, and floodplain areas.
    - fish removal, channel dewatering (pump and gravity system), and in-channel vegetation removal are integrated and iterative; this phase will require several weeks to complete as outlined in the Regulatory Compliance Strategy (Section 6.6)
- Conduct in-channel sediment remediation, working with mechanical equipment in-channel and along channel banks, utilizing designated access and staging areas, proceeding from upstream to downstream, covering approximately 5,000 ft (0.95 mi) of channel (from RR Xing at Sta. 53000 toSta. 48000), excavating and removing sediment, and hauling to sediment re-use areas.
    - in-channel vegetation removal
    - sediment remediation from channel banks, floodplain features, pool enlargement
- Install large wood structures to enhance in-channel salmonid rearing habit.
- Install and implement erosion control measures, in conjunction with removal of water bypass and fish exclusion system and the return of bypassed streamflow to the restored channel.
    - temporary pumping of turbid water may be necessary to reduce sediment discharge into downstream reaches.

<u>Year-2 Fall/Winter Vegetation Management (Nov – Mar)</u>
Beginning in Fall:

- Plant 10-15 acres of riparian vegetation in floodplain swales and at Berta Road area

<u>Year-2 Summer In-Channel Sediment Remediation (Sta 53000 to 48400)</u>
Beginning in Summer:

- Remove and relocate fish; dewater channel.
- Clearing and grubbing to remove rooted vegetation from channel; target approximately 4,600 ft per year.
    - Fish removal, channel dewatering (pump and gravity system), and in-channel vegetation removal are integrated and iterative; takes about 3-4 weeks to complete as outlined in Section 6.6.
- Conduct in-channel sediment remediation, working from upstream to downstream, covering approximately 4,000 ft of channel (from Sta. 48000 next to Elk River Road to Sta. 44000 below Elk River Court).
    - in-channel vegetation removal
    - sediment remediation from channel banks, pool enlargement
    - haul sediment to fill sites
    - install large wood structures
    - install erosion control measures

<u>Year-3 Fall/Winter Vegetation Management (Nov – Mar)</u>
Beginning in Fall:

- plant 10-15 acres of riparian vegetation in floodplain swales and along channel riparian zones,
- conduct vegetation management from Shaw Gulch downstream to Showers Road
- transport and dispose of vegetation waste, or chip and spread on floodplains as soil amendment

<u>Year-3 Summer In-Channel Sediment Remediation (Sta 48400 to 43800)</u>

- Conduct in-channel sediment remediation, working from upstream to downstream, covering approximately 4,800 ft of channel (from Sta. 44000 below Elk River Court (ERC) to Sta. 39200 at Shaw Gulch);
- Fill ranching roads to adjacent floodplain levels to reduce risk of fish entrapment during high winter flows

6.3 Planning Area 3: North Fork, South Fork, and Upper Mainstem Elk River

Reach Extents	Mainstem Sta. 53000 (at RR Xing) to Sta. 56000 (at NF/SF confluence) SFR: Sta. 56000 to 66000; NFR: Sta. 56000 to 62000;
PA3 Channel Lengths	MSR= 3,000 ft; SFR= 10,000 ft; NFR= 6,000 ft = 19,000 ft (3.60 miles) total channel length
PA3 Floodplain Area	288 acres
# Landowners/Parcels	12/13
Construction Phases:	Phases 1-6
Total Sediment Remediation Volume in PA3	160,800 cu yds
o Mainstem	57,600
o North Fork	43,200
o South Fork	60,000

Planning Area Overview (Geographic Extent, Objectives)

Planning Area 3 encompasses approximately 18,200 ft (3.4 mi) of stream channel, and roughly 100 acres of surrounding floodplain and riparian forest, including the lower 6,000 ft of the North Fork, the lower 10,000 ft of the

South Fork, and the uppermost 3,000 ft of the mainstem Elk River downstream to approximately the abandoned Elk River RR Xing. This portion of the mainstem is included in this Planning Area along with the North and South Forks because it exerts a strong hydraulic control causing backwatering upstream into the two Forks during flood events. This entire Planning Area (Figure 4-8) is thus hydraulically linked with hydraulic constrictions that underly the nuisance flooding problems in this area and upstream in the Elk River forks. These reaches also have in common a similarly entrenched and confined channel morphology, are surrounded by rural-residential homes, and have been the primary focal area of regulatory efforts intended to remediate excessive sedimentation and nuisance flooding conditions. Addressing impaired sediment and flooding conditions in Planning Area 3 is a high priority. Addressing these concerns will require that these proposed enhancement and restoration actions be augmented with health and safety actions, as well (e.g., reliable water supply, public road and bridge retrofits, and private infrastructure retrofits).

Elk River reaches in Planning Area 3 (PA3) are accessed from Elk River Road and Wrigley Road, and four bridges – Steel Bridge on the mainstem, North Fork bridge on Elk River Road, a private residential bridge on the South Fork, and a private bridge on the Save the Redwoods League (SRL) property. One tributary (Tom's Gulch) enters the South Fork just below the BLM Headwaters Reserve boundary; two tributaries (Railroad Gulch and Clapp Gulch) enter the mainstem just downstream of the confluence of the Forks. There are 12 landowners and 13 residential parcels in PA3, with nearly all landowners supportive of the proposed remediation and flood-reduction actions described here.

The primary proposed restoration actions in this PA3 are sediment remediation and vegetation management – i.e., widening the channel and deepening pools to reduce the volume of stored sediment, and removing native and non-native invasive vegetation from the channel, both of which are intended to increase channel conveyance capacity and reduce nuisance flooding. In suitable locations, sediment should be excavated from pools and large wood structures should be constructed to improve juvenile salmonid rearing habitat. Several floodplain benches and off-channel habitat features are proposed on parcels with willing landowners. Where feasible, the streamside riparian habitat should be expanded and/or planted with more diverse and dense vegetation to offset the vegetation removed from within the channel. There is considerable habitat rehabilitation opportunity on the South Fork Elk River, mainly on Save the Redwoods League property where land uses are focused primarily on habitat enhancement.

Current Status of Planning and Design

Conceptual designs have been developed to approximately the 10% design level for the majority of Planning Area 3, with some reaches advanced to 65% engineering designs, and some gaps on the North Fork spanning several landowner parcels. The next phases of planning and design for PA3 will include the following steps:

- Continue landowner and stakeholder outreach and coordination through the Elk River Stewardship Program, with newsletters, individual meetings with landowners, and public meetings; develop landowner access and maintenance agreements.
- Conduct baseline studies to fill-in data gaps.
- Advance all reaches in PA3 to the 65% engineering and revegetation design level, with robust topographic and hydraulic detail, refined grading plan, aquatic habitat opportunities, and robust revegetation plan, to enable an analysis of the flood reduction and habitat restoration benefits of the design.
- Quantify temporary impacts and environmental benefits from project construction; prepare and submit the SWRCB Statewide Restoration General Order NOI Application to the Regional Water Board for CEQA authorization and to initiate regulatory permit coverage.

  a. Prepare a Mitigation and Monitoring Plan as part of the NOI Application submittal.

- Submit a USACE CWA Section 404 Individual Permit application and initiate Federal ESA Section 7 consultation with NOAA Fisheries to obtain a Biological Opinion for PA1.
  a. Prepare a joint Biological Assessment for three federal ESA threatened salmonid species and federal ESA endangered tidewater goby.
- Initiate wetland, riparian, and conifer plant propagation for initial project construction phases, to begin revegetation implementation in advance of vegetation management and earthworks construction.
- Prepare bid documentation, solicit contractor bids, select contractors for earthworks and revegetation; then, in conjunction with contractors, advance the project designs and construction specifications to 100%.

Implementation Strategy and Construction Phases

This implementation framework proposes six phases of annual sediment remediation and habitat rehabilitation for PA3, with each phase encompassing treatment of approximately 3,000 linear feet of stream channel, an annual average of approximately 10 acres of riparian and floodplain habitat, and approximately 20-30,000 cubic yards sediment remediation per each annual phase. These implementation actions will result in annual construction costs of approximately $2-3 million; with additional permitting, engineering design, and monitoring costs of another $0.65 million. More refined cost estimates will be available once project designs are advanced to the 65% engineering design level.

Annual construction phases would be implemented in a similar sequence of annual revegetation and earthworks construction, as follows:

Year-1 Fall/Winter Vegetation Management (Nov – Mar)

- remove non-native invasive vegetation from floodplain (English Ivy, Himalaya Blackberry, other)
- identify "save" vegetation to be avoided during summer construction.
- remove otherwise unavoidable riparian vegetation at staging and access route locations.
- plant 10-15 acres of wetland, riparian, and conifer vegetation, to achieve a much higher ratio of planted vegetation relative to vegetation removal; early phases of revegetation should target planting locations away from subsequent channel and floodplain work; later stages of vegetation will revegetate temporary impact areas.

Year-1 Summer In-Channel Work (Jun – Oct)

- implement fish removal and relocation, and channel dewatering steps according to stepwise plans described in the Regulatory Compliance Strategy (Section 7 below)
- once a Notice to Proceed is provided, equipment operation can begin clearing and grubbing to remove rooted vegetation from in-channel, channel banks, and floodplain areas.
  - fish removal, channel dewatering (pump and gravity system), and in-channel vegetation removal are integrated and iterative; this phase will require several weeks to complete as outlined in the Regulatory Compliance Strategy (Section 7)
- conduct in-channel sediment remediation, working with mechanical equipment in-channel and along channel banks, utilizing designated access and staging areas, proceeding from upstream to downstream, excavating and removing sediment, and hauling to sediment re-use areas
  - in-channel vegetation removal
  - sediment remediation from channel banks, floodplain features, pool enlargement
- install large wood structures to enhance in-channel salmonid rearing habit.

- install and implement erosion control measures, in conjunction with removal of water bypass and fish exclusion system and the return of bypassed streamflow to the restored channel;
  - temporary pumping of turbid water may be necessary to reduce sediment discharge into downstream reaches.

With an annual stepwise sequence of revegetation, vegetation management, and sediment remediation, this process will be repeated following a similar sequence for six consecutive annual treatments. The following sequence of reaches is proposed based on the high priority need to implement advance revegetation to offset subsequent temporary vegetation impacts:
[note: the following sequence of phased implementation may be revised at the 65% design level pending input from landowners, engineers, regulatory agencies, and construction/revegetation contractors and with cost considerations]:

Year-1: South Fork Upper Reach on Save the Redwoods (Sta. 64500 to 61300)
Year-2: South Fork Middle Reach (Sta. 61300 to 58300)
Year 3: North Fork Upper Flood Curve (Sta 59000 to 56000)
Year 4: South Fork Lower Reach (Sta. 58500 to 56000; 66000 to 64500)
Year 5: North Fork Upper Reach (Sta. 62000 to 59000)
Year 6: Mainstem down to RR Railroad Crossing (Sta. 56000 to 53000)

6.4 Program Cost Estimate

Because of the complexity and extent of measures needed to achieve the Recovery Plan goals, a substantial investment of public and private restoration funds will be required to accomplish the proposed sediment remediation and habitat rehabilitation. The means to implement the Recovery Plan will be achieved by working with a variety of funding agencies, resource agency partners, and experts in implementation planning, design, and construction.

Given this program is in the very early stages of engineering design and construction planning, we can only provide very provisional cost estimates for planning and design, construction, and monitoring, with broad contingencies associated with these program phases. We provide a Program cost estimate based primarily on sediment excavation volumes, which is the highest cost-driver in this project, with planning, design, and monitoring costs based on recent experienced by our planning team. Table 6-1 provides the estimated project cost.

Table 6-1. Estimates costs for the Elk River Stewardship Project. Project implementation includes project management and administration, public outreach and communications, all necessary baseline studies, engineering design and regulatory compliance, construction and revegetation, and monitoring. Costs are in FY22 dollars and not inflated for future years' construction. Total costs are estimated at $92 per cubic yard of sediment remediation for each Planning Area.

Stewardship Program Communications	$534,000
Design Data Collection	$640,000
Project Management and Administration	$1,816,000
Engineering and Revegetation Design, Permitting, and Construction Management	$8,814,000
Earthworks Construction and Revegetation	$29,343,000
Contingency (30% of Construction Costs)	$8,716,000
Compliance and Performance Monitoring	$2,419,000
TOTAL PROJECT COST	**$52,300,000**

6.5 Project Construction Schedule

The Elk River Recovery Program will be implemented in multiple phases over the course of 8-10 years (depending on various contingencies), commencing in 2024. In general, each Planning Area will require funding for all phases of project development including engineering and revegetation design, regulatory compliance, construction, and monitoring.

Each project phase will focus on enhancement and restoration actions within a specific river reach along single or multiple property ownerships. Most construction activities will occur within the regulated in-water construction season, typically June 15 through October 15, i.e., during late summer and fall when streamflows are at their annual minimum. The presence of nesting birds in the project area may delay the initiation of construction until after the nesting season on approximately August 1. If no rain is forecast, construction activities may be extended through October 31 with regulatory agency authorization. If the stream is flowing at the time of construction, the construction reach will be hydrologically isolated and dewatered in accordance with regulatory requirements. Equipment will work from the streambank and within the dewatered channel. Some pre-construction or maintenance activities outside the wetted channel may take place outside the construction season; for example, tree removals may take place prior to the bird nesting season to preclude nesting.

Table 6-2. Preliminary schedule for engineering design and regulatory compliance, project construction, and monitoring for each Planning Area. This schedule is dependent on availability of funding from State and Federal programs.

Proposed Design and Construction Schedule				2023				2024				2025				2026				2027				2028				2029				2030				2031			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Planning Area 1 Engineering Design and Construction																																							
Funding Proposal and Contracting		■	■	■	■																																		
Engineering Design to 10% (SCC and WCB Funding)	■	■	■	■	■																																		
Engineering Design to 65%					■	■	■	■	■	■																													
Revegetation Design					■	■	■	■	■	■																													
Regulatory Compliance					■	■	■	■	■	■																													
Engineering Final Design and Constuction Documents										■	■	■	■				■				■				■														
Construction Management													■	■			■	■			■	■			■	■													
Construction and Revegetation (3-Year Phased Implementation)													■	■			■	■			■	■			■	■													
As-Built Monitoring															■				■				■				■												
Planning Area 2 Engineering Design and Construction																																							
Funding Proposal and Contracting												■	■	■	■	■																							
Prepare NTMP and Conservation Easements					■	■	■	■	■																														
Phase I Timber Harvest										■	■																												
Engineering Design to 10% (NFWF Funding)		■	■	■	■	■	■	■	■	■	■																												
Engineering Design to 65%																	■	■	■	■																			
Revegetation Design																	■	■	■	■																			
Regulatory Compliance																				■	■	■	■																
Engineering Final Design and Constuction Documents																					■	■	■	■					■				■				■		
Construction Management																													■	■			■	■			■	■	
Construction and Revegetation (3-Year Phased Implementation)																													■	■			■	■			■	■	
As-Built Monitoring																															■				■				■
Planning Area 3 Engineering Design and Construction																																							
Funding Proposal and Contracting		■	■	■	■																																		
Engineering Design to 10%																																							
Engineering Design to 65%					■	■	■	■	■	■																													
Revegetation Design					■	■	■	■	■	■																													
Regulatory Compliance					■	■	■	■	■	■																													
Engineering Final Design and Constuction Documents										■	■	■	■				■				■				■				■				■						
Construction Management													■	■			■	■			■	■			■	■			■	■			■	■					
Construction and Revegetation (6-Year Phased Implementation)													■	■			■	■			■	■			■	■			■	■			■	■					
As-Built Monitoring															■				■				■				■				■				■				

6.6 Implementation Methods and Approach

Project Site Safety Plans, Access, Staging Areas, and Utilities

All project and construction activities will maintain health and safety standards. The project will be designed by licensed engineers and constructed by general contractors licensed in CA, with independent construction oversight. Contractors and subcontractors will follow all applicable Best Management Practices (BMPs) and safety procedures contained within Cal-OSHA or other standard protocols.

The Project areas will be accessed via Elk River Road, Pine Hills Road, Showers Road, Berta Road, Zanes Road, Elk River Court, Wrigley Road, several unimproved private roads, and participating private properties. No new permanent access roads are anticipated to be constructed to implement the Project.

Temporary disturbance would occur at pre-designated staging areas within the project area for each project phase. Construction equipment, materials, and removed vegetation will be stockpiled in designated staging locations. Staging areas will not be located in or near wetlands or other sensitive habitats areas and will implement best management practices (BMPs) to prevent construction materials, fuels and equipment supplies, and other hazardous materials from impacting the environment. Following construction of each project phase, associated staging area will be restored to pre-construction conditions.

Existing utilities would be identified throughout the design process and marked out prior to construction. Existing utilities would be protected in place or relocated if necessary.

Fish Relocation and Water Management

Prior to the initiation of earthworks and excavation activities in the stream channel, all fish, amphibians, and reptiles will be captured and relocated to similar habitat outside of the project area. The stream channel will then be dewatered with a water bypass system. Dewatering will utilize temporary coffer dams, storage tanks, hoses and pipelines, diesel and electrical pumps, and/or other similar equipment. Fish and wildlife removal and relocation will occur by qualified biologists following requirements from the California Department of Fish and Wildlife (CDFW) and the National Marine Fisheries Service (NMFS), according to the following general steps:

1. Conduct pre-construction fish surveys
2. Install fish screens at upstream and downstream ends of reaches to be dewatered
3. Deploy minnow traps to live-trap fish until few or no fish are captured
4. Remove small (<4 inch diameter and 6 ft long) in-channel wood pieces to simplify channel and facilitate seine netting
5. Seine and electrofish through the reach, working downstream to upstream, until few or no more fish are captured
6. Install cofferdams and water bypass system
7. Decrease streamflow
8. Seine and net remaining fish and amphibians within reduced streamflow volume
9. Electrofish remaining fish and amphibians with reduced pool volume (if needed)
10. Bypass entire streamflow to dewater the reach, remove any remaining fish and amphibians
11. Provide documentation on fish species and abundance, estimated mortality, and fish relocation sites to relevant permitting agencies.

Fish will be transported in aerated buckets, relocated within a short distance of the project site, and distributed across numerous high-quality habitat sites to avoid overcrowding the destination habitat. Temporary water supplies will need to be provided to residents who rely on Elk River for domestic water supplies in reaches where stream channels are temporarily dewatered for construction.

Exclusion Areas and Erosion Control

Prior to construction, any exclusion areas to protect delineated wetlands, Environmentally Sensitive Habitat Areas, or Sensitive Natural Communities would be identified and protected by the construction contractor according to the final engineering design and permitting plans. To minimize erosion, sediment, and pollutant contribution to the Elk River watershed, BMPs will be instituted, including:

- Construction would occur during the summer low-flow season (June 15-October 15) when the chance of precipitation is lowest and Elk River instream flows are at their annual minimum.
- Construction equipment would be cleaned and inspected prior to use. Equipment maintenance and fueling would be done at designated staging areas and away from the Elk River or any delineated wetlands.
- On-site stockpiles would be isolated with silt fence, filter fabric, and/or straw bales/fiber rolls, following standard BMPs.
- Silt fence or fiber rolls would be placed to contain loose rolling rocks and sediment. Silt fence/fiber rolls would be kept in place and maintained during the entire Project. Any sediment caught by the fence or rolls would be removed before the fence/rolls are pulled.
- Ground disturbed by construction work would be revegetated with fast-growing native grasses and sterile hybrids and mulched when work is complete.
- The site would be monitored by Project personnel during winter rains and any evidence of erosion (rilling, gullies, etc.) would be repaired immediately. In addition, areas where revegetation is not successful would be reseeded and remulched to ensure vegetative ground cover.

Vegetation Management (Clearing and Grubbing, Vegetation Removal)

Vegetation removal will occur in many locations throughout the Project Area. To minimize potential impacts to birds, vegetation will be removed prior to March 15 whenever feasible, or after August 15 to avoid the nesting bird season. If vegetation removal or ground disturbance cannot be confined to work outside of the nesting season, a qualified ornithologist would conduct pre-construction surveys within the vicinity of the project area, to check for nesting activity of native birds and to evaluate the site for presence of raptors and special-status bird species. If active nests were detected within the construction footprint or within the construction buffer established by the Project biologist, the biologist would flag a buffer around each nest in consultation with the appropriate permitting agency (CDFW or USFWS).

Tree stumps and trunks will be left on reconstructed floodplains and streambanks to provide structure for wildlife habitat, or else placed instream as fish habitat structures. Tree and shrub foliage will be chipped and ground on-site to be re-used as mulch, or spread on exposed dirt surface to aid in erosion control.

Nonnative weeds are distributed throughout the project area. The prevalence of English ivy and Himalayan blackberry within the existing riparian corridor will require various management strategies to control, reduce, and remove them. To the extent possible, nonnative management activities will be aligned with each implementation phase to minimize the impact on native vegetation. Development of a nonnative weed management strategy will review access for mechanized equipment and constraints such as onsite or offsite disposal mechanisms, availability and approval for chemical herbicide application, and the potential for phased management. BMPs to reduce the spread of nonnatives during implementation will be included in the nonnative weed management strategy.

Potential actions to manage nonnative vegetation in upland areas prior to construction will also be assessed to identify the most impactful strategy to reduce nonnative weed seed sources into the lower riparian area during project implementation.

Channel Modification (Sediment Excavation and Re-Use, Habitat Features)

Equipment required for construction will include tracked excavators, backhoes, graders, bulldozers, dump trucks, water trucks, skid steers, and pick-up trucks. In addition, small equipment such as generators, small water pumps, chainsaws, and wood and brush chippers and grinders will be used.

Excess soils and construction materials will be stored within designated staging areas prior to on-site placement for beneficial reuse within the Project Area. Excess materials will not be stockpiled on-site once the Project is complete. If on-site beneficial re-use is not feasible, the contractor will haul additional excess materials off site for beneficial re-use, recycling, or legal disposal.

All construction activities will be accompanied by both temporary and permanent erosion and sediment control BMPs. Project construction will include the following activities:

- Clearing and grubbing to clear vegetation and brush from Project work areas and to construct Project features;
- Grading throughout the project area;
- Excavation throughout the project area to remove and place material, upgrade infrastructure, complete in-channel and channel adjacent construction, modify floodplain surfaces, and place large wood;
- Hauling to transport sediments and materials;
- Revegetation of temporary and permanently impacted areas;
- Installation of erosion control measures.

Following construction, coffer dams and other structures used during dewatering will be removed and the temporary diversion site remediated to pre-project conditions.

Erosion prevention, sediment control, and final stabilization

After completion of all seasonal construction elements, all non-bedrock bare soil areas will be seeded and mulched with certified weed free straw mulch. Labor crews will apply a native seed mix prior to mulching bare soil areas with straw. Native seed will be applied at 50 lbs/acre or at the application rate listed by the manufacturer. Straw mulch will be applied at a rate of 4,000 lbs/acre, so as to observe no bare soil. If deemed necessary by the project engineer or construction manager, straw wattles, jute netting or other secondary surface erosion control measures may be used to prevent rill and gully erosion. Seed and mulch will not be applied on exposed bedrock. To achieve long term, permanent site stabilization, revegetation will occur as designed for each project phase.

Revegetation

This program aims to achieve a considerable increase in net area of shrub, riparian hardwood, and conifer vegetation throughout the Elk River project area. However, to accomplish other primary project objectives related to sediment remediation and instream habitat rehabilitation, some vegetation removal will be required to provide construction equipment access, and/or to convert vegetation patches to more desirable and valuable vegetative habitat types. A major component of ecologically beneficial project actions is therefore re-planting of native vegetation within the project area, both to offset and mitigate for unavoidable vegetation removal as well as for its inherent value as wetland, riparian, and forest habitat.

Riparian planting will occur in late-summer and fall (Sept 15 – Dec 1), once earthworks construction and site remediation phases are complete, and when the need for irrigation for plant survival is minimal. Field crews experienced with plant installation will conduct all tree and shrub planting, using small equipment (augurs) and hand tools. Ground surfaces within revegetated areas will be grass seeded and mulched with straw or other materials as appropriate. Fencing and/or other plant browse protection will be installed where needed, to prevent domestic animals or wildlife from damaging planted plants.

Signs and Interpretive Aids

To enhance community outreach efforts, the project will include installation of interpretive signage where feasible, to describe the project goals and objectives, targeted species and habitats, and beneficial outcomes. Signage will include research, development of layout, final designs and fabrication, preparation and coordination of materials, and installation of signs in strategic locations. Aluminum signs with vinyl display graphics, pedestals, and other mechanisms to enhance displays, will be used. Signage will include funder and landowner acknowledgments where appropriate.

7 Regulatory Compliance Strategy

To successfully implement a restoration program of the scale proposed for the Elk River, an effective and transparent regulatory compliance strategy is needed. The Stewardship Program will be required to comply with all applicable federal, state, and local regulatory statutes as summarized in Table 7-1, as well as CEQA (the CA Environmental Quality Act). If federal implementation funds are obtained, NEPA (the National Environmental Policy Act) compliance would also be required. In addition, the project must comply with Federal and State Endangered Species Acts (ESA) for fish, wildlife, and plant species that have ESA protection. CEQA and NEPA compliance, preparation of documentation for ESA consultation, and processing of regulatory permit applications all require an extensive amount of information describing the project Actions, the intended benefits, and the temporary, permanent, and cumulative impacts that result from the project Actions. In addition, these compliance steps may require several years to complete before implementation is authorized. Finally, the private landowners in Elk River will have to participate in this complex regulatory process in order for the Program to receive authorization to implement these Actions with public funding on their private properties.

The Stewardship Program has sought to consult with federal, state, and local resource agency staff (agency partners) early in this process in order to fully describe the Program, seek their input on a comprehensive regulatory strategy that they support, and then document that strategy so that our agency partners are all in agreement early on and each agency is aware of the other agencies' authorization process. This report Section is thus intended to describe the steps we've taken to consult with our agency partners, document their guidance and recommendations, and then articulate a comprehensive regulatory strategy. Finally, this Regulatory Strategy was developed with consideration of the Implementation Framework presented in Section 6 of this Report as well as our understanding of state and federal funding sources. The regulatory strategy, implementation strategy, and funding sources will have to be integrated for this Program to be successful.

As described in Section 6, the program has been partitioned into four Planning Areas (Figure 2-2) in part to facilitate the fund-raising and engineering design activities at a manageable scale, but also to accommodate our regulatory strategy. The Planning Areas described above are thus an appropriate scale to accommodate fund-raising, engineering design and construction planning, as well as our proposed regulatory compliance strategy. The following sections describe this Strategy.

Table 7-1. Permits and regulatory requirements applicable to the Elk River Stewardship Program.

Regulatory Agency	Law/Regulation	Purpose	Permit/Authorization Type
United States Army Corps of Engineers (USACE)	Clean Water Act (CWA) Section 404	Regulates placement of dredged and fill materials into waters of the United States.	Individual Permit
	Rivers and Harbors Act Section 10	Regulates work in navigable waters of the United States.	Section 10 Compliance
US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS)	Federal Endangered Species Act (FESA)	Requires USACE to consult with USFWS and NMFS if federally threatened or endangered species may be affected by the project.	Biological Opinion issues in conjunction with USACE Section 404 compliance
California Coastal Commission (CCC)	Coastal Act	Regulates development within the Coastal Zone.	Consolidated Coastal Development Permit
North Coast Regional Water Quality Control Board (RWB)	CWA Section 401	Regulates the placement of materials into or work performed within waters of the United States.	401 Water Quality Certification is required for federal permits. [Issued through the State Restoration General Order] or an Individual 401 WQC, depending on project type.
California Department of Fish and Wildlife (CDFW)	Fish and Game Code (F&G Code) Section 1600	Regulates activities that will substantially modify a river, stream, or lake.	A Master Lake and Streambed Alteration Agreement (Master LSAA)/ Restoration Management Permit
	California Endangered Species Act (CESA) (F&G Code Section 2081[b])	Requires avoidance, minimization, or mitigation for take (harm, mortality, etc.) of state-listed species.	To be included in the Master LSAA/Restoration Management Permit
State Lands Commission (SLC)	Divisions 6, 7, 7.5, 7.7, 7.8, and 36 of the Public Resources Code and Government Code	Regulates activities on public trust lands within the jurisdiction of the State Lands Commission.	Lease or permit. Note may be issued by the Humboldt Bay Harbor, Recreation, and Conservation District pending project location.
State Historic Preservation Officer (SHPO)	National Historic Preservation Act (NHPA) Section 106	USACE must consult with State Historic Preservation Officer if historic properties or prehistoric archaeological sites may be affected by the project.	Consultation in conjunction with USACE Section 404 compliance.
Humboldt County	County Code	Grading over 50 cubic yards requires a County Grading Permit. Work in the active floodway requires a Special Permit from the County.	County Grading and Floodplain Management Permit. Special Permit to construct in the Streamside Management Area. Use Permit for restoration activities in the Coastal Zone.
	Federal Code of Regulations Title 44 Emergency Management and Assistance	The Project may affect the hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective Base Flood Elevations, or the Special Flood Hazard Area.	Will require a Memo to the Humboldt County Floodplain Administrator stating the Project will not increase base flood elevations.

7.1 Summary of Agency Outreach Process

Outreach meetings were held with staff representatives from the California Department of Fish and Wildlife (CDFW), North Coast Regional Water Quality Control Board (RWB), California Coastal Commission (CCC), U.S.

Army Corps of Engineers (USACE), National Marine Fisheries Service/NOAA Fisheries (NMFS), the US Fish and Wildlife Service (USFWS), and the Humboldt County Building and Planning Department, as summarized in Table 7-1. Coordination with the State Lands Commission and Humboldt Bay Harbor, Recreation, and Conservation District has also not yet occurred for activities which may be within their jurisdictions.

Table 7-2. Agency staff consulted for development of a regulatory strategy for the Elk River Stewardship Program.

Agency	Staff	Date of Meeting
California Department of Fish and Wildlife	*Michael Van Hattem* *Michael.vanHattem@wildlife.ca.gov*	*October 14, 2021* *February 18, 2022*
North Coast Regional Water Quality Control Board	*Jake Shannon* *Jacob.Shannon@Waterboards.ca.gov*	*October 14, 2021* *February 18, 2022*
California Coastal Commission	*Melissa Kraemer* *Melissa.Kraemer@coastal.ca.gov* *Catherine Holloway* *catherine.holloway@coastal.ca.gov*	*October 25, 2021*
US Army Corps of Engineers	*Kasey Sirkin* *L.K.Sirkin@usace.army.mil*	*November 9, 2021 and* *January 14, 2022* *February 24, 2022*
National Marine Fisheries Service	*Jeffrey Jahn* *jeffrey.jahn@noaa.gov* *Matt Goldsworthy* *matt.goldsworthy@noaa.gov*	*October 19, 2021 and* *November 9, 2021* *February 24, 2022*
US Fish and Wildlife Service	*Nathan Berg* *Nathan_Berg@fws.gov*	*February 24, 2022*
Humboldt County Building and Planning Department	*Trevor Estlow* *testlow@co.humboldt.ca.us*	*November 16, 2021*

7.2 Regulatory Requirements and Strategies

Based on our consultations with our agency partners, and in consideration of the Planning Areas developed to facilitate funding and engineering design, we have determined that the regulatory coverage for each of the three Planning Areas will be pursued separately. The project will seek CEQA authorization with the Regional Water Board as CEQA Lead Agency for each Planning Area and pursue one set of permits for each Planning Area. Aside from permits required only in the estuary and tidal reaches (e.g., Coastal Commission Coastal Development Permit, Harbor District Shoreline Development Permit), the regulatory strategy for permits and CEQA coverage will be consistent across all three Planning Areas within the Stewardship Program Area. Each set of permits and CEQA coverage will be tailored to the specific actions, impacts, and benefits of the Planning Areas. The primary reasons for this strategy are: (1) funding will not likely be available concurrently for all Planning Areas, and thus all of the detailed information describing project Actions and benefits, and individual and cumulative impacts will not be available to support timely processing of permits; (2) the time required to complete multiple construction phases within a Planning Area may extend longer than most permit authorizations (e.g., 5 years); and (3) the overall cumulative outcome of implementing the full suite of project phases and actions within each Planning Area will most likely result in a net benefit to aquatic and riparian resources, despite unavoidable short-term temporary impacts.

Recommended Technical Studies and Regulatory Documents

Regulatory permits will require foundational technical studies to evaluate and determine potential impacts to biological and cultural resources. Technical studies will also support impact analysis under CEQA. All technical studies should analyze all Planning Areas to best support the overall programmatic approach. Technical studies may encompass the entire Stewardship Program Area or may be specific to each of the three geographic Planning Areas, as funding allows. Recommended technical studies and regulatory documents should evaluate all project work areas where Project Actions are planned to occur and include:

- Cultural resources investigation – Used to support project-specific CEQA impact analysis and required for the USACE Section 404 permit. If the State Water Resources Control Board (SWRCB) Programmatic Environmental Impact Report (PEIR) is used as a CEQA pathway (see Section 3.1), the cultural resource investigation would confirm no additional avoidance or mitigation measures would be necessary in order to avoid any potential site-specific resource impacts or provide a technical basis for supplementing the PEIR if resources of concern are identified through the investigation.
- Wetland Delineation and Ordinary Hight Water Mark Analysis – Used to support project-specific CEQA impact analysis, required for all regulatory permits, and used as a basis for demonstrating the project's wetland impacts are self-mitigating. Within the Coastal Zone, the wetland delineation should identify both one-parameter and three-parameter wetlands. Outside the Coastal Zone, only the identification of three-parameter wetlands is necessary.
- Botanical Investigations – including late and early seasonally appropriate surveys for special status plants, mapping for upland environmentally sensitive habitat areas (ESHA), and Sensitive Natural Communities (SNCs – Used to support project-specific CEQA impact analysis and regulatory permitting with CDFW and the CCC.
- Wildlife Resources Evaluation – Used to determine or exclude potential impacts to state or federally listed wildlife species or habitat that could potentially be impacted by the project, as related to CEQA, Section 7 of the Endangered Species Act (ESA), and CDFW permitting and California Endangered Species Act (CESA) compliance. Special status species would be initially identified through a U.S. Geological Survey (USGS) nine quadrant database search followed by field investigations. Protocol level surveys would not be expected for animals. The wildlife resources evaluation would include general and species-specific protection measures.
- Habitat Mitigation and Monitoring Plan – Used to satisfy compensatory mitigation requirements for wetlands and other sensitive habitat for jurisdictional permitting agencies, including riparian revegetation.
- Habitat Conversion Analysis – Used to evaluate expected habitat conversion for permitting and CEQA purposes and will help to justify the project is self-mitigating.
- Agricultural Conversion Analysis – Used to confirm disallowed agricultural conversion or conflicts with the Williams Act, Humboldt County General Plan, Coastal Act, and CEQA agricultural policies do not occur as a result of the project.
- Statewide Restoration General Order Notice of Intent – The Notice of Intent will be filed as an initial step to utilize the SWRCB's PEIR as a CEQA pathway (see Section 3.1). The Notice of Intent is available at (https://www.waterboards.ca.gov/water_issues/programs/cwa401/docs/2021/draft_order_attachment_b.pdf).
- Biological Assessments – A combined Biological Assessment will be prepared for submittal to NOAA Fisheries for federally listed salmonids under Section 7 of the Endangered Species Act and to the U.S. Fish and Wildlife Service (USFWS) for Tidewater Goby for restoration actions in the Elk River estuary. Any additional federally listed plant or wildlife species that could potentially be impacted by the project, as identified through the wildlife resources evaluation, would also be included in the Biological Assessment.

7.3 Federal Permits and Approvals

Federal permits and approvals will be required by the USACE, NMFS, and USFWS. There are no application fees for federal permits and approvals required for the project. California Trout or other project proponents could serve as the applicant for federal permits and authorizations. If desired, the Regional Board could also be a co-applicant on permit applications. A joint NMFS/USFWS programmatic Biological Assessment would be submitted to the USACE for federal ESA Section 7 consultation for all federally listed species that could be impacted by the project.

NEPA Strategy

If federal funds are used to fund project implementation, compliance with NEPA would be required. The specific level of analysis required for NEPA would be determined by the federal lead agency (e.g., Categorical Exclusion, Environmental Assessment, or Environmental Impact Statement). When issuing the Section 404 permit, the USACE typically completes a NEPA document for their records. This USACE NEPA document has been deemed acceptable to federal funding agencies on other north coast restoration projects, and an additional NEPA document or public review process has not been required. If NEPA is required for the project as a result of the Elk River Program receiving federal funding, the recommended NEPA strategy is to repurpose the USACE NEPA document, with the concurrence of the federal funding agency and their NEPA guideline.

US Army Corps of Engineers

The project would require a Clean Water Act Section 404 permit from the USACE to be issued under an Individual Permit and will require an alternatives analysis for each Stewardship Program Planning Area. Alternatively, phases could fall under a Nationwide Permit 27 for restoration project if wetland impacts were under one acre and the other Nationwide Permit 27 criteria were met. A Nationwide Permit would not require an alternatives analysis. The Individual Permit application will include impacts for all phases of restoration. If design plans for sequential years of each Planning Area evolve from the original permit submittal, the permit applicant would submit requests for work modifications to the Section 404 permit. An Individual Permit or a Nationwide Permit can be extended up to ten years. Tidal projects near the estuary will also require a Section 10 permit. A joint Section 404/Section 10 permit application would be submitted to the USACE along with a Programmatic Biological Assessment for the lower Elk River Tidal Estuary Planning Area of the project. Within each Planning Area, CalTrout would need to submit annual notifications to the USACE each year, and the USACE would issue an annual authorization. Evidence of self-mitigation would be required for any impacts to Waters of the U.S, as documented in the Habitat Mitigation and Monitoring Plan for that Planning Area. The USACE would lead ESA Section 7 consultation with NMFS and the USFWS. Annual authorizations would be contingent on confirmation that NMFS and USFWS ongoing ESA obligations were met over the duration of the project. The joint Section 404/Section 10 permit application does not currently require landowner information or signatures. No additional project-specific constraints or requirements were identified during outreach.

National Marine Fisheries Service

Based on pre-application outreach to NMFS, NMFS recommends a standard ESA Section 7 consultation for each Planning Area to provide ESA and Magnuson-Stevens Fishery Conservation Management Act (MSA) coverage under the USACE CWA 404 permit. This will require a Biological Assessment (BA) to be prepared for each Planning Area (likely two BA's within a 10-year span), and issuance of a Biological Opinion to cover implementation of annual construction phases within each Planning Area. Each Biological Assessment would describe the Planning Area extent, project Actions and temporary, permanent, and cumulative impacts, minimization and mitigation measures, annual construction phases, and the annual maximum level of fish relocations and consequent take per construction season. NMFS would then issue a Biological Opinion for each Planning Area. EFH consultation would also be required, and thus an EFH assessment prepared for each of the planning areas. ESA and EFH consultation procedures would be combined. NMFS could request or require annual pre-construction notifications to provide more specific details, including engineering designs to confirm the planned activities for each year fit within the parameters of the Biological Opinion. NMFS would also require annual reporting. Following annual reporting and submittal of required design information, NMFS could issue updated Incidental Take Statements periodically (e.g., every two of three years) for the upcoming phase of work.

US Fish and Wildlife Service

ESA Section 7 compliance with the USFWS is most likely to be limited to Tidewater Goby and the tidal reach of the project where restoration actions have the potential to temporarily impact Tidewater Goby. Thus, the USFWS Action Area would be smaller in scale than the NMFS Action Area. A standard Biological Assessment/Biological Opinion process is likely sufficient to cover Tidewater Goby under Section 7 of the ESA. Pending the outcome of the wildlife technical study and rare plant surveys, additional USFWS wildlife or plant species could also be identified (e.g., Northern Spotted Owl, Western Lily) and also require informal or formal consultation. Additional outreach to USFWS is recommended as the project develops and technical studies are complete to determine additional USFWS ESA Section 7 needs associated with the project.

7.4 State Permits and Approvals

CEQA Strategy

To the greatest extent feasible, the Project will achieve CEQA coverage under the newly developed State Water Resources Control Board (SWRCB) DRAFT Statewide Restoration General Order (General Order) and the associated Programmatic Environmental Impact Report (PEIR) that are expected to be adopted by the State Water Board in mid-2022. All of the Stewardship Actions appear to align with categories of project types proposed in the General Order except for some Community Health and Safety measures and Infrastructure Modification Actions. The initial strategy for CEQA compliance will therefore be to seek authorization under the Programmatic EIR for most Project activities, and if needed, tier off the Programmatic EIR and prepare supplemental environmental documentation (e.g., an Initial Study and Mitigated Negative Declaration IS/MND or a focused supplemental EIR) for specific topics and impact analyses not covered by the Programmatic EIR. Separate CEQA authorization will be pursued for each Planning Area of the Elk River Program. A focused supplemental EIR is anticipated to be necessary. Table 2 provides a crosswalk between restoration actions covered in the Programmatic EIR relative to restoration actions included in the Elk River Program. As required by CEQA, the Elk River Program will avoid impacts where possible, minimize impacts where avoidance is not feasible, and then offset those unavoidable temporary and permanent impacts with a greater ratio of benefits.

Table 7-3. The categories of restoration project types eligible for enrollment under the draft Programmatic EIR are listed in the left-hand column. The right-hand column lists the Elk River Recovery Program's General Enhancement and Restoration Actions that correspond with categories of restoration actions proposed for inclusion in the Programmatic EIR.

Categories of Project Types in Statewide Restoration Anticipated in PEIR	Elk River Recovery Program General Enhancement and Restoration Actions
1. Improvements to Stream Crossings and Fish Passage—for upstream and downstream movement by fish and other species, and to improve functions of streams.	G. Tidal and Freshwater Wetland Restoration
4. Restoration and Enhancement of Off-Channel and Side-Channel Habitat—to improve aquatic and riparian habitat for fish and wildlife;	D. Aquatic Habitat Restoration C. Floodplain Connectivity and Recontouring

to restore the hydrologic, hydraulic, and biogeochemical functions and processes of streams; or both.	
6. Floodplain Restoration—to improve ecosystem function by creating hydrologic connections between streams and floodplains, through such measures as breaching and removal of levees, breaching and removal of berm and dike setbacks, and hydraulic reconnection and revegetation.	C. Floodplain Connectivity and Recontouring H. Sediment Re-Use on Floodplains
8. Removal of Nonnative Invasive Species and Revegetation with Native Plants—to improve watershed functions, such as aquatic and riparian habitat for fish and wildlife.	E. Non-Native and Invasive Vegetation Removal (In-Channel and Floodplain) F. Riparian Habitat Restoration
9. Establishment, Restoration, and Enhancement of Tidal, Subtidal, and Freshwater Wetlands—to create or improve wetland ecological functions.	G. Tidal and Freshwater Wetland Restoration
10. Establishment, Restoration, and Enhancement of Stream and Riparian Habitat and Upslope Watershed Sites—to create or restore the functions of streams and riparian areas, including upslope watershed sites that could contribute sediment to streams or disrupt floodplain and riparian functions.	A. Sediment Load Reduction from Upper Watershed B. Sediment Remediation of In-Channel Aggradation D. Aquatic Habitat Restoration
Not included in the Programmatic EIR	I. Community Health and Safety Measures J. Infrastructure Modifications

An alternative CEQA compliance process could seek to utilize the recently approve CEQA Statutory Exemption for Restoration Projects (SERP). Governor Newsom recently signed Senate Bill (SB) 155, adding Section 21080.56 to California Public Resources Code (Stats. 2021, ch. 258, § 23, effective September 23, 2021.). Section 21080.56 provides a new CEQA statutory exemption until January 1, 2025, for fish and wildlife restoration projects that meet certain requirements. Lead agency application of the exemption for any particular project is subject to the required concurrence of the CDFW Director. Both the CEQA lead agency and CDFW have specific roles for utilization of the SERP. The CEQA lead agency must make a determination that the project meet the requirements of the SERP, get concurrence from CDFW and file the SERP with the Governor's Office of Planning and Research (OPR) within 48 hours of CDFW approval. The project must result in long term benefits to climate resiliency, biodiversity and sensitive species recovery, and must include procedures for ongoing management for the protections of the environment. There are other requirements to which the CEQA lead agencies must adhere to utilize the SERP. CDFW is currently working on the procedures and processes for them to "approve" CEQA lead agency requests to utilize this new SERP.

Required state permits include a Clean Water Act Section 401 from the Regional Water Board, California Coastal Commission (CCC) Coastal Development Permit, and a California Department of Fish and Wildlife (CDFW) 1602 Lake and Streambed Alteration Agreement (LSAA). Outside of the tidal zone, some activities adjacent to the channel, as well as activities within the channel proper, may fall within the jurisdiction of the State Lands Commission. Within the tidal zone, the Harbor District has jurisdiction over these lands (see Section 3.4.2). Depending on the type of activity proposed and the precise location of disturbance, the State Lands Commission will determine if a lease or permit is required. CDFW will also require compliance with the California State Endangered Species Act (CESA) for state-listed species and state-regulated vegetative communities.

North Coast Regional Water Quality Control Board

The Regional Board will require a Section 401 water quality certification for the project. Based on pre-application outreach to the Regional Board, the Section 401 water quality certification is expected to be issued under the State

Restoration General Order (SRGO). As the reviewing Water Board for projects in the North Coast Region seeking coverage under the SRGO, the project's use of the SRGO PEIR as the CEQA pathway is acceptable to the Regional Board. No additional project-specific constraints or requirements were identified during outreach. Evidence of a net benefit to public trust resources would be required for any impacts to Waters of the State, and would be documented in the Habitat Mitigation and Monitoring Plan. CalTrout (or other project proponents) will be the permit applicant. The project is eligible for the Ecological Restoration Enhancement Projects fee category the identified in the 2021/2022 Dredge Fill Fee Calculator, is $645 . Permit fees are increased annually. Property ownership information is required on the Section 401 application, but landowners are not currently required to sign the Section 401 application.

California Coastal Commission

A Coastal Development Permit would be required for project activities within the Coastal Zone, in the Lower Valley and Tidal Reaches Planning Area. A single consolidated application would be submitted to the California Coastal Commission upon approval of the Humboldt County Planning Director. The project would be covered by a single CDP. CDPs do not expire once they are vested (construction starts). A CDP includes a CEQA-equivalent process. Thus, the CDP would not rely on the SRGO PEIR exclusively. The CCC would require the technical studies prepared for the project as described in Section 7-2, to support the permit application and consider all environmental impacts associated with the project. The application would submit 30% and/or 65% engineering designs for proposed activities; the level of design completion would likely vary by design phase. Sediment re-use areas within the Coastal Zone would need to be identified in advance and located in verified upland areas, unless proposed as a specific project Action with a habitat conservation objective. Off-site transport of sediment to White Slough or similarly authorized locations would also be acceptable to the CCC. A public agency should serve as the CDP applicant to avoid a substantial permit application fee; there is no CDP application fee for public agencies. No additional project-specific constraints or requirements were identified during outreach. The application must include evidence of landowner permission for each involved parcel., but landowners are not currently required to sign the CDP application.

California Department of Fish and Wildlife

In pre-application outreach, CDFW expressed support for utilizing the General Order pathway for CEQA authorization, with the Regional Water Board (RWB) as Lead Agency and with the commitment that the Notice of Intent applicant would submit the NOI to CDFW at the same time it is submitted to the RWB, as CDFW has requested. For permitting and CESA purposes, CDFW would issue a "Restoration LSAA" (in development) that would capture all CDFW topics and issues, and would refer to all other documentation in the permitting package, including the Restoration Management Permit (RMP) for state listed (CESA) species coverage. The RMP has no fee, and would be issued after NMFS has issued a Biological Opinion. Riparian revegetation acreages would be documented in the Notice of Intent and in the project's Habitat Mitigation and Monitoring Plan and submitted with the NOI and LSAA applications. No additional project-specific constraints or requirements were identified during outreach. The LSAA fee is approximately $6,000. Property ownership information is required on the 1602 application, but landowners are not currently required to sign the 1602 application.

State Lands Commission

Lands under the State Lands Commission (SLC) jurisdiction include the beds of tidal and navigable waters acquired at statehood in 1850. Tidal lands of the Elk River estuary are under the jurisdiction of the Humboldt Bay Harbor, Recreation, and Conservation District (Harbor District, see Section 3.4.2). However, outside of tidal areas, the SLC may claim jurisdiction over the Elk River channel and adjacent floodplain areas. To formally determine jurisdiction, SLC requires that an inquiry be submitted via their online portal, OSCAR. If jurisdiction of a portion of project area is determined to be within SLC jurisdiction, the project would be required to apply for a permit or a lease (SLC determines which pathway is required, based on the proposed activity and location). The application is also submitted via OSCAR. The application fee is variable, with a minimum 2021 fee of $1,500. Projects that demonstrate environmental benefits are able to request a waiver of the annual lease fee. SLC will require proof of CEQA completion and submittal of all technical studies and designs to finalize the lease or permit. It is assumed the SLC will accept the PEIR CEQA pathway.

7.5 Local Permits and Approvals

Humboldt County Planning & Building Department

Within the Coastal Zone (Lower Valley and Tidal Reaches Planning Area), the County would issue a Use Permit. For Planning Areas occurring outside the Coastal Zone, the County would issue a Special Permit for work within Streamside Management Areas, including work to modify or replace bridges. The application would cover all restoration phases. The application should include the design (ideally a 60% level or similar) and related technical studies. All landowners would sign a single application form to be provided by the County. Through the permitting process, the County would also verify Williamson Act consistency for project actions proposed to occur on properties enrolled in Williamson Act contracts by reducing the area of lands available for agricultural use as a result of the project. Based on previously completed restoration projects in the County that occurred on Williamson Act properties, small reductions in Williamson Act acreage were allowed due to improvements made to the remaining portion of the parcels (e.g., improvements to drainage, fencing, and productivity). Placement of soil for re-use within Streamside Management Areas is allowable for restoration projects. No additional project-specific constraints or requirements were identified during the outreach. The permit fee required by the County will vary is based on the time and materials charges accrued to the application by County staff. A minimum fee of approximately $10,000 should be expected. County fees do increase annually.
Prior to construction, a separate Grading Permit will also be required. The final 100% construction design will be required to complete the Grading Permit application package along with concurrence from the County's Floodplain Administrator.

Harbor District

All restoration within tidal channels and along tidal shorelines, including work related to tide gates, will require a Shoreline Development Permit, which are administered by the Harbor District. The current application fee is $500.

7.6 Protective Measures

Projects authorized under the Statewide Restoration General Order will be required to analyze project impacts to determine if they reach the level of significance, with thresholds of significance provided by the General Order to support the analysis. Impacts determined to rise to the level of significant would then incorporate general protection measures, species protection measures, and incorporation of feasible mitigation measures into project plans to ensure avoidance and minimization of impacts on sensitive resources. With protective measured identified, impacts would then be re-evaluated to determine if protective measures would reduce the identified impacts to a less-than-significant level. General protection measures and species protection measures are intended to be implemented and enforced in the same way as mitigation measures consistent with Section 15126.4 of the State CEQA Guidelines. These general and species measures are provided in the PEIR (https://www.waterboards.ca.gov/water_issues/programs/cwa401/docs/2021/appendix_f_species_protection_measures.pdf).

Specific Measures for Threatened, Endangered, or Sensitive Species

The Elk River Stewardship Program intends to follow all standard conditions and avoidance measures that are included in other required state and federal permits. All efforts will be made to minimize the effect of the project on existing flora and fauna. If any special status or non-special status wildlife are encountered over the course of construction, said wildlife will be allowed to leave the construction area unharmed, and will be flushed, or herded in a safe direction away from the project site. Additional agency consultation (i.e., CDFW, USFWS, NMFS) may occur depending on the location and species encountered.

Salmonids: Southern Oregon and Northern California Coast ESU Coho Salmon (*O. kisutch*), Northern California DPS Steelhead (*O. mykiss*), and California Coastal ESU Chinook Salmon (*O. tshawytscha*) are expected to be present in the Elk River Program Area during project implementation. All activities in this project will be completed in accordance with the CA Department of Fish and Wildlife's Habitat Restoration Manual. The implementation of extensive minimization/avoidance measures identified in the Habitat Restoration Manual are expected to be sufficient to protect salmon and steelhead. To avoid any potential for negative impacts to these species, the following measures will be implemented.

- Instream work will be restricted to the period of June 15 through October 31 or the first significant rainfall, whichever comes first. This is to take advantage of low stream flow and avoid the spawning and egg/alevin incubation period of salmon and steelhead.
- Fish will be excluded from the work area by blocking the stream channel above and below the work area with fine-meshed net or screen. Mesh will be no greater than 1/8-inch diameter. The bottom edge of the net or screen will be completely secured to the channel bed to prevent fish from reentering the work area or to become impinged. Exclusion screening will be placed in areas of low water velocity to minimize fish impingement. Screens will be regularly checked and cleaned of debris to permit free flow of water.
- Suitable large wood pieces removed from the stream channel (to facilitate fish removal) that are not used for habitat enhancement, will be left within the riparian zone to provide a source for future recruitment of wood into the stream, reduce surface erosion, contribute to amounts of organic debris in the soil, encourage fungi, provide immediate cover for small terrestrial species, and to speed recovery of native vegetation
- Prior to dewatering a construction site, fish and amphibian species will be captured and relocated by CalTrout or their subcontractors. Measures will be taken to minimize harm and mortality to listed salmonids resulting from fish relocation and dewatering activities:
- Fish relocation will be performed by a qualified fisheries biologist. Rescued fish will be moved to the nearest appropriate site outside of the work area. A record will be maintained of all fish rescued and moved. The record will include the date of capture and relocation, the method of capture, the location of the relocation site in relation to the project site, and the number and species of fish captured and relocated. The record will be provided to CDFW within two weeks of the completion of the work season.
- Electrofishing will be conducted by properly trained personnel following NOAA Guidelines for *Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act*, June 2000.
- Prior to capturing fish, appropriate release location(s) will be identified, that includes areas with suitable water temperatures and ample habitat for the captured fish.
- Fish handling will be minimized. However, when handling is necessary, it will always include wet hands or nets prior to touching fish.
- Fish may be held temporarily in cool, shaded, aerated water in a container with a lid. Aeration can be provided with a battery-powered external bubbler. Protections will be followed to avoid fish from jostling and noise.

- Air and water temperatures will be measured periodically. A thermometer will be placed in holding containers and, if necessary, water will be exchanged periodically to maintain a stable water temperature. If water temperature reaches or exceeds 18 °C, fish will be released, and rescue operations ceased.
- Overcrowding in containers will be avoided by having at least two containers, and young-of-year (YOY) fish segregated from larger age-classes to avoid predation. Larger amphibians, such as Pacific giant salamanders, will be placed in the container with larger fish. If fish and amphibians are abundant, capture operations will cease periodically, and animals will be released at the predetermined locations.
- Species and year-class of fish will be visually estimated at time of release. The number of fish captured will be counted and recorded; anesthetization or measuring fish will be avoided.
- If feasible, initial fish relocation efforts will be performed several days prior to the start of construction. This provides the fisheries biologist an opportunity to return to the work area and perform additional electrofishing passes immediately prior to construction. In many instances, additional fish will be captured that eluded the previous day's efforts.
- The length of channel that is dewatered will be minimized to the maximum extent possible.
- Additional measures to minimize injury and mortality of salmonids during fish relocation and dewatering activities will be implemented as described in Part IX, pages 52 and 53 of the California Salmonid Stream Habitat Restoration Manual.
- If these mitigation measures cannot be implemented, or the project actions proposed at a specific work site cannot be modified to prevent or avoid potential impacts to anadromous salmonids or their habitat, then activity at that work site will be discontinued and the appropriate agencies will be consulted.

Avian Species

Northern spotted owl (*Strix occidentalis*): The project location is not located within or near critical habitat for spotted owls. Additionally, the project start date is outside of the NSO breeding season.

Marbled murrelet (*Brachyramphus marmoratus*): The project location is not located within or near critical habitat for the marbled murrelet.

Other Aquatic Organisms (Pond Turtles, Salamanders, and Frogs)

For work sites containing western pond turtles, salamanders, foothill yellow-legged frogs, or tailed frogs, exclusion measures will be used to prevent take or injury to specific reptiles and amphibians that could occur on site and will be in place prior to construction activities. Any turtles or frogs found within the exclusion zone will be moved to a safe location upstream or downstream of the project work site prior to construction.

Invasive Species

There are no known aquatic invasive species (AIS), including New Zealand mud snail, quagga mussels and zebra mussels, within the project area. Invasive species protection measures (i.e. cleaning equipment, waders, shoes, etc.) will be strictly adhered to in order to prevent the introduction of AIS. All work will abide by the protective measures outlined in the *CalTrout Invasive Species Prevention Protocol*.

Rare Plants/Botanical Resources:

A review of the California Natural Diversity Database (CNDDB) for the Project Area and surrounding quadrangles and a seasonally appropriate field botanical survey to list and locate potential sensitive species and/or their habitats will be conducted within the Project Area by qualified staff prior to initiating the project construction phase. A Rare plants survey report and technical memo will be provided with the NOI application.

Cultural Resources
Impacts to cultural resources will be avoided during the project. Cultural resource surveys will be conducted by qualified specialists prior to initiating the project construction phase. Any sites, artifacts, or other cultural resources will be identified during the field survey. Cultural resources defined as historical resources, tribal cultural resources, or unique archaeological resources will be identified in the project area. A Cultural Resources Investigation report will document all findings.

If the proposed project activities were to uncover any subsurface archaeological material (e.g., flaked or ground stone; artifacts; historic-era refuse; building foundations; or bone) during ground disturbing activities, all work will immediately be stopped within 20 meters of the discovery. No material remains shall be removed from the discovery site, and a reasonable exclusion zone shall be cordoned off. Work will not recommence until a qualified archaeologist can evaluate the site and make recommendations for further action.

If human remains are discovered during project construction, work shall stop at the discovery location, within 20 meters (66 feet), and any nearby area reasonably suspected to overlie adjacent to human remains (Public Resources Code, Section 7050.5). The county coroner will be contacted to determine if the cause of death must be investigated. If the coroner determines that the remains are of Native American origin, it is necessary to comply with state laws relating to the disposition of Native American burials, which fall within the jurisdiction of the Native American Heritage Commission (NAHC) (Public Resources Code, Section 5097). The coroner will contact the NAHC. The descendants or most likely descendants of the deceased will be contacted, and work shall not resume until they have made a recommendation to the landowner or the person responsible for the excavation work for means of treatment and disposition, with appropriate dignity, of the human remains and any associated grave goods, as provided in Public Resources Code, Section 5097.98. Discovery of Native American remains is a very sensitive issue, and all project personnel shall hold any information about such a discovery in confidence and divulge it only on a need-to-know basis.

General Protection Measures

The following avoidance measures were adopted from the NOAA Restoration Center's *Programmatic Approach to ESA/EFH Consultation Streamlining for Fisheries Habitat Restoration Projects, Section 2.4 – Protection Measures*; and the CDFW *California Stream Habitat Restoration Manual*.

1. Work will not begin until a) NMFS and/or the US ACE has notified the permittee that ESA and CWA requirements have been satisfied and that the activity is authorized, and b) all other necessary permits and authorizations are finalized.
2. The general construction season will be from June 15 to October 31. Restoration, construction, fish relocation and dewatering activities within any wetted or flowing stream channel will occur only within this period. If precipitation sufficient to produce runoff is forecast to occur while construction is underway, work will cease, and erosion control measures will be put in place sufficient to prevent significant sediment runoff from occurring. Exceptions regarding the construction season will be considered on a case-by-case basis only if justified and if measurable precipitation sufficient to produce runoff is not forecast to occur during any of the above activities, and if approved by the NMFS, US ACE, and CDFW. Revegetation activities including limited soil preparation outside the active channel may occur beyond October 31, if necessary, to better ensure successful plant establishment during the onset of winter precipitation.
3. Prior to construction, the land manager and each contractor will be provided with the specific protective measures to be followed during implementation of the project by the project proponent or lead biologist.

In addition, a qualified biologist will provide the construction crew with information on all listed species (including state-listed and state fully protected species) in the project area, the protection afforded the species by ESA and California Endangered Species Act (CESA), and guidance on those specific protection measures that must be implemented as part of the project.

Measures to Minimize Disturbance from Instream Construction

Measures to minimize disturbance associated with instream habitat restoration construction activities are presented below. Measures are excerpted from Measures to Minimize Disturbance from Construction, on page IX-50 of the CDFW Manual:

a. Construction will occur between June 15 and October 31. Revegetation activities, including soil preparation, may extend beyond October 31, if necessary, to better ensure successful plant establishment during the onset of winter precipitation. If precipitation greater than one inch is forecast during the June 15 – October 31 work window, the NOAA Restoration Center (RC) must be notified, implementation work must stop, and erosion control best management practices (BMPs) must be implemented. Extensions of this work window will be considered on a case-by-case basis only if justified and if precipitation sufficient to produce runoff is not forecast to occur during any of the above activities, the effects of this action are not outside the effects analyzed in the BA, and if approved by the NOAA RC, Corps and NMFS.
b. Debris, soil, silt, excessive bark, rubbish, creosote-treated wood, raw cement/ concrete or washings thereof, asphalt, paint or other coating material, oil or other petroleum products, or any other substances which could be hazardous to aquatic life, resulting from projected related activities, will be prevented from contaminating the soil and/or entering the waters of the State. Any of these materials, placed within or where they may enter a stream or lake, by the applicant or any party working under contract, or with permission of the applicant, will be removed immediately. During project activities, all trash that may attract potential predators of salmonids will be properly contained, removed from the work site, and disposed of daily.
c. Where feasible, the construction will occur from the bank, or on a temporary pad underlain with filter fabric.
d. Temporary fill will be removed in its entirety prior to close of work-window.
e. The use or storage of petroleum-powered equipment will be accomplished in a manner to prevent the potential release of petroleum materials into waters of the state (Fish and Game Code 5650).
f. Areas for fuel storage, refueling, and servicing of construction equipment must be located in an upland location.
g. Prior to use, clean all equipment to remove external oil, grease, dirt, or mud. Wash sites must be located in upland locations so wash water does not flow into the stream channel or adjacent wetlands. All construction equipment must be in good working condition, showing no signs of fuel or oil leaks. Prior to construction, all mechanical equipment will be thoroughly inspected and evaluated for the potential of fluid leakage. All questionable motor oil, coolant, transmission fluid, and hydraulic fluid hoses, fitting, and seals will be replaced. The contractor will document in writing all hoses, fittings, and seals replaced and will keep this documentation until the completion of operations. All mechanical equipment will be inspected on a daily basis to ensure there is no motor oil, transmission fluid, hydraulic fluid, or coolant leaks. All leaks will be repaired in the equipment staging area or other suitable location prior to resumption of construction activity.
h. Oil absorbent and spill containment materials will be located on site when mechanical equipment is in operation with 100 feet of the proposed watercourse crossings. If a spill occurs, no additional work will

commence in-channel until (1) the mechanical equipment is inspected by the contractor, and the leak has been repaired, (2) the spill has been contained, and (3) NMFS and CDFW are contacted and have evaluated the impacts of the spill.

Measures to Minimize Degradation of Water Quality

Construction or maintenance activities for the projects proposed under this Program may result in temporary increases in turbidity levels in the stream. In general, these activities must not result in significant, or long-term increases in turbidity levels beyond the naturally occurring, background conditions. The following measures will be implemented to reduce the potential for impacts to water quality during and post-construction:

a. Isolate the construction area from flowing water until project materials are installed and erosion protection is in place.
b. Erosion control measures will be in place at all times during construction. Do not start construction until all temporary control devices are in place downslope or downstream of project site.
c. Maintain a supply of erosion control materials onsite to facilitate a quick response to unanticipated storm events or emergencies.
d. Use erosion controls to protect and stabilize stockpiles and exposed soils to prevent movement of materials. Use devices such as plastic sheeting held down with rocks or sandbags over stockpiles, silt fences, or berms of hay bales to minimize movement of exposed or stockpiled soils.
e. Stockpile excavated material in areas where it cannot enter the stream channel. Prior to the start of construction, determine if such sites are available at or near the project location. If unavailable, determine location where material will be deposited. If feasible, conserve topsoil for reuse at project location or use in other areas. Minimize temporary stockpiling of excavated material.
f. When needed utilize instream grade control structures to control channel scour, sediment routing and headwall cutting.

Please see Monitoring and Reporting Plan for additional information on water quality monitoring.
Post-Construction Erosion Control:

a. Immediately after project completion and before close of seasonal work window, stabilize all exposed soil with mulch, seeding, and/or placement of erosion control blankets. Remove all artificial erosion control devices after the project area has fully stabilized. All exposed soil present in and around the project site will be stabilized within 7 days. Erosion control devices such as coir rolls or erosion control blankets will not contain plastic netting of a mesh size that would entrain reptiles and amphibians.
b. All bare and/or disturbed slopes (larger than 10' x 10' of bare mineral soil) will be treated with erosion control methods such as straw mulching, netting, fiber rolls, and hydro-seed as permanent erosion control measures.
c. Where straw, mulch, or slash is used as erosion control on bare mineral soil, the minimum coverage will be 95% with a minimum depth of two inches.
d. When seeding is used as an erosion control measure, only natives will be used. Sterile (without seeds), weed-free straw, free of exotic weeds, is required when hay bales are used as an erosion control measure.

Measures to Minimize Loss or Disturbance of Riparian Vegetation

Measures to minimize loss or disturbance to riparian vegetation are described below. The revegetation and success criteria that will be adhered to for projects implemented under the proposed Project that result in disturbance to riparian vegetation are also described below:

a. Minimizing Disturbance:
   1. Retain as many trees and shrubs as feasible, emphasizing shade-producing and bank-stabilizing trees and brush.
   2. Prior to construction, determine locations and equipment access points that minimize riparian disturbance. Pre-existing access points will be used whenever possible. Avoid entering unstable areas, which may increase the risk of channel instability.
   3. Minimize soil compaction by using equipment with a greater reach or that exerts less pressure per square inch on the ground, resulting in less overall area disturbed or less compaction of disturbed areas.
   4. If riparian vegetation is to be removed with chainsaws, consider using saws currently available that operate with vegetable-based bar oil.
   5. Revegetate disturbed and decompacted areas with native species specific to the project location that comprise a diverse community of woody and herbaceous species.
b. Revegetation and Success Criteria:
   1. Any stream bank area left barren of vegetation as a result of the implementation or maintenance of the practices will be restored to a natural state by seeding, replanting, or other agreed upon means with native trees, shrubs, and/or grasses. Barren areas will typically be planted with a combination of willow stakes, native shrubs, and trees and/or erosion control grass mixes.
   2. Native plant species will be used for revegetation of disturbed and compacted areas. The species used will be specific to the project vicinity or the region where the project is located and comprise a diverse community structure (plantings will include both woody and herbaceous species).
   3. Re-vegetation monitoring will occur after 2 years to document success. Success is defined as 50% survival of plantings or 50% ground cover for broadcast planting of seed after a period of 2 years. some revegetation efforts will be passive (i.e., natural regeneration), and success will be defined as total cover of woody and herbaceous material equal to or greater than pre-project conditions
   4. If utilized, all exclusion materials placed around plantings will be removed and recycled after 3 years, or earlier if appropriate.

Measures to Minimize Impacts to Aquatic Habitat and Species During Dewatering of Project Site

When construction work must occur within a year-round flowing channel, the work site must be dewatered. Dewatering can result in the temporary loss of aquatic habitat, and the stranding, displacement, or crushing of fish and amphibian species. Increased turbidity may occur from disturbance of the channel bed. Following these general guidelines will minimize impacts:

a. Prior to dewatering, determine the best means to bypass flow through the work area to minimize disturbance to the channel and avoid direct mortality of fish and other aquatic vertebrates.
b. Coordinate project site dewatering with a fisheries biologist qualified to perform fish and amphibian relocation activities.
c. Minimize the length of the dewatered stream channel and duration of dewatering.
d. Bypass stream flow around work area, but maintain stream flow to channel below construction site.
e. The work area must often be periodically pumped dry of seepage. Place pumps in flat areas, well away from the stream channel. Secure pumps by tying off to a tree or stake in place to prevent movement by vibration. Refuel in area well away from stream channel and place fuel absorbent mats under pump while refueling. Pump intakes should be covered with 1/8" mesh to prevent entrainment of fish or amphibians that failed to be removed. Check intake periodically for impingement of fish or amphibians.

f. Discharge wastewater from construction area to an upland location where it will not drain sediment-laden water back to stream channel.

Measures to Minimize Injury and Mortality of Fish and Amphibian Species During Dewatering

Prior to dewatering a construction site, fish and amphibian species should be captured and relocated to avoid direct mortality and minimize take. This is especially important if listed species are present within the project site. The following measures are consistent with those defined as reasonable and prudent by NOAA for projects concerning several northern California Evolutionary Significant Units for coho salmon, chinook salmon, and steelhead trout:

a. Fish relocation activities must be performed only by qualified fisheries biologists, and experience with fish capture and handling.
b. In regions of California with high summer air temperatures, perform relocation activities during morning periods.
c. Periodically measure air and water temperatures. Cease activities when water temperatures exceed temperatures allowed by CDFW and NOAA.
d. Exclude fish from re-entering work area by blocking the stream channel above and below the work area with fine- meshed net or screens. Mesh should be no greater than 1/8 inch. It is vital to completely secure bottom edge of net or screen to channel bed to prevent fish from re-entering work area. Exclusion screening should be placed in areas of low water velocity to minimize impingement of fish. Screens should be checked periodically and cleaned of debris to permit free flow of water.
e. Prior to capturing fish, determine the most appropriate release location(s). Consider the following when selecting release site(s):
f. Prior to dewatering a construction site, fish and amphibian species should be captured and relocated to avoid direct mortality and minimize take. This is especially important if listed species are present within the project site. The following measures are consistent with those defined as reasonable and prudent by NOAA for projects concerning several northern California Evolutionary Significant Units for coho salmon, chinook salmon, and steelhead trout.
g. Electrofishing should only be conducted by properly trained personnel following CDFW and NOAA guidelines:
    1. Minimize handling of salmonids. However, when handling is necessary, always wet hands or nets prior to touching fish.
    2. Temporarily hold fish in cool, shaded, aerated water in a container with a lid.
    3. Provide aeration with a battery-powered external bubbler. Protect fish from jostling and noise and do not remove fish from this container until time of release.
    4. Place a thermometer in holding containers and, if necessary, periodically conduct partial water changes to maintain a stable water temperature. If water temperature reaches or exceeds those allowed by CDFW and NOAA, fish should be released, and rescue operations ceased.
    5. Avoid overcrowding in containers. Have at least two containers and segregate young-of-year (YOY) fish from larger age-classes to avoid predation. Place larger amphibians, such as Pacific giant salamanders, in container with larger fish.
    6. If fish are abundant, periodically cease capture, and release fish at predetermined locations.
    7. Ensure there is similar water temperature in the release location as capture location.
    8. Visually identify species and estimate year-classes of fish at time of release. Count and record the number of fish captured.
    9. Avoid anesthetizing or measuring fish.

Reports of fish relocation activities to NMFS will be submitted in a timely fashion. If feasible, plan on performing initial fish relocation efforts several days prior to the start of construction. This provides the fisheries biologist an opportunity to return to the work area and perform additional electrofishing passes immediately prior to construction. In many instances, additional fish will be captured that eluded the previous days efforts. If mortality during relocation exceeds 5 percent, stop efforts and immediately contact the appropriate agencies.

7.7 Climate Change

Anthropogenic climate change will continue to worsen over the next century, causing higher temperatures, increased extreme weather events, and accelerated sea level rise across California's North Coast (Grantham, 2018). It is necessary to understand climate change impacts on the Elk River watershed to ensure the resilience of restoration and adaptation plans. Previous work estimated projected sea level rise, flood risk, and infrastructure vulnerability for Humboldt Bay; however, it's still unclear how Humboldt Bay and Elk River ecosystems, hydrology, sediment transport, and water quality will respond to future change.

Addressing this deficit will require the creation of a model capable of simulating hydrodynamics, water quality, and sediment transport in the Elk and Humboldt Bay watersheds under future climate scenarios. To initiate this work, our Project Team first performed a literature review summarizing local climate impacts, investigating climate downscaling techniques, surveying suitable watershed models, and evaluating feasibility (Appendix F). Researchers then outlined a modeling approach: a watershed model could be coupled with an existing Elk River hydrodynamic and sediment transport model and a three-dimensional hydrodynamic and transport model for Humboldt Bay. These coupled models would receive Global Climate Model (GCMs) projections downscaled to relevant spatial and temporal extents. The study plan describing the proposed modeling approach can be found in Appendix G.

Model outputs would include key hydrodynamic, water quality, and sediment transport parameters (Table 7-4).

Table 7-4. Model output could be used to track trends in climate, hydrology, and habitat quality in the Elk River Watershed.

Category	Parameters/Model Output
Climate	Air Temperature, Precipitation, Sea Level Rise, Tidal Dynamics
Hydrology and Hydrodynamics	Streamflow, estuarine hydrodynamics
Flood Risk	Inundation vulnerability
Ecology	Algal Community Dynamics, Eel grass communities
Habitat	Riverine Temperature, Estuarine Temperature, Salinity, Tributary Sediment Yield, Estuarine Sediment Accretion and Erosion Rates, Depth, Dissolved Oxygen, Nutrient Loading and Tropic Status

Modeling could be used to investigate future changes in relevant watershed and estuary processes. For instance, research suggests that current sediment accretion rates in Humboldt Bay will not keep pace with relative SLR (HBHRCD, 2019). Researchers anticipate, in the absence of mitigations, conversion of much of existing Bay marshes to subtidal habitat by end of the 21st century. Elk River sediment yield may interact with sea level rise by impacting sediment accretion rates. Thus, modeling could help inform mitigation strategies, such as beneficial use of dredge spoils, to ensure marsh sustainability in future decades.

The coupled modeling approach outlined in the study plan could contribute to the development of climate-resilient restoration and adaptation plans in the Elk River watershed. However, funding is not currently available to create the model or apply model findings to restoration design work.

8 MONITORING RESPONSE TO PROGRAM IMPLEMENTATION

8.1 Introduction

During the planning process, a Monitoring Framework was developed to inform a targeted and objective-driven Monitoring and Adaptive Management Program that will be implemented to evaluate the effectiveness of Recovery Plan actions at achieving Stewardship Program objectives. The Monitoring Framework will be used to guide future development of a comprehensive monitoring plan once more information about Project locations, design elements, implementation phasing and timing, and funding become available. The potential approaches, parameters, and methods identified in this Monitoring Framework will need to be further evaluated during development of a comprehensive monitoring plan based on the priorities and resources available to the program and program partners.

Goals and Objectives of the Monitoring and Adaptive Management Program

The primary goal of a coordinated Monitoring and Adaptive Management Program is to evaluate the effectiveness of Recovery Plan actions and use that information to most effectively implement future Project elements. Specific objectives of the Monitoring and Adaptive Management Program include:

1. Assessing physical process and ecosystem responses across Planning Areas and geomorphic reaches, within Project sites, and associated with individual design features over intra-annual to decadal time scales;
2. Identifying and guiding effort to fill data gaps needed for effective planning, design, implementation, and post-project evaluation of effectiveness;
3. Refining the inputs to and reliability of conceptual and predictive modeling tools that are the basis for a decision support system;
4. Informing adaptive management of Stewardship Program elements, Project types, design features, and monitoring and analysis methods;
5. Guiding construction phasing; and
6. Evaluating progress toward meeting TMDL and other regulatory compliance objectives.

The Elk River Recovery Plan will result in short-term impacts to the channel bed and banks, wetland and riparian habitat, listed salmonids, and agricultural lands. Compliance with CEQA, NEPA, ESA, and other applicable federal, state, and local regulatory statutes (refer to Section 7) will require reporting of short-term impacts to these resources; and a targeted, objective-driven monitoring program will be essential to track the net balance of measurable short-term impacts and longer-term outcomes during each phase of Project implementation.

The objective of this Monitoring Framework is to provide the necessary context, conceptual basis, and structure to guide future development of the Monitoring and Adaptive Management Program and associated comprehensive monitoring plan described above.

Structure of the Monitoring Framework

The Monitoring Framework defines key questions for six functional categories of anticipated physical and ecological responses to Recovery Plan actions and identifies a strategy for addressing these questions through monitoring project effects and longer-term trends at nested spatial and temporal scales.

The six functional categories of anticipated physical and ecological responses include:

- Hydrology and hydraulics,
- Water quality,
- Geomorphology,
- Fish habitat and populations,
- Benthic macroinvertebrates, and
- Riparian vegetation.

A general assessment strategy is outlined for each functional category that includes discussion of approach, rationale, parameters, evaluation, and integration of monitoring elements. The framework for each functional category also includes recommendations for monitoring at nested spatial scales; the timing and periodicity of data collection; as well as general survey protocols, analytical methods, and evaluation procedures (e.g., how results may be used within a decision support system and adaptive management context). The primary spatial scales that may be incorporated into the framework for each functional category include, from largest to smallest: (1) the Stewardship Program Area, (2) individual Recovery Plan areas (i.e., Planning Areas 1-4), (3) geomorphic reaches, (4) Project sites, and (5) individual design features or recovery actions within Project sites. The framework for each functional category also addresses the potential value of incorporating control reaches (within the Stewardship Program Area or in similar river systems) and Before-After Control-Impact (BACI) methodologies to evaluate responses where feasible.

Numerous organizations have conducted different types of physical and biological monitoring and/or collected relevant data in the Stewardship Program Area to achieve specific regulatory and resource management objectives. Although these past and ongoing monitoring efforts vary in their objectives, methods, and periods of record; the information generated by them is nonetheless critical for defining existing conditions from which to evaluate future changes in response to Recovery Plan implementation.

Select historical monitoring and data collection efforts in the Recovery Plan area with relevance to the monitoring framework include the following (Figure 8-1 and Table 8-1):

- Humboldt Redwood Company's Aquatic Habitat Trends Monitoring (ATM) sites initiated with adoption of Pacific Lumber Company's Habitat Conservation Plan in 1999 and continued by HRC in 2008 with the goal of collecting data to determine if salmonid habitat conditions across the property meet or are trending towards Aquatic Properly Functioning Conditions; primary measurement parameters include channel dimensions, bed surface particle size, pool characteristics, large woody debris characteristics, water temperature, and riparian canopy cover.
- Humboldt Redwood Company's Hydrologic Trends Monitoring (HTM) stations; primary measurement parameters include streamflow, turbidity, and suspended sediment concentration.
- Salmon Forever's monitoring of streamflow, turbidity, and suspended sediment concentration at two stations, one in South Fork Elk River and another in North Fork Elk River.

- Representative Intensive Study Sites established in geomorphic reaches throughout the Recovery Plan area during the Elk River Recovery Assessment in 2014; primary measurement parameters include channel dimensions; bed, bank, and floodplain particle size; pool characteristics; large woody debris characteristics; and riparian canopy cover.
- Stream flow, stage and water quality monitoring locations established throughout the Recovery Plan area during the Elk River Recovery Assessment in 2014 and during subsequent planning efforts conducted by the California Trout technical team.
- Historical cross-sectional channel surveys conducted prior to 2014 and reoccupied during the Elk River Recovery Assessment, as well as transect and longitudinal profile surveys at new locations during the Elk River Recovery Assessment and during subsequent planning efforts conducted by the California Trout technical team.
- Detailed field assessment of fish habitat and channel conditions, large woody debris loading and functions, species composition and structure of riparian vegetation, and invasive plant species conducted by the California Trout technical team in the South Fork Elk River and Elk River estuary portions of the Recovery Plan area as part of the South Fork Elk River 10% Design Project and Elk River Estuary 10% Design Project (in preparation).
- Dissolved Oxygen monitoring sites established and monitored by California Trout; measurement parameters include water temperature, dissolved Oxygen concentration, and conductivity.
- Sites where the North Coast Regional Water Quality Control Board conducts Stream Condition Index monitoring; data collection includes benthic macroinvertebrate sampling and synoptic sampling of turbidity, water temperature, and other water quality parameters.
- CDFW Coastal Monitoring Program spawning surveys upstream of Planning Area 3 (2008- present), estuarine fish sampling from 2005-2010 (Wallace et al. 2015), and various stream inventory reports to assess habitat conditions for anadromous salmonids.

More specific information and references related to these efforts can be found in Appendix D of the Elk River Recovery Assessment. These and other organizations that collect, process, store, and analyze physical and biological data throughout the watershed are considered key partners in developing and implementing the Monitoring and Adaptive Management Program. A more comprehensive database of historical and existing information potentially useful in defining existing conditions from which to evaluate future changes in response to Recovery Plan implementation will be compiled during development of the comprehensive monitoring plan described above.

Results from the Monitoring and Adaptive Management Program should be incorporated within a structured decision support system (DSS) to adaptively manage ongoing Recovery Plan actions and analysis methods. A comprehensive DSS should include both conceptual and quantitative models grounded in processes-based hypotheses important to management decisions; with the goal of providing a structure and process for coherent, complete, and recurrent evaluation of future planning and design alternatives. An objective-driven monitoring program that provides the necessary empirical information to inform conceptual and quantitative models and test hypotheses is an essential component of a DSS.

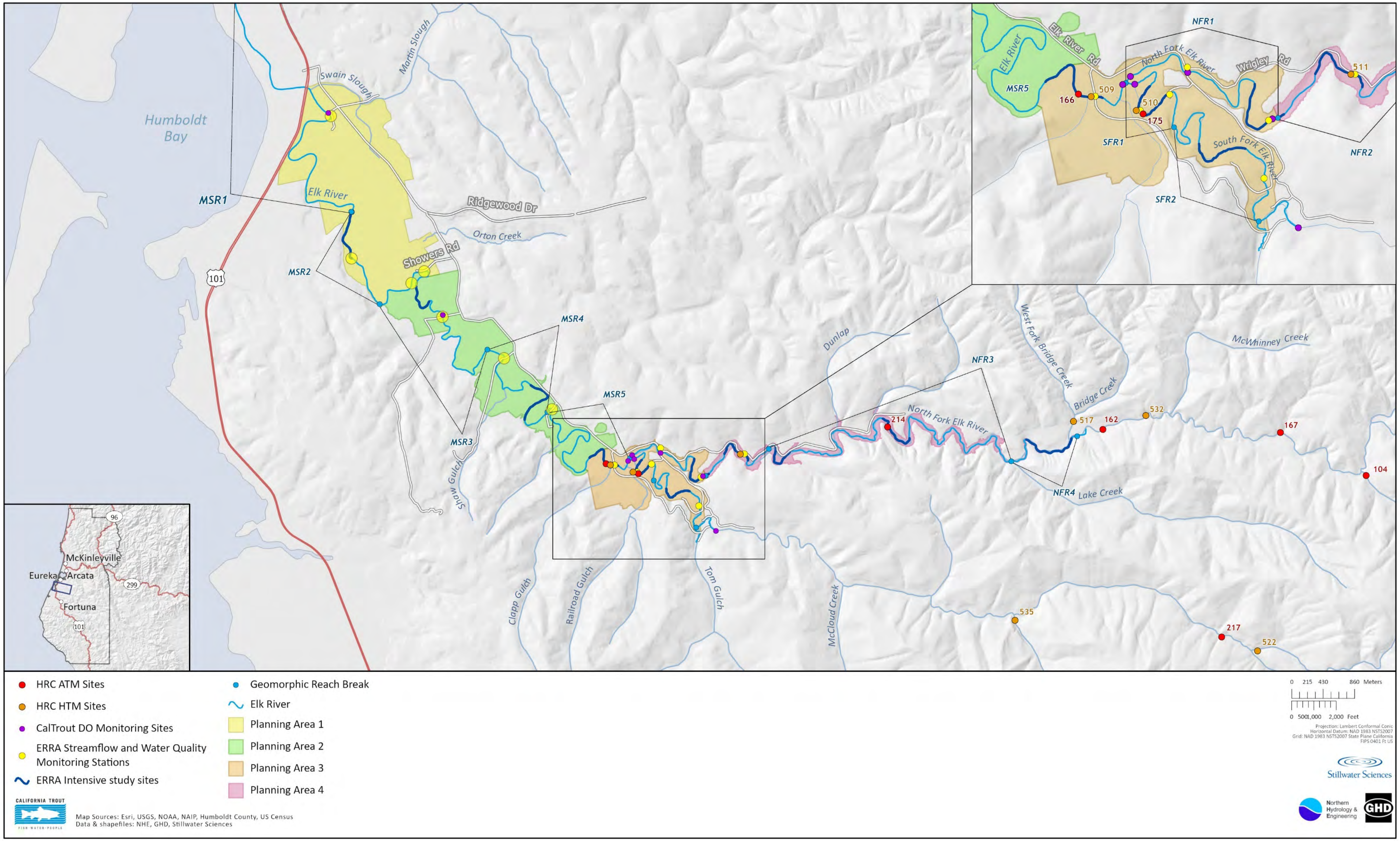

Figure 8-1. Location of select historical data collection and monitoring efforts in the Stewardship Program Area with relevance to the monitoring framework.

Table 8-1. Select historical data collection and monitoring efforts in the Stewardship Program Area with relevance to the monitoring framework.

Monitoring Site/Reach			Hydrology and Hydraulics				Water Quality				Geomorphology				Fish Habitat and Populations					Riparian Vegetation			
			Streamflow	Flow Hydraulics	Flow Inundation	Groundwater	Suspended Sediment & Turbidity	Temperature	Dissolved Oxygen	Conductivity & Salinity	Sediment Supply, Transport, & Storage	Channel Geometry and Morphology	Bed Material Composition	Large Wood Loading	Habitat	Distribution and Abundance	Juvenile Salmonid Growth & Survival	Adult Salmonid Abundance	Benthic Macroinvertebrates	Shaded stream canopy	Vegetative cover	Species diversity	Invasive weed cover
Planning Area 1		MSR1	x	x	x	x	x	x	x	x		x	x		x	x	x			x	x	x	x
		MSR2	x	x	x	x	x	x		x	x	x	x	x	x	x	x			x	x	x	x
Planning Area 2		MSR3	x	x	x		x	x	x		x	x	x	x					x	x	x	x	x
		MSR4	x	x	x	x	x	x			x	x	x	x					x	x	x	x	x
Planning Area 3	MS	MSR5		x	x				x		x	x	x	x					x	x	x	x	x
		ATM 166										x	x	x	x	x				x	x		
		HTM 509	x				x	x															
	NF	NFR1		x	x				x		x	x	x	x	x				x	x	x		x
	SF	SFR1		x	x	x			x		x	x	x	x	x					x	x	x	x
		SFR2	x	x	x	x		x	x		x	x	x	x	x				x	x	x	x	x
		HTM 510	x				x	x															
		ATM 175										x	x	x	x	x			x	x	x		
Planning Area 4		NFR2									x	x	x	x	x			x					
		NFR3									x	x	x	x	x			x					
		NFR4										x	x	x	x			x					
		HTM 511	x				x	x															
		ATM 214										x	x	x	x	x				x	x		
Upstream of Stewardship Planning Area		HTM 517	x				x	x															
		ATM 162										x	x	x	x	x				x	x		
		HTM 532	x				x	x															
		ATM 167										x	x	x	x	x				x	x		
		ATM 104										x	x	x	x	x				x	x		
		HTM 535	x				x	x															
		ATM 217										x	x	x	x	x				x	x		
		HTM 522	x				x	x															

8.2 Hydrology and Hydraulics

Many key strategies of the Recovery Plan are aimed at restoring natural hydrologic regimes and flow hydraulics in the Stewardship Program Area. The hydrology and hydraulics (H&H) component of the Elk River Monitoring Framework, outlines the objectives, methods, parameters, and performance standards that will allow stakeholders to measure the effectiveness of H&H-related restoration measures over time and under a range of environmental conditions. Key monitoring questions to address project effectiveness include:

- Are Recovery Plan actions reducing the frequency, magnitude and duration of nuisance flooding?
- Are inundation targets met at design flows?
- Was the project successful in improving and restoring natural tidal flow regimes and flow pathways?

The proposed monitoring framework will also address several key monitoring objectives aimed at filling critical data gaps to inform planning and design efforts, including:

- Characterizing groundwater and soil moisture dynamics in select floodplain wetland sites to shed light on the depth, duration, frequency and timing of saturation, which will govern wetland potential and influence wetland design parameters (e.g., planting design, etc.).
- Characterizing the hydrologic regimes and flow pathways of numerous tributaries in key Planning Areas to ascertain restoration potential and inform design of confluence (e.g., Tom's Gulch), wetland (floodplain wetlands in SFR2) and tidal areas (e.g., Swain Slough).

Our approach will entail tracking pre- vs. post-project H&H conditions and will include qualitative and quantitative monitoring of streamflow, channel hydraulics, and flow inundation. In addition to facilitating adaptive management through identification of project maintenance needs, the proposed framework will help refine restoration strategies for future projects through the incorporation of lessons learned.

Streamflow

Approach and Rationale

Monitoring of streamflow will focus on characterizing stage and discharge at numerous strategic locations throughout the project reach to help determine the extent to which restoration interventions were successful in enhancing channel conveyance capacity, reducing flooding and restoring natural tidal flow regimes and flow pathways. This will involve the collection and analysis of continuous pre- and post-project stage data from a network of pre-existing, long-term stream gages with integrated data loggers. At a minimum, the streamflow monitoring network will occupy the gaging stations established in the ERRA (Table 8-1 and Figure 8-1). One additional long-term gaging station should be installed to provide continuous measurements of stage, discharge and key water quality parameters (e.g., turbidity, temperature) in the MSR2 Reach downstream of the Steel Bridge.

Pre-existing, long-term gaging sites will be supplemented by the installation of several short-term continuous streamflow monitoring stations at select locations of interest in Planning Areas 1-3. For example, installation of gaging stations in the tidally influenced project sites in Planning Area 1 (e.g., DFW and Swain Slough project sites) will facilitate effectiveness monitoring of Recovery Plan Actions for restoration of natural tidal flow regimes and will be augmented by water quality measurements detailed in section 8.3. Instrumentation of Orton Creek (located near the upstream boundary of Planning Area 1) with a stage data logger, coupled with periodic velocity and discharge measurements will also help inform future design efforts and habitat enhancement potential in the confluence area. The design of project sites and individual design features would similarly benefit from additional continuous streamflow gaging in Planning Area 2 (i.e. Shaw Gulch and Unnamed tributary near Sta. 47500 on river left, upstream of Elk River Ct).

The remainder of new gaging stations will be installed in select tributaries and confluence zones in Planning Area 3 with the objective of characterizing hydrologic regimes to inform design of confluence, backwater, and wetland features. For instance, instrumentation of two unnamed tributaries that flow into proposed floodplain wetland features in SFR2 will shed light on the timing, magnitude and seasonality of surface water inflows to these features, which will influence wetland design parameters. Likewise, continuous short-term monitoring of the Tom's Gulch-South Fork confluence area will provide important hydrologic data pertinent to the design of the Tom's Gulch delta and upstream sediment detention basins. This may be especially useful as the existing hydrodynamic model domain does not extend this far upstream.

It may also be prudent to install short-term streamflow gaging stations in several, potentially consequential, smaller tributaries and springs to enable more detailed evaluation of fish habitat potential, which is strongly influenced by hydrological, hydraulic, water quality conditions. The following tributaries/springs are provided as examples:

- Tributary/springs along Swain Slough (Unnamed) (3) – downstream of Orton Creek
- Tributary downstream of Zanes Road on river left near Sta. 35,000
- Spring near Sta. 21,000 on river left

Stage observations at established locations will be augmented with periodic velocity and discharge measurements over a range of flow and tidal conditions to enable the construction and/or refinement of stage-discharge relationships. Where possible, any additional long-term gaging stations will be installed near bridge crossings as to ensure safe access during high flow events. In some cases, it may be necessary to extend observed stage-discharge relationships using HST design model results. These synoptic field campaigns may opportunistically sample additional locations of interest as they arise and, in many cases, may include the collection of additional water quality parameters detailed in section 8.3. Much of the field data describe above will be used as calibration and validation data for future hydraulic modeling to inform design efforts and potentially to evaluate as-built conditions.

Parameters and Evaluation

Stream velocity and discharge measurements at low to moderate flows will be collected using either mechanical (Price AA or Pygmy) or electromagnetic (Hach FH950) current meters. High flow measurements of discharge and velocity profiles will be collected with Acoustic Doppler Current Profilers (ADCP) deployed in a small, tethered boat and manually pulled across measurement transects. All new stage data loggers (water-level loggers) will be housed in PVC stilling wells and secured to t-posts in the channel. Stage data will be recorded at six-minute intervals in accordance with the existing gaging stations. Streamflow parameters will be monitored in coordination with other relevant functional categories (i.e., water quality and fish habitat).

The continuous and synoptic stage, velocity and discharge measurements, coupled with hydraulic modeling results will enable the computation of a number of potential parameters and performance measures that will assist in project design and the quantitative tracking of project efficacy, including:

- Stage-discharge relationships
    - Deviations (positive departure) from existing conditions indicates increased channel and floodplain capacity and reduced flood frequency
- Percent change in channel and floodplain conveyance capacity

- Change in the frequency of overbank flooding
- Change in the timing, duration, magnitude (tidal prism) and longitudinal extent of tidal flows
- Flow exceedance
- Pre- vs. post-implementation statistics, trends and correlations at individual stations and between stations
- Pre- vs. post-implementation statistics, trends and correlations at project site and reach scales using hydraulic modeling results.

Flow Hydraulics

Approach and Rationale

Understanding how water moves into and through the project site is critical to developing appropriate design elements and quantifying project success across all six functional categories (e.g., fish habitat, riparian vegetation, etc.). Key hydraulic parameters relevant to Recovery Plan objectives and actions include velocity, depth and water surface elevation. As outlined in the streamflow section above, continuous observations of water surface elevation (stage) will be supplemented with periodic spot measurements of velocity and depth along monumented cross-sections at select short- and long-term gaging stations. These measurements will facilitate computation of stage-discharge rating curves, as well as afford snapshots into local hydraulics that may inform fish habitat monitoring and provide calibration and validation data for hydrodynamic modeling. Synoptic velocity and depth observations will also be collected pre- and post-implementation at select project sites and design features to support effectiveness monitoring of fish and macroinvertebrate habitat over time. Site-specific field observations will be supplemented by validated hydrodynamic modeling results of as-built conditions to provide better spatial coverage and enable the calculation of reach-wide performance measures pertinent to H&H and aquatic habitat objectives.

The effectiveness of actions to mitigate nuisance flooding will primarily focus on monitoring water surface elevations and stage-discharge relationships in strategic locations proximal to known flood-prone areas, such as: Berta Road, Showers Road, Elk River Road at the Flood Curve, Elk River Court and Zanes Road. Field measurements will complement and validate hydrodynamic modeling results related to the frequency, timing, duration, and magnitude of flooding in the key flood-prone areas.

Parameters and Evaluation

The approach described above will provide information to support the calibration and validation of future design and as-built hydraulic modeling, as well as the computation of a variety of potential performance measures from field observations and model results, including:

- Percent change in area meeting habitat criteria thresholds outlined in the Fish Habitat section (e.g., depths > 1 ft, velocities < 1ft/s)
- Reductions in water surface elevations and flood velocities for high flow events in areas targeted for mitigation of nuisance flooding.
- Increased depths and reduced velocities within specific design features intended enhance in-channel habitat.
- Pre- vs. post-implementation statistics, trends and correlations at individual stations and between stations
- Pre- vs. post-implementation statistics, trends and correlations at project site and reach scales using hydraulic modeling results.

Flow Inundation

Approach and Rationale

Recovery Plan objectives and proposed actions seek to simultaneously enhance floodplain connectivity in select areas – particularly in the tidally-influenced lower reaches and lower lying areas adjacent to the channel that may have functioned as alcoves, backwater areas, etc. – while also enhancing channel capacity and reducing overbank flooding in other areas. For example, proposed slough channel and off-channel pond enhancements, replacement of derelict drainage infrastructure, levee modifications and floodplain recontouring in the tidal reaches will serve to restore natural lateral and longitudinal connectivity. In contrast, proposed channel widening, and vegetation modification in the upper reaches, and re-activation of filled in backwater areas, side channels, and alcoves is intended to ameliorate documented nuisance flooding by reducing the frequency, duration, and magnitude of overbank events onto historically, less frequently inundated terraces or floodplains and increase inundation of features that serve as winter rearing habitat.

Monitoring efforts to characterize pre- and post-implementation flow inundation conditions will be multifaceted and will have important connections to key questions and monitoring objectives identified within other functional monitoring categories (e.g., fish habitat). Flow inundation extents may be monitored using a combination of synoptic flagging campaigns, drone surveys, photo points and landowner observations made during select pre- vs. post-implementation high flow events. As with other H&H monitoring categories, field measurements of flow extents will help in the design project elements and in the calibration and validation of as-built modeling scenarios. Hydraulic model results will, in turn, facilitate reach-scale estimates of out-of-bank flood inundation extent, area, frequency and duration. Hydraulic modeling will also help to evaluate the extent to which project actions improved off-channel habitat over a range of ecologically important flows.

Parameters and Evaluation

The approach described above will support the computation and tracking of a variety of potential H&H and habitat performance measures, such as:

- Area and frequency of inundation of off-channel habitats over a range of flows (i.e., winter baseflows, winter floods, and spring recession). To ensure suitable habitat quality as well as quantity, this will be coupled with field measurements and model predictions of relevant flow and water quality parameters (e.g., depth, velocity, temperature and D.O.), and distance to cover.
- Extent of frequent flooding as measured achievement of inundation targets and specified design flows to reduce nuisance flooding.
- Frequency, duration, magnitude and area of floodplain inundation in tidal sections of Planning Area 1 focused on restoration of natural tidal flow regimes.

8.3 Water Quality

Suspended Sediment Concentration and Turbidity

Approach and Rationale

Monitoring of suspended sediment concentration (SSC) and turbidity will focus on expanding the existing SSC and turbidity sampling network, which is primarily focused on the North Fork and South Fork Elk River, into the lower Mainstem Elk River Reaches. Monitoring SSC and turbidity over the Stewardship Project area can help to inform current planning and design actions, and to better understand Project effects. Collected SSC and turbidity data can be analyzed directly or can be used as calibration and validation data for future modeling efforts.

SSC and turbidity sampling should include both continuous and synoptic sampling. The continuous sampling should follow the turbidity threshold sampling (TTS) approach used at the existing HTM long-term gaging sites. One additional TTS station should be added to the long-term gaging station proposed for Streamflow monitoring in Planning Area 2. Additional synoptic SSC and turbidity sampling should occur at the monitoring network established in the ERRA, and any additional short-term streamflow monitoring sites as described above.

Parameters and Evaluation

Synoptic sampling will consist of depth integrated SSC sampling following USGS protocols at each long-term and short-term sampling site. Depth integrated sampling will occur over a range of flow conditions. Synoptic turbidity grab samples will be collected at the time of each depth integrated sample. Depth integrated SSC samples will be analyzed for total SSC and particle size distribution. Turbidity can be assessed using a field turbidimeter or correctly stored and analyzed at the laboratory.

The TTS station will follow existing TTS sampling protocols used at the Elk River HTM sites. SSC will be pump sampled at predefined intervals once river stage or turbidity exceeds a threshold; turbidity will be is continuously monitored. An important step in is to calibrate the TTS point SSC measurements to the depth integrated SSC each year.

At station statistical analysis and between station trend analysis can be conducted with the SSC data. An important component of the Stewardship Project and channel modifications is to increase channel capacity and velocity, which should increase sediment transport of the non-cohesive sediment, especially the coarse silt and fine sand. The SSC particle size distributions can be used to better understand changes in sediment transport and particle class transport.

Temperature

Approach and Rationale

Continuous and synoptic temperature measurements should be conducted, at minimum, during the warm season (e.g., March through October) when stream temperatures most influence salmonids and other ecosystem functions (e.g., dissolved oxygen). Stream temperature and thermal regimes are important physical parameters for aquatic ecosystems, and can dictate species distributions, productivity, and abundance. For example, salmonid species have critical temperature thresholds over various life stages. Pre and post project temperature monitoring can inform the short-term effects of vegetation removal and management on in-stream temperatures.

Temperature sampling should include both continuous and synoptic sampling. Continuous temperature loggers can be added to all long-term and short-term monitoring sites used for monitoring. Synoptic temperature sampling can occur in existing and constructed off-channel habitats, smaller tributaries and channels, wetlands, and drainage infrastructure. Synoptic depth integrated temperature sampling should also be conducted to understand temperature stratification in pools, and within the estuary in Planning Area 1 to understand temperature and salinity related stratification.

Parameters and Evaluation

At station statistical analysis and between station trend analysis can be conducted with the temperature data. Specific temperature metrics include, but are not limited to:

- Daily mean, minimum, and maximum temperatures,

- Maximum weekly average temperature (MWAT) and maximum weekly maximum temperature (MWMT), and
- Species specific maximum or critical temperature suitability thresholds.

Dissolved Oxygen

Approach and Rationale

Like temperature, dissolved oxygen is another important parameter for aquatic ecosystems and species productivity and distribution. Continuous dissolved oxygen sampling with data sondes should be considered at the long-term gaging sites during spring, summer and fall periods. Continuous dissolved oxygen measurements are likely not required during the winter period. Synoptic dissolved oxygen measurements should occur at all remaining long-term and short-term sampling sites; and can simultaneously occur in existing and constructed off-channel habitats, smaller tributaries and channels, wetlands, and drainage infrastructure during synoptic temperature monitoring. Sampling should also occur within the estuary reach of Planning Area 1, as brackish and saline areas have lower dissolved oxygen levels than freshwater. Sampling should include methods to detect depth stratification of dissolved oxygen particularly in conjunction with salinity related stratification.

Previous dissolved oxygen sampling during the ERRA indicated low dissolved oxygen levels with specific Elk River reaches during the later summer to fall months. The increase in channel capacity and velocity anticipated with the Stewardship Project should increase dissolved oxygen levels within these reaches over existing conditions.

Parameters and Evaluation

At station statistical analysis and between station trend analysis can be conducted with the dissolved oxygen data, using daily, annual, and seasonal means, minimums, and maximums. Dissolved oxygen levels can also be compared to salmonid and other regulatory dissolved oxygen thresholds.

Conductivity and Salinity

Approach and Rationale

Conductivity and salinity (referred to as salinity from here forward) only needs to be monitored within the estuary portions of Planning Area 1. Continuous salinity sampling should be made year-round at all short-term monitoring sites within the estuary. Synoptic salinity measurements should be made at all estuary or tidal constructed off-channel habitats, smaller tributaries and channels, wetlands, and drainage infrastructure simultaneously with temperature and dissolved oxygen. Depth integrated salinity sampling should occur to better understand salinity related stratification with Planning Area 1.

Salinity measurements can also help to understand increases in tidal prism from Stewardship Project actions compared to existing conditions. Increases in upstream salinity extent can also be used as an indicator of long-term sea-level rise.

Parameters and Evaluation

At station statistical analysis and between station trend analysis can be conducted with the salinity data, using daily, annual, and seasonal means, minimums, and maximums.

8.4 Geomorphology

Channel and floodplain geomorphic processes, morphology, and composition are the physical template upon which aquatic and riparian ecosystems are created and maintained. The Recovery Plan goals of restoring a properly functioning, self-maintaining, and resilient ecosystem; recovering beneficial uses of water; and abating nuisance flooding in Elk River are intrinsically linked to the geomorphic forms and processes comprising this physical template. Monitoring dynamic geomorphic processes and corresponding changes in channel and floodplain form are therefore essential elements of a monitoring and adaptive management program intended to evaluate the effectiveness of Recovery Plan actions and guide restoration efforts.

Key questions related to the response of geomorphic forms and processes to Recovery Plan actions:

- How are Recovery Plan actions changing the amount of sediment supplied to and transported within the channel and across floodplains at the scale of individual Planning Areas and geomorphic reaches (e.g., are Recovery Plan actions reducing the supply of fine sediment to downstream reaches, does the channel transport most of the incoming sediment through the Plan Area and/or geomorphic reach)?
- How are Recovery Plan actions affecting the amount of sediment stored in the channel and on floodplains at the scale of Planning Areas and geomorphic reaches? (e.g., is there a net increase or decrease in channel sediment storage or is the channel storage capacity maintained, is the balance of sediment storage between channel and floodplain areas changing, is the channel in dynamic equilibrium)?
- How are Recovery Plan actions changing channel and floodplain morphology within a reach (e.g., is the channel aggrading or incising, narrowing or widening, becoming more complex or more simplified)?
- How are Recovery Plan actions affecting channel bank stability (e.g., is sediment being accreted to banks or eroding from banks)? If sediment is being recruited to the channel through bank erosion, how is it changing sediment storage and channel morphology within a Planning Area or geomorphic reach?
- How are Recovery Plan actions affecting the particle size distribution and texture of channel bed material (e.g., are Recovery Plan actions remediating the impacts of legacy fine sediment deposited in the channel, is the channel fining or coarsening, is the channel becoming more patchy or more uniform)?
- How are Recovery Plan actions changing the frequency, size, and depth of pools within a reach?
- How are Recovery Plan actions affecting the supply and storage of large woody debris to the channel, and how is this large wood affecting channel form and process?
- Are observed geomorphic changes the result of Recovery Plan actions or other factors?

The approach to monitoring geomorphic responses to Recover Plan actions can be divided into the following four components:

- Sediment Supply, Transport, and Storage
- Channel Geometry and Morphology
- Bed Material Composition
- Large Wood Loading

These key questions and components related to the response of geomorphic forms and processes to Recovery Plan actions have important linkages and interdependencies to the key questions and components identified within other functional monitoring categories (e.g., hydrology and hydraulic, fish habitat, riparian vegetation).

Representative locations for monitoring geomorphic components will be determined during development of a comprehensive monitoring plan based on the Project types being implemented and the stated objectives of those actions; the locations, magnitude, and extent of the anticipated process-based and form-based responses within the physical system; the relative importance of ecological responses to the anticipated geomorphic changes; and the long-term Project phasing. Humboldt Redwood Company's ATM sites, the Intensive Study Sites established during the Elk River Recovery Assessment, and the network of cross-sectional channel surveys established and reoccupied during the Elk River Recovery Assessment and subsequent planning efforts are the primary locations where existing geomorphic information has been collected and are therefore the most important locations to initially consider future monitoring to evaluate the effectiveness of Recovery Plan actions and longer-term trends. Additional spatially distributed and site-specific monitoring locations will need to be considered based on the anticipated physical responses to specific Project actions, phasing of Project sites, and data gaps within historical monitoring networks. Provided sufficient information exists to characterize pre-project conditions at the scale and resolution (e.g., Planning Area, geomorphic reach, or Project site) necessary to detect anticipated responses to Recovery Plan actions, these geomorphic components are best monitored following Project implementation at a periodicity triggered by exceedance of flow magnitude-duration thresholds that control flow connectivity, sediment transport, and change in channel and floodplain morphology.

The suite of necessary geomorphic monitoring components, measurement locations, triggers for conducting measurements, and duration of monitoring are all informed primarily by the Decision Support System. The conceptual model of existing hydrogeomorphic processes and quantitative HST model developed during the ERRA and refined during development of this Recovery Plan are two important existing tools for informing hypothesis-driven geomorphic monitoring within the Decision Support System. Adaptive management should allow for the future location, timing, frequency, and duration of geomorphic monitoring to change in response to new knowledge of the state, trajectory, and anticipated future responses within the physical system.

The approach and rationale, general parameters and evaluation methods, and potential suitability of existing information for characterizing pre-project baseline conditions are discussed below for each geomorphic monitoring component.

Sediment Supply, Transport, and Storage

Approach and Rationale

The balance between sediment supply and transport fundamentally controls within-reach sediment storage; channel and floodplain morphology; the grain size distribution of bed, bank, and floodplain material; and the rate of change in these characteristics. The form and rate of change then has important linkages to aquatic and riparian habitat that affect ecosystem functions, the distribution of streamflow between the channel and floodplains that affects nuisance flooding and habitat availability; and the recruitment and transmission of sediment sources that affect water quality in downstream reaches.

A sediment budget is an organizational tool to help understand sediment supply, transport, and storage patterns within a system. Sediment budgets vary in their spatial scale and complexity, but can be simplified to input, output, and storage terms with the following relation: Input (I) – Change in Storage (ΔS) = Output (O).

Parameters and Evaluation

Fluvial sediment budgets were developed in non-tidal reaches of Elk River during the Elk River Recovery Assessment and this Recovery Plan to assess sediment transport and storage patterns at several spatial scales: (1) the Recovery Plan area; (2) the North Fork, South Fork, and Mainstem Elk River downstream of the North Fork and South Fork confluence; and (3) individual geomorphic reaches. Individual geomorphic reaches are the finest resolution of the sediment budget since they were delineated as units within which fluvial geomorphic forms and processes are relatively homogenous. Examining the sediment budget at these spatial scales demonstrates unique responses to potential management actions throughout the Project area and helps inform appropriate strategies for ecosystem restoration, recovering beneficial uses of water, and abating nuisance flooding.

An unsteady application of the HST model has been the primary tool for predicting sediment responses in the Elk River system. Sediment budgets were developed for existing conditions and Project conditions based on the HST predicted sediment fluxes into and out of Planning Areas and geomorphic reaches. The input term of the sediment budget accounts for sediment generated from upstream reaches and tributaries, including within-channel and floodplain sediment sources generated through erosion. Change in storage was computed as the difference between erosion and deposition within an area. The outputs were calculated using the sediment budget equation above (Input – Change in Storage). The sediment budget excluded the tidal reaches (MSR1 and MSR2) which have more complex routing of tidally influenced water and sediment.

If future resources and technological capabilities allow for the cost-effective development of detailed digital terrain models from repeat high-resolution topographic and/or bathymetric surveys before and after implementation and following high flow events that trigger monitoring, estimates of change in storage based on predicted sediment fluxes may be adapted or augmented by reach-scale estimates of volumetric changes in bed, bank and floodplain material calculated from elevation differences between surfaces.

The sediment budget approach to evaluating sediment fluxes and storage changes provides a process-based foundation for developing, refining, and interpreting the results of other monitoring components related to channel morphology and bed material composition.

Channel Geometry and Morphology

Approach and Rationale

Complex channel morphology provides the physical basis for diverse, high-quality aquatic and riparian habitat. The assessment strategy focuses on remote sensing approaches at the scale of the Stewardship Project Area, individual Recovery Plan areas, and geomorphic reaches, (e.g., using aerial photography and digital terrain models developed from LiDAR, UAV, topographic, and/or bathymetry data); as well as geomorphic mapping at the scale of Project sites and design features within Project sites to inform and improve the design process. The assessment strategy should include a network of longitudinal profiles, channel transects, and topographic surveys of design features that are periodically re-surveyed over time to document physical evolution, and to correlate short-term and long-term changes with flow characteristics, morphology, sediment supply, and other driving factors. Assessments may also include documenting naturally formed and maintained features to better understand the mechanisms that are successfully maintaining them.

Parameters and Evaluation

The approach described above will provide information for a variety of potential performance measures. Many additional layers and/or spatially distributed statistics will be generated (e.g., the number and size of bars and pools, bank lengths, planform statistics, measures of topographic variation, and hydraulic model outputs, among other). All these layers and outputs could be combined with additional data describing physical attributes or biological attributes.

Potential performance measures extracted from the data described above may include:

- Channel sinuosity and/or radius of curvature determined from air photo analysis.
- Longitudinal profiles of thalweg and water surface elevations, channel and water surface slopes.

- Variability of bed elevations in a digital terrain model.
- Variability in channel width (or other aspects of channel geometry), as determined from air photos, channel surveys, or topographic and bathymetric data.
- Channel cross sectional area, width to depth ratio, and entrenchment.
- Residual pool depths, pool frequency and spacing, pool area and volume determined from longitudinal profiles and other surveys.
- Frequencies, areas, or lengths of specific geomorphic features identified on geomorphic maps and supplemented by survey data.
- Frequencies or areas of bars or pools as mapped on air photos and supplemented by survey data.
- Bank instability and/or erodibility index inventory that is descriptive of the type and mode of bank instability.
- Floodplain erosion and depositional patterns, height of floodplain above main channel thalweg, avulsion/breach geometry, formation of floodplain flow paths.

The data and products of these physical assessments are key to integrating analyses of geomorphic forms and processes with fish habitat and riparian vegetation assessments. New topographic and bathymetric data will also be useful as a baseline for site design and for updating/constructing 1- D and 2-D hydraulic models.

Bed Material Composition

Approach and Rationale

Bed material composition reflects the quantity and size distribution of the sediment supply, the balance between sediment supply and transport rates, and the direction channel morphology may be trending towards aggradation or degradation. Bed material composition also has important linkages to hyporheic and hydraulic flow characteristics, benthic macroinvertebrate assemblages and productivity, fisheries habitat quantity and quality (e.g., spawning habitat and emergent success), and wetland and riparian vegetation establishment and growth.

Bed material composition is typically characterized by mapping bed surface textures (i.e., facies), pebble counts of bed surface material, and by bulk sampling bed material within representative sites or reaches. Facies mapping may also be cost-effectively achieved using digital image-processing and computer software methods in areas where high resolution aerial imagery can be obtained with a UAV. Facies mapping, pebble count, and bulk sampling data can then be integrated to calculate area-weighted bed material grain size distributions for a facies type or geomorphic feature type throughout a site or reach. This sampling and analytical approach was used within intensive study sites throughout the Recovery Plan area to support development of a conceptual model of hydrogeomorphic processes and parameterize the HST model (e.g., sediment grains size distribution, effective diameter, porosity, and bulk density) during the Elk River Recovery Assessment.

Parameters and Evaluation

The approach involves mapping polygons representing bed surface sedimentary facies within the approximate bank toe elevations onto field tiles following conventions of Buffington and Montgomery (1999). The median particle size (D50), the D84 (that particle size at which 84% of the grain size distribution is finer), and the D16 (that particle size at which 16% of the grain size distribution is finer) are typically visually estimated for each sediment facies polygon and calibrated with pebble counts, as necessary. Facies polygons should also be classified into geomorphic feature types, with an associated activity level (or relative residence time) related to height above the thalweg, degree of vegetative cover, and particle characteristics. Mapping suitable spawning gravel availability based on particle size criteria is another potential important attribute rather to consider in monitoring changes in bed material in gravel-bedded and coarser reaches.

An important component of the approach is to determine the bulk density, porosity, and grain size distribution of channel bed deposits through bulk sampling and laboratory analysis of sediment samples. Bulk sample locations are typically selected during facies mapping to represent the dominant (i.e., most aerially extensive) facies types.

Area-weighted average bed particle size distributions can then be calculated from facies areas and bulk sample results, and a single average bed particle size distribution may be calculated for the study site or reach by weighting the cumulative percent size distribution for each facies type according to the total mapped area occupied by that facies type.

The facies maps and associated particle size information can be used as an overlay with fish habitat mapping (e.g., assess suitable spawning or rearing habitat based on specific criteria) and/or as a grain attribute for modeling. The riparian vegetation assessments can also utilize substrate mapping information on bars and floodplains.

Large Wood Loading

Approach and Rationale

From a geomorphic perspective, large logs (with or without rootwads) and complex log jams are important features that help form and maintain channel morphology, store and sort sediment, and create hydraulic complexity in low gradient coastal streams like the Elk River within the Recovery Plan area. Large wood pieces and jams can also function as key hydraulic and geomorphic grade controls that influence channel aggradation or degradation and flow connectivity between the channel, floodplain, and other off channel features. Describing the location, size, geometry, and functions of instream large wood quantity is therefore fundamental to assessing the physical process and ecosystem responses to Recovery Plan actions as part of a monitoring and adaptive management program.

Parameters and Evaluation

A comprehensive large wood survey involves documenting the occurrence, location, size, and function of all large wood pieces, key pieces, and wood jams within the bankfull channel. Key pieces (i.e., logs or root wads that are independently stable during larger flood events and have the potential to retain more mobile pieces) are defined based on length, diameter, and/or volume criteria. Wood jams are defined as a group of at least three key pieces where individual pieces are touching at least one other key piece. Large wood pieces are typically tallied into classes based on length and diameter. Additional information regarding the features and function of large wood should include species, condition, stability, input mechanism, pool formation, and sediment storage.

The primary metrics for describing large wood loading are large wood piece frequency (i.e., pieces per unit length), key piece frequency, wood jam presence and distribution, and wood volume. Wood volumes are typically calculated from tally data. The deficit of large wood in a planning area or reach relative with respect to regional large wood targets is another useful parameter to include when evaluating large wood within a Project reach.

8.5 Fish Habitat and Populations

A core component of the Monitoring and Adaptive Management Program is collection of data needed to (1) evaluate the response of fish habitats (effectiveness monitoring) and populations (validation monitoring) to implementation of Elk River Recovery Plan actions and (2) fill key data gaps in fish ecology and population dynamics. Fish habitat and population monitoring will be primarily focused on ESA-listed Coho Salmon, Chinook Salmon, and Steelhead (focal species). However, data will also be gathered to improve understanding of habitat availability, seasonal distribution, and relative abundance of Coastal Cutthroat Trout, Pacific Lamprey, Tidewater Goby, and other aquatic species encountered during monitoring. Additionally, fish habitat and population monitoring will be focused primarily on the juvenile life stages (fry, parr, and outmigrants) of focal species, rather than the adult life stages (migration from ocean and spawning). This focus is because most restoration actions are intended to improve habitat conditions for the juvenile life stages and much of the Stewardship Program Area occurs downstream of the primary spawning reaches. Where possible, however, data informing spawning habitat quantity and quality will be collected to describe potential changes in response to restoration actions, particularly near the upstream extents of Planning Area 3 and in Planning Area 4. Likewise, if funding allows, adult salmonid abundance data will be collected and evaluated to (1) better understand life history timing and diversity and population dynamics across the entire life cycle and (2) to describe trends in adult abundance and overall progress towards species recovery in the Elk River watershed. Evaluation of adult population data would integrate potential spawning survey data collected as part of CDFW's California Coastal Monitoring Program (CMP) and collection and evaluation of both adult and juvenile data will be coordinated closely with and contribute to state and federal efforts to evaluate species recovery.

Monitoring will be conducted at varying scales, to understand responses of salmonid habitat and population parameters to individual Recovery Plan actions, suites of actions within each reach and planning area, and cumulative, longer-term changes across the larger Stewardship Program Area. Evaluating fish habitat and population response to recovery actions at varying scales will help determine which actions are most successful and guide future restoration priorities and designs within each planning area though an adaptive management process. Importantly, systematic monitoring of fish habitats and populations will also fill key gaps in our understanding of the life histories, seasonal distributions, and population dynamics of focal species. Filling these data gaps will allow refinement of species conceptual models and/or development of population dynamics models that will further inform restoration strategies and integrate with a DSS to allocate resources to actions that will have the greatest population-level benefits. A secondary, but important, objective of pre-implementation fish monitoring is to gather accurate information on fish utilization and densities in each planning area to support the permitting process (e.g., take estimates) and aid in planning for fish salvage operations that will be required during project implementation.

For this framework fish habitat and population monitoring are broadly categorized into the following components, which are outlined in the sections that follow:

- Fish habitat
- Juvenile salmonid seasonal distribution, habitat use, and abundance
- Juvenile salmonid growth and survival.
- Adult salmonid abundance.

Fish Habitat

Approach and Rationale

A core goal of the Recovery Plan is to implement actions that will promote aquatic and riparian habitat remediation and the recovery of threatened salmon and steelhead populations. A primary emphasis of salmonid habitat restoration is creating and enhancing both in-channel and off-channel winter and spring rearing habitats for juvenile and pre-smolt life stages of salmonids. Actions to improve winter rearing habitat conditions are also intended to benefit summer rearing habitat conditions. Many of the planned recovery actions are be designed to accomplish one or more of the following fish habitat-related objectives in restored reaches:

- Increase pool frequency.

- o Increase surface area and residual depth of individual pools.
- o Increase large wood volume, in-channel key pieces, and woods jams.
- o Increase frequency and area of off-channel habitats that are connected over a range of flows (i.e., winter baseflows, winter floods, and spring recession)
- o Protect and restore water quality from impairment by suspended sediment and turbidity, water temperature, and dissolved oxygen.

Fish habitat monitoring will be aimed at evaluating the extent to which these objectives are achieved. Fish habitat conditions are strongly influenced by hydrological, hydraulic, water quality, geomorphic, and vegetations conditions along the stream corridor. For this reason, monitoring approaches, parameter selection and evaluation of fish habitat conditions will need to be closely coordinated with other functional monitoring categories described in this framework. For example, water temperature and dissolved oxygen directly affect fish habitat suitability and have a strong influence fish distribution, growth, and survival.

Fish habitat monitoring will be designed to evaluate the extent to which key, measurable habitat elements are responding to restoration actions at the planning area, reach, Project site, and design feature scales. This approach will entail collection of pre-implementation and post-implementation data across these scales. In general, habitat monitoring will emphasize elements that can be measured to objectively describe quantity and quality of summer and winter rearing habitats for juvenile salmonids. During collection of these data, more qualitative observations of certain habitat conditions will also be recorded.

Fish habitat monitoring will be structured to answer the following key questions:

- o How do the quantity and quality of selected fish habitat parameters change in response to Recovery Plan actions at the site, planning area, and Stewardship Program Area scales?
- o Which restoration actions provide the most benefit to fish populations in terms of increased quantity and quality of habitat and how can this information improve restoration planning and designs?
- o How do pre-implementation (baseline) and post-implementation habitat conditions compare with other regional watersheds and desired/target conditions based on more pristine, reference watersheds?

In addition to answering key questions related to effectiveness monitoring, collection of habitat data will help refine understanding of planning area scale habitat limitations (i.e., juvenile rearing habitat carrying capacity in summer versus winter). Likewise, data collected on both physical habitat and water quality parameters will be used to help explain observed patters of fish distribution, abundance, and growth within and between restoration sites and planning areas.

Primary habitat elements that will be monitored at the reach or site scales to answer these questions include the following indicators of fish habitat suitability and quality:

- o Pool frequency, spacing, and depth
- o Large wood volume, density, and wood jam frequency
- o Off-channel winter rearing habitat
- o Water depth and velocity (primarily site scale)
- o Water quality variables important to fish, including:
    - o Water temperature
    - o Dissolved oxygen
    - o Salinity
    - o Suspended sediment and turbidity.

Data informing changes in spawning gravel availability and quality may also be collected in coordination with geomorphic monitoring in reaches with potential to support spawning habitat. Finally, data from planned benthic macroinvertebrate sampling (Section 8.6), would also inform overall habitat quality and food resources for fish in sampled reaches.

Exact habitat monitoring approaches will be developed as part of a more detailed monitoring plan and implemented in coordination with monitoring activities described for the other functional monitoring categories. General approaches for habitat monitoring are outlined below.

Data on pools, large wood, and spawning gravel availability (for applicable reaches) will be collected at the habitat-unit scale at evaluated by reach in each planning area using established habitat typing and stream inventory methods. These surveys will be conducted least once prior to implementation of recovery actions and once following completion of each phase of implementation. Area of off-channel winter rearing habitat will be estimated at ecologically important stream flows through flow inundation monitoring at Project sites and/or modelling with pre-and post-implementation topographic data (Section 8.2). Velocity and depth data will also be collected pre- and post-implementation at select Project sites and design features to support effectiveness monitoring of fish habitat. These site-specific field measurements will be most relevant to habitat monitoring, but depths and velocities predicted from hydrodynamic modeling of as-built conditions (Section 8.2) be used to provide better spatial coverage and enable the calculation of reach-wide performance measures pertinent to aquatic habitat objectives. Approaches for collecting continuous water temperature, dissolved oxygen, salinity, and suspended sediment data are described in Section 8.3.

Habitat monitoring to evaluate effectiveness of specific recovery actions at achieving site-specific objectives will also be conducted. Site-specific monitoring will vary by the fish habitat objectives of each action and will be determined as part of a more detailed monitoring plan. For example, if the objective of a site is to create high quality off-channel winter rearing habitat, monitoring will focus on documenting changes in inundation extent and frequency at the site, as well as measuring water temperature and dissolved oxygen at the site to ensure water quality is suitable to support focal species.

Parameters and Evaluation

The general approach described above, along with monitoring conducted for the other functional monitoring categories, will provide data needed to calculate a variety of potential parameters for answering key fish habitat monitoring questions. Some of the key habitat parameters that may be calculated to support evaluation of program and project effectiveness at improving juvenile salmonid habitat are listed below for each habitat element.

- Pool frequency, spacing, and depth
    - Habitat type composition (percent of pool, riffle, and flatwater types by number and unit length)
    - Bankfull widths per pool
    - Maximum residual pool depth
- Off-channel winter rearing habitat
    - Length of side-channels per length of main channel length by reach
    - Area of inundated off-channel habitat with suitable depth connected during different flow exceedances (e.g., 10% exceedance, 1.25 yr. R.I.)
    - Temperature, dissolved oxygen, and turbidity of constructed off-channel features to evaluate suitability for salmonids.
- Water depth and velocity

    - Area of a Project site or restored reach meeting depth or velocity habitat suitability criteria or restoration targets selected for focal species. For example, for juvenile Coho Salmon rearing, area with depths >1 ft and velocity <0.6 ft/s.
- Large wood
    - Large wood piece frequency (pieces per unit length) by reach
    - Key piece frequency by reach
    - Large wood volume by reach.
    - Wood jam frequency, distribution, and functionality by reach.
- Water temperature
    - Daily mean, minimum, and maximum
    - Maximum Daily Maximum Temperature (MDMT) in a year
    - Maximum Weekly Maximum Temperature (MWMT), or the average of the daily maximum temperature during the warmest 7-day period of a year
    - Maximum Weekly Average Temperature (MWAT), or the average of the daily mean temperature during the warmest 7-day period in a year.
    - Frequency and duration above specific-specific temperature criteria
- Dissolved oxygen
    - Daily mean, minimum, maximum
    - Frequency and duration below species-specific minimum thresholds suitable for salmonids
- Salinity
    - Daily mean, minimum, maximum
    - Frequency and duration above maximum thresholds suitable for juvenile salmonids
- Suspended sediment and turbidity
    - SSC and TTS parameters described in the Water Quality section.

Depending on sampling scale and Project-specific objectives, one or more of these parameters will be computed and evaluated at the site, reach, and planning area scales seasonally and before and after implementation of recovery actions. For certain habitat parameter, evaluation will entail calculating percent change in area of habitat area meeting suitability criteria (e.g., depth and velocity) or conducting statical analyses of trends over time. Where feasible, habitat parameters measured within restored sites or reaches will be compared to accepted restoration targets for Northern California streams (e.g., Fitzgerald 2004) or that reported for other regional coastal streams where similar sampling methods and scales were used. Depending on phasing and spatial distribution of recovery actions, it may be feasible to evaluate habitat response (using one or more the parameters listed above) to recovery actions with a BACI sampling design and analysis framework (Stewart-Oaten et al. 1986, Smith 2002). For example, a BACI analysis could evaluate systematic changes in the relationship between large wood volume in treatment (impact) and control reaches before and after restoration (Smith 2002). The potential for applying a BACI framework for fish habitat assessment will be further evaluated as part of a more detailed and comprehensive monitoring plan developed after phasing and spatial distribution of recovery actions are finalized.

Fish Distribution, Habitat Use, and Abundance

Approach and Rationale

Monitoring approaches, parameters, and evaluation strategies for juvenile fish distribution, habitat use, and abundance are intended to answer the following key questions about where, when, and to what extent focal fish species are utilizing different portions of the Stewardship Program Area before and after implementation of recovery actions:

- Under existing conditions (pre-implementation), what is seasonal distribution and relative abundance of fish species within each planning area?
- How does juvenile salmonid seasonal distribution and relative abundance change in response to Recovery Plan actions at the site and reach scale?
- To what extent are constructed and reconnected off-channel habitat features utilized by juvenile salmonids for summer and winter rearing?
- Which recovery actions and design features provide the most benefit to salmonid populations in terms of increased juvenile salmonid habitat utilization and abundance?
    - Which sites support the highest densities of juvenile salmonids?
    - Which sites have the longest duration of use by juvenile salmonids?
- How does salmonid relative abundance at restoration sites or reaches compare with regional reference watersheds?

Data from juvenile fish monitoring would also be used to fill general data gaps on diversity and prevalence of life history strategies and movement timing to refine species conceptual models and restoration strategies and inform permitting and planning for fish salvage.

The data needed to answer these questions will be collected through systematic sampling of juvenile salmonids and other focal fish species within each reach before and after restoration. Within each planning area, sampling will be conducted monthly or quarterly for an entire year at representative index sites (one or more habitat units) in each reach to describe existing patterns in fish distribution and how they change seasonally. Depending on location and conditions (habitat complexity, streamflow, and water clarity) sampling methods at each site likely include seine netting, minnow trapping, or snorkel surveys. Detection of PIT-tagged fish at antenna arrays deployed to evaluate juvenile salmonid survival (described below) will also be used to describe seasonal distribution and movement of juvenile salmonids at the reach and planning area scales. Sampling methods will be selected with the primary purpose of capturing juvenile salmonids, but targeted sampling with gear designed to capture other species of interest may be required at certain sites (e.g., Tidewater Goby in Planning Area 1). In addition to the targeted monitoring summarized above, results from previous juvenile fish monitoring in Elk River (e.g., Wallace et al. 2015, HRC 2021) will be used to help describe seasonal distribution patterns and relative of each species in reaches where it has been conducted (Table 8-1). During each fish distribution sampling event, where possible, data on fish habitat and water quality conditions will be collected and used (along with the regular reach-scale habitat monitoring described above) to help explain factors controlling observed distribution patterns at each site.

Focused monitoring will also be conducted to (a) determine if and when focal fish species are utilizing specific restoration sites and where possible (b) describe abundance relative to other sites and reference locations. Ideally this will include seasonal sampling at locations where specific recovery actions are planned before and after restoration. PIT antenna arrays may also be deployed at certain restoration sites (e.g., entrances to constructed side channels, off-channel ponds, or reconnected tributaries) to help describe timing and duration of fish utilization relative to stream flow or other environmental variables at these sites. Site-specific monitoring approaches will be developed as part of a more detailed and comprehensive monitoring plan and informed by site-specific recovery action objectives and initial years of existing conditions monitoring.

Parameters and Evaluation

In addition to filling important data gaps on focal fish species, the juvenile fish distribution, habitat use, and abundance data described above will be analyzed to evaluate effectiveness of recovery actions at meeting their objectives and used to adaptively refine future restoration priorities, strategies, and designs. Where possible, measurable parameters will be calculated to allow objective evaluation of the key monitoring questions listed above. Potential evaluation parameters include:

- Species presence (by location and date)
- Duration of presence at locations of interest
- Juvenile salmonid density (fish per unit length)
- Juvenile salmonid catch per unit effort (CPUE)

Where possible and depending on sampling method, one or more of these parameters will be computed for each site. Evaluation will be focused on comparing juvenile salmon seasonal utilization and relative abundance at various restoration sites and reaches encompassing multiple restoration sites before and after restoration. If possible, to help place juvenile salmonid densities observed post-implementation in context, densities within restored sites and sub-reaches will be compared to that reported for other regional coastal streams where similar sampling methods and scales were used.

Depending on phasing of spatial distribution of recovery actions, it may be feasible to evaluate fish response (using one or more the parameters listed above) to recovery actions with a BACI sampling design and analysis framework (Stewart-Oaten et al. 1986, Smith 2002). For example, a BACI analysis would evaluate systematic changes in the relationship between juvenile Coho Salmon densities at treatment (impact) and control sites before and after restoration (Smith 2002). Such a design would help control for annual variability in the Elk River Coho Salmon density that could be independent of the effects of restoration (e.g., variability due to ocean conditions). The potential for applying a BACI framework will be further evaluated as part of a more detailed and comprehensive monitoring plan developed after phasing and spatial distribution of recovery actions are finalized.

Juvenile Salmonid Growth and Survival

Approach and Rationale

Monitoring the growth and survival of juvenile salmonids rearing in restored sites and the reaches encompassing them is a useful way to validate the success of recovery actions at providing high quality habitat relative to other locations. Juvenile growth is a core driver of salmonids population dynamics, since larger individuals are more likely to survive and return as adults to spawn. Monitoring approaches, parameters, and evaluation strategies for juvenile salmonid growth and survival will be structured around answering the following key questions:

- How does juvenile salmonid growth and survival change in response to Recovery Plan actions at the site and reach scale?
- How does growth and survival vary across the Stewardship Program Area? For example, do juvenile salmonids of a given species that reared through the winter at a given location have higher seasonal growth and survival relative to another location?
- Which recovery actions and design features provide the most benefit to salmonid populations in terms of increased juvenile salmonid growth and survival?
- How does growth and survival at restoration sites or reaches compare with regional reference watersheds?

The data needed to answer these questions will be primarily collected through capture, measurement, PIT tagging, recapture, and tag detection of juvenile salmonids across the Stewardship Program Area before and after restoration. Growth and survival monitoring will be focused on juvenile Coho Salmon and steelhead, which typically spend at least one year in freshwater (and reach taggable size). Chinook Salmon are generally expected to leave freshwater reaches and enter the estuary by summer before they reach taggable size. For this reason, length frequency data from juvenile Chinook Salmon will be evaluated to understand seasonal growth patterns and how they vary between locations, seasons, and years. Additionally, if Chinook Salmon of taggable size are captured in the Planning Area 1 or elsewhere, they will be tagged.

Lengths of all fish captured during fish distribution monitoring will be measured to describe variation in size-at-age of focal species between sampling locations before and after restoration. Individual growth rates will also be calculated for periods of interest by PIT tagging juvenile salmonids during the late summer or early fall (when they typically become larger enough to be tagged) and recapturing them during subsequent sampling in winter and spring. PIT tagging will be done during (1) planned fish distribution sampling across the Stewardship Program Area and (2) additional targeted efforts to tag juvenile salmonids across the larger watershed. Tagging fish across the larger watershed will allow growth of individuals rearing in reaches upstream of the Stewardship Program Area to be compared with growth of those rearing at sites within the Stewardship Program Area before and after restoration.

Juvenile salmonid survival between summer tagging and spring smolt outmigration will be estimated based on recaptures of tagged fish during various sampling activities and through detection of PIT tagged fish at a network of channel-spanning radio frequency identification (RFID) antennas deployed at key locations across the Stewardship Program Area. Exact locations for RFID antennas would be identified during development of a more detailed monitoring plan and depend on funding. Siting antennas at the upper and lower ends of each planning area would allow survival and movement timing within each reach to be closely monitored. Operation of antenna arrays for multiple consecutive years would also allow for coarse estimates of smolt-to-adult (ocean) through detection of returning tagged adults.

If funding allows, outmigrant trapping could also be deployed to seasonally capture large numbers emigrating juvenile salmonids as they move downstream from fall through spring, increasing the sample size of tagged and recaptured fish to improve growth and survival analyses. Such trapping efforts would also and help describe (1) juvenile movement timing into each planning area and (2) diversity in juvenile salmonid life history patterns in the watershed. Ideally, outmigrant traps would be deployed near the lower ends of spawning reaches on both the South and North forks of Elk River to intercept individuals entering Planning Area 3. If funding allows, trapping could also be conducted near the upper end of Planning Area 1 and/or Planning Area 2 to increase recaptures and improve evaluation of growth of individuals that reared in upstream reaches (within Planning Areas 2 and 3). Depending on resources, traps could be either deployed continuously or for a sub-sample of days during each month of the emigration period. Exact trapping methods would depend on available funding and site-specific constraints, but fyke nets with pipe traps would likely be the most portable and affordable option.

Similar watershed-wide efforts to monitor juvenile salmonid growth, survival, and life history variation through tagging, recapture, and antenna detection have been implemented successfully other north coast streams (e.g., Freshwater Creek; Rebennack et al. 2015 and Prairie Creek; Deibner-Hanson and Henderson 2021). These efforts will serve as a model for further developing this component of the monitoring program. Structuring elements of the Elk River monitoring program like these existing programs will also all for comparison of observed fish growth and survival in Elk River to these watersheds.

A more comprehensive and detailed monitoring plan, informed by existing conditions monitoring and specific recovery action objectives, will be developed to guide the sampling needed to describe growth and survival at specific restoration sites relative to other sites and reference locations. This will likely entail seasonal sampling at locations where specific recovery actions are planned before and after restoration.

Parameters and Evaluation

Data from the juvenile salmonid growth and survival monitoring will be analyzed to help evaluate effectiveness of recovery actions at meeting their objectives and to refine future restoration priorities, strategies, and designs. Potential evaluation parameters for growth and survival include:

- Length frequency distributions by month or season
- Minimum, maximum, and mean lengths by month or season
- Instantaneous growth rate (mm/mm/day) for periods of interest (summer, fall, winter, spring)
- Summer fry to smolt survival (apparent overwinter survival)

Where data allows, one or more of these parameters will be computed for each site or reach. Evaluation will be focused on comparing juvenile growth and survival between various restoration sites and reaches encompassing multiple restoration sites before and after restoration. To help put juvenile salmonid growth and apparent survival into context, densities within restored sites and sub-reaches will be compared to that reported for other regional coastal streams. Depending on phasing and spatial distribution of recovery actions, it may be feasible to evaluate fish how fish growth or survival changes at restored locations (treatments) relative to unrestored locations (controls) with a BACI sampling design and analysis framework as described above.

Adult Salmonid Abundance

Approach and Rationale

Since most recovery actions are intended to improve habitat conditions for the juvenile life stages, rather than adults, monitoring abundance of adult salmonids is a lower priority of the monitoring program relative to juveniles. However, adult salmonid abundance monitoring would improve overall understanding of life history timing and population dynamics and contribute to evaluating longer-term trends in species recovery in the Elk River watershed in response to the cumulative effects of recovery actions. For this reason, potential approaches and evaluation strategies for adult salmonid monitoring are outlined here. The primary question adult salmonid monitoring is intended to answer is: how does the abundance of Chinook Salmon, Coho Salmon, and steelhead returning to the Elk River change over time?

One approach for counting the number of adult salmonids returning to spawn in the Elk River watershed involves deploying a Dual Frequency Identification Sonar (DIDSON) camera at a suitable site in mainstem Elk River. Ideally, the DIDSON unit would be deployed throughout the adult salmonid migration period, from fall through spring, on an annual basis. Collected data would be used together with any spawning survey data that may be collected in the watershed by CDFW as part of the Coastal Monitoring Program to evaluate adult abundance over time.

One advantage of applying sonar technology in the Elk River is that migrating fish can be detected and counted even during periods of high turbidity. A significant challenge with using DIDSON technology is that it is difficult to differentiate between species of salmonids. As with other recent efforts to monitor migrating adult salmonids with sonar (e.g., Kajtaniak and Gruver 2020, Metheny 2020), observed fish would be apportioned by species based primarily on known differences in run timing the species from observations of live adults during previous spawning surveys conducted in the watershed. Timing of movement of adult Coho, Steelhead, and possibly Chinook Salmon past the DIDSON camera could also be accurately described from RFID antenna detections of returning adults that are PIT tagged as part of juvenile monitoring. Operating a DIDSON camera would also provide a unique opportunity to describe Pacific Lamprey run timing and enumerate the population in the watershed, since lampreys can be distinguished from other fish species due to their unique shape and anguilliform swimming mode.

Genetic approaches for monitoring trends in adult population size of focal species may also be considered, including (1) estimating the number of successfully spawning adults (or the breeding population: Nb) based on genetic diversity of juvenile tissue samples (Yates et al. 2017) or (2) estimating the size of adult spawning population using genetic mark-recapture based on analysis of DNA from carcass and juvenile tissue samples (Rawding et al. 2014).

Parameters and Evaluation

The primary parameters for evaluating trends in adult salmonid abundance would be (1) total number of migrating adult salmonids and (2) estimated number of each focal species by water year. These parameters would be plotted by year to allow trends to be analyzed. Adult abundance would also be evaluated by comparing it to federal recovery plan targets for each species and potentially other targets of adult abundance based the number of population size that could be supported in a healthy watershed of similar.

8.6 Benthic Macroinvertebrates

Sampling of benthic macroinvertebrates (BMIs) and calculation of indices derived from BMI data is an accepted approach to monitoring overall stream health and the cumulative effects of various chemical and physical stressors. Taxonomic diversity, compositional abundance, and ecological characteristics (e.g., feeding types, habits, and stressor tolerance values) each conveys information potentially useful in detecting and understanding degradation and biological responses to it. An effort is typically made during the study design development to have one or more individual metrics represent as many different information types, or metric categories, as possible associated with the biological assemblage, including taxonomic richness, community composition, stressor or pollution tolerance, functional feeding types, and locomotory habit. Benthic macroinvertebrate data can also help provide information about food resources available to fish and other aquatic organisms.

Key questions related to the response of benthic macroinvertebrates to Recovery Plan actions:

- Have conditions changed in the Elk River since the initial assessment of stream condition?
- Are conditions within the Elk River improving or degrading over time with respect to algal and benthic macroinvertebrate abundance, diversity, species richness, temperature, and dissolved oxygen?

Approach and Rationale

The California Stream Condition Index (CSCI) is a statewide biological scoring tool that translates data about stream benthic macroinvertebrates into a measure of stream health. CSCI. The CSCI combines two separate types of indices, each of which provides unique information about the biological condition at a stream: a multi-metric index (MMI) that measures ecological structure and function, and an observed-to-expected (O/E) index that measures taxonomic completeness. The CSCI score indicates whether, and to what degree, the ecology of a stream is altered from a healthy state.

Parameters and Evaluation

The California Stream Condition Index (CSCI) established three stations in the Elk River and gathered baseline information roughly a decade ago (2010-2011). The State Water Board is implementing monitoring in partnership with Chico State University to reoccupy those stations and establish five additional stations. The state board proposes one sampling per year in July or August through 2023. In addition to macroinvertebrate sampling at planned CSCI sites, the monitoring will include deployment of instruments to measure turbidity, water temperature, specific conductivity, salinity, alkalinity, pH, and dissolved oxygen at sample sites.

8.7 Vegetation

Riparian vegetation recovery actions are intended to improve multiple ecological functions in impaired habitats within Elk River. Riparian vegetation restoration targets associated with the recovery, restoration, and enhancement actions include:

- Establish a diverse native riparian corridor to enhance terrestrial and aquatic resource habitat
- Form a contiguous, expanded, and self-sustaining riparian streamside and floodplain buffer
- Control and suppress nonnative invasive weeds in riparian understory and floodplain areas
- Reduce encroachment of live vegetation within the bankfull channel
- Retain and reduce temporary impact to sensitive natural communities

The approach to measure the long-term success of riparian restoration recovery actions can be divided into two quantitative monitoring components—riparian species cover and composition and riparian habitat continuity. Survival assessments to confirm whether the initial implementation actions associated with revegetation were successful (e.g., survival and vigor of streamside and floodplain plantings) will be incorporated into site-specific vegetation monitoring plans and should occur within the first three years post-planting.

In addition to riparian habitat enhancement and restoration effectiveness monitoring, sensitive aquatic habitat associated with eelgrass beds within Planning Area 1 (MSR1) may require further assessment if project activities do not avoid these habitats or are proposed immediately adjacent to these populations. An eelgrass monitoring component will be evaluated and addressed in the applicable study reach vegetation monitoring plan and if deemed necessary, will be conducted in accordance with the requirements of current *California Eelgrass Mitigation Policy and Implementing Guidelines* (National Oceanic and Atmospheric Administration 2014).

Riparian Cover and Species Composition

Approach and Rationale

Riparian vegetation restoration and enhancement treatment areas can be assessed for riparian vegetative cover and species composition parameters to inform on the effect Recovery Plan actions have on native plant cover establishment, in-channel live vegetation encroachment, shaded stream cover, and nonnative invasive weed control. Key questions that can be evaluated from these monitoring components include:

- Did native riparian vegetation cover increase in retained riparian areas with enhancement (e.g., nonnative invasive weed removal, interplanting for increased mid-story component)?
- Did riparian species diversity increase within the enhanced treatment areas?
- Did native riparian vegetation successfully establish within revegetated floodplains and revegetated managed or expanded streamside areas?
- Was there a shift in dominant canopy structure within the streamside riparian area to promote more structural diversity and/or shaded streamside (bank/channel) cover from Recovery Plan actions?
- Were Recovery Plan actions successful in reducing live vegetation encroachment in the active channel?
- Did hydrophytic vegetation establish within restored or enhanced wetlands?
- Did the Recovery Plan actions contribute to riparian vegetation stream canopy cover along the channel?
- Did the Recovery Plan actions reduce nonnative invasive weed pressure on riparian vegetation communities in enhanced and restored treatment areas?

This monitoring component will be conducted at the site, reach, or planning area scale (dependent on Recovery plan action and implementation timing) with emphasis on including all treated vegetation community types with an even distribution throughout the sampling location. The prescribed monitoring duration should at minimum include one existing condition survey, one baseline survey (immediately post-implementation), and one effectiveness monitoring survey. The effectiveness monitoring interval and frequency may vary by study reach and will be defined in the planning area-specific vegetation monitoring plan. An effectiveness monitoring interval that spans multiple years will inform on trends of vegetation establishment and inform on whether early adaptive management strategies are needed prior to the end of the monitoring period to achieve riparian vegetation targets. Successful achievement of the vegetation targets can be determined by assessing riparian condition before and after project implementation.

Site selection, sample size, field methodology, monitoring duration, and performance standards will be assigned based on the Recovery Plan action and riparian vegetation target within each selected study reach and will be identified in the vegetation monitoring plan. In general, site selection should be well-distributed to capture the variance in riparian condition throughout the sampled reach and will be stratified by riparian feature (i.e., instream channel, intact streamside riparian with enhancement treatments, revegetated floodplain, revegetated streamside, emergent wetlands). Temporary or permanent plot selection should be determined based on anticipated monitoring interval.

Parameters and Evaluation

Five measurable parameters will be assessed before and after implementation to answer key monitoring questions and assess the effectiveness of the riparian restoration and enhancement recovery actions within each study reach (e.g., establish native plant cover in revegetated floodplain planting zones, removal and control of non-native invasive weeds, retain overstory riparian canopy over channel). These parameters are listed and described below.

Vegetative cover

Riparian cover monitoring will measure absolute percent cover of established plant species within a sampled location by stratum (tree, shrub, and herbaceous). By measuring individual species cover within sampled locations in a study reach the monitoring results can be analyzed to inform on the riparian condition and habitat function of the treatment area (e.g., multi-tiered structure, bare ground, high density, dominant stratum). It will indicate dominant species within each canopy layer and allow the evaluation of native and naturalized plant establishment and nonnative invasive species prevalence.

To analyze the key monitoring questions on riparian vegetation restoration and enhancement treatments, the location of the sampling plots and field sampling methods will vary. Vegetative cover assessments will occur before and after treatments. The following riparian treatment areas will be sampled and analyzed independently:

- Instream channel (i.e., channel bed to top of bank)
- Enhanced streamside vegetation (i.e., retained riparian vegetation with nonnative, invasive weed management, disturbed understory, and/or interplanting treatments)
- Revegetated floodplain riparian (expanded riparian corridor)
- Revegetated streamside riparian (e.g., areas void of trees and shrubs within 20 feet from top of bank [or other specified distance where streamside vegetation is considered directly influencing shaded stream surface])
- Emergent wetland habitat

Nonnative invasive weed cover

The absolute percent cover of all nonnative invasive weeds (defined as those with a California Invasive Plant Council rating of "high," an invasive weed listed by the Humboldt County Weed Management Area, or any other species deemed appropriate by a qualified biologist in consideration of the site) will be measured in each treatment area in conjunction with vegetative cover monitoring.

Species diversity

Species diversity within a sampled vegetation community can be measured using the vegetative cover results. Species composition data from the vegetative cover monitoring will be used to compute the species diversity and evenness values by applying diversity and equitability indices.

Stream canopy cover

Assessment of shaded stream cover can be monitored in conjunction with instream channel vegetation cover monitoring. Measuring stream canopy cover using a densiometer or similar equipment before and after project implementation will answer whether the recovery action influenced stream canopy cover within the reach. Assessment should occur during the growing season but targeted to occur during low flow conditions.

The effectiveness monitoring data from these five parameters will be analyzed and presented in monitoring reports based on the schedule provided in the vegetation monitoring plans. The quantitative effectiveness monitoring results will be compared to pre-implementation and baseline surveys and, dependent on the frequency of monitoring, will be compared to results from other post-implementation monitoring efforts to identify possible trends. To determine the success of recovery plan actions, the vegetation monitoring plan will include a comparison of monitoring data to performance standards. Quantitative performance standards will be specific to the riparian vegetation treatments (e.g., nonnative invasive weed control) and treatment location (i.e., riparian feature) and will be designed to include specific cover thresholds or target measurements related to each monitoring parameter. Criteria may be developed from a defined reference location, or an achievable target based on the desired future condition of the treatment area and the pre-implementation riparian condition. If performance standards are not met, recommendations for adaptive management will be provided.

Riparian Habitat Continuity

Approach

A main riparian vegetation target of the Recovery Plan is to form a contiguous, expanded, and self-sustaining riparian corridor to improve aquatic and terrestrial ecosystem function of the larger Stewardship Program Area. The Recovery Plan actions involve the conversion of intact streamside riparian vegetation for aquatic enhancement of intact riparian habitats and select expansion and revegetation of streamside and floodplain areas lacking riparian cover. This riparian habitat establishment can be assessed at the Planning Area- or Stewardship Program Area-scale to identify whether recovery plan actions were successful in achieving an increase in overall riparian habitat cover. A key question of the post-implementation effectiveness monitoring is:

- Did the restoration action increase the connectivity and overall area vegetated by native riparian plant communities?

Parameters and Evaluation

Spatial distribution

Measurable changes of the riparian river corridor from recovery plan actions can be determined using a GIS-based approach to generate pre- and post-treatment land cover types and extents. Assessment of aerial imagery from pre- and post-project implementation will detect changes in the spatial distribution of riparian habitat communities in the larger planning areas. This approach will quantify measured changes in land cover features (e.g., riparian canopy extent, vegetation communities) and assess whether Recovery Plan actions were successful in closing canopy gaps, generating moderate cover in revegetated areas, expanding narrow riparian corridors, and increasing the overall net area of intact, revegetated riparian vegetation. The assessment should delineate the contiguous boundary around established riparian habitat communities excluding canopy gaps.

The post-treatment aerial imagery should be generated or obtained after riparian cover and composition monitoring has been successfully completed throughout the Planning Area or larger Stewardship Program Area. This parameter will require procurement of the most recent pre- and post-aerial imagery with adequate resolution to note changes in riparian vegetation. The areal coverage assessment will provide before and after project acreages and will measure the net increase in riparian habitat from recovery actions. These results can be overlaid with the site-specific vegetation monitoring reports to indicate the range in riparian conditions within the Stewardship Program Area.

9 Recovery Plan Next Steps

The Elk River Recovery Program is a large and ambitious program that, to succeed, will require the support and approval of regulatory agencies, significant investment of public funds, and the voluntary participation of private landowners throughout the watershed (particularly those with river-adjacent properties). Landowner outreach will be an essential next step, and frequently throughout the subsequent design phases. The Elk River Stewardship Program will continue to be the best venue for landowner outreach and communications.

This Plan presents conceptual designs for 19.2 miles of stream channel and over 1,700 acres of wetlands and floodplain. We expect this document to serve as a roadmap to guide subsequent phases of planning, design, and implementation, some of which is already funded and currently underway. But those phases will also need to be flexible and adapt to unforeseen circumstances, availability of funding, landowner input and direction, and regulatory agency input and direction.

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